NDC ASPECTS

Country fiche

Two international sectoral developments affecting options for South Africa's next NDC

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Introduction and overview

As part of the NDC-Aspects project, country partners have produced a country *fiche*, which has the objective of gathering insights emerging from scenario development, relevant to design the next round of NDCs. This brief provides key lessons on (1) long-term transformations, (2) key short term actions to be taken, and (3) insights into cooperation needs to operationalize these transformations. Insights arise out of scenarios developed as part of NDC Aspects and other recent scenario work.

This country *fiche* is targeted at national policymakers.

The NDC-Aspects project explored the logic that powerful emission reduction trends in key sectors transcend national boundaries, and that founded knowledge of such trends may enable national governments to be more ambitious in setting their next NDC targets. NDC-Aspects explored trends in heavy industry, transportation, buildings and agriculture, forestry and land use (AFOLU). This South African country *fiche* analyses trends and scenarios in industry and transportation.

In particular, economy-wide modelling using ESRG's SATIM-GE model was used to study effects of an accelerating **electrification of transport** and new possibilities for earlier decarbonisation in the **steel sector** arising out of rapid recent advances in hydrogen-direct reduction.

Long-term perspective : key transformations to reach carbon neutrality

South Africa's economy remains highly reliant on coal for energy, primarily in electricity generation, for synthetic liquid fuels production, and in industry. The majority of South Africa's GHG emissions are in the energy sector (78%) and mostly from electricity generation (45.5% overall). Owing to a stagnant economy over the last 10 years or more, coupled with an energy crisis in power generation, emissions have trended either flat or on a slight downward path in recent years. This stagnant economy has exacerbated the unemployment crisis in the country, having increased steadily to 32.9% in Q1 of 2024, and disproportionately affecting youth.

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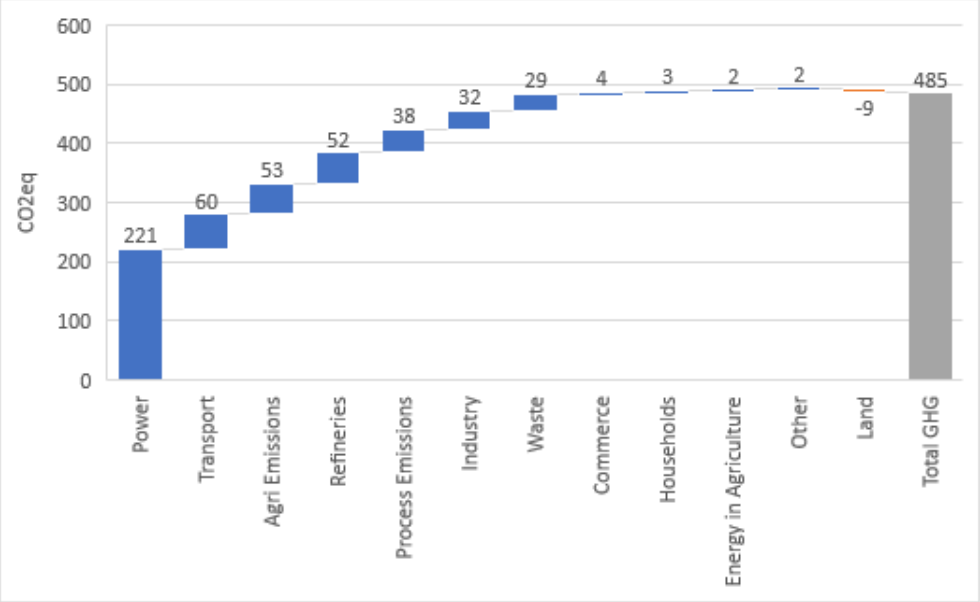

Figure 1: GHG emissions in South Africa in 2019 by sector

The primary transformation for South Africa in long term decarbonization is a transition in the power sector,. This transition is primarily a domestic policy matter and outside the global sector scope of the NDC-Aspects project. It is mentioned here to set the scene. The electricity system will need to transition away from coal power generation to renewable energy electricity generation with solar PV and wind technologies. South Africa's grid is highly carbon intensive because of the large coal power station fleet powering the grid. However, these plants are mostly old with many nearing their end of life. At the same time, South Africa is blessed with renewable energy resources – amongst the best in the world. A transition to renewable electricity generation with solar and wind technologies is economical and will drastically lower the country's emissions.

This transformation of the power grid to renewable electricity generation is central to the decarbonization of the rest of the country: it will enable the other sectors to decarbonize by allowing them to fuel-switch to clean electricity.

The second transformation in South Africa is the **transition to electric vehicles (EVs) in transportation.** A future decarbonized South Africa will likely deploy EVs for both goods and passenger transport, private as well as public. The transition to a lower carbon transportation system in South Africa should also include modal shifting: improving the public transportation systems in buses, minibuses and rail, in an effort to improve efficiency of the transport system, as well as lower costs for those unable to afford private motor vehicles. The global ascent of 2- and 3-wheeler light electric vehicles (LEVs) is a trend studied in the NDC-Aspects project that may enable significant emission reductions coupled with economic productivity gains. The transition to electric vehicles will also impact the carbon-intensive fuel supply chain – not only for the 4 traditional petroleum refineries (of which 2 are currently closed), but also for the globally unique coal-to-liquids (and chemicals) facility in Secunda, which is a highly carbon-intensive process.

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Critically, the EV transition is driven by powerful trends in the global automotive sector. The speed at which it occurs and at which EV prices decrease (e.g. through continued advances in battery technology) has been recognized to be a critical determinant of future prices of petroleum fuels, which are expected to fall as demand for these fuels reduces. This in turn may have positive economic impacts in countries where demand for transportation services is suppressed because of poverty but may drive emissions up, if these services are supplied by traditional rather than electric vehicles. This effect was studied by economy-wide modelling, using two different future trajectories for EVs and liquid fuel prices, based on scenarios from the International Energy Agency (IEA, 2023). Figure 2 illustrates how, somewhat paradoxically, in a world with lower fossil fuel prices due to a faster uptake of electric vehicles, South Africa's transport sector might use more fossil fuels, leading to higher transport sector emissions.

Figure 2: CO_2 emissions trends for two major sectors in net zero pathways for South Africa in two different global contexts: World A: IEA NZ oil prices, World B: IEA APS oil prices

A third major transformation with relevance to South Africa's next NDC is likely to play out in **heavy industry, and notably in steel production**. In the long term, global Iron and Steel production is currently expected to become dominated by a green technology such as green hydrogen direct reduction of iron (gHDRI) with electric arc furnaces; all powered by renewable electricity generation. In the interim period in South Africa, before this major switch to green hydrogen in the industry, coal and gas based DRI will, like in the rest of the world, play a role as a hedging strategy. In South Africa this strategy allows industry to mitigate potential financial and asset risks in the short term while also future-proofing production of steel once the power grid in South Africa is more decarbonized and strengthened.

Closely linked to the steel industry is **ferrochrome** – a metal combination of iron and chromium. Ferrochrome is

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vital as it is used to make special steels, especially stainless steels and other metal alloys. South Africa, owing to its large resource endowment of chromite ores, established a ferrochrome metal producing industry and was the largest producer in the world until a decade ago when China took the top producer spot using imported chrome ore from South Africa. The process to produce ferrochrome requires carbon as coal and coke, and very high temperatures only achievable with electric arc furnaces. Unlike iron and steel industry, hydrogen cannot replace the carbon (coal and coke) to produce ferrochrome, due to the chemical nature of chromium. The typical process today of producing ferrochrome is to use electric arc furnaces with chromium ores combined with coal and coke (carbon). This is highly energy intensive, using about 3500 kWh of electricity per tonne of ferrochrome on average, but with significant gains over the past 2 decades (Dlamini & von Blottnitz, 2023).

Electricity-related emissions of this sector are expected to decrease as ferroalloy producers have pledged to source more of their power needs from renewable energy, and the grid will also decarbonize. The other half of the emissions from the usage of coal and coke needs to be addressed in long-term futures for a world that will still need special steels and alloys. South Africa's future ferrochrome industry may need to look at bio-based carbon replacements for coal and coke to continue production in the mid-2030s and onwards, and/or to add carbon capture for utilization (e.g. in methanol production) or permanent underground storage. This itself will require new technologies to be developed. There are less than a handful of countries that produce ferrochrome in sizable amounts, which equates to less attention on this sector in the decarbonisation discussion; making ferrochrome one of the unrecognized hard-to-abate sectors.

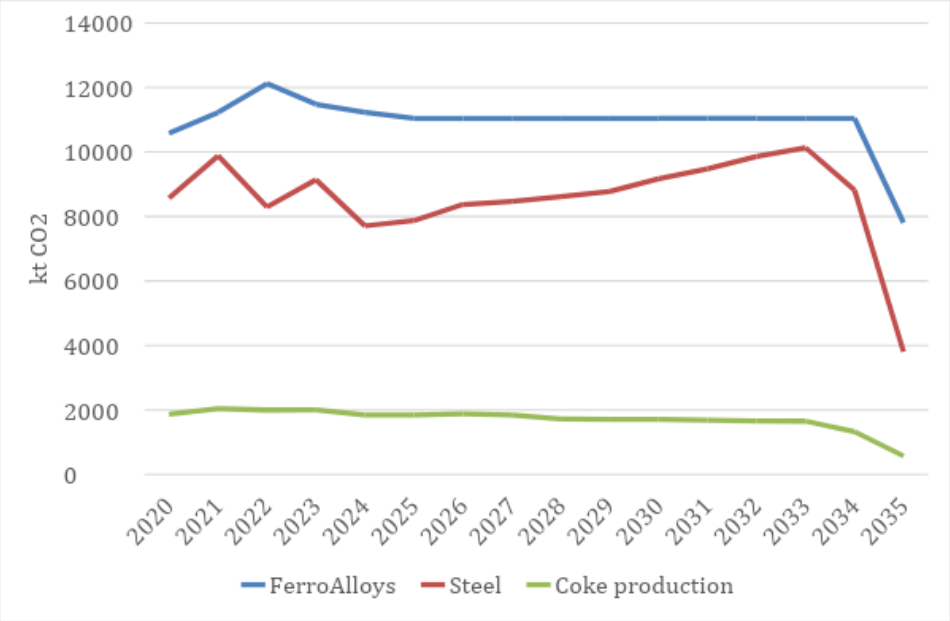

Figure 3: Emissions in the major metals industries of South Africa to 2035 on a net zero 2050 trajectory

Macro-economically, a decarbonising global world will lead to lower fuel costs, which in turn can drive economic growth. This is observed in SATIMGE economy-wide modelling. Figure 4 shows this small, but observable increase in the economy by around 70 billion ZAR by the early 2030s (in these scenarios).

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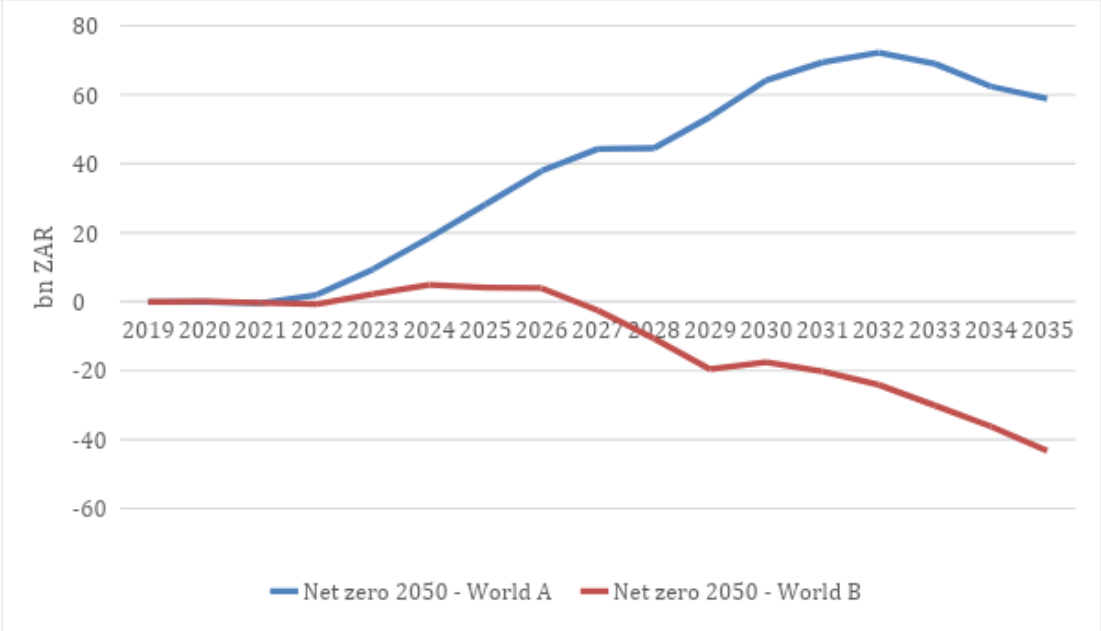

Figure 4: Difference in GDP relative to reference world B scenario - the impact on SATIMGE GDP of South Africa from lower (world A) and higher (world B) oil prices

Informing the national NDC process : key short-term actions necessary to put the country on track to reach long-term goals

Both of the global sectoral trends analysed have implications for South Africa's next NDC process. For context, Figure 4 shows two modelled net-zero CO_2 compatible pathways. Current indications are that 2035 emissions need to dip under 300 Mt CO_{2eq} /a to reach net-zero CO_2 emissions by 2050, though this still depends on an acceleration of emissions reductions post 2045 relying global support to access newer technologies.

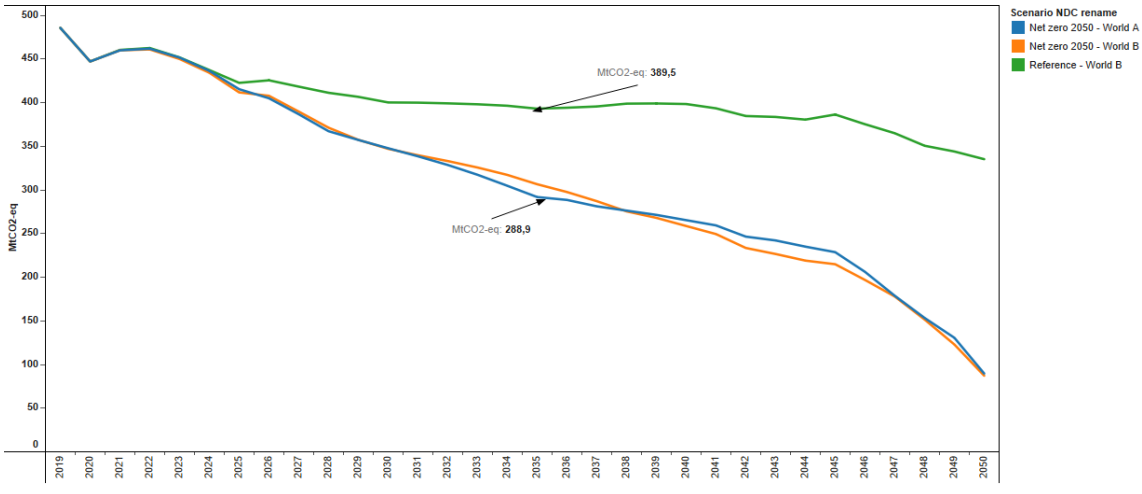

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Figure 5: Emissions for South Africa for a net zero pathway in the long term.

Decarbonisation of both the transport and metals (and other) sectors is heavily reliant on access to clean electricity. Thus, in the short term the primary focus should be on expanding and investing in the electrical transmission grid. The long-term decarbonisation of South Africa requires the power grid to support a large increase in demand for renewable generated electricity. The grid today is close to its limits for exporting electricity out of regions with the best potential for renewables. Much more investment into this critical infrastructure is needed for both expanding the grid, as well as maintaining and upgrading the distribution system. Additionally, to support this, and the future grid, electricity markets must be developed that will support the future consumers, and producers, bringing down the cost of electricity and inherently the cost to decarbonise, while also maintaining the national asset of the grid.

Uncertainty in the global pace of the transport sector transition and the associated global petroleum price regime have a significant bearing on South Africa's GHG emissions to 2035. This is illustrated in Figure 6, which shows by how much South Africa's transport sector emissions in a 'cheap fossil fuels' world could differ from one in which they remain expensive. The top panel shows that the electricity sector would have to decarbonize faster to compensate for these higher transport sector emissions. An important short-term action is to plan for this possible rebound effect of cheaper petroleum-fuel prices and to prepare instruments and measures to make this work for rather than against the national decarbonisation effort. This will be especially important in developing countries where car owners do not have the resources to pursue the more expensive but lower emissions option.

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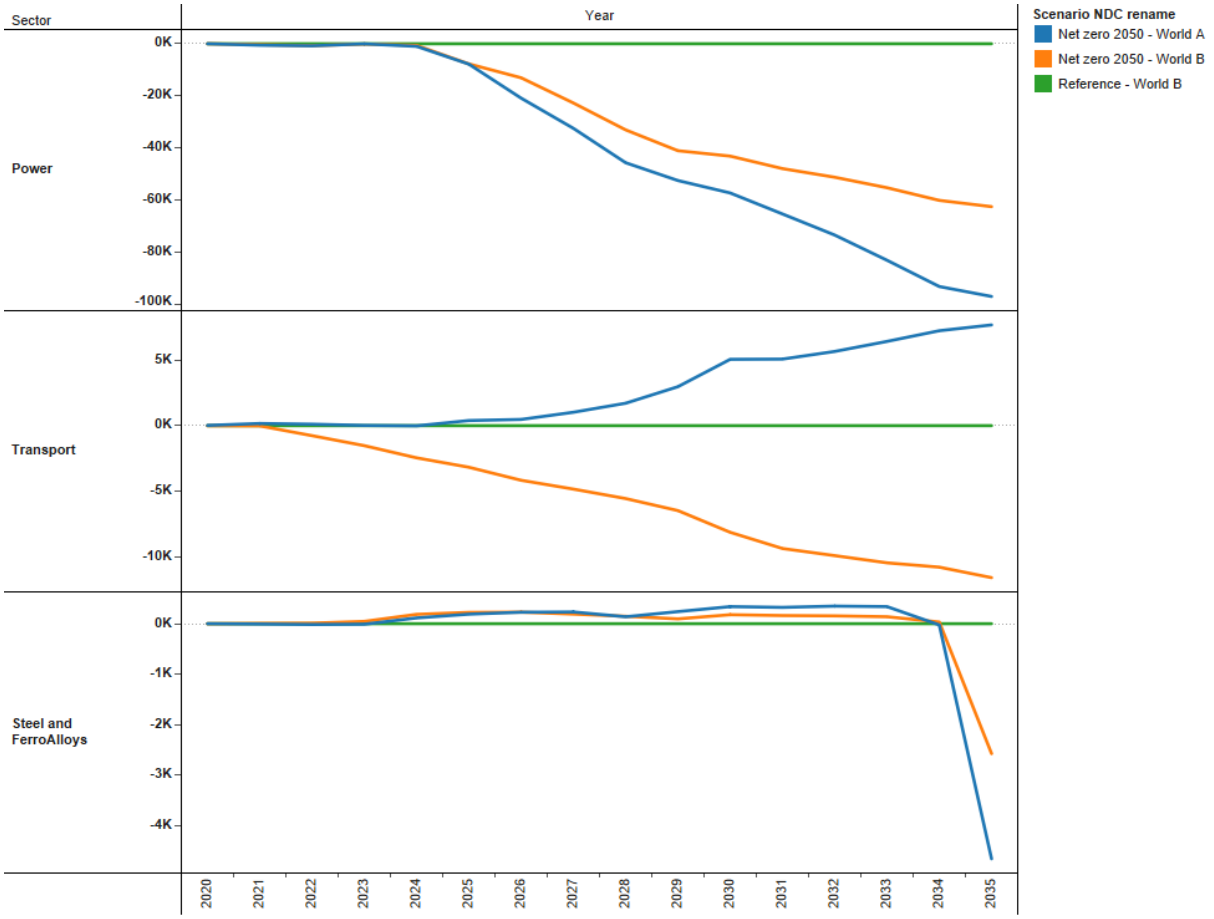

Figure 6: Emissions (kt CO2) difference relative to the 'Reference world B' scenario. Negative indicates fewer.

Innovations, such as a fast uptake of LEVs, were not included in this modelling. These require very little electricity and immediately cater for suppressed demand, lifting local economies with negligible new emissions, and displacing ICE transport in the best case. Innovation support to enhance LEV manufacture and use is a no-regrets key short-term action. It is recommended that the NDC update process pay attention to the scale and reach of LEVs.

In terms of socio-economic impacts, it is noted that the Electric Vehicles White Paper (DTIC, 2023) recognises the large and important auto-motive manufacturing industry in the country and introduces a number of support mechanisms for the manufacturers to transition so as to safeguard employment in this sector, which exports 60% of its production and thus needs to stay up-to-date with market regulations in importing countries, particularly Europe which accounts for 60% of the exports.

The short-term focus in in the steel Industry should be to pursue future-proof strategies by investing into electric arc furnaces fed by direct-reduced iron. The analysis carried out in this work affirmed the steel industry's intentions in this regard. It allows the switch to green technologies (especially hydrogen-based iron production) in the future, but also making use of coal-based iron production methods until then. Emission reduction benefits are likely to be

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seen only by 2035. This strategy is similar to the global trend of using gas DRI with electric arc furnaces, but with DRI technologies capable of switching from natural gas to 100% hydrogen use.

Ferrochrome producers must begin to invest money and effort into R&D for new technologies that can produce vital ferrochrome with lower fossil carbon emission for the global supply for steel alloys. These producers are at future risk of being exposed to further taxes and penalties for their carbon intensive operations should scope 3 emissions be included in various carbon tax schemes around the world. Owing to the need for carbon in the production process, investment into bio-based carbon technologies for chrome production and/or carbon capture for utilisation in chemical manufacture is required in the short term in order to allow sufficient time for development and potential deployment in the coming decade or two.

Vital to both these sectors, is the need to continue to invest in procuring energy from renewable electricity generation, this is a priority for both in the short term.

International cooperation needs identified to accelerate climate action in the transport and metals sectors in South Africa

Emissions-intensive and trade-exposed industries (EITEIs) have particular features that require attention. Firstly, these sectors are based on South Africa's mineral wealth; secondly, they have historically played and continue to play a crucial role in South African economic and industrial development locally and as exports necessary for macro-economic stability; and thirdly, in conjunction with South Africa's excellent abundant renewable energy resources, major new investments in these industries are required as a foundation for green industrialization and socio-economic development. This needs to be achieved in a continuous transition without undue disruption, as in many cases the industries are small links in massive international production chains and highly vulnerable to local disintegration as a direct consequence of international conditions.

National governance actions plus international cooperation in climate finance and technology transfer are basic requirements for industrial decarbonization. Most of these are well understood at the national level by now and are the subject of policy and legislation that is increasingly at the implementation stage. But what is increasingly being realized is how crucial international collaboration will be for EITEIs and how a number of additional cooperative dimensions must be involved. This policy brief thus concludes with a few notes on international cooperation needs.

1) Firstly, the JET-P needs to be understood as a long-term partnership. It is important that the international partners stay the course despite redefinition of priorities on the South African side as the country emerges out of its power sector crisis. The JET-P is a critical enabler of investments into South Africa’s electricity grid, which is a necessary condition for long-term decarbonisation of the country’s economy and the sectors studied here.

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2) In the transport sector, it is important to recognize that the South African based assembly plants of the multinational automotive corporates need to be enabled to transition at a pace and scale that matches regulation change in the importing countries and that can respond to demand growth for electric vehicles in South Africa.

3) Also in the transport sector, support may be needed for development of instruments and measures which can avoid a rebound effect in petroleum fuels use should global fuel prices drop sharply, in a way that still allows for the economic gains associated with cheaper transportation but without the emissions.

4) In iron and steel production, gHDRI 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. Until investments in South African gHDRI can be offered terms that level the international playing field, 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. Means of financing large-scale 'green industrialisation' projects in South Africa should thus be explored.

5) In the ferrochrome sector, support is needed for the R&D needs identified regarding bio-based carbothermic reduction on the one hand, and carbon capture for utilisation in methanol synthesis or underground storage on the other.

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Policy brief

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