2026
Mpumalanga **Energy Sector** Market Intelligence Report

MPUMALANGA
GREEN CLUSTER
AGENCY

Mpumalanga Green Cluster Agency

Acknowledgements

Disclaimer

This document may be downloaded at no charge from https://thegca.co.za/resources/

Subscribe to receive e-mail alerts or MGCA news, events and publications by registering as a member on our website: https://thegca.co.za/cluster-membership/cluster-membership

Mbombela, 1200, South Africa

Document Typesetting & Layout: Muzikayise Mashele Mbungela (TheMousist.co.za)
Images: Supplied

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Introduction

The South African energy sector is a major pillar of the country's economic and social development, shaping industrial activity, household welfare, and national competitiveness.

The industry, which has historically been dominated by coal-fired power, is going through a major change as South Africa deals with issues such as aging infrastructure, growing energy demand, climate commitments, and the requirement for long-term energy security.The state-owned power utility, Eskom remains the cornerstone of South Africa's national grid, serving as the essential foundation upon which the country's entire electrical architecture is built and sustained.

It is generating bulk of the country's power and controlling transmission and distribution. However, persistent challenges in power utility prompt the country to shift towards diversifying energy mix.

1.

THE ENERGY SECTOR IN SOUTH AFRICA

1.1.

Energy Supply

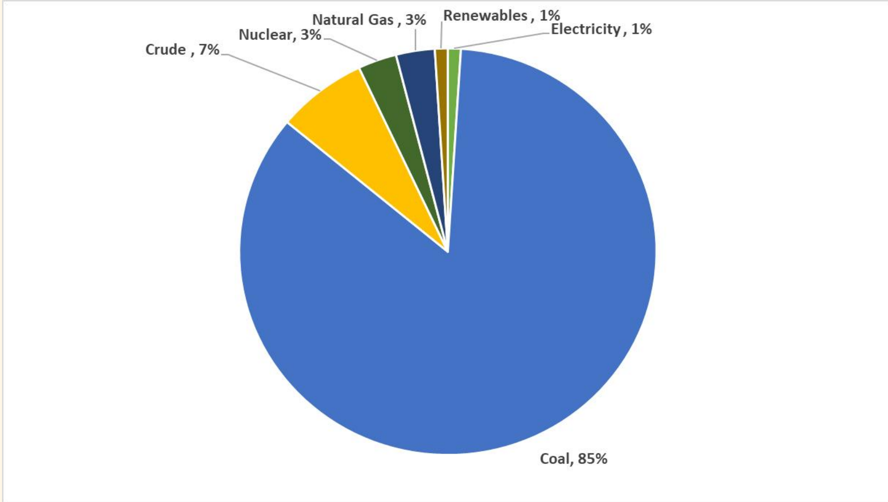
South Africa’s energy landscape remains heavily centralized around fossil fuels. Coal continues to be the undisputed backbone of the country's energy supply, accounting for nearly 85% of the total.

Petroleum products and natural gas follow as secondary sources, while the transition toward cleaner energy specifically nuclear and renewables remains in its beginning, collectively making up a very small fraction of the national footprint. The South African energy supply is still dominated by coal, which made up 85% of the primary energy supply in 2024, followed by crude oil at 7%.

Natural Gas and Nuclear contributed 3% each to the total primary energy supply. Electricity and Renewables contributed 1% respectively to the total energy supply.

The primary energy supply in this case includes indigenous production and imported sources, less exported quantities as shown in the **Figure 1 (right)**.

Figure 1: Total primary energy supply, 2023



Source: DEE Energy Data, 2024

1.1.1.

Crude oil and Petroleum Products

South Africa currently does not have significant proven oil reserves and therefore relies heavily on imports to meet its crude oil needs.

South Africa also imports most of the petroleum products to supplement production shortfall.

During the transformation stage, the country produced approximately 10% of its fuel requirements from gas (GTL), 2% from coal (CTL), and 88% from crude oil (DEE, Energy Balance 2023).

Crude oil was the third most imported product in South Africa for the year 2023. South Africa imports crude petroleum primarily from Nigeria, Saudi Arabia, Angola, Ghana, and the Republic of Congo. The fastest-growing markets in crude for 2023 were Mozambique, Lesotho and Saint Helena.

As it stands, there are six refineries in the country; four are on the coast and two are inland. Two of the refineries are synthetic fuel production facilities that produce liquid fuels from coal and gas, which are owned by Sasol and PetroSA respectively. South Africa is unique in its use of Coal-To-Liquid (CTL) and Gas-To-Liquids (GTL) technologies, which is primarily operated by Sasol.

The synthetic fuel plants, which are owned by Sasol, convert coal and Natural Gas into synthetic petroleum products, therefore reducing dependency on crude oil imports.

The Petroleum Oil and Gas Corporation of South Africa (PetroSA) produces synthetic products using GTL technology.

Major refineries include Sapref and Enref in Durban, Astron Energy in Cape Town, and Natref at Sasolburg.

According to Sapia, in 2023, the Astron refinery at Milnerton in Cape Town commenced with startup operations at the end of 2022 following the major incident at the refinery in 2020 and full production was achieved by the end of the first quarter 2023.

Natref in Sasolburg and Sasol synthetic operations-maintained production throughout the year 2023. The capacity and location of the six refineries are shown in **Table 1 (right)**.

Table 1: Refinery production capacity, 2023

Refinery	Area and Province	Type	Capacity*
Astron Energy	Cape Town, Western Cape	Crude	100 000
Enref	Durban South, KwaZulu Natal	Crude	0
Natref (Sasol Oil owns 64% and Total SA 36%)	Sasolburg, Free State	Crude	108 000
PetroSA	Mossel Bay, Western Cape	Synthetic (GTL)	0
Sasol Synfuels	Secunda, Mpumalanga	Synthetic (CTL)	150 000
Sapref (BP owns 50% and Shell 50%)	Durban South, KwaZulu Natal	Crude	0
Total			**358 000**

Source: SAPIA Annual Report 2023* Crude equivalent (bbl/day)

In 2023, South Africa remained highly reliant on imports for its crude oil requirements. The total primary crude oil supply was used by refineries during the transformation process for liquid fuels production.

Almost all the imported crude oil is used to produce liquid fuels, with a small percentage used for lubricants, bitumen, solvents, and other petrochemicals.

To mitigate the risks associated with this heavy import dependency, the country continues to leverage its sophisticated synthetic fuel capabilities, which convert coal and natural gas into liquid energy.

However, the aging infrastructure of traditional crude refineries has led to frequent operational pauses, further tightening the domestic supply of petrol and diesel.

Consequently, the national energy strategy is increasingly pivoting towards diversifying the energy mix to ensure long-term stability against volatile global oil prices.

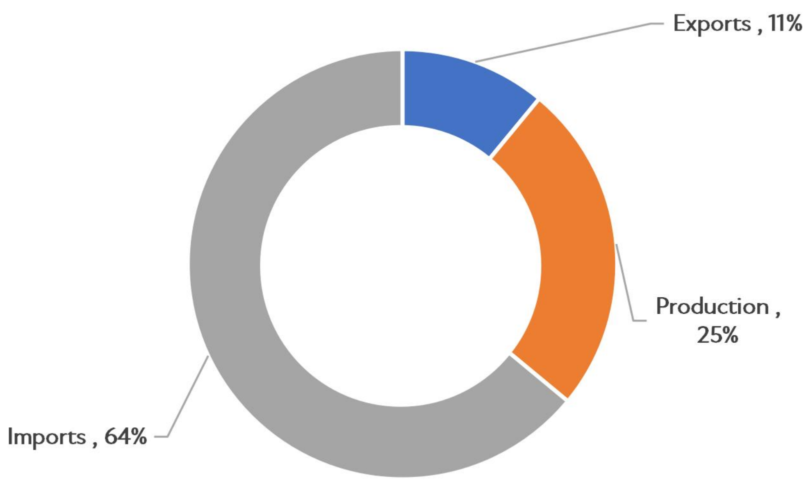
1.1.2. Petroleum Products

According to the 2023 Energy Balances, just 25% of the required petroleum products were produced domestically in South Africa, which relied on a varied supply chain. The country significantly relied on foreign markets for the majority of its fuel needs in order to close the significant gap between local production and national demand.

A smaller percentage of the total supply was also exported to outside markets, but the main objective remained to secure enough energy for domestic use.

It is also shown in the 2023 Energy Balances, that imports of petroleum products amounted to 64% to make up for the local production shortfall and to meet the local demand, while exports amounted to 11%, as shown in **Figure 2 (on the next page).**

Figure 2: Petroleum products supply, 2023



Source: DEE Energy Balances, 2023

The phasing in of cars and other vehicles powered by electricity as a substitute for liquid fuels is also gaining traction within the South African energy landscape. Within this context, there are also questions regarding the powering of tractors in agriculture and heavy vehicles for freight transportation.

1.1.3.

Natural Gas

Currently, Natural gas is imported into South Africa by Sasol Gas via an 865 km pipeline from the Temane and Pande gas fields in Mozambique. Reserves in the Temane and Pande are estimated at around 2.6 trillion cubic feet (TCF). The pipeline has a capacity of 240 million gigajoules (GJ) per annum.

Approximately 120 million GJ is used annually by Sasol in the GTL and chemicals plant in Secunda, while the balance is distributed to commercial and industrial customers via a pipeline network covering more than 3,000 km in the Mpumalanga, Free State, Gauteng, Kwa-Zulu Natal and Northwest.

As per 2023 Energy Balances, South Africa imported all of its natural gas to meet local supply.

There has been no production and exports of natural gas in the year 2023. With regard to the supply of gas in South Africa, gas can either be produced locally, or it can be imported.

Imports

Major gas fields are currently being explored and developed in the SADC region. The three major one's are the Mozambique Gas Fields, the Tanzania Gas Fields and the Namibia Gas Fields.

The Namibia Gas Fields are very much in the infancy stage; however, it is important that the opportunity that the Namibia Gas Field poses for South Africa should also be investigated in tandem with the other two.

Another reason why attention should be given to the Namibian Gas Field is that it stretches into South African territorial sea waters, which will provide an opportunity for joint gas production for South Africa and Namibia.

Local Production

Currently, additional offshore gas fields are being explored by Total Energies at Mosselbay (Brulpadda and Luiperd prospect on Block 11B/12B in the Outeniqua basin); and there is also an opportunity for further gas development by SHELL in the Transkei and Algoa blocks.

Another potential major opportunity is that of fracking, which involves the high-pressure injection of "fracking fluid" into a wellbore to create cracks in the deep-rock formations through which natural gas, petroleum, and brine will flow more freely. This gas will then be collected and stored in gas storage facility for further processing and distribution. The Petroleum Agency of South Africa (PASA) estimates that the Karoo Basin holds around 209 trillion cubic feet (tcf) of technically recoverable shale gas resources - a 2017 study by geologists at University of Johannesburg stated that this was probably 13 tcf, with lower-end estimates ranging between 13 tcf to 390 tcf (source: News24, 18 May 2023).

Gas power plants are based on two main turbine types:

- **Open-cycle gas turbines** (OCGTs): A simple combustion process where the heated gas drives the turbine to generate power, and residual heat is exhausted to the atmosphere.
- **Combined-cycle gas turbines** (CCGTs): A more complex combustion process where residual heat is recovered and used to produce steam that drives a secondary turbine to produce extra electricity.

CCGTs are typically used for bulk supply as they are more efficient (producing more electricity from the same amount of gas), resulting in lower electricity prices,but are best run continuously or for long periods and take about 30 minutes to start up. OCGTs are usually used for peaking, and although less efficient with higher electricity prices, can respond quickly with rapid start-up times of less than 5 minutes. OCGTs are typically used for balancing and backup, but CCGTs could be used if the minimum timeframes (start-up, uptime, and downtime) allow for it (International Renewable Energy Agency, 2019).

A potential source of confusion is that gas turbines can be built to run on liquid fuels, but the name stays the same. South Africa has six utility-scale OCGTs to complement the coal fleet when required, but these all currently run on diesel and would require a conversion process to use gas.

According to Lazard Version 15, the natural gas combined cycle (NGCC) is the most popular and efficient fossil fuel power plant. However, integrating a carbon capture system reduces its performance efficiency.

The demand to reduce the carbon capture cost and improve eco-friendliness drives the development of alternatives. Currently, in almost all electricity systems in which there is a significant level of uptake of renewable energy, gas turbines (open or combined cycle) play a valuable role in supporting the grid when either solar or wind power is unavailable. There are several non-fossil fuel options that can also play this role, such as utility-scale battery storage, pumped storage, or hydro plants, and in the future large-scale hydrogen fuel cells and/or gas turbines.

The following are developing trends in the gas industry in South Africa according to National Energy Regulator of South Africa (NERSA):

- The nature and availability of gas supply and gas infrastructure. The gas supplies available from Mozambique are set to be depleted by 2029. The infrastructure investment is likely to be in the form of regasification and storage facilities that will enable LNG imports to be stored, re-gasified and available for transport (pipelines and trucks) to customers in South Africa.
- The South African government is developing plans to stimulate the gas industry. In this regard, the RSA cabinet approved the promulgation of the Integrated Resource Plan in October 2019 (the IRP 2019). The current base of natural gas installed for the generation of electricity is 3,830 MW. In terms of the IRP 2019, 1,000 MW of new gas to power capacity should be installed by 2023 and 2,000 MW will be installed by 2027. In order to support energy security, taking into consideration that the current base of natural gas installed for the generation of electricity is 3,830 MW, the planned total allocation of natural gas in the energy mix is therefore 6,830 MW.
- Other developments that may increase gas supply to South African customers. These include Luiperd prospect located on Block 11B/12 B in the Outeniqua basin.
- The expansion of operation of existing licenses and potential new entry.
- The revised maximum price methodology

Advantages of including natural gas in South Africa's energy mix

Gas has a unique advantage in that it can be used in all sectors of the economy – power, transport, industry and the built environment. It is a solution for our customers in difficult-to-decarbonise sectors such as construction and the iron and steel industries. Switching to gas from coal in power generation can help to reduce greenhouse gas (GHG) emissions and improve air quality.

According to the Institute of Sustainable Development (IISD, 2022), South Africa should focus on low-risk, future-proof strategies to end load shedding and curb electricity price hikes. The short-term focus must therefore be on a rapid addition of least-cost renewable capacity coupled with storage and increasing energy efficiency. The energy sector is in a disruptive phase due to rapid advances in technologies that compete with gas functions. Because gas is both high risk and not necessary in the power sector until at least 2035, a decision on a future requirement for gas should be revisited around 2030 based on available technologies and costs at that time. In the meantime, a moratorium should be placed on the development of the gas-to-power sector. Therefore, gas-to-power should certainly not be viewed as a way to secure sufficient domestic gas demand to grow broader gas supply in South Africa.

Critical considerations

Five key critical considerations of gas demand, supply, infrastructure, and policy. These features inform the debate on developing a gas-to-power sector in the South African energy context:

- Gas is not yet used for utility-scale electricity production. Gas use is almost entirely for industry, mainly the production of synthetic fuels.
- Gas supply relies on overland piped imports from Mozambique, but future supply options (domestic offshore or land imported) remain on the drawing board.
- There is no existing infrastructure for large-scale liquefied natural gas (LNG) importation via the sea. Existing infrastructure for inland piped gas is limited to three

provinces (Mpumalanga, Gauteng and KwaZulu-Natal).

- Several important gas-related plans and policies are still under development, require updating, or have not been implemented. Overall, the policy framework is incomplete and insufficient to guide sectoral development: there is no integrated energy plan (IEP), and a gas master plan (GMP) has still not been completed.
- Gas is often promoted as a way to complement variable energy sources, but only a tiny fraction of the electricity supply currently comes from variable renewable energy (VRE). Electricity supply is dominated by dispatchable technologies (coal, nuclear, and liquid fuels) at over 93%, while variable sources, mainly wind and solar, account for only about 5% (Statistics South Africa, 2021).

The broader gas industry in South Africa has faced a challenge for many years: without secure and affordable supply, it is difficult to develop localised gas demand, and without guaranteed off-takers it is difficult to develop a supply industry. According to the 2021 stakeholder consultation document for developing a GMP, "One way of breaking this impasse is to create significant 'anchor' gas demand through the development of a gas-to-power programme" (DMRE, 2021b).

This is a problematic approach, as it assumes that gas is both a necessary and an optimal requirement in the power sector without interrogating or proving it.

Decisions need to be made in the right order. National energy planning must first demonstrate that gas-to-power investment is optimal in terms of its primary function (to generate electricity) before it is used as motivation for other investments (such as developing gas supply).

1.1.4.

Electricity

1.1.4.1 Overview

From 1994 to 2025 the volume of electricity distributed (consumption) in South Africa has declined by 0.10% Compounded Annual Growth Rate (CAGR) over the period (from 165 310 GWh to 159 312 GWh). The volume of electricity distributed reached its peak in 2007, accounted for 241 170 GWh, then dropped for the next three years before peaking up in 2010 and 2011. However, since 2011 the volume of electricity has been dropping considerably (figures obtained from Stats SA and NERSA)[1].

The growth of the volume of electricity supply has not been able to address the growth of the demand from an increasing urban development and economic activities, as a result ESKOM has had to develop the electricity expansion programme.

ESKOM's electricity expansion programme began in 2005.

It is the largest in the history of ESKOM's projects and it was expected to extend transmission lines by 4 700 km, whilst increasing generation capacity by 17 120 MW (ESKOM, 2012b).

The main objective of the capacity expansion programme was to meet the ever-increasing demand and to also diversify ESKOM's energy sources (ESKOM, 2012b).

ESKOM budgeted R385 billion for its capacity expansion programme up to 2013 and it was anticipated to increase to a trillion or more by 2026, with a doubling of capacity to 80 000 MW (ESKOM, 2012a).

To finance the expansion of the electricity distribution, the cost of building new generation capacity and introducing new energy technologies is being passed on to consumers, predominantly through the electricity tariff.

However, an increase of the electricity tariff can only lead to an increase in the costs of production processes in every sector that uses electricity to a lesser or larger degree. Ultimately, increases in production costs will filter through to the South African consumer basket (CPI); as well as to export prices, which will also increase. As a result, the cost of living, especially that of low-income households will increase since they spend a large proportion of their income on consumption goods (and on energy carriers). In a country like South Africa, where there is significant income and wealth inequality as well as being a very open economy to international trade, it is important to assess the impact of such decisions on these parameters.

An increase in South African product prices relative to that of its trading partners will impact negatively on export volumes whilst increasing import volumes, which translates into a decrease in domestic production. Naturally, this will in turn have a negative effect on various macroeconomic indicators such as GDP growth and employment. Therefore, any electricity price adjustments should consider the socio-economic impact associated with these adjustments.

[1] The electricity usage per GWh were obtained from Stats SA published document title: "Electricity Generated and Available for Distribution 2019" and NERSA, especially for the last five years.

1.1.4.2 Electricity Generation, Transmission and Distribution

Electricity infrastructure comprises three sub-sectors, namely: generation, transmission, and distribution. Eskom creates value through the generation, transmission, distribution, purchase, and sale of electricity. Electricity is generated by transforming inputs from the natural environment, such as coal, nuclear, fuel, fuel oil, and diesel, as well as water and wind, into electricity. The energy is transmitted over Eskom's 33 000km of network, in which supply and demand of electricity are balanced in real-time, maintaining the frequency of the power system at 50 hertz (Hz). The electricity is distributed through an extensive distribution network that covers the entire country to supply over 86% of South Africa's needs and 20% of the electricity produced in Africa. (Eskom, 2023).

Eskom is a vertically integrated, state-owned power company that owns and operates the National electricity grid and supplies about 90% of the power generation in South Africa. Eskom generates 30% of the electricity that is used in the rest of Africa, respectively exported to neighbouring countries such as Botswana, Eswatini, Lesotho, Mozambique, Namibia, Zambia, and Zimbabwe (Eskom, 2023).

The electricity generated by Eskom and IPPs, combined with imports from neighbouring countries, is supplied in bulk to distributors, i.e., large metros and other municipalities, and distributed to industrial, commercial, residential, and others (Eskom, 2022).

Eskom owns and operates several coal-fired, gas-fired, hydro, and pumped storage power stations, as well as one nuclear power station. Local production amounted to 91% of the total electricity supply in 2023, the country's imports amounted to 4%, with exports amounting to 5%. (**Figure 3 below**).

In terms of generation, Eskom dominates the production of electricity.

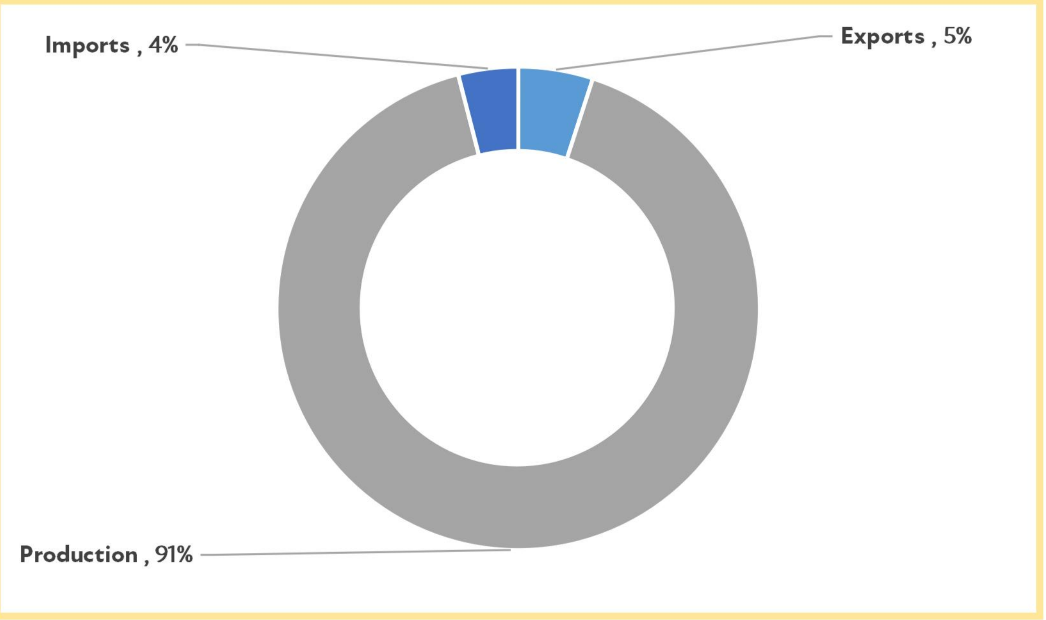
Eskom generates, transmits, and distributes electricity to industrial, mining, commercial, agricultural, and in South Africa, and to municipalities, who in turn redistribute electricity to businesses and households within their areas.

The utility also purchases electricity from Independent Power Producers (IPPs) in terms of various agreement schemes as well as electricity generating facilities beyond the country's borders.

Most power stations are in Mpumalanga, except for Lethabo and Matimba, which are in the Free State and Limpopo provinces, respectively.

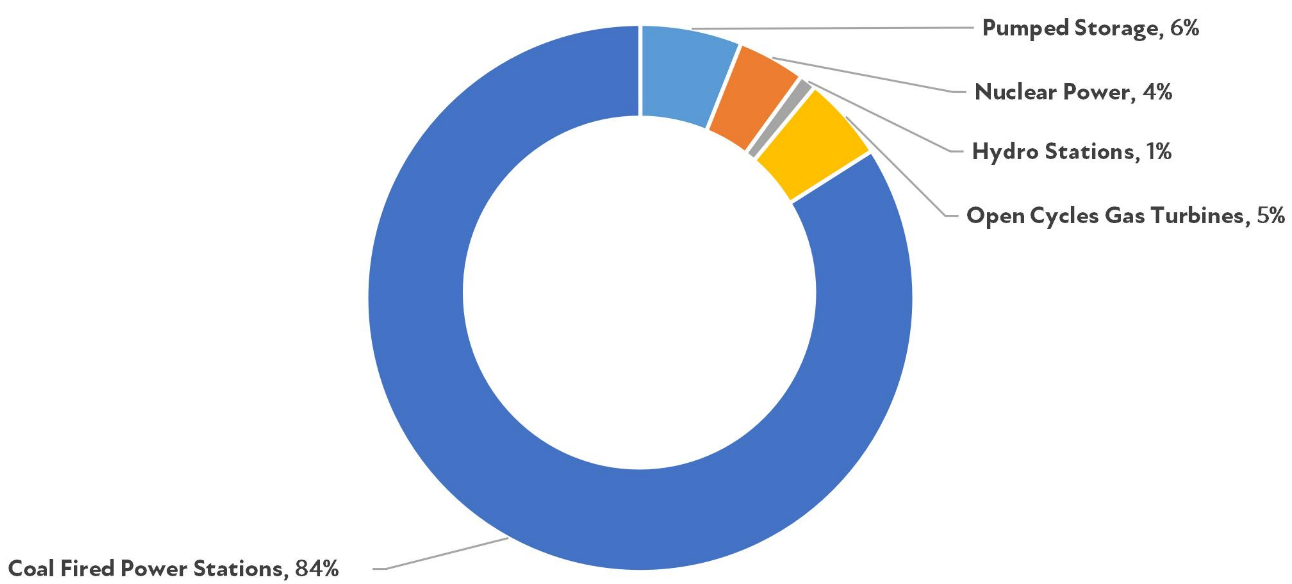
According to Eskom's Integrated Results 2023, the total nominal capacity as of March 2023 amounted to 47 GW.

Figure 3: Electricity supply, 2023



Source: DEE Energy Data, 2023

Figure 4: Power Station Maximum Generating Capacity Mix



Source: Eskom Integrated Results, 2023

Coal-fired power stations made up 84% of the nominal capacity of the total electricity generated in 2023 (Figure 4 above). The rest of the electricity generated came from a combined contribution by other power stations, which accounted for 16% of total nominal capacity, with nuclear contributing 4%, pumped storage at 6%, Open-cycle gas turbines at 5%, and Hydro at 1%.

South Africa's indigenous energy resource base is dominated by coal. Coal is the most common source of electricity production in South Africa.

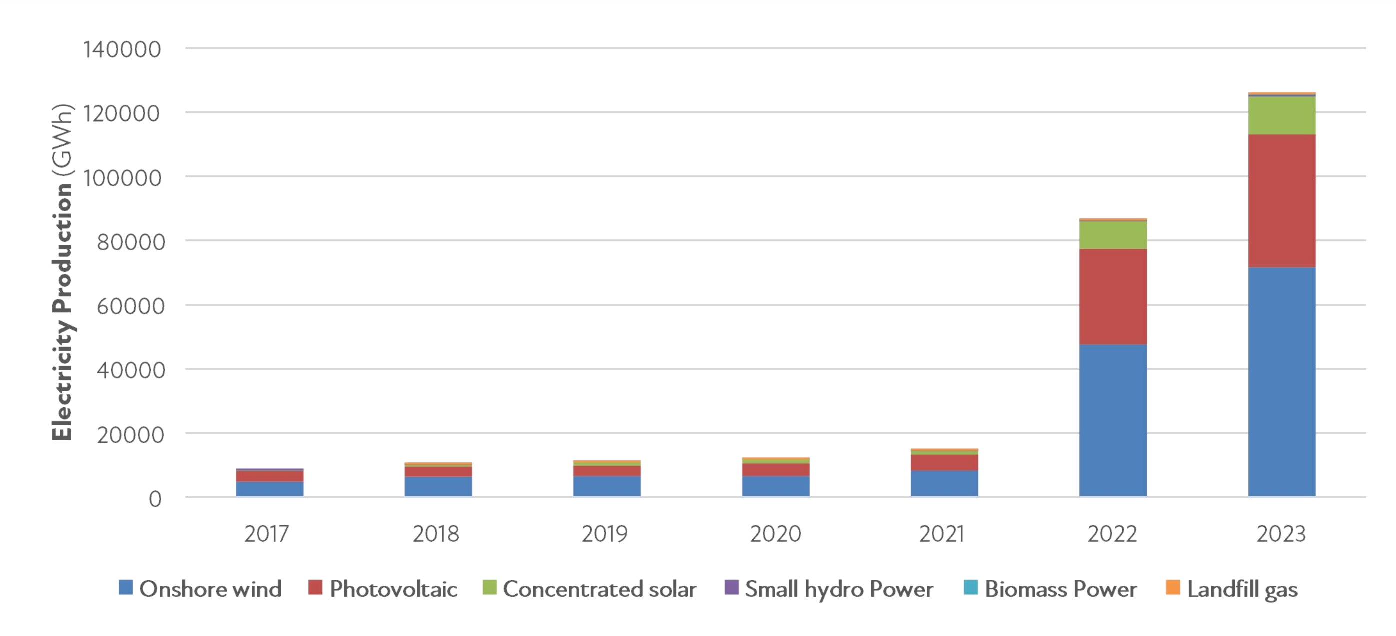
In 2022, fossil fuels accounted for 84.44% of total electricity production (Statista. com, 2024). South Africa exported 16% of coal while it imported 1% in 2023. Domestic production.

1.1.5. Renewables

The REIPPPP is a public procurement program in South Africa that encourages the private sector to invest in renewable energy generation. The REIPPPP is aimed at bringing additional megawatts into the country's electricity system through private sector investment in onshore wind, photovoltaic, concentrated solar power (CSP), biomass, landfill gas, and small hydro technologies. The REIPPP program constitutes one of the energy mixes as outlined in the National Development Plan and the Integrated Resource Plan 2023. According to the Integrated Resource Plan 2030, South Africa continues to pursue a diversified energy mix that will provide security of supply while ensuring compliance with its emissions reduction plan. c 4 and window seven at 2205 MW and 1760 MW, respectively. Window 3.5 was the lowest by 100 MW. The REIPPPP power production in 2023 was dominated by onshore wind power at 57%, followed by photovoltaic power at 33%.

Concentrated solar power contributed 9% while small hydropower contributed 1% to electricity produced through the REIPPPP. A total of 126 191 GWh was produced in the year 2023, as shown in **Figure 5 (next page)**.

Figure 5: Electricity production through REIPPPP, 2017-2023



Source: Department of Electricity and Energy (DEE), 2023

1.1.5.1 Solar Power

Solar energy is radiant energy released by the sun. Solar energy can be converted into electricity directly through using photovoltaic (PV) or indirectly using concentrated solar power (CSP) with the help of lenses or mirrors and tracking systems to concentrate a large area of sunlight. This type of solar energy is particularly useful in solar streetlights, auto solar irrigation systems, traffic junctions signal lighting, etc. The focus in this part will be on CSP and household solar power systems (SHS).

Concentrated solar power (CSP)

CSP systems generate energy through mirrors or lenses to concentrate a large area of sunlight onto a receiver. The concentrated sunlight is converted to heat (solar thermal energy), which drives a steam turbine electric power generator or powers a thermochemical reaction.

CSP had a global total installed capacity in Spain, the USA with notable interest in North Africa, the Middle East, China and India. The global market was initially dominated by parabolic-trough plants, which accounted for 90% of CSP plants at one point. Since about 2010, central power tower CSP has been favored in new plants due to its higher temperature operation and promises greater efficiency.

Household solar electric system

Solar household systems (SHS) are stand-alone photovoltaic systems that offer a cost-effective mode of supplying amenity power for lighting and appliances to remote off-grid households. In rural areas that are not connected to the grid, SHS can be used to meet a household's energy demand fulfilling basic energy needs. Solar photovoltaic (PV) deployment has grown at unprecedented rates since the early 2000s.

Volumes and phasing of solar energy

Most solar panels for residential properties produce between 250 and 400 Watts of electricity. While solar panel systems start at 1 KW and produce between 750 and 850 kilowatt hour (kwh) annually, larger and bigger households typically need to be on the high side.

CSP plants

CSP plants are the most expensive renewable source. Despite its high cost, CSP competes well with fossil fuels in some cases as it is more consistently reliable than other renewables. Solar panels, also known as photovoltaic or PV panels, are made to last more than 25 years. Not only are solar panels remarkably reliable, but solar panel longevity has also increased dramatically over the last 20 years. The load factor for CSP plants is about 60%. Although this factor is lower than that of nuclear (90%) and coal plants (85%), it is far better than wind power plants at 28%. South Africa in recent years constructed a number of CSP plants in the Northern Cape.

Cost (capital and operation) of solar energy technologies

The table below illustrates the operational and capital costs of solar energy production.

Table 2: Solar energy – Operational and capital costs

Solar thermal/ concentrated solar power	**Lead time** (years)	**Load factor** (%)	**Levelized cost of electricity** (R/KWh)	**Levelized cost of electricity** (R/GWh)	**Capital cost (overnight cost)** (R/MWh)
	3	60	2.60	2,602,492	1,544

Concentrated solar power (CSP) plants

CSP deployment has slowed down as the process turned out to be more expensive per kw/h than solar PV and wind power.

Furthermore, thermal energy storage materials that can withstand high temperatures are costly and difficult to source.

Molten salt that is used to longer utilise boiling point has a limited operating time because it solidifies at low temperatures and decomposes at high temperatures.

Effectiveness of solar energy

Solar energy systems (turning the primary source into electricity) are about 15% to 20% efficient, while coal has an efficiency of up to 40% and natural gas reaches up to 60%.

The remaining energy of fossil fuels and coal is lost in the form of heat and the loss is permanent. Wind turbines turn roughly 50% of captured wind into energy.

Thus wind energy appears to be more than twice as efficient as solar energy.

Investing in solar energy has the following advantages:

- A renewable source
- Lower electricity costs
- Various applications
- Low maintenance costs
- Continuing technological developments

Disadvantages include the following:

- Capital costs are relatively high
- Sensitive to weather conditions
- Energy storage is expensive
- Occupy huge areas
- Pollution by obsolete equipment

Energy savings of solar energy compared to other sources

Solar and wind energy have continued to occupy the top spots in terms of the cheapest renewable energy sources. Both energy sources cost significantly less than fossil fuel alternatives and continue to become more affordable every year. However, the load factor is around 60%.

Although solar power may initially be one of the more expensive forms of energy, there are some simple ways to cut these costs.

One of the easiest ways to cut down on the cost of solar would be to lease a solar panel system instead of buying it.

By comparing solar electricity installation cost with the energy saved indicate that the initial investment is paid off by a lower annual municipal electricity bill after four to six years.

With manufacturers issuing warranties that last up to 25 years, it is likely to begin saving money beyond the sixth year of installation.

1.1.5.2 Hydrogen

Hydrogen is an energy carrier, not an energy source, and can be used to store, move and deliver energy produced from other sources. Hydrogen fuel can be produced from diverse domestic resources, such as natural gas, nuclear power, biomass, and renewable power like solar and wind. The most common methods of production are natural gas reforming (a thermal process), which account for 90% of hydrogen production, and electrolysis. Other methods include solar-driven and biological processes.

There are three types of hydrogen based on the production process namely **grey, blue** and **green** hydrogen. *Grey hydrogen* is produced from natural gas, or methane, using steam methane reformation but without capturing the carbon dioxide made in the process while in the production of blue hydrogen the carbon dioxide made is captured and stored permanently underground. *Green hydrogen* is produced using renewable energy sources, such as solar and wind power, and does not release any carbon emissions into the atmosphere. However, it is more expensive to produce *green hydrogen* than *grey* or *blue* hydrogen. The cost is highly contingent on the renewable energy source, regardless of whether it comes from solar, wind or hydropower. Only about 0.1% of current global hydrogen production is green, but big expansions are envisaged.

South African situation

According to the Centre for Strategic and International Studies (CSIS), South Africa's hydrogen ambitions are driven partly by its decarbonisation goals and partly by a desire to support economic growth and exports. Hydrogen is seen as an opportunity to revamp the country's industrial sector and achieve its emissions reduction goals by 2050 while reducing socioeconomic inequality. The country's vision is guided by its Hydrogen Society Roadmap (HSRM) released in February 2021, which sets clear targets to reach by 2050. South Africa aims to deploy 10 gigawatts (GW) of electrolysis capacity in the Northern Cape by 2030 and produce about 500 kilotons of hydrogen annually by 2030. This growth is forecasted to create 20,000 jobs annually by 2030 and 30,000 by 2040.

Green hydrogen can also help South Africa decarbonise. Economy-wide decarbonisation in South Africa is crucial to maintaining global temperature increases at 1.5°C, as the country is the world's 14th-largest emitter of greenhouse gases. Hydrogen has the potential to help the country reach a net-zero economy by 2050 (CSIS, 2022). As mentioned in the business media magazine (October 2022), a study conducted by South Africa's Department of Science and Innovation (DSI) found that establishing a "hydrogen valley", anchored in the Bushveld geological area, which is rich in platinum group metals (PGMs), could add more than R56.8 billion to the country's GDP by 2050, while creating more than 14,000 jobs per year.

Technical aspects

The greatest challenge for hydrogen production, particularly green hydrogen, is providing hydrogen at lower cost. For transportation fuel cells, hydrogen must be cost-competitive with conventional fuels and technologies on a per-mile basis. Nowadays, green hydrogen has an estimated energy equivalent cost of between US $250 and US $400 (between R4,500 and R7,300) per barrel of oil at the factory gate, according to the International Renewable Energy Agency. Future cost reductions are forecast but are uncertain. Current oil prices are around US $100 (R1,800) a barrel, much less than it would cost to use green hydrogen instead of conventional petroleum products (Farmer's Weekly, 28 October 2022).

1.1.5.3 Wind

Wind power is the process of harnessing energy from the movement of the wind and converting it to useful forms of mechanical power and electricity. Most wind energy comes from turbines – essentially giant windmills. The wind turns two or three of the turbine's propeller-like blades around the turbine's rotor. The rotor is connected to a main shaft, which spins a generator to create electricity.

There are two branches of wind turbines: onshore turbines and offshore turbines. The differences between the machines used for each are very marginal. Most significant is size, with offshore turbines tending to be larger than those used onshore.

The advantage of wind power is that it is derived from a virtually unlimited and inexhaustible resource: the wind. Unlike energy that relies on fossil fuels, wind energy produces far fewer carbon emissions and less pollution. In addition, most wind turbines and wind farms, once established, do not have exhausting operational costs. However, the process of transporting and erecting a very large turbine onshore can be very challenging in many locations, whereas there are no limits offshore, provided only that vessels are available that can carry and install them. The installation of turbines offshore is much more difficult than onshore and costlier (Breeze, 2021).

South African situation

In South Africa, more than 1,400 MW of wind turbines currently produce power, with another 2,300 MW at various stages of planning and construction. Wind turbines for commercial power generation are generally arranged in an

array, collectively called a wind farm. South Africa has more or less 33 wind farms across the country. Wind farms are typically located in areas with a consistently high level of wind. Their performance increases exponentially with an increase in wind speed. Wind speeds are stronger at higher elevations, which is why most wind turbines are mounted on masts around 100 m high. The output of a wind turbine is determined by its power rating and the load factor.

Recent research by the CSIR found that South Africa has excellent wind resources. If appropriate turbines for higher or lower wind speeds are selected, 80% of the South African land mass has sufficient wind for turbines to achieve a load factor of more than 30%, which makes them economically viable. Therefore, wind turbines could be installed in many parts of the country, taking advantage of the different weather patterns of each area to produce more consistent output from this source of energy.

Technical aspects

Wind turbines and wind power take up a large portion of land and the process can be costly to set up. When built close to residential areas, turbines can be noisy and unsightly. Additionally, the amount of energy harnessed from wind power can vary daily, depending on wind conditions.

However, the cost of wind energy has fallen dramatically over the last decade and over the 5 years to the end of 2019, the cost of both onshore and offshore wind had fallen on average by more than 50%, according to the Global Wind Energy Council (GWEC). The table (right) illustrates the operational and capital costs of wind energy production.

Table 3: Wind Energy – Operational and Capital Costs

Lead time (years)	Load factor (%)	Levelized cost of electricity (R/KWh)	Levelized cost of electricity (R/GWh)	Capital cost (overnight cost) (R/MWh)
3	30	1.14	1,137,928	336

1.2 Nuclear

South Africa stands at a critical juncture in its energy trajectory. The nation faces the pressing triple challenge of energy security, affordability, and sustainability. Persistent power supply constraints (exemplified by ongoing load shedding) underscore the urgent need for reliable and consistent baseload electricity to power economic growth and improve the lives of its citizens.

Concurrently, global pressures and domestic commitments to combat climate change necessitate a significant shift away from a carbon-intensive energy mix, predominantly reliant on coal. Achieving energy independence, fostering industrial development, and ensuring a stable and predictable electricity supply are paramount to realizing the ambitions of the National

In this context, nuclear power presents a compelling case as a viable and essential component of South Africa's future energy landscape. As a clean energy source, it offers significant advantages in terms of greenhouse gas emission reduction, directly contributing to climate change mitigation targets.

Crucially, nuclear power plants provide high-capacity, dispatchable baseload electricity, capable of operating continuously for extended periods, thereby offering unparalleled energy security and stability compared to intermittent renewable sources. Modern Small Modular Reactors (SMRs) can also operate with greater flexibility to meet supply variability in grids with high intermittent renewable penetration.

While the upfront capital investment is substantial, the long-term operational stability, low fuel costs, and negligible carbon footprint make it an attractive option for sustainable energy generation, diversifying the energy mix and reducing reliance on volatile fossil fuel markets.

The Nuclear Energy Policy of 2008 states that for South Africa, "the long-term goal is to be self-sufficient in all aspects of the nuclear fuel cycle where, for each aspect, a feasibility study has been conducted".

In accordance with the 2025-2030 Strategic Plan for the Department, "the department will work closely with South African Nuclear Energy Corporation (NECSA) and other state-owned entities to finalize the Strategic Plan and Business Case to support

investments for re-establishment of South Africa's full nuclear fuel cycle (NFC), encompassing mining, conversion, enrichment, fabrication, reactor operations and waste management and disposal.

The economic viability of re-establishing the nuclear fuel cycle rests on using nuclear for power and industrial uses (non-power). The long-term vision is to achieve self-sufficiency in nuclear fuel cycle capabilities, subject to feasibility assessments.

To sustain a robust nuclear fuel cycle, South Africa must invest in the full nuclear fuel cycle (NFC), encompassing mining, conversion, enrichment, fabrication, reactor operations and waste management and disposal.

The economic viability of re-establishing the nuclear fuel cycle rests on using nuclear for power and industrial uses (non-power). Studies show that a 10 GWe nuclear power programme would provide the scale needed to justify local NFC facilities, granting South Africa energy sovereignty whilst generating significant socio-economic benefits.

The potential development of an up to 10 GW nuclear energy programme represents a significant long-term investment with far-reaching socio-economic implications for the country.

Nuclear power is an important clean energy source for electricity generation. It can complement other clean energy technologies in reducing power sector emissions while also contributing to electricity security as a dispatchable power source. Nuclear facilities offer a consistent "baseload" of electricity that keeps the system stable during times of low renewable output, in contrast to intermittent sources like wind and solar. Nuclear fission, which produces steam by splitting uranium atoms and releasing huge quantities of thermal energy, is the method used to attain this dependability. Modern small modular reactors (SMRs) can be integrated with conventional large-scale plants to give countries greater flexibility in replacing old coal-fired facilities with carbon-free alternatives. In 2023, Nuclear energy contributed about 2% to the total energy supply.

Koeberg is the only nuclear power station in Africa and has the largest turbine generators in the Southern Hemisphere and is the most southerly-situated nuclear power station in the world. Koeberg ranks amongst the safest of the world's top ranking PWR's of its vintage and is the most reliable Eskom power station. The station is located 30 km north of Cape Town (Eskom, 2023).

Currently, Eskom has two 900 MWe pressurised water reactors (PWRs) which were commissioned in 1984/85 at the Koeberg site. This plant produces around 4% of the country's electricity.

Following the construction of the two reactors at Koeberg, in the 1980s Eskom embarked on a nuclear site expansion project. Five nuclear sites were shortlisted, two in the Northern Cape, two in the Western Cape and one in the Eastern Cape. These sites are well suited to large conventional nuclear units of 1000MW or more but can also accommodate Small Modular Reactors (SMRs).

In November 2012 Cabinet endorsed a "phased decision-making approach for the implementation of a nuclear programme", along with the "designation of Eskom as the owner-operator as per the Nuclear Energy Policy of 2008".

In October 2019, the Department of Energy gazetted its Integrated Electricity Resource Plan (IRP) for

2019-2030. The IRP outlines the country's electricity demand, how this demand might be supplied, and what it is likely to cost. Its balanced scenario represents the best trade-off between least investment cost, climate change mitigation, diversity of supply, localisation, and regional development. The IRP requires 2,5 GW of new nuclear capacity after 2030 as a no regret option. The IRP included as a policy position "immediately commence the nuclear build programme to the extent of 2 500MW because it is a no-regret option in the long term and in case the Inga project does not materialize".

Later in January 2024, the draft IRP2023 was gazetted for public comment which discusses nuclear as an option of up to 14GW between 2035 and 2050. This draft IRP has not yet been finalized.

The IRP2019 indicates that nuclear has a role to play with the replacement of the phase-out of the coal plant programme after 2030. Further, the role of small modular reactors (SMRs) is flagged as an interest in the IRP. The siting of small modular reactors at decommissioned coal plants is an attractive opportunity given the grid capacity is already available and the deployment of SMRs is possible on sites that might not be suitable for large NPPs.

SMRs have the advantage of being more flexible than larger conventional NPPs given their safer and simpler design. As a result, SMRs can be located at sites that might not be suitable for large NPPs. SMRs might be better suited for dry or hybrid cooling which is therefore aligned to the needs of a water scarce country like South Africa.

In order to support South Africa's nuclear ambitions, new sites will need to be identified. In order to ensure the timely completion of the necessary legislative requirements associated with the commissioning of new nuclear capacity, a process to identify, rank and secure the required new sites is required.

Eskom embarked in a repurposing/ repowering approach for coal power plant sites where coal plants are planned to be shutdown. The JET strategy includes a significant renewable energy establishment at those sites but the grid capacity at those sites will not be fully realized.

The establishment of SMRs at or near those sites can add significant value and is an opportunity that needs to be assessed. Eskom has decided that a suitability assessment and a site ranking process is followed to identify and rank a number of old coal sites which will be suitable for the location of SMRs (either on the site or near the site), based on a Strategic Environmental Assessment (SEA) approach.

The outcome of the SEA is therefore to identify and rank a number of preferred sites as well as the further site specific assessment that will be required through the EIA process which will finalize the siting process. This site identification is to start with the development of various acceptance or ranking criteria related to the specific sites.

The Integrated Resource Plan 2019, draft IRP2023 and the national nuclear policy represents an expansion of new nuclear energy capacity as well as the contributing technologies, especially to replace the coal plant to be decommissioned after 2030 with low carbon technologies.

In order to meet the IRP2019, draft IRP2023 nuclear ambitions new sites will be required especially at or near old coal sites. This study focuses on the existing coal fired sites in support of the repowering and repurposing and use of the existing infrastructure.

The process of identifying, ranking and securing preferred sites for the location of new nuclear power plants is extremely thorough from a nuclear safety, technical, environmental and consultation perspective and takes several years to complete.

In response to the anticipated demand Eskom is proposing to develop a Nuclear PP and associated infrastructure, with an installed generating capacity of 4000/5000 MW. The proposed sites are Thyspunt and Bantamsklip **(Figure 4)**.

Thyspunt project site (250 ha in extent) is situated approximately 7 km of Oyster Bay and 11 km of St. Francis within the jurisdiction of the Sarah Baartman District Municipality, Eastern Cape Province. Eskom owns the land. Bantamsklip project site (170ha in extent) is situated on the Southern Cape coast, mid-way between Danger and Quoin Points.

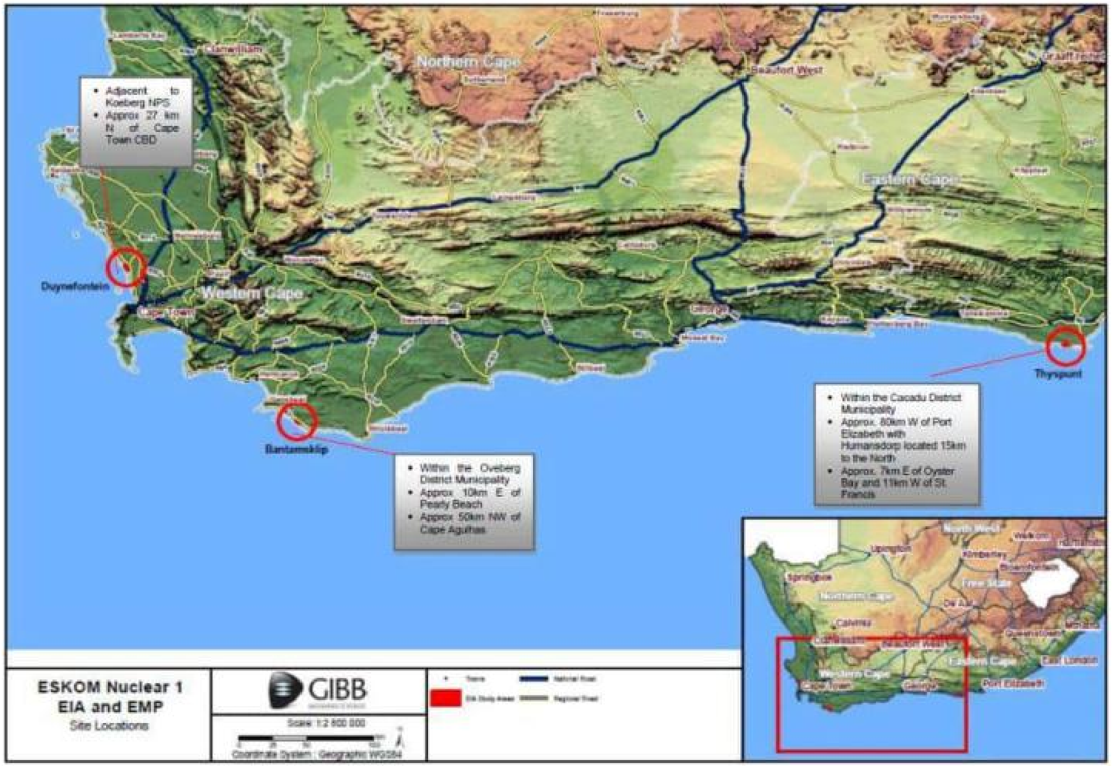


Figure 6: Map illustrating the location of Bantamsklip and Thyspunt sites

Eskom is considering the use of Pressurised Water Reactor (PWR) technology, which utilizes water as a coolant and moderator, and High Temperature Reactor (HTR) technology, which employs gas as a coolant. Internationally, large PWRs (approximately 1000 MWe or larger) are the most used nuclear reactors. Eskom is well-versed in PWR technology from both a health and safety standpoint, as well as an operational perspective, having employed it for the past 40 years at the Koeberg.

Nuclear Power Station (KNPS). Additionally, Eskom has experience with HTR technology through its involvement in the development of the Pebble Bed Modular Reactor (PBMR) project.

A nuclear power station of standard Generation III design large PWR or a Generation IV SMR (PWR or HTR) is considered by Eskom due to the operational simplicity and rugged design, availability, reduced possibility of core melt accidents, minimal effect on the environment, optimal fuel use and minimal waste output. Detailed descriptions of the proposed nuclear plant are not available since a preferred supplier has not been selected. The approach to be used in this ESIA process has to specify enveloping environmental and technical parameters, to which the power plant design and placement on site must comply with.

In addition to the footprint of the nuclear power station, there will be two categories of exclusion zones for emergency planning purposes, around the power station complex. The NNR will make the final decision regarding the size of the emergency planning zones (EPZ), as per the NNRA. The proposed power plant complex will include inter alia the nuclear reactor, turbine halls, fuel storage facilities, waste storage facilities, intake and outfall structures required to obtain / release water used to cool the process, a desalinisation plant, power lines within the plant site, internal and access roads, the high voltage yard, and any other auxiliary service infrastructure. Further, with the inclusion of Small Modular Technologies (including enveloping criteria).

The role of nuclear in the energy supply mix, where a comparison is being made between nuclear and green technology supported by battery storage systems (source: Beeld, Monday 24th July 2023). Green technology supported by battery storage systems is equivalent to: Total cost per kWh = R2.00, Green Energy emissions of Carbon Dioxide Gas is 45g per kWh, and battery storage systems emissions of Carbon Dioxide gas is 300g per kWh. furthermore, energy delivered by green energy can be for a period greater than 25 years; however, there is also the inherent probability of a lack of assurance of supply.

On the other hand, regarding Nuclear energy the Total cost per kWh = R1.35, emissions of Carbon Dioxide Gas are 10g per kWh. The long term operational costs of nuclear energy are R0.40 per kWh. Energy delivered by Nuclear can be delivered for a period of more than 80 years whilst providing stable energy availability

Nuclear is an energy option that provides access to clean, reliable, and affordable energy and moderating the negative impacts of climate change. It should be a significant part of the global energy mix, and its application is expected to grow exponentially in the future.

Conventional nuclear power stations

Nuclear energy has the highest estimated capital costs of any energy technology used in the United States. As the radioactive materials used and the waste created require careful handling, nuclear plants are among the most expensive to build.

Building plant components, or even the entire plant, off site under controlled factory conditions could substantially cut extra costs. This approach is already being encouraged for small and modular reactors, which could be completely manufactured off site.

South Africa is an arid country and is prone to droughts.

Furthermore, its future coal supply reserves are situated mainly in the Waterberg region, which is a water-scarce region.

In contrast, to overcome this constraint, renewable electricity supply sources require far less water than coal-fired power stations. Nuclear power stations must therefore be situated at the coast and utilise sea water as coolant.

Larger plants could be considered to be assembled on site from an array of smaller (modular) factory-built sub-assemblies.

Specific design changes to containment buildings, such as using new kinds of concrete, could also help reduce costs significantly by reducing the overall amount of material needed. This would cut on-site construction time as well as the material costs.

The environmental impact of nuclear power plants and associated infrastructure is critical.

The construction of nuclear plants has to take various preparatory steps into account:

- Land acquisition
- Site preparation
- Reactor construction
- Imported material – port to site (abnormal loads)
- Construction village
- Access road
- Connection to the national grid
- Personnel travel from lodging to site

Skill requirements and the members of staff of a nuclear power plant collectively have a variety of scientific, engineering and other technical backgrounds in fields required to effectively and safely operate and maintain the plant.

Modular nuclear power stations

Small modular reactors (SMRs) are advanced nuclear reactors that have a power capacity of up to 300 MW(e) per unit, which is about one-third of the generating capacity of traditional nuclear power reactors. SMRs, which can produce a large amount of low-carbon electricity, are:

- Small – physically a fraction of the size of a conventional nuclear power reactor
- Modular – making it possible for systems and components to be factory-assembled and transported as a unit to a location for installation
- Reactors – harnessing nuclear fission to generate heat to produce energy

SMRs are nuclear fission reactors and are smaller than conventional nuclear reactors. They can be constructed in one location (typically a factory) and shipped to the site where they will operate.

Cost (capital and operation) of nuclear energy

The table below illustrates the operational and capital costs of nuclear energy production.

Table 4: Nuclear energy – Operational and capital costs

Nuclear	Lead time (years)	Load factor (%)	Levelized cost of electricity (R/KWh)	Levelized cost of electricity (R/GWh)	Capital cost (overnight cost) (R/MWh)
Conventional nuclear – Light water reactor	6	90	1.56	1,560,001	1,375
New nuclear – Modular reactor	6	90	1.67	1,667,540	1,476

Skilled personnel required

The possibility of a nuclear incident is intimately connected to the issue of skills requirements, particularly with regard to the training and preparedness to which the people who operate these stations are exposed.

The members of staff of a nuclear power station collectively have a variety of specialised scientific, engineering and other technical backgrounds in fields required to effectively and safely operate and maintain the plant. These specialised skills include nuclear engineering, radiation protection, chemistry, physics and neutronics.

Effectiveness of nuclear energy

Building plant components (modular nuclear plants – SMRs) could substantially cut extra costs. This approach is already being encouraged for small regions and areas and SMRs could be completely manufactured off site. SMRs are physically small and a fraction of the size of a conventional nuclear power reactor.

SMRs make it possible for systems and components to be factory-assembled and transported as a unit to a location for installation – either area-specific or industry-specific. Nuclear power stations must preferably be located at the coast and utilise sea water as coolant. It is a further requirement to have access to national or international expertise to support the nuclear power station operating organisation and regulatory body in terms of scientific areas such as neutronics, physics and thermo-hydraulics.

Of the permanent staff at a nuclear power station, 72% should be professional and technical personnel, i.e. they will have some tertiary qualification or trade. The balance (28%) will involve of secretarial and support staff.

Nuclear reactors are refuelled less frequently than other energy sources and is a cheaper source than other taking the efficient use of energy released into account. Waste volumes are also less than conventional coal-fired plants.

Critical considerations

- High capital costs
- Less refuelling
- Lower operational cost
- Highly skilled personnel requirements
- Consistent water availability
- High load factor of 90% (energy delivery at % of capacity)

2.

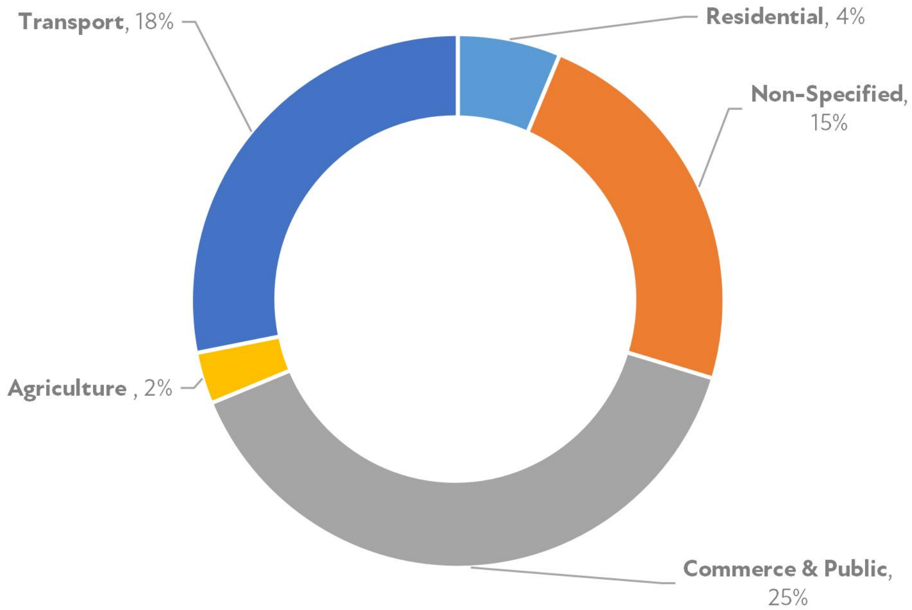
ENERGY DEMAND

Energy is the core of the South African economy and a major economic sector that creates jobs and value through the extraction, processing, and distribution of goods and services related to energy throughout the whole economy.

The energy sector in South Africa is essential to social advancement, job creation, economic growth, and environmental sustainability.

Figure 7 below, depicts the share percentage of energy consumed by various sectors in the economy. The five sectors identified in this report are industrial, transport, agriculture, residential, commerce, and public services. The sector "non-specified" refers to unaccounted energy (energy that has not been classified into a specific sector). The industrial sector contributed the highest by 36% to the energy demand in 2023.

Figure 7: Energy demand by sector, 2024



Source: Department of Electricity and Energy (DEE), 2024

2.1.

Electricity Tariffs in South Africa

2.1.1 Eskom Historical Tariff Increases

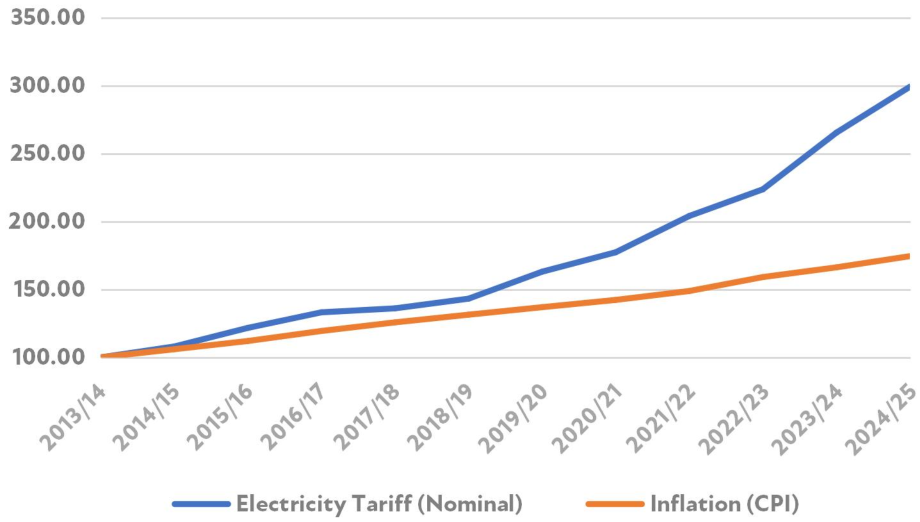
Figure 8, to the right shows ESKOM's nominal electricity tariff from 2013/14 to 2024/25 Financial Years, plotted against inflation (CPI) over the same period.

Bearing in mind the power that compound interest has on growth, it is interesting to examine where ESKOM's (effectively South Africa's) electricity tariffs have come from, and where they seem to be going.

The following observations are worth highlighting:

- From the 2008 electricity crisis onwards, there is a clear and sharp inflection point for electricity tariffs in South Africa. From 2013 to 2018, electricity tariffs increased by 43.2%, almost trebling during this five-year period, whilst inflation over this same period increased by only 31.4%;
- The total electricity tariff from 2013 to 2023 has increased at a higher rate than the inflation rate; and
- The electricity price increased by a thousand-fold (199.2%) over the period 2013 to 2023 which translates to approximately 11% p.a. over the period. Over this same period, inflation increased by 74.5%, which translates to 5% p.a.

Figure 8: ESKOM's nominal electricity tariff vs inflation (CPI) from 2013/14 to 2024/25



Source: Own calculation from Eskom Tariffs and Charges Booklet (2024/25FY)

2.1.2 South Africa's Historical Electricity Prices

When looking at the inflation-adjusted prices, South Africans enjoyed the cheapest electricity prices – between 37 and 38 cents per kW in today's terms – from 1999 to 2004. Between 2007 and 2020, however, ESKOM's average electricity price rose by around 460%, not accounting for inflation. When we factor in inflation of around 100% from July 2007 up to July 2020, the average price is still 180% more expensive.

The graph below compares the average nominal price of electricity and inflation prices over the course of 1994 to 2020.

It shows a steep incline in both the nominal and inflation-adjusted electricity price from 2007 onwards.

The chart below stacks the annual increase percentages against inflation in the same year.

The blue represents inflation, while the red is ESKOM's price increase by percentage.

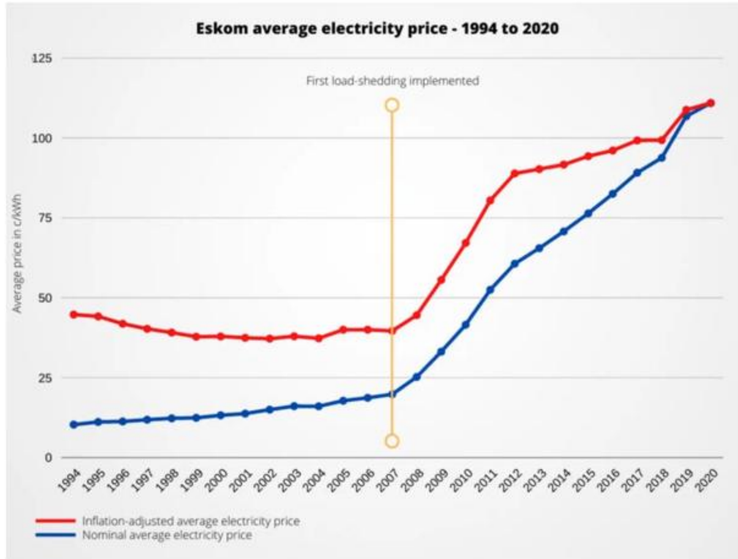


Figure 9: South Africa's Historical Electricity Prices

Source: ESKOM Annual Report 2020

2.1.3 Electricity tariff Increases and Competitiveness in the international market

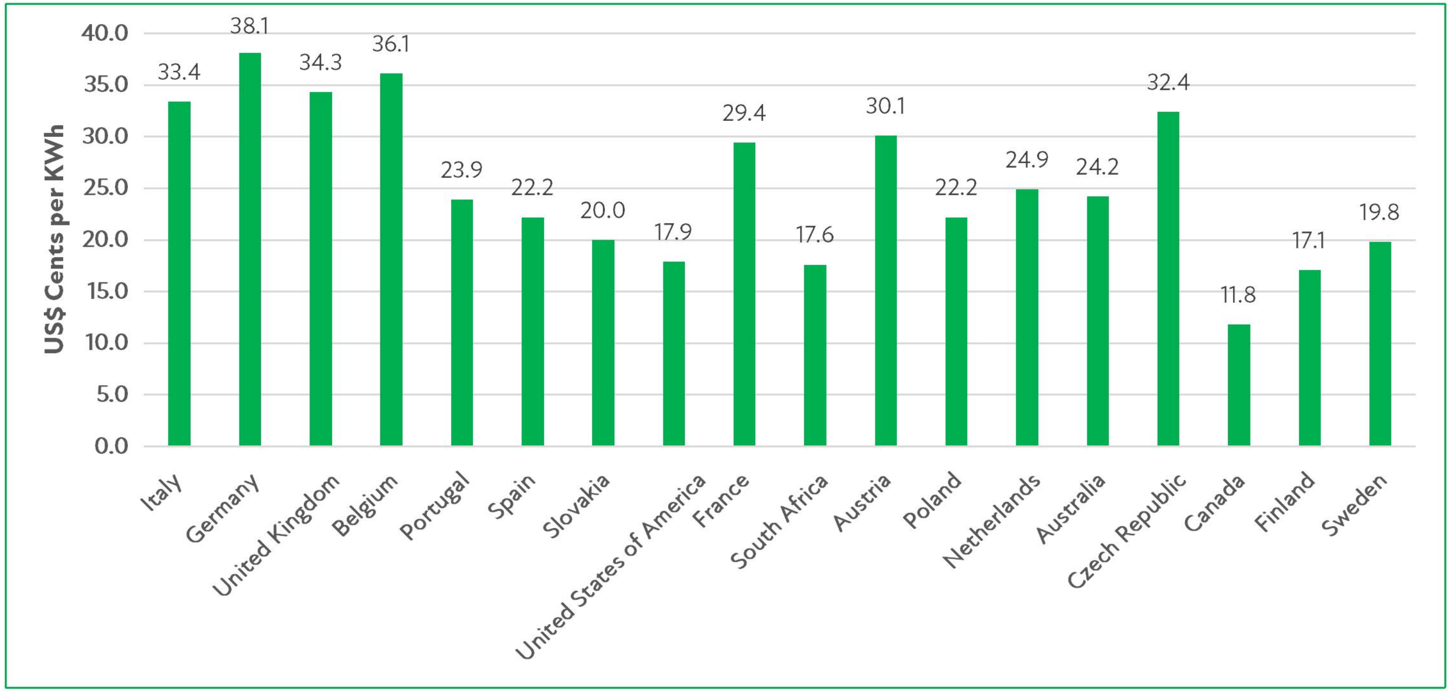
Competitiveness is generally defined as the measure of efficiency with which a nation or firm utilises its human resources, capital, entrepreneurial skills, and appropriate technologies. This yardstick is more or less equated with the level of productivity that a firm or country can attain and, from a supply side point of view, has a major bearing on determining unit costs of products and services to be presented to the market. Electricity input costs in production processes and its sustained availability is another important cost element in production functions that affect the competitiveness of firms.

The competitiveness of South African based firms' products is affected by both controllable and uncontrollable factors. Controllable factors include infrastructure (including energy), the regulatory environment, management efficiencies, the labour market, etc.; whilst uncontrollable factors consider geology, ore grades, location of minerals relative to the surface, etc. It is important to note that electricity tariff increases have an impact on the competitiveness of South Africa's exports, especially with regard to leading mining and manufacturing value chains.

2.1.4 Comparative World Electricity Tariff

The price of electricity varies enormously around the world. In some cases, the cost of electricity is high due to additional delivery fees or taxes in certain countries. On the other hand, some countries are able to lower electricity costs for their citizens by subsidizing electricity tariffs, meaning that Government absorbs a portion of the electricity price. The figure below presents the cost per kilowatt hour (KWh) that people pay for a selected sample of countries around the world that have been assembled from various sources, expressed in US$ cents per KWh.

Figure 10: Global electricity prices for households (US$ cents per KWh)[2]



Source: GlobalPetrolPrices.com (June 2024)

[2] It is important to note that the purchasing parity pricing method was used to compare the electricity tariff across different countries

The figure above provides a comparison of electricity tariffs within the leading economies around the globe in the 2024calendar year. From the above figure it can be observed that Germany is the country with the highest electricity price. The average cost was much higher at US$ 38.1 per kWh in Germany. However, Countries such as South Africa and the Western nations such as Finland, Canada, and Sweden and United States of America had rates of less than US$ 20 cent per kWh.

As indicated above, South Africa's electricity price is still not very high when compared to the rest of the world, or even to other African countries. For instance, Uganda, Namibia, and Ghana all have electricity tariffs that are more than double that of South Africa. However, the problem is that the South African economy has (especially mining and manufacturing), in the long term, been structured around relatively cheap electricity, and it will not be easy to change this situation in the short to medium term. This will ultimately come about when ESKOM's pricing policy moves towards a marginal cost basis and possibly bringing in less expensive alternate electricity generating sources.

2.1.5 Impact of High Electricity Tariffs on the Behaviour of Small and Medium Enterprises

South Africa is a developing nation and has, over quite a number of years, grown its economy through establishing and growing, in a meaningful number of cases, manufacturing and mining industries, which were traditionally more energy intensive.

However, it is important to note that, over the past two decade or so, the structure of the South African economy has changed drastically, where economic activity has shifted more towards the tertiary and service sectors, which are less electricity intensive in their production processes.

Together with these structural changes in the South African economy in favour of a more services-based economy, it has become less dependent on the primary sectors (mining and agriculture) and, to a lesser extent, also manufacturing. These changes also started to manifest in a slowdown in electricity demand. A sector's vulnerability to rising electricity tariffs depends, most obviously, on its physical reliance on electricity as an input into the production processes (which is technology bound), but also the importance of electricity costs as part of its unit production costs. This, together with its relative market dominance, will determine the extent to which it is able to mitigate against the impact of rising electricity tariffs. In South Africa, the number of SMME's in the Mining Sector is not significant relative to those in the Tertiary Sector.

Although SMME's are less electricity intensive, due to the fact that they operate mostly in the tertiary sector, than the larger industries which are mostly situated in the primary and secondary sectors, it is still vulnerable to electricity tariff increases. This is specifically true in a period where the demand for products and services is under pressure and producers, specifically SMME's, find it difficult to pass on any cost increases to their customers, also due to the tight competitive situations they have to endure.

Small and Medium Enterprises (SMMEs) are also particularly vulnerable to shocks emanating from their external environment over which they have little control due to a general lack of skills and resources to absorb these influences. A reliable, abundant, affordably priced source of electricity is critical to the success of the business sector in South Africa in general but more so in the SMME environment. As indicated before, SMMEs in South Africa are generally more vulnerable to excessive and disproportionate tariff hikes.

2.1.6 Impact on Electricity Sales Volumes

The impact of electricity tariff increases on electricity demand itself has also been estimated. It is imperative to understand that a relatively high electricity tariff increase, for instance, the 8.62% increase contained in the ESKOM MYPD 6 settlement proposal and implementation plan, must ultimately result in a decline in overall electricity demand (GWh volume) emanating from the economy; and, consequently, a decline in electricity revenue.

This immediately dispels the expectation that a nominal increase of 8.62% in the electricity tariff will result in an increase in revenue.

This analysis indicates that there is an inverse relationship between electricity tariff increases, volume of electricity demanded, and revenue generated by ESKOM. The table below presents the impact of the various electricity tariff increases associated with each of the scenarios on electricity demand volumes.

Forecasting of total RSA economy and demand for electricity

Three economic growth scenarios were developed: a low growth scenario, a likely growth scenario and high growth scenario.

Gross domestic product (GDP) and electricity demand were projected for all three growth scenarios.

Electricity demand was also determined for both on-grid and off-grid usage.

The future of price of on-grid electricity usage is the focus of this study due to its importance in regard to future investments by the private sector, parastatals and government.

However, to calculate the demand for on-grid electricity, it is necessary to take a view on the development of off-grid electricity facilities.

Currently, there is a significant drive to implement off-grid electricity by both households and industries.

Households mostly implement solar PV rooftop electricity-generating capacity without storage, whereas commerce and industry opt for solar PV with storage.

For purposes of calculating the on-grid electricity demand, it was assumed that off-grid will increase from a meagre current capacity to nearly 12% of electricity demand to the end of the programming period.

The tables below depict the medium- and long-term electricity forecasts for GDP as well as electricity production with and without electric vehicles. It was conducted for all three economic scenarios.

Table 5: Electricity Production Projections for the Medium Term (2023-2030)

Growth rates	Likely growth scenario p.a	High growth scenario p.a	Low growth scenario p.a
Electricity production without electric vehicles	1.96%	2.72%	1.20%
Electricity production with electric vehicles	2.55%	3.27%	1.83%
Total GDP growth	2.72%	3.47%	1.88%

Table 6: Electricity Production Projections for the Long-Term (2023-2052)

Growth rates	Likely growth scenario p.a	High growth scenario p.a	Low growth scenario p.a
Electricity production without electric vehicles	2.36%	3.25%	1.51%
Electricity production with electric vehicles	2.81%	3.60%	2.07%
Total GDP growth	2.94%	3.86%	2.19%

From the above tables, the following deductions can be made:

- In terms of the GDP growth and electricity growth, the long-term projections are close to 0.5% higher than those for the medium term. This is probably due to the aftereffects of Covid-19 and the current effects of the war in Ukraine.
- The introduction of electric vehicles increases production by about 0.5% per year. The difference in growth in the generation of electricity for the lower growth scenarios is slightly higher than that for the higher growth scenarios.
- The GDP growth is on average higher for all the scenarios and also for all the periods than for the demand in electricity, specifically before the introduction of electric vehicles. Electricity generation is relatively lower than the total growth of the economy.

The difference can be attributed to two reasons: the share of the electricity-intensive sectors will decrease in the future due to a shift in the intensity of electricity usage regarding all sectors. In the first instance, the South African economy gradually moves away from a primary- to tertiary-oriented sectoral composition, where tertiary sectors are much less electricity-intensive than primary sectors. Secondly, the use of electricity by machinery and equipment is much more efficient, leading to a reduction in electricity usage. An exception to this rule may be the use of electric vehicles that are imposed on society to mitigate the emission of harmful substances into the environment.

2.1.7 Electric Vehicles

The conversation about climate change has seized the limelight across the world in a way that few other topics have over the past century, threatening the viability of businesses, infrastructure and natural ecosystems.

The connections between energy, trade and manufacturing are deepening, and governments continue to further shape energy transition policies to support their industries and economic ambitions. Sustainability is now a focal point in the mobility conversation, driven by environmental concerns and the demand for cleaner, more efficient transportation.

Sustainability is now a focal point in the mobility conversation, driven by environmental concerns and the demand for cleaner, more efficient transportation.

The global transition towards decarbonisation presents challenges, particularly for an emerging economy like South Africa, but also offers immense opportunities for the domestic automotive industry and the crucial role it plays in promoting a green, sustainable future.

From an automotive perspective, the link to a low carbon economy is e-mobility, and in view of the inevitable transition to electric vehicles (EVs), the global automobile landscape is undergoing major changes.

It is very important, as is the acceleration of decarbonisation of the vehicle market, and this cannot just be export-driven.

Domestic demand stimulation includes addressing the luxury ad-valorem tax to stimulate demand, as well as developing

Table 7: New Energy Vehicle Sales - 2020-2024

	2020	2021	2022	2023	2024
Plug-in hybrids	131	54	126	368	738
Traditional Hybrids	101	624	4066	6485	13616
Battery electric vehicles	92	218	502	929*	1257*
Total	324	896	4694	7782	15611

Source: NAAMSA/Lightstone Auto

* *Including heavy commercial vehicles*

Transforming transportation, as a major contributor to greenhouse gas emissions globally, is essential and involves a massive shift toward a clean mobility solution, particularly for road transport.

Energy consumption with clean mobility solutions has become a priority and EVs have emerged as one of the preferred options due to their zero tailpipe emissions, ability to be powered by renewable energy, and potential to reduce air pollution and dependence on fossil fuels.

An encouraging trend is the increasing introduction of electric trucks in the domestic market since 2022, with 26 EV truck sales in 2024.

Challenges remain the much higher upfront costs of these vehicles compared to equivalent ICE vehicles as well as the lack of public charging infrastructure development.

3.

MPUMALANGA CONTEXT

3.1.

Electricity

The analysis of Electricity in Mpumalanga is not so much about the demand and supply of electricity for Mpumalanga per se, but about the supply of electricity of Mpumalanga to the Rest of South Africa.

The supply of electricity from Mpumalanga from coal fired power station will diminish in future with significant impact on the direct and indirect effects on the Mpumalanga economy.

Indirect impacts refer mostly to the supply of coal and its effect on employment opportunities.

It is envisaged that in the event that all coal fired power stations are decommissioned in Mpumalanga, close to 91 000 job opportunities in the coal mines and related industries will be lost in the province.

However, this can to a large extent be counteracted by replacing the coal power fires stations with green energy such as solar and to a lesser extent, wind. This analysis on energy infrastructure focuses on the positive effects of introducing green energy in Mpumalanga.

The transmission of electricity is always going hand in hand with its production.

Due to the fact that on a net basis, there will be surplus transmission capacity in Mpumalanga, this aspect will not be dealt with in this section.

Coal Fired Power Stations

According to the Department of Energy6, 77% of South Africa's energy needs are currently provided for by coal.

Eskom produces 95% of the electricity used in South Africa, and its coal-fired stations produce about 90% of electricity produced by the utility.

Twelve of South Africa’s coal fired power stations are located in Mpumalanga Province. These power stations, their capacities as well as their commissioned and planned decommission dates are presented in Table 8 Currently, 33 131 MW are produced by coal fired power stations in Mpumalanga. This constitutes about 57 % of South Africa’s total usage of electricity of 58 095 MW and 72.6% of total electricity produced from coal in South Africa.

Next Page - Table 8: **Eskom – Decommissioning/End of Life Dates & Mes Applications Per Coal-Fired Power Station**

	Station	IRP 2019	Eskom Schedule June 2020	First unit/s to come offline	Units (15) shutdown as of July 2020	Current MES application Mg/Nm3 limits effective 1 April 2020: PM – 50 NOx – 750 SO2 - 1000	New plant (2020) postponements in place – granted in 2015	NAQO decisions – 30 October 2021
	OLDEST ESKOM COAL-FIRED POWER STATIONS							
1	Camden	2020	2025	First to last units		Suspension of compliance applications (must be decommissioned by 31 March 2030), in accordance with a detailed decommissioning schedule.		• Suspension of compliance granted for SO2 (3500 mg) and NOx (1100 mg); - Decommissioning plan by November 2022.
2	Hendrina	2020	2021	Unit 4	Units 1,3 and Units 8			• Suspension of compliance granted for SO2 (3200 mg) and NOx (1100 mg); - Decommissioning plan by November 2022.
3	Arnot	2021	2021	Unit 1				• Suspension of compliance granted for SO2 (2500 mg) and NOx (1000 mg); - Decommissioning plan by November 2022.
4	Komati	2019	2022	Unit 9	Units 1-8			• Suspension of compliance granted for PM (100 mg); SO2 (2600 mg) and • NOx (1100 mg); • Decommissioning plan by November 2022.
5	Grootvlei	2018	2021	Units 1 and 2	Units 4-6			• Suspension of compliance granted for SO2 (3500 mg) and NOx (1100 mg); - Decommissioning plan by November 2022.
6	Kriel	2026	2026	Unit 1				• Suspension of compliance granted for PM (100 mg); SO2 (2800 mg) and NOx (1100 mg); • Decommissioning plan by November 2022.
	OLDER ESKOM COAL- FIRED POWER STATIONS							
7	Duvha	2030	2031	Unit 1 and Unit 2		Except for the 2020 PM limit, compliance postponement to April 2025; alternatively, a weaker NOx limit (1100 mg/Nm3) and SO2 limit (2600 mg/Nm3) THROUGH TO DECOMMISSIONING	SO2 limit: 2300 mg (April 2020 – March 2025) NOx limit: 1100 mg (April 2020 – March 2025)	• Application refused in its entirety; Must comply with PM limit of 50 mg; - Must comply with SO2 limit of 2300 mg until 31 March 2025; • Must comply with NOx limit of 1100 mg until 31 March 2025
8	Matla	2029	2030	Unit 1		Compliance postponement to April 2025; alternatively, a weaker PM limit (80 mg/nm3) from 2025 until decommissioning; NOx limit (1200 mg/Nm3) through to 2027; and SO2 limit (2600 mg/Nm3) THROUGH TO DECOMMISSIONING	SO2 limit: 2600 mg (April 2020 – March 2025)	• Alternative limit for PM declined; postponement to March 2025 also declined as there is no intention to comply with new plant standard; • Postponement/alternative limit application for SO2 declined; limit of • 2600 mg remains in place to March 2025; • Alternative limit request for NOx declined; • postponement to March 2025 also declined as there is no intention to comply with new plant standard.
9	Kendal	2038	2039	Unit 1		Compliance postponement to April 2025; alternatively, a weaker PM limit (85 mg/nm3) from 2025 until decommissioning; NOx MONTHLY limit (750 mg/Nm3); and SO2 limit (3000 mg/Nm3) THROUGH TO DECOMMISSIONING	SO2 limit: 2600 mg (April 2020 – March 2025)	• Alternative PM limit is declined; PM compliance postponement until 31 March 2025 is declined; • Alternative SO2 limit is declined; SO2 compliance postponement is declined; must comply with limit of 2600 mg until 31 March 2025;
10	Lethabo	2035	2036	Unit 1		Compliance postponement to April 2025; alternatively, a weaker PM limit (80 mg/nm3) from 2025 until decommissioning; NOx limit (1100 mg/Nm3); and SO2 limit (2600 mg/Nm3)	SO2 limit: 2500 mg (April 2020 – March 2025) NOx limit: 1100 mg (April 2020 – March 2025)	• Alternative PM limit is declined; PM postponement of compliance is declined – must comply with PM limit of 50 mg; • Alternative SO2 limit is declined – must comply with 2500 mg limit until 31 March 2025; • Alternative NOx limit declined – must comply with 1100 mg limit until 31 March 2025

						THROUGH TO DECOMMISSIONING		• Alternative NOx limit is declined; NOx postponement of compliance is granted – comply with a limit of 1100 mg until 31 March 2025
11	Majuba	2046	2046	Unit 1		Except for the 2020 PM limit, compliance postponement to April 2025; alternatively, a weaker NOx limit (1400 mg/Nm3) to 2026; and SO2 limit (3000 mg/Nm3) THROUGH TO DECOMMISSIONING	SO2 limit: 3200 mg (April 2020 – March 2025)	• Alternative SO2 limit is declined; postponement of compliance for SO2 beyond 2025 is declined – must comply with 3200 mg limit until 31 March 2025; • Alternative NOx limit is declined; postponement of compliance for NOx beyond 2025 is declined – must comply with 1300 mg limit (Note: should be 750 mg)
12	Matimba	2037	2038	Unit 1 and Unit 2		Alternative MONTHLY NOx limit (750 mg/Nm3), SO2 limit (4000 mg/Nm3), and PM limit (50 mg/Nm3)	SO2 limit: 3500 mg (April 2020 – March 2025)	• Alternative PM limit is declined – must comply with 50 mg; • Alternative SO2 limit is declined – must comply with 3500 mg limit until 31 March 2025; • Alternative NOx limit is declined – must comply with 750 mg;
13	Tutuka	2035	2035	Unit 1		Alternative PM limit (300 mg/Nm3) until 2027; alternative NOx limit (1200 mg/Nm3) until 2027; and alternative SO2 limit (3000 mg/Nm3) THROUGH TO DECOMMISSIONING	PM limit: 100 mg from January 2020 SO2 limit: 3400 mg (April 2020 – March 2025)	• Alternative PM limit is declined – must comply with 100 mg limit until 31 March 2025; • Alternative SO2 limit is declined – must comply with 3400 mg limit until 31 March 2025; • Alternative NOx limit is declined; postponement of compliance is granted – must comply with 1100 mg limit until 31 March 2025
	NEW BUILD COAL-FIRED POWER STATIONS							
14	**Kusile**		2069	Unit 1		“Eskom will comply”.		N/A
15	**Medupi**		2065	Unit 6		Alternative MONTHLY SO2 limit (4000 mg/Nm3) until 2030, when installation of the FGD is complete; thereafter an alternative MONTHLY SO2 limit (1000 mg/Nm3) until decommissioning.		• Alternative SO2 limit is declined; SO2 postponement of compliance beyond 2025 is declined – must comply with 3500 mg limit until 31 March 2025.

Table 9: Coal Fired Power Stations in Mpumalanga Province

No	Power plant	Total Capacity (Mega-Watt)
1	Arnot Power Station	2100
2	Camden Power Station	1561
3	Duvha Power Station	3600
4	Grootvlei Power Station	1200
5	Hendrina Power Station	2000
6	Kendal Power Station	4116
7	Komati Power Station	990
8	Kriel Power Station	3000
9	Kusile Power Station	3200
10	Majuba Power Station	4110
11	Matla Power Station	3600
12	Tutuka Power Station	3654
	Total Mpumalanga	**33131**
	Total RSA	**45618**
	Mpumalanga Share	**72,6%**

Source: Eskom, RSA 2022

For purposes of a scenario calculating the impact of the replacement coal fired power stations with green energy technologies, it is assumed that all the coal fired power stations with a decommission date of 2060 will be decommissioned.

Based on this assumption, nine coal fired power stations in Mpumalanga totaling 18 051 MW (54.4% of the current coal fired power station in Mpumalanga) will be decommissioned by 2069 (**See Table 8 -** ***Previous Page***).

From a positive point of view, this decommissioning presents an opportunity for the introduction of Green Energy Technologies. The coal power plants that are planned to be decommissioned will be converted into a renewable generation site powered with, 900MW hybrid renewable energy facility comprising of: 750MW of wind energy consisting of 111 turbines 150MW of Solar PV 800MWh of Batteries, thereby continuing to put the site and its associated transmission infrastructure into good use and to provide economic opportunities to the community.

Table 10: Decommissioned Coal Fired Power Stations in Mpumalanga Province before 2069

No	Power plant	Total Capacity (Mega-Watt)
1	Arnot Power Station	2100
2	Camden Power Station	1561
3	Duvha Power Station	3600
4	Grootvlei Power Station	1200
5	Hendrina Power Station	2000
6	Komati Power Station	990
7	Kriel Power Station	3000
8	Matla Power Station	3600
	Total Mpumalanga Decommissioned Before 2040	**18051**
	Total Mpumalanga	**33131**
	Mpumalanga Share	**54,5%**

Source: Eskom RSA 2022

Electricity for Petrochemicals (SASOL)

As far as the intensive usage of electricity in Coal to Liquid processes (CTL) and the Gas to Liquid Processes (GTL) and in view of the shortage of electricity in South Africa, Sasol has embarked on a program to generate its own renewable energy of 1 200MW by 2030. The capital cost of this renewable energy investment comprising of Wind and Solar PV is in the order of R37 billion. For purposes of analysis, the green energy mix will probably comprise of a third of Wind energy and two thirds Solar PV with Battery Storage energy.

Definition and Description of Petro Chemicals

Petro chemicals are the chemical products obtained from the refining process of petroleum. Some chemical compounds made from petroleum are also obtained from other fossil fuels, such as coal or natural gas, or renewable sources such as maize, palm fruit or sugar cane.

This industry and the products it produces play an enormous role in our daily lives. Imagine life without gasoline, cosmetics, fertilizers, detergents, synthetic fabrics, asphalt, and plastics. All of these products—and many more—are made from petrochemicals—chemicals derived from petroleum or natural gas.

Petro chemicals production plays a very important role in the current and future economy of Mpumalanga. Due to the lack of coal deposits that form the basis of the feedstock of producing petro chemicals by SASOL Limited (LTD) at Secunda coupled with the shortage of electricity, forces SASOL to adjust its infrastructure. The analysis of the petro chemicals component of the project is critical to establish the impact of these adjustment in infrastructure and its impact on the Mpumalanga economy.

Petro chemical Plants (SASOL Secunda)

Sasol has pioneered the commercial application of Fischer-Tropsch technology since the early 1950s when it built the first petro chemical plant at Sasolburg and began producing fuel based synfuels and chemicals. Since then, Sasol 2 and Sasol 3 plants were put into operation at Secunda. Sasol currently supplies about 28% of South Africa's fuel needs from coal.

Over time innovations have enabled Sasol and other leading petrochemical producers to use gas as a feedstock to produce more environmentally friendly liquid fuels and other products from natural gas. This process is referred to as Gas to Liquid (GTL). An example of this process is the production of diesel which is virtually Sulphur free and has been proven in the USA and Europe to be far more environmentally benign than existing diesel.

The above investment is projected at R25 – R35 billion (bn) cumulative total capital up to 2030, inclusive of maintaining current gas feedstock and roadmap costs (transform capital).

The availability of coal at Sasol Secunda has become a challenge. Due to this fact, Sasol has already reconfigured a portion of its plant to use Natural Gas as feedstock. It is envisaged that SASOL will replace a further 10 Mtpa of coal by 2030 (representing a 25% reduction in the current usage of 40 million tons per annum.

Sasol is in advanced negotiation of a term sheet for 40 – 60 PJ/a of liquefied natural gas (LNG) as additional gas over and above the current requirements of 160 PJ/a to replace 10 Mtpa of coal by 2030.

Due to the intensive usage of electricity in Coal to Liquid process (CTL) and the Gas to Liquid Process (GTL), and in view of the shortage of electricity in South Africa, Sasol has embarked to generate its own renewable energy of 1 200MW by 2030. The capital cost of this renewable energy investment comprising of Wind and Solar PV is in the order of R37 billion. It is assumed that for purposes of analysis, the green energy mix will probably comprise of a third of Wind energy and two thirds Solar PV with Battery Storage energy.

The financial and macroeconomic impact of the introduction of green energy by SASOL is discussed under the electricity infrastructure section.

Just Transition

Just Transition means protecting workers and communities as the economy shifts to cleaner energy. A just transition means planning, skills, and support not leaving employees behind It was created by unions to demand fair treatment when jobs are at risk from environmental pressures. It means:

- Early warning and planning
- Training and new skills
- Decent work alternatives
- Fair support for communities and families
- It requires lots of funding & supporting government policies

Climate science is unequivocal. A rapid and deep decarbonisation of the economy and society is necessary to avoid catastrophic climate changes and associated impacts. Economics is also unambiguous. New technologies have arisen, displacing increasingly expensive and obsolete ones in every sector. Accordingly, public policy has provided the direction of travel, with goals of NetZero carbon emissions.

Such dynamics are particularly acute in the coal value chain, which still accounted for 36% of global electricity supply in 2019. An increasing number of countries have committed to phasing out coal.

Similarly, financial institutions have increasingly pledged to stop funding coal-related investments.

South Africa is in the midst of such forces. The country depends heavily on coal for its energy supply and is also a key coal producer and exporter. About 86% of electricity came from coal in 2019, and so did about 20% of liquid fuels. Coal is also a key input into other industries, such as iron and steelmaking.

Overall, the coal value chain, from mining, to transport, to use, directly employed about 150 000 people in 2019. And many more people indirectly rely on the value chain for their livelihood, both in the formal and informal sectors. At the same time, South Africa is in a precarious socio-economic situation, with high levels of poverty, unemployment and inequality. In addition, environmental damage and impacts, such as land, water and air pollution, are rampant in many areas of the country, with disastrous social consequences for the population.

South Africa has committed to a significant phasing down of its fleet of coal-fired power stations and associated coal mines (DoE, 2019).

As the country embarks on a shift away from coal, the need for a just transition is acute. Most people and communities have low levels of resilience to shocks. People employed in the coal value chain face job losses. Those who depend on them, as well as those who indirectly service the industry or the people employed in it see their livelihood disappearing. At the community level, the concentration of coal-related activities in a few locations, primarily Emalahleni and Steve Tshwete in Mpumalanga, makes the risk of ghost towns real.

Within this context, a core component of a just transition in South Africa is the economic diversification and rejuvenation of the coalfields. This is critical to at least compensate for upcoming losses of employment and livelihood and ideally generate even more economic activity than exists at present. It is also an opportunity to pivot the economy of coal-dependent municipalities towards more sustainable and diversified activities.

Importantly though, every local context is different – a starting point often overlooked by national level analysis and policymaking. Even in Mpumalanga's coalfields, the operation of mines, power plants and heavy industries has affected specific towns differently – and so will their phasing out or restructuring.

Economic structures, social and political fabrics, and environmental health vary between locations. Transition trajectories will also differ.

Suggested Mitigation and Interventions

Legacy infrastructure across Emalahleni and Steve Tshwete, in general, has been identified as advantageous for regional economic development. Infrastructure investment planned for the Nkangala District exceeds R10 billion (2019/20 FY), of which R467 million is private investment underway (CoGTA and Nkangala District Municipality, 2020). Energy generation and transmission infrastructure, in particular, could be leveraged to maintain key regional relevance within the country's electricity system. The fact that Eskom has begun a process to divisionalise its generation, transmission and distribution could make space for more opportunities in this space. As South Africa continues to invest in renewable energy generation, existing transmission grid capacity will be essential to accommodate additional plants. This is particularly relevant for Emalahleni, which has been identified as a Renewable Energy Development Zone (REDZ) (DEA, 2020). Both towns rely heavily on the coal-to-power value chain and face significant risks as coal-fired power plants are decommissioned.

However, as they are mothballed, the power stations themselves have physical infrastructure which Eskom is already working on repurposing. For example, the Komati Power Station is being installed with agri-voltaics and a microgrid assembly plant. On the other end of the value chain, mining land rehabilitation presents its own opportunities.

Mining

Decades of mining, power and industrial pollution have had devastating consequences. Given the rapid growth and encroachment of mines in urban Mpumalanga, particularly in Steve Tshwete and Emalahleni, the phase-out of coal-based activities will not change the status quo in and of itself. Indeed, simply moving away from coal mining and industry will not solve the accumulation of decades of environmental and ecosystem neglect and damage, including air, water and land pollution.

For a successful "just transition" away from coal and toward a more prosperous, inclusive, and sustainable future, Mpumalanga must leverage the economic potential of its local municipalities and settlements. This involves capitalizing on existing strengths while addressing weaknesses to foster sustainable development. This chapter aims to provide an assessment of where Mpumalanga's "economic potential" lies, where, for the purposes of this report, economic potential is defined as ***the possibility to achieve high levels of productivity and employment in non-coal related sectors that can act as a foundation for economic diversification and transformation, resulting in shared improvements in living standards.***

It is also important to consider an explicitly spatial approach by introducing a composite index, called the economic potential index (EPI). This index evaluates the underlying characteristics of various settlements and local municipalities in Mpumalanga, including those hosting coal communities, to gauge their potential for medium- to long-term productivity and employment growth based on economic diversification away from coal related activities (e.g., coal-fired power plants and coal mining). This index assesses settlements and municipalities based on three types of characteristics that are essential for economic diversification away from coal related activities:

- **Natural endowments and resources:** factors like agricultural suitability, tourism potential, and mineral mining/processing potential.
- **Long-lived sunk investments in local infrastructure:** including established infrastructure such as roads, digital connectivity, and the water supply system; and
- **Potential agglomeration advantages**: factors such as population density, access to national and international markets, and the existence of a relatively skilled local workforce.

Through the consideration of the index, and the analysis of its associated component indicators, the research team will analyse during the Trade and Investment Review the underlying strengths and weaknesses of Mpumalanga's settlements and local municipalities. This, in turn, provides insights into possible investments and other policy priorities.

Managing the successful transition away from coal and increasing economic diversification requires tailoring investment strategies to the unique characteristics of each region, ranging from densely populated urban centres to sparsely populated rural areas.

Mpumalanga can partially retain its reputation as the energy hub of the country through the development of sustainable and low-carbon energy. Renewable energy generation and beneficiation through green hydrogen represents an opportunity that aligns with the substitution of coal use. This relates to the repurposing of coal-based generation plants and supplementing petrochemical production with green hydrogen. As highlighted, this conforms, and responds to, the envisioned solar and wind capacity additions in the 2019 Integrated Resource Plan (IRP), which totals in excess of 20 000 MW (DMRE, 2019). Emalahleni has been approved as a REDZ for wind and solar photovoltaic (PV) projects (CSIR, 2019). This is a positive step in diversifying the local economy and a further rollout of REDZs in other vulnerable municipalities, such as Steve Tshwete, could be explored.

Eskom has begun looking at the decommissioning of the existing coal fleet and repurposing the power stations. Renewable energy generation and green hydrogen production are being investigated as energy options for deployment at the power stations. In January 2022, the utility announced the intent to invite bids from private renewable energy developers for projects on its land in Mpumalanga (Creamer, 2022).

Eskom is currently at the research and development (R&D) stage for hydrogen and anticipating finalising its hydrogen strategy by March 2022. Eskom views green hydrogen as a promising, however, early technology, which is still associated with substantial capital and operational expenditure costs and requiring some period (from 2030 onwards) to be cost feasible.

Currently, hydrogen is imported or produced at some of the coal-based power stations and is used for cooling purposes.

Sasol is also investigating opportunities around renewable energy and green hydrogen. Sasol produces about 2.7 million tonnes per annum of grey hydrogen (based on coal and gas) at both its Secunda and Sasolburg plants. The bulk of the production is reserved for captive (internal) use within Sasol's existing production routes to produce chemicals such as ammonia and methanol. Sasol is considering how green hydrogen production can be phased into its production sites in Secunda.

Based on consultations with Sasol, green hydrogen can be easily incorporated in low volumes through gradual supplementation. Investments would involve changing the energy input to renewable energy-based electricity and retrofit the existing electrolysers, which are currently used to produce chlorine. In April 2021, a collaboration between Sasol, Linde, Enertrag, and Navitas Holdings was announced to bid for the production of sustainable aviation fuel (SAF) through the German Federal Government's H2Global auction platform. This involves the production of green hydrogen at the Secunda plant to produce SAF for export to Germany (Sasol, 2021).

Sasol's Secunda and Sasolburg plants are interconnected and are already under financial pressure. The following are worth highlighting:

- **Secunda:** Feedstock is coal. At 55 million tons of CO2 - one of the largest carbon emitters globally. Commissioned in 1980 & now too costly and too old to easily transform.
- **Sasolburg:** Its feedstock natural gas from Mozambique is running out (mid 2030s)
- Sasol plans to keep Secunda going by burning more coal — but this won't work forever. Rising costs as coal & gas fields deplete, regulations, and carbon costs are catching up.

Sasol's Economics: Key Points for Workers

- Sasol South Africa spends R21 bn on employee salaries and contributes 5% of South Africa's GDP
- In the 2023/24 period, Sasol invested R790 million in social value initiatives, with a strong emphasis on education and skills
- Significant debt from previous mega-projects, made worse by bonds rated non-investment grade (junk) & rising interest costs.
- Needs oil prices of $59/barrel just to break even
- If profits fall, so do jobs, bonuses, and investment
- Cutbacks and loss of jobs remain a real risk
- Sasol's current focus is the period to 2028 and continued use of coal
- Sasol is financially vulnerable as seen in the share price

In the short term, Sasol is more at risk from business pressures than Just Transition pressures.

Around 27 000 direct and 425 000 other jobs in South Africa depend on Sasol.

- Secunda and Sasolburg towns rely heavily on Sasol
- A big restructuring is likely in both towns; planning needs to start now.
- Cutbacks unlikely to happen all at once
- Heavily linked into the RSA economy, e.g. Sasol raw plastics production alone multiplies into 25 000 direct jobs*1 downstream
- Skills in coal-based industries don't easily transfer to solar, wind or new industries (even less so for unskilled workers

Suggested Mitigation and Interventions

Beyond these developments, other opportunities exist to transition workers in the coal value chain to other economic activities. Coal truckers are vulnerable to declines in coal activities, particularly businesses which are small and black-owned. About 4 000 workers are employed as drivers in coal logistics in Mpumalanga. Given the wide biomass feedstock base and similarities between the hauling practices of coal and biomass, coal truckers could, in the future, switch to transporting sustainable biomass for new green industries.

Chireshe and Bole-Rentel (2022) highlight that transporting lignocellulosic biomass for the production of SAF, such as cleared invasive alien plants or garden waste, could create almost 3 000 jobs for drivers of side tipper trucks (used currently for coal transportation), meaning that almost 75% of the current coal jobs could be directly transitioned to biomass transport.

Intertwined with mining rehabilitation is the development of biomass production on mining land, which in turn can be used as the basis for producing electricity, heat, biofuels or biomaterials. In cases where food crops are not viable (because land is contaminated or less fertile), then biomass production for other purposes, such as biofuels, biochemical and biomaterials, could be investigated.

Municipalities in the coal fields should moreover support the development of the renewable energy supply chains.

This can include developing skills in the maintenance and repair of renewable generation infrastructure, the manufacturing of renewable energy generation components and allied services, and the use of TVET colleges to train technicians and artisans in green hydrogen technology.

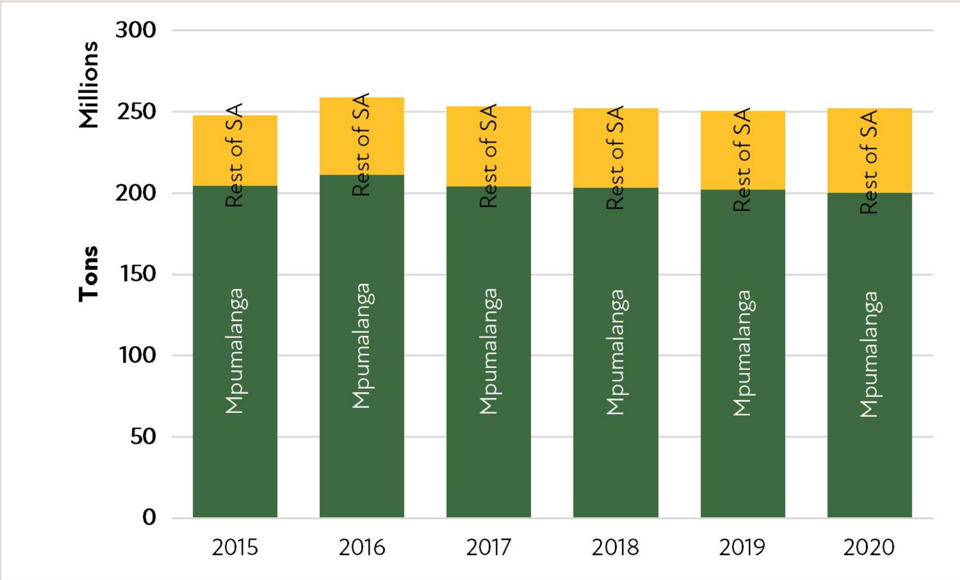
Further, the rollout of rooftop solar systems to local households and businesses can also assist local communities in transitioning towards low-carbon energy production.

Production of coal

South Africa's coal production has increased from 222.3Mt a year in 2000 to 248.1Mt in 2020. It has, however, remained stagnant at levels around 250Mt a year since 2007.

Mpumalanga dominated coal production in this period and consistently added around 80% to total coal mining volumes in South Africa. In 2020, Mpumalanga hosted 149 of the 180 coal mines in South Africa. Figure 11 displays coal production volumes in South Africa between 2015 and 2020 with specific reference to production in Mpumalanga.

Table 11: Volume of Coal Production in South Africa with specific reference to Mpumalanga, 2015-2020



Source: Minerals Statistical Tables B1/2021 – DMRE, 2021

South Africa produces significant quantities of thermal coal (bituminous and anthracite) but has limited domestic resources of high-quality metallurgical coal (coking coal) and currently imports all of its hard coking coal requirements mainly from China, Zimbabwe, USA, and Columbia. The bulk of coal mined in South Africa is bituminous coal and only 10 of the 180 coal mines in South Africa extracts anthracite. Only 2 of the 10 coal mines that extracts anthracite lies within Mpumalanga.

Coal Mining Employment

According to the DMRE, direct employment in the South African coal industry has increased from 77 747 in 2015 to 91 231 in 2020.

The employment increase of 3.3% per annum over the 5-year period in the coal mining industry, stands in contrast to the respective annual employment declines over the same period of 3.9% in gold mining and 2.8% in platinum group metals mining.

According to the Quarterly Labour Force Survey (QLFS) of Stats SA, the mining industry in Mpumalanga contributed 6.1% to total provincial employment in Q4 2021, and coal mines provided the bulk (81.4%) of those employed by mines in Mpumalanga.

Furthermore, coal mines in Mpumalanga provided employment to approximately 85% of those employed in South Africa's coal mining industry in 2021. In 2021, the majority (85%) of the employed in the South African coal industry were males, whereas males accounted for approximately 89% of Mpumalanga's coal industry employment.

The MCSA calculates that one employee in the South African coal mining industry provides, on average, for 5 dependants.

The result of this is that approximately 350 000 to 400 000 people in Mpumalanga are dependent on coal mining for their livelihood.

The MCSA further calculates that the coal mining industry creates roughly 29 000 South African job opportunities in the various upstream supply industries of the coal mining industry.

Coal Markets

Domestic utilization of coal

About 75% of South Africa's marketable coal is used domestically. Some 53% of the more than 180Mt sold locally ends up as feedstock for Eskom's coal-fired power stations. The petrochemical sub-industry (33%) is the second largest domestic user, followed by the metallurgical sub-industry (12%) and lastly domestic heating and cooking (2%). Figure 11 displays the breakdown of the estimated domestic coal usage in South Africa.

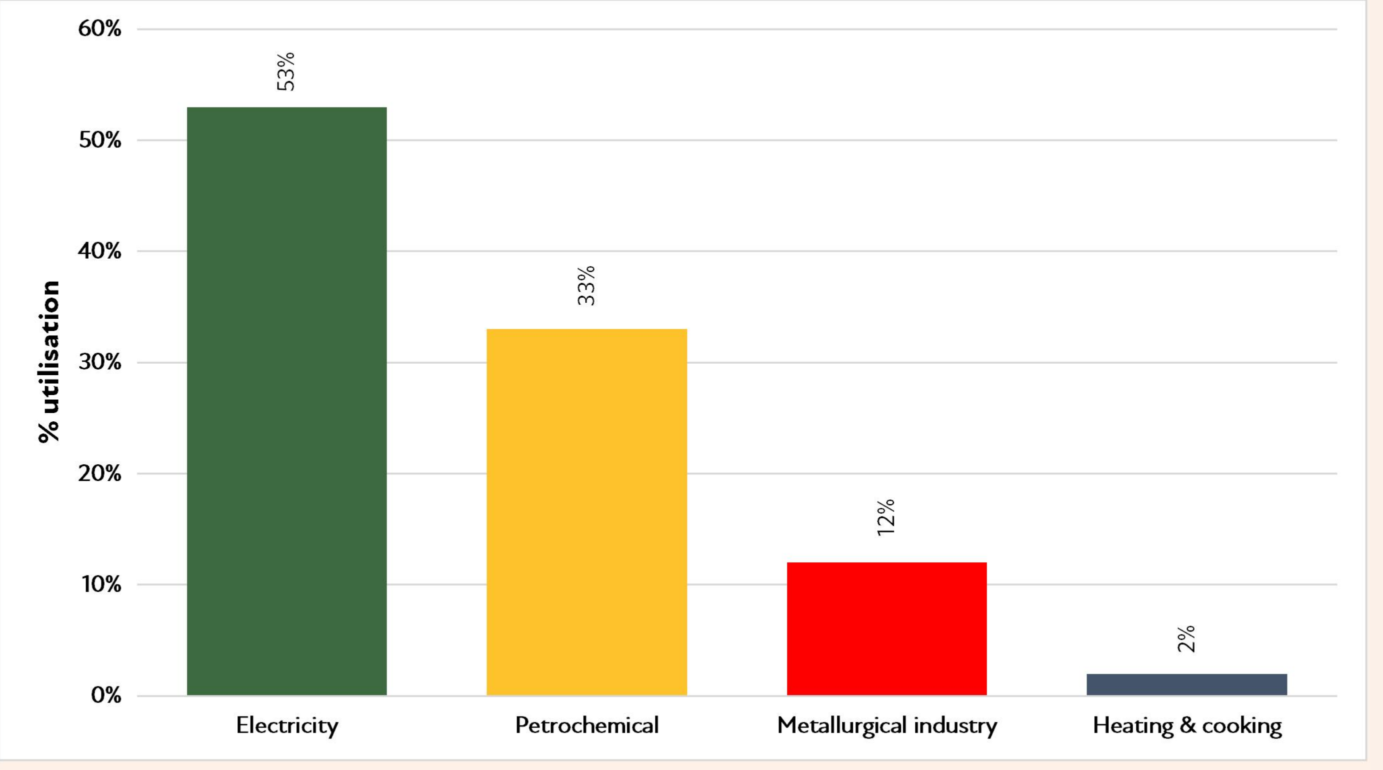
According to the CSIR[3], the electricity mix in South Africa is still dominated by coal-fired power generation which contributed 81.4% to the system demand in 2021.

Renewable energy (wind, solar, and hydro) contributed 11.9% to the electricity mix in 2021, and although the contribution of hydro remained unchanged between 2020 and 2021, the contribution of wind and solar increased by 1 percentage point to 6.7%.

[3] Statistics of utility scale power generation in South Africa in 2021.


H_2

Figure 11: Domestic use of Coal Produced in South Africa, 2021



Source: Coal in South Africa – Eskom, 2021

Global coal exports

According to the harmonised system of the World Customs Organisation, trade in coal is generally captured under the heading HS2701: Coal; briquettes, ovoids, and similar solid fuels manufactured from coal.

The specific 6-digit HS codes included under the HS2701 heading are:

- **HS270111 – Coal**: anthracite, volatile matter limit not exceeding 14%;
- **HS270112 – Coal**: bituminous, volatile matter limit exceeding 14% & a calorific value limit equal to or greater than 5.833 kcal/kg;
- **HS270119 – Coal**: other, that does not meet requirements of anthracite or bituminous;
- **HS270120 – Briquettes**, ovoids and similar solid fuels: manufactured from coal.

The volume of bituminous coal (HS270112) exports made the largest contribution to global coal exports in the 5-year period between 2016 and 2021. The volume of bituminous coal as a share of total coal exports declined from 77.5% in 2016 to 70.6% in 2021.

The volume of other coal[4] (HS270119) exports made the second largest contribution over the 5-year period.

The share of other coal increased from 18.8% in 2016 to 26.6% in 2021.

Figure 12 displays the composition of global coal exports by volume between 2016 and 2021.

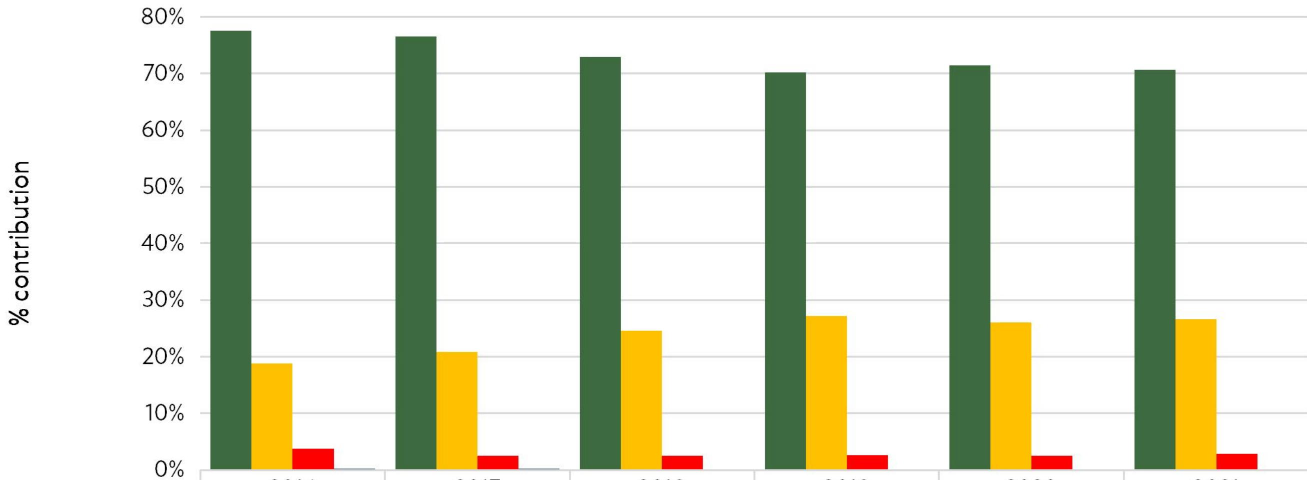
The volume of global coal exports increased by 0.3% per annum between 2016 and 2021.

Among the abovementioned four products, the export volumes of other coal increased by 7.6% per annum, whereas the export volumes of bituminous coal (-1.5% per annum), anthracite coal (-5.3% per annum), and briquettes[5] (-27.0%) all declined over the 5-year period.

[4] Other coal is coal of a lower quality than bituminous and anthracite witnessing increased demand from India and China.

[5] The material for the preparation of coal briquettes is coal fines from dry, poorly sintered coals, which cannot be used for direct combustion in the furnace.

Figure 12: Composition of Global Coal Exports by Volume, 2016-2021



	2016	2017	2018	2019	2020	2021
Bituminous	77.5%	76.5%	72.9%	70.2%	71.4%	70.6%
Other	18.8%	20.9%	24.6%	27.2%	26.0%	26.6%
Anthracite	3.7%	2.5%	2.5%	2.6%	2.5%	2.8%
Briquettes	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%

Source: ITC – Trade Map, 2022

Energy

Mpumalanga can partially retain its reputation as the energy hub of the country through the development of sustainable and low-carbon energy. Renewable energy generation and beneficiation through green hydrogen represents an opportunity that aligns with the substitution of coal use. This relates to the repurposing of coal-based generation plants and supplementing petrochemical production with green hydrogen. As highlighted, this conforms, and responds to, the envisioned solar and wind capacity additions in the 2019 Integrated Resource Plan (IRP), which totals in excess of 20 000 MW (DMRE, 2019). Emalahleni has been approved as a REDZ for wind and solar photovoltaic (PV) projects (CSIR, 2019). This is a positive step in diversifying the local economy and a further rollout of REDZs in other vulnerable municipalities, such as Steve Tshwete, could be explored.

Eskom has begun looking at the decommissioning of the existing coal fleet and repurposing the power stations. Renewable energy generation and green hydrogen production are being investigated as energy options for deployment at the power stations. In January 2022, the utility announced the intent to invite bids from private renewable energy developers for projects on its land in Mpumalanga (Creamer, 2022).

Eskom is currently at the research and development (R&D) stage for hydrogen and anticipating finalizing its hydrogen strategy by March 2022. Eskom views green hydrogen as a promising, however, early technology, which is still associated with substantial capital and operational expenditure costs, and requiring some period (from 2030 onwards) to be cost feasible. Currently, hydrogen is imported or produced at some of the coal-based power stations and is used for cooling purposes.

Sasol is also investigating opportunities around renewable energy and green hydrogen. Sasol produces about 2.7 million tonnes per annum of grey hydrogen (based on coal and gas) at both its Secunda and Sasolburg plants. The bulk of the production is reserved for captive (internal) use7 within Sasol's existing production routes to produce chemicals such as ammonia and methanol. Sasol is considering how green hydrogen production can be phased into its production sites in Secunda.

Based on consultations with Sasol, green hydrogen can be easily incorporated in low volumes through gradual supplementation. Investments would involve changing the energy input to renewable energy-based electricity and retrofitting the existing electrolyzes, which are currently used to produce chlorine.

In April 2021, a collaboration between Sasol, Linde, Enertrag, and Navitas Holdings was announced to bid to produce sustainable aviation fuel (SAF) through the German Federal Government's H2Global auction platform. This involves the production of green hydrogen at the Secunda plant to produce SAF for export to Germany (Sasol, 2021).

Beyond these developments, other opportunities exist to transition workers in the coal value chain to other economic activities. Coal truckers are vulnerable to declines in coal activities, particularly businesses which are small and black-owned. About 4 000 workers are employed as drivers in coal logistics in Mpumalanga. Given the wide biomass feedstock base and similarities between the hauling practices of coal and biomass, coal truckers could, in the future, switch to transporting sustainable biomass for new green industries.

Chireshe and Bole-Rentel (2022) highlight that transporting lignocellulosic biomass for the production of SAF, such as cleared invasive alien plants or garden waste, could create almost 3 000 jobs for drivers of side tipper trucks (used currently for coal transportation), meaning that almost 75% of the current coal jobs could be directly transitioned to biomass transport Intertwined with mining rehabilitation is the development of biomass production on mining land, which in turn can be used as the basis for producing electricity, heat, biofuels or biomaterials. In cases where food crops are not viable (because land is contaminated or less fertile), then biomass production for other purposes, such as biofuels, biochemical and biomaterials, could be investigated Municipalities in the coal fields should moreover support the development of the renewable energy supply chains.

This can include developing skills in the maintenance and repair of renewable generation infrastructure, the manufacturing of renewable energy generation components and allied services, and the use of TVET colleges to train technicians and artisans in green hydrogen technology. Further, the rollout of rooftop solar systems to local households and businesses can also assist local communities in transitioning towards low-carbon energy production.

Opportunities

Coal Ash

Besides the transformation of existing economic sectors, some liabilities could be turned into short-term assets. The use of coal ash, a by-product of coal combustion, is one such interesting opportunity. While coal ash beneficiation is linked to the historical and ongoing coal use, and therefore not viable over the long term, it provides crucial opportunities for the transition.

Eskom's power stations and Sasol's Secunda plant use coal as an input. When combusted, the process produces coal combustion products (CCPs), which include fly ash, bottom ash, boiler slag and flue gas desulphurisation gypsum. This ash, deemed hazardous waste, is stored in close proximity to the facilities in ash heaps. There has been a surge in interest recently in the ash value chain with major producers, such as Eskom and Sasol, showing interest in selling the ash that is produced at their processing facilities. The beneficiation of fly ash presents an opportunity for Mpumalanga given the diversity of end-products that can be produced from it. Ash can be used to manufacture a diverse array of goods and can be incorporated into processes to serve many needs. These include the production of cement and bricks, mine backfilling, mine drainage treatment, soil amelioration, and land reclamation. Rare earth metals can also be extracted from coal ash.

Eskom is by far the primary producer of coal ash in the country. About 30% of residual ash is left over after a unit of coal is burned in Eskom's power stations and about 90% of the CCPs produced at Eskom's power stations are fly ash (Eskom, 2018). The utility faces rising costs and legislative challenges with the storage of coal ash at its power stations and is interested in selling a greater share of ash to limit its own costs (Reynolds-Clausen and Singh, 2017). Eskom's storage facilities are approaching their maximum capacity at power stations and building additional storage involves substantial capital expenditure.

Strict environmental regulations surrounding ash storage and landfilling further increase the costs of such storage expansions. Only about 7% of Eskom's ash is sold (from six power stations), and Eskom has embarked on reviving its Ash Utilisation Project to limit costs of expanding storage.

On average, about 19% of ash produced at a power station can be sold (Reynolds-Clausen and Singh, 2017). Eskom's main off-taker for ash is the construction industry which uses ash in the production of cement and bricks.

The South African Coal Ash Association (SACAA) also supports the development of ash opportunities. Large ash producers such as Eskom, Sasol and Sappi are members of this association. There is also academic research at institutions such as the University of Pretoria supporting the development of the ash value chain. The university is notably involved in research on the use of fly ash in construction and agricultural applications.

Utilising coal ash is, however, not without problems. Since ash is considered hazardous waste, its use must be accompanied by a Waste Management Licence which is issued by the Department of Forestry, Fisheries and the Environment (DFFE).

While necessary for environmental protection, the difficulty in obtaining such a licence is one of the key factors hindering the development of the value chain. For small businesses interested in entering the ash recycling or management value chain, accessing a Waste Management Licence is costly and time-consuming.

It costs about R200 000 to get a licence, and the process is typically accompanied by a two-year processing period (Reynolds-Clausen and Singh, 2017). Eskom has engaged with DFFE about the possible exemption from the legislation for ash purchasers. Exemptions, which also take about two years to be processed, have been granted to some large.

Beyond coal in addition, a strong “coal mining” identity exists in the region, making it harder for many local residents to conceive a future beyond coal. Despite knowing the negative impacts associated with coal mining (at the individual and community levels), many workers and jobseekers in the area continue to see the industry as their best employment prospect.

Poverty is endemic and the promise of a green economy does not guarantee a door out of their current situations. Jobs provided by the coal industry are relatively well remunerated and provide noteworthy benefits, particularly for the level of skills required (Patel et al, 2020).

Coal employment has enabled many people and their families to achieve a decent standard of living. This is a challenge when thinking about the future of the province. New jobs that are expected to replace current coal-based employment are likely to be rejected by the community if they do not provide the same levels of remuneration and benefits as the coal industry.

Environmental impact Decades of mining, power and industrial pollution have had devastating consequences. Given the rapid growth and encroachment of mines in urban Mpumalanga, particularly in Steve Tshwete and Emalahleni, the phase-out of coal-based activities will not change the status quo in and of itself. Indeed, simply moving away from coal mining and industry will not solve the accumulation of decades of environmental and ecosystem neglect and damage, including air, water and land pollution. At least 60% of the province’s land is mined or under prospecting applications (Simpson et al, 2019).

Often, mining rights have been granted without due regard for water resources, air quality and food security, and there is little enforcement of environmental regulations. Government has not upheld some of the legal and regulatory frameworks in place dealing with air and water pollution, fly ash and waste deposits. Mines have also opened illegally, affecting trust that government can manage the transition smoothly and in the interests of the local communities. In addition, the environment is generally not rehabilitated, leaving acid mine drainage, degraded land and polluted air and water to impact communities for decades.

Attempts made to rehabilitate the land have been often unsatisfactory. In many cases, communities have had to stop growing their own vegetables and raising cattle as the land is too damaged and water not suitable for small-scale agriculture and drinking, compromising food security. More broadly, a strong tension exists around land competition, which also affects food security given large-scale agriculture and coal mining. Historically, the focus has been on economic development, namely mining and associated industries at a cost to social, developmental, ecological and environmental sustainability and justice. Changing that paradigm will take time.

Transforming into a low-carbon economy would demand changes at an individual, government and industry level. While there is a general consensus on the need for a just transition, conflicting and divergent views remain. There is much fragmentation and little honest discussion that deals head on with the opposing positions. Until this is addressed, the transformation will be problematic.

Opportunities

Looking ahead, diversifying the economy of South Africa’s coal-reliant municipalities demands that all possibilities are considered. Economic history presents relevant lessons on how to approach economic diversification, pointing to the importance of building diversification strategies in line with local contexts and capabilities and the need to proactively drive inclusivity to contribute to a just transition through economic rejuvenation. Aligning vested interests towards a common purpose is a cornerstone of change. Taking into consideration the existing economic structure of Mpumalanga, and internalising present assets and liabilities, a number of rejuvenation avenues emerge. This chapter reviews a (non-exhaustive) list of economic opportunities which could be developed to diversify the economy of South Africa’s coalfields, unpacking their potential, strengths and shortcomings.

Manufacturing

Historically, along with power generation and coal mining, a number of manufacturing activities developed in Mpumalanga's coalfields. As raised in Chapter 1, manufacturing in the area has been dominated by energy-intensive value chains, namely the metals value chain (Columbus Stainless, Samancor, Macsteel, Thos Begbie, Ferroglobe/Silicon Smelters, Neven Matthews, Bushveld Minerals), industrial coke furnaces (African Fine Carbon, CharTech, Rand Carbide) and chemicals production and associated products (Gradco South Africa). The food and beverage industry (agro-processing) also has a noteworthy footprint in the region (Blinkwater Meule, Witbank Abattoir). Other industries, such as wood and paper (Sappi, Mpact), non-metallic mineral production, machinery and equipment and transport equipment, have a marginal presence as well.

Manufacturing accounted for 21% of Mpumalanga's economy in 2020 (from a peak of 28% in 2010) and 8% of employment. In Nkangala, manufacturing represented 19% of the district's local output in 2020. At the municipal level, manufacturing was relatively more significant in Steve Tshwete (21% of output and 10% of employment in 2020) than in Emalahleni (17% of output and 8% of employment). Building on existing strengths, a variety of manufacturing opportunities could be explored in the region. The metals sector, and particularly the iron and steel value chain, is a natural first port of call.

As the industry transitions to a low-carbon business model, the region has the potential to be a player in the production of green iron and steel products, powered by green hydrogen (as unpacked in the section on energy in this chapter). More broadly, the long-term growth in steel demand regionally and globally (including for rail, construction and renewable energy) provides the impetus to further develop the sector. Mineral processing and beneficiation is another industry that could be expanded. The presence of significant vanadium reserves in the surrounding areas and the existing Vanchem plant at Emalahleni's Ferrobank Industrial Park, which produces a range of vanadium-based products, provides an interesting foundation for expansion, notably to tap into the prospected demand for vanadium-based batteries.

Leveraging South Africa's leading manganese endowment, the only plant outside of China producing electrolytic manganese metal (that is also the world's largest producer of 99.9% manganese) is located in Mbombela. The Manganese Metal Company beneficiates manganese for a variety of applications, including lithium-ion battery production (Montmasson-Clair, Moshikaro and Monaisa, 2020). Opportunities in the energy sector could materialise on the back of a large rollout of renewable energy and battery technologies. Many parts of the renewable energy value chain, which is set to grow in the province (see section on energy in this chapter), could be developed. The South African Renewable Energy Master Plan process has identified a number of parts and components which could be localised in South Africa, such as the balance of system (cables and ancillaries), towers and internals and mounting structures but also turbine hubs, inverters, solar modules, trackers and blade post-moulding (GreenCape, 2021).

For instance, Eskom has announced plans to repurpose the Komati Power Station's workshops, in Steve Tshwete, to manufacture microgrid (so-called containerised) solutions (Creamer, 2021). They have a demonstration container on site and have plans to expand this project. Beyond beneficiation, opportunities abound in the lithium-ion battery value chain, with the potential to manufacture many parts and components as well as assembly battery packs (Montmasson-Clair, Moshikaro and Monaisa, 2020). Depending on the transition pathways followed in the province, other manufacturing opportunities could be worthwhile in the region.

A strong growth in agricultural activities (see section on agriculture in this chapter) would, for example, support the production of machinery and equipment as well as the chemicals (fertilisers) industry.

A sustainable fuel and green chemicals industry could also be built on the back of biomass availability and green hydrogen, leveraging the existing chemicals complex in Secunda in Govan Mbeki Municipality (Gert Sibande district) (see Chireshe and BoleRentel, 2022). The Mpumalanga's coalfields are strategically located in the Maputo Development Corridor and the axis of economic integration between Gauteng, Limpopo, Swaziland and Mozambique. They are also positioned close to two (of the three) envisaged hubs for the country's Hydrogen Valley, i.e. Johannesburg and Mogalakwena in Limpopo.

The Highveld Industrial Park, located on the outskirts of Emalahleni (on the erstwhile Evraz Highveld Steel and Vanadium facility), also provides an interesting location for investment in manufacturing, particularly heavy industrial activities. The park has direct access to Eskom's grid, piped natural gas, oxygen, nitrogen and argon, road and rail facilities. Environmental services and fully equipped metallurgical and chemical laboratories, as well as a Sector Education and Training Authority (SETA)-accredited training centre are available on site. However, a key interrogation remains on the competitiveness of manufacturing activities in the existing coalfields.

Many industrial activities, while technically possible and (marginally) viable financially, would not be economically competitive (against other countries but also other parts of the country) without a degree of support (for instance, see Semelane et al, 2021 on the manufacturing of solar PV panels in Steve Tshwete). The existence of strong industrial parks, and ideally a Special Economic Zone (which could match the Emalahleni REDZ), would assist to develop manufacturing in the region. Further support, through industrial policy, sector-specific policy (such as energy or agriculture) as well as the successful operation of an economic cluster (of which the Mpumalanga Green Cluster Agency is an example) linking government, business, academia and local communities appear paramount for development.

Mine Rehabilitation

Mining land, through rehabilitation, is another liability which could be turned into an opportunity. There were 64 registered coal mines in Emalahleni and Steve Tshwete in 2021, in the former and 30 in the latter. Unsustainable management of mines and their impacts over their entire lifespans and postclosure is one of the most serious impediments to a just transition in Mpumalanga. The water, land and air pollution arising from mining activities in the Nkangala District are well-documented (Mhlongo, et al, 2018). This pollution has impacts on individual and community health and safety, ground and surface water availability, biodiversity, and air and soil quality. It also affects livelihoods, limiting the potential for agricultural and other economic activities (Laisani and Jegede, 2019). Managing mining impacts includes implementing rehabilitation activities to restore mining land to a state approximating its pre-mining condition and productive potential. To this end, South Africa’s environmental legislation and mining rights require mining land rehabilitation plans with financial provision made until a “closure certificate” is issued (Minerals Council South Africa, 2020).

Successful rehabilitation requires effective governance mechanisms to monitor the appropriateness of activities and apportioning of costs and liabilities arising over time. However, the full cost of ameliorating the ecological damage caused by mining far outstrips historical requirements of mining companies. This presents a significant barrier to closure and raises serious questions as to who should fund the shortfall. The financial question is more serious in the case of smaller mining companies, which make up the majority of mine owners in the Steve Tshwete municipal area (Steve Tshwete Local Municipality, Letsema and GIZ, 2020).

This is a serious challenge for governance, with government reluctant to sanction rehabilitation activities and transfer liabilities away from mining companies where the scope and timescale for impacts is uncertain. This complex multi-level, multi-sector governance challenge has led to high levels of inertia between public and private actors. As of December 2021, not a single mine closure certificate had been issued for a coal mine by the Department of Mineral Resources and Energy (DMRE). For Mpumalanga, and the Nkangala District, in addition to managing the impacts of operational mines, the result of this inaction is that the region is marked with non-operational mines (predominantly coal mines) that are “derelict and ownerless” (abandoned with untraceable owners), abandoned with traceable owners, or under “care and maintenance”, without a clear plan to achieve rehabilitation and closure. Whether abandoned or under maintenance, unproductive mines continue to generate ecological risks, most notably acid mine drainage, and subsidence, with serious socio-economic consequences.

Failure to rehabilitate land carries an opportunity cost, preventing local authorities from including mining land in economic development plans, rezoning the land for agriculture and tourism, and facilitating the sale thereof. What is required is a governance solution, and urgent implementation. At the end of 2021, the DMRE was finalising updated guidance for mine closure, with input from the DFFE, the private sector (mining companies and industry bodies) and civil society.

Beyond this, there is a need for all parties to get behind the successful closure of a mine to test assumptions about cost, appropriate finance mechanisms, as well as the job creation potential of interventions. The private sector, in partnership with government, researchers, local governments and affected communities, has piloted activities that support sustainable mine rehabilitation and closure.

These activities include water treatment, water use and bioremediation, with links to existing and future agricultural and tourism development. Water risks have drawn particular investment, due to mining activities placing strain on the Olifants River Catchment, particularly affecting Emalahleni.

In 2004, Anglo American Coal (now Thungela) and BHP Billiton Energy Coal South Africa formed a joint venture to form the eMalahleni Water Reclamation Plant (Thungela Resources, 2021).

Operating since 2007, the plant has the capacity to treat and supply 50 megalitres (Ml) of acid mine drainage-affected water. Water treatment is energy-intensive and therefore also costly. Actors, such as GreenCape, have investigated more cost-effective decentralised onsite water treatment options.

The Mine Water Coordinating Body (MWCB) facilitates multi stakeholder (private and public) planning on water issues. Through this platform, a number of rehabilitation and livelihood pilot projects have been implemented in the region. One example is a project that uses mine water for crop irrigation for emerging farmers. Other researchers have investigated the potential of bioremediation, using specific crops to restore soil quality and generate incomes for local residents.

However, key questions still remain. First, it is unclear whether and how these pilot projects will add up to a full rehabilitation and closure ending in certification by the DMRE. It is unclear how complete land rehabilitation will be, and how this curtails agricultural development, for example.

Third, even attempts to ensure labour-intensive rehabilitation may fall far short of the required employment in the region, and below existing labour quality.

The ability of these investments to play a catalytic role in longer-term economic development remains entirely unclear, given that there are no concrete cases on which to start basing forecasting and planning.

Coal-Based Tourism Assets

Besides existing nature-based assets, an opportunity exists to turn coal-based liabilities into tourism assets in and around Steve Tshwete and Emalahleni. The rehabilitation and repurposing of closed power stations and mines in both municipalities could offer new tourist prospects. This would entail restoring the land into sustainable and usable spaces while taking into consideration not only affected communities but biodiversity loss (Beuermann, 2021). For instance, the Komati power station came on line in 1961 and has one of the country’s tallest chimneys. It could become a just transition hub or museum showcasing the history of coal mining and coal-fired power generation in the country.

Examples from Other Countries

Looking at examples in other countries, interesting initiatives highlight the possibility of turning abandoned mines and power stations into parks, nature reserves or museums: The horizontal Eiffel Tower of Lusatia, Germany:

In 1995, a 350m long and 80m high conveyor steel bridge became an adventure area and museum that attracts many tourists (70 000 in its first year of operation) as part of German industrial heritage. Lake Kepwari, Australia: After 30 years of open-cut coal mining, the site in Collie, in Western Australia, has been converted to a water sports landmark.

Opened in 2020, Lake Kepwari is anticipated to attract up to 22 000 overnight stays and 37 000-day trip visitors per annum. The lake and river Collie are also important for the indigenous Nyungar people in providing food and water. The Hoge Kempen National Park in Genk, Belgium: Following the closure of seven coal mines and 60 000 job losses, the area was converted into national parks by non-government organisations and communities. It boasts about 150 000 visitors annually. The Lusatian Lake District in Germany: 30 years ago, the district was a major coal mining area with numerous pits affecting 26 000 inhabitants. Today, it is one of Europe's largest artificial lake complexes with lakes, restored forests, a cycling network, water sports, fishing, restaurants and hotels all attracting large numbers of tourists. The Eden Project, in the United Kingdom (UK): Through an ecotourism project, an abandoned clay quarry in the UK was transformed into a successful adventure park and garden.

It comprises an indoor rainforest, outdoor gardens and concert facilities.

The Eden Project has brought 2 billion pounds into the regional economy and hosted more than 20 million visitors over the past two decades.

Some potential to develop more traditional tourist attractions also exist. Looking specifically at Steve Tshwete, it is strategically placed in terms of tourism destinations (Steve Tshwete Local Municipality 2019b). The 2020/2021 IDP targets heritage and culture as important elements of tourism.

The Urban Middelburg Innercity Renewal Project is considering the establishment of an art gallery and centre, and a museum. Overall, to be successful, the development of tourism in the region should be undertaken as a partnership between all stakeholders, with local communities at the core.

This requires substantial financing, political will and careful strategic planning which should commence long before the closure of coal-based facilities takes place. The 1996 White Paper on the Development and Promotion of Tourism in South Africa called for communities to be involved in the development of and benefit from local tourism, as well as the respect of the environment, and natural and cultural diversity (DEAT, 1996).

The potential exists to develop responsible tourism that focuses on local goods, services, ecosystems and people. Most of the success stories around the world and in South Africa have come out of partnerships between the public and private sectors, with the voices of communities at their core, from planning and finance to reskilling.

4.

CONCLUSION

As South Africa's electricity market shifts into competitive mode, 2026 may be a year of deal-making and portfolio realignment across the energy value chain. We expect to see increased activity in mergers, acquisitions and strategic joint ventures, as both international investors and regional platforms look for scalable entry points.

At the same time, established players are reassessing their portfolios, rebalancing asset mix, reallocating capital, and recalibrating exposure to new market risks. The centre of gravity is likely to be cross-border transactions, the consolidation of operating renewable portfolios, and restructuring to accommodate competitive trading and market price exposure.

Sophisticated empowerment and governance structures will remain integral to deal execution, reflecting South Africa's transformation agenda. For market participants, success will depend on navigating multi-jurisdictional complexity, aligning regulatory risk with transaction structures, and deploying capital efficiently in a rapidly liberalising electricity sector.

Within the transformed electricity regulatory landscape introduced by the coming into force of the ERAA, Battery Energy Storage Systems (BESS) have emerged as essential strategic assets for market participants, offering both critical risk mitigation and diversified revenue generation capabilities. The Market Code will impose significant financial penalties on Balance Responsible Parties for deviations between forecasted and actual energy production and consumption. BESS can smooth the output of intermittent renewable energy generation, ensure compliance, and effectively convert a potential penalty liability into a predictable operational cost. BESS also enables power producers to sell dispatchable renewable energy, transforming intermittent generation into a baseload supply and to deliver energy according to offtake demand profiles rather than renewable resource availability patterns, commanding premium pricing in power purchase agreements.

The Government of South Africa is on its third bid window under its Battery Energy Storage IPP Procurement Programme. As South Africa progresses toward May 2031, market participants must recognise BESS not as future technology but as a present necessity for competitive success in the transformed electricity sector.

4.1. Projects to look out for – offshore wind

In 2025, South Africa's offshore wind sector was characterised by foundational work and preparatory initiatives, even as formal regulatory guidance remains pending. The DEE has indicated its intention to publish an offshore wind guideline to cover key areas, but the release has been delayed.

Looking ahead to 2026, the government's focus is expected to shift from preparatory activities to the formalisation and implementation of offshore wind projects. Key developments to monitor include the expected launch of the DEE's offshore wind guideline, strategic investor interest, and pioneering project announcements. South Africa's vast offshore wind resources present significant growth potential.

4.2. ERAA Commences: South Africa's move towards a competitive electricity market

The Electricity Regulation Amendment Act 38 of 2024 (ERAA) came into force on 1 January 2025, marking the formal start of South Africa's shift from a vertically integrated monopoly to a competitive, multi-market electricity sector. The Act establishes the Transmission System Operator (TSO), which will have responsibility for system operation, market operation and transmission operation, and be the central purchasing authority.

This represents the most significant structural reform since Eskom's inception a hundred years ago.

The ERAA expands NERSA's regulatory mandate, introduces broader ministerial discretion on new capacity determinations, and opens a pathway for willing-buyer-willing-seller arrangements through competitive trading.

However, some ambiguities around tariff approvals and the definition of "direct supply agreements" create early interpretive challenges. 2025 serves as the structural turning point that enables South Africa's transition towards a competitive electricity market.

2025 also revealed critical institutional tensions around municipal roles, tariff oversight, and ministerial discretion. SALGA's concerns over municipal reticulation led to the delayed commencement of certain ERAA definitions, while potential litigation remains on the horizon.

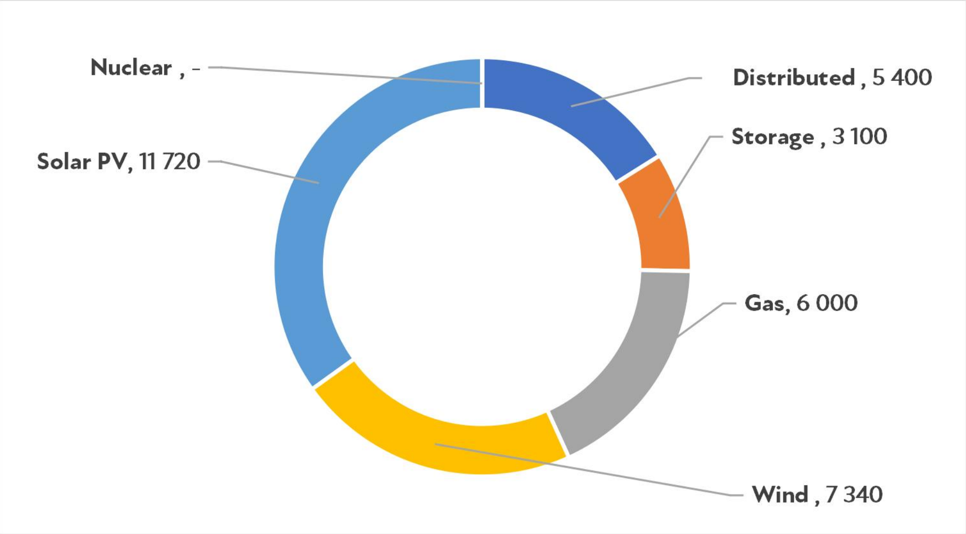
4.3.

IRP 2025 New Generation Capacity

4.3.1 Proposed Electricity Generation Capacity by 2030

The figure below represents proposed electricity generation capacity by 2030

Figure 13: Electricity generation capacity by 2030

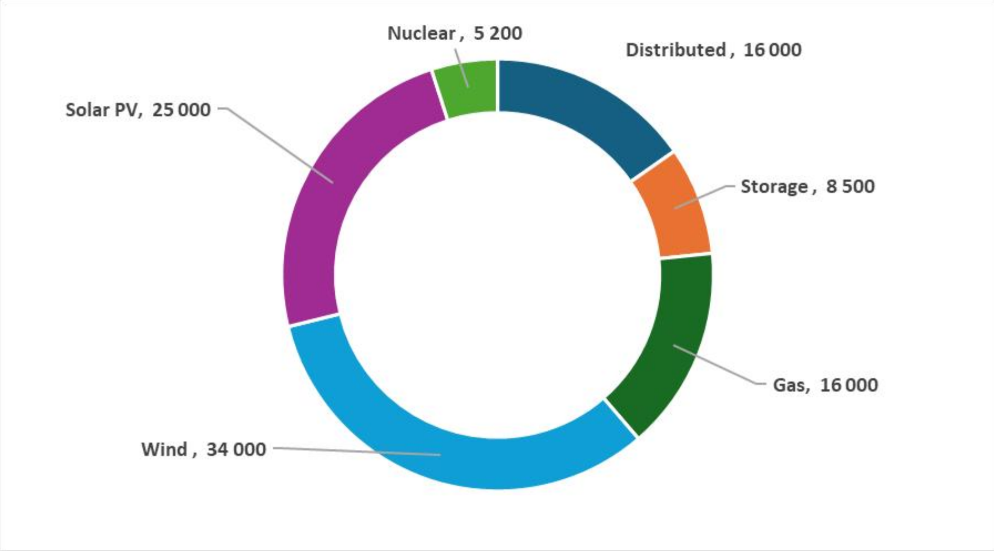


Clean Coal technologies demonstration plant by 2023. South Africa Explores alternative solutions that are cheaper and more efficient than flue gas. Desulphurisation for the continued use of coal power generation.

4.3.2 Proposed Electricity Generation Capacity by 2035

The figure below represents proposed electricity generation capacity by 2035

Figure 14: Electricity generation capacity by 2035



The nuclear industrialization plan will determine the merits of 10 000 MW new nuclear generations capacity.


GENERATION MIX
64%
COST BREAKDOWN
REGIONAL OVERVIEW

2026
Mpumalanga **Energy Sector** Market Intelligence Report

MPUMALANGA **GREEN CLUSTER** AGENCY