Eskom
National Transmission
Company South Africa ™

Transmission Development Plan (TDP)

2025 - 2034

FOREWORD BY GROUP EXECUTIVE

"As we embark on this journey, NTCSA's success will not be determined solely by the infrastructure we build or the systems we establish. It will depend equally on the relationships we foster, the talent we cultivate, and the innovation we embrace." – Segomoco Scheppers

It gives me great pleasure this year to present the 2024 Transmission Development Plan (TDP). As many of our stakeholders may recall, there was no TDP and associated public forum in 2023 since Eskom had applied for and was granted an exemption by the National Energy Regulator of South Africa (NERSA). This decision was made due to the ongoing development of the new Integrated Resource Plan (IRP) by the Department of Mineral Resources and Energy (DMRE). Additionally, the generation capacity assumptions outlined in the TDP 2022 extended beyond the IRP 2019 period, so no major changes were anticipated for the five-year planning horizon in transmission infrastructure. In place of the usual TDP public forum, we held a Transmission Development Plan Implementation Forum last year. This reflects our commitment to transparency and accountability. We value the opportunity to engage stakeholders in discussing progress and addressing the accelerated roll-out needed for South Africa's energy security and transition.

Before reflecting on this year's TDP, it is important to highlight that we are presenting it as the newly established National Transmission Company South Africa (NTCSA) — a four-month-old, independent, wholly-owned subsidiary of Eskom Holdings. With our board, we are now fully operational. It is broadly acknowledged that NTCSA's establishment represents a significant milestone in South Africa's Electricity Supply Industry (ESI), following a long, complex unbundling process involving collaboration with the government, lenders, and other key stakeholders.

As we embark on this new chapter for South Africa's ESI, NTCSA will play a pivotal role in maintaining and ensuring the reliability of the transmission network, expanding and modernising the network, and ensuring non-discriminatory access to all market participants. With the recent enactment of the Electricity Regulation Amendment Act (ERAA), NTCSA is not only fulfilling a legislative requirement but also enabling the rollout of critical transmission infrastructure to connect new generation capacity and secure South Africa's energy future. At the official launch of NTCSA on 7 October 2024 we shared our vision, which is to be a world-class enabler for a thriving power market benefiting people, the economy and the environment. This vision is anchored by four strategic objectives:

1. Delivering reliable and sustainable access to affordable power
2. Creating an inclusive and competitive electricity market
3. Ensuring a financially sustainable business
4. Achieving digital transformation for efficiency and effectiveness

These objectives are supported by strong relationships with key stakeholders, clear internal governance, world-class talent, and a high-performance culture.

Recap of TDP 2022

TDP 2022 projected the need for 53 GW of new generation capacity by 2032, with nearly 39 GW expected from renewable sources such as solar PV and wind. To deliver TDP 2022, approximately 14,200 km of extra-high-voltage transmission lines and 170 transformers, providing 105,000 MVA of capacity, were required. It gives me pleasure to report that, since the last TDP Forum, notable progress has been made.

- There are now 61 projects in the execution phase which will unlock approximately 30,000 MW of new generation connection capacity by 2030.
- Of these 61 projects, 31 projects are currently under construction and will deliver 1,445 km of transmission lines and 16,945 MVA of transformer capacity to enable the safe and reliable connection of nearly 16,000 MW of generation by 2028.
- The remaining 30 projects in the execution phase are in procurement and will enable nearly 14,000 MW of new generation connections by 2030.

NTCSA has also identified 47 priority projects that can be fast-tracked to accelerate TDP delivery. These projects are expected to unlock 37 GW of new generation capacity by FY2033. Notably, the number of projects in the definition phase—the last stage before execution—has increased from 5 in FY2022 to 22 in FY2023, emphasising our commitment to advancing these projects. I want to take this moment to thank the NTCSA team for their hard work and dedication in expediting the implementation of the TDP.

Delivering TDP 2024

TDP 2024 forecasts that approximately 56 GW of new generation capacity will need to be integrated into the transmission network between 2025 and 2034, similar to the 53 GW projected in TDP 2022. To meet this demand, nearly 14,500 km of new transmission lines and 210 transformers, providing 133,000 MVA of capacity, will be required. This represents a fivefold increase in delivery over the next 10 years compared to the previous decade. R112 billion has been approved for the TDP programme over the next five years.

We certainly recognise the magnitude of this challenge and delivering on these targets requires a fundamentally new approach. We are working closely with the government, private sector, and stakeholders to implement a hybrid delivery model that includes in-house delivery, Engineering, Procurement, and Construction (EPC), Procurement and Construction (PC), and Independent Transmission Projects (ITP). This hybrid model maximises capacity without overburdening our balance sheet or the fiscus.

One key challenge we face is overcoming local supply chain constraints as the industry ramps up to meet these increased demands. In August 2024, we signed 19 long-term agreements with local EPC companies to expedite transmission line construction. We also launched an incubation programme to build local high-voltage line construction capacity, with two contractors having already completed the programme. This initiative, supported by the Ministry of Electricity and Energy, the Industry Development Corporation (IDC), and the Department of Trade, Industry, and Competition (DTIC), is helping expand local expertise in high-voltage line construction. We will continue with this initiative to ensure that we can meet the requirements of TDP 2024.

Additionally, we are addressing global supply chain challenges for key equipment such as transformers. We have appointed a panel of transformer suppliers to compete for 101 upcoming contracts. Contracts for 26 large transformers, expected to be delivered within 12 to 36 months, have already been placed, ensuring we stay on track despite potential global constraints. We are also working to secure contracts for the remaining transformers needed for TDP 2024.

While we explore new initiatives, our commitment to local economic development remains unwavering. TDP 2024 presents a unique opportunity for localisation and industrialisation. NTCSA's infrastructure demands over the next five to ten years offer a critical window to foster local industries and develop supply chains. Collaboration with local industry associations will be key to maximising the benefits of localisation and contributing to broader economic growth, without inhibiting the required speed of execution.

In addition to delivering on expansion projects, NTCSA is fully committed to operating, maintaining and renewing our existing assets. With the necessary expertise and resources, we will ensure the continued reliability of the grid while investing in its long-term resilience.

Conclusion

As we embark on this journey, NTCSA's success will not be determined solely by the infrastructure we build or the systems we establish. It will depend equally on the relationships we foster, the talent we cultivate, and the innovation we embrace. Open dialogue, mutual understanding, and shared responsibility will be essential as we work together to build a grid that not only meets current needs but is also flexible enough to accommodate future demands and emerging technologies. We are committed to delivering on this ambitious plan mindful of the safety of people and the environment, compliance, and ethical conduct. We expect the same from all our partners.

I thank you for being part of this year's TDP public forum. The importance of a reliable national transmission grid cannot be overstated, and your input and contribution are invaluable as we shape the future of South Africa's electricity supply industry. Together, through collaboration, we can create an electricity supply industry that best meets South Africa's power needs.

NTCSA's purpose is to connect Southern Africa to its power and potential. As we move forward, we trust that we can count on your unwavering support to make this a reality.

Thank you.

Segomoco Scheppers

Interim Chief Executive Officer

NTCSA

DISCLAIMER

The purpose of publishing the National Transmission Company South Africa “NTCSA” Transmission Development Plan (TDP) is to inform stakeholders about the proposed developments in the 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.

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Although the TDP is updated periodically, NTCSA makes no representation or warranty as to the accuracy, reliability, validity, completeness, usefulness, or timeliness of the information contained in this document. NTCSA 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), NTCSA 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. The TDP is not regarded, and should not be regarded, as an investment commitment, and all IPP or other connections will be treated on merit based on actual information and feasibility outcomes.

EXECUTIVE SUMMARY

The NTCSA Transmission Development Plan (TDP) is a requirement of the South African Grid Code, which states that “The *NTC* shall annually publish a minimum five-year-ahead TS development plan by end October, indicating the major capital investments planned (but not necessarily approved).” The purpose of the TDP is to assess network requirements and propose plans to meet the load demand and generation forecasted in the subsequent 10-year period.

This publication contains information about projects intended to extend or reinforce the transmission system that are planned for the next 10 years (2025-2034). 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 NTCSA owns them.

The TDP 2024 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 power 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.

The foundational assumptions on electricity generation and load demand are key to ensuring the strength of the TDP planning process. They drive analysis of supply, future demand growth, and technology impacts, providing a solid basis for informed decision-making and sustainable energy strategies. Furthermore, the generation capacity and load assumptions are in line with NTCSA’s strategy, to provide reliable and sustainable access to affordable power while assisting in the operations of a financially sustainable business.

The forecasted generation and load assumptions are developed in-house by the Strategic Grid Planning department within the NTCSA. These are both done on a national level and disaggregated to spatial point loads connected to the transmission substations within the network. The Draft Integrated Resource Plan (IRP) 2023 by the Department of Mineral

Resources and Energy was used as an input and verification of in-house results. The Generation Assumptions Report 2024 and the Transmission Demand Forecast Report for the TDP 2024 provide details on the methodology and analysis of each of the generation and load assumptions and forecasts.

Despite the assumptions for both new generation capacity and demand being based on the draft IRP 2023, and noting that the final IRP is still under development, the NTCSA is confident that the first five years of the TDP 2024 have a high level of certainty. This is based on applications processed as per the DMRE and non-DMRE generation procurement programmes and projects that have been conceived which were based on Budget Quotes (BQs) issued and will likely not be affected by any changes in the assumptions. There is more uncertainty in the assumptions beyond the year 2030. This is mitigated by also factoring in information from grid connection applications processed and customer feedback from industry surveys, apart from the draft IRP 2023 assumptions.

Key drivers of change in South Africa's electricity demand and generation forecasts include economic growth, technological advancements, and the shift towards renewable energy driven by decarbonisation efforts. Government policies, regulatory shifts, and the unbundling of Eskom will also influence the landscape, along with infrastructure challenges like grid stability and load-shedding. Increased urbanisation, electrification, and private sector involvement in power generation will reshape demand and supply dynamics. Each of these factors creates variability and complexity in forecasting the generation and demand, necessitating integrated approaches that can handle multiple uncertainties. Any changes in input data in the months to come, including the release of the final IRP, will be factored in with the development of the next version of the TDP.

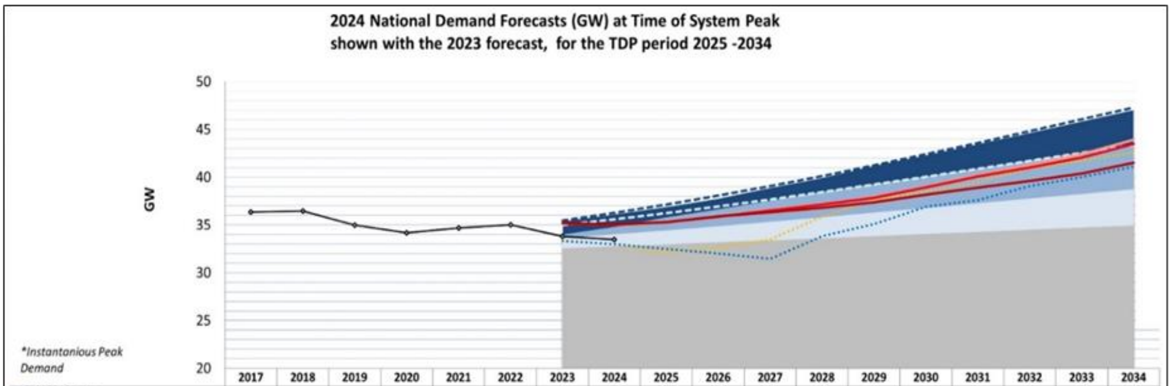
The strategic planning process is dynamic and any changes to input data will be factored into the next TDP as new information is received. It is noted that the interaction between supply and demand planning is harmonised and verified against each other continuously as the plans from internal and external developments unfold. It has been proven that there is a correlation between energy availability and demand uptake in the country and therefore the interoperability of these assumptions on both load and supply, is extremely important to the development of the power system.

The TDP 2024 high-level summary is encapsulated as follows:

i) **Demand forecast.**

The demand forecast provides four main scenarios that can be considered for the development of the grid. The high scenario aligns with the National Development Plan (NDP), with 4% gross domestic product (GDP) growth, industry revival, and highly grid-dependable renewable energy expansion, at 47 GW by 2034. The moderate-high scenario projects economic recovery with up to 1.6% GDP growth, reaching 43 GW by 2034. The medium scenario emphasises technological advances and sustainable energy with lower grid connections, predicting 39 GW by 2034 with lower GDP growth at 1% for the decade. The low scenario forecasts minimal growth due to economic decline, staying consistent at 35 GW by 2034, with GDP growth on average below 0.5%.

The moderate-high scenario is preferred for the TDP planning cycle which is aligned to the Draft IRP 2023 reference forecast. A macroeconomic forecast of up to 1,6% GDP growth in the TDP period was used and up to 3,2% from a global GDP to positively influence South African growth. This indicates an increase in the system peak demand from ~ 33.5 GW in 2024 to ~ 43 GW by 2034, which is consistent with the TDP 2022 forecast that also forecasted ~ 43 GW by 2034.



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
2024 Tx High							35	36	37	38	39	40	41	42	43	45	46	47
2024 Tx Moderate High							34	35	36	37	38	38	39	40	41	42	43	43
2024 Tx Medium EE / EI							34	34	34	35	35	36	36	37	37	38	38	39
2024 Tx Low							33	33	33	33	33	34	34	34	34	34	35	35
2023 Tx High							35	36	37	38	39	40	41	42	44	45	46	47
2023 Tx Moderate High							35	36	36	37	38	38	39	40	41	42	43	43
Actual Peak Demand (GW) *	36.4	36.4	35.0	34.2	34.7	35.0	33.8	33.5										
Constrained Scenario 1							33	33	32	33	33	36	38	39	40	41	42	43
Constrained Scenario 2							33	33	33	32	31	34	35	37	38	39	40	41
2023 IRP Demand (GW) High scenario							35	35	35	36	37	37	38	39	40	41	42	44
2023 IRP Demand (GW) REF scenario							35	35	35	36	36	37	38	39	40	41	42	43
2023 IRP Demand (GW) Lowscenario							35	35	35	36	36	37	37	38	39	40	40	42

Figure 1-1: 2024 Demand Forecasts

ii) Generation assumptions.

The generation assumptions for TDP 2024 were based on the draft IRP 2023, Eskom Generation Planning Schedule (decommissioning and new generating units), applications processed for new generation integration and budget quotations processed by Eskom. The high-level generation forecast is shown in the figure below with the total capacity expected to reach ~106.5 GW by 2034.

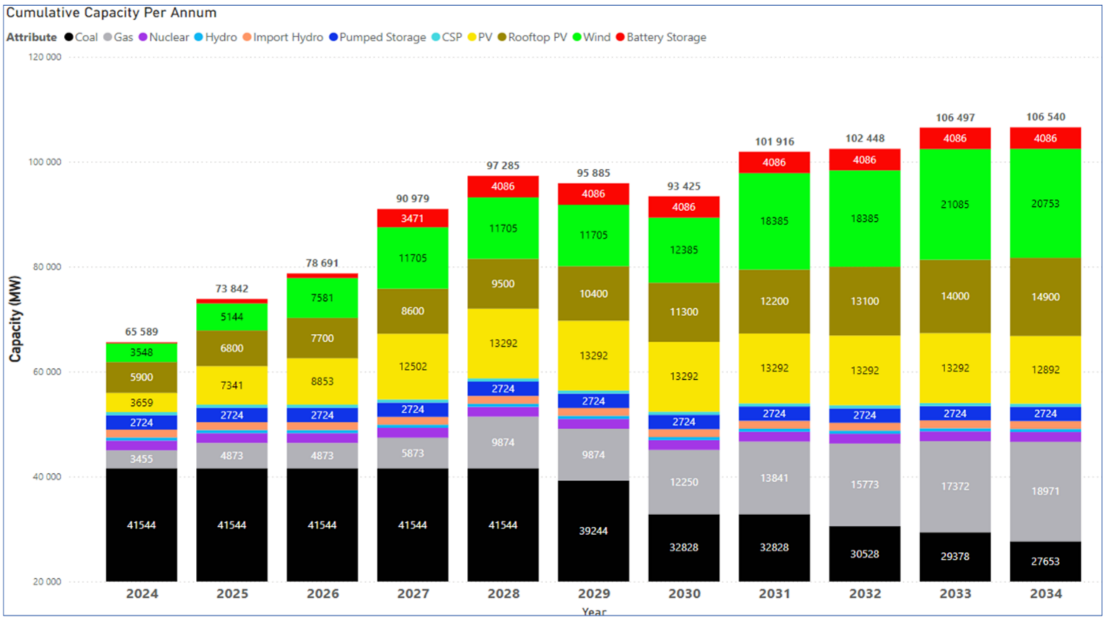


Figure 1-2: NTCSA Generation Assumptions for TDP 2024

The key observations from the generation assumptions are that:

- ~ 30 GW of new generation capacity is projected in the draft IRP 2023 up to 2030, which is similar to the assumptions used in the TDP 2022 which was based on the IRP 2019.
- For the TDP 2024, a new generation capacity totalling 56 GW is expected over the period from 2025 up to 2034 when taking into consideration the Reference Case (Pathway One) in the draft IRP 2023 for the period 2031 - 2035. The table below compares the generation assumptions considered in TDP 2022 vs TDP 2024.

Table 1: Generation Assumptions Comparison

Technology	TDP 2022 (GW)	TDP 2024 (GW)	Variance (GW)
PV	16	9.6	-6.4
Wind	23	17.5	-5.5
BESS	6.5	3.9	-2.6
Gas	5	15.9	10.9
Hydro	2.5	0	-2.5
Rooftop PV	0	9	9
Total	**53**	**55.9**	**2.9**

- ~ 56 GW of new generation capacity is projected in the draft IRP 2023 over the TDP 2024 period (2025 to 2034), which is similar to the 53 GW planned for in the TDP 2022; however, noting the reduction of PV, wind, BESS and hydro with an increase in gas and rooftop PV in the TDP 2024.

iii) Summary of major TDP projects

The new infrastructure additions to the TDP 2024, when compared to the TDP 2022, relate to the installation of synchronous condensers at seven sites that are required to maintain system stability and supply security due to large-scale penetration of RE and planned decommissioning of conventional thermal plants. Also, additional transformers have been included to expedite the integration of RE resources at existing substation sites in a relatively short space of time.

The figure below illustrates the major transmission projects over the TDP 2024 period. A significant amount of 765 kV power corridors (indicated in pink dashed lines in the diagram below) will be required in the Northern Cape and Central Cape regions as well as interconnecting Eastern Cape to KwaZulu-Natal. This is for the evacuation of the excess RE generation to the load centres in the northern parts of the country. Furthermore, strengthening of the 400 kV network across the system is needed in the form of interconnecting corridors between the 765 kV lines and the underlying 400 kV networks, as well as for local and regional strengthening.

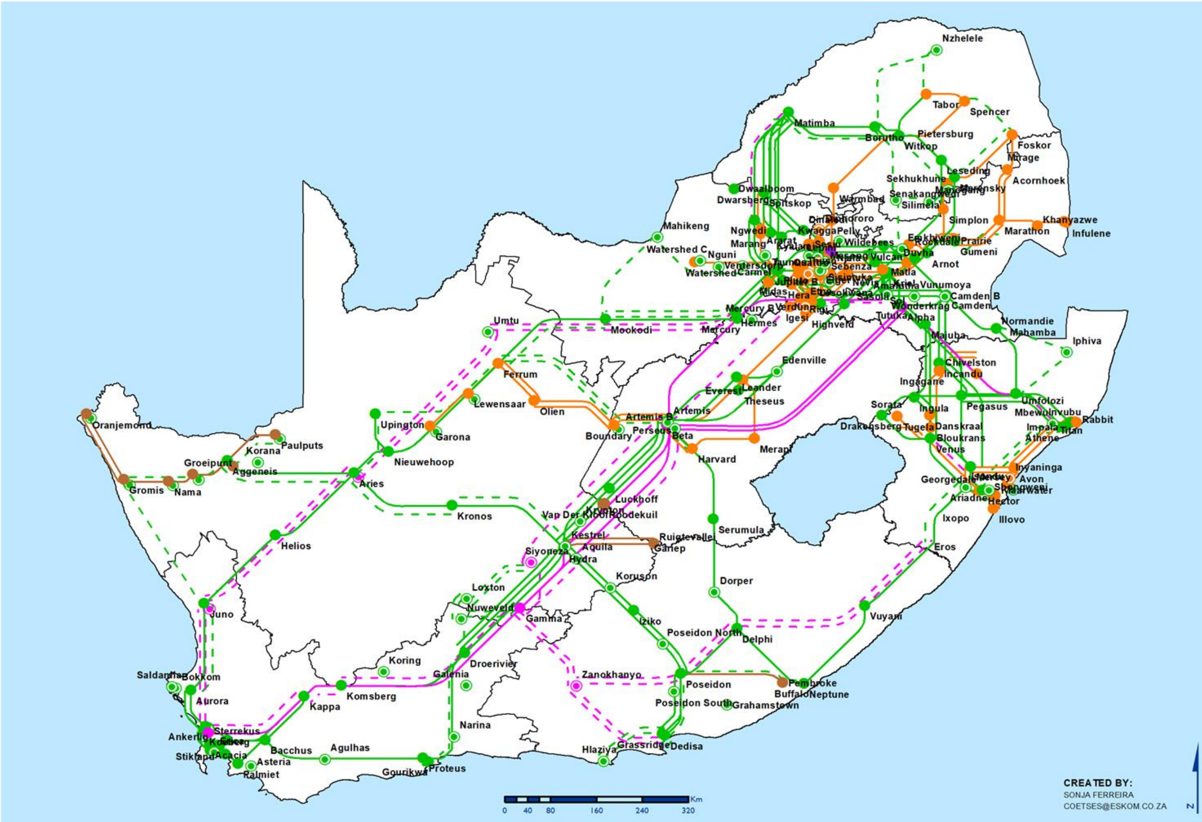


Figure 1-3: Major Transmission Projects over the TDP 2024 Period

iv) Summary of TDP 2024 infrastructure requirements

The TDP is an unconstrained plan based on the assumption that capex, servitudes, and resource capacity and capability across the EPCM value chain will not pose any hindrance to the implementation of the TDP rollout programme.

Based on the TDP 2024, it is anticipated that some 14 494 km of lines and 133 GVA of transformations (210 transformers) will be required to augment the transmission system over the TDP 2024 period. These infrastructure developments will resolve existing network reliability issues, integrate the new generation capacity and connect customers needing additional or new loads.

Due to the current network constraints especially in areas with strong RE potential, the augmentation of the transmission system will need to be expedited to meet the draft IRP 2023 requirements as well as to integrate the committed and potential RE connection applications processed. The table below provides a breakdown of the new assets that are planned for expansion projects for the TDP 2024.

Table 2: TDP 2024 Asset requirements for Expansion

TDP 2024 Infrastructure Requirements	New Assets expected 2025 - 2029	New Assets expected 2030 - 2034	TDP 2024 New Assets: 2025 - 2034
Power lines (km)			
765 kV	767	6190	**6957**
400 kV	4251	3226	**7477**
275 kV	26	34	**60**
Total length (km)	**5044**	**9450**	**14494**
Transformers			
Number of units	87	123	**210**
Total capacity (MVA)	41 325	91 325	**132650**
Capacitors			
Number of units	15	25	**40**
Total capacity (MVar)	1032	1 660	**2692**
Reactors			
Number of units	14	45	**59**
Total capacity (MVar)	3260	13 000	**16260**
Synchronous Condensers			
Number of units	7	1	**8**
Total capacity (Mvar)	5850	900	**6750**

v) Summary of refurbishment plans

The performance of the existing transmission infrastructure is critical to the reliability and sustainability of the Integrated Power System (IPS). Hence the Transmission Network Refurbishment Plan (TNRP) is intended to sustain network reliability and availability by systematic replacement of identified network assets based on plant performance and equipment condition. The table below depicts the refurbishment plan for substation assets to be replaced over the next 10 years.

Table 3: Summary of Refurbishment Plans (2025-2034)

CATEGORY	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	Grand Total
CAPACITOR	1	5	4	7	12	5	5	9	1	6	55
CIRCUIT BREAKER	48	87	131	90	115	69	105	117	83	85	930
CURRENT TRANSFORMER	192	425	577	438	460	406	438	394	293	239	3 862
DC & STANDBY	80	43	28	28	22	14	6	28	4	28	281
ISOLATORS	139	213	416	331	332	324	431	501	343	343	3 373
PROTECTION	35	141	214	256	249	275	315	257	201	51	1 994
REACTOR	-	-	-	-	-	4	9	2	1	-	16
SURGE ARRESTER	68	116	280	182	231	230	265	431	245	307	2 355
TRANSFORMER	1	1	8	7	13	13	15	27	31	8	124
VOLTAGE TRANSFORMER	23	100	206	193	115	182	216	221	96	166	1 518
Grand Total	**587**	**1 131**	**1 864**	**1 532**	**1 549**	**1 522**	**1 805**	**1 987**	**1 298**	**1 233**	**14 508**

The systematic renewal of the aged asset base is depicted below in major substation and major powerline refurbishments per province.

Figure 1-4: Major Substation Refurbishments per Province

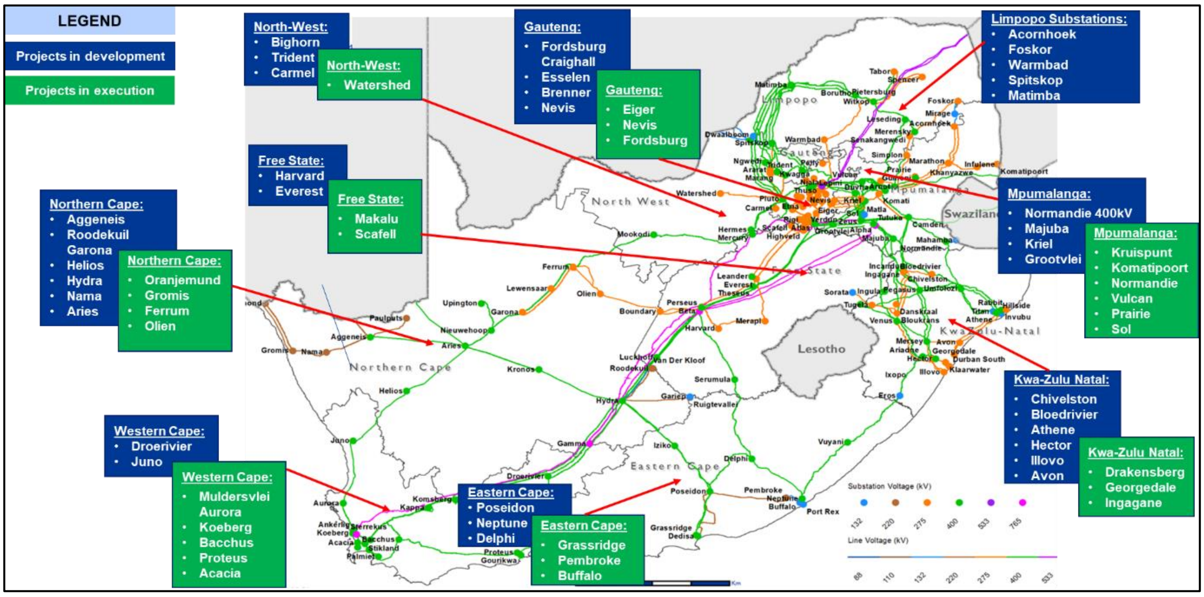
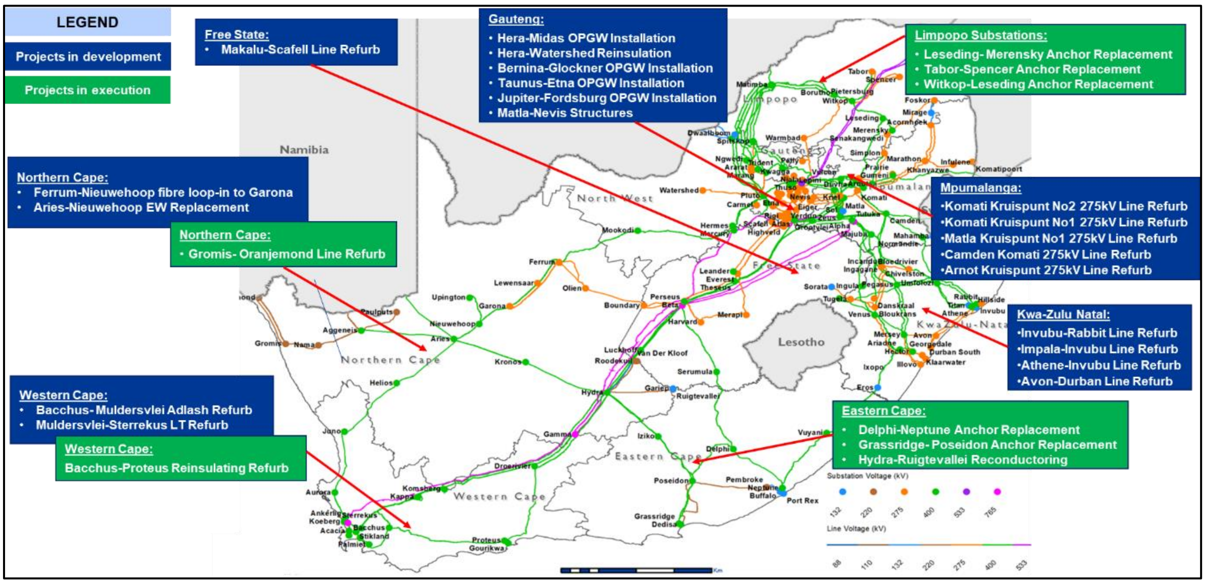


Figure 1-5: Major Powerline Refurbishments per Province



vi) 5 Year Capex summary for the TDP 2024

The table below provides the capital requirements for the TDP 2024 incorporating the full capital portfolio of the NTCSA in the first 5-year period (FY25 – FY29). This includes the capital requirements for transmission capacity expansion projects, refurbishment, production equipment, EAs, land and servitudes acquisition, telecommunications, real estate, and information management. The total estimated capital for the TDP 2024 amounts to R112.5 bn, with close to 80% (R85.6bn) estimated for the capacity expansion portfolio including EAs, land and servitudes acquisition.

Table 4: 5 Year Capex summary table for TDP 2024

NTCSA capex categories	R million
Capacity expansion:	80 707
New Generation Integration	*54 277*
Network strengthening	*26 430*
Land & Rights	4 880
Refurbishment	17 828
Telecommunications	5 316
Real Estate	369
Information Management	801
Production equipment	2 633
Total	**112 534**

As per the NTCSA's licence and Grid Code, the NTCSA is required to produce a TDP for the country that addresses the system needs for new generation, demand, reliability, and sustainability of the IPS. The TDP 2024 based its assumptions on the draft IRP 2023, which is currently under review.

The NTCSA Transmission Development Plan (TDP) is a critical requirement of the South African Grid Code, guided by in-house generation and load assumptions developed by the Strategic Grid Planning Department. These assumptions form the foundation for informed decision-making, driving analysis on supply, demand growth, and technology impacts. The TDP 2024 for the period 2025-2034 reflects both NTCSA's strategic goals and the national energy strategy, aligned with the Integrated Resource Plan (IRP) 2023.

Based on these factors, the TDP 2024, being NTCSA's inaugural plan and fulfilling its regulatory obligations, is published with a focus on the first five years of the plan while it awaits the release of the IRP 2024 / 2025 and gathers more intelligence on the country's energy needs. The later five years of the TDP will be communicated for completeness with an emphasis on the flexibility of the TDP 2024 especially in the latter years to meet the country's energy requirements.

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 as well as to explore alternate funding models. 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.

vii) Alternate delivery and funding models to expedite the TDP 2024

The TDP 2024 requires that inter alia 14,494 km of transmission lines be built, as well as the installation of 210 transformers. This requires a significant capital investment to fund the TDP projects, estimated at R112 billion in the first 5-years. While adequate capital budget has been secured for the first 5-year horizon of the TDP, the bulk of the capital spend is in the later 5-year period. NTCSA's capital plan is limited by its balance sheet and its allowable revenue stream. Considering this, the NTCSA has taken a stance to focus on the delivery of the first 5-years of the TDP while engaging and collaborating with key stakeholders in Government to resolve the medium to long term challenges required to expedite the TDP delivery.

A simplified implementation framework has been developed, highlighting the key and critical elements required for the successful delivery of the programme. Several project delivery methods are being employed to implement transmission projects, including Engineering Procurement and Construction Management (EPCM), Engineering Procurement and Construction (EPC), and Owner's Engineer (OE).

Private Sector Participation (PSP) through Independent Transmission Projects (ITPs) in transmission has been a focal point for enhancing efficiency of implementation, increasing investment, and promoting innovation in the energy sector. In this regard, the Ministry of Energy and Electricity (MoEE) and National Treasury (NT) are exploring funding models that can be considered to encourage private sector to participate in the acceleration of the Transmission investments. The NTCSA is working with MoEE and NT to implement a pilot project to introduce ITPs with the intention of obtaining key learnings that will guide the programme going forward.

The NTCSA recognises that it needs additional capacity to deliver the TDP to ensure South Africa' continued economic development. The Ministry and NTCSA are working together on ITP solutions to attract additional investments from the private sector. The regulations to support the ITP delivery solutions are in progress and will be followed by a Ministerial determination for an ITP pilot. To advance these important initiatives and support the acceleration of transmission project implementation, further engagement is ongoing among the Government, NERSA, Eskom and NTCSA. This collaboration is focusing on developing a framework for cost-reflective tariff structures, adequate capitalisation of NTCSA and policies that will ensure the financial sustainability of NTCSA, thereby enabling it to implement TDP projects through proven methods.

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ABBREVIATIONS AND DEFINITIONS

ASTR ancillary services technical requirements

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 in accordance with 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.

BESS battery energy storage system

BQ budget quotation/quote

A quotation giving customers the costs and scope at an 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.

CAGR compound annual growth rate

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.

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.

CO commercial operation

CoCT City of Cape Town

CSIR Council for Scientific and Industrial Research

CSP concentrated solar power

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
DTIC	Department of Trade, Industry, and Competition
EA	environmental authorisation Authorisation for implementation of a listed activity as listed in the EIA Regulations by the competent authority.
EAF	energy availability factor
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 environmental management programme (EMPr).
EGI	electricity grid infrastructure
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 in accordance with 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.
EL	East London
EM	emerging market

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.
EMS	energy management system
EPC	engineer, procure and construct
EPCM	engineer, procure, construct and manage
FCLR	fault current limiting reactor
FS	Free State
FY	financial year
GAU	Grid Access Unit
GCCA	grid connection capacity assessment
GDP	gross domestic product
HV	high voltage
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.
ICT	information and communications technology
IDC	Industry Development Corporation
IDZ	industrial development zone
IPP	independent power producer These are power stations owned by independent parties other than Eskom.
IPPO	Independent Power Producers Office

IPS	integrated/interconnected power system
IRP	integrated resource plan
ISED	integrated strategic electricity demand
ITP	independent transmission project
KSACS	Key Sales and Customer Service
KZN	KwaZulu-Natal
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.
MI	market intelligence
MoEE	Ministry of Electricity and Energy
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.
NATJOINTS	National Joint Operational and Intelligence Structure
NDP	National Development Plan
NECOM	National Energy Crisis Committee
NEMA	National Environmental Management Act
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.

NMD	notified maximum demand
NT	National Treasury
NTCSA	National Transmission Company South Africa 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.
PC	procure and construct
PE	Port Elizabeth
PPA	power purchase agreement
PSP	private sector participation
PV	Photovoltaic
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.
RE IPP	renewable energy independent power producer
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
RMIPPPP	Risk Mitigation Independent Power Producer Procurement Programme
RTS	return to service A previously mothballed power station undergoing recommissioning.
SADC	Southern African Development Community
SAGC	South African Grid Code
SAPP	Southern African Power Pool
SCO	synchronous condenser operation

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.
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.
SG	surveyor-general
SO	System Operator
SOC	state-owned company
SOW	scope of work
SSEG	small-scale electricity generation
SVC	static var compensator
TBD	to be determined
TDP	Transmission Development Plan A development plan produced annually by NTCSA 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 a vertically integrated company licensed to generate, transmit, and distribute electricity in South Africa. Eskom is a 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. The transmission licence is held by the National Transmission Company South Africa (NTCSA). Planning for the expansion of the transmission network is the responsibility of the Grid Planning and Development Department in the NTCSA.

1.1 CONTEXT OF THE TDP

According to the Grid Code, NERSA requires NTCSA 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 NTCSA to host a public forum annually to disseminate the intended TS development plan to facilitate a joint planning process.

This is the 14th publication of the TDP, which was shared at a public forum hosted via Microsoft Teams and at Eskom Academy of Learning on 30 October 2024.

The TDP, which covers a 10-year period from 2025 to 2034, seeks to meet the long-term requirements of electricity producers and 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 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 to five years (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 TDP 2022

The changes from the TDP 2022 to this revision of the TDP 2024 is associated with assumptions about the future generation capacity of the country. The TDP 2022 was informed by the IRP 2019, which was gazetted in November 2019, while the TDP 2024 is based on the Draft IRP 2023 published in January 2024. The Draft IRP 2023 provides capacities per annum for each technology up to 2030 however beyond 2030; the policy guiding principles and energy pathways of the IRP were utilised to assume values beyond 2030 for wind, photovoltaic (PV), battery storage, and gas.

1.3 STRUCTURE OF THE DOCUMENT

The document is structured in the following manner:

Chapter 2, **GENERATION ASSUMPTIONS**, outlines generation assumptions for the 2024 revision of the TDP, which was primarily informed by the Draft IRP 2023.

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

Chapter 4, **COMPLETED PROJECTS**, summarises the completed projects since the TDP 2022 was published.

Chapter 5, **CUSTOMER APPLICATIONS**, provides a summary of the grid connection applications processed by NTCSA during the 2023/24 financial year (April 2023 to March 2024).

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, **SUPPLY AREA DEVELOPMENT PLANS**, focuses on the planned generation integration and reliability projects per supply area.

Chapter 8, **REFURBISHMENT PLANS**, focuses on the planned refurbishment of assets at substations and transmission lines.

Chapter 9, **ANCILLARY SERVICES**, provides an overview of the obligations bestowed on the System Operator (SO) to ensure system reliability, security, safety, and efficient operation of the interconnected power system (IPS).

Chapter 10, **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 11, **CONCLUSION**, provides the concluding remarks on the 2024 version of the TDP.

2 GENERATION ASSUMPTIONS

The generation assumptions are a crucial input to the TDP, they provide the annual generation capacity that is to be modelled at each station during the TDP period. The main input to the generation assumptions is the Integrated Resource Plan (Draft IRP 2023) released by the DMRE in January 2024. The generation assumptions are primarily based on the preferred scenario as indicated in Table 2 (p. 22 of the Draft IRP 2023 document) and shown in Table 2-1 below. Other inputs to the generation assumptions are the customer applications in the form of budget quotations in progress, previous renewable energy IPP programmes' winning bids, annual renewable energy survey outcomes, and the Eskom Generation fleet plans.

Since the amendment of Schedule 2 of the ERA, there has been high interest in IPPs seeking to connect to the grid, at the time of releasing the assumptions, there was roughly 8.8 GW of BQs under progress related to the schedule 2 amendment. Rooftop PV was not accounted for in the previous versions of the TDP, however, the interest in rooftop PV has warranted its inclusion going forward. It is currently estimated that there is close to 6 GW of Rooftop PV connected in South Africa.

Table 2-1: Draft IRP 2023 capacity per technology (Source: DMRE)

Table 2: Emerging Plan from Horizon One Analysis

	Coal	Gas – IPP Programme	Gas - Eskom	Dispatchable Capacity	Nuclear	Hydro	Pumped Storage	CSP	Solar PV	Wind	Hybrid IPP Programme	Distributed Generation*	BESS – IPP Programme	BESS - Eskom	Unserved Energy (TWh)
Current Base (MW)	38 800	1 005	2 825	-	1 860	1 600	2732	500	2 287	3 443	-	5 000	-	20	
2024	720							100			150	900		199	13.06
2025	720	1 220							2 115	644	476	900	513	141	7.63
2026										140		900			7.66
2027		1 000								684		900	2 000 615		4.55
2028		1 000	3 000						500			900	615		0.22
2029									500	1 500		900			0.25
2030		1 000		1 376					500	1 500		900			0.27
Additional New Capacity (MW)	**1 440**	**4 220**	**3 000**	**1 376**				**100**	**3 615**	**4 468**	**626**	**6 300**	**3 743**	**360**	

Installed Capacity
Capacity under construction
Capacity procured
New Capacity
Distributed Generation Capacity for own use
Unserved Energy, preferred as low as possible

The decommissioning of coal plant was adjusted to align with the decommissioning plan that Eskom Generation envisages. Decommissioning of conventional plant is set to resume in 2029/2030 and accelerate in the early 2030s. It is estimated that by 2035, about 17 GW of coal and gas plants would have collectively been decommissioned.

The major outputs from the generation assumptions are as follows:

(i) The generation capacity which will be installed by Eskom in the next 10 years
(ii) The generation capacity, by technology type, which will be installed by IPPs in the next 10 years
(iii) The generation that is expected to be decommissioned in the same period
(iv) The spatial locations of the generation represented by the substation where the technology is allocated

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 technologies 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 (around 7-8 PM).

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.

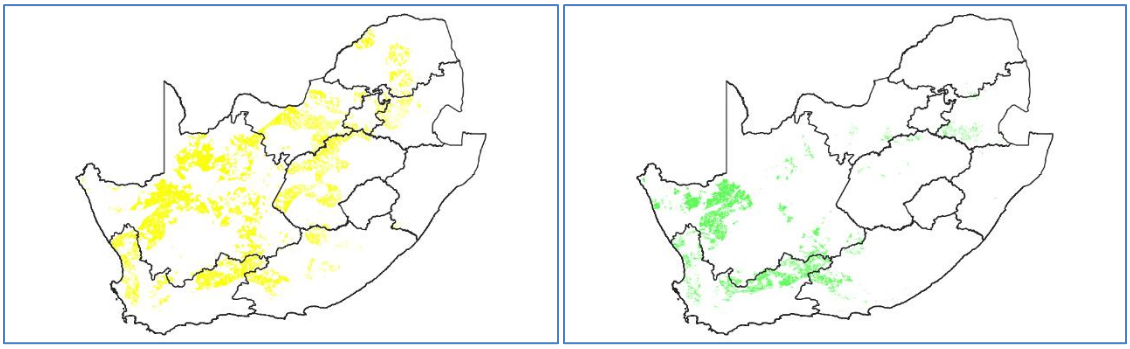


Figure 2-1: Areas of high solar irradiance (yellow) and wind potential (green) after considering environmental restrictions

ii. BQ applications in progress received from Grid Access Unit (GAU)

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

Figure 2-2 indicates the BQ applications as well as the EIA applications.

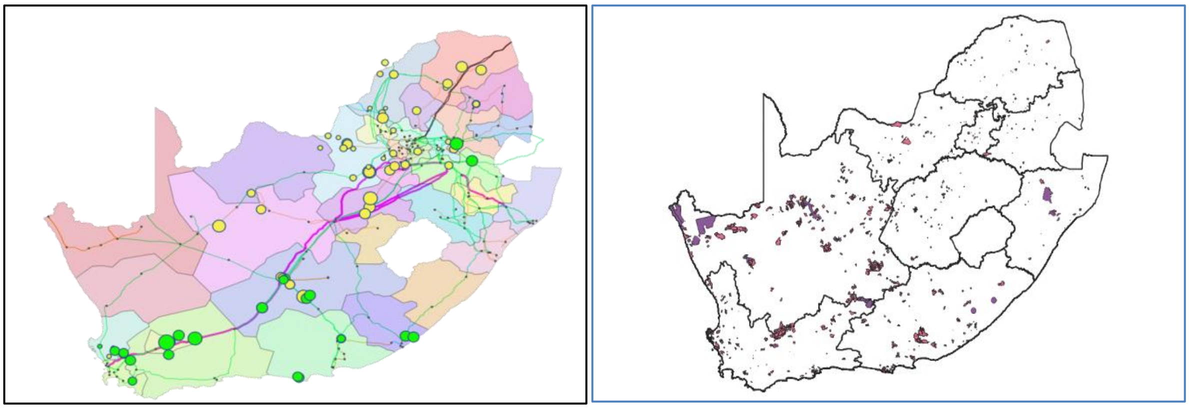


Figure 2-2: Areas of interest (left) with the yellow dots indicating solar and the green dots indicating wind, and EIA applications (right)

iv. Annual Renewable Energy Survey conducted by NTCSA in conjunction with SAPVIA and other RE associations to assess areas of high interest, for this TDP the 2023 survey was used, this is shown in Figure 2-3 below.

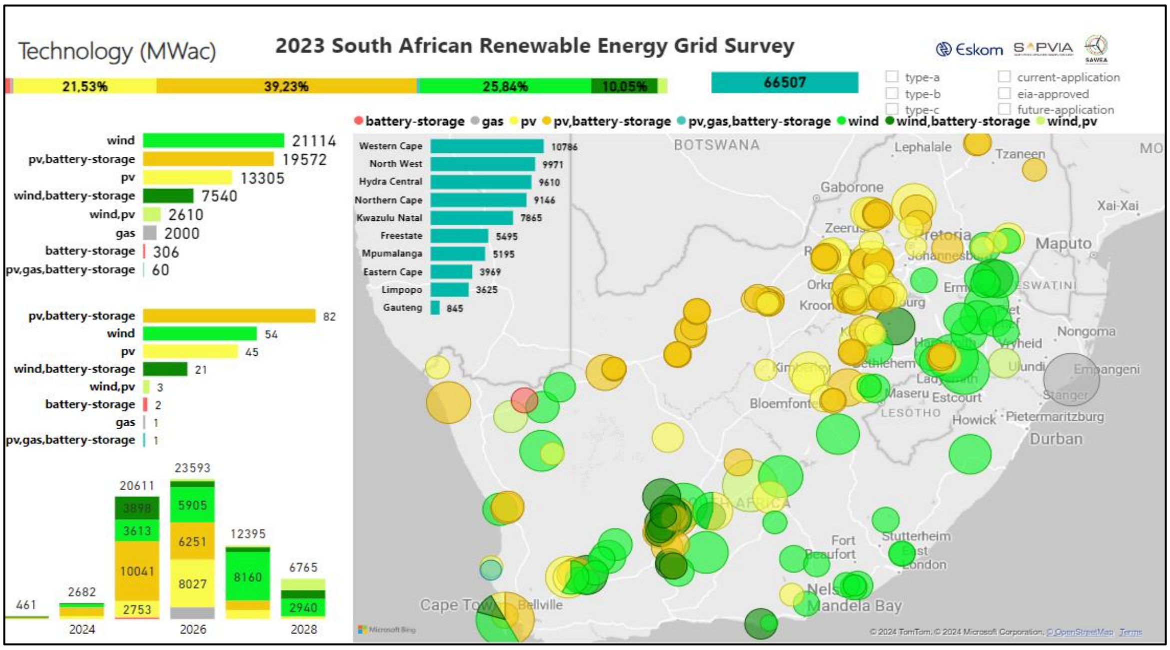


Figure 2-3: 2023 Renewable Energy Survey Results

v. Areas where there is network capacity as per the GCCA.

At the time of producing the generation assumptions, the Grid Connection Capacity Assessment (GCCA 2025) indicated that there was no capacity in the Northern Cape, Western Cape, and Eastern Cape grids. The only way to create capacity in the short term in those areas will be by means of curtailment. All the REIPPPP allocations in the Greater Cape are reliant on curtailment to be approved, and all the BQs were already in the GCCA. Because of this, there is very limited capacity allocated in the Greater Cape area before 2027 except for the BQs which are already in progress, most of which were considered in the GCCA results. Figure 2-4 and Figure 2-5 show the GCCA and the allocation in different years up to 2027, respectively.

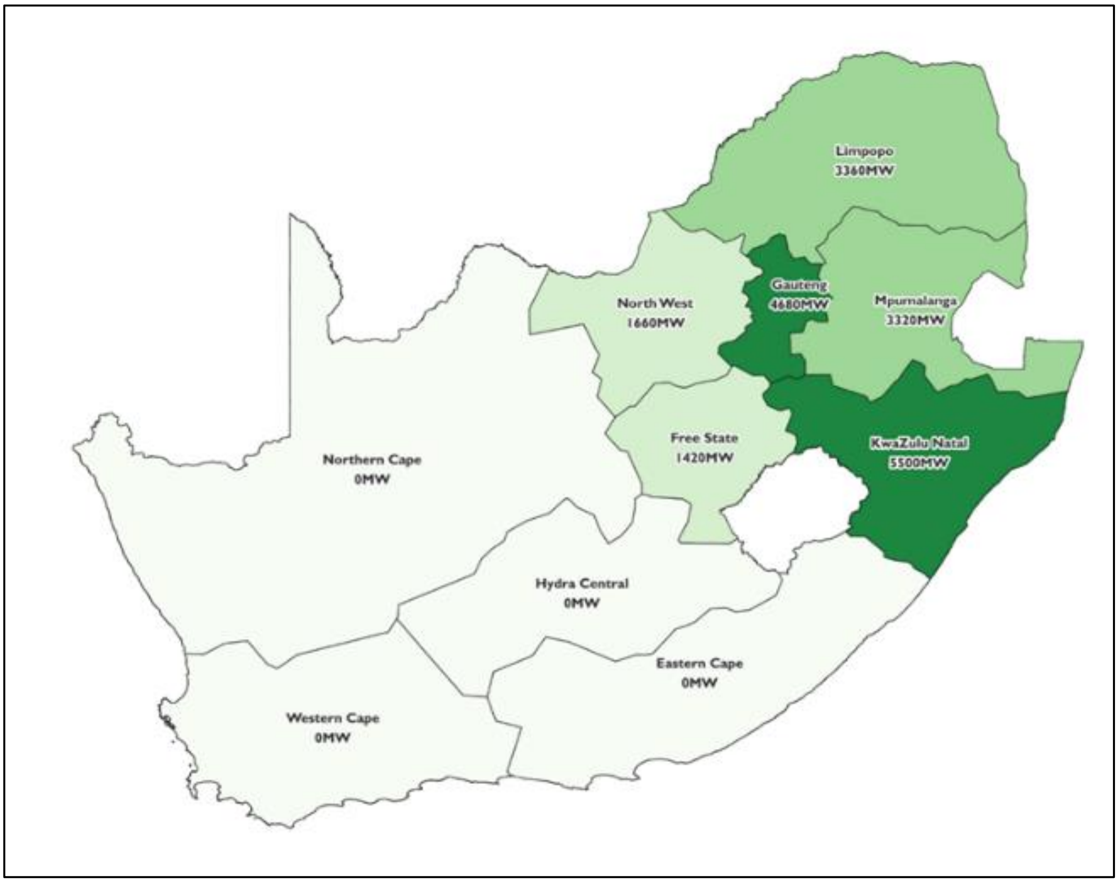


Figure 2-4: GCCA 2025 outcomes indicating no capacity in the Greater Cape area

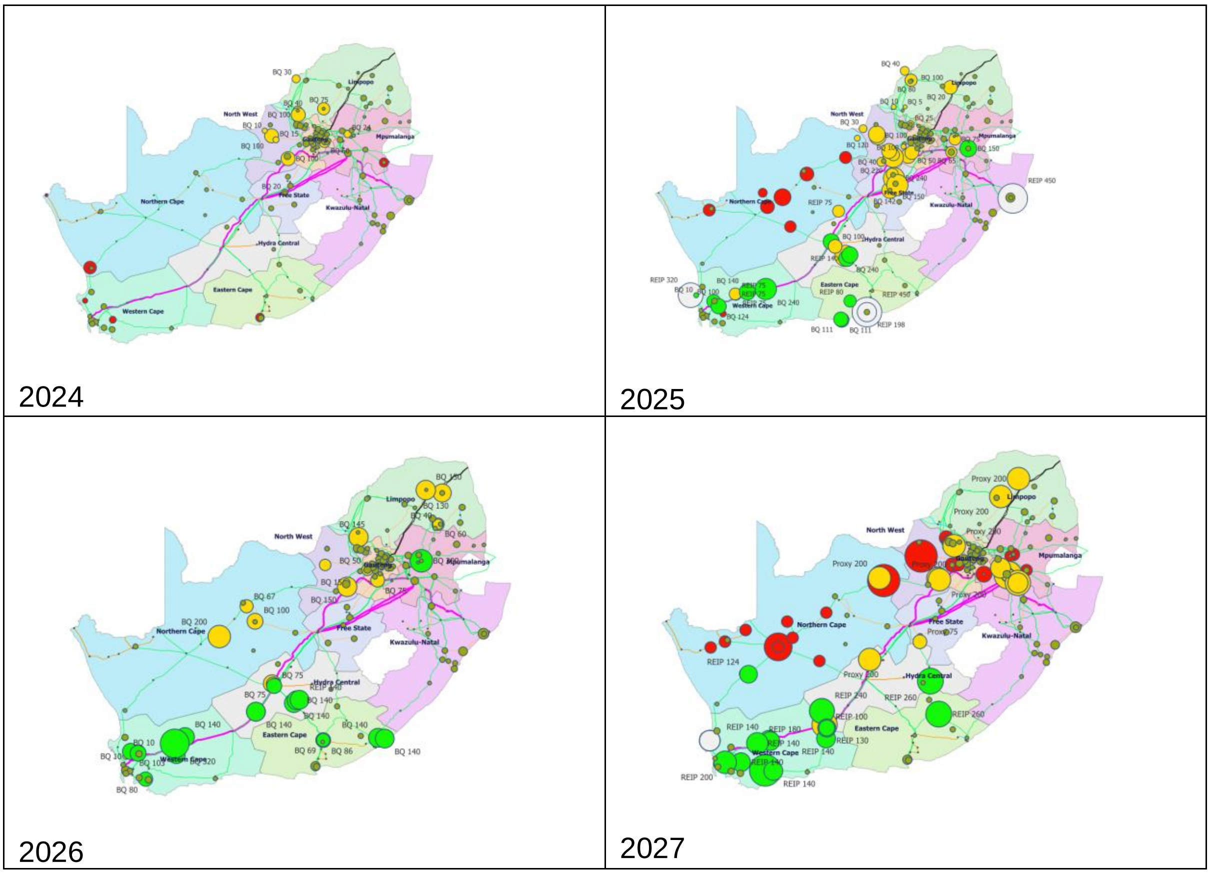


Figure 2-5: Allocation of renewables from 2024 up to 2027 – mostly battery storage (red) and minimal wind (green) and solar PV (yellow) allocated in the Greater Cape

2.1 GENERATION FORECAST

The generation composition of all the technologies forecasted at the end of this TDP period is presented in Figure 2-6. It is anticipated that there will be a total of approximately 49.1 GW of RE, 4.1 GW of battery storage, 27.7 GW of coal, and 19.0 GW of gas installed in the system by 2034. Some of these plants exist, while others are in execution or are to be executed in the future.

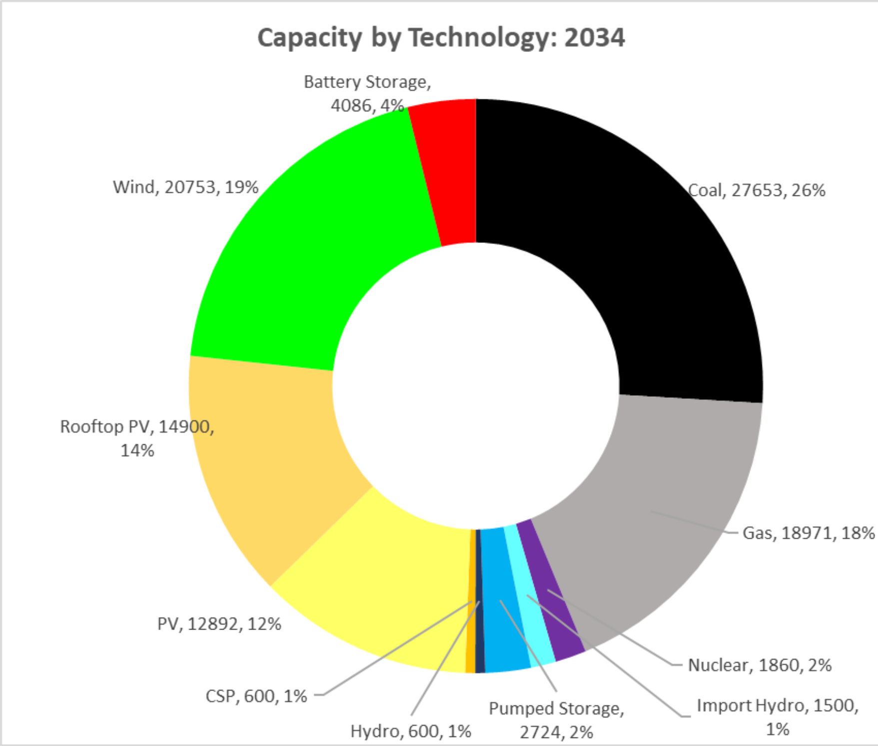


Figure 2-6: Generation capacity composition of all the technologies in 2034

Renewable capacity as a percentage of total capacity is expected to accelerate from 21% in 2024 to 50% in 2034. By this time, renewable energy capacity in the network will have increased approximately two-and-a-half times. Figure 2-7 shows the contribution of conventional and renewable capacity in the energy mix.

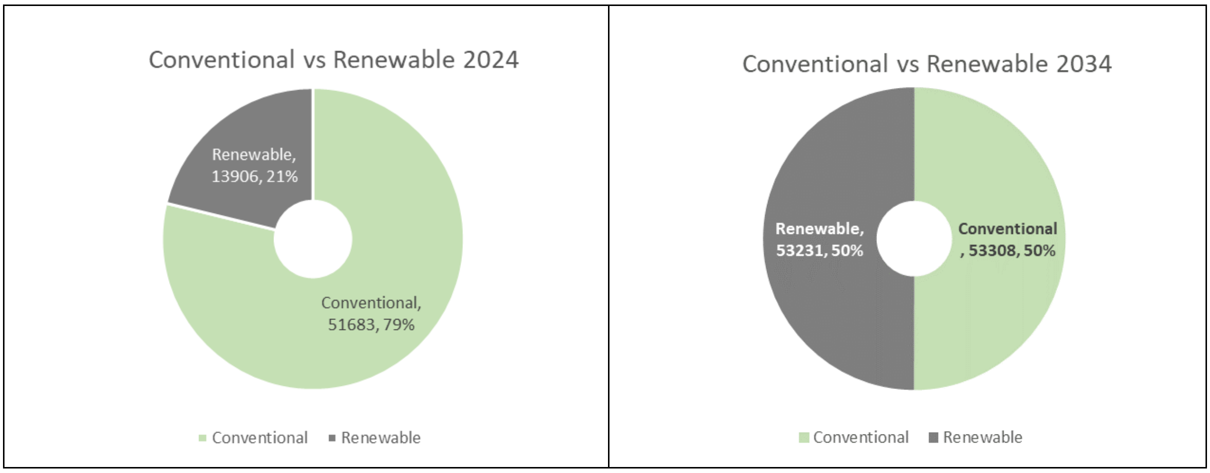


Figure 2-7: Conventional energy and renewable energy in 2024 and 2034

2.2 CONVENTIONAL GENERATION

Figure 2-8 shows the cumulative conventional capacity allocation for power stations with net increases. Increases are only observed for gas fired power stations, the net gain in capacity for gas power stations is 14.3 GW excluding current capacity (3.4 GW) and Karpowerships (1.4 GW) which are not likely to proceed.

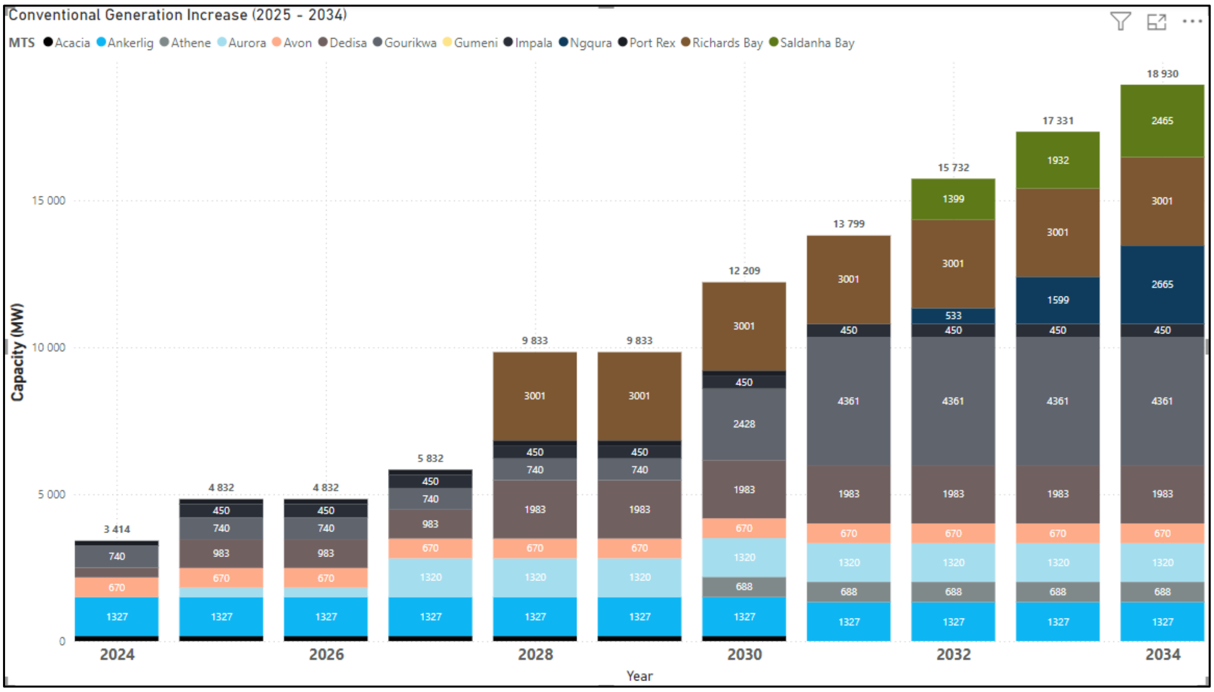


Figure 2-8: Conventional generation cumulative capacity schedule (by substation)

Coal will decrease by 13.9 GW over the TDP period as seen in the chart depicting conventional generation in **Figure 2-9** below, gas has a net increase of 14.3 GW over the same period, the total conventional generation increases slightly by 1.6 GW.

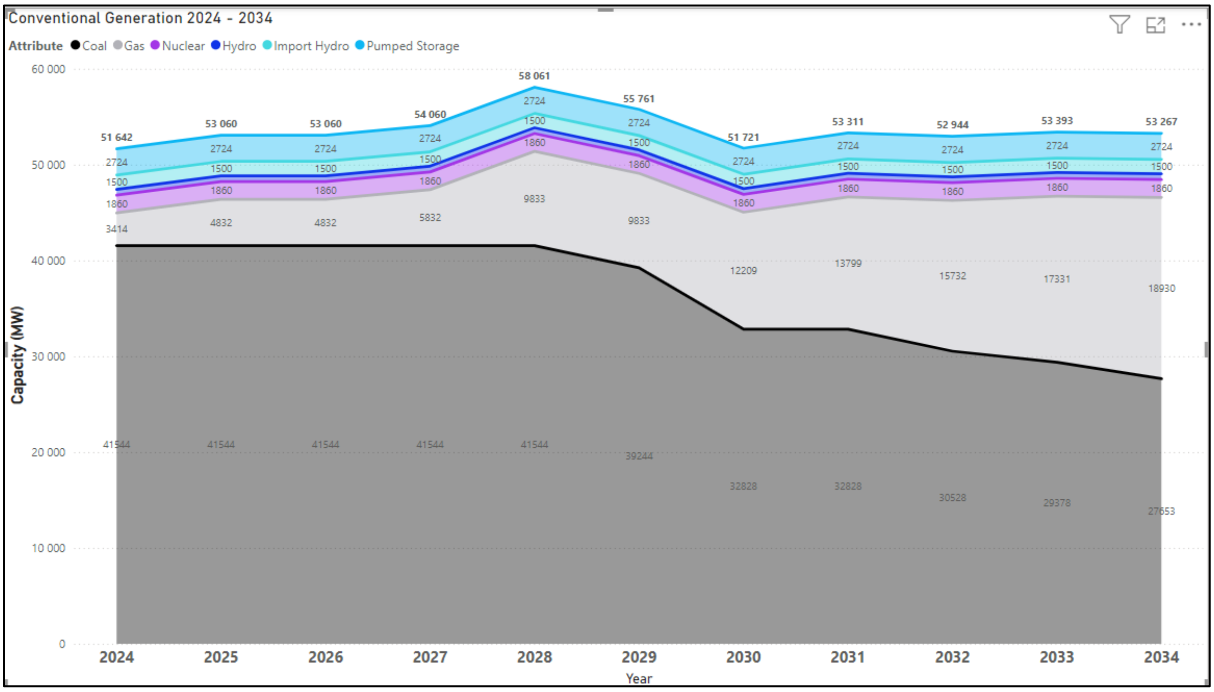


Figure 2-9: Conventional generation cumulative capacity schedule (by technology)

2.2.1 Nuclear Generation

There is no new nuclear generation in the TDP period in the Draft IRP 2023. Thus, the generation assumptions do not have additional nuclear generation either.

2.2.2 Gas Generation

The Draft IRP 2023 allocated 14.3 GW of gas up to 2034. The Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP) approved 1.4 GW of additional gas to be installed by 2025 (previously this was envisaged in 2022). The total additional gas generation capacity catered for in the generation assumptions is 15.7 GW including the RMIPPPP gas allocation in 2025.

2.2.3 Coal

There is no additional coal in the TDP period, the coal IPP projects previously envisaged have all been cancelled due to lack of funding.

2.3 RENEWABLE GENERATION

The total renewable generation capacity added to the system (including units from inception) is 53.2 GW by 2034, including battery capacity of 4.1GW, as shown in **Figure 2-10**. The total renewable capacity that will be added in the TDP period is 32.5 GW, including battery storage and rooftop PV.

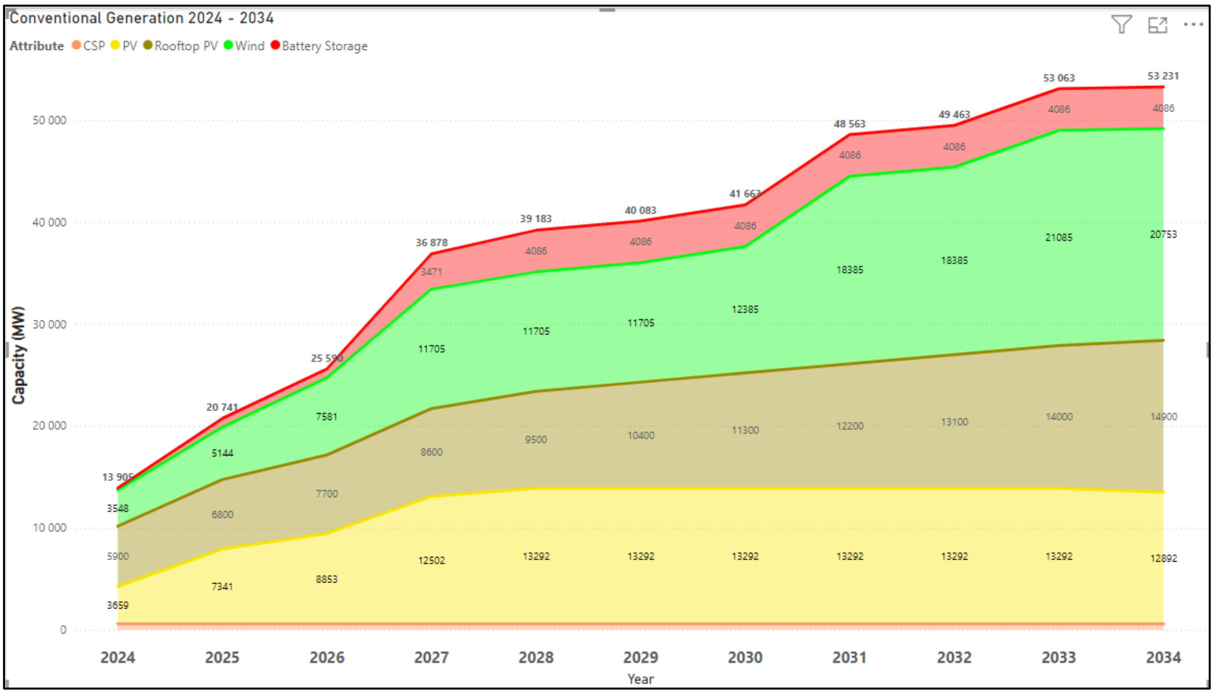


Figure 2-10: Renewable generation cumulative capacity schedule (by technology since RE build inception)

2.3.1 PV GENERATION

Solar PV is expected to reach 27.7 GW by 2034 including 14.9GW of rooftop PV. **Figure 2-10** indicates that 13.7 GW of PV capacity will be added in the TDP period alone. The PV installed in the TDP period includes 4.9 GW of BQs which were also taken into consideration as well as the 1.8 GW allowance for PV in REIPPPP BW 7.

2.3.2 WIND GENERATION

Wind is expected to reach 20.8 GW by 2034 including 3.2 GW of BW 7 and 3.9 GW of applications for wheeling IPPs. **Figure 2-10** shows that 15.6 MW of wind capacity will be added in the TDP period.

2.3.3 CSP GENERATION

Concentrated solar power (CSP) is expected to reach 600 MW by 2034, there is no additional CSP capacity during the TDP period. This is the same as the previous generation assumptions.

2.3.4 BATTERY CAPACITY

Battery capacity is expected to reach 4.1 GW by 2034. This is a reduction of 4.4GW from the TDP 2022 generation assumptions.

2.3.5 CAPACITY BUILD-UP

Figure 2-11 provides the generation build-up according to different categories. The total generation capacity in the final year of the TDP will be 106.6 GW. It is apparent from the graph that there is a huge increase in gas and renewables and an overall decline in coal. Values beyond the TDP period have been given to allow for strategic planning considerations beyond 2034.

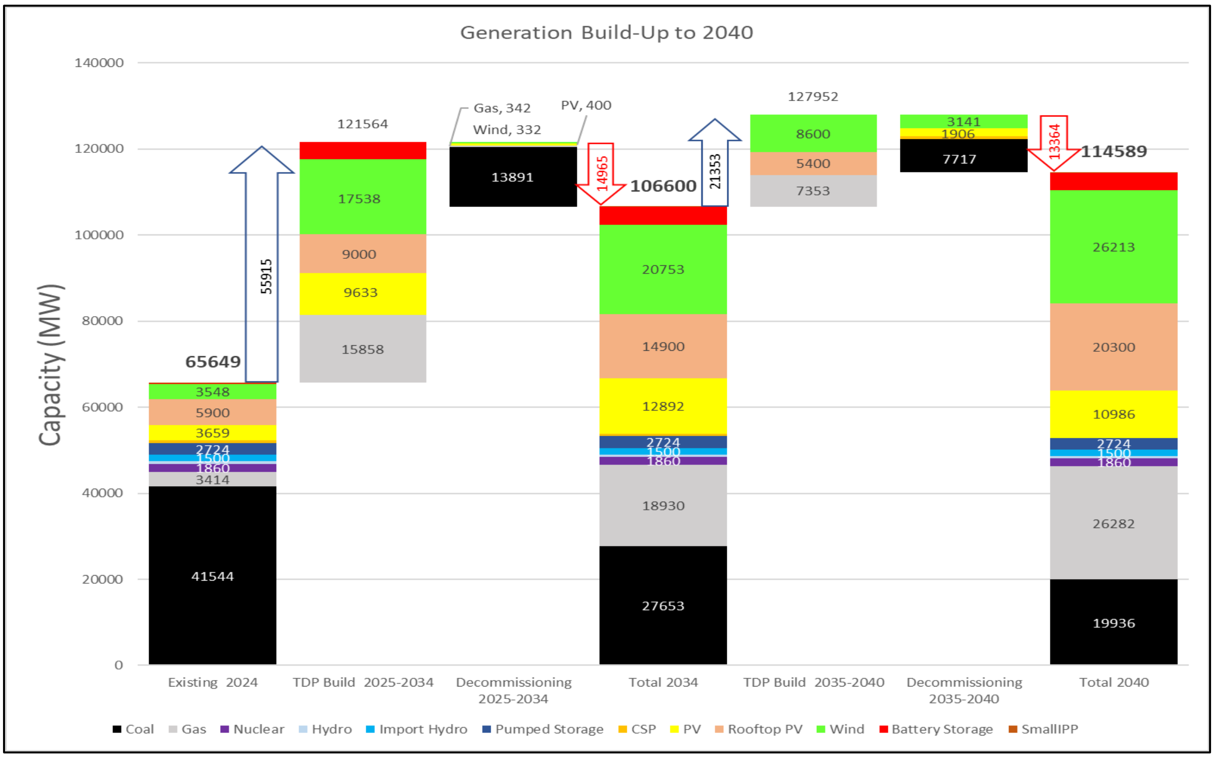


Figure 2-11: Generation build-up in different technology categories

2.4 DECOMMISSIONING OF POWER STATIONS

Figure 2-12 shows the decommissioning of plant up to 2040. By 2034, 17.6GW of generation of coal, gas, wind and solar generation would have been decommissioned. Out of this, 15.9 GW will be decommissioned during the TDP period. Solar and wind decommissioning has been allowed for as some of the REIPPPP BW 1 and BW 2 PPAs will come to an end.

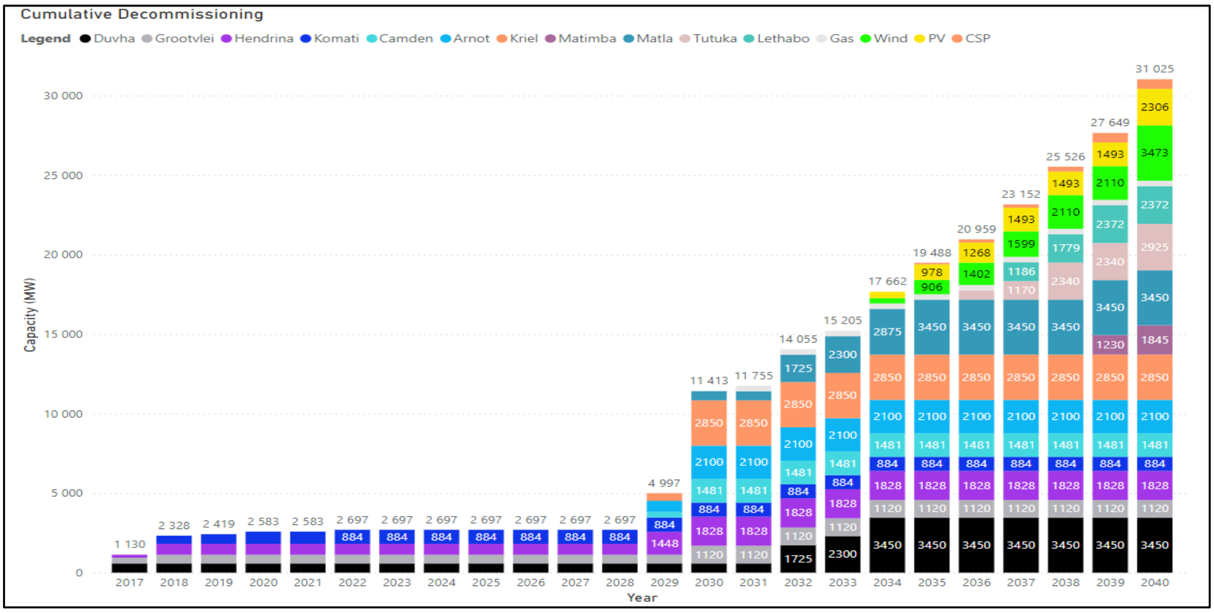


Figure 2-12: Decommissioning of generation (from decommissioning programme inception)

2.5 MAJOR DIFFERENCES FROM PREVIOUS ASSUMPTIONS

Figure 2-13 shows the differences between different technology categories in TDP 2024 and TDP 2022 (the last published TDP). The delta bar in each graphic shows the differences.

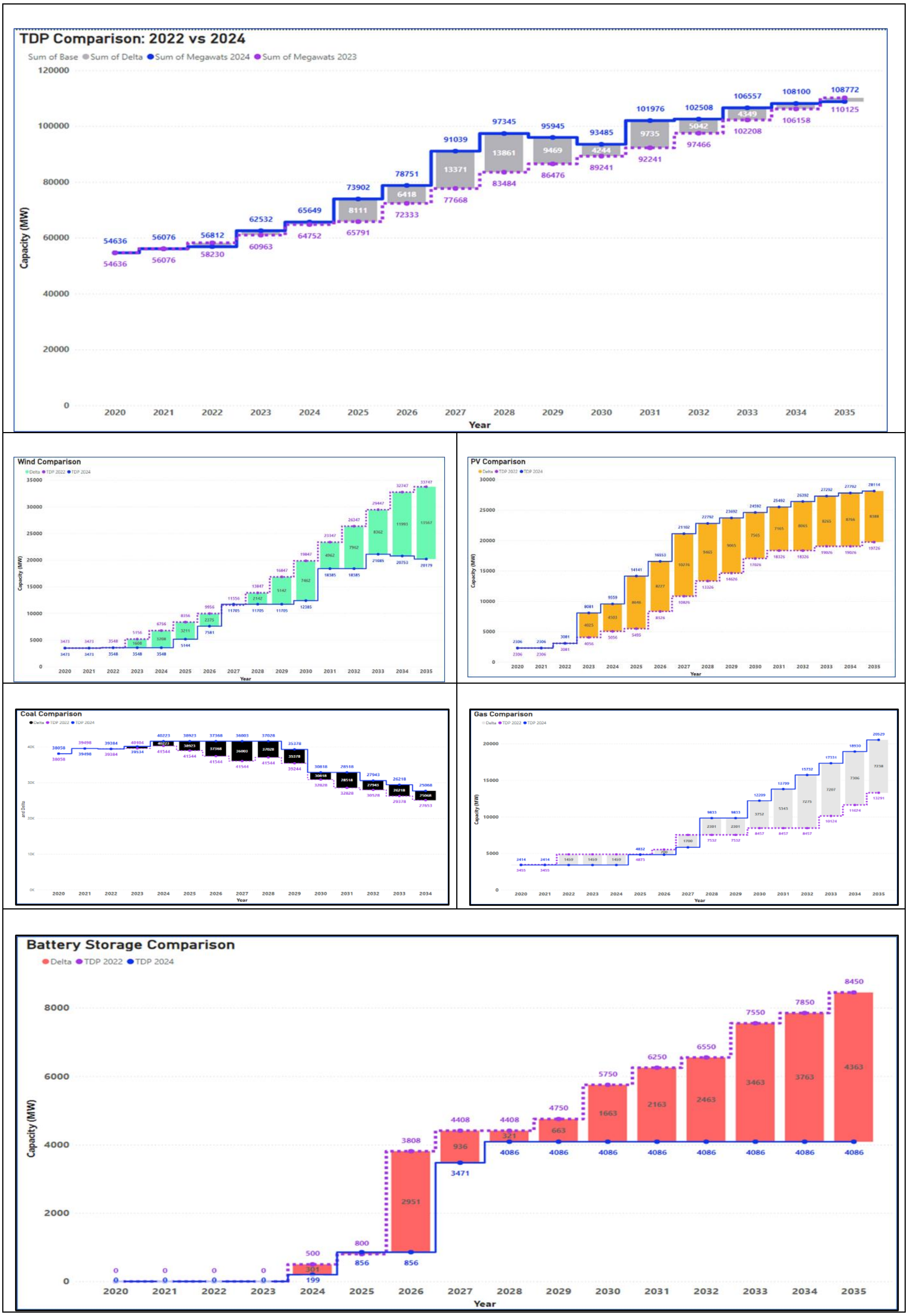


Figure 2-13: Differences in major technology categories

2.6 SPATIAL ALLOCATION

The spatial allocation of the generation capacity considers different attributes to ensure that the allocation is sound and can be reasonably implemented in the period under review. The factors that were considered are as follows:

a) Outcomes of the SEA regarding areas suitable for solar and wind after sensitive areas have been excluded (see **Figure 2-14**)

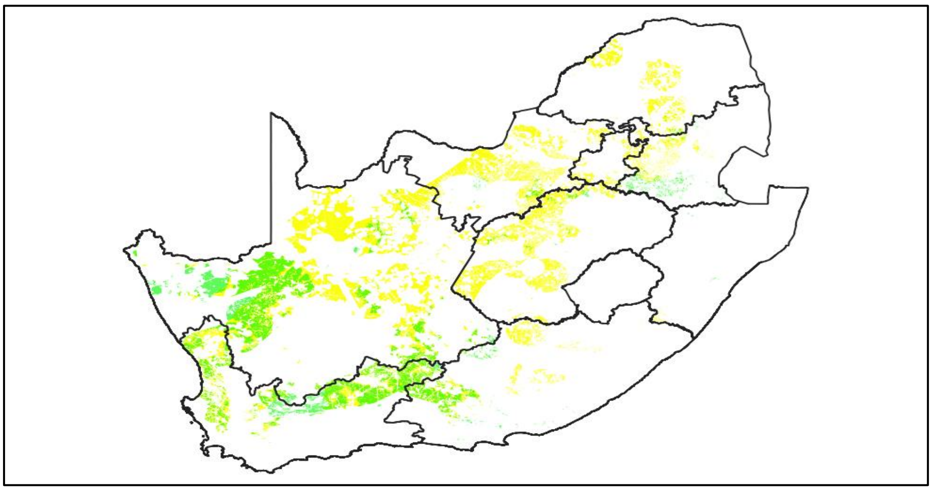


Figure 2-14: Areas suitable for PV (yellow) and wind (green)

b) EIA applications from IPPs in the past few years (see **Figure 2-15**)

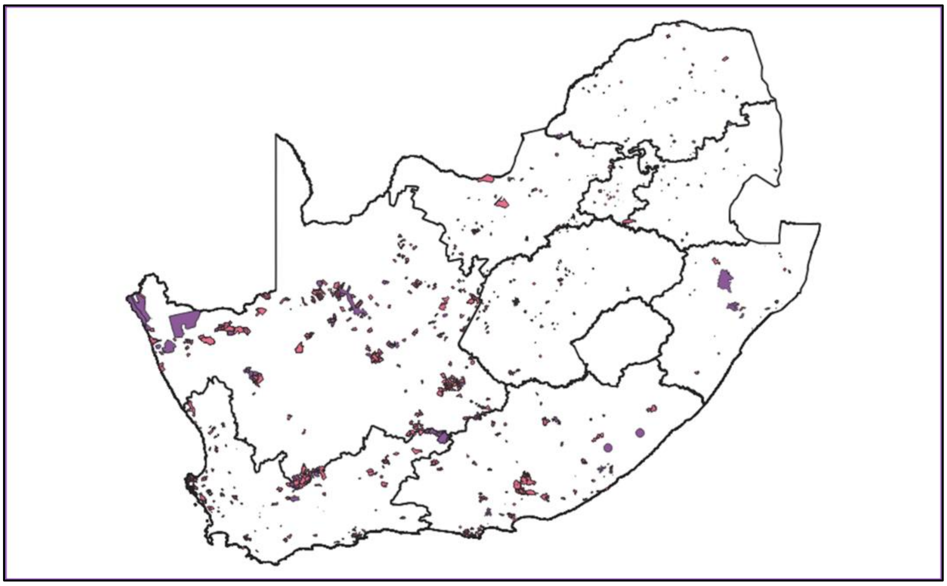


Figure 2-15: EIA applications from IPPs

c) BQ Applications for grid connection by IPPs in progress (see **Figure 2-16**)

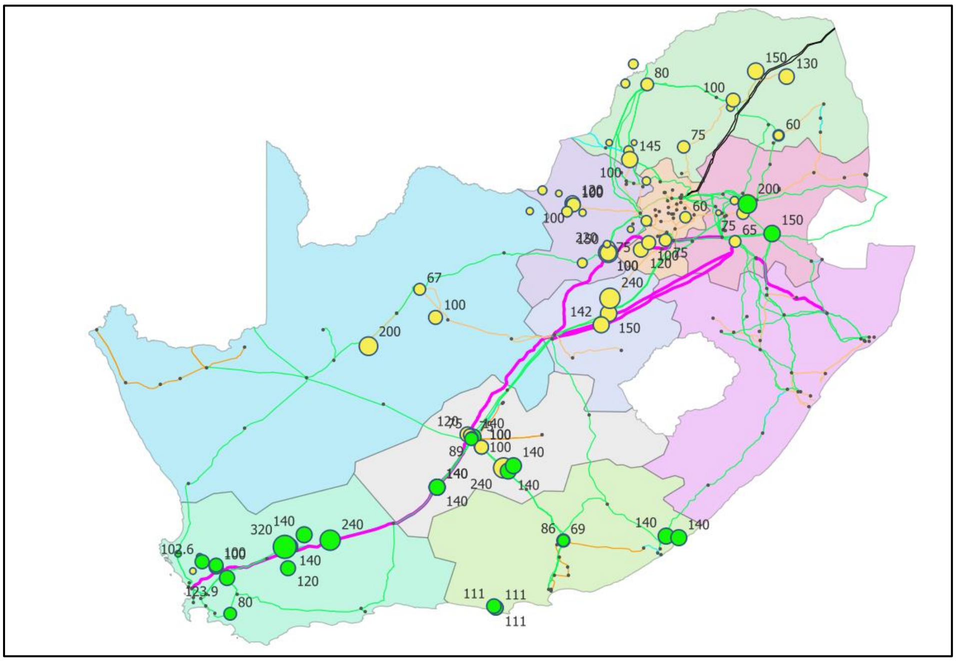


Figure 2-16: Substations with high concentrations of grid applications

d) SAPVIA/NTCSA 2023 RE Survey (see Figure 2-17) of IPPs regarding which technologies may be installed at different locations in the next few years

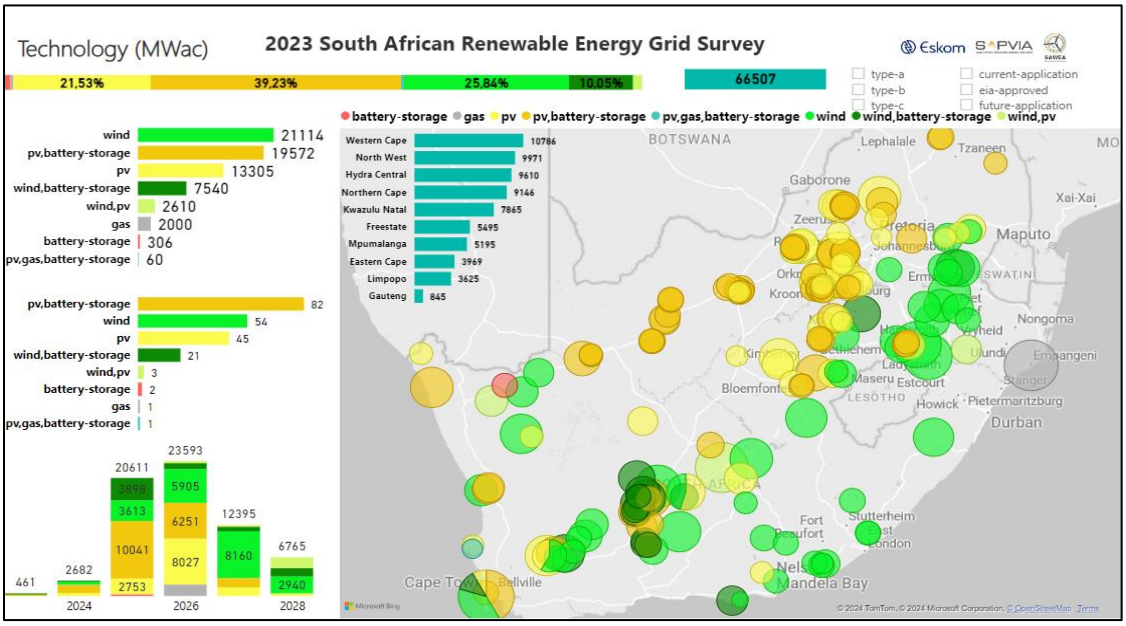


Figure 2-17: IPP survey of possible areas for PV and wind

e) GCCA 2023 results (see Figure 2-18) indicating capacity availability in the different Supply Areas.

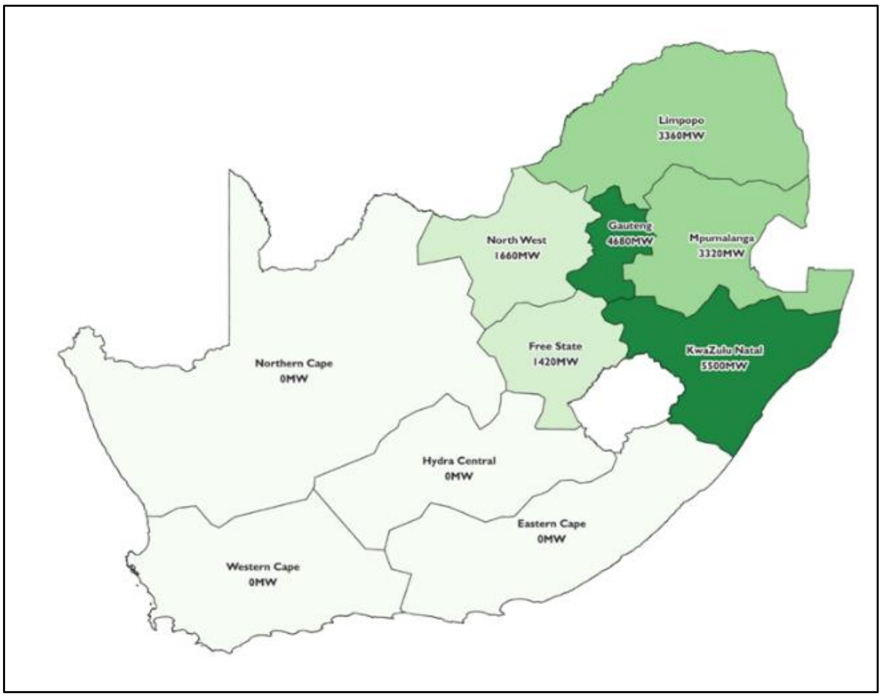


Figure 2-18: GCCA 2023 results per grid

f) Projected dates of major strengthening projects

After considering the combined effect of the above factors, the allocation results shown in Figure 2-19 (labels only shown for capacities > 500 MW) were obtained. It can be observed that the traditional coal areas of Mpumalanga also contain wind and solar generation. This is due to the fact that capacity has been exhausted in the Greater Cape region in the short to medium term and some of the generation is migrating there, rooftop generation is also prominent (light brown).

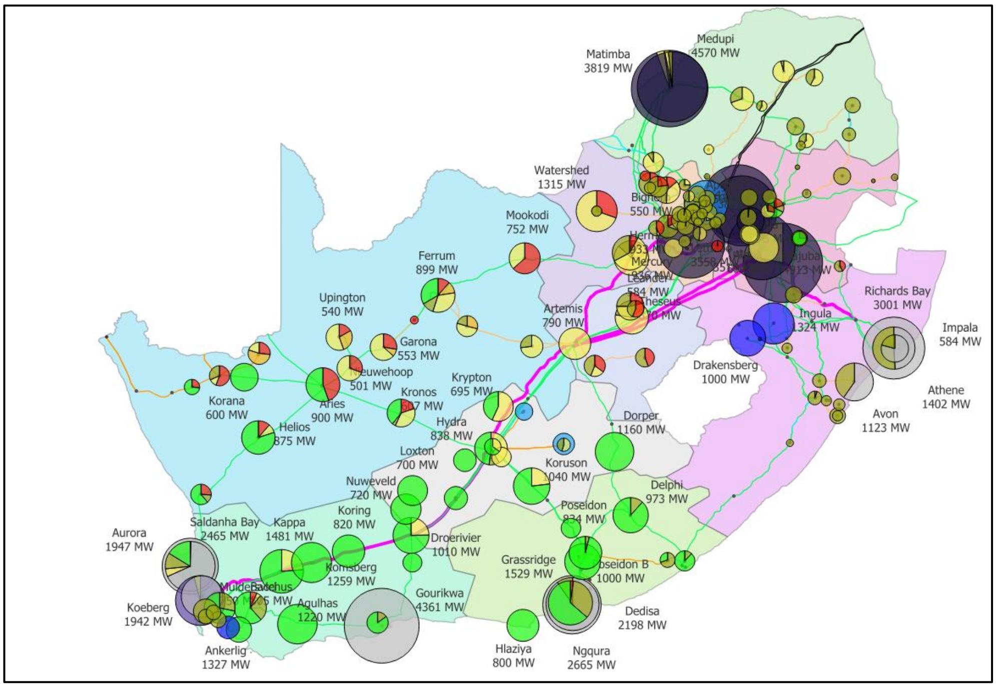


Figure 2-19: Spatial allocation of generation by technology

2.7 SUPPLY AREA ALLOCATIONS PER TECHNOLOGY

The cumulative provincial allocation for the different technologies by 2034 is shown in Figure 2-20. Western Cape has the highest installed capacity, followed by the Mpumalanga. Free State has the least amount of capacity, comprising mainly PV and Battery Storage.

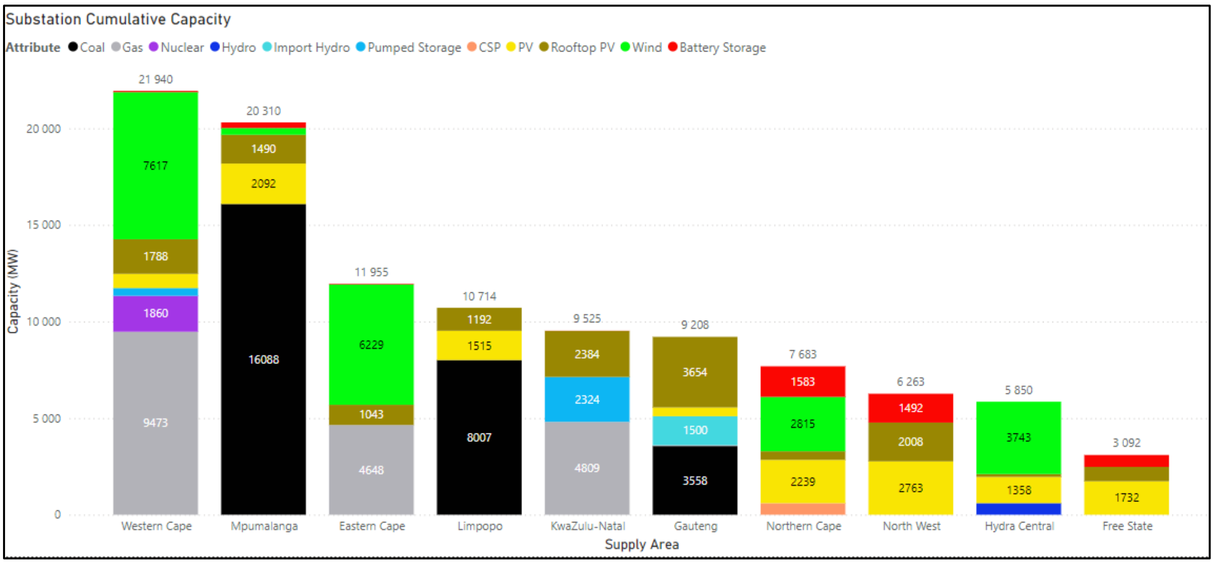


Figure 2-20: Allocation of generation by technology

3 DEMAND FORECAST

Electricity consumption is rising globally, driven by the transition to cleaner energy sources. Demand forecasts are essential for both short-term and long-term planning and are becoming increasingly complex due to the rapid adoption of new technologies and external factors influencing demand patterns.

The energy landscape is shaped by factors such as a country's utility structure, economic conditions, security of supply, pricing, and the introduction of new generation sources. Forecasting the demand patterns for the country while considering these factors becomes a crucial starting block in the planning process. Globally, electricity systems are transforming, with shifts from traditional supply chains to cleaner, more distributed energy sources. This evolution empowers consumers to influence demand patterns and supports the goal of achieving net-zero emissions. However, challenges such as the economic impact of the COVID-19 pandemic, the Russian-Ukrainian conflict, and global supply chain disruptions complicate demand forecasting. South Africa, in particular, faces unique drivers of electricity demand, including rising urbanisation, changes in heating and transportation preferences, and the rapid adoption of rooftop solar systems.

The NTCSA Demand Forecast Report is a key component in South Africa's energy planning, guiding the NTCSA Transmission Development Plan (TDP) for 2025-2055. Although the focus is on the period from 2025 to 2034, long-term planning remains crucial. This section of the document offers a comprehensive overview of the transmission network demand forecast forming the base of the strategic grid planning and development.

The transmission forecast methodology is based on a collective framework called the Integrated Strategic Electricity Demand (ISED) forecast framework which culminates the qualitative and quantitative factors included in the forecast. Figure 3-1 shows the framework.

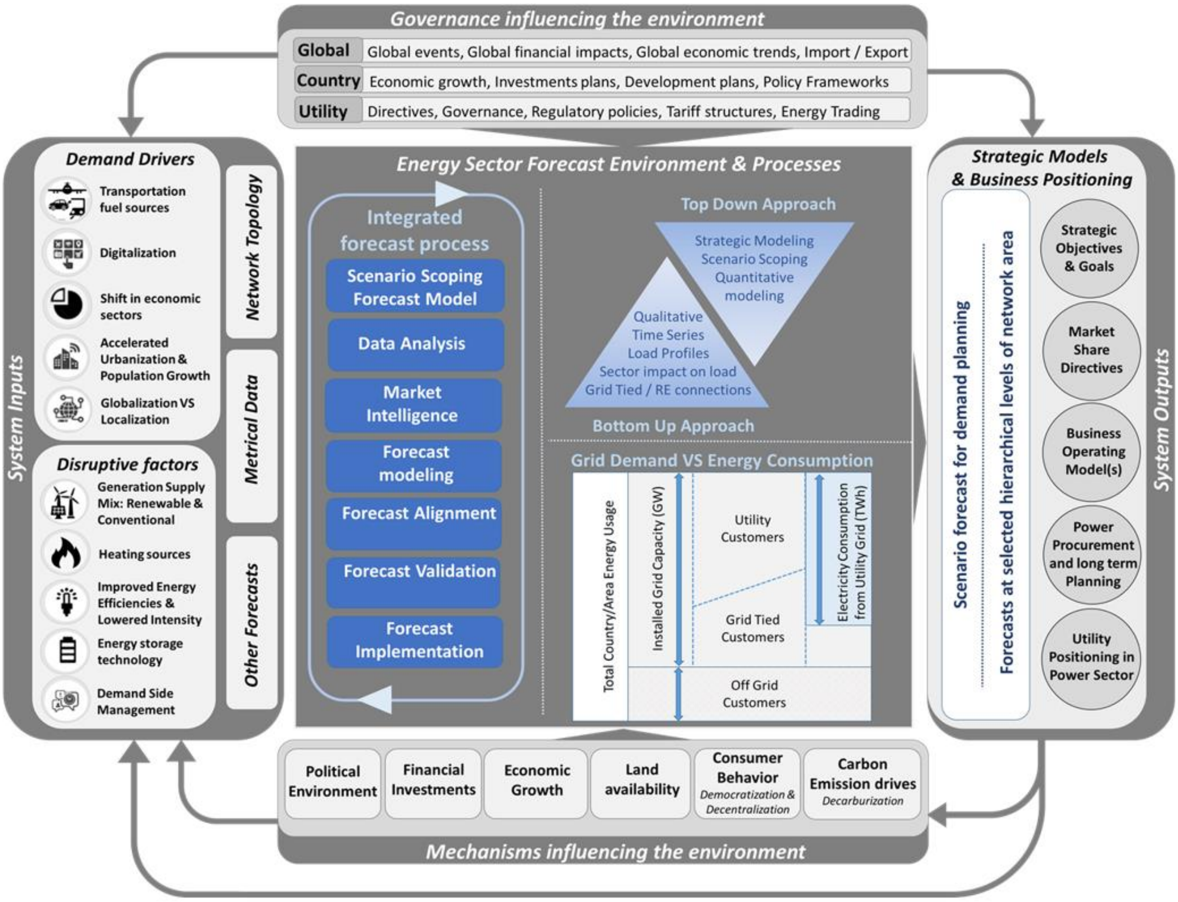


Figure 3-1: ISED forecast framework

The framework is then used to scope the forecast scenarios and from there the scenarios are modelled taking an S-Curve approach and using a transhipment nodal model to disaggregate load into spatial areas. The key input parameters from the framework are used as part of the modelling input to the forecast. Figure 3-2 depicts the interconnected information sets utilised as inputs and the subsequent outputs crucial to the forecast.

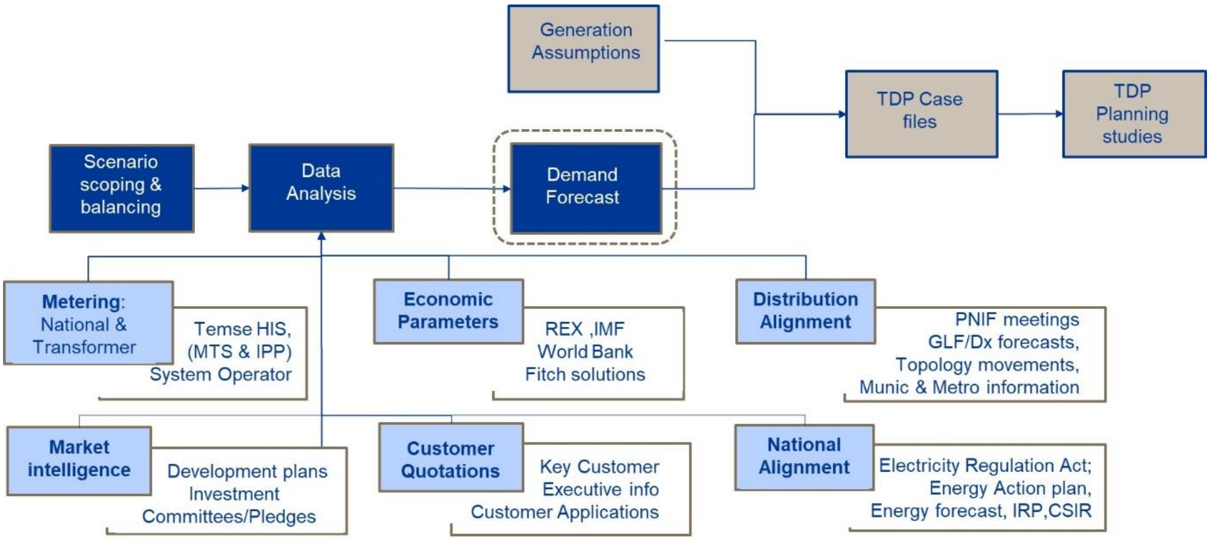


Figure 3-2: Information flow of forecast data

From the data analysis and top-down load forecast, the disaggregated spatial load is verified with bottom-up information that includes interaction with each Distribution division and the available Geo Load Forecasting files used from the Distribution level and aggregated up to Transmission station supply areas. Further alignment is done with metropolitan areas and Key Customers through the Customer Executives allocated to these customers, and engagements are held and forecasts exchanged where available and updated. Further Market research is used to unlock potential load for future developments.

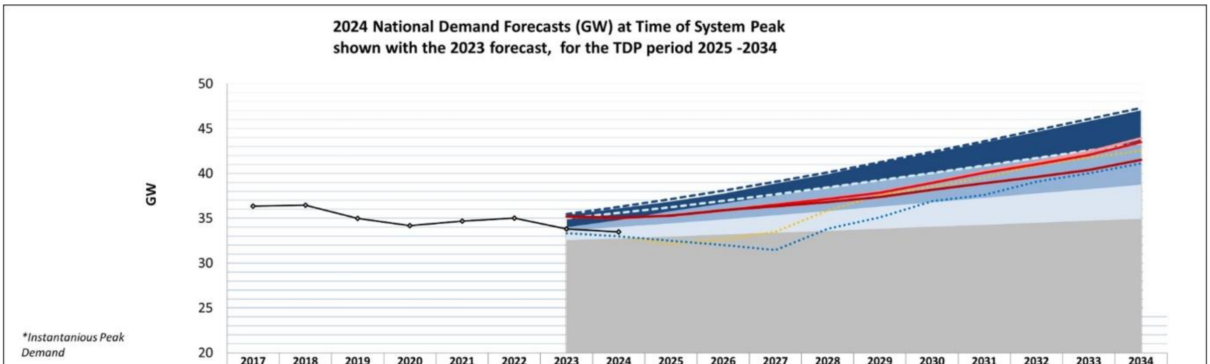
3.1 TRANSMISSION DEMAND FORECAST SCENARIOS

The TDP planning period from 2025 to 2034 considers four main forecasting scenarios, each with different implications for grid connectivity, technological innovation, and energy efficiency. These scenarios range from a high-demand future, driven by increased electrification and digitalisation, to lower-demand scenarios focused on renewable energy and reduced reliance on fossil fuels. Figure 3-3 provides a summary table on the demand forecast scenarios.

Parameter	High *"Fly high and Enable Green Exports"*	Moderate High *"Enable, collaborate with RE grid solutions & markets"*	Medium (Energy Efficiency) *"Sharing the energy supply market"*	Low *"Losing Market Share in the industry, persistent slow economy"*
Worldwide & Country Economic conditions (GDP%)	Excellent growth >3% in long term	Steady Growth >1,5% in short term and >2% in long term	Moderate to slow growth of <1% in short term and >1% in long term	Deteriorating economic growth <0.5%.
Load supplied from NTCSA	High – 46GW in 2034 up to **60GW 2050**	Moderate high- 43GW in 2034 up to **52GW 2050**	Lower – 39GW in 2034 Up to **44GW 2050**	Very low, sustaining current – 34GW in 2034 up to **36GW in 2050**
Energy Availability (EAF%)	Very High	High	Moderate	Low
Network strengthening implementation enabling demand	Surpass targets	On par with latest TDP Plans	Below TDP aims, with low growth & maintenance	Sustain current network only
Installation of DER including Rooftop, and storage	Low off grid use, mostly using NTCSA for wheeling and grid backup.	Some peak deflection, mostly off peak use, back up. Wheeling of RE by larger companies.	Great peak deflection and off grid solutions increasing	Mostly grid deflection, great increase in battery storage solutions not connected to the national grid.
Infrastructure development role out from Government	High	Moderate high	Low	Extremely low
Hydrogen role out	Hydrogen for local use and export markets	Hydrogen only for local use increasing local beneficiation/manufacturing	No hydrogen local use, no Hydrogen plant connected to NTCSA	No hydrogen developments
Energy intense industry for load growth	Hydrogen, Data Centers Local beneficiation & Manufacturing of Steel, Platinum, Battery and PV manufacturing	Data Centers, some hydrogen in the long term. Localized beneficiation of increase in steel, motor vehicles and Battery and PV Manufacturing	Some Data centers, Greater export market for raw materials, no inhouse beneficiation.	Declining data centers connections, all manufacturing exported.
IRP alignment	Greater than IRP short term Lower than IRP in 2050 (IRP 67GW)	On Par with IRP Reference scenario Lower than IRP in 2050 (IRP 64GW)	Below IRP Low and Reference scenarios, on par with IRP 2040 in long term	Below IRP Low and Reference scenarios, on par with IRP 2030 in long term

Figure 3-3: Demand Forecast Scenarios

The four main scenarios linked with two constrained forecasts with recorded actuals can be seen in Figure 3-4. In 2022, the recorded system peak reached 34.66 GW, marking a modest 0.6% increase from the 2021 peak of 34.4 GW. The 2023 system peak was recorded as 33.8 GW, reflecting a substantial 2.4% decrease compared to 2022, and 2024 is currently projected as 33.4 GW another 400MW decrease over the peak period. This decline can be attributed to the extensive implementation of load shedding and economic limitations, returning the system peak to levels last seen in 2004. Despite this reduction in energy consumption, the network must maintain its capacity liability and continue to meet peak capacity demands.



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
2024 Tx High							35	36	37	38	39	40	41	42	43	45	46	47
2024 Tx Moderate High							34	35	36	37	38	38	39	40	41	42	43	43
2024 Tx Medium EE / EI							34	34	34	35	35	36	36	37	37	38	38	39
2024 Tx Low							33	33	33	33	33	34	34	34	34	34	35	35
2023 Tx High							35	36	37	38	39	40	41	42	44	45	46	47
2023 Tx Moderate High							35	36	36	37	38	38	39	40	41	42	43	43
Actual Peak Demand (GW) *	36.4	36.4	35.0	34.2	34.7	35.0	33.8	33.5										
Constrained Scenario 1							33	33	32	33	33	36	38	39	40	41	42	43
Constrained Scenario 2							33	33	33	32	31	34	35	37	38	39	40	41
2023 IRP Demand (GW) High scenario							35	35	35	36	37	37	38	39	40	41	42	44
2023 IRP Demand (GW) REF scenario							35	35	35	36	36	37	38	39	40	41	42	43
2023 IRP Demand (GW) Lowscenario							35	35	35	36	36	37	37	38	39	40	40	42

Figure 3-4: 2024 Demand Forecasts

3.2 SCENARIO OVERVIEW

The Transmission High scenario targets a net sent-out capacity of 65 GW by 2045, anticipating a 3% average annual demand growth, requiring a 10 GW system expansion and considers high energy-intensive demands such as Hydrogen expansions additional to current known loads. The Transmission Moderate-High scenario, aligning with historical growth trends, also aims for 65 GW only by 2060, with a peak load of 43 GW by the end of the Transmission Development Plan (TDP) period and 47 GW by 2040, considering increased electricity usage in sectors like ICT (Data Centres), transportation including electric vehicles (EVs). The Transmission Mid Energy Efficiency scenario adjusts the Tx High forecast by factoring in more distributed generation, projecting 39 GW during peak times by 2034 and 40 GW by 2040, with a focus on enhanced energy efficiency and off-grid connections. Lastly, the Low Transmission forecast aims for 36 GW by 2040, reflecting low energy demand with a 0.6% annual growth rate, emphasising renewable generation and reduced reliance on fossil fuels, this will hinder economic growth and is not advisable.

3.3 CONSTRAINED SCENARIOS

Two constrained scenarios are included to address expected low demand in the near term, influenced by the economic impacts of the COVID-19 pandemic and current electricity supply constraints. These scenarios expect a five-year lag in demand uptake but propose planning based on unconstrained forecasts to facilitate future demand growth. It can be noticed that the actual data is trending close to this forecast and the expectation is that the demand from the country will be met gradually as the EAF trends into higher availability ranges as part of the turnaround plan coming into effect.

3.4 PREFERRED SCENARIO

The Tx Moderate-High scenario is favoured for the TDP 2025-2034 planning cycle, serving as the primary basis for supply area and substation forecasts. While adjusted for current baseload conditions, it remains consistent with previous forecasts. Other scenarios are suggested for sensitivity analysis due to the uncertain forecasting environment.

3.5 DRAFT IRP 2023 COMPARISON

The 2023 IRP Draft forecast was compared to the TDP forecast and it is observed that it correlates well with the preferred, Moderate high Scenario forecast used as input to the TDP

2024. The IRP includes demands such as Hydrogen and Electric Vehicles mostly in periods beyond the TDP timeline.

Despite the current challenges, South Africa has significant potential for growth, supported by local and international investment initiatives. Aligning transmission demand forecasts with national goals and policies, such as the National Development Plan (NDP) and Integrated Resource Plan (IRP), is essential for the country's economic development. Additionally, decarbonisation efforts, including the development of green hydrogen and other electricity-based fuels, will play a critical role in shaping future demand.

Long-term forecasting remains uncertain, requiring both quantitative and qualitative approaches to ensure robust decision-making. The forecast methodology for South Africa's electricity demand involves scenario planning and a comprehensive analysis of various factors that influence demand. The preferred scenario for the TDP 2025-2034 cycle is the moderate-high scenario, which is used as the primary input for supply area and substation forecasts.

The success of South Africa's energy transition depends on collaboration between government and private sector investments. By supporting the growing demand for electricity and ensuring a stable energy supply, South Africa can foster economic growth and improve the quality of life for its citizens.

4 COMPLETED PROJECTS

A summary of transmission expansion projects completed since the publication of the previous TDP in 2022 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 2022

Province	Project name
Free State	Waterberg Fault Level Management Plan (Perseus)
Mpumalanga	Highveld South Reinforcement SoI MTS Phase 1
Northern Cape	Loeriesfontein Orange IPP Integration at Helios
Northern Cape	Northern Cape Strengthening: Ferrum-Nieuwehoop
Northern Cape	Scatec Kenhardt 3x50 MW PV Plants Integration
Western Cape	Ankerlig-Sterrekus 400 kV Line
Western Cape	Excelsior IPP Integration at Bacchus
Western Cape	Deep Strengthening for IPP (Komsberg)

5 CUSTOMER APPLICATIONS

Table 5-1 below outlines the number of indicative cost estimates (ICEs) and budget quotations processed by NTCSA during the 2023/24 financial year (April 2023 to March 2024). 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.

Table 5-1: Connection applications received and accepted in FY2023/24

Type of quotation	Budget		ICEs		Total	
Service required	**Quote**	**Accepted**	**Quote**	**Accepted**	**Quote**	**Accepted**
Generation	24	0	390	12	**414**	**12**
Load	13	0	20	6	**33**	**6**
Network service	2	0	9	3	**11**	**3**
Total	**39**	**0**	**419**	**21**	**458**	**21**

6 NATIONAL OVERVIEW

The establishment of large-scale RE generation is still the primary driver of network development in the country, especially in the three Cape provinces. A significant amount of 765 kV power corridors will be required in the Northern Cape and Central Cape regions as well as interconnecting Eastern Cape to KwaZulu-Natal. This is for the evacuation of the excess RE generation to the load centres in the northern parts of the country. Furthermore, strengthening of the 400 kV network across the system is needed in the form of interconnecting corridors between the 765 kV and the underlying 400 kV networks, as well as for local and regional strengthening.

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.

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 below 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.

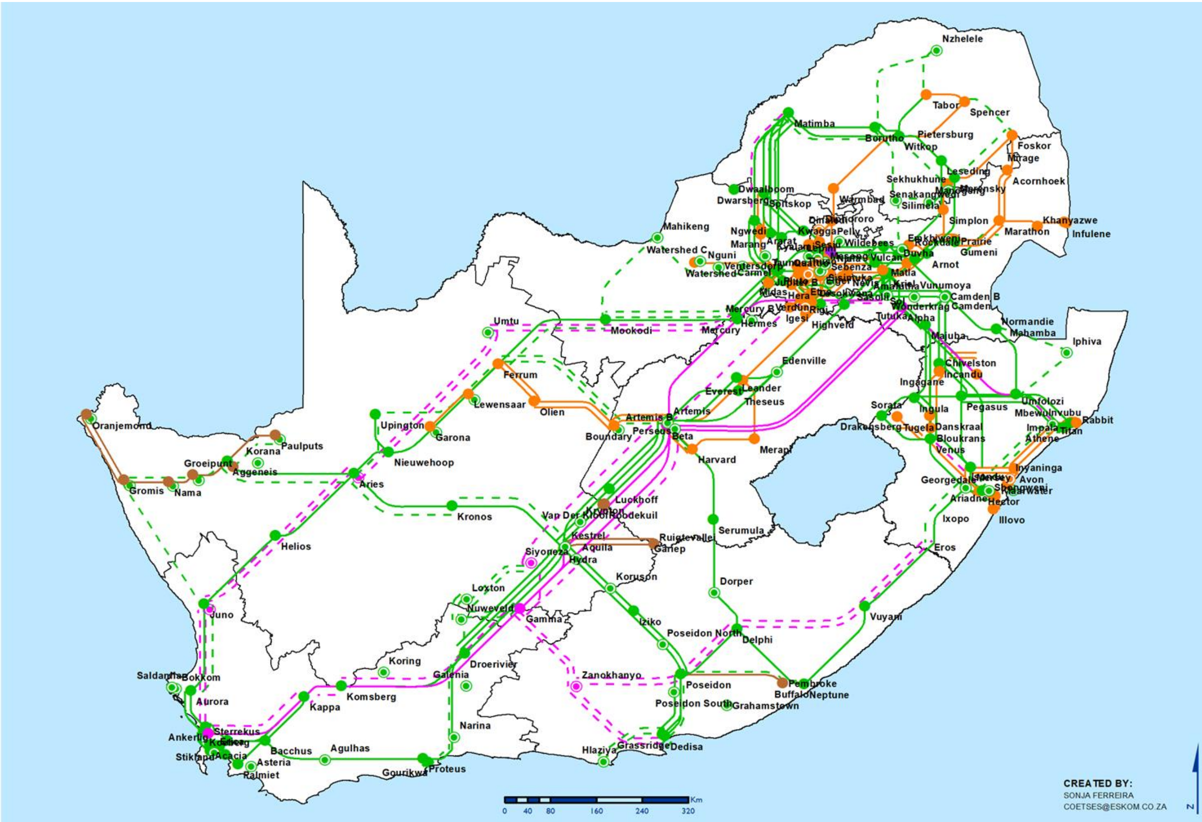


Figure 6-1: High-level overview of the major TDP scheme projects

The TDP is an unconstrained plan based on the assumption that capex, servitudes, and resource capacity and capability across the EPCM value chain will not pose any hindrance to the implementation of the TDP rollout programme.

Based on the TDP 2024, it is anticipated that some 14,494 km of lines and 133 GVA of transformations (211 transformers) will be required to augment the transmission system over the TDP 2024 period. These infrastructure developments will resolve existing network reliability issues, integrate the new generation capacity for the country and connect customers needing additional or new loads. The table below provides a breakdown of the new assets that are planned for expansion projects for the TDP 2024.

Due to the current network constraints especially in areas with strong RE potential, the augmentation of the transmission system will need to be expedited to meet the draft IRP 2023 requirements as well as to integrate the committed and potential RE connection applications processed.

Table 6-1: TDP 2024 Asset requirements for Expansion

TDP 2024 Infrastructure Requirements	New Assets expected 2025 - 2029	New Assets expected 2030 - 2034	TDP 2024 New Assets: 2025 - 2034
Power lines (km)			
765 kV	767	6190	**6957**
400 kV	4251	3226	**7477**
275 kV	26	34	**60**
Total length (km)	**5044**	**9450**	**14494**
Transformers			
Number of units	87	123	**210**
Total capacity (MVA)	41 325	91 325	**132650**
Capacitors			
Number of units	15	25	**40**
Total capacity (MVar)	1032	1 660	**2692**
Reactors			
Number of units	14	45	**59**
Total capacity (MVar)	3260	13 000	**16260**
Synchronous Condensers			
Number of units	7	1	**8**
Total capacity (Mvar)	5850	900	**6750**

The table above also makes reference to the installation of eight synchronous condensers which will be required to provide system security due to the decommissioning of conventional power stations and the introduction of large-scale renewable energy located in the Greater Cape, far from the load centres in the IPS.

- **Significant rise in renewable energy penetration levels*:***

  The planned decarbonization of the South African generation asset mix has seen a steady increase in the level of penetration of the national RE capacity. The acquisition of RE, consisting mainly of wind and PV generation solutions, is planned by the IRP and driven by national procurement and development programmes. This RE capacity is planned to rise significantly over the next several years. The IRP also directs the expected decommissioning of the coal generation fleet given the advanced age of the majority of the power stations making up this component of the generation fleet. This planned decommissioning also adds significantly to the relative penetration level of RE.

- **High RE penetration levels cause grid instability:**

  RE technologies do not have high inertia rotating masses that synchronize with the national grid as is the case of thermal stations utilizing large turbines and generators. Instead, RE technologies make use of inverter technologies to condition the power generated to match the grid phase and voltages to feed the power onto the grid. As the penetration level of RE increases so the number of high inertia synchronous generators connected to the national grid will decrease. Synchronous generators naturally provide frequency, fault level and reactive power support to the grid enhancing its stability. Given the absence of high inertia rotating masses these stability characteristics are not inherent in RE technologies. Instead, the control logic and inverter technologies used in RE technologies create additional instabilities that do cause problems in maintaining the stability of the grid.

- **Need identified for synchronous condensers (SynCons):** During the compilation of the TDP 2022 the increased renewable generation capacity coupled with a slower rate of the implementation of projects raised grid stability concerns. In order to assess these concerns a system security assessment for the year 2027 was initiated analysing grid frequency and angular stability. Synchronous condensers include support with inertia, voltage and system strength in one package and are a preferred way of replacing the lost inertia in a grid when synchronous generators are replaced with high levels of RE penetration. The table below highlights the relative advantages of synchronous condensers when comparing them to other grid stabilizing technologies.

Table 6-2: Effectiveness of synchronous Condensers in comparison to other technologies

Solution	Continuous voltage control	Dynamic voltage support	Overload	Short-circuit duty	Inertia
Capacitors	Weak	No	No	No	No
Static VAR Compensator (SVC)	Weak	Yes	No	No	No
Static Synchronous Compensator (Statcoms)	Strong	Yes	No	No	No
Synchronous Condensers	Strong	Yes	Yes	Yes	Yes

The key assumptions from the IRPs that were used in the technical studies are listed below:

- ~ 30 GW of new generation capacity is projected in the draft IRP 2023 up to 2030, which is similar to the assumptions used in the TDP 2022 which was based on the IRP 2019.
- For the TDP 2024, a new generation capacity totalling 56 GW is expected over the period from 2025 up to 2034 when taking into consideration the Reference Case (Pathway One) in the draft IRP 2023 for the period 2031 - 2035. The table below compares the generation assumptions considered in TDP 2022 vs TDP 2024.

Table 6-3: Generation Assumptions Comparison

Technology	TDP 2022 (GW)	TDP 2024 (GW)	Variance (GW)
PV	16	9.6	-6.4
Wind	23	17.5	-5.5
BESS	6.5	3.9	-2.6
Gas	5	15.9	10.9
Hydro	2.5	0	-2.5
Rooftop PV	0	9	9
Total	**53**	**55.9**	**2.9**

- ~ 56 GW of new generation capacity is projected in the draft IRP 2023 over the TDP 2024 period (2025 to 2034), which is similar to the 53 GW planned for in the TDP 2022; however, noting the reduction of PV, wind, BESS and hydro with an increase in gas and rooftop PV in the TDP 2024.

System Security studies based on the IRP 2019 and then optimised utilising the Draft IRP 2023 have identified seven sites to integrate the synchronous condensers and associated plant to provide inertia, voltage support and short circuit power. The eight site is currently being optimised for beyond 2030 and will be detailed in the next TDP report. The first seven synchronous condensers will be located at the following sites and depicted in Figure 6-2:

- Gromis

- Aggeneis
- Ferrum
- Gamma
- Koruson
- Grassridge
- Vuyani

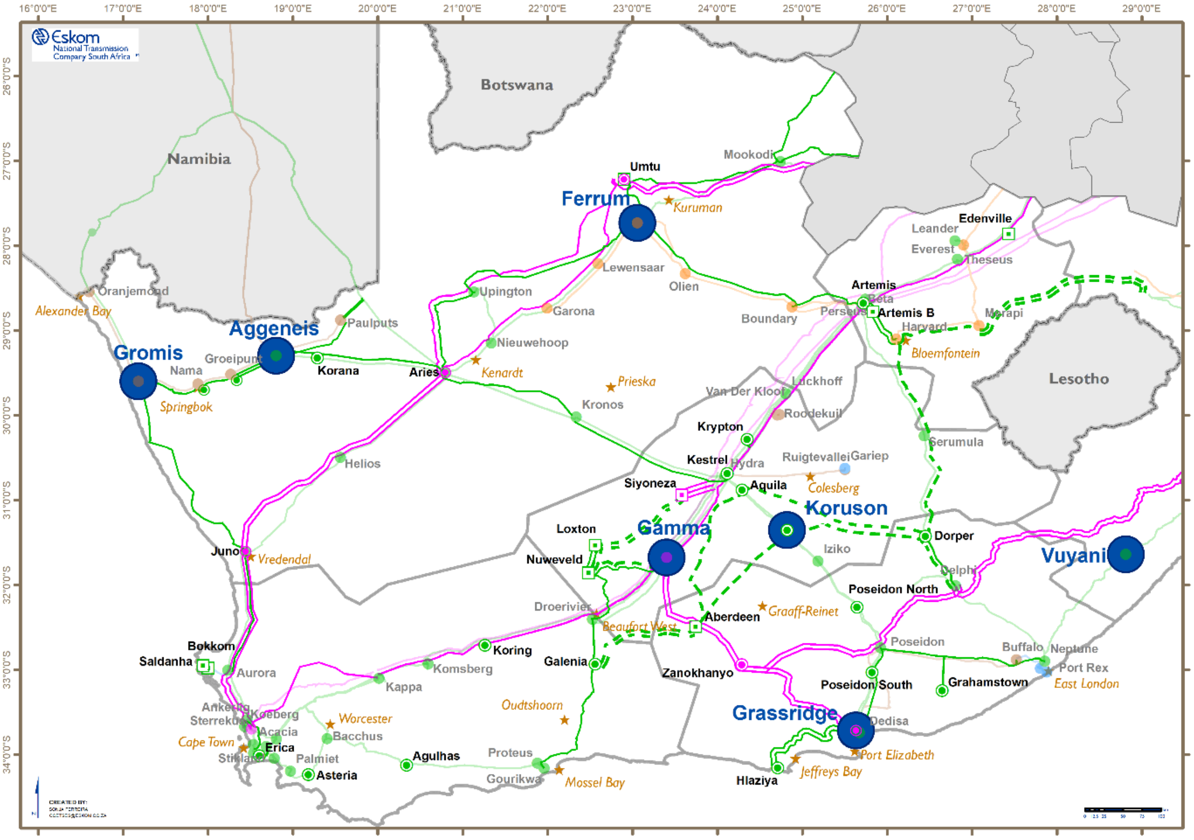


Figure 6-2: Locations of Synchronous Condensers

7 SUPPLY AREA 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 with the two largest cities and major industrial centres in the province being Gqeberha (formerly known as 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 (NMBM) in Gqeberha and Buffalo City Metropolitan Municipality (BUF) in East London are the two major automotive 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 Gqeberha 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 network infeeds into the East London area consists 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.

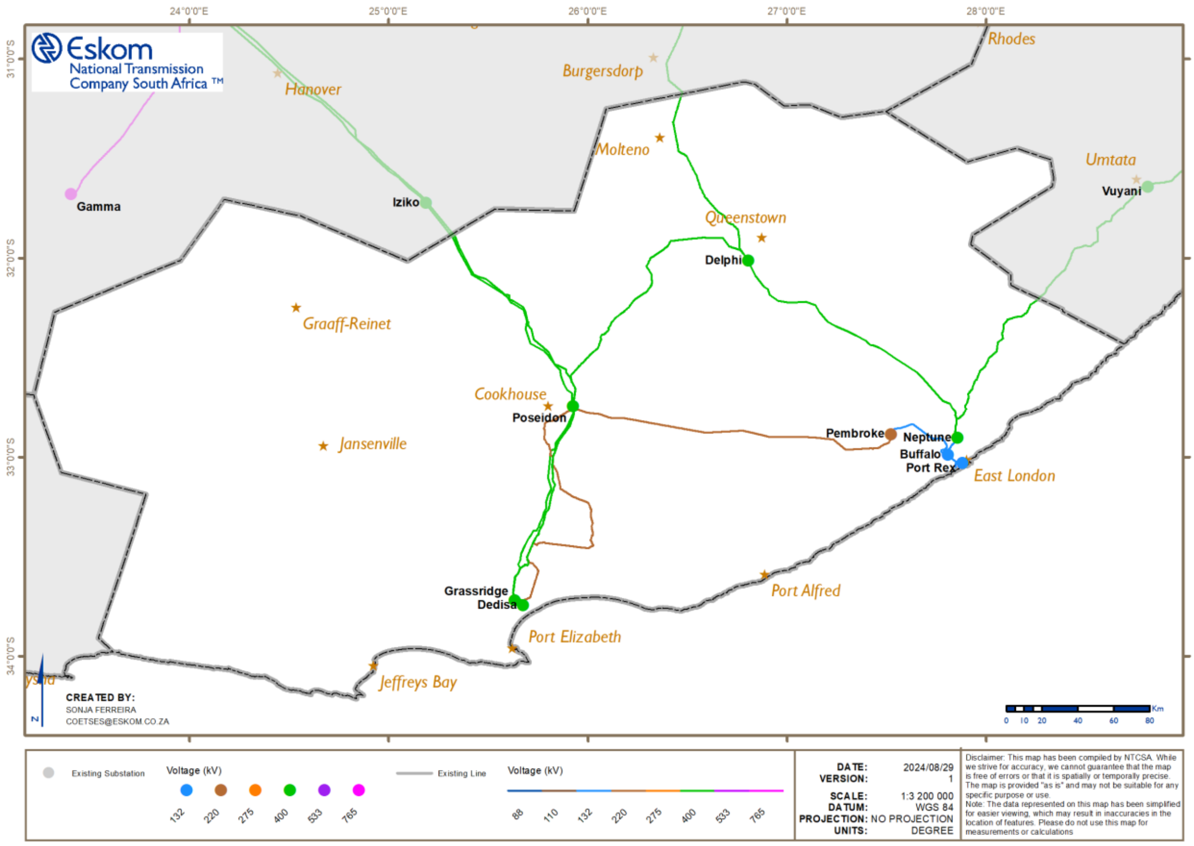


Figure 7-1: Current Eastern Cape transmission network

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 generating capacity of 171 MW (three units rated at 57 MW each), operating as a peaking plant. Since the introduction of the REIPPPP programme, additional gas generation at Dedisa substation (known as Dedisa OCGTs) was introduced with a generating capacity of 335 MW, operating as a peaking plant. In recent times, the national power deficit has resulted in these peaking plant power stations generating outside the typical peak periods.

The total approved generating capacity in the Eastern Cape, since the introduction of renewable energy independent power producers (RE IPPs) in the province, amounts to 1883 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)	Gas (MW)	Grand total (MW)
DoE Gas Peaker	0	0	335	335
IPP RE 1	482.1	0	0	482.1
IPP RE 2	339.7	75	0	414.7
IPP RE 3	196,6	0	0	196,6
IPP RE 4	420	0	0	420
IPP RE 4B	34.5	0	0	34.5
Grand total	**1 472.9**	**75**	**335**	**1882.9**

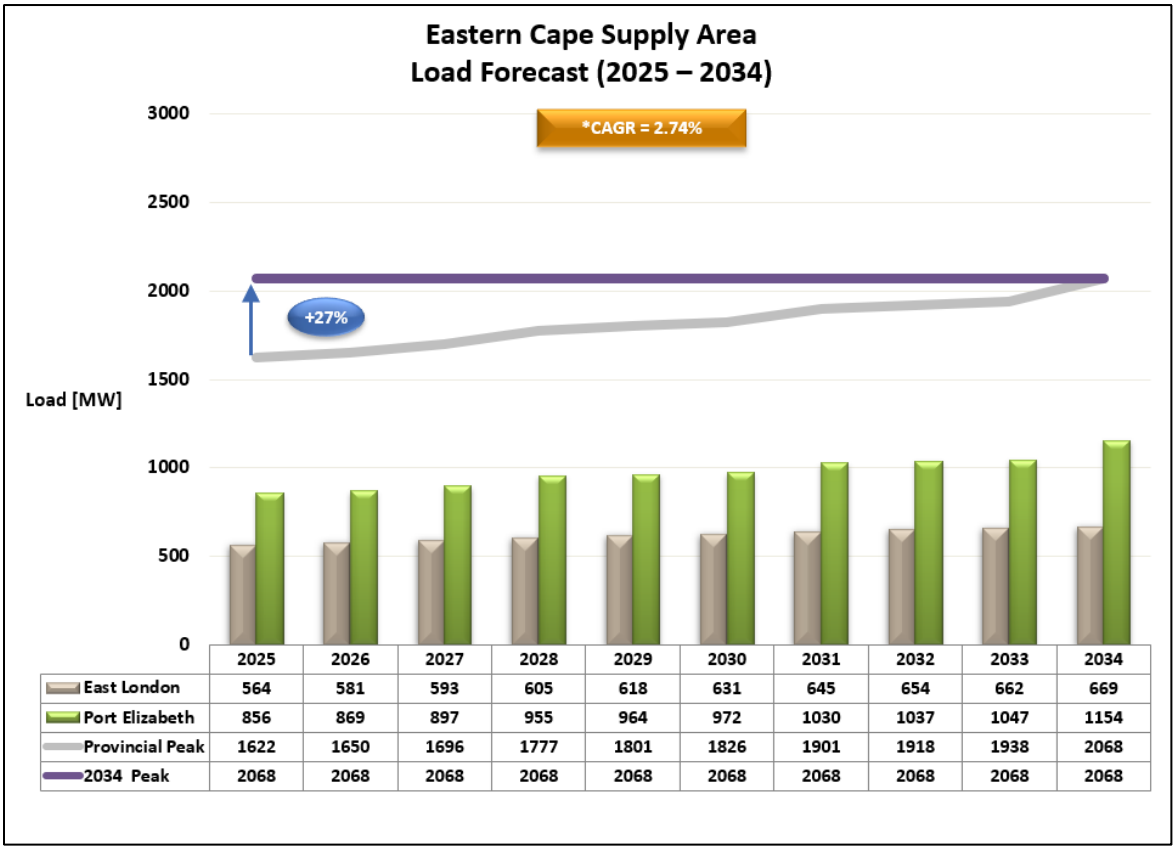
7.1.2 LOAD FORECAST

The provincial load for the Eastern Cape peaked at around 1 785 MW in 2023, and it is expected to increase to about 2 068 MW by 2034. 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 Local Area is forecasted to increase from 805 MW to about 1 154 MW in the next 10 years. The bulk of the expected load increase in the Local Area is attributable to the industrial development at Coega. Another potential load in the Eastern Cape is the introduction of green hydrogen production and is not included in the load forecast yet.

The East London Local Area has a mixture of rural and urban loads. Most of the rural electrification is anticipated to be in the northern parts of East London Local Area, in and around the Mthatha area.

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



	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
East London	564	581	593	605	618	631	645	654	662	669
Port Elizabeth	856	869	897	955	964	972	1030	1037	1047	1154
Provincial Peak	1622	1650	1696	1777	1801	1826	1901	1918	1938	2068
2034 Peak	2068	2068	2068	2068	2068	2068	2068	2068	2068	2068

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

The Southern Grid Strengthening Phase 3 and 4 projects have been merged to just be the Southern Grid Strengthening and entails introducing 765 kV into the Eastern Cape by means of both the first and second Gamma-Grassridge 765 kV lines.

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 Local Area network and assist with the evacuation of generation in the Port Elizabeth Local Area.

7.1.3.4 Reactive power compensation

Reactive power compensation projects (capacitor banks and/or static var compensators (SVCs)) are expected to improve the voltages in the Eastern Cape as more generation is transported over long distances.

7.1.3.5 Network strengthening projects

The following strengthening projects are planned for the period from 2025 to 2034.

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

TDP scheme	Project name	Expected commercial operation (CO) year	Phase
Greater EL Phase 3	• Neptune-Pembroke 400 kV line	2025	Execution
	• Pembroke first 400/132 kV 500 MVA transformer	2025	Execution
	• Pembroke first 132/66 kV 160 MVA transformer	2025	Execution

TDP scheme	Project name	Expected commercial operation (CO) year	Phase
Grassridge third 500 MVA 400/132 kV transformer	• Grassridge third 500 MVA 400/132 kV transformer	2027	Execution
Dedisa third and forth 500 MVA 400/132 kV transformer with series FCLRs	• Dedisa 400/132 KV 500 MVA Transformer 3 and 4	2027	Execution
Delphi 1st 500 MVA 400/132 kV transformer	• Delphi 400/132kV transformer 3	2027	Execution
Greater EL Phase 4	• Poseidon-Pembroke 400 kV line	2030	Definition
	• Pembroke second 400/132 kV 500 MVA transformer	2030	Definition
	• Pembroke second 132/66 kV 160 MVA transformer	2030	Definition
Southern Grid Strengthening Phase	• 2x Gamma-Grassridge 765 kV lines • Install 2x 2000MVA 765/400 kV transformers at Grassridge Substation • Install 2x 2000MVA 765/400 kV transformers at Gamma Substation	2029	Definition
Poseidon 80 MVA 132/66 kV transformer	• Poseidon 80 MVA 132/66 kV transformer	2027	Execution
Poseidon 220/132 kV transformation upgrade	• Poseidon 220/132 kV transformation upgrade	2028	Execution
Dedisa-Grassridge 132 kV to 400 kV Line Conversion	• Dedisa-Grassridge 400 kV line 2	2029	Pre-Concept

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. The following projects are based on the generation assumptions and are within the current TDP period:

- 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 in Jeffrey's Bay
- Poseidon North 400/132 kV substation, positioned south of the Iziko series capacitor station
- Grahamstown 400/132 kV substation in Makhanda
- Aberdeen 400/132 kV substation

The envisaged generation growth in the Eastern Cape supply area will result in the existing Poseidon-Pembroke 220 kV line overloading, under certain contingencies, as power is evacuated towards KwaZulu-Natal via the Vuyani-Eros 400 kV line. To mitigate this overload, the construction of the Poseidon-Pembroke 400 kV line will alleviate the constraint and is expected to increase generation evacuation through the Vuyani-Eros 400 kV line. However, the 400 kV network will be constrained as more generation is added to the Eastern Cape. To reduce the future constraints on the 400 kV network, a KZN-EC 765 kV link is planned to evacuate power on the 765 kV level instead of the 400 kV level towards KwaZulu-Natal from the Eastern Cape. To manage voltage levels in the Eastern Cape province, Synchronous Condensers will be established for voltage support at the Grassridge and Vuyani substations.

The strengthening projects in the table below are required to facilitate future IPP integration for the period 2025 to 2034.

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

TDP scheme	Project name	Expected CO year	Phase
Poseidon North 400/132 kV substation integration	• Poseidon North new 400/132 kV substation south of Iziko series capacitor station	2030	Concept
Poseidon South 400/132 kV	• Poseidon South 400/132 kV substation and loop-in	2029	Concept

TDP scheme	Project name	Expected CO year	Phase
substation integration	between Grassridge and Poseidon		
Hlaziya 400/132 kV substation integration	• Hlaziya new 400/132 kV substation and 400 kV lines	2030	Definition
Dorper 400/132 kV substation integration	• Dorper new 400/132 kV substation and loop-in between Beta and Delphi	2031	Concept
Synchronous Condensers - Phase 1	• Grassridge Substation Synchronous Condenser •	2028	Concept
	• Vuyani Substation Synchronous Condenser	2028	Concept
Ngqura (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	2032	Pre-Concept
Grahamstown 400/132 kV substation integration	• Loop-in-and-out on future Poseidon-Pembroke 400 kV line	2033	Concept
Grassridge 4th 500MVA 400/132kV transformer	• Grassridge 4th 500 MVA 400/132 kV transformer with series FCLRs	2030	Pre-Concept
Eastern Cape-KwaZulu-Natal 765 kV Link	• EC - KZN 765kV Strengthening	2035	Concept
Aberdeen 400/132 kV Substation Integration	• 2 x Aberdeen - Galenia 400 kV lines • 1 x Aberdeen – Aquila 400 kV line • 1 x Aberdeen – Koruson 400 kV line • 1 x Aquila – Dorper 400 kV line • 1 x Dorper – Koruson 400 kV line	2032	Pre-Concept

TDP scheme	Project name	Expected CO year	Phase
	• 1 x Delphi - Dorper 400 kV line 2 • 1 x Dorper – Harvard 400 kV line1 x Harvard – Merapi 400 kV line • 2 x Drakensburg – Merapi 400 kV line		

7.1.3.7 Key Eastern Cape projects to unlock capacity for renewable energy generation

The Eastern Cape was identified as one of the provinces where additional capacity was necessary to enable access to connect renewable energy generation by the year 2027. The projects identified at the existing substations are listed below.

- Delphi 1st 500 MVA 400/132 kV transformer
- Grassridge 4th 500 MVA 400/132 kV transformer
- Dedisa 3rd and 4th 500 MVA 400/132 kV transformers

Additional substations, namely, Poseidon, Pembroke, and Neptune, were also identified for connection of renewable energy generation; however, no network reinforcements were identified as a result of this initiative.

7.1.3.8 Projects for alternative generation scenario

Interest has been shown in the integration of generation from natural gas close to the 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 the proposed 3 000 MW of gas, located in Gqeberha, is connected by 2034. 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 by 2032
- Grassridge substation 132 kV fault current limiting reactors (FCLRs)
- Dedisa substation 132 kV fault current limiting reactors (FCLRs)
- Dedisa-Grassridge 132 kV to 400 kV Line Conversion

7.1.3.9 Provincial summary

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

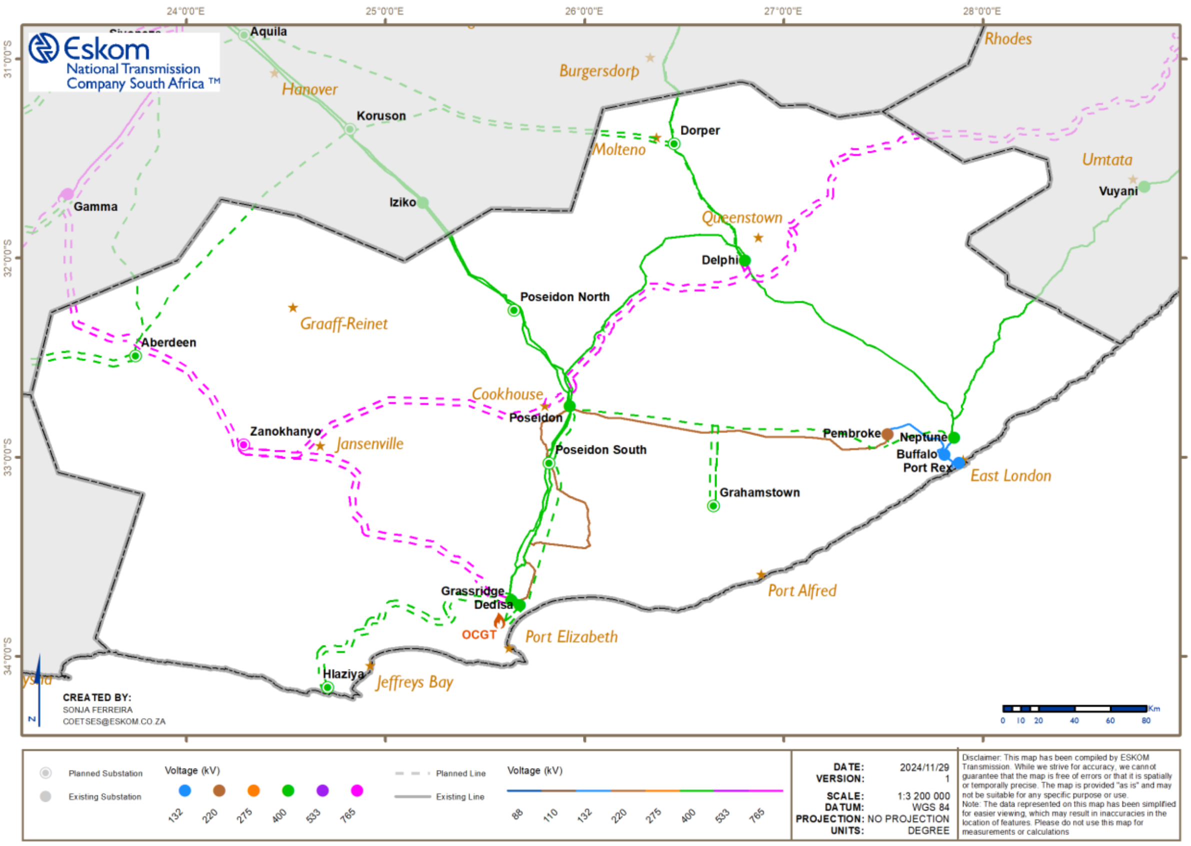


Figure 7-3: Future Eastern Cape transmission network

A summary of all new major assets planned for both the expansion and refurbishment portfolios for this province is provided in the tables below.

Table 7-4: Planned transformers for the Eastern Cape

Transformer type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
Less than 100 MVA	1	10	-	-
Less than 500 MVA	5	1265	3	970
500 MVA	9	4500	13	6 500
2 000 MVA	-	-	4	8 000
Grand total	**15**	**5 775**	**20**	**15 470**

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

Line voltage	2025 to 2029	2030 to 2034
	Total length (km)	Total length (km)
400 kV	232	720
765 kV	240	1910
Grand total	**472**	**2630**

Table 7-6: Planned capacitors for the Eastern Cape

Capacitor type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
40 Mvar 132 kV	-	-	2	80
72 Mvar 132 kV	-	-	2	144
Grand total	**-**	**-**	**4**	**224**

Table 7-7: Planned reactors for the Eastern Cape

Reactor type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	1	400	1	100
200 Mvar 765 kV	-	-	10	2000
400 Mvar 765 kV	-	-	3	1200
Grand total	**1**	**400**	**14**	**3300**

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 and has Lesotho as its eastern neighbour. For many decades, mining and agriculture were the bedrock of the economy in the province, but the mining sector's productivity has been on a steady decline.

This has had a negative impact on the economy and the demand for electricity in the province. Renewable energy generation is however becoming a key focus area for the province. This is due to good solar radiation. A total of 8584 MW RE generation has been procured up to Bid Window 6.

The Free State comprises of 275 kV, 400 kV and 765 kV lines. These powerlines extend from the Mpumalanga Province to the greater Cape. Free State is also electrically connected to Lesotho via two Merapi-Tweespruit 132 kV lines. The existing transmission network is shown in Figure 7-4.

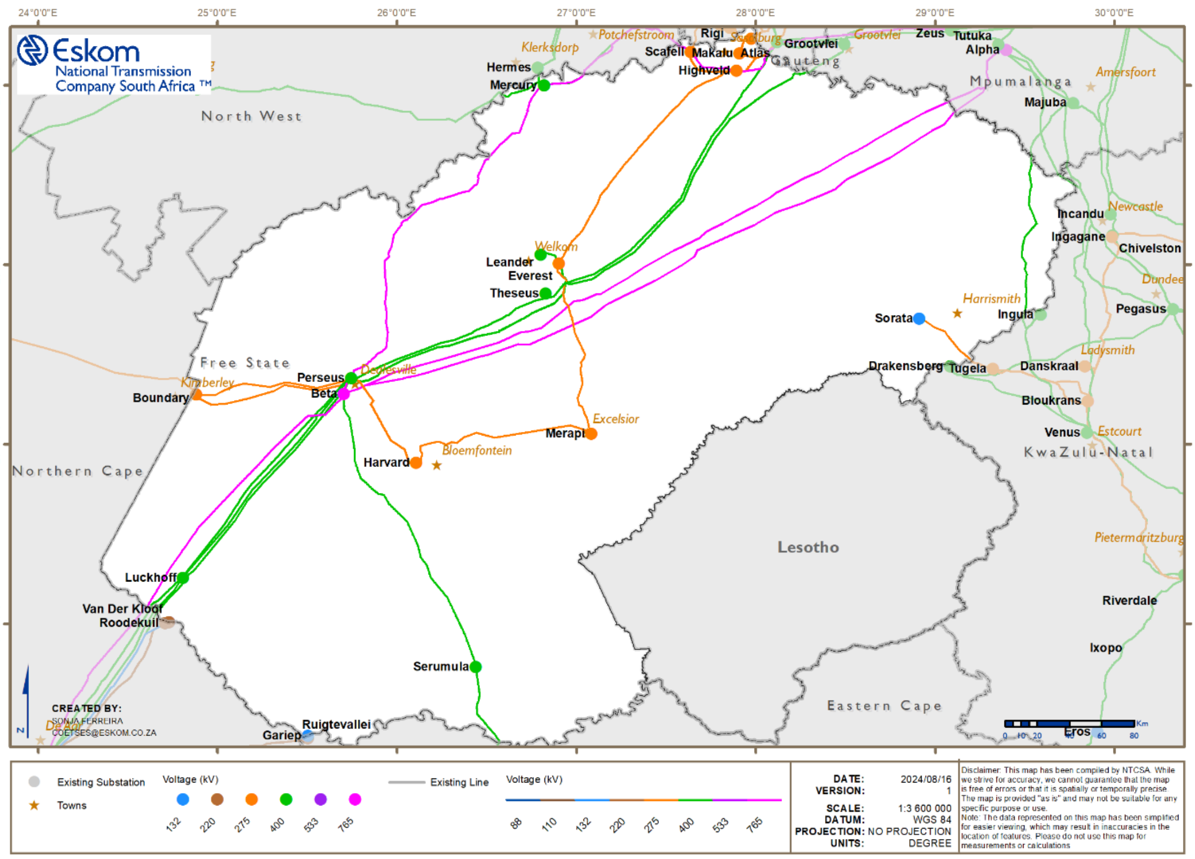


Figure 7-4: Current Free State transmission network

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 consists of six generating units with a total generating capacity of 3 558 MW.

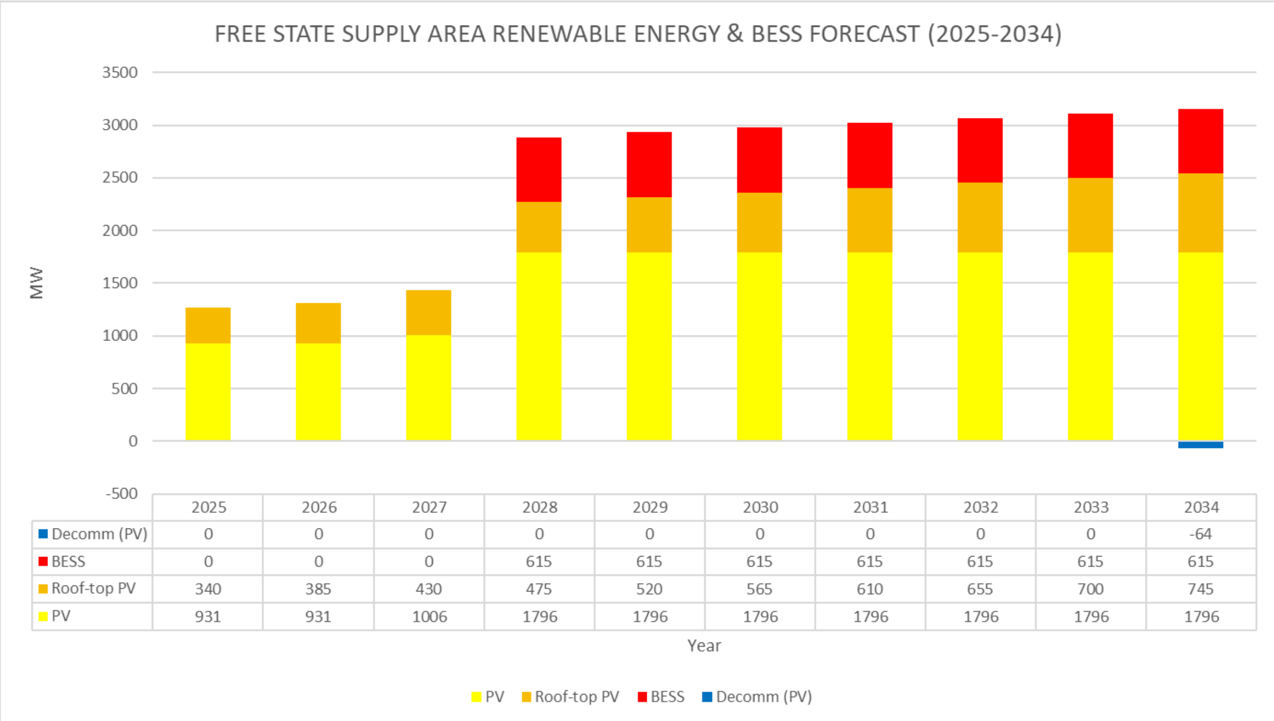
7.2.1.1 Renewable energy-independent power producers

The total generation that has been procured since REIPPPP 1 up to 6 is 858.4 MW as shown in Table 7-8.

Table 7-8: 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
IPP RE 5	0	75	75
IPP RE 6	0	580	580
Grand total	**4.4**	**854**	**858.4**

The generation forecast for the Free State is shown in Figure 7-5. The provincial renewable energy production is expected to increase from 1271 MW in 2025 to 3092 MW in 2034.



	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Decomm (PV)	0	0	0	0	0	0	0	0	0	-64
BESS	0	0	0	615	615	615	615	615	615	615
Roof-top PV	340	385	430	475	520	565	610	655	700	745
PV	931	931	1006	1796	1796	1796	1796	1796	1796	1796

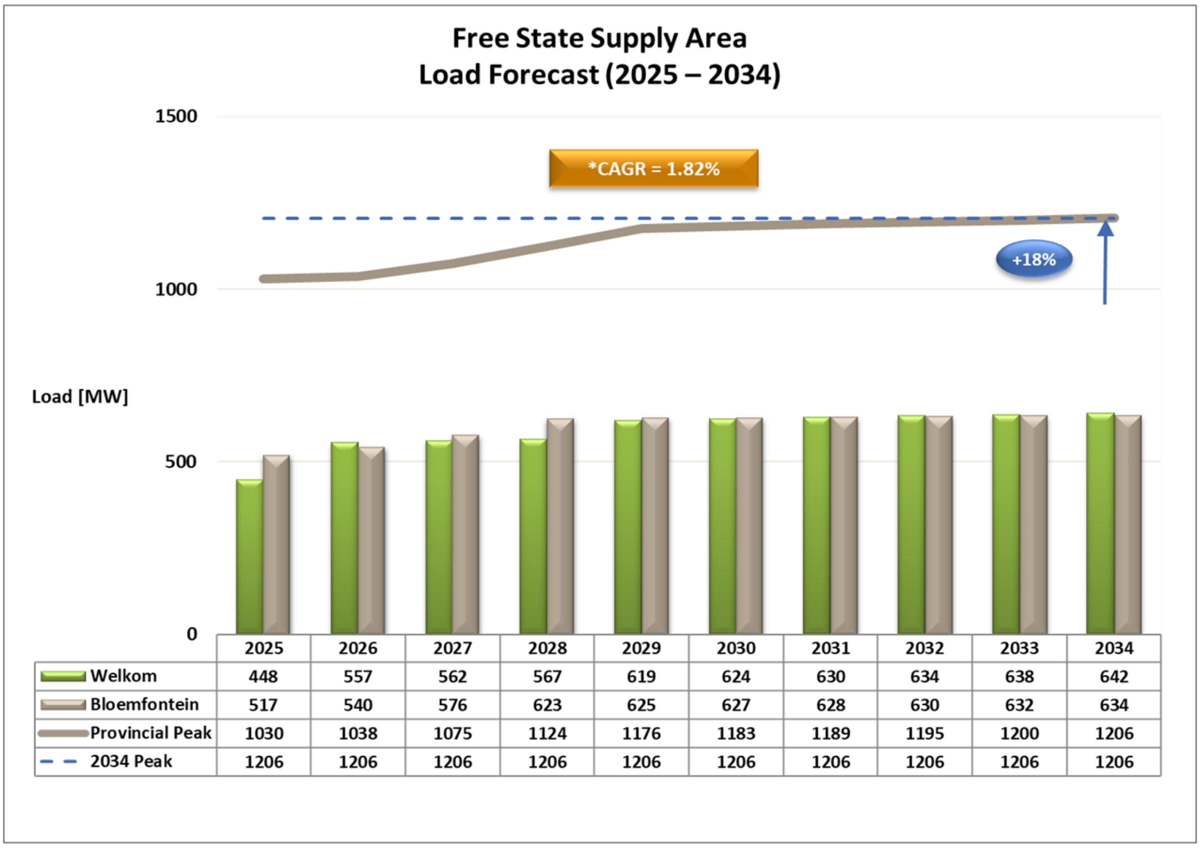
Figure 7-5: Free State RE Forecast

This is a substantial increase in generation in the province. Approximately 1.82 GW of additional RE generation is expected between 2025 and 2034.

7.2.2 LOAD FORECAST

The provincial load peaked at around 1450 MW in 2023, and it is forecasted to grow steadily from 1 030 MW in 2025 to 1 206 MW by 2034. The load forecast now excludes the Sasolburg CLN which is based on the new Free State supply area.

The Free State comprises two local supply areas, namely Bloemfontein, and Welkom. The Welkom supply area consumed approximately 43.49% of the load and the Bloemfontein supply area makes up the remaining 56.51% of the demand in the province. The load forecast for the Free State is shown in Figure 7-6.



	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Welkom	448	557	562	567	619	624	630	634	638	642
Bloemfontein	517	540	576	623	625	627	628	630	632	634
Provincial Peak	1030	1038	1075	1124	1176	1183	1189	1195	1200	1206
2034 Peak	1206	1206	1206	1206	1206	1206	1206	1206	1206	1206

Figure 7-6: 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

This project involves acquiring servitudes for future 400 kV lines and will be broken up into 2 phases, that is, Beta-Harvard 400 kV line (Phase 2A) and Harvard-Merapi 400 kV line (Phase 2B) and the introduction of 400 kV at Harvard and Merapi substations. The Bloemfontein Strengthening Phase 2 project was initially developed and approved to cater for future load growth in the area, however, it is now required due to renewable energy interest in the area.

Sorata substation strengthening

Load forecasts indicate that the capacity at Tugela Substation will be depleted and network constraints on the 132 kV Distribution network will be experienced. The load growth is driven mainly by public infrastructure delivery (i.e., electricity, water), housing, industrial and commercial activities. 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 250 MVA transformer at Sorata Substation. Sorata Substation was established to address both the future NTCSA and Distribution network constraints. As part of the solution, upgrades will need to be carried out at both Sorata and Tugela Substations along with a new 400 kV transmission line between the stations. The line will initially be operated at 275 kV until the need arises to convert Sorata substation to 400/132 kV.

Makalu substation strengthening

Load growth, potential IPP interest and fault level exceedances at Makalu 275/88 kV substation have required the strengthening of the network through the introduction of a new substation in the area to resolve these constraints. This project involves establishing Igesi 275/88 kV Substation and looping into one of the Lethabo-Makalu 275 kV lines to create Lethabo-Igesi and Igesi-Makalu 275 kV lines.

Kimberley Strengthening Phase 4: Beta – Boundary 1st 400 kV Line

The Kimberley Strengthening Phase 4 scheme (CRA phase) identified the need for the 400 kV strengthening of the Boundary Substation via a loop-in loop out from the proposed Beta – Ferrum 400 kV line. The expected generation may require acceleration of a single Beta– Boundary 400 kV line to enable the first 500 MVA 400/132 kV expansion at the Boundary. If the 400 kV line is not available on time, a third 500 MVA 275/132 kV transformer may be considered that will later replace the existing 250 MVA ageing transformation at the substation. The second 500 MVA 400/132 kV transformer will be required by 2030 to avoid overload of the existing 400/132 kV transformer.

7.2.3.2 New substations

Igesi 275/88 kV Substation

Igesi 275/88 kV Substation will be established in the province to de-load Makalu Substation. It will also assist in reducing the network fault levels at Makalu Substation and connect potential renewable energy interests around the area.

Mercury B 400 /132 kV Substation

Mercury B 400/132 kV 500 MVA substation is proposed for renewable energy interest integration around the Mercury substation.

Artemis 400/132 kV Substation

Artemis substation will consist of 1 x 400/132 kV 500 MVA transformer, with additional 400/132 kV 500 MVA transformers planned to be commissioned withing the TDP 2024 period.

Artemis B 400/132 kV Substation

Artemis B substation is proposed with an establishment of 4 x 400/132 kV 500 MVA transformers as a phased approach and a 5km loop in and out 400 kV line. This substation will be constructed for the renewable energy interest in the area.

7.2.3.3 New lines

Sorata-Tugela 275 kV Line

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.

Beta-Harvard and Harvard-Merapi 400 kV Lines

Beta-Harvard and Harvard-Merapi 400 kV lines will be constructed as Bloemfontein Strengthening Phase 2 project.

Kimberley Strengthening Phase 4 and Phase 5

Beta-Boundary 400 kV lines 1 and 2 will be constructed as Kimberley Strengthening Phase 4 and Phase 5.

7.2.3.4 Reactive power compensation

There are no reactive power compensation projects (capacitor banks and/or SVCs) planned for the Free State within the current TDP period. Reactive power compensation will be investigated in the next TDP cycle due to a large number of renewable interests in the Free State province.

7.2.4 NETWORK STRENGTHENING PROJECTS

The following strengthening projects are planned for the period 2025 to 2034.

Table 7-9: Free State – summary of projects and timelines

TDP scheme	Project name	Expected Year	Phase
Makalu Strengthening	• Establish 2 x 315 MVA 275/88 kV Igesi Substation	2028	Concept
	• Loop-in one of Lethabo-Makalu 275 kV lines into Igesi Substation		
Bloemfontein Strengthening Phase 2A	• Construct 2 x Beta-Harvard 400 kV lines	2032	Definition
	• Install 1 x 500 MVA 400/132 kV transformer at Harvard Substation		
Bloemfontein Strengthening Phase 2B	• Construct Harvard-Merapi 400 kV line	2031	Pre-concept
	• Install 1 x 500 MVA 400/132 kV transformer at Merapi Substation		
Sorata Substation Strengthening	• Construct Sorata-Tugela 400 kV line (to be operated at 275 kV)	2030	Concept
	• Install second 275/132 kV 250 MVA transformer at Sorata Substation		

7.2.5 PROJECTS FOR FUTURE INDEPENDENT POWER PRODUCERS

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

Table 7-10: Free State – projects required to facilitate IPP integration

Project name	Expected Year	Phase
Artemis 500 MVA 400/132 kV substation	2030	Definition
Artemis 2nd 500 MVA 400/132 kV transformer	2030	Definition
Scafell 275/132 kV transformer upgrade	2026	Execution
Mercury B 500 MVA 400/132 kV Substation	2034	Pre-concept
Mercury 1st 2000 MVA 765/400 kV transformer	2031	Concept
Artemis 3rd 500 MVA 400/132 kV transformer	2030	Definition
Edenville 500 MVA 400/132 kV transformer	2031	Pre-concept
Theseus 3rd 500 MVA 400/132 kV transformer	2028	Execution
Mercury 3rd 500 MVA 400/132 kV transformer	2028	Execution
Artemis B 4 x 500 MVA 400/132 kV Substation	2034	Pre-concept
Mercury 4th 500 MVA 400/132 kV Transformer	2036	Pre-concept
Harvard 3rd 500 MVA 275/132 kV transformer	2031	Pre-concept
Everest 3rd 500 MVA 275/132 kV transformer	2030	Pre-concept
Leander 3rd 500 MVA 400/132 kV transformer	2031	Pre-concept
Beta 3rd 2000 MVA 765/400 kV transformer	2029	Concept
Artemis 4th 500 MVA 400/132 kV transformer	2034	Definition

7.2.7 PROVINCIAL SUMMARY

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

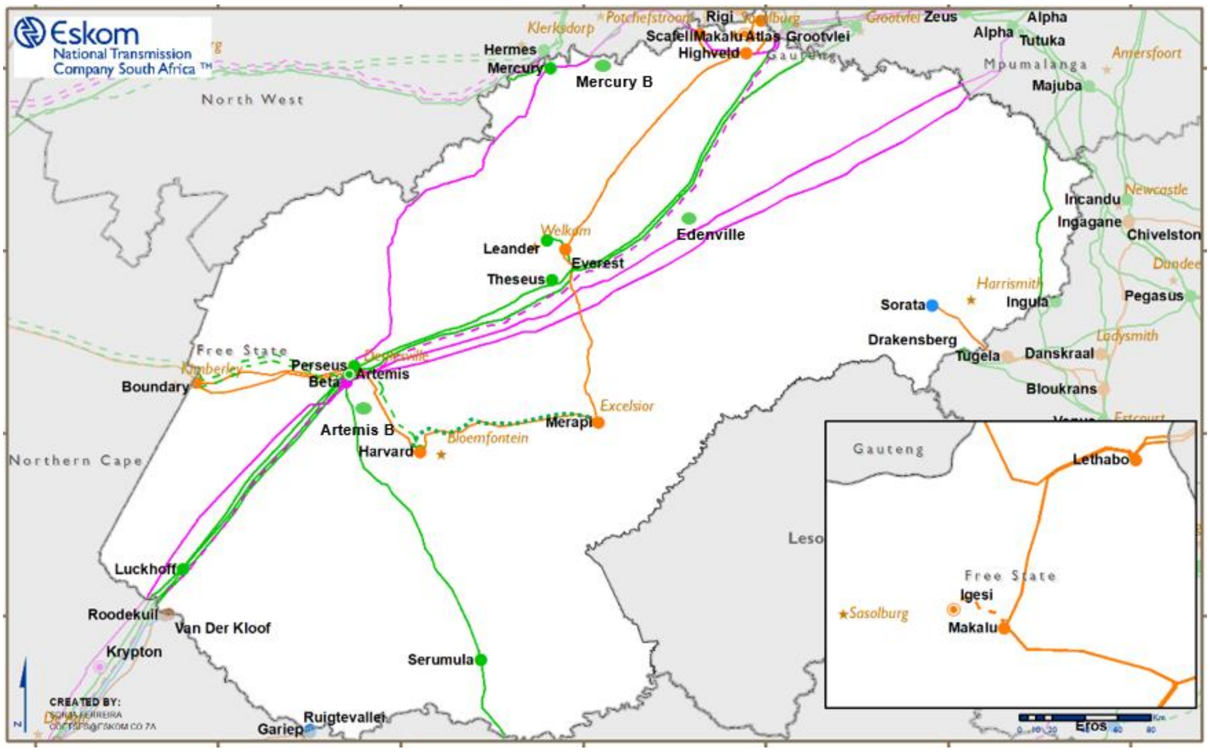


Figure 7-7: Future Free State transmission network

A summary of all new major assets planned for both the expansion and refurbishment portfolios for this province is provided in the tables below.

Table 7-11: Planned transformers for the Free State

Transformer type	2025-2029		2030-2034	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
Less than 100 MVA	**-**	**-**	**1**	**10**
Less than 500 MVA	-	-	4	1430
500 MVA	5	2500	20	10000
800 MVA	-	-	-	-
2000 MVA	-	-	3	6000
Grand total	**5**	**2500**	**28**	**17440**

Table 7-12: Planned overhead lines for the Free State

Line voltage	2025-2029	2030-2034
	Total length (km)	Total length (km)
275 kV	2	14
400 kV	161	225
765 kV	160	270
Grand total	**323**	**509**

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 (Jhb). 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 7-8.

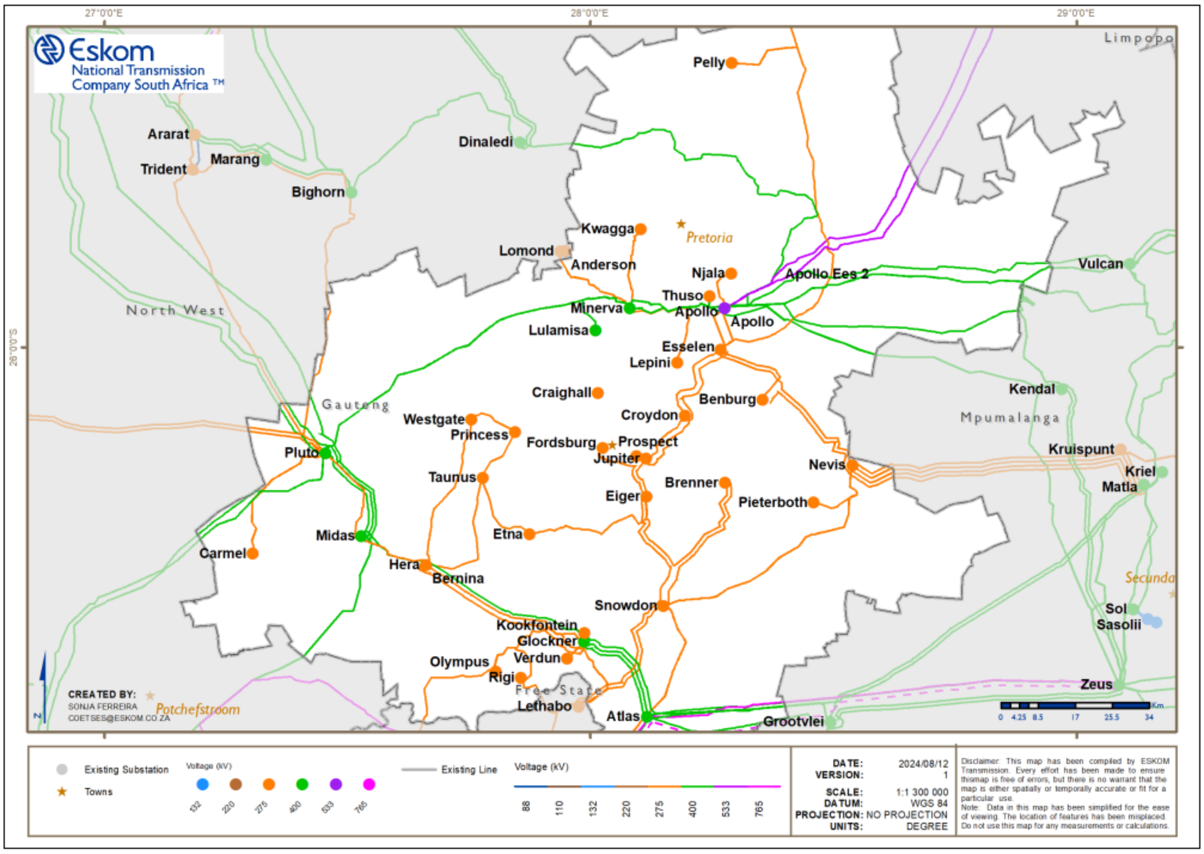


Figure 7-8: Current Gauteng transmission network

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 in 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 the 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 will 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. There are no significant IPPs planned for the Gauteng Grid for the foreseeable future.

Table 7-13: IPPs integrated in Gauteng

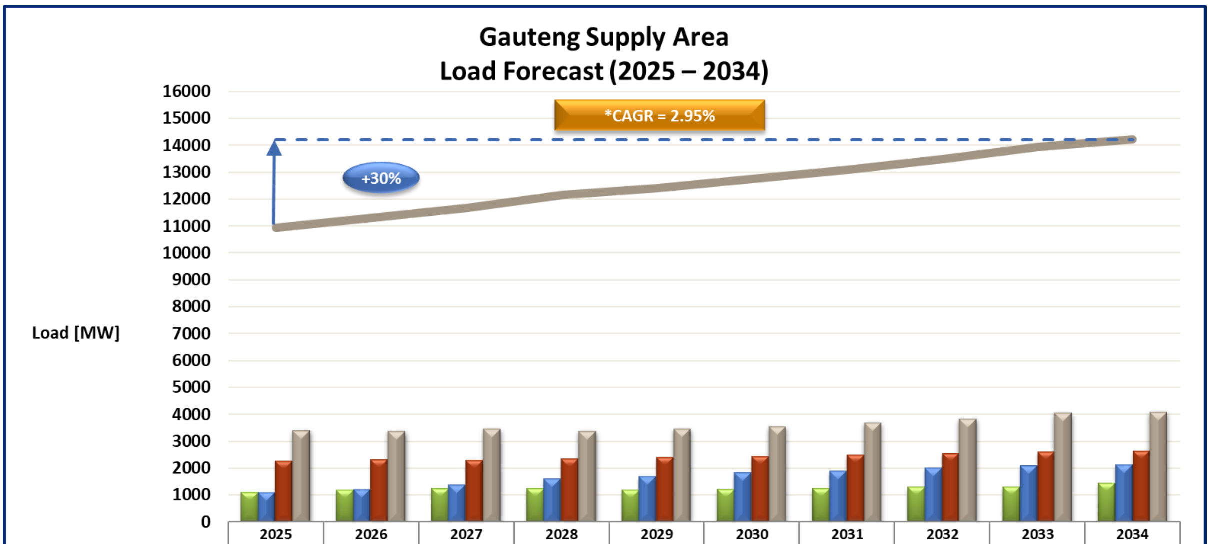
Generation Technology	Size (MW)
Landfill Gas	41
PV	715
Rooftop	1417
Total	**2173**

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.

As already mentioned, the economic mix in the province comprises residential customers, gold mines, and commercial and services customers, as well as logistics, technology, and industrial customers. The provincial electricity demand peaked at about 9351 MW in 2023 and is forecasted to grow steadily at about 2.87% annually in this TDP window, from 9744 MW in the year 2025 to 12,538 MW by the year 2034.

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 7-9**.



	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Nigel	1115	1187	1248	1238	1177	1209	1256	1302	1308	1444
Midrand	1110	1221	1397	1623	1715	1856	1902	2011	2101	2140
Pretoria	2290	2328	2320	2363	2413	2451	2506	2564	2624	2657
Johannesburg	3422	3396	3477	3379	3470	3544	3681	3822	4050	4090
Supply Area Peak Peak	10943	11296	11675	12143	12416	12757	13081	13469	13924	14210
2034 Peak	14210	14210	14210	14210	14210	14210	14210	14210	14210	14210

Figure 7-9: 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 recently installed at Lepini substation 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 (SOW) includes establishing a 275 kV transmission substation adjacent to the Simmerpan distribution substation and installing a 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 NTCSA. 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 a 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 to being 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 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 7-14below.

Table 7-14: Planned reactive power compensation in Gauteng

Substation	Voltage (kV)	Size (Mvar)
Brenner	88	2 x 48
Princess	88	1 x 48
Quattro	132	2 x 72
Taunus	132	1 x 72
Westgate	132	1 x 72
Wildebees	400	1 x 100
Minerva	400	1x100
Lulamisa	400	1x100

7.3.3.5 Summary of network strengthening projects

The following strengthening projects are planned for the period 2025 to 2034.

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

TDP scheme	Project name	Expected Year	Phase
Vaal strengthening Phase 2	Glockner-Etna first and second 400 kV line (operated at 275 kV)	2030	Execution
Brenner strengthening Phase 1	Brenner 2 x 88 kV 48 Mvar capacitors	2028	Definition
Tshwane Metro – Diphororo Phase 1	Diphororo 400/132 kV substation integration	2031	Execution
Tshwane Metro – Wildebees Phase 1	Wildebees 400/132 kV substation integration	2032	Execution
Tshwane Metro: Thuso third transformer	Thuso 400/132 kV substation (third 250 MVA transformer)	2029	Concept
Etna strengthening: third transformer	Etna 275/88 kV substation (third 315 MVA transformer)	2027	Execution
Soweto Phase 1: Quattro 275/88 kV	Quattro 275/88 kV substation integration	2031	Definition
Soweto Phase 2: Quattro 275/132 kV	Quattro 275/132 kV substation integration	2031	Definition
West Rand strengthening Phase 1	Westgate 400/132 kV substation integration	2029	Definition
West Rand strengthening Phase 2A: capacitors	1 x 72 Mvar cap bank at Westgate 132 kV	2028	Definition
	1 x 72 Mvar cap bank at Taunus 132 kV		Definition
	1 x 72 Mvar cap at Quattro 132 kV		Definition
	1 x 48 Mvar cap at Princess 88 kV		Definition
Jhb North Phase 2	Jhb North: Apollo-Lepini first 400 kV line (operated at 275 kV)	2030	Definition
West Rand strengthening Phase 2B	Pluto-Westgate 400 kV and 2nd 400/132 kV 500 MVA transformer at Westgate	2029	Definition
Simmerpan Phase 1B	Sisimuka 275/88 kV substation integration	2029	Concept
Jhb North: Sesiu integration	Sesiu 400/88 kV substation integration	2029	Definition
Jhb East: Mesong integration	Jhb East: Mesong 275/132 kV integration	2030	Definition
Jhb East: Jupiter B integration	Jupiter B 275 kV switching station		Definition

TDP scheme	Project name	Expected Year	Phase
	Matla-Jupiter B 1st and 2nd 400 kV lines	2031	Definition
	Jupiter B 275 kV loop-ins (Prospect-Sebenza 1 and 2, Jupiter-Prospect 1, Jupiter-Fordsburg 1)		Definition
Jhb North: Kyalami substation	Kyalami 400/132 kV substation integration	2034	Pre-concept
Brenner Phase 2: Lesokwana substation	Lesokwana 275/88 kV substation integration	2030	Definition

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 7-10below.

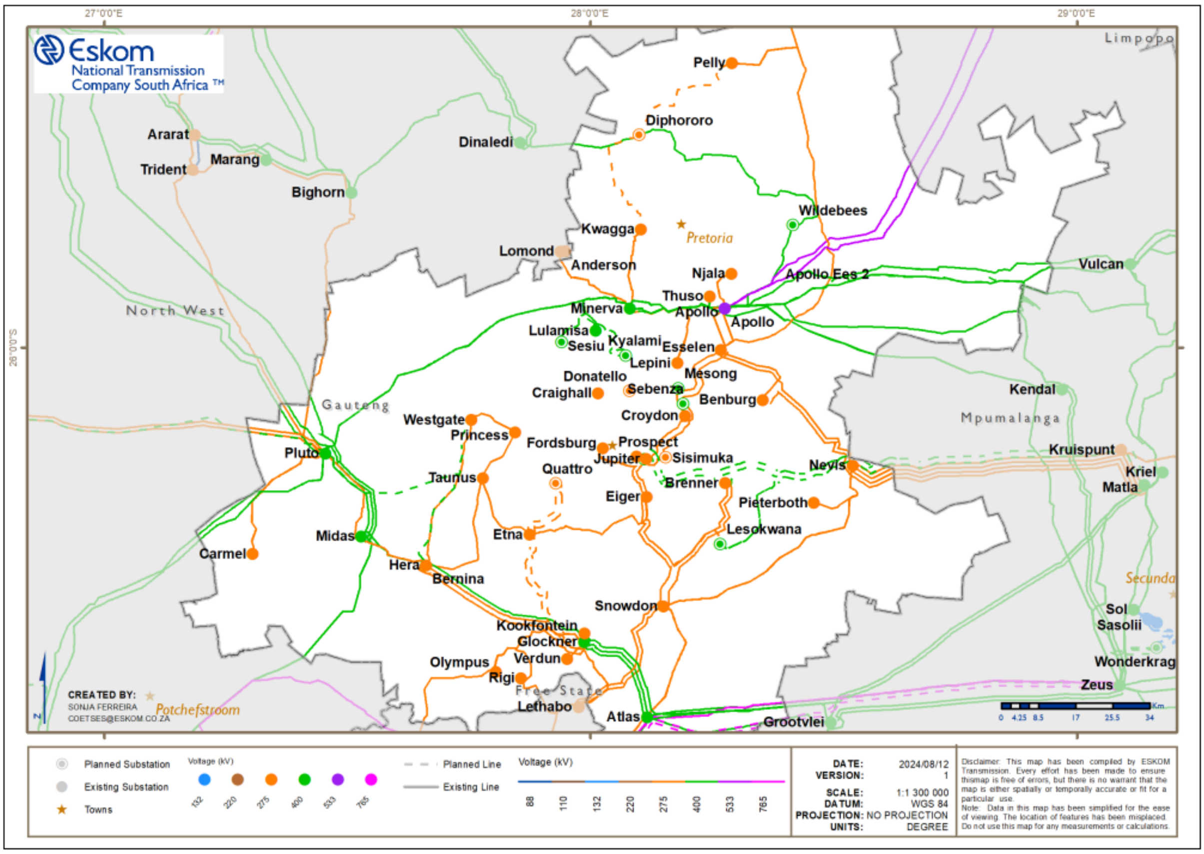


Figure 7-10: Future Gauteng transmission network

A summary of all new major assets planned for both the expansion and refurbishment portfolios for this province is provided in the tables below.

Table 7-16: Planned transformers for Gauteng

Transformer type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
Less than 100 MVA	-	-	21	1 754
Less than 300 MVA	-	-	7	1 610
Less than 500 MVA	3	945	3	945
500 MVA	5	2500	13	6 500
800 MVA	-	-	4	3 200
Grand total	**8**	**3 445**	**48**	**14 009**

Table 7-17: Planned overhead lines for Gauteng

Line voltage	2025 to 2029	2030 to 2034
	Total length (km)	Total length (km)
275 kV	19	20
400 kV	78	80
Grand total	**97**	**100**

Table 7-18: Planned capacitor banks for Gauteng

Capacitor type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
48 Mvar 88 kV	-	-	2	96
72 Mvar 132 kV	-	-	5	360
Grand total	**-**	**-**	**7**	**456**

Table 7-19: Planned reactors for Gauteng

Reactor type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
48 Mvar 88 kV	-	-	3	144
40 Mvar 132 kV	-	-	-	-
72 Mvar 132 kV	-	-	4	288
100 Mvar 400 kV	-	-	-	-
Grand total	**-**	**-**	**7**	**432**

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 region.

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 several 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 7-11.

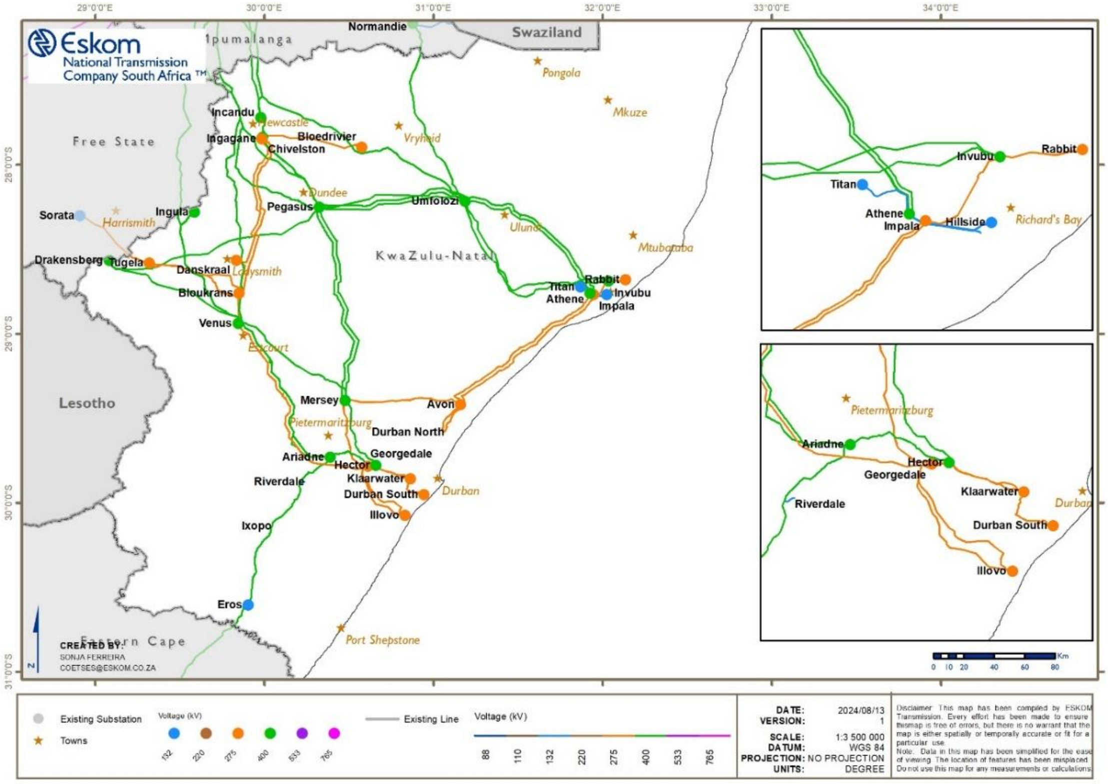
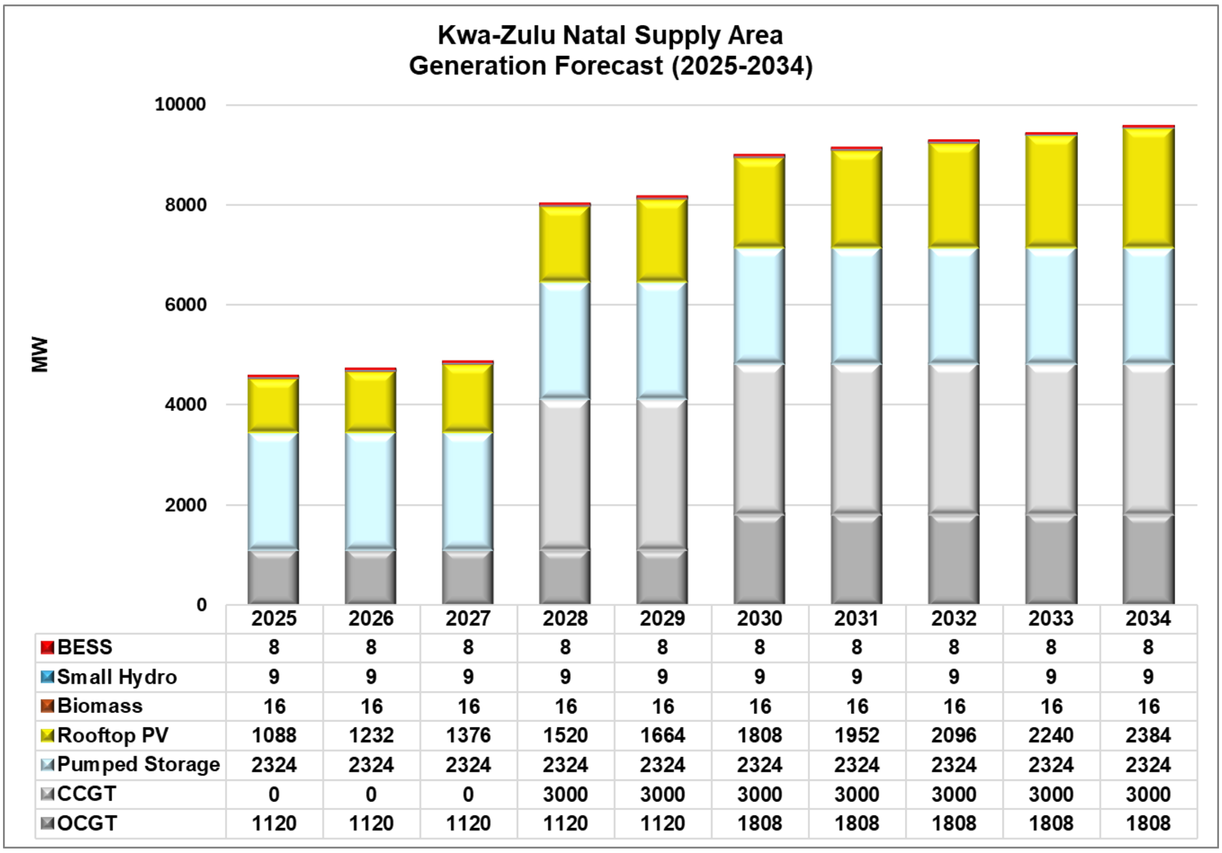


Figure 7-11: Current KwaZulu-Natal transmission network

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 670 MW. Drakensberg and Ingula Pumped-Storage Stations have generating capacities of 1 000 MW and 1 333 MW, respectively. The generation forecast is shown in Figure 7-12.



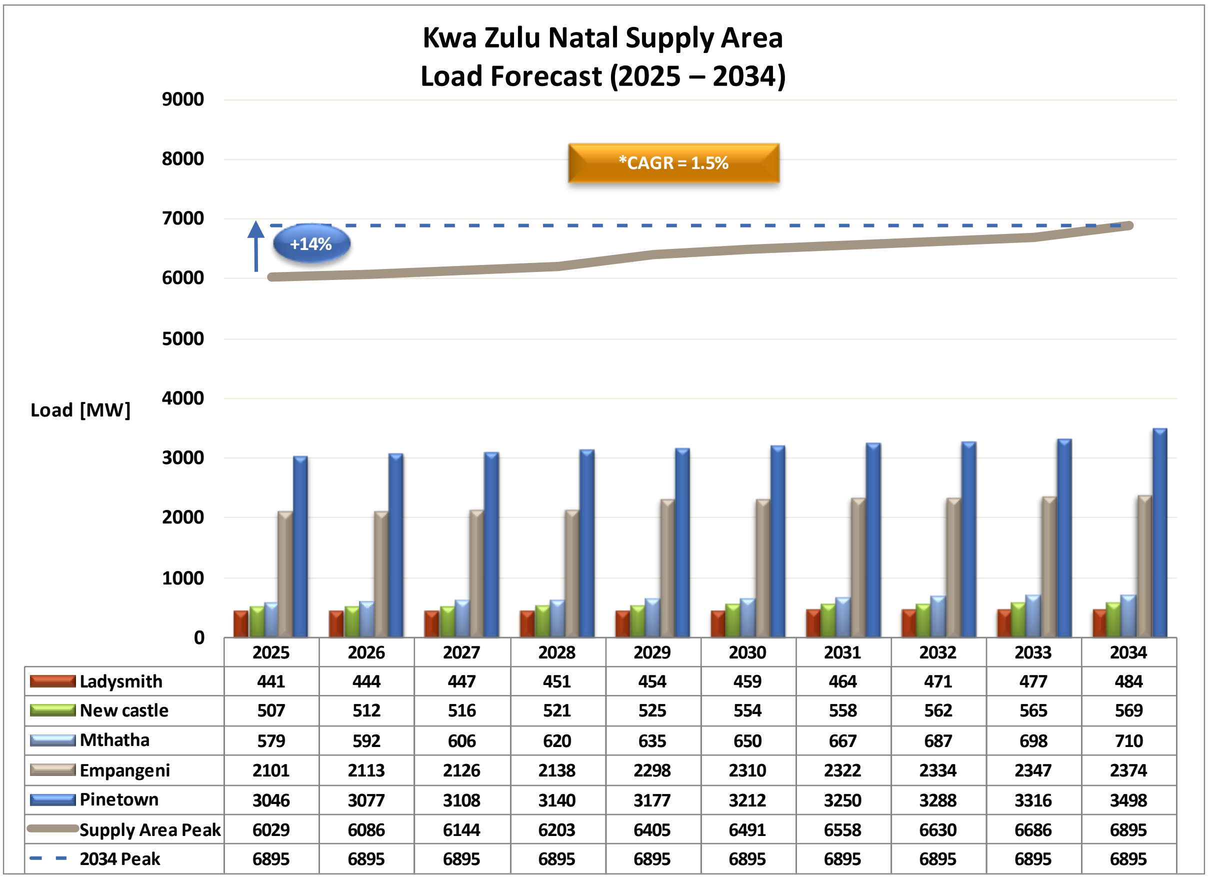
	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
BESS	8	8	8	8	8	8	8	8	8	8
Small Hydro	9	9	9	9	9	9	9	9	9	9
Biomass	16	16	16	16	16	16	16	16	16	16
Rooftop PV	1088	1232	1376	1520	1664	1808	1952	2096	2240	2384
Pumped Storage	2324	2324	2324	2324	2324	2324	2324	2324	2324	2324
CCGT	0	0	0	3000	3000	3000	3000	3000	3000	3000
OCGT	1120	1120	1120	1120	1120	1808	1808	1808	1808	1808

Figure 7-12: KZN Generation Forecast

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 5600 MW in 2023. The load in the supply area is expected to increase annually, from 6029 MW in 2025 to 6 895 MW by 2034.

The KwaZulu-Natal supply area is the second largest load centre and comprises of five local areas, namely, Empangeni, Ladysmith, Newcastle, Pinetown, and Mthatha. Empangeni and Pinetown are the two main load centres, consuming approximately 35% and 51% of the load, respectively. Ladysmith, Newcastle and Mthatha make up the remaining 14% of the demand in the supply area. Significant load growth is expected in the Pinetown and Empangeni local areas due to industrial, commercial, and residential developments. The load forecast for KwaZulu-Natal is shown in Figure 7-13.



	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Ladysmith	441	444	447	451	454	459	464	471	477	484
New castle	507	512	516	521	525	554	558	562	565	569
Mthatha	579	592	606	620	635	650	667	687	698	710
Empangeni	2101	2113	2126	2138	2298	2310	2322	2334	2347	2374
Pinetown	3046	3077	3108	3140	3177	3212	3250	3288	3316	3498
Supply Area Peak	6029	6086	6144	6203	6405	6491	6558	6630	6686	6895
2034 Peak	6895	6895	6895	6895	6895	6895	6895	6895	6895	6895

Figure 7-13: 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.

Northern 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 Umfolozi -Iphiva 400 kV lines.

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 established in phases and supplied by Isundu-Inyaninga and Mbewu-Inyaninga 400 kV lines. It will de-load 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 de-load the Hector-Klaarwater and Georgedale-Klaarwater 275 kV system and supply the projected demand growth around Hillcrest and Ntshongweni.

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 will 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:

- Mbewu 400 kV switching station near Empangeni town.
- Iphiva 400/132 kV substation near Mkuze town.
- Inyaninga 400/132 kV substation near King Shaka Airport in Durban.
- 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.
- Iphiva-Umfolozi 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, the Athene and Impala static var compensators (SVCs) have been refurbished and Illovo SVC has been decommissioned.

7.4.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period between 2025 and 2034.

Table 7-20: KwaZulu-Natal – summary of projects and timelines

TDP scheme	Scope of work	Expected Year	Phase
Ariadne-Venus 400 kV Line 2	Construct Ariadne-Venus 400 kV Line 2 by recycling Georgedale-Venus 275 kV Line 2	2024	Execution
South Coast strengthening	Construct Ariadne-Eros 400 kV Line 2	2026	Execution
KZN 765 kV strengthening – Empangeni integration	Mbewu 400 kV switching station	2028	Execution
	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	2031	Definition
	Construct Normandie-Iphiva 400 kV Line 1		
	Establish 2nd 500 MVA 400/132 kV Transformer		
Northern KZN strengthening – Phase 2	Construct Iphiva - Umfolozi 400 kV line 1	2031	Concept
eThekwini electricity network strengthening	Establish 2 x 500 MVA 400/132 kV Inyaninga substation	2033	Concept
	Construct Inyaninga-Mbewu 400 kV Lines 1 and 2		
	Establish 2 x 500 MVA 400/132 kV Shongweni substation	2033	Concept
	Construct Hector-Shongweni 400 kV Lines 1 and 2		
KZN 765 kV strengthening – Pinetown integration	Isundu 400 kV switching station	2032	Concept
	Loop-in Ariadne-Venus 400 kV Line 1 into Isundu substation		
	Construct Isundu-Venus 765 kV line; operate at 400 kV		
KZN 765 kV strengthening –	Construct Isundu-Mbewu 400 kV Lines 1 and 2	2032	Concept

TDP scheme	Scope of work	Expected Year	Phase
Isundu-Mbewu 400 kV interconnector			

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-Mbewu 400 kV lines.

There have been several renewable generation applications in KZN, however no IPP has progressed to execution. There is significant capacity within KZN to accommodate renewable generation but due to environmental sensitivities, solar and wind capabilities KZN is not the most attractive option at this stage.

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 7-14 below.

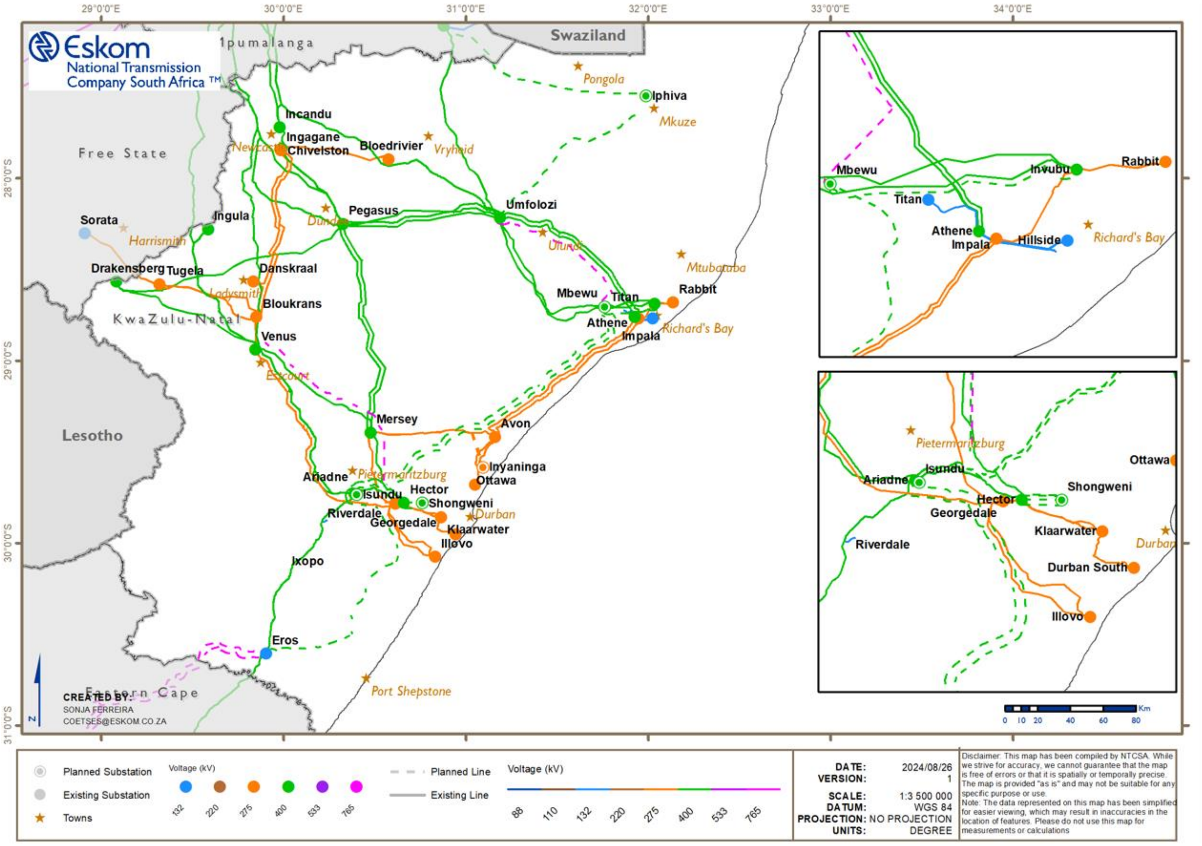


Figure 7-14: Future KwaZulu-Natal Transmission Network

A summary of all new major assets planned for both the expansion and refurbishment portfolios for this province is provided in the tables below.

Table 7-21: Planned transformers for KwaZulu-Natal

Transformer type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
Less than 100 MVA	-	-	-	-
Less than 300 MVA	3	750	5	980
Less than 500 MVA	-	-	1	315
500 MVA	-	-	4	2000
800 MVA	-	-	3	2400
2000 MVA	-	-	2	4000
Grand total	**3**	**750**	**15**	**9695**

Table 7-22: Planned overhead lines for KwaZulu-Natal

Line voltage	2025 to 2029	2030 to 2034
	Total length (km)	Total length (km)
400 kV	255	272
765 kV	97	430
Grand total	**352**	**702**

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.

Renewable energy generation interest is becoming a key focus area for the province. This is due to good solar radiation and reduced available capacity in other Provinces for RE integration.

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 7-15.

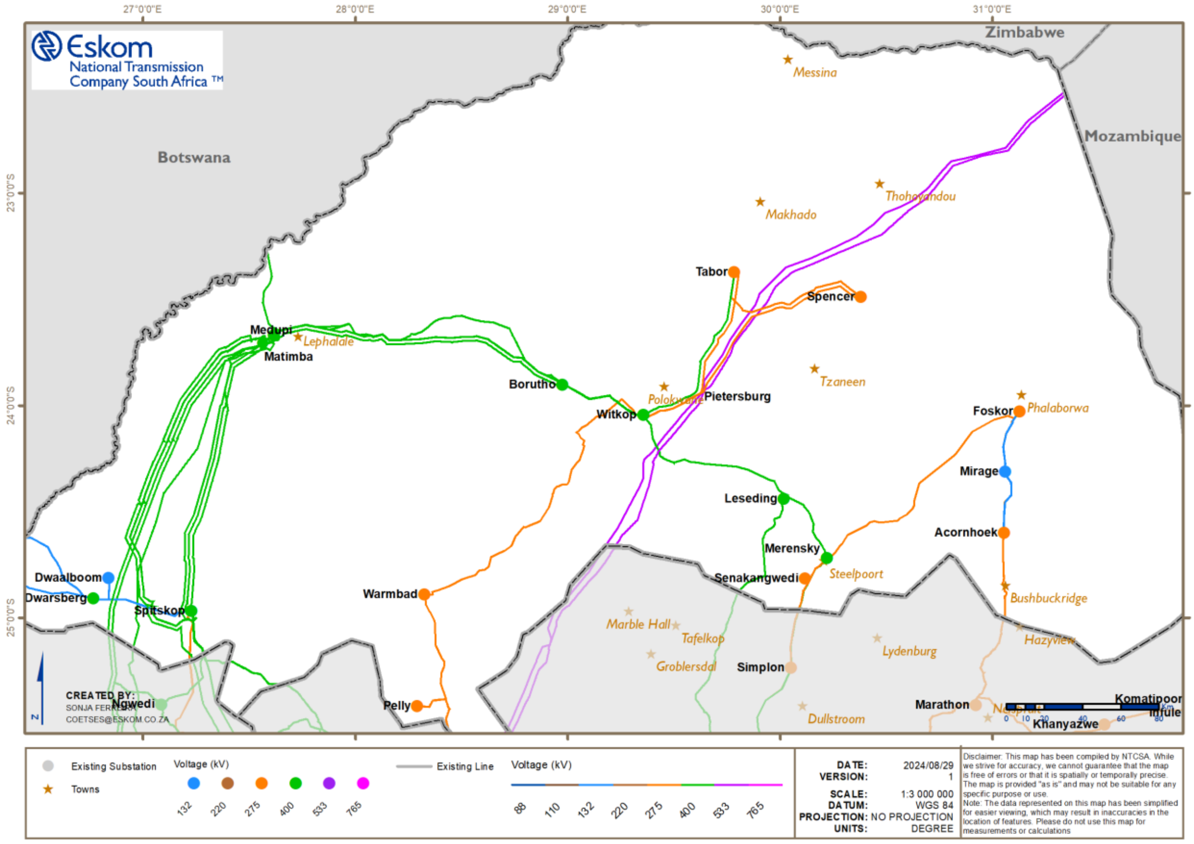


Figure 7-15: Current Limpopo transmission network

7.5.1 Generation

The baseload generation in Limpopo is in the coal mining town of Lephalale, which has rich coal reserves. Two coal-fired power stations are 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.

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 7-23.

Table 7-23: Approved projects in Limpopo under the REIPPPP

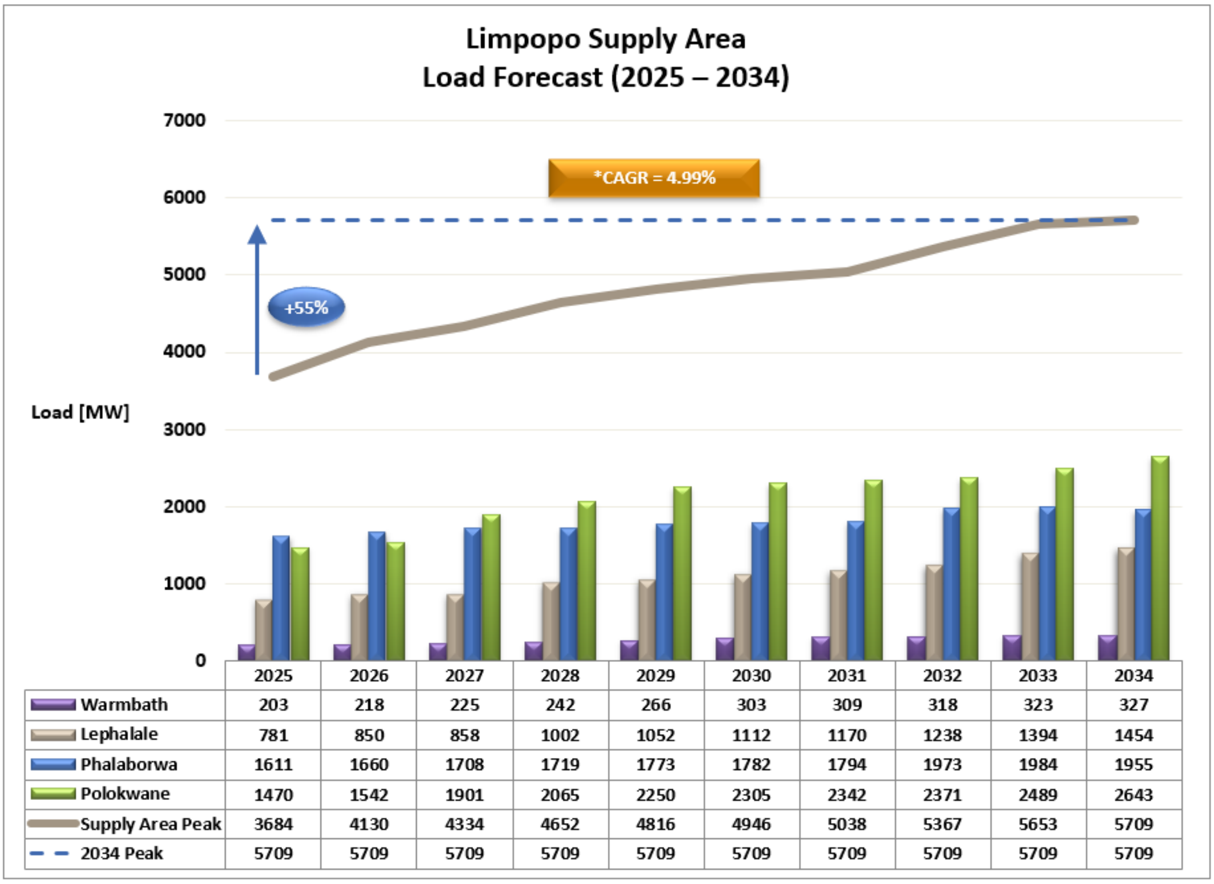
Programme and bid window	Name of project	Type	Capacity (MW)	NTCSA substation
IPP RE 1	Tabor PV plant	PV	28	Tabor 132 kV
	Witkop PV plant	PV	30	Witkop 132 kV
IPP RE 3	Matimba PV plant	PV	60	Matimba 132 kV

7.5.2 LOAD FORECAST

The 2023 peak load for the province was 3 462 MW. There was an increase of 439 MW compared to the peak demand of 3 023 MW that was experienced for the year 2022.

The province consists of four CLNs: Lephalale, Polokwane, Phalaborwa, and Warmbath. The Lephalale CLN is expected to have a steady growth rate of 8,61%. 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 7,97%. The Phalaborwa CLN is predicted to have a growth rate of 2,14%. This can be attributed to an increase in mining activities and possible smelting operations near Leseding Substation over the next 10 years. The Warmbath CLN is predicted to have a growth rate of 6.10%.

The load forecast for Limpopo is shown in Figure 7-16.



	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Warmbath	203	218	225	242	266	303	309	318	323	327
Lephalale	781	850	858	1002	1052	1112	1170	1238	1394	1454
Phalaborwa	1611	1660	1708	1719	1773	1782	1794	1973	1984	1955
Polokwane	1470	1542	1901	2065	2250	2305	2342	2371	2489	2643
Supply Area Peak	3684	4130	4334	4652	4816	4946	5038	5367	5653	5709
2034 Peak	5709	5709	5709	5709	5709	5709	5709	5709	5709	5709

Figure 7-16: 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 Province. The last line of this scheme is in execution phase, namely Masa – Ngewi 765 kV line (operate at 400 kV)

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)

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.

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 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.
- **Manogeng 400 kV Switching Station**: This station is established to cater for the establishment of Tubatse pump storage generation in the province. The station is planned to be commission in this financial year.
- **Silimela Substation:** A new transmission substation has been established 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 to cater for future load growth in the Steelpoort area. Sekhukune Substation will deload Merensky and Leseding Substation.

Some of the new substations have been renamed as indicated in Table 7-24.

Table 7-24: 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 Limpopo supply area to ensure transient stability of the generation, connect new substations, and to alleviate network constraints in the area:

- 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 400 kV line
- Foskor-Spencer 400 kV line

7.5.3.4 Additional Transformers

There have been 4 projects raised to add new transformers at existing substations to increase capacity to enable load growth:

- Acornhoek additional 250 MVA 400/132 kV transformer
- Warmbad 1st 500 MVA 275/132 kV transformer

- Borutho 3rd 500 MVA 400/132 kV transformer
- Leseding 3rd 500 MVA 400/132 kV transformer

7.5.3.5 Reactive power compensation

Given the existing voltage constrained network between Tabor and Spencer and the long timelines to execute the Limpopo East Strengthening. 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

7.5.3.6 Network strengthening projects

The following strengthening projects are planned for the period between 2024 and 2034.

Table 7-25: Limpopo – summary of projects and timelines

TDP Scheme	Project name	Expected Year	Phase
Medupi Transmission Integration	Medupi-Ngwedi 1st 765 kV line (Energised at 400 kV)	2024	Execution
Waterberg Generation 400 kV Stability Enhancement	Medupi – Witkop 1st 400 kV line	2024	Execution
	Borutho – Silimela 1st 400 kV line	2028	Definition
Polokwane Reactive Power Compensation	Tabor 2 x 36 Mvar Capacitor Banks	2027	Concept
	Spencer 2 x 36 Mvar Capacitor Banks	2027	Concept
Warmbad Transformation Upgrade	Warmbad 1st 500 MVA 275/132 kV transformer	2027	Definition
Acornhoek Transformation Upgrade	Acornhoek additional 250 MVA 400/132 kV transformer	2029	Definition

TDP Scheme	Project name	Expected Year	Phase
Borutho Transformation Upgrade	Borutho 3rd 500 MVA 400/132 kV transformer	2028	Concept
Highveld North-West and Lowveld North Reinforcement-Phase 1	Emkhiweni – Silimela 400 kV line	2028	Definition
Foskor & Acornhoek 275/132 kV Transformation Upgrades	Foskor-Merensky 400 kV Line	2029	Definition
Leseding Transformation Upgrade	Leseding 3rd 500 MVA 400/132 kV transformer	2029	Definition
Limpopo East Corridor Strengthening	Establish 400 kV busbars at Spencer Substation and Foskor Substation	2030	Definition
	Foskor 1st 400 MVA 400/275 kV Transformer		
	Spencer 1st 500 MVA 400/132 kV Transformer		
	Foskor - Spencer 1st 400 kV line (110km)		
	Merensky-Foskor 2nd 275 kV line change-over to 400 kV line		
Limpopo Strengthening to Enable RE Integration	Tabor 2nd 500 MVA 400/132 kV transformer	2029	Pre - Concept
	Warmbad B 1 x 500 MVA 400/132 kV Substation	2032	Pre - Concept
	Masa 1 x 500 MVA 400/132 kV Substation	2036	Pre - Concept

TDP Scheme	Project name	Expected Year	Phase
Sekhukhune Integration Phase 1	Sekhukhune 400/275/132 kV Substation (1 x 800 MVA 400/275 kV transformer & 2 x 500 MVA 400/132 kV transformers)	2029	Definition
	Loop in Arnot –Merensky 400 kV into Sekhukhune Substation		
	Manogeng – Sekhukhune 1st 400 kV line		
	Sekhukhune - Senakangwedi 1st 275 kV line		
Nzhelele 400 kV Integration	Nzhelele 400/132 kV Substation (2 x 500 MVA 400/132 kV Transformers)	2030	Definition
	Tabor - Nzhelele 400 kV line		
	Borutho-Nzhelele 1st 400 kV line		
Sekhukhune Integration Phase 2	Witkop – Sekhukhune 1st 400 kV line	2032	Concept

7.5.3.7 Projects for future independent power producers

The following transmission network strengthening projects will be required to enable the connection of the future IPPs located in the province within the current TDP period based on the generation assumptions, customer applications in the last year and the 2024 South African Renewable Energy Grid Survey results.

Previously the plans at Warmbad Substation were to replace 2 x 160 MVA 275/132 kV transformers with 2 x 250 MVA transformer for load growth. One transformer is addressed as part of refurbishment and one transformer as part of a reliability project., this has since been revised to cater for 2 x 500 MVA transformer due to high IPP interest.

Furthermore, Warmbad Substation is limited by the carrying capacity of the ageing 275 kV lines. Therefore, the need to explore the establishment of a Warmbad B 400/132 kV Substation. This substation will be the first step to exploring a 400 kV corridor to Gauteng Province.

At Tabor Substation, the installation of a 2nd 500 MVA transformer will enable IPP integration and further reduce the dependence on the 275 kV. Plan is to strategically phase on 275/132 kV transformation at Tabor Substation.

Masa 400/132 kV Substation establishment is an opportunity to repurpose the planned Masa Substation for the previously proposed Thabametsi Coal Generation since it is no longer planned for. The Masa – Ngwedi 765 kV line was designed to direct power flow to North West Province. Thus, enabling RE integration given the limitations at Medupi Substation.

Table 7-26: Limpopo - Projects required to facilitate IPP integration

Project name	Required CO year	Phase
Warmbad 1st 500 MVA 275/132 kV transformer	2027	Pre-concept
Warmbad B 1x 500 MVA 400/132 kV substation	2032	Pre-concept
Tabor 2nd 500 MVA 400/132 kV transformer	2029	Pre-concept
Masa 1 x 500 MVA 400/132 kV Substation	2036	Pre-concept

7.5.3.8 Provincial summary

The future transmission network for the province is shown in Figure 7-17 below.

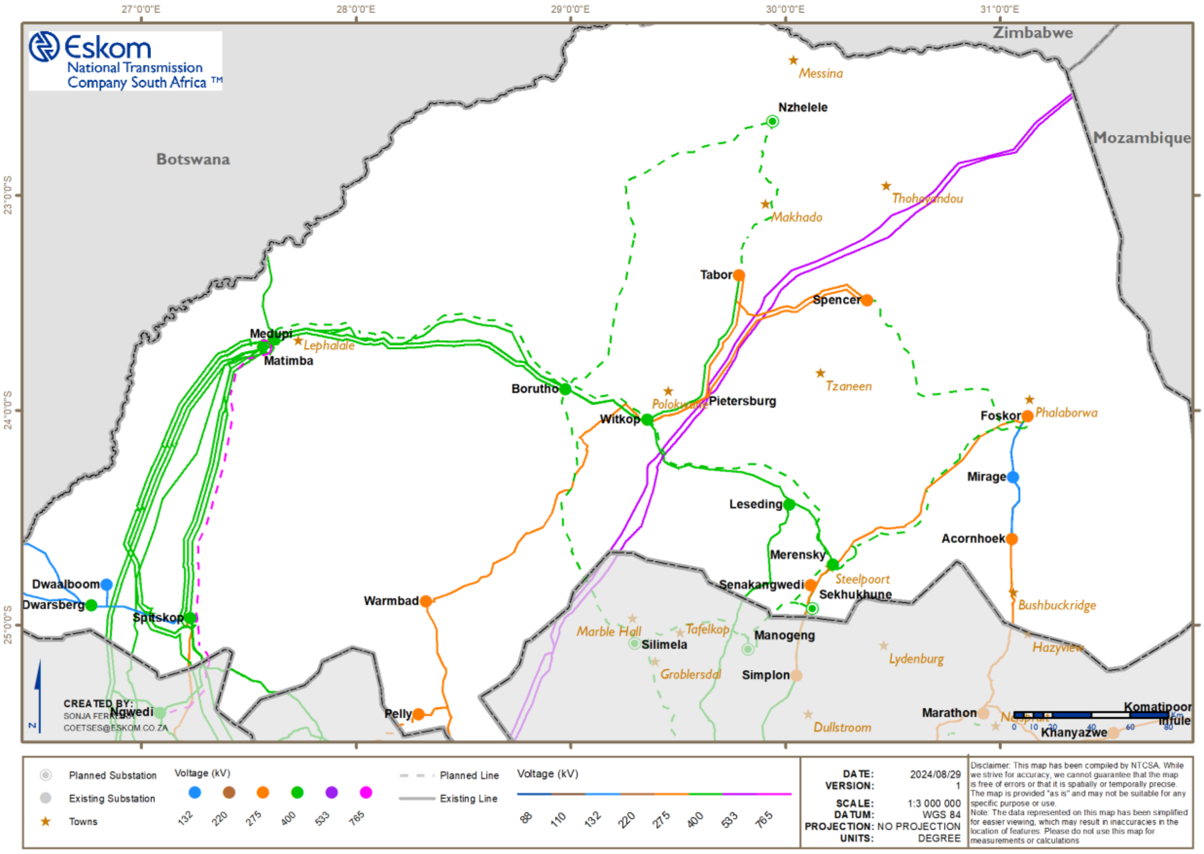


Figure 7-17: Future Limpopo transmission network

A summary of all new major assets planned for both the expansion and refurbishment portfolios for this province is provided in the tables below.

Table 7-27: Planned transformers for Limpopo

Transformer type	2025-2029		2030-2034	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
Less than 100 MVA	**3**	200	2	60
Less than 300 MVA	1	160	1	250
Less than 500 MVA	2	630	-	-
500 MVA	18	8 500	8	4 000
667 MVA	-	-	1	667
800 MVA	1	800	1	800
2000 MVA	-	-	2	4 000
Grand total	**25**	**10 290**	**14**	**9 527**

Table 7-28: Planned overhead lines for Limpopo

Line voltage	2025-2029	2030-2034
	Total length (km)	Total length (km)
400 kV	563	261
Grand total	**563**	**261**

Table 7-29: Planned capacitor banks for Limpopo

Capacitor type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
72 Mvar 132 kV	4	288	-	-
100 Mvar 400 kV	-	-	-	-
Grand total	**4**	**288**	**-**	**-**

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 NTCSA network at 132 kV, 275 kV, and 400 kV. Figure 7-18 represents the current transmission network in Mpumalanga.

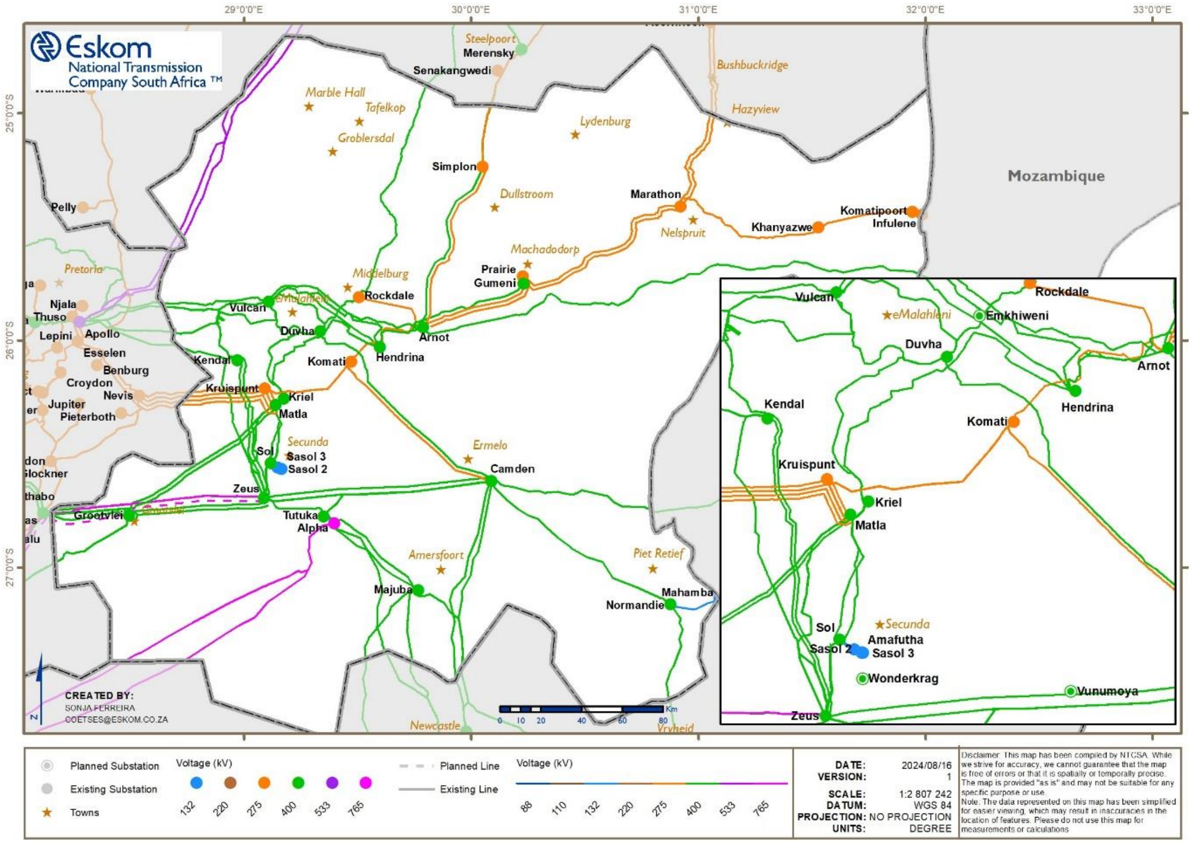


Figure 7-18: Current Mpumalanga transmission network

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 7-30 details the programme for the Kusile units becoming commercially available.

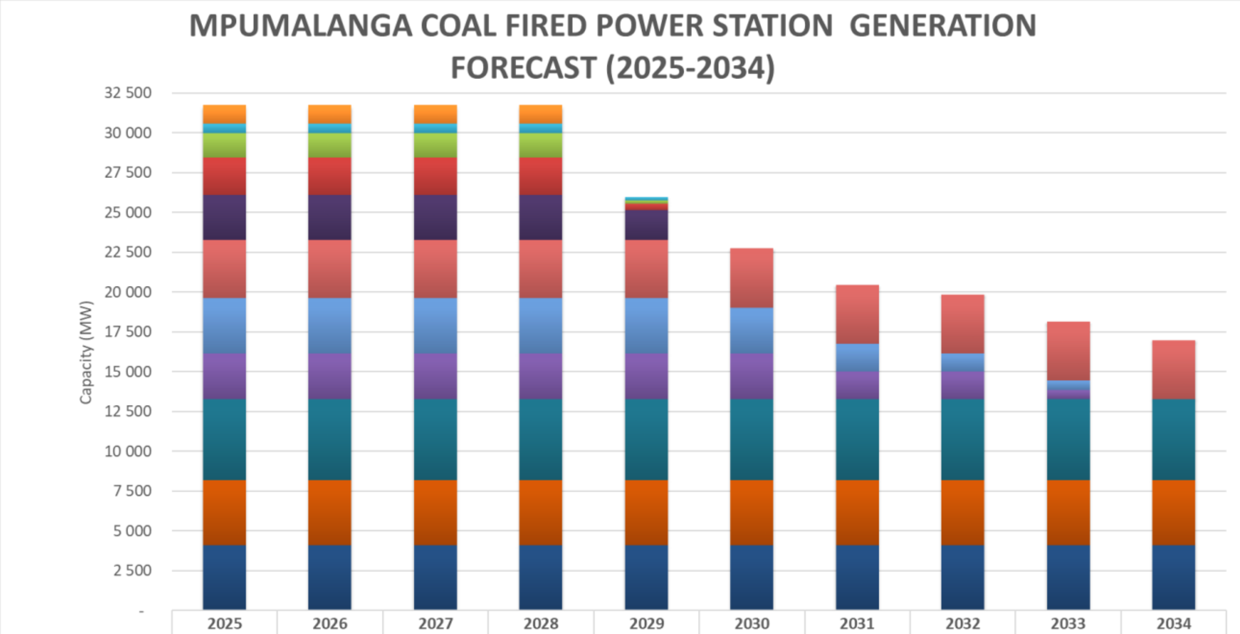
Table 7-30: Kusile Power Station schedule

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

Unit 5 of Kusile Power Station was commissioned onto the grid in June 2024, whilst Unit 6 is expected to be commissioned in the last quarter of 2024.

The only remaining transmission project for the integration of Kusile Power Station is the Kusile-Lulamisa 400 kV line. This project was delayed due to servitude acquisition challenges, however, is now close to completion.

Komati Power Station has reached the end of its economic life. Hendrina and Grootvlei Power Stations were also close to reaching the end of their economic life, however, there are extension plans for these and several other power stations in Mpumalanga Figure 7-19 shows the existing nominal generation capacity of the coal-fired power stations in Mpumalanga and the expected drop in capacity over the TDP period, inclusive of the life extension plans. The capacity is expected to decrease from approximately 31 GW in 2025 to 16 GW by 2035.



	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Hendrina	1 140	1 140	1 140	1 140	-	-	-	-	-	-
Grootvlei	570	570	570	570	190	-	-	-	-	-
Camden	1 520	1 520	1 520	1 520	190	-	-	-	-	-
Arnot	2 352	2 352	2 352	2 352	392	-	-	-	-	-
Kriel	2 850	2 850	2 850	2 850	1 900	-	-	-	-	-
Tutuka	3 654	3 654	3 654	3 654	3 654	3 654	3 654	3 654	3 654	3 654
Matla	3 450	3 450	3 450	3 450	3 450	2 875	1 725	1 150	575	-
Duvha	2 875	2 875	2 875	2 875	2 875	2 875	1 725	1 725	575	-
Kusile	5 076	5 076	5 076	5 076	5 076	5 076	5 076	5 076	5 076	5 076
Majuba	4 110	4 110	4 110	4 110	4 110	4 110	4 110	4 110	4 110	4 110
Kendal	4 116	4 116	4 116	4 116	4 116	4 116	4 116	4 116	4 116	4 116

Year

Figure 7-19: Coal-fired Generation forecast for Mpumalanga

As the grid connection capacity in high-yield areas in the country for RE diminishes, there has been interest in connecting RE plants in Mpumalanga. Figure 7-20 shows the expected RE and battery energy storage system (BESS) integration forecasted for Mpumalanga according to the TDP 2024 Generation Assumptions Paper. There is an expected 4.6 GW of RE and battery energy storage system integration by 2035.

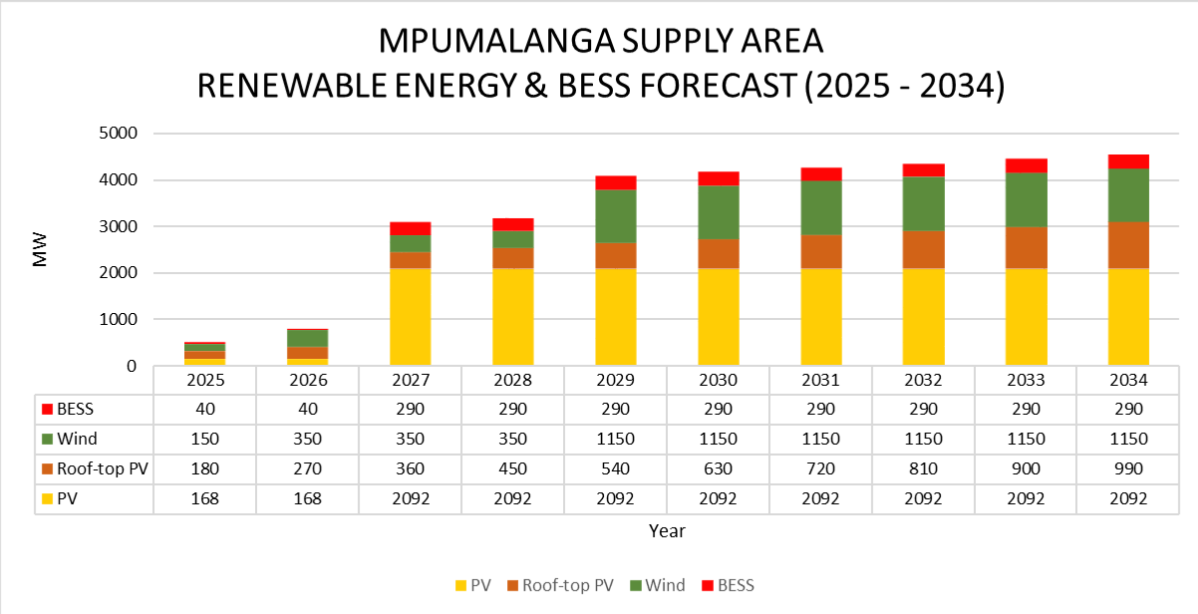


Figure 7-20: Renewable energy generation forecast for the North East Grid

Renewable energy drivers in Mpumalanga include Eskom programmes (land lease and power station repurposing), rooftop PV uptake in residential areas due to the impacts of load shedding, IPP wheeling applications, and transmission network capacity creation and availability in the province.

The following transmission projects have been identified for the integration of renewable energy in Mpumalanga and are in concept or detailed design phases.

1. Alpha 2 x 500 MVA 400/132 kV transformers
2. Alpha 4th 2000 MVA 765/400 kV transformer
3. Camden B 400 kV substation integration
4. Gumeni 2nd 500 MVA 400/132 kV transformer
5. Hendrina 500 MVA 400/132 kV transformer 3
6. Majuba 3rd 160 MVA 400/88 kV transformer
7. Majuba 2 x 500 MVA 400/132 kV transformers
8. Prairie 2 x 500 MVA 275/132 kV transformer upgrades
9. Vunumoya 400 kV substation integration
10. Zeus 3rd 2000MVA 765/400 kV transformer

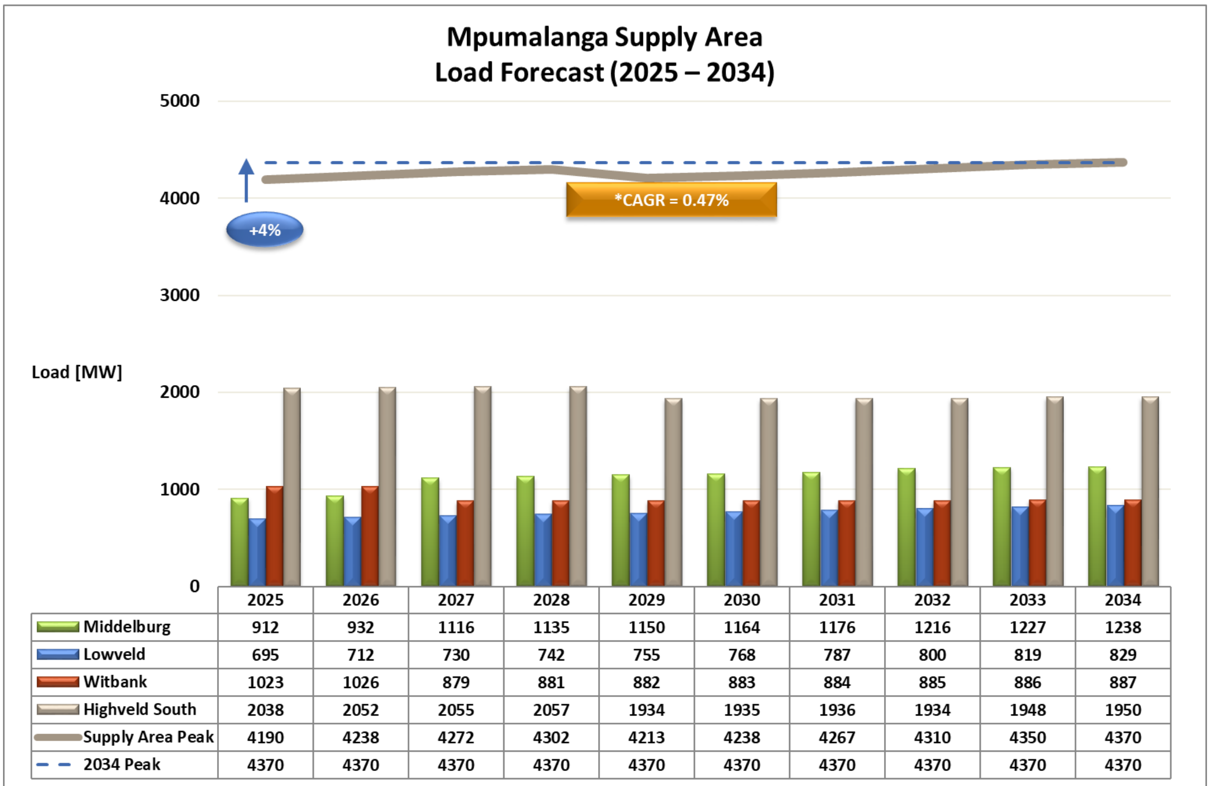
7.6.2 LOAD FORECAST

Minimal load growth is expected in the province due to low development across the commercial, electrification, and industrial sectors. The future load mix is not likely 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 0.47% per annum, from 4190 MW (at provincial peak) in the year 2025 to 4370 MW in the year 2034.

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 7-21.



	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Middelburg	912	932	1116	1135	1150	1164	1176	1216	1227	1238
Lowveld	695	712	730	742	755	768	787	800	819	829
Witbank	1023	1026	879	881	882	883	884	885	886	887
Highveld South	2038	2052	2055	2057	1934	1935	1936	1934	1948	1950
Supply Area Peak	4190	4238	4272	4302	4213	4238	4267	4310	4350	4370
2034 Peak	4370	4370	4370	4370	4370	4370	4370	4370	4370	4370

Figure 7-21: 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 recently entered the execution phase and is also dependent on Eskom Distribution integration plans. The second phase of this scheme includes the Emkhiweni-Silimela 400 kV line.

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
- The project has been delayed for longer than expected, as the servitude challenges included an expropriation process which has now been concluded. The development phase is nearing completion.

Camden B 400/132 kV integration

This new project is in the concept phase and is required due to RE IPP interest in the vicinity of Camden Power Station. The scope of work for this project is the following:

- Camden B 4 x 500 MVA 400/132 kV Substation
- Loop-in Camden-Incandu 400 kV line

Vunumoya 400/132 kV Substation

This is a new substation for the integration of potentially the first wind energy farm in the Mpumalanga Province. The scope of work for this project is the following:

- Vunumoya 1 x 500 MVA 400/132 kV Substation
- Loop-in Camden - Sol 400 kV line

Majuba 400/132 kV Substation Extension

This project entails the establishment of 132 kV at Majuba Substation for the integration of IPPs. The scope of work for the project is the following:

- Establish 132 kV yard
- Install 2 x 500 MVA 400/132 kV transformers

Alpha 400/132 kV Substation Extension

This project entails the establishment of 132 kV at Alpha Substation for the integration of IPPs. The scope of work for the project is the following:

- Establish 132 kV yard
- Install 2 x 500 MVA 400/132 kV transformers

7.6.3.2 New substations

The following 400/132 kV substations will be established due to load growth and renewable energy interest in Mpumalanga in order for the networks to remain Grid Code compliant and to create additional capacity.

- Emkhiweni 400/132 kV substation
- Wonderkrag 400/132 kV substation

- Camden B 400/132 kV
- Vunumoya 400/132 kV substation

7.6.3.3 New lines

Additional 400 kV, 275 kV, and 132 kV lines will be established to increase power evacuation capacity, ensure Grid Code compliance and to strengthen the Mpumalanga Province networks and its major power corridors.

- Emkhiweni-Silimela 400 kV line
- Emkhiweni 400 kV turn-ins
- Kusile-Lulamisa 400 kV line
- Gumeni-Marathon 400 kV line
- Camden B 400 kV turn-ins
- Amafutha – Sol 132 kV lines
- Matla – Kruispunt 275 kV line 2
- Vunumoya 400 kV turn-ins
- Wonderkrag – Sasol 2 132 kV lines
- Wonderkrag – Sasol 3 132 kV lines
- Wonderkrag 400 kV turn-ins

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 2025 and 2034.

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

Scheme name	Project/SOW	Expected CO date	Phase
Kusile integration Phase 2: Lulamisa	Kusile - Lulamisa 1st 400 kV line	2024	Execution
Sol underrated equipment upgrade and FCLRs	Upgrade underrated equipment at Sol substation	2024	Execution
	Install FCLRs	2024	Finalisation
Mpumalanga underrated equipment upgrade	Upgrade underrated equipment at Vulcan 400 kV, Rockdale 132 kV, Hendrina 400 kV, Kruispunt 132 kV, Komati 275 kV, Arnot 400 kV and 275 kV, Tutuka 400 kV, Alpha 400 kV, Majuba 400 kV, and Matla 275 kV.	2026	Execution
Emkhiweni 400 kV integration	Establish Emkhiweni 2 x 500 MVA 400/132 kV substation	2027	Execution
	Kendal - Arnot 400 kV turn-ins	2027	Execution
	Emkhiweni-Silimela 1st 400 kV line	2028	Definition
Amafutha 132 kV switching station	Establish Amafutha switching station	2028	Definition
	2 x Sol-Amafutha 132 kV lines		Definition
Wonderkrag 400 kV integration	Establish Wonderkrag 5 x 500 MVA 400/132 kV substation	2028	Execution
	Kriel - Zeus 400 kV turn-ins		Execution
	Kriel - Tutuka 400 kV turn-ins		Execution

Scheme name	Project/SOW	Expected CO date	Phase
Marathon 400 kV integration	Gumeni – Marathon 1st 400 kV line	2028	Definition
	Marathon 1 x 500 MVA 400/132 kV substation		Definition
Mpumalanga Underrated Terminal Equipment	Upgrading of the terminal equipment of several line bays	2029	Pre-concept
Matla 800 MVA 400/275 kV Transformer 2	Install the 2nd 800 MVA 400/275 kV transformer	2031	Pre-concept
Tutuka FCLRs	Installation of FCLRs at Tutuka substation	2029	Pre-concept
Matla – Kruispunt 275 kV line 2	Matla -Kruispunt 2nd 275kV line	2033	Pre-concept

7.6.3.6 Projects for future independent power producers

The table below outlines the RE integration projects in Mpumalanga.

Table 7-32: Summary of expected RE generation integration projects for Mpumalanga

Scheme name	Project/SOW	Expected CO date	Phase
Vunumoya 400 kV substation integration	Establish Vunumoya 1 x 500 MVA 400/132 kV Substation	2025	Execution
	Camden – Sol 400 kV turn-ins		
Gumeni 2nd 400/132 kV transformer	Install the 2nd 500 MVA 400/132 kV transformer	2027	Execution
Majuba 3rd 160 MVA 400/88 kV transformer	Install the 3rd 160 MVA 400/88 kV transformer	2027	Definition
Prairie 275/132 kV transformer upgrades	Upgrade transformers to 2 x 500 MVA 275/132 kV	2029	Definition
Majuba 400/132 kV extension	Install 2 x 500 MVA 400/132 transformers	2027	Definition

Scheme name	Project/SOW	Expected CO date	Phase
Alpha 400/132 kV extension	Install 2 x 500 MVA 400/132 kV transformers	2028	Concept
Hendrina 500 MVA 400/132 kV Transformer 3	Install 1 x 500 MVA 400/132 kV transformer	2028	Concept
Alpha 4th 2000 MVA 765/400 kV transformer	Install the 4th 2000 MVA 765/400 kV transformer	2029	Concept
Zeus 3rd 2000 MVA 765/400 kV transformer	Install the 3rd 2000 MVA 765/400 kV transformer	2030	Concept
Camden B 400 kV substation integration	Establish Camden B 4 x 500 MVA 400/132 kV substation	2030	Concept
	Camden-Incandu 400 kV turn-ins		
Zeus equipment upgrades	Upgrade equipment at Zeus substation	2030	Pre-concept

7.6.3.7 Projects for alternative generation scenario

A number of grid connections for gas powered plants were noted post the conclusion of the generation assumptions for the TDP 2024. Many of the applications were located in the Lowveld CLN, which has restrictive power evacuation corridors. Plans to increase network capacity in this region for gas and other generation facilities will be investigated in the next TDP cycle.

7.6.3.8 Provincial summary

The future transmission network for the province is shown in Figure 7-22 below.

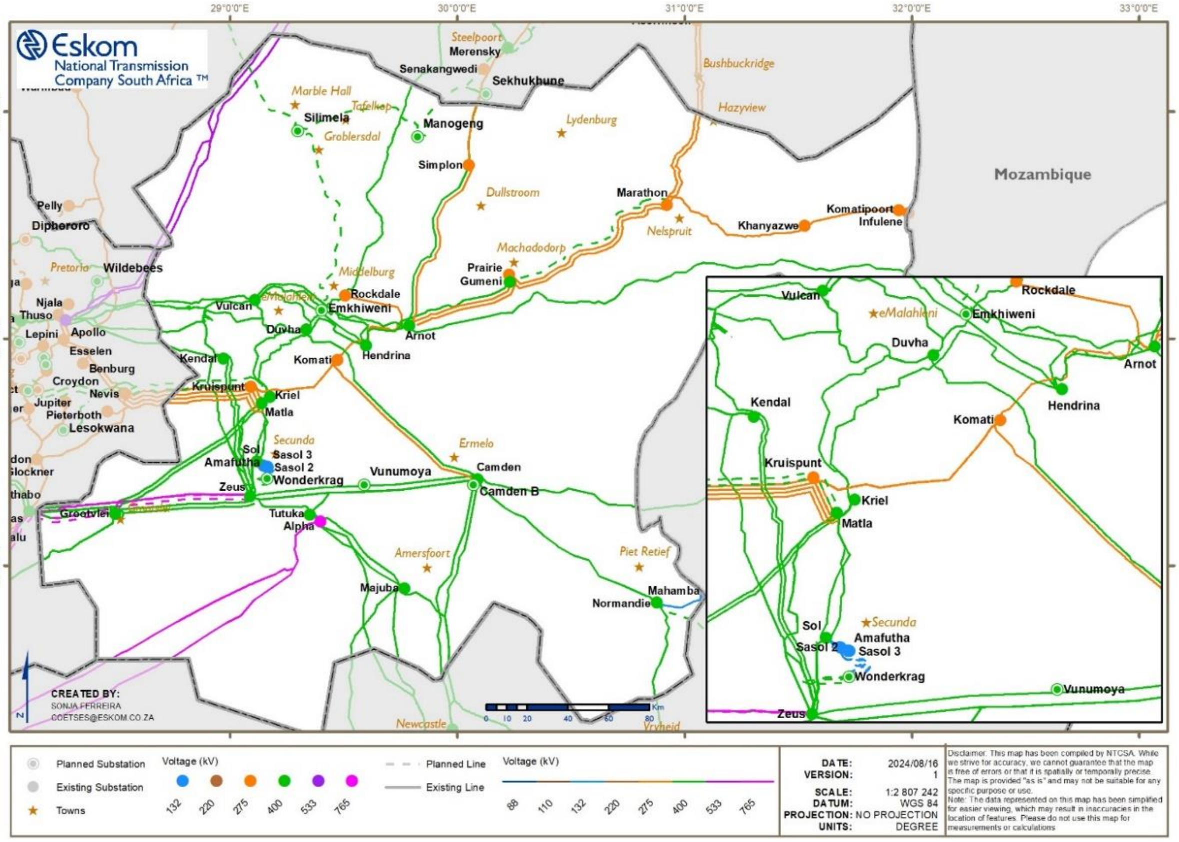


Figure 7-22: Future Mpumalanga transmission network

A summary of all new major assets planned for both the expansion and refurbishment portfolios for this province is provided in the tables below.

Table 7-33: Planned transformers for Mpumalanga

Transformer type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
Less than 100 MVA	3	200	2	60
Less than 300 MVA	1	160	-	-
Less than 500 MVA	2	630	-	-
500 MVA	18	9000	8	4000
667 MVA	-	-	1	667
800 MVA	1	800	1	800
2 000 MVA	-	-	2	4000
Grand total	**25**	**10 790**	**14**	**9 527**

Table 7-34: Planned overhead lines for Mpumalanga

Line voltage	2025 to 2029	2030 to 2034
	Total length (km)	Total length (km)
400 kV	563	261
Grand total	**563**	**261**

Table 7-35: Planned reactors for Mpumalanga

Reactor type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
400 Mvar 765 kV	1	400	-	-
133 Mvar 765 kV	-	-	3	399
Grand total	**1**	**400**	**3**	**399**

7.7 NORTHERN CAPE

The Northern Cape and Hydra Central supply areas are situated in the western part of South Africa. It is bordered by Botswana, Namibia, and North West to the north, by the Free State and the Eastern Cape to the east, by the Western Cape to the south, and by the Atlantic Ocean to the west. The provincial economy is primarily driven by mining and agriculture. Lately, there has also been considerable interest in green hydrogen production in the region. The two supply areas consist of vast tracts of land with excellent solar radiation and wind resources, which makes it an attractive location for solar and wind energy production.

The transmission network comprises 220 kV, 275 kV, 400 kV, and 765 kV. The network is sparse, historically having to cater for only the relatively small load in comparison to the land mass. The connection to Namibia is at 220 kV and 400 kV via the Aries – Kokerboom 400 kV line 1 and Aggeneis – Harib 220 kV lines 1 and 2. The existing transmission network is shown in Figure 7-23.

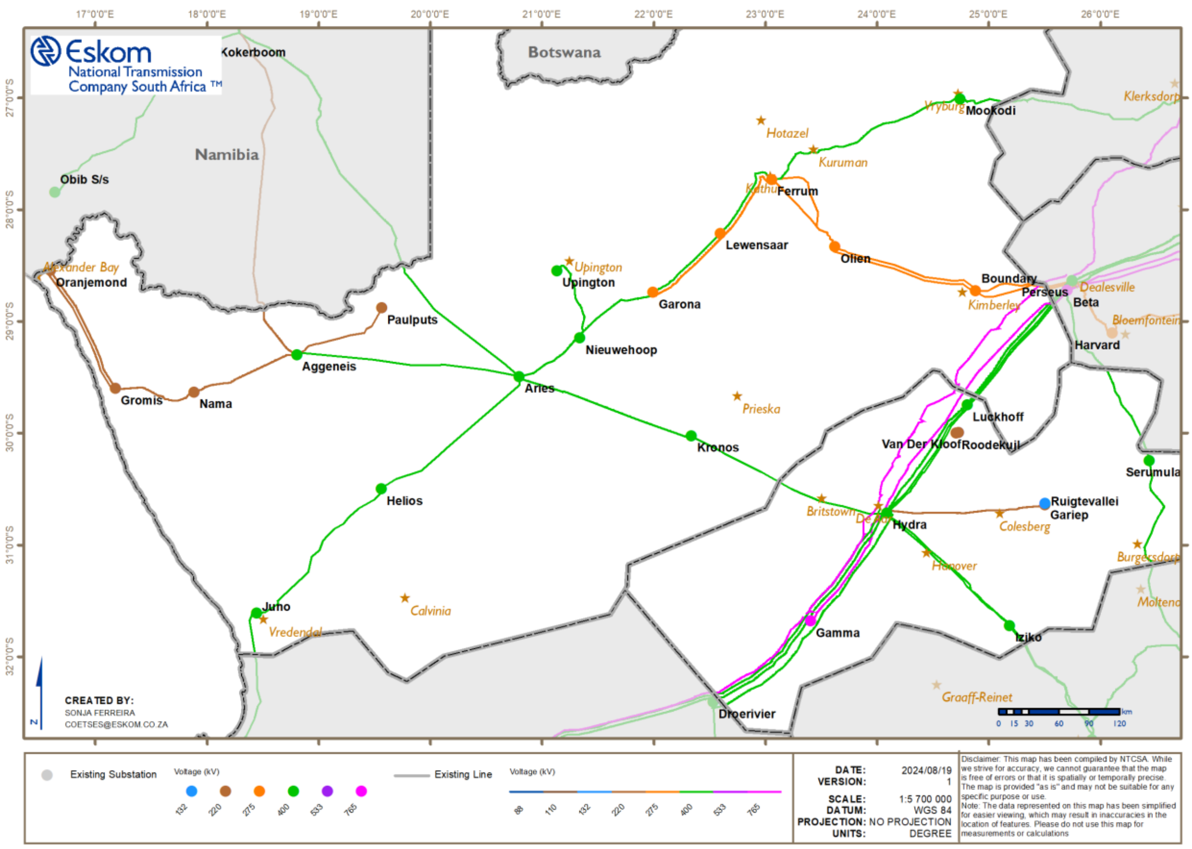


Figure 7-23: Current Northern Cape and Hydra Central transmission network

7.7.1 GENERATION

7.7.1.1 Conventional Generation

There are two conventional power stations in the Hydra Central supply area, both of which are hydropower stations and are situated along the Orange River.

Vanderkloof Power Station is located on the provincial border of the Northern Cape and Free State. It is built adjacent to the Vanderkloof Dam and consists of two 120 MW generators, with a total generating output of 240 MW. Vanderkloof's first unit went into commercial operation in December 1976 and the second in February 1977. It is integrated into the transmission grid at Roodekuil Substation via two 220 kV lines. Roodekuil Substation is connected to Hydra Substation via the Hydra – Roodekuil 220 kV and Hydra – Roodekuil 132 kV lines.

Gariep Power Station is located on the provincial border of the Eastern Cape and Free State and is built adjacent to the Gariep Dam. It has a generating capacity of 360 MW, with four units rated at 90 MW each. Gariep's first two units went into commercial operation in September 1971 and November 1971 and the last two units in January 1976 and February 1977. It is integrated into the transmission grid at Ruigetevallei Substation via four 132 kV lines. Ruigetevallei Substation is connected to Hydra Substation via two 220 kV lines.

Gariep Power Station (source Eskom)

The electricity produced by these two power stations feeds into the NTCSA national grid to supply power for peak and emergency demand periods, as well as base load energy when excess water poses a flood risk.

7.7.1.2 Renewable Energy Generation

Since the first release of the GCCA in 2012, IPP developers' interest in pursuing solar PV and concentrated solar power (CSP) projects in the Northern Cape supply area has been highly apparent.

However, the "weak" transmission network would not cater for the full interest of renewable energy generation in the area. Only 129 MW of generation connection capacity was available in 2012.

The release of the GCCA 2024 in March 2022 indicated that the Northern Cape transmission network was congested, and the generation connection capacity was reduced to 0 MW. The concept of a "constrained transmission grid" had emerged.

However, during the period 2012 to 2022, NTCSA constructed six major transmission lines spanning just over 1 170 km, which contributed significantly to the generation connection capacity from the previous 129 MW:

1) 130 km Gromis – Oranjemond 220 kV
2) 258 km Ferrum – Nieuwehoop 400 kV
3) 88 km Nieuwehoop – Upington 400 kV
4) 67 km Aries – Nieuwehoop 400 kV
5) 199 km Ferrum – Mookodi 400 kV
6) 430 km Gamma – Perseus 765 kV

By this time, the Northern Cape supply area was also interconnected to the North West supply area. As the generation connection capacity increased, the bid windows rapidly consumed the capacity. To date, 3 463 MW of renewable energy generation has been integrated into the Northern Cape supply area.

The total RE generation procured in the Northern Cape and Hydra Central supply areas from REIPPPP 1 to REIPPPP 6, including the RMIPPPP, is just over 4 800 MW with 600 MW of battery storage, as shown in Figure 7-24.

Of this total, and by 2027, and only considering the public procurement programme:

- the Northern Cape (NC) supply area will host 3 526 MW of renewable energy (RE) generation by 2027, comprising 600 MW of CSP, 2 052 MW of PV and 875 MW of wind.

- the Hydra Central (HC) supply area will host 1 279 MW of renewable energy (RE) generation, comprising, 546 MW of PV and 734 MW of wind generation.

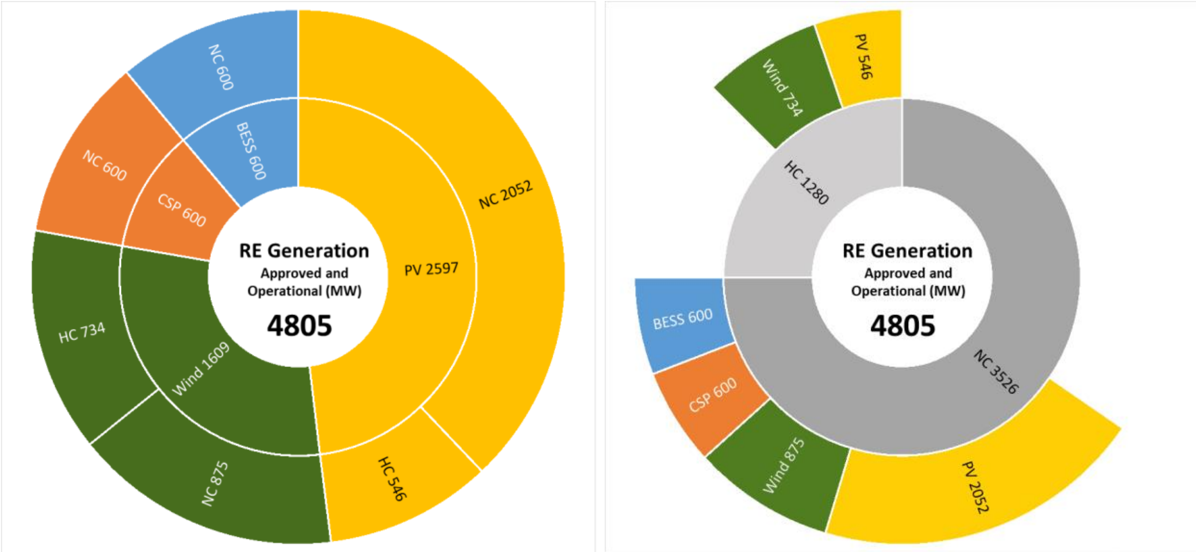


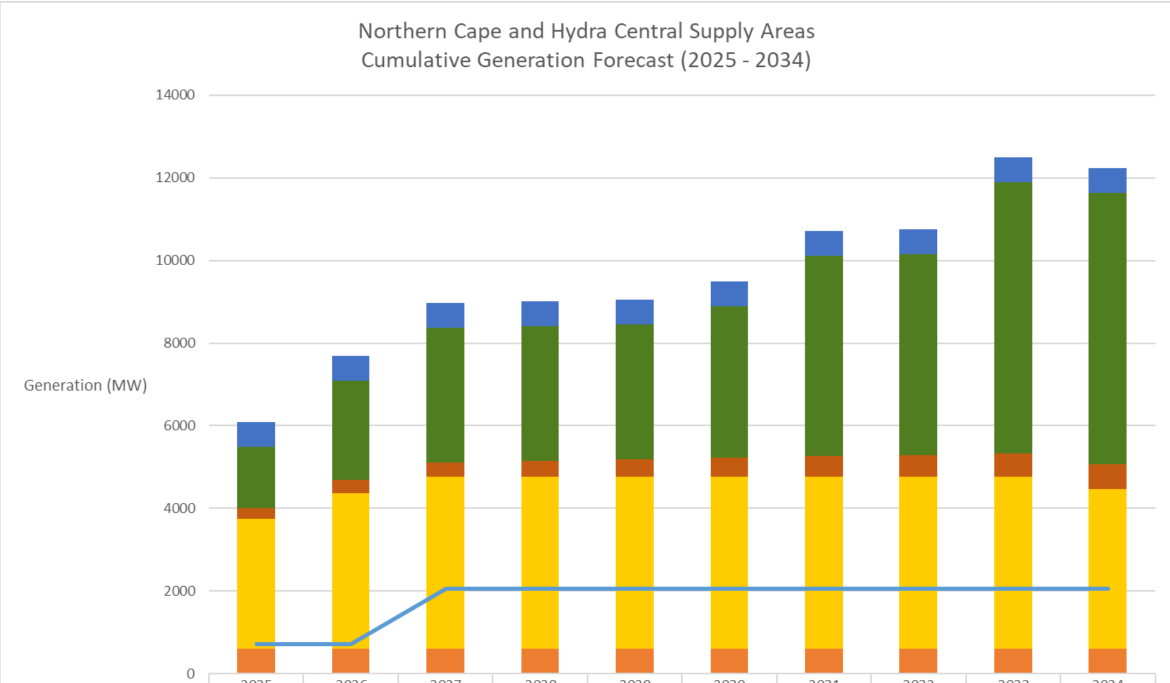
Figure 7-24: RE generation up to 2027 under REIPPPP and RMIPPPP

7.7.2 GENERATION FORECAST

There are four designated renewable energy development zones (REDZs) in the Northern Cape supply area, namely, Springbok (REDZ8 wind and solar), Upington (REDZ7 solar), Vryburg (REDZ6 solar) and Kimberley (REDZ5 solar). These were identified as areas with strategic importance for RE generation and were gazetted as such in February 2018.

The 2024 RE survey has also identified substantial interest in IPP projects that are already at an advanced level of development in the Northern Cape and Hydra Central supply areas. The total interest is around 26 GW, with an almost equal share between the two supply areas.

The Northern Cape and Hydra Central supply areas are therefore prime locations for RE generation. As a result of this, 6 225 MW of additional utility-scale RE generation is forecasted in these two supply areas by 2035. This is in addition to what has already been commissioned or approved.



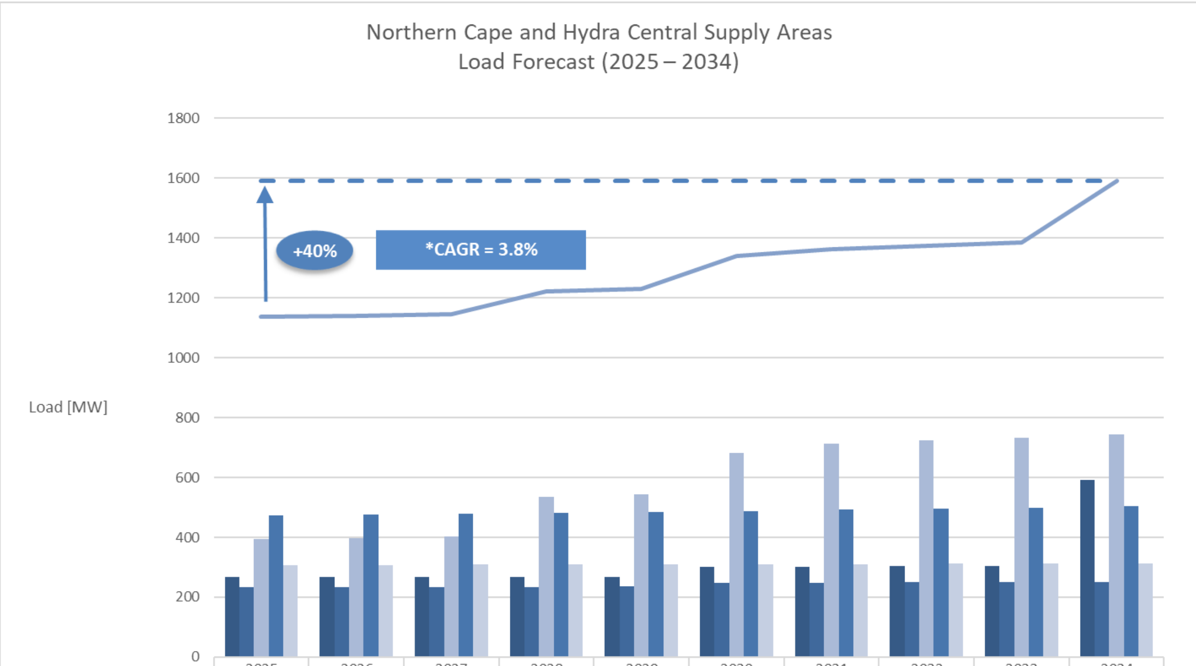
	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Hydro	600	600	600	600	600	600	600	600	600	600
Wind	1485	2414	3258	3258	3258	3658	4858	4858	6558	6558
Rooftop PV	272	308	344	380	416	452	488	524	560	596
PV	3136	3773	4173	4173	4173	4173	4173	4173	4173	3872
CSP	600	600	600	600	600	600	600	600	600	600
Battery Storage	710	710	2060	2060	2060	2060	2060	2060	2060	2060

Figure 7-25: Northern Cape and Hydra Central generation forecast

7.7.3 LOAD FORECAST

The Northern Cape and Hydra Central supply areas comprise five local areas, namely, Kalahari, Vredendal, Kimberley, Namaqualand and Hydra Central. The load peaked at around 1 088 MW over the past year and is forecasted to increase by 40% from 1 137 MW in 2025 to 1 591 MW in 2034. This equates to a compound annual growth rate (CAGR) of 3.8%.

The load forecast for the five local areas and the diversified total for the two supply areas is shown in Figure 7-26.



	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Namaqualand	267	267	268	268	269	301	302	303	304	592
Vredendal	233	233	234	235	235	248	249	250	251	252
Kalahari	394	398	401	535	544	682	713	723	733	743
Kimberley	475	476	478	480	483	487	492	495	499	503
Hydra Central	308	308	308	309	309	310	311	311	312	313
2034 Peak	1591	1591	1591	1591	1591	1591	1591	1591	1591	1591
Supply Area Peak	1137	1141	1145	1222	1231	1341	1363	1373	1384	1591

Figure 7-26: Northern Cape and Hydra Central load forecast

The steep load increase is mainly due to mining, and associated rail and industrial activities.

- Transnet is in the process of upgrading its iron ore line. Together with the coal line, the iron ore line is one of the two main heavy haulage lines in South Africa and stretches over 861 km from Sishen to Saldanha Bay. Consequently, to enable Transnet Freight Rail to expand its operations, upgrades to the electrical infrastructure are required coupled with an increase in demand.

- Phase 2 of the Gamsberg mining expansion project located in the Namakwa Special Economic Zone will double the capacity of the Gamsberg mine and plant and include the construction of a second concentrator. The project is targeted to be completed around 2026.

  There are plans to construct a new zinc smelter and associated infrastructure to produce 300,000 tonnes per annum of special high-grade zinc metal. The smelter project is expected to increase the load in the Namaqualand local area by 160-200 MVA but has been deferred to much later in the load forecast until the project is confirmed.

Gamsberg Zinc Mine (source Vedanta)

7.7.4 PLANNED PROJECTS

Several projects have been initiated to resolve the existing and future network constraints, supply the forecasted load, and integrate the additional generation. These projects take the condition of existing assets, potential costs of the proposed solutions, and environmental impacts and challenges into consideration.

7.7.4.1 Development Plans for Namaqualand

Wildflowers of Namaqualand (source PlanetWare)

The strengthening in the Namaqualand supply area involves reinforcing the existing 400 kV network and extending it to the radial 220 kV networks, thereby assuring the required level of network redundancy and providing for additional network capacity.

NamPower's long-term supply options include a second NTCSA-NamPower 400 kV interconnector. Aside from preventing a voltage collapse within the NamPower transmission network during a contingency on the existing supply, secondary benefits include increasing the power that can be transferred between the two utilities and the power that can be wheeled to other neighbouring utilities.

Dynamic voltage control will be provided by the Aries dynamic var device and the Aggeneis and Gromis synchronous condensers. The synchronous condensers will also provide inertia, voltage support and short circuit power which will enable the connection of additional renewable energy generation.

Additional substations and transformers are also required mainly to create local capacity to connect renewable energy generation.

Figure 7-27 and Figure 7-28 below are the locations of the planned strengthening projects in the area.

No.	Project	Expected	Phase
1	Aggeneis – Paulputs 400 kV line	2030	Execution
2	Aries – Kokerboom 400 kV line loop-in to Paulputs	2030	Concept
3	Juno – Gromis 400 kV line & Gromis 400/220 kV transformer	2027	Execution
4	Oranjemond – Obib 400 kV line & Oranjemond 400/220 kV transformer	2027	Execution
5	Gromis – Nama – Groiepunt 400 kV line	2029	Definition
6	Aggeneis – Groeipunt 1st and 2nd 400 kV lines	2028	Definition
7	Aries – Aggeneis 2nd 400 kV line	2029	Definition
8	Aries Dynamic Var Device	2028	Execution
9	Aggeneis Synchronous Condenser	2028	Concept
10	Gromis Synchronous Condenser	2028	Concept
11	Aggeneis BESS 77 MW (self-build)	2027	Definition

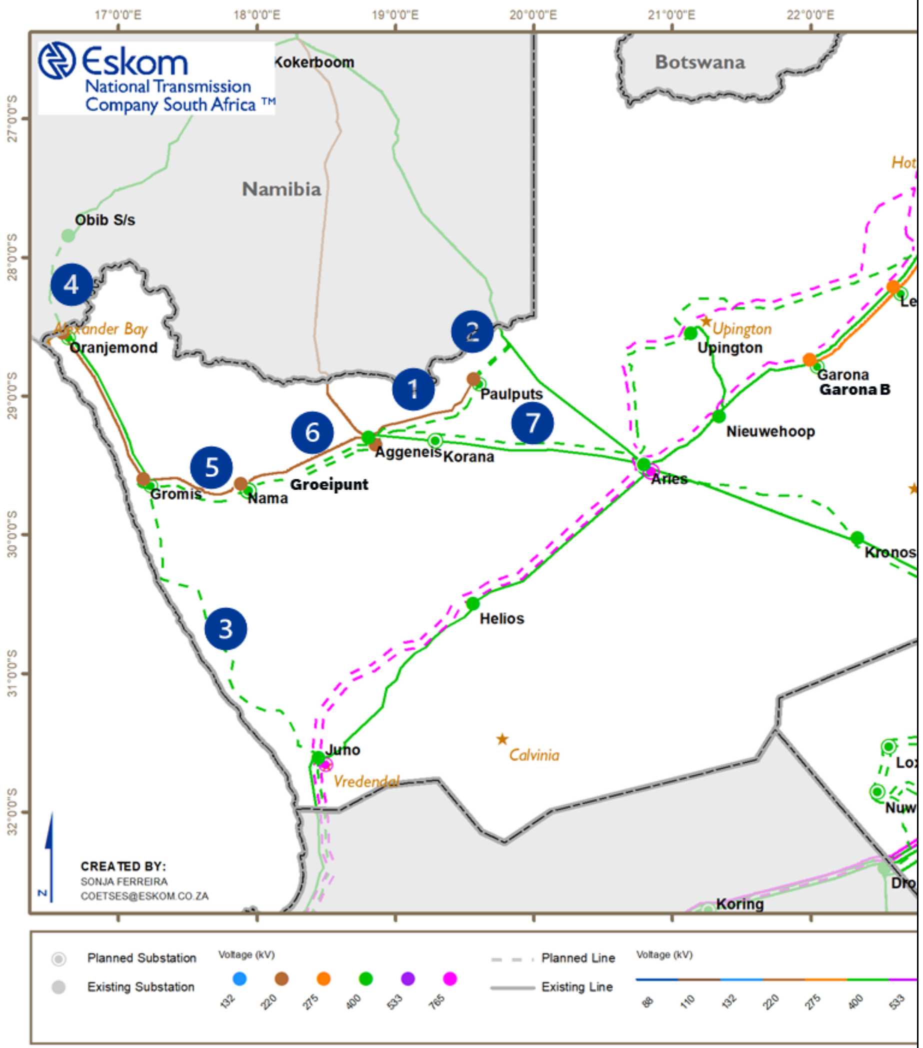


Figure 7-27 Future Namaqualand Network – Lines and Facts Devices

No.	Project	Expected	Phase
1a	Aggeneis 1st 400/132 kV 500 MVA (self-build)	2027	Definition
1b	Aggeneis 2nd 400/132 kV 500 MVA	2030	Pre-concept
2a	Aries 1st 400/132 kV 500 MVA	2028	Execution
2b	Aries 2nd 400/132 kV 500 MVA	2030	Pre-concept
3	Groeipunt 1st 400/132 kV 500 MVA	2028	Definition
4	Gromis 1st 400/132 kV 500 MVA	2028	Definition
5a	Helios 2nd 400 /132 kV 500 MVA (self-build)	2028	Execution
5b	Helios 1st 132/66 kV 40 MVA	2028	Pre-concept
6a	Juno 3rd 400/132 kV transformer (1st 500 MVA)	2028	Execution
6b	Juno 132/66 kV Transformers Upgrade	2032	Definition
7a	Korana 400/132 kV substation (1st 500 MVA)	2028	Definition
7b	Korana 2nd 400/132 kV 500 MVA	2030	Pre-concept
8a	Nama 1st 400/132 kV 500 MVA	2028	Definition
8b	Nama 1st 66/22 kV 20 MVA	2025	Execution
9a	Paulputs 1st 400/132 kV 500 MVA	2030	Execution
9b	Paulputs 2nd 400/132 kV 500 MVA	2030	Concept

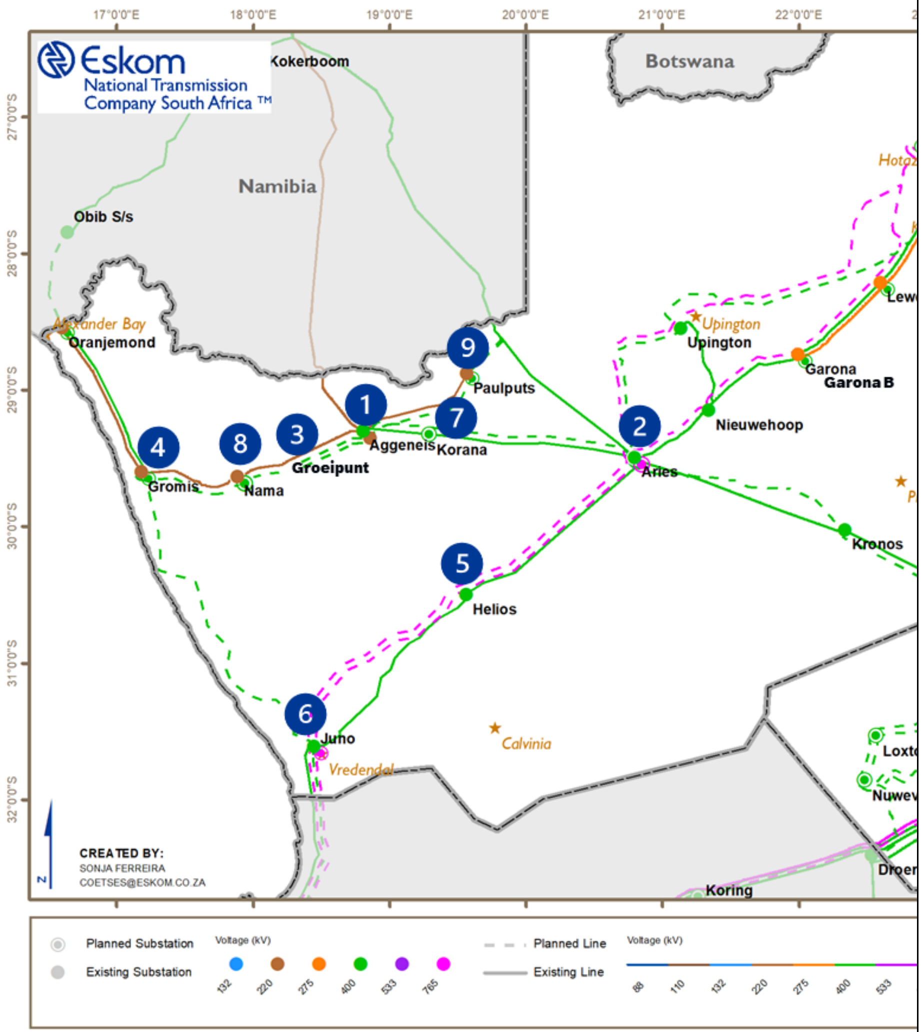


Figure 7-28 Future Namaqualand Network – Substations and Transformers

7.7.4.2 Development Plans for Karoo, Kalahari and Kimberley

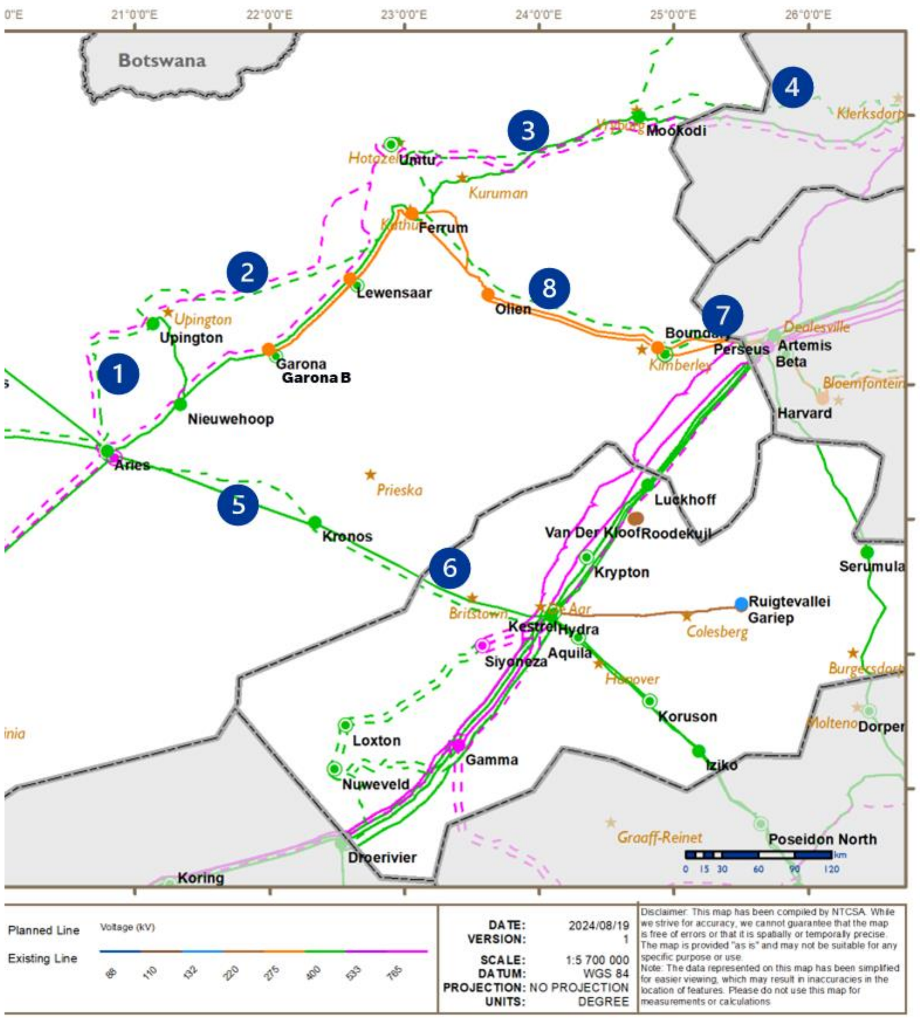
The Big Hole, Kimberley (source PlanetWare)

The strengthening in the Karoo, Kalahari and Kimberley supply areas involves reinforcing the existing 400 kV network and also overlaying it onto the 275 kV networks, thereby catering for the latent mining loads in the area, assuring the required level of network redundancy and providing additional export capacity for the excess renewable energy generation.

Dynamic voltage control will be provided by the Mookodi dynamic var device and the Ferrum synchronous condenser. The synchronous condenser will also provide inertia, voltage support and short circuit power which will enable the connection of additional renewable energy generation.

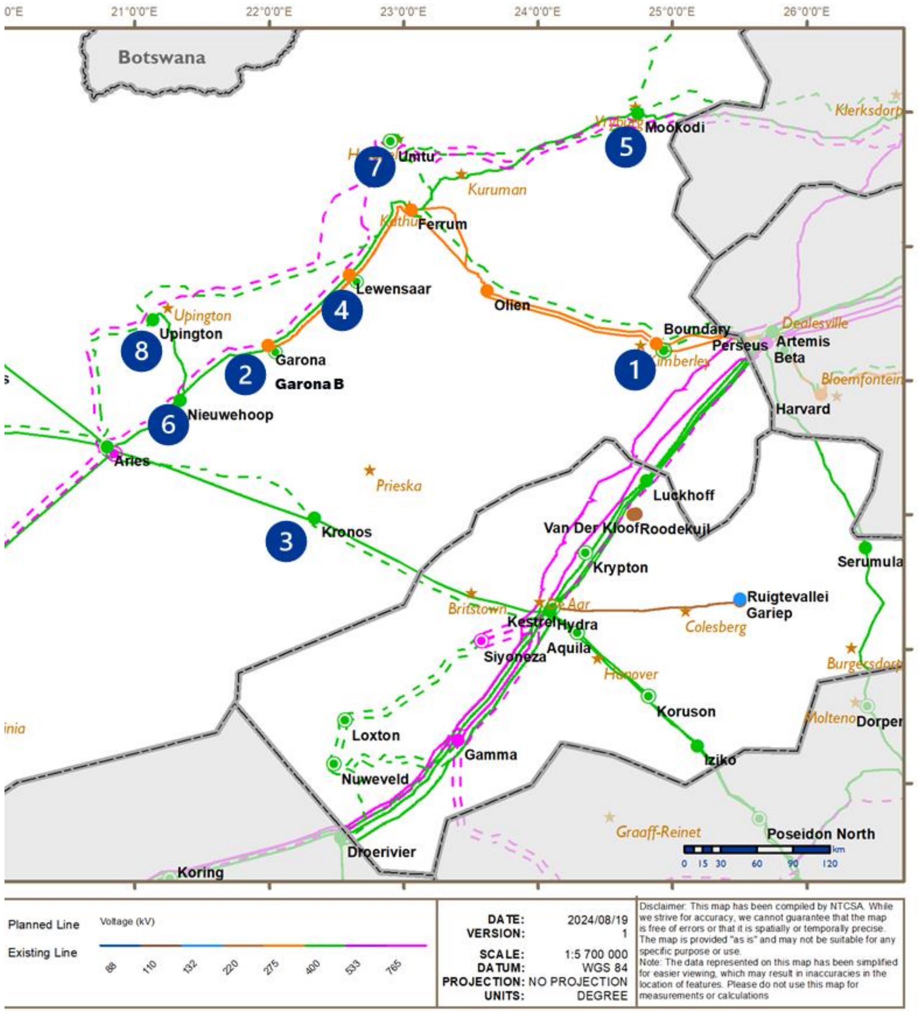
Additional substations and transformers are also required mainly to create local capacity to connect renewable energy generation. The construction of the Umtu 400/132 kV substation will be triggered by load growth or IPP applications in the area.

Figure 7-29 and Figure 7-30 show the locations of the planned strengthening projects in the area.



No.	Project	Expected	Phase
1	Aries – Upington 400 kV line	2029	Execution
2	Ferrum – Upington 400 kV line	2032	Execution
3	Ferrum – (Umtu) – Mookodi 2nd 400 kV line	2027	Definition
4	Hermes – Mookodi 400 kV line	2028	Definition
5	Aries – Kronos 2nd 400 kV line	2028	Execution
6	Hydra – Kronos 2nd 400 kV line	2028	Execution
7	Beta – Boundary 400 kV line	2029	Execution
8	Boundary – Ferrum 400 kV line	2029	Definition
9	Mookodi Dynamic Var Device	2028	Execution
10	Ferrum Synchronous Condenser	2028	Concept
11	Ferrum BESS 103 MW	2026	Definition
12	Garona BESS 153 MW	2027	Definition
13	Nieuwehoop BESS 103 MW	2027	Definition
14	Mookodi BESS 77 MW	2026	Definition

Figure 7-29 Future Karoo, Kalahari and Kimberley Network – Lines and Facts Devices



No.	Project	Expected	Phase
1a	Boundary 1st 400/132 kV 500 MVA	2029	Execution
1b	Boundary 2nd 400/132 kV 500 MVA	2029	Definition
2a	Garona 275/132 kV transformer upgrade	2029	Pre-concept
2b	Garona B 400/132 kV substation (1st 500 MVA transformer) (self-build)	2027	Definition
3a	Kronos 3rd 400/132 kV 500 MVA	2028	Execution
3b	Kronos 4th 400/132 kV 500 MVA	2031	Pre-concept
4a	Lewensaar 1st 400/132 kV 500 MVA	Cancelled	
4b	Lewensaar 1st 275/132 kV 500 MVA	Pre-concept	
5	Mookodi 1st 400/132 kV 500 MVA	2028	Execution
6a	Nieuwehoop 2nd 400/132 kV (1st 500 MVA) (self-build)	2027	Definition
6b	Nieuwehoop 3rd and 4th 400/132 kV (2nd and 3rd 500 MVA)	2031	Pre-concept
7	Umtu 1st and 2nd 400/132 kV 500 MVA	2033	Pre-concept
8a	Upington 2nd 400/132 kV 500 MVA	2027	Execution
8b	Upington 3rd and 4th 400/132 kV 500 MVA	2029	Pre-concept

Figure 7-30 Future Karoo, Kalahari and Kimberley Network – Substations and Transformers

7.7.4.3 Development Plans for Hydra Central

Church in Britstown (source gemeentegeskiedenis)

The strengthening in the Hydra Central supply area involves establishing a new 400 kV corridor on the western side of the central corridor, thereby catering for IPP interest in the area, and also providing additional export capacity for the excess renewable energy generation.

Dynamic voltage control will be provided by the Gamma and Koruson synchronous condensers. The synchronous condensers will also provide inertia, voltage support and short circuit power which will enable the connection of additional renewable energy generation.

Additional substations and transformers are also required mainly to create local capacity to connect renewable energy generation. The construction of Nuweveld, Loxton, Siyoneza and Luckhoff substations will be triggered by IPP applications in the area.

Figure 7-32 and Figure 7-33 show the locations of the planned strengthening projects in the area.

No.	Project	Expected	Phase
1	Droerivier – (Nuweveld) – Gamma 400 kV line	2033	Concept
2	Nuweveld – Gamma 2nd 400 kV line	Pre-concept	
3	Nuweveld – Loxton 1st and 2nd 400 kV lines	Pre-concept	
4	Loxton – Siyoneza 1st and 2nd 400 kV lines	Pre-concept	
5	Hydra – Perseus 765 kV line and Gamma – Perseus 765 kV lines loop-ins to Siyoneza	Pre-concept	
6	Gamma Synchronous Condenser	2028	Concept
7	Koruson Synchronous Condenser	2028	Concept

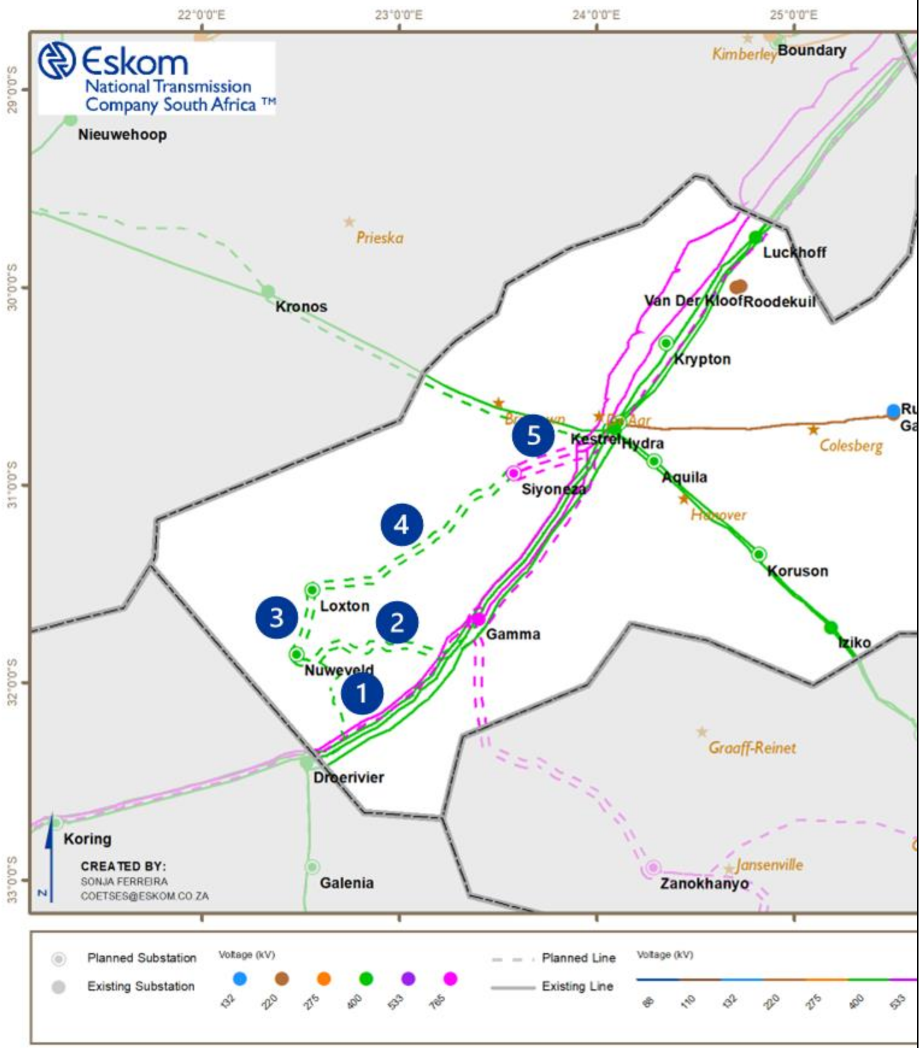


Figure 7-31 Future Hydra Central Network – Lines and Facts Devices

No.	Project	Expected	Phase
1	Aquila 400/132 kV substation (1st 500 MVA) (self-build)	2026	Execution
2a	Gamma 1st 400/132 kV 500 MVA (self-build)	2025	Execution
2b	Gamma 2nd 400/132 kV 500 MVA	2028	Definition
3	Hydra 400/132 kV Transformers Upgrade	2028	Execution
4	Kestrel 400/132 kV substation (1st 500 MVA) (self-build)	2027	Execution
5a	Koruson 400/132 kV substation (1st 500 MVA) (self-build)	2025	Execution
5b	Koruson 2nd 400/132 kV 500 MVA (self-build)	2027	Definition
6a	Krypton 400/132 kV substation (1st and 2nd 500 MVA)	2028	Definition
6b	Krypton 3rd and 4th 400/132 kV 500 MVA	2033	Pre-concept
7	Loxton 400/132 kV substation (1st and 2nd 500 MVA)	Pre-concept	
8	Nuweveld 400/132 kV substation (1st and 2nd 500 MVA)	Pre-concept	
9	Ruigtevallei 132/22 kV 10 MVA	2027	Definition
10	Siyoneza 765/400/132 kV substation (1st and 2nd 500 MVA and 1st and 2nd 2000 MVA)	Pre-concept	
11	Luckhoff 765/400/132 kV substation	Pre-concept	

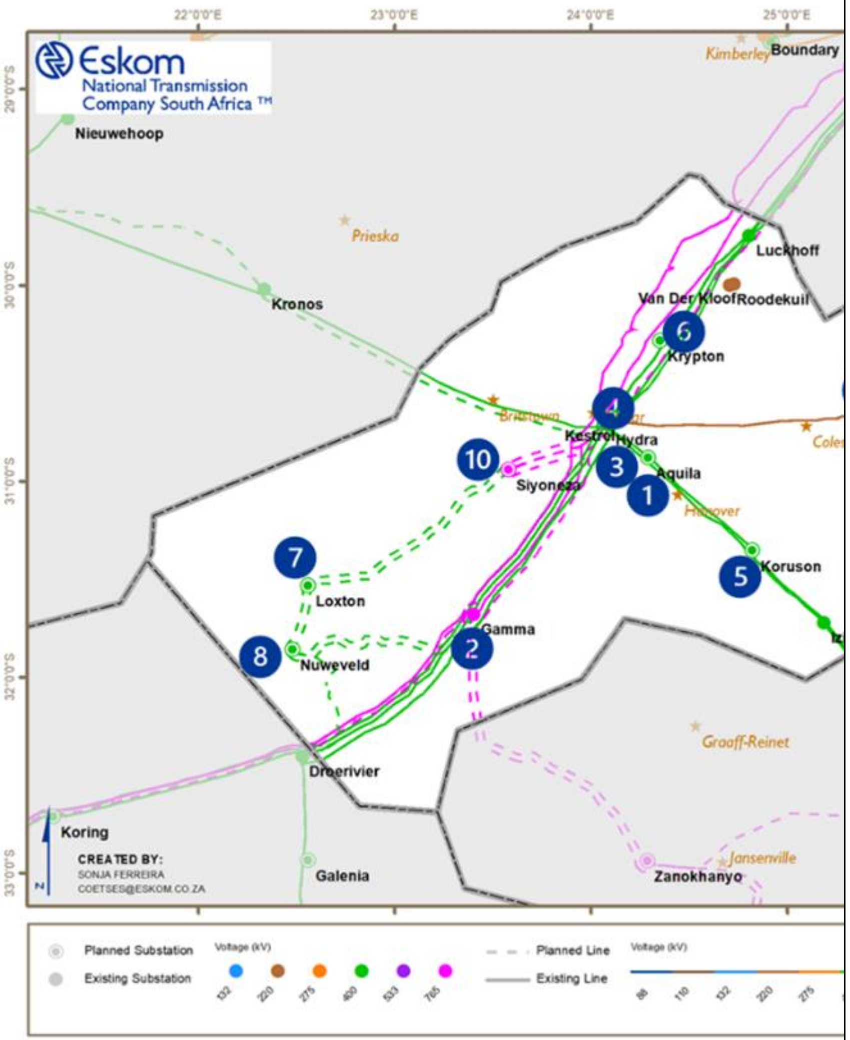
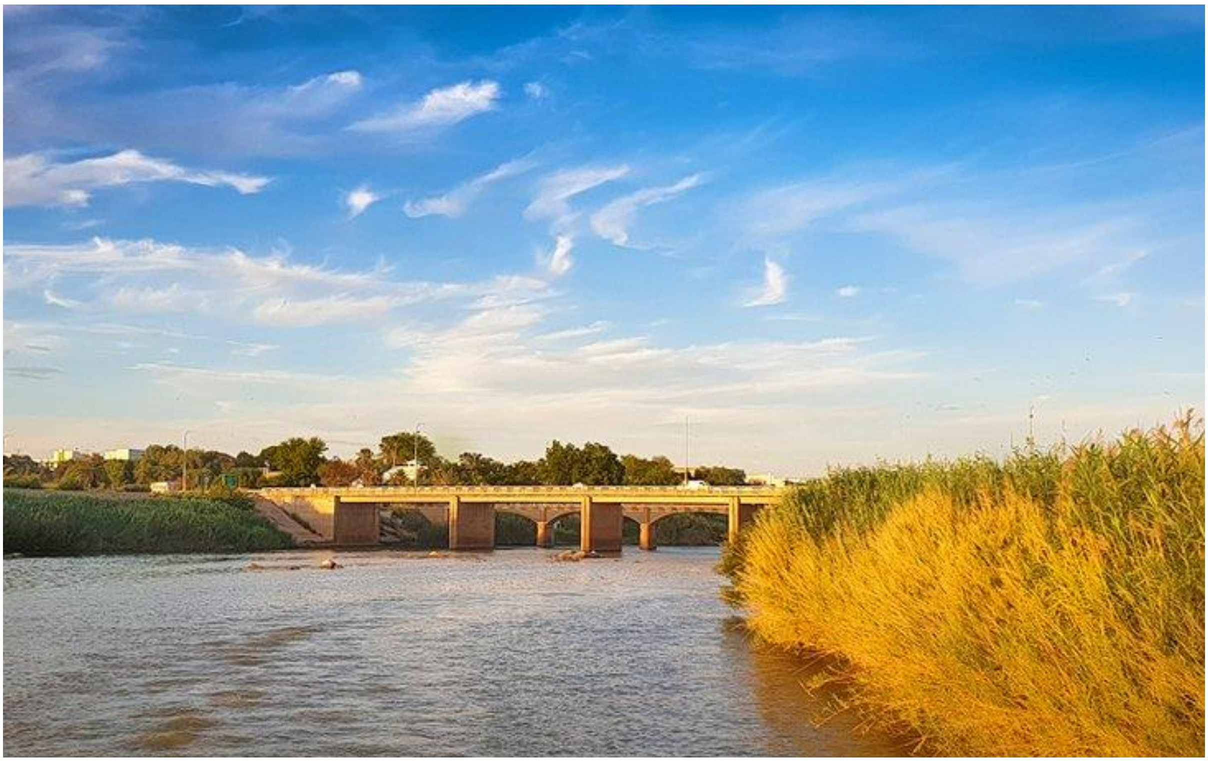


Figure 7-32 Hydra Central Network – Substations and Transformers

7.7.4.4 Development Plans for the Central and Western Corridors

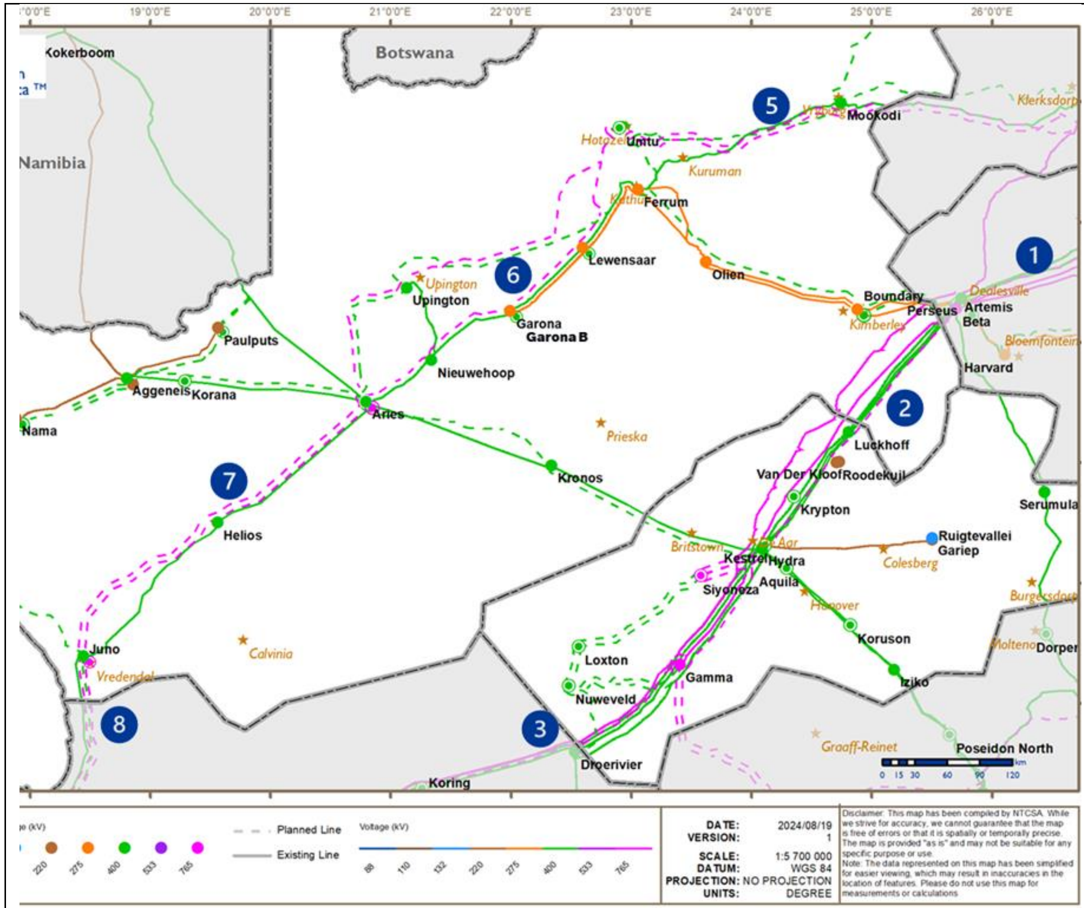


Orange River, Upington (source PlanetWare)

Having both RE deployment processes (public and private) running concurrently has led to an overwhelming uptake of RE generation especially in areas of high renewable energy resources. The bulk of this generation is located in the Western Cape, Northern Cape and Eastern Cape, referred to as the Greater Cape.

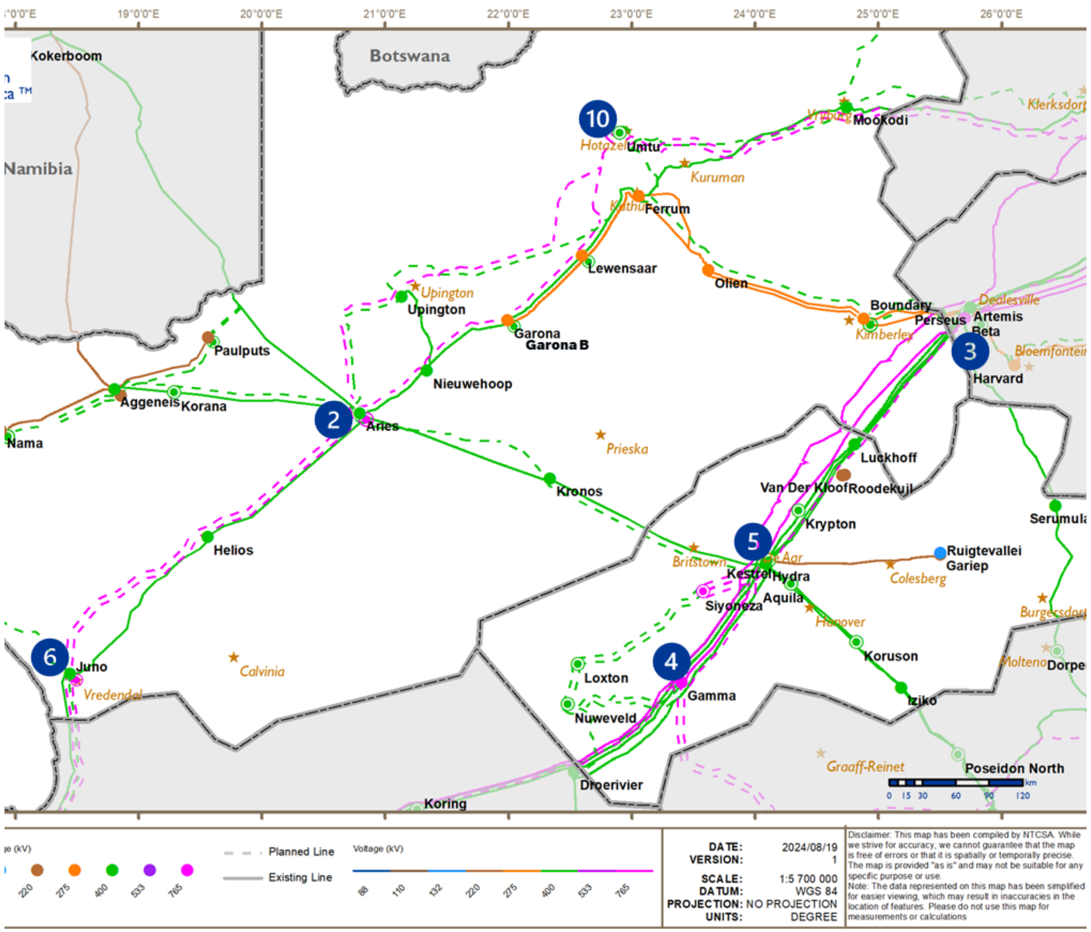
With the expected increase in generation in the Greater Cape, and with the decommissioning and reduced dispatch of remaining coal generation in Mpumalanga, there is a need to strengthen the central and western corridors to facilitate bulk power transport from the south of the country towards the north of the country where more than 75% of the load is located.

Figure 7-33 and Figure 7-34 show the locations of the planned strengthening projects within the two corridors. For the most part, the line routes lie within the recently gazetted electricity grid infrastructure (EGI) corridors.



No.	Project	Expected	Phase
1	Zeus – Perseus 1st 765 kV line	2028	Definition
2	Perseus – Gamma 2nd 765 kV line	2029	Definition
3	Gamma – Kappa 2nd 765 kV line	2029	Definition
4	Kappa – Sterrekus 2nd 765 kV line	2030	Definition
5	Mercury – Umtu 1st and 2nd 765 kV lines	2033	Concept
6	Umtu – Aries 1st and 2nd 765 kV lines	2033	Concept
7	Aries – Juno 1st and 2nd 765 kV lines	2033	Concept
8	Juno – Sterrekus 1st and 2nd 765 kV lines	2033	Concept

Figure 7-33 Central and Western Corridors – Lines



No.	Project	Expected	Phase
1	Alpha 4th 765/400 kV 2000 MVA	2029	Concept
2	Aries 1st and 2nd 765/400 kV 2000 MVA	2033	Concept
3	Beta 3rd 765/400 kV 2000 MVA	2029	Concept
4a	Gamma 1st 765/400 kV 2000 MVA	2028	Concept
4b	Gamma 2nd 765/400 kV 2000 MVA	2033	Pre-concept
5	Hydra 2nd 765/400 kV 2000 MVA	2029	Concept
6	Juno 1st and 2nd 765/400 kV 2000 MVA	2033	Concept
7	Kappa 2nd 765/400 kV 2000 MVA	2030	Concept
8a	Mercury 1st 765/400 kV 2000 MVA	2031	Concept
8b	Mercury 2nd 765/400 kV 2000 MVA	2033	Concept
9	Sterrekus 2nd 765/400 kV 2000 MVA	2030	Definition
10	Umtu 765/400 kV substation (1st and 2nd 2000 MVA)	2033	Concept
11	Zeus 3rd 765/400 kV 2000 MVA	2030	Concept

Figure 7-34 Central and Western Corridors – Substations and Transformers

7.7.5 PROVINCIAL SUMMARY

The future transmission network for the two supply areas is shown in Figure 7-35 below.

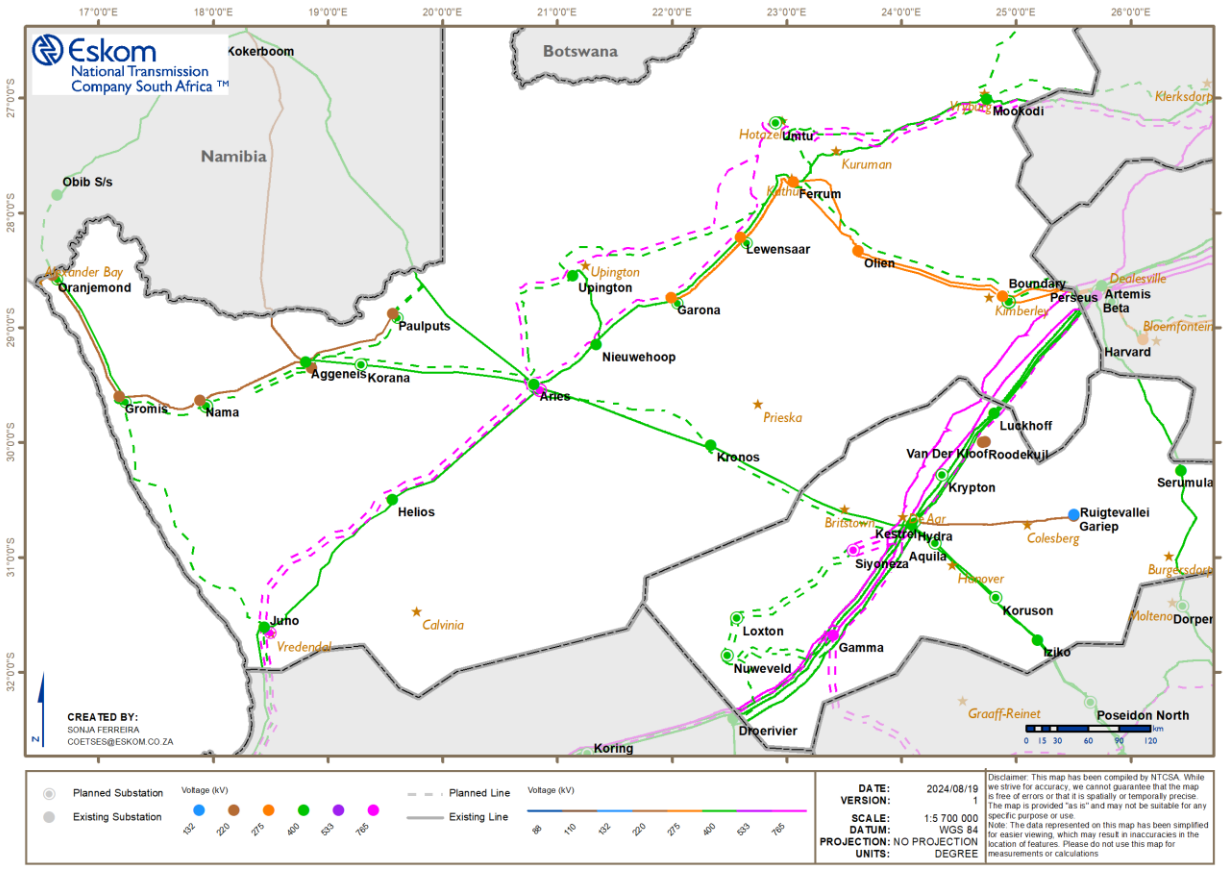


Figure 7-35: Future Northern Cape and Hydra Central transmission network

A summary of all new major assets planned for both the expansion and refurbishment portfolios for this province is provided in the tables below.

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Table 7-36: Planned transformers for Northern Cape and Hydra Central

Transformer type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
Less than 100 MVA	-	-	6	320
Less than 300 MVA	1	250	2	375
Less than 500 MVA	2	630	2	630
500 MVA	18	9000	10	5000
800 MVA	-	-	-	-
2 000 MVA	1	2000	6	12 000
Grand total	**22**	**11880**	**20**	**18325**

Table 7-37: Planned overhead lines for Northern Cape and Hydra Central

Line voltage	2025 to 2029	2030 to 2034
	Total length (km)	Total length (km)
400 kV	1752	572
765 kV	220	2580
Grand total	**1 972**	**3152**

Table 7-38: Planned capacitor banks for Northern Cape and Hydra Central

Capacitor type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
72 Mvar 132 kV	3	216	-	-
100 Mvar 400 kV	-	-	1	100
Grand total	**3**	**216**	**1**	**100**

Table 7-39: Planned reactors for Northern Cape and Hydra Central

Reactor type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
40 Mvar 220 kV	-	-	2	80
100 Mvar 400 kV	2	200	5	500
200 Mvar 765 kV	1	200	2	400
400 Mvar 765 kV	1	400	12	4800
Grand total	**4**	**800**	**21**	**5780**

7.8 NORTH WEST

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

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

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 fruits.

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 7-36.

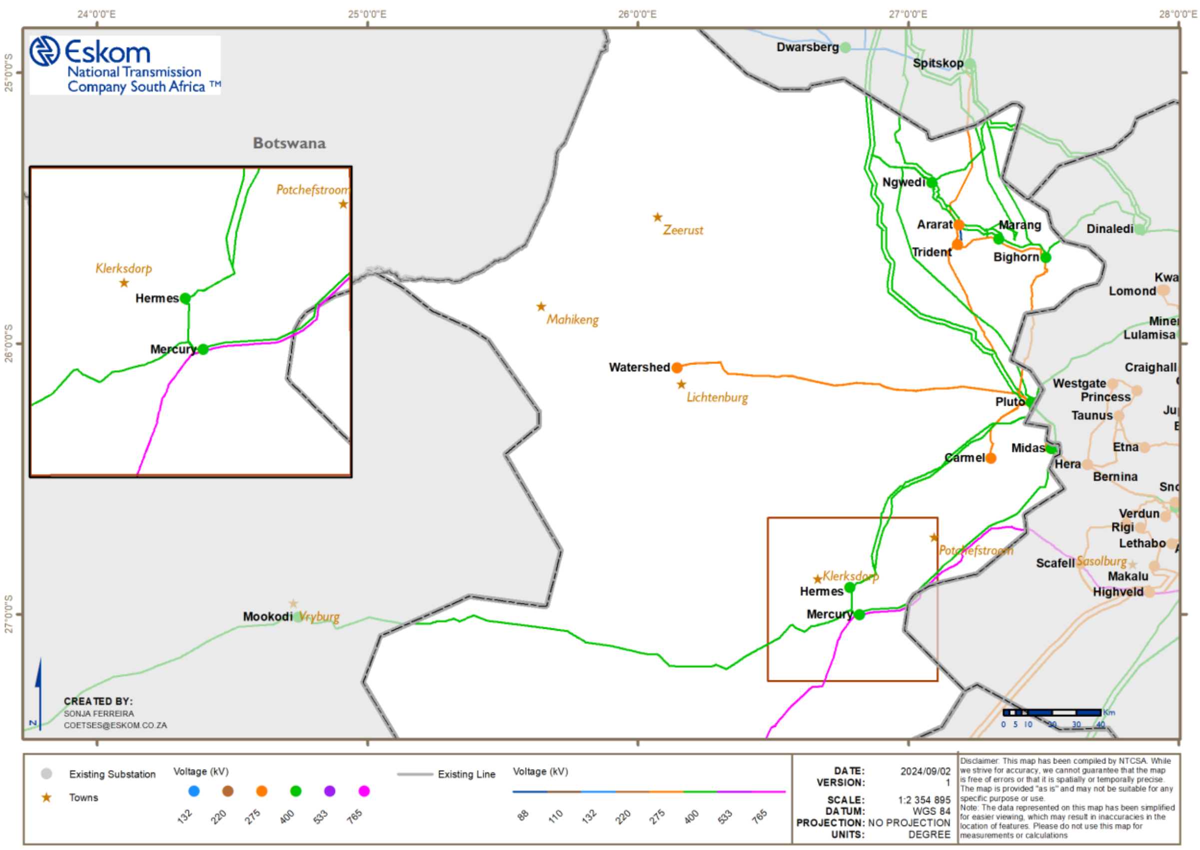


Figure 7-36: Current North West supply area transmission network

7.8.1 GENERATION

There are no power stations located in North West supply area. 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 150 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 REIPPPP are summarised in Table 7-40 below.

Table 7-40: Approved projects in North West under the REIPPPP

Programme and bid window	PV (MW)	Grand total (MW)
IPP RE 1	7	7
RE IPP 4B	143	143
Grand total	**150**	**150**

7.8.2 LOAD FORECAST

The mainstay of the economy of North West supply area is mining, which generates more than half of the GDP of the province. There is an abundance of livestock farming, as well as 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 supply area comprises two local areas, namely, Rustenburg and Carletonville, with Rustenburg accounting for the majority of the load in the supply area. The electricity demand peaked at around 3 145 MW in 2023, with the load in the supply area projected to increase to about 3 878 MW by the year 2034. The load forecast is shown in Figure 7-37.

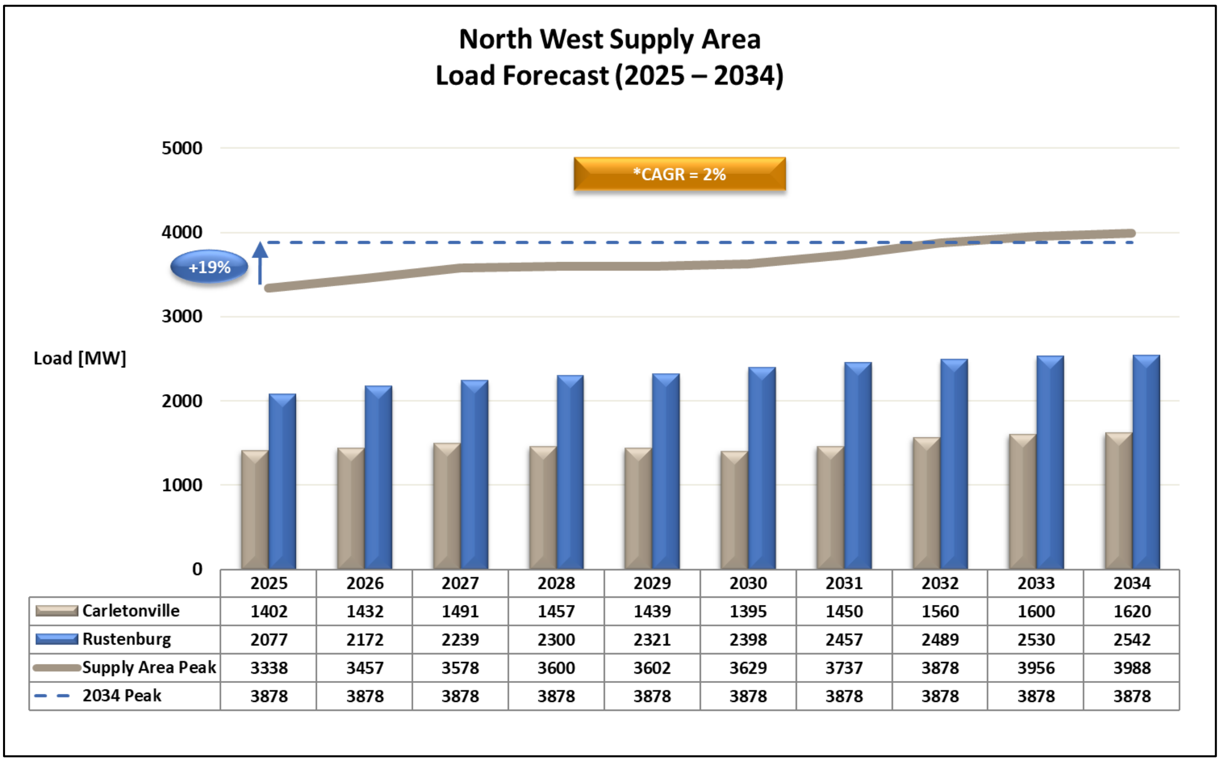


Figure 7-37: North West load forecast

7.8.3 PLANNED PROJECTS

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

7.8.3.1 Major schemes

The major TDP schemes planned in the supply area 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. This project will be aligned with the load forecast and is customer dependent.

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 local area 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 local area.

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 was installed in September 2021; the installation of 1 x 30 Mvar 88 kV and 2 x 30 Mvar 132 kV shunt capacitor banks is in the execution phase and is currently expected to reach commercial operation by 2025. Furthermore, an installation of additional 2 x 48 Mvar 88 kV shunt capacitors is proposed to alleviate the under-voltages anticipated during the loss of Pluto – Watershed 275 kV line.

New 2 x 500 MVA 275/132 kV transformers are proposed to facilitate the integration of RE generation in the area, mainly solar power, in the next five years or so; one 500 MVA unit will replace the 250 MVA unit.

To address long-term load requirements, without local PV generation or BESS, some load will be shifted from Watershed substation to Mookodi substation. A new Mahikeng substation, designed at 400/132 kV and operated at 400/88 kV, is planned approximately 60 km west of Watershed substation and will be integrated into the transmission system via a Pluto – Mahikeng 180 km 400 kV line and the Mookodi – Mahikeng 160 km 400 kV line. Mahikeng substation will address both the load and generation integration requirements around Mahikeng.

7.8.3.2 New substations

To address load growth and RE generation integration, local strengthening is planned across the supply area, mainly comprising additional transformers at existing substations, one new 400/88 kV, and four new 400/132 kV substations:

- Mahikeng 400/88 kV substation (2 x 315 MVA) will be established around Mahikeng. Mahikeng substation will also provide a possible strategic connection corridor to the Southern African Development Community (SADC) region through Botswana as the first point of entry.
- Ventersdorp 400/132 kV (2 x 500 MVA) will be established in the Ventersdorp area.
- Nguni 400/132 kV (2 x 500 MVA) will be established approximately 60 km west of Pluto substation.
- Watershed C 400/132 kV (2 x 500 MVA) will be established approximately 140 km west of Pluto substation.
- Pluto Cluster 400/132 kV (2 x 500 MVA) will be established approximately 30 km North West of Midas substation.

7.8.3.3 New lines

- The Medupi – Ngwedi first 765 kV line (energised at 400 kV) near Mogwase is under construction and 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 (via Nguni and Watershed C substations), and Mahikeng – Mookodi 400 kV line.
- Hermes – Mookodi 400 kV line.
- Mercury – Hermes 400 kV line.
- Mercury – Midas 400 kV line.
- Midas – Pluto cluster 400 kV line, and Pluto Cluster – Ngwedi 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 2 x 48 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 2025 to 2034.

Table 7-41: North West – summary of projects and timelines

TDP scheme	Project name	Expected Year	Phase
Watershed strengthening	Watershed substation 132 kV reactive power compensation (2 x 30 Mvar capacitors)	2025	Execution
	Watershed substation 88 kV reactive power compensation (1 x 30 Mvar capacitor)	2025	Execution
	Watershed substation 88 kV reactive power compensation (2 x 48 Mvar capacitors)	2029	Pre-concept
Watershed (backbone) strengthening Phase 3	Mahikeng integration phase 1	2032	Definition
	Mahikeng integration phase 2		Concept
Kimberley strengthening Phase 3	Hermes – Mookodi first 400 kV line	2028	Definition
Rustenburg strengthening Phase 1	Bighorn 2 x 500 MVA 400/132 kV transformer	2036	Pre-concept

TDP scheme	Project name	Expected Year	Phase
Rustenburg strengthening Phase 2	Marang extension 2 x 500 MVA 400/132 kV substation	2036	Definition
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)	2034	Pre-concept
Medupi integration	Medupi – Ngwedi first 765 kV line (energised at 400 kV)	2024	Execution
Ararat upgrade	Ararat 275/88 kV transformer 4	2033	Pre-concept
Bighorn upgrade	Bighorn 275/88 kV transformer 4	2031	Pre-concept
Trident upgrade	Trident 275/88 kV transformer 3	2032	Pre-concept
Hermes upgrade	Hermes 400/132 kV transformer 4	2032	Pre-concept
Hermes - Mercury 400 kV line 2	Hermes - Mercury 400 kV line 2	2033	Pre-concept
Mercury – Midas 400 kV line 2	Mercury – Midas 400 kV line 2	2034	Pre-concept

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 supply area within the current TDP period based on the generation assumptions.

Table 7- 42: North West – projects required to facilitate IPP integration

Project name	Expected CO year	Phase
Watershed upgrade: 1 x 500 MVA 275/132 kV transformer	2029	Pre-concept
Carmel S/S upgrade: 1 x 500 MVA 275/132 kV transformer	2028	Definition
Ventersdorp 400/132 kV substation	2030	Pre-concept
Nguni 400/132 kV substation	2031	Pre-concept
Pluto cluster 400/132 kV substation	2033	Pre-concept

Project name	Expected CO year	Phase
Watershed C 400/132 kV substation	2034	Pre-concept

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 supply area is shown in Figure 7-38 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 local areas.

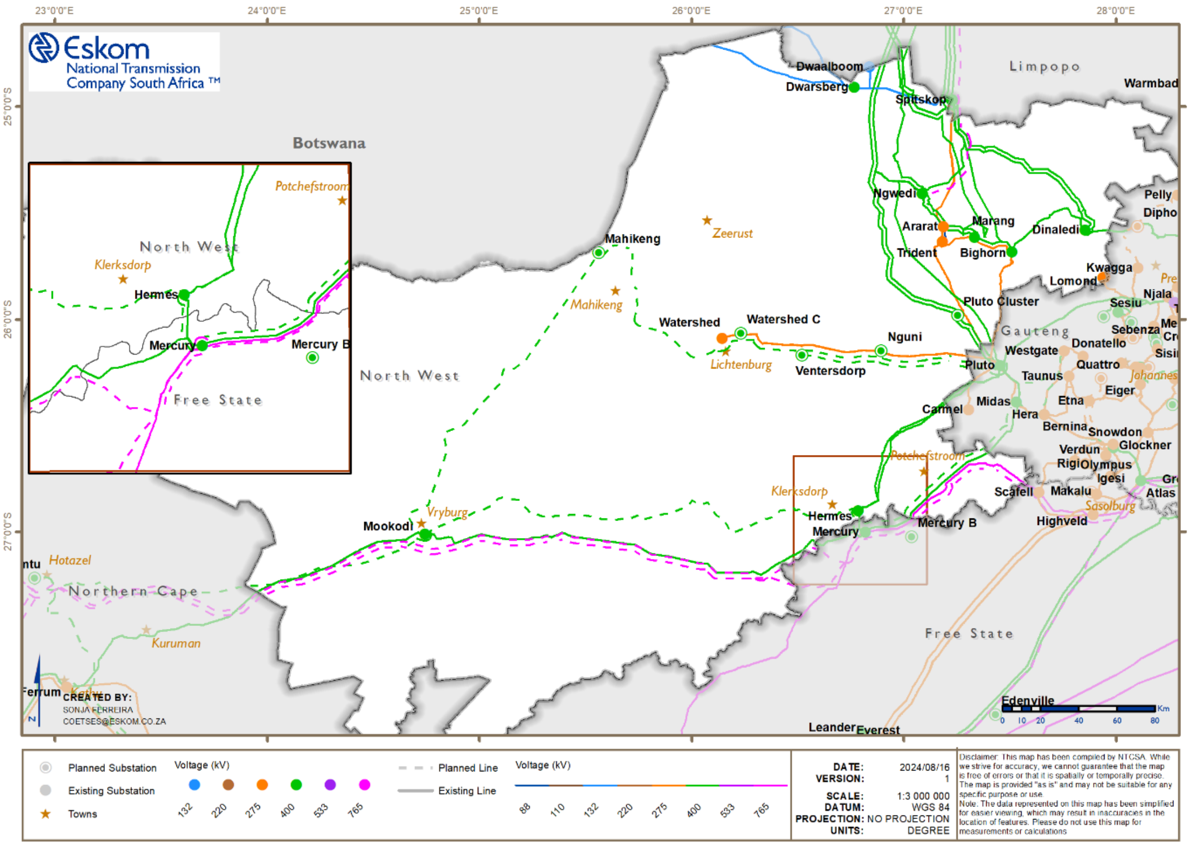


Figure 7-38: Future North West supply area transmission network

A summary of all new major assets planned for both the expansion and refurbishment portfolios for this province is provided in the tables below.

Table 7-43: Planned transformers for North West

Transformer type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
Less than 300 MVA	2	360	-	-
Less than 500 MVA	-	-	7	2 205
500 MVA	2	1 000	7	3 500
Grand total	**4**	**1 360**	**15**	**5 705**

Table 7-44: Planned overhead lines for North West

Line voltage	2025 to 2029	2030 to 2034
	Total length (km)	Total length (km)
400 kV	290	398
Grand total	**290**	**398**

Table 7-45: Planned capacitor banks for North West

Capacitor type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
30 Mvar 88 kV	1	30	-	-
48 Mvar 88 kV	4	192	8	384
30 Mvar 132 kV	2	60	-	-
72 Mvar 132 kV	-	-	5	360
165 Mvar 275 kV	1	165		
Grand total	**8**	**447**	13	744

Table 7-46: Planned reactors for North West

Reactor type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (MVAr)	Quantity	Total capacity (MVAr)
100 MVAr 400 kV	2	200	-	-
Grand total	**2**	**200**	-	-

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 3 500 MW in 2023, and it is expected to increase to about 5 000 MW by 2034.

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, 1 010 MW of RE generation plants have been integrated into the Western Cape. There has also been considerable interest in gas generation.

The Western Cape transmission network consists mostly of 400 kV lines. It stretches over 550 km from Droërivier substation (near Beaufort West) to Philippi substation (near Mitchells Plain). It is also interconnected to the Northern Cape along the West Coast. The current transmission network is shown in Figure 7-41.

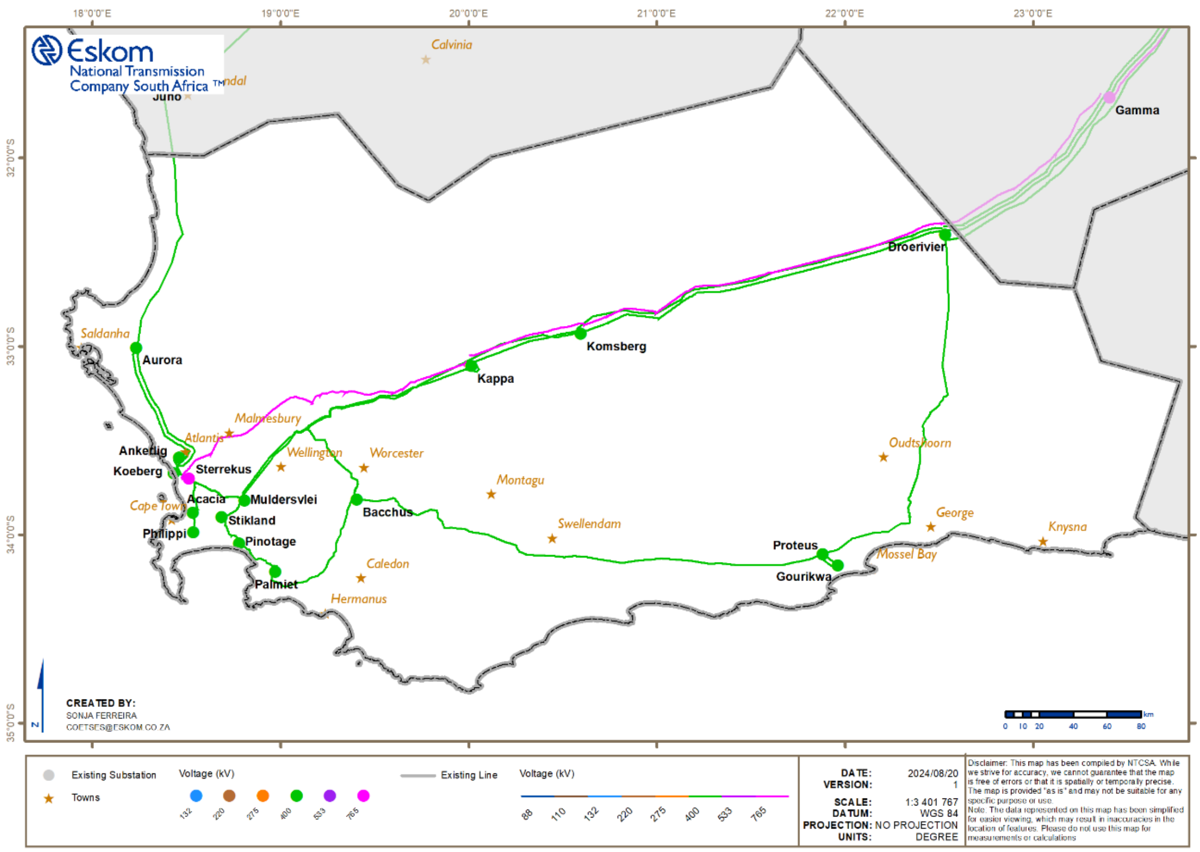


Figure 7-39: Current transmission network for the Western Cape supply area

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 comprise 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. The steam generator replacement (SGR) project is currently underway which will result in an increase of 28 MW at each of the two units.

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 operation (SCO) mode 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 NTCSA 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 in Atlantis in the Western Cape and has an installed capacity of

1,350 MW (9 x 150 MW). Gourikwa Power Station is 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. 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 NTCSA 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 Gordons Bay, near Cape Town. In 1979, 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.

Independent power producers (Bid programme)

The renewable energy independent power producer procurement programme (REIPPPP) and the risk mitigation independent power producer procurement programme (RMIPPPP) have resulted in 1 643 MW of IPP generation being procured in the Western Cape, with 1 010 MW in commercial operation, as shown in Table 7-47. No IPPs were connected in the Western Cape for Bid Window 6 as no capacity was available. Bid Window 7 is currently underway where it is anticipated that some IPPs will be awarded to connect to the Western Cape grid, due to the additional capacity that is created under the curtailment framework.

Table 7-47: Commissioned and approved IPP projects in the Western Cape supply area

Bid window	Name of project	Type	Capacity (MW)	NTCSA substation	Commercial operation
1	Dassiesklip Wind Energy Facility	Wind	27	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	138	Muldersvlei	Aug. 2015
	West Coast 1	Wind	94	Aurora	June 2015
	Aurora-Rietvlei Solar Power	PV	9	Aurora	Dec. 2014
3	Electra Capital (Pty) Ltd	PV	75	Aurora	Sept. 2015
4B	Perdekraal East	Wind	110	Kappa	Oct. 2020
	Excelsior Wind	Wind	32	Bacchus	Aug. 2020
	Soetwater Wind Farm	Wind	139	Komsberg	July 2022
4	Karusa Wind Farm	Wind	140	Komsberg	July 2022
	Roggeveld	Wind	140	Komsberg	May 2022
RMIPP	Oya Energy Hybrid Facility	Hybrid	128	Kappa	
5	Grootfontein PV 1, 2, and 3	PV	3 x 75	Kappa	
	Brandvalley Wind Farm	Wind	140	Komsberg	
	Rietkloof Wind Farm	Wind	140	Komsberg	
TOTAL			**1 643**		

Independent power producers (wheeling)

A growing number of IPPs have opted to connect to the grid through wheeling. This process can be used for the producer's own consumption or to deliver energy to an end-user in a different location via an existing distribution or transmission network. As shown in Table 7-48, 2 127 MW of IPP generation is expected to be connected in the Western Cape, via wheeling.

Table 7-48: Commissioned and approved IPP wheeling projects in the Western Cape supply area

NTCSA Substation	Type	Capacity (MW)
Aurora	Wind	123
	PV	10
Muldersvlei	Wind	200
Bacchus	Wind	324
Agulhas	Wind	380
Komsberg	Wind	460
Koring	Wind	380
Droërivier	PV	250
TOTAL		2 127

7.9.2 LOAD FORECAST

The Western Cape comprises of four local areas, namely, Peninsula, Outeniqua, West Coast and Greater Komsberg. The Peninsula area is the main load centre in the province, consuming approximately 67% of the load. Outeniqua and West Coast areas make up the remaining 33% of the demand in the province. The Greater Komsberg area does not supply any load.

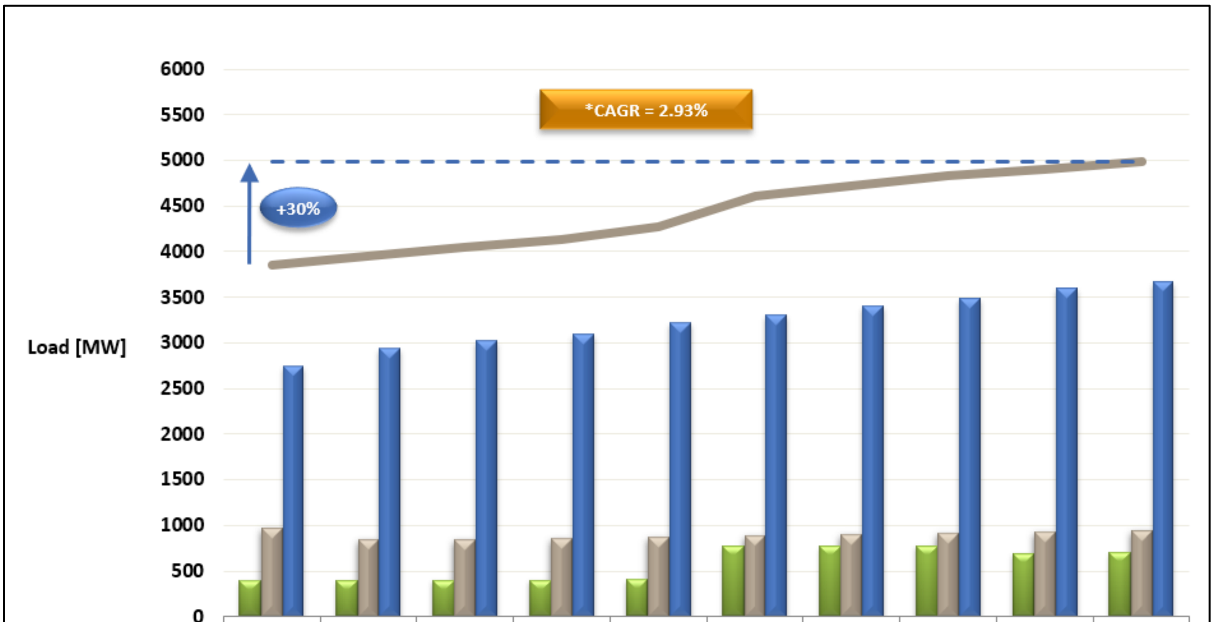
The past strong residential, commercial, and light industrial load growth in the Peninsula CLN is expected to continue for several years. Some areas of interest are the area around Philippi, where higher-density residential properties are being developed on existing residential stands. City of Cape Town residential as well as light industrial sectors are contributing to growth in Stikland and Muldersvlei areas. The growth of streaming-based entertainment and digitisation has also prompted a growing demand for data centres in the Peninsula CLN.

Load growth in the West Coast area is expected due to the Saldanha Bay Industrial Development Zone (IDZ). The 120ha 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 region also hosts the Atlantic Special Economic Zone (SEZ) which is targeting renewable energy. Load growth is also expected in the Vredenburg area. Saldanha Steel, which is supplied from Aurora substation, has closed down its primary operations. Uncertainty remains if they will be sold out and return to service, but it is not foreseen in the next five years.

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 local areas in the Western Cape is shown in Figure 7-40. The load is forecasted to grow from 3 850 MW in 2025 to 4 991 MW in 2034. This translates to 30% over the next 10 years, with a compound annual growth rate (CAGR) of 2,93%.



	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
West Coast	389	393	397	401	405	767	771	775	693	698
Outeniqua	956	830	841	852	863	876	891	905	921	936
Peninsula	2739	2941	3015	3097	3219	3304	3400	3487	3597	3670
Supply Area Peak	3850	3956	4043	4139	4276	4613	4726	4830	4901	4991
2034 Peak	4991	4991	4991	4991	4991	4991	4991	4991	4991	4991

Figure 7-40: Load forecast for the Western Cape supply area

7.9.3 Planned Projects

Several projects have been initiated to resolve the existing and future network constraints, supply the forecasted load, and integrate the additional generation. These projects take the condition of existing assets, potential costs of the proposed solutions, and environmental impacts and challenges into consideration.

7.9.3.1 Major schemes

Cape corridor Phase 4: second Zeus-Sterrekus 765 kV line

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 Sterrekus substation (near Melkbosstrand).

The Cape corridor has been strengthened, with the first 765 kV line comprising the following sections that were constructed and energised over a period of more than 10 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 of the Cape corridor.

Additional improvements will be brought about by the following strengthening projects in the Northern Cape:

- Juno-Gromis 400 kV line
- Aries SVC

The capacity created by this strengthening has however already been exhausted by the committed IPP wheeling projects. The preferred strengthening to provide additional transfer capacity is constructing a second 765 kV line.

7.9.3.2 Substations

Local strengthening is planned across the province, mainly comprising additional transformers at existing substations and seven new 400/132 kV substations:

- Asteria substation (3 x 500 MVA) near Bot River (Botrivier)
- Erica substation (3 x 500 MVA) near Philippi
- Agulhas substation (3 x 500 MVA) near Swellendam
- Bokkom substation (2 x 500 MVA) near Langebaanweg
- Koring substation (4 x 500 MVA) near Merweville
- Galenia substation (4 x 500 MVA), 60 km south of Beaufort West
- Nuweveld substation (4 x 500 MVA), 90km north of Beaufort West

7.9.3.3 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 to meet the required level of network reliability. This line is expected to be commissioned at 400 kV when the Koeberg emergency off-site supply is relocated from Acacia Power Station to Ankerlig Power Station.

A project for an additional 400 kV line between Droërivier substation and Gourikwa Power Station has been initiated to cater for gas generation projects that may emanate in the Mossel Bay area as well as for potential renewable generation projects towards Beaufort West. Furthermore, additional 400 kV lines between Galenia substation and Aberdeen in the Eastern Cape will be required to evacuate the power out of the Western Cape supply area.

A project for an additional 400 kV line between Aurora and Juno has been initiated to cater for gas generation projects that may also be introduced in the Saldanha Bay area.

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 Major projects for future IPPs

There are three designated renewable energy development zones (REDZs) in the Western Cape, namely, Overberg (REDZ1), Komsberg (REDZ2), and Beaufort West (REDZ11). These were identified as areas with strategic importance for RE generation and were gazetted as such in February 2018 and February 2021.

The Western Cape is, therefore, a prime location for wind generation as well as for some PV generation. As a result of this, ~ 7 100 MW of additional RE generation (excluding rooftop PV of 1 188 MW) is forecasted in the Western Cape by 2034. This is in addition to what has already been commissioned or given preferred bidder status. The Western Cape is also forecasted to accommodate an additional ~7 400 MW of gas, particularly around the Saldanha Bay and Mossel Bay areas.

With the integration of large-scale renewable generation over the next 10 years, the Western Cape will become a net exporter of power, with as much as ~17 GW of excess generation during peak load. The actual amount is dependent on the utilisation of the peaking GAS generation and the baseload nuclear generation in future.

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.

The required strengthening can be summarised as follows:

- 2 x Mercury-Sterrekus 765 kV lines (via Umtu, Aries, and Juno substations), with series compensation between Umtu and Mercury substations
- 765/400 kV transformation at Juno, Aries, and Umtu substations
- 765/400 kV transformation may also have to be introduced at Mercury and Gamma substations, and additional 765/400 kV 2 000 MVA transformers may be required at Zeus, Perseus, Hydra, Kappa, and Sterrekus substations.

7.9.3.5 Provincial summary

The Western Cape transmission development plan for the period 2024 to 2034 is summarised in Table 7-49.

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

TDP scheme	Project name	Expected Year	Phase
Establish 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	2025	Execution
2nd Koeberg-Acacia 400 kV line	• 2nd Koeberg-Acacia 400 kV line	2026	Definition
Koeberg 400 kV busbar reconfiguration	• Koeberg 400/132 kV GIS substation • Install 2 x 250 MVA 400/132 kV transformers • Reroute existing Koeberg 400 kV and 132 kV lines to the new substation	2031	Execution
Acacia 1st and 2nd 66/33 kV transformers	• Replace the 2 x 80 MVA 132/33 kV transformers with 2 x 10 MVA 66/33 kV units	2028	Definition
Erica substation	• Erica substation (1st and 2nd 400/132 kV 500 MVA transformers) • Philippi-Erica 400 kV line	2029	Execution
	• Loop-in-and-out Pinotage-Stikland 400 kV line	2030	Definition

TDP scheme	Project name	Expected Year	Phase
Erica 3^{rd} 400/132 kV transformer	• Install 3^{rd} 400/132 kV 500 MVA transformer and FCLRs	2030	Concept
Philippi substation extension	• Establish 400 kV busbar • Install 3^{rd} 400/132 kV 500 MVA transformer as a hot standby	2028	Execution
Pinotage 3^{rd} 400/132 kV transformer	• Install 3^{rd} 400/132 kV 500 MVA transformer and FCLRs	2028	Concept
Stikland 3^{rd} 400/132 kV transformer	• Install 3^{rd} 400/132 kV 500 MVA transformer and FCLRs	2028	Concept
Cape corridor Phase 4: 2^{nd} Zeus-Sterrekus 765 kV line	• Zeus-Perseus 1^{st} 765 kV line • Series compensation at Zeus and Perseus	2028	Definition
	• Perseus-Gamma 2^{nd} 765 kV line	2029	Definition
	• Gamma-Kappa 2^{nd} 765 kV line	2029	Definition
	• Kappa-Sterrekus 2^{nd} 765 kV line • Loop-in-and-out Koeberg-Stikland 400 kV line into Sterrekus • Sterrekus substation 2^{nd} 765/400 kV 2 000 MVA transformer	2030	Definition
Agulhas substation (self-build)	• Agulhas substation (1^{st} and 2^{nd} 400/132 kV 500 MVA transformers) • Loop-in-and-out Bacchus-Proteus 400 kV line • Bypass Bacchus series capacitor bank	2027	Execution
Agulhas 3^{rd} 400/132 kV transformer	• Install 3^{rd} 400/132 kV 500 MVA transformer	2028	Concept
Asteria substation	• Asteria substation (1^{st} and 2^{nd} 400/132 kV 500 MVA transformers) • Loop-in-and-out of Palmiet-Bacchus 400 kV line	2027	Execution
Asteria 3^{rd} 400/132 kV transformer	• Install 3^{rd} 400/132 kV 500 MVA transformer	2028	Concept

TDP scheme	Project name	Expected Year	Phase
Kappa 2nd 400/132 kV transformer (self-build)	• Install 2nd 400/132 kV 500 MVA transformer	2027	Execution
Kappa 3rd and 4th 400/132 kV transformers	• Install 3rd and 4th 400/132 kV 500 MVA transformers and FCLRs	2030	Concept
Kappa 2nd 765/400 kV transformer	• Install 2nd 765/400 kV 2000 MVA transformer	2030	Concept
Komsberg 2nd 400/132 kV transformer (self-build)	• Install 2nd 400/132 kV 500 MVA transformer	Commissioned	
Komsberg 3rd 400/132 kV transformer	• Install 3rd 400/132 kV 500 MVA transformer	2027	Execution
Komsberg 4th 400/132 kV transformer (self-build)	• Install 4th 400/132 kV 500 MVA transformers and FCLRs • Loop Kappa – Droërivier 400 kV line 1 into Komsberg	2028	Execution
Koring substation	• Koring 400/132 kV substation (4 x 500 MVA transformers and FCLRs) • Loop Droërivier - Komsberg 400 kV line 1 into Koring • Loop Droërivier – Komsberg 400 kV line 2 into Koring • Decommission Komsberg series capacitors	2030	Definition
Droërivier 3rd 400/132 kV transformer (self-build)	• Install 400/132 kV 500 MVA transformer • Establish new 132 kV busbar	2027	Execution
Droërivier 400/132 kV transformers 1 and 2 upgrade	• Upgrade existing 400/132 kV 125 MVA and 250 MVA transformers to 2 x 500 MVA units	2028	Concept
Droërivier dynamic device	• Install dynamic voltage device at Droërivier substation	2032	Pre-concept
Droërivier – Gourikwa 400 kV line	• Droërivier – Gourikwa 400 kV line	2029	Concept
Galenia substation	• Galenia 400/132 kV substation (4 x 500 MVA transformers and FCLRs) • Loop-in-and-out of Droërivier-Proteus 400 kV line	2030	Definition

TDP scheme	Project name	Expected Year	Phase
Galenia integration into Droërivier – Gourikwa 400 kV line	• Loop Droërivier – Gourikwa 400 kV line into Galenia • Restring/rebuild existing Droërivier – Galenia 400 kV line	Pre-concept	
Galenia integration into Aberdeen	• Build 2 x 400 kV lines from Galenia to Aberdeen	Pre-concept	
Nuweveld substation	• Droërivier – (Nuweveld) – Gamma 400 kV line	2033	Concept
	• Nuweveld (1st and 2nd 400/132 kV 500 MVA transformers) • Loop-in-and-out of Droërivier – (Nuweveld) – Gamma 400 kV line	Pre-concept	
	• Install 3rd and 4th 400/132 kV 500 MVA transformers	Pre-concept	
Saldanha Bay network strengthening (Phase 1)	• Strategically acquire a substation site in the Saldanha Bay area • Construct 2 x 400 kV lines (operated at 132 kV) from Aurora substation to Blouwater substation	2028	Definition
Saldanha Bay network strengthening (Phase 2)	• Bokkom substation (1st and 2nd 400/132 kV 500 MVA transformers) • Loop-in-and-out of Ankerlig-Aurora 1 400 kV line	Pre-concept	
2nd Aurora-Juno 400 kV line	• 2nd Aurora-Juno 400 kV line	2028	Definition
Cape corridor Phase 5	• Establish Umtu (Hotazel) 765/400 kV substation • Umtu 765/400 kV (1st 2 000 MVA transformer) • Aries extension 765/400 kV (1st 2 000 MVA transformer) • Juno extension 765/400 kV (1st 2 000 MVA transformer) • Mercury-Umtu 1st 765 kV line • Umtu-Aries 1st 765 kV line • Aries-Juno 1st 765 kV line • Juno-Sterrekus 1st 765 kV line	2033	Definition

TDP scheme	Project name	Expected Year	Phase
Cape Corridor Phase 6	• Umtu substation 2nd 765/400 kV 2 000 MVA transformer • Aries substation 2nd 765/400 kV 2 000 MVA transformer • Juno substation 2nd 765/400 kV 2 000 MVA transformer • Sterrekus substation 3rd 765/400 kV 2 000 MVA transformer • Mercury-Umtu 2nd 765 kV line • Umtu-Aries 2nd 765 kV line • Aries-Juno 2nd 765 kV line • Juno-Sterrekus 2nd 765 kV line • Install 50% series compensation on Mercury-Umtu 765 kV lines	2033	Definition

The future Western Cape transmission network is shown in Figure 7-41.

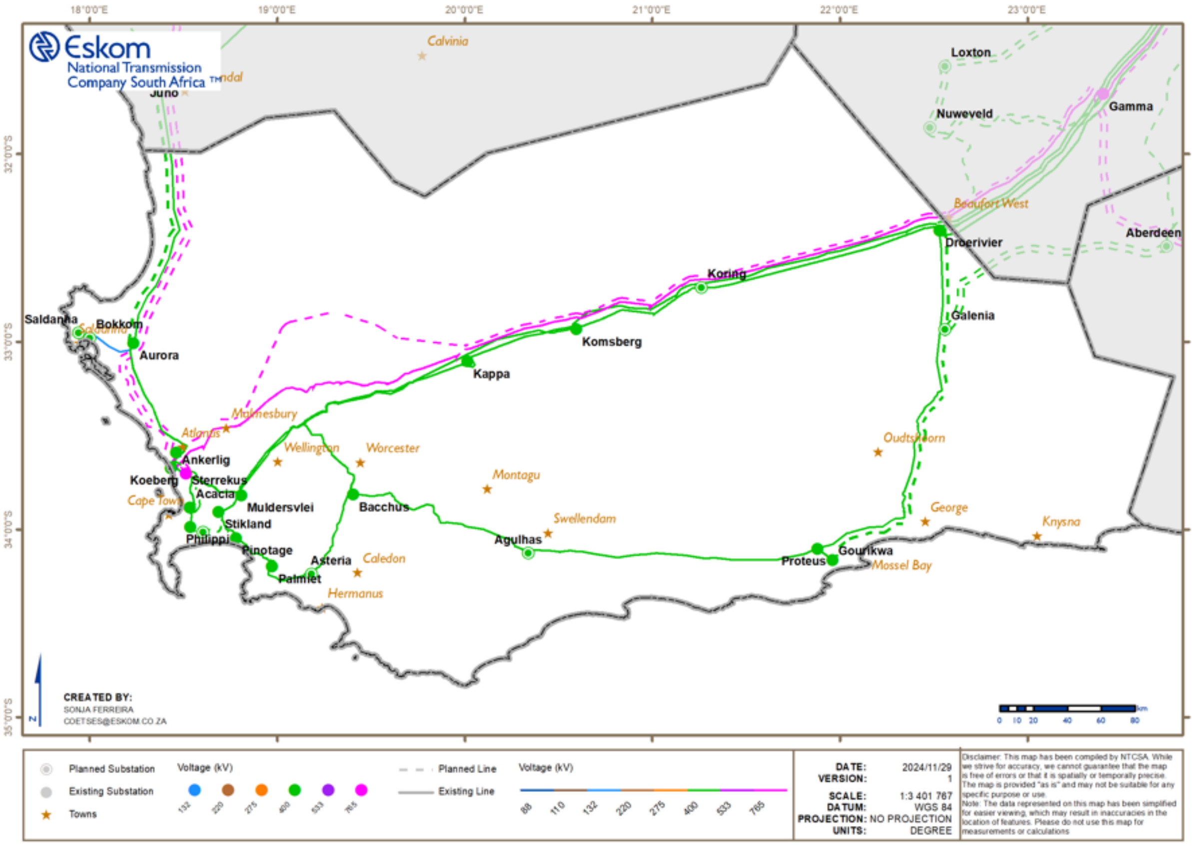


Figure 7-41: Future transmission network for the Western Cape supply area

A summary of all new major assets planned for both the expansion and refurbishment portfolios for this province is provided in the tables below.

Table 7-50: Planned transformers for the Western Cape supply area

Transformer type	2025 to 2029		2030 to 2034	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
Less than 100 MVA	2	30	5	260
Less than 300 MVA	-	-	1	160
Less than 500 MVA	1	315	-	-
500 MVA	20	10 000	15	7 500
2 000 MVA	-	-	4	8 000
Grand total	**23**	**10 345**	**25**	**15 920**

Table 7-51: Planned overhead lines for the Western Cape supply area

Line voltage	2025 to 2029	2030 to 2034
	Total length (km)	Total length (km)
400 kV	216	287
765 kV	50	1000
Grand total	**266**	**1 287**

Table 7-52: Planned capacitor banks for the Western Cape supply area

Capacitor type	2024 to 2029		2030 to 2034	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
72 Mvar 132 kV	-	-	4	288
Grand total	**-**	**-**	**4**	**288**

Table 7-53 : Planned reactors for the Western Cape supply area

Reactor type	2024 to 2029		2030 to 2034	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	1	100		
400 Mvar 765 kV	1	400	4	1600
Grand total	**2**	**500**	**4**	**1600**

8 REFURBISHMENT PLAN

8.1 BACKGROUND

The NTCSA plans, operates, maintains, refurbishes, and augments the transmission grid within South Africa. The Transmission System (TS) consists of lines and substation equipment that were demarcated to the transmission network and therefore includes both transmission and sub-transmission level assets. The grid currently comprises approximately 33,067 km of high-voltage transmission lines and has assets at 181 substations.

The Transmission Network Refurbishment Plan (TNRP) is intended to sustain network reliability and availability by systematic replacement of identified network assets. Refurbishment is critical to network sustainability and deals with the systematic renewal of the network assets, based on plant performance and equipment condition.

This is further supported by ensuring an adequate capital spares level, availability of emergency preparedness plans, system operator guidelines, production equipment and asset maintenance.

8.2 KEY ASSUMPTIONS

The Transmission Network Refurbishment Plan (TNRP) addresses the replacement of assets in the existing network to ensure sustainable and reliable electricity transmission across the grid from the generators to the distributors. Asset Management principles form the basis of prioritising which assets need to be replaced whilst maintaining a balance between performance, cost, and risk.

NTCSA has been plagued by issues related to deteriorating network assets, security breaches and theft. Of specific note on the network, is the protection equipment that has become increasingly unreliable, instrument transformer and surge arrestor failures, and poor performance of certain circuit breaker types. Large portions of assets that have deteriorated and become unreliable over the years are addressed by major substation refurbishments, in conjunction with specific reliability issues that are addressed through smaller initiatives dealing with problematic equipment.

The refurbishment plan further incorporates the statutory requirements that have arisen due to fault level increases, compliance changes and security upgrades to address breaches and theft, to protect infrastructure and personnel.

Transmission lines are also dealt with in a very similar fashion to substation assets, by either having complete line refurbishments or targeting identified problematic line components, thereby addressing specific risks. In addition, some projects contribute to ensuring the integrity of the civil infrastructure that supports the functioning of the substation plant. The charts below provide an overview of the asset conditions per category for substations and lines.

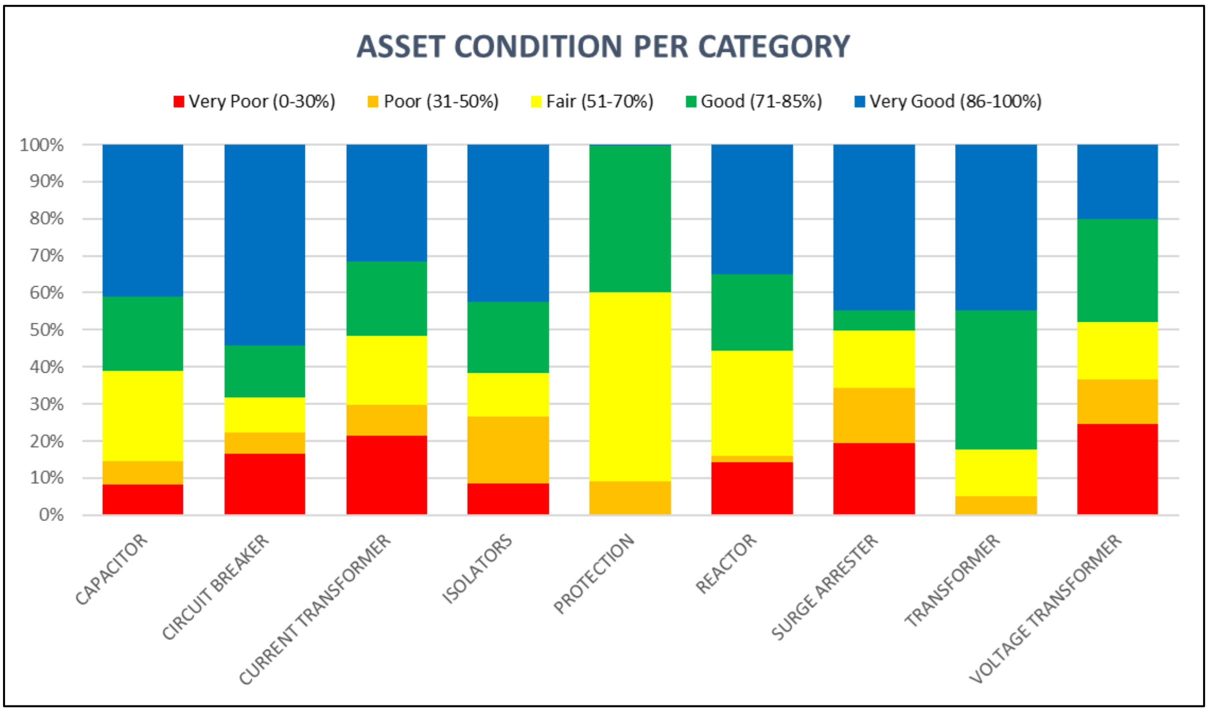


Figure 8-1: Substation Asset Condition per Category

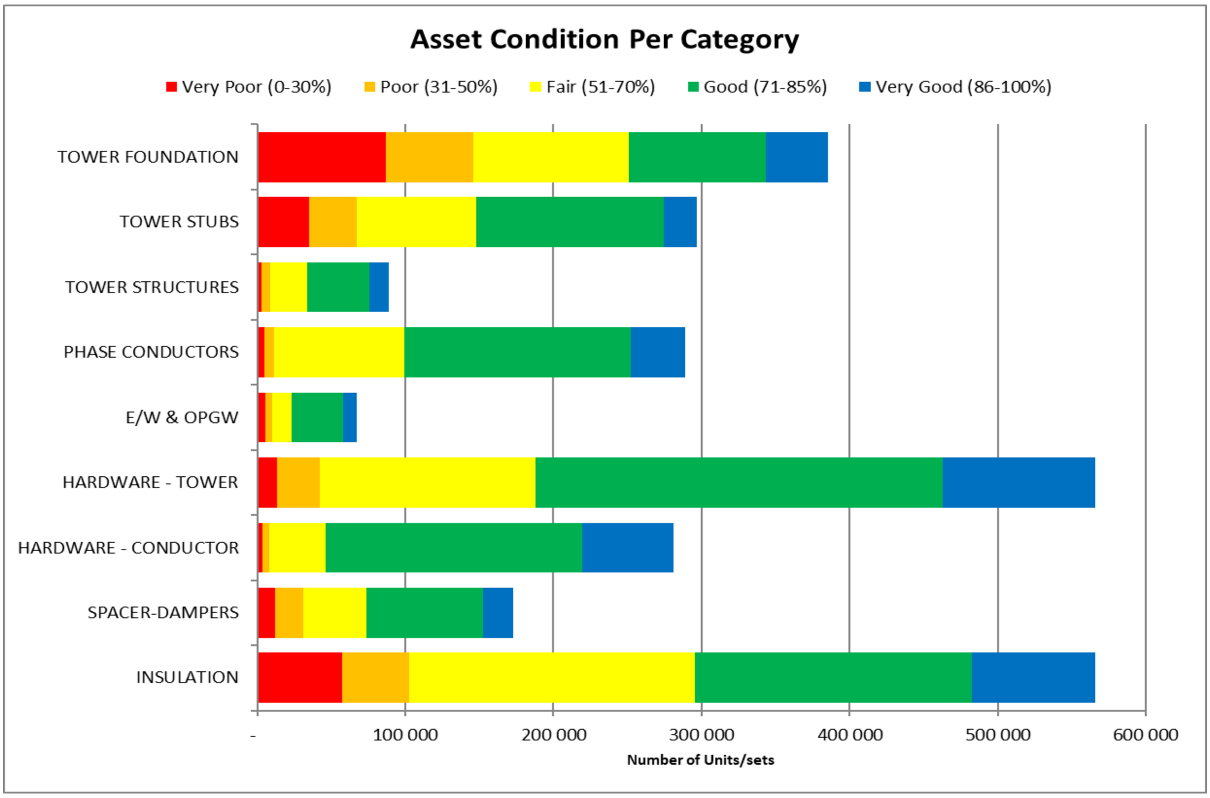


Figure 8-2: Overhead Powerline Asset Condition per Category

8.3 REFURBISHMENT PLAN

The compilation of the plan as well as the phasing of the asset replacement projects is influenced by various constraints e.g., financial, resource, outage, statutory/legal compliance, plant operations and equipment performance. The plan for each grid has been developed to address the specific needs and asset risks and reflects the priority assets to be replaced. The plan is continually optimised/prioritised as mitigation to reduce the impact of arising constraints.

The successful compilation of the plan is informed by the quality of assessments, grid and engineering involvement and stakeholder participation. The integrity of the refurbishment plan is reliant on the quality and availability of the input data.

Asset management-related structures, committees and work groups have been established to focus on and seek opportunities and solutions to improve the effectiveness of the value chain from planning and design, through to project delivery.

The refurbishment plan therefore focuses on problematic and unreliable assets, as indicated in the table below, that have impacted the organisation over the past years due to deterioration, mal-operation, latent defects, performance issues, obsolescence, and statutory fault-level compliance.

The table below depicts an overview of the refurbishment plan for substation assets to be replaced over the next 10 years. That is the quantities planned to be replaced per financial year per asset category.

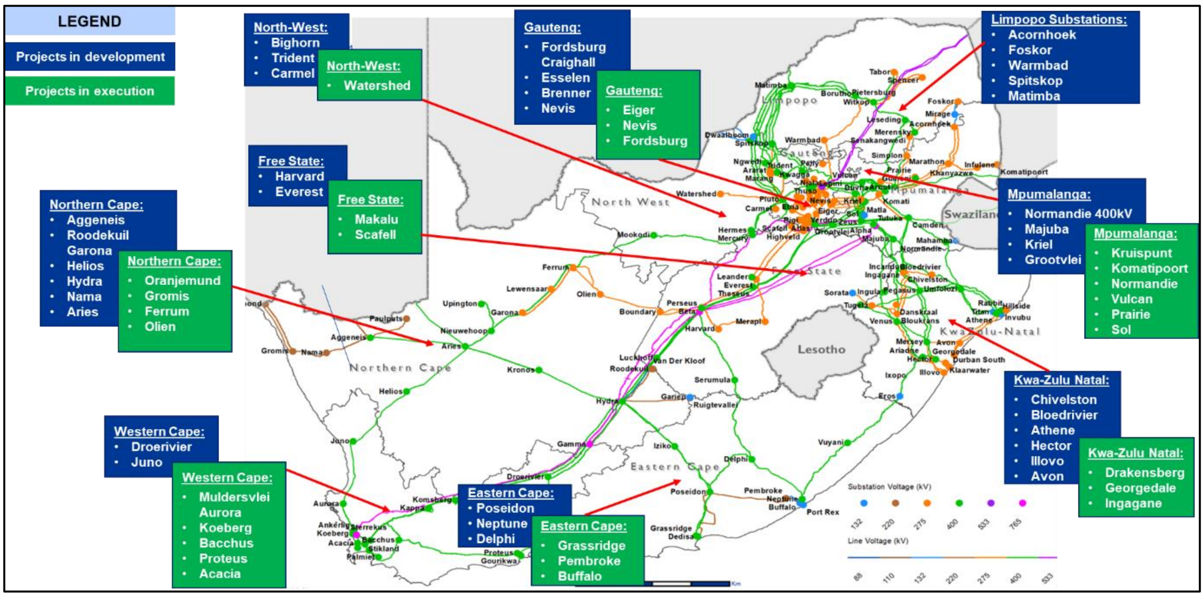
Table 8-1: Refurbishment Plan per Asset Category

CATEGORY	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	Grand Total
CAPACITOR	1	5	4	7	12	5	5	9	1	6	55
CIRCUIT BREAKER	48	87	131	90	115	69	105	117	83	85	930
CURRENT TRANSFORMER	192	425	577	438	460	406	438	394	293	239	3 862
DC & STANDBY	80	43	28	28	22	14	6	28	4	28	281
ISOLATORS	139	213	416	331	332	324	431	501	343	343	3 373
PROTECTION	35	141	214	256	249	275	315	257	201	51	1 994
REACTOR	-	-	-	-	-	4	9	2	1	-	16
SURGE ARRESTER	68	116	280	182	231	230	265	431	245	307	2 355
TRANSFORMER	1	1	8	7	13	13	15	27	31	8	124
VOLTAGE TRANSFORMER	23	100	206	193	115	182	216	221	96	166	1 518
Grand Total	**587**	**1 131**	**1 864**	**1 532**	**1 549**	**1 522**	**1 805**	**1 987**	**1 298**	**1 233**	**14 508**

8.3.1 Major Substation Refurbishments: FY2025 – FY2034

The systematic renewal of the aged asset base considering the extensiveness of the installed asset base in the network, is depicted below in major substation refurbishments per province.

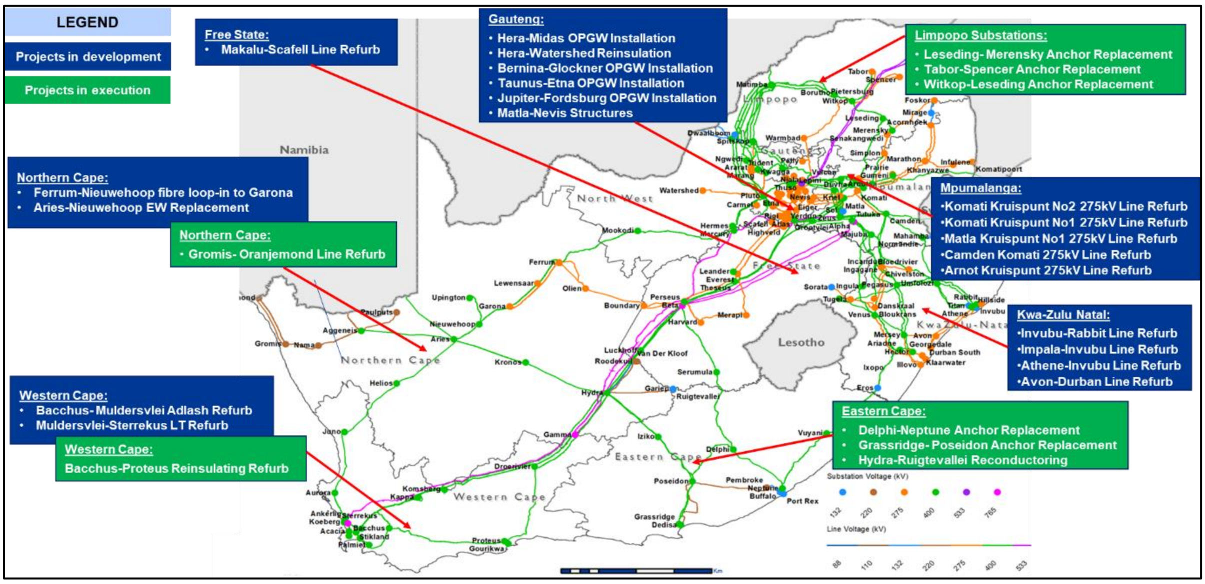
Figure 8-3: Major Substation Refurbishments per Province



8.3.2 MAJOR POWERLINE REFURBISHMENTS: FY2025 – FY2034

Specific problems on powerlines are addressed to mitigate the highest risk component on the powerline and to only consider a full line refurbishment when several components exhibited high risk on the same line. These are depicted below as major powerline refurbishments per province.

Figure 8-4: Major Powerline Refurbishments per Province



9 ANCILLARY SERVICES

9.1 ANCILLARY SERVICES CONSIDERATIONS

The South African Grid Code (SAGC) System Operation Code identifies obligations bestowed on the System Operator (SO) to ensure system reliability, security, safety, and efficient operation of the IPS. These services are covered by:

1. system reserves to combat generation/load contingencies, forecast errors and variability due to renewables;
2. system restoration services to expedite system restoration resulting from regional and system-wide interruption of supply;
3. reactive power and voltage control to maximise system security and reduce network losses; and
4. constrained generation to compensate those generators dispatched out of the merit order and who suffer financial loss due to a lack of related market rules dealing with transmission constraints and units in strategic positions. In future, this may also include congestion curtailment relating to the increased penetration of renewable energy resources.

Reactive power and voltage control, as well as constrained generation, are services that are directly affected by the development of the transmission network. Furthermore, as the network is strengthened, the possibility of getting reserves from generation is improved. In addition to the requirements from the SAGC and IRP stated above, expansion plans and their resultant effect on the TDP will also have an impact on ancillary services generally. (For example, increasing renewable generation and coal decommissioning will reduce reserve provision from conventional coal plants.)

Section 4 of the SAGC System Operation Code requires that the SO optimise related reliability targets annually for budgeting and publish opportunities for the provision of ancillary services in line with section 7.4 of the SAGC Network Code. In the referenced section 7.4, the code requires that the NTC not only publish an updated TS development plan annually by the end of October but also provide a five-year statement of opportunities to render ancillary services to mitigate network constraints and other IPS development plans as defined in the licence and/or market rules.

The Ancillary Services Technical Requirements (ASTR) are compiled based on an approved ASTR methodologies document and include input from generation, load forecasting, and the

IRP. This includes the use of approved information, updated annually, covering the forthcoming five-year time horizon. Once the ASTR has been approved, it is published on the NTCSA public website: https://www.ntcsa.co.za/wp-content/uploads/2024/07/240-159838031-ASTR-2024-2028-rev1.pdf. The purpose of this document is to clearly outline the criteria used to determine optimum and economic technical requirements for all ancillary service categories. These technical requirements should achieve the minimum reliability required by the grid code.

After the technical requirements have been approved, the SO procures ancillary services from generators, BESSs, distributors, or end-use customers. This is followed by a process of certification, contracting, monitoring, and payment of service providers, as required by section 4 of the SAGC System Operation Code.

The reserves requirements as stated in the 2024/25 ASTR are shown in Table 9-1.

Table 9-1: Reserves requirements as stated in the 2022/23 ASTR

Reserve	Season	Period	2024/25 MW	2025/26 MW	2026/27 MW	2027/28 MW	2028/29 MW
Instantaneous	**Summer**	**Peak**	650	650	650	650	650
		Off-peak	850	850	850	850	850
	Winter	**Peak**	650	650	650	650	650
		Off-peak	850	850	850	850	850
Regulating	**Summer**	**Peak**	650	725	800	875	950
		Off-peak	650	725	800	875	950
	Winter	**Peak**	650	725	800	875	950
		Off-peak	650	725	800	875	950

Reserve	Season	Period	2024/25 MW	2025/26 MW	2026/27 MW	2027/28 MW	2028/29 MW
Ten-minute	**Summer**	**Peak**	900	825	750	675	600
		Off-peak	700	625	550	475	400
	Winter	**Peak**	900	825	750	675	600
		Off-peak	700	625	550	475	400
Operating	**Summer/ Winter**	**Peak/ Off-peak**	2 200	2 200	2 200	2 200	2 200
Emergency			1200	1200	1 200	1200	1200
Supplemental			400	400	400	400	400
Total			**3 800**	**3 800**	**3 800**	**3 800**	**3 800**

- The system restoration service requirements, reactive power and voltage control, and constrained generation are specified as outlined in the published ASTR.
- The SO expects the procurement of more services through the IPP programmes, which include renewable energy, battery energy storage, gas and the ancillary services standard offer (AS_SO) pilot programme.
- It is anticipated that the changing generation mix will require new ancillary services, including fast-frequency response, self-start, and inertia.

10 CAPITAL EXPENDITURE PLAN

The table below provides the capital requirements for the TDP 2024 incorporating the full capital portfolio of the NTCSA in the first 5-year period (FY25 – FY29). This includes the capital requirements for transmission capacity expansion projects, refurbishment, production equipment, EAs, land and servitudes acquisition, telecommunications, real estate, and information management. The total estimated capital for the TDP 2024 amounts to R112.5 bn, with close to 80% (R85.6bn) estimated for the capacity expansion portfolio including EAs, land and servitudes acquisition .

Table 10-1: 5 Year Capex summary table for TDP 2024

NTCSA capex categories	R million
Capacity expansion:	80 707
New Generation Integration	*54 277*
Network strengthening	*26 430*
Land & Rights	4 880
Refurbishment	17 828
Telecommunications	5 316
Real Estate	369
Information Management	801
Production equipment	2 633
Total	**112 534**

The TDP 2024 requires that inter alia 14,494 km of transmission lines be built, as well as the installation of 210 transformers. This requires a significant capital investment to fund the TDP projects, estimated at R112 billion in the first 5-years. While adequate capital budget has been secured for the first 5-year horizon of the TDP, the bulk of the capital spend is in the later 5-year period. NTCSA's capital plan is limited by its balance sheet and its allowable revenue stream. Considering this, the NTCSA has taken a stance to focus on the delivery of the first 5-years of the TDP while engaging and collaborating with key stakeholders in Government to resolve the medium to long term challenges required to expedite the TDP delivery.

A simplified implementation framework has been developed, highlighting the key and critical elements required for the successful delivery of the programme. Several project delivery methods are being employed to implement transmission projects, including Engineering

Procurement and Construction Management (EPCM), Engineering Procurement and Construction (EPC), and Owner's Engineer (OE).

Private Sector Participation (PSP) through Independent Transmission Projects (ITPs) in transmission has been a focal point for enhancing efficiency of implementation, increasing investment, and promoting innovation in the energy sector. In this regard, the Ministry of Energy and Electricity (MoEE) and National Treasury (NT) are exploring funding models that can be considered to encourage private sector to participate in the acceleration of the Transmission investments. The NTCSA is working with MoEE and NT to implement a pilot project to introduce ITPs with the intention of obtaining key learnings that will guide the programme going forward.

The NTCSA recognises that it needs additional capacity to deliver the TDP to ensure South Africa' continued economic development. The Ministry and NTCSA are working together on ITP solutions to attract additional investments from the private sector. The regulations to support the ITP delivery solutions are in progress and will be followed by a Ministerial determination for an ITP pilot. To advance these important initiatives and support the acceleration of transmission project implementation, further engagement is ongoing among the Government, NERSA, Eskom and NTCSA. This collaboration is focusing on developing a framework for cost-reflective tariff structures, adequate capitalisation of NTCSA and policies that will ensure the financial sustainability of NTCSA, thereby enabling it to implement TDP projects through proven methods.

11 CONCLUSION

As per the NTCSA's licence and Grid Code, the NTCSA is required to produce a TDP for the country that addresses the system needs for new generation, demand, reliability, and sustainability of the IPS. The TDP 2024 based its assumptions on the draft IRP 2023, which is currently under review.

The NTCSA Transmission Development Plan (TDP) is a critical requirement of the South African Grid Code, guided by in-house generation and load assumptions developed by the Strategic Grid Planning Department. These assumptions form the foundation for informed decision-making, driving analysis on supply, demand growth, and technology impacts. The TDP 2024 for the period 2025-2034 reflects both NTCSA's strategic goals and the national energy strategy, aligned with the Integrated Resource Plan (IRP) 2023.

Based on these factors, the TDP 2024, being NTCSA's inaugural plan and fulfilling its regulatory obligations, is published with a focus on the first five years of the plan while it awaits the release of the IRP 2024 / 2025 and gathers more intelligence on the country's energy needs. The later five years of the TDP will be communicated for completeness with an emphasis on the flexibility of the TDP 2024 especially in the latter years to meet the country's energy requirements.

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 with the available budget by reprioritising projects as well as exploring alternate funding models. 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.

12 ACKNOWLEDGEMENTS

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