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IGCAR – LESSONS LEARNT

Seetsele Seetswane

20 May 2025

Brief history

2022 First ready first served concept

- Criteria very simple provision of end user information in end user letter head
- Grid capacity check done before BQ development will proceed
- Attempts to apply it towards the end of 2022 in the Cape provinces

2023 GCAR proposed for codification

- A comprehensive criteria developed assessing readiness of the project
- Criteria include w.r.t facility
- Sufficient Land rights,
- EA,WULA and CAA approvals,
- PPA Heads of Terms

- W.r.t grid capacity optimization for use by NSP
  - resource measurement data
  - Technology type
  - Project size
  - Timelines to execute project
- w.r.t grid connection works readiness
  - Design consultants
- Other:
  - NSP would provide real-time data on capacity allocations

2023 IGCAR adopted as clarified

- A comprehensive criteria developed assessing readiness of the project
- Criteria include w.r.t facility
  - Sufficient Land rights,
  - EA,WULA and CAA approvals,
  - PPA Heads of Terms
- W.r.t grid capacity optimization for use by NSP
  - resource measurement data
- w.r.t grid connection works readiness
  - Design consultants
- Other:
  - NSP would provide regular update via the GCCA on allocations information

IGCAR March 2025 Update

Criteria	Clarification	Problem being solved
3(1) (b) Proof of payment	BQ fee invoice maybe withheld & issued only when all documents have been provided, except NERSA registration application proof	Developers pay QF and don't submit other docs, therefore attempting to reserve a space/hog capacity
Cover letter	Indicating all info submitted and dates such approval was obtained	Ensure there is alignment in documents and establishing when last of criteria was met
3(1) (c)NERSA Proof of application for registration/Generation License	IPPs may require an NSP letter before they can apply to NERSA. NSP Consent letter only issued after BQ payment. Generator MEC/installed capacity to match end-user NMD on NSP Consent letter	To ensure generation and demand balance. Current applications at various stages exceed 200GW, BQ requests/development>23GW. Current Eskom peak demand 32GW
	No traders' details will go into NSP consent letters going forward (from 08 November 2024). Traders (licensed, unlicensed, aggregators) will be seen as end users who actually consume energy (e.g. large mines) and therefore must provide account details of account /Point of Delivery for the NSP letter	There are no NERSA rules for traders, Eskom is working with relevant stakeholders including NERSA to develop a framework (or Rules) to regulate trading.

IGCAR March 2025 Update

Criteria	Further Clarification	Problem being solved
3(2)(b) PPA HoT	• Section 34 IPPs must issue a preferred bidder appointment letter. Whether there is a firm intention to sell or buy power between both parties. Generator Capacity must match offtaker/end user NMD.	To remove doubt To keep to the purpose of IGCAR to prevent hogging of capacity where Gx capacity is exceedingly higher than offtaker NMD
3(2) (c) Design consultants	**Appointment Letter from IPP Developer Appointing Design Consultant(s) for Substation and Power Line Designs** • It must be indicated on the appointment letter if the appointed design consultant is going to subcontract other services.	Further clarity
	Appointed Design Consultant Company Profile indicating projects. • Relevant projects related to Tx (NTCSA), Dx and Renewable Energy. • The resource names and roles in the project must be indicated by the Design Consultant(s) on the supplementary letter of design consultant(s).	Further clarity
	Appointed Design Consultant(s) Lead Designers and Engineers CV's and Relevant Qualifications • 1 x Overall Lead Engineer, 2 x Electrical Substation Engineers (1 x Primary and 1 x Control Plant), 1 x Overhead Line Engineer, 1 x Civil, 1 x Structural Engineer, 1 x PTM&C, SCADA and Telecoms Engineer. • Other relevant disciplines with clearly marked electrical and renewable energy projects experience and Valid ECSA registration. • Not applicable for an Eskom build.	Further clarity

IGCAR March 2025 Update

Criteria	Further Clarification	Problem being solved
3(2)(d) Measurement data	• LIDAR may be used for at least a year of measurement for the four corners of the site. • No data may be used from adjacent sites. • For dispatchable technologies, generation profiles are required i.e. when will power be dispatched, when the BESS charges/discharges, and any seasonal changes e,g, a hydro plant that generates during the rainy season (winter only in the Western Cape).	Further clarity not previously provided
3(4) (a) Grid Capacity Allocation guarantee	• Guarantee is based on new Installed generation capacity. For existing plants that apply to increase their MEC and/or Installed capacity, IGCAR Guarantee is based on additional capacity, that is the difference between the original MW value and new MW value. • Where the generator is behind the meter and the customer will increase the load to at least match the generator capacity, then the IGCAR guarantee will not be payable (zero-sum generation impact on the network). This is applicable only where the CEL was issued based on an additional load matching the generator capacity and the zero-sum generation impact is confirmed. • Similarly, if the customer is installing BESS to be charged from PV as an example, the customer will be liable to provide the guarantee that is the higher of the generation capacity (PV) and the BESS (export) capacity.	Generators installed behind the meter with zero export capacity (MEC) have an impact on the integrated power system, so the capacity that matters is the installed capacity.

Challenges

- Exponential increase in applications requires that a proper system be put in place to ensure transparent , consistent and fair management. Reconciliation for energy accounting.
- Problems picked up and we are working on:
  - Same CV for consultants used repeatedly by various developers
  - Simulation of PPAs, HoTs and insufficient and effective mechanisms to validate firm intention to contract.
  - End users/offtakers are repeatedly used many times especially where there is a trader in submission by many developers/IPPs
  - Land rights w.r.t. tribal land and no delegation from Minister of DALRRD.
  - A lot of developers with scope that is dependent on strengthening of the evacuation corridors in the Cape (765kV lines etc), expect that they should not provide the guarantees. Developers must provide IGCAR guarantee or await the evacuation corridors then apply to connect.
  - Consultation process to review IGCAR and migrate towards GCAR.

Conclusion

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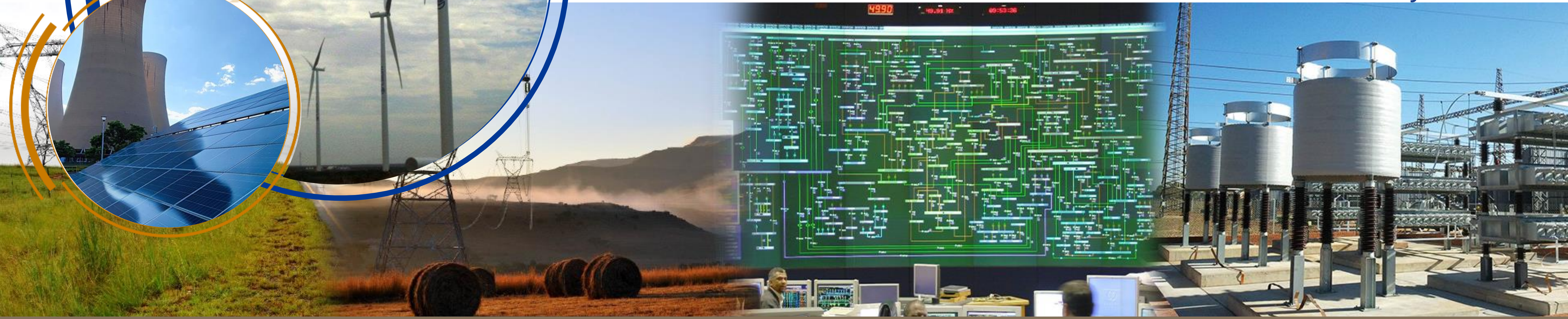
Guidance Notes Related to the Grid Code Requirements of Hybrid Power Plants

Presented By: Jesse Mekwa
Themba Khoza
Target Mchunu

Date: 20 May 2025



Overview

- Introduction
- Grid Code Evolution
- Objective of the Hybrid Power Plant Guidance Note
- Hybrid Power Plant Guidance Note
    - New Terms
    - Connection Requirements
    - Testing and Compliance Monitoring
- Lessons Learnt and Progress to date

Grid Code Objectives

Establishes reciprocal obligations of ESI participants

- Connection and use of the distribution and transmission power systems
- Development of the network
- Operation of the Interconnected Power System (IPS)

Defines minimum technical requirements

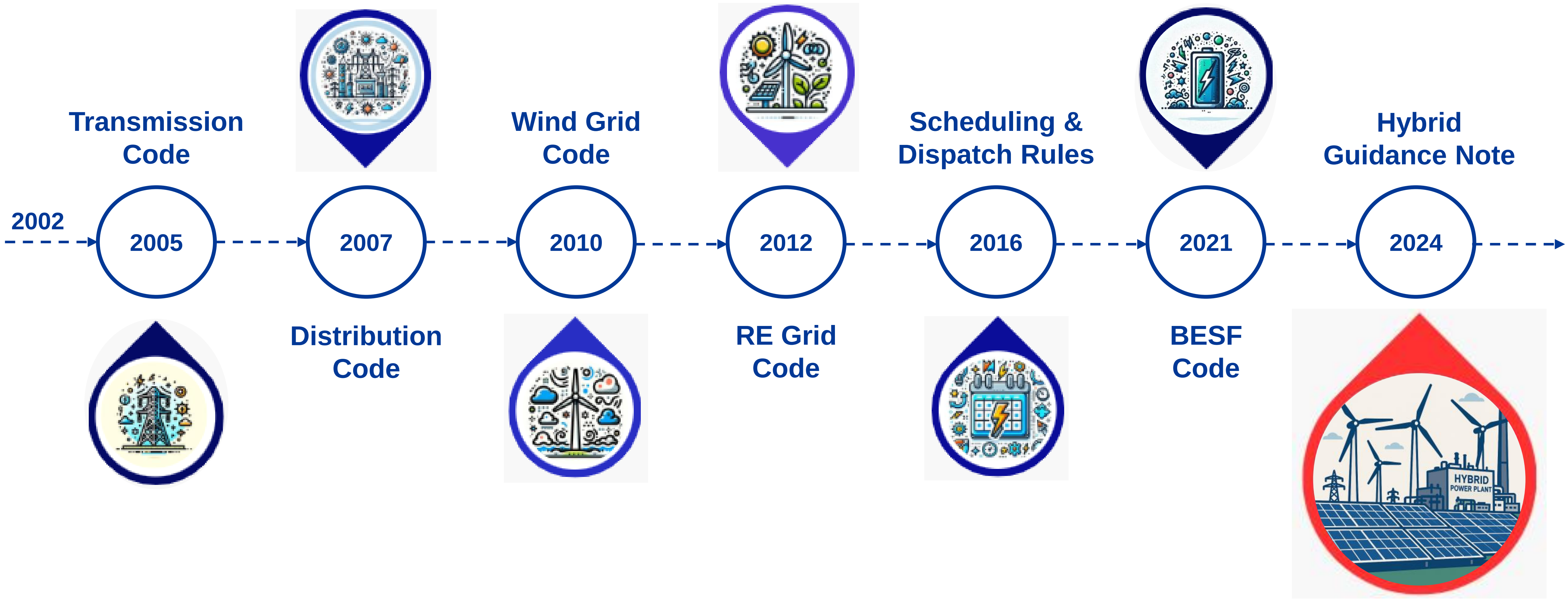
- Network Service Providers (NSPs)
- Generators (all types)
- Load customers

Ensures

- Non-discriminatory access to the IPS by both generators and loads customers
- Adherence to minimum technical requirements
- Maintain system integrity & adequate service delivery
- Defined accountabilities
- Information availability

Security Reliability Stability Efficiency

Grid Code Evolution



Objective of the Hybrid Power Plant Guidance Note

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Problem

- Hybrid Power Plants came in response to the RMIPPPP
- Technical requirements for Hybrid Technology not specified in the Code
- Nor did it envisage Hybrid technology being configured as part of an existing generation or demand scheme
- Hybrid technology is not defined in the Grid Code

Solution

- To facilitate the RMIPPPP
- To assist Hybrid Power Plants to comply to the approved SAGC, where two or more Codes have different capability requirements under similar operating scenarios
- No clause or condition in the Hybrid Guidance Note takes precedence over any clause or conditions in the SAGC

Applicable Codes

- SAGC Preamble Version 10.1 (i.e. Preamble Code)
- SAGC Network Version 10.1 (i.e. Network Code)
- Grid Connection Code for Renewable Power Plants v3.1 (i.e. RPP Code)
- Battery Energy Storage Facility Code v5.3 (i.e. BESF Code)
- Depending on the technologies used, more than one Code may be applicable

GUIDANCE NOTE – GRID CODE REQUIREMENTS FOR HYBRID POWER PLANTS

New Terms

Hybrid Power Plant:

A Facility that has a combination of two or more of the following technologies connected to the same *POC* and operate as a single entity:

- PV
- Wind
- Energy storage
- Alternator

Operating Scenario:

Operation of a *Hybrid Power Plant* such that one or more technologies (e.g., PV, Wind, BESF and/or Alternator) are in operation at the same time (refer to Appendix A).

Scenario	BESS disch.	PV	BESS charging	Description
A	✓	✗	✗	Only BESS available to meet dispatch instruction prior to sunrise
B	✓	✓	✗	BESS supplements PV to meet dispatch instruction
C	✗	✓	✓	PV alone meets dispatch instruction and excess PV charges BESS
D	✗	✓	✗	PV curtailed to MEC, BESS fully charged

Renewable Energy Technical Evaluation Committee (RETEC):

RETEC is a technical team within the *System Operator* established to validate or verify compliance to the *SAGC* as demonstrated by the *RPP Generator* in respect of his/her *RPP*.

Connection Requirements

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Table 1: *Hybrid Power Plants* Categories

Category	*Hybrid Power Plant's MCR*		
A	>0	to	< 1 MW
A1	>0	to	≤ 13.8 kW
A2	>13.8 kW	to	<100 kW
A3	≥100 kW	to	<1 MW
B	≥1 MW	to	<20 MW
B1	≥1 MW	to	<5 MW
B2	≥5 MW	to	<20 MW
C	≥20 MW	to	<800MW
C1	≥20 MW	to	<100 MW
C2	≥100MW	to	<800 MW
D	≥800 MW		

The requirements of the Grid Code are applicable to Hybrid Power Plants depending on the rated capacity according to Table 1

Hybrid Power Plants shall operate continuously, at any power between Minimum Generation and MCR, within voltage range at the POC according to Table 2

Table 2: Minimum and maximum operating voltages at *POC*

Nominal voltage, Un [kV]	U_{min} [pu]	U_{max} [pu]
765	0.95	1.05
400	0.95	1.05
275	0.95	1.05
220	0.95	1.05
132	0.90	1.0985
88	0.90	1.0985
66	0.90	1.0985
44	0.90	1.08
33	0.90	1.08
22	0.90	1.08
11	0.90	1.08
6.6	0.90	1.08
3.3	0.90	1.08

Frequency response, active power constraint functions, reactive power capability, reactive power and voltage control, fault ride through, power quality and protection are all referenced in the Hybrid Guide Note and refer to the relevant code for applicability.

A.1 Studies and Tests Requirements

Requirements	Pre-connection study	GCC Tests	RMS Model validation
Reactive power capability	All operating scenarios		All operating scenarios (Updated)
20 degree phase jump	All hybrid operating scenarios (more than one technology in operation)		All hybrid operating scenarios (more than one technology in operation) (Updated)
Frequency trips (Under and Over)	All hybrid operating scenarios (more than one technology in operation)		All hybrid operating scenarios (more than one technology in operation) (Updated)
Fault ride through	All operating scenarios		All operating scenarios (Updated)
Absolute		All operating scenarios unless otherwise agreed with the system operator	All operating scenarios as per the site testing
Gradient		All operating scenarios unless otherwise agreed with the system operator	All operating scenarios as per the site testing
Delta		All operating scenarios unless otherwise agreed with the system operator	All operating scenarios as per the site testing
Frequency Response		All operating scenarios unless otherwise agreed with the system operator	All operating scenarios as per the site testing
Reactive power control		All operating scenarios unless otherwise agreed with the system operator	All operating scenarios as per the site testing
Power factor control		All operating scenarios unless otherwise agreed with the system operator	All operating scenarios as per the site testing
Voltage Control		All operating scenarios unless otherwise agreed with the system operator	All operating scenarios as per the site testing

First Hybrid Power Plants Tested: SK1, SK2 and SK3

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- Scatec Kenhardt 1, 2 and 3 Solar PV and BESS hybrid plants were successful bidders in the RMIPPPP
- Each plant is required to dispatch MEC from 05:00 to 21:30 daily
- The plants are located just outside the Northern Cape town of Kenhardt

Item	Value
Maximum Export Capacity at POC	**50 MW**
Installed PV Capacity	180 MWp
Installed BESS Capacity	380 MWh (75MWp)
Installed HV Transformer	80 MVA

Scenario	Time (typical)	BESS disch.	PV	BESS charging	Description
1	05:00 – 06:30	✓	✗	✗	Only BESS available to meet dispatch instruction prior to sunrise
2	06:30 – 08:00	✓	✓	✗	BESS supplements PV to meet dispatch instruction
3a	08:00 – 17:00	✗	✓	✓	PV alone meets dispatch instruction and excess PV charges BESS
3b		✓	✓	✗	BESS supplements PV to meet dispatch instruction during periods of cloud cover
3c		✗	✓	✗	PV curtailed to MEC, BESS fully charged
4	17:00 – 19:00	✓	✓	✗	BESS supplements PV to meet dispatch instruction
5	19:00 – 21:30	✓	✗	✗	Only BESS available to meet dispatch instruction prior to sunrise
6	21:30 – 05:00	✗	✗	✗	Plant curtailed to zero

Lessons Learnt and Progress to date

01 **Multiple teams are required to test the different technologies separately and together**

02 **Pre-planning and preparation are vital i.e., testing procedure**

03 **Understanding practical vs theorical**

04 **Review to include Zero MW Export Hybrid Plants**

Conclusion

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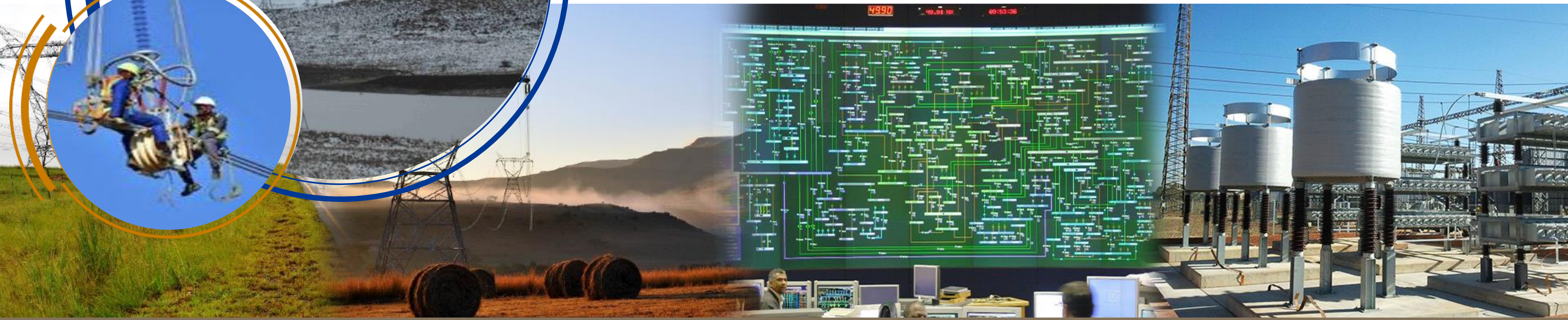
Accelerating Grid Connection for IPPs and Generators
Grid Connections Enablement

Presented By: Makoanyane Theku (NTCSA), Caswell Ndlhovu (NTCSA) & Crescent Mushwana (IPPO)

Date: 20 May 2025



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Grid Connections Enablement Overview

Accelerating Grid Connection for IPPs and Generators
Grid connection enablement initiatives

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Several grid connections enablement initiates have been initiated (at different stages of life-cycle), notably:

- Interim Grid Capacity Allocation Rules (IGCAR)
- Expediting TDP implementation
- Congestion curtailment as constrained generation ancillary service
- Grid Stability Enhancement
- Batched Generation Connections Framework (BGCF)
- Renewable Energy Surveys
- Private sector participation
- National Collector Substation Networks

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The presentation focus areas

- TDP implementation, Grid Stability Enhancement, Renewable Energy Surveys and National Collector Station Enablement

Outline

1. Grid Capacity Allocation and TDP Delivery progress
2. Sustainable connection of Energy from Renewables Sources
    i. South African Renewable Energy Grid Survey
    ii. Grid Stability Enhancement
3. National Collector Substation Networks

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Grid Capacity Allocation and TDP Delivery progress

Presented By: Makoanyane Theku

Date: 20 May 2025

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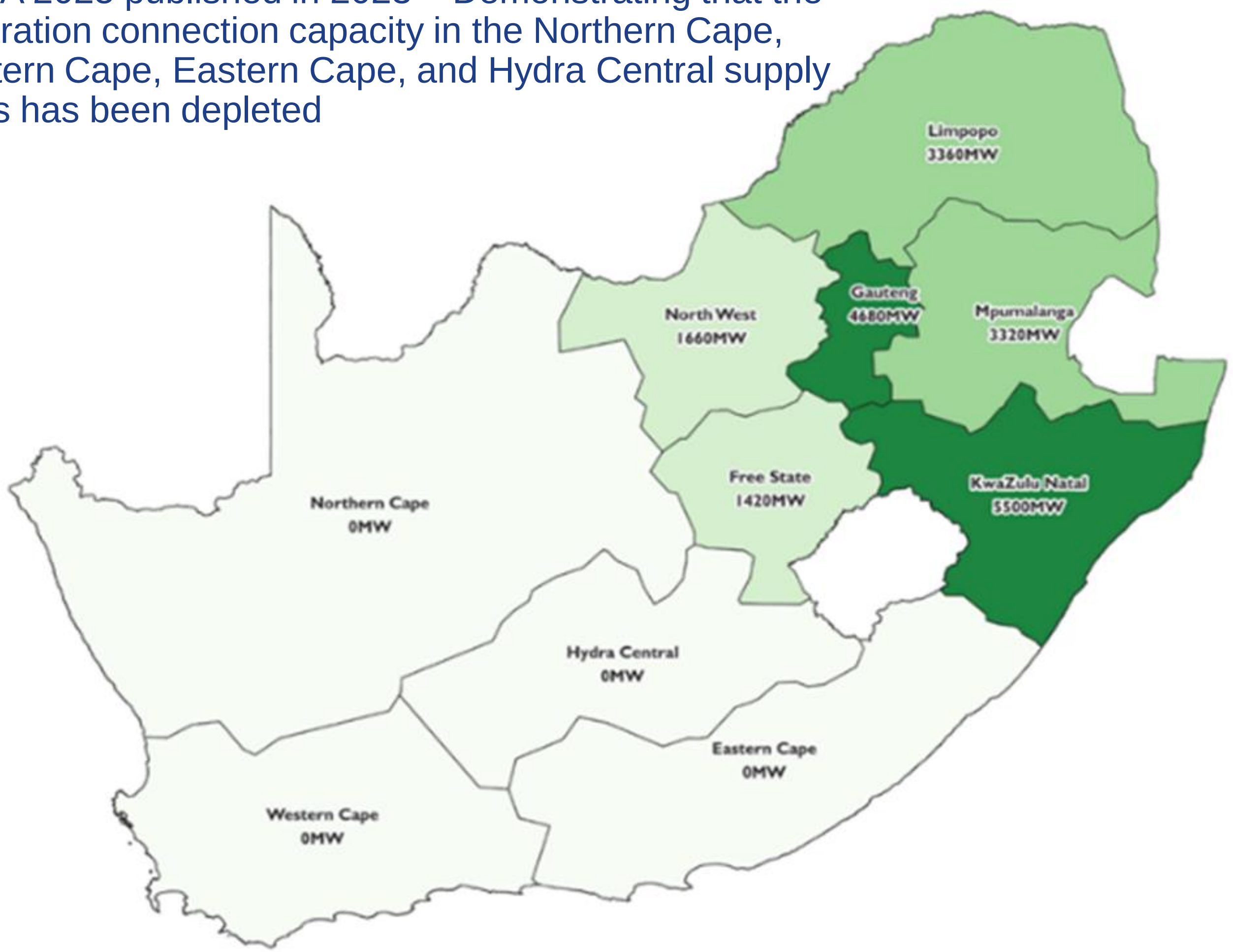
Grid Connections and Capacity Allocation

Introduction and background

GCCA 2025 published in 2023 – Demonstrating that the generation connection capacity in the Northern Cape, Western Cape, Eastern Cape, and Hydra Central supply areas has been depleted



- The IRP and other studies indicate that solar, wind, energy storage and gas will dominate the South African generations mix
  - The best renewable energy sources (Solar PV and Wind power) are located in the greater Cape areas.
  - Most of the potential sites for gas-power generation are also located in the greater Cape area.
  - The greater Cape is historically not a major load center
- Positive outcomes of grid capacity allocation
  - The connection of substantial renewable energy projects has been achieved
  - Furthermore, collaboration between stakeholders has enabled effective allocation of capacity (in GCCA 2025) to many IPP projects in the rest of the grid

Grid capacity constraints (strong demand for grid connection)

- Investment in long transmission lines is required
- Execution timeframes – long transmission lines

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Grid Connections overview – end April 2025 (Public procurement)

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

Programme	Projects / Capacity	Status
Peakers	2 projects 1135 MW	All projects connected
REIPP BW1	28 projects 1434 MW	All projects connected
REIPP BW2	19 projects 1070 MW	All projects connected
REIPP BW3&3.5	18 projects 1628 MW	17 projects connected, 1 project in execution
REIPP BW4&4B	26 projects 2205 MW	All projects connected
RMIPPP	11 projects 1998 MW	4 Projects connected, 3 in execution
REIPP BW5	25 projects 2583 MW	3 projects connected, 8 project in execution
REIPP BW6	6 projects 1000 MW	6 PB announced, of which 2 are in execution & 2 in development
BESIPP BW1	5 projects 513 MW	5 PB announced, 4 in execution & 1 in development
BESIPP BW2	8 projects 615 MW	8 PB announced, of which 5 are in development
REIPP BW7	8 projects 1760 MW	8 PB, of which 7 are currently in development

Total preferred bidders projects announced ~ 15,9 GW from 156 individual projects

99 projects totalling 8017 MW have been commissioned, of which 6882 MW is from RE Sources

17 projects totalling 1754 MW are in execution

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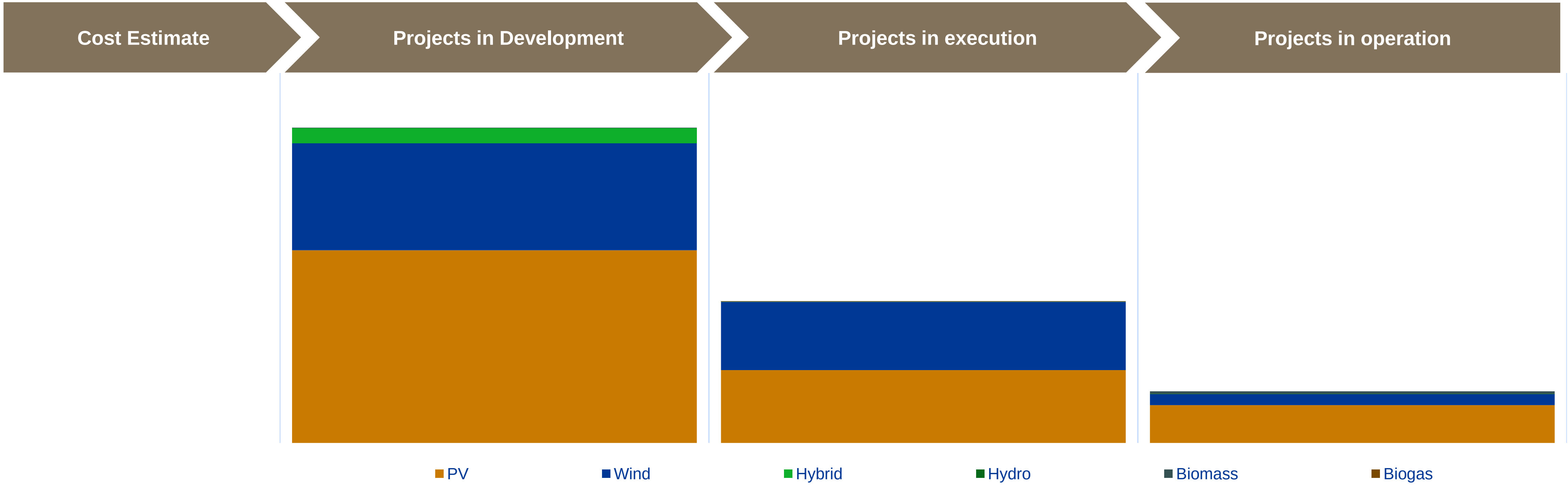
Grid Connections overview – end April 2025 (Private off-take mechanisms)

Capacity allocation for Private off-take projects



36 projects totaling over 1.2 GW of energy from renewable sources are in commercial operation

38 projects totaling over 3.4 GW of energy from renewable sources are in execution

59 projects totaling over 7.6 GW of renewable energy are in development phase

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Transmission Development Plans (TDP) Delivery progress

TDP Summary of Major Projects / Schemes

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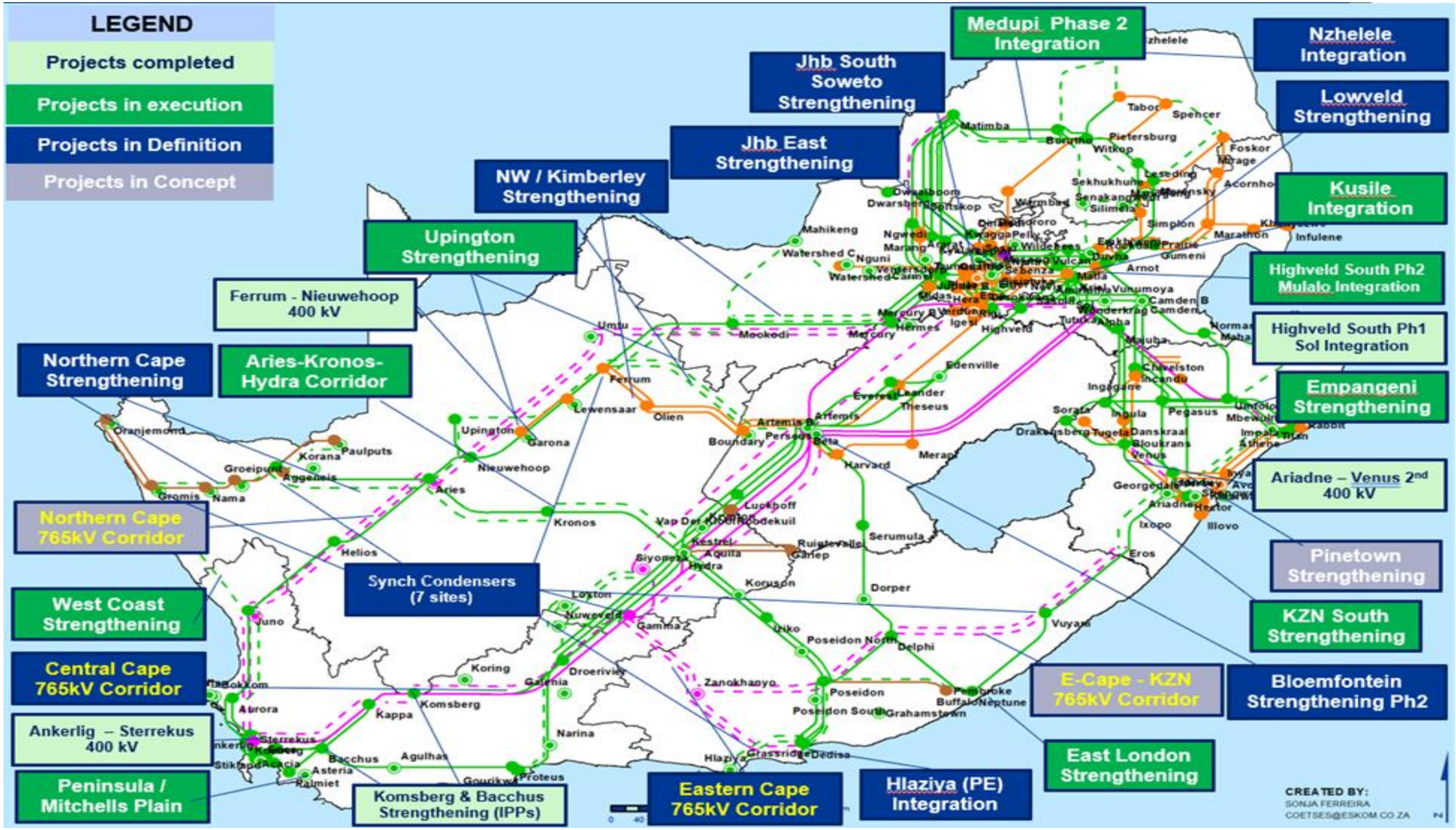

Priority Programme | 44 priority projects have been identified to accelerate the new connection capacity by 2033

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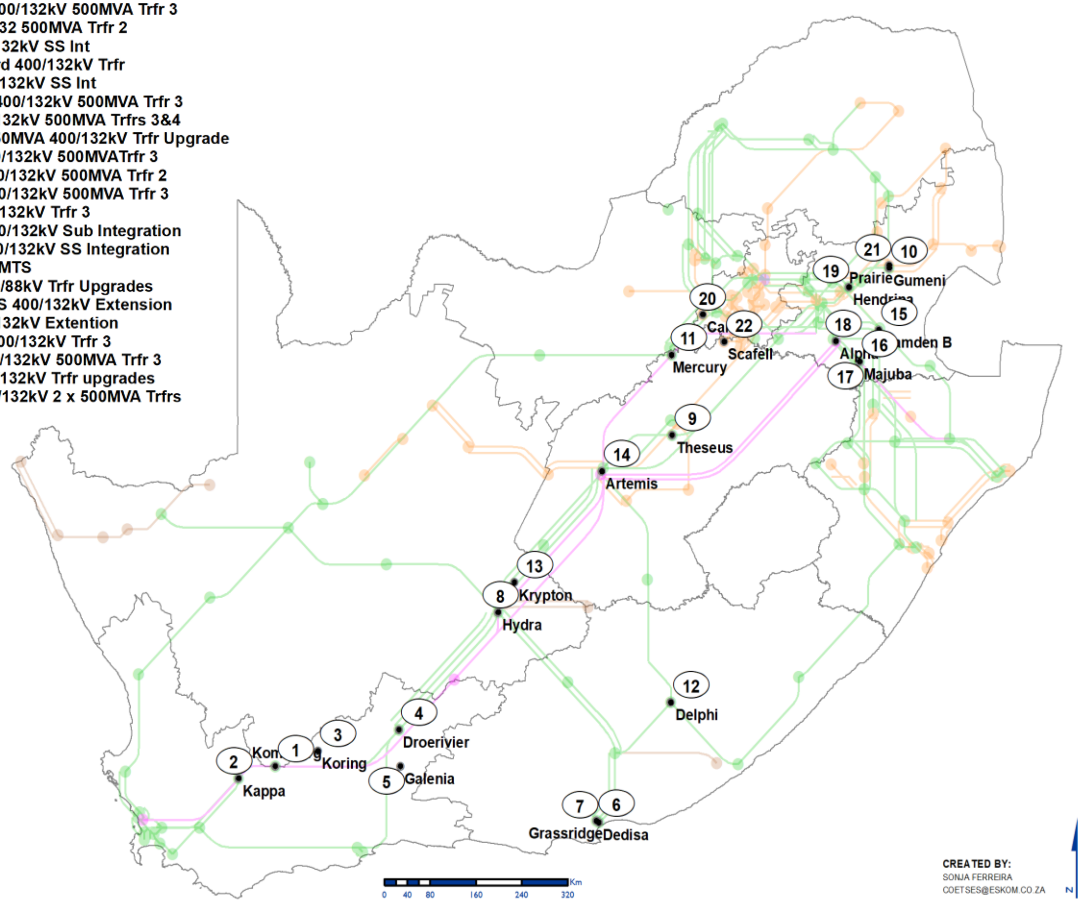
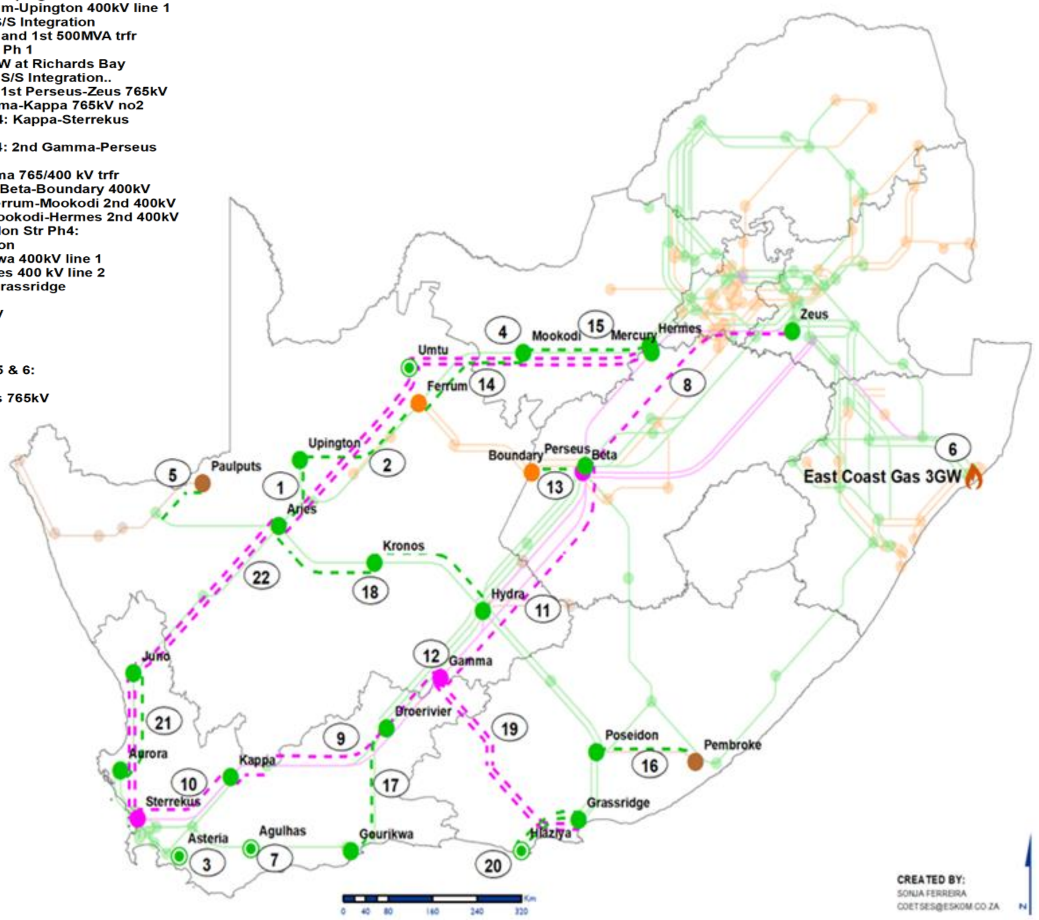
1- Komsberg 400/132kV 500MVA Trfr 3
2- Kappa 400/132 500MVA Trfr 2
3- Koring 400/132kV SS Int
4- Droërivier 3rd 400/132kV Trfr
5- Galenia 400/132kV SS Int
6- Grassridge 400/132kV 500MVA Trfr 3
7- Dedisa 400/132kV 500MVA Trfrs 3&4
8- Hydra 2 X 250MVA 400/132kV Trfr Upgrade
9- Theseus 400/132kV 500MVATrfr 3
10- Gumeni 400/132kV 500MVA Trfr 2
11- Mercury 400/132kV 500MVA Trfr 3
12- Delphi 400/132kV Trfr 3
13- Krypton 400/132kV Sub Integration
14- Artemis 400/132kV SS Integration
15- Camden B MTS
16- Majuba 400/88kV Trfr Upgrades
17- Majuba MTS 400/132kV Extension
18- Alpha 400/132kV Extention
19- Hendrina 400/132kV Trfr 3
20- Carmel 275/132kV 500MVA Trfr 3
21- Priarie 275/132kV Trfr upgrades
22- Scafell 275/132kV 2 x 500MVA Trfrs



Additional transformers: 22 Transformer projects will unlock 14 GW of new Gx capacity

- **5** projects in development stages to deliver **5 700 MW**
- **14** projects in procurement and construction stage to deliver **6 784.5 MW**
- **3** projects cancelled consisting of **1 339.5 MW**

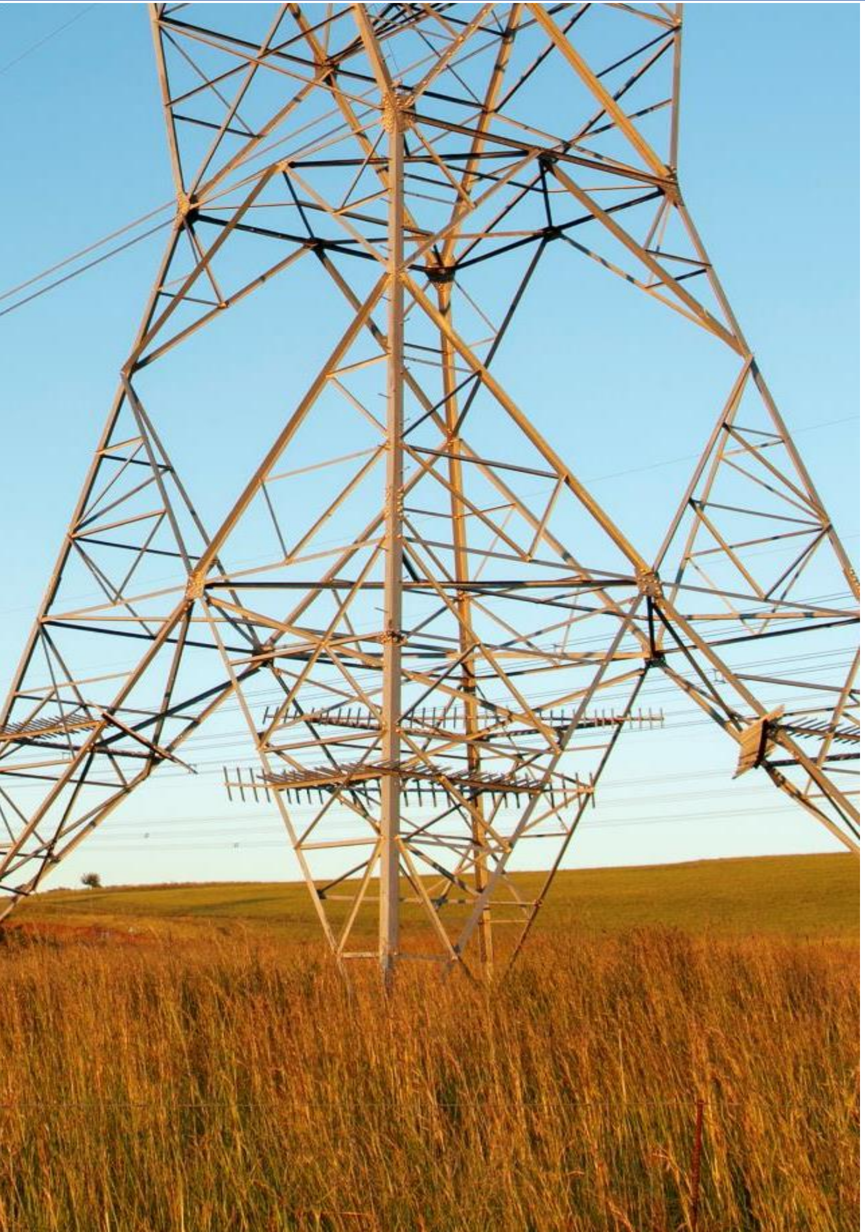
1- Upington Str: Aries-Upington 400kV line 1
2- Upington Str: Ferrum-Upington 400kV line 1
3- Asteria 400/132kv S/S Integration
4- Mookodi Extention and 1st 500MVA trfr
5- Paulputs 400kV Str Ph 1
6- East Coast Gas 3GW at Richards Bay
7- Agulhas 400/132kv S/S Integration..
8- Cape Corridor Ph4:1st Perseus-Zeus 765kV
9- Cape 765 ph4 Gamma-Kappa 765kV no2
10- Cape Corridor Ph4: Kappa-Sterrekus 2nd 765kV
11- Cape Corridor Ph4: 2nd Gamma-Perseus 765kV
12- Gamma Str: Gamma 765/400 kV trfr
13- Kimberley Ph 4A: Beta-Boundary 400kV
14- Kimberley Ph 3 Ferrum-Mookodi 2nd 400kV
15- Kimberley Ph 3 Mookodi-Hermes 2nd 400kV
16- Greater East London Str Ph4: Pembroke-Poseidon
17- Droerivier-Gourikwa 400kV line 1
18- Hydra-Kronos-Aries 400 kV line 2
19- SGS-2x Gamma-Grassridge 765kV lines
20- Hlaziya 400/132 kV MTS integr IPP
21- Aurora - Juno 400kV line 2
22- Cape Corridor Ph5 & 6: 1st and 2nd Mercury-Sterrekus 765kV



Expedited projects: 22 new line projects will unlock 22 GW of new Gx capacity

- **12** projects in development stages to deliver **5 670km** and **16 154 MW**
- **10** projects in procurement and construction stage to deliver **1 640.4 km** and **6 565 MW**

TDP pipeline | Projects in execution and procurement, with remaining projects under development on track



Tx lines

Execution and procurement

- 2919 km in various stages of procurement and others under construction

In development

- 11 542 km under various stages of development

Transformer Capacity

Execution and procurement

- 23 115 MVA in various stages of procurement and others under construction;

In development

- 108 220 MVA under various stages of development

TDP delivery mechanisms

- Owner’s Engineer (OE) and Engineering Procurement and Construct (EPC) panels

Delivery challenges

- Mitigation measures including escalation to NECOM-Presidency for increased focus have been adopted to mitigate several identified delivery risks to the overall program

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Conclusion

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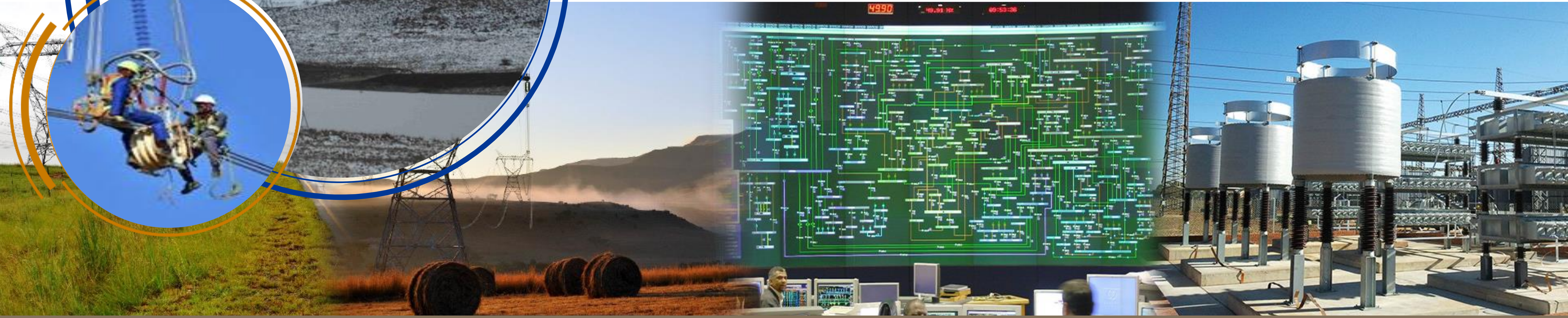
Grid Connections Enablement Sustainable connection of Energy from Renewables Sources

Presented By: Caswell Ndlhovu

Date: 20 May 2025



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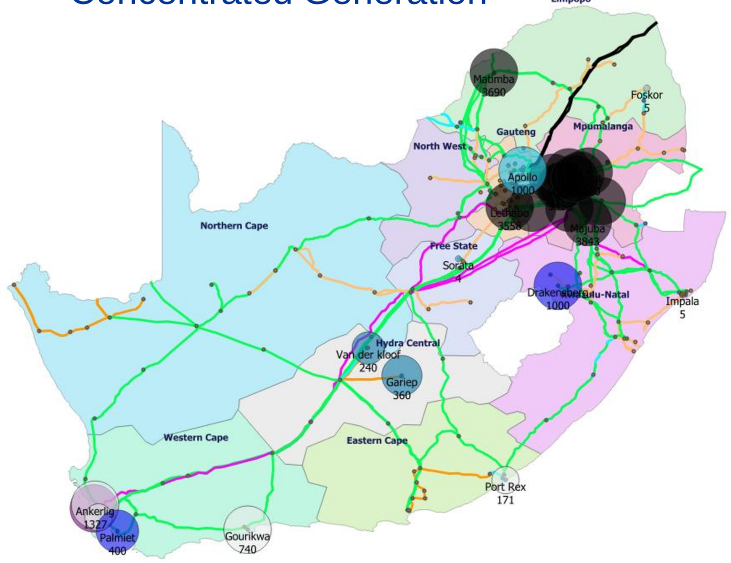
South African Renewable Energy Grid Survey

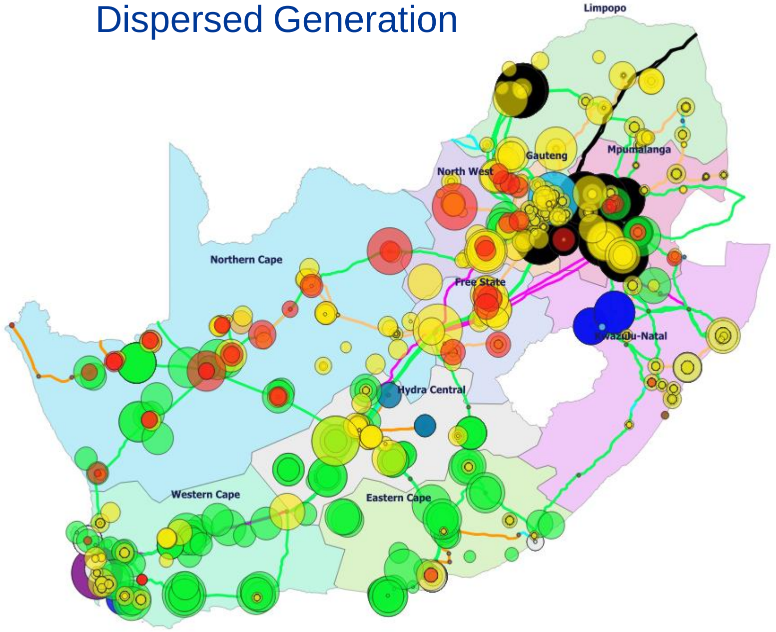
Introduction – Location Predictability

- Energy transition has led to many challenges with respect to RE generator location predictability
  - Dispersed RE generation results in strengthening path uncertainty
  - Attempts to lobby for geographically targeted bid windows not successful due to competition considerations
  - Each BW round located RE in varied locations
  - ERA Schedule 2 amendment resulted in unprecedented RE Applications (Approximately 13GW)

Concentrated Generation

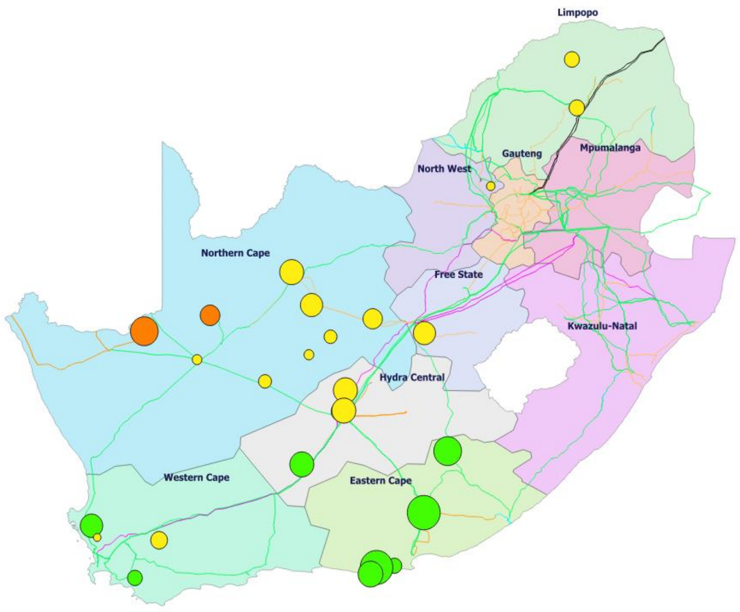


Dispersed Generation



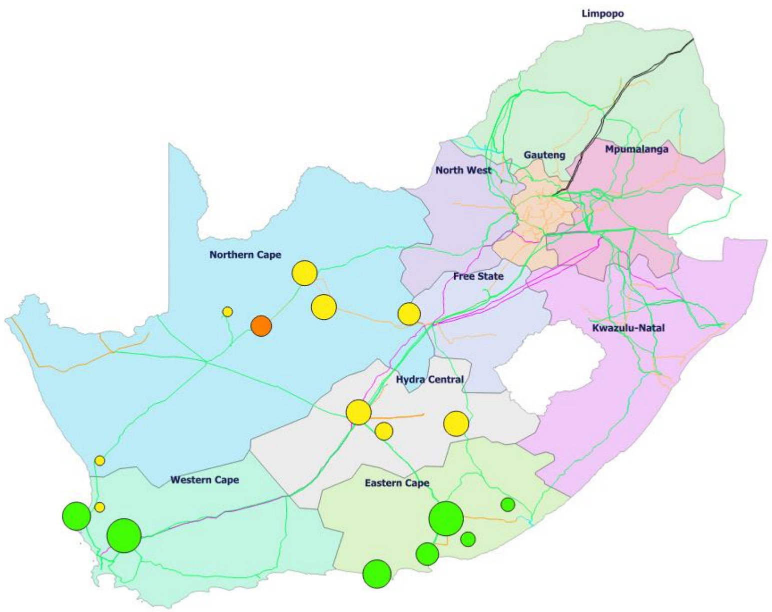
Geographic Dispersion of different Bid Windows

Bid Window 1



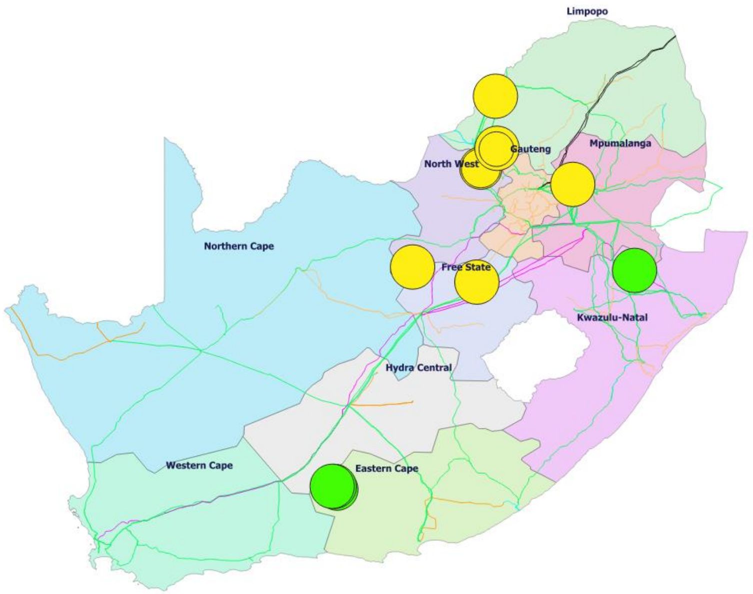
1436 MW in 6 supply Areas

Bid Window 2



1044 MW in 4 supply Areas

Bid Window 7



2692 MW in 6 supply Areas

- **Strengthening is a challenge when location is not known upfront**

Renewable Energy Survey Initiative

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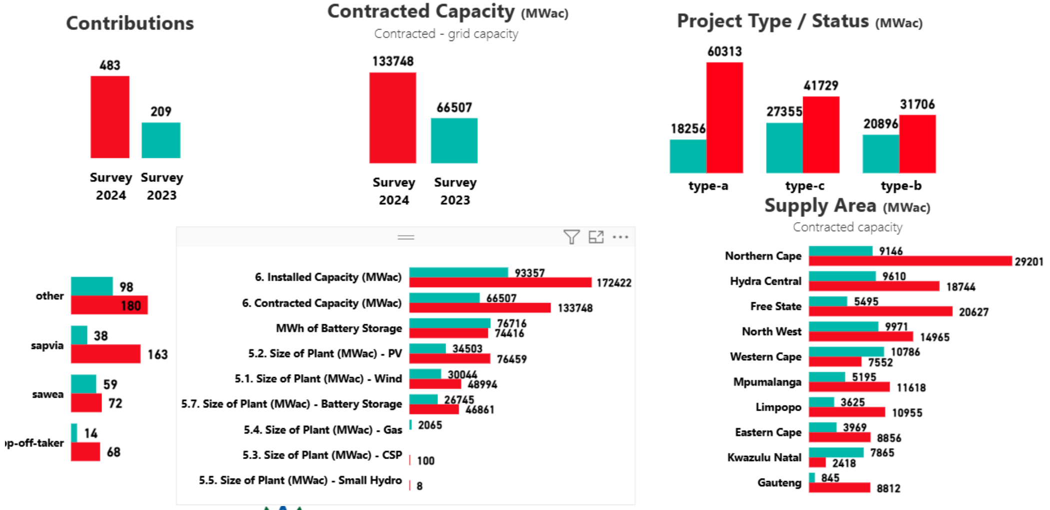
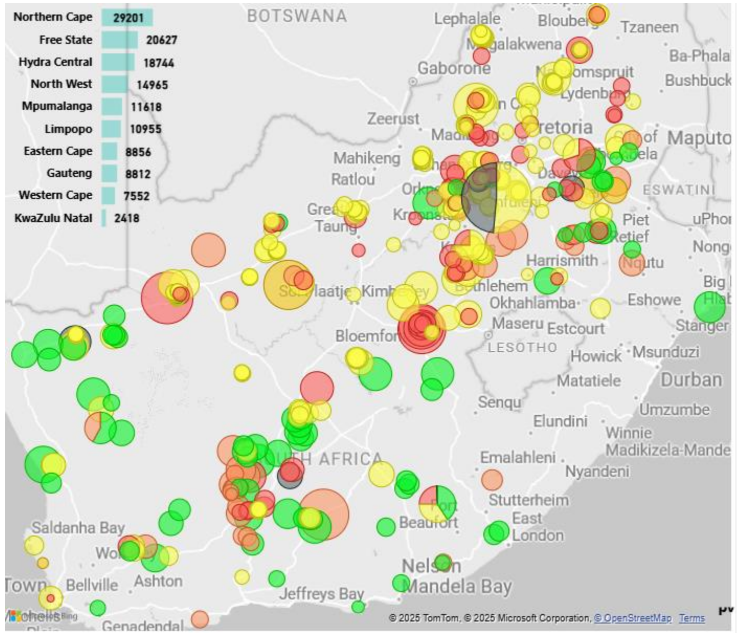
- To mitigate for location uncertainty
  - Eskom initiated and partnered with SAPVIA to conduct an annual RE survey (sent to all other Associations)
  - Targets the IPP sector (PV, Wind, Storage, Gas, etc.)
  - Participants indicate where they are planning to install RE Plants as well as the state of readiness backed by EIA's
  - The results in 2023 indicated that 66000 MW can potentially connect to the grid, this increased to 133000 GW in the 2024 survey
- Benefits
  - The intelligence allows strengthening to be targeted at the right places
  - Informs generation assumptions for the TDP,
  - TDP projects become consistent from year to year
  - Long-term strategic plans





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Alignment between Survey and Generation Assumptions

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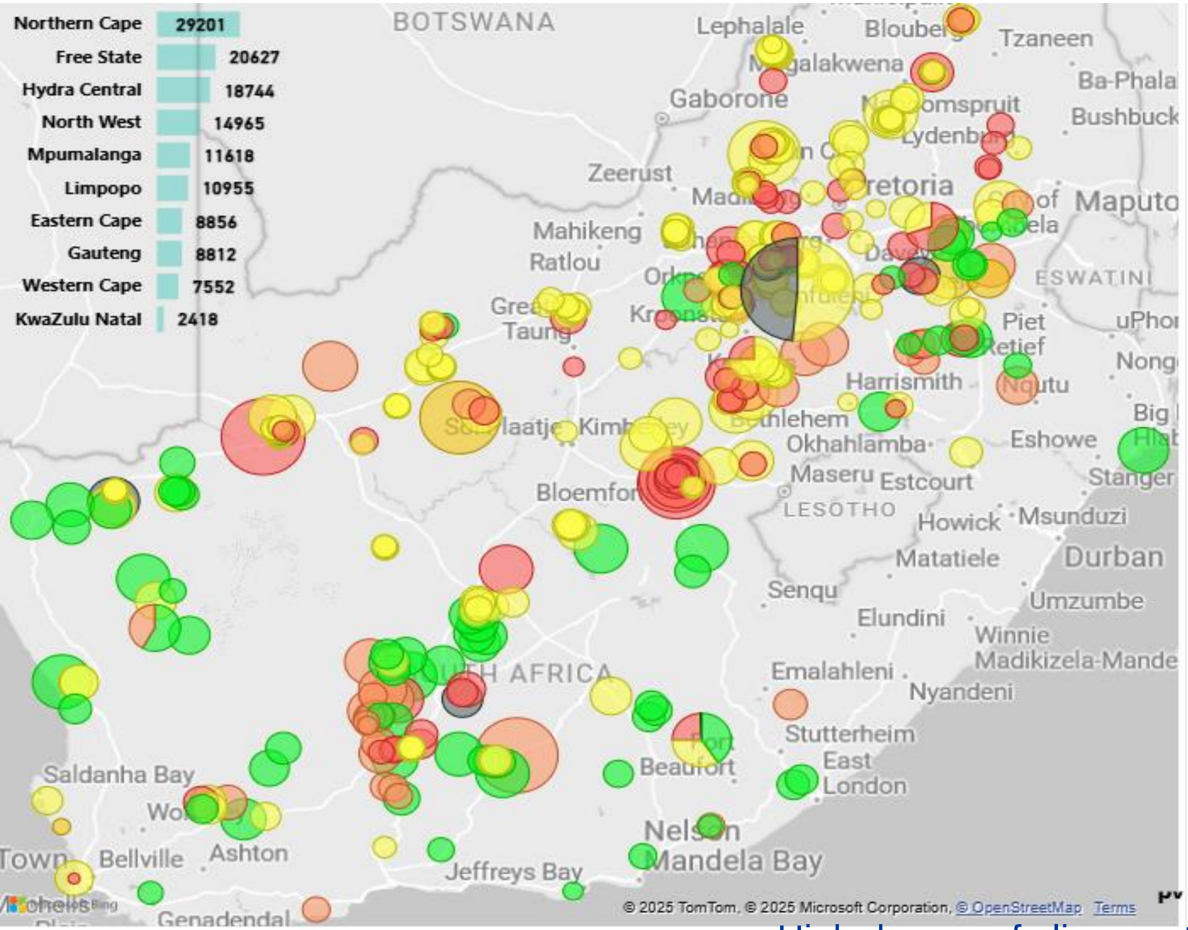
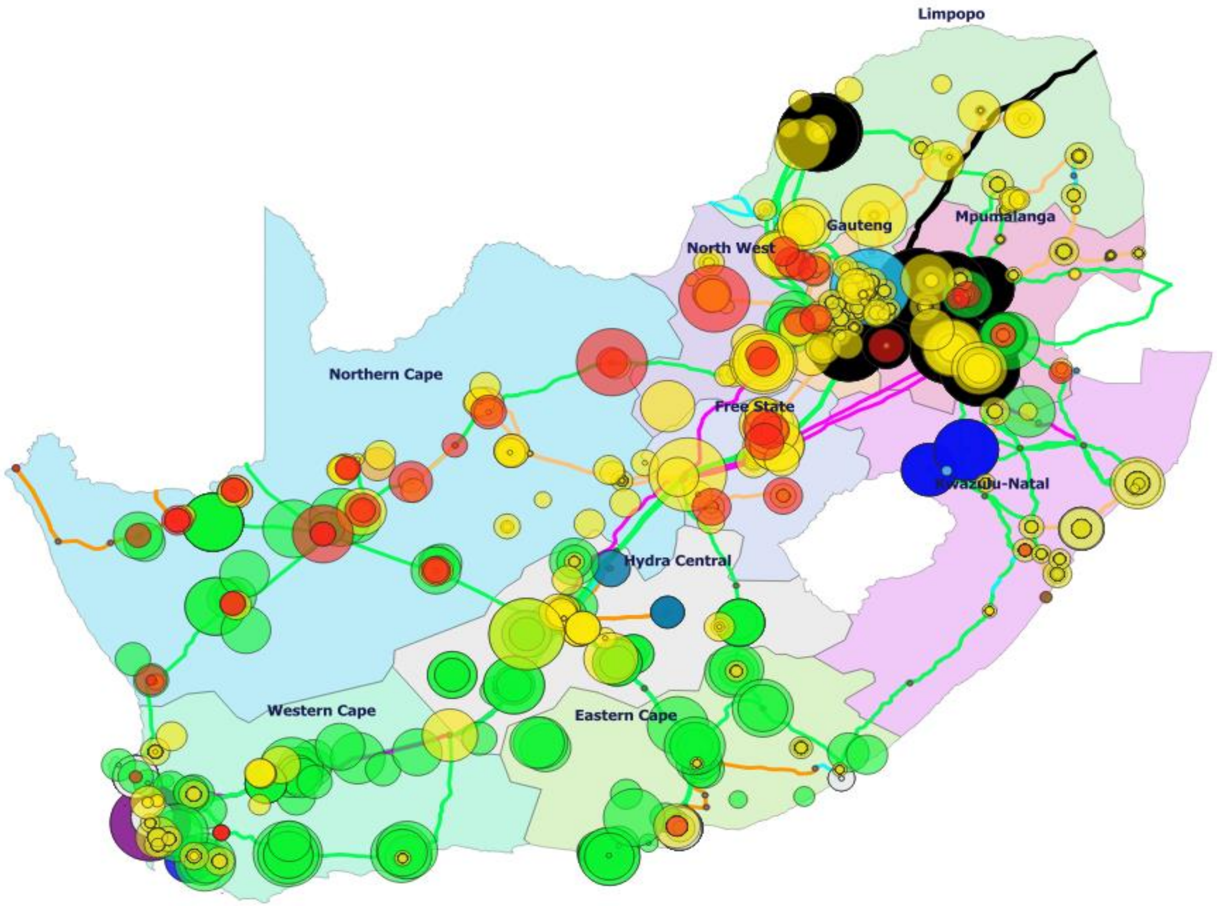
Survey Results



Generation Assumptions



- High degree of alignment between Survey results and Generation Assumptions
- TDP has a high degree of reliability and projects are implemented where they will be needed
- Although there is no geographically targeted bid windows, long-term UPFRONT planning is fostered due to a high degree of confidence

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Summary

- High degree of alignment between Survey results and Generation Assumptions
- TDP has a high degree of consistency and projects are implemented where they will be needed
- Although there is no geographically targeted bid windows, long-term UPFRONT planning is fostered due to a high degree of confidence
- Other distribution level initiatives are done with the help of the survey

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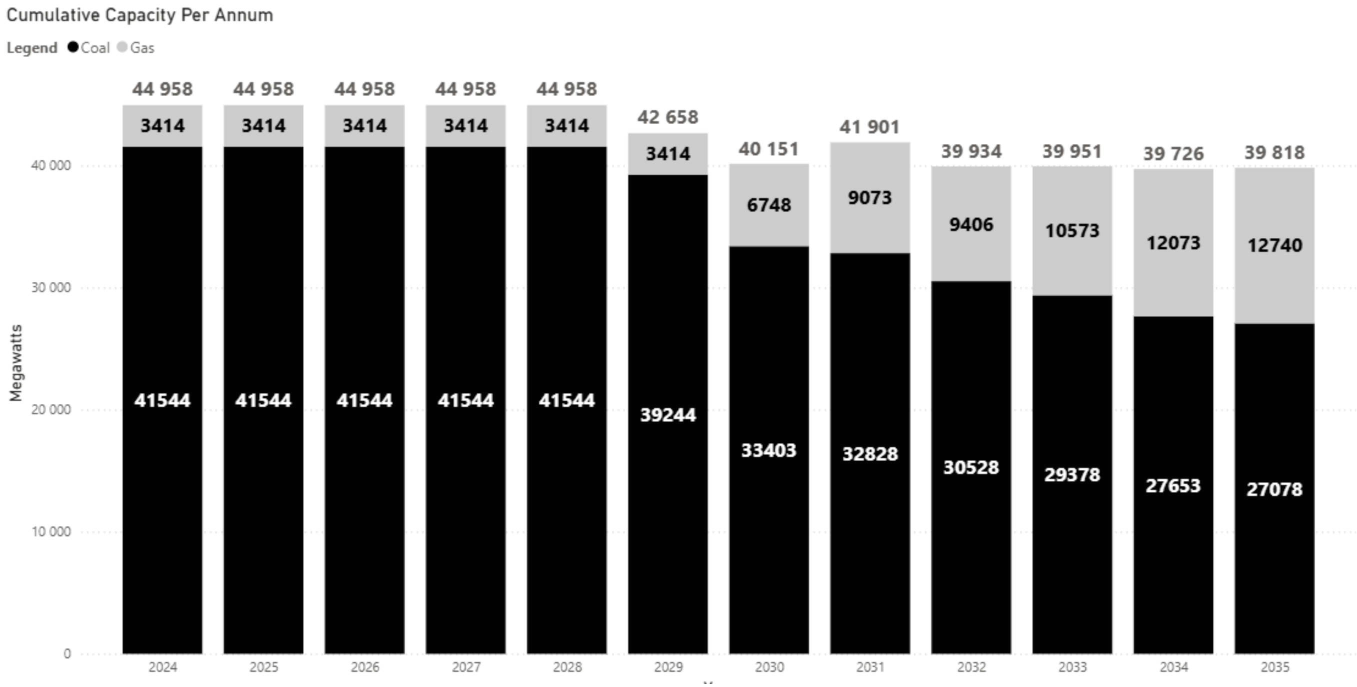
Grid Stability Enhancement

Introduction – Grid Stability

- Energy transition has many environmental benefits and many exciting challenges for Power Grid,
- Current IRP projections indicate the following trend:
  - Synchronous generation (Coal) will be decommissioned and mostly replaced with variable RE resources
  - System Inertia is depleted with every unit of generation that is decommissioned

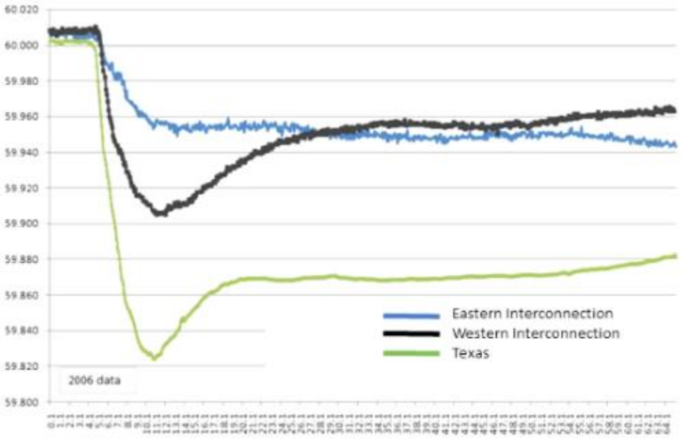


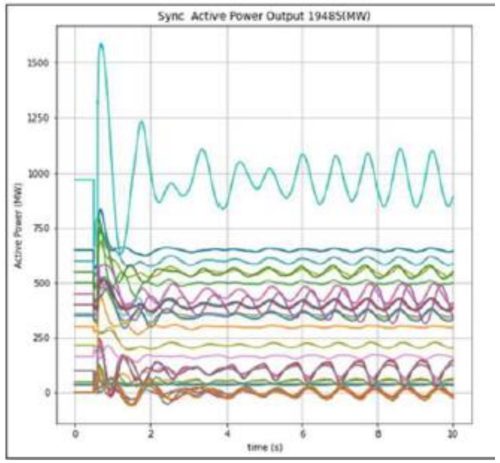
- A loss of approx. 15GW of synchronous generation
- This is replaced 50GW of RE+Storage and 9GW Gas
- Gas will run at a low to moderate load factor
- Contribution of Wind and PV (~ 46GW) to inertia in minimal

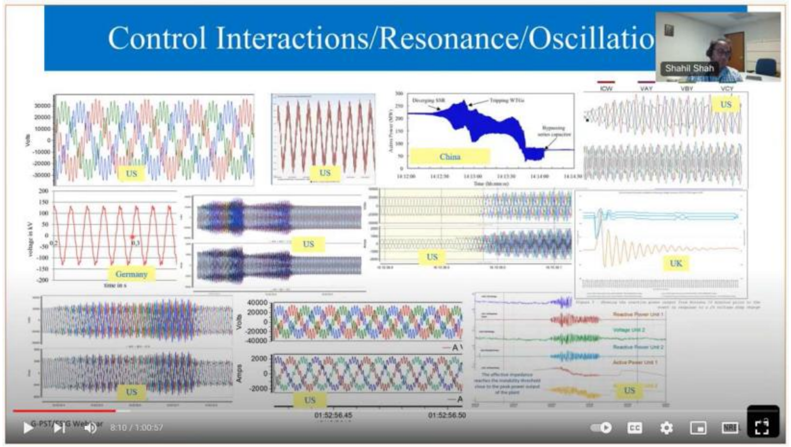
Challenges with high RE and Low Synchronous Generation

Eskom National Transmission Company South Africa ™

- The ability of the system recover from system events is curtailed
  - Rate of change of frequency increases, leading to higher chances of frequency instability and loadshedding -> blackouts
  - Reduced system strength result in inverter and voltage instability
  - Oscillations are likely in increase in the system - this can be damaging to plant
- Without any mitigation, it gets progressively difficult to increase penetration
- Increasing number of blackouts can partially be attributed to instability related to high RE penetration







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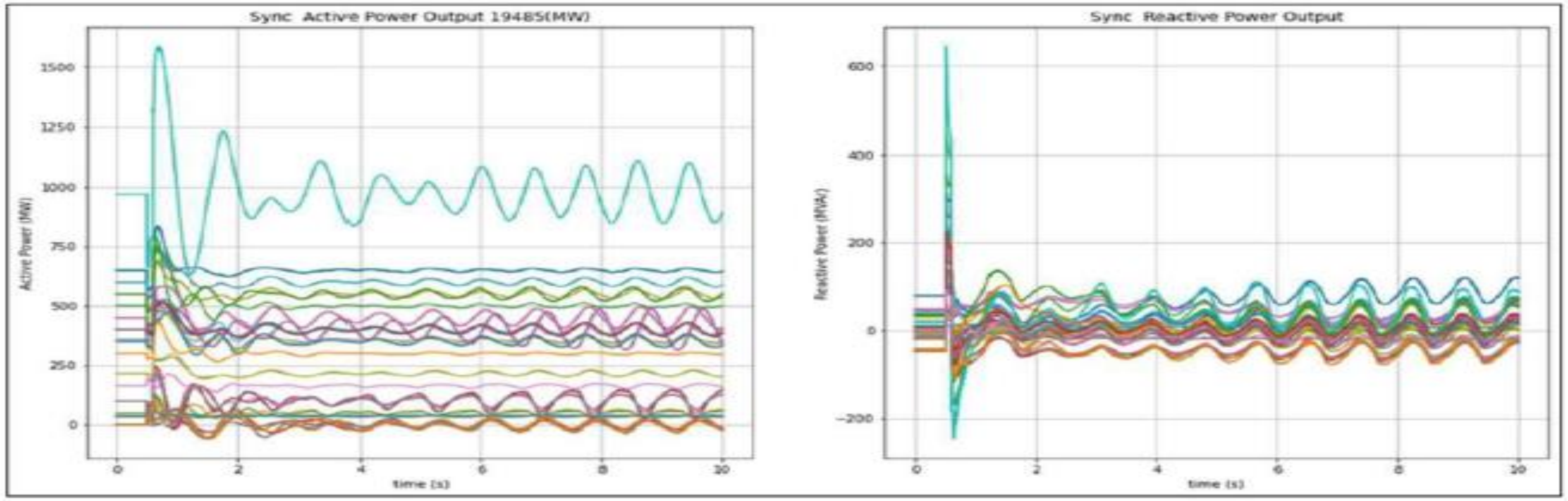
Mitigation Measures

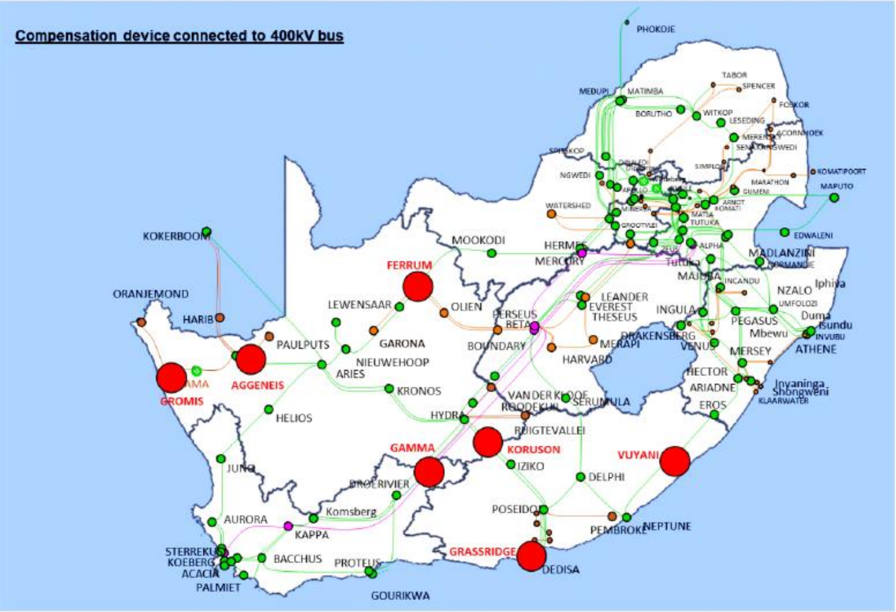
- Grid Planning conducted a stability study with forecasted levels of new RE and decommissioned coal generators
- This was before there was a relaxation in decommissioning rates
- Results indicated instability in the system for many scenarios

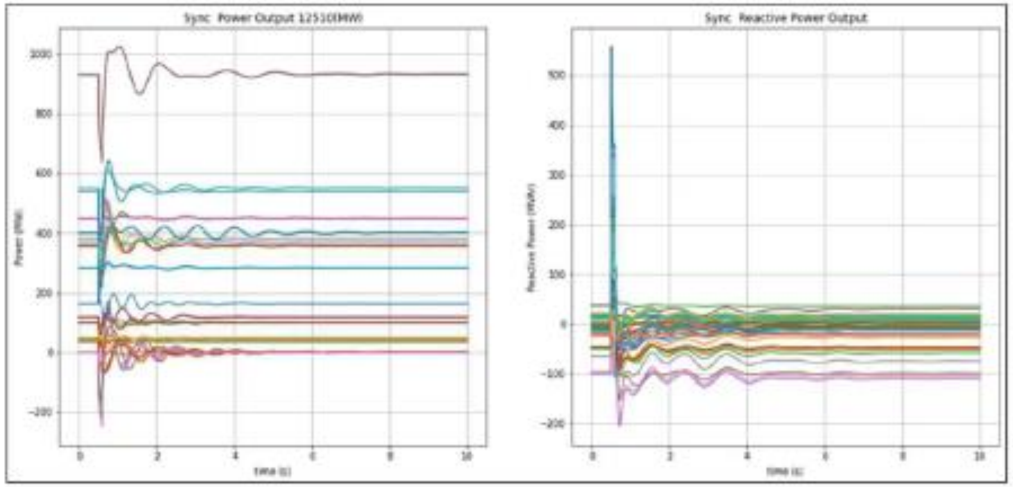


System without Synchronous Condensers
(uncompensated Inertia ~ 50% SNSP)

Mitigation Measures …/cont

- Proposed solution was the installation of synchronous condensers in different parts of the network
- This is an active project with Owner Engineers already appointed
- Results indicate that the solution will result in a stable system enabling the grid to accommodate the required levels of RE





System with Synchronous Condensers (compensated inertia - ~ 50% SNSP)

Future Initiatives

- PSCAD training initiated to enable planners to interactions and oscillations at a higher resolution
- A BESS study will investigate the usage of grid forming inverters for fast frequency response in our system – these systems are being proposed in other parts of the world
- A future system is likely to contain both Syn Cons as well as GFI BESS for FFR and system strength

Conclusions

- The cooperation between NTCSA and RE Associations in concluding RE Surveys is a key success factor for orderly and certain grid development
- Synchronous condensers will be deployed in South Africa for the first time, thus joining other countries with high RE penetration in their deployment
- Synchronous condensers and Grid forming technologies are more likely to work together in future to mitigate for lost stability due to decommissioning
- Skills upgrading of Power Systems engineers will ensure that they stay abreast with this quickly developing environment

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Conclusion

INDEPENDENT POWER PRODUCER CONFERENCE

Accelerating Grid Connection for IPPs and Generators

NATIONAL COLLECTOR SUBSTATION NETWORKS – AN ENABLER FOR EFFICIENT GRID CONNECTIONS

IPP Office

20 MAY 2025

www.ipp-projects.co.za

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PRESENTATION OVERVIEW

CONTENTS

1. What and why of collector substations?
2. 1st Study (Case/Conceptual) – Methodology, Results and Recommendations
3. 2nd Study (National Study) – SOW and Expected Results/Outcomes
4. Key benefits of the study

COLLECTOR SUBSTATIONS

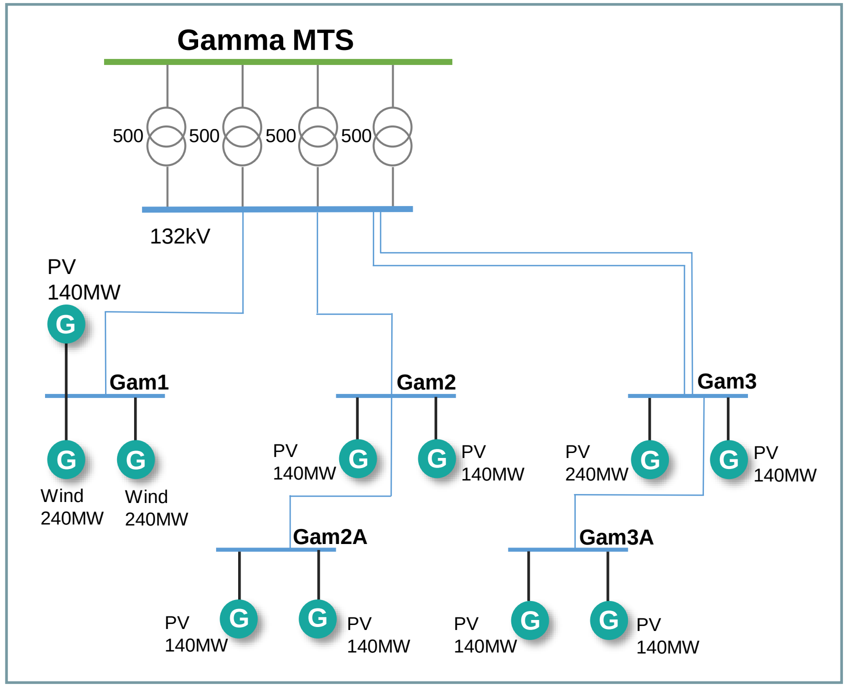
WHAT AND WHY COLLECTOR SUBSTATIONS?

What?

- The collector network is for ensuring coordinated planning for the integration of RE IPPs.
- A proactive, and optimal network design to integrate large amounts of RE in one geographic area

Why?

- Concentration of RE power plants in high-yield areas
- RE projects development around transmission substations with the capacity to integrate RE
- Ensure grid preparation work is done to create capacity to align with the development of the anticipated RE generation
- Reducing the environmental impact of and streamlining the integration of RE



1st Study (Case Study) – Methodology, Results and Recommendations

Acknowledgements

GLS Infrastructure planning

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electricity & energy
Department: Electricity and Energy
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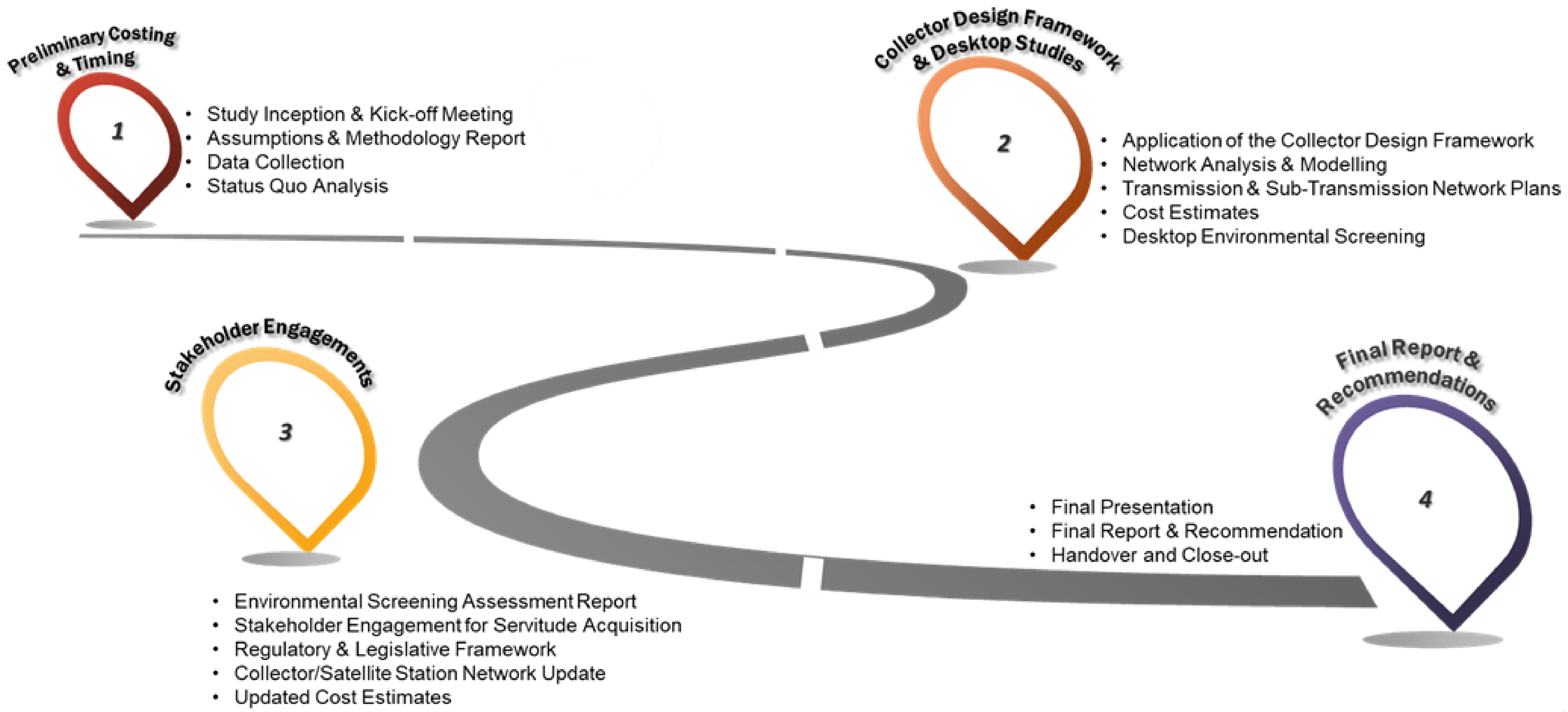
FIRST STUDY
APPROACH (4 PHASES)



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DELIVERABLES OVERVIEW

Phase	Deliverable	Timelines
Phase 1: Status Quo	Assumptions and Methodology Report	February – May 2023
	Status Quo Report • High-level generation spatial location per Technology • Identify areas of focus: High-interest; Medium-interest and Low-interest	February – July 2023
Phase 2: Collector Design Framework & Desktop Studies	Reviewed Collector Station Framework	July – August 2023
	Environmental Screening Assessment Report	July – August 2023
	Transmission and Sub-Transmission Infrastructure Requirements	September – October 2023
Phase 3: Stakeholder Engagements	Regulatory and Legislative Opportunities and Constraints	March – April 2024
	Procurement Strategies for Servitude Acquisition	March – April 2024
	Revised Collector Station Framework	February – April 2024
	Updated Transmission and Sub-Transmission Infrastructure Requirements	February – April 2024
Phase 4: Final Report & Recommendations	Final Report and Presentation	May 2024
	GIS Datasets (.mpk & .shp) and Maps	April – May 2024
	Network Simulation Casefiles (PowerFactory)	April – May 2024

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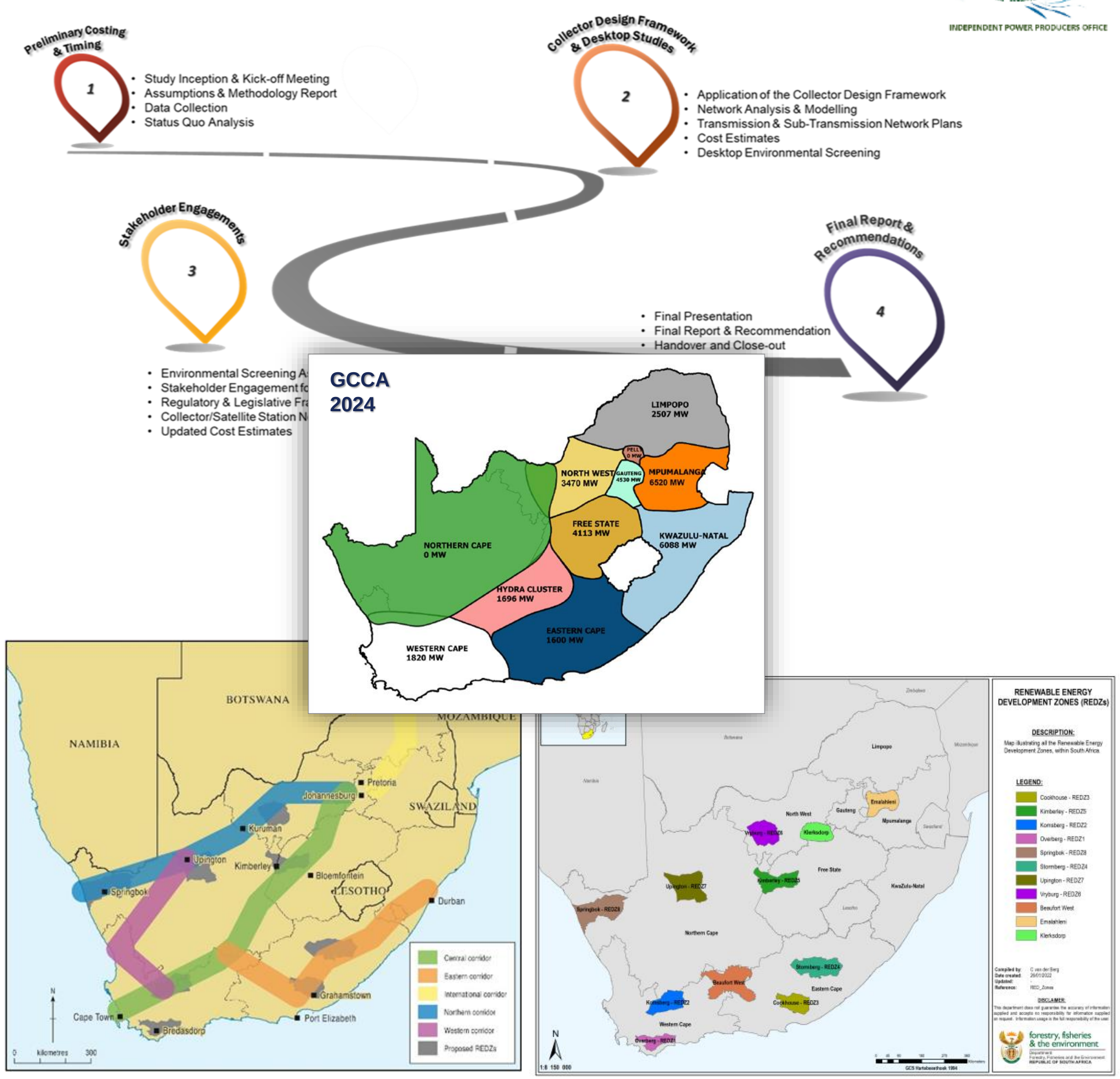
STUDY APPROACH
PHASE 1 OVERVIEW

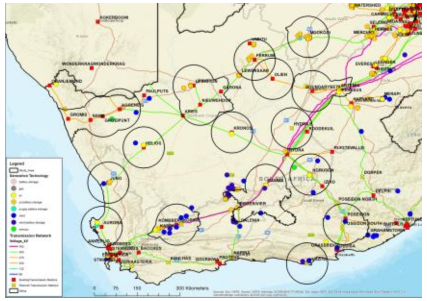
- The objective of this phase is to develop a spatial presentation of known and future IPPs for the RE capacity allocation per REDZ / RE nodes
- Source publicly available information and other information sets supplied by the IPPO
- Information Gathering:
  - EIA applications,
  - Transmission network plans and case files,
  - GCCA 2023 (2024),
  - REDZ,
  - Power corridors (SEA),
  - Topographic and environmental datasets,
  - Regulatory and legislative information,
  - Previous reports, etc.
- Stakeholder Identification
- Project Implementation Plan (PIP) & Project Schedule
- Agreed RE capacity allocation per Tx Substation, REDZ / RE nodes
- Identify three areas of focus
  - High-interest
  - Medium-interest
  - Low-interest

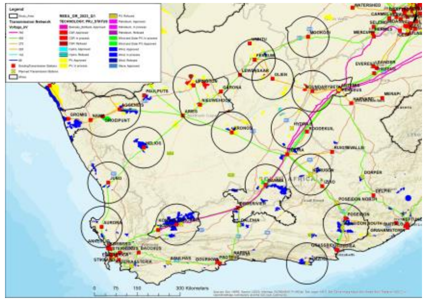


PHASE 1 RESULTS

RE INTEREST TOTAL CAPACITY (MW)

- The RE projects from the EIA dataset and survey results were consolidated to determine the overall interest in MW per technology type within the study areas.
- These were based on the projects EIA status. The assumption was made that the projects within the study areas from the survey results with approved EIA status would appear in the EIA dataset as approved projects, therefore these project MW were not added. An exception is made to projects that have RE technology types not included within the EIA dataset under the same study area. The same exercise was performed for the “current application” status which in the EIA dataset would fall under “In Process” applications.
- RE projects from the survey results that are future applications were added to the overall combined totals.
- Thus, the total generation capacity ***interest*** in the study area is ~80 GW.





Study Area	Substation	REDZ	Biomass (MW)	Hydro (MW)	Petroleum (MW)	Solar (MW)	Wind (MW)	Total (MW)	Rank	Solar Rank	Wind Rank	Selected Sites	Reason
Study Area E	Komsberg	REDZ2: Komsberg	-	-	-	5 226	7 372	12 598	1	2	2	X	High RE Interest
Study Area B	Gamma	REDZ11 Beaufort West	-	-	-	3 920	8 461	12 381	2	6	1	X	High Wind Interest
Study Area I	Nieuwehoop & Upington	REDZ7: Upington	-	10	-	10 817	20	10 847	3	1	13	X	High Solar Interest
Study Area F	Aggeneis & Groeipunt	REDZ8: Springbok	-	-	-	5 205	1 586	6 493	4	3	6		
Study Area O	Aurora		1507	-	3 334	608	860	6 309	5	12	10		
Study Area H	Kronos		-	-	-	4 553	320	4 873	6	4	12		
Study Area L	Ferrum		-	-	-	4 359	401	4 760	7	5	11		
Study Area C	Iziko B		-	-	-	1 935	2 759	4 694	8	7	3	X	Medium RE Interest
Study Area A	Poseidon B	REDZ3: Cookhouse	-	-	-	505	2 648	3 153	9	13	4		
Study Area G	Helios		-	-	-	397	2 545	2 942	10	14	5		
Study Area N	Juno		-	-	-	1 569	1 016	2 585	11	11	9		
Study Area K	Mookodi	REDZ6: Vryburg	-	-	-	1 904	20	1 924	12	9	13		
Study Area J	Boundary	REDZ5: Kimberley	-	-	-	1 917	-	1 917	13	8	14		
Study Area M	Olien		-	-	-	1 636	-	1 636	14	10	14		
Study Area D	Hydra B		-	40	-	800	643	1 483	15	15	7		
Study Area P	Thyspunt		-	-	19	5	1 438	1 462	16	15	8	X	Low RE Interest
		Totals	**1 507**	**50**	**3 353**	**45 356**	**30 087**	**80 702**					

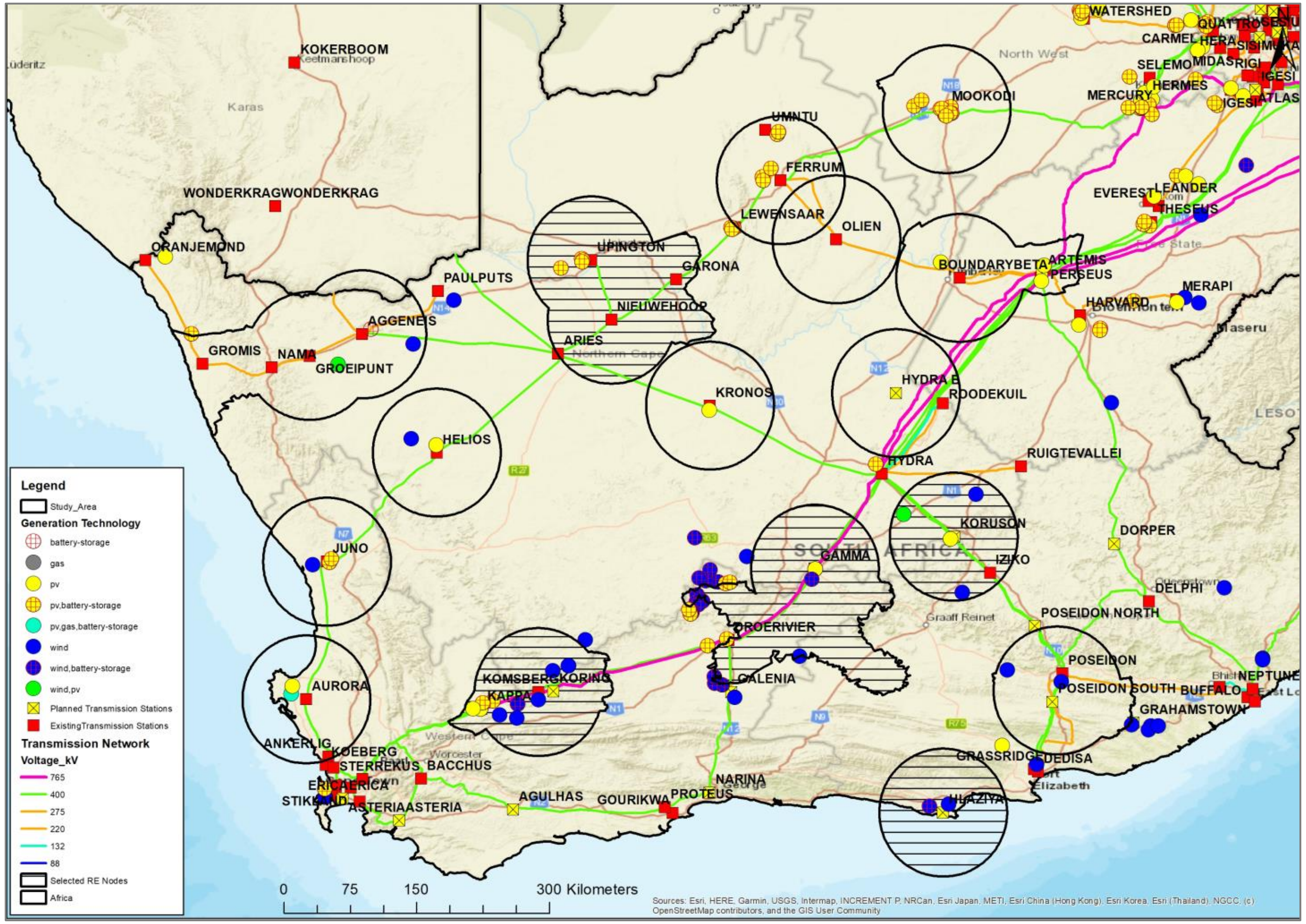
PHASE 1 RESULTS
RE NODES SELECTION

The selected RE nodes to be assessed further in Phase 2, spans over the 3 Greater Cape provinces (Eastern, Northern and Western Cape). The selection categories were as follows:

- High RE Interest: Study Area E – Komsberg
- High Wind Interest: Study Area B – Gamma
- High Solar Interest: Study Area I – Upington
- Medium RE Interest: Study Area C – Koruson
- Low RE Interest: Study Area P – Hlaziya

CEL dataset provided insight into the RE interest project readiness. This insight was used in the grid integration plans in Phase 2

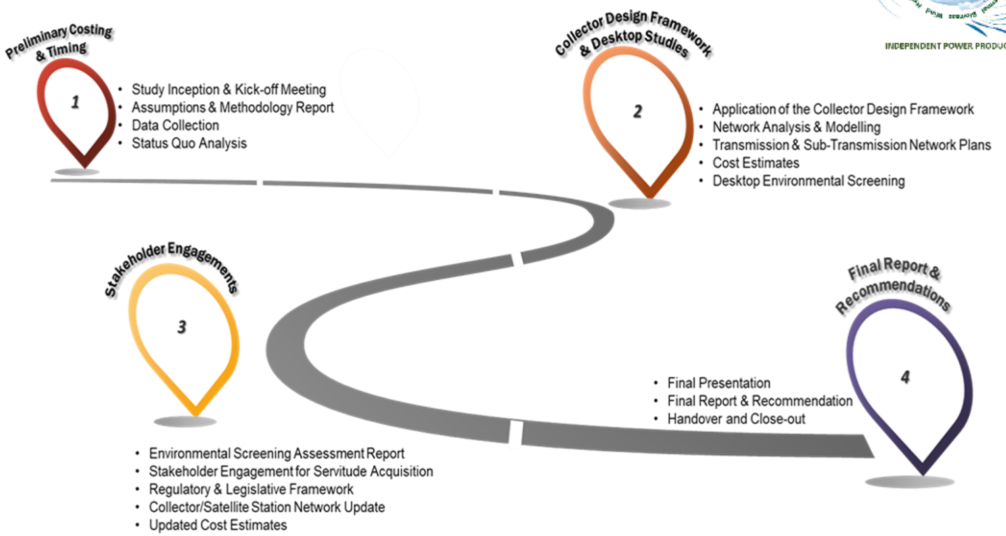
Study Area	RE Interest (MW)	Solar (MW)	Wind (MW)	Reason	Province
Study Area E	12 598	5 226	7 372	High RE Interest	NC & WC
Study Area B	12 381	3 920	8 461	High Wind Interest	NC, WC & EC
Study Area I	10 847	10 817	20	High Solar Interest	NC
Study Area C	4 694	1 935	2 759	Medium RE Interest	NC & EC
Study Area P	1 462	5	1 418	Low RE Interest	EC

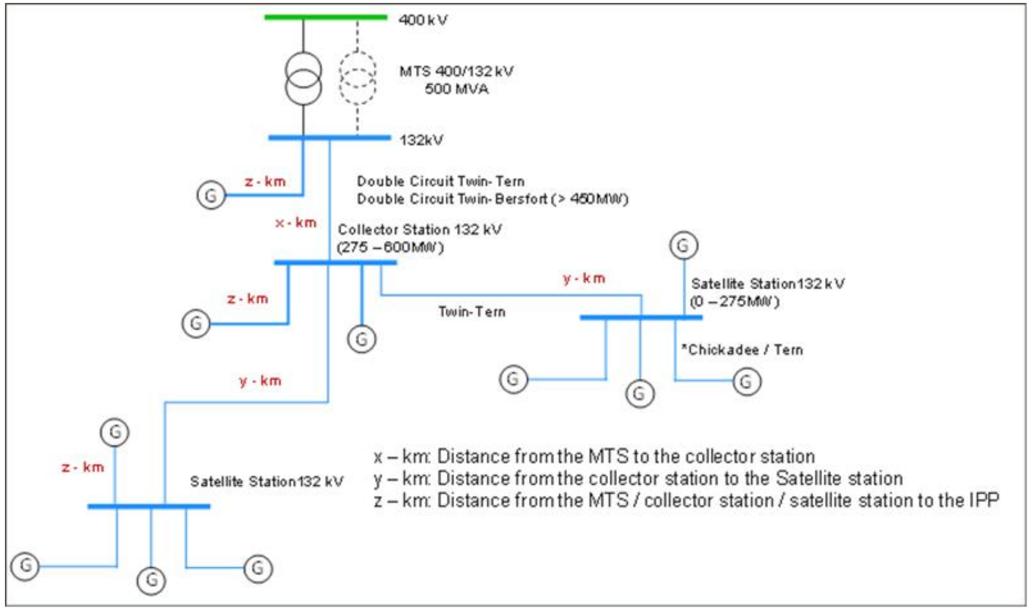


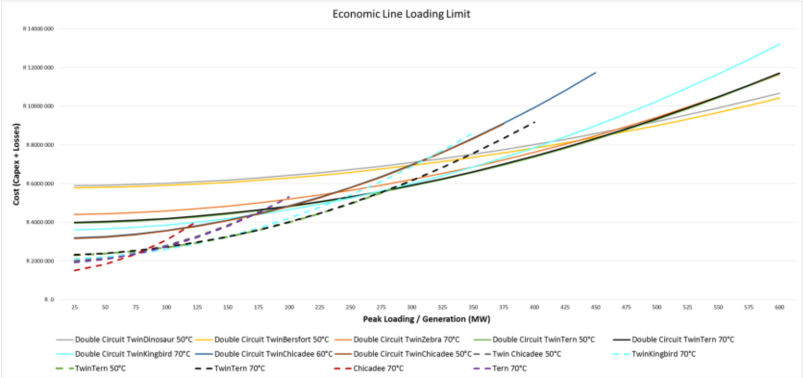
STUDY APPROACH

PHASE 2 OVERVIEW

- Review & apply collector & satellite framework for integrating RE
- Planning criteria
- Desktop environmental screening to identify opportunities & constraints map using various GIS layers
- Network modelling & analysis
- Network development plans (Tx & Sub-Tx)
- Cost estimates per Tx substation / Node







Project Packages	Level of Development	Additional Grid Capacity (MW)	Distribution SoW Summary: 132kV Collector Station	Distribution SoW Summary: Double Circuit Twin Tern 70°C [km]	Distribution SoW Summary: 132kV Satellite Station	Distribution SoW Summary: Twin Tern 70°C [km]	Distribution SoW Summary: 132kV Feeder Bay (Dx)	Transmission SoW Summary: 2x500 MVA, 400/132 kV	Transmission SoW Summary: 400/132kV, 1x500MVA	Transmission SoW Summary: 500 MVA, 400/132 kV	Transmission SoW Summary: 400kV Line [km]	Distribution Cost: Development Cost (R'm)	Distribution Cost: Capital Cost (R'm)	Distribution Cost: Total Cost (R'm)	Transmission Cost: Development Cost (R'm)	Transmission Cost: Capital Cost (R'm)	Transmission Cost: Total Cost (R'm)	Total Project Package Cost (R'm
Boundary MTSA	Phase0	235	-	-	2	20	7	-	-	-	-	12	85	97	0	0	0	97
Kronos MTSA	Phase0	225	-	-	-	-	3	-	-	-	-	1	9	10	0	0	0	10
Watershed MTSA	Phase0	574	-	-	5	78	4	-	-	-	-	31	230	262	0	0	0	262
Mookodi MTSA	Phase0	476	1	4	3	90	5	-	-	-	-	37	273	310	0	0	0	310
Nama MTSA	Phase0	120	-	-	1	5	2	-	-	-	-	4	28	32	0	0	0	32
Ferrum MTSA	Phase0	460	1	18	-	61	4	-	-	-	-	30	223	254	0	0	0	254
Aurora MTSA	Phase0	713	-	-	4	71	2	-	-	-	-	27	198	225	0	0	0	225
Leander MTSA	Phase0	235	-	-	2	10	2	-	-	-	-	7	51	58	0	0	0	58

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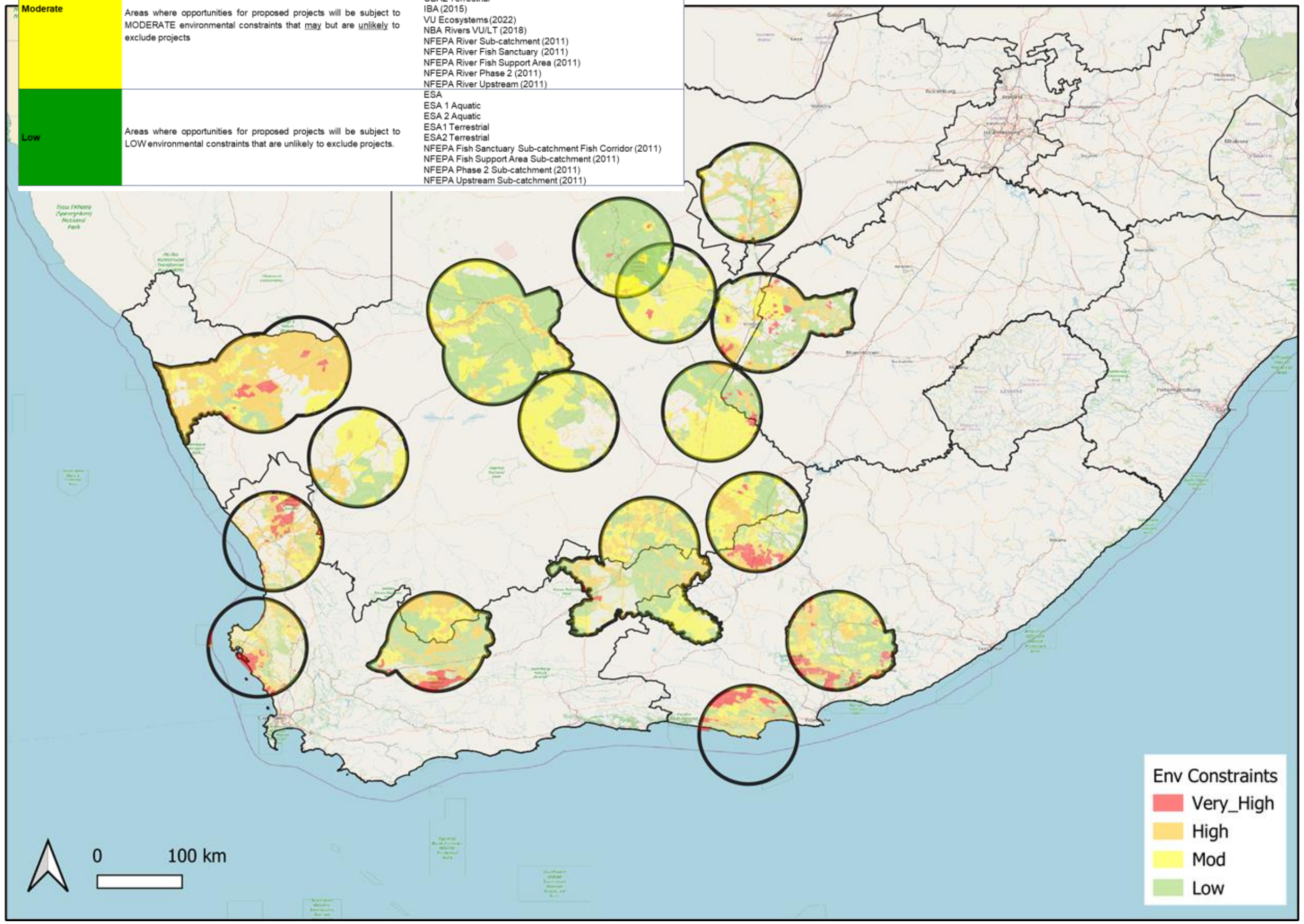
PHASE 2 RESULTS

ENVIRONMENTAL SCREENING

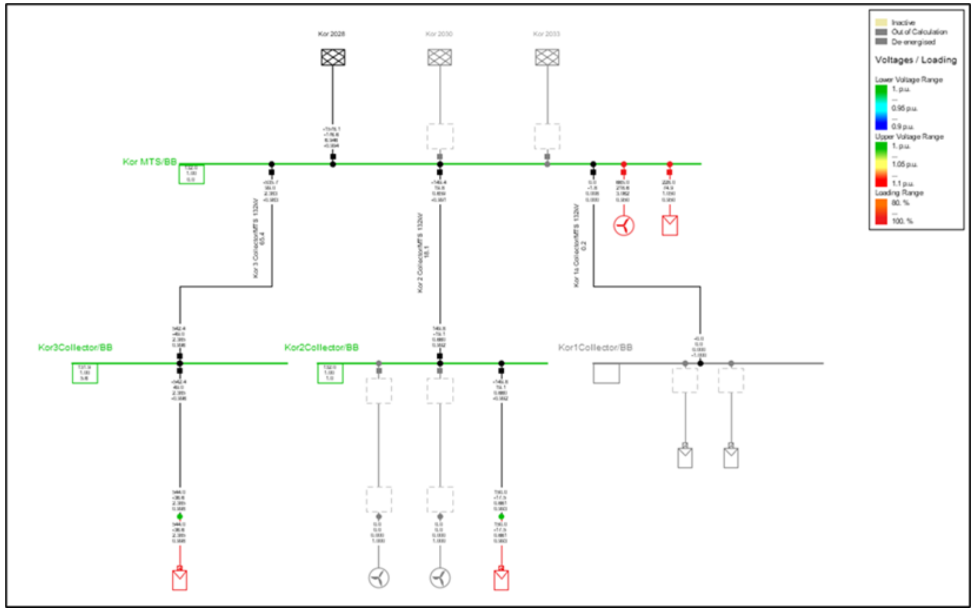
- Results provide an indication of the likely environmental constraints
- Higher-level constraints = greater risk of not obtaining Environmental Authorization
- Site-level investigation may reveal constraints not identified by available tools (e.g., due to scale of the plans, mapping errors, incomplete information)
- May also reveal opportunities in areas indicated as having higher-level constraints
- Other constraints still need to be considered (e.g., heritage, agricultural)
- Detailed Environmental Screening – National Web Based Env Screening Tool
- Identify which specialist studies will be required as part of Environmental Authorisation process

Environment Constraints	Description	Spatial layers / features
Very High	Areas where opportunities for proposed projects will be subject to VERY HIGH environmental constraints (such as formally protected areas) that would likely exclude projects.	World Heritage Site (SAPAD / NPAES / Biodiversity Plans; 2022) National Parks (SAPAD / NPAES / Biodiversity Plans; 2022) Nature Reserves (SAPAD / NPAES / Biodiversity Plans; 2022) Protected Environment (Biodiversity Plans)
High	Areas where opportunities for proposed RE projects will be subject to HIGH or environmental constraints that could possibly exclude projects. However, there may still be site specific conditions that may still permit a project. For example, while a proposed project may occur within an area identified as a CBA1 area (or equivalent) or an Threatened Ecosystem, there may be existing transformed land that could accommodate energy infrastructure without compromising biodiversity values.	Protected Environment (SAPAD / NPAES) CBA / CBA1 Terrestrial CBA / CBA1 Aquatic ECBCP – Vultures (2019) NBA Springs (50 m; 2018) NBA Natural Wetlands (2018) NBA Rivers CR/EN (50 m; 2018) NFEPA Rivers (2011) NFEPA Wetlands (2011) CR / EN Ecosystem (2022)
Moderate	Areas where opportunities for proposed projects will be subject to MODERATE environmental constraints that may but are unlikely to exclude projects	NPAES – Priority Focus Area (2018) NPAES – Under Negotiation (2018) CBA2 Aquatic CBA2 Terrestrial IBA (2015) VU Ecosystems (2022) NBA Rivers VU/LT (2018) NFEPA River Sub-catchment (2011) NFEPA River Fish Sanctuary (2011) NFEPA River Fish Support Area (2011) NFEPA River Phase 2 (2011) NFEPA River Upstream (2011)
Low	Areas where opportunities for proposed projects will be subject to LOW environmental constraints that are unlikely to exclude projects.	ESA ESA 1 Aquatic ESA 2 Aquatic ESA1 Terrestrial ESA2 Terrestrial NFEPA Fish Sanctuary Sub-catchment Fish Corridor (2011) NFEPA Fish Support Area Sub-catchment (2011) NFEPA Phase 2 Sub-catchment (2011) NFEPA Upstream Sub-catchment (2011)



PHASE 2 RESULTS

APPLICATION OF COLLECTOR FRAMEWORK

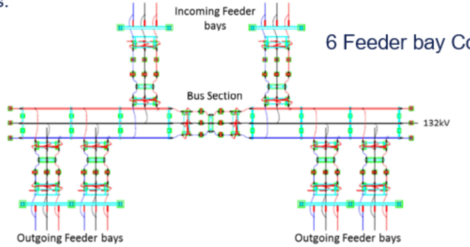


Study Area	Substation	Collector Substation [Rmil]	Qty	Satellite Stations [Rmil]	Qty	Sub-Transmission Lines [Rmil]	km	Total Cost (Rmil)
	Droerivier	R139,5	3			R1 099,80	90	R1 239
	Gamma	R186,0	4	R14	1	R1 457,99	85	R1 665
B	Galenia	R93,0	2			R415,60	50	R509
	Lox	R139,5	3			R1 102,18	90	R1 242
	Nuweveld	R232,5	5			R2 564,33	125	R2 797
C	Koruson	R139,5	3			R610,07	48	R750
D	Hydra B	R46,5	1	R14	1	R703,36	150	R750
	Siyaneza	R186,0	4			R1 007,48	63	R1 193
E	Komsberg	R186,0	4			R1 075,86	64	R1 262
	Aries	R93,0	2			R682,24	82	R775
I	Garona	R46,5	1	R14	1	R94,80	4	R162
	Nieuwehoop	R46,5	1			R327,69	80	R374
	Upington	R186,0	4			R2 488,54	149	R2 675
	Capital Cost Estimates							**R15 392**

The collector stations and satellite stations will be designed as six and three feeder bay configurations respectively [2]. Below is the high-level cost estimates used for the lines, collector and satellite stations.

Line Capital Costing Summary

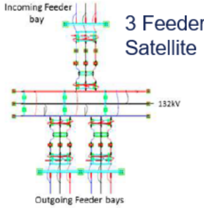
Conductor	Tower Type	Unit Capital Cost(Rm/km)
	70°C	
Double Circuit Twin Tern	247	R6,10
Twin Tern	224	R3,95
Tern	248	R1,86



6 Feeder bay Collector

Estimated Costs of Collector and Satellite Stations (R'm)

Station Type	Feeder Bay	Qty	Bus Section	Qty	Busbar (up to 7 Feeders)	Qty	Civils and Switchroom	Total Cost	Additional Feeder-Bay
Collector Station	R5	6	R5,5	1	R5	1	6	R46,5	R5
Satellite Station	R5	3	R5,5	0	R3	1	3	R21	R5
MTS (132kV Feeder Bay)	R7,8	1						R7,8	R7,8
Dx (132kV Feeder Bay)	R6	1						R6	R6



3 Feeder bay Satellite

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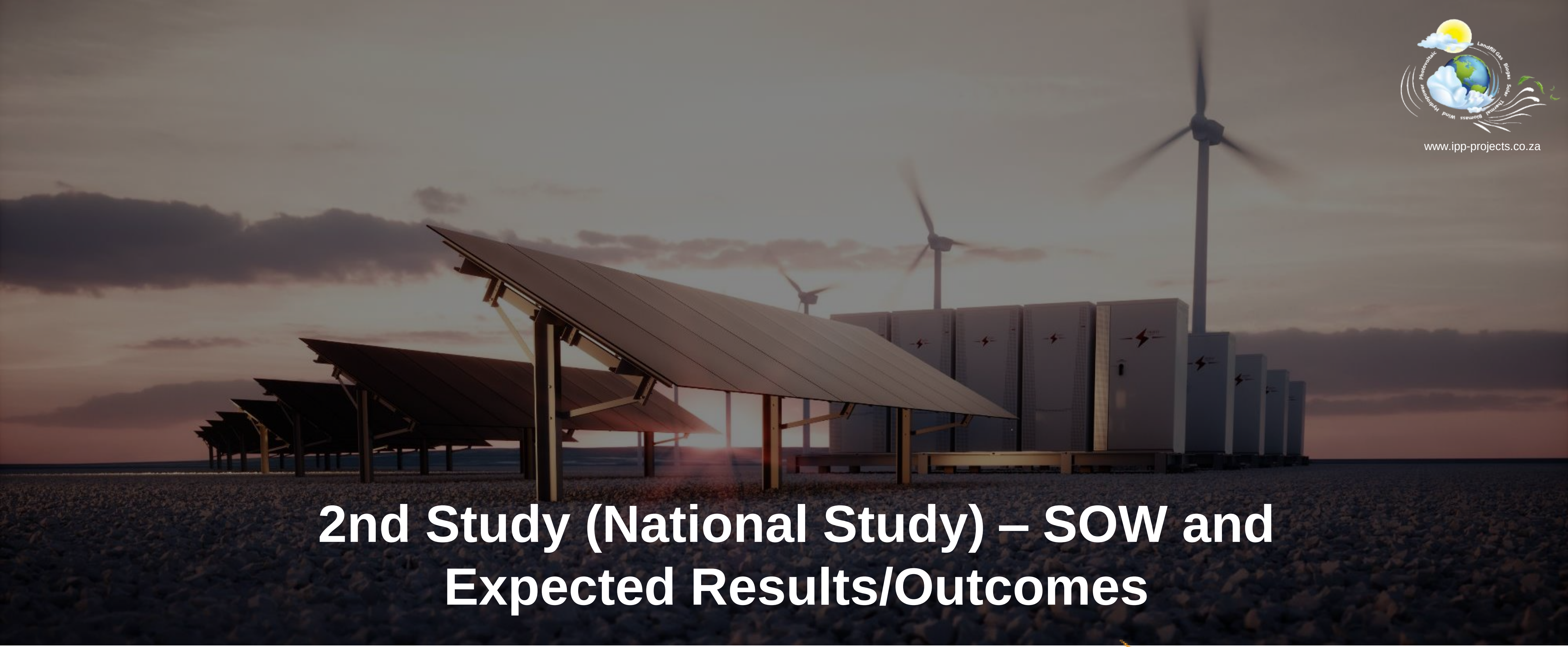
PHASE 4
RECOMMENDATIONS

LONG-TERM INITIATIVES

1. To improve the overall product, Eskom Transmission Division along with RE industry experts, should **create a comprehensive template that can be used by key players within the supply chain** such as land and rights, planners, substation design and asset procurement
2. Eskom Transmission Division should **collaborate with local/provincial government within area identified for collector network development and communities, landowners, and relevant authorities** to ensure alignment of project goals, long-term strategies and minimise potential conflicts.
3. It is recommended that **a dedicated Guideline for Servitude Acquisition be developed by Eskom Transmission Services Land and Rights in collaboration with the relevant Tender committee for future collector station network projects** that is based on the Expropriation Act as well as the Eskom Guideline for determining fair and equitable consideration for servitude acquisition.
4. Eskom Transmission Division should look into **utilising Aluminium Conductor Composite Core (ACCC) as an improved alternative for the collector network development, offering potential cost savings through reduced line losses and additional line current carrying capacity.** In addition, the standardising of the type of sub-transmission conductors as far as possible used in planning collector networks will aid in quicker procurement and planning of the networks.
5. **Establish a periodic review process for the collector design framework**. Regularly update and refine the criteria based on emerging technologies, industry best practices, and lessons learned from previous projects.

NEW Research and Further Studies

- **A national rollout of the revised collector framework** to the remaining RE Clusters to inform future REIPPP and RE integration for **Eskom Tx/Dx and Metros**
- Further development of the RE Diversity calculation tool for use by the IPPO for determining the most appropriate RE mix from IPPs that will maximise energy yield and that considers energy as a function of cost for efficient generation, presenting potential cost savings.



2nd Study (National Study) – SOW and Expected Results/Outcomes

www.ipp-projects.co.za

Partners:

Eskom

Eskom National Transmission Company South Africa

nersa NATIONAL ENERGY REGULATOR OF SOUTH AFRICA

KFW

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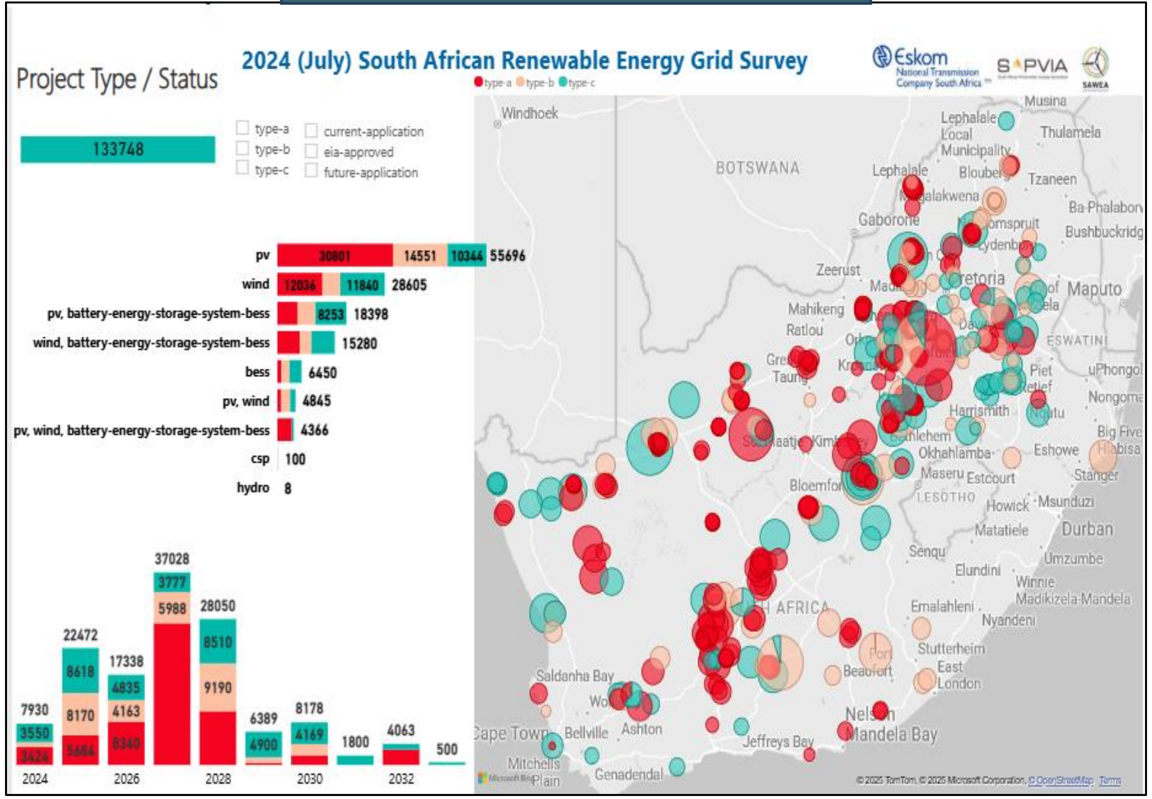
Study on the National Implementation of Collector Substations for IPP Integration to the Grid

~ 133 GW potential



Study Objective

To implement cost-effective means to facilitate grid integration of IPPs countrywide through a Collector Substation framework

Key outcome:

The outputs of the study will, amongst others, provide a comprehensive report which details the number of collector substations per Renewable Energy Park (REP) and the associated costs for implementation with requisite regulatory requirements.

Note: Figure SA RE Grid Survey Study by NTCSA, SAWEA and SAPVIA

INDEPENDENT POWER PRODUCERS OFFICE

STUDY APPROACH AND SOW

ESTIMATED 24 MONTHS PROJECT TIMELINE

INDEPENDENT POWER PRODUCERS OFFICE

(A)
Technical study

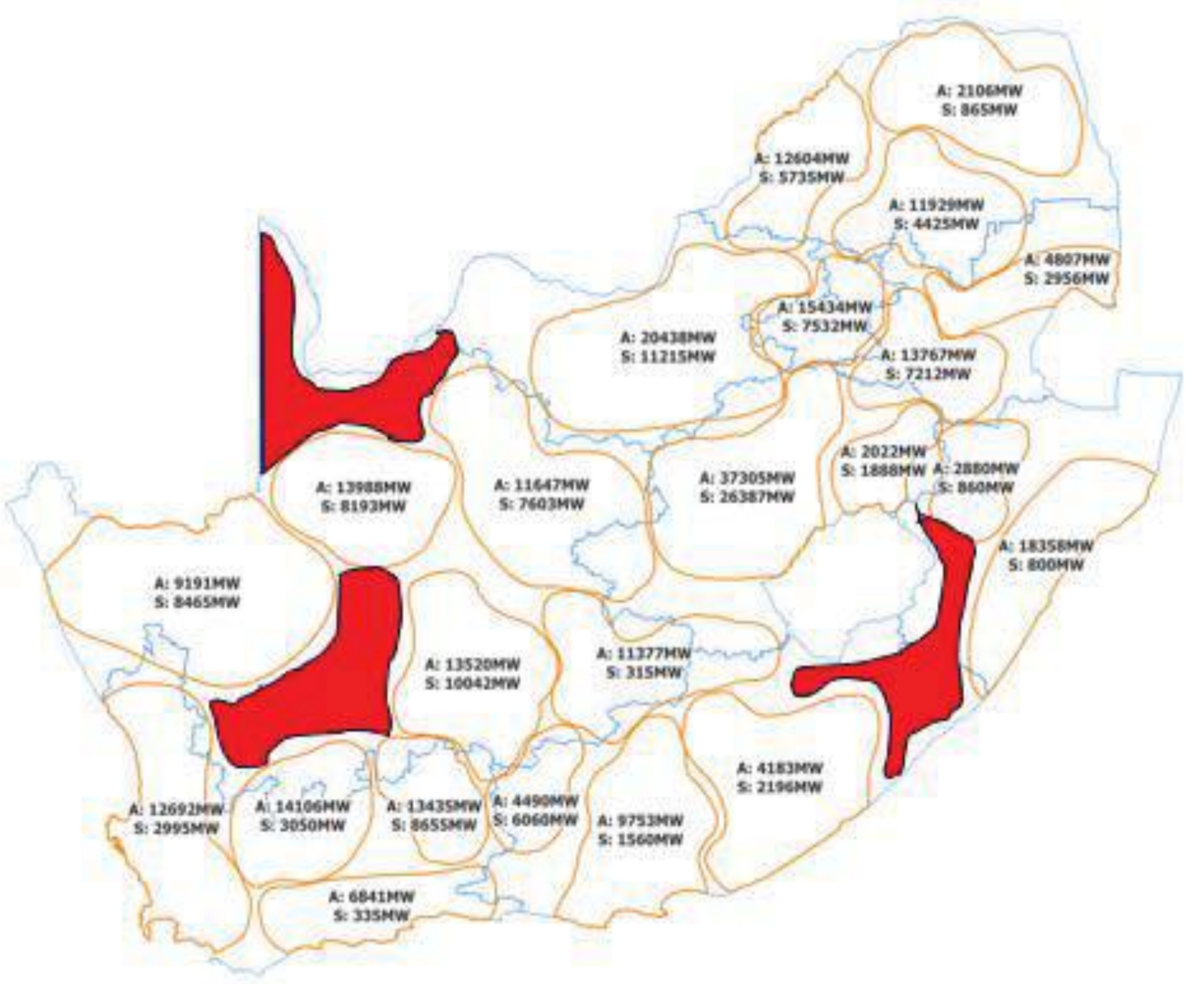
(C)
Regulatory/Implementation study

(B) Project Management study

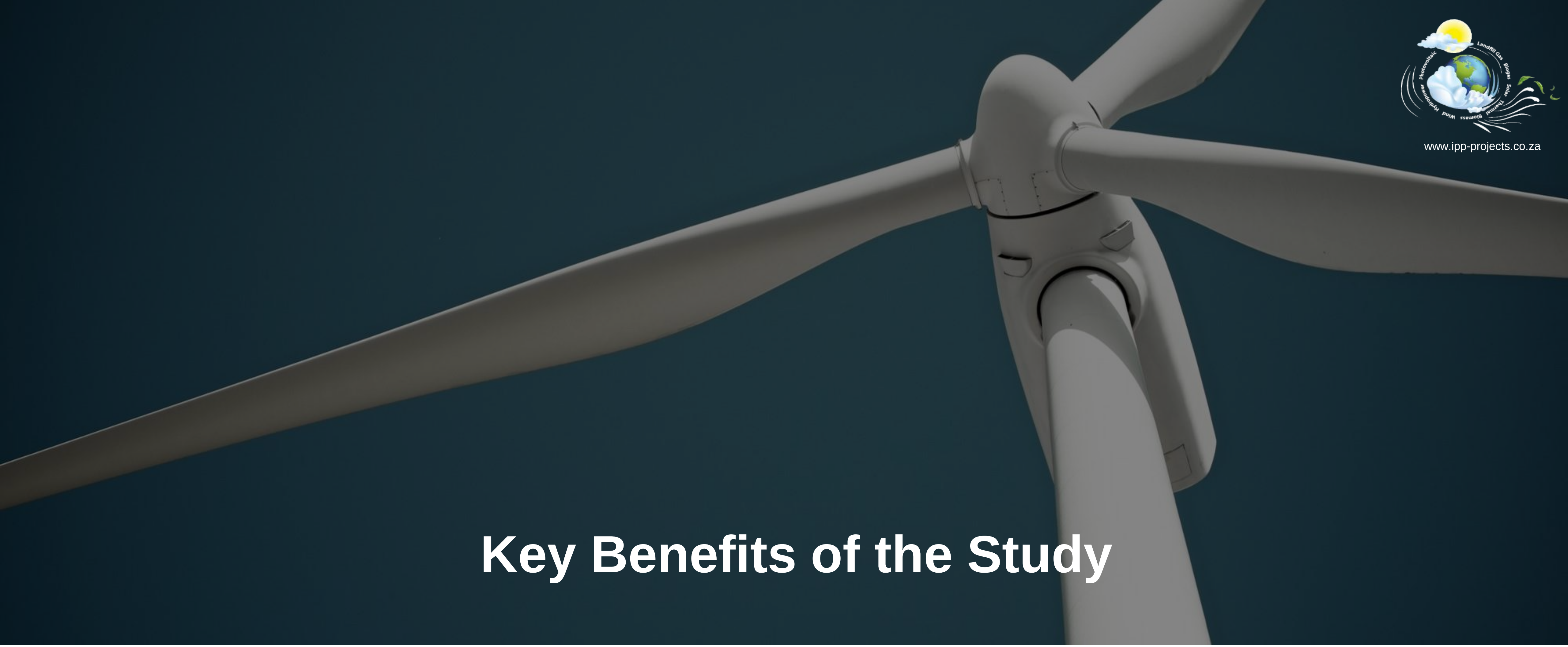
Technical study	Description	Outcomes
Phase 1	Inception	Detailed methodology; Validate the GIS information provided with the original data sets.
Phase 2	Application of the collector design framework	Report on the number of optimally distributed substations, collector substations, and satellite stations
Phase 3	Stakeholder engagements on prelim designs	Report of each collector network based on these engagements and likelihood of attaining these servitudes based on engagements.
Phase 4	Report and recommendations	recommendations on all the all tasks as well as a possible re-allocation of capacity and various procurement strategies for land and rights as well as infrastructure needs
Phase 5	Public version report	Produce a concise report which does not include sensitive details.
Phase 6	Knowledge transfer	Classroom format and training/demonstration. Training manual

National study based on “Renewable Energy Parks” (REPs) in each OU

Operating Unit	No. of REPs	Virtual REPs
Limpopo	3	0
Gauteng	1	0
North West	1	0
Mpumalanga	2	0
Kwazulu Natal	2	0
Free State	2	0
Northern Cape	5	2
Eastern Cape	3	1
Western Cape	4	0



Key: REP – Renewable Energy Park; OU – Operating Unit



Key Benefits of the Study

www.ipp-projects.co.za

electricity & energy
Department:
Electricity and Energy
REPUBLIC OF SOUTH AFRICA

THE STUDY WILL BENEFIT THE ENTIRE ESI

Eskom and NTCSA

- A blueprint (standardisation) of grid connection scope in each Province. This will help streamline the grid application/connection phase of RE projects, and associated grid costs (T&D).
- The study will assist Eskom to optimise grid connection capacities by considering diversity between various generation projects, and to locate mitigation measures to address system strength issues.
- Using the environmental screenings to assist with initial infrastructure placements (avoid no-go areas), and this will assist Eskom to proactively start with the required servitude acquisition processes associated with the sub-transmission shared grid infrastructure such as the collector substation site.

RE Developers / IPP's

- This will assist developers in the planning of their respective projects to align with Eskom standards, especially regarding the grid connection building blocks.
- If the collector locations are shared publicly, this will assist the developers with more accurate grid connection and cost assumptions.

INDEPENDENT POWER PRODUCERS OFFICE

THE STUDY WILL BENEFIT THE ENTIRE ESI

Land-Owners

- This will provide sufficient information for engagements with landowners upfront, and potentially reduce negotiation timelines.

IPP Office

- Increase the success of future procurement programs. A possibility of using the collector substation concept to design bespoke RE IPP Programs.
- IPPs reaching financial close COD within prescribed timelines. The study's application can assist in addressing prevailing grid unavailability issues that lead to long delays, thus compromising efforts to address the energy crisis.

THANK YOU

INDEPENDENT POWER PRODUCERS OFFICE

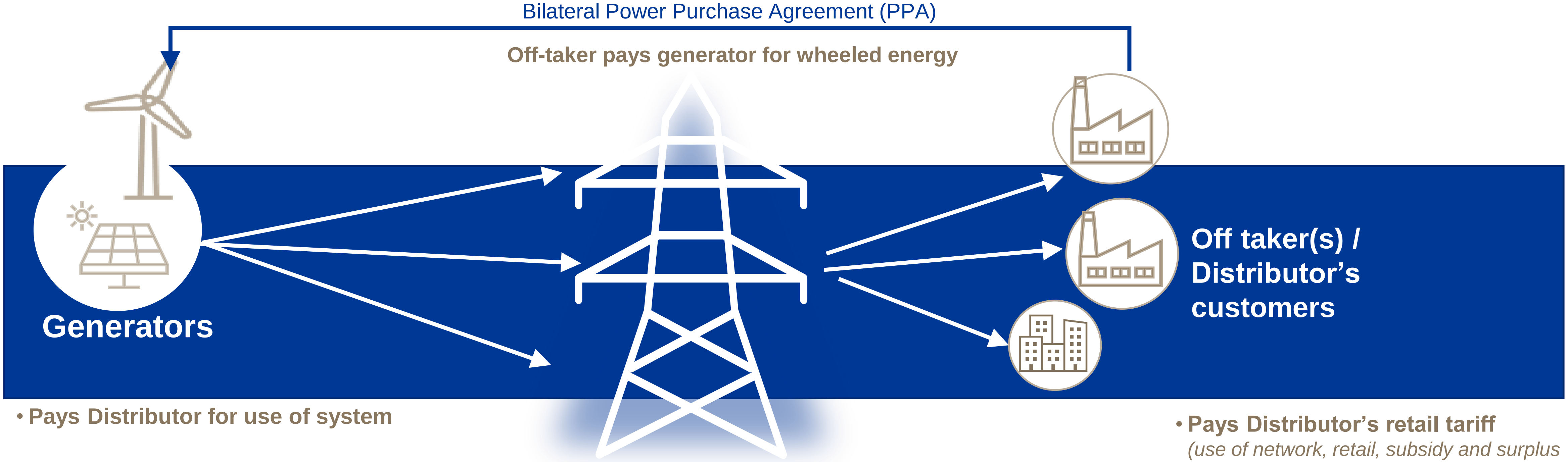
Wheeling service refinement

Lehlohonolo Mashego
Electricity Pricing

20 May 2025

Wheeling overview

- Third-party transportation of electricity
- No separately identifiable electrons transported
- Needs to balance distributors, generators, and off-taker needs.



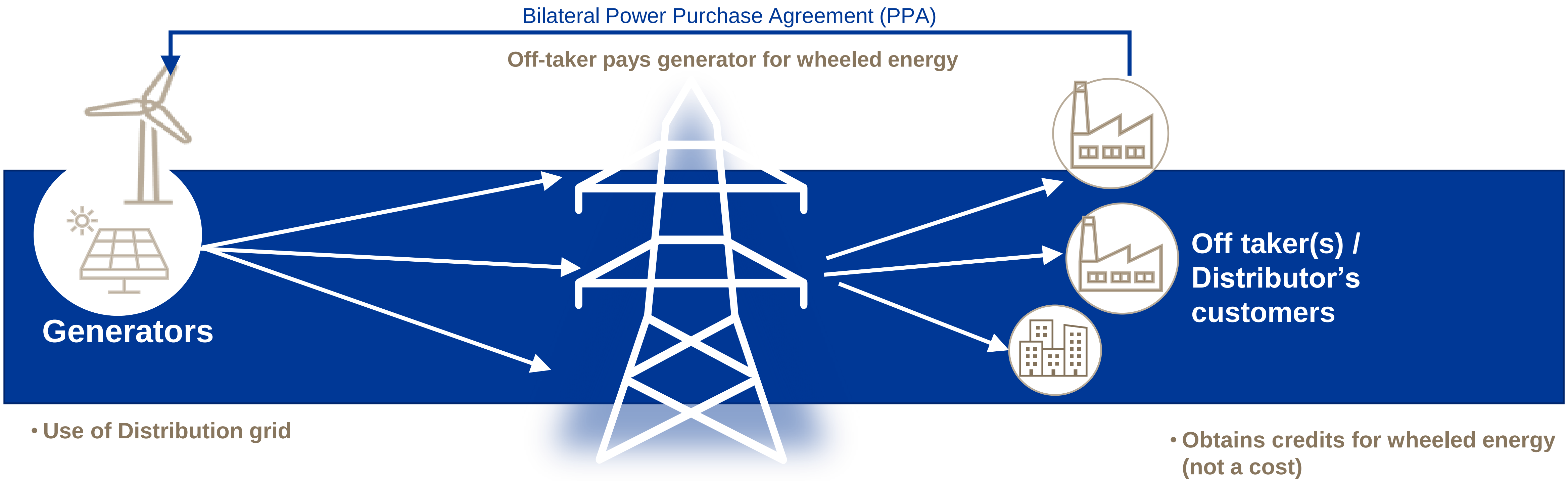
- Pays Distributor for use of system

Distributor

- Provides network access and capacity
- Regulates flow and voltage
- Builds, maintains, and refurbishes network
- Incurs time-of-use differentiated costs for network losses

- Pays Distributor's retail tariff *(use of network, retail, subsidy and surplus contributions).*
- Obtains credits for wheeled energy
- Pays for network losses

Wheeled energy costs



- Use of Distribution grid

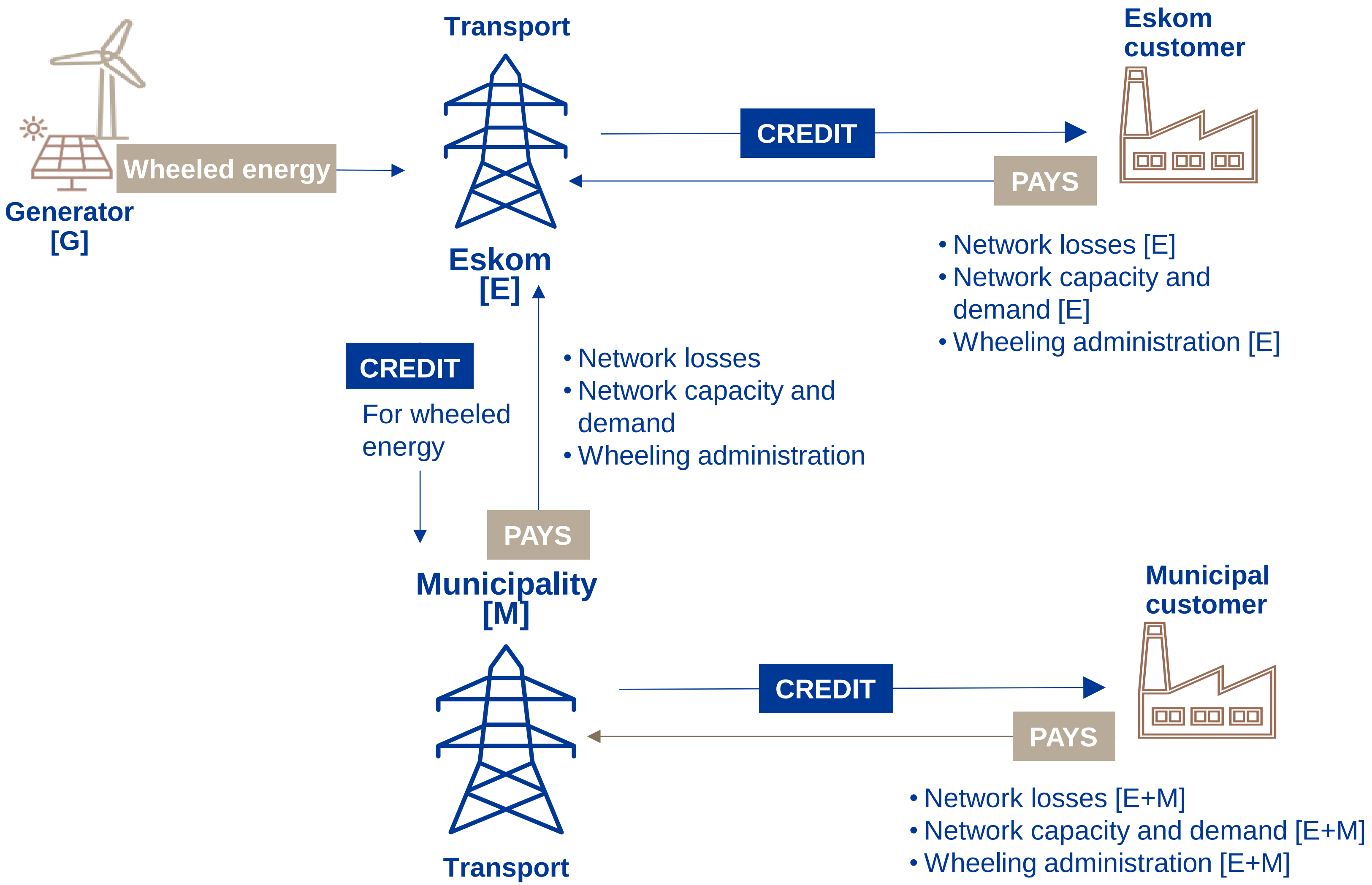
Distributor

- Distribution system operations (regulates flow and voltage).
- Builds, maintains and refurbishes network.
- Incurs time-of-use differentiated costs for network losses (Transmission and Distribution grids).
- Incurs fixed generation capacity costs and legacy costs in the purchase of network losses.

- Obtains credits for wheeled energy (not a cost)
- Pays for network losses
- Pays for wheeling administration of each service agreement

Wheeling transaction

- **Enables non-discriminatory access to the Distributor's network.**
- **Distributor credits wheeled energy to the off-taker account.**
- **Off-takers pay for the cost of losses, use of network, administration, and subsidies.**
- **Generators pay for the use of system.**
- **Municipal customers receive energy from a generator connected to the Eskom/NTCSA network.**
- **Distributors charge for:**
  1. **Network losses:** credit at a lower rate than the tariff to recover the cost of losses.
  2. **Network capacity and demand:** to recover the costs and returns for the grid.
  3. **Wheeling administration:** to recover the cost of administering the wheeling service.

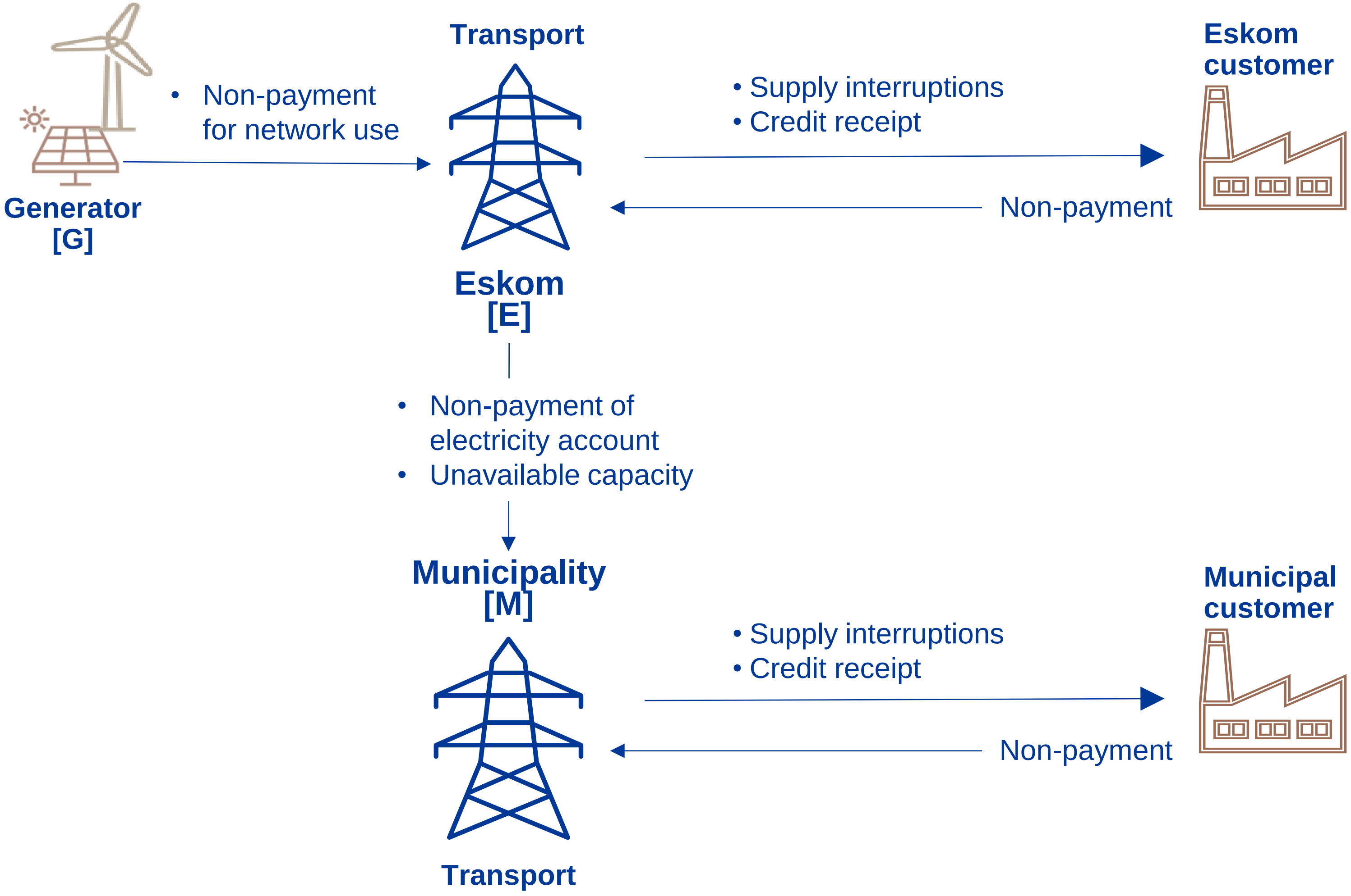


Wheeling service sustainability

For a sustainable wheeling service:

1. **Paid-up** accounts are required for a wheeling transaction in a new month to enable the distributor to meet their obligations.
2. **Alternate payment options** for off-taker participants whose accounts are not paid-up.
3. **Monthly credit pass-through** compliance and conformity to enable off-takers and generators to meet their obligations.
4. **Wheeled energy TOU forecasts among participants** to enable planning for network losses purchases, grid operations, and cash-flows.
5. The Wheeled energy TOU forecast will assist in **creating a robust practice in the advent of a central electricity market**.

Supply interruptions and non-payment of electricity accounts by any participant renders wheeling unsustainable.



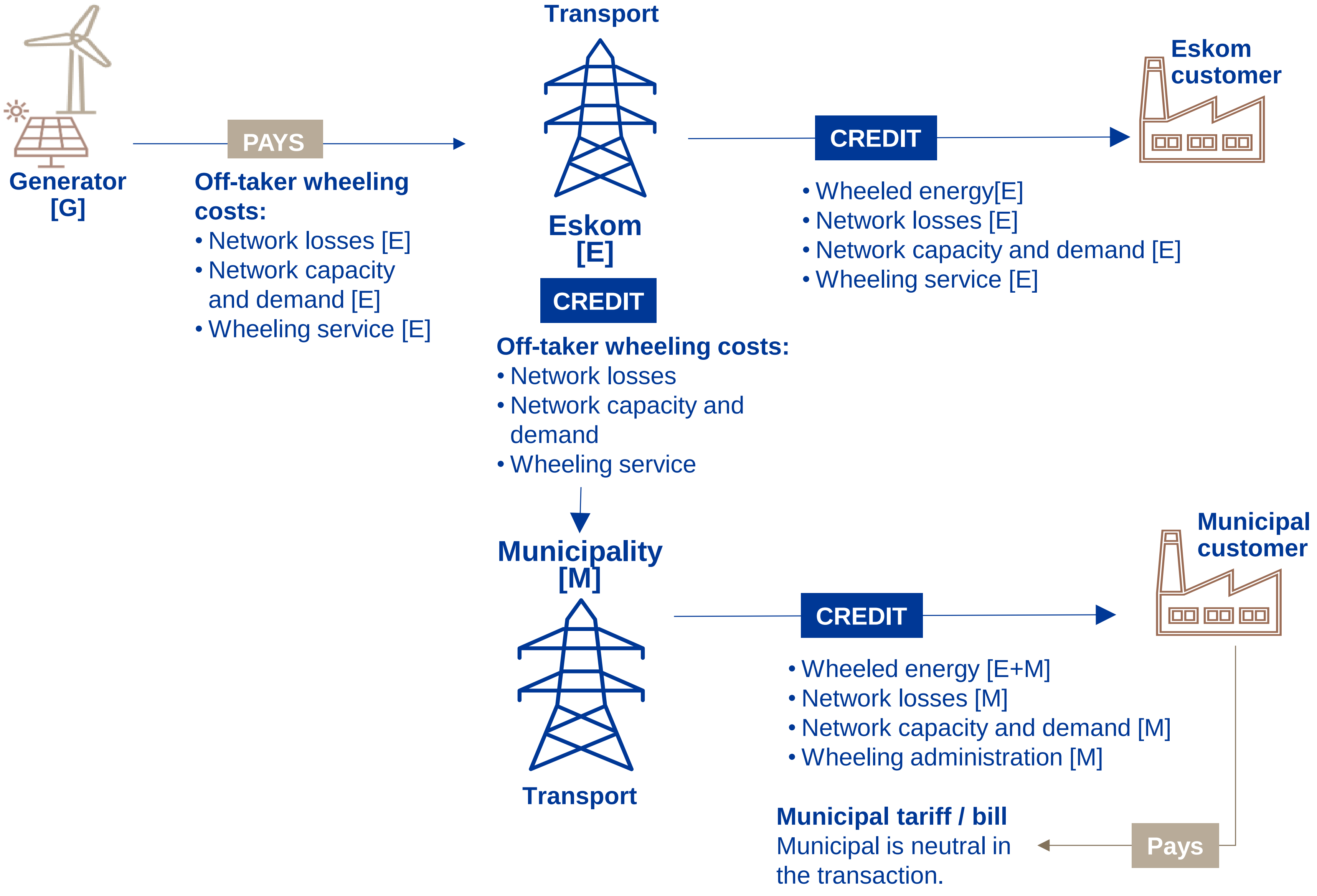
Generator billed payment option

Generator billed option

Alternate payment for wheeling service

Eskom

- **Generators can opt to pay** for the Wheeling service on behalf of the off-taker.
- **Generators contract to pay for the off-takers wheeling service** and the payment credited on an off-taker bill is posted on the Generator's bill.
- Off-taker wheeling costs are **raised and credited on the end-customer bill.**
- **Paid-up** accounts for generators are required for a wheeling transaction in a new month to enable the distributor to meet their obligations
- In the wheeling transaction involving an Eskom embedded generator and a municipal customer, the **municipal customer still pays for the services provided by the municipality**



Generator billed option example

Eskom to Municipality wheeled energy costs

Wheeled energy

	Volume	@Tariff	@WEP EL Credit	Losses cost
Peak	0.3 GWh	R 535 213	-R 489 396	R 45 817
Standard	0.7 GWh	R 938 450	-R 858 143	R 80 307
Offpeak	1.2 GWh	R 1 035 869	-R 947 333	R 88 536
Total	2.1 GWh	R 2 509 531	-R 2 294 872	R 214 659

Wheeling use of network (s)

	Volume	Network cost
Tx NCC	48 kVA	R 770
Tx Ancillary	2.1 GWh	R 15 512
Dx NCC	48 kVA	R 558
Dx NDC	48 kVA	R 1 032
Total		R 17 873

Wheeling service fee

	Volume	Service cost
	1 Acct	R 7 553
Total		R 7 553

Tariff subsidies

	Volume	Network cost
Low -voltage	48 kVA	R 601 153
ERS	2.1 GWh	R 332 982
Affordability	2.1 GWh	R 0
Total		R 934 135

Total wheeled costs for Generator	R 1 174 220

Generator pays Eskom, Eskom credits municipality and municipality credits the off-taker that is a municipal customer.

Generator pays for the losses that is the difference between the customer tariff and the WEPS excluding losses (credit)

Generator pays for the portion of the network associated with the wheeled energy based on demand derived using the offtaker's account weighted load factor and average energy in a month.

The Wheeling service fee that would have been paid by the off-taker.

The subsidy charges that would have been paid by the offtaker.

Generator billed option example

Demand related charges

Generator pays Eskom, Eskom credits municipality, and municipality credits the off-taker that is a municipal customer.

Load factor = (monthly electricity use) / (peak demand) / (number of days in billing cycle) / (24 hours)

Determining Wheeled energy demand

	Load factor (LF)	Max demand (MD)	Weighted LF[2]	Wheeled energy kWh	Hours in month	Average energy in month	Demand for Wheeled energy (kVA)
PoD1	59	198 096	61.1	2 124 966	720	2 951	48.3
PoD2	62	451 874					

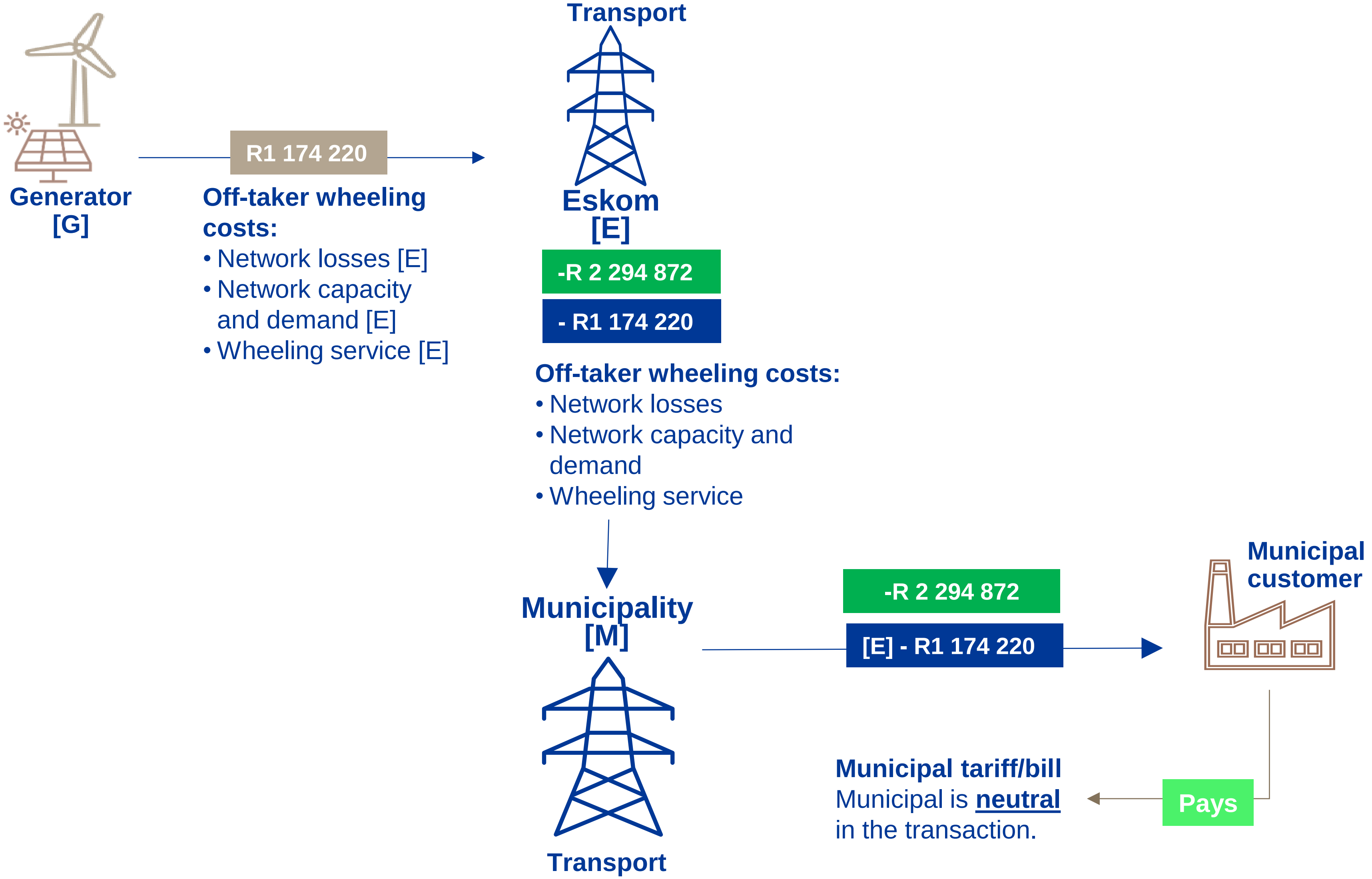
Note:

1. Weighted LF: [PoD1(LFxMD) + PoD2(LFxMD)] / (PoD1MD + PoD2MD)

2. Demand for wheeled energy average monthly energy / weighted LF

Generator billed option example:
Eskom to Municipality wheeling transaction

- **Generators opts to pay on behalf of the off-taker** in its Wheeling agreement with the distributor(s) (payment option change only after 12 months).
- **Off-taker supply agreement amended** to reflect Generator to pay for wheeling costs**.**
- **Eskom Municipal supply agreement amended** to reflect that credits to be passed on to municipal off-taker customer.
- **Municipality amends municipal customer supply agreement for wheeling.**



Wheeling conditions

Credits, nominations, forecasts, and contract duration

To enhance efficiency and sustainability, conditions for wheeling now include:

Payments and wheeled energy credits

- Generator and Off-taker previous month bills to be settled in full for wheeled energy credits to be provided.
- A generator can pay for costs associated with wheeled energy on behalf of the off-taker by contracting for Wheeling on the generator billed (Gx-billed) option.

Cut-off for nominating wheeled energy allocations

- Generators can nominate different off-takers for Eskom to allocate the wheeled energy.
- Generators are required to submit their updated nomination and allocations to Eskom at least 24 hours before the billing date.

Forecast requirements for wheeled energy

- The generator exporting energy for wheeling and off-takers / customers are both required to provide a 3-year wheeled energy forecast by time-of-use and month.
- The forecast must be updated and submitted bi-annually by 30 April and 31 October.

Agreement duration

- Customers are required to specify the end date of their wheeling agreement for Eskom's planning purposes.

More information on wheeling

Eskom Distribution

ESKOM HOME CONTACT US

Home | Customer service | Outages | Smart prepaid split meters | Virtual Wheeling | New and additional supply | SSEG | Demand Management Programme | Load Limiting | Standard Offer

What you need to know about wheeling of electricity

What is wheeling?

Wheeling is the delivery of energy from a generator to an end-user located in another area through the use of an existing distribution or transmission networks. This may also be across multiple different distribution networks, such as through Eskom to a municipality. All customers therefore have energy wheeled to them, whether it's supplied by Eskom or from a third party IPP. A simple example of wheeling could be an IPP solar farm based in the Northern Cape, selling its energy to a corporate company in Gauteng and the electricity is delivered using Eskom's transmission network and the municipal distribution network.

Wheeling does not necessarily mean that the electrons entering the transmission network at point A will be used at point B – it's rather the act of balancing the energy from the generator with the end user consumption within the **time-of-use** (TOU) period, thus wheeling is more of a financial transaction.

In South Africa, wheeling can be used for any form of power available in our energy mix.

https://www.eskom.co.za/distribution/tariffs-and-charges/wheeling

Thank you

Eskom
National Transmission Company South Africa ™

Connection Charges

Presented By: Lolo Buys

Date: 20 May 2025

Contents of presentation

Background

National Transmission Company South Africa TM

- Connection charges cover the cost of network assets that are specifically installed to connect a user or (a group of users) to the grid.
- Connection charges are payable by both load and generation customers.
- The connection charges rules, methodology and implementation for both the generators and loads, including distributors are in the South African Grid Code, Tariff Code.
- This connection charges rules align and comply with the Code, Electricity Pricing Policy of 2008, and the Electricity regulation Act of 2006 (ERA).

Contents of presentation

Scope, purpose and applicability

Eskom National Transmission Company South Africa ™

Scope

The connection charges policy caters for:

- Charges for standard and premium connections.
- Charges applicable for self-build connection applications.
- Charges applicable for Eskom build connection applications.
- Refund of connection charges.

Purpose

The purpose of the policy is to set out the rules and principles for implementing connection charges .

For each connection, the following principles must be met:

- Transmission network service provider (TNSP) recovers the costs involved in providing the assets.
- Connection charges encourage users to share connection sites.
- Charges and allocation methods are based on clear and transparent rules.
- TNSP does not discriminate between any users connecting onto the TS.

Applicability

- The policy is applicable to all applications for connection to the NTCSA owned Transmission System (TS).
- The applications for connection could be from Generators, End-use Customers, Distributors, and Distributor Customers with direct and/or indirect connections to the TS.

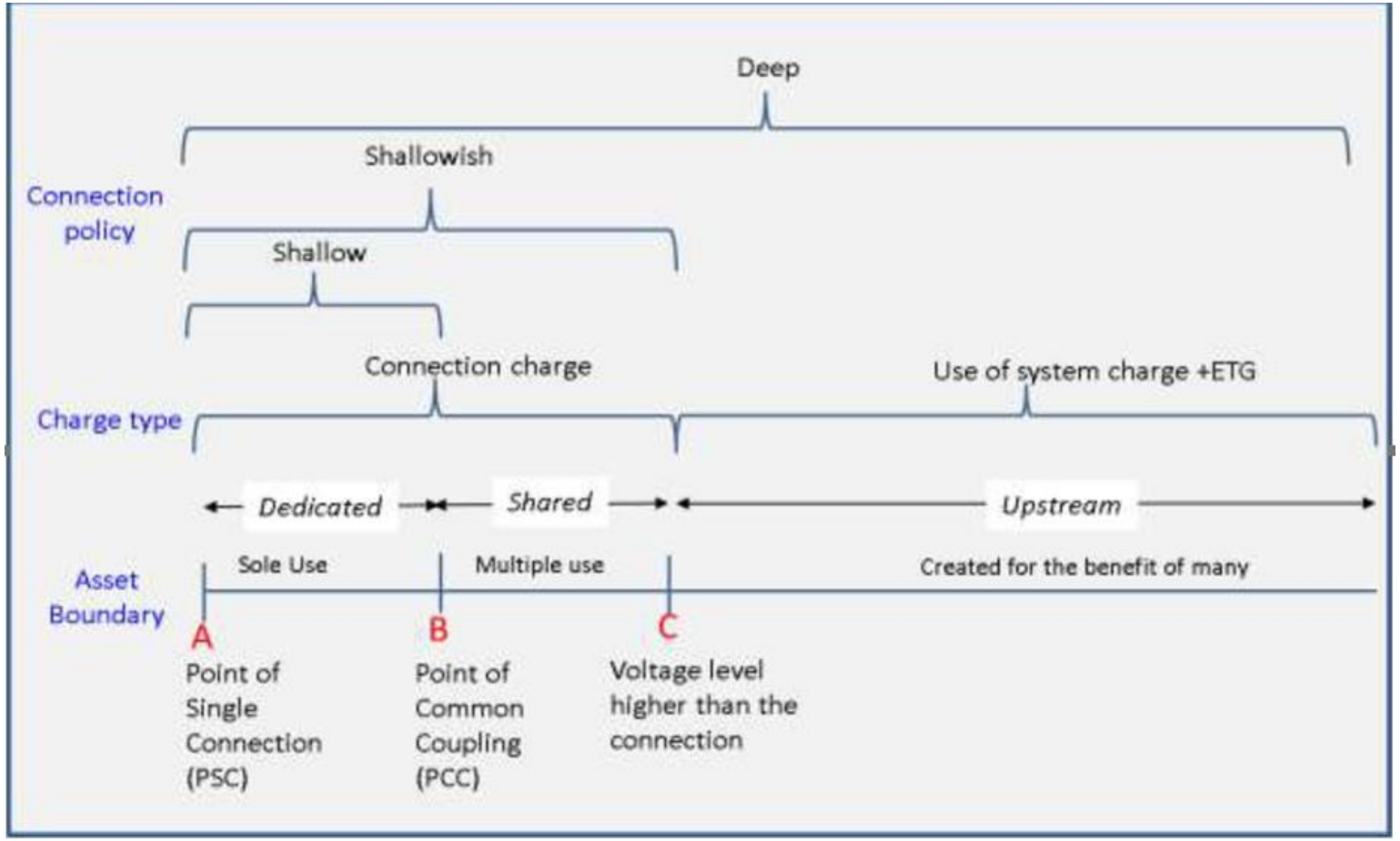
Contents of presentation

Connection charges policy and assets boundaries

connection charges policy

- A "Shallow-ish" connection charge policy was adopted for connection charges.
- Under "Shallow-ish" connection charge policy, the customer is responsible for the costs of the dedicated assets and a portion of the shared assets.
- The rate base through network charges will fund the remaining portion of the shared costs.
- Deep connection charge for self-build

connection charges boundaries



Policy principles

The various policy principles	Brief details
The General principles	▪ The TNSP recovers the costs involved in providing the assets which enable the customer a connection to the TS. ▪ Users are encouraged to share connection sites, which promotes efficiencies in the provision of assets and costs sharing between users. ▪ Charges and allocation methods are based on clear and transparent rules that avoid arbitrariness and limit administrative burden. ▪ The TNSP does not discriminate between any users connecting onto the TS
Principles for connection charges	▪ Ensure adequate recovery of all costs. ▪ Encourage sharing of assets. ▪ Ensure clarity and transparency in the application of the rules. ▪ Ensure equitable treatment between all connecting customers. ▪ Ensure that no customers receive windfall profits. ▪ Ensure that there are no free riders. ▪ Facilitate competition in the electricity supply industry. Should as far as possible avoid creating barriers to entry.
Principles to be applied for the transmission transformation capacity (TTC) charge	▪ The TTC charge applies to customer connection in the distribution and transmission systems where there are no requirements for a new transmission substation or transformation assets, where there are no actual costs for the shared asset and to: - All suppliers and demand customers with nominal voltages from 33kV and above that require new capacity or capacity upgrades at; existing Distribution systems, or new Distribution systems. - For direct transmission connections, all customers of all nominal voltages are required to pay a TTC charge. ▪ Where there is a requirement for new transmission transformation assets and the actual costs are known, the actual costs shall be used instead of a standard TTC. ▪ Where there is a requirement for transmission transformation assets and the substation is not yet complete, the allocated shared costs based on the project costs shall be used and reconciled under the refund procedure once actual costs are known when the substation project is complete.

Policy principles Continued

The various policy principles	Brief details
Principles to be applied for the transmission transformation capacity (TTC) charge cont.	▪ For the treatment of distributers in terms of the code, the distributors – Eskom distribution, Municipalities, and other licenced NSPs – do not pay TTC charge. Tthey pay for a feeder bay needed and dedicated to them at the MTS. ▪ Customers that are only requesting for a reduction of their NMD will not be charged a TTC charge. ▪ The distributor customer is liable for connection charges. If the distributor applies for a connection on behalf of a single customer, or a group of customers, the connection is seen as a distributor customer connection, and it will attract a TTC charge. ▪ The connection charges rule applies only to customers requiring permanent connections. Temporary supplies should be assessed on a case-by-case basis.
Principles for standard connection charges	▪ An asset that is considered dedicated is an asset whose costs is directly caused by the customer or group of customers and whose cost is allocable to a single or a set of customers. ▪ If at the time the original connection application is received by the TNSP, there is a reasonable likelihood of asset sharing taking place in the foreseeable future, then the original connection assets will be classified as Shared Connection Assets. ▪ Each customer connected to the shared assets will be charged a pro rata share of the cost of the connection asset. ▪ The share of a connection asset will be determined on a per MW basis, regardless of whether the connecting or connected parties are generation or demand facilities.
Principles for standard connection charges (when funding is approved)	▪ For assets dedicated to a single customer - The connection charge will be based on the cost of the new assets required for the connection including all works associated with the connection. ▪ For shared assets – 1. When new shared assets are recently installed or to be precured and/or whose actual costs are known, the connection charge will be based on a proportion of the actual costs of any new connection assets and associated works. 2. - Where the shared assets are existing and/or assets whose actual costs are not known including those constructed through self-build, the connection charge will be based on a standard TTC charge of (R/kVA). ▪ For assets dedicated to a single customer and upstream reinforcements are required - The connection charge will be based on; the shared connection charge or standard TTC charge, plus and an ETG will be raised for upstream assets.

Policy principles Continued

The various policy principles	Brief details
Principles for standard connection charges (when funding is approved) cont.	▪ For dedicated assets and shared assets, where upstream reinforcements are required - The connection charge will be based on: The dedicated connection costs, the shared connection costs or standard TTC, and an ETG will be raised. ▪ For distribution embedded connections, with Transmission dedicated assets – 1. The connection charge will be based on the connection charge for the distribution portion of the project. 2.Where connection triggers the installation of new assets at the MTS, the portion of the cost of the new assets including all works associated and full costs where the customer requirements exceed the minimum standard or least cost technically acceptable to provide capacity. 3. Where the transmission assets are existing and shared, a proportion of the cost of the existing connection assets to be shared with other users who are already connected. 4. Where the shared assets are existing and/or assets whose actual costs are not known including those constructed through self-build, the connection charge will be based on a standard charge of (R//kVA). ▪ For distribution embedded connections, with Transmission dedicated assets and upstream reinforcements required – The connection charge will be based on the cost, and an ETG will be raised for upstream assets.
Principles for standard connection charges (when funding is not approved)	▪ Connection charges will be funded fully by the customer. ▪ Subsequent customers making use of the same connection assets will be charged a pro-rata share of the connection costs
Principles for premium connection charges	▪ Premium connection charging (where all assets are premium) - It does not matter whether funding of the connection project has been approved or not. 1. The connection costs will be funded fully by the customer. 2. Subsequent customers making use of the same connection assets will be charged a pro-rata share of the connection costs. ▪ Premium connection charging (where some assets are premium) - The connection costs for assets above the standard solution, will be funded fully by the customer.

Example: Eskom-built

Example 1: A standard connection in a substation planned to accommodate multiple developers

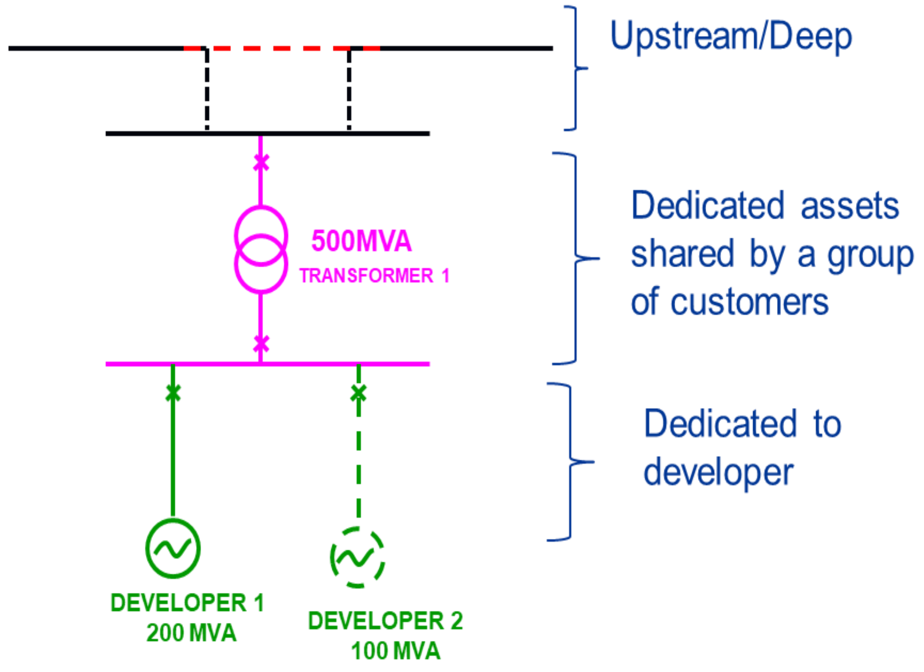
A new customer connects to the systems, the network provider installs a bigger transformer than the customer requires for the benefit of future customers.

- The initial customer (Developer 1) will pay:
  - full costs for the assets dedicated solely for their use, e.g. the feeder bay, plus
  - a pro-rata share of the costs of the shared dedicated assets, in this case the transformer.
- The subsequent customers will pay
  - full costs for the assets dedicated solely for their use, e.g. the feeder bay, plus
  - a pro-rata share of the shared dedicated assets
- In case of a generator pro-rata share is calculated based as a ratio of the MEC of the generator to the transformer capacity as per the following formula:

$$Customer\ Prorata\ share\ = \frac{MEC}{500\ \mathrm{MW}} X\ Cost\ of\ shared\ assets$$

- In case of a load pro-rata share is calculated based as a ratio of the MIC of the load to the transformer capacity as per the following formula:

$$Customer\ Prorata\ share\ = \frac{MIC}{500\ \mathrm{MVA}} X\ Cost\ of\ shared\ assets$$



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Payment of connection charges

Eskom National Transmission Company South Africa ™

Financing of connection charges

- The connection charge shall be payable in full and in advance of energizing the connection assets.
- Where a connection is to be commissioned or constructed in phases, payments shall correspond with the agreed phases or key milestones.

Upfront payment of connection charges

- Connection charges are payable up-front before Transmission will commence with the connection works.
- Transmission may allow phased payments.

Phased payment of upfront connection charges

- Phased payments are only allowed for major works projects due to the time taken to construct such projects.
- A phased payment schedule must be based on logical periods such as work progress stages or fixed periods.
- In the event of an approved phased payment schedule, this will be conditional on the provision of a connection charge guarantee to cover the outstanding connection charge payments.
- Transmission reserves the right to call upon the guarantee and/or halt the project until the payments have been made, should payments not be made in accordance with the payment schedule.
- Work will not proceed to the next phase until the required connection charge for that phase is paid in full, failing which Transmission could opt to draw on the connection charge guarantee or halt the project.
- The connection will not be commissioned until all payments have been made and all the relevant contracts have been signed.
- Where phased payments are allowed the minimum contribution payable up front at time of accepting the quotation is the first phase of the instalment or 25% whichever is the higher.
- The phasing must be included in the submission to the investment committee for their information.

Contents of presentation

Refund policy

Introduction

The developer will receive a refund only when there is a new connection that share the available capacity of connection assets.

Eskom built projects, fully funded by the customer

Refunds shall be calculated using the present value of the outstanding annuity value of the connection charge, pro-rated on capacity. The refund for the original qualifying developer shall be calculated according to the following formula below.

$$Refund = \frac{PMT(1-(1+r)^{-N})}{r} \times S$$

Where:

r = monthly compounded interest rate $r = (1+i)^{1/12} - 1$

i = prime interest rate when subsequent customer connects

N = remainder of loan period

S = pro-rata ratio on a per MW basis $S = \frac{Z}{W}$

Z = MEC/MIC of connecting customer

W =Total installed capacity

PMT =monthly repayment/ monthly annuity value PMT=ICC × r/⟦1-(1+r)⟧^(-n)

ICC = initial connection charge

n = loan recovery period = life of the asset

Customer built projects (Self-build projects)

The original qualifying developer shall be refunded for the portion of the shared connection assets that they are not utilizing within the first 10 years since the commissioning of the plant based on:

- The lower of the standard TTC charge of (R/kVA) that was paid by the new customer, and the TTC amount paid by the new connecting customer towards the shared assets.
- Records of the refunds made to the original developer should be kept ensuring that the refunds do not extend beyond what is due to the customer.

Refund example: Self-Build

Year	**0**	**0**	**0**	**0**	**0**	**1**
	1	**2**	**3**	**4**	**-**	**-**
Project Name	**P1**	**P2**	**P3**	**P4**	**-**	**-**
ICC	750 000 000	750 000 000	750 000 000	750 000 000	750 000 000	750 000 000
i	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%
r	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
n	360	360	360	360	360	348
PMT	2 086 468	2 086 468	2 086 468	2 086 468	2 086 468	2 158 308
Z (MW/MVA)	140	120	75	75	2	0
W (MW/MVA)	475	475	475	475	475	475
TTC (R/kVA)	328					
Connection charge (based on	-	39 360 000	24 600 000	24 600 000	656 000	-
Refund	**221 052 632**	**189 473 684**	**118 421 053**	**118 421 053**	**3 149 136**	**-**
Higher of the TTC and Refund calc.	**221 052 632**	**189 473 684**	**118 421 053**	**118 421 053**	**3 149 136**	**-**
	1	**1**	**1**	**1**	**1**	**1**
Full Term	360	360	360	360	360	360
Balance Self-Build	750 000 000	560 526 316	442 105 263	323 684 211	320 535 075	320 535 075
Refund to developer (Self-build)	**221 052 632**	**189 473 684**	**118 421 053**	**118 421 053**	**3 149 136**	**-**
	221 052 632	189 473 684	118 421 053	118 421 053	3 149 136	-
Total Refund	**650 517 557**					

Procedure

- P1 is awarded self-build option for the shared assets
- In the same year developers p2, p3,and p4 connect 120, 75, 75 and 2 MW generators, to use up the capacity.
- Developers P2,P3 and P4 will pay connection charges based on the standard TTC for the shared assets.
- Eskom passes the connection charges to developer P1 and remains revenue neutral.
- The total refund to P1 including the costs that they would have incurred amount to R 651 million.

Refund example: Eskom-Build

Eskom National Transmission Company South Africa ™

Procedure

- Qualifying developer P1 invested R750 million on the shared assets.
- P1 connects a 140 MW generator. The equivalent connection charge would have been R 221, 052
- Developer 2 connects a year after commission of assets and pays actual costs. The calculated actual costs rate is R 1579.
- Eskom will receive a connection charge of R 190.633 million from P2, for the connection of 120 MW generator.
- The amount will be passed through to P1 by Eskom to remain revenue neutral.
- When capacity is taken up by developers, the total refunded amount will amount to R 221, 052 million,

Year	**0**	**0**	**0**	**0**	**1**	**2**	**3**	**4**	**5**	**6**
	1	**2**	**3**	**4**	-	-	-	-	-	-
Project Name	**P1**	**P2**	**P3**	**P4**	-	-	-	-	-	-
ICC	750 000 000	750 000 000	750 000 000	750 000 000	750 000 000	750 000 000	750 000 000	750 000 000	750 000 000	0
i	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
r	0.80%	0.80%	0.80%	0.80%	0.80%	0.80%	0.80%	0.80%	0.80%	0.80%
n	360	360	360	360	348	336	324	312	300	288
PMT	6 344 181	6 344 181	6 344 181	6 344 181	6 382 985	6 426 221	6 474 462	6 528 371	6 588 718	-
Z (MW/MVA)	140	120	75	75	0	0	0	0	65	0
W (MW/MVA)	475	475	475	475	475	475	475	475	475	475
TTC (R/kVA)	1579									
Connection charge (based on										
Refund	**221 052 632**	**189 473 684**	**118 421 053**	**118 421 053**	-	-	-	-	**106 587 512**	-
Higher of the TTC and Refund calc.	**221 052 632**	**189 473 684**	**118 421 053**	**118 421 053**	-	-	-	-	**106 587 512**	-
	1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Full Term	360	360	360	360	360	360	360	360	360	360
Balance Self-Build	528 947 368	339 473 684	221 052 632	102 631 579	102 631 579	102 631 579	102 631 579	102 631 579	(3 955 934)	(3 955 934)
Refund to developer (Self-build)	**221 052 632**	**189 473 684**	**118 421 053**	**118 421 053**	-	-	-	-	**102 631 579**	-
	221 052 632	189 473 684	118 421 053	118 421 053	-	-	-	-	102 631 579	-
Total Refund	750 000 000									

Thank you