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Transmission Development Plan (TDP)

2025 - 2034

Welcome

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Safety evacuation procedure

NTCSA Transmission Development Plan 2025 to 2034 (TDP 2024)

Date: 30 October 2024

Programme

TDP 2025 – 2034 Public Forum

30 October 2024

08:30 - 09:00	**Join MS Teams Live Event**	**All**
09:00 - 09:05	Opening and welcome	**Dudu Hadebe** Senior Consultant: Grid Planning
09:05 - 09:20	Keynote address	**Segomoco Scheppers** Interim Chief Executive Officer: NTCSA
09:20 - 09:45	TDP 2024 Background & Grid Connection Progress	**Makoanyane Theku** Senior Manager: Customers and Grid Connection
09:45 - 10:00	RE Impacts on System Operations & Implications to Ancillary Services	**Paul Davel** Chief Engineer: System Operations
10:00 - 10:25	TDP 2024 Assumptions (Demand & Generation)	**Jana Breedt / Caswell Ndlhovu** Chief Advisor / Engineer: Strategic Grid Planning
10:25 - 10:40	Generation Capacity Analysis and Grid Impacts	**Ronald Marais** Senior Manager: Strategic Grid Planning
10:40 - 11:10	***Tea Break***	**All**
11:10 - 12:00	Provincial Development Plans (Southern & Northern Supply Areas)	**Ahmed Hansa / Caroleen Naidoo** Chief Engineers: Grid Planning
12:00 - 12:15	Summary of Grid Assets Refurbishment Plans	**Atha Scott** Senior Manager: Asset Investment Planning
12:15 - 12:30	TDP 2024 Summary	**Leslie Naidoo** Senior Manager: Grid Planning
12:30 - 13:30	***Lunch Break***	**All**
13:30 - 14:00	Progress on TDP Implementation Plan	**Makgwanya Maringa** Senior Manager: Project Delivery
14:00 - 14:30	Panel Q&A Session	All
14:30	Closure	**Dudu Hadebe**

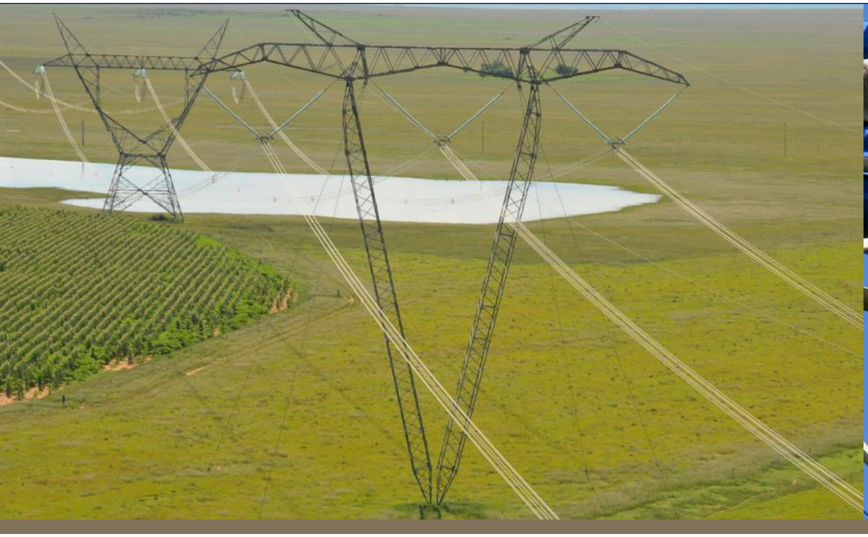
Keynote Address:

Segomoco Scheppers

Interim Chief Executive Officer NTCSA

TDP 2024 Background & Grid Connections Progress:

Makoanyane Theku
Senior Manager: Customers & Grid Connection



Background to the TDP 2024

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- **The TDP emanates from the 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 **key changes** from the last TDP 2022 is associated with the **new generation capacity assumptions** for the country as proposed in the **draft IRP 2023**. Apart from the draft IRP 2023, the TDP 2024 also considered:
  - Eskom's revised generation decommissioning strategy,
  - Connection applications processed through the various DMRE procurement programmes,
  - Applications processed from the non-DMRE "private sector" procurement programmes,
  - Information obtained through Renewable Energy (RE) surveys and consultations with RE associations, as well as
  - The impact of large scale RE integration on system stability and security of supply.

Background to the TDP 2024 *(cont.)*

- The outcome of the TDP is a list of projects with a high-level scope, cost, and time for the new infrastructure requirements to meet the specific objectives of each project.
- Following the publication of the TDP, each project undergoes a detailed power system analysis study in accordance with the Grid Code, considering alternative options, to determine the most technically and economically viable solution.
- The execution of individual transmission expansion projects follows the project life cycle model (PLCM) and is contingent on business case approvals in accordance with the NTCSA governance approval process.
- On an annual basis, NERSA conducts an audit on the TDP, the assumptions and process followed, and on a selection of approved projects for compliance to the Grid Code.

Background to the TDP (consultative process)

Development of the TDP is on a consultative basis

Distributors / Redistributors / Load Customers / Int Customers /

- Demand forecast
- Network plans
- Market intelligence

SOCs: NERSA, MoEE, DMRE, NT, DFFE, DPWI

- Policy alignment and compliance
- Alignment of plans with Country aspirations
- Assistance with e.g. Servitudes, PFMA, industry capacity matters etc.

Generators (Eskom and IPPs)

- Generation forecast
- Future aspirations

Investors / Financiers

- Project funding opportunities

RE Associations

- Understanding the RE plans for the Country
- Alignment of plans
- Addressing technical matters ~ inverter based technologies

Suppliers / Manufacturers / Construction Industry

- Industry capacity assessment
- Sharing of TDP build requirements

Overview and purpose of the TDP Public Forum

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The purpose of the presentation is to:

- Contextualise the planning timelines relating to the demand forecast and generation patterns
- Share information and results relating to the integration of new generation capacity and address the future network requirements
- Share assumptions and results from the Transmission Development Plan 2025 – 2034 for both the capacity expansion and refurbishment portfolios
- Share information on the initiatives undertaken to implement the TDP, as well as challenges experienced on projects in execution
- More importantly, to solicit comments and inputs to improve on the Transmission Plans

The objectives of the TDP are to attain Grid Code compliance and determine new infrastructure and asset replacement requirements

The Transmission Development Plan has four main objectives

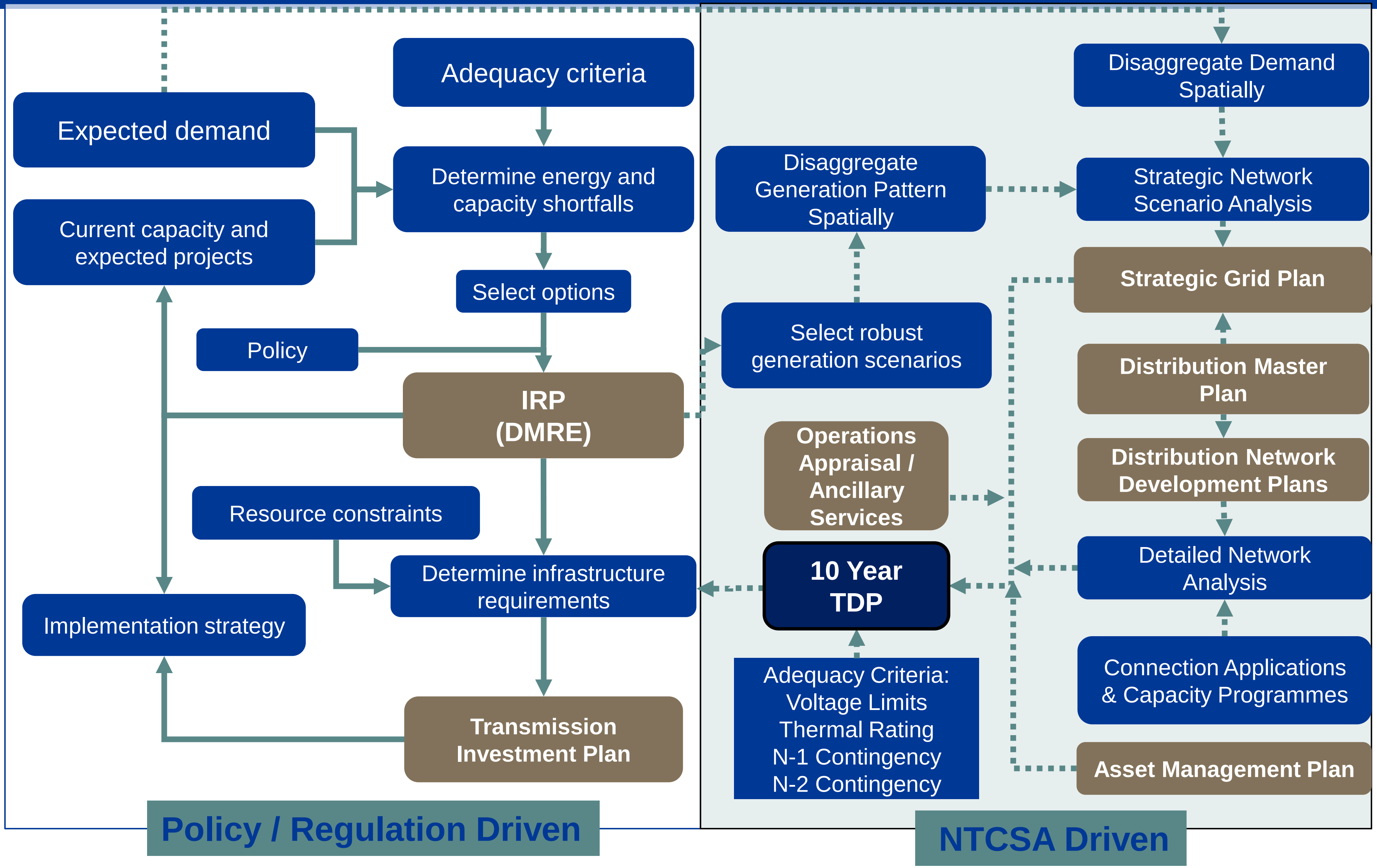
1. **Attain Grid Code compliance** by resolving both substation and line violations (N-1)

2. Determine **new network infrastructure requirements** to sustain and **allow for future demand growth**

3. Determine **new network infrastructure requirements** to **integrate new generation capacity** and **address system stability requirements**

4. **Consider asset replacement requirements** to ensure **reliability of supply** and **network optimisation**

Planning for the integrated power system



Grid Connections overview – end Sept 2024

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Announced preferred bidders for Department of Energy and Electricity Independent Power producers programmes

Peakers	REIPP BW1	REIPP BW2	REIPP BW3&3.5	REIPP BW4&4B	RMIPPP	REIPP BW5	REIPP BW6	BESIPP BW1
2 projects 1135 MW	28 projects 1434 MW	19 projects 1070 MW	18 projects 1628 MW	26 projects 2205 MW	11 projects 1998 MW	25 projects 2583 MW	6 projects 1000 MW	5 projects 513 MW
All projects connected	All projects connected	All projects connected	17 projects connected, 1 project in execution	All projects connected	3 Projects connected, 3 in execution	25 preferred bidders, of which 11 projects are in execution	6 Preferred bidders announced, of which 2 projects are in execution	5 Preferred bidders announced and currently in development

Total preferred bidders projects announced ~ 13,5 GW from 140 individual projects

95 projects totalling 7522 MW have been commissioned, of which 6387 MW is from RE Sources

17 projects totalling 1797 MW are in execution

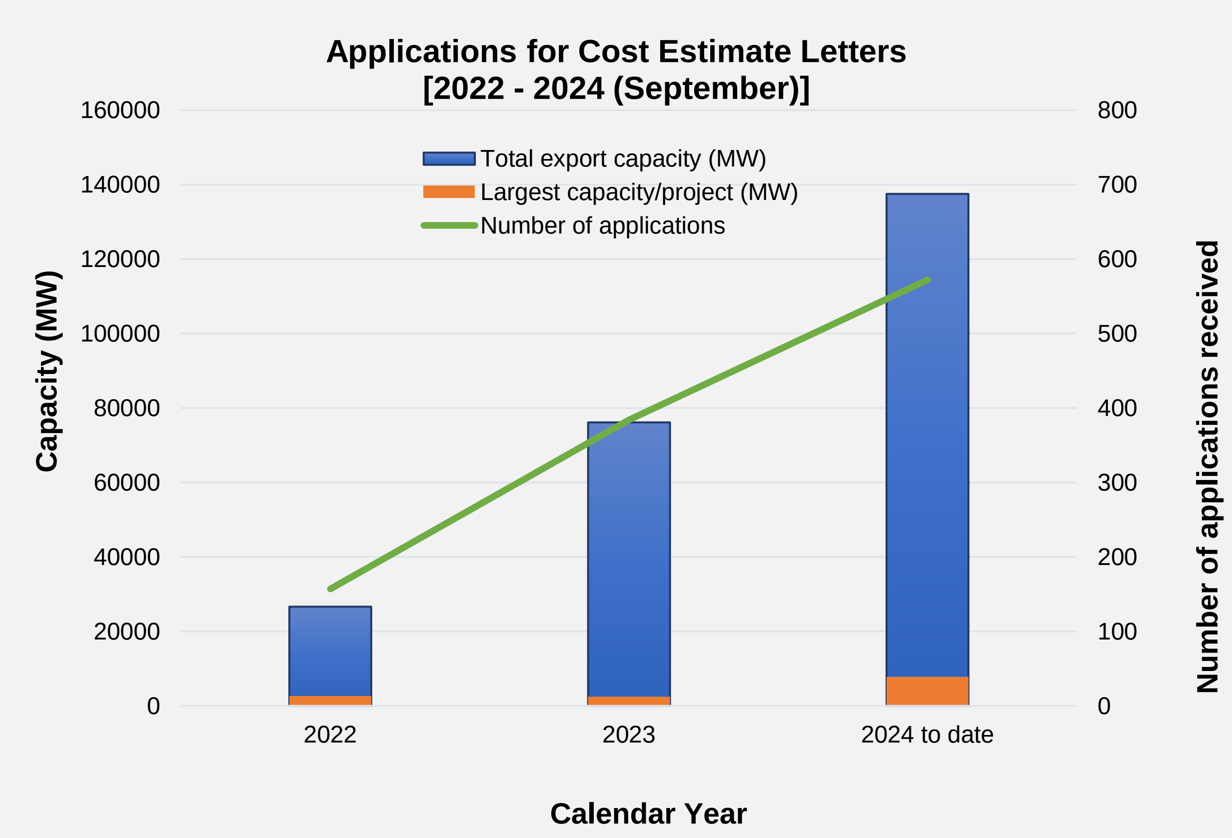
Private off-taker projects

585 MW of renewable energy projects have been connected to the grid for private-offtake mechanisms

48 additional renewable energy projects for private-offtake mechanisms, totalling 3.4 GW are currently in execution

Grid connections summary and trends analysis

- In total, more than 8 GW of generation from IPPs has been connected to the grid, with additional 5.2 GW currently in execution.
- NTCSA has committed Capital to enable the grid connection of projects in execution, where required.
- The transmission network capacity in the Western, Eastern, Northern Cape and parts of the North-West supply areas is severely constrained and would require substantial strengthening at local and corridor level to provide additional network capacity to integrate the new generation plants to the system.



Observations

- Rapid increase in the volume of grid connection applications since 2022:
  - Increase in number of applications, connection capacity and plant sizes

Challenges

- Supply vs sink mismatch for grid connection studies
- Increased connection studies complexity and processing time

Therefore, continued collaboration and timeous sharing of accurate information is essential for efficient and effective management of grid connections.

Today's programme

Apart from the TDP assumptions and provincial plans that we normally share at the public forum, today's presentation also includes:

1) The System Operator's experiences with RE connected to the grid and impacts to Ancillary Services
2) Progress on the TDP implementation programme
3) Experiences related to projects in execution

I hope you find today's engagements fruitful, and we look forward to your feedback!

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Renewable Energy (RE) Impacts on System Operations & Implications to Ancillary Services

Paul Davel
Chief Engineer: System Operator

Introduction

- The role of the System Operator (SO) is to control and operate the system in a way that is safe, reliable and efficient.
- Ultimately, SO is technology neutral in terms of energy sources – we just need to ensure that we have tools at our disposal to manage frequency, voltage, network loading, etc. under normal and emergency conditions.
- The operation of networks supplied by conventional generation is well understood, both internationally and locally. The increasing penetration of RE means that different challenges arise that may, or may not, require different tools to satisfy the mandate of the System Operator. Fortunately, there is international experience and best practices that can be applied and modified to suit South African conditions.
- The system is changing rapidly, particularly due to the proliferation of rooftop PV systems – these have changed the behaviour of the load in many instances and their installation has rapidly outstripped the installation of contracted installations.
- The proliferation of rooftop PV has helped to suspend load shedding – mostly by reducing reliance on emergency resources (OCGTs and pumped-storage) during daylight hours, which means that diesel and dam levels can be maintained. This is a secondary effect – the biggest contributor is the improvement of fossil stations’ Energy Availability Factor (EAF).

State of RE Integration

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October 2021

Current Installed Capacity (MW)	
CSP	500.0
PV	2,212.1
Wind (Eskom+IPP)	3,023.4
Total (Incl other REs)	5,761.0

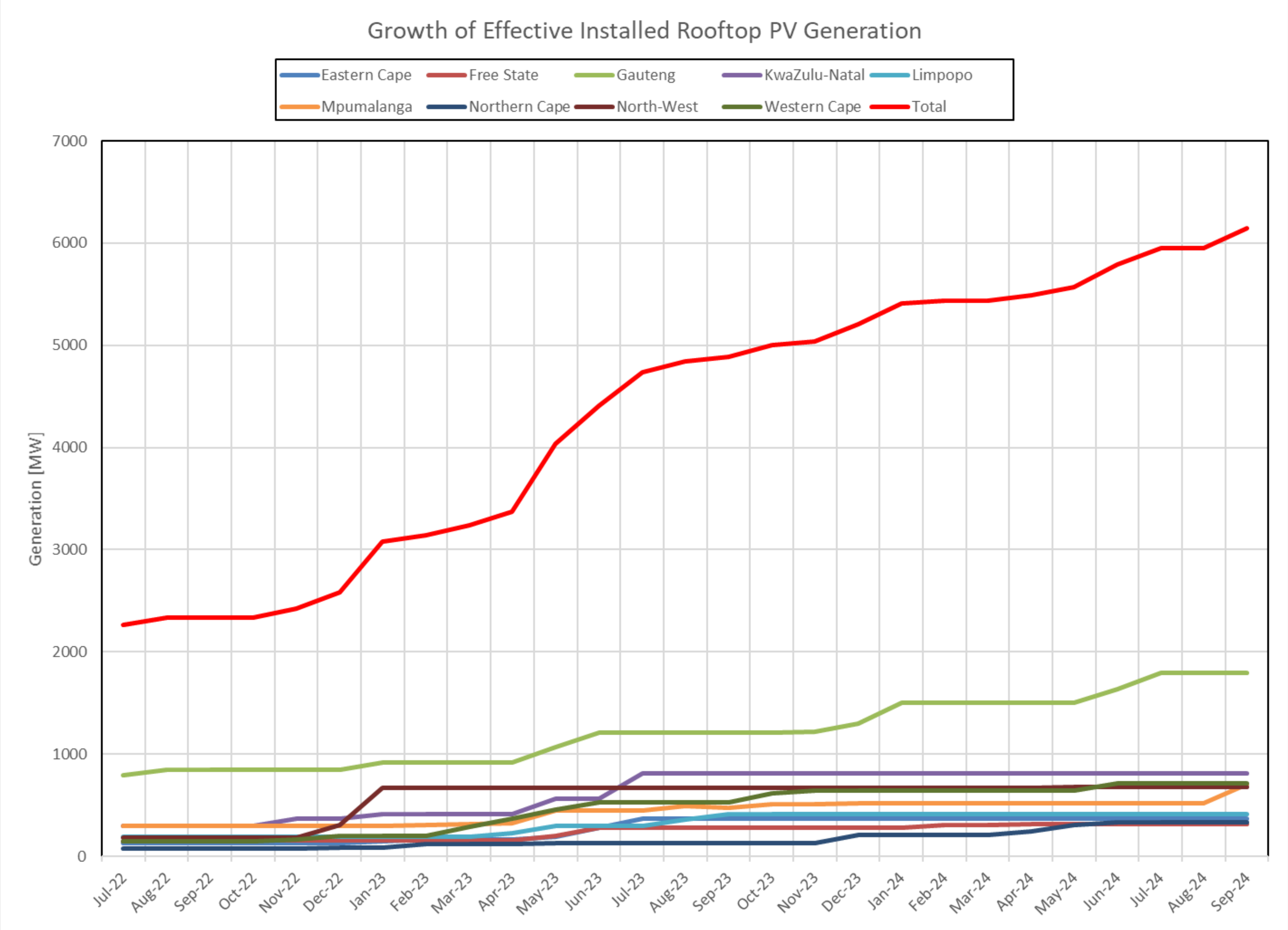
October 2024

Current Installed Capacity (MW)	
CSP	500.0
PV	2,287.1
Wind (Eskom+IPP)	3,442.6
Hybrid	150.0
Total (Incl other REs)	6,430.2
Estimated Rooftop PV*	6,141.4

- Minimal increase in PV
- Approximately 420 MW additional Wind
- New Hybrid generation
- Total increase of almost 670 MW

- **Consistent load shedding during 2022 and 2023, coupled with double digit price increases, have driven the growth in behind-the-meter installations.**

Growth of "Rooftop" PV



Impact of rooftop (behind the meter) PV

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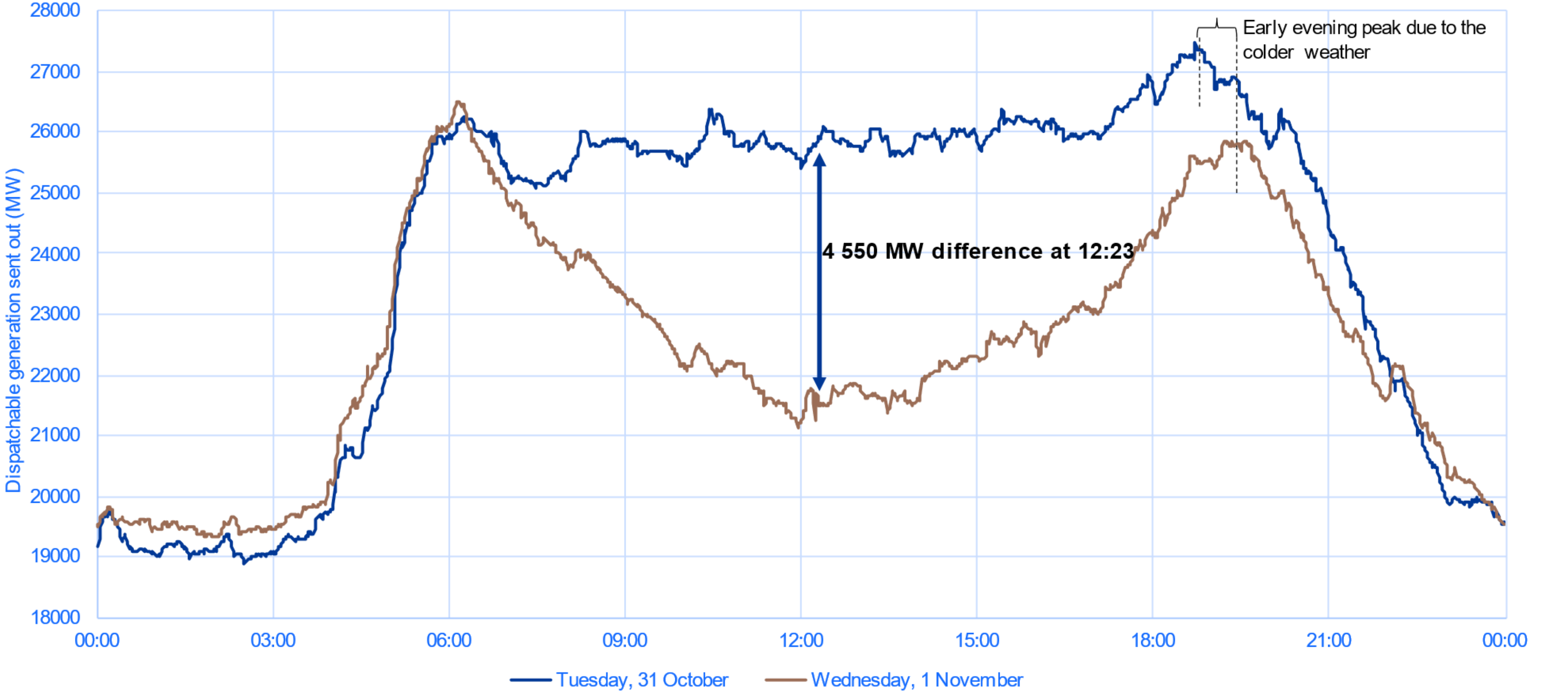
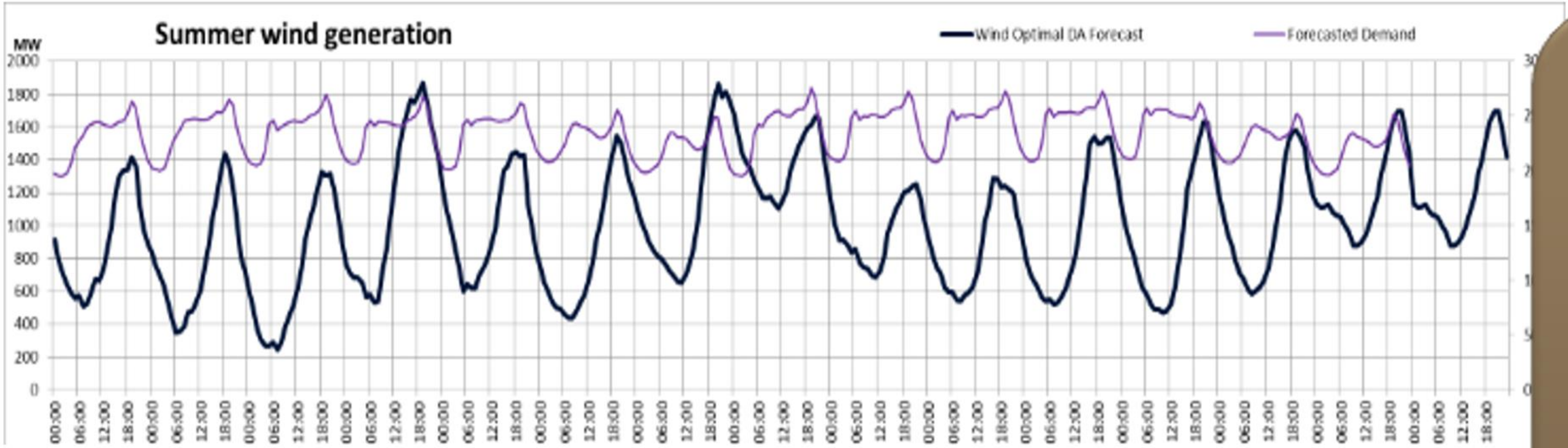
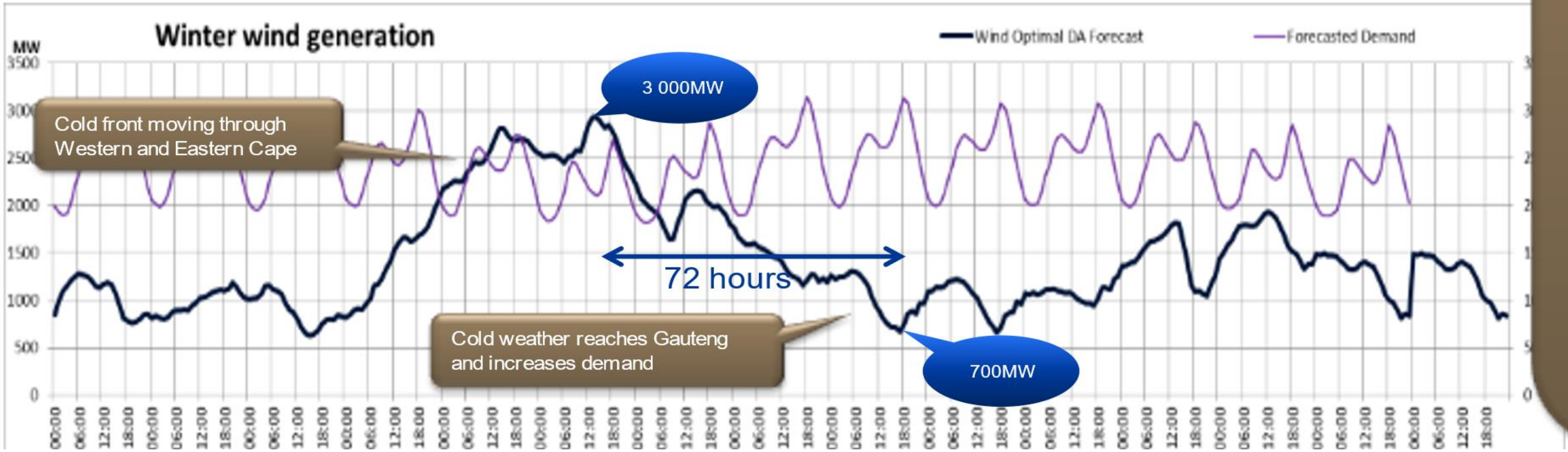
Comparison of a cold day with poor PV vs a warmer day with abundant PV
Identical stages and times of load shedding on both days



Wind generation characteristics





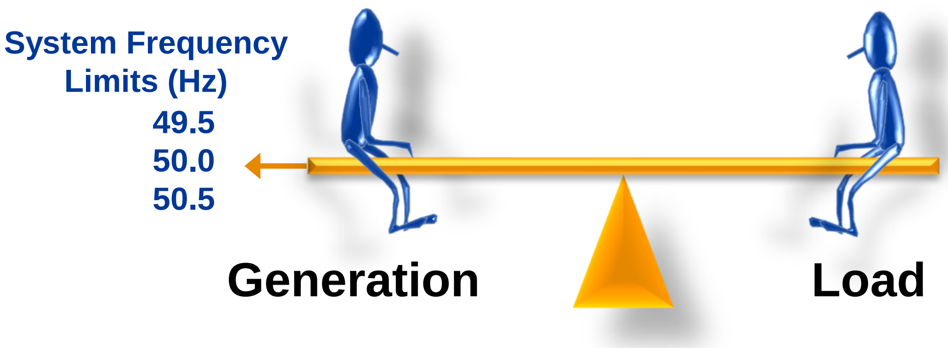
During the summer months, the wind generation aligns almost perfectly to the high evening peak demand and the low night minimum demand.

However, in winter, when the cold front passes through the Western and Eastern Cape, the wind generation increases significantly.

As the cold front arrives in densely populated Gauteng, the cold weather drives demand for electricity up and at the same time the wind generation reduces significantly due to the low trough behind the front.
This double whammy requires 1000's of MW of generation to be dispatched in a short period of time to compensate for the reduced generation and increased demand.

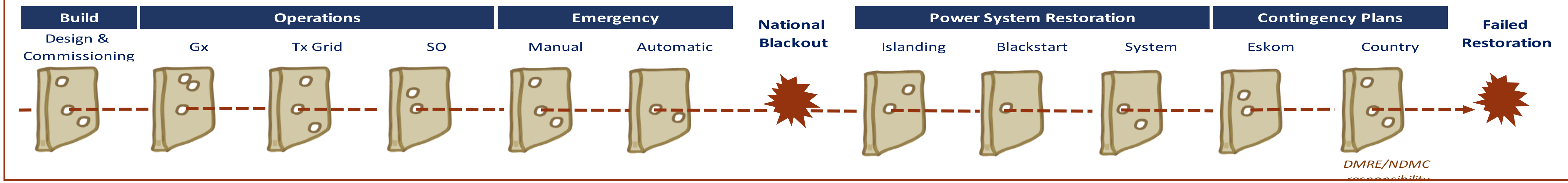
Ancillary services overview

- **System reserves** to combat generation/load contingencies and forecast errors. These include instantaneous, regulating, ten-minute, supplemental and emergency reserves



- **Reactive power and voltage control** to maximise system security and reduce network losses.
- **Constrained generation** to compensate those generators dispatched out of the merit order and suffer financial loss due to lack of related market rules dealing with transmission constraints and units in strategic positions.
- **System restoration** services to expedite system restoration resulting from regional and system-wide interruption of supply. These include Black-start, Islanding and in future self-start facilities

National Blackout Prevention & Readiness (barrier analysis)



Ancillary services providers in South Africa (today, tomorrow)

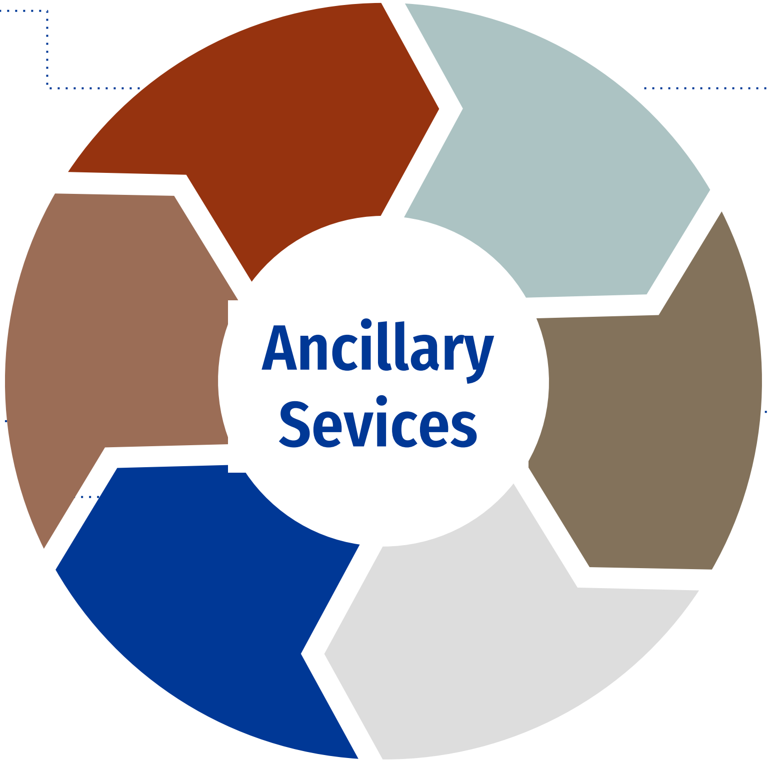
CURRENT PROVIDERS

Eskom Gx

- Procured through PPAs
- Meant to provide all services

Demand Response

- Procured through contracts
- Provides three categories of reserves



FUTURE PROVIDERS

Section 34 programs

- Energy Storage
- RMIPP
- BW 6 and 7
- Gas IPP

Other Initiatives

- AS Standard Offer
- Loadshedding reduction program
- Sync. Con. project

Changes in the Ancillary Services space

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Behind the meter PV

Financial

System reliability

Curtailment

Governance

Regional voltage issues

BESS and Gas

Decommissioning Coal

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TDP 2024 Assumptions (Demand & Generation)

Jana Breedt / Caswell Ndlhovu
Chief Advisor / Engineer: Strategic Grid Planning

The TDP follows a rigorous and iterative development process, primarily driven by electricity demand and supply assumptions

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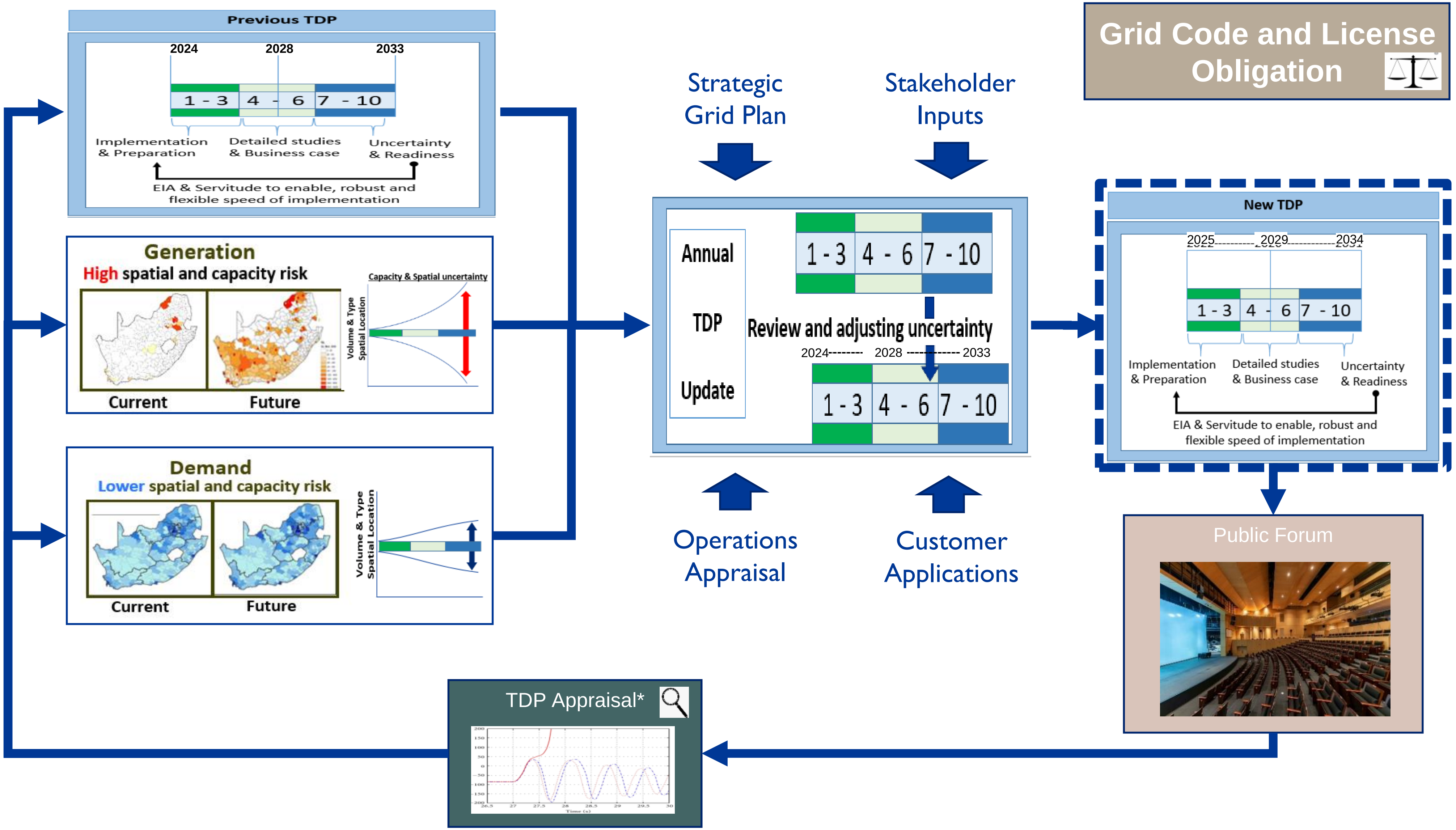
The TDP follows a **rigorous** and **iterative** development **process** which is primarily informed by:

- **Expected generating capacity** and spatial distribution
- **Expected electricity demand** and spatial distribution
- **Stakeholder inputs** from various sources
- **Previous TDPs** and **other planning activities**



Generation and Load Assumptions
Supporting the Business Case for the TDP 2025 - 2034

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. The Grid Code mandates the NTCSA to produce a TDP by October each year, with generation capacity and load assumptions as key inputs. The planning process is dynamic and any changes to input data will be factored into the next TDP as new information is received.

Generation Assumptions

The TDP Generation Assumptions are the generation capacity input to the TDP and uses the Draft IRP 2023[1], currently under review, as its primary source. The IRP Draft 2023 provided 5 pathways for future generation scenarios beyond 2030, 3 are consistent with the reference case and 2 where extreme, therefor the reference pathway 1 was used. Furthermore, key programs like RMIPPPP and REIPPPP BW5, BW6, and BW7, along with Budget Quotation applications (calls for up to 8.9 GW) [2], land lease applications at old power stations (1.9 GW PV), and Eskom's Generation Production Plan[3] are factored into the generation assumptions. The total capacity is expected to reach 106.5 GW by the end of the TDP period (2034).[4]

Demand Forecast

The Demand Forecast outlines 6 scenarios for the TDP grid development. Top-down strategic scenarios are supported by bottom-up Customer applications [2] and network analysis. The **high scenario** aligns with the National Development Plan[5], with 4% 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% GPD 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, GDP growth on average below 0.5%. The **moderate-high scenario** is preferred for the TDP planning cycle, aligned with the Draft IRP 2023 [1] reference forecast, a Macro economic forecast up to 1,6% GDP growth in the TDP period, and up to 3,2% from a global GDP to positively influence South African Growth was used [6] [7].

(1) Integrated Resource Plan (IRP) Draft 2023 | Department of Mineral Resources and Energy.
(2) Customer Applications Quotation Eskom NTCSA | Grid Planning (2024)
(3) Eskom Generation Production Plan. (2023)
(4) Generation Assumption Report 2024.
(5) National Development Plan 2032 | South African Government (2010).
(6) National Treasury. (2024). *Budget review: Fiscal policy*.
(7) *Econometrix (Pty) Ltd (HIS REX Explorer), Eskom service provider.*

Information flow & data collection

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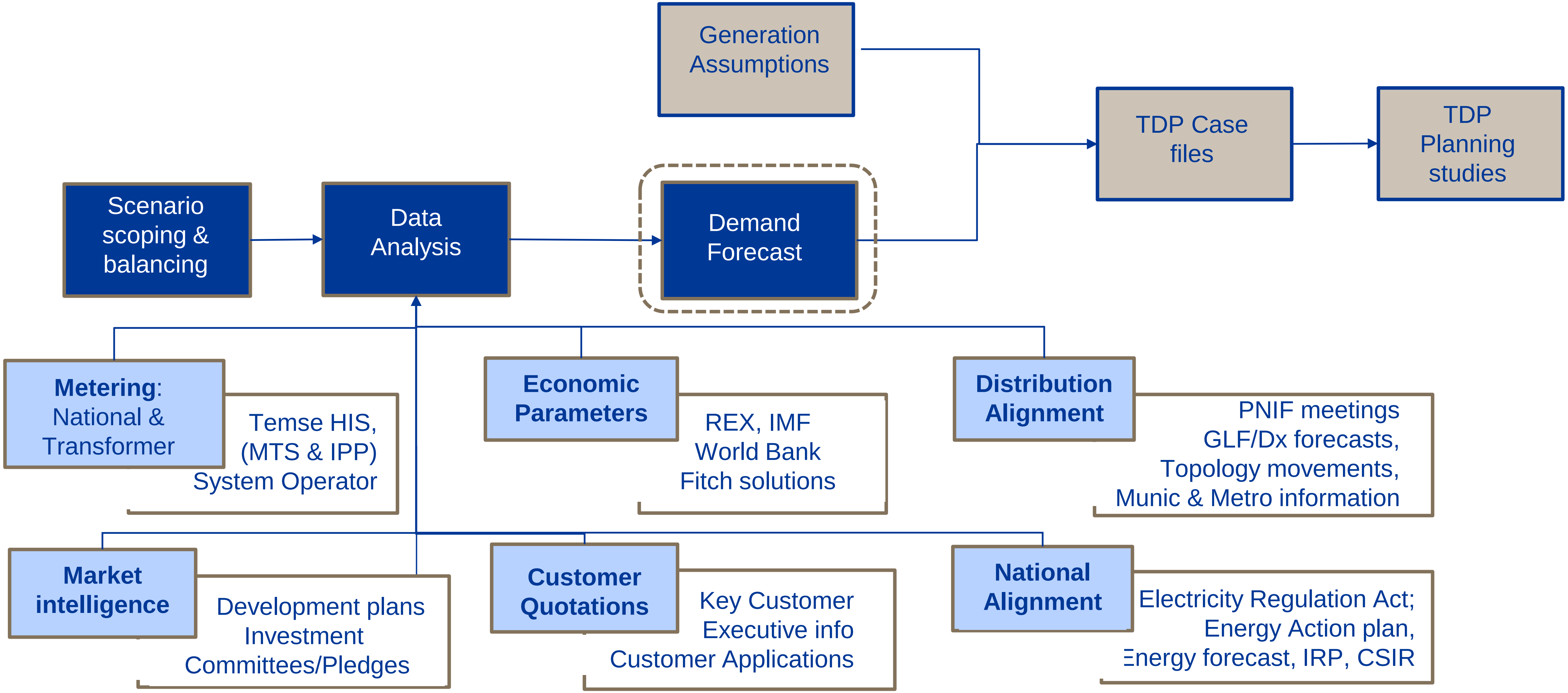

The TDP 2024 assumed a Moderate High demand growth scenario for the infrastructure requirement analysis

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Demand assumptions

Selected demand scenario for TDP 2024

Parameter	High demand *"Fly high and Enable Green Exports"*	Moderate High demand *"Enable, collaborate with RE grid solutions & markets"*	**Medium (Energy Efficiency) demand** *"Sharing the energy supply market"*	Low demand *"Losing Market Share in the industry, persistent slow economy"*
Global & local 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, >1% in long term	Deteriorating economic growth <0.5%.
Load supplied from NTCSA	46GW in 2034 up to **60GW 2050**	43GW in 2034 up to **52GW 2050**	39GW in 2034 Up to **44GW 2050**	34GW in 2034 up to **36GW in 2050**
Energy Availability (EAF%)	Very High	High	Moderate	Low
Network strengthening	Surpass targets	Achieve targets	Below target	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 or production 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 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

Along with the above, the demand forecast does not indicate a significant change in spatial distribution of demand with majority of demand remaining in northern parts of country

Transmission System National Forecast Cycles 2025-2034

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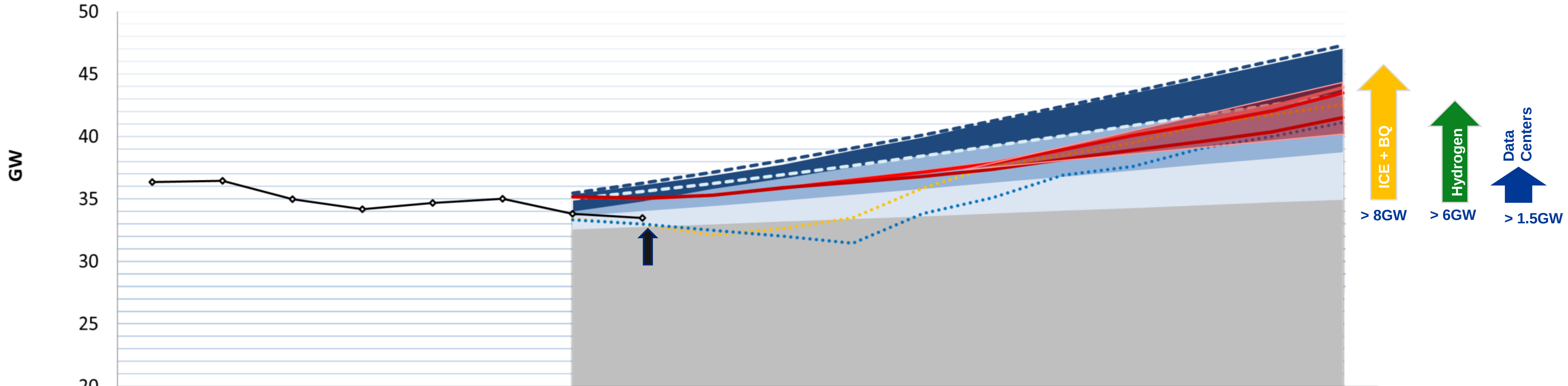
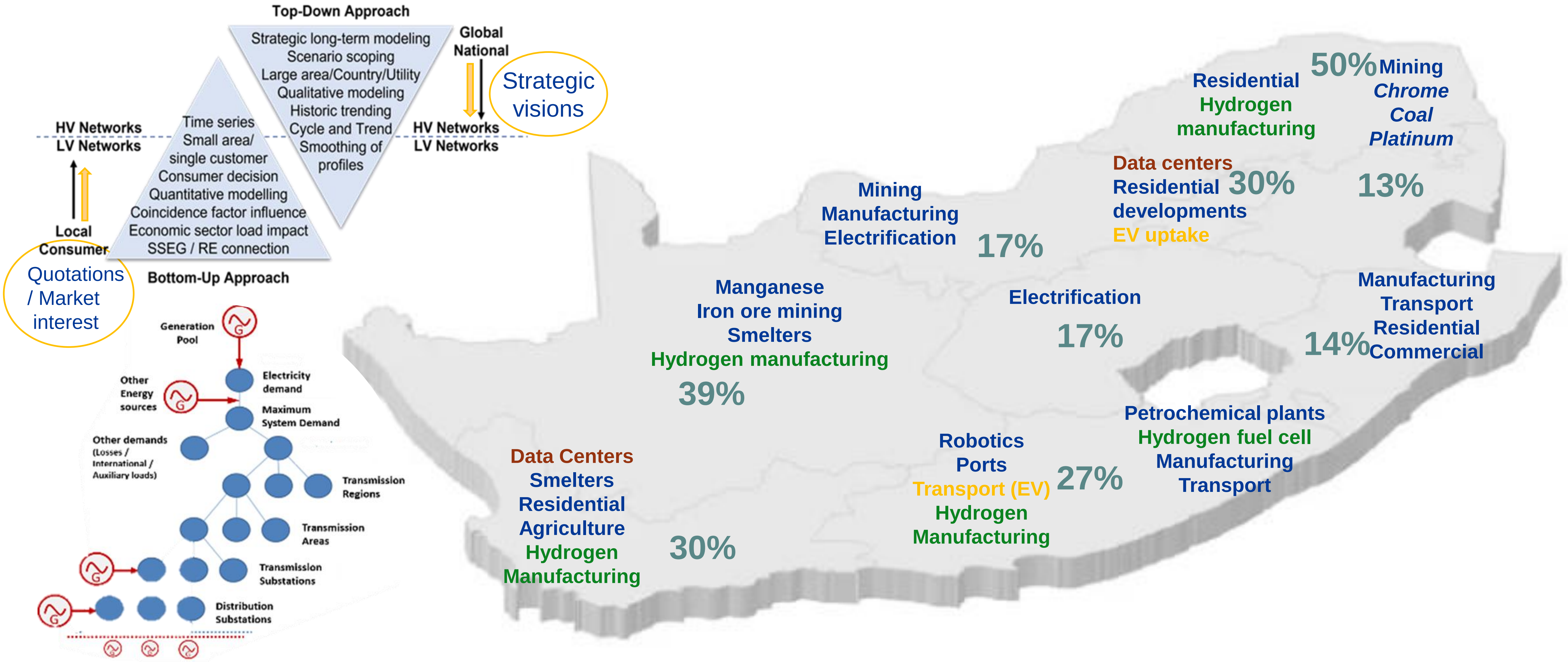


*Instantanious Peak Demand

	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

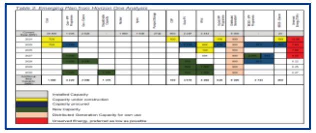
Provincial allocation of demand potential for TDP period 2025 – 2034



Generation Assumptions Components

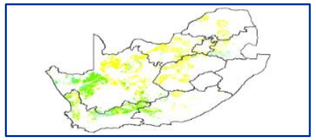
Generation assumptions

NTCSA utilises various insights from internal and external sources…

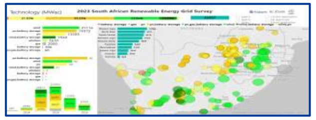


Integrated Resource Plan (regionally aggregated)

Eskom Generation Plan

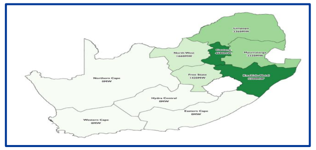


Renewable energy resource data and DFFE EIA applications

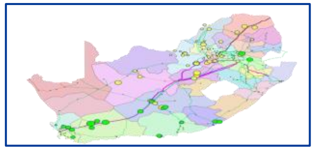


Annual Renewable Energy Survey

Government capacity procurement programmes

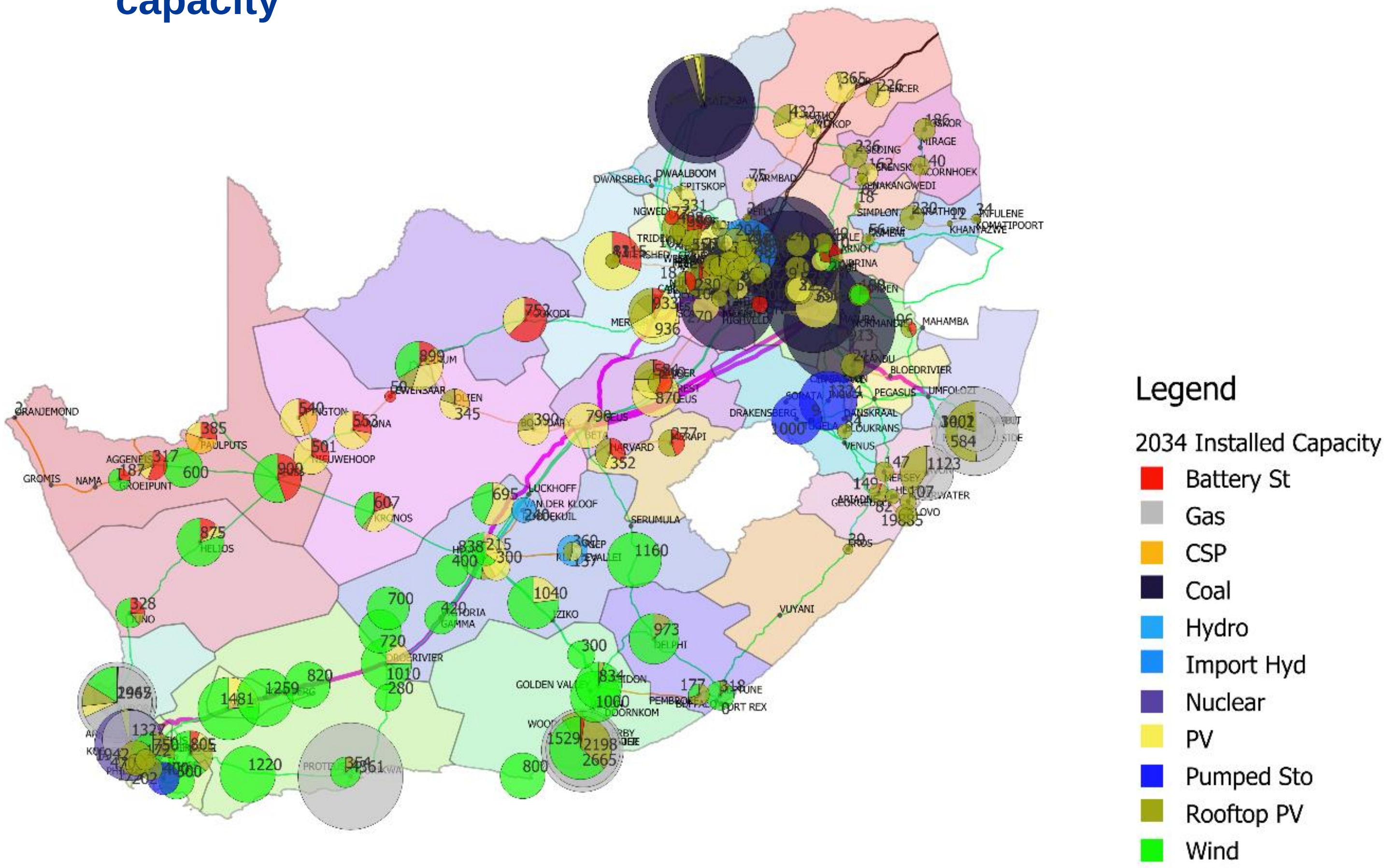


Generation Connection Capacity assessment and applications (GCCA)



Budget Quotations and Land Lease Projects

…which ultimately **informs the magnitude** and **spatial distribution** of **expected** new **generation capacity** across South Africa, indicating a **shift** from **largely centralised generation** to **spatially distributed capacity**



Total 107 GW by 2034

The TDP 2024 expects generating capacity to increase from 66GW in 2024 to 107GW in 2034, along with a substantial change in technology mix

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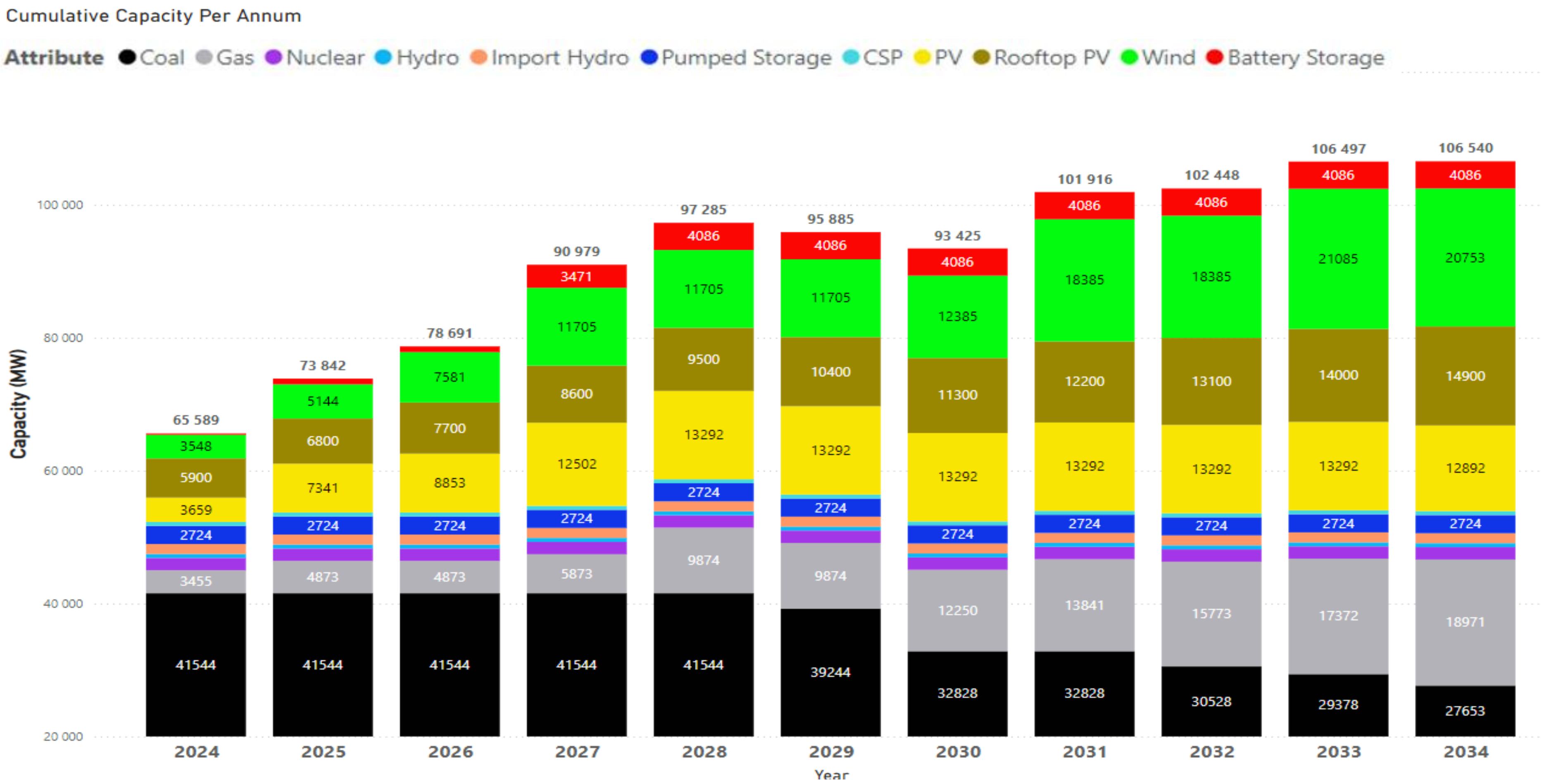
Generation assumptions

Summary of annual capacity expectations between 2024 and 2034

MW

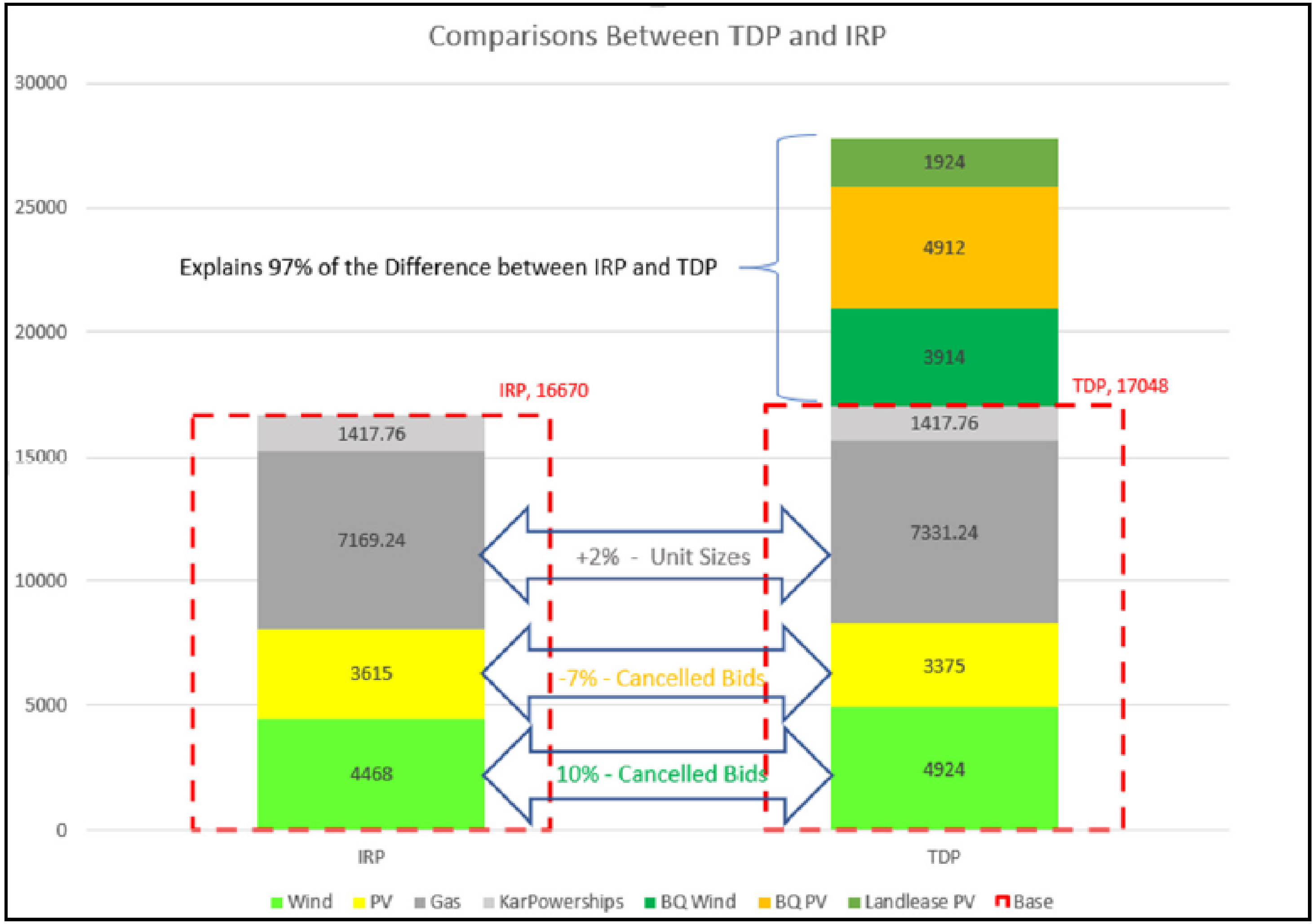


1: Includes other technologies with minimal changes from previous TDP: Nuclear, Imports, Hydro and Pumped Storage, CSP etc.

Insights

- Based on the insights from various sources, **capacity** is expected to **increase** from **66GW in 2024** to **107GW in 2034.**
- The **increases** are mainly driven by **Wind**, **Gas**, **Rooftop Solar PV**, and **utility Solar PV** capacity.
- This is **offset by** a **decrease** in **Coal capacity,** as Eskom generation decommissions it’s Coal fleet.
- The **magnitude of the increases**, specifically from sources which are **typically more distributed** based on geographic resource potential (Wind, Solar PV and Gas), illustrates the **significant additional transmission capacity required.**

Comparison between the IRP and TDP



- The land lease programme (1.9 GW) addresses replacement projects at different power stations earmarked for decommissioning

Compared to TDP 2022, the TDP 2024 expects an increase in Solar PV, Gas and Coal by 2034 and a decrease in Wind and Battery Storage

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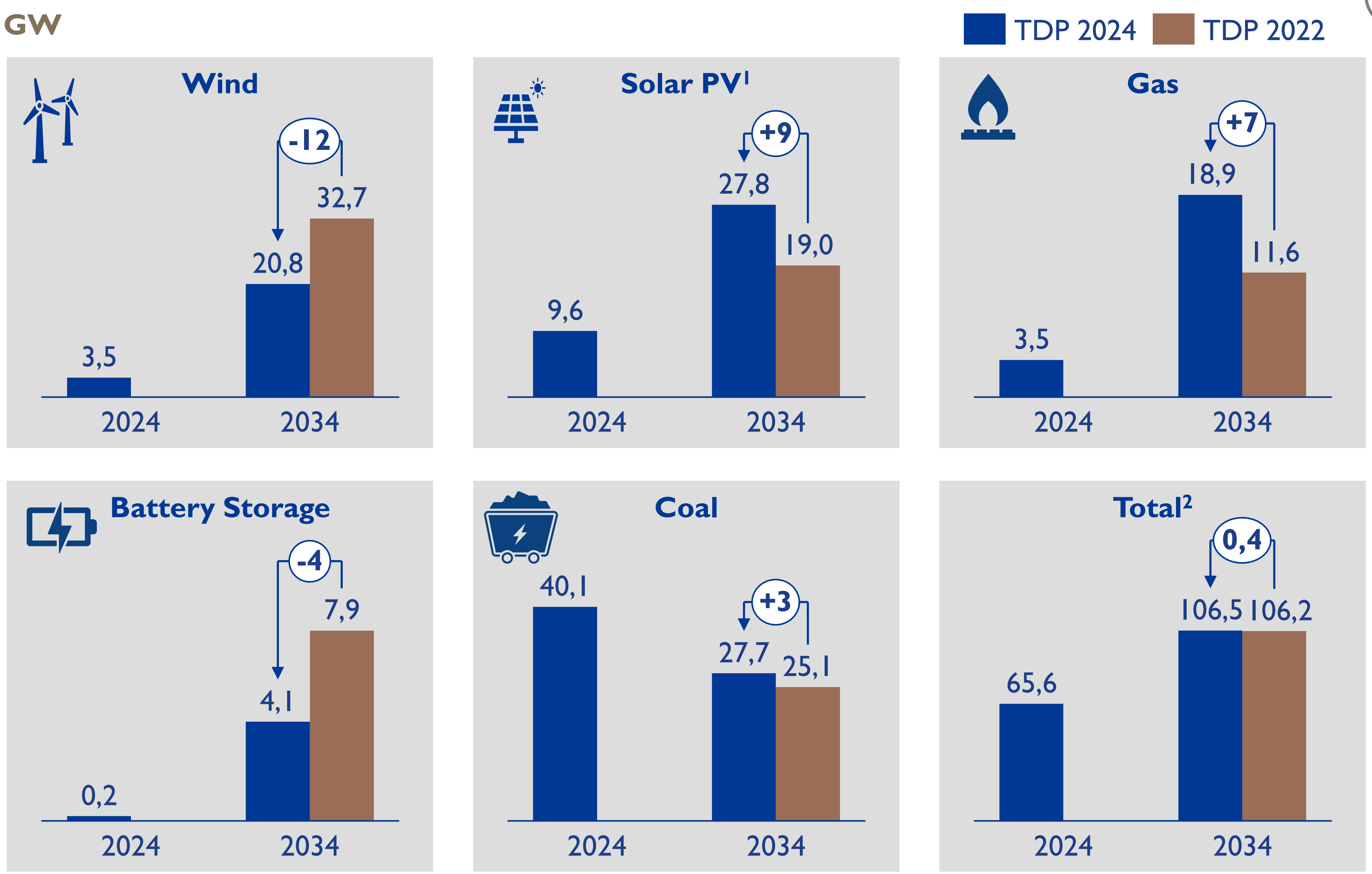
Generation assumptions

Comparison of total capacity expected by 2034 (TDP 2022 vs TDP 2024)



1: Includes Rooftop Solar PV; 2: Includes other technologies with minimal changes from previous TDP: Nuclear, Imports, Hydro and Pumped Storage, CSP etc.

Insights

- **Overall capacity** expected in the TDP 2024 by 2034 **remains similar** to TDP 2022, with a **0.4GW increase, primarily driven** by increased **Solar PV (+9GW), Gas (+7GW) and Coal capacity (+3GW)** capacity.
- The **increase** in **Solar PV** capacity is driven by **Rooftop PV expectations** (+9GW by 2034), while the **Gas increase** (+16GW by 2034) is driven by **IRP indications.**
- **Coal** is **3GW higher in 2034** compared to TDP 2022, due to **revised shutdown plan** which expects Tutuka to run until 2041.
- **BESS and Wind** reductions are informed by **IRP indications** and **grid constraints**, particularly in the earlier periods.

Summary

- Wind capacity decreased by 11.9 GW compared to the last TDP Assumptions
- PV capacity (incl Rooftop) increased by 8.7 GW
- Cumulative Gas increased by 7.3 GW and Battery Storage decreased by 3.8 GW by 2034
- Cumulative Coal and Gas decommissioning will be 17.6 GW by 2034
- Rooftop PV is expected to outstrip utility scale PV by 2034 (14.9 GW v 12.9GW) – some say the rooftop is highly underestimated – volatile – lately subdued
- Conventional and imports stabilise at **about** 50% of capacity and RE+ Batteries at 50% by 2034
- The Load forecast selected Moderate High scenario aligns with the IRP load forecast by 2034 and it also tracks the developments in the form of quotations closely

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Generation Capacity Analysis & Grid Impacts

Ronald Marais

Senior Manager: Strategic Grid Planning

What generation will supply the demand?

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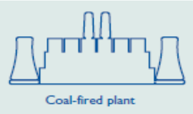
1. We are facing coal shutdown

Shutdown

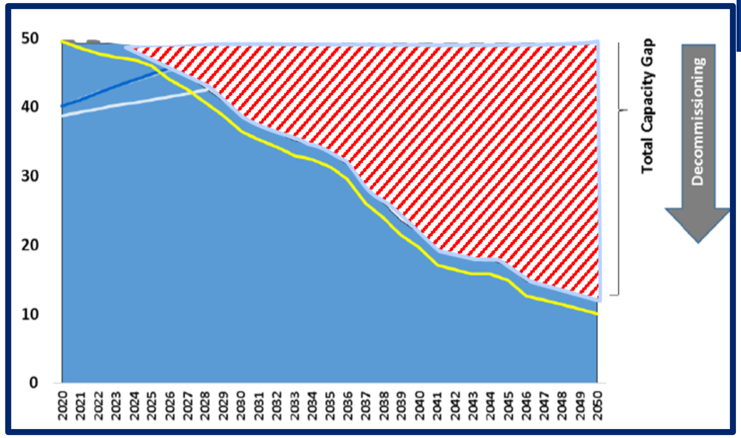
Coal



2025 – 2034

-12GW

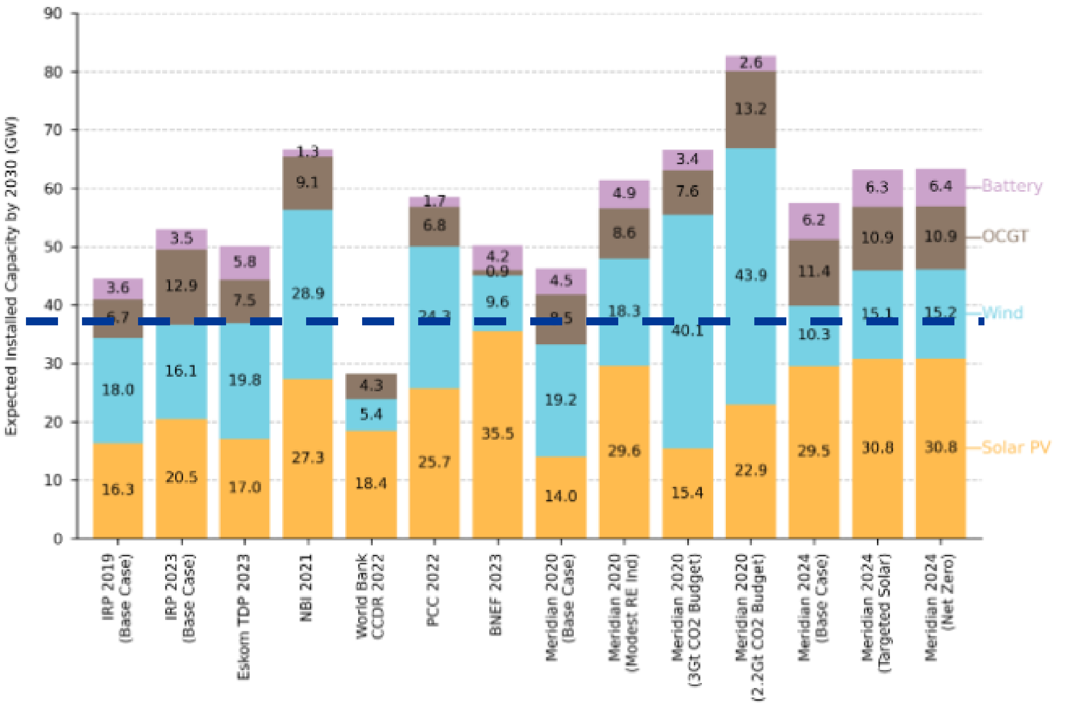
Continues beyond 2030



This means new generation is required to replace the existing generation and to supply future load growth

2. IRP and other studies are consistent that solar, wind, energy storage and gas will dominate

IRP 2023 – 36GW renewable by 2030



(1)

Figure 8: New Generation Capacity Expected in 2030 by various studies

(1) https://poweroutlook.meridianeconomics.co.za/

Where will renewable generation be located?

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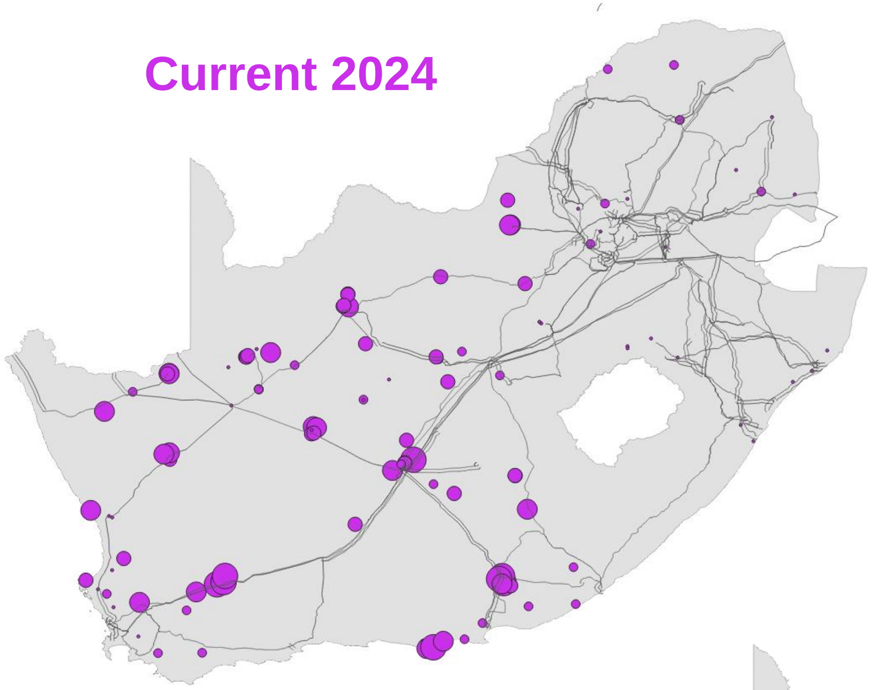
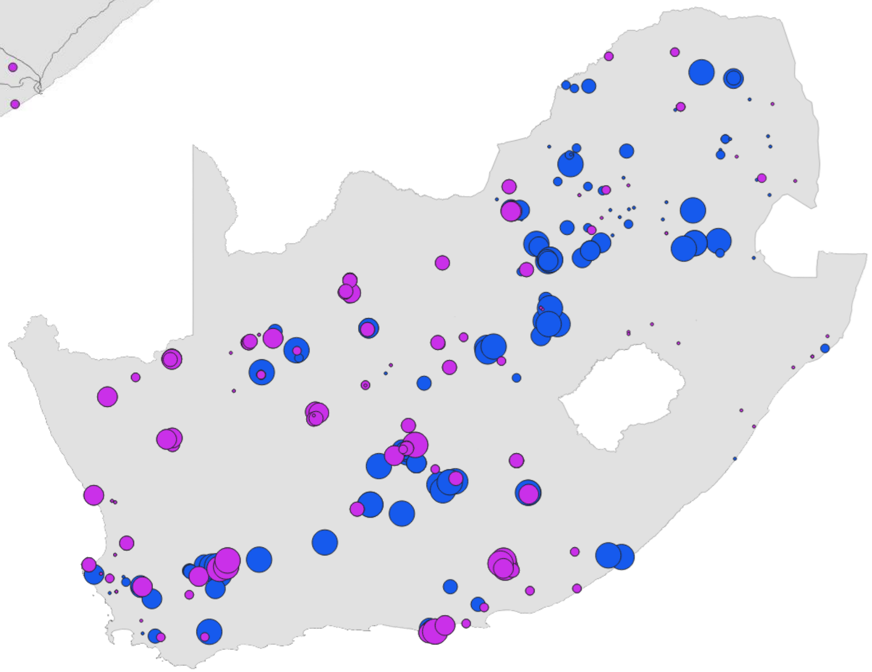
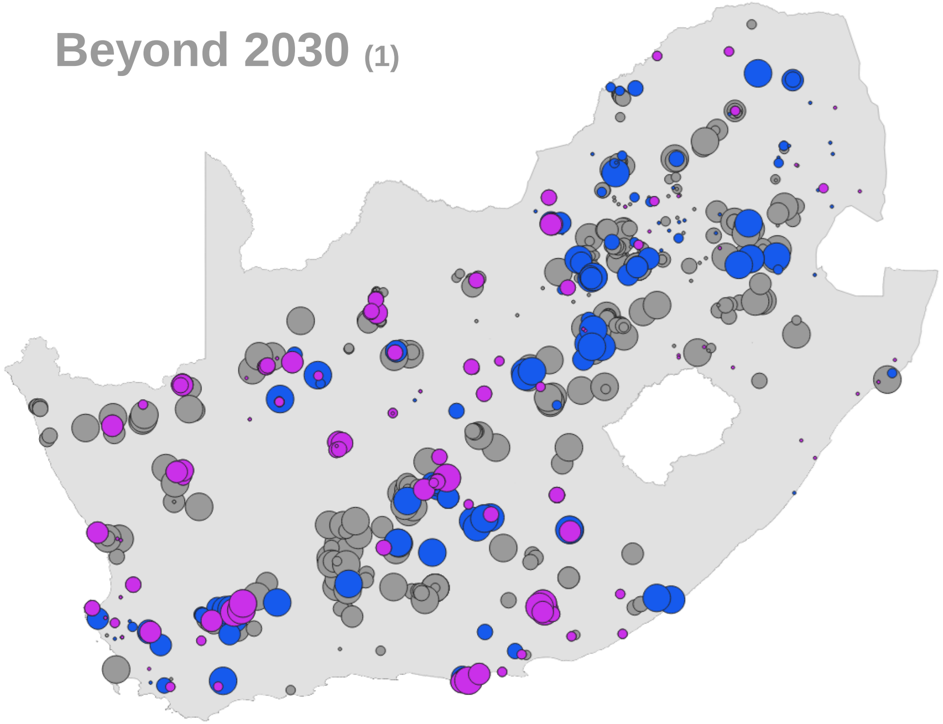
Current 2024



By 2030



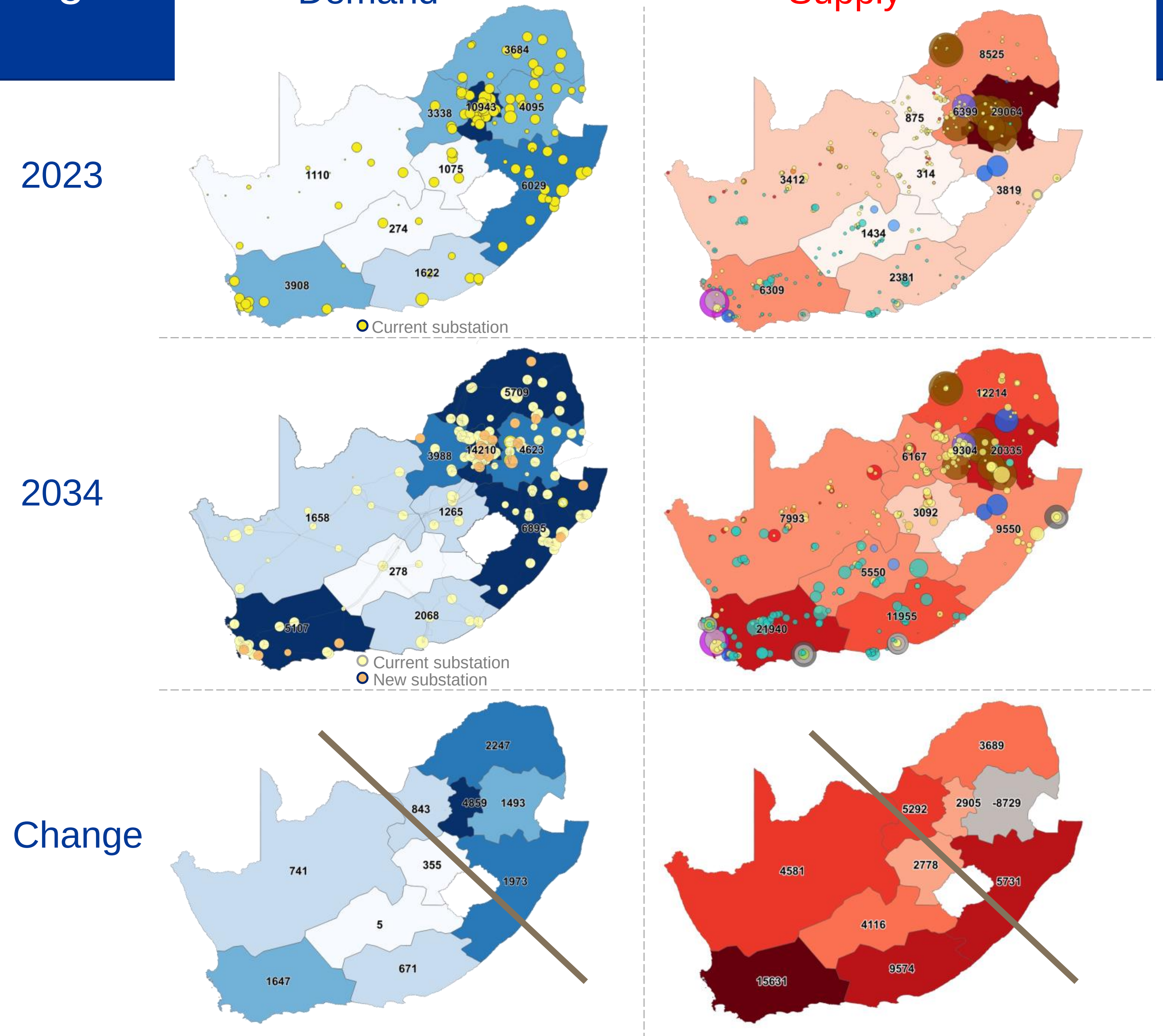
Beyond 2030 (1)

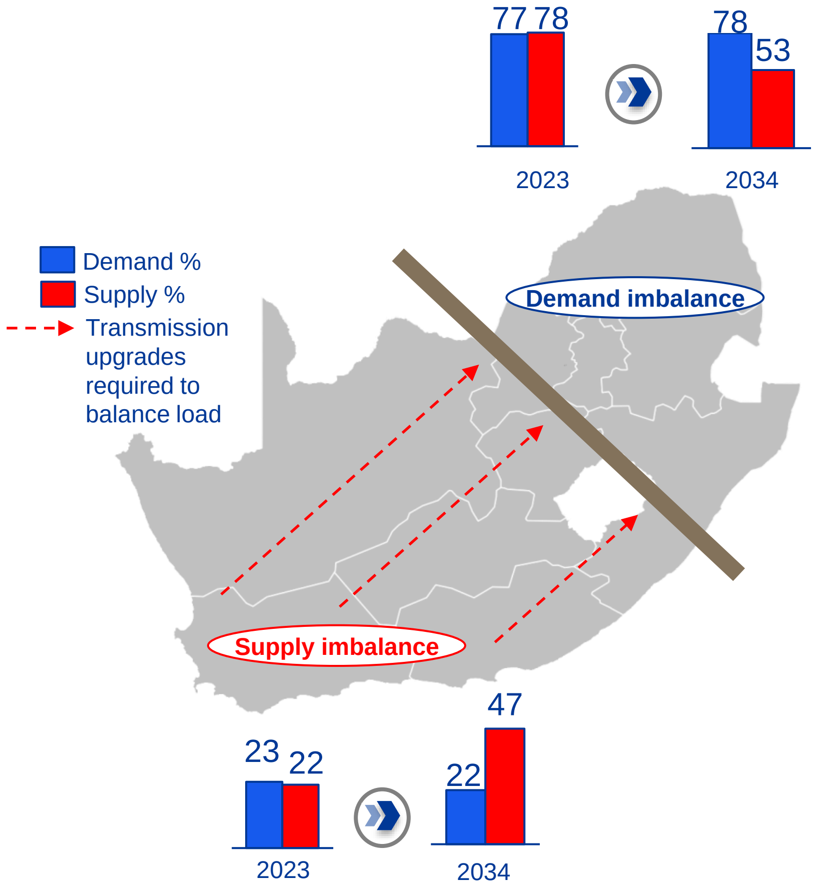


- Existing
- Budget quotation requests
- Future market connections

(1) https://www.ntcsa.co.za/south-africa-renewable-energy-grid-and-survey/

Change in Demand and Supply





Coal replacement with new generation requires grid access and transportation to load centers traditionally supplied by the local coal generation

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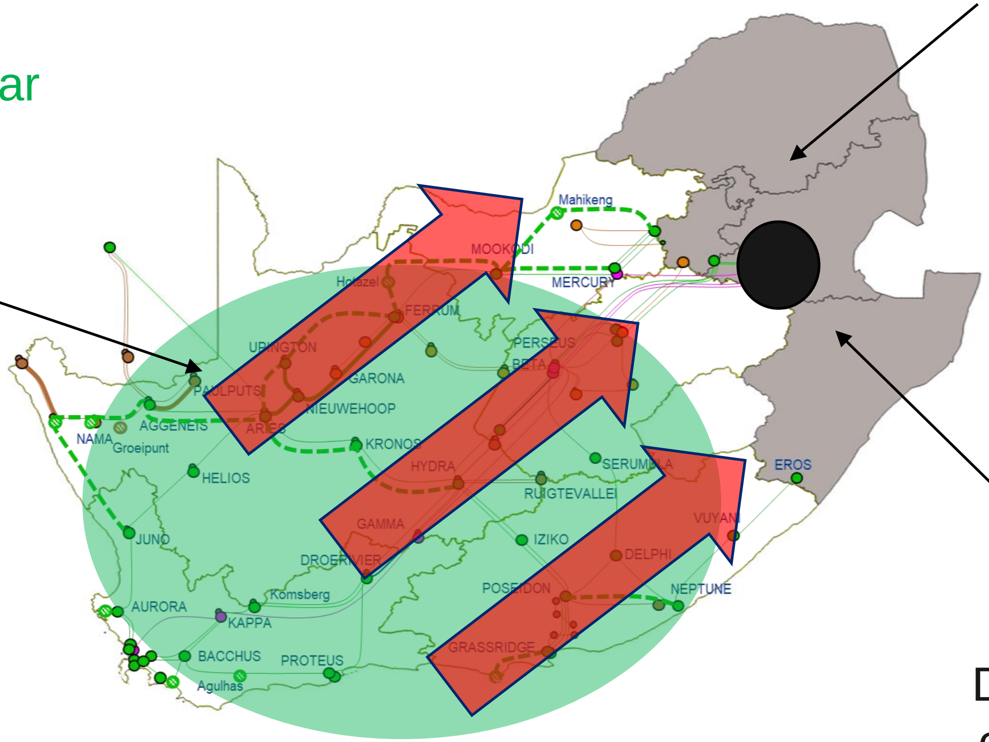
North
Dominant load

Cheap wind and solar to replace coal energy

Enable reliable grid capacity strengthening for load



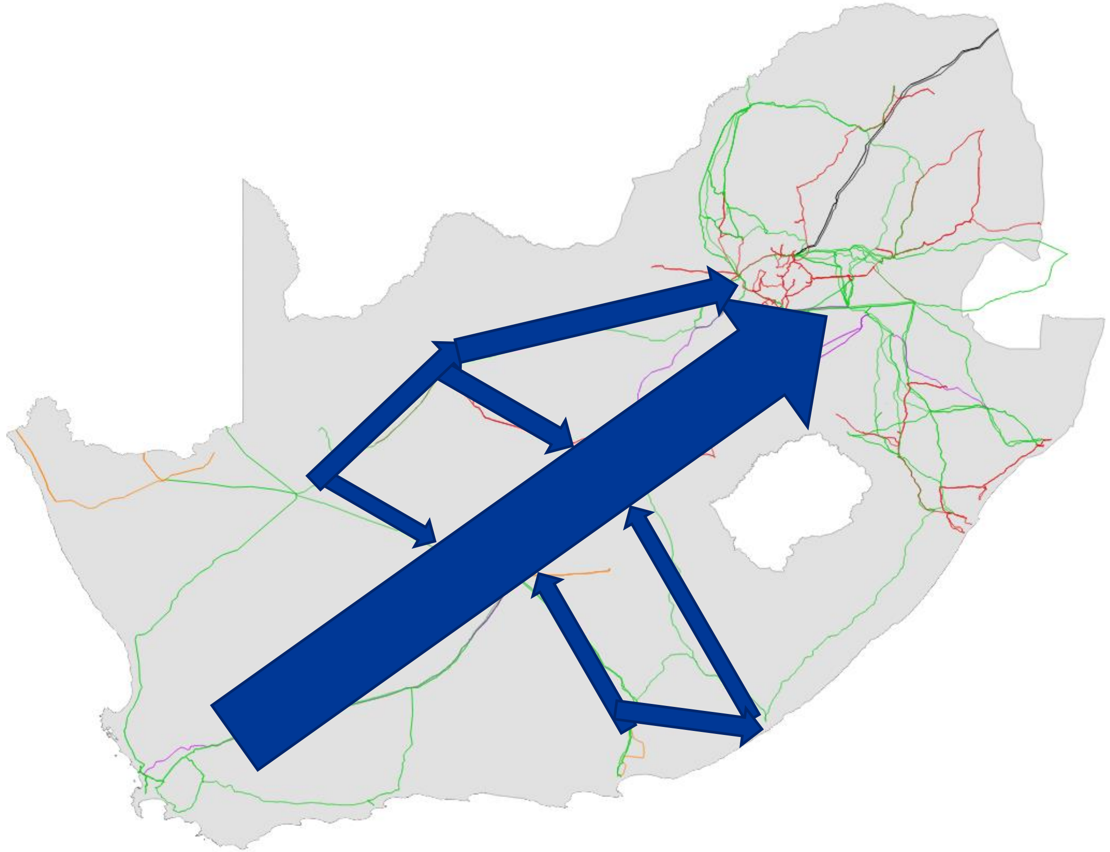
Decommissioned coal near to load centre

South
Dominant Renewables & Gas
Large volumes of generation integration requires grid access and transportation to the load centre

Wind & Solar dominantly located in the South, which is far from the load, hence requires additional grid to enable open access and security of supply to load centers.

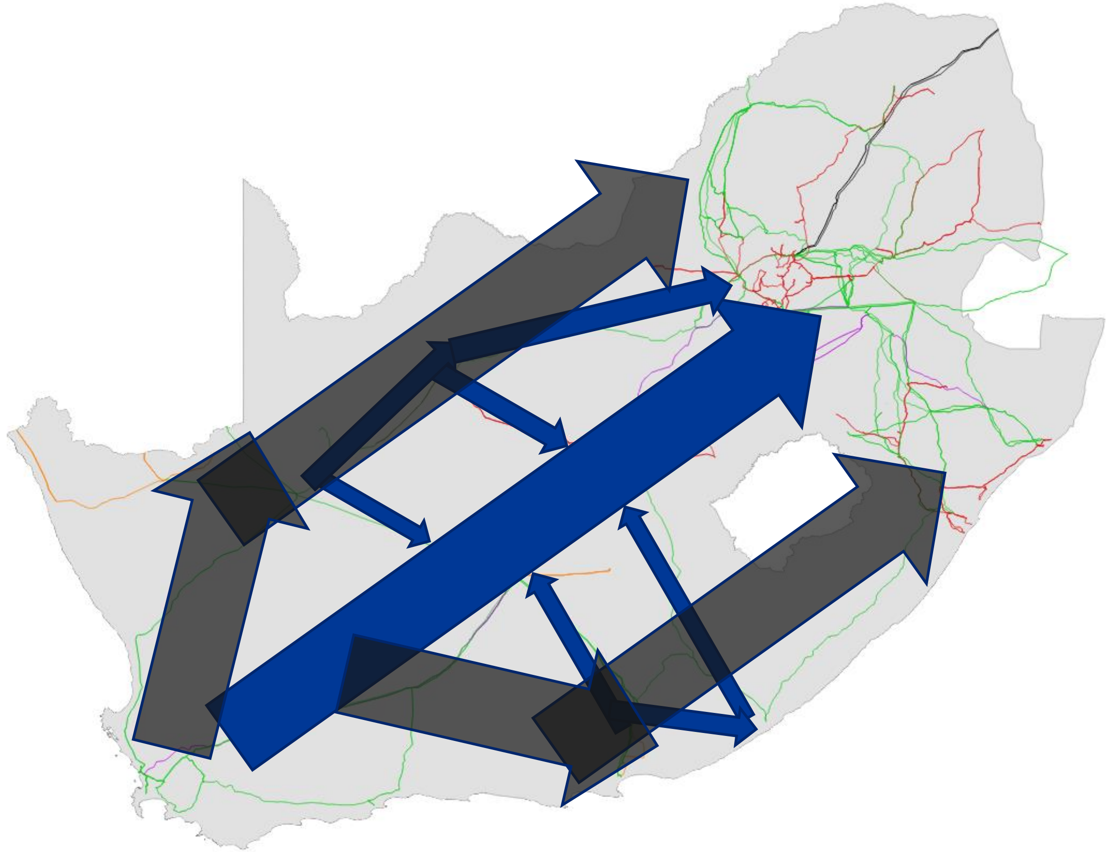
Reconfiguring the grid to flow from South to North in two phases

Phase 1
Enhance and optimise existing corridors



- Reconfigure flow from South to North
- Optimise use of existing assets (Curtailment)

Phase 2
Establish new corridors



- Create two new corridors from south to north to unlock capacity for new generation and decongest the existing corridor
- The two corridors are the South North Solar corridor in the north and South North costal corridor in the South

Reconfigure Grid to flow from South to North in two phases

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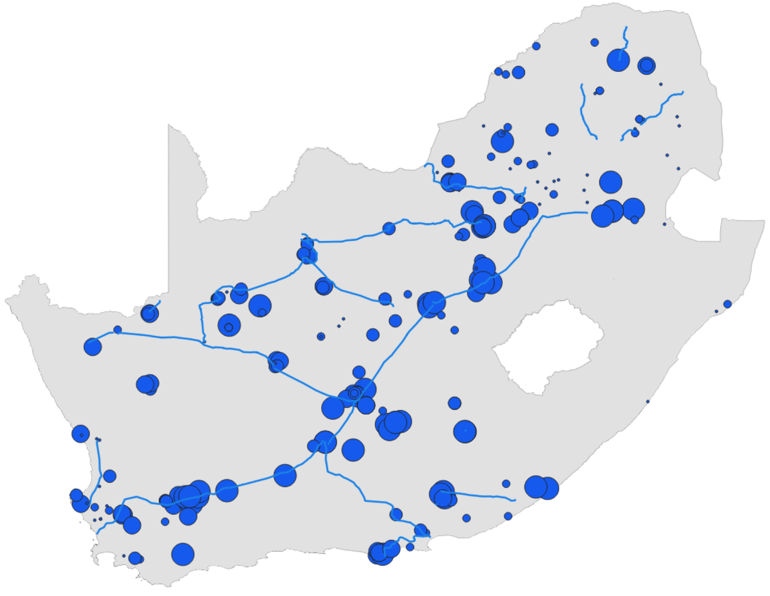
Phase 1
Enhance and optimise existing corridors

By 2030

Renewable
~38 GW



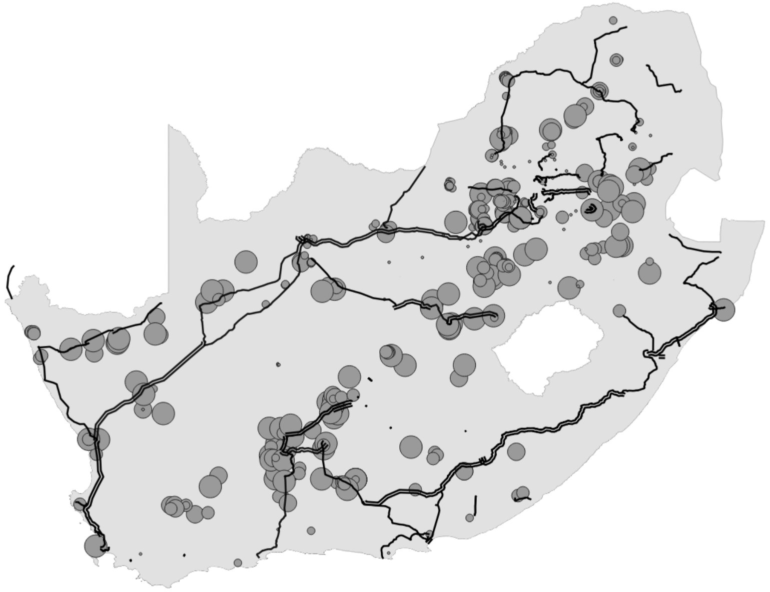
In budget quotation (BQ) process

Existing application and procurement

Phase 2
Establish new corridors

Beyond 2030

Renewable
~50 GW



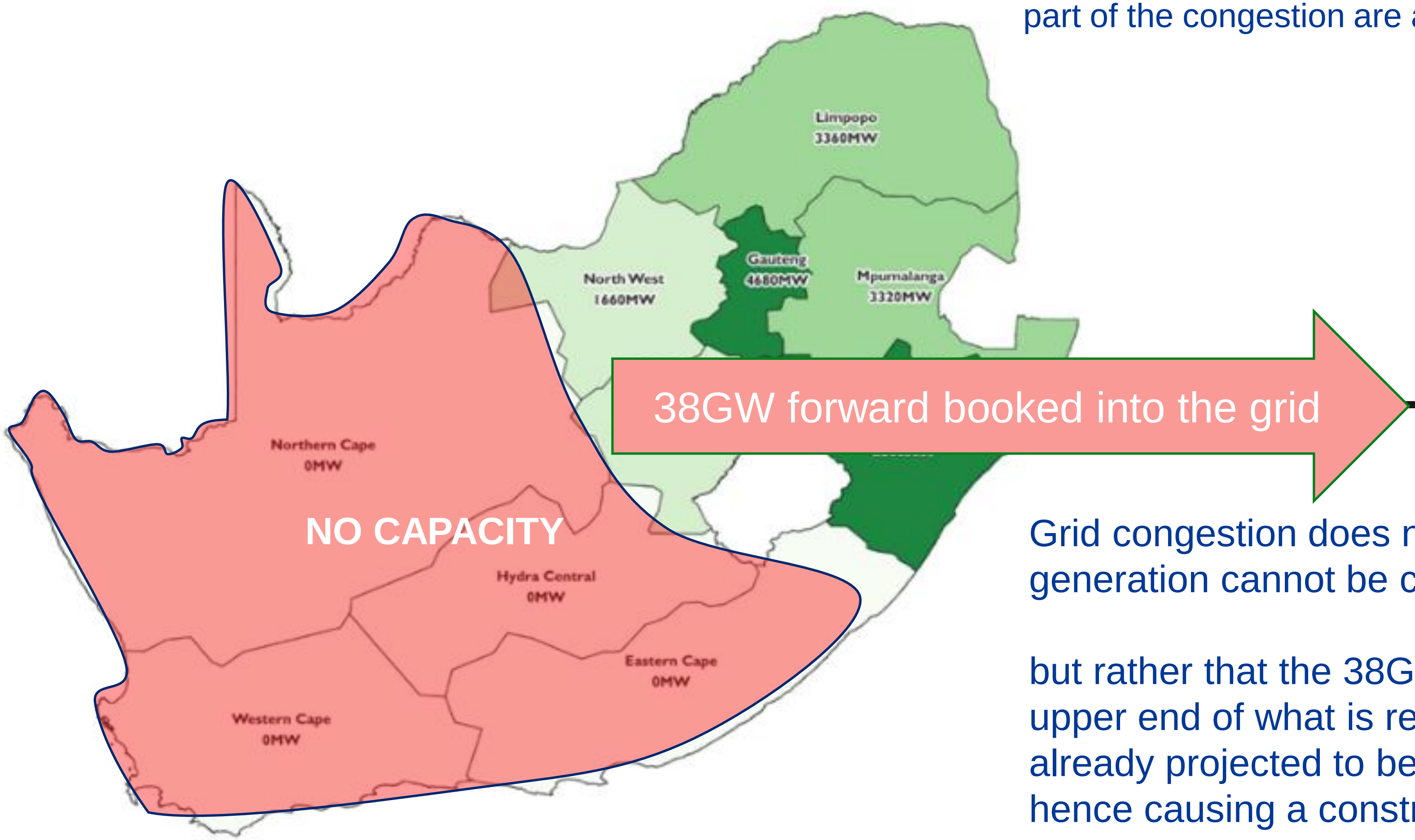
2024 (July) South African Renewable Energy Grid Survey 133GW

Future survey requirements

Understanding grid congestion

- The generation connection capacity assessment 2025 (GCCA 2025 (1))

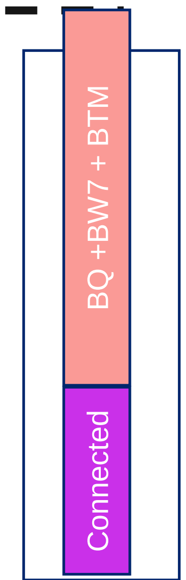
- The cause of the network congestion is the forward quotation applications that are in the budget quotation (BQ) process complemented with the TDP rollout up to 2030.
- The total connected, budget quotation and behind the meter, which form part of the congestion are as follows:



Renewable
7 GW Connected
16 GW BQ (5.5GW under construction)
5 GW BW7
<u>10 GW Behind the meter (BTM) (6GW already)</u>
38GW is greater than the renewables in the IRP required 36GW

Grid congestion does not mean generation cannot be connected,

but rather that the 38GW, which is on the upper end of what is required by 2030, is already projected to be connected and hence causing a constraint.



(2)

(1) https://www.ntcsa.co.za/gcca/
(2) https://poweroutlook.meridianeconomics.co.za/

How does the generation compare to other plans?

The 38GW is above the IRP and aligned with most other studies except high emission target scenarios.

38GW forward booked into the grid

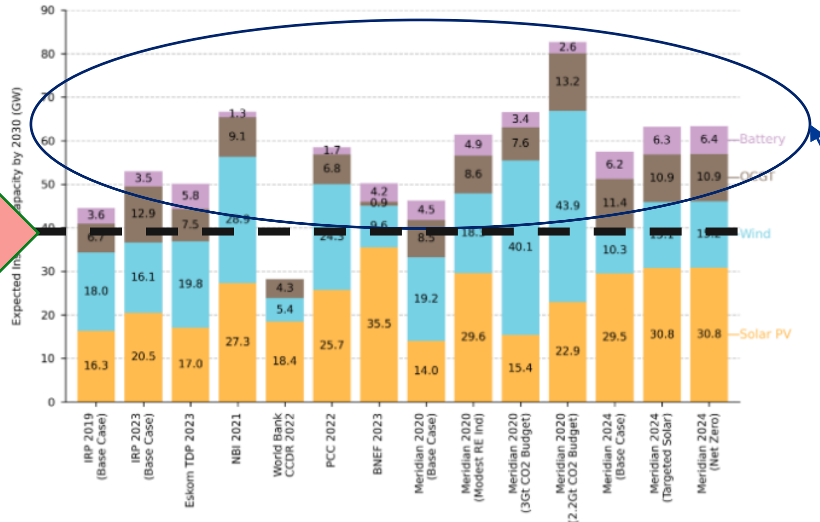
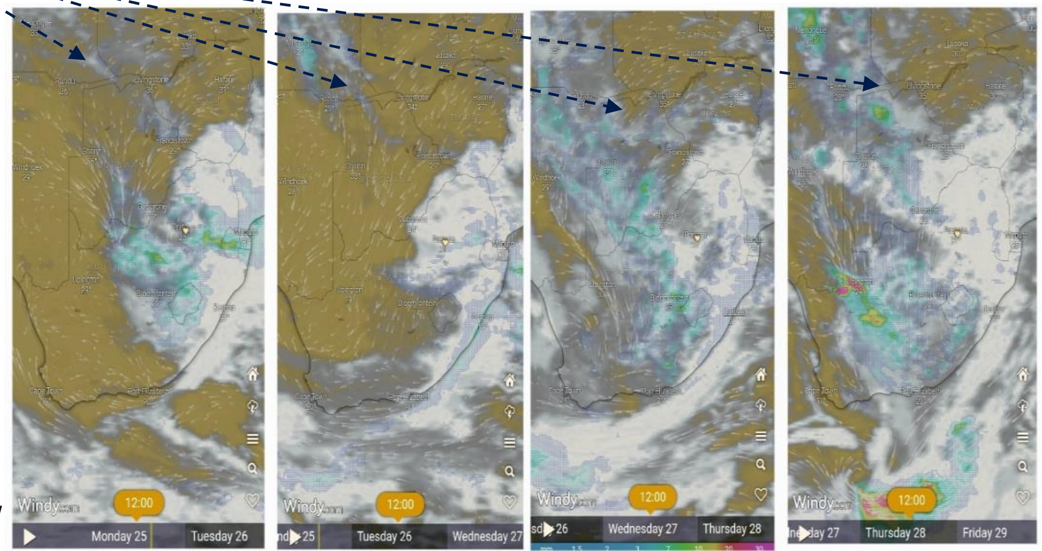


Figure 8: New Generation Capacity Expected in 2030 by various studies (1)

Weather conditions create dependency of flexibility for multiple days risk



Increased urgency for flexibility from energy storage and gas as identified in the various studies to mitigate variability risk

(1) https://poweroutlook.meridianeconomics.co.za/

System security and stability considerations

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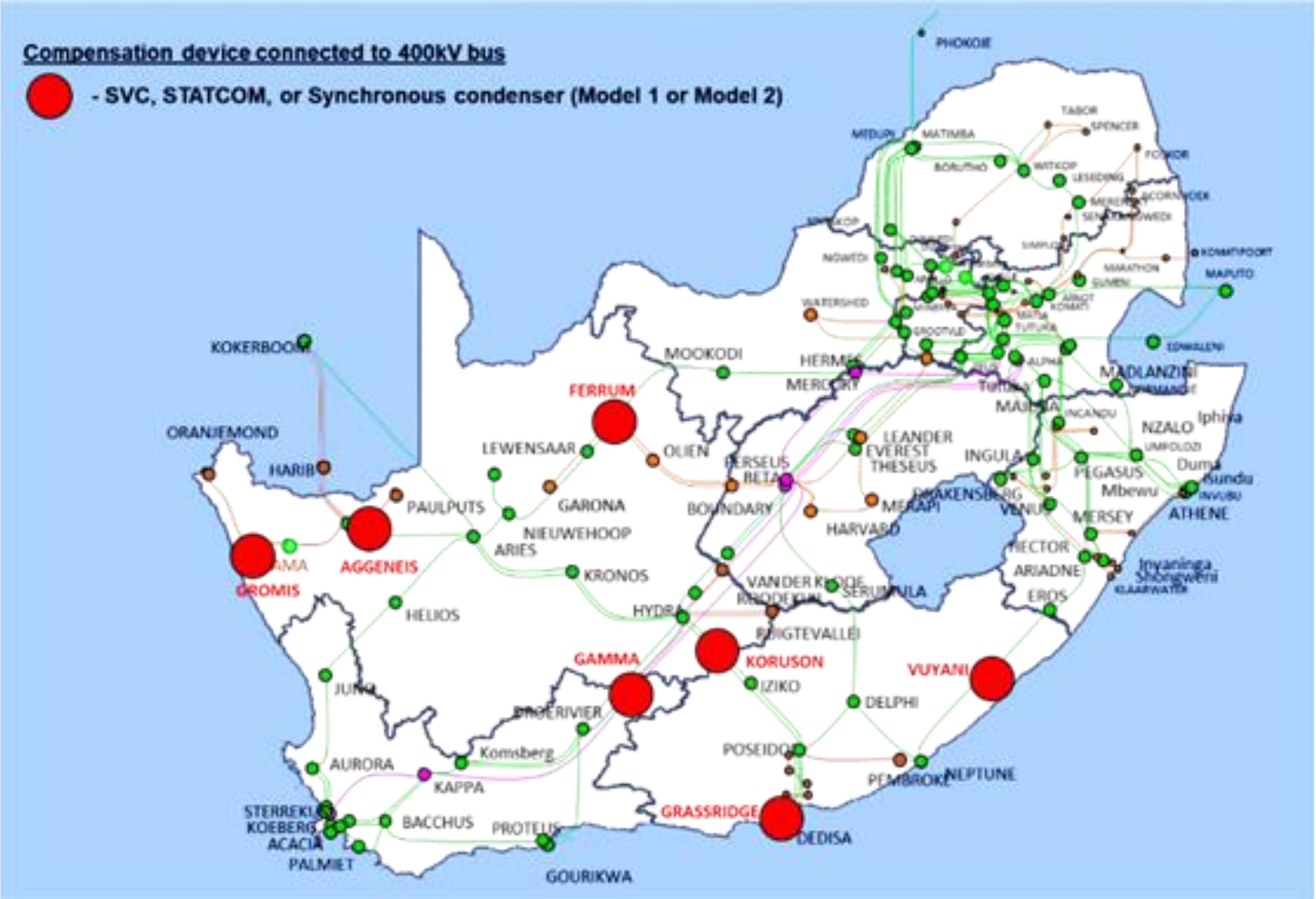
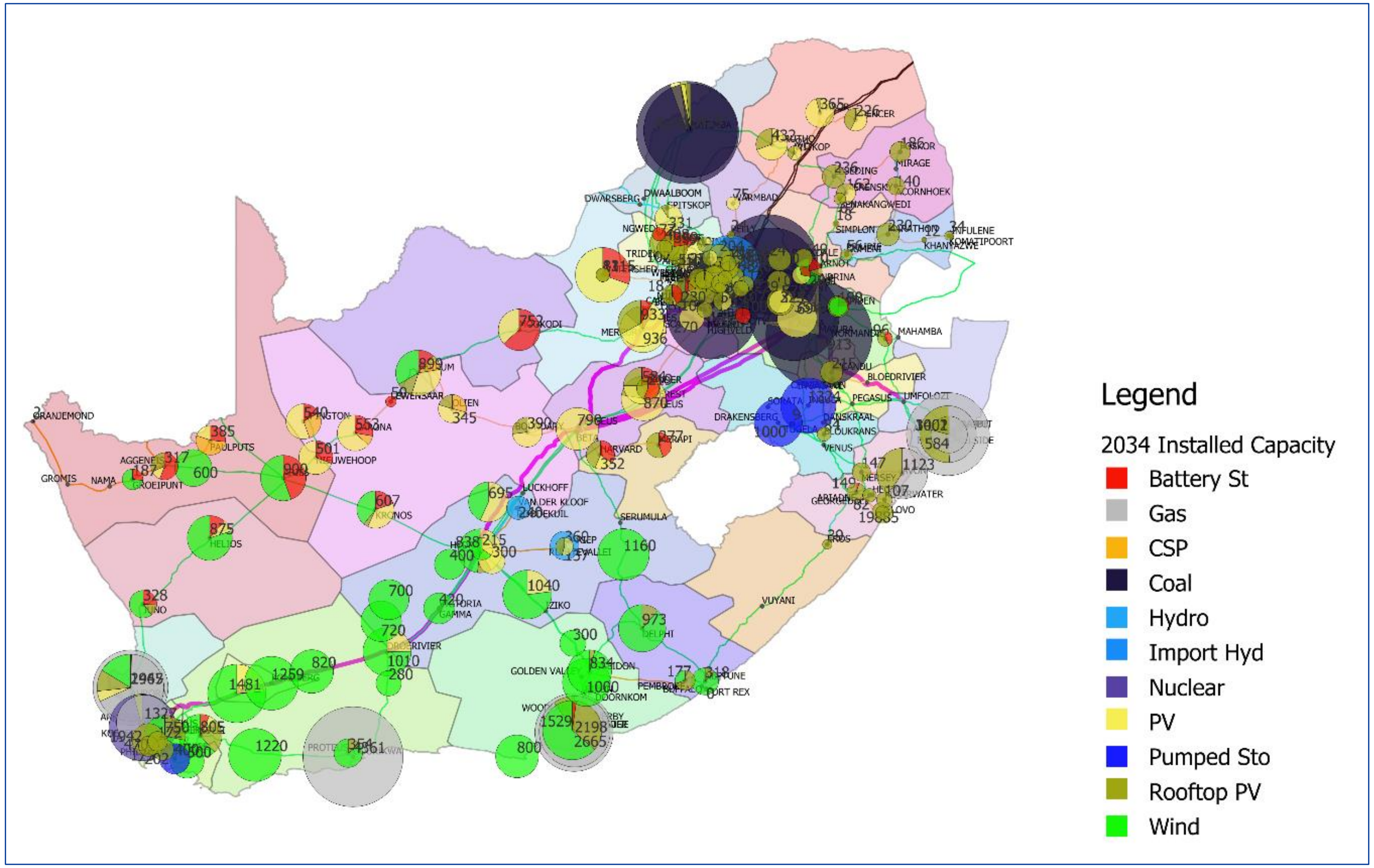


- The TDP highlighted potential system security and stability concerns due to large scale integration of RE that could result in reduced system inertia and strength (short circuit current), voltage and frequency deviations.

- Power system dynamic studies confirmed the need for synchronous condensers to maintain system security and stability thereby preventing a grid collapse

- The results of the studies recommended the following:
  The installation of new synchronous condensers at the following Transmission substations sites:
  Koruson, Gamma, Grassridge, Ferrum, Vuyani, Aggeneis and Gromis, as indicated on the map.

2034 Forecasted Generation Capacity



Need to balance the **speed of renewables** with the **speed of flexibility** from energy storage and gas

Flexibility in other countries use **large interconnection** to adjacent countries to create flexibility. **South Africa does not have this flexibility option**

Tariff structure are critical to provide incentives for flexibility

Grid-enhancing Technologies

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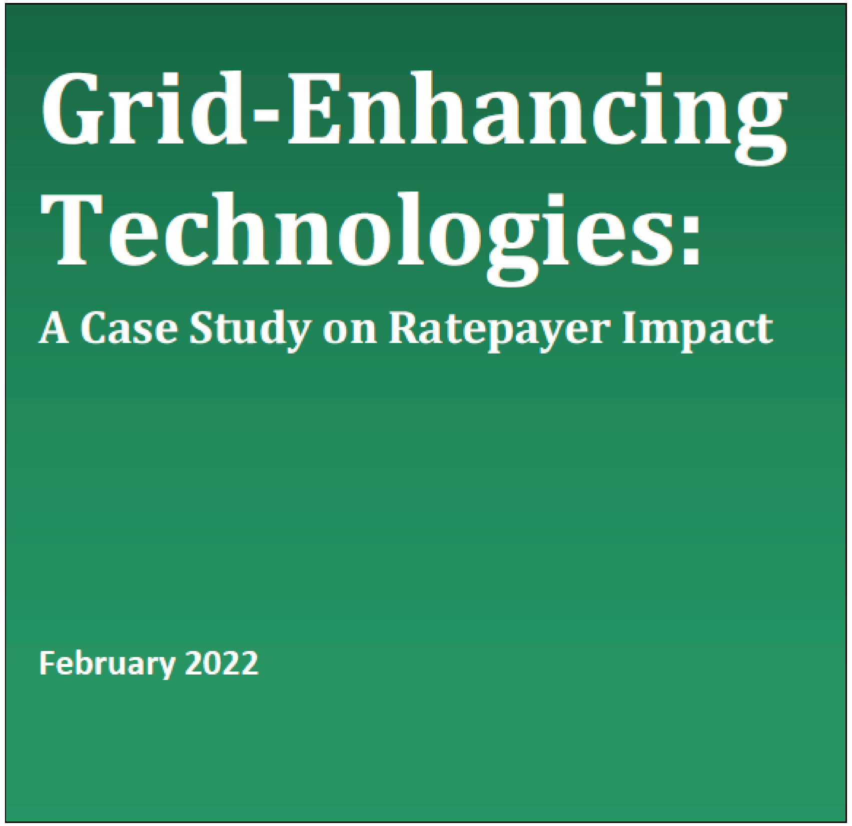
- **Dynamic Line Rating (DLR)** – Hardware and/or software used to appropriately update the calculated thermal limits of existing transmission lines based on real-time and forecasted weather conditions. Often, these schemes establish new limits that safely allow more energy transfer across existing infrastructure.
- **Power Flow Controllers (PFC)** – Hardware and software used to push or pull power, helping to balance overloaded lines and underutilised corridors within the transmission network.
- **Topology Optimisation -** is a software technology that identifies reconfigurations in the grid to route power flow around congested or overloaded transmission elements.
- **Advanced high temperature low sag (HTLS) conductor -** can withstand operating temperatures of up to 210 °C, thus carrying higher power compared to conventional conductors.



These technologies are applicable to short distance meshed networks. Although there are some application near Gauteng, the main capacity challenge in South Africa’s grid is long distance large power transfer.

(1) https://www.energy.gov/sites/default/files/2022-04/Grid%20Enhancing%20Technologies%20-%20A%20Case%20Study%20on%20Ratepayer%20Impact%20-%20February%202022%20CLEAN%20as%20of%20032322.pdf

What emerging technologies have potential for the future grid services?

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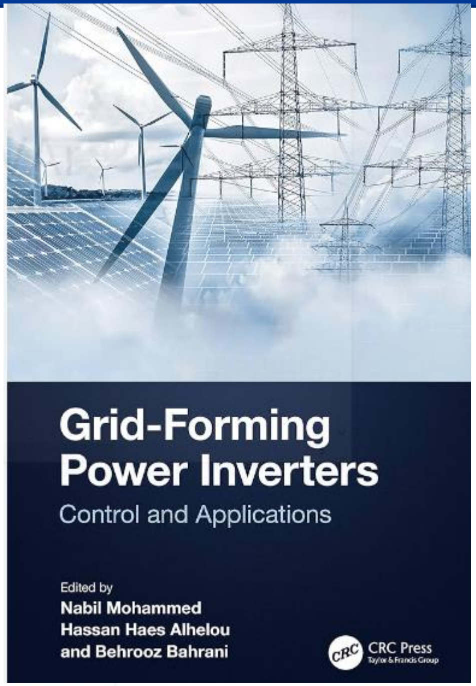

First Grid-Forming 300 MVAr STATCOM in Germany

June 4, 2024 by Moritz Mittelstaedt, Amprion GmbH

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TDP 2024:
Provincial Development Plans

Compiled by: Grid Planning Chief Engineers
Presented by: **Ahmed Hansa** / **Caroleen Naidoo**

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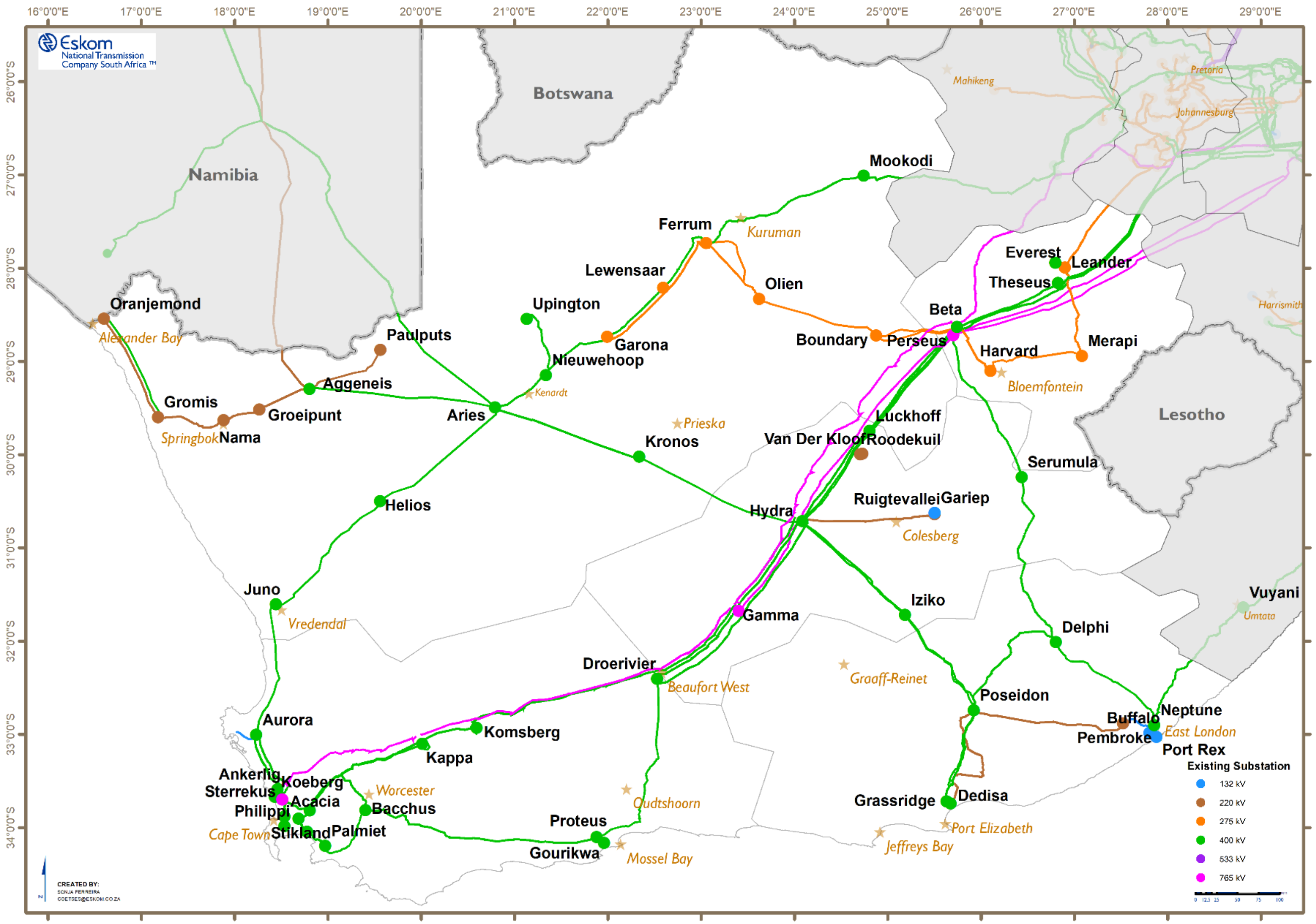
TDP 2024:
Southern Supply Area

(Free State, Northern Cape, Eastern Cape and Western Cape)

Ahmed Hansa
Chief Engineer: Grid Planning

Southern supply areas – existing network overview



- The Southern supply areas are:
  - Northern Cape
  - Eastern Cape
  - Western Cape
  - Hydra Central
  - Free State
- The **peak load** in 2024 was **7 GW**, which is 20% of the national peak load of **34 GW**.
- The installed generation is **14 GW**.

Type	**Base Load**	**Peaking**	**Renewable**
Nuclear	1860		
Hydro		600	
OCGT Gas		2744	
Pumped Storage		400	
Battery Storage			151
CSP			600
PV			2783
Rooftop PV			1652
Small Hydro			10
Wind			3548
Sub Total	**1860**	**3744**	**8744**
Grand Total		**14 348 MW**	

Southern supply areas – expected generation capacity and forecasted peak load

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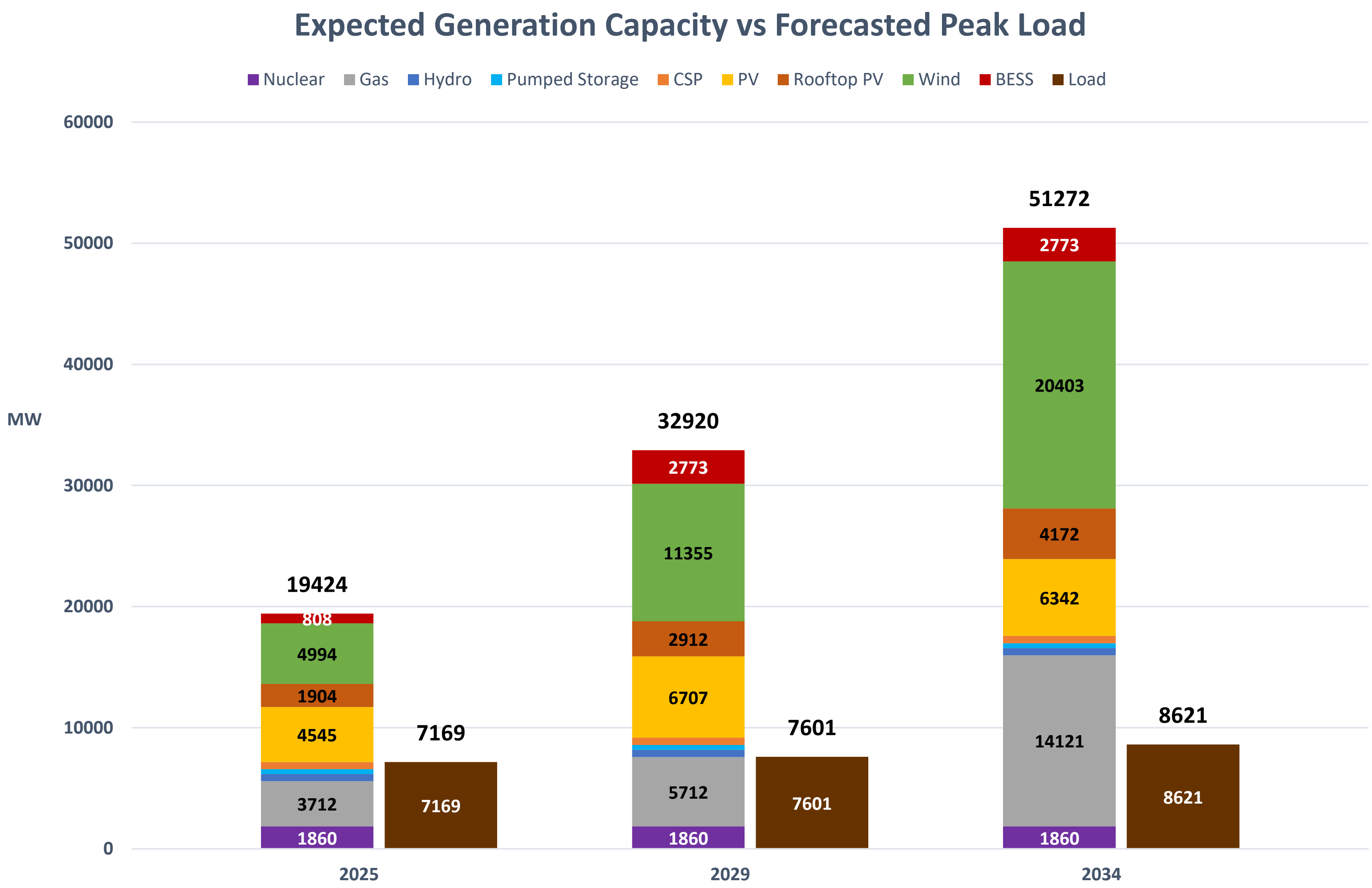
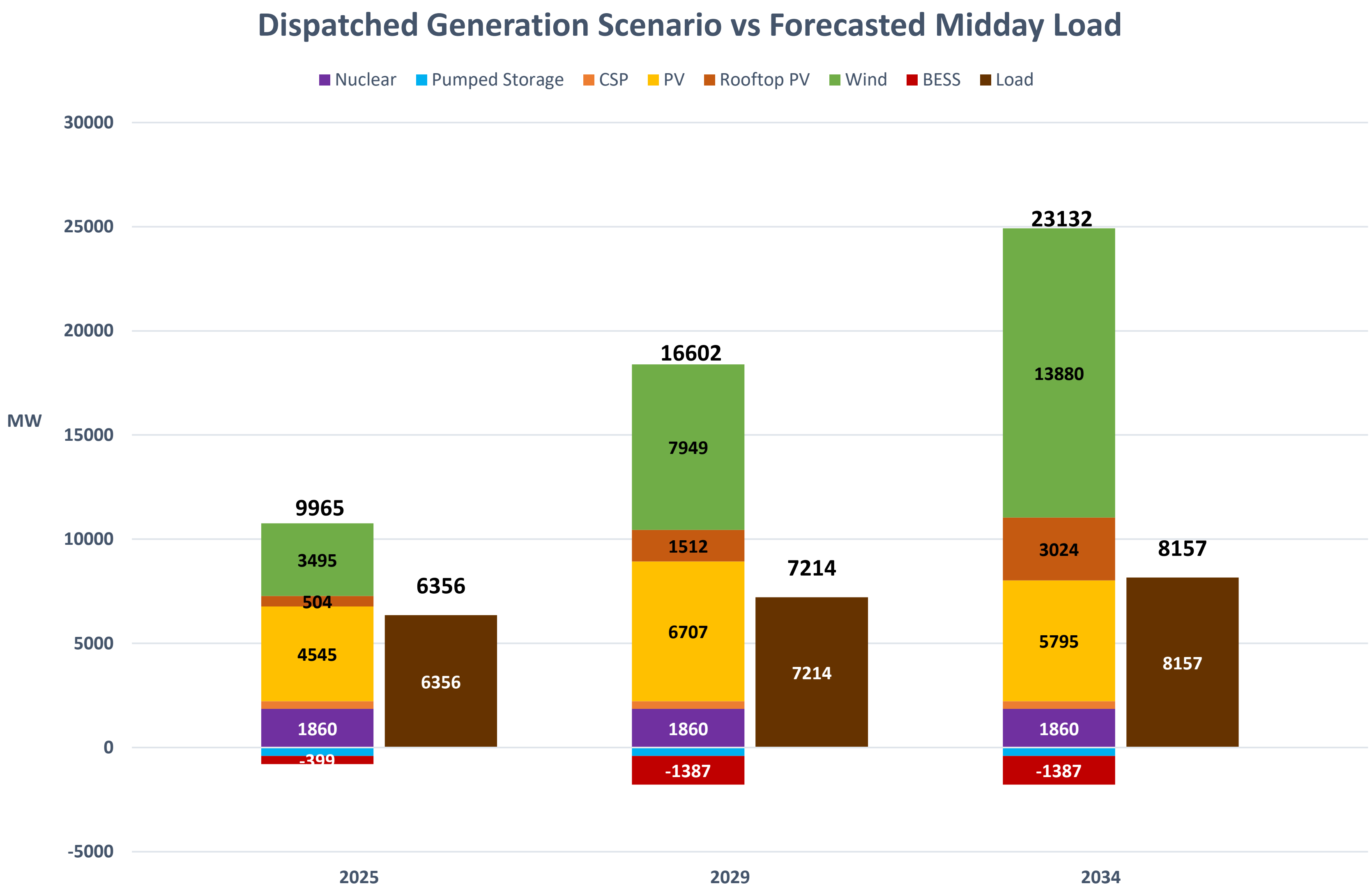


- The peak **load** is forecasted to grow from **7 GW** to **9 GW**.
- With the transition towards cleaner and greener energy, the generation capacity is expected to increase from **19 GW to 51 GW.**
- Therefore, a substantial number of transformers, substations and lines are required for local generation integration and evacuation.

Southern supply areas – dispatched generation scenario and forecasted midday load



- The midday **load** is forecasted to grow from **6 GW** to **8 GW**.
- Considering capacity factors and economic generation dispatch, the Southern supply areas become net exporters of power with as much as **15 GW of excess power** over the next ten years.
- Therefore, major corridors are required to export power to the north of the country.

Southern supply areas – additional transformers (132 kV only)

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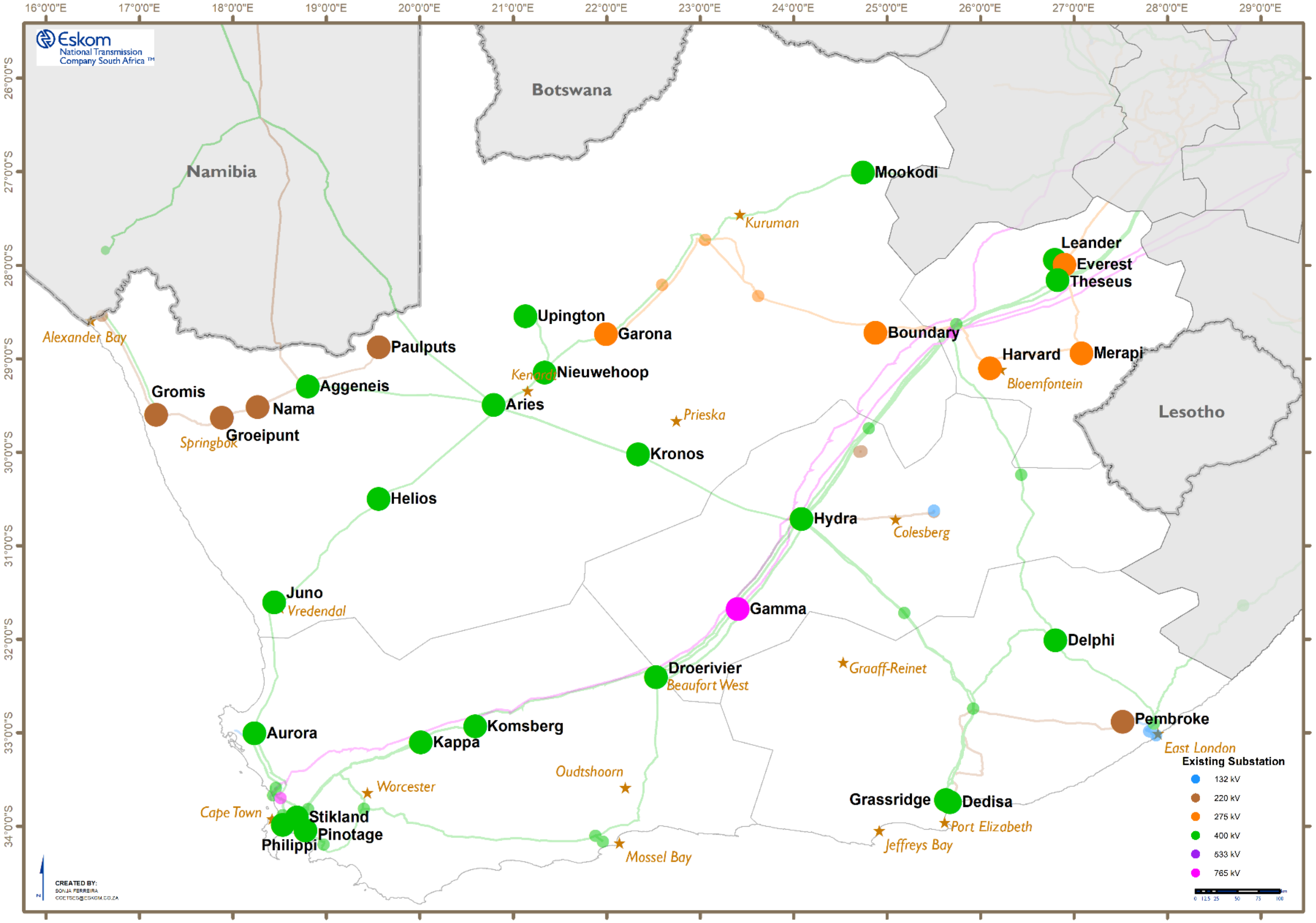

- **32 existing substations** were identified where **53 additional transformers** will be installed.
- **42** of these transformers will enable connection of up to **20 000 MW** of RE generation, **11** will provide redundancy for both load and generation.

2025 – 2029

Aggeneis transformer (1)
Aries transformer (1)
Boundary transformers (2)
Dedisa transformers (2)
Delphi transformer (1)
Droerivier transformers (3)
Gamma transformers (2)
Garona transformers (2)
Grassridge transformer (1)
Groeipunt transformer (1)
Gromis transformer (1)
Helios transformer (1)
Hydra transformers (2)
Juno transformer (1)
Kappa transformer (1)
Komsberg transformers (2)
Kronos transformers (2)
Mookodi transformer (1)
Nama transformer (1)
Paulputs transformer (2)
Pembroke transformers (2)
Philippi transformer (1)
Pinotage transformer (1)
Stikland transformer (1)
Theseus transformer (1)
Upington transformers (3)

2030 – 2034

Aries transformer (1)
Aurora transformer (1)
Aggeneis transformer (1)
Everest transformer (1)
Grassridge transformer (1)
Harvard transformers (2)
Kappa transformers (2)
Kronos transformer (1)
Leander transformer (1)
Merapi transformer (1)
Nieuwehoop transformers (2)

Southern supply areas – new 400/132 kV substations

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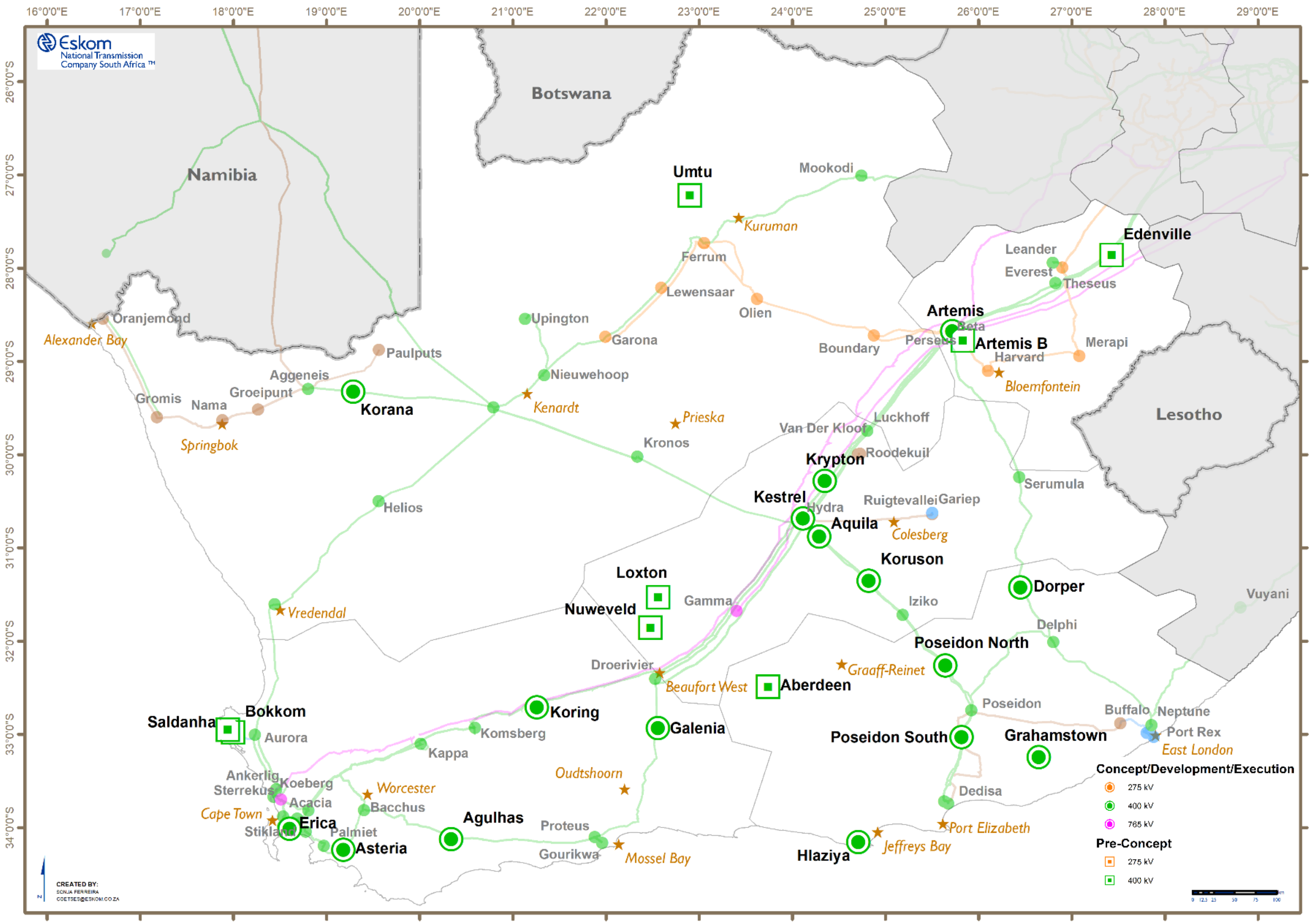
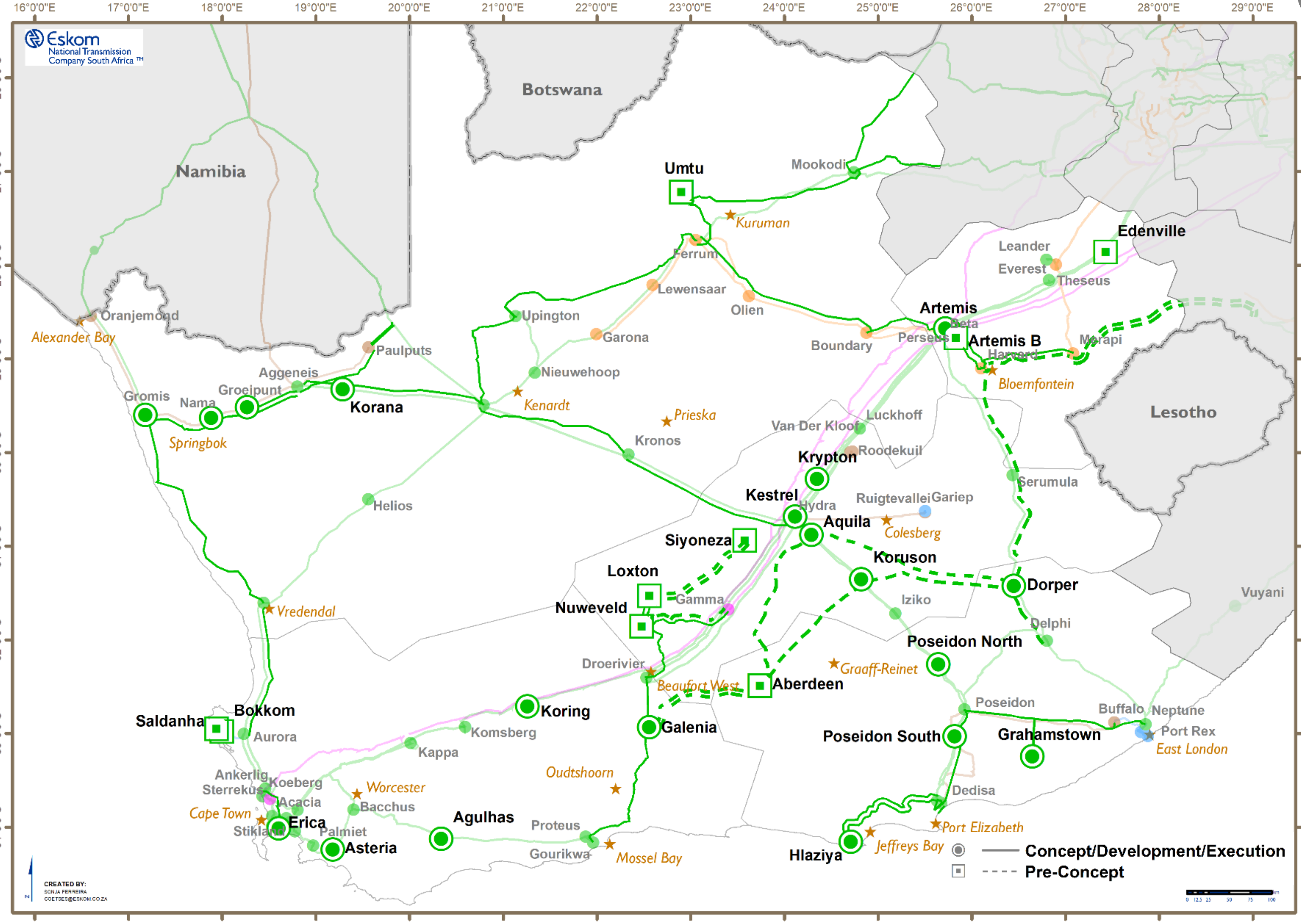


2025 – 2029
Agulhas Substation
Aquila Substation
Asteria Substation
Erica Substation
Kestrel Substation
Korana Substation
Koruson Substation
Krypton Substation
Poseidon South Substation

2030 – 2034
Artemis Substation
Dorper Substation
Galenia Substation
Grahamstown Substation
Hlaziya Substation
Koring Substation
Poseidon North Substation

- **24** new substations were identified where existing substations are inadequate or distant.
- **16** of these are current projects where **42 additional transformers** will be installed.
- **15** of these substations will enable connection of up to **21 375 MW** of RE generation.

Southern supply areas – additional 400 kV lines

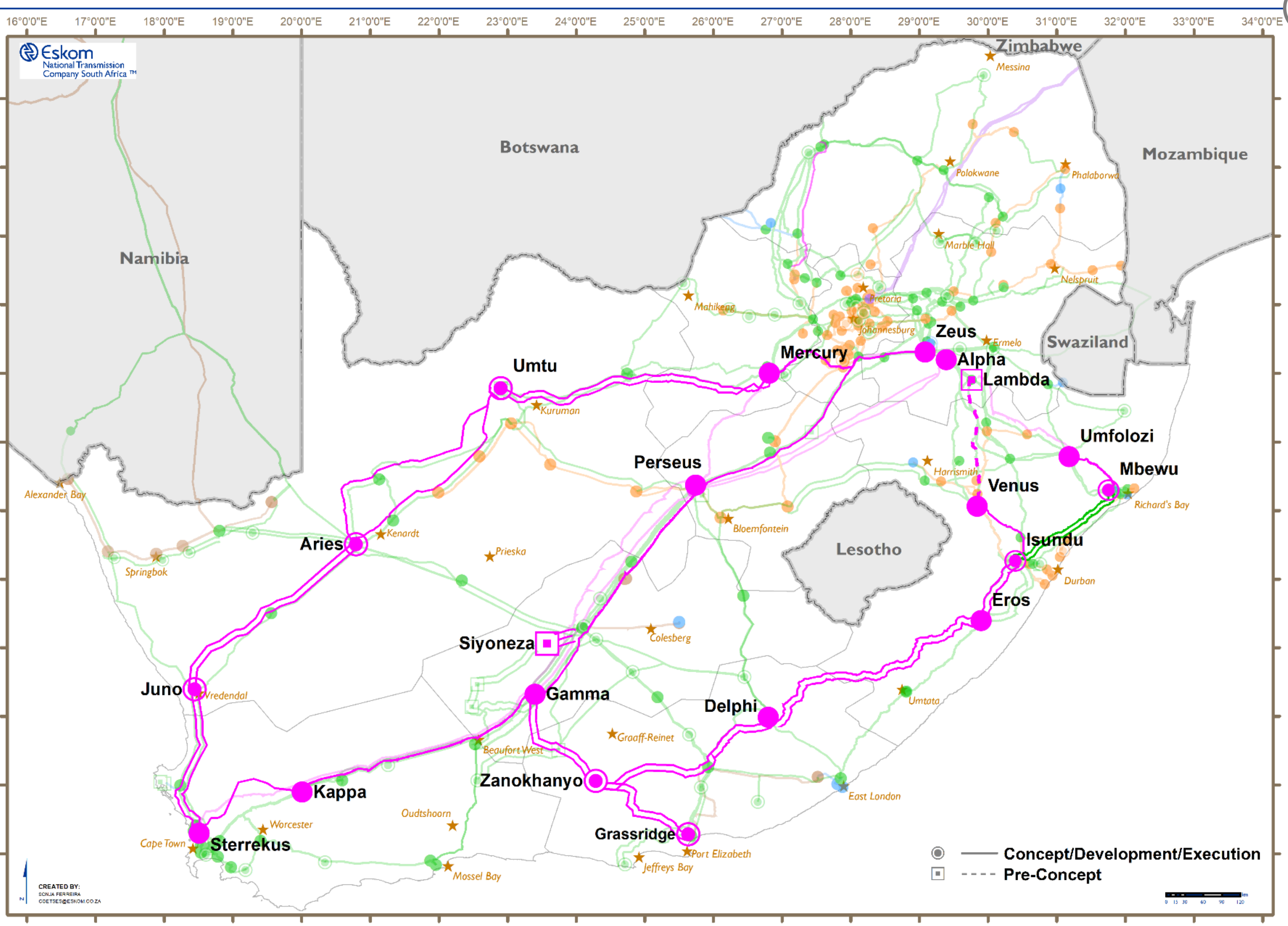


- Whilst most of the new substations are connected to existing lines, new lines are required to integrate and evacuate excess power to the main corridors.
- **3 655 km of 400 kV lines** will need to be constructed.

2025 – 2029	
Juno – Gromis 1	280 km
Aries – Upington 1	144 km
Ferrum – Upington 1	260 km
Aggeneis – Paulputs 1	93 km
Hydra – Kronos 2	190 km
Kronos – Aries 2	162 km
Aggeneis – Groeipunt 1 & 2	126 km
Aurora – Bokkom 1 & 2	50 km
Aurora – Juno 2	160 km
Beta – Boundary 1	95 km
Boundary – Ferrum 1	265 km
Ferrum – Mookodi 2	260 km
Groeipunt – Nama 1	41 km
Gromis – Nama 1	76 km
Pembroke – Poseidon 1	162 km
Pembroke – Neptune 1	50 km

2030 – 2034	
Aggeneis – Aries 2	200 km
Beta – Harvard 1	70 km
Coega – Dedisa 1	8 km
Coega – Dedisa 2	8 km
Coega – Grassridge 1	15 km
Coega – Poseidon 1	110 km
Dedisa – Hlaziya 1	123 km
Droerivier – Gourikwa 1	235 km
Gamma – Droerivier 1	200 km
Grassridge – Hlaziya 1	116 km
Harvard – Merapi 1	110 km
Paulputs loop-ins	96 km

Additional corridors



- **New transmission corridors** are required to transport the excess power to the **load centres** in the **northern parts of the country**
- **6 850 km of 765 kV lines** will need to be constructed.

2025 – 2029		
Central Corridor	Perseus - Zeus 1	430 km
	Gamma - Perseus 2	400 km
	Gamma - Kappa 2	400 km
2030 – 2034		
Central Corridor	Kappa - Sterrekus 2	150 km
Eastern Corridor	Gamma - Grassridge 1 and 2	710 km
	Delphi - Zanokhanyo 1 and 2	600 km
	Delphi - Eros 1 and 2	800 km
	Eros - Isundu 1 and 2	320 km
	Isundu - Venus 1	140 km
Western Corridor	Juno - Sterrekus 1 and 2	500 km
	Aries - Juno 1 and 2	700 km
	Aries - Umtu 1 and 2	900 km
	Mercury - Umtu 1 and 2	800 km

Synchronous condensers

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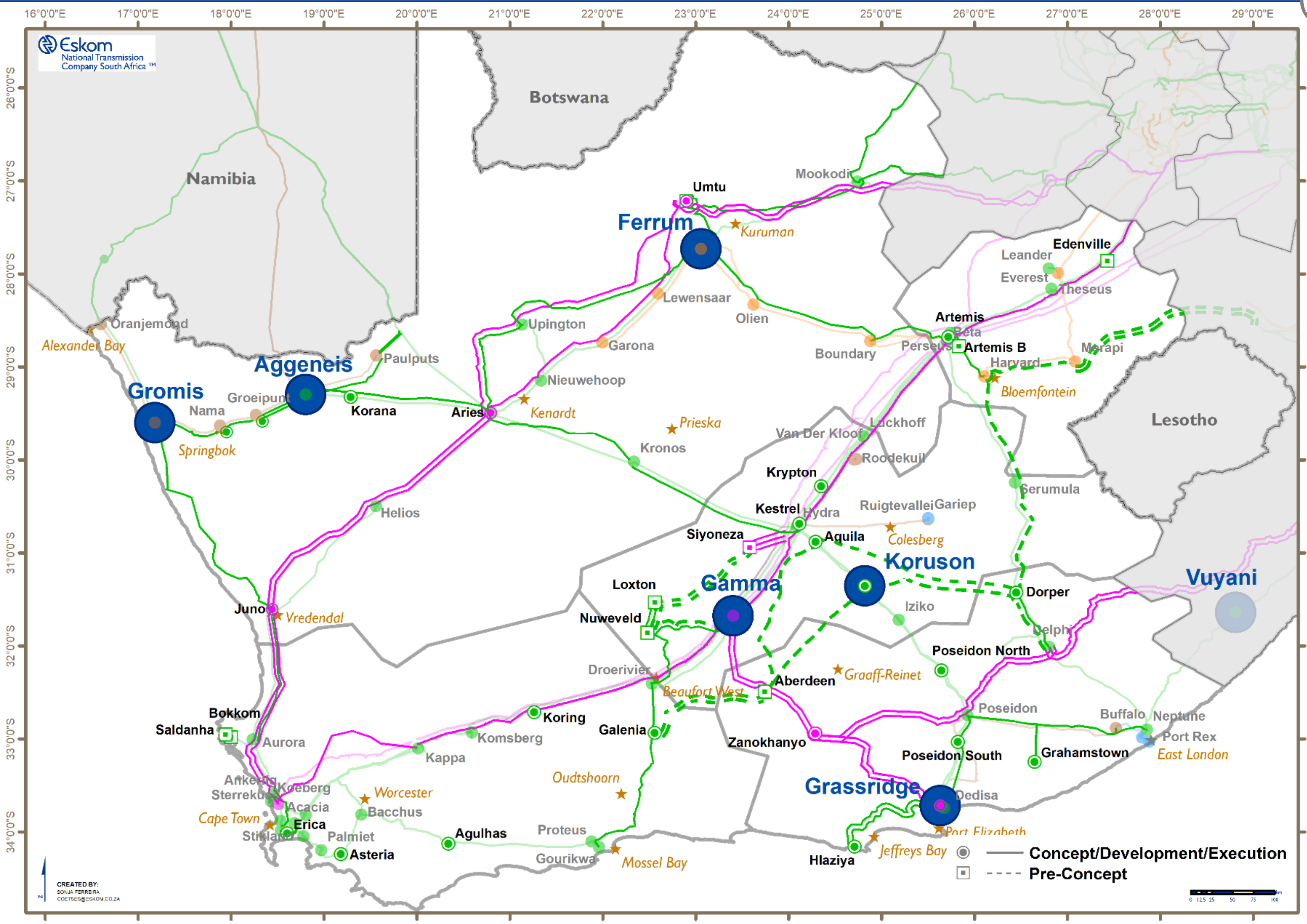


- Decommissioning of some of the **baseload coal plants** in **Mpumalanga** will likely be **replaced with inverter based RE**, mainly wind and solar in the **Greater Cape regions.**

- This will result in a need for **7 sites for synchronous condensers** to provide inertia, voltage support and short circuit power.

- These will be installed at:
  - **Gromis**
  - **Aggeneis**
  - **Ferrum**
  - **Gamma**
  - **Koruson**
  - **Grassridge**
  - **Vuyani**

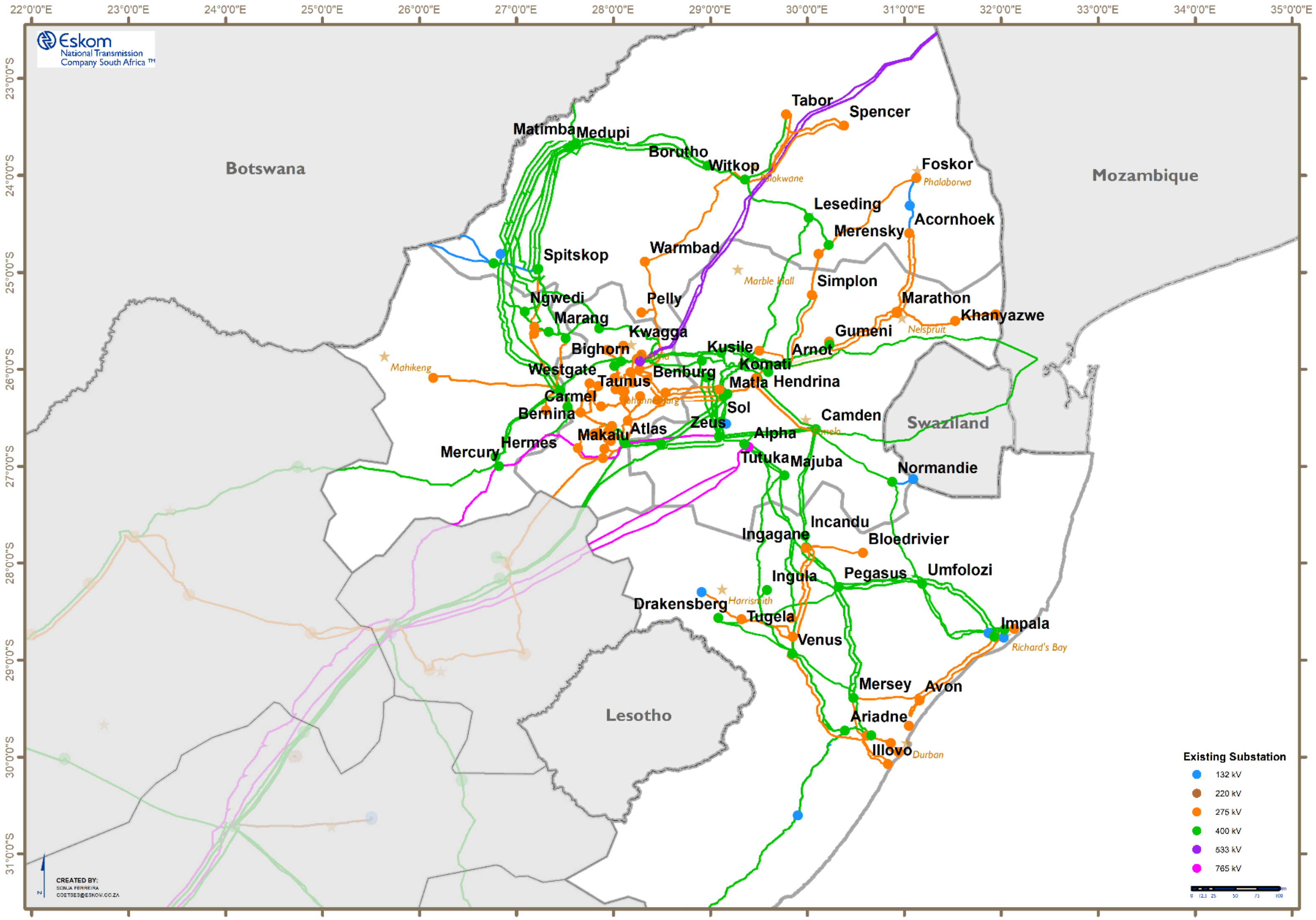
TDP 2024:
Northern Supply Area

(Limpopo, North West, Gauteng, Mpumalanga and Kwa-Zulu Natal)

Caroleen Naidoo

Chief Engineer: Grid Planning

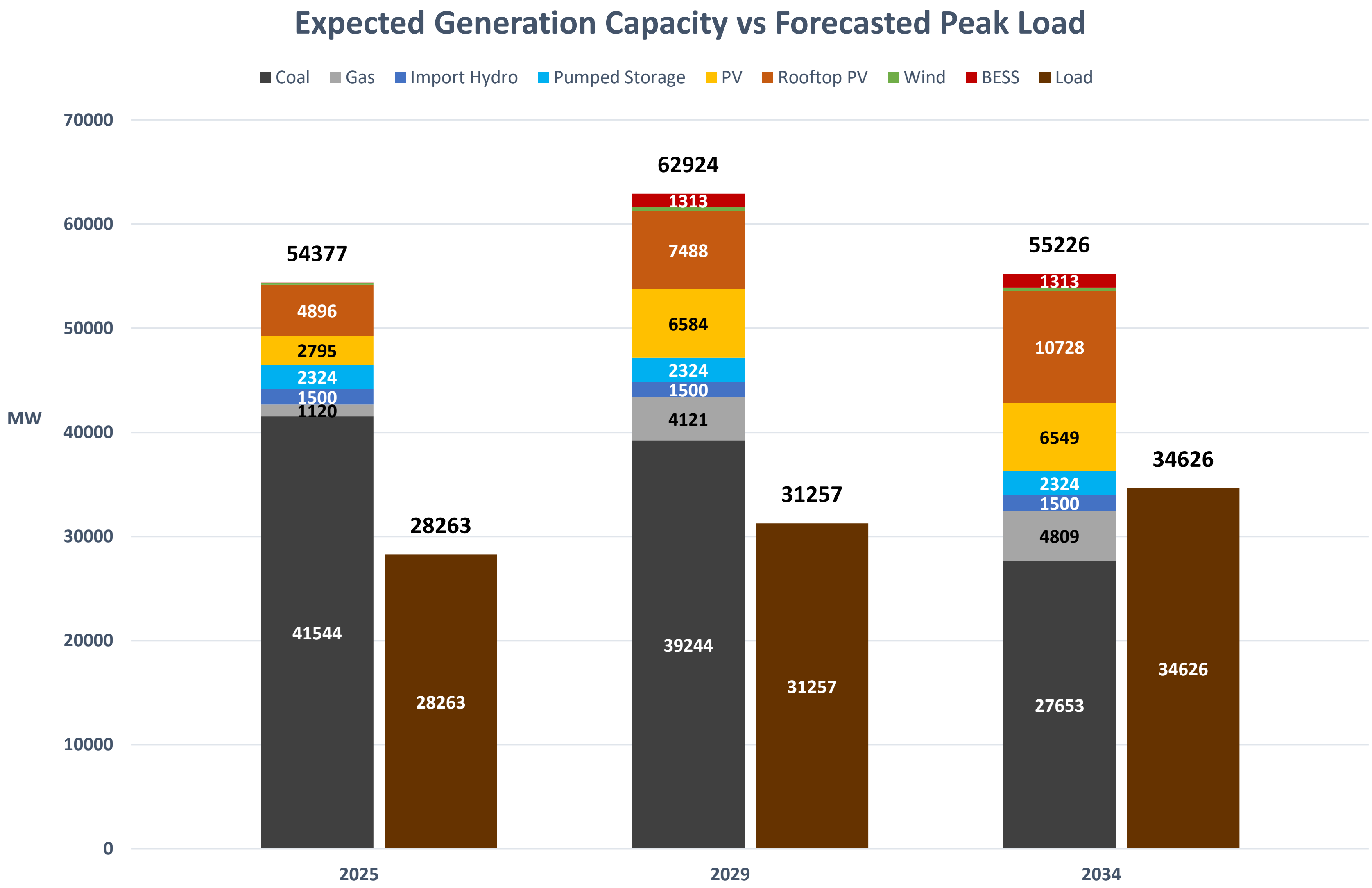
Northern supply areas – existing network overview



- The Northern supply areas are:
  - North-West
  - Gauteng
  - Limpopo
  - Mpumalanga
  - KwaZulu-Natal
- The **peak load** in 2024 was **27 GW**, which is 80% of the national peak load of **34 GW**.
- The installed generation is **51 GW**.

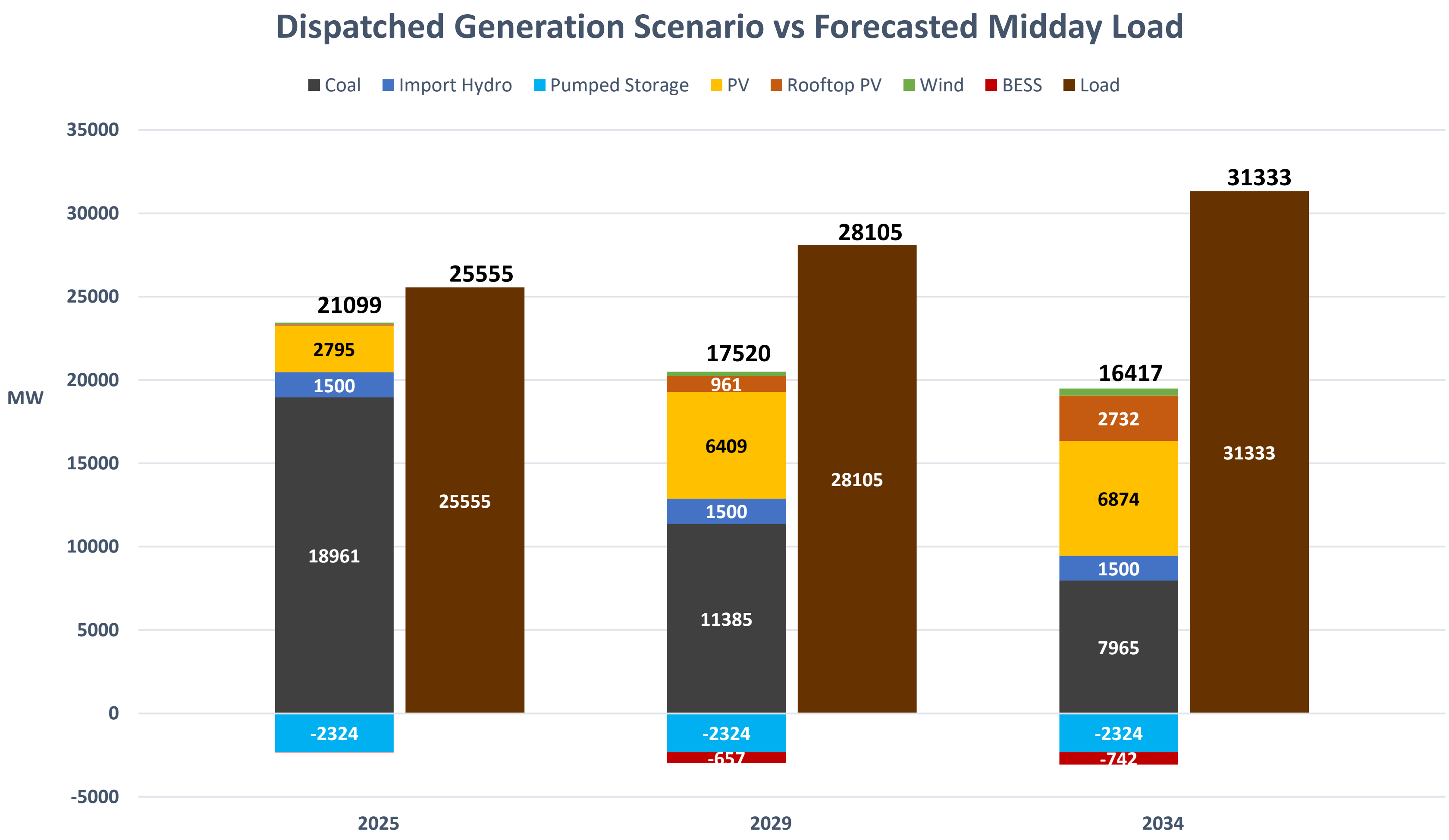
Type	Base Load	Peaking	Renewable
Coal	41544		
Import Hydro	1500		
OCGT Gas		670	
Pumped Storage		2324	
Biomass			41
Landfill Gas			41.4
PV			875
Rooftop PV			4248
Small Hydro			9
Sub Total	**43044**	**2994**	**5215**
Grand Total	**51 253 MW**		

Northern supply areas – expected generation capacity and forecasted peak load



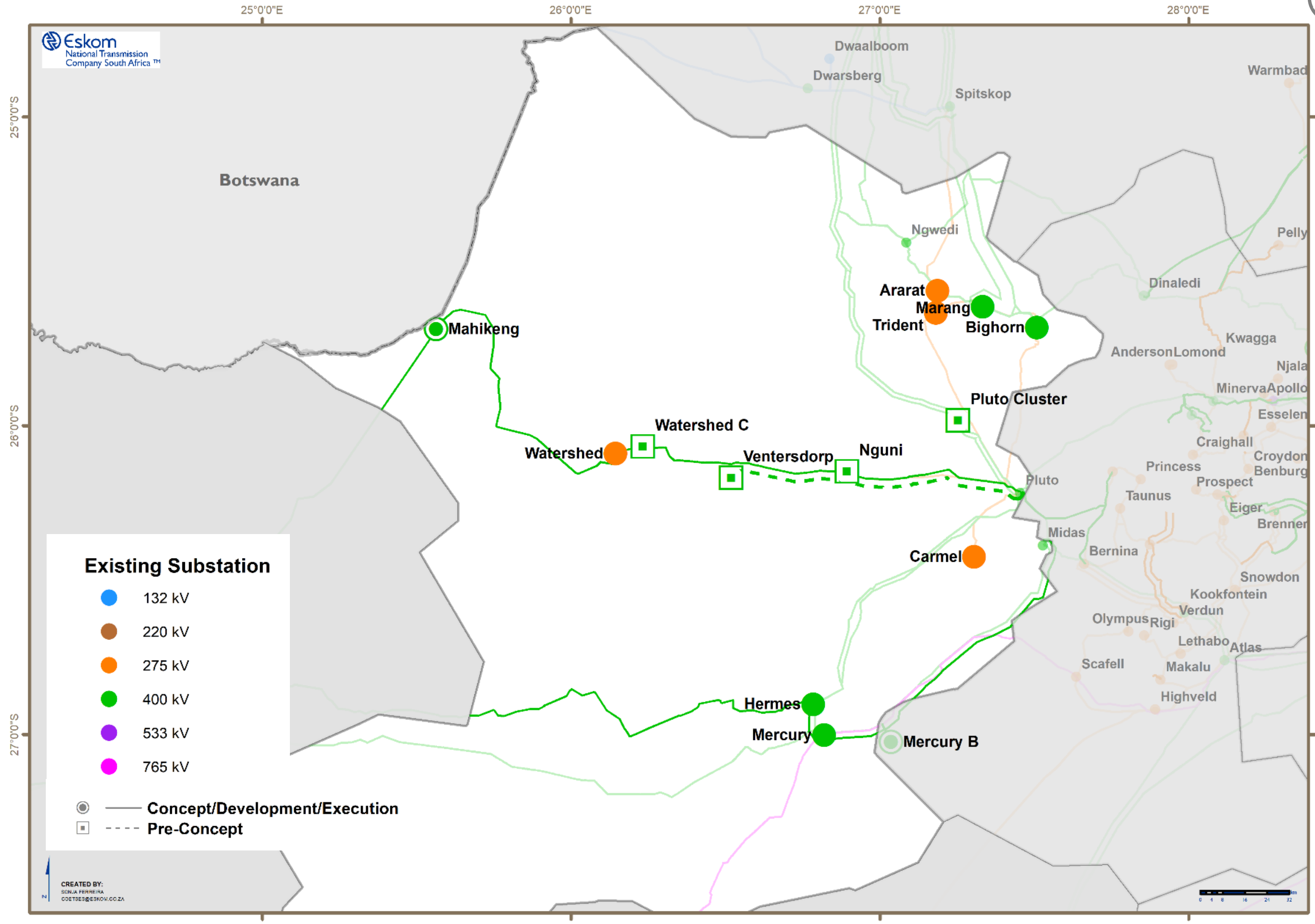
- The **peak load** is forecasted to grow from **28 GW** to **35 GW**.
- With the transition towards cleaner and greener energy, **and the decommissioning of coal generation**, the generation capacity in the north is expected to remain around **55 GW.**

Northern supply areas – dispatched generation scenario and forecasted midday load



- **The midday load** is forecasted to grow from **26 GW to 31 GW.**
- Considering capacity factors and economic generation dispatch, the Northern supply areas become net **importers** of up to **15 GW** of power over the next ten years.
- Therefore, major corridors are required to import power from the south of the country.

North West – transformers, new substations and lines



2025 – 2029

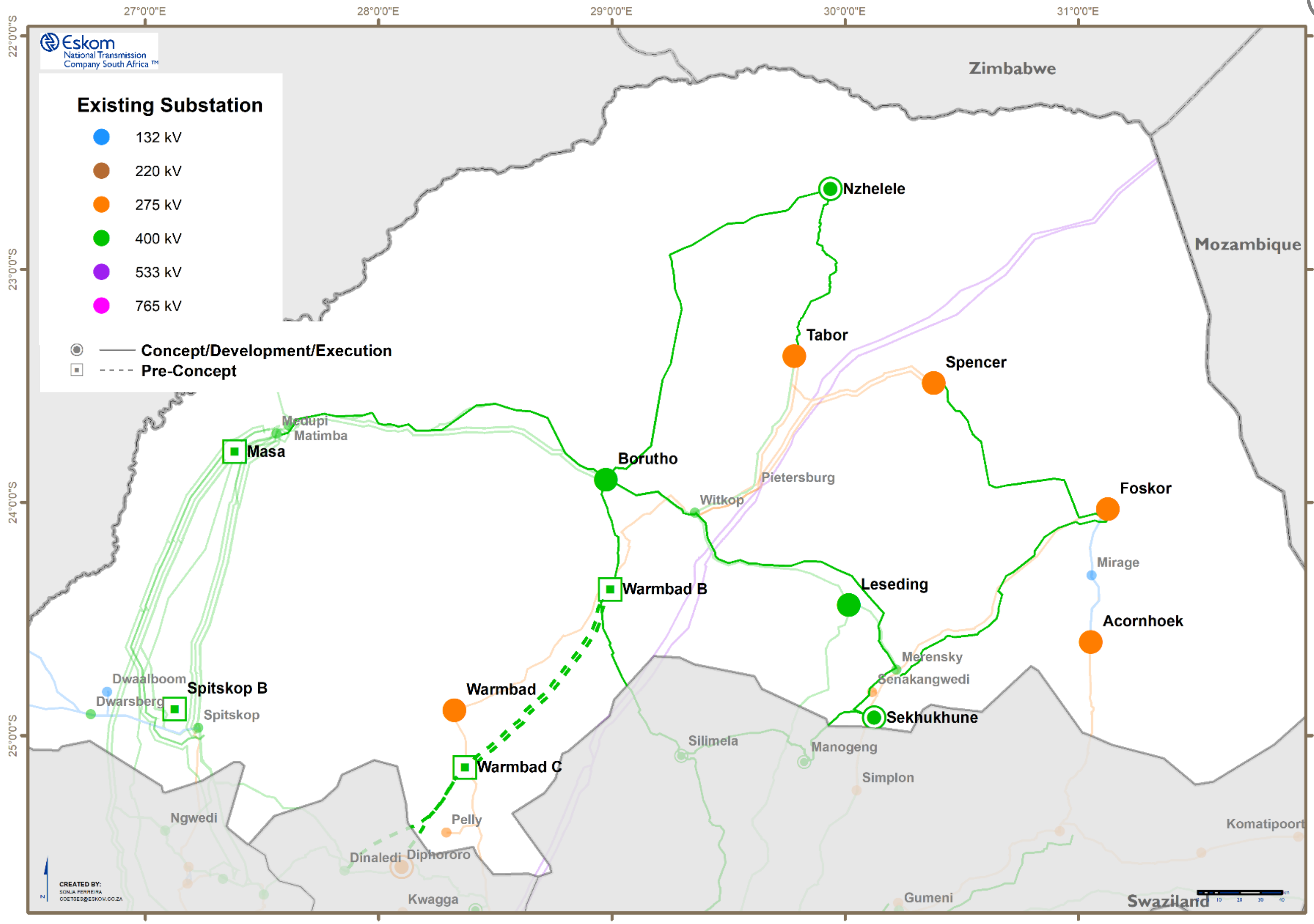
Carmel transformer (1)	
Mercury transformers (1)	
Watershed transformers (2)	
Mookodi – Hermes line	240 km

2030 – 2034

Ararat transformer (1)	
Bighorn transformer (1)	
Hermes transformer (1)	
Marang transformer (2)	
Mercury transformer (1)	
Trident transformer (1)	
Mahikeng Substation and lines	340 km
Nguni Substation	
Pluto Cluster Substation	
Ventersdorp Substation and lines	90 km
Watershed C Substation	
Mercury – Midas line 2	110 km
Mercury-Hermes line 2	14 km

- **11** new transformers will be installed at **8** existing substations.
- **5 new substations** were identified where existing substations are inadequate or distant. All 5 of these substations will enable connection of RE generation.
- **800 km of 400 kV lines** will need to be constructed in North West.

Limpopo – transformers, new substations and lines



2025 – 2029

Acornhoek transformer (1)	
Borutho transformer (1)	
Foskor transformer (1)	
Leseding transformer (1)	
Spencer transformer (1)	
Warmbad transformers (2)	
Medupi – Ngwedi line	200 km
Medupi – Witkop line	220 km
Merensky – Foskor line	135 km
Foskor – Spencer line	110 km
Borutho - Silimela line	160 km

2030 – 2034

Tabor transformer (1)	
Masa Substation	
Nzhelele Substation and lines	340 km
Sekhukhune Substation and lines	226 km
Spitskop B Substation and lines	10 km
Warmbad B Substation and lines	10 km
Warmbad C Substation and lines	220 km

- **7 existing substations** were identified where **8 additional transformers** will be installed.
  - 1 transformer at Tabor and 2 at Warmbad Substation are to enable RE integration.
  - 5 of these transformers will increase firm capacity for load growth.
- **6** new substations were identified where existing substations are inadequate or distant. 4 of them are to enable RE integration. Nzhelele and Sekhukhune Substations are to enable load growth.
- **1 640 km of 400 kV lines** will need to be constructed.

Mpumalanga – transformers, new substations and lines

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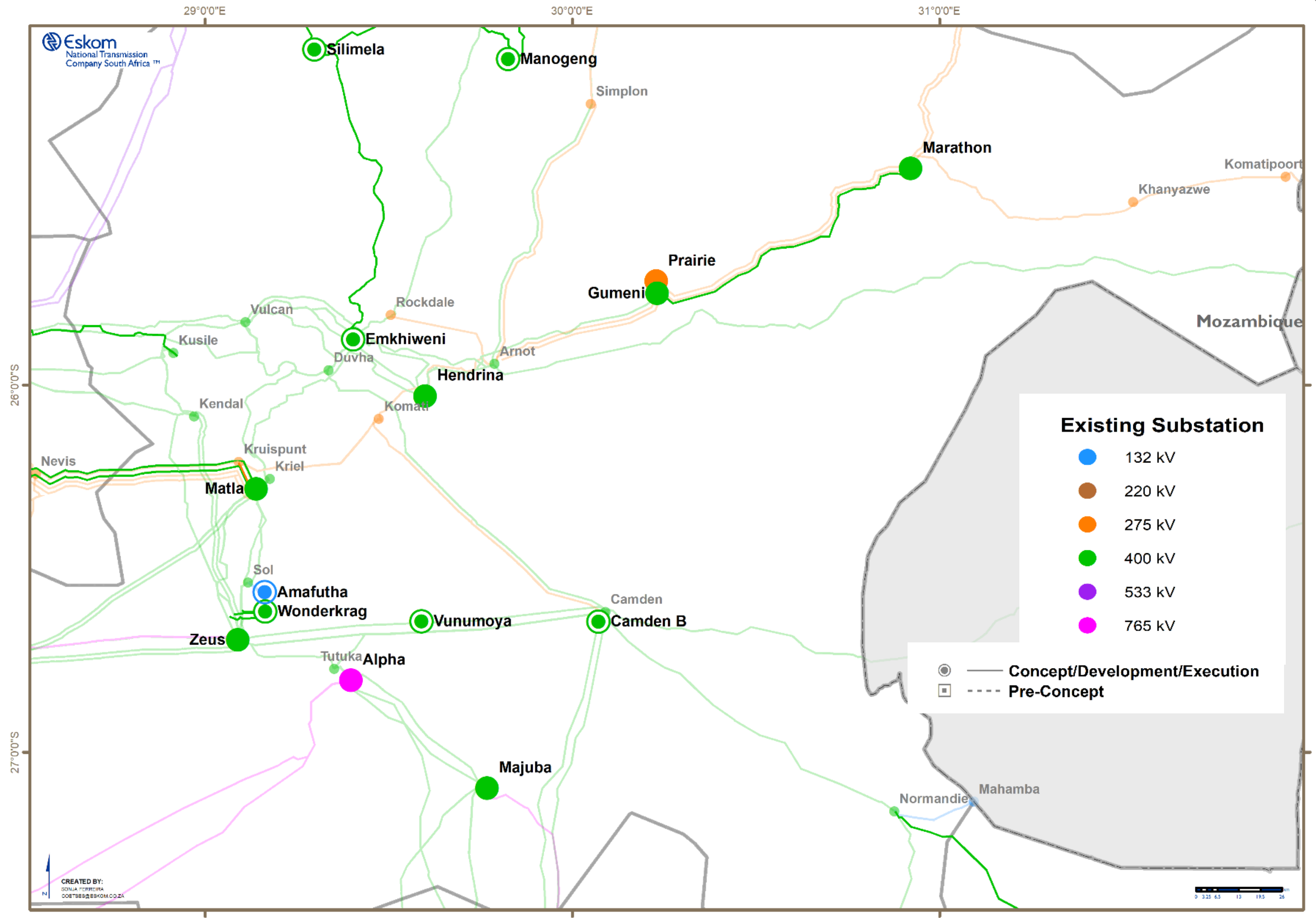


2025 – 2029

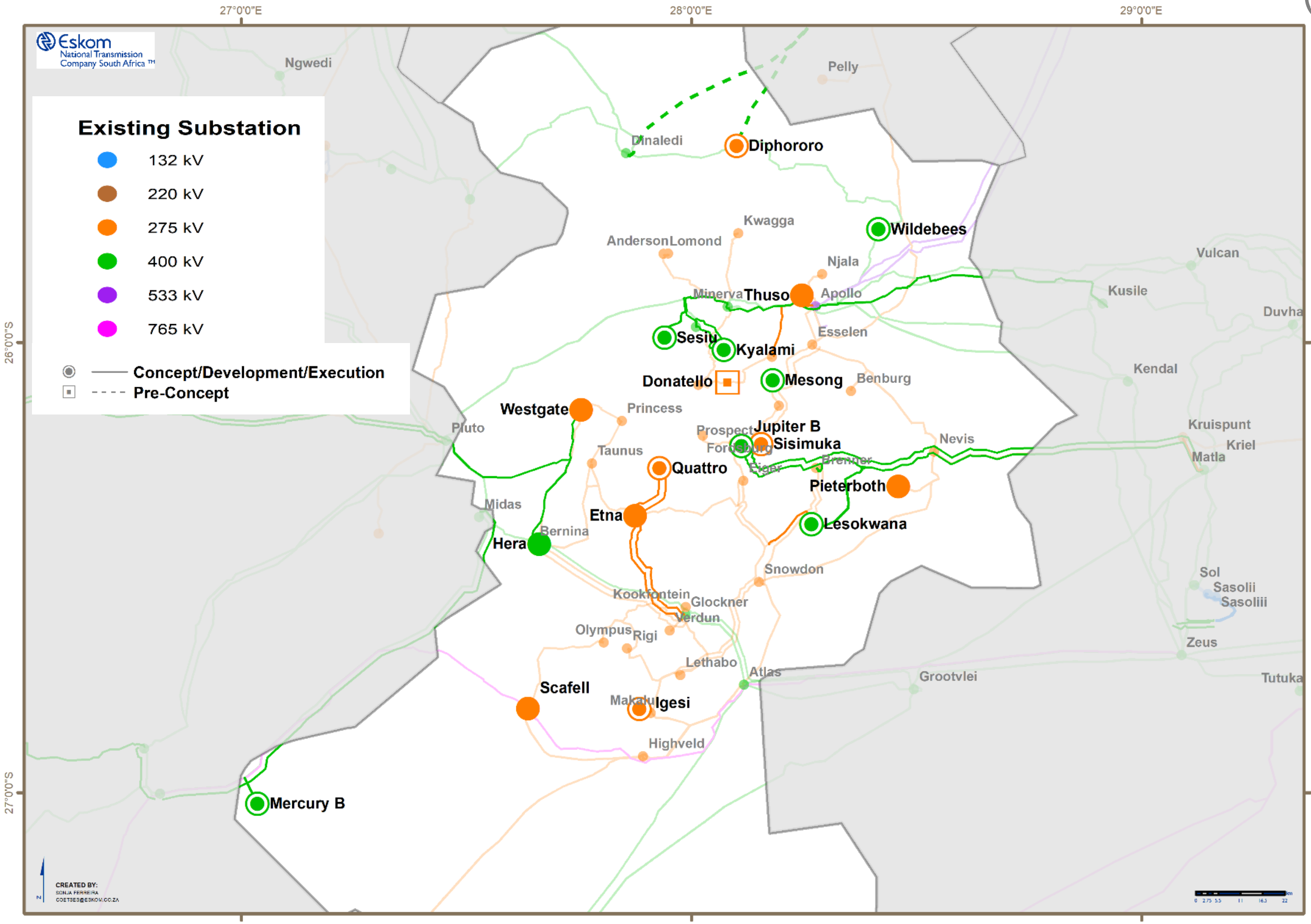
Alpha transformers (2)
Gumeni transformer (1)
Hendrina transformer (1)
Majuba transformers (3)
Prairie transformers (2)
Marathon transformer (1)
Amafutha Switching Station
Manogeng Switching Station
Silimela Substation
Emkhiweni Substation and line 115 km
Vunumoya Substation
Wonderkrag Substation and lines 86 km
Gumeni – Marathon line 101 km
Kusile – Lulamisa line 117 km
Matla – Kruispunt 275 kV line 10 km

2030 – 2034

Matla transformer (1)
Camden B Substation

- **7 existing substations** were identified where **11 additional transformers** will be installed:
  - 9 transformers will enable connection of RE generation.
  - Marathon and Matla transformers will increase firm capacity for load growth.
- **7 new substations** were identified where 13 transformers will be installed. Vunumoya and Camden B substations will enable RE generation connection.
- **430 km of lines** will need to be constructed.

Gauteng – transformers, new substations and lines



2025 – 2029

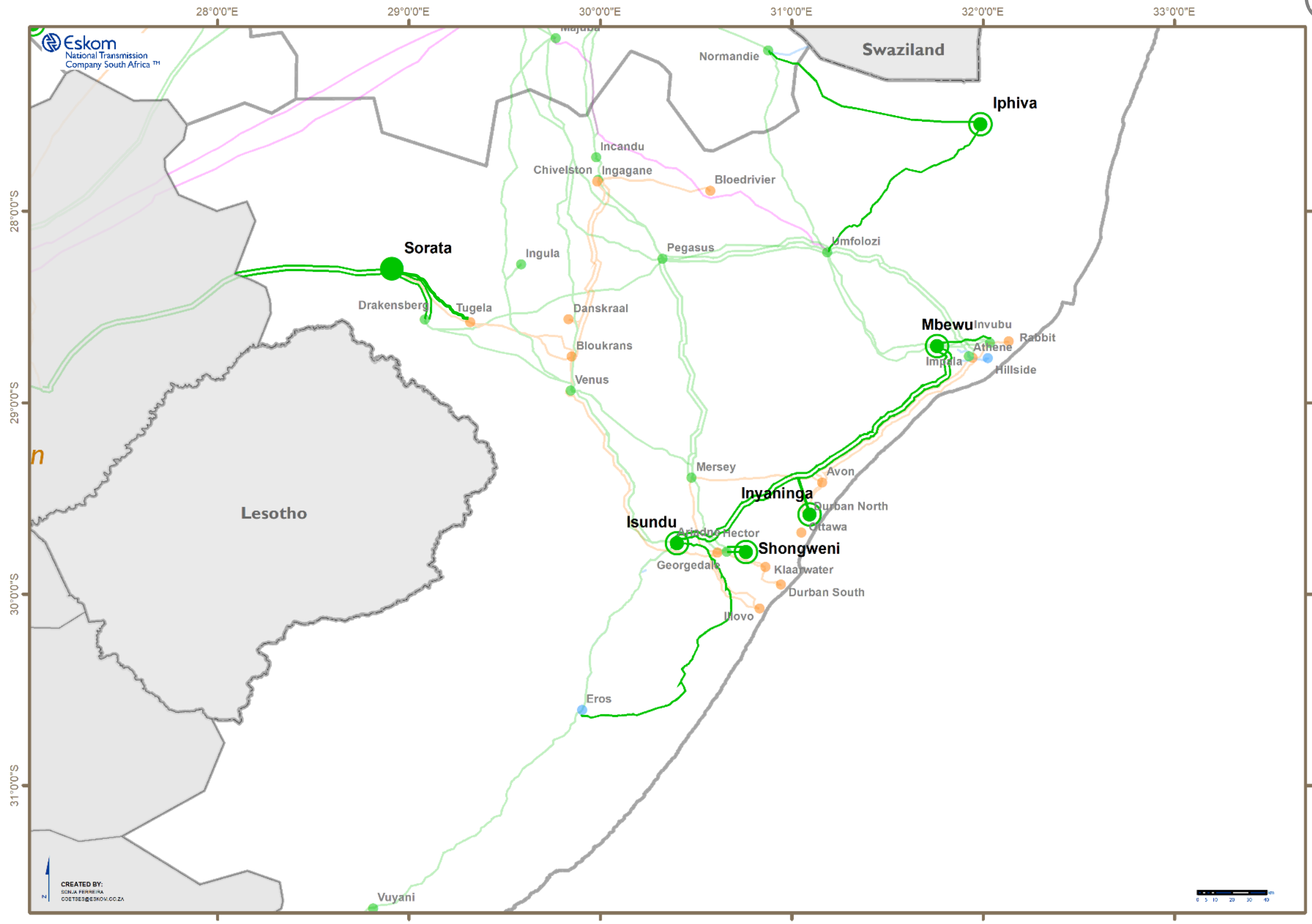
Etna transformer (1)	
Scafell transformer (2)	
Diphororo Substation	
Quattro Substation	
Hera – Westgate line	40 km
Etna - Quattro 2 x 275 kV lines	30 km
Etna-Glockner 2 x 275 kV lines	60 km

2030 – 2034

Hera transformer (1)	
Pieterboth transformer (1)	
Thuso transformer (1)	
Westgate transformer (1)	
Igesi Substation	
Jupiter B Substation	
Kyalami Substation	15 km
Lesokwana Substation	
Mercury B Substation	
Mesong Substation	
Sesiu Substation	30 km
Sisimuka Substation	
Apollo - Lepini 275 kV line	27 km
Pluto-Westgate line	50 km
Matla – Jupiter line	300 km

- **6 existing substations** were identified where **7 additional transformers** will be installed to increase firm capacity for load growth.
- **10 new substations** were identified where existing substations are inadequate or distant. Donatello Substation is at pre-feasibility stage.
- **560 km of 400 kV and 275 kV lines** will need to be constructed in Gauteng.

KwaZulu-Natal - transformers, new substations and lines



2025 – 2029

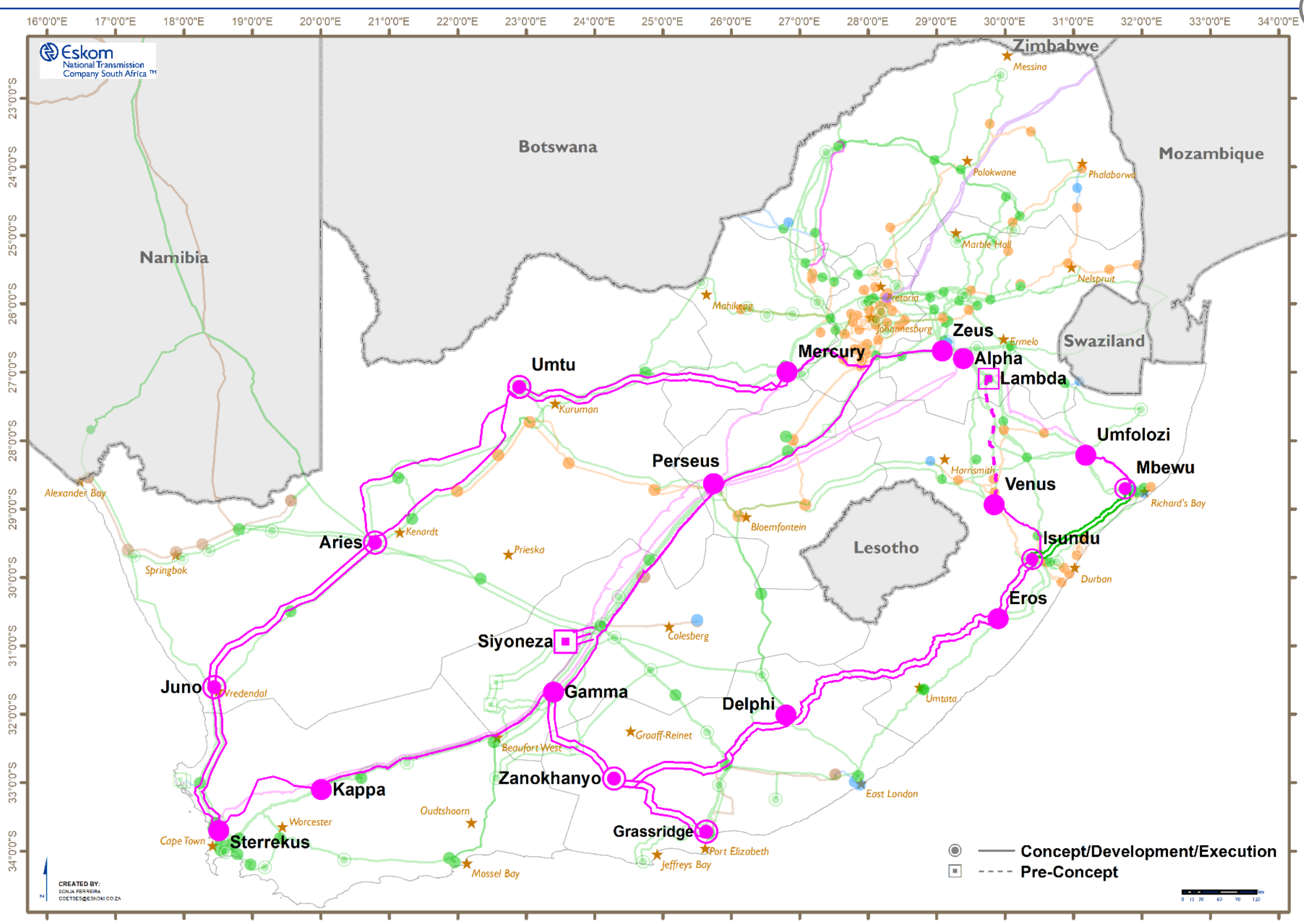
Sorata transformer (1)	
Sorata – Tugela line 2	60 km
Ariadne - Eros line 2	170 km

2030 – 2034

Iphiva Substation and line	160 km
Inyaninga Switching Station	10 km
Isundu Switching Station	12 km
Mbewu Switching Station	
Shongweni Substation and lines	40 km
Iphiva – Umfolozi line	110 km
Isundu – Mbewu lines (2)	160 km
Mbewu – Invubu line	30 km

- **1 transformer** to be installed at Sorata Substation for load growth.
- **5 new substations** are current projects where **4 transformers** will be installed. All substations are to enable load growth in KZN. 3 of the new substations will be established as switching stations strategically.
- **760 km of 400 kV lines** will need to be constructed.

Additional corridors

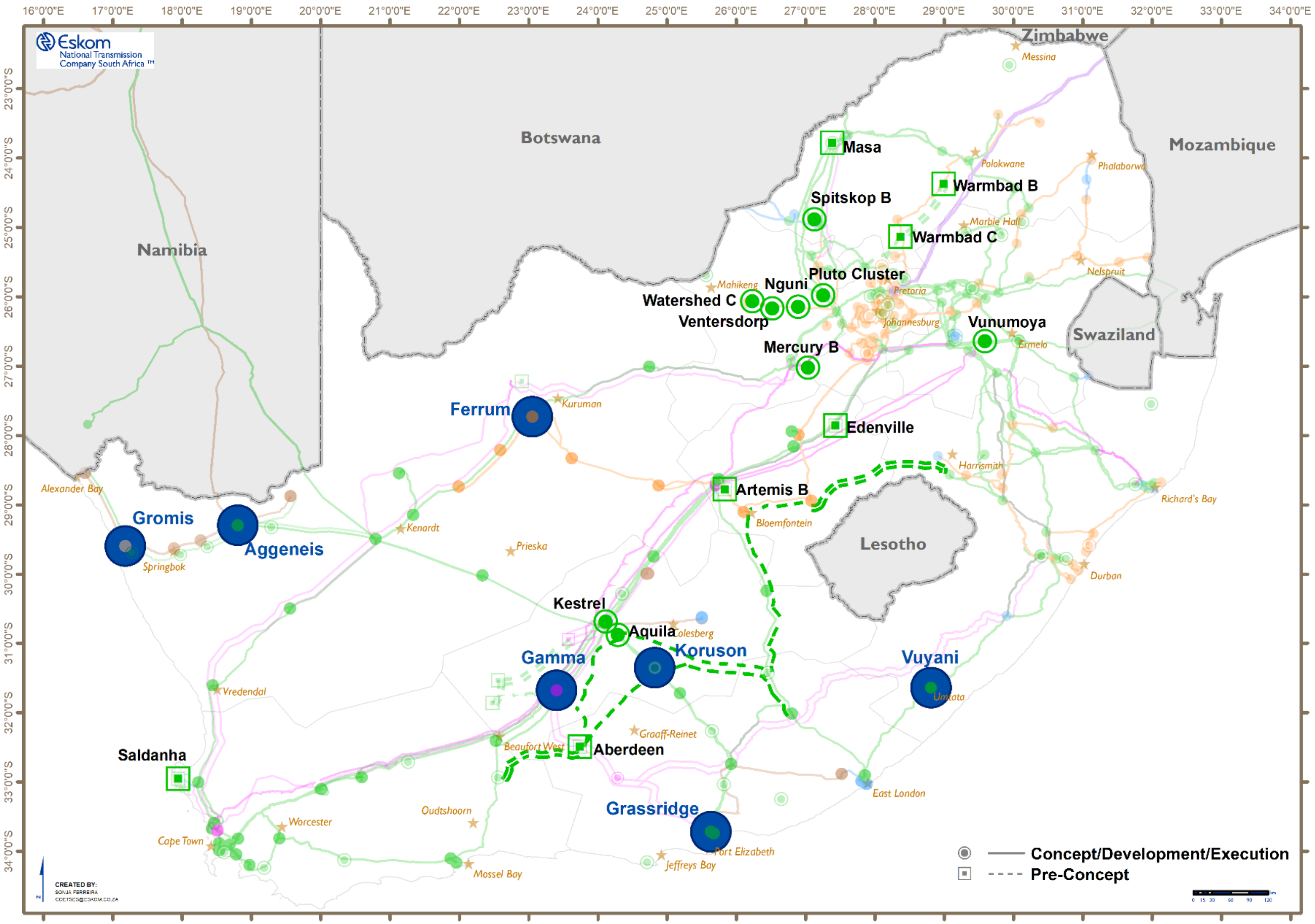


- **New transmission corridors** are required to transport the excess power to the **load centres** in the **northern parts of the country**
- **6 850 km of 765 kV lines** will need to be constructed.

2025 – 2029		
Central Corridor	Perseus - Zeus 1	430 km
	Gamma - Perseus 2	400 km
	Gamma - Kappa 2	400 km
2030 – 2034		
Central Corridor	Kappa - Sterrekus 2	150 km
Eastern Corridor	Gamma - Grassridge 1 and 2	710 km
	Delphi - Zanokhanyo 1 and 2	600 km
	Delphi - Eros 1 and 2	800 km
	Eros - Isundu 1 and 2	320 km
	Isundu - Venus 1	140 km
Western Corridor	Juno - Sterrekus 1 and 2	500 km
	Aries - Juno 1 and 2	700 km
	Aries - Umtu 1 and 2	900 km
	Mercury - Umtu 1 and 2	800 km

Additional Projects since TDP 2022
Transmission Development Plan

Additional projects since TDP 2022



- TDP 2024 has been revised to factor in new capacity requirements.
- The TDP 2024 requires **similar transmission line build** and **increased transformer capacity** compared to TDP 2022.
- In addition, the TDP 2024 highlights the need for:
  - 7 sites for synchronous condensers
  - 16 substations of which 9 are current projects
  - 40 transformers

Summary of Grid Assets Refurbishment Plans

Atha Scott
Senior Manager: Asset Investment Planning

Introduction

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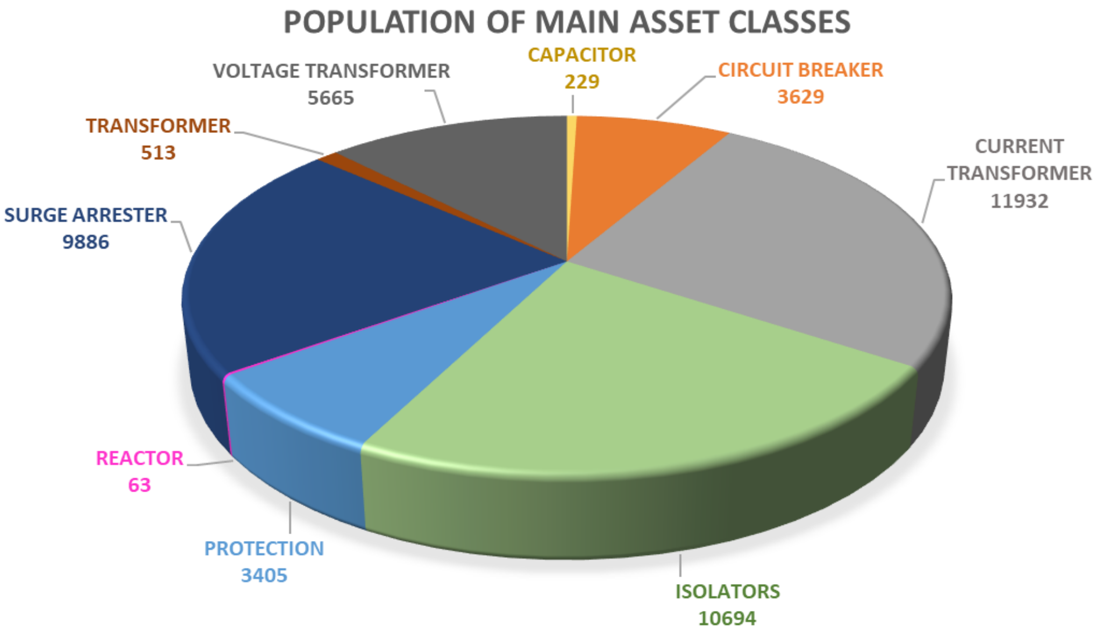
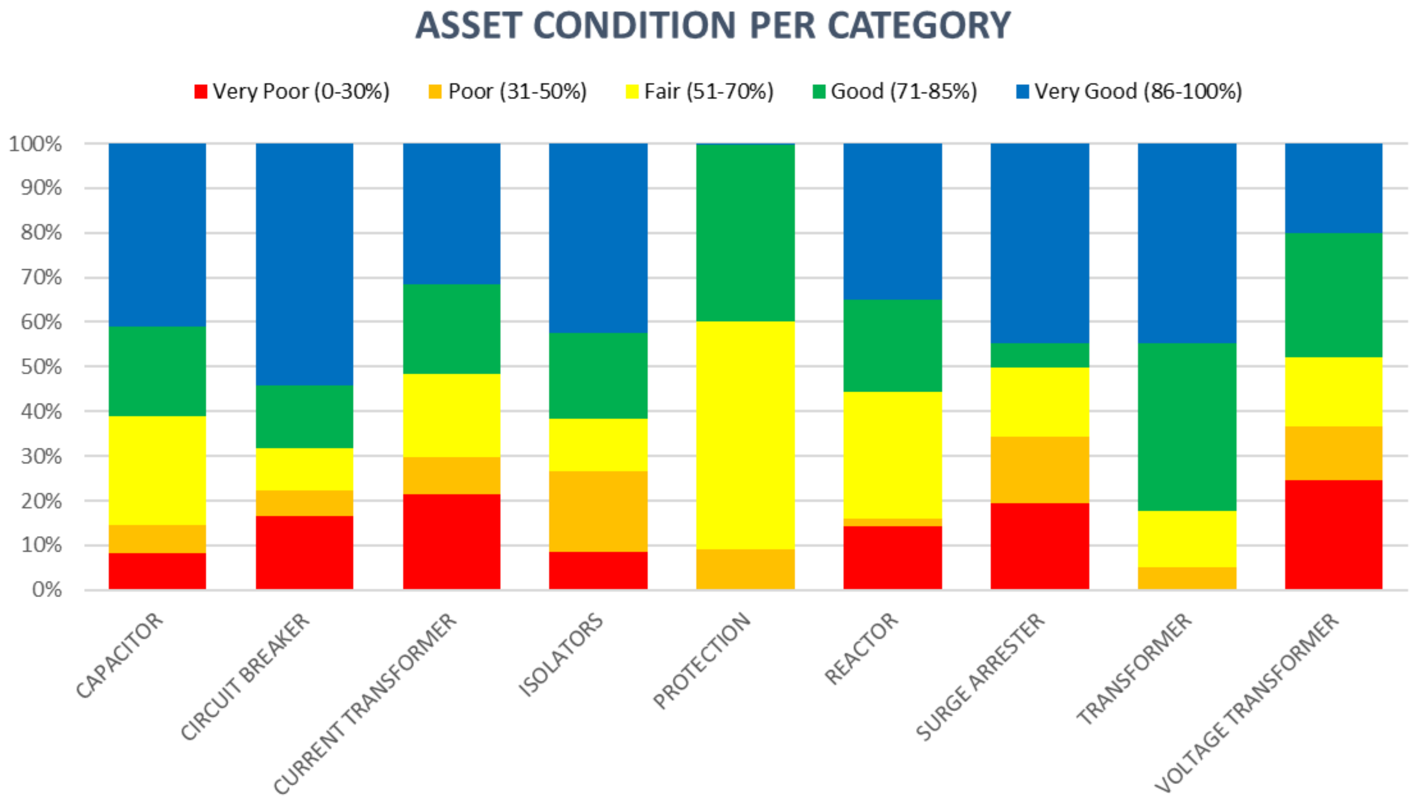
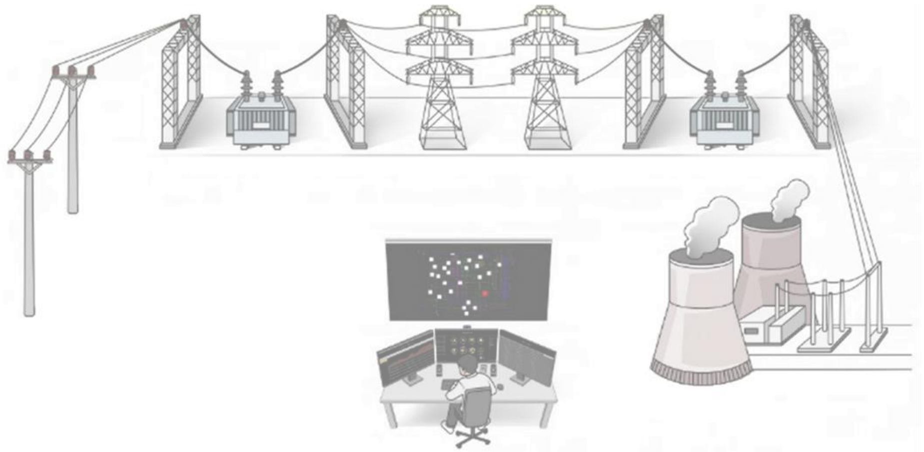
- Refurbishment is critical to network sustainability and deals with the ***systematic renewal of the network assets***, based on *plant performance and equipment condition*.
- This is further supported by the assurances provided by ensuring ***adequate capital spares***, ***availability of emergency preparedness plans, system operator guidelines, production equipment and asset maintenance***.
- Asset Management is focused on the existing network assets (or the installed base of assets), and to *sustain that existing network infrastructure at desired performance levels*.
- This is achieved by removing risks from the network through the ***replacement of poor condition / unreliable assets***, with consideration of network constraints. Asset Management principles form the basis of prioritising which assets need to be replaced, whilst ***maintaining a balance between performance, cost, and risk***. This is supported by a standardised refurbishment prioritisation methodology.
- The development of a robust Refurbishment Plan is therefore crucial and is formulated by identifying refurbishment requirements in terms of capital investments that would ensure that the network ***conforms to the required reliability and statutory standards***.
- The purpose of the presentation is to give an overview of the status of the existing network assets and the planned investments to address the network risks by means of asset replacements.

Substation Asset Condition Assessment:
(National View of the Main Asset Classes)

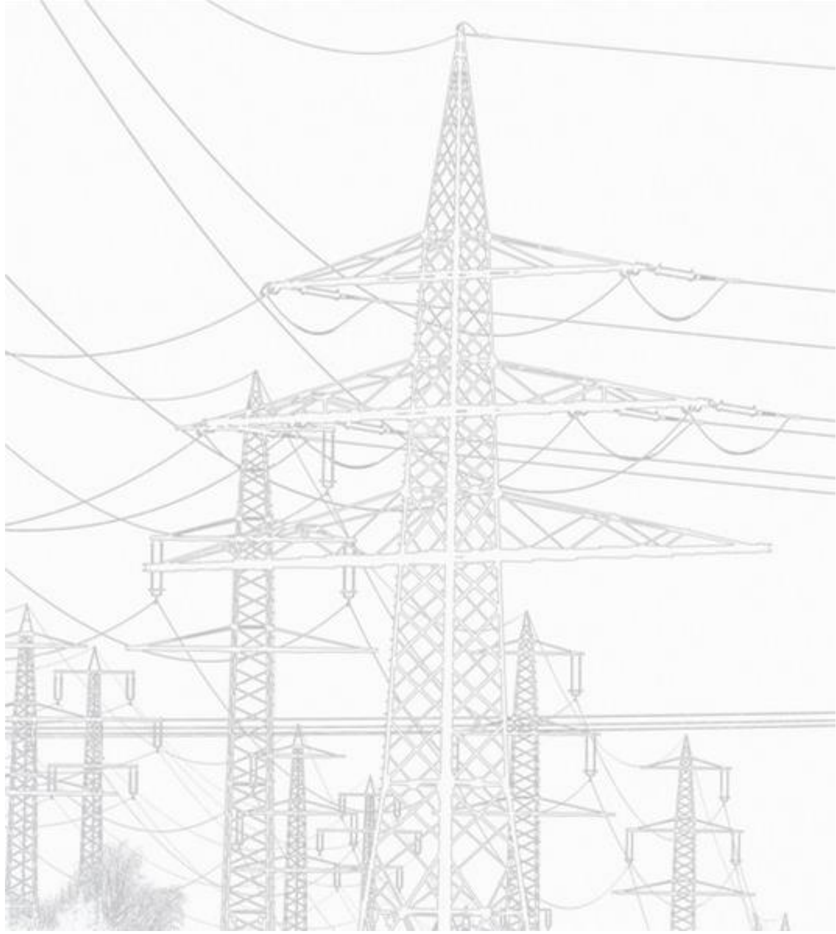


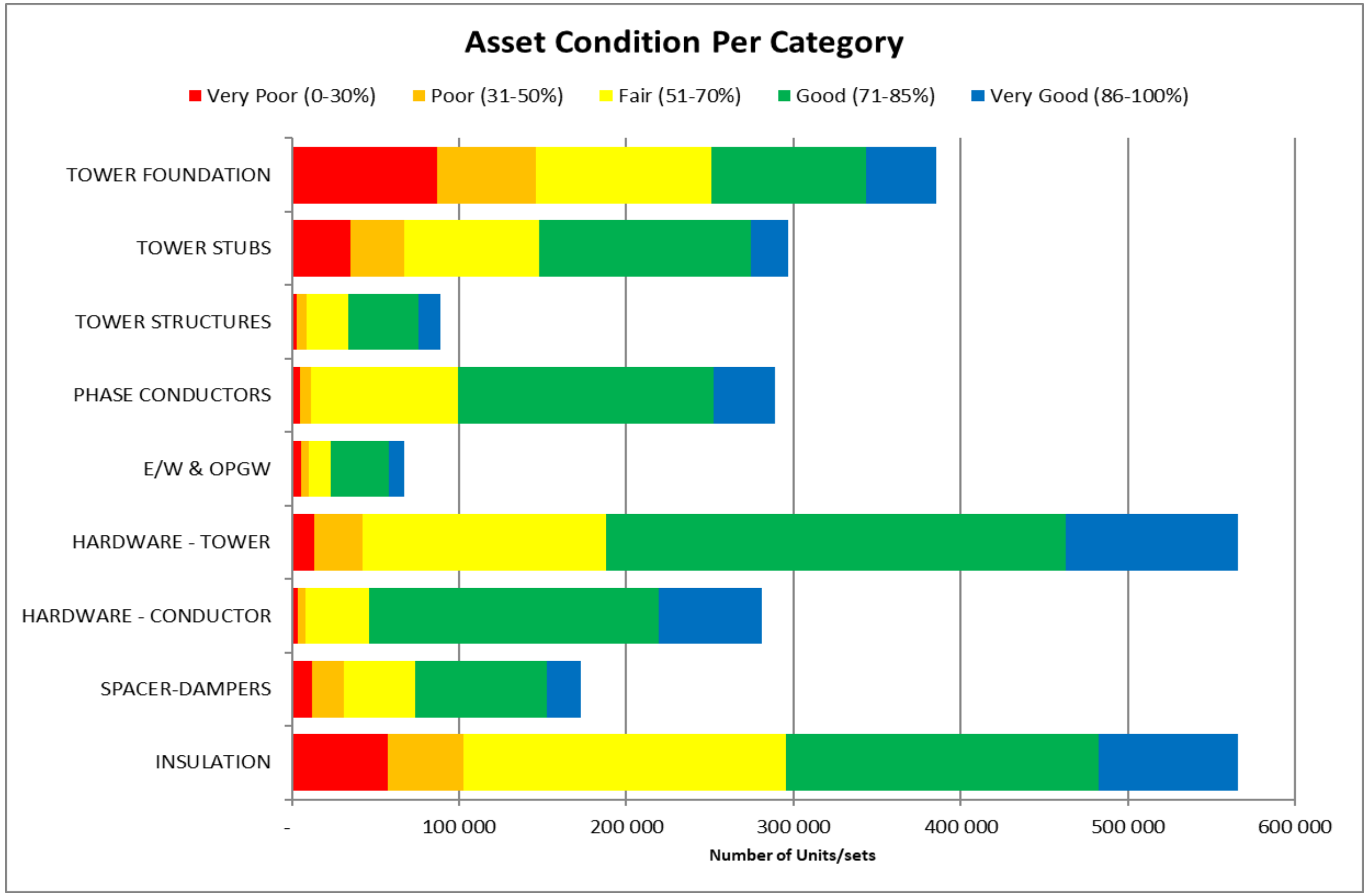




- Periodic asset assessments of all substation asset classes across the transmission network are conducted.
- The graph represents the latest overall condition of the key asset classes of the installed base.

Overhead Powerlines: Asset Condition Assessment
(National View of the Main Asset Classes)





- The Overhead Powerlines were broken up into its key components that make up a powerline and evaluated to generate the overall asset condition based on a weighted condition assessment.
- This condition assessment was done per line component to derive an overall assessment across all the powerlines in the transmission network.

Assets replaced and planned for replacement

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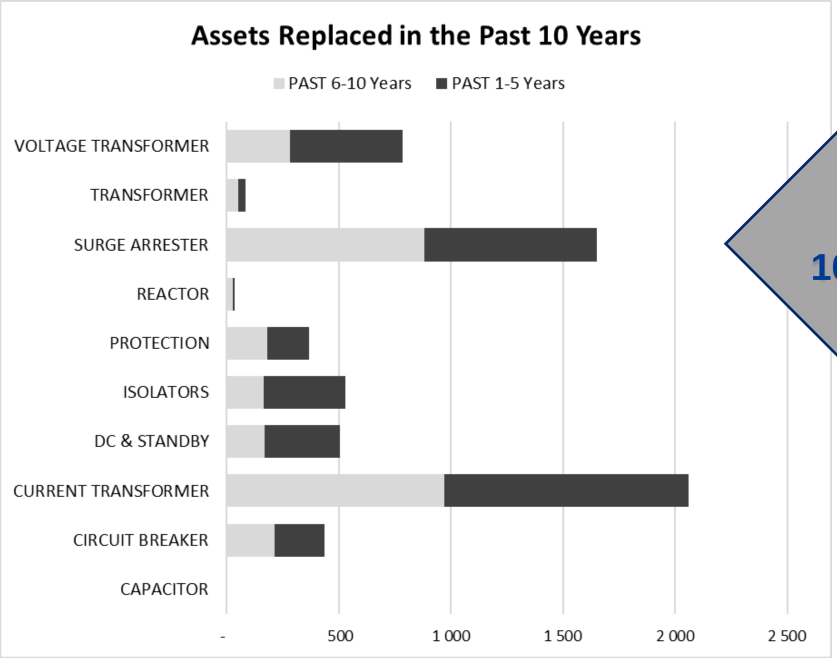
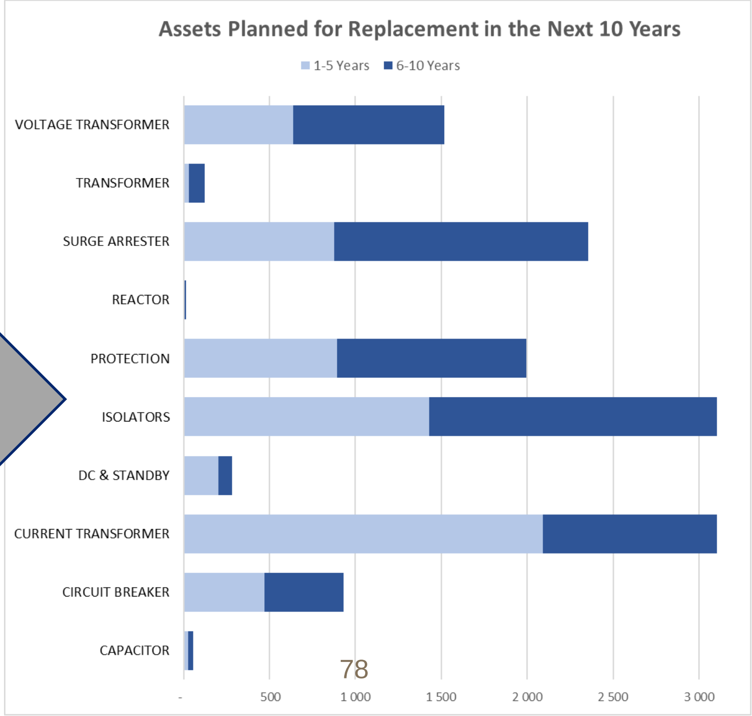


PAST 10 YEARS

CATEGORY	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Grand Total
CAPACITOR	-	-	-	-	-	-	-	-	-	2	2
CIRCUIT BREAKER	55	55	41	29	41	48	37	40	59	39	
CURRENT TRANSFORME	96	194	190	140	228	225	236	202	219	182	1 912
DC & STANDBY	70	29	62	22	19	41	5	5	28	89	370
ISOLATORS	22	35	40	24	31	34	43	57	101	85	472
PROTECTION	20	37	36	31	51	26	37	40	43	28	349
REACTOR	6	19	6	3	1	2	1	2	1	-	41
SURGE ARRESTER	128	192	276	112	155	187	200	131	165	126	1 672
TRANSFORMER	9	12	13	9	11	8	4	4	4	15	89
VOLTAGE TRANSFORME	47	54	45	39	77	81	138	59	103	89	732
Grand Total	**453**	**627**	**709**	**409**	**614**	**652**	**701**	**540**	**723**	**655**	**6 083**

FUTURE 10 YEARS

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**



Focus Areas of the Refurbishment Plan

A. **Operational Risks:**

1. **HV Plant Assets:**

- **High-Risk Transformers and Reactors** are addressed in a phased approach based on network risk.
- Insulation flashover mitigation by re-insulation or surface coating at highly polluted areas.
- Problematic **Instrument Transformers and Surge Arrestors** that have degraded and become unreliable. These are addressed as targeted replacements.
- **Circuit Breakers**: Application requiring technological advancements and improved functionality.
- Replacement of the poor condition **Breakers** due to degradation.
- Performance improvement of **Shunt Capacitor Banks.**

2. **Protection Schemes:**

- Protection schemes are being addressed as a priority focus area and will require an extended replacement programme.
- The strategy is to replace the protection schemes that are showing performance deterioration due to failures and are being prioritised for replacement by specific protection replacement projects.
- The strategy going forward is to replace up to phase 5, as it is deemed prudent as these are past end of design life.
- However, certain schemes need replacement due to obsolescence and the unavailability of spares.
- As an interim measure, spares are being harvested to address the schemes that are problematic.

Refurbishment Plan Focus Areas (cont.)

3. Powerline Assets:

- **Foundations**: Several line foundation designs (built prior to 2004) allowed for bare steel to be in direct contact with the soil, which results in degradation based on soil type and weather.
- **Insulation and Hardware**: Spacer dampers exhibit a lower level of reliability due to the accelerated wear and tear on the conductor.
- **Line Insulation** is the least reliable of the line components, being under-insulated brought about by changes in design standards, thus forming the bulk of the line asset replacements.

4. Fibre:

- Fibre Wrap (e.g. Adlash) installed on some line earth-wires have exceeded their expected lifespan and are now impacting on the line performance. These need to be replaced with **Optical Ground Wire** (OPGW), which generally is very costly and outage dependent.

B. Statutory Risks:

1. Compliance Requirements:

- Assets requiring replacement due to fault-level exceedances becoming under-rated for its location due to network expansion
- Environmental legislation in terms of Asbestos and PCB phase-out (completed)
- Adequacy of Oil Containment

2. Infrastructure Security:

- Addressing statutory fencing requirements for safety, operating and proximity to High Voltage
- Security upgrades to address breaches and theft

Major Substation Refurbishments: FY2025 – FY2034

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LEGEND

- Projects in development
- Projects in execution

North-West: (in development)
- Bighorn
- Trident
- Carmel

North-West: (in execution)
- Watershed

Gauteng: (in development)
- Fordsburg Craighall
- Esselen
- Brenner
- Nevis

Gauteng: (in execution)
- Eiger
- Nevis
- Fordsburg

Limpopo Substations: (in development)
- Acornhoek
- Foskor
- Warmbad
- Spitskop
- Matimba

Free State: (in development)
- Harvard
- Everest

Free State: (in execution)
- Makalu
- Scafell

Northern Cape: (in development)
- Aggeneis
- Roodekuil Garona
- Helios
- Hydra
- Nama
- Aries

Northern Cape: (in execution)
- Oranjemund
- Gromis
- Ferrum
- Olien

Mpumalanga: (in development)
- Normandie 400kV
- Majuba
- Kriel
- Grootvlei

Mpumalanga: (in execution)
- Kruispunt
- Komatipoort
- Normandie
- Vulcan
- Prairie
- Sol

Kwa-Zulu Natal: (in development)
- Chivelston
- Bloedrivier
- Athene
- Hector
- Illovo
- Avon

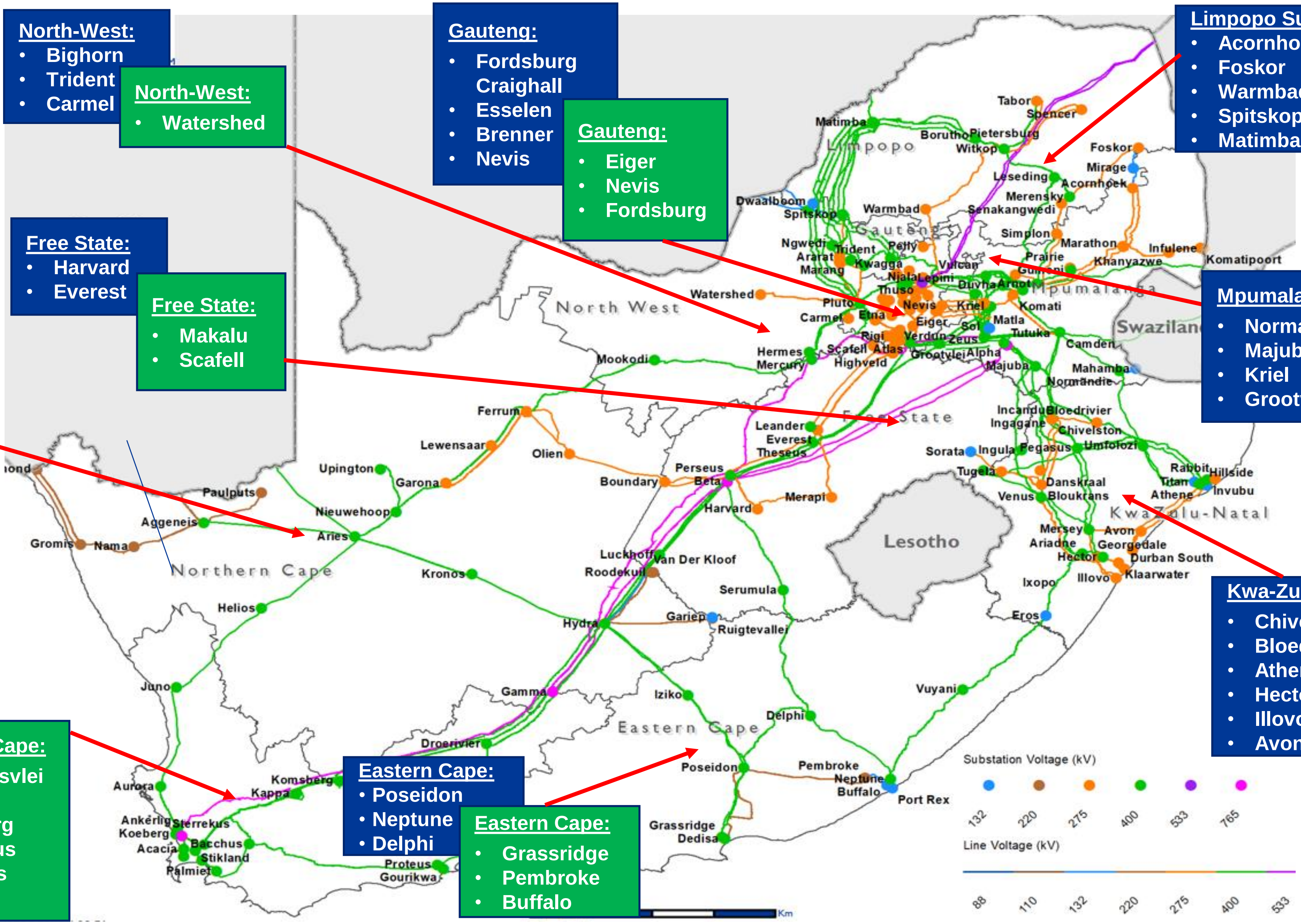
Kwa-Zulu Natal: (in execution)
- Drakensberg
- Georgedale
- Ingagane

Western Cape: (in development)
- Droerivier
- Juno

Western Cape: (in execution)
- Muldersvlei Aurora
- Koeberg
- Bacchus
- Proteus
- Acacia

Eastern Cape: (in development)
- Poseidon
- Neptune
- Delphi

Eastern Cape: (in execution)
- Grassridge
- Pembroke
- Buffalo



Major Powerline Refurbishments: FY2025 – FY2034

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LEGEND

- Projects in development
- Projects in execution

Free State: (in development)
- Makalu-Scafell Line Refurb

Gauteng: (in development)
- Hera-Midas OPGW Installation
- Hera-Watershed Reinsulation
- Bernina-Glockner OPGW Installation
- Taunus-Etna OPGW Installation
- Jupiter-Fordsburg OPGW Installation
- Matla-Nevis Structures

Limpopo Substations: (in execution)
- Leseding- Merensky Anchor Replacement
- Tabor-Spencer Anchor Replacement
- Witkop-Leseding Anchor Replacement

Northern Cape: (in development)
- Ferrum-Nieuwehoop fibre loop-in to Garona
- Aries-Nieuwehoop EW Replacement

Northern Cape: (in execution)
- Gromis-Oranjemond Line Refurb

Mpumalanga: (in development)
- Komati Kruispunt No2 275kV Line Refurb
- Komati Kruispunt No1 275kV Line Refurb
- Matla Kruispunt No1 275kV Line Refurb
- Camden Komati 275kV Line Refurb
- Arnot Kruispunt 275kV Line Refurb

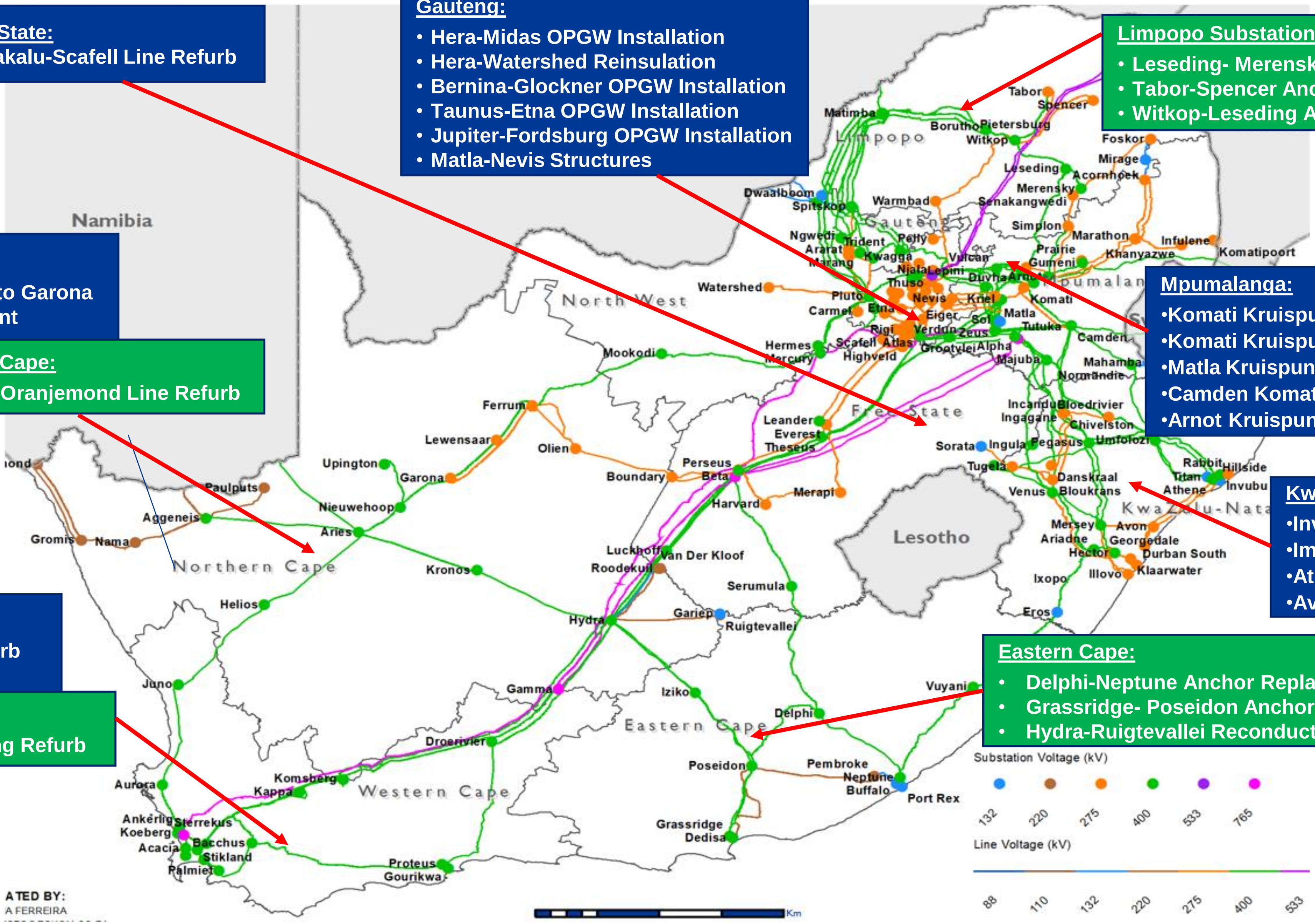
Kwa-Zulu Natal: (in development)
- Invubu-Rabbit Line Refurb
- Impala-Invubu Line Refurb
- Athene-Invubu Line Refurb
- Avon-Durban Line Refurb

Western Cape: (in development)
- Bacchus-Muldersvlei Adlash Refurb
- Muldersvlei-Sterrekus LT Refurb

Western Cape: (in execution)

Bacchus-Proteus Reinsulating Refurb

Eastern Cape: (in execution)
- Delphi-Neptune Anchor Replacement
- Grassridge- Poseidon Anchor Replacement
- Hydra-Ruigtevallei Reconductoring



Capital Investment Requirement for the Refurbishment Plan

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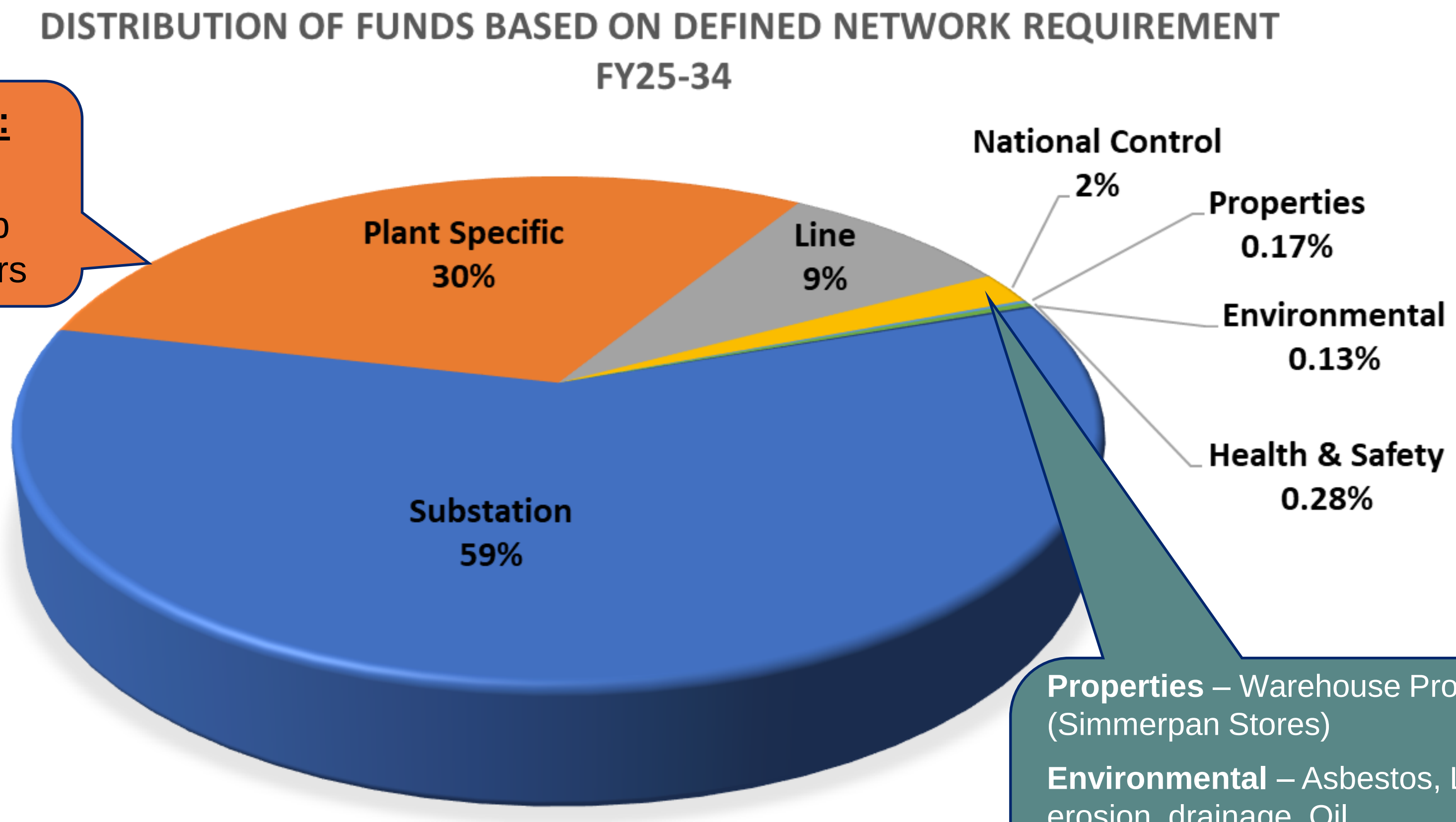
Plant Specific:

Transformers, Protection, Cap Banks, Breakers



Descriptions	Percentages
Substation Refurbishment	58.91%
Plant Specific	30.12%
Line Various	8.36%
National Control	2.03%
Properties	0.17%
Health & Safety requirements	0.28%
Environmental requirements	0.13%
	100%

Properties – Warehouse Project. (Simmerpan Stores)

Environmental – Asbestos, Line erosion, drainage, Oil Containment

Health & Safety – Line and SS Labels, Anti-Climb, Clearance violations.

Conclusion

- The refurbishment plan focusses on ***problematic and unreliable assets*** that have impacted the NTCSA over the past years due to deterioration, mal-operation, latent defects, performance issues, obsolescence, and statutory fault-level compliance.
- The objective of the refurbishment plan is to ***ensure long-term sustainability*** of the network and optimal usage of the capital allocation.
- The NTCSA has an ***adequate planning process*** to determine asset replacement requirements, which is aligned to Asset Management principles.
- The current portfolio of projects in the Transmission Network Refurbishment Plan (TNRP) considers the risks to the network and embodies the requirements and stipulations of the Grid Code.
- The 10-year refurbishment plan is based on ***actual asset condition assessments, asset criticality, network risks that undergoes a robust prioritisation process***.
- The plan is further flexible enough to accommodate emerging operational risks and current requirements in addition to the planned asset replacement program.
- In conclusion, the major refurbishment projects as displayed, are an indication that the refurbishment plan addresses requirements across the country.

TDP 2024 Summary

Leslie Naidoo
Senior Manager: Grid Planning

The TDP challenges

Eskom National Transmission Company South Africa TM

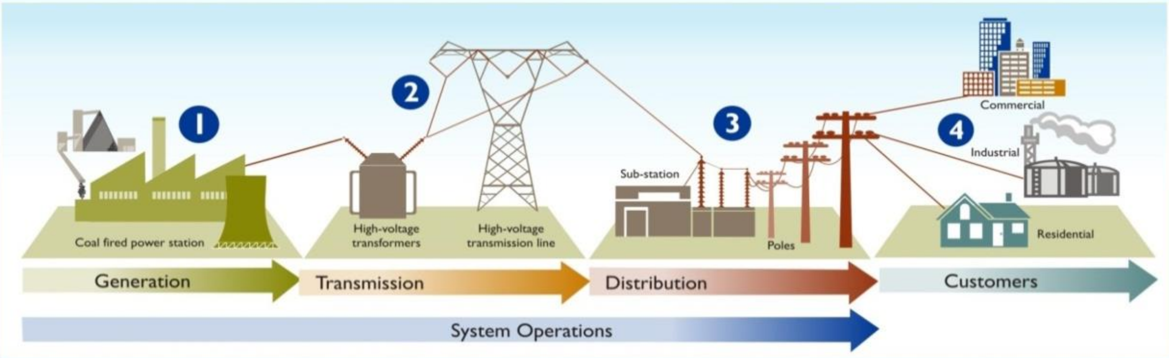
Current situation

- The draft IRP 2023 proposes ~ **30 GW** of new generation capacity by **2030.** By **2034** this increases to ~ **56 GW** based on the draft IRP 2023 base case, and applications processed via the DMRE and non-DMRE (private sector) procurement programmes.
- Large scale penetration of RE coupled with reduction in base load generation will impact the system stability from an inertia, voltage and system strength perspective and will require compensation devices.
- Current network reliability constraints (N-1), as well as meeting the anticipated demand growth also requires significant new grid infrastructure.
- This necessitates an **acceleration of investments** in transmission infrastructure by development of new corridors and substations, and strengthening at existing substations over the period 2025 – 2034 to address both the **new generation capacity,** as well as the network strengthening requirements across the country to ensure **security of supply.**

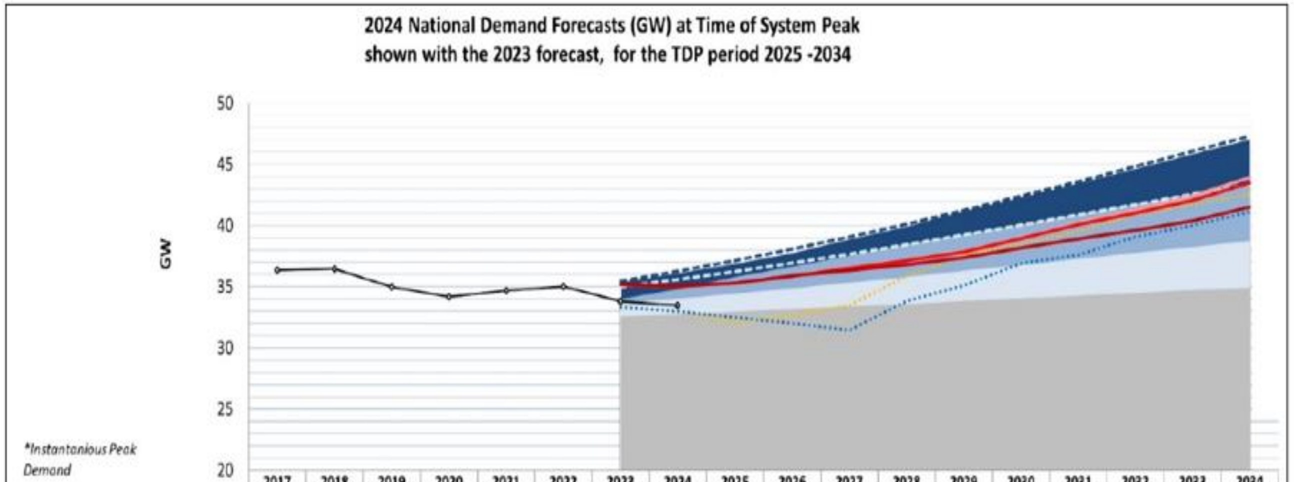
Problem statement

- The grid strengthening required to accommodate this aggressive renewable integration, as well as ensuring the sustainability of the network requires **significant investments.**
- Timelines to implement transmission infrastructure takes **~ 8 – 10 years** to build due to **servitude challenges**
- The **resource capacity** in the country across the EPCM value chain is limited.
- The TDP 2024 is based on the draft IRP 2023, while the new IRP is being finalised. However, the TDP analysis indicates that, at least in the **first 5-year period, not much changes are anticipated**. Hence, there is **more confidence in the infrastructure and capital requirements** for this period. Beyond the 5-year horizon, the "uncertainty" increases and as more information becomes available, it would be factored in the next version of the TDP. **The focus of the TDP 2024 is therefore on the first 5-year horizon, while the next 5-years is more for information of what could be expected based on the assumptions considered**.

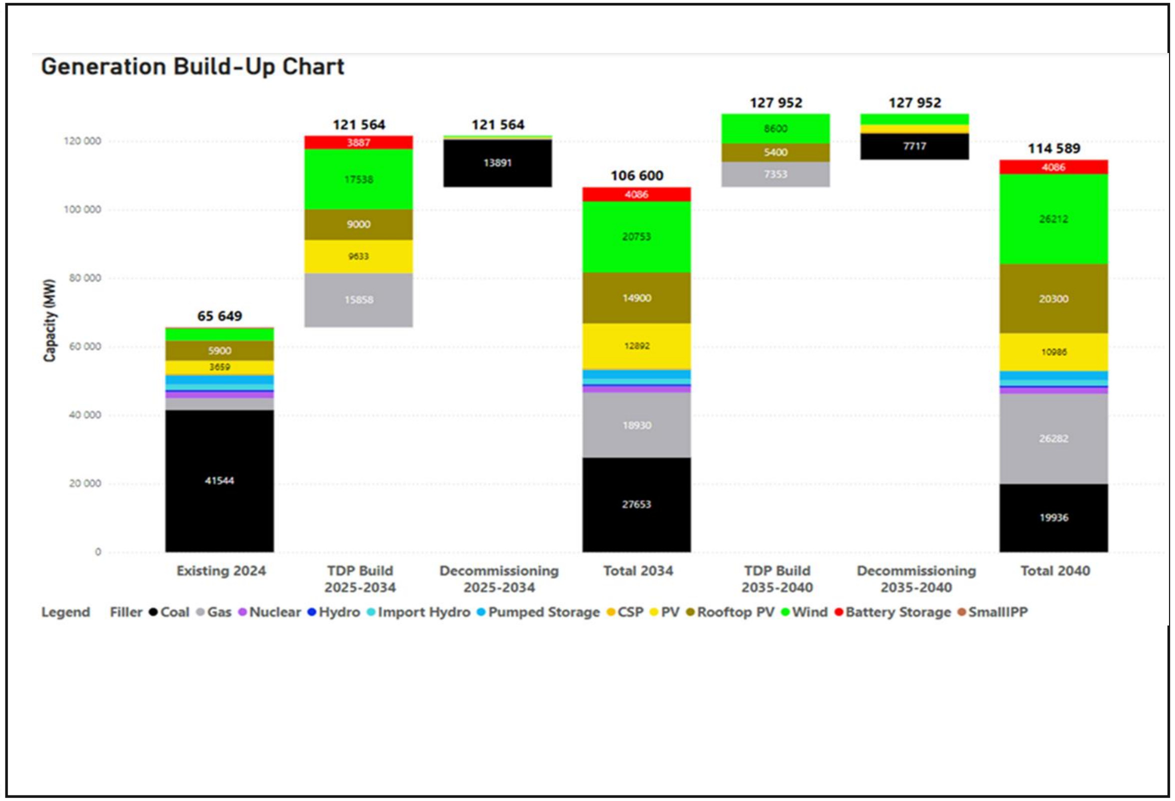
Electricity value chain



Transmission demand and generation summary



	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



- A moderate-high forecast was used for planning purposes that indicates a national peak demand of ~ 43 GW by 2034
- Expected generation capacity to reach ~ 107 GW by 2024, an increase of ~ 56 GW of new capacity

Transmission network challenges

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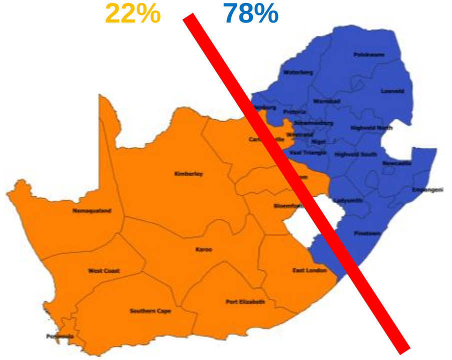
LOAD

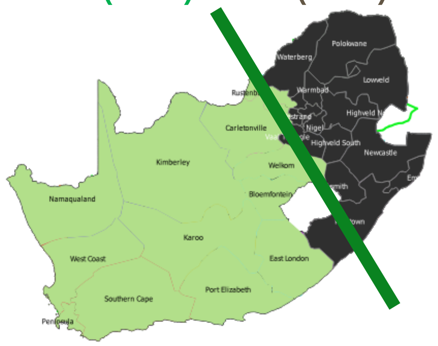
22% 78%



Lower load in the South remains

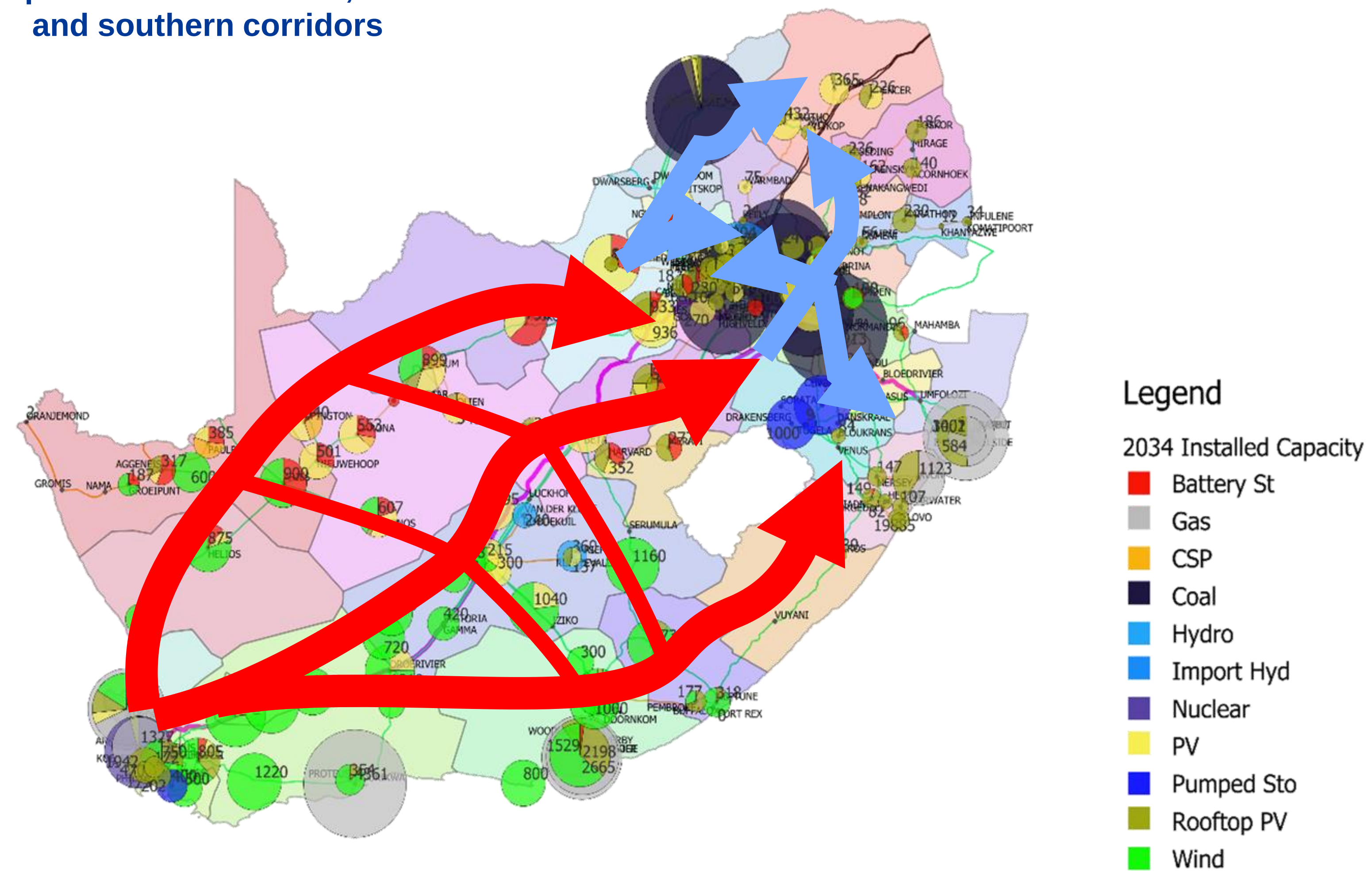
GENERATION

52% (~28%) 48% (~72%)



Generation increase in the South

Significant transmission development is required in the northern, central and southern corridors



TDP 2024 ~ Summary of major projects / schemes

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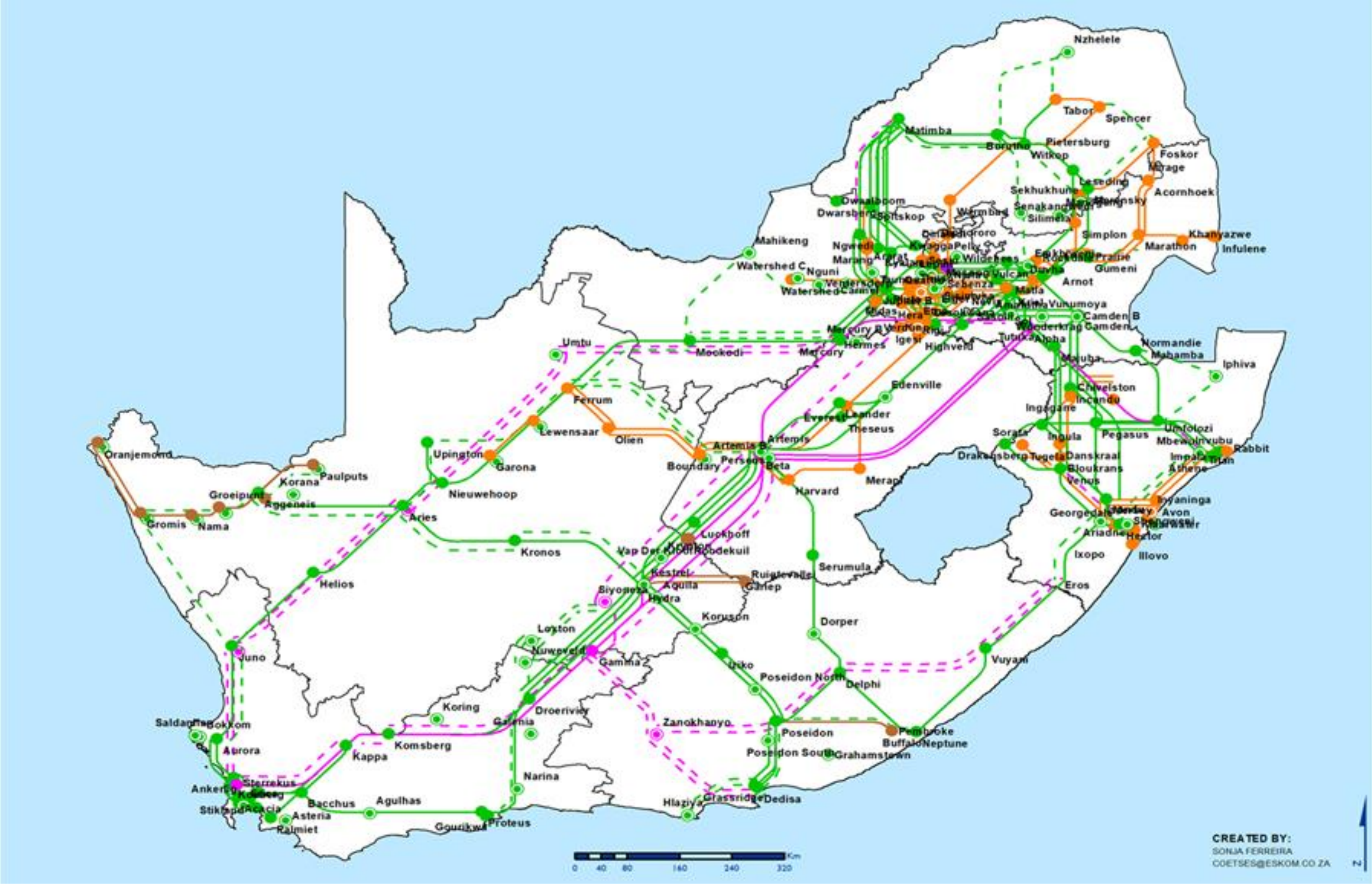
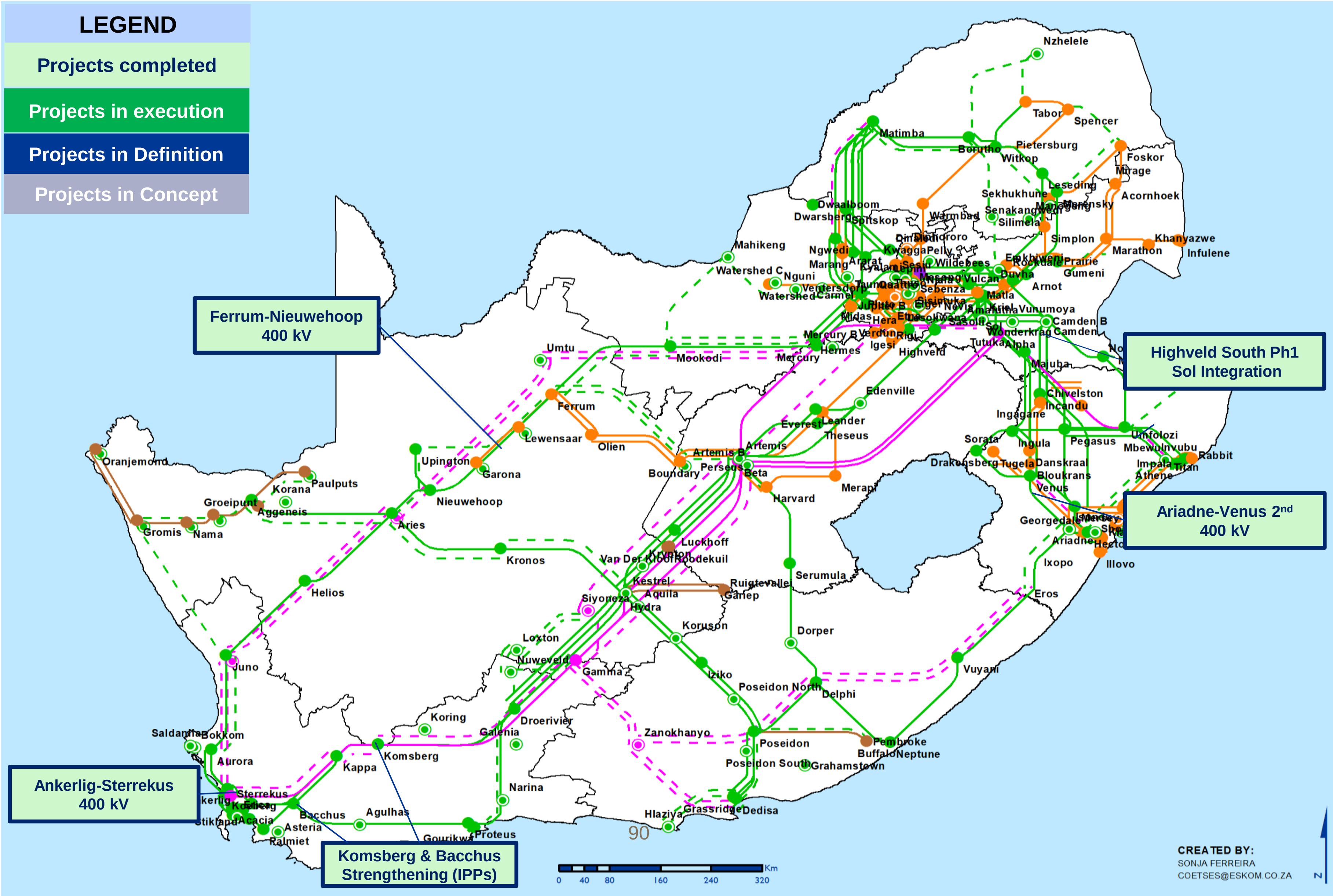


TDP 2024 ~ Summary of major projects / schemes

Eskom National Transmission Company South Africa ™



TDP 2024 ~ Summary of major projects / schemes

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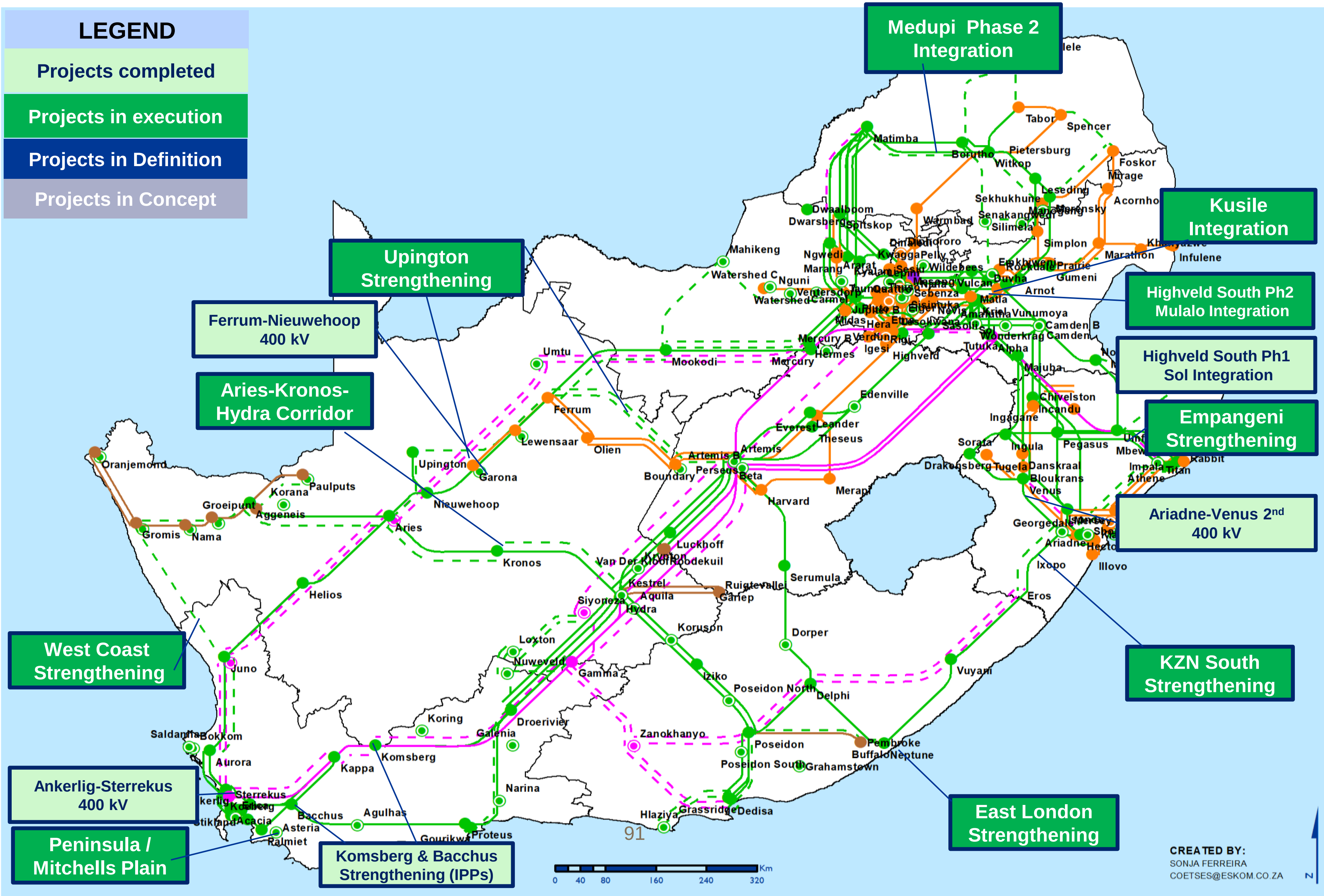

TDP 2024 ~ Summary of major projects / schemes

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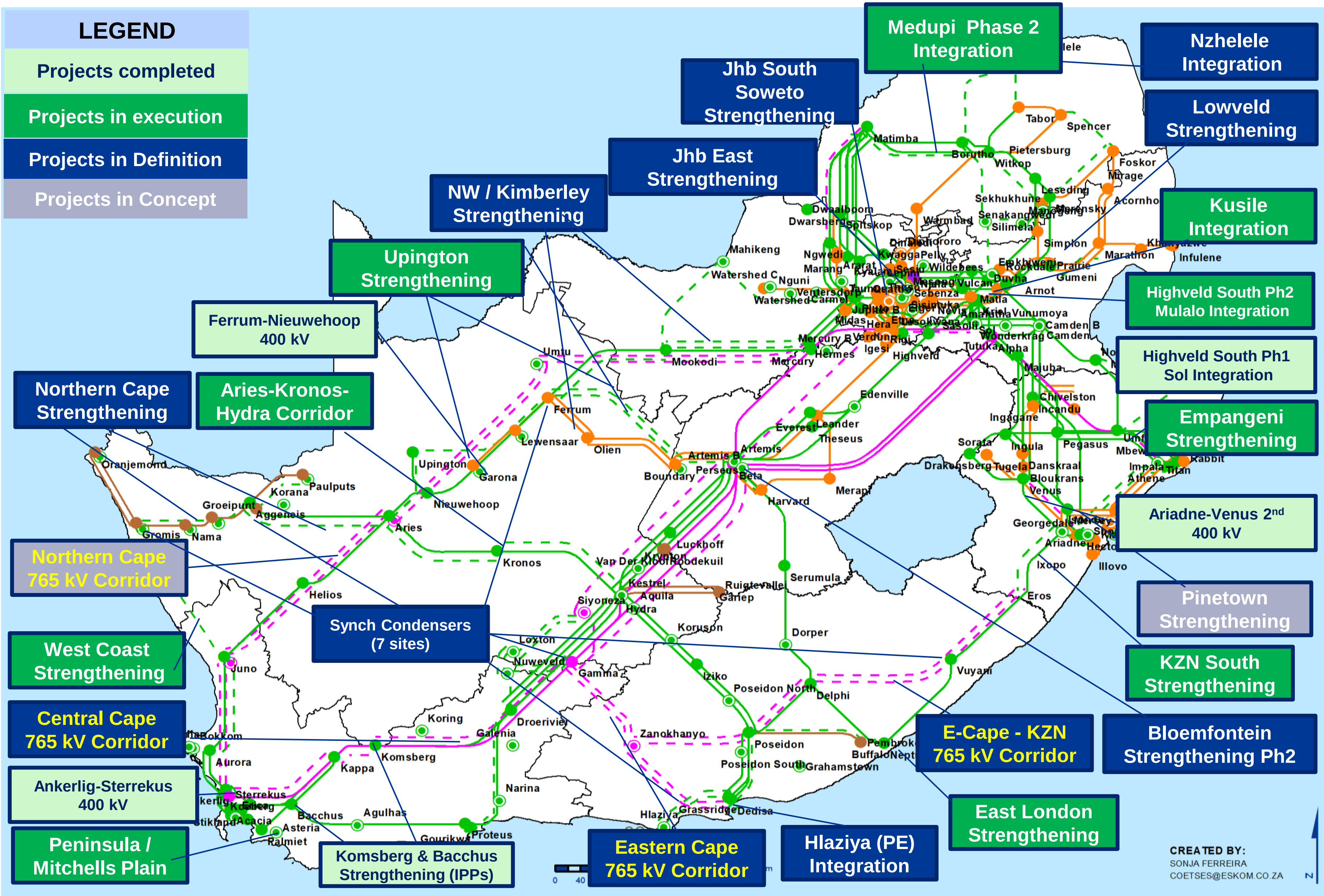
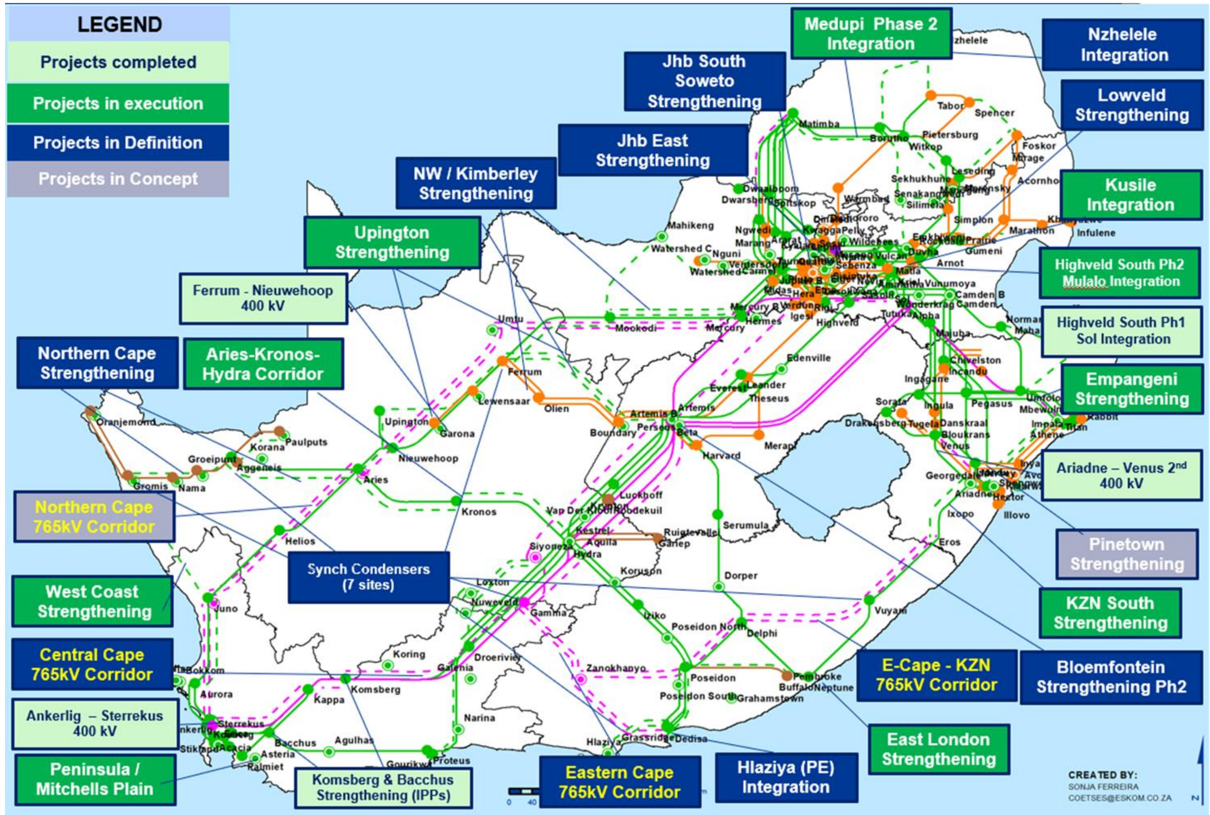


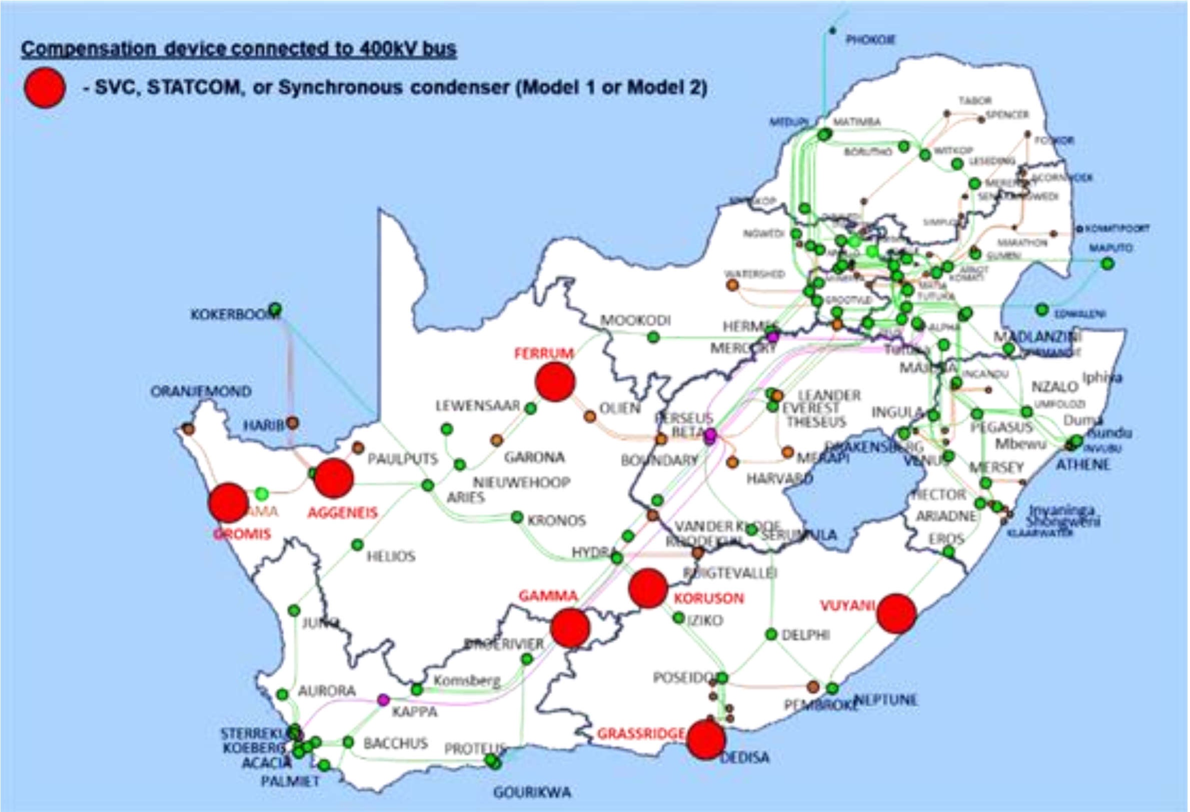
The transmission infrastructure expansion projects will stretch across all provinces in South Africa

Infrastructure requirements

Spatial overview of transmission capacity expansion projects



Spatial overview of Synchronous Condenser requirements



NTCSA is also driving actions to increase grid connection capacity and streamline grid connection process in the short term

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Short term initiatives

Increased connection capacity

Congestion curtailment:

- **3.5 GW** of additional connection capacity in the Western and Eastern Cape

Priority Projects

- **13 GW** via priortised transformer projects by 2030
- **24 GW** via expedited projects by 2033

Connection streamlining

Industry surveys

- **2025 RE Grid Survey** to better understand IPP demand for grid development
- **GCCA 2025** makes visible the available grid connection capacity

Accelerating grid capacity for RE integration: Priority transformer and line projects to integrate 37GW of new generation capacity

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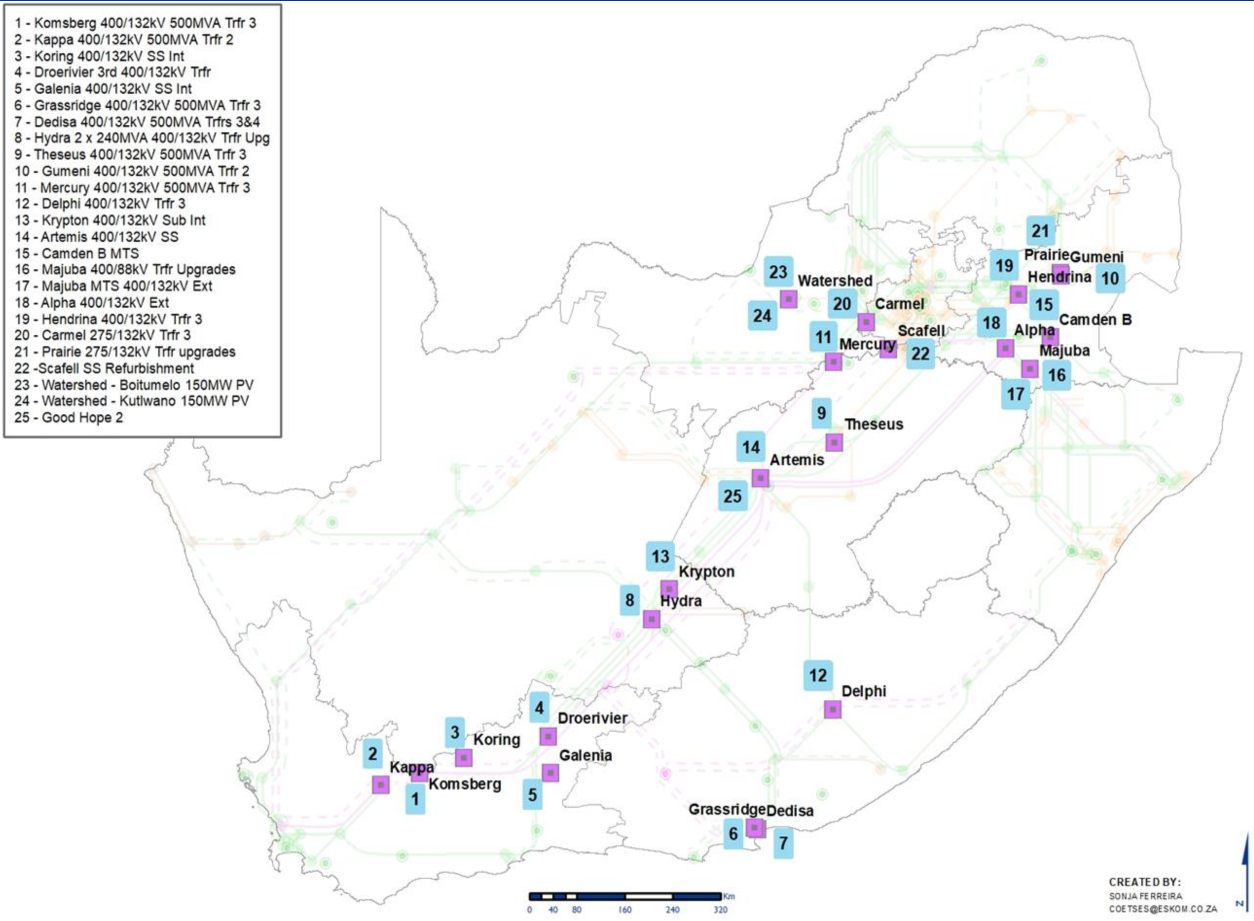

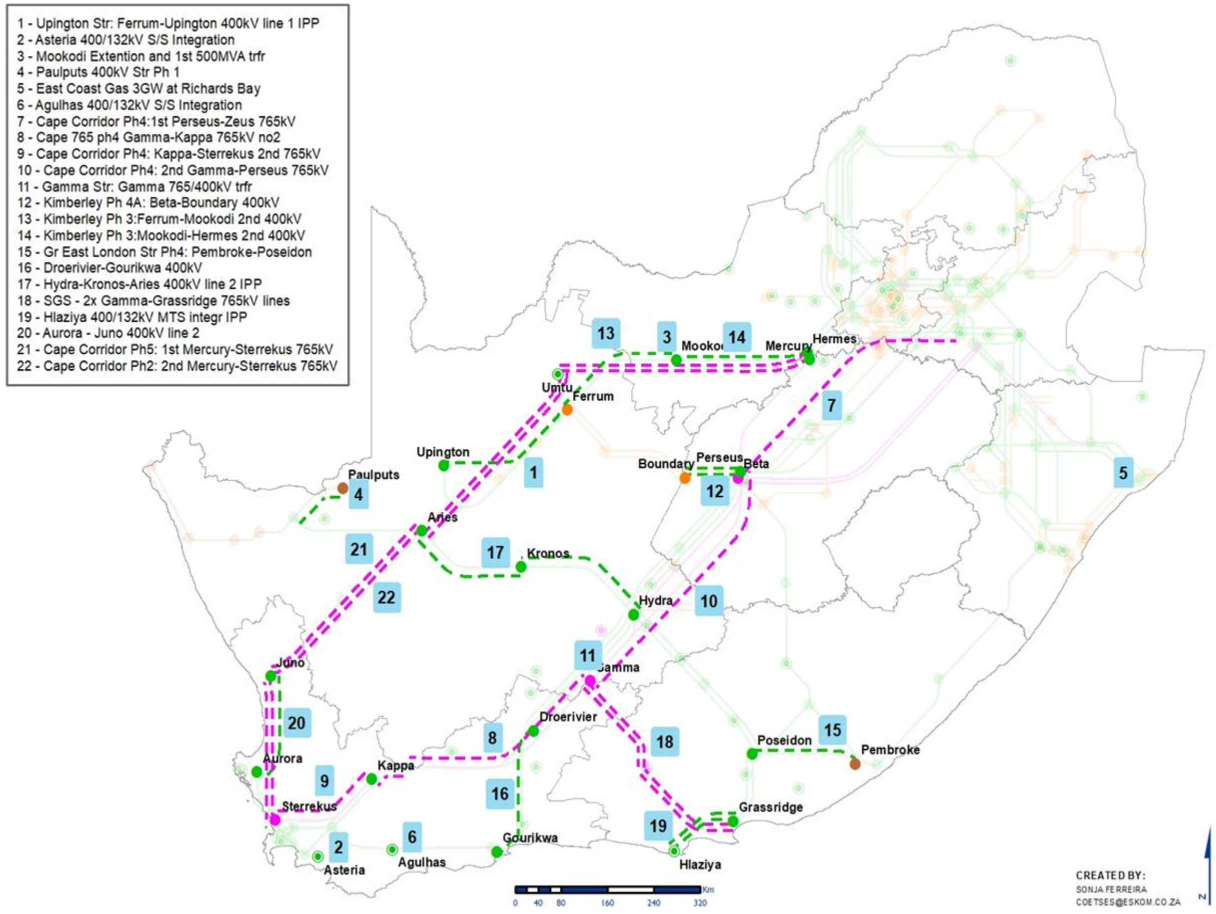

Transformers

Expedited Transformer Projects

- **25** Additional Transformer projects will enable **13 GW** of grid capacity connection starting in **2026** and ending in **2030**.

Power Lines (km)

Expedited Line Projects

- **22** power line projects will enable **24 GW** of grid capacity connection starting in **2026** and ending in **2033**.

TDP 2024 | Summary of infrastructure requirements

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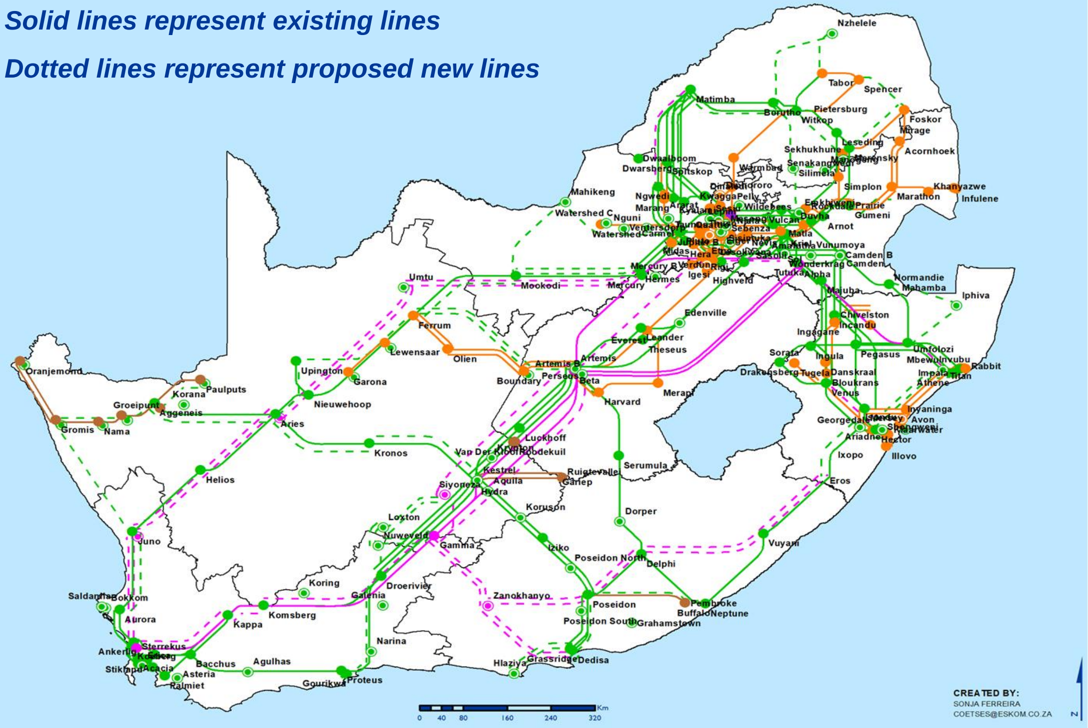
- *Solid lines represent existing lines*
- *Dotted lines represent proposed new lines*



Power Lines (km)

Transmission Assets Nationally	Total New Assets: 2025 - 2029	Total New Assets: 2030 - 2034	Total 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

Transmission Assets Nationally	Total New Assets: 2025 - 2029	Total New Assets: 2030 - 2034	Total New Assets: 2025 - 2034
Transformers			
Number of Units	87	123	210
Capacity (MVA)	41325	91325	132650

Reactors

Transmission Assets Nationally	Total New Assets: 2025 - 2029	Total New Assets: 2030 - 2034	Total New Assets: 2025 - 2034
Reactors			
Number of Units	14	45	59
Capacity (MVar)	3260	13000	16260

Synchronous Condensers

Synchronous Condensers to be to installed at 7 substations

Capacitors

Transmission Assets Nationally	Total New Assets: 2025 - 2029	Total New Assets: 2030 - 2034	Total New Assets: 2025 - 2034
Capacitors			
Number of Units	15	25	40
Capacity (MVar)	1032	1660	2692

While this is a huge challenge, The immediate focus is in the Next 5 years!

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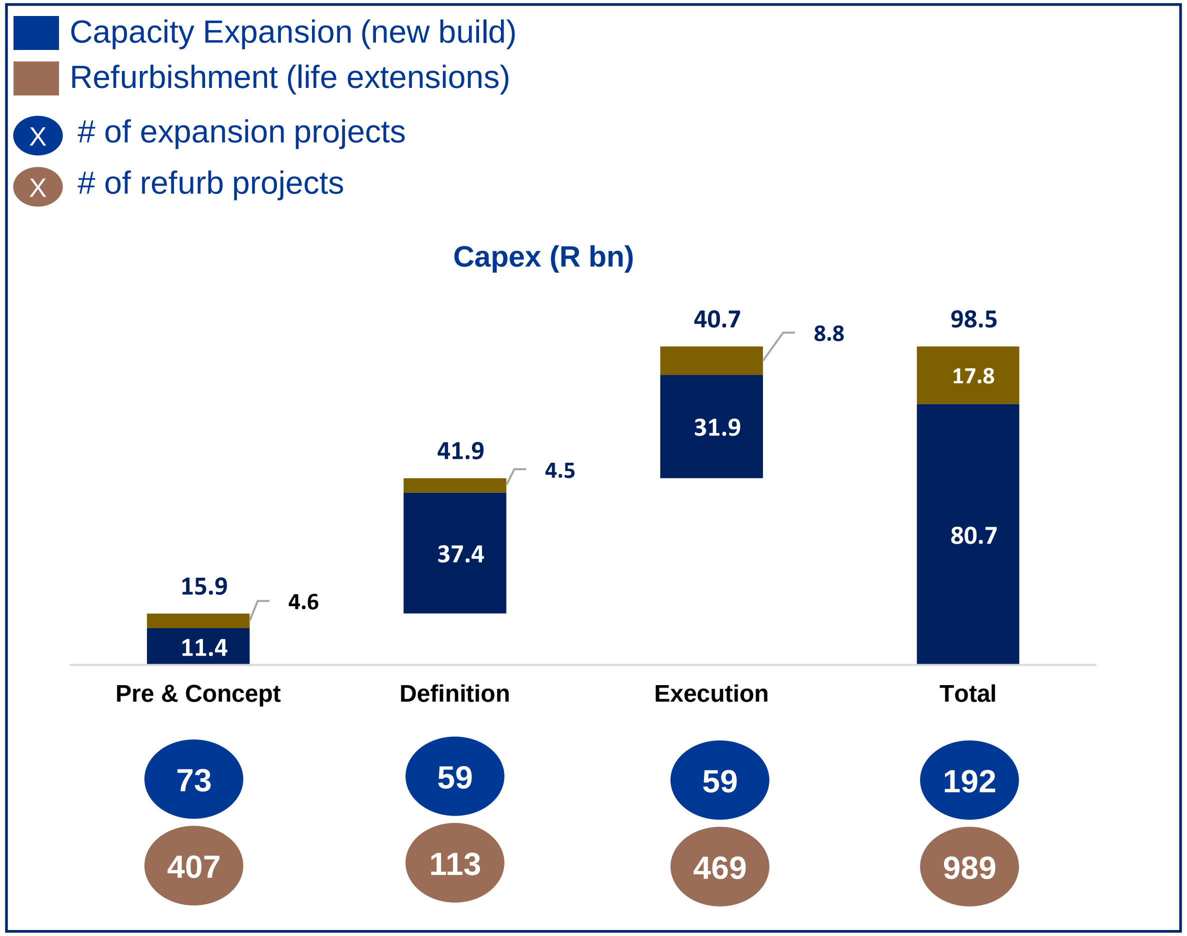
TDP 2024: Capex Analysis and Challenges



TDP 2024 ~ 5-year capital plan FY25 – FY29

Transmission TDP 2024 PLCM Capex Summary (R bn):



Challenges / Actions:

- **Based on the network requirements, ~ 5 044 km of power lines and 87 transformers are expected between 2025 – 2029**

Key Challenges:

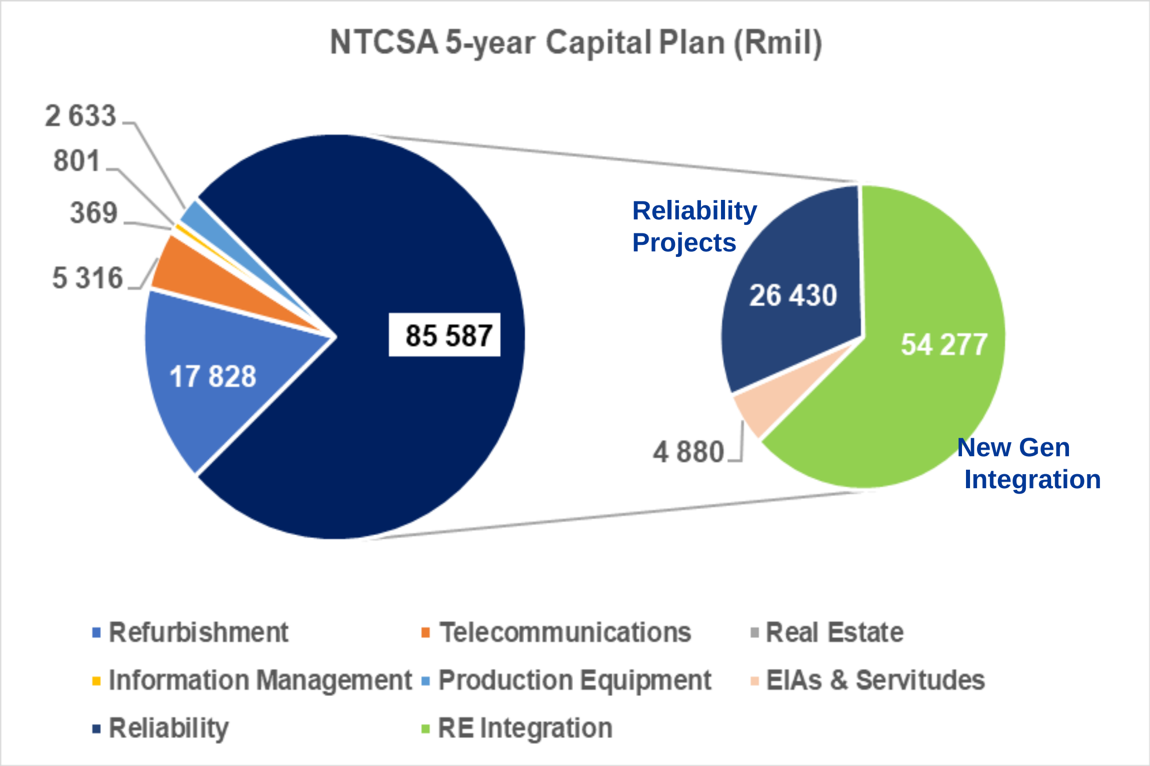
- **Securing servitudes timeously**
- **Supplier and construction capability**

Actions taken:

- **NECOM Work Stream 4 and TDP implementation Steerco established to oversee and expedite the TDP roll-out programme**
- **Prioritisation of the project portfolio**
- **Secured adequate capex for the first 5-years of the plan**

NTCSA's 5-year capex plan: FY25 – FY29

NTCSA Capex: Category (Rmil)	Total: FY25 - FY29
Capacity Expansion	85 587
Refurbishment	17 828
Telecommunications	5 316
Real Estate	369
Information Management	801
Production Equipment	2 633
	112 534



Note:

- The TDP is an unconstrained plan that addresses the country's aspirations (IRP)
- In the short-term, the focus is on expediting the TDP delivery and maximizing on available capex

Funding solutions to accelerate medium to long term implementation of TDP projects

NTCSA is supportive of innovative funding solutions such as ITPs…

The NTCSA Board has ratified the Build and Transfer model

Board supports proposed ITP pilot project

Management exploring other models such as Build, Operate and Transfer

Board mandated CEO to secure resources to support PSP initiatives

…but enablers need to be put in place to ensure successful implementation

Implementation of ERAA to enable S34B Ministerial determinations for new transmission infrastructure procurement

NTCSA is working with Ministry to develop regulations needed for ITP

Innovative solutions required to avoid encumbering NTCSA balance sheet

Cost-reflective tariff structures, policies and adequate capitalisation to ensure the NTCSA's financial sustainability

Major risks to deliver the TDP for which the NTCSA is already implementing solutions

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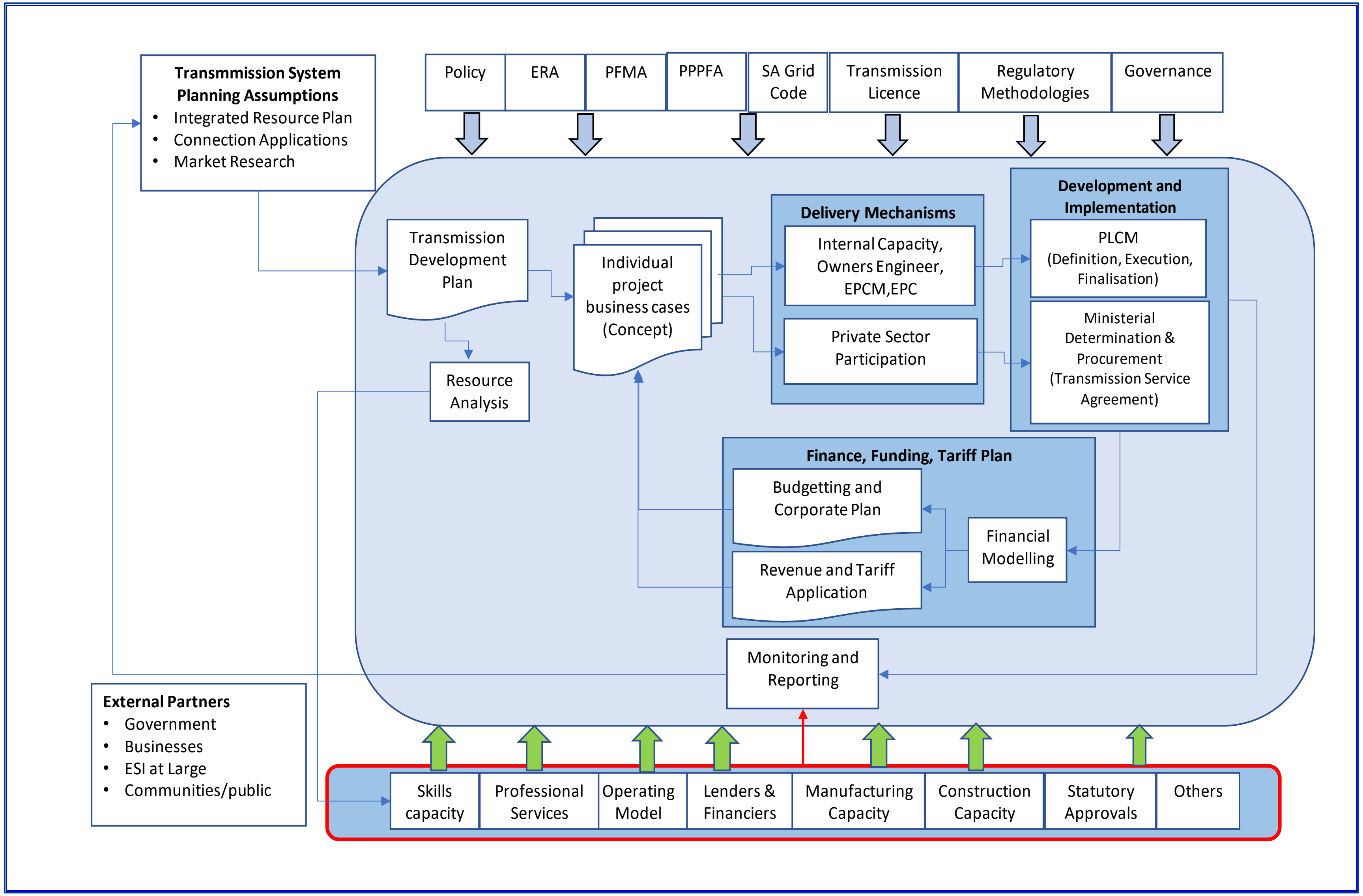
	Challenge	Solutions
Servitude Acquisition	▪ Servitude acquisition is a multi-year process, limiting the pace of the overall TDP ▪ Processing delays on expropriation applications	▪ Engagements with DPWI to address servitude challenges associated with expropriation and access to government-owned land ▪ Support from DoEE from time to time may be required
Constrained resource capacity	▪ Global supply chain constraints ▪ Local constraints in engineering, procurement and construction value chain resources throughout RSA ▪ PSP encumbrance of the NTCSA's balance sheet	▪ Project prioritisation ▪ Revised procurement strategies ▪ Developing incubators for local delivery capacity Developing new delivery models (e.g., EPC) ▪ Securing contracts for key commodities (e.g., transformers)
Capex requirements	▪ Robust revenue model required to secure capex	▪ Engage NERSA in pursuit of a cost reflective tariff; sustainable tariff model to provide capex needed, whilst ensuring affordability ▪ Engage Shareholder to ensure support and adequate capitalisation

Summarised framework for planning and rollout of TDP projects



- The outcome of the TDP is a list of projects with a high-level scope, cost, and time for the new infrastructure.
- Each project then goes through an individual detail technical / economic analysis and culminates with a business case.
- The execution of individual projects follows the project life cycle model (PLCM) and the NTCSA's governance approval process prior to development and implementation.
- Current implementation practices involve internal engineering, procurement and construction management (EPCM) and recently introduced owner's engineer (OE) and engineering, procurement and construction (EPC) panels to supplement internal capacity.
- Working closely with the DoEE to develop a framework to introduce private sector participation (PSPs) / independent transmission projects (ITPs) as an alternate model to develop and fund infrastructure roll-out for the NTCSA.

Progress on TDP Implementation Plan

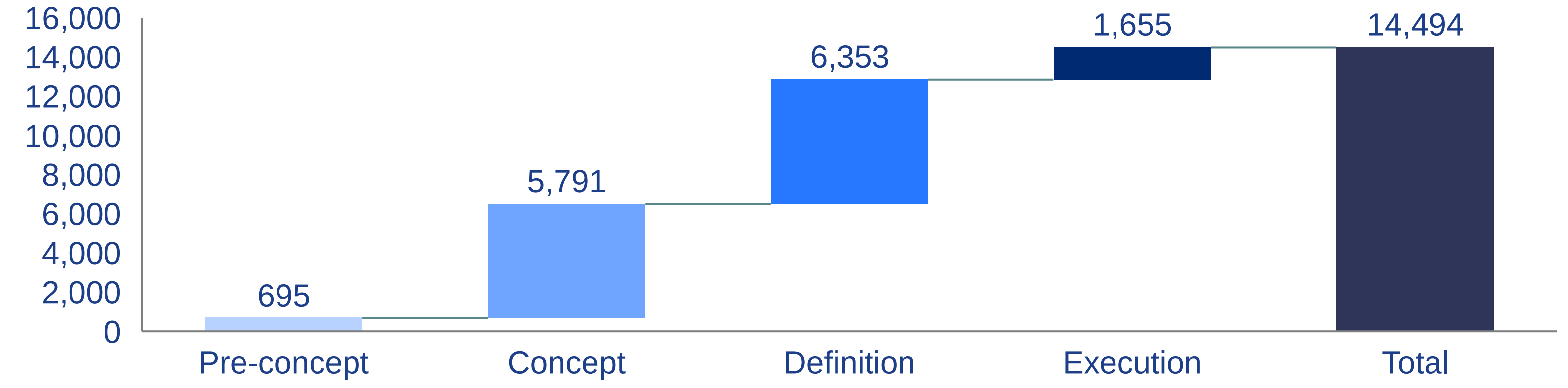
Makgwanya Maringa
Senior Manager: Project Delivery

Introduction

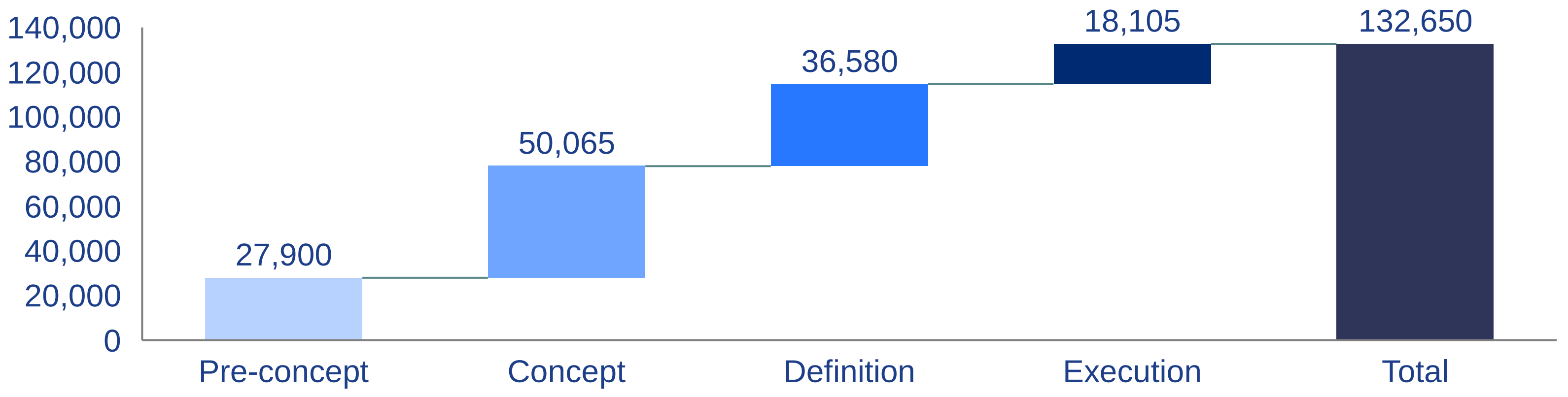
- NTCSA has a mature pipeline of project at various stages of development to deliver the TDP 2024 targets.
- NTCSA has identified priority projects to implement in the medium to long-term strategies to unlock 37 GW.
- NTCSA is already implementing strategies to overcome challenges across the value chain.
- The TDP Implementation Steering Committee and Energy NatJoints Workstream 4 were established to ensure the successful delivery of the TDP.

TDP 2024 | Expansion Projects across the Project Life Cycle Model (PLCM)

Expansion Projects across PLCM as of 30 September 2024
Overhead power lines (circuit kilometers)



Expansion Projects across PLCM as of 30 September 2024
Transformer capacity (MVA)



Pre-Concept

- Planning report
- User Requirements Specification(URS)
- Prepare for concept design approval

Concept

- Preferred technical solution & concept design
- Site and route selection
- Environmental screening studies

Definition

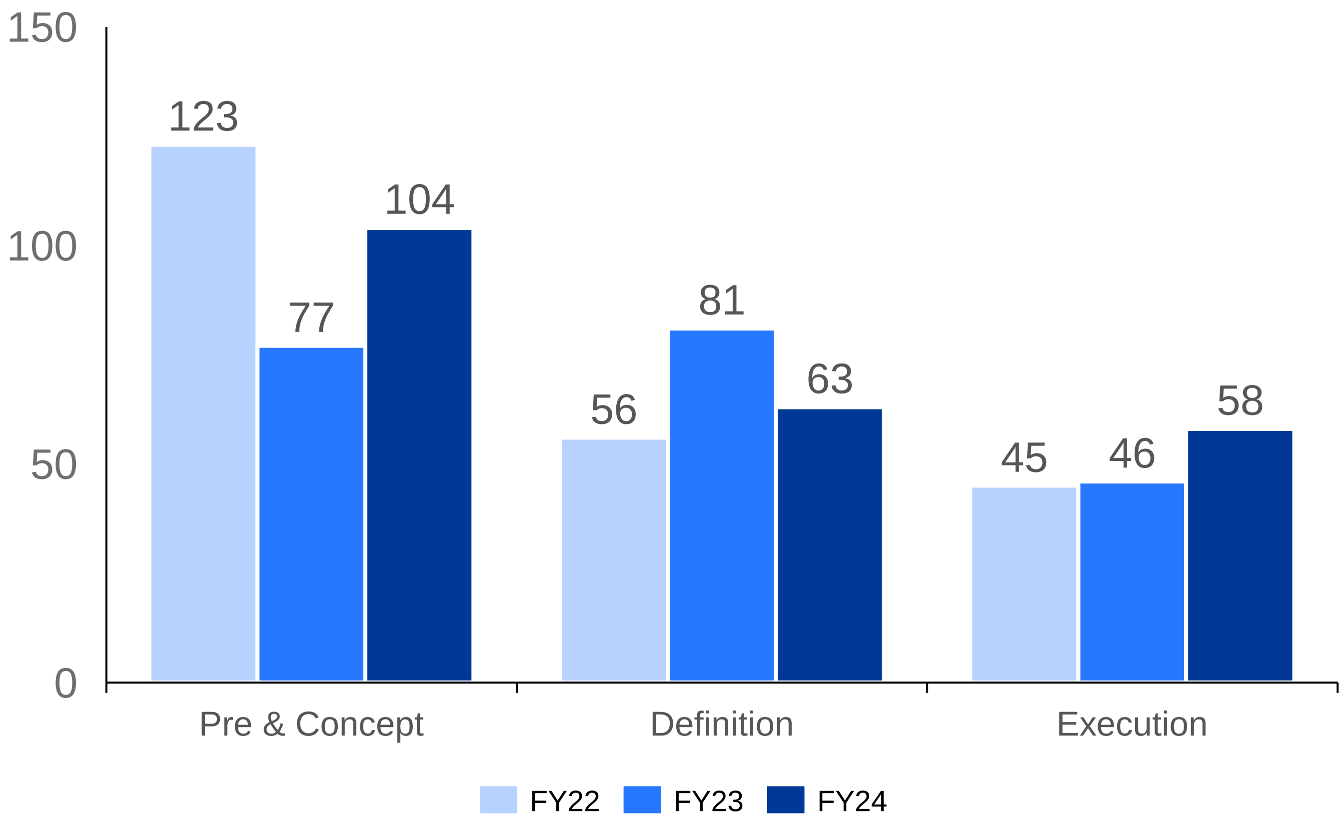
- Detailed design
- Securing land & regulatory approval

Execution

- Equipment & contractor procurement
- Construction of infrastructure

TDP 2024| Expansion Projects progress across the PLCM

Progress in Expansion Program from 1 November 2022 to 30 September 2024
(# of projects)



Expansion Projects Progress

- Projects moved into various stages of development to deliver the TDP 2024 targets

- Increase of projects in execution phase

Priority programme | 47 priority projects have been identified to accelerate 37 GW of new connection capacity by 2033

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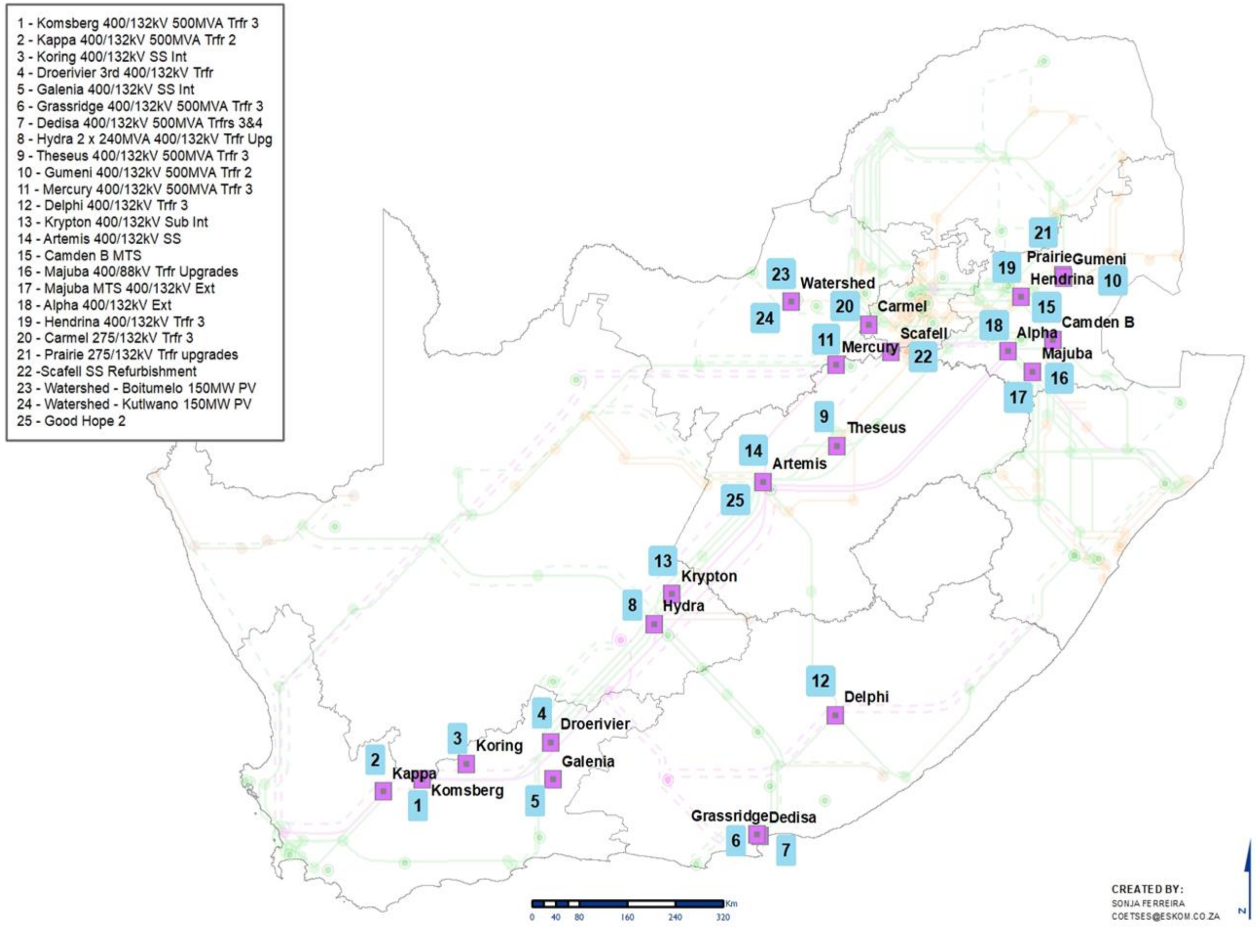
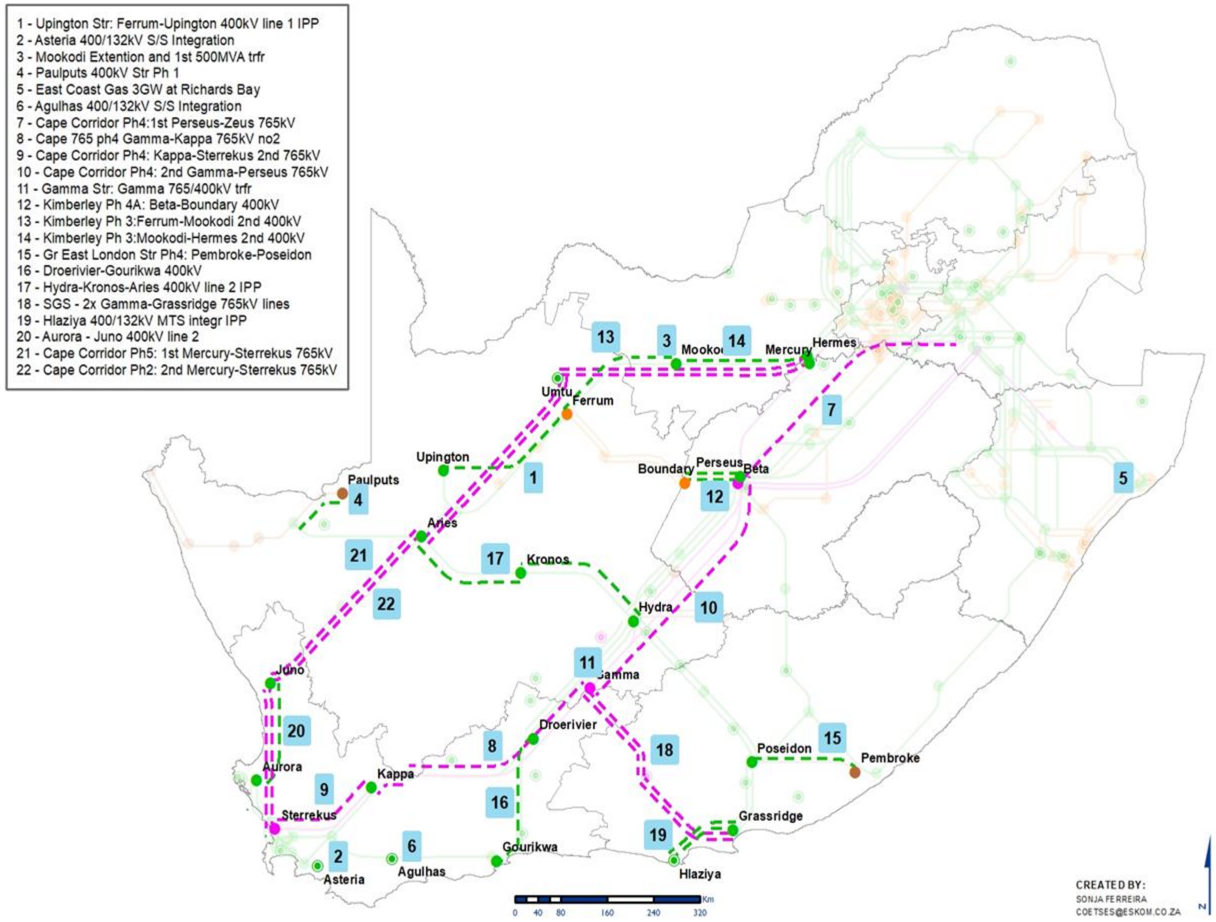


Transformers

- **13** projects in development stages to deliver **8 531 MW**
- **10** projects in procurement and construction stage to deliver **4 051 MW**
- **2** projects at PCA consisting of **950 MW**

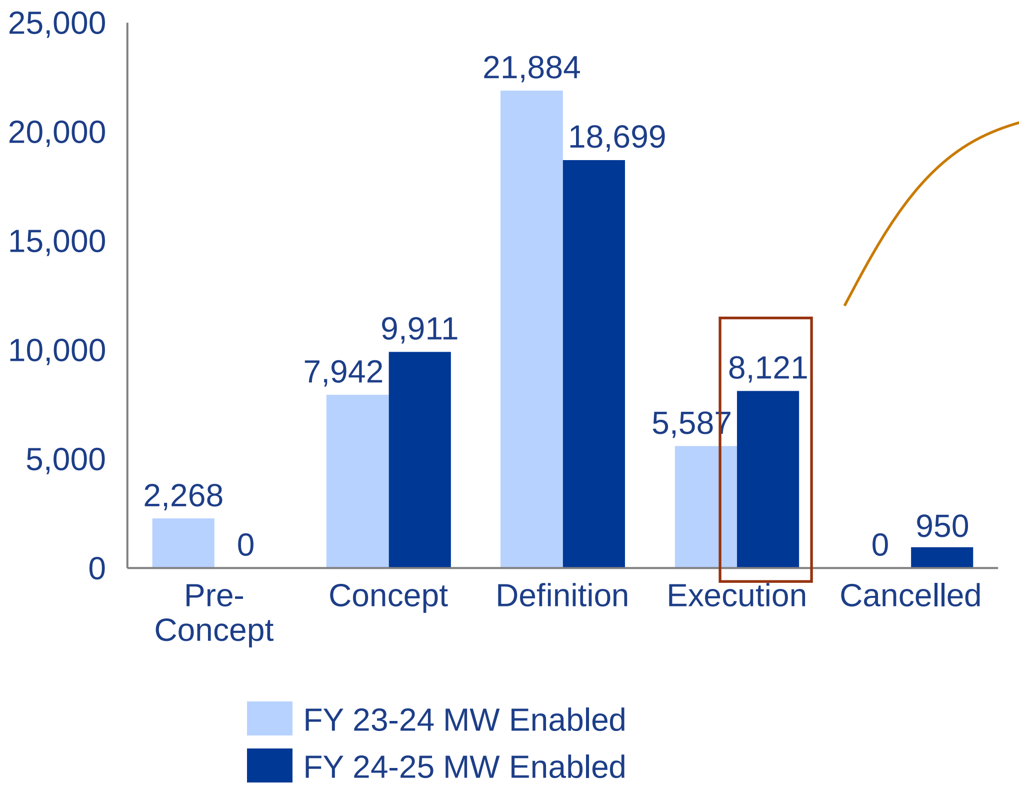


Power Lines (km)

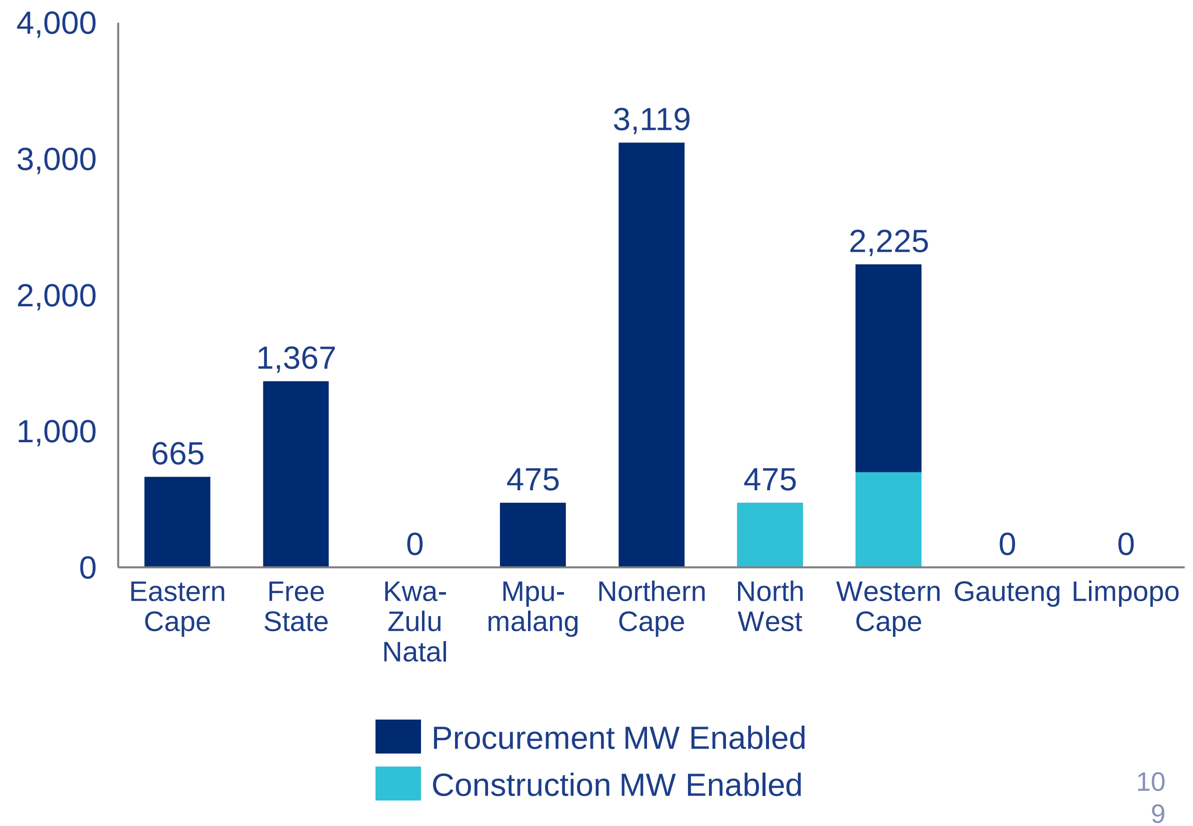
- **15** projects in development stages to deliver **6 269 km** and **20 079 MW**
- **7** projects in procurement and construction stage to deliver **808.4 km** and **4 070 MW**

Priority programme | Projects have shifted to the execution phase since 2023

Distribution of priority programme projects across PLCM as at 30 September 2024
Capacity enabled (MW)

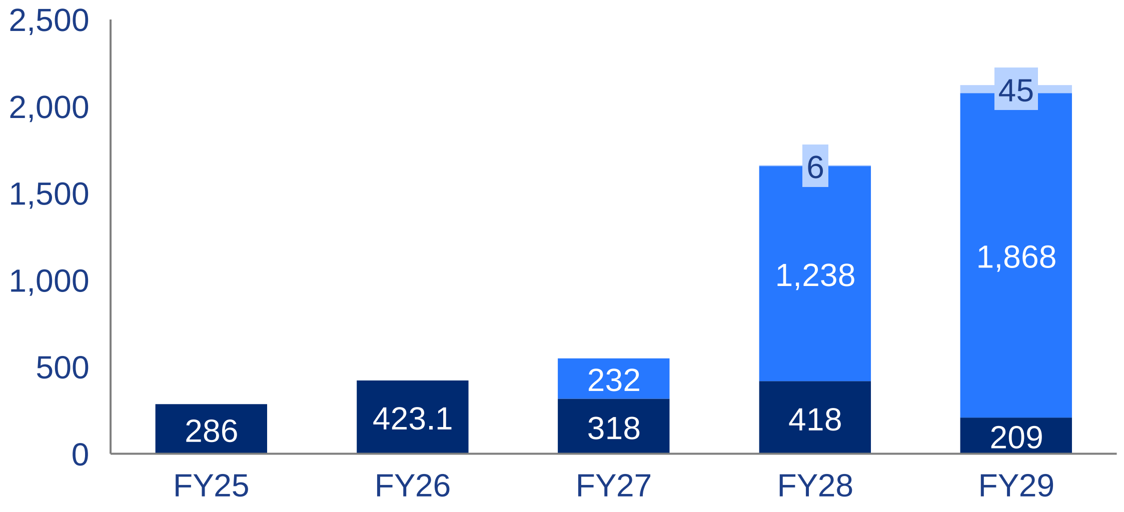


Priority Program in Procurement and Construction as at 30 September 2024
Capacity enabled (MW)

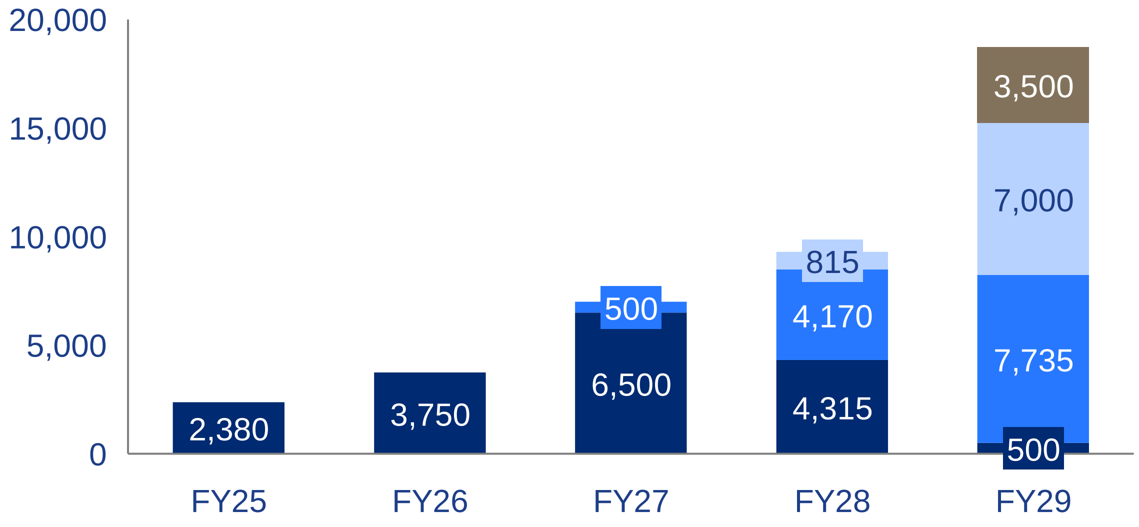


TDP2024 | 5-year delivery plan (FY25 to FY29)

Overhead power line delivery pipeline for FY 2025-2029
(km)



Transformer delivery pipeline for FY 2025-2029
(MVA)



- FY25 plan as of September 2024 was 89km, 75.8km has been achieved, which is 84% of the YTD plan (Sep 2024)
- For FY26 363km (86%) is already in construction and 60km (14%) is in the final stages of procurement
- 5 043km to be achieved by FY29, these includes projects both in development and execution phases.

- FY25 plan of 2380MVA (6 transformers) is planned to be commissioned by March 2025.
- For FY26, 2250MVA (5 transformers) civil work has commenced and 1500MVA (3 transformers) the contracts for civil work are in the final stage of procurement. All the transformers have been ordered.
- 41 165 MVA to be achieved by FY29, these includes projects both in development and execution phases.

Execution Definition Concept Pre-Project

Delivery initiatives | Development and execution challenges

Development Phase Challenges

- Servitude acquisition
- Environmental approval
- Constrained resource capacity

Execution Phase Challenges

- Safety performance
- Tender re-issue and non-responsive tenders
- Primarily delays in the manufacturing and delivery of equipment (e.g., transformer and steel supply)
- Community unrests
- Contractor performance

Delivery initiatives | Initiatives in place

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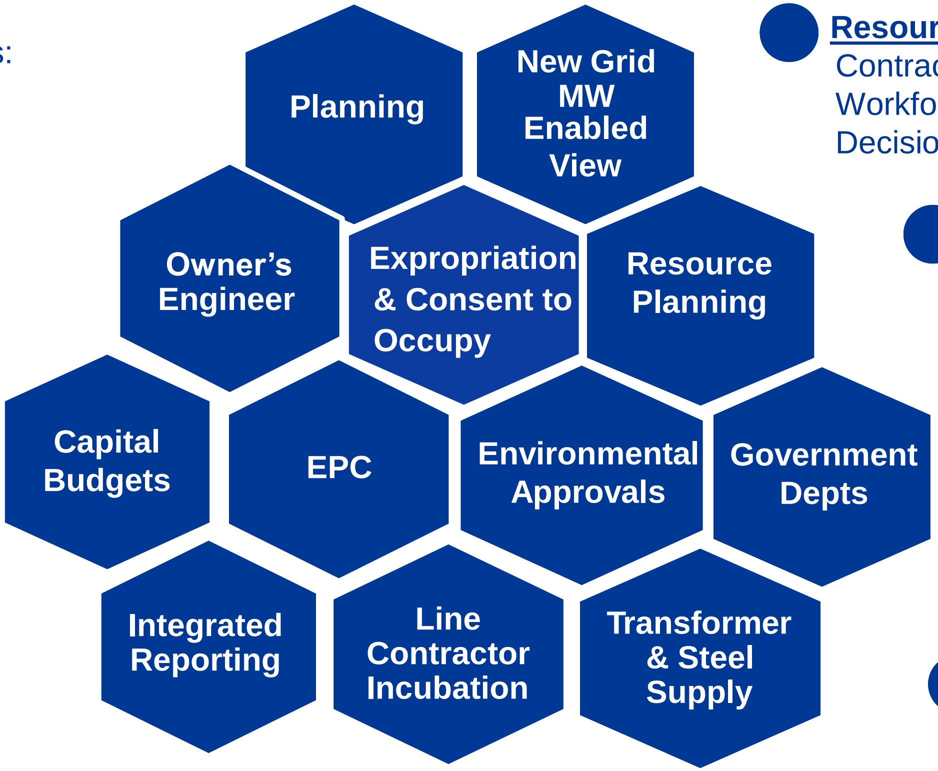
Planning
Planning and release of URSs and Reports:
- 100% reports and URS for next 3 yrs
- 100% reports and URS for next 5 yrs

Owners' Engineer (OE) & EPC
Owners' Engineer (OE) contracts **awarded Dec '23**
Lines EPC – contract **awarded Jun '24**
Substation EPC – contract **awarded Jul '24**

Capital Budgets
R112,5Bn over 5 yrs allocated

Integrated Reporting
1145 schedules captured in one tool
Analytics tool showing milestones and physicals is now in use



Line Contractor Incubation
Line contractor incubation has started. **2 Suppliers** completed the program in **Oct '24**.
Intake will be annual

Resource Planning
Contracts validity at 99%
Workforce plan revised and approved
Decision - 40% of the TDP to be executed using OE/EPC

Environmental Approvals
DFFE improved turnaround – from 107 to 57 days
NatJoints WS04 and EOSS assisting

Expropriation & Consent to Occupy
DPWI Minister approved 23 expropriations effective **Feb '23** and 10 effective **Jun '24**
DPWI Minister signed consent to occupy for 27 government properties; more submitted
Challenges have been escalated at WS10

Government Depts
Engagements with Government departments and NatJoints for additional support needed to deliver the program (one-stop shop)

Transformer & Steel Supply
Accredited 22 factories for Class 3B Transformers
101 Transformer contracts **awarded May '24**.
1st batch (22/26 Transformers) **awarded Aug'24**

6 Steel suppliers invited to prepare prototype towers;
2 suppliers delivered prototypes for final inspection in **Oct' 24**

Delivery initiatives | Initiatives in place

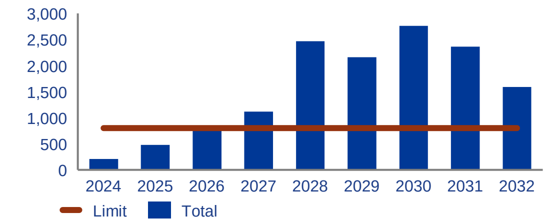
Challenge

Progress

Line construction capacity

- The required build out rate averages 1,400km per year and peaks at 2,700km.
- Our industry capacity is 800km per year, at a stretch.

Line construction demand & shortfall (km)

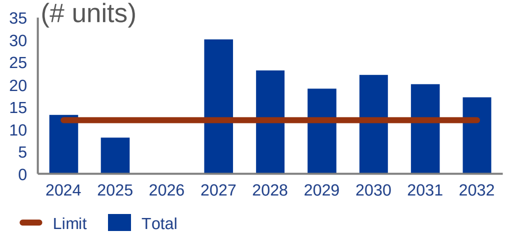


- Line contractor incubation has started. 2 Suppliers completed the program in Oct '24. Intake will be annual
- OE panel contract has been established.
- EPC Lines Engineering panel contract has been established.
- EPC Substation panel contract has been established.

Transformers

- Local supply capacity is adequate for Class 1 & 2.
- One single supplier for Class 3b. No local supplier for Class 4.

Class 3b transformer demand & shortfall (# units)

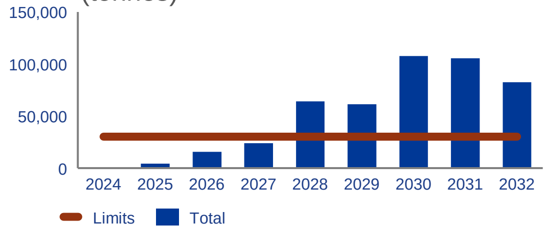


- Eskom has pre-qualified 22 international factories
- 101 transformer panel contract Class 3b transformers.
- Processes are underway to cater for all transformer classes.

Steel

- The country has one supplier of fabricated structural steel.

Steel demand & shortfall (tonnes)



- An RFI was issued to the market for structural steel for Transmission powerlines to determine the capability and capacity of the local industry. 6 Steel suppliers invited to prepare prototype towers; 2 suppliers delivered prototypes for final inspection in Oct' 24

Delivery initiatives | NTCSA will pursue different delivery models

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	Internal EPCm	EPC	EPCm	ITP
Who designs & executes	**NTCSA manages entire project** incl. design & execution	3rd party **designs and executes** based on scope	NTCSA **owners' engineers manage 3rd party** to design & execute	3rd party **designs and executes** based on scope
Who owns	**NTCSA**			3rd party **owns specific project assets for fixed period,** after which it returns to NTCSA
Enablers	Ensure adequate resource planning, programme management & project planning.	EPC Panel established	OE Panel established	▪ Pilot project supported ▪ Awaiting Regulations and Determination, enable S34B ▪ Cost-reflective tariff structures, policies & adequate capitalisation to ensure NTCSA's financial sustainability

Conclusion

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- Acceleration of projects into execution
- Significant progress has been made on key delivery initiatives
- NTCSA continues to implement strategies to deliver infrastructure that will unlock the grid
- Strategic and operational forums have been established to address challenges during the infrastructure delivery program
- Current outlook indicate shift in readiness and capability to deliver set targets
- The TDP delivery challenges such as construction capacity, equipment supply, and statutory approvals are being addressed to ensure successful delivery of the programme

What does TDP delivery success look like?

- Safe execution - *Zero Harm*
- Ethical behavior - *Integrity*
- Deliver excellently engineered, constructed, best performing assets
- Positive impact on communities

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Thank you

Conclusion

Q & A Session


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Thank you
for attending!