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Inclusive Industrial Decarbonisation Policies to Effectively Integrate Energy, Climate, and Development Goals in Emerging and Developing Economies

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Abstract

Industrial decarbonisation is a critical pillar of the global energy transition, accounting for 37% of total final energy use and one-third of global greenhouse gas (GHG) emissions. Reframing heavy industries from “hard-to-abate” to “priority-to-abate” is essential to accelerate progress in energy efficiency, renewable energy, hydrogen, and carbon capture. For developing economies in Sub-Saharan Africa, Asia, and Small Island Developing States (SIDS), this represents an opportunity to leapfrog towards green industrialisation by adopting scalable low-carbon technologies and localising value chains. This paper highlights the strategic importance of industrial decarbonisation, outlines pathways for sustainable industrial growth, and proposes a global partnership framework enabling inclusive and equitable green transformation across emerging economies.

1 Trends in industrial emissions

Historical trends indicate that industrial emissions have grown steadily since 1990, albeit at a slower pace than in sectors such as electricity, heat production, and transportation, as shown in Figure 1. Driven by rapid industrialisation and global economic integration, the demand for materials such as steel, cement, chemicals, textiles, food and beverages, and pulp and paper has expanded significantly, resulting in a threefold increase in industrial GHG emissions since 1990. Industrial emissions are increasing faster than those in any other primary sector. Between 1990 and 2020, global emissions from heavy industry rose by nearly 70% (Verdolini et al., 2023).

Over the same period, global gross domestic product (GDP) per capita has more than doubled, rising from approximately USD 7,000 in 1990 to over USD 16,000 in 2022 as shown in Figure 2. This parallel growth underscores the strong linkage between industrial output and economic development, highlighting the sector's dual role as both a driver of prosperity and a source of emissions. Advanced economies have gradually decoupled economic growth from emissions through efficiency gains and structural shifts toward value-added manufacturing and services. At the same time, emissions in emerging economies have surged as heavy industries relocated from advanced economies. Cement and steel emissions alone have multiplied two to three times since 1990, particularly in Asia and Africa, while in advanced economies, emissions have stabilised or declined.

Emerging economies, such as China (1.23 gigatonnes of carbon dioxide equivalent ($GtCO_2e$) industrial emissions in 2021), India (178.61 million tonnes of carbon dioxide equivalent ($MtCO_2e$) in 2021), and Brazil (37.35 $MtCO_2e$ in 2021) (Climate Watch, 2025), are now driving the bulk of emissions growth, fuelled by rapid urbanisation and

Figure 1 CO_2 Emissions by Sector (1990-2021)

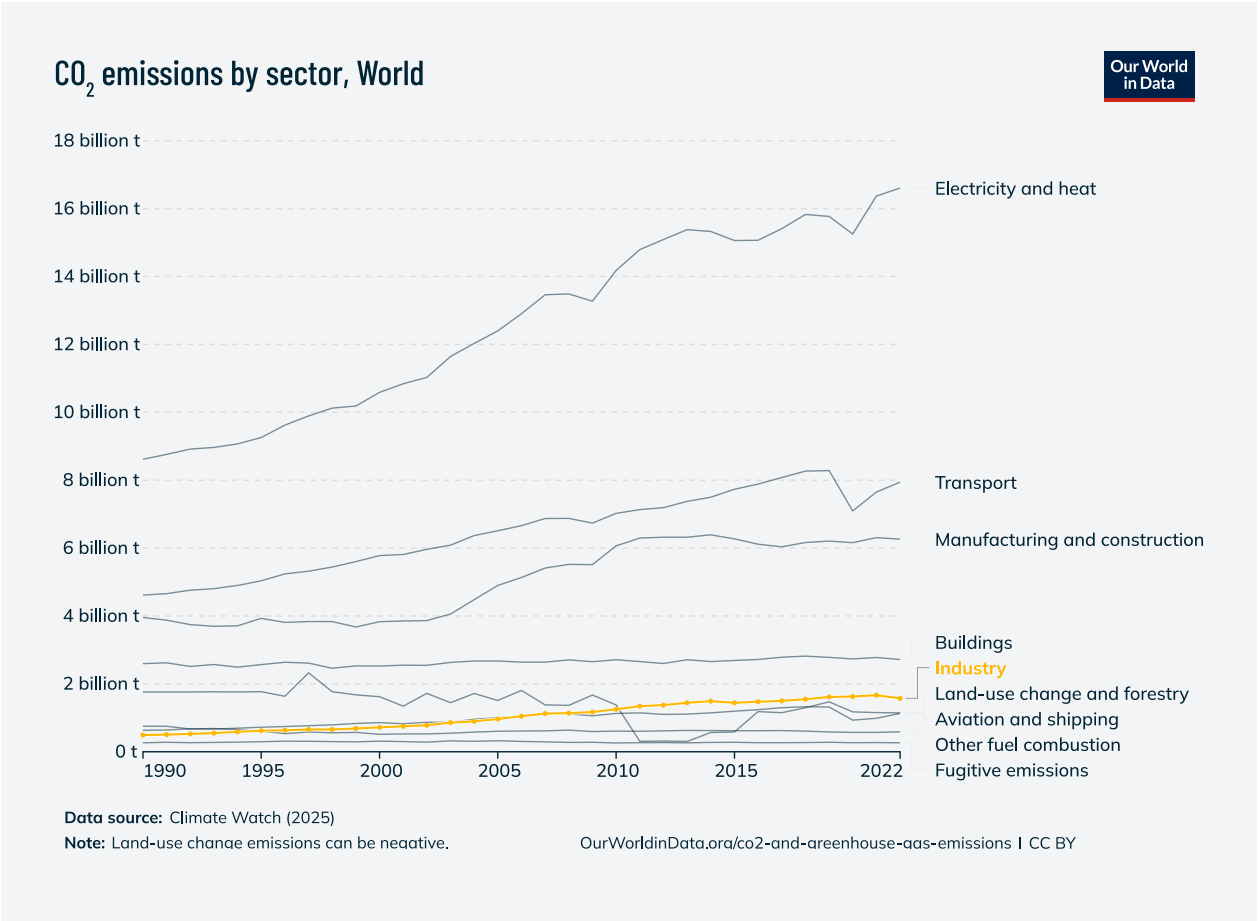
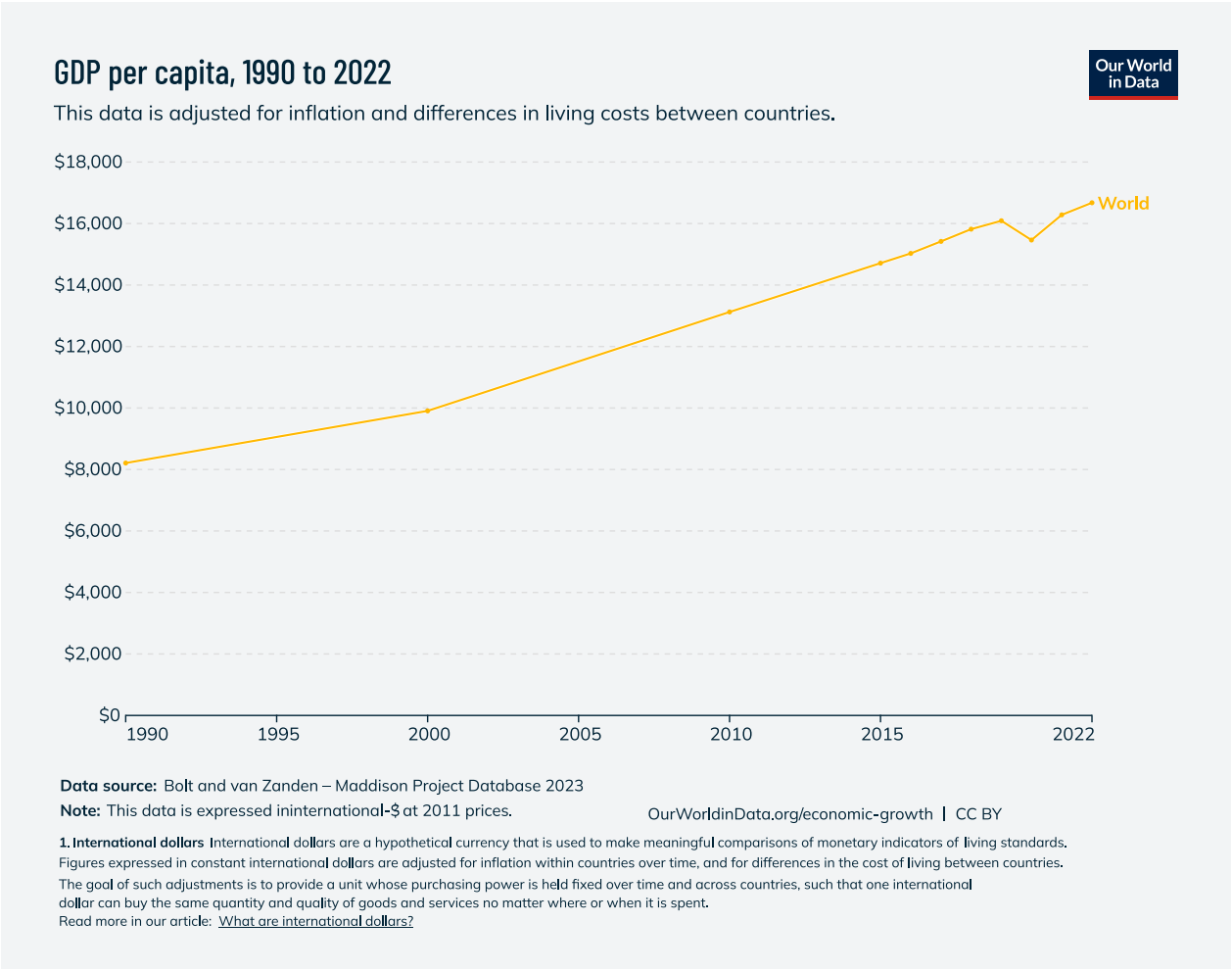


Figure 2 GDP per Capita (1990-2022)



infrastructure expansion. Developing and least developed economies contribute far less to absolute terms but often exhibit higher emission intensities due to outdated technologies and limited access to low-carbon alternatives. This divergence highlights the core challenge of aligning industrial growth with decarbonisation.

In Sub-Saharan Africa, energy efficiency improvements and electrification with renewables—often through captive generation—represent cost-effective pathways to power light industries, overcome unreliable grid access, and establish a competitive industrial base. The persistence of the emissions–growth link makes clear that achieving rising prosperity while lowering carbon intensity will require innovation, strong policy support, and the widespread deployment of low-carbon solutions. This trend highlights the uneven distribution of industrial emissions: relocating production does not alleviate the global environmental burden, and vulnerable populations often bear the brunt of these impacts.

Framing a global partnership architecture for industrial decarbonisation cannot be viewed solely through an emissions lens. The interventions in energy efficiency and the electrification of industrial processes with renewable energy also serve as a fulcrum for industries to become cost-competitive in the future. In Sub-Saharan African countries, the adoption of captive generation with renewable energy is a cost-effective means of powering commerce and light industries, laying the groundwork for an industrialised economy by overcoming the lack of access to or the unreliability of grid electricity. The persistence of this link highlights the challenge of achieving rising prosperity worldwide while reducing industrial carbon intensity through innovation, policy support, and the widespread adoption of low-carbon solutions.

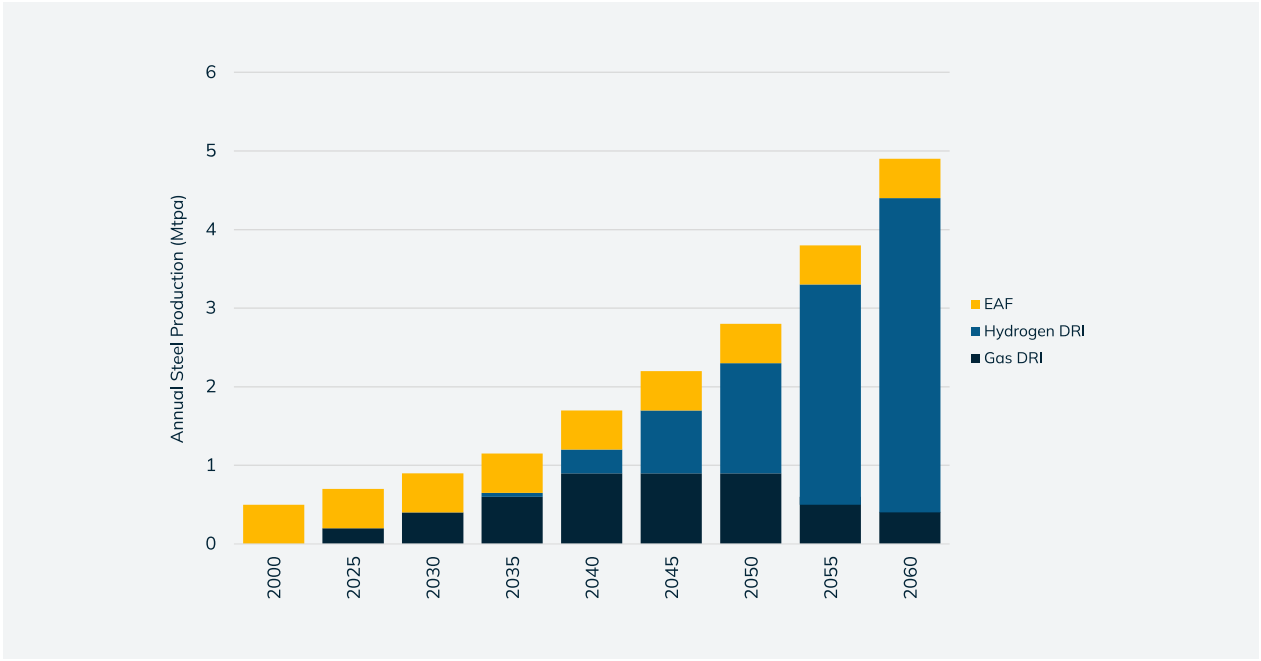
2 Policy and technology bottlenecks

Emission reductions in hard-to-abate industries such as cement, steel, chemicals, and aluminium will hinge on rapid technology scale-up and significant reductions in capital costs. As electricity will increasingly be generated from renewable sources, hydrogen—both as a fuel and a feedstock, especially in electric arc furnaces—and carbon capture, utilisation and storage (CCUS) are among the technologies that need rapid scaling. At the same time, efficiency improvements in industrial motors, boilers and drives remain indispensable. While breakthrough technologies such as hydrogen steelmaking and electric arc furnaces dominate discussions, incremental improvements in high-efficiency motors, variable-speed drives and advanced boilers can deliver substantial near-term emission reductions. For Emerging Markets and Developing Economies (EMDEs), where industrial infrastructure is still being built or modernised, integrating the best available technologies from the outset can prevent decades of inefficiency and lock-in to high-emissions systems. Combined with clean electricity and low-carbon fuels, these measures enhance industrial resilience, reduce costs and strengthen global competitiveness.

Nevertheless, many transformative technologies remain nascent, expensive and concentrated in a handful of countries, leaving developing economies with limited access. The pace of technology transfer and diffusion has been insufficient, widening the gap between advanced economies, which can deploy breakthrough solutions and emerging regions at risk of long-term dependence on carbon-intensive production. Addressing this disparity requires stronger international cooperation, open frameworks for technology sharing and innovative financing mechanisms, such as concessional lending and blended finance, to lower adoption barriers.

For example, as per the Ghana Energy Transition and Investment Plan[1], the nation's steel sector could grow significantly from its current base to about 5 Mt per annum by 2060 with expansion into virgin steel production from the current scrap steel mix. Hydrogen-based Direct Reduced Iron (DRI) and Electric Arc Furnaces (EAF) would play a key role to ensure the sector's net-zero contribution to the national commitment. The capital cost to transitioning this sector alone is expected to be about USD 1.5 billion and majority of it hinges on technology transfer.

Figure 3 Ghana Steel Sector Transition, Ghana Energy Transition & Investment Plan



[1] Ghana Energy Transition & Investment Plan was support by SEforALL

This challenge is evident even in China, where the steel sector accounts for over 15% of national CO_2 emissions. To meet its 2025 pledges, the government must reduce coal-based steel output by 90 $MtCO_2e$ (Reuters, 2025). A shift from blast furnace–basic oxygen furnace (BF-BOF) to EAF systems could reduce emissions by over 160 $MtCO_2e$; yet, the EAF share of production remains below 12%, significantly lower than the global average of 30% (LBNL, 2023). In India, the industrial sector accounts for more than one-third of total emissions, with cement, steel, and fertilisers among the most significant untapped opportunities for mitigation (IEA, 2025). Bridging these gaps will require scaling up finance, strengthening technology transfer, harmonising industrial standards and aligning policy frameworks to support green industrial growth. Industrial decarbonisation, therefore, sits at the intersection of climate mitigation, energy transition and economic development; its success will be decisive in achieving global net-zero ambitions.

3 Choices that developing economies make matter for industrial decarbonisation

The scale and speed at which EMDEs transform their existing and future industries into low-carbon emitting assets will be essential to climate-proofing and ensuring no roll-back of the gains achieved in industrial decarbonisation. Industrial demand in developing economies is projected to grow rapidly due to urbanisation, infrastructure development and increasing domestic and export needs. Without clean-tech shifts, these countries would continue to rely on conventional, fossil-fuel-intensive pathways in heavy industry. They would carry the bulk of new industrial emissions, increasing their share in industrial emissions from today's 5-10% to 25-30% in the next 30-40 years (Vashold, 2024). In such a scenario, even deep emission reductions achieved in advanced economies would not be sufficient to offset the continued carbon-intensive industrialisation in developing countries.

Industrial decarbonisation is a business opportunity for developing countries. Investing in low-carbon cement, hydrogen-based steelmaking and circular material flows helps prevent stranded assets and reduces the long-term costs of transitioning away from fossil fuels. Leapfrogging directly into sustainable technologies and production methods can enhance competitiveness in international markets, for instance, where the carbon border adjustment mechanism (CBAM) would make carbon-intensive commodities more challenging to export to the European Union (EU). Building localised value chains around green industrial production strengthens economic resilience, creates high-quality jobs and reduces reliance on volatile fossil fuel imports. These leapfrog opportunities are already being leveraged, demonstrating that emerging economies are reaping the benefits of such strategic choices. For example, India has 50% of its installed power capacity from renewables, five years ahead of the 2030 milestone (Govt. of India, 2025). The creation of green hydrogen corridors and renewable-powered industrial parks (such as those in Tamil Nadu and Gujarat) reflects an emerging integration of energy and industrial planning (Mission Possible Partnership, 2025). In another instance, Indonesia's nickel smelters in Sulawesi are increasingly powered by hydropower. In Malaysia, the Sarawak Corridor of Renewable Energy (SCORE) has combined clean electricity with industrial zoning to attract over USD 27 billion in investment and generated more than 17,000 jobs since its inception in 2010 (Sarawak Energy, 2024). These examples illustrate the potential of cluster-based models, where energy supply, industrial demand and infrastructure planning are coordinated both spatially and financially. This calls for developing countries to approach their energy and industrial planning in an integrated manner.

We must make access to key technologies easier for developing countries to address significant industrial decarbonisation challenges. The successful decarbonisation of industries in developing economies depends on access to a set of critical technologies, including high-temperature EAFs, low- and medium-temperature

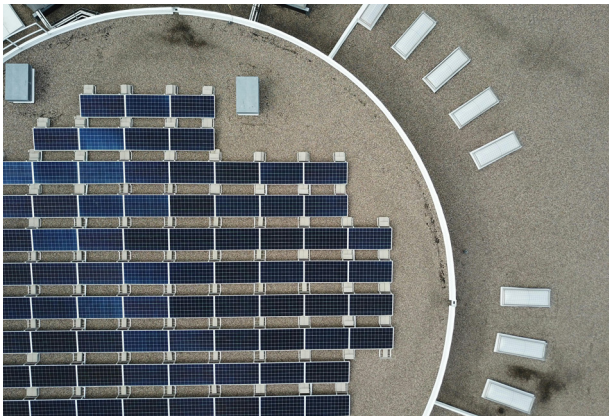
heat pumps, super-efficient industrial motors and compressors, electrolysers, short- and long-term energy storage and advanced biofuels. These technologies remain expensive, are often demonstrated only in advanced economies and require specialised expertise that is not always available locally. To close this gap, international cooperation on technology transfer and capacity building will be vital. Equally important are innovative financing mechanisms, including concessional lending, blended finance and green bonds, that can lower the cost of adopting these solutions.

Supportive policy frameworks, including industrial decarbonisation roadmaps, performance standards and targeted incentives, can further accelerate the transition and ensure the deployment of clean technologies on a large scale. The technology transfer and financing architecture must be just and inclusive. The focus must be on institutional strengthening and enabling strategic use of public finance. Less than 20% of clean energy investment reaches developing economies, according to the IEA (2021). Mechanisms such as concessional loans, blended finance and sovereign green bonds can de-risk private capital. Recent announcements from the Climate Investment Funds (USD 12.5 billion in 2024) and Just Energy Transition Partnerships (JETPs) for South Africa and Indonesia provide instructive templates. These global developments are summarised in Table 1, which outlines major industrial decarbonisation financing mechanisms and policy instruments announced across key regions.

Table 1 Major Announcements on Industrial Decarbonisation Financing Support[2]

REGION	PROGRAM/INITIATIVE	AMOUNT	INSTRUMENT
Australia	Powering the Regions Fund - Safeguard Transformation Stream (Australian Govt., 2024)	600M AUD (300M AUD Round 1)	Grants
	Powering the Regions Fund - Industrial Transformation Stream (AREA, 2024)	400M AUD envelope	Grants (via ARENA)
EU	Innovation Fund 2025 awards (European Commission - Climate Action, 2025)	4.2B EUR	Grants
	European Hydrogen Bank (1st auction) (European Commission – Press Corner 1, 2024)	720M EUR	Contracts for Difference
	IPCEI Hy2Infra (European Commission – Press Corner 2, 2024)	up to 6.9B EUR	State aid for H2 infrastructure
Germany	Klimaschutzverträge (Carbon Contracts for Difference) first auction (BMWK, 2024)	maximum 2.8B EUR	CCfDs
	tkH2Steel Duisburg (European Commission – Press Corner, 2024)	2B EUR	State aid grant
India	SIGHT Scheme (Tranche-I) (Govt. of India, 2025)	130B INR for H2, 130 B INR for electrolysers	Offtake support + capex incentives
The Netherlands	Porthos CCS (Porthos CO2, 2023)	1.3B EUR	Shared CCS infrastructure
Spain	PERTE Descarbonización Industrial (MIT, 2024)	3.17B EUR (public) mobilising 11.8B EUR	Grants + loans
	PERTE Línea First Awards (La Moncloa, 2024)	97.5M EUR (to 14 projects)	Grants
Sweden	H2 Green Steel Boden (H2 Green Steel, 2024)	4.5B EUR debt and 300M EUR equity	Mixed private/public finance
UK	CCUS Track-2 clusters (Acorn & Viking) (UK Govt. - DESNZ, 2024)	200M GBP (Acorn + Viking)	CCUS cluster funding
	CCUS overall commitment (UK Govt. – HMT, 2024)	21.7B GBP for 25 years	Long-term support envelope
USA	DOE Industrial Demonstrations Program (US-OCED, 2024)	up to 6B USD	Grants
	48C Advanced Energy Project Credit (Round 1) (USD-DoE, 2024)	4B USD	Tax credits

[2] Non-exhaustive



Many of these initiatives build on frameworks highlighted in the Policy Toolbox for Industrial Decarbonisation (IEA, 2024) and the Climate Club Financial Toolkit (OECD, 2024), which provide detailed guidance on policy coordination, financing structures and international collaboration for industrial transformation.

4 Strategic opportunities for green industrialisation in the Global South

Industrialisation is a key priority for developing countries to create jobs and advance economic transformation. With the growing demand for industrial products, increasing ambition to reduce commodity dependence and build local production capabilities, the industry will emerge as a key driver of energy use and emissions. In Africa, 83% of countries remain commodity-dependent, with export earnings largely reliant on primary commodities (UNCTAD, 2022). This persistent reliance limits opportunities for value addition and exposes economies to price volatility in global markets. Reconciling industrialisation priorities with climate imperatives in the Global South will require strong partnerships with the Global North to enable the flow of clean technology, investments, and know-how.

Localising value chains constitutes a cornerstone of this transformation. Currently, the structure of Sub-Saharan Africa's participation in global value chains is dominated by the export of primary products rather than the import of intermediate goods for further upgrading and re-export (Abreha et al., 2021). Between 2022 and 2024, Africa imported over USD 12 billion in solar PV modules, lithium-ion batteries, and assembled electric vehicles (UN Comtrade Database), underscoring the significant economic leakage associated with limited regional manufacturing. Building domestic manufacturing capacities for renewable energy technologies, energy storage and clean industrial equipment enables developing countries to capture more value along the supply chain, rather than remaining solely exporters of raw minerals. This is particularly relevant given that the continent holds around 30% of the world's known mineral reserves, including cobalt, lithium and nickel, critical inputs for the global clean energy transition (UNECA, 2024).

Recognising this potential, several resource-rich countries are pursuing greater local beneficiation of minerals and developing manufacturing ecosystems that enable deeper backward integration. Regional initiatives such as the United Nations Secretary-General's Panel on Critical Energy Transition Minerals and the Africa Green Minerals Strategy (AGMS) underscore the importance of using Africa's mineral wealth to drive domestic value addition, job creation and regional industrialisation. The AGMS outlines four pillars: mineral development, human and technological capability, supply chain development, and mineral stewardship; forming a strategic blueprint to transform resource endowments into long-term industrial competitiveness (African Union, 2025).

Research by the OECD (2023) and UNIDO (2022) underscores the critical importance of localised supply chains for renewable energy and clean technology components. Africa's sizeable deposits of lithium, cobalt and rare earths present an opportunity to develop domestic battery manufacturing industries, reducing dependency on volatile global raw material markets and fostering indigenous technological capabilities. South Africa, for instance, is actively developing green hydrogen hubs, including the Boegoebaai Green Hydrogen Cluster in the Northern Cape (Mining Weekly, 2024) and the Coega Green Ammonia project (Hive Energy, 2025), both of which are tied to industrial parks to leverage renewable energy resources and decarbonise domestic industries, ultimately facilitating the export of low-carbon finished goods.

Similarly, Latin America's green hydrogen initiatives in Chile and Brazil are designed not only to scale production but also to create jobs and advance broader industrial strategies that diversify economies away from their traditional resource bases. These efforts exemplify how green industrialisation strategies can simultaneously address climate goals and promote inclusive economic development.

To unlock these opportunities, developing economies must prioritise the development of enabling policy frameworks. This includes aligning industrial policies, energy planning, mining strategies and skilling, research, and development efforts to create synergies across sectors. Innovative financing mechanisms, concessional funding and public-private partnerships play vital roles in derisking investments and accelerating the deployment of green technologies. Supply-side support could also include grants for capital equipment or preferential financing for firms meeting local content and skills development criteria. A relevant example is the Brazilian Development Bank's (BNDES) lending model for wind energy under the Programme of Incentives for Alternative Electricity Sources (PROINFA), which successfully tied financing conditions to local manufacturing and workforce development (SEforALL, 2025). Complementary measures, such as technology transfer, skill development and institutional strengthening, can ensure that gains from green industrialisation are sustainable and widely shared.

To conclude, industrial decarbonisation cannot occur in isolation in developing countries, it must align with broader development goals such as employment, poverty reduction and trade competitiveness. A coordinated global partnership, anchored in clean technology transfer, investment and fair trade, would not only accelerate these outcomes but also advance the strategic interests of advanced economies by enhancing supply chain resilience and supporting a just and inclusive global energy transition.

5 A Global Partnership Framework for Industrial Decarbonisation

Achieving rapid and inclusive industrial decarbonisation will require coordinated international action that transcends the limitations of individual countries and institutions. A global partnership framework for industrial decarbonisation can serve as a unifying architecture to align stakeholders, accelerate the deployment of clean technologies and ensure that the transition remains equitable. Such a framework must be rooted in mutual accountability, structured cooperation and recognition of the differentiated capacities and development priorities of participating countries.

This partnership framework needs to involve a broad coalition of actors. National governments, particularly EMDEs, must be central to shaping priorities, ensuring that the framework responds to domestic industrialisation goals and development pathways. Advanced economies have a critical role in providing access to finance, technology and markets. Multilateral agencies and regional development banks can serve as technical enablers and policy conveners. For instance, SEforALL-led initiatives such as Mission Efficiency (Mission Efficiency, 2025), Green Industrialization Hub (Green

Industrialization Hub, 2025) and Energy Transition and Investment Plans (ETIP, 2025) could be leveraged to provide enabling frameworks for EMDEs to be ready to participate in this framework. It is important that the collaboration framework and its steering have an equal voice among advanced and developing economies. The private sector, including industrial technology providers, off-takers and financial institutions, must also be engaged to scale up investments and facilitate market access for low-carbon industrial products. Finally, academic institutions and civil society organisations can support innovation, monitoring and knowledge dissemination.

The framework could be structured around four priority pillars. The first is technology transfer and co-development, which would facilitate access to critical industrial decarbonisation technologies, such as EAFs, low-temperature heat pumps, hydrogen electrolysers, and advanced energy storage. Some of these technologies are currently deployed mainly in high-income countries, creating a global diffusion gap. Addressing intellectual property barriers, enabling policies and regulations, enhancing local manufacturing capabilities, supporting joint research and demonstration projects will be essential.

The second pillar is finance mobilisation and de-risking. Despite significant capital needs for industrial transformation, only a small share of global climate finance reaches developing economies. The framework should enable concessional finance, sovereign guarantees and blended capital instruments that reduce investment risks and improve the bankability of clean industrial projects. Instruments such as carbon contracts for difference (CCfDs), green public procurement and performance-linked incentives can provide market certainty for investors and firms in low-carbon industrial sectors.

A third pillar must focus on policy alignment and regulatory cooperation. The framework should support countries in developing national industrial decarbonisation strategies that are aligned with

development plans, energy access and transition targets, localisation and trade competitiveness. Harmonisation of emissions accounting standards, carbon intensity benchmarks and environmental product declarations will be key to ensuring compatibility across markets. This is particularly relevant in light of emerging CBAMs, which must be designed to avoid penalising developing countries and instead offer pathways for participation.

The fourth pillar is capacity building and institutional development. The transition to the green industry will require significant upgrades in planning institutions, technical knowledge and workforce skills. A coordinated framework can support training programmes, university-industry partnerships and regional/national centres of excellence focused on industrial energy planning, industrial energy efficiency, clean manufacturing and sustainable value chain design.

With the four pillars, the Climate Club can serve a catalytic role in global architecture. Launched initially by Germany during its G7 presidency, the Climate Club aims to align international efforts on industrial decarbonisation and prevent carbon leakage. Today, the Climate Club has 46 member governments across the globe representing both developed economies and EMDEs and is uniquely positioned to offer a governance platform for the global partnership framework on industrial decarbonisation. It could promote transparency by supporting common emissions accounting methodologies and providing a forum for aligning standards. Crucially, the Club could connect the implementation of CBAMs in advanced economies with financial and technical support mechanisms for developing economies, thus enabling fair participation in global green value chains.

By institutionalising cooperation across these pillars, the global partnership framework can help shift industrial decarbonisation from a fragmented effort to a coordinated global transformation. It would reflect the shared responsibility of all countries to meet climate goals while acknowledging the unequal capacities and resources available to them. It would also enable emerging economies to transform industrialisation into a development pathway that is not only low carbon but also resilient, inclusive and competitive.

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