THE COAL VALUE CHAIN IN SOUTH AFRICA

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Trade & Industrial Policy Strategies (TIPS) is a research organisation that facilitates policy development and dialogue across three focus areas: trade and industrial policy, inequality and economic inclusion, and sustainable growth

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ABBREVIATIONS

AMSA	ArcelorMittal South Africa
BBBEE	Broad-Based Black Economic Empowerment
CPI	Consumer Price Index
DMR	Department of Mineral Resources
DFFE	Department of Environmental Affairs, Forestry and Fishing
DMRE	Department of Mineral Resources and Energy
EU	European Union
GEPF	Government Employees Pension Fund
IDC	Industrial Development Corporation
IRP	Integrated Resource Plan
NERSA	National Energy Regulator of South Africa
NEDLAC	National Economic Development and Labour Council
PCCC	Presidential Climate Change Coordinating Commission
REIPP	Renewable Energy Independent Producers Programme
SANEDI	South African National Energy Development Institute
SEZ	Special Economic Zone
US	United States

EXECUTIVE SUMMARY

South Africa has long been an international outlier as a producer and consumer of coal. In 2019, it accounted for 3,6% of global coal production compared to 0,4% of the world's gross domestic product and 0,8% of its population. In the 2010s, coal fuelled over 80% of South African electricity and generated 5% of its exports, while Sasol's oil-from-coal refineries produced a fifth of the national petrol supply. Over the past decade, however, fundamental changes in electricity technology and the risks posed by the climate emergency have profoundly disrupted the coal value chain. This paper analyses these disturbances and their implications for the South African economy as the basis for more strategic responses.

By 2020, escalating cost and growing interruptions in the electricity supply had become a central constraint on growth and job creation, as well as affecting the quality of life. At the macroeconomic level, the impacts emerged in falling demand for grid electricity, which contributed to stagnant domestic coal sales; the rise, despite this, in Eskom and coal mine revenues as a percentage of GDP; and in 2020, during the COVID-19 pandemic, the lagging recovery in electricity generation. The electricity malaise arose chiefly from Eskom's reliance on an increasingly uncompetitive and fault-ridden fleet of coal power stations. A shift in rents from Eskom to the coal mines during the 2010s aggravated the situation.

South Africa's electricity crisis was ultimately shaped by the global climate emergency. The coal value chain accounted for 60% of South Africa's greenhouse gas emissions. In 2020, Eskom alone emitted 45%; Sasol, over 10%; and the aluminium smelters Hillside (in Richard Bay) and Mozal (in Mozambique but fuelled by Eskom), another 5%. From the 2010s, the coal value chain faced an accelerating decline in international and domestic demand as producers sought cleaner fuels; the prospect of limits on emissions-intensive imports by major trading partners; growing pressure from domestic and foreign financial institutions and investors to move out of coal; and a range of domestic policy initiatives to discourage greenhouse gas emissions as well as air pollution generally.

In effect, the coal value chain was mired in a classic process of creative destruction. The term refers to situations where disruptive new technologies develop to the point where older assets can no longer compete and ultimately have to be written off. Global efforts to promote cleaner energy in the 2010s vastly reduced the cost and increased the flexibility of electricity generated from renewable sources and gas. In these circumstances, clinging to coal increasingly raised both the cost and the unreliability of the national grid. Simultaneously, the accelerating climate crisis intensified domestic and international pressure to limit the use of coal and coal-based products. The result was a marked expansion in public and private initiatives to raise the relative price of coal and to limit financing and investment for coal-based production. That led to rising costs along the coal value chain, making it less and less competitive with alternative energy sources.

These realities meant South Africa had no real choice except to transition away from coal over the medium to long term. The challenge was to manage the value chain in ways that minimised the costs and risks for society while maximising the benefits of the new technologies. If successful, the result would be a more diversified and competitive economy, based on a stable, low-cost electricity system. Despite these potential benefits, the shift will inevitably be disruptive. For over a century, a range of government supports embedded the coal value chain in core economic systems, including electricity, exports, rail infrastructure; most investment portfolios; a range of regulatory and fiscal arrangements; and four municipalities in Mpumalanga. Given these realities, strategies on the coal value chain had to aim, not to save production at any cost, but to ensure that the transition was efficient, sustainable and equitable. It also had to be viable politically. Analysis of the costs, benefits and risks of the transition away from coal for different stakeholders inside and outside of the coal value chain point to hard policy choices in three areas.

1. How fast to move into cleaner energy sources. Delays increasingly disrupted the international electricity supply and led to higher tariffs. The result was higher production costs across the economy, undermining national competitiveness and slowing growth in production and employment. Rapid innovation increasingly devalued existing investments along the coal value chain, from coal reserves to production lines at Eskom and Sasol to the aluminium and ferroalloys refineries.
2. How much effort and resources to dedicate to supporting and empowering workers and communities to move out of the coal economy. The value chain as a whole employed around 200 000 formal workers and was the main source of livelihoods in eMalahleni (Witbank), Steve Tshwete (Middelburg), Govan Mbeki (Secunda) and Msukaligwa (Ermelo). Absent public support, most of the workers and small businesses in these towns lacked the capacity and funds to find new livelihoods even though the shift to more efficient technologies should promote broader national growth and economic diversification.
3. How to capacitate the responsible government institutions to secure consistent implementation of key decisions around the transition, while promoting constructive engagement and action from stakeholders and civil society. The transition will impose significant costs on the comparatively small group of companies, workers and communities that depend on coal. The benefits to the rest of the economy and society will be far larger, but less tangible and more widely spread. Experience in South Africa and internationally shows that these conditions make it harder to ensure consistent implementation of economic policies. The fragmentation of state governance of the coal value chain aggravated the problem.

In the short run, critical steps to ensure a more equitable and efficient transition away from coal included the following.

- Freezing investment in new private coal plants, including the 3,5 gigawatt (GW) coal plant currently proposed for the Musina Makhado Special Economic Zone in Limpopo that would make it virtually impossible to achieve national commitments on reducing emissions.
- Lifting unnecessary regulatory limits on investment in renewable capacity and storage, including restrictions on Eskom investment in cleaner energy sources. In the longer run, this approach depended on more advanced grid management to coordinate many smaller suppliers. It would also necessitate greater clarity about the role of Eskom in electricity generation in the long run.
- Encouraging the aluminium and ferroalloy refineries and Sasol to safeguard their longer-term export prospects by developing cleaner energy sources and introducing electricity-saving processes as rapidly as possible.
- Reviewing the timeline for closing down coal plants. Eskom has proposed shutting down some of its power station earlier than originally planned in order to open space for other energy sources. It aims to reduce greenhouse gas emissions and pollution, increase its access to finance, and avoid the cost of retrofitting to meet national requirements.

The fragmentation of government oversight over the coal value chain made it harder to manage the transition away from coal. Responsibilities were divided unsystematically between various national departments, the provincial governments in Mpumalanga and Limpopo, municipalities that housed mines and refineries, and a range of state-owned companies. The result was a cacophony of contradictory measures. Disagreements centred on the following questions.

- How fast to move in reducing emissions and other coal-based pollution, and by extension the rigor of the associated incentives and penalties, including the carbon tax and the implementation of the national Integrated Resource Plan for electricity.
- The need for new coal capacity. Proponents of new build argued that it was necessary to provide a stable baseload and take advantage of coal rents. Opponents argued that the potential benefits were outweighed by the relatively high costs. These included comparatively high market prices of coal-based generation; the unreliability of both old and new coal plants in the early 2020s; the burdens of climate change and pollution; and the risk of international trade measures affecting exports.
- How much private competition Eskom should face, and whether it should be able to invest in renewables – a precondition for it to maintain its market share in the medium term.
- Whether the state should continue to incentivise energy-intensive metals refineries, including through subsidies on Eskom electricity.
- How much the state should subsidise Eskom itself, which ultimately reduced the cost to users of coal-based electricity.

In addition, the existing system of mandates entirely left out responsibility for ensuring a just transition for communities, workers and small businesses as the economy moved away from coal, although a number of agencies began work on the issue in the 2020s.

A first step toward a strategy on the transition away from coal, then, was to ensure more coordinated oversight of the coal value chain. Key changes included the following.

First, all of the relevant agencies, especially the relevant government departments, Eskom and the National Energy Regulator of South Africa (NERSA), should explicitly include a just, efficient and urgent energy transition as a priority in their mandates. Their activities should be measured more consistently against the impacts on national emissions targets; the cost and reliability of electricity for both large and small producers; and opportunities for vulnerable groups to move away from dependency on the coal value chain.

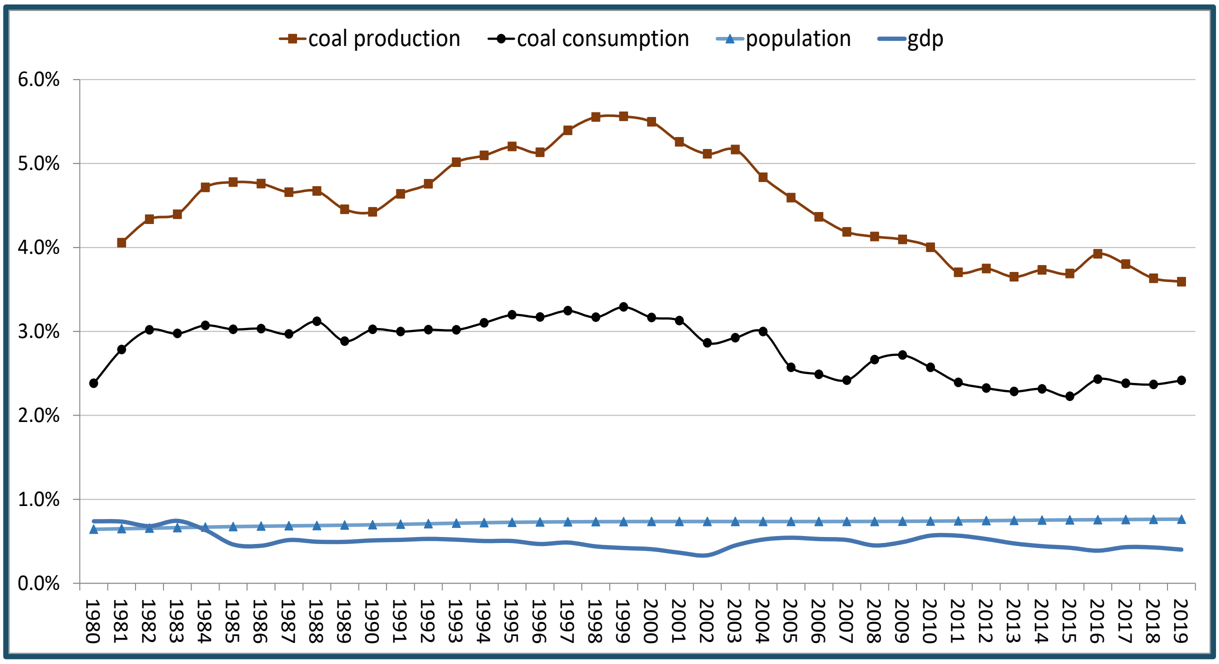
Second, the process required a capacitated leadership structure that could give voice to all of the relevant agencies but then make binding decisions in areas of disagreement. Since 1994, this kind of national project has usually been led by the Presidency, which convened forums for consistent engagement by the relevant ministers, premiers and mayors, and provided a strongly capacitated secretariat. For the coal value chain, the Presidential Climate Change Coordinating Commission could provide decision support and facilitate consultation with stakeholders. The National Economic Development and Labour Council (NEDLAC) could also facilitate engagement with economic stakeholders both inside and outside of the coal value chain.

The energy transition will take decades. That gives time to establish structures to manage it effectively with a whole-of-government approach – a critical first step toward maximising the benefits while managing the risks and costs of the inevitable disruption to the coal value chain.

1 PROBLEM STATEMENT

South Africa has long been an international outlier as a producer and consumer of coal. In 2019, it accounted for 3,6% of global coal production compared to 0,4% of the world's gross domestic product and 0,8% of its population. (Graph 1). In the 2010s, coal fuelled over 80% of South African electricity and generated 5% of its exports, while Sasol's oil-from-coal refineries produced a fifth of the national petrol supply.

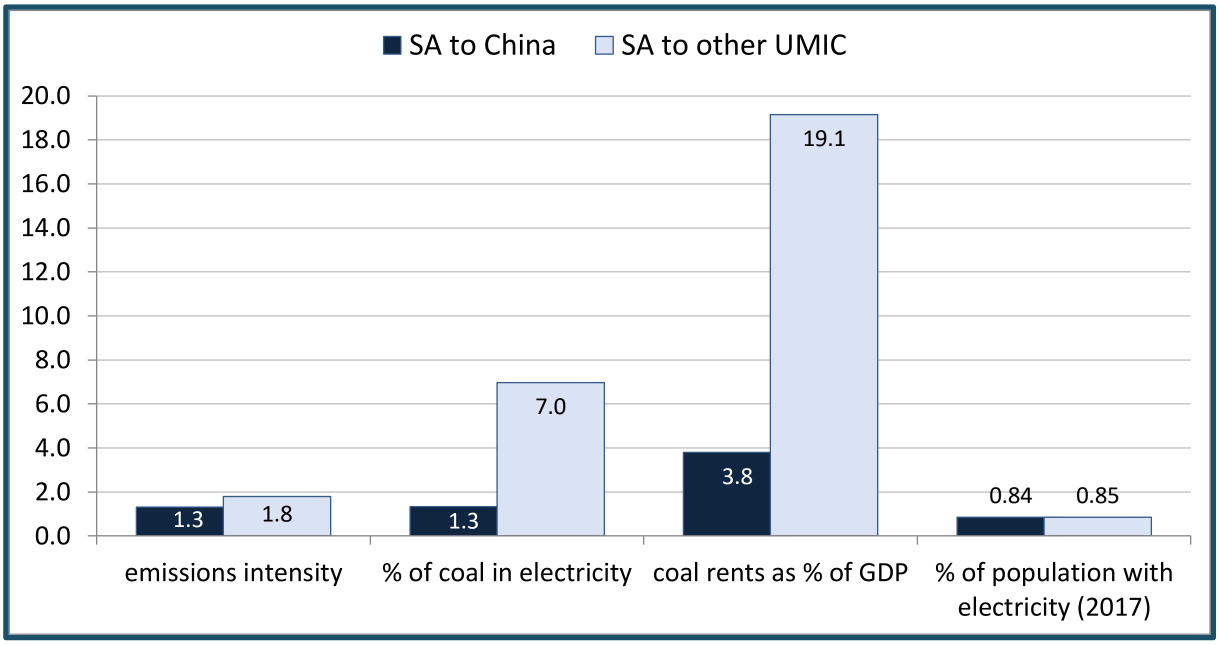
Graph 1. South African share in world coal production and consumption, population and GDP, 1980 to 2019



Source: Coal consumption and production calculated from Oxford University. Our World In Data. Interactive dataset. Downloaded from https://ourworldindata.org/fossil-fuels in May 2021. GDP and population calculated from World Bank. World Development Indicators. Interactive dataset. Downloaded from www.worldbank.org in May 2021.

As Graph 2 shows, in 2015 coal rents as a percentage of the GDP were 19 times higher in South Africa than in other upper-middle-income economies excluding China; the share of coal in fuelling electricity was seven times higher; and emissions per rand of GDP were 80% higher. South Africa also relied on coal more than China, but the differences were less pronounced.

Graph 2. Ratio of South Africa to China and to other upper-middle-income countries (UMIC) for emissions intensity, share of coal in electricity, coal rents and household access to electricity, 2015



Source: Calculated from World Bank, World Development Indicators. Interactive database. Downloaded from www.worldbank.org in February 2020.

For over a hundred years, quality state-supplied electricity for formal businesses and wealthy households constituted a key attraction for investors in South Africa, and especially the extraordinarily energy-intensive aluminium, ferroalloys and steel refineries. From the early 2000s, however, the coal value chain was profoundly disrupted. That in turn initiated far-reaching changes in cost and production structures in virtually every industry. This paper examines the nature of the disruption and the impacts on the broader economy. It concludes that the best option for the value chain is a managed decline over the coming 20 years.

The immediate disruption to the coal value chain arose from the national electricity system. In the 2010s, electricity became a core constraint on economic growth through a toxic combination of soaring costs and increasing interruptions. Its deteriorating quality and cost largely reflected the rapid decline in the competitiveness of coal-based power generation. Renewables and gas both provided lower-cost energy with increasingly efficient and flexible technologies. Simultaneously, shifts in power within the coal value chain meant that the mines were able to raise their prices to Eskom. In effect, they seized rents that had previously supported downstream producers, especially metals exports.

The disruption in the electricity system was ultimately shaped by the more profound challenge of the deepening climate crisis. In the 21st Century, South Africa's unusually strong reliance on coal for energy made it a global outlier in emissions relative to the size of both the economy and the population. The climate crisis brought growing domestic regulation to reduce environmental costs from the value chain, as well as increasingly constrained financing, gradual disinvestment by major companies, and stagnant export demand. Key trading partners considered carbon taxes on imports, which could prove a drag on all export industries and would severely affect the most coal-intensive – that is, aluminium, ferroalloys and polymers.

The fundamental importance of the coal value chain to the South African economy means that its dual crises required a consistent, strategic and whole-of-government response. This study aims to provide a holistic analysis of the value chain as the basis for developing more strategic options.

Section 2 outlines the scope of the coal value chain and its impact on the economy overall. Section 3 describes the disruption in the electricity supply, and Section 4 the impact of the climate emergency. Section 5 reviews factors in the policy environment that made it more difficult to establish a coherent and strategic national response to the disruptions in the coal industry. Based on this analysis, the conclusions outline the implications for policy options.

In 2021, a particular challenge was that leading stakeholders had an interest in avoiding a rapid, or in some cases any, move to clean energy sources, even when they would be cheaper than coal. In this context, Eskom's monopoly on the national grid gave it extraordinary power relative to both government and private actors. Other stakeholders in the coal value chain were also relatively well organised, which enabled them to lobby against innovation and for government support for the existing system. On the other side, the fragmentation of the state – above all the relative autonomy of the mining and environment ministries as well as NERSA – enabled stakeholders to lobby and to forum shop.

2 THE ROLE OF THE COAL VALUE CHAIN IN SOUTH AFRICA

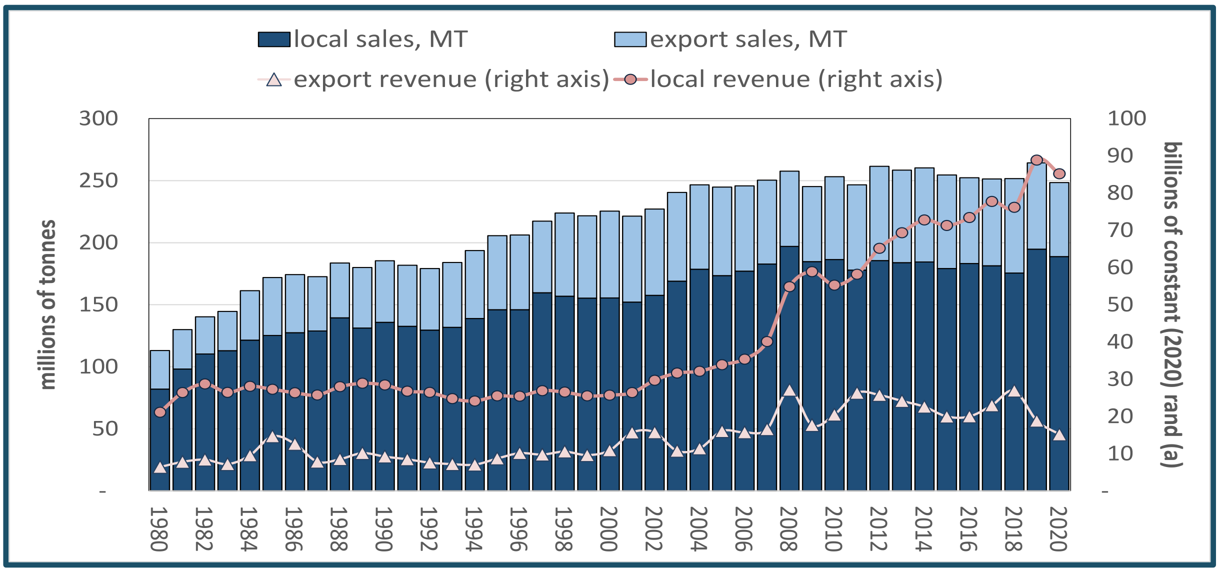
This section first reviews the evolution of coal mining. It then maps the value chain, which was far more important for the economy as a whole.

2.1 Coal mining and the South African economy

Like the rest of mining, coal production faced substantial reversals after the global commodity boom ended in 2011. The declining importance of coal in both the national and the global economy aggravated these problems. The result was stagnant coal production and exports, and disinvestment by global mining companies. As a result, local enterprises increasingly owned the coal mines. Many had substantial government financing through the Industrial Development Corporation (IDC) and public service retirement fund.

Coal production declined slowly from 2008 to 2020, after climbing steadily by an average of 3% a year from 1980 to 2008 (Graph 3). In 2019, exports accounted for 26% of production in tonnes but 39% in revenue terms. Domestic sales rose in 2019 and 2020 compared to the previous few years, but the increase was not likely to be sustained since it resulted mostly from Eskom's efforts to increase its stockpiles rather than from higher consumption. Revenues from both domestic and coal sales dropped from 2008, although they had increased an average of 4,4% annually in constant rand (deflated with CPI) from 1980 to 2008. As a result of these trends, from 2011 to 2020 the contribution of coal mining to the GDP fell from 2,3% to 1,9%. In 1993, the industry contributed 1,3% of the GDP.

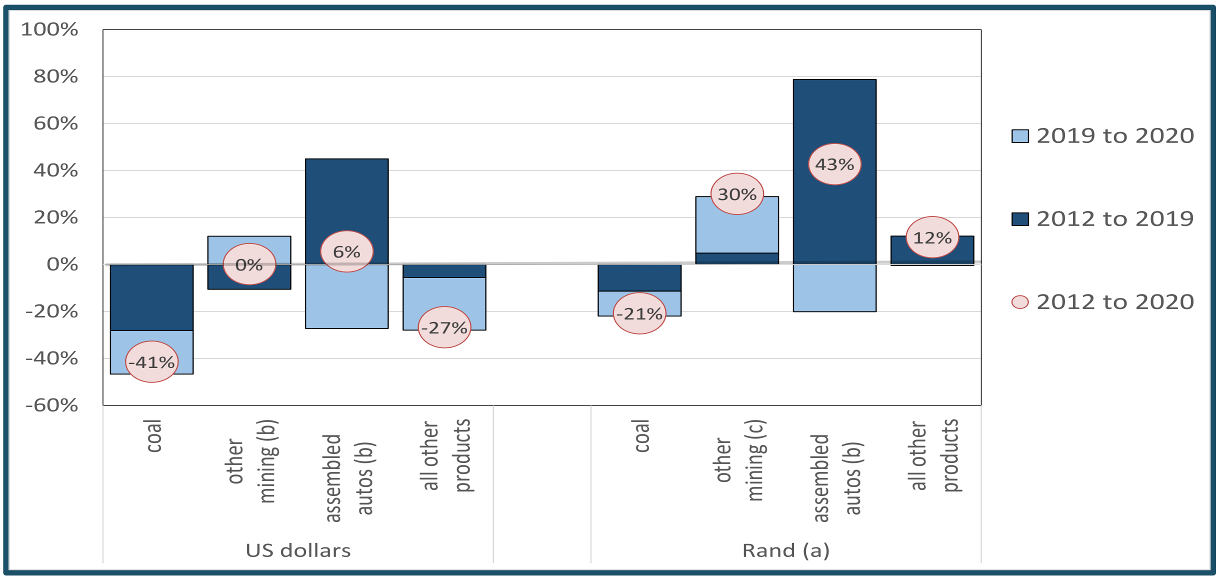
Graph 3. Coal production in millions of tonnes and revenues in billions of constant (2020) rand, 1980 to 2020



Note: (a) Reflated with CPI. *Source:* Calculated from the Department of Mineral Resources (DMR). Mineral Statistics. Accessed at Quantec. EasyData. Interactive dataset. Accessed at www.quantec.co.za in May 2021.

Like other mining, coal had a larger share in exports than in the economy, although its significance declined in the 2010s. Coal exports dropped from 7% of South Africa's total foreign earnings in 2011 to 4,6% in 2020. Still, coal continued to rank around ninth in South Africa's top ten export commodities. In tonnes, coal exports shrank 8% from 2012 to 2019, then another 14% from 2019 to 2020 as the COVID-19 pandemic hit. As Graph 4 shows, in United States (US) dollar terms, coal exports declined far more rapidly than other mining exports in the 2010s, while auto exports grew rapidly. In constant rand terms, depreciation moderated the decline, but even by this measure coal export revenues dropped a fifth from 2012 to 2020.

Graph 4. Change in value of exports of coal and other major commodities in US dollars and constant rand (a), 2012 to 2019 and 2019 to 2020

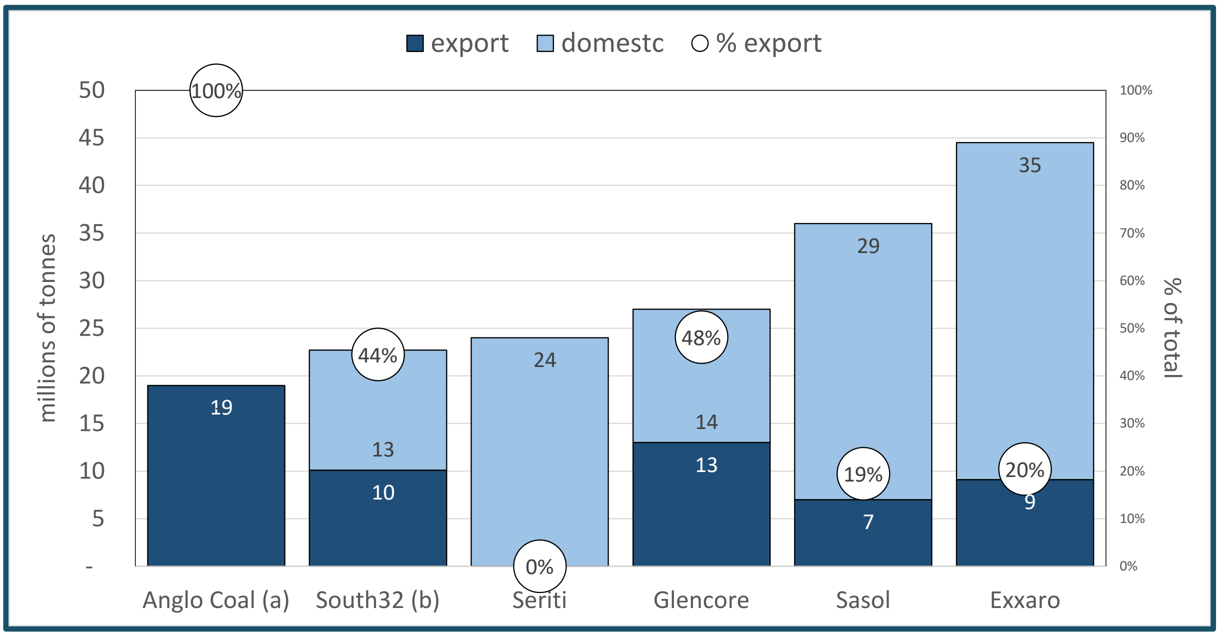


Notes: (a) Deflated with CPI. (b) Both autos and trucks. (c) Includes platinum (with catalytic converters), gold, ferroalloys, manganese, chromium and diamonds. *Source:* Calculated from ITC. Trade Map. Interactive dataset. Accessed at www.trademap.org in May 2021.

Because coal production is highly capital intensive, its contribution to employment lagged its share in the GDP and exports. Its share in national employment was just 0,7% in 2019. The number of coal miners climbed from 50 000 in the early 2000s to 90 000 in 2014, as higher coal prices led companies to open up more hard-to-reach seams, but then flattened out. Coal employment in 2019 was still far lower than in the early 1980s, when it was around 130 000. Still, the rest of mining shed jobs more quickly than coal for most of this period, mostly because of the long-term decline in gold production. As a result, the share of coal in mining employment climbed from a tenth at the start of the 21st Century to a fifth in the late 2010s.

South Africa had around 150 coal mines in 2020. Six companies, half of them foreign owned, accounted for three quarters of production. The share of foreign ownership had declined rapidly through the 2010s, as multinational mining conglomerates divested from coal. These companies responded to two pressures: on the one hand, worsening global and environmental prospects, and on the other Eskom's policy of guiding procurement toward local black-owned companies. The withdrawal of foreign companies opened up extraordinary opportunities for empowered South African capital, which also inherited the risks from declining national and global coal sales.

Graph 5. Major coal mine operators: Production for local use and exports in millions of tonnes and share going for export in 2019/20 financial year



Note: (a) Anglo Coal transferred ownership to a new company, Thungela, owned by Anglo American shareholders, in mid-2021. (b) South32 committed to sell its coal holdings to Seriti in 2021. *Source:* Company reports (Annual Reports and websites), accessed in May 2021.

Anglo American was historically the main player in South African coal production. From 2006, however, it gradually divested all if its mines to Exxaro, Seriti and, from mid-2021, a new company named Thungela. In 2021, South32 agreed to sell its coal mines to Seriti. As of 2020, Glencore expected to exit coal in South Africa in around 15 years, in line with its plan to wind down its coal holdings worldwide.

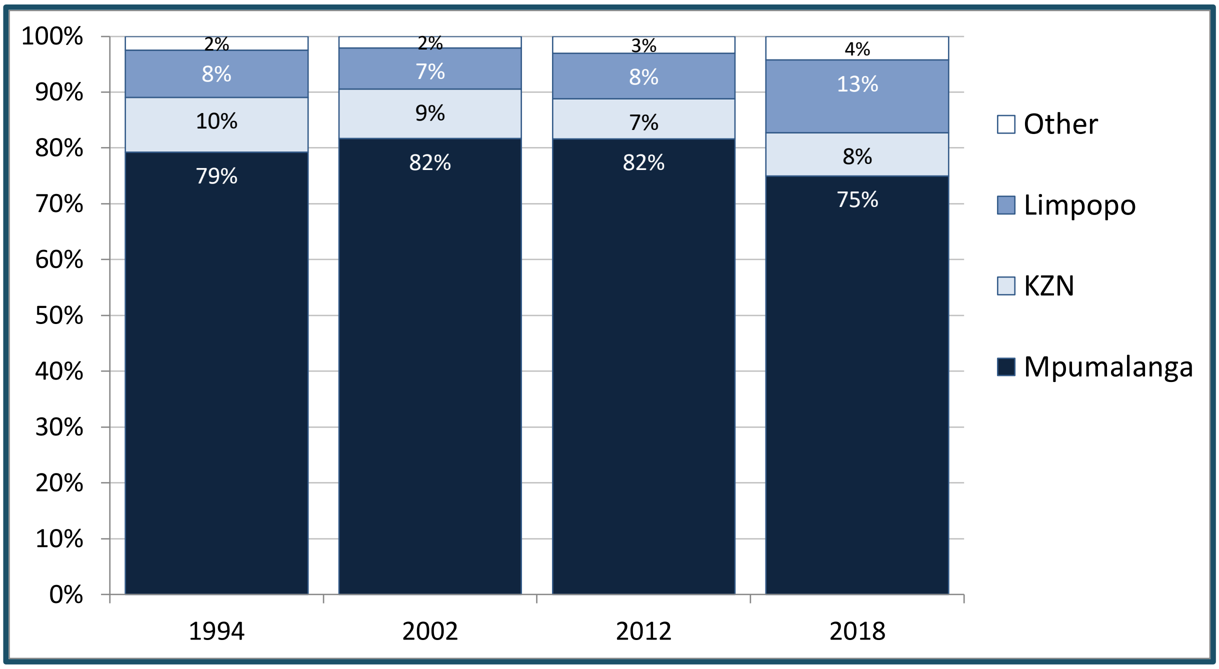
Exxaro became the largest coal producer in South Africa by expanding its market share while overall output stagnated and foreign companies withdrew. From 2014 to 2018, its coal production climbed 3,4% a year, although national coal output dropped 0,7%.

In consequence, Exxaro's share in South African coal output rose from around 15% to almost 20%. In the following two years, both Exxaro and national coal production dropped by around 1,5%.[1] From this perspective, Exxaro illustrated the risks that empowerment in a declining industry can end up stranding the new black investors. In 2020, coal provided 96% of Exxaro's revenues and over 99% of its operating profits.

Sasol owned six mines in Mpumalanga and the Free State. It utilised most of its production in its own chemicals plants, and exported the remainder. In 2020, however, it announced that it would shift to gas feedstock if possible, and make no new coal investments.

From the 1990s, the coal mining industry in South Africa was increasingly concentrated in a few districts in Mpumalanga. As of 2018, the province accounted for 75% of value added and 85% of employment in coal. New developments in the 2010s were, however, mostly located in Limpopo in the Waterberg and Soutpansberg coalfields. As a result, the share of Limpopo in value added from coal rose from 5% in 2012 to 13% in 2019, as Graph 6 shows. KwaZulu-Natal accounted for around a tenth of South Africa's coal production in the early 1990s, but its share gradually declined from then.

Graph 6. Provincial shares in national gross value added from coal mining, 1994, 2002, 2012 and 2018

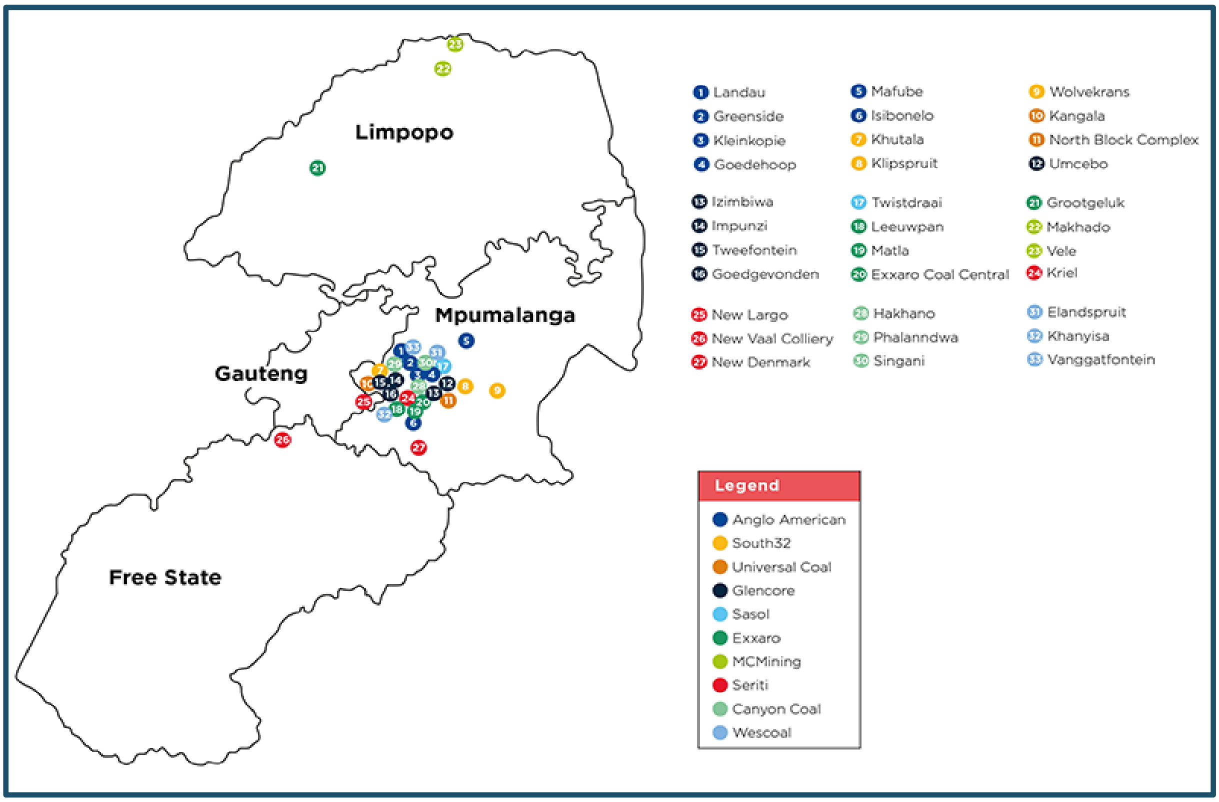


Source: Quantec EasyData. Interactive database. Standardised regional dataset. Series on gross value added. Downloaded from www.quantec.co.za in January 2020.

Figure 1 indicates the location of the major coal mines in South Africa.

[1] Calculated from Exxaro Annual Reports and Annual Financial Statements for relevant years.

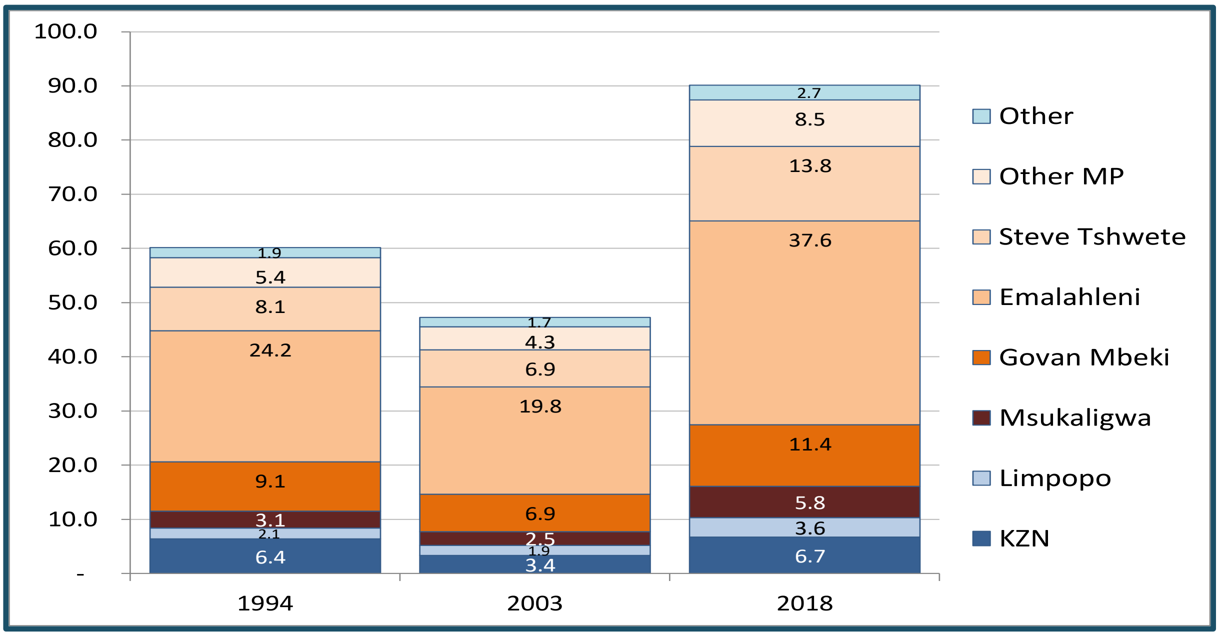
Figure 1. Location of coal mines



Source: Minerals Council of South Africa. 2019. Available: https://www.mineralscouncil.org.za/sa-mining/coal.

Within Mpumalanga, the bulk of coal mining employment was in four municipalities. Two out of five coal miners worked in eMalahleni (formerly Witbank), with around one in seven each in Steve Tshwete and Govan Mbeki.

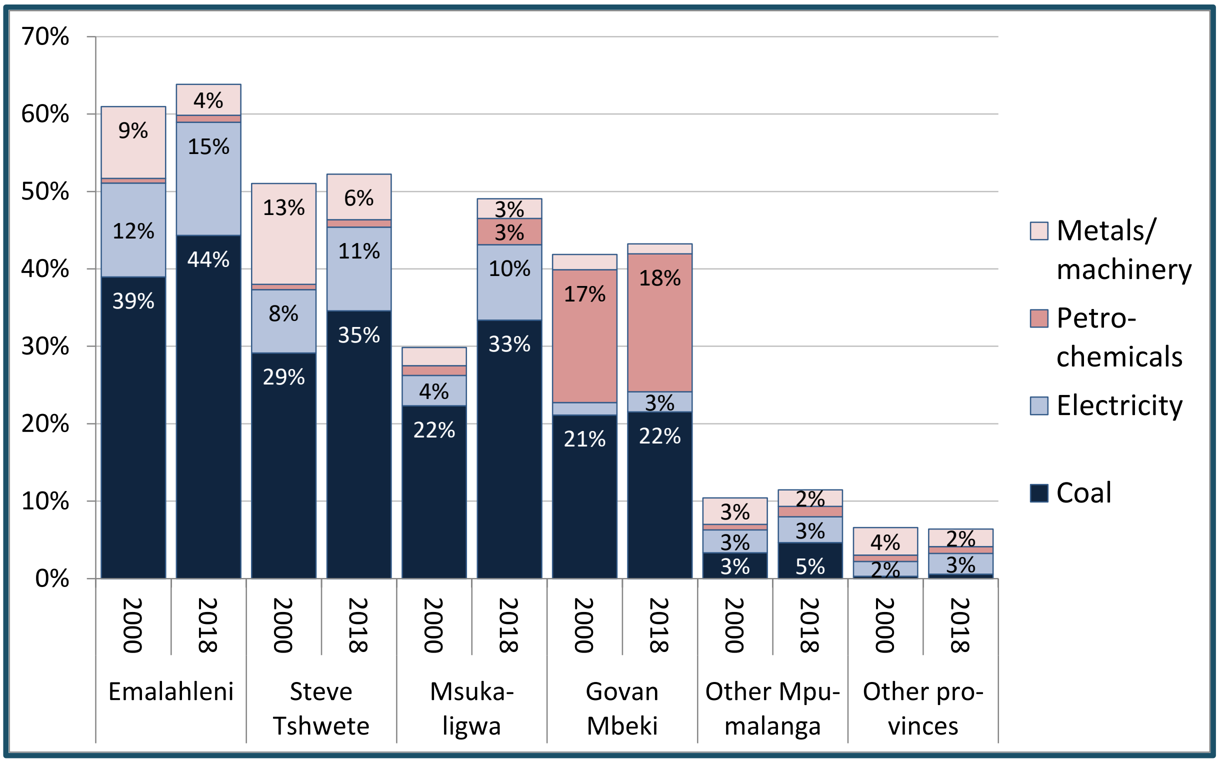
Graph 7. Formal employment in coal mining by location, in thousands, 1993, 2003, 2018 (a)



Note: (a) Quantec provides estimate by region. Its figures for formal employment align with official data, but its estimates for informal employment diverge. The figures here are only for formal employment. *Source:* Calculated from Quantec. EasyData. Interactive dataset. Standardised regional employment series. Downloaded from www.quantec.co.za in January 2020.

Four towns in Mpumalanga relied almost exclusively on coal mining in the 2010s – eMalahleni (Witbank), Steve Tshwete (Middelburg), Govan Mbeki (Secunda) and Msukaligwa (Ermelo). Taken together, the coal municipalities in Mpumalanga accounted for only 2% of the population and 2% of the economy outside of the coal value chain. Their population size varied from 450 000 in Emalahleni to 175 000 in Msukaligwa. Yet together, these four towns generated 67% of South Africa's total value added in coal. They also played a disproportionate role in downstream coal refining, contributing 20% of value added in petrochemicals and 14% in electricity. Graph 8 indicates the extent of their dependence on coal and coal refineries compared to the rest of Mpumalanga and to other provinces.

Graph 8. Gross value added in the coal value chain as percentage of total in coal towns, 2000 and 2018



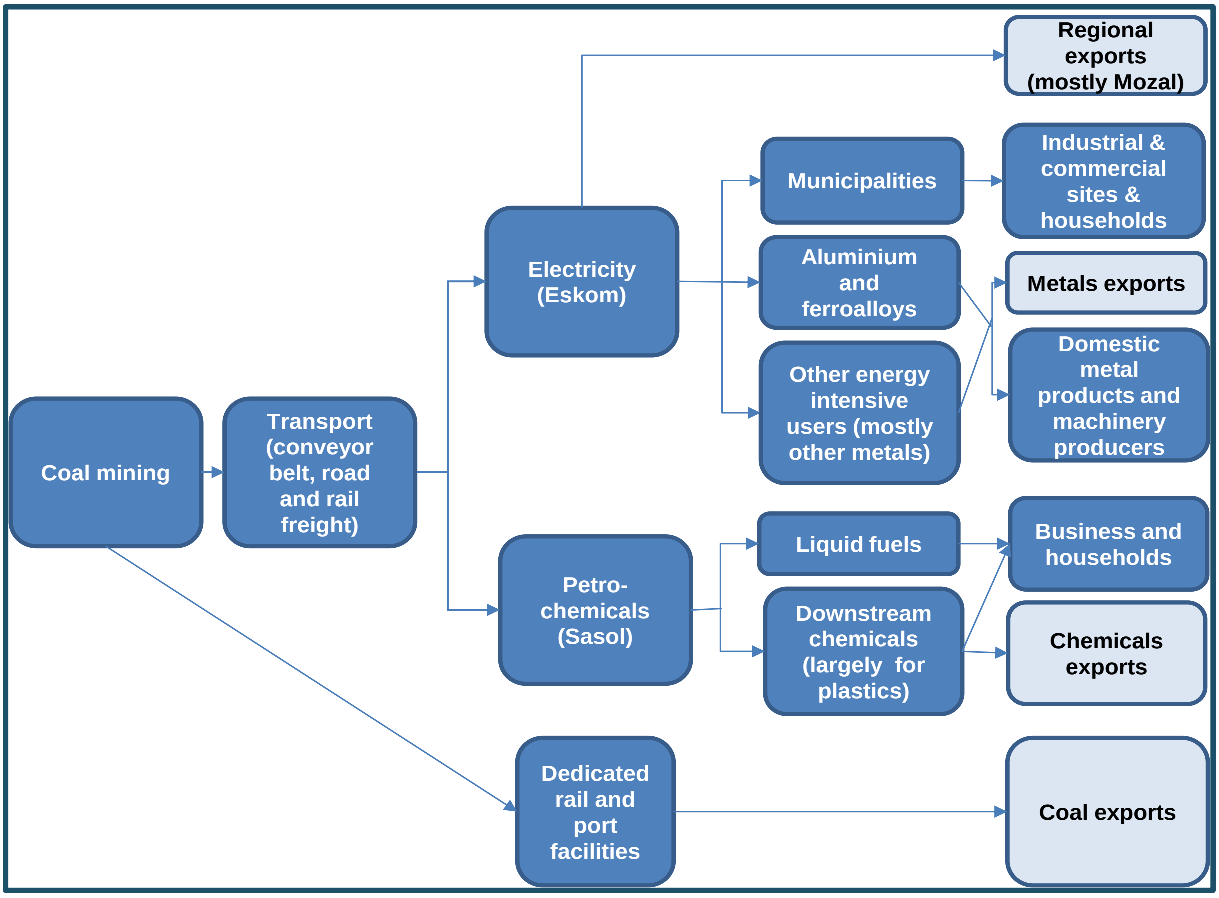
Source: Calculated from Quantec. EasyData. Interactive dataset. Standardised regional income and production series. Downloaded from www.quantec.co.za in January 2020.

In the early 2020s coal mining played a relatively small and declining role in the national economy by virtually every measure, although it was critically important in some parts of Mpumalanga. But focusing on mining underplays the significance of coal for the economy as a whole, and consequently the impact of the disruptions that emerged in the 2010s. To understand these impacts requires an analysis of the whole coal value chain.

2.2 The coal value chain

As Figure 2 indicates, in the early 2020s the coal value chain still had a determinant impact on the South African economy, primarily because it fuelled most of the national electricity grid. Three quarters of South Africa's coal output was beneficiated into electricity and liquid fuels. Aluminium and ferroalloys production, mostly for export, effectively constituted a secondary beneficiation phase, since electricity accounted for the lion's share of their production costs. That said, virtually every sector of the economy depended on electricity, and consequently the coal value chain, to some degree.

Figure 2. The coal value chain



In economic outcomes, the coal value chain directly contributed 5,4% of the GDP in 2018, mostly from mining and electricity generation. Electricity generation made up 2,7% of national value added in 2019; coal mining, 2,1%; chrome, manganese and aluminium refining, 0,3%; and coal-based liquid fuels, 0,2% (Calculated from Quantec 2020).[2] Because the coal value chain as a whole is capital intensive, its share in employment was lower. From 2008 to 2019, the number of jobs along the value chain climbed from around 150 000 to almost 200 000. They fluctuated around 1,5% of all formal employment in South Africa, with between half and a third in coal mining itself. Outside of coal, Eskom added most of the new jobs over the past decade, as its employment climbed from 33 000 in 2008 to 49 000 in 2019, before falling to 47 000 in 2020. Sasol's employment remained essentially unchanged at just over 25 000 in this period. In contrast, the base metal refineries shed 25 000 positions, falling from 72 000 in 2008 to 47 000 in 2019. (Calculated from annual reports for Eskom and Sasol, and from Quantec 2020a for metals and coal mining.)

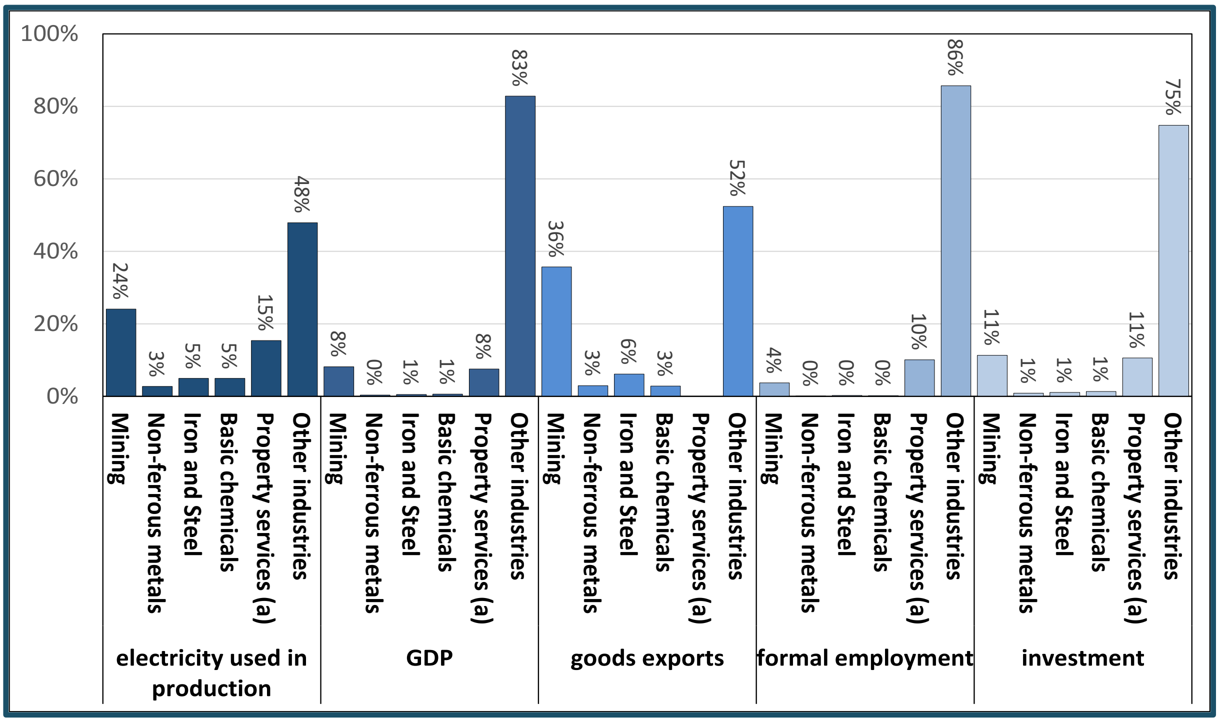
Coal fuelled 86% of South African electricity in 2020, down from 92% in 2010. Eskom alone used around 60% of all South African coal in its 30 power stations. That percentage had fallen from 70% a decade earlier. Almost 40% of Eskom's electricity went to approximately 3 500 energy-intensive users. Of these, around a thousand were mines and the rest mostly metals refineries plus Sasol and paper producers. In this group, the handful of aluminium, ferrochrome and manganese refineries used a tenth of Eskom's electricity, while Sasol and

[2] Liquid fuels estimated as 21% of total value added for the industry, based on SAPIA 2018:59. Ferroalloys and aluminium estimated at 40% of total metal refining, based on their share in sales of refined base metals.

ArcelorMittal South Africa (AMSA), the dominant national steel producer, utilised around 3,5%. Eskom exported 7% of national electricity production. Two thirds of its exports, or about 5% of its total generation, supplied South32's Mozal aluminium smelter in Mozambique.

Electricity dependency varied greatly by sector and, within manufacturing and services, by industry. Mining as a whole was the most energy-dependent sector, followed by property-related services (property management plus security and cleaning). Within manufacturing, the metals refineries and basic chemicals – dominated by Sasol – were unusually reliant on electricity, with paper in third place. In the rest of manufacturing, electricity constituted less than 2% of intermediate costs, according to Quantec estimates. As the following graph shows, the most electricity-intensive producers were critical for exports, but far less important for the GDP and employment.

Graph 9. Share in electricity use for production and in GDP, goods exports, employment and investment of electricity-intensive industries compared to all others, 2019



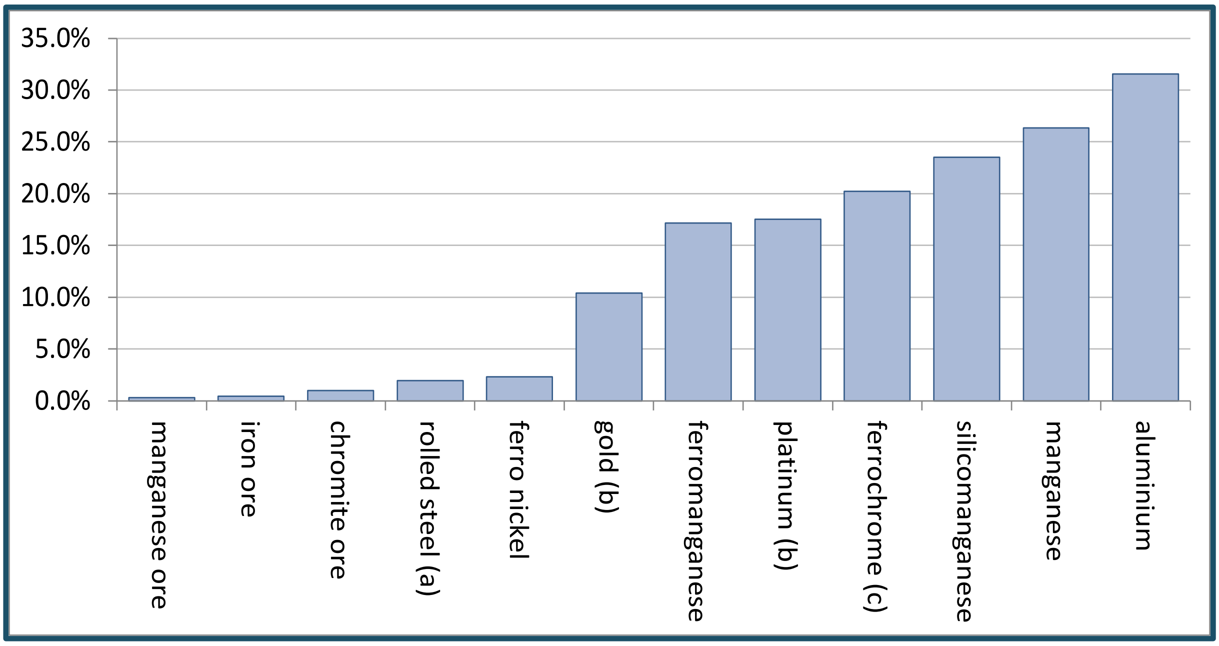
Note: (a) Real estate, security and cleaning. Reliable data on service exports are not available, and figures here relate exclusively to goods exports. *Source:* Calculated from Quantec. EasyData. Standardised Industry series. Downloaded from www.quantec.co.za in February 2021.

Electricity accounted for 20% to 30% of the price of ferroalloys and aluminium in the 2010s – more than any other input, including ore. In effect, these industries largely exported coal that had been beneficiated into electricity; indeed, the aluminium smelters imported all of their alumina from Australia. They used around a tenth of Eskom's electricity although they generated less than 3% of the GDP, 5% of exports, and under 0,3% of formal employment. As Graph 10 shows, ferroalloys and aluminium refineries were far more electricity-intensive than the rest of the mining value chain. The graph relies on international estimates, which do not always reflect South African realities because of differences in technology and raw materials. In 2018, for instance, electricity accounted for 31% of the unit cost of South African ferrochrome production, higher than international estimates.[3]

[3] Data provided by CRU. Accessed at www.crugroup.com in 2019.

Graph 10. Modelled estimates of electricity as percentage of export unit price for major metals, 2019

Note: Estimates are derived by multiplying the normed electricity requirement for producing each metal in kilowatt hours (kWh) by the unit export price of the output and the Eskom unit price for 2019. Gold and platinum figures include electricity used in mining.



Notes: (a) This estimate appears low; in 2019, electricity accounted for around 10% of operating costs at ArcelorMittal South Africa, according to its 2018/19 Annual Report. (b) Includes mining as well as smelting and refining. (c) Industry data suggest that in South Africa, electricity accounted for 30% of the unit cost of production of ferrochrome. *Sources:* Electricity per unit of output (tonne or troy ounce) from Bleiwas, D.I. Estimates of Electricity Requirements for the Recovery of Mineral Commodities, with Examples Applied to Sub-Saharan Africa. 2011. Open-File Report 2011-1253. US Geological Survey. Washington, D.C. Unit export prices from ITC. Trade Map. Interactive dataset. Downloaded from www.trademap.org in January 2020. Eskom tariffs calculated from the 2018/19 Annual Report as average for mining for all metals except aluminium, for which the average price for Eskom's "industry" category is used. The aluminium refineries got a concessionary rate, which meant the average for all refineries was lower than the tariff other metals producers paid.

The development of aluminium refining in Southern Africa relied heavily on government funding. In the 1990s, the state-owned IDC provided a significant share of the initial capital for both Mozal and Hulamin. The latter mostly produced rolled aluminium, primarily for export, using inputs from its smelters in Richard Bay. In 2020, the IDC still held 30% of Mozal and 24% of Hulamin. In real terms the value of its Mozal shares stagnated from 2010 to 2020, however, while its Hulamin holdings shrank sharply in 2020. As a result, these investments dropped relative to the IDC's total assets. In 2020, Mozal accounted for 14% of the IDC's total exposure, down from 24% in the first half of the 2010s. Hulamin contributed 3% in 2020, having fallen from 9% in 2010.

Eskom's customers outside of the mining value chain were comparatively small and diverse. The energy-intensive users included paper producers, commercial buildings, Transnet and Prasa. Eskom sold 40% of its output to municipalities, which in turn supplied the vast majority of industrial and commercial sites as well as around half of all households. Eskom itself supplied the remaining six million households directly, mostly in rural areas but including Soweto, parts of the Vaal, and a few other large townships. Most of the households it supplied used relatively little electricity. Taken together, they accounted for only 5% of electricity demand in 2020.

The limited available data suggest that business accounted for the bulk of municipal sales, at least in the economic hubs around the metros and secondary cities. Labour-force surveys found that in 2019 there were almost 800 000 formal businesses with 11,5 million employees outside of the mining value chain. In addition, 1,8 million informal enterprises provided livelihoods for three million workers. (Calculated from Stats SA 2019). Virtually all of these businesses purchased electricity from municipalities. Around a third of informal enterprises did not have connections at all, however. (Stats SA 2021:33)

In their annual reports, eThekwini and Johannesburg both said that two thirds of their electricity sales, by volume, went to business, with the rest purchased by households. Like Eskom, they distinguished between large users and smaller businesses. EThekwini had 45 000 business customers for electricity in 2018, but only 1 000 of them accounted for two fifths of its total electricity sales. In Johannesburg, around 4 000 large users bought over half. (eThekwini 2018:58 and City Power 2020:78)

After Eskom, Sasol was the second largest coal refinery in South Africa, using around 10% of domestic coal or 17 million tonnes. (Sasol 2020e:71) Coal accounted for three quarters of its total feedstock. In 2020, it operated two coal-to-liquid-fuel plants, at Sasolburg in the Free State and Secunda in Mpumalanga. They met a fifth of South African demand for liquid fuels (down from a third in the early 1990s). (SAPIA 2018:35). Sasol used a quarter of its fuel output to produce polymers, paint, fertilisers and explosives for domestic use and exports. Its largest chemicals product, polymers (around half of the total), is the main feedstock for plastics.

The coal value chain depends heavily on bulk transport both for coal itself and for downstream base metals and chemicals. Both Eskom and Sasol mostly used conveyor belts to move coal to their plants from nearby mines. Still, local roads and rail, mostly in Mpumalanga, carried around half of coal for domestic use. Exports depended on dedicated rail and port facilities supplied by Transnet, almost exclusively through a specialised coal terminal at Richards Bay that was owned jointly by the mining companies.

The coal value chain formed a major source of income for freight transport. Coal contracts, mostly for export, accounted for 20% of Transnet revenue in 2019. (Transnet 2019:52). As a rough estimate, coal accounted for around 6% of the total payload (by weight) for road freight in the late 2010s.[4] In March 2020, Eskom had contracts with 54 coal transport companies. (Eskom 2020b:104). Around 1 500 independent transport companies, mostly very small subcontractors, trucked coal to Eskom daily in the mid-2010s. (Eskom 2016:46)

Overall, the coal value chain had an outsized impact on the economy compared to its direct contribution to the GDP and its limited employment creation. Its main impacts were through the supply of electricity, disproportionately to electricity-intensive metals refineries, and secondarily through the production of petrochemicals. It was particularly important for a few major local mining companies plus the communities that housed the mines and Sasol, most of which were in Mpumalanga.

[4] Calculated based on Eskom coal tonnage carried by road (Greve 2018) compared to total road freight payload in tonnes (Stats SA 2021).

3 COAL AND THE DISRUPTION OF THE ELECTRICITY SYSTEM

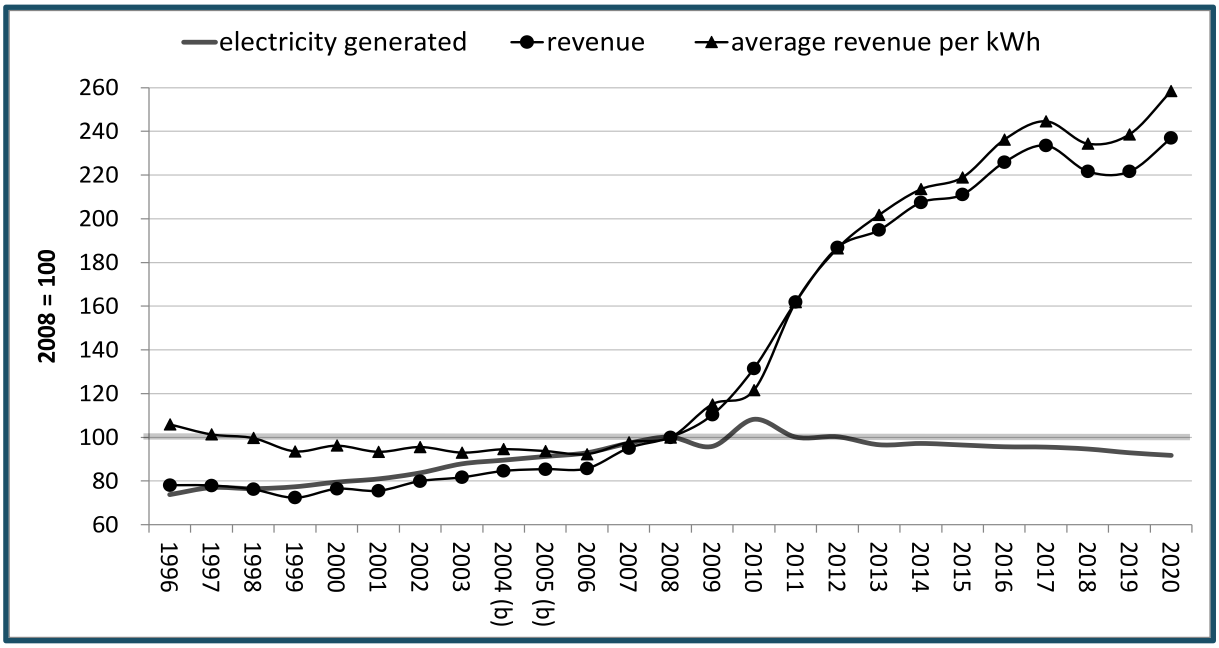
By 2020, the escalating cost and growing interruptions in electricity supply had become a central constraint on growth and job creation, as well as affecting the quality of life. At the macroeconomic level, the impacts emerged in the steep increase in Eskom and coal revenues relative to the economy; falling demand for grid electricity, which contributed to stagnant domestic coal sales; and in 2020/21, during the pandemic, the slow recovery in electricity production. The principal cause of the electricity challenges lay in Eskom's reliance on an increasingly uncompetitive and fault-ridden fleet of coal power stations. A shift in rents from Eskom to the coal mining companies during the 2010s aggravated the situation.

This section first outlines the dimensions of the electricity crisis and its economic impacts. It then explores the factors behind the disruption and the implications for the coal value chain.

3.1 The nature of the disruption

The electricity crisis emerged in three ways: through soaring prices for businesses and households; reduced reliability, with mounting interruptions to both the national and municipal grids; and declining demand. Eskom's sales in gigawatt hours (GWh) fell 15% from 2010 to 2020, after rising 45% over the previous decade. Yet its revenues doubled in real terms, as Graph 11 shows.

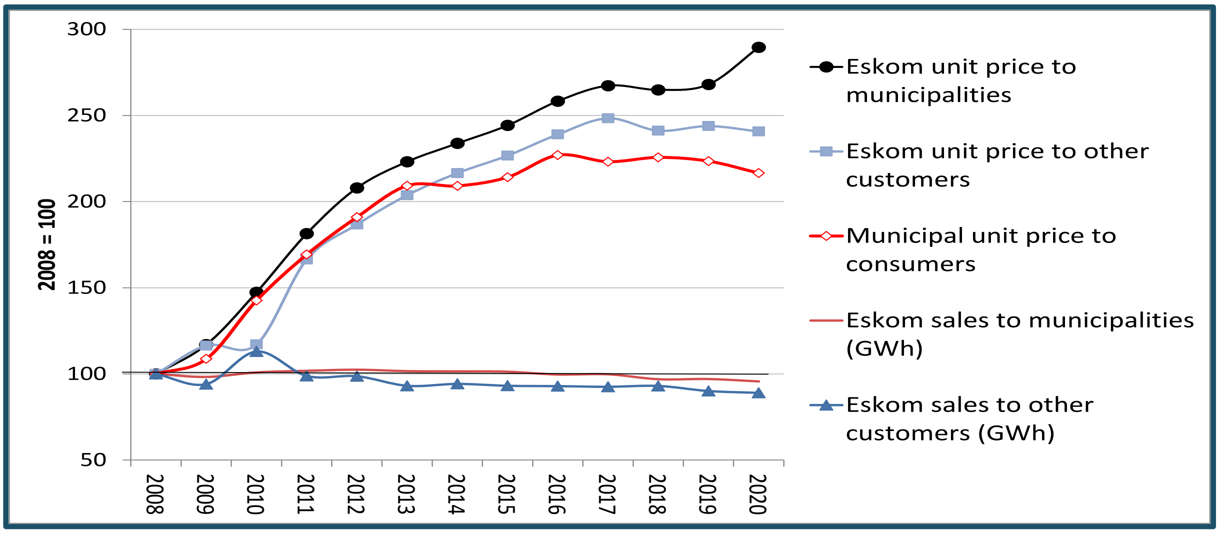
Graph 11. Indices of Eskom electricity generated in GWh, and total revenue and average revenue per kWh in constant rand (a), 1996 to 2019 (2009 = 100)



Note: (a) Deflated with CPI. (b) Estimated due to change in financial year in 2004/5. *Source:* Calculated from Eskom Annual Reports for relevant years.

For businesses, the extent of electricity price increases varied depending on whether they purchased it directly from Eskom or from municipalities. From 2009 to 2020, in constant rand, the overall Eskom unit price climbed 160%, while the municipal unit price rose 117%. After initially declining relatively slowly, from 2015 to March 2020 Eskom's sales to municipal customers in volume terms dropped 6%, while its other sales contracted by 4%. The figures to March 2020 do not reflect the even sharper decline in electricity sales from April 2020 as a result of the pandemic.

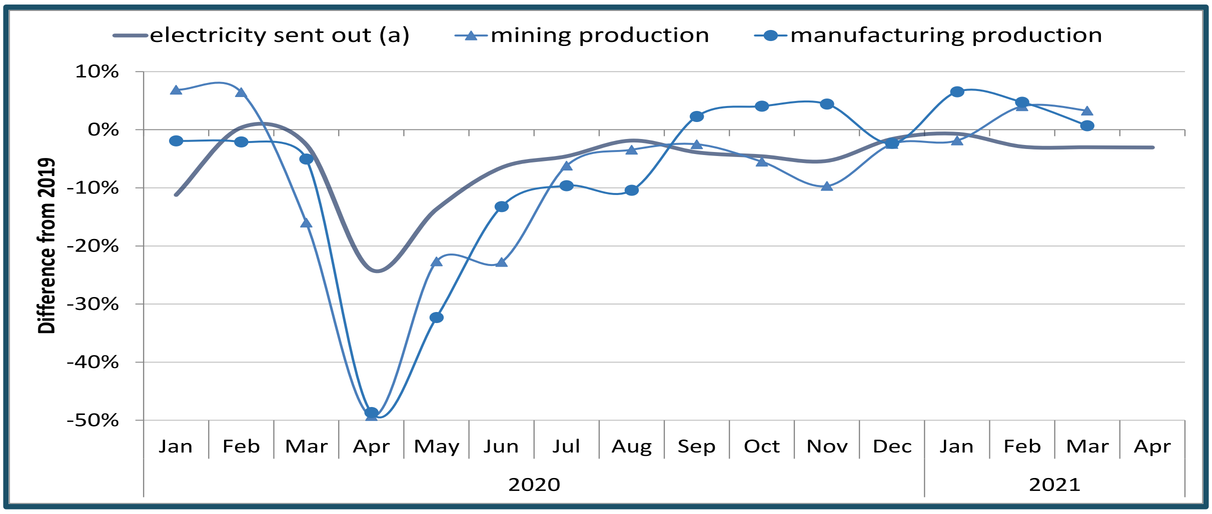
Graph 12. Indices of Eskom electricity sales to municipalities and other customers in GWh, and average Eskom and municipal revenue per kWh (a) in constant rand (b), 2008 to 2019 (2008=100; financial years)



Notes: (a) Calculated as budgeted municipal revenue divided by Eskom sales to municipalities. Data for municipal revenue are budgeted figures, around 10% higher than actual sales during this period. Budgeted figures are used because only 130 out of over 270 municipalities reported actual electricity revenue from 2017 to 2019. These municipalities accounting for between half and three quarters of total sales. (b) Deflated with CPI. *Source:* Eskom sales and unit prices calculated from Eskom Annual Reports for relevant years. Municipal unit price calculated from Eskom sales figures from Annual Reports and budgeted revenues for electricity from National Treasury. Municipal Budget information for relevant years. Accessed at www.mfma.treasury.gov.za in January 2021.

As well as escalating in cost, electricity supply was increasingly unreliable and constrained. That proved particularly damaging as the economy struggled to recover from the COVID-19 pandemic in late 2020. Although electricity generation did not fall as far as mining and manufacturing during the lockdown in April 2020, it recovered far more slowly (see Graph 13).

Graph 13. Eskom electricity, mining and manufacturing production as a percentage of the previous year, monthly, January 2000 to April 2021 (April 2021 for Eskom only)



Note: (a) Estimated from daily averages derived from weekly data. *Source:* For Eskom, System adequacy reports for the relevant weeks. PowerPoint presentations. Downloaded from www.eskom.co.za in February 2021. For mining, calculated from indices for volume of production from Statistics South Africa. Mining Production and Sales. Excel spreadsheet. Downloaded from www.statssa.gov.za in February 2021. For manufacturing, calculated from indices for volume of production from Statistics South Africa. Manufacturing Production and Sales. Excel spreadsheet. Downloaded from www.statssa.gov.za in February 2021.

Eskom imposed loadshedding in seven of the 13 financial years (ending in March) from 2008 to 2021, including every year from 2019 through 2021. Loadshedding resulted because Eskom's coal power plants were unable to generate as much electricity as planned. It rationed electricity use through:

- Reduced but uninterrupted supply to the mines, refineries and other energy-intensive users that Eskom served directly; and
- Rotating hours-long blackouts for businesses and households supplied through municipalities as well as the households that relied on Eskom.

The extent of loadshedding varied substantially by year, with a surge to the highest recorded levels in 2019 and 2020. In 2019, announced loadshedding aimed to reduce demand by 1 350 GWh; in 2020, the figure came to 1 800 GWh. (Calitz and Wright 2021:190). As of mid-2020, Eskom anticipated that loadshedding would continue through 2023 as it struggled to maintain and repair its coal plants. Loadshedding equalled 0,6% of Eskom sales in 2019, and 0,8% in 2020.

These figures understate the disruption to producers because losses were concentrated on a few days. In 2020, loadshedding took place over 860 hours, or almost 10% of the total. When it was in force, it reduced electricity use by 9% on average. (Calculated from Calitz and Wright 2021:190).

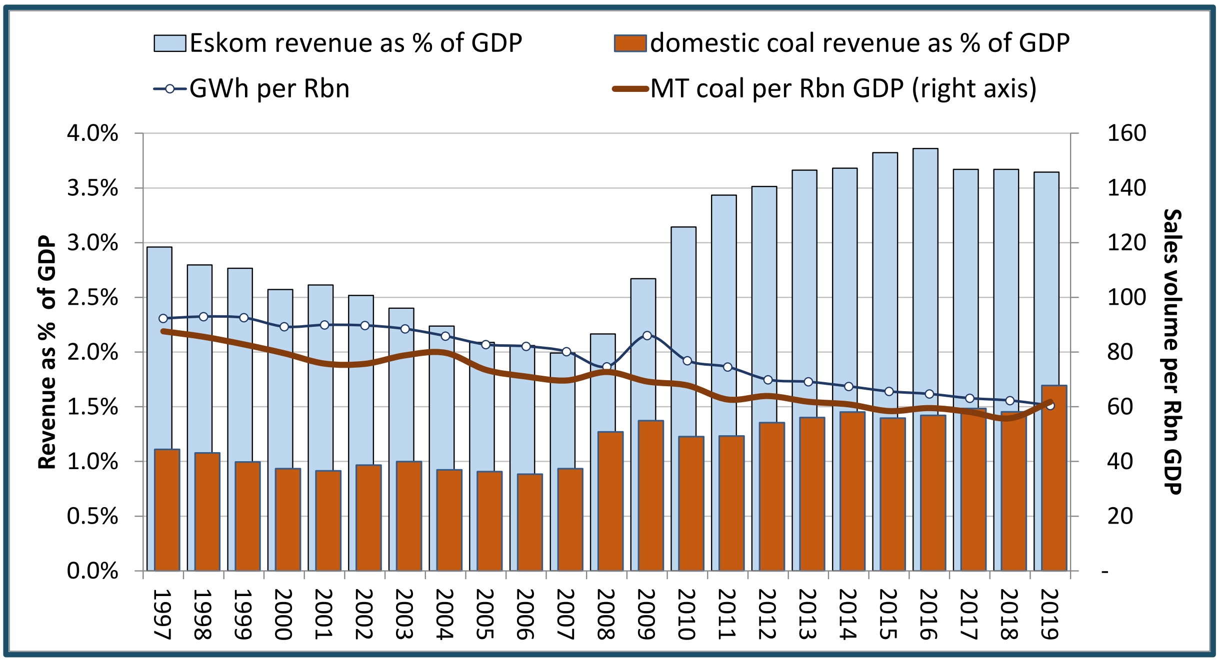
In addition to interruptions by Eskom, the available data suggest that the 2010s saw growing breakdowns and deteriorating quality in the municipal supply, although the impact varied by municipality. Unfortunately, there was no consistent public reporting on the extent of interruptions, which varied strongly between municipalities. Ekurhuleni estimated its electricity downtime at 0,64% in 2017/8 (Ekurhuleni 2018:404), for an average of ten minutes a day. In 2018, Cape Town reported just under one interruption daily per customer, which was somewhat better than the average for the US. But the figure was 2,5 in eThekwini; in Johannesburg, it was 6,5, up from 1,1 in 2010. Other metros and secondary cities did not publish standard data on interruptions at all. (World Bank 2018:48)

3.2 Economic impacts

Higher electricity tariffs and regular disruptions in supply effectively raised the costs of production across the economy, making it harder for enterprises to compete with imports or on export markets. The impact on individual industries varied depending on the extent of energy intensity; the need for high-quality and consistent current; the ability to limit electricity use by going off-grid or increasing electricity efficiency; and location, since the quality of supply varied between municipalities. Most obviously, the disruption of the national grid made electricity-intensive, coal-based minerals beneficiation much less competitive globally. But it also proved a growing burden for other manufacturing and services. Many producers were severely affected by the combination of higher prices and repeated interruptions.

From 2008, the revenues for Eskom and domestic coal sales captured a rising share of the national economy. Eskom's revenues climbed from 1,8% of the GDP in 2007 to 3,7% in 2016. They then levelled out through 2019, but ticked up sharply in 2020. In 2021 and 2022, Eskom won a double-digit increase in electricity tariffs. Combined with the economic decline due to the COVID-19 pandemic, that meant it was likely to capture over 4% of the GDP. That would constitute its highest share since the transition to democracy. Rising revenues for coal producers paralleled the increase in Eskom earnings. They climbed from 0,9% of the GDP in 2007 to 1,7% in 2020.

Graph 14. Domestic Eskom and coal revenues as percentage of the GDP and sales by volume per billion rand of GDP (a)



Note: (a) Figures for coal relate to total domestic sales, not just sales to Eskom. Figures for electricity intensity and revenue relate only to electricity sold by Eskom through the national grid, and exclude exports. Eskom and domestic coal revenue given as percentage of current GDP; volume of use per billion rand of GDP measures GDP using constant rand. Figures for Eskom are year from March; other data are calendar year. *Source:* Eskom revenue and sales from Eskom Annual Reports for relevant years; coal data from DMR. Mineral Statistics (annual until 2018, then monthly). Downloaded from www.quantec.co.za in April 2021. GDP data from Statistics South Africa. GDPp 2q20 previous format. Excel spreadsheet. Downloaded from www.statssa.gov.za in April 2021.

The deteriorating cost and reliability of coal-based electricity from 2008 initiated a gradual decline in demand. As Graph 11 shows, in volume terms, Eskom's sales of electricity peaked in 2015 and then fell 15% through 2019.[5] Because the economy expanded over this period, the electricity intensity of the GDP – that is, the electricity required for each billion rand of added value – dropped even more rapidly, by 21%, over the same period (see Graph 14).

The mining value chain (including the metals refineries and Sasol), dominated the decline in electricity use from 2008 to 2017. The trend reflected the closure of particularly electricity-intensive lines; a shift to more electricity efficient technologies, where possible; and a move to off-grid electricity sources, almost all either gas or renewables rather than coal.

The mines and other companies that purchased electricity directly from Eskom utilised 36% of all grid electricity in 2019, down from 42% in 2008 (and around half in the early 1990s). From 2008 to 2019, the mines' use of Eskom electricity dropped by over 10%, while industrial users reduced their consumption almost 25%. According to Quantec estimates, electricity use

[5] In its 2019/2020 Integrated Report, Eskom said that its sales fell 4% from its financial year 2007/8 to 2019/20, which it argues shows that electricity demand is highly inelastic (Eskom 2020a:49). According to its own reports, however, the fall was actually 8% over this period. Moreover, its sales peaked in 2009/10, with a 15% decline over the subsequent decade.

in mining (by volume, measured using constant prices) fell from 5% of value added in 2009 to 3% in 2019. In basic metals, it dropped even harder, from 27% to 15%. Measuring in current prices reversed the trend, because electricity tariffs escalated in the 2010s while mining and metals returns stagnated. Quantec estimated that the cost of electricity climbed from 5% of value added in mining to 7% between 2009 and 2019; in basic metals, it escalated from 19% in 2009 to 34% in 2017, before falling back to 23% in 2019. (Calculated from Quantec 2020)

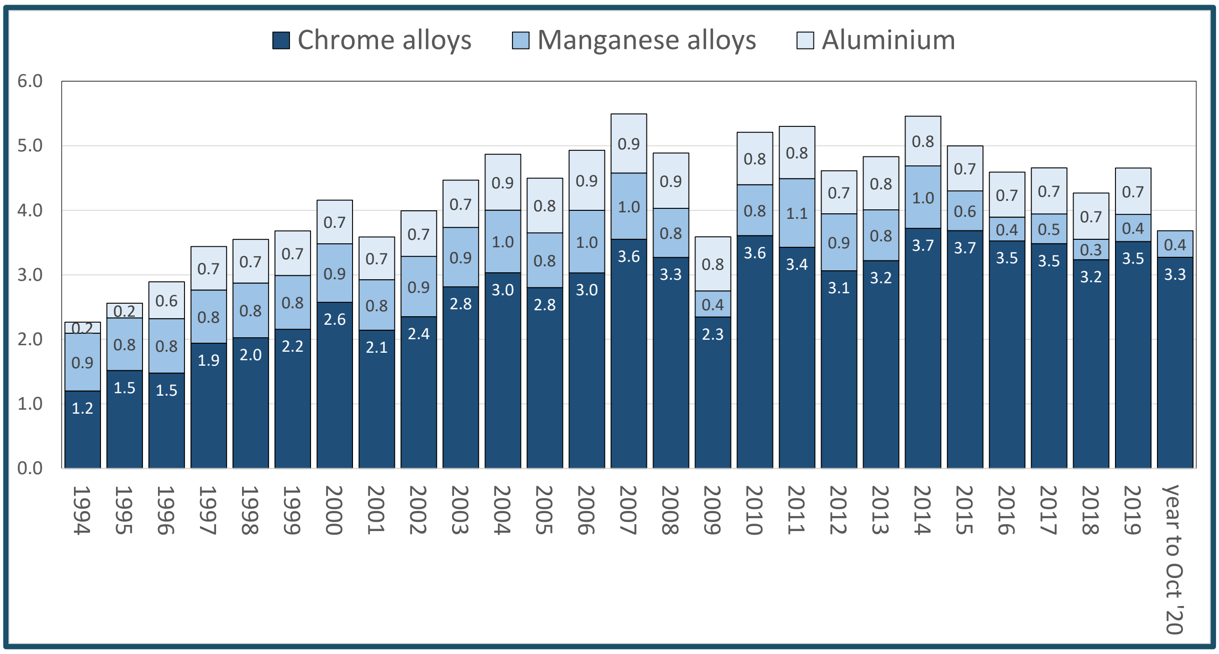
AMSA, the leading steel producer, illustrated the response by major companies in the mining value chain. In response to soaring electricity prices, it cut its energy use in volume terms by a third from 2009 to 2019. In 2019, its electricity purchases equalled 1,4% of Eskom's sales, down from 2% in 2009. The closure of a relatively new but electricity-intensive plant at Saldanha Bay achieved most of the savings. AMSA attributed the closure to rising prices for electricity, transport and iron ore. (AMSA 2019:20). In addition, AMSA introduced more energy-efficient production technologies, which it expected to reduce purchases from Eskom by 4% in 2020, and it planned to use gas by-products to generate between 7% and 8% of its electricity needs in the next few years. (AMSA 2019:45). Nonetheless, in 2019 it argued that "Despite continued efforts to improve our plants' energy efficiency, our current electricity cost burden poses a direct threat to our competitiveness and survival." (AMSA 2019:45)

Another major customer, Sasol, began to use gas from Mozambique to replace a share of Eskom electricity from 2015. In May 2020, it issued a request for information to generate 600 megawatts (MW) of renewable electricity by 2030; in February 2021, it increased the target to 900 MW. It also issued a request for proposals for two solar plants to provide 10 MW each at Secunda and Sasolburg.

The higher price of electricity was particularly disruptive for South Africa's highly electricity-intensive ferroalloy and aluminium refineries. From 2008 to 2019, the average electricity tariff[6] more than doubled, while the prices of ferroalloys and aluminium dropped around 50%. In contrast, before 2008, the unit price of electricity declined steadily while international metals prices generally climbed. As a result, from 2008, the refineries saw gradual disinvestment, falling production and improved energy efficiency, all of which contributed significantly to the decline in Eskom's sales. From 2014 to 2019, the combined national production in tonnes of these three metals fell by a fifth, with the sharpest decline in ferromanganese followed by ferrochrome. (See Graph 15). From 2007 to 2019, the average amount of electricity used per tonne of South African ferrochrome fell by over 10%; for aluminium, it dropped 5%. (Calculated from company Annual Reports)

[6] The ferroalloy refineries paid a higher price than the aluminium producers, which had a preferential agreement with Eskom.

Graph 15. Production in millions of tonnes of ferroalloys and aluminium, 1994 to 2019 and in the 10 months to October 2020 (a)



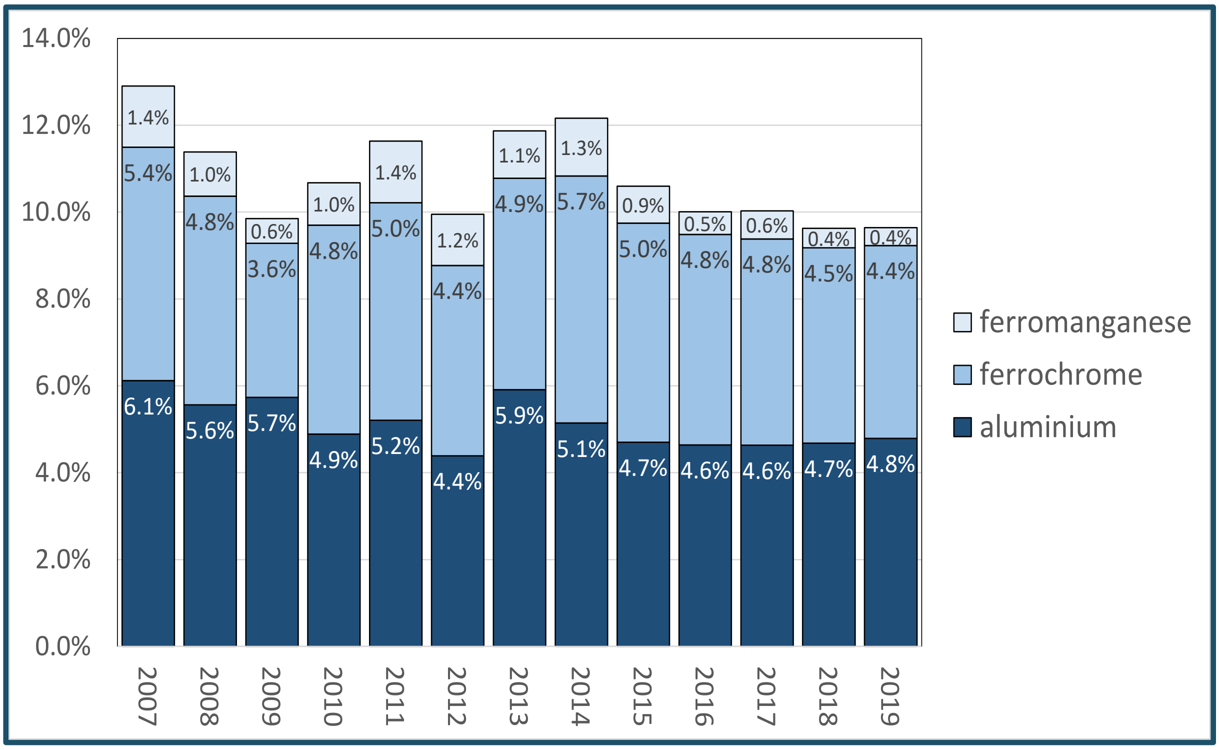
Note: (a) Data are not available for aluminium in 2020. *Source:* Production for ferrochrome, ferromanganese and, until 2009, aluminium from Department of Mineral Resources and Energy (DMRE) via Quantec. Mineral Statistics: National production and sales (aggregate of monthly figures after 2017); from 2009, aluminium production calculated from South32 Annual Reports for relevant years.

The average tariff for Eskom's industrial customers concealed the effective subsidy that Eskom provided to the aluminium producers, which in 2020 were Hillside in KwaZulu-Natal and Mozal in Mozambique. In the 2010s, Hillside's electricity price was linked directly to the price of aluminium on the London Metals Exchange. As long as international aluminium markets stagnated, it was effectively cross-subsidised by Eskom's other customers. South32, which owned Hillside and Mozal, estimated in 2019/20 that its electricity costs dropped by over R500 million because preferential electricity deals offset lower aluminium prices. (South32 2020a:39). From 2021, Eskom and Hillside agreed to tie Eskom's tariff for the aluminium smelters to the producer price index rather than the international aluminium price.[7] From 2008 to 2020, while the average electricity tariff climbed 430% in current rand, the Producer Price Index (PPI) rose only 90%.

From 2008 to 2019, the estimated electricity use by South African producers of aluminium and ferroalloys (excluding Mozal) dropped 10% due to the combined effect of lower production and greater energy efficiency. Eskom's sales to other users fell 7% in the same period. Shrinking demand from these refineries alone accounted for a sixth of the total decline in Eskom's electricity sales, and their share in Eskom's output dropped from 13% in 2007 to 9,5% in 2019. Falling output and reduced electricity per tonne of production contributed almost equally to this trend.

[7] NERSA, the electricity regulator, still had to approve this contract as of February 2021.

Graph 16. Estimated share of ferroalloys production in Eskom generation (a), 2007 to 2019



Note: (a) Estimate based on figures for production in tonnes multiplied by estimated electricity use per tonne as a share of total Eskom sales in GWh. The figures for electricity use per tonne for aluminium derive from figures for all African producers. The figures for ferrochrome are estimated using Merafe's detailed figures in its annual reports combined with industry studies for other producers. Information on manganese are not consistent, ranging from 1700 to 4000 kWh per tonne. The figure used here is 3000 kWh, based on ARM's figures for electricity use and production at Cato Ridge in 2018 and 2019. The ARM figures increased from around 2500 kWh per tonne, presumably because it shut down half of the furnaces at Cato Ridge. A constant figure is used for manganese, however, because it is not clear if this was a common trend across producers. *Source:* Merafe and Eskom Annual Reports for relevant years. For other ferrochrome producers, Fowkes, K. 2013. Developments in production costs and competitiveness in ferrochrome. Presentation to Metal Bulletin 29th International Ferroalloys Conference. Barcelona, 12 November. Downloaded from www.metalbulletin.com in February 2020. For electricity per tonne in aluminium, International Aluminium Institute. Kilowatt hours (kWh) per tonne of aluminium (AC). Downloaded from statistics page at www.worldaluminium.org in February 2020. For manganese, ARM Annual Report and Sustainability Data Tables for 2019; Kalenga, M., Xiaowel, P. and Tangstad, M. 2013. Manganese Alloys Production: Impact of Chemical Compositions of Raw Materials on the Energy and Materials Balance; and Ladam, Y., Tangstad, M. and Ravary, B. 2013. Energy Mapping of Industrial Ferroalloy Plants. The Thirteenth International Ferroalloys Congress. Almaty, Kazakhstan. 9-13 June. For production, DMR. Mineral Statistics – National Annual Production and Sales. Downloaded from Quantec. EasyData. Interactive database. Downloaded from www.quantec.co.za in February 2021.

In contrast to the mining value chain, most producers relied primarily on the municipal electricity supply, which meant their costs rose more slowly than Eskom tariffs. They experienced more unplanned outages, however, due to breakdowns at the local level in addition to loadshedding. The impact of the deterioration in the electricity system varied substantially by municipality, depending on the extent of electrification, broader trends in the regional economy, and the quality of municipal management. The hardest hit were secondary cities in the Free State and Mpumalanga that faced a long-run decline because they had historically depended on gold, steel or coal. Most informal businesses operated from the owners' homes, which meant that some were also affected by Eskom's policy of interrupting service to selected townships in the name of load reduction.

For less energy-intensive businesses, loadshedding and municipal grid breakdowns often proved more burdensome than rising prices. The costs were, however, hard to quantify since they were externalities, excluded from the electricity price and spread across many dimensions. They included:

- Lost production time generally, leading to lower revenues. The alternative was for individual companies to invest in off-grid electricity or batteries, adding to their costs and maintenance burdens.
- Damage to electronic equipment, which was not designed to deal with periodic shutdowns or the electricity surges that often followed. This risk was particularly strong for more technologically advanced and competitive industries. It was likely to expand as production equipment of all kinds increasingly incorporated digital controls.
- Damage to continuous processing equipment, as in chemicals and foundries. These processes required considerable cost and work to close down even for planned loadshedding, and could be destroyed by unplanned interruptions.
- Managing labour costs as the resulting closures disrupted shifts. Managers faced hard choices between declining to pay workers for time out, absorbing the cost without getting the anticipated production and revenues to pay for it, or moving shifts to take loadshedding into account, which disrupted work organisation and often caused workplace conflict.

3.3 Mechanisms behind the disruption

From the standpoint of the coal value chain, three mechanisms underpinned the disruption of the national electricity supply in the 2010s. First, cheaper as well as cleaner and more flexible generation technologies emerged rapidly in the 2010s just as Eskom doubled down on large-scale coal plants, investing in two of the largest in the world. Delayed and faulty construction of the new power plants strained the national electricity system and pushed Eskom into a debt crisis. Second, through the 2010s the coal mines began to charge Eskom more, approaching the export price. These developments escalated Eskom's costs and reduced its reliability. In response, its customers turned both to off-grid generation and to more energy-efficient production processes. Those reactions underpinned the long-run shrinkage in domestic demand for coal.

The operational and financial crisis at Eskom can be understood as a failure to adapt its business model, which dated back to its foundation in 1923, to the very different realities of the 21st Century. Eskom originally aimed to provide low-cost electricity to facilitate continual expansion in the mines and refineries. It held down costs to customers by investing in modern large power stations, purchasing coal at below international market prices, and not paying for the resulting pollution. From this perspective, the Mineral Energy Complex (see Fine and Rustomjee 1996) was based in the ability to utilise rents from coal to develop the rest of the mining value chain. By 2020, however, coal was no longer competitive with either renewables or gas, Eskom's production technology was rapidly falling behind and often faulty, and the company faced growing pressure to reduce emissions.

Substantial evidence globally and internationally pointed to the growing competitiveness of new electricity technologies compared to coal over the two decades to 2020. (See for instance Arndt et al. 2019). Most obviously, in South Africa, the latest tender process for renewable energy for the national grid, in 2016, brought bids at almost 20% less per kWh than the Eskom tariff at the time. The generation cost had fallen from around ten times as high as Eskom prices five years earlier. (See IPPO 2020:3-4). Moreover, because the new technologies were smaller scale, they were more flexible and could adapt more easily to increasingly unpredictable electricity demand.

The divergence in generation cost between coal-fuelled and other electricity continued to increase after 2016. In 2021, Eskom's tariff was more than 20% above its 2016 levels in constant rand terms, but the generation costs for renewables and gas had declined. Market realities emerged in accelerating investment by large companies and households seeking to escape the costs and interruptions of national and municipal grids. Modelling suggested that the lowest cost path for electricity generation in South Africa would reduce coal-fuelled electricity to just over half of national generation by 2030, and to a tenth by 2050. (Wright and Calitz 2020:IV; see also Arndt et al.:160)

Comparatively low-cost renewable electricity made it almost inevitable that large coal plants would lose market share both in South Africa and worldwide. As of 2021 the path of the transition was not easy to define, however, since generation costs alone were not determinant even in economic terms. Additional costs and benefits included the following:

- For renewables, output varied depending on the time of day and the weather, while most plants were relatively small. The transition therefore required more complex grid management and storage systems. The requisite technologies were new to South Africa and in some cases did not yet exist in 2021. Virtually all analysts expected that the technological trajectory had evolved to the point where viable solutions would ultimately emerge. There was still a risk that they would fall short, however. In addition, in South Africa renewables projects were often in rural areas, forcing Eskom to expand its transmission networks substantially, often at significant cost. Finally, rapid introduction of renewables would force Eskom to write off investments in coal plants earlier than planned. The DMRE[8] did not publish an estimate of these costs and risks in the 2019 Integrated Resource Plan (IRP). Nonetheless, it argued that they justified a cap on new generation from renewables through the 2020s, which would add 10% to electricity tariffs by 2030. (See DMRE 2019:92 ff)
- Generation costs also understated the burdens of continued reliance on coal. To start with, as of 2021 Eskom tariffs did not include the full economic costs of pollution in general and greenhouse gas emissions in particular (see section 4.2.4). Nor did they reflect the burdens imposed on consumers by breakdowns in Eskom's coal plants and the attendant loadshedding. If these costs were included, coal generation would be even less competitive than the market price indicated. Moreover, the costing models assumed that Eskom would pay a stable price for coal (see Wright and Calitz 2020:29). In fact, the unit cost increased steadily over the previous decade, and its future trajectory was uncertain.

The past 10 years underscored the growing tribulations attendant on large-scale coal plants. In 2007, Eskom already operated seven of the 90 largest coal plants in the world. In that year,

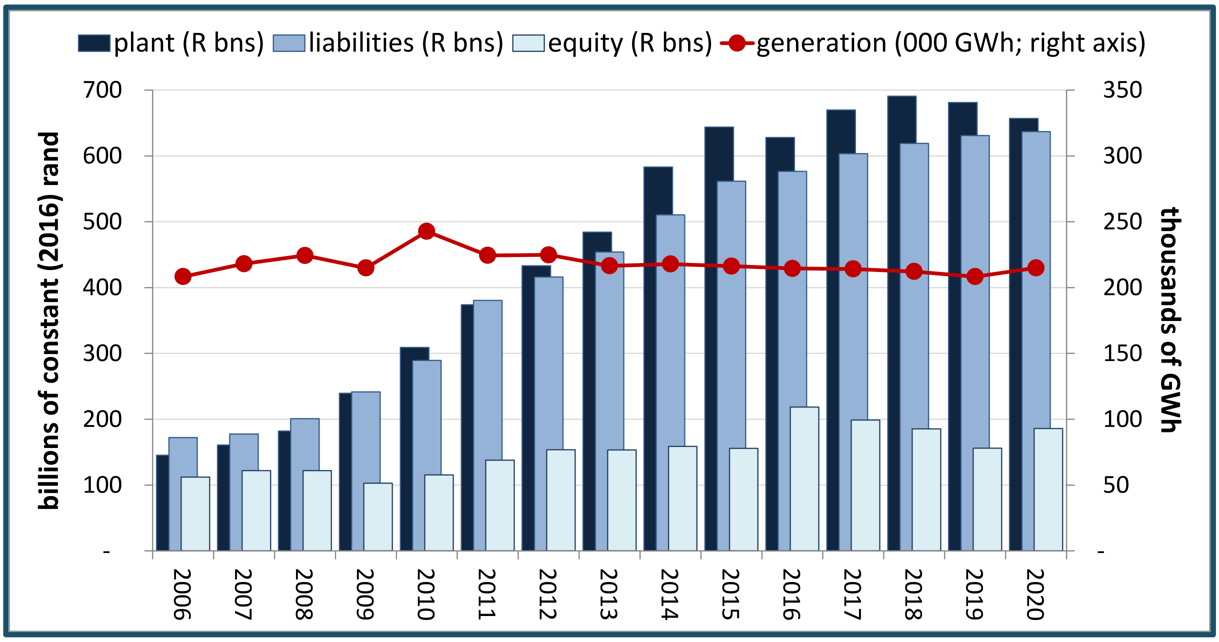
[8] In May 2019, the Department of Mineral Resources and the Department of Energy were merged into one department as the Department of Mineral Resources and Energy (DMRE).

it initiated Medupi and Kusile, which were each around 15% larger than any of Eskom's older plants. They came online a decade later than expected due to construction delays and faults. Medupi began production in 2019, but technical problems meant it that it generated at less than 70% of its capacity (Creamer 2019). As of 2021, Kusile was expected to open fully only in 2023, but it also experienced major defects. Construction costs for both plants reportedly climbed 10% in real terms over the original 2007 estimates, reaching R300 billion in 2019 (Standing Committee on Appropriations 2019). Eskom estimated that at least R4 billion represented overpayments arising from corruption and fraud. (Eskom 2020b:10)

Delayed production increased Eskom's financing costs as its revenue stream from the new plants was deferred. It also meant Eskom ran its older plants harder, leading to escalating breakdowns and loadshedding.

As the following graph shows, from 2008 to 2020 (in financial years to March), the value of Eskom's plant and liabilities more than doubled in constant rand, but its sales of electricity fell 4%.

Graph 17. Eskom assets, liabilities and equity in billions of constant (2020) rand (a), and generation in GWh, financial years, 2008 to 2020

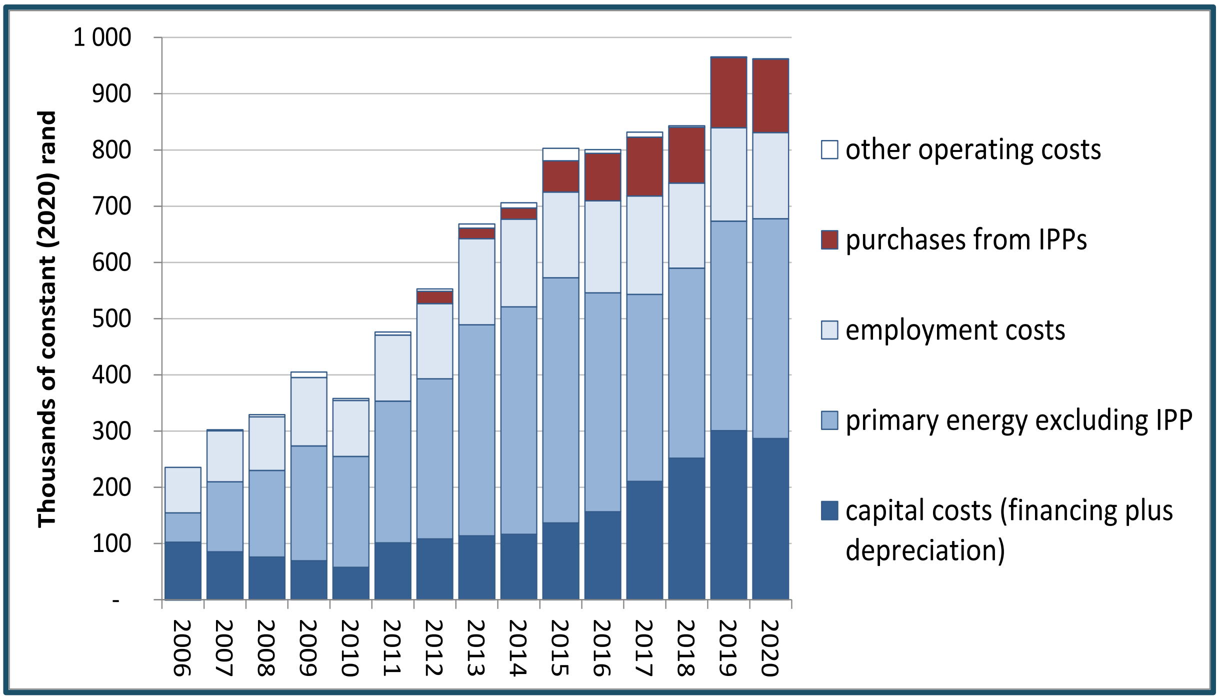


Note: (a) Deflated with CPI for March rebased to 2020. *Source:* Eskom Financial Statements for relevant years.

As Eskom's debt soared, its borrowing costs rose rapidly. In 2020, the annual yield on Eskom bonds climbed to 8% above inflation, compared to an average of 3,5% above inflation from 2002 to 2014. From the 1980s through 2010, the yield on Eskom bonds averaged 3% below the prime lending rate. From 2011 to 2019, it was 0,7% above prime, and in 2020, it climbed to 3,3% over prime.[9] As Graph 18 shows, from the mid-2010s capital costs (financing plus depreciation) became Eskom's most important cost driver.

[9] Calculated from South African Reserve Bank. Online statistical query. Interactive dataset. Accessed at www.resbank.co.za in May 2021.

Graph 18. Operating and capital costs at Eskom in constant (2020) rand (a), 2006 to 2020



Note: Deflated with CPI to March, rebased to 2020. *Source:* Calculated from Eskom Financial Statements for relevant years.

In early 2021, Eskom sought refinancing. It hoped to access additional and more affordable finance (and secure its future) in part by committing to cleaner generation on a large scale. (See section 4.3) That could mean closing down some of its coal plants earlier than originally planned.

A central part of Eskom's problem was increasing resistance as its tariffs climbed to cover its rising costs. Through the 2010s, Eskom argued that elasticity of demand for electricity was near zero, so tariff hikes would lead to proportionate increases in revenue. In practice and in theory, however, elasticity normally rises over time. In this case, Eskom's customers found substitutes in the form of off-grid generation; introduced electricity-saving technologies; and in some cases simply shut down electricity-intensive lines. Since Eskom considered most of its costs fixed in the medium term, locked into its large coal plants, it responded to lower sales by raising its tariffs even further. That in turn accelerated the loss of demand.

The phenomenon of rising tariffs leading to falling demand and then a renewed tariff increase is known as the "utility death spiral". Eskom's 2018/19 Integrated Report noted the threat it posed. In the previous year's report, it provided a definition:

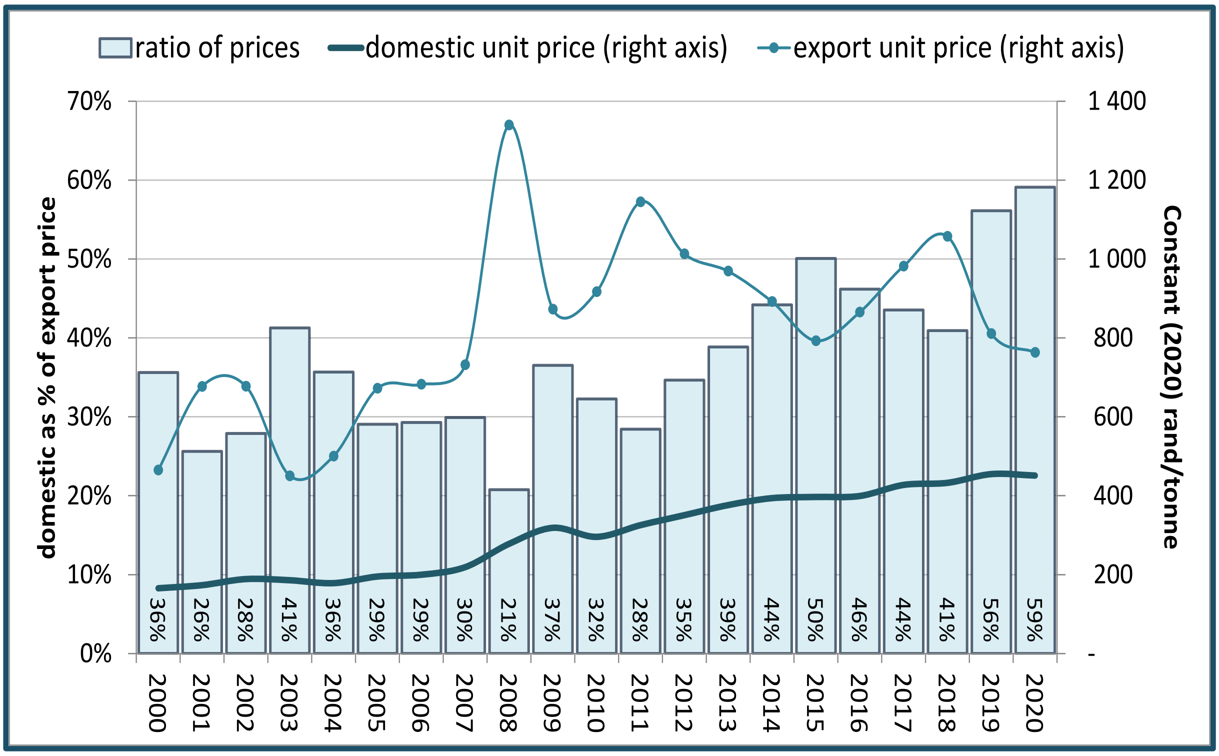
> "The utility death spiral: Traditional utility business models around the world are under threat due to a number of transformational changes and energy disrupters. As new technology allows self-generation to become increasingly price competitive for the consumer, a utility's sales decline. The utility, having invested in long-term assets with a large proportion of fixed operational costs, requires an ever-increasing tariff to generate the required revenue from declining sales. These price increases add to customers' incentive to move off-grid, further decreasing the customer base." (Eskom 2018:26)

Despite this recognition, Eskom continued to argue that it could not cut its costs and therefore required double-digit tariff increases to compensate for falling sales. This logic led to its renewed 15% price hike in 2021, in the midst of the COVID-19 depression.

The delays at Medupi and Kusile also meant that Eskom kept its older plants in production longer than anticipated. In consequence, they began to fail. Their position was worsened by weak procurement and oversight practices for much of the 2010s, which led to sluggish and deficient maintenance and repairs. The result was a secular increase in unplanned outages through the 2010s. In the most recent cycle, Eskom's Energy Availability Factor fell from 78% of installed capacity in 2018 to 67% in 2020. It anticipated recovery only to 72% by 2022. Rising breakdowns also added to the financial pressure on Eskom as it sought to make up the gap with diesel generators, which were costly to run (although far cheaper for the economy than loadshedding). Eskom's use of diesel generators climbed more than tenfold from 118 GWh in 2018 to 1328 GWh in 2020, with the cost escalating from R320 million to R4,3 billion. (Eskom 2020a:94)

Rising prices for domestic coal sales added to Eskom's financial woes. The average unit price for coal sold in South Africa climbed 40% in constant rand from 2008 to 2020. In contrast, the unit price for export coal dropped 14% over this period. The domestic price climbed from less than a third of the export price before 2008 to over half in 2019 and 2020. If the local price for coal had remained at 30% of the export price in 2019 – that is, at the average level from 2000 to 2008 – then local consumers would have paid R45 billion for coal in 2019, instead of the actual figure of R85 billion. Eskom would have saved over R25 billion, extrapolating from its share in domestic coal sales (see Graph 22).

Graph 19. Domestic and export unit price for coal in constant (2020) rand over five-year intervals, 1980 to 2020 (a)



Note: (a) Prices deflated with average CPI for the year, rebased to 2020. *Source:* Calculated from DMRE. Mineral Statistical Tables. Accessed through www.quantec.co.za in February 2021.

Various mechanisms explained the shift in coal rents from Eskom to the mines. Since at least the 1980s, coal producers used lower-priced sales to Eskom to stabilise production at scale, which enabled their more profitable although smaller exports. (See Ryan 2020). As export prices fell in the 2010s, they apparently sought higher returns on domestic sales instead. In addition, from the 1990s the dominant mining groups gradually disposed of their South African interests, mostly in gold and platinum. That reduced their interest in securing cheap electricity in South Africa. Finally, Eskom encouraged new, smaller empowered coal producers, including by committing to higher prices. As the process disrupted long-standing supplier relationships, it provided an opening for state capture, reflected in overpriced deals and unreliable coal supply. (Eskom 2020:38)

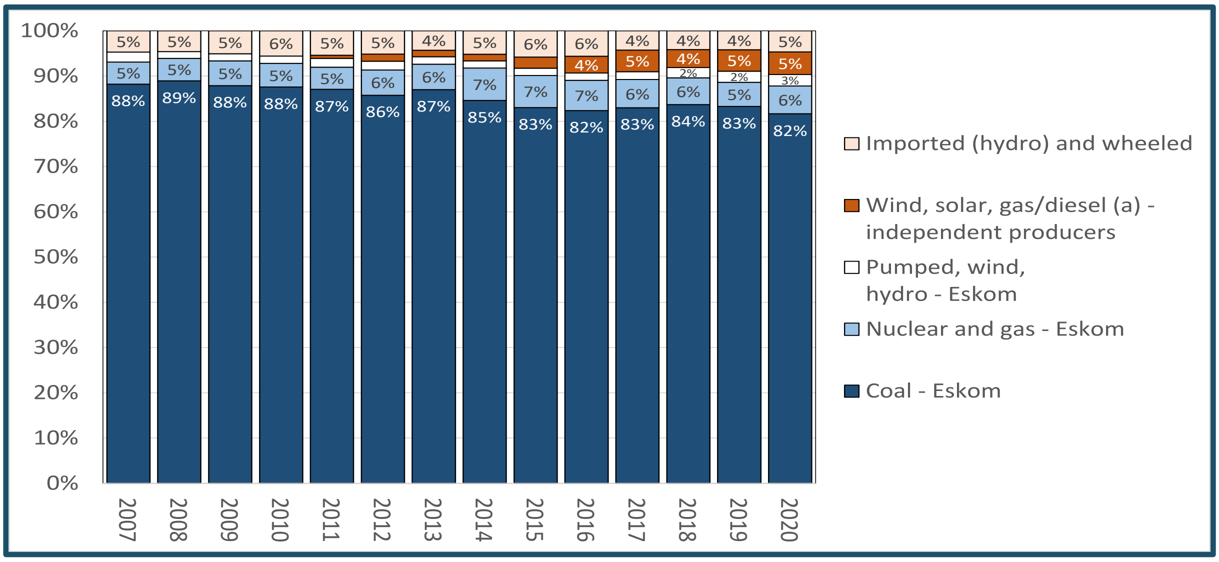
Eskom's inability to supply reliable, affordable electricity opened a market gap that private investors were eager to fill. Until early 2021, however, the DMRE sought to avoid writing off coal plants early by limiting most private generation and preventing Eskom from investing in renewables. As of 2020, private generation accounted only for 5,5% of grid electricity, up from under 1% in 2011. In June 2021, however, as electricity shortages blocked recovery from the COVID-19 depression, the government lifted the effective ceiling on self-generation from 1 MW to 100 MW. That seemed likely to lead to a surge in new, mostly renewable and gas generation. It would vastly reduce the risk of loadshedding while cutting demand for coal. Still, private suppliers had only limited access to the national grid. For the most part, they could supply it only following slow tender processes through which the DMRE purchased specified amounts of electricity on long-term contracts on behalf of Eskom. The Department held nine bidding rounds from 2011 through mid-2021, with none between 2016 and 2020. In 2020, it announced plans to procure 11 GW, equal to almost a fifth of the national grid's total supply, with around 1,5 MW allocated to new coal plants.

In sum, Eskom was caught in a process of creative destruction. This situation occurs when a new, overwhelming technology trajectory displaces existing productive assets, boosting overall economic prosperity but imposing write-offs on producers left with suddenly obsolete facilities. In this context, Eskom's insistence on increasing its prices as demand fell seemed likely to accelerate the loss of market share for its coal-fuelled plants. By the early 2020s, that had begun to impose considerable changes onto the coal mines, their workers and the communities that depended on them.

3.4 Impacts on the coal value chain

The disruption of the electricity system brought a decline in the share of coal-fuelled electricity from 89% of the national grid in 2008 to 82% in 2020. These figures understated the decrease in the share of coal in total electricity supply, as many companies and households moved off the national grid altogether.

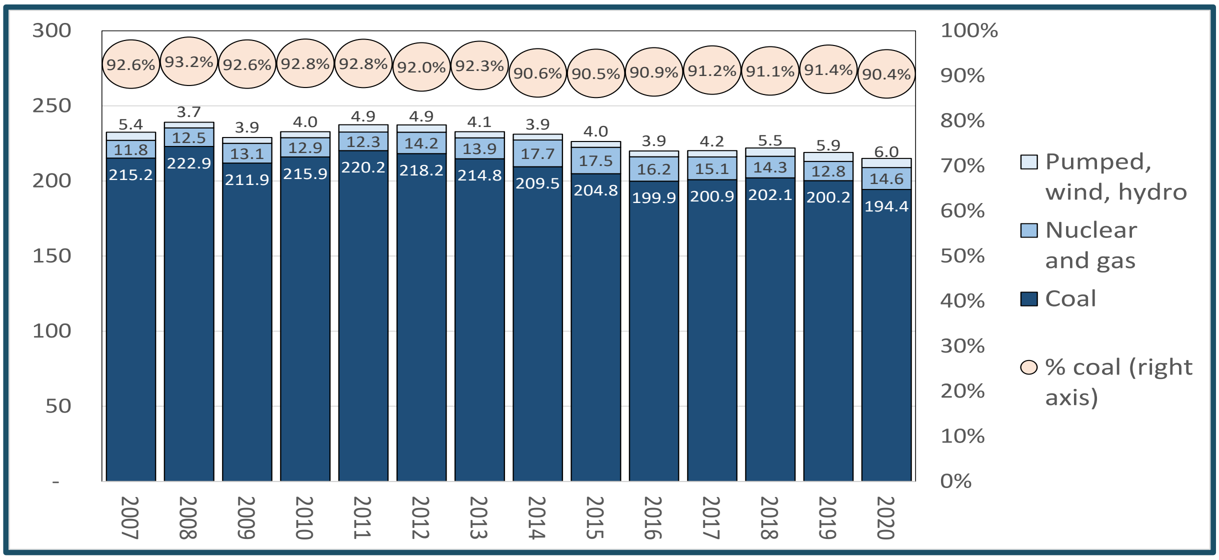
Graph 20. Sources of electricity on the national grid, 2007 to 2020



Note: (a) Around 20% of independent producer capacity was in gas and diesel peaking capacity in 2020. Eskom only provides aggregate data for all of them, so it is not clear how much electricity came from the individual sources. *Source:* Calculated from Eskom. Integrated Report. 2020. Statistical Tables. Pp 140 ff.

The fall in Eskom's sales mostly resulted from a decline in its coal-fuelled generation. From 2008 to 2020, the amount of electricity Eskom generated using coal dropped from 223 000 GWh to 194 000 GWh. Meanwhile, its generation from other sources climbed from 16 000 GWh to 21 000 GWh. Nuclear and gas climbed around 15%, while renewables – mostly pumped storage and a wind farm – rose over 60%, although off a very small base. As a result, coal-fuelled electricity dropped from 93% of Eskom's sales in 2008 to 90% in 2020.

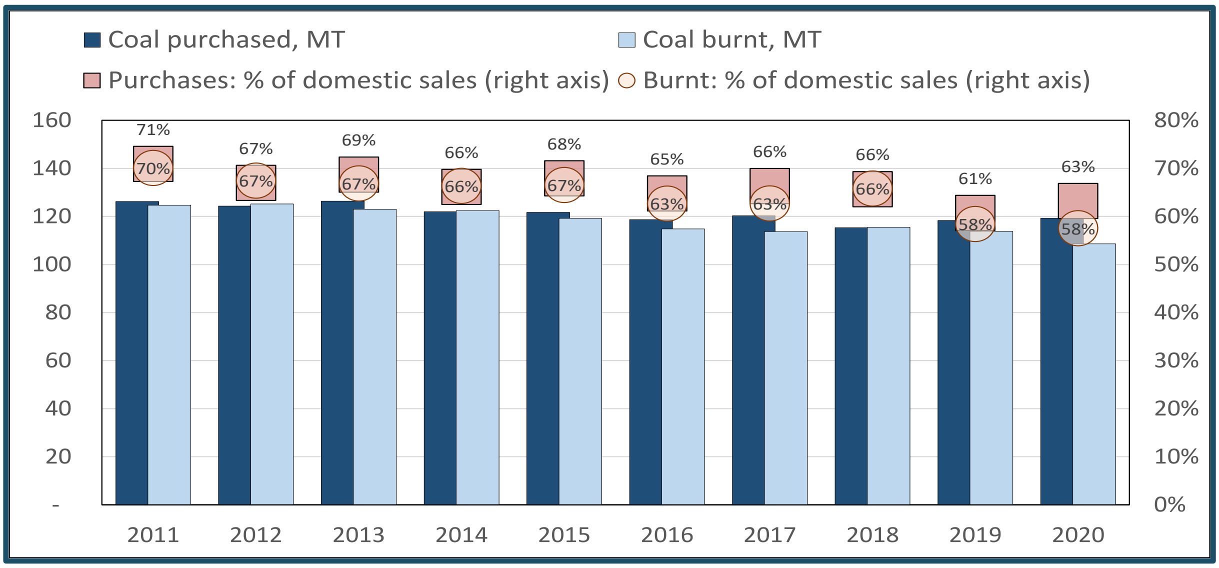
Graph 21. Eskom sent-out electricity by source in thousands of GWh, 2007 to 2020



Source: Calculated from Eskom. Integrated Report. 2020. Statistical Tables. Pp 140 ff.

As Graph 22 shows, Eskom's falling output meant that its purchases of coal shrank 6% from 2010/11 to 2019/20, while the amount of coal it actually burnt dropped 12%. Its share in domestic coal sales decreased from 71% in 2010/11 to 63% in 2019/20. The proportion of domestic coal production that it burnt fell even faster, from 70% in 2010/11 to 58% in 2019/20.

Graph 22. Eskom purchases and processing of coal in millions of tonnes and as a share of domestic coal sales, year to March



Source: Eskom coal purchases and processing from Eskom. Integrated Report 2019/20. Pages 142-143; total domestic coal sales from DMR. Mineral Statistics (annual until 2018, then monthly). Downloaded from www.quantec.co.za in April 2021.

3.5 Conclusions

Declining demand for coal for electricity in South Africa mostly resulted from an international technology trajectory that favoured renewable and gas generation. In these circumstances, Eskom's efforts to maintain large-scale coal plants in the 2010s made it increasingly uncompetitive and disruptive for the economy as a whole. To survive, both Eskom and the industries it served would have had to shift as rapidly as possible to more competitive sources of energy. Realistically, that meant the coal industry could not avoid substantial downsizing. The only viable policy option was to manage the transfer of capacity and jobs into more promising production lines.

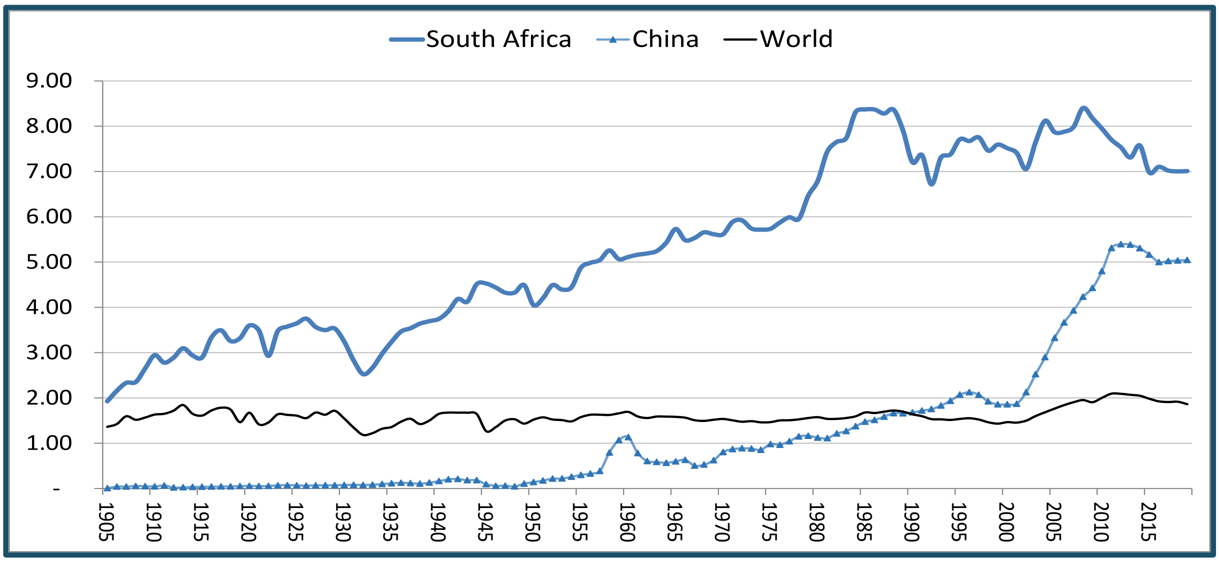
4 COAL IN THE CLIMATE EMERGENCY

South Africa's unusually pronounced reliance on coal made it an international outlier for greenhouse gas emissions. Given the deepening climate crisis, that led to growing pressure to shift to cleaner production processes. This section first reviews the effects of coal on South Africa's emissions. It then outlines various mechanisms that began to militate against coal use as the climate crisis deepened. They included falling international and domestic demand; trade measures designed to raise the cost of emissions-intensive products; limits on private and public financing for new investments in the coal value chain; and domestic policies.

4.1 The coal economy and greenhouse gas emissions

In 2019, South Africa emitted around seven times as much CO^2 from coal per person as the international average. In contrast, its emissions from other fossil fuels were lower than the international average. Still, its coal emissions were so large that it still ended up emitting greenhouse gases at almost twice the rate of other upper-middle-income countries excluding China. As Graph 23 shows, CO^2 emissions from coal per person in South Africa peaked in the 1980s. After 2013, they declined as electricity intensity and the share of coal in power generation both dropped.

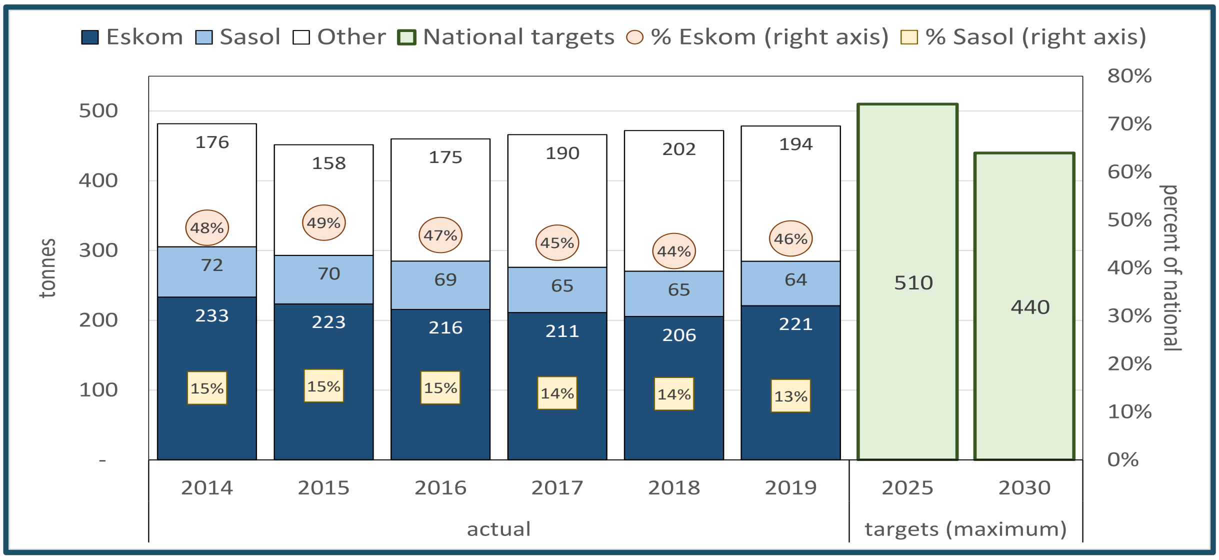
Graph 23. Coal-based CO² emissions per person in South Africa, China and the world in tonnes, 1905 to 2019



Source: Oxford University. Our World In Data. Interactive dataset. Downloaded from https://ourworldindata.org/fossil-fuels in May 2021.

Sasol and Eskom together accounted for over half of greenhouse gas emissions from South Africa (Graph 24). Their share declined from almost 65% in 2014 to under 60% in 2019, mostly because of shrinking production. Eskom's emissions reportedly fell by 5% in this period, and Sasol's by 12%. Eskom's emissions fell around five times as fast as its electricity output, reflecting cleaner production processes. In contrast, the decline in Sasol's emissions was due exclusively to falling output, as its emissions intensity increased by 20%. In 2020, Sasol was the largest single emitter of greenhouse gases in the world. (Sasol 2020e:8)

Graph 24. Sasol and Eskom contribution to greenhouse gas emissions by South Africa in tonnes of CO_2 and as percentage of total, 2014 to 2019, and draft national targets for 2025 and 2030



Source: Eskom and Sasol figures from Integrated Reports for relevant years; total South African emissions from Oxford University. Our World In Data. CO_2 and other greenhouse gases. Interactive dataset. Accessed at https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions in May 2021; draft targets from DFFE. South Africa's First Nationally Determined Contribution under the Paris Agreement. Updated in 2021. Pretoria. 2021. Page 14.

The metals refineries generated substantial emissions directly and, even more, because they used coal-fuelled electricity. In 2020, South32 estimated emissions from its own production processes at Hillside and Mozal aluminium smelters at 10 million tonnes a year, or 2% of total South African emissions. The electricity it purchased from Eskom added another 12 million tonnes, which would bring it up to almost 5% of the national total. (Calculated from South32 2020a:41)

In April 2021, as part of the United Nations' Paris Agreement process, South Africa set draft targets to reduce emissions by at least 8% as of 2030, despite a possible initial increase through 2025. The new maximum target for 2030 was a third lower than initial aims set in 2015. As of mid-May, it still had to be finalised followed consultation with stakeholders. Government expected the bulk of the reduction in emissions to come from the electricity system, followed by reduced use of fossil fuels especially for transport.

4.2 Mechanisms affecting coal use

Various pressures arising from the climate crisis affected the competitiveness of the coal value chain. They included the decline in international and domestic demand for coal; the potential for trade partners to adopt measures that would reduce carbon-intensive exports; pressure from domestic and foreign financial institutions and institutional investors to move out of coal; and a range of domestic policy initiatives.

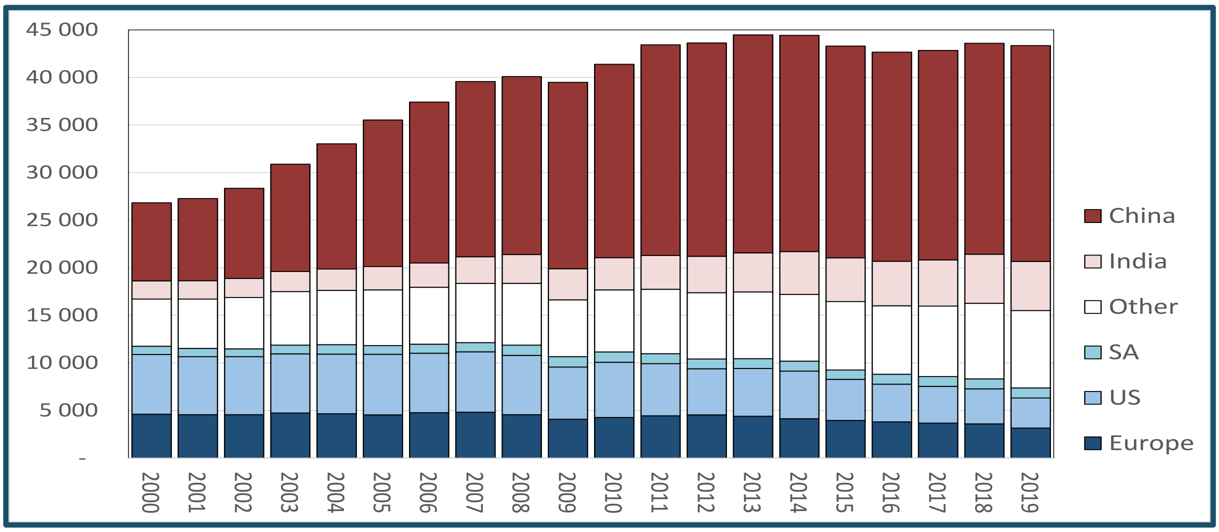
Managing the transition away from coal was particularly difficult because of South Africa's unusually deep economic inequalities; the concentration of coal in a handful of districts in Mpumalanga; pressure from some foreign companies to accept "dirty" industries; and the embedding of coal in the mining value chain. As of 2021, the trajectory was unmistakeable and unstoppable, but the timing over the coming 20 years remained unclear. This situation gave stakeholders in South Africa, both inside and outside of the coal value chain, an opportunity to ensure an efficient and just transition. But it could also increase the temptation to defer action until the costs of relying on coal escalated even further.

4.2.1 Demand for coal

Both domestic and export demand for coal declined in volume terms over the decade to 2020, as discussed in section 2.1. Eskom reduced its coal use through the 2010s as its sales shrank. Sasol planned to end new investment in coal and to shift gradually to natural gas as its main feedstock. (Sasol 2020d:10)

The decline in exports resulted primarily from shrinking international demand after 2013, as Graph 25 shows. The contraction started with a sharp reduction in coal use in Europe. The US and China followed from the mid-2010s. From this standpoint, stagnant coal consumption in South Africa from 2009 formed part of a broader global pattern.

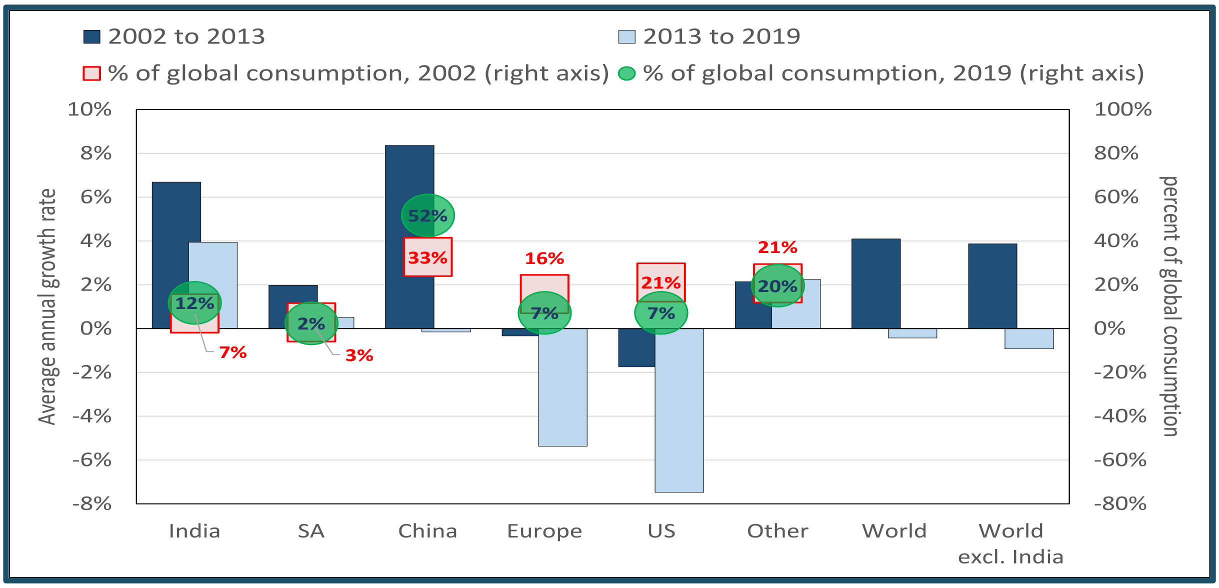
Graph 25. Coal consumption by region in equivalents of thousands of GWh annually, 2000 to 2019



Source: Oxford University. Our World In Data. Interactive dataset. Downloaded from https://ourworldindata.org/fossil-fuels in May 2021.

Soaring Chinese coal consumption drove global demand higher in the decade to 2013, counteracting shrinking use in the global North. Thereafter Chinese consumption flattened out, however, while the US and Europe cut consumption by over 5% a year from 2013 to 2019. India bucked the trend, with coal consumption climbing 4% a year in the 2010s. Nonetheless, global coal consumption shrank almost 0,4% a year from 2013 to 2019. Excluding India, it fell almost 1% annually.

Graph 26. Average annual growth in coal consumption by region and share of regions in global consumption, 2002 to 2019 (a)

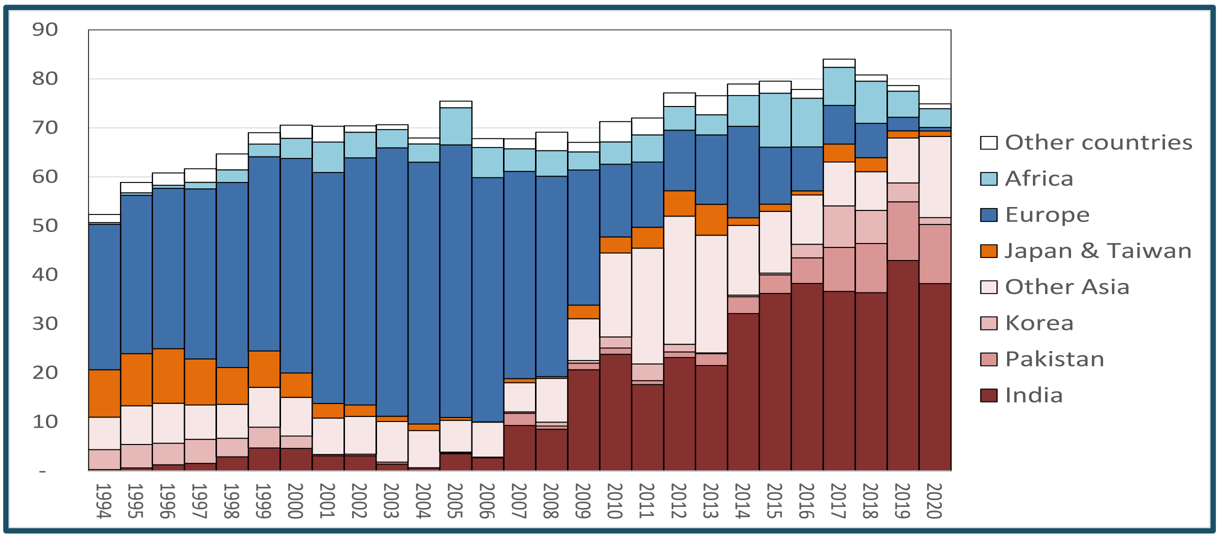


Note: (a) Measured in thousand GWh equivalents. *Source:* Calculated from Oxford University. Our World In Data. Interactive dataset. Downloaded from https://ourworldindata.org/fossil-fuels in May 2021.

Coal producers in South Africa effectively responded to declining global demand by increasing domestic prices, as discussed in 3.3. They also shifted exports away from the US and Europe and toward Asia, especially India. The redirection to Asia emerged even though the unit price on coal sales to Asia consistently averaged more than 5% less than for Europe. In effect, falling demand in the global North gave exporters no choice.

Graph 27 shows the shift in South African coal exports toward lower-income Asian countries and away from Europe, Japan and Taiwan. In 1994, Europe, Japan and Taiwan bought three quarters of South Africa's foreign coal sales. In 2019, their share had shrunk to 5%, while other Asian countries purchased 86%. In 2020, India alone accounted for over half of South Africa's coal exports, and Pakistan a sixth. Destinations for South Africa's remaining exports to Asia fluctuated sharply year on year, with Vietnam accounting for most of the jump in 2020.

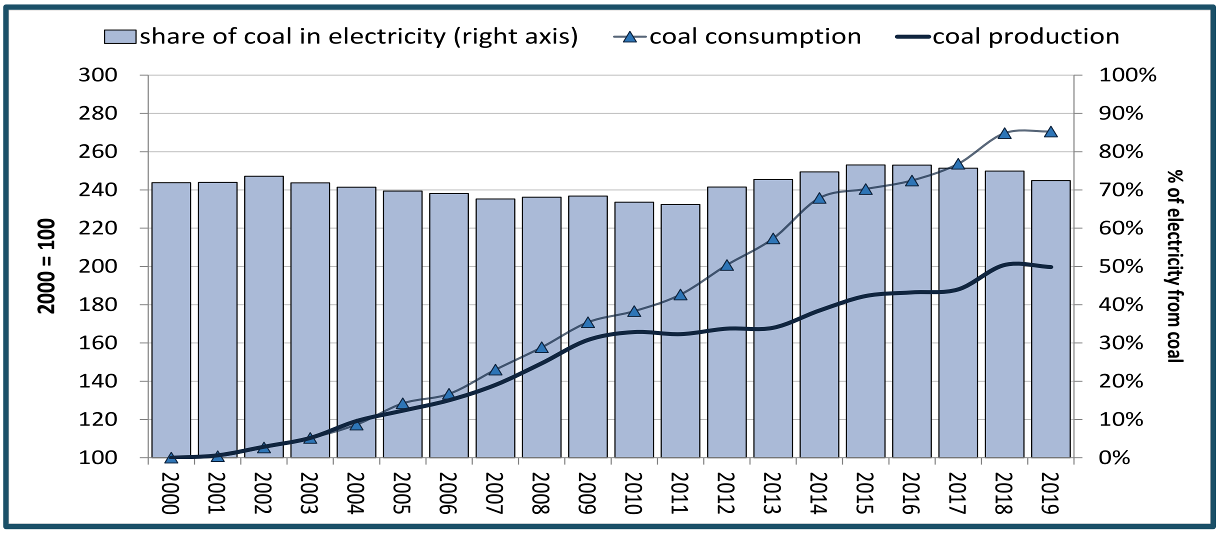
Graph 27. Destination of South African coal exports in millions of tonnes, 1994 to 2020



Source: Quantec. EasyData. RSA Trade HST 6-Digit. Interactive dataset. Downloaded from www.quantec.co.za in May 2021.

While India became South Africa's dominant export market for coal, it also began to turn away from coal-fuelled electricity in the mid-2010s. As Graph 28 shows, from 2015 to 2020 India's reliance on coal-fuelled electricity fell from 77% to 72%. Its coal consumption grew 6,3% a year from 2000 to 2014 but only 2,8% a year from 2014 to 2019.

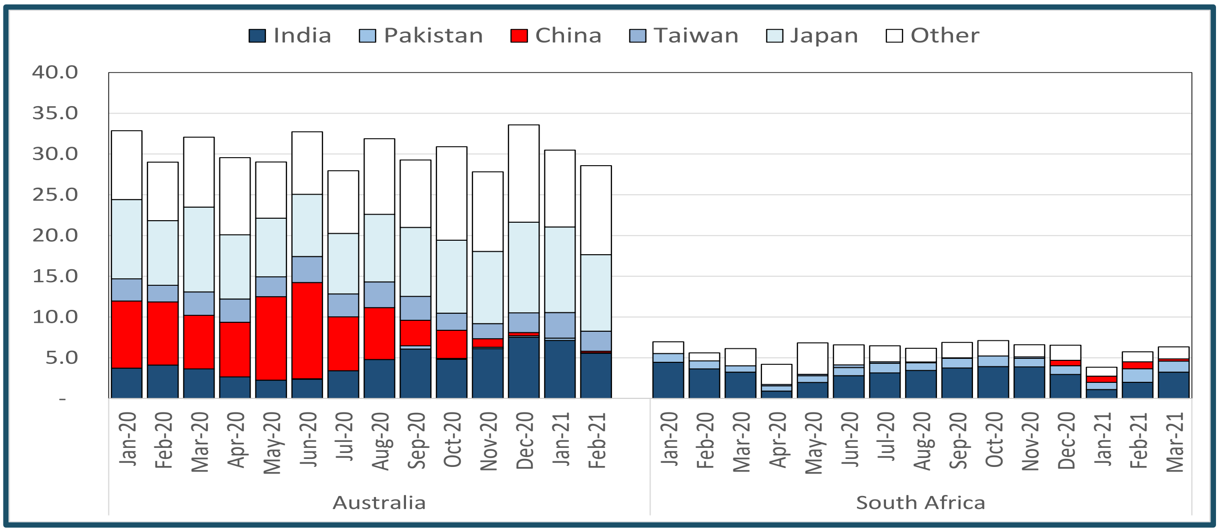
Graph 28. Indices of India's coal consumption and production (2000 = 100) and share of coal in electricity generation, 2000 to 2019



Source: Calculated from Oxford University. Our World In Data. Fossil fuels. Interactive dataset. Downloaded from https://ourworldindata.org/fossil-fuels in May 2021.

When China ended coal imports from Australia during the pandemic, South African exporters hoped for an uptick in sales. In the event, they rose from zero in December 2020 to 0,8 million tonnes in January and February 2021, although they fell back to 0,3 million tonnes in March. That equalled a seventh of South African coal exports in the first two months of 2021, and around a fifteenth of Chinese coal imports. The increase was offset, however, by Australia's turn to other markets. Australia's exports to India totalled 31 million tonnes from October 2020 to January 2021, up from 21 million tonnes in the same period a year earlier. In the same period, South African sales to India came to 14 million tonnes in total, compared to 20 million tonnes a year before (Graph 29).

Graph 29. South African and Australian monthly exports of coal by destination in millions of tonnes, January 2020 to March 2021



Source: January 2020 to February 2021 from ICT. Trade Map. Interactive dataset. Accessed at www.trademap.org in May 2021. March 2021 for South Africa from Quantec. EasyData. Interactive dataset. Accessed at www.quantec.org.za in May 2021.

The rate of decline in coal use worldwide remained hard to predict, since it depended on economic trends as well as policy decisions by both public and private actors. Moreover, because South African producers contributed only 4% of world coal exports, marginal shifts in world market shares could periodically offset the overall downward trend. That said, the trajectory of a long-run decline seemed unavoidable, with the effects already perceptible in the direction, value and volume of coal exports in the 2010s.

4.2.2 Foreign pricing measures

South Africa faced an increasing risk that other countries would impose taxes on coal-intensive products. If its major trading partners followed through on commitments to this effect, it would impinge on the competitiveness especially of electricity-intensive exports, notably aluminium and ferroalloys, as well as coal-based petrochemicals. Except in Asia, other large-scale producers of aluminium and similarly electricity-intensive products relied mostly on hydroelectricity, which meant they would be much less affected by measures to control emissions.

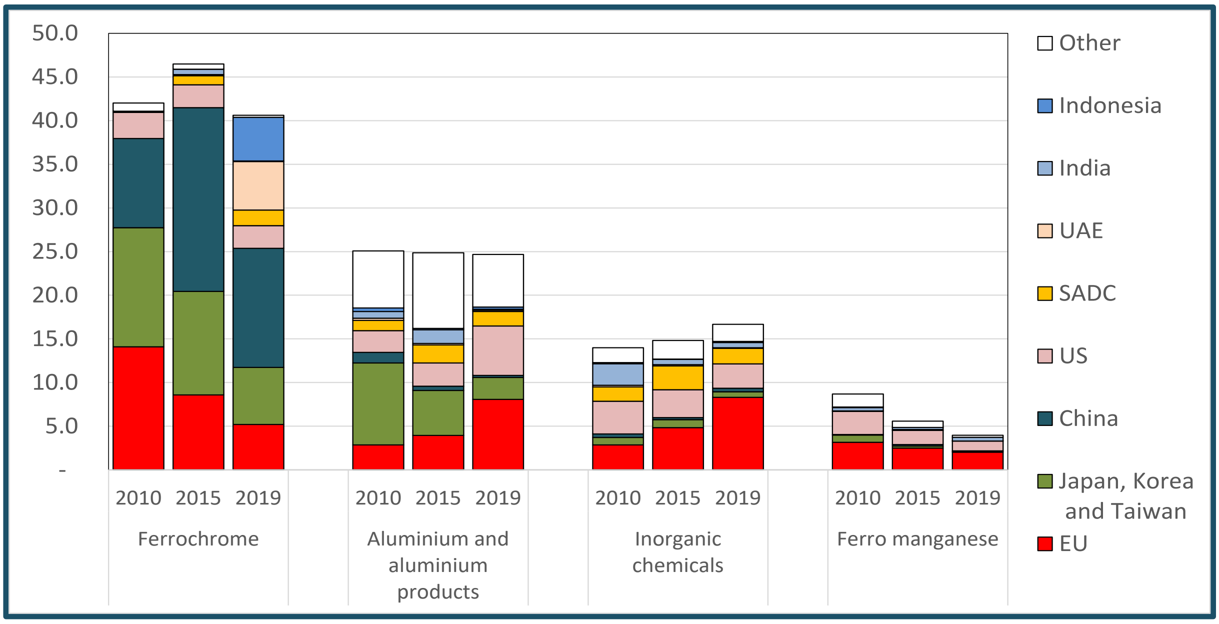
Taxes and other pricing measures frame greenhouse gas emissions as a market failure. When producers emit carbon, they impose a burden on society that is not included in their costs or the price of their output. By this logic, government should step in to make sure their output reflects the full cost of production to society, including the impact of the climate crisis.

The cost and coverage of emissions levels was set to rise rapidly rise over the coming decade as the climate emergency deepened. (See European Commission 2021 and Dlouhy 2021). As of 2021, 35 national jurisdictions plus the EU had already imposed taxes or other price-based restrictions on emissions-intensive products, covering around a fifth of global emissions. In addition to Europe, they included China, which accounted for half of the emissions affected; Japan; South Korea; and South Africa itself (see section 4.2.4). The number of countries imposing an emissions levy had doubled from five years earlier. Another eight subnational regions, including eight Chinese provinces and the US states of California and Massachusetts, had adopted local measures affecting a further 4% of global emissions. (World Bank 2021)

The level of emissions levies varied widely between jurisdictions, ranging from over US$150 per tonne of CO_2 to virtually zero. In 2020, it averaged US$22, weighted by the share of emissions covered. (Calculated from World Bank 2021)

As the following graph shows, the bulk of South Africa's energy-intensive exports went to high-income countries in Europe, Asia and the US as well as to China. That meant they were particularly likely to come up against measures designed to raise the cost of emissions-intensive products.

Graph 30. South African energy-intensive exports by destination in billions of constant (2020) rand (a), 2010, 2015 and 2019



Note: (a) Reflated with CPI, rebased to 2020. *Source:* Calculated from Quantec. EasyData. RSA Trade HS-8 Digit. Interactive dataset. Accessed at www.quantec.co.za in May 2021.

4.2.3 Financing and investment

In the second half of the 2010s, major foreign and domestic investors increasingly adopted policies to limit or end funding for new projects in the coal value chain, especially in mining and electricity generation. These policies typically ended or severely restricted loans to new projects but avoided withdrawal from existing commitments. The result was a marked slowdown in new coal investments, especially in electricity generation. Chinese companies proved an exception, however, as they continued to offer financing for large-scale, coal-based investments, notably for Eskom and the Musina Makhado power plant.

As of 2020, over 100 development banks and many private multinational banks pledged to end funding for coal projects. BlackRock, the world's largest asset manager, planned to divest from companies that generated over 25% of their sales from coal (Davie 2020). In the early 2020s, the main overseas funders for coal projects in lower-income economies, including in South Africa, had become China, South Korea and Japan. South Korea ended the practice in April 2021, and a month later the governments of the largest economies outside of China, the G7 (Canada, France, Germany, Italy, Japan, the United Kingdom and the US), agreed to end all new financing for overseas coal plants (Harvey 2021).

From the late 2010s, the dominant mining conglomerates based in the global North also committed to a gradual divestment from coal. In South Africa, the impact was visible in the sale of coal mines by Anglo American and South32 to locally-owned companies. In addition, in the early 2020s Glencore, Sasol and Exxaro all announced that they would avoid new coal projects. In effect, that meant their holdings in coal would wind down over the coming 20 years or so as existing mines matured.

In South Africa, by 2021 the four largest banks had adopted policies that restricted lending to new coal projects. Table 1 outlines the policies as of May 2021. Only Nedbank adopted a complete ban, and none divested from their existing holdings or from Eskom bonds. The banks argued that as long as the South African economy depended on coal-fuelled electricity, they could not fully abandon coal. Nonetheless, they committed to subjecting all new coal plants to intensive due diligence around environmental impacts, and some required exploration of alternative energy sources.

Table 1. Leading South African banks' policies on lending to the coal value chain as of May 2021

BANK	YEAR ADOPTED	STRATEGY	REQUIREMENTS FOR NEW LOANS
ABSA	2020	Continue financing for coal mines but expect to phase out over long run; aim to increase financing for renewable electricity.	Finance coal-based electricity only when no other option is viable; projects must align with national and global climate targets and best practice on emissions.
FNB	2019	Limit investment in new coal projects to 0,5% of total lending, and all coal to 2%. Long-term aim of total divestment.	Ensure best practice in minimising emissions.
Nedbank	Initial 2019; revised 2021	Immediately end funding for new power plants, and for new or foreign coal mines from 2025. Limit financing for the coal value chain (except Eskom) to under 1% of advances, falling to 0,5% in 2030, with no exposure to fossil fuels after 2045. Target R2 billion financing for renewables by 2022.	No funding for new projects.
Standard Bank	2020 (fossil fuels and coal mines); 2019 (power plants)	Aim to reduce exposure to thermal coal over time in line with policies in the relevant country.	Ensure best practice in minimising emissions and in the case of power plants evaluate alternatives.

Source: First Rand. Policy on thermal coal financing. 2019. Accessed at www.firstrand.co.za. Nedbank. Financing policy on thermal-coal-related activities. 2019. Accessed at www.nedbank.co.za. Absa. Summary coal financing standard. 2020. Accessed at www.justshare.org.za. Standard Bank. Coal-Fired Power Finance Policy (2019), Fossil Fuels Financing Policy (2020) and "Thermal Coal Mining Policy" (2020). All downloaded in May 2021.

The IDC did not have an explicit policy limiting coal financing as of 2021, although it announced in 2020 that it was reviewing its position. (IDC 2020:64). From the early 2000s, it actively supported coal mining, largely in an effort to promote black ownership. It stopped reporting separately on coal investments in 2016, however. In that year, it lent R660 million to coal compared to almost R4 billion for electricity, mostly for private-sector renewable projects. It had R2 billion invested in coal compared to R3 billion in electricity. As of 2021, the IDC held 8% of Sasol; a significant share of Exxaro through its holdings in Eyesizwe; and retained large investments in aluminium processing, as described in section 2.2.

The Government Employees Pension Fund (GEPF) and the Public Investment Corporation, which mostly manages GEPF assets, also had substantial holdings in the coal value chain. In 2020, the GEPF held 14% in Exxaro. The Public Investment Corporation had 14% in Resource Generation and 7% in Anglo American, which presumably translated into a similar share in Thungela, the new company that Anglo set up for its coal mines. Neither the GEPF nor the Public Investment Corporation had published a policy on investing in the coal value chain as of May 2021.

The limited available data indicate that domestic financing for coal declined in the 2010s, while financing for renewable energy surged. For instance, in 2020, coal received only 0,3% of all Absa lending. Renewable electricity got 2,2% of the bank's total loans and over two thirds of its energy financing. (Absa 2020:8). The loss of financial support from domestic and foreign institutions helped scupper plans for two private coal power plants (Khanyisa and Thabametsi) initially approved in the early 2010s for Limpopo and Mpumalanga. The projects were valued at over R40 billion. By 2021, both had foundered as financial institutions withdrew support while local environmental activists challenged their environmental and water licences.

Chinese firms often filled the financing gap for coal-based producers in the late 2010s. They also faced intensifying pressure to divest, however. In late 2020, the Chinese government committed to reaching carbon neutrality by 2060. In these circumstances, it was unclear as of May 2021 whether Chinese companies would continue to support large new coal projects. (See Lo 2020 and Pike 2020)

In the late 2010s, the China Development Bank became a critical source of funding for Medupi and Kusile as other sources of funding dried up. From 2018 to 2020, it provided two thirds of Eskom's total new borrowing, equal to some R36 billion. Its share in Eskom's new borrowing increased from 20% in 2018 to almost 90% in 2020. Meanwhile, World Bank lending for Medupi and Kusile fell from 15% of Eskom's total borrowing in 2017 to 2% in 2020.[10] Loans to Eskom represented around a tenth of total Chinese lending to Africa in these two years, up from virtually zero South African borrowing from China over the previous decade (Calculated from China-Africa Research Initiative 2021)

Chinese companies began planning the Musina Makhado Special Economic Zone (SEZ) as a ferroalloys refining complex at a cost of US$10 billion, with around half for a new 3,5 GW coal-fuelled power station. The plant's proposed capacity exceeded 5% of the national grid in

[10] Calculated from Eskom Annual Reports for relevant years.

2021. The Power Construction Corporation of China (PowerChina) would own the power plant. It was constructing a similar-size coal-fuelled plant in Zimbabwe. (Zhuwakinyu 2021)

Musina Makhado would be the first foreign-owned SEZ in South Africa. As such, it benefited from a range of government incentives, including a reduced company tax rate of 15%. The IDC and the Development Bank of Southern Africa were reportedly considering providing some financial support. (See Makgetla 2021)

As of May 2021, the future of the Musina Makhado power plant remained unclear. The SEZ as a whole faced concerns about emissions and water use, and had failed to gain approval for its Environmental Impact Assessment. The coal plant fell outside of the IRP's prescripts, which provided for only 1,5 GWh in additional coal-based capacity through 2030. It would virtually rule out achievement of South Africa's national emissions targets. Finally, it was not clear how Chinese investors would respond to growing pressure at home and abroad to limit investment in both domestic and foreign coal plants.

4.2.4 Domestic policy

From the early 2000s, the South African government committed to mitigating climate change, primarily by reducing emissions from electricity, which inevitably entailed a "shift away from coal." (DFFE 2021:27). In April 2021, it published new draft targets for emissions, with a maximum of 510 million tonnes of CO_2 equivalents in 2025, and 440 million tonnes in 2030. That would mean emissions would climb 6% from 2019 to 2025 – the same rate as from 2015 to 2019 – and then fall 14% by 2030. (Calculated from DFFE 2021:14). The targets were still subject to consultation and final approval. They were considerably more ambitious than initial objectives from 2015, which foresaw an increase of 35% through 2025 and then a plateau. The proposed new targets implied at best flat domestic demand for coal through 2025, since other emissions (largely from liquid fuels and agriculture) would continue to increase. From 2025 to 2030, the targets required a sharp fall in coal demand.

The commitment to gradually reducing dependence on coal reversed over a century of state support for the value chain. From the start of the last Century, systems to promote mining and beneficiation of coal were deeply entrenched across a variety of government functions, including freight infrastructure, industrial finance, and the regulation of ownership and pollution. Moreover, as with many environmental initiatives, the benefits of change were diffuse and often took the form of avoided damage, while the costs were specific to a relatively small number of companies, workplaces and communities. That is a recipe for fierce contestation over specific measures. These factors often led to compromises over standards, delayed implementation, and poor alignment across the state.

The primary mechanisms for implementing the emissions targets were the IRP for electricity; levies on greenhouse gas emissions; and strategies to encourage more emissions-efficient technologies.

4.2.4.1 The IRP

The IRP provided a long-run roadmap for electricity generation by source as a way to guide investment decisions. The government adopted the most recent iteration in 2019. It proposed to cut coal-fuelled electricity generation by 3,8 GWh or 10% from 2020 to 2030 as aging plants closed down. Electricity from other sources, dominated by solar and wind, would almost double. (Calculated from DMRE 2019:42). The IRP included only two small new coal plants but noted that financing and legal challenges meant they might not actually materialise, which in fact occurred, as described in the section on financing and investment (4.2.3). It also allocated all renewable generation to private producers. (DMRE 2019:34). If that stricture were sustained, it would inevitably squeeze Eskom's market share over time.

The authorities did not fully enforce the IRP's requirement of a shift toward cleaner energy. Most obviously, the plan ruled out construction of the Musina Makhado coal plant. Furthermore, the DMRE expected to issue bids for only 4 200 GW of new renewables in 2021 and 2022, although the IRP anticipated 5 600 GW of new renewable energy in 2022 and 2023. In contrast, the department planned to procure 3 GW of gas-fuelled electricity in 2021/22, which was the entire amount foreseen through 2030. It also planned to replace the two abandoned coal projects, readvertising the entire 1,5 GW allowed for new coal projects through 2030. (DMRE 2019:42 and SA News 2021)

Despite these limitations, the IRP marked a decisive shift away from coal for South African electricity. Under its terms, Eskom's demand for coal would shrink by over 10% by 2030, cutting domestic demand for coal by more than 6%.

4.2.4.2 Carbon pricing

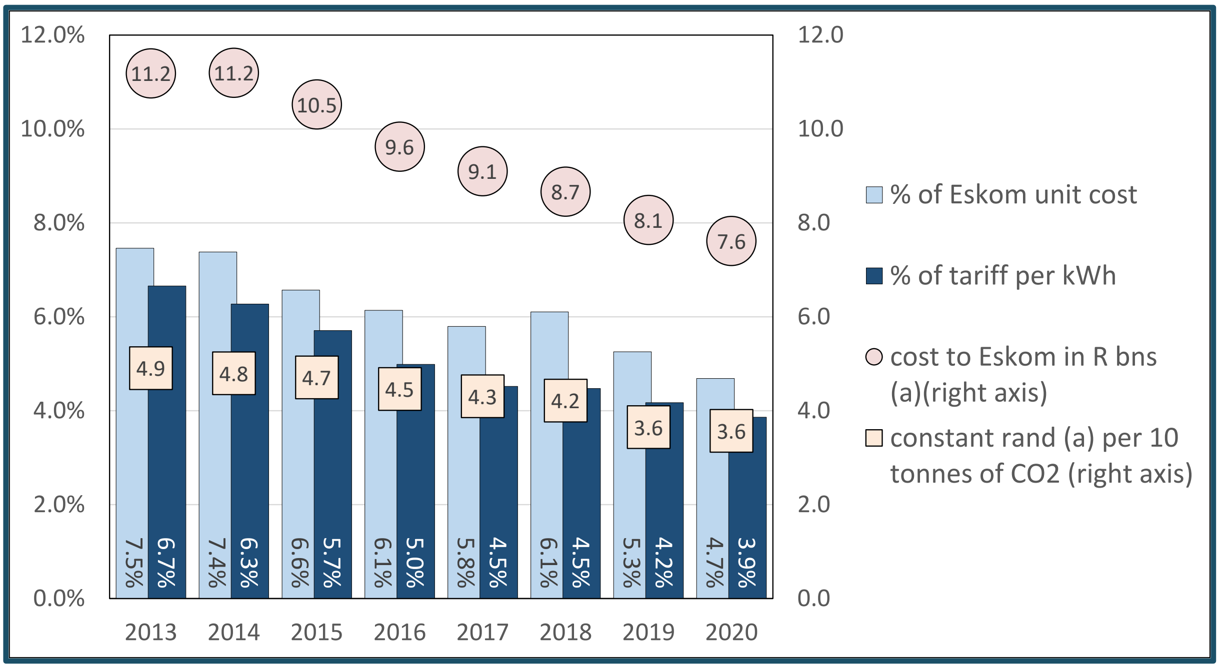
The government adopted two main carbon-pricing measures: an environmental levy on non-renewable energy in 2009, and a carbon tax in 2019. Both priced carbon at levels well below the international norm. In real terms, the value of the environmental levy fell steadily through the late 2010s.

The environmental levy was a tax on Eskom's sales of non-renewable electricity, not directly on greenhouse gas emissions. It effectively increased the relative cost of generation from fossil fuels for Eskom. It did not affect final consumer choices, however, because Eskom averaged it into all sales from the national grid.

The environmental levy fell 10% in constant rand from 2013 to 2020 (deflated with CPI), although it rose in nominal terms from two cents a kilowatt hour in 2009 to 3,5 cents in 2020. For comparison, in 2020/21 alone the Treasury transferred to Eskom the equivalent of 27 cents per kilowatt-hour.

Eskom's actual payments for the environmental levy came to R36 per tonne of CO_2 emissions in 2020, or around a tenth of the average levy internationally excluding South Africa. The figure had declined, in constant rand terms, from R49 per tonne in 2013. Rising electricity tariffs meant that the levy fell from 6,7% of the average price per kilowatt-hour in 2013 to 3,9% in 2020 (see Graph 31). In constant (2020) rand, the total cost to Eskom fell from R11 billion in the early 2010s to under R8 billion in 2020. The fall in total payments resulted mostly because the rate declined in real terms, although Eskom's shrinking sales of coal-based electricity also contributed.

Graph 31. The environmental levy as a percentage of Eskom's tariff per kilowatt hour and of its unit operating costs, and Eskom's total payments and per tonne of CO_2 emissions in constant rand (a)



Note: (a) Deflated with average annual CPI rebased to 2020. *Source:* Calculated from Eskom's Annual Reports for relevant years.

In 2019, the government instituted a carbon tax, with the first payments due in October 2020. The first phase of the carbon tax effectively excluded grid electricity and had a very low effective rate. As a result, the initial impact on the coal value chain was small and borne mostly by Sasol. The costs to other producers seemed likely to increase substantially over the coming decade, but as of May 2021 government had not published details of the second phase, due to start in 2023.

Phase 1 of the carbon tax effectively exempted most greenhouse gas emissions from coal use outside of Sasol. It exempted Eskom because of the environmental levy. For other companies, it applied only to emissions arising from their own production process – known as scope 1 emissions – and not to those generating in production of other inputs (scope 2 emissions), including electricity. Coal mines only paid for "fugitive emissions" generated during their own production, which excluded the much larger emissions resulting from coal usage. (SARS 2020a:54)

The carbon tax priced emissions at a fraction of the amount levied in other countries. In 2020, the nominal rate, before deductions, was R127/tonne (SARS 2020a:9) – over three times the environmental levy on electricity, but only around 40% of the global norm. In the first phase, however, the tax only applied to between 5% and 40% of emissions, with discounts available for imports; for compliance with sectoral carbon targets agreed with the Department of Environmental Affairs, Forestry and Fishing (DFFE); and for investment in emissions-efficient technologies, renewable energy, and projects that absorbed carbon from the atmosphere, such as tree planting. As of 2020, the revenue authorities expected that the tax would range in practice between R6 and R48 per tonne (SARS 2020a:9), or between 2% and 15% of the global norm. For most companies, it was far lower than the environmental levy on Eskom.

The Act provided for the nominal rate to increase by 2% above inflation annually until 2023, and thereafter at the inflation rate.

4.2.4.3 Promoting low-emissions technologies

The government established a number of programmes to encourage less emissions-intensive technologies. The most important were the Renewable Energy Independent Producers Programme (REIPP), sectoral carbon budgets, a range of regulations on pollution, and various incentives to encourage investment in energy efficiency.

As discussed in section 3.3, under the REIPPP the government procured renewable energy on behalf of the national grid, paid for by Eskom. In 2020, the programme reduced emissions by around 12 tonnes or 2,5% of the national total. As of September 2020, 4,5 GW of renewable capacity had been connected to the grid from 71 projects, equal to around 10% of national capacity. Another 2 GW had been contracted but not yet connected. In the year to September 2020, the projects generated 11 100 GWh, or almost 5% of electricity supplied through the national grid. (Calculated from IPPO 2020:3-4). As a result, renewable energy produced per person climbed from 5% of the global average in 2013 to 24% in 2019. The IDC and the Development Bank of Southern Africa provided a significant share of the investment financing.

The REIPPP faced considerable resistance from actors in the coal value chain, who saw it as a source of competition that would inevitably reduce their market share. Eskom in particular argued that the earliest projects locked in high costs per kilowatt hour, and that it had to pay for transmission lines that were not costed into the original contracts. These factors contributed to the delay in tender rounds from 2015 to 2021. As a result, after a rapid increase from 2013, renewable production for the grid remained essentially unchanged from 2017. (Calculated from Our World In Data 2021).

Carbon budgets represented a central pillar of the 2011 *National Climate Change Response White Paper* (DEA 2011:28 ff). They set national targets for emissions; on that basis, determined realistic emissions trajectories for individual industries; and then incentivised and empowered stakeholders to meet their targets through changes in technology choices and production structure.

The development and implementation of industry-level carbon budgets faced two major challenges, however. First, most industries lacked structures for the engagements and research needed to agree on targets and strategies to achieve them. Specifically, the government departments regulating individual industries, such as mining and agriculture, historically functioned mostly to regulate the industries they oversaw (for instance around safety and water use), rather than to promote technological transitions. They lacked the capacity and in most cases mandates to promote systemic change to reduce emissions. Second, the environmental affairs department did not have the power to establish incentives or sanctions to encourage compliance with carbon budgets. It brought together stakeholders in some industries to develop targets and strategies but was unable to ensure consistent support for their implementation across the state. The only major incentive in this period came from the carbon tax, which from 2019 provided a 5% allowance for companies that submitted a carbon budget with data on their emissions.

In 2021, DFFE announced that from 2023 it would require companies (not industries) to submit their own carbon budgets. It planned to develop the methodology to set meaningful targets through engagements with stakeholders in 2021 and 2022. Government would then amend the carbon tax to incentivise achieving emissions targets rather than just developing a plan to achieve them. As of February 2021 DFFE had not finalised the proposed reforms, but it intended to increase the tax significantly for companies that did not meet their emissions targets. (DFFE 2020)

Finally, South Africa adopted various measures to facilitate and incentivise more efficient electricity use across the economy. In the early 2020s, the DMRE targeted a reduction of 0,5 million tonnes a year in carbon emissions through programmes to promote electricity efficiency. To that end, it provided around R300 million annually in incentives, with two thirds as a grant to municipalities and the rest funding the South African National Energy Development Institute (SANEDI). The DMRE also provided close to R200 million for research into carbon capture and storage at the Council for Geoscience. (National Treasury 2021)

SANEDI targeted reductions of 1,5 million tonnes of greenhouse gas emissions for 2021, or almost 1% of national emissions. (SANEDI 2021a:36). In addition to research on energy-saving technologies, it administered a company tax incentive (section 12L of the Income Tax Act) to encourage more energy-efficient production. Section 12L was introduced in 2013 and extended to 2022. It provided that if a company saved electricity through a defined project, it could write off R0,95 for each kilowatt-hour of audited reduced demand for a year. At the nominal company income tax rate of 28%, the company would increase its financial savings from the project by over 25%. Section 12L led to claims worth R22 billion from 2013 to 2021 in nominal terms. In constant rand, the figure would be substantially larger. Section 12L incentivised a total of 27 000 GWh in savings, but most came from gas rather than grid electricity or coal. (SANEDI 2021b). Sasol appeared to be by far the largest beneficiary of the incentive, as detailed in the following section.

4.3 Impacts on the coal value chain

The coal mines themselves faced declining demand as countries and businesses moved toward cheaper and cleaner energy. They also experienced substantial changes in ownership and financing as major mining conglomerates and banks divested. The carbon tax affected them only marginally, however, since they only paid for emissions from mining itself. Especially for open-pit mines, these emissions were tiny compared to coal refineries.

Exxaro exemplified the contradictory pressures on the coal mines. In 2020, it estimated that its emissions from mining itself and its inputs together totalled around 900 000 tonnes. That was around 1,5% of the emissions resulting from the use of its coal, mostly by Eskom, which it calculated at almost 70 million tonnes. For calendar 2019, Exxaro reported carbon tax of R5,4 million, or 0,02% of its coal revenues and 0,11% of its pre-tax profits from coal. (Exxaro 2020a:34). That rate barely raised the relative price of coal for users. Exxaro expected the tax rate to rise sharply from 2023, however, reaching between 1% and 4% of its operating costs in 2025 if it failed to reduce its own emissions. (Exxaro 2020b:17)

Exxaro argued that it could get to net zero emissions in coal production by 2050. (Exxaro 2020a:10). This target still excluded downstream emissions, however. The company nonetheless concluded that, "While coal is the core of our business now and for decades to come, Exxaro understands the finite nature of the fossil-fuel sector and changing global imperatives." (Exxaro 2020a:13). It therefore planned to move into renewable energy generation. Still, in 2020 it invested R3 billion in its coal mines, of which a third was on new projects. (Exxaro 2020a:8)

Eskom was entirely exempt from the carbon tax, but other measures to reduce emissions depressed demand for its output. The REIPPP cut into its market share, while efforts to promote energy efficiency reduced total demand for grid electricity. Eskom also faced growing pressure to comply with clean-air requirements, which it claimed would force closure of some of its older plants.

In the early 2020s, Eskom began to change course on the climate emergency, although as of May 2021 it had not set its own emissions targets. (Eskom 2020a:113). It argued that the physical risks from climate change would ultimately exceed the cost of accelerating the move to clean energy. It explicitly supported greater investment in renewables and infrastructure for electric vehicles, with earlier closure of some coal plants than initially foreseen. (Eskom 2020a:112)

In part, Eskom's changed stance reflected the new realities on financial markets. From 2020, its efforts to refinance its excessive loans centred on a Just Energy Transition Transaction. The proposal aimed to unlock lending from domestic and foreign markets by committing to "a significant reduction in carbon dioxide emissions over the next 30 years". It would finance Eskom's transition to renewables and the transition to new kinds of production for communities in Mpumalanga's coal belt. (Eskom 2020a:114). It would necessitate a change in the 2019 IRP ruling that limited new renewable generation to private investors.

Eskom also faced pressure from clean-air standards introduced in 2013. The rules initially aimed principally to reduce pollution, including greenhouse gases, affecting communities near power plants in Mpumalanga. In light of the high cost of retrofitting Eskom's coal plants, DFFE granted it a delay until after 2020. In 2021, Eskom contended that it would cost R300 billion to meet the requirements. It argued that the investment was not worthwhile since the plants would have to close in five to 15 years due to age. (Eskom 2021:2 and Eskom 2020a:111)

Sasol's production process was even more emissions-intensive than Eskom. As of 2020, it argued it had to "reduce or stop the use of coal," and that measures to mitigate the climate crisis strand its assets in South Africa. (Sasol 2020d:6-7). It noted that, "Our relatively high carbon emissions and the use of coal as a key feedstock could also impact negatively our potential base of shareholders and our ability to source financing on the capital markets or increase capital cost." (Sasol 2020b:16). In effect, it argued that it had to disrupt its business model and switch to new technologies in the short to medium term in order to survive in the longer run. (Sasol 2020a:40)

Sasol adopted a target of reducing emissions by 10% from 2017 to 2030, although as of May 2021 it had not set targets beyond that. (Sasol 2020a). Ten percent of Sasol's 2017 emissions would come to 6,5 million tonnes of CO_2. That equalled 1,4% of national emissions in 2019, or around 17% of the reduction in greenhouse gas emissions set in the draft national targets. To achieve this goal, Sasol planned to replace coal with natural gas as its main feedstock for petrochemicals in South Africa, although it did not identify timelines or sources. Because it owned its coal suppliers, the shift would not directly affect the price of coal produced by other companies.

Sasol expected its full-year carbon tax to reach between R800 million and R1,1 billion in 2020, depending on its ability to take advantage of the various offsets and allowances. (Sasol 2020a:41) For the second half of 2019, it owed R308 million. (Sasol 2020d:29). That equalled around 2% of its revenues from synthetic fuels. (Calculated from Sasol 2020b:G-8). For comparison, in 2019 the South African Revenue Service collected R10 billion from all environmental levies excluding Eskom. From 2013 to 2020, however, Sasol claimed R16 billion under the energy-efficiency tax incentive (Section 12L) (Sasol 2020d:29), or over two thirds of all 12L benefits provided in this period. Sasol did not specify what projects qualified for the incentive, but they likely related largely to its replacement of Eskom electricity with gas over the past decade.

In the early 2020s, neither domestic nor foreign measures to reduce investment in the coal value chain targeted aluminium or ferroalloys, which generated emissions primarily through their electricity use. As of May 2021, South32 did not report any carbon-tax payments in South Africa. (South32 2020b:8). In 2020, DFFE approved South32's carbon budget.

5 GOVERNMENT OVERSIGHT

Government oversight over the coal value chain was fragmented between various government departments, the provinces of Mpumalanga and Limpopo, municipalities that housed mines and refineries, and a range of state-owned companies. Table 2 summarises their mandates and responsibilities.

Table 2. Government oversight of the coal value chain

DEPARTMENT/ AGENCY	MANDATE	ROLE IN COAL VALUE CHAIN
Mineral Resources and Energy	Regulate, transform and promote minerals and energy in the interests of South Africa; ensure reliable energy supply.	Guide investment in new generation capacity through the IRP, and allocate it between Eskom and private suppliers. Establish regulatory framework for coal mines and energy producers (licencing, empowerment requirements, health and safety), including through the Mining Charter. Contract renewable energy through the REIPPP. Promote metals beneficiation, which affects demand for electricity and consequently coal.
Trade, Industry and Competition	Promote structural transformation towards a dynamic industrial, globally competitive and inclusive economy.	Industrial financing (through the IDC) and incentives for metals refineries. Broad-Based Black Economic Empowerment (BBBEE) requirements. Oversee SEZs, including the Musina Makhado complex in Limpopo. Localisation mandates for Eskom. Manage competition policy.

DEPARTMENT/ AGENCY	MANDATE	ROLE IN COAL VALUE CHAIN
Environmental Affairs, Forestry, and Fisheries	Environmental management, conservation and protection towards sustainability for the benefit of South Africans and the global community.	Set national emissions targets and negotiate them with international partners. Regulate air and water pollution. Approve and monitor emissions targets at company and potentially industry level. Identify technological pathways to reduce emissions. Develop just transition strategies for affected industries, workers and communities. Regulate environmental impact assessments and appeals.
Public Enterprises	Create an enabling environment for state-owned corporations to contribute to developmental objectives, industrialisation, job creation and skills development.	Shareholder representative for Eskom and Transnet Approve key strategic decisions such as unbundling, executive hiring and local procurement strategies.
National Treasury	Oversee the management of public finance in ways that realise national potential and maintain stability.	Regulate taxes and tax incentives, including the Carbon Tax and Section 12L for energy efficiency. Provide loan guarantees and subsidies for Eskom. Enforce the Public Finance Management Act and oversee the Auditor General. Regulate municipal and provincial treasuries and budgets. Allocate and transfer the municipal and provincial shares in national revenues.
Eskom	Generate, wheel and supply electricity through the national grid in an efficient and sustainable manner.	Manage existing capacity to ensure stable supply as far as possible (it does not have a mandate on affordability). Manage the national grid. Invest in new capacity in line with the IRP, which foresees no new Eskom investments through 2030. Purchase energy from REIPPP on terms agreed by DMRE and link it to the national grid.
Transnet	Enable economic growth and security of supply through affordable and efficient ports, rail and pipeline infrastructure.	Bulk coal lines from mines to the coast and to Eskom.

DEPARTMENT/ AGENCY	MANDATE	ROLE IN COAL VALUE CHAIN
Mpumalanga and Limpopo governments	Manage constitutional competences to benefit provincial residents.	Promote a just transition through engagements with public and private stakeholders. Maintain provincial roads from mines to Eskom. Manage environmental impact assessments. Manage and promote SEZs, including the Musina Makhado complex in Limpopo.
Mining towns in Mpumalanga and Limpopo	Maintain and extend community facilities and infrastructure as well as industrial and commercial sites.	Work with national and provincial governments, mining companies and Eskom to secure a just transition. Ensure adequate housing and other municipal services for employees in the coal value chain.
Other municipalities	Maintain and extend electricity for residents and local businesses.	Purchase (and pay for) electricity for Eskom and, from 2020, from private producers. Extend local grids to historically underserved communities and new settlements. Maintain local grids for households and economic sites. Provide free basic electricity for poor households. Collect payments for electricity from residents and businesses.

Rifts emerged between the various state agencies overseeing the coal value chain around a variety of issues, making it difficult to manage the downsizing in the coal value chain in the 2010s. The most obvious disagreements centred on the future value of coal in light of the climate emergency. As the debates on the IRP showed, the DMRE generally argued that South Africa's coal resources were too valuable to relinquish and that they provided a critical baseload for the electricity grid. In contrast, other state actors generally saw coal resources as inevitably depreciating in value as the associated technology became obsolete.

A further, underlying debate related to risk management. On the whole, the South African state tended to punish leaders and officials who undertook risky innovations that went wrong, but not those who failed while sticking to pre-existing rules and conventions. Moreover, it did not generally provide consistent rewards for risky decisions that turned out right. In this context, pushing for new technologies was often less attractive for officials than maintaining the existing regime, even as it grew increasingly dysfunctional.

These debates emerged in a range of practical debates, including the following:

- How fast to move in reducing emissions, and by extension how rigorous to make the associated incentives and penalties, including the IRP and the carbon tax.
- Whether South Africa could develop an alternative way to stabilise the grid, whether through another baseload fuel, the combination of a wider variety of energy sources, or storage.
- How much private competition Eskom should face, and whether it should be able to invest in renewables – a precondition for it to maintain its market share in the long run.
- Whether the state should continue to incentivise energy-intensive metals refineries, including through subsidies on Eskom electricity.

- How much the state should subsidise Eskom, which effectively reduced the relative cost of coal-based electricity.

The existing system of mandates entirely left out responsibility for ensuring a just transition for communities, workers and small businesses as the economy moved away from coal. As of the early 2020s, the DFFE, the DMRE, Mpumalanga and some local governments had all initiated efforts in this regard, with limited formal coordination or alignment.

The establishment of the Presidential Climate Change Coordinating Commission (PCCC) in December 2020 aimed to assist in securing alignment across the state around environmental issues and the just transition. The Commission only had power to advise and facilitate, however. It did not have authority to settle the underlying disputes between stakeholders around the future of the coal value chain, which ultimately underpinned the differences between the various state agencies involved in the process.

6 IMPLICATIONS FOR RESEARCH

By the early 2020s, the coal value chain in South Africa and worldwide had entered a gradual but unstoppable decline.[11] The contraction in coal had two roots.

- First, the value chain faced a classic process of creative destruction, as coal-fuelled electricity generation rapidly became obsolete. Global efforts to promote cleaner energy in the 2010s established a new technology trajectory that increasingly reduced the cost and improved the flexibility of renewables and gas generation. In these circumstances, clinging to coal began to raise the cost and reduce the reliability of the national grid.
- Second, the accelerating climate crisis intensified domestic and international pressure to limit the use of coal and coal-based products. The result was acceleration in measures to raise the relative price of coal and to limit financing and investment for coal-based production. In consequence, cost structures rose along the coal value chain, making it less and less competitive with alternative energy sources.

In the medium to long run, these realities meant South Africa had to transition away from coal. The challenge was to manage the value chain down in ways that minimised the costs and risks and maximised the benefits for society. If successful, the result would be a more diversified and competitive economy, above all by establishing a more stable and affordable electricity system. But the shift would be profoundly disruptive. For over a century, the coal value chain was embedded in core economic systems, including electricity, exports, rail infrastructure, most investment portfolios, a range of regulatory and fiscal arrangements, and two districts in Mpumalanga.

In these circumstances, the core policy aim was to ensure that the transition was both efficient and sustainable from the standpoint of the economy and the climate crisis, and viable in political-economic terms. South Africa faced particular contestation as its democracy gave the majority a degree of political power while economic power remained largely in the hands of dominant companies. As a result, sustainable measures generally had to

[11] The only possibilities that seemed able to save the coal value chain internationally were an improvement in clean-coal technologies or vastly improved systems to reduce carbon from the air. As of 2021, neither seemed viable or affordable for the foreseeable future. (See Arndt et al. 2019).

achieve both support from the majority of voters and at least a degree of acquiescence from big business.

Table 3 indicates the costs, benefits and risks of the transition away from coal for different stakeholders. It points to hard policy choices in three areas.

1. How fast to move into cleaner energy sources. Delays increasingly undermined national competitiveness and disrupted the electricity supply, damaging overall economic growth and development. Rapid innovation, however, devalued existing investments along the coal value chain, from coal mines to Eskom and Sasol to the aluminium and ferroalloys refineries.
2. How much effort and resources to dedicate to support and empower workers and communities in the coal economy. Absent public support, most did not have the capacity or funds to adapt to and benefit from the opportunities generated for new kinds of production.
3. How to develop and capacitate government institutions to ensure consistent and agile implementation of key decisions around the transition across the state, while promoting constructive engagement and action from stakeholders and civil society.

This section deals with each of these areas in turn.

Table 3. The costs, benefits and risks of the transition away from coal

STAKEHOLDER	BENEFITS	COSTS	RISKS
Government	Reduced subsidies for electricity and refineries. More reliable and cheaper electricity in medium term, resulting in faster growth and higher tax revenues. Reduced healthcare costs in communities from Eskom pollution. Mitigate impact of climate emergency and consequent periodic disasters and overall slowdown in economic growth. Reduce effects of foreign emissions taxes on exports.	Need to allocate capacity, resources and political capital manage the transition consistently and appropriately. Capacity and resources to engage with stakeholders to reach agreement as far as possible, without compromising transition. Fiscal and regulatory support for new generation capacity and economic diversification for coal communities.	Unable to manage lobbying or implement measures consistently, resulting in incoherent or inappropriate approach, higher costs in the long run, and reduced benefits. Unable to support affected constituencies, resulting in political opposition and impoverishment.

STAKEHOLDER	BENEFITS	COSTS	RISKS
Workers and businesses outside the mining value chain	Faster growth and job creation due to diversification from coal mining and refineries into more labour-intensive activities. Limit impacts of emissions taxes on South African exports. Lower-cost and more reliable electricity for households and producers.	Public and private resources to fund just transition and new generation capacity over the coming decade.	More disruption and higher costs for electricity if investment in cleaner energy stalls and/or technological challenges are not fixed timeously.
Communities outside the coal value chain	Lower cost and more reliable electricity, leading to improved growth and living conditions. Reduced air pollution. Limit impacts of emissions taxes on South African economy.	National resources used to support just transition and fund new generation capacity.	As above.
Coal miners	Opportunity to move into new occupations that are safer and healthier, with better prospects for promotion and rising incomes over time. Access to resources to assist in transition to new livelihoods.	Loss of stable, relatively secure employment with comparatively high pay for workers without a degree. Devaluation of existing skills and occupations.	Alternative employment is unavailable, worse paid and/or insecure. Social protection to assist the transition does not materialise or is inadequate.
Communities that depend on coal	Diversification into cleaner, more dynamic and sustainable industries. Improved health as pollution declines. Access to resources to cushion transition.	Coal mines and power stations shed jobs when they close. Closure of coal enterprises leads to decline in businesses that supply them or that serve their workers.	Failure of programmes to promote diversification. Inadequate social protection to manage the transition. Out-migration of people with marketable skills or assets.
Coal mining companies	New and more sustainable opportunities arise as economy diversifies.	Loss of historically profitable activities, and significant asset write-offs.	Write-off of assets leaves without capacity to take advantage of new opportunities.

STAKEHOLDER	BENEFITS	COSTS	RISKS
Eskom	Escape the utility death spiral. Opportunities for new investment in renewable generation.	Loss of historically profitable activities. Write-off of assets. Culture change from protected (near) monopoly to competition. Need to develop more sophisticated grid management.	Not allowed to get into new technologies, so access to funding and market share crash in 2020s. Unable to develop new skills sets and capacities for more competitive market based on new technologies. New grid technologies prove inadequate.
Transnet	New opportunities as economy diversifies and grows.	Loss of profits from coal lines and handling for aluminium and ferroalloys.	Bulk coal lines and port facilities do not or cannot adapt to new products, leading to write downs.

6.1 Phasing

A central question for the energy transition was how quickly to phase in new technologies, especially in electricity generation and Sasol's production. Because government regulates electricity, mining and pollution comparatively strictly, the speed of the transition depended in large part on policy choices. By the early 2020s, a number of studies, including the IRP, demonstrated that an energy transition over the coming ten to 20 years was both viable and economically desirable. The failure to implement the IRP consistently, however, pointed to continued contestation within government, risking inconsistent and less desirable outcomes. The regulatory frameworks for electricity and liquid fuels initially arose to promote coal-based technologies, so they tended to block alternatives except where government acted decisively to change them.

From the standpoint of the evidence, the difficulty of pricing emissions and risks around new technologies underpinned the contestation about how quickly the transition should take place. This section describes the kinds of evidence that would make it easier to reach agreement on how much government should invest in new technologies in order to minimise the cost of using coal. That in turn informs how quickly South Africa should phase down coal.

6.1.1 Carbon pricing and the cost of electricity

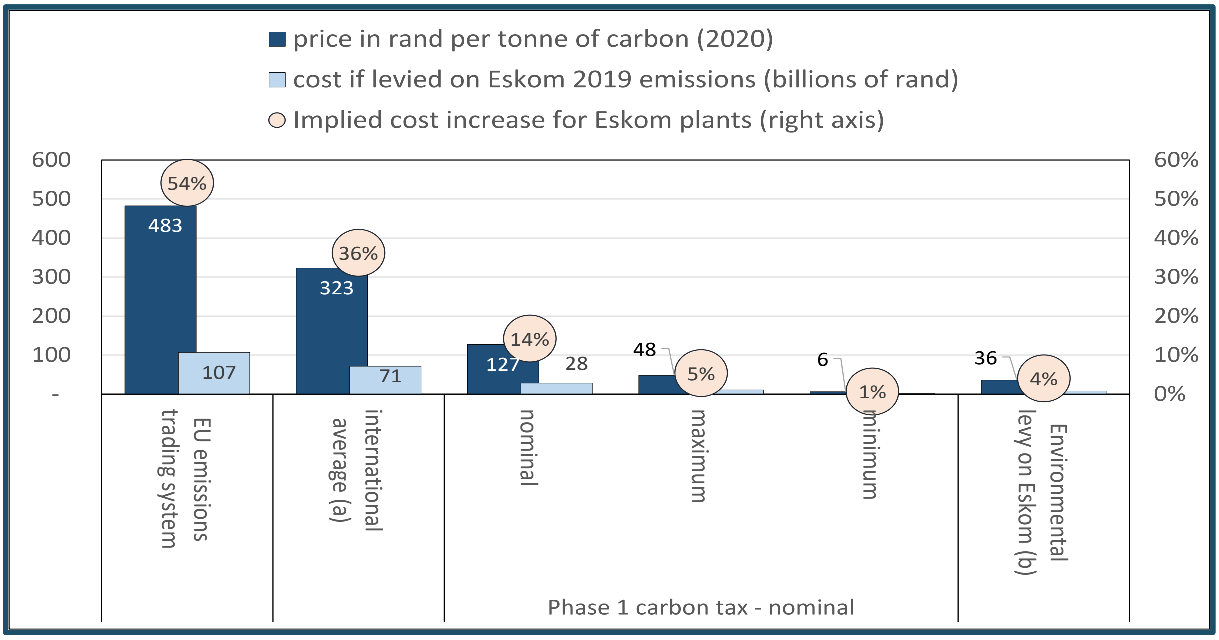
In terms of prices, the main issue was how quickly to phase out older coal plants in favour of new technologies. For new capacity, renewables were clearly cheaper. The calculation on when to retire older plants was more difficult. An evidence-based approach had to weigh their full costs of production, including imputed costs for pollution, against the cost of writing down their assets.

Two strategies generally inform estimates of the cost of emissions from existing coal plants.

One strategy extrapolates the costs of pollution from the expense of retrofitting plants to conform to national clean-air standards. In the early 2020s, Eskom itself argued that it would be cheaper to close down its older plants than to refit them (see section 4.2.4.3.) That is, Eskom agreed that its older coal plants were already only viable because they did not pay the full cost of production, including pollution. Given this agreement, the only possible economic justification for keeping the plants open was that the air-pollution standards were set too high – that is, that they overestimated the cost of pollution, including greenhouse gas emissions, for society.

Second, the cost analysis could add a market price for carbon emitted to the cost of electricity production. In the early 2020s, however, carbon pricing varied widely between different markets and measures, as illustrated by Graph 32. Lower estimates would justify a delayed transition. In contrast, applying the average international price for carbon would increase the cost of Eskom's electricity by over a third. Using the European Union (EU) price would see it climb by over half.

Graph 32. Estimates of the cost for Eskom electricity from different prices per tonne of carbon



Notes: (a) Average weighted by share of emissions covered; excludes South Africa. (b) Derived from levy per kilowatt-hour. *Source:* EU and international average calculated from World Bank. Carbon Pricing Dashboard. Interactive dataset. Accessed at https://carbonpricingdashboard.worldbank.org/ in May 2021. South African taxes and levies use cost estimates provided in section 4.2.4.2.

The implicit debates around the cost of coal-based energy could not be resolved through evidence alone, because the transition had a divergent impact on different stakeholders, and the market did not set a price on emissions. Still, research on the probable impacts of climate change and pollution on the economy and society over the next ten to 20 years could help narrow differences around the urgency of the energy transition.

6.1.2 The risk and cost of new technologies

Contestation over phasing was also rooted in disagreements about the viability of the new technologies. It was easy to see the risks of investing in renewables, which were undergoing rapid changes in generation processes, grid access and storage, compared to coal, which relied primarily on centuries-old practices.

A core question arose around how to stabilise the grid in the absence of coal. Most countries relied on hydroelectricity, nuclear or gas to provide a baseload. For South Africa, all of these solutions could be explored, but faced some obvious obstacles. Large-scale hydroelectric power would have to be sourced from other countries in the region; as of mid-2021, the availability of gas supplies was unclear; and nuclear was prohibitively expensive. In addition to these historic forms of baseload, some countries stabilised the grid by combining a range of smaller sources. That reduced the risk of fluctuations in supply if any plant fell out. It also made it possible to use electricity more efficiently across the grid, reducing the amount generated to meet a given demand. Managing this kind of grid required advanced technology and risk management. (See Arndt et al. 2019:156-7). Still, it also avoided the risk of a collapse at a baseload plant leading to major shortfalls in electricity, as happened frequently in South Africa in the late 2020s as Eskom's coal plants deteriorated.

Improved methods to store electricity over time could also smooth out renewables supply. Here, while the technology was evolving rapidly in the early 2020s, it remained inadequate to meet national requirements. The IRP anticipated that new electricity storage would reach 5000 GW, by 2030, which means it would remain at 3% of national capacity.

In addition to fluctuating supply, it was difficult to forecast the cost of cleaner energy technology. The price internationally and in South Africa fell rapidly through the 2010s, but future trends were unpredictable Furthermore, in future costing had to include the expense of transmission to users.

6.1.3 Managing novel crises

Evidence of the need for early action to pre-empt a new kind of crisis is almost never conclusive because, by definition, there has not been time to collect data on the likelihood and extent of potential harm. Yet debates around the quality of the evidence can fuel inertia until the costs grow overwhelming. The debates around what measures to use to limit the spread of COVID-19 demonstrated this process.

The precautionary principle represents an effort to avoid paralysis in the face of novel crises. While various definitions exist, the concept centres on requiring the state to take action to minimise potentially highly damaging risks even if the evidence on costs and benefits is incomplete or disputed.[12] A study for the European Union proposes:

> "… a procedural interpretation characterised by four elements: (1) the potential hazards are characterised by serious, irreversible and uncertain consequences; (2) dynamic decision-making processes are both iterative and informative to allow learning over time; (3) the burden of proof is shared between the regulator and the proponent; and (4) no decision is prescribed *a priori*." (Bourguignon 2015:8)

[12] The precautionary principle has been used in various laws and treaties over the past 50 years, although its definition is debated. For instance, the 1992 Rio Declaration on the Environment and Development holds that "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation." Bourguignon (2015:5ff) cites this and other examples.

For decision-making around the energy transition, this approach would mean acting urgently, due to the severity of the crisis for society and the economy, but building in monitoring mechanisms to permit course corrections as required. It would also mean that proposals to delay the transition could not be justified solely in terms of the cost burdens on some stakeholders. Rather, they would have to show that the delay would ultimately contribute to a better response to the climate emergency.

6.1.4 Some key decisions

In practice, a number of government decisions in 2020 and 2021 could effectively delay the transition away from coal, at considerable cost to the economy as a whole. A policy based on the reality that a transition was inevitable would address the following measures.

- Freezing proposals for new private coal plants, including ending the new tenders to replace the failed Thabametsi and Khanyisa projects and developing alternative energy sources for the Musina Makhado SEZ.
- Reviewing the timeline for closing down older coal plants, as Eskom has proposed, which would increase the space for other energy sources while reducing the cost from pollution itself, or from retrofitting to reduce it.
- Lifting artificial limits on investment in renewable capacity and storage, especially the restrictions on Eskom investment in cleaner energy sources and the limits imposed in the IRP. This approach would require upgrading grid management to balance a larger number of smaller suppliers. It would also require greater clarity about the ultimate market structure in electricity generation.
- Reviewing the potential for expanding regional hydroelectricity generation, taking into account the fact that climate change may make it less reliable in the long run.
- Encouraging the aluminium and ferro alloy refineries and Sasol to safeguard their longer-term export prospects by developing cleaner energy sources as rapidly as possible, and by increasing the incentives for them to save electricity through a combination of regulatory standards and tax benefits.

6.2 The just transition

The cost of the energy transition was necessarily higher for stakeholders in the coal value chain, as Table 3 indicates. The burden seemed likely to prove heaviest for coal miners and small businesses in the coal-dependent districts of Mpumalanga. In contrast, larger mining companies and coal refineries, as well as highly skilled people, had more resources to take advantage of opportunities in other industries, if necessary moving to more prosperous areas. As a result, the shift away from coal could deepen South Africa's already profound inequalities. It could also lead to a significant loss of productive capacity in the Vaal triangle, including Eskom's transmission centres and a network of supportive manufacturing businesses.

The risk of deepening inequalities and unnecessary capacity loss during economic structural change gave rise to the concept of just transition. It refers to the need to ensure that the vulnerable groups and regions do not end up bearing a disproportionate burden in periods of economic transformation, including but not limited to the energy transition. (See TIPS 2020a)

The aims of the just transition align with the belief, enshrined in the Constitution, that the state should support the vulnerable. But they also have a political-economic rationale. In South Africa and internationally, experience has repeatedly showed the difficulty of implementing policies that impose a heavy cost on a minority, especially if the benefits to the majority are comparatively diffuse. In these circumstances, the cost-bearers often mobilise to resist the policy, while the majority take their benefits for granted. The situation is aggravated where a policy aims to prevent a crisis, as with the climate emergency, so that the benefits remain intangible.

In the case of South Africa's energy transition, the shift away from coal would take over a decade. That provided time to establish effective institutions and systems that could develop and implement sustainable plans. By 2021, a number of initiatives aimed to promote a just transition, sponsored amongst others by the DFFE, the National Planning Commission, Eskom, the Mpumalanga government and overseas donors. A core challenge was to establish institutions, including at local level, that had both the capacity to facilitate a just transition and the authority to align all government agencies to support it.

Effective just transition strategies combine three elements. Ideally, the process would be managed by an adequately resourced and capacitated regional coordinating agency since it requires a whole-of-government approach. (See TIPS 2020b)

First, the strategy has to start by identifying realistic and sustainable options to diversify regional economies in ways that provide livelihoods on the necessary scale for the affected communities. Diversification could include new energy-related activities, but also any other sustainable industries. New economic activities would have to build on the region's long-standing economic strengths, and link into dynamic national and international value chains. In Mpumalanga, proposals have arisen around using Eskom's transmission infrastructure for new renewable energy projects; expanding high-value agriculture; and redirecting the region's relatively advanced manufacturing base toward sustainable industries.

Second, a just transition process must assist the people and businesses concerned to take advantage of the identified opportunities. In South Africa, that required the use of standard industrial-policy instruments to promote new productive clusters in the affected communities of Mpumalanga. It also entailed active-labour-market policies to assist individual workers and small business owners to transit to new livelihoods. These policies include retraining, support in job search or establishing new small businesses, and income support for workers as they establish new livelihoods.

Finally, effective just transitions should give vulnerable communities and workers agency, including through voice in decision-making and ownership in new production capacity. That would require structures that enabled communities to engage on opportunities, reach agreement on priorities, and engage in implementation. This approach requires transformation of the top-down management systems that characterised most South African development initiatives.

6.3 Government coordination

Improved coordination across the state was critical for developing and implementing strategies to manage down reliance on the coal value chain. In particular, it required that the government make and stick to tough choices around:

- The end-state for the electricity system, in terms of both technologies and the role of Eskom, and
- The just transition for coal-based communities.

Greater coordination required substantial systemic changes in oversight of the coal value chain. Key changes included the following.

First, all of the relevant agencies, especially government departments, Eskom and Nersa, should explicitly be mandated to promote a just, efficient and urgent energy transition.

Second, the process required a capacitated leadership structure that could engage the relevant agencies but also providing binding decisions on disputes, including around how to value emissions within government, the phasing of the energy transition as captured by the IRP, the end-state for Eskom, and resourcing for just transition measures. The leadership structure should aim to shift from a discourse of power within the state to a discourse of reason by requiring all the agencies to provide evidence to support their decisions.

This basic system looks systems established to manage other national priorities. They are usually led by the President and provide a forum for consistent engagement by the relevant Ministers, Premiers and mayors. They depend on a strongly capacitated secretariat, typically located in the Presidency or a lead department. In the case of the energy transition, the PCCCC could provide decision support and facilitate consultation with stakeholders. NEDLAC could also act as a forum to engage economic stakeholders both inside and outside of the coal value chain.

6.4 Conclusions

Because coal was deeply embedded in the economy but also in state systems in South Africa, the energy transition was inherently disruptive and controversial. It imposed really hard choices on policy makers, including around how to value the long-term impact of the climate emergency over the immediate challenges of poverty, inequality and joblessness; balancing benefits to society as a whole relative to the interests of actors directly in the coal value chain; and the future of Eskom, a major state agency in itself. Delaying or weakening decisions, however, would only add to the ultimate costs without securing sustainable benefits.

The energy transition will take decades. That provides time to establish structures able to manage it effectively through a whole-of-government approach – a critical first step toward maximising the benefits while managing the risks and costs of the inevitable disruption to the coal value chain.

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