TRADE & INDUSTRIAL POLICY STRATEGIES

INDUSTRIAL POLICY AND THE ELECTRICITY VALUE CHAIN

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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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CONTENTS

ABBREVIATIONS

AMSA	Arcelor Mittal South Africa
ARM	African Rainbow Minerals
CPI	Consumer Price Index
DMR	Department of Mineral Resources
DMRE	Department of Mineral Resources and Energy
DPE	Department of Public Enterprises
dtic (the)	Department of Trade, Industry and Competition
GDP	Gross Domestic Product
KPI	Key Performance Indicator
IRP	Integrated Resource Plan
NERSA	National Energy Regulator of South Africa
NT	National Treasury
PFMA	Public Finance and Management Act
REIPP	Renewable Energy Independent Power Producer
UMIC	Upper-Middle-Income Countries

EXECUTIVE SUMMARY

Industrial policy in South Africa faces the challenge of overcoming profound inequalities while building a more dynamic, productive and competitive economy. In this context, the current disruption in the electricity system provides both opportunities and threats. This paper reviews the nature, impacts and causes of the disruption as the basis for understanding the implications for policies to promote inclusive industrialisation.

The far-reaching changes in the electricity system from 2008 took the form of soaring tariffs combined with increasing interruptions due to both loadshedding and breakdowns in municipal grids, especially in some metros and secondary cities. From the standpoint of industrial policy, the effects on manufacturing and advanced services outside of the mining value chain were particularly serious. Their dependency on local electricity systems meant they faced faster tariff increases and more frequent interruptions.

The disruption in the electricity system arose from the failure of Eskom to adapt its business model to the slowdown in the mining value chain; growing contestation over coal rents; and the emergence of new, more competitive and cleaner electricity sources. From 2008, Eskom over-invested in new coal plants, which were both delayed and faulty. That led to excessive demands on its older plants, escalating breakdowns and loadshedding. The cost of the new plants plunged Eskom into a debt crisis. Then, from 2011, Eskom's traditional customers in the mining value chain reduced demand because the global commodity boom ended. Since Eskom's costs were largely fixed, it responded by raising its tariffs even further. In the long run that strategy deepened the decline in demand, meeting the definition of a utility death spiral. Meanwhile, over the past 20 years, Eskom lost its historic ability to capture rents from coal, which had long effectively reduced the cost of electricity for downstream users. Finally, over the coming decade measures to compel the internalisation of the costs of coal pollution at home and abroad will inevitably add to the price of coal-fuelled electricity.

The complex governance system for the national grid largely excluded departments concerned with industrial policy and thwarted efforts to address the electricity crisis quickly and coherently. Regulatory authority was divided between a number of national departments, the independent regulator, the courts and Eskom. The result was ongoing conflict and myriad inconsistencies. No platform existed to ensure that policies on electricity tariffs and generation prioritised industrial policy concerns, especially around improving the quality of the electricity supply for established and emerging businesses outside of the mining value chain.

At the local level, from 1994 municipalities focused primarily on extending electricity to historically underserved communities, rather than the supply for existing or new formal industrial and commercial sites. Most municipalities did not even report on the extent of breakdowns in their electricity supply for producers. The rapid increase in Eskom tariffs from 2008 initially increased municipal revenues, but from 2015 led to falling demand and a growing failure to pay, and a decline in returns after payment for bulk electricity. The problems were deepest in a handful of secondary cities that historically depended on steel, coal or gold production. Johannesburg and Ekurhuleni, two of the most important industrial centres in the country, also had unusually high levels of breakdowns in the local grid.

In response to the disruption in the electricity system, the Department of Mineral Resources and Energy[1] established a scheme to subsidise large-scale coal generation for energy-intensive companies in the mining value chain. That approach would shift the burden to taxpayers and to producers in other, potentially more competitive and labour-intensive industries. In consequence, it seemed likely to undermine the overarching aims of industrial policy. Sustaining dependence on coal would also pose a growing hindrance to export markets. In short, trying to restore the historic electricity system ultimately risks deepening the crisis by avoiding more sustainable energy solutions.

The differentiated impact of the crisis on the electricity-intensive mining value chain and other industries points to two more sustainable responses. While these can be combined, limitations on resources and capacity mean that some tough choices will be unavoidable.

- The obvious and easier solution is urgently to promote cheaper and cleaner energy sources on a scale sufficient to retain the global competitiveness of electricity-intensive production along the mining value chain, while simultaneously assisting these producers to introduce more efficient technologies. This option requires institutional mechanisms and regulatory frameworks able to fast-track large-scale construction of new energy sources; substantial investment in generation and in transmission, and in new refinery technologies; and smart grids that can maintain a stable electricity supply combining multiple generation sources in place of a limited number of large (coal-fired) plants.
- South Africa could also use the electricity system to promote a wider array of competitive manufacturing and services industries. That would require stabilising municipal grids as well as the national supply. At the municipal level, the greatest impact would arise from improving the reliability and extent of supply in the metros and secondary cities, especially for industrial and commercial sites. Solutions would involve improving equipment, making up on maintenance backlogs, and encouraging larger off-grid generation. In addition, the government could strengthen incentives for more energy-efficient technologies in manufacturing and services.

Eskom would have to undergo substantial changes to support industrial policy aims more effectively. Above all, it would have to shift to lower-cost, cleaner and more flexible energy sources, which in turn necessitate new and more complex grid management systems. An efficient outcome will inevitably involve writing off some generation assets. The challenge will be to accept the requisite degree of creative destruction without imposing unnecessary costs through disruptions, unneeded manufacturing closures and/or inadequate measures to ensure a just transition. Ultimately, any effective solution requires fundamental changes in governance of the electricity system in order to align its aims and practices consistently with industrial policy imperatives. That, in turn, necessitates that the industrial-policy authorities, led by the Department of Trade, Industry and Competition (the dtic), define the outcomes of industrial policy more clearly, and on that basis spell out the requirements for the electricity system. It also entails the establishment of effective platforms and capacity for the dtic to engage consistently, effectively and robustly on strategies and decisions around electricity tariffs, energy sources, and better ways to manage shortfalls at national and local level.

[1] The Department of Mineral Resources (DMR) and the Department of Energy were merged in 2019 into one department as the Department of Mineral Resources and Energy (DMRE).

1 AIMS AND APPROACH

Industrial policy in South Africa faces the unique challenge of overcoming profound inequalities while building a more dynamic, productive and competitive economy. In this context, the current disruption in the electricity system provides both opportunities and threats. This paper reviews the nature, impacts and causes of the electricity crisis as the basis for understanding the implications for policies to promote inclusive industrialisation.

The disruption of the electricity system started around 2008, with increasing interruptions at national and municipal level combined with soaring tariffs. Simultaneously, the deepening climate crisis began to impel a shift away from South Africa's unusually strong dependency on coal, both to reduce South Africa's contribution to climate change and to mitigate the growing risk of sanctions by major trading partners.

Fundamental shifts in the quality and cost of electricity have hit the South African economy particularly hard because historically government provision of cheap and reliable coal-fuelled electricity, together with logistics (rail, roads, ports and communications), constituted a pillar of economic development. Government led the construction of the electricity system over the past century through investments in large-scale coal plants by a powerful dedicated agency, Eskom. These efforts were critical for the growth of mining and, especially in the 1990s, the highly energy-intensive ferroalloys and aluminium industries. At the same time, reliable, high-quality and affordable infrastructure for industrial and commercial sites in South Africa's economic centres was a critical enabler and incentive for investment in manufacturing and advanced services. Both manufacturing and modern professional, financial and business services depend on reliable electricity to maintain electronics and digital connectivity.

The challenge for industrial policy is to ensure that the disruption in the electricity value chain promotes both a stronger middle class, rooted in decent work and small business development, as well as improving long-run competitiveness and sustainability. In the short run, the core challenge is to increase the supply of energy and improve its reliability. In the longer run, a coherent industrial policy response must answer two sets of questions.

First, what structure of production should the electricity system support going forward? Decisions around technologies, location and pricing have a crucial effect on innovation and diversification. A core issue for diversification is how to secure appropriate electricity supplies for new activities in manufacturing and services, which use relatively little energy but require reliability. A related challenge is to define the role of the mining value chain, which remains South Africa's main source of exports but generates relatively few jobs or opportunities for small business and has historically depended on plentiful, cheap electricity. In the long run that means it can only survive by accessing cleaner as well as more affordable energy, replacing Eskom's increasingly expensive and constrained coal-based supply.

Second, what role should Eskom and, more broadly, the coal value chain play in any new dispensation? A shift to greener energy can provide an important boost to employment and innovation, but also imposes hard choices around the future of existing assets and jobs, especially for the coal regions of Mpumalanga. Unless these costs are addressed, the substantial power of the affected companies will be deployed to delay the ultimately unavoidable changes, at great cost to the broader economy and society over the coming decade.

To assist in dealing with these tough choices, this paper:

- Starts by reviewing the dimensions of the disruption in the electricity value chain since 2008;
- Evaluates the macroeconomic implications as well as the impact on leading South African industries, distinguishing primarily between the energy-intensive industries in the mining value chain and other producers in manufacturing and services;
- Analyses factors behind the current crisis, which centre on profound changes in electricity supply and demand; contestation over coal rents; the economic and governance challenges facing metros and secondary cities; and the climate crisis; and
- On that basis, indicates and briefly evaluates some alternative strategic responses.

2 THE EXTENT OF THE DISRUPTION

By 2020, the escalating cost and growing interruptions in electricity supply had become a leading constraint on growth and job creation, as well as affecting the quality of life. At the macroeconomic level, the impacts emerged in the increase in Eskom and municipal revenues relative to the economy; falling demand for grid electricity; and in 2020, during the COVID-19 pandemic, the fact that the recovery in electricity use lagged the return to production. This section first outlines the dimensions of the electricity crisis and then its macroeconomic impacts, followed by an assessment of the implications for the mining value chain and other industries.

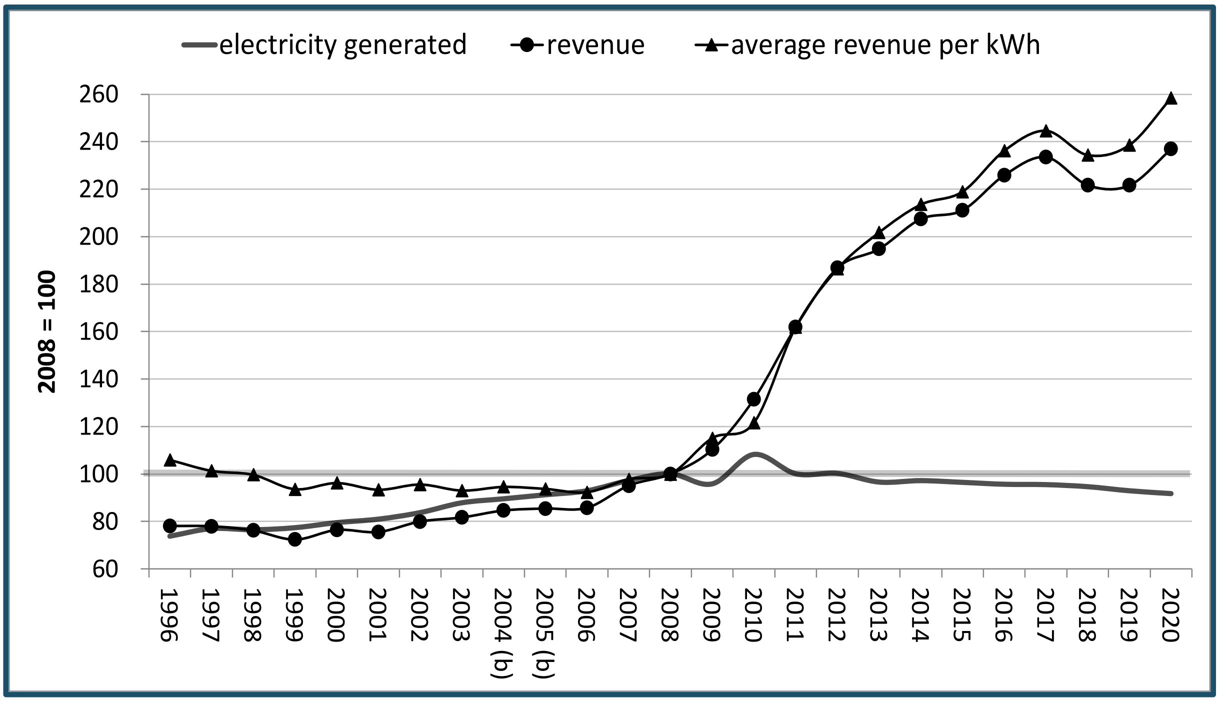
2.1 Dimensions of the electricity crisis

The electricity crisis emerged in two ways: through the soaring cost to businesses and households and worsening quality, including mounting interruptions to both the national and municipal grids. Eskom directly supplied around 3 500 large energy-intensive businesses, primarily in the mining value chain, as well as 6,6 million mostly low-income households. The municipalities purchased electricity almost entirely from Eskom, and resold it to the remaining businesses and another seven million households across all income groups. They supplied almost 800 000 formal enterprises, including the vast majority of manufacturing, retail, services, construction and agricultural producers.

In real terms, the average unit price of electricity more than doubled from 2008 to March 2020. The Eskom price dipped slightly in constant rand in 2018 because the regulator over-ruled Eskom's application and granted a below-inflation increase. In April 2021, however, the company intended to increase tariffs by 15% in nominal terms, or more than 10% above inflation. (The details of the convoluted price-setting mechanism for electricity are discussed in Section 2.2.) As Graph 1Graph 1 shows, these trends resulted in a sharp rise in Eskom's revenues despite falling sales of electricity in volume terms. In constant 2020 rand, the company's sales climbed from R90 billion in the year to March 2008 to R220 billion in

2020.[2] In gigawatt hours (GWh), however, Eskom's sales fell 15% from 2010 to 2020, after rising 45% over the previous decade.

Graph 1. 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.

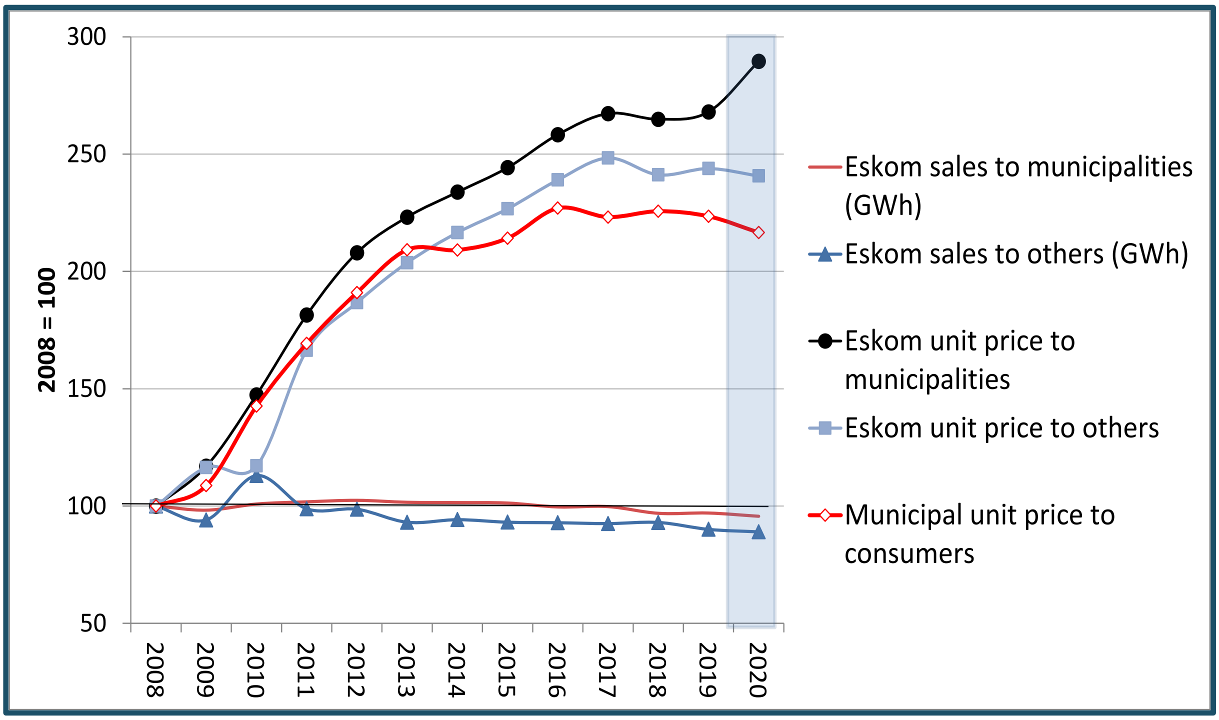
Municipal electricity tariffs applied to virtually all producers outside of the mining value chain. They rose less steeply than the unit price charged by Eskom from 2008, the earliest year with comparable published data. The municipalities' sales by volume also declined steadily from 2012. The decline accelerated from 2015 as the overall economy slowed.

From 2009 to 2020, in constant rand, the overall Eskom unit price climbed 160%, but the municipal unit price rose only 117%. Eskom electricity sales to the municipalities fell by 1% from 2011 to 2015, compared to a 6% fall in its sales to other customers, mostly energy-intensive producers in the mining value chain. From 2015 to March 2020, however, Eskom's sales to municipal customers dropped 6%, while its other sales contracted by 4%.

The figures for Eskom and municipal sales are not fully comparable for 2020, however, because Eskom's financial year ends in March while the municipal year goes to June. As a result, the municipal figures include the lockdown period, which saw a sharp decline in electricity use and payments.

[2] Deflated by CPI (consumer price index) rebased to March 2020.

Graph 2. Indices of Eskom electricity sales to municipalities and other customers in GWh, and average Eskom and municipal revenue per kWh in constant rand, 2008 to 2019 (a) (2012=100)

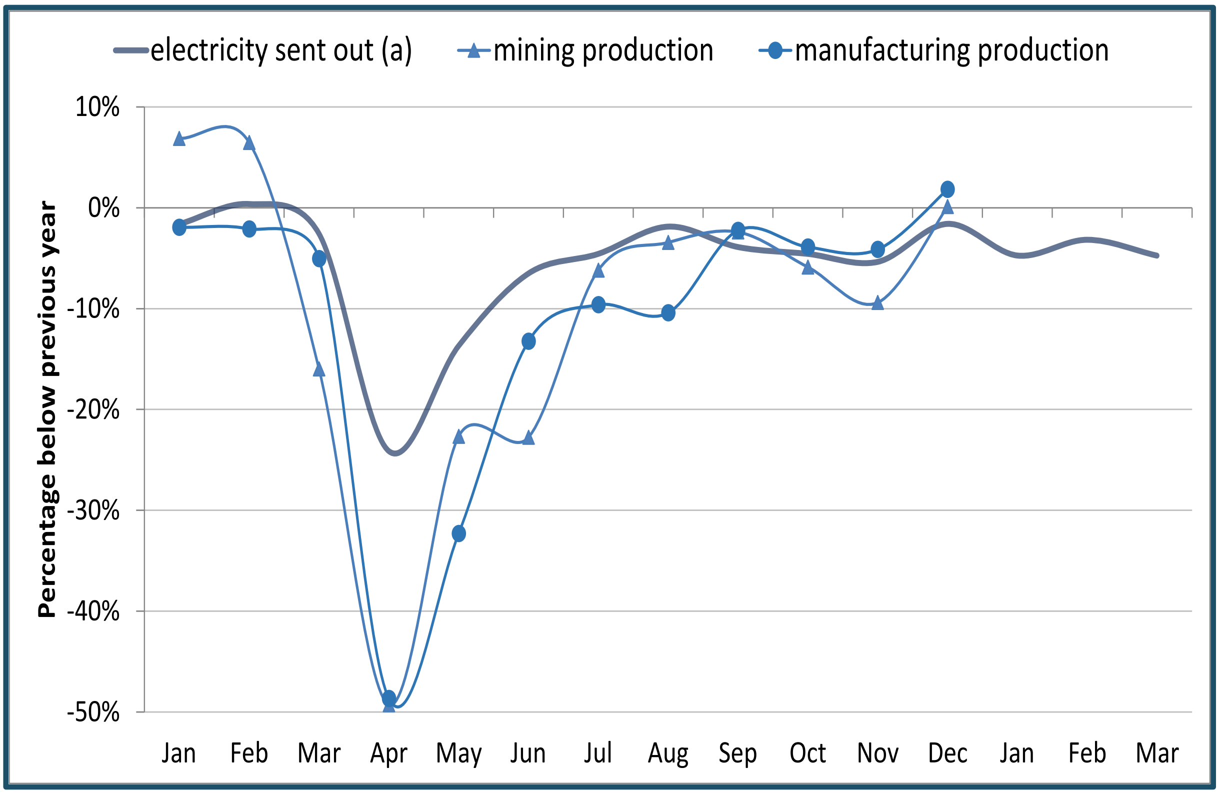


Notes: (a) Deflated with CPI. Data for municipal revenue are budgeted figures, which appear to have been around 10% higher than actual sales during this period. Budgeted figures are used because only 130 out of over 270 municipalities reported their actual electricity revenue from 2017 to 2019, accounting for between half and three quarters of total sales. The Eskom financial year runs to March; the municipal figures however run to June. (b) Calculated as budgeted municipal revenue divided by Eskom sales to municipalities. *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 mfma.treasury.gov.za in January 2021.

In addition to higher tariffs from 2008, the supply of electricity was increasingly unreliable and constrained. Limited and interrupted supply proved particularly deleterious as the economy struggled to recover from the COVID-19 pandemic in late 2020.

As Graph 3 shows, although electricity generation did not fall as far as mining and manufacturing during the lockdown, it recovered comparatively slowly. From January September 2020 to February 2021, Eskom's electricity sales in GWh stabilised at about 4% lower than a year earlier, although mining production was 0,1% above the level in December 2019, and manufacturing was 1,8% higher. Eskom's electricity sales grew 23% from their April low point through December. In the same period, manufacturing output expanded 80% and mining production by 100%.

Graph 3. Eskom electricity, mining and manufacturing production as a percentage of the previous year, monthly, January 2000 to January 2021 (January-March 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 volumes 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 volumes of production from Statistics South Africa. Manufacturing Production and Sales. Excel spreadsheet. Downloaded from www.statssa.gov.za in February 2021.

From 2008, Eskom's electricity supply proved increasingly unreliable and subject to interruptions and constraints. It imposed loadshedding in seven of the 13 financial years (ending in March) from 2008 to 2021, including every year from 2019 through 2021. As of mid-2020, Eskom anticipated that loadshedding would continue through 2023 as it struggled to maintain and repair its plants.

Loadshedding 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.

In the year to March 2019, Eskom enforced 30 days of loadshedding; in the year through March 2020, the number climbed to 46 (Eskom 2019:29 and 2020:8). Loadshedding brought a 3% fall in Eskom's sales in GWh in 2019, and a 4% cut through September 2020. (Calculated from Businesstech 2020).

Loadshedding was not the only measure disrupting the provision of electricity. Eskom also interrupted the supply to some municipalities and townships for failing to pay their bills or overloading the local grid. Moreover, many municipal grids saw rising breakdowns and reduction in the quality of electricity through the 2010s, although no comprehensive figures were available.

From 2013, Eskom imposed periodic blackouts on municipalities that owed it money. For this purpose, it threatened to cut electricity for up to 14 hours, including to most industrial and commercial sites. Eskom did not publish consistent details about which municipalities it sanctioned or for how long, making it difficult to quantify the economic and social impacts. In 2019, Eskom interrupted supply to 15 municipalities for at least some period of time. It wanted to sanction 25 municipalities, but was prevented by court interdicts. (Eskom 2019:92) According to its periodic media announcements, the number of municipalities threatened by interruptions was over 20 in 2015, 2017 and 2018, but fell to eight in 2020.

It is not clear how many municipalities actually experienced periodic Eskom shut-offs, or for how long. Once Eskom announced sanctions, cities often immediately entered a payment agreement. In response, Eskom suspended the threatened interruption to the power supply. Some municipalities went through this process more than once in the course of a year. In 2019, Eskom had payment agreements with 51 municipalities, although that number included only 11 of its top 20 debtors. Only six of the towns involved fully implemented the agreements, however, and just one of the top 20 debtors. (Eskom 2019:92).

In 2020, during the pandemic, Eskom began to interrupt supply for the peak morning-demand period (05:00 to 09:00) to townships where it suspected a high level of illegal connections. It argued this process, which it labelled “load reduction”, would limit overload damage to its distribution networks. Eskom did not publish comprehensive figures on the areas or number of households affected, but it appears that tens of thousands of informal businesses and families were affected, mostly in Gauteng and Mpumalanga.

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 greatly by location. Unfortunately, there was no consistent public reporting on this issue. The National Treasury required municipalities to publish data on electrification and costs for households, but not on breakdowns or on the supply to industrial and commercial sites or to businesses.

The extent of interruptions appeared to vary strongly by municipality. Ekurhuleni estimated its electricity downtime at 0,64% in 2017/8 (Ekurhuleni 2018:404), for an average of 10 minutes a day. In 2018, Cape Town reported just under one interruption daily per customer, which was somewhat better than the average for the United States. 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)

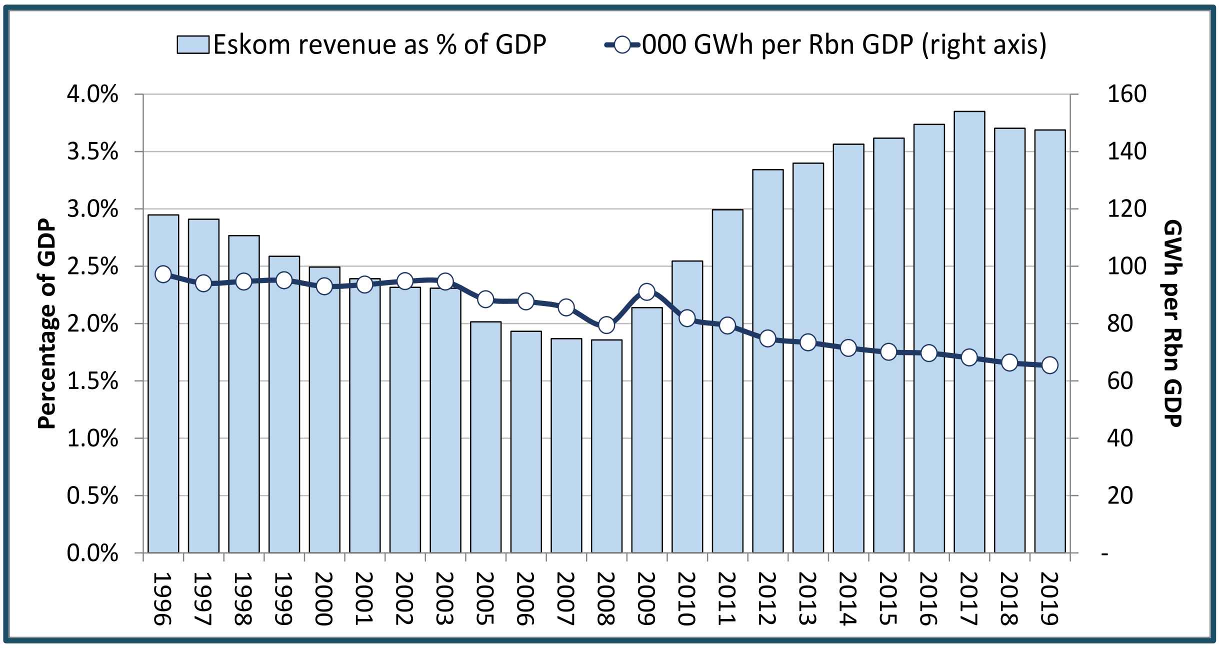
In short, the disruption of the national electricity supply in the 2010s emerged in a combination of rising costs and interruptions both from Eskom and from most metros and secondary towns. The following subsections outline the economic implications of these trends.

1.1 Macroeconomic effects

Higher electricity tariffs and regular disruptions in supply effectively raised the costs of production across the economy, making it harder for producers to compete with imports or on export markets. It was easier to calculate the impact of soaring tariffs, however, since neither Eskom nor most municipalities published regular statistics on disruptions, the costs were largely intangible and spread across thousands of producers and households.

From 2008, Eskom's revenues captured a rising share of the national economy. From 2008 to 2016, they climbed from 1,9% to 3,7% of the gross domestic product (GDP). They then levelled out through 2019. In 2021 and 2022, however, the anticipated double-digit increase in electricity tariffs, combined with the economic decline as a result of the COVID-19 pandemic, meant that Eskom was likely to capture over 4% of the GDP. That would constitute the highest share since the transition to democracy.

Graph 4. Eskom revenues as percentage of the GDP and GWh sold per billion rand of GDP (a)



Note: (a) Figures for electricity intensity relate only to electricity sold by Eskom through the national grid. Eskom revenue given as percentage of current GDP; electricity intensity relative to GDP in constant rand. *Source:* Eskom revenue and sales from Eskom Annual Reports for relevant years; GDP data from Statistics South Africa. GDPp 2q20 previous format. Excel spreadsheet. Downloaded from www.statssa.gov.za in November 2020.

The deteriorating cost and reliability of grid electricity from 2008 initiated a gradual decline in demand. As Graph 1 shows, Eskom's sales of electricity fell 15% from 2009 to 2019 in volume terms.[3] The electricity intensity of the GDP – that is, the electricity required for each billion rand of added value – dropped even more rapidly, by 28%, over the same period. As Graph 5 shows, virtually every sector reduced its use of electricity in volume terms after 2008. Nonetheless, the share of electricity in intermediate inputs, at current prices, climbed from 1,3% in 2008 to 2,0% in 2019. (Calculated from Quantec 2020a).

[3] 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 2020:49). 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.

While the disruption to the electricity supply brought short-run pain, it also opened the door for strategic gains around emissions and industrialisation.

First, the decline in electricity demand reduced South Africa's greenhouse gas emissions. That was a critical step in assuring access to export markets in the longer run, as well as contributing to moderating the climate crisis. Inland Southern Africa saw faster-than-average warming over the 2010s, and repeated droughts dragged down economic growth in South Africa through the 2010s.

Second, in theory, higher-cost electricity can promote diversification into new, more dynamic and labour-intensive industries by making highly energy-intensive producers, most of which are in the mining value chain, less competitive. As discussed in the following section, first-stage beneficiation (that is, the refining of metals as opposed to the manufacture of final consumer and capital goods) is extraordinarily electricity-intensive. Unfortunately, experience shows that outside of the theoretical construct of perfect competition (in which information is perfect, factors are mobile and markets are competitive) changes in market conditions can lead to prolonged downturns, as investors take time to find new opportunities, or even move overseas.[4] In practice, as the cost of electricity rose, the dominant mining and refining conglomerates tended to embark on mining-based projects outside of South Africa, rather than diversifying into more dynamic sectors inside the country. (See Makgetla 2021, forthcoming).

1.2 Impacts by sector and industry

The impact of the disruption on individual value chains varied depending on the extent to which they required affordable or reliable electricity. The most electricity-intensive industries were major exporters but also highly capital intensive, generating limited opportunities for employment and small businesses. They were dominated by the mining value chain, especially the extraordinarily electricity-intensive ferroalloys and aluminium refineries (which are therefore discussed in more detail in section 1.2.2). For less electricity-intensive producers, interruptions to supply often proved more costly than the rise in tariffs, as they damaged equipment and unsettled work organisation.

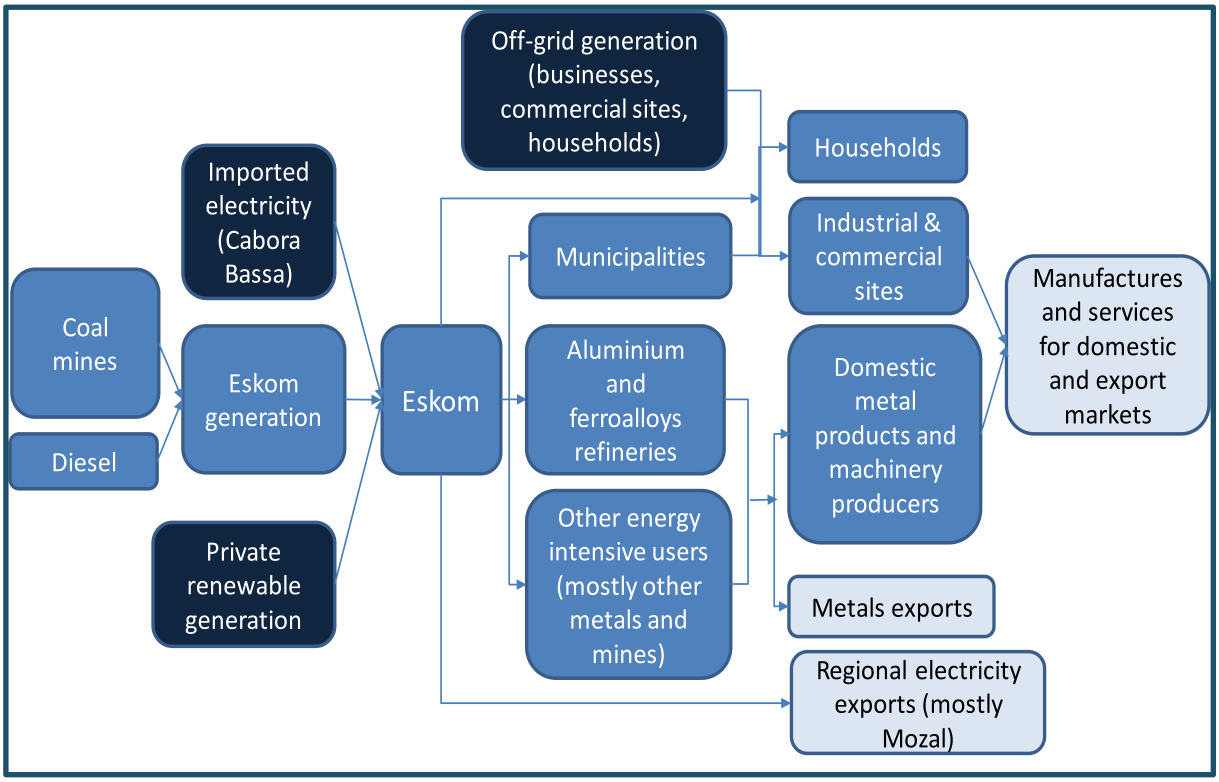
The disruption in the electricity supply was particularly problematic for investors for whom, since the apartheid era, South Africa's cost-effective and quality infrastructure for industry and high-income suburbs constituted a core inducement. In effect, the provision of world-class infrastructure for business and well-off households was an important advantage compared to other upper-middle-income economies, helping to offset South Africa's distance from major markets, sometimes burdensome regulatory frameworks, and messy democracy.

The economic impacts of the electricity system resulted from the way it articulated with different sectors, as illustrated by the value chain in Figure 1. For individual businesses, the effects of the disruption depended on how they obtained electricity as well as their electricity intensity. Smaller and less electricity-intensive large producers typically obtained their electricity through municipal distributors. As the previous section showed, the municipalities

[4] This is why John Maynard Keynes noted that "In the long run we are all dead. Economists set themselves too easy, too useless a task if, in tempestuous seasons, they can only tell us that when the storm is long past the ocean is flat again." (Keynes 1924:80).

effectively absorbed some of the increase in Eskom tariffs, but their customers suffered more frequent outages and generally worse quality than enterprises that purchased electricity directly from Eskom.

Figure 1. The electricity value chain in South Africa (a)



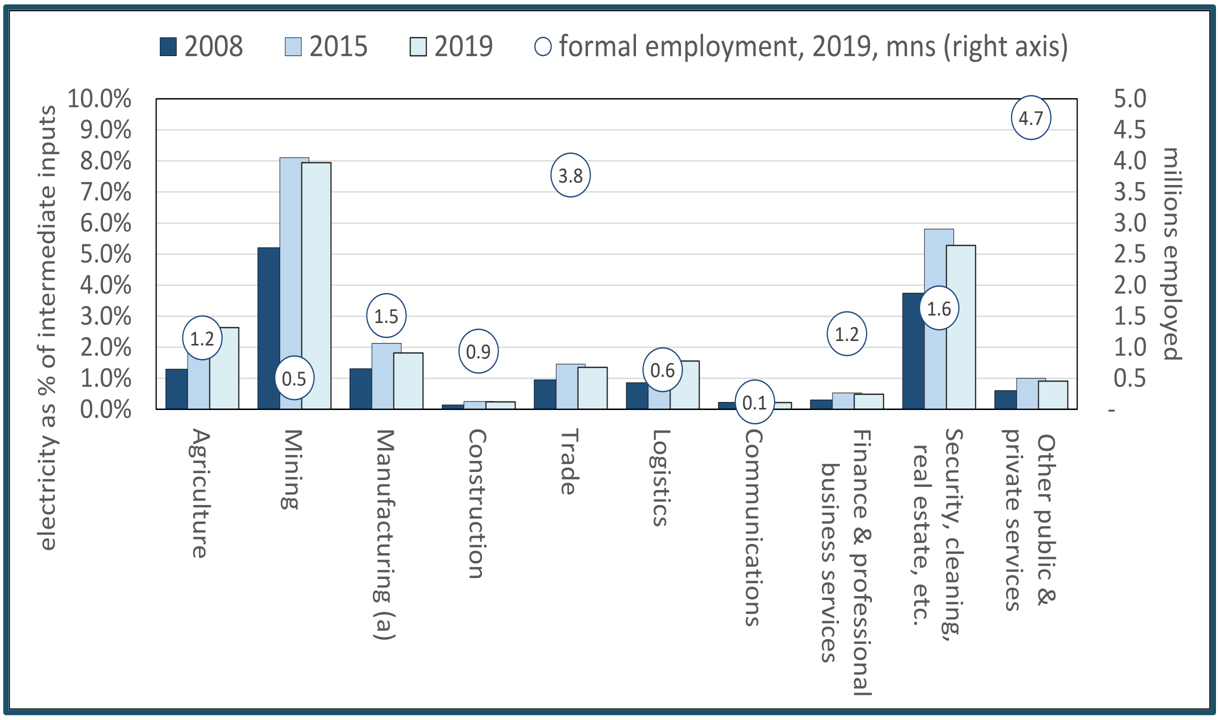
Note: (a) Eskom produced only a trivial amount of renewable energy as of 2021, so it is not included in this figure.

Electricity dependency varied greatly by sector and, within manufacturing and services, by industry, as Graph 5 shows.

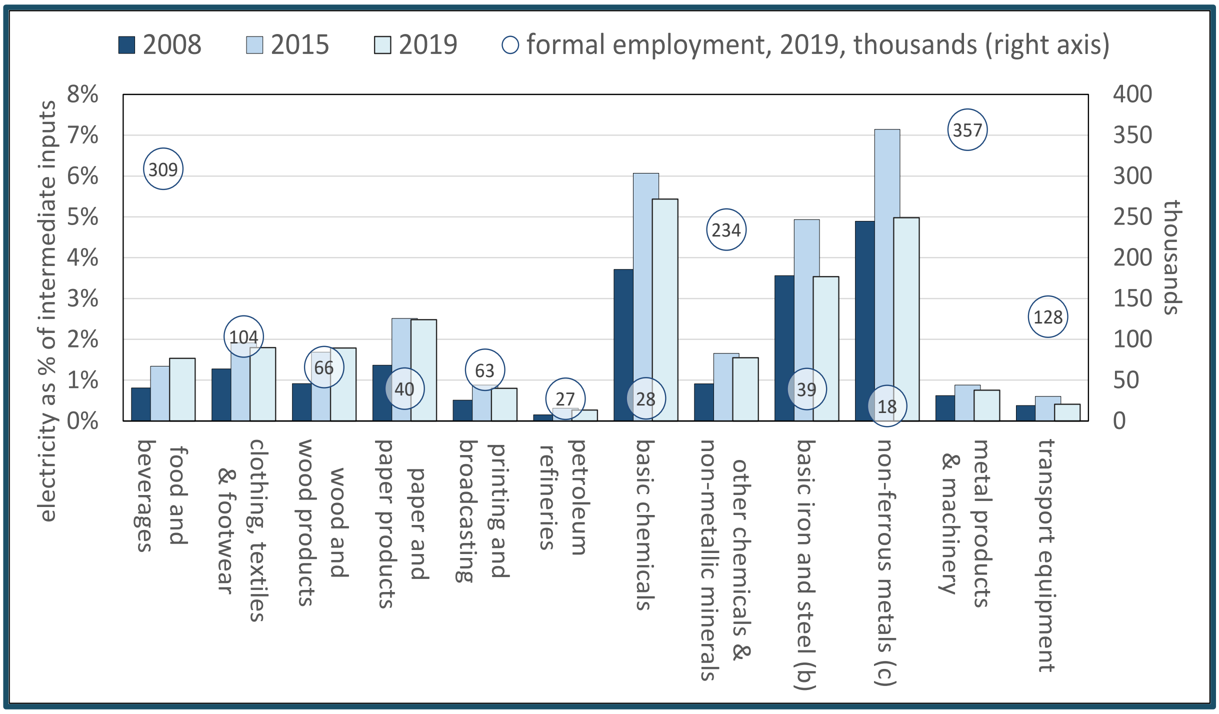
Mining as a whole was the most energy-dependent sector, followed by property-related services (property management and real estate, security and cleaning). Within manufacturing, the metals refineries and basic chemicals – dominated by Sasol – were unusually reliant on electricity, with paper in third place. In the rest of manufacturing, electricity constituted less than 2% of intermediate costs, according to Quantec estimates.

Graph 5. Electricity (a) as a percentage of intermediate inputs and formal employment, 2008, 2015 and 2019, by sector and manufacturing industry

A. By sector



B. By manufacturing industry

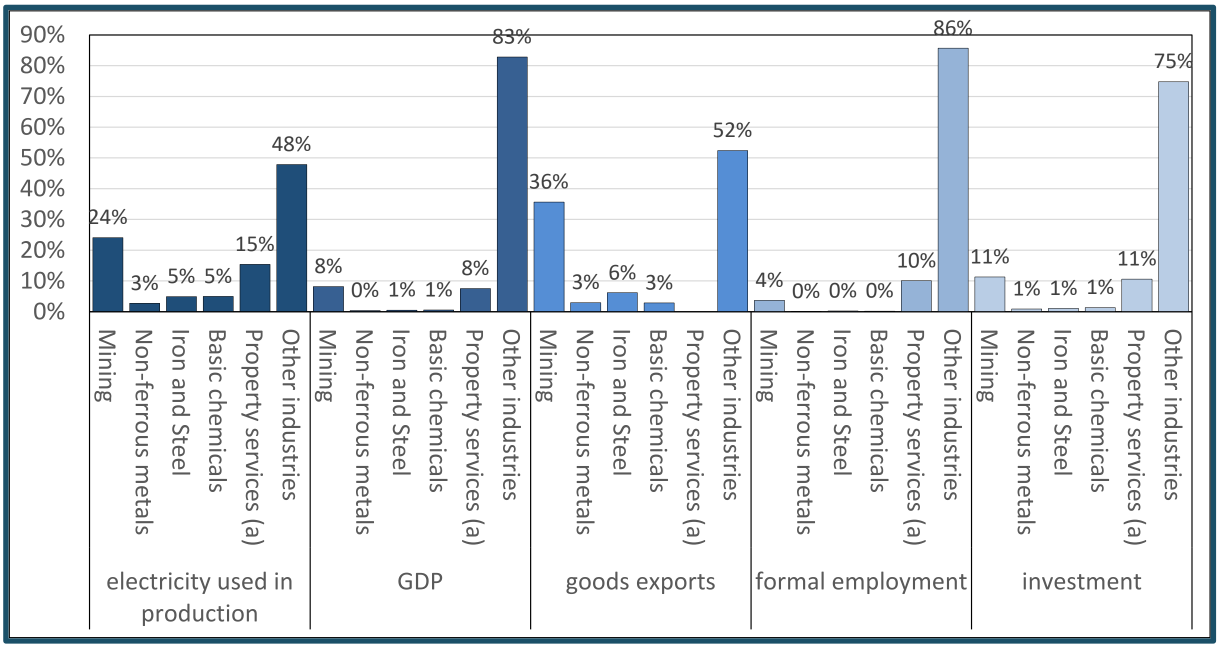


Note: (a) Includes gas. Calculated as percentage of intermediate inputs, including imported inputs. (b) Includes ferroalloys. (c) Includes platinum, gold and aluminium, as well as other metals. *Source:* Calculated from Quantec. Standardised Industry Service. Downloaded from www.quantec.co.za in February 2021.

As Graph 5Graph 5 also shows, in almost every industry the initial surge in tariffs meant that the share of electricity in total costs, in current rand terms, increased sharply from 2008 to 2015. Gradually, however, as tariff hikes and disruptions persisted, companies began to reduce their reliance on electricity. Through the 2010s, they closed down production that was no longer viable, introduced more energy-efficient technologies, and developed off-grid energy sources. As a result, most industries saw a fall in electricity intensity from the mid-2010s. The sharpest declines emerged in basic metals and chemicals. In contrast, mining and paper production saw only a modest fall in electricity use.

The energy-intensive industries in the mining value chain were major exporters but comparatively small employers, generating almost half of exports, a tenth of the GDP but under 5% of formal employment, or around 530 000 jobs. In contrast, property-related services sustained 1,2 million formal jobs, almost entirely in cleaning and security. They accounted for 10% of the total formal workforce and 8% of the GDP. Figures for exports by services (which in this case would comprise primarily rentals and sales for foreigners) are mostly not recorded. As a group, the remaining, less electricity-intensive industries contributed 83% of the GDP, 86% of employment and 75% of investment, but only 52% of goods exports.

Graph 6. Share in electricity use for production, GDP, goods exports, employment and investment of electricity-intensive compared to all other industries, 2019

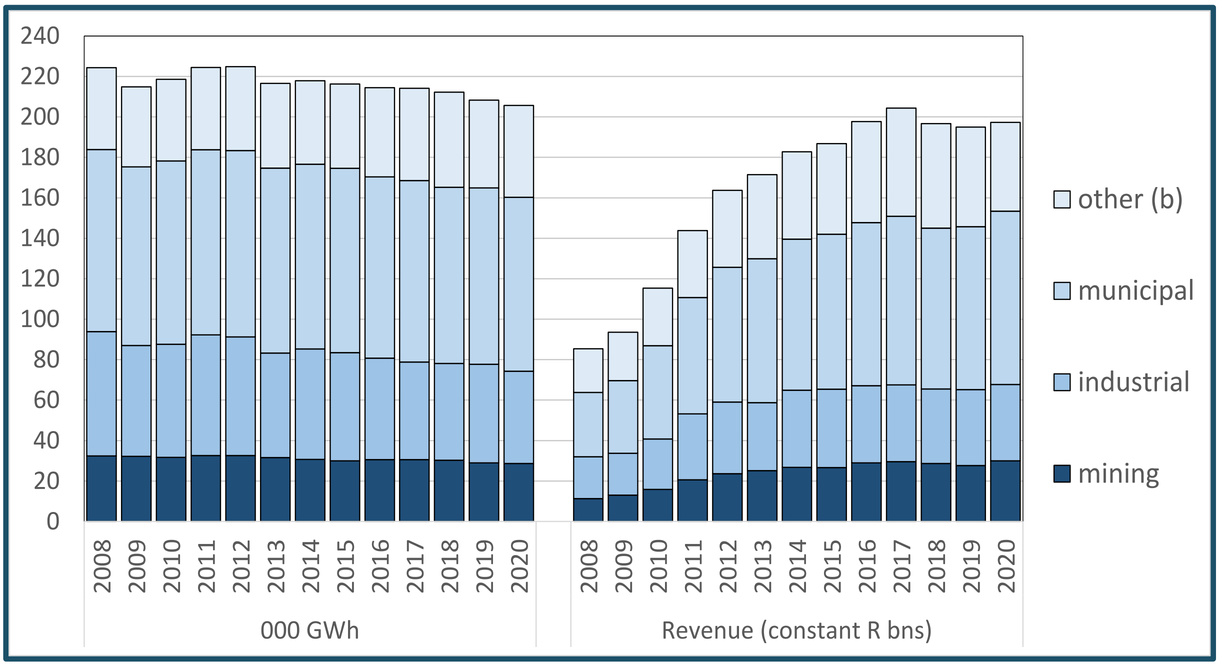


Note: (a) Real estate, security and cleaning. Reliable data on service exports are not available, and figures here show shares in goods exports only. *Source:* Calculated from Quantec. EasyData. Standardised Industry series. Downloaded from www.quantec.co.za in February 2021.

As Graph 7Graph 7 shows, both the energy-intensive producers in the mining value chain and municipal customers as a whole reduced their consumption of electricity but paid more for it from 2008 to 2020 (in the financial year ending in March, before the lockdown).

Eskom's revenues from municipal customers rose most steeply because their electricity consumption started to decline only from 2017. In contrast, the mines and refineries supplied directly by Eskom began to reduce electricity use earlier, and their total electricity cost essentially flattened out from 2012.

Graph 7. Consumption of Eskom electricity and payment for it by Eskom customer category, 2008 to 2020 (year to March), in 000 GWh and billions of constant (2020) rand (a)



Note: (a) Deflated with average CPI to March, rebased to 2020. (b) Includes exports, agriculture, Transnet, and households and commercial properties supplied directly by Eskom. *Source:* Calculated from Eskom Annual Reports.

The following section provides an overview of the impact of the disruption in the electricity system on the mining value chain, with a separate section on the ferroalloys and aluminium refineries. The subsequent section outlines the position of enterprises supplied through municipal grids.

1.2.1 The mining value chain

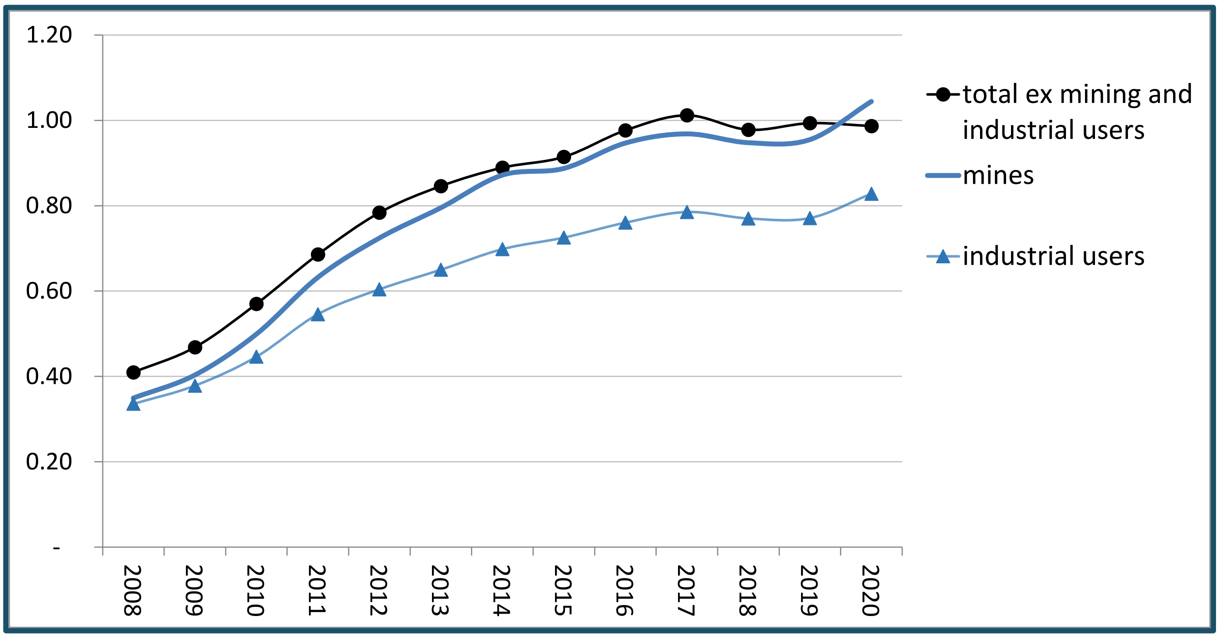
The mining value chain, especially coal and metals mines and refineries (including Sasol), dominated the decline in electricity use from 2008 to 2017. The value chain encompassed mostly large, technologically advanced companies, which were able both to negotiate comparatively favourable terms with Eskom and to invest in electricity-saving technologies. Still, the gold, platinum, iron ore and coal producers found it increasingly difficult to manage after their export prices dropped precipitously from 2011, when the global commodity boom ended. In response to the double hit of lower export prices and soaring electricity costs, these producers often downsized or sold their South African operations. As discussed in the following section, prices for the ferroalloys refineries did not track the commodity boom as closely, but they were even more affected by higher electricity prices.

Eskom reported that it provided electricity directly to about 1 000 mines and 2 500 “industrial users”. The latter were mostly metals refineries but included Sasol and paper factories. Sasol mined its own coal for processing into liquid fuels, but historically used Eskom electricity.

Eskom’s direct customers were affected more by rising prices and constraints on supply than by interruptions. In 2008 they negotiated to avoid loadshedding in exchange for a 10% reduction in consumption. They argued that loadshedding would be risky for underground mining operations and devastating for continuous processing in the refineries. They were not affected by the rising breakdowns and interruptions at some municipal grids. Still, the ongoing constraint on use generally constrained production.

From 2008, electricity tariffs climbed faster for mining than for other customers, as Graph 8 shows. In constant rand, tariffs for the mines rose 200% from 2008 to 2020, compared to an increase of under 150% for the rest of the economy. In 2008, the mines paid 10% less per kilowatt hour (kWh) than other users; in 2020, they paid 2% more. On average, tariffs for industrial users supplied directly by Eskom, mostly metals refineries, rose far less rapidly. But these averages concealed substantial price concessions to the aluminium refineries, as discussed in the following section. For other industrial users, tariffs presumably rose at more or less the same pace as in mining.

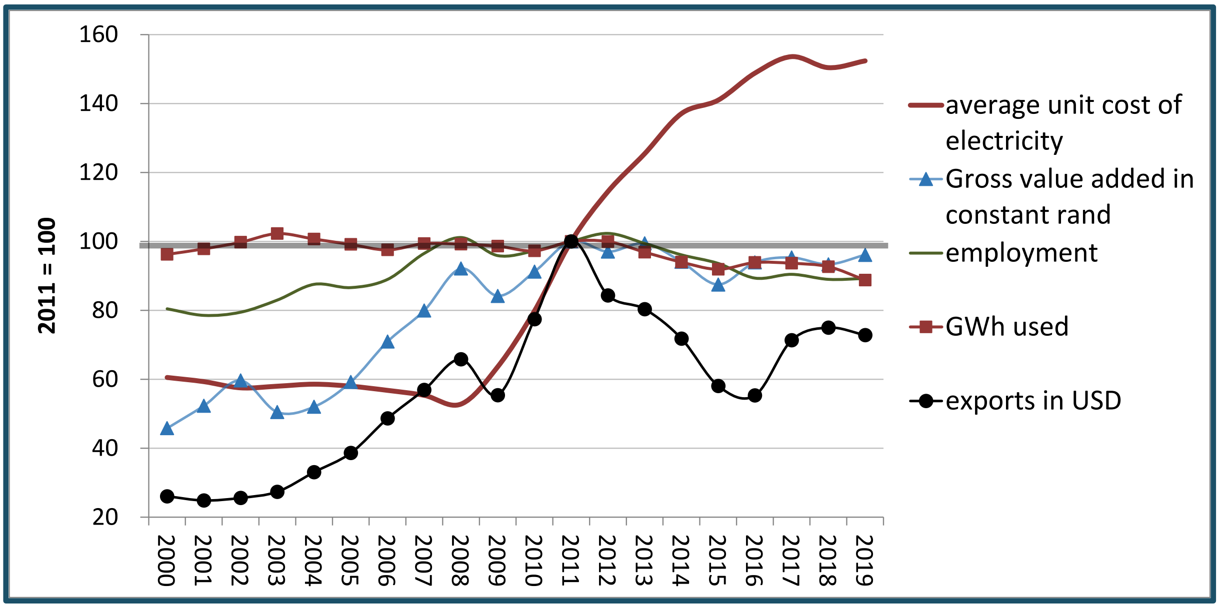
Graph 8. Average Eskom unit tariff for mines, industrial users and other customers, 2008 to 2020 (year to March) in constant rand per kWh (a)



Note: (a) Reflated with CPI for March rebased to 2020. *Note:* Calculated from Eskom Annual Reports for relevant years.

For the mining value chain, it is difficult to disentangle the impacts of the disruptions to the electricity supply from the precipitous fall in global metal and coal prices after 2011. In US dollar terms, global prices for platinum, gold, iron ore and coal fell between 50% and 75% in 2011, although they recovered around half of their losses between 2015 and 2019. Except for coal, they soared above 2011 levels toward the end of 2020, but it was too soon to discern the durability and implications of this trend. As Graph 9 shows, as a whole mining value added was 4% lower in 2019 than in 2011 in constant rand (deflated by CPI) and export revenues in US dollars were 27% lower. Employment and electricity usage were both 11% below 2011 levels. The sectoral decline largely resulted from stagnant export prices, but it was aggravated by the higher cost and constrained supply of electricity. In real terms, the mines paid 52% more per kWh in 2019 than at the peak of the commodity boom.

Graph 9. Indices of gross value added (GVA) in constant rand (a), exports in US dollars, employment, electricity utilised and average electricity price per kWh in mining, 2008 to 2019 (2011 = 100)



Note: (a) Deflated with CPI, not at constant prices, in order to show the impact of relative price changes for mining products during the commodity boom. *Source:* Calculated from Quantec. Standardised industrial series. Accessed at www.quantec.co.za in February 2021.

The combination of slowing production and higher electricity costs led to a marked fall in electricity use along the mining value chain after 2008. In addition to using electricity more efficiently, many major companies began to generate more of their own supply, mostly using renewables and by-products such as gas and steam. In mid-2020, the government decided to facilitate own-generation up to 100 MW. That decision should, in future, make it easier and quicker for major enterprises to go off grid.

The mines and big industrial users that purchased electricity directly from Eskom accounted for 36% of its sales 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 the big industrial users reduced their consumption almost 25%. According to Quantec estimates, mining electricity use (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%. The trend was sharply reversed if measured using current prices, because electricity tariffs escalated while mining and metals returns stagnated. Quantec estimates that, in practice, 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 2020a)

The experience of Arcelor Mittal South Africa (AMSA), formerly Iscor, illustrates the impact on the mining value chain of electricity price escalations and loadshedding (which forced it periodically to curtail electricity use). AMSA, formerly the parastatal Iscor but owned since the early 2000s by the multinational Arcelor Mittal, dominated basic steel production in South Africa. In 2019, its electricity purchases equalled 1,4% of Eskom's sales, down from 2% in 2009. In 2019, energy purchases equalled over a tenth of AMSA's sales revenues.

Since 2008, as the cost of electricity escalated, AMSA faced slowing domestic and export demand. Together with a steep rise in iron ore prices in the early 2000s, mounting electricity costs made it increasingly difficult for AMSA to compete with imports and sustain exports. From 2007 to 2019, in constant rand (deflated with CPI), its sales revenues dropped by 28%, while energy costs rose 75% and other operating costs by 14%. As a result of these trends, energy costs climbed from 4,7% of AMSA's revenue in 2007 to 10% in 2011, then fluctuated around 11% through 2019. AMSA reported pre-tax operating losses in seven of the 10 years to 2019. (Calculated from AMSA annual reports for relevant years).

In response to soaring electricity prices, AMSA cut its energy use in volume terms by a third from 2009 to 2019. Much of the fall was achieved in 2019 by closure of a relatively new but electricity-intensive plant at Saldanha Bay. AMSA attributed the closure to rising electricity, transport and iron ore prices. (AMSA 2019:20) In addition, it introduced more energy-efficient production technologies, which it expected to reduce purchases from Eskom by 4% in 2020, and shifted to 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, similarly illustrates the efforts of Eskom's major customers to reduce dependence on grid electricity. From 2015, Sasol began to use gas from Mozambique to replace a share of Eskom electricity. In May 2020, it issued a request for information to generate 600 megawatt (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 mines were also turning to off-grid, mostly renewable energy. In February 2021, Gold Fields obtained initial permission to build a 40 MW solar plant for its South Deep mine. The plant will supply 20% of the mine's electricity needs. According to Gold Fields, the plant will make electricity cheaper and more reliable for the plant, while reducing emissions. The company has initiated similar projects at mines in Australia and Chile. (Gold Fields 2021) It had first proposed the South Deep plant in 2017, but the National Energy Regulator of South Africa (NERSA), only finalised the submission in 2020, and it took a year to get preliminary approval.

1.2.2 The ferroalloy and aluminium refineries

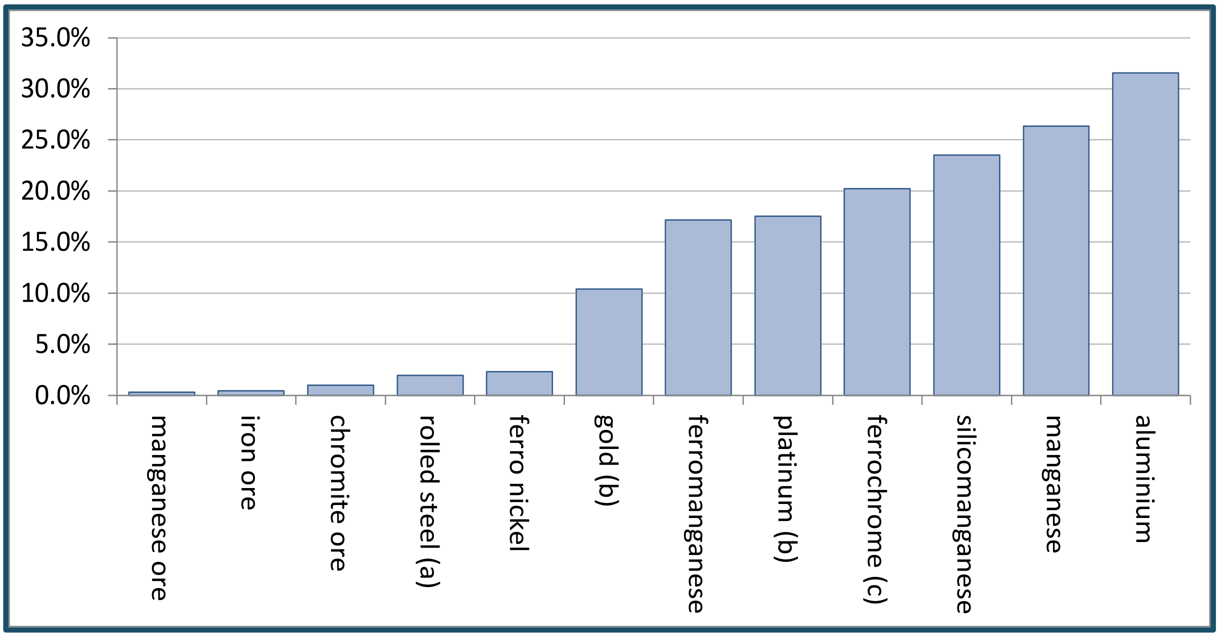
South Africa's highly electricity-intensive ferroalloy and aluminium refineries accounted for around a tenth of Eskom's electricity sales although less than 3% of the GDP, 5% of exports and under 0,3% of formal employment. They were particularly harshly affected by soaring electricity prices and limited supply, which both increased their unit costs and effectively eliminated the prospect of expansion. From 2008, the refineries saw gradual disinvestment, falling production and improved energy efficiency, all of which contributed significantly to the decline in electricity sales.

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, all of the alumina used in South Africa was imported from Australia.

As Graph 10 shows, ferroalloys and aluminium globally were far more electricity intensive than the rest of the mining value chain. The graph is, however, only illustrative, since in practice differences in technology and the quality of ore mean that the electricity required by individual refineries varies widely. In 2018, for instance, electricity accounted for 31% of the unit cost of South African ferrochrome production, higher than international estimates. Reductants (mostly imported coking coal) contributed 27% of the unit cost, and chrome ore, 23%.[5]

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 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 Arcelor Mittal 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, 2011. 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 platinum, for which the average price for industry is used. Mining tariffs more accurately reflect the average for "industry" customers excluding aluminium producers, which enjoyed a concessionary rate.

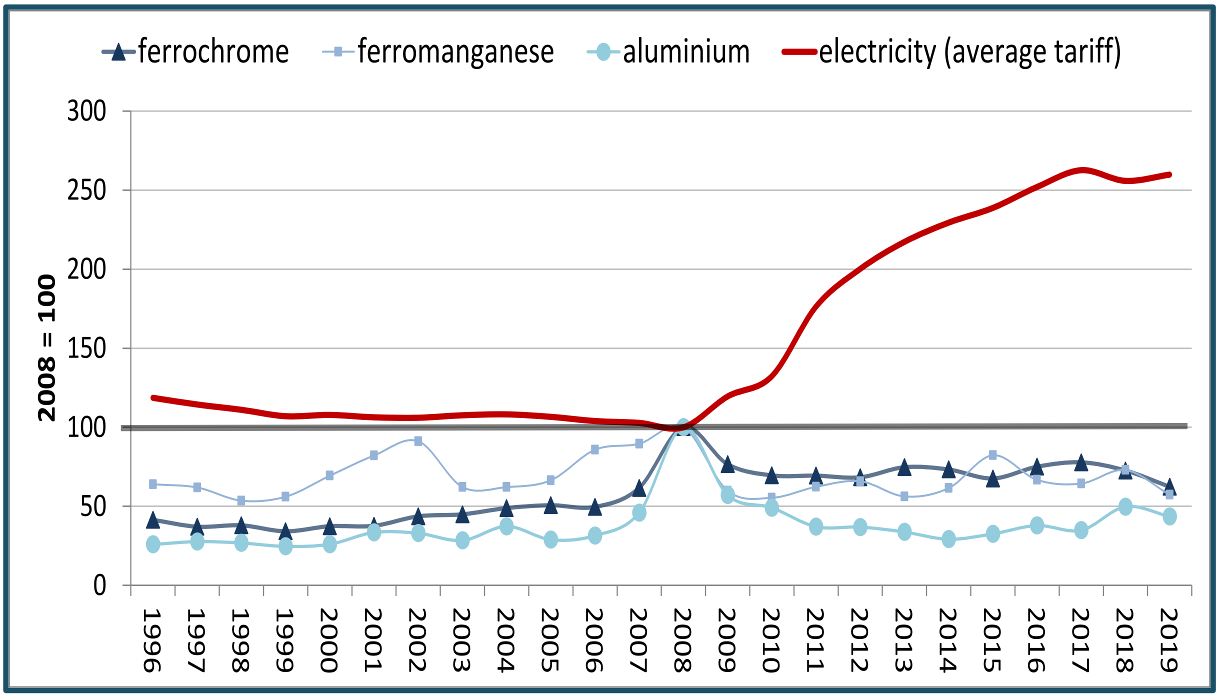
The increased price of electricity from 2008 effectively disrupted the fundamental business model in South Africa's ferroalloy and aluminium refineries. From 2008, the average electricity tariff[6] more than doubled, while the prices of ferroalloys and aluminium dropped around 50%. (See Graph 11). In contrast, before 2008, the unit price of electricity declined

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

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

steadily while metals prices generally climbed. Ferroalloys and aluminium prices were relatively unaffected by both the commodity boom after 2008 and the sharp improvement in prices for precious metals and iron ore in the second half of 2020.

Graph 11. Indices of unit prices of ferrochrome, aluminium and ferromanganese compared to unit price of electricity (a) in constant rand terms (b) 1994 to 2019 (2008 = 100)



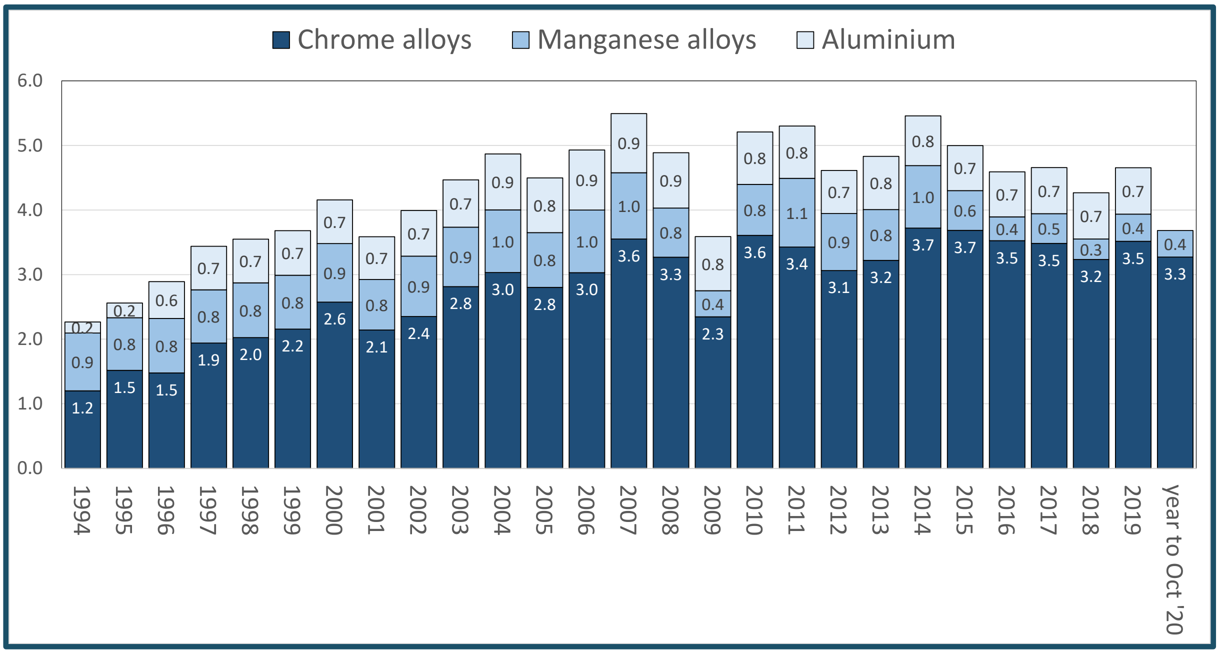
Note: (a) Average tariff for all users. (b) Deflated with CPI. *Source:* Unit price for ferromanganese and ferroalloys and, until 2006, for aluminium from DMR. Mineral Statistics (annual until 2018, then monthly). Downloaded from www.quantec.co.za in February 2021. For aluminium after 2006, annual reports for Billiton and then South32. For electricity, calculated from Eskom Annual Reports for relevant years based on data for sales in rand and GWh.

In volume terms, South African production of aluminium peaked in 2006; manganese, in 2011; and ferrochrome, in 2014. Since 2014, the combined national production in tonnes of these three metals has fallen by a quarter, with the sharpest decline in ferromanganese followed by ferrochrome. In constant rand terms, the combination of depreciation and relatively stable prices from 2008 meant that sales were flat until 2018, although they dropped sharply in 2019.

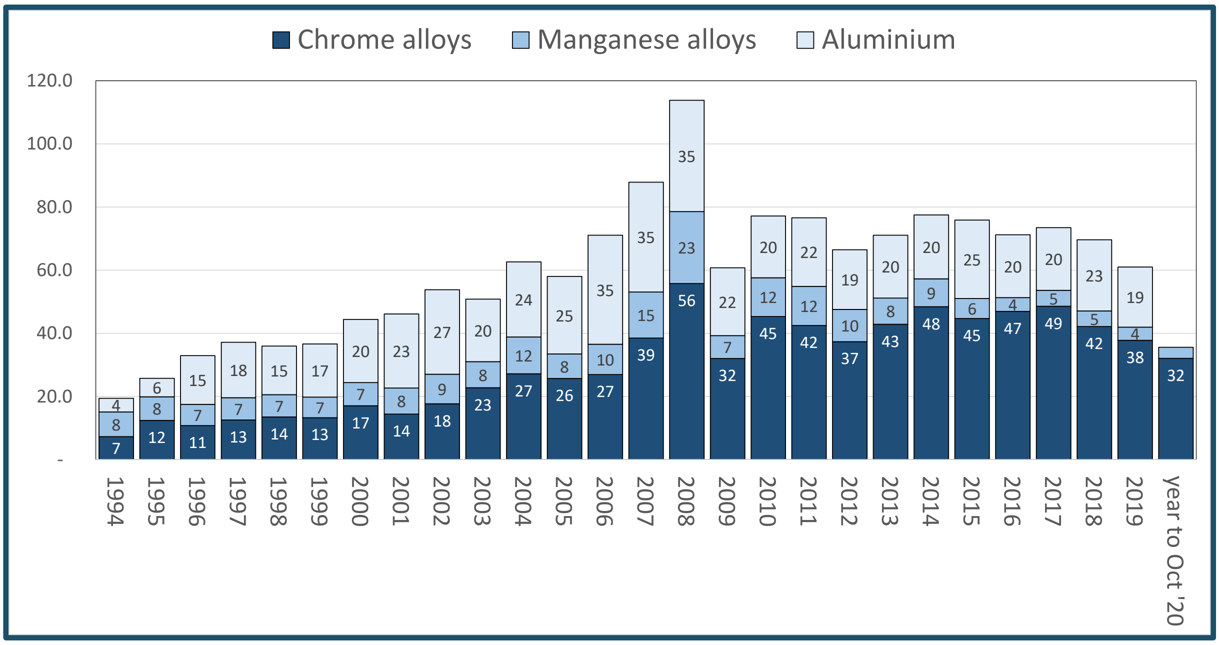
The COVID-19 pandemic brought a further sharp fall in both sales and output in the year to October 2020, but most of the losses occurred in April. In the three months to October 2020, ferrochrome production was 6% lower than in 2019, but ferromanganese was still down by over 50%.

Graph 12. Production and sales (in constant rand) of ferroalloys and aluminium, 1994 to 2019 and in the 12 months to October 2020 (a)

A. Production in millions of tonnes



B. Sales in billions of constant (2020) rand (b)



Note: (a) Data are not available for aluminium in 2020. (b) Deflated with CPI rebased to 2020. *Source:* Production for ferrochrome, ferromanganese and, until 2009, aluminium from the DMRE via Quantec. Mineral Statistics: National production and sales (aggregate of monthly figures after 2017); from 2009, aluminium production calculated from Annual Reports for relevant year for South32.

As commodity producers for overseas markets, the metals refineries have little scope to increase prices when the cost of electricity, their main cost driver, rises. In the 2010s, the ferroalloys producers exported around 90% of their output, and aluminium around 70%.

The average tariff for energy-intensive industry conceals the effective subsidy that Eskom provided to the aluminium producers, which in 2020 were Hillside in KwaZulu Natal and Mozal in Mozambique (which purchased its electricity from Eskom). 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, then it was effectively cross-subsidised by Eskom's other customers. From 2021, Eskom and Hillside agreed to link Eskom's tariff for the aluminium smelters to the producer price index (PPI).[7] That would still lead to far lower increases in the electricity cost for aluminium than foreseen for other customers. From 2008 to 2020, while the average electricity tariff climbed 430% in current rand, the PPI rose only 90%.

Hillside was owned by South32, which also held 44% in Mozal. Both plants processed alumina from South32 mines in Australia. Eskom did not publish its tariffs for the aluminium refineries, but South32 estimated that electricity costs at Hillside and Mozal dropped by over R500 million in its 2019/20 financial year because preferential electricity deals offset lower aluminium prices. (South32 2020:39).

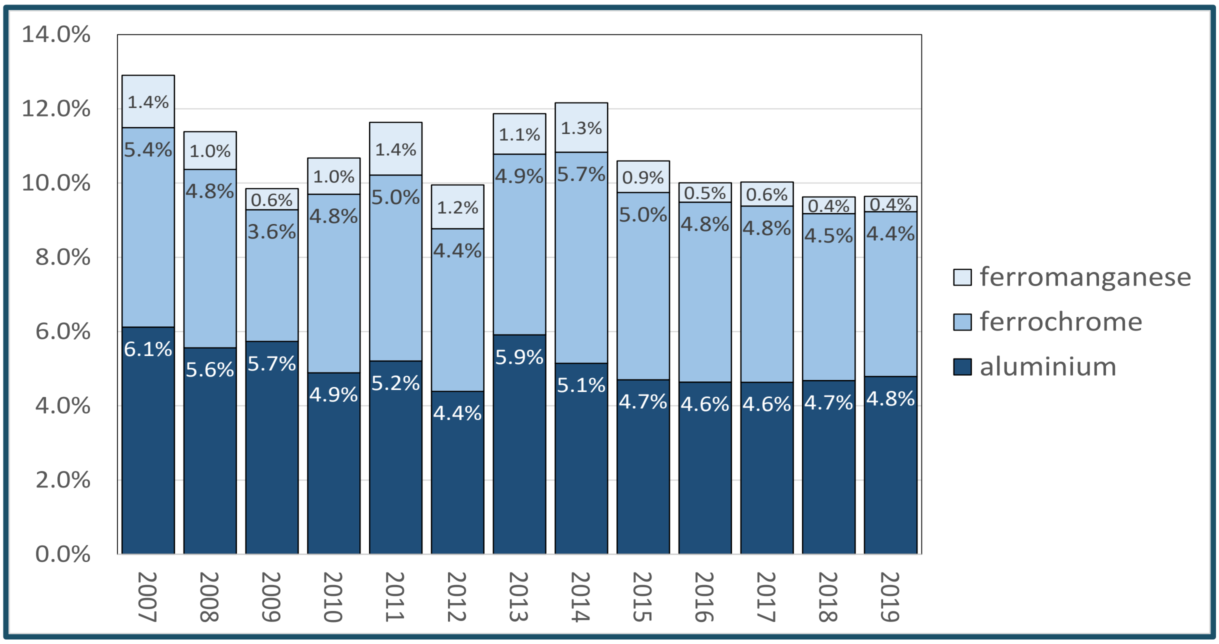
In addition to reducing output as electricity prices climbed, the metals refineries began to install new, less electricity-intensive technologies, as well as exploring off-grid renewable generation. From 2007 to 2019, the average amount of electricity used per tonne of South African ferrochrome fell by over 10%; for aluminium, it dropped 5%. (Calculated from company Annual Reports). Before 2008, South African ferroalloys producers historically used submerged arc furnaces, which are highly electricity-intensive compared to blast furnaces. They had favoured this technology for fifty years, in large part because Eskom supplied low-cost and reliable coal-fuelled electricity. (See Sithole et al. 2018:2). Since 2008, however, they have increasingly turned to technologies that significantly reduce electricity use.

Glencore Merafe, which accounts for around two thirds of South Africa's ferrochrome production, illustrates these developments. In the early 2010s, it began to introduce a pre-reduction technology that cuts electricity use per tonne by over a third. The Lion II smelter, opened in 2014, supplied around a tenth of South African ferrochrome production in the late 2010s using this technology. In 2019, Glencore Merafe also initiated a system to use flare gas, a refinery by-product, to generate 6% of the electricity used at its Lydenburg smelter, replacing Eskom's supply. (Glencore 2019:70).

The combined effect of lower production and greater energy-efficiency meant that from 2008 to 2019 the estimated electricity use by South African producers of aluminium and ferroalloys (excluding Mozal) dropped 10%. 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 13. 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 1 700 to 4 000 kWh per tonne. The figure used here is 3 000 kWh, based on figures from African Rainbow Minerals (ARM) for electricity use and production at Cato Ridge in 2018 and 2019. The ARM figures increased from around 2 500 kWh per tonne, presumably as a result of closing 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 electricity use in ferrochrome for the Glencore Merafe share in production and for total Eskom sales. For other ferrochrome producers, Fowkes, 2013. 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; and Kalenga, et al. 2013 and Ladam, et al. 2013. For production, DMR. Mineral Statistics – National Annual Production and Sales. Downloaded from Quantec. EasyData. Interactive database. Downloaded in February 2021.

The decline in ferroalloys production had a mixed impact on South Africa's economic prospects. Fundamentally, given the climate crisis, ferroalloys production seemed unsustainable in the medium term unless it moved away from coal-based energy. The refineries depended on exports, and over the medium term will face escalating carbon taxes and other barriers as trading partners seek to address the climate emergency. Most energy-intensive refineries internationally use hydroelectricity, which means they will be unaffected by these measures. By extension, unless South African producers shift to cleaner energy sources, they will become increasingly uncompetitive over time. From this standpoint, higher Eskom tariffs effectively compel them to internalise the external costs of coal-based production, which is unavoidable in light of the climate crisis.

The risk is that, rather than shifting to cleaner energy sources and more efficient technologies, ferroalloys producers further reduce output and effectively disinvest. In effect, that would shift the beneficiation of South African chrome and manganese overseas. This trend emerged from the 2000s, mostly as a result of soaring international prices for ores during the global commodity boom from the early 2000s to 2011. Domestic sales of chrome and manganese ore for local refining rose rapidly from the early 1990s through 2003, peaking at over 80% for chrome ore, and 40% for manganese. By 2019, however, only around half of South African chrome ore and under a twentieth of its manganese ore was processed locally. From 2003 to 2019, production of chrome ore rose five fold in constant rand, while local ferrochrome production only tripled. In contrast, domestic use of ferroalloys increased over time. The share of ferrochrome used in local manufacturing more than doubled from 7% in 1994 to 18% in 2019.

These trends meant South Africa became increasingly reliant on exports of ores. The share of alloys in overseas sales by the chrome and manganese value chains declined from over 80% in the early 2000s to under 40% by the end of the 2010s. Chrome and manganese ores rose from less than 1% of South African exports to 5%; ferrochrome and ferromanganese slipped from above 4% in the 2000s to around 3,5% in the 2010s. South Africa's share in global ferrochrome exports fell from between 55% and 65% in the early 2000s to just over 40% from 2017 to 2019. For ferromanganese, its share dropped from over 40% in the early 2000s to 15% in 2017-19. In contrast, exports of chrome ore climbed from 25% of the global total to over 70%, while manganese ore exports rose from 30% to over 50%. In 2004, China imported 10% of South African exports of chrome and manganese ores; by 2009, the figure had risen to over 60%, where it levelled out.

In sum, the energy-intensive ferroalloy and aluminium refineries were profoundly affected by the soaring costs and increased unreliability of Eskom's electricity. But they could not survive in the long run if they remained dependent on coal-based electricity because of the pushback due to the global climate emergency. Moreover, the refineries generated limited employment directly, and had only relatively minor linkages downstream to local manufacturing. In these circumstances, it was neither desirable nor viable to negotiate cheaper electricity in order to maintain exports of basic metals. Rather, to promote more inclusive, sustainable and dynamic industrialisation required a shift to cleaner energy combined with identification of downstream opportunities that could generate more jobs, increase local value added, and lessen vulnerability to global commodity cycles.

1.2.3 Impacts on other industries

Other businesses mostly relied 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, however, 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.

The vast majority of businesses using municipal electricity were medium and small in size. In addition, most large but not very electricity-intensive producers also bought electricity through local governments. Labour-force surveys indicate 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 StatsSA 2020a) Virtually all of these businesses purchased electricity from municipalities. Around a third of informal enterprises did not have connections at all, however. (StatsSA 2021:33). 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.

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. Most municipalities do not publish data on electricity sales by type of user, however. 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. In eThekwini, 1 000 large users out of a total of 45 000 business customers accounted for two fifths of total electricity sales; in Johannesburg, around 4 000 large users bought over half. (eThekwini 2018:58 and City Power 2020:78).

While municipal tariffs rose on average more slowly than Eskom tariffs from 2008 to 2020, they still climbed far faster than inflation. Annual increases also varied somewhat by locality, with some seeing sharper increases than others.

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 to invest in solar or diesel generators or in battery storage. All three options represented additional costs, and were often not fully reliable.
- Damage to electronic equipment, which was not set up to deal with periodic shutdowns or the electricity surges that often accompanied loadshedding. This risk was particularly severe for more technologically advanced and competitive industries. Generally it was likely to grow 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, leading to 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, with the attendant disruption to work organisation, and often workplace conflict.

The shortcomings in the municipal supply to industry appeared likely to prove increasingly damaging to South African competitiveness. Internationally, the climate crisis accelerated efforts to replace liquid fuels with electricity, including but not only for cars. Programmes to promote recovery from the COVID-19 depression in the global North generally included measures to support this trend. As a result, the trajectory of innovation globally has bent toward increased electricity use, mostly from renewables and gas. South Africa cannot lag too far behind this curve and remain competitive. Keeping up requires both more plentiful and more secure electricity, with more expansive and reliable local grids, notably for electric-vehicle charging points and for industrial and commercial sites.

The economic impacts of the disruption in the electricity system varied substantially between different types of municipality. Three broad groups emerged:[8] municipalities in the historic labour-sending regions, which held a third of the population but contributed only 15% of the GDP, 6% of formal businesses and 7% of municipal bulk electricity purchases; the five major metros in Gauteng, Cape Town and eThekwini, with 40% of the population, 55% of the GDP and two thirds of formal businesses, which used 66% of municipal bulk purchases; and the remaining municipalities, with roughly a quarter of the population, the GDP and bulk purchases. In the latter group, five municipalities accounted for over half of all municipal arrear debt to Eskom although only 5% of bulk electricity purchases. One, Maluti-a-Phofung in the Free State (stretching from Harrismith to Phuthadijhaba), owed Eskom over R5 billion, or almost a fifth of total municipal debt for electricity, although it used only 1% of bulk purchases. Most of the debt dated back to the early 2010s. (See Table 1.)

Table 1. Characteristics of municipalities by group

INDICATOR	METROS	MALUTI-A-PHOFUNG	NEXT 4 MOST INDEBTED (a)	OTHERS OUTSIDE HLS (b)	HLS (b)
share of GDP	52%	0.3%	5%	18%	24%
share of population	40%	1%	4%	23%	34%
municipal revenues per person	R13 900	R5 500	R8 100	R8 800	R3 700
payment to Eskom per resident	R2 900	R2 900	R2 100	R1 800	R350
% of bulk electricity purchases by municipalities	66%	1%	4%	22%	7%
electricity as % of total operating revenue	37%	23%	33%	35%	20%
electricity revenue as % of bulk payments to Eskom	157%	37%	121%	131%	137%
% of municipal arrear debt to Eskom	1%	17%	36%	42%	4%
arrear debt to Eskom per person	R20	R15 800	R6 100	R1 100	R70

Note: (a) Govan Mbeki and Emalahleni (Mpumalanga coalfields), Matjhabeng (Free State gold fields), Emfuleni (Gauteng – centred on the historic steel hub around Vanderbijlpark). (b) HLS = Historic Labour-Sending. Municipalities are here considered part of the HLS areas if more than half of their population lives in areas designated as historic "homeland" areas before 1994. By this measure, Maluti-a-Phofung belongs to the HLS, since 58% of its population lives in former "homeland" territory. *Sources:* For debt to Eskom, calculated from Parliamentary Monitoring Group. Municipal debt to June 2020. Response to PQ1681 by Minister of Public Enterprises on 1 August 2020. Annexure A. Downloaded from www.pmg.org.za in January 2021. For municipal revenues and bulk payments for electricity, calculated from National Treasury. Medium-term municipal budgets for 2019/20. Excel spreadsheet. Downloaded from mfma.treasury.gov.za in January 2021. For GDP, population and share of population by in HLS and other areas, calculated from Quantec. EasyData. RSA Standardised Regional Series. Downloaded from www.quantec.co.za in January 2021.

[8] Unless otherwise noted, data in this section on electricity use are calculated from StatsSA 2020b. Data on municipal budgets are calculated from National Treasury 2020.

The impact on businesses and the national economy of shortcomings in the electricity supply in each of these groups of municipality varied substantially.

- The historic labour-sending regions did not house much of the economy or formal businesses. This situation represented a vicious spiral, since the high cost of electricity combined with shortfalls in services dating back before 1994 made it harder for new productive activities to emerge. The limited established enterprises often argued that the quality of municipal electricity was poor compared to other regions. Still, because the historic labour-sending regions held relatively few formal producers, the impact on the national economy was limited.
- A far greater economic impact emerged from those metros that experienced a significant increase in breakdowns and costs. As noted above, the quality of electricity varied substantially by metro. Johannesburg and Ekurhuleni apparently had unusually high levels of breakdowns in the late 2010s. Still, both business and local governments in the metros had more resources than most other municipalities. In consequence, companies were more able to adapt to the deterioration in the electricity system, generally by investing in off-grid sources and more energy-efficient technologies.
- The impact was harsher for secondary cities and smaller towns in areas designated “white” before 1994, which were typically dependent heavily on mining, agriculture or tourism. In these towns, both industries and residents had fewer options. Many found it increasingly difficult to meet the new Eskom charges, especially where they relied on mining or had set up in smaller towns before 1994 to take advantage of “border-area” subsidies.

A handful of secondary towns that depended principally on gold and steel mining and refining were severely affected by the deterioration in the electricity system. Five of these towns accounted for over half of the total municipal debt to Eskom. As Table 2 indicates, two depended on the coal value chain in Mpumalanga; two on the Free State goldfields, of which Maluti-a-Phofung was indirectly involved through historic migrant labour; and one, Emfuleni (centred on Vanderbijlpark in Gauteng), on steel.

In the 2010s, these municipalities faced long-standing decline in their core industries even as electricity prices soared. Their increasingly high debt for electricity in turn led to both reduced funding for maintenance and periodic interruptions in supply by Eskom. That in turn made it harder for businesses in these municipalities to develop alternative production in response to the long-term decline in their traditional lead industries.

Table 2. Economic structure of Eskom’s five top municipal debtors

MUNICIPALITY	MAIN INDUSTRY (% OF GVA IN MUNICIPALITY)	POPULATION GROWTH FROM 1994 TO 2019 (NATIONAL = 44%)	AVERAGE ANNUAL GVA GROWTH FROM 1994 TO 2019 (NATIONAL = 2,4%)
Maluti-a-Phofung (FS)	Labour sent to Free State gold fields, but data not available Food processing at Harrismith; tourism	4%	1,6%
Emfuleni (GT)	Steel and metal products: 27% in 1994; 8% in 2019	29%	1,7%

MUNICIPALITY	MAIN INDUSTRY (% OF GVA IN MUNICIPALITY)	POPULATION GROWTH FROM 1994 TO 2019 (NATIONAL = 44%)	AVERAGE ANNUAL GVA GROWTH FROM 1994 TO 2019 (NATIONAL = 2,4%)
Matjhabeng (FS)	Gold: 59% in 1994; 35% in 2019	-8%	-0,9%
Govan Mbeki (MP)	Coal: 19% in 1994; 27% in 2012; 21% in 2019 Chemicals (based in Sasol's Secunda complex): 22% in 1994; 19% in 2019	60%	1,1%
Emalahleni (MP)	Coal = 35% in 1994; 48% in 2012; 44% in 2019 Electricity: 15% in 1994 and in 2019 Metals and machinery: 12% in 1994, 4% in 2019	76%	2,0%

Source: Calculated from Quantec. Standardised regional series. Downloaded from www.quantec.co.za in February 2021. *Note:* FS – Free State, GT – Gauteng, MP – Mpumalanga.

Overall, the vast majority of businesses were supplied through municipalities, which meant they bore the brunt of the disruption to the electricity system in the 2010s. The effects varied, however, depending on the nature of the enterprise and its ability to adapt by supplementing the local grid or reducing its dependency on electricity altogether. The effects on the national economy differed by municipality, with the biggest impact from a few metros and secondary cities that were important industrial centres but fell behind on the reliability and affordability of their electricity supply.

1.3 Summary and conclusions

The disruption to the electricity supply had both macroeconomic and industry-specific impacts. At the macro level, limits to generation capacity increasingly constrained overall growth. Moreover, escalating tariffs shifted a growing share of the GDP to electricity, which necessarily raised production costs and reduced competitiveness across the economy.

The impact by industry varied depending on the extent of energy intensity; the vulnerability of the production process to poor quality or interrupted current; the ability to limit electricity use by going off grid or increasing electricity efficiency; and location, since the quality of supply varied strongly between municipalities. Most obviously, the systemic electricity disruption made electricity-intensive, coal-based minerals beneficiation much less competitive globally as costs soared while the risk of international sanctions on high-emissions products loomed. But shortcomings in the electricity system also proved a growing burden to less electricity-intensive manufacturing and services. Electricity was not as large an input for most as in the mining value chain. Still, these industries faced both higher prices and more interruptions as loadshedding increased while the grids in some secondary cities and metros deteriorated. In the coming decade, the intensifying international effort to replace liquid fuels with (clean) electricity, notably but not exclusively in cars, will further raise the stakes of fixing the electricity supply for innovative producers as a pillar of international competitiveness and inclusive growth.

2 FACTORS BEHIND THE DISRUPTION

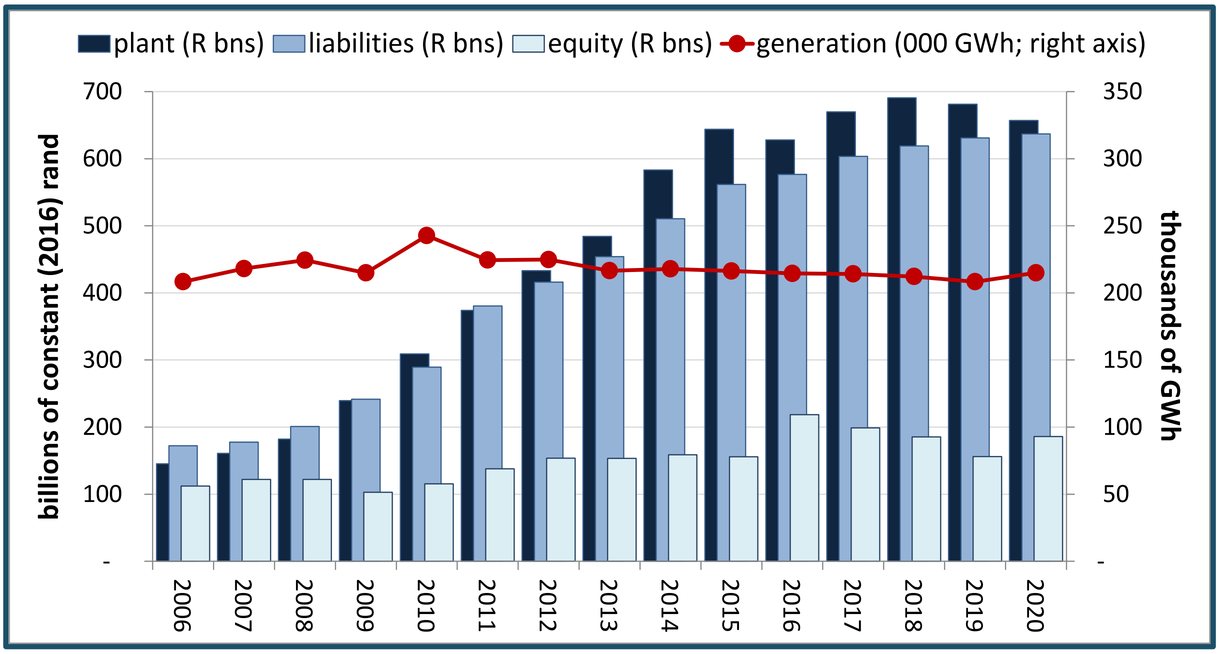
To address the disruption of the electricity system while building broader competitiveness and inclusion requires an understanding of its roots. The immediate cause was Eskom's inefficient and immensely expensive investment in large coal plants after 2008 even as demand declined. This outcome reflected the growing irrelevance of the historic Eskom business model, which originated to guarantee coal-fuelled electricity to large-scale producers in the mining value chain. The model was undermined by slowing demand after the global commodity boom ended in 2011; the emergence of newer, cleaner, smaller and more efficient renewable and gas generation; and the loss of coal rents to the mines over the course of the decade.

The metros and secondary cities also faced fundamental challenges to their historic electricity-supply models. After the transition to democracy, they necessarily sought to extend services to myriad new households, many of which could not pay for them, while maintaining adequate supply to industrial and commercial sites. This balancing act was particularly challenging in secondary cities that faced a downturn in their main industries but lacked the metros' economic resilience and institutional capacity.

2.1 Eskom

The disruption to the electricity system resulted from a dual crisis at Eskom in the 2010s. First, most of its plants were aged and often broke down, largely due to delays and then faults in its newly built Medupi and Kusile complexes. Second, it faced a financial crisis rooted primarily in overinvestment in the new plants and a rising price for coal, both of which were aggravated by large-scale corruption in procurement. As Graph 14 shows, from 2008 to 2020 (in financial years to March), in constant rand the value of Eskom's plant rose over 250%, its liabilities climbed almost 220%, but its sales in volume terms fell 4%.

Graph 14. Eskom assets, liabilities and equity in billions of constant (2020) rand (a), and sales in GWh, financial years, 2008 to 2020



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

These twin crises fuelled three vicious cycles.

First, Eskom increased its prices from 2008 to pay for new investments in generation capacity. Over time, however, higher tariffs led to falling demand. Eskom initially assumed elasticity of demand for electricity was near zero. In practice and in theory, however, elasticity inevitably increases over time, as consumers find substitutes of various kinds – in this case, off-grid production and electricity-efficient technologies – or simply shut down electricity-intensive production. 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 unit costs even further. That in turn accelerated the loss of demand.

This cycle, which threatens large infrastructure providers worldwide, is known internationally as the "utility death spiral". Eskom's 2018/9 Integrated Report noted it constituted a leading risk. 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 [increasingly renewable electricity] 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, faced with declining demand, it could not cut its costs and therefore required double-digit tariff increases. In consequence, it planned a 15% increase – more than 10% above inflation – for April 2021.

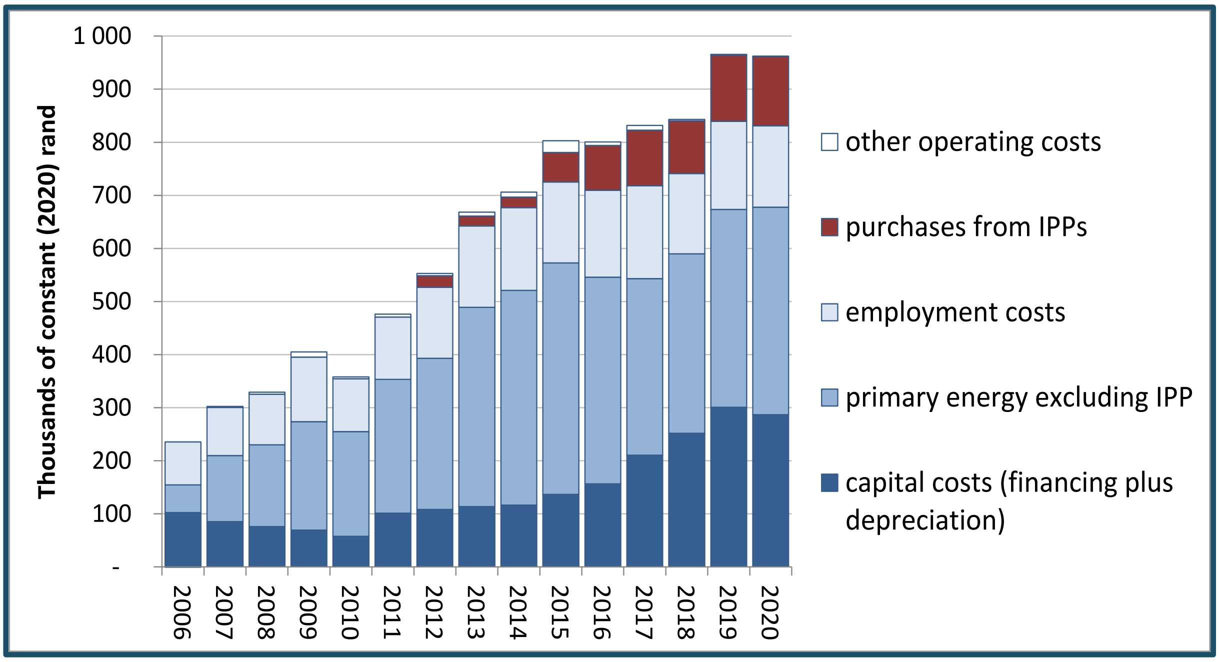
Second, in the late 2010s, Eskom consistently found it difficult to shut down plants for repairs or maintenance because even flat demand outstripped its deteriorating generation capacity. That in turn led to a rising number of breakdowns, which again increased the pressure to avoid planned shutdowns for maintenance. In the 2010s, a secular rise in unplanned outages resulted. In the most recent cycle, the Energy Availability Factor fell from 78% in 2018 to 67% in 2020, with a recovery to only 72% targeted for 2022. Rising breakdowns added to Eskom's financial pressure as it sought to make up the gap with diesel generators, which were relatively 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 1 328 GWh in 2020, with the cost escalating from R320 million to R4,3 billion. (Eskom 2020:94).

The high rate of breakdowns largely resulted because Eskom's enormous new coal plants were both delayed by years and faulty. In consequence, it kept its older plants in production longer than anticipated, and they began to break down more frequently. The situation was not helped by poor procurement and oversight practices for much of the 2010s, which meant that maintenance and repairs were often also faulty.

Finally, Eskom fell into a debt trap as it faced huge capital costs for its new investments while revenues remained lower than hoped due to delays and faults in the new plants; enormous financial losses in the few years when the regulator did not approve hoped-for tariff increases; falling demand; and leakages due to state capture.

As Graph 15 shows, from the mid-2010s capital costs (financing plus depreciation) became Eskom's most important cost driver. In 2020, the state transferred funds to Eskom that relieved the debt burden, but a larger solution was needed. Eskom itself argued that "a cost-reflective tariff is necessary to cover our cost of capital and, combined with cost efficiencies and reducing debt levels, will restore financial sustainability." (Eskom 2020:30). That solution would, however, aggravate the decline in demand, which in turn added to the company's financial burdens. In early 2021, it also began to engage on a refinancing package on more favourable terms.

Graph 15. Operating and capital costs at Eskom in constant (2020) rand (a), 2006 to 2020

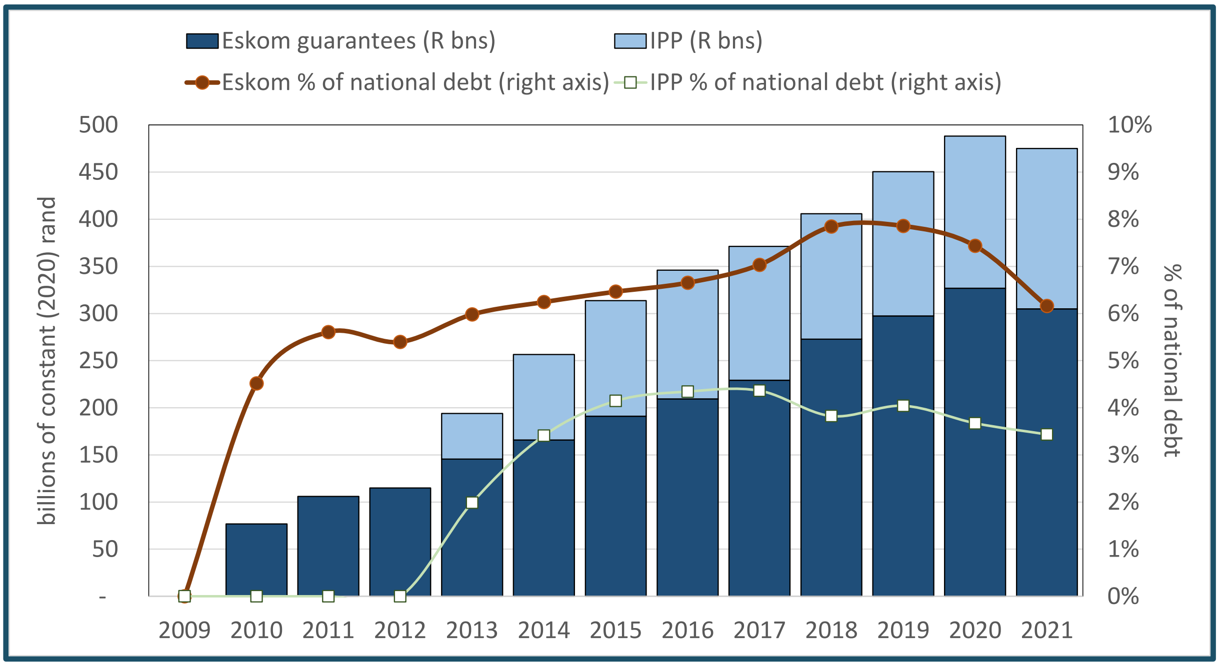


Note: Deflated with CPI to March, rebased to 2020. *Source:* Calculated from Eskom Financial Statements for relevant years.

Eskom's financial crisis placed a significant burden on the national fiscus. In addition to transfers of almost R90 billion committed in 2020 and 2021 (National Treasury 2021:95), public guarantees for Eskom debt climbed from none in 2008 to R325 billion in 2020 in constant (2021) rand, before falling to R305 billion as of March 2021. Debt guarantees count as part of the national debt, and the increase from 2008 to 2020 accounted for 11% of the growth in total national debt in this period.

Through the 2000s, guarantees for Eskom comprised over half of guarantees for all state-owned companies. In addition, from 2012 to March 2021, Treasury guaranteed R170 billion in debt for independent power producers. All told, by 2021 guarantees for electricity generation, both public and private, accounted for 10% of the national debt, down from 12% in 2018 and 2019.

Graph 16. Government guaranteed debt for Eskom and Independent Power Producers (IPPs), in billions of constant (2020) rand and as a percentage of total government debt, 2009 to 2021 (a)



Note: (a) Figures in billions are reflated using CPI for March rebased to 2020; the figure for 2021 uses CPI inflation as reported on page 7 of the 2021/22 Budget Review. IPPs are private electricity generators that are contracted to supply Eskom. *Source:* Calculated from National Treasury. Budget Review. Table 11. Excel spreadsheet. Downloaded from www.treasury.gov.za in February 2021.

The operational and financial crisis at Eskom reflected its failure to adapt its long-standing business model, essentially dating back to its foundation in 1923, to the very different realities of the 21st Century. Historically, Eskom was established to build big coal plants able to serve large customers in the mining value chain. In the process, it entered into agreements with the coal mines in Mpumalanga that effectively held the price for domestically used coal below the export price. The rents from coal – which in turn depended on externalisation of pollution costs – were sustained by squeezing domestic suppliers combined with large-scale power plants that were advanced for their time. From this standpoint, the core of the Mineral Energy Complex (see Fine and Rustomjee 1996) was the ability to utilise rents from coal to develop the rest of the mining value chain.

This business model was built on four core assumptions: continued robust growth in demand from big customers in the mining value chain; the absence of technologies able to compete with large-scale coal generation; continued ability to externalise the pollution caused by coal use; and a supply of low-cost coal. All four assumptions began to fail in the 2010s, ultimately generating the vicious cycles that plagued the electricity system.

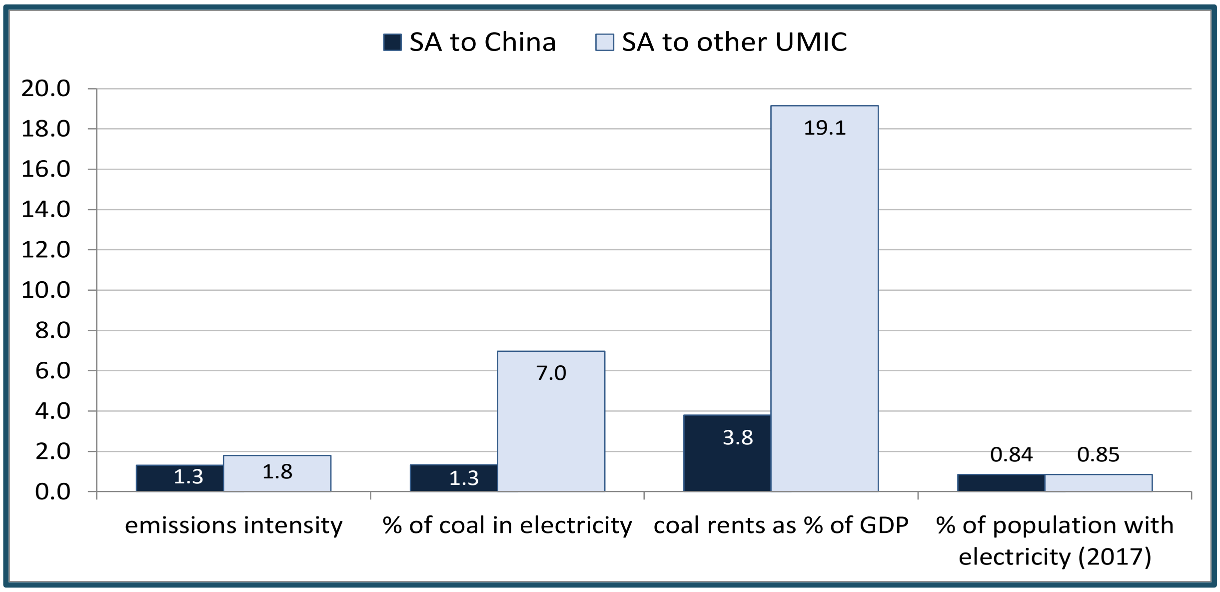
First, tariff hikes from 2008 and the end of the global mining price boom in 2011 led to falling demand from the mining value chain. In 2013, an update report on the 2010 Integrated Resource Plan (IRP) argued that demand had become unpredictable, so South Africa should build only smaller plants to retain flexibility and avoid disastrous increases in unit cost. (DOE 2013:25) Instead, Eskom planners continued to argue that demand would recover, based, among others, on the (very optimistic) 5% target set for GDP growth in the National

Development Plan.[9] Eskom had already embarked on Medupi and Kusile, two of the largest coal plants in the world. That in turn increased its fixed costs, leading to disaster when demand failed to match up to expectations.

Second, new technologies emerged to challenge Eskom's large-scale coal plants. That made it easier for customers to develop alternatives as its tariffs escalated. It also meant that the electricity price climbed relative to foreign competitors, making it a growing drag on the economy as a whole rather than a source of advantage. By 2020, both renewables and gas were cheaper than coal for generating electricity, although they required substantial additional investments in, respectively, transmission and pipelines. Solar and wind plants also required supplementation with base-load plants. Still, these options and a number of others, such as using flare-gas from metals refineries, provided more flexible and lower-cost electricity sources. From this standpoint, Eskom's huge investments from 2008 effectively locked it into obsolete technologies. The 2019 IRP foresees very little new coal generation, but that still leaves Eskom with increasingly uncompetitive assets absent a significant change in the relative price of coal.

Third, coal faced further disadvantages because of the deepening climate emergency. Increasingly, both generators and users of coal-fuelled electricity faced international and domestic pressure to limit emissions or at least internalise their cost in their sales price. As Graph 17 shows, largely thanks to Eskom (with some help from Sasol), South Africa was unusually dependent on coal by international standards in the late 2010s.

Graph 17. Ratio of South Africa to China and to other upper-middle-income countries (UMIC) for emissions intensity, share of coal in electricity, coal rents relative to GDP, and household access to electricity, 2015



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

In South Africa, measures to internalise the full cost of electricity mostly did not change the calculation of the tariff directly. Instead, they took three forms. To start, Eskom was compelled to accommodate private renewable generation under the Renewable Energy

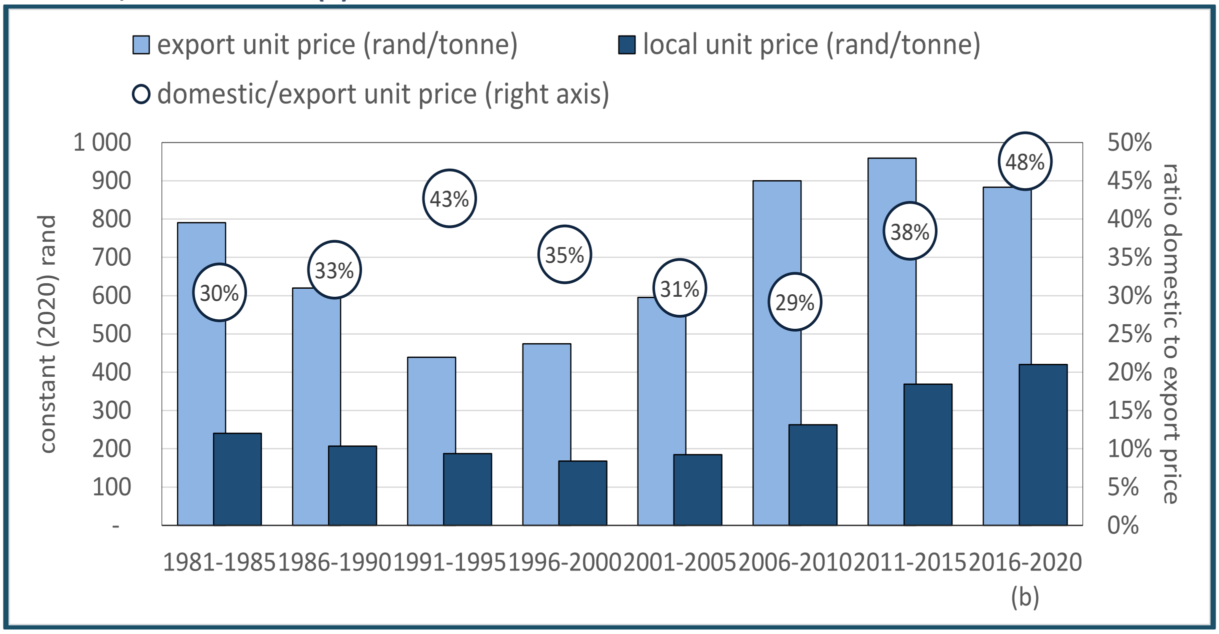
[9] Based on interviews with Eskom personnel in 2013/4.

Independent Power Producer (REIPP) Programme. Initially, the unit cost for the REIPP, contracted over the medium term, was substantially higher than Eskom's own coal-fuelled tariff. The tariff for producers that entered later was lower than Eskom's baseline. Still, from Eskom's standpoint, it was still compelled to allow new entrants into the market to compete at a time of falling demand. It also had to pay for transmission for the new suppliers, which were based outside of its traditional centre in the Mpumalanga coalfields. In addition, Eskom's older plants had to be retrofitted to reduce pollution, at a cost which it argued made them uneconomic. Most visibly, the Treasury introduced a carbon tax in 2019. Although the tax was initially set at a low rate and effectively excluded grid electricity, it is expected to rise substantially in the second phase, starting in 2023.

Besides these measures, the 2019 IRP aimed to reduce coal use to 44% of the national grid by 2030, down from 70% in the late 2010s. Achieving that goal would require that almost all new electricity investments go into other technologies, although Eskom would not have to retire any plants early. The IRP did not, however, spell out whether Eskom should take a significant role in renewables.

Finally, the price of domestic coal rose faster than export coal through the 2010s. In effect, that meant the mines captured the rents rather than Eskom and its downstream customers. Eskom did not publish its coal costs in the 2010s, but it accounted for around two thirds of all domestic coal sales. The average unit price of domestic coal climbed 40% in constant rand from 2008 to 2020, while the unit price for export coal dropped 14% in the same period.

Graph 18. 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. (b) Figures for 2020 extrapolated based on first ten months; deflated with average CPI to October. *Source:* Calculated from DMRE. Mineral Statistical Tables. Accessed through www.quantec.co.za in February 2021.

Various factors explained the shift in control over coal rents. The opening of the economy from 1994 made it easier for the mines to export, which in turn reduced Eskom's grip on the industry. Furthermore, from 1994 the dominant mining groups gradually disposed of much of their South African holdings outside of coal (mostly in gold and platinum). That made them less likely to accept lower coal prices, especially since they no longer needed the cheaper electricity for their other operations. Finally, Eskom sought to bring in new empowered producers, which disrupted its old alliances and provided an opening for state capture. Corrupt businesses and managers locked Eskom into some over-priced deals at a cost of billions.

Ultimately, Eskom was caught in a process of creative destruction, where innovative technologies displace existing assets, increasing the productivity of the national economy but imposing write-offs on newly uncompetitive producers left with obsolete facilities. In South Africa, the underlying technological shifts applied both to the electricity system as a whole, and to the broader process of diversifying away from mining over the longer run. In these circumstances, the challenge for the national electricity system, and Eskom in that context, was how to manage the transition more effectively, minimising the costs of the unavoidable disruption, without entrenching uncompetitive and costly plants that would prove increasingly unsustainable.

2.2 Governance

The governance of the national grid was effectively divorced from industrial policy, despite the critical importance of the energy system for economic development. The dtic had no direct role in decisions that profoundly affected investment and production decisions, including on the pricing of electricity, generation technologies and the design of loadshedding. More broadly, the institutions, policies and regulatory frameworks governing the electricity system were fractured, making it difficult to establish and implement a strategic response to the disruption of the 2010s.

A number of national departments, an independent regulator, and Eskom itself were jointly responsible for maintaining and guiding the electricity supply. Table 3 shows the role of different agencies in core regulatory components, from strategic decision making through to implementation. As the table indicates, responsibilities were divided, often fuzzily, between both:

- The various elements of system governance; and
- A host of different agencies, encompassing Cabinet, the Presidency, various national departments, NERSA, the Auditor General, and the courts.

Table 3. Oversight functions with regards to dimensions of Eskom operations as of 2021 (a)

FUNCTION	STRATEGY	POLICY AND REGULATION	INTERPRETATION OF REGULATIONS	IMPLEMENTATION
Licence to private generators	Define the role of non-Eskom generation	Determine licensing criteria and payment for transmission and generation	Establish licensing or registration procedures Approve licences	Generate electricity if approved
	Cabinet/ Presidency	*DMRE*	*NERSA*	*Private companies*

FUNCTION	STRATEGY	POLICY AND REGULATION	INTERPRETATION OF REGULATIONS	IMPLEMENTATION
New Eskom capacity	IRP sets overall targets by source, although does not define Eskom role	Agreement on specific projects with financing	Licensing of new projects	Construction
	DMRE (approved by Cabinet)	*DMRE, NT*	*NERSA*	*Eskom*
Set prices for electricity	Electricity Regulation Act limits to normal rate of return for efficient suppliers	Electricity Pricing Policy (last published in 2008)	Set tariffs for Eskom and guidelines for municipalities	Charge approved tariffs
	Parliament	*DMRE*	*NERSA (based on Act)* *Courts on appeal from NERSA*	*Eskom* *Municipalities*
Operational strategy	Eskom Act (sets core responsibilities, powers and outcomes)	Select board and executives; set key performance indicators (KPIs)	Monitoring, evaluation and action to correct as required	Actions to achieve KPIs
	Parliament	*DPE*	*DPE* *Auditor General* *Parliament*	*Eskom*
Funding strategies	No specific published strategy; governed by Eskom and Companies Acts and PFMA	Policy on criteria for Eskom borrowing (none published)	Provision of subsidies and credit guarantees	Decisions on individual credits and investments
	Eskom	*Eskom, DPE, NT*	*NT*	*Eskom, NT, DPE*

Notes: (a) Abbreviations are: DMRE – Department of Mineral Resources and Energy; DPE – Department of Public Enterprises; NT – National Treasury; NERSA – National Energy Regulator of South Africa; PFMA – Public Finance and Management Act.

Rifts emerged between the various decision-makers in the system over a variety of issues. The most obvious centred on the role of private generators; the speed with which to move away from coal; whether to expand nuclear generation; how to manage the impact of higher electricity prices on energy-intensive users; and what to do about municipal debt. Contestation led to uneven and heavily delayed implementation of strategic decisions, as well as some contradictory policies and measures. Core areas of misalignment included the following.

In terms of government objectives for Eskom, the Department of Public Enterprises, as Eskom's shareholder on behalf of the state, established core aims for Eskom through its "strategic intent statement" and annual targets expressed as Key Performance Indicators (KPIs). As of 2019, its requirements centred on affordable and reliable electricity combined with financial viability, much improved reporting and a reduced environmental impact. (Eskom, n.d.). Eskom's published KPIs in 2019, however, did not include indicators for affordability, reliability, or expanded renewable energy. The DMRE did not foresee a significant expansion in Eskom's generation of renewables.

On pricing, the Electricity Regulation Act of 2006 required that NERSA set tariffs to allow efficient producers to cover their costs with a "reasonable" rate of return. The aim was to ensure sustainable supply without simply sanctioning escalating costs. This approach was copied from jurisdictions where independent regulators managed multi-supplier markets. Unfortunately, given Eskom's near-monopoly position, it proved almost impossible for NERSA either to disallow any costs as inefficient or to limit tariff hikes to inflation.

In theory, when NERSA calculated tariffs, it could exclude costs claimed by Eskom that it considered unnecessary or excessive. At various points in the 2010s, NERSA sought to limit Eskom's use of diesel generators and its procurement from outside suppliers, on the grounds that the unit costs of these sources were higher than the normal tariff. If this decision led Eskom to loadshed, however, then the costs to customers and the economy far exceeded any savings. Estimates in the 2010s suggested that the cost of diesel generation per kWh, while more than three times as high as coal plants, was less than a third the cost to businesses and the economy imposed by loadshedding the same amount of electricity.

In the late 2020s, the regulator sought to restrain prices to near the inflation level. Eskom argued that its costs were fixed, mostly because it could not downsize its plants. So instead of slashing costs to meet the revenue shortfall, it ran up billions of losses. The government ultimately ended up covering the deficits because it guaranteed Eskom debt. Then, in 2020, the courts overturned NERSA's decision, leading to an extraordinary 15% tariff increase in 2021, 12% over inflation, despite the COVID-19 depression.

NERSA's price-setting system was also notably rigid, making it harder to address emerging crises in the electricity system. Soon after its establishment in 2006, NERSA began to set tariffs through multi-year determinations, defining the price trajectory over three years based on pre-determined formulae. This procedure aimed to improve predictability, but in practice slowed down responses to changing costs or demand. And it did not substantially improve certainty, because when demand fell short of predictions, tariffs often increased by far more than provided by the multi-year determination.

In sum, despite the Act's clear intent, the regulator had no real power to force the dominant supplier to cut costs through the tariff mechanism. A more effective response would require a coherent strategy from government on moving to lower-cost technologies and strengthening management. That, however, lay beyond NERSA's competence, and the relevant departments did not provide coherent guidelines.

The DMRE did not set tariffs, but its policies influenced them heavily. These policies did not always align well with industrial policy aims. Most obviously, in 2020, the DMRE introduced a programme that would enable NERSA to set a lower tariff for individual energy-intensive users so that they could compete internationally. In practice, if implemented, this programme would require other Eskom customers to subsidise a few energy-intensive producers in the mining value chain.[10] More fundamentally, a number of DMRE decisions vastly increased Eskom's costs. In particular, it permitted investment in large plants, which reduced Eskom's ability to respond to falling demand and increased its debts; limited Eskom's scope for moving into cheaper renewables; and required it to provide transmission facilities for far-flung REIPP suppliers while paying them prices above the standard tariff that were contracted by the DMRE. All of these actions increased Eskom's costs while reducing its long-term competitiveness and sustainability.

Decision-making on new supply was similarly uneven, leading to the delays even as loadshedding mounted. In 2019/20, as Eskom faced mounting breakdowns and loadshedding, Cabinet agreed that the DMRE and NERSA should ease the regulatory requirements for small-scale private suppliers to join the grid, both by facilitating licensing for generators up to 10 MW, and by putting out a tender for emergency supplies. Although the decision was announced at the start of 2020, the DPME and NERSA only finalised the regulations in October. They expected to approve new sources of power in the first half of 2021, and that the emergency power would come online at most a year later – that is, almost two years after Cabinet recognised the crisis. In June 2021, as loadshedding continued, the government agreed to further ease requirements on own generation up to 100 MW. If implemented as planned, that would vastly accelerate access to new sources of power.

At the highest strategic level, the DPME was responsible for drafting the IRP, which laid out the desired sources of electricity through 2030. From an industrial-policy perspective, however, the IRP left out key variables. Above all, the DMRE did not publish the implications of its choices for production costs, including externalities, or for tariffs. That in turn led to contestation over the relative economic costs and benefits of different options, centring on the future of nuclear and coal. The IRP also did not specify whether Eskom or private suppliers would be responsible for meeting the generation targets. These gaps made it difficult to determine the long-run impact of the IRP decisions on the affordability and reliability of electricity for producers, as well as the scope for investment in the electricity value chain.

In short, the fragmented governance of the electricity system was entirely unsuited to an effective industrial policy. In practice, it largely ruled out a coordinated and rapid response when the electricity supply became a stumbling block to inclusive industrialisation. Moreover, there was no easily accessible and effective platform to ensure that industrial-policy concerns were taken on board consistently in setting and implementing policies around electricity. Above all, concerns about reliability and affordability for manufacturing and advanced services often came second to other demands, such as bolstering Eskom's balance sheet, supporting the mining value chain and promoting specific technologies.

[10] The first application under this programme was made in 2021, but the applicant's name was hidden and it was not clear when NERSA would make a decision. Reportedly the ferrochrome refineries hoped to benefit, with Eskom support in an effort to bolster its long-run sales, even though it faced loadshedding at least through 2022. (Creamer 2021).

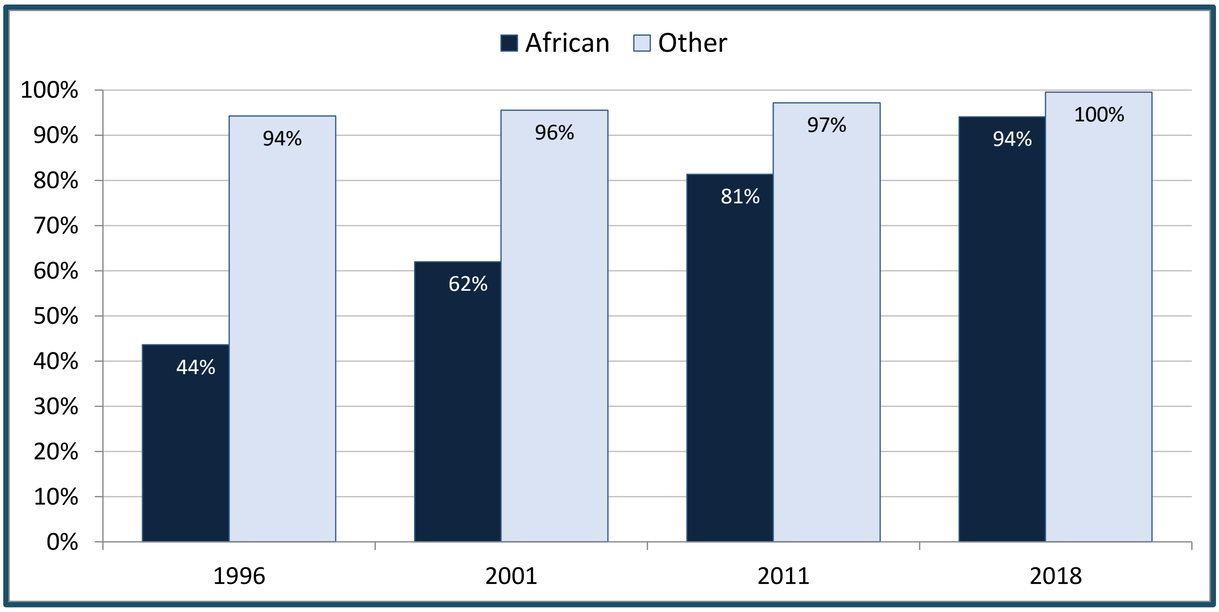
2.3 The municipal electricity supply

The financial aspects of the municipal electricity supply – both the level of tariffs and some municipalities' debts to Eskom – have attracted a lot of attention in recent years. For industrial policy, however, growing numbers of breakdowns in many metros and secondary cities, compounding the rise in tariffs, were vastly more significant. These issues resulted in large part from the difficulty of prioritising maintenance and quality services for established businesses when so many communities remained underserved, especially as rapidly increasing tariffs led to falling demand and payment levels from 2008.

The municipal system established with the transition to democracy consolidated historically unserved (mostly African) communities with more privileged areas and industrial sites. At the same time, the elimination of apartheid residential restrictions enabled all citizens to live in the country's economic centres, resulting in rapid rural-urban migration. These developments multiplied demand for electrification even as industrial and commercial needs continued to grow. The municipalities' situation was further burdened by the fact that South Africa's peculiarly unequal pay scales and high joblessness meant many households could not afford to pay the full cost of services.

As Graph 19 shows, in the mid-1990s only 44% of African households had access to electricity. By 2018, the figure had risen to 94%. Pressure for electrification increased as a result of migration from the historic labour-sending regions to the urban areas, and especially the metros in Gauteng. From the late 1980s to 2019, the population of the historic labour-sending regions fell from half to a third of the national total. From 1994 to 2019, according to Quantec estimates, Gauteng's population climbed by 100%, and the Western Cape by 70%. The rest of the country grew only 26%, with growth of less than 10% over the 25 years in the Free State and the Eastern Cape. (Calculated from Quantec 2020b)

Graph 19. Household access to electricity for lighting by race, 1996, 2001, 2011 and 2018

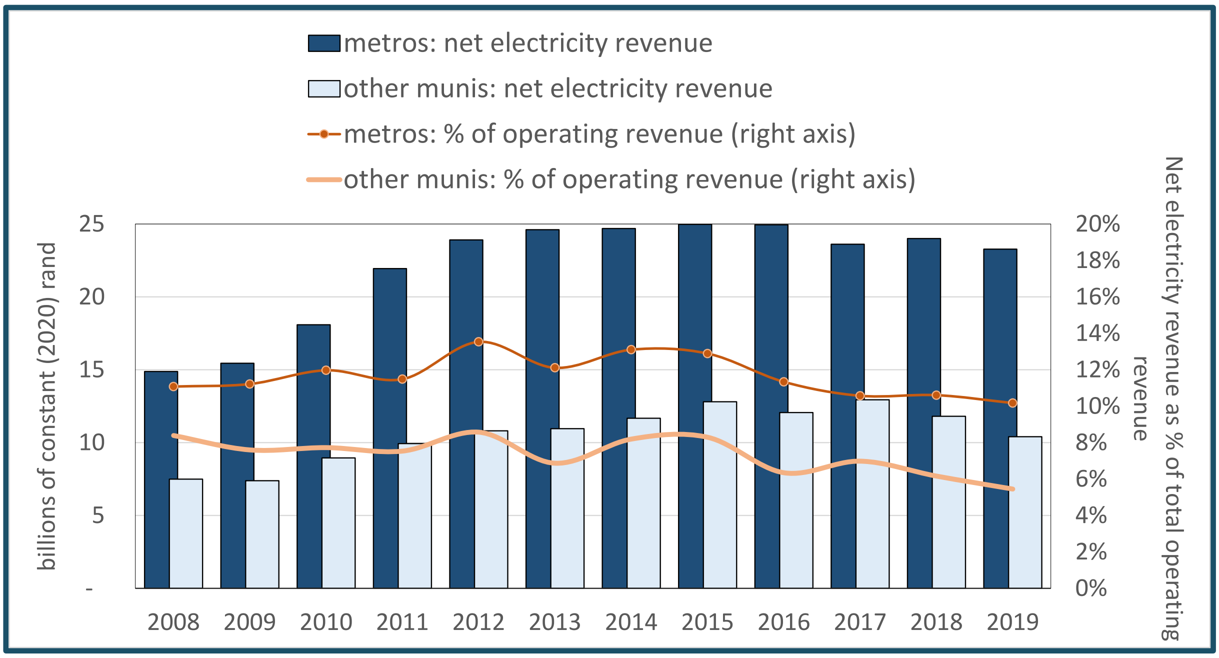


Source: Calculated from Statistics South Africa. Census data for 1996, 2001 and 2011. Interactive data set. Accessed at SuperWeb site at statssa.gov.za; and from Statistics South Africa. General Household Survey 2018. Electronic database. Downloaded from Nesstar facility at www.statssa.gov.za.

In these circumstances, from 1994 the municipalities faced growing competition for electricity. Many responded by limiting maintenance on existing infrastructure in order to expand services to historically excluded and new areas. That approach conformed to a post-colonial strategy found throughout Africa, since maintenance can be neglected for many years before systems begin to collapse. It also reflected the political-economic realities of a profoundly unequal economy. Voters often saw established businesses as long privileged. It was therefore politically difficult in many areas to increase spending to meet needs in the formal economy while impoverished informal settlements and long-established and long-underserved townships went without.

The municipalities' situation was aggravated by falling electricity revenues in real terms from 2015. Initially, the rapid increase in Eskom tariffs after 2008 led to higher net municipal revenues in constant rand, despite rising costs for bulk purchases. From 2015, however, municipal electricity revenues began to flatten as residents and businesses reduced their electricity use and increasingly defaulted on payments. As Graph 20 shows, from 2008 to 2014, the metros' income from electricity, net of bulk payments for it, mostly to Eskom, climbed 65%; other municipalities saw an increase of 45%. From 2015 to 2019, however, the income for all municipalities fell 5%. As eThekwini observed, continuing to increase prices was beginning to result in more customers moving off the local grid and to more illegal connections. The resulting decline in the volume of sales meant that revenues fell even when tariffs increased, which had begun "impacting on our collections and the financial viability and sustainability of the Municipality" (eThekwini 2020:46). The average bulk customer in eThekwini reduced their electricity use by over 20% from 2008 to 2019, while their electricity bills tripled in current terms. (eThekwini 2019:31).

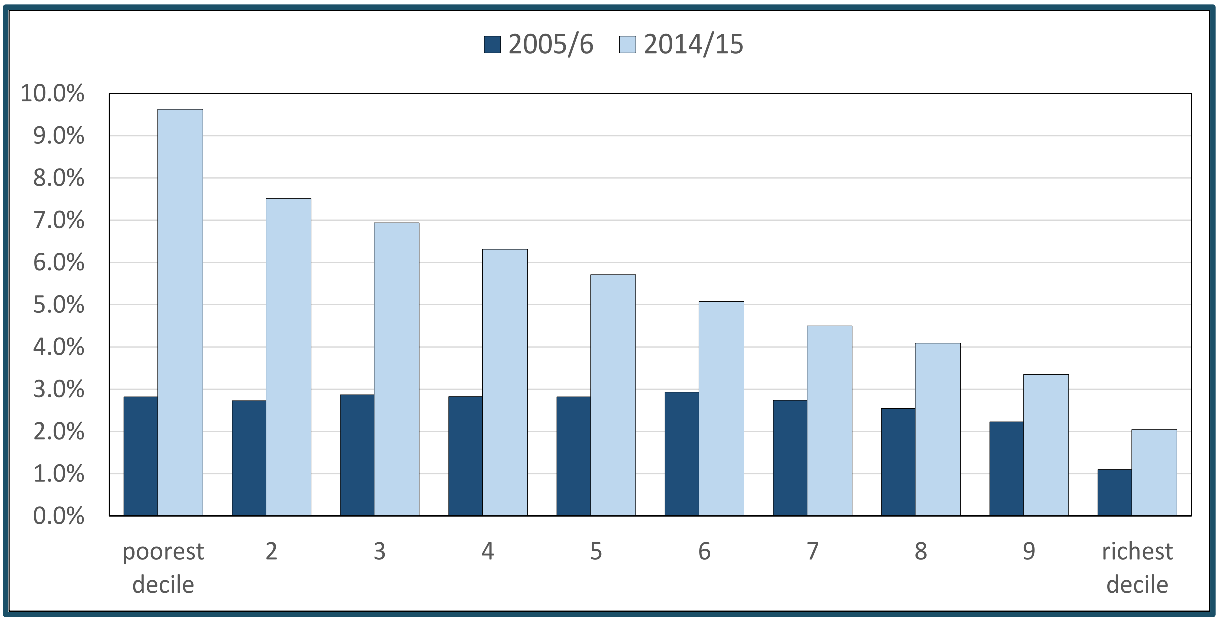
Graph 20. Net electricity revenue (a) in constant rand (b) and as percentage of operating expenditure for metros and other municipalities, 2008 to 2019



Note: (a) Revenue from sale of electricity less cost of bulk purchases, which were mostly from Eskom. (b) Reflated with CPI for March rebased to 2020.

Predictably, as tariffs soared collection rates on electricity payments declined in most municipalities. Figures on collections do not indicate the extent to which businesses fell behind. The increase in electricity costs as a share of spending by low-income households, however, points to the growing pressure. In 2005, electricity accounted for under 3% of household spending for the poorest 50% of households; by 2015/6, it had risen above 6,5%, even with the provision of free basic services. The share of income going on electricity also rose for high-income households, but still accounted for a much smaller share of their expenditure. For the top decile, it climbed from 1,1% of expenditure in 2005 to 2,0% a decade later. The richest decile consumed almost a third of all electricity used by households, however, and they found it easier to find alternative sources such as generators and solar panels.

Graph 21. Share of household expenditure on electricity by expenditure decile, 2005/6 and 2014/15



Source: Calculated from Statistics South Africa. 2008. Income and expenditure of households 2005/2006. Statistical Release P0100. Pretoria; and Statistics South Africa. 2017. Living Conditions of Households in South Africa: An analysis of household expenditure and income data using the LCS 2014/2015. Statistical Release P0310. Pretoria.

The tendency to prioritise electrification over a stable and affordable supply for production was reinforced by the national system of grants to municipalities and the associated KPIs. The national government subsidised electrification and free basic services for households. It required municipalities to target the extension of electricity in informal settlements and to publish both tariff increases and the cost of tariffs to households. But it did not set either quality or quantity targets for the supply of electricity for manufacturing and advanced services. Municipalities also did not have to publish standard data on outages or on the cost of electricity to producers.

As noted, the situation was particularly stressed in the five secondary cities that accounted for over half of all municipal debt to Eskom. Eskom itself had little choice but to pursue its municipal debts in order to maintain its credit status. The end result was to push important economic centres further into decline, rather than promoting a just transition that would utilise their significant industrial capabilities to build new activities. A more constructive approach would, however, require a whole-of-government strategy with clear objectives, support systems and resourcing. Atlantis on the West Coast suggested the potential of a more proactive industrial-policy strategy for municipalities faced with structural change.

Among the metros, Johannesburg stood out for poor electricity quality. That was due in part to its extraordinarily rapid growth, with the population climbing 125% from 1994 to 2020, according to Quantec estimates. But it also reflected the decision to corporatise the electricity utility, City Power. Experience internationally suggests that in the absence of stringent oversight, corporatised utilities maximise their returns by skimping on maintenance.

In sum, the rapidly rising cost of electricity combined with the inherited inequalities in provision and in some areas rapid in-migration placed enormous burdens on secondary cities and metros. In response, many municipalities neglected industrial and commercial customers in an effort to improve services for voters. As soaring tariffs led to lower payments from households, especially in secondary cities confronting structural decline, a relatively small number of local governments found it socially, economically and politically more sustainable to delay payments to Eskom than to worsen already low living standards by shutting off voters who could not pay.

Ultimately, both the municipalities and Eskom were caught in the contradictions of national policy. On the one hand, the national government set few standards for municipal electricity for producers, even though maintaining and indeed improving the electricity supply constitutes a central instrument for industrial policy. On the other, it required the extension of services to households while providing only limited subsidies even as Eskom tariffs soared. As a result, both households and businesses responded by reducing their use of grid electricity, which in turn squeezed municipal finances to maintain and extend local grids.

3 THE IMPLICATIONS FOR INDUSTRIAL POLICY

South Africa's historic path dependency on mining exports was rooted in large part in cheap, reliable coal-fuelled electricity. The disruption to the electricity system meant it was increasingly difficult to sustain this reliance. Proposals to subsidise large-scale coal generation for energy-intensive companies in the mining value chain would merely shift the cost to taxpayers and producers in other, potentially more productive, competitive and labour-intensive industries. Sustaining dependence on coal will also become a growing hindrance to exports in the coming decade. Ultimately, this approach would effectively divert resources from more sustainable energy solutions.

The differentiated impact of the crisis on the electricity-intensive mining value chain and other industries points to two more sustainable responses, which can be combined.

- South Africa can urgently develop cheaper and cleaner energy sources on a scale sufficient to permit continued globally competitive electricity-intensive production, while simultaneously assisting producers to introduce more efficient technologies. This option requires institutional mechanisms and regulatory frameworks able to fast-track construction of new energy sources; substantial investment in generation and in transmission, and in new refinery technologies; and smart grids that can maintain a stable electricity supply combining multiple generation sources rather than a limited number of large (coal-fired) plants.

- South Africa can promote growth in a wider array of competitive manufacturing and services industries. In terms of the electricity system, that would require stabilising municipal as well as national supply. The greatest value added would arise from improving the reliability and extent of supply in the metros and secondary cities, especially for industrial and commercial sites. Solutions could either utilise the grid or permit larger off-grid generation. In addition, the government could introduce stronger incentives for more energy-efficient technologies in manufacturing and services.

To be effective, both of these strategies would have to be on a disruptive scale, which would make them risky. In this context, the mining-based strategy may seem safer because it relies on strong existing systems and institutions while protecting South Africa's core export industries. But it would do little directly to promote a stronger middle class. Unless complemented by measures to promote new economic opportunities, it would therefore leave the country vulnerable to policy contestation and instability, with the associated slow economic growth. A more robust diversification strategy, however, requires that government gamble heavily on new industries and businesses, some of which will inevitably fail. Success can be supported by improved alignment across the state as well as rigorous risk-management procedures, but some failures would have to be accepted.

The decision on how to shape the electricity system to support industrial policy has significant implications for Eskom.

First, unless it is allowed to diversify more vigorously away from coal, it will likely become increasingly irrelevant over the long run. The internalisation of coal costs through national and global policies will simply make it unable to compete with private suppliers over time.

Second, the management of the national grid – whatever its relationship to Eskom – will have to promote a cost-effective transition to renewables that reduces unit costs across the economy while improving the quality of supply. Core challenges relate to the management of multiple suppliers and the development of new baseload technologies that permit gradual reduction in dependency on coal, in line with the IRP.

Finally, industrial policy imperatives should have far more influence in decisions on electricity tariffs and energy sources, whether embedded in enterprises or controlled by Eskom or independent producers. The focus should be on ensuring that the electricity system supports increasingly advanced clusters and industrial sites as well as township industries, rather than focusing on maintaining services to the established consumers in the mining value chain.

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