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DDP REPORT 2025

A Decade of National Climate Action:

Stocktake And The Road Ahead

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The JUSTPATH project

The JUSTPATH project (2025-2028) funded by the European Commission's DG CLIMA, supports climate action in Argentina, Brazil, China, India, Indonesia, Mexico, Nigeria, Senegal, and South Africa through strong collaboration with in-country partners. The project advances climate mitigation modelling and scenarios developed and operated by partners in developing and emerging economies, ensuring independent and authoritative insights into pathways aligned with limiting global warming according to the Paris Agreement goal.

JUSTPATH pursues four main objectives:

1. To enhance national-level and sub-national level mitigation models operated by partners in developing countries and emerging economies to provide authoritative, independent insights on climate action that is aligned with the objectives of the Paris Agreement.
2. To improve understanding among all participants of how national actions shape global emissions.
3. To have a better understanding of socioeconomic impacts of mitigation action,
4. To synthesize available knowledge and identify opportunities to assess and accelerate national and global climate action in the context of the second Global Stocktake of the Paris Agreement

Building on the expertise of partner institutions in modelling, scenario development, and stakeholder engagement, the project generates robust policy-relevant insights to contribute to climate processes at all scales.



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Executive Summary

The Paris Climate Agreement has provided the international framework for climate policy since 2015. It defines collectively agreed global goals and an innovative process to achieve these objectives, and has become a compass guiding governments, businesses, and citizens towards a net-zero world. From a global perspective, the assessment of the Paris Agreement a decade after its adoption is mixed. On the one hand, its impact is visible and tangible through many elements of progress, which have triggered a significant shift in the expected temperature trajectory. On the other hand, global emissions have continued to increase and the lower range of the temperature targets set in the Paris Agreement is now widely considered as out of reach. These outcomes highlight the incomplete realization of the theory of change that lies at the core of the Paris Agreement – namely, the assumption that the Agreement creates conditions conducive to changes on the ground, which in turn reinforce the collective dynamics it promotes.

To understand the underlying drivers of this outcome, this report analyzes how countries have implemented climate action since the signature of the Paris Agreement. More specifically, it covers 21 countries, representing a diversity of geographies, stages of development and sizes.

It analyses national climate action not only in terms of immediate emission reductions but also in the light of the long-term radical transformations required by the ambitious goals of the Paris Agreement

This assessment highlights effective progress (including those that may not have yet translated into concrete emission reductions) and reveals challenges encountered in each country, as presented in dedicated country chapters. The cross-cutting analysis of these country assessments leads to a set of generic lessons on governance and policies:

- The Paris Agreement has spurred the emergence and broad adoption of new approaches to climate governance at the national level. Climate-focused mandates, bodies, and processes were once the exception. Today, approaches grounded in science, framed by a long-term perspective, and involving diverse stakeholders have become much more widespread, helping to raise climate priorities in decision-making. Continued progress will depend on improving the effectiveness of these new forms of governance. This will require overcoming coordination challenges and establishing robust structures capable of managing political trade-offs, ensuring policy coherence and long-term direction, and building broad alignment in the face of change.
- Over the last decade, national policies have effectively supported the global trend on low-carbon technologies, enabling the acceleration of their development and practical implementation at country level in a number of sectors. On the other hand, few pro-active measures have been introduced to pave the way for the longer term evolution of infrastructure and behaviors needed to reach carbon neutrality. In parallel, there has been a growing recognition of the close links between climate and social priorities, as well as the need to articulate climate policies with industrial, trade and other socio-economic policies. Key concerns at national level about security, competitiveness and employment, as well as around the management of the social impacts of climate action, particularly the risk of increasing inequalities and poverty, have triggered resistance and, in some cases, slowed or reduced climate ambition.

These findings from the analysis of a decade of national climate action highlight three areas where efforts must now focus — both within national governance and policy frameworks, and through international processes:

- The establishment or strengthening of national processes that bring together government, businesses, civil society, and local actors to collectively shape climate action. Given the scale and specificity of the transformations required by the Paris Agreement, the establishment of cutting-edge governance structures specifically designed for these objectives is more likely to respond to coordination needs and addressing trade offs and inevitable political negotiation in a context of transformational change.
- The adoption of comprehensive policy packages that address multiple objectives, notably accelerating immediate emission reductions in sectors where technical solutions are already available; the fostering of pro-active actions on technological progress, infrastructure and behavioral change that prepare conditions for long-term deep emission reductions; the strengthening of synergies between climate, industrial and economic agendas, and finally; the management of the social impacts of the transition, notably with regard to the most vulnerable.
- An innovative approach to international cooperation in a way that captures best the specific transition needs of countries. In a context characterized by strong tensions surrounding multilateralism, a pragmatic and operational approach based on mutual interests of different countries, in light of their national strategies, can help unlock barriers linked to technology, finance and trade and therefore support the decarbonization agenda while serving the specific interests of a variety of countries.

These recommendations can define the road ahead and guide decisions at both national and international levels, notably in the context of the upcoming COP30, to be held in Belem, Brazil. In particular, they can guide decisions around dedicated coordination processes among countries in the coming years, in a way that supports the ratchet mechanism established by the Paris Agreement.



Introduction

CONTEXT-SETTING

The Paris Climate Agreement has provided the international framework for climate policy since 2015. It defines collectively agreed global goals and an innovative process to achieve these objectives, and has become a compass guiding governments, businesses, and citizens towards a net-zero world.

From a global perspective, the assessment of the Paris Agreement a decade after its adoption is mixed.

On the one hand, the impact of the Paris Agreement is visible and tangible. Almost all countries have adopted medium-term climate pledges, and many have raised their ambition since 2015 and/or set long-term carbon neutrality objectives as a reference point. Transformations are underway across many sectors worldwide, and key components of a low-carbon and resilient economy are emerging. Most notably, many mitigation options, including most notably solar, wind and batteries are scaling up faster and have come down in cost faster than anticipated when the Agreement was signed.¹ These developments have fundamentally changed the way the climate issue is framed: whereas a decade ago, the low carbon transition was seen solely as a cost, it is increasingly viewed as an economic opportunity. This evolution is accompanied by a change in medium- and long-term expectations, including among businesses and citizens. These non-state actors are playing a growing role in the net-zero transition, reflecting a broader recognition across society of both the necessity and the feasibility of climate action. Taken together, these changes have triggered a significant shift in the expected temperature trajectory: at the time of the Paris Agreement, global estimates suggested a risk of a dangerous pathway reaching up to 4°C above preindustrial levels, whereas current projections point to a range of around 2.1–2.8°C. This is not aligned with the Paris Agreement's goal of "1.5°C/well below 2°C" yet, but it nonetheless represents substantial progress within just one decade.

On the other hand, global emissions have continued to increase, and, while at the signing of the Paris Agreement in 2015, peaking at 1.5C was still a possibility, to attain this temperature target is now considered to be out of reach. Global assessments thus

¹ https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Summary-ForPolicyMakers.pdf

consistently find that the progress achieved until now remains insufficient to put the world on a realistic path towards achieving the Paris Agreement's objectives. Structural transformations are incomplete, uneven and too slow. Commitments to ambition and action are not sustained and even show signs of weakening in some countries. Transformations fail to adequately address inequalities and entrenched interests. Voluntary efforts by non-state actors often lack robustness, coherence, and accountability. Adaptation continues to lag behind, while climate finance falls short of the scale and pace required. More broadly, the evolution of international climate discussions shows growing divergence from the key principles underlying the Paris Agreement. Global debates are marked by high levels of ambiguity and mistrust, with specific interests dominating and persistent divisions between developed and developing countries – in contrast to the principle of universality under “common but differentiated responsibilities”. Discussions also tend to focus on narrow points of disagreement, rather than advancing a shared project of transformation around which all countries can rally.

These tensions highlight the incomplete realization of the theory of change at the core of the Paris Agreement – namely, the assumption that the Agreement creates conditions to support changes on the ground, which in turn reinforce the collective dynamics it promotes. When analysing progress on climate action since the Paris Agreement, a key question is therefore to understand why this theory of change has not fully materialized: why have the important global changes of the past decade been unevenly realized at the local level and only partially translated into effective action at the scale and pace required?

Part of the answer lies in underused mechanisms and shortcomings of the treaty that have hindered progress, pointing to the need for enforcement and adaptations in the multilateral climate regime. But the explanation also lies in the detailed understanding of the drivers of action on the ground, which help explain why global changes do not automatically or immediately translate into tangible transformations. Notably, the diverse range of actors central to the transition have found it diffi-

cult to adapt to the rapid global shifts of recent years, and their decisions have not fully adjusted to these new realities. In addition, the major changes envisaged threaten powerful entrenched interests and create fear among the most vulnerable, which in turn contributes to political economy challenges and resistance to change, with a strong impact on political leaders and decision makers. The translation of global trends into emission reductions is also constrained by inertia within technical and socio-economic systems, slowing the pace of transformation.

To examine more closely the role of these factors in shaping effective climate ambition, this report adopts a country-level perspective and analyses how countries have implemented the Paris Agreement since its adoption. As such, it provides a necessary complement to the broad perspective taken in other Iddri reports assessing the achievements of the climate framework, including the Paris+10 diagnosis: Looking back to look forward² and the paper on COP30: Addressing implementation³.

This report does not attempt to attribute specific effects at the national level directly to individual arrangements or articles codified in the Paris Agreement, and it recognizes the impossibility of determining with certainty whether the Agreement is directly responsible for specific observed changes. But this report also starts from the recognition that the Paris Agreement has played a decisive role in driving climate action since its signature through the various processes and requirements it introduces and, even more importantly, through the paradigm of transformation it establishes. This means that, even without specific formal attribution, analysing the trends of the past decade remains valuable for assessing action against the theory of change underpinning the Paris Agreement, and for judging the extent to which it has delivered expected benefits in terms of translation into tangible decisions and actions over the past decade.

² https://www.iddri.org/sites/default/files/PDF/Publications/Catalogue%20iddri/Document%20de%20travail/202506-WP0125-Paris%20Agreement%20Diagnosis_0.pdf

³ <https://www.iddri.org/en/publications-and-events/policy-brief/cop30-addressing-implementation-0>

APPROACH TAKEN IN THIS REPORT

A country-level perspective

Although the objectives of the Paris Agreement are global in nature and international cooperation is recognized as essential to their achievement, the Agreement itself places strong emphasis on the role of countries and is built around a bottom-up paradigm that establishes country decisions as the cornerstone of global action. Each country defines its own targets and designs the measures it will take to meet them – and by doing so, countries need to justify how they contribute to these global goals. Nationally Determined Contributions (NDCs) and Biennial Transparency Reports (BTRs) form the backbone of collective discussions, starting from this national perspective.

The successful implementation of the Paris Agreement is therefore both driven and embodied by the actions taken by countries, beyond assessments of global trends. It also requires attention to the underlying drivers of national transitions, beyond a narrow focus on emission outcomes, which too often remain the sole basis for assessing national ambition.

This is why the report examines developments across a diverse set of countries to track the effects of the Paris Agreement on national climate action over the past decade. This approach helps to show how countries have translated the Paris Agreement into domestic action, and makes explicit the tangible challenges they have faced and the solutions they have put into practice.

The national analyses are carried out by experts from the Deep Decarbonization Pathways (DDP)⁴ network and presented in stand-alone country chapters. They are not intended as comprehensive reviews of climate action in each country, but rather as expert-driven selections of key elements of climate action as implemented in response to the Paris Agreement's theory of change. Most importantly, these analyses go beyond official policy documents such as NDCs or

Long-Term Low Emissions Development Strategies (LT-LEDS), and consider more broadly the underlying drivers of national transformations as reflected in governance and policy. The relevance, robustness and neutrality of these assessments are ensured by the authors' detailed knowledge of their countries, their deep understanding of policy dynamics through direct involvement in national climate strategies and policies, their analytical and scientific expertise as academic researchers, and the rigorous independent review process conducted by IDDRI. The report covers 21 countries, including major emitters (large industrialized and emerging economies) as well as smaller and less advanced economies, to reflect a wide diversity of situations.

The analysis of national climate action in this report focuses largely on mitigation, given the expertise of the DDP network. Other important dimensions of the Paris Agreement such as adaptation and finance are considered only sporadically in country analysis. The assessment is anchored in key principles of the DDP: the analysis is not limited to assessing emissions trends but it seeks to analyse their underlying drivers and to understand the link with national socio-economic objectives. It provides a more granular view of what measures countries have implemented, how political economy dynamics have evolved, what steps national actors have taken in response, and how these measures have altered the domestic situation. The aim is not to judge the quality or merit of national ambition, but to draw on this detailed analysis to identify success factors, implementation challenges, risks of failure and, most importantly, identify priorities for enhancement in the next decade.

⁴ <https://ddpinitiative.org/>

Benchmarking against the profound transformations required by the long-term goals

The Paris Agreement frames climate action around the requirement to achieve net-zero greenhouse gas (GHG) emissions (“balance between anthropogenic emissions by sources and removals by sinks”) in the second half of this century, as codified in its Article 4.1. Although this objective is defined at the global scale, it is widely acknowledged that it requires all countries to achieve carbon neutrality (albeit at different dates depending on national circumstances). Detailed scientific studies since the adoption of the Paris Agreement consistently highlight that this long-term goal in turn requires far-reaching transformations across all economic systems.⁵ In other words, the net-zero economies envisioned by the Paris Agreement require profound changes in the organization of society and the emergence of technical, economic and social systems that operate under fundamentally different paradigms, alongside the progressive but proactive phase-out of the systems currently in place.⁶ The paradigm of the Paris Agreement is grounded on the idea that decarbonization can go hand-in-hand with the promise of tangible and shared benefits towards a more prosperous and equi-

table world. The underlying theory of change is therefore that net-zero economies can become a unifying project for a wide range of countries and actors who, in aspiring to this goal, help create the conditions to accelerate the transformations required to reach carbon neutrality.

This makes the long term the relevant timeframe to guide national climate action, so that the state of climate action must be assessed in terms of its consistency with the long-term goal, in contrast with the short and medium-term horizons of most policy documents, notably NDCs.

This report therefore reviews evidence on how countries have tried and established the foundations of their governance and policy actions in the light of the radical transformations required to achieve net-zero economies in the long term. The analysis explores a wide range of underlying drivers and enabling conditions for long-term structural change at the national level. Sections *National Governance* and National Policies of this chapter highlights key findings from this cross-country assessment while Section *Recommendations* derives some recommendations emerging from the lessons learnt from this assessment.

⁵ <https://unfccc.int/documents/631600>

⁶ <https://sdgs.un.org/gsdrgsdr2023>

Supporting the progressive increase of ambition

The Paris Agreement is organized as an iterative process of five-year cycles, through which the ambition of plans and action is meant to be progressively increased to enhance alignment with the global goal. In this cycle, 2025 marks the milestone when national ambitions must be revised upwards, based in particular on insights gathered during the previous stage of the Global Stocktake in 2023. In such a dynamic and iterative process, where the Global Stocktake is intended to inform national ambitions, stocktaking should not be limited to assessing whether current trends are aligned with the stated objectives. The most important task is to draw lessons

from past experience to guide the evolution of action and potentially inform decisions on enhancing existing measures or introducing new ones to support the progressive increase of ambition in subsequent phases.

The analysis of a decade of national climate action presented in this report is intended to inform the road ahead and guide decisions at both national and international levels in the coming years, in support of the ratchet mechanism established by the Paris Agreement. These conclusions can feed into this year's Conference of the Parties, which the Brazilian COP30 Presidency has framed as

a “COP of implementation”. At a more procedural level, this analysis can also help clarify what information should be exchanged between the stages of the Global Stocktake and the definition of national pledges, thereby serving as a guide for improving the operation of national and international policy processes. Indeed, the approach adopted in this report is consistent with the rationale of the Global Stocktake, according to which country perspectives are discussed as inputs for global assessments of progress, but it operationalizes it in a rigorous manner through consideration of details of progress on governance and policy in each individual country and through the identification of cross-country lessons learnt as emerging from a composite of country perspectives, without imposition of a global top-down perspective.







Key Findings

The below sections [National Governance](#) and [National Policies](#) provide the key cross-cutting findings of the report, with specific link to the detailed analysis in the country reports, across two key components of national climate action: governance and policies.

The high-level messages emerging from these assessments on these two components are as follows:

- The Paris Agreement has spurred the emergence and broad adoption of new approaches to climate governance at the national level. Climate-focused mandates, bodies, and processes were once the exception. Today, approaches grounded in science, framed by a long-term perspective, and involving diverse stakeholders have become much more widespread, helping to raise climate priorities in decision-making. Continued progress will depend on improving the effectiveness of these new forms of governance. This will require overcoming coordination challenges and establishing robust structures capable of managing political trade-offs, ensuring policy coherence and long-term direction, and building broad alignment in the face of change (Section [National Governance](#)).
- Over the last decade, national policies have effectively supported the global trend on low-carbon technologies, enabling the acceleration of their development and practical implementation at country level in a number of sectors. On the other hand, little pro-active actions have been taken to prepare for the longer term evolution of infrastructure and behaviors needed to reach carbon neutrality. In parallel, there has been a growing recognition of the close links between climate and social priorities, and the need to articulate climate policies with industrial, trade and other socio-economic policies. Key concerns at national level about security, competitiveness and employment, as well as around the management of the social impacts of climate action, particularly the risk of increasing inequalities and poverty, have triggered resistance and, in some cases, slowed or reduced climate ambition (Section [National Policies](#)).



NATIONAL GOVERNANCE

KEY FINDING 1.1

Integrating Long-Term Perspectives

Evidence from most countries analysed in this report shows that governments are increasingly relying on long-term goals and strategies to guide climate action, although translating these perspectives into consistent and tangible policy decisions remains a work in progress. Gradual steps in this direction include formally embedding long-term perspectives in policy documents, adopting explicit, sectorally detailed action plans with clear milestones along trajectories consistent with long-term goals, and implementing policies that align with these objectives.

The evidence in this report points to a strong trend towards greater awareness of the need for long-term planning to address climate challenges. This reflects a new paradigm of political commitment to climate objectives by governments worldwide.

As illustrated by LT-LEDs submission figures reported by UNFCCC⁷, the adoption of long-term planning documents based on Paris Agreement objectives and priorities has now become a mainstream feature of national climate policy. The past decade has also seen a sharp rise in national net-zero emissions targets,⁸ some of which have even been codified in climate laws (CS 1.1.1; CS 1.1.2; CS 1.1.3; CS 1.1.4).

⁷ By mid-2025, 79 long-term low-emission development strategy (LT-LEDs) documents had been submitted by national governments to the UNFCCC (<https://unfccc.int/process/the-paris-agreement/long-term-strategies>), representing over 40% of UN member states.

⁸ As of 2025, over 143 countries had set net-zero targets (<https://zerotracker.net/>), covering roughly three quarters of the international community.

In some countries, where a long-term perspective was previously absent – or even prohibited by national legislation across public policy – the Paris Agreement has introduced a major shift. It has encouraged the adoption of long-term approaches as a way to broaden the range of possibilities and explore ambitious trajectories that had previously been excluded from national debates (CS 1.1.5).

However, LT-LEDS submissions and stated net-zero targets do not provide a full picture, particularly when it comes to integrating long-term perspectives into concrete national decision-making. Indeed, the existence of a long-term roadmap does not automatically ensure integration of long-term goals into national policies. Progress depends heavily on the quality and detail of the measures set out in each LT-LEDS.⁹ Best practice examples include national long-term strategies with a high level of sectoral detail (CS 1.1.6; CS 1.1.7; CS 1.1.8) in areas such as energy, transport, and waste management, or integration of social aspects (CS 1.1.9). In some cases, this sectoral depth has even led to the creation of monitoring and control mechanisms for emission trends at the sectoral level (CS 1.1.10).

When considering the key question whether long-term perspectives have truly shaped policymaking in practice, evidence shows that long-term strategies are increasingly being used as references to guide sectoral policies and action plans (CS 1.1.11; CS 1.1.12; CS 1.1.13; CS 1.1.14; CS 1.1.15). But this central role of long-term perspective as a guide to decision-making is fragile in the absence of political consensus and consistency across planning documents, creating a risk of strong variations across political cycles (CS 1.1.16; CS 1.1.17). Uncertainties over continuity of long-term planning and implementation also have significant consequences for business climate and investor confidence, which comes at

the cost of hindering investments in clean infrastructure (CS 1.1.18).

National-level evidence highlights that long-term will be even better embedded in policy processes when aligning climate strategies with existing and future economy-wide and sectoral policies (e.g. legislation, national development plans, and sectoral regulations) (CS 1.1.19). This translation into concrete policy action is facilitated when long-term climate goals are embedded in key national frameworks beyond climate policy (CS 1.1.17; CS 1.1.20; CS 1.1.21; CS 1.1.22). Effective implementation of long-term planning also depends on strong coordination across government structures, agencies and bodies (CS 1.1.11).

The embedding of long-term climate priorities in policy packages marks a significant shift from the pre-Paris Agreement context. Newly enacted sectoral and economy-wide policies are increasingly designed with long-term perspectives as a reference point for objectives and measurement (CS 1.1.23)

This aspect is explored further in Key finding 2.1, which examines policies and actions adopted to prepare for deep long-term emission reductions. Anchoring policy decisions in a long-term perspective can lead to comprehensive policy packages that translate the long-term goal into multisectoral measures and regulations, ensuring consistent implementation (CS 1.1.24). It can also drive the adoption of ambitious plans for long-lived infrastructure, setting changes in motion to support achievement of long-term objectives (CS 1.1.25). In the absence of a clear strategic translation of long-term goals into practical action, however, evidence points to risks of counterproductive effects, where long-term perspectives are not translated into relevant strategies and targets consistent with long-term needed efforts (CS 1.1.26).

⁹ <https://www.iddri.org/en/publications-and-events/study/country-driven-perspective-long-term-low-emission-development>
<https://ddpinitiative.org/wp-content/uploads/pdf/ndc-lts.pdf>

Key Finding 1.1 - Case Studies

CS 1.1.1 NIGERIA – LT-LEDS was submitted to the UNFCCC on 25 April 2024, elaborating on the 2060 net-zero pledge already embedded in the Climate Change Act (2021) and the Energy Transition Plan (ETP).

CS 1.1.2 GERMANY – LT-LEDS was first embedded in a Climate Action Plan (2016) and later translated into legislation under the Federal Climate Action Act (2019). Upon its entry into force, the Climate Action Act included a sector-specific control mechanism with an ex-post perspective: if a sector exceeded the permitted annual emissions based on the previous year's data, the responsible ministry was required to present an immediate action programme.

CS 1.1.3 USA – U.S. climate targets under the Paris Agreement have led to the passing of historic climate laws, including the Bipartisan Infrastructure Law (2021) and the Inflation Reduction Act (2022) which invest over a trillion dollars into clean energy, energy efficiency, methane mitigation, climate resilience, and more. Since their enactment, these laws have catalyzed \$321 billion in private sector clean energy investments. Notably, the IRA's household tax credit program has surpassed expectations, with 3.4 million households having invested \$8 billion in clean energy technologies in 2023, including rooftop solar and heat pumps.

CS 1.1.4 JAPAN – The country has adopted the long-term goal of achieving net-zero by 2050, amended the Act on Promotion of Global Warming Countermeasures to reflect this ambition, submitted an LT-LEDS consistent with this ambition and adopted an NDC target for 2030, 2035 and 2040 in line with the linear pathway toward net-zero emissions by 2050.

CS 1.1.5 KAZAKHSTAN: Paris agreement pushed the country to adopt longer term strategic planning approach (up to 2060), in contrast to the traditional practice of 10-15 years planning (largest timeframe allowed by domestic legislation)

CS 1.1.6 COSTA RICA – LT-LEDS contains a high level of sectoral detail, especially for energy and transport sectors

CS 1.1.7 USA – LT-LEDS contains a high level of sectoral detail, including multiple pathways that prioritize different aspects of the transition, for example prioritizing lower non-CO₂, lower removals, lower electricity, lower industry, etc.

CS 1.1.8 NIGERIA – Nigeria submitted its LT-LEDS to UNFCCC in April 2024. The LT-LEDS is stratified along sectors

CS 1.1.9 INDIA – India's LT-LEDS takes an economy-wide, multi-objective approach that consciously seeks to transition to a low-carbon development path, integrating dimensions of local adaptation needs, gender equity and the inclusion of marginalised and vulnerable groups.

CS 1.1.10 GERMANY – Germany's legally binding climate target includes a control mechanism which means that if a sector exceeds its permitted emissions, the responsible ministry has to present an immediate action programme, this ensures that the short term aligns with the long term.

CS 1.1.11 NIGERIA – LT-LEDS (2024) is conceived as a comprehensive framework to guide sectoral policy-making and public investment decisions, aiming at conveying a coherent message to international investors with a 2060 net-zero goal in sight.

CS 1.1.12 THAILAND – Thailand's climate policy is increasingly informed by a long-term perspective, anchored in national targets for carbon neutrality (2050) and net-zero GHG emissions (2065). The LT-LEDS serves as an overarching framework for long-term climate action and strategic guidance for transition of key sectors. Long-term goals are embedded in key national frameworks such as the 20-Year National Strategy, the Climate Change Master Plan (2015–2050), and the National Energy Plan (2022).

CS 1.1.13 CHINA – LT-LEDS with 2060 carbon neutrality target embedded in five-year development plans and dedicated action plans, delivery of NDC objectives organized through a common policy framework to ensure GHG emission peak before 2030.

CS 1.1.14 SENEGAL – The long-term perspective provided by Vision 2050 will not only inform the revision of Senegal's NDC (currently underway), but also more general ensure the consistency of various medium- and long-term sectoral development strategies including sectoral policies and strategies (energy, industry, waste, agriculture, water resources), NDC 3.0, and the National Adaptation Plan (NAP), etc.

CS 1.1.15 EUROPEAN UNION – Breakdown of overarching targets into specific and sectoral legislative and financial frameworks allows for a structured conversation to occur at every level of policy making in the EU. Every piece of legislation discussed and eventually adopted is considered in light of their potential climate impact and alignment with domestic and international commitments.

CS 1.1.16 ARGENTINA – Long-term sectoral level studies & plans are developed within government agencies or with the support of academia and CSOs. Implementation of many of these documents/strategies that incorporate long-term perspective is dependent on the political cycle, in absence of a clear political consensus over long-term policy.

CS 1.1.17 BRAZIL: Short-term policies are yet to fully integrate long-term perspectives, and the 2050 net-zero goal notably through the elaboration of a Brazilian LT-LEDS and policy integration with Brazil's NDC targets for 2030 and 2035; the establishment of milestones for emission drivers based on a back casting approach would allow for periodic review and adjustments helping to improve implementation continuity.

CS 1.1.18 MEXICO – Policies supporting renewables have been put in place, but the lack of continuity in implementation, particularly across changes of government, has created deep uncertainties and shaken the confidence of a broad range of stakeholders to further invest in renewables.

CS 1.1.19 INDONESIA – Climate policies are fully integrated into the National Medium-Term Development Plan (RPJMN) and cascaded into Regional Medium-Term Development Plans (RPJMD) through Indonesia's National Development Planning Agency (BAPPENAS). This agency also steers the integration of mitigation and adaptation policies with economic, social, and infrastructure planning, thereby aligning Indonesia's climate commitments with long-term development objectives.

CS 1.1.20 CÔTE D'IVOIRE – Ecological planning is embedded in the country's economy-wide long-term development and economic plans.

CS 1.1.21 BRAZIL – Remarkable progress on alignment is happening in the area of economic policy through the "Ecological Transformation Plan", a long-term economic vision launched in 2024 by the Ministry of Finance, which offers long-term guidelines for enhancing sustainable finance, innovation, bioeconomy and green investment facilitation in the country.

CS 1.1.22 COSTA RICA – The Sugarcane Nationally Appropriate Mitigation Action (NAMA), although designed for mitigation, is a real innovation in the way it builds data systems and traceability into agricultural policy from the start. In the pilot phase, the full package of planned activities is implemented, and all indicators are measured to test and validate technologies that raise agro-industrial productivity and reduce total GHG emissions ($\text{tCO}_2\text{e-yr}^{-1}$). The pilot also generates the high-quality datasets needed to calibrate the emissions model.

CS 1.1.23 FRANCE: Long-term perspective has triggered a clear shift in decarbonization priorities, attracting more focus on discussions about transport and buildings, two sectors which will require extensive transformations in the coming years to keep on track with national climate objectives. This is a notable shift from the pre-Paris Agreement era, where discussion was mainly focused on energy policy choices and the horizon of infrastructure deployment. This shift to long-term thinking has come with its share of step backs in implementation.

CS 1.1.24 EUROPEAN UNION – has backed long-term overarching targets by adopting several sectoral strategies and laws which have created intermediate targets which are well anchored at EU level, they are economy-wide and to be achieved domestically (eg. 2030 Climate Target Plan, "Fit for 55 Package").

CS 1.1.25 USA – The federal government built out research and development plans and strategies to spur innovation and begin implementation for the industrial and aviation sectors, CDR technologies, and domestic clean manufacturing.

CS 1.1.26 KAZAKHSTAN – Until the adoption in 2023 of the Strategy for Achieving Carbon Neutrality by 2060 and the still-to-be-approved corresponding roadmap, targets and action adopted in the country reflected incremental improvements rather than systemic decarbonization, relying heavily on efficiency gains and modest structural changes, in contrast with the practical requirements for long-term net zero trajectories.



KEY FINDING 1.2

Considering Scientific Inputs

Country-driven scientific analysis of national climate policies – including the use of modeling tools – has gained decisive ground and is now increasingly used to guide government decision-making. To fully unlock its potential, countries are continuing to refine analytical methods and strengthen governance structures so that scientific evidence can more effectively inform, assess and monitor climate policies.

As highlighted by the IPCC's Sixth Assessment Report,¹⁰ there has been an encouraging rise in country-based technical capacity for analysing climate mitigation. This trend has been accompanied by broader access to scientific tools and analysis to support climate policymaking at the national level, an area where significant progress has been achieved. The crucial question now is whether this increased capacity has translated into national policymaking that is more effectively supported by scientific analysis. Progress can be observed along two main dimensions, which determine the ability of scientific evidence to guide decision-making.

First, scientific methods have improved to capture national circumstances more accurately and comprehensively. Over the past decade, technical capacity for climate modelling and policy analysis at the national level has grown considerably – in some cases dramatically. Progress has taken different forms: the creation of entirely new national capacities where none previously existed (CS 1.2.1; CS 1.2.2; CS 1.2.3); the coordination of existing modelling capacities within structured analytical approaches for deep decarbonization (CS 1.2.4; CS 1.2.5); and the enhancement of existing tools and approaches to design policies better tailored to local circumstances (CS 1.2.6; CS 1.2.7).

Examples from the country level illustrate that creation of independent research entities has played an important role in developing national

¹⁰ IPCC AR6 WG3 chapter 4

technical capacity (CS 1.2.8). In some cases, the introduction of new scientific tools has triggered cross-sectoral cooperation among public actors (CS 1.2.5). Governments have also drawn on modelling capacity from external technical partners to inform domestic policy processes, an approach that can raise concerns about the relevance of modelling results to national contexts (CS 1.2.9).

In countries with a broad ecosystem of technical tools and methodologies, policy decisions can be grounded on more robust evidence as informed by cross-cutting comparisons and benchmarking across a diverse range of scientific outputs (CS 1.2.10; CS 1.2.11; CS 1.2.12; CS 1.2.13)

Yet evidence also shows significant room for improving existing models and tools for scenario development. While there are limits to how far analytical tools can be refined, country-based models and methodologies can still be strengthened to better reflect new sectors and emerging economic activities resulting from the transition (CS 1.2.14). More advanced tools would deliver more policy-relevant results, which in turn could enhance the value of well-structured deliberative processes.

Another critical dimension of progress concerns the establishment of governance processes that enable scientific knowledge to be meaningfully incorporated into decision-making. Such processes must be supported by strong guidelines to ensure that robust scientific evidence informs policy choices and helps mediate political conflicts within government, especially in increasingly contentious contexts.

Science-policy interfaces can sometimes act as barriers to effective integration, since existing governance arrangements were not always designed to give a central role to scientific evidence in the policymaking process. For decision-making to be genuinely informed by science, governance structures must be in place that can accommodate scientific inputs (CS 1.2.14;

CS 1.2.15; CS 1.2.16; CS 1.2.17; CS 1.2.18; CS 1.2.19) . Such arrangements can also enable the co-construction of scientific insights, helping to ensure both the relevance of results and greater ownership by decision-makers (CS 1.2.20 (CS 1.2.21; CS 1.2.1; CS 1.2.22)

Dedicated institutional arrangements, including ad hoc expert agencies and institutions, can also create conditions for ex post integration of scientific inputs into the policymaking process, through assessment and monitoring of policies and actions (CS 1.2.23) and official mandates for overseeing implementation and providing concrete recommendations (CS 1.2.24).

A specific barrier to integration at the national level can arise when technical capacity exists in the country but lies outside government structures and workforces. At the same time, technical capacity housed within government structures needs protection from political influence, which can be achieved by entrusting it to independent technical agencies. This highlights the need for compromise: technical expertise must be appropriated by governments, but institutional arrangements should shield policy processes from biased use of scientific evidence by policymakers.

The creation of mechanisms such as steering committees, which allow for regular interaction with decision-makers throughout the different stages of scientific analysis, has proven to be an effective way of preventing technical experts from losing control over the process and its results (CS 1.2.25; CS 1.2.10)

However, national examples also reveal cases of challenges in the integration of scientific analysis into policymaking, notably when politically-decided objectives are imposed to the scientific process in the form of external assumptions that shape and constrain the analysis (CS 1.2.26).

Key Finding 1.2 - Case Studies

CS 1.2.1 DOMINICAN REPUBLIC – Modeling tools have been essential in facilitating climate action, but gaps remain. A foundational enabler for climate action is the ability to plan, model, and monitor complex transitions. The Dominican Republic has made strides through the CLEW++ model and tools like MAURISE-RD, which were co-developed with national consultants and international partners. These tools have helped visualize trade-offs, test policy levers, and inform stakeholder dialogues. Still, technical capacity gaps persist—especially in sector-specific institutions and local governments.

CS 1.2.2 GUATEMALA – The country has been working on developing improved modeling using the OSeMO-SYS platform, robust decision-making frameworks, and a detailed cost-benefit analysis. Importantly, this update process has focused on setting a clearer vision: not limited to emissions reductions but extending further into the cost and benefit implications of each action.

CS 1.2.3 SENEGAL – The long-term strategy is developed with a national version of the LEAP model, which was domesticated according to national data and economic structure. The model was developed with the support of international partners, it has been fully transferred and is now used autonomously by national experts.

CS 1.2.4 NIGERIA – Building of national technical capacity in energy-environment-macroeconomic modelling frameworks (e.g. LEAP, KLEM and IMACLIM) has allowed for country-driven scenario building which was a decisive enabler for the development of the national LT-LEDs.

CS 1.2.5 COSTA RICA – New modelling tools providing comprehensive pathways used for NDC development have laid the foundations for broader institutional integration.

CS 1.2.6 INDONESIA – The Indonesian LTS-LCCR uses detailed and robust modeling and scenario development to ensure sectoral targets and policies (including FOLU Net Sink 2030) are consistent with overarching national climate goals, economic growth, and sustainability considerations.

CS 1.2.7 SOUTH AFRICA – Strengthening of a national climate-energy-economy modelling ecosystem comprising different modelling teams and a wide array of analytic tools. This ecosystem includes teams undertaking net zero pathways analysis using energy-economy modelling tools such as SATIMGE, but also incorporating adaptation costs into long-term economic modelling; different types of economic models (CGE, multiplier models, micro-sim), as well as spatially and temporally detailed power

system modelling (PypSA, Plexos), and the integration of co-benefits analysis such as air pollution and water into energy systems analysis.

CS 1.2.8 NIGERIA – Independent local modelling team, supported by the Deep Decarbonization Pathways (DDP) project, established standardized, transparent, and country-owned methods, and developed sustainable analytics for sector pathways, including power, industry, and transport, providing a reference point for both government and civil society to discussions about climate finance and transition strategies.

CS 1.2.9 KAZAKHSTAN – During the last decade, the national government was supported by extensive analytical work, including cost-benefit analyses, emissions scenarios, and macroeconomic modeling aligned with Paris-compatible trajectories, as well as development of financing strategies and technology deployment. Projects supported by internationally led technical assistance significantly contributed to outlining Kazakhstan's decarbonization opportunities and timelines and strengthening knowledge and capacity for socio-economic and financial analysis of low-carbon transformation across sectors.

CS 1.2.10 INDIA – The inter-ministerial task force drafting the Indian LTS drew on a review of various quantitative and analytical studies from different institutions, synthesizing a range of modeling outputs to build a cohesive national strategy. This indicates the expanding technical capacity in India especially in reference to climate modelling. An additional development in this regard is the establishment of the India Climate and Energy Modelling Forum (ICEMF), launched by NITI Aayog- the government think tank, and development of the India Energy Security Scenarios (IESS) 2047 tool, by NITI Aayog, for policy-focused scenario assessments.

CS 1.2.11 FRANCE – The institutionalization of the planning process and its participative elaboration have contributed to a better understanding and ownership of the climate issue, namely through the induced analytical quality of the debate: it facilitated the recognition of independent expertise and gave a voice to different type of stakeholders offering them a chance to express their views in the administrative process, or in parliament hearings.

CS 1.2.12 GERMANY – Long-term scenarios are the main scientific basis for long-term policy strategies and decisions in the field of energy and climate policy. A comprehensive set of indicators extracted from scenario analysis to guide political steering has not yet been officially established in Germany by the Federal Government.

CS 1.2.13 USA: Long-term climate modeling studies have informed the trajectory of sectoral trends needed to achieve net-zero, including a rapidly decarbonized electricity grid, electrification of end-use sectors, and the use of carbon dioxide removal technologies.

CS 1.2.14 BRAZIL: Country-driven long-term analytical output by climate scientists has supported decision-making by the Ministry of Finance and other economic governance bodies and the NDC mitigation targets design process; a key methodological challenge is to depict new economic activities that will result from the transition.

CS 1.2.15 THAILAND: Long-term climate targets have been reinforced by strong analytical foundations, including scenario modeling and sectoral roadmaps for energy, transport, and land use, ensuring that national mitigation targets are evidence-based and grounded in realistic transition pathways.

CS 1.2.16 SOUTH AFRICA – The Presidential Climate Commission (PCC), launched in 2019, is a multi-stakeholder body comprising a technical secretariat and Commissioners from across the political spectrum, including youth, labour, civil society, and business. The PCC led the development of the National Just Transition Framework, approved by the Cabinet in 2022, and provides advice on just transitions in the mitigation and adaptation spheres, as well as climate finance issues. The PCC conducts independent analysis and commissions research, coordinates ongoing and frequent stakeholder engagement at local, provincial and national scales, and across key sectors, and monitors climate action.

CS 1.2.17 JAPAN – At the meetings of the advisory bodies to the Ministry of Environment (MOE) and the Ministry of Economy, Trade and Industry (METI) held at the end of 2024 to discuss the NDC and the energy mix after 2030, various model-based scenarios were considered, including contributions from the AIM (Asia-Pacific Integrated Model).

CS 1.2.18 SENEGAL – Setting an emissions reduction target based on analytical output developed by local experts and in consultation with a wide range of national stakeholders has favoured effective domestic ownership of the JET-P target, which is now enshrined in official policy documents such as the National Energy Strategy

CS 1.2.19 EUROPEAN UNION – Existing EU policy processes have put scientific analysis and climate modeling at the center of rationale supporting enactment of laws and regulations

CS 1.2.20 COSTA RICA: Scientific tools increasingly inform policy processes and provide evidence to public stakeholders, enhancing decision-making and the overall coherence of national policies with climate objectives.

CS 1.2.21 GUATEMALA – The creation and strengthening of technical working groups in areas such as climate change mitigation and adaptation has provided spaces for policy dialogue and coordination. These platforms bring together diverse stakeholders from key sectoral institutions to identify challenges, share knowledge, and develop consensus-based solutions. They have become instrumental in aligning sectoral plans and visions with national climate goals.

CS 1.2.22 SENEGAL – The long-term strategy was elaborated according to a co-construction process combining modelling and consultation process a diversity of stakeholders and experts organized in dedicated working groups.

CS 1.2.23 GERMANY – Germany's legally binding climate target includes a control mechanism which means that if a sector exceeds its permitted emissions, the responsible ministry has to present an immediate action programme, this ensures that the short term aligns with the long term.

CS 1.2.24 FRANCE – An independent body of climate experts regularly evaluates compatibility of national low-emission strategies with long-term 2050 net-zero objective to ensure decarbonization efforts are on track.

CS 1.2.25 SENEGAL – Involvement of policy makers at the different stages of development of scientific analysis has taken place through the establishment of a Strategy Steering Committee in the Long-Term Vision and Long Term Strategy process. The Committee has a mandate to guide the process strategically and ensure integration with government authorities (notably to support data access) and eventually validate the results. This committee has provided very valuable insights including high level dialogue contributions and in-depth reflection about the alignment between short- and long-term targets.

CS 1.2.26 INDONESIA – Scientific analysis plays a critical role in developing the LTS and other climate policies and ensuring coherence with national sectoral goals (FOLU Net Sink). Yet, their influence on actual target-setting and political decision-making has been partial, with evidence sometimes subordinated to economic or political interests.

KEY FINDING 1.3

Enhancing Intra-governmental Coordination

Since the Paris Agreement, decisive progress has been made in establishing government-led mandates, institutions, and processes on climate at the national level, involving a diversity of stakeholders, including from the economic and finance spheres. Ensuring effective interministerial coordination remains a work in progress, but countries are steadily learning how to foster stronger collaboration and build governance structures that can withstand political shifts and sustain climate action over time

Countries worldwide are reforming their institutional structures to improve coordination of climate policy across all levels of government. While challenges remain, our findings highlight numerous cases that demonstrate practical steps towards tighter national climate action and an ongoing collective push to reform national governance structures since the signing of the Paris Agreement.

Over the last decade, changes in national climate-related governance have been numerous and diverse in both scale and approach, ranging from structural reform (CS1.3.1; CS1.3.2) to minor institutional adjustments (CS1.3.3). To ensure that national strategies and plans adequately address sectoral priorities, cross-sectoral initiatives have already been established, and interministerial efforts toward net zero are progressing further, including through financial support (CS1.3.4). Taken as a whole, these measures share a common goal: to develop and adapt institutions, mandates, and processes for stronger government-wide integration of climate objectives and priorities.

In countries with no dedicated governance structure for climate issues, consensus is emerging on the need for reform to address gaps in coordination and overlapping challenges (CS1.3.5). National assessments highlight lack of interministerial coordination as a major challenge (CS1.3.6), which often undermines overall policy coherence, resulting in weak enforcement, limited stakeholder involvement and poor local ownership (CS1.3.3).

Experience from other countries that have created such governance structures shows, however, that simply establishing a coordinating body is not enough to guarantee policy coherence, particularly when it comes to ensuring subnational implementation (CS1.3.7; CS1.3.8). In these contexts, the absence of a clear mandate and allocation of responsibilities can fuel intra-government competition, creating a significant hurdle for coordinated action. More broadly, coordination challenges are often amplified when it is unclear which government entity has the authority to convene climate processes. This can arise, for example, when government structures include a dedicated planning ministry. Such a situation can help to mainstream climate change into national development plans (CS1.3.9), but it may also create confusion if the respective roles of the planning ministry and environment ministry are not sufficiently well defined. Planning minis-

tries often play a central role in operationalizing the integration of climate objectives into long-term economy-wide and sectoral strategies, particularly through interministerial fora created specifically for this purpose (CS 1.3.10).

One clear area of progress at the national level is the establishment of dedicated institutional bodies or agencies responsible for coordination between public bodies across government, ensuring that national strategies and plans adequately address sectoral priorities. Evidence shows these structures can take different forms: evolving from pre-existing interministerial climate bodies adapted to the Paris Agreement (CS 1.3.11); reforming ad-hoc bodies with new mandates and missions (CS 1.3.12); creating new institutions for interministerial coordination (CS 1.3.13; CS 1.3.14); or establishing new administrative bodies to support the implementation of national strategies (CS 1.3.15). Informal bodies have also influenced national governance through the strategic steering of national climate efforts (CS 1.3.16).

All of these approaches aim to improve the integration of climate priorities into sectoral decision-making structures in ways that did not exist before, marking an important first step towards more coherent policymaking. Different governance structures each have strengths and weaknesses, particularly in relation to their role in providing a framework for political arbitration between conflicting positions. Long-established bodies benefit from more robust mandates, but their rigidity can make it difficult to align with the Paris Agreement, especially as they are rooted in decades-old dynamics from a period when changes were expected to be more marginal and did not require as many compromises from different actors. By contrast, newly created organizations can take advantage of the flexibility of a recent mandate, more aligned with the paradigm of the Paris Agreement, but may also face limitations when it comes to supporting political trade-offs in the face of widespread stakeholder disagreement (CS 1.3.17).

Another important evolution in national governance over the past decade has been the inclusion of new public actors in policy discussions on climate priorities. In particular, the unprecedented involvement of economic authorities and finance minis-

tries marks the significant progress towards more integrated management of climate priorities at the national level (CS 1.3.18; CS 1.3.19). One remarkable example is a comprehensive economic transition policy led by a finance authority, which brought all socio-economic aspects of the transition together under a single framework (CS 1.3.20). More generally, evidence from this study also suggests that, beyond heterogeneity of national governance structures, climate-related processes are more likely to translate into concrete decisions if they involve high-level actors inside national governance structures (e.g. heads of government, cabinets, or ministries of finance and planning), whether in centralized processes (CS 1.3.21) or under more horizontal processes (than those supported only by environmental authorities (CS 1.3.22).

Further efforts will be necessary to ensure overall coherence and implementation (CS 1.3.23), to manage competing policy agendas between ministries in the absence of clear mechanisms for resolving disputes (CS 1.3.24), and in contexts where existing coordinating bodies risk being overruled by higher authorities.

Furthermore, institutional coordination mechanisms may also struggle to withstand major shifts in policy direction between successive national administrations (CS 1.3.25; CS 1.3.26; CS 1.3.27). However, evidence shows that strong subnational climate governance can provide resilience and stability by limiting the rollback of national climate commitments (CS 1.3.28).

Overlapping policy processes can pose significant challenges for governance coherence when each follows its own independent institutional pathway. Noteworthy examples are provided by countries engaged in a Just Energy Transition Partnerships (JET-Ps), which works under its dedicated governance process; in these countries, coordination with country-driven climate processes have created challenges, particularly when the two processes are led by different governmental authorities and when there is a perceived risk of misalignment of the international cooperation process with national priorities (CS 1.3.29; CS 1.3.30).

Key Finding 1.3 - Case Studies

CS 1.3.1 COSTA RICA – Creation of a directorate of Climate Change is leading implementation of National Decarbonization Plan and coordinating efforts across several layers of governance structures

CS 1.3.2 FRANCE – Establishment of the SGPE in France entailed a direct linkage of the Ministry of Environment to the Chief of Government (Prime Minister), which gave legitimacy and strength to environmental issues. In recent years, the Ministry of Environment has progressively been downgraded in the hierarchy of ministries.

CS 1.3.3 KAZAKHSTAN – Minor expansion of climate governance brings improvements but lots of shortages pertain, including institutional fragmentation, weak enforcement and limited stakeholder participation

CS 1.3.4 JAPAN – Interministerial cooperation has evolved to become more regular and systematic through mechanisms such as the GX Implementation Council, officially established in July 2022 and which guides overarching strategies. Initiatives such as carbon pricing and the designation of decarbonization-leading areas are coordinated through these mechanisms, enabling cross-sectoral dialogue across energy, transportation, and urban policy.

CS 1.3.5 DOMINICAN REPUBLIC – While there is growing acknowledgment in government circles of the need for coordinated cross-ministerial action for climate policy, many challenges are yet to be tackled, in particular institutional fragmentation and mandate overlapping

CS 1.3.6 GUATEMALA – Limited inter-institutional coordination is a persistent challenge

CS 1.3.7 CANADA – Overall coherence of climate policies is challenged by a splintered governance and mandate overlap in climate issues

CS 1.3.8 THAILAND – Centralized governance with minimal roles of local government, insufficient budgetary delegation and mandates for sub-national implementation risks missing out on sub-national opportunities

CS 1.3.9 INDONESIA – The Ministry of Environment plays a central role in Indonesia's climate governance as the National Focal Point for climate change and leads the formulation and implementation of national climate policies. This ministry coordinates especially with BAPPENAS (National Development Planning Agency), which has a pivotal role in mainstreaming climate change into national development planning frameworks. This agency steers the integration of miti-

gation and adaptation policies with economic, social, and infrastructure planning, thereby aligning Indonesia's climate commitments with long-term development objectives.

CS 1.3.10 INDIA – Effective involvement of the Ministry of finance and coordination with the Ministry of Environment for the issuance of Green Bonds.

CS 1.3.11 JAPAN – The Headquarters for Global Warming Countermeasures was established under the Kyoto Protocol, but since the Paris Agreement, stronger frameworks—such as the Green Transformation (GX), which also enhance the financial dimension—have been put in place.

CS 1.3.12 BRAZIL – An interministerial Commission on Climate Change fosters coordination among ministries.

CS 1.3.13 COSTA RICA – Creation of a directorate of Climate Change is leading implementation of National Decarbonization Plan and coordinating efforts across several layers of governance structures

CS 1.3.14 INDIA – Innovation on governance to support coordination in support of a transition for a key sector and recognition of socio-economic impacts

CS 1.3.15 FRANCE – New dedicated and independent agency for ecological transition in charge of operationalizing strategies, coordinating cross-ministerial implementation and reducing frictions between ministries

CS 1.3.16 CHINA – Cross-ministerial coordination is organized through the National Leading Group on Climate Change, Energy Conservation and Emissions Reduction (NLGCC), an informal but powerful State Council “leading group” chaired by the Premier. Its mandate is to advise on strategy, coordinate ministries, and review international cooperation and negotiation plans—giving it strong convening power even though “leading groups” are, in form, ad hoc rather than statutory.

CS 1.3.17 SOUTH AFRICA – The Presidential Climate Commission (PCC), an independent multi-stakeholder body providing technical advice to the government has notably hosted and engaged public consultation processes on the NDC, which have sparked widespread stakeholder disagreement on mitigation ranges.

CS 1.3.18 NIGERIA – National debates on climate priorities are drawing the involvement of a widening range of stakeholders from other non/climate spheres such as finance, fiscal policy, foreign trade and social welfare

CS 1.3.19 GUATEMALA - Enhanced institutional frameworks including involvement of Ministry of Finance have enabled integration of climate considerations into public investment and fiscal planning

CS 1.3.20 BRAZIL - The Ecological Transformation Plan, a long-term economic policy promoting a model for growth with reduced environmental footprint of economic development which takes a comprehensive approach to the transition, encompassing its environmental, social and economic aspects under one policy instrument.

CS 1.3.21 CHINA - China's climate governance rests on a party-state hierarchy that sets political direction at the top, translates it into state policy at the center, and implements it through provinces and sectors. The Communist Party's Central Committee frames the problem and proposes high-level targets (e.g., peaking and intensity goals), which are then affirmed in the National People's Congress (NPC) Five-Year Plans and related laws and programs

CS 1.3.22 EUROPEAN UNION - Within EU governance, the European Commission is arguably the key institutional actor with regards to climate policy. Since 2019, the Commission has also boasted an Executive Vice-President for the European Green Deal, an official position mandated with environmental policy coordination duties across all sectors, with climate action as the key goal.

CS 1.3.23 BRAZIL - Remaining challenges to enhance governance of climate issues include consistency among existing policies, unified means for monitoring, reporting and verification, and ex-ante stakeholder engagement processes to ensure co-construction of plans and programmes

CS 1.3.24 ARGENTINA - Further challenges stem from misalignment of policy agendas and political priorities among different public stakeholders within the same administration

CS 1.3.25 USA - Alternating agendas of the last three administrations have created challenges domestically for delivering the short-term NDC targets and making needed progress toward long-term net-zero goals

CS 1.3.26 ARGENTINA - Continuity of climate policy and climate-related governance is jeopardized by administration shifts and drastic reversals in foreign policy

CS 1.3.27 MEXICO - Successful climate governance needs dedicated institutions and interministerial coordination, backed by strong mandates and clear work programmes to re-enforce continued leadership with a long-term perspective.

CS 1.3.28 USA - Sub-national climate governance has proven to be a resilience factor for climate policies in spite of federal administration shifts. States and cities have distinct authorities over climate policy in the U.S., which can support a more durable climate strategy in the long term.

CS 1.3.29 SOUTH AFRICA - The Presidential Climate Commission (PCC), launched in 2019, is a multi-stakeholder body comprising a technical secretariat and Commissioners from across the political spectrum. The PCC conducts independent analysis and commissions research, coordinates ongoing and frequent stakeholder engagement at local, provincial and national scales, and across key sectors, and monitors climate action.

CS 1.3.30 INDONESIA - Just Energy Transition Partnership faces significant governance-related challenges, such as limited implementation capacity and risks of policy misalignment with national priorities.



KEY FINDING 1.4

Recognizing Non-Party Stakeholders

With the adoption of the Paris Agreement, sub-national governments, businesses, and civil society have taken on an increasingly important role in shaping national climate agendas. The growing involvement of these non-party stakeholders has helped unlock new opportunities and drive tangible progress. At the same time, as countries are undergoing deep transitions, divergent voices emerge in the public debate — including from groups seeking to slow or redirect the transition. Identifying oppositions, balancing priorities, managing tensions, and fostering collaboration are central to how countries advance collective climate action.

Overall, the Paris Agreement, a legally binding international treaty with universal scope, has been instrumental in raising the profile of climate change as a prominent matter of public interest in both developing and developed countries. The influence of the Agreement in national policy-making is evident, as reflected in numerous findings of this report.

Beyond the political arena, public awareness and understanding of systemic impacts of climate change on human activities and the need for a just transition have also increased at the national level (CS 1.4.1). This heightened awareness has led interest groups and stakeholders to adopt different stances and forge new alliances across the political spectrum, triggering social mobilization and the emergence of narratives and arguments supporting different agendas.

As a result, non-party actors to the Paris Agreement – including the business community (from micro, small, and medium-sized enterprises to large commercial corporations), civil society organizations (CS 1.4.2; CS 1.4.3), and local governments – have played an important role in shaping national climate agendas. Dedicated consultation platforms have been established to organize the contribution of non state actors to national policy processes (CS 1.4.4).

Subnational governments have played a key role in the establishment of concrete strategies and implementation of actions on climate, notably in countries with a federal organization whereby the capacity to take actions lies in the hands of States. This can create diverse levels of engagement, notably in contexts with heterogeneous contexts in terms of geography, resource endowments or political situations therefore creating challenges of consistency (CS 1.4.5). Continuous efforts at subnational level can help ensure resilience in case of backsliding of ambition at national level (CS 1.4.6). State-level engagement has played a particularly important role where the low-carbon transition may affect the very fundamentals of the local economy therefore requiring dedicated governance and strategy to support the transition and manage its effects; this is for example the case in coal-dependent regions (CS 1.4.7). Also importantly, several of the specific transitions required by the net zero target depend on actions at the local level, notably when it comes to spatial organization and infrastructure, which will drive transport and building sectors. (CS 1.4.8; CS 1.4.9; CS 1.4.10)

Corporate and business actors at the core of national economic and industrial activity have played a major role in shaping the climate agenda, acting both as drivers and obstacles to the development and implementation of Paris-compatible policies and objectives. Dedicated efforts were made to instill confidence among private investors, drawing in more private companies and investors in green activities (CS 1.4.11). Voluntary net-zero emissions commitments from business actors have increased significantly since the adoption of the Paris Agreement, with strong engagement by national companies through internationally established initiatives for corporate climate ambition, such as the Science Based Targets initiative.¹¹ (CS 1.4.12) In parallel, the diffusion of reporting and disclosures standards according to international standards are a key lever to push companies to adopt ambitious climate commitments (CS 1.4.13). These developments point to a consistent trend: climate change has become a concern

for the business world, or at least a factor influencing strategy and reputation.

At the same time, the private sector and businesses with vested interests have influenced the national climate policy agenda to slow or hinder ambitious sectoral measures. The political economy of change has proven particularly complex in such multi-interest contexts, given the high level of access to political and financial resources held by incumbent industry actors (CS 1.4.14). As a result, resistance from industries whose business models are threatened by ambitious long-term planning has delayed the adoption of targeted sectoral transition legislation, sometimes by several years (CS 1.4.15), thereby weakening the intended impact of new policies or leaving legislative bills in stalemate (CS 1.4.16). Similar resistance has obstructed sectoral regulations that could translate medium-term milestones into a long-term vision (CS 1.4.17).

In terms of civil society's influence on national agendas, governments are increasingly recognizing the importance of engaging civil society organizations and communities in policy processes leading to transition policies. This helps measure and anticipate potential social impacts and build stronger ownership (CS 1.4.18). A practical step forward in this direction has been the release of national target policy documents for public comment (CS 1.4.19). Evidence from the cross-country analysis conducted in this report suggests that civil society actors have gradually taken ownership of some of the climate narratives embedded in the Paris Agreement, such as the need for a just transition (CS 1.4.1). However, the contributions of these non-party stakeholders to national policy dynamics have varied across social groups, creating diverse impacts on climate action at the national level.

Climate issues have also fallen victim to growing social polarization in domestic contexts. The challenges facing climate policy are particularly evident where climate action has tangible social impacts (CS 1.4.20), or where it has become heavily entangled with partisan identity and "culture wars" (CS 1.4.21).

¹¹ <https://sciencebasedtargets.org/>

Key Finding 1.4 - Case Studies

CS 1.4.1 SOUTH AFRICA – Domestic recognition of the need for a just transition has strengthened climate policy and institutions, allowing for some concrete successes in renewable energy deployment and in just transition planning and institutions. Civil society actors play a key role in new institutional approaches for a just transition (e.g. Funding platform for concrete transition projects).

CS 1.4.2 COSTA RICA – Public support for the decarbonization agenda, emergence of CSO advocating for the right to participate in the stakeholder process on NDC.

CS 1.4.3 GERMANY – Strong civic engagement –including legal action by public interest groups– has contributed to raise ambition of national climate targets and ensure that established targets are legally binding.

CS 1.4.4 JAPAN – The advisory bodies to the Ministry of the Environment (MOE) and the Ministry of Economy, Trade and Industry (METI) engage experts, industry and civil society actors to discuss the NDC and the energy mix. The GX Implementation Council provides a forum for dialogue with the business sector. The GX League is a voluntary corporate platform, which brings together companies, research institutions, and local governments through a public-private platform.

CS 1.4.5 CANADA – Conflicting interests at the sub-national, mainly due to geography and resource endowments, are creating major incoherence in development and maintenance of provincial and federal climate policy.

CS 1.4.6 USA – Numerous non-federal actors have remained engaged with climate issues over the years, both individually and collectively. States, cities, businesses, and other non-federal entities have formed *America Is All In*, representing nearly 75% of US GDP; over half of U.S. state governors joined the *U.S. Climate Alliance*.

CS 1.4.7 INDIA – The State of Jharkhand, one of the coal States in India where the local economy is particularly dependent on coal revenue, was the first to establish a Just Transitions Taskforce to focus on development framework to transit away from coal

CS 1.4.8 INDONESIA – The development of microgrids led by local governments will be essential to enable renewable energy access to rural and remote areas.

CS 1.4.9 MEXICO – Several climate-compatible subnational public transport initiatives have been launched, including the Metrobús BRT system in Mexico City which now covers about 125 km and is beginning fleet electrification.

CS 1.4.10 SENEGAL – A Bus Rapid Transit (BRT) system has been developed in Dakar. The new system is fully electric, runs on dedicated lanes, and marks a departure from diesel minibuses and informal transit.

CS 1.4.11 INDIA: The Government of India has taken steps to develop a market for Green bonds, and the Reserve Bank of India (RBI) has created a framework for the same. Several public and private entities like State Bank of India, National Thermal Power Corporation, and REC) have been actively issuing green bonds since 2016. The RBI issued a sovereign green bond worth almost USD 2 billion in 2023 earmarked for clean energy, transport and sustainable agriculture. This helps expand and strengthen India's green bond market, drawing in more private companies and investors.

CS 1.4.12 USA – Many businesses have set net-zero targets for carbon emissions, including utility company Duke Energy, which plans to reach this goal by 2050. Other businesses driving the clean energy transition include NextEra Energy Resources, Ørsted US, AES Corporation, Invenergy, and Pattern Energy, all of which are leading the way in developing large-scale wind, solar, battery storage, and transmission projects

CS 1.4.13 KAZAKHSTAN – The rapid diffusion of ESG reporting standards and carbon footprint disclosure requirements – often demanded by foreign partners and international capital markets – are placing increasing pressure on Kazakhstani companies to improve transparency and align with global low-carbon practices

CS 1.4.14 THAILAND – Resistance from fossil fuel incumbents and legacy industries is a persistent challenge, as these dynamics have contributed to policy stagnation on crucial market-based instruments and slowed the phasing out of coal and other high-emission sources.

CS 1.4.15 SOUTH AFRICA – Between 2015 and 2019, policy debates were dominated by attempts to operationalise instruments that had long been under discussion. Chief among these was the carbon tax, first proposed in 2010 and only passed into law with the Carbon Tax Act of 2019 (RSA, 2019). The long delay reflected the influence of powerful stakeholders in energy-intensive and coal-related industries, notably concerns about the economic burden it would place on energy-intensive firms and competitiveness effects.

CS 1.4.16 BRAZIL – Weak enforcement and resistance from agriculture business actors and local governments remains a major challenge to ensure systemic shifts in agriculture and forest management

CS 1.4.17 EUROPEAN UNION – This is currently the case in the transport sector. There is a growing amount of pressure on the EU to weaken the initiative on a EU ban on the sale of new petrol and diesel cars from 2035. Historically, EU legislators have often been forced to water down policy proposals relating to environmental protection in the transport sector, in the face of lobbying from structurally powerful incumbent industry actors, particularly large car manufacturers with close connections with their national governments.

CS 1.4.18 FRANCE – Establishment of a consultative permanent body of stakeholder representation has contributed to a better understanding and ownership of the climate issue from both government and French civil society.

CS 1.4.19 SOUTH AFRICA – The draft second Nationally Determined Contribution for 2035 was released for public comment in July 2025.

CS 1.4.20 FRANCE – Yellow jackets movement, mobilization of civil society against climate action based on social concerns

CS 1.4.21 USA – Climate policy in the U.S. has become increasingly entangled with partisan identity and has become a focal point in a broader culture war. Ideological polarization and industry resistance remain a challenge for long-term progress, and effectively navigating this divide will be key for achieving meaningful climate policy.



NATIONAL POLICIES

This section reviews the state of national policies against the benchmark provided by the DDP Report 2024 "Making it happen: National pathways to net zero"¹², which identifies four characteristics of immediate actions needed to put national economies on track for the long-term transformations required by the Paris Agreement objectives:

- *Short-term actions across infrastructure, technology, governance and institutions, and lifestyle and behaviour. While these may not deliver immediate emission reductions, they are essential foundations for the long-term changes needed in each country.*
- *Immediate CO₂ emission reductions in power generation, passenger transport and land use. Technical solutions already exist in these sectors, and the policies needed to accelerate their deployment are often well identified at the national level.*
- *Structural changes in economic and industrial systems. Turning these transformational challenges into development opportunities requires determined, country-specific action as well as active pursuit of partnerships and international cooperation.*
- *Short-term measures to avoid development delays and support disadvantaged and vulnerable populations. These must be tailored to national contexts and may be macroeconomic or sectoral in nature, possibly involving international cooperation.*

¹² <https://ddpinitiative.org/ddp-annual-report-2024/>

KEY FINDING 2.1

Enabling Long-Term net-zero Transformations

Over the past decade, national policies have largely triggered the rapid development of new low-carbon technologies and their cost reduction, establishing the conditions for long-term deep emission reductions. However, they have paid little attention to directing investment towards long-lived infrastructure and to triggering behavioural change, both of which are equally essential for achieving very low emission levels in the long run.

Analysis of national pathways to net zero shows that achieving carbon neutrality requires immediate action to enable long-term structural changes in all sectors. These changes may not deliver significant emission reductions in the short term, but they are essential to secure deeper reductions by mid-century. They include the emergence of new technologies, the development of infrastructure, the establishment of appropriate governance and institutions, and shifts in lifestyles and behaviours. All sectors are affected by these structural changes and they have sector and country-specific characteristics. But they share a common feature: significant inertia, that is, a substantial time lag between the implementation of measures and their effective translation into large-scale change (CS 2.1.1).

Consideration of these inertial effects makes it crucial to assess short-term actions not only in terms of their immediate impact on emissions, but also in light of their longer-term effects. For example, short-term measures that risk creating new carbon lock-ins should be avoided, even if they deliver marginal near-term reductions. Conversely, actions that address the various sources of inertia behind structural change should be prioritized, even if they do not deliver short-term emission reductions, because they are essential for achieving deeper reductions over time.

This time lag between actions and their outcomes presents a critical challenge for public and private

decision-makers. The national-level analysis highlights proactive movement on transforming governance and institutions (see *Section National Governance*), as well as on technologies, but much less emphasis on infrastructure development and behavioural patterns.

Since the Paris Agreement, countries have actively pursued policies to support innovation in energy efficiency and zero-emission technologies across a wide range of sectors. The goal has been to ensure that new technologies reach maturity and become technically and economically viable alternatives to emitting technologies as national transitions advance. Their effective diffusion within sectors then depends on complementary policy measures that adapt sectoral and socio-technical systems (as discussed in Key Finding 2.2).

At the global scale, the trend has been the rapid emergence of new technologies accompanied by steep cost declines. National policies have played a central role in enabling this technological progress. They have done so by combining targeted public-private funding for research and development, organizing large-scale demonstration and pilot projects, and aligning expectations and reducing uncertainties for private actors by setting clear time horizons for specific technological transitions. This policy mix has delivered practical results in many sectors. In transport, for example, CO₂ performance standards for new light vehicles, with intermediate-year targets (CS 2.1.2), and blending mandates for biofuels (CS 2.1.3) have been effective in driving technological development. In the power sector, alongside decades of large-scale public-private research funding, recent investments in PV and wind parks have helped reduce costs by accelerating deployment (CS 2.1.4). In industry, R&D investments are insufficient, but necessary to support the emergence of new technologies at commercial scale. Some of these are identified as critical for long-term transformation but are not yet fully developed, such as innovative zero-emis-

sion industrial processes or carbon capture and storage (CCS) (CS 2.1.5, CS 2.1.6).

In recent years, policies on energy distribution infrastructure have evolved to reflect the radical transformation of energy production in the low-carbon transition. Key developments include the rising share of intermittent renewables in electricity generation, increased electricity production and consumption within distribution grids, or the emergence of new low-carbon energy carriers. However, these changes have not occurred at the scale or pace required to support the anticipated expansion of these options. Delays in planning and investment in the power network have slowed the development of critical long-lived infrastructure. For example, electricity grids remain insufficiently robust and flexible to integrate high shares of intermittent power sources (CS 2.1.7, CS 2.1.8, CS 2.1.9, CS 2.1.10; CS 2.1.11). Similarly, inadequate investment in charging networks and in reinforcing distribution grids has slowed the uptake of electric vehicles (CS 2.1.12). In addition, recent targets for green hydrogen production are not yet matched by the necessary investment in transport and distribution infrastructure (CS 2.1.13).

In transport and buildings, progress has been similarly limited. Such infrastructure is integral to the low-carbon transition and relies heavily on national policy, through dedicated public investment and incentives for private investment. Some specific measures could be identified that effectively support needed transitions, such as revised building codes enabling investment in upgrading existing buildings or constructing new climate-adapted ones (CS 2.1.14), and some public-private partnerships have supported targeted transport projects such as Bus Rapid Transit (CS 2.1.15) or dedicated freight corridors (CS 2.1.16). But overall progress in this area has been limited. In particular, trends in investment, planning and design rules in recent years largely reflect a continuation of past approaches – many of which run counter to low-carbon objectives. This is particularly evident in the impact of infrastructure deployment on urban and land-use organization. For example, development has

continued to promote car-oriented, low-density environments, despite their clear incompatibility with sustainable mobility systems that depend on collective and non-motorized transport (CS 2.1.17).

Finally, incentives to influence collective lifestyles and behaviours, and to prepare for their evolution over the long term, have received very little attention in concrete policy action to date, despite their structural impact on future emissions. Values and norms that shape these behaviours can be influenced by targeted national policies such as information campaigns, advertising obligations, educational measures, or other regulatory and economic incentives. One notable example is the LIFE initiative in India, a rare coordinated policy explicitly aimed at encouraging individuals and communities to adopt lifestyles more in harmony with nature. Its effects are expected only after 2035–2040, as scaling up and nationwide implementation will take at least a decade, but it could be decisive in the pathway to net zero after mid-century (CS 2.1.18). A broader outlook, however, shows very few policies in the past decade explicitly targeting long-term collective behaviour to foster modern societies less dependent on energy and resource consumption (CS 2.1.19). In fact, many national policies have worked against the behavioural shifts compatible with low-carbon societies. For example, policies to regulate mobility speeds – such as reducing speed limits, restricting maximum engine power, or running campaigns on the benefits of low-speed mobility – remain underrepresented, even though high-speed mobility consumes more energy, creates inefficient logistical behaviours compared with lower speeds, and poses barriers to collective and bulk transport. Car manufacturers continue to promote even more powerful and heavier vehicles. These require more resources and consume more energy without providing significantly greater services than smaller cars (CS 2.1.20, CS 2.1.21). Production regulations based on weight, material use, or environmental impact are not yet in place to counter this trend, and advertising regulations could help curb the pervasive “bigger is better” message.

Key finding 2.1 – Case Studies

CS 2.1.1 MEXICO & NIGERIA – Oil-dependent economies face structural inertias that are challenging to overcome in order to put countries on track with the low carbon transition.

CS 2.1.2 EUROPEAN UNION – The decarbonization of Europe's passenger and freight transport sectors relies on the phase out of internal combustion engines linked to the uptake of zero or low-emission vehicles. Emission performance standards and targets have been critical in driving technological innovations and production

CS 2.1.3 BRAZIL – The Renovabio Program supported innovations in biofuel production and fixed mandates for ethanol and biodiesel blends in gasoline and diesel oil, and caps to carbon intensity of fuels distributed for consumption.

CS 2.1.4 GERMANY – Political efforts to accelerate planning and permitting procedures may already allow increased efficiency and declining module prices, in turn helping the LCOE for photovoltaics to drop significantly. Currently, both PV and wind power have become the most cost-effective forms of electricity generation.

CS 2.1.5 CHINA – Decarbonizing energy-intensive industries will be critical in the long-term and hinges on overcoming technological uncertainty, high investment requirements, and limited short-term market signals.

CS 2.1.6 USA – The decarbonization of the industrial sector has seen limited progress, namely because investments to drive down costs for decarbonized industrial processes are insufficient.

CS 2.1.7 BRAZIL – Renewable power production exploded, but the development of the power network and storage capacities has not been planned accordingly to accommodate a very high share of renewables.

CS 2.1.8 INDONESIA – In order to connect dispersedly located renewable resources, enhance system reliability and enable electricity access to rural and remote areas, public policies have been actively enabling the development of both super grids and micro grids.

CS 2.1.9 USA – Public policies have supported the growth in renewables, helping the levelized cost of energy for solar and wind fall sharply, and yet interconnection has been a major obstacle in accelerating clean energy deployment in the US.

CS 2.1.10 INDIA – Some efforts to create the conditions for future integration of high share of renewables but challenges to deploy batteries consistently with requirements of renewable energy because of uncertainties and high short-term capital costs.

CS 2.1.11 SOUTH AFRICA – Since 2022, independent power producers have been able to contract directly with private offtakers, expanding the pipeline dramatically, but without having correctly expanded the grid infrastructures. By 2023, the pipeline for new variable renewable energy projects reached 64 GW, rising to 134 GW of wind, solar, and hybrid storage projects by 2024.

CS 2.1.12 THAILAND – Efforts are made to facilitate EV uptake through a comprehensive set of policy packages, ranging from EV production, to infrastructure investment in charging stations and facilitating grid modernization.

CS 2.1.13 ARGENTINA – Looking at green hydrogen, two national strategies and plans list targets regarding its production (National Energy Transition Plan 2030), and its use and export (National Strategy for the Development of the Hydrogen Economy).

CS 2.1.14 FRANCE – The building codes and energy efficiency building labeling system have been revised in order to drive a shift towards more energy-efficient building envelopes and low energy consumption buildings (BBC).

CS 2.1.15 SENEGAL – A Bus Rapid Transit (BRT) system has been developed in Dakar. Fully electric and running in dedicated lanes, it is projected to serve around 300 000 passengers a day. The development of this BRT infrastructure and system was enabled by a public-private partnership structure that mobilized international financing, and by effective measures to allow dedicated lanes and the integration of the informal sector.

CS 2.1.16 INDIA – To reach 45% rail freight by 2030, one prominent infrastructure project that enabled the modal shift to railways is the Dedicated Freight Corridor (DFC).

CS 2.1.17 MEXICO – Despite the evidence that compact urban form, transit-oriented development, and accessibility planning are essential to reducing vehicle use and emissions, while highway expansion tends to induce traffic and lock in fossil fuel dependency, car-centric infrastructure continues to be prioritized.

CS 2.1.18 INDIA – Mission LiFE is an initiative which seeks to encourage a lifestyle in harmony with nature and reflect the principles of climate justice, by focusing on three main changes, i.e. in demand, supply and policy. It encourages 75 individual actions ranging from reducing consumption and waste to saving water and energy.

CS 2.1.19 GERMANY – No targeted climate policy approach has explicitly addressed the potential of sufficiency measures and activity reduction in demand-side sectors.

CS 2.1.20 FRANCE – The focus on electric vehicles has evicted the concern on the size and cost of vehicles (energy efficiency & affordability), letting the industry develop a strategy towards larger, heavier and more expensive propositions, now a difficulty in the transition towards electrification for many reasons (just transition, resource sovereignty and recycling, urban space, etc.).

CS 2.1.21 GERMANY – Emission reductions stemming from technical efficiency gains have been largely undermined by countervailing developments in vehicle characteristics, particularly increases in vehicle mass and engine power.

An abstract illustration on the left side of the page. It features several hands in various shades of grey, holding sticks of different colors (purple, pink, red). Dashed lines in red, blue, and green swirl around the sticks, creating a sense of movement and interconnectedness. The background is a light, warm tone.

KEY FINDING 2.2

Triggering immediate emission reductions

Over the past decade, significant emission reductions in power generation, passenger transport and land use have been enabled by regulatory and economic policies that accelerated the diffusion of energy-efficient and low-carbon solutions. Much less attention has been paid to policies aimed at reducing energy demand or transforming agriculture, forestry and land-use practices, despite their critical role in immediate emission reductions.

The analysis of national pathways to net zero shows that immediate emission reductions are essential for putting countries on track towards the long-term net-zero objective. These can be achieved when the economic and regulatory environment facilitates the large-scale adoption of existing mitigation options. Across all countries, three sectors consistently hold the greatest potential: power generation, passenger transport and land use. Indeed, in each of these sectors, solutions such as renewable power generation, electric vehicles, public and non-motorized transport, forest development and agroforestry are technically viable, cost-effective, and ready for deployment on an industrial scale.

In the last decade, national policies combining economic and regulatory measures have effectively supported the adoption of low-carbon technologies and solutions by shaping the incentives faced by households and companies.

Key economic policies include subsidies to support adoption by end-users, such as for electric vehicles (CS 2.2.1) or heat pumps (CS 2.2.2); increased taxes or carbon pricing to discourage fossil fuel use (CS 2.2.3, CS 2.2.4, CS 2.2.5); regulated auctions or tenders, sometimes combined with feed-in tariffs or feed-in premiums, to support wind and PV deployment (CS 2.2.6, CS 2.2.7); and direct public investment, for example in hydropower (CS 2.2.8). In developing country contexts, international cooperation will be crucial to improve access to affordable public and private finance, a necessary condition to enable deployment at scale of solutions with high capital cost (CS 2.2.9). In large countries, manufacturing subsidies and investments could also be implemented to increase production and reduce technology costs through economies of scale, and lower global market prices, thereby improving worldwide accessibility (CS 2.2.10, CS 2.2.11, CS 2.2.12).

Regulatory policies have included renewable energy quotas, mandates and standards, such as obligations for minimum biofuel content in blended fuels (CS 2.2.13, CS 2.2.14), and fuel efficiency and emission standards to encourage EV adoption (CS 2.2.15, CS 2.2.16). Other measures include the installation of energy-efficient, low-emission technologies such as heat pumps in buildings (CS 2.2.17); power market and infrastructure access rules to support the penetration of new technologies and actors (CS 2.2.18); and governance mechanisms to ensure private power producers comply with obligations.

However, these measures have frequently faced obstacles in practice. In some countries, a lack of political continuity and sustained support for climate transitions has led to policy interruptions (CS 2.2.19, CS 2.2.20, CS 2.2.21). In others, political fragmentation and polarization have eroded backing to specific policies, leading to their dilution or even dismantling (CS 2.2.22). Delays in implementation have also been experienced due to insufficient consensus and communication (CS 2.2.23). In many cases, policies have also been introduced in a scattered or partial manner: some measures incentivized low-carbon technologies while others discouraged fossil fuel use, but without the complementary actions needed to form coherent packages capable of fully shifting investment and behaviour (CS 2.2.24).

The analysis of national policy action in the last decade shows that greater emission reductions could have been achieved if countries had adopted a broader approach that proactively targeted final energy consumption. Moderating energy demand lowers the volume of low-emission fuels required in the energy system, reduces energy dependence, offers substantial mitigation potential at lower cost, and delivers strong co-benefits. For example, in the power sector, economic incentives such as differentiated electricity tariffs or pricing mechanisms to reward demand flexibility and reduction have been largely absent, even though they could support the transition of the energy system (CS 2.2.25). Similarly, in passenger transport, very little progress has been made in reducing unnecessary kilometers

travelled or shifting towards collective modes, despite well-known economic and regulatory levers (CS 2.2.26). In particular, little evidence could be found of policies directly targeting this energy demand component. These include economic measures such as increased subsidies for public transport tickets or bicycles, higher car parking taxes, and road tolls (CS 2.2.27); this also includes regulatory policies such as urban policy measures related to land-use planning, small adaptations of existing road infrastructure to dedicate lanes to buses or non-motorized transport and reduce the space for individual cars, or regulations on public transport service quality covering frequency, punctuality and comfort. Such measures can be implemented and reduce emissions quickly.

Finally, key strategic policy frameworks have been adopted for the land use sector, particularly in countries where it represents a large share of national emissions, given the critical role of natural carbon sinks in short-term mitigation. These frameworks set out objectives such as forest protection or afforestation and reforestation targets (CS 2.2.28; CS 2.2.29), and in some cases have recently introduced initial economic measures (CS 2.2.30) and land tenure reforms (CS 2.2.31) to ensure progress. However, the effective implementation of policies is often hindered by entrenched local interests and by the absence of complementary measures, such as financial support for ecosystem services or resources for enforcement (CS 2.2.32, CS 2.2.33, CS 2.2.34).

In addition, the land use sector is intrinsically related to the agriculture sector. The transition towards agroecological production systems and agroforestry is critical, but the vast number of small and independent farmers with low income make the implementation harder (CS 2.2.35). Beyond farmers, policies do not sufficiently engage all actors, from local farmers to major agribusinesses and final consumers, despite a shared responsibility to drive the transition (CS 2.2.36, CS 2.2.37).

Key finding 2.2 - Case Studies

CS 2.2.1 USA – Economic incentives, mandates and rapid investments in charging infrastructures facilitated the penetration of electric vehicles over the last years.

CS 2.2.2 CANADA – The “electroprovinces”, such as Québec and British Columbia, are moving fast to electrify the buildings of all sizes using subsidies for heat pumps and regulations to reduce building gas hookups.

CS 2.2.3 CANADA – A large final emitter carbon pricing system is still in place (despite political backlash), partly because this tool has been identified as having the most impact and least political costs to reduce emissions.

CS 2.2.4 KAZAKHSTAN – Strengthening Kazakhstan's ETS is essential. Introducing a minimum carbon price floor of at least USD 10 per ton of CO₂, phasing out free allocations, and aligning caps with the 2060 neutrality target will create market incentives for emission reductions and support clean investment.

CS 2.2.5 JAPAN – Japan has introduced subsidies to encourage end users to adopt low-carbon technologies and has also implemented carbon pricing. The government plans to further strengthen its carbon pricing measures in the coming years.

CS 2.2.6 BRAZIL – Dedicated tendering of PV power plants and strong incentives to the installation of grid-connected individual PV systems at consumer level have contributed to improving the penetration of solar PV in the Brazilian energy system.

CS 2.2.7 KAZAKHSTAN – In order to enable the deployment of renewable energy sources, renewable energy auctions were organized, amounting to 3 GW capacity by 2024.

CS 2.2.8 NIGERIA – Despite the weak fiscal and infrastructure landscape, Nigeria has started to convert its climate commitments into concrete assets, regulations, and revenue streams that will keep future emissions on a downward trend. Efforts include investments in renewable energy projects, such as the 700 MW Zungeru hydropower project.

CS 2.2.9 MEXICO – Achieving Mexico's climate and energy transition goals will require large amounts of external financing, especially private and foreign, in order to accelerate the roll-out of sustainable technologies to meet new energy demand and rapidly replace the operating fossil fleet.

CS 2.2.10 CHINA – Policies focusing on technological innovation and manufacturing helped drive down global wind and PV costs by 60% and 80% in the past decade. This is a structural condition for the large-scale expansion of renewable energy globally.

CS 2.2.11 JAPAN – GX strategies have been established to drive energy-efficient and renewable energy-based systems, including GX Economic Transition Bonds.

CS 2.2.12 BRAZIL – Biodiesel production and use has nearly tripled from 3.2 to 8.8 billion Liters/year between 2014 and 2024, enabling economies of scale and cost reductions, and helping reduce emissions in the energy supply.

CS 2.2.13 BRAZIL – Regulations in the form of mandates for ethanol and biodiesel blends in gasoline and diesel oil as well as caps to carbon intensity of fuels distributed for consumption were efficient in driving up the use of biofuels, and reducing emissions linked to the energy supply.

CS 2.2.14 ARGENTINA – Policy instruments, namely in the form of target-setting, renewable energy biddings, managed to increase the share of solar and wind generation. Attempts were also made to increase distributed generation through regulatory actions, whose share is now increasing due to the recent decrease in PV costs and the progressive increase in electricity tariffs.

CS 2.2.15 USA – Economic incentives, mandates and rapid investments in charging infrastructures facilitated the penetration of electric vehicles over the last years.

CS 2.2.16 EUROPEAN UNION – Regarding transport vehicles, the strategy sets a target of 30 million electric vehicles by 2030 in parallel with the new car emissions standards set to effectively phase out internal combustion engines by 2035, with intermediary targets for 2020, 2025 and 2030.

CS 2.2.17 FRANCE – Labelling system on both the energy consumption and the GHGs emissions for buildings, complemented by minimum performance standards for building, selling or renting, supports the dissemination of decarbonized heating equipment.

CS 2.2.18 MEXICO – The electrical sector reform contained several measures with true potential to enable progress towards climate goals. Among them, the opening of renewable capacity auctions accessible to other private companies, than the national utility CFE, will enable new players to share their experience and competences in the national power market.

CS 2.2.19 USA - At the federal level, the alternating agendas of the last three administrations have limited the U.S.'s ability to deliver consistent global leadership under the Paris Agreement, while also creating challenges domestically for delivering the short-term Nationally Determined Contribution (NDC) targets and making needed progress toward long-term net-zero goals.

CS 2.2.20 ARGENTINA - Argentinean environmental governance has been characterized in recent decades by significant changes, and climate policies have been subject to various fluctuations, some related by changes in foreign policy, which resulted in changes in negotiations.

CS 2.2.21 MEXICO - "Policies supporting renewables have been put in place, but the lack of continuity in implementation, particularly across changes of government, has created deep uncertainties and shaken the confidence of a broad range of stakeholders to invest in new renewables".

CS 2.2.22 CANADA - A large final emitter carbon pricing system is still in place (despite political backlash), partly because this tool has been identified as having the most impact and least political costs to reduce emissions.

CS 2.2.23 GERMANY - The technological shift from gas heaters to heat pumps in buildings started, but was hindered by political and social barriers.

CS 2.2.24 MEXICO - Policies supporting renewables have been put in place, but their specific design and implementation have limited their effectiveness in driving a real shift away from fossil fuels.

CS 2.2.25 CHINA - Compared to supply-side measures, demand-side mitigation approaches offer greater mitigation potential, lower costs, and stronger co-benefits. They are critical to peaking final energy consumption by 2030. For example, energy tariff signals remain weak, while they could motivate behavioral change.

CS 2.2.26 USA - The transport decarbonization mostly relies today on the transition of vehicle motorizations towards EVs. Additional policies to reduce unwanted kilometers and shift to collective transport should receive more attention.

CS 2.2.27 INDONESIA - Transport policies combine disincentives for private vehicle use such as congestion charging, higher parking fees, fuel and vehicle taxes, as well as incentives for mass transit and integrated ticketing.

CS 2.2.28 INDONESIA - The FOLU Net Sink 2030 strategy prioritizes reforestation, peatland restoration, and mangrove conservation. By curbing deforestation, restoring degraded peatlands, and protecting mangrove ecosystems, Indonesia leverages the critical role of these landscapes as carbon sinks.

CS 2.2.29 CÔTE D'IVOIRE - To achieve its new NDCs, Côte d'Ivoire has resolved to restore 20% of the forest cover of the national territory.

CS 2.2.30 BRAZIL - New norms created by the new Federal Government in 2023 and 2024 are an effort to accelerate the destination of public forests, about 50 Million hectares unprotected yet, including partnerships with private capital to restore the original forest cover.

CS 2.2.31 CÔTE D'IVOIRE - To facilitate reforestation measures, the State has initiated the process of securing land tenure in the national territory.

CS 2.2.32 BRAZIL - The implementation of existing policies to reduce deforestation is complicated by local and business vested interest.

CS 2.2.33 INDONESIA - Efforts to decarbonize the land-use sector materialize through strengthened policies, community engagement and restoration initiatives, yet stable land governance and implementation are necessary to reach the FOLU Net Sink 2030 objective.

CS 2.2.34 DOMINICAN REPUBLIC - Attempting to ensure that the AFOLU sector remains a carbon sink through dedicated short-term measures.

CS 2.2.35 INDIA - The increased adoption of agroforestry on croplands offers multiple benefits. But the configuration of the Indian food market with a large number of smallholders complicates the penetration of these new farming practices.

CS 2.2.36 BRAZIL - Reducing emissions from cattle farming is critical in the long-term but is currently limited by a lack of policies to embark all suppliers, including farmers and the main beef producers.

CS 2.2.37 EUROPEAN UNION - One of the reasons explaining why the overall environmental and climate ambition of Member States in agriculture has not increased as much as is necessary to meet the EU climate goals is the lack of knowledge, capacity, support and/or financial means at the farm level to embark upon a transition to more sustainable farming systems.

KEY FINDING 2.3

Aligning long-term climate and industrial objectives

There is growing recognition of the need to better align climate and industrial transitions. In practice, however, this convergence remains limited and far from systemic. While measures have been adopted to attract investment in key national industries compatible with climate goals, climate policies are still often perceived as conflicting with national priorities such as competitiveness and employment, which can slow progress.

Analysis of national pathways to net zero shows that the global transition will require fundamental shifts in economic systems, driven by the decline of carbon-intensive activities and the emergence of new industries providing the goods, technologies, and services needed for a low-carbon economy. The resulting structural changes will significantly affect employment, production assets, and trade across sectors. Without dedicated action, major macroeconomic tensions may arise in national economies, particularly in the most carbon-intensive countries. Such tensions can stem from trade imbalances, especially in countries heavily reliant on fossil fuel and carbon-intensive exports, or from deindustrialization and job losses. New dependencies could also emerge around access to low-carbon technologies and critical minerals if domestic industries are unable to supply them.

Over the past decade, an increasing number of strategic industrial visions and sectoral plans have explicitly incorporated the transition to a low-carbon economy, most of them focusing on industries of particular national relevance. The elaboration of sectoral roadmaps for key sectors, including through a dedicated involvement of relevant stakeholders, provides vision on opportunities and difficulties of each of the sectors and evaluates (private and public) investment needs (CS 2.3.1).

A common strategy observed in large economies is to develop the domestic manufacture of low-emission technologies and critical materials for their own transitions, recognizing the potential to create new local economic activities, jobs and skills, while reducing dependence on imports (CS 2.3.2, CS 2.3.3,

CS 2.3.4). Another strategy consists in developing export-oriented industries in these areas, positioning countries in future global value chains (CS 2.3.5, CS 2.3.6, CS 2.3.7, CS 2.3.8). In trade-exposed economies, industrial adjustments are often driven by shifts in international competition. For example, as value chains and goods progressively decarbonize, countries have an incentive to adopt proactive national measures to reduce the carbon content of light manufacturing industries, with the objective to maintain or gain international market share (CS 2.3.9, CS 2.3.10). In many countries though, the integration between climate and industrial agendas has not materialized in tangible climate-industrial strategies despite emerging convergence in political discourse (CS 2.3.11, CS 2.3.12).

Developing sectoral roadmaps for key sectors, with the active involvement of relevant stakeholders, has helped identify opportunities and challenges, and assess both public and private investment needs. But, such processes, based on assessments of the potential and risks of different industries, are also vulnerable to capture and information asymmetries (on innovation opportunities, costs, etc.), which can bias strategic directions (CS 2.3.13). In addition, this scattered approach focused on specific sectors only may overlook the systemic perspective needed to assess the full range of opportunities and enabling conditions for the industrial transition to carbon neutrality (CS 2.3.14).

These trade and industrial strategies draw on a range of economic and regulatory policies designed to foster a trade and investment environment that supports national industrial transitions while promoting economic growth and job creation.

Among the main economic policy instruments used to align climate and industrial transitions are carbon pricing mechanisms, whether market or tax-based. Many countries have developed these instruments in specific industries to tax production according to its carbon intensity (CS 2.3.15, CS 2.3.16, CS 2.3.17). In complementarity, large industrial and investment programs are a classical way to drive national industries towards the green economy (CS 2.3.18).

In recent years, national taxonomies have emerged – that is, attempts by countries to define explicit criteria for classifying economic activities according to their alignment with a net-zero trajectory and broader environmental goals (CS 2.3.19). This approach has also started to emerge at the sectoral level, complementing proactive sectoral strategies, for example, in the steel industry (CS 2.3.20). A holistic approach of this kind can provide private actors with greater clarity when setting investment directions, and can serve as a foundation for reshaping existing consumption and production subsidies and taxes towards sustainable activities. It can also be used to adjust trade tariffs or to condition market access in trade agreements on sustainability guarantees for imported products.

Local content requirements are another important policy tool, used in various forms to stimulate national industrial development. They may be conditions for access to national markets in trade agreements, or attached to subsidies, public investment guarantees, or public procurement. They can also be applied to low-interest loans from public development banks to finance renewable energy projects, while at the same time supporting national industrialization objectives (CS 2.3.21).

Depending on national circumstances and the availability of natural resources, some countries have also introduced preferential trade tariffs to import raw critical minerals to limit dependencies on final products (CS 2.3.22) or export/import bans to protect national natural resources (CS 2.3.23). Such policies can create opportunities to upgrade domestic industries and strengthen their position in value chains of clean technologies.

In other situations, trade agreements can be complemented with measures to drive a sustainable industrialization and development, which consist in defining sustainability rules to access the domestic markets, such as criteria about ecodesign and circularity of products, about the impact on deforestation, or about the carbon content of the products (CS 2.3.24).

More recently, new forms of international financial cooperation have emerged through Just Energy Transition Partnerships (JET-Ps). These frameworks can help developing countries access international

resources to finance sustainable investments of national relevance. While often focused on the power sector, JET-Ps can also support other key future industries such as green hydrogen or electric vehicles. Importantly, they can be used to accompany the industrial transition by building institutional capacity with local participation, adapting workforce skills, diversifying local economies, and protecting workers and communities (CS 2.3.25, CS 2.3.26).

This economic and industrial transition under climate constraints inevitably raises concerns, given the fundamental links between industrial dynamics and key socio-economic indicators such as growth, employment, and export revenues.

In countries where fossil fuel industries have underpinned the economy for decades, public finances often depend heavily on fossil revenues. This creates short-term pressures and forces to consider the industrial transition as a complex structural issue requiring diversification of the economy (CS 2.3.27). In regions highly dependent on carbon-intensive industrial ecosystems, workforce transition risks can also generate tensions that may slow progress if reskilling, upskilling and the creation of new economic activities are not properly anticipated (CS 2.3.28, CS 2.3.29, CS 2.3.30).

Overall, we noted that climate policies proposing shifts in trade and industrial policies are often challenged by local business interests, which tend to defend vested positions by delaying action rather than identifying new business opportunities (CS 2.3.27, CS 2.3.31, CS 2.3.32, CS 2.3.33).

Existing fossil fuel subsidies persist in many sectors, slowing the transition to renewables and complicating economic diversification (CS 2.3.34). International finance raises further questions and challenges in recipient countries, particularly around the risks of foreign influence over national priorities, or the debt burdens created by loan-based support (CS 2.3.35).

Finally, national trade and industrial policies are not designed in isolation, but within a global context of cooperation. The main challenge, therefore, is to ensure industrial policies foster mutually beneficial partnerships and take better account of the real needs of countries (CS 2.3.36, CS 2.3.37).

Key finding 2.3 - Case Studies

CS 2.3.1 FRANCE - Sectoral roadmaps (steel, chemistry, cement, etc.) have been negotiated with the concerned stakeholders, to better translate the SNBC orientations into tangible pathways for each industry, inform bottom up the opportunities and difficulties of each of the sectors and evaluate (private and public) investment needs, knowing that large emitters are at the same time covered with the EU ETS market obligations.

CS 2.3.2 INDONESIA - Complimentary policies (for RES) include encouragement of investment in battery industries, which are integrated with critical minerals processing to supply raw materials. These policies align with the government macro policy on the development of downstream industries to increase value added to the national mineral resources for achieving high economic growth in the short term.

CS 2.3.3 INDIA - India is dependent on imports of critical minerals for clean-energy and high-tech goods manufacturing, therefore strategies to augment domestic resources and ensure resilient supply chains are being put in motion actively since 2023.

CS 2.3.4 CHINA - Industrial policies drove the Chinese automotive industry towards electric vehicles enabling a convergence between climate and industrial goals.

CS 2.3.5 SOUTH AFRICA - South Africa has a high potential for low-cost production of green steel due to its renewable energy resources and iron ore reserves, and could use these competitive advantages to supply national needs in steel and to export green steel.

CS 2.3.6 CHINA - New energy, new materials, and green manufacturing is not only a strategy for climate mitigation, but also a critical engine for future economic growth.

CS 2.3.7 INDIA - The role of green hydrogen is critical for the Indian low-carbon transitions, which thus launched the National Green Hydrogen Mission to prepare the deployment of a new industrial structure organized around Green Hydrogen. The overarching objective is to make India the global hub for production, usage and export of green hydrogen and its derivatives.

CS 2.3.8 ARGENTINA - The 2023 National Energy Transition Plan proposes among others to explore different strategies for green hydrogen (blend with natural gas, and green ammonia to be used in electricity generation and exports) and the 2024 National Strategy for the Development of the Hydrogen Economy proposes the production, use, and export of green, blue, and pink hydrogen.

CS 2.3.9 THAILAND - In response to the introduction of the European Union's Carbon Border Adjustment Mechanism (CBAM), Thailand's export-driven economy must adapt and reduce its emission levels to be able to remain trade competitive.

CS 2.3.10 SOUTH AFRICA - Sectors such as automotive manufacturing, which face bans on internal combustion engine vehicles in major export markets are particularly exposed. Recognising that automotives, among other sectors, underpin jobs, livelihoods, and regional economies, policymakers began to integrate considerations of economic diversification into climate planning.

CS 2.3.11 CÔTE D'IVOIRE - Recent strategic development plans take into consideration the challenges faced by the ecological transition. Favoring social dialogues and consensus about the alignment of climate and development priorities will be key.

CS 2.3.12 THAILAND - Social considerations are emerging in climate policies but remain incomplete. The lack of an integrated climate–employment strategy presents a risk to both social stability and political support for transition measures.

CS 2.3.13 FRANCE - In recent years, a part of the French industry insisted on the importance of maintaining a significant supply of methane in the forthcoming decades to limit the transition cost, but their evaluation was much higher than previous evaluations and conflicted with French commitments and objectives on fossil fuel phase out. Planning documents integrating these industry-requested solutions are now fragilized by a recent report on the impact of climate change on biomass production in France.

CS 2.3.14 EUROPEAN UNION - The new EU "Clean Industrial Deal" aims to develop a systemic approach to enable the deployment of clean technologies in Europe through a mix of new industrial subsidies and regulations.

CS 2.3.15 EUROPEAN UNION - As a carbon cap-and-trade program, the ETS internalizes the social costs of GHG emissions into (energy) market prices, which in turn promotes further investments in low-carbon technologies.

CS 2.3.16 KAZAKHSTAN - An ETS has been developed but has exerted only little pressure on industry to adopt low-carbon technologies : carbon prices are below USD 1 per ton of CO₂, there is minimal compliance flexibility and continued free allocation of allowances.

CS 2.3.17 BRAZIL - A cap-and-trade system applicable to companies emitting more than 25 ktCO₂e/y (excepted in the agricultural sector) has been approved at the end of 2024. Its full implementation is expected after 2030 only, but it will provide a carbon pricing tool indispensable for the net-zero transition.

CS 2.3.18 JAPAN - Japan is promoting decarbonization investment under the Green Transformation (GX) strategy through GX Economic Transition Bonds, tax incentives, and carbon pricing.

CS 2.3.19 EUROPEAN UNION - The EU taxonomy is a transparency tool for investors and companies. It enabled from 2022 to unveil the compatibility of investments from large EU companies.

CS 2.3.20 INDIA - The green steel taxonomy supports shifts in industrial structure through greening the steel sector, through green hydrogen, CCUS and use of biochar.

CS 2.3.21 BRAZIL - The National Development Bank (BNDES) has supplied long-term funding to the wind industry conditional to an initial national content level of 60% (later adjusted) of the total investment, allowing domestic manufacturing of most wind power equipment to reach an 85%-95% level today.

CS 2.3.22 INDIA - Customs duty has been cut on imports of raw mineral products to encourage domestic processing.

CS 2.3.23 INDONESIA - National policy and its recent implementation officially bans the export of raw materials and provides several facilities and incentives for local companies to create downstream mineral industries.

CS 2.3.24 EUROPEAN UNION - The EU recognises its global impact and aims to steer its relevant extraterritorial policy framework in a more inclusive and sustainable direction. Through a revision of its Trade and Sustainable Development Strategy, it has adopted several domestic measures in this direction such as the Carbon Border Adjustment Mechanism (CBAM), Corporate Sustainability Due Diligence Directive (CSDDD), EU Deforestation Regulation (EUDR) and EU Sustainable Product Regulation (ESPR).

CS 2.3.25 SOUTH AFRICA - The JETP identified priority sectors beyond coal, also considering socio-economic aspects of clean electricity, new energy vehicles, and new export products such as green hydrogen and derived products. The JETP Investment Plan (JET IP) also included two additional priority areas that were deemed critical for the successful implementation of a just transition (skills and municipalities). In particular, there is a significant momentum in building institutional capacity and governance structures and developing the climate knowledge needed for addressing social, technical, and other aspects of the transitions.

CS 2.3.26 INDONESIA - The JETP is one of the international solutions to support the decarbonization of the power sector, yet with political and social limits.

CS 2.3.27 BRAZIL - Strategic industrial policies to lead to a new Paris-Compatible Brazilian economy is under way, but facing challenges related to competing interests in oil and gas sectors, as well as short-term financing pressure.

CS 2.3.28 CHINA - Transitioning away from coal-fired power is central for China to achieve carbon neutral-

ity, but may be delayed if major barriers related to the economic and employment reliance on coal in some provinces are not addressed.

CS 2.3.29 INDONESIA - Reaching carbon neutrality requires an inclusive and sustainable green economic transformation. Current strategies include the creation of green industries, and roadmaps for reskilling and upskilling workforce to ensure a just and inclusive transformation.

CS 2.3.30 INDIA - The inter-ministerial committee on just transitions from coal proposed a framework and a roadmap focused on human-centric approach for energy transitions, assessing the stranded assets, alignment with national policies, regional diversification, local adaptation, and community engagement. Jharkhand, the coal producing state was the first to establish a Just Transitions Taskforce to focus on development framework to transit away from coal.

CS 2.3.31 CHINA - Transitioning away from coal-fired power is central for China to achieve carbon neutrality, but may be delayed if major barriers related to the economic and employment reliance on coal in some provinces are not addressed.

CS 2.3.32 FRANCE - Current trade and industrial policies are not yet fully integrating the climate transition. When discussed, the private sector highlights a potential loss of competitiveness.

CS 2.3.33 MEXICO - Prioritising short-term policy objectives in energy investments, at the cost of obstructing future system change plays to the false trade-off between growth and zero-carbon future.

CS 2.3.34 KAZAKHSTAN - Coal production and use receives substantial subsidies. Such measures distort energy markets, undermine the competitiveness of renewables, and weaken incentives for diversification.

CS 2.3.35 INDONESIA - The JETP is one of the international solutions to support the decarbonization of the power sector, yet with political and social limits.

CS 2.3.36 EUROPEAN UNION - Current policies face the challenge of combining on one hand a fair and sustainable trade regulations supporting developing nations, and on the other hand industrial policies supporting industrial development in the European Union.

CS 2.3.37 SOUTH AFRICA - Green hydrogen direct reduction is slated to be the mainstay of a fully decarbonized global production route and South Africa has real competitive advantages for low-cost production. However, cooperation will be needed in both climate finance and technology transfer to enable large-scale 'green industrialisation' projects in the country.



KEY FINDING 2.4

Ensuring equitable transitions

Recognition of the close links between climate policy and social priorities has grown in the years following the Paris Agreement, alongside widespread acknowledgment that well-designed climate policies should support more equitable transitions.

In many countries, however, concerns about the social impacts of the climate transition — particularly the risk of increasing inequalities and poverty — have triggered resistance and, in some cases, slowed or reduced climate ambition. Progress in aligning social, economic, and climate objectives remains limited, making this one of the most pressing challenges ahead.

Analysis of national pathways to net zero shows that the transition entails several socio-economic challenges, primarily driven by price increases that can undermine the affordability of essential services (e.g., energy and transport) when short-term alternatives are lacking. Such price surges can occur even without climate policies; however, ambitious climate action, if not carefully managed, can accelerate price rises while restricting carbon use, particularly in energy. These effects disproportionately impact disadvantaged and vulnerable groups, who are more sensitive to cost fluctuations and risk losing access to basic services. For example, the increased penetration of renewables is expected to have an incremental impact on energy costs, which may have a negative effect on low and middle-income households' energy bills.

If not specifically addressed, these dynamics can significantly exacerbate inequalities and undermine the acceptability of the low-carbon transition. Experiences over the past decade illustrate the consequences of climate policies designed without sufficient attention to social concerns. For example, measures such as carbon pricing, low-emission zone regulations, or undifferentiated subsidies for low-carbon technologies, which affect all households equally, can create a risk of increasing inequalities (CS 2.4.1) and provoking social pushback against the transition (CS 2.4.2). But other policies such as those driving the transition in the building sectors towards more ener-

gy-efficient and low-carbon buildings can cause an increase in rental and selling prices. After the energy costs, a critical budget item is the housing price (CS 2.4.3).

Finally, in some cases, the absence or withdrawal of social public policies related to the most vulnerable can slow down the transition or significantly accelerate the deterioration of their income and quality of life (CS 2.4.4; CS 2.4.5).

Learning from these experiences, and aided by stronger capacity for anticipation, there is growing acknowledgement in strategic planning documents that climate policy packages must address risks to household living standards, particularly for low-income groups (CS 2.4.6). An emerging movement is also visible towards integrating socio-economic priorities at the core of climate strategies (CS 2.4.7; CS 2.4.8), for example by linking them to energy access, food security (CS 2.4.9), air pollution (CS 2.4.10), economic growth, employment (CS 2.4.11), and inequalities (CS 2.4.12).

In some countries, building clear political bridges between climate and socio-economic agendas has helped overcome barriers and secure ambitious climate policy packages by framing climate action as a national security imperative and linking it to health, social, and economic co-benefits (CS 2.4.13).

This strategic convergence has given rise to initial economic policies and measures aimed at managing, or even reducing, inequalities and poverty through the climate transition. For example, in the case of carbon taxes, which are difficult to differentiate socially, revenues can be an instrument to support the social objectives through adequate redistribution to support the most vulnerable households and offset the impact on their budgets (CS 2.4.14). Many other economic instruments, such as subsidies, taxes, and loans, can be socially differentiated to improve the affordability of zero-emission technologies and energy efficiency solutions while moderating potential impacts on household budgets and helping to reduce inequalities and poverty. In some countries, subsidies for purchasing elec-

tric vehicles are higher for low-income groups, or loans for energy efficiency improvements and zero-emission technologies are offered at lower interest rates for disadvantaged households. Another approach is to increase investment in solutions that primarily benefit low-income groups (CS 2.4.15), such as energy-efficient renovation of social housing or strengthening public transport to provide more frequent, reliable, comfortable and affordable services (CS 2.4.16, CS 2.4.17, CS 2.4.18).

While solutions exist to make the climate transition socially acceptable and supportive of reducing poverty and inequalities, convergence and integration remain largely at an early stage and incomplete (CS 2.4.19). The number of socially differentiated tariffs or redistributive economic policies is still limited, for example in the case of energy tariffs (CS 2.4.20).

Key Finding #4 - Case Studies

CS 2.4.1 GERMANY - Several recent climate policy instruments tend to increase inequalities. Socially differentiated policies will be essential to ensure that the costs of decarbonisation are distributed fairly and do not fall disproportionately on vulnerable groups.

CS 2.4.2 FRANCE - The unanticipated and unaddressed effects of carbon pricing and low-emission zones regulations for people's ability to move has been counterproductive for the climate transition.

CS 2.4.3 USA - Upgrading buildings towards zero energy buildings may cause an increase in rental prices, thus placing a financial burden on low and middle-income households.

CS 2.4.4 USA - Without social policies, the upfront cost of energy-efficient and electrified appliances in buildings prevents low and medium-income households from purchasing them.

CS 2.4.5 ARGENTINA - Public policies are crucial to face the socio-economic challenges of climate change and the current withdrawal of public funding for policies related to the most vulnerable is negative for the popular classes.

CS 2.4.6 DOMINICAN REPUBLIC - The convergence of climate and development priorities has been put in place in order to leverage climate strategies as a means to improve livelihoods, reduce inequalities, and modernize infrastructure.

CS 2.4.7 INDIA - India's LT-LEDS is based upon an economy-wide multiple objectives approach, including integrating dimensions of gender equity and inclusion of marginalized and vulnerable groups, that consciously seeks to move to a low-carbon development path.

CS 2.4.8 SOUTH AFRICA - South Africa remains one of the most unequal societies globally. This situation gives rise to an acute sense of risk in policy discussions related to low-carbon transition, leading to a better integration of the socio-economic challenges of the transition.

CS 2.4.9 CÔTE D'IVOIRE - Climate change negatively affects all aspects of Ivorian society, including food security, public health, and the income of populations, especially the most vulnerable living in rural areas and women. Integrating these social aspects is a priority.

CS 2.4.10 CHINA - Establishing a cross-sectoral policy approach centered on pollution reduction and carbon synergy has been key to tackling PM2.5 air pollution and consequences on health.

CS 2.4.11 NIGERIA - Nigeria's NDC and LT-LEDS promise positive growth in jobs, especially from smart agriculture. The newly launched National Employment Policy 2025 identifies renewable energy, waste-to-energy, and the "green economy" as priority sectors.

CS 2.4.12 MEXICO - Over the past decade, climate and environmental issues were framed as less urgent than reducing inequality and achieving energy self-sufficiency, but this situation is slowly changing through a better integration of both questions.

CS 2.4.13 USA - Framing climate action as a national security imperative and linking it to health, social and economic co-benefits attracted bipartisan support to pass ambitious climate policies better aligning development and climate agendas.

CS 2.4.14 USA - The funds generated by California's cap and trade carbon market are used to help state agencies implement programs to further reduce GHGs, with 35% of the revenue directed to disadvantaged and low-income communities.

CS 2.4.15 USA - States have also provided funding and incentives for EV charging infrastructure; for example the California Electric Vehicle Infrastructure Project offers incentives for public EV chargers, prioritizing low-income and disadvantaged communities.

CS 2.4.16 SENEGAL - The electric BRT is supporting the transition towards net-zero, while representing at the same time an important policy towards inclusive access for all.

CS 2.4.17 MEXICO - At the local level, several cities have advanced with innovative public transport projects, often in response to strong social demand.

CS 2.4.18 GUATEMALA - Enhancing public transit is a clear national priority to support social inclusion by providing affordable and energy-efficient mobility options for low-income populations.

CS 2.4.19 THAILAND - Social considerations are emerging in climate policies but remain incomplete.

CS 2.4.20 ARGENTINA - Energy tariffs relying on blanket subsidies continue to promote non energy-efficient and inequitable consumption patterns from middle and upper income segments, which do not contribute to the alignment of mitigation and social equity goals.

Recommendations

The findings from the assessment of a decade of national climate action summarized in the previous section lead to the following three recommendations, which highlight where efforts must now focus — both within national governance and policy frameworks, and through international processes such as the Global Stocktake (GST2). Strengthening action at national level in these areas would be enabled by structured exchanges among countries and enhanced efforts on international cooperation to support more ambitious and coordinated climate action.

- Countries must establish or strengthen national processes that bring together government, businesses, civil society, and local actors to shape climate action. These processes need to ensure diverse perspectives are represented — particularly economic and finance actors — while keeping a long-term vision at the heart of decision-making, which is one of the critical legal elements that the Paris Agreement provides to national policy contexts. Given the scale and specificity of the transformations required by the Paris Agreement, the establishment of cutting-edge governance structures specifically designed for these objectives is more likely to respond to coordination needs and addressing trade offs and inevitable political negotiation in a context of transformational change. Overlaps between different national governance structures are probably unavoidable and necessary to deal with complex, systemic issues like climate change but clarity of roles, mandates and responsibilities, as well as practical cooperation between the national institutions should be a priority to ensure effective governance. When competing priorities arise, such structures can help governments resolve tensions and support policies that prioritize climate goals. Science must play a central role in these processes, helping to design effective policies, compare different options and pathways and assess and monitor their implementation.

Building local ownership of data, models and scenarios in the national context is critical, so that national strategies are guided by country-driven and locally grounded evidence.

- The acceleration of national transitions in the next decade requires comprehensive policy packages that address multiple issues and policy coordination across a variety of policy actions including national development and investments plans. National policies must build enabling conditions for immediate emission reductions where technical options are available. They should also encourage the longer-term structural changes needed by providing targeted support for infrastructure development, accelerating the market readiness of new technical options, and encouraging behavioural change. In addition, public policies should play a critical role in accompanying structural economic and industrial shifts and strengthening synergies between climate and industrial and economic agendas. In a moment when all countries are developing or redeveloping their industrial policies, it would be very relevant to benchmark these industrial policies against required long term economy wide transformation objectives, such as those implied by decarbonization. By integrating climate ambition with industrial development, countries can accelerate decarbonization while fostering sustainable economic growth and resilience. Public policies also need to manage the socio-economic impacts of the transition, for which examples of well designed policy processes exist. To meet all these requirements consistently, the design of national policy packages grounded in a clear national strategic perspective.
- Strengthening international cooperation is critical to support greater national climate ambition, given that enabling conditions for transitions are also largely determined beyond national borders. To be effective, new

approaches must be adopted – ones that better place the needs and priorities of countries, as outlined in their national strategies, at the centre. Our analysis highlights three areas where specific improvements would be needed to better enable greater national ambition over the next decade. First, and in line with renewed discussions on country platforms, international finance mechanisms should ensure that financial flows effectively support countries' investment needs for technological innovation and infrastructure development, particularly in developing countries. Second, broad deployment of the most advanced, best available technologies across countries is a necessity to support country transitions; international processes must therefore be established to allow greater knowledge of existing technologies and connecting relevant countries together to support effective diffusion. Third, trade policy must evolve from a model based on competition to one that fosters collaboration; such renewed approach to the twin industrial and climate transitions would provide an opportunity to rethink approaches of partnerships and value sharing in value chains, unlocking the shared benefits of industrial transitions, and removing some of the structural barriers to national ambition in critical sectors.



Country chapters



A decade of national climate action: Stocktake and the Road Ahead

ARGENTINA DECARBONIZATION UNDER CONSTRAINT: CLIMATE ACTION AND POLICY DILEMMAS

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Argentina is a country with a population of around 46 million people, according to the 2022 Census. According to the World Bank, Argentina is classified as an upper middle-income country, whose GDP per capita (in current values) in 2023 was US\$14,187, placing it around the 60th position worldwide. Argentina has also been a member of G20 since 1999. The country has a total area of 3.7 MM km², of which 2.78 MM km² is continental. Of the continental territory, 47 MM hectares are covered by native forest, 1.3 MM hectares by cultivated forest, and 42.5 MM hectares by cropland.

In 2022, the country's global emissions were 401 MtCO₂e, with Energy representing 50% of total emissions and the Agriculture, Forestry, and Other Land Use (AFOLU) sector comprising 38%. Per capita emissions have remained close to 8 tCO₂ since 2015, significantly below the 12 tCO₂e/capita in 2007 (mainly due to a reduction in deforestation). This is above the Latin Americas average of about 5 tCO₂e/capita (CEPALSTAT, 2024). In 2023 Argentina's final energy consumption per capita was 50 GJ, while per capita electricity consumption has reached approximately 2,700 kWh, growing at an annual rate of 3.5%.

ROLE OF LONG-TERM

Argentina ratified the United Nations Framework Convention on Climate Change (UNFCCC) (December 7, 1993), and the Kyoto Protocol (June 20, 2001). In line with the ratification of these international agreements, it has developed many regulations and policy documents. The country submitted three national communications (1997, 2008, and 2015). The First Biennial Update Report was presented in 2017, the second in 2019, the third in 2021, and the fourth in 2023. Argentina presented its first Biennial Transparency Report (BTR)¹ in accordance with the PA's Enhanced Transparency Framework in 2024. The first NDC was submitted in 2016, the second in 2020, and in 2021 a revision of the target was submitted, establishing that «*Argentina's GHG emissions will not exceed, in 2030, 349 MM tons of CO₂e*»². In 2022, the country presented its LTS for 2050, approved by Resolution No. 218 of 2023. The NIR corresponding to 2022 (included in BTR1) shows net GHG emissions of 401 MM tons of CO₂e (using AR5 GWPs). Meanwhile, the

target-compatible indicator³ is 378 MM tons of CO₂e. For comparative purposes, the revised NDC2 includes an indicative GHG emissions value of 372 MM tons of CO₂e for the year 2025, which provides a reference for the progress of NDC implementation⁴.

At the sectoral level, there are various long-term studies & plans developed within government agencies or with the support of academic institutions and diverse think tanks, which demonstrate the existence of national capacity in the application of long-term planning methodologies. Indeed, Argentina is characterized by the existence of an interesting capacity in science and technology that supports the climate debate, as well as different think tanks that reflect the country's capacity. Nevertheless, many of these documents/strategies are modified when governments change. As a result, some strategies are not implemented as they were originally intended to be.

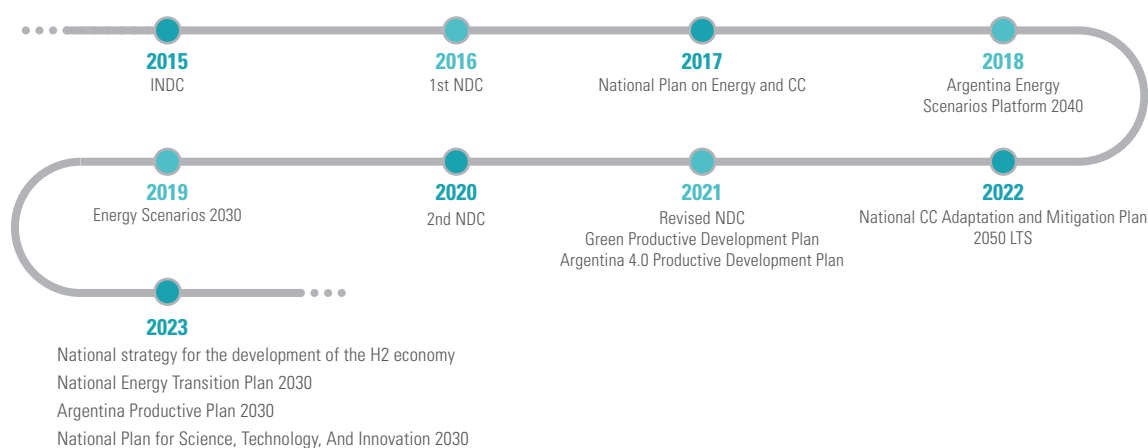
¹ The BTR1 reports mitigation measures in Energy, Agriculture, and Native Forests.

² Implementation period between January 1, 2021, and December 31, 2030

³ This indicator includes: (a) changes in common metrics (recalculating NIR 2022 with AR2 GWPs, which reduces total net emissions by 7.11%); (b) elimination of categories (26 estimates associated with 16 categories not considered in BUR3 were excluded from the previous value, leading to an additional reduction of 3.59%); and (c) methodological changes (by applying an adjustment factor based on a comparison of the implicit emission factor between BTR1 and BUR3, which results in a 5.2% increase in emissions adjusted using the two previous criteria).

⁴ These values correspond to the NIR 2022, prior to the change in government administration and the change in climate policy regarding Argentina's participation in international negotiations.

Figure 1. Some recent adaptation, mitigation and transition Strategies and Plans (2015-2023)



Source: Own elaboration.

In other words, there are several studies that incorporate a long-term perspective, but there certainly does not exist a consensus on long-term policy to take these long-term studies seriously as a basis. Instead, there are changes depending on the political cycle. **Figure 1** shows a summary of the main documents concerning plans, strategies, and reporting since the signing of the Paris Agreement.

Figure 2 shows the evolution of GHG emissions and GDP. It is important to highlight the “mitigation effect” of the economic stagnation since 2011, driven by the political and economic instability that characterized the last 15 years, compounded by the impact of the external crisis. The slowdown in emissions responds more to the stagnation in the level of activity rather than to the success of climate policies. GDP in 2023 (and estimates for 2024) are still below 2015 and 2017, with industrial GDP 8% lower than in 2015. It is straightforward that in the context of eventual growth in economic activity in the future, the current trend may not be sufficient to fulfill the commitment made for 2030.

SOME SLIGHT PROGRESS IN ENERGY AND LULUCF SECTORS

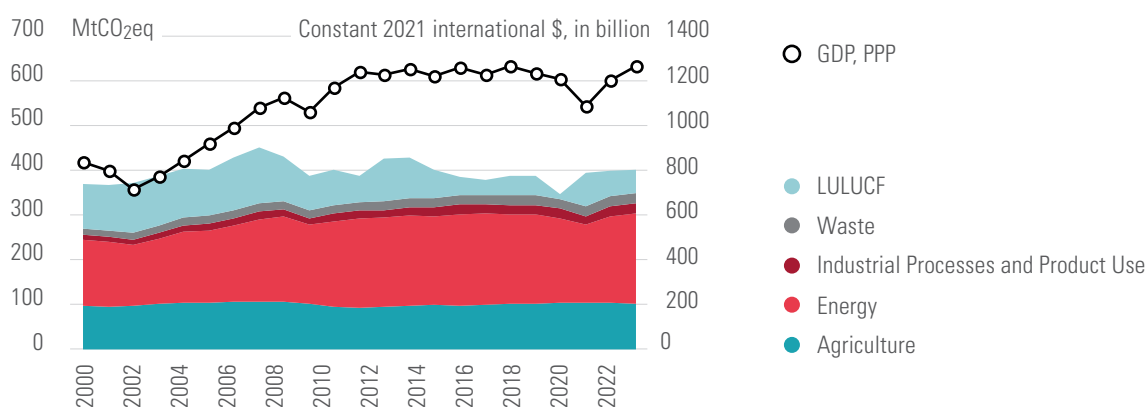
From the 1990s onwards and following ratification of the UNFCCC, environmental laws contributed to the institutionalization of the environmental

agenda with some progress: increase in public knowledge and professional training, capacity building at different governmental levels, reduction of deforestation, increased clean electricity generation, re-evaluation of hydropower potential, and increased involvement of stakeholders (civil society and industrial sector).

One of the most relevant milestones in the **energy sector** was setting a target for non-conventional renewable generation, consolidated with the Law 27,191 of 2015 and subsequent renewable energy biddings and plans with specific policy instruments (mainly economic). These instruments managed to increase the share of solar and wind generation (although with FITs set at values higher than the average economic cost of the national electricity system). Attempts were also made to increase distributed generation through regulatory actions, whose share is now increasing due to the recent decrease in PV costs and the progressive increase in electricity tariffs.

In 2023, the Secretary for Energy published the National Energy Transition Plan 2030, which establishes aspirational objectives and targets to 2030: 50% renewable generation; 1 GW of distributed generation capacity (3% of electricity demand for 2030); increase the high-voltage transmission system (additional capacity representing 35% of current one); promote energy efficiency measures to reduce consumption by 8%; nuclear development, with the completion

Figure 2. GHG emissions 2000-2022



Sources: Own elaboration based on Instituto Nacional de Estadística y Censos (INDEC).

of the Argentine-designed SMR as an intermediate step towards increasing the nuclear share of electricity generation; increase hydroelectric development (less than 50% of it has been developed); explore different strategies for green H₂ (blend with natural gas, and green ammonia to be used in electricity generation and exports); among others. In 2024, the National Strategy for the Development of the Hydrogen Economy was published, which proposes the production, use, and export of green, blue, and pink hydrogen.

In the case of the **land use, land-use change, and forestry sector (LULUCF)**, the Law on Minimum Standards for the Environmental Protection of Native Forests (2007), modified the national scenario for the protection of native forests and highlights problems and importance of the conservation of these ecosystems. In addition, it promoted a progressive decrease in the annual rate of deforestation in Argentina, between 2007 and 2015, stabilizing in the period 2016 to 2019, at which time the rate of deforestation increased again. In this sense, a report from the former Ministry of Environment of the Nation indicated that instruments implemented between 2007-2015 had a positive impact on the reduction of deforestation. The annual percentage of loss with respect to the total remaining (rate) in the country decreased from 0.94 % in 2007 to 0.34 % in 2015. However, since 2016 it increased to 0.42 in 2018 (about 180 thousand hectares).

BLOCKAGES FOR DECARBONIZATION & DEVELOPMENT PROCESS

However, while some policy progress was occurring and increasingly ambitious commitments were being announced, emissions did not decrease (as shown in **Figure 2**) but instead they increased between 1990-2007, before falling slightly by 2022. According to data from the latest BTR (2024), the change in the trend is explained by LULUCF, whose emissions decreased between 2012 and 2020 and then increased slightly. Meanwhile, emissions from industry and waste increased, while those from agriculture and

energy have remained roughly stable since 2010. This situation has been caused by several factors. Some authors identify as a key issue the disconnection between the agendas of different areas of government and the climate agenda, coupled with resistance from certain key stakeholders, which may have led to a lack of consistency between the commitments and the implemented policy guidelines (Aneise and Möhle, 2024). In this regard, while some progress can be highlighted in each of the key emitting sectors, energy, transport (within energy), LULUCF, and agriculture, there have been many blockages that have impacted negatively in the performance of the policies.

Many of these initiatives face effective resource constraints, mainly those that are difficult to partition and require high access costs. A concrete example is hydroelectric projects that have detailed feasibility studies with extensive information but have not obtained local or international financing for their deployment. The hydrogen strategy will very likely suffer the same fate, as it was directly designed to be driven by foreign direct investment. This confronts Argentina with the old dilemma of development versus enclave, as historically the conditions that must be set to attract foreign investment have always been very unfavorable for local development. Other barriers to further progress in the transition to a more decarbonized power sector have been the existence of badly designed and oriented energy subsidies (particularly in electricity) leading to inefficiencies and increased energy consumption while failing to reduce energy poverty, a policy that has been sustained with fewer differences over the last 3-4 administrations.

The **transport sector**, which accounts for 28% of emissions from the energy sector and 14% of global emissions, and whose emissions have increased significantly since 2010, is a very complex sector. For urban passenger transport, by 2021, public transport was only present in big / medium metropolitan areas, and its importance is declining rapidly in other urban centres. Most of the transport is motorized, with only Buenos Aires offering rail transport. In intercity passenger

transport, individual transport is also more relevant than public transport, with very low participation of rail transport. In the case of freight transport complexity increases due to Argentina's dependence on agricultural exports, which are transported 90% by trucks⁵, with rail accounting for less than 3% (Müller & Di Sbroiavacca, 2019). In **LULUCF**, despite the existence of the above-mentioned law, Argentina's native forests have been undergoing major changes because of land use changes for agricultural, forestry, urban and road activities. The advance of deforestation and conversion of these natural environments for such activities causes serious social, environmental and economic consequences, often irreversible (FARN, FVSA, 2024). The main problems were related to a decrease in the political relevance of the sector, reflected in a reduction in financial support and especially to economic interests. All these aspects resulted in increased deforestation. Vida Silvestre and FARN (2024) indicate that since 2014, the law has received less than 10% of its budget. They also point to a lack of defined goals and deficiencies in impact assessment. According to inventory information, the largest number of emissions corresponds to forest land converted to pasture and forest land converted to cropland. These aspects highlight recent weaknesses in regulatory enforcement, associated with the lack of control over ille-

gal deforestation. The close link between the economic interests of the agricultural sector and its impact on deforestation for land conversion to cropland is also evident. Meanwhile, **live-stock-related emissions** have shown greater stability. This behaviour is explained by the fact that the main driver for these emissions is the cattle population, which in Argentina has stabilized for many years at around 50 MM (SSAmb, 2024). Jointly, these two sources account for more than 90% of Argentina's AFOLU emissions since 1990.

LINK WITH NON-CLIMATE QUESTIONS

Directly related to the aspects mentioned below, there are some aspects of the Argentinean economy over the last decades closely related to, or having an impact on climate change aspects that need to be evaluated in the framework of climate commitments.

First, in the last decade (2015 to the present), Argentina has experienced a noticeable deterioration in income distribution, reflected in a significant drop in the share of national income received by workers and other lower-income sectors, in favour of the higher-income and more concentrated sectors of the economy. This behaviour results from the economic and social local policies applied in the last decade,

⁵ Less than 10% of transported products consists of industrial products; almost 70% is made up of primary goods.

Figure 3. GINI coefficient for per capita household income in Argentina

(3rd quarter of 2003 to 3rd quarter of 2022)



Source: Own elaboration based on Instituto Nacional de Estadística y Censos (INDEC).

together with exogenous factors, such as the impacts of the COVID-19 pandemic and the local consequences of the repercussions on international markets of the war in Europe. This can be observed in **Figure 3** that shows an increase in the Gini coefficient from 2015 to the present. The previously discussed trajectory of emissions in the last decade has been coupled neither to an improvement in the quality of life of the population, nor to greater equity in the distribution of the benefits of economic activity. For instance, emissions grew steadily between 1990 and 2002, despite stagnation, and subsequent sharp drop-in economic activity and population income between 1997 and 2002. Inequality in income distribution could exacerbate the challenges of the energy transition, affecting the most vulnerable low-income households, mainly indigenous communities and rural areas, who face energy poverty and greater difficulties in accessing basic services and sustainable energy sources and technologies.

Also, being Argentina a country heavily indebted in foreign currency, it is a significant challenge to meet external debt service obligations without compromising the availability of resources needed to address urgent adaptation needs and respond to potential damages caused by extreme weather events, climate variability, and climate change. Added to this is the obligation to fulfil the mitigation commitments established in its NDC, all within a context of shrinking domestic economic activity, structural adjustment measures, declining incomes, deteriorating living standards for middle and working classes, and an increasing shortage of foreign currency. These conditions can lead to a scenario in which, to meet climate objectives, other environmental aspects may be jeopardized due to intensified exploitation, private appropriation, and export of natural resources and common goods. In such a scenario, Argentina may face severe financing constraints that hinder investment in recovery and resilience.

Furthermore, public policies are crucial to face the challenges of climate change, and, in Argentina, there is a significant withdrawal of public fund-

ing for policies related to the most vulnerable sectors of the population, a reduction (interruption) of public investment in infrastructure (both expansion and maintenance), a drop in funds allocated to public health and education, and a strong deterioration of policies under Federal Government. This reduction in public investment and spending has the objective of reducing inflation, stabilizing the exchange rate and complying with the objectives committed with international financial organizations. It generates, amongst other effects, an increase in vulnerability to the consequences of extreme weather events and climate variability and change, as shown by the recent episodes of torrential rains and floods in various localities of the country, with the consequent material damage and human losses⁶. These episodes have happened in the context of deterioration of the population's real income and a general fall in consumption and quality of life of the popular classes. These macroeconomic policies that result in increasing inequality in income distribution can be considered as an example of «maladaptation» for facing climate change challenges. The IPCC defines "maladaptation" as those actions that may lead to increased risk of adverse climate-related outcomes, increased GHG emissions, increased or shifted vulnerability to climate change, more inequitable outcomes, or diminished welfare, now or in the future. "Maladaptation" is a process that results in increased vulnerability to climate variability and change, directly or indirectly, and/or significantly undermines current and future adaptive capacities or opportunities (Magnan, 2014).

In the case of Argentina, energy transition could lead to a significant increase in socio-environmental conflicts due to the intensification of exploitation of critical resources and inputs for

⁶ In March 2025, unusual torrential rains in a few hours affected the city of Bahía Blanca (500 km from the country's capital), resulting in 16 deaths and damage to local infrastructure, public services, and total losses in various sectors of the local economy. Monetary losses reached 500 billion pesos. This event was considered one of the worst storms in the city's history, quickly exceeding the amount of rain that normally falls throughout the entire year. A couple of months later, in May 2025, another storm caused flooding in Zárate and Campana, cities closer to the country's capital. In both cases, the cities were unprepared for the situation and did not receive sufficient funding for relief efforts afterward.

the development of low-carbon technologies (lithium, copper, silver, lanthanides, etc.) which are located in territories far from the main urban centres, ancestrally occupied by indigenous, extremely poor and vulnerable populations. The deepening of «extractivist» policies, which involve maximising the exploitation of these resources without paying attention to their impacts on those vulnerable populations, may affect their forms of subsistence and cultural practices and increase disparities in income and quality of life and generate more unfavourable conditions for adaptation.

Moreover, another important factor hindering the progress and effective implementation of mitigation measures within the country is the absence of a clear domestic policy that incorporates the principle of common but differentiated responsibilities (CBDR). This shortcoming is evident in the stark disparities in consumption and emission patterns between different segments of the population. In particular, the upper middle income class segment displays consumption habits comparable to, and in some cases even exceeding, developed countries, while the most vulnerable groups still face unmet basic material needs. Public policy has so far inadequately addressed the implementation of mechanisms that allocate climate responsibilities in line with each social group's economic capacity and consumption level. A clear example of this is the long-standing practice of generalized and bad oriented energy subsidies, promoting non-efficient and inequitable consumption patterns. In this sense, moving towards a more progressive energy tariff structure, consistent with the principle of CBDR, could make a significant contribution to aligning domestic policy with both mitigation goals and social equity objectives in the energy sector.

Finally, it is important to highlight a close relation between the energy sector and the Argentinean macroeconomy, with clear climate implications. The energy sector's structural problems have constituted a substantive barrier for the country's economic development, impacting the growth of GDP and, due to the high dependence of the

Argentinean economy on currency (especially US dollars), strengthening the external restriction (Basualdo, 2006; Barrera, 2021; Barrera et al., 2022). Indeed, the energy sector currently accounts for 5.6% of GDP and representing 9.4% of total exports in 2023 and it is expected to gain relevance in the coming years due to the exploitation of the Vaca Muerta formation, which may lead Argentina to a low-cost long-term reserves' horizon economy⁷. Developing just 50% of its potential could generate annual oil and gas exports valued at an estimated USD 34 billion (Arceo et al., 2022), representing approximately 41% of Argentina's total goods and services exports in 2023. There is a clear official consensus on the recognition of the economic relevance of the exploitation of fossil fuels. It is expected that the development of the natural gas complex may contribute not only to the global energy transition but also to increase exports, improving the performance of the Argentine economy in the generation of foreign currency and reducing external vulnerability. However, given that the global decarbonization process is underway and natural gas is clearly a contested market, the proper timing of export infrastructure investments face the risk of an international market with little room for export potential (Aneise and Möhle, 2024).

GOVERNANCE

According to Argentina's federal organization, environmental governance is distributed between the national government and the provinces. This distribution is determined by the National Constitution (amended in 1994) and the General Environmental Law (2002). This demands institutional and organizational structures at different levels and imposes challenges to the federal government to implement national policies, which must be approved by provinces, with "original ownership" of the natural resources in their territory and the right to exploit, distribute, and commercialize them.

⁷ Lifting costs in Vaca Muerta approached 1 USD per MMBtu in 2023

The two most relevant environmental laws are the General Environment Law, and Law on Minimum Requirements for Adaptation and Mitigation of Global Climate Change (the Climate Change Law of 2019). The former lists environmental policy and management instruments, including the institutionalization of the Federal Environment Council (COFEMA), responsible for coordination between the provinces and the federal government. The latter ratifies the international commitments and strengthens climate policy and planning, establishes minimum environmental protection budgets to guarantee policy instruments, stimulates the development of the National Climate Change Adaptation and Mitigation Plan, the Jurisdictional Climate Change Response Plans⁸, and institutionalizes the National Climate Change Cabinet (created in 2016) (NCCC).

In Argentina environmental and climate change policy is under the responsibility of the Secretariat of Environment and Sustainable Development, with many institutional changes in recent decades. It was a secretariat between 1990 and 2015. In 2015, it was granted the status of Ministry, in 2018 it became a secretariat again (under the General Secretariat of the Presidency). In 2019, it was once again classified as a Ministry. Finally, in 2024 it was turned into an Undersecretariat under the Secretariat of Tourism, Environment, and Sports. This clearly indicates that the Climate Governance hierarchy has been highly dependent on the incumbent national government.

Indeed, Argentinean environmental governance has been characterized in recent decades by significant changes, and climate policies have been subject to various fluctuations, some related by changes in foreign policy, which resulted in changes in negotiations. Nevertheless, since the ratification of the UNFCCC agreement, regardless of the political governing party, Argentina has always had a positive attitude and has shown an environmental international commitment. However, the recent arrival of President Milei is

very challenging for Argentine climate diplomacy. The environmental authority was highly downgraded, in line with the government's anti-globalist rhetoric, its denial of climate change, and its opposition to the 2030 Agenda (Aneise and Möhle, 2024). This was clear in 2024 when the Argentinean delegates at COP29 (Baku) were ordered to withdraw from negotiations and return home. This, nevertheless, is contradictory to the President's willing to include Argentina in OECD and other organizations of developed nations, which may claim for the inclusion of the climate agenda within national priorities.

It seems important to return to the previous climate position as a necessary condition to enable private and multilateral financing opportunities, which is a necessary (although not sufficient) condition to undergo a decarbonized path compatible with socioeconomic development.

INTERNATIONAL COOPERATION

In the past decade, Argentina has received substantial international funding (from multilateral organizations such as the IMF, the World Bank, and the IDB), to address critical short and medium-term macroeconomic crises, while financing allocated to projects with positive impact on climate action or sustainable development has been comparatively limited. The most notable case was the 2018 Stand-By Agreement with the IMF, amounting to USD 44.5 billion (the largest loan in the Fund's history, exceedingly even the statutory limits and conditions, and making Argentina responsible for 29% of the IMF's total outstanding credit). However, most of these funds did not aim to support sustainable economic development but primarily used to cover the sharp depletion of the Central Bank's reserves and to attempt to stabilize the financial system amid a severe financial and currency crisis triggered by the sudden outflow of short-term speculative capital following a period of carry-trade inflows. Despite this, the strategy notably failed to prevent a sharp devaluation and a significant increase in public debt, further undermin-

⁸ According to the federal organization, these plans must be developed by the provinces and the Autonomous City of Buenos Aires

ing the sustainability of the country's economic growth. In 2022, under a new government, Argentina renegotiated with the IMF through an Extended Fund Facility Agreement, to refinance the repayments of this previous loan. In contrast, resources allocated to climate change mitigation and adaptation, such as renewable energy, resilient infrastructure, or environmental protection, have been significantly more limited (BTR, 2024). There are many examples of situations where these mitigation and adaptation infrastructure investments have been neglected. Such is the case of multipurpose hydroelectric power plants or renewable energy parks, intended to promote local integration and development and strengthen disadvantaged areas. For instance, Chihuido I and II hydroelectric dam projects, which have remained on the public agenda for several decades and failed to get accessible international financing to make them viable. Another emblematic case has been the expansion of nuclear generation capacity, both aiming to increase its share in electricity power and to develop local capacities, including venturing into light water PWR reactors and further developing SMRs. A financial and construction agreement was about to be finalized with the Chinese government, but pressure from the US during the agreement with the IMF contributed to its paralysis. The hydroelectric plants under construction in the south of the country (on the Santa Cruz River in the heart of a sparsely populated area with great difficulties in promoting regional development), built with Chinese support and financing, also suffered multiple paralysis and redesigning processes aimed in budget cuts without solid technical arguments. These cases reveal a marked imbalance in the priorities of international cooperation with Argentina.

The critical link between external debt and low-carbon environmentally compatible development processes has been discussed throughout recent decades. Some authors stress the need for a redefinition of financial markets to support energy changes in the low- and medium-income countries, derisking investments in emerging countries, which usually receive low

credit ratings that generate high interest rates on loans (Dixon-Declève et al., 2022). Similarly, the recently published Jubilee Report argues that the debt crisis plaguing global financial system is also fueling a development crisis, as many developing countries now spend 10% or more of their tax revenues just on interest burdens, and they have nearly doubled in the past decade (Pontifical Academy of Social Sciences, 2025). To meet obligations to their external creditors, debt-distressed countries are sacrificing investments in education, healthcare, infrastructure, and climate resilience; therefore, unresolved debt crises have both short- and long-term adverse effects on development. There are local reasons for these debt crises: Governments borrowing too much at too high rates and failing to adopt capital accounting regulations to deter destabilizing speculative flows and prioritizing short term; and external reasons: creditors providing excessive financing, international financial institutions with lending policies enabling speculative behavior. As stressed by the literature it may be important that the international community can address the problems of the global financial architecture, and IFIs need to take stronger measures to prevent and resolve recurrent debt and development crises. This approach, accompanied by a local strategy that removes many of the barriers mentioned above and creates the necessary conditions, would be particularly important for Argentina to move forward on the path to fulfilling its climate commitments. It may probably require different alternatives of Blended Finance specially directed to energy industries, which may include soft loans (convenient rates & time-frames) and guaranteed funds (help overcome reluctance amongst private sector lenders or equity investors). All of this should be accompanied by domestic policies incorporating the concept of CBDR, reducing the inequalities and distortions in income, prices, and tariffs.

It is also worth critically questioning whether the very design of the PA contains a structural contradiction between the stated principle of CBDR and the way in which the NDCs effectively distribute the burden of climate action. The flexibility in

setting targets, combined with repeated deadline extensions and the lack of robust binding mechanisms, ultimately dilutes the responsibility of historically high-emitting countries, increasingly shifting the mitigation pressure onto emerging economies with later or more recent industrialization. As a result, the current framework risks reproducing structural asymmetries and perpetuating inequality throughout the climate transition, raising questions about the fairness and effectiveness of the international climate regime. Although the PA formally maintains the principle of CBDR, the way in which it is applied and discussed raises doubts about the real recognition of the historical responsibility of industrialized countries, mainly about the ambition of their NDCs and the fulfillment of their commitments on financing and technology transfer. Some of these industrialized countries, which, in accordance with their historical responsibility, should have taken the lead in implementing measures, signed the Kyoto Protocol but never ratified it or participated as Parties to it.

The Paris Agreement recognizes that all countries must take climate action, and in fact, all countries ultimately make some kind of commitment. However, the measures are limited by their national circumstances and their capacity for intervention.

REFERENCES

- Arceo, N., Bersten, L. y Wainer, A. (2022). La evolución del sector de hidrocarburos. Potencialidades de la matriz energética argentina. Fundar.
- Aneise, A. J.; Möhle, E. (2024). Argentina frente al cambio climático Un nuevo modelo de desarrollo para un mundo en transición. Fundar.
- Basualdo, E. (2006). Estudios de historia económica: desde mediados del siglo XX a la actualidad. Siglo XXI.
- Barrera, M. A. (2021). El complejo energético argentino y los impactos estructurales sobre el sector externo. Ensayos de Economía 31(59), 89-111.
- Barrera, M. A.; Sabbatella, I.; Serrani, E. (2022). Macroeconomic barriers to energy transition in peripheral countries: The case of Argentina Energy Policy 168 (2022) 113117
- Dixon-Declève, S., Gaffney, O., Ghosh, J., Randers, J., Rockström, J., Stoknes, P. E. (2022). Earth for All: A Survival Guide for Humanity. New Society Publishers
- EIA. 2013. *Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States* June 2013. U.S. Department of Energy.
- IPCC (2022). AR6 Annex II. Glossary. Cambridge University Press. New York.
- Magnan (2014). Avoiding maladaptation to climate change: towards guiding principles. *Surveys and Perspectives Integrating Environment and Society*. 7.1. 2014. Vol.7. Nº1. Perspectives.
- Ministerio de Ambiente y Desarrollo Sostenible. 2021. *Actualización de la meta de emisiones netas de Argentina al 2030*. Octubre 2021.
- Secretaría de Asuntos Económicos y Financieros Internacionales. 2023. *Marco de financiamiento sostenible de Argentina*. IF-2023-135932158-APN-SSCYGI#MEC.

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A decade of national climate action: Stocktake and the Road Ahead

BRAZIL

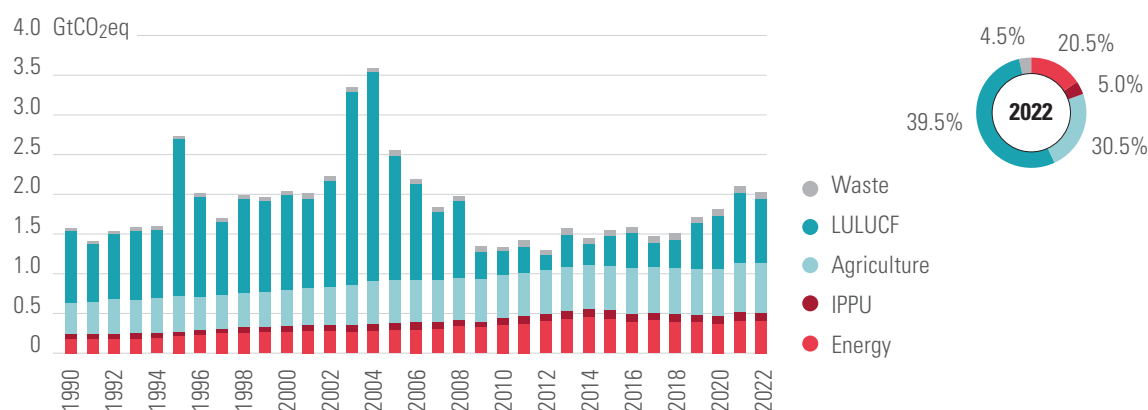
INSIGHTS ON CLIMATE ACTION TEN YEARS AFTER THE PARIS CLIMATE AGREEMENT

Emilio Lèbre La Rovere (UFRJ - COPPE)

KEY NUMBERS

Brazilian total GHG emissions were stagnant around 1.5 GtCO₂e/y in the period from 2015 to 2018, due to the economic recession hitting the country in the 2015-2020 period (GDP average annual change rate of – 1.0%). From 2019 to 2022, economy-wide GHG emissions have increased to reach a level of over 2 GtCO₂e/y, due to the sharp increase in annual deforestation rates promoted by the policies adopted during the Bolsonaro's Federal Government term. Since 2023, a new term under President Lula has managed to reduce deforestation again and therefore total GHG emissions in 2025 are estimated to be around 1.7 GtCO₂e. This level will thus be roughly 0.4 GtCO₂e above the NDC target of 1.32 GtCO₂e in 2025, with a 33% reduction of the 2005 level achieved against a 48% target.

The profile of GHG emissions per source and per sector is quite different from the prevailing pattern across the world, where CO₂ emissions from Energy account for the bulk of total GHG emissions. Instead, in Brazil, as of the latest official data available for 2022, AFOLU accounts for 70% of the total 2.0 GtCO₂e emissions: 39.5% from LULUCF and 30.5% from Agriculture, including methane from the enteric fermentation of livestock, which accounts for the bulk of

Figure 1. Net emissions by sector with LULUCF

Source: Brasil (MCTI), 2024.

agricultural GHG emissions. Energy-related emissions are 20.5% only, with the balance coming from IPPU with 5% and from Waste with 4.5% (see **Figure 1** above).

As a result of these national circumstances, nearly 40% of Brazilian total GHG emissions are released under the form of non-CO₂ gases. Another key country specificity is its clean electricity (88% of power generation from renewables) and the worldwide record high share (50%) of renewables in its overall energy mix (fossil fuels are limited to half of the domestic energy supply) (EPE/MME, 2025).

ROLE OF LONG-TERM

The Brazilian government submitted its first NDC to the UNFCCC in 2016. In its first update in 2020, an indicative target of achieving climate neutrality by 2060 was added. In the second update of March 2022, the target of achieving net-zero GHG emissions was anticipated to 2050. This target was confirmed in the third update of the first NDC in 2023 and in the 2nd NDC submitted to the UNFCCC during COP 29 in November 2024. These announcements were primarily political statements, as they were not based on a Long-term Low Emissions Development Strategy (LT-LEDS) designed through a stakeholder engagement process. The Govern-

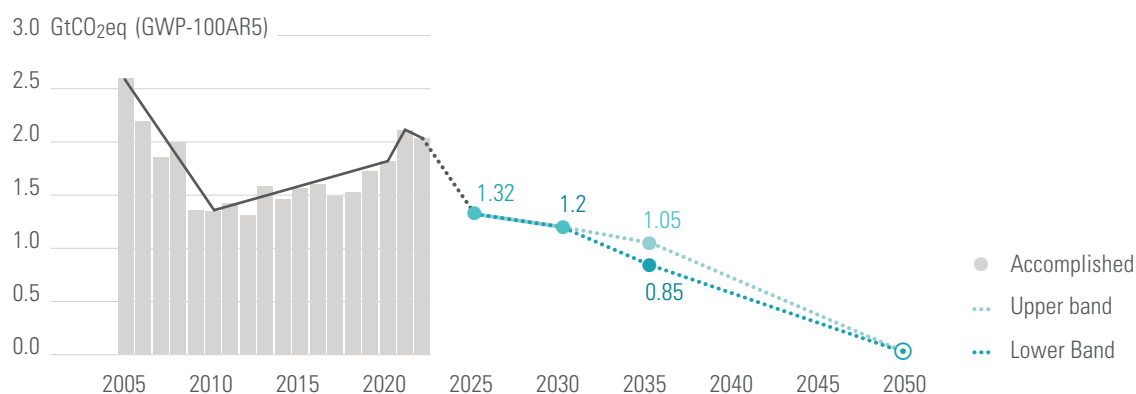
ment plans to submit its LT-LEDS to the UNFCCC by 2026, before the end of its term.

The NDCs were based on forward-looking scenarios, leading to GHG emissions targets of 1.2 GtCO₂e/y in 2030 and of 0.85-1.05 GtCO₂e/y in 2035 (announced at COP29). The recently completed preliminary version of seven Sectoral Mitigation Plans of the "Plano Clima Mitigação" (Brasil, 2025), presented to public consultation in July-August 2025, includes a list of sectorial policies and measures to achieve the targets up to 2035, but after that they simply connect the 2035 emissions endpoint to zero in 2050 by a linear pathway (see **Figure 2** below).

However, the Ministry of Finance made a remarkable effort of launching an Ecological Transformation Plan at COP 29 in November 2024, presenting a long-term vision for Brazilian development based on a green economy. It is axed in six priority dimensions: sustainable finance; enhanced technological innovation and productivity; bioeconomy and food production systems; energy transition; circular economy; and green infrastructure and adaptation. Besides, it has launched some key initiatives to mobilize long-term private domestic and international capital at lower cost to foster the transformation:

- the Brazilian Investment Platform (a portfolio of investment opportunities with a list of key information about low-carbon projects to attract the interest of potential private investors).

Figure 2. GHG Emissions Pathway and Current Brazilian NDC economy-wide Targets



Source: Brasil (2025).

- Eco Invest (a hedge fund to supply guarantees to foreign investors against future exchange rate devaluations affecting their revenues and profits in hard currency).
- the Brazilian Sustainable Taxonomy (to define criteria for green investments labelling).
- emission of sovereign green bonds (to attract investors and channel private capital to fund the transition in partnership with the government).
- and the Green Tax Reform (still underway), aiming at a tax increase on products harmful to the environment while supplying fiscal incentives to biofuels, low-carbon hydrogen, materials recycling and reuse.

A recent study has also pointed to the opportunities for Brazil tapping its competitive advantages in some promising industrial sectors within the context of a global energy transition: critical minerals; batteries and its components; hybrid and electrical vehicles; sustainable aviation fuels (SAF); wind power generators; low-carbon steel; and green fertilizers (Guerra et al, 2025).

Long-term analyses of GHG emission pathways are available from the studies developed by Centro Clima within the DDP initiative in the last ten years. From its main findings, a long-term decarbonization strategy emerges, including: a key role of stopping deforestation and increasing forest sinks; and progressively moderating the use of fossil fuels and increasing renewables in the energy mix, through enhanced use of solar

and wind energy, biofuels, electrical transportation, transmission lines and storage in batteries. Centro Clima results were quoted by the Ministry of Finance in the ETP - Ecological Transformation Plan¹ concerning its economic and social implications and helping to justify its targets: a GDP per capita growth of 10% by 2026 and of 100% up to 2050, and reduction of income inequalities leading to a Gini coefficient below 0.5 in 2026 and at most 0.4 in 2050.

A long-term perspective can point to a roadmap to enlighten the required short and medium-term policies, helping to make them more effective and consistent with the long-term vision of Brazilian society and economy. The ETP can be further detailed and periodically updated, guiding the adoption of a similar approach in sectorial planning (for example, the 2055 Plan under preparation by the Energy Planning Agency – EPE of the Ministry of Mines and Energy to update the previous 2050 Strategic Energy Plan). The LT-LEDS that the Government plans to submit to UNFCCC before the end of its term in 2026 can help catalyze these planning efforts and support the revision of future NDCs every five years.

¹ Brasil, Ministry of Finance (2024); Centro Clima's DDS = Deep Decarbonization Scenario results (La Rovere et al, 2021) are quoted in page 96: "by 2050, compared to 2020, a GDP growth over 90%, and real income of the 20% lower household income class 130% higher".

EXAMPLES OF CONCRETE PROGRESS

Since the signature of the Paris Agreement in 2015, the major progress in the implementation of a net-zero transition in Brazil was observed in the Energy sector. Thanks to the sharp cost decrease of solar PV and wind power, 75% of the annual power generation growth now comes from these two sources combined. Biofuels (ethanol and biodiesel) production and use has also significantly increased in this period. Surplus from two annual harvests of corn is now being used for producing billions of litres of ethanol, complementing a continuous increase of ethanol production from sugarcane. Biodiesel production and use has nearly tripled from 3.2 to 8.8 billion litres/year between 2014 and 2024. Brazil is also pioneering the production of advanced biofuels potentially leading to a substantial production of sustainable aviation and maritime fuels from sugar cane and corn in the medium term. In the last two years it is also worthwhile mentioning the increase of electrical vehicles sales and the launching of several green hydrogen production hubs (primarily directed to exports).

This progress was made possible in first place by international technological progress allowing for solar PV and wind power becoming competitive sources of power generation in Brazil, where low-cost large-scale hydropower is facing increasing difficulties to get environmental permits for greenfield projects. In the country's total power generation of 751 TWh in 2024, after hydropower contribution (56%), wind power (14%) was ranked second, and solar PV (9.5%) was third ranked. At the end of April 2025, 3.5 million rooftop PV systems (80% in the residential sector) with a total installed capacity of 39 GW were connected to the Brazilian grid.

Governmental policies have also contributed to some breakthroughs, including, among others: subsidies to rooftop PV cells, dedicated tendering of PV power plants, increasing mandates for ethanol and biodiesel blends in gasoline and diesel oil, caps to carbon intensity of fuels distributed for consumption (Renovabio program). The National

Development Bank – BNDES has supplied long-term funding to the wind industry conditional to an initial national content level of 60% (later adjusted) of the total investment, allowing to ensure domestic manufacturing of most wind power equipment and to reach an 85%-95% level today.

In the last three years there was also a confirmation of the effectiveness of a mix of command-and-control and economic instruments to reduce by 40% the annual deforestation rate in the Amazon, along the same lines of the strategy implemented in the period 2005-2012 that had achieved a remarkably sharp decline of Brazilian GHG emissions. The creation of the Amazon Fund, soon after COP15 in Copenhagen (in 2009) was also important to channel international cooperation funds to the protection of Amazon ecosystems.

There are around 50 million hectares² of public forests in the Amazon with no use defined yet. They were not transformed in Conservation Units and not regularly transferred to private operators yet. They are vulnerable to illegal occupation by farmers who occupy and claim them as private properties. Farmers clear the forest and have a few heads of cattle sparsely occupying the land (at low density and cost). This enables them to claim the ownership of the land at local land ownership registry offices³. This illegal occupation is one of the main emission drivers in the Amazon. The main challenge to reduce it is the enforcement of environmental laws and regulations in faraway remote access territories, especially in the Amazon. It is very hard for the Federal Government to control all these vast territories and in many case states' governors and local land ownership registry offices tolerate illegal practices by powerful vested interests of big producers. Command-and-control instruments to reduce deforestation of public land include joint

² 49.5 million hectares of continuous forests of 10 thousand hectares or more; adding smaller areas on the top of it, total forest surface reaches 56.5 million hectares (IPAM, 2024).

³ The Observatory of Public Forests has found that around 60% of non-designated public forests in the Amazon were claimed as private property, totaling more than 30 million hectares, according to the Rural Environmental Registry established by the Forest Code (IPAM, 2024).

operations of the Federal Environmental Agency (IBAMA) with the Federal Police and the Federal Road Police. The collaboration with the States' authorities and with the Justice institutions is key to ensure its effectiveness, seizing cattle and equipment in the illegally occupied land. New norms created by the new Federal Government in 2023 and 2024 are an effort to accelerate the destination of public forests, including partnerships with private capital to restore the original forest cover (see next section).

Economic policy tools were successfully used to reduce illegal deforestation in private properties. Most farmers and ranchers depend on public credit lines to get soft loans to fund agricultural activities before they can sell the production. The governmental Harvest Plan (Plano Safra) for 2025/2026 allocates around USD 90 billion to large properties and around 16 billion to small farmers (Talanoa Institute, 2025). The approval of these soft loans by public banks were made conditional to compliance with environmental laws and regulations, including the Forest Code (that defines the cap for clearing original vegetal cover in the private property according to the biome of location: 20% in the Amazon and 80% elsewhere). Many private agricultural properties have cleared more than allowed by law to increase the crop or ranching area. As access to the public credit privileged conditions is key to agricultural producers, this is a powerful incentive for compliance with the conservation of forest cover. There is scope to go much further: from 2025/26, a share of these credits will require compliance with the Climate Risk Agricultural Zoning established by the government, aiming to reduce losses caused by climate extreme events; and as of today, only 1.6% of the total credit allocated to large properties by the Harvest Plan will be used to promote low-carbon agricultural practices (Instituto Talanoa, 2025). Progressively increasing these shares in the future may represent a substantial economic incentive to the adoption of low-carbon and resilient agriculture practices.

The New Industry Brazil - NIB Plan, launched by the government in January 2024 (Brasil, MDIC,

2024), covering a period up to 2033, includes a decarbonization mission and a complementary infrastructure mission. It is an attempt to reverse the deindustrialization of the country in the last 40 years: the share of industry in its GDP has declined from 36% in 1985 to 13% in 2022. Besides launching public investments, soft loans, fiscal incentives and public/private partnerships, the NIB Plan has established targets for increasing the use of biofuels, incentives for the manufacturing of more sustainable cars and the development and production of low-carbon hydrogen. The target of increasing fertilizer production to meet 55% of domestic demand for reducing the dependency on fertilizer imports opens a good opportunity for a decentralized production of green fertilizers using solar and wind power. It has also created an Interministerial Commission of Public Procurement for Sustainable Development. Finally, the approval at the end of 2024 of a cap-and-trade system applicable to companies emitting more than 25 ktCO₂e/y (excepted in the agricultural sector) is also a major achievement to put the economy on track to a net-zero transition. Its full implementation is expected after 2030 only, but it will provide a carbon pricing tool indispensable for the net-zero transition. Moreover, it will also create a strong incentive to forest offsets that were included in the design of the domestic emissions trading system. The major enabler of the approval by the Congress of the bill creating the regulated carbon market in Brazil was the political support of the agricultural sector, looking for a scaling-up of the gains already obtained in the voluntary carbon market: farmers were strongly supportive of the bill expecting short-term additional revenues from forest restoration and REDD+ projects. Its powerful representation in both legislative houses has secured a double dividend from the creation of the domestic carbon market, as its GHG emissions were excluded from the scope of the caps but they will be able to sell GHG emissions offsets.

EXAMPLES OF CONCRETE BLOCKAGES

The Lula's government is committed to reach zero net annual deforestation in the country by 2030. However, in spite of the recent success in reducing it by 40% in the three years in the Amazon region, this target looks particularly challenging in view of the uprise in illegal small-scale gold mining and drug dealing activities. Therefore, the task is considerably more complex than in the period 2005-2012 and the enforcement of laws and regulations is even more pressing.

Brazilian new Forest Code approved by a federal law in 2012 requires the restoration of natural vegetal cover in medium and large-size private rural properties (80% of the original cover in the Amazon and 20% elsewhere). Around 20 million hectares of private land should be restored by farmers, allowing for a substantial increase of carbon removals. The initial deadline for compliance across the country was 2032. However, there were delays in the registry of rural properties and the deadline was suspended (cancelled) by the Bolsonaro government in 2019. Still today the enforcement of this law is very slow. This hampers a key feature of a net-zero transition in Brazil: the increase of carbon sinks by forestry. The main explanation for this blockage is once again the power of the agricultural lobby, particularly strong in the Northern region where state governors are generally supportive of farmers' interests. Farmers and ranchers simply don't want to pay for the restoration of the missing share of forest cover required to ensure compliance with the Forest Code in their properties.

Deforestation of non-destinated public land was also important (see the previous section). Only in 2025 the National Development Bank has started a program targeting the reforestation and afforestation of public land in the borders of the Amazon region (the "deforestation arch"), through tenders to private operators. This is a promising initiative, as it is estimated that the amount of public degraded land in the Amazon exceeds 60 million hectares, but still at a very incipient stage. Its main challenge is the diffi-

cult logistics and the lack of infrastructure for planting and forestry activities in general, under Amazonian conditions.

The lack of progress in the decarbonization of the beef production chain is another key blockage. It prevents the reduction of methane emissions from the enteric fermentation of cattle and of indirect CO₂ emissions from land use change (induced illegal deforestation) in the supply chain of meat production. Currently, there is no federal policies to moderate these emissions, but only voluntary and limited private commitments. The three main beef producers (JBS, Minerva and Marfrig) have GHG emissions reduction targets limited to their direct GHG emissions only. Except for Marfrig, they are committed to net-zero before 2040 or 2050, which may seem very ambitious. However, these targets include scope 1 emissions only. Most of GHG emissions induced by beef production are located along the supply chain. Indeed, their direct emissions occur in the final stage of the production (a few days before slaughtering) and are very low because the cattle spend most of its whole lifetime (around three years) in several different ranches of primary, secondary, and other suppliers. Tracking and reducing GHG emissions (both methane from enteric fermentation and CO₂ from induced illegal deforestation) is needed along the whole supply chain through the adoption of good practices: more intensive ranching with increased the current very low average number of heads of cattle per hectare (from 1.3 in 2020 to 2.0 by 2050); ensuring that pastureland is not result of illegal deforestation; and supplying appropriate feeding to reduce cattle lifetime from 37 months in 2020 to 27 months by 2050) (La Rovere et al, 2023). This would require the engagement of all suppliers, which is costly and difficult under Amazonian conditions of lack of infrastructure and tolerance of informal activities (e.g. cattle raising in pastureland obtained by illegal clearing of forest areas). The enforcement of a certification procedure to ensure the compliance with the European Union Deforestation Regulation – EUDR can represent a key transparency rule

if properly applied, which will remain a difficult challenge if local governments, farmers and largest beef producers remain opposed to it. In the power sector, a near-zero carbon electricity is hindered by a lack of sufficient storage capacity in the national grid. The solution to get there may come from the use of a combination of batteries and hydropower plants reservoirs', allowing to avoid the use of natural gas-fired thermopower plants.

However, the right decisions and investments have not been taken on time, and for short-term requirements, solar and mainly wind energy are victims of new rules of new rules enforced by the National Grid Operator (ONS) imposing a curtailment of wind and solar power dispatching, since a blackout in 2023. It was due to similar reasons as in the 2025 Iberian Peninsula blackout (high share of mini/micro decentralized PV systems preventing the stabilization of electrical grid fluctuations). The curtailments are mainly hitting wind farms in the Northeastern region (with the highest concentration of wind farms and PV power generation with large surplus transported to the Southeast region). Average curtailment last year was of 18 TWh from wind and solar power, representing 11% of the total potential generation from these sources, a considerable waste of energy and economic loss for the renewable power generators.

The situation will be aggravated in the future as solar and wind power show a fast-growing pathway: from 60 GW at the time of the 2023 blackout, the combined installed capacity of these two sources has grown to reach 90 GW in 2025, a 50% increase in less than two years. The Power Regulatory Agency (ANEEL) has thus to urgently implement measures to face this challenge: strengthen and enhance the transmission grid; compensate for the economic losses of solar and wind energy generators; adjust the regulations to control the power injection of decentralized PV systems in the grid; gradually reduce the subsidies to rooftop PV systems as they are already competitive; relax the constraints to increase the flexibility of hydropower plants in contributing to meet

peak load; negotiate a shift of thermopower generation out of the periods with highest availability of solar and wind energy; and accelerate the tender of power storage capacity (battery systems) scheduled for 2025 but delayed in favour of natural-gas fired thermopower reserve capacity.

Finally, there is a political pressure to increase the production of oil and gas, given its high potential to supply short-term revenues through the royalties distributed to neighbour areas (states and municipalities) in producing regions. It pushes for the opening of new fields in Brazilian Northern shore, with some fields dangerously close to fragile ecosystems in the Amazon River delta (see the next section).

COMPETING INTERESTS AROUND THE ROLE OF OIL & GAS PRODUCTION

Brazilian economy has become strongly dependent of the production and exports of commodities (iron ore, oil, meat and agricultural produce such as soybeans, meat, orange juice, sugar, coffee, cocoa, etc.) for ensuring public revenues and the hard currency required by the equilibrium of its balance of payments. Brazil has discovered huge oil resources in deep fields offshore (the so-called pre-salt layer) and plans to continue oil production growth up to 2050, with an increasingly important share directed to exports. Exports of oil products are key to Brazilian trade balance as they have already become the single highest item of Brazilian exports (overcoming the hard currency earnings from soybeans). The government's hope is that Brazilian oil will remain competitive even when global oil demand peak and decline, thanks to its low extraction cost and low CO₂ content. Technically, this does not prevent Brazilian economy to follow a decarbonization pathway, as GHG emissions from oil exploration and production can be kept at a relatively small level.

On the other hand, the considerable natural gas resources associated to oil production lead to

a strong political pressure from the Congress, state governors and economic interests to push for its use, allowing for short-term development benefits. They want the Federal Government to mandate the building of greenfield gas-fired thermopower plants (combined-cycle plants operating all year round to supply baseload power) in regions far away from the oil&gas fields. This would require huge investments in the building of infrastructure for natural gas storage and transport to these regions, making these projects far from cost-effective compared to other available power generation options in Brazil. Such natural gas projects would create a lock-in effect slowing the phase-down of fossil fuels required in the transition to a net-zero economy. Moreover, solar and wind power are not only cheaper but also obviously capable of generating electricity with a much lower carbon footprint.

Looking at the full picture in a broader view, climate change and a global transition towards net-zero will demand the building of a new Brazilian economy, based on new activities such as bioeconomy, a natural vocation of the country. The Ecological Transformation Plan recently launched by the Ministry of Finance supports this long-term vision (see section 1). The oil&gas sector might be a facilitator of this transformation, providing resources to progressively transition from oil to renewable economic activities. In 2024, only 0.16% of the oil rent is targeted to the environmental and climate-related activities (INESC, 2025). Technically, an initial step towards this goal would be the reduction of subsidies to fossil fuels (mostly to oil&gas, with less than 1% to coal) that have reached an amount of USD 16.4 billion in 2023 (51% to production and 49% to consumption) and shift them towards technologies required for the transition (subsidies to renewable energy were of 3.6 USD billion in 2023, 4.5 times less than for fossil fuels) (INESC, 2024). However, the Congress has approved in 2017 a law extending the duration of the subsidies to oil&gas production up to 2040.

Another key step would be the transformation of Petrobras in an Energy company. Up to 2022

Petrobras was lagging other oil majors in its diversification efforts. The new Federal Government started in 2023 has led to the nomination of a new Board of Directors of Petrobras, including an Energy Transition and Sustainability Director. However, by mid-2024 the President of Petrobras was changed and in May 2025 this Directorate (formerly occupied by an academic) was occupied by a natural gas expert. Brazilian President has been aligned to the official position of the Brazilian Minister of Energy that oil resources are necessary to fund the energy transition of the country. However, in practice Petrobras is focusing on oil&gas only, planning to accelerate the extraction of Brazilian oil resources until the last drop.

GOVERNANCE

An Interministerial Commission on Climate Change was created in 1999, mainly to serve as the DNA – Designated National Authority, required by UNFCCC to approve CDM – Clean Development Mechanism projects in Brazil. It was enlarged with new members and a wider scope of action in 2007, when it became a committee. In 2023, the new Federal Government restructured again the Committee, now formed by 20 ministries, 2 secretaries of the Presidency of the country and the Attorney General's Office (AGU), besides representatives from the Social Participation Chamber (including the National Forum on Climate Change – FBMC), a Chamber gathering subnational level entities and the Congress, and a Scientific Advisory Chamber. The general coordination of the elaboration of the National Mitigation Strategy was jointly ensured by the Civil House of the Presidency, the Ministry of Environment and the Ministry of Science and Technology. The seven Sectoral Mitigation Plans were elaborated and are to be implemented by the corresponding ministries: Energy, Industry, Transport, Agriculture, Nature Conservation (Land Use Change and Forestry, by the Ministry of Environment), Cities and Waste (including urban transport, by the Ministry of Cities).

A Management Body must be created before the end of 2026 to handle the Brazilian System of Emissions Trading (SBCE), according to the law approved in 2024 establishing the cap-and-trade system and its implementation phases in the next five years. A Secretary within the Ministry of Finance will serve as a temporary management body, as it is difficult to create new bodies under severe federal budget deficit constraints. The scope of its activities is very broad, according to the law, and its decision power regarding the approval of eligibility of credits to be traded internationally under Article 6 of the Paris Agreement, as well regarding REDD+ credits, will be shared with other existing governmental bodies.

The position of the country in international fora is established by the Ministry of Foreign Affairs, under the political guidance of the Presidency and the technical support of the ministries of Environment and Science and Technology.

The main challenges concern the coordination of the domestic governance split by many plans and policy tools across different ministries. There is a need for improving mainly three features of Brazilian climate change policy governance:

- the need for consistency with other public policies, such as the Pluriannual Plan (PPA), a four-year government investment plan, spelled by budget lines; the Growth Acceleration Plan (PAC), a selection of priority governmental programs with an implementation schedule closely monitored
- monitoring, reporting and verification (MRV), based on the establishment and follow-up of milestones, helping to ensure continuity in the implementation of climate change plans (and avoid the bad experience of some Mitigation Plans elaborated in 2010, such as Industry and Transport, that have not been translated into concrete actions)
- a stakeholder engagement process to ensure real public participation, beyond the formal processes of calls for on-line comments and suggestions to preliminary drafts of already finalized plans and programs; the Climate Plan (Plano Clima) elaboration has included an effort to organize hearings with selected

stakeholders about its sectoral mitigation and adaptation plans, but still lacking transparency about assumptions used in the analyses and the engagement of stakeholders at earlier stages of designing the plans.

Another proposal put forward by the Ministry of Environment would be to create a Federal Climate Change Agency, with the exact scope of its activities to be defined, but the idea has raised negative reactions, partly due to budget constraints but also to the political difficulties in having the required approval by Congress to create new governmental bodies. Anyway, there is a pressing need of defining at least the governing institution of the Brazilian emissions trading system, and initially it will be hosted by a special Secretariat at the Ministry of Finance.

INTERNATIONAL COOPERATION

International cooperation has been helpful to strengthen the capacity of the Brazilian public sector, sometimes facing difficulties to have sufficient staff due to budget constraints, through the supply of punctual services of consultants and temporary personnel.

Another dimension of international cooperation with Brazil is through direct investment of foreign companies in local manufacturing of green technology. A good example is the case of wind energy equipment manufacturers who installed production plants in Brazil, mainly after the financial crisis of 2008-2009 that caused the reduction of subsidies to renewables in developed countries. This has allowed wind park investments to be eligible to soft loans from the National Development Bank (BNDES) with at least 60% of the investment in each project being manufactured in Brazil, leading to a level of 85%-95% today. More recently, Chinese companies have contributed new business plans to the electrification of urban buses in Brazilian cities and this could offer avenues for future manufacturing of electric trucks. Additionally, in 2025 two Chinese manufacturers are starting electric cars production in Brazil.

International capital flows to fund low-carbon projects in Brazil have supported the transition to net-zero GHG emissions. One good example is the Amazon Fund, to avoid deforestation in the region with substantial grants reaching around 0.7 - 0.8 billion of dollars, mainly from Norway (90%) and Germany (8%). Going beyond grants, Brazil has launched in COP 28 the proposal of a Tropical Forests Fund Forever – TFFF to reward good performance of forest countries in reducing annual deforestation rates below a baseline related to the historical average. The funding would be raised through blended finance mechanisms, with benefits distributed to investors, countries, and communities in proportion to the protected forest area.

However, the amount of international capital flows is insufficient to complement domestic sources and fund the huge potential of economically viable investment opportunities in low-carbon and resilient projects in Brazil. The main gap to be filled to support the country's transition is to de-risk these projects to increase the mobilization of private capital and to reduce the cost of capital in Brazil, still higher today than in other emergent economies. Brazilian Ministry of Finance has already made an effort in this direction through the creation of the Brazilian investment platform (BIP) and of the hedging fund Eco Invest (see first section). International cooperation can contribute to its success by mobilizing institutional investors and other sources of private capital to tap opportunities not only of mitigation projects but also for "powershoring"⁴ based on the genuine competitive advantage of Brazil thanks to its natural resource's basis and clean energy mix. Another win-win international cooperation option would be the creation of Multi Sovereign Guarantee Mechanisms⁵, with contributions from triple A rated countries to de-risk investments in low-carbon projects in Brazil.

These contributions would respect public finance constraints as they would be spent in the case of project failures only (default rates are typically around 5-10%), while allowing a leverage of private capital of up to 10-20 times their amount.

Finally, there are two main fields of specific cooperation opportunities with the European Union:

- certification programs compatible with EUDR (see section 3): a variety of deforestation-free certification programmes exist internationally (e.g. RSPO, PNCCS and CBS/FSC in Brazil), and it is important to ensure consistency among programmes, certification methodologies and the underlying technology.
- how to make the design of the upcoming Brazilian emissions trading system compatible with the European Carbon-Based Adjustment Mechanism - CBAM? What mechanisms would be required to adjust the level of border taxes in Brazil and in the EU, at what disaggregation level, and what methodologies to use?

CONCLUSION

After a spectacular decrease of roughly 3.5 to 1.5 GtCO₂e/y between 2004 and 2014, Brazilian GHG emissions have been stable from 2015 to 2018, increased again to over 2 GtCO₂e/y from 2019 to 2022 and were brought back to 1.7 GtCO₂e/y in 2025. Command-and-control (enforcing environmental laws and regulations) and economic policy tools (public credit conditional to environmental constraints) have been crucial to cut down annual deforestation rates and resulting emissions from 2004 to 2012 and from 2023 to 2025. The energy policy adopted since the oil crisis in the early seventies (when Brazil was relying on imports for 83% of its domestic oil consumption) has allowed to build up renewable energy production (first hydro-power, bioethanol from sugarcane and wood/charcoal; and more recently, biodiesel, wind and solar energy). As of today, 50% of the overall energy mix is supplied by renewables and 88%

⁴ The concept of powershoring refers to the decentralization of production from developed countries to third countries near to consumption centers and supplying clean, safe, cheap and abundant energy, besides other advantages to attract industrial investments (see Arbache, J. and La Rovere, E. L., 2024).

⁵ As proposed by Hourcade et al, 2025.

of power generation is green. Therefore, Brazil is already halfway in its energy transition and able to embark in a GHG emissions declining pathway to reach climate neutrality by 2050. The Paris Agreement in Brazil was not the driver to reach this privileged situation but it has helped not only the government but mainly the private sector to believe that sooner or later the transition to climate neutrality is really going to happen. In the last ten years, many governmental regulations and corporate decarbonization targets have been announced not only by multinational but also by Brazilian companies.

However, Brazilian economy has become strongly dependent of the production and exports of commodities with the deindustrialisation trend of the last 40 years. The huge oil resources found in deep fields offshore have started to increase production from 1975 and today Brazil is a large oil exporter (exports of oil products have become essential to the equilibrium of Brazilian trade balance as the single largest provider of hard currency) who has recently joined OPEC+. The fast track to short-term prosperity is therefore to accelerate the production and exports of oil products, together with agricultural and mineral commodities. It is understandable that this development strategy receives strong political support from less developed regions (including the Amazon states) and powerful vested interests in all the country. Looking at the full picture in a broader view, the main challenge to reach a net-zero GHG emissions in Brazil is to overcome the conflict between short-term quick gains from exploiting non-renewable resources and the short, medium and long-term benefits of building a green economy based upon the vast potential of renewable resources of the country. The transition towards net-zero will demand the building of a new Brazilian economy, based on new activities such as bioeconomy, a natural vocation of the country. The Ministry of Finance made an important step to this end, launching an Ecological Transformation Plan at COP 29 in November 2024, presenting a long-term vision for Brazilian development based on a green economy.

It is essential to build not long a vision of this long-term sustainable economy but also elaborate its roadmap to enlighten the required short and medium-term policies and the benefits of following this pathway from today. The ETP can be further detailed and periodically updated, guiding the adoption of a similar approach in sectorial planning. The LT-LEDS that the Government plans to submit to UNFCCC before the end of its term in 2026 can help catalyze these planning efforts and support the revision of future NDCs every five years. These processes can help to give concreteness to the benefits provided by the Brazilian competitiveness within a global transition to net-zero and progressively increase the political support to a low emissions development strategy.

REFERENCES

- Arbache, J. and La Rovere, E. L., 2024; "Transição Energética e Powershoring na América Latina e Caribe: Oportunidades, Desafios e Políticas Públicas", CAF – Development Bank of Latin America and the Caribbean, 43 pages, March 2024.
- Brasil, 2024. Ministry of Science and Technology (MCTI); Biannual Transparency Report to the UNFCCC.
- Brasil, Ministry of Finance, 2024. New Brazil. Ecological Transformation Plan (Novo Brasil. Plano de Transformação Ecológica), 106 pages, in Portuguese. Brasília, November 2024.
- Brasil, Ministry of Development, Industry, Trade and Services – MDIC, 2024. Nova Indústria Brasil: missões, metas e ações da política industrial. Brasília, January 2024.
- Brasil, 2025. Climate Plan: National Mitigation Strategy (Plano Clima Mitigação). National Mitigation Strategy (Estratégia Nacional de Mitigação). 113 pages, preliminary version in Portuguese, Brasília, July 2025.
- EPE/MME – Empresa de Pesquisa Energéticas (Agency for Energy Planning), Ministério de Minas e Energia (Ministry of Mines and Energy); National Energy Balance, 2025.
- Guerra, A. M. et al, 2025. "New industrial policy for a new world: Seizing Brazil's opportunities in the energy transition", NZIPL - Net Zero Industrial Policy Laboratory, Johns Hopkins University, in Carta IEDI nº 1324, 15 August 2025.
- Hourcade et al, 2025; "A Climate Finance Initiative for COP 30: A Multi-sovereign Guarantee Mechanism for Accelerated Climate Investments in Developing Countries", Submission to the UNFCCC Baku to Belém Roadmap to 1.3 trillion.

- INESC – Instituto de Estudos Sócio-econômicos, 2024. "Subsídios às Fontes Fósseis e Renováveis (2022-2023)", 34 pages study, Brasília, September 2024.
- INESC – Instituto de Estudos Sócio-econômicos, 2025. "Renda do petróleo no Brasil", 35 pages technical note, Brasília, April 2025.
- Instituto Talanoa, 2025. "Safrá Bilionária, desafio climático. Plano Safrá 2025/2026", Política por Inteiro, Tá lá no gráfico, nº 41.
- IPAM – Instituto de Pesquisa Ambiental na Amazônia, 2024. Observatório de Florestas Públicas (Observatory of Public Forests). <https://deolhonasflorestaspublicas.org.br/>
- La Rovere, E. L.; Dubeux, C. B. S.; Wills, W. et al, 2021. Policy Lessons on Deep Decarbonization in large emerging economies, Brazil. 28 pages, Deep Decarbonization Pathways (DDP) Initiative – Centro Clima/COPPE/UFRJ and IDDRI. Paris.
- La Rovere, E. L.; Dubeux, C. B. S.; Wills, W. et al, 2023. A Decarbonization Strategy for a 2050 Net-zero Carbon Brazilian Economy: Enablers and Sectoral Mitigation Plans. DECARBOOST Project: Enabling conditions for investment in the transition to a low-carbon society in Latin-american countries. 269 pages. International Climate Initiative – IKI of the German Federal Government - Centro Clima/COPPE/UFRJ. Rio de Janeiro, February 2023.

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A decade of national climate action: Stocktake and the Road Ahead

CANADA AT A CLIMATE POLICY CROSSROADS: PETROSTATE OR ELECTROSTATE? A DDP UPDATE

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Canada is a complicated country, a federation where the federal and provincial governments have constitutionally distinct and strong powers, leading to joint custody over climate policy. The provinces have explicit powers over natural resources and energy production and processing, including electricity production and transmission, all of which are key to climate policy. The federal government, on the other hand, negotiates treaties, has broad taxation powers, controls inter-provincial and international trade, and has ultimate “peace order and good government” powers. It is key to funding almost all large energy and transport infrastructure as well. This might indicate the federal government has overriding authority over climate policy, but this not the case. The provinces are not passive, and fight for their rights passionately within their constitutional authority. For example, a foundational court case was fought between the petroleum rich provinces and the federal government all the way to Canada’s Supreme Court in 2021¹, where it was decided that while the federal government does have the power to impose policy to reduce greenhouse gas emissions, e.g., through carbon pricing, it does not have the power to control production of fossil fuels or any other resources. This ruling is core to understanding climate policy in Canada.

¹ Greenhouse Gas Pollution Pricing Act, 2021 SCC 11

The siloed nature of climate policy governance in Canada is reflected in the division of powers amongst federal ministries as well. Environment and Climate Change Canada champions climate policy, Natural Resources Canada plays a mixed role of championing efficiency and both low and high GHG intense energy forms, Finance Canada holds ultimate control of any policies that affect government revenues and taxation powers, while a multitude of other ministries intersect with federal climate policies on transport, infrastructure and housing. Each of the provinces have mirror ministries for each of the federal ministries, but usually of a far less funded character but specializing in the needs and resources of the province in question. Finally, at the bottom of the pile are the municipalities, some with economies larger than some provinces, that are governed by provincial acts but whose infrastructure are co-paid by the federal, provincial and municipal governments. This fragmented structure means all but the simplest climate policies become a matter of national negotiation and usually politics.

Another defining feature is Canada's location next to the United States. While the country has a distinct political tradition descending from Great Britain, France and the First Nations, its economy is intimately tied into that of the much larger US. Canada's economy is 67% traded², and the US is its largest trading partner, which makes it difficult to pursue climate policy that causes the costs of GHG intense goods and services to deviate strongly from US equivalents without experiencing strong real and perceived competitiveness issues.

Of absolute importance, the provinces differ in their endowments of fossil fuels. In a seminal article, Mitrova and Corbeau³ contrast the fundamental approaches to the clean energy transition of China and the European Union (EU) against those of the United States, Saudi Arabia, and Russia. The authors define China and the EU

as "Electrostates" and the US, Saudi Arabia and Russia as "Petrostates". To be an *Electrostate* or *Petrostate* is more than just about the current primary and final energy mixes. It's about how a country approaches its endowment of fossil fuels and potential clean energies and how it strategizes, invests and incentivizes its firms and workforce looking towards the global transformation to clean energy and low GHG emissions more broadly. Petrostates see fossil fuel reserves as an untapped resource that they should hurry up and exploit before it's too late. They are reluctant to transform, invest in the clean energy transformation hesitantly and slow it where they can. Electrostates, on the other hand, use fossil fuels a short to medium term complement for electrification while investing aggressively to transform. Petrostates see the clean energy transition as an impediment to growth and well-being, Electrostates the opposite.

It can be argued that Canada is caught squarely and internally between the philosophical viewpoint of a Petrostate and an Electrostate, leading to schizophrenic incoherence in development and maintenance of provincial and federal climate policy. On the one hand we have our "electro-provinces": Québec, British Columbia (BC) and Manitoba. All three have majority hydropower systems, so carbon pricing does not immediately lead to electricity price increases, and they can attract industry seeking low GHG electricity. Québec and BC have long been the strongest supporters of climate policy in Canada across several federal administrations and were some of the earliest adopters of carbon pricing in the world. Québec joined the California lead Western Climate Initiative cap and trade system, and BC pioneered the first use of direct carbon price excise taxation outside Scandinavia. They both have large investments in wind and or solar (despite their relatively poor solar resource) and are moving fast to electrify the transport fleet and buildings of all sizes using zero emissions vehicle standards and subsidies for heat pumps and regulations to reduce building gas hookups. Québec, the province with the least fossil fuel extraction, can now be called the province most

² <https://ourworldindata.org/grapher/trade-as-share-of-gdp>

³ "PetroStates and ElectroStates in a World Divided by Fossil Fuels and Clean Energy" <https://nationalinterest.org/blog/energy-world/petrostates-and-electrostates-in-a-world-divided-by-fossil-fuels-and-clean-energy>

committed to climate action across the economy, being the last province to maintain a form of consumer pricing.

The provinces of Alberta (AB) and Saskatchewan (SK), on the other hand, are mostly Petrostates, with large fossil fuel endowments that they view as key to their economic development and future prosperity. BC can be argued to also be an inconsistent "CoalState" based on its metallurgical coal exports from the Rockies to mainly Asia. Despite Alberta and Saskatchewan having the potential for high-quality wind and solar power, driven by strong oil and gas lobbying, North American right-wing politics and the social media sphere that reinforces it, they have enacted policies to slow and effectively stall low GHG investment of all kinds, and are pushing back against federal zero emissions vehicle mandates. Ontario (ON), by far the largest province by population and economic size, sits uneasily between them, with a large and potentially growable nuclear power industry but also a financial sector deeply invested in oil and gas, likely contributing to its historically inconsistent approach to climate policy. Manitoba and the four Atlantic provinces (New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador) also sit uneasily on the spectrum between electrostate and petrostate, with conflicting interests in both due to geography and resource endowments.

Canada's emissions have stabilized and are generally falling but progress is not in line with net-zero by mid-century and is sector and regionally dependent, reflecting the internal Petrostate and Electrostate tensions. Canada has a federal Net-Zero Emissions Accountability Act (C-12), to which the federal government is accountable through normal Westminster parliamentary processes and a required plan, progress report and compliance schedule, but there has been strong push back at the provincial level. For example, Saskatchewan now insists on refurbishing its coal plants, and Alberta has an put effective ban on wind and solar. Despite this, Canada's electricity generation has had a high penetration of renewable and low carbon energy (hydro and nuclear) for many decades, and overall emissions continue

to decline in the sector due to increasing wind and solar renewables and fuel switching to lower emission intensive generation. Building and transport emissions are falling despite increasing demand with new technology adoption including heat pumps, hybrid drive trains and electric vehicles. Non-fossil fuel industry emissions have also slowly steadily declined; however, progress has recently been stagnating due to a lack of capital investment. The only sector that has seen a dramatic increase in the share of national emissions is the oil and gas sector, rising from 19% in 1990 to its highest level of 30% of national emissions in 2023. Emissions per capita are more than three times higher than the national average in the Petrostate provinces (AB and SK), while the leading Electrostate province of Québec is nearly half the national average.

A large part of Canadian politics regarding climate policy can therefore be characterized as the Electrostate regions wanting to robustly embrace the global low carbon energy transition, with another arguing that commercially ready, investable, and sufficiently low risk solutions are not yet available, and the transition costs still outweigh the economic and social benefits. These Petrostate advocates argue that Canada's short to mid-term prosperity is dependent on continued and expanding coal, crude oil and gas (as LNG) sales. The petrostate-electrostate collision it is a very useful concept for understanding Canada's often schizophrenic climate ambition and successively missed targets and rising emissions until very recently.

This long run tension has played out through successive federal and provincial governments and across the main political parties. Despite the public impression of the Liberals as climate policy friendly and the Conservatives as focussed on fossil fuel development, Brian Mulroney's government signed the UNFCCC in 1992. Chretien's Liberals helped save the oil sands from bankruptcy in the mid-1990s when oil prices were low, specifically with the 1996 Accelerated Capital Cost Allowance reform. Under Harper in 2008 there was almost a requirement that all new oil sands be built with CCS, with the

aborted “Turning the Corner” policy package. Under Justin Trudeau and his cabinet, Canada’s hybrid general carbon levy and large final emitters carbon pricing system was enacted, as was the zero-emissions vehicle schedule (the *Electric Vehicle Availability Standard*), Clean Electricity Regulation and subsidies for transport and building electrification. Paradoxically, Trudeau’s government also attempted to placate Alberta by forcing through the TMX crude oil pipeline to the west coast, despite BC provincial, municipal and First Nation’s opposition. This did not however prevent Trudeau’s climate policies helping push the Conservatives fully into the Petrostate camp, leading to Pierre Poilievre’s “Axe the (Carbon) Tax” campaign. After faring progressively worse through two elections, and under the intense pressure of falling popularity, the Trudeau government, to protect votes in a critical region, then exempted home fuel oil heating in the Atlantic provinces (New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador) from the carbon levy. Basic low-income home heating across Canada could have been subsidized another way and the carbon pricing signal preserved, e.g., through the income tax system, but this was not explored. This exemption effectively spelled the end to the general carbon levy under Mark Carney after the very dramatic and close election of early 2025.

So, we have arrived at the present, summer 2025, with the general carbon levy zeroed except the provincial equivalent in Québec (which is tied to California’s cap and trade system), but the large final emitter carbon pricing system is still in place, partly because it has been identified as having the most impact⁴ and least political costs. The zero-emissions vehicle standard is under political threat, the more so for Canada’s auto industry being fully integrated with the US, e.g., the US federal government is removing its emissions standards, and Canada has matched US 100% tariffs on imports of inexpensive Chinese electric

vehicles. The chaotic Trump tariff war shambles on, killing investment through uncertainty and sucking all political attention from the room. Carney’s government is focussed on “nation building projects” which will likely involve some fossil fuel investments, but of what kind, we likely won’t know until the fall budget in probably early November. More broadly, Carney’s government has said nothing about where federal climate policy will go, leaving the public and investors guessing and frantically lobbying to protect their interests.

Rubbing a crystal ball in mid 2025, there are likely three ways this could go out past 2030 toward 2050, assuming the last decade of Chinese, EU and US developments continue, and the world keeps doggedly pursuing the goals of the Paris agreement despite current US resistance:

1) Petrostate rustbelt. Federal climate policy is deprioritized while any and all short to medium term exports of fossil fuels are emphasized. Climate policy ambition again falls to key Canadian Electropvinces such as Québec and to a lesser extent British Columbia, Manitoba, Ontario and the Maritimes. The zero-emission vehicle mandate dies or is delayed to the far future. Building and industrial electrification is spotty and municipal. Weak progress on climate policy means that Canada mostly slides into the Petrostate camp by default, with some crude oil, LNG and coal growth, which raises the Canadian dollar, making other greener investments more expensive to make. While short term investment confidence is high, stranded assets start to emerge as global crude oil, metallurgical coal and LNG demand begins to slow in the early 2030s. Several parts of Canada face unsettled “rustbelt” politics. Québec, which maintained its climate policies, and watches Chinese and EU developments on climate continue apace, is again chafing at the bit for independence.

2) Canada takes the “Norway”. While LNG, more oil sands, and some coal reserve replacement projects go ahead, they are done with best-in-class upstream production mitigation of fugitive methane and combustion controls. Aggressive electrification occurs where possible in the fossil

⁴ Canadian Climate Institute. (2024). Industrial carbon pricing the top driver of emissions reductions, new analysis shows. Canadian Climate Institute. <https://climateinstitute.ca/news/industrial-carbon-pricing-the-top-driver-of-emissions-reductions-new-analysis-shows/>

fuel extraction industry, and transport, buildings, and light and heavy industry more broadly. For example, Québec invests in green iron exports, which also helps Ontario decarbonize the steel sector.⁵ Some of the world's first CCS projects are in Alberta in the oil sands, chemical production (jet fuel and chemical feedstocks) and cement sectors. There is, however, no long run plan for a fossil fuel phase out unless driven by market forces, and stranded assets and communities emerge in the 2030s and 2040s, dragging on Canada's growth and politics. Decarbonisation reaches 60-80% by mid-century, without an unclear path to Electrostate status, and growth is structurally slowly than China's. Investment confidence is good but not great, and Canada evolves as a mid-tier nation.

3) Canada finds its own way from Petrostate to Electrostate. It is unrealistic to assume it will make an immediate U-turn on fossil fuel production, but a working majority of necessary parties at the federal, provincial and sectoral levels recognize the need to eventually end the use of unabated fossil fuels.⁶ There are multiple, multi-level federal, provincial, municipal, community and sector conversations on how to maximize benefits for all as the country decarbonizes, including a long term fossil fuel phase out. Some low upstream GHG intense fossil fuel investment occurs, perhaps in LNG targeted at Asian markets for chemical feedstocks and to support wind and solar electrification, and reinvestment and retirement of oil sands production is timed to meet demand as the global overall market falls, but there is a conscious transition to lower GHG intensity products.⁷ A clear path to Electrostate status emerges, including

for Alberta and Saskatchewan as key low GHG industrial nodes in North America, based on their high-quality wind, solar and CCS geology. In the longer term, stranded assets and impacts on communities are lower, investment confidence and growth are higher, and Canada emerges as a global net-zero development leader, having successfully navigated the transition.

The three articulated paths are narratives, stories if you will, but they are based on almost three decades of watching Canada and the globe evolve in the face of climate change and other pressures. Each are quite plausible, a matter of investment choices, preparation and directionality given over the next decade. Choosing an alternative path from the United States will be difficult, especially given Canada's economic interconnectedness with the US, but the need for this was already signalled in this year's tariff war with the current administration, which is bent on a full transformation of the US into a Petrostate. It will be up to Canadians to signal to their federal, provincial and municipal leaders which future they desire.

5 Algers, J., & Bataille, C. (2025). Strategic decarbonisation of the Canadian iron and steel industry. https://lucris.lub.lu.se/ws/portal-files/portal/218312088/Algers_Bataille_2025_Strategic_decarbonisation_ENG_CLEAN.pdf

6 Bataille, C., Al Khourdajie, A., de Coninck, H., de Kleijne, K., Nilsson, L. J., Bashmakov, I., Davis, S. J., & Fennell, P. S. (2025). Defining 'abated' fossil fuel and industrial process emissions. *Energy and Climate Change*, 6, 100203. <https://doi.org/10.1016/j.egycc.2025.100203> <https://www.sciencedirect.com/science/article/pii/S2666278725000303?via%3Dihub>

7 Bataille, C. (2022). Transition Pathways for Canada's Oil and Gas Sector (p. 14). Canadian Climate Institute. <https://climateinstitute.ca/wp-content/uploads/2022/07/Transition-pathways-oil-and-gas-sector.pdf>

A decade of national climate action: Stocktake and the Road Ahead

CHINA

LOW-CARBON TRANSITION TOWARD CARBON NEUTRALITY

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2025 marks ten years since the Paris Agreement was adopted and five years since its full implementation phase began. Over that decade China—now the world's largest producer of renewable-energy equipment, the holder of the largest single-sector carbon market, and a major actor in South–South cooperation—has shifted from pilot projects and policy experimentation to a system-wide low-carbon transition aligned with its dual-carbon goals: peaking CO₂ emissions before 2030 and achieving carbon-neutrality before 2060. This report takes stock of that transition in five tightly linked sections: first, it examines long-term targets and the “1 + N” policy architecture—showing how China's nationally determined contribution (NDC)¹ and long-term strategy (LT-LEDS)² translate political commitments into measurable action; Second, it assesses what has been “unlocked”, highlighting four pillars underlining China's low carbon transition: Emission Trading Scheme (ETS), renewables, new-energy vehicles, methane control which have moved from pilots to national roll-out. Third, it analyses key obstacles—coal exit,

¹ China. (2022). *Progress Report on the Implementation of China's Nationally Determined Contribution (2022)*. United Nations Framework Convention on Climate Change. Retrieved from <https://unfccc.int/sites/default/files/NDC/2022-11/%E4%B8%AD%E5%9B%BD%E8%90%BD%E5%AE%9E%E5%9B%BD%E5%AE%B6%E8%87%AA%E4%B8%BB%E8%B4%A1%E7%8C%AE%E8%B-F%9B%E5%B1%95%E6%8A%A5%E5%91%8A%202022.pdf>

² China. (2020). *China's Mid-Century Long-Term Low Greenhouse Gas Emission Development Strategy* (unofficial translation). United Nations Framework Convention on Climate Change. Retrieved from <https://unfccc.int/sites/default/files/resource/China%E2%80%99s%20Mid-Century%20Long-Term%20Low%20Greenhouse%20Gas%20Emission%20Development%20Strategy.pdf>

demand-side mitigation, and hard-to-abate industries—to explain why progress lags in these areas. Fourth, it explores non-climate linkages, detailing how pollution control, green finance and “new-quality productivity” embed climate objectives into China’s broader development agenda. Fifth, it considers governance and international cooperation, outlining the domestic climate-governance hierarchy and China’s dual role as both receiver and provider of international climate finance and capacity building.

CHINA’S NDC AND CARBON NEUTRALITY: TARGETS, PROGRESS, AND PATHWAY

China’s updated NDC (2021) anchors a dual long-term vision: peak CO₂ emissions before 2030 and strive for carbon neutrality before 2060. Quantitatively, the NDC commits to: cutting CO₂ intensity by over 65% from 2005 levels by 2030; raising non-fossil energy to around 25% of primary consumption; increasing forest stock by 6 billion m³ vs. 2005; and bringing wind and solar installed capacity to over 1,200 GW by 2030. Delivering these goals is organized through a “1+N” policy framework. The “1” is the high-level Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality, complemented by the Action Plan for Carbon Dioxide Peaking Before 2030 (ten key actions across energy, industry, transport, circular economy, technology, sinks, society, and region-specific peaking). The “N” comprises sectoral and provincial implementation plans. Together with the Mid-Century Long-Term Low GHG Emission Development Strategy submitted to the UNFCCC, this provides the strategic spine for the 2060 neutrality pathway. From the standpoint of institutions and implementation, China’s carbon-neutrality target is grounded in a robust vision for low-carbon transition rather than a mere political declaration: first, the long-term vision has been embedded in Five-Year Plans and dedicated action programs, with interim targets, pathways, and divisions of responsibility clearly specified; second, a set of

tracking indicators aligned with the NDC—such as carbon-intensity reduction, the share of non-fossil energy, installed wind and solar capacity, and forest stock—has been established, and progress is reported regularly in accordance with greenhouse-gas inventory and statistical protocols. China reports its progress towards NDC and carbon neutrality in its first Biennial Transparency Report: CO₂ from fuel combustion and industrial process and product use (IPPU) at 11.62 Gt in 2021; CO₂ intensity fell by 50.9% from 2005 levels by 2021; the share of non-fossil energy rose to 17.9% of total energy consumption in 2023; forest stock increased to 19.493 billion m³ in 2021—surpassing the NDC forest target ahead of schedule; and wind and solar capacity expanded to around 1,050 GW by the end of 2023 and reached about 1,280 GW by Oct-2024, overachieved the 2030 goal of 1,200 GW goal. In sum, China’s NDC sets measurable 2030 milestones while the “1+N” architecture and mid-century strategy translate the 2060 neutrality vision into an implementation roadmap across sectors and regions. Early results—on intensity reduction, carbon sinks, and renewable build-out—indicate momentum toward peaking this decade and laying the foundations for long-term decarbonization.

PROGRESS TO DATE: WHAT HAS BEEN “UNLOCKED” IN CHINA’S LOW-CARBON TRANSITION?

Over the past decade, China has moved from piloting to scaled, system-level implementation across several pillars of the low-carbon transition that now operate at national scope and are broadly aligned with the country’s peak-carbon and carbon-neutrality goals. Four areas stand out as effectively “unlocked”: (1) a national carbon market with clear rules and growing coverage; (2) rapid renewable-energy deployment underpinned by technology advances and supportive policy; (3) the new-energy vehicle (NEV) industry’s leap from policy-nurtured infancy to global competitiveness; and (4) the elevation of

methane governance from co-benefit control to a climate priority with an emerging MRV backbone; Together these pillars have shifted China from isolated initiatives to a more coherent portfolio of market instruments, industrial policy, and regulatory standards capable of delivering durable, economy-wide emissions outcomes.

National Carbon Market (ETS)³

China's carbon market evolved from concept to national institution in a little over a decade. Following early legal foundations on energy conservation and renewables, and experience gained through the Clean Development Mechanism, China launched seven sub-national ETS pilots (2013–2014). These pilots tested data accounting methods, allocation approaches, and compliance design—clarifying the balance between fairness and efficiency and building supervisory and penalty mechanisms that later informed national rules.

A national ETS was announced in 2017 and went live for trading in 2021, initially covering 2,162 power generators—about 4.5 Gt CO₂, making it the world's largest single-sector carbon market at launch. Regulatory scaffolding has since been strengthened through climate-related administrative rules, sectoral norms, and technical specifications governing accounting, reporting, verification (MRV), allocation, settlement, trading, and compliance. From 2021 to 2024, the carbon price rose steadily (ranging from roughly CNY 40–100/tCO₂, with an average of about CNY 66/tCO₂), placing it mid-range globally and signaling rising compliance stringency.

In 2025, the national ETS expanded beyond power to include cement, iron & steel, and aluminum smelting, and broadened its greenhouse-gas scope from CO₂ to also include CF₄ and C₂F₆. Coverage rose to an estimated ~8 Gt, exceeding 60% of national emissions. With the market now operating at multi-sector scale, the ETS has effectively “unlocked” a durable market signal that apportions reduction responsibility

among high-emitting industries, internalizes carbon costs to steer capital toward efficiency and cleaner processes, and reduces system-wide abatement costs compared with purely administrative controls. Continued progress, however, will depend on improvements in data quality, the tightening of allowances, broader sectoral inclusion, and the orderly linkage with complementary instruments.

Renewable Energy

China's renewable-energy expansion has moved from policy formulation to large-scale system deployment. A series of laws and plans established the initial framework, while the 2022 multi-agency plan and the 2024 guidance accelerated renewable substitution, clarified the relationship between traditional and new energy, emphasized supply–demand balance, and promoted technology R&D, innovative business models, and enabling market mechanisms.

Technological progress has provided the foundation for this scale-up. Hydropower has benefited from digital construction and intelligent O&M; wind power has advanced toward larger, smarter, and more diverse applications; solar has expanded manufacturing scale and achieved significant improvements in crystalline-silicon conversion efficiency, complemented by cost-reducing solar-thermal innovations; biomass power and heating technologies have been optimized; new energy storage technologies (including compressed-air systems) have developed rapidly; and hydrogen electrolysis equipment has scaled up quickly. These advances, combined with manufacturing scale, have contributed to sharp global LCOE declines—over 60% for wind and 80% for solar in the past decade.

Measured by outcomes, China now hosts the world's largest and fastest-growing renewable system. New energy capacity has ranked first globally for years, accounting for roughly 40% of worldwide additions; since 2020, annual new wind and solar capacity has repeatedly exceeded 100 GW, reaching about 290 GW in 2023 (~63% of global additions). By 2023, renewable installed capacity reached 1.516 TW (51.9% of national

³ Zhang X, Yu R, Karplus V J. The development of China's national carbon market: An overview[J]. *Energy and Climate Management*, 2025

power capacity). By May 2025, installed renewables had expanded to ~2.09 TW, more than double the end-2020 level. Power generation from renewables rose from ~1.41 to ~3.47 TWh (2015–2024), lifting the generation share from 24.2% to 34.4%. With policy support, grid integration improvements, and storage expansion, renewables have shifted from marginal additions to a core, steadily growing pillar of China's power system and a central enabler of the net-zero pathway.

Persistent challenges remain, particularly the intermittency of renewables. Addressing this issue will require accelerated development of storage technologies, the construction of smart grids, optimization of the power generation mix, and stronger regional power interconnections to cope with variability in renewable output and ensure secure and stable system operation. A further structural difficulty is the geographic mismatch between renewable generation potential, concentrated in resource-rich western regions, and electricity demand, centered in the industrialized and densely populated east. Although China is advancing ultra-high-voltage and long-distance transmission technologies to facilitate cross-regional power flows, the wider deployment of distributed solar and the strategic relocation of energy-intensive industries will also be essential.

New Energy Vehicles (NEVs)

China's new energy vehicle (NEV) industry has evolved from policy-incubated pilots into a globally competitive sector. Since 2007, standards and industrial plans have provided the framework for development. The 2012 plan emphasized pure-electric drive, set a 2020 sales target of at least 5 million cumulative units, and aimed to build internationally competitive capabilities in vehicles, batteries, and key components. Government support combined R&D programs, pilot fleets, and supply-chain cultivation, while firms advanced early and aggressively on product development, core technologies, and intelligent features.

Production and deployment outcomes have been transformative. Annual NEV output rose

from fewer than 10,000 units in 2011 to around 9.59 million in 2023, representing a compound annual growth rate of about 71 percent. In 2023 alone, 7.43 million NEVs were newly registered, accounting for roughly 30 percent of all new vehicle registrations, while the overall NEV stock reached approximately 20.4 million vehicles, or 6.1 percent of the national fleet. Charging and swapping infrastructure expanded in parallel, with about 3.39 million charging facilities added in 2023 (bringing the total to 8.60 million) and 3,567 battery-swap stations in operation⁴. Internationally, leading OEMs and battery suppliers extended overseas manufacturing footprints, Chinese firms ranked prominently in global NEV sales and battery installations, and NEV exports reached about 679,000 units in 2022, an increase of around 120 percent year on year.

The NEV ecosystem has now reached national scale. Vehicle platforms, battery supply chains, power electronics, software, and charging and swapping networks are jointly supported by industrial policy, market demand, and rapid technological iteration. This expansion has reduced dependence on niche pilots and enabled tangible oil-demand displacement, generated air-quality co-benefits, and facilitated integration with the power system through vehicle-grid coupling. At the same time, it has reinforced China's clean-technology manufacturing base and enhanced export competitiveness.

Methane Emission Control

China's methane policy began largely outside the climate frame—driven by safety, energy utilization, and pollutant control in coal, agriculture, and waste—but has since been elevated to a climate priority. A turning point came at COP26 with the China–U.S. Glasgow Declaration, followed by China's national methane action plan (2023)⁵—its first top-level blueprint for methane control—which assigned responsibilities across relevant ministries and sectors.

⁴ Responding to Climate Change: China's Policies and Actions (2024 Annual Report). Ministry of Ecology and Environment of the People's Republic of China. 2024.

⁵ Action Plan for Methane Emission Control. Ministry of Ecology and Environment of the People's Republic of China. 2023

Since then, China has been constructing a methane MRV architecture: building data-submission platforms, issuing sectoral submission guidelines (coal; oil & gas; waste treatment), piloting submissions, updating emission factors, and running demonstrations on coal-mine gas utilization and coalbed-methane development. It has advanced methodologies for voluntary methane reductions, revised landfill standards to co-control greenhouse gases and odor, and undertaken capacity-building programs for local regulators and firms.

Reported national methane emissions (including LULUCF) stabilized around 1.65–1.70 GtCO₂e (2014–2021) with slight fluctuations. While China remains the world's largest methane emitter due to its economic structure and energy mix, the institutionalization of methane governance—move to MRV, clearer standards, pilots that link safety, utilization, and climate goals—marks a shift from incidental co-benefits to purposeful climate management. What is now “unlocked” is the policy and technical pathway for measurable, reportable, and verifiable reductions, positioning methane as a near-term, high-impact lever in China's broader mitigation strategy.

KEY OBSTACLES OF CHINA'S NET-ZERO TRANSITION

Despite notable progress in China's net-zero transition, actual outcomes in several critical areas are still lagging behind policy targets. This section highlights three typical challenges—coal phase-out, demand-side mitigation, and decarbonization of energy-intensive industries—and analyzes the structural constraints and mechanisms behind them.

The coal phase-out challenge

Transitioning away from coal-fired power is central for China to achieve carbon neutrality. To align with the 2°C and 1.5°C targets, coal's share in energy consumption must fall to less than 10% by 2050. Since 2015, China has introduced policies to improve coal-power efficiency, including

“large-for-small replacement” (replacing small, inefficient units with larger, high-efficiency ones), “capacity-neutral replacement”, and the accelerated retirement of outdated units. The role of coal-power plants has also been transformed from power generators to flexible power sources. Despite these, coal still accounts for 53.2% of energy consumption in 2024, down from 63.8% in 2015. In fact, 2024 marked a record high in coal power expansion since 2015, with 94.5 GW of new capacity started and 3.3 GW of previously suspended projects resumed⁶. This trend runs counter to the country's net-zero goals.

The persistence of coal power is primarily due to its triple role in China's energy system. First, coal ensures reliable supply amid growing electricity demand. Second, it compensates for the intermittency of renewables in the absence of sufficient flexible generation resources. Third, especially in northern China, coal remains essential for centralized winter heating. These factors combine to make coal power functionally irreplaceable in the short term, reinforcing its continued expansion despite decarbonization goals.

In addition to these functional dependencies, China faces three structural barriers that complicate its coal transition. One major barrier is regional economic reliance on coal, particularly in provinces such as Shanxi, Inner Mongolia, and Shandong, where coal power forms the backbone of local economies and employment. Phase-out could trigger economic decline, prompting resistance from local authorities. A second challenge concerns employment and just transition pressures. Capacity reductions risk mass layoffs. Coal companies face steep resettlement costs, and displaced workers—often single-skilled—struggle to find new employment. A third constraint is the so-called “lock-in effect” of coal assets. China operates the world's youngest and most efficient coal fleet. Premature retirement of these assets could lead to major financial risks, including stranded investments and credit defaults.

A secure transition away from coal power requires

⁶ Qi Q, Shearer C. When Coal Won't Step Aside: The Challenge of Scaling Clean Energy in China[R]. Centre for Research on Energy and Clean Air & Global Energy Monitor, 2025.

a fundamental shift in its revenue model. Rather than relying primarily on electricity sales, coal plants need to earn income by providing backup capacity and flexibility to support the rapid growth of renewables, while their overall generation gradually declines. Introducing a capacity payment has been one policy instrument to support this shift, enabling plants that undergo technical upgrades to serve as reserve providers instead of baseload generators. Looking ahead, multiple measures will be needed to ensure an orderly phase-out. These include strengthening incentives in the capacity market and linking them with carbon pricing to create clear economic drivers for exit, developing financial tools to restructure coal assets and support worker transitions, and upgrading heating systems so that electric or renewable alternatives can gradually replace the heat currently supplied by coal. Together, these steps can guide coal's role toward backup support in the near term and create the conditions for its safe and sustainable retirement.

Demand-side emission reduction

Demand-side mitigation focuses on three primary pathways: shifting production and consumption patterns, improving technical efficiency, and substituting fuels. Compared to supply-side measures, these approaches offer greater mitigation potential, lower costs, and stronger co-benefits. Scenario analyses suggest that demand-side strategies are critical to peaking final energy consumption by 2030. However, policy progress in this area remains limited. For example, national electricity consumption rose from 5.55 TWh in 2015 to 9.85 TWh in 2025—an increase of nearly 80%. With continued electrification and the rise of green hydrogen, electricity demand is projected to grow further. By 2050, electricity use is expected to rise by 80% under a 2°C scenario and by 95% under a 1.5°C scenario, relative to 2020⁷.

Despite this, China's power system lacks a robust demand response mechanism due to prolonged government-controlled pricing. Tariff signals remain weak, peak-to-valley price differentials are narrow, and user incentives to shift consumption are limited. As a result, demand-side flexibility is insufficient to accommodate large-scale renewable energy integration. Industry accounts for over 60% of electricity consumption, yet the proportion of responsive loads remains well below the 3–5% target set by the National Development and Reform Commission (NDRC). On the residential side, peak-valley pricing pilots are limited to 14 provinces, with pricing spreads too small to motivate behavioral change. Emerging flexible loads such as electric vehicles and data centers have yet to be effectively aggregated, with technical feasibility outpacing policy implementation. Additionally, public awareness and participation in energy-saving and emission-reduction efforts remain weak. There is a clear disconnect between consumer engagement strategies and pricing mechanisms, undermining demand-side momentum and limiting policy effectiveness.

Decarbonization of energy-intensive industries

China's energy-intensive industries—such as iron and steel, cement, and aluminum—account for over 50% of global production and consumption. These sectors emit approximately 3 billion tons of CO₂-equivalent annually, representing over 20% of China's total emissions. Under a carbon neutrality scenario, the iron and steel industry would need to reduce emissions from nearly 1.6 billion tons in 2020 to around 150 million tons by 2060. Similarly, the cement sector must cut emissions from 1.3 billion tons to 120 million tons over the same period. These targets present a considerable decarbonization challenge. Although these industries have been designated as priority areas within China's "1 + N" policy framework—and are slated for inclusion in the national carbon market by 2025—they still face major structural obstacles to deep decarbonization.

⁷ He, J., Li, Z., Zhang, X., Wang, H., Dong, W., Du, E., Chang, S., Ou, X., Guo, S., Tian, Z., Gu, A., Teng, F., Hu, B., Yang, X., Chen, S., Yao, M., Yuan, Z., Zhou, L., Zhao, X., ... Zhang, D. (2022). Towards carbon neutrality: A study on China's long-term low-carbon transition pathways and strategies. ENVIRONMENTAL SCIENCE AND ECOTECHNOLOGY, 9. <https://doi.org/10.1016/j.ese.2021.100134>

One core barrier lies in China's resource structure, which remains heavily coal-dependent. Iron and steel production is still dominated by the blast furnace–basic oxygen furnace (BF–BOF) route, which has nearly triple the carbon intensity of the electric arc furnace (EAF) route. Over 95% of heat used in cement production is derived from coal. In the chemical sector, coal accounts for roughly 80% of feedstock used in synthetic ammonia and methanol, further entrenching the system's high-carbon profile⁸. In addition to energy constraints, these industries face the dual challenge of reducing process-related emissions and substituting energy sources. For example, two-thirds of emissions in cement production stem from limestone decomposition, which cannot be addressed through energy substitution alone. Scalable alternative processes are not yet commercially viable, and deep decarbonization depends on emerging technologies such as alternative materials and carbon capture and storage (CCS), which remain in early stages of development. Furthermore, industrial transformation is also constrained by the long life cycles of capital assets, typically ranging from 30 to 40 years. Accelerated decarbonization risks stranding existing investments. Meanwhile, green industrial products continue to carry a cost premium, limiting market demand and dampening firms' incentives to invest in low-carbon upgrades. In sum, decarbonizing energy-intensive industries hinges on overcoming technological uncertainty, high investment requirements, and limited short-term market signals.

Overall, the challenges of phasing out coal, advancing demand-side mitigation, and transforming energy-intensive industries reflect deeper structural barriers in China's net-zero transition. These sectors are shaped by competing policy objectives, entrenched path dependencies, and institutional constraints. Addressing these obstacles requires a coordinated approach that integrates energy security, economic development,

and climate goals—supported by optimized policy frameworks and accelerated technological innovation in decarbonization pathways.

LINKAGES WITH NON-CLIMATE ISSUES

In China, climate policy has evolved beyond the traditional confines of environmental protection and is now closely integrated with broader national priorities, including economic development, financial reform, and industrial upgrading. A growing number of government agencies and market actors are actively engaged in climate-related policymaking, facilitating the incorporation of climate goals into mainstream development strategies. This section examines how climate objectives are substantively embedded in the environmental, financial, and economic spheres, using the cases of air pollution control, green finance, and new quality productivity as key examples.

Pollution reduction and carbon synergies

China has long recognized the need to link climate action with air pollution control, establishing a cross-sectoral policy approach centered on “pollution reduction and carbon synergy.” Greenhouse gases (GHGs) and conventional air pollutants often share common emission sources and control pathways. This overlap is particularly relevant in developing economies, where decarbonization coincides with ongoing industrialization and urbanization, making coordinated action more effective. In China, the synergistic approach first emerged through the urgent need to tackle PM_{2.5} air pollution. Government measures targeting coal consumption and promoting structural energy shifts have not only improved air quality but also contributed significantly to reducing carbon intensity. These co-benefits have since become a cornerstone of national climate policy. Policy integration has continued to deepen through the development of a unified accounting framework for GHGs and air pollutants,

⁸ Li S, Li W, Lu S, et al. Financing the low-carbon transition in heavy industry[R]. Rocky Mountain Institute, 2023.

the incorporation of carbon metrics into environmental impact assessments, and the launch of synergistic governance pilots at both the park and city levels. Between 2013 and 2023, national emissions of sulfur dioxide and nitrogen oxides declined by more than 85% and 60%, respectively, while carbon intensity dropped by over 34%. These results highlight the effectiveness of coordinated environmental and climate policy. The MEE has emerged as a key driver of climate governance, using air quality management as a central policy instrument. Meanwhile, the NDRC, Ministry of Finance, and National Energy Administration are increasingly engaged in climate action through industrial regulation, fiscal mechanisms, and the promotion of clean energy deployment.

Green finance

Green finance is a key component of China's financial supply-side structural reform and a vital tool for addressing climate crisis while guiding the green transformation of the economy. As climate risks increasingly affect the financial system—through physical damage, transition pressures, and asset revaluation—climate considerations have been integrated into financial regulation and macroeconomic stability frameworks. Green finance plays a central role by enabling risk mitigation and directing capital flows toward sustainable development. China has prioritized green finance at the policy level. In 2016, the People's Bank of China, along with the Ministry of Finance, the NDRC, the MEE, and seven other agencies, jointly issued *the Guidelines for Establishing the Green Financial System*. The document called for mobilizing social capital toward green industries through instruments such as green credit, green bonds, and green insurance, while restricting financing for high-pollution, high-carbon projects. Since then, the regulatory framework has steadily evolved. A green finance classification system has been established, and financial tools such as carbon credits and transition finance mechanisms have continued to expand. As a result, China's green finance market has grown rapidly.

By the end of 2023, the balance of domestic and foreign currency green loans in China reached 30.08 trillion yuan, the highest in the world, with a significantly lower non-performing loan ratio than general credit. Green bond issuance exceeded 5,479 bonds, totaling 7.78 trillion yuan, making China the world's largest green bond market, surpassing the United States. Financial instruments such as green equity indices, green insurance products, and carbon emissions trading continue to diversify, while investor preferences for environmental sustainability are driving further market expansion. China's green financial system has taken shape, with active participation from central banks, regulatory agencies, securities institutions, and investment entities. Overall, policy momentum remains strong. Nonetheless, key challenges remain. These include the need to standardize green project classification, improve environmental information disclosure mechanisms, and enhance the capacity to price carbon-related risks. Addressing these gaps will be essential to ensuring the long-term credibility and effectiveness of green finance in China.

New quality productivity

In China, climate goals are increasingly driving the emergence of new quality productivity as a core engine of economic transformation. First introduced by President Xi Jinping at the Central Economic Work Conference in late 2023, the concept emphasizes innovation-driven, high-quality development, with a clear declaration that “new quality productivity is, by nature, green productivity.” The advancement of green sectors such as new energy, new materials, and green manufacturing is not only a strategy for climate mitigation but also a critical engine for future economic growth. Climate action and industrial upgrading reinforce each other through improvements across supply chains, investment, trade, and employment. Modeling studies show that China's GDP continues to grow steadily under multiple transition scenarios from 2020 to 2050. In a low-carbon pathway, roughly 8 million jobs are expected

to be lost in coal power and related supply chains, yet about 15 million jobs are created in non-fossil energy, generating a net gain of around 7 million. More ambitious climate targets under 1.5°C and 2°C scenarios also drive significantly higher investment demand, with total investment projected to reach between RMB 70.51 trillion and 174.38 trillion by 2050—underscoring the scale of financial commitments required.

The scale of growth in green industries already reflects this momentum. Since 2013, China's installed wind power capacity has increased sixfold, while photovoltaic capacity has grown more than 180-fold. By the end of 2024, wind power reached approximately 510 GW and solar power about 840 GW, with utilization rates consistently above 95%. New energy vehicle ownership rose from 580 thousand in 2015 to 31.4 million in 2024, representing 8.9% of all vehicles. Electric vehicles, lithium batteries, and photovoltaic modules, known as the “new three” export categories—surpassed RMB 1 trillion in export value in 2023, becoming a key driver in restructuring China's foreign trade profile.

Under the central government's strategic guidance, agencies including the NDRC, Ministry of Industry and Information Technology (MIIT), Ministry of Science and Technology (MoST), and Ministry of Finance are actively engaged in shaping policies and allocating resources to support green innovation. This has catalyzed coordination across industries, financial markets, and local governments, fostering a unified effort to promote sustainable economic growth.

Overall, climate issues in China are gaining policy momentum by aligning with broader development goals, and stakeholders across sectors are generally supportive. However, climate objectives remain largely embedded within other agendas and have yet to emerge as a standalone policy priority. Looking ahead, stronger policy coordination and institutional safeguards will be essential to elevate climate action as a central, coherent driver across more core areas of national development.

CHINA'S CLIMATE GOVERNANCE ARCHITECTURE⁹

China's climate governance rests on a high-level political consensus that ensures both full implementation and accountability across the system. The Communist Party's Central Committee frames climate change as a strategic priority, sets overarching objectives such as peaking and neutrality, and embeds them in Five-Year Plans and related legislation through the National People's Congress. Provinces and sectors are then held jointly accountable, with performance regularly assessed, creating a strong chain of responsibility down to local levels.

Policy design and day-to-day coordination are anchored in the Ministry of Ecology and Environment (MEE), through its Department of Climate Change (CCD). CCD drafts national strategies and programs, manages the national emissions trading system, monitors progress, and represents China in UNFCCC negotiations. Housing the Office of the National Leading Group, it serves as the standing lead agency for climate policy, ensuring continuity and cross-ministerial coordination.

Mediating and balancing among powerful line ministries is the task of the National Leading Group on Climate Change, Energy Conservation and Emissions Reduction (NLGCCR), an inter-ministerial “leading group” chaired by the Premier. Though informal in institutional form, its strategic role is central: it reviews climate plans, arbitrates ministerial interests across energy, industry, transport, and construction, and approves key submissions such as the NDC. Expert advice supplements this system. Bodies such as the Chinese Academy of Sciences (CAS), Chinese Academy of Engineering (CAE), the National Expert Committee on Climate Change (NECCC), and policy think tanks (e.g., ERI under NDRC; NCSC under MEE) provide technical assessments and policy recommendations. Platforms such as Politburo study sessions and the

⁹ Teng, F., & Wang, P. (2021). The evolution of climate governance in China: Drivers, features, and effectiveness. *Environmental Politics*, 1–21. <https://doi.org/10.1080/09644016.2021.1985221>

China Council for International Cooperation on Environment and Development (CCICED) connect domestic and international expertise to top leadership. While advisory in nature, these expert channels have influenced major commitments and added credibility to decision-making. In short, China's climate governance combines: (i) high-level political consensus to secure implementation and accountability, (ii) an institutional anchor in MEE/CCD to draft and coordinate policy, (iii) a national leading group to mediate across ministries, and (iv) expert panels and think tanks to inform policymaking. This structure provides strong convening authority at the center while distributing implementation across sectors and regions, reinforced by codified monitoring, reporting, and verification procedures.

CHINA'S INTERNATIONAL CLIMATE COOPERATION: BOTH A RECIPIENT AND A PROVIDER

China's international climate cooperation exhibits a dual role. On the one hand, China brings in finance, technology, and capacity-building support through multilateral, bilateral, and development-finance channels. On the other hand, it provides assistance to the broader Global South via South–South cooperation—sharing experience, technology, and equipment to help partner countries strengthen their climate response. According to China's First Biennial Transparency Report (BTR)¹⁰, during 2020–2022 China received about US\$141 million through UNFCCC/Paris Agreement funds (GEF/GCF); around US\$2.07 billion in concessional loans and US\$9.13 million in grants from multilateral development banks; and approximately US\$406 million in bilateral loans and US\$1.24 million in grants. These resources supported mitigation, adaptation, capacity building, and technology coop-

eration, supplying critical external, incremental finance aligned with domestic action. The BTR highlights support focused on Enhanced Transparency Framework (ETF) compliance, policy design capacity, human-resource development, and inter-agency coordination. For example, the EU–China emissions trading cooperation—via policy dialogue, technical workshops, and online training—has improved literacy and compliance capacity among ministries and covered enterprises, while providing analytical inputs for the national ETS design.

On adaptation, China works with multilateral institutions and regional partners on risk assessment, coastal and urban resilience, ecosystem and marine cooperation, and data/method sharing—emphasizing joint research, demonstrations, and knowledge exchange to improve climate-risk management capacity in China and other developing countries.

Under the principle of common but differentiated responsibilities and respective capabilities, China's South–South climate cooperation shares low-carbon and adaptation practice with developing countries through joint research and technology pilots, training and talent programs, policy exchanges, and equipment donations or small demonstration projects tailored to partner needs. The objective is to enhance capabilities through joint research, demonstrations, and knowledge sharing, while ensuring localization and sustainable operation in recipient countries. In areas such as carbon markets, GHG statistics and accounting, urban and coastal adaptation, and ecosystem and marine governance, China co-develops methodologies, shares data platforms and governance tools with partners, helping shift capacity building from project-based upgrades to systemic institution-building. Regional and bi/multilateral platforms amplify diffusion and peer learning. This complements North–South cooperation: on one side, China leverages GEF/GCF and MDB resources to upgrade its own institutions and capacity; on the other, it converts domestic, context-tested approaches into replicable South–South solutions, shortening the policy and technology learning curve for partner countries.

¹⁰ China. (2024). The People's Republic of China First Biennial Transparency Report on Climate Change. United Nations Framework Convention on Climate Change. Retrieved from <https://unfccc.int/sites/default/files/resource/The%20People%E2%80%99s%20Republic%20of%20China%20First%20Biennial%20Transparency%20Report%20on%20Climate%20Change.pdf>

Yet when compared to the scale of China's own low-carbon transition needs, the volume of international climate finance it has received to date remains far below requirements. In practice, China's transition has been financed overwhelmingly by domestic resources, while international funds and cooperation have concentrated mainly on capacity-building. Looking ahead, because climate finance available to developing countries is expected to remain constrained, China will not compete with other developing nations for limited funds. Instead, it will aim to maximize the efficiency and impact of existing flows through South–South cooperation and complementary initiatives.

Moreover, future international cooperation will extend beyond finance and technology transfers. A central priority will be maintaining the stability and efficiency of global green-technology supply chains, which are critical to lowering the cost of key transition technologies. Coordinating fairer and more effective participation of all countries in these supply chains will thus become a core agenda item for climate cooperation, linking global industrial policy with collective decarbonization goals.

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A decade of national climate action: Stocktake and the Road Ahead

CÔTE D'IVOIRE NATIONAL PERSPECTIVES FOR ON CLIMATE ACTION TEN YEARS AFTER THE PARIS CLIMATE AGREEMENT

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INTRODUCTION

Côte d'Ivoire is located in West Africa with an area of 322,462 km². It is home to a population of 29,389,150 inhabitants, 47.8% of whom are women and 52.2% are men. The average annual growth rate is 2.9% between 1998 and 2021 (RGPH, 2021). Côte d'Ivoire shares borders with 5 countries (Mali, Burkina Faso, Guinea, Liberia, Ghana) and has a maritime facade (the Gulf of Guinea) with a 522 km long coastline. The country benefits from a transitional climate between the humid equatorial climate and the semi-arid tropical climate, which is characterized by rainy and dry seasons with a rainy and humid region in the south and a dry and hot region in the north. In view of this geographical location, Côte d'Ivoire pays particular attention to the problem of climate change, which is shaking the whole world.

In 2015, Côte d'Ivoire committed through its first Nationally Determined Contributions (NDCs) to reduce its greenhouse gas (GHG) emissions by 28.25%, representing a reduction of approximately ten (10) million tonnes of CO₂ equivalent by 2030 compared to the reference scenario. The major shortcomings of the said NDCs were the failure to take forestry into account in the estimates and the lack of a system for monitoring and evaluating the country's performance. In accordance

with the requirements of the Paris Agreement, the State of Côte d'Ivoire increased its NDCs in 2022 to 30.41%, corresponding to a reduction of thirty-seven (37) tonnes of CO₂ equivalent in GHG emissions from all sectors compared to the reference scenario by 2030 (Ministère de l'Environnement, du Développement Durable et de la Transition Ecologique/ Commission Nationale de Lutte contre les Changements Climatiques (Ministry of the Environment, Sustainable Development and Ecological Transition / Commission for the Fight against Climate Change), 2022). Ten (10) years after the Paris Agreement, it is necessary to take stock of the national perspectives on climate action in Côte d'Ivoire.

A SIGNIFICANT CHANGE IN GREENHOUSE GAS (GHG) EMISSIONS FROM 1990 TO 2020 IN CÔTE D'IVOIRE

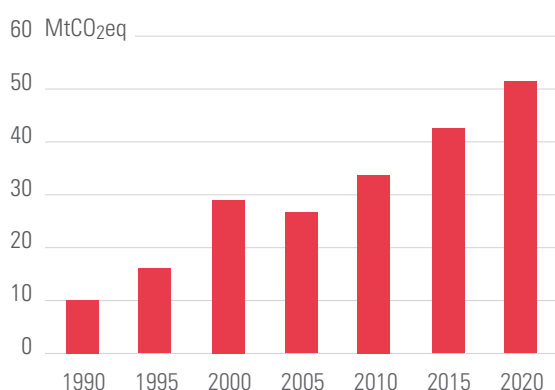
Pursuant to Articles 4, paragraph 1 (a) and 12, paragraph 1 (a) of the United Nations Framework Convention on Climate Change (UNFCCC) and in accordance with decisions 17/CP.8, 1/CP.16, 2/CP.17, Côte d'Ivoire carried out a GHG inventory in 2023 to demonstrate its commitment to implementing the convention. This report shows the evolution of Côte d'Ivoire's GHG emissions from 1990 to 2020 (see **Figure 1**).

The examination of **Figure 1** shows an increase in greenhouse gas emissions ranging from 10,306.153 Gg eqCO₂ in 1990 to 26,649.509 Gg eqCO₂ in 2005, then to 51,535.157 Gg eqCO₂ in 2020. This significant change in emissions reveals a reduction in the national sequestration capacity which goes from 63,748.351 Gg eqCO₂ in 1990 to 16,762.926 Gg eqCO₂ in 2020, a reduction of 73.70%. This moves Côte d'Ivoire from the status of carbon sink to the status of source of GHG emissions.

The major emission sectors are, among others, land use, including Agriculture, Forestry and Other Land Uses (AFOLU) with 65.19% emission rate, followed by the energy sector with an estimated rate of 25.77%. The third sector consists of solid and liquid waste with a rate of 7.69% while the last is all Industrial Processes and Product Uses (IPPU) which represents 1.35% of GHG emissions (see **Figure 2**).

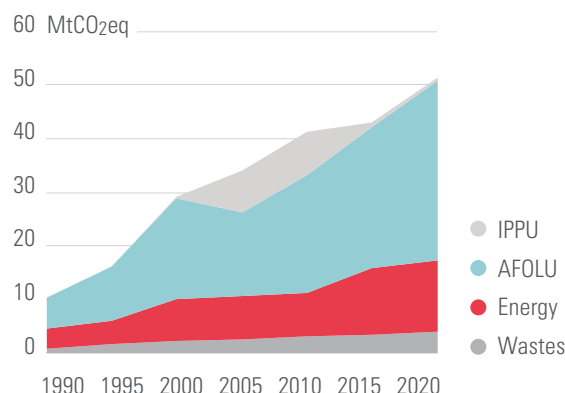
Emissions from the land use sector increased from 5,611.814 Gg CO₂ eq in 1990 to 15,690.278 Gg CO₂ eq in 2005 and then to 33,593.308 Gg CO₂ eq in 2020, an increase of approximately 80%. As for the energy sector, emissions increased from 3,842.135 Gg CO₂ eq in 1990 to 7,855.663 Gg CO₂ eq in 2005, compared to 13,280.701 Gg CO₂ eq in 2020. In this sector, transport emitted 31.76% and industry 37.73%. As for the waste sector, solid waste emits 70.92% of GHGs, compared to 27.11% for liquid waste and 30.49%

Figure 1. Evolution of GHG Emissions from 1990 to 2020



Sources: MINEDDTE, DLCC, Rapport national d'inventaire (National Inventory Report), 2023.

Figure 2. Evolution of GHG Emissions by Production Sector



Sources: MINEDDTE, DLCC, Rapport national d'inventaire (National Inventory Report), 2023.

for waste sector factors. The latter sector emitted respectively 8, 249 Gg eqCO₂ (1990), 437,448 Gg eqCO₂ (2005) and 696,099 Gg eqCO₂ in 2020 (MINEDDTE/DLCC: *Rapport national d'inventaire de la Côte d'Ivoire* (Côte d'Ivoire's 2020 National Inventory Report), 2023).

CLIMATE ISSUES AT THE HEART OF STRATEGIC PLANNING POLICIES IN CÔTE D'IVOIRE

Côte d'Ivoire's planning policy, which guides the national debate in the long term, follows a top-down approach. In 2015, the State adopted the results of the National Prospective Study Côte d'Ivoire 2040 (ENP-CI 2040). It is structured around the vision: **"Côte d'Ivoire, an industrial power, united in its cultural diversity, democratic and open to the world."** The interest of the ENP-CI 2040 is to promote social dialogue on the country's major structural problems with a view to seeking consensus around the desired future of the Nation, developing a framework for intervention by all development actors, including external partners, promoting a national capacity for forward-looking thinking and strategic monitoring, and establishing an institutional mechanism for strategic monitoring.

On the climate front, the ENP-CI 2040 draws the attention of decision-makers through thematic scenario 1 of theme 6 on the ecological disaster which will intensify GHG emissions by 2040. It is part of the dynamics of the United Nations Agenda 2063 (Ministère de l'Economie, du Plan et de Développement/Bureau National de la Prospective et de la Veille Stratégique - Ministry of Economy, Planning and Development/National Office of Foresight and Strategic Monitoring), 2016).

In 2020, Côte d'Ivoire adopted the Côte d'Ivoire 2030 Strategic Plan, which sets out the strategic axes for the country's structural transformation over ten (10) years. It serves as a strategic framework for the country's journey towards achieving the Sustainable Development Goals (SDGs) by 2030.

The above-mentioned strategic documents served as the basis for the development of the National Development Plans (NDPs) 2016-2020 and 2021-2025, which define the concrete actions to be implemented each year in order to achieve the medium and long-term visions.

Based on national planning documents, each local authority (district, region and municipality) draws up its Territorial Development Planning Scheme or Development Plan, which defines the strategic directions of their interventions at the local level. Most of these local plans are organized into development axes, including that of local sustainable development, which defines actions in the fight against climate change.

These plans are generally called Green Plan or Climate Plan. For example, we can cite the Green Plan of the Mé region which defines concrete actions for environmental protection and natural resource management with a view to mitigating local emissions (Conseil Régional de la Mé - Regional Council of Mé), GIZ, *European Forest Institute*, 2024). We also note the Sustainable Natural Resource Management Plan of the San Pedro region which aims to ensure sustainable management of natural resources, sustainable low-emission agricultural production and the improvement of living conditions for communities (Proforest, 2023).

In the same perspective, the Ministry of Water and Forests adopted in 2018 the National Strategic Plan for the Preservation, Rehabilitation and Extension of Forests by 2045. This plan aims to improve forest governance, strengthen the protection of residual forest areas, extend and manage them sustainably in classified forests, restore degraded forest areas in rural areas and strengthen resilience to the effects of climate change.

There is also a National Action Plan for Renewable Energy in Côte d'Ivoire for the period 2016-2030. This plan indicates an installed capacity of power plants operating on the basis of renewable energy of 604 MW in 2010, which increases to 1,894 MW in 2020 and is estimated at 3,259 MW in 2030. As for the total electricity production based on renewable energies, it is projected at

11,293 Gwh by 2030, compared to 5,148 Gwh in 2020 and 1,618 Gwh in 2010. Côte d'Ivoire's ambition is to increase the share of renewable energies to 45% in the energy mix by 2030 with 26% from hydroelectric and 16% from biomass and solar (Ministère des Mines du Pétrole et de l'Energie - Ministry of Mines, Petroleum and Energy), 2016).

All these planning documents that focus on the issue of climate change aim to strengthen governance, frame the intervention of actors, facilitate the search for financing, communication on actions to combat climate change and monitoring and evaluation of performance for the implementation of NDCs.

SIGNIFICANT PROGRESS IN THE NATIONAL TRANSITION TO CARBON NEUTRALITY

Côte d'Ivoire has taken several important steps in its national transition process towards carbon neutrality, including the aspects of emissions mitigation, adaptation to climate change, climate governance and international cooperation and mobilization of financing.

Mitigation of GHG emissions

Côte d'Ivoire's new ambition to reduce its greenhouse gas emissions by 30.41% by 2030 corresponds to a reduction of thirty-seven (37) million tonnes of CO₂ equivalent in 2030. It is based on thirty-eight (38) mitigation measures, including twenty-seven (27) unconditional measures and eleven (11) conditional measures.

Unconditional measures refer to actions that Côte d'Ivoire commits to implementing regardless of the conditions based on its own capabilities. As for conditional measures, these are complementary mitigation actions implemented by the country on the condition that it receives external technical and financial support. The implementation of these conditional measures should allow a reduction of 98.95% of total emissions in 2030 (Ministère de l'Environnement, du Développement Durable et de la Transition

Ecologique /Direction de la Coopération Internationale et de la Mobilisation des Financements: *CDN Côte d'Ivoire* - Ministry of the Environment, Sustainable Development and Ecological Transition / Directorate of International Cooperation and Funding Mobilization: *Nationally Determined Contributions of Côte d'Ivoire (NDC)*, 2022).

To achieve its new NDCs (30.41%), Côte d'Ivoire has resolved to restore 20% of the forest cover of the national territory and increase the share of renewable energy to 45% in the energy mix by 2030. Thus, mitigation measures are spread across five (5) sectors. In the energy sector, the Ivorian State is implementing 24 mitigation measures due to 17 unconditional and 7 conditional measures, representing a reduction of -37.66% of the sector's emissions. The waste sector is affected by 5 mitigation measures (4 unconditional and 1 conditional) aimed at reducing emissions by -12.96% from the said sector. The third is agriculture with 5 measures, including 3 unconditional and 2 conditional for a mitigation of -19.16%. The forestry sector with 3 measures could reduce emissions related to forest degradation by -150%, or 18%. The last sector is Industrial Processes with one (1) GHG mitigation measure. The estimated cost of implementing the 27 mitigation measures amounts to \$10 billion out of an overall cost of \$22 billion for NDCs (30.41%).

The 2024 National Climate Action Assessment Report in Côte d'Ivoire reveals 180 low-carbon transition projects are currently being implemented across the country. As a result, actions have been carried out in various sectors. In the forestry and land use sector, the Greenhouse Gas Emission Reduction (GRE) projects and the Forest Investment Project Phase 1 (PIF1) are the most representative projects that have achieved significant mitigation. Implemented around the Taï National Park, the main forest area of Côte d'Ivoire, these projects have sequestered 7 million tonnes of CO₂ eq and 1.5 million tonnes of CO₂ eq respectively, representing a total reduction of 8.5 million tonnes of CO₂ eq of GHG emissions in 2022. The reduction trend is significant with the implementation of phase 2 and the start

in 2025 of reforestation projects as part of the Forest Strategy for 2030. These projects include the ProForêt project and the Cocoa-based Food Systems, Land Use and Restoration project in Côte d'Ivoire (SCOLUR-CI) and the Promoting Deforestation-Free Cocoa Production to Reduce Emissions in Côte d'Ivoire (PROMIRE) project. These projects were carried out in several regions of Côte d'Ivoire, namely the regions of Mé, Indénié-Djuablin, Nawa and San Pedro.

In the energy sector, energy efficiency and renewable energy production measures will be implemented in 2023-2024. These measures aim to improve people's access to electricity and energy by making the price affordable for the majority of the population. They also involve increasing the level of use of renewable energy in electricity production. Côte d'Ivoire's objective is to increase the share of renewable energy to 31% in 2024 and to 45% by 2030, with 33% hydroelectricity and 12% biomass and solar. These objectives are focused on the development of 829 MW of hydroelectric energy, 545 MW of other renewable energies including 146 MW of biomass and 399 MW of solar, representing an additional capacity of 1,374 MW of which the share of renewable energies will be 2,283 MW out of the total capacity of 5,128 MW (République de la Côte d'Ivoire (Republic of Côte d'Ivoire), *Le Pacte National Energie (National Energy Pact)*, 2025). The planned efficiency measures should make it possible to reduce 807 kt CO₂ eq, or 87% of GHG emissions. With this in mind, Côte d'Ivoire has set a target of 490 MW of its solar photovoltaic capacity by 2030. This system has made it possible to reduce GHG emissions by 9.33 kt CO₂ eq in 2023.

In the transport sector, the process of renewal and diversification of the Ivorian vehicle fleet and the adoption of Euro VI standards have made it possible to reduce emissions by 86 kt CO₂ eq in 2023 (Ministère de l'Environnement, du Développement Durable et de la Transition Ecologique, 2024, *Rapport national sur l'évaluation de l'action climatique* - Ministry of the Environment, Sustainable Development and Ecological Transition, 2024: *National Report on the Evaluation*

of Climate Action), 2024). In this sector, there is also talk of emphasizing public or mass transport through buses and the Abidjan metro.

In the waste sector, the commissioning of the Kossihouen Waste Recovery and Technical Landfill Centre (CVET) and the biomethanisation project at the Akouédo landfill are contributing to a reduction of 25,000 tCO₂ eq/year (Ministère de l'Environnement, du Développement Durable et de la Transition Ecologique, 2024, *Rapport national sur l'évaluation de l'action climatique* - Ministry of the Environment, Sustainable Development and Ecological Transition, 2024: *National report on the evaluation of climate action*), 2024).

Adaptation to climate change, a priority for Côte d'Ivoire

The adaptation component is a priority for Côte d'Ivoire because of its vulnerability to the effects of climate change. Indeed, the country ranks 147th out of the 178 countries most vulnerable to climate change. To reduce this vulnerability and increase resilience, Côte d'Ivoire has implemented 20 climate change adaptation measures for a total cost of \$12 billion out of \$22 billion of the new NDCs (30.41%). These measures are envisaged in five (5) priority sectors: water resources, agriculture (livestock and aquaculture), forestry and land use, health, and coastal areas. The implementation of these 20 measures is expected to create 580,000 to 870,000 employments.

In the water sector, measures include promoting integrated management and technology transfer for better resource management. In the agricultural sector, Côte d'Ivoire is developing sustainable agricultural and agroforestry practices, such as climate-smart practices, which are strategies for adapting cocoa plantations to the effects of climate change. There are also deforestation-free production systems and agroforestry, which involve introducing trees into agricultural plantations. These adaptation strategies are part of the National Sustainable Cocoa Strategy (SNCD) and the Reducing Emissions from Deforestation and Degradation (REDD+) mechanisms. The flagship projects developed by Côte d'Ivoire for

the implementation of these practices include, among others, the Greenhouse Gas Emissions Reduction (PRE) project, the Promoting Deforestation-Free Cocoa Production to Reduce Emissions in Côte d'Ivoire (PROMIRE) project and the Scaling Up Transformative Innovations in Food Systems, Land Use and Cocoa-Based Restoration in Côte d'Ivoire (SCLOUR-CI) project.

At the Forest and Land Use sector level, the aim is to strengthen land governance, combat land degradation, protect forests and restore degraded forests and lands. To this end, the State has decided, since 2019, to transform classified forests with a degradation rate of less than 25% (category 1) into Nature Reserves (Mabi-Yaya and Bossématié Nature Reserves in the southeast and Cavally in the west). For those with a degradation rate of between 25% and 75% (category 2), the objectives are to strengthen the status and protection of said forests. As for those with a degradation rate of more than 75% (category 3), the aim is to establish them as an agroforestry system (Ministère des Eaux et Forêts (Ministry of Water and Forests: *Ivorian Forest Code*), 2019). In order to improve land governance, the State has initiated the process of securing land tenure in the national territory *through* the pilot phase of the project to Support the Improvement and Implementation of Rural Land Policy (PAMO-FOR) and the extension phase of the Rural Land Security Strengthening Program (PRESFOR). In the coastal areas sector, the State has developed an early warning system that is accompanied by support for vulnerable communities through physical and social investments.

A multitude of actors involved in climate governance in Côte d'Ivoire

Effectively combating climate change requires collective and coordinated action, given the cross-cutting nature of the impacts that affect all development sectors in Côte d'Ivoire. To achieve this, the NDC development process (30.41%) follows a consultative and participatory approach, including key ministries, the private sector, technical partners, local authorities, civil society, and non-governmental organizations

(NGOs). To honor the commitments made to the Paris Agreement in 2015, the State of Côte d'Ivoire has established several complementary structures under the leadership of the Ministry of the Environment, Sustainable Development, and Ecological Transition.

Prior to the Paris Agreement, the State created the National Program to Combat Climate Change (PNCC) on November 30, 2011, as the body responsible for setting up GHG mitigation projects and implementing climate actions.

The country also committed to the international REDD+ mechanism in 2011, with the ambition of restoring 20% of its forest cover by 2030. This commitment was reaffirmed in October 2012 with the creation of the National REDD+ Commission. This mechanism (REDD+) is based on an integrated approach, which combines economic development, social well-being and the conservation of natural resources, mainly in the agricultural sector.

In 2021, Côte d'Ivoire established the Directorate of International Cooperation and Funding Mobilization (DCIMF) to implement mitigation actions. The role of this Directorate is to develop strategies for mobilizing climate finance, ensure international cooperation, and guide the design of projects eligible for climate finance. Similarly, a new Environmental Code will be adopted in November 2023, establishing the Ivorian Environmental Code.

To better organize coordination between these structures through a multi-stakeholder and multi-sectoral consultation framework, the State will create the National Commission for the Fight against Climate Change (CNLCC) in 2024.

In order to better structure its carbon market, Côte d'Ivoire is creating the Carbon Market Office (BMC) in August 2024 as a one-stop shop for coordinating activities relating to carbon market mechanisms. It is a one-stop shop responsible for implementing the overall framework for Côte d'Ivoire's participation in carbon mechanisms. The BMC is made up of two (2) bodies, namely the Supervisory Board headed by the Prime Minister or his representative and the Technical Secretariat, the management of which is entrusted to a Tech-

nical Secretary, appointed in December 2024. The Office ensures the day-to-day management of carbon mechanism implementation activities, in accordance with the procedures manual applicable to activities eligible under Article 6 of the Paris Agreement and the Voluntary Carbon Market. In addition, the Interprofessional Fund for Agricultural Research and Advice (FIRCA) was created to position itself as an institution facilitating the search for financing for mitigation projects accredited to the United Nations Framework Convention on Climate Change.

Efforts to develop international cooperation aimed at mobilizing climate finance

In terms of international cooperation and the search for climate finance, the Government of Côte d'Ivoire has taken an important step by creating the Directorate for International Cooperation and Funding Mobilization (DCIMF). It is responsible for seeking all funding opportunities for climate change mitigation actions from climate finance agencies and developing projects to reduce the country's greenhouse gas emissions.

Thus, the MINEDDTE, through the DCIMF, has developed a national portfolio of 300 Low Carbon Transition projects containing projects eligible for climate finance. The overall cost of implementing these projects amounts to 16 billion US dollars, or approximately 9,500 billion CFA francs. Among these 300 projects, fifty-three (53), or 18%, divided into six (6) priority programs, have feasibility studies and are bankable, of which ten (10) already have financing to start implementation. The priority programs in which the projects are defined are (1) National Integrated Program to Combat Climate Change, (2) National Agro-ecological Transition Programme/Agriculture Component, (3) National Circular Economy and Waste Management Program, (4) National Energy Transition Program/Electric Mobility, (5) National Agroecological Transition Programme/Forestry Component and (6) Water Resources Management Program.

Funding for climate change mitigation actions in Côte d'Ivoire comes from various sources, the

best known of which are the State, the private sector, Technical and Financial Partners (TFPs), the Green Climate Fund (GCF), the Global Environment Facility (GEF), the Climate Adaptation Fund and the World Bank (WB). In the dynamic of seeking funding for sustainable agriculture, Côte d'Ivoire is setting up the Interprofessional Fund for Agricultural Research and Advisory Services (FIRCA), accredited to the Adaptation Funds and Green Climate Funds under the climate window of the United Nations Framework Convention on Climate Change (UNFCCC). FIRCA's main mission is to mobilize funds from agricultural sectors, the State, the private sector and Technical and Financial Partners to ensure the financing of service provision programs in the crop, forestry, animal and fisheries production sectors.

Côte d'Ivoire is implementing a web-based platform for tracking and tracing green and sustainable financing in accordance with Article 13 of the Paris Climate Agreement. It provides real-time information on Côte d'Ivoire's financial needs, the funding secured, and the remaining resources to be mobilized to achieve the NDC objectives, both in the mitigation and adaptation components.

The implementation of these mechanisms has enabled Côte d'Ivoire to mobilize a budget of \$2,425 million for climate financing between 2015 and 2022, of which more than 88% comes from public funds and 11% from the private sector (Ministère de l'Environnement, du Développement Durable et de la Transition Ecologique: *Rapport national sur l'action climatique* - Ministry of the Environment, Sustainable Development and Ecological Transition: *National Report on the Evaluation of Climate Action*), 2024). In 2023, Côte d'Ivoire spent more than \$597 million on actions to combat climate change. In 2024, the country mobilized 1,800 billion FCFA, or \$3.6 billion, to finance 530 green projects. Thus, Côte d'Ivoire benefited from \$10 million in support from the Green Fund for the implementation of PROMIRE projects. UN-Habitat also supported Côte d'Ivoire with \$7 million from the Adaptation Fund to finance coastal adaptation measures. Similarly, the Green Climate Fund, through the World Food Programme, provided \$10 million to Côte d'Ivo-

ire as part of the Women's Adaptation project in the Poro region in the North (Ministère de l'Environnement, du Développement Durable et de la Transition Ecologique: *Rapport national sur l'action climatique* - Ministry of the Environment, Sustainable Development and Ecological Transition: *National Report on the Evaluation of Climate Action*, 2024). Despite the efforts made by Côte d'Ivoire, some aspects are hindering the national transition to carbon neutrality.

Structuring climate governance in Côte d'Ivoire

For several years, the State of Côte d'Ivoire has been striving to structure climate governance by strengthening the legal and institutional framework. With the environment at the heart of the issue, the State updated the Forestry Code in 2019 to adapt it to the new requirements of the fight against climate change. This new code establishes six (06) new provisions, such as the plurality of actors (private sector, local authorities, in particular Regional Councils and rural communities), the ownership of trees and forests in favor of legal entities and individuals who have preserved a natural forest and trees outside the forest, the concept of agro-forest (a space defined and delimited by a regulatory text in the private forest domain of the State and in which agricultural plantations and forest trees coexist). This provision directly involves the private sector, local communities and local authorities in the protection of the forestry sector, the driving force in the fight against global warming. Similarly, the environmental code was revised in 2023 to take into account the issue of climate change. Furthermore, the Ministry of the Environment and Sustainable Development was reorganized with the concept of Ecological Transition in order to ensure the overall coordination of all the structures created and attached to it.

This is the National Environment Agency (ANDE) responsible for reviewing Environmental and Social Impact Studies, the National Commission for the Fight against Climate Change (CNLCC). Placed under the supervision of the Prime Minister, the CNLCC is defined as a reference body for

consultation and coordination on climate change issues at the national and international level and for supporting the search for funding. It is made up of three (03) bodies, namely the Steering Committee, the Executive Secretariat and the working groups, composed of focal points from key sectoral ministries. The Committee meets twice a year in ordinary session and as many times as necessary in extraordinary session.

In addition, there is the Carbon Market Office (BMC), attached to the MINEDDTE as a one-stop shop for the implementation of the overall framework for Côte d'Ivoire's participation in carbon mechanisms. The BMC is composed of a Supervisory Council (all sectoral ministries) and a Technical Secretariat. It ensures the daily management of carbon mechanism implementation activities, in accordance with the procedures manual approved by order of the Minister of the Environment. The MINEDDTE, through the BMC, has established a procedures manual applicable to activities eligible under Article 6 of the Paris Agreement and the voluntary carbon market. There is also the Directorate of International Cooperation and Funding Mobilization (DCIMF), under the supervision of the MINEDDTE, whose main mission is to seek funding opportunities for action both nationally and internationally, in close collaboration with the CNLCC and other structures.

Beyond these structures, it is worth mentioning the REDD+ mechanism, which is a system for reducing greenhouse gas emissions linked to deforestation and forest degradation. It supports its policy of deforestation-free agriculture and payment for environmental services (PES) through sustainable management projects and increased carbon storage.

Thus, these different structures ensure the steering of the national policy to combat climate change in a concerted and participatory manner. Key sectoral ministries, such as the Ministry of Planning, the Ministry of Water and Forests, the Ministry of Finance, the Ministry of Agriculture, the Ministry of Energy, the Ministry of Sanitation, the National Commission of the Global Environment Facility (CN-GEF) and the Société

d'Exploitation, de Développement Aéroportuaire, Aéronautique et Météorologique en Côte d'Ivoire (Airport, Aviation and Meteorological Exploitation and Development Company in Côte d'Ivoire) (SODEXAM), local authorities and the private sector have focal points within the CNLCC. This led to the adoption by the Council of Ministers of a draft law on climate change which provides for the creation of a National Climate Agency and the National Fund for the Environment and Sustainable Development (FNEDD) whose missions will be known upon the promulgation of the climate law in Côte d'Ivoire.

THE CHALLENGES OF THE NATIONAL TRANSITION TO CARBON NEUTRALITY

Since the Paris Agreement in 2015, Côte d'Ivoire has made significant progress in combating climate change and transitioning to carbon neutrality. However, enormous challenges stand in the way of an effective transition to carbon neutrality. These challenges include the country's resilience to climate change, sustainable agriculture without deforestation, integrating gender into climate policies and programs, building the capacity of national stakeholders on climate mechanisms and the transition to carbon neutrality, and mobilizing climate finance.

Challenges of resilience of the country's socio-economic sectors in the face of climate change

According to the World Bank, Côte d'Ivoire is one of the most vulnerable countries to climate change. This vulnerability is a result of the structure of its economic fabric, which remains dependent on the deforestation-driven agricultural sector to this day. Indeed, the deforestation rate in Côte d'Ivoire is one of the highest in Africa, with more than 86% of natural forests lost. This deforestation dynamic linked to unsustainable agriculture intensifies climate change, negatively impacting the country's socioeconomic sectors. The 2024 climate report showed that Côte d'Ivo-

ire's GDP will be reduced by 13% by 2050 due to the negative effects of climate change. This will prevent 1.63 million people from escaping poverty.

Similarly, the climate impact negatively affects all aspects of Ivorian society, including food security, public health, and the income of populations, especially the most vulnerable living in rural areas and women. The COP29 national report shows that the impact of climate change, particularly rising temperatures, could reach 4%, further exacerbating the poverty rate, which currently hovers around 70% in rural areas. These effects will lead to a 9% drop in GDP in the agricultural sector and a 26% drop in the fishing sector on the coast, with rising sea levels causing coastal erosion. However, the coast is home to 30% of the Ivorian population and 80% of economic activities. As for the agricultural sector, it produces 25% of GDP and employs 46% of the working population. In reality, climate change, marked by scarce rainfall, rising temperatures, and disruption of agricultural calendars, is leading to a decline in the production of cocoa, rubber, cotton, cashew nuts, and food and market garden crops. This could jeopardize 26% of income by 2050, and thus food security. These challenges require strengthening sustainable agricultural practices without deforestation, restoring forests and degraded lands, and agricultural practices adaptive to climate change, such as agroforestry, which involves the coexistence of forest species and agricultural plantations.

Challenges of integrating gender into climate policies and programs

Taking gender into account in actions to combat climate change remains one of the challenges facing Côte d'Ivoire, especially since this aspect is increasingly decisive in the mobilization of climate financing. According to the report on Gender and Climate Change in Côte d'Ivoire by the United Nations Development Programme in 2019, the blockage of this aspect is linked to a lack of mastery of the concept of Gender in relation to climate. This is seen in a tendency to consider the concept of gender exclusively

towards women, the theoretical nature of official texts on gender without any real application and a low availability of updated data on gender and climate at the national level. Côte d'Ivoire therefore needs to guarantee an inclusive and equitable approach to gender, by integrating the perspectives of marginalized groups in all climate actions (United Nations Development Programme, 2019).

Challenges of capacity building of national actors on climate mechanisms

To implement mitigation and adaptation strategies developed in the case of the revision of the NDCs (30.41%) by 2030, Côte d'Ivoire intends to take up the challenge of building the capacities of national stakeholders, including local authorities. Indeed, the conclusions of the first Forum on Carbon Markets in West Africa, held on February 23 and 24, 2025, at the Pullman Abidjan-Plateau Hotel, revealed the importance of improving the understanding of national stakeholders of the issue of climate change, the challenges of the transition to carbon neutrality and the mechanisms of the carbon market. Unlocking this aspect would make it possible to territorialize the fight against climate change through local authorities, civil society, young people, women and the private sector. Indeed, the legal and regulatory framework aimed at governing carbon credit payment mechanisms remains poorly understood at the national level, in particular the variation in the price of carbon credits and the process of calculating credits. The effectiveness of climate action therefore requires additional efforts on the part of the State in terms of deploying climate investments and strengthening the capacities of national actors in order to make climate governance structures operational.

Challenges related to the climate action financing system

To facilitate the search for climate financing, the State of Côte d'Ivoire has implemented strategies, including the 300 mitigation and adaptation projects formulated in the MINEDDTD project portfolio, 53 of which have completed feasibility

studies and 10 projects that have obtained financing. The effective implementation of Côte d'Ivoire's new NDCs requires the mobilization of 13,000 billion CFA francs, or 22 billion dollars. The country has been able to mobilize 22% of the financing, or 1.5 billion euros or 1,000 billion CFA francs. As a result, 78% of the needs for mobilizing climate financing remain uncovered for the financing of 43 mitigation and adaptation projects (Ministère de l'Environnement, du Développement Durable et de la Transition Ecologique Ministry of the Environment, Sustainable Development and Ecological Transition : National Report on the Evaluation of Climate Action in Côte d'Ivoire), 2024). To achieve this, the support of international climate finance, the increase in the capitalization of climate funds, namely the Green Climate Fund (GCF), the Adaptation Fund (AF) and the disbursement for countries like Côte d'Ivoire is strongly expected.

Challenges of developing renewable energy in Côte d'Ivoire

Increasing the share of renewable energy in the energy mix remains one of the fundamental challenges of the transition to carbon neutrality. Indeed, the use of biomass energy (firewood, charcoal, plant waste) represents more than 2/3 of the total energy consumption of Ivorian households, or 85 to 92% of the population. There is also a strong predominance of fossil fuel sources such as natural gas for electricity needs, which exposes the sector to risks of price fluctuations and fuel shortages (Ministère des Mines, du Pétrole et de l'Energie, (Ministry of Mines, Petroleum and Energy), 2016). Thus, Côte d'Ivoire's vision is to abandon natural gas fuel to focus on clean energy in order to converge towards a low-carbon economic model. As a result, the country plans to increase the share of renewable energy in the energy mix by 45% by 2030.

CONCLUSION

Since Côte d'Ivoire ratified the Paris Agreement in 2016, numerous actions have been undertaken to effectively combat the effects of climate change. Thus, this report on the assessment of national perspectives on climate action in Côte d'Ivoire highlights the efforts already undertaken and the achievements in the transition to climate-resilient development. However, considerable challenges remain, both financially, technically and institutionally. Furthermore, these important issues call for continued strengthening of national capacities, increased resource mobilization, and greater synergy between public, private, community actors, and technical and financial development partners. This is the condition for the country to achieve its objectives set under the Paris Agreement.

BIBLIOGRAPHIC REFERENCES

- Conseil régional de la Mé, GIZ, Institut Européen de la Forêt, 2024, *Plan Vert de la Région de la Mé*, Adzopé, 42 p.
- Conseil Régional de San Pedro et Proforest, 2023, *Plan de Gestion et d'Investissement Durable du Paysage de San Pedro*, San Pedro, 94 p.
- Decree No. 2024-594 of June 26, 2024 establishing the creation, powers, organization and operation of the National Commission for the Fight against Climate Change, Abidjan, 10 p.
- Ministère de l'Economie, du Plan et de Développement, 2020, *Plan Stratégique Côte d'Ivoire 2030*, Abidjan, 51p.
- Ministère de l'Economie, du Plan et de Développement/ Bureau National de la Prospective et de la Veille Stratégique, 2016, *Etude Nationale Prospective Côte d'Ivoire 2040*, Abidjan, 162p.
- Ministère de l'Environnement et du Développement Durable, 2019, *Stratégie Nationale Genre et Changements Climatiques de la Côte d'Ivoire 2020-2024*.
- Ministère de l'Environnement, du Développement Durable et de la Transition Ecologique (MINEDDTE)/ Commission Nationale de Lutte contre les Changements Climatiques, 2024, *Rapport sur l'état d'avancement de la transition climatique*, Abidjan, 83 p.
- Ministère de l'Environnement, du Développement Durable et de la Transition Ecologique /Direction de la Lutte contre les Changements Climatiques, 2023, *Rapport National d'Inventaire 2020 de la Côte d'Ivoire*, Abidjan, 197 p.
- Ministère de l'Environnement, du Développement Durable et de la Transition Ecologique /Direction de la Coopération Internationale et de la Mobilisation des Financements, 2022, *Contributions Déterminées au niveau National (CDN) de la Côte d'Ivoire*, Abidjan, 48 p.
- Ministère de l'Environnement, du Développement Durable et de la Transition Ecologique, 2024, *Rapport national sur l'évaluation de l'action climatique*, Abidjan, 100 p.
- Ministère de l'Environnement, du Développement Durable et de la Transition Ecologique, 2022, *Portefeuille Nationale de Projets, changement climatique et environnement*, Abidjan, 100 p.
- Ministère des Eaux et Forêts, 2018, *Stratégie Nationale de Préservation, Réhabilitation et d'Extension des Forêts à l'horizon 2045*, Abidjan, 52p.
- Ministère des Mines, du Pétrole et de l'Energie, 2016, *Plan d'Actions National des Energies Renouvelables en Côte d'Ivoire sur la période 2016-2030*, Abidjan, 67 p.
- Programme National Changements Climatiques (PNCC), 2019, *Rapport sur le Genre et changement climatique en Côte d'Ivoire*, Abidjan, 80 p.
- République de Côte d'Ivoire, 2025, *Le Pacte National Energie*, Abidjan 42 p.

A decade of national climate action: Stocktake and the Road Ahead

COSTA RICA **FIRST MOVERS BY DESIGN:** **CLIMATE LEADERSHIP** **BEYOND EMISSIONS**

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Costa Rica often defies conventional metrics of power, reminding the world that climate ambition is not reserved for the largest economies. Its leadership on climate and environmental protection stands out not only in emissions figures, but in the depth of its cultural values, public awareness, and institutional commitment to sustainability.

Costa Rica's leadership is also rooted in a long-standing national ethos. The country's environmental legacy, initiated with renewable energy deployment and early reforestation programs in the 1950s and later gaining strong political traction in the 1990s (Blum, 2008), has yielded tangible results: nearly 100% renewable electricity (IRENA, 2025; ICE, 2020) and approximately 60% forest cover (MINAET, 2011). These achievements represent more than technical milestones; they embody a national identity deeply shaped by ecological responsibility (Estado de la Nación, 2023, pp. 21–23).

The trajectory of Costa Rica's greenhouse gas emissions reinforces the environmental ethos. Between 1990 and 2021, while absolute emissions increased, the economy expanded much faster, cutting emissions intensity by half. Agriculture, once the dominant source, has steadily declined, while energy has become the principal contributor, driven above all by transport, which now accounts for nearly two-thirds of energy-related emissions. At the same time, renewable electricity has enabled an 80% reduction in power sector emissions since 1990, demonstrating how structural transformation and

clean energy deployment have tempered overall growth in emissions.

Moreover, the participatory dynamic resonates with Costa Rica's broader climate trajectory: a country that has consistently acted ahead of the curve, embracing ambitious policy measures even in the absence of precedent or guaranteed outcomes. It can be said that rather than waiting for global consensus, Costa Rica has often chosen to lead from the front, demonstrating that climate ambition is as much about political will and societal engagement as it is about emissions metrics.

However, acting without full certainty is not a sign of carelessness, but of leadership. Costa Rica has opted to advance climate policy pragmatically, building what is needed along the way, because delaying action until conditions are ideal is no longer viable, not when it comes to climate change. This reflects a political and societal understanding that climate ambition requires both speed and resolve.

This chapter sets the stage by outlining Costa Rica's national climate governance context, the modelling tools that inform policy, and the dynamics of policymaking and implementation. It also previews the challenges and impacts that frame the country's climate action, providing the foundation for the analysis and conclusions that follow.

CLIMATE CHANGE CONTEXT IN COSTA RICA

Greenhouse gases Emissions Trajectories

Costa Rica's emissions trajectory between 1990 and 2021 reflects both notable progress and remaining challenges. During this period, the economy grew by almost 250 percent, while emissions increased by about 180 percent, reducing emissions intensity by half (*Gobierno de Costa Rica, 2024*). This relative decoupling indicates that the country has been able to expand economic activity at a faster pace than emissions growth, a meaningful outcome in the regional context. However, the continued rise in absolute

emissions highlights the limits of this progress and the need for deeper structural changes.

The composition of emissions has shifted over time. In 1990, agriculture was the main source, but energy has since become the dominant contributor, driven largely by transport, which today represents nearly two-thirds of energy-related emissions. Waste has remained broadly stable at 15–20 percent of the total, while industrial processes have nearly doubled their share from 6 to 11 percent. Agricultural emissions, in contrast, have declined by about 20 percent since 1995, reducing their overall weight in the national profile (*Gobierno de Costa Rica, 2024*). These developments point to a transition in Costa Rica's climate challenge, moving away from land-use pressures toward energy and industry, where mitigation is often more complex.

Electricity generation stands out as an exception. Owing to Costa Rica's reliance on hydropower and other renewable sources, emissions from power generation are more than 80 percent lower than in 1990, despite significant economic expansion (*Gobierno de Costa Rica, 2024*). This outcome has positioned renewable electricity as a cornerstone of the country's decarbonization strategy, laying the groundwork for further progress through the electrification of transport. At the same time, the transport sector continues to present the most pressing challenge: it has remained consistently above 59 percent energy emissions and has grown faster than other subsectors. Without major transformations in mobility systems, through expanded public transport, electrification, and modal change, emissions will remain on an upward trend despite advances elsewhere. In sum, the emissions trajectory illustrates both Costa Rica's capacity for leadership and the areas where further action is required. The country has already demonstrated its ability to align growth with sustainability through renewable energy deployment and reduced agricultural pressures. Yet absolute reductions will depend on extending this leadership into sectors such as transport and industry, ensuring that the gains achieved so far are consolidated into longer-term transformations (*Gobierno de Costa Rica, 2024*).

Addressing these dynamics requires policy instruments that are both technically robust and institutionally grounded. This is why modeling tools and evidence-based planning have become central components of Costa Rica's climate governance, while national governance structures have been deliberately strengthened to lead the country along its decarbonization path.

National Governance of Climate Change Policies

Costa Rica's high-level ambition is reflected not only in national plans and policy instruments, but also in the evolving practices of climate governance, particularly in the way institutions are leveraging tools and technologies to inform decisions and accelerate implementation.

Over the past decade, Costa Rica has increasingly integrated data-driven approaches, modeling platforms, and digital systems into its climate governance, enabling more precise planning, monitoring, and cross-sectoral coordination. These innovations have helped bridge the gap between long-term goals and operational realities, reinforcing a governance model that is strategic, adaptive, and evidence based.

To do so, institutions have played a decisive role in translating this vision into action, allowing Costa Rica's national climate governance to be anchored to a robust institutional framework that ensures both strategic direction and participatory processes. At the core is the *Dirección de Cambio Climático* (DCC or Climate Change Directorate), created in 2010 within the Ministry of Environment and Energy (MINAE), which acts as the technical authority responsible for coordinating climate policy, developing the National Decarbonization Plan, and overseeing implementation of the country's Nationally Determined Contribution (NDC). The DCC has led coordination efforts across ministries, sectors, and territories, engaging hundreds of organizations and local governments through initiatives such as the carbon neutrality program (MINAE, 2020).

Notably, climate change governance in Costa Rica goes beyond institutional structures, as the country has a long-standing tradition of

stakeholder consultations involving civil society, academia, local governments, and community representatives. First, those processes also ensure broad ownership, allowing diverse actors to shape the design, prioritization, and monitoring of climate actions. However, these consultations are not limited to validating policy tools; they also provide critical inputs to the actions of institutions and organizations, enabling the collection of data and the validation of assumptions that often arise when building tools in contexts where information is incomplete or missing. This combination of institutional leadership, inter-sectoral coordination, and participatory engagement builds consensus and continuity in the national agenda.

Understanding how this governance framework translates into real-world outcomes requires looking at Costa Rica's elaboration of public policies, which offers a clear picture of both the country's achievements to date and the challenges that continue to shape its climate agenda.

Development of modeling tools to guide public policy elaboration

As global momentum for decarbonization intensifies, countries are increasingly turning to science-based tools and financial mechanisms to operationalize climate ambition. For Costa Rica, advancing the climate agenda alongside other development priorities revealed the need for robust analytical tools to support long-term planning and policy coherence, while also presenting an opportunity for institutional and technical innovation.

In response, the country embraced specialized modeling systems, often developed in collaboration with academic and international partners, to assess complex decarbonization scenarios and support evidence-based decision-making.

The first of these tools, the TIMES-CR model, was introduced in 2017 with support from the World Bank's Partnership for Market Readiness (PMR) program. It provided the basis for the country's first quantitative decarbonization pathway analysis and directly informed the design of Costa Rica's National Decarbonization Plan (World

Bank, 2021). Costa Rica's initial development of its energy sector model significantly influenced the formulation and implementation of the National Decarbonization Plan, launched in 2019. Building on this experience, Costa Rica transitioned to more flexible and transparent tools such as the Open-Source Energy Modeling System for Costa Rica (OSeMOSYS-CR) and, later, the Climate, Land, Energy, and Water (CLEW-CR) framework. The development of OSeMOSYS-CR, focused initially on the energy sector, played a pivotal role in refining the NDP and supporting its implementation (UCR & KTH, 2020). The CLEW model expands upon the initial energy sector model by providing a more holistic view, ensuring cross-sectoral coherence and enabling more strategic decision-making.

Costa Rica's innovative use of the CLEW framework has not only reshaped sectoral governance but also laid the foundation for broader institutional integration. Its influence is evident in the development of the country's third Nationally Determined Contribution (NDC 3.0), where CLEW continues to provide a strategic lens for aligning climate action with national development priorities. This integration reinforces Costa Rica's leadership in climate policy and supports clear, evidence-based pathways toward achieving both national and international sustainability targets.

Implementation challenges

Costa Rica's path to decarbonization also faces significant challenges. A first concern is aligning management instruments, international commitments, national plans, and public policies to avoid overlap, duplication, and inefficient use of public funds. The parallel existence of the National Strategic Plan 2050 (PEN 2050) from MIDEPLAN and the National Decarbonization Plan 2018–2050 highlights the need for robust inter-institutional coordination so that actions are optimized and priorities are aligned across public entities and relevant stakeholders, including the private sector and civil society (Contraloría General de la República, 2024). To address this, the government instituted a participatory design process

using the same actors responsible for both plans, ensuring that all relevant institutions, private sector representatives, and civil society voices coordinated under a unified platform.

A second, cross-cutting challenge is mainstreaming climate change across the entire public administration. Mitigation and adaptation are not the sole responsibility of MINAE or the Climate Change Directorate (DCC); they require political leadership, internal and external awareness-raising, and explicit integration of climate objectives into strategic and operational planning, including clear responsibilities, staffing, and dedicated budgets (Contraloría General de la República, 2024). To meet this need, the government implemented participatory processes during strategy formulation, embedding climate considerations across ministries and agencies so that the same actors responsible for policy planning also co-design targets, allocate resources, and monitor progress within their institutional mandates.

Significant gaps remain in measurement, reporting, and verification (MRV). Many projects lack methodologies to assess their impact, and databases are often incompatible with indicators used in national planning instruments. Many projects lack robust methodologies to assess their impact, and databases are often incompatible with indicators used in national planning instruments. This undermines traceability, transparency, and accountability. Strengthening SINAMECC was and remains essential to consolidate information, monitor progress, and inform timely, data-driven decisions (Contraloría General de la República, 2024).

Moreover, the impact of the planning frameworks has extended well beyond the energy or land-use sectors, shaping broader governance processes and policy continuity across electoral cycles. Although subsequent administrations have demonstrated varying levels of political commitment to climate action, the robust institutional embedding, technical credibility, and cross-sectoral support for these models have compelled even less ambitious governments to maintain and operationalize them. Their enduring presence in national planning reflects not only their technical

soundness, but also the widespread recognition of their value by public agencies, civil society, and international partners.

Finally, despite high levels of public awareness, environmental issues often remain at the margins of daily social and political life. Surveys indicate that most Costa Ricans recognize the importance of climate change, but engagement often stays at the level of individual practices rather than collective action or political advocacy. However, Costa Rica's climate ambition is increasingly reflected in the evolving landscape of civic engagement, particularly through the growing visibility of youth networks and civil society organizations advocating for sustainable urban development, low-carbon transportation, and environmental justice. Their involvement in national climate governance processes, such as the revision of the Nationally Determined Contribution (NDC) and the development of long-term decarbonization strategies, points to a shift toward more inclusive, participatory policy frameworks (La Ruta del Clima, 2023). While youth engagement continues to be largely centered on individual environmental practices, there is increasing emphasis on integrating collective civic participation into structured climate governance processes (Programa Estado de la Nación, 2023).

Additional effort to decarbonization

Alongside this technical evolution, Costa Rica is also fortifying its financial infrastructure to sustain climate ambition. A major milestone was the 2023 launch of the Sustainable Finance Taxonomy, developed by the Ministry of Environment and Energy (MINAE) and the General Superintendency of Financial Institutions (SUGEF), with support from UNEP and the European Union via EUROCLIMA+ (UNEP, 2023). The taxonomy defines criteria for identifying climate-aligned economic activities, helping public and private actors align investments with national mitigation, adaptation, and environmental objectives. By offering standardized tools for financial institutions, the taxonomy enhances transparency, builds investor confidence, and accelerates the scaling of green finance.

These efforts are complemented by innovative financial mechanisms. In 2024, Banco Nacional de Costa Rica (BNCR) issued the country's first blue bond in partnership with IDB Invest, raising US\$50 million for marine conservation, sustainable water and waste systems, and circular economy initiatives. The bond, aligned with international sustainability standards, attracted capital from FinDev Canada and LAGreen, underscoring growing confidence in Costa Rica's environmental finance architecture (IDB Invest, 2024).

Expanding this portfolio, BNCR launched the Pura Verde program in 2025, a credit facility providing preferential financing for environmentally beneficial projects across renewable energy, clean transportation, sustainable agriculture, and water management (Banco Nacional de Costa Rica, 2025). Developed with the support of AFD and the European Union, the program applies rigorous eligibility and impact verification criteria aligned with the national taxonomy. While specific modeling tools were not disclosed, the program's design suggests the use of structured assessment methodologies to ensure consistency, transparency, and measurable environmental returns (Steer Group, 2024).

IMPACTS OF PUBLIC POLICIES ON KEY SECTORS, SOCIETY AND GLOBAL ECONOMY

Positive impacts of climate change mechanisms across key sectors

Governance reforms have strengthened the institutional foundation for policy implementation, enabling measurable progress across sectors. A key example is the Law on Incentives and Promotion for Electric Transportation (Law No. 9518, 2018), which advances electromobility through fiscal and non-fiscal measures. By underpinning the transport pillar of the National Decarbonization Plan, the law supports Costa Rica's NDC under the Paris Agreement and demonstrates alignment between domestic policy, international commitments, and early energy-sector modeling (IRENA, 2021).

Within this evolving governance landscape, the Sugarcane NAMA also stands out. Although designed for mitigation, its real innovation is the way it builds data systems and traceability into agricultural policy from the start. In the pilot phase, the full package of planned activities is implemented, and all indicators are measured to test and validate technologies that (1) raise agro-industrial productivity and (2) reduce total GHG emissions ($\text{tCO}_2\text{e}\cdot\text{yr}^{-1}$). The pilot also generates the high-quality datasets needed to calibrate the emissions model (LAICA, 2022).

That model then became the decision engine for scaling up. Using pilot data, it quantified expected abatement and productivity gains by region and technology package, set baselines, and defined adoption trajectories across the six sugarcane-producing regions. It also underpinned three feasible scaling scenarios, allowing policymakers to compare trade-offs (abatement potential, cost, and speed of adoption), allocate incentives and finance, and set realistic annual targets. As the intervention expanded, the model fed into a standardized MRV and traceability system, enabling course corrections and ensuring that the commercial rollout delivered both productivity improvements and verifiable emissions reductions (LAICA, 2022).

Finally, adaptation planning is also being reshaped by modeling innovations. Advanced tools, such as integrated vulnerability assessments and climate risk scenarios, are enabling countries to anticipate climate impacts across agriculture, infrastructure, water systems, and public health. Costa Rica has begun investing in these capabilities, reflecting a shift toward proactive and data-informed adaptation policies that guide resource allocation and build systemic resilience.

Together, these initiatives illustrate how Costa Rica is translating its climate vision into concrete, system-level interventions, combining data-driven planning, innovative finance, and institutional coordination. They also demonstrate the country's ability to anticipate global trends and respond with integrated, locally grounded solutions that reinforce its commitment to a just, resilient, and low-emission future.

Social and economic impact of the National Decarbonization Plan

Costa Rica's transition to decarbonization is planned to deliver sizable socio-economic gains. Implementing the National Decarbonization Plan (PND) yields an estimated net economic benefit of US\$41 billion by 2050 (about 64% of 2019 GDP), with major contributions from the energy and transport sectors. Beyond GDP, expanded public transport would cut congestion and accidents, while lower emissions improve cardio-respiratory health. Although transport decarbonization has fiscal implications, the analysis finds these are smaller than the benefits and can be managed through smart fiscal adjustments that fairly distribute gains. International evidence also points to broad labor benefits: moving toward net-zero in Latin America and the Caribbean could create 15 million net jobs by 2030, and coupling clean energy with e-mobility could reach 35 million net jobs by 2050 (AFD, 2022).

For Costa Rica specifically, investing in renewables, sustainable mobility (electrification, public transit, active mobility), and digitalized institutions could generate 135,000 net jobs by 2050. Of these, roughly 24,000 are direct jobs in transforming activities, 70,000 are indirect through supply-chain linkages, and more than 41,000 are induced by higher household spending. The transition is also inclusive: just over 30% of these jobs would be filled by women, and about 10% by people with disabilities, migrants, or Indigenous peoples. Most employment would concentrate in commerce, clean energy production, water distribution and sanitation, education, and information and communications (AFD, 2022).

Job creation is expected to accelerate over time. In the short term (2021–2025), around 11,000 net jobs are tied to energy, transport, and education activities. This figure quintuples in the medium term (2026–2035) as large, transformative investments come online across the 3D economy. In the long term (2036–2050), consolidation and the mass uptake of electromobility could lift net job creation to about 65,000 (AFD, 2022).

Targeted policy can maximize these gains. By 2050, renewables and sanitation systems alone could add approximately 52,000 jobs; new commercial activities and business models around electromobility add approximately 27,000 and 3,000 jobs, respectively; ICT contributes approximately 14,000; and transport (public and ecotourism) adds approximately 16,000. As sectoral linkages and household consumption patterns evolve, public policy should closely monitor new value-chain connections and respond proactively, with enabling laws, standards, and well-designed incentives or subsidies, to keep the transition aligned with 3D objectives and to equitably distribute its benefits across the population (AFD, 2022).

CONCLUSIONS

Costa Rica's climate trajectory challenges traditional assumptions about what constitutes leadership in the global transition. It demonstrates that transformational change is not the exclusive domain of major economies but can also emerge from countries that are willing to lead with conviction, coherence, and creativity.

Ambition before certainty: leading by doing.

Costa Rica has repeatedly chosen to act in the absence of guarantees, setting bold decarbonization targets, piloting sectoral policies, and institutionalizing climate governance even when outcomes were not assured. This “act first, refine later” ethos reveals a national identity grounded in ecological responsibility and political courage. Rather than waiting for consensus, Costa Rica has often created the precedent.

Costa Rica's distinctiveness lies not only in its ambition, but in its investment in reducing uncertainty through knowledge. The country has embedded science into governance, developing national models, MRV systems, and integrated planning tools that enable scenario analysis, adaptive management, and transparent accountability. Science thus becomes a strategic enabler, turning deep uncertainty into informed, iterative action.

Inspired by Costa Rica's success, several Latin American countries have been expressing interest in adopting and customizing similar modeling frameworks. This trend underscores a growing regional recognition of the value of comprehensive, flexible, and integrated planning tools in enhancing governance, improving policy coherence, and effectively addressing complex climate challenges.

For example, in the Dominican Republic, the CLEW framework has been combined with Robust Decision Making (RDM) methodologies to inform long-term decarbonization strategies under deep uncertainty. This case illustrates the broader potential of integrated modeling and decision-support tools to guide resilient and adaptive climate planning across diverse institutional and socio-economic contexts (Rodríguez-Arce et al., 2021; Quirós-Tortós et al., 2024).

International cooperation support

International cooperation can accelerate Costa Rica's path to carbon neutrality by channeling concessional, results-based finance into the country's biggest near-term levers, grid resilience, zero-emission public transport, and drought-proof power, while expanding results-based forest finance to scale FONAFIFO's Payment for Environmental Services, especially in indigenous territories and biodiversity corridors. Credit lines from development banks can de-risk clean industry and build upgrades, and targeted support can scale the agriculture NAMAs. All cooperation should be tied to 2026–2028 milestones, with clear adoption targets to keep progress measurable. Over time, the goal is to transition toward a self-financing system in which early grants and concessional loan crowd in private capital and are gradually replaced by durable domestic revenue streams, so programs can sustain themselves without ongoing external support.

Alignment is the engine of transformation.

Costa Rica's experience shows that true ambition only delivers results when governance, finance, and technical planning are aligned. Its climate

architecture, built on participatory planning, robust data systems, and sustainable finance mechanisms like taxonomies and blue bonds, enables the translation of long-term goals into actionable pathways. This systemic alignment enhances resilience, credibility, and investor trust, reinforcing the country's capacity to sustain its leadership role even in challenging political or economic contexts.

As the world searches for models of transformational yet grounded climate action, Costa Rica shows its strong environmental leadership and pioneering role in climate action, notably through the leadership of Christiana Figueres in achieving the Paris Agreement. The country actively participates in the UN Framework Convention on Climate Change (UNFCCC), serves as a co-leader in climate conferences, and is a member of negotiating groups like the Independent Association of Latin America and the Caribbean (AILAC) (UNFCCC, 2020).

Costa Rica's climate journey is more than a technical roadmap; it is a statement to the power of purposeful governance, societal alignment, and strategic risk-taking in the face of global uncertainty. By prioritizing ambition over delay, embedding science in decision-making, and fostering systemic coherence across sectors and scales, the country offers a living example of how small states can shape big transitions. Its leadership illustrates that climate action is not only a moral imperative but a pragmatic strategy for national development, resilience, and global influence.

REFERENCES

- AFD (2022). *El empleo en un futuro de cero emisiones netas en Costa Rica: Las energías renovables como habilitador de amplios beneficios para el país* (Questions de développement, n.º 59). Agence Française de Développement. https://www.afd.fr/sites/default/files/2022-10-11-31-25/QDD_59_VE_v2_BD.pdf
- Asamblea Legislativa de la República de Costa Rica. (2018). Ley N.º 9518: Incentivos y promoción para el transporte eléctrico. La Gaceta, Alcance N.º 26 a la Gaceta N.º 21. https://www.imprentanacional.go.cr/pub/2018/02/06/ALCA26_06_02_2018.pdf
- Blum, N. (2008) Environmental education in Costa Rica: building a framework for sustainable development? *International Journal of Educational Development*, 28(3): 348-358
- Costa Rica energy profile. International Renewable Energy Agency (IRENA). (2021). Policies for renewable energy in cities: Case studies – Costa Rica. <https://www.irena.org/publications/2021/Nov/Policies-for-Renewable-Energy-in-Cities-Costa-Rica>
- Estado de la Nación. (2023). Informe Estado de la Nación en Desarrollo Humano Sostenible. Programa Estado de la Nación.
- Frontiers in Climate. (2024). Electricity decarbonization in the Dominican Republic using robust decision making. <https://bvearmb.do/bitstream/handle/123456789/4671/fclim-06-1380382.pdf>
- IDB Invest. (2024, July 15). IDB Invest champions Costa Rica's inaugural blue bond. <https://www.idbinvest.org/en/news-media/idb-invest-champions-costa-ricas-inaugural-blue-bond>
- Instituto Costarricense de Electricidad (ICE). (2020). Costa Rica: A sustainable model, unique in the world – Energy matrix. ICE. Retrieved July 7, 2025, from <https://www.grupoice.com/wps/wcm/connect/d1121f13-4784-48dd-9b13-f9a17e0aeb11/Matriz%2Belectrica%2BINGLES.pdf?MOD=AJPERES>
- International Energy Agency. (n.d.). Costa Rica energy profile. IEA. Retrieved July 7, 2025, from <https://www.iea.org/reports/costa-rica-energy-profile>
- La Ruta del Clima. (2023, September 21). La juventud de Costa Rica exige respuestas a las contribuciones climáticas del país. <https://larutadelclima.org/2023/09/21/la-juventud-de-costa-rica-exige-respuestas-ndc>
- Liga Agrícola Industrial de la Caña de Azúcar. (2022). *NAMA caña de azúcar Costa Rica: Manual descriptivo y operativo del piloto nacional*. <https://www.mag.go.cr/bibliotecavirtual/P40-11129.pdf>
- Ministerio de Agricultura y Ganadería (MAG). (2022). Plan Nacional de Acción de Mitigación del Cambio Climático para el sector agropecuario: Caña de azúcar (NAMA Caña). Gobierno de Costa Rica.
- Ministerio de Ambiente y Energía (MINAE). (2023). Estrategia Nacional de Economía Circular. <https://minae.go.cr/documentos/archivos/Estrategia%20Nacional%20de%20Economia%20Circular%20CR.pdf>

- Ministerio de Ambiente y Energía. (2019). Plan Nacional de Descarbonización 2018–2050.
- Ministerio de Ambiente y Energía. (2020). Programa País Carbono Neutralidad 2.0.
- Ministerio de Ambiente y Energía. (2022). Plan Nacional de Adaptación al Cambio Climático 2022–2026.
- Ministerio de Ambiente y Energía & CIMS. (2019). Herramientas de modelación para el Plan Nacional de Descarbonización. Centro Internacional de Política Económica para el Desarrollo Sostenible.
- Ministerio de Ambiente y Energía & Inter-American Dialogue. (2021). Evaluación económica del Plan Nacional de Descarbonización.
- Ministerio de Ambiente, Energía y Telecomunicaciones (MINAET). (2011). Plan Nacional de Desarrollo Forestal 2011–2020 (1a ed.). San José, Costa Rica: Comunicaciones Milenio
- Ministerio de Planificación Nacional y Política Económica. (2023). Plan Nacional de Desarrollo y de Inversión Pública 2023–2050.
- NAMA Facility. (2022, March 23). Costa Rica celebrates transformational change in coffee production. <https://mitigation-action.org/news/costa-rica-celebrates-transformational-change-in-coffee-production/>
- Programa Estado de la Nación. (2023). Informe Estado de la Nación en desarrollo humano sostenible: Resumen ejecutivo (30.º ed.). Consejo Nacional de Rectores (CONARE). https://estadonacion.or.cr/wp-content/uploads/2023/11/PEN_informe_estado_nacion_resumen-2024.pdf
- Quirós-Tortós, J., Gallardo, L. V., Rodríguez-Arce, M., & Howells, M. (2024). Integrating CLEW and RDM to develop long-term climate strategies in the Dominican Republic. European Commission Climate Knowledge Portal. <https://ec.europa.eu/newsroom/clima/items/863755/>
- RAND Corporation, EPERLab, & Inter-American Development Bank. (2023). Costa Rica Integrated Decarbonization Pathways Model: A Decision Support Tool for Robust Climate Policy Implementation. RAND Corporation. https://www.rand.org/content/dam/rand/pubs/research_reports/RRA600/RRA633-1/RAND_RRA633-1.pdf
- Rodríguez-Arce, M. et al. (2021). Integrated Climate, Land, Energy, and Water Framework to Support the Nationally Determined Contribution Updating Process. UK Government Research for Development Outputs. <https://www.gov.uk/research-for-development-outputs/integrated-climate-land-energy-and-water-framework-to-support-the-nationally-determined-contribution-updating-process>
- United Nations Environment Programme. (2023, February 28). Costa Rica lanza proyecto para reforzar su marco de finanzas sostenibles. <https://www.unep.org/es/noticias-y-reportajes/comunicado-de-prensa/costa-rica-lanza-proyecto-para-reforzar-su-marco-de>
- United Nations Framework Convention on Climate Change. (2019, September 20). *Costa Rica named 'UN Champion of the Earth' for pioneering role in fighting climate change*. <https://unfccc.int/news/costa-rica-named-un-champion-of-the-earth-for-pioneering-role-in-fighting-climate-change>
- Universidad de Costa Rica (UCR), & Royal Institute of Technology (KTH). (2020). OSeMOSYS-CR: Open-Source Energy Modeling System for Costa Rica [Technical paper and repository]. GitHub. <https://github.com/EPERLab/OSeMOSYS-CR>
- World Bank. (2021). Partnership for Market Readiness: Costa Rica program – Decarbonization pathways modeling in Costa Rica (Report No. 923041617603388931). <https://documents1.worldbank.org/curated/en/923041617603388931/pdf/Partnership-for-Market-Readiness-Costa-Rica-Program-Decarbonization-Pathways-Modeling-in-Costa-Rica.pdf>

A decade of national climate action: Stocktake and the Road Ahead

DOMINICAN REPUBLIC LONG-TERM STRATEGY: CLIMATE RESILIENCE AND ECONOMIC TRANSFORMATION

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A NEW PATH FORWARD: TURNING VULNERABILITY INTO LEADERSHIP

The Dominican Republic, a Small Island Developing State (SIDS), faces severe and accelerating climate risks—hurricanes, sea level rise, and prolonged droughts threaten lives, infrastructure, and economic stability. Yet this vulnerability has not led to paralysis. On the contrary, it has sparked a new national conversation about development: one that views climate action not as a cost, but as an enabler of resilience, energy security, and inclusive growth.

The country's high dependence on fossil fuels—about 82 % of electricity was generated from coal, oil, and gas in 2024¹—has long exposed it to volatile fuel prices, external shocks, and balance-of-payment pressures. Meanwhile, tourism accounts for 5–16% of GDP² and is highly sensitive to climate variability, while mining, though a small contributor to GDP, represents 12% of total exports³. These structural features have elevated the importance of transitioning to a more diversified and climate-resilient economic base.

¹ <https://mem.gob.do/wp-content/uploads/2025/01/Boletin-Informativo-Generacion-y-Gestion-Energia-2024-V.2.pdf>

² <https://bancentral.gov.do/a/d/2533-sector-real>, <https://www.unwto.org/investment/tourism-doing-business-investing-in-dominican-republic>

³ <https://bancentral.gov.do/a/d/2532-sector-externo>

The Dominican Republic's greenhouse gas emissions remain modest in global terms, but rising. Since 2005, national emissions have increased by roughly 35–40%, reflecting both economic expansion and a gradual shift in energy use⁴. The power sector has consistently been the largest source, growing from about one-fifth of total emissions in the mid-2000s to nearly 28% in 2015, as electricity demand rose and fossil-fuelled generation expanded⁵. Transport emissions have also climbed steadily, driven by rapid motorization and continued dependence on imported petroleum products. Waste-related emissions, particularly methane from landfills and open dumps, have become a more visible share of the inventory as urbanization has accelerated. By contrast, emissions from agriculture and industry have grown more moderately, with industry's share tied mainly to cement and mining. This trajectory highlights a pattern of increasing dependence on energy- and mobility-related emissions, while other sectors have remained comparatively stable⁶. While the country has valuable forest and coastal ecosystems, its carbon sink capacity remains limited and underutilized, with mangroves, in particular, receiving insufficient attention in mitigation planning⁷.

To address these interlocking vulnerabilities and emissions trends, the government has signalled its intention to transform its development model. It has committed to a 27% emissions reduction by 2030 under its updated Nationally Determined Contribution (NDC)—including a 7 % unconditional target—and is working toward a mid-century net-zero vision.

A significant catalyst in this transformation was the comprehensive assessment of the electricity sector conducted in 2022–2023, supported by the Inter-American Development Bank and Climate Lead Group. This study—based on open-source models and a robust participatory process—quantified the benefits of a renewable-driven energy

transition⁸. The analysis showed that shifting to a cleaner electricity system could reduce cumulative emissions by 140 MtCO₂, create over 160,000 jobs, and lower average electricity generation costs by 8 %, with an investment need of approximately USD 3.3 billion⁶.

Crucially, the study did more than produce numbers: it reshaped public and political discourse as detailed below. The findings brought to light the risks of continued fossil fuel dependence, the feasibility of a high-renewables future, and the tangible social and economic co-benefits of a low-carbon pathway. It helped position the electricity sector as a linchpin for broader climate and development objectives and provided a technical foundation for the emerging Long-Term Low-Emission Development Strategy (LT-LEDS). Though still pending official launch, the LT-LEDS was developed throughout 2024 and 2025 with support from the World Bank Group and technical assistance from the Climate Lead Group and the NTT Data consortium⁹ - section 2 further details key aspects of the LT-LEDS. It serves as a critical roadmap for aligning climate ambition with national development priorities. Importantly, it is not being developed in isolation: the LT-LEDS process is closely linked to ongoing reforms in the electricity, transport, land use, and waste sectors, and has already begun influencing policy thinking and institutional coordination.

The Dominican Republic's story offers a valuable case for other small, service-oriented island economies. It demonstrates how a crisis-prone context—marked by physical vulnerability, fiscal constraints, and capacity limitations—can evolve into a testing ground for long-term, systemic change. By anchoring climate ambition in evidence-based planning and inclusive dialogue, the country is charting a development path that is both feasible and future-facing.

⁴ https://edgar.jrc.ec.europa.eu/report_2023

⁵ <https://unfccc.int/sites/default/files/resource/Dominican%20Republic-%20BUR1.pdf>

⁶ <https://unfccc.int/sites/default/files/NDC/2022-06/Dominican%20Republic%20First%20NDC%20%28Updated%20Submission%29.pdf>

⁷ <https://repositorio.catie.ac.cr/handle/11554/11589>

⁸ <https://publications.iadb.org/es/evaluacion-economica-de-la-des-carbonizacion-del-sector-electrico-en-la-republica-dominicana>

⁹ <https://www.presidencia.gob.do/noticias/republica-dominicana-prepara-estrategia-de-largo-plazo-para-alcanzar-neutralidad-de>

ANCHORING LONG-TERM STRATEGY IN SUSTAINABLE DEVELOPMENT

Building on the momentum from sectoral breakthroughs, the Dominican Republic – through the Ministry of Economic Planning and Development (MEPyD, recently merged with the Ministry of Finance) and the National Council of Climate Change and Clean Development Mechanisms (CNCCMDL from its Spanish) – is now embedding climate ambition into the core of its national development planning. The goal is not simply to meet emissions targets, but to leverage climate strategies as a means to improve livelihoods, reduce inequalities, and modernize infrastructure. This approach reflects a shift from climate policy as a stand-alone agenda to climate as a structural lens through which development is assessed and reimaged.

A central feature of this effort is the adoption of the CLEWWI modelling framework—an integrated tool that links Climate, Land, Energy, Water, Waste, and Industry systems. Unlike conventional energy models that focus narrowly on generation or supply, CLEWWI enables planners to understand how interventions in one sector ripple across others. For example, decarbonizing the electricity sector affects land use through solar deployment, water demand through technology choice, and waste flows through industrial processing. It also allows for simulation of equity impacts and regional trade-offs—critical in a country marked by spatial inequalities and resource constraints.

The CLEWWI model underpins the technical foundation of the draft LT-LEDS, enabling the government to analyze long-term mitigation pathways in a way that is responsive to national realities. Importantly, this modelling work has been developed in parallel with the update of the National Development Strategy 2030 (NDS 2030). With support from United Nations – Department of Economic and Social Affairs (UNDESA), national consultants, and the Climate Lead Group, the government is revisiting its long-term development vision with a view to incorporating sustain-

ability, resilience, and decarbonization as core pillars. The NDS 2030 is the Dominican Republic's highest-level planning instrument, setting out four overarching objectives: strengthening democratic governance, ensuring a society free of poverty and inequality, achieving a competitive and environmentally sustainable economy, and fostering territorial cohesion. First adopted in 2012, the strategy provides continuity across administrations and serves as the backbone for sectoral plans and budget allocations. Its ongoing update offers a critical window to embed climate ambition at the heart of national development priorities.

This long-term framework does not operate in isolation but is articulated with other key national strategies. The NDS 2030 provides the overarching vision, while the updated *Nationally Determined Contribution (NDC)* sets near- and medium-term climate commitments, and the draft LT-LEDS establishes the mid-century decarbonization pathway. Sectoral instruments—such as the *Indicative Power Expansion Plan*, the *National Energy Policy 2021–2036*, and the forthcoming *Transport Electrification Roadmap*—translate these objectives into concrete actions at the sector level. Together, these instruments form a nested hierarchy: the NDS 2030 as the guiding umbrella, the NDC and LT-LEDS as climate-specific roadmaps, and sectoral plans as implementation vehicles. This articulation ensures that climate ambition is mainstreamed into development priorities while preserving coherence across planning horizons and institutional mandates.

This convergence of climate and development planning is timely. The country faces mounting infrastructure gaps, territorial disparities, and service delivery challenges—especially in transport, water, and waste management. At the same time, it is grappling with high electricity losses and underinvestment in distributed energy. Without long-term alignment, short-term policy decisions risk locking in carbon-intensive trajectories or worsening social inequities.

The LT-LEDS offers a structured process to avoid these risks. It provides a common reference point for ministries, development banks, and private

investors, guiding investment toward projects that deliver both mitigation benefits and socio-economic returns. For instance, electrification of public transport could reduce emissions while also addressing air pollution and improving mobility for low-income communities. Similarly, shifting from open dumps to controlled waste management offers mitigation gains alongside public health improvements.

Beyond its role as a long-term vision, the LT-LEDS has also acted as a catalyst for other climate policy processes. The analytical results and participatory discussions that shaped the strategy directly informed the revision of the *Indicative Power Expansion Plan*, which is now more closely aligned with renewable energy and storage targets. In parallel, the LT-LEDS scenarios are expected to support the *National Development Strategy 2030*, embedding low-carbon pathways and resilience objectives into a document that guides sectoral investment. The process also provided technical evidence for the transport sector's emerging electrification roadmap—prioritizing electric buses and charging infrastructure in Santo Domingo and Santiago—and reinforced regulatory discussions on waste management reforms, including the transition from open dumping to controlled landfills.

These links illustrate how the LT-LEDS has served more as a driver of policy coherence than as a stand-alone document. By establishing common baselines, conducting cost-benefit analyses, and facilitating multi-sectoral dialogues, the strategy has given decision-makers the confidence to advance reforms that were previously stalled. In this way, it is already contributing to concrete emissions reductions through sectoral policies and investment signals, while also building the institutional habit of integrating climate considerations into core development decisions.

What distinguishes the Dominican Republic's approach is the deliberate effort to align technical modelling with institutional coordination. The LT-LEDS process has been inclusive, involving line ministries, civil society, and local governments from the outset. A series of structured consultations was held in 2024, including national work-

shops convened by MEPyD and CNCCMDL with participation from energy, transport, land-use, and finance institutions. Civil society organizations, academia, and representatives from the private sector were invited to co-design scenarios and assess their socioeconomic implications. Local governments from Santo Domingo, Santiago, and coastal municipalities joined consultations on land use and waste management, bringing territorial perspectives often absent from national planning. These dialogues provided a forum to discuss policy trade-offs—such as the balance between renewable energy deployment and land availability—and helped identify enabling conditions like regulatory reform, capacity building, and access to finance. This consultative process strengthens policy ownership and increases the likelihood that long-term strategies will be implemented, rather than shelved.

In sum, while the strategy is still in formation, the Dominican Republic has laid important institutional and analytical foundations. It is advancing an integrated model of development in which climate action is not an add-on, but a means to address structural gaps, empower local institutions, and guide investments toward a more equitable and sustainable future.

FROM ELECTRICITY TO ECONOMY-WIDE ACTION: BUILDING MOMENTUM FOR DECARBONIZATION

Among the many decarbonization opportunities in the Dominican Republic, the electricity sector stands out as the most actionable and impactful. It represents nearly 28 % of national emissions and is almost entirely fossil fuel-based—over 80% of power generation is derived from imported coal, oil, and gas. The country's energy matrix has historically been a source of economic vulnerability, amplifying exposure to global fuel price volatility and weakening its trade balance. However, it is also a space of opportunity where the alignment between climate, economic, and energy security goals is most visible.

This recognition catalyzed the 2022–2023 electricity sector decarbonization study, supported by the Inter-American Development Bank and Climate Lead Group. Using an open-source optimization model (MAURISE-RD, based on OSeMO-SYS), the study evaluated scenarios ranging from business-as-usual expansion to high-renewables and deep decarbonization. Results showed that a clean energy transition could reduce cumulative emissions by 140 MtCO₂ between 2022 and 2050, lower generation costs by 8 %, create more than 160,000 jobs, and attract over USD 3.3 billion in new investments.

Equally important, the study reshaped the public discourse around the energy transition. Policy-makers across government agencies began reassessing long-term investment signals, distributed generation policies, and power market regulations. Utilities and energy authorities recognized the value of integrating storage, updating grid codes, and supporting distributed energy resources. The study also helped position electricity decarbonization as the cornerstone of the country's broader climate strategy and an essential pillar of the draft LT-LEDS.

However, transforming potential into reality will require overcoming structural barriers. Existing regulatory frameworks still favor conventional generation and offer limited incentives for flexibility, storage, or demand-side participation. Project permitting processes are slow and fragmented, with significant delays at the municipal level. Tariff structures and procurement modalities remain misaligned with long-term decarbonization objectives, and grid infrastructure requires substantial reinforcement.

To address these barriers, the LT-LEDS process has initiated discussions on updating the Indicative Generation Expansion Plan, incorporating grid-enhancing technologies (GETs), and improving land-use planning for renewable deployment. It has also called for stronger links between electricity sector governance and climate policy. These links are currently under discussion in the country. These actions aim to shift the focus from short-term reliability concerns to long-term system resilience, cost-effectiveness, and emissions performance.

BEYOND ENERGY: UNLOCKING CROSS-SECTORAL SYNERGIES

While the electricity sector provides a clear entry point, the Dominican Republic's mitigation efforts must go well beyond energy. Several non-energy sectors—transport, land use, waste, and industry—contribute significantly to emissions and face pressing sustainability challenges. In transport, emissions have grown steadily due to increased vehicle ownership and fossil-fueled road transport. The current system is dominated by light-duty private vehicles, with limited investment in mass transit. Electrification of fleets, especially public and commercial vehicles, offers clear mitigation benefits. However, modal shift, compact urban design, and mobility-as-a-service solutions are equally important. Without these, electrification could increase congestion and electricity demand in an uncoordinated manner.

In land use, while the Dominican Republic has forested areas and coastal ecosystems with mitigation potential, carbon sinks are under pressure from urban expansion and unsustainable practices. The emissions inventory lacks detailed accounting of these sinks—especially mangroves and wetlands—and current policy frameworks offer limited protection. Enhanced mapping, modelling, and institutional mandates are needed to integrate these ecosystems into mitigation planning and adaptation strategies, including measures such as expanding protected areas for mangroves and coastal wetlands, introducing payment for ecosystem services schemes to incentivize forest conservation, strengthening enforcement against illegal logging and land conversion, and advancing restoration programs for degraded mangrove belts and watersheds. Integrating nature-based solutions—such as coastal buffers and urban green corridors—into adaptation plans would also reinforce both carbon storage and resilience to storms, flooding, and heat stress. Waste management is another high-impact sector. Methane from organic waste, open dumps, and poor landfill practices contributes to

national emissions while generating severe environmental and health risks. Scaling up composting, controlled landfilling, and bioenergy recovery could reduce emissions and support circular economy goals. The strategy highlights the need for data improvement, performance-based financing for municipalities, and stronger mandates for local governments.

Industrial processes, including cement and mining, also present mitigation opportunities, particularly in energy efficiency and fuel switching. While the sector is a smaller emissions source relative to energy and transport, its strategic importance for exports and employment warrants attention in the long-term strategy.

The CLEWWI model has proven instrumental in revealing cross-sectoral trade-offs. For instance, large-scale bioenergy development affects land and water systems; transport electrification reshapes electricity demand curves; and waste-to-energy solutions intersect with both land use and power planning. Understanding these linkages has helped the government avoid fragmented or conflicting policy decisions and prioritize interventions with multiple co-benefits.

Overall, by moving beyond an energy-centric approach, the Dominican Republic is embracing a more systemic view of decarbonization. This broader framing will be critical to align different policy instruments (i.e., LT-LEDS, NDS 2030, NDCs), mobilize investment, and deliver climate action that supports inclusive and resilient development.

KEY ENABLING CONDITIONS TO MOVE FROM PLANS TO ACTION

Developing a robust long-term strategy is a necessary first step, but turning plans into implementation requires a broader enabling ecosystem. In the Dominican Republic, four key enabling conditions will shape the success of its low-emission development trajectory: institutional coordination, regulatory reform, data and modelling capacity, and access to finance.

Existing measures and progress to date

While many reforms are still in preparation, the Dominican Republic has already advanced a number of measures that signal the shift toward a more climate-aligned policy framework. In the energy sector, the *National Energy Plan 2022–2037* outlines the established renewable energy targets and highlights the regulatory framework for independent power producers, which has led to the auctioning of new solar and wind projects. The revision of the *Indicative Generation Expansion Plan* now incorporates renewable generation and storage, and the electricity regulator has begun consultations on grid codes that recognize the role of distributed energy resources and storage technologies.

In transport, progress is evident in the introduction of fiscal incentives for electric vehicles, including exemptions from import duties and reduced circulation fees. Pilot programs for electric buses have been launched in Santo Domingo, supported by international finance, and the Ministry of Transport is developing a roadmap for wider electrification of public fleets. Complementary measures such as the modernization of the metro and cable-car systems also contribute to a shift toward low-emission mobility.

On the land-use and ecosystem side, the government has expanded conservation areas in coastal zones, strengthened reforestation programs under *Quisqueya Verde*, and launched community-led mangrove restoration projects in Montecristi and Samaná. Waste sector reforms are also underway: the *General Law on Integral Solid Waste Management* (2020) prohibits open dumping and establishes guidelines for recycling and controlled landfilling, with municipalities gradually adopting compliance measures.

These initiatives represent important building blocks of the ongoing reform agenda referenced in the introduction. Although not yet sufficient to put the country on a net-zero trajectory, they provide concrete entry points for scaling up ambition through the LT-LEDS. Linking these measures with long-term planning instruments increases their coherence and ensures they

contribute not only to emission reductions but also to resilience, job creation, and service delivery improvements.

Strengthening institutional coordination

The country's climate governance architecture remains fragmented. Multiple ministries and agencies share responsibility for climate, energy, transport, land, and waste, with limited mechanisms for cross-sectoral coordination. While the Ministry of Environment leads the climate agenda, implementation responsibilities are scattered across technical institutions, regulators, and local governments.

The LT-LEDS process has begun to address this through inter-institutional technical working groups, stakeholder mapping, and joint scenario design. However, institutional memory and staff turnover pose challenges for continuity. Establishing a permanent inter-ministerial committee on climate strategy—with clear mandates, budgetary authority, and planning functions—would enhance coherence, improve accountability, and streamline decision-making.

Advancing regulatory reform and planning alignment

Misalignments between regulatory frameworks and climate goals risk locking in carbon-intensive infrastructure. Power purchase agreements (PPAs), land-use codes, fuel subsidies, and public procurement rules are often inconsistent with decarbonization objectives. For instance, while the National Energy Commission (CNE) promotes renewable energy, procurement processes still tend to favor centralized fossil fuel plants.

To enable low-carbon investment, regulations must evolve to recognize system-wide value, not just short-term costs. This includes enabling remuneration for storage and flexibility, improving permitting frameworks for renewable projects, and mainstreaming climate criteria into infrastructure planning. Crucially, regulatory reforms should also reflect social inclusion, ensuring that underserved communities benefit from clean energy access, mobility, and resilient infrastructure.

Building national data and modelling capacity

A foundational enabler for climate action is the ability to plan, model, and monitor complex transitions. The Dominican Republic has made strides through the CLEWWI model and tools like MAURISE-RD, which were co-developed with national consultants and international partners. These tools have helped visualize trade-offs, test policy levers, and inform stakeholder dialogues. Still, technical capacity gaps persist—especially in sector-specific institutions and local governments. Data systems remain fragmented, with limited interoperability between agencies. Key gaps exist in land-use change monitoring, transport emissions tracking, waste flows, and distributed energy uptake. The LT-LEDS process has called for the establishment of an integrated national climate data platform, investment in localized MRV systems, and continuous training programs to expand national analytical capacity.

Mobilizing climate finance and investment mechanisms

Even with strong planning and governance, ambitious climate action requires significant investment. The electricity transition alone is estimated to require USD 3.3 billion in additional capital by 2050 (relative to a baseline scenario), while transport, waste, and land interventions will add further demands. Yet access to concessional finance and blended investment instruments remains limited, and national banks have not yet mainstreamed climate criteria.

To close the gap, the government is exploring partnerships with development finance institutions, green bond issuances, and climate investment funds. There is also space to use public finance more strategically—for example, to de-risk early-stage projects, aggregate small-scale investments, or pilot innovative business models. Coordination between the Ministry of Finance, Ministry of Economy, and sectoral institutions is crucial to align budgets, investment plans, and international funding opportunities.

GOVERNANCE AND INSTITUTIONAL COORDINATION: TOWARD CLIMATE COHERENCE

Over the past two years, the Dominican Republic has made tangible progress toward more integrated climate governance. While institutional fragmentation and overlapping mandates remain challenges, there is a growing recognition across ministries that climate policy requires coordinated, cross-sectoral action.

The LT-LEDS process helped catalyze this shift by fostering dialogue between key actors—including the ministries of Environment, Economy, Energy, and Finance—around shared long-term goals. Technical teams from sectoral institutions worked together to co-develop scenarios, enabling a common understanding of emissions drivers and potential mitigation pathways. This collaboration laid the groundwork for greater policy alignment and institutional buy-in.

Progress is also evident in the increased efforts to integrate climate targets into existing planning frameworks. For instance, MEPyD (now in the Ministry of Finance) is working to reflect the LT-LEDS insights in the upcoming revision of the DNS 2030. Likewise, the National Energy Commission has begun incorporating decarbonization considerations into energy expansion plans such as the Generation Expansion Plan.

Despite these advances, gaps remain—particularly in vertical coordination with subnational governments, which are essential to implement land use, transport, and waste interventions. Municipalities are often under-resourced and disconnected from national planning processes, limiting the feasibility of local climate action.

To address these challenges, the LT-LEDS recommends strengthening interministerial coordination mechanisms and investing in institutional capacity at all levels of government. The transition toward a more collaborative climate governance model is still underway, but recent progress offers a strong foundation to build on. The transition envisioned in the LT-LEDS is not only about emissions reduction but also about shaping a more inclusive development trajectory.

Modelling exercises and stakeholder consultations have consistently shown that decarbonization can generate significant employment gains, particularly in renewable energy, energy efficiency, sustainable transport, and ecosystem restoration. Estimates from the electricity transition study suggest that more than 160,000 jobs could be created by 2050, many of them in construction, operations, and maintenance of renewable infrastructure. Complementary investments in transport electrification and waste management are also expected to spur local economic activity and improve service delivery, with positive spillovers for small and medium-sized enterprises.

Equally important are the social and distributional dimensions of the transition. Poverty reduction and resilience building are central to the Dominican Republic's development priorities, and the LT-LEDS process has emphasized the need to align climate action with these objectives. For example, expanding access to clean and affordable energy can reduce household expenditure on fuel imports, while electrification of public transport can lower commuting costs and improve air quality in urban areas—benefits that disproportionately help low-income and vulnerable groups. Community-led reforestation and mangrove restoration projects further provide livelihoods while strengthening adaptation to storms and coastal flooding. Embedding these social co-benefits into the design of climate policies not only enhances their legitimacy but also ensures that the transition is coherent with the country's broader goals of equity and poverty reduction.

MOBILIZING IMPLEMENTATION THROUGH INTERNATIONAL COOPERATION

International support has played a critical role in shaping the Dominican Republic's emerging climate strategy—and remains essential as the country pivots from planning to implementation. This cooperation spans technical assistance, climate finance mobilization, and capacity-building across sectors.

Global partnerships and technical assistance

The development and refinement of the LT-LEDS have benefited significantly from technical and financial support by international actors. Additionally, the country's engagement with the Data-to-Deal (D2D) approach – deployed in countries by Climate Lead Group and established by the Climate Compatible Growth programme – has enhanced capacity in translating data into climate finance pipelines, marking a shift toward evidence-driven, globally connected policy frameworks¹⁰.

Mobilizing climate finance: successes and remaining gaps

Between 2010 and 2018, the Dominican Republic received approximately USD 1.5 billion in international climate-related finance—mostly from multilateral development banks (57%) and bilateral sources (41), focusing disproportionately on mitigation projects in energy, agriculture, and transport¹¹. These inflows have supported early-stage action including energy planning, waste management, and adaptation.

In recent years, sectoral finance mobilization has strengthened:

- The IDB-supported electricity decarbonization study (2022–2023) provided a business case for renewables and scalability.
- USD 200 million from the IDB's "Climate Resilience Program for Bridge Infrastructure" is earmarked for enhancing transport and water infrastructure resilience
- Alignment with UNFCCC finance mechanisms—such as GCF readiness proposals—has enabled access to catalytic funds, though full project pipelines are still pending.

These developments reflect strong early momentum, but also underscore that **climate finance needs far outstrip current coverage**. Global financing benchmarks suggest developing countries require above **USD 1 trillion annually** by 2030, yet only about USD 150 billion was mobi-

lized in 2020¹²—mostly for energy, with adaptation lagging behind¹³. Caribbean SIDS like the Dominican Republic have struggled to access their fair share, often receiving grants rather than loans and facing fragmented finance streams¹⁴.

The Data-to-Deal agenda

New global initiatives offer opportunities to scale up both funding and local ownership:

- The **Data-to-Deal (D2D)** framework emphasizes “bridging the gap between climate data and finance deals” for Low and Middle Income Countries (LMICs). It calls for integrating technical modelling, political engagement, capacity building, policy reform and finance strategy—exactly the approach the Dominican Republic is following.
- At COP29, developed countries agreed to channel at least **USD 300 billion annually by 2035** to developing nations (with a USD 1.3 trillion ambition)¹⁵—if this commitment materializes, it could unlock new funding for grid modernization, transport electrification, and nature-based solutions.

Next steps: broadening funding, deepening inclusion

To optimize these opportunities, the Dominican Republic must:

- **Expand project pipelines** to include transport, waste-to-energy, ecosystem restoration, and water management—linked directly to the LT-LEDS and NDC.
- **Design blended finance mechanisms** that de-risk private investment while crowding in concessional and multilateral funds (e.g., via D2D-style projects).
- **Strengthen domestic finance architecture**, including green bonds and climate criteria in public investment systems (UNFCCC NBF roadmap).

¹⁰ <https://www.cambridge.org/engage/coe/article-details/6602ec3c66c1381729e01b1b>

¹¹ https://unfccc.int/sites/default/files/resource/UNFCCC_NBF_TA_DRepublic_2022_1.pdf

¹² <https://www.iea.org/reports/financing-clean-energy-transitions-in-emerging-and-developing-economies/executive-summary>

¹³ https://www.oecd.org/content/dam/oecd/en/publications/reports/2023/11/climate-finance-provided-and-mobilised-by-developed-countries-in-2013-2021_517fec8e/e20d2bc7-en.pdf

¹⁴ <https://www.sei.org/mediamanager/documents/Publications/SEI-WP-2017-climate-finance-caribbean.pdf>

¹⁵ https://unfccc.int/sites/default/files/resource/cma2024_L22E.pdf

- **Engage subnational governments in finance mobilization**, enabling municipalities to access resilience funding and invest in local mitigation projects.
- **Accelerate readiness activities**, including capacity-building, project preparation, and transparent data systems to meet donor requirements and attract climate finance.

CONCLUSION: THE ROAD AHEAD

The Dominican Republic stands at a critical juncture. It has:

- **Sequenced its entry** by starting with electricity—the sector with high emissions and quick returns;
- **Built a governance ecosystem** using integrated modelling and cross-sector coordination;
- **Mobilized initial finance**, and shown increasing competence in accessing global climate funds.

Yet the scale and complexity of the climate challenge demand escalation. The country must now shift from discrete interventions to systemic change—integrating finance, institutional innovation, and territorial implementation. International cooperation must transition from supporting planning to **co-financing transformation**.

As the global climate finance architecture evolves post-COP29, the Dominican Republic is positioned to secure a larger share of climate investment—especially if it continues to apply pioneering tools like CLEW++ and D2D. The blueprint exists; the opportunity now is to execute.

A decade of national climate action: Stocktake and the Road Ahead

EUROPEAN UNION PERSPECTIVE ON CLIMATE ACTION TEN YEARS AFTER PARIS

Antoine Oger, Institute for European Environmental Policy (IEEP)

INTRODUCTION

Europe is the fastest warming continent in the world, and climate risks are threatening its energy and food security, ecosystems, infrastructure, water resources, financial stability, and people's health. Extreme weather events like storms, heatwaves and flooding accounted for 85,000 to 145,000 human fatalities across Europe, over the past 40 years. Over 85% of those fatalities were due to heatwaves. Economic losses from weather and climate-related extremes in Europe reached around half a trillion euros over the same period. Many of these risks have already reached critical levels and could become catastrophic without urgent and decisive action. Severe climate events already experienced throughout Europe are expected to worsen even under optimistic global warming scenarios and affect living conditions throughout the continent. Different regions in Europe are also more vulnerable to different climate risks. Changes in rainfall for instance differ considerably throughout Europe, with expected heavy rain in the north while lower rainfall combined to more frequent heatwaves will present a greater risk of drought and forest fires in the south of the continent.

EU GHG emissions

The EU has engaged in more ambitious climate action in the last decades which yielded results. Since 2005, EU domestic greenhouse gas (GHG) emissions, i.e. excluding Land use, Land-Use Change and Forestry (LULUCF) and international transport, have decreased by 29%. The GHG emission intensity of the EU economy, defined as the ratio between EU GHG net domestic emissions (i.e. including LULUCF net removals and excluding international transport) and GDP, was halved from 2005 to 2023 from close to 400 down to 207 gCO₂-eq/EUR. This decline was accompanied by a convergence among EU Member States. GHG emissions per capita followed a similar pattern, decreasing to 6.4 tonnes of CO₂-eq in 2023 (down from 10t in 2005), even though convergence among Member States is less rapid¹. The main conclusion of the latest EU-wide assessment of the final updated national energy and climate plans (NECPs) published at the end of May 2025 estimates that the continent is on track to achieve its objective of reducing GHG net emissions by at least 55% by 2030, compared to 1990 levels¹.

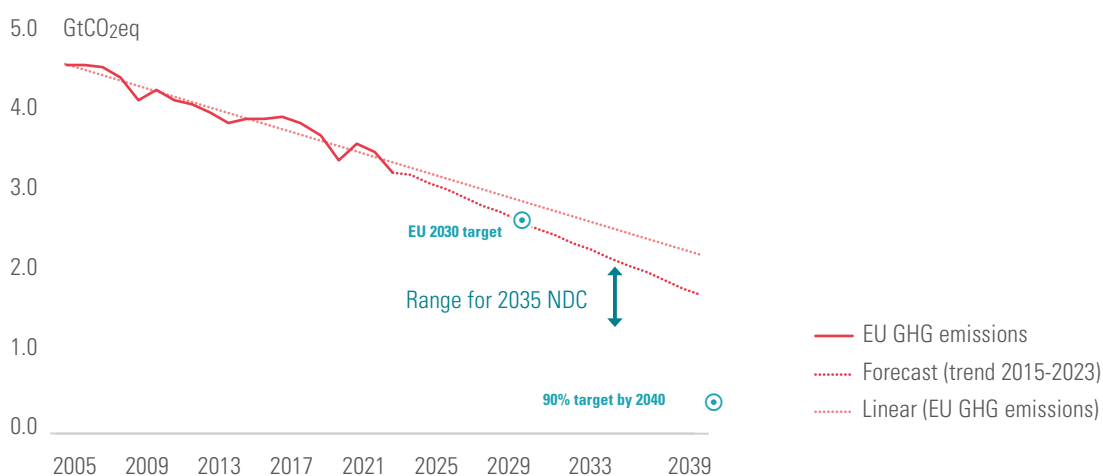
However, this is assuming that Europe will at least keep the pace of its emission reduction

since the adoption of the Paris agreement in 2015, and that Member States fully implement their climate-related policy frameworks. This assumption is somewhat ambitious as recent policy developments at EU level tend to demonstrate not only a lack of interest in further climate and environmental measures but more worryingly a tendency to weaken previously agreed commitments. The difficulty to agree on an emission reduction target for 2040 (see section 2) or recent developments in the hard-to-abate agriculture and transport sectors (section 4) are illustrative of this new political context. The EU has also engaged in reviewing and potentially weakening flagship EGD legislations such as the Corporate Sustainability Reporting Directive (CSRD), the Corporate Sustainability Due Diligence Directive (CSDDD), or more recently the EU Deforestation regulation.

This does not bode well to the notion that significant additional efforts will be required to achieve a net zero economy by 2050 which is the stated objectives of the European Union, nor to achieve a 90% emission reduction target by 2040 as per the current proposal by the European Commission or even the broader range of emission indicated in the statement of intent for the EU revised NDC (**Figure 1**).

¹ The EU expects a decrease in total net GHG emissions of around 54% in 2030 compared to 1990 according to its latest internal assessment.

Figure 1. EU GHG emissions



Source: author from EU EDGAR database

Historically, power industry represented the main polluting sector in Europe, accounting for 29% of total EU GHG emissions in 2005, followed by transport and building (18% and 15% respectively, see **Figure 2a**). However, EU undertook significant efforts in the decarbonisation of the sector since then, notably through electrification of its energy systems and the scaling up of renewables. In 2023, renewable energy was the leading source of electricity in the EU, accounting for 24% of all energy production². This trend combined with the stagnation of transport emissions, saw the latter becoming the most polluting sector for the first time in 2023 (24% of total GHG emissions against 20% for the power industry). Transport is thus a key sector to be prioritised in the coming years as it becomes increasingly important in the emission mix of the EU (see **Figure 2b**). Emissions linked to agriculture and building, where the pace of decarbonisation has remained limited or even moving in the opposite direction are also to be considered in priority. Meanwhile, action in the LULUCF sector is essential to enhance carbon removals.

Imported emission

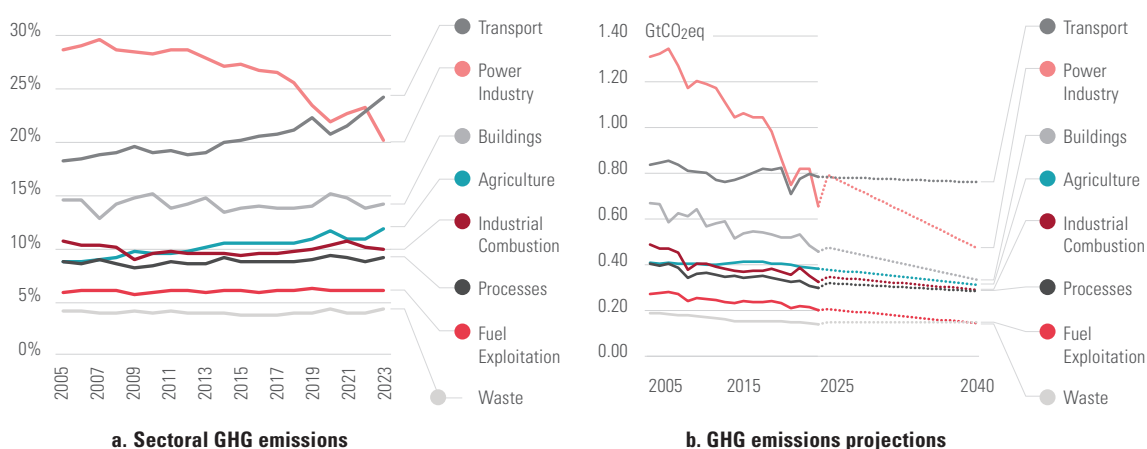
It is now well documented that the EU's consumption pattern and corresponding supply chains organisation generate negative spillover

effects on other countries. This external spillover occurs mostly through trade, although macroeconomic and financial policies (such as unfair tax competition or profit shifting) can contribute negatively on top of the trade-related impact³. We should note that the relations between trade and global CO₂ emissions are rather ambiguous. On the one hand, trade does support the competitiveness and thereby distribution of lower-emission goods, services and technologies around the world, which leads to lowering global emissions. On the other hand, trade can generate carbon leakage, meaning that it allows producers facing heightened sustainability standards in one region (say the EU) to simply move the production of their emission-intensive goods to a zone with lower CO₂ emission standards (and thereby costs). Trade also contributes to CO₂ transportation emissions.

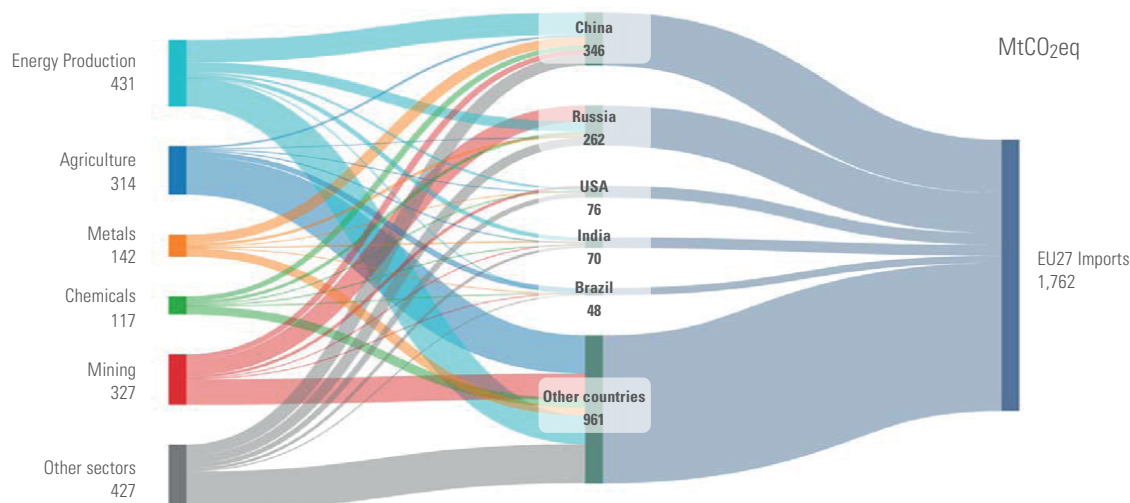
Overall, it is estimated that the EU's imports represent nearly half of its territorial emissions⁴. Energy production, agriculture and other sectors (including textiles) as the main contributor for EU imported emissions (**Figure 3**).

These "imported emissions" are not taken into account in the continent climate-related legal framework (see next sections), thereby questioning the validity of the domestic targets for the EU (and other developed nations).

Figure 2. Sectoral shares of total EU GHG emission (2005-2023) and projections per sector toward 2050



Note: projection over the period 2024-2050 is based on trends from the 2015-2023 period.
Source: author from EU EDGAR database.

Figure 3. Imported emissions – EU27 Top Countries and sector sources (2021)

Source: Carbon 4 & ECF - Imported emissions: from co-dependence to co-operative action (Ibid).

ROLE OF LONG-TERM

The EU possesses a very detailed climate policy framework that has achieved a central status in legal landscape. Although the EU's founding treaties do not explicitly define climate policy, Article 191(1) of the Treaty on the Functioning of the European Union (TFEU) refers to combating climate change as one of the core objectives of its policy on protecting the environment. The year 2019 marked a tectonic shift with the publication by European Commission of its communication on the European Green Deal (EGD)⁵, which put the EU firmly on track to tackling climate and environmental-related challenges in accordance with the Paris Agreement by achieving climate neutrality by 2050. In 2021, EU Institutions subsequently adopted the European climate law which enshrines this pledge into EU law and further sets an intermediate target to reduce GHG emissions by 55% by 2030 compared to 1990⁶. These commitment to climate neutrality by 2050 with intermediate targets are of great significance as they are relatively well specified: they are set at EU level, are economy-wide and to

be achieved domestically (i.e. without the use of international credits).

Looking ahead, the European Commission published a communication on 6 February 2024 recommending a 90% reduction in net GHG emissions by 2040 relative to 1990 as well as an impact assessment on possible pathways to reach climate neutrality by 2050⁷. The European Commission followed through with the submission of its formal policy proposal for a 2040 climate target of 90% GHG reduction on 2nd July 2025⁸. EU Member States and the European Parliament are now tasked to issue their position on this proposal and engage in a trilogue negotiation to formalise this target into the EU climate law. On that basis, the EU was also expected to submit its revised NDC At the UN General Assembly of September 2024 as per the deadline set by the Brazilian presidency of COP30.

However, as of end of September 2025, EU Member States and the European Parliament had not been able to agree neither on the 90% domestic reduction target nor on the subsequent NDC for 2035. The EU published a "statement of intent" on 18 September 2025 with an indic-

ative 2035 target in a range between 66.25% and 72.5% ⁹GHG emissions reduction, relative to 1990 levels. We provide an overview of the EU climate policy framework as of end of September 2025 in **Table 1**.

The EU reflected this domestic ambition in its international commitments by submitting an updated nationally determined contribution (NDC) that integrates its 55% GHG emissions reduction target to the United Nations Framework Convention on Climate Change (UNFCCC) in December 2020. The EU then submitted an updated NDC in October 2023 that maintains the 55% reduction but increased the land sector target by 85 MtCO₂e, thus enabling the EU to assert that it will overachieve its target. The EU is now expected to submit a second updated NDC before COP30 to reflect its new internal intermediate target of GHG emission reduction by 2040. These EU climate objective earn the mention “acceptable” by the climate action tracker¹⁰ (although the overall rating of the EU framework for climate action is generally deemed

“insufficient”). Perhaps most importantly, The EU did not limit itself to long-term overarching targets but adopted several complementary and / or sectoral strategies and legislations such as the 2030 Climate Target Plan or the Fit for 55 Package (**Box 1**) to drive and operationalise this transition.

This breakdown of overarching targets into specific and sectoral legislative and financial frameworks does allow for a structured conversation to occur at every level of policy making in the EU, i.e. every single piece of legislation discussed and eventually adopted is considered in light of their potential climate impact and alignment with domestic and international commitment. More recent landmark EU sustainability legislations such as the Nature Restoration Law or the Deforestation regulation make direct mention of the EU climate framework and its objectives. Agriculture, through recent evolution of the Common Agricultural Policy (CAP), is another example with Member States now obligated to demonstrate that their CAP Strategic Plans (i.e their reporting requirements

Table 1: overview of EU current climate commitment and legislations.

Legislation / Commitment	International commitments	EU domestic legislation							
	Paris Agreement (NDC)	2020 Climate and Energy Package		2030 Climate and Energy Framework				2040	2050
		EU ETS	Effort Sharing Decision (ESD)	EU ETS (ETS1)	ETS 2	Effort Sharing Regulation (ESR)	LULUCF	Revised Climate law	EU Climate Law
Overall emission reduction target	at least -55% net emissions in 2030 vs 1990	-20% GHG emissions reduction vs 1990		at least -55% net domestic reduction vs 1990				-90% GHG emissions reduction vs 1990	Climate neutrality
Sectoral Emission reduction target		-21% in 2020 vs 2005 for ETS emissions	-10% in 2020 vs 2005 + Annual MS targets	-62% in 2030 vs 2005	-42% in 2030 vs 2005	-40% in 2030 vs 2005 + Annual binding targets by MS.	2021-2025: stable carbon sinks; 2026-2030: EU target of -310 Mt CO ₂ eq. removals + MS targets	N.A. so far	N.A. so far
Sectors included	Energy, IPPU, agriculture, waste, LULUCF	Power & heating, energy-intensive industry, aviation	Transport (ex. aviation), buildings, non-ETS industry, agriculture and waste	Electricity, heating, energy-intensive industry, aviation, maritime	Buildings, road transport and small-emitting sectors	Domestic transport (ex. aviation), buildings, non-ETS industry, agriculture and waste	Land use, land use change and forestry	N.A. so far	Economy-wide

Source: author from EU Climate Action Progress Report 2024.

Box 1. The EU Fit for 55 package.

The proposals of the Fit for 55 package were presented by the European Commission in July 2021 to provide a clear framework and operationalise the overarching ambition to reduce GHG emissions by 55% by 2030. The package included the following main legislation:

- Setting of **national emissions reduction targets** for MS with the aim to break down the overall 55% reduction target and account for the various challenges and opportunities faced by MS.
- Extension and strengthening of the **EU Emissions Trading System** including:
 - Faster reduction of emissions allowances in the system and gradual phasing-out of free allowances for some sectors.
 - Extension to emissions from maritime transport and implementation of the global carbon offsetting and reduction scheme for international aviation (CORSIA) through the EU ETS. The fit for 55 package also included dedicated legislations to increase capacities on **decarbonised fuels in shipping and aviation**, aka the REFuelEU and FuelEU Maritime regulations.
 - Increased funding for the modernisation fund and the innovation fund.
 - Revision of the market stability reserve.
- **Land use, land-use change and forestry (LULUCF) regulation**: binding commitment for the EU to reduce emissions and increase removals in the land use and forestry sectors to at least 310 million tonnes of CO₂ eq. net removals for 2030. The regulation also sets binding national targets for Member States.
- Revision of the **EU renewable energy directive** to increase the share of renewables in the EU's overall energy consumption to 42.5% by 2030. The directive also includes sectorial sub-targets and measures across sectors.
- Revision of the **EU energy efficiency directive** to reduce final energy consumption at EU level by 11.7% in 2030, compared to projections made in 2020 through increased annual energy savings obligations and decreased energy consumption of public sector buildings. The fit for 55 package also included a legislation dedicated to improving the **Energy performance of buildings**.
- **CO₂ emission standards for cars and vans**: progressive EU-wide emissions reduction targets for 2030 and beyond, including a 100% reduction target for 2035 for new cars and vans.
- **Carbon Border Adjustment Mechanism (CBAM)**: avoid relocation of production to non-EU countries with less ambitious climate policies or increased imports of carbon-intensive products.
- Other pieces of legislations covered reducing **methane emissions in the energy sector**, fostering a **Hydrogen and decarbonised gas market** or proposal on **energy taxation** (although there was still no agreement on this proposal by spring of 2025).

on agriculture to the EU) are consistent with and contributing to environmental and climate legislation, including new legislations when they enter into force. In addition, The EU Governance Regulation¹¹ set out in 2020 a process for the Member States to prepare long-term strategies with a perspective of at least 30 years. The new strategies are now expected by 1 January 2029 and every 10 years thereafter.

Overall, the EU now has arguably one of the most developed climate policy framework in the world

and is successfully reducing its GHG emissions. The adoption of the EGD in 2019 further accelerated the speed and scope of the EU climate policy especially with regard to GHG emission reductions targets, an integrated policy approach and efforts to advance adaptation policy.

Yet this acceleration also creates tension in terms of effectiveness, coherence with other environmental issues and just transition aspects at the EU and global levels. It also questions the mere capacity of the EU to implement its own policies

in fraught political context. Recent policy developments in Brussels, tend to suggest a slowing down of climate and environmental policy-related efforts which may eventually jeopardise the past positive trend. In particular, and in response to the request from the European Council, the Commission has presented a series of simplification proposals, also referred to as “omnibuses”. The stated aim of omnibuses is to reduce administrative costs and reporting requirements for EU businesses. They are the main vessels to carry the simplification agenda outlined by Ursula Von Der Leyen in her program for 2024-2029¹² and reiterated through the publication of the “Competitiveness Compass” on 29 January

2025¹³. The first omnibus package released soon after on 26 February 2025 and covering sustainability reporting includes concrete targets include reducing both costs and reporting obligations by at least 25% for all businesses and by at least 35% for SMEs by 2030¹⁴. Since then, 5 more omnibuses procedures have been launched, while a 6th “environmental” omnibus is under preparation (See **Box 2**).

Furthermore, the European Commission published its proposal for the next Multiannual Financial Framework (MFF), the EU budget, on 16 July 2025¹⁵. The MFF proposal entails an increased EU overall budget of €2 trillion in current prices but proposing a closer alignment

Box 2. A story of omnibuses

As of end of September 2025, 6 omnibus procedures are under considerations by the EU institutions⁴⁹, with a 7th one under preparation:

- Omnibus I: launched on 26 February 2025. Covers due diligence obligations and sustainability reporting through reopening the Corporate Sustainability Reporting Directive (CSRD), the Corporate Sustainability Due Diligence Directive (CSDDD) and the EU taxonomy. It also proposed to simplify and strengthen the EU's carbon border adjustment mechanism through the update of the de minimis threshold (see box 3).
- Omnibus II: launched on 26 February 2025: Covers existing legislation regarding EU investments, such as on the InvestEU programme.
- Omnibus III: launched on 21 May 2025. Covers the Common Agricultural Policy
- Omnibus IV: launched on 21 May 2025 introduces a stop-the-clock measure by postponing by two years (i.e. until August 2027) battery due diligence requirements. It also extend certain mitigating measures for SMEs and small mid-cap enterprises while addressing digitalisation and alignment of common specifications for certain products.
- Omnibus V: launched on 20 June 2025 proposes to facilitate defence investments and conditions for the defence industry, and to simplify security and defence procurement. It follows the publica-

tion on 19 March 2025 of ReArm Europe plan/Readiness 2030 by the European Commission.

- Omnibus VI: launched on 8 July 2025 aims to simplify EU chemical legislation by decreasing compliance costs and administrative procedures for businesses across the chemical value chain.
- Omnibus VII: expected in October 2025. It should cover administrative requirements related to the environment in the areas of waste, products, and industrial emissions. A consultation process was conducted from 22 July to 10 September 2025 with close to 200.000 submissions received⁵⁰ which is by far an absolute records for an EU public consultation demonstrating the high political visibility of such processes in current EU politics. Beyond the (legitimate) stated aim to simply rules and regulations within the single market, there is a general interpretation that this strong political drive will result in weakening existing climate-related legislations, thus putting into question the capacity of the EU to accelerate the reduction of emission that is necessary to achieve a net-zero economy by 2050. Furthermore, many private operators lament the current lack of clarity and have long called for the EU to set a clear direction of travel for a transition towards a climate neutral economy within the EU by 2050⁵¹.

with the Commission's current priorities (i.e. security, defence, improved competitiveness, and significantly greater flexibility to adapt to unforeseen events), while references to the environment, climate, sustainability, and resilience more broadly, appear to be a lesser priority compared to the current MFF.

These elements question the solidity of the EU long-term commitments toward a transition to net-zero when facing contradictory political winds.

EXAMPLES OF CONCRETE PROGRESS

Efficiency

A combination of factors can be linked to the reduction of EU emissions but recent progresses in energy and carbon intensity stand out (Figure 4). Compared with 1990, 45% less energy was needed to produce a unit of GDP in 2022. Emission reduction from the subsequent decrease in primary energy use per unit of output generated contributed to a reduction of emissions by 51%. These efficiency gains are primarily driven by better energy transformation processes, notably through electrification. There is also a general shift to the less energy-hungry sectors¹⁶.

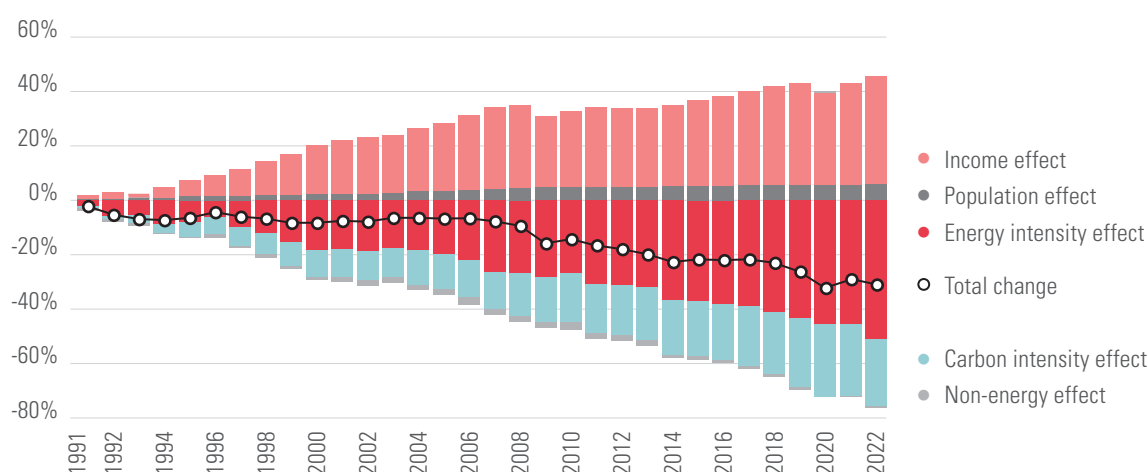
The carbon intensity effect, i.e. the volume of emissions from one unit of produced energy, is associated with a 25% reduction of emissions, notably from the transition away from fossil fuels and toward renewable and nuclear energy¹⁷.

Energy

Reflecting these overarching trends, EU GHG emissions in the energy supply sector have halved since 2005 as of 2023, driving the decarbonisation of the European economy. This is related to the rapid expansion of renewable energy, paired with the reduced use of fossil fuels. According to EEA estimates, the share of renewable energy has grown from 10% in 2005 to an estimated 24% of the EU's gross final energy consumption by 2023. Further, the EU has managed to continue reducing its energy consumption: primary energy use has fallen by 19% since 2005, while final energy consumption saw a 11% reduction during the same timeframe, according to early estimates for 2023.

The EU has continued to set ambitious climate-related energy targets aimed at increasing the share of renewable energy sources in the overall energy mix and saving energy through conservation and efficiency improvement measures (see box 1). Yet, despite these progress that put the EU on track to achieve its 2030 targets, the Commission still estimate that despite national strategies

Figure 4. Drivers of total GHG emissions cumulated over 1990-2022



Source: EU inventories to the UNFCCC, AMECO, Eurostat energy balances.

reflecting the ambition to be climate neutral by 2050, they point to a reduction of GHG emissions of around 85% by 2050 for the EU as a whole and thus cannot be deemed adequate for the collective achievement of the objectives and targets of the Energy Union¹⁸. Further efforts will thus be required for the EU and its Member States to achieve its long-term goal of net zero economy by 2050.

EXAMPLES OF CONCRETE BLOCKAGES

Despite the recent efforts by the EU to maintain its climate ambitions, recent estimates conclude that the EU will need to more than double the average reduction that was achieved each year between 1990 and 2020 to reach its objectives (EEA, 2024). Looking at the sectoral distribution of EU GHG emissions, two sectors stand out at

particularly concerning, these are agriculture and transport. Accounting for over a combined third of all EU GHG emissions, these sectors have seen their associated emissions largely stagnating since 2005 (Table 1) and are set to become the two most emitting sectors by 2045 (Table 2). This section dives down into the sectors to identify the main blockades and propose solutions to ensure that they contribute their fair share to the EU climate ambition.

Transport

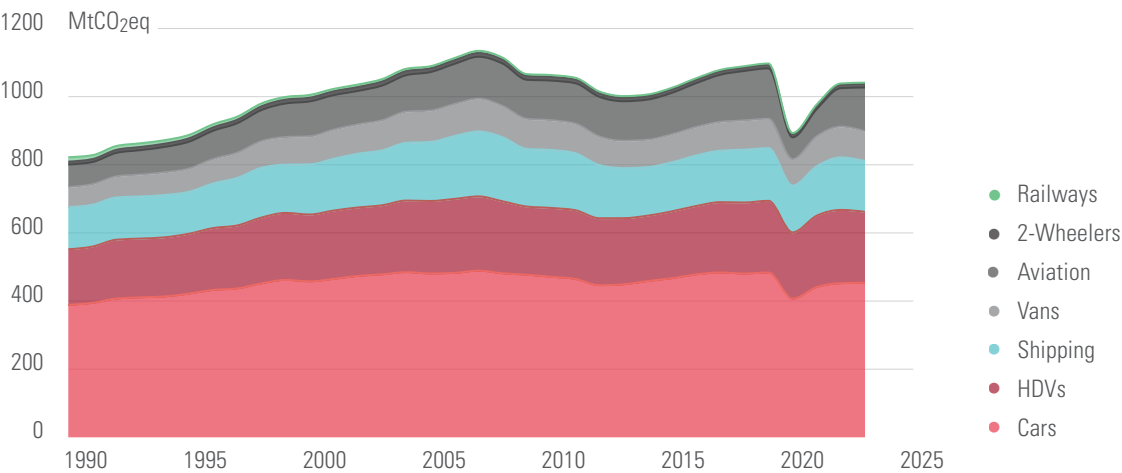
Transport overall accounts for 24.6% of the EU's total GHG emissions, historically largely dominated by transport by road (over 70% of all GHG emissions from transport, see Figure 5), and overall is the only sector where emissions remained largely stable since 2005 as all transport modes (road, rail, waterborne, aviation) have come to rely on fossil fuel-based technologies. Some transport modes, like roads and railways,

Table 2: Reduction of EU GHG emission per sector per period (in MtCO₂ eq.)

Periods	Agriculture	Buildings	Fuel Exploitation	Industrial Combustion	Power Industry	Processes	Transport	Waste	TOTAL
2005 - 2023	6%	31%	27%	34%	50%	26%	6%	26%	29%
2015 - 2023	7%	15%	17%	12%	39%	13%	0%	7%	17%

Source: Author from EU EDGAR database

Figure 5. GHG emission by transport mode



Source: Transport & Environment (2024). State of European Transport. <https://www.transportenvironment.org/state-of-european-transport/state-of-transport>

have already largely engaged in technological development for decarbonisation, while aviation and maritime are only just starting their energy transitions. Thus, different transport modes face different challenges.

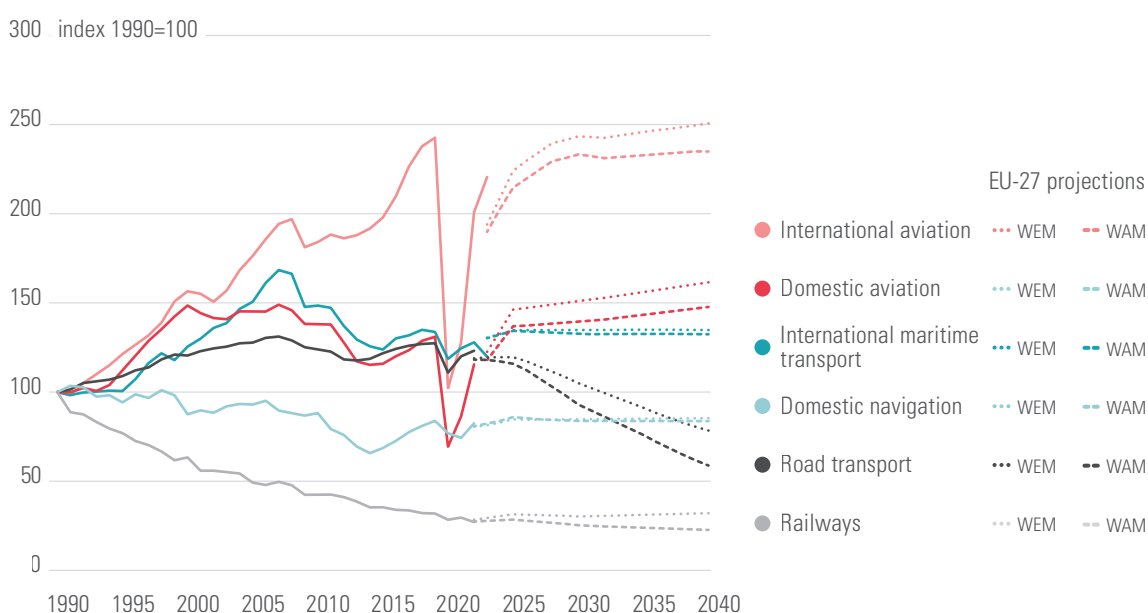
Eventually road transport emissions are projected to decrease to below 1990 levels in 2030¹⁹, however this is compensated by aviation which emissions have more than doubled since 1990 and remains one of the fastest-growing sources of emissions. Similarly, while maritime transport plays an essential role in the EU economy and is one of the most energy-efficient transport modes, it is also a large and growing emissions source (Figure 6). Efforts should thus be made in both shifting freight and passenger transport, and at the same time improving the efficiency and electrification of motor vehicles, while addressing the rapidly growing emissions from aviation²⁰.

EU climate mitigation legislation covering transport previously largely relied on regulatory measures such as standards for fuel efficiency and vehicle emissions, or instruments to incentivize investment in alternative fuels, for example promoting renewable energy and biofuels. The EGD and 'Fit for 55' package initiated a turn toward market-

based instruments, including efforts to extend the scope of the EU emission trading system (ETS).

The European Commission published in 2020 its Sustainable and Smart Mobility Strategy²¹ with the objective to transform the transport system with sustainable and digital measures and to achieve a 90% reduction of GHG emissions in the sector by 2050. It entails the objectives to double high-speed rail traffic by 2030 and triple by 2050; to increase freight rail transport by 50% by 2030 and doubling by 2050. The strategy also sets a target of 30 million electric vehicles by 2030 in parallel with the new car emissions standards set to effectively phase out internal combustion engines by 2035. Guided by this strategy, the EU enacted legislations setting CO₂ emission performance standards and targets for new passenger cars and for new light commercial vehicles²² as well as setting minimum national targets for the procurement of clean vehicles²³ as well as unlocking E-fuel potentials through the REFuelEU and FuelEU Maritime initiatives. The adequate adoption, transposition and implementation of these initiatives into MS national laws will be a first step for the EU to mitigate emission in the sector. The European Commission also launched

Figure 6. Greenhouse gas emissions from transport in the EU, by transport mode and scenario



Source: European Environmental Agency (2024). <https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-transport>.

a public consultation in August 2025 for a European Sustainable Transport Investment Plan²⁴. The publication of this strategic document would also be an important milestone to guide future legislative development.

Clean hydrogen has been repeatedly floated as a solution to decarbonise transport, yet according to the staff working document accompanying the Sustainable and Smart Mobility Strategy, hydrogen is projected to represent only 2.4% of energy use in transport by 2050²⁵, while expectations of clean hydrogen supplies are filled with uncertainties²⁶. This should call for a very precautionary approach in terms of investment strategy in that sector in particular.

Overall, two flagship policy milestones are expected to be instrumental in decarbonising the transport sector: 1- The EU ban on the sale of new petrol and diesel cars from 2035; and 2- The deployment of the second iteration of the Emission Trading System (aka ETS2) to cover and address CO₂ emissions from fuel combustion in buildings and road transport. There is a growing amount of pressure on the EU to weaken these two initiatives²⁷. Historically, EU legislators have often been forced to water down policy proposals relating to environmental protection in transport, in the face of lobbying from structurally powerful incumbent industry actors, particularly large car manufacturers that often have close relationships with their national (Member State) governments²⁸. The European Commission should now remain strong as the successful implementation of the above-mentioned initiatives is absolutely crucial to increase efforts for decarbonisation and electrification and achieving ambitious climate-related results in the sector

Agriculture

Agriculture is the source of 12% of all greenhouse gases emitted in the EU (up from 9% in 2005), including over 54% of all methane emissions as well as a significant emitter of ammonia. Most strikingly, the political discourse on the EU agricultural policy has now long been clear about the need for the sector to contribute toward the climate goals of the continent, for instance in the

Farm to Fork and Biodiversity Strategies. Several recent reforms went in that direction, such as the CAP Strategic Plans (CSP) Regulation requiring MS to demonstrate that their CSPs are consistent with and contributing to environmental and climate legislation as mentioned above, or with the new CAP Performance, Monitoring and Evaluation Framework (PMEF) including new indicators covering climate-related issues. There are several concrete recommendations that can be made to further advance these issues:

- The lack of binding sector-specific EU environmental and climate targets for agriculture, making it hard to hold Member States to account. *Potential recommendation: EU environmental legislation outside the CAP should identify sector-specific objectives and targets for agriculture and forestry at the EU level, which could then be transcribed at national level by Member States.*
- Limitations in the monitoring and evaluation framework for the CAP as well as gaps in indicators and the availability of data to assess the environmental and climate outcomes achieved through CAP support. *Potential recommendation: strengthen the CAP's PMEF to allow for continuous assessment of performance and impact and provide adequate investment to enable more effective monitoring of the impact of CAP interventions.*
- Lack of knowledge, capacity, support and/or financial means at the farm level to embark upon a transition to more sustainable farming systems. *Potential recommendation: ensure that payment levels are sufficiently attractive to make the transition to sustainable farming systems alongside encouraging greater ownership by farmers of the outcome to be achieved. Greater investment in knowledge exchange, capacity building, advice and training is essential, for example by making it a compulsory condition for receiving CAP funding.*
- Governance issues: e.g. political and capacity issues in Member States to embrace a significant departure from the status quo, and challenges for the European Commission in holding Member States to account on the environmen-

tal and climate ambition of their CSPs. *Potential recommendation: Member State to scale up environmental and climate considerations within CSPs and foster greater internal dialogue and collaboration between the relevant ministries and agencies.*

Despite these evolutions, most recent assessments suggest that the overall environmental and climate ambition of Member States in agriculture has not increased as much as is necessary to meet the EU climate goals. On the contrary, EU agricultural policy has undergone a significant narrative shift over the past five years. The Farm to Fork Strategy (2020) placed sustainability, climate action, and food system transformation at the heart of its agenda. In contrast, the Vision for Agriculture and Food (2025) reframed the central challenge as securing European farming through competitiveness, simplification, and strategic autonomy. This shift reflects broader political changes and has real implications for policy and funding²⁹.

EU agricultural policy is indeed currently subject to several proposed reforms, most notably through the new MFF proposal which includes a reorganisation into fewer, broader funding headings. The CAP appears to receive less funds than under the previous iteration and is now included within a newly created fund — the “European Fund for Economic, Social and Territorial Cohesion, Agriculture and Rural, Fisheries and Maritime, Prosperity and Security”— alongside policies like Cohesion Policy. Together, CAP and Cohesion allocations make up the majority of this fund. Member States are expected to outline their use of the funding through National and Regional Partnership Plans (NRPPs) covering the full seven-year period. This has sparked controversy among relevant stakeholders and among countries so the discussions promise to remain heated until an agreement can be achieved, expected before the end of 2026. Yet, overall, environmental objectives are deprioritized in the CAP and MFF proposals, with simplification used to justify regulatory rollback³⁰.

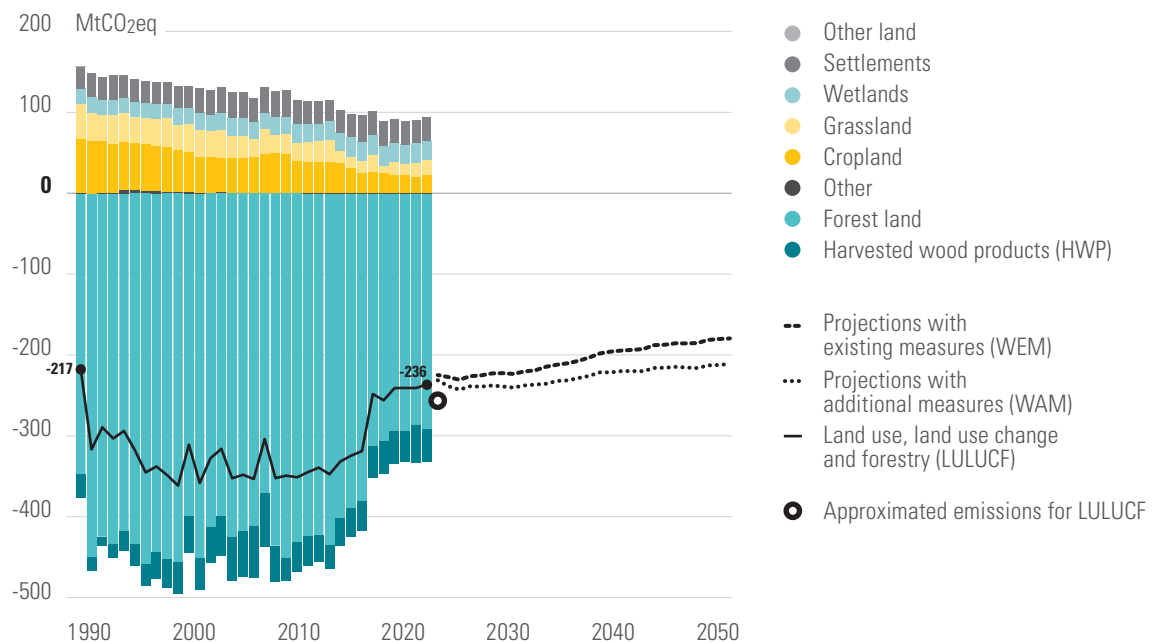
Land carbon sink

The EU climate target and strategy framework consistently emphasizes the importance of the

land sink to the achievement of climate mitigation objectives, as well as the related synergies with other strategic goals, including nature restoration and climate adaptation. The significance of the LULUCF sector is reflected in the legislative framework establishing a dedicated Union-wide target of -310 MtCO₂e of net removals in 2030, split into national targets for each EU Member State and made binding under the LULUCF Regulation. Currently, the sector is reported to still sequester -236 Mt CO₂ eq from the atmosphere most notably through living biomass in forests and harvested wood products. Meanwhile other land use categories, such as cropland, settlements, and grasslands, act as net sources of emissions.

But worryingly, the EU's total reported LULUCF net removals have decreased by nearly one third between 2012 and 2022, driven by the forest sink decline largely offsetting the limited decrease of net emissions from non-forest land use categories (Figure 7).

This forest decline is itself primarily due to decrease in gross annual increment (i.e. forest biomass growth before accounting for natural mortality and harvesting), increased mortality (including from natural disturbances), and higher harvesting rates³¹. Unfortunately, the mitigation effectiveness of LULUCF related policies is extremely challenging to establish, notably due to lack of monitoring capacities deployed by most governments. This eventually poses major challenges in the design and implementation of adequate policies in different countries or regions, which can explain this declining trend. It is estimated that policies that conserve natural ecosystems through zoning policies like protected areas and prevent the removal or reduction of large carbon sinks are found to mitigate the most GHG emissions per hectare on average³². The recovery of the EU forest sink will thus be a decisive factor in the achievement of the EU climate objective. Technology standards are also reported to have some GHG mitigation potential, although there is little to no Ex-post evaluation that can be done to ascertain that assumption yet. Government investment in research and development can also

Figure 7. EU emissions and removals of the LULUCF sector by main land use category

Source: European Environmental Agency (2024).

<https://www.eea.europa.eu/en/analysis/indicators/greenhouse-gas-emissions-from-land?activeAccordion=309c5ef9-de09-4759-bc02-802370dfa366>

improve productivity and reduce emissions intensity. Eventually, the effectiveness of these mitigation policies, as well as the comparative costs of regulatory policies and economic policies, largely depend on contextual factors including the presence of other existing policies, and environmental, social, and economic conditions.

Climate adaptation

Over the past 4 decades, the cost of weather- and climate-related extremes amounted to EUR 650 billion (in 2022 values) spread out relatively evenly between hydrological events (floods), meteorological events (storms including lightning and hail) and climatological events (mostly heatwaves but also droughts, forest fires and cold waves). Statistical analysis over a 30-year moving average shows that losses have increased over time³³.

The EU climate policy framework requires continuous progress in enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change. The European Commission adopted its new EU strategy on adaptation

to climate change in 2021 for the EU to plan how to adapt to the unavoidable impacts of climate change and become climate resilient by 2050³⁴. Yet, the indicators and corresponding targets for 2030 to capture aspects of progress on climate change adaptation² included in the 8th EAP monitoring framework³⁵ estimate that it will be unlikely that the ambition levels for climate adaptation set for 2030 will be met as past trends in both cases show a deterioration of the situation. Furthermore, and according to the recent assessment by the European Commission of Member States national plans, only some of them sufficiently integrate preparedness and resilience to climate impacts, while only a limited number of plans consider measures in terms of water resilience.

The European Commission President Ursula von der Leyen announced a European Climate Adaptation Plan (ECAP) to support the Member States

² These include an indicator on economic losses from weather- and climate-related extremes in the EU and an indicator on drought impact on ecosystems.

on preparedness and resilience planning to address these shortcomings. A policy package is expected to be presented during the 2nd half of 2026.

GOVERNANCE

The depth of the EU climate policy framework is somewhat remarkable when considering its complex governance structure. With 448 million citizens and a €17 trillion economy it is neither a sovereign state nor an international organisation, but a multilayered governance body bounding 27 Member States of varying levels of wealth and economic size and relying on the concept of subsidiarity to allocate competences among the different sectors of the economy. This poses both opportunities and challenges in terms of governance for climate.

As a governance 'laboratory', the EU has introduced innovations in many areas relevant for climate policies. For example, the Effort Sharing Regulation (ESR)³⁶ adopted in 2018 and amended in 2023 "allocates" the climate mitigation efforts between Member States, and across different economic sectors. The EU was also on the forefront of the development of an emissions trading system (ETS) as a novel policy instrument to reduce GHG emissions and which has been emulated elsewhere. As a carbon cap-and-trade program, the ETS internalizes the social costs of GHG emissions into (energy) market prices, which in turn promotes further investments in low-carbon technologies. We also note that it is important for the system to rely on its two legs, cap and trade, to manage not only prices through the alignment of supply and demand. As an example, oversupply during the period 2009–2013 led to the creation of a large "bank" of allowances, i.e. allowances that are issued in earlier years but are unused and remain valid in later years as they have an infinite lifetime. Important commitments to dedicate increasing proportions of the EU budget to climate purposes have also been made. With for instance a transversal target for 30% of the current iteration of the EU MFF to be dedicated to climate action

(and 10% in 2026 and 2027 for biodiversity, up from 7.5% previously). This aggregated 40% target in the current MFF is replaced by a target of 35% for climate resilience and environment in the proposal for the next MFF which again shows a tendency toward less actions and efforts for the environment when more is needed.

The EU is composed of a large number of institutions (European Commission, Member States under the European Council, European Parliament, European Economic and Social Committee etc.) with varying degrees of influence on policy-making, including depending on thematic sectors and priorities. Eventually it is the way that these EU institutions interact with one another, and with the array of non-state actors that orbit around them, that shapes specific policies and thus constitutes the politics and governance of the EU. The intensity of the political integration process that shaped the EU over the last 50 years has now blurred the boundaries between national policy and EU policy in many sectors, including on climate. However, there is a clear trend that the EU competence in relation to climate policy has grown over time. Climate issues (and environmental matters in general) are now considered primarily at supra-national rather than national policy. This process was driven by a mixture of factors e.g. avoiding national policy differences that may pose the risk of fragmentation of the single market, the need to improve energy security or the more recent competitiveness agenda for the European industry through the development of clean tech. Climate ambition was also leveraged to support the legitimacy of the European integration project and the desire to develop a distinct European identity on the global stage³⁷. Today, and with regards to climate policy, the European Commission is arguably the key institutional actor³⁸. The Commission also acts as a scene setter and a driving force for EU climate policy. The Commission also acts as the EU's external representative and takes a leading role in the international climate negotiations at the United Nations Framework Convention on Climate Change (UNFCCC).

This does not go without significant issues of clarity of competence. As an example, the EU was

expected to table its updated NDC in September 2024 to the UNFCCC however the lack of agreement on the adoption of an emission reduction target by 2040 among the three institutions prevented the Commission to take on this lead role in the run up to COP30. EU Member States were adamant that the decision ultimately must reside with their elected leaders and thwarted the efforts of the Commission to achieve an ambitious results. Such a return of national politics does not bode well for a harmonised EU approach toward climate action.

in addition, in some specific areas that touch upon core state powers, yet are extremely linked to climate policy, Member States have preserved a high degree of autonomy through the subsidiarity principle. Such issues cover for instance taxation, energy supply, or land-use planning which can lead into a lack of coordinated approach and, eventually, of ambition. Lack of competence over land use planning, for instance, has been linked to the incrementalist nature of EU policy on adaptation³⁹. That being said, the increased EU competence on climate policy arguably remains the reason why the continent today presents among the most ambitious and detailed climate framework in the world.

CLIMATE FINANCE AND INTERNATIONAL COOPERATION

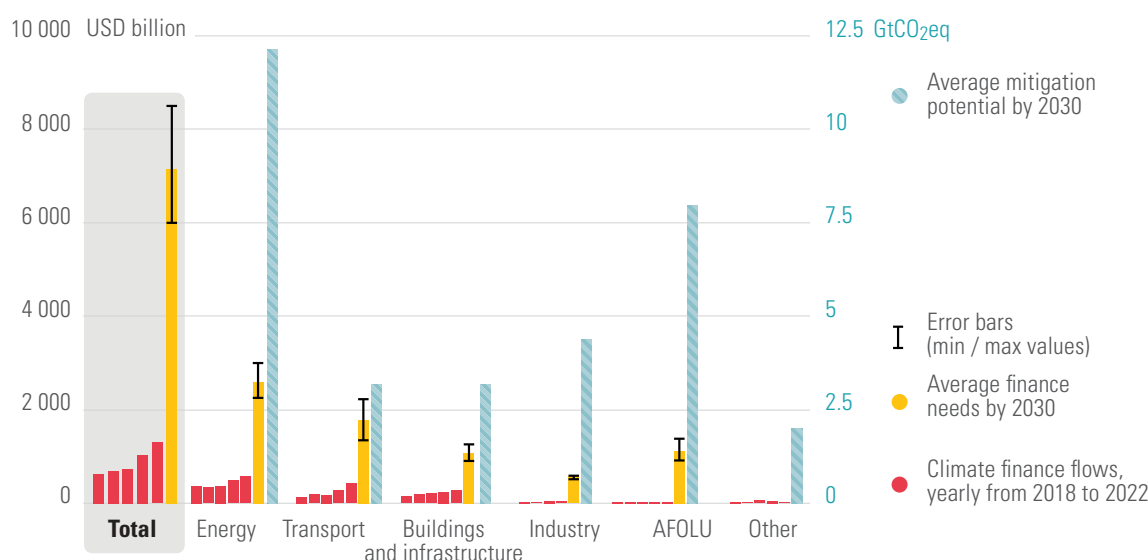
It is clear that the objectives of the Paris Agreement will not be met unless emerging economies decarbonise much more rapidly, which in turn necessitates concrete action to redirect and regulate flows of public and private finance. Yet, the current global financial architecture remains misaligned with climate objectives by locking in high-carbon development pathways while inadequately resourcing climate adaptation⁴⁰. This can be due to incentives and political-economy challenges such as advanced countries not likely to commit to climate finance outside their borders where they have less control over how this money is spent, while emerging economies are reluctant to phase out fossil-fuels without significant (i.e.

derisking) financial support for renewable investments consistent with their development goals⁴¹. Bridging the 'finance gap'³ is arguably the most difficult yet important challenge for the global community. Developed economies have eventually managed to meet their commitment of \$100bn a year by 2020 for climate finance made in Copenhagen in 2009 with a total of \$115bn mobilised in 2022⁴². Overall, the Climate Policy Initiative estimates that climate flows are likely to have surpassed USD 1.5tn in 2023, with key increases continuing to be led by renewable energy and low-carbon transport. While this constitutes a significant increase from the 600bn estimated in 2018, a further fivefold increase is necessary to achieve the estimated needs of 7.4 trillion dollars mobilised by 2030⁴³.

While this can appear realistic, we must recall that the achievement of the Paris Agreement goal of 1.5°C warming will require 5 times less finance than the projected economic losses by 2100 under a business-as-usual scenario. Said otherwise, it is way cheaper to achieve the goal of the Paris Agreement than not. It can also be noted that some sectors, such as energy or AFOLU, show more mitigation and adaptation potential than others and could therefore be prioritised in a context of scarce financial capacities (see **Figure 8**).

The EU can leverage its climate regulatory framework, especially in sectors listed above, to play its fair share in the effort to scale up international cooperation for climate. It is also important to note that alongside the key objective of mobilising new finance, the EU and Member States should engage on concrete actions to redirect, redistribute and regulate existing flows of public and private finance toward climate objectives. To that end, Member States and the EU should leverage according to their competences all regulatory tools at their disposal, including taxation, as well as engaging in reforms for debts swaps and scaling up the role of multilateral development banks and of national financial institutions such as central banks.

³ i.e. the difference between the amount of finance necessary to meet the objective of the Paris Agreement and current actual commitments from countries and global institutions.

Figure 8. Climate finance flows and mitigation potential per sectors

Note: Historical finance flows (2018-2022) are expressed in nominal USD. Climate finance needs for 2023-2030 are expressed in constant 2022 USD. Average mitigation potential is sourced from UNEP (2024). Emissions Gap Report. This applies to similar analyses hereafter.

Source: Climate Policy Initiative.

CPI (2024). Global Landscape of Climate Finance 2024. <https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2024/>

LINK WITH NON-CLIMATE QUESTIONS

Trade and trade-related measures

The EU gave signs since the adoption of the Paris Agreement, and most notably in the context of the European Green Deal, that it recognises its global impact and aimed to steer its relevant extraterritorial policy framework in a more inclusive and sustainable direction. We note a tentative reform of its bilateral relations, with the revision in 2022 of its Trade and Sustainable Development Strategy⁴⁴, as well as through a flurry of domestic policy measures⁴. These efforts from the EU have led to unintended socio-economic impacts in third countries which generated significant frustrations. The so-called EU autonomous policies with extraterritorial reach (labelled “unilateral” outside of the EU) have triggered unprecedented backlash due to expected compliance costs and impacts on the terms of

global production and supply of specific goods. The EU deployed several initiatives aiming to maintain close ties with its partners, notably through its cooperation policy with for instance the EU Global Gateway Program and Team Europe approach. Yet these recent efforts do not seem transformational enough to assuage the concerns of its partners. The new EU “Clean Industrial Deal” for instance aims to enable the deployment of clean technologies in Europe through a mix of new industrial subsidies and regulations. One might argue that this could eventually carry opportunities for exporting “developing economies” to fuel this “acceleration” in the EU, but in the current political context, the EU may also be perceived as erecting further trade barriers (e.g. pertaining to local content, import restrictions) to focus its effort on domestic industrialisation processes with little considerations to the impact in exporting countries. International cooperation will thus be crucial to align domestic and international ambition for climate action.

The EU repeats at length that it is “collectively (i.e. the EU plus its Member States) the biggest donor for international aid in the world⁴⁵ in a

⁴ E.g. among others the Carbon Border Adjustment Mechanism (CBAM), Corporate Sustainability Due Diligence Directive (CSDDD), EU Deforestation Regulation (EUDR) and EU Sustainable Product Regulation (ESPR).

Box 3. The EU CBAM

In the context of a challenged multilateral trading system, the EU seeks to address its external spill-over impacts mainly through autonomous measures with extraterritorial effects. The most emblematic of these measures arguably remains the Carbon Border Adjustment Mechanism (CBAM), adopted in May 2023 (EU, 2023). The EU CBAM aims to ensure that a price is paid for the embedded carbon emissions¹ generated in the production of certain goods imported into the EU and, thereby, aims to mitigate the risk of carbon leakage by accompanying the gradual phase-out of the allocation of free allowances under the EU emissions trading system (ETS). The sectors covered are cement, iron and steel, aluminium, fertilizers, electricity, and hydrogen. The EU CBAM is expected to cover approximately 5% of the bloc's imports⁵² and its overall macroeconomic impact on Europe is projected to remain small with an estimated contraction of EU GDP by 0.22% by 2030 due to CBAM. We note that this is lower than under a baseline scenario without CBAM but with continued free allocation of ETS allowances⁵³.

Main challenge for CBAM declarants remains the difficulty to precisely account for specific embedded emissions in the imported goods, resulting from the production process and which need to be reflected in CBAM certificates. Some degree of uncertainty also remains on the methodology to be used which complicates the calculation of embedded emissions. Most importantly, the involvement of the 27 competent MS authorities with varying

administrative practices may very well lead to a lack of harmonized standards and practices across the EU, further complicating the system for importers and exporters. Businesses have also alerted to the missed opportunity of leveraging CBAM to foster circularity in EU trade relations by failing to include scrap from CBAM goods as well as downstream products with high CBAM-covered content (such as aluminum) into scope. This could have a detrimental impact on the capacity of the EU to upscale market opportunities for secondary materials and eventually achieve a circular single market. The EU recognized some of these challenges and published a proposed simplification of CBAM on 26 February 2025 to reduce the administrative burden on EU businesses⁵⁴ by updating the de minimis threshold from €150 per consignment to 50 metric tons of net mass material annually. The EU estimates that this would exempt 90% of businesses from CBAM reporting scope, while the remaining 10% are deemed to capture 99% of the emissions imported into the EU (Ibid.) although independent research will be necessary to confirm these estimates.

Low- and middle-income countries (LMICs) have expressed strong concerns against the initiative, denouncing the measure as "protectionist" and "coercive"² and having been instated without prior consultations. The World Bank's CBAM Exposure Index helps identify countries most at risk (see **Table 3**). Zimbabwe, Ukraine, Georgia, India, and Belarus rank highest in terms of aggre-

Table 3. CBAM Exposure Index per country and sector

Iron and steel		Fertilizers		Electricity		Cement		Aluminum		Aggregate	
Country	Index	Country	Index	Country	Index	Country	Index	Country	Index	Country	Index
Zimbabwe	0.09	Ukraine	0.08	Russia	0.23	Belarus	0.31	Mozambique	0.06	Zimbabwe	0.09
Ukraine	0.05	Georgia	0.08	Turkey	0.21	Ukraine	0.24	Kazakhstan	0.04	Ukraine	0.05
India	0.04	Belarus	0.05	Ukraine	0.19	Malaysia	0.03	Egypt	0.01	Georgia	0.05
Albania	0.04	Trinidad and Tobago	0.04	Belarus	0.10	Saudi Arabia	0.01	Venezuela	0.01	India	0.03
Egypt	0.02	Russia	0.03	UK	0.03	Tunisia	0.01	Cameroon	0.01	Belarus	0.03

Source: Author from World Bank (2025)

Note: Countries with an exposure index over 0.1 are marked in red, between 0.1 and 0.05 in orange, and below 0.05 in green.

¹ Embedded emissions of a good is calculated at the manufacturing installation level and cover direct emissions (scope 1 i.e. emissions occurring during the manufacturing process) and indirect emissions (scope 2 i.e. emissions generated in the production of the electricity used in the manufacturing process).

² Available here: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12228-Carbon-Border-Adjustment-Mechanism/public-consultation_en

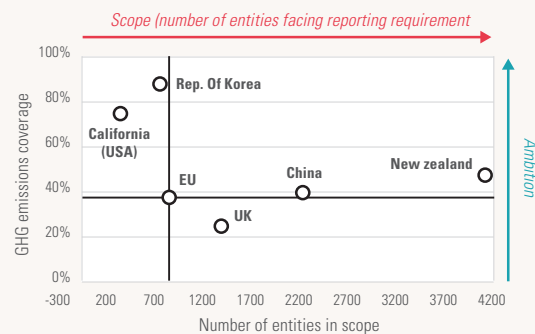
gated impact, although a deeper dive into each CBAM sector identifies other countries exposed, such as Trinidad and Tobago for fertilizers, Malaysia for cement, and Egypt for aluminium.

African countries might be the most negatively affected by CBAM due to high ad valorem rates on exports. The projected loss of income across the continent is estimated to reach up to 0.5% due to a decrease in exports from Africa to the EU of up to 5.72%⁵⁵. That said, some of these exports may also be diverted to other markets, such as China and India, thus limiting the loss in economic or social terms.

The CBAM is expected to eventually cover more than 50% of GHG emissions within the scope of the EU ETS, thus playing an important role in achieving the EU climate objectives. Arguably, a system would be ideally designed when covering the largest share of emissions from a given territory while impacting the lower number of entities from potentially burdensome reporting requirements. **Figure 9** below outlines 6 carbon pricing systems reviewed based on these two criteria and proposes a comparison with the EU ETS system in terms of ambition and scope. The systems in South Korea and California appear to be the most efficient with respectively 88.5% and 75% of emissions covered by only 804 and 400 entities in scope. On the other hand, the system in the UK for instance covers less emissions despite impacting on a larger number of entities than the EU system.

CBAM eventually presents a policy trilemma between climate ambition, technical feasibility, and international equity. The mechanism aims to support ambitious climate objectives of decarbonisation but must remain interoperable for businesses to be able to adequately implement it and to reach its full potential. Last but not least, other carbon-accounting border measures currently being developed or implemented by other countries raise the risk of carbon markets fragmentation across the world at the expense of global climate goals. Official Development Assistance.

Figure 9. Scope and ambition of carbon pricing systems



Note: based on the simplified CBAM expected to result in a drastic reduction of the number of entities into scope.

Source: Author from ICAP

context where international aid from official donors - Official Development Assistance (ODA) – rose steadily to a new all-time high of USD 223.7 billion in 2023, up from USD 211 billion in 2022⁴⁶. The EU and EU countries are also the world's leading providers of ODA in grant equivalent (methodology in which only the grant elements of loans are reported, instead of their full-face values), Europe disbursed €66.8 billion in 2020, 46% of world's total⁴⁷. Yet, behind these positive figures lies a more contrasted picture. First, ODA levels have decreased in 2024, down to USD 212.1 billion, for the first time in 7 years. In a very concerning move, many countries including the largest donors (either in absolute value

or proportion of GNI), such as Germany, Finland, Sweden, the Netherlands or France, are currently decreasing significantly their budget for ODA in a context of strained public finances and security concerns. The average share of the Gross National Income (GNI) of OECD countries dedicated to ODA fell from an already low 0.37% in 2023 to 0.33% in 2024, quite far from the official target of 0.7% target which was first agreed upon by the EU and OECD members in 1970 and repeatedly reindorsed since then⁴⁸. Norway (1.02%), Luxembourg (1%), Sweden (0.79%), and Denmark (0.71%) are the only donors meeting that objective so far, even though these numbers are also down in 2024 compared to 2023. Germany for

instance fell off the mark passing from 0,79% in 2023 down to 0,67% in 2024. France stands at 0,48%, the United States at 0,22%.

The EU typically aims to present itself through 'leadership by example' approach, advocating for 'targets and timetables', and to drive action through collective engagement around these very structuring objectives. Yet the recent developments mentioned above, and potential frustrations displayed by international partners may very well be weakening the position of the EU on the international stage.

CONCLUSION

With the impact of climate change growing at an accelerating pace, Europe has an historic opportunity and responsibility to act as a global leader for climate ambition. Over time, the EU has built arguably the most developed, structured and ambitious climate policy framework in the world. However, the context has drastically shifted since the early days of the European Green Deal. Systemic challenges to climate policy are now arising both globally and domestically. The risk is high now to see a lack of further ambition in EU environmental leadership at a time where the United States pulled out of the Paris Agreement yet again, while China continues to pose a systemic challenge to EU green industrialisation. This eventually could put into jeopardy the global efforts that are required to achieve the objectives of the Paris Agreement on its 10 years anniversary. Countries must now come together to find again the spirit that led to the conclusion of the agreement and work together toward a shared vision of a decarbonised world that can sustain the life and wellbeing of future generations.

REFERENCES

- 1 European Commission (2024). Staff Working Document accompanying the EU Climate Action Progress Report 2024. https://climate.ec.europa.eu/eu-action/climate-strategies-targets/progress-climate-action_en
- 2 European Commission (2025). EU-wide assessment of the final updated national energy and climate plans Delivering the Union's 2030 energy and climate objectives. COM/2025/274 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX-3A52025DC0274&qid=1749138488640>
- 3 G. Lafortune, G. Fuller, A. Kloke-Lesch, P. Koundouri and A. Riccaboni (2024). European Elections, Europe's Future and the SDGs: Europe Sustainable Development Report 2023/24. Paris: SDSN and SDSN Europe and Dublin: Dublin University Press, <https://doi.org/10.25546/104407>
- 4 Carbon 4 & ECF (2024). Imported emissions: from co-dependence to co-operative action. <https://www.carbone4.com/publication-imported-emissions>
- 5 EC Communication on the EGD. COM/2019/640 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX-3A52019DC0640>
- 6 Article 2(1) of the European Climate Law provides that Union-wide greenhouse gas emissions and removals regulated in Union law shall be balanced within the Union at the latest by 2050, thus reducing emissions to net zero by that date, and the Union shall aim to achieve negative emissions thereafter.
- 7 European Commission (2024). Staff working document impact assessment report part 1. Securing our future Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society SWD/2024/63 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52024SC0063>
- 8 European Commission (2025). Proposal for a regulation of the European Parliament and of the Council amending Regulation (EU) 2021/1119 establishing the framework for achieving climate neutrality. COM(2025) 524 final 2025/0524 (COD). https://climate.ec.europa.eu/document/download/e1b5a957-c6b9-4cb2-a247-bd28bf675db6_en
- 9 European Council (2025). Press release. Paris Agreement: EU submits statement of intent to the UNFCCC on the post-2030 NDC. <https://www.consilium.europa.eu/en/press/press-releases/2025/09/18/paris-agreement-eu-submits-statement-of-intent-to-the-unfccc-on-the-post-2030-ndc/>
- 10 Climate Action Tracker assessment of EU climate action: <https://climateactiontracker.org/countries/eu/targets/>
- 11 Article 15 of Regulation (EU) 2018/1999.
- 12 A. Oger (2024). A deep dive into the programme of the new President of the European Commission for 2024-2029. IEEP. <https://ieep.eu/wp-content/uploads/2024/07/A-deep-dive-into-the-programme-of-the-new-President-of-the-European-Commission-for-2024-2029-IEEP-2024.pdf>
- 13 European Commission (2025). Competitiveness Compass. https://commission.europa.eu/topics/eu-competitiveness/competitiveness-compass_en
- 14 European Commission (2025). Omnibus I. https://commission.europa.eu/publications/omnibus-i_en
- 15 European Commission (2025). Proposal for a 2028-2034 EU budget. https://commission.europa.eu/strategy-and-policy/eu-budget/long-term-eu-budget/eu-budget-2028-2034_en
- 16 For example, the share of whole industry in total gross value added decreased by 14% from 1995 to 2021, moreover the share of energy intensive industry in manufacturing gross value added decreased by 17% in the same period.
- 17 European Commission (2024). Ibid
- 18 European Commission (2023). staff working document accompanying the 2023 Climate Action Progress Reports. https://climate.ec.europa.eu/document/download/60a04592-cf1f-4e31-865b-2b5b51b9d09f_en

- 19 <https://www.eea.europa.eu/publications/rail-and-water-borne-transport/rail-and-waterborne-best/#notes>
- 20 <https://www.eea.europa.eu/publications/rail-and-water-borne-transport>
- 21 <https://ec.europa.eu/transport/sites/transport/files/legislation/com20200789-annex.pdf>
- 22 <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX-3A02019R0631-20210301>
- 23 <https://eur-lex.europa.eu/EN/legal-content/summary/clean-and-energy-efficient-road-transport-vehicles.html>
- 24 Feedbacks on a Sustainable transport investment plan available here: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14802-Sustainable-transport-investment-plan_en
- 25 European Commission (2020). Staff working document accompanying the Sustainable and Smart Mobility Strategy. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020SC0331>
- 26 Transport and Environment (2023). Less is more – time for a hydrogen reality check. <https://www.transportenvironment.org/articles/less-is-more-time-for-a-hydrogen-reality-check>
- 27 ACEA & CLEPA letter to the President of the European Commission (2025). <https://www.acea.auto/files/Joint-ACEA-CLEPA-letter-to-President-von-der-Leyen.pdf>
- 28 H. Dyrhaug & T. Rayner (2023). Transport: evolving EU policy towards a 'hard-to-abate' sector. Handbook on European Union Climate Change Policy and Politics - Chapter 21. P. 305–320. <https://doi.org/10.4337/9781789906981.00035>
- 29 IEEP (2025). From sustainability to competitive-ness: what shifting narratives means for EU agricultural policy. <https://ieep.eu/publications/from-sustainability-to-competitive-ness-what-shifting-narratives-means-for-eu-agricultural-policy/>
- 30 IEEP (2025). The post-2027 CAP and MFF proposals for the EU: first reflections on their environmental implications. <https://ieep.eu/publications/the-post-2027-cap-and-mff-proposals-for-the-eu-first-reflections-on-their-environmental-implications/>
- 31 Korosuo, A., et al. (2023). The role of forests in the EU climate policy: are we on the right track?. Carbon Balance and Management, 18, 15. <https://doi.org/10.1186/s13021-023-00234-0>
- 32 L. Lee, A. Ignaciuk (2025). Mitigating climate change in the agriculture, forestry and other land use (AFOLU) sectors: A literature review on policy effectiveness. OECD. <https://dx.doi.org/10.1787/166b6c31-en>
- 33 EEA (2023). Monitoring report on progress towards the 8th environment action programme objectives. 2023 edition. Chapter on 8TH EAP thematic priority objective Climate change adaptation
- 34 Communication from the Commission (February 2021). Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change. COM/2021/82 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:82:FIN>
- 35 EC, 2022, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the monitoring framework for the 8th Environment Action Programme: Measuring progress towards the attainment of the Programme's 2030 and 2050 priority objectives. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022DC0357>
- 36 Regulation (EU) 2018/842 of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement (Effort Sharing Regulation). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.156.01.0026.01.ENG
- 37 Hofmann, A. (2021). Making EU environmental policy more legitimate? In A.J. Jordan and V. Gravey (Eds.), Environmental Policy in the EU. Fourth Edition. London: Taylor and Francis, pp. 317–333.
- 38 Rayner, T., Szulecki, K., Jordan, A. J., & Oberthür, S. (2023). The global importance of EU climate policy: an introduction. In *Handbook on European Union climate change policy and politics* (pp. 1–21). Edward Elgar Publishing. <https://doi.org/10.4337/9781789906981.00011>
- 39 Russel, D. et al. (2020). Policy coordination for national climate change adaptation in Europe: all process, but little power. Sustainability, 12: 5393. doi:10.3390/su12135393
- 40 Newell, P. (2024). Towards a more transformative approach to climate finance. *Climate Policy*, 25(2), 257–268. <https://doi.org/10.1080/14693062.2024.2377730>
- 41 P. Bolton, A. Kleinnijenhuis, J. Zettermeyer (2024). The economic case for climate finance at scale. Bruegel Policy Brief No. 09/2024. Bruegel. <https://hdl.handle.net/10419/302289>
- 42 OECD (2024). Climate Finance Provided and Mobilised by Developed Countries in 2013–2022. https://www.oecd.org/en/publications/climate-finance-provided-and-mobilised-by-developed-countries-in-2013-2022_19150727-en.html
- 43 CPI (2024). Climate finance needs. <https://www.climatepolicyinitiative.org/climate-finance-needs/>
- 44 Blot, A. (2023). Reflections on the new approach to the TSD Chapters for greener trade. Institute for European Environmental Policy (IEEP): https://ieep.eu/wp-content/uploads/2023/02/D14_D7.2-TSD-Review-Reflections-on-the-new-approach-to-the-TSD-Chapters-for-greener-trade_IEEP-2023.pdf
- 45 We note that levels of aid should be viewed with a lens of European colonial history and the Global North's excessive resources and labour extraction from the Global South. For instance, an analysis reveals a net appropriation of value from the Global South to the Global North that amounted to 30 times the total international aid between 1990 and 2015.
- 46 See OECD: <https://www.oecd.org/en/topics/official-development-assistance-oda.html>
- 47 S. Tagliapietra (2021). The Global Gateway: a real step towards a stronger Europe in the world? <https://www.bruegel.org/blog-post/global-gateway-real-step-towards-stronger-europe-world>
- 48 O C E D : <https://web.archive.oecd.org/temp/2024-06-17/63452-the07odagnitarget-ahistory.htm>
- 49 All information on the 6 omnibuses packages currently under consideration can be found here: <https://www.consilium.europa.eu/en/policies/simplification/>
- 50 All feedbacks submitted under the consultation process on the environmental omnibus can be accessed here: <https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14794-Simplification-of-administrative-burdens-in-environmental-legislation-en>
- 51 Corporate Leaders Group (2023). Raising European Climate Ambition for 2040: A CLG Europe position paper. <https://www.corporateleadersgroup.com/reports-evidence-and-insights/raising-european-climate-ambition-2040>
- 52 A. Bonnet and I. Baršauskaitė (2025). The State of BCAs 2025. International Institute for Sustainable Development (IISD). <https://www.iisd.org/system/files/2025-02/state-of-bcas-2025.pdf>
- 53 E. Cornago, A. Berg (2024). Learning from CBAM's transitional phase: Early impacts on trade and climate efforts. Center for European Reform – CER. Policy brief. 03 December 2024. <https://www.cer.eu/publications/archive/policy-brief/2024/learning-cbams-transitional-impacts-trade>
- 54 European Commission (2025). REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Regulation (EU) 2023/956 as regards simplifying and strengthening the carbon border adjustment mechanism. COM(2025) 87 final. https://commission.europa.eu/document/download/606b4811-9842-40be-993e-179fc8ea657c_en?filename=COM_2025_87_1_EN_ACT_part1_v5.pdf
- 55 African Climate Foundation and The London School of Economics and Political Science (2023). Implications for African countries of a carbon border adjustment mechanism in the EU. <https://african-climatefoundation.org/wp-content/uploads/2023/05/800756-AFC-Implications-for-Africa-of-a-CBAM-in-the-EU-06A-FINAL.pdf?page=28>

A decade of national climate action: Stocktake and the Road Ahead

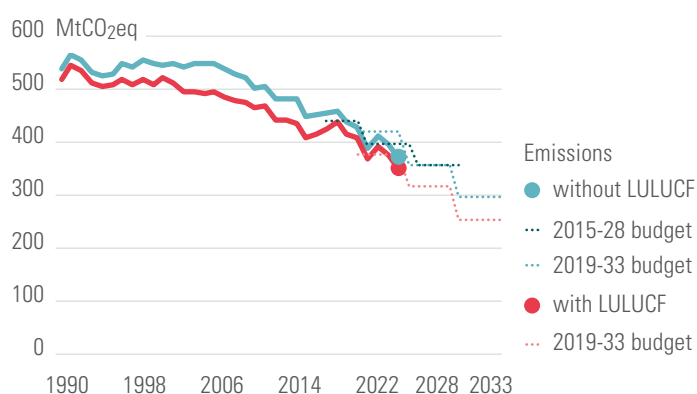
FRANCE INSIGHTS ON CLIMATE ACTION TEN YEARS AFTER THE PARIS CLIMATE AGREEMENT

By Michel Colombier, IDDRI

KEY NUMBERS

French gross emissions have peaked in the early 90's, plateaued around 550 MtCO₂e until the mid-2000's, then decreased by around 30% until 2023. French net emissions are about 10% lower (LULUCF contribution being negative) and have somehow followed the same trend during this period (**Figure 1**). After the success of the Rio Earth Summit and the ratification of the UNFCCC treaty, France created in 1993 a specific Climate Change Department (in French "mission

Figure 1.
Historical national emissions compared to national emission budgets



Source: Citepa (2024).

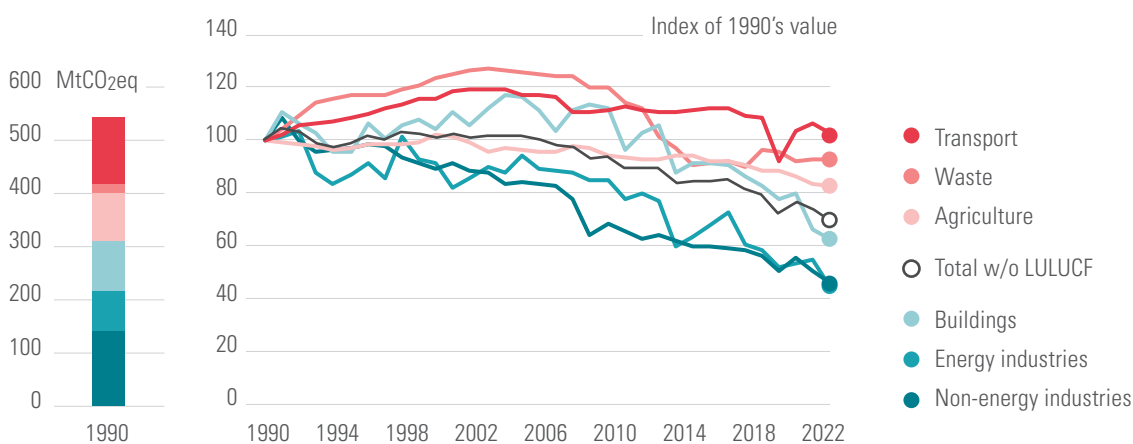
effet de serre") attached to the Prime Minister and adopted 2 years later a first package of measures specifically dedicated to reducing GHGs emissions. The French power sector emissions are relatively low compared with European members for historical reasons, the development of large hydro after World War II, and of nuclear power after the 70's oil crisis. Depending on meteorological conditions, about 80 to 85% of French power domestic demand was already covered with low carbon sources and this plan was therefore more focused on other sectors. The stabilization of emissions and then decrease during the following decade was actually the result of opposing trends (Figure 2), reductions in some sectors (mostly in energy intensive industry, with important efficiency improvements in response to the oil crisis, but also a reduction of domestic production) and still a rise in end uses direct emissions (building and transport) where the introduction of efficiency measures, such as building codes, were not sufficient to offset the rise of activity (square meters of residential and service buildings, important increase in transport demand).

A step change occurred in 2015, with the adoption of the Energy Transition law (see more details below) and of the first long term low carbon strategy. More ambitious and systematic measures were introduced, covering new subsec-

tors : development of renewables in the power system allowing for a reduction in fossil fuel powered capacities (explaining the inflexion of the "energy industry" curb after 2015 in Figure 2); specific measures dedicated to the existing stock of buildings, to support envelope renovation and fuel switch; development of urban public transport; waste management (such a methane capture) or rationalization of N fertilizer use in agriculture etc. (Figure 2).

Figure 3 gives a breakdown by gases for the period 1990-2022: in addition to the reduction of CO₂ emissions (by 40%), we observe a regular reduction of N₂O emissions (-50%) and of methane emissions after 2000 but to a lesser extent (-25%). But if CO₂e emissions trends are useful indicators to illustrate the effectiveness of climate policies, they need contextualization to avoid misinterpretation: these reductions can partly be explained by proactive policies, but partly by other factors: rise in the price of fertilizers, reduction of the livestock due to economic difficulties. If the rationalization of the use of fertilizers is almost not reversible (development of new practices supported with new mechanical equipment), the decrease of meat production is not associated with a decline in meat consumption, and the carbon footprint of diet in France was actually not much improved.

Figure 2. National emissions w/o LULUCF, by sectors



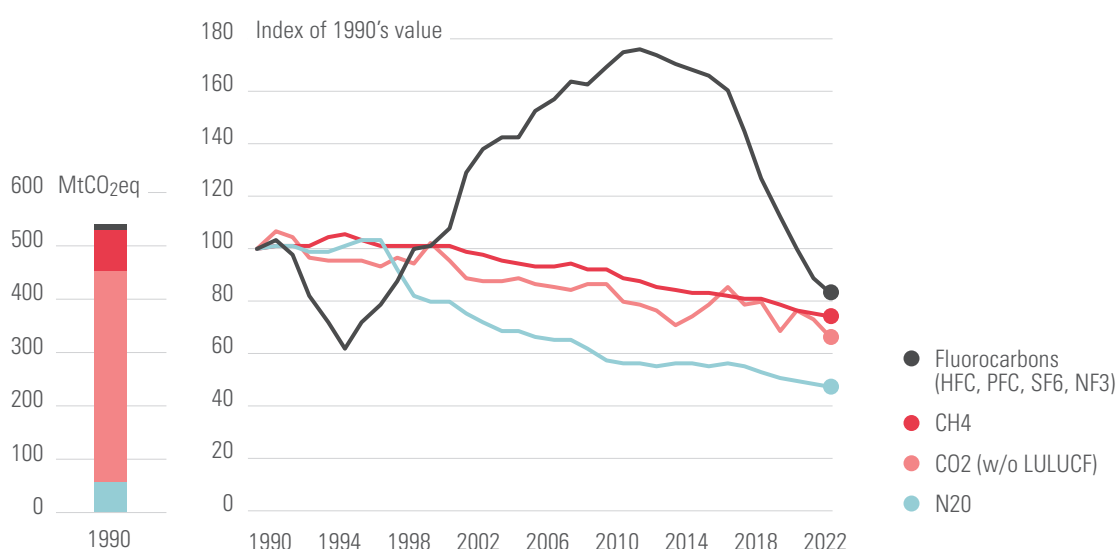
Source: inspired by the Annual Report of HCC (2025), Citepa (2024).

The 2015 Energy Transition Law has introduced carbon budgets in the toolbox of French decarbonization policies. Three 5-years carbon budget were then set for the upcoming 15 years, to be updated every five years with the introduction of a new 5-year budget. **Figure 1** shows that since their adoption in 2015, the trend of emissions is in compliance with the obligation introduced by this new instrument. But the last annual report issued by the French High Council on Climate (HCC, an independent expert body in charge with the evaluation of the Climate policy) pointed out

a worrying slowdown in the annual reduction rates in most sectors.

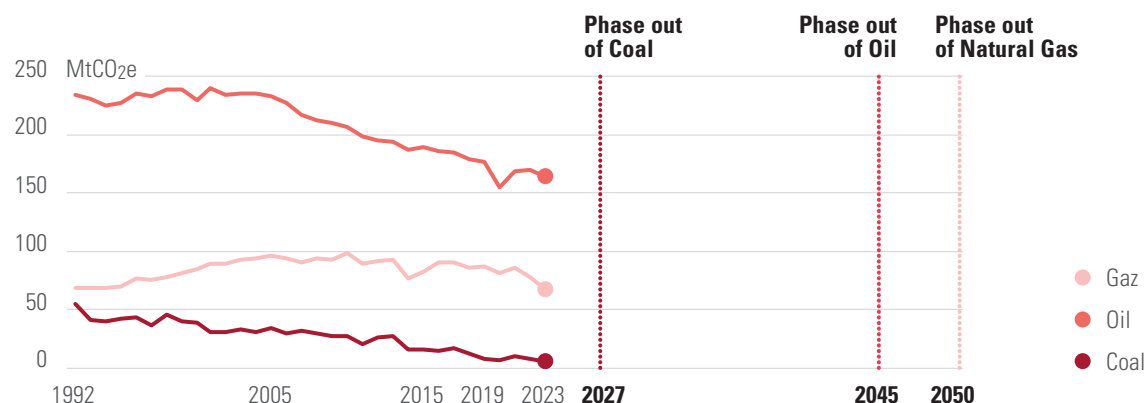
Figure 4 illustrates the specific issue of Fossil Fuel (FF) phase-out. The French decarbonization strategy now incorporates FF phase-out horizons for coal, oil and natural gas. **Figure 4** shows that the objective for coal is already almost achieved, after the retirement of the last coal power plants. Delivering the oil phasing-out objective remains clearly a challenge : the trend of reduction is rather steep but not yet sufficient; if the phasing out in the domestic building subsector appears to be

Figure 3. National emissions w/o LULUCF, by gases



Source: Citepa (2024).

Figure 4. Emissions from fossil fuels (1992-23) and phase-out horizons



Source: inspired by the Annual Report of HCC (2025), Citepa (2024).

at hand (existing policies supporting the switch to electricity or district heating), oil remains the main contributor to domestic emissions and the switch to alternative fuels, or alternative modes in the transport sector (passengers and freight) one of the most challenging policy objectives. The evaluation of the trend for natural gas is more complex and uncertain: according to the first set of scenarios and objectives, natural gas was supposed to steadily decline in the traditional sectors (building and industry) while its role in the power sector is already limited. But in recent years a push from industry at national and European levels have fragilized this vision and progressively installed the idea that natural gas could be a “transitional” option (power, transport, but also buildings and industry) and could be progressively decarbonized through the injection of biomethane. Policies and financial frameworks have since been adapted accordingly. While meaningful in specific sectors and national situations, this option rely on limited biomass resources and cannot substitute natural gas in its current (building, industry, power..) and potential future (transport) markets. Decarbonizing natural gas through biomethane injections requires a drastic selection of high value markets. But a “supply only” approach would certainly create new stranded assets and vested interests and make it difficult to reach the objective of total phase out by 2050.

Role of Long-Term

France has a long tradition in energy planning, and climate issues have been integrated since 1997, necessitating at that time an expansion of the horizon (up to 2050). In 2005 France adopted its first long term objective named F4 (factor four: to cut 75% of GHGs gross emissions by 2050). In 2013, the recently elected President F. Hollande organized a 2 years national debate, where a dozen of different scenarios (developed by academics, civil society, or energy firms) served to inform a discussion on the options at hand to reach that goal. The debate was organized and moderated by a group of independent experts, and an assembly of all stakeholders (industry,

NGOs and civil society, academics, local authorities) was convened once a month in plenary, and more frequently in smaller thematic groups, to discuss options and formulate proposals. Following the debate, an “energy transition law” was adopted in 2015 (LOI n° 2015-992 du 17 août 2015) introducing a series of long-term 2050 GHGs and shorter-term 2030 energy and infrastructure targets aligned with the F4 objective, along with several governance innovations:

- a long-term low carbon strategy named SNBC: 2050 vision plus three successive 5 year's period budget and respective policy orientations, to be updated every 5 years;
- an energy plan named PPE, pluriannual program for Energy investment covering two successive 5 years period, compatible with the SNBC and updated simultaneously;
- an independent Expert Panel on Energy Transition, in charge of the evaluation of the strategy, and its implementation.

Several adaptations have been introduced since, including the substitution of the 2050 F4 objective with the PA art2 Neutrality objective after the ratification of the Paris Treaty, and a reform of the expert committee (now HCC : High Council on Climate) expanding its role to adaptation and reenforcing its institutional position (direct reporting to the Prime Minister, autonomous communication capacity, obligation for the government to publicly respond to the annual report, and hearings in the parliament). The third generation of SNBC and PPE are currently in the process of adoption. There is no doubt that this institutionalization of the planning process, and its participative elaboration (with a consultative, permanent body of stakeholder representation) have contributed to a better understanding and ownership of the climate issue, starting with the government and the administration but more generally within the French society. Concretely, several policy discussions have clearly benefited from this long term perspective (see 2 below) for several reasons : obviously because of the “planning” dimension of the exercise per se, questioning the compatibility of short term decisions with the longer term objectives; but also because of the induced

analytical quality of the debate: it facilitated the recognition of independent expertise and gave a voice (not just a seat) to different type of stakeholders, from the industry to the civil society, offering them a chance to express their views in the administrative process, or in parliament hearings. It has clearly reinforced the liability of the government and facilitated the adoption of decisions (laws, budget orientations, procedures, etc.) supportive of the climate ambition.

According to independent evaluation (including the HCC reports) the GHGs budget adopted with the SNBC 1 and 2 (up to 2033) were reasonably compatible with the long term objective, and the set of policies adopted allowed for a global compliance of the targets during the last budget period (2018 to 2023).

But the HCC reports repeatedly highlighted several points of attention:

- The breakdown by sectors reveals that the dynamics are quite unequal and, even though all sectors are now on a reducing trajectory, some are still far from their (indicative, non prescriptive) sectoral target.
- More importantly, structural changes that the SNBC pointed out as "necessary" to reach the long-term goal are not engaged yet/ not sufficient (see 3 below). Reductions are sometimes rather contextual and not always the result of proactive transition actions, or even desirable changes: for instance, the reduction of the livestock together with the stability of meat domestic consumption boosted imports.
- The compliance with the 2050 objective depends obviously on the capacity to reduce emissions, but although on the capacity to deliver the objective on sinks (mostly forestry and agriculture). But the recent surveys have revealed that the sequestration capacity of the French forest was far below the historical trends, certainly a consequence of climate change already. This evolution is clearly visible in the figure 2 above, where the difference between gross and net emissions is progressively diminishing after 2015. Future gross emissions targets and budgets need certainly to be adapted accordingly in the new SNBC#3.
- The planning documents provide a transcription of the long term commitment into short term (10/15 years) desired transformation, but need further elaboration to be translated into detailed policy design; this is not just a top-down process and implementation difficulties need to be reflected in the actualization of the strategy : but there is no evaluation available, and the discussions on the forthcoming periods take place without serious return on experience.

It is also noteworthy that:

- More recently, sectoral roadmaps (steel, chemistry, cement, etc.) have been negotiated with the concerned stakeholders, to better translate the SNBC orientations into tangible pathways for each industry, inform bottom up the opportunities and difficulties of each of the sectors and evaluate (private and public) investment needs, knowing that large emitters are at the same time covered with the EU ETS market obligations. These roadmaps are aimed at complementing the short term ETS "price pressure" with a more informed, long term compatible vision; and facilitating more proactive response strategies by decision makers and more relevant policy initiatives on the public side. On the other hand, there is a clear risk of capture and asymmetry of information (on innovation opportunities, on costs, etc.) : for instance, part of the industry has insisted on the importance to maintain a significant supply of methane in the forthcoming decades to limit the transition costs, but this bottom-up evaluation of methane demand ended up with much higher figures than the previous modelling evaluations... conflicting with French commitments and objectives on fossil-fuel phase out. The solution envisaged in the planning document (a sharp increase in bioenergy supply, assuming the availability of the resource) is now clearly fragilized by recent reports on the impact of CC on biomass production in France.
- The long-term goals of the PA have also impacted the discussion on adaptation. For the first time (although there has been an "adaptation strategy" for years in France) the last

National Adaptation Plan adopted this year starts with establishing a long term reference and a trajectory for adaptation (TRACC), defining a threshold of 4°C temperature increase by 2050 and a series of consistent sectoral and transversal adaptation strategies. This Plan still needs operationalization, and a supportive investment framework, but it represents a real improvement compared with the previous approaches and provides, as for mitigation, a useful reference for decentralized territorial or private action.

Long term public commitment and its respective shorter term budgets and strategies have been referred to by French Courts (including the “Conseil d'Etat”, the highest jurisdiction re state intervention), considering that these planning documents now represent a legal commitment by the French government, and can be used in litigation to judge the effectiveness and the adequacy of the public action re the PA art 2 objectives : in a recent case, the judge stated that such documents made it possible to establish a clear relationship between the climate policy ambition and performance today and the expected negative impacts of CC by mid-century. On this basis, the Court ruled in favour of the plaintiffs and sentenced the state to increase its action against climate change.

Examples of concrete progresses (where the LT approach has unlocked difficult debates)

Energy Mix, Power Generation and Fossil Fuel Phase Out

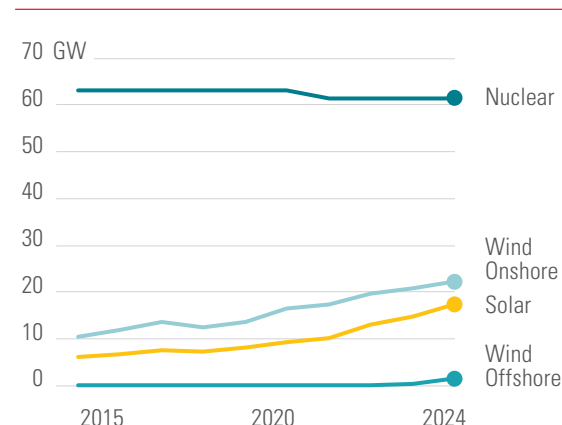
Long term strategies, short term policy objectives and improved governance (see 4 below) have proved efficient to unlock a series of discussions and make progress towards effective implementation of the energy transition.

A first, illustrative example in the French case is the Energy Mix debate in a country where this discussion is usually leading immediately to debating the pros and cons of nuclear energy, neglecting important other issues that need instruction, deliberation and decision in the energy transition process. The introduction of the long-term perspective and at the same time the need to elaborate credible and

resilient transition pathways towards this desired future, the need to widen the scope to all sources of energy (once the issue is precisely on fossil fuels and not on electricity only) have facilitated a more peaceful and contributing discussion. It imposed a more analytical approach where the respective roles of sufficiency, efficiency, electrification and the provision of decarbonized electricity had to be thoroughly discussed. The 2015 law acknowledged the necessity to actively develop RES (Renewable Energy Sources) in a country where nuclear energy will, according to official plans, continue to play an important role anyway. Economic considerations (taking advantage of the reduction on costs and of the significant potential in solar, wind, hydro, geothermal and biomass of the French territory), EU collective engagement, but also diversification of the mix and respective energy security issues, as well as the necessity to develop generation capacity in the upcoming 2 decades to accompany the development of electric vehicles and heat pumps, have resulted in a quite ambitious investment program in the subsequent Energy Programme (PPE1 and PPE 2). Since 2015, the policy support to RES development has been at the same time less chaotic, more effective and more efficient.

Figure 5 shows that during this period, wind capacity has more than doubled and solar capacity almost tripled, expanding the market for the respective industries and benefiting, in return, from drastic reductions in the price of both

Figure 5. Installed power generation capacities



Source: RTE (2025).

technologies. Cumulated RES capacity (including hydro) is now comparable to the nuclear installed capacity. In 2023, RES generation represented 141 TWh, almost one third of total net consumption; gross nuclear generation peaked at 320 TWh and fossil fuel capacities (mostly gas) provided 30 TWh to the grid.

But a controversy has developed since last year, first among experts but rapidly expanding to the political arena. The ambition in RES development was mostly based on the assumption of a rising demand for electricity during the 2025-2035 decade, as a consequence of the policies supporting the electrification of the final demand for energy. But electrification has slowed down recently, in particular in the transport sector where the car industry is clearly pushing back and where the replacement of ICE vehicles with EVs is facing a number of political and social challenges. The opposition to the climate energy transition has recently become more vocal, in connection with the international situation. An intense lobbying has developed to express concerns about this (successful) development of RES, arguing that electrification objectives were too ambitious, that RES would compete with the nuclear programme and that fossil fuel should still play an important role in all sectors for the next 3 decades. At the same time, key features of the current RES strategy are not just climate driven, but respond also to various rising international challenges (energy security/ sovereignty, power generation cost). It is yet too early to tell whether the policy discussion framework developed in a more peaceful and pro- active period will also prove resilient and efficient in this new context.

Building and Electric Vehicles

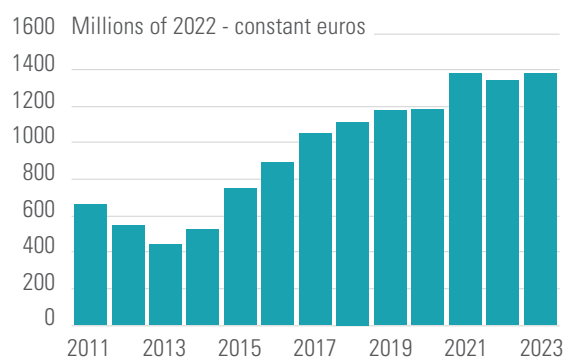
Other important issues have also benefited from this better-informed discussion, where the long-term perspective shed a new light on the value, or the risk of short-term choices.

In the building sector where energy efficiency and electrification has long been considered competing approaches, it has resulted in the progressive recognition that building renovation (as opposed

to construction) was a key challenge to facilitate the dissemination of decarbonized heating equipment, such as heat pumps. It is necessary from an individual perspective to reduce the cost, and from a collective perspective to mitigate the impact of this development on the power sector (generation and grid). Support schemes, although imperfect, have been designed to incentivise ambitious envelope renovation as well as fuel switch: labelling system on both the energy consumption and the GHGs emissions for buildings; regulatory framework on selling and renting obligations setting minimum performance standards for the respective transactions, grants and loans to support investment, equipment market regulation (support to innovation, minimum standards, etc.) in addition to reinforced building codes for new construction. Private investment in residential building renovation has eventually increased by a factor 2 to 3 in the last decade but remains insufficient compared with the projections assumed in the low carbon strategy.

Another example is the central role of electrification in the transport sector, and namely the development of electric vehicles in a country where the automobile industry is quite developed. In the early 2010's, EVs were still considered a marginal option, and official documents were mostly committed to develop "3 litres cars" (meaning cars with a 3l/100km fuel consumption) and biofuels. But in 2023, France has adopted an

Figure 6. Total investment to increase energy-efficiency in building renovations



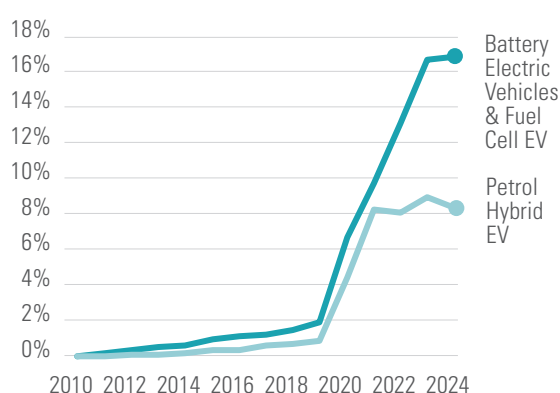
Source: Ademe (2025).

objective to end the production / sales of ICE vehicles by 2035 (a regulation strongly opposed since by the European car industry).

The international dynamic and the rapid innovation on EVs have obviously played an important role in this evolution, as well as EU discussions and decisions (CAFE directive). But it is clear also that the domestic debate on cars has evolved after 2015, with the necessity to consider the neutrality objective: the long-term, aspirational vision has then switched from “fuel efficient cars and biofuels” to “EVs”. But contrary to what happened in the building sector, the focus on EVs (emission free vehicles) has evicted the concern on the size and cost of vehicles (energy efficiency/ affordability), letting the industry develop a strategy towards larger, heavier and more expensive propositions, now a difficulty in the transition towards electrification for many reasons (just transition, resource sovereignty and recycling, urban space, etc.).

Early this year the 2035 objective has been released but this vote was not the result of a change in the decarbonization strategy : it was a response to the intense lobbying of the car industry and may not change much the technology options, mostly determined now at EU and global level, though it will eventually impact the manufacturers strategies and the dynamic of the market.

Figure 7. Share of electric vehicles in annual registrations



Source: SDES (2025).

Examples of concrete blockages (where the LT approach was unable to solve controversies)

Agriculture

The public discussion on climate change and the policy arena have long been dominated by energy considerations, but the agriculture / food sector is also an important contributor to GHGs emissions, and a vulnerable activity as well. This is particularly true in France, due to the importance of agriculture and agrobusinesses in the country's economy. From a strict analytical point of view, there is a number of propositions on the shelves to feed the discussion, from incremental changes to more radical agro-ecological transition visions. But environmental issues remain extremely controversial and public policies remain more reactive to short-term stakeholder demands than responsive to long-term challenges. The political economy of the discussion is extremely complex:

- The transition cannot be discussed with a single climate change focus: biodiversity is equally impacted by agriculture practices and ecological transition visions need to take both issues into consideration.
- the sector is heterogeneous: if large farmers are rather profitable, smaller producers (meat, vegetables, fruits) are already suffering important economic difficulties;
- from a producer point of view, incremental changes have generated additional constraints (ban on some chemicals, water access, etc.) while offering few opportunities because of their poor bargaining capacity on the market.
- the food industry, and distribution firms are price makers, but argue that they are protecting consumers;
- in this context, environmental conditionality (for instance in the CAP Common Agriculture Policy) is not seen as an incentive, but as an additional barrier to access public support;
- public policies have incentivized the development of organic farming, but this market remains limited and organic over production is now sold by farmers with limited or no margin.

On the other hand, the sector is being increasingly impacted by climate change, and this new challenge may be a game changer. There are multiple options to respond to climate change risks, and some will generate controversies with other stakeholders (for instance, on water access). But in any case, BAU will not be an option anymore.

Carbon Tax

Beyond sectoral discussions, blockages have also characterized the very design of climate policies. Economists have long argued that the Pigouvian Tax was the more efficient instrument to incentivize emissions reductions. Following their guidance, the government installed in 2014 a Carbon Tax on top of existing taxes on fuels (gasoline, gasoil, fuel oil, etc.). The level was initially quite low (7€/ton) but a rapid increase was planned in the law, to reach a 100€/ton in 2030. From 2014 to 2017, the progressive increase of the tax was mitigated by the decrease of prices on international oil and gas markets, but the 2018 increase was reinforced by a sudden rise in the international prices.

Although fundamental reasons were much more diversified, the resulting inflation on gasoil and domestic heating fuels served as the spark for a one-year, popular countrywide protest (the yellow jacket movement). Motivation was extremely heterogeneous in this movement, and rather populist narrative emerged to denounce the “ecological bureaucracy” and the urban contempt for the rural areas and the low-income populations. But interestingly, some leaders also argued that they were quite supportive of the environmental intention but that, having no option to adapt to the rising price, they couldn't see the point in increasing the tax: for them, priority had to be given to the development of public transportation, the access to clean vehicles (cheaper new models, second hand market, specific incentives for low income families, etc.) and to salary increases.

This discussion resulted in a growing recognition, among experts and policy makers, that the transport challenge could not be limited to

a fuel/engine discussion, but that personal and freight mobility needed much more comprehensive strategies, including mobility needs (urban planning, logistic, etc) and multiservice supply approaches. Local authorities, quite impacted by the movement, played an important role in this evolution and have since reinforced their actions in the field. But the level of the tax has never been increased since (it's been blocked at 44,60€/ton) and the use of fiscal instruments is now extremely controversial in the country. The implementation of the ETS2 in 2027 (the second pan-European carbon market, covering upstream decentralised emissions) will initially have limited impact on prices because the EU tax will substitute the current instrument. But the planned increase of the ETS2 Carbon price after 2030 will certainly be politically sensitive.

Link with non-climate questions

Just transition and low-income population

Climate policies have raised many interrogations and reactions regarding their potential impacts on vulnerable populations. Beyond the Carbon tax / Yellow Jacket dispute, the recent proposition to develop Low Emissions Zones in large cities resulted in a sharp political divide and, finally, a vote in parliament to postpone the implementation of such regulations. LEZ were designed to respond to local pollution issues through drastic traffic restrictions (after the conviction by EU jurisdiction of a couple of French Cities for excessive exposition of their inhabitants to air pollution). But soon, underestimated implementation issues fed growing discontent in the population, regarding the induced difficulties for commuters unable to buy new cars and living in poorly connected sub urban areas, or professionals. Solutions were progressively designed to accommodate most situations but much too late to avoid social unrest and political pressure. Again, the lack of anticipation resulted in a complete blockage of the discussion and, most probably, a lasting difficulty to reintroduce similar policy intervention.

Just transition and jobs

Trade Unions have also expressed concerns regarding the social consequences of the transition, not necessarily to oppose the movement but sometimes to defend multistakeholder platforms to anticipate response measures to necessary changes: training, relocation, market protection, financial support for innovative initiatives, etc... Economic modelling was not very conclusive regarding the possible impact of the climate transition on jobs : according to models, it could induce a few percentage loss (general equilibrium) of a few percentage gain (Keynesian representation) illustrating two different movements that can actually be observed : on the one hand a competitiveness issue (mitigated by the limited substitution of many products on specific markets); on the other hand the impact of a more CAPEX oriented energy system, on both supply and demand side, where (possibly domestically produced) capital would substitute imported fossil fuels. But even though the industrial decline could remain limited, the phasing out of specific activities, such as casting or mechanical engineering, would impact a majority of workers in certain regions, while new industries such as battery gigafactories will develop in other places, responding to specific location criteria (Power, H₂ or CO₂ grids for instance) The need to support impacted local communities led to the creation of specific forms of contractualization between public and private actors to develop new activities, create new jobs and develop respective skills, but it is a long and sometimes deceptive process.

Competitiveness, innovation and trade

More generally, the private sector keeps complaining about the loss of competitiveness that would result from the ecological transition, leading to a growing share of imports, jobs destruction and environmental delocalization. Despite the responses developed at EU level (and namely the CBAM imposed to compensate for the EU-ETS cost on covered sectors) the political pressure has not diminished and make it difficult to negotiate higher ambition with the industry. The PA transparency framework and global stock-take

exercises, initially aimed at reinforcing mutual information and trust in the conduct of transition policies, have not provided the expected evidence to support domestic discussions with the private sector. Regional trade agreements have been blocked under similar criticism, but no serious effort has been made to date to design and promote a new generation of trade agreement that could be mutually supportive of the transition in connected economic spaces. More recently, the EU "Green Deal" vision has been under attack and, even at domestic level, the demand for "simplification", sometimes legitimate, has resulted in lowering the environmental ambition in various sectors. But the consequential slowing down of the transition may also induce counter-cyclical impacts on green investment and the demand for green goods and equipment... where the success of innovation policies is in turn quite dependent on the quality of procurement: the paradox is that it may therefore, at the end of the day, reduce the efficiency of public/private efforts (and expenses) to develop a competitive and innovative industry.

Public Budget for Investment and Private Action Incentive

Public spending is obviously a key parameter in the policy arena. The 2024 level of public expenses, including direct public investment and the support to private sector/ domestic spending, amounted to 32 billion € (including 10 billion at local authority level), and should rise up to 70 to 100 billion by 2030 according to independent evaluations : the appraisal range is not connected to the ambition of policies (the reference being in both cases the Low Carbon National Strategy official pathway) but to the assumptions regarding the efficiency of public spending (leverage on private expenses), and the importance attached to just transition considerations. If public spending has been increasing regularly in the past decade, the current situation on public debt and the EU regulations will certainly impact the discussion. Another significant but difficult debate concerns the possibility to vote, in Parliament, a pluri-annual budget for the transition attached to the

pluriannual strategy. From a strict legal point of view, State and Local Authorities budgets are annual and there is no possibility to commit to pluri-annual expenses. But in other high-ranking policies (such as Defense Spending), a pluri-annual (indicative) budget comes with a specific pluri-annual plan of investment adopted in parliament and provides a higher level of confidence for all concerned stakeholders regarding state commitment. This discussion has been quite vivid in recent years, but here again recent developments (debt / public spending reduction) may prevent any radical move for the coming years.

Governance

Soon after Rio, a Special Envoy on Climate Change was nominated, and created a specific department in the Prime Ministry cabinet to manage domestic policy planning, EU discussions and UN negotiations. A decade later, this organization was broken, and the implementation activities were placed under the responsibility of the environment and energy minister, while international affairs fluctuated between this ministry and the Foreign Office. Since 2015, the Ministry in charge of Environment remains the convening power and the architect of the planning documents (Low Carbon Strategy, Energy Investment Planning, Adaptation Plan), while other ministries (agriculture, housing, finance, budget, industry...) are involved in the process. This interministerial consultation is also connected to a permanent committee of stakeholders (meeting several times a year in plenary, then in smaller working sessions), to collect proposals, ideas or positions, but also to test specific decisions. Arbitrage remains with the prime minister office whenever necessary, as for any other business in the French executive organization.

Up to 2022, implementation was also 'under the responsibility' of the Ministry of environment, but many initiatives would obviously develop on other ministry's "territories" and make it difficult for the former to deliver the planned actions in case of conflict. An interministerial climate meeting was then created but ceased activity after a

couple of meetings. In 2022, a new interministerial department was created to coordinate State intervention, attached to the Prime Minister : this High Secretariat for Ecological Transition (SGPE) had a quite extensive mission, starting with the operationalization of the strategies into concrete plans for state intervention, the mobilization of stakeholders (from the private sector to local authorities) for the design and then the implementation stage, the coordination of action with the concerned Ministries, and the monitoring of action. This governance innovation certainly improved the dynamic of state action, generating first some conflicts but altogether leading to a wider ownership of environmental issues as well as policy orientations. In 2023/2024, French regions organized decentralized stakeholder processes named COPs, to prepare regional and local action plans informed by the national strategy but identifying specific opportunities and risks for public action.

CONCLUSION

The impact of the Paris Agreement can be observed at three levels of domestic policies:

- first, it had an impact on the substance (ambition, nature of the transition, and of the technological and socio-economic options to be mobilized). In a nutshell, it imposed new visions where the switch towards zero carbon energy carriers (electricity, but also heat, hydrogen etc) became the rule. Before that, energy efficiency was considered a cost effective option to harvest low-hanging fruits and progressively reduce emissions. With the introduction of zero-carbon options for the energy supply, the interest for energy efficiency (and sufficiency) has first decreased but economic and social considerations have since forced experts and policymakers to revisit their role and re-introduce demand policies at the heart of the system, hand in hand with technological fuel-switch solutions. Similar conclusions emerge now regarding the transition in the agriculture / LULUCF sectors where upstream changes at

farm level need to be reflected all along the chain, starting with the agrifood industry, the distribution firms and the final consumers;

- second, it had an impact on the governance of the transition : its design (long term neutrality goal and associated objectives on adaptation and finance, regularly updated NDCs, multistakeholder governance framework) has induced a series of innovations in the design of public intervention, such as long term strategies, carbon budgets, action planning, public-private co-ordination etc, installing climate change higher in the ranking of government priorities and, more importantly, favouring more systemic approaches, interministerial collaboration and just transition considerations beyond environmental effectiveness and economic efficiency;
- third, it has clearly reinforced the bargaining capacity of the executive to raise ambition and focus more on the “how” than on the “what” discussions, in a configuration where stakeholders strategic positioning changed towards more proactive approaches and a priority given to the design of the transition and the mitigation of transition risks.

But it is a fragile equilibrium and the dynamic observed during the last decade is now challenged by a number of difficulties. The changes in the geopolitical landscape and its consequence on the multilateral processes is being reflected domestically where the former consensus gives way to a strong polarization of the debate in the public arena, the expression of stakeholders (namely, the industry) and the policymakers themselves. In particular, the issue of competitiveness is being put forward to claim for more “pragmatic approaches”. This movement is reinforced with difficulties faced in the conduct of the transition, where short term socio-economic impacts have sometimes been underestimated in the design of public policies. In such a situation, several transition options are being reconsidered (on RES, EVs, etc) or postponed. More recently, the CEO of the major oil company argued that “we are too much driven by this 2050 stuff” and that “we should keep the ambition but change

the pace”, confirming that, even at the moment, this cornerstone of the PA package remains a difficulty when it comes to deconstructing climate action.

REFERENCES

- 2015 Energy Transition Law (LOI n° 2015-992) : <https://www.legifrance.gouv.fr/loda/id/JORFTEXT000031044385>.
- 2019 Energy and Climate Law (Loi n°2019-1147) : <https://www.legifrance.gouv.fr/dossierlegislatif/JORFDOLE000038430994/>
- Décarbonation: doutes et retards pour la trajectoire de “verdissement” de l’industrie française, Le Monde, Paris, 05 aout 2025
- Decision Conseil d’Etat – Grande Synthe, Conseil d’Etat Paris 2020 https://laffairedusiecle.net/wp-content/uploads/2020/11/Decision-ConseilDEtat-GrandeSynthe_4273011PR2.pdf
- Energy Pathways 2050, RTE, Paris 2025 : <https://www.rte-france.com/en/home>
- High Council on Climate : annual reports and thematic reports available at <https://www.hautconseilclimat.fr/publications/>
- Landscape of climate finance in France, I4CE, Paris, 2023 : <https://www.i4ce.org/en/publication/landscape-climate-finance-france-edition-2023/>
- Stratégie Nationale Bas Carbone, Ministère de la Transition Ecologique: <https://www.google.com/rl?sa=t&source=web&rct=j&opi=89978449&url=https://www.ecologie.gouv.fr/politiques-publiques/strategie-nationale-bas-carbone-snb&ved=2ahUKewiSmJifsOCPAxVxTDABHQZ-HuUQFnoECBcQAQ&usg=AOvVaw1GftNpxdT2PZYLxGFPmvlS>
- UK’s committee on Climate Change, lessons for France, Iddri 2019: <https://www.iddri.org/en/publications-and-events/study/uks-committee-climate-change>

A decade of national climate action: Stocktake and the Road Ahead

GERMANY

INSIGHTS ON CLIMATE ACTION TEN YEARS AFTER THE PARIS CLIMATE AGREEMENT

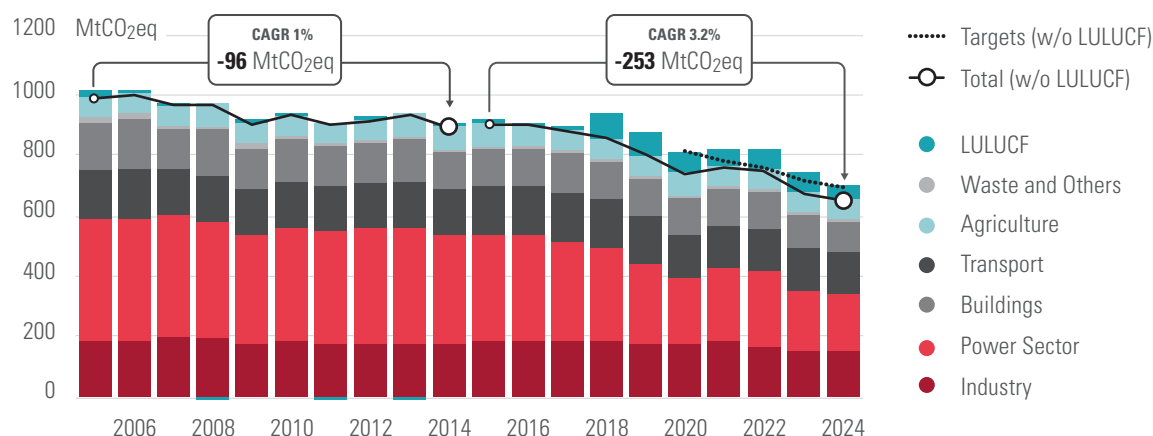
Charlotte Senkpiel and Barbara Schlomann (Fraunhofer-Institut für Solare Energiesysteme ISE)

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DEVELOPMENT OF GHG EMISSIONS IN GERMANY BEFORE AND AFTER THE PARIS CLIMATE AGREEMENT

The look at the development of greenhouse gas (GHG) emissions in Germany shows a clear shift between the years before and after the 2015 Paris Climate Agreement. Between 2005 and 2014, the average annual emission reduction was 1% per year, equating to a total reduction of 96 million tons of CO₂ equivalents (MtCO₂eq). However, this rate increased in the following decade. From 2015 to 2024, the average annual reduction reached 3.2%, corresponding to a total decrease of 253 MtCO₂eq – a threefold increase compared to the previous decade. **Figure 1** illustrates the historical development of greenhouse gas emissions (GHG emissions) in Germany from 2005 to 2024, broken down by sector.

Examining the sectoral distribution of emission reductions shows that the energy sector made by far the largest contribution both before and after the Paris Agreement. In the decade before the Paris Agreement, the total reduction in this sector was 40 MtCO₂eq, averaging 1% per year. After Paris, it reached a total of 166 MtCO₂eq, with an annual reduction of 6.2% per year. The energy sector alone thus accounts for

Figure 1. Development of GHG emissions in Germany since 2005 according to UBA (2025)

CAGR: Compound Annual Growth Rate

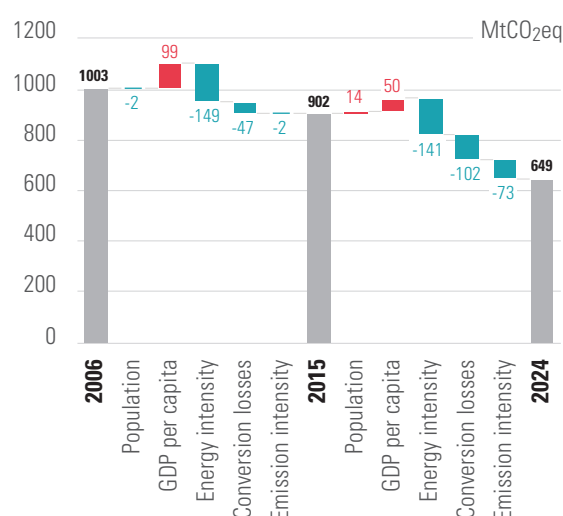
approximately 66% of the total emission reductions between 2015 and 2024. Additional contributions came from industry with 12%, buildings with 10%, transport with 7%, agriculture with 4%, and waste management and others with 1%. Particularly noticeable is the comparatively low reduction rate in the transport sector, which improved only slightly from 0.1% per year before Paris (2 Mt over ten years) to 1.2% per year after the Paris Agreement (19 Mt over ten years). Agriculture also shows a relatively low average annual reduction rate of 1.3%.

Another key development is that the Land Use, Land-Use Change and Forestry (LULUCF) sector has gone from being a net greenhouse gas sink to a net source since 2018. In the year 2024, the sector accounted for net GHG emissions of 51 MtCO₂eq. This shift is primarily attributed to extensive forest damage caused by the drought of 2018 (ERK, 2025). However, the LULUCF sector is not included in the achievement of national climate targets until 2040 (ERK, 2025).

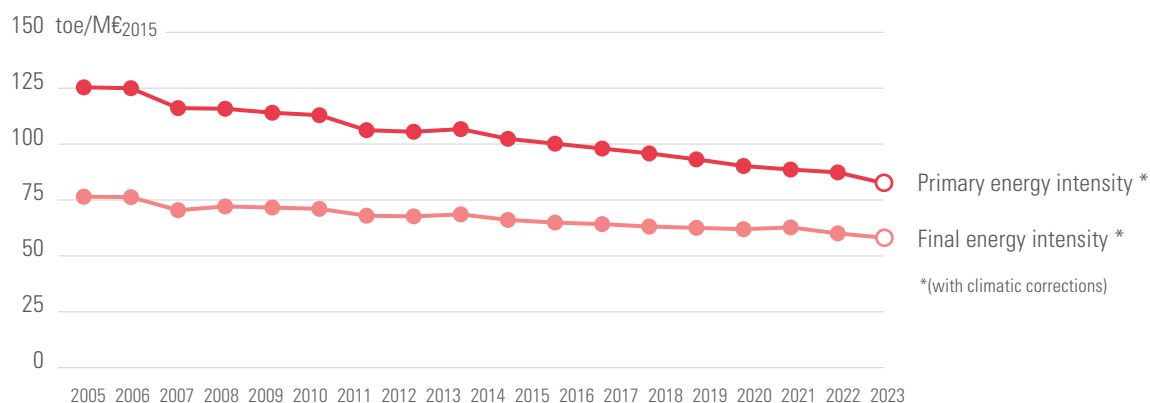
The reduction in GHG emissions cannot be attributed solely to successful climate policy measures. Exceptional, non-structural factors have made a non-negligible contribution to the observed emission reductions as indicated in in-depth analysis of the GHG emissions data in Germany for the period 2020 to 2024. These include the COVID-19 pandemic, the war of

aggression against Ukraine and the resulting gas supply crisis, as well as the associated economic downturn. (ERK, 2021b, 2022b, 2023b, 2024a, 2025; Shammugam, Schleich, Schlomann, & Montrone, 2022)

Figure 2 presents a quantitative decomposition of GHG emissions between the pre-Paris Agreement period (2006–2015) and the post-Paris Agreement period (2015–2024). A significant

Figure 2. Decomposition of GHG emissions in Germany in the decade before and after the Paris Agreement.

Energy intensity = final energy consumption per GDP;
Conversion losses = primary energy consumption per final energy consumption;
Emission intensity = CO₂eq per primary energy consumption

Figure 3. Development of primary and final energy intensities in Germany between 2005 and 2023

Source: Enerdata, 2025b.

increase in the emission-reducing effect can be observed in the improvement of emission intensity during the post-Paris period. Additionally, the reduction of conversion losses contributed substantially to emission reductions after 2015. In both periods, however, the largest contribution to emission reduction stems from the reduction in energy intensity. Increases in per capita GDP led to rising GHG emissions, but these were more than offset in both periods.

Taking a closer look at the intensity component reveals that, since 2005, primary energy intensity – defined as the ratio of primary energy consumption to GDP – has decreased by around 40% (see **Figure 3**). This was strongly driven by the increasing share of wind and solar power as replacements for less efficient energy conversion technologies, such as thermal or nuclear power, during that period. In contrast, the reduction in final energy intensity only amounted to 28% during that period. As with GHG emissions, the decline in the period before Paris was significantly lower at 2.2% per year for primary and 1.6% for final energy intensity respectively, than in the years after, at 3.7% and 2.0% per year.

GERMANY'S LONG-TERM CLIMATE TARGETS AND THE WAY TO GET THERE

Since the mid-1990s, Germany has been committed to reducing its GHG emissions. To this end, successive federal governments have adopted climate action programmes and plans at regular intervals since 2000, which usually contain both reduction targets and measures to achieve the targets. However, the starting point for long-term energy and climate targets until the year 2050 was the “Energy Concept” of September 2010 and the decisions of summer 2011 on the phase-out of nuclear energy (Federal Government of Germany, 2012). With this, Germany initiated a far-reaching transformation of its energy system, known as the “Energiewende” meaning “**Energy Transition**”. At that time the reduction target for greenhouse gas (GHG) emissions was 40% in 2020 and 80-95% in 2050 (both compared to the base year of the Kyoto target, 1990). The energy transition was accompanied by regular monitoring of target achievement by the government and independent experts, a process that continues to this day (Bundesnetzagentur, 2025). However, in the early years, the main focus was on achieving the short-term energy and climate targets by 2020 rather than the long-term targets for 2050.

This only changed with the **Climate Action Plan 2050** (BMUB, 2016), which was adopted by the

Federal Government in November 2016. It also served as the National Long-Term Strategy (LTS), which was submitted under the EU Governance Regulation (EU/2018/1999)¹. With this plan, Germany reaffirmed its long-term GHG reduction target from 2010 and made it more specific by formulating guiding principles and transformative pathways. These serve as the basis for all areas of action by 2050, as well as medium-term milestones and strategic measures by 2030. The guiding principles and milestones were formulated on the basis of an evaluation of the climate action scenarios and further sectoral analyses available at the time of its creation. Notably, this was the first time that the German government had agreed on interim GHG emission reduction targets at the sectoral level up to 2030. The main sectors covered were energy, buildings, transport, industry and agriculture. A key driver for drafting this plan was to make an appropriate contribution to the implementation of the commitment made at the 2015 Climate Change Conference Paris, also with a view to the goal set out in the Paris Agreement of achieving global greenhouse gas neutrality in the second half of the century. The preparation of the Climate Action Plan 2050 was embedded in a broad dialogue and participation process with the federal states and local authorities, as well as the private sector, stakeholder organisations (churches, associations and trade unions), and, for the first time, also direct public participation by citizens (BMUB, 2017). However, from a governance perspective, the issue with all previous targets was that they lacked a legal basis and were therefore non-binding. It took a further three years after the Climate Action Plan was adopted before the sectoral and overall climate targets for 2030 and 2050 set out in it were put on a legal footing. Since 18th December 2019, Germany has had legally binding climate targets in place under the **Federal Climate Action Act** (Klimaschutzgesetz, KSG). The Act was amended twice since then, for the first time in 2021, following a judgement of the Federal Constitutional Court. The target year for achieving greenhouse gas neutrality was brought

forward from 2050 to 2045, the 2030 reduction target was increased from -55% to -65%, and additional annual reduction pathways up to 2040 were introduced to achieve an 88% reduction compared to 1990 levels. Upon its entry into force, the Climate Action Act included a sector-specific control mechanism (§ 8 KSG) with an ex-post perspective: if a sector exceeded the permitted annual emissions based on the previous year's data, the responsible ministry was required to present an immediate action programme. The second amendment of the Climate Change Act, adopted in 2024, fundamentally revised this mechanism in favour of a cross-sectoral and forward-looking approach. Under the new provision, the federal government is only obliged to implement corrective measures if total national emissions exceed the allocated emissions budget for the 2021–2030 period in two consecutive years.

Climate Neutrality Scenarios

As a result of the long-term strategy until 2050, a wide range of normative scenario studies explored how national climate targets can be met. These studies typically model cost-optimized transformation pathways and outline a broad spectrum of possible developments. A comprehensive comparison of key scenario studies was conducted in 2022 (see Stiftung Klimaneutralität et al., 2022). Despite methodological differences, the scenarios deliver similar results: electrification is the dominant decarbonization lever and accounts for the largest share of final energy demand across all pathways. However, notable differences exist in the extent and specific application of hydrogen and its derivatives. Overall, final energy demand declines significantly in all scenarios - driven by improvements in energy efficiency and shifts to low-emission energy carriers. Photovoltaic (PV) and wind energy form the backbone of the future energy supply, complemented by flexible power plants and storages. In the buildings sector, heat pumps, district heating, and increased renovation rates play a central role. In the transport sector, fossil-fuel-based vehicles are largely replaced by

¹ https://ec.europa.eu/clima/sites/lts/lts_de_en.pdf

battery-electric passenger cars. In the heavy-duty segment, alongside direct electrification, some scenarios also foresee a role for hydrogen fuel cells. In the industrial sector, both direct electrification and the use of hydrogen and its derivatives - both as an energy carrier and as a feedstock- are key drivers of decarbonization. Recent scenario studies (Aurora, 2025; BCG, 2025) are proposing a somewhat modified strategy with relevant shares of decarbonised natural gas (blue hydrogen, CCS) and lower increases of renewable power (sun, wind).

Long-term scenarios and Policy Development

The System Development Strategy is a central political instrument. It is based on the so-called "Long-Term Scenarios", which are also the main scientific basis for long-term policy strategies and decisions in the field of energy and climate policy. Its objective is to formulate a cross-sectoral vision and a robust strategy for the transformation of the energy system. The process is designed to be iterative and adaptive, allowing for regular updates and learning. However, Germany currently lacks scenario studies that link long-term climate targets to specific, implementable policy measures. In other words, there is an absence of model-based analyses that, similar to the official projection reports, explicitly demon-

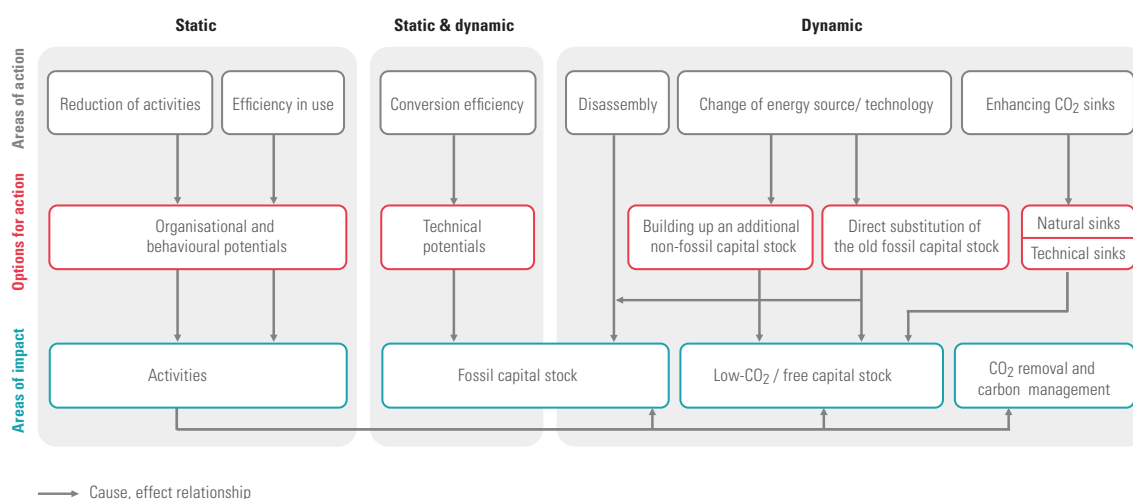
strate pathways to achieve GHG neutrality by 2045 through defined political instruments. To date, such a modeling approach has only been undertaken up to the year 2030, for instance in the KIS scenario (Repenning, Harthan, Blanck, & et. al, 2023). In some cases, political targets are derived from scenario analyses, such as expansion figures for photovoltaics, heat pumps, or electric mobility. However, a comprehensive set of indicators to guide political steering has not yet been officially established in Germany by the Federal Government. Policy areas were placed on the political agenda through targeted initiatives such as the Long-Term Strategy for Negative Emissions Technologies (NETs), the District Heating Summit, the Heat Pump Summit, and the Hydrogen Core Network (H₂-Kernnetz).

CONCRETE PROGRESS AND BLOCKAGES

Areas of action for the reduction of greenhouse gases

The Council of Experts on Climate Change has developed a conceptual framework that identifies key areas of GHG reduction, along with corresponding options for action and areas of impact (see **Figure 4**). These include the reduction

Figure 4. Fields of action and options for reducing GHG emissions according to ERK (2024b)



and modification of emission-relevant activities, improvements in the efficiency of energy use and conversion, the disassembly of fossil-based and emissions-intensive capital stock, the substitution of energy carriers and technologies through the build-up of a non-fossil or low-emission capital stock, and the enhancement of carbon sinks. These areas of action can be understood from both a static and a dynamic perspective within a capital stock-oriented framework. (ERK, 2024b).

EXAMPLES OF CONCRETE PROGRESS

Measurable progress has been made in the identified areas of action, particularly in the following areas: 1) the expansion of new low- or zero-carbon capital stock in the power sector, and 2) the improvement of energy efficiency in conversion and usage.

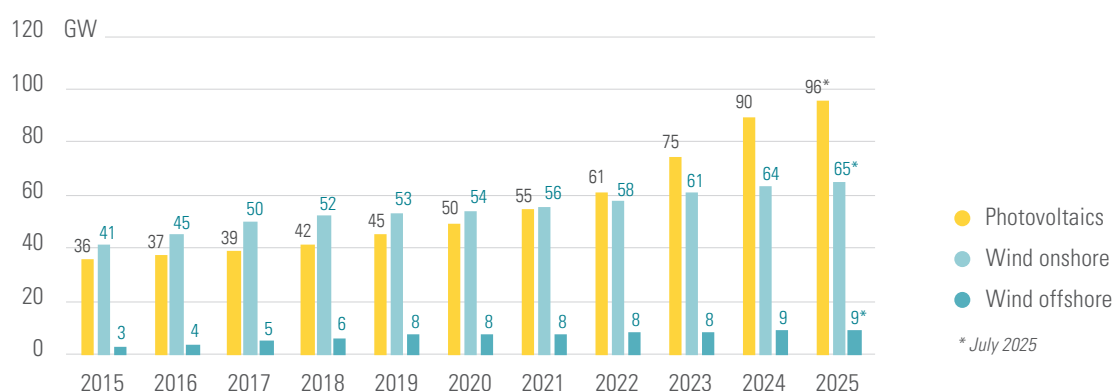
Expansion of Renewable Energy, System Integration, and Phase-Out of Coal-Fired Power Plants

The most significant progress in the transformation of Germany's energy system has been the expansion of renewable energy sources, especially PV and wind (see **Figure 5**), which have been key drivers of the sector's substantial overperformance in relation to its assigned

GHG emission reduction targets. The Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG) is the central instrument for promoting renewable energy technologies in Germany and came into force in 2000. In 2017, a competitive remuneration system through auctions replaced fixed feed-in tariffs. The target of 69 GW installed onshore wind capacity by 2024 was not met. Both onshore and offshore expansion have so far progressed too slowly to meet the Renewable Energy Sources Act (EEG) targets of 115 GW onshore and 30 GW offshore by 2030. However, approvals for onshore wind energy capacity have increased. This suggests that recent political efforts to accelerate planning and permitting procedures may already be having an impact. In 2024, permits were granted for onshore wind turbines with a total capacity of 11.4 GW (ERK, 2024b). Due to increased efficiency and declining module prices, the levelized cost of electricity (LCOE) for photovoltaics has dropped significantly. Both PV and wind power have become increasingly competitive and now represent the most cost-effective forms of electricity generation comparing the LCOE of different technologies (Kost, Müller, Sepúlveda Schweiger, Fluri, & Thomsen, 2024).

At the same time, the capacity of coal power plants has declined from 50 GW in 2015 to 30 GW today (Fraunhofer ISE, 2025). The coal phase-out in Germany is legally enshrined in

Figure 5. Development of the installed capacities of Photovoltaics and Wind power plants since 2015



Source: Fraunhofer ISE, 2025.

the Coal-Fired Power Generation Termination Act (*Kohleversorgungsbeendigungsgesetz*). The nuclear phase-out was completed in 2023. As a result of these structural developments, the share of renewable energy in gross electricity demand rose from 35.3% in 2015 to 55.8% in 2024, while its share of total electricity generation increased from 32.3% to 62.3% (Fraunhofer ISE, 2025).

Energy Efficiency Improvements

Previous analyses by the Council on Experts for Climate Change (see (ERK, 2022c)) have shown that climate policy instruments in Germany have in the past – beside the developments in the power sector – focused mainly on technical improvements in energy efficiency in conversion and use. In particular, increasing the technological efficiency of the fossil capital stock through the use of efficient gas condensing boilers in buildings, more efficient technologies in industry and more efficient (diesel) engines in vehicles has made a significant contribution to reducing GHG emissions. This development is also reflected in the decline in energy intensity described above (see **Figure 3**). The policy mix addressing energy efficiency in Germany is dominated by regulatory and financial instruments (see Bagheri et al. (2025)). The key regulation for energy efficiency is the Energy Efficiency Act (EnEffG), which entered into force in November 2023. The new act creates for the first time a cross-sectoral framework for enhanced energy efficiency in Germany and also establishes efficiency targets for primary and final energy consumption for 2030, 2040, and 2045. At the sectoral level, the Energy Efficiency Act and sectoral regulation as the Building Energy Act (GEG) are accompanied by large funding programmes for efficient buildings and for energy and resource efficiency in industry.

Carbon Pricing

In addition to the policy instruments targeting energy efficiency and renewable energy, the Fuel Emissions Trading Act (*Brennstoffemissionshandelsgesetz*, BEHG) was introduced in 2019 alongside the Federal Climate Action Act (KSG) as

a cross-sectoral measure, effectively being a role model for the EU Emissions Trading System 2 (EU ETS 2). The BEHG established a national carbon pricing mechanism for sectors not covered by the EU Emissions Trading System (EU ETS 1). Until 2025, a fixed price system was established, which will be replaced by a price corridor in 2026. As a result, the majority of greenhouse gas emissions in Germany are currently subject to carbon pricing under either the EU ETS 1 or the BEHG, and in the future, under the extended framework of EU ETS 2.

Examples of concrete blockages

While measurable progress has already been made especially in the energy sector, the buildings and transport sectors show significant shortcomings. Both sectors have failed to meet their annual targets under the KSG since 2020 (buildings) and since 2021 (transport). Current projections suggest that the 2030 targets set by the European Effort Sharing Regulation (ESR) are very likely to be missed. In addition, the latest National Forest Inventory clearly indicates that the LULUCF sector will significantly fall short of its targets for 2030, 2040, and 2045, as it has shifted from acting as a net GHG source instead of a sink.

In recent years the expansion of new capital stock in the form of heat pumps and battery electric vehicles has increased steadily in recent years. However, the stock of fossil-based vehicles and fossil-fuelled heating systems, has remained at comparably high levels or even increased.

Buildings

In the buildings sector, for instance, the number of installed heat pumps has approximately tripled, rising from around 632,000 units in 2015 to nearly two million by 2024 (BWP, 2025). In newly constructed buildings, the share of gas heating systems declined significantly from 50% in 2015 to 4.5% in 2024, while heat pumps accounted for 66.3% of new installations, becoming the dominant heating technology (BDEW, 2025b). However, this shift has not yet translated into a substantial transformation of the total stock: the

share of fossil-fuel heating systems only declined slightly, from 75.5% in 2015 to 73.4% in 2024. Notably, the share of gas heating systems even increased - from 52.4% to 56.1%, over the same period (BDEW, 2025a). In the buildings sector, the implementation of the 2023 Climate Action Programme led to the adoption of key instruments aligned with the EU Buildings Directive. These include the Building Energy Act (Gebäudeenergiegesetz, GEG) in 2020 in combination with the Federal Funding for Efficient Buildings programme (Bundesförderung für effiziente Gebäude, BEG) in 2021, the Heat Planning Act (Wärmeplanungsgesetz, WPG) in 2024, and the Federal Funding Programme for Efficient Heating Networks (Bundesförderung für effiziente Wärmenetze, BEW) in 2024. In conjunction with the BEHG, Germany has implemented a comprehensive policy mix combining market-based (economic), regulatory, and fiscal instruments to advance emission reduction in the buildings sector. As part of the amended GEG, the so-called "65% rule" was introduced in 2024. This regulation stipulates that all newly installed heating systems must derive at least 65% of their energy from renewable sources. Technologies compliant with this requirement were supported through the BEG, aiming to shield households from rising carbon prices. To enhance social equity, the BEG introduced income-dependent subsidy rates. Politically and socially, however, the GEG became highly contentious. The legislative process was marked by months of internal governmental conflict, an intensified campaign by the opposition, widespread public uncertainty, a successful legal challenge by the opposition against the parliamentary vote, and finally, the law's adoption by the Bundestag in September 2023 (Jost, Mack, & Hillje, 2024). The public backlash against the GEG illustrates how insufficient communication, political fragmentation, and misinformation can undermine climate policy. The absence of a proactive communication strategy allowed populist and oppositional narratives to dominate the discourse. Over the course of the debate, the GEG was increasingly framed as the so-called "heating hammer," eroding public

trust and ultimately influencing the legislative outcome. This case underscores the critical need for timely, coherent, and fact-based communication in climate governance, especially under conditions of political polarization (Braungard, Keimeyer, & Loschke, 2024).

Transport Sector

In the transport sector, the number of battery electric vehicles (BEVs) amounts to 1.6 million in 2024 (BMDV, 2025; KBA, 2025). Nevertheless, the total number of passenger cars rose from approximately 45 million in 2015 to 49 million in 2024 (BMDV, 2025; KBA, 2025). As a result, the share of BEVs in the overall vehicle fleet remains marginal at around 3% and, from an emissions perspective, still plays a negligible role. The declining energy intensity in the transport sector since 2000 (i.e. reduced fuel consumption per kilometre) is primarily attributable to the shift towards diesel vehicles as well as improvements in engine and fuel efficiency. At the same time, this trend has been offset by increasing motorisation rates and the growing size and weight of vehicles. As a result, emission reductions stemming from technical efficiency gains have been largely undermined by countervailing developments in vehicle characteristics, particularly increases in vehicle mass and engine power. (ERK, 2022c)

Key national instruments in the transport sector have included the environmental bonus (*Umweltbonus*), introduced in 2016 to encourage the uptake of electric vehicles. The programme was discontinued at the end of 2023, due the fact that the Federal Constitutional Court ruled on November 15, 2023 that the supplementary budget for 2021 was unconstitutional. In addition evidence showed that the *Umweltbonus* disproportionately benefited higher-income households and incurred high public costs per ton of CO₂-equivalent avoided (ERK, 2024b). In contrast, 2023 also saw the introduction of the *Deutschlandticket*, a nationwide public transport pass aimed at promoting low-emission mobility. However, certain existing policy incentives, such as the diesel tax subsidy and the taxation bene-

fits of private use of a company car, continue to undermine the emission reduction efforts required in the transport sector.

Blockages linked to behavioural changes

Another important field of action that can either reduce or increase emissions, is the level and pattern of activity itself. An analysis by the Council of Experts on Climate Change found that, in purely mathematical terms, GHG emissions in the buildings sector could have been reduced by 40% between 2000 and 2020 if per capita residential floor area and GDP had remained constant. In practice, however, emissions declined by only 25%. This shortfall illustrates how rebound effects and prosperity-driven changes in user behaviour can fully negate the benefits of technical efficiency improvements. In the transport sector as well, changes in consumption patterns, driven in part by rebound effects and prosperity-induced shifts in user behaviour, have led to an increase in transport intensity. (ERK, 2022c)

On the other hand, a reduction in emissions due to a reduction in activity levels has been observed in recent years. Particularly in the industrial sector, where elevated energy prices, structural and cyclical factors, and the EU Emissions Trading System (EU ETS) contributed to declines in production. In the buildings sector, gas consumption dropped significantly during the energy crisis, although it increased again in 2024. In the transport sector, both passenger and freight traffic rebounded following Covid-19 related declines. The agricultural sector has seen some reductions in livestock numbers and fertilizer use, alongside a modest expansion of organic farming. While instruments such as the German national emissions trading system (BEHG), the forthcoming EU ETS 2, or the Deutschlandticket may induce limited behavior-based mitigation effects, the broader potential of the mitigation lever of activity reduction remains largely untapped. The Council of Experts on Climate Change highlighted this gap, stressing that achieving climate targets will most probably require sufficiency measures. (ERK, 2022c, 2024b)

LULUCF

Another area of concern is the LULUCF sector. By 2045, the LULUCF sector is to be included in the accounting of Germany's overall greenhouse gas neutrality target. However, since the onset of drought years in 2018, German forests have undergone severe dieback, turning the sector from a carbon sink into a significant net source of greenhouse gas emissions. This transformation has been primarily driven by the collapse of ecologically unsound spruce monocultures planted in unfavorable locations (Riedel et al., 2024). The German Climate Change Act (KSG) sets a target for the LULUCF sector to deliver a net sink of 40 million tonnes of CO₂ equivalents by 2045. Yet, the projection data 2025 show that this target will be substantially missed, with residual emissions from the sector expected to remain at approximately 35 Mt CO₂eq in 2045. The actual trajectory of emissions is highly sensitive to the occurrence of extreme weather events, with estimates suggesting that frequent extreme events could result in net emissions of over 60 Mt CO₂eq. There is no scientific consensus on whether the LULUCF sink targets are still realistically achievable. Depending on the magnitude of residual emissions in the LULUCF sector and the remaining hard-to-abate emissions in other sectors, there may be an increased need for negative emissions to meet the climate neutrality target. (ERK, 2025)

LINK WITH NON-CLIMATE QUESTIONS

There are numerous interdependencies between climate policy and other policy domains, including economic, social, fiscal, labour market, environmental, and security policy (ERK, 2024b). In cases of conflicting objectives, political negotiation and coordination processes are necessary. Ultimately, it is a matter of political prioritisation how such trade-offs are addressed. This includes, for instance, the allocation of public financial resources or the management of environmentally harmful subsidies, which often serve other

purposes such as economic or social policy. A key example of such political trade-offs was the planned reform of agricultural diesel subsidies in Germany: in 2024, it triggered widespread farmer protests, prompting the federal government to reverse its decision and maintain the subsidy in the new federal budget.

Investment Needs and Fiscal Challenges

Fiscal policy plays a pivotal role in shaping the effectiveness of climate action and often poses significant challenges. The transformation of the energy system towards climate neutrality requires substantial investment. A comparative analysis of scenario studies conducted by the Council of Experts on Climate Change (ERK, 2024b) estimates total annual investment needs in the range of €135 to €255 billion. Additional investment, compared to a reference scenario without enhanced climate policy, is estimated at €51 to €150 billion per year, corresponding to approximately 1.2% to 3.6% of Germany's GDP in 2023. While a portion of these investments will be financed by the private sector, the public sector plays a critical role both through direct investment and through subsidies. These subsidies are primarily disbursed via the Climate and Transformation Fund (Klima- und Transformationsfonds, KTF). Shortly before the change in government, the constitutional "debt brake" was temporarily relaxed, enabling the creation of a special fund for infrastructure and climate neutrality. This special fund now provides an additional €10 billion annually in revenues for the KTF (Wiedemann, 2025). In total, the new federal budget allocates €36.7 billion to the KTF.

Social Impacts

From a social equity perspective, several of the climate policy instruments reveal regressive distributional effects. Fiscal support measures in the buildings and transport sectors, such as the purchase subsidy for electric vehicles and the initial design of the Federal Funding for Efficient Buildings (BEG) tended to favour higher-income households. The 2023 reform of the funding program included measures aimed at

improving social targeting. Nevertheless, energy poverty remains insufficiently integrated into the broader climate policy framework in Germany (ERK, 2024b).

Furthermore, the carbon pricing mechanism under the Fuel Emissions Trading Act (BEHG) places a disproportionate burden on low- and middle-income households. This effect is expected to intensify when carbon prices will increase under the forthcoming EU Emissions Trading System 2 (EU ETS 2). To counteract these impacts, accompanying policy instruments will be essential to buffer both social and economic disadvantages resulting from elevated carbon and energy prices (ERK, 2024b).

Beyond distributional questions, structural barriers, such as inadequate infrastructure or persistent lock-in effects, must also be addressed to enable broad and equitable participation in the transition. A comprehensive policy response should involve expanding low-emission infrastructure and essential public services, introducing socially differentiated subsidies, implementing targeted regulatory interventions, and offering direct financial compensation. When effectively combined, these measures can help ensure that the costs of decarbonisation are distributed fairly and do not fall disproportionately on vulnerable groups (ERK, 2024b).

GOVERNANCE

Climate Action Act

Climate protection is legally anchored in the Federal Climate Action Act. If the climate targets set forth in the Act are not met, the federal government is required to adopt additional measures. In such cases, the respective ministries responsible for sectors that have significantly exceeded their emission targets, must propose corrective action. Core elements of climate policy in Germany based on the current (mandatory) Climate Change Act include:

- the legally defined sectoral and annual GHG reduction targets and a budget approach for 2021-2030 and 2031-2040,

- the Climate Action Programme (Klimaschutzprogramm),
- and the corrective mechanism, which is triggered every two years if overall emissions across sectors exceed the set targets.

Based on the most recent emission projections, the **Climate Action Programme** must set out the measures through which the government plans to achieve its climate targets. However, the programme submitted by the federal government in 2023 did not meet the legal and substantive requirements associated with this planning instrument (ERK, 2023c). The new government has now the legal obligation to provide a programme that meets the targets in 2030 and 2040 within the first year of the legislative period, i.e. until March 2026. The work on the programme already started shortly after the new government was formed.

Council of Experts on Climate Change

The role of the Council of Experts on Climate Change is also anchored in the Federal Climate Action Act as an independent scientific advisory body. Its tasks include the examination of emission and projection data. The Council assesses whether the sector-specific annual targets, the emission budget for the relevant period, and the targets under the EU Effort Sharing Regulation have been met or exceeded. Furthermore, the Expert Council evaluates the plausibility of the measures proposed by the federal government in the context of required corrective action or within the framework of a Climate Action Programme. It also analyses emission trends and the effectiveness of climate policy measures. In its reports, the Council comments on the distributional impacts, economic efficiency, and effectiveness of the measures. Additionally, it can prepare independent reports on the further development of climate policy instruments, based on emissions data and projection scenarios.

Federal Ministries

In Germany, climate action is currently situated within the Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear

Safety at the federal level. However, many areas relevant for successful GHG reductions lie outside the ministry's core climate policy portfolio and are distributed across other ministries, e.g. in the ministry for economic affairs and energy, the ministry of transport or the ministry of housing. This fragmentation and the decentralized allocation of competencies pose significant barriers to the transformation process, particularly in the absence of an overarching coordinating body endowed with clear decision-making authority. As a result, outcomes of inter-ministerial coordination processes are often reduced to minimal consensus (ERK, 2024b; Flachsland et al., 2021).

Dialogue, Consultation, and Cooperation

The German federal government conducts comprehensive consultation and participation processes on various climate-related topics. Notable examples include consultations on the Wind and PV Strategies, the System Development Strategy, and the Long-Term Strategy for Negative Emissions. In addition, several dialogue forums have been established on specific issues. The National Platform Future of Mobility served as a central forum for strategic discussions in the transport sector, but concluded at the end of the 2021 legislative period. In addition, Article 10 of the EU Governance Regulation requires Member States to give the public early and effective opportunities to participate in the preparation of their draft National Energy and Climate Plans (NECPs). These are due every 10 years, the next draft NECP by January 1st, 2028, and must also include a summary of the results of the consultation process. In addition the cooperation between the federal government and the federal states plays an important role in terms of climate action, e.g. through the Federal-State Cooperation Committee (Bund-Länder Kooperationsausschuss), which oversees the designation and planning of 2% of land for wind energy across all states.

INTERNATIONAL COOPERATION

At the end of 2023, ahead of COP28 in Dubai, the German federal government released a comprehensive strategy on international climate policy (Federal Government of Germany, 2023). The strategy identifies key instruments of Germany's international climate policy include climate diplomacy, climate finance, bilateral partnerships and dialogues, and multi-donor initiatives such as the Just Energy Transition Partnerships (JETPs), currently in place with South Africa, Indonesia, Vietnam, and Senegal. Additional instruments comprise the Climate Club and other frontrunner initiatives, such as the Forest and Climate Leaders' Partnership, the Global Methane Pledge, the Powering Past Coal Alliance, and the ENACT Partnership. Further elements include foreign trade promotion, as well as carbon pricing and emissions trading (Federal Government of Germany, 2023).

With regard to climate diplomacy, the previous federal government established a special position for international climate policy. This special position was abolished under the current government.

Climate Finance

At COP 29, the Parties to the UNFCCC agreed on a collective climate finance target of USD 300 billion per year through 2035. In 2023, Germany committed approximately EUR 5.66 billion in budgetary resources for mitigation and adaptation measures. Including other public and mobilised private flows, Germany's total climate finance contribution for 2023 amounted to EUR 9.94 billion (BMZ, 2025). Germany has repeatedly taken a leading role by making early commitments to multilateral climate funds, including contributions to the Green Climate Fund or the Fund for Responding to Loss and Damage. Through these actions, the German government has consistently been able to exert a constructive influence on other donor countries and shape the dynamics of the annual UN climate conferences (Heinrich-Böll-Stiftung, 2025).

In the new draft federal budget, Germany is expected to fall short of its international pledge. According to a preliminary analysis of the draft budget, Oxfam estimates that between €5.1 and €5.4 billion in budgetary funds will be allocated for climate finance in 2025, well below the pledged amount. According to the New Climate Institute's Climate Action Tracker, Germany performs better than most developed countries in international climate finance but is still rated as "Insufficient." To improve, Germany must triple its financial support and urgently end public funding for fossil fuels abroad (Climate Action Tracker, 2025). A study by Klima-Allianz Deutschland (2024) outlines potential avenues for significantly increasing Germany's contributions to international climate finance in the coming years.

REFERENCES

- ACEEE. (2025). International Energy Efficiency Scorecard. Retrieved from <https://www.aceee.org/international-scorecard>
- Aurora. (2025). *Systemkostenreduzierter Pfad zur Klimaneutralität im Stromsektor 2040*. Retrieved from https://auroraer.com/wp-content/uploads/2025/04/Aurora_EnBW_Systemkostenstudie_Apr-25_public.pdf
- Bagheri, M., Brunzema, I., Eichhammer, W., Kappler, L., Reinfandt, N., & Schlomann, B. (2025). *Energy Efficiency Trends and Policies in Germany: An Analysis Based on the ODYSSEE and MURE Databases*. Retrieved from <https://www.odyssee-mure.eu/publications/national-reports/energy-efficiency-germany.pdf>
- BCG. (2025). *Energiewende auf Kurs bringen: Impulse für eine wettbewerbsfähigere Energiepolitik*. Retrieved from <https://bdi.eu/artikel/news/transformationsspfade-studie-energiewende-auf-kurs-bringen>
- BDEW. (2025a). Beheizung des Wohnungsbestandes in Deutschland: Darstellung der Entwicklung der Beheizungsstruktur des Wohnungsbestandes nach primärer Heizenergie seit 1998. Retrieved from <https://www.bdew.de/service/daten-und-grafiken/beheizung-des-wohnungsbestandes-in-deutschland/>
- BDEW. (2025b). Entwicklung der Beheizungsstruktur im Neubau - Baugenehmigungen: Darstellung der Entwicklung in den letzten 10 Jahren sowie in den vergangenen 12 Monaten. Retrieved from <https://www.bdew.de/service/daten-und-grafiken/entwicklung-beheizungsstruktur-baugenehmigungen/>
- BMDV. (2025). *Verkehr in Zahlen 2024/2025*. Retrieved from https://www.bmv.de/SharedDocs/DE/Anlage/G/verkehr-in-zahlen24-25-pdf.pdf?__blob=publicationFile

- BMUB. (2016). *Climate Action Plan 2050: Principles and Goals of the German government's climate policy*. Retrieved from BMU website: <https://www.bundesumweltministerium.de/PU395-1>
- BMUB. (2017). *Dialog der Bundesregierung zum Klimaschutzplan 2050: Breite Beteiligung von Bundesländern, Kommunen, Verbänden sowie Bürgerinnen und Bürgern*. Berlin. Retrieved from https://www.bmuv.de/fileadmin/Daten_BMU/Pool/Broschueren/ksp_2050_dialog_bf.pdf
- BMZ. (2025). *Klimafinanzierung: Deutschland als verantwortungsvoller Partner*. Retrieved from <https://www.bmz.de/de/themen/klimawandel-und-entwicklung/klimafinanzierung>
- Braungard, S., Keimyer, F., & Loschke, C. (2024). *Is the "heating hammer" hitting energy efficiency policy? Learnings from the debate around the German Buildings Energy Act*. Retrieved from https://www.oeko.de/fileadmin/oekodoc/3-028-24_Braungardt.pdf
- Bundesnetzagentur. (2025). *Monitoring „Energie der Zukunft*. Retrieved from <https://www.bundesnetzagentur.de/DE/Fachthemen/ElektrizitaetundGas/Monitoringberichte/MonitoringEnergiederZukunft/start.html>
- BWP. (2025). *Zahlen & Daten*. Retrieved from <https://www.waermepumpe.de/presse/zahlen-daten/>
- Climate Action Tracker. (2025). *Germany: Country summary*. Retrieved from <https://climateactiontracker.org/countries/germany/>
- Enerdata. (2025a). *2024 EU Energy Efficiency scoreboard*. Retrieved from <https://www.odyssee-mure.eu/data-tools/scoring-efficiency-countries.html>
- Enerdata. (2025b). *ODYSSEE-MURE project*. Retrieved from <https://odyssee.enerdata.net/database>
- ERK. (2021a). *Bericht zum Sofortprogramm 2020 für den Gebäudesektor*. Retrieved from <https://www.expertenrat-klima.de/publikationen/page/3/>
- ERK. (2021b). *Bericht zur Vorjahresschätzung der deutschen Treibhausgasemissionen für das Jahr 2020: Prüfung und Bewertung der Emissionsdaten gemäß § 12 Abs. 1 BundesKlimaschutzgesetz*. Retrieved from <https://www.expertenrat-klima.de>
- ERK. (2022a). *Prüfbericht zu den Sofortprogrammen 2022 für den Gebäude- und Verkehrssektor*. Retrieved from <https://www.expertenrat-klima.de/>
- ERK. (2022b). *Prüfbericht zur Berechnung der deutschen Treibhausgasemissionen für das Jahr 2021*. Retrieved from <https://www.expertenrat-klima.de/>
- ERK. (2022c). *Zweijahresgutachten: Gutachten zu bisherigen Entwicklungen der Treibhausgasemissionen, Trends der Jahresemissionsgesamtmengen und Jahresemissionsmengen und Wirksamkeit von Maßnahmen (gemäß § 12 Abs. 4 Bundes-Klimaschutzgesetz)*. Retrieved from <https://www.expertenrat-klima.de>
- ERK. (2023a). *Prüfbericht 2023 für die Sektoren Gebäude und Verkehr*. Retrieved from <https://www.expertenrat-klima.de>
- ERK. (2023b). *Prüfbericht zur Berechnung der deutschen Treibhausgasemissionen für das Jahr 2022*. Retrieved from <https://www.expertenrat-klima.de/publikationen/>
- ERK. (2023c). *Stellungnahme zum Entwurf des Klimaschutzprogramms 2023: Gemäß § 12 Abs. 3 Nr. 3 Bundes-Klimaschutzgesetz*. Retrieved from www.expertenrat-klima.de
- ERK. (2024a). *Prüfbericht zur Berechnung der deutschen Treibhausgasemissionen für das Jahr 2023*. Retrieved from <https://www.expertenrat-klima.de/>
- ERK. (2024b). *Zweijahresgutachten 2024: Gutachten zu bisherigen Entwicklungen der Treibhausgasemissionen, Trends der Jahresemissionsgesamtmengen und Jahresemissionsmengen sowie Wirksamkeit von Maßnahmen (gemäß § 12 Abs. 4 Bundes-Klimaschutzgesetz)*. Retrieved from https://expertenrat-klima.de/content/uploads/2025/03/ERK2025_Zweijahresgutachten-2024.pdf
- ERK. (2025). *Prüfbericht zur Berechnung der deutschen Treibhausgasemissionen für das Jahr 2024 und zu den Projektionsdaten 2025. Prüfung und Bewertung der Emissionsdaten sowie der Projektionsdaten gemäß § 12 Abs. 1 Bundes-Klimaschutzgesetz*. Retrieved from <https://www.expertenrat-klima.de>
- Federal Government of Germany. (2012). *Progress Report 2012: Climate and Energy - Germany's Energy Concept and Transition*. Retrieved from <https://www.bundesregierung.de/breg-en/federal-government/climate-and-energy-410416>
- Federal Government of Germany. (2023). *Klimaaußenpolitikstrategie der Bundesregierung*. Berlin. Retrieved from <https://www.auswaertiges-amt.de/resource/blob/2633110/90e88ad741351a8885f478c49a1741eb/kap-strategie-data.pdf>
- Figgenger, J., Hecht, C., Haberschusz, D., Bors, J., Spreuer, K. G., Kairies, K.-P., . . . Sauer, D. U. (2023). *The development of battery storage systems in Germany: A market review (status 2023)*. Retrieved from <https://battery-charts.rwth-aachen.de/>
- Flachsland, C., dem Moore, N. aus, Müller, T., Kemmerzell, J., Edmondson, D., Görlach, B., . . . Pahle, M. (2021). *Kurzdossier: Wie die Governance der deutschen Klimapolitik gestärkt werden kann*. Retrieved from <https://ariadneprojekt.de/publikation/governance-der-deutschen-klimapolitik/>
- Fraunhofer ISE. (2025). *Energy Charts*. Retrieved from <https://www.energy-charts.info>
- Heinrich-Böll-Stiftung. (2025). *DEUTSCHE KLIMAFINANZIERUNG: Der deutsche Beitrag zur internationalen Klimafinanzierung*. Retrieved from <https://www.deutschemklimafinanzierung.de/blog/2025/05/klimafinanzierung-im-bundeshaushalt-2025-kommt-wortbruch/>
- Jost, P., Mack, M., & Hillje, J. (2024). *Aufgeheizte Debatte? Eine Analyse der Berichterstattung über das Heizungsgesetz - und was wir politisch daraus lernen können*. STUDIE. Retrieved from <https://www.progressives-zentrum.org/>

- [wp-content/uploads/2024/04/240418_DPZ_Studie_Aufgeheizte-Debatte.pdf](#)
- KBA. (2025). Bestand nach ausgewählten Merkmalen (FZ 27): Bestand an Kraftfahrzeugen und Kraftfahrzeuganhängern nach ausgewählten Merkmalen (Bundesländern und Fahrzeugklassen), vierteljährlich (FZ 27). Retrieved from https://www.kba.de/DE/Statistik/Produktkatalog/produkte/Fahrzeuge/fz27_b_uebersicht.html
 - Klima-Allianz Deutschland. (2024). Studie: Deutschlands Handlungsoptionen bei der internationalen Klimafinanzierung.
 - Kost, C., Müller, P., Sepúlveda Schweiger, J., Fluri, V., & Thomsen, J. (2024). *Stromgestehungskosten Erneuerbare Energien*. Retrieved from file:///C:/Users/tim16870/Downloads/DE2024_ISE_Studie_Stromgestehungskosten_Erneuerbare_Energien.pdf
 - Lexikon der Nachhaltigkeit. (2015a). IEKP: Energie und Klimaprogramm. Retrieved from https://www.nachhaltigkeit.info/artikel/bmvbs_das_integrierte_energie_und_klimaprogramm_1273.htm
 - Lexikon der Nachhaltigkeit. (2015b). Nationales Klimaschutzprogramm 2000, 2005. Retrieved from https://www.nachhaltigkeit.info/artikel/nationales_klimaschutzprogramm_2000_2005_1742.htm
 - Merkel, A. (2021). Regierungserklärung von Bundeskanzlerin Dr. Angela Merkel: zum Europäischen Rat am 24. und 25. Juni 2021 vor dem Deutschen Bundestag am 24. Juni 2021 in Berlin: Bulletin 91-1. Retrieved from <https://www.bundesregierung.de/breg-de/service/newsletter-und-abos/bulletin/regierungserklaerung-von-bundeskanzlerin-dr-angela-merkel-1937362>
 - Pettinotti, L., Kamninga, T., & Colenbrander, S. (2024). *A fair share of climate finance? The collective aspects of the New Collective Quantified Goal*. ODI Working Paper. Retrieved from <https://odi.org/en/publications/a-fair-share-of-climate-finance-the-collective-aspects-of-the-ncqg>
 - Repenning, J., Harthan, R., Blanck, R., & et. al. (2023). *Klimaschutzinstrumente-Szenario 2030 (KIS-2030) zur Erreichung der Klimaschutzziele 2030*. Retrieved from https://www.umweltbundesamt.de/sites/default/files/medien/11740/publikationen/2023_06_15_climate_change_30_2023_klimaschutzinstrumente_0.pdf
 - Riedel, T., Bender, S., Hennig, P., Kroiher, F., Schnell, S., Schwitzgebel, F., . . . Kühling, M. (2024). *Der Wald in Deutschland: Ausgewählte Ergebnisse der vierten Bundeswaldinventur*. Retrieved from https://www.bundeswaldinventur.de/fileadmin/Projekte/2024/bundeswaldinventur/Downloads/BWI-2022_Broschuere_bf-neu_01.pdf
 - Shammugam, S., Schleich, J., Schlomann, B., & Montrone, L. (2022). Did Germany reach its 2020 climate targets thanks to the COVID-19 pandemic? *Climate Policy*, 22. <https://doi.org/10.1080/14693062.2022.2063247>
 - Stiftung Klimaneutralität, Agora Verkehrswende, Agora Energiewende, Bundesverband der Deutschen Industrie e.V., Deutsche Netzagentur, Bundesministerium für Wirtschaft und Klimaschutz, & KopernikusAriadne. (2022). *Vergleich der „Big 5“ Klimaneutralitätsszenarien*. Retrieved from https://ariadneprojekt.de/media/2022/03/2022-03-16-Big5-Szenarienvergleich_final.pdf
 - Table Media GmbH. (2025). +++ Alert +++ Klimafinanzierung im Bundeshaushalt: KTF stabil, international gekürzt. Retrieved from <https://table.media/climate/professional-briefing/alert-klimafinanzierung-im-bundeshaushalt-ktf-stabil-international-gekuertzt#2936217>
 - UBA (Umweltbundesamt) (2025). *Emissionsübersichten KSG-Sektoren 1990-2024 (MS Excel)*. Retrieved from https://www.umweltbundesamt.de/sites/default/files/medien/11867/dokumente/datentabelle_zu_den_treibhausgas-emissionen_2024.xlsx
 - Wiedemann, K. (2025). Haushaltsplan mit kleinen Überraschungen. Retrieved from <https://background.tagesspiegel.de/energie-und-klima/briefing/haushaltsplan-mit-kleinen-ueberraschungen>

A decade of national climate action: Stocktake and the Road Ahead

GUATEMALA PATHWAY TOWARDS LOW-CARBON DEVELOPMENT

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GUATEMALA'S TRANSITION IS NOT JUST ABOUT REDUCING EMISSIONS, BUT TRANSFORMING WHAT DRIVES THEM

Guatemala stands at a moment of profound opportunity. The country is one of the most biodiverse in Central America. These natural resources are not only globally significant but essential to the well-being, identity, and livelihoods of Guatemalans across urban and rural areas. At the same time, Guatemala faces high climate vulnerability, especially from floods, droughts, and shifting agricultural patterns, underscoring the urgency of climate-resilient development (CATIE, 2024). This dual reality (i.e., rich natural capital alongside developmental and climate challenges) makes Guatemala uniquely positioned to outline a low-carbon development pathway that aligns emissions reduction with improvements in human well-being. The country's structural development challenges, such as poverty, energy access gaps (~10% of the population remain without access to electricity (Ministerio de Energía y Minas, 2022)), deforestation (from 2001 to 2024, there was a 25% reduction in the 2000 forest cover, equivalent to 1.89 Mha of tree cover (Global Forest Watch, 2024)), and waste management deficits, are not merely obstacles but gateways for transformative solutions that can drive inclusive growth while attending the underlying drivers of emissions.

For instance, agriculture and forestry remain at the heart of the Guatemalan economy, supporting millions of livelihoods. Yet these same sectors also contribute significantly to national greenhouse gas (GHG) emissions. In 2018, the LULUCF sector (i.e., Land Use, Land-Use Change and Forestry) accounted for approximately 50% of emissions, primarily from deforestation and land-use change (Ministerio de Ambiente y Recursos Naturales, 2022). Expanding agricultural frontiers and the use of firewood for cooking have placed pressure on forests. This is an issue that simultaneously affects biodiversity and public health.

At the same time, the country's energy and transport systems are evolving in the face of rapid urbanization. Fleet growth (e.g., after the COVID-19 pandemic, the number of motorcycles increased by 30% (Superintendencia de Administración Tributaria, 2025)), outdated public transport infrastructure, and a surge in second-hand vehicle imports have increased congestion and fossil fuel consumption. While the electricity matrix has begun to diversify, a significant portion of the population depends on biomass fuels with high emission implications and health risks. In fact, firewood is the main source of energy in the country, underscoring how there are shared opportunities and benefits to be unlocked with a low-carbon transition across sectors (e.g., LULUCF and Energy, in this case). In 2018, the energy sector, including transportation, accounted for 33.8% of national emissions.

Guatemala's emissions have grown steadily since 2005, according to the 2022 National Greenhouse Gas Inventory—from 53 Mt CO₂eq in 2005 to 62 Mt CO₂eq in 2018—(Ministerio de Ambiente y Recursos Naturales, 2022). This trend reflects both economic growth and has been mostly driven by an expanding energy demand, but also highlights the opportunity for leapfrogging into sustainable, low-emissions technologies. The decomposition of CO₂ emissions across sectors reveals clear entry points for change: modernizing transport systems, scaling renewable energy, and preserving forest ecosystems.

In line with centering development opportunities in emission reducing efforts, when we look at the waste management sector, over 45% of households still burn their waste, contributing to air pollution and related health burdens (Instituto Nacional de Estadística, 2018). The Ministry of Environment and Natural Resources (MARN) has made this issue a central part of its agenda, recognizing that even though its contribution to emissions is small (~3%), better waste infrastructure and practices (e.g., circular economy) can improve local environments and the population's health (Ministerio de Ambiente y Recursos Naturales, 2022; Ministerio de Ambiente y Recursos Naturales, 2024).

Rather than treating emissions as the end goal, Guatemala's low-carbon transition has started to be fundamentally about transforming the development model and recognizing the co-benefits in emissions reductions that comes with that. It is about shifting towards a system that values natural capital, increases productivity, improves health, and builds resilience to future shocks.

THE ENDBE AND CENTERING DEVELOPMENT IN LONG-TERM CLIMATE PLANNING

The National Low-Carbon Development Strategy (*Estrategia de Desarrollo con Bajas Emisiones*, ENDBE) is a long-term planning instrument that plays a central role at guiding and aggregating Guatemala's national targets towards low-carbon development. It serves as a roadmap for Guatemala's climate policy by promoting the reduction of greenhouse gas emissions with targeted actions across all emitting sectors (Ministerio de Ambiente y Recursos Naturales, 2021).

As required by law, Guatemala has been working on updating their ENDBE over the last two years. During this process, the country has made a fundamental stance in how it approaches climate policy, establishing a model for others to follow. Rather than focusing narrowly on emissions targets, this updating process has adopted a development-centered lens. It sees mitigation

as a pathway to achieve broader societal goals: improved public health, rural development, enhanced productivity, and long-term economic resilience.

The ENDBE was first developed in 2018 and submitted to the United Nations Framework Convention on Climate Change (UNFCCC), in 2021 as part of Guatemala's long-term low-emission development strategy. The ongoing update process, supported by international partners and national institutions, significantly expands on this foundation and focuses on prioritizing a strong participatory process to strengthen sectoral ownership of the strategy and its targets. The country has been working on developing improved modeling using the OSeMOSYS platform, robust decision-making frameworks, and a detailed cost-benefit analysis. Importantly, this update process has focused on setting a clearer vision: not limited to emissions reductions but extending further into the cost and benefit implications of each action. The process sought to incorporate the most recent data into the models, updated sectoral policies by consulting with stakeholders on the key policy instruments to consider in this ENDBE update, and ambitious yet feasible pathways based on historical adoption rates and institutional capacity. In fact, this modeling effort was developed with a forward-looking approach, aiming to serve as a foundation for future processes, particularly the updating of the Nationally Determined Contribution (NDC).

A cornerstone of the ENDBE update is its emphasis on co-benefits. Modeling tools have been able to prove that implementing ENDBE's actions and targets could yield significant benefits between 2025 and 2050. These benefits stem from reduced fossil fuel imports, lower healthcare costs, job creation in green sectors for instance in circular economy and improved environmental quality. The analysis underscores that climate action is not a trade-off against development, but a catalyst for it.

Participation has been a key strength of the update process. More than 150 stakeholders took part through workshops, over 40 bilateral

meetings, and validation sessions. Participants included government ministries, local governments, private sector actors, academic experts, indigenous and community-based organizations, and civil society groups. This process not only enhanced the technical quality of the strategy but also pursued broad-based ownership and ensured that the strategy was grounded in the realities, priorities, and constraints of each sector and the entities responsible for implementation. At the same time, it is important to recognize that a broad participatory process can compromise pre-established timelines to finalize a Long Term Strategy (LTS) and be a complex endeavor, particularly when working toward consensus among a diverse set of stakeholders. For this reason, documenting agreements carefully and treating the LTS as a living document (i.e., one that can be updated and adjusted as new realities emerge) is essential to maintaining its relevance. Institutionally, the ENDBE is designed to play a guiding role in the evolution of Guatemala's climate governance. It is expected to inform the next update of the NDC, the update of the National Climate Change Action Plan (Plan de Acción Nacional de Cambio Climático, PANCC), and sectoral development plans. The PANCC and the ENDBE are both LTSs that inform climate policy from different perspectives. The ENDBE sets long-term quantitative mitigation targets for each sector (e.g., the share of renewable energy to be deployed, the percentage of electric vehicles to be introduced, among other targets). The PANCC, on the other hand, focuses on defining the specific strategies that government institutions will follow to achieve the country's climate change mitigation and adaptation goals (i.e., it emphasizes the means of implementation that entities will pursue).

The ENDBE's modeling and financial analysis components have also served as a bridge between sectoral planners and the Ministry of Finance. For instance, the cost-benefit analysis can support the integration of climate goals into budgetary planning, a critical step toward mainstreaming climate policy across government institutions.

KEY INSTITUTIONAL AND REGULATORY CHANGES HAVE HAPPENED IN THE LAST DECADE

Over the past ten years, Guatemala has made notable structural changes that lay the groundwork for low-carbon development. These changes span institutional arrangements, policy frameworks, and sectoral initiatives. At the institutional level, one of the most significant advances is the active involvement of the Ministry of Public Finance (MINFIN) in climate planning. Their participation in the ENDBE process marks a turning point in integrating climate considerations into public investment and fiscal planning. MINFIN's role in developing financing scenarios and identifying budgetary implications of mitigation measures is critical for future implementation.

In fact, a key milestone is the development of the ENDBE financial dashboard. This tool translates the ENDBE's cost-benefit analysis into relevant indicators for financial and budgetary planning. The tool sought to be a starting point for a new level of integration of the Finance Ministry into the climate process. This dashboard was based on a dashboard developed by the Institute for Climate Economics (I4CE, 2022).

The creation and strengthening of technical working groups ("mesas técnicas") in areas such as climate change mitigation and adaptation have provided spaces for policy dialogue and coordination. These platforms bring together diverse stakeholders from key sectoral institutions to identify challenges, share knowledge, and develop consensus-based solutions. For instance, the creation of a sustainable agriculture working group enabled the coordination among stakeholders to create a concrete plan to pursue sustainable agricultural practices under a shared model. They have become instrumental in aligning sectoral plans and visions with national climate goals.

Several sectoral reforms have also contributed to enabling climate action. The PROBOSQUE program, which incentivizes forest conservation and reforestation, has become a central pillar

of mitigation in the land-use sector. It provides economic incentives to landholders and communities, supporting sustainable forest management and ecosystem restoration (Instituto Nacional de Bosques, n.d.).

In the energy sector, regulatory advances include the introduction of mandates for biofuel blending. The 2023 regulation sets a pathway for ethanol blending in gasoline, starting with 10% (E10) in 2026 and increasing over time (Ministerio de Energía y Minas de Guatemala, 2023a). This measure is expected to reduce fossil fuel dependency and stimulate local bioenergy markets. In parallel, the National Energy Efficiency Policy 2023-2050 (Ministerio de Energía y Minas, 2023b) and the update of the 2020-2050 Rural Electrification Policy (Ministerio de Energía y Minas, 2020) aim to expand access to clean and modern energy services. In 2024, the Ministry of Energy and Mines presented their electricity generation expansion plan, where Guatemala sets the goal of achieving 80% of renewable energy by 2027 (Ministerio de Energía y Minas, 2024).

In waste management, the 2024 launch of the National Strategy for Circular Economy (ENECG) marked a paradigm shift (Ministerio de Ambiente y Recursos Naturales, 2024). The strategy promotes waste reduction, material reuse, and value-chain development, moving away from traditional disposal models. These sectoral initiatives also highlight the country's vision of pursuing low-carbon initiatives that support Guatemala's development goals.

ENABLING CONDITIONS THAT WILL SUSTAIN LOW-CARBON DEVELOPMENT

Guatemala is making determined strides toward low-carbon development, and these efforts will be further strengthened by a set of enabling conditions that are progressively being consolidated. Financial readiness is one of the most important enablers. Through the ENDBE update, the country has developed detailed investment scenarios for different levels of ambition. These scenarios

identify sector-specific investment needs, providing a roadmap for engaging both domestic and international resources. As a result, the country is now in a strong position to understand the scale and distribution of its investment needs, which in turn enhances its ability to engage effectively in climate finance discussions and funding proposals.

What remains, however, is to fully address the implementation challenge and unlock access to the required climate finance at scale. Turning plans into action will require not only continued political will and technical capacity, but also well-defined mechanisms for financing, coordination, and monitoring. Consolidating project pipelines will be essential to translate ambition into results on the ground.

From their climate planning and reporting processes, Guatemala understands that the forestry sector offers substantial mitigation potential and multiple co-benefits, especially considering the contribution of land-use change to the country's emissions. The country has prioritized conservation, focusing on reducing deforestation in existing forests through programs such as PROBOSQUE not only reduce emissions but also enhance ecosystem services, biodiversity, and rural incomes. Promotion of clean cookstoves further contributes to forest protection while addressing health concerns related to indoor air pollution, which disproportionately affects women and children (Ndikubwimana, A. et al, 2025).

In transport, the country has been clear about increasing electric mobility and enhancing public transit. Implementation of mass transit systems in major urban centers will reduce traffic congestion and accidents, and improve air quality (Agencia Nacional de Alianzas para el Desarrollo de Infraestructura Económica, n.d.). These projects also support social inclusion by providing affordable and efficient mobility options for low-income populations.

The waste sector has made progress through policy reforms and increased awareness, but infrastructure development remains essential. The ENECG and other regulatory instruments

have laid the groundwork for a transition to circular economy practices. However, the next phase requires investments in sanitary landfills, methane capture systems, and material recovery facilities. Strengthening coordination between national and local governments will be crucial for implementation. An essential next step will be the development of local waste management plans, as many local governments are already doing, tailored to the specific realities and waste generation patterns of each community, with the creation of local baselines of waste generation as a first step.

Capacity building and institutional strengthening are also necessary enablers. While technical capacity has improved, many institutions still face limitations in staffing, data management, and project execution. Continued support for training and knowledge exchange between local institutions will be vital to maintain momentum. Guatemala has identified limited inter-institutional coordination as a persistent challenge for fully articulated climate action. Addressing this challenge has required deliberate efforts to improve dialogue and foster joint ownership of the transition. For example, as mentioned before, the government has established working groups that bring together key institutions to develop shared policies and priorities. The modelling effort for the future ENDBE update also illustrates Guatemala's commitment to a participatory approach: stakeholders from across government, the private sector, and civil society contributed insights that helped shape investment scenarios and policy options. This approach aims at strengthening buy-in and the co-creation of climate policy.

The country has also recognized that co-existence of a large number of actors across sectors creates challenges for coordinated climate action. With many actors involved—such as farmers, municipalities, and private enterprises—there are limitations in how information is shared and how stakeholders access the data needed for informed decision-making. To address this, Guatemala has developed tools such as the Agroclimatic Information

Bulletins ("*Boletines Agroclimáticos*"), which provide producers with climate information to guide agricultural practices (Ministerio de Agricultura, Ganadería y Alimentación, 2025). In addition, the government has advanced the establishment of the National Climate Change Information System ("*Sistema Nacional de Información de Cambio Climático*"), designed to centralize and disseminate climate-related data, thereby strengthening transparency, coordination, and evidence-based policymaking (Ministerio de Ambiente y Recursos Naturales, n.d.).

EXISTING CLIMATE GOVERNANCE IS ADVANCING TOWARDS INTERINSTITUTIONAL COLLABORATION AND ALIGNMENT

At its core, the Ministry of Environment and Natural Resources (MARN) leads national climate planning, overseeing coordination of key instruments such as the ENDBE and the PANCC. The *Mesa Técnica de Mitigación* and the *Mesa Técnica de Adaptación* provide institutional spaces for dialogue, knowledge sharing, and consensus building across government sectors. These platforms bring together representatives from a wide range of sectors. They have played a pivotal role in shaping the ENDBE update and ensuring consistency with sectoral priorities and national development goals. These working groups also provide a mechanism for continuous learning and feedback, which is essential in a dynamic policy environment shaped by evolving climate science and international commitments.

Beyond MARN, several institutions have responsibilities that are critical to climate action. The National Council for Protected Areas (CONAP) and the National Institute of Forests (INAB) are responsible for forest governance and conservation. Their overlapping areas of focus highlight the critical need for securing coordination. Similarly, the Ministry of Agriculture, Livestock, and Food (MAGA) manages sustainable land use

and agricultural practices, while the Ministry of Energy and Mines (MEM) governs energy policy. The participatory approach adopted during the modelling effort for the ENDBE update exemplifies Guatemala's commitment to inclusive governance. Indigenous groups, women's organizations, youth associations, and municipal authorities were all consulted. Their contributions were essential in shaping a strategy that reflects national realities and diverse perspectives. The overall broad participation in the update process enhanced both the technical relevance and political legitimacy of the strategy. However, it also highlights the cross-sectoral commitment of the country to low-carbon and resilient development.

Nevertheless, there are next steps. In order to enhance inter-institutional collaboration, the country is working to understand what the adequate platforms are to share information, perspectives, and align incentives. Moving forward, Guatemala intends to strengthen institutional frameworks that reinforce coordination at all levels of government, from national ministries to local municipalities. In the same line, the country will continue to strengthen the link between climate policy and development goals. For instance, during participatory processes for climate policy development, emphasis is placed on how climate action can secure resilient rural energization, expand access to clean cooking options that reduce exposure to indoor air pollution, safeguard ecosystem services through forest conservation and sustainable agricultural practices, and reduce pressure on waste management systems through the implementation of circular economy approaches. These efforts are intended not only to enhance environmental outcomes, but also to generate social and economic co-benefits (e.g., poverty reduction, improved public health, and employment opportunities) ensuring that the transition remains coherent with the country's broader development priorities.

INTERNATIONAL COOPERATION FOR IMPLEMENTATION AND THE ROAD AHEAD

International support has been instrumental in enabling Guatemala's climate planning achievements. Development partners such as the Inter-American Development Bank (IDB), UNDP, the 2050 Pathways Platform, and various bilateral agencies have contributed technical assistance, capacity building, and financial resources. Their efforts have been vital in strengthening climate planning, enhancing MRV systems, and mainstreaming climate change across sectors.

As Guatemala transitions from planning to implementation, the nature of international cooperation must evolve accordingly. The next phase will require scaled-up climate finance to support infrastructure projects, technology deployment, and institutional development. The ENDBE's investment scenarios indicate substantial financing needs to meet mitigation pathways.

Guatemala is well-positioned to attract international climate finance. The updated models for the ENDBE future update features detailed cost-benefit analyses and prioritization frameworks, strengthening the country's case for investment. It highlights high-impact interventions with strong returns in emissions reductions, development co-benefits, and long-term resilience. For example, the promotion of clean cookstoves simultaneously mitigates emissions, improves health outcomes, and curbs deforestation.

Multilateral climate funds can play a key role. Blended finance instruments and public-private partnerships are also essential for mobilizing capital at scale and unlocking sectoral opportunities. In this context, international partners can support the development of robust project pipelines and assist local institutions in meeting access criteria for international funding.

Beyond financial support, technical strengthening remains equally important. Prioritizing data systems, policy design, and institutional capacity is needed to maintain momentum. Peer-to-peer exchanges with countries on similar trajectories can foster innovation and shared learning.

Looking forward, several strategic priorities will shape Guatemala's low-carbon development pathway. First, placing adaptation at the center of the climate agenda is essential. While the ENDBE focuses primarily on mitigation, Guatemala's vulnerability to climate impacts (e.g., droughts, floods, and temperature variability) demands robust adaptation planning. Integrating adaptation into development and infrastructure strategies will enhance resilience and reduce long-term risks. In fact, multiple mitigation initiatives such as reforestation, conservation, agroforestry systems, renewable energy, among many others, are a clear bridge between the mitigation and adaptation agenda.

The upcoming update of the NDC and the revision of the PANCC provide important opportunities to align mitigation and adaptation efforts. These instruments are expected to reflect the integrated nature of climate challenges, prioritize co-beneficial actions, and maintain coherence with the ENDBE. Leveraging the analytical tools and data developed through the ENDBE will be key to improving their ambition, quality and incorporating new perspectives from stakeholders.

Ultimately, implementation is the final frontier. Achieving the vision set out in the future update of the ENDBE will require strong governance, predictable financing, and broad-based societal support. Scaling successful pilots, aligning regulatory frameworks, and empowering subnational governments will be essential for delivering results on the ground. Investment in human capital (e.g., training programs and community engagement and involvement in climate change mitigation, adaptation and risk management) will serve as the foundation of implementation success.

The path ahead is challenging but achievable. Guatemala has laid a solid foundation grounded in evidence, participation, and ambition. With continued domestic leadership and adaptive international cooperation, the country can transform its emissions trajectory into a model of climate-compatible development. It can be one that reduces emissions while delivering prosperity, equity, and sustainability for generations to come.

REFERENCES

- Agencia Nacional de Alianzas para el Desarrollo de Infraestructura Económica (ANADIE). (n.d.). *Sistema de Transporte Público Masivo del Eje Oriente–Occidente del Área Metropolitana de Guatemala (STPM)*. Retrieved July 9, 2025, from <https://anadie.gob.gt/project/stpm/>
- CATIE. (2024). *Informe de análisis de riesgo y vulnerabilidades: Guatemala*. Programa EbA LAC. <https://www.catie.ac.cr/wp-content/uploads/2024/03/Informe-de-Analisis-de-Riesgo-y-Vulnerabilidades-Guatemala-.EbA-LAC.pdf>
- Global Forest Watch. (2024). *Guatemala: Panel de control forestal*. World Resources Institute. Recuperado el 9 de julio de 2025, de <https://www.globalforestwatch.org/dashboards/country/GTM/>
- I4CE. (2022). *The economic implications of the transition to a low-carbon and resilient economy: An LTS dashboard for Finance Ministers*. Institute for Climate Economics. <https://www.i4ce.org/wp-content/uploads/2022/11/20221108-17h16-I4CE3682-PC71-LTS.pdf>
- Instituto Nacional de Bosques (INAB). (n.d.). *Programa de incentivos forestales PROBOSQUE*. Retrieved July 9, 2025, from <https://www.inab.gob.gt/index.php/probosque>
- Ministerio de Agricultura, Ganadería y Alimentación (2025). Boletines agroclimáticos son clave para el sector agropecuario. Retrived August 28, 2025 from <https://www.maga.gob.gt/boletines-agroclimaticos-son-clave-para-el-sector-agropecuario/>
- Ministerio de Ambiente y Recursos Naturales (MARN). (2022). *Anexo técnico del Primer Informe Bienal de Actualización de Guatemala: Informe del Inventario Nacional 2022 (1990–2018)*. Convención Marco de las Naciones Unidas sobre el Cambio Climático (CMNUCC). https://unfccc.int/sites/default/files/resource/2022/IIN_GT-v2.pdfUNFCCC
- Ministerio de Ambiente y Recursos Naturales (MARN). (2021). *Estrategia Nacional de Desarrollo con Bajas Emisiones de Gases de Efecto Invernadero*. https://www.marn.gob.gt/wpfd_file/endbe/
- Ministerio de Ambiente y Recursos Naturales (MARN). (2024). *MARN lanza la Estrategia Nacional para la Transición hacia una Economía Circular en Guatemala 2024–2045*. <https://www.marn.gob.gt/marn-lanza-la-estrategia-nacional-para-la-transicion-hacia-una-economia-circular-en-guatemala-2024-2045/>
- Ministerio de Ambiente y Recursos Naturales (n.d.). Sistema Nacional de Información sobre Cambio Climático. Retrived August 28, 2025 from <https://snicc.marn.gob.gt/Home>
- Ministerio de Energía y Minas (MEM). (2020). *Política de Electrificación Rural 2020–2050*. Guatemala: MEM. Retrieved July 9, 2025, from <https://mem.gob.gt/wp-content/uploads/2020/09/Politica-de-Electrificacion-Rural-2020-2050.pdf>
- Ministerio de Energía y Minas (MEM). (2022). Índice de cobertura eléctrica 2021. <https://mem.gob.gt/wp-content/uploads/2022/02/Indice-de-Cobertura-Elctrica-2021-01.pdf>
- Ministerio de Energía y Minas de Guatemala. (2023a). *Política Nacional de Eficiencia Energética 2023–2050*. <https://mem.gob.gt/wp-content/uploads/2023/06/POLITICA-NACIONAL-DE-EFICIENCIA-ENERGETICA-2023-2050.pdf>
- Ministerio de Energía y Minas (MEM). (2023b). *Política Nacional de Eficiencia Energética 2023–2050*. Guatemala: MEM. Retrieved July 9, 2025, from <https://mem.gob.gt/wp-content/uploads/2023/06/POLITICA-NACIONAL-DE-EFICIENCIA-ENERGETICA-2023-2050.pdf>
- Ministerio de Energía y Minas (Guatemala). (2024). Plan de Expansión Indicativo del Sistema de Generación 2024–2054. Retrieved from <https://mem.gob.gt/wp-content/uploads/2024/01/Plan-de-Expansion-Indicativo-del-Sistema-de-Generacion-2024-2054.pdf>
- Ndikubwimana, A., Checkley, W., Chen, Y. et al. Exposure–response relationship of household air pollution on body mass index among women in rural areas of Guatemala, India, Peru and Rwanda: household air pollution intervention network trial. *BMC Public Health* **25**, 2163 (2025). <https://doi.org/10.1186/s12889-025-23380-1>
- Superintendencia de Administración Tributaria (SAT). (2025). *Análisis estadístico del parque vehicular*. Retrive July 9, 2025, de <https://portal.sat.gob.gt/portal/parque-vehicular/>

A decade of national climate action: Stocktake and the Road Ahead

INDIA INSIGHTS ON CLIMATE ACTION TEN YEARS AFTER THE PARIS AGREEMENT

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INTRODUCTION

India is one of the largest democracies with the largest population in the world¹. It is the fourth-largest economy by GDP (nominal) and the third-largest economy by GDP-PPP basis^{2,3}. As a lower-middle-income country, it has set a goal to become a self-sufficient \$30 trillion economy by 2047, which marks the 100th anniversary of its independence⁴. In terms of development (SDGs) since 2015, India has been able to achieve near-universal energy and water access, increased renewable energy share, improved waste management efforts, and expanded social security⁵. It focuses on the welfare and quality of life of its citizens through policies such as Pradhan Mantri Awas Yojana (Housing for All), Ujjwala Yojana (Clean cooking (LPG connection) to low-income households), Swachh Bharat Abhiyan (Clean India), Jan Dhan Yojana, Ayush-

¹ United Nations Population Fund (UNFPA). (2025). *The State of World Population 2025: The real fertility crisis*. <https://www.unfpa.org/swp2025>

² World Bank. (2025). *Global Economic Prospects*. Retrieved from <https://www.worldbank.org/en/publication/global-economic-prospects>

³ International Monetary Fund. (2025). *World Economic Outlook*. Retrieved from <https://www.imf.org/en/Publications/WEO>

⁴ NITI Aayog. (2024). *Viksit Bharat @ 2047: Vision for Developed India*. Retrieved from <https://www.niti.gov.in/publications>

⁵ United Nations. (2025). *The Sustainable Development Goals Report 2025*. <https://unstats.un.org/sdgs/report/2025/>

man Bharat- Pradhan Mantri Jan Arogya Yojana (Health insurance to poor families), Ayushman Arogya Mandir (comprehensive primary health care), PM-Mudra Yojana, Saubhagya (Universal household electrifications), and Start-up India⁶.

INDIA'S CLIMATE COMMITMENTS

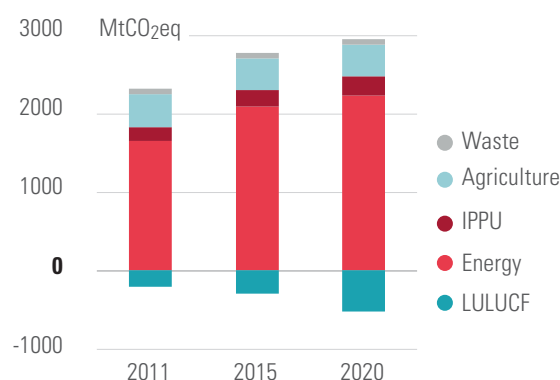
Nationally Determined Contributions (NDCs)

India's NDC, which was submitted under the Paris Agreement, outlines its climate action targets for 2030. India submitted its first NDC in 2015 at COP21 and committed to reducing the GHG emission intensity of its GDP by 33–35% by 2030 and to achieve about 40% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030⁷. These targets were updated in August 2022 to reduce the GHG emission intensity of its GDP by 45% and about 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030 at COP26 in Glasgow⁸. India has also set a net-zero emissions target for 2070. These actions are a part of the 'Panchamrit' (five nectars) strategy as the pillars of India's climate action. **Figure 1** shows the trend in the evolution of India's emissions between 2011 and 2020. By 2020, the total GHG emissions reached almost 3000 million tonnes, with the energy sector contributing up to 75% and about 8% by industry sector.

India balances sustainable development with a strong commitment to climate action. This can only be achieved with international cooperation and support on technology and finance.

India is working on its third NDC update. It should be noted that India is one of the largest economies that is on track to achieve its 2030

Figure 1. India's GHG emissions by sectors



Source: India's Bur-1, BUR-2, BUR-3 & BUR- 4.

commitments. **Table 1** presents the list of main targets in the past ten years (IND 2015⁹, NDC 2022¹⁰, NC 2024¹¹, ES 2025⁶).

LOW-EMISSIONS LONG TERM STRATEGIES (LTS)

India submitted its LT-LEDs to the UNFCCC in 2022 at COP27 as a follow-up to the Glasgow declaration. India's long-term strategies document aims to achieve a low-carbon transition while balancing its development needs. It is built on ambitious social, economic, environmental, and technological goals to transform the economy structurally. To become Aatma Nirbhar Bharat (Self-Reliant India), the document systematically outlines the current policies and accelerated action required in electricity, industry

⁶ Ministry of Finance, Government of India. (2025). *Economic Survey 2024-25*. Retrieved from <https://www.indiabudget.gov.in/economic-survey/>

⁷ MoEFCC. (2015). *India's intended Nationally Determined Contribution: Working towards climate justice*. http://www4.unfccc.int/submissions/INDC/Published_Documents/India/1/INDIA_INDC_TO_UNFCCC.pdf

⁸ MoEFCC. (2022). *India's Updated First Nationally Determined Contribution Under Paris Agreement*. Ministry of Environment, Forest and Climate Change, Government of India.

⁹ Ministry of Environment, Forest and Climate Change, Government of India. (2015). *India's Intended Nationally Determined Contribution: Working towards climate justice and sustainability*. United Nations Framework Convention on Climate Change. <https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/India%20First%20INDC%20TO%20UNFCCC.pdf>

¹⁰ Ministry of Environment, Forest and Climate Change, Government of India. (2022). *Updating India's First Nationally Determined Contribution pursuant to decision 1/CP.21 (Paris Agreement)*. United Nations Framework Convention on Climate Change. <https://unfccc.int/sites/default/files/NDC/2022-08/India%20Updated%20First%20NDC.pdf>

¹¹ Ministry of Environment, Forest and Climate Change, Government of India. (2023). *Third National Communication to the United Nations Framework Convention on Climate Change*. United Nations Framework Convention on Climate Change. <https://unfccc.int/documents/637380>

Table 1. Tracking India's targets and commitments under the Paris Agreement

Targets by 2030	INDC (First NDC) (2015)	Updated NDC (2022)	Status as of Nov. 2024	Comments
Emissions intensity reduction of GDP (from 2005 level)	33-35%	45% [NDC 3 updated]	36% in 2020 from the 2005 level (BUR-4)	On track
Share of non-fossil fuel electric power capacity (from 2005 level)	40%	50% [NDC 4 updated]	50.1% of the total non-fossil fuel power capacity achieved as of July 2025 ¹	Achieved
Additional carbon sink (billion tonnes of CO ₂ equivalent) (BtCO ₂ e)	2.5-3 BtCO ₂ e	2.5-3 BtCO ₂ e [NDC 5, no update]	Additional carbon sink of 2.29 BtCO ₂ e created in 2021	On track
Net Zero by 2070 target	Not applicable	Not in NDC	Mentioned in LT-LEDS 2022. Net Zero to be achieved by 2070.	The document is not clear if the NZ includes or excludes non-CO ₂ emissions.
Lifestyle for Environment (LiFE)	NDC Goal 1	First goal of the updated NDC [NDC1 goal modified and promoted as global mass movement]	Encourage energy saving measures such as using LED lights, setting AC temperatures to 24-26°C keeping electronic devices in energy-saving mode, utilizing smart switches for frequently used appliances, etc ² .	Reflects principle of climate justice. Mindful production and consumption. Pro circular economy. Yield co-benefits in reduced air pollution and improved health.
Adaptation component	NDC Goal 6	Adaptation is actively promoted with multifaceted approach.	Adaptation Communication submitted to UNFCCC. National Adaptation Plan is under preparation	Aligns with sustainable development and climate resilience across regions.
Mobilization of funds	NDC 7	Remains same	Around US\$ 4.5 trillion worth of investments is required by India till 2040 to develop infrastructure, to improve economic growth and community wellbeing ³	Aligned with article 4.4 of the UNFCCC
Building capacities [national and international cooperation]	NDC 8	Remains same	Fostering innovation and collaboration in the field of climate technology, integrate advanced solutions, promote R & D for future technology, etc.	Aligned with article 4.5 of the UNFCCC

¹ Press Information Bureau (PIB). (2025, July 14). *India's Renewable Rise: Non-Fossil Sources Now Power Half the Nation's Grid*. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2144627>

² LiFE Life style for Environment (2022). <https://www.niti.gov.in/sites/default/files/2023-02/Brochure-10-pages-op-2-print-file-20102022.pdf>

³ Ministry of Finance, Government of India. (2018). Economic Survey 2017-18. Retrieved from <https://www.indiabudget.gov.in/economicsurvey/>

(energy-intensive and light industries), transport (passenger and freight), buildings (residential and commercial), agriculture, and the forestry sector¹².

India's LT-LEDS highlights the importance of energy in meeting the nation's development needs and aspirations to support its demographic shifts from rural to urban areas and the resulting need for infrastructure. Hence, the strategy focuses on key areas such as the decarbonization of the energy sector, sustainable urbanization, and building climate resilience. India continues its efforts to decouple its emissions from economic growth by promoting low-carbon development in every sector. LT-LEDS acts as a master document that links various ongoing and planned initiatives across sectors. For example, it frames the National Green Hydrogen Mission, the Production Linked Incentive (PLI) scheme for EVs, and the National Clean Air Programme as integral parts of India's long-term climate strategy. Mindful of the tradeoffs and related costs, India has recognized the co-benefits of integrating climate action in its development pathways, considering its national circumstances¹³.

India's LT-LEDS is based upon an economy-wide multiple objectives approach, including integrating dimensions of gender equity and inclusion of marginalized and vulnerable groups, that consciously seeks to move to a low-carbon development path. It is one of the LTS documents that is also closely aligned with its NDC targets. It also emphasizes on the 'Mission LiFE' which focuses on three main changes, i.e., change in demand, supply, and policy through a comprehensive approach, and contributes directly and indirectly to almost all SDGs. Mission LiFE lists a broad and non-exhaustive list of 75 individual LiFE actions across 7 main categories (energy saved, water saved, reduced consumption of single use plastic, adopting sustainable food systems, reduction of waste, adoption of healthy lifestyles and reduction of e-waste). These were identified such that

most actions are: 1) Specific and measurable, 2) Easy to practice by individuals, communities and institutions with minimal supply-side dependencies, and 3) Non-disruptive to ongoing economic activity^{14, 15}.

Reaching this goal will necessitate cost-effective and sustainable investment options. There are several estimates with a wide range for the financing needs of achieving India's net zero targets. As per the first NDC, India would require investments worth almost USD 170 billion per year between 2015 and 2030 – a total of USD 2.5 trillion.¹⁶ For a net-zero 2070, India would require approximately USD 10.1 trillion as per an IFC estimate¹⁷ while an assessment by CEEW from 2021 also puts total investment needs at USD 10.1 trillion between 2020 and 2070 for achieving the net zero target¹⁸. An assessment by IEA puts the investment needs at an average of USD 160 billion per year between 2022 and 2030 in India's energy sector¹⁹. A Moody's-ICRA assessment report from February 2025 pegs the need for investment in the power sector alone at USD 53 billion to USD 76 billion until 2035²⁰.

WHAT HAS PARIS AGREEMENT TRIGGERED IN INDIA? – PROGRESS ACROSS NATIONAL TRANSITIONS

Even though it is a developing country, India has played an active role and made significant prog-

¹² MoEFCC - Ministry of Environment, Forest and Climate Change, Government of India. (2022). *India's Long-Term Low-Carbon Development Strategy*. Retrieved from <https://unfccc.int/documents/623511>

¹³ Ministry of Finance, Economic survey 2017-18

¹⁴ MoEFCC - Ministry of Environment, Forest and Climate Change, Government of India. (2022). *India's Long-Term Low-Carbon Development Strategy*. Retrieved from <https://unfccc.int/documents/623511>

¹⁵ LiFE Life style for Environment (2022). <https://www.niti.gov.in/sites/default/files/2023-02/Brochure-10-pages-op-2-print-file-20102022.pdf>

¹⁶ Vishwanathan, S.S., and Garg, A. (2020). Energy system transformation to meet INDC, 2°C and well below 2°C targets for India Climatic Change.

¹⁷ IFC, 2023. Blended Finance for Climate Investments in India. Available at: <https://www.ifc.org/en/insights-reports/2023/blended-finance-for-climate-investments-in-india>

¹⁸ CEEW, 2021. "Investment Sizing India's 2070 Net-Zero Target". Available at: [CEEW-CEF-Investment-Sizing-India's-2070-Net-Zero-Target.pdf](https://www.ceew.in/Investment-Sizing-India's-2070-Net-Zero-Target.pdf)

¹⁹ IEA, 2022. "India's clean energy transition is rapidly underway, benefiting the entire world"

Available at: <https://www.iea.org/commentaries/india-s-clean-energy-transition-is-rapidly-underway-benefiting-the-entire-world>

²⁰ Moody's, 2025. <https://www.icra.in/CommonService/OpenMediaS3?Key=b8af5de7-ceb3-4030-806d-7f2557c6255f>

ress toward its climate commitments since the Paris Agreement. The national transitions unlike many countries need to encompass energy security, energy access, energy affordability in addition to its development priorities and climate ambitions related to GHG mitigation, resilience to climate impacts and adaptation actions. The Indian Government has introduced/implemented more than 650 policies across the national, state and sectoral levels since 2015 to till date. This section describes transitions that have been initiated in the past decade. This includes energy transitions for sectors such as power (including coal), and industry (steel). The section discusses selected policy, technology, finance, and governance aspects at the national and subnational levels that have enabled the transition and/or the discourse around them. We also discuss Impacts, vulnerability, and adaptation here.

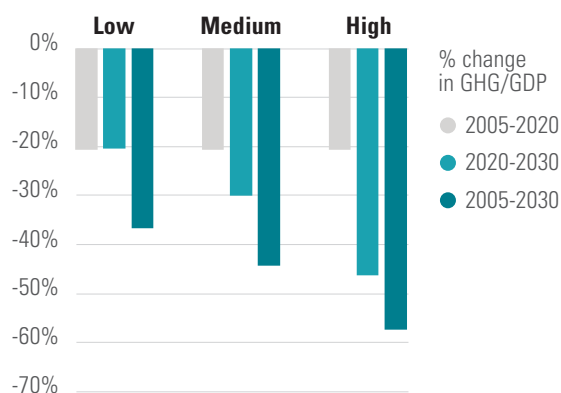
Energy Transitions

Power Sector

Fossil fuels dominate India's current primary energy mix. The share of coal in total primary energy supply (TPES) stood at 60.21%, followed by crude oil at 29.83% and natural gas at 6.99% in 2023-24²¹. Over the past decade, the share of renewable energy sources has consistently increased - 17,682 ktoe during 2014-15 to 31,847 ktoe by 2023-24. While final energy consumption has also experienced a rise of almost 38% in the past decade, the GHG emissions from the energy sector have not followed a similar trajectory. India's current climate commitments like the NDC and LTS, coupled with the existing development and economic policies, have contributed to the decoupling of economic growth and emissions and led to decarbonization of the economy in the past decade. **Figure 2** presents an assessment of the decoupling under various growth scenarios. The share of electricity in India's final energy

consumption stood at 19% in 2023²². The power sector in India has been growing significantly in the past decade. The total installed capacity increased from 305 GW in 2015-16 to 475 GW by 2024-25, leading to an increase in electricity generation from 1168 billion units to 1824 billion units in the same period²³. The per capita electricity consumption also observed a proportional rise from 957 kWh in 2013-14 to 1395 kWh in 2023-24²⁴. While India is rapidly expanding its renewable energy capacity and has reached the NDC target of achieving 50% installed capacity of electricity generation from non-fossil sources in 2025 (5 years ahead of the 2030 target)²⁵, coal-based thermal power will continue to play a crucial role. Projections indicate it will account for 55% of the power mix by 2030, before its

Figure 2. Decoupling energy and emissions in India



Source: Garg et al (2024).

²¹ Ministry of Statistics and Programme Implementation, Government of India. (2025). *Energy Statistics India 2025*. https://mospi.gov.in/sites/default/files/publication_reports/Energy_Statistics_2025/Energy%20Statistics%20India%202025_27032025.pdf

²² International Energy Agency. (2025). *Electricity*. <https://www.iea.org/countries/india/electricity>

²³ Central Electricity Authority. (2025). *Installed Capacity Report March 2025*. Retrieved from https://cea.nic.in/wp-content/uploads/installed/2025/03/IC_March_2025_allocation_wise.pdf

²⁴ Ministry of Power. (2025, January 1). *Year End Review - 2024*. Press Information Bureau (PIB), Government of India. <https://pib.gov.in/PressReleasePage.aspx?PRID=2089243>

²⁵ Press Information Bureau, Government of India. (2025, July 14). *India's Renewable Rise: Non-Fossil Sources Now Power Half the Nation's Grid*. Retrieved from <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2144627#:~:text=by%20PIB%20Delhi-India%20has%20achieved%20a%20landmark%20in%20its%20energy%20transition%20journey,Prime%20Minister%20Shri%20Narendra%20Modi>

share decreases to 27% by 2047²⁶. As of June 2025, the share of installed capacity of coal-based power plants in India stood at almost 44%²⁷. Hence, coal is here to stay as the backbone of India's economy until at least the next two decades^{28,29,30}.

Coal transitions require a large-scale transformation of the Indian economic systems, energy mix, labor markets, and production processes. In the past few years, due to the international commitments (Glasgow Pact 2021) to phase down fossil fuels, there has been an active debate at the national and subnational levels to transition away from coal. The Government of India set up an inter-ministerial committee on just transitions from coal at the national level as part of the India-U.S. Strategic Clean Energy Partnership. Formed in 2021 and chaired by the Ministry of Coal, the committee consisted of representation from Indian Bureau of Mines, Central Electricity Authority, Coal India Ltd., NITI Aayog, and civil society organization, academician, and counterparts from the US. The committee's report, which was finalized in 2023, has proposed a framework and a roadmap, focused on human-centric approach for energy transitions, assessing the stranded assets, alignment with national policies, regional diversification, local adaptation, and community engagement³¹. The report's recommendations are being integrated into existing policy and regulatory mechanisms. One

outcome that can be attributed to the report is the establishment of a Sustainability & Just Transition Division within the Ministry of Coal. Jharkhand, the coal producing state was the first to establish Task Force on Sustainable Just Transition to focus on development framework to transit away from coal³².

There have also been some noteworthy advancements in making coal use more efficient and less polluting. India has promoted supercritical and ultra-supercritical thermal power plants, which operate at higher efficiencies and produce fewer emissions per unit of electricity generated. The government has also encouraged biomass co-firing especially utilizing agricultural waste.

India updated its Energy Conservation Act in 2022 to support its climate pledges, known as 'Panchamrit,' made under its revised Nationally Determined Contribution. The amendments aim to boost energy efficiency, accelerate the reduction of carbon emissions, and promote sustainable development. Other key features included developing a carbon credit market to incentivize emission reductions, mandatory use of non-fossil fuels in emission-intensive industry, a penalty for not meeting the requirements of non-fossil fuel share, the energy conservation building code for residential and commercial buildings, and introducing energy codes for vehicles and ships³³. The electricity sector has already implemented several policies that have induced a shift towards low-carbon electricity generation. These measures include: a) phasing out of old, inefficient power plants and replacement with new supercritical plants with higher efficiency, b) adjusting the power market design to integrate renewables and thermal power generation more efficiently, and c) removing existing barriers to the achieving India's current renewable energy goals in the power sector³⁴.

India has made substantial progress in pushing renewables, which is evident from achieving the

²⁶ Ministry of Coal, Government of India. (2024, February 26). Economic significance of the Coal Sector Extends Beyond Energy Production. Press Information Bureau. Retrieved from <https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2009196#:~:text=in%3A%20Urdu%20%2C%20Hindi-,Ministry%20of%20Coal,7%3A05PM%20by%20PIB%20Delhi>

²⁷ Central Electricity Authority. (2025). Installed capacity report June 2025. Retrieved from https://cea.nic.in/wp-content/uploads/installed/2025/06/IC_June_2025_allocation_wise.pdf

²⁸ Garg A., Patange, O., Vishwanathan S.S., Nag, T., Singh, U., and Avashia V., (2024). Synchronizing energy transitions toward possible Net Zero for India: Affordable and clean energy for all. Retrieved from [ESN Report-2024_New-21032024.pdf](https://www.esnreport.com/2024/02/21/032024.pdf)

²⁹ 1. Vishwanathan, S.S., Bataille, C., Nogueira, E., Cunha, S., Rovere, E., Wrs, U., Patange, O., Garg, A., McCall, B., Trillo, H., Burton, J., and Gunfaus, M. (2025, Accepted). Power Sector Transformation in emerging economies. Climate Policy.

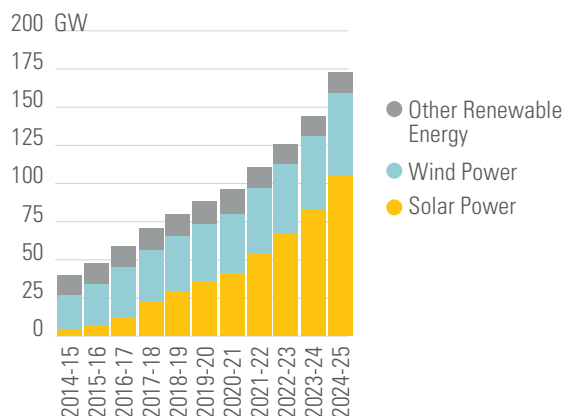
³⁰ Singh, U., Vishwanathan, S.S., Garg, A., Singh, A. K., Iyer, S.H. (2025). Socio-technical feasibility of coal transitions in India: Results from stakeholder interviews, Energy and Climate Change, 6 (100188).

³¹ NITI Aayog, Government of India. (2023). Report of the Committee on Just Transition. Retrieved from https://www.niti.gov.in/sites/default/files/2023-02/Report_Just-Transition-Committee_compressed.pdf

³² <https://www.justtransition-jharkhand.in/about-us/>

³³ Government of India. (2022). The Energy Conservation (Amendment) Act, 2022.

³⁴ Vishwanathan, S.S., Bataille, C., Nogueira, E., Cunha, S., Rovere, E., Wrs, U., Patange, O., Garg, A., McCall, B., Trillo, H., Burton, J., and Gunfaus, M. (2025, Accepted). Power Sector Transformation in emerging economies. Climate Policy.

Figure 3. Growth of renewable energy in India

Source: Garg et al (2024).

NDC target of 50% of its installed electricity capacity from non-fossil sources five years ahead of its 2030 timeline. The renewable energy capacity increased from 76 GW in 2014 to 227 GW in 2025. **Figure 3** describes the growth in renewable energy capacity in India over the past decade. This renewable energy penetration was possible as India has implemented more than 230 national and sub-national policies, measures and programs over the past decade to accelerate the clean transition from renewable energy sources. These include the PLI scheme (financial) to boost domestic manufacturing of solar PV modules, Solar Park scheme with capacities of more than 500 MW to facilitate rapid deployment of solar power, Wind re-powering policy to replace less efficient wind turbines with newer, more efficient ones, Wind Solar hybrid policy, National offshore wind energy policy and several others. The key feature of development of solar park policy includes setting up of solar projects by project developers with suitable developed land with all clearances, transmission system, water access, road connectivity, communication network, etc. It also facilitates and accelerates the installation of grid-connected solar projects for large scale generation with financial assistance of up to 2 million INR per MW (~\$22555.00 at current exchange rate) or 30% of the project cost. Solar Parks are developed in collaboration with the state governments and their agencies, central

public sector undertakings, and private entrepreneurs. Approved solar parks (total capacity ~38 GW) across 12 states are at various stages of implementation in India as on June 2023.³⁵ Garg et al. (2024) emphasized the role of nuclear as an alternative to decarbonize India's power generation sector by the baseload power required to complement the intermittency of renewables and provide grid stability along with existing hydropower. Nuclear is also one of cost-effective sources of electricity and can compete with renewables in the medium to long-term horizon. The government has set a goal of expanding the nuclear capacity from 8 GW (2024) to 22.5 GW in 2032 and 100 GW in 2047 (PIB 2025).³⁶ The Union Budget introduced Nuclear Energy Mission to accelerate the deployment of small modular reactors (SMRs) to expand the nuclear role in the decarbonization of industries.³⁷

A successful renewable energy transition requires a multifaceted approach that goes beyond simply installing solar panels and wind turbines. Energy storage is important for large-scale deployment and grid integration of variable renewable energy sources like solar and wind. Although pumped hydro storage is the dominant technology for energy storage right now, Battery energy storage system (BESS) is catching up due to falling costs, suitable characteristics, and scalability of battery technologies.³⁷ Further, to promote the use of battery storage systems, the Government of India has put some initiatives in place. The Ministry of Power introduced Energy Storage Obligation in July 2022 as a regulatory mechanism for utilities and power distribution companies to gradually increase their energy storage capacity, rising from 1% in 2023-24 to 4% by 2029-30. The PLI scheme includes finances to promote domestic manufacturing of batteries. A policy to waive off

35 <https://mnre.gov.in/en/development-of-solar-parks-and-ultra-mega-solar-power-projects/>

36 Source: Press Information Bureau (PIB). (2025, August 7). Nuclear Power in Union Budget 2025-26. <https://www.pib.gov.in/PressNoteDetails.aspx?NotelId=153709&ModuleId=3#:~:text=The%20government%20has%20allocated%20%E2%82%B9,and%20operational%20SMRs%20by%202033.>

37 Garg, A., Singh, U., Patange, O., Jain, S. K., Maheshwari, J., Nag, T., Avashia, V., Vishwanathan, S. S., & Singh, A. K. (2023). *Financing needs for new age critical clean energy technologies: Battery energy storage (BES)*. Indian Institute of Management Ahmedabad.

inter-state transmission system charges has also been put in place to incentivize BESS projects in 2025.

The renewable energy ecosystem and BESS expansion need the underpinning of the availability and access of critical minerals. Over the past decade, the discourse on critical minerals has come to the forefront due to the push for clean-energy and high-tech goods manufacturing. Since India is dependent on imports, strategies to ensure resilient supply chains are being put in motion. In 2023, a committee from the Ministry of Mines identified 30 critical minerals essential for India's economic development and national security. Further, Mines and Minerals (Development and Regulation) Act Amendments (2023) de-listed six minerals, including lithium and beryllium, from the list of "atomic minerals," thereby allowing private sector participation in their exploration and mining. There has also been an emphasis on domestic exploration and resource augmentation. In 2024, National Critical Mineral Mission (NCMM) outlined the targets for domestic and foreign sourcing of minerals. Further, there have been customs duty cuts on mineral imports to encourage domestic processing.

With the increase in energy demand as India develops and the increasing share of renewable energy in the power sector, evacuation infrastructure and transmissions lines become critical. Over the past decade, India has expanded and strengthened its grid infrastructure. An inter-state Transmission system is also being put in place. The average technical and commercial losses at the national level have reduced from 23% to 16% in the past decade. This has been made possible through the policy support from initiatives like the Ujjwal DISCOM Yojana, Revamped Distribution Sector Scheme and Re-structured Accelerated Power Development and Reforms Programme. The target is to further reduce these losses to 10-12%.

Bioenergy is another element of India's energy transition story that the Government of India has been pushing since 2018 to move towards cleaner energy systems along with renewables and hydrogen. All forms of bioenergy are being

promoted - Solid biofuels (biomass) is burned for production of electricity and heat as co-firing thus replacing coal to a certain extent in India. Biogas generated from livestock waste, wastewater treatment, landfill gas capture and processing of industrial and municipal wastes now has a mandatory blending mandate with natural gas in a phased manner for natural gas supplied for transportation and domestic uses. Liquid biofuels - ethanol and biodiesel are under a blending mandate. ethanol blended petrol programme was launched in India in 2003. However, the big push for the programme came in 2018 through the National Biofuel Policy. The ethanol blending rates in petrol increased from 1.5% in 2014 to 20% in 2025. This was achieved 5 years ahead of initial target for 2030. The new aim is to reach E27 (27% blending of ethanol in petrol) by 2030. Going bullish on sugarcane based ethanol production has its limitations and socio-economic and environmental impacts. Thus, the government is pushing grain-based ethanol production capacity augmentation.

The role of green hydrogen is deemed indispensable for enabling the developmental and low-carbon transitions that India envisions. Thus, the Government of India has expressed its commitment to transitioning towards a clean hydrogen economy through the National Green Hydrogen Mission announced in January 2023. The mission aims to develop a green hydrogen production capacity of at least 5 MMT (Million Metric Tonne) per annum. The overarching objective of the Mission is to make India the Global Hub for production, usage and export of Green Hydrogen and its derivatives. One of the key tenets of the mission is the allocation of Rs 17,490 crore (~USD 1.98 Billion) under Strategic Interventions for Green Hydrogen Transition (SIGHT) programme, which will be distributed through a Production-Linked Incentive (PLI) scheme for manufacturing electrolyzers and production of green hydrogen³⁸. The Ministry of New & Renewable Energy has defined Green Hydrogen as having a well-to-gate emission (i.e., including water treatment, electrolysis, gas purification,

³⁸ <https://mnre.gov.in/en/national-green-hydrogen-mission/>

drying and compression of hydrogen) of not more than 2 kg CO₂e/kg H₂³⁹. India's Green Hydrogen Roadmap presents a clear vision for transitioning towards a hydrogen-powered economy through a combination of policy movement and business interests to accelerate the deployment of green hydrogen projects and drive innovation in the sector.

Transport Sector

Battery technologies are also vital in driving transitions in the transport sector. The shift to electric vehicles (EVs) is one of the critical elements of transport sector transition along with other policies such as promotion of alternative fuels like biofuels and green hydrogen. The government has set aggressive targets for EV adoption, aiming for EVs to make up 30% of private car sales, 70% of commercial vehicle sales, and 80% of two- and three-wheeler sales by 2030⁴⁰. Key policies to promote and incentivize the purchase of electric vehicles by offering financial subsidies include Faster Adoption and Manufacturing of Hybrid & Electric Vehicles (FAME) since 2015 i.e. FAME Phase I (2015), FAME Phase II (2019), PM E-DRIVE Scheme (FAME III in 2024). About 1.47 million electric two wheelers (e-2W), 0.18 million e-3W and 0.023 million e-4W have been sold under FAME (Phase I & II) policy with offered financial incentives of 68250 million INR as on 17th September 2025⁴¹. While EV sales are growing, particularly in the two- and three-wheeler segments (due to PM E-DRIVE scheme), challenges such as high upfront costs and a lack of charging infrastructure remain. Beyond the fuel, modal shift especially in freight and urban transport is a strategy that Government of India is promoting. India aims to increase the modal share of railways in freight transport from the current ~36% to 45% by 2030. PM Gati Shakti (power of speed) National Master Plan, National Logistics Policy Inland Waterways policies are some

initiatives undertaken to increase the share of railways and waterways in freight transport. One prominent infrastructure project that enabled the modal shift to railways is the Dedicated Freight Corridor (DFC). DFC, freight transport policy started in 2006, aims to develop the freight corridors to decongest already saturated road network and promote shifting of freight transport to more efficient rail transport and would save more than 450 Mt-CO₂ in first 30 years of operation. More than 96% of total length (2843 KMs) of DFC has been commissioned with about 93% of financial progress till date and remaining DFC length will be commissioned by December 2025^{42,43}.

Building Sector

Various energy efficiency policies and demand side management (DSM) measures have been initiated and implemented at national and sub-national level to decarbonize building sector in India. Some of these key policies/measures include energy efficiency labeling program called 'Standards & Labeling' program (regulatory program for about 34 end-use appliances since 2006), Building codes to improve energy efficiency in residential buildings (ECO Niwas Samhita 2018, updated in 2021 & 2024) and commercial buildings (Energy Conservation Building Code-2017 in new commercial buildings, Energy Conservation and Sustainable Building Code-2024 for commercial and office buildings), Star Rating of Commercial Buildings-2009 to benchmark the energy usage (kWh/sqm/year) for commercial building⁴⁴, 'Building Energy Efficiency Programme-2017' to reduce energy consumption and costs in public/commercial buildings through energy-efficient retrofitting of lights, AC, ceiling fans, and implementing smart energy management systems⁴⁵, promoting use of energy efficient LED lighting (lamps and tubelights) in building sector through 'Unnat Jyoti

³⁹ <https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1950421>

⁴⁰ <https://economictimes.indiatimes.com/industry/renewables/india-aims-for-30-percent-of-all-vehicle-sales-to-be-electric-by-2030-care-edge-ratings/articleshow/108746707.cms?from=mdr>

⁴¹ <https://fame2.heavyindustries.gov.in/dashboard.aspx>

⁴² <https://dfccil.com/Home/ProgressStatusImage>

⁴³ <https://dfccil.com/Home/DynemicPages?MenuId=3>

⁴⁴ <https://beeindia.gov.in/star-rating-for-buildings.php#en/programmes>

⁴⁵ <https://eesindia.org/en/building-energy/>

by Affordable LEDs to All' since 2015⁴⁶, 'Energy Efficient Fan Programme-2023' to promote the use of energy efficient fans, 'Street Lighting National Programme-2015' to improve public lighting infrastructure across India by replacing conventional streetlights with energy efficient LED streetlights⁴⁷.

Industry (Steel)

Industry is a hard to abate sector for India, however the major energy intensive sector like steel, cement, chemicals have been actively discussing sub sectoral measures with either a firm level goal to achieve net zero (SBTi 2025) and/or targets to assist with India achieve its Net Zero 2070 mission. The steel sector in India was driven by energy efficiency mandates since the Government of India had introduced the Perform, Achieve and Trade (PAT) scheme in 2012. However, over the past decade, it has moved to a more comprehensive approach towards climate action. Large steel sector players have committed to net-zero goals. In the annual sustainability disclosures, mandated by the market regulator, 6 large firms indicated a net-zero target independently or as a part of the Science Based Target initiative (SBYi). The union budget 2025 introduced the Green Steel Mission to decarbonize India's steel industry with the mission to make it competitive at the global level. It proposes integration with renewable energy policy, a green hydrogen mission, and mainstreaming the steel scrap industry to promote a circular economy. In December 2024, India came out with a Green Steel Taxonomy becoming the first country to define 'green steel' based on the carbon intensity of steel. The government and industry are exploring options in green hydrogen, carbon capture, utilization and storage (CCUS) and use of biochar.

Adaptation

India is preparing its National Adaptation Plan (NAP) to be submitted to the UNFCCC as outlined in the outcomes of the 1st Global Stocktake (GST) of the Paris Agreement. In December

2023, as a part of its Third National Communication, India submitted its Adaptation Communication to the UNFCCC, a key mechanism under the Paris Agreement that provides countries a platform to share their efforts, priorities, and needs related to adapting to climate change. The adaptation communication describes the adaptation efforts in critical sectors such as agriculture, water management, forestry, and disaster risk reduction. While India's LT-LEDS is focused on mitigation, it also integrates adaptation into its framework, particularly in urban development, with a focus on sustainable urbanization, energy, and material efficiency in buildings. Over the past decade, the adaptation strategies in India have also evolved. Instead of a single national plan, now there are more specific, local, and sector-focused approaches to build resilience in areas like farming, water, and urban development. Beyond the National Action Plan on Climate Change (NAPCC) launched in 2008, in the case of adaptation planning, the State Action Plans on Climate Change (SAPCCs) are also a critical contributor in tailoring national priorities to regional vulnerabilities and local contexts.

Urban Heat

Adaptation isn't just a top-down effort but bottom-up initiatives also influence the discourse. A good example is the Heat Action Plans (HAPs). It was originally a new local initiative by the Ahmedabad city, launched in 2013 after a devastating heatwave in 2010 that led to over 1,300 deaths. As the initiative started showing tangible success, it started getting adopted by other cities and states, serving as a blueprint and developed into a wide-spread, multi-level policy tool. It demonstrated to the national policy makers that long-term resilience requires integrating public health, urban planning, and climate science. Local HAPs influenced the National Disaster Management Authority (NDMA) to create a national framework for heatwave management. By adopting lessons from these local initiatives, the NDMA's guidelines now prioritize proactive, multi-sectoral strategies, showing how grassroots efforts can drive significant national policy changes. The

⁴⁶ <http://ujala.gov.in/documents/about-ujala.pdf>

⁴⁷ <https://eeslindia.org/en/ourslnp/>

HAPs are also an example of evolving adaptation-related governance in India. This has been instrumental in shifting the national discourse from a reactive, disaster-centric approach to one of proactive climate adaptation.

Agriculture Sector

India has been promoting sustainable agriculture practices for sustainable transition in agriculture sector via National Mission on Sustainable Agriculture (NMSA) in 2010 through various adaptation measures focusing on Improved crop seeds, livestock and fish cultures, water use efficiency, pest management, improved farm practices, soil and nutrient management, agricultural insurance, credit support, markets, access to information and livelihood diversification, etc. NMSA also targets to promoting location specific improved agronomic practices through soil health management, enhanced water use efficiency, wise use of chemicals, crop diversification, progressive adoption of crop-livestock farming systems and integrated approaches like crop-sericulture, agro-forestry, fish farming, etc⁴⁸. Other key policies/measures in agriculture sector include National Policy on Agriculture 2000, National Project on Organic Farming 2010, National Project on Management of Soil Health & Fertility 2007, Neem Coated Urea application 2004 (higher use efficiency and lower loss of nitrogen due to inhibition of nitrification process in soil), Crop Diversification Programme 2014, Direct Seeded Rice 2014 (Water conservation, reduction in production costs and emissions), etc.

Climate finance

Climate Policy Initiative (CPI) has been tracking the green financial flows. Their “Landscape of Green Finance in India 2024” report states that mitigation finance flow in India reached a total of USD 57.3 billion in 2021/22 from USD 15 billion in 2016/17, growing at a rate of 20% between 2019/21 and 2021/22 despite of COVID-19 impacts⁴⁹. Around 34% came from

public sources in 2019/21 as compared to 29% in 2017/18. The adaptation-related financial flows have also increased by almost 3 times between 2019/20 and 2021/22. 98% of the USD 14.7 billion (total finance flow) for adaptation in 2021/22 came for state and central government budgets. These trends show that there has been progress in India on the climate finance aspects in past decade and steps have been taken to strengthen the climate finance framework.

A large share of India's climate finance flows is publicly funded. The Union budget 2023–24 allocated almost USD 4.2 billion for the energy transition and steps toward Net Zero emissions by 2070. The governments have introduced several policies specifically in energy and transport sectors to push a transition towards low-carbon future. A portfolio of policies for renewable energy push include the budgetary allocations on the National Solar Mission and its schemes and programmes like the PM Surya Ghar- Muft Bijli Yojana -2024 (residential solar roof-top scheme to light up 10 million households), Grid Connected Rooftop Solar Programme, PM-KU-SUM Scheme-2019 (solar agricultural pump-sets and grid-connected solar power plants for farmers), and Development of Solar Parks (40 GW by 2026) and Ultra Mega Solar Power Projects-2014. National Biofuels policy and waste to energy programmes also contribute towards the transition away from fossil fuels. National Green Hydrogen Mission has also come into play. In its 2025-26 budget, the Government of India has also made financial allocations to the nuclear energy development⁵⁰.

National Clean Energy and Environment Fund (NCEEF) replaced the National Clean Energy Fund (NCEF) that was established using a cess on coal to finance and advance clean energy initiatives, support research in clean energy. The change aligned the fund with India's larger environmental aspirations (like waste management and river cleaning) beyond just energy and is serving as an extra-budgetary resource for environmental and clean energy initiatives. The National Adaptation Fund for Climate Change

⁴⁸ <https://nmsa.dac.gov.in/>

⁴⁹ CPI, 2024. “Landscape of Green Finance in India 2024”. Available at <https://www.climatepolicyinitiative.org/publication/landscape-of-green-finance-in-india-2024/>

⁵⁰ <https://www.indiabudget.gov.in/doc/bh1.pdf>

(NAFCC) in India, was established in 2015 to provide financial assistance to states and union territories vulnerable to climate change's adverse effects. There have also been efforts on piloting Climate Budget Tagging (CBT) initiatives at state level (e.g. Orisa, Meghalaya) and city level (e.g. Mumbai, Indore) for tracking the investments going towards climate change mitigation and adaptation. This indicates the increasing awareness and integration and mainstreaming of climate finance and governance across various tiers (center, state, local). However, there is no formal national-level framework yet. Putting in a finalized climate finance taxonomy will provide a standardized system to define and classify green activities, which will be a significant step toward a formal national climate budget tagging system. For stimulating the wind energy sector, a viability gap funding scheme was introduced to develop offshore wind projects in Tamil Nadu and Gujarat. Investments have also been budgeted for setting up infrastructure for e.g. Green Energy Corridor Scheme, Ultra Mega Renewable Energy Parks, Waiver of Inter State Transmission System charges, Viability Gap funding for battery energy storage systems (BESS), and PLI scheme for manufacturing of solar PV and batteries.

Even with significant domestic public funding, private investment is crucial for climate action given the financial requirements. For attracting private investments, the climate finance should align with the way financial markets operate. Since private investors tend to avoid risk, they seek higher returns to compensate for any added risk they take on. When a project involves multiple risks, investors expect even greater returns, and the mere uncertainty around those risks can deter investment altogether. Hence, the Government of India has taken steps to instill confidence of private investors. The efforts have been in place for developing a market for Green bonds, and the Reserve Bank of India (RBI) has created a framework for the same. Several public and private entities like State Bank of India, National Thermal Power Corporation, and REC) have been actively issuing green bonds since 2016. With Ministry of

Finance, the MoEFCC has worked on initiatives such as the issuance of Sovereign Green Bonds. The RBI issued a sovereign green bond worth almost USD 2 billion in 2023 earmarked for clean energy, transport and sustainable agriculture. This helps expand and strengthen India's green bond market, drawing in more private companies and investors. India is also actively pushing blended finance models. They use public or concessional capital—like grants, low-cost loans, first-loss capital, or guarantees—to make projects less risky. This strategy is designed to attract a much larger pool of private investment.

Further India is preparing to put a carbon market in place through the carbon credit trading scheme (CCTS), the framework for which is evolving.

India has been progressively strengthening its sustainability disclosure ecosystem. Transparency is a critical element in preventing greenwashing and attracting private investors. In 2021-22, India's market regulator, Securities Exchange Board of India (SEBI), launched the Business Responsibility and Sustainability Report (BRSR), a disclosure framework mandatory for top 1000 listed companies. The RBI issued a "Disclosure framework on climate-related financial risks, 2024," which emphasized on climate risk assessments, green lending frameworks, and potential stress testing for banks. It is aligned with similar international frameworks like the EU CSRD, the US SEC's climate disclosure rules, the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD), and IFRS S2 (Climate-related Disclosures), thereby enhancing the competitiveness and resilience of India's financial sector⁵¹. In 2025, India introduced a draft Climate Finance Taxonomy to guide and standardize green investment, prevent greenwashing and align capital flows with national goals. The taxonomy supports mitigation, adaptation and transitions of hard-to-abate sectors.

⁵¹ Advancing ESG: India's New Disclosure Frameworks by RBI and SEBI, accessed on May 22, 2025, https://www.nishithdesai.com/fileadmin/user_upload/Html/Hotline/Yes_Governance_Matters_June0424-M.html

STILL A LONG ROAD AHEAD

Energy Transitions

Power Sector

Coal transitions is and will remain one of the toughest policy measures to be implemented in India. This is because coal remains the cheapest, most convenient domestic source of energy that provides energy security at affordable prices and accessible to all at 24X7. It is most difficult where the revenue generation at subnational and local level cross-subsidies development policies. Without diversification of economy, reskilling policies, safety net for livelihoods, it will be really tough for states to transform to newer systems. Energy transitions in India would need to prioritize equity and justice in its role as a major Global South economy. Energy transitions require a large amount of financing. Coal sector contributes over USD 7.94 billion annually to the central and state governments through royalties, GST, and other levies. Additionally, it contributes to the District Mineral Fund, National Mineral Exploration Trust, and GST. The revenue generated bolsters government finances, supporting socio-economic and infrastructure development initiatives. Energy transitions will affect the fiscal and economic losses (revenue from mining and power sector). Furthermore, it will induce loss of employment (direct and indirect), and socio-economic loss in communities. Each state's ability to diversify its economy, power mix through understanding its resource availability in addition to state government's governance capacity and the management of the state finances will play a crucial role. Energy systems mitigation with CO₂ capture, utilization and storage (CCUS) will be increasingly important over the next three decades as unabated fossil fuel use would look incompatible with global 1.5/2°C targets of the Paris accord. CCUS is expected to be a key part of the future clean energy investments globally in scenarios where the end-of-century temperature rise is limited to 1.5°C. If India continues to rely on coal, it will be essential to invest in CCUS infrastructure and technology. Currently, only

the enhanced Oil Recovery and urea production are the most feasible CO₂ Removal technology used in India. Along with green hydrogen, CCUS (use for blue hydrogen and otherwise), would be particularly significant for decarbonizing hard-to-abate sectors in India.

Significant progress has been made in battery energy storage, but few barriers still prevent it from fully supporting the energy transition. One is the technological uncertainty since many battery technologies are still in the development stage, and their scalability for commercial use poses a significant risk for project developers. This can lead to uncertainties in the cost of energy storage and, consequently, the cost of electricity. The second is high short-term capital costs, despite the falling costs of Li-ion batteries over the past decade. High financing costs and need for low-cost financing options are a challenge. Availability of efficient grid infrastructure is another challenge. All these converge to the commercial viability challenge – add on to this are the delays in the purchase agreements. The Central Electricity Regulatory Commission (CERC) cancelled a major Solar Energy Corporation of India (SECI) BESS tender in January 2025 due to significant delays in signing project agreements.

As indicated earlier, critical minerals and their availability have a huge bearing on the growth of BESS. There is substantial reliance on minerals like Lithium, Cobalt, Nickel, and Manganese, and their limited availability and concentration in a few geographic locations pose an energy security risk. To reduce its dependence on the import of critical minerals, India needs to invest in developing renewable and battery technologies that are based on domestically available mineral resources. Further, new research investments are coming into developing alternative technologies. Because of sodium's abundance and cost-effectiveness, sodium-ion batteries have great potential to be a counterpart to lithium-ion batteries, both for stationary energy storage and EVs.

Refurbishing, recycling, and mineral recovery will play a vital role in meeting future mineral demands and limiting import dependencies and therefore as a country India needs to prioritize

investing in such new technologies and processes. India would also need to propel ahead in not just research and development of the recycling and mineral recovery technologies but also promoting it at commercial scale and putting in place appropriate regulations to drive this market.

On the bioenergy and ethanol blending front, India needs a longer term vision on what comes after the 20% target. The implementation of E27 target needs to be strategically designed. The scenario options could be many and varied specially in reference to India's Net zero 2070 commitment. One of the options is to allow higher blending rates in states that produce higher quantities of ethanol – thus reducing ethanol transportation needs and related emissions. Also, transportation and inter-state movement of ethanol needs to be eased in order to achieve uniform blending rates across the country. Again, an increased blending mandate would require switch in the automobile technology (upgrading certain vehicle parts) and bringing in flex-fuel vehicles. Investing in 2nd generation ethanol is another way forward. There are possibilities of crop waste-based ethanol production from locally grown crops and from plantations such as bamboo. Recently, Indian Oil Corporation operationalized a 2G ethanol plant at its Panipat refinery that would utilize agricultural waste. On the green hydrogen front also costs are a concern. The current cost of green hydrogen is in the range of \$5-6 per kg of which 20-25% can be attributed to the cost of electrolyzers. Similar to the BESS situation, the capital costs for green hydrogen facilities are high. Storage and transport infrastructure and their costs also pose significant hurdles. India needs to establish a market for green hydrogen through strong demand, supportive policies, and infrastructure development to drive down costs and ensure commercial viability.

While essential for a low-carbon energy, nuclear power's expansion in India also faces challenges. Large-scale nuclear projects are capital-intensive and even with private sector involvement, securing long-term, low-cost financing remains a significant challenge. Small Modular Reactors

(SMRs) are relatively new technology hence, research, development, and commercial-scale deployment will require substantial time and resources. There are also concerns of long-term fuel security due to reliance on imported uranium. These are compounded by the legislative challenge of amending the Atomic Energy Act and the Civil Liability for Nuclear Damage Act.

Adaptation policy

Beyond the financial gap related challenges that have been discussed in section 4.3, there have been impediments on the governance and socio-technical fronts that hampers progress in adaptation planning, policy and implementation. Adaptation is a cross-cutting issue that requires coordination across multiple government departments and ministries, from agriculture and water to health and urban development. Efficient communication and alignment of initiatives is required for adequate and effective adaptation. A large share of adaptation happens at the local level. The road ahead requires focusing on building the capacity of local officials to utilize funds effectively and avoid implementation lags.

Climate Finance

Several nations including India have either established a green taxonomy or are in the process of doing so. However, a global alignment of these taxonomies is essential to reduce information asymmetry and transaction costs for international investors. A common ground globally accepted green taxonomy would indeed significantly ease financial flows towards sustainable activities. To prevent greenwashing, this taxonomy must be paired with transparent reporting. In 2021, SEBI mandated that the top 1000 Indian listed companies submit Business Responsibility and Sustainability Reports (BRSR). Several global disclosure frameworks make the landscape complex. Linking these disclosures to the taxonomy could simplify reporting for green projects. This would not only benefit large firms but also help MSMEs access climate finance by making compliance easier while ensuring transparency.

India is shifting its disaster management from a reactive, relief-focused approach to a proactive, mitigation-centric strategy. This is evidenced by increased budgetary allocations for the National Disaster Mitigation Fund and improved early warning systems. Despite this progress, a significant gap exists between policy and implementation. A major issue is the underutilization of allocated funds, which compromises the effectiveness of these initiatives. There has also been a reduction in the funds available under the National Adaptation Fund for Climate Change (NAFCC) between 2017-18 and 2022-23. Furthermore, broader climate adaptation and resilience-building efforts continue to face a financial deficit.

CLIMATE GOVERNANCE

National

The Ministry of Environment and Forest was officially re-christened to Environment, Forest and Climate Change in 2014, expanding its scope and mandate. It has played critical role in initiatives like the International Solar Alliance and the Global Biofuels Alliance. The MoEFCC is a key member of several inter-ministerial committees that address climate-related issues. It works with the Ministry of Power, the Ministry of New and Renewable Energy, and the Ministry of Heavy Industries to ensure that environmental goals are integrated into industrial and energy policies including co-chairing the National Steering Committee for the Indian Carbon Market alongside the Ministry of Power.

In the past, the NDCs have been prepared by an expert committee that developed the document. However, for the LT-LEDS, Ministries that govern the resources, electricity, industry, transport, urban, agriculture, forestry and land use sectors have been brought together under seven taskforces to develop the document. The taskforce led by MoEFCC composed of members from the NITI Aayog, Ministries of Power, Finance, New and Renewable Energy, Coal, and Heavy Industries as well as research support from civil society organizations and academia. The document

development underwent consultations with state governments, think tanks, research organizations, civil society and private sector representatives. This institutional set-up ensures policy coherence across ministries and organizations. Each of the ministries in India is working towards transforming the systems not only national level but also the institutional processes as well. The inter-ministerial task force also drew on a review of various quantitative and analytical studies from different institutions, synthesizing a range of modeling outputs to build a cohesive national strategy. This indicates the expanding technical capacity in India especially in reference to climate modeling. The establishment of the India Climate and Energy Modelling Forum (ICEMF), launched by NITI Aayog, and development of the India Energy Security Scenarios (IESS) 2047 tool, by NITI Aayog, for policy-focused scenario assessments are some examples of the same.

As a consequence of India's strong commitment, the governments at national and now at state level have championed the cause leading to multiple inter-ministerial and/or committees with ministries and representatives from private firms and academia to discuss and develop relevant climate policies at national, sectoral and subnational levels.

Climate Finance

The Government of India has also put in active efforts to create institutional mechanisms that support in mobilizing climate finance through specialized public financial institutions like the Indian Renewable Energy Development Agency (IREDA), Power Finance Corporation (PFC), Rural Electrification Corporation (REC) and National Bank for Agriculture and Rural Development (NABARD) to channelized funds for renewable and clean energy as well as rural infrastructure development. India Infrastructure Finance Company Ltd (IIFCL) is a Government of India owned company, established in 2006 has expanded into green and sustainable projects. The National Investment and Infrastructure Fund (NIIF) was established in 2015 as India's first sovereign-anchored investment fund, to augment

and channelize capital for the infrastructure and related sectors including renewable energy. GIFT City (Gujarat International Finance Tec-City) hosts the International Financial Services Centre (IFSC) and the International Financial Services Centres Authority (IFSCA) – a unified regulatory body to attract foreign capital and sustainable/green finance. The IFSCA is actively looking into making it a Re-insurance hub, hosting alternative investment funds (AIFs) for pooled investments, supporting the India International Bullion Exchange (IIBX), and initiatives to strengthen access to sustainable finance.

ily concessional loans with low-cost financing. Insurance and re-insurance sectors have to be involved through MDBs. The G20 2023 endorsed a "Roadmap towards Better, Bigger, and More Effective MDBs" outlining concrete recommendations for enhancing their capacity and impact. This roadmap is a result of collaborative work between G20 members and MDBs themselves.

INTERNATIONAL COOPERATION

Institutions

India has played a significant role in establishing the International Solar Alliance (ISA) in 2015. It aims to mobilize USD 1 trillion in solar investments globally by 2030. Coalition for Disaster Resilient Infrastructure (CDRI) was launched by India, CDRI aims to promote resilience of new and existing infrastructure systems to climate and disaster risks, involving collaboration on knowledge sharing, capacity building, and financing for resilient infrastructure.

Climate Finance

In order to continue the momentum of efforts being put in ensuring smooth financial flows for climate change mitigation and adaptation, international cooperation is paramount. Beyond the national efforts on streamlining climate finance and its easy access, India played a crucial role during its G20 Presidency in 2023 to call to attention the need for transfer of climate finance and also low-cost climate finance by developed countries and multilateral development banks (MDBs) for implementation of climate actions by the developing countries⁵². MDBs have a significant role to play in climate finance since loan is the key instrument second only to grants. Hence, MBDs need to provide grants and heav-

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⁵² G20 (2023) 2023 Sustainable Finance Report 1 under Indian G20 Presidency. New Delhi: Sustainable Finance Working Group (SFWG), G20

A decade of national climate action: Stocktake and the Road Ahead

INDONESIA LESSONS LEARNT AND CHALLENGES FOR IMPLEMENTATION OF THE PARIS AGREEMENT

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INTRODUCTION

The Paris Agreement, adopted at COP21 in 2015, established a global framework to limit temperature rise to well below 2°C, with efforts to pursue 1.5°C, primarily through nationally determined contributions (NDCs) and long-term strategies. Indonesia ratified the Agreement in 2016 via Law No. 16/2016, committing to significant emission reduction targets and integrating climate action into its national development agenda (BPK-RI, 2016). Indonesia's NDCs have been periodically updated, with the Enhanced NDC (ENDC) raising targets to 31.89% unconditionally and 43.20% with international support by 2030 (Gol, 2022).

Indonesia's long-term strategy, including the LTS-LCCR 2050, outlines a pathway toward a low-carbon, climate-resilient economy, targeting net zero emissions by 2060 or earlier. Central to this strategy are the FOLU Net Sink 2030, energy transition, and sustainable land-use reforms, aiming to peak emissions around 2030 (Gol, 2021). These measures reflect Indonesia's efforts to balance economic growth with environmental sustainability, while leveraging international partnerships for finance, technology, and capacity support.

Over the past decade, Indonesia has made notable progress in policy development, regulatory frameworks, and the establishment of financial mechanisms, such as sustainable finance initiatives and carbon trading platforms (Made et al., 2024; Nusantara & Rahadi, 2024). The implementation of Carbon Economic Value (NEK) policies and the introduction of a carbon tax are key steps toward incentivizing emission reductions and supporting sustainable development (Made et al., 2024; Fajarianti & Novitasari, 2025). However, challenges persist, including heavy reliance on fossil fuels, infrastructure gaps, weak regulatory enforcement, and the tension between development needs and climate ambition (Yonathan et al., 2024; Syabriyana, 2024; Suroso et al., 2022). This report aims to provide an assessment of Indonesia's progress in implementing its Paris Agreement commitments. It will analyze the effectiveness of existing policies, highlight lessons learned, and identify key obstacles hindering the full realization of climate goals. Furthermore, the report will offer recommendations and outline next steps to enhance Indonesia's capacity to meet its commitments and contribute meaningfully to global climate efforts.

INDONESIA'S EMISSION TRENDS SINCE 2005

In 2005, Indonesia's total national emissions reached 1,307,115 kt CO₂e, with the largest share coming from LULUCF (54%), followed by energy

(29%), agriculture (8%), waste (5%), and IPPU (3%). By 2022, total emissions had increased slightly—by around 0.19% compared to 2005—yet the energy sector had overtaken LULUCF as the largest contributor (**Table 1**). The emission trajectory from 2005 to 2022 shows significant growth in the energy, IPPU, and waste sectors, driven by economic and population growth, as well as changes in lifestyle and consumption patterns (e.g., food, energy use, and transport demand; **Figure 1**). Emissions in these sectors grew annually by 3.39%, 4.03%, and 4.01%, respectively.

Indonesia's emission trajectory from roughly 2005 until now shown there are significant growth in GHG emissions in energy sector, which is as the consequence of economic and population growth, change of lifestyle and behavior on consumption patterns (energy demand, transport demand, etc.). The significant increase of emissions in the energy sector is also caused by a shift of energy type, i.e. natural gas to coal in power and energy intensive industries due to the shortage of natural gas supply while massive shift to renewable energy is still constraint by the high capital cost. The type of energy technology in industry is usually bound by processing technology so that it is not easy to shift the energy to low carbon one. In addition, economic growth drives higher demand for transport, in which public transport is still limited and used fossil fuels.

Emissions from the agriculture sector grew at a much lower rate compared to energy, IPPU, and waste. In contrast, LULUCF emissions showed

Table 1. The sectoral greenhouse gases emission and growth

	Emission		Average Annual Emission (2005-2022)	Annual Growth (2005-2022)
	2005	2022	ktCO ₂ e	%
Energy	377,183	738,753	529,142	3.39%
IPPU	39,017	57,362	44,419	4.03%
Agriculture	110,132	135,566	118,798	1.25%
LULUCF	709,681	312,312	755,345	-2.97%
Waste	71,103	138,862	100,820	4.01%
Total	1,307,115	1,382,855	1,548,525	0.19%

Source: Gol (2024)

a significant overall decline, though with high interannual variability largely driven by forest and peat fires (**Figure 1**). Substantial emission spikes occurred during drought years associated with El Niño—particularly in 2006, 2009, 2015, and 2019. However, the increase in 2019 was considerably lower than in earlier El Niño years, reflecting the effectiveness of fire management measures and law enforcement. Additional efforts, including social forestry, ecosystem restoration and forest moratorium policies, have also contributed to curbing emissions in this sector.

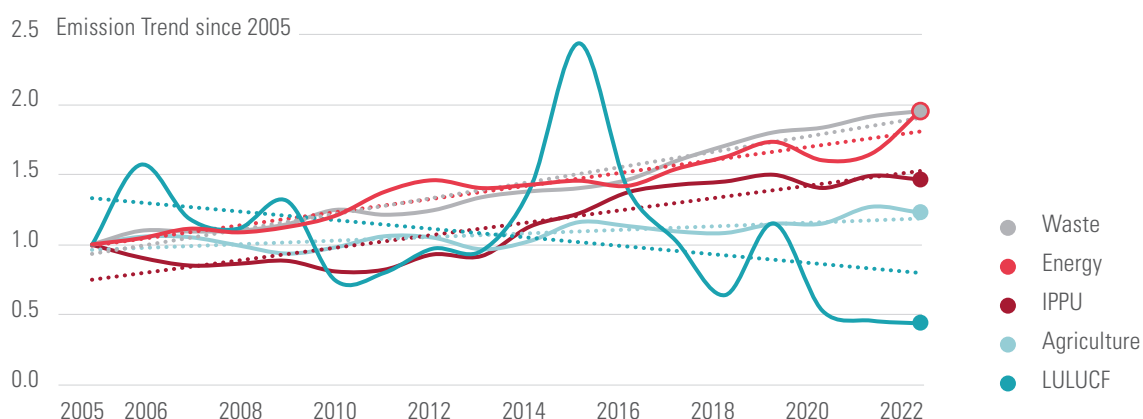
In the energy sector, intermediate indicators have not shown the reduction of emissions instead the emissions still increased due to low contribution of RE in the energy supply mix and increase in fossil fuels, particularly coal use in power plants and industries. The projection of emissions indicates that the emissions level will keep increase because the current planning in energy development, particularly power and industry sectors, still cannot significantly push the share of renewable in energy supply mix. However, the energy policy aims to provide directive to increase the share of low and zero carbon emitting energy and technology. The expected effects of the policy will appear after 2035, the GHG emissions peak is in 2035 and decline after this year because significant investments in renewable energy begins to increase.

INDONESIA'S LONG TERM PERSPECTIVE ON CLIMATE

Indonesia's Long-Term Strategy for Low Carbon and Climate Resilience 2050 (LTS-LCCR 2050) is a cornerstone policy document articulating the nation's vision for a low-carbon, climate-resilient future, in line with its Paris Agreement commitments and the pursuit of net-zero emissions by 2060 or earlier. The strategy is designed to ensure coherence between long-term climate goals and national development priorities, integrating the Nationally Determined Contribution (NDC), National Medium-Term Development Plan (RPJMN), and Long-Term Development Plan (RPJPN) (GoI, 2021; Maharani et al., 2024; Ershov, 2024).

The LTS-LCCR operationalizes Indonesia's climate ambitions by aligning sectoral policies and NDC roadmaps with broader development plans. This integration is essential for translating high-level targets into actionable programs, facilitating coordinated implementation and resource mobilization across national and sub-national levels (Maharani et al., 2024). The strategy anticipates ongoing policy adjustments to maintain alignment between immediate actions and long-term objectives, ensuring that early investments and reforms are consistent with the overarching vision. The LTS-LCCR uses detailed modeling and scenario development to ensure sector targets

Figure 1. Sectoral emission trend from 2005-2022



Source: GoI, 2024

are consistent with overarching climate goals, economic growth, and sustainability considerations [Gol, 2021]. Cross-sectoral coordination mechanisms are established to resolve competing land uses, avoid negative side effects (e.g., food security impacts from biofuel use), and optimize co-benefits (Maharani et al., 2024; Sambodo et al., 2022; Tarigan, 2025). The LTS promotes continuous monitoring, capacity building, and policy evaluation to adapt pathways while maintaining alignment with the Paris Agreement and Indonesia's development aspirations.

Key pillars of the LTS-LCCR include the Forestry and Other Land Use (FOLU) net sink target and a comprehensive energy transition. The FOLU sector is expected to deliver significant emissions reductions. In the energy sector, the strategy emphasizes a shift from fossil fuels to renewables, particularly solar PV. However, the continued reliance on coal and the need for technological, financial, and regulatory reforms present persistent challenges (Ershov, 2024; Maharani et al., 2024; Sambodo et al., 2022; Zahari & Mclellan, 2024).

The FOLU net sink target and the energy transition are both recognized and modeled within Indonesia's long-term climate strategy (LTS-LCCR 2050), contributing to emissions pathways aimed at achieving net zero emissions by 2060 or sooner (Gol, 2021). Despite robust modeling and participatory planning, the translation of the LTS-LCCR into consistent sectoral policies faces barriers such as financial constraints, regulatory uncertainty, and governance fragmentation. Effective implementation requires strong policy frameworks, innovative financing, and enhanced collaboration between central and local governments (Rakatama et al., 2023; Sambodo et al., 2022). Governance and technological barriers are particularly significant, underscoring the need for capacity building, stakeholder engagement, and adaptive policy evaluation (Sambodo et al., 2022).

Overall, the long-term strategy acts as a guiding framework integrating medium-/short-term policies, ensuring sectoral commitments in FOLU and energy transition contribute coherently to Indonesia's climate and development objectives through 2050.

CLIMATE GOVERNANCE IN INDONESIA

The Ministry of Environment and Forestry (MoEF)¹ plays a central role in Indonesia's climate governance as the National Focal Point for climate change and leads the formulation and implementation of national climate policies. MoEF coordinates the development of the Nationally Determined Contributions (NDCs) and the Long-Term Strategy for Low Carbon and Climate Resilience (LTS-LCCR), while also managing platforms for knowledge sharing and adaptation planning. Its leadership is complemented by strong inter-ministerial coordination to ensure that climate actions are embedded across development priorities and sectoral strategies.

Bappenas (National Development Planning Agency) has a pivotal role in mainstreaming climate change into national development planning frameworks. It ensures that climate policies are fully integrated into the National Medium-Term Development Plan (RPJMN) and cascaded into Regional Medium-Term Development Plans (RPJMD). Bappenas also steers the integration of mitigation and adaptation policies with economic, social, and infrastructure planning, thereby aligning Indonesia's climate commitments with long-term development objectives. This role makes Bappenas a key bridge between MoEF's climate policy leadership and broader economic and sectoral planning.

Sectoral ministries—including those responsible for agriculture, forestry, finance, industry, trade, energy, transport, public works and housing, and home affairs—are tasked with operationalizing climate policies within their respective domains. Their responsibilities include: Designing and implementing sector-specific emission reduction and adaptation programs; Ensuring consistency between sectoral strategies and Indonesia's overall NDC and LTS commitments; Coordinating infrastructure development, energy demand management, and land-use

¹ In the new government the MoEF has been separated to Ministry of Environment (MoE) and Ministry of Forestry (MoFor), whereas the MoE acts as the National Focal Point for Climate Change.

planning to avoid trade-offs and maladaptation; Working with local governments to cascade national targets into provincial and district-level climate action plans.

Cross-sectoral coordination is facilitated through inter-ministerial mechanisms and national coordination forums (e.g. Change Steering Committee under MoEF, Bappenas-led Forums on Low Carbon and Climate Resilience, National FOLU Net Sink 2030 Task Force, National Energy Council (DEN), National Action Plan for GHG Reduction & National Action Plan for Climate Change Adaptation, Inter-Ministerial Committees on Climate Finance and Carbon Market Mechanisms), which seek to harmonize sectoral initiatives, promote knowledge management, and align investment priorities. These platforms emphasize the need to avoid maladaptation, ensuring that progress in one sector does not inadvertently undermine resilience or emission goals in another. Policy frameworks such as the Strategic Environmental Assessment (KLHS), the Regional Environmental Protection and Management Plan (RPPLH), and regional climate change action plans provide both vertical (national–regional–local) and horizontal (cross-sector) coherence. These frameworks support the iterative updating of the NDCs and the LTS, allowing climate policy to adapt to new scientific knowledge and stakeholder feedback. Stakeholder engagement is institutionalized through consultations with civil society, academia, the private sector, and local communities. While these mechanisms enhance transparency and inclusiveness, challenges remain—particularly the underrepresentation of vulnerable groups and limited influence of civil society in decision-making. Powerful vested interests, and the absence of a formal just transition framework highlights gaps in inclusive and equitable climate governance.

Science and modeling play a critical role in underpinning Indonesia's climate strategies. Advanced analyses provide emission projections, land-use and energy scenarios, and risk assessments that inform evidence-based policy-making. These tools are essential for identifying

cost-effective pathways toward low-carbon and climate-resilient development. However, their influence on actual target-setting and political decision-making has been partial, with evidence sometimes subordinated to economic or political interests. Strengthening the use of science in decision-making is crucial for aligning Indonesia's policies with the Paris Agreement.

INDONESIA'S INTEGRATED CLIMATE CHANGE MITIGATION POLICIES: PROGRESS, STRATEGIES, AND INSTITUTIONAL INNOVATIONS

Indonesia adopts a comprehensive approach to climate change mitigation, integrating policies across land use, energy transition, carbon pricing, and sustainable finance. These measures are designed to reduce emissions while supporting sustainable development, underscoring the country's commitment to a low-carbon and climate-resilient future (Muhammad et al., 2025; Brata & Toparakkasi, 2023; Djalante et al., 2021; Yamin et al., 2024).

A cornerstone of this approach is the FOLU Net Sink 2030 strategy, which prioritizes reforestation, peatland restoration, and mangrove conservation (MoEF, 2022). By curbing deforestation, restoring degraded peatlands, and protecting mangrove ecosystems, Indonesia leverages the critical role of these landscapes as carbon sinks. Safeguarding peatlands and mangroves not only reduce emissions but also enhances biodiversity and strengthens ecosystem resilience (Basuki et al., 2022). Indonesia has made notable progress in reducing deforestation and peatland degradation efforts. Despite some fluctuations due to economic and development pressures, overall trends show a decline in deforestation rates attributed to strengthened policies, community engagement, and restoration initiatives, including peatland and mangrove ecosystem conservation (MoEF, 2024; Wongkar, 2021). These efforts support Indonesia's goal to enhance natural carbon

sinks and sustain its emission reduction targets. Lately, after LTS LCCR has been submitted to UNFCCC in 2021 there are many positive climate change mitigations endeavor that lead to many important decisions in energy plans and policies. The energy sector, Indonesia's largest source of emissions, is undergoing significant reform. Through updated the National Energy Policy (KEN) and Power Generation Plan (RUKN) in 2024, the government has set ambitious renewable energy targets, aiming to expand solar, wind, hydro, and geothermal utilization as part of Indonesia's Energy Transition. In both KEN and RUKN, instead of planning for early retirement of coal power plant the GoI aims to increase the share of renewable energy, which eventually reduces the use of coal and other fossils. Complementary policies that address challenges such as intermittency (via battery storage systems or BESS), high investment costs, and stranded fossil fuel assets are needed.

The complimentary policies include encouragement of investment in battery industries, which are integrated with critical minerals processing to supply raw materials. These policies align with the government macro policy on the development of downstream industries to increase value added to these mineral resources for achieving high economic growth in the short term. Currently, to deal with high investment costs, the development of renewable energy can use domestic capital sources available from Sovereign Wealth Fund (DANANTARA) and international funds or partners. DANANTARA is established by the GoI to finance high capital investment, including investment for energy infrastructure. Concerning the stranded fossil fuel assets issues, complementary policies include significant increase of renewables that eventually will avoid the need to do coal early retirement.

Super grid development is needed to enable access to dispersedly located renewable resources and enhance system reliability, while micro grid is also needed for rural and remote areas. To attract investment, GoI has intro-

duced feed-in tariffs (FiTs), power purchase agreements or PPAs (Yudha & Tjahjono, 2019 and Erdiwansyah et al., 2020), fiscal incentives (Yoo & Ha, 2024), simplification of renewable development permits, and gradual fossil fuel subsidy reforms. Additional measures include biomass co-firing in power generation plants and industry—while ensuring feedstock comes from agricultural and plantation waste rather than deforestation (Muhammad et al., 2025; Yamin et al., 2024), and continued development of biofuels for transport. Efforts to enhance energy efficiency are advancing across industry, buildings, and transport, through an integrated mix of regulations, fiscal incentives, and technological innovation. Green Industry standards and Green Building Codes promote low-carbon manufacturing, construction, and urban development. While the transport sector combines disincentives for private vehicle use such as congestion charging (Shiddiqi et al., 2024; Wicaksono et al., 2025), higher parking fees (Shiddiqi et al., 2024; Arifianto et al., 2024), fuel and vehicle taxes (Shiddiqi et al., 2024; Barus, 2022), and traffic management measures such as Odd-Even License Plate Policy (Arifianto et al., 2024) with major investments in mass transit systems and commuter rail, supported by integrated ticketing to promote sustainability mobility (Pujiati et al., 2022; Ardi et al., 2024; Syafruddin, 2025). These efforts are complemented by the growing role of domestic and international Energy Service Companies (ESCOs) in financing and delivering efficiency projects (Brata & Toparakkasi, 2023; Djalante et al., 2021), alongside policies to accelerate decarbonization technologies such as electric vehicles and hydrogen, with incentives like preferential EV parking and a strong emphasis on expanding renewable-based electricity to ensure genuine emissions reductions. To accelerate market-based solutions, Presidential Regulation No. 98/2021 established a legal framework for carbon pricing, covering both emissions trading and offsets. This was followed by OJK Regulation No.14/2023, which set operational guidelines and confirmed OJK's

supervisory role². Building on this foundation, the Indonesia Carbon Exchange (IDXCarbon) was launched in September 2023 as the official platform for carbon transactions. In its first year, IDXCarbon recorded more than 1.6 million tons of CO₂-equivalent traded, valued at IDR 78.4 billion, involving 129 entities across eight projects—a promising start for Indonesia's carbon market (Muhammad et al., 2025; Djalante et al., 2021).

Strengthening climate finance systems is also a priority. Climate budget tagging helps track expenditures and align them with national priorities, while fiscal policies—such as taxes, incentives, and subsidies—support renewable energy, energy efficiency, and reforestation. The Indonesian Environmental Fund Agency (BPDLH) manages dedicated funds for climate projects and encourages sustainable investment. Blended finance approaches mobilize both public and private capital to scale up green infrastructure. International collaborations, including the Just Energy Transition Partnership (JETP), Green Climate Fund (GCF), and bilateral agreements, provide additional financing and technical support.

Key institutional mechanisms reinforce transparency and accountability. The National Registry System (SRN), GHG emission reduction certificates (SPE-GRK), MRV protocols, and corresponding adjustment frameworks underpin both domestic and international carbon trading. Complementary digital systems such as SRN-PPI and SIGN SMART enable monitoring of emission reductions and data-driven policy adjustments. In parallel, the Sustainable Finance Taxonomy (TKBI) supports environmentally sound investments, laying the foundation for a robust green finance market.

² OJK is Indonesia's independent financial services authority mandated by Law No. 21/2011 to regulate and supervise banking, capital markets, insurance, pension funds, and other financial sectors through an integrated approach that ensures the security, stability, and integrity of the financial system by monitoring risks, enforcing compliance, investigating violations, imposing sanctions, and coordinating with Bank Indonesia and the Deposit Insurance Corporation to maintain systemic stability.

PERSISTENT CHALLENGES HINDERING INDONESIA'S CLIMATE COMMITMENTS

Despite notable progress, Indonesia still faces critical challenges that hinder the full realization of its climate commitments. These challenges span mitigation efforts, financial mobilization, institutional capacity, governance, and socio-economic dimensions. Addressing them is essential to ensure effective and equitable climate actions. A key mitigation hurdle lies in balancing emission reductions with the risk of reinforcing fossil fuel lock-in. The FOLU Net Sink 2030 strategy, while ambitious, is complicated by fluctuating forest cover and land-use practices, making it difficult to secure sustained carbon sequestration. Reliance on carbon offsets from forestry and land use requires strong enforcement, yet persistent gaps in land governance and tenure issues weaken implementation (Meehan et al., 2019; Novita et al., 2022; Wongkar, 2021). At the same time, the continued operation and expansion of coal-fired power plants—especially proposed captive coal projects—pose serious risks to Indonesia's climate ambitions. Existing infrastructure and new fossil-based investments deepen the threat of long-term lock-in, while the limited deployment of renewable energy further compounds the challenge. The expansion of bioenergy, such as wood pellets and palm biodiesel, introduces additional risks tied to sustainability, land-use change, and potential harm to forest conservation, requiring careful oversight (Novita et al., 2022; Mardiatmoko, 2021). Renewable energy penetration remains relatively low, far from the 23% target for 2025. High costs, policy uncertainty, perceived risks, and infrastructural barriers continue to constrain large-scale deployment (Sembiring, 2025; Resosudarmo et al., 2023; Grigoryan, 2024).

Indonesia faces a substantial climate finance gap, estimated to be around two-third of the required investment for aligning with its climate goals. Although Indonesia has mobilized funds through innovative mechanisms like green sukuk and international climate finance

partnerships, domestic sources remain insufficient to meet the ambitious investment needs. The reliance on international supports is vital but also indicates a dependence that could undermine long-term sustainable financing. Indonesia's efforts to develop domestic financial instruments and leverage private sector investment are ongoing but face challenges related to risk perception, market maturity, and capacity constraints (Rakatama et al., 2023; Idris et al., 2024; Suroso et al., 2022; Setiawan et al., 2021; Resosudarmo et al., 2023).

Policy coherence across sectors remains a concern, with existing policies sometimes conflicting or lacking integration—particularly between forest, land use, and energy policies—reducing overall effectiveness (Ritonga et al., 2025; Mardiatmoko, 2021; World Bank Group 2023). Enforcement gaps are evident in forest governance, where illegal logging and land clearing continue, undermining reforestation and land management efforts (Alisjahbana & Busch, 2017; Meehan et al., 2019; Sinaga, 2020).

The MRV systems require further strengthening to accurately track emissions reductions and ensure transparency. Limited capacity and technical expertise hamper the development of a comprehensive and reliable data regime necessary for credible climate accountability (Wongkar, 2021; World Bank Group 2023).

A critical socio-economic obstacle is ensuring a just transitions that balances climate ambition with social equity. Concerns over job-loss in fossil fuel sectors, energy affordability, and regional disparities threaten public support for climate policies. Transitioning workers from coal and other carbon-intensive industries must be managed carefully to prevent social discontent and economic dislocation (Sembiring, 2025; Resosudarmo et al., 2023; World Bank Group 2023).

Regional disparities between urban and rural areas, and among islands—also pose challenges to equitable policy implementation. Ensuring inclusive participation, especially for vulnerable communities and indigenous peoples, remains a priority but requires targeted strategies and social safeguards.

The Indonesian government's commitment to climate change and the Net Zero Emissions (NZE) target by 2060 requires an inclusive and sustainable green economic transformation. One of the key elements in this transformation is the creation of green job opportunities, namely jobs that support environmental sustainability, reduce carbon emissions, and manage natural resources sustainably. The potential for green jobs is enormous, especially in the context of a green economy transition and a Just Energy Transition (Resosudarmo et al., 2023; World Bank Group 2023). According to the Green Economy Index publication, the green economy could create 1.8 million new jobs by 2030 (Bappenas, 2021).

Indonesia's forthcoming energy transition is poised to significantly impact industries integral to the electricity supply ecosystem—such as mining, quarrying, electricity generation (including the expansion of renewables), and construction. Notably, there is also considerable emphasis on sectors aimed at driving up electricity demand, particularly clean transport and electronics manufacturing (PAGE, 2023). Consequently, shifts within the energy sector will likely precipitate comprehensive changes across Indonesia's broader economy.

The effects on employment in the electricity supply sector are likely to vary widely depending on region and the phase of transition. For instance, coal-dependent areas such as East Kalimantan, West Kalimantan, and South Sumatra are expected to face job losses within coal mining and quarrying industries. Conversely, regions like West Papua, Central Sulawesi, and Maluku are poised to see job growth, largely due to increased demand for their copper and nickel resources. In essence, regional outcomes will differ as the energy landscape changes over time (PAGE, 2023).

As Indonesia embarks on its energy transition toward a greener, low-carbon future, the reskilling and upskilling of its workforce has become essential to ensure a just and inclusive transformation. The move from fossil fuels to renewable energy sources such as solar, wind, and geothermal demands new technical competencies and

green job readiness across various sectors. By investing in training programs and educational initiatives, Indonesia can equip workers—particularly those in traditional energy industries—with the necessary skills to thrive in emerging green roles. This reskilling effort not only helps mitigate potential job displacement but also fosters inclusive economic growth by creating employment opportunities aligned with the country's climate goals. A well-prepared workforce is essential to ensuring a just and smooth transition to sustainable energy systems across the archipelago. Nonetheless, structural challenges persist: underinvestment in the green sector, lack of targeted training, rural–urban disparities in education access, and limited public awareness of green job opportunities. To address these gaps, Bappeenas (Mariska, 2024) recommends an integrated regulatory framework and roadmap for green workforce development. This includes vocational training, certification standards, and cross-sectoral collaboration. Coordinated efforts—linking reskilling programs with investment-driven job creation and systemic policy integration—are critical to equipping Indonesia's workforce for a green economy, while supporting both climate goals and sustainable employment.

KEY LESSONS FROM INDONESIA'S CLIMATE ACTIONS

Indonesia's climate action journey has generated valuable insights into effective strategies, persistent challenges, and enabling factors that are critical for advancing its climate agenda. Reflecting on these experiences offers important lessons that can guide future policy and implementation.

The execution of flagship sectoral programs—most notably the FOLU Net Sink 2030 initiative and the energy transition agenda—has been central to translating commitments into action. The FOLU Net Sink program targets emissions and carbon sequestration in forestry and land use, which account for a significant share of Indonesia's greenhouse gas inventory. Its time-bound

roadmap to achieve a net sink in Forestry and Other Land Use (FOLU) by 2030 underscores the essential role of forest conservation and peatland management in the national climate strategy. Targeted interventions have helped prioritize actions, mobilize resources, and engage stakeholders more effectively. Multi-year declines in deforestation rates suggest progress in governance and conservation, though these gains remain fragile due to ongoing land-use pressures and enforcement challenges (Meehan et al., 2019; Tacconi et al., 2019; Ruyschaert & Hufty, 2020; Novita et al., 2022).

In parallel, the energy transition agenda—focused on scaling up renewable energy and gradual reduction of fossil fuels utilization—has been a critical driver of power sector decarbonization. Together, these flagship programs provide concrete frameworks around which policies, investments, and institutional efforts can be aligned, fostering clarity of purpose and enabling coordinated action (Wurarah, 2024; Alisjahbana & Busch, 2017). The Ministry of Finance (MoF) has implemented legislation that provides financial benefits to power providers, thereby promoting their shift towards more environmentally friendly energy sources. The Regulation of MoF No. 103 of 2023 provides fiscal support for the acceleration of energy transition in the electricity sector and was implemented on 13 October 2023 (Askandar & Putro, 2025).

High investment costs of RE development and other climate actions can be financed through domestic and international funds. International funds generally have requirements that difficult to fulfill as sometime do not align with government policy in maximizing the utilization of domestic energy resources to achieve self sufficient energy. As one of the international partners, the Just Energy Transition Partnership (JETP) offers Indonesia a major opportunity to accelerate its energy transition by mobilizing \$20 billion in international finance to support early coal retirement, renewable energy expansion, and a more equitable shift toward low-carbon development. It provides a structured framework for coal phase-out, enhances energy security, and

promotes job creation and community support, positioning Indonesia as a potential model for other countries. However, JETP also faces significant challenges, including political and social resistance rooted in concerns about foreign influence and debt-driven financing (Jazuli et al., 2024; Wardhana et al., 2024; Banerjee, 2024), as well as regulatory complexity, limited implementation capacity, and risks of policy misalignment with national priorities (Wardhana et al., 2024; Maskun et al., 2023). Questions remain over the clarity of its “just” dimension, with insufficient involvement of local stakeholders (Maskun et al., 2023; Banerjee, 2024) and risks of inequitable compensation for coal investors (Boute, 2025), raising concerns that without stronger domestic ownership, JETP could be perceived as externally imposed and fail to deliver a truly inclusive transition. To accelerate RE development as one of climate mitigation actions in Indonesia’s energy transition, the RE investment can use DANANTARA (Indonesia’s Sovereign Wealth Fund). For example, development of Geothermal Power Plant has been financed using DANANTARA fund. A robust measurement, reporting, and verification (MRV) system is fundamental for transparency and accountability. Indonesia’s development of MRV frameworks has strengthened the credibility of emission reduction claims and improved progress tracking. Yet, challenges remain in ensuring data consistency, interoperability across institutions, and strict adherence to standardized methodologies. Sustained capacity building and clear regulatory guidance are needed to safeguard MRV reliability and maintain stakeholder trust, both domestically and internationally (Wiati et al., 2022; Meehan et al., 2019; Dirgantara, 2022; Novita et al., 2022).

International cooperation has also played a pivotal role, providing financial resources, technical expertise, and knowledge transfer. Partnerships with multilateral funds, development agencies, and bilateral contributors have accelerated climate action through grants, concessional loans, and capacity-building initiatives. These collaborations have supported policy learning, adoption of best practices, and mobilization of

climate finance, particularly in light of Indonesia’s domestic finance gap (Wiati et al., 2022; Wurarah, 2024). Continued engagement with the global community remains critical to bridge capability constraints and sustain momentum. Results-Based Payment (RBP) schemes under REDD+ have provided crucial funding and incentives for reducing emissions from deforestation and forest degradation, but their lasting effectiveness depends on overcoming persistent challenges. Key lessons emphasize the complexity of safeguard implementation and verification, the critical need for transparent and equitable benefit-sharing mechanisms (Morita & Matsumoto, 2023), the importance of strong national ownership and policy integration, and the ongoing requirement to strengthen MRV capacity and improve forest governance (Kim et al., 2021). Looking ahead, streamlining safeguard requirements, reinforcing national systems and legal frameworks, ensuring inclusive and fair benefit-sharing, fostering private sector participation (Morita & Matsumoto, 2023), and aligning REDD+ outcomes with NDCs and net-zero strategies (Kim et al., 2021) will be vital to enhance the accessibility, credibility, and sustainability of RBP finance while delivering stronger climate and social benefits.

Indonesia has also made progress in developing a carbon market to incentivize emission reductions and monetize climate actions. Foundational regulatory frameworks and registries have been established, laying the groundwork for market-based mechanisms. However, challenges persist, including limited market liquidity, a small pool of licensed verifiers, insufficient tradable credit volumes, and concerns about transparency. Addressing these issues by strengthening verification capacity and improving market oversight will be key to building trust and encouraging broader participation (Dirgantara, 2022).

Coherent and integrated policy frameworks are equally important. The development of the Taxonomy for Sustainable Finance (TKBI), aligned with ASEAN standards, provides clear guidance for channeling investments toward environmen-

tally sustainable activities and advancing green economic growth. When corporate transition plans align with national targets and taxonomy criteria, they reduce investor uncertainty and foster consistency. Clear regulatory signals and long-term planning also help financial institutions and businesses allocate capital effectively, supporting sustainable investment flows. Anchoring domestic regulations in international best practices further enhances credibility and attracts global capital (Putri & Bakhtiar, 2023; Wurarah, 2024).

Long-term engagement, coalition-building, and social learning—such as those seen in REDD+ projects and NGO-led forest governance initiatives—are crucial for policy innovation and effective implementation. Flexibility in project design and openness to local learning agendas can yield more meaningful and sustainable outcomes (Sanders et al., 2020; Ruysschaert & Hufty, 2020; Resosudarmo et al., 2019). Beyond these, sustainable REDD+ and forest governance outcomes also rely on complementary factors: secure land tenure and recognition of local rights as the basis for equitable participation and benefit-sharing; conditional incentives supported by transparent, context-specific mechanisms to foster legitimacy and sustained engagement (Wunder et al., 2020; Shah & Race, 2024); and strong national ownership with integration into broader policy frameworks to maximize effectiveness. Meaningful community participation—grounded in free, prior, and informed consent (FPIC; Shah & Race, 2024; Lawlor et al., 2013; Awung & Marchant, 2020) strengthens local well-being and support for forest protection, while investments in technical and institutional capacity, adaptive project design, and rigorous monitoring and transparency of both carbon and non-carbon outcomes reinforce accountability and long-term sustainability (Nantongo et al., 2024). Together, these elements form a comprehensive foundation for REDD+ initiatives that are effective, equitable, and resilient.

Taken together, these lessons highlight Indonesia's evolving institutional, regulatory, and financial frameworks underpinning its climate agenda.

They also reinforce the importance of integrated approaches, transparency, and sustained political commitment as Indonesia advances toward its climate objectives.

STRATEGIC PRIORITIES FOR INDONESIA CLIMATE ACTIONS 2025-2030

As Indonesia strengthens its climate commitments for 2025–2030, a series of strategic actions will be essential to consolidate progress and accelerate the transition to a low-carbon, climate-resilient pathway. Building on past experiences and existing frameworks, the following priorities will guide Indonesia's efforts during this critical phase:

Lock in FOLU Net Sink gains through stronger enforcement and real-time monitoring

Securing the achievements of the FOLU Net Sink 2030 program requires robust governance, improved law enforcement, and the adoption of real-time monitoring technologies. Illegal logging and land-use conflicts remain major threats to carbon stock preservation. Deploying advanced satellite-based monitoring and transparent data systems can provide timely information on deforestation and peatland degradation, enabling rapid response to violations. Community engagement through social forestry programs is also vital for sustaining carbon sequestration gains and safeguarding critical ecosystems (Novita et al., 2022; Basuki et al., 2022; Resosudarmo et al., 2019; Tacconi et al., 2019)

Update the RUPTL to accelerate renewable energy and limit captive coal

Indonesia's electricity supply plan (RUPTL) must be urgently updated to reflect ambitious renewable energy targets and climate goals. The revised plan should prioritize renewables in line with Presidential Regulation No. 112/2022, set clear targets and timelines for scaling up low-carbon energy sources, and introduce stricter controls on captive coal power plants. A clear coal decom-

missioning timetable, integrated into the electricity planning framework, will provide certainty for investors and stakeholders (Siagian et al., 2017; Sarjiya et al., 2023; Rahman et al., 2021; Firmansyah et al., 2023).

Scale up the carbon market with compliance demand and Article 6 readiness

Expanding the domestic carbon market is critical for creating compliance demand and incentivizing emission reductions across sectors. A clear roadmap for mandatory participation, aligned with emerging international rules under Article 6 of the Paris Agreement, will help integrate Indonesia into global carbon markets. Efforts should focus on improving market liquidity, strengthening verification systems, and ensuring transparency and integrity (Fajarianti & Novitasari, 2025; Alisjahbana & Busch, 2017).

Accelerate deployment of low-carbon technologies

Rapid scaling of low-carbon technologies—including solar, wind, biogas, energy storage, and smart grid management—is vital for achieving mid-century climate targets. Investment in research and development, capacity building, and supportive regulatory frameworks will drive adoption. Integrating digital solutions for energy management and resource efficiency can further optimize Indonesia's transition pathways (Siagian et al., 2017; Sarjiya et al., 2023; Ramadhan et al., 2024; Firmansyah et al., 2023).

Mobilize climate finance

Bridging Indonesia's climate finance gap requires scaling up blended finance mechanisms that combine public, private, and international capital for mitigation and adaptation projects. Expanding sovereign financial instruments—such as green bonds and climate risk insurance—will strengthen fiscal capacity and risk management. At the same time, improving access to international climate funds, including the Green Climate Fund (GCF), is crucial (Suroso et al., 2022; Rahman et al., 2021). Streamlining project pipelines, enhancing proposal quality, and meeting fund requirements

will help secure greater financing for transformative initiatives.

Strengthen institutional coherence

Policy coherence across sectors is essential for harmonized climate action. Institutional mechanisms should enable integrated planning and coordination among key ministries. Establishing inter-ministerial commissions or task forces can facilitate alignment of policies, regulations, and financial instruments, improving resource allocation and supporting integrated implementation of climate and development goals (Ershov, 2024).

Build confidence through transparency and early wins

Sustaining stakeholder confidence requires transparent tracking of progress and outcomes. Institutionalizing regular, publicly accessible reporting and strengthening MRV systems will enhance accountability and trust. Proactive engagement with government, private sector, civil society, and local communities will enrich dialogue and foster collective ownership of climate goals. Demonstrating early wins—particularly in coal retirement and forest protection—will showcase tangible progress and reinforce public confidence in Indonesia's climate leadership (Novita et al., 2022; Alisjahbana & Busch, 2017; Resosudarmo et al., 2019).

REFERENCES

- Alisyahbana, A., & Busch, J. (2017). Forestry, Forest Fires, and Climate Change in Indonesia. *Bulletin of Indonesian Economic Studies*, 53, 111 - 136. <https://doi.org/10.1080/00074918.2017.1365404>
- Ardi, R., Widjaya, T., Putri, S., & Syaifullah, D. (2024). Multi-Generational Analysis on Behavioral Intention to Use Public Transportation using Structural Equation Modeling: Evidence from Indonesia. *International Journal of Technology*. <https://doi.org/10.14716/ijtech.v15i2.6704>
- Arifianto, S., Irawan, M., Thaithatkul, P., Rizki, M., Krisna, A., Tarigan, M., & Widiastuti, N. (2024). Enhancing Urban Resilience through Strategic Parking Pricing in Jakarta's Bus Rapid Transit Corridors. *Journal of the Civil Engineering Forum*. <https://doi.org/10.22146/jcef.13568>
- Askandar, A., & Putro, U. S. (2025). Strategy to Achieve Indonesia's Nationally Determined Contribution Target by Developing a Sustainable Carbon Market. *European Journal of Business and Management Research*, 10(1), 92-107. <https://doi.org/10.24018/ejbmr.2025.10.1.2494>
- Awung, N., & Marchant, R. (2020). Transparency in benefit sharing and the influence of community expectations on participation in REDD+ Projects: an example from Mount Cameroon National Park. *Ecosystems and People*, 16, 78 - 94. <https://doi.org/10.1080/26395916.2019.1698658>
- Banerjee, A. (2024). Transforming the rhetoric of Just Energy Transition Partnerships into reality: The devil lies in the details. *PLOS Sustainability and Transformation*. <https://doi.org/10.1371/journal.pstr.0000121>
- Bappenas (2021). Green Economy Index: A Step Forward to Measure the Progress of Low Carbon & Green Economy in Indonesia. Badan Perencanaan Pembangunan Nasional. Jakarta.
- Barus, L. (2022). Mass public transportation system policy in the millennium era in indonesia. *Journal of Sustainable Development Issues*. <https://doi.org/10.56282/jsdi.v1i1.104>
- Basuki, I., Adinugroho, W., Utomo, N., Syaugi, A., Tryanto, D., Krisnawati, H., Cook-Patton, S., & Novita, N. (2022). Reforestation Opportunities in Indonesia: Mitigating Climate Change and Achieving Sustainable Development Goals. *Forests*. <https://doi.org/10.3390/f13030447>
- Boute, A. (2025). Phasing Out Coal Investment Contracts: Does Just Transition Finance Legitimize Unjust Compensation. *ICSID Review - Foreign Investment Law Journal*. <https://doi.org/10.1093/icsidreview/siae037>
- BPK-RI, 2016. Pengesahan Paris Agreement to The United Nation Framework Convention On Climate Change. <https://peraturan.bpk.go.id/Details/37573>
- Brata, J., & Toparakkasi, F. (2023). Public Policies for Climate Change Mitigation in Indonesia. *Jurnal Aktor*. <https://doi.org/10.26858/aktor.v2i3.46879>
- Dirgantara, P. (2022). Reflecting on REDD+: Challenges Towards Indonesia's Carbon Pricing. *IOP Conference Series: Earth and Environmental Science*, 1105. <https://doi.org/10.1088/1755-1315/1105/1/012003>
- Djalante, R., Jupesta, J., Editors, E., & Aldrian, E. (2021). Climate Change Research, Policy and Actions in Indonesia: Science, Adaptation and Mitigation. *Climate Change Research, Policy and Actions in Indonesia*. <https://doi.org/10.1007/978-3-030-55536-8>
- Erdiwansyah, E., Mahidin, M., Husin, H., Nasaruddin, N., Khairil, K., Zaki, M., & Jalaluddin, J. (2020). Investigation of availability, demand, targets, and development of renewable energy in 2017–2050: a case study in Indonesia. *International Journal of Coal Science & Technology*, 8, 483 - 499. <https://doi.org/10.1007/s40789-020-00391-4>
- Ershov, D. (2024). Features of Indonesia's Low-Carbon Development Strategy. *Problemy Dalnego Vostoka*. <https://doi.org/10.31857/s0131281224030071>
- Fajarianti, A., & Novitasari, D. (2025). Kesiapan Pajak Karbon Indonesia dan Implementasinya

- Dalam Mewujudkan Sustainability Living. *Jati-jajar Law Review*. <https://doi.org/10.26753/jlr.v4i1.1590>
- Firmansyah, V., Adinarayana, M., Tetrisyanda, R., & Wibawa, G. (2023). Scenario of renewable energy transition from fossil energy resources towards net zero emission in Indonesia. *E3S Web of Conferences*. <https://doi.org/10.1051/e3sconf/202346704005>
 - Gol. 2021. Indonesia long-term strategy for low carbon and climate resilience 2050. https://unfccc.int/sites/default/files/resource/Indonesia_LTS-LCCR_2021.pdf
 - Gol. 2022. Enhanced National Determined Contribution, Republic of Indonesia. https://unfccc.int/sites/default/files/NDC/2022-09/23.09.2022_Enhanced%20NDC%20Indonesia.pdf
 - Gol. 2024. Indonesian first Biennial Transparency Report (BTR1). Government of Republic of Indonesia. <https://unfccc.int/documents/645085>
 - Grigoryan, H. (2024). Characteristics of Indonesia's Energy Transition Policy: The Role of Foreign Business in Decarbonization. *Analysis and Forecasting. IMEMO Journal*. <https://doi.org/10.20542/afij-2024-2-57-71>
 - Halimatussadiah, A., Afifi, F., Lufti, R., Pratama, A., & Wibowo, D. (2024). Assessing Risks of Decarbonization Pathways in Indonesia. *Asian Economic Papers*, 23, 125-148. https://doi.org/10.1162/asep_a_00912
 - Hartanto, H. (2024). The Role of Indonesia in Leading Efforts to Mitigate Climate Change in ASEAN in 2023. *JDKP Jurnal Desentralisasi dan Kebijakan Publik*. <https://doi.org/10.30656/jdkp.v5i1.8456>
 - Hasegawa, T., & Matsuoka, Y. (2015). Climate change mitigation strategies in agriculture and land use in Indonesia. *Mitigation and Adaptation Strategies for Global Change*, 20, 409-424. <https://doi.org/10.1007/s11027-013-9498-3>
 - Idris, S., Chang, L., Prihandono, I., & Rasidi, S. (2024). Green financing and climate change: challenges and regulatory mechanisms in Malaysia and Indonesia. *Clean Technologies and Environmental Policy*. <https://doi.org/10.1007/s10098-024-02829-8>
 - Jazuli, M., Roll, K., & Mulugetta, Y. (2024). A review of Indonesia's JETP through the dynamics of its policy regime. *Global Policy*. <https://doi.org/10.1111/1758-5899.13452>
 - Kim, R., Kim, D., Cho, S., Choi, E., Park, J., Lee, S., & Son, Y. (2021). Assessment of REDD+ MRV Capacity in Developing Countries and Implications under the Paris Regime. *Land*. <https://doi.org/10.3390/land10090943>
 - Lawlor, K., Madeira, E., Blockhus, J., & Ganz, D. (2013). Community Participation and Benefits in REDD+: A Review of Initial Outcomes and Lessons. *Forests*, 4, 296-318. <https://doi.org/10.3390/F4020296>
 - Made, I., Wijaya, M., & Sudaryanto, A. (2024). Questioning Sustainable Environmental Policies and Practices in Indonesia: Would Durkheim's Structural Functionalism Theory Have a Relevance?. *Udayana Journal of Law and Culture*. <https://doi.org/10.24843/ujlc.2024.v08.i02.p03>
 - Maharani, Y., I., & Wibowo, T. (2024). Renewable energy transition in facing climate change in Indonesia. *IOP Conference Series: Earth and Environmental Science*, 1339. <https://doi.org/10.1088/1755-1315/1339/1/012036>
 - Mardiatmoko, G. (2021). Opportunities and Challenges of Mitigation and Adaptation of Climate Change in Indonesia. *Climate Issues in Asia and Africa - Examining Climate, Its Flux, the Consequences, and Society's Responses*. <https://doi.org/10.5772/INTECHOPEN.97027>
 - Mariska. (2024). Optimalisasi Peluang Green Jobs Melalui Penyiapan Tenaga Kerja Hijau. *Bappenas Working Papers*, 7(3), 227 - 242. <https://doi.org/10.47266/bwp.v7i3.365>
 - Maskun, M., Paliling, V., Hamzah, A., & Mukarrahmah, N. (2023). Justice element in just energy transition partnership decarbonization policy: a conceptual legal analysis. *E3S Web of Conferences*. <https://doi.org/10.1051/e3sconf/202346705003>
 - Mazouz, S., & Jotzo, F. (2010). Economic and fiscal policy strategies for climate change mitigation in Indonesia. <https://www.idxcarbon.co.id/>

- Meehan, F., Tacconi, L., & Budiningsih, K. (2019). Are national commitments to reducing emissions from forests effective? Lessons from Indonesia. *Forest Policy and Economics*. <https://doi.org/10.1016/J.FORPOL.2019.101968>
- Mendrofa, A., Sugandi, Y., Rusli, B., & Amalia, P. (2024). Policy Diffusion on New and Renewable Energy in Indonesia. *Journal of Ecohumanism*. <https://doi.org/10.62754/joe.v3i8.4752>
- Merten, J., Nielsen, J., , R., & Faust, H. (2021). Climate change mitigation on tropical peatlands: A triple burden for smallholder farmers in Indonesia. *Global Environmental Change*. <https://doi.org/10.1016/j.gloenvcha.2021.102388>
- MoEF, 2024. The state of Indonesia's forests 2024: Toward sustainability of forest ecosystems in Indonesia. Ministry of Environment and Forestry, Jakarta. https://indonesianembassy.de/wp-content/uploads/2024/08/EBook_SolFo-2024_B5_ENG-07.14.24_compressed.pdf
- MoEF. 2022. Rencana operasional FOLU Net Sink 2030. Kementerian Lingkungan Hidup dan Kehutanan. Republik Indonesia. Jakarta
- Morita, K., & Matsumoto, K. (2023). Challenges and lessons learned for REDD+ finance and its governance. *Carbon Balance and Management*, 18. <https://doi.org/10.1186/s13021-023-00228-y>
- Morizane, J., Enoki, T., Hase, N., & Setiawan, B. (2016). Government Policies and Institutions for Climate Change Mitigation and Its Monitoring, Evaluation, and Reporting. **, 27-54. https://doi.org/10.1007/978-4-431-55994-8_2
- Muhammad, A., Rizky, L., Sahide, A., Candra, I., & Prasetyo, S. (2025). Multilevel Governance and Indonesia's Strategy for Climate Change Mitigation and Adaptation. *Jurnal Hubungan Internasional*. <https://doi.org/10.18196/jhi.v13i2.20999>
- Nantongo, M., Vatn, A., & Soka, G. (2024). REDD+: The perfect marriage between conservation and development? A comparative study of the impacts of REDD+ on livelihoods and deforestation in Tanzania. *World Development*. <https://doi.org/10.1016/j.worlddev.2023.106432>
- Novita, N., , S., Lestari, N., Anshari, G., Lugina, M., Yeo, S., Malik, A., Asyhari, A., Putra, C., Gangga, A., Ritonga, R., Albar, I., Djaenudin, D., Arifanti, V., Poor, E., Jupesta, J., Tryanto, D., Basuki, I., & Ellis, P. (2022). Natural climate solutions in Indonesia: wetlands are the key to achieve Indonesia's national climate commitment. *Environmental Research Letters*, 17. <https://doi.org/10.1088/1748-9326/ac9e0a>
- Nusantara, T., & Rahadi, R. (2024). Integrating ESG Principles in Financing Practices at Clove Bank: A Literature Review. *Journal Integration of Management Studies*. <https://doi.org/10.58229/jims.v3i1.271>
- PAGE, 2023. Green Jobs and Just Transition Policy Readiness Assessment in the Energy Sector in Indonesia. <https://www.un-page.org/static/f5fe8fd6775c56d380ecad06748bf38b/green-jobs-and-just-transition-policy-readiness-assessment-in-the-energy-sector-in-indonesia.pdf>
- Pramudianto, A. (2019). Paris Agreement Agreement 2015 and its Impact on Indonesian National Law. *Proceedings of the Proceedings of the 1st Workshop on Multidisciplinary and Its Applications Part 1*, WMA-01 2018, 19-20 January 2018, Aceh, Indonesia. <https://doi.org/10.4108/eai.20-1-2018.2281915>
- Pujiati, A., Murniawaty, I., Nihayah, D., Muarifah, I., & Damayanti, N. (2022). A Simulated Policy towards Green Public Transportation in a Metropolitan in Indonesia. *International Journal of Energy Economics and Policy*. <https://doi.org/10.32479/ijeep.13121>
- Putri, W., & Bakhtiar, I. (2023). Interconnecting Science-Based Target with company supply chain to contribute climate action – lesson learned from Indonesia. *E3S Web of Conferences*. <https://doi.org/10.1051/e3sconf/202346705005>
- Rahman, A., Dargusch, P., & Wadley, D. (2021). The political economy of oil supply in Indonesia and the implications for renewable energy development. *Renewable and Sustainable Energy Reviews*. <https://doi.org/10.1016/J.RSER.2021.111027>

- Rakatama, A., Maharani, D., Syafrian, D., & Yuniarti, F. (2023). Green financing for climate resilience and low-carbon development in Indonesia: viewpoints for the road ahead. *Development in Practice*, 34, 1048 - 1057. <https://doi.org/10.1080/09614524.2023.2295790>
- Ramadhan, R., Mon, M., Tangparitkul, S., Tansuchat, R., & Agustin, D. (2024). Carbon capture, utilization, and storage in Indonesia: an update on storage capacity, current status, economic viability, and policy. *Energy Geoscience*. <https://doi.org/10.1016/j.engeos.2024.100335>
- Resosudarmo, B., Rezki, J., & Effendi, Y. (2023). Prospects of Energy Transition in Indonesia. *Bulletin of Indonesian Economic Studies*, 59, 149 - 177. <https://doi.org/10.1080/00074918.2023.2238336>
- Resosudarmo, I., Tacconi, L., Sloan, S., Hamdani, F., S., Alviya, I., & Muttaqin, M. (2019). Indonesia's land reform: Implications for local livelihoods and climate change. *Forest Policy and Economics*. <https://doi.org/10.1016/j.FORPOL.2019.04.007>
- Ritonga, A., Amin, M., & Situmorang, T. (2025). Indonesia's policy responses to climate change in sustainable natural resource management: Jokowi's tenure. *IOP Conference Series: Earth and Environmental Science*, 1445. <https://doi.org/10.1088/1755-1315/1445/1/012063>
- Ruyschaert, D., & Hufty, M. (2020). Building an effective coalition to improve forest policy: Lessons from the coastal Tripa peat swamp rainforest, Sumatra, Indonesia. *Land Use Policy*, 99, 103359. <https://doi.org/10.1016/j.LANDUSEPOL.2018.04.034>
- Sambodo, M., Yuliana, C., Hidayat, S., Novandra, R., Handoyo, F., Farandy, A., Inayah, I., & Yuniarti, P. (2022). Breaking barriers to low-carbon development in Indonesia: deployment of renewable energy. *Heliyon*, 8. <https://doi.org/10.1016/j.heliyon.2022.e09304>
- Sanders, A., Sanders, A., Ford, R., Keenan, R., & Larson, A. (2020). Learning through practice? Learning from the REDD+ demonstration project, Kalimantan Forests and Climate Partnership (KFCP) in Indonesia. *Land Use Policy*, 91, 104285. <https://doi.org/10.1016/j.landuse-pol.2019.104285>
- Sarjito, A. (2023). Evaluation of Indonesian Government Policies in Addressing Climate Change and Natural Disasters. *JISHUM : Jurnal Ilmu Sosial dan Humaniora*. <https://doi.org/10.57248/jishum.v2i1.283>
- Sarjiya, S., Putranto, L., T., Budi, R., Novitasari, D., & D. (2023). Generation expansion planning with a renewable energy target and interconnection option: A case study of the Sulawesi region, Indonesia. *Renewable and Sustainable Energy Reviews*. <https://doi.org/10.1016/j.rser.2023.113489>
- Sembiring, M. (2025). Critical Geopolitics of Global Environmental Norms: Exploring Indonesia's Response to Climate Mitigation Agenda. *Geopolitics*. <https://doi.org/10.1080/14650045.2024.2446435>
- Setiawan, S., Ismalina, P., Nurhidajat, R., Tjahjapriyadi, C., & Munandar, Y. (2021). Green finance in indonesia's low carbon sustainable development. *International Journal of Energy Economics and Policy*. <https://doi.org/10.32479/ijeep.11447>
- Shah, S., & Race, D. (2024). Greening the blue Pacific: Lessons on reducing emissions from deforestation and forest degradation (REDD+). *Forest Policy and Economics*. <https://doi.org/10.1016/j.forpol.2024.103263>
- Shiddiqi, A., Sutjiningsih, D., Tjahjono, T., Darmajanti, L., & Suprayoga, G. (2024). Modal Shift in Public Transport Under Fiscal-Based Policies Scenarios for Jakarta. *International Journal of Technology*. <https://doi.org/10.14716/ijtech.v15i6.5723>
- Siagian, U., Yuwono, B., Fujimori, S., & Masui, T. (2017). Low-Carbon Energy Development in Indonesia in Alignment with Intended Nationally Determined Contribution (INDC) by 2030. *Energies*, 10, 1-15. <https://doi.org/10.3390/EN10010052>
- Sinaga, L. (2020). Assessing The Commitment of Indonesian Government Towards Climate Change Policy: The Yudhoyono Presidency 2004-2014 [Menilai Komitmen Pemerintah Indonesia terhadap Kebijakan Perubahan Iklim:

- Pemerintahan Presiden Yudhoyono 2004-2014], 11, 163-182. <https://doi.org/10.22212/J.P.V11I2.1752>
- Sumarno, T., Sihotang, P., & Prawiraatmadja, W. (2022). Exploring Indonesia's energy policy failures through the JUST framework. *Energy Policy*. <https://doi.org/10.1016/j.enpol.2022.112914>
 - Suroso, D., Setiawan, B., Pradono, P., Iskandar, Z., & Hastari, M. (2022). Revisiting the role of international climate finance (ICF) towards achieving the nationally determined contribution (NDC) target: A case study of the Indonesian energy sector. *Environmental Science & Policy*. <https://doi.org/10.1016/j.envsci.2022.01.022>
 - Syabriyana, M. (2024). Progress and Challenges of Renewable Energy Transition in Indonesia's Energy Mix Towards Net Zero Emissions. *JURUTERA - Jurnal Umum Teknik Terapan*. <https://doi.org/10.55377/jurutera.v11i02.10810>
 - Syafruddin. 2025. Enhancing mobility: strategies for integrated public transportation in Jakarta's metropolitan area. *Int. j. inf. tecnol.* **17**, 2919–2926. <https://doi.org/10.1007/s41870-024-02112-5>
 - Tacconi, L., Rodrigues, R., & Maryudi, A. (2019). Law enforcement and deforestation: Lessons for Indonesia from Brazil. *Forest Policy and Economics*. <https://doi.org/10.1016/j.FORPOL.2019.05.029>
 - Tarigan, E. (2025). Role of Solar Photovoltaic Energy in GHG Emission Reduction within Indonesia's Long-Term Strategy for Low Carbon and Climate Resilience 2050. *International Journal of Energy Economics and Policy*. <https://doi.org/10.32479/ijeep.18352>
 - Wardhana, A., Aji, P., Prasetyo, K., Ma'rifatullah, W., Budiarto, R., & Mada, G. (2024). Breakthrough on Indonesia's Energy Policy: Adaptive Governance Perspective for Just Energy Transition Partnership (JETP). *Journal of Physics: Conference Series*, 2828. <https://doi.org/10.1088/1742-6596/2828/1/012001>
 - Wiati, C., Dharmawan, I., Sakuntaladewi, N., Ekawati, S., Wahyuni, T., Maharani, R., Hadyan, Y., Naibaho, Y., Satria, W., Ngatiman, N., Abdurachman, A., Karmilasanti, K., Laksmi, A., Angi, E., & Khadka, C. (2022). Challenges to and Strategies for the Climate Village Program Plus: A Lesson Learned from Indonesia. *Sustainability*. <https://doi.org/10.3390/su14095530>
 - Wicaksono, A., Andari, T., Hakim, L., Alamsyah, P., & Wijaya, G. (2025). Measuring electronic road pricing with MICMAC analysis: A case study of Jakarta, Indonesia. *IOP Conference Series: Earth and Environmental Science*, 1438. <https://doi.org/10.1088/1755-1315/1438/1/012038>
 - Wongkar, E. (2021). Achieving the Nationally Determined Contribution (NDC) in Forestry Sectors: Challenges for Indonesia. *IKAT: The Indonesian Journal of Southeast Asian Studies*. <https://doi.org/10.22146/IKAT.V5I1.64974>
 - World Bank Group. (2023). Indonesia Country Climate and Development Report. <https://doi.org/10.1596/39750>
 - Wunder, S., Duchelle, A., Sassi, C., Sills, E., Simonet, G., & Sunderlin, W. (2020). REDD+ in Theory and Practice: How Lessons From Local Projects Can Inform Jurisdictional Approaches. **, 3. <https://doi.org/10.3389/ffgc.2020.00011>
 - Wurarah, R. (2024). Indonesia's economic and environmental resilience in the face of climate change: Analysis and implementation strategies. *Calamity: A Journal of Disaster Technology and Engineering*. <https://doi.org/10.61511/calamity.v2i1.2024.940>
 - Yamin, M., Arya, P., Utama, A., Rautakivi, T., Rosyadi, S., & Ganjar, A. (2024). Transforming Indonesia's Climate Strategy: Analyzing Policy Shifts and Global-Local Dynamics Post-COP 26. *Jurnal Hubungan Internasional*. <https://doi.org/10.18196/jhi.v13i1.18020>
 - Yonathan, S., Wicak, R., Saffanah, R., & Thufaila, A. (2024). Assessing the Legal Implications of Alleged Fuel Blending on Indonesia's Compliance with the Paris Agreement. *BELLI AC PACIS*. <https://doi.org/10.20961/belli.v10i2.100748>
 - Yoo, Y., & Ha, Y. (2024). Market attractiveness analysis of battery energy storage systems

in Indonesia, Malaysia, the Philippines, Thailand, and Vietnam. *Renewable and Sustainable Energy Reviews*. <https://doi.org/10.1016/j.rser.2023.114095>

- Yudha, S., & Tjahjono, B. (2019). Stakeholder Mapping and Analysis of the Renewable Energy Industry in Indonesia. *Energies*. <https://doi.org/10.3390/EN12040602>

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A decade of national climate action: Stocktake and the Road Ahead

JAPAN

TEN YEARS AFTER THE PARIS AGREEMENT: PROGRESS AND CHALLENGES CLIMATE POLICY

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THE ROLE OF A LONG-TERM PERSPECTIVE

Commitment to long-term goal

In his policy speech at the National Diet on October 26, 2020, then-Prime Minister Yoshihide Suga declared that Japan would aim to achieve carbon neutrality by 2050. In April 2021, at the Leaders Summit on Climate, he stated, "Japan aims to reduce its greenhouse gas emissions by 46 % in fiscal year 2030 from fiscal year 2013 levels, setting an ambitious target which is aligned with the long-term goal of achieving net-zero by 2050." In May 2021, the Act on Promotion of Global Warming Countermeasures¹ was amended to reflect this ambition. In October 2021, Japan submitted its updated fiscal year (FY) 2030 Nationally Determined Contribution (NDC) and its Long-Term Low Emission Development Strategy (LT-LEDS) to the United Nations Framework Convention on Climate Change (UNFCCC), reaffirming its commitment to achieving carbon neutrality by 2050.

¹ Enacted in 1998 in response to the adoption of the Kyoto Protocol in 1997.

On February 18, 2025, Japan submitted a new NDC to the UNFCCC, setting targets: a 60% reduction in greenhouse gas (GHG) emissions by 2035 and a 73% reduction by 2040, in line with the linear pathway toward net-zero emissions by 2050.

Figure 1 shows the trend in GHG emissions from 2005 to 2023, along with the reduction targets for 2030, 2035, 2040, and 2050.

Discussions on the quality of carbon net-zero commitments

To develop the NDC for the period after 2030, two important meetings were held: the meeting of the Joint Working Group of the advisory bodies to the Ministry of the Environment (MOE) and the Ministry of Economy, Trade and Industry (METI), and the meeting of the Basic Subcommittee of METI's Advisory Committee for Natural Resources and Energy.

At the 6th meeting of the Joint Working Group on 25 Nov. 2024, a "linear GHG reduction" pathway was proposed by the secretariat to ensure predictability and economic compatibility, though some stakeholders called for deeper cuts.

At the 66th meeting of the Basic Subcommittee

on December 3, 2024, discussions were held on the energy mix needed to achieve a linear reduction in GHG emissions toward 2050. Various model-based scenarios were considered, including contributions from the AIM (Asia-Pacific Integrated Model).

After asking for public comment process, in February 2025, the Cabinet approved the 7th Strategic Energy Plan², Green Transformation (GX) 2040 Vision, and the Global Warming Countermeasures Plan, and submitted the Japan's 2035/2040 NDC to the UNFCCC.

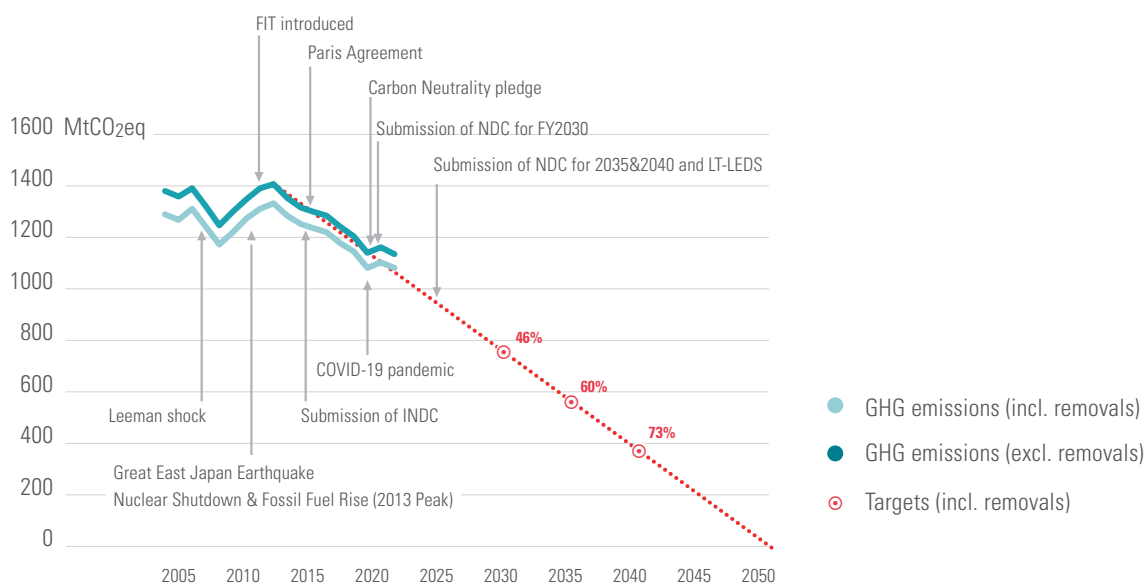
In May 2025, the revised GX Promotion Act³ was enacted, legally mandating participation in the GX-Emission Trading System (ETS), Japan's national emissions trading scheme, from FY 2026. Additional frameworks, like the Regional Decarbonization Roadmap and Green Innovation Fund, support the net-zero transition.

Figure 2 shows the process by which the Japan's 2035/2040 NDC was developed.

² The first plan was approved by the Cabinet in 2003 and has been revised every three to four years.

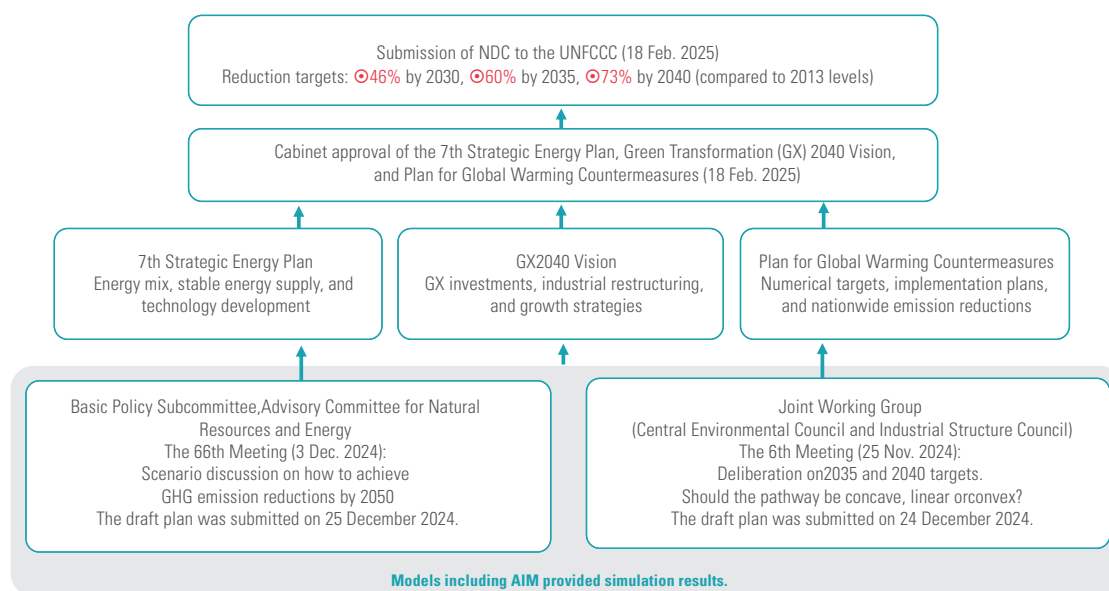
³ Originally enacted by the Japanese Diet in May 2023. Its implementation includes the GX League, launched in 2022 and serving as the pilot phase of the GX-ETS, which involved about 700 companies in FY 2023.

Figure 1. Trends in Japan's Greenhouse Gas Emissions and the 2050 Target



Source: National Institute for Environmental Studies, Greenhouse Gas Inventory Report 2024. <https://cger.nies.go.jp/publications/report/i171/>

Figure 2. Japan's 2035/2040 NDC Development Process



Scenario analysis of Japan's transition pathways using the AIM

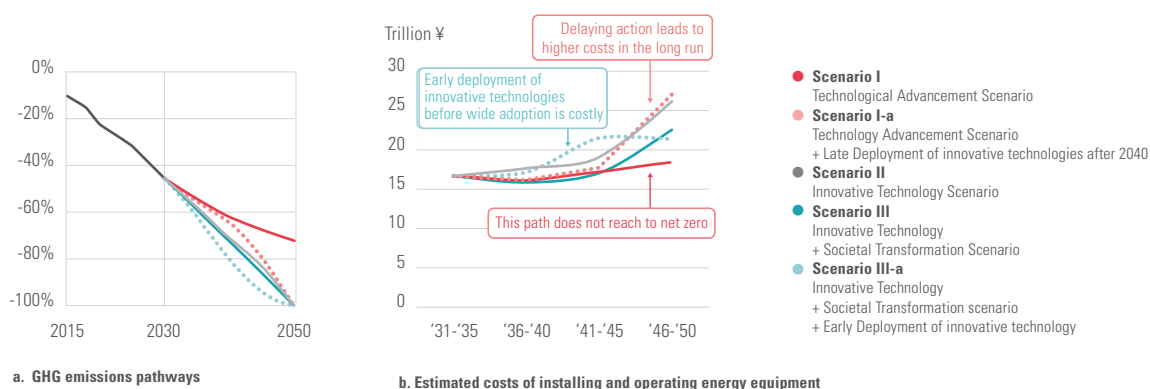
Using the AIM, five scenarios were analyzed to explore GHG emission pathways and associated costs for Japan's decarbonization by 2050 (Figure 3), and presented at the 6th meeting of the Joint Working Group. The scenarios are:

- Scenario I: Technological Advancement Scenario
- Scenario I-a: Technological Advancement + Late Deployment of Innovative Technologies after 2040
- Scenario II: Innovative Technology Scenario

- Scenario III: Innovative Technology + Societal Transformation
- Scenario III-a: Innovative Technology + Societal Transformation + Early Deployment of Innovative Technology

In Scenario I, where the deployment of innovative technologies does not progress significantly by 2050, a considerable level of emissions remains in 2050. In Scenario I-a, postponing innovative technology deployment until after 2040 delays electrification and energy efficiency gains,

Figure 3. Scenario analysis of net-zero pathways using the AIM model



Source: Hibino G, Ashina S, Masui T (2025) 2nd additional analysis of GHG emission pathways realizing a decarbonized society in 2050 in Japan. Discussion Paper Series, Social Systems Division, NIES. <https://www.nies.go.jp/social/publications/dp/pdf/2025-01.pdf>

increasing reliance on low-carbon fuels such as hydrogen-based fuels and sharply driving up costs after 2040.

Conversely, Scenario III-a, which combines early deployment of innovative technologies with social transformation, achieves substantial emissions reductions. However, introducing technologies before they are widely available in the market results in steep cost increases after 2030, followed by a decline in costs around or after 2045.

Across all scenarios, demand-side emissions reductions play a decisive role in achieving overall targets.

Long-term targets in climate policy

Japan's 2050 carbon neutrality target has provided clear direction and policy consistency, sending a strong signal to investors and innovators. The GX2040 Vision further outlines concrete pathways toward these long-term goals and promotes collaboration among industry, government, and civil society. These long-term commitments not only enhance Japan's role in global climate action but also open opportunities for sustainable economic growth and technological advancement.

JAPAN'S PROGRESS IN CLIMATE CHANGE POLICY

Japan has expanded renewable energy deployment through the Renewable Energy Special Measures Act⁴ — including feed-in tariff (FIT, started in 2012) and feed-in premium (FIP, introduced in 2020 and fully implemented since 2022) schemes — along with improved grid connection rules.

Energy efficiency has advanced under the Act on Rationalizing Energy Use⁵ and Building Energy Efficiency Act⁶, which include regulations on energy efficiency and energy-saving performance of automobiles, appliances, and buildings.

Further measures are in place to reduce CO₂ emissions in the industrial sector and mitigate non-CO₂ greenhouse gases (see [Table 1](#)).

Introduced in 2012, Japan's carbon tax has been ¥289 per ton of CO₂ (about USD 2) since 2016, generating approximately ¥220 billion annually (about USD 1.5 billion), both converted at 2025 exchange rates; the revenue figure is based on FY2021 data. This revenue is used for climate change mitigation purposes, including supporting clean energy deployment, energy efficiency

⁴ Enacted in August 2011 and amended since the adoption of the Paris Agreement to support achievement of Japan's NDCs, including major revisions in 2017 and 2020.

⁵ Enacted in 1979; since the Paris Agreement, it has promoted integrated measures for CO₂ reduction and renewable energy utilization.

⁶ Enacted in 2015; it separated and strengthened the building-related provisions of the Energy Conservation Law.

Table 1: Key Drivers of GHG Emissions Reduction in Japan and Associated Challenges

Key Drivers	Policies and Initiatives	Key Challenges
Expanding Renewable Energy	Feed-in Tariff (FIT); Renewable Energy Special Measures Act; FIP scheme; Grid connection rule revisions	Grid integration constraints; Intermittency management; Balancing cost reductions with investment needs
Promoting Energy Efficiency	Energy Conservation Act, including the Top Runner Program, subsidies for ZEH/ZEB with mortgage reductions, and for energy-saving appliances	High upfront costs; Slow uptake in certain sectors; Behavioral change needed to sustain savings
Advancing Low-carbon Industrial Transformation	Support for upfront investments through the use of GX Economic Transition Bonds; GX investment incentives via growth-oriented carbon pricing.	High technology deployment costs; Constrained low-carbon feedstock supply; Managing employment impacts of the transition
Reducing Non-energy Emissions (e.g., F-gases)	Fluorocarbon Emissions Control Act (enforced in 2015); Kigali Amendment compliance (entered into force in 2019); Mandatory refrigerant recovery (institutionalized in 2001)	Difficulties reducing agricultural methane and nitrous oxide; Preventing refrigerant leakage and ensuring recovery; Slow dissemination of low-GWP technologies
Using International Credits	Joint Crediting Mechanism (JCM) under Article 6.2 – Bilateral offset crediting scheme implemented with 30 partner countries (as of 2025); Financial cooperation for credit-generating projects	Ensuring transparency, environmental integrity, and avoidance of double counting; Limited scalability of projects

improvements, and technological development. The GX Transition Bonds, totaling ¥20 trillion (about 133 billion USD), began issuance in FY 2023 and will continue over a ten-year period to accelerate public-private investment in hydrogen, renewable energy, and the decarbonization of heavy industry. To secure a stable repayment source for these bonds, a new carbon levy will be introduced in FY 2028 on fossil fuel supplies. The GX Strategy includes the strengthening of green finance, with green bonds playing a key role in mobilizing funds for climate action and economic growth.

LINKAGES BETWEEN CLIMATE CHANGE AND KEY SOCIAL, ECONOMIC, AND FISCAL ISSUES

Japan's climate policy must address a web of interlinked challenges spanning energy security, economic competitiveness, regional development, climate adaptation, and fiscal sustainability.

Japanese companies are actively participating in international initiatives. As of August 2025, 444 companies worldwide are certified under RE100, including 93 from Japan, placing Japan alongside the United States with the largest number of member companies. As of February 2025, more than 10,000 companies worldwide have obtained SBT certification, of which 1,522 are Japanese

companies—the highest number of SBT-certified companies in the world.

The TCFD itself was dissolved in October 2023 and its responsibilities were handed over to the IFRS Foundation's ISSB. As of November 24, 2023, a total of 4,932 companies and organizations worldwide had expressed their support, including 1,488 from Japan. Japan had the largest number of supporting companies in the world, with many Japanese companies actively disclosing information in line with the TCFD framework compared to other countries.

Corporate participation in international initiatives is contributing to the expansion of renewable energy.

Across Japan, municipalities are promoting local production and consumption of renewable energy, for example by establishing local power companies and implementing municipality-led power purchase agreements (PPAs). In addition, many municipalities are introducing regional renewable energy promotion ordinances in conjunction with their Zero Carbon City declarations. Furthermore, citizens and local businesses are increasingly installing and jointly operating solar power systems, supporting the wider adoption of renewable energy at the community level.

Table 2 summarizes the connections between climate change action and key national initiatives.

Table 2: Examples of Linkages Between Climate Change Action and Key Social, Economic, and Fiscal Issues

Theme	Trends	Key Initiatives
Energy Security & Decarbonization	Following the Fukushima nuclear halt, energy imports increased; renewable energy (RE) expanded gradually; the 2022 crisis revived concerns over supply stability.	FIT/FIP schemes; grid connection rule improvements; battery storage pilot projects; demand-side management programs.
Industrial Competitiveness & Carbon Pricing	Gradual shift from strong resistance to acceptance of carbon pricing	GX Economic Transition Bonds; subsidies for low-carbon technologies
Just Transition (JT) in Regional Economies	Renewables create rural jobs; structured JT frameworks remain limited	Local RE cooperatives; employment retraining programs
Climate Adaptation & Vulnerable Populations	More frequent extreme weather events have spurred adaptation planning	National Adaptation Plan (2015, updated 2021); disaster-resilient infrastructure
Green Finance & GX Strategy	Strong growth in green bond issuance; GX strategy links finance to the transition	Green Bond Guidelines (2014, updated 2022); GX Basic Policy
Social Inclusion in Dialogue	Stakeholder engagement expanding slowly	Multi-actor councils including NGOs and labor unions

GOVERNANCE

Inter-Ministerial Processes on Climate Change

Since the Kyoto Protocol, Japan has had a cross-ministerial framework for climate change policy through the Global Warming Prevention Headquarters, established in 1998 and chaired by the Prime Minister with all Cabinet members as participants. This body approved enduring strategies such as the 2002 Outline for Global Warming Countermeasures and subsequent plans.

Since the Paris Agreement, inter-ministerial cooperation has evolved to become more regular and systematic through mechanisms such as the GX Implementation Council, operated by the Cabinet Secretariat and officially established in July 2022. Overarching strategies are now guided by this body, while regular Cabinet-level meetings integrate inputs from MOEJ, METI, Ministry of Land, Infrastructure, Transport and Tourism (MLIT), and other ministries. Key policy documents, including the Plan for Global Warming Countermeasures and the Basic Policy on GX, are jointly developed and supported by working-level coordination teams. Initiatives such as carbon pricing and the designation of decarbonization-leading areas are coordinated through these mechanisms, enabling cross-sectoral dialogue across energy, transportation, and urban policy.

Under the Act on Promotion of Global Warming Countermeasures, prefectures and municipalities are required to endeavor to formulate and implement comprehensive and well-planned measures to reduce greenhouse gas emissions in accordance with the natural and social conditions of their respective areas. Based on this framework, as of June 30, 2025, a total of 1,182 local governments—including the Tokyo Metropolitan Government, Kyoto City, and Yokohama City (comprising 46 prefectures, 655 cities, 22 special wards, 398 towns, and 61 villages)—have declared their commitment to achieving net-zero carbon dioxide emissions by 2050.

Stakeholder Consultation Platforms for Climate Change

Japan has established multiple platforms for stakeholder consultation on climate change. The Headquarters for the Promotion of Climate Change Measures, chaired by the Prime Minister, leads policy direction within the government. The advisory bodies to the Ministry of the Environment (MOE) and the Ministry of Economy, Trade and Industry (METI) to discuss the NDC and the energy mix engage experts, industry, and civil society in advising on policies such as the Plan for Global Warming Countermeasures.

The GX Implementation Council provides a forum for dialogue with the business sector. The GX League⁷ brings together companies, research institutions, and local governments through a public-private platform.

Region- and sector-specific platforms have also emerged, including the Climate Change Adaptation Information Platform (A-PLAT) by NIES and the Zero Carbon City Network, a coalition of carbon-neutral municipalities.

INTERNATIONAL COOPERATION

Some of Japan's international cooperation initiatives in Asia predate the Paris Agreement, while others emerged afterward. The Joint Crediting Mechanism (JCM), initiated in 2011, has served as a formal Article 6.2 mechanism since the adoption of the rulebook at COP26 in 2021.

In contrast, the Green Growth Strategy (Cabinet-approved in 2020) and the Asia Zero Emissions Community (AZEC, first leaders' meeting in 2023) were designed after the Paris Agreement to align with long-term decarbonization goals. As of May 2025, the JCM is implemented in 30 partner countries, with 80 registered projects, of which 37 have generated GHG reduction credits. As of Oct 2024, AZEC has led to 121 memoranda of understanding covering renewable energy, hydrogen, and ammonia supply chains, backed

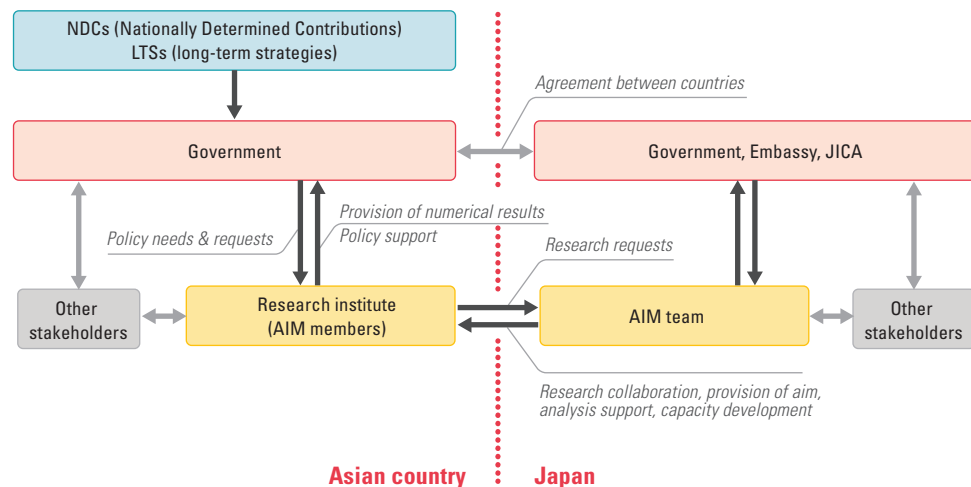
⁷ Launched by METI in 2022 and operating at full scale since FY 2023, the GX League is a voluntary corporate platform that serves as the pilot phase of the GX-ETS, scheduled to become mandatory in FY 2026 under the GX Promotion Act.

by Japanese technical and financial assistance. Green bonds and transition finance have also mobilized substantial capital for low-carbon infrastructure across the region. These efforts are driven by integrated financing and technology transfer, public-private collaboration, and alignment with international rules. The development of NDCs and long-term strategies in each country requires close collaboration between researchers and governments. The AIM team has supported capacity building in vari-

ous countries and facilitated knowledge sharing through international workshops. Recently, partnerships have been strengthened with MOEJ, the Japan International Cooperation Agency (JICA), and Japanese embassies abroad, reinforcing Japan's international cooperation efforts.

Figure 4 illustrates the ideal framework of cooperation between Japan and Asian countries. In countries such as Thailand and Indonesia, the AIM is being used to analyze NDCs and Long-Term Low Emission Development Strategies (LT-LEDS).

Figure 4. Scheme for supporting scenario analysis of long-term strategies in Japan and partner countries using the AIM model



Source: Hibino and Masui (2023) Development of AIM (Asia-Pacific Integrated Model) and its contribution to policy making for the realization of decarbonized societies in Asia. *Sustainability Science, Special Feature, Accelerating Actions for Leveraging a Climate-Neutral, Sustainable Society*. <https://doi.org/10.1007/s11625-023-01393-2>

A decade of national climate action: Stocktake and the Road Ahead

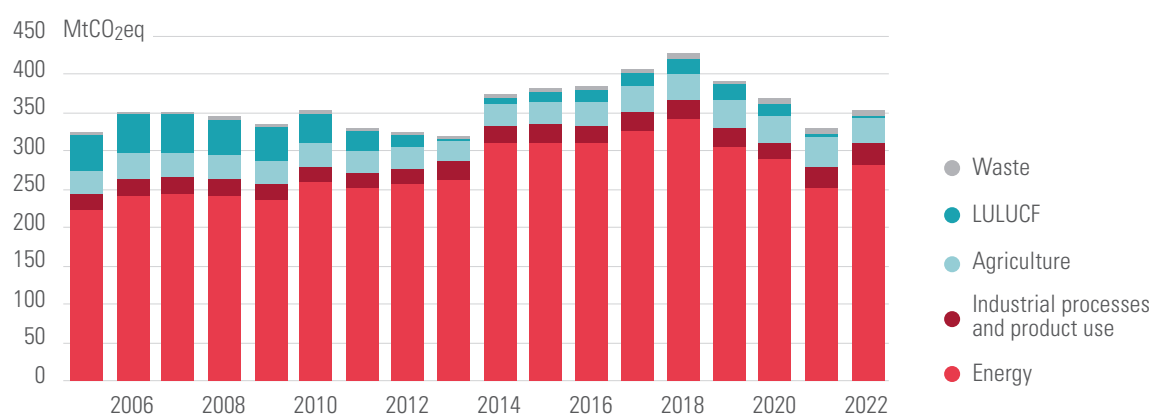
KAZAKHSTAN POST-PARIS DECARBONIZATION ACTIONS AND STRATEGIC PLANNING FOR CARBON NEUTRALITY

George Safonov, IDDRI

KEY NUMBERS

Kazakhstan, the largest economy in Central Asia, has positioned itself as a prospective regional leader in green and low-carbon development. During the 1990s, the country experienced a dramatic 40% decline in net greenhouse gas (GHG) emissions (including LULUCF), reflecting what can be described as an “unwilled and costly decarbonization.” This drop was primarily the result of a deep economic crisis, with GDP contracting by an estimated 35–40%, triggered by the dissolution of Soviet-era economic structures, widespread industrial collapse, and a sharp drop of population wellbeing. Following this turbulent decade, Kazakhstan entered a period of “recarbonization” beginning in 2000. Over the next two decades, net GHG emissions increased by 53%—an average annual growth rate of nearly 2%—driven by the recovery and fossil fuel-intensive development of the national economy.¹ Between 2005 and 2015, prior to Kazakhstan’s ratification of the Paris Agreement, net GHG emissions rose from 323 MtCO₂e to 380 MtCO₂e, marking a 23% increase despite emerging climate policy efforts (**Figure 1**). In 2013, Kazakhstan launched its national emissions trading scheme (ETS), the first in Central Asia. However, the scheme’s initial design failed to drive significant corporate mitigation. It was suspended

¹ UNFCCC, Kazakhstan - National Inventory Submissions 2024.

Figure 1. GHG emissions in Kazakhstan

Source: UNFCCC, Kazakhstan - National Inventory Submissions 2024.

in 2016–2017 to resolve operational issues and reform quotas allocation rules. Today, the ETS covers nearly half of national emissions and is regarded as the country's main regulatory tool for emission control. Its planned expansion to additional sectors and offset projects is expected to strengthen Kazakhstan's Paris Agreement implementation.

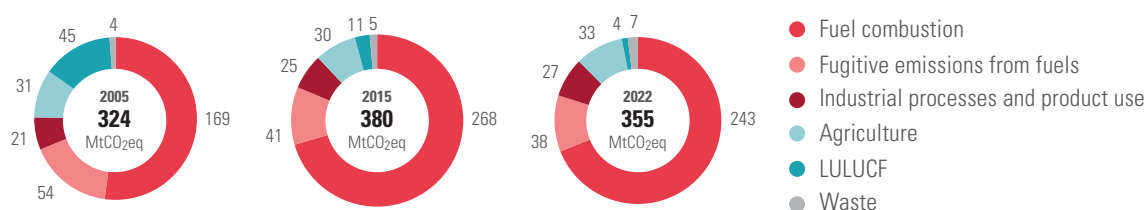
Following Kazakhstan's accession to the Paris Agreement in 2016, emissions continued to rise for three years (up 12%) before falling by 23% in 2019–2021. The initial decline in 2019 was driven mainly by weaker industrial output and lower energy demand, as several energy-intensive sectors—particularly metallurgy and oil refining—reduced production due to global market conditions and maintenance outages. Domestic coal use also dropped slightly, supported by milder weather and modest efficiency gains in the power sector. This temporary dip was amplified in 2020–2021 by the COVID-19 pandemic, which sharply reduced industrial activity, transport, and fossil fuel consumption, while also disrupting oil production and exports. Although energy efficiency improvements and the gradual uptake of renewables contributed marginally, the national ETS played only a secondary role compared to the pandemic-induced contraction. By 2022, emissions had rebounded slightly to around 350 MtCO₂e, underscoring that the decline reflected temporary circumstances rather than structural decarbonization. In 2023, GHG

emissions (excluding LULUCF) remained almost stable, according to the World Bank Group database.²

The fuel and energy sector remains a cornerstone of Kazakhstan's economy. In 2022, the hydrocarbon industry accounted for approximately 18% of GDP, generated over 35% of state budget revenues, and comprised around 60% of total exports (World Bank, 2023). For decades, coal has continued to dominate electricity and heat generation, shaping the country's emissions profile.

Fuel combustion represents the principal source of Kazakhstan's greenhouse gas emissions, with its share increasing from 52% in 2005 to 69% in 2022 (Figure 2). Fugitive emissions, primarily methane from oil, gas, and coal operations, constituted 17% of national GHG emissions in 2005 but declined to 11% by 2022, reflecting modest progress in leak detection and infrastructure improvements. The contribution of land use, land-use change and forestry (LULUCF) to net emissions dropped markedly over the same period, from 14% in 2005 to 2% in 2022, largely due to forest conservation efforts and changes in land management practices. Meanwhile, the shares of industrial processes, agriculture, and waste sectors have remained relatively stable, averaging 8%, 9%, and 2% of total emissions, respectively. Kazakhstan's ratification of the Paris Agreement in 2016 did not mark an immedi-

² <https://data.worldbank.org/indicator/EN.GHG.TOT.ZG.AR5?end=2023&locations=KZ&start=2005>

Figure 2. Structure of GHG emissions in Kazakhstan in 2005, 2015, 2022.

ate inflection point in these trends: emissions continued to grow until 2018 and only declined thereafter due to temporary economic factors, most notably the COVID-19 crisis, rather than structural mitigation efforts. This suggests that, up to now, the Paris Agreement had limited direct impact on the trajectory and structure of Kazakhstan's emissions.

A critical factor influencing Kazakhstan's GHG emissions trajectory is the aging and deteriorating production infrastructure, particularly within the energy sector mostly inherited from the Soviet era. The majority of the country's power plants operate on outdated technologies that have exceeded their design lifespans. As of recent assessments, approximately 60% of key power plant equipment is depreciated, with certain facilities exhibiting even more advanced stages of deterioration. Compounding this challenge is the poor condition of electricity and heat distribution systems, which suffer from systemic inefficiencies. In some regions, technical losses in distribution networks reach as high as 35% of total electricity transmitted. These infrastructure deficits significantly undermine energy efficiency and contribute to elevated emission intensities, underlining the urgent need for large-scale modernization and targeted investment in resilient, low-carbon energy infrastructure.

Kazakhstan's energy sector also faces other challenges, including methane emissions, which are a significant contributor to its GHG output. Efforts are underway to implement projects aimed at reducing methane leaks and improving overall emission control. The inclusion of methane in the national ETS and participation in the Global

Methane Pledge (GMP) initiative further underscore these efforts.

Nuclear energy is emerging as a potential cornerstone of Kazakhstan's strategy to enhance both energy security and decarbonization. Leveraging its status as one of the world's leading uranium producers, Kazakhstan is well-positioned to develop a domestic nuclear power sector. In 2024, a national referendum supported the construction of a nuclear power plant. Prospective reactor suppliers include Russia and China, with operations expected to commence by 2035. However, the proposed development has drawn strong criticism from environmental NGOs and independent experts. Opponents cite concerns over water scarcity, heightened risks from severe climate change, environmental impacts, and the long-term safety of nuclear technologies. Geopolitical risks, particularly the potential dependence on Russian nuclear technology, have also been flagged as a major vulnerability.

Agriculture is the second-largest emitter in the country, producing 33 MtCO₂e per year (as of 2022), primarily methane emissions from livestock. The sector is both impacted by and contributing to climate change, affecting water availability, land degradation, and deforestation. Forest management, afforestation and reforestation, modern agroforestry solutions, and land use practices can contribute significantly to reaching the decarbonization goals of the country. The initiative of expanding carbon farming was announced by Kazakhstan's President Tokayev in 2024, aiming to effectively utilize the vast land resources, especially in the areas affected by degradation and desertification.

ROLE OF LONG-TERM PERSPECTIVE

Kazakhstan's Doctrine (Strategy) for Achieving Carbon Neutrality by 2060 marks the culmination of nearly a decade of progressive efforts to “domesticate” the Paris Agreement and translate its global commitments into a coherent national policy framework. The Strategy estimates \$610 billion in required investments for deep decarbonization, of which only 4% is expected from government funds. More than half of the required financing (\$386 billion) is anticipated through reallocation of existing investment plans in the energy, transport, and industrial sectors, while \$224 billion will need to come from additional new investments. In the short term, about \$10 billion by 2030 is required to kick-start priority decarbonization measures.

The Strategy is closely linked to the government's sequential steps in aligning national policy with the Paris Agreement and its long-term development goals. The country has progressively strengthened its climate governance architecture since ratification of Paris Accord in 2016:

2016–2019: With support from international partners, Kazakhstan initiated capacity-building and analytical work to mainstream climate objectives into national and sectoral strategies. Early activities included modeling and analysis of long-term low-emission development scenarios, pilot studies and trainings on carbon markets, and incremental refinements of the domestic regulatory framework, particularly the national ETS. These efforts laid the groundwork for a more structured approach to implementing the Paris Agreement.

2020–2022: Comprehensive analytical materials were developed to assess longer-term decarbonization options. These served as the basis for the Strategy of Carbon Neutrality, which established a national strategic vision for achieving net-zero emissions by 2060. The Doctrine provided an initial assessment of the socio-economic and environmental impacts of the transition, as well as indicative cost estimates. This was the first official articulation of Kazakhstan's carbon neutrality goal.

2023–2025: These earlier building blocks converged in the adoption of the Strategy for Achieving Carbon Neutrality by 2060, formally endorsed at the highest political level. The Strategy set out detailed sectoral decarbonization pathways, including coal phase-out, large-scale renewable and nuclear energy development, hydrogen deployment, electrification of transport, improved energy efficiency, and the introduction of carbon capture technologies. To operationalize these commitments, the government launched in 2024 the development of a comprehensive Roadmap for Strategy implementation, supported by international partners. This unprecedented exercise—expected to be completed in 2025—engages hundreds of experts and think tanks across 18 thematic areas, ranging from sectoral targets (energy, transport, oil and gas, etc.) to financing instruments and regulatory mechanisms, making it one of the most ambitious climate policy design processes in the country.

Kazakhstan has committed to achieving carbon neutrality by 2060 - a goal first announced at the Climate Ambition Summit in December 2020. The Strategy was published for public comments in 2021 and officially adopted via Presidential Decree in February 2023. This Strategy represents a fundamental scaling up of ambition compared to the country's intended nationally determined contribution (iNDC) submitted ahead of COP21 in 2015, which was far from transformational. At that time, Kazakhstan pledged an unconditional reduction of 15% below 1990 emission levels by 2030, with the possibility of a conditional reduction of up to 25%, subject to international support. These targets reflected incremental improvements rather than systemic decarbonization, relying heavily on efficiency gains and modest structural changes. The shift from such limited, conditional pledges to a long-term carbon neutrality goal marks a significant change in Kazakhstan's climate policy narrative, aligning it more closely with global net-zero trajectories, even though implementation challenges remain substantial.

This long-term commitment is underpinned by several strategic frameworks. The Green Economy Concept, originally adopted in 2013 and operationalized in the updated plan in 2024, sets targets for “alternative” electricity - defined as a mix of renewable and nuclear sources - at 30% by 2030 and 50% by 2050. To some extent, this marks a noteworthy change that can be attributed to the momentum created by the Paris Agreement: while the original 2013 concept emphasized incremental diversification of the energy mix, the 2024 plan situates renewable and low-carbon energy expansion more explicitly within Kazakhstan’s carbon neutrality narrative. This reflects a shift from policy measures framed largely around energy efficiency and diversification toward an integrated decarbonization agenda, consistent with the broader international pressure and norm-setting effects of the Paris process. At the same time, the context for Kazakhstan’s businesses and investors has changed significantly: global growth in green investment flows is reshaping access to finance, while international carbon regulation frameworks such as the EU’s Carbon Border Adjustment Mechanism (CBAM) directly affect Kazakhstan’s export-oriented industries, especially in steel, cement, and fertilizers. In parallel, the rapid diffusion of ESG reporting standards and carbon footprint disclosure requirements - often demanded by foreign partners and international capital markets - are placing increasing pressure on Kazakhstani companies to improve transparency and align with global low-carbon practices. Together, these external drivers reinforce the domestic policy shift, suggesting that Kazakhstan’s 2024 plan reflects not only internal political will but also the international dynamics catalyzed by the Paris Agreement.

A key element of Kazakhstan’s forward-looking climate policy is the Roadmap to Carbon Neutrality, drafted by a large group of experts under the supervision of the Ministry of National Economy. As of May 2025, the Roadmap has been released for stakeholder and public consultations. It includes sectoral decarbonization plans for energy, transport, industry, waste, forestry, land use, and

agriculture, alongside regulatory mechanisms such as an emissions trading system, green finance mechanisms and carbon offsetting projects. The Roadmap adopts a phased approach, outlining near-term regulatory reforms, medium-term technology deployment, and long-term structural shifts across the national economy. The Strategy estimates a total investment requirement of \$500-610 billion by 2060, with financing mapped across a range of public and private instruments designed to intensify the green transition.

Despite these high-level commitments, Kazakhstan faces significant challenges in operationalizing its long-term vision. Institutional fragmentation, overlapping mandates, and policy inconsistencies persist. While strategic goals are well-articulated in national documents, their implementation is hampered by continued coal subsidies, delayed energy pricing reforms, and weak enforcement of environmental and energy efficiency standards. These issues contribute to a disconnect between ambition and execution, undermining investor confidence and slowing progress.

Nevertheless, the long-term perspective has provided a critical anchor for Kazakhstan’s climate policy discourse, helping to align national objectives with global climate goals, promote cross-sectoral coordination, and attract international cooperation. The continued refinement of the Long-Term Low Emission Development Strategy (LT-LEDS) and integration of its scenarios into public investment and regulatory processes remain essential to closing the gap between vision and action.

According to the Ministry of National Economy, Kazakhstan’s GHG emissions are projected to decline from 353 MtCO₂e in 2022 to 327 MtCO₂e by 2030, 163 MtCO₂e by 2050, and reach net zero by 2060. Sectoral projections indicate substantial reductions in the energy, transport, building, and waste sectors, alongside incremental carbon removals from forestry and large-scale deployment of carbon capture and storage (CCS) technologies, although the latter remain under-defined.

Kazakhstan’s analytical and scientific support for decarbonization policy dates back to 2014, when government agencies coordinating the country’s

iNDC initiated expert and stakeholder consultations on 2030 targets, ahead of the Paris COP21. Early assessments by teams from EBRD, USAID, and Nazarbayev University proposed moderate targets of 10–15% reductions from 1990 levels by 2030. However, after a critical review and assessment of adopted sectoral goals by a group of independent experts and the Green Academy Centre, the government approved more ambitious targets: a 15% unconditional and 25% conditional reduction by 2030.

Despite resistance from anti-decarbonization lobbies, these targets were retained in Kazakhstan's first NDC (2016) and updated NDC (2023), forming the foundation of the country's long-term carbon neutrality strategy. However, this continuity does not represent a genuine rise of ambition as envisioned under the Paris Agreement's five-year review cycle, but rather the avoidance of backsliding. The NDC targets for 2030 remain modest and essentially incremental when compared to the transformational challenge of achieving net-zero by 2060. The critical issue lies in the internal consistency of Kazakhstan's long-term perspective: the 2030 targets, if left unchanged, risk locking in a pathway that is incompatible with a credible 2060 net-zero trajectory. Without a strengthened interim target that reflects both the Paris ratchet mechanism and the mounting international pressures the credibility of the 2060 neutrality pledge remains questionable, as short-term ambition does not yet align with the long-term vision. However, the ongoing preparation of NDC3.0 reflects a continued lack of ambition, as policymakers tend to debate whether to adhere to the previously determined 15–25% reduction targets rather than advancing more stringent goals.

The policy landscape now increasingly reflects the integration of long-term climate goals into national development planning. The government was supported by extensive analytical work, including cost-benefit analyses, emissions scenarios, and macroeconomic modeling aligned with Paris-compatible trajectories. Notably, the GIZ-supported project (2020–2022), in cooperation with local think tanks, significantly contrib-

uted to outlining Kazakhstan's decarbonization opportunities and timelines. The analysis provided sectoral pathways, investment needs, socio-economic and environmental benefits, and policy sequencing options, thereby helping to translate the 2060 carbon neutrality goal into more tangible medium-term actions. Other key contributors include the World Bank, EBRD, and ADB, which emphasized financing strategies and technology deployment, as well as the OECD and IDDRI under the Sustainable Infrastructure Programme in Asia (SIPA), which highlighted governance reforms and cross-sectoral integration. Collectively, these analytical inputs serve to bridge the gap between high-level political commitments and actionable policy measures, offering Kazakhstan a more structured basis for aligning near-term targets with its long-term neutrality trajectory. Future research - such as the application of the IDDRI's Deep Decarbonization Pathways (DDP) Dashboard and the AFD-ESTEEM model - aims to further strengthen knowledge and capacity for the socio-economic and financial analysis of low-carbon transformation across key sectors.

EXAMPLES OF CONCRETE PROGRESS

Progress over the past decade includes meaningful developments in several sectors. In the energy sector, Kazakhstan has adopted renewable energy support programmes, initiated electricity grid modernization, and energy efficiency improvement through advanced standards, smart metering, and electrification of heating.

The renewable energy sector has witnessed significant expansion, particularly following the introduction of an auction mechanism in 2018. This competitive procurement system replaced earlier feed-in tariff schemes with technology-specific tenders, increasing transparency, reducing investor risk, and providing long-term power purchase agreements guaranteed by the state. According to some estimates, the auctions stimulated strong competition and resulted in a 55% reduction in renewable energy tariffs compared to pre-auction

levels.³ As of 2024, Kazakhstan had 154 operational renewable energy facilities with a combined installed capacity of just over 3 GW, comprising 51% wind, 40% solar, and 9% small hydropower. In that year, these renewables generated about 7.6 billion kWh of electricity, accounting for 6.4% of national output. The national plan aims for 8.4 GW of renewables by 2035, with investment inflows already exceeding USD 5 billion, largely supported by international financial institutions such as the EBRD, ADB, and Chinese development banks. The auction mechanism's strengths lie in its ability to attract foreign capital, lower generation costs, and create a predictable framework for investors. It also helped diversify Kazakhstan's energy mix while reducing fiscal burdens associated with fixed feed-in tariffs. However, its limitations include relatively small auction volumes compared to the scale of needed decarbonization, concentration of projects in resource-rich regions (southern and western Kazakhstan), and persistent challenges with grid integration and balancing capacity. In addition, limited local manufacturing capacity and policy uncertainty around future auction schedules have constrained the development of domestic supply chains. Thus, while the auction system proved effective in catalyzing initial growth in renewables, scaling up toward the 2035 and 2060 targets will require addressing these structural barriers, alongside complementary investments in transmission infrastructure, storage, and regulatory reform.

Electricity market reforms initiated in 2019 sought to increase competition and transparency in Kazakhstan's wholesale power market. Key elements included the gradual move from administratively set tariffs toward market-based pricing for generation, the strengthening of the Financial Settlement Center to ensure reliable payments to independent producers, and the introduction of clearer rules for market access. These changes helped reduce payment risks, improve contract enforcement, enhance investor confidence and facilitate greater participation by private and foreign investors, particularly in renewables.

The strengths of this reform design lie in its improved transparency, reduced counterparty risk, and more predictable investment environment. The reforms also created a framework that could, in principle, better integrate renewable projects through auctions and long-term power purchase agreements. However, several limitations have constrained the decarbonization impact. Persistent fossil fuel price distortions, especially state-regulated, below-cost coal and natural gas prices, undermine the competitiveness of renewables by artificially lowering baseline electricity costs. Cross-subsidization between industrial and household consumers continues to obscure true cost signals, dampening incentives for efficiency and low-carbon investment. The absence of a robust balancing market and limited grid flexibility hampers large-scale integration of variable renewable energy. As a result, the reforms improved market functioning but fell short of creating strong structural incentives for decarbonization, which will require addressing fossil fuel subsidies, strengthening carbon pricing, and modernizing the grid.

Kazakhstan joined the Global Methane Pledge in 2022 and considers concrete actions to reduce methane emissions, primarily in the energy sector at the first stage. Pilot leak detection and repair (LDAR) programs have been introduced in cooperation with the World Bank and UNEP. Satellite monitoring technologies are now utilized for flare verification and leakage detection. Also, Kazakhstan is aligning its methane reporting protocols with international MRV standards through steps toward compliance with Oil & Gas Methane Partnership 2.0 (OGMP 2.0) requirements.

In the transport sector, the government has launched a phased vehicle renewal program, eased regulations for EV imports, and invested in rail and public transport improvements. This integrated approach combines technology adoption, infrastructure upgrades, and fleet modernization, which helps reduce emissions and improve air quality. Its strengths include a clear focus on shifting away from the most polluting vehicles and supporting alternatives to private car use. However, EV adoption is still hampered by high

³ https://www.korem.kz/eng/press-centr/novosti-otrasli/?cid=0&rid=7283&utm_source=chatgpt.com

costs and limited charging infrastructure, while rail and public transport expansion requires long-term financing and better institutional coordination. Overall, these steps move the sector in the right direction but remain insufficient to fully align with long-term decarbonization roadmaps, which foresee near-total electrification of transport and major reductions in car dependency. In the buildings sector, stricter thermal insulation norms and programs for the deployment of heat pumps are being introduced to cut emissions and reduce energy demand. This approach leverages both regulation and technology deployment, with strong potential for energy savings and cost reductions for households. Its strengths lie in creating structural efficiency gains and promoting cleaner heating systems. Yet, progress is limited by the slow turnover of building stock, high upfront costs of retrofits, and insufficient household access to finance and subsidies. Without stronger support schemes and wider private investment mobilization, the pace of efficiency improvements will fall short of long-term strategies and the 2060 carbon neutrality roadmap, which require widespread deep renovations and near-zero-emission buildings.

EXAMPLES OF CONCRETE BLOCKAGES

Despite notable policy reforms and strategic commitments, Kazakhstan's decarbonization efforts continue to face significant structural and systemic barriers. Coal remains deeply entrenched in the country's energy system, both politically and economically. It accounts for approximately 67% of electricity generation and 80% of thermal energy production.⁴ About 32,000 direct jobs in coal-dependent regions⁵ create strong socio-political inertia against rapid phase-out.

One major challenge is the slow pace of fossil fuel subsidy reform, which continues to distort energy prices and weaken market signals for low-carbon investments. IEA estimated the total subsidy level at 1.8% of national GDP (as of 2019).⁶ These subsidies continue to distort price signals, discourage private investment in low-carbon technologies, and impede energy market liberalization. Efforts to reform subsidies have encountered strong resistance from vested interests in the coal and oil sectors.

Coal production and use receives substantial subsidies, estimated at around USD 2.2 billion annually.⁷ These subsidies are delivered in various forms, including direct financial support to energy producers, public investment in coal-related infrastructure, tax incentives for mining operations, and price controls on goods and services that reduce production costs. Such measures distort energy markets, undermine the competitiveness of renewables, and weaken incentives for diversification.⁸

Decarbonization of the industrial hard-to-abate sectors, especially in steel and cement production, is constrained by technological and financial limitations. Kazakhstan's ETS remains underdeveloped, with carbon prices below USD 1 per ton of CO₂,⁹ minimal compliance flexibility, and continued free allocation of allowances. As a result, the ETS exerts little pressure on industry to adopt low-carbon technologies. There is also a notable absence of commercial-scale CCS initiatives, green hydrogen pilots, or electrification strategies, which are critical for aligning heavy industry with long-term emission reduction pathways.

Urban transport and building energy efficiency remain underdeveloped largely due to a combination of weak enforcement, insufficient supporting policies, and gaps in strategic imple-

⁴ Beisengazin K. (2025) Coal Sector of Kazakhstan: Challenges and Opportunities for Decarbonizing the Economy, UNCTAD, Integrated Policy Strategies and Regional Policy Coordination for Resilient, Green and Transformative Development: Supporting Selected Asian BRI Partner Countries to Achieve 2030 Sustainable Development Agenda, Project Paper No. 26.

⁵ Ministry of Industry and Construction of Kazakhstan, AMM: Coal industry of Kazakhstan, 7 June 2024 <https://www.gov.kz/memleket/entities/mps/press/news/details/788299?lang=ru>

⁶ IEA (2020) Value of fossil-fuel subsidies by fuel in the top 25 countries, 2019 <https://www.iea.org/data-and-statistics/charts/value-of-fossil-fuel-subsidies-by-fuel-in-the-top-25-countries-2019>

⁷ IEA (2020) Value of fossil-fuel subsidies by fuel in the top 25 countries, 2019 <https://www.iea.org/data-and-statistics/charts/value-of-fossil-fuel-subsidies-by-fuel-in-the-top-25-countries-2019>

⁸ Agora Energiewende and Qazaq Green (2024): Enabling a just coal transition in Kazakhstan. Opportunities, challenges and strategic pathways.

⁹ ICAP, Kazakhstan Emissions Trading System 2025. https://icapcarbonaction.com/fr/ets_system/46

mentation. Electric vehicles account for less than 1% of the national vehicle fleet, reflecting both the absence of strong financial incentives and the lack of adequate charging infrastructure. Similarly, while building codes intended to enhance energy efficiency formally exist, enforcement is limited, and compliance remains low, especially outside major cities. Public transport infrastructure is unevenly distributed, with metro systems confined to Almaty and most other urban centers lacking comprehensive electric mobility solutions. Deployment of electric buses and other low-carbon options remains negligible, in part because of inadequate subsidy schemes, limited municipal financing, and insufficient integration of urban transport planning into national climate strategies. Taken together, these gaps suggest that the main barriers are not only technological or financial but institutional — namely, weak enforcement capacity and the absence of a coherent, well-resourced policy framework to accelerate change at scale. Progress in emissions reduction within the Agriculture, Forestry, and Other Land Use (AFOLU) sectors remains limited. In agriculture, sustainable land-use practices and low-emission production methods have not been sufficiently scaled up. The sector continues to lack dedicated mitigation programs, policy incentives, and investment frameworks to support a transformative shift toward climate-resilient and low-carbon agricultural systems. Sustainable forest management and afforestation are recognized as important pillars of the national carbon neutrality strategy. However, the scale and effectiveness of mitigation actions remain constrained. Despite the launch of the Presidential “Two Billion Trees by 2030” initiative, implementation has been modest, and afforestation outcomes have yet to match the ambition of the target.

Kazakhstan's pathway to a low-carbon economy is obstructed by a complex mix of economic dependencies, institutional inertia, distorted market incentives, and technological gaps. Overcoming these barriers will require coordinated policy action across sectors, acceleration of subsidy reform, enhanced enforcement of regulatory frameworks, and substantial investment in inno-

vation and green infrastructure. Without systemic interventions, the country's long-term climate commitments risk remaining largely aspirational.

LINKS WITH NON-CLIMATE QUESTIONS

Climate policies in Kazakhstan intersect closely with key economic, social, and fiscal priorities. Its economic growth is largely based on gas and oil revenues, accounting for around 35% of GDP and 75% of exports (as of 2023).¹⁰ This dependency creates significant vulnerability to fossil fuel market volatility and introduces tension between climate objectives and fiscal sustainability.

Since 2015, there has been little substantive evolution in addressing the social dimension of the transition. While national strategies increasingly emphasize carbon neutrality and sectoral decarbonization measures, policies to support workers and communities dependent on fossil fuel industries have not advanced. Employment transitions remain a critical blind spot: coal regions such as Karaganda and Pavlodar still host tens of thousands of jobs directly linked to the fossil fuel economy, yet no comprehensive national just transition strategy has been adopted. The absence of retraining programs, labor mobility measures, or targeted social protection mechanisms means that local populations see decarbonization primarily as a threat to livelihoods, rather than an opportunity. This neglect has generated persistent resistance to reform among affected communities and local authorities, reinforcing political inertia. The lack of progress on the social dimension stands out as one of the most significant gaps between the net zero target and the strategies designed to achieve it, undermining both the feasibility and social legitimacy of the transition.

From a macroeconomic perspective, delayed reforms in Kazakhstan's climate policy and energy systems pose growing risks to competitiveness. The introduction of the EU CBAM and tightening global ESG requirements may reduce access to

¹⁰ Crédit Agricole Group (2025), Kazakhstan - Economic and political overview <https://international.groupecreditagricole.com/en/international-support/kazakhstan/economic-overview>

international markets and capital for carbon-intensive industries if proactive adjustments are not implemented. Kazakhstan's key export sectors - aluminium, iron and steel, and fertilizers - are directly affected by the EU's CBAM, with potential export losses of up to \$250 million/year by 2035. If CBAM expands to more sectors, petroleum products and chemicals could also face major trade impacts, raising potential losses to over \$1.4 billion/year.¹¹

There are initial signs that these threats are beginning to trigger policy attention, though not yet at the scale needed for a credible low-carbon transition. CBAM could potentially create a strong indirect incentive for Kazakhstan to decarbonize its industrial base in order to maintain EU market access. Sectoral discussions have emerged around deploying renewable electricity for energy-intensive industries, investing in green hydrogen pilots, and considering carbon footprint certification for exports. However, progress has been negligible yet: industrial modernization projects remain limited, the carbon pricing system is underdeveloped, and no comprehensive industrial decarbonization strategy has been adopted. Without stronger policies, such as targeted support for low-carbon industrial technologies, robust carbon pricing aligned with EU benchmarks, and measures to integrate producers into green value chains, the response risks being too slow and fragmented. As it stands, CBAM pressure is acting more as a warning signal than a transformative driver, but it could evolve into a catalyst if accompanied by a clear strategic pivot by the government.

Key socio-economic issues such as employment in coal-dependent regions, affordability of energy services, and the fiscal implications of climate-related investments are increasingly part of the national discourse. However, there remain significant gaps in the assessment of the socio-economic impacts of decarbonization policies and measures. While climate priorities are often linked rhetorically to economic diversifi-

cation, energy security, and investment strategy, these connections are not yet well studied or systematically integrated into policy frameworks.

GOVERNANCE

Climate governance in Kazakhstan has evolved significantly in recent years, though it still remains fragmented and inconsistent. Several institutional enablers have supported these changes. The creation of a dedicated Green Finance Committee, proposals for a more effective carbon pricing and reforms in national ETS, and gradual introduction of green procurement mechanisms demonstrate an expanding governance framework. Coordination across ministries has improved, with a central climate policy unit under the Ministry of Ecology, and inter-ministerial groups supporting policy design. Green financing channels are gradually maturing, with increased issuance of green bonds and development of taxonomies aligned with international standards.

The Ministry of Ecology and Natural Resources serves as the lead institution responsible for coordinating national climate policy and representing Kazakhstan in international climate negotiations under the UNFCCC framework. However, MENR's authority is limited by institutional capacity constraints and a lack of enforcement powers, which hinders its ability to ensure implementation across sectors, socio-economic assessments and sectoral regulations.

Core economic ministries, particularly the Ministry of National Economy and the Ministry of Finance, have yet to fully integrate climate objectives into macroeconomic planning, fiscal policy, and public budgeting processes. This disconnect weakens the government's capacity to strategically manage the transition to a low-carbon economy in a socially inclusive and economically sustainable manner. While international partners and donors have played an essential role in supporting Kazakhstan's climate agenda - offering technical expertise and financial assistance - there is an increasing need for more targeted cooperation. Priority areas include innovation

¹¹ World Bank Group (2024) Kazakhstan - Country Climate and Development Report, Background note - EU CBAM: Modelling the Impacts on Kazakhstan's Economy <https://openknowledge.worldbank.org/server/api/core/bitstreams/8ff1c67a-12c7-5b19-bcd6-bb89d3f14d87/content>

systems, green industrial policy, and financing mechanisms to support a just transition.

Institutional coordination remains a critical gap. Although inter-agency working groups exist, their mandates are often limiting their strategic impact. The National Coordination Council on Sustainable Development, established in 2018 to serve as a cross-sectoral platform, is coordinated by the Ministry of National Economy and plays a role of high-level advisory on SDGs. The Presidential Council on the Transition to a Green Economy provides a forum for discussion of green policy issues. However their mandates are consultative and their influence on policy implementation is limited.

A recent draft law proposes the establishment of a high-level Climate Council under the Prime Minister to centralize coordination and drive climate-related reforms. However, this body remains in the planning phase and currently lacks allocated funding. The absence of such an institution significantly impedes the integration of climate objectives into national development strategies and undermines efforts to implement systemic policy reforms.

Stakeholder participation in climate governance is also limited. Civil society organizations, private sector actors, and subnational authorities remain underrepresented in strategic planning and decision-making processes. Broader public engagement, including that of local communities and vulnerable populations, is minimal, reducing the legitimacy and effectiveness of climate policy. There have been meaningful steps toward strengthening institutional capacity in decarbonization and sustainability issues. Zhasyl Damu has taken on a central role in supporting the technical implementation and monitoring of Kazakhstan's ETS. Several ministries, including the Ministry of National Economy and the Ministry of Finance, have begun to engage with climate-related fiscal and investment planning, signaling a gradual shift toward mainstreaming climate considerations into economic governance.

In 2024, a new expert advisory group was established to guide the revision of Kazakhstan's NDC and coordinate international engagement. This group includes representatives from government

bodies, academic institutions, international partners, and the private sector, reflecting a more inclusive approach to climate policy formulation. While these developments mark important progress, sustained political commitment and institutional reform remain essential. Without a more integrated governance architecture and stronger enforcement mechanisms, Kazakhstan may struggle to achieve its long-term decarbonization targets and fully align with its international climate commitments.

INTERNATIONAL COOPERATION

International cooperation has been instrumental in supporting Kazakhstan's decarbonization. Over the past decade, multilateral development banks, UN agencies, and bilateral donors have provided analytical, financial, and capacity-building support. The EU, OECD, EBRD, ADB, and GIZ have contributed to sectoral strategies, infrastructure investments, and regulatory reform.

The European Bank for Reconstruction and Development (EBRD) has been a major partner, investing approximately USD 4.6 billion in green infrastructure since 2015. The Asian Development Bank (ADB) has played a key role in supporting renewable energy auctions and institutional capacity building, particularly in the solar sector. The World Bank has provided technical assistance on developing measurement, reporting, and verification (MRV) frameworks and methane emissions reduction strategies.

Despite these achievements, critical gaps remain. There is currently no targeted Just Transition Fund to retrain or support workers in coal-dependent regions, leaving a major gap in addressing social equity concerns within the transition. Reform of Kazakhstan's ETS requires international expertise and financial support, particularly to design and implement carbon allowance auction systems and to progressively tighten emissions caps in line with net-zero goals.

The technological cooperation remains underdeveloped. Pilot projects for carbon capture and storage (CCS), green hydrogen, and digital energy systems remain at a nascent stage,

with limited domestic funding and insufficient international co-financing. Bridging these gaps through expanded and targeted international partnerships will be critical to Kazakhstan's ability to deliver on its 2060 carbon neutrality ambition. Enhanced focus on technology transfer, concessional finance, and implementation of Paris Agreement's Article 6 mechanisms can provide the foundation for a resilient and inclusive low-carbon transition.

PATHWAYS FORWARD: STRATEGIC PRIORITIES

Kazakhstan's decarbonization trajectory depends on its ability to overcome structural inertia and fully leverage regional and international opportunities. The path to carbon neutrality by 2060 demands focused strategic action in five key areas:

- 1. Coal phase-out strategy:** The government must develop a comprehensive, socially just plan for transitioning away from coal. This includes preparing detailed timelines for mine closures, establishing robust job retraining and relocation programs for displaced workers, and supporting economic diversification initiatives in coal-dependent regions such as Karaganda and Pavlodar.
- 2. Institutional reforms:** Establishing a permanent, high-level climate coordination body under the Prime Minister's Office would enable more coherent, cross-sectoral governance. This institution should have a clear mandate, legal authority, adequate funding, and the ability to convene ministries, regional authorities, and key stakeholders.
- 3. Carbon pricing reform:** Strengthening Kazakhstan's ETS is essential. Introducing a minimum carbon price floor of at least USD 10 per ton of CO₂, phasing out free allocations, and aligning caps with the 2060 neutrality target will create market incentives for emission reductions and support clean investment.
- 4. Green industrialization:** The government should promote domestic value chains for green technologies, including wind and solar components, energy-efficient materials, and battery storage. Specific attention should

be given to the decarbonization of steel and cement sectors and to piloting green hydrogen production and application in industry.

- 5. Finance mobilization:** Kazakhstan must enhance access to climate finance through the issuance of sovereign green bonds, development of sustainable finance taxonomies, and participation in global climate funds. Blended finance instruments and public-private partnerships can help scale investments in infrastructure, innovation, and resilience.

These strategic priorities will be pivotal in shifting Kazakhstan from incremental changes toward a transformative, resilient, and inclusive net-zero development model.

CONCLUSIONS

Kazakhstan is at a critical crossroads. Its 2060 carbon neutrality pledge signals a clear ambition to lead regional efforts in climate action. Over the past decade, the country has made tangible progress in renewable energy deployment, institutional reform, and international cooperation. However, systemic barriers, including fragmented governance, fossil fuel dependence, and inadequate enforcement, continue to undermine the pace and depth of the transition. Bridging the implementation gaps will be decisive for Kazakhstan's climate credibility. Advancing policy coherence, scaling up investment, and delivering a just transition for workers and communities are essential next steps. Success will depend on transforming political will into operational capacity, aligning economic structures with climate goals, and sustaining international partnerships. By confronting these challenges, Kazakhstan can affirm its role as a regional climate leader and chart a path toward a sustainable and inclusive low-carbon future.

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A decade of national climate action: Stocktake and the Road Ahead

MEXICO

SINCE THE PARIS AGREEMENT: ACTION AND DELAY IN THE FACE OF CLIMATE CHANGE

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OVERVIEW: MEXICO HAS FALLEN FROM CLIMATE LEADER TO CLIMATE LAGGARD

When the Paris Agreement was adopted, Mexico was recognised for its record of climate leadership. In 2010 it had hosted COP 16 in Cancún, which was crucial to rebuild trust in the UNFCCC process after the acrimony of Copenhagen the previous year. 2012 had seen the unanimous adoption of the national Climate Change Law (LGCC), making Mexico one of the first countries to do so. And the previous 15 years had seen a steady reduction in energy system costs, emissions, and air pollution, largely driven by a replacement of oil products by imported natural gas, primarily for electricity generation but also for industrial and commercial energy needs. Today, however, Mexico is a visible climate laggard, with NDC ambition behind many of its Latin American peers, weakened budgets and institutions to support planning and action, years of stagnant investment in renewables, and a renewed commitment to fossil fuel production, commercialization and use.

While the impact of the Paris Agreement on global climate action is a topic for debate, Mexico's climate and energy policy over the past 10 years have followed the country's internal political journey far more than any external

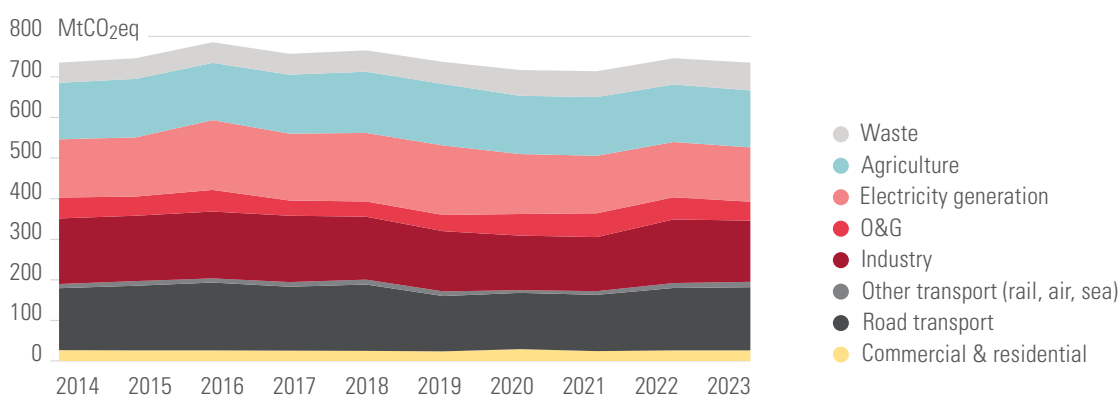
driver. Energy policy has been central to all Mexican governments during this period, with climate concerns playing a distant second, meaning that climate (in)action has largely been a consequence of the political priorities for energy of the administration in turn. As for Mexico's standing in the international community, this has reduced in importance for Mexico's leaders compared to 2015, diminishing the influence of one of the key mechanisms originally expected to drive progress in the Paris Agreement architecture.

Key data on emissions and electrification testify to Mexico's decline from climate leader to climate laggard. Over the past decade Mexico has shown

low economic growth (1.2% pa) and somewhat lower GHG emissions growth (0.4% pa), pointing to a 0.8% annual reduction of emissions intensity per GDP. This is consistent with gradual efficiency improvements rather than any evidence of climate action.

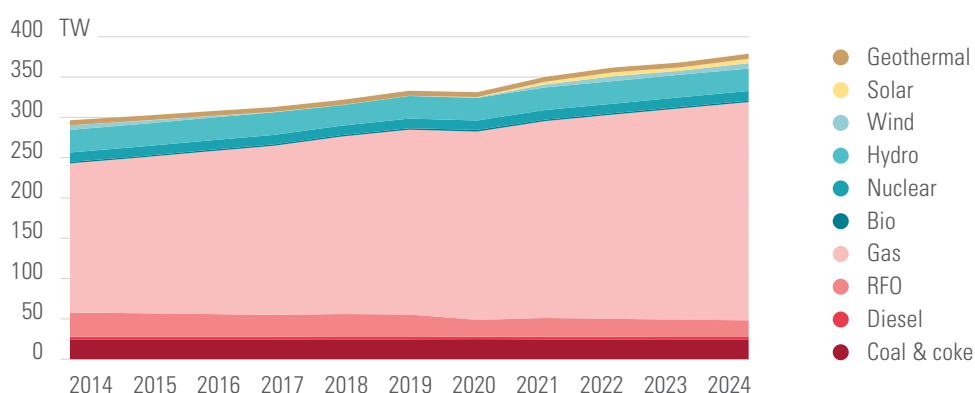
With regards to the electrification and decarbonization of the electricity sector central to any decarbonization scenario for Mexico, electricity has maintained a similar share of the national energy balance, with the share of fossil fuels in electricity production increasing slightly, as the growth of generation with natural gas has been faster than that of renewables.

Figure 1. GHG emissions by sectors in Mexico over the past decade



Source: Own analysis based on official information: the national GHG inventory (INEGyCEI_1990-2023)
(see <https://www.gob.mx/inecc/documentos/investigaciones-2018-2013-en-materia-de-mitigacion-del-cambio-climatico>).

Figure 2. Electricity generation by energy source in Mexico over the past decade



Source: Own analysis based on official information: the national GHG inventory (INEGyCEI_1990-2023)
(see <https://www.gob.mx/inecc/documentos/investigaciones-2018-2013-en-materia-de-mitigacion-del-cambio-climatico>).

At the time of the adoption of the Paris Agreement, there was a broad recognition among scientists, civil society, and parts of the government that a shift away from fossil fuels would be needed, and that nascent green industries such as renewable energy, electric vehicles, and green fuels (including hydrogen and derivatives) would all require significant stimulus to drive continuing economic growth as fossil fuel activity declined. This concept of green growth showed Mexico to be a country well placed to take advantage of the shift, with its huge and high-quality renewable resource (particularly solar), high level of industrialization, infrastructure and integration into global supply chains (particularly in the automotive industry and manufacturing more broadly), and its economic openness and qualified workforce. Today, Mexico has failed to scale up renewable generation capacity, it has yet to formulate an approach to the green fuels / green hydrogen opportunity, and has hardly engaged with the green industrial potential other countries are leading on. Recent announcements of EV manufacture in Mexico are driven by US and Chinese companies seeking to locate their own manufacturing, reflecting how other countries that moved faster are now consolidating global positions in industries that Mexico has yet to engage with, despite its favourable initial conditions.

How did this happen? Structural inertia, political discord, and an unwillingness to engage with a vision of sustainable economic and energy system development have slowed Mexico's entry into the green economy, committing its economic structures to decades of further emissions, and making the transition even harder today than it was a decade ago. In spite of this, many green economy opportunities are still available to Mexico,

but can only be achieved if the transition to a carbon-neutral future is put at the centre of development plans from this moment onwards.

TIMELINE: HOW THE FOSSIL FUEL DEVELOPMENT PARADIGM STRENGTHENED ITS GRIP ON POLICY AND REVERSED INITIAL CLIMATE GAINS

Climate, environmental and energy policy in Mexico from 2015 to date have been dominated by the vision of economic development guiding each of the three presidential administrations in office during this time. At the time of the Paris Agreement adoption, Mexico was generally perceived to be a leader in climate action within Latin America and globally, largely because of the importance of COP16 held in Cancún in 2010, the adoption of the General Climate Change Law by a unanimous Congress in 2012, and the important reduction in emissions from the power sector during the previous decade. However, all of these were achieved during the Calderón administration (2006-2012), prior to the Enrique Peña Nieto (EPN) administration, which took office in December of 2012 and presided over the country during the negotiation and adoption of the agreement and until 2018.

2015-18

Upon taking office, the EPN government stated its intent to continue the successes in climate policy from its predecessor – despite representing a different political party – including within the sweeping energy sector reform it proposed as one of its flagship policies. The reform addressed both hydrocarbons and electricity, with the

Table 1: Fuel shares in Mexican electricity generation since 2014

	Power generation by fuel type (GWh)			Share of generation by fuel type (%)	
	2014	2024	CAGR	2014	2024
Fossil fuels	243,272	319,056	2.70%	82%	84%
Nuclear	11,800	11,800	0.00%	4%	3%
Renewables	41,634	48,303	2.10%	14%	13%

intention of increasing investment – including foreign investment – to enable Mexico to increase energy production and reduce energy costs for the economy. The reform introduced new modalities for foreign participation in oil and gas upstream operations, which until that time had been exclusively in hands of PEMEX, the state-owned oil company. These ranged from co-investment with PEMEX to licence contracts for offshore exploration and production, ending decades of exclusive state monopoly. In addition, the growth in imports of cheap shale gas from the US was further stimulated by investments in additional pipelines from the border to Mexico's centres of demand.

While these measures clearly intended to increase fossil fuel production and use, they were presented as aligned with climate objectives under the guise of driving cleaner and more efficient operations (e.g. reducing scope 1 and 2 emissions from hydrocarbon production) and, in the case of natural gas imports, driving the substitution of dirtier fossil fuels. This inclusion of natural gas as a “clean” fuel was not unique to Mexico in the pre-Paris Agreement era, however, it became one of the central pillars supporting the claim by the EPN administration that the energy reform was in line with the requirements of the General Law for Climate Change.

In contrast, the electrical sector reform, dominated by national utility CFE, contained several measures with true potential to enable progress towards climate goals. These include the introduction of “Clean Energy Certificates” (CELs) and an obligation on CFE to produce such certificates for a share of its yearly sales (broadly analogous to renewable energy obligations but applicable to the definition of “clean” energy as presented in Mexican regulation); renewable capacity auctions for private development of renewable generation capacity which included power purchase agreements from CFE; the introduction of carbon tax on fossil fuels; and the promotion of an Emissions Trading Scheme (ETS) for major emitters.

The renewable energy auctions achieved notable successes, bringing down the levelized cost of Solar PV and Wind energy far below expect-

tations. For instance, in the third long-term auction (2017), solar bids reached as low as USD 20.82 MWh + CELs, with earlier rounds already delivering bids around USD 31.37 MWh + CELs¹. Across the first three auctions (2015-2017), contracts for approximately 4.9 GW of new renewable capacity were awarded. However, the level of CELs required of CFE was initially set at only 5% of electricity sales by 2018, a threshold widely considered insufficient to drive deployment of renewable generation consistent with Paris Agreement trajectories². In a similar vein, the carbon tax on fuels, adopted in 2014 was fixed at USD 3.5 per ton of CO₂, a rate so low that it was barely perceptible, especially for gasoline. Moreover, natural gas was fully exempt from the tax, ensuring that the policy – a potential game changer – had a marginal impact on the real energy economy. The ETS has undergone numerous design and consultation processes since its initial announcement in 2014, but is not yet operational over 10 years later. In this manner, the climate change elements of the EPN administration energy reform allowed Mexico to claim important progress in climate action, while not significantly interfering with the core vision of the energy sector reform, nor reducing the participation of fossil fuels in the energy mix.

On the international arena, Mexico's climate action sought to demonstrate leadership through timely reporting. Mexico was one of a handful of countries to present its INDC by March of 2015, meeting the request that it be delivered well in anticipation of COP21. Likewise, Mexico's LTS was presented at COP22 in Marrakesh in November of 2016, far before most other countries. However, while these displays of prompt observance won initial praise, the content of both documents was eventually seen as disappointing, with low-ambition targets and very limited clarity on implementation.

Internal climate policy included numerous instruments, of which the only one with concrete

¹ See: <https://psj.lse.ac.uk/articles/72/files/submission/proof/72-1-141-1-10-20190813.pdf>

² See: <https://www.hks.harvard.edu/sites/default/files/degree%20programs/MPAID/files/Guadarrama%2C%20Carlos%20SYPA%20final.pdf>

commitments from government agencies was the PECC (Special Programme for Climate Change), which solely addressed changes within the operations of the federal government. To illustrate how limited this is, in many countries the commitments of the Ministry of Transportation or of Agriculture describe actions to be taken within those sectors of the economy, to reduce emissions by millions of tons of CO₂ across roads, farms, etc; in Mexico, the equivalent Ministries committed only to managing their own estates and transportation fleets, targeting reductions in thousands of tons of CO₂, and setting no expectations regarding emissions within the broader economy.

Despite the laxity and limited ambition with which the EPN administration implemented climate policy, the adoption of the relevant instruments in national legislation is recognized as an important step and a clear climate success. Environmental groups at the time considered that accepting the initial low requirements in order to not disrupt immediate energy investments was a price worth paying to achieve such policy gains: going forward, the climate debate could focus on increasing the ambition of these obligations and taxes to guide the energy system towards lower emissions, rather than struggling to create legislation to put such instruments in place.

2018-24

In December of 2018, Peña Nieto was succeeded by Andrés Manuel López Obrador (AMLO) as President of Mexico. AMLO's campaign claimed many of EPNs policies were contrary to his aspirations for social justice and poverty reduction, leading his government to dismantle many of the EPN policies and institutional arrangements. Energy policy – core to Mexico's concept of national sovereignty since the nationalization of the oil industry in 1938 – was an area of particular focus. In addition, AMLO emphasized how his government would cease to favour the more affluent over lower income groups. As part of this narrative, climate and environmental issues were framed as less urgent than reducing inequality and achieving energy self-sufficiency. For exam-

ple, he dismissed international climate forums such as COP26 as “hypocrisy and fashions,” arguing that the true global challenge was inequality³. As a result, the change of administration severely disrupted the nascent climate policy regime, with state ownership and direction of energy production retuning to centre stage, closing down options for private and foreign capital to participate.

AMLO's administration prioritized large-scale fossil fuel infrastructure as the central element of its energy policy, deliberately increasing the importance of PEMEX, despite its financial and operational challenges. Notable initiatives include the construction of the Dos Bocas (Olmeca) refinery and the acquisition of the Deer Park refinery in Texas. The Dos Bocas project, initially budgeted at approximately USD 8 billion, has more than doubled in cost to around USD 16.8 billion⁴ and continues to underperform operationally. In May 2025, the plant processed a total of 43,392 barrels per day of gasoline, which represents approximately 25% of its intended gasoline production capacity. However, the plant's overall crude throughput is still significantly lower than its 340,000 barrels-per-day capability⁵.

In the same period, PEMEX acquired Shell's 50 percent stake in the Deer Park refinery for USD 596 million, in addition to assuming about USD 1.2 billion in debt⁶. These investments took place despite Pemex's fragile financial situation: between 2019 and 2024, the federal government injected roughly MXN 1.38 trillion in tax relief and direct support to sustain the company, without reversing its position as the most indebted oil firm in the world⁷. Instead of consolidating PEMEX's finances, these projects deepened its

3 See: <https://elpais.com/mexico/2021-11-03/lopez-obrador-se-lanza-contrala-cop26-ya-basta-de-hipocresia-y-de-modas.html>

4 See: <https://www.reuters.com/business/energy/mexicos-new-pemex-refinery-still-needs-important-work-is-far-ready-sources-say-2024-06-24/>

5 See: <https://elpais.com/mexico/2025-07-20/sobrecostos-y-pocos-litros-de-gasolina-la-refineria-dos-bocas-entre-las-mas-caras-del-mundo.html>

6 See: <https://www.reuters.com/business/energy/mexico-says-us-government-approves-deer-park-refinery-deal-2021-12-22/>

7 See: <https://imco.org.mx/pemex-en-la-mira-analisis-de-resultados-al-segundo-trimestre-2025/>

debt burden and channeled public resources into capital-intensive fossil fuel projects with significant financial risks.

The negative impact of these actions on Mexico's decarbonization cannot be overstated. They aimed to strengthen energy sovereignty by increasing the share of Mexico's fuel consumption refined by the national oil company instead of in the US, however there was no refining bottleneck to address, nor did these investments reduce fuel costs for Mexican businesses and households. On the contrary, they represented important capital investments that have so far made little difference to fuel prices, with refinery delays and continued import dependence limiting any potential benefits, while diverting capital from renewable investments which would result in a lower LCOE, as proven by the low renewable electricity production costs revealed by the EPN auction process. While the EPN approach sought to increase oil export revenues leveraging foreign capital, the AMLO investments represent significant fossil lock-in – entirely on Mexico's books – with no revenue upside for the government and no cost upside for the economy, thus significantly hindering the country's ability to meet its international climate commitments.

On the electricity front, the AMLO administration cancelled the clean energy and transmission auctions, and reactivated coal and fuel-oil plants. The 2021 reform of the Electrical Industry Law prioritized dispatch from CFE assets over privately owned generation (as opposed to the lowest-cost criteria established previously, which favoured low-cost renewables), and re-defined the scope of the CEL renewable obligation certificates, granting certificates to legacy renewables instead of only new installations as per the original policy design, creating a glut which destroyed the market. This eliminated both drivers for CFE to buy the renewable power generated by the projects born of auctions held during the previous regime, and also weakened the ability of CELs to drive emissions reductions. The mandate of the network operator shifted from seeking to dispatch according to the system cost of energy, to doing so according to the strategic needs of

the new energy policies, which included the ability of PEMEX to place its “bottom of the barrel” fuel-oil. These measures favored PEMEX fuel use, with implications for electricity costs, renewable project revenues, and local air quality.

In terms of transportation, at the federal level, AMLO's administration published the General Law on Mobility and Road Safety (LGMSV) in May 2022, establishing the legal framework for mobility and road safety across the country, with no GHG reduction or climate content (23 states have harmonized local laws with the LGMSV⁸). This omission is a significant missed opportunity, since sustainable mobility policies could simultaneously reduce emissions, improve air quality, and enhance safety. Implementation is constrained by financing: most of the burden falls on states and municipalities, while federal resources are limited. For example, the National Road Infrastructure Program alone received about USD \$3.3 billion in 2025 for federal highways and bridges⁹, while no comparable federal allocation exists for urban public transport or non-motorized mobility. This imbalance highlights how federal priorities remain car-oriented, limiting the transformative potential of the LGMSV.

At the local level, several cities have advanced with innovative public transport projects, often in response to strong social demand rather than federal leadership. Mexico City now operates two Cablebús lines (9.2 km and 10.6 km), while the Metrobús BRT system – which began during the Calderón administration – has expanded to about 125 km and is beginning fleet electrification. Guadalajara inaugurated Line 3 of Mi Tren in 2020, stretching 21.5 km with 18 stations. Mérida recently launched the IE-TRAM, a 100% electric BRT system projected to cover more than 100 km and connect with the Maya Train. Cycling infrastructure has also expanded, exemplified by Mexico City's 28.5 km Insurgentes bikeway, created as a pandemic emergency lane and later consolidated. These city-level examples show

⁸ See: <https://www.gob.mx/sedatu/prensa/reporta-sedatu-avances-en-armonizacion-de-23-leyes-locales-con-la-ley-general-de-movilidad-y-seguridad-vial>

⁹ See: <https://mexicobusiness.news/infrastructure/news/road-infrastructure-program-advances-us33-billion-2025>

some successes in promoting urban transportation alternatives to private cars.

However, Mexico remains far from aligning its transport emissions with the Paris Agreement. The country's NDC commits to a 35% overall reduction by 2030, including 22% in the transport sector, with current measures falling very short. Despite the evidence that that compact urban form, transit-oriented development, and accessibility planning are essential to reducing vehicle use and emissions, while highway expansion tends to induce traffic and lock in fossil fuel dependency, car-centric infrastructure continues to be prioritized. The elevated expressways in Mexico City, for instance, which were started over a decade ago and have continued to be a priority for Mexico City and neighbouring States, are built exclusively for private vehicles, with no provisions for mass transit, active mobility, or electric or hydrogen fleets. Such investments entrench automobile dependence and make it harder to redirect cities toward sustainable, low-carbon futures.

Internal climate and environmental policy and institutions were also directly weakened by the AMLO administration. Budget cuts to SEMARNAT (Ministry of Environment and Natural Resources), the elimination of the Climate Change Fund, and the abolition of the arms-length technical body INECC (National Institute for Ecology and Climate Change) created by the 2012 LGCE, reduced technical and financial capacities for long-term and cross-government planning. This significant reduction of government capabilities set back years of progress from previous administrations, and was implemented at the same time as the international community was undertaking the first global stocktake of the Paris Agreement, which found that such capabilities must be significantly strengthened, particularly in developing countries.

The NDC update presented to the UNFCCC in 2020 repeated the mitigation goal of the 2015 INDC, going directly against the spirit of progression of the Paris Agreement. The international community noted these setbacks: the Climate Action Tracker rated Mexico's actions as "highly

insufficient," citing fossil fuel expansion and weakened policy instruments as incompatible with Paris goals¹⁰

2024-25

December of 2025 will mark the 10th anniversary of the adoption of the Paris Agreement and the first anniversary of the administration of Claudia Sheinbaum Pardo (CSP) in Mexico. Although promising political continuity with her predecessor and mentor López Obrador, Sheinbaum's administration has adopted a very different narrative with regards to energy, climate, and sustainability. During the past year, Mexico has formally adopted a net-zero target by mid-century, as well as the concept of eventually transitioning to a more renewable energy matrix. The President's own background as an energy and climate scientist and a former member of the IPCC has also given cause for optimism.

Indeed, energy system plans presented at the beginning of the current administration set a target of USD 23.4 billion in investment through CFE to add 13GW of new capacity by 2030, of which approximately 7 will be renewable and 6 fossil based, to be complemented by another 6.4 GW at least of new renewable capacity installed by private developers¹¹. To enable private participation, the government announced new mechanisms such as bilateral long-term contracts with CFE and "mixed producer" schemes¹², in which CFE retains majority ownership while private actors provide capital and technical expertise. These instruments are intended to bring in private investment without returning to the fully liberalized auction system used under the EPN administration. These plans represent a notable shift on renewable energy when compared to the

¹⁰ See: <https://climateactiontracker.org/countries/mexico/>

¹¹ See: <https://factorenergetico.mx/wp-content/uploads/2025/02/05febrero26-Plan-Fortalecimiento-y-Expansion-Sistema-Electrico-Nacional.pdf> <https://imco.org.mx/plan-nacional-de-energia-implicaciones-para-la-competitividad/#:~:text=El%20d%C3%ADa%20de%20hoy%2C%20la,capacidad%20instalada%20y%20transici%C3%B3n%20energ%C3%A9tica,&text=El%20plan%20de%20inversiones%20de,mmd%20a%20proyectos%20de%20distribuci%C3%B3n>

¹² "New arrangements are proposed such as 'mixed producers,' in which CFE will hold a majority stake while private actors contribute investment and technology, replacing the auction scheme of the previous administration." IMCO, 2024.

AMLO administration, although the new capacity will likely increase fossil generation by more than renewable generation (due to the very different utilization factors).

While the inclusion of utility-scale renewables and storage in energy system planning reflects an important shift, the centrality of CFE in planning and execution replaces market-based auctions with state-led expansion, narrowing the role of private and foreign investment. In practice, renewable growth is now being channelled through CFE-led projects or mixed ventures rather than through open competition that previously achieve reductions in renewable costs. The design aligns with the administration's emphasis on sovereignty and state planning, but raises questions about whether the scale and pace of deployment required to meet Mexico's international climate commitments can be achieved under this approach.

More recently, the federal government approved a major financial rescue of PEMEX that combines sovereign bond placements and structured operations to refinance near-term debt and provide fresh liquidity to the company. However, this package aims for stability more than growth for PEMEX, setting a production ceiling of 1.8 million barrels in recognition of the difficulty in increasing production from Mexico's depleting reserves. This is noteworthy in the context of previous production targets (never achieved): 3.2 mbpd (EPN) and 2.3 mbpd (AMLO), with the remainder of future energy demand officially expected to be covered by renewables.

The policy signal is mixed: on the one hand, the government has set an oil production ceiling and emphasized that in future demand growth should be met through renewable generation; on the other, it has committed substantial public resources to support PEMEX a heavily indebted company. The long-term narrative sees the share of renewable energy grow as it steps up to satisfy future demand growth, although the replacement of existing fossil fuel activity – responsible for the lion's share of current and future emissions given the low expected growth rates, is not contemplated. While stabilizing PEMEX is an understand-

able political objective to prevent disruptions to the energy and financial markets, only an investment programme that includes a strategic phase down of some assets and re-tooling of others towards green fuels can put Mexico back on the path to climate leadership: the current approach risks allocating scarce public capital to fossil fuel assets, limiting the scope for investment in lower-cost renewable energy.

ANALYSIS: GOVERNANCE, FISCAL, AND STRUCTURAL BARRIERS HAVE BLOCKED CLIMATE ACTION

These events and the resulting deterioration of Mexico's climate policy reveal important barriers to progress.

Governance

The preponderance of presidential preference as a core driver of climate policy, and the subservience of climate policy to energy policy, represent the most notable governance challenges behind Mexico's poor climate performance. Formally, the LGCE lays out an institutional framework to ensure that all three levels of government participate in climate policy formulation through the SINACC, with policy coordination in hands of an interministerial committee (CICC) chaired by the President. SEMARNAT (Ministry of Environment) is charged with leading policy formulation, in consultation with diverse stakeholders and leveraging inputs from INECC (National Climate Change Institute), an arms-length body charged with gathering scientific and technical information and insights to inform policy. However, these institutions have had little influence on climate policy decisions in practice (indeed INECC has been formally abolished with its functions subsumed into SEMARNAT). The ministries involved in the CICC define and pursue their climate goals (if any) in silos, with no instruments or processes in place to effectively set expectations or foster cooperation towards common goals, nor collaborative planning.

While Mexico's federal structure gives the 32 states important attributions, tax revenue is primarily gathered centrally and distributed to the states and municipalities by the federal government, limiting the scope of actions states can take autonomously. Furthermore, the energy market is dominated by the two state-owned monopolies PEMEX (oil, oil derivatives, and natural gas) and CFE (electricity) which have specific legal status as national companies and are both run by presidential appointees. As a result, Mexico's energy market rules and investments have favoured fossil fuels across the board, despite most states in Mexico not being oil states (i.e. without significant crude oil or oil refining operations), while failing to capitalise on the opportunities of renewable and distributed renewable generation for many States particularly those in the north and west of the country with high levels of solar irradiation and limited oil activity.

As a result, Mexico's official climate policy instruments since the adoption of the Paris Agreement reflect very limited ambition, and no plans for deep-seated system change, while they enjoy very little recognition within a broader economic and political audience in Mexico.

Fiscal regime

Mexico's fiscal space is already very limited. The country collects relatively little in taxes, with a tax-to-GDP ratio of 17.7 percent in 2023, one of the lowest among OECD members¹³. At the same time, around four-fifths of the 2025 federal budget is already committed to mandatory items such as pensions, social transfers, and debt service, leaving little room for discretionary investment. Pensions alone absorb roughly six percent of GDP and close to a quarter of programmable spending, while rising debt service costs further reduce fiscal flexibility¹⁴. Under these conditions, public investment has been constrained for years. This means that achieving Mexico's climate and energy transition goals will require large amounts

of external financing, especially private and foreign, in order to fill the gap and accelerate the roll-out of sustainable technologies.

At the same time, public finances remain closely tied to oil. Although oil's weight in the wider economy has fallen to around one to two percent of GDP in recent years¹⁵, oil revenues are still projected to make up about 14.1 percent of total federal revenues in 2025¹⁶. In practice, these revenues come mainly from PEMEX through taxes, royalties, and dividends that flow directly into the federal budget, as well as transfers managed via the Mexican Oil Fund. Academic sources such as the Natural Resource Governance Institute estimate PEMEX's contribution to public revenues at closer to 22 percent once all channels are considered¹⁷. In short, even as oil output declines, Mexico's federal budget continues to rely heavily on hydrocarbon income.

Therefore, Mexico's fiscal structure creates a strong dependence on hydrocarbon income that is difficult to unwind. As the IMF notes¹⁸, PEMEX remains subject to a heavy fiscal burden, and the federal government in turn relies on these oil revenues as a predictable and immediate source of funding. This mutual dependence discourages the diversification of revenue sources, effectively locking the state into continued reliance on fossil fuel rents to sustain public spending and public finances. For Mexico to meet its long-term climate targets and lead a just energy transformation, it will need to restructure its fiscal system while ensuring innovative financial instruments and large-scale private and international investment gradually replace oil-derived income with sustainable sources of growth.

International community

The nationally determined character of national climate targets by Parties to the Convention that forms a central pillar of the Paris Agreement architecture was seen as a potential

¹³ See: <https://www.oecd.org/content/dam/oecd/en/topics/policy-sub-issues/global-tax-revenues/revenue-statistics-mexico.pdf>

¹⁴ See: https://www.finanzaspublicas.hacienda.gob.mx/work/models/Finanzas_Publicas/docs/paquete_economico/cgpe/cgpe_2025.pdf

¹⁵ See: <https://data.worldbank.org/indicator/NY.GDP.PETR.RT.ZS?locations=MX>

¹⁶ See: <https://imco.org.mx/paquete-economico-2025/>

¹⁷ See: <https://resourcegovernance.org/publications/national-oil-company-profile-pemex-mexico?utm>

¹⁸ See: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4026473&utm

enabler of peer dynamics within the international community to motivate higher ambition over time. This was effective to a limited extent in Mexico between 2015 and 2018, as the EPN administration made efforts to submit formal requirements before most other countries in order to maintain the perception of climate leadership inherited from the Calderón years. However, these documents did not commit to ambitious targets, which gradually became evident as other countries promised greater emission reductions within their own NDCs. By the time international civil society recognised that Mexico was not showing the expected leadership in mitigation ambition, the AMLO administration had taken office, bringing with it a discourse of national sovereignty which disregarded the views of the international community since, it was argued, these did not represent the best interests of Mexico's poor. This framing of international cooperation as interference with national priorities weakened the ability of peer comparisons under the Paris Agreement to encourage greater ambition in Mexico.

Furthermore, while international collaboration played a significant role in supporting analytical and stakeholder work for climate policy development – as well as providing finance for energy investments – throughout the Calderón and EPN administrations, the AMLO administration sought to limit the role of foreign governments and multilateral institutions in the internal affairs of Mexico, and also avoided taking on foreign debt to avoid the perception of dependency on foreign agents. Therefore, international cooperation and the international community more broadly have been limited in their ability to contribute to Mexico's implementation of the Paris Agreement since 2018.

Political economy structures and underlying development paradigm

The challenges of shifting from a fossil fuel driven development paradigm to one of sustainable energy are not unique to Mexico. The IPCC

acknowledged this difficulty by dedicating Chapter 4 of the WGII contribution to its Sixth Assessment Report to the shifting of development pathways. However, these challenges are particularly acute in Mexico for both structural and historical reasons.

Mexico's nationalisation of petroleum in 1938 is a milestone for the history of the oil industry as well as for that of Mexico: the successful takeover of operations from foreign companies overnight, and subsequent growth of production and exports presented an example to Venezuela, Iran, Saudi Arabia, and other significant oil exporters of the time, shifting the balance of power between Western companies and Global South countries and providing a source of pride for Mexicans. Oil sales during WWII and the post-war boom provided Mexico with steady income which supported its industrial growth and social development from the 40s to the 70s, including dramatic improvements in housing, water access, electrification, education, and public health. While the first oil crisis of 1973 led many countries, including large Latin American economies like Brazil, to seriously consider alternatives to oil, for Mexico the resulting boom increased confidence in oil, which was further boosted by the discovery of offshore reserves in the Gulf of Mexico – ultimately leading to excessive public borrowing and spending and the Mexican debt crisis of 1982. Since the democratic opening of Mexico's electoral politics in the 1990s, energy reform has been a core topic of political discussion, with arguments of sovereignty, export revenues, increasing capital for investment, promoting economic diversification, and ensuring good management of national assets all contributing to the debate. Therefore, while no country faces climate policy questions in a vacuum, in Mexico they confront a pillar of national identity.

The structural impacts of 80 years of oil-led development are evident in Mexico today, as illustrated by the prevalence of gas for domestic and commercial water heating, where countries with similar or less solar irradiation have been using solar heaters for 40 years. With PEMEX providing local gas distribution companies with

gas to supply households at controlled prices for decades, the Mexican market never considered the solar heaters that dominate Southern Europe, despite their obvious economic advantages. Societal aspirations also drive demand for fossil fuels, particularly in urban transport where owning a private vehicle is a sign of social status and an aspiration for many. However, while many Mexicans look to the affluence of the USA as a role model for their own vision of success, that country has almost 4 times greater car ownership per 1000 citizens, meaning Mexican cities would be unable to cope with comparable volumes of vehicles, even if Mexicans could afford them.

Over the past decade, a concern over potential risks to the environment and poorer segments of the population has proven insufficient motivation for climate concerns to supersede these long-established energy and lifestyle considerations in the mind of most Mexicans. Mexico's government, civil society, and business leaders must formulate a vision of aspirational growth for citizens based on the green economy before people believe that phasing out fossil fuels can make life better for them. While scientific evidence suggests the country stands better chances than most to succeed in this change, today, progress has stalled, leaving Mexico no closer to this transition than it was a decade ago.

While Mexico made significant contributions to international climate policy in the decade prior to the adoption of the Paris Agreement, internal progress was largely driven by the political agenda of the Calderón administration, focusing on marginal gains and cost-negative actions across the energy system. The deep challenges of energy and food system change and urban structural shift were not tackled, while the cost savings from the initial shift from oil products to gas in power and industry cemented the belief that successful climate policy should not imply additional costs. Thus, since the adoption of the Paris Agreement, Mexico has not embraced the scale of transformation required, continuing to bet on a development pathway based on fossil fuels that increases environmental and social risks. Only clear leadership from the current President can reverse this trend, laying out a planned phase out of fossil fuel activities, dramatically increasing investments in renewable energy and the transmission and distribution required to support them, implementing a green fiscal reform, and finding ways to increase foreign capital in energy investments to accelerate the rollout. These accelerated investment in renewables must also foster quality jobs to ensure they reduce inequality. As long as renewable investments remain secondary to sustaining fossil fuel operations, Mexico will not achieve its climate commitments.

CONCLUSION: A RADICAL CHANGE IN ENERGY, FISCAL AND DEVELOPMENT STRATEGIES WILL BE NEEDED TO ACHIEVE CLIMATE COMMITMENTS

The Paris Agreement was seen as a landmark in global climate policy by setting global goals to limit the adverse effects of climate change. Scientific progress since its adoption, as highlighted by the IPCC Special Report on 1.5C (2018) and 6th Assessment Report (2023) have further emphasised the challenges of shifting from the old, fossil-centred development paradigm to a different model of sustainable development, and identified significant barriers to achieving this.

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A decade of national climate action: Stocktake and the Road Ahead

NIGERIA TEN YEARS OF TRANSITION UNDER THE PARIS AGREEMENT

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CONTEXT

Nigeria is the most populous country in Africa, with over 200 million people, and it boasts the largest economy in sub-Saharan Africa, with a real Gross Domestic Product (GDP) of approximately USD569.52 billion in 2024¹. From 2011 to 2022, the country's GDP annual growth rate averaged 2.67%, reaching an all-time high of 6.88% in the first quarter of 2011 and a record low of -6.10% in the second quarter of 2020 due to the COVID pandemic. The International Monetary Fund (IMF) recently projected a growth rate of 3.4% for Nigeria in 2025². Much of this growth is driven by fossil fuel exports and usage. Consequently, Nigeria is susceptible to fluctuations in global energy prices and international geopolitical tensions, as well as rapid advancements in low-carbon technologies and resources, in response to the climate crisis.

However, Nigeria ratified the Paris Agreement in March 2017, thereby affirming its commitment to the global ambition of limiting average global temperature rise to well below 2°C, with efforts to further constrain it to 1.5°C above pre-industrial levels. This landmark decision underscored Nigeria's recogni-

¹ <https://data.worldbank.org/indicator/NY.GDP.MKTP.KD?locations=NG-ZA-EG-DZ>
² <https://www.imf.org/en/Publications/CR/Issues/2025/07/01/Nigeria-2025-Article-IV-Consultation-Press-Release-Staff-Report-and-Statement-by-the-568220>

tion of the severe implications of climate change, particularly for vulnerable countries in Sub-Saharan Africa. Climate-related challenges such as desertification in the North, coastal erosion in the South, increased frequency of floods, and food insecurity threaten the country's economic development and human wellbeing³.

In line with the Paris Agreement, Nigeria submitted its first Nationally Determined Contribution (NDC) in 2015 and reaffirmed it with an update in 2021. The NDC articulates an ambitious dual target, to reduce greenhouse gas (GHG) emissions by 20% unconditionally and up to 47% conditionally by 2030 compared to a business-as-usual (BAU) scenario. The conditional component is predicated on international support through finance, technology transfer, and capacity building⁴. In July 2021, Nigeria submitted its updated NDC, which highlights a more robust climate ambition, incorporating gender responsiveness, just transition principles, and expanded mitigation actions in key emitting sectors. Notably, the energy sector, which accounts for over 55% of national emissions, has received increased attention, with strategic plans for renewable energy penetration, energy efficiency, and gas flare reduction⁵.

Nigeria's evolving climate response showcases a growing alignment between global commitments and national priorities. The country's ratification of the Paris Agreement, updated NDC, LT-LEDS, and the DDP initiative reflect a multidimensional approach that integrates climate mitigation, adaptation, and sustainable development. However, the successful implementation of these frameworks will require enhanced financial and regulatory instruments for climate-compatible investments, institutional coordination, technological innovation, and stakeholder engagement, particularly from the private sector, sub-national actors, and civil society.

GREENHOUSE GAS EMISSION TRENDS

Total economy-wide emissions, including land-use, have risen from approximately 333 MtCO₂e in 2005 to about 408 MtCO₂e in 2015 and 435 MtCO₂e in 2021 (see Figure X.1), with the energy sector contributing over 56% of the emissions. Post-2015 data show a gentle upward bend led principally by the energy sector (fuel combustion plus fugitive methane) and agriculture (enteric fermentation, rice paddies, land clearing). Specifically, the energy sector dominates because gas-fired generation (approx. 75% of grid output) and widespread fossil-fuelled mobilities and diesel back-up generators drive CO₂⁶. Meanwhile, Nigeria's NDC measures could eliminate 30 Mt CO₂e of emissions from AFOLU by 2030.

The gentle upward growth is an indication that the country's effort to bend the emission curve is undermined by the effort to grow the economy through industrialisation and a massive increase in oil and gas exploration and refining. Nigeria has witnessed a rebound in oil production, with output reaching approximately 1.8 million barrels per day in late 2024, up from 1.2 million barrels per day in previous years⁷. One of the most significant infrastructure milestones is the commissioning of the Dangote Refinery, with a daily capacity of 650,000 barrels⁸. Moreover, Nigeria is increasingly diversifying its exploration focus toward deep offshore fields. This strategic shift is exemplified by ExxonMobil's USD1.5 billion investment in deepwater operations⁹. However, Nigeria legally enshrined a net-zero target year of 2060 in its Climate Change Act, and the goal

3 Federal Ministry of Environment. (2021). Second Biennial Update Report of the Federal Republic of Nigeria to the UNFCCC. Abuja: Government of Nigeria.

4 Federal Ministry of Environment. (2021). Nigeria Updated Nationally Determined Contribution (NDC). Abuja: Government of Nigeria

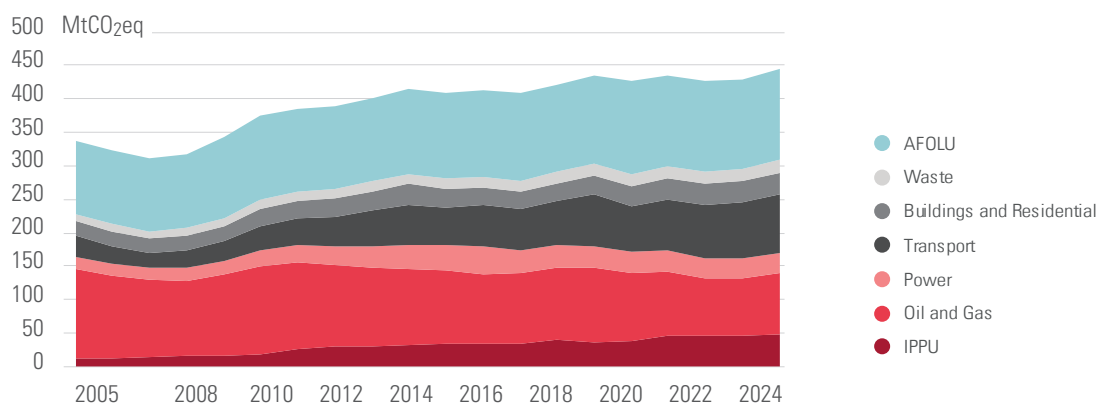
5 UNFCCC (2021): <https://unfccc.int/sites/default/files/NDC/2022-06/NDC%20INTERIM%20REPORT%20SUBMISSION%20-%20NIGERIA.pdf>

6 Owebor, K., Okereke, C., Diemuodeke, E.O., Owolabi, A.B., and Nwachukwu, C.O. (2025) *A systematic review of literature on the decarbonization of the Nigerian power sector*, Energy, Sustainability and Society, Vol. 15(34). <https://doi.org/10.1186/s13705-025-00527-x>

7 NNPC Ltd Announces 1.8mbpd Production, Eyes 2mbpd by Year End 2024. <https://nnpcgroup.com/insights/nnpc-ltd-announces-1-8mbpd-production-eyes-2mbpd-by-year-end-1>

8 Dangote Refinery (2025). Dangote Refinery's a Game Changer capable of driving Africa's Refining Revolution. <https://www.dangote.com/fg-dangote-refinerys-a-game-changer-capable-of-driving-africas-refining-revolution/>.

9 Szymczak PD (2025). ExxonMobil to Invest \$1.5 Billion in Nigeria's Usan Deepwater Oil Field. *Journal of Petroleum Technology* 2025

Figure 1. Nigeria's emissions profile and share by sources

Sources: harmonised from multiple sources by the authors : UNFCCC Nigeria's BUR2, EDGAR, Climate Watch, Climate Brief and Gütschow, J.; Pflüger, M. (2023): The PRIMAP-hist national historical emissions time series v2.4.2 (1750-2021). zenodo. doi:10.5281/zenodo.7727475

is reiterated across its updated Nationally Determined Contribution (NDC), its Energy Transition Plan (ETP) and its Long-Term Low-Emission Development Strategy (LT-LEDS)¹⁰.

Oil and gas-dependent economy and economic diversification

Nigeria has proven oil reserves of approximately 37.5 billion barrels and natural gas reserves of about 210.5 trillion cubic feet, making it a significant player in the global fossil energy market. This wealth of resources offers substantial potential for economic development and energy security¹¹. In 2022, the oil-and-gas sector contributed only about 5.7% of Nigeria's GDP, yet it still generated more than 85% of merchandise export earnings and roughly half of federal revenues¹². The 2024 WTO Trade-Policy Review draws the same picture, i.e., in 2023, crude oil still accounted for 80.6% of goods exports, LNG another 10.5%. This concentration leaves public finances, and by extension, climate spending, highly exposed to oil-price swings. However, the government has committed to diversifying the economy away

from oil and gas through deliberate policies and actions, including the Nigeria Agenda 2050¹³ (a long-horizon commitment to shift from oil dependency toward a knowledge-based and export-diverse economy), Nigeria Startup Act 2022¹⁴ (to drive innovation and startups in the creative and digital sector), Fuel Subsidy Removal (reallocation of revenue to develop power, transport and human capital) and Sustainable Bond Framework 2025¹⁵ (provide a framework for a green and diversified economy).

Energy mix and electricity energy mix

Biofuels and waste dominate the country's energy at 43.4%, which is followed by crude oil (32.2%), natural gas (22.2%), renewable energy (1.1%) and coal (1.1%) in 2022. The domination of the energy mix by biofuels is undermining forest reserves vis-à-vis a natural carbon sink. The electricity access hovered around 62% in 2022, with rural access lagging below 40%¹⁶. The poor electricity access is compounded by frequent grid collapses and capacity shortfalls (only one-third of the 13.5 GW installed power plant capacity

¹⁰ Federal Government of Nigeria. (2024). Nigeria's Long-Term Low Emission Development Strategy – 2060 (LT-LEDS). <https://unfccc.int/documents/638193>

¹¹ NUPRC (2024). Nigeria's Oil and Gas Reserves Soar: NUPRC Unveils Impressive Figures 2024. [https://www.nuprc.gov.ng/nigerias-oil-and-gas-reserves-soar-nuprc-unveils-impressive-figures/#:~:text=Engr Komolafe revealed that as, trillion cubic feet \(TCF\)](https://www.nuprc.gov.ng/nigerias-oil-and-gas-reserves-soar-nuprc-unveils-impressive-figures/#:~:text=Engr%20Komolafe%20revealed%20that%20as, trillion%20cubic%20feet%20(TCF))

¹² World Trade Organisation (2024). *Trade Policy Review: Nigeria (WT/TPR/S/462), Geneva, Switzerland: WTO Secretariat

¹³ Nigeria Agenda 2050, <https://faolex.fao.org/docs/pdf/nig217433.pdf?>

¹⁴ Federal Government of Nigeria (2022) <https://pwnigeria.typepad.com/files/nigeria-startup-act-2022-signed.pdf?>

¹⁵ Nigeria Debt Management Office (2025) <https://www.dmo.gov.ng/fgn-bonds/green-bond/5336-federal-republic-of-nigeria-sustainable-bond-framework/file>

¹⁶ International Energy Agency, World Bank, & UN DESA. (2023). Tracking SDG 7: The Energy Progress Report 2023. Paris: IEA

is typically available), pushing households and SMEs to rely heavily on petrol/diesel generators, which aggravates emissions. On this basis, the NDC, LT-LEDS and ETP target universal and reliable electricity by 2030 as a core social-justice pillar, by front-loading mini-grids and solar home systems for rural communities.

In 2022, Nigeria's electricity grid mix remained dominated by fossil fuels (mainly natural gas-fired power plants at 75.4% share)¹⁷, as renewable energy supplied roughly 24.6% of total electricity, almost wholly from large hydropower (Kainji, Jebba, Shiroro), since utility-scale solar and wind together accounted for less than 1%¹⁸. However, solar PV electricity generation through mini-grids and rooftops has been increasing in recent times, driven by upward adjustments in electricity tariffs and the removal of fuel subsidies¹⁹. Looking forward, the ETP targets a 30% renewable share (mostly solar PV + hydro) by 2030 and 60% by 2060, conforming with the LT-LEDS net-zero pathway; yet, unlocking that pipeline will require de-risking PPAs, strengthening transmission corridors, and scaling concessional finance.

ROLE OF LONG-TERM VISION

Nigeria developed and submitted a robust Long-Term Low-Emission Development Strategy (LT-LEDS)²⁰, which provides the keystone of Nigeria's post-Paris transition architecture. The quantification of the LT-LEDS was anchored on Nigeria's Deep Decarbonisation Pathways (DDP) programme²¹. Nigeria's LT-LEDS was submitted to the UNFCCC on 25 April 2024, elaborating on the 2060 net-zero pledge already embedded in the Climate Change Act (2021) and the Energy Transition Plan (ETP). It provides four unique actionable strategies that the updated NDC (2021) and the ETP horizon instruments cannot do on their own, as presented in **Table 1**.

The LT-LEDS and Nigeria's transition

In the energy and industrial sectors, the strategy aims to eliminate unabated gas-firing in the power sector by the year 2040. Furthermore, it mandates that upstream operators adhere to rigorous methane leak and flaring reduction standards, as enshrined in the Petroleum Industry Act 2021. These standards provide clarity for utilities, independent power producers (IPPs), and financiers regarding the depreciation schedule for gas assets, but recent reports

¹⁷ K. Owebor, E.O. Diemuodeke, T.A. Briggs, M. Imran (2021) Power Situation and Renewable Energy Potentials in Nigeria – a Case for Integrated Multi-generation Technology, *Renewable Energy*, Vol. 177, Pp. 773-796, <https://doi.org/10.1016/j.renene.2021.06.017>

¹⁸ Federal Ministry of Power. (2022). Nigeria Energy Transition Plan. Abuja: Government of Nigeria

¹⁹ Business day (2025) https://businessday.ng/news/article/nigerias-solar-industry-sees-unprecedented-growth-but-affordability-remains-a-challenge/?utm_source=chatgpt.com

²⁰ https://unfccc.int/sites/default/files/resource/Nigeria_LT-LEDS_01122023_240425_094617.pdf?

²¹ Okereke, C., et al. (2024) Deep Decarbonisation Pathways (DDP) for Nigeria's Low Emission Development Up to 2060, National Council on Climate Change

Table 1. Strategic roles of LT-LEDS

	Implication
Sets the endpoint and pace	Defines a whole-economy GHG budget to 2060 and provides sector-based action plans so investors and ministries can backcast sector pathways.
Aligns near-term policies	Serves as the platform that screens new programmes, e.g. the 2024 NDC-Implementation Framework and the Petroleum Upstream Decarbonisation Template (UPDT) for oil-licence bidders, ensuring they drive toward net-zero rather than lock in high-carbon assets.
Creates a finance and investment narrative	Provides a pathway to estimating finance and investment volume in additional capital and prioritising pipelines (e.g. renewable, low carbon energy and afforestation) for concessional and private funding windows. It can thus turn the ETP's sector wish-lists into bankable project pipelines.
Hard-wires governance and accountability	Provides a governance structure for climate actions and transition to integrate climate criteria in fiscal policy, and reporting, closing the oversight gap identified in earlier NDC reviews.

indicate poor adherence to the standards²². Concurrently, within the Agriculture, Forestry, and Other Land Use (AFOLU) sector, the LT-LEDS prioritises agroforestry, climate-smart rice production, and extensive afforestation and reforestation initiatives to facilitate significant carbon dioxide removal. This approach integrates AFOLU firmly within the national carbon budget rather than permitting it to serve merely as an offset for deferred reductions in the energy sector.

From a social justice and just transition perspective, the LT-LEDS anticipates job creation and incorporates metrics for gender and youth inclusion. Nigeria's LT-LEDS serves as more than merely a vision document; it functions as a comprehensive framework that integrates Nigeria's diverse climate initiatives, guides public investment decisions, and conveys a credible message to both domestic and international investors regarding the country's coherent strategy for achieving net-zero emissions by 2060. In its absence, the Nationally Determined Contributions (NDC) and the Energy Transition Plan (ETP) would remain uncoordinated policy silos, with their implementation evolving into a series of interconnected actions within a single, measurable transition pathway.

CONCRETE PROGRESS AREAS

Paris-compatible policies

Renewable energy market reforms

Three market-moving regulations were enacted after the 2023 Electricity Act: (i) service-reflective tariffs for grid customers, approved by Nigerian Electricity Regulation Commission (NERC) in September 2023, narrow the utilities' revenue shortfall and unlock PPAs for utility-scale solar and wind²³ (ii) mini-grid Regulations 2023

replace the 2017 rules, granting developers the right to set retail tariffs, raise the project-size ceiling to 5 MW, and streamline dispute resolution, which is already spurring 250 MW of new mini-grid permits in Q1 2025²⁴, and (iii) the Electricity Act 2023 devolves generation licensing to the states, catalysing sub-national solar parks and crowding in private investment.

Clean-cooking initiatives

Nigeria adopted a National Clean-Cooking Policy in May 2024, backed by the LPG Expansion Plan and a new e-cooking component (target: 30 million electric + LPG stoves by 2030). Implementation began with a free-cylinder scheme aimed at five million rural households and a Central Bank of Nigeria (CBN) credit line for local cylinder manufacturing²⁵.

Methane reduction in oil and gas

The Nigerian Gas Flare Commercialisation Programme (NGFCP), a government initiative aimed at eliminating gas flaring by attracting investments and creating a transparent market for gas, completed its first competitive bid round in September 2023, awarding 49 flare sites to 42 domestic firms, projects now in Engineering, Procurement and Construction (EPC) that will capture an estimated 2.8 MtCO₂e annually and mobilise USD 2.5 billion in private capital²⁶. Complementing this is the Upstream Petroleum Decarbonisation Template (UPDT), effective January 2025, which requires every new field licence to submit methane-management and energy-efficiency plans aligned with the Global Methane Pledge, as part of the Petroleum Industrial Act.

Carbon-Market Activation Policy

Nigeria has moved from exploratory discussions to the full design phase of a regulated carbon-market architecture that can coexist with voluntary, high-integrity crediting schemes

²² Africa oil and gas report (2025) [https://africaoilgasreport.com/2025/05/in-the-news/operators-poor-compliance-with-greenhouse-gas-emissions-puts-nigerian-regulator-in-a-bind/#:~:text=A%20review%20by%20Adeniyi%20Adeoloye,Industries%20Transparency%20Initiative%20\(NEITI\)%20](https://africaoilgasreport.com/2025/05/in-the-news/operators-poor-compliance-with-greenhouse-gas-emissions-puts-nigerian-regulator-in-a-bind/#:~:text=A%20review%20by%20Adeniyi%20Adeoloye,Industries%20Transparency%20Initiative%20(NEITI)%20)

²³ <https://pubs.naruc.org/pub/CA69CDF2-0442-54F0-1273-D800CD2E8733?>

²⁴ <https://www.dentonsacaslaw.com/en/insights/articles/2024/january/6/key-highlights-of-the-nerc-mini-grid-regulations>

²⁵ <https://naccnigeria.org/wp-content/uploads/2024/05/National-Clean-Cooking-Policy-v2.pdf?>

²⁶ <https://nannews.ng/2025/02/27/nigerias-gas-flare-commercialisation-programme-to-unlock-2-5bn-investment-nuprc/>

through the Carbon Market Activation Policy²⁷. The policy, finalised in March 2025, aimed at unlocking a carbon market worth between USD 736 million and USD 2.5 billion by 2030. The policy is part of broader energy reforms and seeks to generate green jobs and attract investment in sustainable initiatives. The policy establishes a national carbon registry and framework for participating in the Article 6 Carbon Market, also aiming to establish a robust and transparent carbon market, attracting both local and foreign investment.

Paris-compatible projects

Table X.2 shows eight concrete, “on-the-ground” projects that moved from policy announcement to full-scale implementation between 2015 and 2025 and are explicitly aligned with Nigeria’s transition to a net-zero economy by 2060. Each example shows (i) when it crossed the implemen-

tation threshold, (ii) the scale of the intervention, and (iii) how it contributes to long-term decarbonisation. Aggregating the projects, it shows that, despite the weak fiscal and infrastructure landscape, Nigeria has started to convert its climate commitments into concrete assets, regulations, and revenue streams that will keep future emissions on a downward, i.e. Paris-compatible track.

CONCRETE BLOCKAGES

Despite the observed positive progress in climate-responsive policies and projects, there are entrenched bottlenecks (demonstrated in Table X.3) that continue to slow Nigeria’s progress towards its 2060 net-zero goal. The bottlenecks spread across finance, implementation, technical, policy planning, MRV capacity, etc.

²⁷ Carbon Market Activation Policy: <https://ossapcfse.org/wp-content/uploads/2025/04/Nigerias-Carbon-Market-Activation-Policy-Draft-020425.pdf>

Table 2. Concrete Paris-compatible projects

S/No	Sector and intervention	Implementation milestone (2015-25)	Net-zero relevance
1	700 MW Zungeru hydropower project	Started operation in October 2023 to delivers about 2.6 TWh annually	To avoids approx.1.4 MtCO ₂ e annually
2	Nigeria Electrification Project (NEP);125 solar-hybrid mini-grids, etc.	5.5 million new beneficiaries, at least 5,000 green jobs, and 85 % of funds disbursed	Permanent displacement of diesel generators ¹
3	Solar Power Naija (5 million connections)	National roll-out launched in 2021; over 500,000 units installed by mid-2024 across 36 states	Universal electricity access goal without extra fossil capacity ²
4	Sovereign Green Bonds (USD16.7 million*, 2017 and 2019) ³	23 completed projects: 7 university solar grids, afforestation in 31 states, etc. ⁴	Delivers verified annual cuts of about 42 ktCO ₂ e
5	NGFCP and first floating LNG licence	NGFCP bid awards (2023) now entering EPC stage; UTM Floating LNG got FGN licence in Sept 2024	Captures 2.8 MtCO ₂ e annually of flared gas, supporting the NDC pledge to end routine flaring by 2030 ⁵
6	Presidential Compressed Natural Gas Initiative (Pi-CNG)	Convert 100,000 vehicles by late 2024, convert an additional 1 million vehicles by 2027, unveiling 64 CNG buses to drive mass transit ⁶	Cleaner air and reduced greenhouse gas emissions
7	Clean cooking (LPG) and improved cookstoves	LPG demand hits 1.5 million tons/year (2024); the 80 million improved cookstoves initiative was launched in 2023	Reduces the 3.5% annual forest loss to support natural carbon capture and storage

¹ World Bank: <https://www.worldbank.org/en/news/feature/2025/03/07/expanding-nigeria-s-mini-grid-market?>

² Nigeria’s Rural Electrification Agency: <https://rea.gov.ng/solar-power-naija/149/?>

³ Nigeria’s Debt Management Office: <https://www.dmo.gov.ng/fgn-bonds/green-bond/5338-fgn-series-iii-green-bond-investor-presentation/file>

⁴ Nigeria’s Debt Management Office: <https://www.dmo.gov.ng/fgn-bonds/green-bond/5337-green-bond-issuance-impact-report-may-2025/file>

⁵ <https://gasoutlook.com/analysis/utm-offshore-license-to-build-nigerias-first-floating-lng-a-milestone-experts/#:~:text=%E2%80%9CThe%20NMDPRA%20issued%20a%20Licence,is%20a%20multibillion%20dollar%20project.%E2%80%9D>

⁶ <https://finance.gov.ng/fg-rolls-out-sixty-four-cng-buses-to-mark-nigerias-64th-independence-anniversary/>

* At 1USD to N1,535

Table 3. Bottlenecks to Nigeria's transition to a net-zero economy

Blocked domain	
How the blockage shows up in practice	Why it matters for the national transition
Gas-centric development model	
The Decade of Gas policies prioritise LNG export and CNG vehicles, yet gas flaring rose 12% in 2024, giving Nigeria the world's second-largest increase¹. The 614 km Ajaokuta-Kaduna-Kano (AKK) natural gas pipeline, the backbone of domestic gas supply, remains delayed after financiers quit over cost inflation. Most gas-fired power plants still run below 40% capacity because of the feed gas. CNG vehicle conversions number only about 100,000 versus the 1 million target due to limited petrol-to-CNG conversion stations and fuelling stations.	Lock-in to gas crowds out renewables in the generation mix and worsens the risk of stranded gas assets after 2030. Persistent flaring negates methane-abatement pledges and weakens Nigeria's claim to transition finance.
Power sector reform delays	
A decade after privatisation, six of eleven distribution companies and Nigeria's largest generator (Egbin) are now in court-ordered receivership, with an estimated sector debt of USD1.31 billion². Key market stabilisation rules in the 2023 Electricity Act, cost-reflective tariffs, contractual PPAs, and a sector liquidity fund are still awaiting implementing regulations. Unresolved gas-supply arrears continue to strand about 3 GW of installed capacity.	Investors demand higher returns or sovereign guarantees, delaying new solar, wind and hybrid projects tendered under the Energy Transition Plan. This is associated with high risk perceptions and the high cost of capital. Without reliable off-take agreements, international climate finance cannot securitise utility-scale renewables.
Poor infrastructure and technology base	
The national grid rarely transmits more than 5 GW (against more than 13 GW installed), with frequent collapses³. World Economic Forum analysis highlights grossly under-investment in transmission, metering and digital monitoring as a top barrier to the green transition⁴. The productive sectors, e.g power and transport, are dominated by ageing equipment, skill shortages, and corruption as systemic obstacles to integrating variable renewables⁵.	Frequent grid failures force industries and households to use diesel gensets, erasing emissions gains. Inadequate data and SCADA systems make grid-level demand forecasting, large-scale renewable penetration, technically risky and costly. Inadequate infrastructure to support transport modal shift because road and rail networks are in a poor state.
Capacity shortage (technical, managerial and institutional)	
There is fragmented climate and transition-oriented knowledge Limited staff in key ministries Limited monitoring, reporting, and verification (MRV) expertise.	Poor human and institutional capacity slows the delivery of transition policies, which may push project timelines beyond the 2030 and 2060 target horizons. Limited engineering and regulatory expertise increases project risks and raises the cost of capital, deterring private investors from grid upgrades, renewables and clean-cooking supply chains. Weak MRV capacity undermines access to results-based climate finance and carbon market revenues
Climate finance (volume, terms and allocation)	
Total tracked climate finance reached only USD 1.2 billion in 2023, an order of magnitude below the USD 10–17 billion per year implied by the ETP. Nigeria lacks the financial capacity to match the over USD1.9 trillion cumulative funding required to achieve net-zero by 2060. There is an absence of clear de-risking instruments for investors	Without closing the finance gap, critical investments, renewable generation, transmission reinforcement, e-mobility, methane-flaring abatement and clean-cooking roll-outs cannot scale at the speed required for a net-zero pathway. Heavy reliance on hard-currency debt exposes Nigeria to exchange rate shocks and heightens sovereign risk premiums, crowding out social spending and eroding political support for the transition. Limited concessional and blended finance slows technology adoption and keeps household energy costs high, threatening the "just" dimension of Nigeria's transition.

¹ <https://www.worldbank.org/en/programs/gasflaringreduction/global-flaring-data>

² <https://www.reuters.com/sustainability/boards-policy-regulation/lenders-appoint-receiver-major-nigerian-power-firms-notice-shows-2025-08-06/>

³ Emodi, N.V. and Diemuodeke, E.O. (2022) Why Nigeria's electricity grid collapses and how to shore it up, The Conversation.

⁴ World Economic Forum: <https://www.weforum.org/stories/2023/05/how-nigeria-is-tackling-barriers-to-its-green-energy-transition/>

⁵ Adeshina, M.A. et al. (2022) From Potential to Power: Advancing Nigeria's Energy Sector through Renewable Integration and Policy Reform. <https://doi.org/10.3390/su16208803>

LINK WITH NON-CLIMATE QUESTIONS

Nigeria's climate debate has steadily spilt out of the environment levers and into the country's fiscal space, financial regulation, export strategy, job creation and social welfare linkage. However, when there is a lack of capacity, concessional capital, or safety nets, this same linkage can lead to resistance. This highlights that Nigeria's journey towards achieving net-zero emissions depends not only on technological choices but also significantly on macroeconomic reforms and social policies. In Nigeria, five broad fronts illustrate how climate objectives are intertwined with questions of growth, equity and financial stability, as demonstrated in the following.

Fiscal stability and macroeconomic policy

The Central Bank of Nigeria (CBN) increasingly frames climate change as a fiscal-risk story. The country's transition needs about USD 1.9 trillion by 2060, according to the Energy Transition Plan. Yet, a single season of extreme floods in 2022 wiped out an estimated USD 6.7 billion, while the government still spent USD 9.3 billion on fuel subsidies in the same year. This perspective supported the removal of petrol subsidies and the push to phase out subsidies in the power sector, as well as the unification of exchange rates and the allocation of free budget space for green spending. Broadly, the conversation in Nigeria treats fiscal and macroeconomic stability as a prerequisite for climate investment, giving the transition steam to propel.

Domestic and international finance

The financial sector has identified a significant funding gap, with climate-tagged investments averaging only USD 2.5 billion per year in 2021/22, compared to an estimated annual need of nearly USD 30 billion. To address the funding gap, new initiatives are being introduced, such as the 2025 Sovereign Sustainable

Bond Framework²⁸, the 2025 Carbon Market Activation Policy, and a USD 500 million Distributed Renewable Energy Fund led by the Nigeria Sovereign Investment Authority (NSIA), SEforALL, International Solar Alliance (ISA), and Africa50. However, high-risk premiums and currency volatility continue to impede the flow of deals. In response, regulators, including CBN, the Securities and Exchange Commission (SEC), and Nigerian Exchange Group (NGX), investors (such as pension funds), and the sovereign wealth fund are now working together to foster a supportive environment.

Trade, competitiveness and industrial policy

The Ministries of Trade and Finance, along with Afreximbank and export lobbies, are linking climate action to market access under the African Continental Free Trade Area (AfCFTA) and the upcoming carbon-border measures. The 2024 African Trade Report emphasises that low-carbon supply chains and eco-labelling could protect Nigerian steel, aluminium, and agro-exports from tariff shocks. Since the debate focuses on export opportunities rather than constraints, it tends to promote rather than hinder climate-compatible trade reforms.

Employment, labour and skills

Nigeria's NDC and LT-LEDs promise positive growth in jobs, especially from smart agriculture. The newly launched National Employment Policy 2025 identifies renewable energy, waste-to-energy, and the «green economy» as priority sectors. Trade unions are actively involved in this process; for instance, the Nigeria Labour Congress' 2025 position paper calls for re-skilling pathways as essential conditions for a just transition²⁹. As a result, tripartite dialogue has emerged as a platform that generally supports climate initiatives, although funding for large-scale reskilling remains inadequate.

²⁸ <https://www.dmo.gov.ng/fgn-bonds/green-bond/5336-federal-republic-of-nigeria-sustainable-bond-framework/file>

²⁹ <https://www.nlcng.org/wp-content/uploads/2025/07/NIGERIA-LABOUR-CONGRESS-POSITION-ON-NDC-2.0-AND-ACTION-PLAN-1.pdf>

Inequality and social protection

Only about 14.8% of Nigerians have access to any formal social protection benefits³⁰. Since the expansion of safety nets is not keeping pace with climate-related shocks, civil society organisations argue that this lack of coverage could make the transition unjust, potentially hindering more aggressive climate mitigation measures.

GOVERNANCE

The Nigerian Climate Change Act (CCA), which came into force in November 2021, provides the country's first comprehensive legal framework for addressing climate change in line with its international obligations. The Act established the National Council on Climate Change (NCCC) as the coordinating authority for all climate-related actions across sectors, with direct oversight from the Presidency. Among its key provisions are the requirements to develop a National Climate Change Action Plan and to implement a system of five-yearly carbon budgets, which set legally binding ceilings for national greenhouse gas emissions. In addition, a special Presidential Envoy on Climate (SPEC) and the Presidential Committee on Climate Action and Green Economic Solutions (P-CAGE) have been created to enhance cross-government coordination and mobilise green finance. This process reflects the country's commitment to the Paris Agreement, operationalises its Long-Term Low Emission Development Strategy (LT-LEDS, 2024), and positions the country on the path of net-zero emissions by 2060.

The National Council on Climate Change
The Department of Climate Change (DCC) within the Federal Ministry of Environment serves as the technical focal point for engagements with the UNFCCC and leads climate reporting efforts. Inter-ministerial coordination takes place at three levels: within the National Climate Change Council (NCCC), through the Federal Executive

Council, and the P-CAGE/SPEC. Various stakeholder channels include non-state actors and facilitate discussions across federal, state, and local levels. Furthermore, the Energy Transition Plan (ETP) was unveiled in August 2022. It is housed in a dedicated Energy Transition Office with the Vice President's oversight. The ETP aims to decarbonise the energy sector to achieve net-zero by 2060.

The overall governance approach aims to align political, technical, and financial efforts in addressing climate change and promoting a green economy in Nigeria. The post-Paris policy suite, including the 2021 Climate Change Act, the updated Nationally Determined Contributions (NDC), the 2022 Energy Transition Plan (ETP), and the 2024 Long-Term Low Emission Development Strategy (LT-LEDS), directly address these challenges.

INTERNATIONAL COOPERATION

Nigeria's Energy Transition Plan (ETP) estimates about USD 1.9 trillion in cumulative funding requirements by 2060. Against that, only USD 2.5 billion annually was tracked for 2021/22, which is a fraction of the required investment volume, and roughly equal to what Nigeria paid in foreign-debt service over the same period. Climate finance in 2022 was also dwarfed by US\$9.3 billion in fuel subsidies and USD 6.7 billion in flood losses, illustrating why current volumes are insufficient. International public climate finance to Nigeria is mostly debt (about 54% concessional + 35% non-concessional), which strains already tight fiscal space³¹. However, private flows are rising but remain small. By sector, finance is concentrated in solar PV and power access, while buildings, industry, and waste lag. On resilience, adaptation received about USD 0.74 billion, meeting only about 6% of estimated adaptation needs, with significant shortfalls for flood risk and resilient infrastructure. Dual-benefit (mitigation + adaptation) finance exists but

³⁰ ILO: https://www.ilo.org/sites/default/files/2025-06/CO-Abuja%20ToR_Social%20Protection%20Sector%20Review_001.pdf?utm_source=chatgpt.com

³¹ CPI: <https://www.climatepolicyinitiative.org/wp-content/uploads/2025/05/Landscape-of-Climate-Finance-in-Nigeria-2025.pdf>

is modest. Over the past decade, international cooperation has shaped Nigeria's transition through the following space.

- Nigeria Electrification Project (NEP) is achieving targets and disbursing a significant portion of funds, along with new programs attracting private developers.
- World Bank's large-scale financing supports macroeconomic stability and household protection to enable climate investments.
- Initiatives like the Siemens Presidential Power Initiative are aimed at improving transmission and grid upgrades for renewable integration.
- The establishment of the USD 500 million DRE Nigeria Fund to promote blended finance for distributed renewables.
- The Carbon Market Activation Policy aims to unlock significant funding by 2030 and international trade rules encouraging industrial decarbonisation.

However, more international cooperation is required in the following priority areas to accelerate Nigeria's transition.

- Increased concessional and local-currency financing: Given Nigeria's heavy debt burden, the country requires a larger share of grants and other friendly climate finance streams to enable pension funds and local banks to participate at scale, particularly in decentralised renewable energy (DRE), commercial and industrial solar projects, and resilient infrastructure.
- A significant focus on adaptation and resilient infrastructure: Current flows for adaptation funding meet only about 6% of the existing needs, while flood losses amount to billions. Partners should prioritise investments in urban drainage, flood protection, water and wastewater systems, climate-resilient roads and power infrastructure, as well as shock-responsive safety nets.
- Enhanced project preparation and pipeline development: The Climate Policy Initiative identified a shortage of bankable, appropriately sized projects. Nigeria and multilateral development banks (MDBs) should expand project preparation facilities, establish standardised power purchase agreements (PPAs) and envi-

ronmental, social, and governance (ESG) templates, and create data rooms to expedite due diligence across the sectors of power, clean cooking, methane abatement, and adaptation.

- Scaling up methane reduction and flare-out initiatives: Nigeria is one of the leading countries in gas flaring. Cooperation between the Gas Flare Measurement and Reporting (GFMR) initiative and the Nigeria Gas Flare Commercialisation Programme (NGFCP) should be enhanced through friendly financing, standardising offtake agreements, and facilitating carbon crediting. These efforts will provide high-impact, quickly deployable mitigation strategies with significant developmental co-benefits.
- Industrial decarbonisation and trade readiness: It is essential to support measuring, reporting, and verification (MRV) systems, enhance energy efficiency, and promote low-carbon heating in sectors such as cement, steel, and aluminium.
- Ensuring carbon market integrity and transparency: With policy frameworks now in place, Nigeria needs to develop MRV systems, registries, and safeguards to transform Article 6 and voluntary market opportunities into reliable revenue streams, rather than risks.

CONCLUSION

Nigeria's decade-long journey under the Paris Agreement reflects both measurable progress and persistent challenges in aligning climate ambition with economic and social realities. The country has moved from policy aspiration to tangible action, with frameworks such as the Climate Change Act, the updated NDC, the Energy Transition Plan, and the LT-LEDS providing a coherent strategic direction. Notable achievements, including grid-scale renewable projects, distributed energy roll-outs, clean-cooking programmes, methane-reduction initiatives, and the activation of a national carbon-market policy, demonstrate that Nigeria can convert commitments into concrete results, even within a constrained fiscal and infrastructure context. These advances indicate a growing integration of climate objectives into broader national development priorities.

However, the pace and scale of transformation remain insufficient for the 2060 net-zero goal. Entrenched bottlenecks, for example, a gas-centric development model, slow power sector reforms, inadequate infrastructure, technical and institutional capacity shortages, and a climate finance gap an order of magnitude larger than current flows, pose serious risks of delay and lock-in. The success of Nigeria's transition will depend on addressing these constraints through strengthened governance, accelerated project pipeline development, targeted capacity building, and above all, a significant increase in concessional and local-currency finance to unlock both mitigation and adaptation opportunities.

Looking ahead, Nigeria's pathway requires deepening the synergy between domestic reform and international cooperation. Priorities include scaling adaptation and resilience investments, de-risking renewable and clean energy projects for private capital, expanding methane-abatement programmes, and ensuring industrial readiness for low-carbon trade regimes. By embedding climate action into fiscal policy, industrial strategy, and social protection systems, Nigeria can deliver a transition that is not only Paris-aligned but also inclusive, competitive, and resilient, setting a benchmark for large, fossil-dependent economies in the Global South.

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A decade of national climate action: Stocktake and the Road Ahead

SENEGAL INSIGHTS ON CLIMATE ACTIONS TEN YEARS AFTER THE PARIS AGREEMENT

Samba Fall, Ansoumana Djite, Cheikh Abdou Khadre Dieylani Diop, Maimouna BA, Ndeye Martinia Gomis - Enda Energie

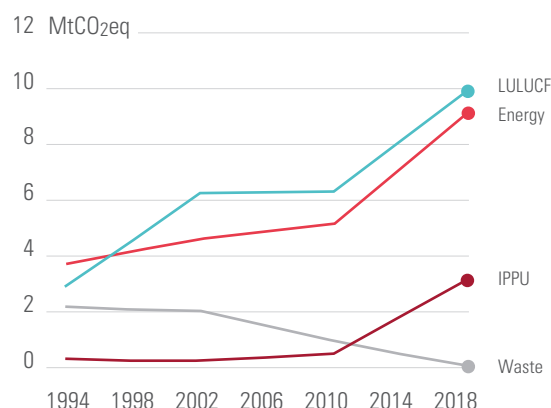
KEY NUMBERS

Senegal is a lower-middle-income country of 17 million inhabitants, marked by a young population. The economy is relatively diversified, with strong contributions from services, agriculture and fisheries, and extractive industries. Urbanization is accelerating, with nearly half the population concentrated around Dakar.

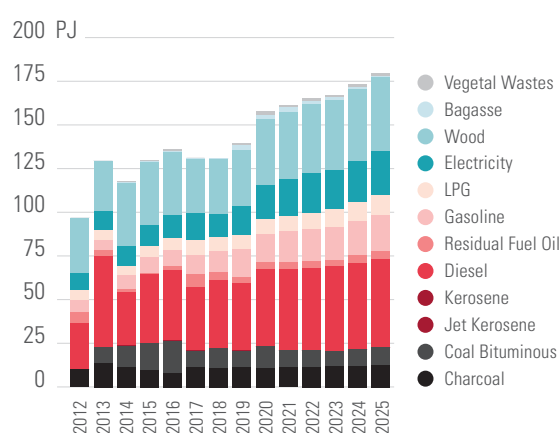
GHG missions have continuously increased in the last ten years, correlated with economic growth (+ 5,3% per year between 2015 and 2024), urbanization (+ 5% of urban population on the same period), and increased energy demand (+27% of final energy demand). The BUR of Senegal (published in 2025) estimated total greenhouse gas emissions approximately 22 387,43 Gg eq CO₂¹ in 2018 (**Figure 1**). Agriculture and land use is the most emitting sector, representing 41% of the total GHG emissions, with methane dominating and is followed by energy emissions. Apart from this category, energy represents more than 81% of GHG emission. In 2018, energy production, manufacturing industries and transport are the most energy-emitting sectors²; representing respectively 32%, 37% and 29% of energy-related CO₂ emissions. Increases in energy demand have been supported by a continuous electrification process: from 9% of energy uses in 2015

¹ BUR Senegal (2025): <https://unfccc.int/documents/645426>

² BUR Senegal (2025): <https://unfccc.int/documents/645426>

Figure 1. Comparative evolution of emissions excluding absorption

to 14% in 2024 (**Figure 2**), with still a predominant place of diesel (around 30%) and wood (from 30% to 24%). However, use of coal has been reduced, from 15 PJ to 10 PJ, direct effect from the intensive renewable electrification and political attention switching from coal to gas potential. Notably Sendou/Barny coal-fired plant was shut down since 2019 due to technical and financial difficulties only 3 years after starting operating and will potentially be reconverted from coal-fueled to gas-fuels (125 MW). Increase of electrification capacities is strongly due to the installation of new renewable capacities, representing from 13% of total electric capacities in 2015 to 29% in 2024, on the road towards JETP objective of 40% in 2030 (developed below).

Figure 2. Final energy demand per energy type

ROLE OF LONG-TERM

The process towards the elaboration of a Long-Term Low Emission Development Strategy (LT-LEDS) that Senegal intends to submit to the UNFCCC in accordance with Article 4.19 of the Paris Agreement started in 2022. For instance and due its economic circumstances, Senegalese process defines alternative development pathways for Senegal up to 2050, including appropriate scenarios considering its climate vulnerability and efforts on GHG emissions reduction and consequently, the LT-LEDS is depicted as Low Emission and Climate Resilience Development (LECRDS). For example, the most ambitious scenario considers climate resilient sectors (i.e agriculture) combined with a smooth path of reduction in energy-related GHG emissions per capita by 2050, which is a very important effort for a country like Senegal which starts from a very low level and has very important development needs. Other scenarios explore variants that focus on the use of oil and gaz to overcome short and medium term target of energy access for the household and the agricultural and industrial need. This analysis demonstrates that you can have a very different look at short-term policy decisions if you put them in the long-term context. Notably the respective roles of renewables and natural gas in supporting the development agenda are very different if you look at long-term trends instead of just sticking to the short-term policy targets.

This strategy is grounded on a very granular vision of sectoral transformations and clear identification of key drivers of change in each sector (energy, industry, transport, agriculture, waste, etc.) as well as an explicit set of narratives supporting the sectoral transitions. In addition, this strategy provides a first step of economic assessments on key indicators of the transition, notably the cost of electricity and the investment needs. The process that led to the elaboration of this strategy was based on the principles of co-construction with stakeholders and capacity building as described in subsequent sections of this report.

In parallel with this long-term strategy process undertaken under the UNFCCC umbrella (LECRDS), the new administration which came in power in 2024 under President Bassirou Diomaye Faye and Prime Minister Ousmane Sonko published its long-term vision for the country in a document called “Vision 2050: Une ambition collective pour une nation souveraine, prospère et solidaire”³ This document marks a significant step forward in aligning national development with the requirements of a net zero transition. It is worth mentioning the alignment of this new vision to the Long-Term Vision co-defined in 2023 within the LTS process. Over the past decade, the country has advanced from planning to active implementation, and this long-term strategy crystallizes those efforts into a coherent framework with specific objectives of increasing GDP per capita above 4500 USD and reducing poverty below 15%. This plan is based on four axes: competitive economy, sustainable development, human capital and social equity, and governance and African engagement. It aims at addressing economic dependence, reduce inequalities and ensure energy and food sovereignty. It adopts a new economic map structured around eight poles, and is operationalized through a master-plan for the next decade and 5-year strategies. Vision 2050 positions clean and competitive energy as a central pillar of the nation's transformation, defining specific objectives for the development of installed power generation capacity at 10 000 MW in 2050 and building on the expansion of solar and wind projects that are already operational. It also strengthens institutional governance, ensuring that regulatory systems can support and sustain the low-carbon transition. Importantly, the strategy embeds climate objectives within broader socio-economic planning, explicitly linking resilience, industrialization, and human development to low-emission growth. By sequencing reforms and investment priorities over the coming decades, Vision 2050 provides a stable framework for mobilizing resources and

scaling structural change, demonstrating that key elements of a national net zero transition have already entered full implementation.

The LECRDS integrate targets and guidelines from “Vision 2050” to reach a reference document that integrates the long-term perspective into a consistent vision of the national transition. By providing a long-term perspective, this process is instrumental for alignment of short-term actions with the long-term requirements of the transition. In particular, this strategy will in turn inform the revision of Senegal's NDC, which is also currently underway. More generally, this initiative process has ensured the consistency of these various medium- and long-term sectoral development strategies, including sectoral policies and strategies (energy, industry, waste, agriculture, water resources), NDC 3.0, and the National Adaptation Plan (NAP), etc. This work also informed the discussions during the JET-P agreement negotiation process. Furthermore, the process put in place aims to contribute, from a technical and strategic point of view to the development of national development policies and policies for climate resilience and carbon sobriety.

GOVERNANCE

Senegal has established a structured governance system to manage climate-related issues, integrating climate considerations into national policies and international engagements. The Ministry of Environment and Sustainable Development is the primary governmental body responsible for environmental policy, climate monitoring, and international representation on climate matters. The National Committee on Climate Change (COMNAC) is an intersectoral advisory and coordination body under the Ministry of Environment. It is responsible for coordinating climate initiatives, facilitating stakeholder consultation, sharing information, and monitoring key climate projects. Its membership spans ministries, the presidency, parliament, public agencies, the private sector, trade unions, and academic

³ <https://www.presidence.sn/fr/actualites/vision-senegal-2050-une-ambition-collective-pour-un-avenir-souverain-prospere-et-solidaire>

institutions. COMNACC leads national climate coordination, supported by regional committees (COMREC) that extend operations to the local level. COMNACC also serves as Senegal's focal point under the UN Framework Convention on Climate Change (UNFCCC).

Senegal features a situation where a diverse set of policy targets must be articulated including development targets (eg, electricity access by 2029), sectoral goals (eg; 40% renewable capacity by 2030 as per the JETP, see below) and longer-term objectives such as those set in the Vision 2050 document. The work of the LECRDS is the first opportunity to anchor the development agenda in a long-term perspective, by opposition with the approach which had prevailed until recently and focused on 2030.

The analytical processes supporting policy decisions has been organized in a way that involves policymakers at the different stages of development of scientific analysis, but without them controlling it. In Senegal this has gone with the establishment of a Strategic Steering Committee in the LTV and LECRDS process, under leadership and led by the Ministry of the Environment and Ecological Transition and the Ministry of Energy, Petroleum, and Mines, with a mandate to guide the process strategically and ensure integration with all sectors' needs and plans (notably to support data access, prospective capacity building, etc.) and validate eventually the results. This committee has made a tremendous insight including high level dialogue contribution, in-depth reflection about the alignment between short- and long-term targets. The steering committee is complemented by a pool of five ambassadors who have longstanding and strategic experiences about policymaking process, civil society needs, research gaps, subnational perceptions and private actors' expectations.

On the technical side the process was operationalized in five thematic groups (four transitional working groups (TWG) focused respectively focused on energy, infrastructure (transport, waste and spatial planning) industry and agriculture as well as a last crosscutting group related to climate change and sustainable development).

Each group gathers stakeholders and experts from ministries and public agencies, academia, private sector, civil society.

The analysis was conducted by experts gathered in these specific working groups. The participation of ministry of energy and ministry of economy together with ministry of environment helped a lot anchor the LTS process into concrete decision-making such as:

- The elaboration of the Long-Term Vision (LTV) in 2023 and presented in the margin of CoP27: this report was one of the requirements of JETP of Senegal
 - The energy transition scenarios as a political and analytical tool for the JETP process
 - The review and update of sectoral and climate policies (i.e. NDC 3.0, LTS Agriculture)
 - The ongoing elaboration of LTS of Senegal to comply with Article 4.19 of Paris Agreement inviting parties to submit or update their LTS.
- The process was designed to improve the traditional, compartmentalized planning approach, moving towards a systemic foresight dynamic that integrates: i) the challenges and interrelationships between sectors, ii) the multifaceted contributions and expectations of key stakeholders (decision-makers, experts, researchers, communities, private individuals, etc.), iii) long-term sequencing, and iv) territorial and spatial equity.

This process involves a strong component of capacity mobilization and capacity building to ensure smooth capacity development about transitional prospective in key economic sectors and therefore build conditions for continuity of the process over time (see below)

The bottom-line of this process is to ensure broad participation by diversity of actors, including line ministries and stakeholders to establish appropriate solutions to the priority challenges of the population and the economic system, including energy poverty, climate vulnerability of primary sector, weak industrial status, low productivity of the production system and dependency on specific energies for different uses, such as oil for transport or wood for residential uses in rural areas.

CAPACITY-BUILDING AND ENHANCEMENT OF DOMESTIC SCIENTIFIC INPUTS

Senegal has a wealth of scientific and field expertise on issues related to energy, industrial, and infrastructure transitions. However, a detailed analysis conducted with local experts identified gaps and needs regarding the deployment of technical capacity building activities. Major limitations were highlighted, including, among others, a lack of expertise in the complex models targeted at informing the analysis of transitions, the absence of consolidated databases, and weak forward-looking dynamics at the sectoral level. Based on this diagnosis, it was agreed to strengthen national technical capacities in terms of forward planning for transitions, which was done very importantly with the approach to ensure domestication of these modelling tools and analytical methods with local actors and authorities. Two parallel capacity building processes were conducted

On the one hand, in the context of the LECRD process described above, an initiative supporting capacity building was launched with the support of the Agence Française de Développement and the African Climate Foundation (ACF) to identify modelling capacity options relevant in each of the different sectors was conducted. This has led notably to the development of a specific version of the model *Low Emissions Analysis Platform* (LEAP), an internally recognized and widely distributed modelling platform of the energy system covering energy production and consumption with a high-level of detail. The flexibility of the modelling platform and the close collaboration between international LEAP experts at Fundacion Bariloche, the transitional working groups (energy and transport) under the overall and technical support of Enda Energie allowed the development of a domesticated version of the model for Senegal, which captures available data and represents the specific structure of the Senegalese economy. Importantly, this modelling tool is in the hands of the Senegalese team which has developed the capacity to use it autonomously. On the other hand, since March 2023, GIZ and

IRENA have been helping the Senegalese Ministry of Petroleum, Energy and Mining (MPEM) to build up institutional capacity for long-term energy planning with a national Energy Masterplan Development. They deployed IRENA's SPLAT-MESSAGE model to develop power system capacity expansion scenarios. The program includes hands-on training and scenario development throughout an intensive collaboration with the LEAP modelling team and also the integration of LEAP model insights (hypothesis and results) already validated. Therefore, key improvements were made in terms of domestic capacity building in the last decade; that are still ongoing and now focusing on the better integration of all sectors in prospective work, and on the connection to socio-economic analysis.

In parallel and in support of these modelling developments or improvements, an extensive work was conducted for data collection, refinement and desegregation, which is necessary to support the sectoral planning process and the prioritization of measures including energy access for different household's types, energy needs of a set of agricultural systems.

These technical capacity enhancements have allowed develop analytical exploration supporting a better understanding of transition pathways. Energy System modelling including energy production, transport, and industry was notably important to better analyze the practical implications of the use of oil and gas under different trajectories for energy access, deployment of renewables, industrial paths, mobility trends, etc. This led for example to revisit the initial understanding that maximizing oil and gas production would naturally be the best option to deliver energy access; analysis has helped the diffusion of the idea that, instead, different options can be considered with pros and cons and that the scale and timing of this exploitation should be scrutinized closely. In addition, the ongoing agricultural modelling work will help also the exploration of different trajectories by Senegalese actors to increase the collective capacity of appropriating complex systemic effects including food sovereignty issues in the context of climate change.

JETP PROCESS

In June 2023, Senegal formalized its Just Energy Transition Partnership (JETP) with the International Partners' Group (France, Germany, the European Union, the United Kingdom, and Canada), mobilizing around €2.5 billion in financing over an initial period of 3 to 5 years. The JETP sets a clear national target of reaching 40% renewable energy in the installed electricity mix by 2030, supported by an investment plan to be developed within twelve months of the agreement and structured governance mechanisms involving ministries, development partners, civil society, and the private sector.

For Senegal, a future gas producer, the JETP represents a crucial opportunity to prevent “gas lock-in,” which could lead to high energy costs, increased dependence, and less sustainable energy. Indeed, a few years earlier, in 2018, after the large offshore natural gas discoveries (Greater Tortue Ahmeyim, Yakaar-Teranga), the government launched a “Gas-to-Power” strategy, setting the basis for the development of electricity production from natural gas. The objective of this strategy is multiple, in line with the commitments of the country's highest authorities:

- Gaining energy independence by securing SENELEC's fuel supply.
- To structurally abolish the tariff compensation paid by the State; Reduce considerably the cost of energy for the population and companies in Senegal.
- And finally, to achieve universal access to energy by 2025 as well as the objective of clean energy for all Senegal. The convertible gas production capacity is estimated to be between 400 MW and 530 MW with an estimated investment need of 40.9 billion Francs. In addition, the construction of other power plants is planned with a total capacity of over 1000 MW⁴.

Even though gas was recognized during the JETP-Senegal process as a “transitional energy”, JETP-Senegal set a quantitative target for renewables and allows renewable capacities to be

developed in parallel to gas process, avoiding a tremendous share of electricity coming from gas and potential “lock-in” effects by creating a financial asymmetry (Gas-to-Power investments were meant to be funded largely through domestic resources and conventional project finance). JETP also included a commitment for Senegal to submit its LECRDS consistent with the Paris Agreement: the scale and timing of gas exploitation is still subject to changes which may affect the long-term energy and emissions trajectories. Additionally, a notable strength of the process is that the renewable energy is aligned with the long-term trajectories as for example set in the LECRDS, ensuring alignment with Senegal's Integrated Low-Cost Electricity Plan and its long-term development strategies. This grounding in national insights enhances the ownership, credibility, and feasibility of the transition pathway, while also providing a platform for mobilizing international support that responds to the country's specific circumstances.

CONCRETE PROGRESS IN SECTORAL TRANSITIONS

Renewables

Over the past decade, even though the JETP financing package is still in the programming and project preparation phase, Senegal has made tangible progress in deploying renewable energy projects, marking a decisive shift from ambition to implementation in its transition pathway. The country has successfully commissioned large-scale infrastructure, most notably the Taiba N'Diaye wind farm, which is the largest in West Africa, alongside several solar photovoltaic plants such as those in Diass and Bokhol. These projects have diversified the national electricity mix, reduced reliance on imported fossil fuels, and positioned renewables as a competitive and reliable source of energy. Beyond their immediate impact on installed capacity, they demonstrate the technical and financial feasibility of scaling clean energy in the Senegalese context, while also creating domestic expertise and open-

⁴ Just Energy Transitions and Partnerships in Africa: a Senegalese Case Study, Secou Sarr and Samba Fall, 2022

ing avenues for further private and international investment. This rollout shows that renewable energy deployment has moved into a phase of full implementation consistent with the requirements of a long-term net zero transition.

This also answered electricity access targets: national electrification rate rose from 55% in 2015 to 78% in 2022, with rural areas catching up through grid extensions and off-grid solar; and aims to reach national universal electrification in 2029.

Transport

Additionally, in the transport sector, Senegal developed an urban public transport: the Bus Rapid Transit (BRT) system in Dakar. The new system is fully electric, runs on dedicated lanes, and marks a departure from diesel minibuses and informal transit. The BRT is projected to serve around 300,000 passengers per day along an 18km corridor with 23 stations linking 14 densely populated districts between the northern suburbs (Guédiawaye) and the city center. Travel times along this corridor are expected to be cut roughly in half, from about 90 minutes down to 45 minutes. On emissions, the all-electric fleet of the BRT is estimated to reduce or avoid between 53,000 and 60,000 tCO₂/year compared with what similar operations with fossil-fuelled buses would emit. The game changers behind this shift are a political decision at national and municipal levels to prioritize clean mobility; a public-private partnership structure (with Dakar Mobilité, Meridiam, FONSIS) that mobilized large international financing (World Bank, EIB, Climate Funds) to reduce financial risk; the technological availability of high-capacity electric buses (130 buses) and charging infrastructure (23 stations) capable of serving large flows; regulatory alignment (dedicated lanes, restructured informal sector integration); and strong public discourse about congestion, air pollution, and climate impacts. While the BRT is not yet generating its full emissions savings, its design and implementation are very consistent with what is required for a national net zero transition: electrification, modal shift, infrastructure planning, regulatory reform, inclusive access, and institutional coordination.

Energy transition

Senegal has made important discoveries of natural gas and oil reserves and is now in the process of starting its exploitation. This goes with the adoption of a “Gas-to-power” strategy according to which Senegal will use gas for electricity production by converting fuel plants and building new gas plants, in parallel with the expansion of renewable capacities.

Beyond national plans, Senegal has also elaborated several sector-specific strategies that provide a more detailed roadmap for key areas of the energy transition. These include:

- Political Plan of Energy Sector Development (LPDSE 2024–2028): which defines the government's priorities for expanding access, ensuring energy security, and fostering a diversified energy mix.
- Strategic Plan for Energy Management Development (PSD 2025–2029): focused on improving energy efficiency across sectors, reducing consumption, and promoting more sustainable energy use.
- Domestic Fuel and Biofuel Strategy 2030–2035: which addresses the critical issue of household energy by promoting cleaner cooking solutions and supporting the sustainable development of biofuels.

Together, these strategies complement national frameworks by offering operational pathways for implementation in specific sub-sectors, thus strengthening Senegal's capacity to meet its long-term decarbonization and energy access objectives.

EXAMPLES OF CONCRETE BLOCKAGES

It is important to note that the co-construction process has faced some challenges. The existence of parallel and overlapping analytical processes has at times limited the effective and consistent participation of key actors, who occasionally encounter conflicting agendas. Apart the equity and climate justice matter, there is still a lack of interconnected planning process and low prospec-

tive capacity of national institutions are some bottlenecks which drive the rationale of LECRDS co-construction initiative set up by the ministries in charge of environment and energy and being implemented by Enda Energie in Senegal. Indeed, Senegal features a situation where a diverse set of policy targets must be articulated and aligned including Senegal 2050 Vision, the universal electricity access by 2029, JETP goal (40% renewable energy targets by 2030), etc. The insight and work of the LTS is the first climate process that the development agenda in the country is anchored in a long-term perspective, by opposition with the approach focused on 2030. This experience demonstrates that you can have a very different look at short-term policy decisions if you put them in the long-term context. Notably the respective roles of renewables and natural gas in supporting the development agenda are very different if you look at long-term trends instead of just sticking to the short-term policy targets. In fact, the LECRDS process helps to define intermediate targets (2025, 2030, 2035, etc.) related to industrial, energy, infrastructural and agricultural transitions. This approach adopted and defined by national experts is aligned with sectoral policies (i.e. LPSDE 2024-2029) and is supporting also the revision of current climate policies (i.e. NDC 3.0). To address this, a series of planning meetings and ad hoc bilateral discussions are conducted to identify shared interests and complementarities while respecting the objectives of each initiative.

Data sharing has also been a challenge, despite significant efforts by line ministries. Within the co-construction approach, members of the working groups are increasingly given active and prominent roles, enabling them to act as focal points for data collection and refinement. This mechanism strengthens collaboration and ensures that data is more systematically shared and leveraged across initiatives.

Additionally, despite progress in several areas, some aspects of Senegal's national transition have remained constrained. In the case of the Just Energy Transition Partnership (JETP), while an investment plan was developed with support from an external consultant, its impact was limited. The plan was not

sufficiently anchored in national realities and did not fully reflect the structural foundations of the JETP agreement, which reduced its effectiveness in guiding actionable investments. This highlights the importance of ensuring that externally supported planning processes are closely integrated with domestic priorities and institutional capacities to advance the national net zero transition.

LINK TO NON-CLIMATE QUESTIONS

Senegal has made significant progress in integrating climate considerations into its national policy processes, recognizing the interconnectedness of climate action with critical social, economic, and financial issues. The country's long-term development strategy, Vision 2050, emphasizes the transition to a low-carbon, resilient, and inclusive economy as central to its growth trajectory. This vision underscores the necessity of aligning climate objectives with broader development goals to ensure sustainable prosperity.

One of the key strategic objective of this document: "Ensuring sustainable land use planning and organized urbanization" includes targets of building sustainable cities (green, resilient, and smart) through coordination of sectoral policies, promoting sustainable land use planning, with the development of integrated economic hubs; but also other objectives such as promoting sustainable management of natural ecosystems, driving a fair and equitable energy transition or establish connectivity infrastructure⁵.

⁵ Stratégie nationale de développement, 2025-2029

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A decade of national climate action: Stocktake and the Road Ahead

SOUTH AFRICA **INSIGHTS ON CLIMATE ACTION** **TEN YEARS AFTER THE PARIS** **CLIMATE AGREEMENT**

Jesse Burton, Julia Tatham, Andrew Marquard (Energy Systems Research Group, University of Cape Town)

INTRODUCTION

South Africa is one of the most energy- and carbon-intensive economies in the world, due largely to its historical reliance on coal for primary energy. It also remains one of the most unequal societies globally, with a Gini coefficient of 0.67, around 60 percent of the population living below the upper-bound poverty line, very high levels of unemployment, and weak performance on human development measures, especially once adjusted for inequality (WB, 2023). Unlike many countries, higher levels of absolute and per capita energy use (and hence greenhouse gas emissions) have not translated into broad-based social or economic development. This disconnect reflects the structural legacies of an energy-intensive, extractive economy shaped during apartheid and left largely intact thereafter. Coal further remains an important (though shrinking) export and with coal production and use highly concentrated in Mpumalanga, it is an important contributor to employment and local economies in the province. These conditions give rise to an acute sense of risk in policy discussions related to low-carbon transition, particularly in coal-dependent provinces such as Mpumalanga and in energy-intensive, trade-exposed industries. At the same time, the costs and risks of climate impacts are already high and growing, while South African business and policymakers increasingly recognise the risks of being uncompetitive in a

global economy shifting rapidly toward low-carbon production and trade (PCC, 2023b). Sectors such as automotive manufacturing, which face bans on internal combustion engine vehicles in major export markets, and energy-intensive commodities subject to emerging carbon border adjustment mechanisms, are particularly exposed (DTIC, 2023).

The question for South Africa then, is how to manage the climate transition without worsening socio-economic indicators, and indeed, how the process of transition can improve them. Climate action is thus framed predominantly through the lens of a “just transition” to a net-zero and climate resilient economy and society, although within this framing, competing views of mitigation ambition and development continue to affect the shape and pace of transition in different sectors.

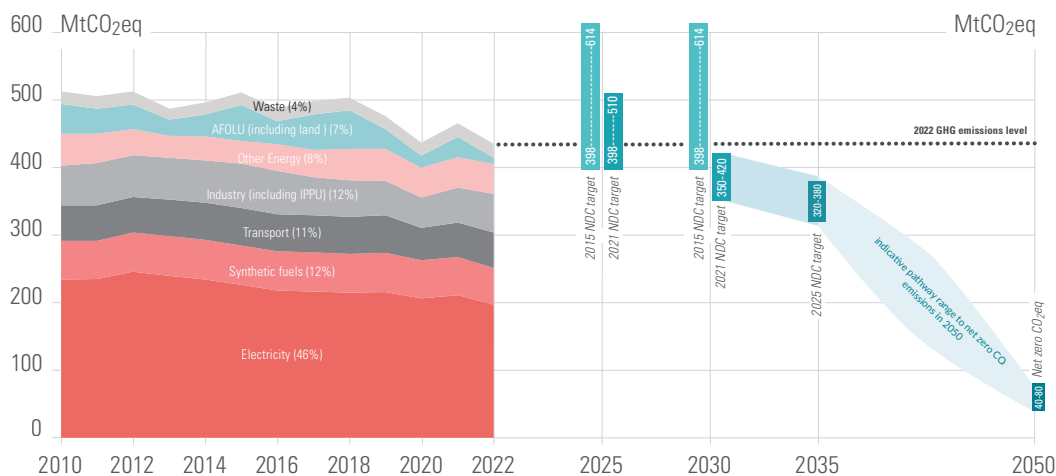
Over the past 10-15 years, the institutional architecture for climate policy and planning has been put in place, including through legislation, regulations, long-term policies and planning, carbon pricing, data and monitoring/reporting frameworks, and the emergence of new institutions to advise on and govern climate action. While early

mitigation efforts may have had smaller impacts in emissions terms, they signalled important institutional shifts (Burton et al, 2022). These have been gradually strengthened and expanded over time, including through incorporation into sectoral strategies, sometimes explicitly through climate targets and processes, and sometimes indirectly through synergies with development goals and mitigation co-benefits. International cooperation and domestic coordination mechanisms such as the Just Energy Transition Partnership (JETP) provide early insights into assessing and addressing barriers to action, mobilising and allocating finance, and aligning climate and development goals. Nonetheless, gaps in planning and implementation persist.

Given its centrality to GHG emissions (**Figure 1**), the energy sector, which accounted for 86% of GHG emissions in 2022 (including LULUCF), is critical to both South Africa's climate ambitions and developmental goals. The energy supply industries, predominantly electricity and coal-to-liquids, account for 59% of emissions. Energy policy, and electricity policy within it, is thus a critical domain with major effects on GHG emissions pathways. Concrete actions to deploy

Figure 1. GHG emissions by sectors

Historical GHG emissions (2010-22) as reported in the National Inventory Document submitted as part of South Africa's first Biennial Transparency Report (percentages are average shares of total annual GHG emissions, including land use, over the period 2010-22).



Notes: Historical GHG emissions are sourced from South Africa's first Biennial Transparency Report, and include LULUCF emissions. NDC target levels presented here do not take into account the accounting approach that South Africa has stated in its NDCs and in its first BTR will be applied to reporting on the implementation and achievement of these NDC targets - the exclusion of land sector emissions from natural disturbances. The process and methodology for accounting is stated in South Africa's first BTR. Application of the accounting approach could result in an effective increase in South Africa's target levels of between 20 and 50 Mt, if this approach is applied up to 2030 and 2035 respectively (in other words, South Africa will be able to meet its NDC targets if its total net GHG emissions are 20-50 Mt higher than the respective target ranges in 2025, 2030 and 2035). South Africa's NDCs, and specifically its most recent NDC (submitted in 2025) affirm South Africa's long-term GHG emissions target of net zero CO₂ emissions in 2050. This outcome, based on existing analysis, would result in GHG emissions (non-CO₂) of between 40 and 80 Mt-CO₂-eq in 2050 (Marquard et al 2022).

renewable energy have yielded successes and nascent sector reforms have enabled a substantial new renewable pipeline to emerge, though concrete reductions beyond electricity are yet to emerge.

Overall, the pace and scale of change remain slow. While South Africa's emissions peaked in 2009, much of this is explained by challenges in electricity planning and infrastructure execution, and poorly performing coal plants, as well as price increases. This led to an electricity supply crisis characterised by ongoing loadshedding over many years, coupled with stagnant economic growth and underwhelming per capita GDP growth, which has translated into lower electricity use, especially in industry.

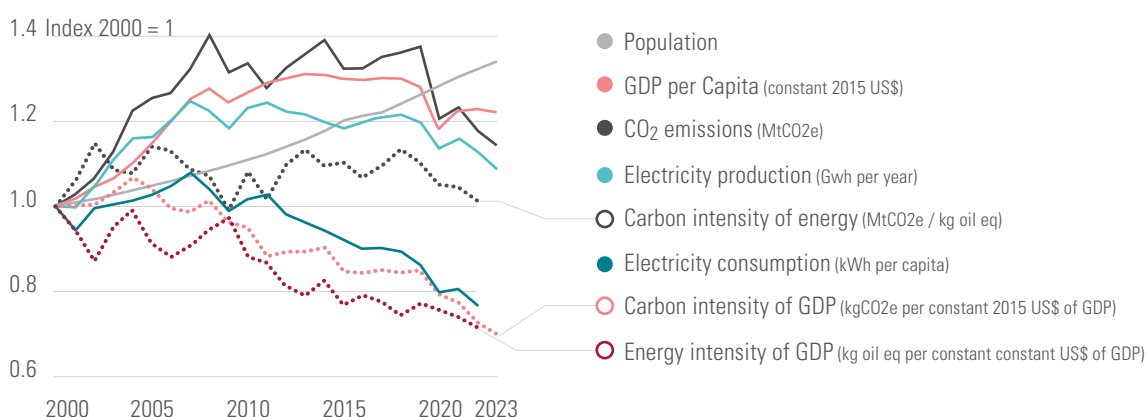
Sustained GHG emissions reductions, driven by decoupling economic growth and emissions through cleaner technologies and practices and purposeful structural diversification of the economy is only now beginning to emerge. New institutions and emerging coordination mechanisms will need to scale up rapidly, in action, policy, implementation, and finance, to keep emissions reductions on track in context of a global economic reordering, deliver co-benefits such as cleaner air and health gains, and unlock the developmental potential of stable power supply and new climate-compatible sectors and value chains (Zalk et al., 2024).

Sustained progress rests on faster implementation and scaled-up financing in the power sector, particularly to address critical grid constraints and ensure a just transition in closing coal assets, attention on maximising energy efficiency, the development of pathways for major emitting industrial firms and sectors, and transforming just transition and economic diversification plans in the transport sector into actively shifting modes, enhancing electrified public and private transport, and transitioning supply chains in automobiles towards new energy vehicles chains in automobiles.

CLIMATE POLICY DEVELOPMENT AND CONTEXT SINCE 2015

South Africa's formal climate policy framework took shape with the 2011 National Climate Change Response White Paper (DEA, 2011), adopted the same year South Africa hosted COP17 in Durban. The White Paper drew on over a decade of preparatory policy processes and South Africa's long participation in the UNFCCC. An early measure implemented alongside the White Paper was the launch of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), a renewables auction scheme launched in 2011 (see below).

Figure 2. Indexed decomposition of drivers of GHG emissions in South Africa 2000-2023



In 2015 South Africa submitted its first Intended Nationally Determined Contribution (INDC), ahead of COP21 in Paris. This commitment, later formalised as its first Nationally Determined Contribution (NDC) upon ratification of the Paris Agreement in 2016, largely reiterated the mitigation framework introduced in the 2011 White Paper. The NDC restated the country's greenhouse gas (GHG) emissions trajectory, which would peak in 2025 and plateau to 2035 in a range of 398-614Mt CO₂eq, and then decline to mid-century (Climate Transparency, 2021). At this stage, policy ambition was framed more by continuity than by transformation, reflecting the still-limited political and institutional capacity to advance implementation of key mitigation measures.

Between 2015 and 2019, policy debates were dominated by attempts to operationalise instruments that had long been under discussion. Chief among these was the carbon tax, first proposed in 2010 and only passed into law with the Carbon Tax Act of 2019 (RSA, 2019). The long delay reflected the influence of powerful stakeholders in energy-intensive and coal-related industries (Baker et al, 2015; Just Share, 2025), notably concerns about the economic burden it would place on energy-intensive firms and competitiveness effects. This was despite significant work by the National Treasury to examine questions of design, effects on poor households and sectors, and revenue recycling options. While the tax is now in place, the effective tax rate remains lower than has been proposed, with higher allowances (Mxakaza, 2024).

Alongside the tax, the mandatory reporting of GHG emissions by large emitters (through the National Greenhouse Gas Emission Reporting Regulations) began to be implemented in this period, laying the groundwork for improved data, more transparent monitoring and future compliance systems (DFFE, 2020). Other sectoral policies and measures to manage greenhouse gas emissions included the green transport strategy (DoT, 2017), and planned national energy efficiency standards/policies (post-2015 NEES) (DoE, 2016). A number of policies and measures were

put in place though thus far with limited or small effects on emissions reductions.

South Africa complemented these developments with the submission of its Long-Term Low Emission Development Strategy (LT-LEDS) to the UNFCCC in 2020. The LT-LEDS sets out potential pathways for achieving a just transition to a low-carbon economy by mid-century, with a particular focus on decarbonising the electricity sector and balancing climate ambition with pressing development priorities. The Lt-LEDS provides a strategic vision rather than a binding plan, providing a framework to guide future iterations of the NDC and related policies. It included a 'soft commitment' to net-zero carbon emissions by 2050, already committed to (in principle) by stakeholders during consultations undertaken by the National Planning Commission on the just transition vision for South Africa, over 2018-2019 (NPC, 2019). South Africa is currently deepening analysis and stakeholder engagement to inform an update its LT-LEDS with sector measures and pathways, in the context of meeting development goals and building prosperity, and by linking short/medium term sector targets to the long term 2050 goals.

In 2021, South Africa submitted an updated first NDC that progressed the mitigation target ranges of its 2015 INDC, lowering the upper bound significantly, from 398-614Mt CO₂-eq to 398-510 Mt CO₂-eq for 2025 and 350-420 Mt CO₂-eq for 2030. These revisions were widely regarded as more credible and ambitious compared to the earlier targets, which had been partially based on modelling, stakeholder engagement and analysis undertaken in the LTMS process from 2006-2008. The broad range from 2015 represented an accommodation by government of stakeholders with "diametrically opposed views on mitigation" (Burton et al, 2022), and also did not reflect the changing techno-economics especially of the power sector globally and in South Africa. Notably, coal capacity additions by Eskom and planned by IPPs had proven to be significantly more expensive than renewable alternatives (Bischof-Niemz, 2018; Ireland & Burton, 2018; Merven et al, 2021).

The updated first NDC range reflected emission outcomes consistent with existing policies, notably the 2019 Integrated Resource Plan for Electricity. However, at the time, reaching the lower bound/most ambitious outcome of the target range for 2030 implied the need for enhanced implementation of policies and scaling up of measures, primarily in the electricity sector (since alongside EEDSM, it remains the most cost effective policy domain for action). Specifically, this would involve a faster and higher roll-out of wind and solar, greater energy efficiency, progress in transport modal shifts and electrification, and earlier retirement or reduced utilisation of coal-fired power plants (Marquard et al., 2021; PCC, 2021).

Since 2021, much slower than expected economic growth has translated into lower-than-expected economy-wide emissions and lower electricity demand, altering the degree of effort needed to attain the target ranges for 2025 and 2030. However, Eskom has also recently extended the lives of some of its coal power stations as a supply security measure, and has sought postponements or exemptions for compliance with air pollution laws. Practical planning towards widespread coal plant repurposing, repowering, or closure remains partial at best, even as Eskom plants are reaching the end of their techno-economic lives. Eskom now faces the challenge to manage the closure/repurposing of at least seven plants by 2035, while it has struggled to progress the transition at Komati, the first and only plant to shutdown so far (PCC, 2023a).

Domestic mitigation policy strengthening has been accompanied by the emergence and development of institutions to implement and manage South Africa's climate transition, led by the Department of Forestry, Fisheries and the Environment, and now concretised in the newly promulgated Climate Change Act of 2024. It took 6 years for the draft Climate Change Bill, initially proposed in 2018, to be signed into law in mid-2024, with organised business strongly opposing elements of the Bill that would have imposed emissions limits or be accompanied by legal, criminal, or financial effects for firms (Just

Share, 2025). The Act establishes arrangements for cross-governmental coordination on climate, includes a national emissions trajectory, as well as sectoral emission targets (SETs) and carbon budgets for sectors and firms; requires city- and provincial climate plans to be developed; and institutionalises formally the Presidential Climate Commission (PCC) to advise on matters related to climate change and the just transition.

The PCC was launched in 2019 as a multi-stakeholder body comprising a technical secretariat and Commissioners from across the political spectrum, including youth, labour, civil society, and business. In that capacity, it led the development of the National Just Transition Framework, approved by the Cabinet in 2022, and provides advice on just transitions in the mitigation and adaptation spheres, as well as climate finance issues. The PCC conducts independent analysis and commissions research, coordinates ongoing and frequent stakeholder engagement at local, provincial and national scales, and across key sectors, and monitors climate action. Mitigation-related work is diverse and includes just energy transition and coal plant closures, market reforms, grids, CBAM response, urban/municipal transitions, a draft transport just transition plan, and skills. One area has also been the strengthening of a national climate-energy-economy modelling ecosystem comprising different modelling teams and a wide array of analytic tools. This ecosystem includes teams undertaking net zero pathways analysis for the Commission (PCC, 2025) using energy-economy modelling tools such as SATIMGE, but also incorporating adaptation costs into long-term economic modelling; different types of economic models (CGE, multiplier models, micro-sim), as well as spatially and temporally detailed power system modelling (PypSA, Plexos, grid modelling), and the integration of co-benefits analysis such as air pollution and water into energy systems analysis. Finally, the PCC facilitates stakeholder engagement and provides advice for policy processes, including the first updated NDC in 2021 and the second NDC in 2025.

South Africa released its draft second NDC for 2035 for public comment in July 2025, with the final NDC expected to be submitted to the UNFCCC in advance of COP 30. The technical work comprised analysis covering equity/fair shares; economy-wide emissions modelling including implementation of packages of policies and measures; mitigation and adaptation investment and just transition needs assessment; and detailed power system and air pollution modelling. The range proposed in the draft for stakeholder comment was 320–380 Mt CO₂-eq for 2035, with existing measures able to reduce emissions to 366 Mt in 2035 and full policy implementation, even with high economic growth assumptions, reaching 322 Mt in 2035.

The PCC released a proposed range of 248–329 Mt in advance of the draft NDC, with stakeholders and commissioners advocating for a wide and varying range. Public consultation on the NDC hosted by the PCC demonstrated widespread disagreement on the mitigation ranges, with some stakeholders advocating a return to the pre-2021 NDC benchmark range for 2035 (up to 614Mt). Such levels, as with the upper level of the proposed NDC range of 380Mt, would require slowing down planned transformation of the energy system and actively maintaining and refurbishing fossil fuel assets (Marquard et al, 2025).

The period since 2015 has seen South Africa move from reiterating its earlier policy commitments to tightening its emissions targets and making more concrete progress on implementation. The policy landscape remains constrained by economic challenges and the structural dominance of coal, but the combination of falling renewable costs, improved coordination of and quantities of international climate finance, and domestic recognition of the need for a just transition has strengthened climate policy and institutions. The following sections discuss the concrete successes in renewable energy deployment and in just transition planning and institutions.

CONCRETE PROGRESS IN ELECTRICITY PLANNING AND NEW RENEWABLE GENERATION CAPACITY

The Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), launched in 2011, is one of South Africa's most notable mitigation successes. Its first three bid windows (2011–2014) secured more than 6,300 MW of renewable capacity from 92 projects, mobilising over ZAR 200 billion (USD ~15 billion) in private investment with cumulative emissions reductions of 102 Mt CO₂-eq by 2022 (BTR1, DFFE, 2024). The programme built on the first public electricity planning process undertaken in South Africa, culminating in the Integrated Resource Plan (IRP) 2010, and became a key mechanism for implementing the IRP 2010 renewable energy capacity. The IRP 2010 introduced the practice of imposing GHG emissions limits into electricity planning, although this practice has had limited effects on the final capacity expansion plans under various IRP processes, thus far.

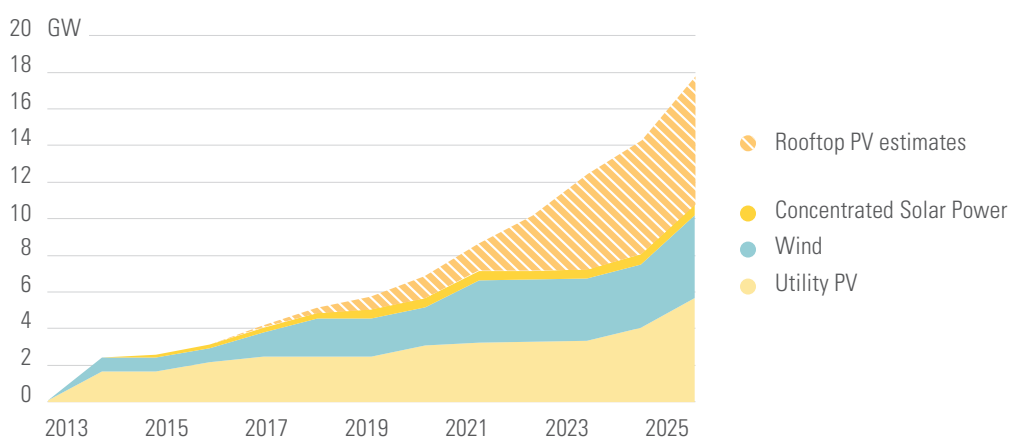
Although the renewables programme has faced challenges, including political barriers, and now network infrastructure constraints, the pipeline of wind, solar, batteries and hybrid plants has grown substantially over the past 5 years. Concrete regulatory changes and sector reforms are enabling deployment at scale, with sufficient projects under development to meet the levels of installed renewable generation capacity aligned with ambitious climate targets in 2030 and beyond.

Despite the early success of the programme, progress stalled in 2015 when Eskom refused to sign further power purchase agreements, citing cost and over-supply concerns. A multi-year REIPPPP hiatus then ensued, reflecting political contestation over independent power producers and the role of the private sector in electricity, the dominance of coal interests, and uncertainty in energy planning. Investor confidence fell, and no new projects reached financial close until a new administration and Minister of Energy resolved the blockage in 2018 (Hanto et al, 2022).

Although procurement restarted with Bid Window 5 in 2021, momentum had slowed. Projects faced delays from high interest rates, supply chain issues, and especially transmission bottlenecks in resource-rich provinces. Eventually, almost half of the projects in round 5 failed to reach financial close, leaving a gap in planned capacity additions, despite extensive supply shortages. Meanwhile, rooftop and embedded generation remained constrained by licensing and regulatory barriers. The worsening power crisis after 2019 changed this dynamic. Escalating load-shedding and falling technology costs drove rapid growth in embedded generation and renewed interest in utility-scale projects and the attempted reinvigoration of the REIPPPP. In 2022, government declared an emergency and introduced major reforms: lifting licensing thresholds, simplifying registration with NERSA, and offering tax incentives for households and firms for rooftop solar. These measures triggered a surge of private investment outside the REIPPPP. Rooftop and embedded PV grew from under 1 GW in 2019 to an estimated 7 GW by 2025, nearly double the solar capacity procured through REIPPPP since 2013 (CRSES, 2025). This shift marked a fundamental turning point in South Africa's renewable trajectory and contributed to reducing load shedding. Under the REIPPPP, however, challenges persisted. Round 6, launched in 2022, resulted in no wind

projects proceeding due to grid constraints, further widening the gap between planned and constructed new generation additions. In round 7, launched in January 2024, wind projects have continued to face similar challenges, with capacity reallocated to solar and negotiations ongoing for some wind projects to reach financial close. South Africa's severe capacity shortages, combined with transmission constraints, prompted government to introduce large-scale battery storage to stabilise the grid and support variable renewable energy. In November 2023, preferred bidders were announced for the first Battery Energy Storage Independent Power Producer Procurement Programme (BESIPPPP) (IEA, 2024). Since then, three bid windows have been completed, with the third concluding in May 2025 and securing a total of 6,976 MWh of planned utility-scale storage capacity (Murray, 2025). Further reforms strengthened the shift. Amendments to the Electricity Regulation Act paved the way to unbundle Eskom, creating the new National Transmission Company of South Africa (NTCSA) albeit under an Eskom Holding Company, and launch a process to create a competitive wholesale market, expected to launch in April 2026. Since 2022, independent power producers have been able to contract directly with private offtakers, expanding the pipeline dramatically by creating avenues to market that did not rely solely

Figure 3. Historical RE build, planned expansion and rooftop PV estimates (as of June 2025)



Source: These values are obtained and combined from various sources including the Eskom TDP, GCCA, and RE Grid Survey, as well as from REDIS, the GSB Power Futures Lab, various news articles, with manual cross-checking, updating, research, and validation from the ESRG power sector modelling team.

on the government's public auction rounds. By 2023, the pipeline for new variable renewable energy projects reached 64 GW, rising to 134 GW of wind, solar, and hybrid storage projects by 2024 (REGS, 2023, 2024).

The National Treasury is furthermore developing an innovative financing mechanism with development finance partners – a Credit Guarantee Vehicle – to derisk grid expansion through independent transmission auctions (to be launched in late 2025) (RSA, 2025). This will however finance only a small share of the grid expansion contemplated by the NTCSA in its Transmission Development Plan by 2030. The TDP requires a significantly scaled up rate of deployment and finance than has been achieved historically, to alleviate grid constraints in the short term and enable much greater evacuation of new renewable power by 2035.

CONCRETE PROGRESS IN CLIMATE AND DEVELOPMENT PLANNING: THE JUST ENERGY TRANSITION PARTNERSHIP

Considering South Africa's structural carbon-intensity and high levels of poverty and inequality, a crucial aspect within climate policy development and institution-building is related to the links between the socio-economic and development elements of climate transition. Mitigation approaches have expanded to actively consider the justice implications of transition (for example on workers, communities) and opportunities in new sectors (for example, new industrial and economic diversification opportunities). Recognising that coal, automobiles and other sectors underpin jobs, livelihoods, and regional economies, policymakers began to integrate considerations of social equity and economic diversification into climate planning, and especially since 2021/2022, just transition has become central to climate policy discussions. The vision of the national just transition framework addresses all elements of the climate transition (mitigation and adaptation, physical and

transition risks), while the Climate Change Act is intended to enable “a long-term, just transition to a low-carbon and climate-resilient economy and society for South Africa” and defines a just transition as a shift towards a low-carbon, climate-resilient and ecologically sustainable economy and society which contributes toward the creation of decent work for all, social inclusion and the eradication of poverty (RSA, 2024). Policy developments within national sector departments include the DFFE's National Employment Vulnerability Assessment and Sector Jobs Resilience Plans, the DMRE's JET Framework for Energy and Minerals, a recent draft Transport Just Transition plan; in provinces (for example, Mpumalanga's Phase I JT plan); in municipalities; and in firms e.g. Eskom's JET Office overseeing coal plant closures.

This domestic approach was reinforced by diplomatic developments, notably the announcement of the (initially) \$8.5 billion Just Energy Transition Partnership (JETP) with the International Partners Group (IPG) in 2021. The Partnership signalled a shift in climate diplomacy, positioning South Africa as an early mover in new climate finance and diplomatic modalities for mobilising climate finance to support coal-dependent economies in transition. However the identified priority sectors went beyond coal, to consider also socio-economic aspects of clean electricity, new energy vehicles, and new export products such as green hydrogen and derived products, i.e. direct or indirect interventions in major industrial sectors facing transition impacts or opportunities.¹

South Africa put together a Presidential Climate Finance Task Team and a JETP Secretariat to develop over the course of 2022 and to identify the investments needed to deliver a just transition across the priority sectors. The JET Investment Plan (JET IP) was launched in November 2022. It lays out investment needs totalling \$98bn over

¹ The national Just Transition Framework (2022), the JETP, and institutions such as the Presidential Climate Commission have also broadened the scope of climate policy beyond coal and electricity to include value chains such as automotive manufacturing and transport. South Africa's EV white paper aims to leverage local mineral resources to build regional value chains in batteries and EV components and promote green industrialisation through localisation and integration with clean energy (DTIC, 2023).

2023-2027 and included two additional priority areas that were deemed critical for the successful implementation of a just transition (skills and municipalities).

The predominant investment is in the electricity sector, recognising both the extant challenges (coal dependence and supply insecurity) and the opportunities for mitigation, improved supply and affordability. The infrastructure investment needs for coal plant decommissioning, transmission, distribution, and wind, solar PV and batteries would reach a low-middle range of the 2030 NDC (the IP included modelling of tens of scenarios to assess options and investment needs for the 2030 NDC mitigation target range). Additional focus areas were on elements to improve social outcomes in the sector, including piloting social ownership models, manufacturing and localisation, and a coal region focused set of programmes to protect workers and communities and promote diversification and repurposing of coal assets. The latter identified nine key investment areas, based on existing literature from government, civil society, unions, and business, totalling ~\$4bn over the period to 2027. Importantly, the JET-IP was the first explicit analysis of climate and development ambition financing needs and gap analysis.

Until now, most support has flowed to the programmes in Mpumalanga and into green hydrogen-related areas, while new energy vehicles received less funding attention, despite its importance to industrial output and manufacturing.²

South Africa's automotive manufacturing sector is a large employer with an integrated component value chain that is a major contributor to manufacturing jobs and value add in the country, and a small player globally. It faces challenges in that production for domestic and export markets are co-dependent and major export markets such as the UK and EU (accounting for 46% of exports in 2022) have either imposed bans on ICE vehicles in support of their own domestic mitigation pathway, or global markets are shift-

ing away from ICE specific components and towards electric vehicle components (with 67% of components at risk). As production turnover occurs approximately every 7 years, this leaves little room for production shifts before ICE bans and market shifts puts these exports at risk (DTIC, 2021; DTIC, 2023). Transitioning the vehicle manufacturing sector is thus important given the high number of quality jobs in the sector – at 110 000 direct jobs the sector surpasses coal – and the concentration of manufacturing in certain regions such as the Eastern Cape. In response, the National Treasury has allocated fiscal resources totalling R1 billion in tax incentives to encourage the upstream sector to transition and ensure that decarbonisation is a driver of growth, rather than of de-industrialisation. Nonetheless, challenges remain – despite lower total costs of ownership already, capital cost parity is a major driver of uptake and has not yet been reached in South Africa. And a large share of passenger transport is not in private vehicles but in minibus taxis, requiring a separate set of incentives for both manufacturing and consumer uptake (including resolving operational questions).

The diplomatic and political efforts under the JET IP have also created focused attention on issues of finance (PCC JTFM, 2024), the explicit challenges of novelty, small ticket size, and innovation facing just transition projects (Lowitt, 2021, 2022), and especially to access private finance due to lack of information and 'bankability', and high transaction costs (PCC JTFM). The efforts have broadened attention to new areas for mitigation and development action, and have galvanized non-state actors to address gaps in the partnerships (for example by developing funding modalities to support bottom-up project development and address community needs). It has triggered a concerted diplomatic, cooperative, and focused process on the realities of delivery and implementation and the financing modalities to achieve this.

The JETP has contributed to building institutional and governance capabilities and structures, and the technical and social knowledge required for transition. The project management unit in the

² The JET Investment register is available here: <https://justenergy-transition.co.za/jet-investment-register-dashboard> and NEVs have received the smallest allocation thus far.

Presidency (JET PMU) oversees implementation of the JET Investment and the subsequent Implementation Plans, including financial tracking and a grants register, monitoring, evaluation and learning, and coordination. While critiques of the quantity and quality of finance persist, both grant and concessional finance have flowed, as can be seen in the quarterly grants register reports, and concessional/policy loans, while adding to debt, come with very attractive terms compared to borrowing. One critique has been the overemphasis of grants for technical assistance, research/consulting, and foreign entities, instead of benefiting people most impacted by transition, with projects struggling to find funders struggling to get funding to projects on the ground.

A major innovation in response was the recent launch of the JET Funding Platform to directly support projects on the ground and ensure scarce grant funding flows to projects beyond technical assistance. Projects that meet just transition criteria are assisted with business development and project preparation, and then with match-making to funders. The focus is on community originated and driven projects, covering economic diversification, enterprise development, skills/training, community and government support, and clean energy and just transition models, i.e. also supporting initiatives to address poverty in the coal region and beyond.

However the process has not been without challenges. Civil society has criticised (especially early in the process) the lack of transparency and inclusion in the process as well as in data and beneficiaries. There are limitations to how funding can be deployed in terms of flexibility and funder requirements, as well as geopolitical interests; in the long-term some areas requiring support would be difficult to fund via grants without significant reforms. On the other hand, policy and concessional loans provide significant flexibility to the government to channel to those areas with the greatest need, but will require being translated or mainstreamed into public sector just transition programmes and activities. And new and additional, high quality funding will be needed as mitigation ambition scales up and accelerates.

Despite the significant efforts outlined above, political fragmentation and contestation have persisted and intensified as the practicalities of transition start to draw nearer. While the JET IP implementation unit sits in the Presidency, reporting to a JET inter-ministerial committee, and works toward successful implementation of the investment plan, much sectoral decision-making resides within associated ministries or firms. Policy processes therein do not yet reflect the latest science or comprehensively integrate climate considerations and typically are more accommodating of entrenched sectoral interests that promote alternative or slower sectoral transformations than required by a fair contribution to the Paris goals.

Significant work is thus still needed to translate the depth of vision and the early insights into a stronger and deeper programme of action across multiple policy areas and sectors

WHERE IS FURTHER PROGRESS NEEDED IN MITIGATION?

While concrete progress has been made in the power sector (notwithstanding that challenges remain especially for network investments and in just transition implementation, and that blockages could re-emerge,) other transformations and interventions have not progressed significantly despite their importance for achieving net zero in the longer term.

After electricity, the largest emitting sectors are in industry (especially synthetic fuel but also other sectors such as iron and steel) and transport. Transformations required in the transport sub-sectors, and barriers to action, include:

- Transport modal shifts and electrification (rail and buses) : upfront costs, political economy of existing industries;
- Electrification of private passenger vehicles and associated value chain diversification: upfront costs for consumers and producers; institutional barriers to coordination and funding;

Civil society has also criticised heavily the emphasis on green hydrogen for export, seeing it as undermining domestic clean power transi-

tion and putting communities at risk. However, one element with wide agreement is the transition of the existing carbon-intensive steel industry to one based on green iron ore for export and for domestic steelmaking. While industrial decarbonisation is held back by political opposition and firm hedging, high upfront investments with limited financial resources, and undeveloped markets for products or a lack of green product premia. McCall et al (2025) note, green hydrogen direct reduction “is slated to be the mainstay of a fully decarbonized global production route. However, to be bankable, these require large direct capital subsidies, large operational subsidies in hydrogen supply and, understandably, commensurate protection against high embedded emissions imports”, and thus require terms that “level the international playing field” as otherwise “such projects will likely not be bankable despite the country’s potential as a low-cost production location due to its renewable energy resources and iron ore reserves”. A particular opportunity thus lies in a stepwise process for the local industry (which faces significant competitiveness challenges already) – starting with electric arc furnaces that can in time be fed by green direct reduced iron. But cooperation is needed in both climate finance and tech transfer to enable large-scale ‘green industrialisation’ projects in South Africa. Finally, mobilising finance remains an acute challenge. Estimates to reach net zero by 2050 require investment of \$224bn in power, transport, and industry to 2050 (NPV) (CCDR, 2023). The availability and cost of capital is thus critical, with South Africa, like many emerging markets, facing higher rates than developed countries due to real or perceived risk premia. It is likely that the quantum of funding required for the energy transition will soon exhaust domestic financing capacity without some forms of financial innovation and greater international flows (Intellidex, 2022). Furthermore, South African commercial banks are constrained by implicit sector limits imposed by ratings agencies and regulatory rules (B20, 2025), and further innovations are needed domestically to unlock domestic resources at scale.

REFERENCES

- Baker, L., Burton, J., Godinho, C. & Trollip, H., 2015. The political economy of decarbonisation: Exploring the dynamics of South Africa’s electricity sector. Cape Town: Energy Research Centre, University of Cape Town.
- B20 (2025). Finance and Infrastructure. Available at <https://www.b20southafrica.org/wp-content/uploads/2025/09/B20-Finance-and-Infrastructure.pdf>
- Bischof-Niemz, T., 2018. The long-term viability of coal for power generation in South Africa. Available at: https://www.researchgate.net/publication/324409134_The_long-term_viability_of_coal_for_power_generation_in_South_Africa
- Burton, J., Baker, L., Marquard, A., Lehmann-Grube, P. (2022). From MEC to Net-Zero: the role of
- The energy sector in the Just Transition. In Xaba, N & Fakir, S (eds). *A just transition to a low carbon future in South Africa*. Mapungubwe Institute for Strategic Reflection
- Burton, J., Baker, L., Marquard, A., Lehmann-Grube, P. (2022). *From MEC to Net-Zero: the role of the energy sector in the Just Transition*. In Xaba, N & Fakir, S (eds). *A just transition to a low carbon future in South Africa*. Mapungubwe Institute for Strategic Reflection
- Center for Renewable and Sustainable Energy Studies (CRSES), 2025. South Africa energy statistics. Available at: <https://www.crses.sun.ac.za/sa-energy-stats/>
- Climate Transparency, 2021. NDC Transparency Check – South Africa. Available at: <https://www.climate-transparency.org/wp-content/uploads/2021/10/NDC-Transparency-Check-South-Africa.pdf>
- Country Climate and Development Report : South Africa. World Bank Group. 2022. CCDR Series. <https://hdl.handle.net/10986/38216>
- Department of Energy (DoE), 2016. Post-2015 National Energy Efficiency Strategy: Draft for Public Comment. Pretoria: Department of Energy. Available at: https://www.gov.za/sites/default/files/gcis_document/201612/40515gen948.pdf
- Department of Forestry, Fisheries and the Environment (DFFE), 2020. Regulations: National Greenhouse Gas Emissions Reporting (Amendment) (Government Notice 994, Government Gazette 43712). Available at: https://www.dffe.gov.za/sites/default/files/legislations/nemaqa_greenhousegasreporting_regulationsamendment_g43712rg11174gon994.pdf
- Department of Trade, Industry and Competition (DTIC), 2023. Electric vehicle white paper. Available at: <https://www.thedtic.gov.za/wp-content/uploads/EV-White-Paper.pdf>
- Department of Trade, Industry and Competition (DTIC), 2021. Geared for Growth : South Africa’s Automotive Industry Master Plan to 2035. Available at https://www.thedtic.gov.za/wp-content/uploads/Masterplan-Automotive_Industry.pdf
- Department of Transport (DoT), 2017. Green Transport Strategy (2017–2050). Government Gazette No. 41064. Pretoria: Department of Transport. Available at: https://www.gov.za/sites/default/files/gcis_document/201708/41064gon886.pdf

- Department of Environmental Affairs (DEA), 2011. National Climate Change Response White Paper. Pretoria: Department of Environmental Affairs. Available at: https://www.dffe.gov.za/sites/default/files/legislations/national_climatechange_response_whitepaper.pdf
- Department of Forestry, Fisheries and the Environment (DFFE) (2024). *First Biennial Transparency Report of South Africa under the Paris Agreement* [PDF]. UNFCCC. Available at: https://unfccc.int/sites/default/files/resource/First%20Biennial%20Transparency%20Report%20of%20South%20Africa%20under%20the%20PA_20%20December%202024.pdf
- Hanto, R., et al., 2022. South Africa's energy transition – Unraveling its political economy. *Energy Policy*, 166, 112953. Available at: <https://www.sciencedirect.com/science/article/pii/S0973082622000928>
- Intellidex, 2022. Financing South Africa's Just Energy Transition: Capital Market developments to scale private sector mobilisation.
- International Energy Agency. (2024). *Utility-scale batteries in South Africa: Improving grid stability and renewables integration with dedicated tenders*. <https://www.iea.org/reports/south-africa-case-study/utility-scale-batteries-in-south-africa-improving-grid-stability-and-renewables-integration-with-dedicated-tenders>
- Ireland, G. & Burton, J., 2018. An assessment of new coal plants in South Africa's electricity future: The cost, emissions, and supply security implications of the coal IPP programme. Available at: <https://www.cer.org.za/wp-content/uploads/2018/05/ERC-Coal-IPP-Study-Report-Finalv2-290518.pdf>
- Just Share, 2025. Lobbying Report <https://justshare.org.za/wp-content/uploads/2025/05/JS-Lobbying-Report-Obstruction-Playbook-digital-1.pdf>
- Lowitt, S. 2021. A Just Transition Finance Roadmap for South Africa: A First Iteration. Trade & Industrial Policy Strategies. Available from: https://www.tips.org.za/images/TIPS_UK_PACT_A_Just_Transition_Finance_Roadmap_for_South_Africa_First_Iteration_December_2021.pdf
- Lowitt, S. 2022. Toward a Just Transition Finance Roadmap for South Africa: Action Agenda 2022-2025. POLICY BRIEF: 2/2022. Trade & Industrial Policy Strategies.
- Marquard, A., McCall, B., Caetano, T., Burton, J., Stevens, L., Ireland, G., Keen, S. & Winkler, H. et al. 2025. *Draft Technical analysis to inform the development of the mitigation component of South Africa's second NDC*. Cape Town: Energy Systems Research Group.
- Mxakaza, K. 2024. *Environmental tax reform and carbon pricing to facilitate the transition to a green economy* [Webinar paper]. Network of Tax Organisations (NTO). Available at: <https://www.taxcompact.net/sites/default/files/resources/ENVIRONMENTAL%20TAX%20REFORM%20AND%20CARBON%20PRICING%20IN%20SOUTH%20AFRICA.pdf>
- McCall, B., von Blottnitz, H. & Trollip, H., 2025. Two international sectoral developments affecting options for South Africa's next NDC. [online]. Available at: https://ddpinitiative.org/wp-content/uploads/pdf/ddp_countryfiche_zaf.pdf
- Merven, B., et al., 2021. Assessing the impacts of new coal plants in South Africa. Available at: <https://lifeaftercoal.org.za/wp-content/uploads/2021/10/Merven-et-al.-2021.-Assessing-the-impacts-of-new-coal-plants-in-South-Africa-20210715.pdf>
- Murray, C., 2025. South African government's 11GWh BESS procurement in charts. *Energy-Storage.News*, 4 September. Available at: <https://www.energy-storage.news/south-africa-governments-11gwh-bess-procurement-visualised/>
- National Planning Commission (NPC), 2019. Social partner dialogue for a just transition. Pretoria: National Planning Commission. Available at: <https://www.nationalplanningcommission.org.za/assets/Documents/Vision%20and%20Pathways%20for%20a%20Just%20Transition%20to%20a%20low%20carbon%20climate.pdf>
- The Presidential Climate Commission (PCC), 2023a. *Early lessons and recommendations from Komati's decommissioning and repurposing project: Presidential Climate Commission – Komati Power Station Recommendations Report*. Retrieved from <https://climatecommission.imgix.net/uploads/documents/PCC-Komati-Power-Station-Recommendations-Report.pdf>
- Presidential Climate Commission (PCC), 2023b. Carbon border adjustment mechanisms and implications for South Africa. Pretoria: PCC. Available at: <https://www.climatecommission.org.za>
- Presidential Climate Commission (PCC), 2024. Net zero CO₂ emission pathways for South Africa: Technical report. Available at: https://pcccommissionflo.imgix.net/uploads/images/Technical-Report_NetZero-Decarbonisation-Pathways-for-South-Africa.pdf
- Presidential Climate Commission (PCC), 2025. South Africa's Nationally Determined Contributions – NDC update 2030–2035. Available at: <https://climatecommission.imgix.net/uploads/images/PCC.NDC.Support.Technical.Report.Final.pdf>
- Republic of South Africa (RSA), 2019. Carbon Tax Act 15 of 2019. Available at: https://www.gov.za/sites/default/files/gcis_document/201905/4248323-5act15of2019carbontaxact.pdf
- Republic of South Africa (RSA), 2025. Media statement – National Treasury on Independent Transmission Programme. Pretoria: Government of South Africa.
- The World Bank, 2023. World Development Indicators: South Africa. Available at: <https://www.worldbank.org/en/country/southafrica/overview>
- Zalk, N., Keane, J. & Nater, L., 2024. Strategic issues for the African Continental Free Trade Area (AfCFTA) towards COP29. London: Overseas Development Institute. Available at: https://media.odi.org/documents/Greening_African_trade_and_industrialisation_-_strategic_issues_for_the_AfCFTA_8Xm6Upm.pdf

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A decade of national climate action: Stocktake and the Road Ahead

THAILAND CLIMATE GOVERNANCE AND LOW CARBON TRANSITION TO A NET ZERO FUTURE

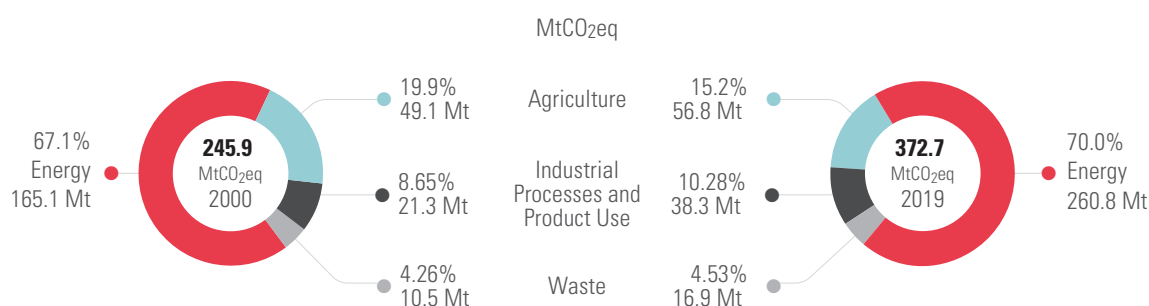
Jakapong Pongthanaisawan and Phimsupha Kokchang,
Energy Research Institute, Chulalongkorn University

Over the past two decades, Thailand's greenhouse gas emissions have increased sharply - rising by more than 50% between 2000 and 2019, as presented in **Figure 1**. This growth reflects the combined effects of rapid economic expansion, urbanization, industrial development, and a steep rise in energy use and transportation demand.

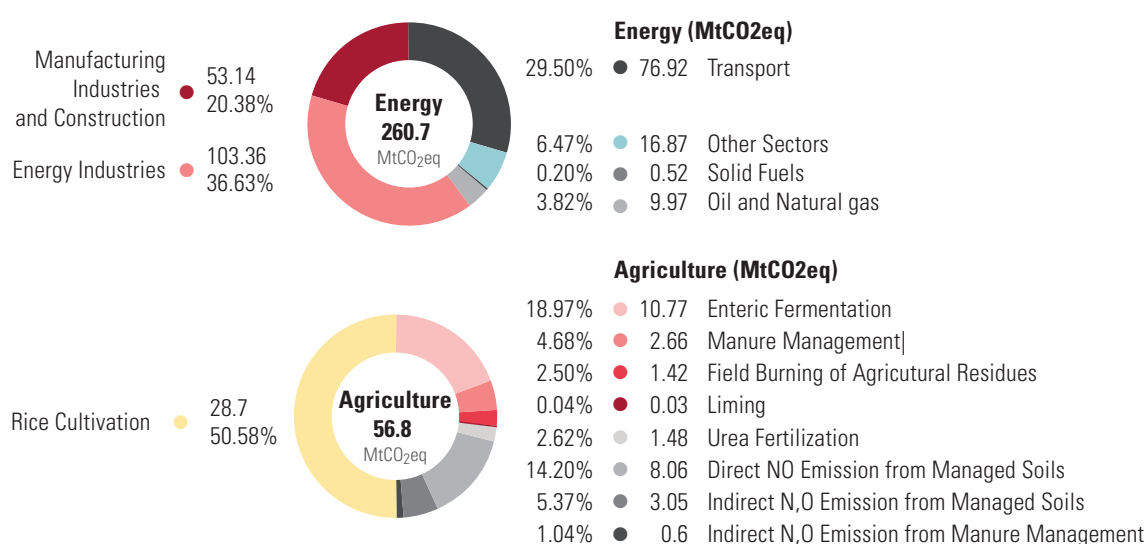
By 2019, total national emissions were estimated at around 373 million tonnes of CO₂ equivalent (MtCO₂eq) (excluding land-use and forestry). The energy sector was the dominant source, responsible for nearly 70% of emissions, followed by agriculture (15%), industrial production (10%), and waste management (5%).

As shown in **Figure 2**, within energy, most emissions came from electricity generation (about 93 MtCO₂eq), road transport (72 MtCO₂eq), and fuel consumption in manufacturing (52 MtCO₂eq). In agriculture, the largest contributor was rice cultivation (29 MtCO₂eq), alongside methane from livestock. Industry-related emissions were mainly from cement and chemical production, while emissions from waste came largely from landfills and wastewater treatment.

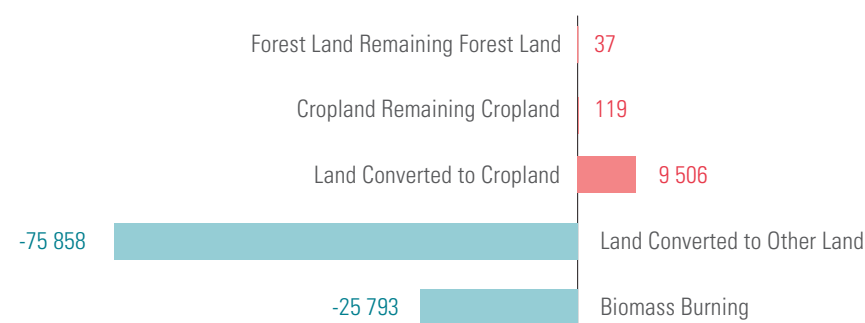
In contrast, Thailand's land use and forestry sector provided an important carbon sink, absorbing nearly 92 MtCO₂eq in 2019. Much of this was linked to croplands and rubber plantations, with emissions from deforestation declining significantly since 2000. This highlights the critical role of land and forest management in balancing the country's emissions profile.

Figure 1. Total GHG emissions by sector (excluding LULUCF), 2000 and 2019


Source: ONEP, 2022.

Figure 2. GHG emissions in energy sector and agriculture sector, 2019


Source: ONEP, 2022.

Figure 3. Figure 3 GHG emissions in LULUCF sector, 2019


Source: ONEP, 2022

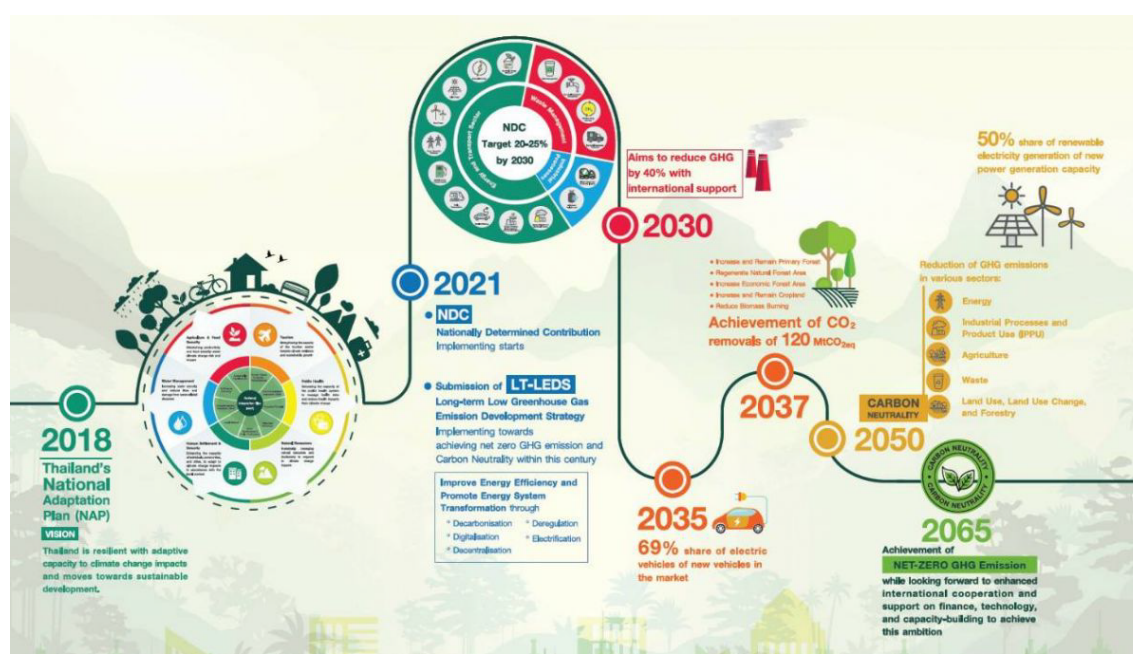
THAILAND'S LONG-TERM LOW GREENHOUSE GAS EMISSION DEVELOPMENT STRATEGY

Thailand's climate policy is increasingly informed by a long-term perspective, anchored in its commitment to achieve carbon neutrality by 2050 and net-zero GHG emissions by 2065. This vision is outlined in the Long-Term Low Greenhouse Gas Emission Development Strategy (LT-LEDS), revised in November 2022, which serves as the nation's overarching framework for long-term climate action. Unlike many long-term strategies that remain primarily economy-wide, Thailand's LT-LEDS sets out sectoral pathways for energy, transport, industry, agriculture, waste, and forestry, with varying degrees of detail from renewable energy expansion and coal phase-out in the power sector, to EV adoption in transport, clinker substitution in cement, and low-methane rice cultivation in agriculture. These targets were formally announced at COP26, where Thailand also pledged to enhance its Nationally Determined Contribution (NDC)—raising its 2030

GHG reduction target from 20–25% to 30–40%, conditional on international support. Importantly, these long-term goals are embedded in key national frameworks: 20-Year National Strategy, which serves as the country's legally binding development blueprint guiding all ministries; the Climate Change Master Plan (2015–2050), which provides the overarching framework for mitigation, adaptation, and climate governance; and the National Energy Plan (2022), which defines medium- and long-term energy system transformation. Together, these frameworks signal a coordinated and integrated approach to aligning climate ambition with Thailand's broader development agenda.

Thailand's Long-Term Greenhouse Gas Emission Development Strategy (LT-LEDS, 2021) outlines a carbon neutrality pathway that primarily targets CO₂ emission reductions in the energy sector, which is the country's largest GHG emitter. Key initiatives include the National Energy Plan 2022, which aims for at least 50% renewable energy in new power generation capacity by 2050, and for electric

Figure 4. Thailand's Long-term Greenhouse Gas Emission Development Strategy



Source: LT-LEDS, 2021.

vehicles (EVs) to comprise 69% of new vehicles by 2035. Carbon removal from LULUCF sector is expected to increase to 120 MtCO₂ by 2037. For the 2065 net-zero GHG emission pathway, LULUCF's contribution is projected to stabilize from 2037 onwards, aligning with the national target to increase forest and green areas to 55% of Thailand's total land area. This phase will also require a coal phase-out and the deployment of negative emission technologies, such as Bioenergy with Carbon Capture and Storage (BECCS). While these transitions may lead to a modest decline in GDP—1.31% by 2050 and 2.6% by 2065—they are expected to generate positive economic gains in green industries and bring co-benefits such as improved public health. The LT-LEDS outlines long-term mitigation actions across various sectors:

- **Energy:** Large-scale expansion of renewables, with solar and wind projected to supply 65% of electricity by 2060, supported by EV adoption under the 30@30 policy and the longer-term introduction of CCS/CCUS.
- **Industrial:** Transition toward the **Bio, Circular and Green (BCG) economy**, Thailand's flagship model launched in 2021 to integrate bio, circular, and green principles across key sectors (e.g. food and agriculture, energy and biochemicals) alongside clinker substitution in cement and the longer-term use of CCS/CCUS in hard-to-abate industries
- **Agriculture:** Adoption of low-methane rice cultivation practices and improved manure management as key mitigation measures.
- **Forestry:** Expansion of forest and green areas to 55% of land by 2037 through afforestation, reforestation, and community forest management.
- Beyond mitigation, Thailand is dedicated to a Climate-Resilient Development Pathway, vital for a country highly vulnerable to climate change impacts. The National Adaptation Plan (NAP) guides adaptation efforts across six priority sectors: water resource management, agriculture and food security, tourism, public health, natural resource management, and human settlements and security.

The quality of Thailand's long-term climate commitment is reinforced by a strong analytical foundation, including scenario modeling and sectoral roadmaps for energy, transport, and land use. These technical studies—developed with support from domestic institutions and international partners such as GIZ, UNDP, and the NDC Partnership—ensure that the country's mitigation targets are evidence-based and grounded in realistic transition pathways.

LT-LEDS now plays a central role in shaping national and sectoral policy discourse. It directly informs NDC updates and has led to improved inter-ministerial coordination, particularly through the National Committee on Climate Change Policy (NCCC). As part of Thailand's climate governance framework, the LT-LEDS is institutionalized through Cabinet endorsement and serves as a reference for sectoral action plans prepared by line ministries under the NCCC's oversight. The proposed Climate Change Act¹ seeks to further institutionalize this long-term outlook by mandating carbon budgeting, aligning sectoral plans, and establishing monitoring and reporting systems, thereby providing legislative backing for sustained climate action. Despite persistent implementation challenges—such as mobilizing finance, building private sector readiness, and addressing local capacity gaps—the long-term vision has supported policy progress. It has helped identify actionable strategies, emphasized the need for systemic reforms like energy market restructuring, and laid the groundwork for investment mobilization.

Enabling conditions for this transformation include strengthening the regulatory framework, most notably through the forthcoming Climate Change Act, which also aims to introduce a domestic climate financing mechanism and incorporate carbon pricing instruments. Financial incentives—such as Board of Investment (BOI) tax exemptions for low-carbon technologies—and sustainable financing tools, including green and blue bonds, are actively promoted to attract investment. Thailand is also advancing its

¹ <https://www.tilleke.com/insights/thailands-draft-climate-change-act-key-business-considerations/>

carbon market infrastructure, with mechanisms such as the Thailand Voluntary Emission Reduction Program (T-VER)² already in place and plans underway to develop a mandatory cap-and-trade system. Additionally, public-private partnerships—such as memoranda of understanding (MoUs) with government agencies and networks like the Thailand Climate Network (TCNN)—are helping scale up action. International collaborations also play a pivotal role, including the Glasgow Leaders' Declaration on Forests, the Thai-German Climate Programme, and initiatives like the SHIFT Program with Switzerland to scale electric bus deployment.

Collectively, these enablers address Thailand's needs in terms of technical assistance, technology transfer, and climate finance access, while reinforcing the credibility and feasibility of its long-term climate ambition. Rather than being a constraint, Thailand's long-term strategy serves as a strategic anchor that aligns policy priorities, signals investment readiness, and steers the country toward a low-carbon, climate-resilient future.

EXAMPLES OF CONCRETE PROGRESS

Over the past decade, Thailand has made notable progress in aligning its national development with long-term climate goals. While absolute emission reductions are still emerging, the country has undertaken a series of regulatory, institutional, and technological transformations that lay the groundwork for a viable transition toward a net-zero economy by 2065.

One of the most significant developments has been the consolidation of energy policy through the National Energy Plan, which integrates five key strategies: the Power Development Plan (PDP), Alternative Energy Development Plan (AEDP), Energy Efficiency Plan (EEP), Gas Plan, and Oil Plan. Together, these documents outline a coherent, cross-sectoral vision for decarbonization. The draft PDP proposes to increase total electricity generation capacity to 112 GW by 2037, with

50% from renewables, including 17% from solar PV. It also introduces hydrogen blending (5%) in gas-fired generation—a signal of Thailand's openness to cleaner fuels. Meanwhile, the AEDP targets 73 GW of renewable electricity capacity, with a strong focus on floating PV, bioenergy, and Sustainable Aviation Fuel (SAF) for decarbonizing hard-to-abate sectors like aviation.

The EEP aims to reduce energy intensity by 36% relative to 2010 levels by 2037, while the Oil and Gas Plans promote the use of hydrogen, biofuels, and gasohol, indicating a shift toward low-carbon fuels in transport and industry. Collectively, these draft plans reflect a strategic reorientation of Thailand's energy and fuel systems, designed to align with long-term climate and economic goals. Progress has also been made on the institutional front. The establishment of the Department of Climate Change and Environment (DCCE) under the Ministry of Natural Resources and Environment (MNRE) represents a structural upgrade in climate governance. The proposed Climate Change Act will further institutionalize climate action by mandating carbon budgeting, inter-ministerial coordination, and the development of a national Monitoring, Reporting, and Verification (MRV) system. A second draft, consulted in late 2024, added provisions on a Carbon Border Adjustment Mechanism (CBAM), an updated taxonomy, and clearer sanctions. The Act is expected to be submitted to Cabinet and Parliament, with implementation currently anticipated around 2027. These frameworks ensure that climate ambition is not only a policy aspiration but also an operational reality within the public sector.

Thailand's transport sector is undergoing a parallel transformation, led by the National Electric Vehicle Policy Committee's 30@30 target, which positions EVs to account for 30% of domestic vehicle production by 2030. This target is more than a production goal; it is reshaping industrial policy by attracting BOI-supported investment, accelerating charging infrastructure rollout, and anchoring a broader shift toward electrification. At the same time, the deployment of Battery Energy Storage Systems (BESS) and ongoing

² <https://ghgreduction.tgo.or.th/en/t-ver-en.html>

grid modernization are not standalone projects but critical enablers of variable renewable energy integration, particularly solar and wind. On the finance side, instruments such as the Thailand Voluntary Emission Reduction Program (T-VER), ESG disclosure guidelines, and the sustainable finance taxonomy under development by the SEC and NESDC illustrate how market mechanisms are being institutionalized to mobilize private investment. Together, these policies are creating the structural conditions for decarbonization across both the transport and power sectors.

International partnerships have played an enabling role—technical support from agencies such as GIZ, UNDP, and the Thai-German Climate Programme, along with enhanced NDC targets announced at COP26, reflect growing alignment between domestic ambition and global best practice.

While full-scale emissions reductions remain a work in progress, these foundational shifts signal that Thailand's low-carbon transition is well underway, backed by clear targets, evolving institutions, and increasing stakeholder alignment.

EXAMPLES OF CONCRETE BLOCKAGES

Despite Thailand's growing commitment to long-term decarbonization, several structural and systemic blockages continue to impede the effective implementation of its net-zero transition. While the country has made substantial progress in setting targets and aligning long-term plans with international expectations, the translation of ambition into implementation remains uneven and often hindered by political, technical, and financial constraints. These challenges manifest across governance, planning, institutional coherence, innovation systems, and social inclusion. One of the most prominent and persistent blockages lies in centralized governance and planning. Thailand's climate and energy policy architecture continues to operate under a top-down, ministry-centric model, where key decisions are shaped by a small number of agencies, particularly the

Ministry of Energy, Office of Natural Resources and Environmental Policy and Planning (ONEP), and Electricity Generating Authority of Thailand (EGAT). While this has allowed for consistency in planning, it has also led to rigidities that limit bottom-up innovation, regional flexibility, and stakeholder diversity. Local governments have minimal roles in climate action planning, and there is insufficient budgetary delegation or mandate for provincial-level implementation. This centralized model risks missing out on subnational opportunities and local knowledge that could otherwise accelerate just and place-based transitions.

Another critical challenge is the lack of clear and enforceable implementation roadmaps for sectoral mitigation. Although Thailand's LT-LEDS and National Energy Plan outline ambitious pathways, many sectors still lack operational frameworks—such as sectoral decarbonization roadmaps, carbon budgets, or enforceable GHG reduction caps. The forthcoming Climate Change Act, while a potentially transformative policy, remains in draft form. It is expected to introduce mechanisms such as carbon budgeting, MRV (Monitoring, Reporting, and Verification) systems, and legal accountability for sectoral performance, but its delay has created policy uncertainty. Moreover, new policy topics like hydrogen energy or SAF are reflected in plans but not backed by specific strategies, regulatory incentives, or infrastructure plans. This lack of downstream policy design weakens investor confidence and hinders scale-up.

A shortfall in research, development, and technology transfer is another major obstacle. While Thailand has identified new energy technologies—such as carbon capture, utilization and storage, green hydrogen, and battery energy storage—as essential to achieving net-zero, national R&D investment remains well below global averages. There is also limited cross-ministerial collaboration or private sector engagement in high-risk, high-impact innovation. International technology cooperation remains fragmented, typically confined to bilateral grants or small-scale pilots with agencies such as GIZ or UNDP.

Without enhanced support for domestic innovation ecosystems, public-private partnerships, and international R&D alliances, Thailand risks becoming a late-stage adopter rather than a proactive developer of clean technology.

Institutional and financial misalignments also slow down Thailand's progress. While the financial sector is beginning to embrace ESG principles and green taxonomies—led by the Bank of Thailand and the Securities and Exchange Commission (SEC)—public finance mechanisms are not yet fully aligned with climate goals. Key ministries, such as Finance and Labour, have yet to adopt frameworks for climate-responsive budgeting, green procurement, or climate investment evaluation. Tools such as carbon pricing, subsidy reform, and green employment funds are under discussion but remain politically sensitive and technically underdeveloped. Without these foundational mechanisms, it is difficult to reorient national development finance toward low-carbon priorities.

Another significant blockage is resistance from fossil fuel incumbents and legacy industries. State-owned enterprises and large industrial actors continue to wield considerable influence over energy planning. The continued prioritization of natural gas as a “transition fuel” in PDP and NEP documents reflects a cautious approach to phasing out fossil fuels. Proposals for carbon pricing or mandatory emissions trading are often met with opposition from industries fearing cost escalation and competitiveness loss. These dynamics have contributed to policy stagnation on crucial market-based instruments and slowed the phasing out of coal and other high-emission sources.

Finally, social inclusion and just transition considerations remain underdeveloped in Thailand's climate strategy. While “just transition” is increasingly part of the national vocabulary, concrete measures to address inequality, worker transition, and community resilience are lacking. There are no comprehensive strategies for worker reskilling, region-specific transition planning, or compensation mechanisms for communities dependent on fossil-intensive industries. Vulnerable groups—such as low-income households, informal work-

ers, or rural communities—are rarely consulted in climate planning processes, and policy design often overlooks their specific needs.

Taken together, these blockages highlight a persistent gap between policy intent and implementation readiness. Bridging this gap will require not only legal and regulatory reform but also greater inter-ministerial coordination, investment in knowledge systems, stakeholder engagement, and the mainstreaming of equity into climate policy. Without tackling these underlying constraints, Thailand risks falling short of its climate ambitions despite commendable long-term goal setting.

LINK WITH NON-CLIMATE QUESTIONS

Thailand's national climate agenda is increasingly intertwined with broader economic, financial, and social dimensions. Policymakers, regulators, and private sector actors are beginning to understand climate change not only as an environmental threat but as a critical factor shaping the country's long-term competitiveness, financial stability, and social cohesion. Nevertheless, while momentum is growing, the depth of cross-sectoral integration remains uneven, with substantial gaps between recognition of the challenge and concrete institutional or budgetary alignment.

One of the most visible and catalytic linkages is between climate policy and trade competitiveness. The introduction of the European Union's Carbon Border Adjustment Mechanism (CBAM) has acted as a wake-up call for Thailand's export-driven economy. Thai exporters in high-emitting sectors—such as cement, steel, aluminum, and petrochemicals—now face the dual imperative of decarbonizing operations and demonstrating transparency in emissions accounting. This has prompted significant engagement from the Ministry of Commerce, the Federation of Thai Industries (FTI), and the National Economic and Social Development Council (NESDC). These actors are working together to design carbon footprint labeling, sector-level emissions bench-

marks, and explore potential carbon pricing instruments, which had previously been politically sensitive. In this context, climate policy is seen not only as a sustainability imperative but as a trade and industrial survival strategy. At the political level, CBAM has been received with concern but also as a catalyst: ministries such as Commerce and Finance quickly convened discussions with industry groups, framing CBAM as both a risk to Thailand's export competitiveness and an opportunity to accelerate domestic carbon accounting and market instrument.

In the financial sector, climate risk is increasingly viewed as a systemic risk. Institutions such as the Bank of Thailand, and leading financial institutions have joined forces to promote sustainable finance, align disclosure standards, and assess the exposure of banks and insurers to climate-related risks. The ongoing development of the Thailand Green Taxonomy, led by the SEC and NESDC, aims to classify economic activities according to their environmental impact and align capital flows with the country's decarbonization objectives. This effort complements ESG disclosure guidance, pilot climate stress-testing initiatives, and green bond frameworks, which are intended to build a more climate-resilient financial system. By aligning financial regulation with climate goals, Thailand is gradually building the market infrastructure needed to attract both domestic and international green investment.

From a social and equity perspective, the integration of climate considerations remains emergent but incomplete. Issues of energy access, affordability, and just transition are becoming more prominent, particularly in the context of rising electricity prices and the shift toward VRE. Concerns about tariff structures, the costs of system flexibility, and their impacts on low-income households and SMEs are now featuring more prominently in policy discussions involving policymakers, regulators, electric utilities, and civil society stakeholders. The need for energy equity—ensuring that vulnerable groups are not disproportionately burdened by the energy transition—is increasingly acknowledged but lacks robust policy instruments or targeted subsidies.

At the same time, Thailand's labor and industrial transformation in response to climate challenges remains in the early stages. The Ministry of Labour has not yet developed comprehensive programs for workforce reskilling, employment transition, or social safety nets for workers in carbon-intensive industries. Where the link to the broader development agenda does appear is in documents such as the 20-Year National Strategy and the BCG Economy framework, both of which frame climate action as integral to competitiveness, poverty reduction, and regional development. However, this connection is still largely rhetorical, as dedicated budgets or just transition mechanisms remain absent. The lack of an integrated climate–employment strategy presents a risk to both social stability and political support for transition measures.

On the fiscal and macroeconomic front, efforts to embed climate considerations into budgeting and public investment remain fragmented. While climate public investment management (PIM) reform is under consideration, there is no formal process yet to integrate GHG impact assessments into budget planning. Carbon taxation, while periodically discussed, remains politically sensitive and has not advanced beyond preliminary stakeholder consultations. The Ministry of Finance has not yet adopted a formal roadmap for aligning fiscal policy with climate objectives, such as adjusting subsidies, mobilizing green infrastructure funds, or incorporating shadow carbon pricing into cost-benefit analyses for infrastructure. At the macroeconomic level, modelling studies suggest that Thailand's net-zero transition could reduce GDP by around 1–3% by 2050–2065 compared to a business-as-usual trajectory, but these costs are expected to be offset by gains in green industries, reduced fossil fuel import dependency, and public health benefits.

Moreover, regional and subnational integration is still underdeveloped. While the NESDC has initiated some regional dialogues on climate and development planning, most provincial and local governments lack the mandates, resources, and technical capacity to meaningfully contribute to climate mitigation or adaptation planning. The

absence of decentralized climate governance frameworks risks reinforcing urban-rural disparities and overlooking local resilience needs.

In sum, climate policy in Thailand is beginning to intersect with critical domains such as trade, finance, and energy access, and in these areas, integration is supporting climate action. However, in fiscal, labor, and regional development policies, the institutional structures and political will needed to integrate climate considerations remain limited. For Thailand to deliver a truly inclusive and resilient net-zero transition, these connections must be deepened, and climate ambition must be fully embedded across all sectors of economic and social policy

CLIMATE GOVERNANCE FRAMEWORK

Thailand's climate governance has evolved into a comprehensive, multi-layered structure integrating policy, implementation, and international cooperation. Since 2007, the government has embedded climate change into national development agendas and created pivotal institutions to coordinate mitigation and adaptation efforts. Thailand's climate planning instruments are led by the Climate Change Master Plan (2015–2050), which outlines strategies for adaptation, mitigation, and enabling environments. Supporting instruments include the LT-LEDS and NDC Roadmap, sectoral action plans, and the National Adaptation Plan (NAP)—the latter targeting six vulnerable sectors: water, agriculture, tourism, health, natural resources, and human settlements. These instruments were developed through iterative processes that combined analytical modeling with extensive stakeholder consultations. Ministries, local governments, private sector representatives, academia, and civil society groups were all engaged through public hearings and expert workshops, with their feedback incorporated into revised drafts. This participatory approach not only enhanced the legitimacy of the policies but also ensured that they reflected both technical evidence and societal perspectives.

A cornerstone of future governance is the Climate Change Act, currently in its second draft (as of 2025). This legislation will codify Thailand's GHG targets: 30–40% reduction by 2030 (with support), carbon neutrality by 2050, and net zero by 2065. The Act introduces binding mechanisms such as an Emissions Trading System (ETS), a carbon tax, carbon credit frameworks, and a Climate Change Fund to support low-carbon technologies. Drafting of the Act has been accompanied by nationwide consultations, and its provisions—such as carbon budgets per sector, a national MRV system, and compliance obligations—will institutionalize the alignment between the NDC, LT-LEDS, and sectoral plans. The DCCE is designated as the supervisory body for ETS allocation and overall implementation. The analytical tools developed for the LT-LEDS, including economy-wide scenario modeling and sectoral decarbonization pathways, continue to be used by DCCE and ONEP to monitor NDC progress and design new policies. This continuity ensures consistency between long-term targets and near-term actions. Importantly, Thailand's LT-LEDS goes beyond economy-wide declarations by providing sector-specific guidance. For example, it sets targets for 74% renewable electricity by 2050 and 69% EV penetration by 2035, identifies clinker substitution and CCS in industry, promotes methane reduction in rice cultivation and manure management in agriculture, and commits to expanding national green cover to 55% by 2037 under the Community Forest Act and T-VER. Such sectoral detail provides actionable signals to ministries and industries, improving the usability of the LT-LEDS compared to more general long-term strategies.

Thailand's climate governance is structured around several key political and administrative entities, each with distinct mandates and levels of authority. The integration of climate change considerations into national economic and social development plans began as early as 2007. This initial recognition led to the establishment of pivotal bodies such as the National Committee on Climate Change Policy (NCCC) and the Thailand Greenhouse Gas Management Organization

(TGO) in the same year. A more recent and significant development is the establishment of the DCCE within the Ministry of Natural Resources and Environment in August 2023.

At the center of Thailand's governance structure is the NCCC, a high-level political body chaired by the Prime Minister. Comprising key ministry officials and expert representatives, the NCCC sets national climate policy, oversees international negotiations, and monitors alignment of domestic actions with strategic objectives. To manage its wide scope, the NCCC supervises seven specialized subcommittees focusing on policy integration, data management, legal frameworks, and sector-specific mitigation.

The Thailand Greenhouse Gas Management Organization (TGO), established in 2007, plays a central role in GHG mitigation and carbon market development. As an autonomous public agency, TGO certifies carbon credits, promotes low-carbon technologies, and facilitates trading in both domestic and international markets. Its role signals Thailand's emphasis on economic and market-based tools for climate action.

The newly established Department of Climate Change and Environment (DCCE), created in August 2023 under MNRE, enhances Thailand's operational capacity. DCCE coordinates implementation of climate policies, manages national GHG databases, assesses risks, and monitors the Climate Change Master Plan. It also leads the development of the Climate Change Act and acts as the national operational focal point for climate change.

The Office of Natural Resources and Environmental Policy and Planning (ONEP) operate under the Ministry of Natural Resources and Environment (MNRE). Prior to the establishment of the DCCE, ONEP held central responsibilities in climate governance. Although some functions have transitioned to the DCCE, ONEP continues to play a key strategic and coordinating role, particularly in policy formulation, environmental planning, and oversight. It remains responsible for environmental impact assessments, managing the Environment Fund, and driving Sustainable Development Goals 12 and 13. While no longer the primary

climate focal point or Green Climate Fund (GCF) authority, ONEP still engages in international coordination, supports access to climate finance, and collaborates with stakeholders, including international partners, to align national climate priorities with available resources.

Together, these institutions and legal instruments illustrate a deliberate shift toward legally binding, data-driven, and participatory governance. With clear institutional mandates, cross-sector integration, and growing emphasis on carbon pricing and accountability, Thailand is positioning itself to deliver on both its domestic climate goals and international commitments under the Paris Agreement.

INTERNATIONAL COOPERATION

Thailand has established ambitious climate goals, aiming to achieve carbon neutrality by 2050 and net-zero GHG emissions by 2065. These targets are supported by its updated NDC, which commits to reducing emissions by 30% unconditionally and up to 40% conditionally by 2030 compared to the business-as-usual scenario. To guide its climate actions, Thailand has developed a comprehensive policy framework that includes the draft Climate Change Act (which would enable carbon pricing), the LT-LEDS, and the NAP, which focuses on six priority sectors. Additionally, the Bio-Circular-Green (BCG) Economy Model plays a key role in promoting sustainable economic development aligned with environmental goals. Despite these plans, Thailand continues to face significant challenges in implementation. External evaluations, such as those by the Climate Action Tracker, have rated Thailand's climate policy framework as "Critically Insufficient." This rating reflects major gaps in enforcement, institutional capacity, and access to adequate financing and technology. To overcome these barriers, Thailand actively seeks international cooperation to strengthen its climate planning, enhance policy execution, and improve access to the technical and financial resources needed to meet its targets.

Over the past decade, international cooperation has played a critical role in supporting Thailand's climate transition. Key partners include the World Bank Group, ADB, the Green Climate Fund (GCF), the European Union (EU), the Japan International Cooperation Agency (JICA), GIZ, UNDP, and the United States Agency for International Development (USAID). These organizations have provided a wide range of support, including technical assistance for carbon pricing, green infrastructure investment, climate-smart agriculture, water management, urban resilience planning, and SME-focused climate projects.

The nature of support has shifted from traditional financing to more targeted assistance focused on institutional development, policy design, and innovative green finance mechanisms. For example, international partners have assisted in developing Thailand's MRV (monitoring, reporting, and verification) frameworks, supported green taxonomy development to guide sustainable investment, and helped design emissions trading and carbon pricing tools. Knowledge exchange—through policy dialogues, training programs, and collaborative research—has further enabled Thailand to align domestic policies with global climate standards and enhance technical capabilities.

To build on this progress and strengthen the effectiveness of future cooperation, five key recommendations are emphasized. These include:

- scaling up and diversifying climate finance to attract broader investment in adaptation.
- prioritizing technology transfer and local innovation through support for domestic R&D and green workforce development.
- strengthening institutional and human capacities to enforce and implement climate policy.
- promoting integrated and participatory approaches across sectors and stakeholder groups; and
- enhancing MRV systems to ensure transparency, performance tracking, and adaptive management. By addressing these strategic areas, international cooperation can continue to play a catalytic role in helping Thailand translate its climate ambitions into tangible, long-term outcomes.

BIBLIOGRAPHY

- ONEP. (2022). *Thailand's Fourth Biennial Updated Report*. Office of Natural Resources and Environmental Policy and Planning.
- ONEP. (2022). *Thailand's Long-Term Low Greenhouse Gas Emission Development Strategy (Revised version)*. Office of Natural Resources and Environmental Policy and Planning.
- EPPO. (2022). *National Energy Plan*. Energy Policy and Planning Office
- DCCE. (2025). *Draft Climate Change Act*. Department of Climate Change and Environment.
- Tilleke & Gibbins (2025). *Thailand's Draft Climate Change Act: Key Business Considerations*. <https://www.tilleke.com/insights/thailands-draft-climate-change-act-key-business-considerations/>
- TGO (2025). *Methodology for Voluntary GHG Emission Reduction*. <https://ghgreduction.tgo.or.th/en/t-ver-en.html>

A decade of national climate action: Stocktake and the Road Ahead

UNITED STATES A DECADE OF CLIMATE ACTION SINCE THE PARIS AGREEMENT

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INTRODUCTION

In the decade following the Paris Agreement, the United States continued a trend of reducing economy-wide greenhouse gas emissions from their peak in 2007 to a level approximately 17% below its base year of 2005. While recognizing this partial progress, the pace of reductions has been too slow to reach the initial U.S. 2025 NDC and is currently slower than needed to reach the 2030 target. Policy and market actions in the United States have been characterized by a temporally shifting patchwork of policies across sectors and gases, at both national and subnational levels, that have occasionally driven major and comprehensive expansions of low-emissions investments and technologies and have at other times reversed course to slow clean technology deployment and support expansion of fossil fuel use and infrastructure. In parallel, U.S. engagement and support for the multilateral UNFCCC and Paris architecture has oscillated from being a core driver of international action to several levels of antipathy ranging from withdrawal to active antagonism. Such whipsawing has, of course, created major obstacles for the type of rapid energy and economic transition needed to support national and global climate outcomes consistent with the goals of the Paris Agreement. In this shifting patchwork of policies and associated chal-

allenges, several factors have stood out as areas of strength. First, there has been relatively consistent climate leadership from a diverse set of subnational governments and other actors, notably U.S. states who have substantial policy authorities in certain sectors such as electricity and buildings. In the highly federalized U.S. system, such actions can, over time, both significantly shift the aggregate level of emissions, and also demonstrate successful policy strategies that can build political consensus toward a broader application—both through federal action and larger coalitions of subnational action. Second, the occasional forceful policies backed by large amounts of federal investments and industrial policies have, in some significant spurts, supported more major infrastructure investments and rapid deployment of renewable energy. Third, and relatedly, the dramatic global reductions in costs for solar PV, wind, batteries, EVs, and other key technologies have shifted the market dynamics substantially in the United States, to the point where some technologies currently outcompete conventional and dirtier technologies even without policy support. These factors can all potentially form the core of continued and eventually accelerated action, but ultimately this will depend on larger and unpredictable political developments. Therefore, the overall situation in the United States has raised questions about the U.S. role in international mechanisms as well as its ability to carry out the level of domestic actions to drive domestic reductions across all sectors and gases at a sufficient pace.

U.S. POLICY EVOLUTION 2015–2025

At the federal level, the alternating agendas of the Obama, Trump and Biden administrations have limited the U.S.'s ability to deliver consistent global leadership under the Paris Agreement, while also creating challenges domestically for delivering the short-term Nationally Determined Contribution (NDC) targets and making needed progress toward long-term net-zero goals. A major effort initi-

ating U.S. climate engagement with China, and associated U.S.-China international leadership, catalyzed greater ambition across countries and led to the successful launch of the Paris Agreement. The subsequent administration reversed course by withdrawing from the Paris Agreement, rolling back 72 federal environmental regulations and undermining climate science, triggering international criticism and domestic backlash.¹ In response, subnational coalitions like *We Are Still In* (later renamed as *America Is All In*) and the *U.S. Climate Alliance* of state governors formed to continue to advance climate action in the United States. Subnational governments continued to implement and in some cases, enhance, their climate policies.

The U.S. federal government under President Biden rejoined the Paris Agreement in 2021, set a new 2030 and 2035 NDC aligned with a 2050 net-zero target, and passed landmark climate legislation including the Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act (IRA). This administration also initiated or advanced major international initiatives like the Global Methane Pledge, while subnational actors expanded clean energy standards, zero-emission vehicle mandates, and building energy efficiency policies.

However, the 2024 election reversed direction in many of these areas. Internationally, the United States re-oriented its foreign policy and its strategy toward the global economy, favoring heavy utilization of tariffs and the elimination or withdrawal from many multilateral initiatives. This included a second withdrawal from the Paris Agreement.² Domestically, executive orders were issued redefining U.S. energy goals,³ propping up the coal industry,⁴ asserting federal precedence over state climate policies,⁵ and proposing the phaseout of environmental legislation.⁶ Actions were initiated within federal agencies, as part of the executive branch, to reinterpret or eliminate regulations that had been previously implemented based on existing legislation. Broad restructuring of the federal budget and priorities led to the elimination of climate and clean energy capacities across a number of federal agencies,

including the State Department, Department of Energy, and Environmental Protection Agency, among others.⁷⁻⁹ Finally, research funding for many areas, including climate, was cut.¹⁰ Presently, the uncertainty surrounding federal climate action has delayed the implementation of climate policies across states and cities,¹¹ discouraged long-term private investment in clean energy technologies,¹² and strained coordination with global allies.^{13,14} It has also cast doubt on whether the United States will follow through on its NDCs.

Even as these federal changes are expected to have major impacts and to slow the rate of emissions reductions across the U.S. economy, a number of subnational governments and other actors continue to implement policies and work toward their own climate goals. In the U.S. federal system, many significant policy authorities are granted to states, cities, counties, and other jurisdictions, including control over the electricity grid, building energy efficiency standards, and zoning strategies. In aggregate, subnational actors taking actions on climate constitute roughly two-thirds of the U.S. population and 75% of U.S. GDP — equivalent to the world's third largest economy.¹⁵ The continued leadership of subnational actors has therefore remained a consistent cornerstone of U.S. climate governance and international climate diplomacy throughout the last decade even as the federal government has shifted.^{16,17,18}

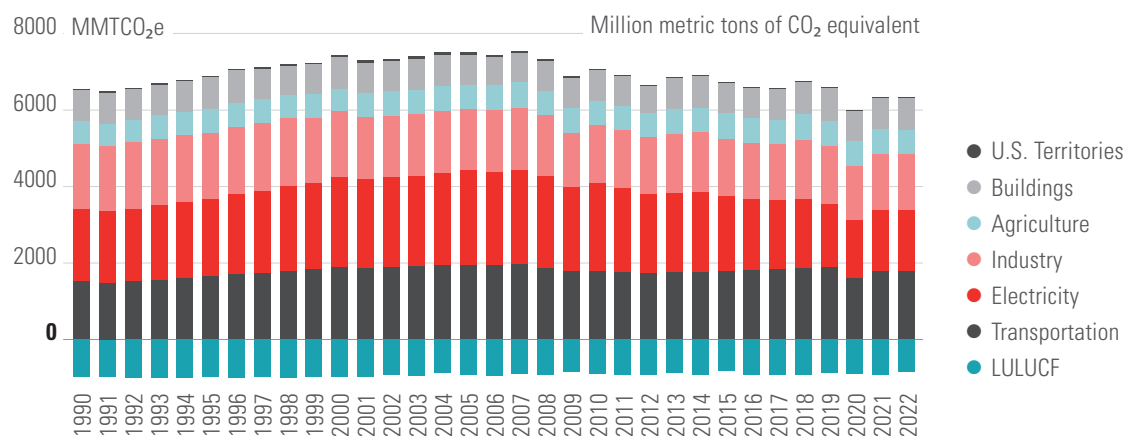
OVERALL EMISSIONS TRENDS AND DRIVERS

As of 2022, U.S. GHG emissions dropped by 17%, relative to 2005 levels (**Figure 1**). This decline reflects a mix of factors, including decarbonization in the power sector and improvements in energy efficiency.²⁰ The most significant drop happened in 2020 due to the impact of the COVID-19 pandemic, though emissions have stayed below 2019 levels even as the economy has recovered.

The electricity sector has driven most of these reductions, with emissions from electricity generation falling by 36% over this period (from about 2,457 MMT CO₂e in 2005 to 1,577 MMT CO₂e in 2022), due to a mix of market and policy forces that have improved energy efficiency and reduced coal use. Transportation is now the largest emitting sector, with only an 8% decline over the same period, as travel demand has grown faster than efficiency gains. Industrial emissions have lowered slightly, mainly due to a shift toward less energy-intensive production. Emissions from agriculture have roughly remained flat. Emissions from buildings went up by 8% in 2022 compared to 2005, with some year-to-year variation depending on energy use.¹⁹

The drop in U.S. electricity sector emissions reflects a shift from coal to natural gas and renewables in the generation mix. From 2005

Figure 1. U.S. Greenhouse Gas Emissions by Economic Sector

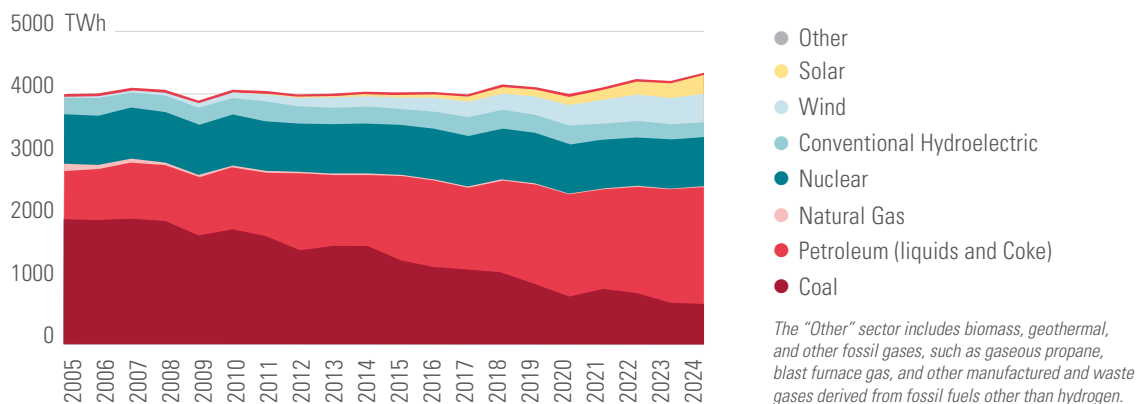


Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022. (2024).

to 2024, coal generation fell by more than two-thirds, from 2,013 TWh to 653 TWh, while generation from natural gas and renewables rose (Figure 2). Wind generation increased to 453 TWh, making up 10% of total electricity in 2024. Solar generation increased to 303 TWh, contributing 7% of the total. Nuclear and hydroelectric generation have remained at historical levels.²¹ Despite continued progress toward renewables, natural gas makes up 43% of the current generation mix, and accelerating its phasedown will be key to further decarbonizing the sector. The transportation sector has seen positive trends for both vehicle use and fuel efficiency.

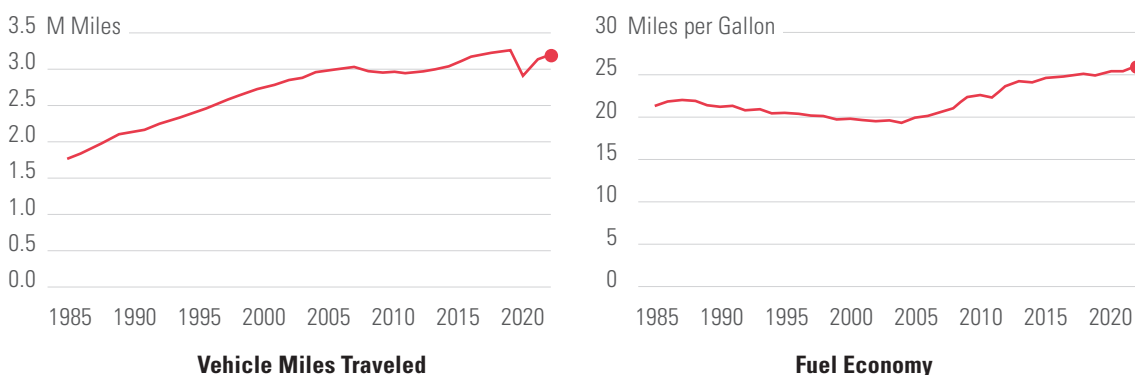
From 1985 to 2020, vehicle miles traveled (VMT) has nearly doubled, from about 1.77 trillion miles to over 3.26 trillion miles (Figure 3). At the same time, light-duty vehicle fuel economy began to improve in 2005, increasing from 19.3 miles per gallon (mpg) in 2004 to 26.0 mpg by 2022, after years of decline.²³ This improvement reflects both the enactment of federal fuel economy standards and the development of newer, more efficient technologies. In addition to fuel efficiency improvements, however, decarbonizing the transportation sector will also require vehicle electrification, shifts to other transport modes, and compact urban planning to reduce VMT.

Figure 2. U.S. Net Electricity Generation by Energy Source



Source: Electricity data browser - Net generation for all sectors. U.S. Energy Information Administration. <https://www.eia.gov/electricity/data/browser/>.

Figure 3. Average Fuel Economy for New Light-Duty Vehicles and Total Vehicle Miles Traveled



Sources:
Bureau of Transportation Statistics. United States Department of Transportation <https://www.bts.gov/>.
The 2023 EPA Automotive Trends Report. <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10191S7.pdf> (2023).

PROGRESS TOWARD NET ZERO

NDC and LTS targets

In November 2021, the Biden administration articulated a strategy to reach net-zero emissions by 2050, aligned with the 2030 NDC of reducing emissions by 50–52% below 2005 levels.^{24,25} Later, in December 2024, the administration announced the third U.S. NDC, setting a target to reduce emissions by 61–66% below 2005 levels by 2035 to keep the 2050 net-zero target within reach.²⁶

Consideration of the long-term perspective has helped drive policy progress under the Biden administration. The net-zero goal has brought attention to sectors like industry, aviation, and short-lived non-CO₂ climate pollutants, as well as carbon sinks and carbon removal technologies — all of which are crucial for limiting peak warming.²⁴ While these sectors are less important for cutting emissions in the near term, early action is needed to prepare for deep decarbonization.

Policy Highlights

U.S. climate targets under the Paris Agreement have led to the passing of historic climate laws, including the BIL in 2021 and the IRA in 2022, which invest over a trillion dollars into clean energy, energy efficiency, methane mitigation, climate resilience, and more.²⁷ Since their enactment, these laws have catalyzed \$321 billion in private sector clean energy investments.²⁸ Notably, the IRA's household tax credit program has surpassed expectations, with 3.4 million households having invested \$8 billion in clean energy technologies in 2023, including rooftop solar and heat pumps.²⁹ Furthermore, 77% of IRA investments have flowed to Republican-led districts, strengthening its bipartisan appeal.²⁸

One of the IRA's most novel elements is its focus on investments in low-income and fossil-fuel-dependent communities to ensure an inclusive and equitable clean energy transition. Of note is the Greenhouse Gas Reduction Fund, which carves out \$15 billion for low-income and disadvantaged communities to support community and rooftop solar and energy efficiency projects. Additionally, bonus tax credits are available for renewable proj-

ects that provide benefits to these communities. However, these investments depend on implementation at the state and local levels to generate tangible benefits for these communities.³⁰

The U.S. government has also taken important steps to enact climate regulations. Corporate Average Fuel Economy standards, one of the longest-running regulations in the U.S., have achieved significant fuel savings and emissions reductions.³¹ Additionally, standards on GHGs and other air pollutant emissions from fossil fuel power plants have been key mechanisms to phase down coal and natural gas generation.

While carbon pricing does not exist at the federal level, the United States has been an innovator in this space. In the 1990s, the Acid Rain program successfully utilized cap-and-trade to reduce sulfur dioxide emissions, serving as a proof of concept for carbon pricing. Starting with the Climate Stewardship Act of 2003, the United States has seen numerous carbon pricing proposals, though none passed both houses of Congress to become law. Notably, the “Waxman-Markey” bill in 2009 received bipartisan support and was approved by the House of Representatives, but ultimately did not pass the Senate.³² Despite lack of action at the federal level, states like California and Washington have enacted their own cap-and-trade programs. California's cap and trade system is among the largest multi-sectoral trading systems globally, and the funds generated from the program are used to help state agencies implement programs to further reduce GHGs, with 35% of the revenue directed to disadvantaged and low-income communities.³³ Additionally, eleven states in northeastern U.S. participate in the Regional Greenhouse Gas Initiative (RGGI), which caps electricity sector emissions.³⁴ Following the formation of RGGI in 2005, the states have conducted periodic program reviews which implemented changes to improve the program design and reduce the emissions cap.

Many individual states have their own legislatively mandated climate targets; Maryland, for example, requires the state to reduce GHG emissions by 60% below 2006 levels by 2031 and achieve net-zero emissions by 2045.³⁵ New York's

Climate Leadership and Community Protection Act requires a 40% reduction in GHG emissions by 2030 and an 85% reduction by 2050.³⁶ States like California, Maryland, Colorado, Washington, and New York have also adopted comprehensive climate policies across sectors, including renewable energy standards,³⁷ zero-emission vehicle programs,³⁸ landfill methane regulations,³⁹ and building performance standards.⁴⁰

Localities drive climate action by enacting climate action plans (CAPs) with strong clean energy goals and GHG emissions reduction targets across different sectors. The city of Milwaukee, Wisconsin, has a target to reduce GHG emissions by 45% by 2030 and achieve net zero by 2050;⁴¹ the city of Tucson, Arizona, aims to increase its renewable energy share to 70% by 2035, with a plan to transition away from coal by 2032, and reduce carbon emissions by 80% by 2035.⁴² Additionally, CAPs often include home energy upgrades, energy benchmarking and building performance standards, mode shift targets, electric vehicle adoption targets, vehicle emissions reduction targets, sustainable procurement policies, clean energy incentives, renewal of green infrastructure and green spaces, and zero waste programs. City-led policies banning new sales of fossil-fuel powered appliances, such as New York City's 2024 ban on fossil fuels in new construction,⁴³ exist across the country, though they continue to face considerable legal pushback.⁴⁴

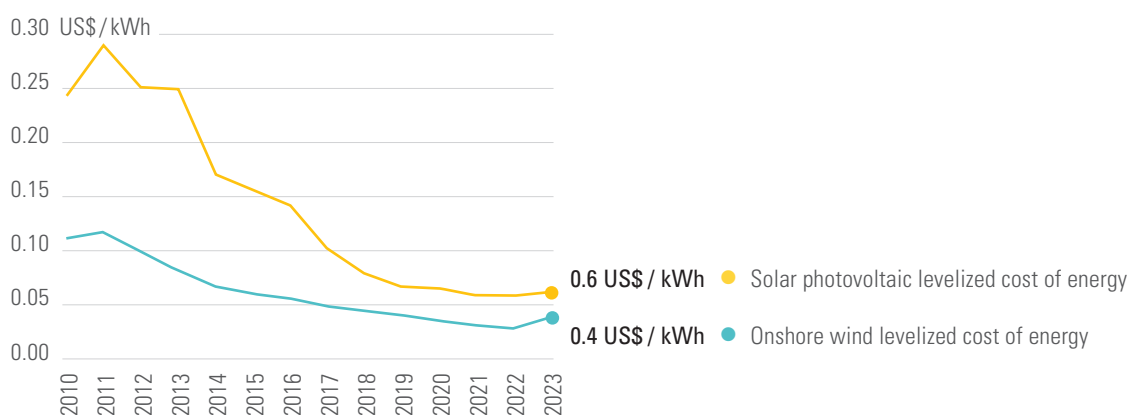
Under the current administration, states and cities have continued to pass ambitious climate policies, including New York City's congestion pricing program,⁴⁵ Oregon's new cap and trade program,⁴⁶ and California's state plan to deploy heat pumps.⁴⁷ Nearly half of U.S. states, as part of the *U.S. Climate Alliance*, have announced they will aim to achieve the emission reduction goals communicated in the 2035 U.S. NDC and 2050 net-zero target,⁴⁸ and a subset of these states launched a multi-state effort to promote clean vehicles.⁴⁹

Sectoral Transitions: Progress

Over the past few decades, the United States has made some progress toward its net-zero target through the electricity, transport, and buildings sectors.

The electricity sector has cut coal-fired generation by more than two-thirds since 2005 while quickly expanding renewable energy deployment in recent years.⁵¹ Coal is expected to continue retiring over the next decade, though supportive policies are needed to ensure the full phaseout and a just transition. The drop in coal power is mainly due to lower costs and better performance from natural gas and renewables, which have undercut coal's competitive advantage.⁵² The levelized cost of energy for solar and wind has fallen sharply over the last decade (**Figure 4**) as a result of technology improvements, better

Figure 4. Levelized cost of energy for wind and solar energy in the United States



Source: Renewable Power Generation Costs in 2023. <https://www.irena.org/Publications/2024/Sep/Renewable-Power-Generation-Costs-in-2023> (2024).

access to high-quality wind resources, more competitive supply chains, and lower operations and maintenance costs.⁵⁰ Federal and state-level policies have supported the growth in renewables.^{53,54} Additionally, efficiency gains in the end-use sectors have helped drive down emissions from the electricity sector.⁵⁵

In the transportation sector, the fuel efficiency of new light-duty vehicles has steadily improved since 2004 (Figure 3), and sales of hybrid-electric and electric vehicles (EVs) have accelerated over the last five years. From 2020 to 2025, EV sales rose from 238,540 to 1,247,656 vehicles, a 423% increase (Fig. 5). Plug-in hybrid-electric and conventional hybrid vehicle sales grew by 366% and 254%, respectively, over the same period. This growth is due in part to EV incentives under the IRA,⁵⁷ along with state-level EV incentives and mandates, which are becoming more widespread. The expansion of EV charging infrastructure has also played a key role in increased EV adoption. From 2015 to 2020, the number of EV charging ports in the United States more than doubled, and in 2021 alone, it increased by over 55% relative to the previous year.⁵⁸ This expansion was supported in part by the IRA and BIL investments in EV infrastructure.^{59,60} States have also provided funding and incentives for EV charging infrastructure; for example the California Electric Vehicle Infrastructure Project offers incentives for public EV chargers, prioritizing

low-income and disadvantaged communities.⁶¹ In the buildings sector, more stringent building codes, appliance standards, and other policies have led to increased electrification and energy efficiency improvements. Electric heat pumps have consistently outsold gas furnaces in recent years, with manufacturers shipping 32% more heat pumps than gas furnaces in 2024.⁶²

Sectoral Transitions: Blockages

Despite substantial progress driven by the IRA, BIL, and other federal and state-level policies, there remain major obstacles to achieving a net-zero transition. Accelerating clean energy deployment has been a challenge in the United States. Many renewable energy projects are stalled in the interconnection queue due to transmission infrastructure constraints and permitting delays. As of the end of 2023, over 1 TW of solar and wind generating capacity were stuck in the interconnection queue.⁶³ At the same time, the rapid growth of data centers in the United States is expected to drive up electricity demand significantly, further highlighting the need to address these interconnection and transmission challenges.⁶⁴

In the transport sector, reducing VMT and decarbonizing aviation, heavy-duty trucking, and shipping sectors have remained barriers. More than 20% of the U.S. population lives in suburban and rural areas, which are highly car-dependent.

Figure 5. Hybrid-Electric, Plug-in Hybrid-Electric, and Electric Vehicle Sales in the United States



Source: Light Duty Electric Drive Vehicles Monthly Sales Updates. Argonne National Laboratory
<https://www.anl.gov/esia/light-duty-electric-drive-vehicles-monthly-sales-updates>.

Investing in adequate transport infrastructure and promoting a cultural shift towards the use of public transportation and alternative modes of transportation remain challenges.⁶⁵ Electrifying heavy-duty trucking requires a high upfront investment and is limited by the lack of charging infrastructure along highways.⁶⁶ Aircraft electrification is still too early in development to support commercial deployment.⁶⁷ Alternative options, like synthetic aviation fuels, green hydrogen, and ammonia, have emerged, but they are not being used at the scale needed for full decarbonization.^{68,69}

In the buildings sector, the main challenges include the age of the existing building stock and the cost of Zero-Energy Building (ZEB) technologies. In some regions of the United States, a significant percentage of buildings are old, leading to a high cost of retrofit and a potential incompatibility with certain ZEB technologies like heat pumps.⁷⁰ Additionally, even though energy-efficient and electrified appliances lead to long-term savings, the upfront cost prevents low and medium-income households from purchasing them. There is also a risk that upgrading buildings with ZEB technologies may cause an increase in rental prices, thus placing a financial burden on low and middle-income households.⁷¹

The industrial sector has seen limited progress in decarbonization compared to other sectors. Industries such as iron and steel, chemicals, and petrochemicals have a high energy demand and emit carbon dioxide as part of their processes, making these industries difficult to decarbonize. Additionally, many of these technologies remain expensive and are not yet ready for commercial-scale deployment.⁷² There is a need for additional investment to support commercial demonstrations and drive broader technological innovation in this sector.⁷³ Deployment of carbon capture and storage and carbon dioxide removal technologies has also faced limitations due to the cost and the need for development of infrastructure to transport and store the captured carbon, which needs further research and development to be deployed at a large scale.^{74,75}

THE CRITICAL ROLE OF NON-FEDERAL ACTORS

Key features of the U.S. policymaking process

Climate policy in the United States reflects a complex interplay of federal leadership, state and local initiatives, subnational coalitions, and shifting political ideologies. Bipartisan support has occasionally emerged when climate action is framed around economic growth or national security; however, persistent political polarization and ideological resistance have repeatedly blocked comprehensive progress. Under the U.S. system of federalism, political power is divided between the federal, state, and local governments. The U.S. federal government is split between three branches: the executive branch, led by the President, the legislative branch, consisting of a bicameral Congress, and the judicial branch, led by the Supreme Court.⁷⁶ Each of these branches has the capacity to impact climate policy.

Numerous federal agencies execute laws passed by Congress by issuing regulations. The Environmental Protection Agency's duties include monitoring polluters, issuing permits and waivers, and enforcing statutes. The Department of Energy is notable for setting energy efficiency standards for appliances, managing nuclear energy regulation, and funding and facilitating research and development for energy systems, especially hard-to-decarbonize sectors. The Department of Transportation's management of infrastructure projects allows it to administer funds for mass transportation and EV infrastructure projects, while federal regulation of lands, forestry, and wildfire mitigation falls under the purview of the Department of Agriculture. The Department of the Interior manages federal lands and energy leasing within, while the National Oceanic and Atmospheric Administration is responsible for GHG emissions tracking, weather and climate tracking, and coastal and marine research, mitigation, and adaptation.

The legislative branch is divided between the House of Representatives and the Senate and is

responsible for passing legislation. Increasing political polarization⁷⁷ means that passing legislation is a difficult feat, especially for partisan issues like climate change. Within the U.S.'s two-party system, the Republican party tends to distrust science, which informs the party's climate denial and near-universal opposition to climate policies.⁷⁸ The judicial branch is responsible for interpreting, applying, and reviewing laws.⁷⁹ For example, the Supreme Court's 2007 ruling in *Massachusetts v. EPA* established that the Environmental Protection Agency can regulate greenhouse gases.⁸⁰ Similarly, lower courts can shape state and local climate laws by determining which regulations are within the rights of these jurisdictions.

During international climate negotiations, the U.S. is represented by a few extensions of the executive branch. The U.S. Special Presidential Envoy for Climate acts as the lead U.S. climate representative and negotiator and is supported by the Office of the Special Presidential Envoy for Climate.⁸¹ Though other American leaders such as governors, mayors, and university presidents may be present at international meetings, they do not have direct authority to speak on behalf of the United States.

Climate policy has also become a focal point in a broader culture war marked by increasing Republican opposition toward progressive social frameworks like environmental justice and diversity, equity, and inclusion.^{82,83} Programs linking climate action with equity, such as those established under the Biden administration's Justice40 Initiative, have become frequent targets of right-wing media and legal challenges.⁸⁴ While bipartisan narratives have occasionally advanced climate action, long-term progress remains hindered by ideological polarization. Advancing meaningful climate policy at the federal level will depend not only on future electoral outcomes but also on the capability of coalitions to effectively navigate this divide.

Subnational Climate Action

Under the U.S. federalist system of governance, states, cities, counties, and other jurisdictions have the capacity to enact climate policies, making them key drivers of climate action. For

example, states arguably have more authority to control the electricity grid mix than the federal government, and the federal government has no ability to set nationwide building energy efficiency standards, as these are set by individual states. Local jurisdictions like cities and counties have more ability to control transportation and zoning strategies. However, climate action at the subnational level is limited by funding constraints, diversity of subnational interests, and, increasingly, federal hostility towards subnational climate action.

Numerous subnational actors have remained engaged with climate issues in the United States despite federal government inaction and rollbacks. California is a notable climate leader, especially in setting stricter air pollution standards for new vehicles. While the Clean Air Act generally blocks states from creating their own standards, California has been exempt because it adopted rules before the Act passed.⁸⁵ Its air board proposes new standards to the Environmental Protection Agency, and once approved, other states can adopt them, allowing stricter rules than federal ones. As of April 2025, 17 states and the District of Columbia have adopted some portion of California's vehicle regulations, representing nearly 40% of the U.S. light-duty vehicle market, and demonstrating the significant influence of these standards on the automobile industry.⁸⁶ However, in May 2025, the Senate voted to revoke California's emissions waivers.⁸⁷ Though California has already challenged the revocation through a multi-state lawsuit, this action poses a long-term threat to state-led transportation mitigation, as policies revoked under the Congressional Review Act cannot be reintroduced in a substantially similar form.

Cities and counties can also advance innovative climate policies that may later be adopted by other localities or state governments. In states that lack strong climate ambition, cities and counties can also play a leading role on addressing climate change. For example, Texas lacks strong statewide climate policies, but its capital city, Austin, has a 2040 net-zero target, driven in part by one of the most ambitious renewable port-

folio standards in the country and comprehensive plans to expand EV adoption and charging infrastructure.⁸⁸ Similar trends can be seen in cities like Miami,⁸⁹ Phoenix,⁹⁰ and Milwaukee,⁴¹ where bold local climate initiatives have emerged despite relatively weak state-level support.

Many businesses have set net-zero targets for carbon emissions, including utility company Duke Energy, which plans to reach this goal by 2050.⁹¹ Other businesses driving the clean energy transition include NextEra Energy Resources, Ørsted US, AES Corporation, Invenergy, and Pattern Energy, all of which are leading the way in developing large-scale wind, solar, battery storage, and transmission projects.

Non-governmental organizations such as the Natural Resources Defense Council, Environmental Defense Fund, Sierra Club, and Union of Concerned Scientists are also heavily involved in climate action. Through litigation, policy advocacy, public mobilization, and research, these organizations work to reduce GHG emissions, accelerate the clean energy transition, and hold governments and corporations accountable for meeting climate commitments.

Modeled National Pathways

Long-term U.S. modeling studies highlight the broader, sectoral trends needed to achieve net-zero, including a rapidly decarbonized electricity grid, electrification of end-use sectors, and the use of carbon dioxide removal technologies.^{92,25,93} These studies tend to use a carbon price or constraint approach to achieve certain sectoral targets, rather than through specific policies. Shorter-term studies have assessed specific, sector-by-sector policies needed to achieve the U.S. 2030 and 2035 NDC, including clean electricity standards, accelerated permitting and siting of electricity transmission and renewables, enhanced incentives and sales targets for EVs, stronger building appliance standards that push the market towards all-electric appliances, and more stringent regulations on oil and gas sector methane.⁹⁴⁻⁹⁸

These analytical insights and targets have helped drive concrete policy discussions in the country. Zhao et al. (2024), for example, leveraged an

extensive stakeholder engagement process with federal and non-federal actors to inform the 2035 NDC and identify barriers and opportunities across sectors.⁹⁴ This study used a version of the integrated assessment model (IAM) Global Change Analysis Model with 50-state resolution to represent a suite of plausible policies across all sectors of the economy from both federal and non-federal actors, with differing assumptions across states based on their potential to adopt ambitious climate policy in the United States. The use of an IAM allows for the simulation of sectoral interactions, and the 50-state resolution enables the modeling of specific state-level policies, including building efficiency standards and renewable energy standards.

In this study, two scenarios are modeled: a current policies scenario, which includes existing federal and state-level policies, and an enhanced ambition scenario, which layers on enhanced and new federal and state-level policies across sectors to help achieve a high-ambition 2035 NDC. To ensure the attainability of the enhanced ambition pathway, modeled policies are based on mechanisms that already exist or have been proposed in at least one state. However, the study does not capture different social, political, and behavioral factors that could create uncertainty in policy uptake. For example, while IRA provisions are modeled at full implementation, in reality, uptake of these provisions would depend on the actions of state, local, and individual actors. The durability of the modeled policies is also called into question, as different federal administrations can alter the climate landscape in significant ways. Modeling studies have also highlighted the importance of subnational actions in driving down emissions in the United States, especially under less climate-friendly federal governments.^{94,95,99,100} Zhao et al. (2025) found that enhanced climate leadership at subnational level has the potential to counteract much of the impacts of recent federal policy rollbacks, allowing the United States to achieve GHG emissions reductions of 54-62% by 2035.¹⁰⁰ The high end of this range, which is based on how extensively federal policies are repealed, would meet the U.S. 2035 NDC.

CO-BENEFITS OF THE ENERGY TRANSITION

Beyond accelerating the clean energy transition and drawing down GHG emissions, climate policies can also yield health and economic co-benefits by reducing air pollutants and spurring economic growth associated with clean energy manufacturing. The Biden administration marked a pivotal shift in federal climate policy, centering decarbonization within a broader economic development agenda. This realignment culminated in the passage of the IRA, which was enacted through the budget reconciliation process.¹⁰¹ The IRA's success was driven by strategic coalition-building that united progressive climate advocates, moderate Democrats and Republicans, and other key stakeholders.¹⁰² By emphasizing job creation and economic revitalization in clean energy industries, the IRA garnered support from a diverse range of constituencies, including those in traditionally conservative regions. Framing climate action as a national security imperative has also attracted bipartisan support. Reducing dependence on foreign oil has long been a strategic priority, driven by concerns over energy price volatility, supply disruptions, and the geopolitical influence of fossil fuel-exporting nations.¹⁰³ This security-based framing continues to resonate across party lines and has supported investments in renewable energy, EVs, and domestic manufacturing of critical technologies such as batteries and solar panels.¹⁰⁴ Full implementation of the IRA and other federal climate policies have been associated with improved respiratory health, fewer working days lost, and reduced mortality from poor air quality.¹⁰⁵ They have also been linked to lower energy bills, as well as GDP and job gains.^{106,107,108} The promotion of domestic clean energy manufacturing through IRA tax credits that provide domestic content requirements and bonuses can also reduce foreign energy dependence. These comprehensive benefits present an opportunity to reframe climate policy in the United States., especially under an unsupportive federal government.

INTERNATIONAL CLIMATE ENGAGEMENT

As the world's largest economy, the largest contributor to historical emissions, the second largest emitter today, and a major geopolitical and diplomatic actor, the United States has historically been a key and influential country in international climate diplomacy. Given that the authority and responsibility of international engagement mostly remain at the federal level, the alternating climate agendas under different federal administrations has generated both leadership and fundamental disruptions to global climate outcomes over the past 10 years. Highlights of U.S. leadership include active bilateral and multilateral engagements before the Paris Agreement, effective influence over China's climate ambition and resulting joint global leadership, and the drawing of global policy attention to non-CO₂ emissions, especially methane. However, U.S. withdrawals from the Paris Agreement have led to significant distrust and risk of ambition rollback across countries.

Historical Leadership for Enhancing Ambition

In its climate-related international engagements, the United States has most heavily focused on supporting and implementing global climate ambition to maximize the possibility of achieving the Paris Agreement temperature goals. This strategy included broad international engagement and diplomacy as part of the UNFCCC and Paris Agreement structures, but also engagement bilaterally and in key regions. As part of that, engagement with China, the world's largest emitter, was a high priority. This bilateral US-China track yielded the important the Obama-Xi joint statement in November 2014, which catalyzed greater ambition in the Intended Nationally Determined Contributions across countries that became the core of the Paris Agreement.¹⁰⁹ Climate engagement with China dropped significantly during the first Trump administration, but restarted quickly after Biden took office despite challenges caused by the COVID-19 pandemic.

Strong dedication and trust between the top American and Chinese climate envoys played a pivotal role in the renewed U.S.-China climate cooperation and leadership.¹¹⁰ At COP26, the two countries agreed on the Joint Glasgow Declaration, which identified key areas for collaboration including energy transition, methane, circular economy, and deforestation.¹¹¹ In 2023, the two countries released the Sunnylands statement calling for the 2035 NDCs to cover GHG emissions from all sectors of the economy, and they also co-convened the first methane and non-CO₂ summit with UAE at COP28, and the second one at COP29.¹¹² After the 2024 election, the U.S.-China bilateral engagements were dropped, but for the most part, the international outcomes that they fed into, such as language in various COP outcomes, remains.

The United States also initiated other global and regional actions outside the formal negotiations. One highlight emerging in Glasgow was the Global Methane Pledge, which sets the global goal of 30% methane reduction by 2030, to be achieved by improving emissions tracking and inventories, sharing knowledge on mitigation strategies and research, and raising private funds.¹¹³ Additional international partnerships include the Just Energy Partnership (JETP) to finance coal phaseout in Indonesia and South Africa, and the Green Shipping Challenge with Norway.^{114,115}

Opportunities for Subnational Engagement

Under the current administration's retrenchment of climate mitigation and international cooperation, collaboration with states, cities, and businesses may provide opportunities for engagement internationally. Though states and cities cannot enter into treaties with other nations or regions, they can identify opportunities for partnership and investment, share knowledge about success in policy design and implementation, sign memorandums of understanding or other agreements, and more.⁷⁶ Existing entities such as the Under2 Coalition, a network of subnational governments that advocates for subnational interests at international conferences and

shares knowledge between members,¹¹⁶ the International Zero Emission Vehicle Alliance, a collaboration between countries and subnational entities to encourage EV adoption,¹¹⁷ the Pacific Coast Collaborative, a coalition of U.S. and Canadian cities,¹¹⁸ and the Western Climate Initiative's emissions trading system¹¹⁹ have previously provided forums for this type of engagement.

CONCLUSION

While historic climate legislation and regulations, subnational ambition, and market momentum have propelled U.S. climate action over the last decade, sharp political swings and implementation gaps have limited the country's ability to reduce emissions at the pace originally envisioned after Paris. Despite these challenges, the United States has made progress in retiring coal, deploying renewable energy, improving energy and fuel efficiency, addressing equity issues, and advancing electrification in the transportation and buildings sectors.

Looking ahead, subnational actors, including states, cities, and businesses, will have a critical role to play in sustaining U.S. climate ambition, accelerating the clean energy transition and advancing international partnership and action. Achieving the near-term NDCs and long-term net zero goal will require addressing natural gas phasedown, transmission expansion, freight electrification, VMT reductions, zero-emission building technology costs, and industrial sector decarbonization. Modeling studies, especially those that incorporate stakeholder engagement, can continue to provide insights on key policy levers in the near-term, as well as those that can lead to deeper reductions in mid-century. Importantly, the health, economic, and national security benefits of climate action offer a pathway to help bridge political divides and reframe climate policy in the United States.

REFERENCES

- 1 Webb, R. M. & Kurtz, L. Politics v. science: How President Trump's war on science impacted public health and environmental regulation. *Prog. Mol. Biol. Transl. Sci.* **188**, 65–80 (2022).
- 2 *Putting America First In International Environmental Agreements*. vol. Executive Order 14162 (2025).
- 3 *Unleashing American Energy*. vol. Executive Order 14154 (2025).
- 4 *Reinvigorating America's Beautiful Clean Coal Industry and Amending Executive Order 14241*. vol. Executive Order 15517 (2025).
- 5 *Protecting American Energy From State Overreach*. vol. Executive Order 14260 (2025).
- 6 *Zero-Based Regulatory Budgeting to Unleash American Energy*. vol. Executive Order 14270 (2025).
- 7 Carroll, A. C., Danya Gainor, Kate. Visualizing Trump's overhaul of the federal workforce | CNN Politics. *CNN* <https://www.cnn.com/politics/tracking-federal-workforce-firings-dg> (2025).
- 8 Stokstad, E. In 'blow to the environment,' EPA begins to dismantle its research office. *Science*.
- 9 Barkoff, S., Brennan, M., Schick, C., Cook, S. & Walsh, J. State Department enacts widespread layoffs, cutting 1,353 staff as part of reorganization - CBS News. *CBS News* (2025).
- 10 Langin, K. 'It's a nightmare.' U.S. funding cuts threaten academic science jobs at all levels. *Science*.
- 11 Wessler, S. Can states and cities lead on climate under Trump? *Yale Climate Connections* <http://yaleclimateconnections.org/2025/05/can-states-and-cities-lead-on-climate-under-trump/> (2025).
- 12 Mooney, A. & Millard, R. Investors in clean energy funds backtrack as rates and Donald Trump cloud outlook. *Financial Times* https://www.ft.com/content/2c8258ba-f7ab-4bd1-8c0c-e25b871812f4?utm_source=chatgpt.com (2025).
- 13 Gibson, K. The Trump Administration's Retreat From Global Climate Leadership. (2025).
- 14 Bergmann, M. The Transatlantic Alliance in the Age of Trump: The Coming Collisions. <https://www.csis.org/analysis/transatlantic-alliance-age-trump-coming-collisions> (2025).
- 15 America Is All In. America is all in. <https://www.americaisallin.com/home>.
- 16 Basseches, J. A. et al. Climate policy conflict in the U.S. states: a critical review and way forward. *Clim. Change* **170**, 32 (2022).
- 17 Jotzo, F., Depledge, J. & Winkler, H. US and international climate policy under President Trump. *Clim. Policy* **18**, 813–817 (2018).
- 18 Arroyo, V. From Paris to Pittsburgh: U.S. State and Local Leadership in an Era of Trump. (2019).
- 19 Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2022. (2024).
- 20 Hausfather, Z. Analysis: Why US carbon emissions have fallen 14% since 2005. *Carbon Brief* <https://www.carbonbrief.org/analysis-why-us-carbon-emissions-have-fallen-14-since-2005/> (2017).
- 21 Electricity data browser - Net generation for all sectors. *U.S. Energy Information Administration* <https://www.eia.gov/electricity/data/browser/>.
- 22 Bureau of Transportation Statistics. *United States Department of Transportation* <https://www.bts.gov/>.
- 23 *The 2023 EPA Automotive Trends Report*. <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1019157.pdf> (2023).
- 24 *The Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050*. <https://bidenwhitehouse.archives.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf> (2021).
- 25 Horowitz, R. et al. The energy system transformation needed to achieve the US long-term strategy. *Joule* **6**, 1357–1362 (2022).
- 26 The United States of America Nationally Determined Contribution. (2024).
- 27 Lashof, D. Tracking Progress: Climate Action Under the Biden Administration. (2024).
- 28 *Clean Investment Monitor: Q1 2025 Update*. https://cdn.prod.website-files.com/64e31ae6c5fd44b10ff405a7/6823633247bb9cf92a074eb5_Clean%20Investment%20Monitor_Q1%202025.pdf (2025).
- 29 The Inflation Reduction Act: Saving American Households Money While Reducing Climate Change and Air Pollution. *U.S. Department of the Treasury* <https://home.treasury.gov/news/featured-stories/the-inflation-reduction-act-saving-american-households-money-while-reducing-climate-change-and-air-pollution> (2025).
- 30 Baker-Branstetter, S. & Chang, R. *The Inflation Reduction Act Reduces Emissions and Income Inequality*. <https://www.americanprogress.org/article/the-inflation-reduction-act-reduces-emissions-and-income-inequality/> (2023).
- 31 Greene, D. L., Greenwald, J. M. & Ciez, R. E. U.S. fuel economy and greenhouse gas standards: What have they achieved and what have we learned? *Energy Policy* **146**, 111783 (2020).
- 32 Kennedy, K., Obeiter, M. & Kaufman, N. Putting a Price on Carbon: A Handbook for U.S. Policy Makers. *World Resources Institute* <https://www.wri.org/research/putting-price-carbon> (2015).
- 33 Cap-and-Trade Program. *California Air Resources Board* <https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program>.
- 34 The Regional Greenhouse Gas Initiative: an initiative of Eastern States of the US. (2025).
- 35 Maryland's Climate Pollution Reduction Plan. (2023).
- 36 Our Roadmap for Cleaner Air and Healthier Communities. *New York State Energy Research and Development Authority* <https://climate.ny.gov/>.

- 37 Renewables Portfolio Standard (RPS) Program. *California Public Utilities Commission* <https://www.cpuc.ca.gov/rps/>.
- 38 Zero-Emission Vehicle Program. *California Air Resources Board* <https://ww2.arb.ca.gov/our-work/programs/zero-emission-vehicle-program>.
- 39 Slinger, D. The Domino Effect: How States Are Leading the Charge on Landfill Methane. *RMI* <https://rmi.org/the-domino-effect-how-states-are-leading-the-charge-on-landfill-methane/> (2025).
- 40 Building Performance Standards. *U.S. Department of Energy Office of Energy Efficiency & Renewable Energy* <https://www.energycodes.gov/BPS>.
- 41 Milwaukee Climate & Equity Plan. *City of Milwaukee Environmental Collaboration Office* <https://city.milwaukee.gov/climate/Climate-Plan>.
- 42 Resilient Together. <https://climateaction.tucsonaz.gov/pages/caap>.
- 43 LOCAL LAWS OF THE CITY OF NEW YORK FOR THE YEAR 2021: No. 154. (2021).
- 44 CRA V. CITY OF BERKELEY, No. 21-16278 (9th Cir. 2023). *Justia U.S. Law* <https://law.justia.com/cases/federal/appellate-courts/ca9/21-16278/21-16278-2023-04-17.html> (2023).
- 45 Kaske, M. NYC Congestion Toll Cuts Manhattan Gridlock by 25%, RPA Reports. *Bloomberg.com* (2025).
- 46 Samayoa, M. Oregon to reinstate ambitious climate program amid divided reactions from industries, environmentalists. *OPB* <https://www.opb.org/article/2024/11/21/oregon-restart-climate-protection-program/> (2024).
- 47 Takemura, A. California unveils first state plan to unleash heat pumps. *Canary Media* <https://www.canarymedia.com/articles/heat-pumps/california-unveils-first-state-plan-to-unleash-heat-pumps> (2025).
- 48 About: United States Climate Alliance. *U.S. Climate Alliance* <https://usclimatealliance.org/about/>.
- 49 U.S. Climate Alliance Governors Launch Affordable Clean Cars Coalition to Expand Americans' Access to Newer and Cleaner Vehicles. *U.S. Climate Alliance* <https://usclimatealliance.org/press-releases/alliance-governors-launch-affordable-clean-cars-coalition-may-2025/> (2025).
- 50 Renewable Power Generation Costs in 2023. <https://www.irena.org/Publications/2024/Sep/Renewable-Power-Generation-Costs-in-2023> (2024).
- 51 US Energy Information Administration. Annual Electric Power Industry Report, Form EIA-861 detailed data files. <https://www.eia.gov/electricity/data/eia861/> (2023).
- 52 Kolstad, C. What Is Killing the US Coal Industry? *Stanford Institute for Economic Policy Research* <https://siepr.stanford.edu/publications/policy-brief/what-killing-us-coal-industry> (2017).
- 53 Mai, T., Cole, W., Lantz, E., Marcy, C. & Sigrin, B. *Impacts of Federal Tax Credit Extensions on Renewable Deployment and Power Sector Emissions*. <https://docs.nrel.gov/docs/fy16osti/65571.pdf> (2016).
- 54 Joshi, J. Do renewable portfolio standards increase renewable energy capacity? Evidence from the United States. *J. Environ. Manage.* **287**, 112261 (2021).
- 55 Electric Power Sector Emissions. *United States Environmental Protection Agency* <https://www.epa.gov/ghgemissions/electric-power-sector-emissions>.
- 56 Light Duty Electric Drive Vehicles Monthly Sales Updates. *Argonne National Laboratory* <https://www.anl.gov/esia/light-duty-electric-drive-vehicles-monthly-sales-updates>.
- 57 Allcott, H., Kane, R., Maydanchik, M. S., Shapiro, J. S. & Tintelnot, F. *The Effects of "Buy American": Electric Vehicles and the Inflation Reduction Act*. <https://www.nber.org/papers/w33032> (2024) doi:10.3386/w33032.
- 58 Alternative Fuels Data Center: Electric Vehicle Charging Infrastructure Trends. *U.S. Department of Energy* <https://afdc.energy.gov/fuels/electricity-infrastructure-trends>.
- 59 Alternative Fuel Vehicle Refueling Property Credit. *Internal Revenue Service* <https://www.irs.gov/credits-deductions/alternative-fuel-vehicle-refueling-property-credit>.
- 60 Alternative Fuels Data Center: Charging and Fueling Infrastructure Grants. *U.S. Department of Energy* <https://afdc.energy.gov/laws/12732>.
- 61 EV Charging for All. *CAL eVIP* <https://calevip.org/>.
- 62 Tracking the Heat Pump & Water Heater Market in the United States. *Rocky Mountain Institute* <https://rmi.org/insight/tracking-the-heat-pump-water-heater-market-in-the-united-states/> (2025).
- 63 Queued Up: Characteristics of Power Plants Seeking Transmission Interconnection. *Berkeley Lab: Energy Markets & Policy* <https://emp.lbl.gov/queues>.
- 64 Powering Intelligence: Analyzing Artificial Intelligence and Data Center Energy Consumption. <https://www.epri.com/research/products/3002028905> (2024).
- 65 Nation's Urban and Rural Populations Shift Following 2020 Census. *United States Census Bureau* <https://www.census.gov/newsroom/press-releases/2022/urban-rural-populations.html> (2022).
- 66 Fleming, K. L., Brown, A. L., Fulton, L. & Miller, M. Electrification of Medium- and Heavy-Duty Ground Transportation: Status Report. *Curr. Sustain. Energy Rep.* **8**, 180–188 (2021).
- 67 Schwab, A., Thomas, A., Bennett, J., Robertson, E. & Cary, S. Electrification of Aircraft: Challenges, Barriers, and Potential Impacts. (2021).
- 68 Kennedy, K. & Feldmann, J. Decarbonizing Freight: Opportunities and Obstacles for Clean Fuels. <https://www.wri.org/insights/decarbonizing-freight-clean-fuels> (2023).
- 69 Decarbonizing Aviation. *Rocky Mountain Institute* <https://rmi.org/decarbonizing-aviation/>.
- 70 Nadel, S. Electrification in the Transportation, Buildings, and Industrial Sectors: a Review of Opportunities, Barriers, and Policies. *Springer Nat.* **6**, 158–168 (2019).
- 71 Decarbonizing the U.S. Economy by 2050: A National Blueprint for the Buildings Sector. (2024).

- 72 Gross, S. The challenge of decarbonizing heavy industry. *Brookings* <https://www.brookings.edu/articles/the-challenge-of-decarbonizing-heavy-industry/> (2021).
- 73 Industrial Decarbonization Roadmap. (2022).
- 74 Gonzales, V., Krupnick, A. & Dunlap, L. Carbon Capture and Storage 101. *Resources for the Future* <https://www.rff.org/publications/explainers/carbon-capture-and-storage-101/> (2022).
- 75 Jones, W. et al. *The Landscape of Carbon Dioxide Removal and US Policies to Scale Solutions*. <https://rhg.com/research/carbon-dioxide-removal-us-policy/> (2024).
- 76 The Constitution of the United States of America.
- 77 Heltzel, G. & Laurin, K. Polarization in America: two possible futures. *Curr. Opin. Behav. Sci.* **34**, 179–184 (2020).
- 78 Bugden, D. Denial and distrust: explaining the partisan climate gap. *Clim. Change* **170**, 34 (2022).
- 79 *Marbury v. Madison*, 5 U.S. 137 (1803). *Justia Law* <https://supreme.justia.com/cases/federal/us/5/137/>.
- 80 *Massachusetts v. EPA*, 549 U.S. 497 (2007). *Justia Law* <https://supreme.justia.com/cases/federal/us/549/497/>.
- 81 Office of the U.S. Special Presidential Envoy for Climate. *United States Department of State* <https://2021-2025.state.gov/bureaus-offices/secretary-of-state/office-of-the-u-s-special-presidential-envoy-for-climate/>.
- 82 Department of Justice Terminates Environmental Justice Settlement Agreement, Advancing President Trump's Mandate to End Illegal DEI and Environmental Justice Policies. *United States Department of Justice* <https://www.justice.gov/opa/pr/departments-justice-terminates-environmental-justice-settlement-agreement-advancing-president> (2025).
- 83 Nicolaus, T. Environmental justice work targeted by Trump DEI orders. *Nations Health* **55**, 1–10 (2025).
- 84 Ali Kanu, H. Trump's DEI Purge Sweeps Up Race-Neutral Environmental Justice Program. *The American Prospect* (2025).
- 85 Vehicle Emissions California Waivers and Authorizations. *United States Environmental Protection Agency* <https://www.epa.gov/state-and-local-transportation/vehicle-emissions-california-waivers-and-authorizations>.
- 86 States that have Adopted California's Vehicle Regulations. *California Air Resources Board* https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program/states-have-adopted-californias-vehicle-regulations?utm_source=chatgpt.com (2025).
- 87 Domonoske, C. Upending norms, the Senate votes to undo California's EV rules. *NPR* (2025).
- 88 Munoz, L. U.S. Cities Leading the Way Toward Net Zero. *Climate Advisers* <https://www.climateadvisers.org/insightsfeed/u-s-cities-leading-the-way-toward-net-zero/> (2024).
- 89 Miami Forever Climate Ready. *City of Miami* <https://www.miami.gov/My-Government/Climate-Change-in-the-City-of-Miami/Climate-Change-Action/MiamiForeverClimateReady>.
- 90 2025 Climate Action Plan. *City of Phoenix* <https://www.phoenix.gov/administration/departments/oep/climate-change/climate-action-plan.html>.
- 91 How Duke Energy will reach net-zero carbon emissions. *Duke Energy* <https://illumination.duke-energy.com/articles/how-duke-energy-will-reach-net-zero-carbon-emissions>.
- 92 Williams, J. et al. Carbon-Neutral Pathways for the United States. *AGU Adv.* **2**, (2021).
- 93 Browning, M. et al. Net-zero CO₂ by 2050 scenarios for the United States in the Energy Modeling Forum 37 study. *Energy Clim. Change* **4**, 100104 (2023).
- 94 Zhao, A. et al. *Toward 2035: Forging a High-Ambition U.S. Climate Pathway*.
- 95 Zhao, A. et al. High-ambition climate action in all sectors can achieve a 65% greenhouse gas emissions reduction in the United States by 2035. *Npj Clim. Action* **3**, 63 (2024).
- 96 Mahajan, M., Orvis, R., Gopal, A., O'Brien, D. & Goldstein, R. *The Second Half Of The Decisive Decade: Potential U.S. Pathways On Climate, Jobs, And Health*. <https://energyinnovation.org/report/the-second-half-of-the-decisive-decade-potential-u-s-pathways-on-climate-jobs-and-health/> (2024).
- 97 King, B. et al. *Pathways to Paris: Post-IRA Policy Action to Drive US Decarbonization*. 9 <https://rhg.com/research/ira-us-climate-policy-2030/> (2023).
- 98 Iyer, G. et al. A multi-model study to inform the United States' 2035 NDC. *Nat. Commun.* **16**, 643 (2025).
- 99 Hultman, N. E. et al. Fusing subnational with national climate action is central to decarbonization: the case of the United States. *Nat. Commun.* **11**, 5255 (2020).
- 100 Zhao, A. et al. *Advancing U.S. Climate Action Under Federal Policy Rollbacks*. (2025).
- 101 INFLATION REDUCTION ACT OF 2022. *U.S. Department of Energy* <https://www.energy.gov/lpo/inflation-reduction-act-2022>.
- 102 Moraal, M., Mueller, E. & Winnick, H. Climate, Jobs, and Growth: How Coalitions Powered Biden's Legislation to Decarbonize America. *Heinrich Böll Stiftung* <https://us.boell.org/en/2023/09/20/climate-jobs-and-growth-how-coalitions-powered-bidens-legislation-decarbonize-america> (2023).
- 103 Energy Independence and Security. *U.S. Department of Energy* <https://www.energy.gov/eere/energy-independence-and-security>.
- 104 The durable, bipartisan effects of emphasizing the cost savings of renewable energy. *Yale Program on Climate Change Communication* <https://climatecommunication.yale.edu/publications/the-durable-bipartisan-effects-of-emphasizing-the-cost-savings-of-renewable-energy/>.
- 105 Kumar, A. et al. The projected impact of the inflation reduction act's climate provisions on cardiovascular and respiratory outcomes. *Am. J. Prev. Cardiol.* **19**, 100707 (2024).

- 106 Zhao, A. et al. *U.S. Clean Energy Policy Rollbacks: The Economic and Public Health Impacts Across States*. 26 <https://cgs.umd.edu/research-impact/publications/us-clean-energy-policy-rollbacks-economic-and-public-health-impacts> (2025).
- 107 King, B., Kolus, H., Gaffney, M., van Brummen, A. & Larsen, J. *The Stakes for Energy Costs in Budget Reconciliation*. <https://rhg.com/research/the-stakes-for-energy-costs-in-budget-reconciliation/> (2025).
- 108 Orvis, R., Mahajan, M., Goldstein, R. & Ashmoore, O. *Inflation Reduction Act Repeal Harms State Economies, Raises Consumer Costs*. <https://energyinnovation.org/report/inflation-reduction-act-repeal-harms-state-economies-raises-consumer-costs/> (2025).
- 109 U.S.-China Joint Presidential Statement on Climate Change. [whitehouse.gov https://whitehouse.archives.gov/the-press-office/2015/09/25/us-china-joint-presidential-statement-climate-change](https://whitehouse.archives.gov/the-press-office/2015/09/25/us-china-joint-presidential-statement-climate-change) (2015).
- 110 Kerry and Xie exit roles that defined generation of climate action. *AP News* <https://apnews.com/article/john-kerry-xie-zhenhua-climate-change-7af155358898a7533946228e110caf50> (2024).
- 111 U.S.-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s. *United States Department of State* <https://2021-2025.state.gov/u-s-china-joint-glasgow-declaration-on-enhancing-climate-action-in-the-2020s/>.
- 112 Sunnylands Statement on Enhancing Cooperation to Address the Climate Crisis. *United States Department of State* <https://2021-2025.state.gov/sunnylands-statement-on-enhancing-cooperation-to-address-the-climate-crisis/>.
- 113 Fast action on methane to keep 1.5° future within reach. *Global Methane Pledge* <https://www.globalmethanepledge.org/>.
- 114 Just Energy Transition Partnerships: Toward a Collective Assessment. (2023).
- 115 FACT SHEET: President Biden to Galvanize Global Action to Strengthen Energy-Security and Tackle the Climate Crisis through the Major Economies Forum on Energy and Climate. *The White House* <https://bidenwhitehouse.archives.gov/briefing-room/statements-releases/2022/06/17/fact-sheet-president-biden-to-galvanize-global-action-to-strengthen-energy-security-and-tackle-the-climate-crisis-through-the-major-economies-forum-on-energy-and-climate/> (2022).
- 116 Under2 Coalition. *Climate Group* <https://www.theclimategroup.org/under2-coalition>.
- 117 Members. *ZEV Alliance* <https://zevalliance.org/members/>.
- 118 Pacific Coast Collaborative: *Pacific Coast Collaborative* <https://pacificcoastcollaborative.org/>.
- 119 Greenhouse gas emissions trading: a cost-effective solution to climate change. *Western Climate Initiative, Inc.* <https://wci-inc.org>.



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