GENERATION CONNECTION CAPACITY ASSESSMENT OF THE 2022 TRANSMISSION NETWORK (GCCA-2022)

June 2015

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EXECUTIVE SUMMARY

The Generation Connection Capacity Assessment (GCCA) document was created in response to the call from government to connect independent power producers (IPPs) to the national electricity grid as part of the implementation of the Integrated Resource Plan (IRP) 2010-2030, in particular, renewable energy. The IRP allocated 17 800 MW of solar and wind generation projects in line with the government's commitment to reduce emissions.

Two previous versions of the GCCA have been issued: one for the 2012 transmission network (GCCA-2012) and one for the 2016 network (GCCA-2016). These provided the expected connection capacity at the busbars of the main transmission system (MTS) substations based on the completion of approved transmission projects by the respective years.

This version of the GCCA report takes a longer view of what potential generation connection capacity <u>could</u> be available by 2022 (GCCA-2022). This is in response to the success of the first four windows of the REIPPP, which already extend to connections up to 2020. The next bid windows and other IPP procurement programmes need to have an indication of what the capacities will be beyond 2020. A number of other changes and improvements have also been made for this GCCA.

The GCCA-2022 now includes all the projects expected to be completed by 2022 as contained in the TDP for the period 2015 to 2024 (issued October 2014). This is to provide developers and investors with an indication of the potential available capacity for the connection of new generation at or within the supply areas of the MTS substations on the Eskom transmission network by 2022 based on the current TDP. The status of the reinforcement projects at each MTS substation is indicated as either approved or proposed, which must be taken into consideration when reviewing the values of a specific MTS substation.

There is a significant change in the capacity calculation in that connection at the distribution-level voltages does not require an N-1 connection. Thus, the full installed transformer MVA capacity at an MTS substation is available for providing generation connection capacity at the LV busbar. The HV busbar connection capacity and the connection capacity of the overall transmission supply area are still calculated taking the N-1 criterion into account as before.

The generation connection capacity of the transmission supply areas that could be available by 2022, assuming that the TDP is fully implemented, is shown in Figure A, which indicates the relative connection capacity. The darker the shade of green, the more connection capacity is available.

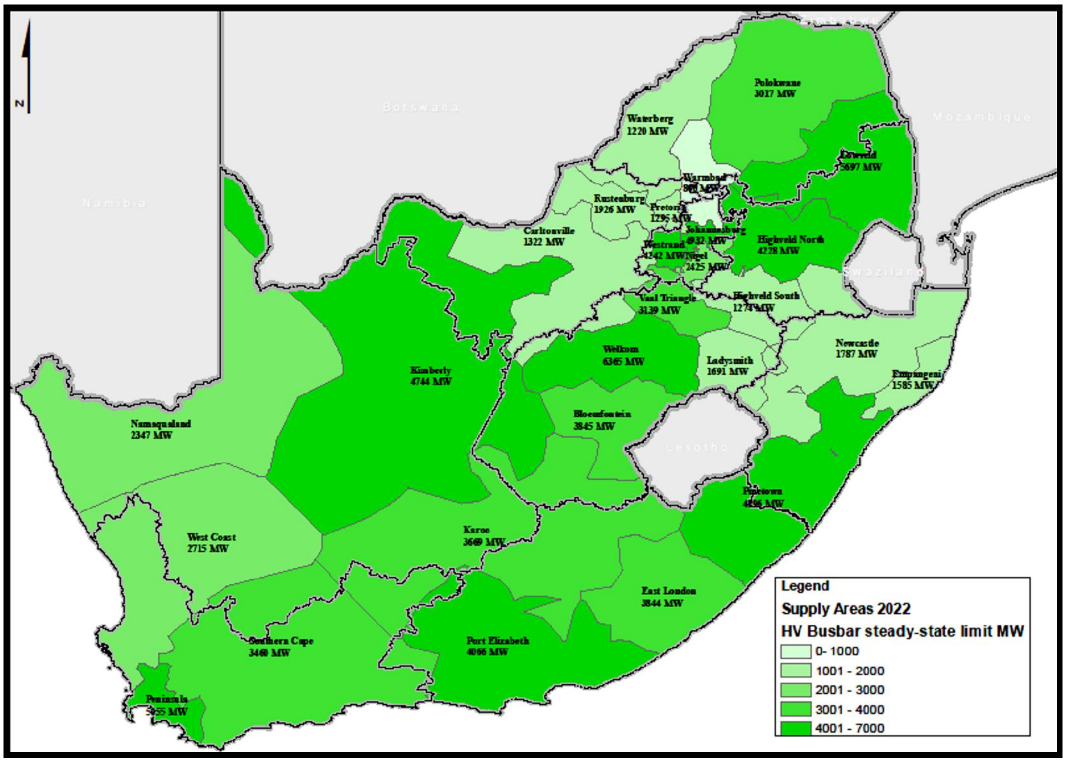

Figure A: The GCCA-2022 transmission supply area generation connection capacities

The biggest improvement in the GCCA-2022 is the creation of an interactive spatial map in PDF format to accompany this document. This interactive PDF document contains a number of different levels of information, which can be toggled on and off on the map, to be displayed spatially. These levels include the existing and planned transmission network, the location of the successful IPP bidders for all the REIPPP rounds, the MTS substation supply areas, and the transmission supply areas. Also included are the GCCA-2022 connection capacity values and other relevant information, which can be accessed in tabular form on the PDF map.

Eskom has identified potential transmission projects that could unlock additional connection capacity by 2022, which are not included in the TDP. These include projects at existing MTS substations and the establishment of new MTS substations with new transmission lines. These potential projects are grouped into four phases based on how long they could take to be completed.

Furthermore, five transmission power corridors have been identified as critical to providing a flexible and robust network that could respond to meet the needs of future IRP and IPP requirements. The Department of Environmental Affairs (DEA) is currently undertaking SEA studies of these routes as part of the SIP 10 initiative of the governmentôs National Development Plan. A new and simpler approval process to obtain the required environmental authorisation (EA) for transmission projects within these corridors is also being developed as part of the SIP 10 project to reduce the response time for releasing and completing transmission infrastructure projects.

The location of the potential MTS substation projects for additional grid access and the transmission power corridor routes are shown in Figure B.

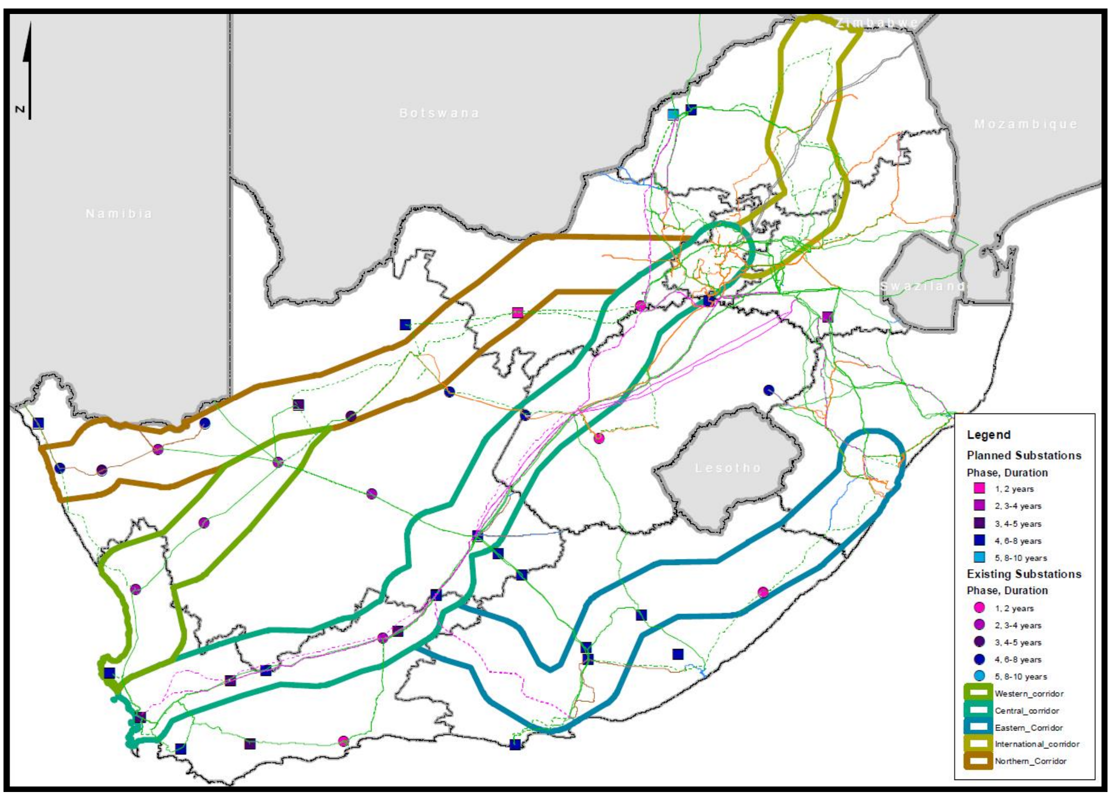

Figure B: The potential MTS substation projects and the five transmission power corridors

LIST OF ABBREVIATIONS

CSP	Concentrating solar power
DEA	Department of Environmental Affairs (Government of South Africa)
DoE	Department of Energy (Government of South Africa)
GCCA	Grid Connection Capacity Assessment
HV busbar	High-voltage busbar of a substation (> 132 kV at transmission level)
IPP	Independent power producer
IRP	Integrated Resource Plan
LV busbar	Low-voltage busbar of a substation (Ò132 kV at transmission level)
MTS	Main transmission system
MVAR	Megavolt-ampere-reactive (power)
MW	Megawatt (power)
N-0	System healthy condition of the network
N-1	Single contingency event on the network
NTC	National Transmission Company
RE	Renewable energy
TDP	Transmission Development Plan
TNSP	Transmission network service provider

CONTENTS

1 INTRODUCTION

1.1 Context of the Generation Connection Capacity document

Eskom Holdings is the biggest producer of electricity in South Africa; it is also the sole transmitter of electricity via a transmission network, which supplies electricity at high voltages to a number of key customers and distributors. Eskom is a vertically integrated company licensed to generate, transmit, and distribute electricity. The transmission licence is held by Eskom Transmission, the transmission network service provider (TNSP). Planning the transmission network is the responsibility of the Grid Planning Department in the Transmission Division.

The intention of this document is to provide an indication of the available capacity for the connection of new generation at the main transmission system (MTS) substations on the Eskom transmission network that may be in service by 2022 based on both approved and proposed new transmission infrastructure projects.

The capacity specifies both the MTS substation limits and the transmission backbone limit for accumulated generation connection at the high-voltage (HV) busbars of the MTS substations within a specific area. The grid is divided into 27 load supply areas, and these supply areas are used as generation connection areas to assess how much generation can be connected within each area. The capacities specified are for steady-state power system conditions, as the expected 2022 grid configuration is not known with enough confidence to undertake realistic transient stability studies. However, the steady-state study values are considered to be appropriate for the purposes of this report.

The provided values are not intended to be fixed specific connection capacities, as each connection is unique, but rather to be used as a guideline to indicate the potential for connecting to a specific point or area in the transmission network and also to identify where network strengthening is required to unlock the network capacity to integrate more IPPs in areas with high generation resource availability.

The steady-state results provide the projected available capacity at the MTS substations and at an area level based on the approved and proposed transmission projects contained in the Transmission Development Plan (TDP) for the period 2015 to 2024, as issued in 2014. The MTS substation results of this study can be used to assess the MW capacity that can be connected at each MTS substation under system healthy conditions (N-0 condition) and the total capacity that a supply area can handle without violating the Grid Code N-1 (single contingency) reliability limits.

There is a companion interactive PDF map document, entitled *GCCA-2022 Spatial Map*, that can be downloaded, which provides the generation connection capacity assessment results and other network information in a spatial format. The geospatial database file, *GCCA-2022_Spatial_Map_Database*, can also be downloaded for use with GIS software by interested parties.

1.2 Structure of the document

The GCCA-2022 document is structured as follows:

Chapter 2 provides the background to the study and the scope of the study.

Chapter 3 highlights the changes and improvements from the GCCA-2016 report and shows the potential increase in connection capacity by 2022.

Chapter 4 outlines the methodology employed in the study and how the results are presented and should be interpreted.

Chapter 5 provides an overview of the generation connection capacity and lists the MTS substations with their respective transmission supply areas.

Chapter 6 describes how additional grid connection capacity could be unlocked, including the development of major transmission power corridors.

Chapter 7 explains how to use the interactive spatial PDF map document that can be downloaded separately, entitled *GCCA-2022 Spatial Map.pdf*.

Chapter 8 gives the definition of the transmission connection to an MTS substation.

Appendix A contains the tables with the generation connection capacity results at each MTS substation per supply area, giving both the current 2015 installed transformer capacity and the planned 2022 installed transformer capacity, as well as the HV busbar steady-state limits, at the MTS substation and supply area.

Appendix B provides the list of potential transmission projects that could provide additional grid access capacity outside of the TDP projects.

2 BACKGROUND

The Generation Connection Capacity Assessment (GCCA) document was created in response to the call from government to connect independent power producers (IPPs) to the national electricity grid as part of the implementation of the Integrated Resource Plan of 2010 (IRP2010), in particular, renewable energy.

The first GCCA document released was in early 2011 for the 2012 transmission grid (GCCA-2012) to assist with the first bid window of the REBID programme. This document initially only covered the Cape provinces due to time constraints and prioritisation of the locations from which enquiries had been directed. The focus was on what could be connected to the low-voltage (LV) busbars of the main transmission system (MTS) substations.

A second version was released in 2013 for the transmission grid expected to be in place by 2016 (GCCA-2016), but the entire country was now included. The focus was on what generation could be connected to the high-voltage (HV) busbars at the MTS substations without the limitations of the transformers. The requirement was that the transmission grid had to still meet the single contingency condition (N-1) criteria of the Grid Code.

This version of the GCCA report now takes a longer view of what potential generation connection capacity could be available by 2022 (GCCA-2022). This is in response to the success of the first four windows of the REIPPP, which already extend to connections up to 2020. The next bid windows need to have an indication of what the capacities will be beyond 2020; thus, not only confirmed and approved new projects, but also proposed new projects need to be indicated.

A number of other changes and improvements have been made from the previous GCCA document to provide better information regarding the potential for increased generation connection capacity in the future to meet the needs of the IRP and the electricity power industry. These include an interactive spatial PDF map and the identification of potential transmission projects to increase grid access that are not currently included in any development plans.

3 CHANGES AND IMPROVEMENTS IN THE GCCA-2022

This chapter deals with the changes and improvements that have been made from the previous GCCA document, GCCA-2016, to produce this new GCCA document, the GCCA-2022 report. The main differences are as follows:

- Future proposed projects are now also taken into consideration, in addition to approved projects.
- The calculation of the connection capacity at the LV busbar uses the full installed transformer capacity and not the single contingency (N-1) value.
- The N-1 criterion is only applied to the HV busbar to determine what power can be evacuated from the MTS substation at transmission level.
- An interactive PDF map, which shows all the information and results in a spatial format, is included as a companion document to this report.

The potential improvement in overall connection capacity from 2016 to 2022 is illustrated, and a list of other projects not yet included in the TDP that could further increase grid connection capacity is described.

3.1 Inclusion of proposed transmission projects

The GCCA-2022 now includes all the projects expected to be completed by 2022 as contained in the TDP for the period 2015 to 2024, which was issued in October 2014. The status of the reinforcement projects at each MTS substation is indicated as either approved or proposed, which must be taken into consideration when reviewing the values of a specific MTS substation.

The objective is to provide developers and investors with an indication of the potential available capacity for the connection of new generation at or within the supply areas of the MTS substations on the Eskom transmission network by 2022 based on the current TDP.

Furthermore, there have been discussions between Eskom and the DoE regarding the creation of additional grid access for new RE and other IPP plants for future IPP procurement programmes. Eskom Grid Planning has identified a number of potential transmission projects, which could unlock additional connection capacity by 2022, that are not included in the TDP, as their requirement has not yet been confirmed or agreed to. These projects include works at existing MTS substations as well as the establishment of new MTS substations with new transmission lines. These potential projects can be undertaken in phases, which are also discussed and identified in Chapter 6 of this GCCA report. The objective of including this information is to indicate to IPP developers what possibilities exist outside of the TDP list of projects.

3.2 Calculation of the connection capacity

The most significant change in the capacity calculation is that connection at the lower distribution-level voltages does not require an N-1 connection. Thus, the full installed transformer MVA capacity at an MTS substation is available for providing generation connection capacity.

Previously, the outputs of the connecting IPP generation plants were assumed to be at a unity power factor; however, to give a more realistic view, a power factor of 0.98 will be applied to make allowance for actual output of the connecting IPP plants. This means that a power factor of 0.98 will be applied to the installed transformer MVA values to provide a MW connection capacity value at the MTS substation.

This MW connection value is at the LV busbar of the MTS substation, which, in this report, refers to the distribution-level voltages. These include voltage levels of 66 kV, 88 kV, and 132 kV (in some cases, 220 kV is also included) and are not to be confused with the lower LV connection voltage levels of 11 kV, 22 kV, and 33 kV.

The calculation of the HV busbar MW connection capacity at the MTS substations and the overall transmission supply area connection capacity is done taking the N-1 criterion into account, the same way as in the previous GCCA-2016 document. However, only the steady-state connection values are calculated, as explained in more detail in Chapter 4.

3.3 Interactive spatial PDF map

The biggest improvement in the GCCA-2022 is the creation of an interactive spatial map in PDF format to accompany this report. This interactive PDF document contains a number of different levels of information, which can be toggled on and off on the map, to be displayed spatially. These levels include the existing transmission network, the planned transmission projects, the location of the successful IPP bidders for all the REIPPP rounds, the MTS substation supply areas, and the transmission supply areas, among others.

Also included are the GCCA-2022 capacity values and other relevant information in tabular form, which can be accessed under the model tree function of the PDF map. Further explanation of what information is contained and how to access it is provided in Chapter 6.

This interactive PDF map will allow potential developers and investors considering IPP projects to interrogate the map spatially to address their own particular issues when investigating their options.

3.4 Increase in connection capacity from 2016 to 2022

The calculation of the connection capacity for the transmission supply areas at the HV busbar MTS level was undertaken using the same methodology in both the GCCA-2016 and GCCA-2022 documents. Therefore, it is possible to compare the expected 2016 capacities with the potential 2022 capacities. This will show the increase in the overall transmission supply area capacities that could be realised with the full implementation of the TDP.

This comparison will show the IPP developers where the future increased capacity is likely to be as well as identify areas where there is insufficient future transmission capacity, which should be unlocked. Analysis of the 2022 results can indicate where proposed transmission projects should be actively supported and where new transmission projects should be seriously considered.

The maps of the generation connection capacity of the transmission supply areas for the 2016 and 2022 networks are shown in Figures 3.1 and 3.2, respectively. The shading of the transmission supply areas indicates the relative connection capacity. The darker the green shade, the more connection capacity is available.

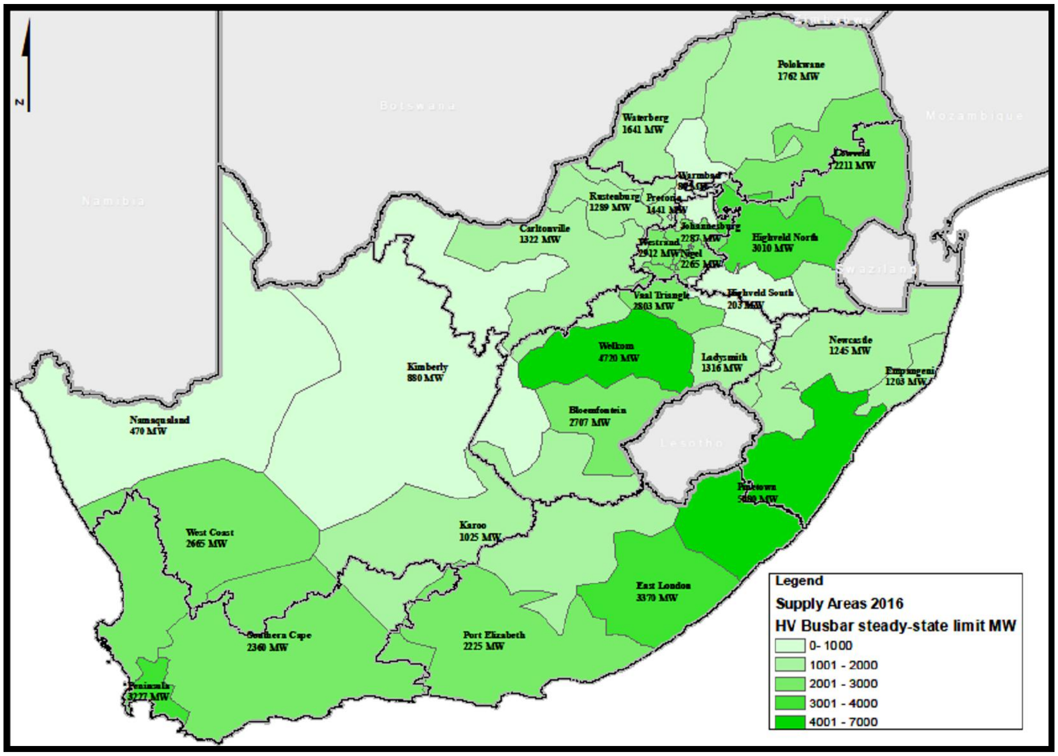

Figure 3.1: GCCA-2016 transmission supply area generation connection capacities

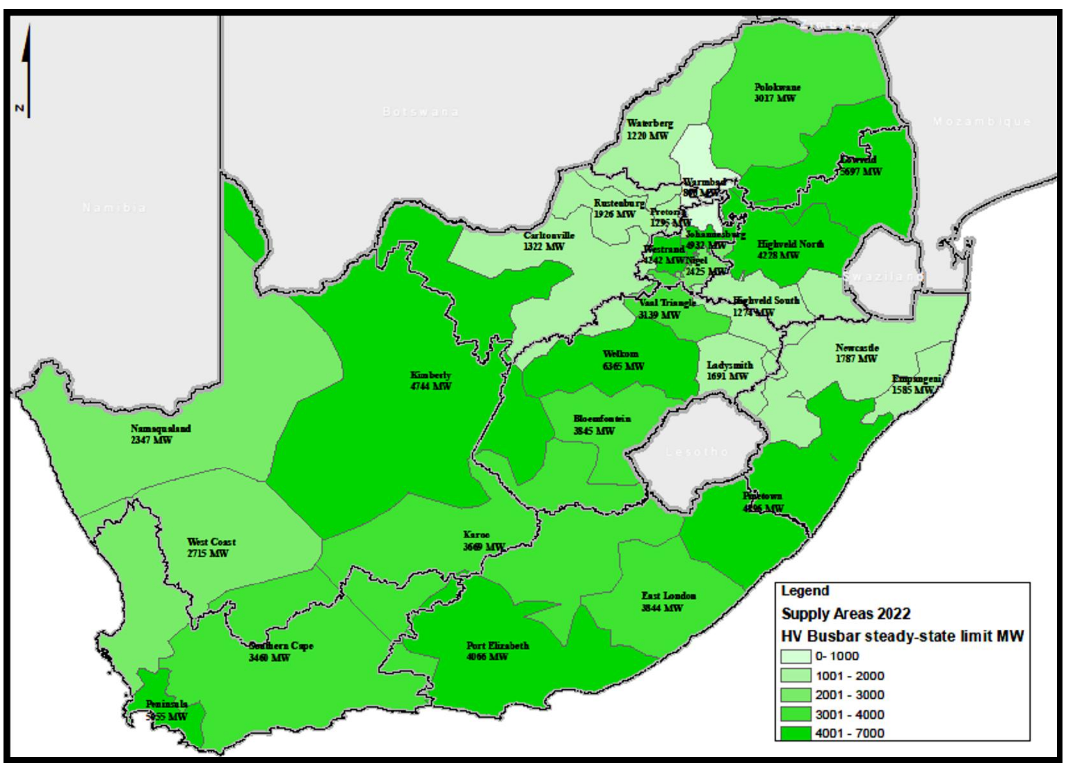

Figure 3.2: GCCA-2022 transmission supply area generation connection capacities

4 METHODOLOGY AND INTERPRETATION

This chapter explains how the generation connection capacities were calculated for the MTS substations and how these values can be interpreted.

4.1 Methodology of calculation

Connection capacity is determined by the available transmission infrastructure in service for a proposed generation project to connect to, and then transport the generated power to, the loads. The document considers the connection capacity that could be available on the transmission grid for the year 2022, taking into account the transmission infrastructure that is expected to be in service in 2022 based on the approved TDP for the period 2015 to 2024.

The distribution infrastructure is not considered in this document due to the sheer volume of infrastructure and rapid changes that can be implemented at the lower voltages. All generation integration requirements will have to be considered at a local level, and the direct connections can, in general, be implemented relatively quickly. The real issue is how much generation can be integrated and transported to where it is required at the transmission level, which this document addresses.

What the Transmission Connection Capacity document provides is the overall capacity that can be absorbed at a specific MTS connection point without any additional reinforcement required (that is, projects not included in the TDP), either directly connected to the MTS substation or via the distribution network supplied by the MTS substation ï in other words, the indicative capacity for connecting new generation within the geographical supply area of that particular MTS substation.

To determine the connection capacity at the MTS substations, certain assumptions were made regarding the potential allocation of the downstream load. Essentially, any new generation will first supply the local load within the supply area of the MTS substation, and the excess will be sent into the transmission network via the MTS substation transformers.

Based on the total MVA of the installed transformers at an MTS substation, the MW installed capacity is calculated by applying the 0.98 power factor. This is done for each LV busbar at the MTS substation, that is, for each set of transformation if there are multiple voltage levels, for example, 400/132 kV and 400/88 kV. If each LV busbar is supplied separately from the HV busbar, the total MW capacities are added to provide the overall installed MW capacity value. Should the LV busbars be connected cascading, for example, 400/132 kV and 132/66 kV, then only the LV capacity directly connected to the HV busbar is considered as the installed MW capacity.

The available capacity is calculated on a conservative basis by first adding the expected MW low load at the MTS substation to the installed MW capacity value and then subtracting the MW value of any successful IPP generation projects from the REIPPP programmes allocated within the supply area of this substation. This includes all the IPP projects from Bid Windows 1, 2, 3, and 3.5, as well the IPP projects of the preferred bidders for Bid Window 4, up to and including the extended Bid Window 4B list released on 7 June 2015.

This MW value is referred to as the ĩ**LV busbar connection capacity**ò of the MTS substation. Two values are provided in the results tables: one for existing 2015 installed transformer capacity and one for the expected installed transformer capacity by 2022.

In the case where the LV voltage is a transmission-level voltage of 400 kV or 275 kV, for example, 765/400 kV and 400/275 kV transformers, the connection capacity is specified as zero, as these are main system substations with no local load connected. Connection of IPPs at these voltage levels requires specialised considerations unique to each MTS site. Similarly, the LV busbar connection capacity at an existing Eskom power station is shown as zero, as it is preferred to not connect new generation at the LV busbar of these sites, but connection to the HV busbar is not excluded.

In keeping with the Grid Code requirement of when a generation plant of more than 1 000 MW is integrated, it being necessary to confirm that the network will remain stable for the loss of a second transmission line after an N-1 transmission line contingency, the maximum connection at an MTS substation has been limited to 1 000 MW for the GCCA-2022. The potential and viability of connecting an accumulated generation total of more than a 1 000 MW at a single substation would require a detailed network study with a high certainty of generation configuration and is beyond the scope of this report.

The potential of *increasing the connection capacity beyond the 2022 installed transformer value* was also investigated. In this case, it is dependent on how much power can be evacuated from the MTS substation HV busbar or at the transmission level, and thus, the N-1 criteria must be applied. This provides the expected firm connection capacity in 2022 at the HV busbar of the MTS substation, which generally exceeds the 2022 MV connection capacity, but, in many cases, is lower. Thus, an *individual* ñHV busbar connection capacity valueò was determined for each MTS substation.

However, the MTS substation is connected within a Transmission load supply area system, 27 in total, and the limit of the supply area dictates the potential limit at the individual MTS substation. The limit at each MTS substation within a supply area provides an indication of the proportional allocation of the supply area limit to the substations. The studies were then rerun, increasing the generation of the supply area with each substation at its relative proportional contribution until the area N-1 limit was reached. This provided an *area* ñHV busbar connection capacity valueò for each MTS substation in the supply area. This area value was compared with the individual value and the lower value selected as the applicable generation connection capacity for the HV busbar at that MTS substation. In all cases, the individual value was the lower.

This MW value is referred to as the ñ**HV busbar connection capacity**ò of the MTS substation. It is only provided for the 2022 year in the results tables.

As the individual HV busbar connection capacity values for each MTS substation were the lower values, the actual area connection capacity value for a specific supply area is determined by the sum of the MTS substation individual limits within the supply area. This value is the HV busbar steady-state limit for the supply area.

The expected 2022 grid and generation configuration is not known with enough confidence to undertake realistic transient stability studies. It must be noted that the transient stability studies could reduce the overall connection capacity limit for a

Transmission supply area. However, the steady-state study values are considered to be appropriate as a guideline for the purposes of this report.

This MW value is referred to as the ñ**supply area HV busbar steady-state limit**ò of the specific supply area. It is only provided for the 2022 year in the results tables.

It must be noted that the cumulative impact of the Transmission supply areas will result in further limitations on the steady-state limits when considering a grouping of adjacent Transmission supply areas. The actual reduction in connection capacity is very dependent on the spread of the new generation and the actual configuration of the transmission networks within and between these supply areas. This is beyond the scope of this document due to the high number of possible configuration combinations. However, the issue can be resolved by the further strengthening of the backbone transmission network within the future power corridors which are addressed in Chapter 6 of this document.

4.2 Interpretation of the connection capacity value

Based on the connection capacity of a specific MTS substation, a developer should be able to make a high-level assessment of what is likely to be required to connect its generation project to this point on the Eskom transmission network.

This would be done by first identifying in which MTS substation supply area the generation project would be located and relating it to the approximate distance to that MTS substation or the nearest distribution substation within that supply area. The maps indicating the supply areas and the list of MTS substation names within each supply area are provided in Chapter 5 as well as on the interactive spatial PDF map.

Then, using the proposed total MW output of the generation plant, the connection requirements and timing assessment can be done as follows:

Project MW output less than MTS connection capacity

The generation project should be able to connect to the transmission network without any additional deep transformation reinforcement required. Only shallow connection works should be required, either via the distribution network or connecting directly to the HV or MV busbar of the MTS substation.

Project MW output around MTS connection capacity

If the generation project MW output is of the same order as the MTS substation connection capacity, around ± 10% variation, then the project may be able to be connected without any additional deep reinforcement required and with only shallow connection works required.

Project MW output greater than MTS connection capacity

The generation project will not be able to connect without some form of additional deep transmission reinforcement (for example, transmission line, transformer) required in addition to the shallow connection works. The deep reinforcement is likely to place a time constraint for connecting the generation plant project, depending on the nature and size of the transmission reinforcement works required.

5 SUPPLY AREA CONNECTION CAPACITY

The transmission grid is divided into 27 supply areas that are used to conduct the load forecast, and those areas have a certain number of MTS substations supplied by them. The supply areas cross provincial boundaries in some cases because these areas are related to the networks from which they are supplied.

In Figure 5.1, the grid layout with all the transmission supply areas shaded is given, and the internal borders between the MTS substation supply areas are indicated. The supply areas and MTS substations are not labelled on this map, but rather labelled on maps of large blocks of supply areas discussed in the subsections following. To make it easier to identify the relevant MTS substation, the transmission grid map is broken down into three large blocks, namely, a southern block, a northern block, and a central block encompassing the greater Gauteng area.

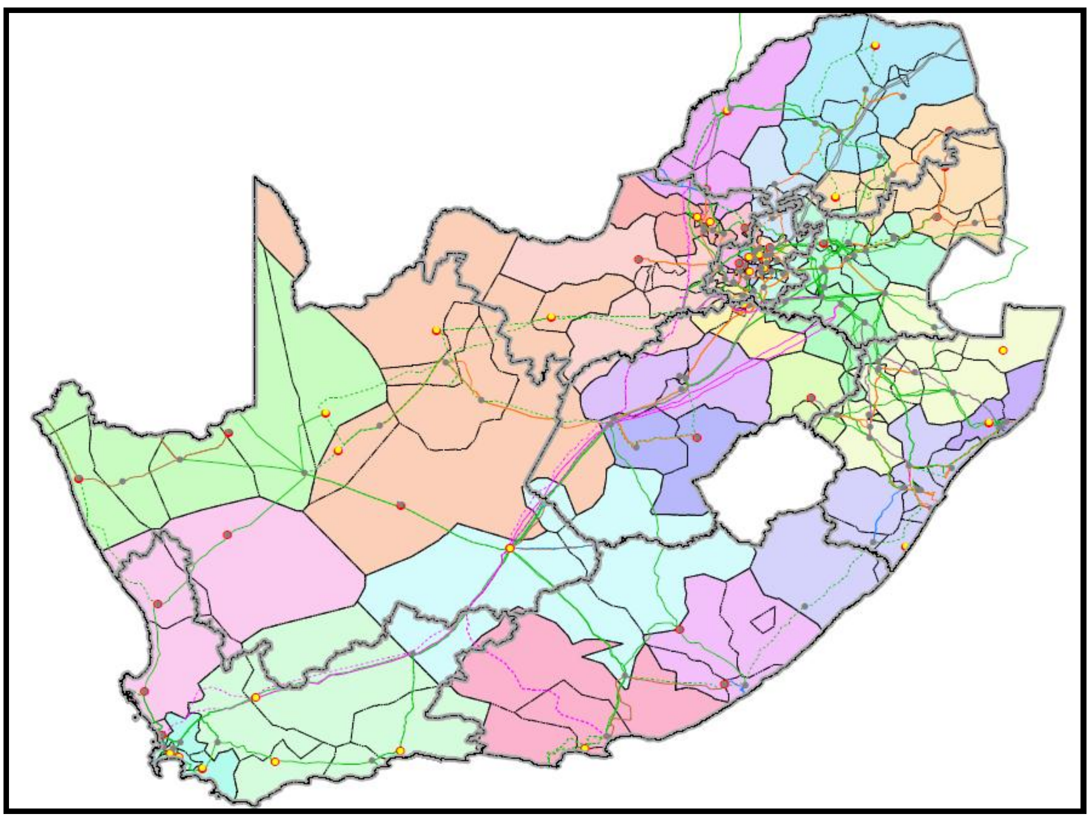

Figure 5.1: Main transmission system grid with transmission supply areas shaded

The MTS substation names and their allocated supply areas are indicated on the maps of the three blocks to make it easier to identify them. Each map block is shown separately below with a table listing the MTS substation names along with the name of the relevant transmission supply area, province, and voltage levels.

A developer can locate the site of its potential IPP plant on the map, identify the relevant *MTS substation supply area*, and from the table determine the associated *transmission supply area.* In Appendix A, there are tables with detailed information on the MTS substations, which are grouped by transmission supply area. The MTS substation groupings are presented in alphabetical order of the transmission supply areas.

The MTS substation tables in Appendix A provide the following information:

Supply Area	The name of the supply area
Province	The name of the province in which the MTS substation is located
Substation	The name of the MTS substation
Transformer Voltages	The transformer voltage levels in the MTS substation
2015 No. of Trfrs	The number of transformers of a specific voltage level and size in the MTS substation at the end of the year 2015
2015 Trfr Size (MVA)	The MVA unit size of transformers of a specific voltage level in the MTS substation at the end of the year 2015
2015 Installed Transformer MVA	The total installed transformer MVA of a specific voltage level and size in the MTS substation at the end of the year 2015
Year of Trfr Upgrade	Year when new transformers are expected to be installed in the MTS substation
Upgrade Status	The project status of the upgrade, either ***approved*** with funding or ***proposed*** as in the TDP for 2015 to 2024
2022 No. of Trfrs	The number of transformers of a specific voltage level and size in the MTS substation at the end of the year 2022
2022 Trfr Size (MVA)	The MVA unit size of transformers of a specific voltage level in the MTS substation at the end of the year 2022
2022 Installed Transformer MVA	The total installed transformer MVA of a specific voltage level and size in the MTS substation at the end of the year 2022
2022 LV Busbar Connection Capacity (MW)	The available generation connection capacity at the LV busbar (132 kV or 88 kV or 66 kV) at the MTS at the end of the year 2022
2022 HV Busbar Connection Capacity (MW)	The generation connection capacity limit at the HV busbar (275 kV or 400 kV) at the MTS at the end of the year 2022
2022 Supply Area HV Busbar Steady-state Limit (MW)	The overall generation connection capacity limit of all the MTS substations within the supply area at the end of the year 2022

5.1 The southern block

The southern block includes the transmission supply areas in the Eastern Cape, Western Cape, and Northern Cape provinces with some overlap into the Free State, KwaZulu-Natal, and North West provinces. The transmission supply areas are shown in a single colour with the borders of the internal MTS supply areas highlighted. The map of the southern block with the MTS substations labelled is shown in Figure 5.2.

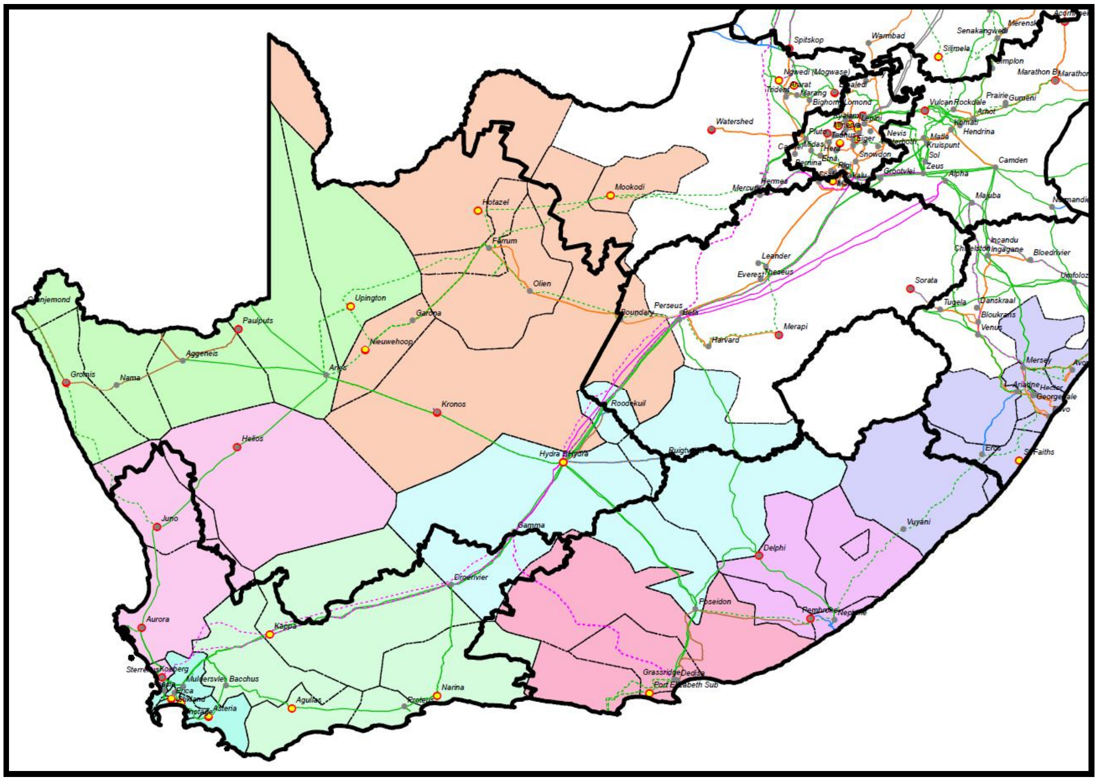

Figure 5.2: The southern block with the transmission supply areas shaded

The MTS substations in the southern block are listed alphabetically in Table 5.1 with the name of the relevant transmission supply area, the province, and the HV and LV voltage levels. The voltage levels are the highest HV and LV voltages in the case of multiple voltage levels as they are in the existing substation or when established after 2015. Further details of the MTS substation are provided in the tables in Appendix A, which are grouped by transmission supply area.

Table 5.1: MTS substations in the southern block

Substation name	Transmission supply area	Province	HV busbar voltage (kV)	LV busbar voltage (kV)
Acacia	Peninsula	Western Cape	400	132
Aggeneis	Namaqualand	Northern Cape	400	220
Agulhas	Southern Cape	Western Cape	400	132
Aries	Namaqualand	Northern Cape	400	22
Asteria	Peninsula	Western Cape	400	132
Aurora	West Coast	Western Cape	400	132
Bacchus	Southern Cape	Western Cape	400	132
Beta	Bloemfontein	Free State	765	400
Boundary	Kimberley	Northern Cape	275	132
Dedisa	Port Elizabeth	Eastern Cape	400	132
Delphi	East London	Eastern Cape	400	132
Droërivier	Southern Cape	Western Cape	400	132
Erica	Peninsula	Western Cape	400	132
Ferrum	Kimberley	Northern Cape	400	132
Gamma	Karoo	Northern Cape	400	132
Garona	Kimberley	Northern Cape	275	132
Grassridge	Port Elizabeth	Eastern Cape	400	132
Gromis	Namaqualand	Northern Cape	400	220
Harvard	Bloemfontein	Free State	275	132
Helios	West Coast	Northern Cape	400	132
Hotazel	Kimberley	Northern Cape	400	132

Hydra	Karoo	Northern Cape	400	132
Hydra B	Karoo	Northern Cape	400	132
Juno	West Coast	Western Cape	400	132
Kappa	Southern Cape	Western Cape	765	400
Koeberg	West Coast	Western Cape	400	132
Kronos	Karoo	Northern Cape	400	132
Merapi	Bloemfontein	Free State	275	132
Mookodi	Kimberley	Northern Cape	400	132
Muldersvlei	Peninsula	Western Cape	400	132
Nama	Namaqualand	Northern Cape	220	66
Narina	Southern Cape	Western Cape	400	132
Neptune	East London	Eastern Cape	400	132
Nieuwehoop	Namaqualand	Northern Cape	400	132
Olien	Kimberley	Northern Cape	275	132
Oranjemond	Namaqualand	Northern Cape	220	66
Paulputs	Namaqualand	Northern Cape	220	132
Pembroke	East London	Eastern Cape	220	132
Perseus	Bloemfontein	Free State	400	275
Philippi	Peninsula	Western Cape	400	132
Pinotage	Peninsula	Western Cape	400	132
Port Elizabeth Sub	Port Elizabeth	Eastern Cape	400	132
Poseidon	Port Elizabeth	Eastern Cape	400	132

Proteus	Southern Cape	Western Cape	400	132
Roodekuil	Karoo	Northern Cape	220	132
Ruigtevallei	Karoo	Northern Cape	220	132
Sterrekus	Peninsula	Western Cape	765	400
Stikland	Peninsula	Western Cape	400	132
Upington	Namaqualand	Northern Cape	400	132
Vuyani	East London	Eastern Cape	400	132

Special note:

In the latest list of preferred bidders for the REIPPP Bid Window 4B, released on 7 June 2015, a number of the IPP projects are dependent on the establishment of 400/132 kV transformation at the Kappa and Komsberg substations as well as a second 400/132 kV transformer at the Kronos substation. None of these transformer projects is in the TDP list of projects, and they have not yet been funded; thus, they have not been included in the connection capacity calculations in this report.

5.2 The northern block

The northern block includes the transmission supply areas in the Free State, KwaZulu-Natal, Limpopo, Mpumalanga, and North West provinces with some overlap into the adjoining provinces. The transmission supply areas are shown in a single colour with the borders of the internal MTS supply areas highlighted. The map of the northern block with the MTS substations labelled is shown in Figure 5.3.

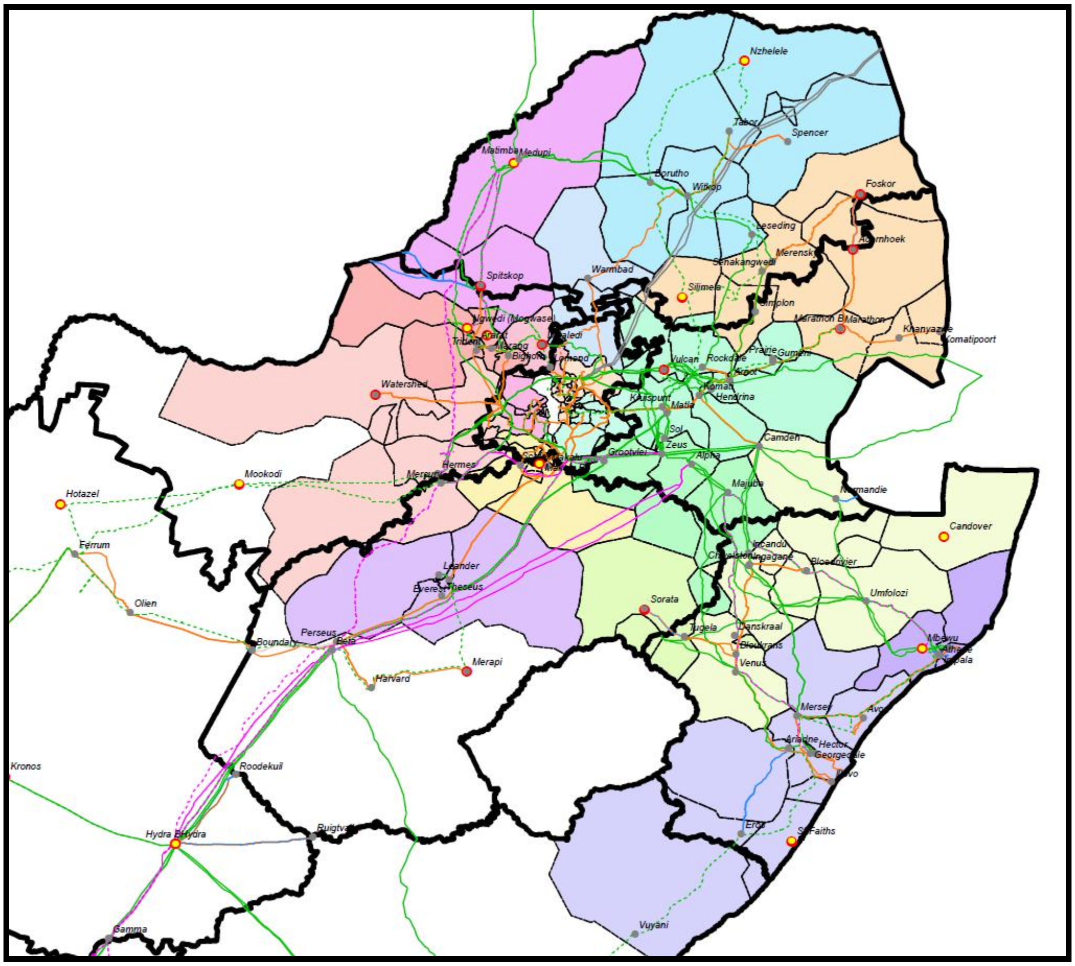

Figure 5.3: The northern block with the transmission supply areas shaded

The MTS substations in the northern block are listed alphabetically in Table 5.2 with the name of the relevant transmission supply area, the province, and the HV and LV voltage levels. The voltage levels are the highest HV and LV voltages in the case of multiple voltage levels as they are in the existing substation or when established after 2015. Further details of the MTS substation are provided in the tables in Appendix A, which are grouped by transmission supply area.

Table 5.2: MTS substations in the northern block

Substation name	Transmission supply area	Province	HV busbar voltage (kV)	LV busbar voltage (kV)
Acornhoek	Lowveld	Limpopo	275	132
Alpha	Highveld South	Mpumalanga	765	400
Ariadne	Pinetown	KwaZulu-Natal	400	132
Arnot	Highveld North	Mpumalanga	400	275
Athene	Empangeni	KwaZulu-Natal	400	132
Avon	Pinetown	KwaZulu-Natal	275	132
Bloedrivier	Newcastle	KwaZulu-Natal	275	88
Bloukrans	Ladysmith	KwaZulu-Natal	275	132
Borutho	Polokwane	Limpopo	400	132
Camden	Highveld South	Mpumalanga	400	275
Candover	Newcastle	KwaZulu-Natal	400	132
Carmel	Carletonville	Gauteng	275	132
Chivelston	Newcastle	KwaZulu-Natal	400	275
Danskraal	Ladysmith	KwaZulu-Natal	275	132
Eros	Pinetown	KwaZulu-Natal	400	132
Everest	Welkom	Free State	275	132
Foskor	Lowveld	Limpopo	275	132
Georgedale	Empangeni	KwaZulu-Natal	132	88
Georgedale	Pinetown	KwaZulu-Natal	275	132
Grootvlei	Highveld South	Mpumalanga	400	88

Gumeni	Highveld North	Mpumalanga	400	132
Gumeni	Lowveld	Mpumalanga	400	132
Hector	Pinetown	KwaZulu-Natal	400	275
Hendrina	Highveld North	Mpumalanga	400	132
Hermes	Carletonville	North West	400	132
Illovo	Pinetown	KwaZulu-Natal	275	132
Impala	Empangeni	KwaZulu-Natal	275	132
Incandu	Newcastle	KwaZulu-Natal	400	132
Ingagane	Newcastle	KwaZulu-Natal	275	88
Invubu	Empangeni	KwaZulu-Natal	400	275
Khanyazwe	Lowveld	Mpumalanga	275	132
Komati	Highveld North	Mpumalanga	275	132
Komatipoort	Lowveld	Mpumalanga	275	132
Kruispunt	Highveld North	Mpumalanga	275	132
Leander	Welkom	Free State	400	132
Leseding	Polokwane	Limpopo	400	132
Majuba	Highveld South	Mpumalanga	400	88
Marathon	Lowveld	Mpumalanga	275	132
Marathon B	Lowveld	Mpumalanga	400	132
Matimba	Waterberg	Limpopo	400	132
Matla	Highveld North	Mpumalanga	400	275
Mbewu	Empangeni	KwaZulu-Natal	765	400

Medupi	Waterberg	Limpopo	400	132
Mercury	Carletonville	Free State	400	132
Merensky	Lowveld	Limpopo	400	132
Mersey	Pinetown	KwaZulu-Natal	400	275
Midas	Carletonville	Gauteng	400	132
Normandie	Newcastle	Mpumalanga	400	132
Nzhelele	Polokwane	Limpopo	400	132
Pelly	Warmbad	Gauteng	275	132
Pluto	Carletonville	Gauteng	400	275
Prairie	Highveld North	Mpumalanga	275	132
Rockdale	Highveld North	Mpumalanga	400	132
Senakangwedi	Lowveld	Limpopo	275	33
Senakangwedi B	Lowveld	Limpopo	400	132
Silimela	Lowveld	Limpopo	400	132
Simplon	Lowveld	Mpumalanga	275	132
Sol	Highveld South	Mpumalanga	400	132
Sorata	Ladysmith	Free State	275	132
Spencer	Polokwane	Limpopo	275	132
Spitskop	Waterberg	Limpopo	400	132
St Faiths	Pinetown	KwaZulu-Natal	400	132
Tabor	Polokwane	Limpopo	400	132
Theseus	Welkom	Free State	400	132

Tugela	Ladysmith	KwaZulu-Natal	275	132
Umfolozi	Newcastle	KwaZulu-Natal	400	88
Venus	Ladysmith	KwaZulu-Natal	400	275
Vulcan	Highveld North	Mpumalanga	400	132
Warmbad	Warmbad	Limpopo	275	132
Watershed	Carletonville	North West	275	132
Witkop	Polokwane	Limpopo	400	132
Zeus	Highveld South	Mpumalanga	765	400

5.3 The central block

The central block is all the transmission supply areas in the Gauteng province with their overlap into the adjoining provinces. The transmission supply areas are shown in a single colour with the borders of the internal MTS supply areas highlighted. The map of the central block with the MTS substations labelled is shown in Figure 5.4.

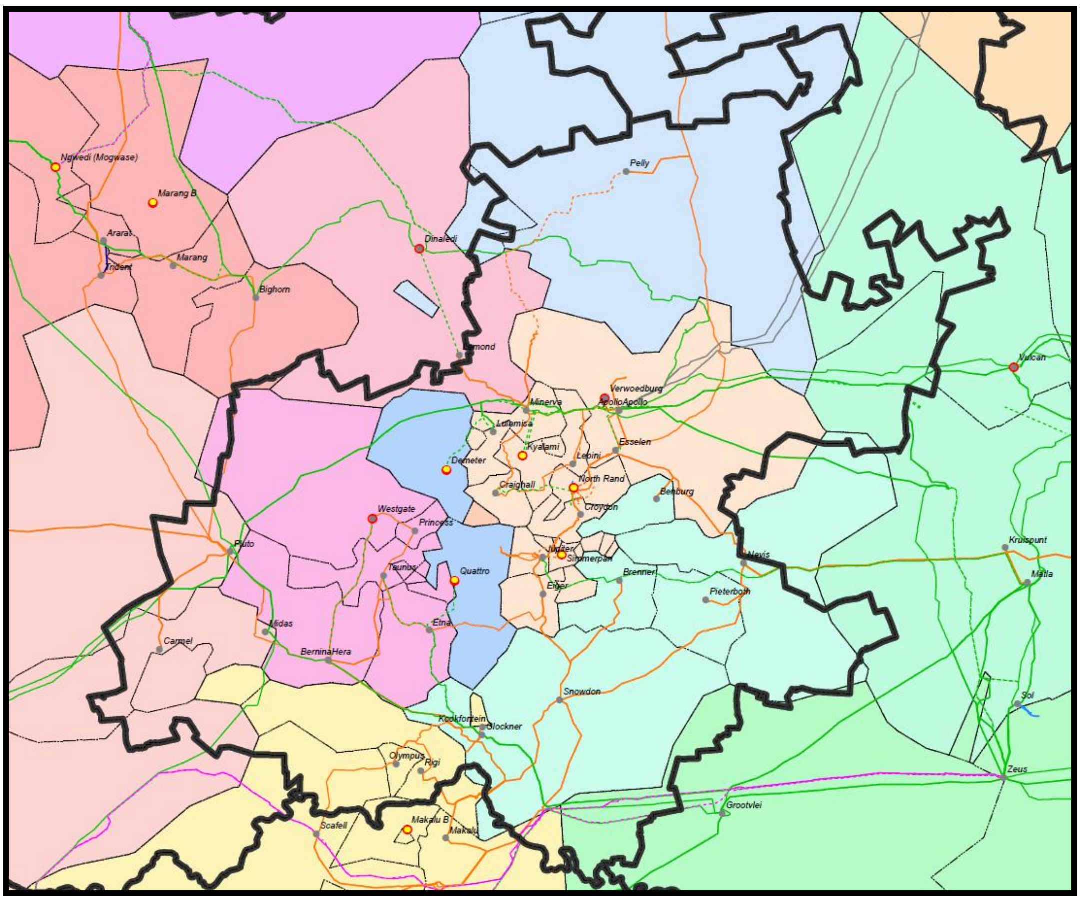

Figure 5.4: The central block with the transmission supply areas shaded

The MTS substations in the central block are listed alphabetically in Table 5.3 with the name of the relevant transmission supply area, the province, and the HV and LV voltage levels. The voltage levels are the highest HV and LV voltages in the case of multiple voltage levels as they are in the existing substation or when established after 2015. Further details of the MTS substation are provided in the tables in Appendix A, which are grouped by transmission supply area.

Table 5.3: MTS substations in the central block

Substation name	Transmission supply area	Province	HV busbar voltage (kV)	LV busbar voltage (kV)
Apollo	Pretoria	Gauteng	400	275
Ararat	Rustenburg	North West	275	88
Benburg	Nigel	Gauteng	275	132
Bernina	West Rand	Gauteng	275	132
Bighorn	Rustenburg	North West	400	132
Brenner	Nigel	Gauteng	275	88
Craighall	Johannesburg	Gauteng	275	88
Croydon	Johannesburg	Gauteng	275	132
Demeter	West Rand	Gauteng	400	88
Dinaledi	Pretoria	North West	400	132
Eiger	Johannesburg	Gauteng	275	88
Esselen	Johannesburg	Gauteng	275	132
Etna	West Rand	Gauteng	275	88
Glockner	Vaal Triangle	Gauteng	400	275
Hera	West Rand	Gauteng	400	275
Jupiter	Johannesburg	Gauteng	275	88
Kookfontein	Vaal Triangle	Gauteng	275	88
Kyalami	Johannesburg	Gauteng	400	132
Lepini	Johannesburg	Gauteng	275	88
Lomond	Pretoria	North West	275	88

Lulamisa	Johannesburg	Gauteng	400	88
Makalu	Vaal Triangle	Free State	275	88
Makalu B	Vaal Triangle	Free State	275	88
Marang	Rustenburg	North West	400	88
Marang B	Rustenburg	North West	400	132
Minerva	Pretoria	Gauteng	400	275
Nevis	Nigel	Gauteng	275	132
Ngwedi (Mogwase)	Rustenburg	North West	400	132
North Rand	Johannesburg	Gauteng	275	132
Olympus	Vaal Triangle	Gauteng	275	132
Pieterboth	Nigel	Gauteng	275	132
Princess	West Rand	Gauteng	275	88
Quattro	West Rand	Gauteng	275	132
Rigi	Vaal Triangle	Gauteng	275	88
Scafell	Vaal Triangle	Free State	275	132
Simmerpan	Johannesburg	Gauteng	275	88
Snowdon	Nigel	Gauteng	275	88
Taunus	West Rand	Gauteng	275	132
Trident	Rustenburg	North West	275	88
Verwoerdburg	Pretoria	Gauteng	400	132
Westgate	West Rand	Gauteng	400	132

6 UNLOCKING OF ADDITIONAL GRID CONNECTION CAPACITY

This chapter presents the possibilities and options for the creation of additional grid connection capacity beyond what has been calculated for this report. The objective of including this information is to indicate to IPP developers what possibilities exist outside of the TDP list of projects.

The MTS substation tables regarding installed transformer capacity and generation connection capacity contained in Appendix A are all based on only the transmission projects proposed in the TDP for the period 2015 to 2024. Discussions between Eskom and the DoE have been held over the past year regarding the creation of additional grid access for new RE and other IPP plants for future IPP procurement programmes. Other initiatives between Eskom and the DEA have also been undertaken to develop a more flexible and faster process of acquiring the necessary authorisations for transmission infrastructure projects to enable the more rapid creation of new grid access capacity.

6.1 Additional transmission infrastructure projects

Eskom Grid Planning has identified a number of potential transmission projects, which could unlock additional connection capacity by 2022, that are not included in the TDP, as their requirement has not yet been confirmed or agreed to. These projects include works at existing MTS substations as well as the establishment of new MTS substations with new transmission lines.

These potential projects can be grouped into four phases based on how long they would take to be completed, assuming that funding were made available, allowing time for the necessary approvals and scope of work involved.

The phases are as follows:

Phase 1:	2 years:	Limited work at existing MTS substations
Phase 2:	3-4 years:	Limited work at existing MTS substation with limited transmission line work
Phase 3:	4-5 years:	Existing or new MTS substation project that requires more transmission line work with full EIA study

Phase 4: 6-8 years: Existing or new MTS substation project that requires backbone transmission line work with longer lead times

The list of these potential transmission projects is provided in a table in Appendix B. The table groups the projects into their respective phases in MTS substation alphabetical order and provides the following information:

- How much new connection capacity could be added in MW
- A brief description of the network strengthening scope of work
- The province
- Expected duration of project development to completion if funded

The location of these potential transmission projects is shown on the map in Figure 6.1 with the different phases highlighted in different colours. The circle symbols indicate projects at existing MTS substations, while the square symbols indicate projects at new MTS substation sites, planned or proposed. This information is also included on the accompanying interactive spatial PDF map.

6.2 SEA study of future transmission power corridors

To understand the future transmission grid needs, Eskom Grid Planning completed a long-term strategic study, entitled the “2040 Transmission Network Study”. This study identified five major transmission power corridors that would need to be developed, regardless of which future generation scenario unfolded. Securing these power corridors for transmission development would provide a flexible and robust network that could respond to meet the needs of future IRP and IPP requirements.

One of the challenges to providing new grid access in time is the uncertainty in obtaining all the necessary authorisations before construction of transmission projects can start. New IPP generation plant can be completed long before new transmission infrastructure can be put in place based on the current planning and approval processes. There is a large discontinuity between when IPP and transmission projects can be started and completed, posing severe risk to future IPP procurement programmes.

Discussions were held with the DEA regarding this issue, and it was agreed that a new and much simpler approval process to obtain the required environmental authorisation (EA) from the DEA for transmission and distribution lines and substations had to be created. The DEA undertook to use the five transmission power corridors as a basis for a strategic environmental assessment (SEA) study of these corridors as part of the Strategic Integrated Projects (SIP) programme introduced by the 2012 National Infrastructure Development Plan, namely SIP 10. The objective of this SIP is to enable the transmission and distribution infrastructure to serve the needs of the country.

In parallel, as part of SIP 10, the DEA, with its appointed consultant, the CSIR, is developing a new authorisation process that will include all the necessary environmental studies and licence approvals required to obtain a final EA being put in place for projects within these corridors. The EIA study results and EAs granted for specific transmission lines are proposed to be valid for extended periods to allow for strategic acquisition of servitudes long before actually required. This, in turn, will enable the preparation and design work for transmission projects, especially lines, to commence early and be in place for final approval for release when required by the REIPPP and other IPP programmes, providing grid access within the same time frames as the IPP projects.

The power corridors for the SEA studies will be 100 km wide for most of their length to allow for flexibility of final transmission line route options. The corridor routes have taken into account the SIP 8 (ñgreen energy in support of the South African economy) project to identify suitable corridors and zones that would be ñhigh-potential areas for wind and solar PV energyò. The eight ñRE focus zonesò that have been identified are either crossed by, or close to, the five power corridor routes.

The public participation process has already finalised the power corridor boundaries, and the required environmental studies are under way. It is anticipated that all the necessary work will be completed to present the final proposal of corridor routes and the new EA process to government by the end of 2015.

The five transmission power corridor routes are indicated on the map in Figure 6.1 as well as on the accompanying interactive spatial PDF map. The five corridor routes are colour-coded and labelled. The ñinternational corridorò is primarily for unlocking grid access to IPPs and the supply of new load demand in this area, despite the name, and the potential for future interconnections via Zimbabwe.

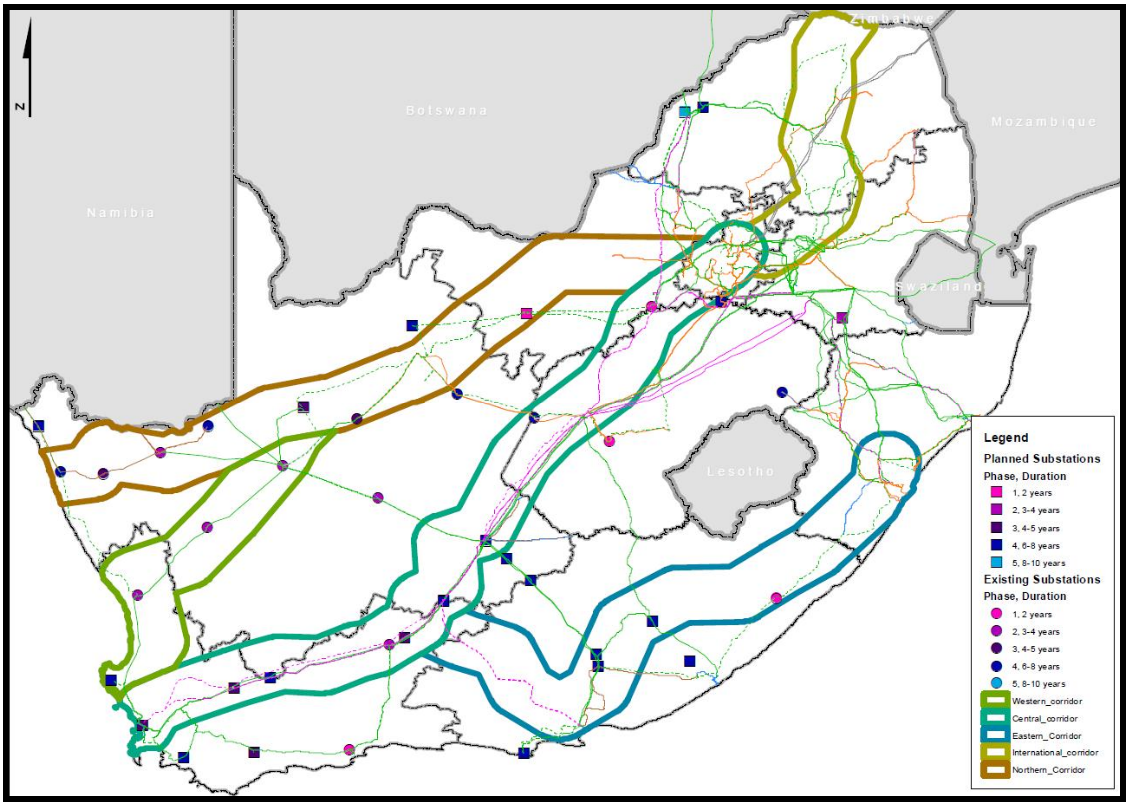

Figure 6.1: The potential MTS substation projects and the five transmission power corridors

7 THE INTERACTIVE SPATIAL PDF MAP

A new interactive spatial map in PDF format has been created to accompany this GCCA-2022 document, which is the biggest improvement from the previous GCCA. This interactive PDF map contains a number of different layers of information, which can be toggled on and off on the map, to be displayed spatially. These layers include the existing transmission network, the planned transmission projects, the location of the successful IPP bidders for all the REIPPP rounds, the MTS substation supply areas, and the transmission supply areas, among others.

The list of available layers of information is shown in Figure 7.1. On the left side of the PDF map, the ñtwo squaresò button must be clicked to open up the available layers. In order to activate or disable a layer on the map, the cursor must be placed on the ñeyeò button and clicked. When opened, the PDF map has all the layers activated. The PDF map contains an insert map of the greater Gauteng area to provide better clarity in the congested network diagram and the layers must be selected separately under the ñInsertò layer option. The main map is under the ñSouth Africaò layer option.

On the map, the MTS network information is indicated as follows:

Existing MTS substation	Black circle
Existing MTS substation with upgrade	Black circle with red outline
New MTS substation	Yellow circle with red outline
Transmission line voltages	765 kV purple, 400 kV green, 275 kV and 220 kV red
Existing transmission lines	Solid lines
New transmission lines	Dashed lines
Phasing of potential MTS upgrade projects	Phase 1 pink, Phase 2 maroon, Phase 3 dark purple, Phase 4 dark blue, Phase 5 light blue
Potential upgrade at existing MTS substation	Circle in colour of phase
Potential upgrade at new MTS substation	Square in colour of phase
Transmission power corridors	Colour-coded by name

The transmission supply areas are shaded in one colour with the internal borders of the MTS substation supply areas indicated.

The steady-state limit levels indicate the overall generation connection capacity of the transmission supply areas for 2016 and 2022, shaded in green relative to their connection capacity.

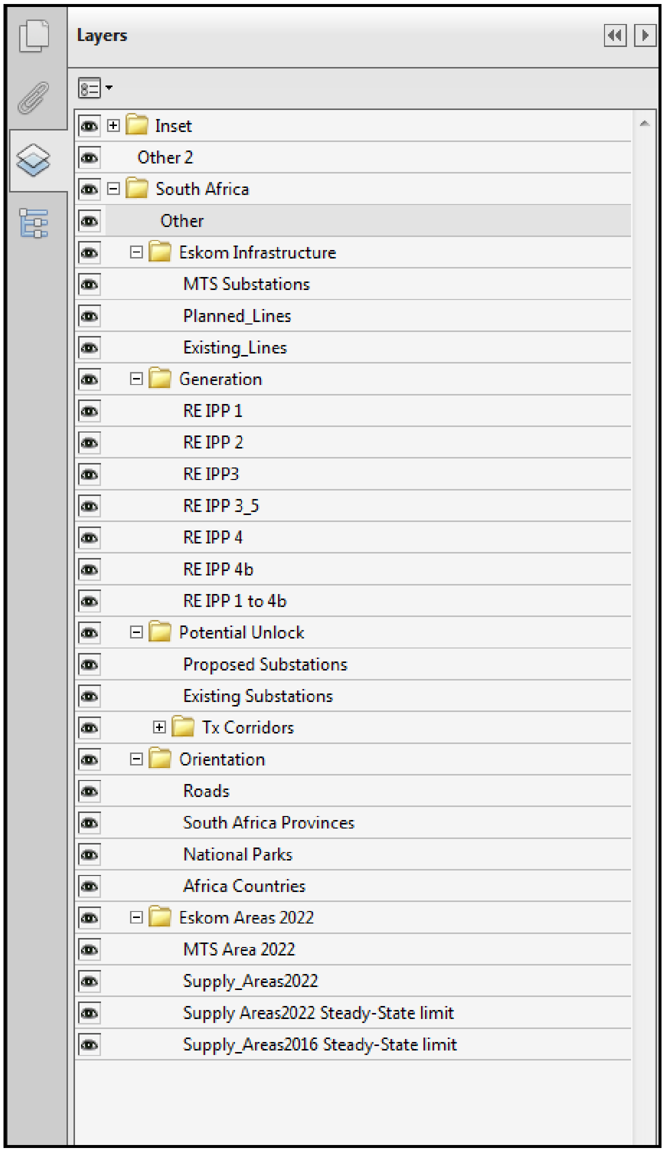

Figure 7.1: The available layers of spatial information on the PDF map

Included in the PDF map document are the GCCA-2022 connection capacity values and other relevant information in tabular form, which can be accessed under the model tree function. This is activated by clicking on the button that looks like the letter ñEò

The level of the information available is shown in Figure 7.2. The required level must be selected, and a drop-down list of the infrastructure will appear. The MYS substations are grouped into their respective provinces. Clicking on a particular MTS substation will display the available information in tabular form in the window below the list. A red square will highlight the selected MTS substation on the map.

If the location of the MTS substation is not known then after highlighting the name and right clicking an option list will appear. Selecting the ñZoom to Selectionò option will jump directly to the location on the map.

This interactive PDF map can be interrogated spatially as desired by potential developers and investors to address their own particular issues regarding their specific IPP projects under consideration.

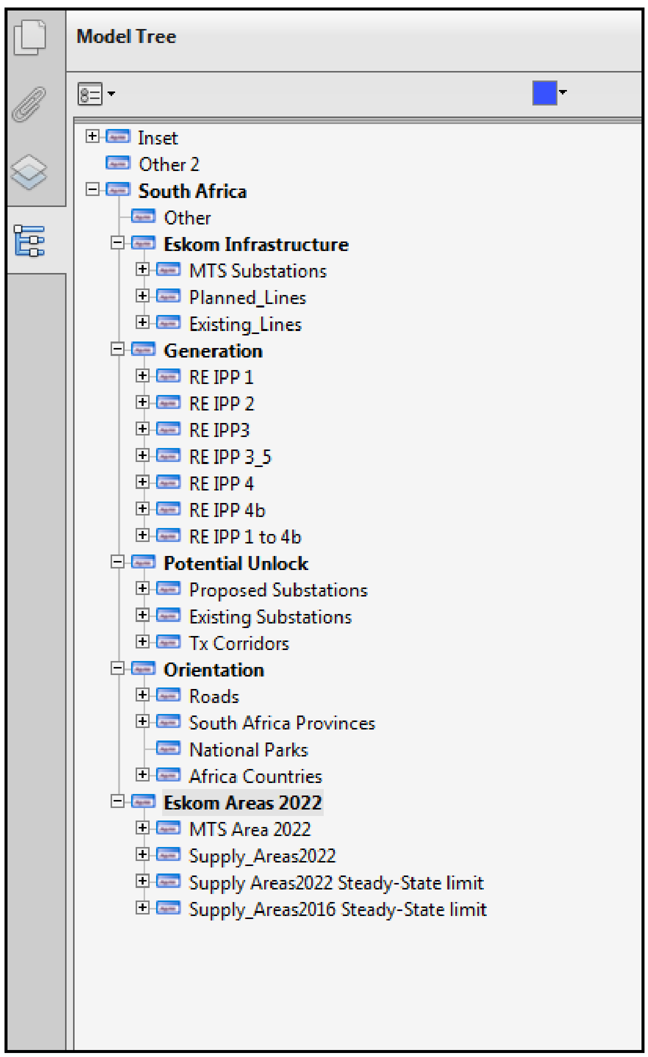

Figure 7.2: The available levels of tabular information in the PDF map document

8 DEFINITION OF A TRANSMISSION CONNECTION

A ñtransmission connectionò is defined, for the purposes of this document, as the direct or indirect connection to an MTS substation at either the LV or the HV busbar.

A direct connection at the HV busbar would require the construction of a transmission voltage-level line (400 kV, 275 kV, or 220 kV) from the generation plant directly to the MTS substation. The connection to the MTS substation LV busbar can be done in a number of ways, namely:

- direct connection from the generation plant substation to the MTS substation via a dedicated transmission line;
- looping in an existing distribution line, which is connected to the MTS substation, into the generation plant substation; and
- direct connection from the generation plant substation to a distribution substation, which is supplied by the MTS substation.

The three LV busbar connection options are shown diagrammatically in Figure 8.1.

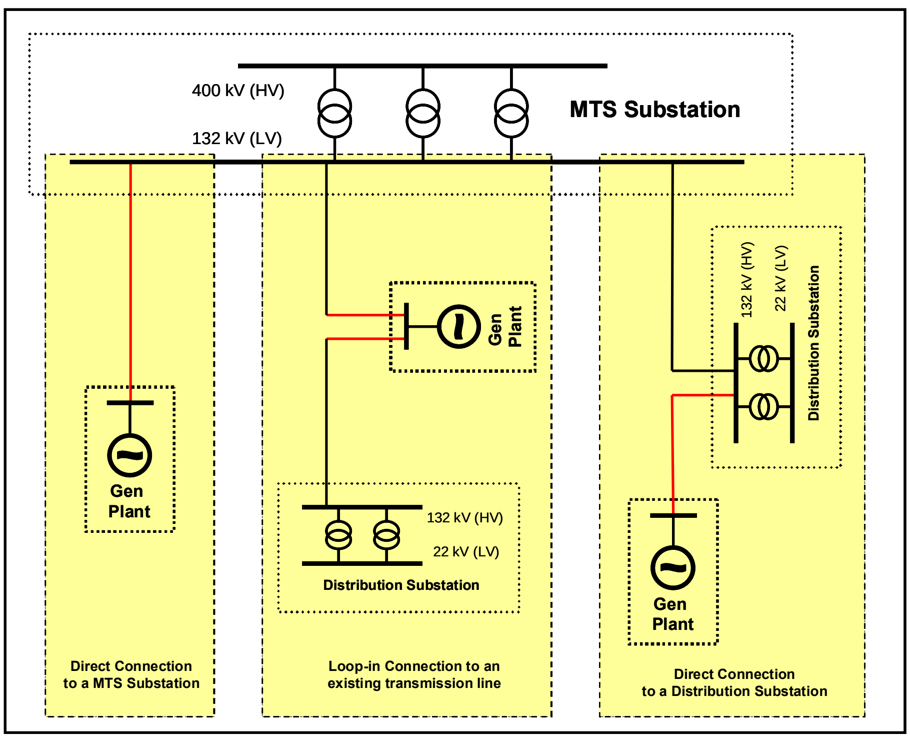

Figure 8.1: Generation plant connection to the LV busbar options

APPENDIX A

MTS SUBSTATIONS

TRANSFORMER AND GENERATION CONNECTION CAPACITY

CONTENTS

The MTS substations are grouped into their transmission supply areas, which are listed alphabetically. The installed transformer capacity and the calculated generation connection capacity for each MTS substation are provided in the transmission supply area tables as listed above.

Each transmission supply area table provides the following information:

Supply Area	The name of the supply area
Province	The name of the province in which the MTS substation is located
Substation	The name of the MTS substation
Transformer Voltages	The transformer voltage levels in the MTS substation
2015 No. of Trfrs	The number of transformers of a specific voltage level and size in the MTS substation at the end of the year 2015
2015 Trfr Size (MVA)	The MVA unit size of transformers of a specific voltage level in the MTS substation at the end of the year 2015
2015 Installed Transformer MVA	The total installed transformer MVA of a specific voltage level and size in the MTS substation at the end of the year 2015
Year of Trfr Upgrade	Year when new transformers are expected to be installed in the MTS substation
Upgrade Status	The project status of the upgrade, either ***approved*** with funding or ***proposed*** as in the TDP for 2015 to 2024
2022 No. of Trfrs	The number of transformers of a specific voltage level and size in the MTS substation at the end of the year 2022
2022 Trfr Size (MVA)	The MVA unit size of transformers of a specific voltage level in the MTS substation at the end of the year 2022
2022 Installed Transformer MVA	The total installed transformer MVA of a specific voltage level and size in the MTS substation at the end of the year 2022
2022 LV Busbar Connection Capacity (MW)	The available generation connection capacity at the LV busbar (132 kV or 88 kV or 66 kV) at the MTS at the end of the year 2022
2022 HV Busbar Connection Capacity (MW)	The generation connection capacity limit at the HV busbar (275 kV or 400 kV) at the MTS at the end of the year 2022
2022 Supply Area HV Busbar Steady-state Limit (MW)	The overall generation connection capacity limit of all the MTS substations within the supply area at the end of the year 2022

Note: The cumulative impact of the grouping of adjacent Transmission supply areas will result in further limitations on the steady-state limits which will require additional transmission backbone network to accommodate the total of all the affected Transmission supply areas.

Table A-1: Transmission supply area of Bloemfontein

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Beta	765/400	2	2000	4000	-	-	2	2000	4000		0	2142	3845
Harvard	275/132	2	500	1000	-	-	2	500	1000	64	917	670	
Merapi	275/132	1	250	250	2016	Approved	2	250	500		490	912	
Perseus	400/275	2	400	800	-	-	2	400	800	60	725	2263	
	400/275	1	800	800	-	-	1	800	800		0		

Table A-2: Transmission supply area of Carletonville

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Carmel	275/132	2	500	1000	-	-	2	500	1000		980	92	1302
Hermes	132/88	3	180	540	-	-	3	180	540		529	291	
	400/132	3	500	1500	-	-	3	500	1500		980		
Mercury	400/132	2	500	1000	-	-	2	500	1000	67.9	913	284	
Midas	400/132	2	500	1000	-	-	2	500	1000		980	172	
Pluto	400/275	2	750	1500	-	-	2	750	1500		980	311	
Watershed	132/88	2	180	360	-	-	2	180	360		353	172	
	275/132	0	0	0	2016	Approved	1	250	250	75	172		
	275/88	2	315	630	-	-	2	315	630		617		

Table A-3: Transmission supply area of East London

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Delphi	400/132	2	120	240	2020	Proposed	3	120	360	97	258	1228	3844
Neptune	400/132	2	500	1000	-	-	2	500	1000		980	852	
Pembroke	132/66	0	0	0	2022	Proposed	2	250	500		490	780	
	220/132	2	250	500	2022	Proposed	0	0	0		0		
	220/66	2	90	180	-	-	0	0	0		0		
	400/132	0	0	0	2022	Proposed	2	500	1000	53.3	928		
Vuyani	400/132	2	250	500	-	-	2	250	500		490	984	

Table A-4: Transmission supply area of Empangeni

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Athene	400/132	4	500	2000	-	-	4	500	2000		980	517	
Georgedale	132/88	2	45	90	-	-	2	45	90		88	0	
Impala	275/132	4	250	1000	-	-	4	250	1000	16.5	964	528	1585
Invubu	400/275	3	800	2400	-	-	3	800	2400		0	540	
Mbewu	765/400	1	2000	2000	-	-	1	2000	2000		0	0	

Table A-5: Transmission supply area of Highveld North

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Arnot	400/275	2	400	800	-	-	2	400	800		0	0	
Gumeni	400/132	1	500	500	-	-	1	500	500		490	921	
Hendrina	400/132	2	250	500	-	-	2	250	500		0	0	
Komati	275/132	2	250	500	-	-	2	250	500		0	0	
Kruispunt	275/132	4	250	1000	-	-	4	250	1000		980	592	
Matla	400/275	1	800	800	-	-	1	800	800		0	0	
Prairie	275/132	2	500	480	-	-	2	240	480	6.76	464	921	4228
Rockdale	132/88	2	90	180	-	-	2	90	180		0		
	275/132	2	500	1000	-	-	2	500	1000		980	873	
	400/132	2	500	1000	-	-	2	500	1000		980		
Vuclan	400/132	2	500	1000	2022	Proposed	4	500	2000		980		
	400/132	2	300	600	2022	Proposed	0	300	0		0	921	
	400/132	1	250	250	2022	Proposed	0	250	0		0		

Table A-6: Transmission supply area of Highveld South

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Alpha	765/400	3	2000	6000	-	-	3	2000	6000		0	1216	
Camden	275/88	2	160	320	-	-	2	160	320		0	1200	
	400/275	2	400	800	-	-	2	400	800		0		
Grootvlei	400/88	2	160	320	-	-	2	160	320		0	0	1574
Majuba	400/88	2	160	320	-	-	2	160	320		0	0	
Sol	400/132	4	500	2000	-	-	4	500	2000		980	374	
Zeus	765/400	2	2000	4000	-	-	3	2000	6000		0	7325	

Table A-7: Transmission supply area of Johannesburg

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Craighall	275/88	3	315	945	-	-	3	315	945		926	418	4932
Croydon	275/132	3	250	750	-	-	3	250	750		735	187	
Eiger	275/88	3	315	945	-	-	3	315	945		926	440	
Esselen	132/88	1	160	160	-	-	1	160	160		0	545	
	275/132	2	180	360	-	-	2	180	360		353		
	275/132	1	250	250	-	-	1	250	250		245		
	275/88	2	315	630	-	-	2	315	630		617		
Jupiter	275/88	3	180	540	-	-	3	180	540		529	496	
Kyalami	400/132	0	0	0	2022	Proposed	2	500	1000		980	780	
Lepini	275/88	4	315	1260	-	-	4	315	1260	3.2	980	531	
Lulamisa	400/88	3	315	945	-	-	3	315	945		926	475	
North Rand	275/132	0	0	0	2022	Proposed	2	500	1000		980	530	
Simmerpan	275/88	0	0	0	2021	Proposed	2	160	320		314	530	

Table A-8: Transmission supply area of Karoo

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Gamma	400/132	1	250	250	-	-	1	250	250		245	0	3669
	765/400	1	2000	2000	-	-	1	2000	2000		0		
Hydra	400/132	2	500	1000	2018	Approved	3	500	1500	235.5	980	1722	
	400/220	2	315	630	-	-	2	315	630		617		
	765/400	1	2000	2000	-	-	1	2000	2000		0		
Hydra B	400/132	0	0	0	2021	Proposed	2	500	1000		980	780	
Kronos	400/132	0	0	0	2016	Approved	1	250	250	462.83	-209	915	
Roodekuil	220/132	1	125	625	-	-	1	125	125		0	83	
Ruigtvallei	132/66	2	20	40	-	-	2	20	40		0	169	
	220/132	2	250	500	-	-	2	250	500	69.9	0		

Table A-9: Transmission supply area of Kimberley

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Boundary	275/132	2	250	500	-	-	2	250	500	228.15	266	1422	4744
Ferrum	132/66	3	80	240	-	-	3	80	240		0	974	
	275/132	2	250	500	-	-	2	250	500	224	270		
	400/132	2	500	1000	-	-	2	500	1000	100	882		
Garona	275/132	1	125	125	-	-	1	125	125	50	74	241	
Hotazel	400/132	0	0	0	2020	Proposed	2	500	1000		980	780	
Mookodi	400/132	2	500	1000	-	-	2	500	1000	75	907	924	
Olien	275/132	2	150	300	-	-	2	150	300	239	60	403	

Table A-10: Transmission supply area of Ladysmith

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Bloukrans	275/132	2	250	500	-	-	2	250	500		490	530	1691
Danskraal	275/132	2	125	250	-	-	2	125	250		245	344	
Sorata	275/132	0	0	0	2021	Proposed	1	250	250		245	380	
Tugela	275/132	2	180	360	-	-	2	180	360	9	344	437	
Venus	400/275	2	800	1600	-	-	2	800	1600		980	0	

Table A-11: Transmission supply area of Lowveld

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Acornhoek	275/132	2	75	150	2017	Approved	2	125	250		245	472	5698
Foskor	275/132	2	250	500	2017	Approved	3	250	750		735	373	
Gumeni	400/132	0	0	0	2018	Proposed	2	500	1000		980	690	
Khanyazwe	275/132	1	250	250	-	-	1	250	250		245	350	
Komatipoort	275/132	2	125	250	-	-	2	125	250		245	275	
Marathon	132/66	2	30	60	-	-	2	30	60		59	619	
	275/132	2	500	1000	-	-	2	500	1000	25	956		
MarathonB	400/132	1	800	0	2020	Proposed	1	800	800		784	66	
Merensky	275/132	2	250	500	-	-	2	250	500		490	882	
	400/132	1	500	500	-	-	1	500	500		490		
	400/275	2	400	800	-	-	2	400	800		0		
Senakangwedi	275/33	2	180	360	-	-	2	180	360		353	143	
Senakangwedi B	400/132	0	0	0	2020	Proposed	2	500	1000		980	720	
	B400/275	0	0	0	2020	Proposed	1	800	800		0	0	
Silimela	400/132	0	0	0	2020	Proposed	2	500	1000		980	680	
Simplon	275/132	2	250	500	-	-	2	250	500		490	177	

Table A-12: Transmission supply area of Namaqualand

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Aggeneis	220/66	2	40	80	-	-	2	40	80	40	39	121	2348
	400/220	2	315	630	-	-	2	315	630	471.35	155		
Aries	400/22	1	40	40	-	-	1	40	40	9.65	30	116	
Gromis	220/66	2	40	80	-	-	2	40	80		78	180	
	400/220	0	0	0	2020	Proposed	1	315	315		0		
Nama	220/66	2	80	160	-	-	2	80	160		157	150	
Nieuwehoop	400/132	0	0	0	2016	Approved	1	250	250		245	750	
Oranjemond	220/66	2	80	160	-	-	2	80	160		157	100	
Paulputs	132/33	1	10	10	-	-	1	10	10	10	0	120	
	220/132	1	125	125	2019	Proposed	2	250	500	119.65	373		
Upington	400/132	1	500	500	2022	Proposed	2	500	1000	383.9	604	680	

Table A-13: Transmission supply area of Newcastle

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Bloedrivier	275/88	2	160	320	-	-	2	160	320		314	155	1787
Candover	400/132	0	0	0	2021	Proposed	2	500	1000		980	780	
Chivelston	400/275	1	800	800	-	-	1	800	800		0	238	
Incandu	400/132	2	315	630	-	-	2	315	630		617	207	
	400/132	0	0	0	2017	Approved	1	500	500		490		
Ingagane	275/88	2	160	320	-	-	2	160	320		314	192	
Normandie	132/88	1	160	160	-	-	1	160	160		157	162	
	400/132	2	250	500	-	-	2	250	500		490		
	400/88	2	160	320	-	-	2	160	320		314		
Umfolozi	400/88	2	160	320	-	-	2	160	320		314	291	

Table A-14: Transmission supply area of Nigel

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Benburg	275/132	3	250	750	-	-	3	250	750		735	252	2425
Brenner	275/88	3	315	945	-	-	3	315	945		926	677	
Nevis	275/132	2	500	1000	-	-	2	500	1000		980	485	
Pieterboth	275/132	2	315	630	-	-	2	315	630		617	334	
Snowdon	275/88	3	160	480	-	-	3	160	480		470	677	

Table A-15: Transmission supply area of Peninsula

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Acacia	132/66	2	120	240	-	-	2	120	240		0	729	5052
	400/132	3	500	1500	-	-	3	500	1500		980		
Asteria	400/132	0	0	0	2022	Proposed	2	500	1000		980	590	
Erica	400/132	0	0	0	2021	Proposed			0		0	580	
Muldersvlei	132/66	2	80	160	-	-	2	80	160		157	729	
	400/132	3	500	480	-	-	3	500	1500		980		
Philippi	400/132	2	500	1000	-	-	2	500	1000		980	729	
Pinotage	400/132	0	0	0	2017	Approved	2	500	1000		980	605	
Sterrekus	765/400	0	0	0	2016	Approved	1	2000	2000		0	562	
Stikland	400/132	3	500	1000	-	-	3	500	1500		980	528	

Table A-16: Transmission supply area of Pinetown

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Ariadne	400/132	2	500	1000	-	-	2	500	1000		980	279	4296
Avon	275/132	3	250	750	-	-	3	250	750		735	522	
Eros	400/132	2	500	1000	-	-	2	500	1000		980	688	
Georgedale	275/132	3	250	750	-	-	3	250	750		735	445	
Hector	400/275	3	800	2400	-	-	3	800	2400		0	663	
Illovo	132/88	1	80	80	-	-	1	80	80		78	484	
	275/132	2	250	500	-	-	2	250	500		490		
Mersey	275/132	2	250	500	-	-	2	250	500		490	1071	
	400/275	3	800	2400	-	-	3	800	2400		0		
St Faiths	400/132	0	0	0	2021	Proposed	2	500	1000		980	680	

Table A-17: Transmission supply area of Polokwane

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Borutho	400/132	2	500	1500	-	-	2	500	1000		980	348	3018
Leseding	400/132	2	500	1000	-	-	2	500	1000		980	785	
Nzhelele	400/132	0	0	0	2022	Proposed	2	250	500		490	395	
Spencer	275/132	2	250	500	-	-	2	250	500		490	306	
Tabor	275/132	2	250	500	-	-	2	250	500	28	463	296	
	400/132	1	500	500	-	-	1	500	500		490		
Witkop	400/132	3	500	1500	-	-	3	500	1500	30	980	602	
	400/275	2	400	800	-	-	2	400	800		0		

Table A-18: Transmission supply area of Port Elizabeth

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Dedisa	400/132	3	500	1500	-	-	3	500	1500		980	524	4300
Grassridge	220/132	2	360	720	-	-	2	360	720	26.19	680	1362	
	400/132	4	500	2000	-	-	4	500	2000	616.06	980		
PE Sub	400/132	0	0	0	2022	Proposed	2	500	1000		980	390	
Poseidon	220/132	2	125	250	-	-	2	125	250	158.4	90	1260	
	220/66	1	40	120	-	-	1	40	40		39		
	400/132	0	0	0	2016	Approved	1	500	500	481.12	19		
	400/220	2	500	1000	-	-	2	500	1000		980		

Table A-19: Transmission supply area of Pretoria

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Apollo	400/275	1	800	800	-	-	1	800	800		0	1353	1295
	400/275	2	1000	2000	-	-	2	1000	2000		0		
Dinaledi	400/132	2	500	1000	2016	Approved	3	500	1500		980	567	
Lomond	275/88	2	315	630	-	-	2	315	630	50	568	228	
Minerva	400/275	4	800	3200	-	-	4	800	3200		0	1227	
Verwoedburg	400/132	2	250	500	2021	Proposed	3	250	750		0	500	

Table A-20: Transmission supply area of Rustenburg

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Ararat	275/88	3	315	945	-	-	3	315	945		926	143	1929
Bighorn	275/88	3	315	945	-	-	3	315	945		926	299	
	400/132	2	500	1000	-	-	2	500	1000	6.76	973		
	400/275	2	800	1600	-	-	2	800	1600		0		
Marang	400/88	4	315	1260	-	-	4	315	1260		980	205	
Marang B	400/132	0	0	0	2022	Proposed	2	500	1000		980	640	
Ngwedi (Mogwase	400/132	2	500	1000	2021	Proposed	3	500	1500		980	350	
Trident	275/88	2	315	630	-	-	2	315	630		617	149	

Table A-21: Transmission supply area of Southern Cape

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Agullas	400/132	0	0	0	2021	Proposed	2	500	1000		980	550	3460
Bacchus	400/132	2	500	1000	-	-	2	500	1000	94.09	888	924	
Droerivier	400/132	2	120	240	-	-	2	120	240		235	951	
Kappa	765/400	1	2000	2000	-	-	1	2000	2000		0	910	
Narina	400/132	0	0	0	2022	Proposed	2	500	1000		980	550	
Proteus	132/66	2	80	160	-	-	2	80	160		157	485	
	400/132	2	500	1000	-	-	2	500	1000		980		

Table A-22: Transmission supply area of Vaal Triangle

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Glockner	400/275	3	800	2400	-	-	3	800	2400		0	1024	3139
Kookfontein	275/88	3	315	945	-	-	3	315	945		926	240	
Makalu	275/88	4	160	640	-	-	4	160	640		627	326	
Makalu B	275/88	0	0	0	2022	Proposed	2	315	630		617	350	
Olympus	275/132	2	250	500	-	-	2	250	500		490	559	
Rigi	275/88	3	315	945	-	-	3	315	945		926	337	
Scafell	275/132	2	135	270	-	-	2	135	270		265	303	

Table A-23: Transmission supply area of Warmbad

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Pelly	275/132	2	250	500	-	-	2	250	500		490	474	860
Warmbad	132/66	2	40	80	-	-	2	40	80		78	386	
	275/132	2	125	250	-	-	2	125	250		245		

Table A-24: Transmission supply area of Waterberg

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Matimba	400/132	2	250	500	-	-	2	250	500		490	748	1220
Medupi	400/132	0	0	0	-	-	2	250	500		0	748	
Spitskop	275/88	2	315	630	-	-	2	315	630		617	472	
	400/132	1	500	500	2016	Approved	3	500	1500		980		
	400/13	2	250	500	2016	Approved	0	0	0		0		
	400/275	2	800	1600	-	-	2	800	1600		0		

Table A-25: Transmission supply area of Welkom

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Everest	275/132	2	500	1000	-	-	2	500	1000		980	1055	6365
Leander	400/132	2	500	1000	-	-	2	500	1000		980	2106	
Theseus	400/132	2	500	1000	-	-	2	500	1000		980	3204	

Table A-26: Transmission supply area of West Coast

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Aurora	400/132	4	250	1000	2021	Proposed	2	500	1000	250.2	735	1702	2715
Helios	400/132	0	0	0	2017	Approved	1	500	500	350.9	146	571	
	400/22	1	40	40	-	-	1	40	40		39		
Juno	132/66	2	40	80	2020	Proposed	2	80	160	8.8	148	442	
	400/132	2	120	240	2020	Proposed	2	500	1000		980		
Koeberg	400/132	2	250	500	-	-	2	250	500		0	780	

Table A-27: Transmission supply area of West Rand

Substation	Transformer Voltages	No. of Trfrs	Trfr Size (MVA)	2015 Installed Transformer (MVA)	Year of Trfr Upgrade	Upgrade Status	No. of Trfrs	Trfr Size (MVA)	2022 Installed Transformer (MVA)	REIPPP Gen Allocated (MW)	2022 LV Busbar Connection Capacity (MW)	2022 HV Busbar Connection Capacity (MW)	2022 Supply Area HV Busbar steady-state limit (MW)
Bernina	275/132	4	240	1000	-	-	4	240	960		941	699	4242
Demeter	400/88	0	0	0	2022	Proposed	3	315	945		926	780	
Etna	275/88	2	315	630	-	-	2	315	630	1	616	746	
Hera	400/275	2	800	1600	-	-	2	800	1600		0	508	
Princess	275/88	3	315	945	-	-	3	315	945		926	183	
Quattro	275/132	0	0	0	2021	Proposed	2	500	1000		980	550	
Taunus	275/132	3	500	1500	-	-	3	500	1500	4.8	980	555	
Westgate	275/132	2	500	1000			2	500	1000		980	221	
	400/132	0	0	0	2021	Proposed	1	500	500		0		

APPENDIX B

MTS SUBSTATIONS

POTENTIAL PROJECTS FOR ADDITIONAL GRID ACCESS

The table with the potential transmission projects to provide additional grid access is grouped into the phases based on the time frame in which they could be completed as discussed in Chapter 6, that is, the time for final design, construction, and commissioning, assuming all authorisations and funding are in place.

Within each phase, the MTS substation sites where the projects would provide new connection capacity are listed in alphabetical order.

The table provides the following information:

Tx project phase	The phase of the project from 1 to 5
Substation site	The name of the MTS substation at which the transmission infrastructure works will be located
Unlocking (MW)	The MW amount of connection capacity that could be unlocked
Network strengthening	Brief description of the scope of work of the proposed project Note: an item shown as “500 MVA 400/132 kV” refers to a transformer
Province	The province in which the project is located
Duration for project development	The estimated time required to prepare, construct, and commission the project (assuming all authorisations and funding are in place)

Table B-1: Potential transmission projects for additional grid access

Tx project phase	Substation site	Unlocking (MW)	Network strengthening	Province	Duration for project development
1	Harvard	475	None	Free State	2 years
1	Hermes	306	None	North West	2 years
1	Mookodi	271	None	North West	2 years
1	Proteus	442	None	Western Cape	2 years
1	Vuyani	600	None	Eastern Cape	2 years
2	Aggeneis	220	New 132 kV S/S, 2 x 250 MVA 400/132 kV	Northern Cape	3-4 years
2	Aries	270	New 132 kV S/S, 2 x 250 MVA 400/132 kV	Northern Cape	3-4 years
2	Droërivier	137	500 MVA 400/132 kV	Western Cape	3-4 years
2	Helios	307	1 x 500 MVA 400/132 kV	Northern Cape	3-4 years
2	Juno	602	Replace 125 MVA 400/132 kV with 500 MVA	Western Cape	3-4 years
2	Kronos	878	3 x 500 MVA 400/132 kV, replace 250 MVA with a 500 MVA	Northern Cape	3-4 years
2	Lambda	121.2	New 88 kV S/S, 2 x 315 MVA 400/88 kV	Mpumalanga	3-4 years
3	Droërivier B	1 100	New 400 kV S/S, 500 MVA 400/132 kV, 2 x 10 km Hydra-Droërivier 3 400 kV loop-in	Western Cape	4-5 years

3	Gamma	974	400 kV S/S, 3 x 500 MVA 400/132 kV, 2 x 4 km Hydra-Droërivier 2 400 kV loop-in	Northern Cape	4-5 years
3	Garona	624	400 kV S/S, 2 x 500 MVA 400/132 kV, 2 x 5 km Ferrum-Nieuwehoop 400 kV line loop-in	Northern Cape	4-5 years
3	Koruson (Kappa)	276	132 kV S/S, 2 x 250 MVA 400/132 kV	Western Cape	4-5 years
3	Nama	263	2 x 250 220/132 kV	Northern Cape	4-5 years
3	Sterrekus	400	132 kV S/S, 2 x 500 MVA 400/132 kV	Western Cape	4-5 years
3	Upington Solar Park	1 000	3 x 500 MVA 400/132 kV, 2 x 150 km Upington-Aries 1 and 2 plus 200 km Upington-Ferrum 400 kV line	Northern Cape	4-5 years
3	Vryheid	220	400 kV S/S, 2 x 250 MVA 400/132 kV, loop-in of Proteus-Bacchus 400 kV line	Western Cape	4-5 years
4	Blouwater/ Aurora B	1 325	New 400 kV S/S, 4 x 500 MVA 400/132 kV, 2 x 30 km Aurora-Blouwater 400 kV line	Western Cape	6-8 years
4	Boundary	690	New Ulco S/S, 2 x 500 MVA 400/132 kV, 170 km Beta-Ulco 400 kV line	Northern Cape	6-8 years
4	Delphi B	780	New 400 kV S/S, 3 x 500 MVA 400/132 kV, 2 x 50 km Poseidon-Delphi 400 kV line loop-in	Eastern Cape	6-8 years
4	Gromis	440	New 400 kV busbar, 2 x 500 MVA 400/132 kV, 2 x 400 MVA 400/220 kV, 260 km 400 kV line and 130 km 400 kV line	Northern Cape	6-8 years
4	Hotazel	200	2 x 500 MVA 400/132 kV, 100 km Ferrum-Hotazel 400 kV line, 125 km Hotazel-Mookodi, Mookodi-Hermes 190 km 400 kV line	North West	6-8 years
4	Houhoek	189.22	New 400 kV S/S, 2 x 500 MVA 400/132 kV, loop-in of the Bacchus-Palmiet 400 kV line	Western Cape	6-8 years
4	Hydra B	1 355	400 kV S/S, 4 x 500 MVA 400/132 kV, 2 x 10 km 400 kV Hydra-Poseidon line loop-in	Northern Cape	6-8 years

4	Hydra C	990	400 kV S/S, 4 x 500 MVA 400/132 kV, 2 x 10 km 400 kV Hydra-Perseus 1 line loop-in	Northern Cape	6-8 years
4	Hydra D	780	400 kV S/S, 4 x 400/132 kV 500 MVA, 2 x 10 km 400 kV Hydra-Perseus 1 line loop-in	Northern Cape	6-8 years
4	Komsberg B	1 300	4 x 400/132 kV 500 MVA, 2 x 10 km Droërivier-Bacchus 400 kV line loop-in, Komsberg series cap de-rating	Western Cape	6-8 years
4	Makalu B	140	2 x 315 MVA 275/88 kV and 2 x 10 km 275 kV Lethabo-Makalu line loop-in	Free State	6-8 years
4	Matimba B	600	400 kV S/S, 3 x 500 MVA 400/132 kV and 2 x 10 km Matimba-Witkop 400 kV line loop-in	Limpopo	6-8 years
4	Olien	1 100	400 kV S/S, 3 x 500 MVA 400/132 kV, 70 km Olien-Ulco 400 kV line, 107 km Ferrum-Olien 400 kV line	Northern Cape	6-8 years
4	Oranjemond B	150	220 kV S/S, 250 MVA 220/132 kV and 5 km Oranjemond-Gromis 220 kV loop-in	Northern Cape	6-8 years
4	Paulputs	250	400 kV S/S, replace 220/132 kV 125 MVA with 250 MVA 400/132 kV and 100 km 400 kV line	Northern Cape	6-8 years
4	Pembroke B	575	New 400 kV S/S, 3 x 500 MVA 400/132 kV, 150 km Poseidon-Pembroke B 400 kV line and 150 km Pembroke B-Neptune 400 kV line	Eastern Cape	6-8 years
4	Poseidon B	883	New 400 kV S/S, 3 x 500 MVA 400/132 kV, 2 x 1.5 km Poseidon-Dedisa 400 kV line	Eastern Cape	6-8 years
4	Poseidon C	1 000	New 400 kV S/S, 3 x 500 MVA 400/132 kV, 2 x 60 km Poseidon-Poseidon C 400 kV line	Eastern Cape	6-8 years
4	Sorata	307	400 kV S/S, 2 x 500 MVA 400/132 kV, 2 x 70 km Sorata-Ingula 400 kV line	Free State	6-8 years
4	Thyspunt	230	New 400 kV S/S, 2 x 250 MVA 400/132 kV, 2 x 90 km Thyspunt-Dedisa 400 kV line	Eastern Cape	6-8 years
4	Victoria B	750	400 kV S/S, 3 x 500 MVA 400/132 kV, 2 x 50 km Hydra-Droërivier 3 400 kV loop-in, Victoria series cap de-rating	Northern Cape	6-8 years

5	Lephalale Coal	2 000	HVDC to Gauteng	Limpopo	8-10 years