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Energy Chapter

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ABBREVIATIONS

AFOLU	Agriculture, Forestry and other Land Use
BESS	Battery Energy Storage System
CCT	City of Cape Town
CO^2e/capita	Carbon Dioxide equivalent emissions per person in a country or region
CSIR	Council for Scientific and Industrial Research
DFFE	Department of Forestry, Fisheries and the Environment
DMRE	Department of Mineral Resources & Energy
EAF	Energy Availability Factor
GJ	Gigajoules
kWh	Kilo Watt Hours
LNG	Liquid Natural Gas
LPG	Liquid Petroleum Gas
MW	Mega Watt
MWh	Mega Watt Hours
OECD	Organisation for Economic Co-operation and Development
b/d	Barrels per day
SSEG	Small Scale Embedded Generation
IEA	International Energy Agency
IAEA	International Atomic Energy Agency
IPP	Independent Power Producers
IRP	Integrated Resource Plan
ITA	International Trade Administration
LTO	Long Term Operation
PERO	Provincial Economic Review and Outlook
PetroSA	The Petroleum Oil and Gas Corporation of South Africa
Pj/a	Petajoules per annum (1 Peta joule equals 1 million billion joules or 278 gigawatt hours)
PV	Photovoltaic
REDZ	Renewable Energy Development Zones
REIPPPP	Renewable Energy Independent Power Producers

	Procurement Programme
RFP	Request for Proposal
ROMPCO	The Republic of Mozambique Pipeline Investments Company
TWh	Tera Watt Hours
WCCCRS	Western Cape Climate Change Response Strategy
WEC	World Energy Council
ZAR	South African Rand

DEFINITIONS

Energy Availability Factor	The percentage of maximum energy generation that a plant is capable of supplying to the electrical grid, limited only by planned and unplanned outages
Energy Demand	Energy demand is the term used to describe the consumption of energy by human activity. It drives the whole energy system, influencing the total amount of energy used; the location of, and types of fuel used in the energy supply system; and the characteristics of the end use technologies that consume energy.
Energy Poverty	Energy poverty is described as when a household must reduce its energy consumption to a degree that negatively impacts the inhabitants' health and wellbeing. It is mainly driven by 3 underlying root causes. a high proportion of household expenditure spent on energy. low income. low energy performance of buildings and appliances.
Energy Supply	Energy supply is the delivery of fuels or transformed fuels to point of consumption. It potentially encompasses the extraction, transmission, generation, distribution and storage of fuels.
Energy Resilience Programme	The Western Cape Energy Resilience Programme sets the targets for the Western Cape to gradually reduce electricity off take from Eskom between 2025 and 2035
Load Curtailment Programme	Load curtailment is a strategy employed by municipalities and large customers nationwide to manage demand during supply constraints
Primary Energy Supply	An indicator defined as the sum of energy production, minus the sum of energy exports and international bunkers, then plus or minus stock changes.
Primary Energy Consumption	Primary energy consumption measures the total energy demand of a country. It covers consumption of the energy sector itself, losses during transformation (for example, from oil or gas into electricity) and distribution of energy, and the final consumption by end users. It excludes energy carriers used for non-energy purposes (such as petroleum not used not for combustion but for producing plastics).
Total Final Energy Consumption	Final energy consumption is the total energy consumed by end users, such as households, industry and agriculture. It is the energy which reaches the final consumer's door and excludes that which is used by the energy sector itself.

Small Scale Embedded Generation	Small-scale embedded generation (SSEG) refers to power generation facilities, located at residential, commercial or industrial sites, where electricity is generally also consumed. These are mainly solar photovoltaic (PV) systems but include also other technologies such as wind and biogas.
Wheeling	Wheeling involves financial transactions where third-party electrical energy (kWh) is transported over municipal or Eskom distribution networks. It allows a third-party supplier to sell electricity directly to a customer at their point of supply.

1. Introduction

The global primary energy consumption trend increased by three (3%) change since pre-COVID-19 levels with fossil fuel consumption is remaining dominant at 82% when compared to the 7.5% renewable energy consumption, which excludes hydroelectricity (Energy Institute Statistical Review of World Energy 2023). Non-renewable energy sources (Coal, Oil, Brent crude oil, Liquid Natural Gas (LNG,) peaked their historic price records in 2022, however the increased costs of these commodities did not necessarily translate to decreased consumption trends (Energy Institute Statistical Review of World Energy 2023).

The energy landscape in South Africa continues to face rolling blackouts, high energy tariffs, lack of investment in infrastructure, energy poverty for more than a decade (Todd & McCauley 2021). Attempts to mitigate the energy crisis that the country is experiencing were marked by several renewable energy bid windows to allow private energy producers to add energy into the grid since 2011, coupled by increased and on-going investment in renewable energy from own operations (i.e. small scale embedded generation etc.). Just over decade later, prime renewable energy locations reached saturation point, as reported by Eskom in 2022, necessitating additional transmission infrastructure (Greencape 2024). To date, non-renewable energy sources dominate South Africa's the energy generation mix with the Western Cape getting most of its electricity from coal and nuclear power plants (IEA, 2022).

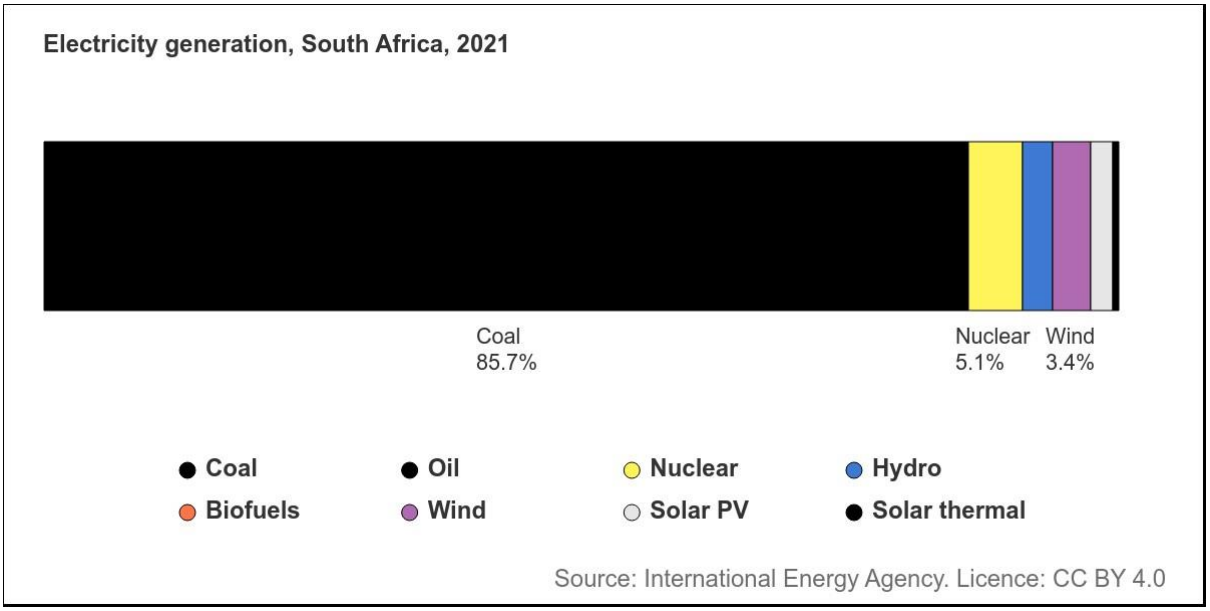

Figure 1 Energy generation by source in South Africa, 2021

(Source IEA 2022)

To better understand South Africa's total energy consumption in addition to electricity energy, the International Energy Agency (IEA) categorised and calculated energy consumption percentages across different sectors as illustrated in Figure 1. From this, the energy generation by source illustrates the current state of energy generation in the wake of aligning with global climate change ambitions to reach Net Zero by 2050.

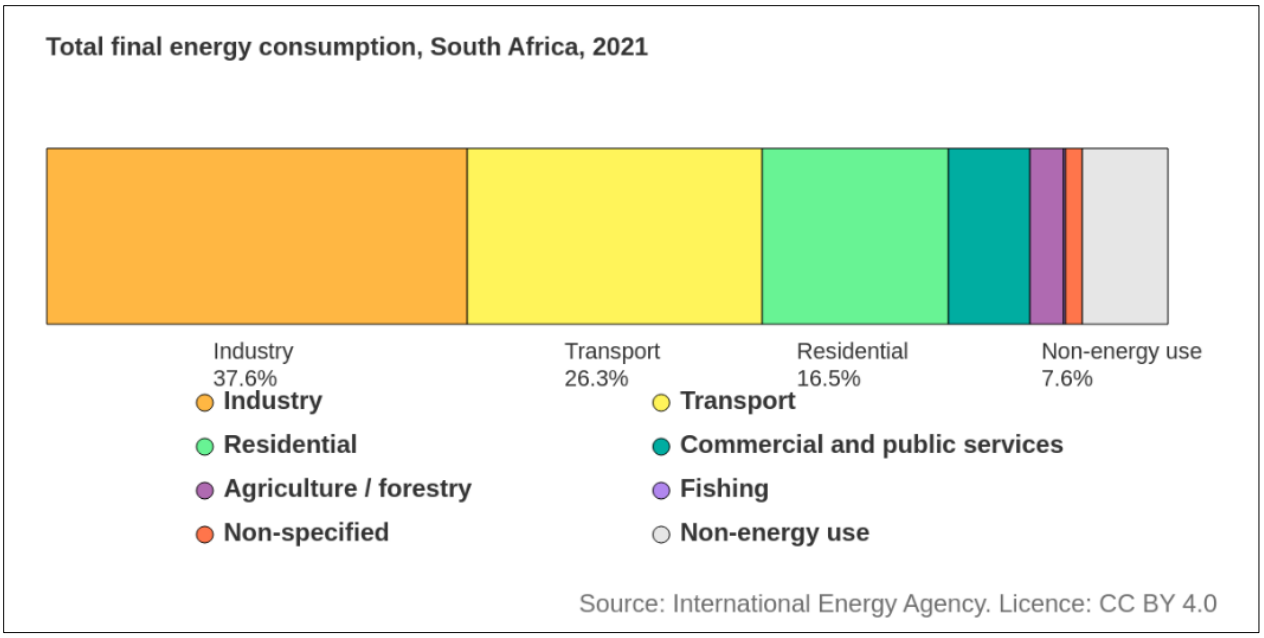

Figure 2 Total final energy consumption in South Africa for 2021

Source: IEA 2022

With nearly two decades of loadshedding impacting energy security in South Africa, the Western Cape through its Energy Resilience Programme (ERP) set targets to diversity the Western Cape energy mix with purpose of maintaining a positive economic growth trend. This is highlighted through the Small-Scale Embedded Generation (SSEG) and rooftop solar photovoltaic (PV) installations to allow private sector, municipalities various other industries to be less reliant on Eskom energy supply.

2. Drivers and Pressures

Combustion of fossil fuels for energy generation, transport, and industrial processes in South Africa continue to dominate the country's energy mix. Greenhouse gas (GHG) emissions from energy generation and waste continued to increase since 2000 whereas Industrial Processes and Product Use (IPPU) and Agriculture, Forestry and other land use change (AFOLU) sectors decreased partly due to the impacts of COVID-19 and increasing Land sink (DFFE 2022). Achieving 'Net Zero by 2050' remains a challenge to South Africa as the country would need to reduce GHG activities close to zero as possible, and balance remaining emissions with carbon removal (Malligen *et al.,* 2023).

Electricity energy demand by province between 2019 and 2022 showed that the Western Cape consumed less electricity energy in terms of gigawatt hours consumed when compared to Gauteng, Kwa-Zulu Natal and Mpumalanga (Hlongwane & Daw 2022; Sats SA 2022). In as much as the Western Cape gets most of its electricity energy from Eskom, the difference in energy consumption is marked by differences in population numbers per province as well as different industry activities.

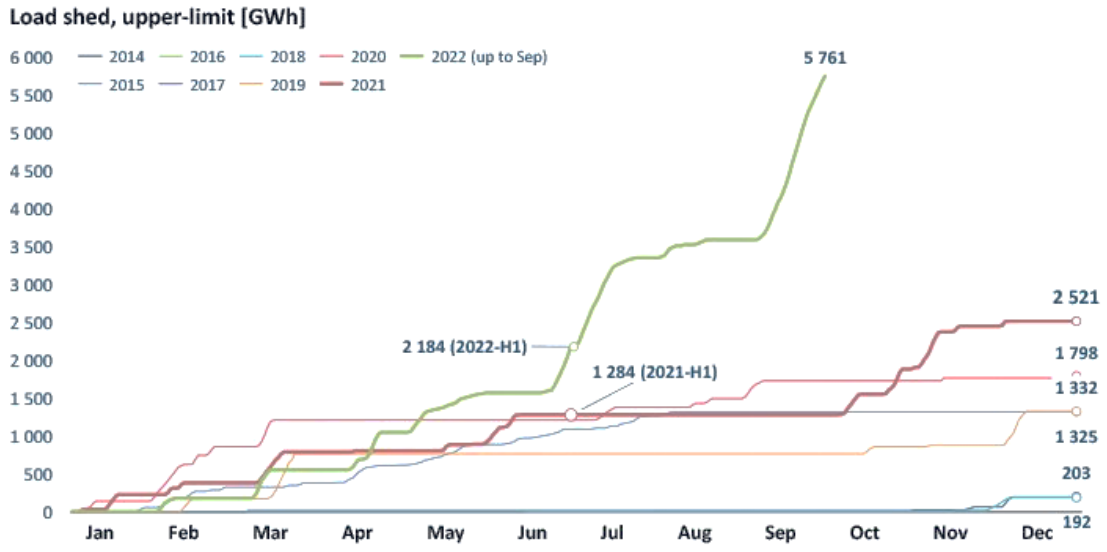

Figure 3 Cumulative annual loadshedding statistics (Jan 2014 - Dec 2022)

Source: BFAP, 2023

Energy intensive industrial processes and the value chains dependent on continuous supply of electricity energy took major financial losses during the peak periods of scheduled loadshedding. Coal power plant fleet maintenance as well as delayed operation of new coal powered energy generation units between 2020 and 2023 has resulted in the economy losing ZAR 850 billion in three years (Bloomberg, 2024). AscelorMittal Saldanha Bay Steel Works provides an example of an employer in the Western Cape having to halt it operations and cut approximately 900 jobs due to energy costs, and losses driven by cheap steel imports, and carbon reduction pressures (Business Standard, 2019). Like the manufacturing industry the Agricultural sector and its production the value chain remains heavily reliant on non-renewable electricity energy. The Western Cape Province has seen food price increases largely by intensifying electricity shortages. Reference is made to a recent assessment (Cloete et al., 2023) on the impact of Stage 6 loadshedding on the Western Cape Agricultural sector. Therein, case studies showed reduced production volumes across different subsectors. Ultimately, energy remains the key driver of economic growth with the inconsistent availability thereof proving to negatively affect local livelihoods in the form of job cuts. It is with reason that the Western Cape has devised and is implementing the Energy Resilience Programme (ERP) to reduce the level of dependence on Eskom.

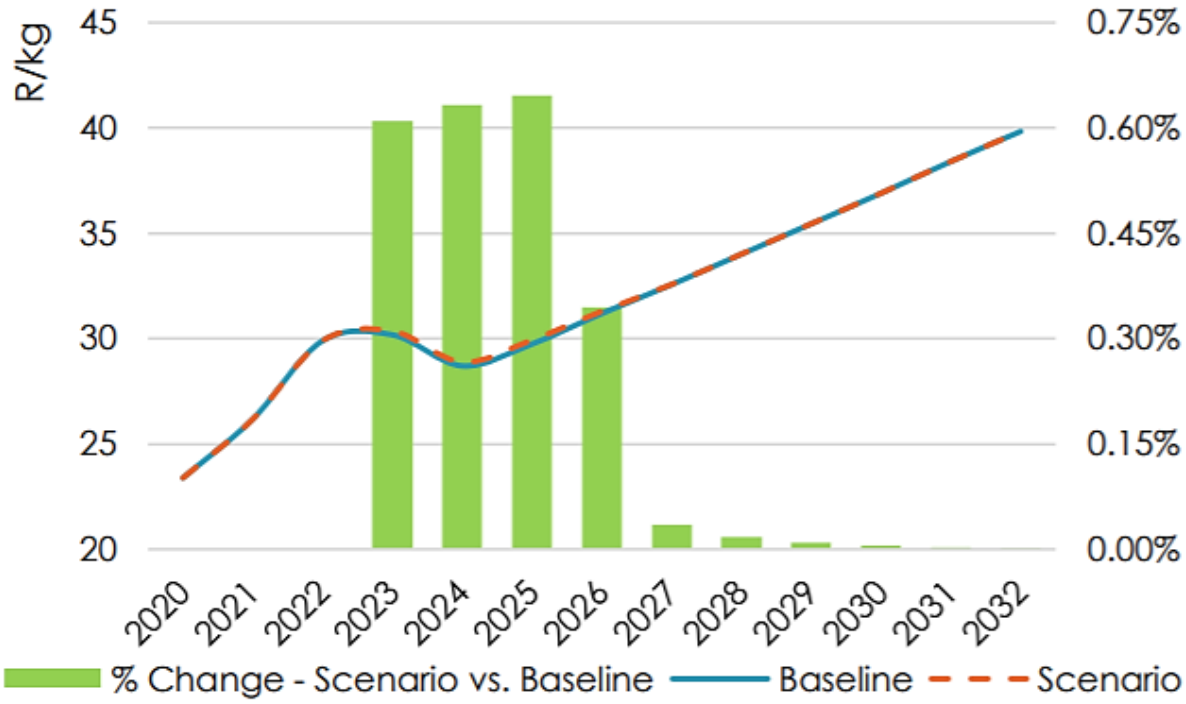

Figure 4 Impact of loadshedding related costs on chicken prices in South Africa

Figure 4 presents the baseline costs versus loadshedding stage 6 costs scenario.

Source: Cloete et al., 2023.

2.1. Population Growth

Correlations between population growth and energy consumption are a common finding in studies seeking to understand the relationships between population growth and energy consumption (Hlongwane & Daw 2022; Ma *et al.,* 2024). In parallel, economic growth which requires increased energy supply, goes hand in hand with urban expansion resulting from inmigration from rural and semi-rural areas into the economic hubs of South Africa (Akintande et al. 2020). As such, domestic migration patterns for the between 2006 and 2019 showed net inward migration into the Western Cape from all other eight provinces of the country (Wesgro 2021).

Our Urban Future, forecasting and analysing projected population growth shifts and urban settlements in South Africa by 2050 projects that the population of the Western Cape will increase by 2.7 million people (CSIR 2019). As of 2021, the Western Cape had an average population density of 49 people per km^2, which is slightly above the national average of 46 people per km^2. At this rate Western Capes metropolitan city will incur the highest projected growth. Thus, accelerating energy security measures in the province, particularly clean energy

is paramount. As such, this calls for accelerating energy generation capacity, including renewable energy, alongside transmission and distribution to meet projected consumption demands driven by both Western Cape population and economic growth.

Figure 5 Projected population growth trends for the Western Cape

Source: CSIR, 2019

2.1. Economic Profile and Growth

Economic activity is largely concentrated in the City of Cape Town where almost two thirds of the provincial population lives. While the province has a well-diversified economic base, as of 2024, the Western Cape's economy has seen some changes in its sector contributions (StatsSA, 2023). Financial services remain the largest economic contributor, now accounting for 30% of the province's value added; manufacturing has increase its share to 16% (StatsSA, 2023). The agricultural sector has however contracted to 12.2% in 2023 (Wesgro, 2024). The transport sector and construction have faced some declines, particularly in the last quarter of 2023 (Wesgro, 2024). Community services and retail and wholesale trade continue to be significant sectors. The Provincial Economic Review and Outlook (PERO) Report (2023), indicates that manufacturing contributed approximately 14.3% towards the Gross Domestic Product per Region (GDPR) in the Western Cape in 2020 (PERO, 2023). Overall, the Western Cape's economy grew by 0.5% in 2023 and is projected to grow by 2.1% in 2024.

A mix of electricity, coal and diesel is used to sustain this growth in manufacturing output. As such, the Western Cape's Energy Resilience Programme discussed to detail further in the report sets out to gradually reduce offtake from Eskom.

2.3. Climate Change

The link between climate change and energy is pivotal and interconnected. Fossil fuel combustion for energy generation is a major source of greenhouse gas emissions, contributing significantly to global warming and climate change.

Globally, the energy sector is the largest emitter of greenhouse gases, accounting for 73.2% of total emissions (Ritchie, Rosado & Roser, 2024). This issue is likely more pronounced in South Africa, with data from 2020 (pre-COVID 19) already indicating that South Africa's energy sector contributed 79.1% of greenhouse gas emissions (DFFE, 2020).

To mitigate the worst impacts of climate change and limit temperature rise to 1.5 degrees Celsius, the United Nations' Intergovernmental Panel on Climate Change (IPCC) has identified several broad and generic actions for the global energy sector:

- *Drastically enhancing energy efficiency — using significantly less energy for the same or greater output.*
- *Expanding renewable electricity generation to at least 70%-85% of total generation by 2050.*
- *Electrifying energy use —substituting fossil fuels with renewable electricity.*

In 2016, South Africa ratified the Paris Agreement, committing to develop Nationally Determined Contributions (NDCs) to reduce emissions and adapt to climate change, with the goal of limiting global temperature rise to below 2 °C, preferably 1.5 °C. Signatories must achieve carbon neutrality by 2050, with developed nations required to start significant reductions immediately. This has led to the establishment of the Presidential Climate Change Coordinating Commission in December 2020 to oversee the national response – that are in line with the broad guideline of the above IPCC recommendations.

Transitioning to renewable energy sources such as solar, wind, and hydroelectric power is essential in the South African and Western Cape context to mitigate these emissions and reduce environmental impacts. Energy efficiency improvements across sectors also play a crucial role in lowering energy consumption and emissions.

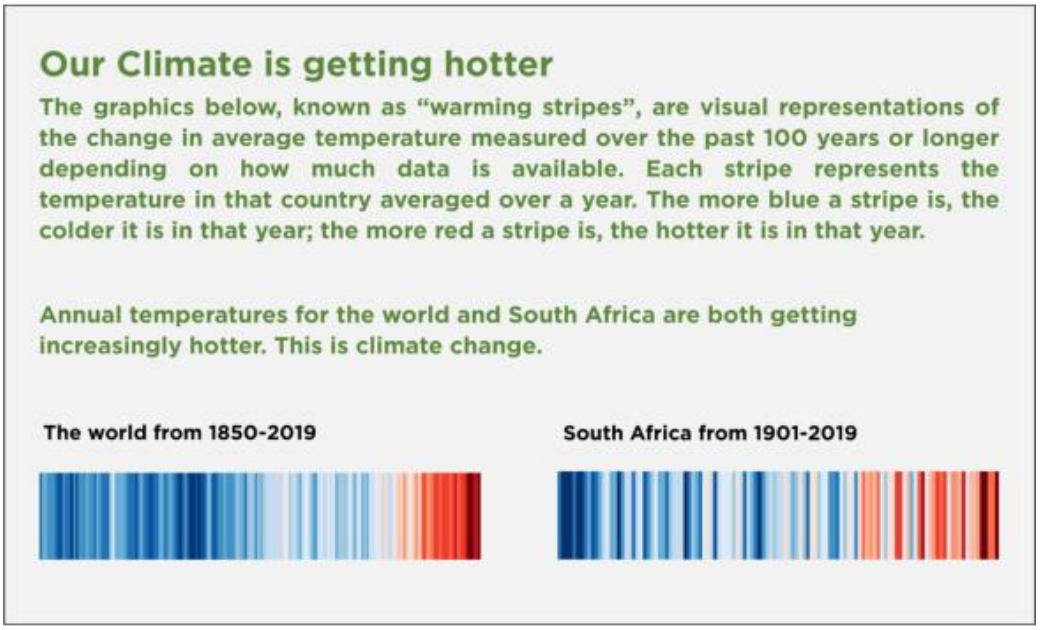

Figure 6 Climate change warming stripes

Source: WCG, 2024a

The "warming stripes" shown in Figure 6 was developed by climate scientist Ed Hawkins and shows the climate heating over time, both globally and in South Africa.

Climate change also drives increased energy demand due to rising temperatures, or cooling needs. Changes in natural resources like water and wind patterns alter energy supply reliability, influencing energy infrastructure planning. Vulnerabilities to extreme weather events threaten energy infrastructure, necessitating resilience improvements. Climate policies drive shifts towards cleaner energy sources and technologies, fostering innovation. Global energy security faces risks from climate-induced disruptions, highlighting the need for robust adaptation strategies. Overall, addressing these challenges requires integrated approaches to ensure sustainable and resilient energy systems amidst climate change impacts – some of which are reflected on in Section 5 "Responses" of this chapter.

From an emissions perspective, the combustion of fuels utilised in the energy sector, such as paraffin, coal, heavy fuel oil and diesel emit air pollutants and heavy metals into the environment, particularly in areas where industrial activities take place. The Western Cape has a mixed industrial energy use profile, with the West Coast District comprising of the highest coal use in its industrial processes in the province. The WCG has also undertaken substantial work on responding to climate change, with the first Western Cape Climate Change Strategy being developed in 2008 and updated in 2014 and 2022, and with multiple climate change mitigation and adaptation interventions towards achieving the strategy's goals being implemented across the Province.

2.4. Energy Policy

The Integrated Resource Plan (IRP) is the key, living plan for South Africa (2019 IRP currently being reviewed) to align its energy generation mix with global trends in parallel with maintaining its

energy security aspirations. For these to materialise, existing policy instruments as well as the government of the day need to find common ground in establishing direction towards the successful implementation of national and international commitments.

Recent literature publication assessing policy barriers to just energy transition in South Africa identified the low uptake of renewable energy into Eskom grid through REIPPP programmes against abundant renewable energy sources since the inception of the programme in 2011. The regulatory environment controlling the amount of energy that IPPs could put into the grid, mainly emanating from concerns linked to the impacts of reduced coal energy demand on livelihoods influenced decision makers to stall the implementation of the REIPPP programme.

Figure 7 Red Rocket Energy wind turbine installations (Roggeveld, Western Cape)

Source: Red Rocket Energy

3. State

The state of electricity in South Africa are facing significant and long-standing challenges, characterised by increasing supply constraints and frequent loadshedding. Regulatory uncertainty has further complicated the management of distribution assets at local municipal level, leading to above-inflation tariff increases for consumers amid ongoing supply interruptions. These elements have a negative impact on the economy including end-users and consumers, placing increasing cost burden on the citizens of South Africa.

Eskom, the national power utility, generates about 95% of the country's electricity and oversees all transmission, while municipalities handle distribution. This dual role creates complexities for the state of energy across the entire South Africa, particularly as some customers are directly supplied by Eskom due to historical reasons, impacting municipal revenues and debt management. The situation has resulted in confusion over service accountability and reduced financial stability for municipalities.

Efforts to streamline electricity distribution in South Africa included a plan, initiated in 2011, to establish six regional electricity distributors. However, this plan was ultimately abandoned. It has left multiple municipalities across South Africa in detriment and in critical need of essential maintenance and investments, all of which has worsened the overall state of energy.

A significant portion of South Africa's energy is utilised in urban areas. In 2019, redistributors, primarily municipalities, accounted for 42% of the country's electricity sales (CSIR, 2021). The distribution of electricity by sector in 2020 highlights the considerable and often inefficient consumption within these urban settings. The industrial sector is the largest consumer, using 52%

of the electricity, while the residential sector accounts for 8%, and the commerce and public services sector consumes 14% (CSIR, 2021). Much of the activity in these sectors occurs within human settlements. Additionally, these areas also consume a substantial amount of water, with municipalities providing 27% of South Africa's water supply to residential, commercial, and industrial users (CSIR, 2021). Although further detailed data for Western Cape level is explored in this chapter, the overarching trends are expected to align with the national context.

Electricity serves as a crucial revenue source for municipalities, but rising tariffs have made affordability a significant concern for consumers. The National Energy Regulator of South Africa (NERSA) regulates these tariffs, yet annual increases have been steep due to Eskom's need to finance its debt. As of 2024, NERSA has proposed electricity tariff increases applicable to both Eskom's direct customers and local authorities. For the period from July 2024 to June 2025, local authority tariff charges will see an increase of 12.72%. Across the board, all tariff charges—excluding the affordability subsidy charge—will rise by 12.74%. Specifically, the Homelight 20A tariff will also increase by 12.74%. In a notable exception, the affordability subsidy charge will see a significant rise of 25.24% (Eskom 2024b). These adjustments reflect Eskom's ongoing financial challenges and the necessity for infrastructure investments.

Municipalities have the potential to enhance revenue by reducing energy distribution losses; however, challenges persist in achieving the internationally accepted loss margin of 3.5%. With electricity prices on the rise and sales declining, some Western Cape municipalities such as the City of Cape Town are re-evaluating their business models. This involves shifting focus toward distributed renewable energy solutions and energy efficiency initiatives, including customer-to-customer energy trading.

There is also another shift that is energy and which is starting to influence the state of energy: Initially, Eskom and via municipalities were the sole service providers, and consumers had a passive role. Now, consumers have more influence over their energy usage and the technologies they adopt. This shift is ongoing, with more residents becoming small-scale energy producers. In response, the energy market is also becoming more inclusive, enabling individuals to actively choose their electricity providers and sell their generated power.

The third iteration of the Western Cape GHG inventory informs indicator data values used in this report to paint the picture of energy consumption in the Western Cape. The data collected to inform the Western Cape GHG inventory dates to 2018, thus the lag in reporting does not allow for this report to contain energy consumption data beyond the 2018 calendar year. To remain consistent with previous reports, where possible, energy supply, energy consumption, energy intensity, domestic use and reliability of energy supply as indicators against which changes over time can be measured. The Western Cape GHG Inventory is currently being updated and will report on data for 2020, 2021 and 2022.

Overall, data (although there is a lag in reporting years) are indicating that the Western Cape electricity consumption patterns are changing, and that self-generation whether at household or commercial level, are rapidly increasing.

3.1. Energy Generation

In the South African context, energy is an allocated national responsibility; the Western Cape has no constitutional mandate for energy generation. Eskom is South Africa's state-owned power

utility, established in 1923, and it plays a critical role in the country's energy landscape. It has historically held a near-monopoly on electricity generation and distribution in South Africa, making it the largest electricity producer in Africa and one of the largest globally. Eskom generates approximately 95% of South Africa's electricity and operates a vast network of power stations, predominantly relying on coal, but increasingly integrating renewable energy sources (Eskom, 2023). Although this is the long-established context, the Western Cape has a standing commitment to improve its energy resilience. This Western Cape SoEOR 2024 highlights the variety of ways in which the Western Cape has started to implement energy system support in the province.

In terms of the Western Cape Energy Resilience Programme, the following targets have been set to reduce reliance on Eskom energy generation:

- *reduce off take between 500MW – 750MW by 2025 (Short Term)*
- *reduce off take between 750MW - 1 800MW by 2027 (Medium Term) and*
- *reduce off take between 1 800MW - 5 700MW by 2035 (Long Term)*.

In the current setting, 1 000 MW of power Nationally and 100 MW in the Western Cape equates to 1 stage of load shedding (WCG, 2024b).

As part of the '*Energy Security Game Changer*,' the province aims to secure its energy supply by collaborating with municipalities and businesses to increase rooftop solar adoption, with an initial target of 10% of electricity generation from alternative sources by 2020 (WCG, 2020). Rooftop solar installations in the Western Cape have made significant progress, with approximately 24% of the province's households having adopted solar installations (Oobla Solar, 2024) which actively supports the provincial energy generation. This reflects a growing trend as the provincial government continues to promote and facilitate the adoption of solar energy among residential and commercial properties.

Figure 8 Red Rocket Energy wind turbines (Roggeveld, Western Cape)

Notably, 70% of South Africa's renewable energy manufacturing occurs in the Western Cape, along with 60% of the country's utility-scale project developers (Western Cape Government, 2012). The newly established Atlantis Special Economic Zone further supports the region's green economy by fostering green technology development.

Case Study: City of Cape Town landfill gas extraction and utilisation

Reducing landfill gas, a significant contributor to global warming, would not only help the City generate green electricity but also support local and national climate change mitigation goals. Waste-to-energy initiatives are part of the City's Integrated Waste Management Strategy and are being carried out through the landfill gas extraction and utilization project. The biogas produced in landfills is flammable and can be harnessed as fuel for heating, electricity generation, or vehicle operation. The City plans to primarily use it for electricity generation and, in September 2014, registered a program of activities under the Clean Development Mechanism for landfill gas extraction and destruction at its landfill sites (UNFCCC, n.d.).

In the first phase, landfill gas extraction and flaring systems were established at the Coastal Park and Bellville South landfills, with a similar system being developed at the Vissershok South landfill. This approach will also be applied to a future landfill. Coastal Park earned its first carbon credits under the Clean Development Mechanism in June 2021, having avoided 126,274 tonnes of CO2-equivalent emissions during the first monitoring period from January 2018 to July 2019. The second phase of the project involves converting landfill gas to electricity. To achieve this, 2 MW of gas engine generation capacity will be installed at Coastal Park in 2021/22, with similar units planned for Bellville South and the Vissershok South and North landfill gas projects. This will further reduce emissions by avoiding coal-fired electricity use and decrease the City's electricity purchases, offsetting installation costs.

Source: Cape Town State of Energy and Carbon Report, 2021.

3.2. Energy Supply

The energy supply indicator depicts the production and supply of energy in the Western Cape, from both renewable and non-renewable sources. The rationale behind the use of the indicator is to identify trends in the responses to changes in energy demand, to highlight what a future, local energy supply mix will look like, and broadly indicate where the local environment will be directly impacted by energy generation. It is worth noting that not all the energy generated in the province is necessarily utilised within the Western Cape, and not all the energy consumed in the province originates in the Western Cape. Therefore, the chapter does not present a Western Cape state specific energy supply.

Coal dominates energy supply in South Africa which supplies 70.1% of the primary energy supply. This is followed by crude oil at 18.1%, biofuels and waste at 4.8% nuclear at 5.1% as reflected in Figure 9. Renewable energy contribution to the grid is below 10%, with the CSIR reporting 7.3% renewable energy supply (CSIR, 2023). Despite numerous sources of energy supply, total energy availability factor (EAF) has been on steady decline since 2010 due to the aging coal power fleet and to Kusile being offline for extended period as reflected in Figure 10 (IRP, 2023).

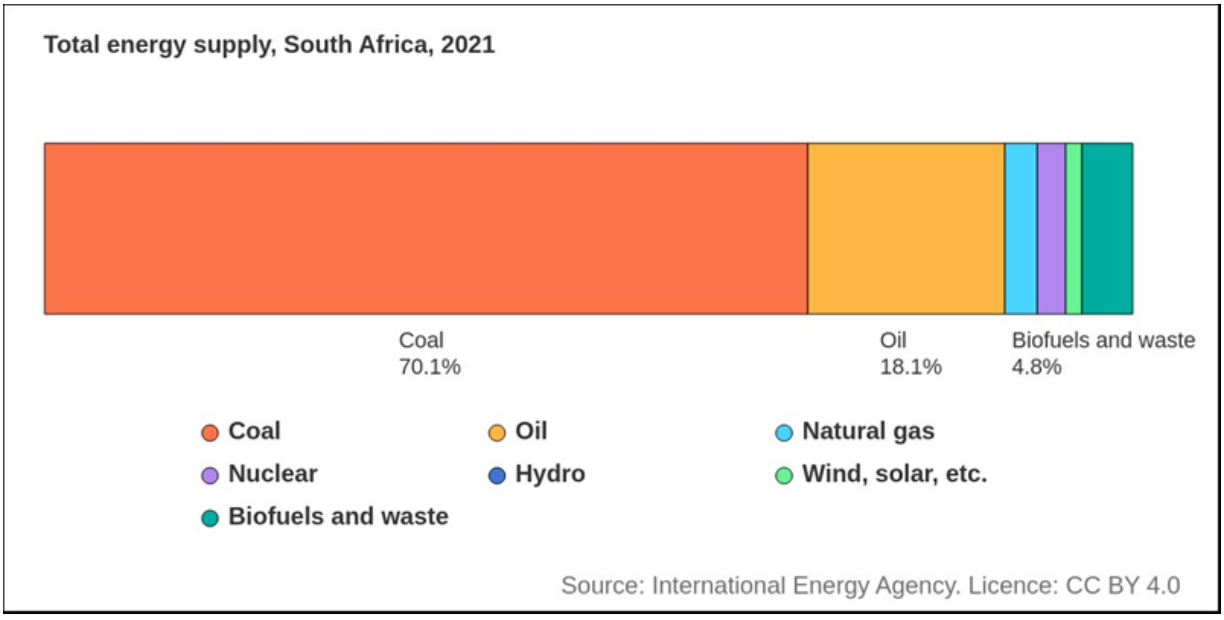

Figure 9 Breakdown of South Africa's total primary energy supply

Source: EIA 2022

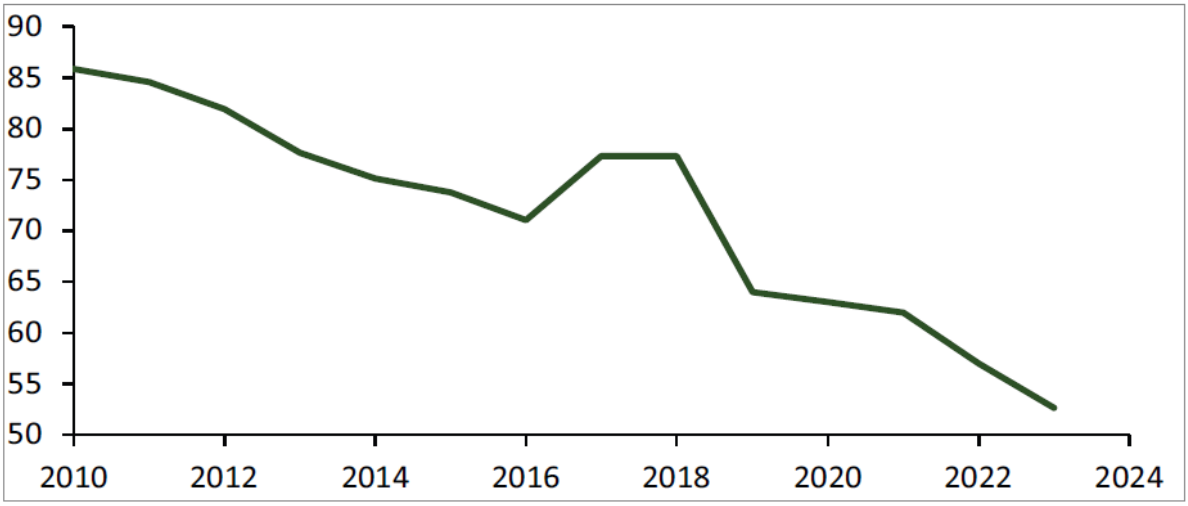

Figure 10 Declining energy availability factor percentages in South Africa from 2010 to 2023

Source: IRP 2023

Electricity energy demand, excluding energy required for green hydrogen is expected to increase gradually between 2024 and 2050 from ≤285TWh in 2024 to ≤422TWh in 2050 (IRP, 2023). To meet projected electricity energy demands by different sub-sectors, the downward EAF trend as seen in figure 10 must change direction to an upward trajectory to stabilise and improve economic activity (University of Cape Town's Demand Projection Model in Support of IRP Update for 2023). The subheadings below give insight into the state the energy generation mix in South Africa as well as highlighting developments in the Western Cape's Energy Resilience Programme.

3.2.1. Coal

Energy generation statistics published by the Council for Scientific and Industrial Research (CSIR) in February 2023, show coal as the dominant source of energy for electricity generation with a contribution of 80.1% to system demand in 2022 (Pierce & Le Roux 2023). The bulk of South Africa's electricity is provided by seventeen (17) coal plants. With Power Stations Medupi and Kusile exceeding 30 years of operational life from present, eleven of Eskoms' coal fed electricity generation plants have (on average) less than 30 years remaining until they are decommissioned (Ramluckun *et al.* 2023). As such, decommissioning coal power fleet units may result in continued decline in EAF.

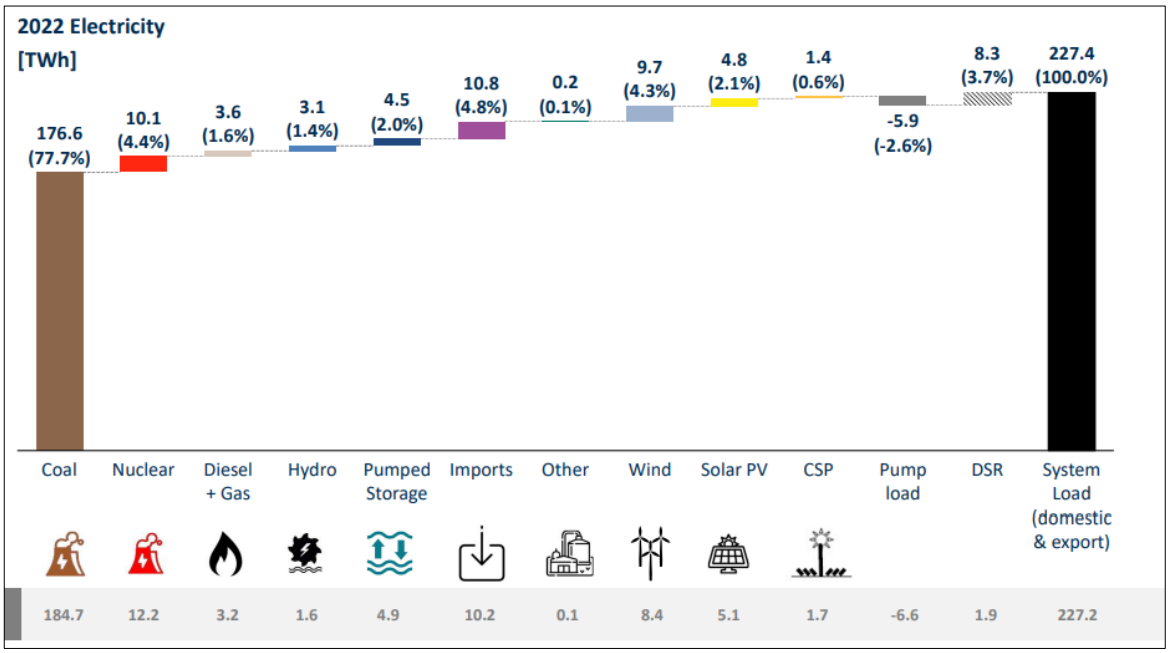

Figure 11 Actuals captured in wholesale market for Jan-Dec 2022

Sources: CSIR Energy Centre (2022)

Figure 11 illustrates the effect without self-consumption of embedded plants. Further explanatory notes that should be taken into account is that "Wind" category includes Eskom's Sere wind farm (100 MW). Wind and solar PV energy excludes curtailment and is thus lower than actual wind and solar PV generation. PS = pumped storage Demand Side Response (DSR) = Manual Load Reduction (MLR) + Interruptible Load Supply (ILS) + Interruption of Supply (IOS).

3.2.2. Oil and Liquid Fuels

South Africa imports more oil products than it can produce owing to low proven oil reserves when compared to the largest oil producers in the world (IEA, 2022). As of 2022, South Africa imported 47% (2.9 billion litres) of if oil from Nigeria, followed by Saudi Arabia at 36% (2.2 billion litres) then Angola at 11% (668 million litres) to satisfy the demand petroleum products/ liquid

fuels (DMRE, 2022). Liquid fuels refined from crude oil consist of diesel, petrol, illuminating paraffin and Liquified Petroleum Gas (LPG). Oil and liquid fuels production in the Western Cape took place in two refineries, Astron Energy (formerly Caltex) in Milnerton processing crude oil and PetroSA, a gas to liquid refinery in Mossel Bay. Combined production capacity refineries equal 145000 b/d however both refineries have not been operational since 2020 owing to PetroSA's feedstock challenges and the catastrophic fire in Milnerton refinery.

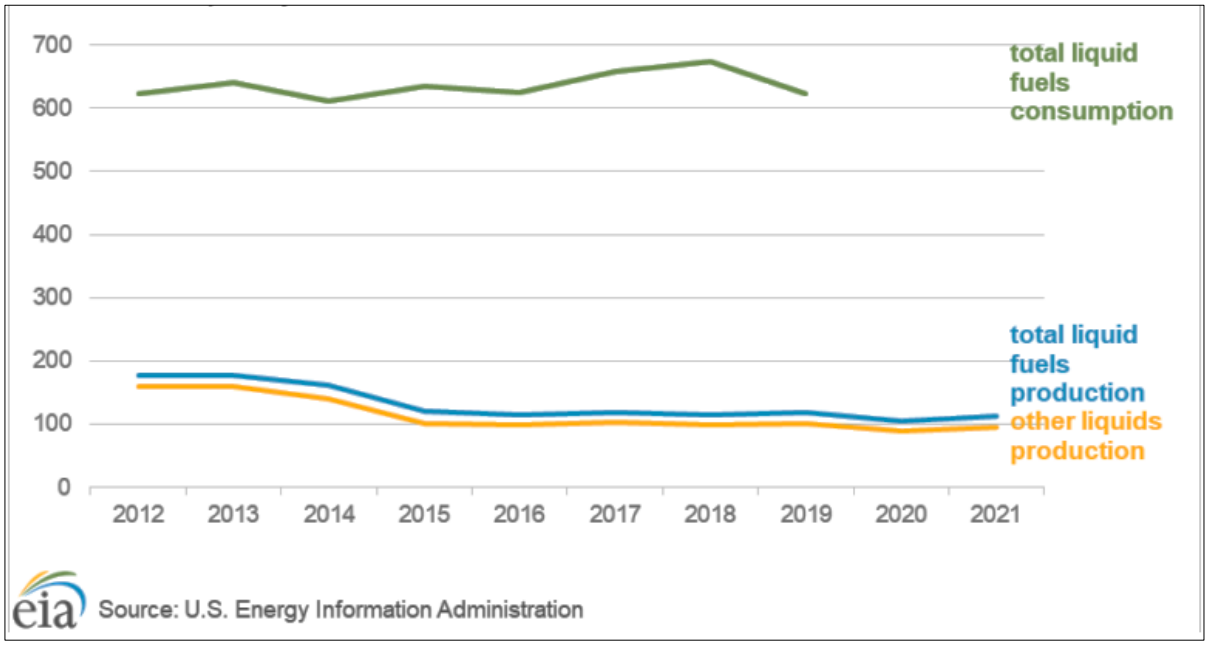

Figure 12 Oil and Liquid fuels production and consumption in South Africa (thousands of b/d)

Source: EIA, 2022

Plans to restore PetroSA began in March 2024 with the issuing of a gas trading license by DRME to the state-owned oil and gas company. From the license, the company intends to secure enough energy for industrial gas users which sits around 190 Pj/a. The amount of gas is set to be secured through two joint ventures with Total Energies for Brulpadda and for the Block 9 development. Negotiations to transport additional gas (2Pj/a with scope of up to 200PJ/a (Reuters 2024) from Mozambique through existing Rompco are ongoing, but not finalised to increase feedstock supply for PetroSA. However, an update as of July 2024 is that TotalEnergies has announced its withdrawal from the Brulpadda and Luiperd exploration blocks and Block 5/6/7 off the southern coast of South Africa, citing economic challenges in developing and monetising the gas discoveries (EngineeringNews, 2024).

Figure 13 PetroSA gas to liquids facility in Mossel Bay, Western Cape

Source: Engineering news (nd)

3.2.3. Natural Gas

Natural gas is a fossil fuel energy source containing many different compounds, with the largest component being methane gas. This energy source is categorised into three categories depending on its origin. Thus, natural gas found between large cracks located beneath bedrock is called conventional gas, that which is found within tiny pores within shale and sandstone rock formations is called unconventional gas and that extracted from crude oil is called associated gas. Natural gas deposits can be found onshore, inland and within coalbed deposits, this energy resource is extracted after performing seismic surveys and drilling to pump the gas or hydraulic fracturing (fracking) which forces water and chemicals under high pressures to extract the gas from shale or sandstone.

Natural gas contributes around three (3%) of South Africa's energy supply and is seen as key to ensuring its energy security (DMRE, 2023). Total Energies previously discovered two gas fields off the South African coast in 2019 and 2020. Its current area of interest covers 10,000km^2 and is located between Cape Town and Cape Agulhas, in water depths between 700 metres and 3,200 metres. It operates activities in the block and holds a 40 percent stake, with Shell holding another 40% and the national oil company PetroSA holding the remaining 20% t (Felicity Bradstock, 2023).

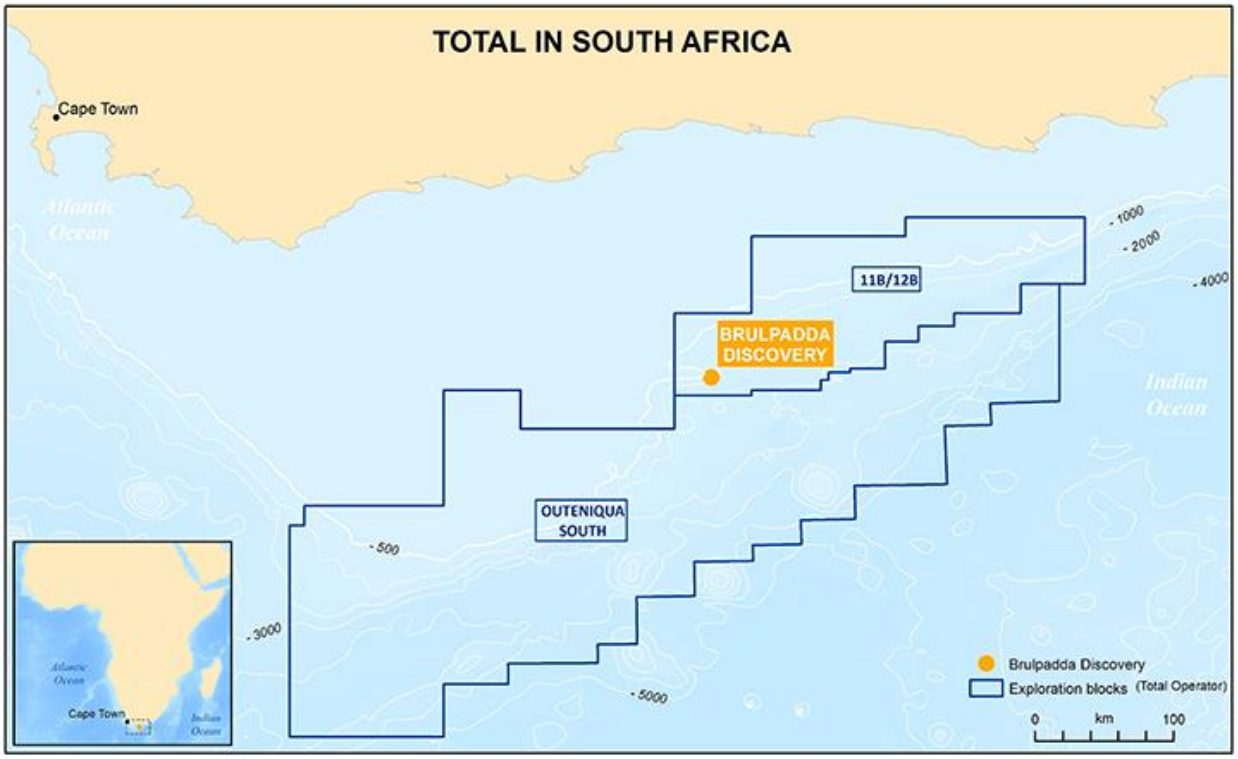

Figure 14 Total Energies offshore gas field discovery in the Southern Cape

Source: Total Energies, 2019

The gas industry in South Africa is undergoing rapid expansion, with neighbouring countries like Mozambique and Namibia having the availability of natural gas. The three largest users of natural gas are industrial, domestic and power generation. Of all the three, the use of natural gas for electricity generation has risen the most. Natural gas powers, heats and cools industries, homes and businesses, and it can be a good partner to renewable energy sources. It can also be used as a lower – carbon fuel for ships, trucks, busses and trains – but this is not yet the case in South Africa.

The Department of Mineral Resources and Energy (DMRE) is tasked with the procurement of 3,126 MW of power from gas in the period 2019–2025. This is to be baseload and mid-merit energy generation capacity needed from gas-fired power generation to contribute toward energy security. The demand for natural gas is expected to expand by an average of 5.2% per year in 2021-2030, boosted by government efforts to encourage its use and reduce reliance on coal (South Africa - Energy (trade.gov), 2024). The switch from diesel to gas is particularly applicable to developments at the domestic Ibhubesi gas field. The map (Figure 14 & 15) provides a location of this gas field for further understanding. This field is being developed by Sunbird Energy and is set to feed a 1,350MW power plant at Ankerlig, which currently runs on diesel. Eskom released a request for proposal (RFP) in May 2024 for the supply, delivery and off-loading of Propane Gas via road tanker to Ankerlig and Gourikwa Power Station.

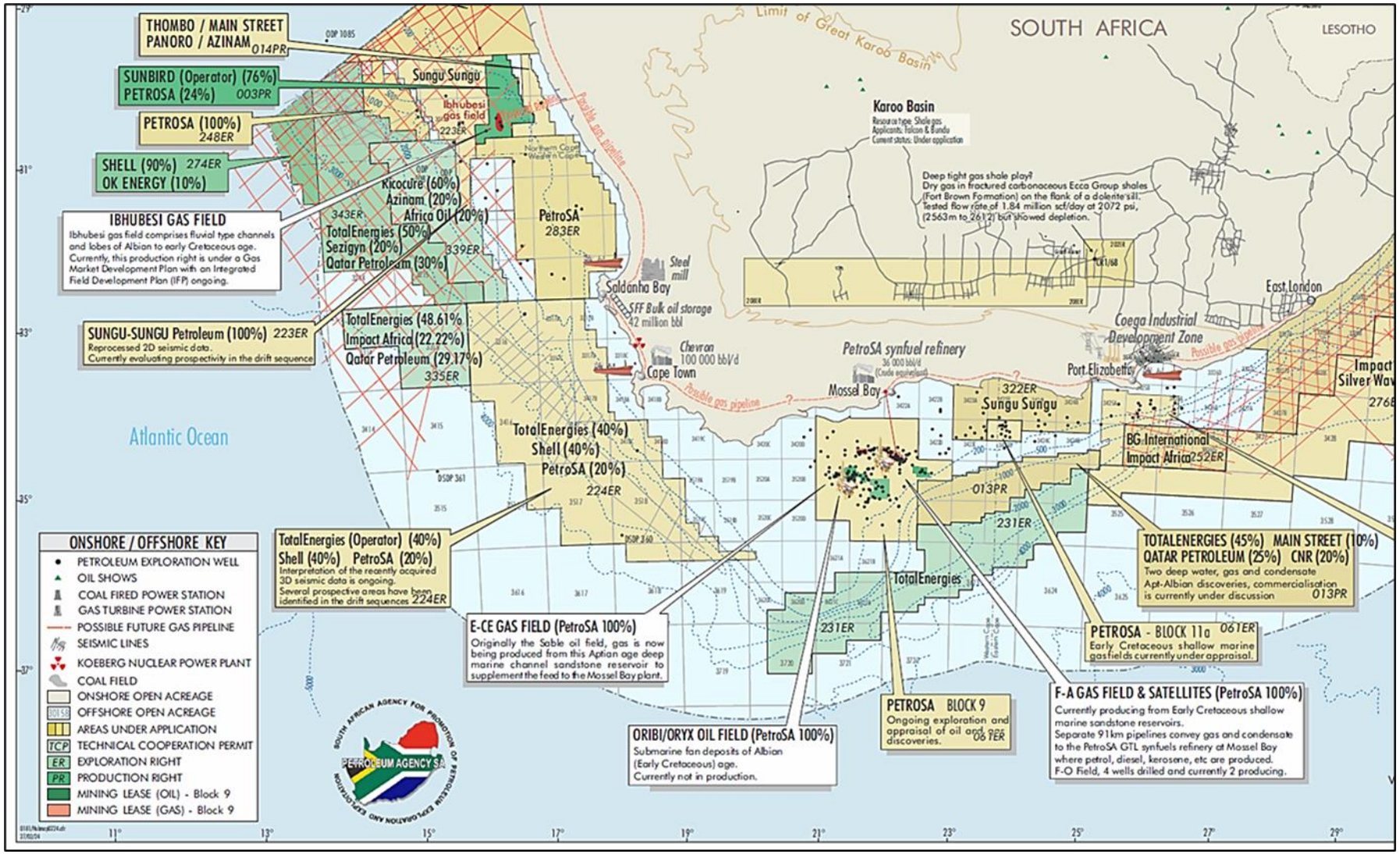

Figure 15 Petroleum exploration and Production Activities Map in South Africa

3.2.4. Nuclear Energy

While wind and solar PV are expected to lead the decarbonisation of the global power mix, flexible and dispatchable resources will be required to complement these supplies. The role of nuclear energy in contribute to the energy sector's transition to net zero emissions and overall energy security, needs consideration. There are environmental, economic and technical challenges to be considered, and not all countries will pursue nuclear energy as an option, but rising climate ambitions in many countries and today's energy crisis offer reasons to consider nuclear energy (IEA, 2022).

Koeberg Nuclear Power Plant, the only nuclear power station in Africa, and situation 27 kilometres north of Cape Town, has a pressurised water reactor (PWR) design. It boasts the largest turbine generators in the Southern Hemisphere and is the most southerly-situated nuclear power plant in the world (Eskom, 2024). This type of reactor uses water as both a coolant and a moderator, circulating it under high pressure to prevent it from boiling (IAEA, 2011). The water footprint of a PWR is significant due to the need for large volumes of water for cooling purposes. Koeberg, for instance, utilises seawater for cooling, which is drawn from the Atlantic Ocean and returned after use (IAEA, 2024). This process ensures that the reactor remains at safe operating temperatures, but it also means that the station's water usage is substantial, impacting local marine environments (IAEA, 2024).

Nuclear power accounts for just over 6% of South Africa's electricity mix. Koeberg nuclear plant is under Eskom operation. Two reactors were completed in the 1980s have a combined generating capacity of 1,830 MW. Although the two units at Koeberg Nuclear Power Plant were planned for closure in 2024 (Unit 1) and 2025 (Unit 2), ongoing upgrades to the reactors include steam generator replacement in 2023 which have extended their lifetimes to 2045 and 2047 respectively (International Trade Administration, 2024).

The Koeberg Nuclear Power Plant has faced significant maintenance and licensing challenges recently. In September 2024, Unit 1 was unexpectedly shut down due to a failed isolation/block valve during routine testing. This incident occurred just months after the unit received a 20-year life extension license, raising safety concerns. Additionally, Unit 2, which is undergoing life extension rehabilitation, is expected to receive only an eight-year extension due to more severe structural issues (BussinessReport, 2024). Eskom has assured stakeholders that the Long-Term Operation (LTO) project is on track, with significant milestones like the replacement of steam generators completed (Eskom, 2024). Ongoing concerns about the deteriorating state of the reactors are however noted (theconversation.com, 2024).

Figure 16 Koeberg Nuclear Power Plant

Source: Eskom (nd)

The extension of nuclear plant operation is common practice in the nuclear industry. Koeberg provides a base load supply of energy that is reliable, cost effective and produces low carbon emissions. The contribution of the electricity generated by the two Koeberg units (Unit 1 and Unit 2) equates to a reduction of loadshedding for the Western Cape, by approximately two stages. This presumably will not be the case as Eskom seeks a license extension to continue operations for the next 20 years. A significant amount of ageing coal fired power plants would have been decommissioned before 2030, however the South African Integrated Resource Plan 2023 (Draft) seeks to extend operations for a number of coal fleet to meet Eskom EAF improvement ambitions. This still does not derail South Africa's and the Western Cape's decarbonisation plans, however, sets out more work in renewable energy procurement to reduce dependence on fossil fuels for electricity energy generation.

3.2.5. Hydro Electricity

Steenbras Hydroelectric Storage Scheme

The Steenbras scheme, established in the late 1970s, continues operates as a crucial energy storage facility, utilising water between Upper and Lower Steenbras dams to generate electricity during peak demand and store energy during off-peak hours, functioning similarly to a battery. The City of Cape Town's 2023/24 'Building Hope' budget proposes significant investment in expanding and maintaining the Steenbras hydroelectric pumped storage scheme. With approximately R1.2 billion earmarked over the next nine years, including R1 billion for refurbishment and expansion and R200 million for maintenance, the city aims to enhance its capacity to shield residents from loadshedding and protect critical infrastructure. This initiative aligns with the city's energy priority programme.

3.2.6. Renewable Energy

South Africa experienced a surge of Solar PV imports between 2022 and 2023 driven by ongoing energy generation crisis, pushing individual households and companies to invest in alternative energy sources. The rapid increase in rooftop solar PV installations in South Africa not only gives consumers electricity security in the face of loadshedding, but it also means loadshedding does not have to be so severe. The investment cost is however high for individual households; and unfortunately, it worsens the energy poverty gradient.

South Africa saw massive solar PV cells modules & panels imports in the second quarter of 2023 (with imports mostly from China) marked by a record high of ZAR8.4 billion worth of Solar PV imports, more than double the entire value of those imported in the whole of 2022 (BusinessTech 2023). While the total value of Solar PV imports translates to a significant portion of energy generation to enable large industry offtakes to continue business operations outside Eskom, the current grid capacity challenge announced by Eskom can potentially impact Independent Power Procures feeding energy into the grid as the Western Cape is said to have reached saturation point, however the load curtailment programme has provided room for additional renewable energy projects to forward under REIPPPP bid 5 . (Terblanche *et. al*, 2024).

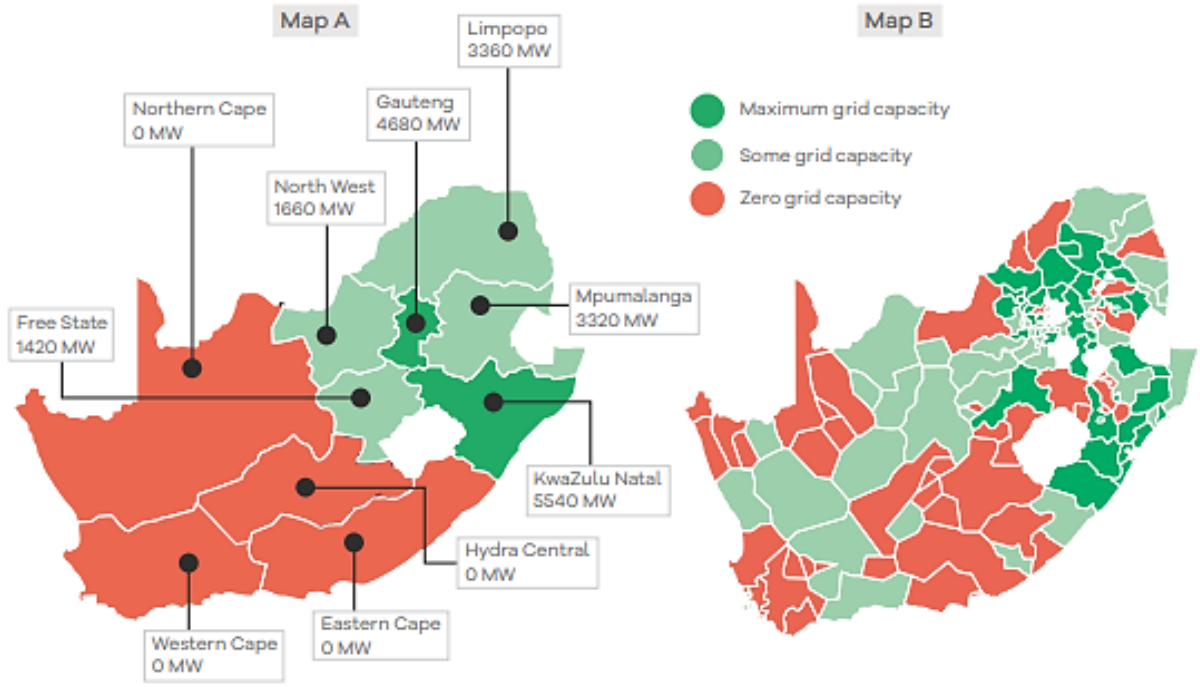

Figure 17 Eskom grid capacity at provincial and substation area level

Source: GreenCape, 2024

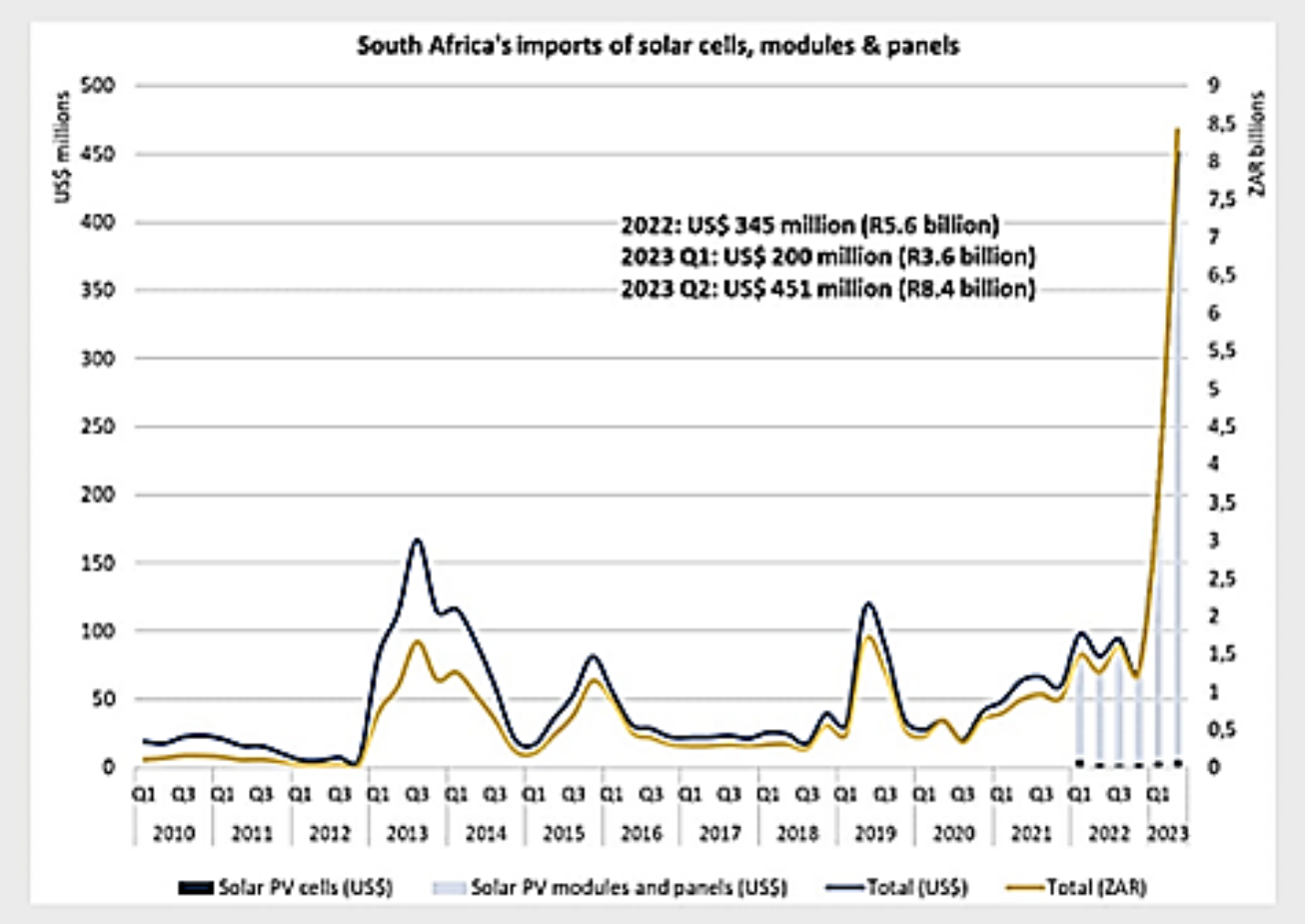

Figure 18 Trends in South African solar PV imports between 2010 and 2023

Source: BusinessTech, 2023a

With its Energy Resilience Programme, the Western Cape is well on its way on reducing its energy demand needs from Eskom, becoming a few loadshedding stages lesser when compared to the other eight provinces province in the country. The Western Cape Energy Resilience Programme has the following strategic objectives:

1) To reduce the impacts of load shedding on businesses and citizens in the Western Cape
2) To facilitate a lower level of reliance on Eskom in the Western Cape
   a. Reduce off take between 500MW – 750MW by 2025 (Short Term)
   b. Reduce off take between 750MW - 1 800MW by 2027 (Medium Term)
   c. Reduce off take between 1 800MW - 5 700MW by 2035 (Long Term)

There are five aspects being focused on to achieve the objectives above:

1) Load Shedding Relief Programme (LSRP)
2) Provincial Integrated Resource Plan (PIRP)
3) Demand Side Management Programme (DSMP)
4) New Energy Generation Programme (NEGP)
5) Network Development Programme (NDP)

Just under R7 billion in total is being spent over the next three years to make the Western Cape energy resilient. This amount is made up of over R1 billion from the province, R3.9 billion from the City of Cape Town and R1.9 billion being spent by other municipalities across the province to enable the private sector and households to find solutions. It is seeing a solar and wind energy surge in the province being led by private households and businesses, like:

- Three 75MW solar farms will be based in the Touwsriver area;
- Atlantis Foundries and their Energy Partner are working together on an extensive embedded solar initiative;
- Prescient Investment Management and H1 Holdings are investing in a solar project that will be radiating power into its system next year. This could power up to 100 000 homes;
- and thousands of households have invested in solar and battery solutions – the latest estimates are that at least 6 GWs have been added.
- Cape Town has already announced that they will pay cash for your excess energy and our other municipalities are busy trying to do the same.
- The province is building an energy ecosystem to bring more private sector role players into the fold to help us overcome the power crisis. Phelan Energy is one such company that is tapping into the green hydrogen (GH2) sector.

Figure 19 Grootfontein Solar Farm (Witzenberg Municipality)

Grootfontien Solar Farm is expected to come online in 2025 to power Atlantis foundries which will be the Western Cape's largest embedded generation solar project. The facility is expected to generate more than ZAR 35 million worth of electricity per year (Source: Venter 2023).

Figure 20 Electricity supply to the Western Cape by Eskom

Source: PERO (2023)

As per figure 20, over the past decade, the amount of electricity supplied by Eskom to the Western Cape has seen a significant decline. In 2022, Eskom distributed 16.9% less electricity to the region compared to 2013, amounting to a reduction of 3,920 GW-hours. This is due to multiple influencing factors. This decrease is equivalent to a shortfall of 2,148 MW in potentially, solar electricity WCG, 2022).

3.3. Energy Security

Energy security is an essential component of economic stability and social well-being. Policymakers and analysts are increasingly adopting a multidimensional approach, often using the 'four A's' to define energy security – availability, affordability, accessibility, and acceptability (Cherp and Jewell, 2014).

As is captured in this Energy chapter, the Western Cape remains heavily reliant on Eskom for energy supply and on national grants for electrification. However with underlying and persistent challenges captured in this chapter, including that of loadshedding, rapidly and persistent rising electricity prices with negative impacts across all sectors and for the citizens of the Western Cape, the high carbon content of fossil fuel generated energy and the substantial debt burdening both Eskom and the national treasury – these are persistent risks to the energy security of South Africa and the Western Cape.

Access to electricity is essential for alleviating poverty and inequality. The Human Settlements and Infrastructure chapter of this Western Cape State of Environment Outlook Report 2024 has done a comprehensive analysis across datasets: *Stats SA Census 2011, 2022 and General Household Survey 2016.* What follows is a conclusion that since 2011, electricity access in the Western Cape has improved significantly, with approximately 600,000 additional households connected to the grid, increasing coverage from 93% to 96% by 2022. However, access gains primarily occurred in

the first half of the decade, with little change from 2016 to 2022. Despite an additional 315,000 households gaining access since 2015, this only matched population growth. While access has generally improved across the districts, it remained static in the Garden Route and slightly declined in the City of Cape Town. Not all reported connections are legal, and some informal settlements in non-serviceable areas, such as wetlands, remain without electricity. Given the high levels of fossil fuels comprising South Africa's electricity generation mix, it is important to note that the number of households mainly using solar energy for lighting has more than doubled since 2016. However, at approximately 8 000 households, it still represents a fraction of the population.

The 'acceptability' aspect is typically viewed through the lens of environmental sustainability. The World Energy Council employs the concept of the energy trilemma to evaluate the trade-offs within the energy sector, focusing on reliable supply, energy equity, and environmental sustainability (WEC, 2017).

Considering the state and outlook of energy, the role of energy in our economy will become even more pronounced as sectors become digitally integrated. This elevates energy security higher on the energy policy agenda (IEA, 2020).

4. Impacts

Global economies continue to face the significant challenge of ensuring environmental sustainability. In a world moving towards net zero emissions by 2050, South Africa is no different from other developing countries confronted with choosing between advancing the economy and the need to protect the environment (Udeagha & Muchapondwa 2022).

4.1. Environmental contamination and degradation

National electricity production in South Africa, heavily reliant on coal-fired power plants, significantly impacts South Africa but not excluding the Western Cape's environment. The pollutants released from these plants, such as sulfur dioxide (SO_2) and nitrogen oxides (NO_x), travel long distances and contribute to air quality degradation. This pollution harms local ecosystems, reduces agricultural productivity, and poses health risks to residents (WCG, 2018). With the surge in alternative energy generation to balance the coal-fired power plant energy mix, environmental contamination and degradation is also associated with solar energy, wind energy, and natural gas. For each energy type, specific contamination and degradation should be explored. Some of the environmental impacts may be off-site, i.e. solar energy have impacts associated with hazardous material, waste generation and lifecycle emissions which may manifest as impacts outside of the Western Cape where it is being installed.

The Renewable Energy Development Zones (REDZ) in South Africa, including those in the Western Cape, are designated areas aimed at streamlining the development of renewable energy projects to meet the country's energy needs while minimising environmental impacts. However, the expansion of renewable energy infrastructure in these zones still pose significant biodiversity risks. In the Western Cape, the development of wind and solar farms can lead to habitat fragmentation and loss, particularly affecting the region's unique fynbos biome, which is home to numerous endemic species (WCG, 2018). Additionally, the construction and operation of renewable energy facilities can disrupt local wildlife, including bird and bat populations, through

collisions with wind turbines and habitat disturbances (DailyMaverick, 2024a). Effective environmental management and careful site selection are crucial to mitigate these impacts and ensure that renewable energy development in the Western Cape aligns with biodiversity conservation goals (SANBI, 2024).

Natural gas exploration in the Western Cape, particularly offshore, has raised several environmental and socio-economic concerns. One significant impact is the potential disturbance to marine ecosystems. The proposed drilling activities by companies like TotalEnergies and Shell in areas such as Block 5/6/7, which stretches from Saldanha Bay to Cape Agulhas, could lead to a reduction in air and water quality, disturbance of marine and coastal animals, and the introduction of invasive species (Natural Justice, 2022).

Another anticipated impact is on the local fishing and tourism industries. The presence of drilling operations can disrupt fishing activities and deter tourists, which are vital to the Western Cape's economy and therefore requires appropriate planning and management. Furthermore, the risk of oil spills, although associated with oil exploration, is a pertinent concern for natural gas operations as well, given the shared infrastructure and operational practices (DailyMaverick, 2024b).

On the socio-economic front, while natural gas exploration can create job opportunities and attract investment, it also poses risks to coastal communities. These communities, already vulnerable to climate change, could face further challenges from the environmental degradation associated with gas exploration. The legal battles and public opposition to these projects highlight the contentious nature of balancing energy development with environmental protection (DailyMaverick, 2024b).

4.2. Short-term solutions to loadshedding: diesel generators

As a short-term solution to loadshedding, many small and medium size businesses and even households have relied on diesel generators during periods of loadshedding. Besides an unfavarouble economic impact on business and households, this short-term solution has direct and indirect environmental impacts.

4.3. Greenhouse gas emissions

Greenhouse gas (GHG) emissions from electricity consumption and combustion of fossil fuels by the transport and manufacturing sectors in the Western Cape has taken a fluctuating trend marked by a decrease in emissions between 2009 and 2012/13, then increasing again between 2012/13 and 2015/16 and now showing a decreasing trend again to 2018. For better understanding, see Table 1 for energy consumption data values against Figure 21 for emissions by district as a percentage of the totals. The fluctuations of the emissions profile have not been analysed to determine the cause; however possible reasons are outline as follows:

- A natural fluctuation across years and sectors due to economic downturns, the impacts of the drought in the Western Cape, amongst others;
- Changes in quality of the data used in the analysis for some of the fuels, in particular coal and liquid fuels; or
- An actual shift in the consumption, due to an increased uptake on low carbon and energy efficient technologies for residential, commercial and industrial purposes

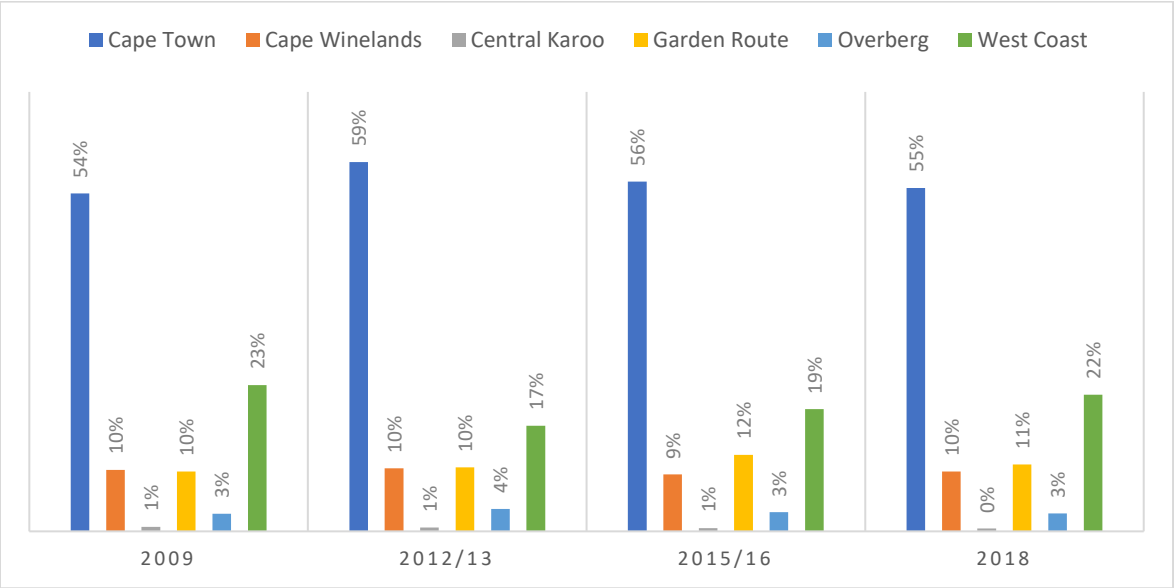

Figure 21 Emissions by district / metropolitan municipality (as % of Western Cape emissions)

(Source: Greenhouse Gas Inventory for the Western Cape, 2023).

4.4. Theft and Vandalism

Transformer theft incidents: 2018/19 to 2023/24							
Operating unit	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**Total**
Eastern Cape	1,171	1,080	1,194	1,280	1,418	986	7,129
Free State	702	582	569	554	518	420	3345
Gauteng	1,849	1,195	1,400	1,116	771	699	7,030
KwaZulu-Natal	2,159	1,290	1,489	1,152	1,125	1,383	8,598
Limpopo	924	828	852	857	707	523	4691
Mpumalanga	732	702	731	837	764	667	4433
North West	892	878	803	767	675	507	4522
Northern Cape	462	434	410	449	422	367	2544
Western Cape	269	274	261	372	322	253	1751
Total	**9,160**	**7,263**	**7,709**	**7,384**	**6,722**	**5,805**	**44,043**

Eskom transformer repair/replacement costs: 2022/23		
Province	**Direct loss value**	**Recovered value**
Eastern Cape	R95,526.00	R0.00
Free State	R4,212,323.00	R4,034,300.00
Gauteng	R2,115,966.70	R25,951.00
KwaZulu-Natal	R199,896.00	R237,028.00
Limpopo	R8,169,166.00	R65,000.00
Mpumalanga	R3,504,533.08	R160,620.00
North West	R460,965.00	R0.00
Northern Cape	R110,000.00	R0.00
Western Cape	R85,292.67	R24,804.00
Total	**R18,953,668.45**	**R4,547,703.00**

Figure 22 Transformer theft incidents (2018/19 - 2023/24) and transformer thefts costs (2022/2023)

(Source: Illidge 2024)

Throughout the Western Cape with specific hotspots around the Cape Town metro, theft and vandalism to electricity infrastructure leaves citizens without electricity supply. This is an energy security matter that is separate from national supply challenges and must be dealt with at provincial or local level in collaboration with Eskom. As a result of theft and vandalism, Eskom network infrastructure must be restored which causes interruption in electricity supply to citizens in the affected area.

The theft of solar panels has been on the rise, driven by the increasing demand for solar energy solutions due to persistent load shedding. As reported in this chapter, South Africa imported R31

billion worth of solar panels from 2010 to 2022, creating a lucrative market for criminals. As a result, the so-called black market for solar panels is also booming, with stolen panels often being stripped for valuable components such as copper or sold as complete units. Insurance companies have also observed an uptick in claims related to solar panel theft, prompting some to offer specialised insurance products to protect against such crimes (BusinessTech, 2023b).

5. Responses

Clear and stable energy policies and regulatory frameworks are crucial for attracting investment in the energy sector and facilitating the development of new technologies – in response to the current state of energy in the Western Cape. Ensuring alignment with national energy policies and addressing regulatory barriers are essential for promoting sustainable energy development across the province. This section highlights these current responses for the Western Cape.

As mentioned in Section 2.4 that the regulatory environment in electricity generation, transmission and distribution is identified as a barrier that led to the slow uptake of renewable energy technologies at National, Provincial, and municipal levels. The Western Cape, through its energy resilience program has set targets to reduce the provinces reliance on Eskom. This work would be made possible through interventions such adding capacity through the REIPPP, municipal IPP, SSEG, demand side management and business support. Therefore, additional capacity to be added onto the grid through these programmes to materialise the targets set out in Western Cape's Energy Resilience Programme are complimented by ZAR R5.8 billion investment from the CCT and other WC Municipalities (reference). Through Eskom's curtailment programme, the Western Cape received and an additional 2680 MW renewable energy capacity to be made available for IPP's (Eskom 2024). To date, the Western Cape hosts eleven operational solar PV and onshore wind installations with total capacity of 1008MW awarded from REIPPP bid window one up until bid window four. REIPPP bid window five comprises of two wind and three solay PV projects with a total capacity of 505 MWh under construction. Added the above, Eskom introduced the Hex Battery Energy Storage System (BESS) in the Breede Valley in November 2023. The Hex BESS is equipped with large scale utility batteries with the capacity of 1 440 MWh per day and a 60 MW PV capacity, enough to power a town the size of Mossel Bay for five hours.

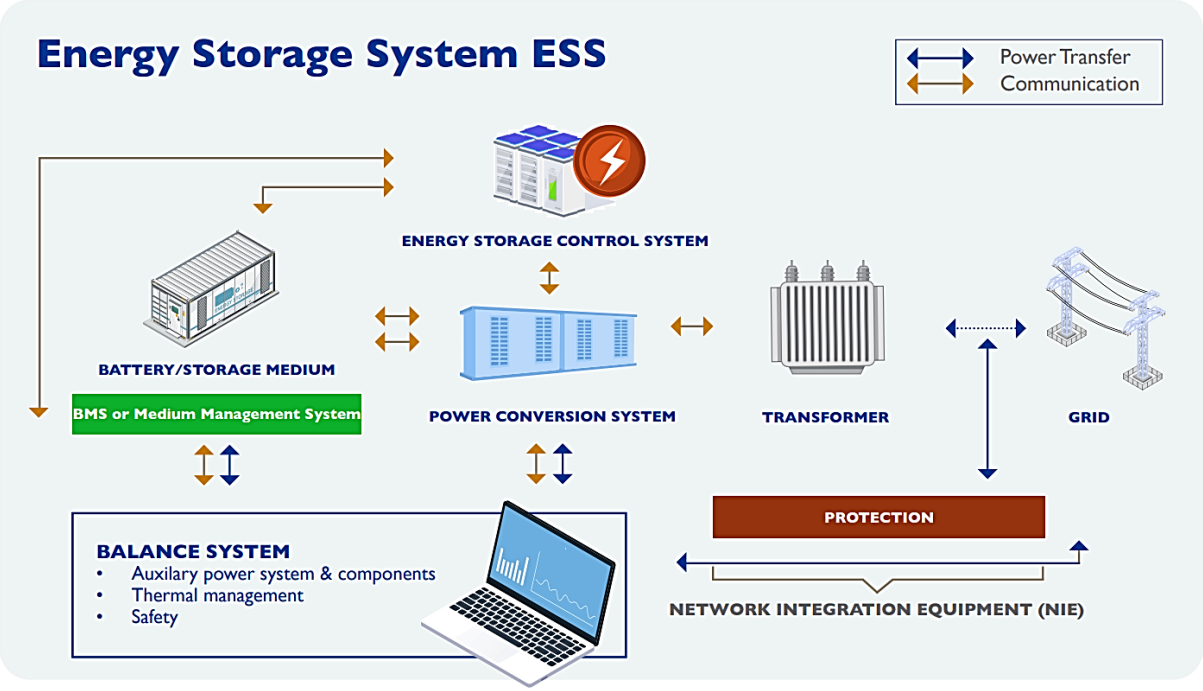

Figure 23 Main components of the BESS

The main components of the BESS include the battery (energy storage medium), Power Conversion System (PCS) and grid integration equipment. When required, the PCS is used to discharge/charge the battery and supply the energy into/from the network. The PCS is connected to a transformer which steps up the voltage required and then sends it into the Eskom grid.

The Western Cape Climate Change Response Strategy (WCCCRS) describes the Western Cape as a province that continues to attract investment in the renewable energy sector. With that comes the potential of contributing significantly to economic growth going forward, not only through providing energy for industries and households but also through job creation within the renewable energy sector itself. It is estimated that by 2032, the southern two-thirds of the country will produce 52% of electricity, up from 22% in 2022. The Western Cape is projected to have a 138% growth in electricity generation, with wind making up half of the generation capacity by 2032.

Net zero

Addressing South Africa's energy crisis necessitates a comprehensive transformation of the power sector, emphasising diversification and decentralisation of the energy supply to enhance resilience and sustainability.

Carbon border adjustment mechanisms (CBAM) are expected to raise import costs from carbon-intensive countries like South Africa. In response to climate change challenges, the Western Cape Government aims to achieve net zero greenhouse gas emissions by 2050.

Carbon tax

South Africa's significant dependence on fossil fuels, especially coal, has positioned it as the 14th largest global CO2 emitter (WEF, 2019). The country ratified the Paris Agreement in 2016, and the

Carbon Tax Act was implemented in June 2019 after nine years of extensive consultation and debate. The Carbon Tax Act (2019) aims to reduce greenhouse gas emissions by promoting renewable energy and low-emission processes. It follows the polluter-pays principle, requiring entities exceeding a certain threshold to pay a carbon tax, which was initially set at R120 per tonne of CO_2-equivalent emissions (National Treasury, 2019). The tax design includes several allowances introduced in the first phase (June 1, 2019 – December 31, 2022), reducing the effective tax rate.

With these allowances, businesses can lower their carbon tax liability by up to 95%, resulting in a reduced rate of R6–R45 per tonne of CO2-equivalent emissions (National Treasury, 2019). The initial tax rate of R120 per tonne (approximately US$8 per tonne) has faced criticism for being relatively low. Estimates suggest that a carbon price consistent with the Paris Agreement's temperature targets should be at least US$40–US$80 per tonne by 2020 and US$50–US$100 per tonne by 2030 (Carbon Pricing Leadership Coalition, 2017). However, lower initial rates can facilitate the transition in carbon-intensive economies, with stronger policies or higher carbon prices needed later to meet the Paris Agreement objectives.

The Taxation Law Amendment Act, 34 of 2019, expanded the definition of 'person' in section 1 of the Carbon Tax Act to include municipalities, making them liable for carbon tax. The City may offset its tax liability through the sale of certified emissions reductions (CERs), enabled by the Carbon Offsetting Regulations published in November 2019.

As of 2024, updates to the Carbon Tax Act have increased the tax rate to R150 per tonne of CO2-equivalent emissions, reflecting a gradual move towards higher carbon pricing to meet climate goals. The carbon tax rate will rise annually by at least R15, with the goal of reaching R300 by an unspecified date. Starting in 2026, the government plans to accelerate this annual increase, aiming to achieve a carbon price of at least R450 by 2030 (GreenCape, 2023). Additionally, new incentives for renewable energy projects have been introduced to further support the transition to a low-carbon economy.

Wheeling

Wheeling refers to the process of transporting electrical energy from a power producer to a consumer via a distribution or transmission network. This mechanism enables independent power producers (IPPs) to sell electricity directly to end-users, known as offtakers, while incurring charges for utilising a third-party electricity grid, such as that owned by a municipal distributor or Eskom (SALGA, 2023).

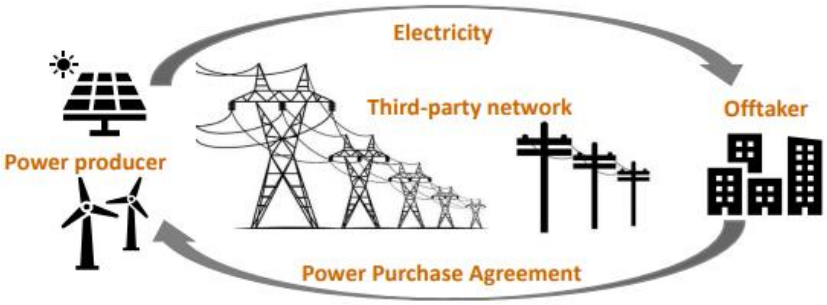

Figure 24 Wheeling process and cycle

Source: SALGA, 2023

It is worth mentioning that wheeling is not a recent development. Eskom has engaged in wheeling agreements through municipal networks for many years, and when a municipality sources energy from an IPP, it often involves using Eskom's grid. In South Africa, "wheeling" specifically describes the transactions involving IPPs, traders, and offtakers that make use of public distribution networks. The various parties involved in wheeling are typically outlined as follows. The George Municipality was the first Municipality in the Western Cape to pilot and then launch an energy wheeling project.

George Municipality established a wheeling pilot in 2021 and Enpower energy trading company participated in the pilot. Wheeling volumes are still small, but the pilot is set to grow as new generators connect to wheel. George Municipality follows the energy credit method and has implemented monthly TOU billing reconcilliation. Roughly 5-10 MWh are currently wheeled per month in George (SALGA, 2023).

The City of Cape Town has initiated a wheeling pilot project allowing private companies to supply electricity to others using the city's infrastructure. This process, known as wheeling, involves buying and selling electricity between private parties across long distances using existing grids. This transaction is governed by a bilateral Power Purchase Agreement (PPA) within a market environment, where the energy price is determined between the parties involved, rather than being regulated by entities like the City of Cape Town, Eskom, or the National Energy Regulator of South Africa (NERSA). This approach enables flexibility and market-driven pricing in the sale and distribution of electricity across different points within the network.

The aim is to increase access to renewable and independent energy, potentially helping businesses mitigate load shedding and reduce dependence on Eskom's generation. Growthpoint Properties, in partnership with Etana Energy, became the first to wheel renewable electricity under this pilot. Solar energy generated at Growthpoint's Constantia Village shopping centre is exported into Cape Town's grid for use at their Foreshore office building. The pilot aims to lay groundwork for future wheeling in Cape Town, supporting businesses to optimise solar capacity across multiple locations. The city plans to add up to 1,000MW of independent power to combat load shedding, with wheeling potentially contributing up to 350MW over time. The pilot also tests contracting frameworks and billing engines for wider implementation, while Vodacom explores a virtual wheeling model with IPPs and municipalities to expand renewable energy access without affecting revenue streams of electricity distributors like Eskom and municipalities (Business Tech, 2023).

The City of Cape Town is emphasising the importance of private sector involvement in addressing future electricity needs, aiming to reduce government funding burdens and Eskom's borrowing requirements. Electricity wheeling plays a crucial role by allowing customers to independently procure electricity from the City, utilising existing infrastructure and reducing carbon footprints. For the City, wheeling offers an opportunity to diversify from Eskom reliance and potentially rent out infrastructure. The City's Electricity Supply By-law permits retail wheeling through licensed third-party suppliers on 11kV and higher lines. The envisioned future includes a competitive electricity retail market with prices set via bidding or bilateral agreements, facilitated by wheeling under current rules. As per the above information, the pilot research project is underway to test and refine the wheeling model, involving selected third-party participants over at least a year to prepare for full implementation (CoCT, 2024).

Table 1 Responses summary of policy, tools and frameworks

Responses	Year	Description
International Responses	2002	**Kyoto Protocol (Ratified by South Africa in March 2002)** The South African government acceded to the Kyoto Protocol in July 2002. By doing so, South Africa committed to specific actions to mitigate climate change.
	2012	**Doha Amendment** In Doha, Qatar, on 8 December 2012, the **Doha Amendment** to the Kyoto Protocol was adopted for a second commitment period, starting in 2013 and lasting until 2020. As of 28 October 2020, 147 Parties deposited their instrument of acceptance, therefore the threshold of 144 instruments of acceptance for entry into force of the Doha Amendment was achieved. The amendment entered into force on 31 December 2020.
	2014	European Union (EU) countries have agreed on a **2030 Framework for climate and energy**, including EU-wide targets and policy objectives for the period between 2020 and 2030. These targets aim to help the EU achieve a more competitive, secure and sustainable energy system and to meet its long-term 2050 greenhouse gas reductions target.
	2015	The Conference of the Parties, at its 21st session, adopted the Paris Agreement on 12 December 2015. The **Paris Agreement** stipulates that it shall enter into force thirty days after the date on which at least 55 Parties to the United Nations Framework Convention on Climate Change (UNFCCC) accounting in total for at least an estimated 55 % of the total global greenhouse gas emissions have deposited their instruments of ratification, acceptance, approval or accession with the Depositary, the Secretary-General of the United Nations. The agreement was opened for signature on 22 April 2016 in New York. On 5 October 2016, the threshold for entry into force was achieved

		and the Paris Agreement entered into force on 4 November 2016.
	2016	The **Paris Agreement** is an international treaty on climate change that was adopted in 2015. The treaty covers climate change mitigation, adaptation, and finance. The Paris Agreement was negotiated by 196 parties at the 2015 United Nations Climate Change Conference near Paris, France. South Africa released its latest national climate commitment under the Paris Agreement. The country intends to limit GHG emissions to 398-510 MtCO2e by 2025, and to 350-420 MtCO2e by 2030, significantly lower than targets communicated in 2016. These new targets will also see South Africa's emissions decline in absolute terms from 2025, a decade earlier than planned.
National Responses	1998	The **White Paper** on Energy Policy for the Republic of South Africa.
	2003	The **White Paper** on Renewable Energy
	2003	**Electricity Basic Services Support Grant** (Free Basic Electricity) Policy
	2011	**National Climate Change Response White Paper** Climate change is already a measurable reality and along with other developing countries, South Africa is especially vulnerable to its impacts. This White Paper presents the South African Government's vision for an effective climate change response and the long-term, just transition to a climate-resilient and lower-carbon economy and society.
	2011	**Renewable Energy Independent Power Producer Procurement Programme**
	2011	**The South African National Energy Development Institute (SANEDI)** was established in 2011 under the National Energy Act, 2008 (Act No. 34 of 2008). The Act provides for SANEDI to direct, monitor and conduct energy research and development, promote energy research and technology innovation as well as undertake measures to promote energy efficiency throughout the economy.
	2011	**National Development Plan 2030**

	2015	**South Africa's integrated energy planning framework, 2015-2050**
	2019	The **Integrated Resource Plan 2019 (IRP 2019)** is an electricity infrastructure development plan based on least-cost electricity supply and demand balance, taking into account security of supply and the environment.
	2022	**Free Basic Services Indigent Support Policy (Amended) 2023-2024**
	2023	An **Energy Action Plan** announced by the President in July 2022, bd updated in January 2023
	2023	**South African Renewable Energy Masterplan (SAREM)** An industrial and inclusive development plan for the renewable energy and storage value chains by 2030.
	2013	**Western Cape Green Economy Strategy Framework**
	2014	**Provincial Strategic Plan**
	2014	**Western Cape Climate Change Response Strategy and Implementation Framework**
	2019	**Provincial Strategic Plan 2019 - 2024**
	2020	**Western Cape Energy Resilience Programme**
	2022	**Small-Scale Embedded Generation (SSEG) Feed-In Tariffs**
Local Authority Responses	2006	**City of Cape Town Energy and Climate Change Action Plan**
	2011	**City of Cape Town State of Energy and Energy Futures Report**
	2011	**City of Cape Town Smart Living Handbook**
	2011	City of Cape Town – **Moving Mountains, Energy and Climate Change Plan of Action**
	2011	**Eden District Demand Side Energy Awareness Program**
	2014	**The Low Carbon Central City Strategy**
	2015	**Cape Town Energy 2040 Vision and Associated Energy and Carbon Targets**

	2015	**Cape Town State of Energy**
	2017	**City of Cape Town Climate Change Policy**
	2020	**The City of Cape Town's Carbon Neutral 2050 Commitment 2020**
	2021	**The City of Cape Town's State of Energy and Carbon 2021 report**. The report outlines key energy and carbon trends and how the city is responding to impossible-seeming trade-offs.
	2023	The **2050 Energy Strategy** for The City of Cape Town With this Energy Strategy, Cape Town is charting the long-term path to 2050.

6. Conclusion

OUTLOOK: CONCERN

The current global and Western Cape drive towards a less wasteful and circular economy is supporting multiple new energy technologies and green economy opportunities that are specific to the local energy sector. The review period of this Energy Chapter (2018-2024) has seen marked improvements in the expansion of utilising technology and embedded generation, and the exploration and piloting of new technologies such as hydrogen production.

Despite many positive changes at local Western Cape level, South Africa's energy landscape is marked by significant challenges that brings the overall energy outlook for the Western Cape to a "concern" state. The country continues to expand its renewable energy capacity, with a strong emphasis on solar and wind power to diversify its energy mix and reduce reliance on coal. The Integrated Resource Plan (IRP) 2019[1] outlines ambitious targets for renewable energy deployment, supported by ongoing projects under the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). Concurrently, Eskom, the state-owned electricity utility, is undergoing reforms to enhance financial sustainability and operational efficiency, crucial for improving energy reliability amid ongoing power supply challenges (DMRE, 2024). The energy transition poses complexities in balancing energy security with climate change mitigation goals, prompting discussions on grid integration of renewables and the future role of gas and nuclear energy. Technological advancements in energy storage and digital solutions are also shaping the sector's evolution (BusinessTech, 2024).

Electricity shortage is currently the foremost constraint limiting economic growth and job creation in South Africa, attributed to a significant 6 GW shortfall in production capacity. Furthermore, the country ranks among the world's most carbon-intensive economies, posing severe implications for climate change, environmental sustainability, and overall economic stability.

The energy landscape in the Western Cape of South Africa shows significant progress and ongoing developments in several key areas. The region continues to prioritise renewable energy projects, particularly in solar and wind power, benefiting from the Western Cape's climate (GreenCape, 2024). Initiatives under the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) have contributed to the establishment of several solar and wind farms, enhancing the region's renewable energy capacity (Western Cape Government, 2024). The province has emerged as the leading provincial recipient of foreign direct investment (FDI) in renewable energy projects. Despite substantial growth potential and the capacity to create 1.2 million jobs, renewable energy currently constitutes a small fraction of South Africa's overall energy production (PERO, 2023).

While there is a push towards renewable energy, the Western Cape also needs to consider diversifying its energy sources. Diversification will help stabilise the energy landscape, mitigate risks associated with over-reliance on specific energy sources and enhances overall energy security for the province.

One of the primary challenges is integrating the increasing share of renewable energy sources, such as solar and wind power, into the existing grid infrastructure and the capacity of transmission infrastructure. Managing the intermittency of renewable energy generation and ensuring grid stability are critical issues that need to be addressed to maintain reliable electricity supply for the Western Cape. Efforts are also underway to strengthen grid infrastructure to accommodate the

[1] *This is currently being revised and however no timeline is currently available as to when the revision period will be complete.*

increasing share of renewables and address grid integration challenges (Western Cape Government, 2024) - and this is a key matter moving the province forward in terms of energy security. Local government initiatives, such as the Green Cape Energy Programme, aim to promote sustainable energy practices and support local renewable energy projects (Green Cape, 2024). Challenges such as regulatory complexities and grid stability issues persist but are being highlighted as critical for addressing to foster a sustainable and resilient energy sector (Green Cape, 2024; WCG, 2024).

Other critical aspects to shift the energy outlook of the Western Cape from a declining-stable to improving state, is on-going infrastructure development and maintenance. Investment is needed for upgrading and maintaining its electricity infrastructure - this includes improving transmission and distribution networks to handle the growing demand and facilitate the integration of renewable energy projects. However challenges persist as the province does not own any of the electricity infrastructure and some of the municipalities are responsible for distribution infrastructure. It remains a responsibility of Eskom and the necessary engagements on these challenges must continue.

The Western Cape is currently prioritising the addressing of the energy crisis and the current concerning outlook for the state of energy. The Growth4Jobs (G4J) strategy, launched by the Western Cape Government in 2023, emphasises the critical role of energy in achieving economic growth and job creation. The strategy acknowledges that reliable and affordable energy is essential for enabling the private sector to thrive and create jobs. To alleviate the Western Cape from the debilitating impacts of energy constraints, the Growth4Jobs Strategy (2023) summarises action points:

- Ensuring the availability of affordable, reliable electricity supply to support economic activities;
- Reducing reliance on Eskom by promoting independent power production and renewable energy sources;
- Creating an enabling environment for the transition from fossil fuels to renewable sources of energy;
- Increasing the use of renewable energy to create a sustainable and resilient economy;
- Leveraging the energy transition as a source of competitive advantage for the Western Cape's economy;
- Investment in energy infrastructure is a priority to support the growth of businesses and industries. This includes upgrading existing infrastructure and developing new projects to meet the increasing energy demands;
- The G4J strategy aligns with the Western Cape's commitment to a green economy, aiming to reduce carbon emissions and promote sustainable practices. This includes supporting green technology and innovation in the energy sector;
- By focusing on energy, the strategy aims to create jobs in the renewable energy sector and related industries. This is part of the broader goal to build a jobs-rich, inclusive, and sustainable economy.

This Energy Chapter has captured various persistent and existing challenges, many of which are long-standing challenges with multi-stakeholder approaches needed to resolve these persistent challenges, alongside committed financial investment. The chapter has also captured various initiatives and responses to improve the state and outlook of energy for the Western Cape. To improve its energy outlook, the Western Cape has made major strategic and investment shifts in

the recent years, with critical areas on diversifying its energy sources, infrastructure development and maintenance, private-public partnerships, energy efficiency and research and market development to ensure uptake and expansion of energy solutions.

The state and outlook are summarised in the following tables.

Table 2 Summary of Key Points

Aspect	Summary of key points
Pressures	• Infrastructure upgrading and maintenance; financial investment to maintain and expand the Western Cape energy infrastructure; • Infrastructure damage from extreme weather events and a slow infrastructure re-build due to fiscal constraint; and • Eskom loadshedding and reliability.
Impacts	• Economic losses both in direct losses (employment and sector pressures directly from loadshedding) and the loss of potential investment and economic growth due to lack of reliable energy; • Cost increases to Western Cape citizens and impacts on living costs;
Challenges	• As more electricity customers turn to self-generation solutions, municipalities face financial sustainability challenges. This shift reduces the revenue municipalities earn from electricity sales, which in turn affects their ability to subsidise services. • Ensuring reliable energy supply remains a challenge, particularly during peak demand periods and adverse weather conditions, the Western Cape remains on high readiness to enhance the province's resilience against power outages, reducing dependency on national electricity as key priorities for enhancing energy security.
Progress	• The Western Cape Government has launched the Energy Resilience Programme to mitigate the impacts of load shedding and reduce reliance on Eskom. The programme aims to reduce offtake by 500-750 MW by 2025, 750-1,800 MW by 2027, and 1,800-5,700 MW by 2035. • Large solar and wind energy developments are underway (described in this chapter) and being planned for the coming short term. • To complement renewable energy sources, the Western Cape is also focusing on battery storage solutions. This includes a battery storage facility to ensure a stable and reliable power supply. • The Western Cape is implementing feed-in tariffs to encourage the adoption of renewable energy by allowing small-scale generators to sell excess power back to the grid.
Critical areas for action	• Diversification of Energy Sources; • Infrastructure Development for renewable energy integration and distribution; • Promoting energy efficiency across various sectors, including residential, commercial, and industrial, helps reduce overall energy demand. This includes initiatives like retrofitting buildings and encouraging the use of energy-efficient appliances;

	• Implementing supportive policies and regulations, such as feed-in tariffs and streamlined approval processes for renewable energy projects, encourages investment and development in the energy sector; • Investing in research and innovation to explore new technologies and solutions, such as green hydrogen and advanced battery storage, can provide long-term benefits and position the Western Cape as a leader in sustainable energy.

Table 3 Summary of the outlook for energy in the Western Cape

Indicator	Quantification	Desired State/target	Trend
Energy supply	• PetroSA gas-to-liquid plant [2] *(no contribution since 2020- feedstock depletion)* • 2x gas turbines (207 MW) • Koeberg nuclear reactor (1 800 MW) • Palmiet pumped storage (580 MW) • 8 wind farms • 7 solar power plants[3] • ESKOM Solar PV Battery Energy Storage Systems (148.5MW of total BESS capacity to be installed) • Implementation of SSEG in 24 municipalities	• Increased energy generation from renewable sources • Decreased dependence on coal	**Improving** 

[2] Suspended in 2020, not operational yet but securing gas supply deals. Must it be kept or removed, they havent supplied energy in the last 3 years
[3] includes operational wind and solar PV installations awarded from REIPPP bid window 1 to 4, plus 5 projects under construction, all in the western capel

Energy use	• Total excluding marine 292 342 004 GJ in 2009 276 333 250 GJ in 2013 299 401 472 GJ in 2016 272 579 266 GJ in 2018[4] • 52% used by transport in 2017/18, 2% down from 2015/16 (previously 35% in 2004 and 52% in 2009) • Mostly coal based electricity and liquid fuels • CCT consumes 56%, West Coast 26%, Garden Route 10%, Cape Winelands 7%, Overberg 2% and Central Karoo 1%	• Decrease in coal-based energy use • Decreased reliance on coal-based electricity and liquid fuels	**Declining** 
Energy intensity	• 41 GJ/capita energy consumption in 2018 decrease from 48 GJ/capita in 2016. • 5t CO^2e/capita in 2018, decrease from 6t CO^2e/capita recorded in 2016 • Decrease in intensity per unit of GDP since between 2016 and 2018 • West Coast higher intensity than other districts (industries) • CCT relatively low intensity due to service industry.	• Decrease in GJ/capita energy consumption • Decrease in tonnes of CO^2e /capita • Decrease in energy intensity per GDP	**Declining** 

[4] Note: there is a two year lag GHG inventory reporting – latest data provided here

Domestic energy use	• Approx 600 000 additional households have been connected to the grid for lighting, increasing access from 93% in 2011 to 96% in 2022. • Although the proportion of serviced households was static over the review period, it is estimated an additional 315 000 households have gained access since 2015 in the Western Cape. • Due to rapid installation of solar PV to households, there is currently a decreasing outlook on the percentage of households utilising electricity – yet this is not enough to turn around the overall domestic energy use.	• 100% of households electrified • Increase in number of households using solar PV instead of grid- based electricity • Decrease in households using biomass and other alternative sources of energy	**No Change** 
Energy Security	• The proportion of households connected to the grid, for lighting, has remained static since 2016 at approximately 96%.	• Fewer interruptions in electricity supply due to load shedding	**Declining**

	• Loadshedding worsened over the review period with 2023 being by far the worst years in terms of load shedding hours and total energy availability.	• Decrease in duration of interruptions to electricity supply • Decreased reliance on Eskom for electricity	

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