


APPENDIX B: TECHNICAL INFORMATION

APPENDIX B-1 : PRELIMINARY TECHNICAL SCOPE REPORT FOR BESS KIWANO PV PROJECT (REV 1)

	Report	Asset Management
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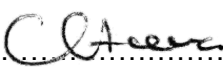
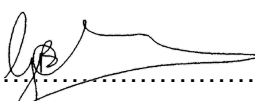


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Compiled by	Functional Responsibility	Authorised by
		
Dr. Oelof de Meyer	Viren Heera	Dr. Gary de Klerk
Senior Engineer: Asset Management Mechanical	Chief Engineer: Asset Management Mechanical	Senior Manager: Asset Management Mechanical Engineering (Acting)
Date: 2021-10-19	Date: 2021/10/19	Date: 2021/10/20

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1. INTRODUCTION

Eskom is in the process of developing and executing the distributed Battery Energy Storage System (BESS) and Photovoltaic (PV) portfolio of projects in two phases, namely BESS and PV Phase 1, and BESS and PV Phase 2.

The Kiwano BESS and PV project is part of Phase 2, and comprises an envisaged PV capacity of 58 MW, and BESS capacity of 40 MW / 200 MWh.

The Kiwano BESS and PV facility will be located at the Eskom owned Kiwano site, near Upington in the Northern Cape.

The Kiwano BESS and PV Project Development department requires preliminary technical information regarding the proposed project scope, equipment, and infrastructure to initiate the environmental approval processes. This report presents preliminary technical information related to the installation of PV, as requested by Eskom's Project Development department in order to assist with the environmental processes. Preliminary layout drawings are included in the Appendix for illustrative purposes, and does not represent the final layout of the PV and BESS facility.

At this stage, it is assumed that Eskom will execute the project utilising an EPC Contractor. The final detailed designs, layout, and construction of the PV and BESS facility will be performed by the selected EPC Contractor, and may differ to the PV and BESS facility configuration and technical information presented in this preliminary report.

2. SUPPORTING CLAUSES

2.1 SCOPE

This report presents preliminary technical information relating to the installation of PV as part of the Kiwano BESS and PV project. The BESS, substation, and overhead line scope is not addressed in this report.

The preliminary technical information contained in this report is intended to inform the Environmental requirements only, and may change when the selected EPC Contractor finalises the detailed designs.

2.1.1 Purpose

The purpose of this document is to present preliminary technical information to Eskom's Project Development department to inform the necessary Environmental and Water applications required for the Kiwano BESS and PV project.

2.1.2 Applicability

This document shall apply to the Kiwano BESS and PV project.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

- [1] BESS PHASE 2: Distribution Planning Proposal Kiwano Substation Northern Cape Operating Unit

2.2.2 Informative

N/A

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2.3 DEFINITIONS

2.3.1 Disclosure Classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
AC	Alternating Current
DC	Direct Current
EMP	Environmental Management Plan
PV	Photovoltaic

2.5 ROLES AND RESPONSIBILITIES

Compiler: Responsible to compile the document and to ensure that the content is integrated to reflect the requirements of every stakeholder forming part of this project.

Functional Responsibility: The Functional Responsible person is responsible to approve the content of the document and assure its correctness before the document is submitted for authorisation.

Authoriser: The document Authoriser is responsible to ensure that the correct processes were followed in developing this document and that the relevant stakeholders have been involved. The Authoriser also reviews the document for alignment to business strategy, policy, objectives and requirements. He/she shall authorise the release and application of the document.

2.6 PROCESS FOR MONITORING

Not applicable

2.7 RELATED/SUPPORTING DOCUMENTS

Not applicable

3. PRELIMINARY TECHNICAL INFORMATION

3.1 SCOPE OF WORK

The proposed Kiwano BESS and PV facility will comprise:-

- PV installation with envisaged capacity of 58 MW,
- BESS installation with envisaged capacity of 40 MW / 200 MWh
- Kiwano 132 kV substation with 5 feeder bays
- Single Twin-Tern 132 kV overhead line on a double circuit support structure, connecting Kiwano substation to Uppington substation.

The PV facility proposed for Kiwano will include the following associated infrastructure:

- Total site area for PV installation up to 1,150,000 m² (115 hectares) to allow for the construction of a PV facility with capacity of 58 MW.
- Solar PV modules, up to a total of 450,000 m², that convert solar radiation directly into electricity. The solar PV modules will be elevated above the ground, and will be mounted on either fixed tilt

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systems or tracking systems (comprised of galvanised steel and aluminium). The Solar PV modules will be placed in rows in such a way that there is allowance for a perimeter road and security fencing along the site boundary, and access roads in between the PV module rows.

- Inverter stations, each occupying a footprint up to approximately 30 m², with up to 60 Inverter stations installed on the site. Each Inverter station will contain an inverter, step-up transformer, and switchgear. The Inverter stations will be distributed on the site, located alongside its associated Solar PV module arrays. The Inverter station will perform conversion of DC (direct current) to AC (alternating current), and step-up the LV voltage of the inverter to 22 kV, to allow the electricity to be fed into the Kiwano substation. Inverter stations will connect several arrays of Solar PV modules and will be placed along the internal roads for easy accessibility and maintenance.
- Below ground electrical cables with trenching - connecting PV arrays, Inverter stations, O&M buildings, and 132kV Kiwano substation.
- Adequately designed foundations and mounting structures that will support the Solar PV modules and Inverter stations.
- Where possible, existing roads that provide access to the Kiwano site will be used, upgraded, and extended as necessary. For Site A, an access road, approximately 6 m wide and estimated up to 5 km long, will be required to provide access to the PV site. For Site B, a new access road from the existing D3276 road to the site will be required, approximately 6 m wide and estimated up to 1 km long. The existing D3276 road will require upgrading, approximately 6 m wide and estimated up to 4 km long (from N14 to site access road).
- A perimeter road around the site, approximately 5 m wide and 4.5 km in length.
- Internal roads for access to the Inverter stations, approximately 5 m wide and 18 km total length.
- Internal roads/paths between the Solar PV module rows, approximately 2-3 m wide, to allow access to the Solar PV modules for operations and maintenance activities.
- Infrastructure required for the operation and maintenance of the Kiwano PV Plant installation:-
 - Meteorological Station
 - O&M Building – comprising control room, server room, security equipment room, offices, boardroom, kitchen, and ablution facilities (including sewage infrastructure)
 - Spares Warehouse and Workshop
 - Hazardous Chemical Store
 - Security Building
 - Parking areas and roads
- Small diameter water supply pipeline connecting existing municipality pipeline, approximately 5 km long.
- Stormwater channels
- Perimeter fencing of the Kiwano site, with access gates. Detailed requirements will be determined following the security risk assessment.
- Temporary laydown area, occupying a footprint up to 100,000 m² (10 hectares). The laydown area will be used during construction and rehabilitated thereafter. The laydown area will also accommodate water storage tanks or lined ponds (estimated 815 kl/month for the first 3 months and 408 kl/month for the remaining 21 months, until construction is completed).
- Temporary concrete batching plant, occupying a footprint up to 10,000 m² (1 hectare). The concrete batching plant area will be used during construction and rehabilitated thereafter.

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- Temporary site construction office area, occupying a footprint up to 10,000 m² (1 hectare). This area will accommodate the offices for construction contractors during construction and rehabilitated thereafter.

3.2 CONSTRUCTION ACTIVITIES

It is estimated that approximately 150-250 construction workers will be required on the site. Most of the unskilled labour will be sourced from the local towns nearby the site, and will be transported daily to site during construction. During the construction phase of the project the following activities are anticipated:

3.2.1 Site Preparation

Vegetation and topsoil will be cleared for the footprint of the infrastructure as well as for the access roads to the solar PV site, internal roads and the laydown yard, etc. The topsoil removed will need to be stored for rehabilitation purposes of the site.

3.2.2 Transportation of Equipment

All equipment to site will be transported by means of national, provincial and district roads. This includes but is not limited to, transformers, solar PV modules, inverters, excavators, graders, trucks, compacting equipment, construction material, etc.

3.2.3 Site Establishment Works

The site will have temporal laydown areas and offices for the construction contractors. This will include the contractor's chosen electricity supply infrastructure e.g. use of generators and fuel storage that will be required to conform to acceptable measures to ensure no harm to the environment. The laydown area will also be used for assembling of solar PV modules and structures. A concrete batching plant may also be required as part of the site establishment works.

3.2.4 Construction of the Solar PV Facility

Trenches would need to be excavated for underground cabling to connect Solar PV arrays and Inverter stations. Foundations for the solar PV array mounting structures and Inverter stations may need to be excavated, with the final extent depending on the geotechnical studies that will be conducted. The geotechnical studies will determine the type of foundations that can be utilised at the PV site. Construction of access, perimeter, and internal gravel roads may require material to be imported from outside the site, from a permitted quarry.

3.2.5 Water consumption during construction phase

The estimation for the water consumption during construction is based on the following assumptions:-

- Construction period will be 24 months
- 250 workers on site during construction, each consuming 50 litres per day. (It is assumed that portable chemical toilets will be used at the construction site)
- 150 litres per m³ will be required for compaction and dust suppression during construction, for approximately 32,000 m³ of construction material.
- Additional 200 kilolitres of water is used for other general uses such as concrete curing, road maintenance, etc.

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The total estimated water required during the construction phase is estimated as 11,000 kilolitres (total for construction period). It is assumed more water will be required in the beginning of the construction period – 815 kilolitres per month for the first 3 months of construction, and 408 kilolitres per month for remaining construction period.

The Contractor should in any case be made responsible for securing electricity, water, and any other services during construction.

3.2.6 Construction of Electrical Interconnection Line

Construction and installation of underground electrical interconnection cables, connecting the Solar PV facility to the 132 kV Kiwano substation.

3.2.7 Site Rehabilitation

Once all the construction activities are completed the site will be rehabilitated where possible and practical. All temporal structures and facilities will be removed from site and the area rehabilitated.

3.3 SOLAR PV FACILITY OPERATION

The solar PV plant has a minimum design life of 25 years.

During the life of the Solar PV facility, there will be normal maintenance of all electrical and mechanical components of the plant.

In addition, there will be periodic cleaning and washing of the solar PV modules. This PV module cleaning will be performed when required, and it is estimated to occur 2-4 times a year, or when the reference cells show a difference greater than 50 W/m² between the clean and soiled cells.

The estimation for the water consumption during operation is based on the following assumptions:-

- 3 litres of water is required to clean 1 m³ of PV modules during a cleaning event.
- 4 cleaning events will be required per year (this is taken as the worst case).
- 20 full time operational staff on site, each consuming 50 litres per day

The total estimated water required per year during operation is 5,240 kilolitres (total per year for design life of plant).

3.4 PLANT DECOMMISSIONING

The Solar PV plant has a minimum design life of 25 years. The extension of the life of the plant will be considered when assessing the plant's economic viability to remain operational after its end of life. The decommissioning of the plant will have similar activities to those that are performed during construction. The decommissioning activities anticipated once the facility reached its end of life are the following:

- Disassembling of the components of the facility, including but not limited to Solar PV modules, structures, foundations, inverters, cabling, etc.
- Site preparation, removal of all equipment for disposal and re-use.
- Site Rehabilitation to acceptable level as per Environmental Management Plan (EMP) guidelines.

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3.5 SUMMARY OF TECHNICAL INPUT

A summary of the preliminary technical input regarding the PV installation at the Kiwano site is provided in Table 1.

Table 1: Summary of technical input

Components	Description / Dimensions	
Electricity - generated power capacity from PV	58 MW	
Extent of the proposed PV development footprint	Up to 1,150,000 m ² (115 hectares)	
Centre point of proposed site (Hartebesthoek '94/LO21)	Site A:- X= 11580.600 Y= -3157584.282	Site B:- X= 12440.600 Y= -3154234.282
Extent of broader site	See appendix	
Site access	Site A:- A new access road to the site will be required from the N14 (approx. 5 km long) Construction access road from the neighbouring IPP access road to be negotiated.	Site B:- The main access to the site will be from the D3276 road, off the N14 (approx. 4 km along the D3276 road)). An access road from the D3276 road to the PV site will be required (approx. 1 km long).
Proposed technology and height of installed panels from ground level	Fixed-tilt or static PV – fixed mounted PV up to 3.5 m above ground level. Tracking – single or double axis tracking up to 6 m above ground level. (EPC Contractor will perform the detail design and final selection of equipment and structures)	
PV modules	200,000 – 235,000 solar PV modules, with a total PV module area up to 450,000 m ² , and total installed power capacity of 58 MW (EPC Contractor will perform the detail design and final selection of components)	
PV module dimensions (for illustrative purposes)	Length = 1.954 m Width = 0.982 m Area = 1.92 m ² (EPC Contractor will perform the detail design and final selection of the PV modules, which may be of a different size)	
Panel orientation	Fixed-tilt or static PV - 25°-30° north facing slope Tracking – PV module rows will track the sun path from east to west daily	
Number of inverters	58 Inverters (EPC Contractor will perform the detail design and final selection of equipment)	
Associated buildings sizes	Meteorological station – 20 m ² . O&M building – 600 m ² Spares warehouse and workshop – 1000 m ² Hazardous chemical store – 24 m ² Security building – 150 m ² (EPC Contractor will perform the detail design – final buildings and sizes may differ)	

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Components	Description / Dimensions
Roads	Site access road from N14 for Site A, or from D3276 road for Site B – approx. 6 m wide Site perimeter road – approx. 5 m wide and 4.5 km total length Internal roads for access to the Inverter stations – approx. 5 m wide and 18 km total length Internal roads/paths between the Solar PV module rows, approx. 2-3 m wide
Below ground Electrical Interconnection Line(s)	Trenched electrical interconnection line(s), for evacuation of power from the Solar PV facility to the 132 kV Kiwano substation.
Below ground water supply pipeline	Small diameter (50-100NB) water supply pipeline connecting existing municipality pipeline, approximately 5 km long.
Services required	Sewerage and refuse material disposal – all sewerage and refuse material generated during the establishment of the proposed site will be collected by a Contractor to be disposed of at a licensed waste disposal site. Water and electricity – water will be stored in water tanks or supplied by the municipality. The Contractor will provide its own electricity during construction of the plant.

3.6 TECHNICAL SELECTION OF PREFERRED SITE

For the installation of PV, both Site A and Site B, as seen on Appendix A, are considered technically feasible. In subsequent project discussions, Eskom Distribution indicated preference for Site B due to the following reasons:

- The Site B location enables expandability in the area, allowing easier electrical connection of future projects via the Kiwano substation.

Hence Site B is the technically preferred site, while Site A can be considered as an alternative for the development of the solar PV plant.

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4. AUTHORISATION

This document has been seen and accepted by:

Name & Surname	Designation
Mbali Mtshali	Asset Management Renewables
Viren Heera	Asset Management Renewables
Miranda Skaka	Asset Management Renewables
Gary de Klerk	Senior Manager Asset Management Mechanical
Prof Saneshan Govender	General Manager Master Specialist
Yugandra Naidoo	Asset Management Renewables
Thomas Conradie	General Manager Generation Engineering

5. REVISIONS

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August 2021	0.1	Oelof de Meyer	First draft for Comments Review Process
October 2021	0.2	Oelof de Meyer	Comments incorporated after Review Process
October 2021	1	Oelof de Meyer	Final Document for Authorisation and Publication

6. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- Miranda Skaka
- Mbali Mtshali
- Viren Heera

7. ACKNOWLEDGEMENTS

- Waleed Moses

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APPENDIX A: PRELIMINARY LAYOUT DRAWINGS

See attached appendices for the following documents separate to this document

- Appendix A1 : Site A - Kiwano Site Layout Drawing
- Appendix A2 : Site B - Kiwano Site Layout Drawing
- Appendix A3 : Kiwano Station Layout Drawing – fixed tilt
- Appendix A4 : Kiwano Station Layout Drawing – 1 axis tracking 2p

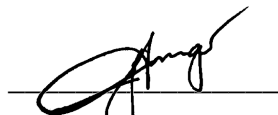
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APPENDIX B-2 : KIWANO BESS PLANNING PROPOSAL

		
Distributed Battery Energy Storage Systems (BESS)		
Author(s)	Robin Buske Monde Soni	
Reviewer(s)	Kurt Dedekind (Middle Manager – Planning CoE) Muzafar Ebrahim (Senior Engineer – Network Planning) Siju Joseph (Middle Manager – Ancillary Services) Marathon Ntusi (Chief Engineer – System Operator) Musa Gumede (Chief Engineer – System Operator) Lumsa Trevor Mkhize (Senior Engineer – Engineering) Thomas Jacobs (Chief Engineer – Engineering) Alkesh Ramprotal (Middle Manager – Engineering) Subhas Maharaj (Middle Manager – PDE) Preshaan Jaglal (Engineer – Planning CoE)	
Date	19 August 2020	

Approved by:



Mfundu Songo

Senior Manager

Planning & GIS CoE

Date: 25August2020

<p style="text-align: center;">BESS PHASE 2</p> <p style="text-align: center;">DISTRIBUTION PLANNING PROPOSAL</p> <p style="text-align: center;">KIWANO SUBSTATION</p> <p style="text-align: center;">NORTHERN CAPE OPERATING UNIT</p>
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GLOSSARY OF TERMS

Terms	Definition
HV	High Voltage
IC	Installed Capacity
kV	Kilovolt
kW	Kilowatt
NCOU	Northern Cape Operating Unit
MVA	Mega Volt Ampere
MVAr	Mega Volt Ampere Reactive
MW	Megawatt
MWh	Megawatt hour

1 INTRODUCTION

As part of Eskom's commitment to implement clean energy projects, Battery Energy Storage System ("BESS") projects totalling approximately 1440 MWh are to be installed at various locations across the country. The project is expected to be executed in two phases namely:

Phase 1 – Installation of around 800 MWh of distributed BESS which is to be implemented during 2021 at Eskom Distribution sites; and

Phase 2 - Installation of around 640 MWh BESS which is to be implemented during 2022 at locations closer to the renewable power plant sites.

The operating units conducted preliminary studies to assess the suitability of selected sites for the Phases 1 and 2 installation of BESS on their electrical grids in the KwaZulu Natal, Eastern, Western and Northern Cape Operating Units and to obtain an indication of the specifications for the proposed BESS at the sites. This report aims to assess the integration requirements of a battery energy storage system (40 MW / 200 MWh) and Solar PV plant (58 MW) at Upington MTS. This project is part of Phase 2 and the planned commissioning date for the scheme is end 2022.

It is important to note that this report serves to provide the technical inputs for the Distribution integration needed to facilitate this BESS and PV connection in the network.

2 METHODOLOGY

The overall objective of the technical study was to determine the integration location of the BESS and PV, and the indicative key BESS and PV parameters based on the network analysis. The key parameters that are to be determined are the indicative PV MW output, BESS MW/MWh and duty cycles based on the BESS primary application identified and on the constraints imposed by the network.

The methodology employed for the technical study is depicted in Figure 1 below. Steps 2-5 are done for both the base year and the future forecasted years (only from a load/generation growth perspective).

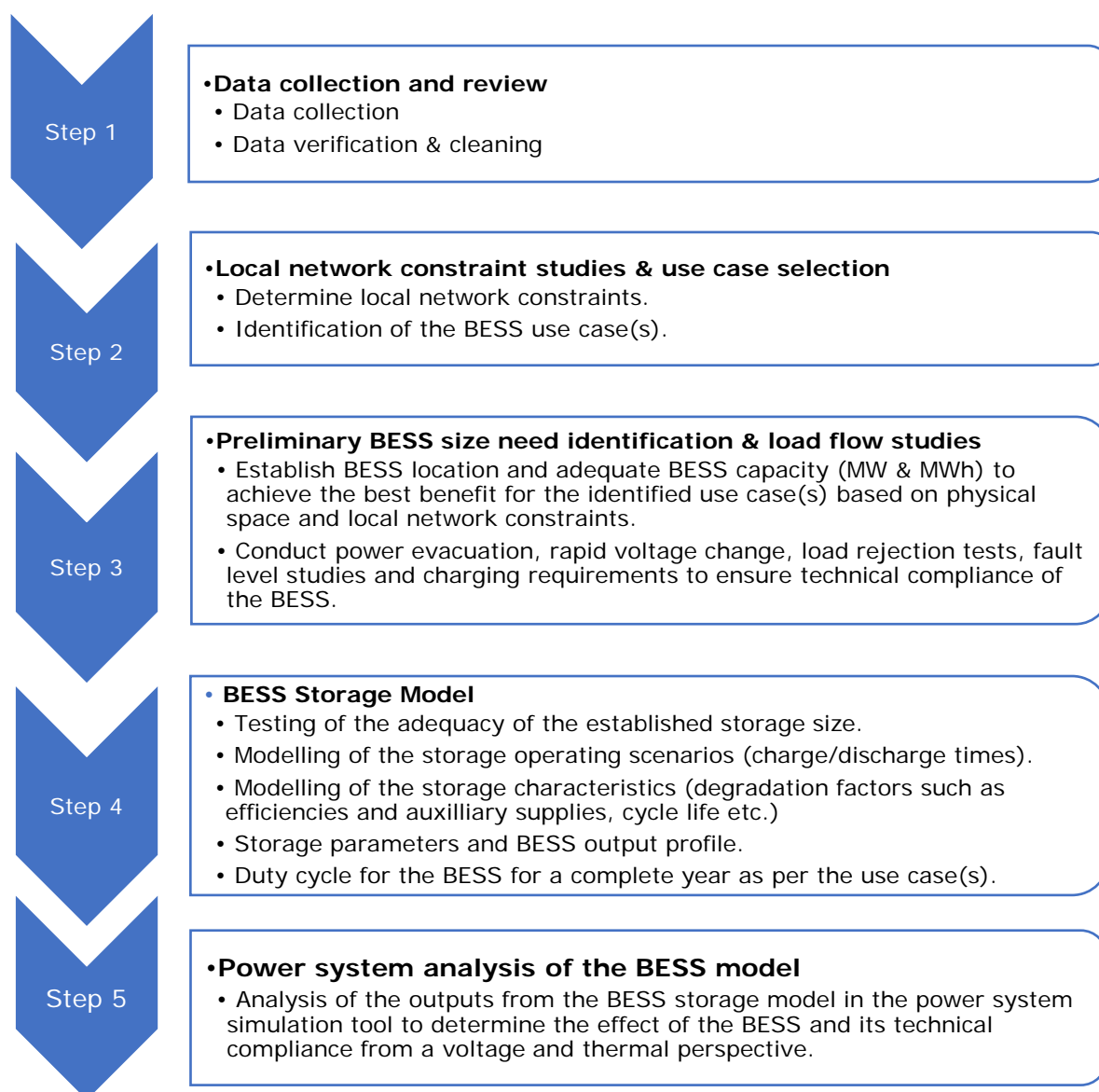


Figure 1 Summary of the Methodology Employed

3 KEY ASSUMPTIONS

The list of information and data requirements for the integration of Kiwano PV Plant and Battery Energy Storage System (BESS):

- Plant size allocation according to the World Bank BESS programme (40MW BESS and 58MW PV)
- Inputs from the Transmission Assumptions Paper
- Distribution Power Factory Case File for Distribution Assessment

3.1 Study Horizon

Kiwano Substation will be a green-field project. Based on the network, it will inject directly via a Distribution substation and line into Upington MTS without connection to any existing load networks. A study horizon of 10 years into the future will be assumed.

3.2 Network Modelling

The Distribution Power Factory software will be used to select the appropriate line type in order to integrate this facility into the Upington network. The Transmission network equivalent model will be used to model Transmission network.

3.2.1 Technical Criteria

The technical criteria that will be applied to the BESS and PV studies are, unless otherwise stated, based on the South African Distribution Code (ver 6.0) and Grid Connection Code for Battery Energy Storage Facilities (BESF) connected to The Electricity Transmission System (TS) or The Distribution System (DS) in South Africa (Draft 5.1) [1].

3.2.2 Voltage Limits

The voltage limits to be adhered to, are shown in **Table 1** below.

Table 1 System Voltage Limits

Network Condition	Voltage range
HV system healthy: No HV customer / or +/- 7.5% customer agreements	0.925 – 1.06 pu
MV system healthy:	0.95 – 1.05
Load rejection before corrective actions:	0.90 – 1.1 pu

3.2.3 Line Thermal Limits

The thermal ratings to be adhered to for lines are shown in **Table 2** below.

Table 2 Line Thermal Limits

Network Condition	Thermal rating limit
System healthy:	Less than 100% of Rate A (Normal Rating)

3.2.4 Transformer Thermal Limits

The transformer thermal limits to be adhered to are shown in **Table 3**.

Table 3 Transformer Thermal Limits

Network Condition	Thermal rating limit
System healthy	Thermal rating of transformers (i.e. the 100% rating)

3.2.5 Rapid Voltage Change Limit

A rapid voltage change (RVC) limit of 5% for the BESS and 3% for the PV plant will be applied. The RVC studies emulate the unplanned switching events for these plants. The RVC tests shall be assessed at the BESS and PV Points of Connection (POC) and Points of Common Coupling (PCC) separately, and will be applicable for events leading to the complete disconnection of these plants during their operation.

The operating power factor of BESS prior to the switching event will be assumed to be 0.95 (BESS Category C) for both leading and lagging conditions as per [2].

The PV plant will be run at unity power factor for RVC studies as per the Planning Standard for Renewable Integration.

3.2.6 Fault Current Contribution

A fault current contribution of 1.1p.u for BESS and PV as per [3] will be utilized.

3.3 Energy Storage Model

3.3.1 BESS Charging

The BESS charges at the maximum rate allowed by the BESS technical constraints and the network constraints. Specifically, it is limited by the following factors:

- Rated BESS power (inverter capacity)
- BESS auxiliary load
- State of charge of the BESS
- Capacity on the local network

3.3.1.1 BESS Charging Power

The BESS is assumed to have auxiliary load which is to be used for housekeeping of the BESS facility. To ensure that the BESS delivers the required 40MW at the POC, the BESS will be allowed to charge at a higher rate in compensation for its auxiliaries. The actual charging rate will be determined by the BESS auxiliary load according to Eq. 1 below.

$$P_{Charge} = P_{BESS} + P_{Aux} \quad \text{Eq. 1}$$

Where: P_{Charge} is the charging power of the BESS. P_{BESS} is the rated BESS power output. P_{Aux} is the power due to auxiliary load of the BESS facility.

The charging power will be limited by the capacity of the 2x40MVA 132/22kV transformation at Kiwano Substation. Thus the maximum charging rate of 80MW may not be exceeded.

3.3.1.2 BESS Charging Time & Duration

Generally, the BESS is expected to charge during low load period which is 23h00 to 4h59 daily, in line with the national low load conditions. It must be noted that the BESS must also be capable of charging outside the stated period when required by the System

Operator.

To cater for the BESS round trip efficiency (RTE), the storage will be allowed to charge for durations longer than 5 hours to ensure that the required and contracted power and energy output of 40MW/200MWh is available at the POC.

Eq. 2 shows the relationship between the BESS RTE, input (charging) energy and output (discharging) energy.

$$\eta = \frac{\text{Output}}{\text{Input}} \quad \text{Eq. 2}$$

$$\text{Input} = \frac{\text{Output}}{\eta}$$

$$P_{\text{charge}} t_{\text{charge}} = \frac{P_{\text{BESS}} t_{4\text{hour}}}{\eta} \quad \text{Eq. 3}$$

Where: η is the BESS facility round trip efficiency. "Output" and "Input" are the BESS output energy (200MWh in this case) and BESS input/charging energy respectively. t_{charge} is the BESS charging time duration.

The actual charge duration will be determined by the round trip efficiency of the BESS in line with the general equation (Eq. 3) above.

3.3.2 BESS Discharging

From the network capacity perspective, the assessments will be done such that the BESS is capable of discharging at any given time of the day via the Distribution network when dispatched to do so. The required BESS discharge capacity is 40MW/200MWh for the Kiwano BESS.

3.3.3 BESS Cycle life

This Planning study assumes that the manufacturer will maintain the BESS such that the required output of 40MW/200MWh is maintained at the POC for the contracted lifecycle period of 20 years. Thus, the manufacture is expected to do the relevant maintenance and regular replacement of cells to maintain the required output. As such, this requirement must be stated on the OEM contract.

3.3.4 PV

The Kiwano PV component will evacuate 58MW into the Distribution network. 58MW may be injected on the grid independent of the BESS state of operation. As such, the PV is not regarded as a sole source of energy for the BESS plant.

Similar to the BESS, the PV cells' degradation risk will not be considered by Eskom, the OEM will be required to do the necessary maintenance and replacements to ensure that the contracted output of 58MW is injected by this plant.

4 OVERVIEW OF THE KIWANO SUBSTATION NETWORK

Upington MTS is located within the Northern Cape Operating Unit (NCOU). It is currently equipped with a 1 x 500MVA 400/132kV transformer. Upington MTS is currently fed via 400kV line from Nieuwehoop MTS. 400kV corridor in this region is interconnected between Aries, Nieuwehoop and Ferrum 400kV MTS. The proposal to connect this Battery Energy Storage System and PV Plant will be at Upington MTS via a Distribution integration network. This integration will take the form of a 132kV line connecting to a new 132kV substation called Kiwano Substation. Kiwano will serve as the connection point for the 40MW/200MWh BESS and 58MW PV installation. Figure 2 below depicts the proposed network connection.

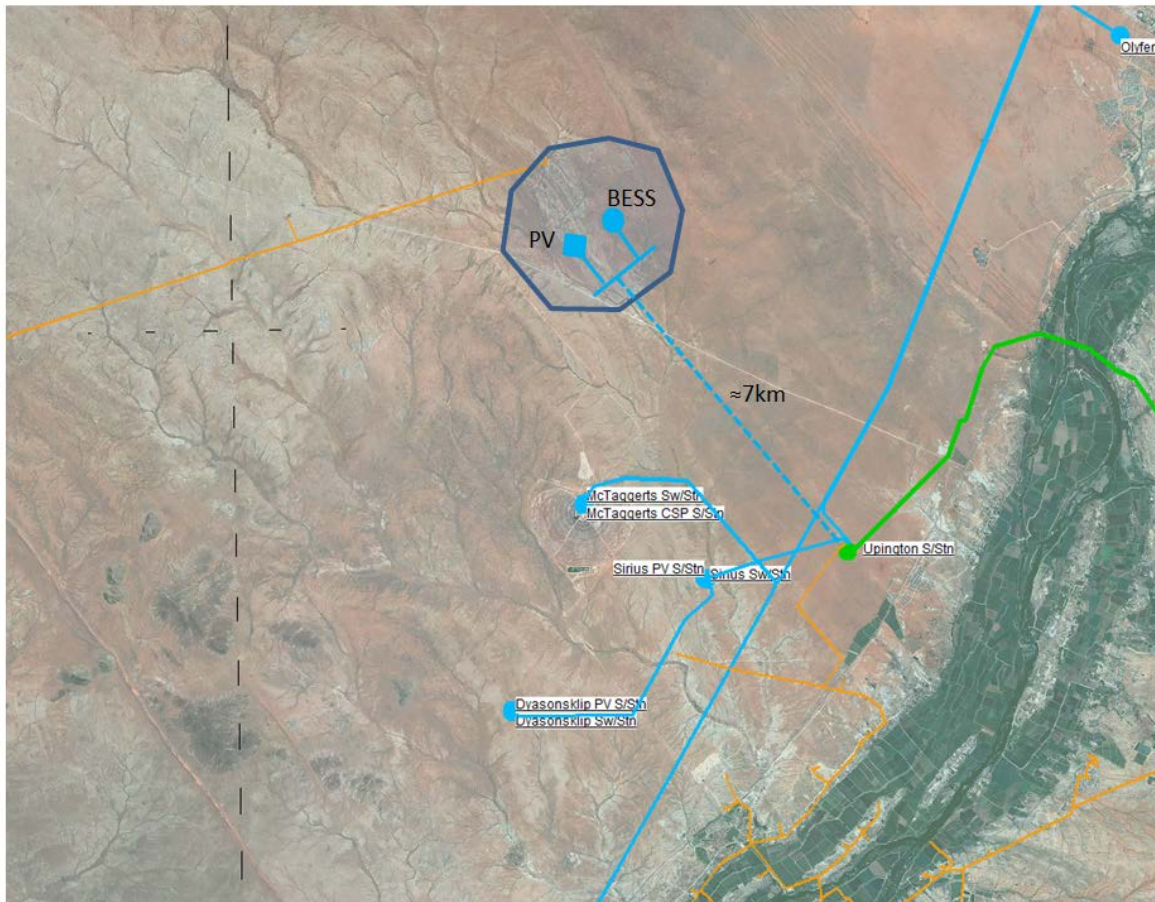


Figure 2 Kiwano Dx/Tx Integration High Level Proposal

5 REIPP OUTLOOK

The Upington area is renowned for its attraction of renewable energy developments. Solar technology has become prevalent in this area with preferred bidders awarded during the last five REIPP DoE programmes. Table 4 below provides an indication of the committed and interested projects in the area. The interested projects are indicated in relation to a known substation name quoted or the closest existing Distribution substation. It is important to note that with the exception of the 2200MW Upington Solar Park, all the interested projects have enquired or applied with the expectation of exportation facilitated through existing integration or new infrastructure into Upington MTS.

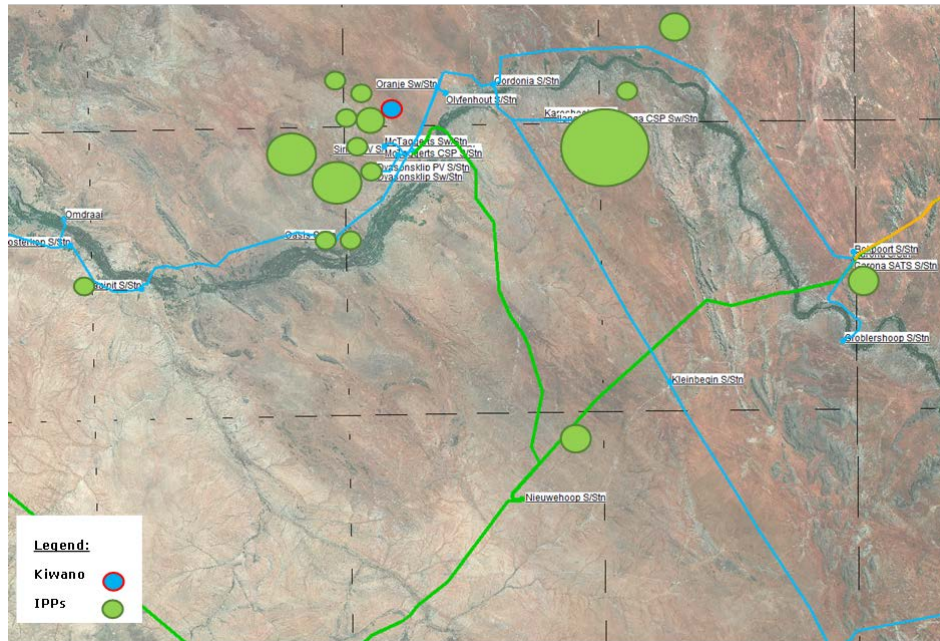
From Table 4 it is noted that there are 405MW of approved projects at Upington MTS. The two 5MW projects were awarded by the DoE in the Small IPP 1-5MW Bid Window but these projects are not yet in execution due to outstanding licensing and contracting issues. They are awarded preferred bidder status but in the last 4 years, no progress has been made on their connection.

Further to this, between the DoE's Round 4B submission until 2020, Distribution Network Planning has received applications and queries in the order of 4925MW already. This list is not exhaustive and there are many additional applications and solar projects under investigation and development. This is purely an indication of the renewable interest in the area which accompanied the motivation and development of Upington MTS and the design plan of a station in the order of 5 x 500MVA 400/132kV transformers.

Table 4 Approved and Interested Renewable Projects in Upington

Name	Technology	Size [MW]	Status	Substation
Gordonia Solar PV	PV	10	Connected	Gordonia
Khi Solar	CSP	50	Connected	McTaggerts
Ilanga CSP	CSP	100	Connected	Ilanga
Neusberg Hydro	HYDRO	10	Connected	Taaipit
Keren Kakamas	PV	5	Preferred Bidder	Taaipit
Keren Keimoes	PV	5	Preferred Bidder	Oasis
Dyasonsklip 1	PV	75	Connected	Dyasonsklip
Dyasonsklip 2	PV	75	Connected	Dyasonsklip
Sirius PV 1	PV	75	Connected	Sirius
Subtotal		405		
Klip Punt Cluster	PV	400	Interested	Klipunt
Bloemsmond Cluster	PV	500	Interested	Bloemsmond
Geelkop Cluster	PV	500	Interested	Geelkop
Ilanga CSP 2	CSP	200	Interested	Ilanga
Upington Solar Park	CSP	2 200	Interested	New MTS
Sirius PV Phase 2	PV	150	Interested	Sirius
Dyasonsklip 3	PV	75	Interested	Dyasonsklip
Eenduin Solar	PV	75	Interested	Oasis
Rooipunt	CSP	150	Interested	McTaggerts
Solis Power Cluster	CSP	300	Interested	McTaggerts
Khunab	CSP	150	Interested	McTaggerts
Kai Garib Solar	CSP	150	Interested	McTaggerts
Blucoso Solar	PV	75	Interested	Oasis
Subtotal (Interested)		4 925		
Total Outlook		5 330		

Figure 3 provides a spatial view of the areas of interest in Upington for renewable development. There is a large interest in development within a 10-15km radius of Upington MTS.



Renewable Energy forecast for Uppington MTS as provided by Transmission Grid Planning is shown in Figure 4:

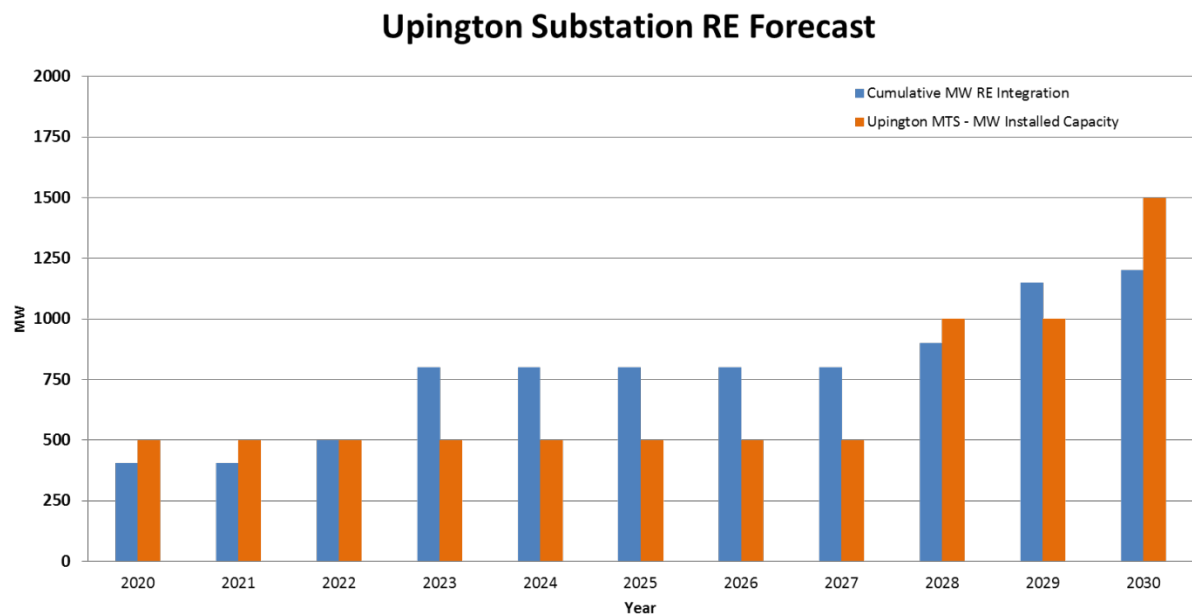


Figure 4 Upington MTS Renewable Forecast

Table 5: Upington strengthening development plan

TDP Scheme	Project Name	Required CO Year
Upington Strengthening (IPP)	Ferrum – Upington 1 st 400 kV line	2026
	Aries – Upington 1 st 400kV line	2026
	Upington 2 nd 500 MVA 400/132 kV transformer	2028
	Upington 3 rd 500 MVA 400/132 kV transformer	2030
	Upington 4 th 500 MVA 400/132 kV transformer	2033
	Aries – Upington 2 nd 400 kV line	2035

The strengthening plan for Upington MTS presented in **Table 5** is indicative in terms of the required commissioning dates. Transmission Grid Planning indicated that these dates will need to be revised to cater for the IPP forecast presented in Figure 4 above.

Figure 5 below shows the latest data retrieved from the Distribution 132kV networks with diversity applied. The graph accounts for all the existing (commissioned) IPP's that are integrated at Upington MTS. The installed capacity is shown with the Power Factor of 0.95 limits shown as well. This graph also shows the import and export of real power at Upington 400/132kV 1x500MVA due to amount of generation connected. Even though there is 395MW of approved and commissioned plants already in service, Upington has good diversity factors between the load and generation.

With regards to generation, between the connected PV, CSP and Hydro plants, the diversity noted is occasionally just slightly less than 85% at worst case on the 400/132kV 1x500MVA transformer.

At times, Upington MTS can be seen to import up to 100MW due to loading interconnection and can export up to 330MW due to excess generation.

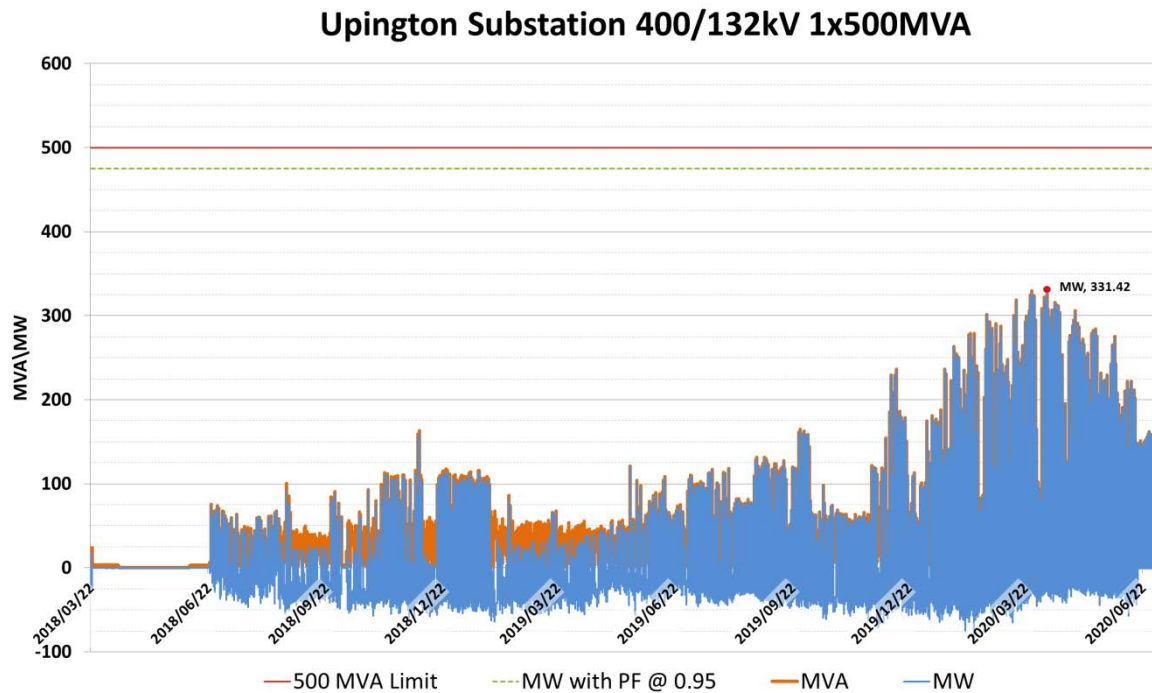


Figure 5 Uppington MTS Transformer Profile

The graph in Figure 5 above indicates that the summation of exported generation from the 132kV network into the 400kV side of Uppington MTS reached a peak of 330MW which occurred in March and April of year 2020. This data accounts for all the connected IPPs on this network.

If the diversity is ignored and the contracted capacities of the existing IPP's are used, the maximum loading (due to generation) at Uppington 500MVA 400/132kV substation is calculated to be 395MW. This shows that the worst case spare capacity at Uppington MTS is 105MW and that is sufficient to accommodate the proposed BESS and PV at Kiwano, noting that their combined output is 98MW.

6 TECHNICAL BESS SPECIFICATION ANALYSIS

This section presents the technical BESS specification analysis based on the methodology described in section 2 of this report. This section will consider points pertinent to Steps 1 to 5 in terms of sizing the Distribution infrastructure in order to connect the BESS and PV generation at Kiwano Substation and to ensure it can fully evacuate the generation to Upington Substation

6.1 Identification of Local Network Constraints & BESS Use Case

6.1.1 Local Network Constraints

Kiwano Substation will be a dedicated substation to integrate the proposed BESS and PV projects into the network. There are currently no known local constraints that would prevent Kiwano BESS and PV from being able to export the 40MW BESS and 58MW PV that will be at the Kiwano site.

As stated, the proposed BESS and PV will be integrated at Upington MTS on the 132kV side. The existing worst case spare capacity at Upington MTS is 105MW. The proposed BESS and PV have a total output of 98MW and thus will not lead to network operating limits' contravention.

6.1.1.1 Kiwano Load Profiles

There will be no Distribution load connected to Kiwano Substation. The substation's purpose is to connect the proposed 40MW/200MWh BESS installation and 58MW of PV generation.

6.1.1.2 Kiwano Forecasts

Kiwano substation MW/MVA forecast is shown Figure 6 below.

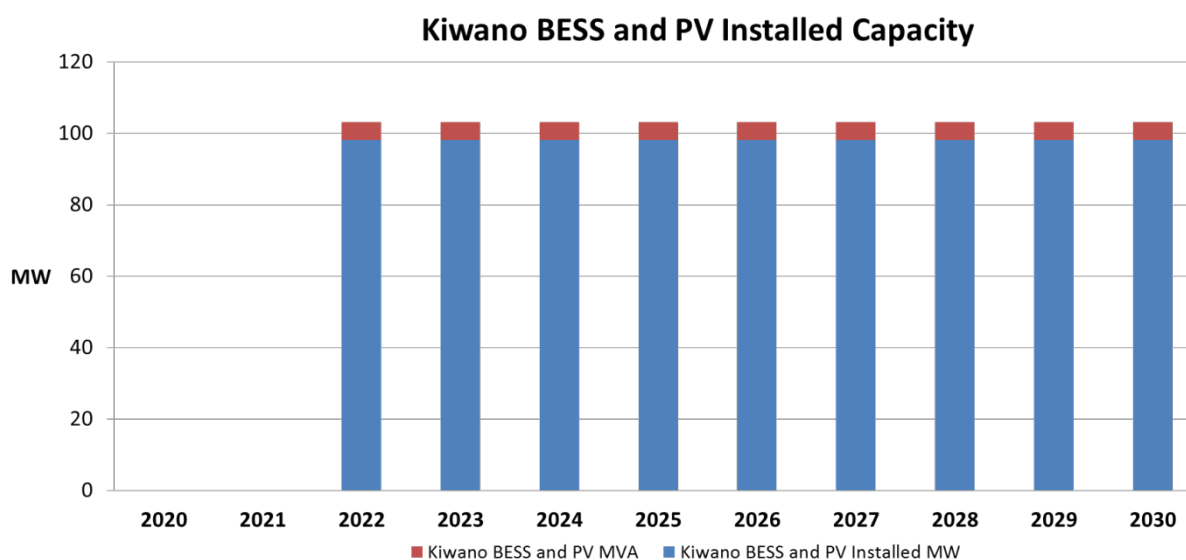


Figure 6 Kiwano Installed Capacity Forecast

6.1.2 BESS Use case

The use cases for Kiwano BESS are **ancillary services support and energy support**. The custodian of ancillary services and energy support service is the System Operator.

Generally, the BESS will be expected to charge during the low load period at night (23h00 to 4h59) and be available to provide ancillary and energy services during the day (5h00 to 22h59). Also, the dispatch instructions from the System Operator will take precedence on the operation of the BESS as per the ancillary services and energy requirements discussed in sections below.

The BESS is required to have flexibility for the System Operator to dispatch it for ancillary services and energy as and when required, for the good of the grid.

6.1.2.1 Energy Support Requirements

The BESS shall have capability to be operated to provide capacity to meet the energy demand on the grid. On a daily basis, the expected hourly availability of the BESS capacity shall be submitted to the System Operator by the BESS Owner. During the hours that BESS is contracted for energy, its capacity shall be made available for supplying energy to the grid. Scheduling and dispatch of BESS capacity to supply energy will be done as per Scheduling and Dispatch Rules [4].

6.1.2.2 Ancillary Services Support Requirements

The System Operator requires the following reserves for ancillary services from the Kiwano BESS, see **Table 6** below.

Table 6: System Operator ancillary services requirements for BESS

Reserve type	% MW Available capacity	Maximum response time (Full activation)	Maximum required duration to maintain response	Notification time	Typical dispatches
Instantaneous	+/-100%	400 milliseconds	10 minutes	Automatic	2/day
Regulating	+/-100%	4 seconds	1 hour	Automatic	300/hour
Ten minute	+/-100%	1 minute	2 hours	1 minute	2/day
Supplemental	+/-100%	1 minute	2 hours	10 minutes	1/day

The proposed Kiwano BESS size is 40MW/200MWh. Thus, this BESS capacity must be available to provide the required services on the System Operator's scheduling instruction.

The BESS Owner will be informed by the System Operator as and when the BESS will be required to deliver ancillary services listed below. It is noted that the BESS will provide such ancillary services subject to its state of charge (SOC).

The dispatch signal and decision is the function of the System Operator; the BESS must be prepared to provide the services when signalled to do so by the System Operator. Thus the BESS must comply with the Scheduling and Dispatch Rules [4] in this regard.

A brief description of each reserve type from **Table 6** is discussed below.

6.1.2.2.1 Instantaneous Reserve

Generation capacity or demand side managed load that is available to automatically respond fully within 400 milliseconds to a change in frequency at the POC. This response must be sustained for at least 10 minutes.

6.1.2.2.2 Regulating Reserve

The provision of generation capacity or demand side load response capability, including capacity, energy and manoeuvrability, that responds to automatic control signals issued by the System Operator in order to recover the frequency to nominal.

6.1.2.2.3 Ten-minute Reserve

Generating capacity (synchronised or not) or demand side managed load that can respond within 1 minute when called upon. The purpose of this reserve is to restore instantaneous reserves and regulation reserves to the required levels after an incident.

6.1.2.2.4 Supplemental Reserve

Generating capacity or demand side managed load that can respond within 1 minute to restore the other reserves.

6.1.3 PV Plant

The proposed 58MW PV plant will contribute its output to the grid. The BESS will have capability to charge from proposed PV as well as from the grid. The dispatching of the BESS will be under the custodianship of the System Operator.

The PV plant will integrate at Kiwano 132kV substation together with the BESS.

To simulate the operation of PV in relation to the BESS, several scenarios were investigated and they are presented in the section below.

6.1.4 PV-BESS Scenarios Investigated

The following scenarios were considered by Distribution in order to determine the selected network size. **Table 7** below depicts the scenarios considered during the study.

Table 7 Scenarios for PV-BESS operation

Scenario	BESS Mode of Operation (40MW/200MWh)	PV Plant (58MW)	Total Output
Scenario 1	• Charging ¹ (~40MW)	• Injecting (58MW)	• 18MW (export)
Scenario 2	• Discharging (40MW)	• Injecting (58MW)	• 98MW (export)
Scenario 3	• Charging (~40MW)	• Idle (0MW)	• ~40MW (import)
Scenario 4	• Discharging (40MW)	• Idle (0MW)	• 40MW (export)
Scenario 5	• Idle (0MW)	• Injecting (58MW)	• 58MW (export)
Scenario 6	• Idle (0MW)	• Idle (0MW)	• 0MW

Based on the above, Scenario 2 and 3 are the extreme cases for the installation at Kiwano Substation. Under Scenario 2, the BESS system will be discharging and the PV will be generating, which will be the largest amount of power that will be evacuated from the site into the network. Under Scenario 3, the BESS system will be seen as a load and will be charging at its capacity (>40MW) from the grid in the event that the PV plant is generating at 0MW or offline. The BESS charging power may not exceed the network capacity, which are the transformers connecting the BESS to the grid – the proposed size of the integration transformers is shown under the proposed scope of work.

In order to provide the correct sizing, Scenario 2 will be used to size the 132kV line and associated Transformer sizes of Kiwano Substation.

¹ The actual charging rate for the BESS will be determined by its auxiliary load requirements. Thus, the charging power will be greater than the discharging power.

6.2 Kiwano BESS and PV Scope of Work

The following proposal facilitates the BESS and PV Plant connection to Upington MTS.

6.2.1 Feeder Bay at Upington MTS

Use the existing 132kV feeder bay at Upington MTS for the Upington/Kiwano 132kV line connection.

6.2.2 Upington/Kiwano 132kV Line Selection

Build a 132kV line using Twin Tern conductor from Upington MTS to Kiwano Substation site. This line is rated at 408MVA at 70°C templating.

It is known through the received enquiries that there is future IPP interest in this area as future REIPP projects to the West and North of the Kiwano site have been shown under the IPP future outlook. This line will be utilised in future to facilitate additional generation connections in the area and Kiwano substation will be a **collector** substation. This will assist in avoiding having many lines that are accessing Upington MTS which could lead to physical space constraints in future. Moreover, Upington/Kiwano 132kV line will accommodate future Kiwano BESS expansions as discussed in 6.2.7.

As such, a **132kV double circuit structure design** with the provision of stringing only one circuit for the commissioning of Kiwano BESS and PV is proposed. The 2nd circuit is to be strung in future when the demand for more capacity at Kiwano materialises. This demand will be dictated by future IPP bids and the future BESS expansions.

6.2.3 Kiwano 132kV Substation

It is proposed to build a 132kV substation called Kiwano at the original 'Kiwano CSP site' with the following configuration:

- 132kV Double Bus-Bar
- 132kV Bus-Coupler
- 132kV incomer feeder bay
- Establish 2x132kV feeder bays for the BESS connection
- Establish additional 2x132kV feeder bays for the PV integration
- Spatial provision for a minimum of additional 4x132kV feeder bays for future use

6.2.4 BESS plant scope

- Create 2 x 40MVA 132/22kV transformers with associated 22kV switchgear and control plant, and connect at Kiwano 132kV busbar
- Establish the BESS POC on the 132kV between the BESS plant and Kiwano 132kV busbar
- Build the BESS plant with an output rating of 40MW/200MWh

6.2.5 PV Plant Scope

- Create 2 x 40MVA 132/22kV transformers with associated 22kV switchgear and control plant
- Build the PV plant with the output rating of 58MW
- Establish the PV plant POC on the 132kV between the PV plant and Kiwano 132kV busbar
- Separate statistical metering points to be commissioned for the BESS plant and the PV plant
- The BESS and PV plant are to be positioned and configured in isolation of each other in terms of connections and dependency

Note: The MV/LV transformation and LV equipment for BESS and PV must be designed by the EPC Contractor according to Eskom specifications.

6.2.6 Summary of the Scope of Works

The Kiwano Project is located within a strategic area in Upington. The scope recommended provides the capability to expand this site for future use, not only within the Kiwano Site, but within the surrounding area. The 132kV busbar and 132kV line will be designed and sized accordingly to be able to cater for future expansions.

It is envisaged that the BESS and PV infrastructure will be managed and controlled independently of each other. At this preliminary proposal stage, it has been proposed to implement infrastructure which separates the operations of the two plants up to the 132kV POC level only.

6.2.7 Future Scenario Considerations

Noting that the proposed Kiwano substation is located on the REDZ zone that boasts high interest for future renewables as shown under the REIPP Outlook section, three future scenarios for BESS development were studied. These scenarios are discussed in the subsections below. For all the studied scenarios, the space availability for future BESS will not be a constraint as the site was acquired for the CSP initially. Thus, these scenarios are mainly studied to determine the network evacuation capacity (MW) at Kiwano and Upington MTSs.

Also, it is worth noting that the South African Integrated Resource Plan (IRP) 2019 has shown a need for energy storage going to the future. As such, 513MW of energy storage is required by 2022 and the additional 1 575MW is required by 2029. The scenarios studied below show the additional BESS capacity that can be hosted at Kiwano site without additional distribution strengthening. It is proposed that Kiwano site be earmarked as a strategic site for future BESS that is required by the IRP 2019.

Scenario 1: Base case scenario

The base scenario takes into consideration the following assumptions:

- The existing Upington MTS capacity of 500MVA
- Existing IPP's with contracted capacity of 395MW (undiversified)
- Upington/Kiwano 132kV line capacity of 408MVA (Twin Tern line)

The available generation spare capacity at Upington MTS is 105MW. Therefore, there is sufficient capacity to cater for the proposed PV of 58MW and BESS of 40MW/200MWh under this scenario.

Scenario 2: Upington MTS capacity upgraded to 1000MVA

This scenario assumes that the second 500MVA transformer is installed at Upington MTS as per the TDP plan, leading to the substation capacity of 1000MVA capacity. In addition, the following assumptions are made:

- A total of 800MW IPP's (undiversified) is integrated at this substation as per the Tx IPP forecast
- Upington/Kiwano 132kV line capacity remains at 408MVA

Based on this scenario, an additional 200MW/800MWh BESS can be integrated at Upington MTS via the proposed Kiwano 132kV substation, in addition to the base case scenario. This means that a total of 240MW/960MWh BESS can be integrated without additional upgrade on the Distribution network.

Scenario 3: Upington MTS capacity upgraded to 1500MVA

The Upington IPP outlook showed a possible further increase in REIPP generation in this area. This scenario is based on the following assumptions:

- Upington MTS capacity upgraded to a sum of 3x500MVA 400/132kV
- The forecast IPP total generation of 1200MW (undiversified) – as the Tx IPP forecast
- Upington/Kiwano 132kV line capacity remains at 408MVA

This scenario will lead to an additional spare capacity (relative to the base scenario) of 300MW available for BESS without requiring any Distribution strengthening. However, the Upington/Kiwano 132kV lines will be approaching their rated capacity as the total generation will be 398MW when the Kiwano BESS and PV are injecting at their capacity.

It must be noted that the total BESS capacity that can be accommodated at Kiwano and Upington MTSs under scenario 3 will be 340MW/1 360MWh. This gives the BESS an extra 68MW that can be used for its auxiliary load when it is charging.

Summary of Kiwano BESS development plan

Figure 7 presents the studied scenarios in onion-layer format. Kiwano substation is situated in the REDZ zone and it makes a perfect strategic location for future BESS developments. As it can be seen on the visual, under the future scenario 3, a total energy storage capacity of 340MW/1 360MWh can be deployed at the proposed Kiwano substation without any additional network capacity upgrade on the Distribution network.

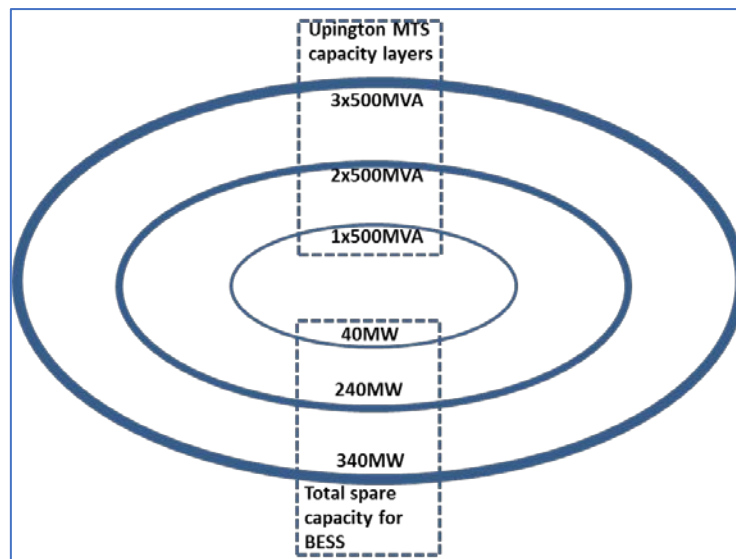


Figure 7: Future scenarios for Upington MTS depicting the substation capacity and spare capacity for possible future BESS developments – visualised in onion layers.

It is further proposed that adequate space be allowed at Kiwano substation to accommodate additional 132kV line bays for future developments, should a need arise.

6.3 Power System Analysis of BESS Model

The 132kV busbar at Upington MTS was set to 105% with a bandwidth of $\pm 1\%$.

For the Distribution assessment, the BESS was set to discharge and charge at a power factor of 0.95 lead/lag and 1.0.

The PV plant was set to Power Factor control mode on PowerFactory and run at a Power Factor of 0.95 lead/lag.

6.3.1 Power System Analysis of the Use Case Scenarios

The Scenarios in Section 6.1.4 were tested to ensure the Distribution network will be

adequately sized to operate correctly. The results are shown in the Table 8 below.

Table 8 Analysis of Scenarios by Distribution

Busbar	Voltage p.u.	BESS (MW)	Bess Mode	PV (MW)	PV Mode
Scenario 1					
Upington 132kV	104.7	40	Charging	58	Generating
Kiwano 132kV	104.3				
Scenario 2					
Upington 132kV	104.3	40	Discharging	58	Generating
Kiwano 132kV	104.1				
Scenario 3					
Upington 132kV	105.6	40	Charging	0	Idle
Kiwano 132kV	105.4				
Scenario 4					
Upington 132kV	105.4	40	Discharging	0	Idle
Kiwano 132kV	105.3				
Scenario 5					
Upington 132kV	105.0	0	Idle	58	Generating
Kiwano 132kV	104.9				
Scenario 6					
Upington 132kV	105.3	0	Idle	0	Idle
Kiwano 132kV	105.3				

Scenario 2 represents the worst case scenario for thermal and voltage variation response and is studied in more detail. During this scenario, both the Battery Energy Storage System and PV Plant would be exporting maximum active power at 40MW and 58MW respectively. In order to simulate the voltage impact under worse case, the Power Factor of the BESS and PV plants are both set to 0.95 p.u. lagging.

6.3.1.1 Transformer Thermal Loading

Figure 8 show highest 24 hour profile for Upington MTS based on the data shown in Figure 5. The Scenarios 2 and 3 were then applied to determine the impact on the transformer thermal loading running the plants at a Power Factor of 0.95 p.u.

Transformer Loading at Upington MTS:

During Scenario 2, Upington MTS will experience higher loading during the day as a result of additional PV generation and the BESS discharging. The loading on the Upington MTS 1x500MVA 400/132kV transformer will increase to 429MVA resulting in 85% loading.

During Scenario 3, with the BESS charging it will increase the loading on the transformer during the evening periods but offset some of the excess generation during the day thus reducing the midday loading.

It is noted that these two scenarios, based on measured the data, represent the worst case boundaries and there are no violations on the network operating limits.

Transformer Loading at Kiwano Substation:

The transformers at the BESS plant will be loaded to 50.3% of installed capacity. The transformers at the PV Plant will be loaded to 77.3% of installed capacity.

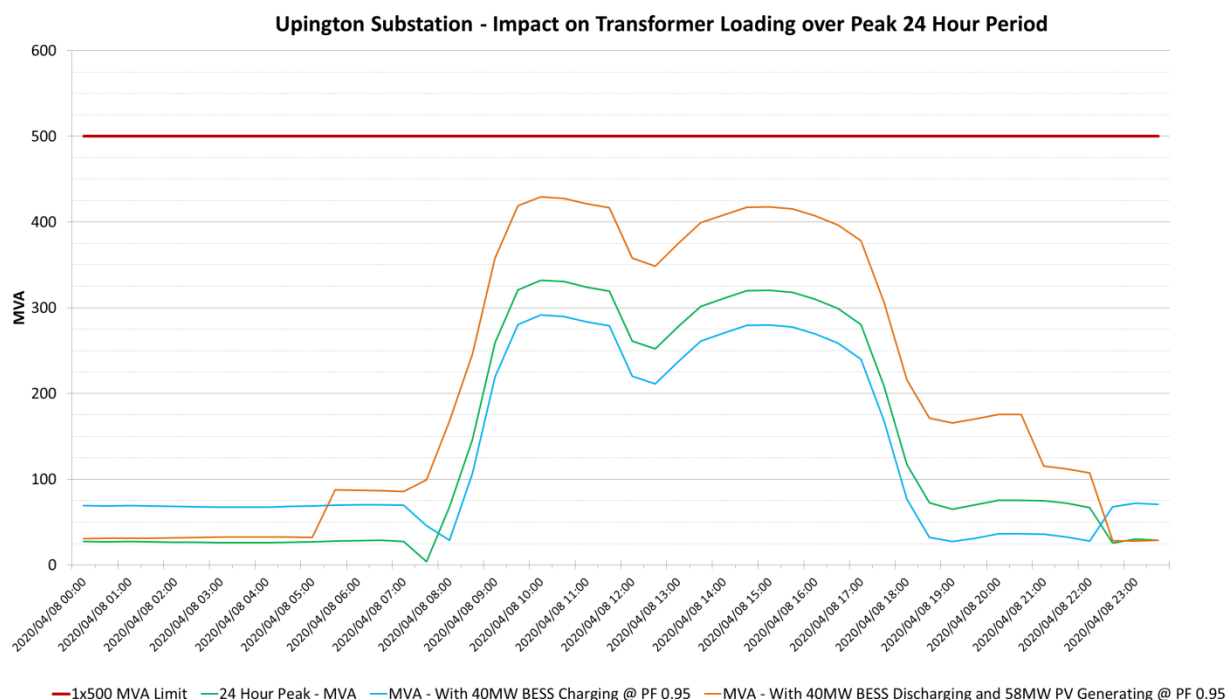


Figure 8 - BESS and PV Impact on Uppington MTS Transformer Loading

6.3.1.2 132kV Line Thermal Loading

During Scenario 2, the thermal line loading on Uppington Kiwano single circuit Twin Tern 132kV Line is 25.1%.

6.3.1.3 Rapid Voltage Change (RVC) Test

The RVC results for scenario 2 are shown in Table 9 below.

Table 9 RVC Test Results for Scenario 2

Busbar	RVC Test %		
	Loss of PV and BESS (98MW)	Loss of BESS (40MW)	Loss of PV (58MW)
Kiwano Substation 132kV	1.662	0.757	1.146
Uppington MTS 132kV	1.823	0.692	1.047

The purpose of the studies above is to ensure that under the current use case and applicable scenarios, the proposed Distribution infrastructure is adequately rated and able to safely export the power from Kiwano substation to Uppington MTS.

6.3.2 Fault Levels

The following fault levels were obtained by increasing the Uppington MTS capacity to a 3x500MVA 400/132kV station and modelling an additional 425MW of generation on the 132kV Uppington busbar giving a total of 815MW forecasted and existing generation in total at the time of the study. The IEC method was used in Power Factory to obtain these fault levels.

The fault levels for the study area are shown in in **Table 10** below.

Table 10 Fault Level Analysis of Kiwano Substation with BESS & PV Connected

Fault Level Location		kV	3-Phase	1-Phase
			kA	kA
Kiwano Substation	BB1	132	14.9	15.7
Kiwano Substation	BB2	132	14.9	15.7
Upington MTS	BB1	132	21.2	26.2
Upington MTS	BB2	132	21.2	26.2

It is recommended that the 132kV equipment be rated for a minimum of 25kA.

7 REVIEW OF PHYSICAL SPACE AVAILABILITY

Research has indicated the below energy densities for 63m² containers per MWh of BESS based on manufacturer capabilities.

Table 11 BESS Densities

Manufacturer	MWh per 63m ² Container
LG Chem	4.8 MWh
LG Chem	6.0 MWh
Samsung SDI	6.0 MWh
Samsung SDI	9.1 MWh
Kokam	2.5 MWh
NEC	2.0 MWh
SAFT	2.4 MWh
BYD	2.7 MWh
Tesla	3.8 MWh
Average	4.4 MWh

The Table 11 indicates an average of 4.4MWh, with a minimum of 2MWh per container.

Assuming the worst case density of 2MWh per 63m² container and 2m spacing between containers, the required space for 40MW/200MWh BESS plant is

$$\text{BESS Space} = 10\,620\text{m}^2$$

The space requirements for the PV were based on the dimensions of an old PV that is in operation. A 10MW PV site of 157 440m² was used as an assumption.

$$58\text{MW PV Space} = 944\,640\text{m}^2$$

For the substation site requirements, the dimensions of the neighbouring Upington MTS site were assumed for Kiwano substation. Upington MTS is a 300mx300m substation. It must be noted that Kiwano substation will be utilised as a collector for other IPP's in future.

$$\text{Kiwano substation site} = 90\,000\text{m}^2$$

The total site space requirements for Kiwano BESS and PV project summed up as follows:

$$\text{Total space required} = 1\,045\,260\text{m}^2 (104.5\text{ha})$$

The size of the Kiwano CSP site is 582ha and it is sufficient to accommodate the proposed developments.

7.1 Land Development and Environmental Requirements

The **environmentalists** have indicated that the environmental authorisation that was previously acquired for Kiwano CSP site may have expired and the process to review its status is now starting. This also applies to the environmental authorisation for the Upington/Kiwano 132kV line.

The environmental scope will include the following:

- EA for the Kiwano site which includes BESS, PV and the substation
- EA for the Upington/Kiwano 132kV line
- Review of all previous authorisations relating to Kiwano CSP.

It must be noted that the average time line for basic assessments is 10 to 12 months, and 12 to 18 months for the environmental impact assessment.

The **Land and Rights** scope will include the following:

- Determine ownership of the affected property, method of acquisition and ascertain the required extent of the facility
- Statutory approvals from other services in the vicinity
- Liaise with stakeholders and owners in conjunction with environmental engagements
- Once EIA approval is granted, then determine market value and request funds approval from investment committee
- Acceptance of offer and registration of asset will be done to conclude the process

The overall process may take 3 to 6 months after the Environmental Authorization has been granted.

8 PROPOSED BESS & PV CONNECTION DIAGRAM

The scope of work for the Kiwano BESS and PV is discussed in section 6.2 and is further summarised below.

- Use the existing 132kV feeder bay at Upington MTS
- Build a 7km **single** Twin-Tern Upington/Kiwano 132kV line on a **double circuit** support structure
- Build Kiwano 132kV substation with 5 feeder bays: 1 for the incoming line, 4 for the BESS and PV plants, and make provision for future expansion to accommodate 4 more bays
- Build the 40MW/200MWh BESS plants equipped with 2x40MVA 132/22kV transformers and connect it at Kiwano substation
- Build a 58MW PV plant with 2x40MVA 132/22kV transformers and connect it at Kiwano substation

Figure 9 below depicts the proposed BESS connection and PV Plant connection at Kiwano Substation.

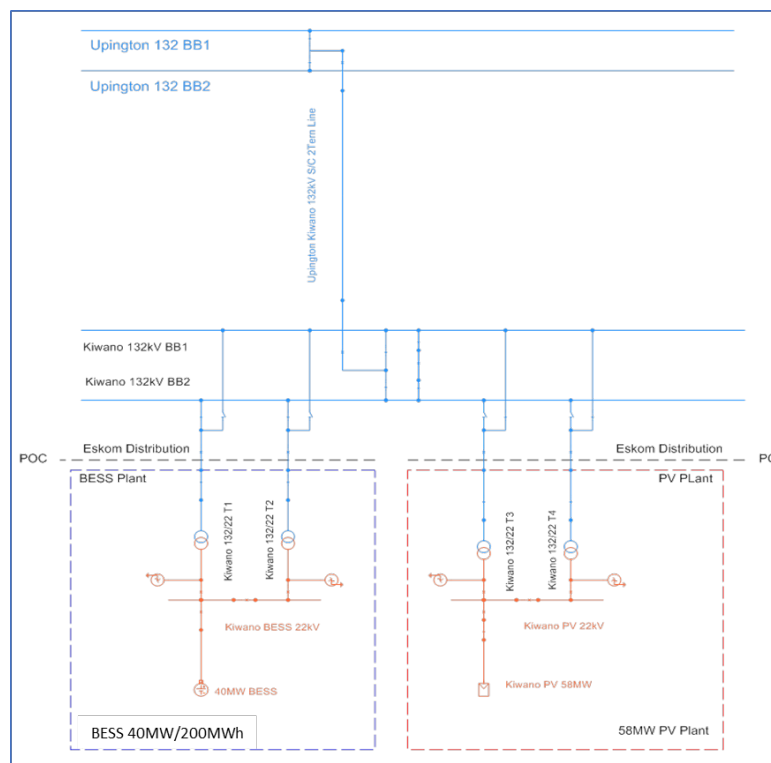


Figure 9 BESS Connection Diagram at Kiwano Substation

9 CONCLUSIONS AND RECOMMENDATIONS

This report details the study for the proposed Kiwano BESS and PV plants.

The proposed plants will be situated at the site that was previously acquired for Kiwano CSP. The BESS and PV plants will be integrated at Upington MTS via the proposed Kiwano 132kV substation. The BESS size of 40MW/200MWh and a PV of 58MW are proposed in this report. It has been established that future expansion of the BESS will be attainable subject to the planned Transmission strengthening. A total of 340MW/1 360MWh BESS is feasible in future, when taking the Transmission expansion plans into consideration.

IRP 2019 shows a need for energy storage of 513MW by 2022 and 1 575MW by 2029. The Kiwano site must be earmarked as one of the strategic sites where more BESS storage can be accommodated in future. Also, this substation must be utilised as a collector station for integration of future IPP's. It is for this reason that the Upington/Kiwano 132kV line must be designed and constructed on a double circuit structure, and be strung with a single circuit initially. The second circuit will be strung in future based on the future IPP bids' approvals.

The operating philosophy for the BESS is that, the BESS will be free to charge from the grid or from the nearby PV based on the dispatch instruction from the System Operator. As such, the PV plant will have its own POC and the BESS will have its own POC. The two plants will be dispatched independently on System Operator's instruction.

The use cases for the BESS are ancillary services and energy support services.

It is critical that a feeder bay be reserved at Upington MTS for the purpose of integrating this BESS and PV. Such application must be done timeously to avoid complications during design and construction.

10 REFERENCES

- [1] NERSA, "Grid Connection Code for Battery Energy Storage Facilities (BESF) Connected To the Electricity Transmission System (TS) or the Distribution System (DS) In South Africa," National Energy Regulator of South Africa, Pretoria, 2020.
- [2] M. Soni, "Technical Bulletin (240-146900837): Rapid voltage change limit for BESS integration studies for Planning," Eskom SOC (LTD), Johannesburg, 2019.
- [3] P. Jaglal, "Battery energy storage system modelling and simulation guideline: 240-150375698," Eskom SOC (LTD), Johannesburg, 2019.
- [4] NERSA, "The South African Grid Code: The Scheduling and Dispatch Rules," National Energy Regulator of South Africa, Pretoria, 2016.

APPENDIX B-3 : TECHNICAL BULLETIN RELIABILITY CRITERIA FOR BESS INSTALLATIONS

 Eskom	Technical Bulletin	Technology
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BESS INSTALLATIONS**

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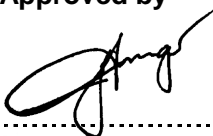
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Compiled by



Kurt DEDEKIND
Planning Manager

Approved by



Mfundu SONGO
Senior Manager Planning and GIS

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Background

The Battery Energy Storage System (BESS) World Bank project was launched in 2017, as an alternative solution to the Kiwano CSP project. It formed the basis of the financing approvals by the World Bank for the coal fired Power Stations at Medupi and Kusile, that a proviso for the loan approval would be a requirement by Eskom to also construct three Renewable Plants at Ingula, Sere Wind Farm and the Kiwano CSP Plant. The Kiwano CSP project was shelved and was accordingly replaced by the BESS project for implementation in the Distribution Wires Business.

Battery Storage devices have as yet not been formally classified as either a Load or Generation device, and the planning and design reliability criteria related to the integration of a BESS Unit into the Distribution Network, required a Guideline to support the project delivery timelines associated with the project.

With regards the BESS project, Reliability criteria at Dx level or particular design thresholds for the following elements require clarity:

- Lines supplying BESS sites (N-1 or N)
- Transformers connecting to BESS Units (N-1 or N)
- BESS availability at sites100% or matching the two above
- Redundancy/ Reliability criteria for the BESS unit itself

This document aims to clarify the high level reliability requirements associated with the installation of BESS units at selected Distribution substation sites.

It is noted that the decisions were guided by the following principles:

- Current Grid Code requirements for Distributed Generation
- An opinion from NERSA that a BESS Unit is classified as Generator
- That the customer is not clearly defined as yet, albeit that the Primary Use Case for the BESS installation was based on the premise of Peak Shaving benefits for each of the sites.
- The draft Battery Energy Storage Code is incomplete and is unclear on any defined reliability requirements.
- Given the current generation supply constraints in the country, that the BESS Unit be viewed as a "Peaking Station" in a sense and that associated reliability criteria may be considered at selected sites.

It is also evident that in the absence of international guidelines in this regard, that the Technical Bulletin may be updated and revised, should appropriate international benchmarking indicate that changes may be required to the stance as recommended in this bulletin.

Revision history

This is the first version of the document.

Date	Rev.	Compiled by	Clause	Remarks
15 March 2019	0	VK DEDEKIND	NA	First draft

1. Reference documents

The following Reference documents provide input and background to the context of the decisions that were proposed to guide the business with respect to the installation of BESS at selected Distribution sites.

- The South African Distribution Network Code
- The South African Transmission Grid Code
- The Planning Standard for Distribution Network Reliability Standard 240-766 13395
- The Interconnection Standard for Embedded Generation 240-612 68576

2. Battery Energy Storage Reliability Criteria

The pointers will serve as a guide to the BESS scoping and RFP documents that are to be completed for the World Bank funded project. It is noted that the **decisions were largely subjective** in nature, and were guided by the existing Codes and Standards within the business as referenced in paragraph 1.

2.1 BESS Redundancy

- Proposed that there will be **no redundancy of BESS units** per site for reliability purposes.

2.2 Reliability Criteria for substations with BESS installations

- BESS installations qualifying as **Category C** ie. (20 MW and larger), **will be considered for Reliability criteria** in line with the current DX Reliability Standard and Interconnection Standard. N-1 reliability criteria may be considered in such circumstances.
- Reliability criteria will only be applied for the transformation requirements and the busbar arrangements at the substation to which the BESS will be connected.
- The reliability criteria must meet the local requirements and comply with constructability criteria for each substation site.
- BESS connections to the appropriate busbar/s in the substation will be made in line with the Interconnection Standard requirements.

2.3 Reliability criteria for lines feeding substations with BESS connections

- Decision was taken that **no reliability criteria** will be applied to any lines feeding substations with BESS connections.

2.4 Islanding requirements

- Islanding requirements will be **specified, as required, per site** where a BESS installation is installed.
- Islanding requirements will be considered in areas where performance and resilience considerations are paramount.
- Scoping document is to specify that the "Islanding option" is included as a separate costing item as part of the commercial process (ie decision can be made to include / defer based on the readiness of the business to implement islanding schemes at selected sites)
- Business needs to ensure that the Operating regulations for field staff and system operators is amended to include the islanding capability
- The draft BESF Code is to be amended to include islanding capability.
- All appropriate safety measures need to be adopted before any islanding operations will be permitted at a site