Immediate actions in
national pathways to net zero

ENABLING LONG-TERM EMISSION REDUCTIONS

National pathways to net zero involve short-term actions across infrastructure and technology, governance and institutions, and lifestyle and behaviour changes. While these short-term actions may not deliver immediate emission reductions, they are essential for laying the foundation for the long-term changes needed in each country

Rapid emission reductions are necessary to put countries on track with carbon neutrality (Section - Triggering short-term emission reductions). However, an excessive focus on immediate emission reductions runs the risk of overlooking an important category of mitigation actions, i.e. those which, while not delivering immediate emission reductions, are nevertheless essential to drive structural changes in infrastructure and organizations, and to achieve deeper emission reductions by mid century, as highlighted in Section - Use of fossil fuels

The challenge with these structural changes is that they are often characterized by significant inertia and resistance to change. For public and private decision-makers, this presents the challenge of a time lag between their actions on the drivers and their tangible effect on emissions. Due to this inertia, it is crucial to consider short-term actions today in the perspective of their longer-term negative or positive impacts on emissions. For example, short-term actions that may create new carbon lock-ins in the future (negative impacts) should be avoided. Conversely, short-term actions that address the various sources of inertia associated with these structural changes and offer potential longer-term emission reductions (positive impacts) should be prioritized.

According to the diversity of national pathways to net zero analysed, the results highlight that all sectors are affected by these structural changes and that the sources of inertia are sector and country-specific. Delving deeper, we identified at least three main sources of inertia: 1) infrastructure and technologies (Case studies - China, Senegal and the United States), 2) governance and institutions (Case study - Nigeria), and 3) lifestyles and behaviours (Case study - India). The following examples illustrate structural changes in different sectors and characterize country-specific actions that address certain sources of inertia. These actions should be better anticipated and implemented in the short term by decision-makers, because these sources of inertia are particularly rooted in the specificities of national contexts.

In the power sector, for example, country analyses show that fossil fuel-based power generation capacities must be drastically reduced by 2050, while renewable energy capacities should be increased. First, all countries recognize the need for long-term investments in adequate infrastructure for the transmission and distribution of power, tailored to the specificities of renewable energy sources (different geographical distribution, intermittencies…) and for the new uses of power systems (distributed generation, power storage, electric vehicles…). These investments should be planned now to facilitate the rapid expansion of renewables in the next decades. Additionally, such long-term transformations will largely depend on upfront investment decisions in power production infrastructure and technologies (1), which have long lifetimes and pose risks of carbon lock-in. Depending on country circumstances, some short-term actions should be taken on current power plant investments (Case study - China and Senegal) or on future technological innovations. These innovations will require significant investment in research and development before they can reach commercial viability, as exemplified by CCS technologies (Case study - United States).

In the freight transport sector, for example, country analyses show that a structural shift away from diesel trucks to rail, inland water and coastal transport will contribute to reducing emissions from freight by 2050. First, all countries recognize the importance of actions on infrastructure and technologies (1) to develop railways, inland waterways and coastal shipping logistics and infrastructure to efficiently connect these modes of transport to road transport. Additionally, a number of targeted and country-specific measures have been identified regarding the governance and institutional conditions (2) in the sector, to effectively support the envisaged sectoral changes (Case study - Nigeria).

Finally, for the transition of food and energy systems, country analyses highlight the need to develop demand-side strategies in all sectors aimed at changing lifestyles and behaviours (3) to facilitate the adoption of low-carbon solutions. Such changes will take time and can only develop progressively as they depend on our collective capacity to change social norms and cultural habits (Case study - India).

CASE STUDY – CHINA

Early termination of new coal-fired power plant construction

China's power sector presents a complex paradox. While the country leads the world in renewable energy installations, accounting for 63% of global wind and solar capacity additions, it nevertheless continues to approve new coal power plants. In 2023 alone, China's photovoltaic (PV) installations exceeded the world's total PV additions from 2022, and the country is set to reach its 2030 target of 1,200 GW of wind and PV capacity by 2024, six years ahead of schedule.

However, despite this remarkable progress, over 200 GW of coal power was approved in 2022 alone, highlighting the complex dilemmas China faces in its transition to a low-carbon economy. The rapid growth in electricity demand is outpacing renewable capacity and while the share of renewables in the energy mix is rapidly increasing, the power system lacks sufficient clean and flexible peaking capacity to ensure grid stability. Additionally, coal remains the dominant source of heat for district heating in northern China, where the adoption of cleaner technologies has not yet gained traction.

China's electricity demand grew by 6.7% in 2023, an annual increase equivalent to Germany's total electricity consumption. Despite the installation of roughly 300 GW of new wind and PV capacity in 2023, this expansion alone is insufficient to meet the rising electricity demand. As a result, China has had to approve new coal power projects to bridge the gap. Compounding this challenge, gas-fired power plants account for only about 5% of China's total generation capacity, which leaves coal as the primary source for meeting peak demand as renewable energy penetration increases. Furthermore, over 50% of winter heating in northern China comes from coal-fired cogeneration plants, complicating efforts to phase out coal power in this region.

While the construction of new coal plants may address short-term power and heating needs, these plants are likely to become stranded assets in the long-term, complicating China's energy transition towards carbon neutrality. From an economy-wide perspective, the analysis reveals that the power generation capacities planned under the Current Policy Scenario (CPS) could quadruple the cost of stranded assets. In contrast, freezing the building of new coal power plants as soon as possible could significantly decrease it. Although reducing or halting new coal-fired power construction is possible, China must simultaneously accelerate efforts to meet incremental power supply needs, enhance grid flexibility, and accelerate the development of low-carbon heating solutions, particularly in northern regions.

CASE STUDY – SENEGAL

Moderate gas development combined with renewables to enable universal access to electricity while mitigating long-term carbon lock-ins

In light of significant gas field discoveries, Senegal aims to rely on its resources to achieve universal access to electricity and foster the socio-economic development of its territories, as outlined in the government's "Gas To Power" strategy established in December 2018. This strategy includes plans to convert existing heavy fuel oil and coal-fired thermal power plants into natural gas plants, with an installed capacity of 3 GW, along with more than 800 MW of additional capacity. This energy policy is expected to increase the share of fossil fuels to about 60% of the energy mix by 2030.

However, while gas-fired power plants emit fewer greenhouse gases (GHGs) than oil and coal plants, they still emit a significant amount of GHGs (more than 400 gCO_2/kWh) and will continue to do so over their operational lifespan of around 40 years. Consequently, ENDA-Energie has developed several scenarios for natural gas development to assess the potential short, medium, and long-term impacts on socio-economic and climate goals.

One of their scenarios focuses on extensive gas development, as outlined in the gas sector master plan. While this scenario meets the objective of universal electricity access, it does so in a suboptimal manner. Indeed, this scenario focuses solely on gas sector development, which could hinder the planned expansion of renewable energy as outlined in the renewable energy strategy. Furthermore, this scenario is not compatible with ambitious long-term climate objectives.

Another scenario emphasizes moderate gas development, combined with the growth of renewable energy production capacity. This scenario not only accelerates universal access to electricity but also achieves more ambitious climate goals in the medium and long-term. Gas development is relevant when it is designed to support the electrification of energy uses (transport, cooking, industrial production...), that are necessary in the long-term. In the short term it facilitates the integration of renewable electricity while gradually decreasing to create space for renewable energy sources over time.

Finally, one of the scenarios shows that efforts to improve energy efficiency can also help achieve universal electricity access and meet climate goals by reducing pressure on electricity generation needs.

CASE STUDY – UNITED STATES

Investing in technological innovations related to CCUS

Carbon capture, utilization and storage (CCUS) development has been a focus in the US since the 1970s, primarily through Enhanced Oil Recovery (EOR) and Enhanced Gas Recovery (EGR) techniques, which were developed to access oil and gas from reserves that required CO_2 injection for extraction.

Since then, the government has taken significant steps to advance CCUS development beyond EOR and EGR. In 2009, the American Recovery and Reinvestment Act allocated $3.4 billion in funding for CCS programmes, although not all of these funds were utilized. Between 2011 and 2023, Congress also allocated $5.3 billion (in nominal dollars) for CCS research and development. Additionally, from 2010 to 2019, companies claimed a total of $1 billion in Section 45Q federal tax credits, which provide subsidies per ton of carbon captured.

The future development of CCS in the US will greatly depend on deployment costs, as this will influence the companies' decisions regarding the adoption of such technologies. The availability of pipelines and underground storage capacity for CO_2 will be crucial for the transportation and storage of captured CO_2, which will require investment amounting to several billion dollars.

The US is well-positioned to further develop CCUS due to its energy economy, abundant natural resources, and innovation-driven manufacturing sector. More than half of all operational, commercial, large-scale CCS facilities are located in the US, and due to the enhanced 45Q tax credit, 12 of the 17 new CCS facilities being developed globally are in the US. The country also possesses significant storage potential, estimated at 3,000 metric gigatons of carbon dioxide.

More recently, the Inflation Reduction Act of 2022, established a tax credit to deploy the least-cost CCS technologies (up to $85 per ton of CO_2 captured), while the Bipartisan Infrastructure Law of 2021 provided $2.5 billion for carbon capture demonstration projects from 2022 to 2026.

At the subnational level, several states are now at the forefront of CCS implementation, having established carbon dioxide removal (CDR) targets. For example, California aims for a 40% CCS target in cement production by 2035 and a 15% emission reduction target for CDR by 2045. New York, New Jersey, Massachusetts, Maryland, and Colorado have established similar targets. Texas and Illinois provide tax credits for carbon sequestration, while states like Wyoming and Louisiana have established financial incentive programmes, providing direct financial assistance, tax incentives, state assumption of long-term liability, and mechanisms for utility cost recovery, among other benefits.

CASE STUDY – NIGERIA

Setting new governance and institutional rules to develop rail freight and limit the dependency on road freight

Nigeria's freight transport is dominated by road transport, which represents 99% of goods traffic. This heavy reliance on road transport has led to issues such as traffic congestion, infrastructure degradation, and high emissions. A transition to rail freight offers substantial benefits,[25] but addressing governance and institutional barriers is critical to unlocking these opportunities. Given the typical inertia associated with governance reforms, it is essential to initiate these changes promptly to secure future emission reductions.

First, the central government must play a leading role in the planning and prioritization of rail network routes. A coordinated, national approach would maximize economies of scale and establish vital regional connections, positioning Nigeria as a central player in regional trade partnerships. Centralized planning is essential to avoid a fragmented and inefficient network, which could emerge if regional politics were the primary driver of decision-making. However, collaboration between central and regional governments is vital to address regional security concerns, particularly in the northeast, where threats have hindered the development of an efficient national rail system. Security risks also loom over potential southern coastal lines, making joint efforts indispensable to achieving a comprehensive and reliable rail network.

Second, a new framework law for rail development must be introduced to establish governance structures that attract investment, ensure safety, and promote efficiency. This law should incorporate best-in-class standards to meet international benchmarks, ensuring that Nigeria's rail system is modern, competitive, and capable of supporting national growth. The government could create public-private partnership (PPP) opportunities, opening the rail sector to private and international investors. These partnerships would generate new financing streams and foster competition between Nigerian and foreign actors, driving innovation and growth. However, governance frameworks must include provisions to ensure that private investments contribute to inclusive, sustainable development. Obligations should be established to prioritize the employment of local workers, support local businesses, and mandate skills training to ensure long-term sustainability and capacity for rail infrastructure operations and maintenance. Furthermore, involving national companies in project structures will facilitate technology transfer, allowing for the growth of domestic expertise.

Finally, in terms of governance, a new framework law must emphasize the central state's pivotal role in planning, while also fostering inclusive governance. A new governance structure should establish rules that require consensus-building on large-scale projects, ensuring that all stakeholders, including Nigeria's indigenous peoples, participate in national development. Additionally, this approach should support the deep decarbonization of the transport sector, aligning with Nigeria's long-term environmental goals. Achieving a modal shift from road to rail freight is a crucial part of this transformation, and without immediate action on governance reforms, this shift—and the corresponding reduction in emissions—may be delayed. Governance and institutional reforms often face delays due to political and bureaucratic inertia, but such delays could exacerbate the country's reliance on road transport, leading to prolonged environmental degradation and missed opportunities for decarbonization.

In conclusion, Nigeria's shift towards rail freight is not just a logistical necessity but a critical component of its long-term decarbonization strategy. Governance and institutional reforms are often slow-moving, but addressing them now is essential for unlocking future emission reductions, improving infrastructure, and fostering sustainable, inclusive development. The time to act is now, and central leadership, strong legal frameworks, and inclusive governance will be key to transforming Nigeria's freight transport system and securing its environmental and economic future.

25 Akujor C.E. et al., 2022; Emodi N.V. et al., 2022

CASE STUDY – INDIA

Embracing Lifestyle For Environment (LiFE) is a necessary global movement to achieve net zero

For the deep decarbonization in India, balancing global climate targets with domestic development goals in the latter half of this century presents significant challenges.

Development and energy security will remain top priorities for India. Key targets of the country's DDS pathway include eradicating poverty and hunger, ensuring housing for all, and boosting employment. With a growing urban population and rising infrastructure demands by 2030, household energy needs are set to rise, thereby requiring industrial production to meet this demand. Rapid urbanization and rising income levels will drive the demand for an improved quality of life. Cumulative investment estimates based on numerous sources range from $6 to $10 trillion between 2015 and 2030. As a result, electricity demand across sectors (industry, transport, buildings) is projected to increase significantly in deep decarbonization scenarios.

Transitioning to a low-emission energy supply is essential and can be achieved in two steps. In the medium term, the simultaneous development of gas and renewable electricity will lead to an increase in emissions in the DDS pathway and may create lock-ins due to reliance on gas infrastructure for several decades. However, in the long-term, India aims to transition entirely to zero-emission electricity. To support this goal, the country plans to invest after 2030 in stationary and mobile battery storage to accommodate the increase in renewable power capacity and generation.

Achieving India's development goals will inevitably increase energy demand, placing significant pressure on the decarbonization of the power supply. To address this, demand-side policies are needed to foster structural changes in lifestyles and behaviours related to energy use. LiFE[26] was introduced by Prime Minister Narendra Modi at COP26 in Glasgow on 1 November 2021 as a mass movement for "mindful and deliberate utilization, instead of mindless and destructive consumption" to protect and preserve the environment. It aims to encourage individuals and communities to adopt lifestyles that are in harmony with nature. India is the first country to include LiFE in its NDC. Lifestyle changes encompass shifts in demand, supply, and policy across end-use sectors which include about 30 actionable items in the energy and Agriculture, Forestry, and Other Land Use (AFOLU) sectors. In the DDS, these changes will impact emission reductions after 2035-2040, as it will take at least a decade for the policies to be scaled up and be implemented nationwide. These measures also align with the Sustainable Development Goals.

The following two examples illustrate lifestyle and behavioural changes that can be achieved by nudging individuals, communities and institutions to adopt simple, environment-friendly actions:

- sustainable food systems can be adopted by prioritizing locally available and seasonal foods, incorporating millets into diets through initiatives like those operated by Anganwadi[27] centres, midday meals, and public distribution schemes for food grains; or even creating kitchen gardens and terrace gardens at homes, schools or offices.
- energy conservation can be achieved by using public transport and carpooling wherever possible, setting air conditioning temperatures only 5 to 7 degrees below the outside temperature, and limiting domestic energy consumption.

26 https://www.niti.gov.in/sites/default/files/2022-11/Mission_LiFE_Brochure.pdf

27 Anganwadi is a type of rural child care centre in India. It was started by the Indian government in 1975. A typical Anganwadi centre provides basic health care in a village (contraception, nutrition education and pre-school activities).