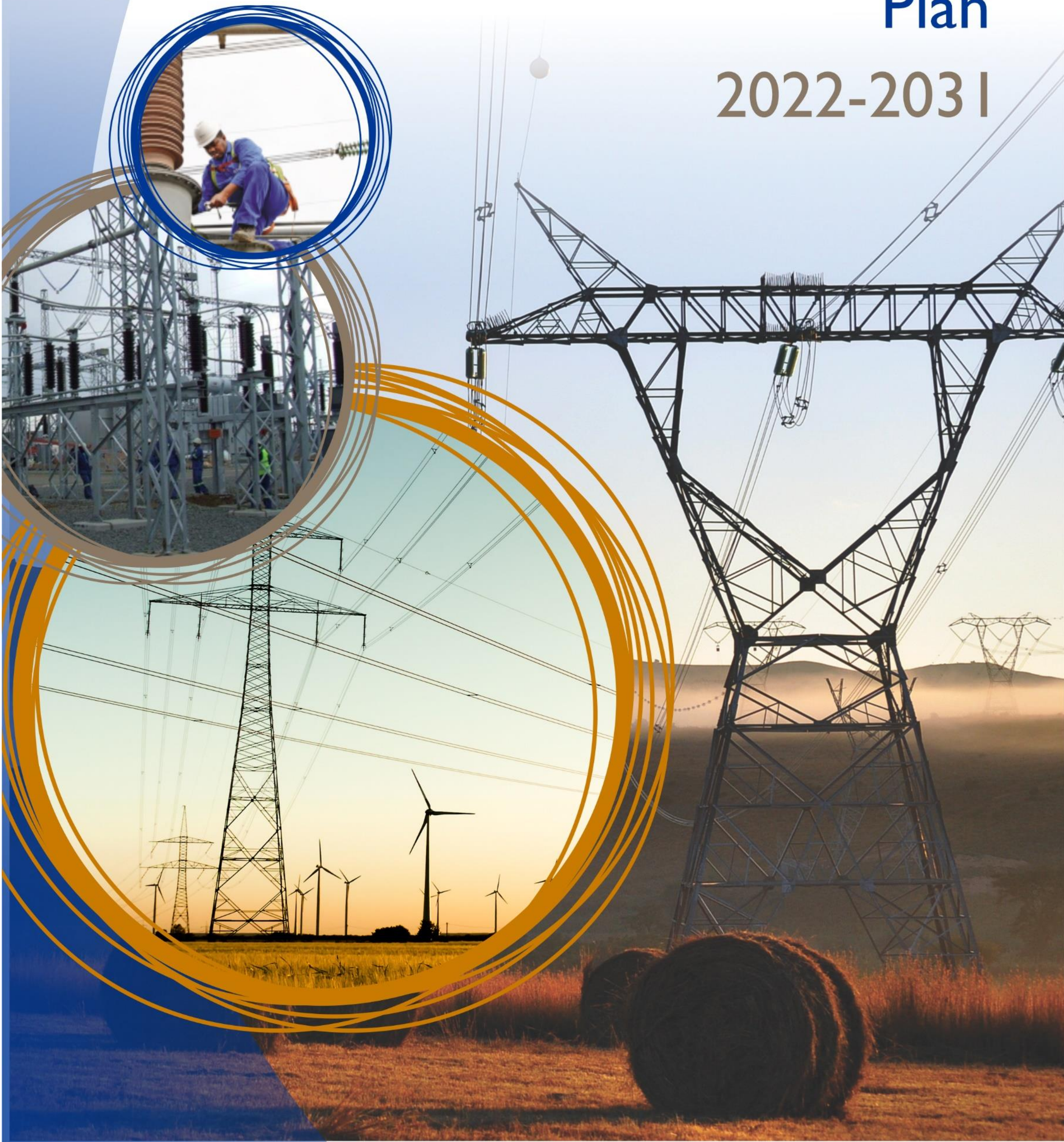
Eskom

Transmission Development Plan

2022-2031



FOREWORD BY GROUP EXECUTIVE

"Our electricity sector, which contributes 41% of South Africa's greenhouse gas emissions, will be the first phase of the transition. It will be the quickest industry to decarbonise and will have a beneficial impact across the economy." – President Cyril Ramaphosa

The Transmission Development Plan (TDP) 2022 to 2031 public forum gave us an opportunity to discuss the development plans for the transmission infrastructure in South Africa over a 10-year period. The TDP remains a living document that takes new developments in the energy landscape into account.

The TDP serves as a response to the country's energy developments, particularly the Integrated Resource Plan of 2019 (IRP 2019), which signalled an important move to a wider range of options for power generation in the country and supported a diverse energy mix to ensure the security of South Africa's electricity supply.

To contextualise this, the IRP 2019 identified an additional 9,8 GW of generation capacity to be connected to the system by 2025 and a further 17 GW to be connected between 2026 and 2030. The expansion of the transmission network is critical to create capacity and access for these new energy sources.

The Transmission Division, as custodian of the Eskom Transmission licence, is required to provide non-discriminatory access to the grid. In alignment with this requirement, and in the spirit of *transparency* that is key to a regulated monopoly, Eskom Transmission has developed and published the Generation Connection Capacity Assessment (GCCA) of the transmission network over the past few years. The GCCA provides information to potential developers of new power stations, public or private, of the available transmission network capacity across various nodes on the network. We believe that this innovation has made a positive contribution to the success of the REIPPPP by providing developers and government with relevant information for developers on where, potentially, to focus their efforts.

The Phase 1 report of the Generation Connection Capacity Assessment (GCCA) of the 2023 Transmission Network (GCCA-2023) was released in July 2021. This GCCA report highlighted the imperative to substantially strengthen the upstream network to enable new generation capacity in the Northern Cape supply area, which is severely constrained and unable to accommodate additional capacity at this stage. An update of the GCCA-2023 report, which provided details of available transmission network in the rest of the country (mainly inland territories), was released in November 2021.

Considering that major transmission projects take between seven and 10 years – and often longer – to complete because of the complexity of obtaining servitude rights over the long distances associated with transmission lines, the grid strengthening projects that we initiate today are likely to be completed only between 2027 and 2032, unless we *collectively take extraordinary measures* to expedite the roll-out of the grid. This will require careful planning on our part as well as alignment, co-ordination, and support among key stakeholders.

We have identified several key enablers pivotal to the successful roll-out of the Transmission Development Plan (TDP) in line with the IRP 2019. These include:

- working closely with industry associations, as well as with the Department of Trade, Industry, and Competition (dtic), to provide assurance regarding adequate capacity and capability in the engineering, manufacturing, and construction sectors to meet this increasing requirement for overhead power lines, substations, and various specialised plant items;
- expediting the granting of environmental authorisations and the issuing of water usage licences;
- expediting the acquisition of servitude rights and land;
- exploring funding opportunities for the strengthening and upgrading of the network, while addressing the tariff structures and levels; and
- addressing community stability issues and servitude encroachment.

Technological advances are changing the global energy landscape and demand that we transition to low- and no-carbon electricity generation technologies. Decarbonisation remained top of the energy agenda ahead of the COP26 climate summit. Closer to home, the Cabinet recently approved more ambitious greenhouse gas emission targets in terms of the nationally determined contributions (NDCs) that will push South Africa's transition to a low-carbon economy.

Notably, the electricity sector has been identified as possibly the fastest industry to transition. This sentiment was recently shared by President Cyril Ramaphosa, who said: "Our electricity sector, which contributes 41% of South Africa’s greenhouse gas emissions, will be the first phase of the transition. It will be the quickest industry to decarbonise and will have a beneficial impact across the economy.”

The global shift towards renewable energy generation will undoubtedly have an impact on Eskom and will shape the transmission utility of the future.

As a responsible corporate citizen, Eskom is already embracing this change. The organisation endeavours to transition to net zero greenhouse gas emissions by 2050, which will greatly assist in curbing the impact of climate change. This will also ensure that Eskom remains relevant and the key player in the energy market. In this regard, the organisation is already embarking on the Just Energy Transition (JET) initiative, which includes repowering our older power stations with cleaner-fuel technologies and renewables as well as developing more renewable projects on land available around Eskom power plant.

For Transmission, this means that there is a continuous need for maintaining the existing transmission infrastructure, networks, and connections to continue extending economic opportunities to the communities that have supported Eskom over the years.

The organisation continues to prioritise investments in the transmission grid. Work is in progress to allow the connection of utility-scale renewable generation projects for Bid Window 5 of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), projects that are expected to be connected to the national electricity grid by 2024/25. We are also making our systems ready to connect the additional 2 000 MW capacity procured through the Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP), and this capacity is expected to be available during the course of 2022.

I am pleased to report that, since the TDP forum held in October 2020 and taking cognisance of the COVID-19 pandemic and its impact on our transmission roll-out plan, progress has been made with implementing the plans put forward, to name but a few:

- Additional transmission 400 kV networks were commissioned to strengthen the system in the Western Cape between the Ankerlig and Koeberg Power Stations as well as networks in the Bloemfontein area between the Everest and Merapi Substations.

- From a safety perspective, fault-mitigation plans were implemented at the Witkop and Merensky Substations.

- Additional transformer capacity was commissioned at the Kronos Substation in the Northern Cape to facilitate the renewable energy projects in the area for Bid Window 4.

- Additional independent power producers (IPPs) in Bid Window 4 were integrated into the national transmission grid in the Northern and Eastern Cape and the North West regions. The successful integration of these IPP projects was underpinned by investments in new substations and enhancements of transformer capacity.

For the period ahead, I would like to highlight the following:

- There is a clear need for significant expansion of the transmission network, which is critical for the connection of utility-scale renewable generation projects, mainly wind and solar, in line with the policy direction highlighted in the IRP 2019 and the Grid Code, namely, to diversify the country's energy mix and to provide non-discriminatory access to the grid.

- Over this planning period, 30 GW of new generation capacity is expected, mainly from renewable energy sources (photovoltaic (PV) and wind) in areas with limited network infrastructure. To provide for an adequate and reliable transmission system, Eskom plans to increase the transmission infrastructure by approximately 8 400 km of extra-high-voltage lines and 119 transformers to bring on board 58 970 MVA of transformer capacity over the next 10 years.

- In addition, significant investments are required for renewing the existing transmission substations and lines.

Eskom's Transmission business plays a pivotal role in the electricity value chain, since the transmission network services the domestic electricity market and also interfaces with the regional market through the Southern African Power Pool (SAPP). Eskom Transmission currently houses the System Operator, which is tasked with managing the supply of, and demand for, electricity and is entrusted with the huge responsibility of making difficult decisions to protect the national electricity grid. Transmission is, furthermore, the liaison among Eskom, the IPP Office, and the Department of Mineral Resources and Energy (DMRE) on incorporating the energy from IPPs into the grid, thereby enabling the organisation to fulfil Eskom's current role as the single buyer of the power produced by IPPs.

An adequate and reliable national transmission grid is of the utmost importance to South Africans. As always, we look forward to your valuable input on the plans that we share at the TDP public forums. It is through a collaborative approach that we can co-create an electricity supply industry that best responds to South Africa's power needs.

Regards

Segomoco Scheppers

GROUP EXECUTIVE: TRANSMISSION

DISCLAIMER

The purpose of publishing the TDP is to inform stakeholders about the proposed developments in the Eskom transmission network. These plans are subject to change as and when updated information becomes available. While considerable care is taken to ensure that the information contained in this document is accurate and up to date, the TDP is only intended for information sharing.

The content of this document does not constitute advice, and Eskom makes no representations regarding the suitability of using the information contained in this document for any purpose. All such information is provided "as is" without warranty of any kind and is subject to change without notice. The entire risk arising from its use remains with the recipient. In no event shall Eskom be liable for any direct or indirect damages and consequential, incidental, special, punitive, or any other damages whatsoever and howsoever arising, including, but not limited to, damages for loss of business profits, business interruption, or loss of business information.

Although the TDP is updated periodically, Eskom makes no representation or warranty as to the accuracy, reliability, validity, or completeness of the information contained in this document. Eskom does, however, endeavour to release plans based on the best available information at its disposal at all times to ensure that stakeholders are kept informed about developments in the transmission network. Therefore, the information contained in this document represents the most up-to-date information that was available at the time of publication.

The costs given in the document are, in general, high-level estimates and can change as global economic conditions change; that is, costs are sensitive to fluctuations in foreign exchange rates and commodity prices.

For the upstream transmission network strengthening projects required to enable the connection of future independent power producers (IPPs), Transmission will conduct the necessary feasibility assessment and develop these projects to the extent possible within the confines of the capital investment process of the approved transmission network service provider (TNSP). However, capital investment in these projects will only be considered if the related IPP projects are announced as preferred bidders in the DMRE IPP Procurement Programme.

EXECUTIVE SUMMARY

The transmission network is the primary network of interest covered in this publication. This mainly covers electrical networks with voltages ranging from 220 kV to 765 kV and the associated transmission substations. A few sub-transmission networks are included due to their strategic nature or when Transmission owns them.

The purpose of the TDP is to assess network requirements and propose plans to meet the load demand and generation integration forecasted in the subsequent 10-year period. This publication contains information about projects intended to extend or reinforce the transmission system that have been completed in the past year as well as about projects that are planned for the next 10 years.

The TDP 2022 to 2031 was formulated to address the following:

- Attain Grid Code compliance by resolving both substation and line constraints.
- Determine new network infrastructure requirements to sustain the current customer base and allow for future demand growth.
- Determine new network infrastructure requirements to integrate new generation (Eskom-owned as well as IPPs, conventional, and renewable).
- Evacuate and dispatch power to the load centres from the power stations connected to the grid.

Eskom Transmission also carries out projects in respect of the refurbishment of ageing infrastructure, strategic projects, environmental authorisations and acquisition of sites and servitudes, facilities, production equipment, and strategic capital spares. The rationale for the aforementioned project categories can be outlined as follows:

- The transmission system requires regular planned maintenance, as well as renewal or replacement of plant that has reached the end of its operational or economic life, to ensure that the network continues to perform its role safely, reliably, and efficiently.
- Strategic projects include the upgrading of the energy management system (EMS) used by the System Operator to monitor, control, and optimise the performance of the power system and respond to network emergencies.
- The acquisition of sites and servitudes and the associated environmental impact assessments (EIAs) and other statutory approvals are necessary in order to construct transmission infrastructure.

- Facilities consist of buildings and associated works located at sites other than substations that Transmission uses for offices, the operation and control of the system, or as maintenance depots and workshops.
- Production equipment consists of office furniture and equipment, computer hardware and software, tools and other equipment used by maintenance staff, and vehicles.
- Strategic capital spares are items not available from suppliers out of stock, for example, large power transformers and circuit breakers. These are kept as strategic stock to allow for units that fail and cannot be repaired on site to be replaced as soon as possible, thereby minimising long-duration outages to customers.

These types of projects are not detailed in this document, but a summary of their costs appears in the chapter on capital expenditure.

Eskom's liquidity position, as well as the National Energy Regulator of South Africa's (NERSA) decision on Eskom's future tariff determination, will have an impact on the execution of the TDP. In the event of capital expenditure restrictions due to any of the above, the plan will have to be revised to fit in with the available budget by reprioritising projects. This will be done in a way that minimises the impact on customers and the national economy due to any delays arising from a shortage of funding or any delays in obtaining environmental authorisations, servitude acquisitions, and other statutory approvals.

It is regrettable, but unavoidable, that the funding constraints will result in more time being taken to bring the transmission system into compliance with the reliability and redundancy requirements prescribed by the South African Grid Code. The effects on customers and the national economy will be minimised through consultation with customers and activation of risk mitigation measures.

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ABBREVIATIONS AND DEFINITIONS

BA basic assessment

The process of collecting, organising, analysing, interpreting, and communicating information that is required to examine the environmental effects of the proposed activity as per the National Environmental Management Act (NEMA), EIA Regulations.

BAR basic assessment report

A report describing the process of examining the environmental effects of a development proposal, the expected impacts, and proposed mitigation measures.

BQ budget quotation/quote

Quotation giving customers costs and scope at 85% accuracy level.

CA competent authority

The authority designated by the Minister that authorises the development of electricity grid infrastructure in terms of the NEMA.

CCGT combined-cycle or closed-cycle gas turbine

An open-cycle gas turbine (OCGT) fitted with a waste heat recovery boiler and steam turbines to increase electricity output by using the exhaust gases of the combustion turbine to raise steam.

CoCT City of Cape Town

CLN customer load network

The network within a specific geographical area which, in turn, is a subdivision of a grid; for example, Johannesburg CLN falls within the Central Grid in Gauteng.

DFFE Department of Forestry, Fisheries, and the Environment

The CA identified by the Minister for the authorisation of activities undertaken for electricity grid infrastructure projects.

DMRE Department of Mineral Resources and Energy

EA environmental authorisation

Authorisation for implementation of a listed activity as listed in the EIA Regulations by the competent authority.

EAP environmental assessment practitioner

An independent consultant who meets the requirements of the Environmental Impact Assessment Regulations to conduct the application and process for the environmental authorisation.

ECO environmental control officer

An independent person appointed on a construction project to monitor and report on compliance with the conditions of an EA and the EMPr.

EHV extra-high voltage

EIA environmental impact assessment

The process of collecting, organising, analysing, interpreting, and communicating information that is required to examine the environmental effects of the proposed activity as per the EIA Regulations.

EIR environmental impact report

A report describing the process of examining the environmental effects of a development proposal, the expected impacts, and proposed mitigation measures.

EMPr environmental management programme

A process that seeks to achieve a required end state of the environment and describes how activities that could have a negative impact should be managed/monitored and affected areas rehabilitated.

GAU grid access unit

GCCA grid connection capacity assessment

GDP gross domestic product

HVDC high-voltage direct current

I&APs interested and affected parties

Individuals or groups concerned with, or affected by, an activity and its consequences.

ICE indicative cost estimate

A cost estimate giving a non-binding indication of the order of magnitude costs.

IDZ industrial development zone

IPP independent power producer

These are power stations owned by independent parties other than Eskom.

IRP	integrated resource plan
Landowner	For the purposes of this document, a landowner is defined as the owner of the land, registered as such in the Deeds Office, and/or his/her assignee.
MVA	megavolt-ampere A million volt-amperes of apparent power, which is the vector sum of real power (MW) and reactive power (Mvar).
Mvar	megavolt-ampere reactive A million volt-amperes reactive – a volt-ampere reactive is a unit of the electrical power required to maintain electromagnetic fields.
MW	megawatt A million watts – a watt is a unit of electrical power production or demand.
MYPD	multi-year price determination A multi-year price determination for tariff increases awarded to Eskom by NERSA.
NERSA	National Energy Regulator of South Africa The body established by an Act of parliament to regulate the production, sale, and pricing of electricity, liquid fuels, and fuel gas in South Africa.
NTC	National Transmission Company The body that is licensed as the national provider of transmission services.
OCGT	open-cycle gas turbine A combustion turbine fuelled by liquid fuel or gas, used to drive a generator.
PPA	power purchase agreement
RE	renewable energy
REBID	Renewable Energy Bid Programme
REDZ	renewable energy development zone Areas identified in terms of a strategic environmental assessment where it is optimal to develop renewable energy projects for wind and solar energy.
REIPP	renewable energy independent power producer
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme

RTS return to service

A previously mothballed power station undergoing recommissioning.

SAPP Southern African Power Pool

SEA strategic environmental assessment (corridors)

Corridors identified through a process of strategic assessment for the development of electrical grid infrastructure that links to the REDZs.

Scoping/ Screening The process of identifying the significant issues, alternatives, and decision points that must be addressed by a particular EIA/BA and may include a preliminary assessment of potential impacts during the screening process applied in the SEA corridors and REDZs.

SG surveyor-general

TDP Transmission Development Plan

A development plan produced annually by Eskom Transmission detailing how the network will develop in the next 10 years. This comprises the proposed new projects listed in this document and the customer projects omitted from this document due to their commercial sensitivity.

TNSP transmission network service provider

A legal entity that is licensed to own, operate, and maintain a transmission network.

TOSP time of system peak

TS transmission system

1 INTRODUCTION

Eskom Holdings is the major producer of electricity in South Africa. It also transmits electricity via the transmission network, which supplies electricity at high voltages to a number of key customers and distributors. Eskom is a vertically integrated company licensed to generate, transmit, and distribute electricity in South Africa. The transmission licence is held by Eskom Transmission, which is the National Transmission Company (NTC). Planning for the expansion of the transmission network is the responsibility of the Grid Planning and Development Department in the Transmission Group.

1.1 CONTEXT OF THE TDP

According to the Grid Code, NERSA requires the NTC to publish a minimum five-year-ahead transmission system (TS) development plan annually, indicating the major capital investments planned (but not yet necessarily approved). The requirements, furthermore, stipulate that the plans shall include at least:

- the acquisition of servitudes for strategic purposes;
- a list of planned investments, including costs;
- diagrams displaying the planned changes to the TS;
- an indication of the impact on customers in terms of service quality and cost; and
- any other information as specified by NERSA from time to time.

A further requirement is for the NTC to host a public forum annually to disseminate the intended TS development plan to facilitate a joint planning process.

This is the 12th publication of the TDP, which was shared at a virtual public forum hosted via Microsoft Teams on 26 October 2021.

The TDP, which covers a 10-year period from 2022 to 2031, seeks to meet the long-term requirements of electricity consumers in South Africa by maintaining the legislated adequacy and reliability of the transmission grid. The objective is to produce a plan containing the expected development projects for the TS for this 10-year period. These expected projects consist of the approved projects that are currently in execution, projects in the developmental phase, and projects that are in the inception phase based on a desktop assessment of the transmission requirements with further engineering feasibility assessment to be conducted during the TDP period.

The projects contained in the TDP can be classified into three categories:

(i) Those that are in implementation and will be commissioned within the next three years or so (projects in execution)

(ii) Those that are in the detailed studies/design phase with business cases being concluded, aimed for implementation within the next seven years (projects in development)

(iii) Projects beyond the seven-year horizon that still have a level of uncertainty and are most likely to be revised in terms of scope (concept projects)

1.2 MAJOR CHANGES FROM THE 2020 TDP

The major change from the 2020 TDP to this revision of the 2021 TDP is associated with assumptions about the country's future generation capacity. The 2020 TDP was informed by the IRP 2019, which was gazetted in November 2019. The IRP does not have capacities per annum beyond 2030; as a result, values for 2031 were assumed for wind, PV, and gas. Wind and PV assumed values were the same as those given in the IRP for 2030, and 3 GW of gas was added for flexibility.

Apart from the expedited new generation capacity expectations in accordance with the IRP 2019, the development plans for the 2021 TDP remain aligned with those of the 2020 TDP regarding the plans for the integration of IPPs from Bid Windows 4 and 4B of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), network reliability enhancements, demand growth, safety, and regulatory network strengthening requirements.

The bulk of the changes in this version of the TDP can be attributed to two main factors, namely, capital constraints and protracted land acquisition processes. These factors necessitated the reprioritisation of the plan based on need criticality assessment and readiness to implement.

1.2.1 CAPITAL CONSTRAINTS

Due to capital constraints emanating from Eskom's liquidity position, projects had to be reprioritised to fit in with the available budget. The reprioritised projects maximise the benefits accruing from the available capital investment budget, while minimising the risks to security and reliability of supply. The high-priority projects were accelerated, provided that the enabling factors were in place. The reprioritisation process will be repeated after each tariff increase ruling by NERSA and Eskom's Corporate Plan approval to ensure optimal allocation of the available budget.

1.2.2 LAND AND SERVITUDES ACQUISITION

The procurement of land and servitudes for substation and line construction projects is one of the essential transmission infrastructure development enablers. The projects affected by challenges in the land acquisition process were mainly deferred in line with the revised project schedule.

1.3 STRUCTURE OF THE DOCUMENT

The document is structured in the following manner:

Chapter 2, **GENERATION ASSUMPTIONS**, outlines generation assumptions for the 2021 revision of the TDP, which was primarily informed by the IRP 2019.

Chapter 3, **DEMAND FORECAST**, provides the location and magnitude of electricity demand forecast (MW) to be supplied within the TDP period.

Chapter 4, **COMPLETED PROJECTS**, summarises the completed projects since the 2020 TDP was published.

Chapter 5, **CUSTOMER APPLICATIONS**, provides a summary of the grid connection applications processed by Transmission during the 2020/21 financial year (April 2020 to March 2021).

Chapter 6, **NATIONAL OVERVIEW**, is a high-level description of the planned transmission infrastructure. This is intended to give a national overview of the major projects planned for the entire period of the TDP and a high-level summary of the planned transmission infrastructure.

Chapter 7, **PROVINCIAL DEVELOPMENT PLANS**, focuses on the planned generation integration and reliability projects per province.

Chapter 8, **LAND AND RIGHTS**, is a new chapter that has been included in this version of the TDP in order to provide an overview of the process for securing land rights for the expansion programme.

Chapter 9, **CAPITAL EXPENDITURE PLAN**, outlines the forecasted costs of implementing the TDP. The costs provided in this publication are high-level costs intended to illustrate the financial requirements of the current revision of the TDP. The actual costs per individual project in the TDP will be refined after feasibility assessment and will be followed by approval of the associated business case before projects advance to execution.

Chapter 10, **CONCLUSION**, provides the concluding remarks on the 2021 version of the TDP.

2 GENERATION ASSUMPTIONS

The generation assumptions are used as a supply-side input into the 2021 TDP. The Department of Mineral Resources and Energy (DMRE) is responsible for the country's energy plan; hence, the generation assumptions are based on the latest Integrated Resource Plan (IRP 2019), as released by the DMRE. The IRP is intended to drive all new generation capacity development for South Africa.

These generation assumptions are based on the official IRP report of 2019, approved in parliament in 2019 and shown in Table 2-1.

Table 2-1: IRP 2019 capacity per technology (Source: DMRE)

	Coal	Coal (Decommissioning)	Nuclear	Hydro	Storage	PV	Wind	CSP	Gas & Diesel	Other (Distributed Generation, CoGen, Biomass, Landfill)
Current Base	**37149**		**1860**	**2100**	**2912**	**1474**	**1980**	**300**	**3830**	**499**
2019	2155	-2373					244	300		**Allocation to the extent of the short term capacity and energy gap.**
2020	1433	-557				114	300			
2021	1433	-1403				300	818			
2022	711	-844			513	400 1000	1600			
2023	750	-555				1000	1600			500
2024			1860				1600		1000	500
2025						1000	1600			500
2026		-1219					1600			500
2027	750	-847					1600		2000	500
2028		-475				1000	1600			500
2029		-1694			1575	1000	1600			500
2030		-1050		2500		1000	1600			500
TOTAL INSTALLED CAPACITY by 2030 (MW)	**33364**		**1860**	**4600**	**5000**	**8288**	**17742**	**600**	**6830**	
% Total Installed Capacity (% of MW)	**43**		**2.63**	**5.84**	**6.35**	**10.52**	**22.53**	**0.76**	**8.1**	
% Annual Energy Contribution (% of MWh)	**58.8**		**4.5**	**8.4**	**1.2**	**6.3**	**17.8**	**0.6**	**1.3**	

Installed Capacity

Commited / already Contracted Capacity

Capacity Decommissioned

New Additional Capacity

Extension of Koeberg Plant Design Life

Includes Distributed Generation Capacity for own use

Although the assumptions are based on the IRP 2019, necessary adjustments were made for alignment with the decommissioning plan that Eskom Generation envisages. Because of this, the decommissioning in the assumptions deviates slightly from that given in the IRP. This is necessary for alignment with the “Consistent Data Set” produced by Eskom Generation. Furthermore, the actual implementation of the IRP is currently behind by about a year in terms of the Renewable Energy Independent Power Producer Programme (REIPPPP). Necessary adjustments were also made in the generation assumptions to cater for this delay.

No additional generation scenarios were included in this round of the TDP. This is because most of the possible scenarios have been studied in the past, and the results are available for implementation should any prevail. Furthermore, the network capacity has decreased to the point where generation can mostly be allocated in places where capacity remains; the luxury of moving generation to different areas has decreased significantly.

The major outputs from the generation assumptions are as follows:

(i) The generation capacity that will be installed in the next 10 years by Eskom
(ii) The generation capacity that will be installed in the next 10 years by IPPs
(iii) The generation that is expected to be decommissioned in the same period

The assumptions allocate capacities for each technology type in spatial and temporal domains. “Technology type” refers to the primary generation technology that will provide the energy, including, but not limited to, solar photovoltaic (PV), wind, open-cycle gas turbines (OCGTs), closed-cycle gas turbines (CCGTs), nuclear, and coal. Because of the different types of profiles from different generation supply-side options, it is important to specify the technology used in order to allocate the correct capacity for the time of the study; for instance, all the PV generation should be OFF at the time of system peak, as the sun is typically not irradiating at that time.

The spatial allocation requirements are met by indicating the closest transmission substation where the generation has been allocated. The time is given in the form of yearly generation capacity allocations per type in those substations. The rationale behind this allocation of different technology types is as follows:

i. PV and wind technologies are allocated according to the Council for Scientific and Industrial Research (CSIR) strategic environmental assessment (SEA) study, which shows spatially where wind and solar technologies are prevalent after taking other environmental restrictions into consideration. Figure 2-1 shows the areas with high solar and wind potential.

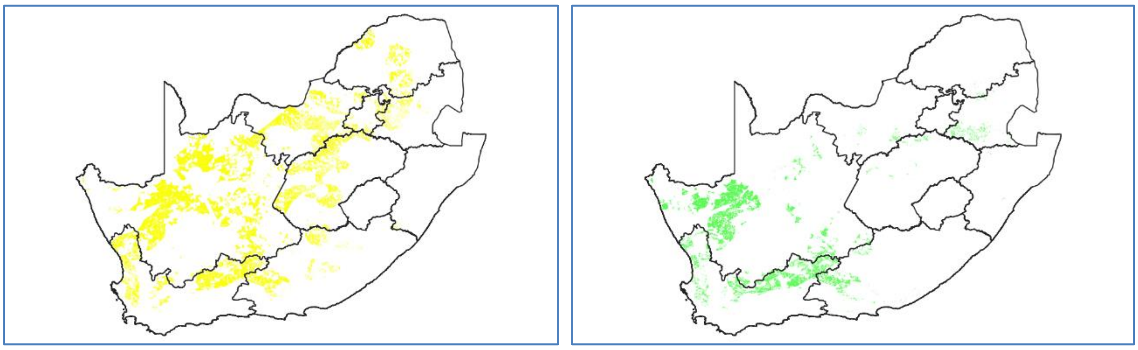


Figure 2-1: Areas of high solar irradiance (yellow) and wind potential (green) after environmental restrictions

ii. Areas where there is high interest as indicated by the large number of applications.

iii. Areas where there have been many EIA applications by prospective IPPs.

Figure 2-2 indicates areas of high interest as well as the EIA applications.

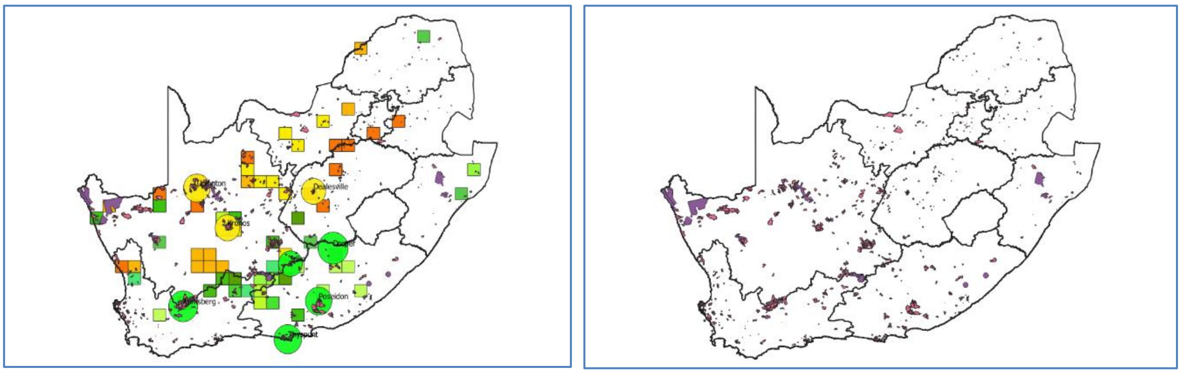


Figure 2-2: Areas of interest (left) with the yellow indicating solar and the green indicating wind, and EIA applications

iv. Areas where there is network capacity in the short term.

The IRP does not have capacities per annum beyond 2030. As a result, values for 2031 were assumed for wind, PV, and gas. Wind and PV assumed values were the same as those given in the IRP for 2030, and 3 GW of gas was added for flexibility. The addition of gas was justified by the decommissioning of coal plant and the need to maintain plant that had inertia in the system to prevent frequency instability. Gas is a preferred flexibility resource for renewables, which have high variability.

2.1 GENERATION FORECAST

The generation composition of all the technologies forecasted at the end of this TDP period is presented in Figure 2-3. It is anticipated that there will be a total of approximately 32 GW of RE, 32 GW of coal, and 10 GW of gas installed in the system by 2031. Some of these plants exist, while others are in execution or are to be executed in the future. It is anticipated that there will be 2 GW of battery storage by 2030.

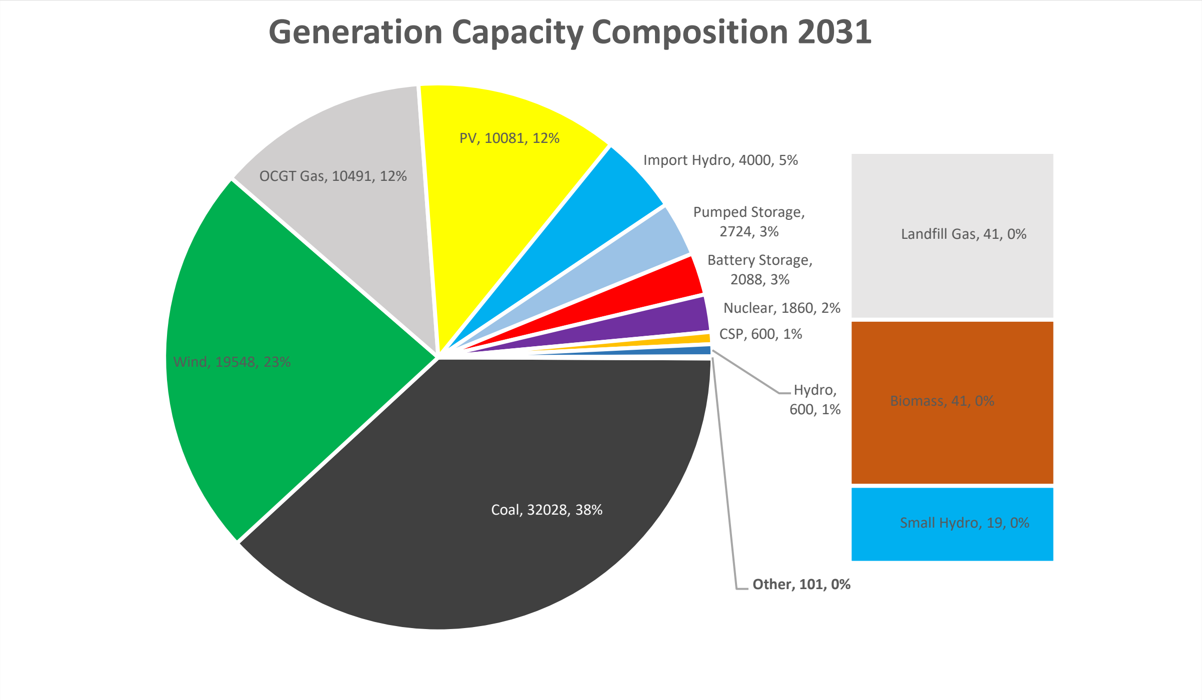


Figure 2-3: Generation capacity composition of all the technologies forecasted in 2031

Renewable capacity as a percentage of total capacity is expected to accelerate from 12% in 2021 to 39% in 2031, whereas conventional generation is expected to increase by only 2 GW and decrease as a percentage of the total energy capacity from 88% in 2021 to 61% in 2031. By this time, renewable energy capacity in the network will have increased approximately fivefold. Figure 2-4 shows the contribution of conventional and renewable capacity in the energy mix.

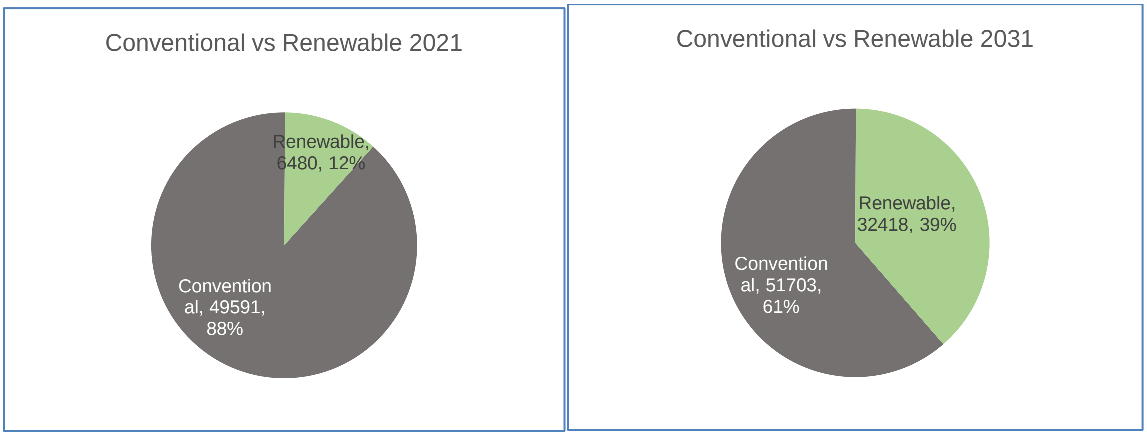


Figure 2-4: Conventional energy versus renewable energy in 2021 and 2031

2.2 CONVENTIONAL GENERATION

Figure 2-5 indicates the cumulative conventional capacity allocation per substation. The total for conventional capacity that will be added to the system (including units from the inception of the Eskom build programme) is 22 385 MW by 2031.

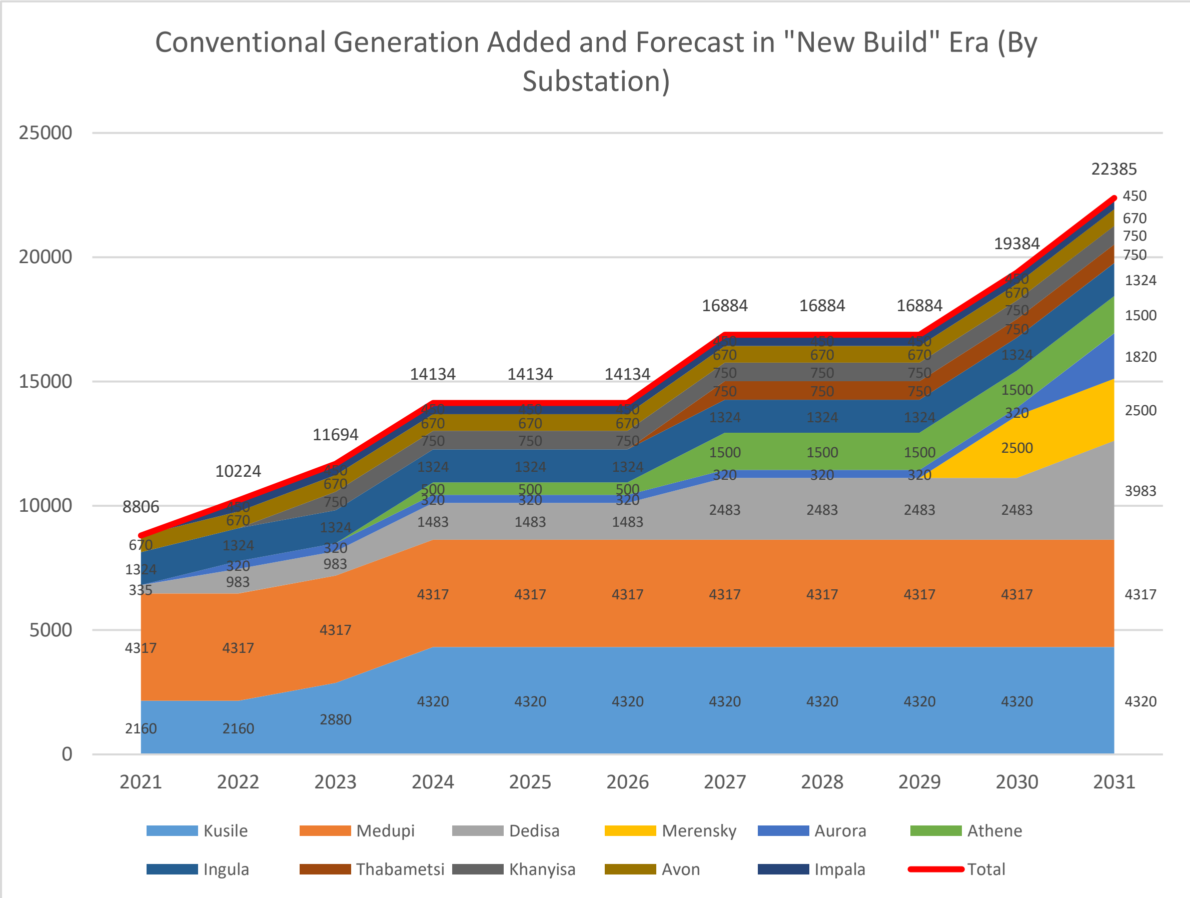


Figure 2-5: Conventional generation cumulative capacity schedule (by substation)

Figure 2-6 shows the cumulative conventional capacity allocation per technology type. The total for conventional capacity that will be added to the system (including capacity from the inception of the Eskom build programme) is 22 385 MW by 2031. Coal has been the most substantial addition by far during this period, but this has also been outpaced by the decommissioning rate of the same technology, as will be discussed later. Although import hydro of 2 500 MW is included in the IRP and the generation assumptions, it is highly doubtful that this will materialise, as there has been no initiation of the Inga hydro project thus far.

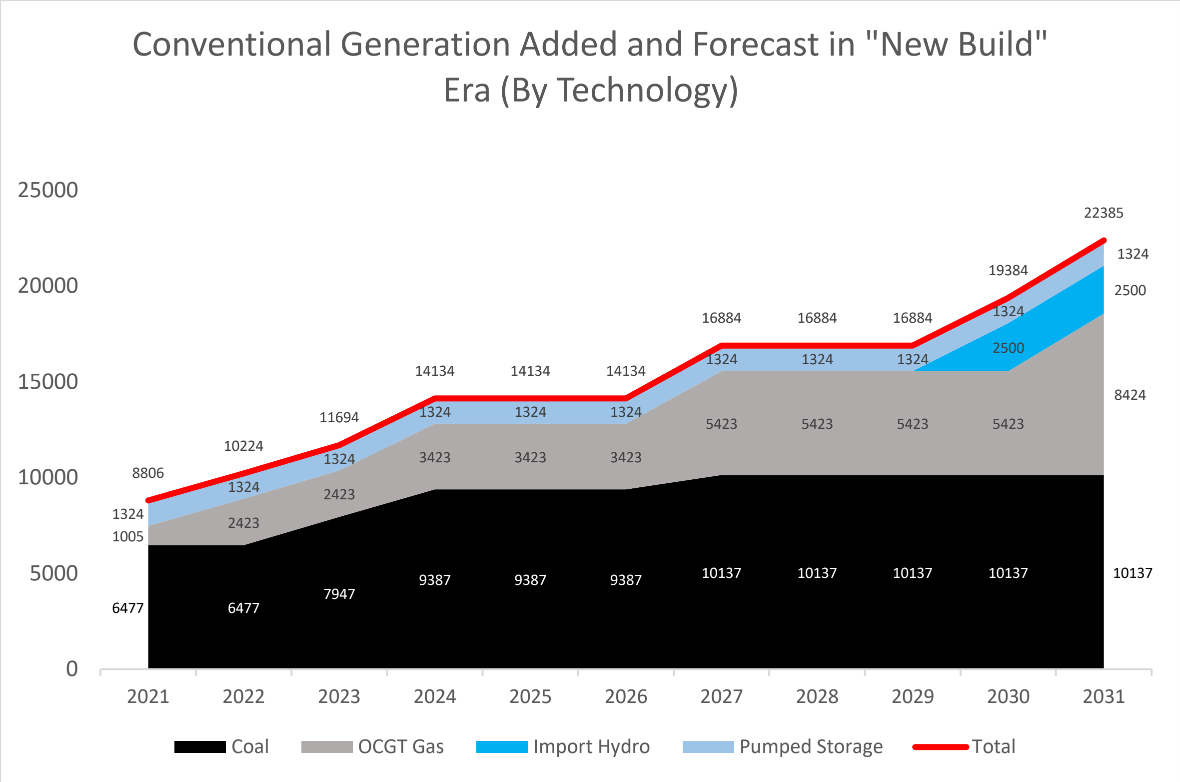


Figure 2-6: Conventional generation cumulative capacity schedule (by technology)

During the TDP period, 13 579 MW of conventional generation will be added to the system, as indicated in Figure 2-7. This is dominated by the new gas, which is increasingly needed as more renewables are installed.

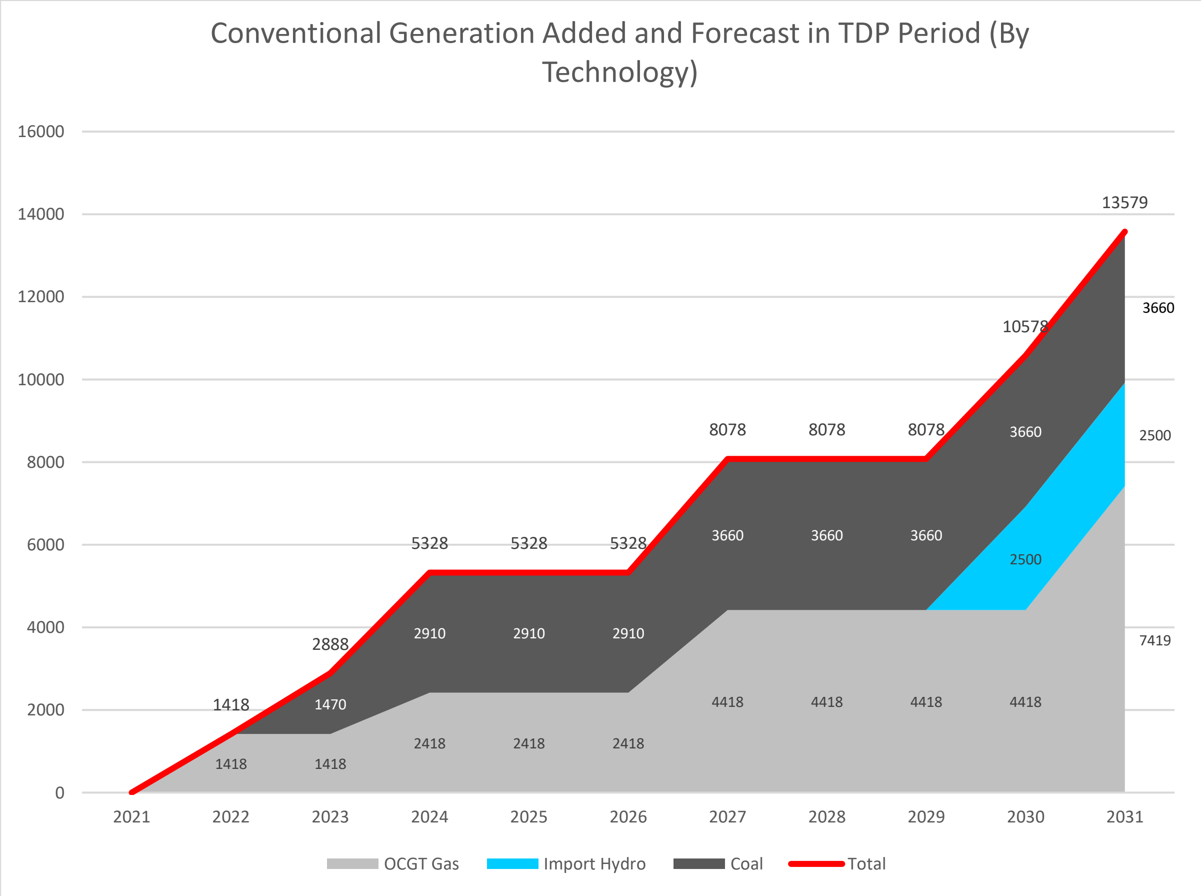


Figure 2-7: Conventional generation cumulative capacity schedule (by technology installed in the TDP period)

2.2.1 Nuclear Generation

There is no new nuclear generation in the TDP period in the IRP 2019. Thus, the generation assumptions do not have nuclear generation either. Possible high-level integrations of nuclear have now been tested at all possible sites, so it is unnecessary to test nuclear again in the current TDP period.

2.2.2 Gas Generation

The IRP 2019 only allocated 3 000 MW of gas in the current TDP period. The Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP) approved 1 418 MW of additional gas to be installed by 2022, and 3 000 MW was added in the final year. The total gas generation capacity catered for in the generation assumptions was 7 419 MW. For this TDP period, the gas was allocated as per the IRP 2019, and only the RMIPPPP gas was included in 2022 as well as the 3 000 MW as in the final year. Indications are that the gas allocation of 1 000 MW might be delayed from 2024 to 2026.

2.2.3 New Coal

The new coal stations are those that have been approved in the coal procurement programme, that is, Khanyisa and Thabametsi. The generation assumptions allocated 750 MW each to the two power stations in 2023 and 2027, respectively.

2.3 RENEWABLE GENERATION

The total renewable generation capacity added to the system (including units from inception) is 32 098 MW by 2031, as shown in Figure 2-8. The total renewable capacity that will be added in the TDP period is 25 739 MW.

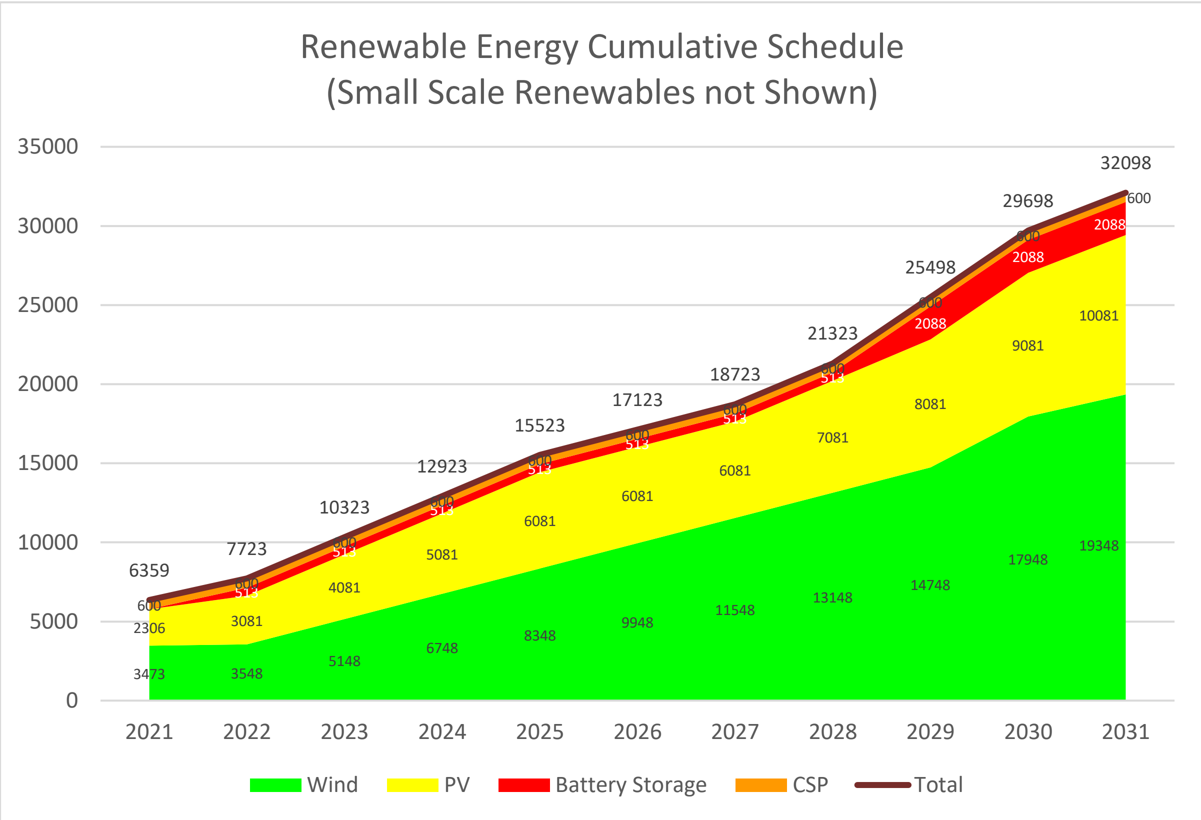


Figure 2-8: Renewable generation cumulative capacity schedule (by technology since RE build inception)

2.3.1 PV Generation

Solar PV is expected to reach 10 081 MW by 2031. It was increased by 1 000 MW in 2031 based on the trajectory of PV in the previous years. In 2022, 776 MW of PV capacity was also added as a result of the RMIPPPP. Figure 2-9 indicates that 7 776 MW of PV will be added in the TDP period. This may be dwarfed by the self-generation that will be installed as a result of the 100 MW cap announced by the President of South Africa, according to which customers can install up to 100 MW without the need for licensing and bidding into the REIPPPP.

2.3.2 Wind Generation

Wind is expected to reach 19 348 MW by 2031. It was increased by 1 600 MW in 2031 based on the trajectory of wind capacity additions in the previous years. In 2022, 75 MW of wind capacity was also added as a result of the RMIPPPP. Figure 2-9 shows that 15 875 MW of wind capacity will be added in the TDP period. This may be dwarfed by the self-generation that will be installed as a result of the 100 MW cap announced by the President, according to which customers can install up to 100 MW without the need for licensing and bidding into the REIPPPP.

2.3.3 CSP Generation

Concentrated solar power (CSP) is expected to reach 600 MW by 2031. This is the same as the 2020 generation assumptions.

2.3.4 Battery Capacity

Battery capacity is expected to reach 2 088 MW by 2031. This is the same as the 2020 generation assumptions.

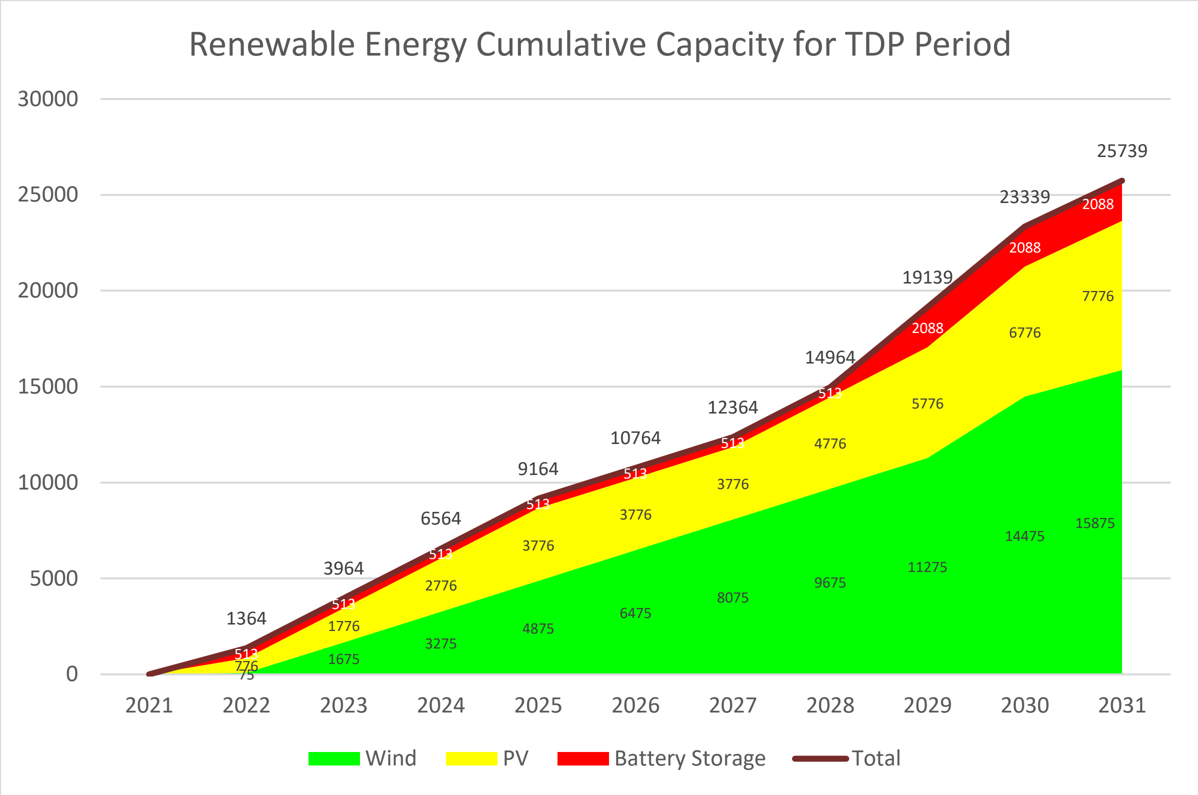


Figure 2-9: Renewable generation cumulative schedule (by technology for TDP period)

Figure 2-10 provides the generation build-up according to different categories. The total generation capacity in the final year of the TDP will be 84 GW. It is apparent from the graph that there is a huge increase in gas and renewables and an overall decline in coal.

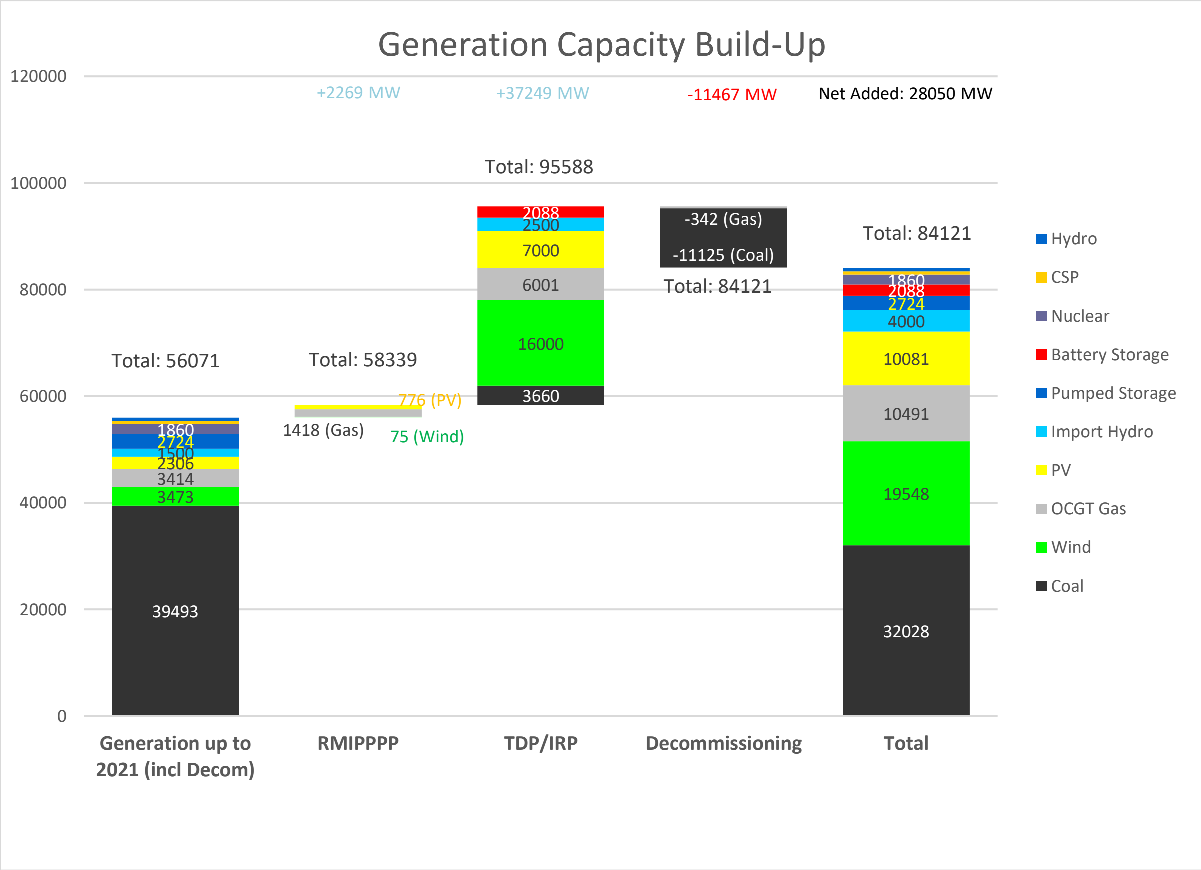


Figure 2-10: Generation build-up according to different categories

2.4 DECOMMISSIONING OF POWER STATIONS

Figure 2-11 and Figure 2-12 show the decommissioning of plant that has taken place and the decommissioning that will still take place in the TDP period. Compared to the amount of new coal that has been added in the new build era, it can be seen that the decommissioning of the coal-fired stations removes much more coal capacity, leading to an overall decline in coal capacity at the end of the period. Port Rex and Acacia gas generators will also be decommissioned during the TDP period; however, more gas stations will be added.

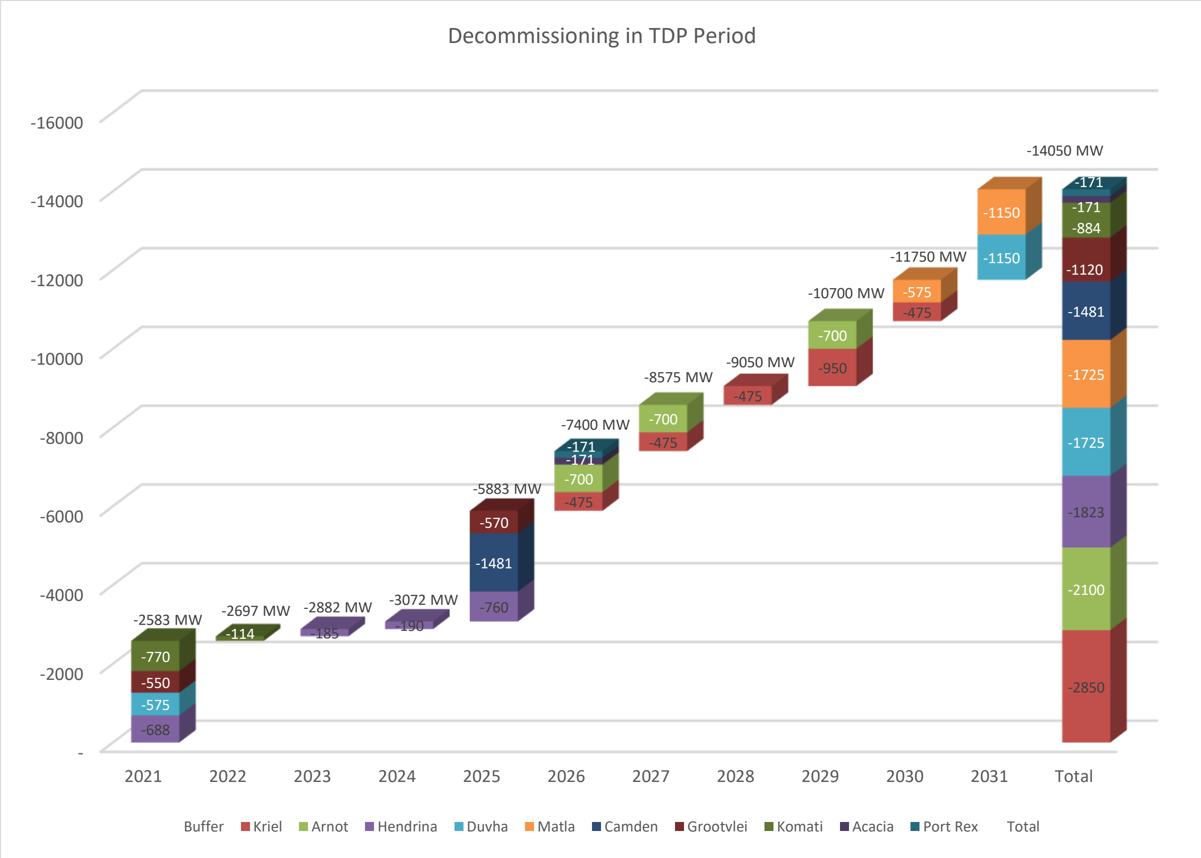


Figure 2-11: Decommissioning of generation (from decommissioning programme inception)

By the conclusion of this TDP period, 14 GW of capacity will have been decommissioned, and 11,5 GW of that will have been in the TDP period.

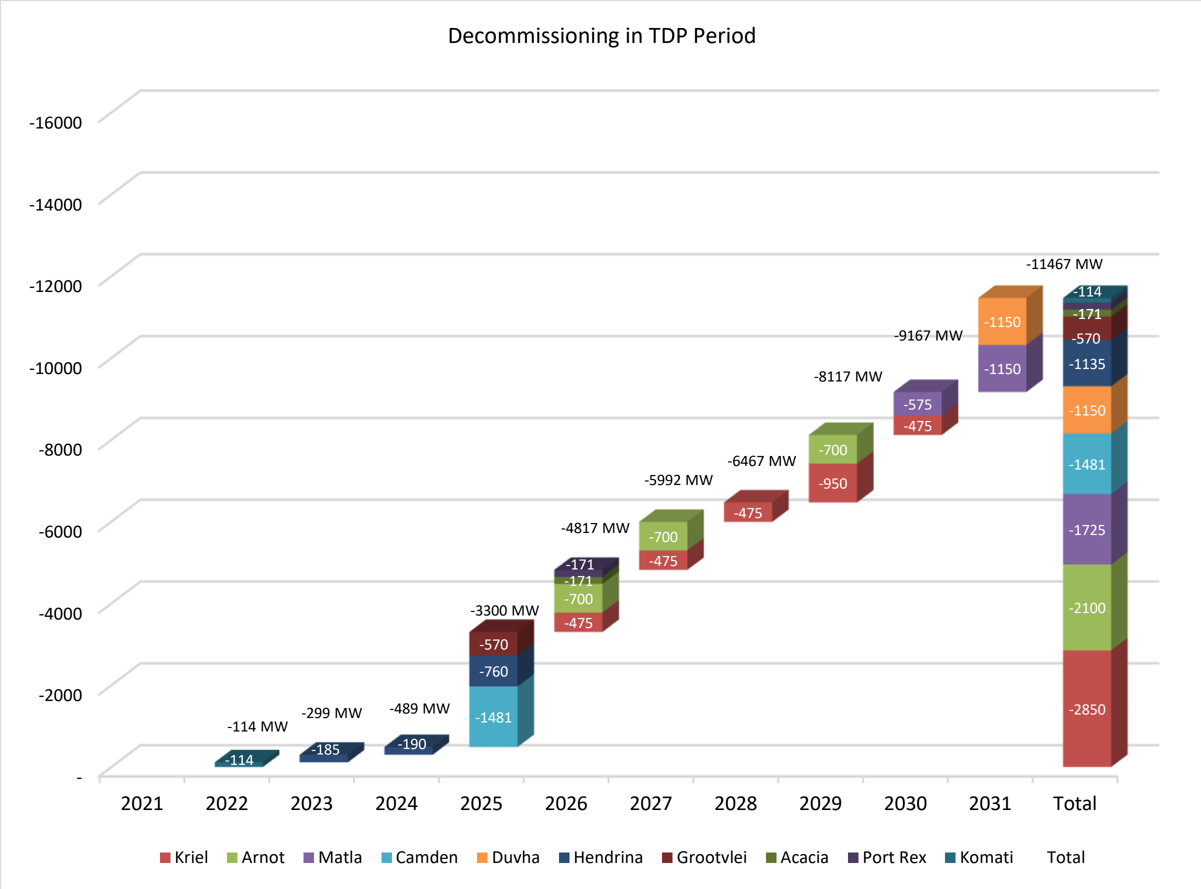


Figure 2-12: Decommissioning of generation (TDP period)

2.5 IRP IMPLEMENTATION PROJECTIONS

The implementation trajectory of the IRP is about a year late, which has resulted in the adjustment of the generation assumptions to align with that and to ensure that the transmission strengthening programme is synchronised with the actual generation procurement. Figure 2-13 shows the IRP and the generation assumptions plan as well as the projection of the IRP implementation. The projection was obtained from the DMRE document dated 24 August 2021. In the charts, the projections are aligned with the generation assumptions if the Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP) is excluded; however, when the RMIPPPP is taken into account, the PV projection is closer to the IRP. For wind, the projection is aligned more with the generation assumptions.

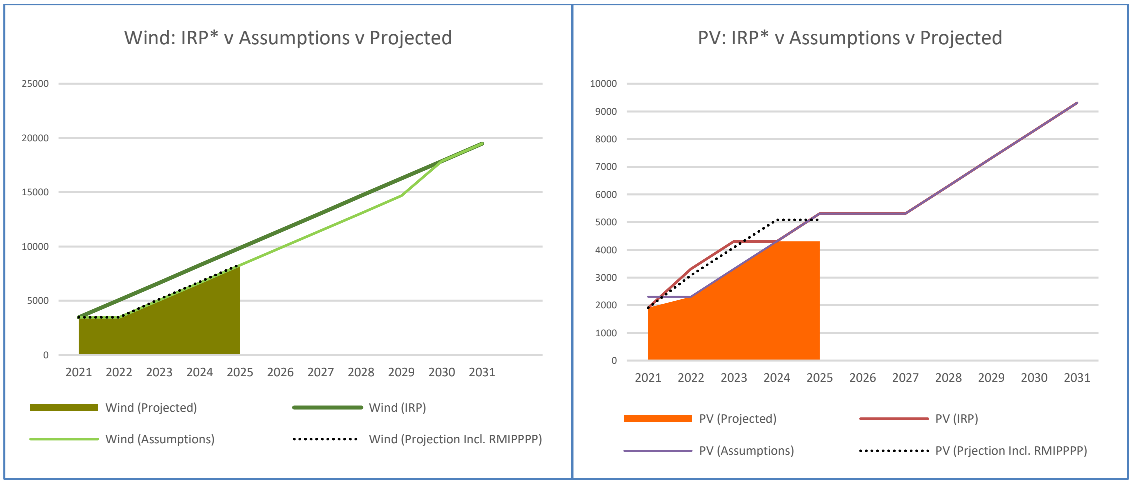


Figure 2-13: IRP versus generation assumptions and implementation projections

3 DEMAND FORECAST

Globally, electricity demand is set to maintain an upward trajectory. The World Energy Outlook report from 2019 assumes that electricity feeds the heart of modern economies, which provide a rising share of energy services. Electricity demand is set to rise due to changes in heating and fuel and transportation choices, rising urbanisation, and a sharp increase in technology and its accessibility to all people. A rise in digitalisation will continue to lead to increased electricity usage in data storage, air conditioning, and digital device maintenance. Worldwide drives to reduce carbon emissions have also provided a rise in demand for cleaner electricity generation sources. Decarbonised electricity can provide a platform for reducing CO_2 emissions in some sectors by advancing electricity-based fuels such as hydrogen and synthetic liquid fuels. Incorporating renewable clean electricity sources in the future plays a significant role in balancing the demand and supply functions of the electricity supply chain (International Energy Agency (IEA), World Energy Outlook, 2019).

Energy is at the forefront of a country's development and is also the vital force that powers businesses, manufacturing, the transportation of goods, and services to a nation. Moreover, it is the sustained source of modern living, as it has an impact on all population activities. Energy is, therefore, considered an essential enabler for economic growth and stability (World Bank, 2019).

The South African Energy Sector Report of 2019 deems the energy sector in South Africa to be the centre of economic and social development. The industry directly affects the economy by using labour and capital to produce energy, enabling other leading industries of the South African economy to function and contribute to GDP growth. Leading sectors include the industrial, transport, agriculture, residential, commerce, and public services sectors (Energy Sector Report, Department of Energy (DoE), 2019).

The purpose of the transmission demand forecast is for capacity planning of the transmission network. The transmission demand forecast continuously needs to be aligned with the aspirations of South Africa's National Development Plan (NDP) and the IRP to facilitate the economic growth of the country. The NDP stipulates a vision to create adequate energy infrastructure to stimulate steady economic growth for South Africa. It, furthermore, encourages diversification in energy generation sources and developing technologies to enable sustainable capacity building. The IRP was updated and gazetted in October 2019, and its demand forecast is used as a guideline forecast in formulating the transmission demand forecast.

3.1 ASSUMPTIONS

The following assumptions are made on demand growth potential in the country:

- Transmission responsibilities will remain similar to the current operations in the Eskom structure, regardless of the pending restructuring.
- Eskom remains a going concern as the primary electricity utility for South Africa.
- Construction of additional generation capacity remains on target and is implemented on time.
- Maintenance and construction of sufficient transmission network equipment are available.
- A reasonable recovery on the energy availability factor (EAF) is assumed.
- The socio-political environment will stabilise or improve in the medium to long term.
- International and local governmental and private investment in the growth of the South African economy is a vital requirement for enablement of potential demand growth.

3.2 METHODOLOGY

Policy guidelines are conformed to and in line with Grid Code requirements to deliver an annual transmission forecast. The forecast methodology is focused on scenario planning by looking at different perspectives of the future. A double S-curve methodology, combined with quantitative and qualitative techniques, produces the national forecast scenarios. The scenarios are tested against external forecasts such as the IRP and aligned with Eskom Distribution's bottom-up formulated forecasts.

The demand forecast is based on the collaborated modelling of both quantitative and qualitative techniques. Quantitative analysis is done on actual data received from in-house metering systems, customer quotation processes, and economic forecasts from service providers. Qualitative analysis is conducted using scenario exploration and external market information sourced from assigned platforms, such as Fitch Solutions and Econometrix. Other forecasts are obtained from research to assist with assumptions regarding new technologies such as electric vehicles and the implementation of renewable generation sources throughout different countries. Continuous scanning and monitoring of market information are, furthermore, used to forecast likely future demand. Such projections are subject to market influences and contingent on matters outside the demand forecasters' control, and assumptions are valid until input variables cause them to change. Historical demand growth patterns do not guarantee future performance, as future trends concerning technological advancement and customer preference change. The availability of generation supply is closely correlated with demand growth in the country and will have a significant influence on future demand realisation. The forecast is continuously monitored, and any financial decisions should be based on sensitivity analysis encompassing all relevant and the most recent information sets. The methodology framework in Figure 3-1 shows the high-level methodology used to conceptualise assumptions as input into the forecast. The assumptions are then used as part of a seven-step process to model the forecast from national to provincial and substation level using nodal disaggregation.

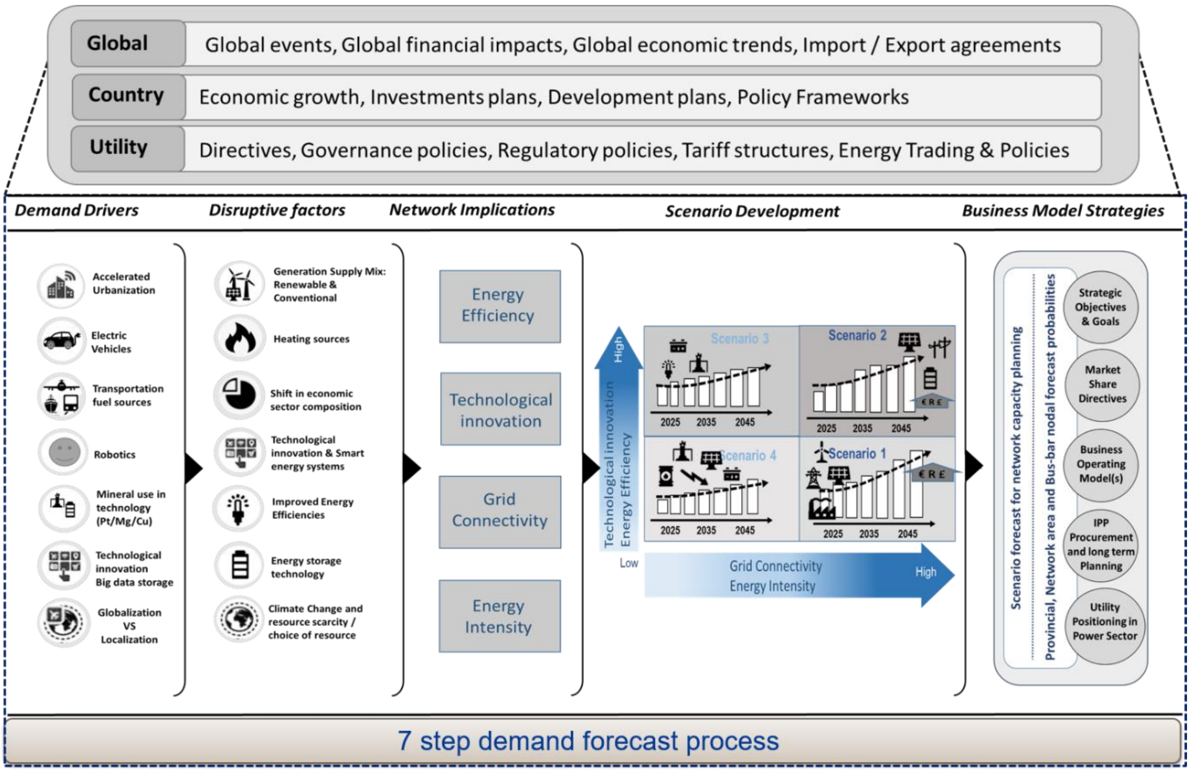


Figure 3-1: Scenario building methodology framework

3.3 DEMAND DRIVERS

In South Africa, the demand is primarily driven by consumer behaviour in the residential sector, investment policies in the industrial sector, and the electricity price structures. Population statistics, economic growth, investment initiatives, and customer behaviour are continuously monitored to enable further forecasting. The NDP notes an increase in urbanisation that will stimulate electrification and urban developments. In 2010, the NDP estimated that approximately 70% of the country’s population would be relocating to city centres; however, recent changes in the work environment due to COVID-19 regulations have resulted in a new drive where more employers have started rethinking the way employees work. Work from home has been implemented to a large extent, and several studies have shown major cost-saving initiatives by not having traditional office workplace environments. The changes in the workplace have led to increased residential demand growth and lower commercial demand due to smaller office space requirements. Many people are also relocating to smaller towns, which brings the opposite growth effect as that initially envisaged by the NDP. Additional growth is now expected in smaller coastal areas. However, a large amount of city centre growth has not yet been ruled out. The total population growth for the TDP period up to 2031 is estimated at 14%, as published by the Global Insight forecast in the second quarter of 2021.

Figure 3-2 shows a high-level summary of the significant demand drivers for electricity load in the country that will significantly affect network planning.

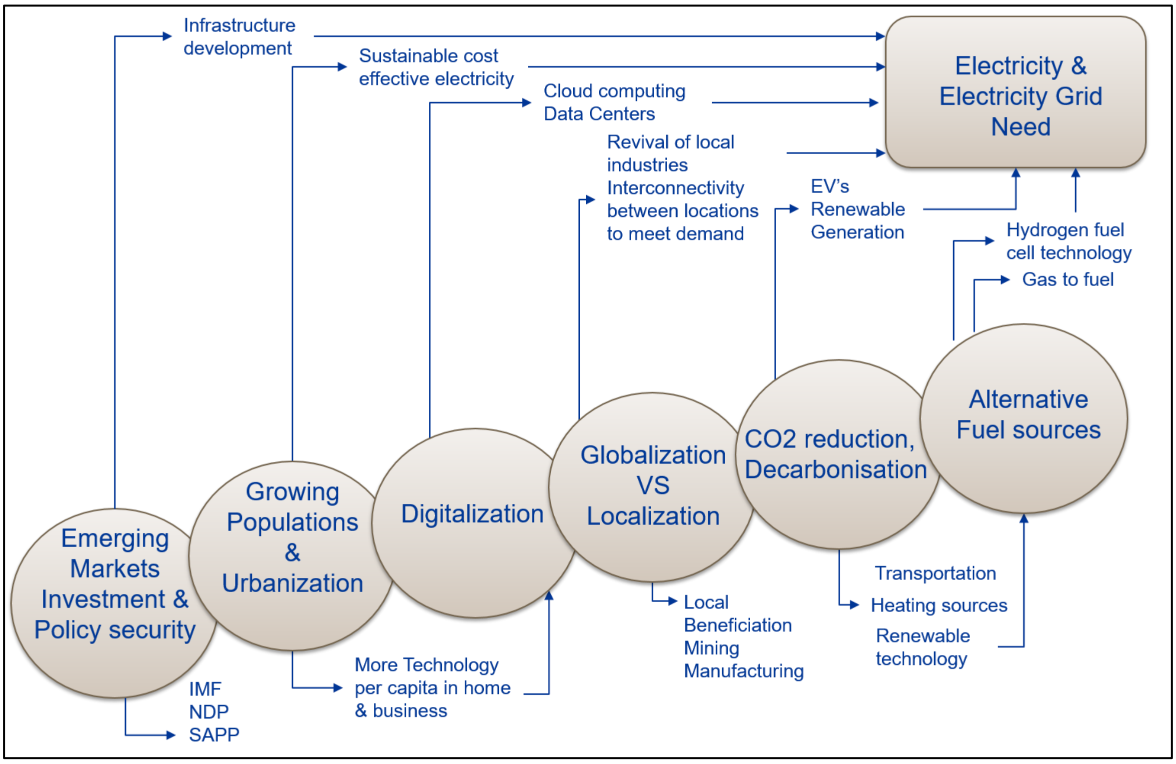


Figure 3-2: High-level country electricity demand drivers

In 2019, investment as a percentage of gross domestic product (GDP) was 17,5%, with South Africa ranked 104th out of 132 emerging market economies. The International Monetary Fund (IMF) has committed itself to investing more than R600 billion in emerging markets. Although the South African growth in investment has been declining since 2008, an increase in investment will drive demand uptake. The South African Investment Conference (SAIC), an initiative to drive investments, now has more than R650 billion worth of investment pledges made in the three events over the past two years. The COVID-19 pandemic has influenced economies worldwide, and a lag in investment initiatives initially planned is expected. However, due to harsh economic circumstances, governments worldwide and in South Africa have set out some recovery initiatives. The South African economic recovery plan was launched to reorient trade policies, to promote local raw material beneficiation, to increase exports, infrastructure roll-out, and local industries, and to enable small businesses. Economic recovery is expected from 2021 to 2023. However, delayed consequences for economic recovery are expected for up to five years, both internationally and locally.

Urbanisation and an increase in technological innovation are driving the densification of already populated areas. Exponential growth in this regard can be seen in Gauteng, KwaZulu-Natal (KZN), and the Western Cape. These provinces, with their city centres of Johannesburg and Pretoria, eThekwini, and Cape Town, respectively, have been declared to be the fastest-growing city-regions. The city centre growth rates have significant implications for infrastructure development and electricity demand.

South Africa has an abundance of mineral-rich areas. Limpopo, North West, and the Northern Cape still show significant interest in mining and beneficiation of minerals in the manufacturing sectors. The Northern Cape houses more than 80% of the world's ferromanganese reserves. Therefore, there is high potential for mining and manufacturing to add additional demand in the future. Coal, uranium, and platinum sources are increasingly in demand throughout Limpopo as the mining operations migrate from North West's platinum resources towards the mineral-rich northern areas of the country.

Globalisation has affected the overall supply chain in the mining and manufacturing sectors, and the export of raw materials has increased, with more competitive commodity processing offers from external countries. Global produce supply has impaired the potential demand growth for manufacturing products such as steel and other local manufacturing opportunities. For example, Saldanha Steel has lowered its notified maximum demand (NMD), as its plant was shut down. Like its predecessor, Highveld Steel (in the northern parts of the country) has also reduced and closed down its steel production in the past five years. Local demand is expected to be driven primarily by the rising global demand for commodities stimulated by COVID-19 trade constraints and an international increase in demand and supply of primary commodities, construction material, and household products. A turn from globalised supply to localised investment in manufacturing will drive demand from a local perspective and initiate job opportunities and economic GDP growth.

The significant drive towards climate change also contributes to new sources of electricity demand. The introduction of charge stations for electric vehicles, hydrogen fuelling, and increased energy efficiency can increase production capacity at manufacturing facilities.

Demand drivers can be gathered from customer applications as another vital input to validate statistical growth patterns from the past and enhance growth possibilities into the future. For example, customer connection applications and scanning of market intelligence and governmental investment declarations and growth initiatives, such as the Special Economic Zone Programmes and strategic investment projects, quantify future potential demand in the various regions of South Africa.

Figure 3-3 provides a spatial view of the demand and its approximate locations. The blue circles indicate customer applications (indicative cost estimates (ICEs) and budget quotation applications (BQs)), and the grey circles represent load growth possibilities identified by the market intelligence gathered from official sources. The highest, most numerous network load quotations are from Gauteng, Limpopo, and the Northern Cape. The qualitative data from customer applications indicates that demand growth is inevitable and that electricity catalyses growth.

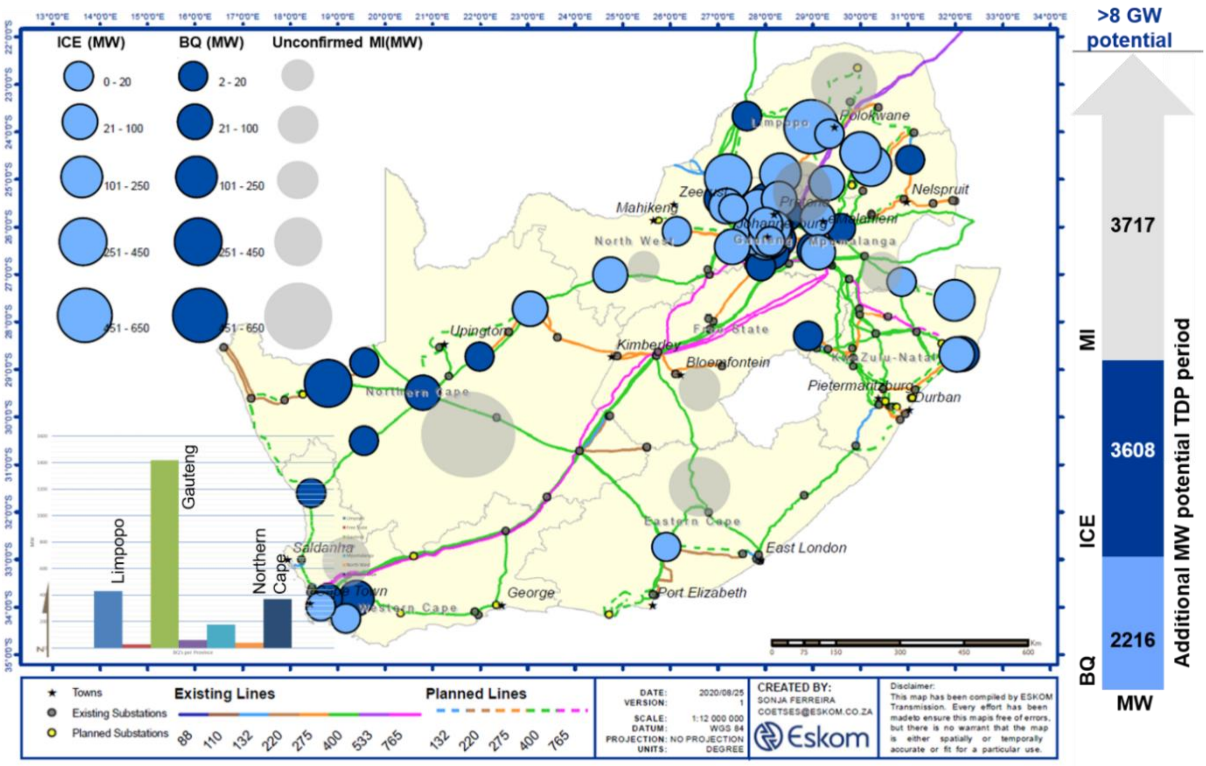
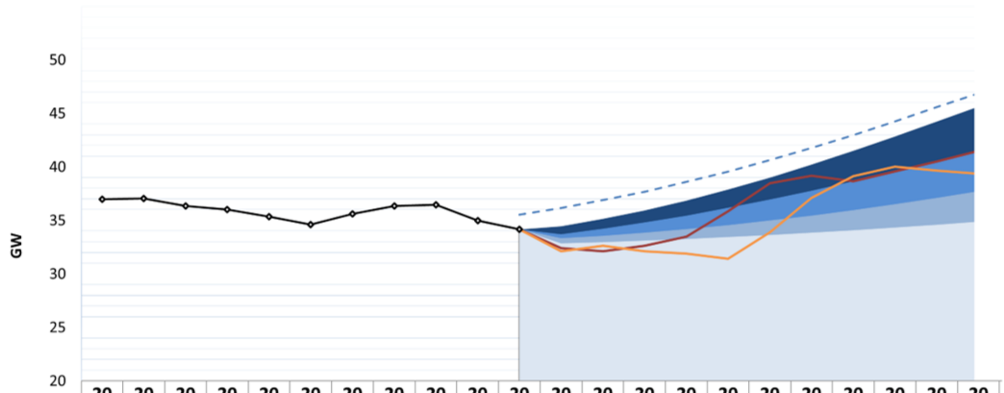


Figure 3-3: Processed customer applications and market intelligence data

3.4 NATIONAL FORECAST

Four distinct national scenarios were created, each with its own set of assumptions. Additionally, two constrained scenarios were formulated to simulate the low demand uptake expectation for the next two to five years. The lowered demand uptake is due to two distinct factors: the economic lag caused by the COVID-19 pandemic and the current generation constraints experienced by Eskom. Thus, a total of six future scenarios, with accompanying assumption sets, were developed. The preferred scenario for the TDP 2022 to 2031 planning cycle is the moderate-high scenario, which was used as the primary input to model the provincial and substation forecasts. The other scenarios are recommended for sensitivity studies to consider future possibilities in a highly volatile forecast space with considerable uncertainty.

Figure 3-4 shows the six scenarios and the actual system peak values (including contracted IPPs).



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
2021 Tx High											34	34	35	36	37	38	39	40	41	43	44	46
2021 Tx Moderate High											34	34	34	35	35	36	37	38	39	40	41	42
2021 Tx Energy efficient											34	33	34	34	34	35	35	35	36	37	37	38
2021 Tx Low											34	33	33	33	33	33	34	34	34	34	35	35
2020 Tx High											36	36	37	38	39	40	41	42	43	44	46	47
Constrained Scenario 1											34	32	32	33	33	36	38	39	39	40	41	42
Constrained Scenario 2											34	32	33	32	32	31	34	37	39	40	40	39
Actual Peak Demand (MW) *	37	37	36	36	35	35	36	36	36	35	34											

Figure 3-4: 2021 National demand forecast scenarios with constrained forecast scenarios, actuals, and 2020 forecast

**Instantanious Peak*

The system peak recorded for 2020 was 34,1 GW, down 1% from 34,5 GW in 2019. It should be noted that the system peak was only reached in September after lockdown restrictions had been lifted. The peak was, therefore, delayed; yet demand was still regained later in the year. It was observed that the peak network capacity decreased marginally; yet a significant deficit in energy actuals (kWh) was noted during 2020, with significant industries losing operational time. As a result, energy contracted by 6% to 194 031 GWh. The short-term forecast for the peak value for 2021 was recorded as 35 GW in the August 2021 short-term forecast. The increase in system peak is consistent with the lockdown restrictions and recovery plans put in place. However, recent political instability in the country will need to be monitored, together with its impact on international investment initiatives, to stimulate economic growth and demand uptake.

Figure 3-5 describes the four Transmission demand forecast scenarios, depicted in a four-quadrant matrix indicating the relation of each scenario to grid connectivity versus energy efficiency and technological innovation. The prescribed Scenario 2 is being considered.

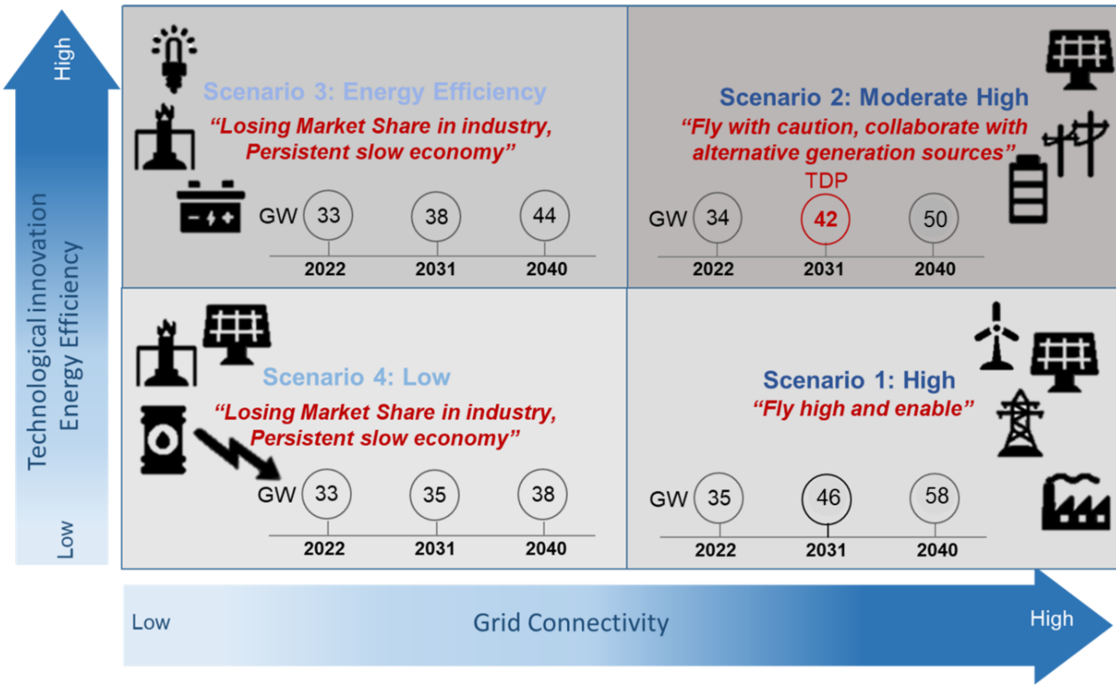


Figure 3-5: Summary of Transmission demand forecast scenarios

3.4.1 High Scenario – "Fly High, and Enable"

The high scenario is based on assumptions that South Africa is a developed country specified by the NDP and indicates optimistic growth figures. The high scenario is in line with projected GDP growth of 4% average year-on-year growth expected for the TDP period of 2022 to 2031. This scenario is optimistic and assumes the return of current suppressed industries due to world economic conditions and trade contracts influencing imports, exports, and local production and, therefore, a move from globalisation to localisation. This scenario is governed by national development targets as set out in the NDP. It assumes that the generation capacity gap is addressed by the Eskom turnaround plan and successful IRP renewable integration.

The scenario satisfies a high amount of grid connectivity caused by many renewable connections for energy trading and connecting supply to the central transmission grid. This scenario needs high capital investment for grid expansion and maintenance to ensure grid sustainability. The average annual growth in demand over the TDP period is estimated at 3%, with a total increase of 11 GW required from the system. A margin of growth is recovery to original demand levels before 2010. From 2022 onwards, the generation of Ingula, Medupi, and Kusile Power Stations will be increasingly available to the system. It is assumed that the combination of other potential generation sources will become available to meet the future demand to enable economic growth for the country. This scenario leads to a nominal capacity forecast of 46 GW by the end of the TDP period and 65 GW in 2040.

3.4.2 Moderate-High Scenario – "Fly With Caution, Enable, and Collaborate with Off-Grid Solutions"

The moderate-high scenario is based on an explorative approach. The scenario assumes collaboration with renewable sources, with a high number of grid connections. Low to medium grid deflection is expected, with the transmission grid still utilised as a backup supply source and, therefore, still highly dependent on grid stability. Growth trends experienced in the past are simulated into the future. The scenario foresees the return of leading industries in South Africa at a slower, steady pace and the capacity gap being addressed, with a higher energy availability factor. The economic recovery plan presented by President Cyril Ramaphosa, combined with investment in public and private infrastructure developments, is assumed to enable demand uptake successfully. Average year-on-year demand growth of 2% is expected, and it is forecasted that the load will reach 42 GW by the end of the TDP period, 50 GW by 2040, and the NDP-envisaged 65 GW only by 2050. The GDP growth coinciding with this forecast is 2,3% average annual growth for the TDP period. This scenario is deemed feasible for TDP implementation plans without constraints.

3.4.3 Medium (Energy-Efficient) Scenario – "Sharing the Energy Supply Market"

The energy-efficient scenario assumes an increase in the uptake of alternative energy generation associated with increased energy efficiency. This scenario speaks to the phenomenon where technology advances in storage and alternative energy generation solutions become increasingly affordable and may surpass the rising cost of electricity provided by the country's power utility. Medium to high grid deflection, low grid-tied connections, and an increase in energy efficiency are envisaged in this scenario. Increased penetration of localised PV and small-scale electricity generation (SSEG) and so-called "behind-the-meter" generation, supplemented by battery storage, is causing higher grid deflection scenarios. With the loss of customers through sustainable alternative electricity and heating solutions, fewer people will be dependent on the central transmission grid. This scenario leads to a nominal capacity forecast of 40 GW by the end of the TDP period, a network capacity average growth rate of 1,3%, and a final forecasted value of 47 GW in 2040, around 15 GW less than initially forecasted in the NDP. A GDP growth of 2% average annual growth for the TDP period is associated with this scenario. With a future banking on renewable generation and a decarbonised environment, the energy efficiency should decrease to bring down the baseload currently fuelled by fossil fuels.

3.4.4 Low Scenario – "Losing Market Share in the Industry, Lagging Economy"

The low scenario is based on assumptions that there will be a continued suppressed development rate in the country and that most industries will not return to their original status. Degrading economic status and political distrust will cause development to decay, and very little to no growth is expected. This scenario is pessimistic, with a year-on-year growth rate of 0,6%, and relates to a low economic growth of below 1% in GDP. This forecast leads to 35 GW towards the end of the TDP period and 38 GW in 2040.

3.4.5 Constrained Forecast

One of the hurdles to unlocking economic growth is the lack of generation supply to meet the demand. A shortage of generation capacity and a decrease in the EAF percentage (trending below 65%) from the country's electricity utility, Eskom, ensure slow demand uptake. This, together with the economic effects of COVID-19, meant that two constrained forecasts were needed. The forecasts were modelled with global and local assumptions based on turnaround strategies and increased structural reforms and infrastructure investments. The business identified some critical aspects that lowered demand expectations. These included increased unplanned unavailability, increased planned maintenance, severe capital constraints, and governance and decarbonisation requirements. The two constrained forecasts were modelled on past cycles multiplied by the forecasted S-curve trends. Turnaround plans will be designed to have an impact both globally and locally, of between three and five years.

It is recommended that the preferred moderate-high forecast scenario still be adopted with sensitivity analysis done using the constrained forecast, especially where the impact on the commercial, industrial, and mining sectors is significant.

Due to the harsh economic circumstances, capital constraints also have to be considered when making strategic investment decisions. Therefore, the long-term effects are still under investigation and will have to be closely tracked and monitored to establish their exact impact on future forecasts.

3.4.6 ESKOM STRATEGY TARGETS

In response to recovery, both the government and Eskom have put reforms in place to add to the investment and development focuses on driving economic influence in the country.

Eskom remains committed to addressing the current electricity supply crisis to support the growth and development of our economy and our society – without a detrimental impact on our economy. A generation shortfall of 6 000 MW over the next five years is estimated as old coal-fired power stations reach their end of life. As a result, the government has announced a 2 000 MW emergency procurement programme and fast-tracked the process to purchase an additional 11 800 MW of capacity, in line with the IRP 2019.

Eskom will continue the intensive maintenance of its power stations, improve on emissions compliance, and complete the construction of the Medupi and Kusile Power Stations. In addition, the Department of Mineral Resources and Energy (DMRE) will open up the power system to renewable energy sources such as wind and solar in collaboration with other relevant entities.

The government will continue to ensure financial sustainability by repositioning Eskom as a pivotal platform in the future electricity supply industry. In addition, Eskom will continue its restructuring to enable the legal separation of its line divisions.

3.5 IMPACT OF COVID-19 PANDEMIC AND ECONOMIC OUTLOOK

The worldwide COVID-19 pandemic and a double downgrade in the financial status of South Africa by two major financial institutions left South Africa's economy in dire straits at the end of 2020. The pandemic has brought two additional waves since the forecast report of 2020. Several drastic measures have been put in place by the government and the World Health Organization to ensure that economic recovery is set in motion. In addition, some pledges have been made to, especially, developing countries by the International Monetary Fund (IMF) to assist in recovering the economy. As a result, South Africa's GDP was expected to rebound by 4,5% in 2021, as the first-quarter 2021 GDP exceeded expectations. It was anticipated that the economy would benefit from a strong global economic backdrop, low interest rates, and the roll-out of the COVID-19 vaccine programme in the second half of 2021.

ReX IHS economic researchers believed that favourable medium-term inflation expectations would likely keep the policy of the South African Reserve Bank unchanged during 2021. Headline inflation would average 4,5% in the year, while the rand was expected to average ZAR 14,20/USD 1,00. Accordingly, South Africa's monetary policy remains expansionary. In the short term, the most significant risks to the economy are sustained by the unfolding COVID-19 pandemic and the repeated electricity disruptions by Eskom due to generation shortages and high maintenance occurrences. COVID-19 has resulted in downward economic activity and electricity demand globally and locally with the implementation of hard lockdowns in 2020 to try to contain it. As a result, vast world economies contracted, with GDP growths ranging between -2% and -10% in 2020.

Figure 3-6 shows the national forecast from three renowned econometric forecast companies used by Transmission. All of these forecasts indicate a high likelihood of a fast recovery. This is similar to the outlook of most countries worldwide.

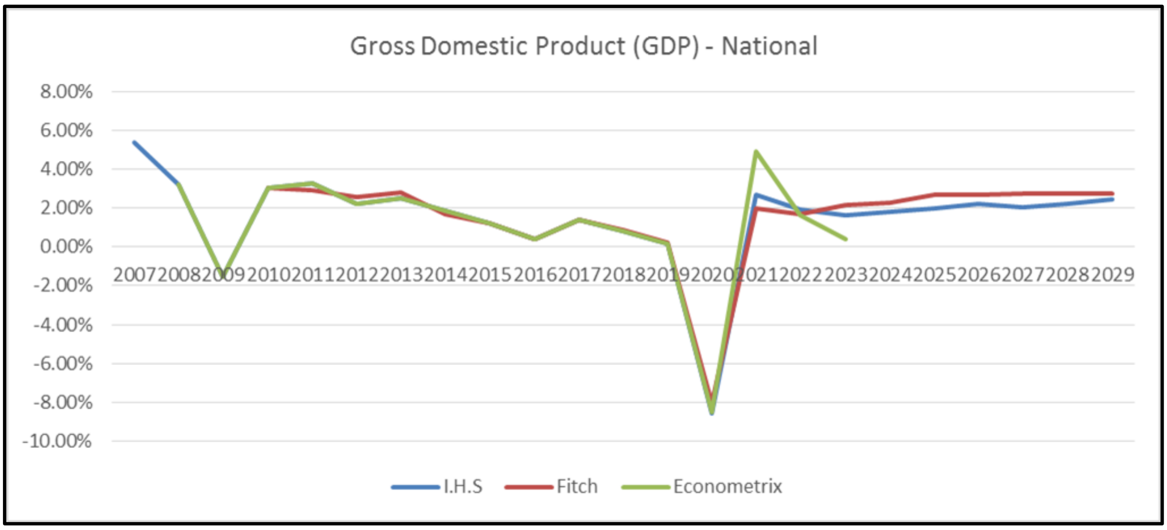


Figure 3-6: 2021 GDP projections for South Africa

Figure 3-7 displays a matrix graph indicating the severity of the economic impact per province. The darker shades indicate provinces in which COVID-19 lockdown restrictions have had an intense impact. Economies worldwide expected to see a drastic recovery in 2021; however, delayed consequences for economic recovery from COVID-19 are expected, and full recovery is only expected in a three- to five-year period.

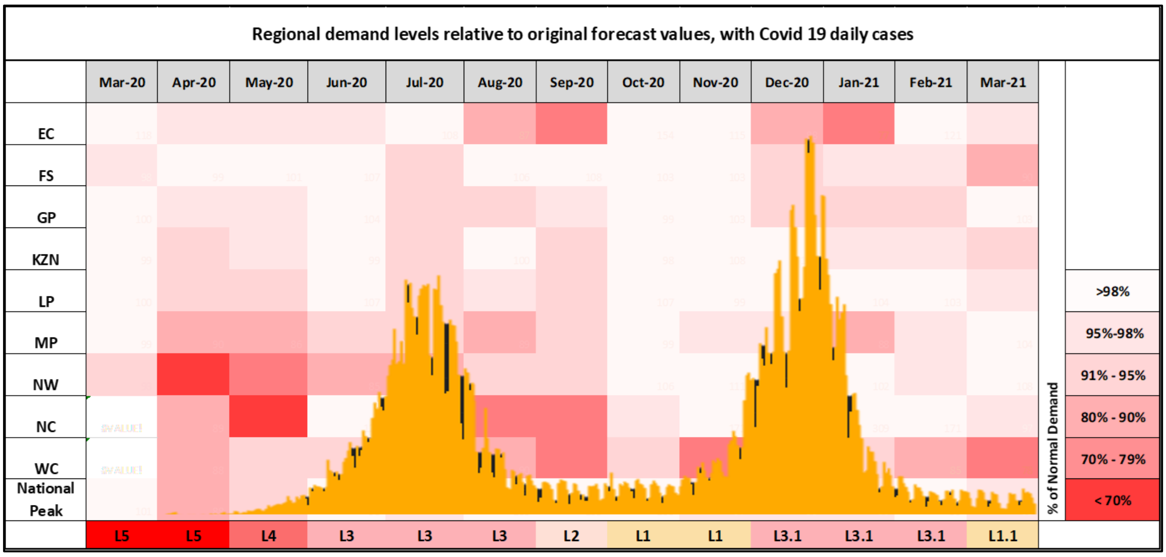


Figure 3-7: Regional demand influenced by lockdown levels imposed due to COVID-19

It was observed that regions with large industry sectors were affected most, such as North West. During the months of September to November 2020 in Level 1 after the first wave, demand was mainly back to standard expectations. During the second wave, demand decreased again, as restrictions increased over December 2020 and January 2021. Most parts of the industrial, mining, and manufacturing industries slowed down production during December 2020 and January 2021 for a year-end break and care and maintenance. A comparison of key customers and demand capacity was analysed. Some correlation can be seen between demand decreases and the COVID-19 numbers from the graph overlay. Key customers account for more than 40% of Eskom load and, therefore, represent a significant impact. Figure 3-8 shows the comparison between utilised capacity throughout the COVID-19 period up to April 2021.

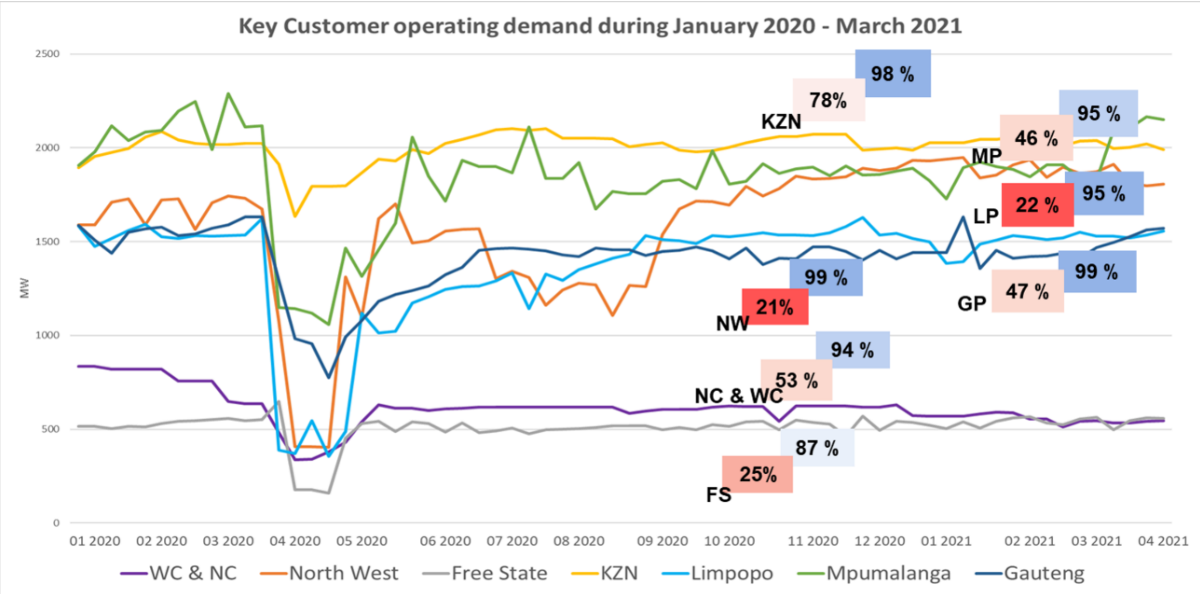


Figure 3-8: Key customer COVID-19 recovery patterns in all nine provinces

Limpopo and North West Key Sales and Customer Service (KSACS) customers had the most significant reduction, but also excellent recovery. Demand reductions of a maximum of 89% could be seen during Level 5. The least-affected customers were from KZN. In addition, minimal NMD decreases were noted throughout the country, suggesting demand recovery in most parts of the country.

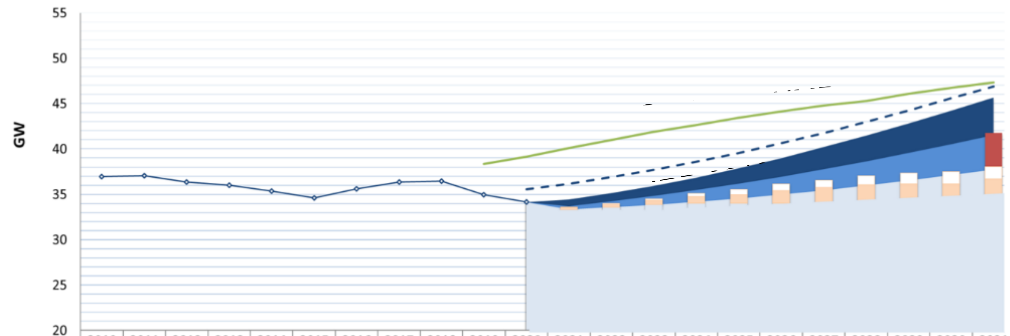
3.5.1 Demand Stimulus as Part of Economic Recovery

Demand is expected to be driven primarily by the rising global demand for commodities. With Eskom's continual commitment to addressing the shortfall and collaboration with governmental programmes to add additional capacity, demand growth is expected to return. In addition, a governmental economic recovery plan was launched for reorientation of trade policies, for promotion of local raw material beneficiation, increased exports, infrastructure roll-out, and localisation of industries, and for enablement of small businesses. All of these initiatives will assist in the economic recovery plan and form the basis from which further economic growth can develop.

3.6 COMPARISON OF FORECASTS

Figure 3-9 shows the transmission demand forecast (2020 and 2021) versus the IRP 2019 demand forecast, as well as the actual customer notified maximum demand (NMD) forecast. It also shows the cumulative customer applications for the TDP period.

The IRP 2019 forecast and the Transmission high scenario merge at the end of the TDP period. Therefore, it is recommended that the high scenario be adopted for planning at a national level, while the moderate-high scenario is used for detailed substation planning.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
2021 Tx High											34	34	35	36	37	38	39	40	41	43	44	46
2021 Tx Moderate High											34	34	34	35	35	36	37	38	39	40	41	42
2021 Tx Low											34	33	34	34	34	35	35	35	36	37	37	38
Market Intelligence																						4
Indicative Cost Estimates												0,1	0,1	0,1	0,3	0,6	0,7	0,8	1,0	1,2	1,3	1,4
Tx Customer Quotations											0,1	0,2	0,3	0,5	0,8	0,9	1,4	1,8	2,0	2,1	2,2	2,7
Customer Quotes Base on Tx Low												33	34	34	34	34	34	34	34	34	34	34
2019 IRP HLI Demand (MW)										38	39	40	41	42	43	43	44	45	45	46	47	47
2020 Tx High											36	36	37	38	39	40	41	42	43	44	46	47
Actual Peak Demand (MW) *	37	37	36	36	35	35	36	36	36	35	34											

*Instantanious Peak Demand

Figure 3-9: Comparison of the forecast with IRP 2019 and customer quotations

3.7 PROVINCIAL FORECAST

The Transmission national forecast is disaggregated into a demand forecast per province, per customer load network (CLN) and transmission substation. Figure 3-10 shows the load density and growth prospects per province. It indicates the change in growth prospects for the TDP, including population growth, total demand growth, compound annual growth, and electric vehicle forecast scenarios per province. Details of the local forecasts can be found in Chapter 7, where each province is addressed.

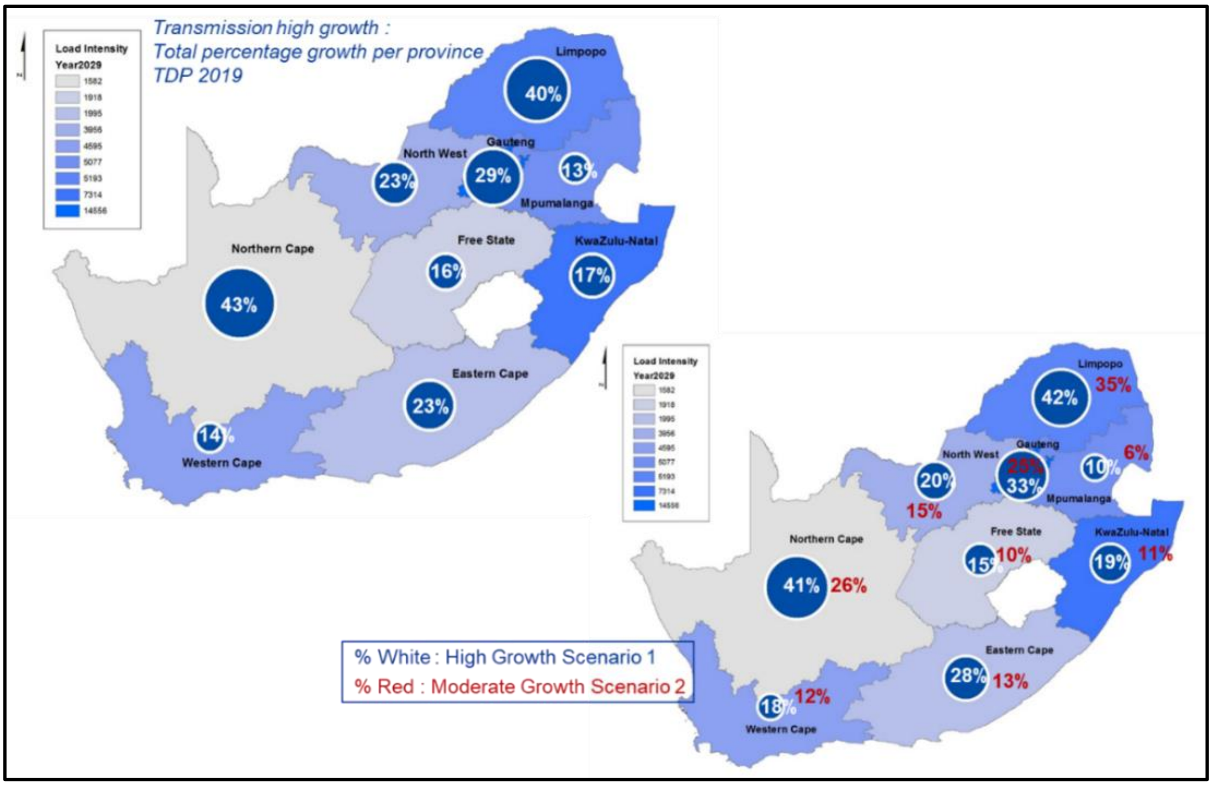


Figure 3-10: Provincial demand forecasts

4 COMPLETED PROJECTS

A summary of transmission expansion projects completed since the publication of the previous TDP in 2020 is given in Table 4-1. The project list excludes all the dedicated components of the projects resulting from the customer connection applications received.

Table 4-1: List of completed transmission expansion projects since October 2020

Province	Project name
Eastern Cape	Riverbank IPP integration at Pembroke
Gauteng	Golden Triangle Craighall-Lepini optical ground wire (OPGW)
Limpopo	Waterberg Gx Fault Level Management Plan Phase 2: Merensky
	Waterberg Gx Fault Level Management Plan Phase 2: Witkop
Western Cape	Ankerlig-Sterrekus 400 kV line

5 CUSTOMER APPLICATIONS

Table 5-1 outlines the number of indicative cost estimates (ICEs) and budget quotations processed by Transmission during the 2020/21 financial year (April 2020 to March 2021). These were as a result of applications for grid connections to the transmission network. The identities of individual applicants are not reported on in order to protect the confidentiality of the parties involved.

The number of connection applications received was 264, which was much higher than the 96 in the 2019/20 financial year.

Table 5-1: Connection applications received and accepted in FY2020/21

Quotation type	Indicative cost estimates		Budget quotations	
	Received	Accepted	Received	Accepted
Generation	218	3	11	0
Load	26	4	9	0
Total	244	7	20	0

6 NATIONAL OVERVIEW

Significant lengths of new transmission lines and associated substations and substation equipment are being added to the system. These additions are mainly due to the major 765 kV and 400 kV network reinforcements required for the Cape and KwaZulu-Natal, as well as the integration of the new Medupi and Kusile Power Stations.

The establishment of large-scale RE generation is becoming the primary driver of network development in the three Cape provinces, apart from the Cape corridor projects. These new transmission lines form part of the long-term strategy to develop a main transmission backbone from which regional power corridors can be supported. These power corridors will connect generation pools to one another and to the country's major load centres. This backbone and regional power corridor structure will allow the increasing system demand to be supplied and the power from new power stations to be integrated more efficiently into the transmission network and distributed where required both under conditions where the system is healthy and when it is experiencing contingency conditions.

The development of the transmission backbone and the associated regional power corridors was reviewed as part of the Strategic Grid Study, which considered the potential development scenarios beyond the 10-year horizon of the TDP. The objective of this strategic study was to align the transmission network with the requirements of the future generation options and those of the growing and future load centres. This strategic grid study has enabled the 10-year TDP to be aligned with the future long-term development of the whole Eskom system. It has also ensured that the most appropriate technologies are used for this purpose by testing whether other technologies (for example, high-voltage direct current (HVDC)) would likely yield better, more practical, and more cost-effective solutions.

The additional transformer capacity added to the TS indicates the increase in load and generation demand and in the firm capacity requirements of the customers, as well as what is required to achieve compliance with the minimum N-1 redundancy requirements in the Grid Code.

Shunt capacitors are required to support the network under contingency conditions to ensure that the required voltage levels are maintained and defer more expensive network strengthening, such as additional transmission lines. Maintaining voltages at desired levels also improves system efficiency by reducing network losses. Additional shunt reactors and line reactors are required due to the length of the 765 kV and the 400 kV transmission lines that will be constructed over this period. They are needed to enable the safe and secure operation of the system and to prevent overvoltage during light loading conditions and line switching operations.

Some projects have associated distribution projects to enable customers to benefit from them. For example, a new substation may require distribution infrastructure to connect it to the existing distribution network or connect new bulk loads. Distribution infrastructure and individual feeder bays to connect distribution infrastructure or bulk loads are not included in this report individually.

The map in Figure 6-1 shows a high-level view of the major TDP scheme projects. The relative location of the new transmission lines and associated transmission substations is indicated schematically in the figure.

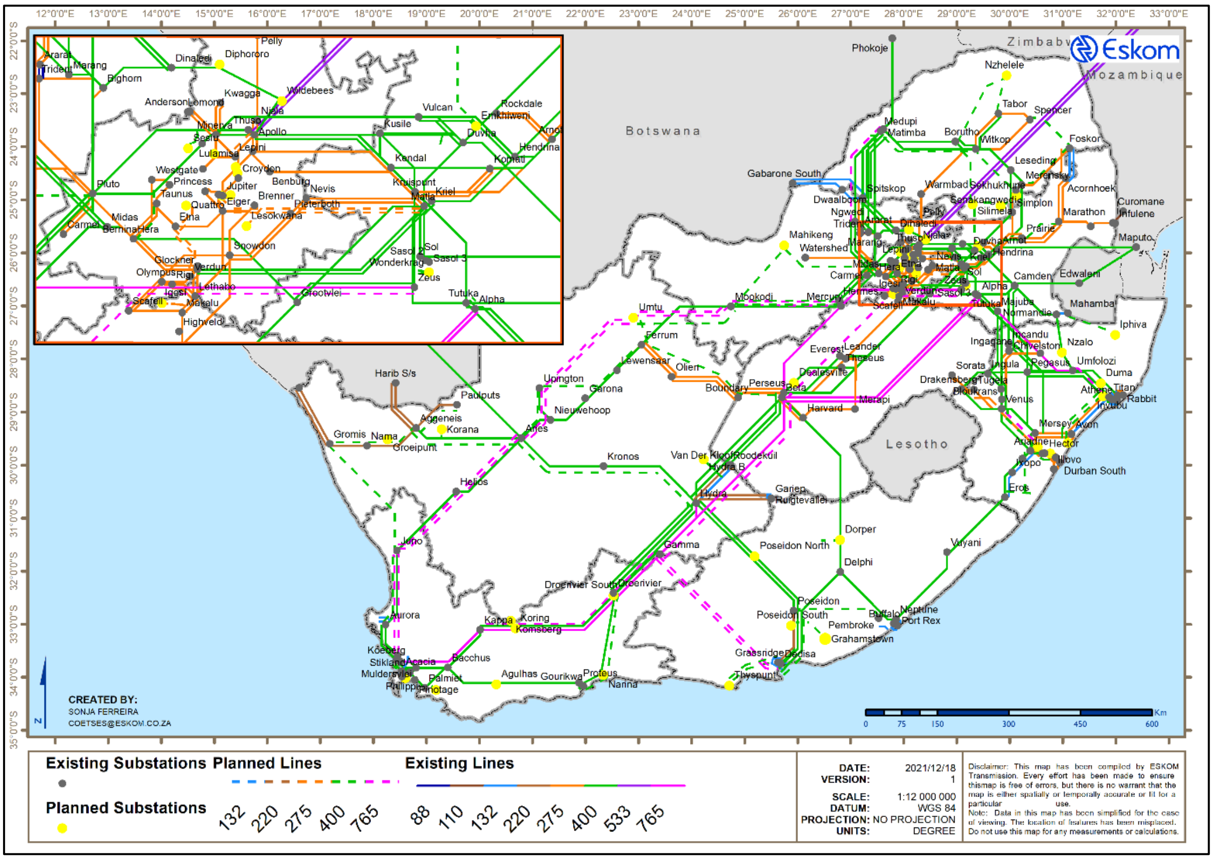


Figure 6-1: High-level overview of the major TDP scheme projects

The major new assets that have either been approved or are planned to be added to the TS over the next 10 years are summarised in Table 6-1 to Table 6-4.

Table 6-1: Planned transformers for TDP period

Transformer type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
125 MVA 220/132/22 kV	-	-	1	125
125 MVA 275/132/22 kV	-	-	2	250
135 MVA 275/132/22 kV	2	270	-	-
150 MVA 275/132/11 kV	-	-	1	150
150 MVA 275/132/22 kV	-	-	2	300
160 MVA 132/66/22 kV	1	160	1	160
160 MVA 275/88/22 kV	-	-	2	320
160 MVA 400/88/22 kV	3	480	-	-
180 MVA 132/88/22 kV	2	360	-	-
2 000 MVA 765/400/33 kV	-	-	5	10 000
20 MVA 132/6,6 kV	1	20	-	-
20 MVA 66/11 kV	1	20	-	-
20 MVA 66/22 kV	1	20	-	-
240 MVA 275/132/22 kV	-	-	2	480
250 MVA 220/132/22 kV	-	-	1	250
250 MVA 275/132/22 kV	-	-	7	1 750
250 MVA 400/132/22 kV	2	500	5	1 250
250 MVA 400/30 kV	-	-	1	250
300 MVA 400/132/22 kV	1	300	-	-
315 MVA 275/88/22 kV	-	-	10	3 150
315 MVA 400/132/22 kV	1	315	1	315
315 MVA 400/220/22 kV	-	-	2	630
315 MVA 400/88/22 kV	-	-	2	630
400 MVA 400/275/22 kV	-	-	2	800
40 MVA 132/33 kV	1	40	-	-
40 MVA 132/66/22 kV	1	40	2	80
40 MVA 220/66/22 kV	1	40	-	-
40 MVA 275/50 kV	-	-	4	160
40 MVA 400/50 kV	-	-	4	160
500 MVA 275/132/22 kV	3	1 500	1	500
500 MVA 400/132/22 kV	20	10 000	63	31 500
500 MVA 400/220/22 kV	1	500	-	-
66,6 MVA 400/15 kV	-	-	4	266

Transformer type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
7 MVA 22/11 kV	2	14	-	-
800 MVA 400/275/22 kV	-	-	6	4 800
80 MVA 132/33 kV	2	160	-	-
80 MVA 132/66/22 kV	2	160	6	480
80 MVA 220/66/22 kV	-	-	3	240
90,8 MVA 107/275 kV	3	272	3	272
Grand total	**51**	**15 171**	**143**	**59 269**

Table 6-2: Planned overhead lines for TDP period

Line voltage	2022 to 2026	2027 to 2031
	Total length (km)	Total length (km)
275 kV	90	209
400 kV	969	4 394
765 kV	76	2 668
Grand total	**1 135**	**7 271**

Table 6-3: Planned capacitor banks for TDP period

Capacitor type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
48 Mvar 88 kV	-	-	10	480
40 Mvar 132 kV	4	160	1	40
72 Mvar 132 kV	2	144	4	288
100 Mvar 400 kV	-	-	1	100
Grand total	**6**	**304**	**16**	**908**

Table 6-4: Planned reactors for TDP period

Reactor type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	3	300	18	1 760

Reactor type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
400 Mvar 765 kV	-	-	8	3 200
Grand total	**3**	**300**	**26**	**4 960**

7 PROVINCIAL DEVELOPMENT PLANS

7.1 EASTERN CAPE

The Eastern Cape is South Africa’s second-largest province by landmass and is located on the country’s south-eastern coast. The capital city of the Eastern Cape is Bhisho, and the two largest cities in the province are Port Elizabeth (PE) and East London (EL). The provincial economy is mainly driven by the automotive sector, which is the biggest manufacturing sector in the urban areas of the Eastern Cape. Nelson Mandela Bay Metropolitan Municipality (Metro) in Port Elizabeth and Buffalo City Metro in East London are the two major motor manufacturing hubs in the province.

Due to its excellent and desirable wind energy sources, the Eastern Cape has attracted a significant share of the RE projects procured to date. It is also expected that the majority of future generation from wind energy will be located in this province.

The Port Elizabeth area is supplied by means of three 400 kV transmission lines and a single 220 kV line, which also supports the manganese traction line. The infeeds into East London consist of three 400 kV lines and a single 220 kV line into the capital city, Bhisho. The current transmission network is shown in Figure 7-1.

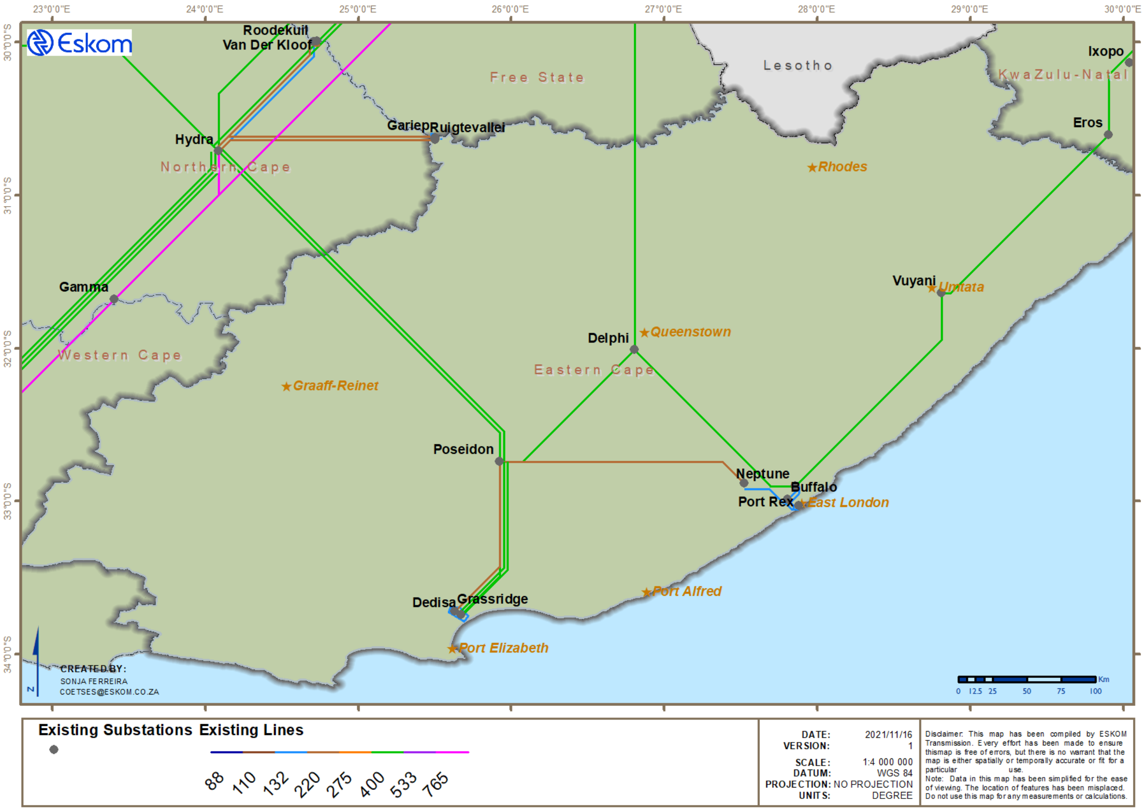


Figure 7-1: Current Eastern Cape transmission network

7.1.1 GENERATION

Historically, the Eastern Cape did not have a prodigious amount of local generation. The only sizeable generation in the province was Port Rex, with a capacity of 3 x 57 MW, operating as a peaking plant. Gariep Hydro Power Station, which is located on the provincial border of the Northern Cape and the Eastern Cape, has a generating capacity of 360 MW, with four units rated at 90 MW each. It evacuates power directly onto the Hydra 220 kV busbar via 220 kV and 132 kV lines. In recent times, the national power deficit has resulted in these peaking plant power stations generating outside the typical peak periods.

The total approved capacity in the Eastern Cape since the introduction of renewable energy independent power producers (REIPP) in the province amounts to 1 526 MW. The composition is shown in Table 7-1 below.

Table 7-1: Approved projects in the Eastern Cape under the REIPPPP

Programme and bid window	Wind (MW)	PV (MW)	Grand total (MW)
IPP RE 1	485	0	485
IPP RE 2	414	70	484
IPP RE 3	197	0	197
IPP RE 4	397	0	397
IPP RE 4B	33	0	33
Grand total	**1 526**	**70**	**1 526**

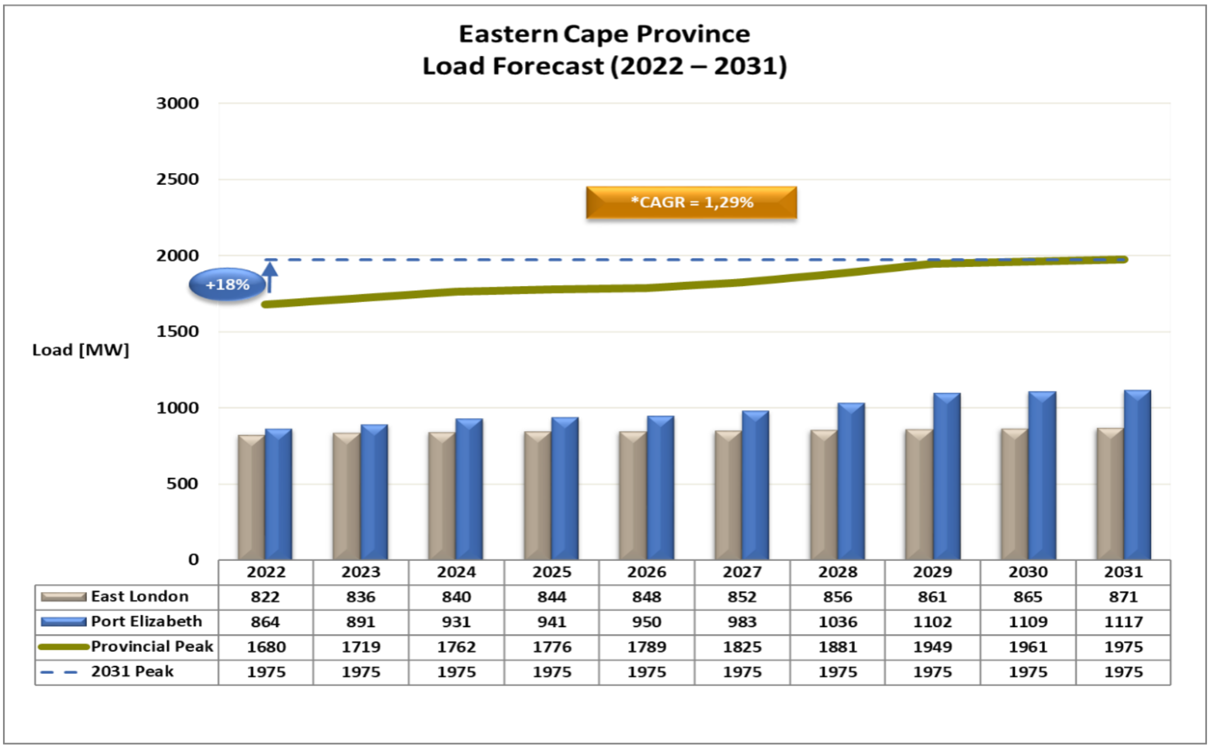
7.1.2 Load Forecast

The provincial load for the Eastern Cape peaked at around 1 545 MW in 2020, and it is expected to increase to about 1 975 MW by 2031. The major economic drivers in the province are the manufacturing sector, construction, the renewable IPP sector, and supporting industries. The rate of load growth has decreased significantly compared to previous TDP cycles. The main reason for the decline in load forecast is the slow realisation of anticipated projects in the Coega Industrial Development Zone and commercial and residential developments.

There is a high potential for developments in the Nelson Mandela Bay Metro in the Port of Ngqura, popularly known as Coega. As a result, the peak demand for electricity in the Port Elizabeth area is forecasted to increase from 864 MW to about 1 117 MW in the next 10 years. The bulk of the expected load increase in the CLN is attributable to the industrial development at Coega.

The East London CLN has a mixture of rural and urban loads. Most of the rural electrification is anticipated to be in the northern parts of East London CLN, in and around the Mthatha area. The Vuyani Substation and associated 400 kV supply lines are expected to unlock future electrification in the Mthatha area. The capacity of Vuyani Substation also has the potential to support and unlock capacity for electrification in the area.

The load forecast for the Eastern Cape is shown in Figure 7-2.



	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
East London	822	836	840	844	848	852	856	861	865	871
Port Elizabeth	864	891	931	941	950	983	1036	1102	1109	1117
Provincial Peak	1680	1719	1762	1776	1789	1825	1881	1949	1961	1975
2031 Peak	1975	1975	1975	1975	1975	1975	1975	1975	1975	1975

Figure 7-2: Eastern Cape load forecast

7.1.3 Planned Projects

Several projects and schemes that aim to address the long-term requirements of the province have been initiated in order to accommodate the forecasted load and generation.

7.1.3.1 Major Schemes

The major TDP schemes planned in the Eastern Cape are as follows.

Greater East London Strengthening Phases 3 and 4

Greater East London Strengthening Phase 3 entails the establishment of 400 kV at Pembroke Substation, the building of the Neptune-Pembroke 400 kV line, and the installation of the first 400/132 kV 500 MVA transformer. Greater East London Strengthening Phase 4 will introduce the second 400 kV corridor into Pembroke, construction of the Poseidon-Pembroke 400 kV line, and installation of the second 500 MVA 400/132 kV transformer.

Southern Grid Strengthening Phases 3 and 4

Southern Grid Strengthening Phase 3 entails introducing 765 kV into the Eastern Cape by means of the first Gamma-Grassridge 765 kV line. Southern Grid Strengthening Phase 4 introduces the second Gamma-Grassridge 765 kV line.

7.1.3.2 New Substations

The low voltages under network contingencies at Pembroke Substation and the underlying network will necessitate the introduction of 400 kV at Pembroke Substation near King William's Town.

7.1.3.3 New Lines

Pembroke experiences low voltages with the loss of the 220 kV line from Poseidon. A 400 kV injection from Neptune (that is, the Neptune-Pembroke 400 kV line) is required to support the 220 kV line from Poseidon. A Poseidon-Pembroke 400 kV line will further strengthen the East London CLN network and assist with the evacuation of generation in the Port Elizabeth CLN.

7.1.3.4 Reactive Power Compensation

No reactive power compensation projects (capacitor banks and/or static var compensators (SVCs)) are planned for the Eastern Cape in the TDP period.

7.1.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period from 2022 to 2031.

Table 7-2: Eastern Cape – summary of projects and timelines

TDP scheme	Project name	Expected commercial operation (CO) year
Greater EL Phase 3	• Neptune-Pembroke 400 kV line	2022
	• Pembroke first 400/132 kV 500 MVA transformer	2022
	• Pembroke first 132/66 kV 160 MVA transformer	2022
Grassridge Third 500 MVA 400/132 kV Transformer	• Grassridge third 500 MVA 400/132 kV transformer	2023
Dedisa Third 500 MVA 400/132 kV Transformer	• Dedisa third 500 MVA 400/132 kV transformer	2026

TDP scheme	Project name	Expected commercial operation (CO) year
Greater EL Phase 4	• Poseidon-Pembroke 400 kV line	2028
	• Pembroke second 400/132 kV 500 MVA transformer	2028
	• Pembroke second 132/66 kV 160 MVA transformer	2028
Southern Grid Strengthening Phase 3	• First Gamma-Grassridge 765 kV line	2024
Poseidon 80 MVA 132/66 kV Transformer	• Poseidon 80 MVA 132/66 kV transformer	TBA

7.1.3.6 Projects for Future Independent Power Producers

The following transmission network strengthening projects will be required to enable the connection of the IPPs located in the province within the current TDP period based on the generation assumptions:

- Dorper 400/132 kV Substation between Beta and Delphi
- Introduction of 765 kV at Grassridge Substation
- Poseidon South 400/132 kV Substation between Grassridge and Poseidon
- Hlaziya 400/132 kV Substation
- Poseidon North 400/132 kV Substation at Iziko Series Capacitor Station
- Grahamstown 400/132 kV Substation

The envisaged generation growth in the Port Elizabeth CLN in 2028 will result in under-voltages at Pembroke Substation, with some circuits out of service. The construction of the Poseidon-Pembroke 400 kV line is expected to have increased generation evacuation through the Vuyani-Eros 400 kV line. The East London CLN will result in low voltage at Pembroke, Neptune, and Vuyani Substations under certain network contingencies. Shunt compensation projects that entail the installation of 100 Mvar capacitor banks at 400 kV will be implemented for voltage support at the following substations:

- Pembroke
- Neptune
- Vuyani

The strengthening projects in the table below are required to facilitate future IPP integration for the period 2022 to 2031.

Table 7-3: Eastern Cape – projects required to facilitate IPP integration

TDP scheme	Project name	Required CO year
Poseidon North 400/132 kV Substation Integration	• Poseidon North new 400/132 kV substation south of Iziko Series Capacitor Station	2029
Poseidon South 400/132 kV Substation Integration	• Poseidon South 400/132 kV Substation and loop-in between Grassridge and Poseidon	2029
Hlaziya 400/132 kV Substation Integration	• Hlaziya new 400/132 kV substation and 400 kV lines	2029
Dorper 400/132 kV Substation Integration	• Dorper new 400/132 kV substation and loop-in between Beta and Delphi	2029
East London Voltage Support: 100 Mvar Shunt Capacitor (Cap) Banks at Pembroke, Neptune, and Vuyani	• 100 Mvar shunt cap banks at Pembroke, Neptune, and Vuyani	2029
Southern Grid Strengthening Phase 4	• Second Gamma-Grassridge 765 kV line	2024
Coega Gas	• 2 x Dedisa-Coega 400 kV lines • Poseidon-Coega 400 kV line • Grassridge-Coega 400 kV line • 2 x Gamma-Grassridge 765 kV lines	2024
Grahamstown 400/132 kV Substation Integration	• Poseidon South-Grahamstown 400 kV line	2025

7.1.3.7 Projects for Alternative Generation Scenario

Interest has been shown in the integration of generation from natural gas close to Coega Industrial Development Zone (IDZ), amounting to approximately 3 000 MW. The proposed plan includes an assessment to determine the impact on the transmission network in the Eastern Cape if all of the proposed 3 000 MW gas located in Port Elizabeth is connected by 2030. The following additional transmission network strengthening projects will be required to enable the evacuation of the gas generation from the province:

- Establishment of a new Coega 400 kV high-voltage (HV) yard with 400 kV busbars
- Coega-Grassridge 400 kV line
- 2 x Coega-Dedisa 400 kV lines
- Coega-Poseidon 400 kV line
- Gamma-Grassridge 765 kV Lines 1 and 2 in 2028 and 2030, respectively
- Grassridge Substation 132 kV fault current limiting reactors (FCLRs)

7.1.3.8 Provincial Summary

The future transmission network for the province is shown in Figure 7-3 below.

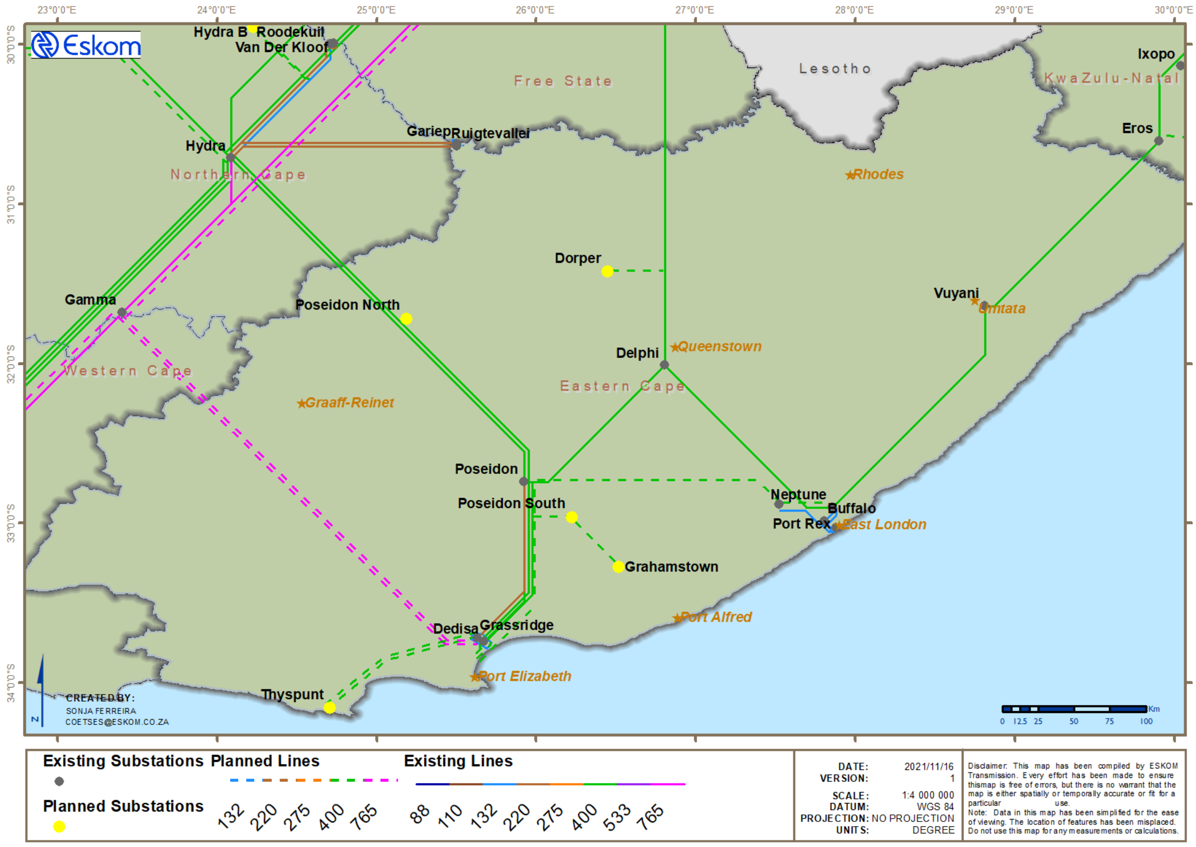


Figure 7-3: Future Eastern Cape transmission network

A summary of all new major assets planned for this province is provided in Table 7-4 to Table 7-6. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-4: Planned transformers for the Eastern Cape

Transformer type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
160 MVA 132/66/22 kV	-	-	1	160
20 MVA 132/6,6 kV	1	20	-	-
80 MVA 132/66 kV	-	-	1	80
2 000 MVA 765/400/33 kV	-	-	2	4 000
500 MVA 400/132/22 kV	-	-	10	5 000
Grand total	**1**	**20**	**14**	**9 420**

Table 7-5: Planned overhead lines for the Eastern Cape

Line voltage	2022 to 2026	2027 to 2031
	Total length (km)	Total length (km)
400 kV	38	565
765 kV	-	730
Grand total	**38**	**1 295**

Table 7-6: Planned reactors for the Eastern Cape

Reactor type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	-	-	1	100
400 Mvar 765 kV	-	-	2	800
Grand total	**-**	**-**	**3**	**900**

7.2 FREE STATE

The Free State is South Africa's most centrally located province and has Bloemfontein as its capital. It has borders with most other provinces, with Lesotho as its eastern neighbour. For many decades, mining and agriculture were the bedrock of the economy in the province, but the productivity of the mining sector has been on a steady decline. This has had a negative impact on the economy and the employment numbers.

Important road and rail links traverse the province, including two of the busiest national highways, the N1 (Cape Town-Johannesburg) and the N3 (Durban-Johannesburg). There are plans to leverage this advantage by creating development corridors for the promotion of manufacturing, warehousing, and storage opportunities. The Harrismith Logistics Hub (HLH) on the N3 is at the centre of these plans. The Free State Development Corporation (FDC) is actively searching for investors in areas such as Harrismith and Botshabelo.

The province has a number of development plans, including several public infrastructure delivery projects. These programmes will not only improve services, but will also benefit local suppliers and boost the construction sector.

The current transmission network is shown in Figure 7-4. The 765 kV network is primarily used to transmit power through the province to the Cape.

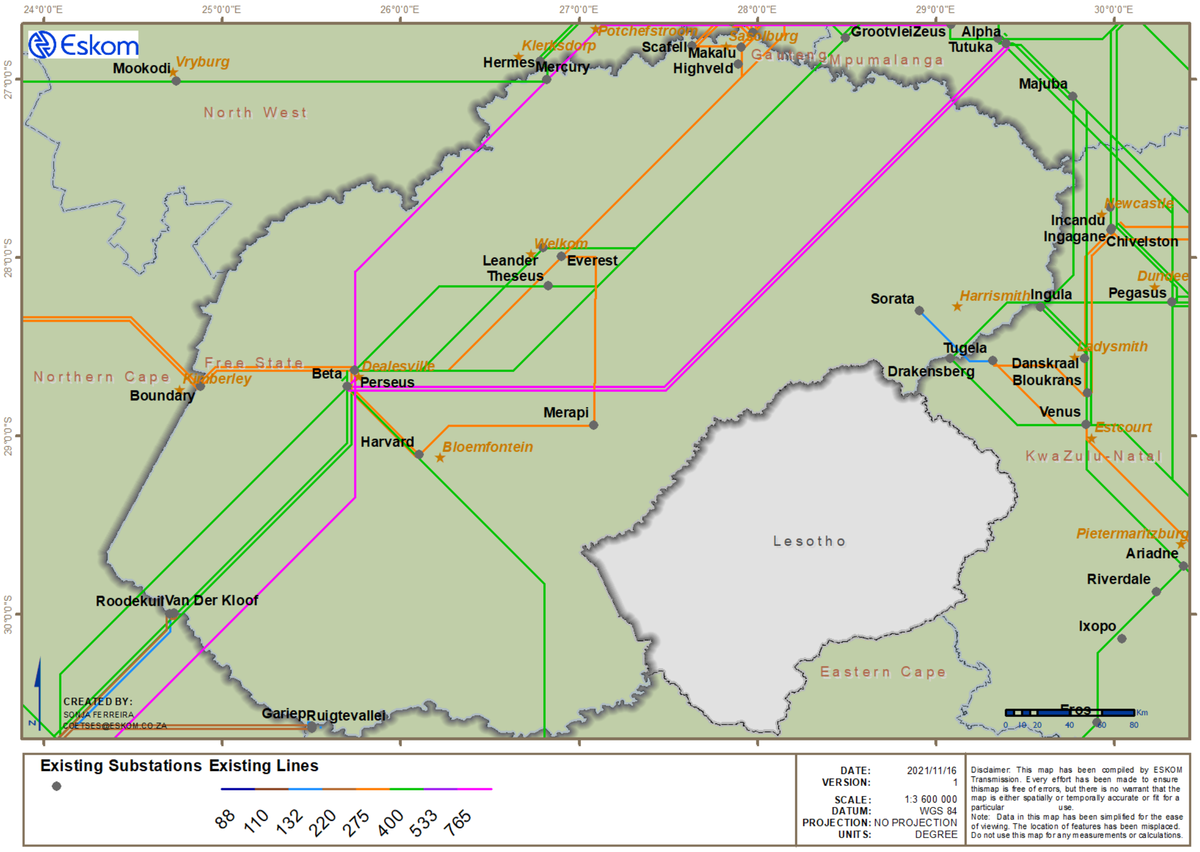


Figure 7-4: Current Free State transmission network

7.2.1 Generation

The power supply into the province is predominantly sourced from Lethabo Power Station and Mpumalanga via 400 kV and 275 kV transmission lines. Lethabo Power Station is a coal-fired power station located in the Vaal Triangle area of the Free State. It has a generating capacity of 3 558 MW.

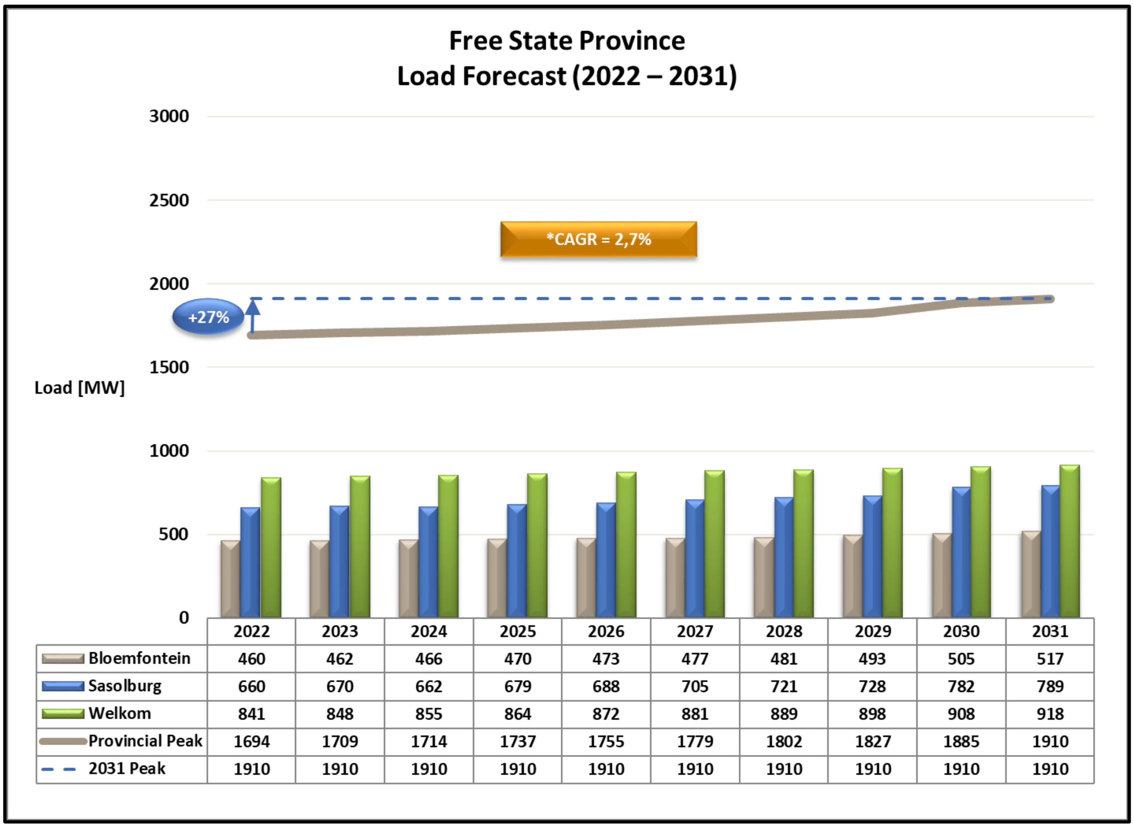
IPPs have shown interest in solar generation in the province, especially in its western parts. Approximately 203 MW of IPPs (PV and small hydroelectric plants) have been integrated into the grid since the inception of the REIPPPP. The current composition of the RE in the Free State is 199 MW of PV plants and 4,4 MW of hydroelectric plants. The composition is shown in Table 7-7.

Table 7-7: Approved projects in the Free State under the REIPPPP

Programme and bid window	Small hydro (MW)	PV (MW)	Grand total (MW)
IPP RE 1	0	64	64
IPP RE 2	4,4	60	64,4
IPP RE 3	0	75	75
IPP RE 4	0	0	0
IPP RE 4B	0	0	0
Grand total	**4,4**	**199**	**203,4**

7.2.2 Load Forecast

The economic mix of the Free State is predominantly comprised of mining, commercial customers, and residential customers. The provincial load peaked at around 1 584 MW in 2020, and it is forecasted to grow steadily at approximately 2,7% annually, from 1 606 MW in 2022 to 1 889 MW by 2031. The Free State comprises three CLNs, namely, Sasolburg, Bloemfontein, and Welkom. The Welkom CLN consumes approximately 46,4% of the load. Sasolburg and Bloemfontein CLNs make up the remaining 53,6% of the demand in the province. The highest provincial load growth is expected in the Sasolburg and Welkom CLNs. The load forecast for the Free State is shown in Figure 7-5.



	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Bloemfontein	460	462	466	470	473	477	481	493	505	517
Sasolburg	660	670	662	679	688	705	721	728	782	789
Welkom	841	848	855	864	872	881	889	898	908	918
Provincial Peak	1694	1709	1714	1737	1755	1779	1802	1827	1885	1910
2031 Peak	1910	1910	1910	1910	1910	1910	1910	1910	1910	1910

Figure 7-5: Free State load forecast

7.2.3 PLANNED PROJECTS

7.2.3.1 Major Schemes

The major projects for the Free State mainly involve overlaying the existing 275 kV networks with 400 kV networks to increase the power transfers into the respective load centres.

The major TDP schemes planned in the Free State are as follows.

Bloemfontein Strengthening Phase 2

The project involves acquiring servitudes for future 400 kV lines, that is, Beta-Harvard and Harvard-Merapi lines, and the introduction of 400 kV at Harvard and Merapi Substations. The project will be executed in various stages. The implementation of each stage will depend on demand growth (generation and/or load) and strengthening requirements in the Bloemfontein CLN.

Harrismith Strengthening Phase 1

This project addresses network capacity constraints in the Harrismith region, which includes Tugela Substation in KwaZulu-Natal and Sorata 132 kV Switching Station in the Free State. Sorata 132 kV Switching Station will be extended to a 275/132 kV substation to deload Tugela Substation. Sorata Substation will be supplied by the existing Tugela-Sorata 275 kV line, currently operated at 132 kV.

Sorata Substation Strengthening

This project involves the construction of the second Sorata-Tugela 275 kV line (built at 400 kV and operated at 275 kV) as well as installing a second 275/132 kV transformer at Sorata Substation.

Makalu Substation Strengthening

This project involves establishing Igesi 275/88 kV Substation and looping into one of the Lethabo-Makalu 275 kV lines to create the Lethabo-Igesi and Igesi-Makalu 275 kV lines.

7.2.3.2 New Substations

Igesi 275/88 kV Substation will be established in the province to deload Makalu Substation. It will also assist in reducing the network fault levels around Makalu Substation.

7.2.3.3 New Lines

A second Sorata-Tugela 275 kV line (built at 400 kV and operated at 275 kV) will be constructed as part of the Sorata Substation strengthening.

7.2.3.4 Reactive Power Compensation

No reactive power compensation projects (capacitor banks and/or SVCs) are planned for the Free State in the TDP period.

7.2.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period between 2022 and 2031.

Table 7-8: Free State – summary of projects and timelines

TDP scheme	Project name	Expected CO year
Harrismith Strengthening Phase 1	• Install first 275/132 kV 250 MVA transformer at Sorata Substation and operate Tugela-Sorata at 275 kV	2021
Makalu Strengthening	• Establish 2 x 315 MVA 275/88 kV Igesi Substation • Loop-in one of Lethabo-Makalu 275 kV lines into Igesi Substation	2028
Sorata Substation Strengthening	• Recycle Groenkop-Tugela 132 kV Line 1 and construct Sorata-Tugela 400 kV line (operated at 275 kV) • Install second 275/132 kV 250 MVA transformer at Sorata Substation	2030
Bloemfontein Strengthening Phase 2A	• Construct 2 x Beta-Harvard 400 kV lines • Install 2 x 500 MVA 400/132 kV transformers at Harvard Substation	2036

7.2.3.6 Projects for Future Independent Power Producers

A 500 MVA 400/132 kV substation near Dealesville will be required to enable the connection of the IPPs located in the province within the current TDP period based on the generation assumptions.

Table 7-9: Free State – projects required to facilitate IPP integration

Project name	Required CO year
500 MVA 400/132 kV substation near Dealesville	2030

7.2.3.7 Projects for Alternative Generation Scenario

No alternative generation scenario has been identified for the Free State.

7.2.3.8 Provincial Summary

The future transmission network for the province is shown in Figure 7-6 below.

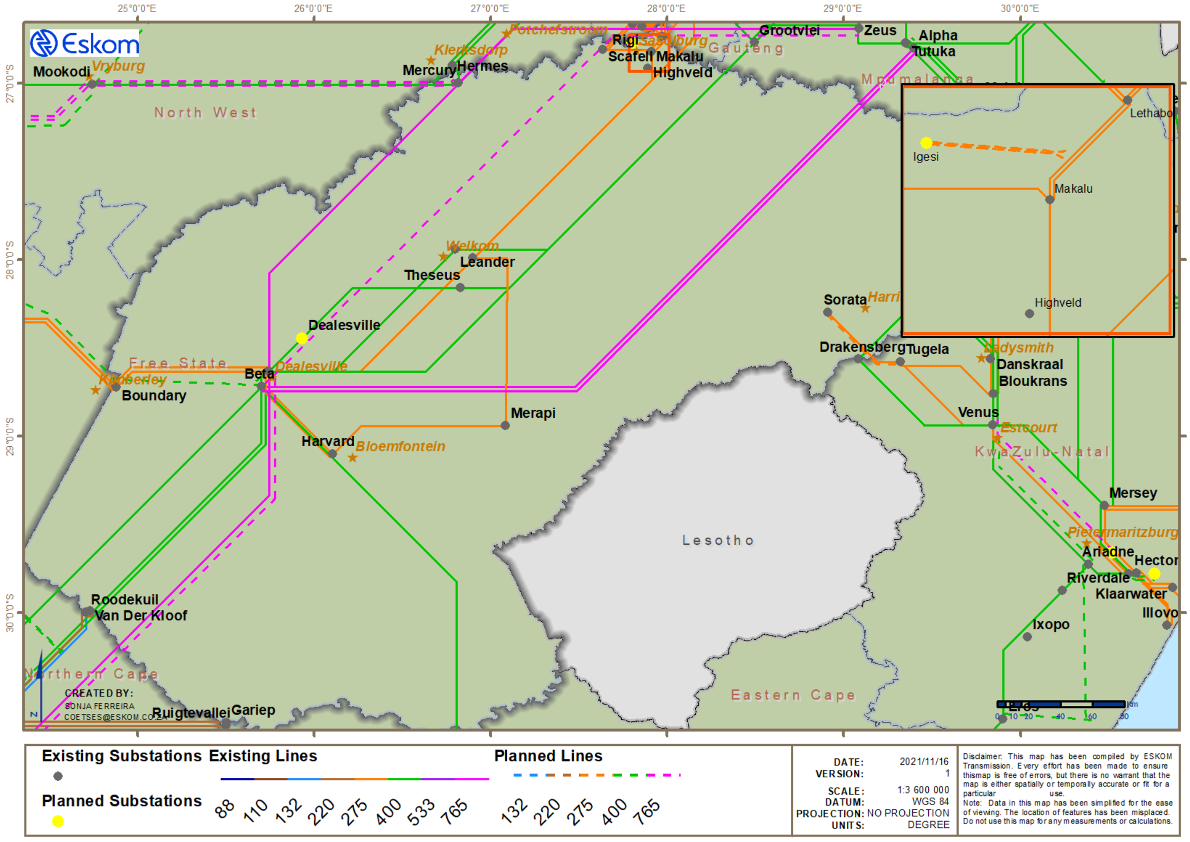


Figure 7-6: Future Free State transmission network

A summary of all new major assets planned for this province is provided in Table 7-10 to Table 7-12. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-10: Planned transformers for the Free State

Transformer type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
250 MVA 400/132/22 kV	-	-	1	250
315 MVA 275/88/22 kV	-	-	2	630
500 MVA 400/132/22 kV	-	-	2	1 000
Grand total	**-**	**-**	**5**	**1 880**

Table 7-11: Planned overhead lines for the Free State

Line voltage	2022 to 2026	2027 to 2031
	Total length (km)	Total length (km)
275 kV	-	14
400 kV	-	86
765 kV	-	430
Grand total	**-**	**530**

Table 7-12: Planned reactors for the Free State

Reactor type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
400 Mvar 765 kV	-	-	3	1 200
Grand total	**-**	**-**	**3**	**1 200**

7.3 GAUTENG

Gauteng is located in the north-eastern part of South Africa. Despite it being the smallest province in the country, it is the economic hub of the country, a gateway to Africa, and the most populous province in South Africa. The capital of the province is Johannesburg. The economic mix in the province comprises the residential sector, gold mines, commercial and service customers, as well as industrial, technology, and logistics customers. Redistributors (metros and municipalities) account for about 75% of electricity consumption in the province.

The transmission infeed network into Gauteng is operated at 400 kV and 275 kV, with most of the local transmission stations in the province operated and interconnected via 275 kV lines and only a few substations run at 400 kV. The sub-transmission system is run and interconnected through the 132 kV and 88 kV underlying distribution networks. The current transmission network is shown in Figure 7-7.

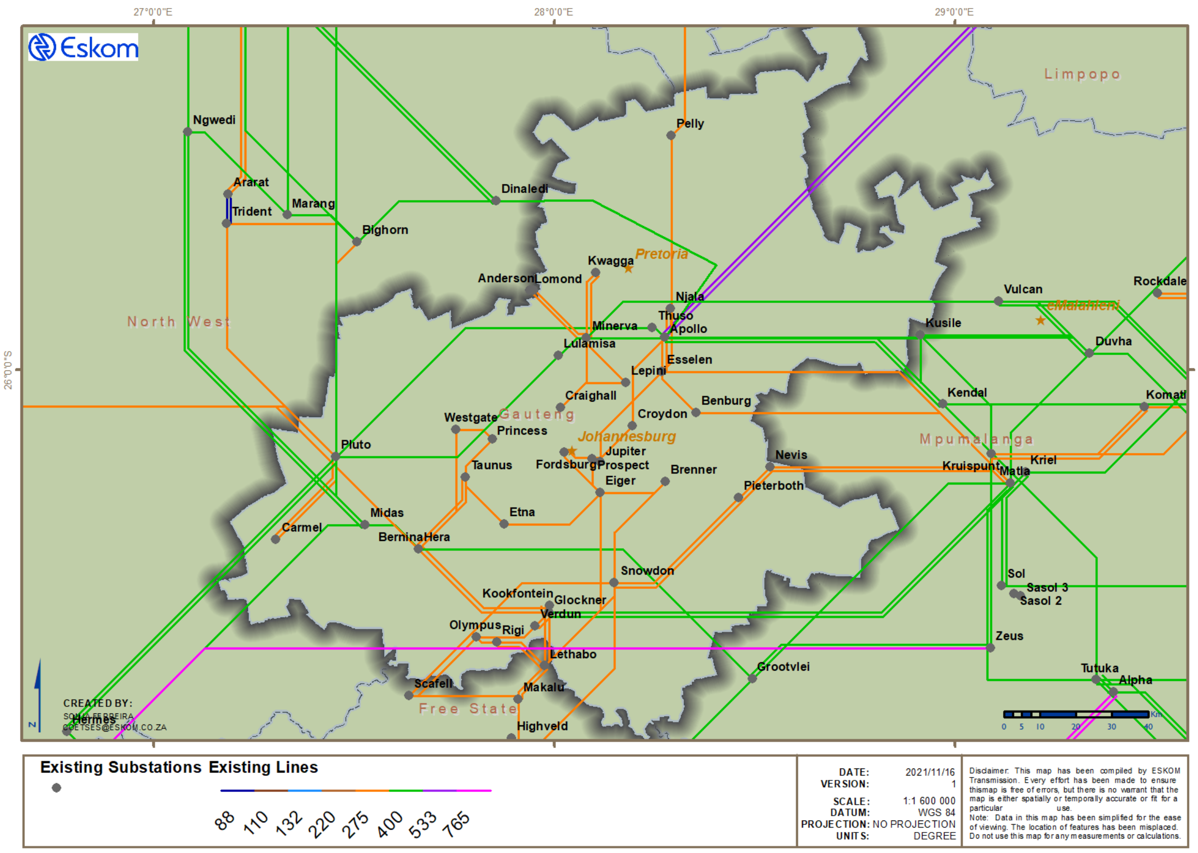


Figure 7-7: Current Gauteng transmission network

7.3.1 GENERATION

There are no Eskom power stations that lie within the defined Gauteng Grid; small municipal power stations include Kelvin and Rooiwal Power Stations. Most of the electricity consumed in Gauteng is sourced from power stations in the neighbouring grids via 400 kV and 275 kV transmission lines, as well as via the 533 kV direct-current (DC) Cahora Bassa line from Mozambique. The primary sources of power are the following power stations:

- Cahora Bassa (through Apollo Converter Station) via 533 kV DC lines
- Duvha Power Station via 400 kV lines
- Grootvlei Power Station via 400 kV lines
- Kendal Power Station via 400 kV lines
- Kusile Power Station via 400 kV lines
- Lethabo Power Station via 275 kV lines
- Matimba Power Station via 400 kV lines
- Matla Power Station via 400 kV lines
- Medupi Power Station via 400 kV lines

Lethabo Power Station, although situated within the Free State Grid, supplies a large percentage of the reactive power requirements of Gauteng. Due to high fault levels, the Lethabo Power Station 275 kV busbar is operated split when five or more units are in service to prevent exceeding the rupturing capacity of equipment in the 275 kV yard. The major injections of reactive power in Gauteng are from Matla Power Station, Midas 400 kV via the Hera 400/275 kV transformers, and Apollo.

The REIPPPP has provided a platform for the private sector to invest in renewable energy that is intended to be connected to the South African power grid. The total number of installed IPPs, including capacity in Gauteng, is shown in Table 7-13. These are already embedded in the municipal and Eskom distribution network. No significant IPPs are planned for the Gauteng Grid for the foreseeable future.

Table 7-13: IPPs integrated in Gauteng

Date commissioned	Technology	Point of Connection	Capacity (MW)
April 2015	Biomass	Municipality	3
April 2015	Biomass	Municipality	2,28
December 2017	Biomass	Municipality	6
2018	Biomass	Eskom Distribution	4
2018	Biomass	Eskom Distribution	1,4
Total capacity			**16,68**

7.3.2 Load Forecast

Gauteng is the economic hub of South Africa and contributes significantly to the financial, manufacturing, transport, technology, and telecommunications sectors, among others. The province currently contributes about 30% to the total transmission system peak load.

The economic mix in the province comprises residential customers, gold mines, commercial and services customers, as well as logistics, technology, and industrial customers. The provincial electricity demand peaked at about 10 355 MW in 2020 and is forecasted to grow steadily at about 2,8% annually in this TDP window, from 11 507 MW in 2022 to 14 744 MW by 2031.

The Gauteng Grid comprises four CLNs, namely, East Rand, Johannesburg, Vaal, and West Rand. The Johannesburg CLN has the highest load growth forecast, followed by the West Rand and East Rand CLNs. The highest provincial load growth is expected in the Johannesburg and West Rand CLNs due to commercial and residential developments. The Vaal CLN has the lowest growth outlook in the province. The load forecast for Gauteng is shown in Figure 7-8.

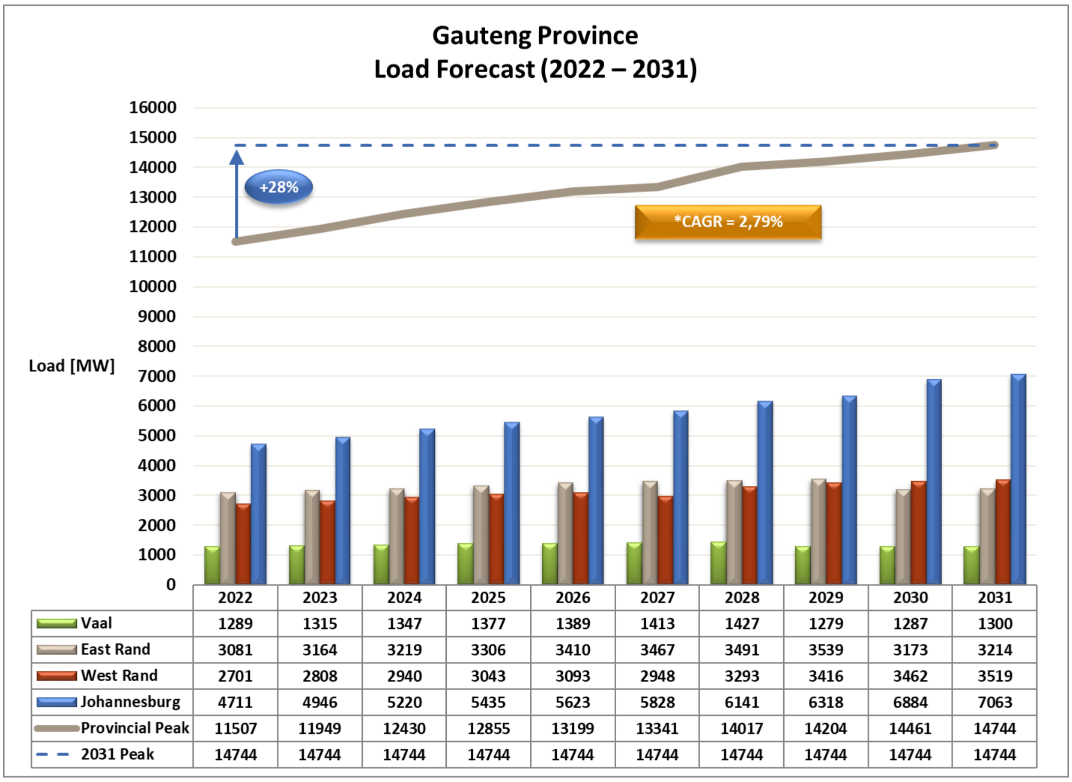


Figure 7-8: Gauteng load forecast

7.3.3 Planned Projects

Several projects and schemes that aim to address the long-term requirements of the province have been initiated to accommodate the forecasted load and generation.

7.3.3.1 Major Schemes

The major TDP schemes planned in Gauteng are as follows.

Johannesburg North Strengthening

The scheme is required to resolve the thermal and voltage constraints in the Johannesburg North CLN and support future loads in the CLN. Two 150 Mvar 275 kV capacitor banks were installed at Lepini Substation recently and went into commercial operation at the end of 2020. This will be followed by the construction of the Apollo-Lepini 275 kV line in the next five years to increase capacity.

Vaal Strengthening

The scheme entails the construction of 2 x Glockner-Etna 400 kV lines (Vaal Strengthening Phase 2) to deload the overloaded Hera Substation and lines in the West Rand CLN. Phase 1 has been completed, and load can now be shifted under contingency from the Hera 400/275 kV transformers onto the Glockner 400/275 kV corridor via the Glockner-Bernina 275 kV lines. Completion of Phase 2 (the 2 x Etna-Glockner 400 kV lines) is expected in 2025. The new lines will be energised at 275 kV until the requirement for 400 kV operation at Etna and Quattro Substations has been established in the future.

Simmerpan 275 kV Integration

Simmerpan strengthening addresses unfirm transformation at Jupiter Substation (due to load increases in the Germiston South area) and the future unfirm capacity at Croydon Substation (due to growth in the Germiston North area). The scope of work includes establishing a 275 kV transmission substation adjacent to the Simmerpan Distribution Substation and installing 1 x 315 MVA 275/88 kV transformer (Phase 1B).

The name of the new substation will be Sisimuka. The substation will be energised from the existing Jupiter Substation initially and later swung over to the planned Jupiter B Substation via one of the existing Jupiter-Simmerpan 275 kV lines (currently energised at 88 kV). Completion of the initial Phase 1B is expected in the next five years. The second 275/88 kV transformer and the second Jupiter-Sisimuka 275 kV line are only required outside the TDP period. In future, the substation will be extended further to accommodate 2 x 250 MVA 275/132 kV transformers, subject to load growth in the Croydon 132 kV network (Germiston North).

Soweto Strengthening

The focus of this scheme is to ensure Grid Code compliance for Taunus and Fordsburg Substations and to address the imminent thermal constraints in the Soweto distribution network. The scope of work includes establishing the new Quattro Substation, which will cater for 4 x 315 MVA 275/88 kV transformers belonging to City Power and 2 x 500 MVA 275/132 kV transformers belonging to Eskom. Two 400 kV lines, energised at 275 kV, will also be built from Etna to Quattro.

Johannesburg East Strengthening

This scheme addresses network constraints in the East Rand and Johannesburg South areas. Sebenza 275/88 kV Substation (400/88 kV construction), which City Power has commissioned, has deloaded Prospect Substation and created more transformer capacity in the East Rand area. The planned construction of two Matla-Jupiter B 400 kV lines will result in increased transfer limits in the East Rand CLN. The planned Mesong (previously North Rand) Substation will be integrated through the loop-in and loop-out of the existing Apollo-Croydon 275 kV line. This solution can be developed faster than the Apollo-North Rand corridor due to environmental and land acquisition challenges.

Westgate 400 kV Integration

This scheme addresses thermal constraints in the West Rand CLN, particularly Hera Substation. The project entails establishing a 400 kV overlay at Westgate Substation by installing 1 x 500 MVA 400/132 kV transformer at Westgate, energised via the proposed Hera-Westgate 400 kV line (West Rand Phase 1). The first 13 km of the Hera-Westgate line will be double-circuit, with the second circuit in the double-circuit section dedicated for the future Pluto-Westgate line (Phase 2B). The Pluto-Westgate 400 kV line and the second Westgate 400/132 kV transformer will be required within about four years of completing Phase 1, but fall outside the TDP period.

Tshwane Reinforcement

The Tshwane reinforcement projects address unfirm substations due to load increases in the Tshwane economic node. A new 400/132 kV Diphororo Substation will be built just outside Soshanguve and will be equipped with 2 x 500 MVA 400/132 kV transformers. This is expected in the next five years to cater for load growth in the Garankuwa and Soshanguve areas. Furthermore, a new Wildebees 400/132 kV Substation will be built in the Mamelodi area to cater for the expected load growth in the Pretoria East area. Expected completion is in the next five years; the project is in the concept phase. (The schedule was revised owing to the relocation of the substation site by the City of Tshwane.)

7.3.3.2 New Substations

The following new substations will be established in the Gauteng transmission network during this TDP period to address load growth and reliability:

- Diphororo 400/132 kV Substation in the Pretoria North area
- Kyalami 400/132 kV Substation in the Johannesburg North area
- Lesokwana 275/88 kV Substation in the Ekurhuleni area
- Mesong 275/132 kV Substation in the Modderfontein area
- Quattro 275/132 kV Substation in the Soweto area
- Sesiu 400/88 kV Substation in the Cosmo City area
- Sisimuka 275/ 88 kV Substation in the Germiston area
- Wildebees 400/132 kV Substation in Pretoria East
- Jupiter B 275 kV Switching Station in Germiston

7.3.3.3 New Lines

- The 2 x Glockner-Etna 400 kV lines (operated at 275 kV) will deload overloaded lines in the Vaal and West Rand CLNs. They will also marginally deload the 2 x 800 MVA 400/275 kV transformers at Hera Substation.
- The Apollo-Lepini 400 kV line (operated at 275 kV) will increase capacity in the Johannesburg North area.
- The 2 x Etna-Quattro 400 kV lines (operated at 275 kV) will enable the establishment of the Quattro Substation to deload Taunus Substation and address imminent thermal constraints in the Soweto distribution network.
- The 2 x Matla-Jupiter B 400 kV lines (operated at 275 kV) will increase transfer limits in the Johannesburg CLN.
- The Hera-Westgate 400 kV line will address thermal and voltage constraints in the West Rand CLN.

7.3.3.4 Reactive Power Compensation

The following reactive power compensation is planned in Gauteng, as shown in Table 7-14 below.

Table 7-14: Planned reactive power compensation in Gauteng

Substation	Voltage (kV)	Size (Mvar)
Brenner	88	2 x 48
Diphororo	400	1 x 100
Princess	88	1 x 48
Quattro	132	1 x 72
Taunus	132	1 x 72
Westgate	132	1 x 72
Wildebees	400	1 x 100

7.3.3.5 Summary of Network Strengthening Projects

The following strengthening projects are planned for the period between 2022 and 2031.

Table 7-15: Gauteng – summary of projects and timelines

TDP scheme	Project name	Expected CO year
Vaal Strengthening Phase 2	• Glockner-Etna first and second 400 kV line (operated at 275 kV)	2025
Brenner Strengthening Phase 1	• Brenner 2 x 88 kV 48 Mvar capacitors	2027
Tshwane Metro: Diphororo Phase 1	• Diphororo 400/132 kV Substation integration	2025
Tshwane Metro: Wildebees Phase 1	• Wildebees 400/132 kV Substation integration	2027
Tshwane Metro: Thuso Third Transformer	• Thuso 400/132 kV Substation (third 250 MVA transformer)	2026
Etna Strengthening: Third Transformer	• Etna 275/88 kV Substation (third 315 MVA transformer)	2026
Soweto Phase 1: Quattro 275/88 kV	• Quattro 275/88 kV Substation integration	2026
Soweto Phase 2: Quattro 275/132 kV	• Quattro 275/132 kV Substation integration	2026
West Rand Strengthening Phase 1	• Westgate 400/132 kV Substation integration	2028
West Rand Strengthening Phase 2A: Capacitors	• 1 x 72 Mvar cap banks at Westgate 132 kV • 1 x 72 Mvar cap bank at Taunus 132 kV	2027

TDP scheme	Project name	Expected CO year
	• 1 x 72 Mvar cap at Quattro 132 kV • 1 x 48 Mvar cap at Princess 88 kV	
Johannesburg North Phase 2	• Johannesburg North: Apollo-Lepini first 400 kV line (operated at 275 kV)	2027
Simmerpan Phase 1B	• Sisimuka 275/88 kV Substation integration	2028
Johannesburg North: Sesiu Integration	• Sesiu 400/88 kV Substation integration	2031
Johannesburg East: Mesong Integration	• Johannesburg East: Mesong 275/132 kV integration	2031
Johannesburg East: Jupiter B Integration	• Jupiter B 275 kV Switching Station • Matla-Jupiter B first and second 400 kV lines • Jupiter B 275 kV loop-ins (Prospect-Sebenza 1 and 2, Jupiter-Prospect 1, Jupiter-Fordsburg 1)	2030
Johannesburg North: Kyalami Substation	• Kyalami 400/132 kV Substation integration	2032
Brenner Phase 2: Lesokwana Substation	• Lesokwana 275/88 kV Substation integration	2031

7.3.3.6 Projects for Future Independent Power Producers

The possible future planned IPPs in the province do not have sufficient capacity to affect the transmission network. Therefore, no additional transmission projects are required to enable the future connection of the IPPs in Gauteng.

7.3.3.7 Projects for Alternative Generation Scenario

No alternative generation scenario has been identified for Gauteng.

7.3.3.8 Provincial Summary

The future transmission network for the province is shown in Figure 7-9 below.

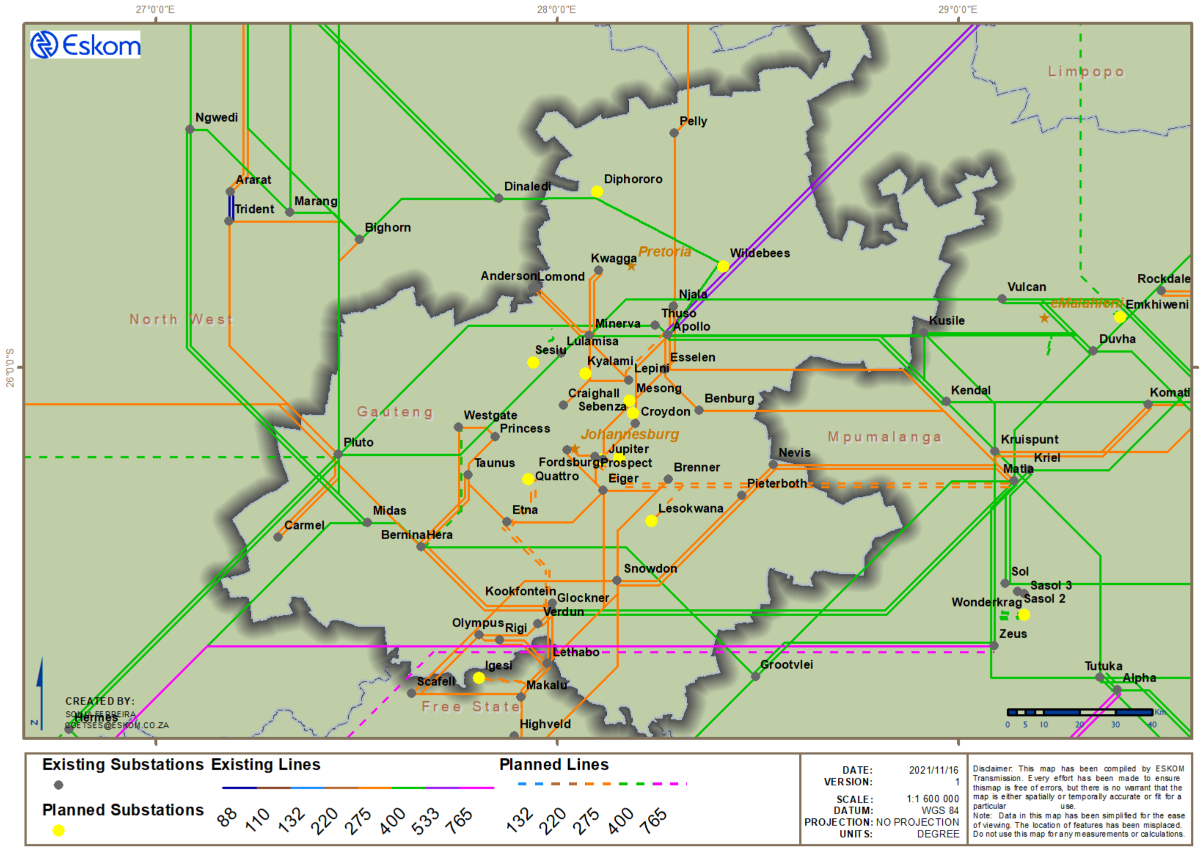


Figure 7-9: Future Gauteng transmission network

A summary of all new major assets planned for this province is provided in Table 7-16 to Table 7-18. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-16: Planned transformers for Gauteng

Transformer type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
160 MVA 400/88/22 kV	1	160	-	-
250 MVA 400/132 kV	1	250	-	-
315 MVA 275/88 kV	-	-	2	630
500 MVA 275/132 kV	2	1 000	-	-
500 MVA 400/132 kV	-	-	8	4 000
Grand total	**4**	**1 410**	**10**	**4 630**

Table 7-17: Planned overhead lines for Gauteng

Line voltage	2022 to 2026	2027 to 2031
	Total length (km)	Total length (km)
275 kV	-	25
400 kV	51	120
Grand total	**51**	**145**

Table 7-18: Planned capacitor banks for Gauteng

Capacitor type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
48 Mvar 88 kV	-	-	2	96
40 Mvar 132 kV	-	-	-	-
72 Mvar 132 kV	-	-	4	288
100 Mvar 400 kV	-	-	-	-
Grand total	**-**	**-**	**6**	**384**

7.4 KWAZULU-NATAL

KwaZulu-Natal is situated on the eastern seaboard of South Africa along the Indian Ocean. The capital of the province is Pietermaritzburg, and its largest city is Durban. The provincial economy is mainly driven by activities concentrated around the Port of Durban and the capital, Pietermaritzburg, with significant contributions in the Richards Bay-Empangeni area, the Ladysmith-Ezakheni area, and the Newcastle-Madadeni regions.

The Port of Durban and the Richards Bay Harbour play a key role in the import and export of goods in South Africa and neighbouring countries. The province has also established the Dube TradePort as an air logistics platform to promote access to global trade and tourist nodes between these two seaports. It opens up new opportunities for the production and export of high-value perishable products and manufactured goods and for shipping them directly from the King Shaka International Airport.

The Dube TradePort and the Richards Bay IDZ have been designated as special economic zones, providing incentives to attract potential investors to the province. These zones are linked to a number of agri-parks and industrial economic hubs that are being established to offer strong production linkages and clustering potential.

The main transmission supply network to KwaZulu-Natal is predominantly connected at 400 kV, with the local transmission stations mostly connected at 275 kV. The current transmission network is shown in Figure 7-10.

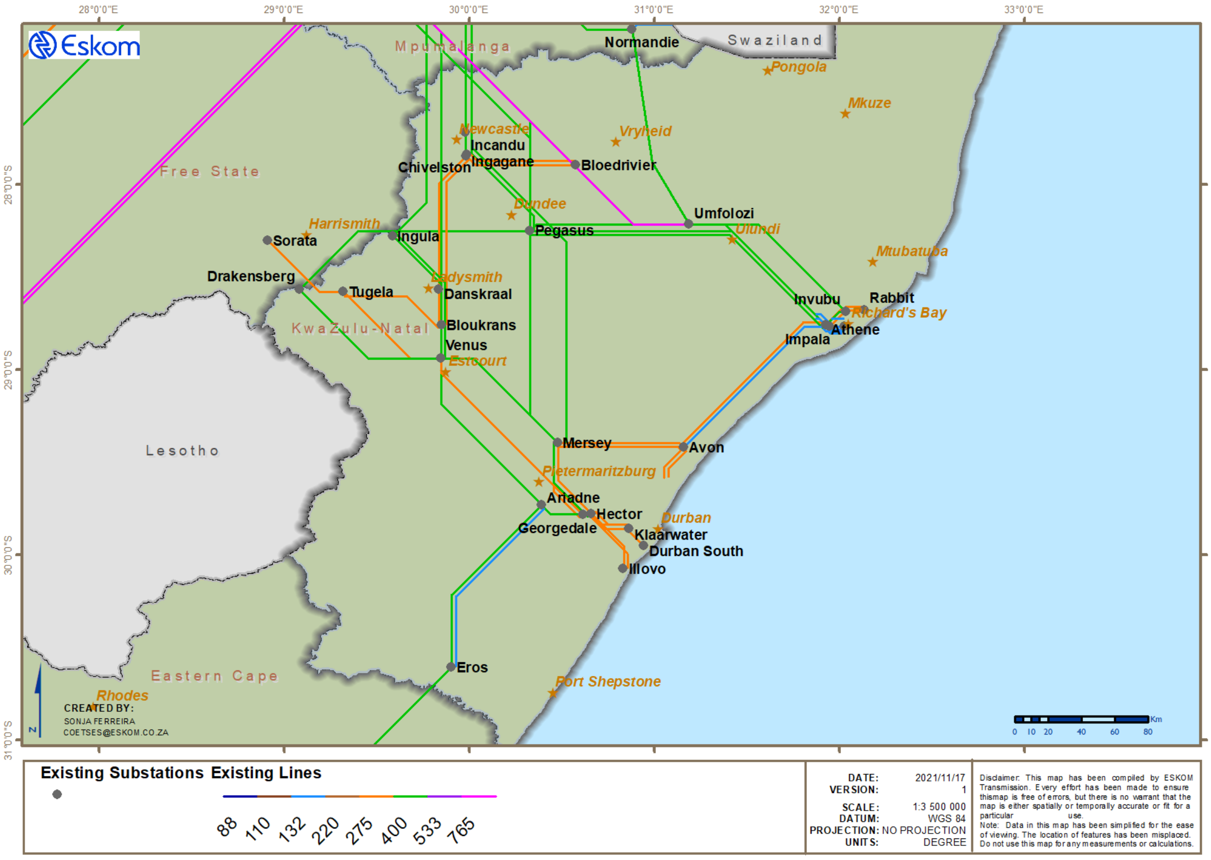


Figure 7-10: Current KwaZulu-Natal transmission network

7.4.1 GENERATION

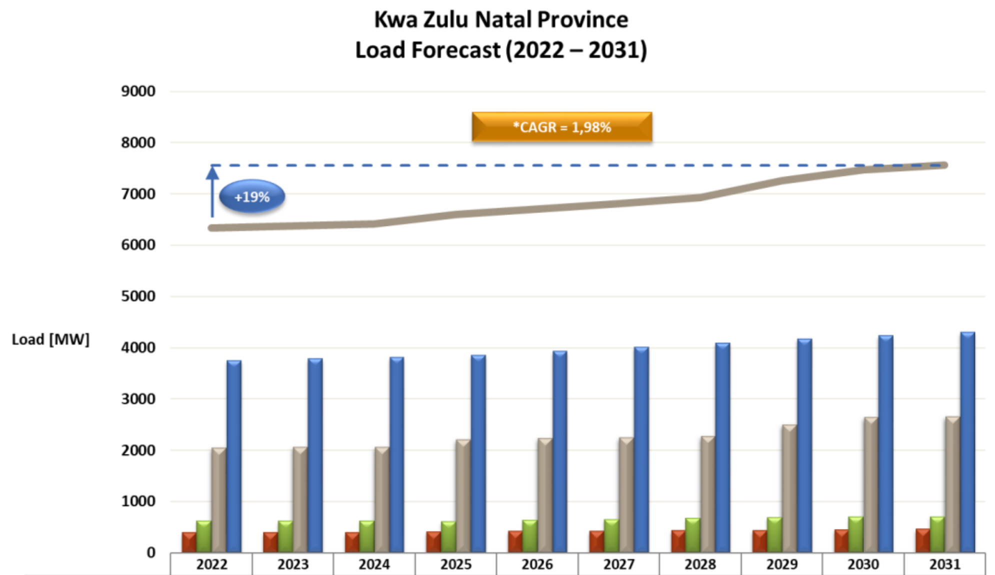
Most of the electricity consumed in KwaZulu-Natal is sourced from the power stations in Mpumalanga via 400 kV transmission lines.

There are three peaking plants in the province, consisting of a gas plant and two pumped-storage plants. These comprise the Avon OCGT and the Drakensberg and Ingula Pumped-Storage Stations. Avon OCGT has a generating capacity of 680 MW. Drakensberg and Ingula Pumped-Storage Stations have generating capacities of 1 000 MW and 1 333 MW, respectively.

7.4.2 Load Forecast

The economic mix in KwaZulu-Natal comprises redistributors, commercial customers, and industrial customers. The provincial electricity demand peaked at around 5 904 MW in 2020 and is forecasted to grow steadily at about 1,9% annually, from 6 341 MW in 2022 to 7 562 MW by 2031.

The KwaZulu-Natal grid comprises four CLNs, namely, Empangeni, Ladysmith, Newcastle, and Pinetown. The Empangeni and Pinetown CLNs are the two main load centres in the province, consuming approximately 31% and 52% of the load, respectively. Ladysmith and Newcastle CLNs make up the remaining 17% of the demand in the province. The highest provincial load growth is expected in the Pinetown and Empangeni CLNs due to industrial, commercial, and residential developments. The load forecast for KwaZulu-Natal is shown in Figure 7-11.



	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Ladysmith	392	395	398	404	413	420	429	438	445	452
Newcastle	626	623	620	617	635	653	672	691	700	708
Empangeni	2046	2051	2056	2206	2225	2244	2267	2495	2635	2649
Pinetown	3751	3781	3817	3853	3928	4004	4081	4161	4227	4294
Provincial Peak	6341	6373	6411	6597	6707	6818	6935	7260	7474	7562
2031 Peak	7562	7562	7562	7562	7562	7562	7562	7562	7562	7562

Figure 7-11: KwaZulu-Natal load forecast

7.4.3 Planned Projects

Several projects and schemes that aim to address the long-term requirements of the province have been initiated to accommodate the forecasted load and generation.

7.4.3.1 Major Schemes

The major TDP schemes planned in KwaZulu-Natal are as follows.

KZN 765 kV Strengthening: Empangeni Integration

This project entails the construction of the Mbewu-Umfolozi 765 kV line and the establishment of Mbewu 765/400 kV Substation near Empangeni. Initially, the planned Mbewu-Umfolozi 765 kV line will be operated at 400 kV, and only the 400 kV yard will be established at Mbewu Substation. Mbewu Substation will be integrated into the 400 kV network by looping in the Athene-Umfolozi and Invubu-Umfolozi 400 kV lines and the new Invubu-Mbewu 400 kV line. The introduction of 765 kV will depend on demand growth (generation and/or load) in the province.

eThekwini Electricity Network Strengthening

This scheme involves establishing Inyaninga 2 x 500 MVA 400/132 kV Substation near King Shaka International Airport and Shongweni 2 x 500 MVA 400/132 kV Substation near Ntshongweni.

Inyaninga Substation will be supplied by two Inyaninga-Mbewu 400 kV lines. It will deload the Mersey-Avon 275 kV system and supply the Dube TradePort Development.

Shongweni Substation will be supplied by two Hector-Shongweni 400 kV lines. It will deload the Hector-Klaarwater and Georgedale-Klaarwater 275 kV system and supply the projected demand growth around Hillcrest and Ntshongweni.

KZN Strengthening: Iphiva 400/132 kV Substation

This project involves establishing Iphiva 400/132 kV Substation near Mkuze to address supply constraints around Pongola, Makhatini Flats, and iSimangaliso (Greater St Lucia) Wetland Park. The planned Iphiva Substation will be supplied by two 400 kV lines, namely, the Normandie-Iphiva and Duma-Iphiva 400 kV lines. The two 400 kV lines will be executed in various stages. The implementation of each stage will depend on demand growth (generation and/or load) and network strengthening requirements.

KZN 765 kV Strengthening: Pinetown Integration

This project entails the construction of the Isundu-Venus 765 kV line and the establishment of Isundu 765/400 kV Substation near Pietermaritzburg. Initially, the planned Isundu-Venus 765 kV line will be operated at 400 kV, and only the 400 kV yard will be established at Isundu Substation. Isundu Substation will be integrated into the 400 kV network by looping in the Ariadne-Hector 400 kV Line 1. The introduction of 765 kV will depend on demand growth (generation and/or load) in the province.

KZN 765 kV Strengthening: Isundu-Mbewu 400 kV Lines 1 and 2

This project entails the construction of Isundu-Mbewu 400 kV Lines 1 and 2 to interconnect Isundu and Mbewu Substations. The two lines will provide redundancy to Isundu and Mbewu Substations during network contingencies. Isundu-Mbewu 400 kV Line 1 will also be the main 400 kV supply to Inyaninga 400/132 kV Substation, although Inyaninga Substation would initially be supplied from Mbewu Substation.

7.4.3.2 New Substations

The following new substations will be established in KwaZulu-Natal during this TDP period to address load growth and reliability:

- Iphiva 400/132 kV Substation near Mkuze town
- Inyaninga 400/132 kV Substation near King Shaka Airport in Durban
- Mbewu 400 kV Switching Station near Empangeni town
- Shongweni 400/132 kV Substation near Ntshongweni
- Isundu 400 kV Switching Station near Pietermaritzburg

7.4.3.3 New Lines

The following new transmission lines will be constructed in KwaZulu-Natal during this TDP period to address demand growth and reliability:

- The Ariadne-Venus second 400 kV line involves dismantling an existing Georgedale-Venus 275 kV line and constructing a second Ariadne-Venus 400 kV line. Construction of the line is under way.
- The Ariadne-Eros second 400 kV line involves constructing a 400/132 kV multi-circuit line between Ariadne Substation and Eros Substation. The 400 kV circuit will extend from

Ariadne Substation to Eros Substation, but the 132 kV circuit will go from Ariadne and terminate in Port Shepstone. Construction of the line is under way.

- Mbewu-Umfolozi 765 kV line (operated at 400 kV)
- Invubu-Mbewu 400 kV line
- Iphiva-Normandie 400 kV line
- Inyaninga-Mbewu 2 x 400 kV lines
- Hector-Shongweni 2 x 400 kV lines
- Isundu-Venus 765 kV line (operated at 400 kV)

7.4.3.4 Reactive Power Compensation

In KwaZulu-Natal, there are plans to refurbish the Athene and Impala static var compensators (SVCs).

7.4.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period between 2022 and 2031.

Table 7-19: KwaZulu-Natal – summary of projects and timelines

<table>
<tr><th>TDP scheme</th><th>Scope of work</th><th>Expected CO year</th></tr>
<tr><td>Ariadne-Venus 400 kV Line 2</td><td>• Construct Ariadne-Venus 400 kV Line 2 by recycling Georgedale-Venus 275 kV Line 2</td><td>2022</td></tr>
<tr><td>South Coast Strengthening</td><td>• Construct Ariadne-Eros 400 kV Line 2</td><td>2025</td></tr>
<tr><td rowspan="4">Transnet Freight Rail Upgrade</td><td>• Madlanzini 1 x 160 MVA 400/88 kV Substation</td><td rowspan="4">2026 to 2029</td></tr>
<tr><td>• Loop-in Camden-Normandie 400 kV Line 1</td></tr>
<tr><td>• Nzalo 1 x 160 MVA 400/88 kV Substation</td></tr>
<tr><td>• Loop-in Normandie-Umfolozi 400 kV Line 1</td></tr>
</table>

TDP scheme	Scope of work	Expected CO year
	• Duma 1 x 160 MVA 400/88 kV Substation	
	• Loop-in Pegasus-Athene 1 400 kV Line 1	
KZN 765 kV Strengthening – Empangeni Integration	• Mbewu 400 kV Switching Station	2028
	• Loop-in Athene-Umfolozi 400 kV Line 1 and Invubu-Umfolozi 400 kV Line 1 into Mbewu Substation	
	• Construct Umfolozi-Mbewu 765 kV line (extension of Majuba-Umfolozi 765 kV Line 1); operate at 400 kV	
	• Construct Invubu-Mbewu 400 kV Line 2	
Northern KZN Strengthening – Phase 1	• Establish 1 x 500 MVA 400/132 kV Iphiva Substation	2029
	• Construct Normandie-Iphiva 400 kV Line 1	
eThekwini Electricity Network Strengthening	• Establish 2 x 500 MVA 400/132 kV Inyaninga Substation	2031
	• Construct Inyaninga-Mbewu 400 kV Lines 1 and 2	
	• Establish 2 x 500 MVA 400/132 kV Shongweni Substation	
	• Construct Hector-Shongweni 400 kV Lines 1 and 2	
KZN 765 kV Strengthening – Pinetown Integration	• Isundu 400 kV Switching Station	2031
	• Loop-in Ariadne-Venus 400 kV Line 1 into Isundu Substation	

TDP scheme	Scope of work	Expected CO year
	• Construct Isundu-Venus 765 kV line; operate at 400 kV	
KZN 765 kV Strengthening – Isundu-Mbewu 400 kV Interconnector	• Construct Isundu-Mbewu 400 kV Lines 1 and 2	2032

7.4.3.6 Projects for Future Independent Power Producers

A 400 kV substation will be required in Richards Bay to integrate the proposed large-scale gas-to-power plants. The high-level scope of work to integrate a large-scale gas-to-power plant into the transmission grid is as follows:

- Establishment of a 400 kV substation at the gas plant facility
- Construction of 4 x 400 kV lines from the gas plant to loop into the Athene-Invubu and Athene-Umfolozi 400 kV lines

7.4.3.7 Projects for Alternative Generation Scenario

No alternative generation scenario has been identified for KwaZulu-Natal.

7.4.3.8 Provincial Summary

The future transmission network for the province is shown in Figure 7-12 below.

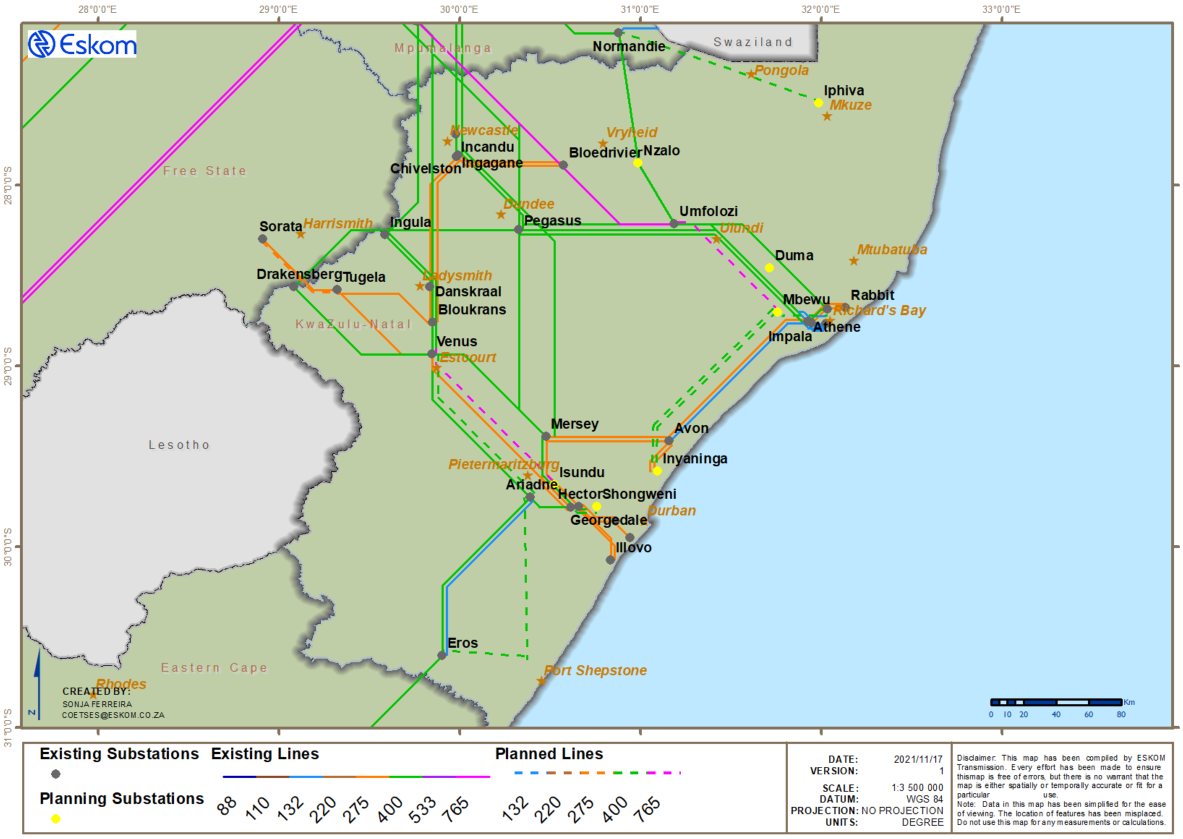


Figure 7-12: Future KwaZulu-Natal transmission network

A summary of all new major assets planned for this province is provided in Table 7-20 and

Table 7-21. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-20: Planned transformers for KwaZulu-Natal

Transformer type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
500 MVA 400/132/22 kV	-	-	5	2 500
Grand total	**-**	**-**	**5**	**2 500**

Table 7-21: Planned overhead lines for KwaZulu-Natal

Line voltage	2022 to 2026	2027 to 2031
	Total length (km)	Total length (km)
275 kV	90	-
400 kV	181	97
765 kV	0	238
Grand total	**298**	**594**

7.5 LIMPOPO

Limpopo is situated in the northernmost part of South Africa and is named after the mighty Limpopo River that runs through it. Limpopo is the fifth-largest province in South Africa and shares international borders with Botswana, Mozambique, and Zimbabwe. The capital city of the province is Polokwane.

The provincial economy is mainly driven by mining, the exportation of primary products, and the importation of manufactured goods. Limpopo is the “bread and fruit basket” of South Africa, producing up to 60% of all fruit, vegetables, maize meal, wheat, and cotton. Major international mining operations contribute 20% to Limpopo’s economy, making mining one of the primary drivers of economic activity in the province. Limpopo’s diverse mining activities include diamonds, iron ore, coal, copper, platinum, and chrome.

The transmission network of the province comprises 400 kV and 275 kV and is interconnected via the 132 kV underlying distribution network. The current transmission network is shown in Figure 7-13.

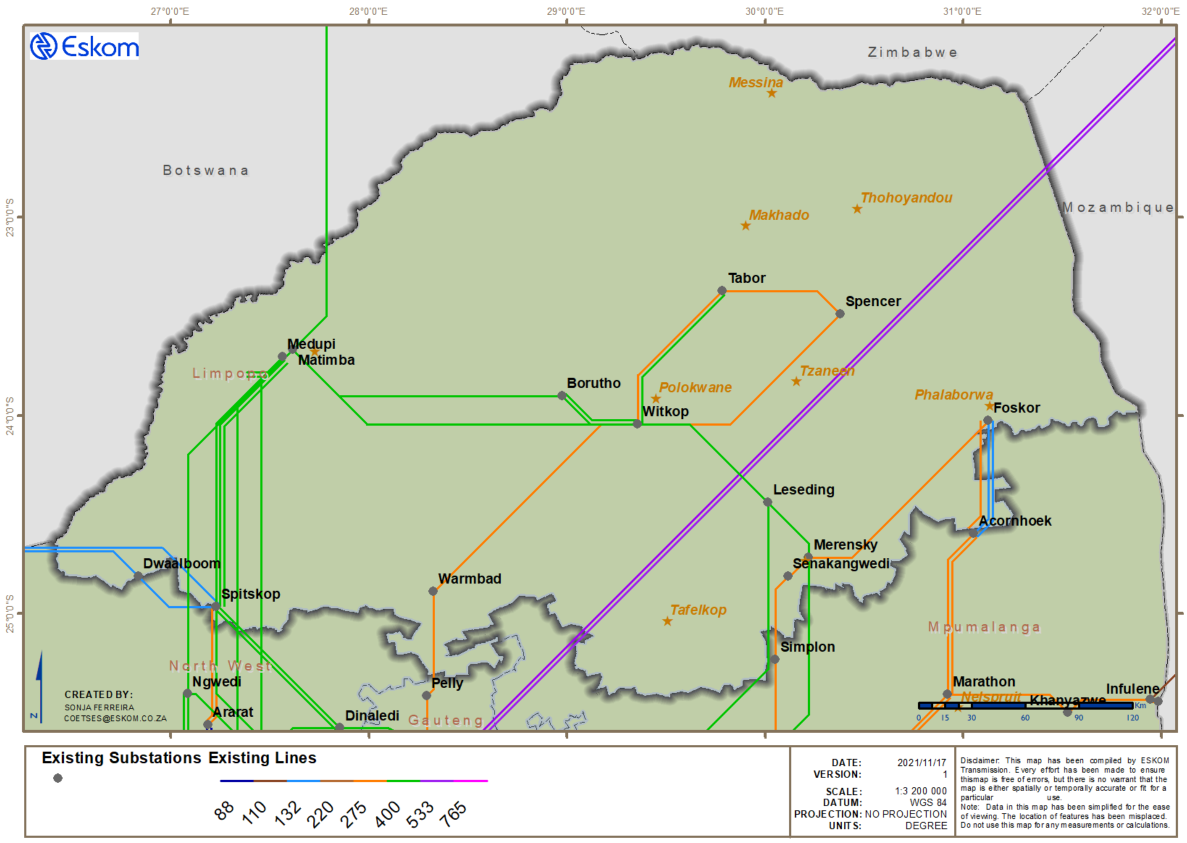


Figure 7-13: Current Limpopo transmission network

7.5.1 Generation

The baseload generation in Limpopo is located in the coal mining town of Lephalale, which has rich coal reserves. Two coal-fired power stations are located in this area, namely, Medupi and Matimba Power Stations. With the completion of Medupi in 2021, these two power stations can provide almost 8,5 GW of generation to the South African grid; however, since 8 August 2021, Medupi Unit 4 has been out of service due to an explosion.

Matimba Power Station, named after the Tsonga word for “power”, is one of the world’s largest direct dry-cooled power stations, with 6 x 665 MW turbo-generator units. Matimba was commissioned in 1989 and is designed to generate 3 990 MW of power. The adjacent Grootegeluk Colliery has sufficient coal reserves to guarantee Matimba a minimum lifespan of 35 years, extending it to a possible 50 years at 2 100 tons of coal per hour.

Medupi Power Station, named after the Sepedi word meaning “gentle rain”, will be one of the largest coal-fired plants and the largest dry-cooled power station in the world. It will be 25% larger than Matimba Power Station in terms of operation, design, and dimensions. The power station has a generating capacity of 4 356 MW (6 x 726 MW units).

The REIPPPP has provided a platform for the private sector to invest in RE connected to the South African power grid. The total approved capacity in Limpopo since the inception of the programme amounts to 118 MW. The composition is shown in Table 7-22.

Table 7-22: Approved projects in Limpopo under the REIPPPP

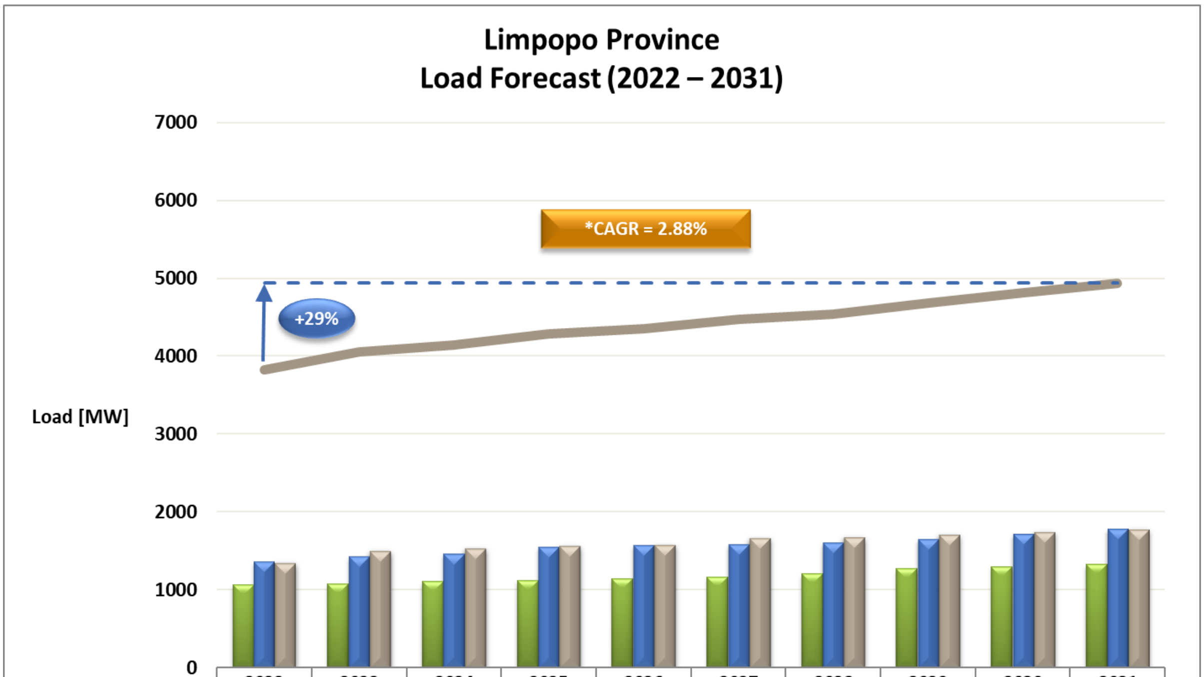
Programme and bid window	Name of project	Type	Capacity (MW)	Transmission substation
IPP RE 1	Tabor PV Plant	PV	28	Tabor 132 kV
	Witkop PV Plant	PV	30	Witkop 132 kV
IPP RE 3	Matimba PV Plant	PV	60	Matimba 132 kV

7.5.2 Load Forecast

The 2019 peak load for the province was 2 899 MW. There was a decrease of 112 MW compared to the peak demand of 3 011 MW that was experienced for the year 2018.

The province consists of three CLNs: Lephalale, Polokwane, and Phalaborwa. The Lephalale CLN is expected to have a steady growth rate of 3,18%. This can be attributed to heavy and light industry and commercial and residential developments as spin-offs. Mining activities are also expected in the areas of Lephalale CLN. Polokwane CLN is expected to experience a load growth at 2,44%. The Phalaborwa CLN is predicted to have a growth rate of 3,02%. This can be attributed to an increase in mining activities and possible smelting operations near Leseding Substation over the next 10 years.

The load forecast for Limpopo is shown in Figure 7-14.



	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Polokwane	1068	1079	1105	1124	1146	1169	1206	1271	1297	1328
Phalaborwa	1367	1438	1461	1557	1573	1589	1607	1658	1724	1780
Lephalale	1344	1494	1530	1561	1579	1662	1677	1705	1743	1772
Provincial Peak	3820	4055	4141	4289	4346	4468	4540	4685	4817	4934
2031 Peak	4934	4934	4934	4934	4934	4934	4934	4934	4934	4934

Figure 7-14: Limpopo load forecast

7.5.3 Planned Projects

Several projects and schemes that aim to address the long-term requirements of the province have been initiated to accommodate the forecasted load and generation.

7.5.3.1 Major Schemes

The major schemes for the province consist of the establishment of a 765 kV network (operated at 400 kV), integration of the Medupi Power Station, and extension of the 400 kV and 275 kV networks, which entails installation of additional transformers at existing and new substations.

The major TDP schemes planned in Limpopo are as follows.

Medupi Transmission Integration (400 kV and 765 kV)

The project is part of the original scope for Medupi Power Station integration into the grid. It entails constructing the 400 kV and 765 kV lines from the vicinity of Medupi Power Station to bulk power evacuation points in Polokwane CLN and North West.

Waterberg Generation 400 kV Stability Enhancement

The following projects are required due to future planned generation projects around the Waterberg area. These projects were raised to ensure that the power stations in the area would remain transiently stable.

- 400 kV line from Medupi to Witkop (~200 km)
- 400 kV line from Borutho to Silimela (~100 km)

Nzhelele 400 kV Integration

The integration of 400 kV into Nzhelele is required to deload Tabor and Spencer Substations and to enable load growth in the northern parts of Limpopo. The 400 kV supply to enable this project will be sourced from Tabor and Borutho Substations through two 400 kV lines.

Limpopo East Corridor Strengthening

These projects will resolve transformation constraints and supply future load growth around Spencer and Foskor Substations for the next 20 years. In addition, this scheme will introduce

400 kV corridors between Spencer, Foskor, and Merensky Substations, resulting in higher transfer limits and savings in losses on the Limpopo transmission network.

Silimela Substation

A new transmission substation will be introduced next to the existing Wolwekraal Distribution Substation to resolve network constraints in the Mapoch and Kwaggafontein areas. In addition, the substation will supply the long-term future load growth expected in the south-western part of the Phalaborwa CLN and deload Simplon Substation. This project is currently in execution.

Sekhukhune Substation

Sekhukhune Substation will be constructed near Uchoba Distribution Substation to create additional transmission network capacity for forecasted future load growth in the Steelpoort area.

7.5.3.2 New Substations

The following new substations will be established in Limpopo to address current and future load growth in the network:

- Nzhelele 400/132 kV Substation
- Silimela 400/132 kV Substation
- Sekhukhune 400/275/132 kV Substation

Some of the new substations have been renamed as indicated in Table 7-23.

Table 7-23: Limpopo substation name changes

Previous name	New name
Marble Hall	Silimela
Mogwase	Ngwedi
Tubatse	Manogeng
Pholo/Maphutha/Senakangwedi B	Sekhukhune
Dwaalboom	Dwarsberg
Rockdale B	Emkhiweni

7.5.3.3 New Lines

The following new lines will be established in the network as part of the Medupi integration requirements in order to ensure transient stability of the generation in the area, to connect new substations, and to alleviate network constraints:

- Medupi-Witkop 400 kV line
- Medupi-Borutho 400 kV line
- Borutho-Silimela 400 kV line
- Borutho-Nzhelele 400 kV line
- Manogeng-Sekhukhune 400 kV line
- Sekhukhune-Senakangwedi 275 kV line
- Manogeng-Silimela 400 kV line
- Witkop-Sekhukhune 400 kV line
- Tabor-Nzhelele 400 kV line
- Foskor-Merensky second 275 kV line (built at 400 kV specification)
- Foskor-Spencer 400 kV line

7.5.3.4 Reactive Power Compensation

The following capacitor banks will be installed for voltage support in Limpopo:

- 2 x 36 Mvar 132 kV capacitor banks at Tabor Substation
- 2 x 36 Mvar 132 kV capacitors at Spencer Substation

7.5.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period between 2022 to 2031.

Table 7-24: Limpopo – summary of projects and timelines

TDP scheme	Project name	Expected CO year
Medupi Transmission Integration	• Medupi-Ngwedi first 765 kV line (energised at 400 kV)	2022
	• Medupi-Borutho 400 kV line	
Waterberg Generation 400 kV Stability Enhancement	• Medupi-Witkop first 400 kV line	2022
	• Borutho-Silimela first 400 kV line	2029
Highveld North-West and Lowveld North Reinforcement Phase 2	• Silimela 400/132 kV Substation	2023
	• Manogeng 400 kV Switching Station	
	• Loop-in Duvha-Leseding 400 kV line into Manogeng Switching Station	
	• Manogeng-Silimela 400 kV line	
Highveld North-West and Lowveld North Reinforcement Phase 1	• Emkhiweni-Silimela 400 kV line	2029
Sekhukhune Integration Phase 1	• Sekhukhune 400/275/132 kV Substation (1 x 800 MVA 400/275 kV transformer and 2 x 500 MVA 400/132 kV transformers)	2029
	• Loop-in Arnot-Merensky 400 kV into Sekhukhune Substation	
	• Manogeng-Sekhukhune first 400 kV line	
	• Sekhukhune-Senakangwedi first 275 kV line	
Sekhukhune Integration Phase 2	• Witkop-Sekhukhune first 400 kV line	2031
Nzhelele 400 kV Integration	• Nzhelele 400/132 kV Substation (2 x 500 MVA 400/132 kV transformers)	2030
	• Tabor-Nzhelele 400 kV line	
	• Borutho-Nzhelele first 400 kV line	
Foskor and Acornhoek 275/132 kV Transformation Upgrades	• Foskor-Merensky second 275 kV line (built at 400 kV specification)	2027
Limpopo East Corridor Strengthening	• Establishment of 400 kV busbars at Spencer Substation and Foskor Substation	2029
	• Foskor first 400 MVA 400/275 kV transformer	

TDP scheme	Project name	Expected CO year
	• Spencer first 500 MVA 400/132 kV transformer • Foskor-Spencer first 400 kV line (110 km) • Merensky-Foskor second 275 kV line change-over to 400 kV line	
Polokwane Reactive Power Compensation	• Spencer 2 x 36 Mvar capacitor banks • Tabor 2 x 36 Mvar capacitor banks	2026
Warmbad Transformation Upgrade	• Warmbad first 250 MVA 275/132 kV transformer	2026
Leseding Transformation Upgrade	• Leseding third 500 MVA 400/132 kV transformer	2026
Acornhoek Transformation Upgrade	• Acornhoek third 125 MVA 400/132 kV transformer	2026
Borutho Transformation Upgrade	• Borutho third 500 MVA 400/132 kV transformer	2026

7.5.3.6 Projects for Future Independent Power Producers

There is sufficient transmission network capacity to integrate future planned IPPs in the province. Therefore, no additional transmission projects are required to enable the future connection of the IPPs in Limpopo.

7.5.3.7 Projects for Alternative Generation Scenario

No alternative generation scenario has been identified for Limpopo.

7.5.3.8 Provincial Summary

The future transmission network for the province is shown in Figure 7-15 below.

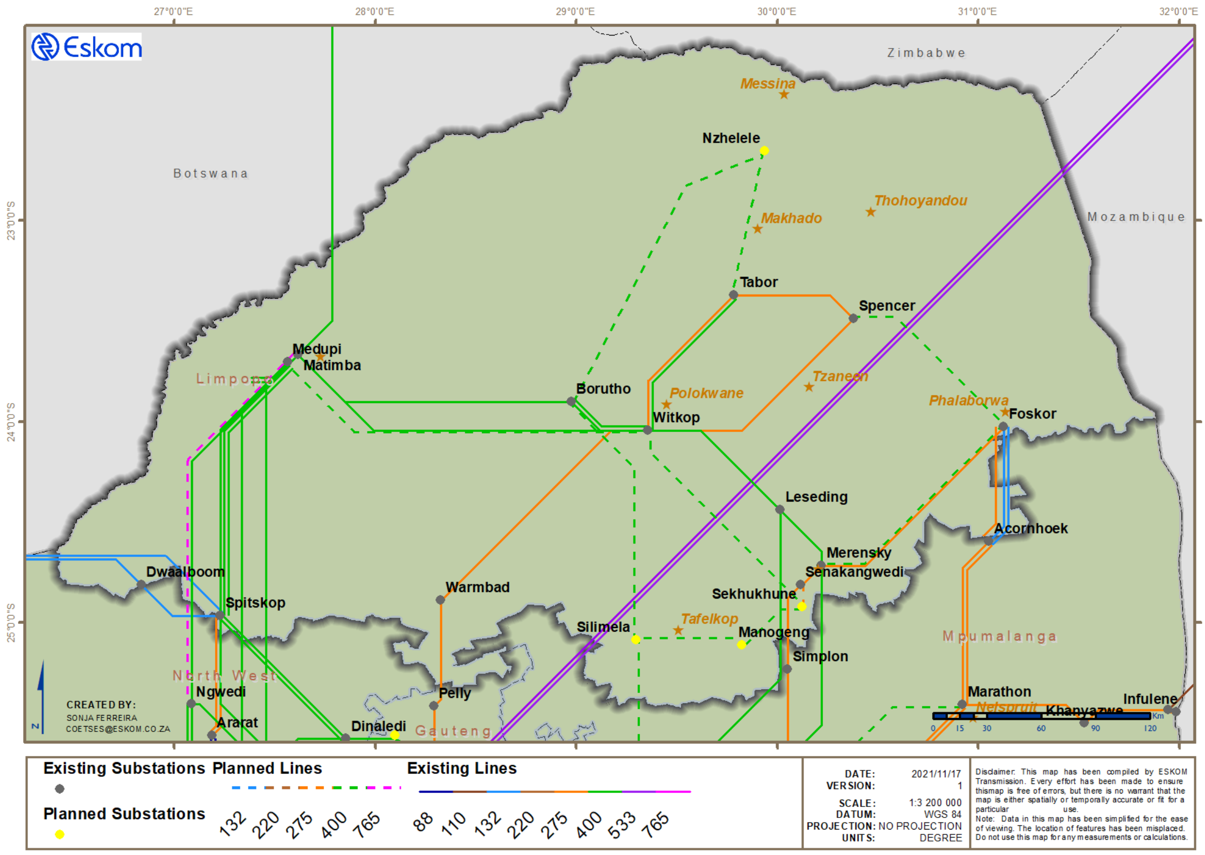


Figure 7-15: Future Limpopo transmission network

A summary of all new major assets planned for this province is provided in Table 7-25 to Table 7-28. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-25: Planned transformers for Limpopo

Transformer type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
125 MVA 275/132/22 kV	-	-	1	125
250 MVA 275/132/22 kV	-	-	1	250
400 MVA 400/275/22 kV	-	-	2	800
500 MVA 400/132/22 kV	-	-	8	4 000
800 MVA 400/275/22 kV	-	-	1	800
80 MVA 132/33 kV	-	-	-	-
80 MVA 132/66/22 kV	-	-	2	160
Grand total	**-**	**-**	**15**	**6 135**

Table 7-26: Planned overhead lines for Limpopo

Line voltage	2022 to 2026	2027 to 2031
	Total length (km)	Total length (km)
400 kV	226	875
765 kV	76	-
Grand total	**302**	**875**

Table 7-27: Planned capacitor banks for Limpopo

Capacitor type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
40 Mvar 132 kV	4	160	-	-
Grand total	**4**	**160**	**-**	**-**

Table 7-28: Planned reactors for Limpopo

Reactor type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	2	200	3	300
Grand total	**2**	**200**	**3**	**300**

7.6 MPUMALANGA

Mpumalanga is a province located in the north-eastern part of South Africa that shares international borders with Mozambique and Swaziland. The capital of Mpumalanga is Nelspruit, the major city in the Mbombela Local Municipality. The provincial economy is largely driven by farming, mining, heavy industry, and tourism – thanks to attractions such as the Kruger National Park, Sudwala Caves, and Blyde River Canyon.

The transmission grid in Mpumalanga is comprised mainly of 275 kV and 400 kV overhead lines. The supply to the Cape corridor is via the Alpha and Zeus 400/765 kV Substations located in Mpumalanga. International customers, namely, Mozambique and Swaziland, also connect to the Eskom network at 132 kV, 275 kV, and 400 kV. Figure 7-16 represents the current transmission network in Mpumalanga.

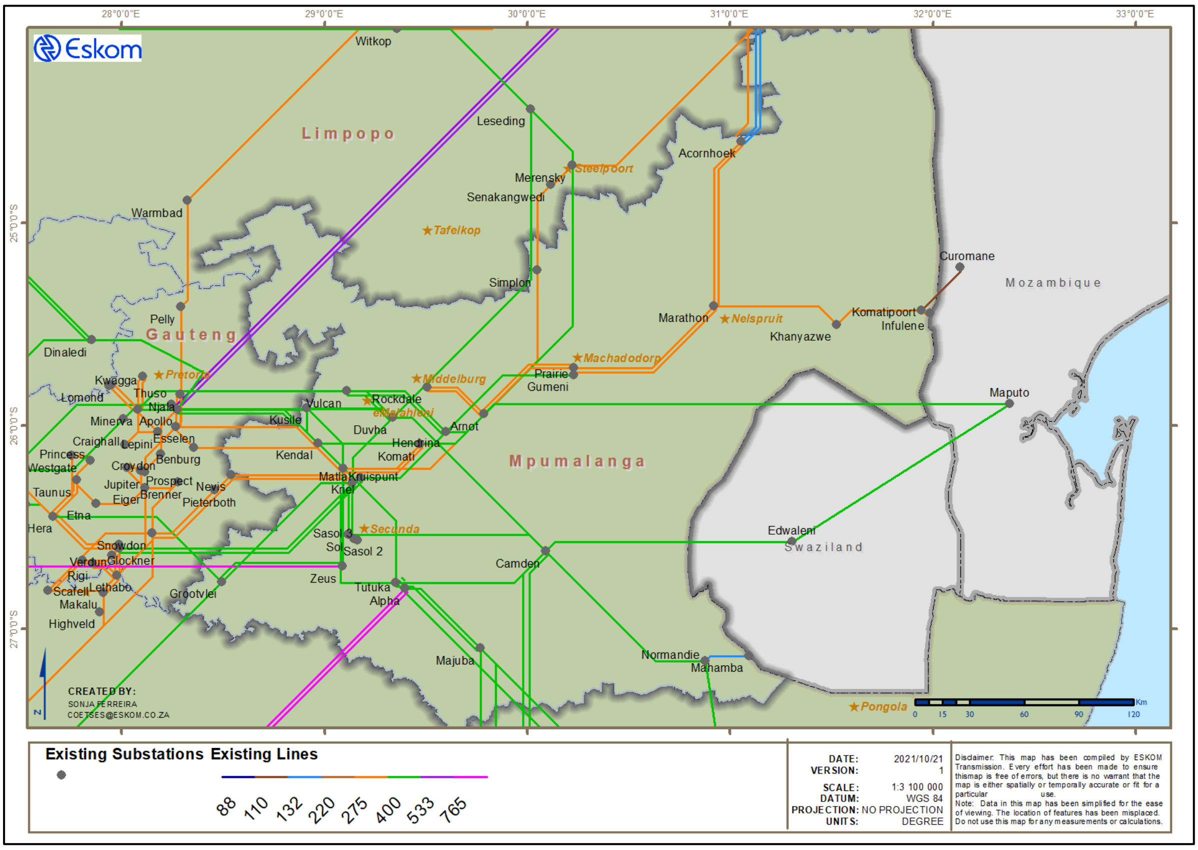


Figure 7-16: Current Mpumalanga transmission network

7.6.1 GENERATION

Mpumalanga is considered the generation hub of South Africa's electricity network due to the concentration of power stations in this region and their proximity to the large load centres. Currently, 12 of 14 Eskom coal-fired power stations, namely, Arnot, Camden, Duvha, Grootvlei, Hendrina, Kendal, Komati, Kriel, Matla, Majuba, and Tutuka, also including one of the two Eskom power stations currently under construction, namely, Kusile Power Station, are located in Mpumalanga.

The total capacity of Kusile Power Station on completion is expected to be 5 076 MW. Table 7-29 details the programme for the Kusile units becoming commercially available.

Table 7-29: Kusile Power Station schedule

Generator unit	Planned CO date
Unit 1	2018
Unit 2	2019
Unit 3	2021
Unit 4	2023
Unit 5	2024
Unit 6	2024

The only remaining transmission project for integration of Kusile Power Station is the Kusile-Lulamisa 400 kV line. This project was delayed due to servitude acquisition challenges and is required before Unit 5 is commissioned.

Hendrina, Grootvlei, and Komati Power Stations are close to reaching the end of their economic life. Early decommissioning of Tutuka Power Station is currently also being investigated, and details will be shared in the next TDP cycle.

Table 7-30 shows the Eskom power station units that are assumed to be decommissioned in the TDP period. Approximately 11,8 GW of capacity is assumed to be removed from the Mpumalanga generation pool over the next 10 years.

Table 7-30: Ageing generators decommissioning schedule

Power station	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total per station
Arnot	0	0	0	0	784	784	784	0	0	0	**2 352**
Camden	0	0	0	0	0	1 561	0	0	0	0	**1 561**
Duvha	0	0	0	0	0	0	0	0	0	1 200	**1 200**
Grootvlei	0	0	0	600	0	0	0	0	0	0	**600**

Power station	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total per station
Hendrina	195	390	200	435	0	0	0	0	0	0	**1 220**
Komati	114	0	0	0	0	0	0	0	0	0	**114**
Kriel	0	0	0	0	500	500	500	1 000	500	0	**3 000**
Matla	0	0	0	0	0	0	0	0	600	1 200	**1 800**
Total per annum	**309**	**390**	**200**	**1 035**	**1 284**	**2 845**	**1 284**	**1 000**	**1 100**	**2 400**	**11 847**

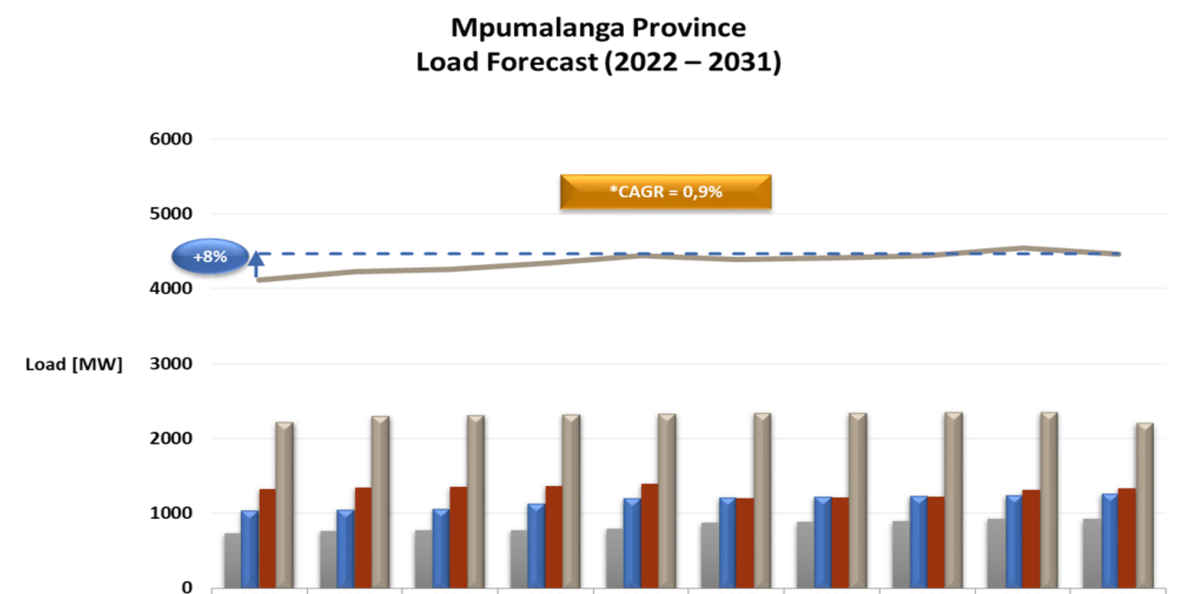
7.6.2 Load Forecast

Load growth is expected in the province due to development in the commercial, electrification, and industrial sectors. The future load mix is not expected to differ from the existing one, mainly comprised of redistributors and mining, commercial, and industrial customers. The cumulative average growth rate in the TDP period is estimated at 0,9% per annum, from 4 120 MW (at provincial peak) in 2022 to 4 466 MW in 2031.

Mpumalanga consists of four CLNs, and each CLN is made up of a number of substations, as follows:

- **Highveld South CLN** – Sol, Camden, Alpha, Tutuka, Normandie, Majuba, Grootvlei, and Zeus
- **Lowveld CLN** – Marathon, Prairie, Simplon, Khanyazwe, Komatipoort, and Gumeni
- **Middelburg CLN** – Rockdale, Hendrina, Duvha, Komati, and Arnot
- **Witbank CLN** – Vulcan, Matla, Kendal, Kriel, Kruispunt, and Kusile

The load forecast for Mpumalanga is shown in Figure 7-17.



	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Middelburg	734	767	770	775	793	881	886	899	922	932
Lowveld	1035	1047	1058	1127	1199	1214	1226	1236	1247	1261
Witbank	1327	1340	1354	1367	1396	1197	1209	1221	1314	1335
Highveld South	2217	2303	2306	2317	2328	2339	2344	2349	2355	2209
Provincial Peak	4120	4229	4254	4338	4445	4386	4414	4444	4543	4466
2031 Peak	4466	4466	4466	4466	4466	4466	4466	4466	4466	4466

Figure 7-17: Mpumalanga load forecast

7.6.3 Planned Projects

Several projects and schemes that aim to address the long-term requirements of the province have been initiated in order to accommodate the forecasted load and generation.

7.6.3.1 Major Schemes

The major TDP schemes planned in Mpumalanga are as follows.

Emkhiweni 400/132 kV Integration

This scheme entails establishing the new Emkhiweni 400/132 kV Substation, which is required to address both Vulcan and Rockdale unfirm transformations. The project is also integral to the line deviation projects planned by Eskom Distribution, related to undermining and burning grounds. The project will comprise 2 x 500 MVA transformers and turn-ins from the existing Arnot-Kendal 400 kV line. This project is currently in the development phase and faces servitude challenges. The project scope of work has also grown to include the Emkhiweni-Silimela 400 kV line, as the Silimela integration project in Limpopo is at an advanced stage and is expected to be completed before the Emkhiweni integration.

Wonderkrag 400/132 kV Integration

This scheme entails establishing the new Wonderkrag 400/132 kV Substation, which is required to address the unfirm transformation and fault level exceedance at Sol Substation. The substation will comprise 4 x 500 MVA transformers as well as a fifth standby transformer. This project is currently in the execution phase.

Marathon 400/132 kV Integration

This project is required to address the low voltages under the loss of any 275 kV line in that corridor. The scope of work for this phase is the following:

- Marathon 400/132 kV Substation (first 500 MVA 400/132 kV transformer)
- Marathon-Gumeni 400 kV line

This project has been delayed for longer than expected, as the servitude challenges include an expropriation process.

7.6.3.2 New Substations

Additional 400/132 kV substations will be established due to load growth in order to remain Grid Code compliant and to create additional capacity.

- Emkhiweni 400/132 kV Substation will address both Vulcan and Rockdale unfirm transformations and improve safe working conditions over burning grounds. It will also address the N-1 line firmness to the future Silimela Substation.
- Wonderkrag 400/132 kV Substation will address the unfirm transformation and high fault levels at Sol Substation.

7.6.3.3 New Lines

- Emkhiweni-Silimela 400 kV line
- Emkhiweni 400 kV turn-ins
- Kusile-Lulamisa 400 kV line
- Gumeni-Marathon 400 kV line

7.6.3.4 Reactive Power Compensation

No reactive power compensation projects (capacitor banks and/or SVCs) are planned for Mpumalanga for this TDP period. Eskom Distribution planned to add some compensation in the Lowveld network to improve voltages under contingency. However, these projects have since been deferred.

7.6.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period between 2022 to 2031.

Table 7-31: Mpumalanga – summary of projects and timelines

TDP scheme	Project name	Expected CO date
Kusile Integration Phase 3A: 400 kV Duvha Bypass	Kusile and Vulcan 400 kV bypass at Duvha (to form Kusile-Vulcan 400 kV line)	2021 (completed)
Kusile Integration Phase 2: Lulamisa	Kusile-Lulamisa first 400 kV line	2023
Emkhiweni 400 kV Integration	Emkhiweni 400/132 kV Substation	2027
	Turn-in of Kendal-Arnot 400 kV line into Emkhiweni 400/132 kV Substation	
	Emkhiweni-Silimela 400 kV line	
Sol Underrated Equipment Upgrade and FCLRs	Upgrade underrated equipment at Sol Substation and install FCLRs	2024
Wonderkrag 400 kV Integration	New Wonderkrag 400/132 kV Substation	2027
	Turn-in of Kriel-Zeus 400 kV line into Wonderkrag Substation	
	Turn-in of Kriel-Tutuka 400 kV line into Wonderkrag Substation	
Mpumalanga Underrated Equipment Upgrade (MURE)	Upgrade underrated equipment at Vulcan 400 kV, Rockdale 132 kV, Hendrina 400 kV, Kruispunt 132 kV, Komati 275 kV, Zeus 400 kV, Arnot 400 kV and 275 kV, Tutuka 400 kV, Alpha 400 kV, Majuba 400 kV, and Matla 275 kV; install Matla FCLRs	2026
Marathon 400 kV Integration	Gumeni-Marathon 400 kV line	2027
	Marathon 400/132 kV Substation	

TDP scheme	Project name	Expected CO date
Transnet Freight Rail Upgrade	Madlanzini 1 x 160 MVA 400/88 kV Substation	2026 to 2029
	Loop-in Camden-Normandie 400 kV Line 1	

7.6.3.6 Projects for Future Independent Power Producers

Additional generation of approximately 300 MW in the form of IPP-operated coal-fired power stations was expected to be integrated into Mpumalanga in 2023. This project has since been cancelled.

There is, however, much more interest in IPPs in the province, as capacity in the Cape is diminishing. The next TDP review will provide further details regarding these developments.

7.6.3.7 Projects for Alternative Generation Scenario

No alternative generation scenario has been identified for Mpumalanga.

7.6.3.8 Provincial Summary

The future transmission network for the province is shown in Figure 7-18 below.

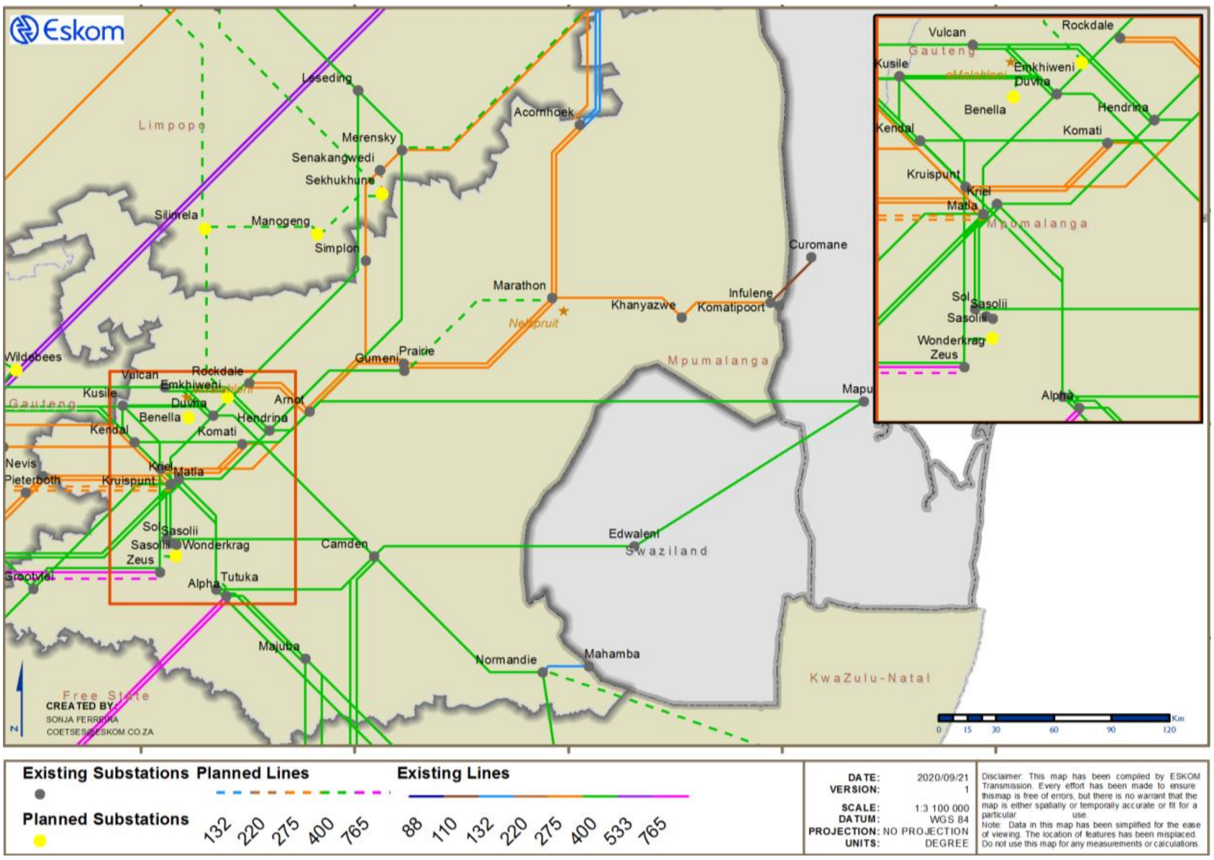


Figure 7-18: Future Mpumalanga transmission network

A summary of all new major assets planned for this province is provided in Table 7-32 and

Table 7-33. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-32: Planned transformers for Mpumalanga

Transformer type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
315 MVA 275/88/22 kV	-	-	2	630
500 MVA 275/132/22 kV	-	-	1	500
500 MVA 400/132/22 kV	-	-	3	1 500
2 000 MVA 765/400/33 kV	-	-	1	2 000
Grand total	-	-	**7**	**4 630**

Table 7-33: Planned overhead lines for Mpumalanga

Line voltage	2022 to 2026	2027 to 2031
	Total length (km)	Total length (km)
400 kV	186	521
Grand total	**186**	**521**

Table 7-34: Planned reactors for Mpumalanga

Reactor type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
400 Mvar 765 kV	-	-	1	400
Grand total	**-**	**-**	**1**	**400**

7.7 NORTHERN CAPE

The Northern Cape is situated in the western part of South Africa and is the largest province by landmass. It is also the most sparsely populated province in South Africa and has Kimberley as its capital. The majority of the economic activity is concentrated in Kimberley and Upington, located to the east and in the northern region of the province, respectively. The Northern Cape landscape has made it the preferred location for the world's largest radio telescope, the Square Kilometre Array (SKA). It also consists of vast tracts of land with good solar radiation and, for that reason, has attracted the most solar photovoltaic (PV) and concentrated solar power (CSP) projects in South Africa. Furthermore, the increased interest in mining operations in the Namaqualand and Kimberley areas is expected to increase electricity demand in the province.

The provincial demand peaked at around 868 MW over the last year, and it is expected to increase to about 1 313 MW by 2031. The Northern Cape is comprised of three customer load networks (CLNs), namely, Kimberley, Karoo, and Namaqualand. Kimberley CLN is the main load centre, consuming more than half of the load in the province. Kimberley is supplied by means of the 275 kV network at Ferrum as well the Aries-Nieuwehoop-Ferrum 400 kV corridor. Namaqualand is supplied by a radial 220 kV network, which is supported by the 400 kV backbone from Aries. The Aries-Kronos-Hydra 400 kV line runs through the Karoo CLN; this line and the 275 kV and 400 kV networks in the Kimberley CLN form the major import and export power corridors in the province.

The geographical layout of the existing Northern Cape transmission network is shown in Figure 7-19.

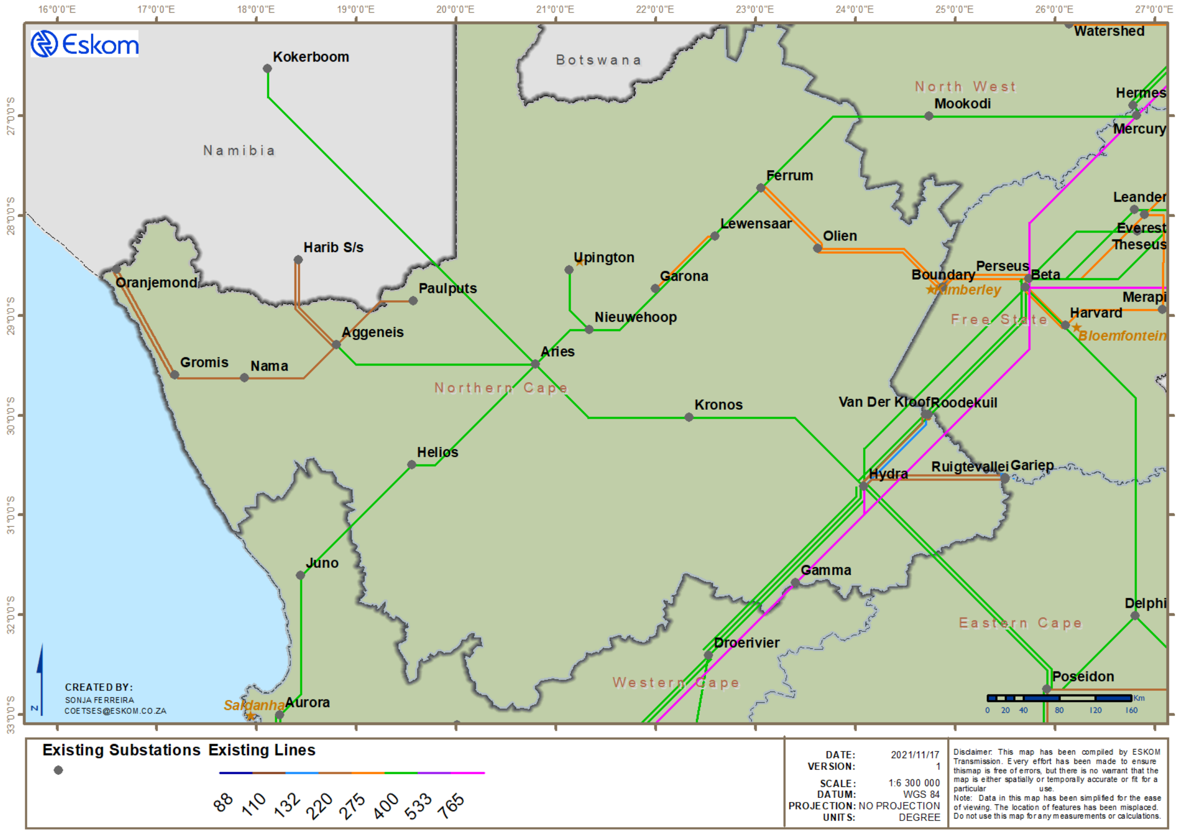


Figure 7-19: Current Northern Cape transmission network

7.7.1 Generation

There is one generation plant located in the Northern Cape, named Van Der Kloof Power Station. It is a hydropower station with two units generating at 120 MW each, providing a total capacity of 240 MW.

Gariep is located on the border of the Eastern Cape, Free State, and Northern Cape and falls inside the border of the Eastern Cape. Gariep has a generating capacity of 360 MW, with four units rated at 90 MW each, evacuating its power directly onto the Hydra 220 kV busbar via the two Hydra-Ruigtevallei 220 kV lines in the Northern Cape.

The REIPPPP has provided a platform for the private sector to invest in renewable generation connected to the South African power grid. The diverse and favourable climatic conditions of the Northern Cape make the province an ideal location for renewable energy projects. Table 7-35 provides an overview of committed generation in the province since inception of the DMRE's REIPPPP up to the risk mitigation (RM) round.

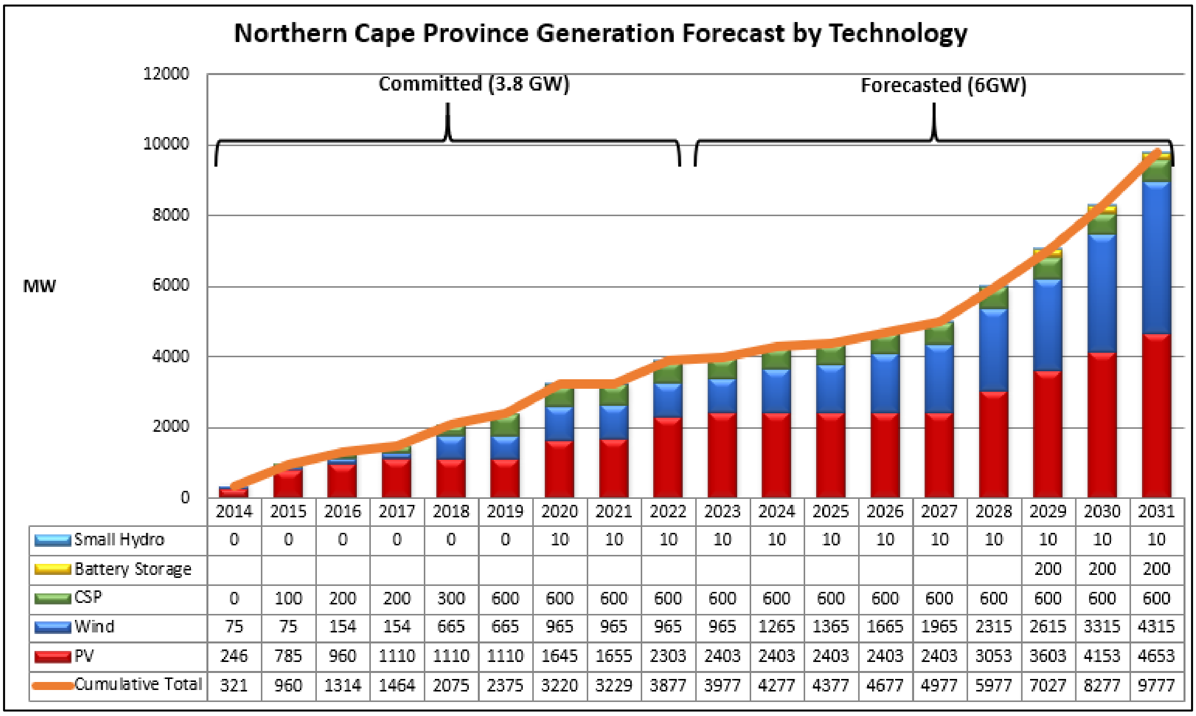
Table 7-35: Summary of approved projects in the Northern Cape under the REIPPPP

Programme and bid window	Technology type	Capacity (MW)	Project name	Substation
REIPP 1	PV	64	Lesedi Power Company	Olien
	PV	19,9	Mulilo Renewable Energy Solar PV Prieska	Kronos
	CSP	100	KaXu Solar One	Paulputs
	PV	9,65	Konkoonsies Solar	Paulputs
	PV	9,65	Aries Solar	Aries
	PV	10	Greefspan PV Power Plant	Boundary
	PV	75	Kathu Solar Energy Facility	Ferrum
	CSP	50	Khi Solar One	Upington
	Wind	72,75	Noblesfontein	Hydra
	PV	9,65	Mulilo Renewable Energy Solar PV De Aar	Hydra
	PV	72,5	Kalkbult	Hydra
	PV	48,25	De Aar Solar PV	Hydra
	PV	75	Solar Capital De Aar	Hydra
	PV	48,25	Droogfontein Solar PV Project	Boundary
	PV	19,9	Herbert PV Power Plant	Boundary
REIPP 2	PV	75	Solar Capital De Aar 3	Hydra
	PV	36,8	Linde	Hydra
	CSP	50	Bokpoort CSP Project	Garona
	PV	74	Sishen Solar Facility	Ferrum
	PV	75	Jasper Power Company	Olien
	PV	8,9	Upington Solar PV	Upington
	Hydro	10	Neusberg Hydro Electric Project A	Paulputs
REIPP 3	PV	75	Adams Solar PV 2	Ferrum
	Wind	138,2	Loeriesfontein 2 Wind Farm	Helios
	Wind	137,7	Khobab Wind	Helios
	CSP	100	XiNa Solar One	Paulputs
	PV	75	Mulilo Sonnedix Prieska PV	Kronos
	PV	75	Mulilo Prieska PV	Kronos
	Wind	139	Longyuan Mulilo De Aar 2 North Wind Energy Facility	Hydra
	Wind	96,5	Longyuan Mulilo De Aar Maanhaarberg Wind Energy Facility	Hydra
	Wind	79,1	Noupoort Mainstream Wind	Hydra
	CSP	100	Ilanga CSP 1/Karoshoek Solar One	Upington
REIPP 3.5	CSP	100	Kathu Solar Park	Ferrum
	CSP	100	Redstone Solar Thermal Power Plant	Olien
REIPP 4	PV	75	Sirius Solar PV Project One	Upington
	PV	75	Dyason’s Klip 1	Upington
	PV	75	Dyason’s Klip 2	Upington
	PV	75	Konkoonsies II Solar	Paulputs
	PV	40	Aggeneys Solar	Aggeneis
	PV	75	Droogfontein Solar Park	Boundary
REIPP 4B	OW	136,8	Kangnas	Groeipunt
	PV	75	Loeriesfontein Orange	Helios
	PV	55	Greefspan PV Power Plant No. 2	Kronos

Programme and bid window	Technology type	Capacity (MW)	Project name	Substation
	OW	102	Copperton Wind Farm	Kronos
	OW	135,93	Garob Wind Farm	Kronos
RMIPPP	Hybrid	75	Umoyilanga Hybrid Facility	Upington
	Hybrid	150	Acwa Power Hybrid Facility	Garona
	Hybrid	198	Mulilo Total Coega Hybrid Facility	Nieuwehoop
	Hybrid	150	Scatec Kenhardt	Nieuwehoop
	Hybrid	75	Mulilo Total Hydra Storage	Hydra

The Northern Cape has 3,8 GW of committed generation, which far exceeds the provincial peak load, and as such, the Northern Cape grid, with the exception of Hydra and Gamma Substations located on the central Cape corridor (Hydra cluster), no longer has capacity to integrate additional generation in the province as highlighted in the GCCA 2023 (GP_21/126). Just under 10 GW of generation is anticipated in the province by 2031, as indicated in Figure 7-20.

The 2031 forecasted generation at each substation in the Northern Cape per technology type is highlighted in Figure 7-21. The generation will be spread across the entire province and be dominated by both wind and PV technologies. The 600 MW of existing CSP plant is not expected to increase in line with the IRP 2019; however, utility-scale battery energy storage systems (BESS) are expected in the province. The installation of BESS in the Northern Cape transmission system will have multiple benefits, which include grid decongestion, energy arbitrage, dynamic voltage support, and fast frequency response (ancillary services).



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Small Hydro	0	0	0	0	0	0	10	10	10	10	10	10	10	10	10	10	10	10
Battery Storage																200	200	200
CSP	0	100	200	200	300	600	600	600	600	600	600	600	600	600	600	600	600	600
Wind	75	75	154	154	665	665	965	965	965	965	1265	1365	1665	1965	2315	2615	3315	4315
PV	246	785	960	1110	1110	1110	1645	1655	2303	2403	2403	2403	2403	2403	3053	3603	4153	4653
Cumulative Total	321	960	1314	1464	2075	2375	3220	3229	3877	3977	4277	4377	4677	4977	5977	7027	8277	9777

Figure 7-20: Northern Cape generation forecast

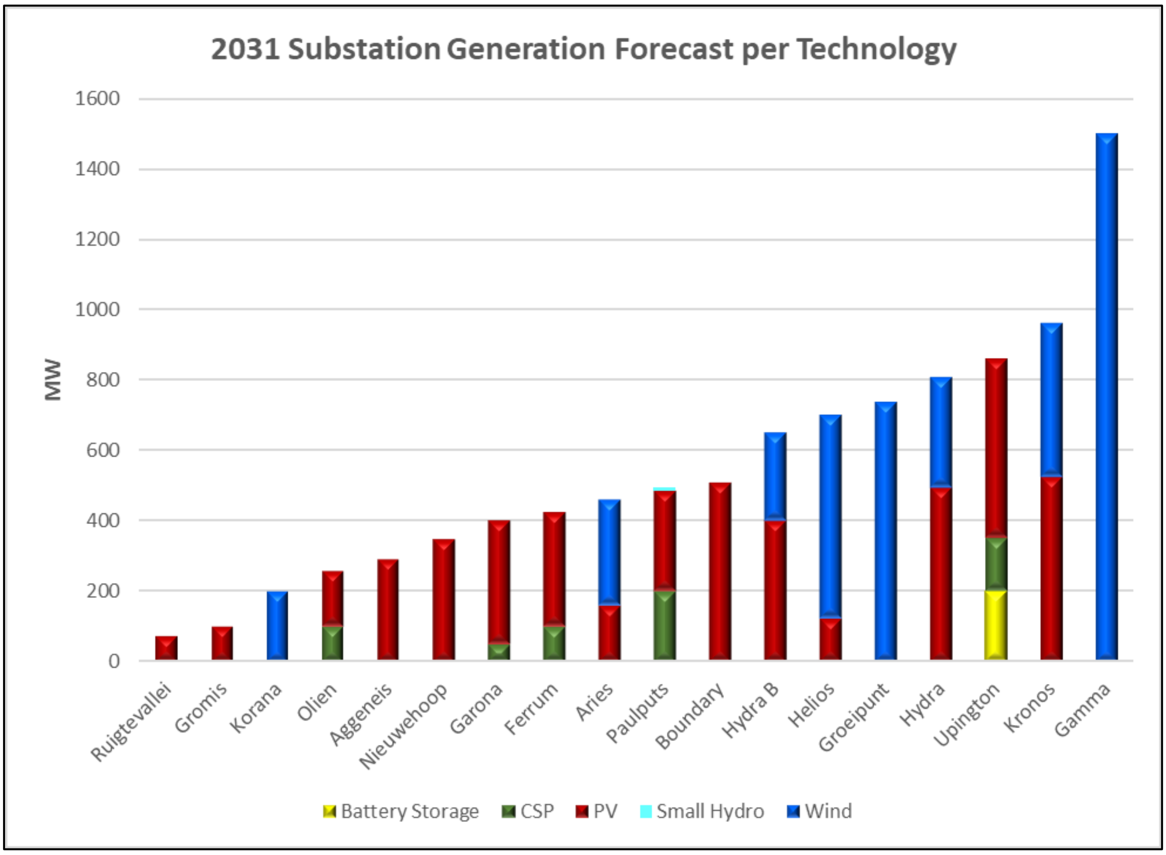
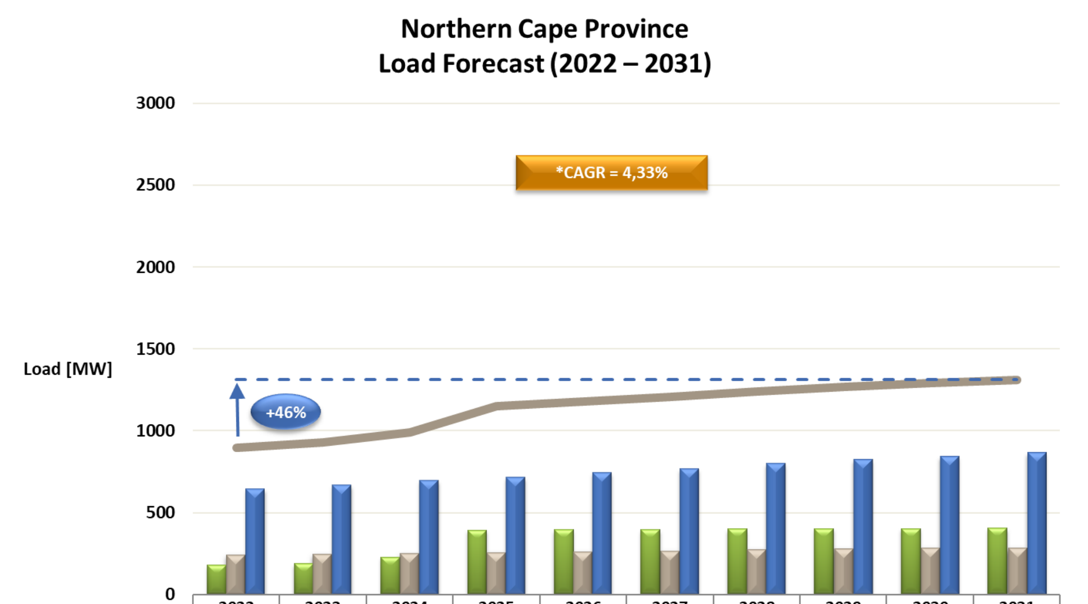


Figure 7-21: Northern Cape substation 2031 cumulative generation per technology

7.7.2 LOAD FORECAST

The provincial load peaked at around 868 MW over the last year, and it is expected to increase to about 1 313 MW by 2031.

As mentioned, the Northern Cape comprises three CLNs, namely, Kimberley, Karoo, and Namaqualand. Kimberley CLN is the main load centre, consuming more than half of the load in the province. The anticipated mining in the Namaqualand CLN, along with possible smelter operations associated with these mines, explains the hike in demand in 2025. The forecast for the remaining CLNs shows a natural load growth. The load forecast for the Northern Cape is shown in Figure 7-22.



	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Namaqualand	180	187	228	394	395	397	400	402	403	405
Karoo	239	244	249	254	259	265	270	276	281	283
Kimberley	643	668	694	715	744	768	801	822	844	867
Provincial Peak	897	928	989	1151	1181	1207	1242	1266	1291	1313
2031 Peak	1313	1313	1313	1313	1313	1313	1313	1313	1313	1313

Figure 7-22: Northern Cape load forecast

7.7.3 PLANNED PROJECTS

The traditionally weak radial transmission network, forecasted demand, and the high potential for the development of generation from RE sources make the Northern Cape a key centre for network development activities within this planning horizon. As such, several projects and schemes that aim to address the long-term requirements of the province have been initiated in order to accommodate the forecasted load and new generation.

7.7.3.1 Major Schemes

The major TDP schemes planned in the Northern Cape are as follows.

Namaqualand Redundancy Project

The Namaqualand redundancy scheme will provide reliability to the radial 220 kV system in the CLN. The projects include the construction of a Juno-Gromis 400 kV line, Gromis 400/220 kV transformation, and the Gromis-Oranjemond 220 kV line (constructed at 400 kV). The Gromis-Oranjemond 400 kV line has been completed, and the other two projects are in the execution phase.

Kimberley Strengthening Phase 3

This strengthening entails the construction of Umtu (Hotazel) 400/132 kV Substation, along with the Hermes (later Selemo)-Mookodi, Mookodi-Umtu, and Umtu-Ferrum 400 kV lines, which are to cater for the increasing load in the area. Distribution has indicated that the demand in the area has not materialised as anticipated, thus resulting in the deferment in the establishment of Umtu 400/132 kV Substation. However, the 400 kV lines are required to enable the evacuation of renewable power out of the province.

Kimberley Strengthening Phase 4

This is a strategic project to support the forecasted demand, which has also not materialised as anticipated. However, the Ferrum-Boundary-Beta 400 kV line will be required within the TDP study period to assist with integration and evacuation of the renewable generation potential in the area.

Upington Strengthening

The Upington strengthening scheme includes the construction of an Aries-Upington 400 kV line, an Upington-Ferrum 400 kV line, and 400/132 kV 500 MVA transformation at Upington Substation.

7.7.3.2 New Substations

The following new substations are required in the Northern Cape over the current TDP period:

- Hydra B 400/132 kV Substation approximately 50 km from the existing Hydra Substation along the Hydra-Perseus 400 kV line
- Korana 400/132 kV Substation between Aries and Aggeneis Substations

7.7.3.3 New Lines

The following new transmission line projects are planned in the Northern Cape for the current TDP period:

- Juno-Gromis 400 kV line
- Ferrum-Upington 400 kV line
- Aries-Upington 400 kV line
- Aries-Hydra 400 kV corridor strengthening
- Aggeneis-Paulputs 400 kV line – initial plans were to operate the line at 220 kV; however, due to the large demand for renewable generation in the vicinity, there may be a requirement to operate the line at 400 kV from the outset.
- Ferrum-Mookodi 400 kV line
- Hermes-Mookodi 400 kV line
- Beta-Ferrum 400 kV line (via Boundary Substation)
- Namaqualand 400 kV strengthening

7.7.3.4 Reactive Power Compensation

Additional reactive compensation will be installed at Aries Substation, that is, an Aries 400 kV dynamic device (-150 Mvar to +250 Mvar), to assist with dynamic voltage control as part of the Northern Cape reinforcement project.

7.7.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period between 2022 and 2031.

Table 7-36: Northern Cape – summary of projects and timelines

TDP scheme	Project name	Expected CO year
Hydra-Roodekuil Refurbishment	Rebuilding of Hydra-Roodekuil 132 kV line	2023
Namaqualand Strengthening	Juno-Gromis first 400 kV line	2024
	Gromis 400/220 kV transformation	
Nama Substation Normalisation	Nama 66/22 kV 20 MVA transformer	2024
Upington Strengthening	Upington second 500 MVA 400/132 kV transformer	2024
Gariep Network Strengthening	Ruigtevallei-Hydra derate 220 kV line to 132 kV	2025
	Ruigtevallei 132 kV feeder bay to Dreunberg	
Olien Transformer Refurbishment	Replacement of 150 MVA 275/132 kV transformer with a 250 MVA 275/132 kV unit	2025
Upington Strengthening	Ferrum-Upington first 400 kV line	2026
Northern Cape Reinforcement	Aries dynamic device	2026
Helios Strengthening	Helios 1 x 20 MVA 132/66 kV transformer	2026
Gromis 400 kV Shunt Reactors	Gromis 2 x 50 Mvar 400 kV shunt reactors	2026
Northern Cape Voltage Unbalance	Northern Cape line transposition	2027
Aggeneis-Paulputs 400 kV Line	Aggeneis-Paulputs 400 kV line	2028
Ruigtevallei Substation Strengthening and Normalisation	Ruigtevallei 132/66 kV strengthening and transformer normalisation	2030
Kimberley Strengthening Phase 3	Umtu 400/132 kV Substation	Deferred
Kimberley Strengthening Phase 4	Olien 400 kV strengthening	Deferred
	Establishment of Ulco and Manganore Substations and Boundary-Ulco-Manganore-Ferrum 400 kV line	Deferred

7.7.3.6 Projects for Future Independent Power Producers

The Northern Cape has seen the committed generation in the province exceeding the peak load more than fourfold. This, along with an aggressive generation forecast over the TDP period, brings about the need for extensive strengthening to enable the integration of additional renewable power plants in the province. The projects below have been proposed to achieve this and will be optimally phased with due consideration to preferred bidders, network requirements, and available resources.

Table 7-37: Northern Cape – projects required to facilitate IPP integration

TDP scheme	Project name
Garona Strengthening Phase 2	Garona Substation first 500 MVA 400/132 kV transformation (loop-in and out of Nieuwehoop-Ferrum 400 kV Line)
Garona 275/132 kV Transformer Upgrade	Upgrade of Garona 125 MVA 275/132 kV transformer with 500 MVA 275/132 kV unit
Upington Strengthening	Aries-Upington first 400 kV Line
Gamma Strengthening	Gamma first 500 MVA 400/132 kV transformation (loop-in and out of Hydra-Droërivier 400 kV Line)
Aggeneis Strengthening Phase 1	Aggeneis first 500 MVA 400/132 kV transformation
Helios Strengthening Phase 2	Helios second 500 MVA 400/132 kV transformer
Aries-Hydra 400 kV Corridor Strengthening	Hydra-Kronos second 400 kV Line
	Aries-Kronos second 400 kV Line
Hydra B 400/132 kV Substation	New Hydra B 400/132 kV Substation (loop-in loop-out of the Hydra - Perseus 400 kV Line)
Korana 400/132 kV Substation	New Korana 400/132 kV Substation (loop-in loop-out of Aries-Aggeneis 400 kV Line)
Gamma Strengthening Phase 2	Gamma second 500 MVA 400/132 kV transformer
Gamma 765/400 kV Transformation	Gamma 2000 MVA 765/400 kV transformer
Kronos IPP Transformation Phase 3	Kronos third 500 MVA 400/132 kV transformer
Paulputs Third Transformer	Paulputs first 500 MVA 400/132 kV transformer
Gromis IPP Transformation	Gromis first 400/132 kV 500 MVA transformation
Gromis-Nama-Groeipunt 400 kV Line	Gromis-Nama 400 kV Line
	Groeipunt-Nama 400 kV Line
Groeipunt 400/132 kV Transformation	Groeipunt 500 MVA 400/132kV transformer
	Aggeneis-Groeipunt 400 kV Line
Kimberley Strengthening Phase 3 (Ferrum-Mookodi-Hermes Corridor)	Ferrum-Mookodi second 400 kV Line (via Umtu site)
	Hermes (later Selemo)-Mookodi first 400 kV Line
Boundary 400 kV Strengthening (Kimberley Strengthening Phase 4)	Establishment of 400 kV yard and 500 MVA 400/132 kV transformer at Boundary Substation
	Construction of Beta-Boundary 400 kV Line

TDP scheme	Project name
Hydra B Strengthening Phase 2	Hydra B second 500MVA 400/132kV transformer
	Loop-in loop-out of the second Hydra-Perseus 400 kV Line at Hydra B
Aries Strengthening Phase 1	Aries first 500 MVA 400/132 kV transformation
Paulputs 400 kV Strengthening Phase 2	Aries-Kokerboom 400 kV Line loop-in loop-out-Paulputs Substation
Aries - Aggeneis second 400 kV Line	Aries-Aggeneis second 400 kV Line
Cape Corridor Phase 4	Gamma-Perseus second 765 kV Line
	Perseus-Zeus 765 kV Line
Upington Strengthening	Upington third 500 MVA 400/132 kV transformer
Gamma Strengthening Phase 3	Gamma third 500 MVA 400/132 kV transformer
Hydra B Strengthening Phase 3	Hydra B third 500MVA 400/132 kV transformer
Boundary-Ferrum 400 kV Line (Kimberley Strengthening Phase 4)	Boundary-Ferrum 400 kV Line
Cape Corridor Phase 5	Establish 765 kV at Aries Substation and Umtu Substation site
	First Aries 2000 MVA 765/400 kV transformer
	First Aries-Umtu 765 kV Line
	First Mercury-Umtu 765 kV Line
Umtu 400 kV Shunt Compensation	Umtu 3 x 100 Mvar 400 kV shunt capacitors
Boundary 400 kV Strengthening Phase 2 (Kimberley Strengthening Phase 4)	Boundary second 500 MVA 400/132 kV transformer
	Boundary-Beta second 400 kV Line
Cape Corridor Phase 6	Aries second 2000 MVA 765/400 kV transformer
	Aries-Umtu second 765 kV Line
	Umtu-Mercury second 765 kV Line
	Install series compensation on the Umtu-Mercury 765 kV Lines
	Zeus third 2000MVA 765/400 kV transformer
	Hydra second 2000 MVA 765/400 kV transformer

7.7.3.7 Provincial Summary

The future transmission network for the province is shown in Figure 7-23 below.

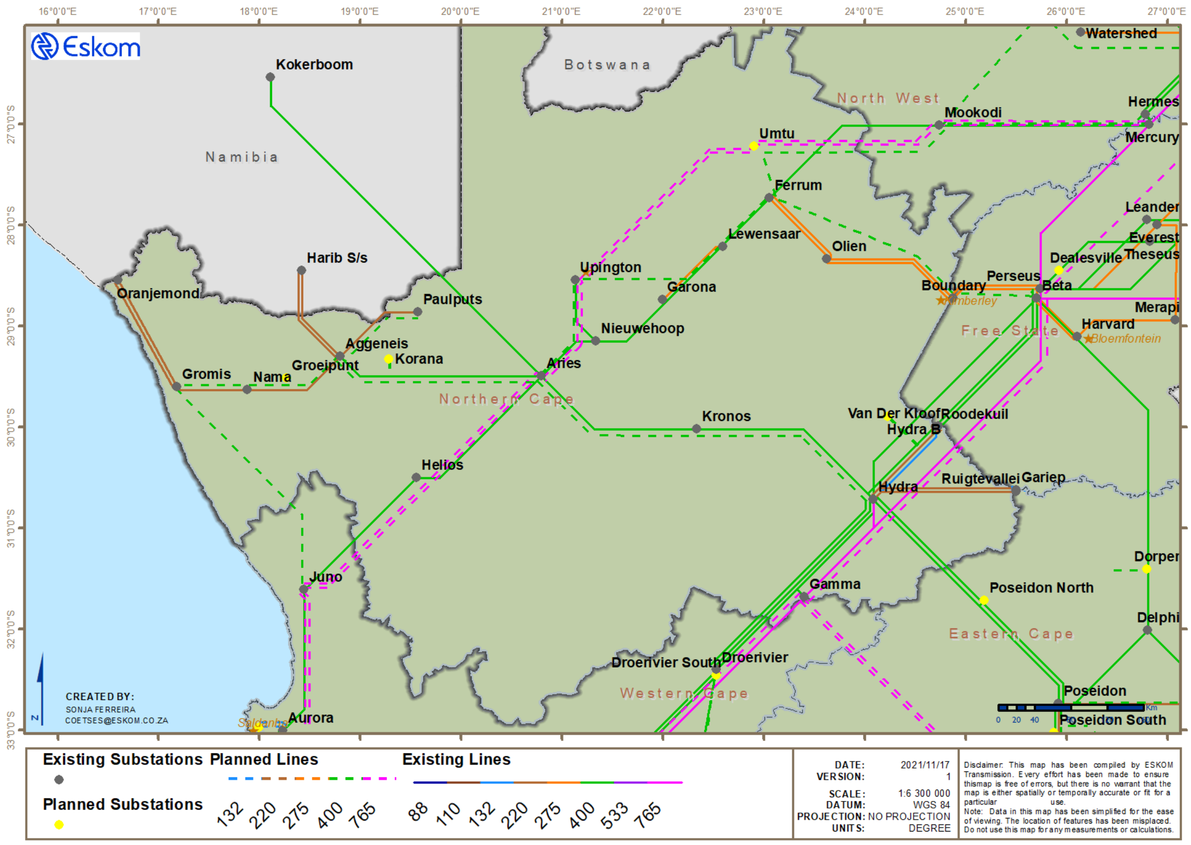


Figure 7-23: Future Northern Cape transmission network

A summary of all new major assets planned for this province is provided in Table 7-38 to Table 7-40.

Table 7-38: Planned transformers for the Northern Cape

Transformer type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
2 000 MVA 765/400/33 kV	-	-	1	2 000
500 MVA 400/132/22 kV	2	1 000	14	7 000
20 MVA 132/66/22 kV	1	20	-	-
315 MVA 220/132/22 kV	1	315	-	-
Grand total	**4**	**1 335**	**15**	**9 000**

Table 7-39: Planned overhead lines for the Northern Cape

Line voltage	2022 to 2026	2027 to 2031
	Total length (km)	Total length (km)
400 kV	285	1 660
765 kV	-	790
Grand total	**285**	**2 450**

Table 7-40: Planned reactors for the Northern Cape

Reactor type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	1	100	10	1 000
400 Mvar 765 kV	-	-	2	800
Grand total	**1**	**100**	**5**	**1 800**

7.8 NORTH WEST

North West, also known as the “Platinum Province”, is a neighbour to Botswana and shares borders with the Free State, Northern Cape, Limpopo, and Gauteng. Its capital is Mahikeng.

The province is enriched with mineral resources, such as gold, uranium, platinum, diamonds, and dimension stone, fertile and vast agriculture soil, a strong manufacturing sector, and plentiful opportunities in RE and agro-processing. North West is a key ferrochrome producer and is home to some of the largest platinum mines and refineries in the world.

In addition, both tourism activities and investment opportunities thrive in the province, which boasts, among others, internationally renowned tourism hubs. These include the Big Five Pilanesberg National Park (located in the crater of an extinct volcano), the Madikwe Game Reserve, the Sun City Entertainment and Golf Complex, the Taung Skull Heritage Site, and the ever-popular Hartbeespoort Dam.

The northern and western parts of the province have many sheep farms and cattle and game ranches. The eastern and southern parts are crop-growing regions that produce maize, sunflowers, tobacco, cotton, and citrus fruit.

The transmission network consists of a highly interconnected 400 kV network, with an underlying 275 kV network. The current North West transmission network is shown in Figure 7-24.

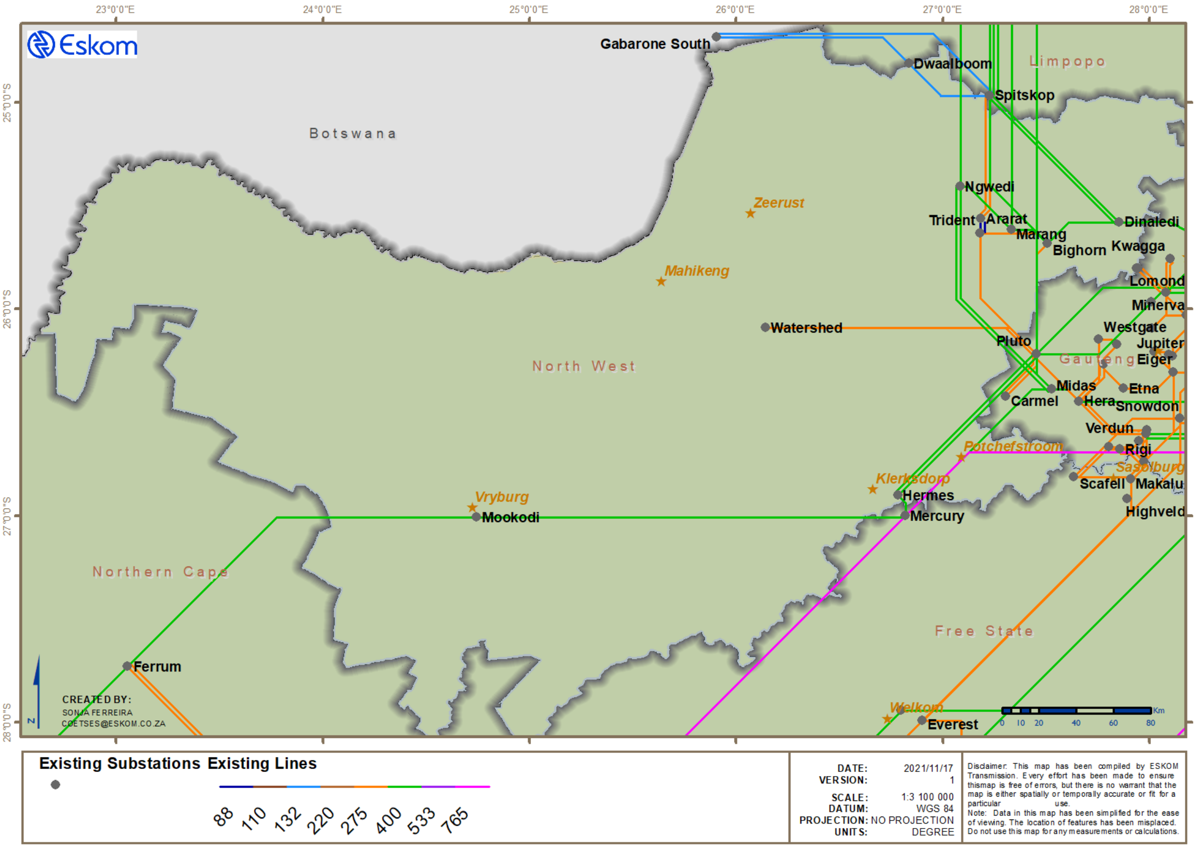


Figure 7-24: Current North West transmission network

7.8.1 Generation

There are no power stations located in North West. All the power consumed in this province is sourced from power stations in Limpopo and Mpumalanga. With the complete integration of the Medupi Power Station, most of the power of the province will be supplied from Limpopo.

The REIPPPP has provided a platform for the private sector to invest in RE connected to the South African power grid. Thus far, in North West, around 275 MW of RE plants have been committed for integration into the power grid from Rounds 1 to 4B, and 100% of these plants are PV. The approved projects in the REIPPP Programme are summarised in Table 7-41 below.

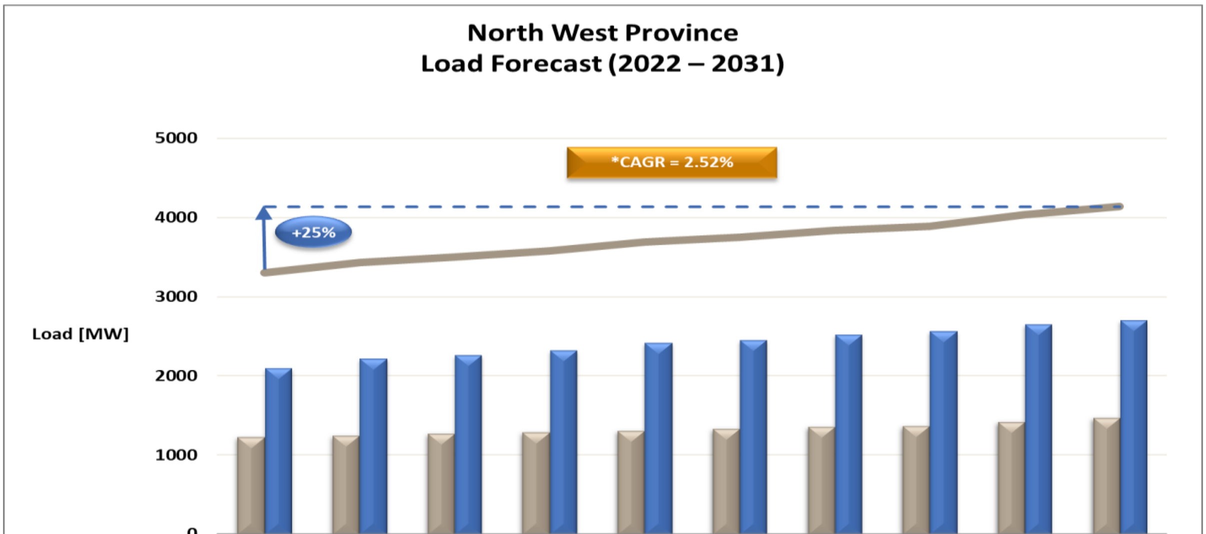
Table 7-41: Approved projects in North West under the REIPPPP

Programme and bid window	PV (MW)	Grand total (MW)
IPP RE 1	7	7
REIPP 4B	268	268
Grand total	**275**	**275**

7.8.2 Load Forecast

The mainstay of the economy of North West is mining, which generates more than half of the GDP of the province. There is an abundance of livestock farming, game ranches, and crop-growing regions that yield a variety of produce. The provincial economy is also driven by the entertainment and casino complex at Sun City and the Lost City.

This province comprises two CLNs, namely, Rustenburg and Carletonville. Rustenburg CLN consumes approximately 65% of the load, with Carletonville CLN making up the remaining 35% of the demand. The electricity demand peaked at around 3 200 MW in 2020, with the load in the province projected to increase to about 4 171 MW by the year 2031. The load forecast is shown in Figure 7-25.



	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Carletonville	1230	1241	1267	1289	1305	1328	1353	1361	1417	1470
Rustenburg	2103	2223	2264	2321	2420	2455	2521	2564	2654	2701
Provincial Peak	3307	3436	3502	3581	3695	3753	3842	3893	4037	4137
2031 Peak	4137	4137	4137	4137	4137	4137	4137	4137	4137	4137

Figure 7-25: North West load forecast

7.8.3 PLANNED PROJECTS

Several projects and schemes that aim to address the long-term requirements of the province have been initiated to accommodate the forecasted load and generation.

7.8.3.1 Major Schemes

The major TDP schemes planned in North West are as follows.

Rustenburg Strengthening Phase 1

The scheme refers to the extension of Bighorn Substation with the installation of 2 x 500 MVA 400/132 kV transformers. Major customers will be supplied at 132 kV, deloading the existing 275/88 kV transformers.

Rustenburg Strengthening Phase 2

Rustenburg Strengthening Phase 2 refers to the extension of Marang Substation, which will also introduce a 132 kV voltage level at the substation. The distribution network will be upgraded from 88 kV to 132 kV in conjunction with introducing a 132 kV line at Marang Substation. Due to the slump in the platinum sector in Rustenburg, this project has been deferred to outside the TDP period.

Rustenburg Strengthening Phase 3

The scheme is expected to address low voltages in the Rustenburg CLN under contingencies by installing shunt capacitors at Marang, Bighorn, and Dinaledi Substations. This will also improve the voltage profile and provide reactive power support in the Rustenburg CLN.

Watershed Strengthening

This scheme addresses substation transformation capacity and under-voltages on the 275 kV Watershed busbar under contingency conditions. In addition, the switching voltage step-change problems associated with the existing 88 kV shunt capacitors will be addressed. A new 250 MVA 275/132 kV transformer will be installed, together with 1 x 30 Mvar 88 kV and 2 x 30 Mvar 132 kV shunt capacitor banks.

Watershed (Backbone) Strengthening Phase 3

The current constraints at Watershed Substation are capacity shortages and poor voltage regulation, emanating from the N-1 of 275 kV infeeds to Watershed Substation. To address this network constraint, load will be shifted from Watershed Substation to both the Mookodi and Ngwedi Substations. Furthermore, a new Mahikeng Substation, designed at 400/132 kV, but operated at 400/88 kV, is planned approximately 60 km west of Watershed Substation. The substation infeeds will comprise the construction of the Pluto-Mahikeng 180 km 400 kV line and the Mookodi-Mahikeng 160 km 400 kV line.

7.8.3.2 New Substations

To address load growth around Mahikeng and improve reliability on the network, Mahikeng 400/132 kV Substation will be established in North West. It will also provide a possible strategic connection corridor to the SADC region through Botswana as the first point of entry.

7.8.3.3 New Lines

- The Medupi-Ngwedi first 765 kV line (energised at 400 kV) near Mogwase will provide the required level of reliability to fully evacuate the power from the Waterberg generation pool to North West.
- Pluto-Mahikeng 400 kV line
- Mookodi-Mahikeng 400 kV line

7.8.3.4 Reactive Power Compensation

Additional shunt capacitors are planned at the following locations:

- Watershed 88 kV 1 x 30 Mvar and 132 kV 2 x 30 Mvar
- Bighorn 132 kV 2 x 72 Mvar and 88 kV 3 x 48 Mvar
- Marang 88 kV 5 x 48 Mvar
- Dinaledi 132 kV 3 x 72 Mvar

7.8.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period between 2022 to 2031.

Table 7-42: North West – summary of projects and timelines

TDP scheme	Project name	Expected CO year
Watershed Strengthening	• Watershed Substation 132 kV reactive power compensation (2 x 30 Mvar capacitors)	March 2022
	• Watershed Substation 88 kV reactive power compensation (1 x 30 Mvar capacitors)	
	• Watershed 275/132 kV Substation 250 MVA 275/132 kV transformer	Commissioned in September 2021
Watershed (Backbone) Strengthening Phase 3	• Pluto-Mahikeng 400 kV line	2033
	• Mahikeng first 315 MVA 400/88 kV transformer	
	• Mookodi-Mahikeng 400 kV line	2034
	• Mahikeng second 315 MVA 400/88 kV transformer	
Kimberley Strengthening Phase 3	• Hermes-Mookodi (Vryburg) first 400 kV line	2030
Rustenburg Strengthening Phase 1	• Bighorn 2 x 500 MVA 400/132 kV transformer	2032
Rustenburg Strengthening Phase 2	• Marang Extension 2 x 500 MVA 400/132 kV Substation	2032
Rustenburg Strengthening Phase 3	• Bighorn reactive compensation (2 x 72 Mvar 132 kV and 3 x 48 Mvar 88 kV shunt capacitors) • Marang reactive compensation (5 x 48 Mvar 88 kV shunt capacitors) • Dinaledi reactive compensation (3 x 72 Mvar 132 kV shunt capacitors)	2028
Medupi Integration	• Medupi-Ngwedi first 765 kV line (energised at 400 kV)	2022
Trident-Ararat 2 x 88 kV Lines Capacity Uprate	• Trident-Ararat 2 x 88 kV lines capacity uprate	2026

7.8.3.6 Projects for Future Independent Power Producers

The following transmission network strengthening projects will be required to enable the connection of the IPPs located in the province within the current TDP period based on the generation assumptions.

Table 7-43: North West – projects required to facilitate IPP integration

Project name	Required CO year	Expected CO year
Mookodi 1 x 500 MVA 400/132 kV transformer	2025	2026
Mookodi reactive power compensation	2023	2026

7.8.3.7 Projects for Alternative Generation Scenario

No alternative generation scenario has been identified for North West.

7.8.3.8 Provincial Summary

The future transmission network for the province is shown in Figure 7-26 below. It is expected that the complete integration of Medupi Power Station will further enhance the major power corridors into Rustenburg and extend into the Carletonville supply zones.

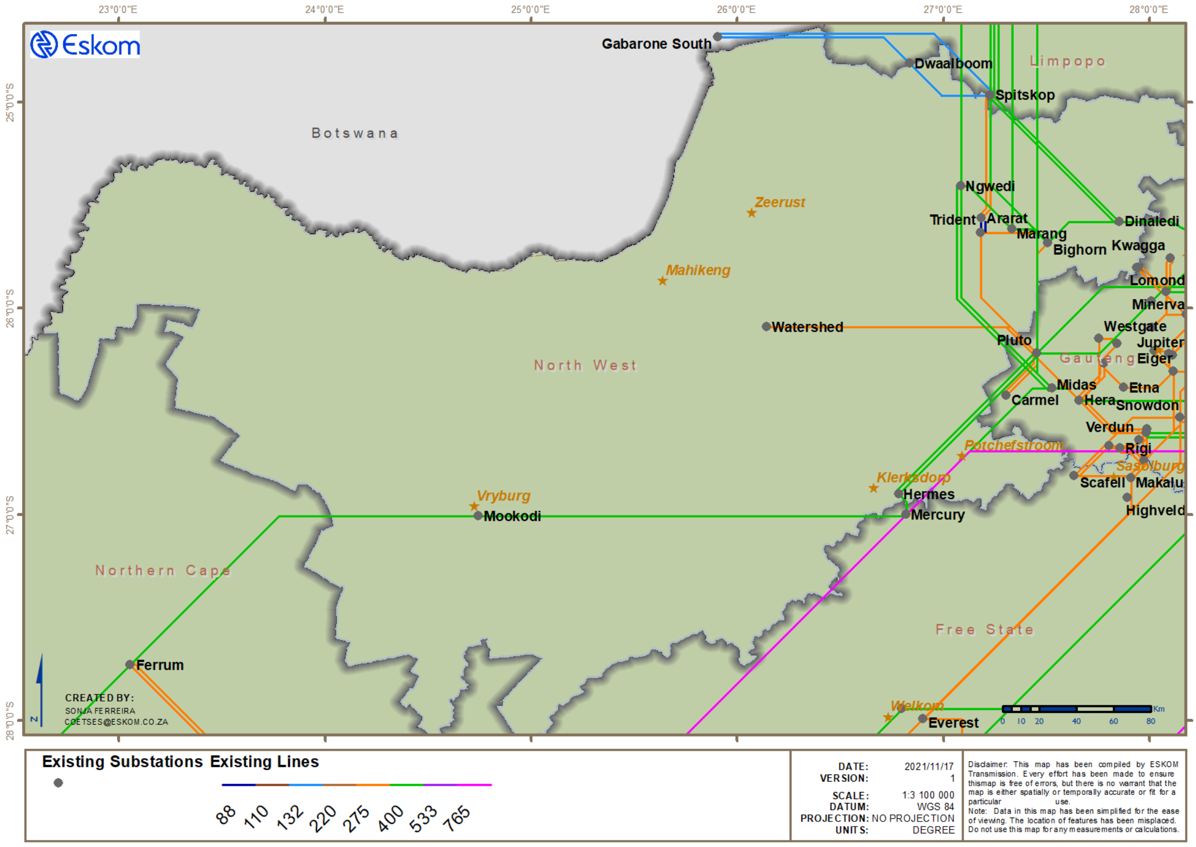


Figure 7-26: Future North West transmission network

A summary of all new major assets planned for this province is provided in Table 7-44 to Table 7-47. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-44: Planned transformers for North West

Transformer type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
500 MVA 400/132/22 kV	1	500	-	-
160 MVA 400/88/22 kV	2	320	-	-
315 MVA 400/88/22 kV	-	-	2	630
Grand total	**1**	**500**	**0**	**-**

Table 7-45: Planned overhead lines for North West

Line voltage	2022 to 2026	2027 to 2031
	Total length (km)	Total length (km)
400 kV	-	200
765 kV	-	50
Grand total	**-**	**250**

Table 7-46: Planned capacitor banks for North West

Capacitor type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
48 Mvar 88 kV	-	-	8	384
72 Mvar 132 kV	2	144	-	-
Grand total	**2**	**144**	**8**	**384**

Table 7-47: Planned reactors for North West

Reactor type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	-	-	4	400
Grand total	**-**	**-**	**4**	**400**

7.9 WESTERN CAPE

The Western Cape is situated in the south-western part of South Africa and has Cape Town as its capital. The provincial economy is mainly driven by tourism, financial services, business services, real estate, agriculture, and the manufacturing sector. Cape Town is the economic hub of the province, with a robust clothing and textile industry that provides significant employment opportunities in the province. The provincial load peaked at around 3 800 MW in 2021, and it is expected to increase to about 4 800 MW by 2031.

Cape Town

The Western Cape region of South Africa is also noted for its abundance of wind resources, making it one of South Africa's ideal locations for wind energy projects, a number of which are already in operation. To date, 689 MW of RE plants have been integrated into the Western Cape, one of which is Sere Wind Farm. This 100 MW Eskom wind generating facility was completed in January 2015. There has also been considerable interest in gas and oil imports, as well as in gas generation.

The Western Cape transmission network consists mostly of 400 kV lines. It stretches over 550 km from Gamma Substation (near Victoria West) to Philippi Substation (near Mitchells Plain). The current transmission network is shown in Figure 7-27.

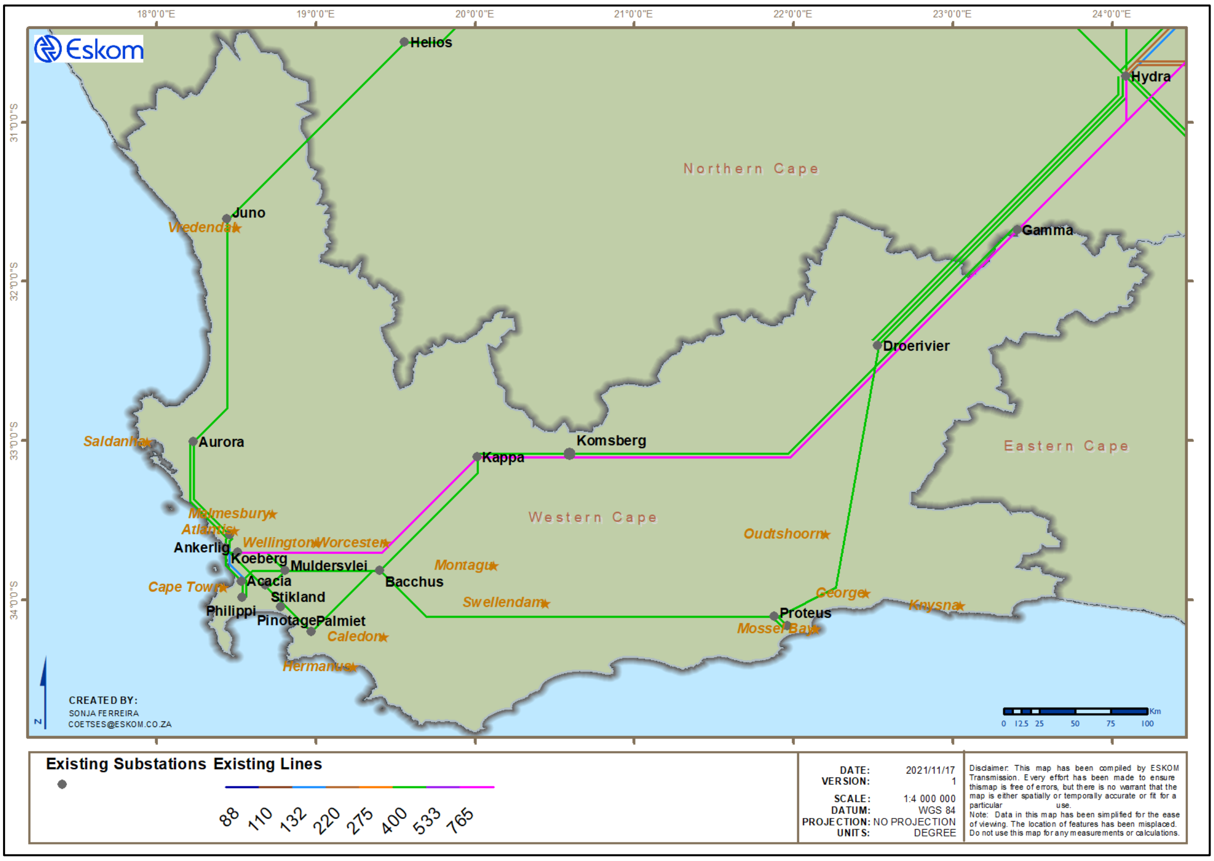


Figure 7-27: Current Western Cape transmission network

7.9.1 Generation

Koeberg Power Station is the only baseload power station situated locally in the Western Cape. There are also four Eskom peaking plants in the Western Cape, consisting of pumped-storage and gas turbine generation, which help to meet the demand in the Western Cape and the national grid during generation shortages. These are the Palmiet Pumped-Storage Scheme, the Ankerlig and Gourikwa OCGT Stations, and the Acacia Gas Turbine Station. In addition, there are three City of Cape Town (CoCT)-owned peaking plants in Cape Town, which help to manage CoCT demand. These are the Steenbras Pumped-Storage Station and the Athlone and Roggebaai Gas Turbine Stations. The Western Cape has also benefited from RE generation due to its climate and proximity to the coastline.

Koeberg Power Station

Koeberg Power Station is situated at Duynefontein, 27 km north of Cape Town, on the Atlantic coast. Koeberg ensures a reliable supply of electricity to the Western Cape. It has operated safely and efficiently for 30 years and has a further active life of about 20 years. Koeberg

Power Station has a generating capacity of 1 860 MW (sent-out). The two units are rated at 970 MW each.

Koeberg Power Station

Acacia Power Station

Acacia Power Station forms part of the peaking group of power stations and consists of 3 x 57 MW gas turbine engines at an installed capacity of 171 MW. Acacia predominantly operates in synchronous condenser mode (SCO) to regulate the voltages in the area. In addition, it provides an off-site emergency supply to Koeberg Power Station in accordance with the National Nuclear Regulator licencing requirement.

Ankerlig and Gourikwa Power Stations

The OCGTs were built to meet the rapidly increasing demand for peaking power on the Eskom grid. The gas turbine engines are similar to those used in the aviation industry and use liquid fuel (diesel). Some of the units have been fitted with dual-fuel burners in anticipation of conversion to CCGT. In addition to their generating capabilities, some of the units at these two power stations are also used to regulate network voltages when running in SCO.

Ankerlig Power Station is located in Atlantis in the Western Cape and has an installed capacity of 1 350 MW (9 x 150 MW). Gourikwa Power Station is located in Mossel Bay and has an installed capacity of 750 MW (5 x 150 MW).

Palmiet Pumped-Storage Scheme

Palmiet Pumped-Storage Scheme is a joint venture between Eskom and the Department of Water Affairs and Forestry (DWAF). It is situated in the ecologically sensitive Kogelberg Nature Reserve in the Western Cape, near Grabouw.

The power station delivers 400 MW (2 x 200 MW) of peak power into the Eskom national grid and carries out a frequency and voltage regulating role. It is also part of an inter-catchment water transfer project supplying water to Cape Town.

Water flows from an upper reservoir to the machines located in an underground power station for generating purposes. The water is collected in a lower reservoir and pumped back to the upper reservoir during off-peak periods.

Steenbras Pumped-Storage Scheme

Steenbras Dam is an earth-fill type of dam located on the Steenbras River in the Hottentots-Holland Mountains, high above Gordon’s Bay, near Cape Town. In 1979, the Steenbras Dam became part of the first pumped-storage scheme in the country to supplement Cape Town’s electricity supply during periods of peak demand.

Steenbras Pumped-Storage Scheme is a CoCT generating facility. It consists of 4 x 45 MW units and is integrated into the CoCT network.

Athlone and Roggebaai Power Stations

Athlone and Roggebaai Power Stations are two gas turbine stations, which are owned and operated by the CoCT. They are used to generate electricity over much shorter periods, as they use much more expensive fuel (aviation Jet-A1).

Athlone Power Station is located at the site of the demolished Athlone Coal-Fired Power Station along the N2 highway near Pinelands and has an installed capacity of 36 MW. Roggebaai Power Station is situated at the V&A Waterfront and has an installed capacity of 42 MW.

Both power stations are used for reducing the peak load of the CoCT, but can also be used to supply local loads during emergencies.

Klipheuwel Wind Energy Demonstration Facility

Klipheuwel Wind Energy Demonstration Facility is an Eskom wind generating facility completed in February 2003 and has a capacity of 3,16 MW, comprising three wind turbines (660 kW, 1,75 MW, and 750 kW). It is located around 50 km north of Cape Town in Durbanville.

Since the commercial operation of the facility, the plant has reached the end of its useful life, and Eskom has decommissioned this demonstration facility. One of the turbines will be used for practical training at the South African Renewable Energy Technology Centre (SARETEC) situated in Bellville, Cape Town. The remainder of the wind farm (that is, the land and the two Vestas wind turbines) will be disposed of following Eskom's commercial processes.

Darling Wind Power

The Darling Wind Power generating facility is a Department of Energy demonstrator site that was completed in 2008 and has a capacity of 5,2 MW. It is located 70 km north of Cape Town, between Darling and Yzerfontein on the West Coast of South Africa.

Sere Wind Farm

Sere Wind Farm is an Eskom wind generating facility that was completed in January 2015 and has a capacity of 100 MW. It is located north-west of Vredendal in Skaapvlei, approximately 300 km north of Cape Town.

Sere Wind Farm

Renewable Energy Independent Power Producers

The REIPPPP and the RMIPPPP have resulted in 1 456 MW of IPP generation being procured in the Western Cape, with 589 MW in commercial operation, as shown in Table 7-48.

Table 7-48: Commissioned and approved projects in the Western Cape under the REIPPPP (BW1 to BW4B) and RMIPPPP

Bid window	Name of project	Type	MW	Transmission substation	Commercial operation
1	Dassiesklip Wind Energy Facility	Wind	26	Bacchus	May 2014
	Hopefield Wind Farm	Wind	65	Aurora	Feb. 2014
	SlimSun Swartland Solar Park	PV	5	Aurora	Aug. 2015
	Touwsrivier Project	PV	36	Bacchus	Dec. 2014
2	Gouda Wind Facility	Wind	135	Muldersvlei	Aug. 2015
	West Coast 1	Wind	90	Aurora	June 2015
	Aurora-Rietvlei Solar Power	PV	9	Aurora	Dec. 2014
	Vredendal Solar Park	PV	9	Juno	July 2014
3	Electra Capital (Pty) Ltd	PV	75	Aurora	Sept. 2015
4B	Perdekraal East	Wind	107	Kappa	Oct. 2020
	Excelsior Wind	Wind	32	Bacchus	Aug. 2020

Bid window	Name of project	Type	MW	Transmission substation	Commercial operation
4	Karusa Wind Farm	Wind	140	Komsberg	Under construction
	Roggeveld	Wind	140	Komsberg	
4B	Soetwater Wind Farm	Wind	139	Komsberg	
RMIPP	Karpowership SA Saldanha	Gas	320	Aurora	
	Oya Energy Hybrid Facility	Hybrid	128	Kappa	

7.9.2 Load Forecast

The Western Cape comprises three CLNs, namely, Peninsula, Outeniqua, and West Coast. The Peninsula CLN is the main load centre in the province, consuming approximately 67% of the load. Outeniqua and West Coast CLNs make up the remaining 33% of the demand in the province.

The past strong residential, commercial, and light industrial load growths in the Peninsula CLN are expected to continue for a number of years. Some areas of interest are the area around Philippi and Mitchells Plain, where higher-density residential properties are being developed on existing residential land. The growth of streaming-based entertainment and digitisation has also prompted a growing demand for data centres in the Peninsula CLN. The July 2020 explosion incident at the Astron Energy refinery, supplied from Acacia Substation, has resulted in a temporary shutdown of the plant.

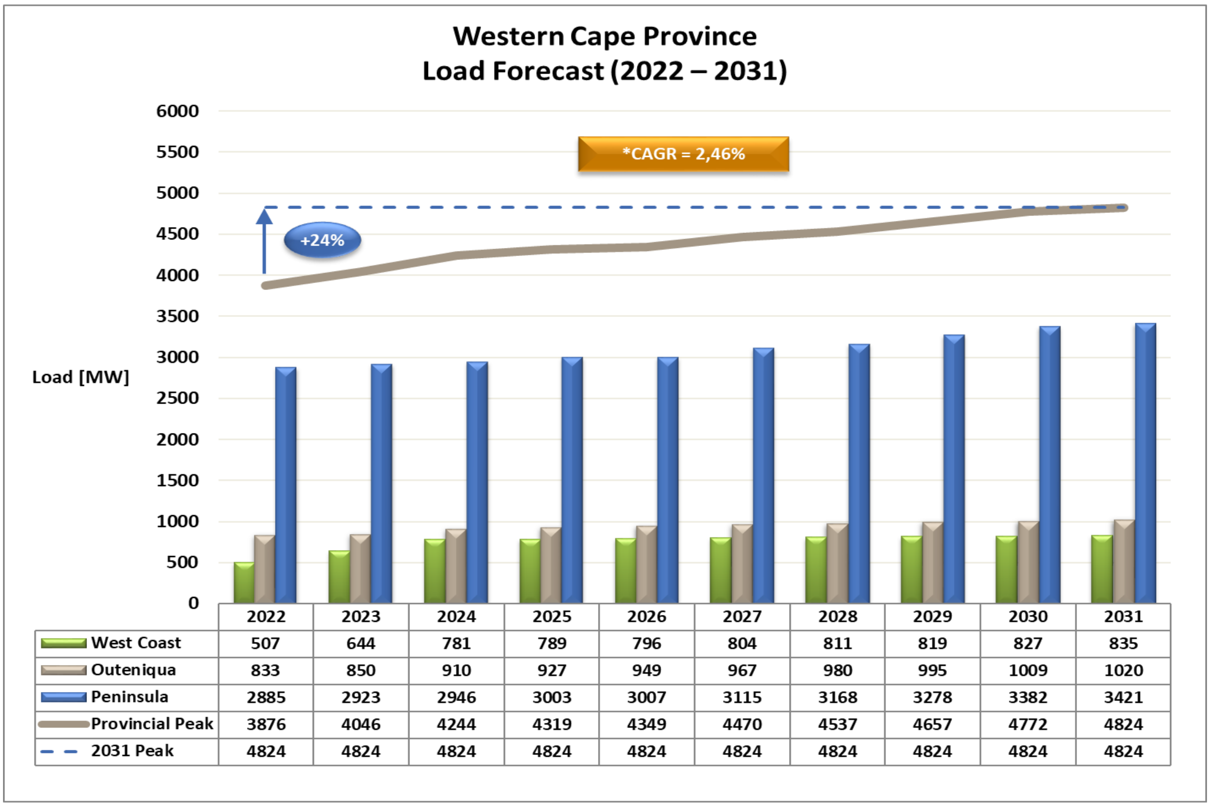
Substantial load growth in the West Coast area is expected due to the Saldanha Bay Industrial Development Zone (IDZ). The 120 ha area, which was designated as an IDZ in October 2013, is well situated to service the marine oil and gas markets on the African continent.

The Western Cape Department of Economic Development is also investigating the feasibility of establishing a floating liquefied natural gas terminal for the importation of gas. In November 2019, Saldanha Steel announced that it would be halting production and reducing operations to a state of care and maintenance.

Saldanha Steel

Demand in the Outeniqua CLN is due to natural load growth and residential developments. In October 2020, PetroSA forecasted that its Mossel Bay plant would run out of gas by December 2020 and, subsequently, applied for a reduction in its notified maximum demand (NMD) at Proteus Substation.

The load forecast for the three CLNs and the Western Cape is shown in Figure 7-28. The load is forecasted to grow from 3 876 MW in 2022 to 4 824 MW in 2031. This translates to ~1 000 MW (24%) over the next 10 years, with a compound annual growth rate (CAGR) of 2,5%.



	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
West Coast	507	644	781	789	796	804	811	819	827	835
Outeniqua	833	850	910	927	949	967	980	995	1009	1020
Peninsula	2885	2923	2946	3003	3007	3115	3168	3278	3382	3421
Provincial Peak	3876	4046	4244	4319	4349	4470	4537	4657	4772	4824
2031 Peak	4824	4824	4824	4824	4824	4824	4824	4824	4824	4824

Figure 7-28: Load forecast for the Western Cape

7.9.3 Planned Projects

Several projects and schemes that aim to address the long-term requirements of the province have been initiated to supply the forecasted load and integrate the additional generation.

Local strengthening is planned across the province, mainly comprising additional transformers at existing substations and new 400/132 kV substations with associated line infrastructure. Further strengthening of the recently completed 765 kV Cape corridor is also envisaged.

7.9.3.1 Major Schemes

Cape Corridor Phase 4: Second Zeus-Sterrekus 765 kV Line

The deficit between local generation and load in the Greater Cape (the Western Cape, Eastern Cape, and Northern Cape) is offset by the generation pool in the Highveld via the Cape corridor.

The Cape corridor comprises high-voltage transmission lines originating from Zeus Substation (near Bethal) and Alpha Substation (near Standerton) in Mpumalanga to Hydra Substation (near De Aar) in the Northern Cape. It then extends into the Western Cape and terminates at Muldersvlei Substation (near Klapmuts) and Sterrekus Substation (near Melkbosstrand).

The OCGT power stations in the Western Cape assist this corridor during the peak. However, the planned duty cycle for the OCGTs and associated fuel costs of running these generators, especially when one Koeberg unit is off for refuelling, may not be able to cater for the growth.

Therefore, the Cape corridor has been strengthened, with the first 765 kV line comprising the following sections that were constructed and energised over several years:

- Zeus-Mercury and Mercury-Perseus in December 2012
- Hydra-Perseus in July 2013
- Perseus-Gamma and Hydra-Gamma in February 2014
- Gamma-Kappa in April 2015
- Kappa-Sterrekus in December 2016

The Aries-Nieuwehoop-Ferrum 400 kV line in the Northern Cape has provided a further improvement in overall power transfer capacity into the Greater Cape. Additional improvements will be brought about by the following strengthening projects in the Northern Cape:

- Juno-Gromis 400 kV line
- Aries SVC

This will result in Cape corridor adequacy until ~2026. Beyond 2026, the preferred strengthening to provide additional transfers into the Greater Cape is constructing a second 765 kV line.

7.9.3.2 New Substations

In the Peninsula CLN, load growth in the residential, commercial, and light industrial sectors will necessitate the introduction of the following 400/132 kV substations:

- Pinotage Substation near Somerset West (which was commissioned in July 2020)
- Asteria Substation near Bot River (Botrivier)
- Erica Substation between Philippi and Mitchells Plain

Pinotage Substation

In the Outeniqua CLN, load growth in the residential, tourism, and agricultural sectors will compel the introduction of two new 400/132 kV substations, namely:

- Agulhas Substation near Swellendam; and
- Narina Substation in the George area.

There are plans to establish an IDZ in Saldanha. To support this development, the new Bokkom 400/132 kV Substation will be integrated into the West Coast CLN near Langebaanweg.

7.9.3.3 New Lines

The Ankerlig-Sterrekus double-circuit 400 kV line, which was commissioned recently, will provide for some level of the required network reliability to evacuate the total power in the Koeberg and Ankerlig generation pool, especially under planned transmission line maintenance in the area. The existing second Koeberg-Acacia 400 kV line, which is currently operated at 132 kV, must also be energised at 400 kV in order to meet the required level of network reliability for the integration of power stations. This is expected to be commissioned when Koeberg off-site supply is relocated to Ankerlig.

A strategic EIA has been initiated for a Gourikwa-Narina and Narina-Droërivier 400 kV line to ensure that servitudes are acquired timeously to cater for additional gas generation projects that may originate in the Mossel Bay area as well as potential renewable generation projects towards Beaufort West.

All of the above projects will also allow for an increase in power output at the existing generating facilities such as Koeberg, Ankerlig, and Gourikwa Power Stations.

7.9.3.4 Reactive Power Compensation

To improve power transfer and system stability, series compensation has been used extensively in the network. Such installations exist throughout the Western Cape. However, some of the installations contain polychlorinated biphenyls (PCBs), and an Eskom directive requires that these be removed from the system in compliance with SANS 290 (the "Regulation to phase out the use of polychlorinated biphenyl (PCB) materials and polychlorinated biphenyl (PCB) contaminated materials"). The Juno 1 and Juno 2 series capacitors were decommissioned in December 2017, the Helios series capacitor was decommissioned in January 2019, and the Victoria 1 and 2 and Hydra series capacitors were decommissioned in October 2020.

With the establishment of 400/132 kV transformation at Komsberg, the Komsberg 2 series capacitor will remain as is without the need for downsizing or bypassing it. As a result of this, the Droërivier-Komsberg 400 kV line will be compensated at 88%. The Bacchus series capacitor will be bypassed by integrating the planned Agulhas Substation, and the Proteus series capacitor will be bypassed with the integration of the planned Narina Substation.

No additional reactive power compensation projects (capacitor banks and/or SVCs) are planned for the Western Cape for the period 2022 to 2031.

7.9.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period between 2022 to 2031.

Table 7-49: Western Cape – summary of projects and timelines

TDP scheme	Project name	Expected CO year
Koeberg Off-Site Supply at Ankerlig Power Station	• Establish Koeberg off-site supply at Ankerlig Power Station • Loop-in and -out of Koeberg-Dassenberg 132 kV line	2022
Koeberg 400 kV Busbar Reconfiguration and Transformers Upgrade	• Koeberg 400/132 kV Geographic Information System (GIS) Substation (first and second 400/132 kV 250 MVA transformers) • Reroute existing Koeberg 400 kV and 132 kV lines to the new substation	2029
Juno Substation Transformation Upgrade	• Replace the 2 x 40 MVA 132/66 kV units with 2 x 80 MVA units	2026
	• Install an additional 20 MVA 66/22 kV unit with the existing 10 MVA unit	
Second Koeberg-Acacia 400 kV Line	• Second Koeberg-Acacia 400 kV line	2026
Erica Substation	• Erica Substation (first and second 400/132 kV 500 MVA transformers) • Philippi-Erica 400 kV line	2028
	• Loop-in and -out Pinotage-Stikland 400 kV line	2029
Philippi Substation Extension	• Establish 400 kV busbar • Install third 400/132 kV 500 MVA transformer as a hot standby	2026
Agulhas Substation	• Agulhas Substation (first and second 400/132 kV 500 MVA transformers) • Loop-in and -out Bacchus-Proteus 400 kV line • Bypass Bacchus series capacitor bank	2028
Saldanha Bay Network Strengthening (Phase 1)	• At Aurora Substation, replace one of the existing 400/132 kV 250 MVA units with a 500 MVA unit as part of the refurbishment	2026
	• Strategically acquire a substation site in the Saldanha Bay area • Construct 2 x 400 kV lines (operated at 132 kV) from Aurora Substation to the new Distribution Blouwater (Anyskop) Substation	2028
Saldanha Bay Network Strengthening (Phase 2)	• Bokkom Substation (first and second 400/132 kV 500 MVA transformers) • Loop-in Ankerlig-Aurora 1 400 kV line	Deferred
Asteria Substation	• Asteria Substation (first and second 400/132 kV 500 MVA transformers) • Loop-in and -out Palmiet-Bacchus 400 kV line	2025

<table>
<tr><th>TDP scheme</th><th>Project name</th><th>Expected CO year</th></tr>
<tr><td>Narina Substation</td><td>Narina Substation (first and second 400/132 kV 500 MVA transformers)
Loop-in and -out Droërivier-Proteus 400 kV line
Bypass Proteus series capacitor bank</td><td>2031</td></tr>
<tr><td>Cape Corridor Phase 3B: Series Compensation on the 765 kV Lines between Perseus and Kappa</td><td>Series compensation on the 765 kV lines between Perseus and Kappa</td><td>Deferred</td></tr>
<tr><td rowspan="3">Cape Corridor Phase 4: Second Zeus-Sterrekus 765 kV Line</td><td>Zeus-Perseus first 765 kV line
Series compensation at Zeus and Perseus
Perseus-Gamma second 765 kV line</td><td>2031</td></tr>
<tr><td>Gamma-Kappa second 765 kV line</td><td>2031</td></tr>
<tr><td>Kappa-Sterrekus second 765 kV line
Loop-in and -out Koeberg-Stikland 400 kV line into Sterrekus
Sterrekus Substation second 765/400 kV 2 000 MVA transformer</td><td>2031</td></tr>
<tr><td>Droërivier-Narina-Gourikwa 400 kV Line</td><td>Droërivier-Narina-Gourikwa 400 kV line
Bypass series capacitor at Narina</td><td>Strategic EIA</td></tr>
<tr><td>Windmill Transmission Substation</td><td>Windmill 400/132 kV Substation (first and second 500 MVA transformers)
Loop-in and -out Bacchus-Muldersvlei 400 kV line</td><td>Deferred</td></tr>
<tr><td>Stikland Third 400/132 kV 500 MVA Transformer</td><td>Install third 400/132 kV 500 MVA transformer and FCLRs</td><td>Deferred</td></tr>
<tr><td>Pinotage Third 400/132 kV Transformer</td><td>Install third 400/132 kV transformer at Pinotage Substation</td><td>Pre-concept</td></tr>
</table>

7.9.3.6 Projects for Future IPPs

A Gas-to-Power Programme has been initiated by the DMRE to achieve a total of up to 3 000 MW of capacity from gas-fired power generation facilities in the vicinity of Coega (Ngqura), Richards Bay, and Saldanha Bay.

The integration for up to 1 GW of gas generation in Saldanha Bay connects the gas power station to the future Bokkom Substation at 400 kV. To increase the capacity to 1,5 GW, the following additional infrastructure will be required:

- Turn-in of the second Aurora-Ankerlig 400 kV line into Bokkom Substation

- Construction of a second Aurora-Juno 400 kV line

There are two designated RE development zones in the Western Cape, namely, Overberg and Komsberg. These were identified as areas with high potential for RE generation and were gazetted as such in February 2016. The Western Cape is, therefore, a prime location for wind generation as well as for some PV generation.

As a result of this, certain generation assumptions were made for RE generation in the Western Cape by 2031, namely:

- 6 600 MW of wind and PV generation (in addition to what has already been commissioned or given preferred bidder status); and
- 375 MW of battery storage.

The transmission infrastructure required to integrate this renewable generation in the Western Cape is as follows:

- Establishment of Komsberg Substation near Sutherland (which was commissioned in June 2021)
- Installation of 400/132 kV transformation at Kappa Substation (which was completed in August 2020)
- Additional 400/132 kV transformers at Droërivier, Juno, Kappa, and Komsberg Substations
- Establishment of Koring Substation near Merweville by turning in the Droërivier-Komsberg 1 400 kV line
- Establishment of a "Droërivier B" Substation 60 km south of Beaufort West by turning in the Droërivier-Proteus 1 400 kV line

With the integration of large-scale renewable generation and gas generation in Saldanha Bay over the next 10 years, the Western Cape will become a net exporter of power, with as much as 9 GW of excess generation during peak load. The actual amount is dependent on the utilisation of the OCGTs at Ankerlig and Gourikwa Powers Stations and the availability of both units at Koeberg Power Station.

Additional infrastructure will, therefore, be required to evacuate the excess power from the Western Cape and to deliver it to the load centres in the central and eastern parts of the country. For the most part, the line routes lie within the recently gazetted electricity grid infrastructure (EGI) corridors.

A first and second 765 kV line from Mercury Substation to Sterrekus Substation (via Umtu, Aries, and Juno Substations) will need to be established. The strengthening can be summarised as:

- 2 x Mercury-Sterrekus 765 kV lines with series compensation between Umtu and Mercury Substations; and
- 765/400 kV transformation at Juno, Aries, and Umtu Substations.

Additional 765/400 kV transformation will also be required at Zeus, Hydra, and Sterrekus Substations.

The projects required for the integration of future IPPs are summarised in Table 7-50.

Table 7-50: Western Cape – projects required to facilitate IPP integration

Scheme	Project name
Droërivier Third 400/132 kV Transformer	• Install third 400/132 kV 500 MVA transformer at Droërivier Substation • Establish new 132 kV busbar
Kappa Second 400/132 kV Transformer	• Install second 400/132 kV 500 MVA transformer at Kappa Substation
Komsberg Second and Third 400/132 kV Transformers	• Install second and third 400/132 kV 500 MVA transformers at Komsberg Substation
Zeus Substation Third 765/400 kV Transformer	• Install third 765/400 kV 2 000 MVA transformer at Zeus Substation
Hydra Substation Second 765/400 kV Transformer	• Install second 765/400 kV 2 000 MVA transformer at Hydra Substation
Koring Substation	• Koring 400/132 kV Substation (first 500 MVA transformer) • Loop-in and -out Droërivier-Komsberg 1 400 kV line • Install 100 Mvar 400 kV busbar reactor
Droërivier B Substation	• Droërivier B 400/132 kV Substation (first 500 MVA transformer) • Loop-in and -out Droërivier-Proteus 1 400 kV line

Scheme	Project name
Cape Corridor Phase 5: Third 765 kV Line	• Establish Umtu (Hotazel) 765/400 kV Substation • Umtu 765/400 kV (first 2 000 MVA transformer) • Aries ext. 765/400 kV (first 2 000 MVA transformer) • Juno ext. 765/400 kV (first 2 000 MVA transformer) • Mercury-Umtu first 765 kV line • Umtu-Aries first 765 kV line • Aries-Juno first 765 kV line • Juno-Sterrekus first 765 kV line
Cape Corridor Phase 6	• Mercury-Umtu second 765 kV line • Umtu-Aries second 765 kV line • Umtu Substation second 765/400 kV 2 000 MVA transformer • Install 50% series compensation on Mercury-Umtu 765 kV lines • Aries-Juno second 765 kV line • Juno-Sterrekus second 765 kV line • Aries Substation second 765/400 kV 2 000 MVA transformer • Juno Substation second 765/400 kV 2 000 MVA transformer • Sterrekus Substation third 765/400 kV 2 000 MVA transformer
Saldanha Bay 1,5 GW Gas Integration	• Turn-in of the second Aurora-Ankerlig 400 kV line • Second Aurora-Juno 400 kV line

7.9.3.7 Provincial Summary

The future Western Cape transmission network is shown in Figure 7-29.

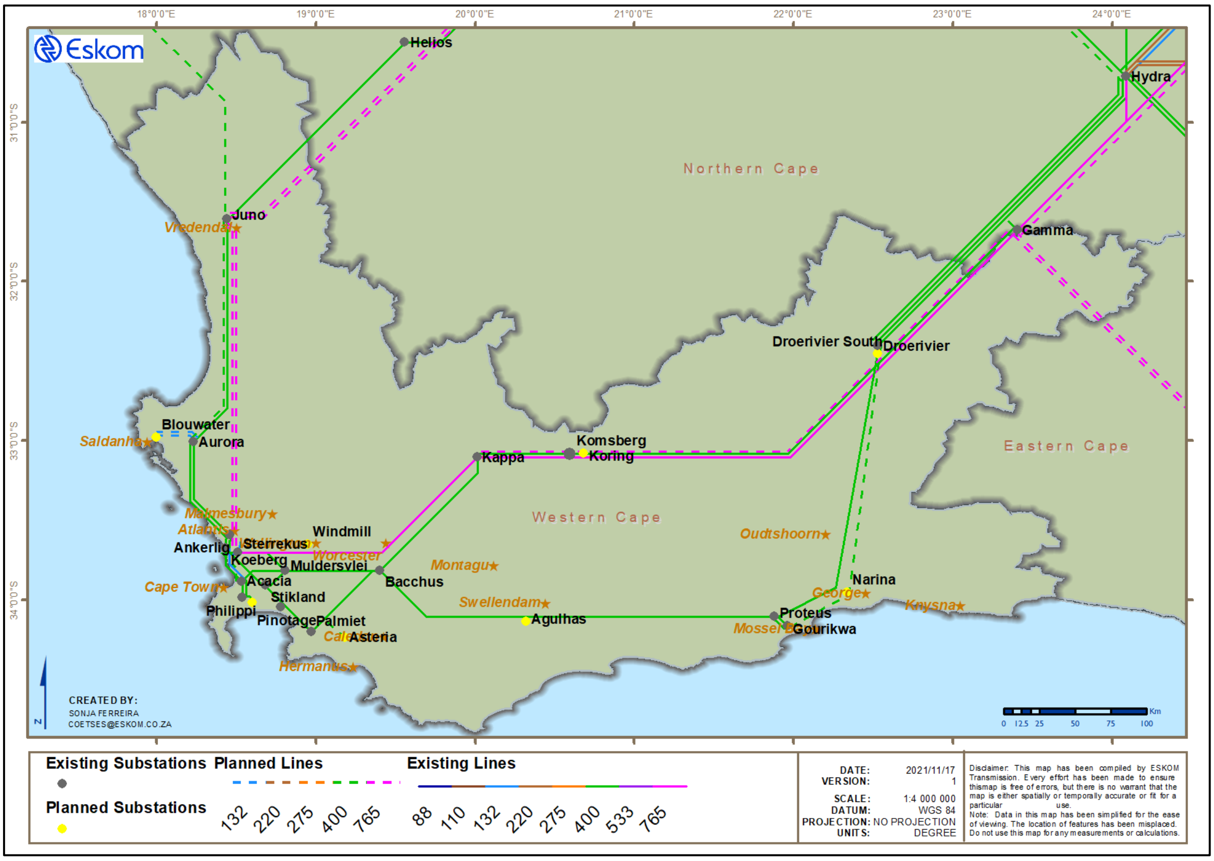


Figure 7-29: Future Western Cape transmission network

A summary of all new major assets planned for this province is provided in Table 7-51 to Table 7-54.

Table 7-51: Planned transformers for the Western Cape

Transformer type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
2 000 MVA 765/400/33 kV	-	-	1	2 000
500 MVA 400/132/22 kV	6	3 000	11	5 500
20 MVA 66/22 kV	1	20	-	-
80 MVA 132/66/22 kV	2	160	-	-
Grand total	**9**	**3 180**	**12**	**7 500**

Table 7-52: Planned overhead lines for the Western Cape

Line voltage	2022 to 2026	2027 to 2031
	Total length (km)	Total length (km)
400 kV	2	270
765 kV	-	430
Grand total	**2**	**700**

Table 7-53: Planned capacitor banks for the Western Cape

Capacitor type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	-	-	1	100
Grand total	**-**	**-**	**2**	**100**

Table 7-54: Planned reactors for the Western Cape

Reactor type	2022 to 2026		2027 to 2031	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
400 Mvar 765 kV	-	-	-	-
Grand total	**-**	**-**	**-**	**-**

8 LAND AND RIGHTS

8.1 INTRODUCTION

The Eskom Transmission Division (or its successor in title) requires the national grid to be expanded in order to comply with the requirements of the Grid Code and to meet the growing demand for electricity supply and new generation evacuation. This new chapter has been included in this version of the TDP in order to provide an overview of the process for securing land rights for the expansion programme.

The expansion of the grid requires that new substations and transmission power lines and associated infrastructure be erected as well as that existing infrastructure be expanded. Before any expansion can occur, land rights must be acquired. The Land and Rights mandate is to provide the required and strategic acquisition of land, influence the legislative framework, ensure stakeholder engagement, make applications for environmental authorisation (EA) in terms of the National Environmental Management Act (NEMA) and its Regulations, acquire permits and licences as statutorily required, and legally secure land rights for the infrastructure expansion programme.

8.2 GRID PLANNING – LAND AND RIGHTS PROJECT INITIATION

Land and Rights receives requests from Transmission Grid Planning to legally secure land rights for the development of new power lines and substations as well as the expansion of existing infrastructure. These requests are based on the Grid Planning load forecasts, new Eskom generation connection requirements, and customer applications for grid connections (load and generation).

A project is initiated to define a study area and to identify viable alternative sites for substation development and viable alternative corridors/routes for the power lines required.

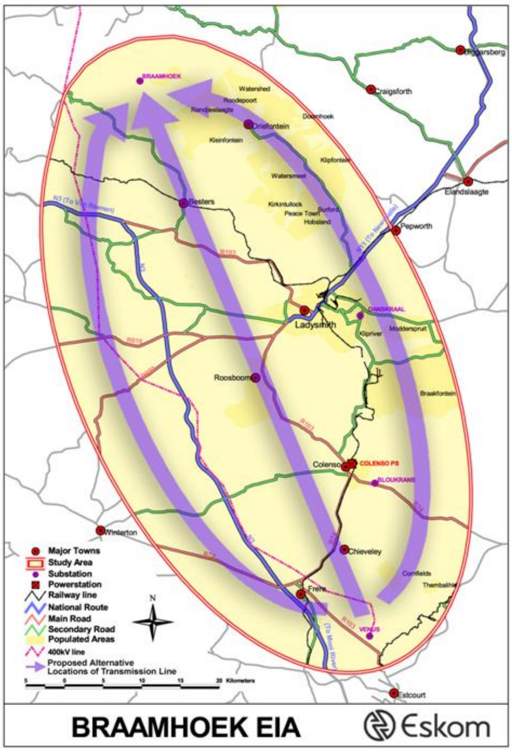


Figure 8-1: Identifying a study area for a new project

Viability is determined in terms of environmental impact, land use, constructability, costs, and the types of towers to be used.

The land required for the development of a 400 kV substation is normally 600 m x 600 m in size, whereas a 765 kV substation can be up to 1 000 m x 800 m in size. Servitude widths required for the various types of power line towers to be used are determined with regard to the extent of land required on the ground for the tower footing, as well as the land use in question. These widths can be increased in forestry areas.

Figure 8-2: Different types of towers that can be used for transmission power lines

A standard 400 kV servitude would be 55 m wide, while a standard 765 kV servitude would be 80 m. Various types of agricultural activities are allowed within power line servitudes; however, activities that may encroach on safety clearances and the electrical safety operation of the power lines are not permitted.

The various steps in acquiring the land rights for a proposed new development are discussed in the sections below.

8.3 ENVIRONMENTAL IMPACT ASSESSMENT

8.3.1 STANDARD PROCEDURES

In terms of the National Environmental Management Act 107 of 1998, certain activities that may have a detrimental impact on the environment have been identified. These activities are listed and gazetted in the Regulations promulgated in terms of the Act. The construction of electrical grid infrastructure (EGI) is such a listed activity that requires an authorisation for implementation in terms of the Regulations. It, therefore, requires that an application be lodged with the Minister of the Department of Forestry, Fisheries, and the Environment (DFFE) for authorisation of the implementation.

To execute such an application, Eskom is required to appoint an environmental assessment practitioner (EAP) who, on behalf of Eskom, must lodge such an application. The EAP must be independent and have no interest in the project other than financial compensation for work done to submit the application and comply with the requirements of the Act and Regulations.

The size of the infrastructure to be developed determines the level of study and the type of application to be lodged with the DFFE. Two distinct processes have been identified in terms of the Regulations: a basic assessment for projects below 275 kV and a scoping/EIA process for projects of 275 kV and above. Due to the size of transmission infrastructure of 275 kV and above, transmission falls within the listed activity requiring the full scoping/EIA process, which is lengthy and requires various stages of public participation, as shown in Figure 8-3 below.

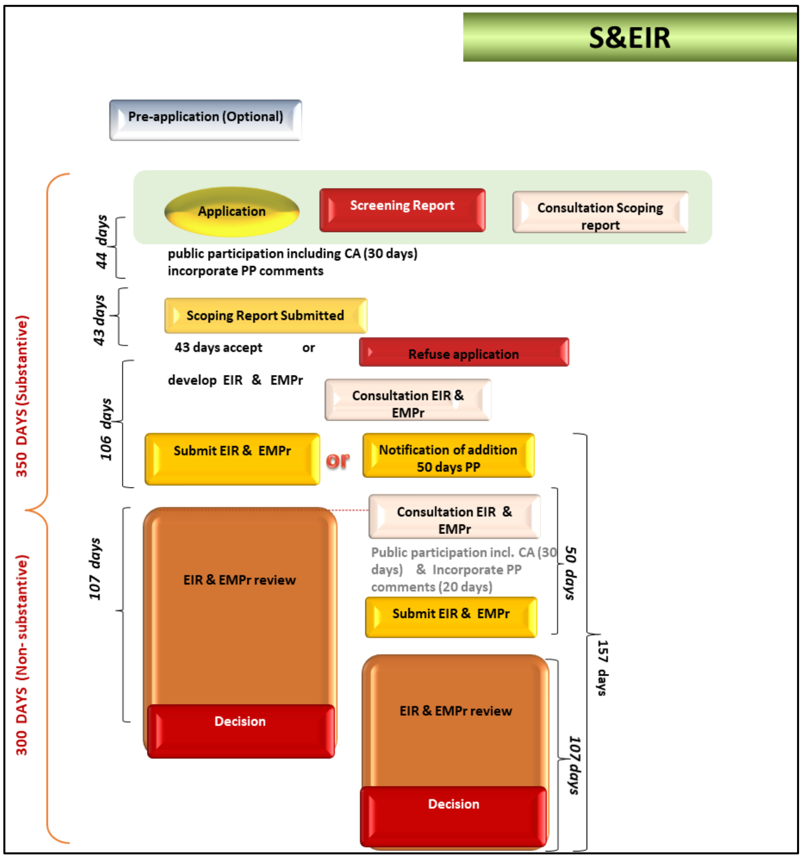


Figure 8-3: Scoping/EIA process for transmission infrastructure

8.3.2 EGI PROCEDURE

Recently, after completion of the strategic environmental assessment (SEA) for EGI in 2016, SEA corridors and renewable energy development zones were identified in which a slightly different process for obtaining and securing land rights for EGI development was identified and promulgated in terms of GN R. 113, dated 16 February 2018. This new process applies to applications where more than 50% of the development falls within the SEA corridors or

REDZs and requires applications based on a prenegotiated route and sites for EGI developments. The basic assessment (BA) process on a prenegotiated route can now be followed within the SEA corridors and REDZs for infrastructure of 275 kV and above to assist Transmission with the roll-out of EGI. The time frames for adjudication and environmental authorisation (EA) once the completed application has been submitted have also been shortened. This SEA on EGI infrastructure was needed and developed to improve the time frame in which EGI infrastructure can be developed to assist with the roll-out of the independent power producer (IPP) programme to include renewable energy in the energy mix of South Africa.

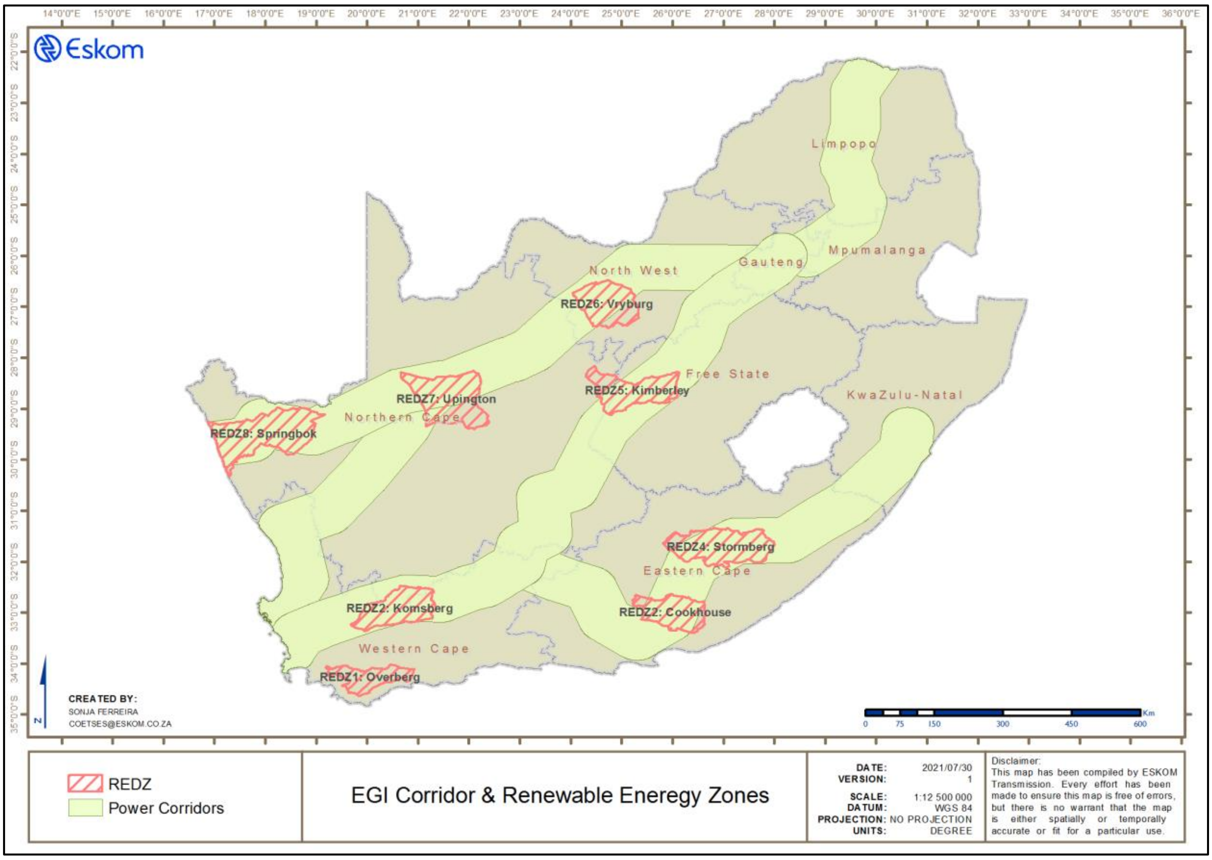


Figure 8-4 below shows the EGI corridors and REDZs promulgated in terms of GN R. 113 of 16 February 2018.

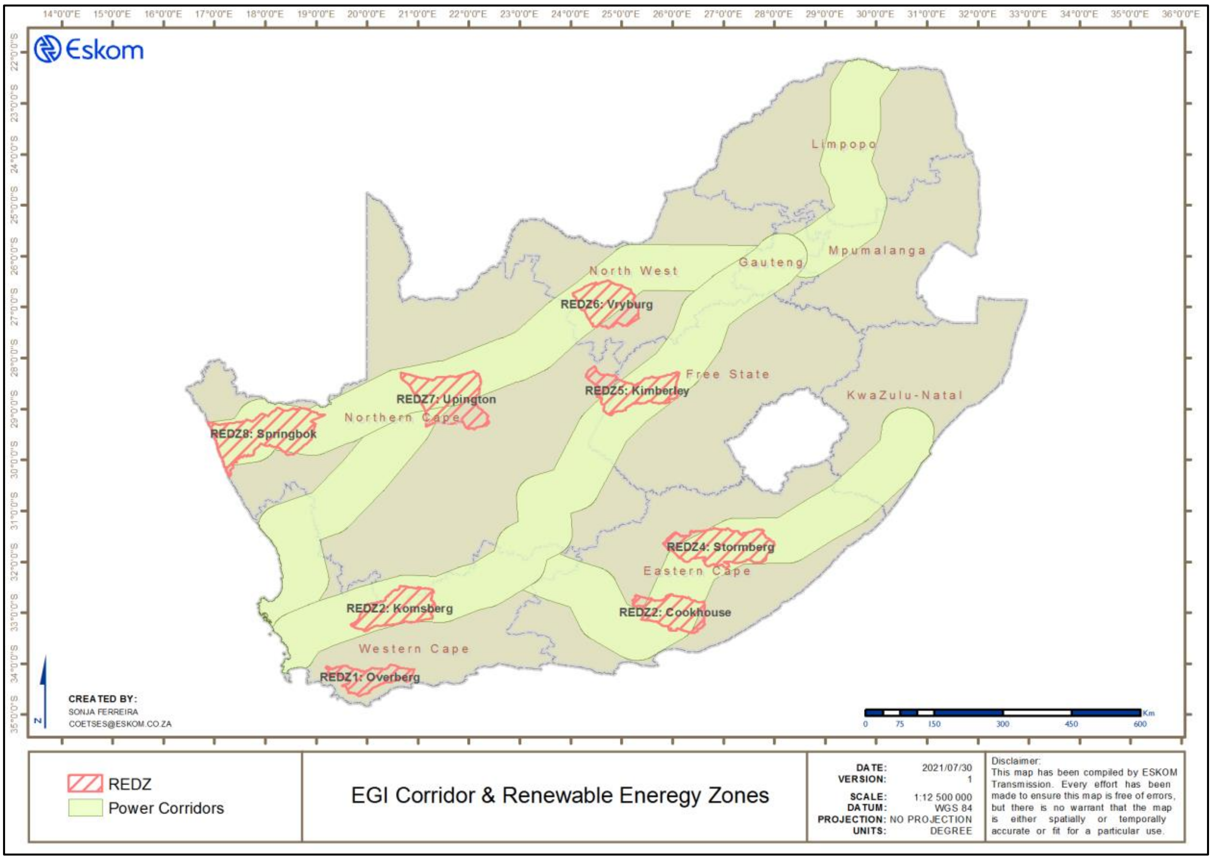


Figure 8-4: Original gazetted EGI corridors and REDZs

A second phase of the SEA completed in 2020 added additional areas to the SEA corridors as per GN R. 383 of 29 April 2021 as well as to the REDZs as per GN R. 145 dated 26 February 2021, as shown in Figure 8-5 and Figure 8-6 below. Within these areas, Land and Rights has adopted the following process:

- Identify feasible routes for power lines and sites for new substations using available screening tools developed by the DFFE as well as inputs from an appointed EAP and specialists.
- Carry out a screening process with public participation and specialist inputs.
- Compile a screening report based on which a viable route and site are identified.
- Acquire land rights on the preferred route and site.
- Apply for an EA using the BA process, including a basic assessment report (BAR), specialist studies, and public participation as required in terms of the NEMA Regulations.
- Obtain an EA and release it to the public for an appeals process.
- Apply for any required environmental permits.
- Hand over to Construction for execution.

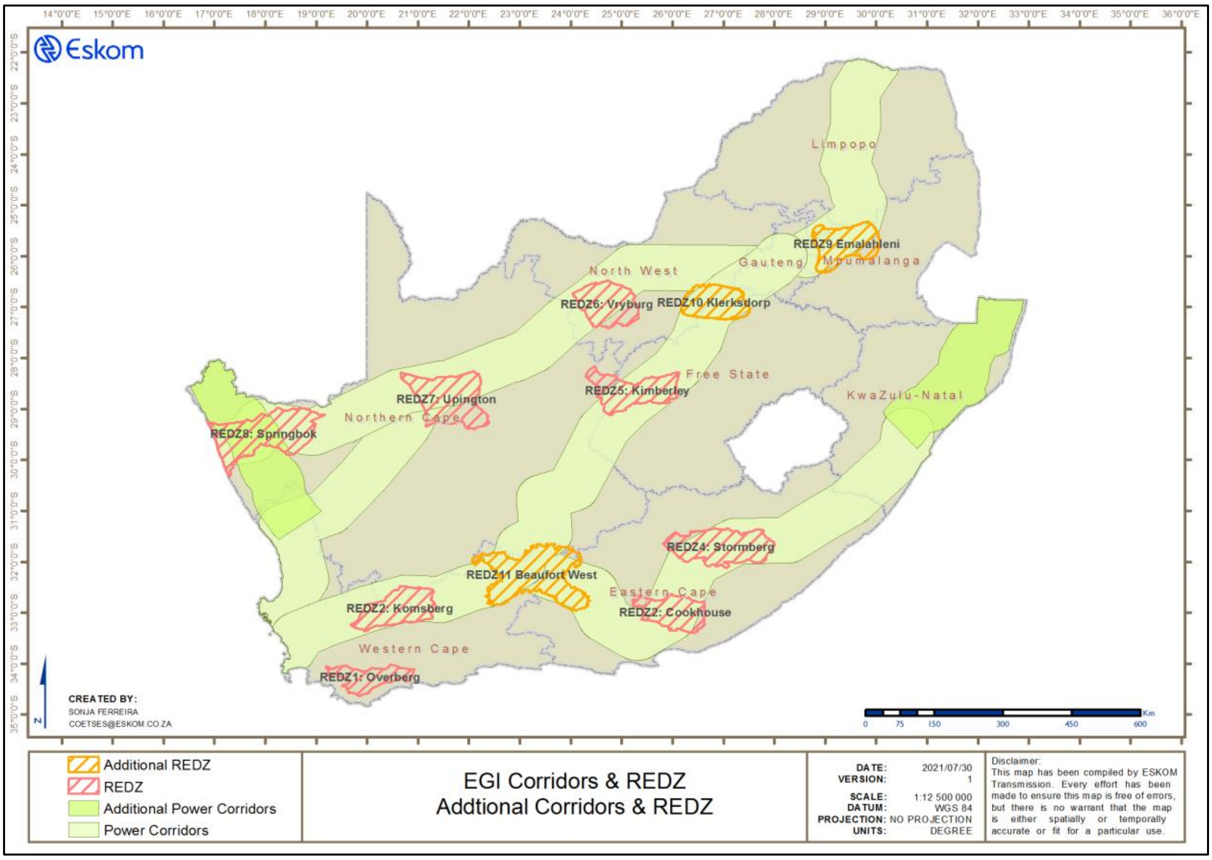


Figure 8-5: Expanded EGI corridors

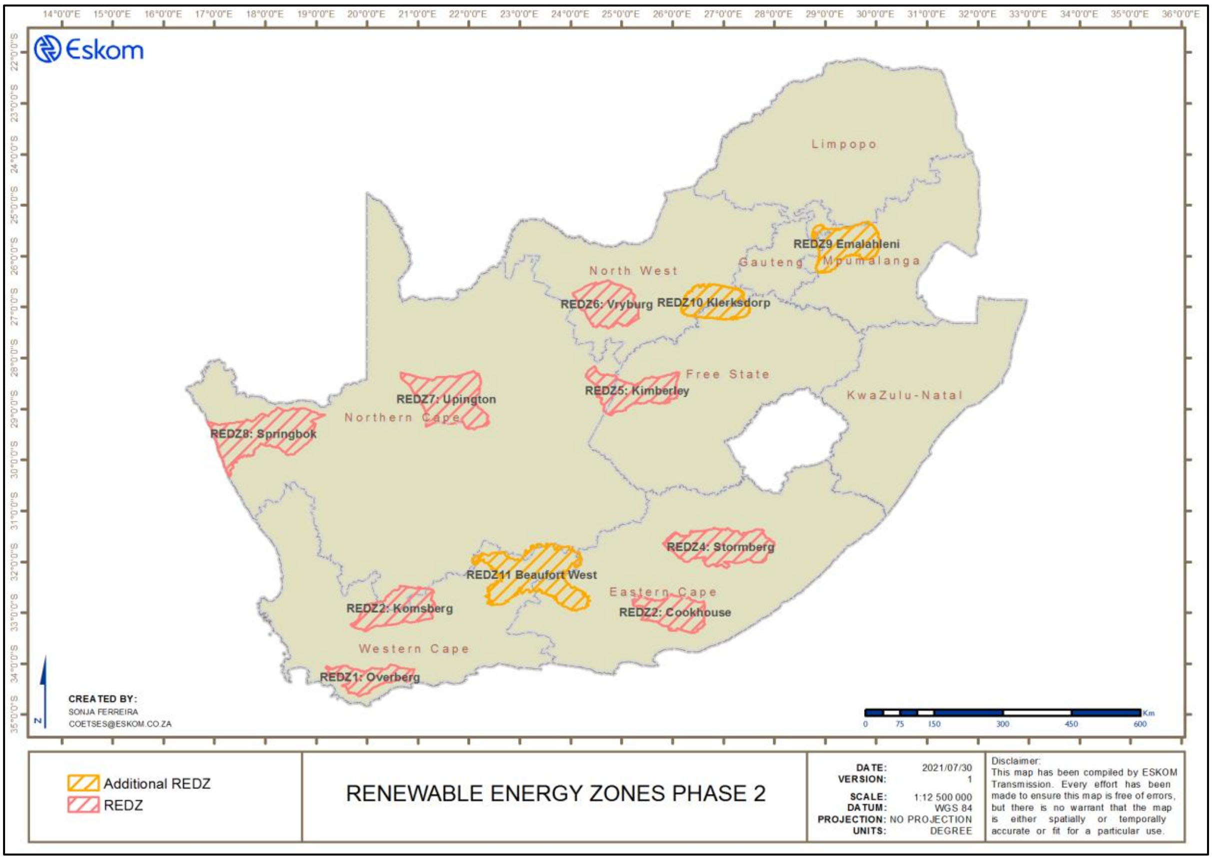


Figure 8-6: Additional REDZs identified

The basic assessment process that can be followed based on a prenegotiated route/site within the EGI corridors and REDZs is depicted below in Figure 8-7. The decision-making time frame of the competent authority (CA) is 57 days.

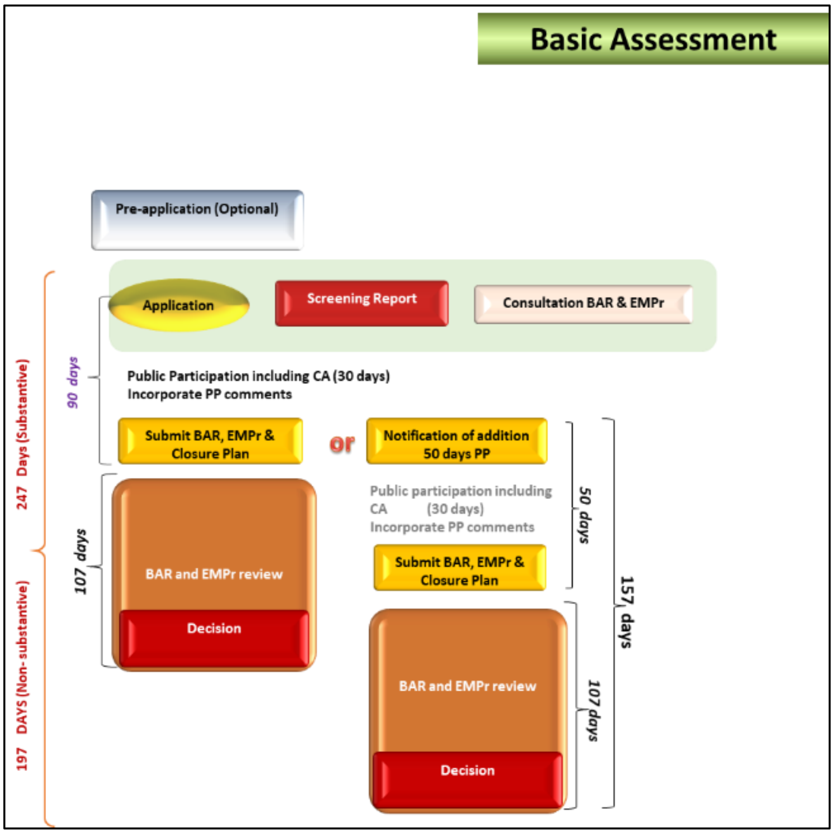


Figure 8-7: Basic assessment process

8.4 LAND RIGHTS AND SERVITUDE ACQUISITION

Once a final route or site has been identified, the process of servitude acquisition of that route or site can commence. The process of obtaining the property rights follows a detailed procedure as described in the following sections.

On receipt of environmental authorisation (EA) of the final route or the final screening report in terms of the EGI process, the Eskom Land and Rights (L&R) negotiator should prepare all documentation required to expedite the acquisition in accordance with the Land and Rights Compensation and Acquisition Standard. Eskom acquires servitude rights over property through negotiations with the registered owner for the purpose of establishing a power line, and in the case of a substation, either a servitude can be registered or Eskom will acquire the land.

8.4.1 VALUATION OF THE PROPERTY

An independent valuer is appointed to do a strip valuation of the land within the proposed line route or site valuation of the identified site. In the case of strip valuation, the value is determined taking land use into account. In the case of site-specific valuation, the value is determined based on the market-related value of land. This guides the negotiator in the process of preparing the necessary documentation, which includes a monetary offer for the servitude or site.

8.4.2 LAND AND SERVITUDE ACQUISITION PROCESS

The negotiator should verify the cadastral boundaries of all the properties affected by the proposed route/site and obtain the necessary compilations and surveyor-general (SG) diagrams. The negotiator then determines registered land ownership of each affected parcel of property. The negotiator requests the preparation of option sketches for each parcel of property indicating the position of the proposed new transmission line/substation servitude from a spatial information officer and adds this to the standard option agreement form to acquire a servitude for a power line/substation site. The negotiator approaches the landowner, and the process of negotiations is executed in line with the Land and Rights Compensation and Acquisition Standard. In this process, it is of utmost importance to build a climate of trust with the landowner and for landowners to understand that the development is in the national interest.

In most cases, a second valuation (site-specific before and after valuation) is required to determine the compensation, taking the impact of the power line/substation site on the specific property and land use into consideration. In such an instance, a new offer to acquire the servitude/site is then prepared, approved, and offered to the landowner. In the event that no negotiated settlement for land rights can be reached with the affected landowner, Eskom may consider using the process of expropriation in terms of legislation to acquire the servitude/site.

8.4.3 REGISTRATION AND SURVEY

Following the signature of the option agreement to acquire a servitude or site by the registered owners, the process of registration of the land right in the name of Eskom against every affected title deed is effected by the deeds office. Eskom appoints a conveyancer who registers the servitude against the affected property title deeds. After registration of the land right in the deeds office, the landowner is paid compensation for the servitude/site.

The negotiator then provides the surveyor with the final route and co-ordinates of each bend point to obtain the lidar data for the route. This process runs concurrently with the registration process and commences once 90% of the line has been negotiated.

The surveyor appoints a lidar supplier to conduct an airborne laser survey of the route/site and forwards the data to Eskom on completion. The spatial information officer digitises and maps all features identified by the lidar survey on the route/site map, which will be used for the design of the power line/substation site.

A walk-down is conducted to verify all the information captured on the route map/site map. The route/site map is then handed over to Line/Substation Design to prepare the designs of the power line/substation site.

Once the designs have been finalised, an updated environmental management programme (EMPr) is prepared, taking all special features and special conditions of landowners as noted during the negotiation process into consideration. The EAP and specialists assist with the finalisation of the EMPr for construction. During the EMPr walk-down, all required environmental permits are identified, after which applications are made to the relevant authorities.

The last phase of the project is to prepare the package for handover to Construction.

8.5 HANDOVER TO CONSTRUCTION

The final phase of the Land and Rights process is to prepare a handover package for construction. This may include the following activities, depending on the specific project:

- Obtain a water use licence (WUL) or general authorisation (GA) for construction activities within the regulated area as defined by the Water Act.
- Obtain vegetation removal permits for indigenous and protected species along the route or on the site.
- Obtain statutory approvals for all crossing of other infrastructure such as roads, rail, pipelines, and telecommunication infrastructure where the power lines cross such infrastructure.

Once all documentation has been finalised and collated in the files, including the EA and EMPr, a formal handover meeting takes place with the Transmission Project Delivery Department to hand the power line servitudes/site over for construction.

It is a statutory requirement that, as part of the construction process, the Transmission Project Delivery Department executing the construction process appoint an environmental control officer (ECO) to monitor compliance with all conditions of the EA and EMPr, WUL/GA, and vegetation removal permits on site, as well as general environmental monitoring, to ensure that all proposed mitigation measures to rehabilitate disturbed areas are implemented. The ECO reports to the DFFE on a monthly basis, carries out compliance monitoring, and also conducts a final compliance audit once construction has been completed and the line has been handed to the Transmission Grid for operation.

Site audits are also done by Land and Rights during the construction period to check compliance with legislation and permits.

8.6 CONCLUSION

The Land and Rights process to secure land rights for the development of new infrastructure or expansion projects is a complex process but is extremely important in the context of delivering supply to the whole country to support economic development. The process is dependent on well-executed processes to ensure that the best environmental solution is identified. Good relations with all affected landowners, who are also Eskom customers in many cases, are of the utmost importance, and establishing a trust relationship between all parties should be at the forefront of all stakeholder interactions. The Land and Rights process is extremely important in realising a network of power lines and substations that can support the initiative of ensuring electricity for all and ensuring that all generated power in the country can be distributed to customers reliant on electricity for their operations and daily consumption.

9 CAPITAL EXPENDITURE PLAN

The total capital expenditure for Transmission amounts to approximately R178 billion and is summarised in Table 9-1.

Almost R144 billion is required for capacity expansion projects to address the following:

- The increase in generation capacity of ~30 GW in the next 10 years, mainly in areas with limited network capacity, which will require a significant number of investments in transmission networks to connect and develop new corridors and substations to dispatch the power to the load centres
- Completing the integration of the Medupi and Kusile Power Stations, as well as the Bid Window 4 and 4B IPPs, resolving network reliability constraints (N-1), connecting customers, ensuring that safety and regulatory compliances are met, and sustaining the network for future growth and the acquisition of servitudes

Further to the above, an amount of R34 billion in capital expenditure is required for:

- refurbishments that address the life extension of existing assets to ensure network sustainability;
- production equipment;
- refurbishment of ageing telecommunications infrastructure; and
- strategic spares for emergency works.

Table 9-1: Capital expenditure per category of projects for FY2022 to FY2031

Transmission capex categories	R million
Capacity expansion:	140 854
IRP 2019 – integration of RE	*69 393*
Network strengthening	*71 460*
Refurbishment	21 453
Production equipment	959
EIA and servitude	3 276
Telecoms	5 753
Strategic spares	6 148
Total	**178 443**

10 CONCLUSION

The major change from the 2020 TDP to this revision of the 2021 TDP is associated with assumptions about the country's future generation capacity. The 2020 TDP was informed by the IRP 2019, which was gazetted in November 2019. The IRP does not have capacities per annum beyond 2030; as a result, values for 2031 were assumed for wind, PV, and gas. Wind and PV assumed values were the same as those given in the IRP for 2030, and 3 GW of gas was added for flexibility.

Apart from the expedited new generation capacity expectations in accordance with the IRP 2019, the development plans for the 2021 TDP remain aligned with those of the 2020 TDP regarding the plans for the integration of IPPs from Bid Windows 4 and 4B of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), network reliability enhancements, demand growth, safety, and regulatory network strengthening requirements.

The bulk of the changes in this version of the TDP can be attributed to two main factors, namely, capital constraints and protracted land acquisition processes. These factors necessitated the reprioritisation of the plan based on need criticality assessment and readiness to implement.

The result is a realistic and achievable development plan, within the constraints imposed by funding, site and servitude acquisition, and supplier and construction lead times. The slower rate of completion of projects regrettably increases the overall risk to the network. However, this risk can be managed, as the N-1 criterion refers to the strict deterministic level, which assumes that an N-1 contingency event will happen at the time of the peak loading. In reality, there is a limited chance of this happening, and operational mitigation plans will cater for most of the events until the required projects have been completed. Some of the risk mitigation measures under consideration are higher reliance on the utilisation of strategic spares, the use of capacitors in the short term for voltage support, and the implementation of emergency preparedness plans. The affected customers are consulted when compiling or reviewing emergency preparedness plans to ensure that emergencies necessitating load reduction are managed in a way that minimises the impact on individual customers and South Africa at large.

Robust and efficient planning requires the timely exchange of credible information between stakeholders. In particular, stakeholders are requested to note that spatial data and development timeline information are critical for the effective planning and development of the transmission network. Transmission infrastructure is generally on the critical path of connecting and integrating large new loads and generation due to the long lead times for securing corridors. It is recommended that, for planning purposes, developers should allow for at least seven years' lead time for new corridors. It should also be noted that, in the EIA process, there are increasing objections from landowners and other stakeholders to proposed power line routes, which may further prolong the time to implement projects. The EIA and environmental approval process is prescribed by law. Changes to the relevant environmental legislation can significantly affect lead times for new projects.

The transmission projects in this TDP will result in the overall network becoming Grid Code compliant, while catering for increased load growth and the integration of new generation, albeit at a later date than previously envisaged, mainly due to protracted land acquisition processes and funding constraints.

11 ACKNOWLEDGEMENTS

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Popi Melato	Chief Engineer Grid Planning	Reliability plans – Eastern Cape
Kabir Singh	Chief Engineer Grid Planning	Reliability plans – Mpumalanga
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Vishnu Naicker	Senior Consultant Engineer	Project development
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This document and the public forum presentation are available for download via the [Eskom website](#).

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