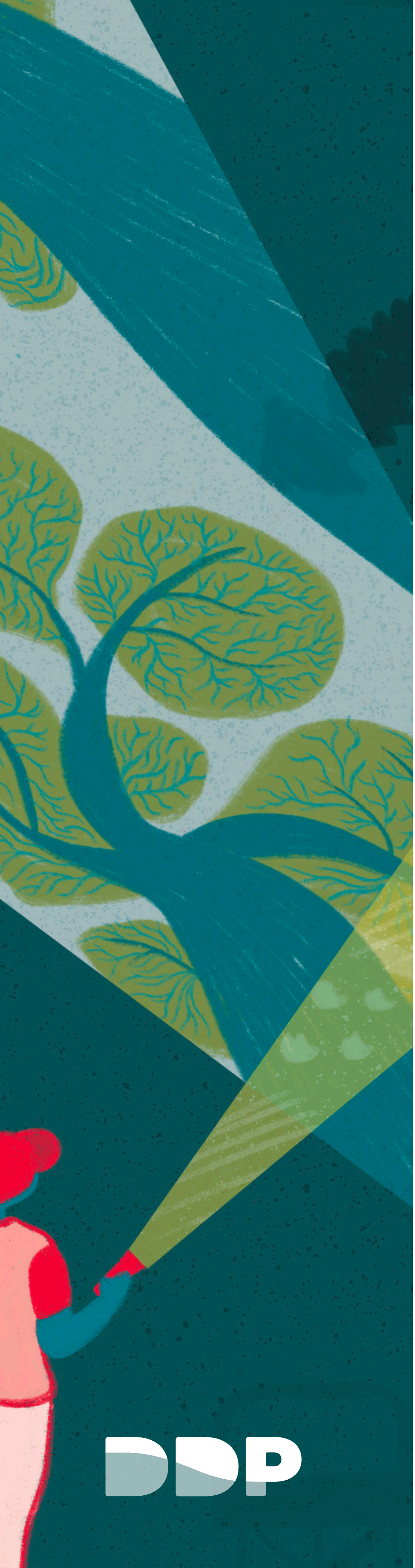

Immediate actions in
national pathways to net zero

ACCOMPANYING STRUCTURAL ECONOMIC AND INDUSTRIAL SHIFTS

National pathways to net zero entail structural changes in economic and industrial systems. Turning these transformational challenges into opportunities for development requires determined country-specific action at the national level but also a proactive search for partnerships and international cooperation

The global transition to net zero necessitates fundamental shifts in the economic system, driven by the decline of carbon-intensive activities and the concurrent emergence of new industries that provide the goods, technologies and services required for the low-carbon transition. The resulting structural changes in national economies will significantly impact employment, production assets, and trade.

In absence of dedicated actions, significant macroeconomic tensions may arise in national economies, particularly in the most carbon-intensive countries. These tensions can be linked to trade imbalances, especially for countries that are heavily reliant on fossil fuel export revenues today, or through deindustrialization. New dependencies could also emerge in accessing low-carbon technologies if local economies are unable to produce them domestically. However, the new global economy, transitioning towards carbon neutrality, can create opportunities for some countries to implement structural changes in their domestic industrial structure. These changes can simultaneously enhance local industrialization and promote decarbonization, as demonstrated in the case studies of Mexico, South Africa, Indonesia, and Nigeria where both added value and job creation have been observed. Maximizing these potential macroeconomic and industrial benefits while minimizing the risks of the transition will often depend on the adoption of adequate measures to direct investments towards green industrial and economic development. These measures should align domestic socio-economic development objectives with the broader context of global change. A diverse range of economic sectors could be involved depending on country circumstances and priorities, such as the mineral value chain industries (Case study - Indonesia), solar PV value chains and other renewable energy components (Case study - Mexico, Indonesia, South Africa, Argentina), chemical industries (Case study - Argentina), and the iron and steel industries (Case study - South Africa). To implement such industrialization and effectively guide investments, countries can adopt a variety of public policies suited to their specific national circumstances. These may include public procurement with local content requirements, subsidies, public loans, or importation bans and duties (Case study - South Africa, Indonesia and the United States).

However, these structural transformations and associated national policies can also generate tensions at the international level, potentially leading to fierce competition among States if they are adopted unilaterally. The risk is particularly acute in the current global context and could undermine both the effectiveness of domestic policy actions and the broader global transition. To avoid this situation, countries must design and implement their national policies in a context of continuous dialogue with other countries and the search for mutually beneficial partnerships. International cooperation, for example, is critical to making the transition away from fossil fuels economically feasible for fossil fuel-dependent countries like Nigeria (Case study - Nigeria). Furthermore, innovative approaches to international cooperation (DDP, 2023)[38] are key components of the steel decarbonization strategy in South Africa, which serves as a model for mutually beneficial outcomes for both the country and its international partners (e.g., Europe) provided that coordinated policy actions are taken (Case study - South Africa: Green steel).

38 https://ddpinitiative.org/ddp-annual-report-2023/

CASE STUDY – SOUTH AFRICA

Economy-wide effects of localizing renewable energy value chains

South Africa has a highly coal-dependent energy system, faces significant energy security challenges, and has an economy characterized by high levels of poverty, inequality, and joblessness. At the same time South Africa has vast renewable energy potential and has expressed its commitment to decarbonizing its energy system in a pathway aligned with the international goal of limiting warming to well below 2°C (i.e. a long-term net zero CO_2 emissions trajectory). Linking low-carbon technology deployment to broader development goals in South Africa is critical. The localization of renewable energy components is a potential strategy to mitigate the negative impacts (e.g., job losses in the coal sector) while simultaneously enhancing the benefits of a net zero transition in South Africa's coal dependent energy system. Utilizing the hybrid energy-economy model SATIMGE, we examined various localization levels as South Africa progresses towards decarbonization by 2050.

Findings show that all localization strategies yield positive economic impacts in the short term (up to 2030), without significantly affecting renewable energy capacity expansion. An ambitious target of 70% local production could create between 18,700 and 25,500 jobs and add R3.5 to R6 billion to GDP (approx. $0.20 billion to $0.34 billion). A moderate target of 55% local production could generate 11,200 to 12,800 jobs and boost GDP by R1.87 to R2.93 billion by 2030 (approx. $0.1 billion to $0.17 billion). Minimum values are reached when localization significantly impacts the final price of products (resulting in a high price premium), while maximum values are reached when no price premium is considered. In the long run by 2050, the effects of the ambitious localization target are expected to amplify as the economy transitions towards net zero, with increasing local production of sub-products potentially creating up to 254,400 jobs and a R69.7 billion increase in GDP (approx. $3.5 billion), assuming no price premium.

The effect of the price premium on local content is also expected to be amplified in the long-term. When the price premium is held at 40% up to 2050, the net gains from ambitious localization are reduced to 32,700 jobs and GDP (approx. $0.51 billion). This demonstrates that achieving carbon neutrality will require South Africa to implement industrial changes in the short term (by 2030) if the country aims to localize its renewable production. These industrial changes must occur in the short-term (by 2030), when price premiums effects are still low, allowing for the realization of economies of scale in the long-term. If localization is not anticipated and occurs rapidly only after 2030, then economies of scale may not be realized and a price premium could persist into 2050. The rising costs of renewable energy investment due to highly uncompetitive local content has the potential to offset most of the benefits of increased localization if local manufacturing fails to establish a competitive advantage in the long-term, despite the widespread deployment of renewables to reach net zero.

Localizing the manufacturing of renewable energy components in South Africa (specifically, the components that can be produced domestically) has the potential to boost the economy and create employment, particularly on a low emissions pathway. Reasearch from the University of Cape Town underscores the need for support mechanisms to build competitive advantage and support increased localization in the renewable energy component manufacturing sector. Strategies to achieve this could include increased public procurement with local content requirements, incentives such as special economic zones and subsidies, as well as import duties on renewable energy components.[39]

39 Tatham et al - 2024 - Assessing the economy-wide effect of localising renewable energy value chains in South Africa. (https://zivahub.uct.ac.za/articles/report/ESRG_Working_paper_-_Assessing_the_economy-wide_effect_of_localising_renewable_energy_value_chains_in_South_Africa/25867093?file=46459039)

CASE STUDY – US

Guiding structural industrial changes in the energy sector

The US has taken significant steps in this direction with the adoption of the Inflation Reduction Act (IRA) in 2022.[40]

For example, through IRA's Energy Infrastructure Reinvestment category, the Department of Energy has identified key characteristics of energy projects that align with the long-term energy transition. The act finances projects aimed at repurposing and replacing energy infrastructure that has ceased to operate due to the energy transition, providing $250 billion in loans to fund the construction of renewable energy facilities in regions where coal-fired power generation once took place. These projects are expected to create jobs and generate income for the local economy and communities affected by these closures. In addition, the IRA also offers bonuses for renewable energy projects developed in energy communities, provided that they meet certain wage and apprenticeship requirements.[41]

These subsidies, loans, and bonuses are essential for guiding economic investments towards the energy transition, and creating positive socioeconomic impacts to balance the negative ones associated with the decline of existing carbon-intensive activities.

CASE STUDY – MEXICO

Macroeconomic impacts of localizing solar panel value chains

In Mexico, solar power generation could play a critical role in the energy transition. Directing investments towards domestic solar panel production and related services can facilitate the national energy transition and create new jobs to mitigate declining employment in traditional fossil fuel industries.

According to modelling results published by the UN Economic Commission for Latin America and the Caribbean (ECLAC/CEPAL),[42] using a scenario comparable to the DDS, the potential increase in jobs due to the energy transition in Mexico is around 8%, while job losses would be approximately 6%, implying a net employment gain of 2%. Job creation benefits from the energy transition in Mexico are further supported by a study conducted by the US National Renewable Energy Laboratory (NREL)[43], which found that if Mexico were to implement large-scale renewable energy projects, it could create over 72,000 new jobs. In addition to creating jobs, this investment would also lead to lower electricity production costs and significant benefits for the national electricity system, including a reduction in greenhouse gas emissions and other pollutants that adversely affect public health.

Hence, total employment does not need to be a barrier to the structural shift and may even become a net beneficiary. However, changes in activity across different sectors will require policies dedicated to ensuring a just transition and guiding the relevant investments.

CASE STUDY – ARGENTINA

Pro-active industrial policies to unlock development opportunities linked to the global "carbon neutral" economy

For Argentina, achieving carbon neutrality while ensuring sustainable economic development requires a careful balance between short-term actions and long-term growth strategies. Short-term measures must not only avoid harming economic development but should also lay the foundation for Argentina to capitalize on the global shift toward a "carbon-neutral" economy. These processes should be guided by proactive industrial and macroeconomic policies designed to strengthen current initiatives and create conditions to unlock new opportunities.

Argentina possesses significant potential for renewable energy production, particularly in wind and solar, but to maximize this potential, it is essential to implement policies that encourage

40 https://www.energy.gov/lpo/inflation-reduction-act-2022
41 https://www.irs.gov/newsroom/irs-issues-guidance-for-energy-communities-and-the-bonus-credit-program-under-the-inflation-reduction-act
42 https://repositorio.cepal.org/server/api/core/bitstreams/e776cadf-97b2-409e-9a1f-4c7e9923c31f/content
43 https://www.nrel.gov/docs/fy22osti/82580.pdf

greater local value-added participation in production and supply chains. By integrating local industries into the global renewable energy value chain, Argentina can ensure that the benefits of the green transition are broadly distributed, driving domestic job creation and economic diversification.

Moreover, as highlighted by the National Secretariat for Strategic Issues (2023)[44] and GIZ (2024)[45], Argentina is well-positioned to develop its chemical industry (with strong local human resources) through power-to-X (P2X) conversion technologies that utilize its hydrogen potential and local CO_2 sources. These resources can be converted into more complex molecules, such as synthetic fuels (e.g. kerosene for aviation or methanol and ammonia for maritime transport), addressing decarbonization in hard-to-abate sectors. This same industrial capacity could also be harnessed to produce chemicals and fertilizers from sustainable sources, further supporting the country's transition to carbon neutrality.

By combining its renewable energy potential with advanced industrial policies, Argentina can ensure that its pathway to carbon neutrality is not only environmentally responsible but also a driver of long-term socioeconomic development.

CASE STUDY – INDONESIA

Downstreaming the Indonesian mineral industry

Indonesia is endowed with abundant mineral resources, including 16 billion tonnes of gold, 10.5 billion tonnes of silver, 7.7 billion tonnes of iron, 16 billion tonnes of copper, 17 billion tonnes of nickel, 6.6 billion tonnes of bauxite, 7.1 billion tonnes of tin, 1.3 billion tonnes of titanium, and 0.55 billion tonnes of quartz. Today, these resources are primarily extracted and sold directly to the export market, with only a limited amount being processed, refined and manufactured into intermediate or finished products by national industries.

In 2021, Indonesia published its long-term climate strategy to achieve net zero by 2060, while satisfying domestic socio-economic objectives. According to the analysis, development pathways to net zero will require a massive deployment of electric vehicles (EVs) and the electrification of energy devices combined with zero-carbon electricity generated from solar photovoltaic (PV) panels, among other solutions. This transition will therefore require a significant increase in the use of batteries and solar energy systems.

According to the analysis, the Indonesian mineral mining industry, combined with the development of modern smelters and processing and manufacturing industries for these minerals, could fulfil the national demand for batteries for EVs and solar panels for the decarbonization of the power system. For example, processing domestic silica sand into solar cells could support the development of local solar PV production.

This "downstreaming" of the mineral value chain has been supported by the Government of Indonesia since 2020. National policy, specifically Law No.3/2020, and its recent implementation through Regulation No.25/2024, officially bans the export of raw materials and provides several facilities and incentives for local companies to create downstream mineral industries. This government policy and strategy are expected to optimize the use of national resources and reduce the importation of critical green technologies, while at the same time increasing the value added of the battery industry by up to 64-fold and the value added of stainless steel production by as much as 9.5-fold, potentially creating hundreds of thousands jobs by 2045.

44 National Secretariat for Strategic Issues (2023). Estrategia Nacional para el Desarrollo de la Economía del Hidrógeno. https://www.argentina.gob.ar/sites/default/files/2023/07/estrategia_nacional_de_hidrogeno_-_sae.pdf

45 GIZ (2024). CO_2 sources for PtX production in Argentina. https://ptx-hub.org/wp-content/uploads/2024/05/International-PtX-Hub_202405_CO2-Sources-Argentina.pdf

CASE STUDY – NIGERIA

Macroeconomic outlooks of international aid on Nigeria's net zero futures

Over the past two decades, Nigeria's GDP growth has slowed, failing to return to the levels seen in the early 2000s despite recovering to pre-pandemic trends by 2021.[46] The Nigerian government projects a growth rate of 3.75% for 2023, contrasting with the World Bank's more conservative estimate of 2.9%, reflecting challenges such as high borrowing costs, underperformance in the non-oil sector, and declining oil production. Unemployment, particularly among the youth, remains a significant concern, peaking at 28.1% in 2019 (World Bank Data).[47]

With its economic structure and natural resources, Nigeria has a high energy intensity. Its unique position as both a crude oil-exporting and oil products-importing country (due to limited refining capacity) highlights the complex interplay between its energy sector and the macroeconomy.[48] As the 14th largest oil producer globally and the second in Africa,[49] Nigeria had an average daily production of 1.5 million barrels in 2021. It is also the third largest producer of natural gas in Africa, behind Algeria and Egypt, and ranks 17th worldwide.[50] The oil and gas sector, contributing approximately 7.3% of Nigeria's GDP and 55% of its trade balance in 2022, underscores the economy's dependency on this sector.[51]

The transition away from the oil and gas sector will significantly impact Nigeria's economic structure and industry. The DDS assumes that the trade deficit will gradually converge to -1% in 2035, down from its observed level of -3.5% in 2021, and then remain constant until 2060 (the net zero year). Such a current account constraint in the context of declining oil and gas export capacity would significantly hinder the growth of the Nigerian economy. To counter this detrimental trend, a scenario was developed within a more favorable macroeconomic context.[52] The scenario suggests a positive non-price competitiveness (trade) shock corresponding to successful economic diversification. The trade shock applies to all scenarios, although the DDS benefits from a more relaxed trade deficit objective. The additional trade deficit permitted for the DDS corresponds to the differential in energy supply investment between the DDS and the CPS. This assumption aims to convey the implicit conditional nature of the net zero emissions target of the DDS on international aid.[53]

The modelling results suggest that emission reductions under the DDS are achievable with a GDP loss of 3.5% and employment losses of 3.2% in 2060, compared to the current oil and gas-based economy. However, by complementing the DDS with international aid, the gap between the energy supply investment requirements of the CPS and DDS can be bridged, allowing GDP and employment performances to align with those of a gas based-economy while reducing emissions to a residual 16 million tonnes of CO_2 equivalent ($MtCO_2eq$) in 2060. Conditional to international aid amounting to $880 billion (2021 value) over 39 years—amounting to an average of 1.1% of Nigerian GDP from 2022 to 2060—Nigeria may be tempted to shift from the shortsighted development path of a gas economy towards a transition towards a net zero, energy-sustainable economy. The international aid will help support sustainable investment (e.g. renewable energy, electrified transport infrastructure and the decarbonization of industries) to diversify Nigeria's economy.

46 The Nigerian Observer, 2023. World Bank projects Nigeria's economy to decelerate to 2.9% in 2023. https://nigerianobservernews.com/2023/01/world-bank-projects-nigerias-economy-to-decelerate-to-2-9-in-2023/ (accessed 20 February 2022)
47 The World Bank's World Development Indicators.
48 OPEC (2021) Nigeria facts and figures, Annual Statistical Bulletin. Available at: https://www.opec.org/opec_web/en/about_us/167.htm
49 Annual petroleum and other liquids production, U.S. Energy Information Administration. Retrieved 15 April 2022.
50 CIA. The World Factbook. Natural gas – production.
51 Central Bank of Nigeria, 2022a. External Sector Statistics. Cent. Bank Niger. Annu. Stat. Bull. https://www.cbn.gov.ng/documents/statbulletin.asp.
52 The procedure amounts to exogenously ameliorating the Baseline, also known as 'central account' by macroeconomists. The absolute characteristics of the central account are commonly considered as having virtually no impact on scenario comparison.
53 The trade deficit gradually decreases from 3.5% of GDP in 2021 to 1% in 2035 and beyond in all scenarios except RES+, in which the trade balance deficit is relaxed.

CASE STUDY – SOUTH AFRICA

National and international perspectives on green steel, as an opportunity to decarbonize the steel sector while supporting domestic industrialization

South Africa needs to develop, and its steel industry is an essential component of the country's economic future. The pace at which green steel production processes are advancing is rapid – green steel was seen as impossible, and the sector was regarded as 'hard to abate' as recently as 2018. Now almost every major steel producer in the world is engaged in green steel projects and R&D. This pace will continue, if not accelerate, as pressure mounts on countries to decarbonize, and international trade mechanisms are introduced to penalize fossil-based producers (as currently being attempted by the EU's Carbon Border Adjustment Mechanism (CBAM)).

The cost for green steel technology is expected to continue declining. However, the main driver of production costs is the energy source, and South Africa is among the leading countries in terms of renewable energy resources. This positions South Africa favourably in terms of pricing for green steel production, making it one of the most cost-effective options for export to the international market. As green steel export facilities are established in South Africa, the ability to produce effectively for the local market will increase over time.

The DDS scenario for South Africa shows that the development of the green steel industry can be an efficient approach to achieve domestic decarbonization while simultaneously supporting effective industrialization with all its developmental benefits. However, for this to succeed, South Africa will need policies to promote industrial competitiveness of local green steel production to both capitalize on South Africa's comparative advantage in making green steel for export, while also to ensure that local green steel production is cost effective compared to cheap fossil-based steel imports.

However, there is also a critical dimension of international cooperation to consider. Current policies in many developed economies, including the European Union and the United States, may inadvertently hinder this potential. By heavily subsidizing domestic green steel production, these nations risk preventing African countries from capitalizing on crucial opportunity for green industrialization, while also potentially compromising their own energy security. The economic and security rationale for this approach is questionable. Developed nations aiming to produce green steel domestically will need to import both iron ore and green hydrogen. This is particularly challenging for the EU, which faces a significant deficit in the renewable energy capacity required for green hydrogen production.

An alternative, more globally efficient and secure approach would involve developed economies promoting Hot Direct Reduced Iron (HDRI) production in the most suitable locations, including African countries rich in both iron ore and renewable energy potential. This strategy offers multiple benefits:

- Economic Efficiency: It would reduce the overall cost of green steel production, enhancing the economic viability of the global transition to low-carbon steel.
- Enhanced Energy Security: By diversifying the locations of primary iron production and relying on easily transportable and storable Hot Briquetted Iron (HBI) instead of volatile hydrogen imports, this approach could significantly improve energy security for developed nations.
- Accelerated Decarbonization: Leveraging the most efficient production locations could expedite the global transition to green steel.
- Development and Industrialization Opportunities: This would provide African nations with a chance to leapfrog into green industrialization, supporting economic growth, job creation, and the development of industrial ecosystems.
- Supply Chain Resilience: A more distributed production network would enhance the resilience of global steel supply chains, reducing vulnerability to regional disruptions.
- Climate Justice: This approach would align climate action with development goals, addressing long-standing economic inequities.

Critics may argue that this approach poses a risk to employment in developed economies. However, it is important to note that the steel industry is rapidly automating, and the number of jobs in primary iron production is relatively small. Furthermore, by fostering a more competitive downstream steel industry and related manufacturing sectors, this approach could potentially increase overall employment in developed nations. The challenge now lies in creating policies that support green industrialization in developing nations while also enhancing global energy security. This could involve redirecting a portion of the funds currently earmarked for domestic subsidies to support the development of green iron capabilities in African nations. It might also entail creating preferential trade agreements for green HBI imports or establishing joint investment funds for HDRI projects in Africa.