TRANSMISSION

GENERATION CONNECTION CAPACITY ASSESSMENT OF THE 2023 TRANSMISSION NETWORK (GCCA – 2023)

Phase 1

Reference No. : GP_21/126

June 2021

Compiled by	Recommended by	Supported by	Approved by
 **Siphesihle Satimburwa**	 **Ronald Marais**	 **Jacob Machinjike**	 **Segomoco Scheppers**
Senior Engineer- Strategic Grid Planning	**Senior Manager- Strategic Grid Planning-**	**General Manager - Grid Planning and Development**	**Group Executive- Transmission Division**
Date: 07/07/2021	**Date:** 07/07/2021	**Date:** 07/07/2021	**Date:** 7 July 2021

DISCLAIMER

The publication of the Generation Connection Capacity Assessment of the 2023 transmission network (GCCA-2023) is to inform stakeholders of the potential capacity available on the Eskom transmission network to facilitate connection of generation projects. The Generation Connection Capacity Assessment (GCCA) is based on the information currently available and is subject to change. The information contained in this document does not constitute advice; it is a guideline to assist stakeholders. Eskom Holdings SOC Limited makes no representations regarding the suitability of the information to be used for any other purpose. All information is provided "AS IS" without warranty of any kind and is subject to change without notice. The entire risk arising out of its use remains with the recipient. In no event shall Eskom Holdings SOC Limited be liable for any direct, consequential, incidental, special, punitive, or any other damages whatsoever.

While the GCCA-2023 will be updated periodically, Eskom Holdings SOC Limited makes no representation or warranty as to the accuracy, reliability, validity, or completeness of the information in this document. Eskom does, however, endeavour to release the GCCA based on the best available information at its disposal at all times to ensure that the stakeholders are kept informed about the developments in the transmission network. Thus, the information contained in this document represents the most up-to-date information that was available at the time it was released.

Eskom Transmission Division
Megawatt Park, Maxwell Drive, Sunninghill, Sandton
PO Box 1091, Johannesburg, 2000, South Africa
www.eskom.co.za

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. Introduction

The launch of the renewable energy independent power producer procurement programme (REIPPPP) attracts a large number of applications from independent power producers (IPP) for connection to the Eskom grid.

To be considered in the REIPPPP, IPPs go through a bidding process where they indicate the amount of power they can supply and the feasibility of supplying this power in a cost effective way. IPPs therefore need to identify sections of the network with available generation connection capacity where they can connect to. This causes IPPs to constantly contact Eskom with requests for information regarding the available capacity on the network at different nodes. To make information on generation connection capacity within the network readily accessible, Eskom developed the generation connection capacity assessment (GCCA) report.

The revision of the GCCA is triggered by the the announcement of a new REIPPPP bid window. The GCCA–2023 is therefore in response to the announcement of bid window round 5 (BW5) for which preferred bidders are expected to be connected in year 2023.

The REIPPPP BW5 aims to procure 2600 MW of renewable energy generation. Table 1 shows the breakdown per technology type of the generation capacity that will be procured in the REIPPPP BW5.

Table 1: REIPPPP BW5 required procurement by generation technology type

Technology	Capacity (MW)
Wind	1 600
Photovoltaic (PV)	1 000
Total IRP renewable energy for BW5	**2 600**

This report details the available generation connection capacity of the 2023 transmission network with all the projects that are expected to be commissioned by then. Phase 1 of this report considers six supply areas covering the area south from the North West and Free State provinces to the Western Cape. Phase 2 will be published later in the year with the remaining supply areas.

2. Assumptions

The key assumption changes from the GCCA-2022 which was published in 2018 are as follows:

- The connection of approved bidders from the Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP) will result in a reduction in the available generation connection capacity, moreso in the already constrained Northern Cape area.
- The reduction in the load forecast due to the downturn of the economy will lower the available capacity at substations as less of the generation will be absorbed by the local load and more of it will have to be exported to the transmission network.
- Delayed implementation of customer projects will result in further network constraints by forcing connections directly onto the transmission network.
- Reprioritisation and deferal of transmission projects mainly due to funding constraints will result in the inability to facilitate new connections.
- Improved correlation data of wind and solar resources will help to improve study results by utilising more credible assumptions.
- Wider area monitoring of the power system will provide improved oversight and identify upstream network constraints that may have been overlooked previously.

3. Methodology

The southern part of the South African transmission network was subdivided into six supply areas covering the area south from the North West and Free State provinces to the Western Cape. The departure from provinces and customer load networks (CLNs) to supply areas is deemed to be more appropriate for this type of assessment. Provincial boundaries may therefore not be respected when referring to provincial names for some supply areas.

The generation connection capacity results are assessed using the hierarchy shown in Figure 1. The generation capacity that can be connected must be restricted by the lowest limit in the overall hierarchy.

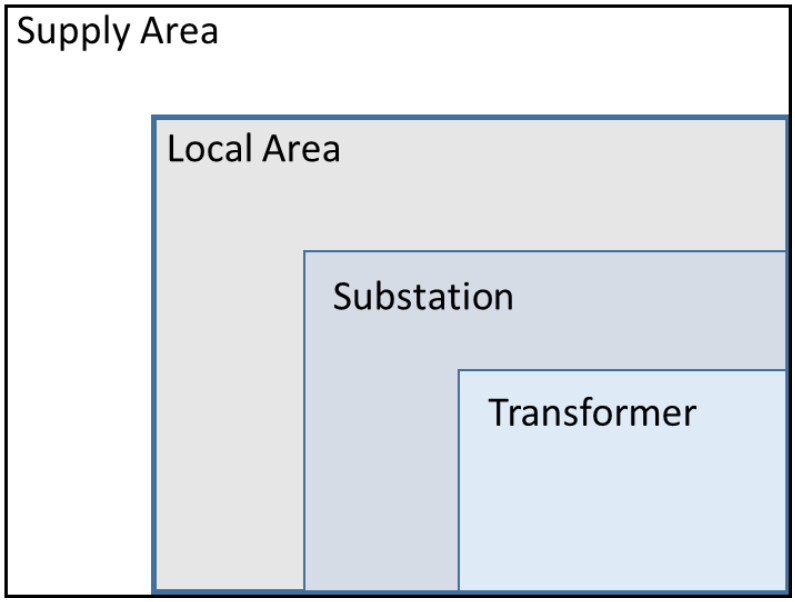

Figure 1: Generation connection capacity limit hierarchy

3.1. Level 1: Transformer Capacity

At level 1, the local substation transformation capacity is assessed assuming an N-0 level of reliability. The generation connection capacity available is evaluated considering the full transformation capacity and assuming that the generators operate at a 0.95 power factor.

When a generator is connected to the secondary busbar in a substation, the power generated is first absorbed by the local load and the excess is fed upstream through the transformers. The red arrows in Figure 2 depict the flow of power when the generator is connected at a substation.

The capacity of a substation's transformation is fixed, but the substation load varies throughout the day. This means that the lower the load connected at a substation, the lower the generation capacity that can be connected at the substation secondary busbar.

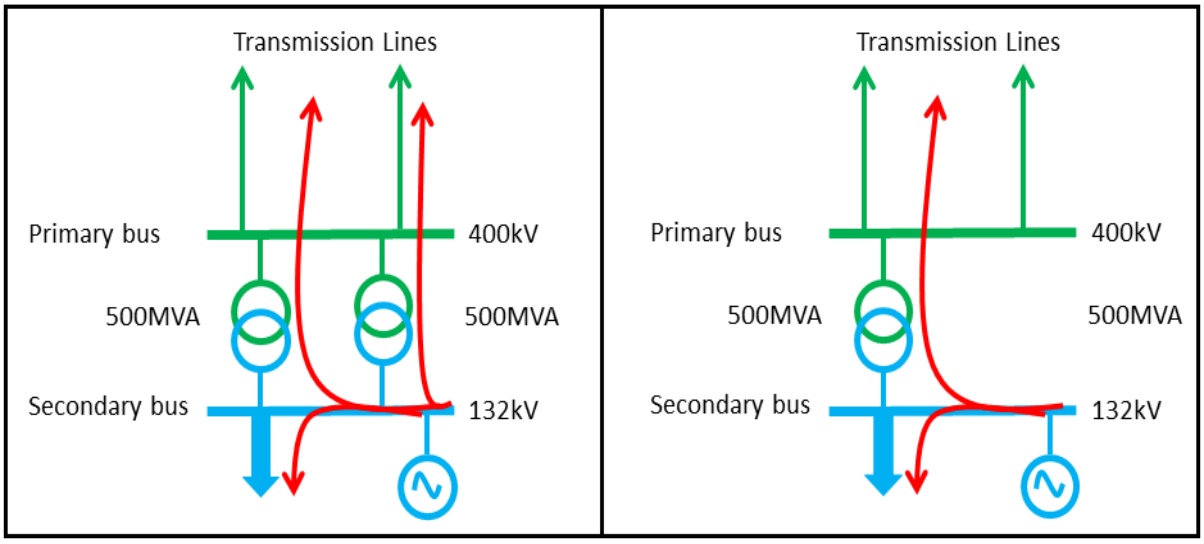

Figure 2: Transformer capacity assessment

3.2. Level 2: Substation Transfer Capacity

At level 2, the substation transfer capacity is evaluated by connecting a generator at each substation primary busbar one at a time, as shown in Figure 3. The network is assessed under all credible N-1 line contingencies.

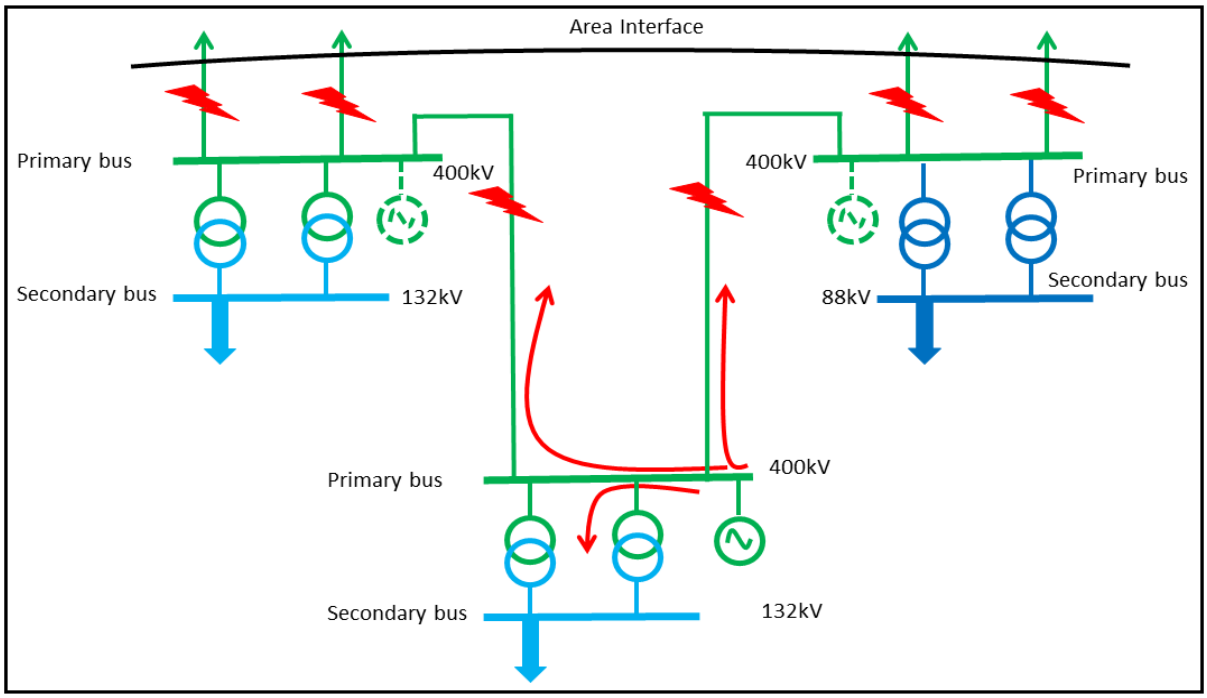

Figure 3: Substation transfer capacity assessment

3.3. Level 3 and 4: Local and Supply Area Capacity

At level 3 and 4, the generation connection capacity is assessed at an area level by scaling all the connected generation in proportion to their values as determined from level 2. The available area generation connection capacity is evaluated by connecting generators at each substation's primary busbar as shown in Figure 4. The network is assessed under all credible N-1 line contingencies.

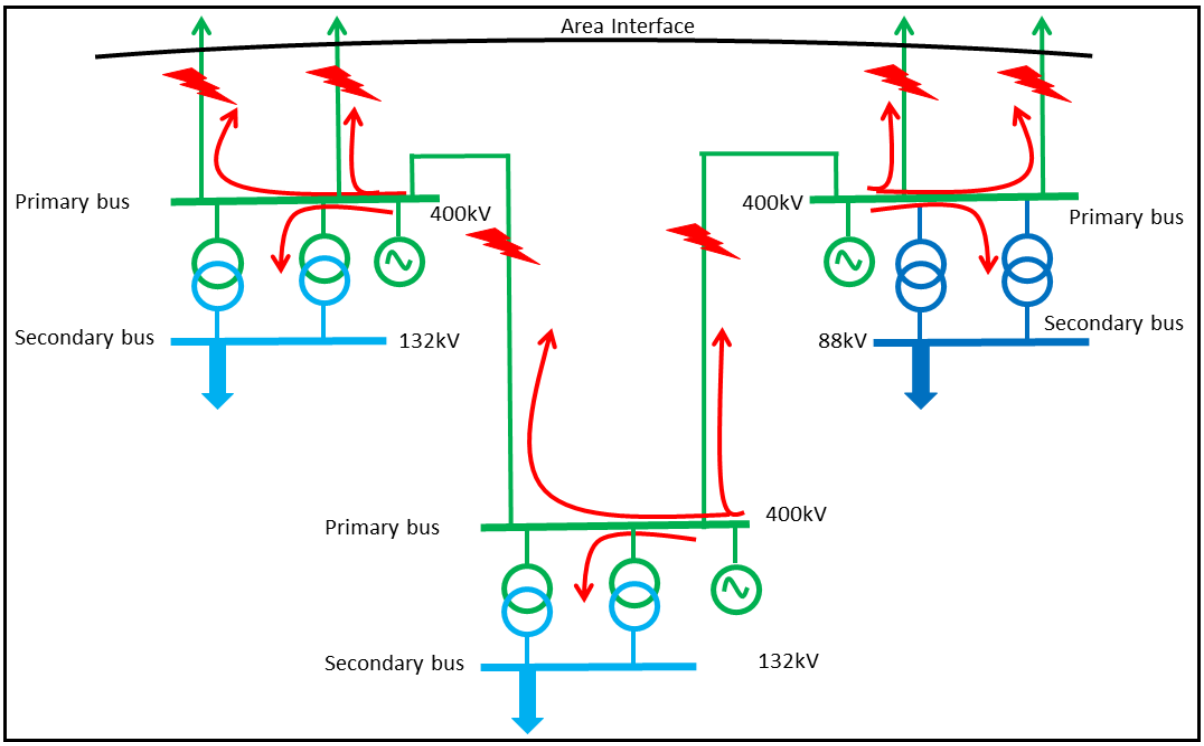

Figure 4: Area limit assessment

4. Results

4.1. Supply Area Capacity

The six supply areas are limited to about 10.5 GW of generation capacity. However, the Northern Cape power corridors are highly constrained and cannot evacuate additional generation further to what has already been approved. Substantial upstream network strengthening will therefore be required to facilitate new generation capacity. In contrast, the North West supply area has the ability to accommodate about 4 GW of generation.

The generation connection capacity available within each supply area is shown in Figure 5.

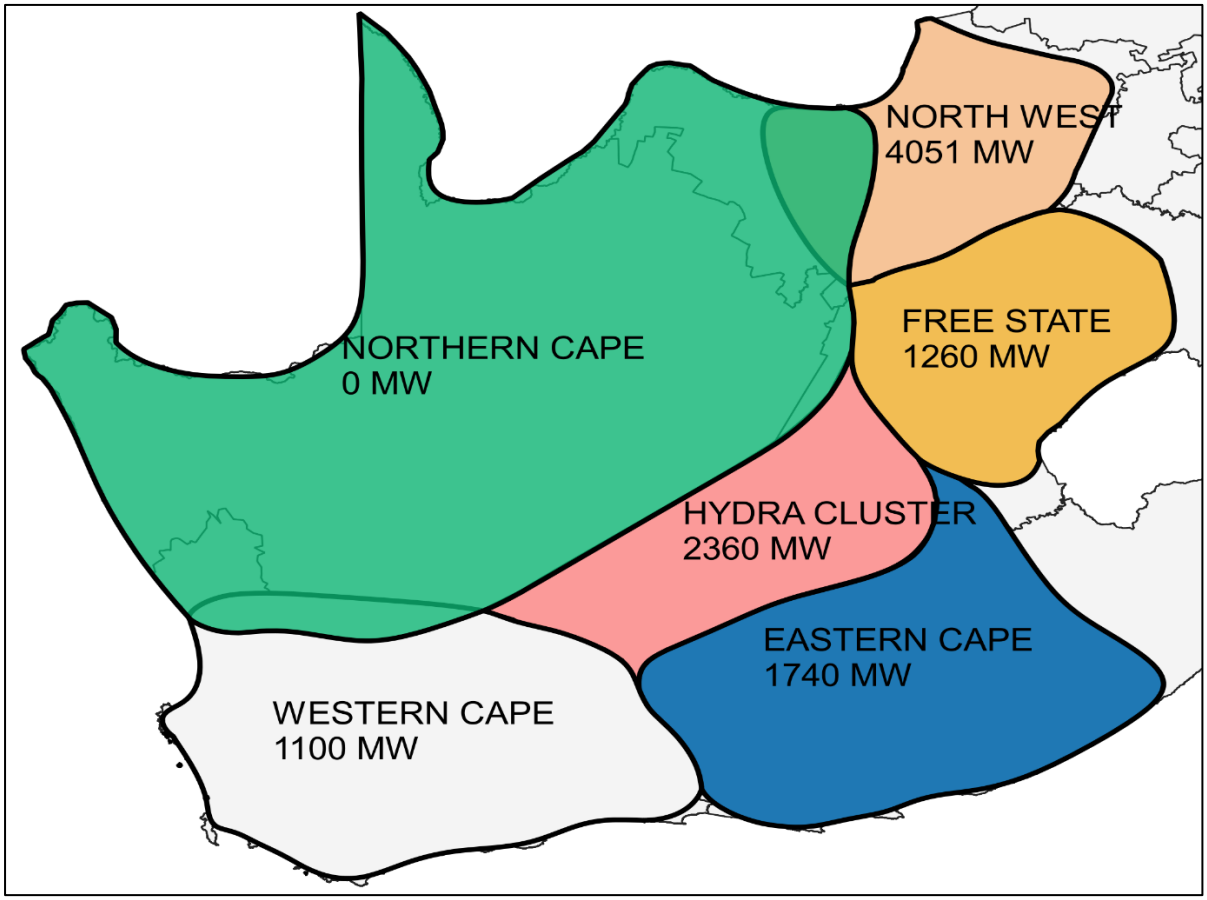

Figure 5: Supply area capacity

4.2. Local Area Capacity

The six supply areas consist of local areas, each of which have their own available capacity. Figure 6 shows the generation connection capacity available in each supply area as well as in their respective local areas.

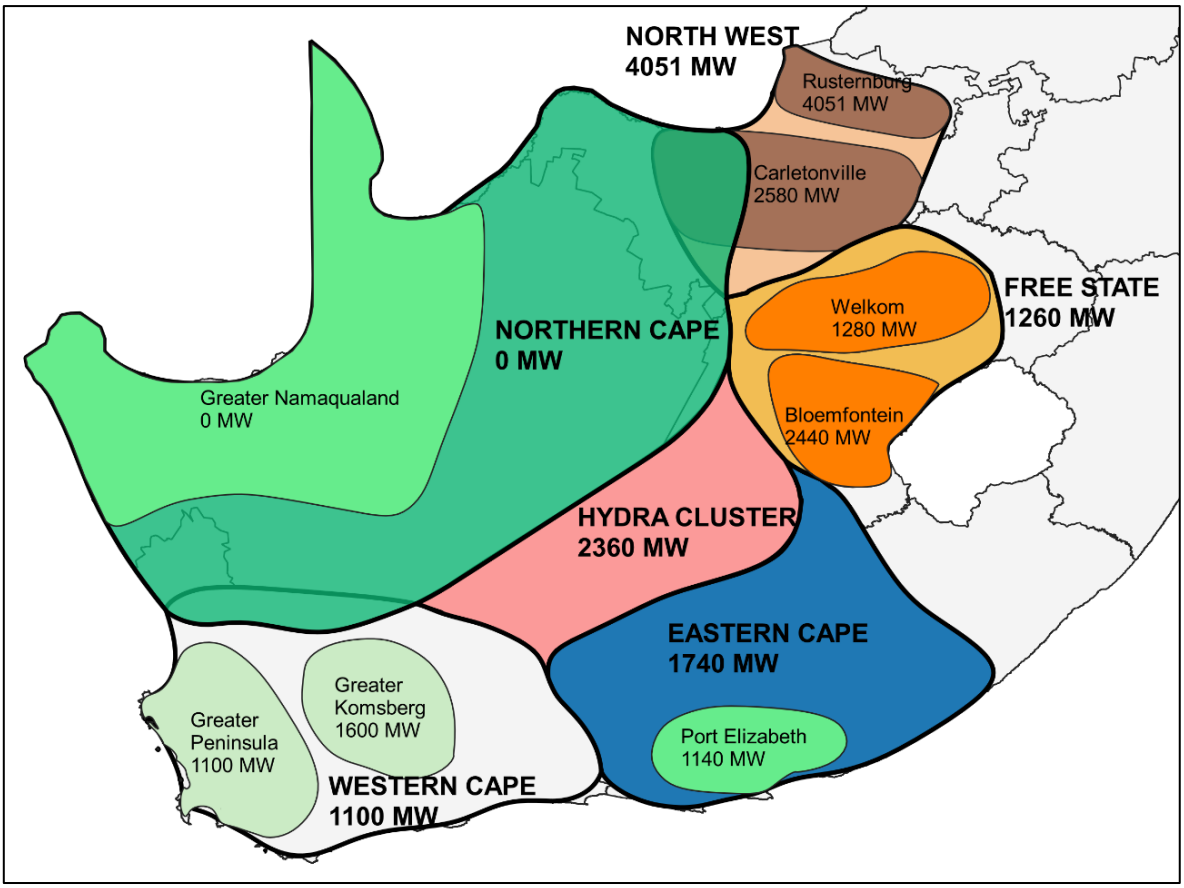

Figure 6: Local area capacity

With the exception of the Northern Cape, it is evident that within the six supply areas, the local areas have capacity ranging from 1 GW to 4 GW. In most cases the supply area becomes the constraint. Therefore, to unlock the available local area capacity, upstream strengthening is required.

4.3. Northern Cape Substation and Transformer Capacity

Figure 7 shows the substation transfer capacity and transformer capacity within the Northern Cape supply area.

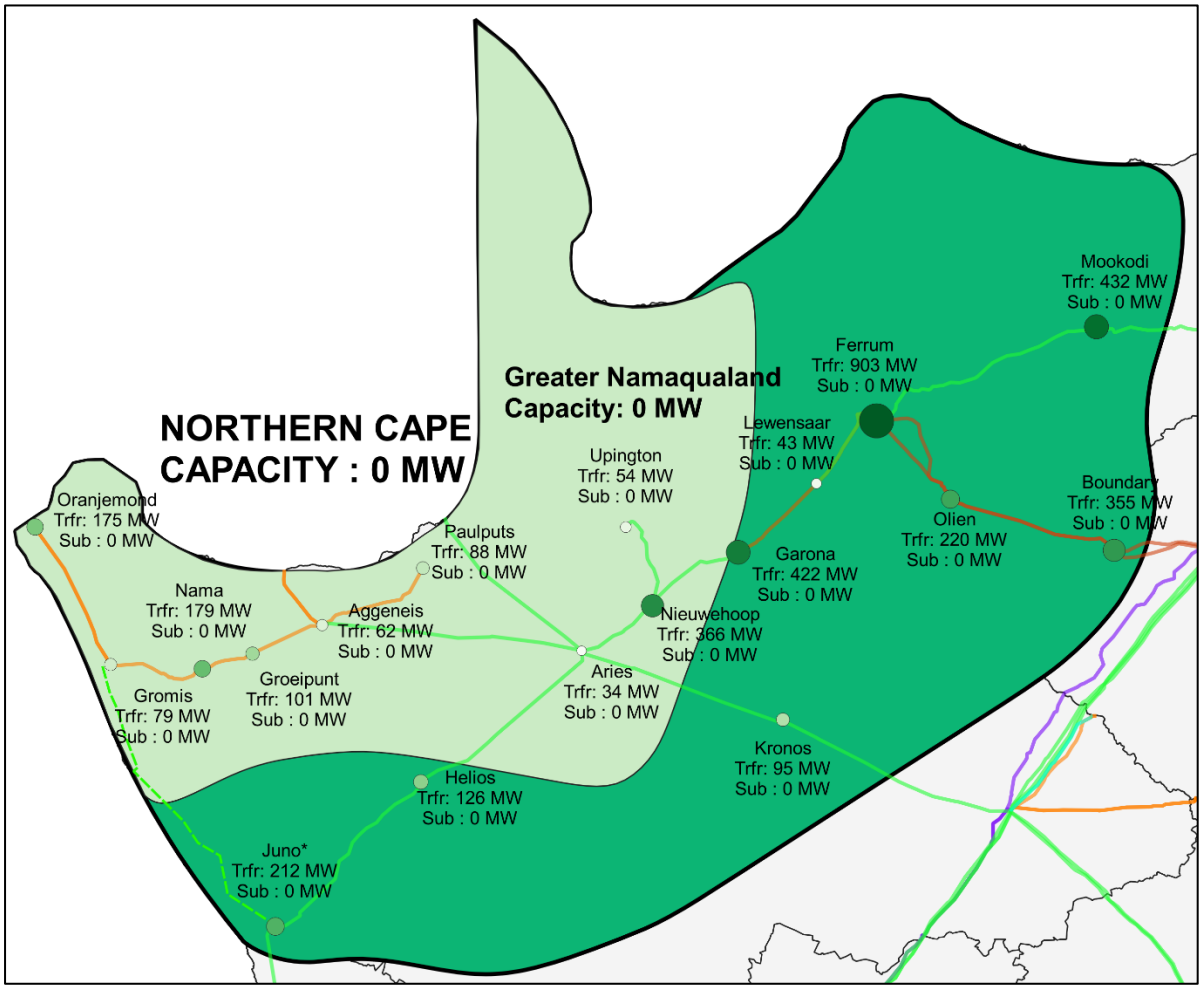

Figure 7: Northern Cape substation transfer capacity and transformer capacity

The Northern Cape supply area has transformation capacity at all of the substations, however it does not have substation transfer capacity.

4.4. Northern Cape Summary of Results

Table 2 summarises the available generation connection capacity within the Northern Cape supply area..

Table 2: Northern Cape summary of results

Supply Area	Local Area	Substation	Voltage (kV)	No. of Transformers	Transformer Size (MVA)	Total Capacity (MVA)	Load (MW)	Approved REIPPPP Solar Gen (MW)	Approved REIPPPP Wind Gen (MW)	Approved RMIPPPP Gen (MW)	Transformer Limit (MW)	Substation Limit (MW)	Local Area Limit (MW)	Supply Area Limit (MW)
Northern Cape	Greater Namaqualand	Aggeneis	220/66	2	40	80	26	40	0	0	62	0	0	0
			400/220	2	315	630	-	0	0	0		0		
		Gromis	220/66	2	40	80	3.38	0	0	0	79	0		
		Groeipunt	220/132	1	250	250	0	0	137	0	101	0		
		Paulputs	220/132	1	250	250	16	294	0	0	88	0		
			220/132	1	125	125		0	0	0				
		Oranjemond	220/66	2	80	160	23	0	0	0	175	0		
		Nama	220/66	2	80	160	27	0	0	0	179	0		
		Upington	400/132	1	500	500	38	383	0	75	54	0		
		Nieuwehoop	400/132	1	250	250	0	0	0	347	366	0		
			400/132	1	500	500		0	0			0		
		Aries	400/22	1	45	45	1.1	9.65	0	0	34	0		
	Northern Cape	Kronos	400/132	1	250	565	21	225	238	0	95	0	0	
			400/132	1	315			0	0	0		0		
		Olien	275/132	1	150	400	78.6	258	0	0	220	0		
			275/132	1	250									
		Ferrum	400/132	2	500	1150	134	324	0	0	903	0		
			275/132	2	250			0	0	0		0		
			132/66	3	80			0	0	0		0		
		Garona	275/132	1	125	125	28	50	0	0	96	0		

Supply Area	Local Area	Substation	Voltage (kV)	No. of Transformers	Transformer Size (MVA)	Total Capacity (MVA)	Load (MW)	Approved REIPPPP Solar Gen (MW)	Approved REIPPPP Wind Gen (MW)	Approved RMIPPPP Gen (MW)	Transformer Limit (MW)	Substation Limit (MW)	Local Area Limit (MW)	Supply Area Limit (MW)
			400/132	1	500	500		0	0	150	325	0		
		Lewensaar	275/22	1	40	40	4.6	0	0	0	42.6	0		
		Boundary	275/132	2	250	500	108	228	0	0	355	0		
		Helios	400/132	1	500	500	1.75	75	276	0	126	0		
			400/22	1	45	45				0		0		
		Juno	400/132	2	120	240	126	9	100	0	212	0		
		Mookodi	400/132	2	250	500	32	75	0	0	432	0		

4.5. Hydra Cluster Substation and Transformer Capacity

Figure 8 shows the substation transfer capacity and transformer capacity within the Hydra cluster.

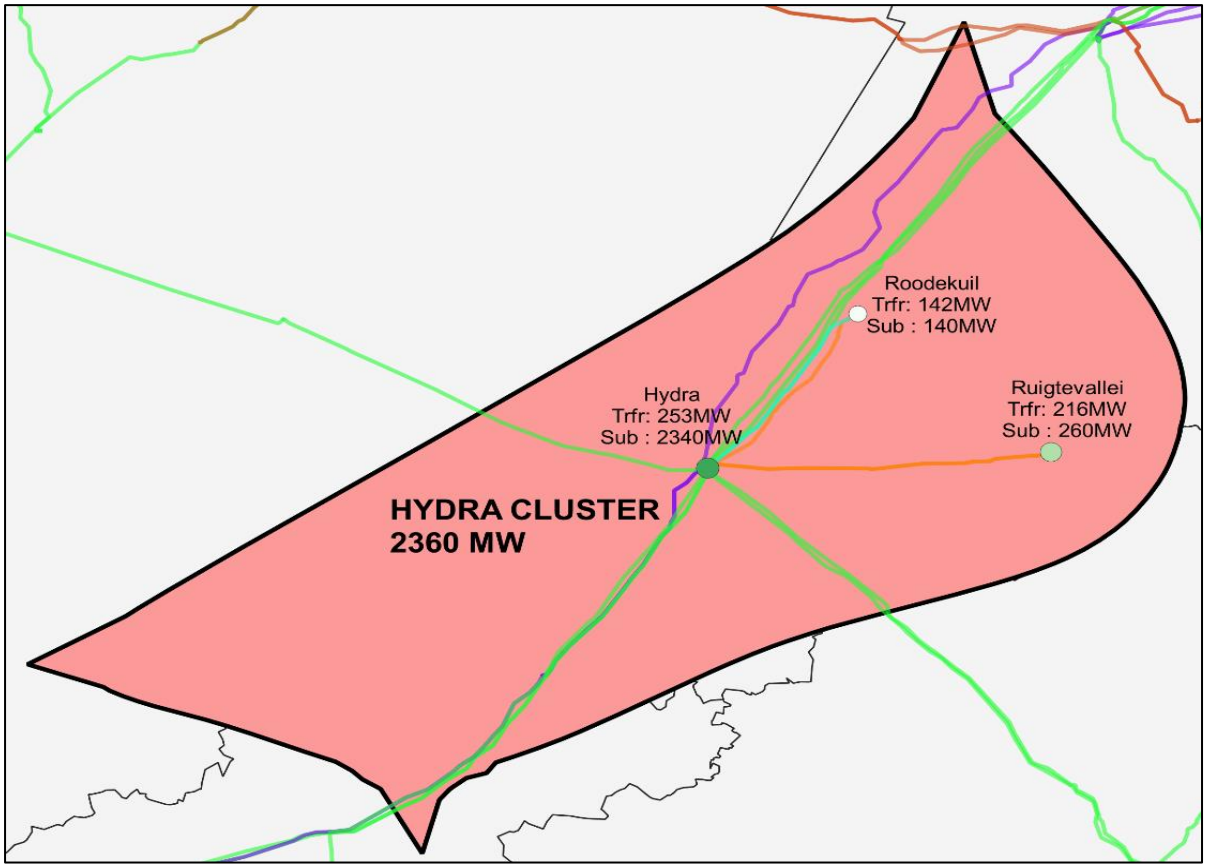

Figure 8: Hydra cluster substation transfer capacity and transformer capacity

The Hydra cluster has transformation capacity and substation transfer capacity available at all of the substations.

4.6. Hydra Cluster Summary of Results

Table 3 summarises the available generation connection capacity within the Hydra cluster supply area.

Table 3: Hydra cluster summary of results

Supply Area	Local Area	Substation	Voltage (kV)	No. of Transformers	Transformer Size (MVA)	Total Capacity (MVA)	Load (MW)	Approved REIPPPP Solar Gen (MW)	Approved REIPPPP Wind Gen (MW)	Approved RMIPPPP Gen (MW)	Transformer Limit (MW)	Substation Limit (MW)	Local Area Limit (MW)	Supply Area Limit (MW)
Hydra Cluster	Hydra Cluster	Hydra	400/132	2	240	480	102	317	152	0	89	2340	2360	2360
			400/132	1	500	500	0	0	236	75	164			
		Roodekuil	220/132	1	125	125	23	0	0	0	142	140		
		Ruigtevallei	220/132	1	250	250	48	70	0	0	216	260		

4.7. Western Cape Substation and Transformer Capacity

Figure 9 shows the substation transfer capacity and transformer capacity within the Western Cape supply area.

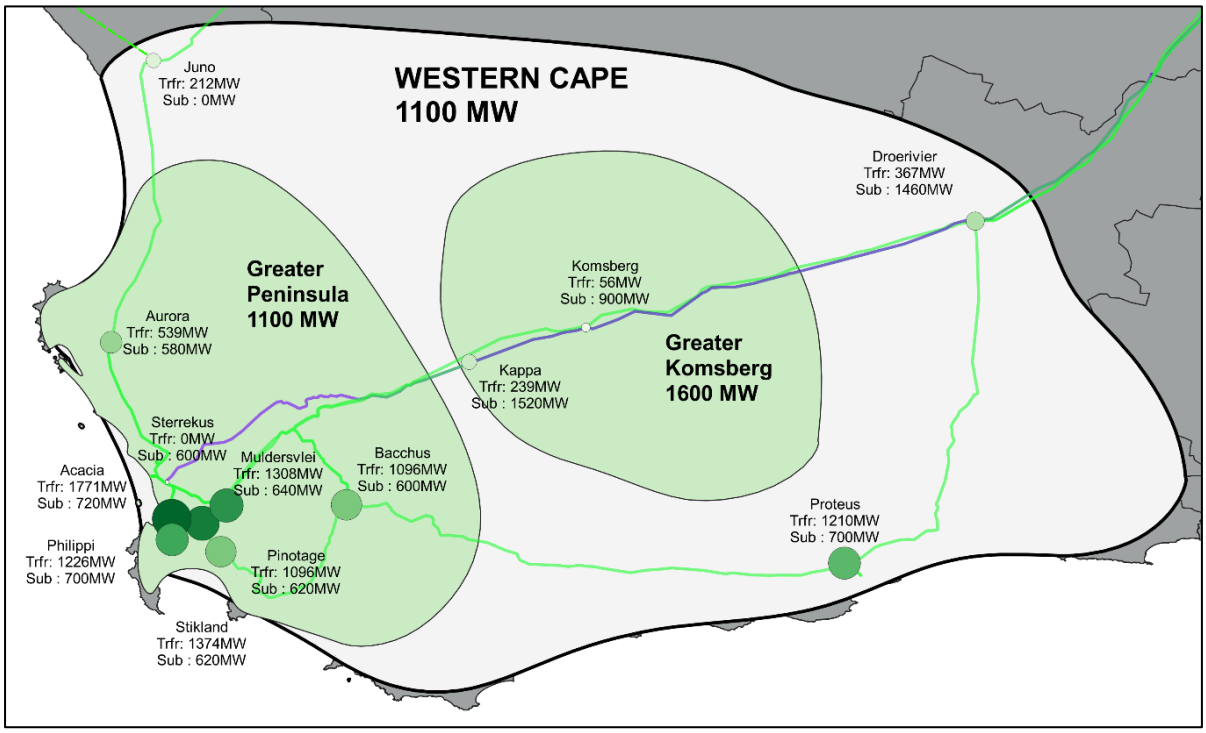

Figure 9: Western Cape substation transfer capacity and transformer capacity

Except for Sterrekus, the Western Cape supply area has transformation capacity at all the substations. Furthermore, the Western Cape supply area has available transfer capacity at all the substations.

4.8. Western Cape Summary of Results

Table 4 summarises the available generation connection capacity within the Western Cape supply area.

Table 4: Western Cape summary of results

Supply Area	Local Area	Substation	Voltage (kV)	No. of Transformers	Transformer Size (MVA)	Total Capacity (MVA)	Load (MW)	Approved REIPPPP Solar Gen (MW)	Approved REIPPPP Wind Gen (MW)	Approved RMIPPPP Gen (MW)	Transformer Limit (MW)	Substation Limit (MW)	Local Area Limit (MW)	Supply Area Limit (MW)
Western Cape	Greater Komsberg	Komsberg	400/132	1	500	500	0	0	419,2	0	56	900	1600	1100
		Kappa	765/400	1	2000	2000	-	0	0	0	-	1520		
			400/132	1	500	500	0	0	108	128	239			
	Greater Peninsula	Stikland	400/132	2	500	1000	118	0	0	0	1374	620	1100	
		Aurora	400/132	1	500	1000	213	89	159,4	320	539	580		
			400/132	2	250									
		Acacia	400/132	3	500	1500	346	0	0	0	1771	720		
		Pinotage	400/132	2	500	1000	146	0	0	0	1096	620		
		Muldersvlei	400/132	3	500	1500	21	0	138	0	1308	640		
		Bacchus	400/132	2	500	1000	236	36	58	0	1096	600		
		Sterrekus	765/400	1	2000	2000	-	0	0	0	-	600		
		Philippi	400/132	2	500	1000	276	0	0	0	1226	700		
		Droerivier	400/132	1	250	250	0	0	0	0	367	1460		
			400/132	1	125	125		0	0	0				
	Western Cape	Proteus	400/132	2	500	1000	239	0	0	0	1210	700		

4.9. Eastern Cape Substation and Transformer Capacity

Figure 10 shows the substation transfer capacity and transformer capacity within the Eastern Cape supply area.

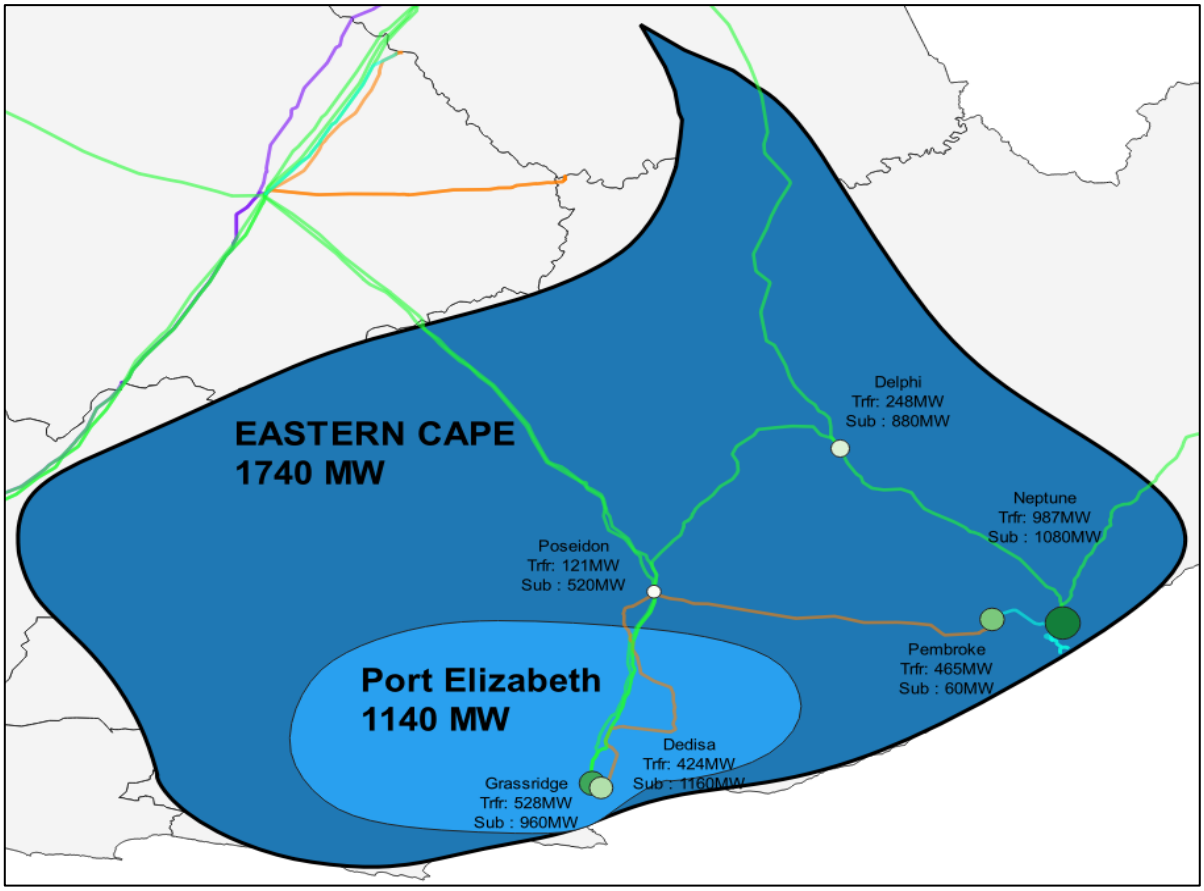

Figure 10: Eastern Cape substation transfer capacity and transformer capacity

The Eastern Cape supply area has transformation capacity and substation transfer capacity available at all the substations.

4.10. Eastern Cape Summary of Results

Table 5 summarises the available generation connection capacity within the Eastern Cape supply area.

Table 5: Eastern Cape summary of results

Supply Area	Local Area	Substation	Voltage (kV)	No. of Transformers	Transformer Size (MVA)	Total Capacity (MVA)	Load (MW)	Approved REIPPPP Solar Gen (MW)	Approved REIPPPP Wind Gen (MW)	Approved RMIPPPP Gen (MW)	Transformer Limit (MW)	Substation Limit (MW)	Local Area Limit (MW)	Supply Area Limit (MW)
Eastern Cape	Port Elizabeth (Gqeberha)	Grassridge	400/132	2	500	1000	302	0	724	75	528	960	1140	1740
			220/132	2	360	720		0	0		609			
		Dedisa	400/132	2	500	1000	122	0	0	648	424	1160		
	Eastern Cape	Neptune	400/132	2	500	1000	38	0	0	0	987	1080	1740	
		Delphi	400/132	2	125	250	110	0	100	0	248	880		
		Pembroke	220/132	2	250	500	43	0	53	0	465	60		
		Poseidon	400/220	2	500	1000	0	0	0	0	-	520		
			400/132	1	500	500	0	0	484	0	0			
			220/132	2	125	250	47	0	164	0	121	320		
			220/66	1	80	80	17	0	0	0	93			
			220/66	1	40	40		0	0	0	38			

4.11. Free State Substation and Transformer Capacity

Figure 11 shows the substation transfer capacity and transformer capacity within the Free State supply area.

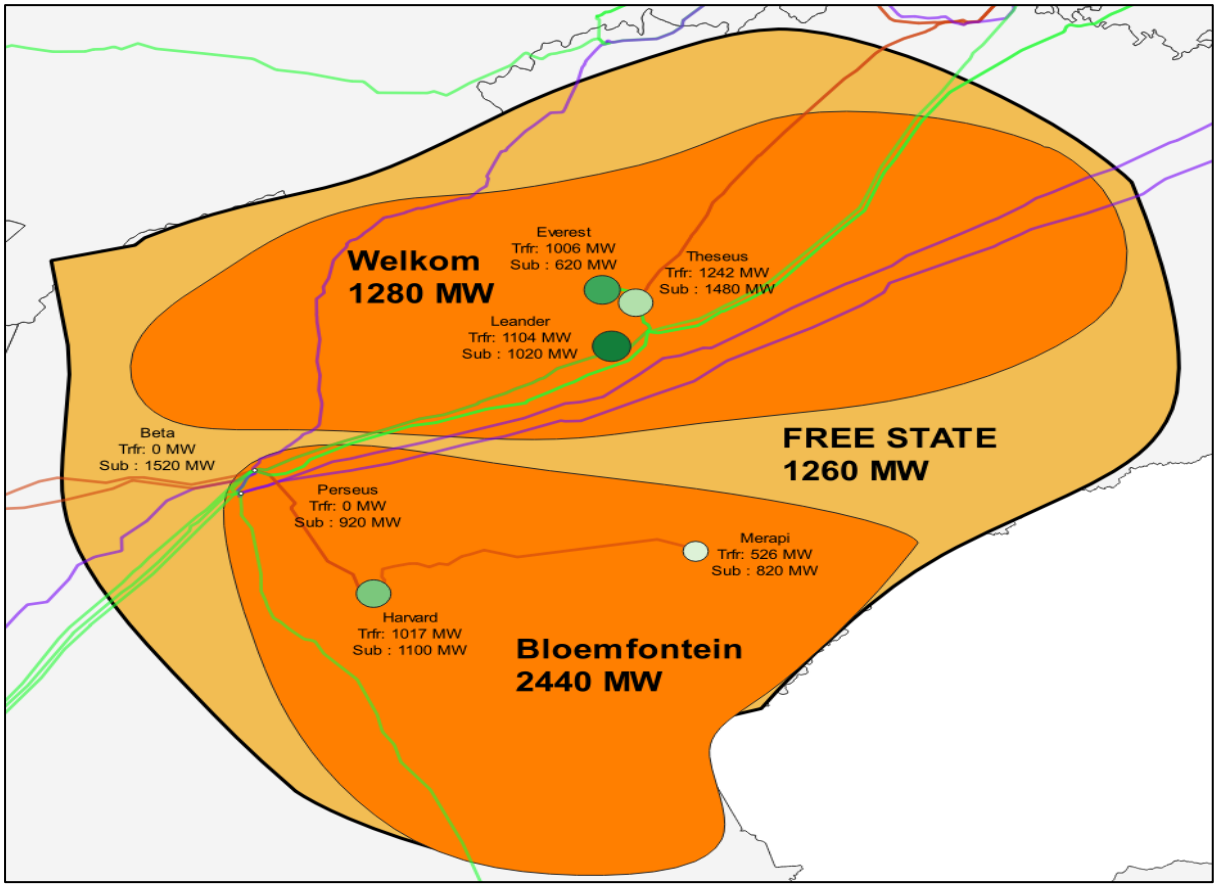

Figure 11: Free State substation transfer capacity and transformer capacity

The Free State supply area has transformation capacity and substation transfer capacity available at all the substations.

4.12. Free State Summary of Results

Table 6 summarises the available generation connection capacity within the Free State supply area.

Table 6: Free State summary of results

Supply Area	Local Area	Substation	Voltage (kV)	No. of Transformers	Transformer Size (MVA)	Total Capacity (MVA)	Load (MW)	Approved REIPPPP Solar Gen (MW)	Approved REIPPPP Wind Gen (MW)	Approved RMIPPPP Gen (MW)	Transformer Limit (MW)	Substation Limit (MW)	Local Area Limit (MW)	Supply Area Limit (MW)
Free State	Bloemfontein	Perseus	765/400	1	2000	2000	0	0	0	0	-	920	2440	1260
			400/275	2	400	800	0	0	0	0	-	760		
			400/275	1	800	800	0	0	0	0	-			
		Beta	765/400	2	2000	4000	0	0	0	0	-	1520		
		Harvard	275/132	2	500	1000	131	64	0	0	1017	1100		
		Merapi	275/132	2	250	500	51	0	0	0	526	820		
	Welkom	Leander	400/132	2	500	1000	154	0	0	0	1104	1020	1280	
		Theseus	400/132	2	500	1000	292	0	0	0	1242	1480		
		Everest	275/132	2	500	1000	56	0	0	0	1006	620		

4.13. North West Substation and Transformer Capacity

Figure 12 shows the substation transfer capacity and transformer capacity within the North West suppy area.

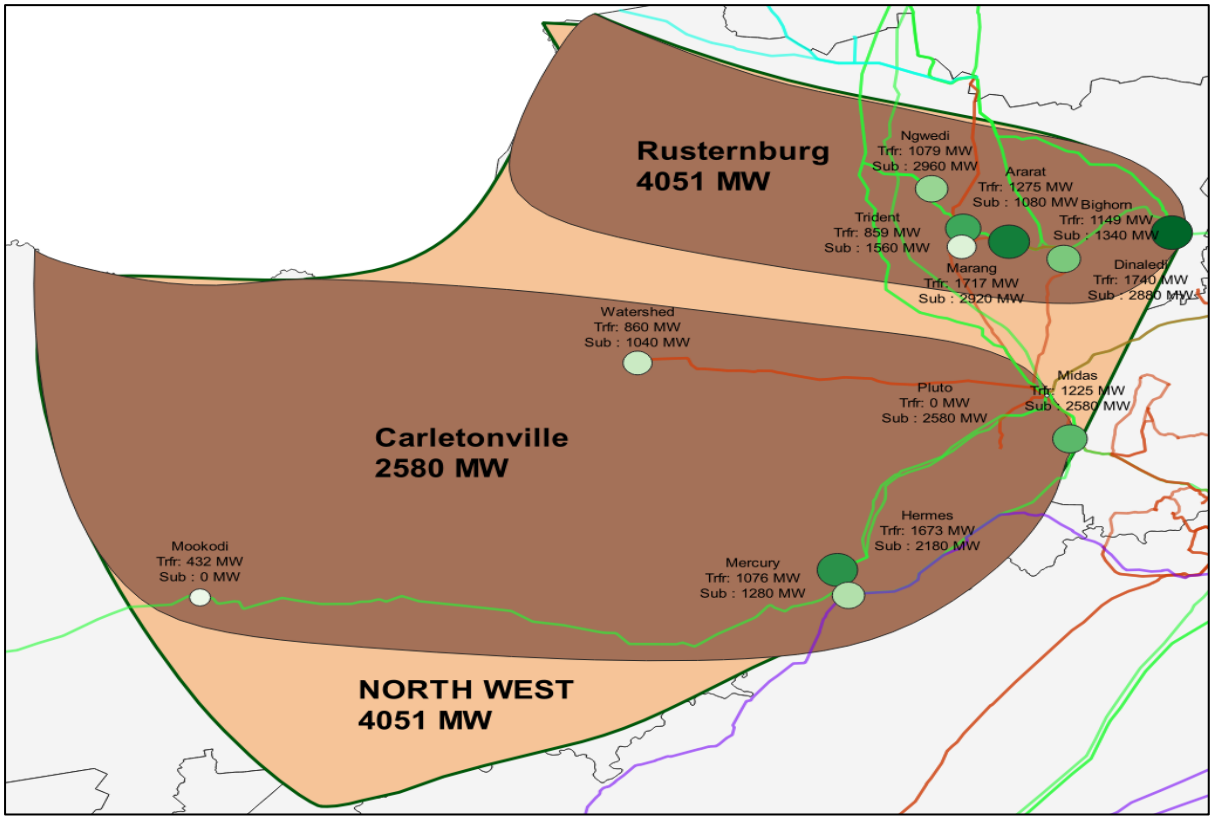

Figure 12: North West substation transfer capacity and transformer capacity

The North West supply area has transformation capacity and substation transfer capacity available at all the substations except for Mookodi and Pluto.

4.14. North West Summary of Results

Table 7 summarises the available generation connection capacity within the North West supply area.

Table 7: North West summary of results

Supply Area	Local Area	Substation	Voltage (kV)	No. of Transformers	Transformer Size (MVA)	Total Capacity (MVA)	Load (MW)	Approved REIPPPP Solar Gen (MW)	Approved REIPPPP Wind Gen (MW)	Approved RMIPPPP Gen (MW)	Transformer Limit (MW)	Substation Limit (MW)	Local Area Limit (MW)	Supply Area Limit (MW)
North West	Rustenburg	Dinaledi	400/132	3	500	1500	315	0	0	0	1740	2880	4051	
		Marang	400/88	4	315	1260	520	0	0	0	1717	2920		
		Ngwedi	400/132	2	500	1000	129	0	0	0	1079	2960		
		Ararat	275/88	3	315	945	377	0	0	0	1275	1080		
		Bighorn	400/275	2	800	1600	0	0	0	0	-	3400		
			275/88	3	315	945	265	0	0	0	1149	1340		
		Trident	275/88	2	315	630	260	0	0	0	859	1560		
	Carletonville	Midas	400/132	2	500	1000	275	0	0	0	1225	2580	2580	4051
		Pluto	400/275	1	800	800	0	0	0	0	-	2580		
			400/275	1	750	750	0	0	0	0				
		Hermes	400/132	3	500	1500	248	0	0	0	1673	2180		
			132/88	1	180	180	38	0	0	0	361			
			132/88	1	160	160		0	0	0				
		Mercury	400/132	2	500	1000	194	67,9	0	0	1076	1280		
		Watershed	275/132	1	250	250	60	75	0	0	223	1040		
			275/88	2	315	630	38	0	0	0	637			

5. Conclusion

The publication of the GCCA-2023 is to inform stakeholders of the potential capacity available on the Eskom transmission network to facilitate connection of generation projects for REIPPPP BW5. Phase 1 of this report considered six supply areas covering the area south from the North West and Free State provinces to the Western Cape. Phase 2 will be published later in the year with the remaining supply areas.

6. Development Team

This document was developed by the following team members.

I. Mokwena	Engineer- Strategic Grid Planning
S. G. Satimburwa	Senior Engineer- Strategic Grid Planning
C. Ndlhovu	Chief Engineer- Strategic Grid Planning
S. Ncwane	Chief Engineer- Strategic Grid Planning
R. Marais	Senior Manager- Strategic Grid Planning