TRADE & INDUSTRIAL POLICY STRATEGIES

POLICY BRIEF: 5/2024

Petrochemicals and South Africa's energy transition: Sasol's Secunda coal-to-chemicals-and-liquids facility

OVERVIEW

What happens to Sasol's Secunda Coal-to-Chemicals-and-Liquids facility, which is a major contributor to the domestic economy, illustrates the difficulties South Africa faces in its transition to a lower-carbon future. Sasol, the only domestic source of petrochemicals for a myriad of downstream industries, is heavily reliant on coal, and hence is a major greenhouse gas emitter. Increasing carbon taxes, environmental pressures and potential carbon border adjustment mechanisms (CBAM), combined with declining coal and gas reserves that could affect its export markets, cloud its future.

To make matters worse, the company is suffering financial pain, caused by, among other things, high debt from the Lake Charles Chemicals Project in the United States. Yet Secunda can probably operate until the end of its useful life unless environmental pressures or a plunge in the oil price force it to close prematurely.

Possibilities for Sasol include a shift to natural gas, green hydrogen, green carbon, and carbon capture and storage – options so fraught with technical, economic, and environmental difficulties that they are not feasible for the short to medium term. Policy options range from leaving the transition to market forces to providing Sasol with exemptions or moderation on carbon emissions to prolong its operations.

INTRODUCTION

The chemicals sector, often neglected but strategically important, is sometimes referred to as the "hidden glue" that holds the rest of the economy together. In South Africa, Sasol towers over the petrochemical industry. Often, Sasol is the sole domestic producer of specific petrochemicals. Traditionally, the primary feedstocks for petrochemical production are oil and natural gas. However, in South Africa, a legacy policy decision from the apartheid era continues to influence the industry. As a result, South Africa's petrochemical sector relies heavily on coal as its primary feedstock.

Globally, the petrochemical industry is recognised as one of the most demanding sectors to achieve significant greenhouse gas emissions reductions. Coal-based chemical production has a much higher carbon footprint than conventional oil-based and natural gas-based chemical production. Consequently, South Africa's reliance on coal presents an obstacle in its transition towards a lower-carbon future.

Given Sasol's size and economic influence, its continued use of coal as a feedstock presents a complex challenge for South Africa's broader decarbonisation efforts. How will Sasol South Africa cope with the Just Energy Transition? What is the future of the South African petrochemicals and plastics, ammonia, fertiliser, explosives and other downstream chemical value chains that are reliant on the Secunda petrochemical complex, given its substantial CO_2 emissions? These are questions of national concern.

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Several considerations make them even more challenging. First, Sasol's technology co-produces both liquid fuels and petrochemicals, simultaneously. You cannot have one without the other. Decisions about liquid fuels affect petrochemicals and vice versa. Also, its Secunda site is integrated with its Sasolburg site so decisions about one site affect the other.

Second, Sasol also uses some natural gas, a cleaner burning fuel than coal. However, its gas supplies in Mozambique are running out and will expire in about 10 years. To conserve gas for its own use, it will stop selling its gas to industrial customers in 2027, placing a large chunk of manufacturing in jeopardy – another problem for the government.

Third, several Eskom coal-fired power stations (with high emissions) are also located on the Mpumalanga coalfields, making it difficult to determine who emitted what.

Fourth, Sasol's fuels and petrochemicals businesses are sensitive to the international oil price and to carbon taxes, in South Africa and in export destinations.

Fifth, Sasol is a company in distress. This is a problem, not just for Sasol, but for South Africa.

Nuanced and strategic government intervention is necessary to manage Secunda's twilight years, balancing economic, environmental, and social considerations to avoid sudden disruptions and ensure a just transition for affected communities.

HOW IMPORTANT IS SASOL TO THE SOUTH AFRICAN ECONOMY?

Sasol's Secunda operations are the heart of its inextricably interdependent liquid fuels and petrochemicals manufacturing activities, which make a considerable contribution to GDP and employment that will be difficult to replace. It is effectively the sole supplier of basic petrochemicals and chemicals such as plastics.

Sasol Secunda is the largest local producer of liquid fuels (petrol, diesel, jet fuel, paraffin), with a 52% share. It adds immense direct and indirect value to an otherwise stranded natural asset, low-grade South African coal.

A Sasol study found that its 2021 contribution to GDP was 1.6% directly and 5.23% if all impacts are included. In 2023 its chemical sales amounted to R70.6 billion. Sasol's chemical exports also contribute to South Africa's balance of trade. Sasol's tax contributions come in various forms, including corporate income taxes and fuel levies. Sasol's study found its contribution to government revenue in 2021 to be R51 billion and including all indirect contributions to be R151.6 billion.

In 2019 Sasol's South African petrochemicals activities directly employed approximately 24 000 people and paid them approximately R35 billion in salaries. Sasol has a Level 3 BEE status and continues to invest in skills development and social investment spending. In 2023, the company contributed R1.4 billion to skills development and R857 million to social investment.

Sasol's factories created the towns of Sasolburg (from 1954) and Secunda which has 40 000 inhabitants, 80% of whom work for Sasol directly or indirectly.

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The commodity chemicals industry is the backbone of modern life. It produces the essential building blocks for countless products we use every day, from plastics and fertilisers to cleaning supplies and medicines.

The Secunda petrochemical complex occupies a critical position within the South African petrochemicals and chemicals value chain. Sasol's operations serve as the foundation of this value chain, transforming low-value coal into essential chemical precursors. These precursors then undergo further processing throughout the value chain, ultimately yielding a diverse array of chemicals and crucial consumer products. The value of these products progressively increases at each stage of processing.

It is important to acknowledge the significant role that these chemicals play in modern life. Many of the products derived from Sasol's operations contribute directly to contemporary lifestyles. Notably, a substantial portion of the output is converted into various types of plastics. These plastics find application in a vast array of products, including motor vehicle components (bumpers, dashboards), packaging materials (shrink-wrap), household goods (Tupperware), essential infrastructure (water pipes), electrical components (insulation), sporting equipment, and countless other essential items. Sasol Secunda currently fulfils approximately 50% of South Africa's domestic demand for plastic raw materials, with the remaining 50% being met through imports.

WHAT DOES SASOL MAKE IN SOUTH AFRICA?

This section deals with the production from Sasol's two manufacturing sites, the larger in Secunda and the smaller in Sasolburg.

What does Sasol make in Secunda?

Secunda's production landscape

Secunda was initially conceived in the 1970s to produce liquid fuels (petrol, diesel, jet fuel, illuminating paraffin) but in the 1990s and after 2000 Sasol unlocked the "the Secunda chemical treasure chest" to produce a wide variety of chemicals. For the last two decades, Secunda has produced roughly 7.5 million tons of fuels and chemicals annually, though this output has recently declined and is projected to continue decreasing as feedstock and environmental pressures increase in the coming decade.

The production breakdown consists of approximately 60% liquid fuels and 40% chemicals.

The importance of commodity chemicals which are mostly consumed in South Africa

The commodity chemicals industry is the backbone of modern life. It produces the essential building blocks for countless products we use every day, from plastics and fertilisers to cleaning supplies and medicines. These chemicals play a vital role in everything from construction and transportation to healthcare and food production.

Plastics are the invisible workhorses of our world. From lightweight packaging that keeps food fresh to medical devices that save lives, their versatility and affordability have revolutionised countless industries. Their durability allows for long-lasting products, while their ability to be moulded into complex shapes creates endless possibilities for innovation.

Secunda's role in South Africa's chemical landscape

Sasol Secunda holds a unique position as South Africa's sole manufacturer of most of South Africa's petrochemicals and plastic raw materials based on ethylene and propylene, as well as ammonia (for fertiliser and explosives), which is vital for South Africa's agriculture and mining industries. Sasol also produces caustic soda and chlorine with a wide range of applications.

Sasol manufactures various polyethylene, polypropylene and polyvinyl chloride (PVC) plastic raw materials. It is also the sole supplier of ethylene and propylene feedstock to Safripol which also produces polyethylene and polypropylene plastic raw materials. Most of the plastics produced in South Africa are consumed locally, except for some polypropylene that is exported. The downstream South African plastics conversion industry is heavily reliant on Sasol, which provides technical and research assistance as well as holding inventory and assisting converters with working capital requirements. The plastics conversion industry in South Africa supports numerous small and medium enterprises (SMMEs) and is a significant employer.

Sasolburg and Secunda operate in a highly integrated manner. Ethylene and propylene produced at Secunda are transported via pipelines to Sasolburg for further processing into polymers and solvents. This physical connection underscores the interdependence of the two facilities.

Sasol actively participates in polymer recycling initiatives and environmental projects to minimise plastic's environmental impact.

Sasol also produces sodium cyanide which is an essential chemical used to produce gold in South Africa. Although underground gold mining is declining the reprocessing of mine dumps will continue for several decades and requires sodium cyanide.

Secunda's export-oriented chemicals

Sasol also produces a range of chemicals primarily destined for export, including:

- **Solvents:** Short-chain alcohols, ketones and acrylates with diverse applications and global reach.
- **Alpha olefin comonomers:** Sasol produces world-scale quantities of comonomers that are used to enhance the performance of plastics. This includes flexibility, toughness, chemical resistance, and other desired attributes.
- **Phenolics and cresylics:** Sasol is a major player in the speciality chemical global cresylic acid market.
- **Detergent alcohols:** used to make a range of detergents and surfactants.
- **Fischer Tropsch (FT) waxes:** Although not directly part of the Secunda value chain they are an integral part of the Sasolburg value chain. Sasol produces world-scale quantities of FT waxes which have a wide variety of applications.

Strategic importance of Secunda

The Sasol Secunda complex, with its unique suite of chemicals, is challenging to replicate affordably within South Africa, particularly in its current location. Conventional production of these commodities is ideally integrated with large coastal refineries using expensive, imported feedstocks. Therefore, the Secunda complex stands as a unique legacy asset of strategic importance to the South African economy.

The symbiotic relationship between Sasolburg and Secunda

Sasolburg and Secunda operate in a highly integrated manner. Ethylene and propylene produced at Secunda are transported via pipelines to Sasolburg for further processing into polymers and solvents. This physical connection underscores the interdependence of the two facilities.

Furthermore, Sasolburg processes large volumes of Secunda primary chemicals which provide economies of scale and efficiency to the Sasolburg site.

In essence, the health and continued success of the Sasolburg ecosystem is directly linked to the operations at Secunda due to the crucial feedstock it receives and its role in the overall value chain.

What does Sasol make in Sasolburg?

Sasolburg utilises two primary feedstocks to produce a diverse range of chemicals:

- **Natural Gas:** Sourced from Mozambique, natural gas is used for wax, ammonia, and methanol production. In addition, it generates electricity for export to the grid, serving as either baseload or peaking power.
- **Ethylene and propylene:** Delivered by pipeline from Secunda, these chemicals are further processed into plastics raw materials, mainly polyethylene and poly vinyl chloride (PVC) but also butanol and acrylates. Sasolburg also supplies ethylene and propylene to Safripol for polyethylene and polypropylene production. Safripol is entirely reliant on Sasol for these feedstocks, lacking the capacity for independent generation or import.

In essence, the health and continued success of the Sasolburg ecosystem is directly linked to the operations at Secunda due to the crucial feedstock it receives and its role in the overall value chain.

Interdependence and cost implications

Sasolburg's operations can be viewed as two distinct value chains:

- **Natural gas-based chain:** Utilises natural gas for chemicals and power generation.
- **Secunda-supplied value chain:** Processes ethylene and propylene from Secunda into various products.

These value chains share essential infrastructure, utilities, and fixed costs. A potential shutdown of either chain would lead to cost increases for the remaining one due to the shared resource pool. This interdependence creates a symbiotic relationship, where the closure of one chain could negatively impact the other's profitability or even trigger a complete shutdown.

WHAT DOWNSTREAM INDUSTRIES USE SASOL PODUCTS?

Most of Sasol's South African products are used to make other products and are thus "hidden" from ordinary consumers. Key among such products are fertilisers for agriculture and explosives for mining and construction. Sasol is a large producer of plastics raw materials that are converted into many types of plastics such as low-density polyethylene, linear low-density polyethylene, high-density polyethylene and polypropylene. These plastic raw materials feed into a wide range of plastic products in the following markets – see Table 1.

Table 1: Plastic market sectors

Sector	South Africa	Global
Packaging	49%	44%
Building and construction	14%	18%
Other	13%	12%
Agriculture	8%	4%
Automotive	6%	8%
Electric and electronic	6%	7%
Household, leisure and sports	4%	7%

Source: Plastics SA. 2022. Analysis of South African plastics industry data. July. Percentages rounded.

WHY IS SASOL IN DISTRESS?

Distress indicators

A company's share price represents an integrated assessment of its state of health. Sasol's share price has declined from an all-time high of R640 (US$59.87) in June 2014 to a May 2024 trading range of about R130 (US$7.05), losing 88% of its value in the process (excluding the March 2020 global market collapse). All things being equal, these should be good times for Sasol with crude oil prices in the range of US$80/bbl and oil refining margins above US20/bbl. Historically, a heuristic for the Sasol share price was about 50% of the oil price, suggesting a current share price in the region of US$40. However, a multitude of reasons are responsible for Sasol's distressed situation including financial (multi-billion debt overhang from the Lake Charles Chemicals Project (LCCP) project in the US), operational, increasing feedstock costs, and more recently, climate change pressure and risk.

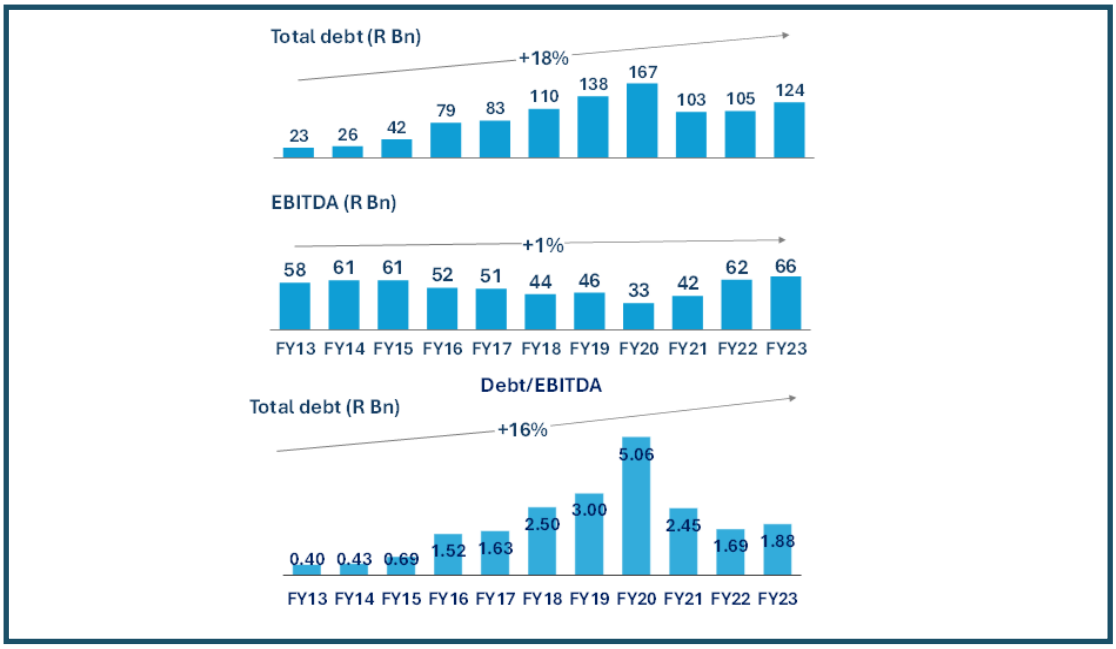
Value drivers at Sasol Secunda

As a large commodity producer, the economic underpinnings of success are relatively simple to understand but often more difficult to maintain. Large production volumes offset large capital investments. Cheap feedstocks and low operational costs ensure consistent profit. Notwithstanding high product selling prices set by the vagaries of the global market, Sasol is struggling with all of these and other metrics. Sasol's coal production is in decline and needs to be supplemented with more costly outsourced coal. Cheap natural gas from Mozambique is in decline with no easy solution in sight. Production volumes remain down, and these are inevitably correlated with increased operating costs.

Financial factors: debt and credit rating

Sasol's financial health is significantly impacted by its high debt burden stemming from the LCCP. This debt persists even after a fire-sale of assets in the wake of COVID-19. To meet debt covenants imposed by banks, Sasol was forced to sell assets in a short timeframe, essentially sacrificing future profits for immediate cash flow. Unfortunately, this was during a strong buyer's market, resulting in a significant loss of potential future earnings. This asset sale further weakens Sasol's financial robustness and flexibility.

Figure 1: Sasol's earnings and debt position



Source: Authors analysis.

Sasol's credit rating has steadily declined since 2005, dropping from Moody's Aa3 to a low of Ba2 in April 2023. A slight recovery to Ba1 in November 2023 is likely due to a combination of improved company performance and a worsening sovereign credit rating (South Africa's credit rating).

Ba1 is the highest rating within the speculative or "non-investment grade" category, just one notch below Baa3, which is the lowest investment-grade rating. While Ba1-rated investments might offer higher returns due to their higher risk, they are not considered suitable for risk-averse investors. These investments are often referred to as "junk bonds" when they refer to corporate bonds. The overall effect is higher borrowing costs and greater complexity in securing loans, further straining Sasol's finances and limiting its options.

Figure 1 illustrates a trend of declining earnings and rising debt:

- Sasol's US dollar earnings have declined by an average of 5.5% annually over the past decade.
- Debt has increased by 10.4% annually over the same period.
- In 2013, Sasol had a strong balance sheet with low debt levels.
- The rapid debt increase led to a crisis in 2020, with a debt-to-EBITDA ratio exceeding 5 and the subsequent forced asset sale.

South African pressures

Sasol faces several pressures in South Africa. Key among them is increasing environmental concerns. In particular, during the period approaching 2030, tightening regulation of sulphur emissions and carbon taxation represent a significant hurdle for Sasol. Capital invested to address these challenges will be significant and "unproductive" in that it may not lead to increased output.

The poor performance of State-Owned Entities puts pressure on Secunda including:

- Transnet Freight Rail (product logistics to coast). Sasol is attempting collaboration with Transnet Freight Rail.
- Transnet National Ports Authority (outbound logistics).
- Eskom (electricity supply reliability and cost). Sasol has begun buying power from other producers, but it is still heavily dependent on Eskom.

A growing risk is the increasing theft and vandalism of network infrastructure such as water, electricity and liquid fuel pipelines, all of which are important to Sasol's business operations.

Secunda is a large water consumer, roughly 5% of the annual supply of Rand Water. Climate change is expected to change rainfall patterns within South Africa. Threats related to physical water supply are recognised by Sasol.

Regulatory risk for Sasol is significant as both petrol prices and natural gas prices are heavily regulated. It has had difficulties with the National Energy Regulator of South Africa's price regulation.

Regulatory risk for Sasol in South Africa is significant as both petrol prices and natural gas prices are heavily regulated. It has had difficulties with the National Energy Regulator of South Africa (NERSA's) price regulation. The latter will fall away when Sasol stops selling gas to industrial customers in 2026. Secunda's monopolies in certain chemicals and natural gas as well as its inland market power in liquid fuels have led to appearances before the competition authorities. Such cases may continue.

Within Secunda itself, Sasol has its own problems:

- Capital projects such as the pioneering coal briquetting project required for the 30% emissions reduction programme represent a significant risk.
- Capital costs for the 30% emissions reduction programme are estimated to be in the range of R20-R25 billion coupled with an 11% reduction in production. This represents further "unproductive" capital and is compliance capital which does not have a capital reward; and further increases in variable costs, for example caused by increasing costs for additional external coal supply as outlined in the feedstock section.

Sasol Secunda's economic vulnerability

A simplified financial model was developed based on Sasol's complex FY2023 financials. This model assesses the economic viability of Sasol Secunda, the company's key coal-to-liquids (CTL) facility.

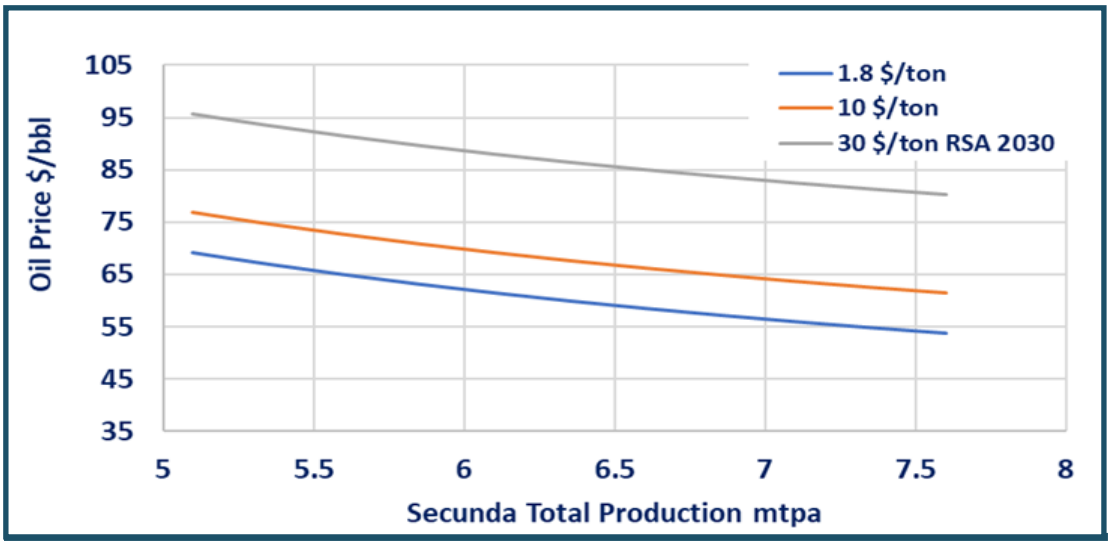
Key findings

- Sasol's US dollar earnings have declined by an average of 5.5% annually over the past decade.
- **Current performance:** While Secunda's operational performance is weak, it remains marginally profitable on a standalone basis. However, significant group debt, primarily from the LCCP project, weighs heavily on its finances.
- **Carbon price vulnerability:** Secunda is particularly vulnerable to carbon pricing due to its CTL technology. Even South Africa's proposed UD$30/ton (approximately R560) CO_2 tax by 2030 (without free allowances) (up from R190 per tonne of CO_2 equivalent from 1 January 2024) could significantly reduce profits and limit cash flow for future investments. This price point is low compared to Europe but high relative to South Africa's BRICS trading partners, putting Secunda at a disadvantage.
- **Long-term threat: Carbon Border Adjustment Mechanisms:** Proposed CBAM like those in the EUROPEAN Union (EU) could pose an even greater threat in the long run.

Detailed Analysis (available in full report)

The model considers various input parameters and a more detailed breakdown is provided in the complete report. Figure 2 illustrates the impact of a carbon tax on Secunda's breakeven oil price. This price represents the minimum oil price required for Secunda to generate positive cash flow. The model indicates that declining production and the US$30/ton carbon tax could push Secunda into negative cash flow territory, potentially leading to closure.

Figure 2: Heuristic model: Breakeven oil price (US$/bbl – effect of carbon price)



Sasol announced in August 2023 it will terminate natural gas and methane-rich gas supplies to its industrial customers in 2026, but has more recently agreed to extend this to 2027.

Threats to export markets – CBAM

The first (reporting) phase of the EU's CBAM came into effect in 2023 covering aluminium, steel, fertilisers and cement (all very carbon-intensive products). Organic chemicals and plastics are not on the initial list but are targeted for inclusion after a review. CBAM will take financial effect in 2026 with carbon prices linked to European Union's Emissions Trading Scheme (EU ETS). Post-COVID EU ETS prices range between €40 and €100/ton CO_2. This level of carbon pricing would, barring extreme oil price events, make exporting to the EU financially infeasible. Sasol, together with other exposed producers, would likely be forced to shift exports to unaffected markets. This concentration effect would, however, also exert downward pricing pressure on their products, harming profitability.

SOUTH AFRICA'S 2026 'GAS CLIFF' FOR INDUSTRIAL CONSUMERS

Sasol announced in August 2023 that it will terminate natural gas and methane-rich gas supplies to its industrial customers in 2026, but has more recently agreed to extend this to 2027. These customers are located in Gauteng, Witbank, Sasolburg,Vereeniging, Newcastle and Durban.

In November 2023 James Mackay, the chief executive officer of the Energy Council of South Africa warned that "We have a supply cliff coming," and that "There isn't currently a supply alternative that will readily be available in the timeframes needed." He estimated that 300 000 to 400 000 jobs at firms that use gas may be at risk. The impact on taxable revenue may be more than R450 billion.

Why is Sasol doing this? Its natural gas fields in Mozambique are running dry after 20 years and it needs all the remaining gas for its own operations in Secunda and Sasolburg. There may also be other reasons related to NERSA's regulation of gas prices. The Sasol CEO said it was doing this "because of Sasol's calculation that it would be unable to recover the cost of its exploration and development investments (for gas in Mozambique) under the **current regulated pricing formula**" (emphasis added). Sasol has also had various issues with the Competition authorities. For example, in May 2023, the Competition Tribunal interdicted Sasol Gas from increasing the price of its piped natural gas above R68.39/GJ for the next six months in response to an application by the Industrial Gas Users' Association of Southern Africa (IGUA-SA).

What options do industrial customers have?

Importing liquefied natural gas (LNG) via Maputo is being considered by TotalEnergies and Gigajoule in a partnership. This would require a pipeline from the harbour to the existing ROMPCO gas pipeline transporting gas from further North in Mozambique to South Africa.

Imported LNG would be significantly more expensive than local Mozambique piped gas. Sasol has said it cannot afford LNG. Consequently, that project has no obvious baseload customer. It is not clear if industrial customers can afford LNG. The combined demand of industrial customers, without Sasol, is insufficient to justify the investment in the LNG and pipeline infrastructure that this project would require. Another baseload option might be gas-to-power in Mozambique but that would require a long-term electricity off-take agreement from Eskom, which is unlikely to materialise as Eskom has plans to build a 3000 MW gas-to-power station in Richards Bay in about 2030.

Small-scale LNG imported in container loads may be possible but may not be affordable for all industrial customers.

Compressed natural gas delivered by road from gas wells in Virginia in the Free State Province is very limited and will be more costly.

Kinetiko Energy has found small quantities of gas at Amersfoort (about 100 km from Secunda). It is unlikely that enough gas can be proven before 2026. But, if sizeable gas fields can be proven in the next several years, it could be a partial lifeline for Sasol and industrial customers, if they can wait that long which is unlikely.

Other alternatives for industrial gas customers include switching from gas to coal, or fuel oil or LPG. Despite substantial infrastructure in Richards Bay to import LPG, the challenge will be transporting it to the inland market.

A consensus has formed that green hydrogen will be critical for a Just Energy Transition. The EU's target of producing and importing 20 million tons annually by 2030 underscores this growing sentiment.

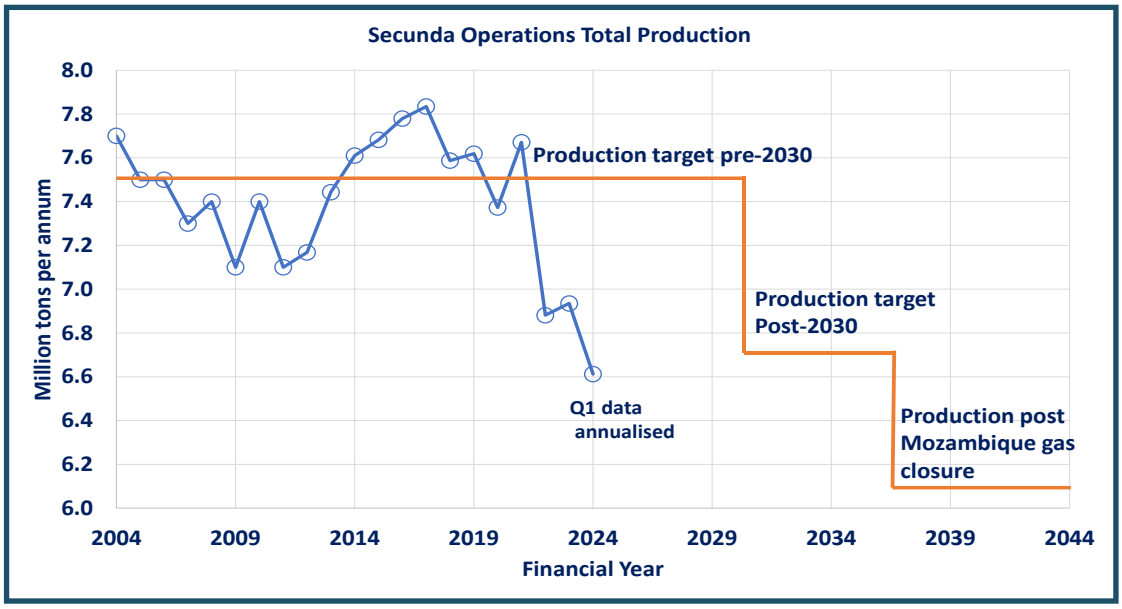
CAN SECUNDA ACHIEVE A 'JUST TRANSITION'?

Globally and in South Africa, climate change is driving efforts to transition large emitters of greenhouse gasses to shift to lower emission technologies in a socially responsible fashion, termed the "Just Transition". The use of coal was imperative for Secunda technologies in the late 1970s. At that time, both the air quality risks of burning coal and the role of CO_2 in climate change were largely unrecognised. Changing these technologies to use feedstocks other than coal and gas at the (large) scale of Secunda, even with the advancement in technology over the subsequent 50 years, would be extremely challenging technically and probably impossible financially for Sasol.

Natural gas

Sasol's machinery and equipment in Secunda is designed to use coal as its feedstock. That technology requires coal and cannot simply be switched to other basic feedstocks cost-effectively. Although Secunda's feedstock is 10% natural gas that *supplements* coal, it cannot easily replace coal entirely as the manufacturing equipment is designed for coal, not gas. When gas from Mozambique runs out in the early to mid-2030s, Secunda production will reduce by about 9%. This will be in addition to the 10% reduction announced for 2030 to reduce greenhouse gas emissions, a total of 19% (see Figure 3). If conversion to gas were possible, it would only be an interim step as the CO_2 emissions from a gas-based process, while significantly less than a coal-based process, are still substantial. They may, however, be small enough that savings in other areas of the South African economy can cover them more cost-effectively.

Figure 3: Secunda total production history and long-term forecast



The Sasolburg plant was able to switch from coal to gas because the gas conversion project complexity and cost were manageable (Sasolburg's production is 10% of Secunda's) and it could piggyback on a much larger gas supply project. Replicating this level of conversion at Secunda today is unlikely given its cost, scale, risk and lack of a suitably cheap source of natural gas. The prospects for additional gas are considered in the subsection *Prolonging Secunda's life – Regional gas for Secunda* (see page 13)

Is green hydrogen the answer?

Green hydrogen: A potential growth driver for Sasol

Sasol needs green hydrogen (made from renewable electricity and water) to reduce its emissions and align with an emerging global trend of using green hydrogen to reduce emissions from economic activity. Emerging from COP26 and the oil and gas industry itself, a consensus has formed that green hydrogen will be critical for a Just Energy Transition. The EU''s ambitious target of producing and importing 20 million tons of green hydrogen annually by 2030 underscores this growing sentiment.

The evolving landscape necessitates careful evaluation of optimistic green hydrogen production forecasts, which are now facing greater scrutiny and criticism. Multi-billion-dollar investments require a thorough risk assessment to account for competitive dynamics and potential market shifts. While new projects are envisioned globally, few have been built.

Sasol is actively positioning itself within this evolving landscape by pursuing several small green hydrogen opportunities. Its Sasolburg facility has commissioned a 3MW solar power station, enabling the production of commercial-scale green hydrogen by leveraging existing assets. In addition, it has secured a 20-year wind energy power purchase agreement (69MW) with the Msenge Emoyeni project to supply a green hydrogen pilot project at Sasolburg.

Sasol, Enertrag, Linde and Hydregen have announced the Hyshift project, which would use energy sources such as wind and solar to power 450MW of renewable electricity and a 200MW electrolyser to produce green hydrogen to manufacture about 40 000 tons per annum of sustainable aviation fuel – enough to fuel two flights between Germany and South Africa a day, or less than 1% of Secunda's production.

Sasol has completed a pre-feasibility study for a large multibillion-dollar green hydrogen export hub at Boegoebaai on the West Coast, but the risks associated with this project are likely to be too big for Sasol to handle. The project has stalled while potential risk-sharing partners are being sought.

It is important to acknowledge that, while the industry consensus suggests promise, historical predictions in the energy sector haven't always materialised. For instance, General Electric's 1970 forecast of fast breeder nuclear reactors supplying 90% of US electricity by 2000 ultimately proved completely inaccurate.

It is also vital to acknowledge the nascent stage of the green hydrogen industry. While forecasts predict significant future production, strong competition is emerging for many of its potential applications. Notably, the direct use of renewable electricity for mobility and industrial applications is becoming increasingly attractive. This evolving landscape necessitates careful evaluation of optimistic green hydrogen production forecasts, which are now facing greater scrutiny and criticism. Consequently, multi-billion-dollar investments in green hydrogen require a thorough risk assessment to account for these competitive dynamics and potential market shifts. While new projects for green hydrogen are envisioned globally, very few have been built and the number of large-scale conversion projects of legacy assets are much less common.

Green hydrogen hurdles for Sasol Secunda

Sasol makes various hydrocarbons from the hydrogen and carbon in coal. To replace coal it needs green hydrogen and green carbon. While green hydrogen presents itself as a promising avenue for clean energy, its complete substitution for coal and gas at Sasol Secunda faces significant technical and economic hurdles. Attaining a production level sufficient to replace current output would necessitate 2.1 million tons of green hydrogen annually. Sourcing sustainable carbon is considered in the following subsection.

The energy consumption considerations add another layer of complexity. Generating the necessary green hydrogen to replace Secunda's current production would demand 18 000 MW of continuous renewable electricity, representing nearly 51% of South Africa's entire current peak electricity demand. The capital expenditure required to construct such a massive infrastructure is estimated to exceed R1 trillion.

Beyond these technical and economic hurdles, efficiency concerns must also be factored in. Converting green hydrogen back into liquid fuels like petrol incurs significant energy losses. Compared to directly powering electric vehicles, using green hydrogen to create petrol represents a significantly less efficient deployment of renewable resources. Modern, efficient petrol vehicles achieve an approximate efficiency of 30%, while electric vehicles boast a considerably higher 80%.

In conclusion, the intricate technical challenges, immense capital costs, and lower overall efficiency compared to electric vehicles present a compelling argument against transitioning Sasol Secunda to utilise green hydrogen as its primary feedstock at this juncture to make hydrocarbon transportation fuels. While the future may hold opportunities for green hydrogen to play a role in Sasol's operations, for the present, it appears to be a technological and economic bridge too far.

Sustainable carbon

Securing sustainable carbon for green hydrogen production

The transition to a lower emissions trajectory at Secunda requires green hydrogen and sustainable or green carbon. Two primary sources of green carbon exist: biomass and captured carbon dioxide (CO_2). These possibilities are considered in the following subsections.

Carbon from biomass at scale

Large-scale biomass utilisation (multi-gigawatt scale for Secunda) requires vast areas (thousands of square kilometres) of dedicated tree plantations. Establishing such plantations encompasses significant land acquisition, decades of tree growth, and complex and costly logistics for wood delivery. These factors render carbon from large-scale biomass utilisation infeasible for Secunda.

Carbon from fossil fuel emissions

Fossil fuel burning factories and power stations emit CO_2 which could be captured, and the carbon extracted. The most cost-effective (albeit still expensive) method of CO_2 capture involves flue gas recovery from steel mills or coal-fired power plants or even Secunda itself. However, this approach raises sustainability concerns. Flue gas originates from fossil fuels, negating the benefits of green hydrogen production although it could lower Sasol's Secunda emissions.

Carbon from the air

Capturing CO_2 from the air (other people's emissions) – Direct Air Capture (DAC) is an alternative source of green carbon. While DAC technology appears to hold promise, the roughly estimated capital cost of R329 billion and an annual operating cost of R64 billion for Secunda pose significant economic challenges. The operating cost alone translates to a feedstock cost of US$56 per barrel of oil equivalent for carbon alone, rendering DAC commercially unviable at this stage. Identifying a commercially viable and sustainable source of carbon remains a critical hurdle for green production at Secunda and there is no obvious solution on the horizon.

Carbon capture and storage in South Africa

To reduce its CO_2 emissions Sasol Secunda could consider capturing them and burying them. Carbon capture and storage (CCS) has been touted as a game-changer in the fight against climate change. This technology captures CO_2 emissions from sources like power plants and factories. Storing the CO_2 deep underground prevents it from entering the atmosphere and contributing to global warming. However, while this sounds simple, the path to implementing CCS in South Africa is fraught with challenges requiring solutions to geological, logistical and regulatory challenges.

Geological and logistical challenges:

Despite being around since the 1970s, CCS technology remains in its infancy. Studies have shown that existing CCS projects often underperform, raising concerns about their cost-effectiveness. Furthermore, South Africa faces logistical difficulties. Suitable geological formations for storing captured CO_2, like deep saline aquifers or depleted oil and gas reservoirs, are not available near Secunda and require costly transport. Secunda's direct CO_2 emissions are about the same as the total global capacity of operational CCS in 2023 being stored in the world's most preferred locations.

CCS pilot project challenges:

The World Bank funded a pilot CCS project in South Africa, aiming to demonstrate the technology's viability. However, the project has encountered significant setbacks. The completion date has been pushed back several years, and the scope has been substantially reduced. This highlights the practical difficulties of implementing CCS at scale.

CCS regulatory challenges:

Implementing CCS requires a robust legal and regulatory framework to ensure safe and responsible storage of captured CO_2. Such a framework still needs to be developed in South Africa, adding another layer of complexity.

CCS: The road ahead: A long and uncertain journey

South Africa has been researching and developing CCS for more than a decade but it is still in its infancy. It still faces significant technical, commercial, geological, logistical, and regulatory hurdles. Given these challenges, large-scale implementation of CCS in South Africa seems unlikely in the near future, or in time to meet Secunda's CO_2 reduction targets.

A key factor determining Secunda's future will be South Africa's environmental policy and regulatory dispensation. The harder these are for Secunda, the sooner it will close .

WHEN WILL SASOL'S SECUNDA AND SASOLBURG OPERATIONS CLOSE?

No coal mines and industrial factories last forever and Sasol's Secunda and Sasolburg factories are no exception. It is not a matter of if, it is rather a matter of when.

As explained in the section *South Africa's 2026 'Gas Cliff' for Industrial Customers* (see page 8), Sasol South Africa is being squeezed between two types of pressures: corporate/market and environmental. Both have their own complexities and permutations. Some depend on Sasol's (undisclosed) new transformational climate projects that it says promise relief. Some depend on global markets and international government policies, and some depend on policy and regulation by the South African government. There is no simple answer.

However, our analysis shows that Sasol is already in distress and that, by the mid-2030s, Secunda will have lost 19% of its output which will probably raise the fixed costs of its remaining output. Sasolburg is gas dependent and will partially close at about that time when gas from Mozambique runs out as imported LNG will be unaffordable.

The South African government cannot control international petrochemical markets. Nor can it control international environment-related decisions. It can, however, control its own policies at home. A key factor determining Secunda's future will be South Africa's environmental policy and regulatory dispensation. The harder these are for Secunda, it will close sooner.

If blunt policy and regulatory instruments are used, the sooner Secunda will close. For example, will the government make a distinction between emissions from power generation and petrochemical manufacture? There are many cleaner than coal power generation technologies available and many are already in use in South Africa. The same is not true for petrochemicals and liquid fuels manufacture. When Secunda closes, it is likely to be the end of petrochemical manufacture in South Africa for a long time, if not forever.

Secunda's survival also depends in part on government policy towards other sectors of the economy, mainly power generation and road transportation. For example, it has been argued that South Africa could reach its Nationally Determined Contribution if nothing changed at Secunda and if power generation from coal was reduced and replaced by renewable power generation. Similarly, if government policy removed obstacles to electric vehicles and promoted them instead, emissions from road transport could be reduced, thus relieving the pressure on Secunda.

A part of the Just Energy Transition envisages that the transition should be thoughtfully managed rather than haphazardly implemented, and that provision should be made to alleviate the stress that will be placed on the towns, communities and workers of Secunda and Sasolburg. What will the Government do about that? When will the Government's ameliorating interventions be operational? The answers to such questions could also influence when Sasol's Secunda and Sasolburg operations close.

In short, the Government holds powerful policy and regulatory levers that will strongly influence, if not determine, when Sasol's Secunda and Sasolburg operations close.

GOVERNMENT POLICY OPTIONS FOR SASOL

Given Sasol South Africa's contributions to the economy and society, both positive and negative, what policy options does the government have?

The options presented in this section reflect a blend of considerations, in part aligned with the theme of climate change robustness. Ultimately, a careful cost-benefit analysis of options is required to ensure informed decision-making at a macroeconomic level.

Successfully navigating the energy transition will involve, *inter alia*, coping with the current situation and navigating through future policy conundrums and contradictions. At present, the government's contradictory policies simultaneously subsidise fossil fuels and renewable energy (e.g. directly via Eskom bailouts and indirectly via renewable power generation (REIPPP) offtake guarantees).

Building Sasol Secunda was a massive state intervention that distorted the economy. Allowing the market to 'correct' the economy back to a 'normal' market economy without state interventions directed at a 'soft landing' carries the risk of sudden large restructuring events that would have considerable economic and social implications.

Coping in the medium term with a declining role in the economy for Sasol's coal-to-liquids-and-chemicals technology may require a similarly contradictory approach during a transitional period. To what extent should taxpayers be responsible for subsidising apartheid-era strategic decisions and the previous poor decisions of a company's management? The policy "trick" will be to get the balance "right" between the carrots and the sticks. Two possible broad approaches are outlined in the following subsections.

Leave it to market forces

Doing nothing is the easiest option. But even that will require substantial investments in the ports and storage and logistical infrastructure to import whatever Sasol South Africa stops producing. Building Sasol Secunda was a massive state intervention that distorted the economy. Allowing the market to "correct" the economy back to a "normal" market economy without state interventions directed at a "soft landing" carries the risk of sudden large restructuring events that would have considerable economic and social implications.

Exemption/moderation for Sasol on carbon emissions

Sasol South Africa is under pressure on many fronts. It has its own significant commercial challenges as well as external ones from carbon taxes, environmental costs, shareholder and environmentalist expectations, and increasing demand for greener products. Globally, carbon border taxes or equivalents are emerging medium-term threats to exports. Continuing to delay carbon taxes will assist Sasol to keep more facilities running for longer. But Sasol is facing an unprecedented level of climate change awareness, activism, pressure and ongoing scrutiny as well as its own announced target of a 30% carbon emission reduction by 2030 (at a cost of between R15 billion to R25 billion).

WHAT ECONOMIC ACTIVITY COULD REPLACE SASOL SOUTH AFRICA?

Building Secunda was a massive and costly state intervention in the market that generated a lot of economic activity. But all factories and mines have a finite useful economic life. As Secunda approaches the end of its life, it is argued that reinvestment (replacement of equipment) is not a commercial proposition. As Secunda winds down it will leave a considerable "hole" in the economy. This section looks at options that might fill that "hole". The subsections consider these options, beginning with prolonging Secunda's life, progressing to alternative petrochemicals/fuels complexes beyond Secunda and concluding with other economic activities that might replace Secunda.

Prolonging Secunda's life – Regional gas for Secunda

It may be possible to prolong Secunda's life if additional supplies of natural gas could be found. Sasol says importing liquefied natural gas is not affordable, so what other alternatives are there for gas? One option envisages finding more gas to supplement the dwindling supplies from the Pande/Temane gas fields in Southern Mozambique. For Sasol Secunda to completely exit coal while maintaining economies of scale would require the import of nearly 10 times the amount of natural gas used today – a tall order.

- Sasol is actively exploring for more gas in Southern Mozambique. However, these efforts have had limited success to date. Sasol has been tight-lipped about future prospects.
- Although there are large gas reserves in Northern Mozambique these are too far away to be piped cost-effectively to South Africa.
- Gas in proximity to Secunda: Tiny gas reserves have been proven thus far. It is unlikely that sufficient gas at a price Secunda can afford will be proven in the short term.

The direct crude oil to chemicals process (COTC) aims to bypass traditional oil refining and convert crude oil directly into valuable chemicals. However, while COTC holds promise, it is still in its early stages commercially.

The following alternative petrochemical/fuel complexes South Africa could consider were suggested by interviewees.

Direct crude-oil-to-chemicals

The direct crude oil to chemicals (COTC) process is a new approach that aims to bypass traditional oil refining and convert crude oil directly into valuable chemicals.

Traditionally, crude oil is refined into products like gasoline and diesel in a refinery and a naphtha cracker can be integrated into the refinery to also produce chemicals. COTC skips the refining step focusing on creating the building blocks for chemicals like plastics, fertilisers, and other industrial products directly from crude oil. It promises a more efficient use of crude oil, potentially generating more valuable chemicals from each barrel. This is a newly emerging processing route for crude oil which has the advantage that a world-scale conventional oil refinery producing liquid fuels (costing approximately R183 billion) is not necessary, saving a substantial investment while providing a higher value product slate of products.

While COTC holds promise, it is still in its early stages commercially. Three possible locations for such a facility could be considered:

- Sasolburg
- Secunda
- Richards Bay

Each has its own advantages and disadvantages which fell beyond the scope of this assessment

Southern Namibia crude-oil-to-chemicals

Namibia could decide to try and exploit the recent significant oil and gas finds offshore Southern Namibia by encouraging the development of crude oil based industries such as refining or direct crude to chemicals. This could be in Luderitz and possibly with South African collaboration.

Such a development would have the following challenges which Namibia would need to weigh on a cost-benefit basis:

a) A world-scale facility would require a costly deep-sea port to be built;
b) Need for greenfield site development in a remote location; and
c) Lack of transport infrastructure to transport its products to the industrial heartland.

South African coastal crude oil refinery plus petrochemicals complex

The idea of building a new coastal refinery and petrochemicals complex started in 1996. Many studies have been done, without a commercially attractive option being identified. The following challenges were identified:

a) This idea would **only be sensible once** the existing crude oil refineries in South Africa have been shut down.
b) A world-scale oil refinery (± 600 000 bbl/day) may have to export some fuels and chemical at low prices and would struggle to compete with Middle Eastern petrochemical complexes.
c) A global expansion in electric vehicles will create a petrol surplus which would threaten profits.
d) A coastal location would be required, meaning that the plastic raw materials would need to be transported to the inland converting industry as would the liquid fuels. If Durban was not the chosen location additional pipeline infrastructure would be needed to transport fuel to the main (inland) market. (About 60% of South Africa's fuel market is in the industrial heartland.) Expanding the Astron Energy refinery in Cape Town is deemed unattractive due to its distance from the industrial heartland.
e) A refinery investment would also require investment in the acquisition of or access to a service station network to dispose of the fuel produced.
f) The capital investment required for a world-scale refinery and petrochemical complex is likely to exceed R366 billion and, given plans for decarbonisation, the risks for such a large investment in a new refinery would need careful scrutiny.

Although green hydrogen can potentially be used for a range of applications, for many of these applications there are renewable alternatives particularly the direct use of renewable electricity.

Alternative economic activities that could replace Secunda's role in the economy and looked at in the following subsectors.

Green hydrogen/fertiliser/ammonia export hub

Green hydrogen is hydrogen produced by splitting water (H_2O) using renewable electricity, resulting in a clean energy source which emits no CO_2 during its production. In addition to its use as an energy, carrier green hydrogen can also be reacted with nitrogen from the atmosphere to produce green ammonia used in making fertiliser and explosives.

Although there is much hype globally and locally about green hydrogen, with many pre-feasibility studies and pilot projects in progress, only one (Saudi Arabian) green hydrogen project has reached a final investment decision. The green hydrogen technology and value chain is not yet commercially proven at the gigawatt scale.

Green hydrogen production and delivery costs are estimated to be in the range of US$250-US$400/bbl (oil price equivalent) when current oil prices are in the US$80 to US$100/bbl range. Green hydrogen is thus considerably more expensive than conventional energy carriers.

Green hydrogen projects require mega project size (>R90 billion) to generate economies of scale which are very high risk in an infant industry.

It is also important to note that although green hydrogen can potentially be used for a range of applications for many of these applications there are renewable alternatives, particularly the direct use of renewable electricity. In addition to project execution risks green hydrogen faces very significant market risks.

Promote electric vehicle manufacturing

Crude oil and petroleum products are South Africa's single most costly import. Replacing it with electricity produced by local sunlight, wind and coal is a perfect fit with South Africa's long-standing import substitution industrialisation policies. The electricity would be used to propel electric vehicles. Electric vehicles when charged from renewable sources and measured on a "well to wheel" basis are more efficient and less polluting than internal combustion engine (ICE) powered vehicles.

South Africa also has an established motor vehicle manufacturing industry and an emerging battery manufacturing industry that would need to switch over to electric vehicles. But there are several considerations to such a switchover:

1) The petroleum industry has a considerable vested interest in retaining ICE vehicles.
2) A transition from conventional fuels to an electric vehicle fleet increases the risk of road degradation.
3) It will take time to replace South Africa's vehicle pool and its related infrastructure, although some progress has been made in infrastructure investments.
4) The risk of loadshedding requires additional energy systems and infrastructure.
5) Current Government policies are mostly anti-electric vehicles despite a limited tax incentive. This is done to protect the local industry players.
6) There is consumer reluctance to electric vehicles based on "range anxiety", price, and lack of sufficient charging infrastructure.
7) The local battery manufacturing industry would need to invest in the expansion of production, as well as meet the quality requirements of the multinational automobile companies.

It will take time to replace South Africa's vehicle pool and its related infrastructure, although some progress has been made in infrastructure investments. However, the petroleum industry has a considerable vested interest in retaining ICE vehicles.

The promotion of a green steel industry is attractive for South Africa due to its renewable energy potential, mineral resources, and its strategic manufacturing sector catering to several global markets including the EU.

Green steel using green hydrogen

Green steel is made from direct reduced iron (DRI), created using hydrogen instead of coal or natural gas and produces very limited greenhouse gas impact. The promotion of a green steel industry is attractive for South Africa due to its renewable energy potential, mineral resources, and its strategic manufacturing sector catering to several global markets including the European Union.

Sasol entered a joint development agreement with ArcelorMittal South Africa in 2022 to develop a competitive green hydrogen hub and ecosystem within Saldanha Bay.

These developments help to position the green steel industry in South Africa, however for the entire industry to convert to this new technology would require significant development in renewables and green hydrogen needs to be undertaken to make these pathways viable.

Green steel comes with its own set of obstacles such as the scale of investment needed and widespread adoption of this relatively new technology against a backdrop of steel producers announcing shutdowns of many of their present-day facilities.

Possible development options compared

All the above options that could replace Sasol Secunda's outputs or its economic impact are compared against desirable policy objectives, using rough estimates, in Table 2.

Table 2: Development options against policy objectives

LOOKING BEYOND THE COAL-BASED PETROCHEMICALS CUL DE SAC							
Project	**Local value added**	**Employ-ment**	**Forex generated**	**Environ-mental impact**	**Commer-cially proven Technology**	**Market opportunity (non-subsidised)**	**Economic viability**
Regional gas to Secunda (not LNG)	✓	✓	✓	?	✓	✓	✓
Thermal crude-oil-to-chemicals	?	✓	?	?	x	✓	?
Southern Namibia crude-oil-to-chemicals	x	x	x	-	✓	✓	?
South African Coastal crude oil refinery plus petrochemicals complex	?	✓	?	x	✓	✓	?
ALTERNATIVES TO SECUNDA'S ECONOMIC CONTRIBUTION							
Project	**Local value added**	**Employ-ment**	**Forex generated**	**Environ-mental impact**	**Commer-cially proven Technology**	**Market opportunity (non-subsidised)**	**Economic viability**
Green hydrogen/ Fertiliser export hub	✓	✓	✓	✓	x	?	?
Promote electric vehicle manufacturing	✓	✓	✓	✓	✓	?	?
Green steel DRI using green hydrogen	✓	✓	✓	✓	✓?	✓	?

According to this crude assessment, the more promising opportunities are regional gas to Secunda (not LNG), green steel, DRI and promoting electric vehicles. None of these are mutually exclusive.

The length of Secunda's sunset phase will be largely influenced by the government and how it manages South Africa's Just Transition.

CONCLUSION

This report focussed on a key question in South Africa's transition to a lower carbon future: What is the future of the South African petrochemicals and plastics, ammonia, fertiliser and explosives value chains in the light of Sasol's stated greenhouse gas emission reduction plans and other assessed business constraints? It has confirmed that the future of those value chains is inextricably bound up with Sasol's future and its Secunda operations in particular, at least in the short term.

Sasol is currently a valuable asset in the South African economy and contributes significantly towards the Southern African Development Community region. It is the only domestic source of petrochemicals for a myriad of downstream industries. It adds significant value to a stranded resource, (low-grade coal) and in the process it makes a significant contribution to GDP, tax revenues, employment and the balance of payments, both through substituting for imported liquid fuels and through chemical exports.

Secunda was designed to use coal as a feedstock and that fundamental fact cannot be escaped. This research found that there is no commercial prospect of coal being replaced with green alternatives.

Unfortunately, Sasol is a company in distress for a variety of reasons, some self-inflicted and some due to domestic and global pressures. It has announced an 11% cutback in Secunda's production in 2030 associated with its commitments to reduce greenhouse gas emissions by 30% by 2030. Secunda can reduce some of its environmental impacts but doing so will not allow it to escape its coal fundamentals. The core technology used at Secunda cannot be incrementally changed, although Sasol believes that it can. Secunda can probably run to the end of its useful life unless environmental pressures (from government, shareholders, South African society and globally) or a downturn in the oil price to below US$65/bbl cause it to close prematurely, or unless (as yet unseen) technological breakthroughs redeem it. Based on contemporary knowledge, Secunda is in its sunset phase over the next 10-15 years.

The length of Secunda's sunset phase will be largely influenced by the government and how it manages South Africa's Just Transition. For example, in meeting South Africa's Nationally Determined Contribution (of greenhouse gas emissions), a reduction in emissions by Eskom's coal-fired power stations would "make space" for Secunda to continue with some of its emissions and preserve the country's only source of petrochemicals. Navigating such a path would require an astute and coordinated state apparatus beyond that seen to date. Consequently, there is even greater pressure on Sasol to devise market and technological solutions for itself.

More optimistic outcomes may be possible if significant natural gas reserves are found in proximity to the ROMPCO pipeline and/or in proximity to Secunda and become available at prices Sasol South Africa can afford and in the requisite quantities.

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