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This document serves to describe the operation of the possible solar PV and BESS system RenEnergy would be installing for the EFRC Kleinfontein Site.

ELECTRIFYING CHANGE

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List of abbreviations:

AC – Alternating Current

DC – Direct Current

kW – Kilowatt (Active Power Unit)

kVA – Kilo-Volt-Amperes (Apparent Power Unit)

V – Volts

kV – Kilovolts

A – Amperes

kA – Kiloamperes

MEC – Maximum Export Capacity

NMD – Notified Maximum Demand

DG – Diesel Generator

NSP – Network Service Provider (in this case Eskom)

PPC – Power Plant Controller

EMS – Energy Management System

LV – Low Voltage

MV – Medium Voltage

HV - High Voltage

RMU – Ring Main Unit

OHL – Overhead Line

UGC – Underground Cable

PF – Power Factor

PFC – Power Factor Correction

LCOE – Levelised Cost of Energy

BESS – Battery Energy Storage System

ATS – Automatic Transfer Switch

PCS – Power Conversion System

SSEG – Small Scale Embedded Generation

Site Location:

GPS Location (LAT; LONG):

Site Location: 33°54'48.23"S; 19°23'2.28"E

The site EFRC Kleinfontein (EK) is located within the Breede Valley Municipality (BVM), approximately 30km south of the town of Worcester (as the crow flies). The site can be accessed from the R43.

Figure 1: Site Locality Map

Background:

EFRC Free Range Chickens (EFRC) a producer of free-range broiler chickens with most of its operations situated in the Overberg region, Western Cape tasked RenEnergy for a solution that will ensure the required energy demand for a planned expansion project is met in the absence of sufficient supply by Eskom for the project.

The company wishes to expand its production capacity and have identified the Kleinfontein farm between Villiersdorp and Worcester as a farm fit to develop into a free-range broiler farm.

As the electrical network of Eskom has insufficient capacity to supply the project with the necessary electricity, RenEnergy was tasked to design a plan where renewable energy is used to supply the electricity needs of the project.

Introduction:

Each broiler house has a footprint of 87 x 12m.

The broiler house has not been erected yet on this farm and therefore no data on the actual load is available, but similar existing installations on other farms were used as basis for the electricity requirement of this development.

Network information:

From the information gathered, the Electrical Network Service Provider (NSP) for the Site is Eskom. The site is being fed from the Haamanshof-Farmers 3 11kV overhead line (OHL) feeder which is then stepped down to the 400V voltage level via a 100kVA distribution transformer.

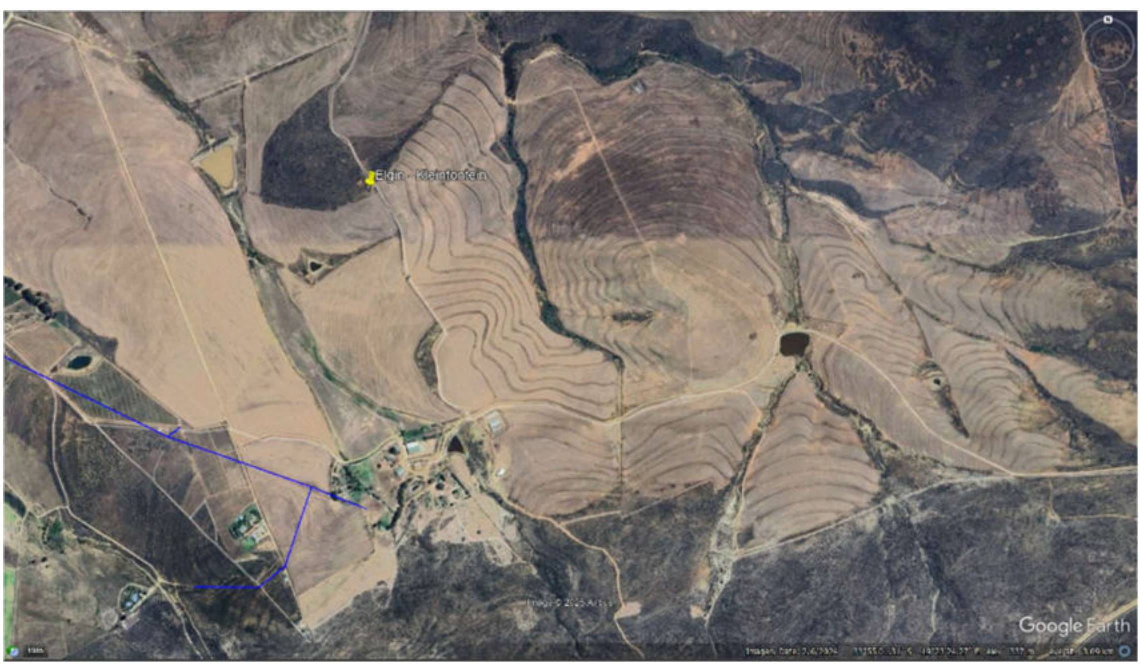


Figure 2: Eskom 11kV Incoming Feeder

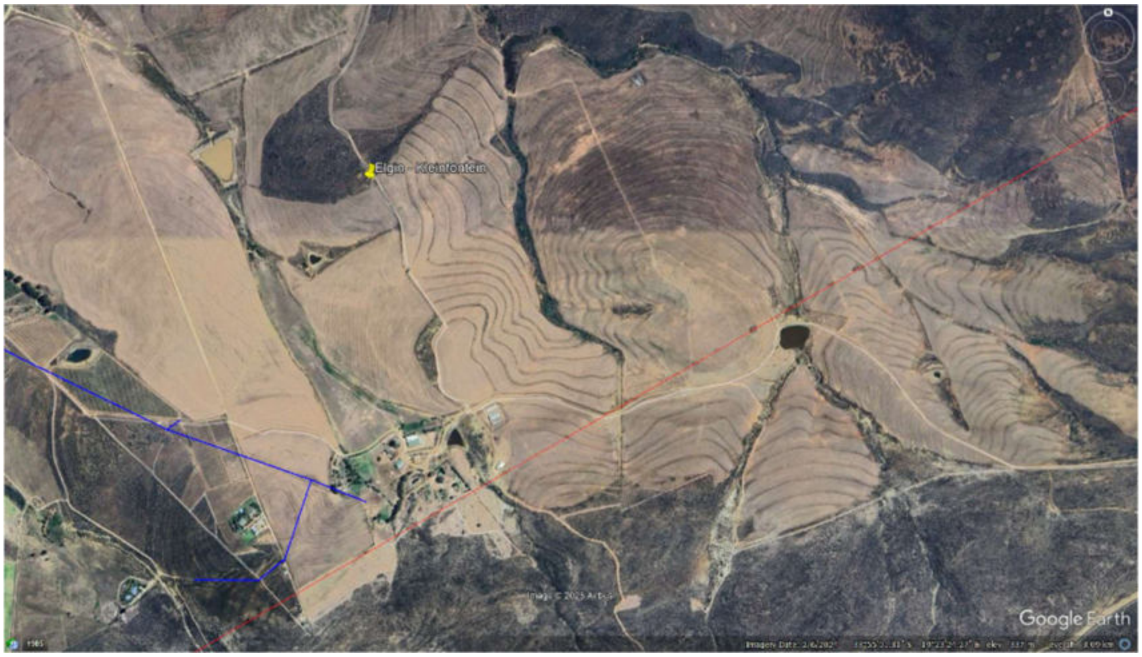


Figure 3: Eskom (High Voltage) HV OHL running on the southern boundary of the site

Site information:

Figure 4: Building layout for the site Kleinfontein

Figure 5: Existing infra-structure on the farm Kleinfontein

Each Broiler house will have a building footprint of approximately 87m x 12m.

Table 1: Building size and power requirements

Category	Description	Number of units	Load/ unit	kVA
Existing infra-structure				
Dwellings	Manager Houses	2	1.5	3
	Supervisor houses	9	0.5	4.5
Out buildings	Site Office	1	0.5	0.5
Services	Workshop with cold room	1	15	15
	Farm Store	1	1	1
Sub-total				**10.5**
Planned new infra-structure				
Poultry Houses	Broiler Houses (20 houses)	20	14	280
Dwellings	Foreman Houses	1	0.5	0.5
Ablution	Showers and Toilets	2	3	6
Freezer	Refrigerated Container for mortalities	1	15	15
Sub-total				**301.5**
Total				**312.0**

Based on the electrical equipment that would be installed inside each one of the 20 broiler houses, it is assumed a broiler house will have a total peak power requirement of around 301.5kVA, including the new infrastructure at the entrance of the farm and requirement of the existing infrastructure, the total load requirement for the farm is estimated to be 312kVA.

Based on the above power requirement, EFRC has approached their NSP for 500kVA Notified Maximum Demand (NMD), which is currently underway, to ensure that there would be enough power should the NSP be providing power to supply the entire site.

Based on the peak load requirements of each one of the broiler houses a synthetic load profile has been determined based on the operation of equipment and when load is required based on the activities that are occurring during the growing period of the birds.

Below is the typical monthly representation of these load profiles during the summer and winter periods for the site.

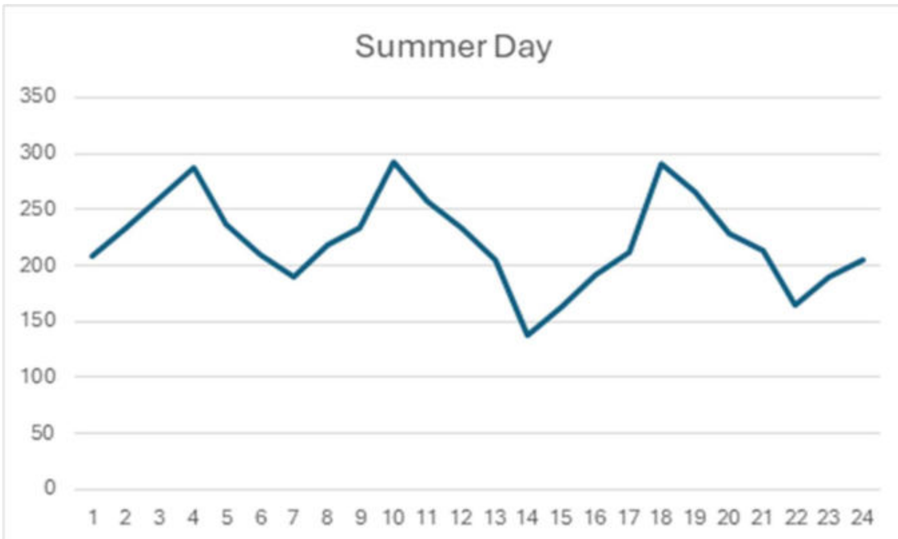


Figure 6: Typical daily energy consumption for the site load for a typical summer month.

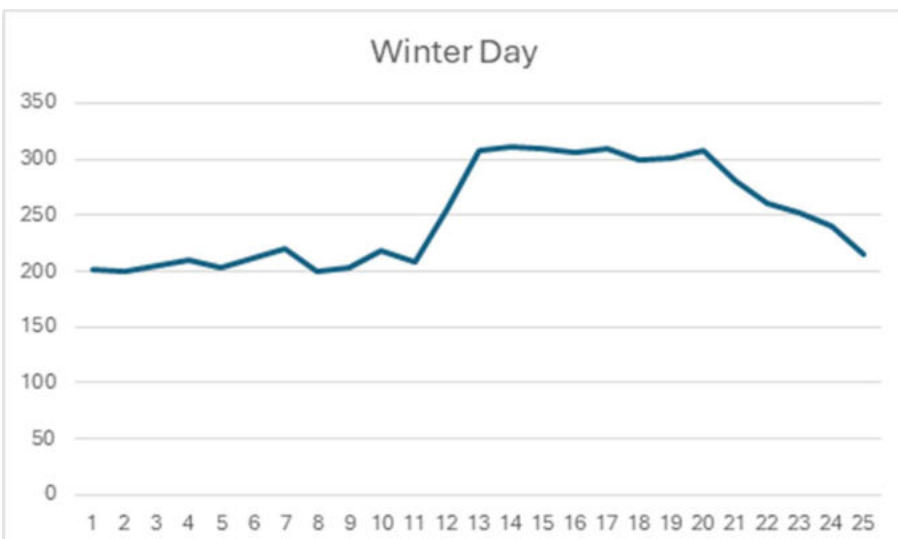


Figure 7: Typical daily energy consumption for the site load for a typical winter month.

Assumptions:

- *Follow the trend of a similar size building, with daily and seasonal fluctuations as per the activities that are to take place within this building.*

This means the load will fluctuate between 120kW and 312kW, with the minimum values (during off-peak hours) varying between 120kW and 200kW, and the profile will be adjusted to ensure the yearly average is around 175kW.

Daily Cycle:

- *Peaks around midday (e.g., 12 PM - 2 PM) reaching up to 312kW.*
- *Troughs in the early morning (e.g., 3 AM - 5 AM) fluctuating between 120–200kW*

Seasonal Adjustment:

- *Higher peaks and baseline in summer (June-July) to match the graph's trend, reaching closer to 312kW.*
- *Lower troughs in winter (December-January), closer to the 120–200kW range.*
- *Adjust the amplitude to ensure the average remains ~175kW.*

Minimum Fluctuation:

- *During off-peak hours (e.g., nighttime), the load will fluctuate randomly between 120kW and 200kW.*
- *Add random noise (±3%) to the overall profile for variability, ensuring the minimum range is respected.*

Trend Alignment:

- *The graph shows daily peaks and troughs, with a slight seasonal increase mid-year. The profile will reflect this with more pronounced daily fluctuations and a seasonal shift.*

System Solution:

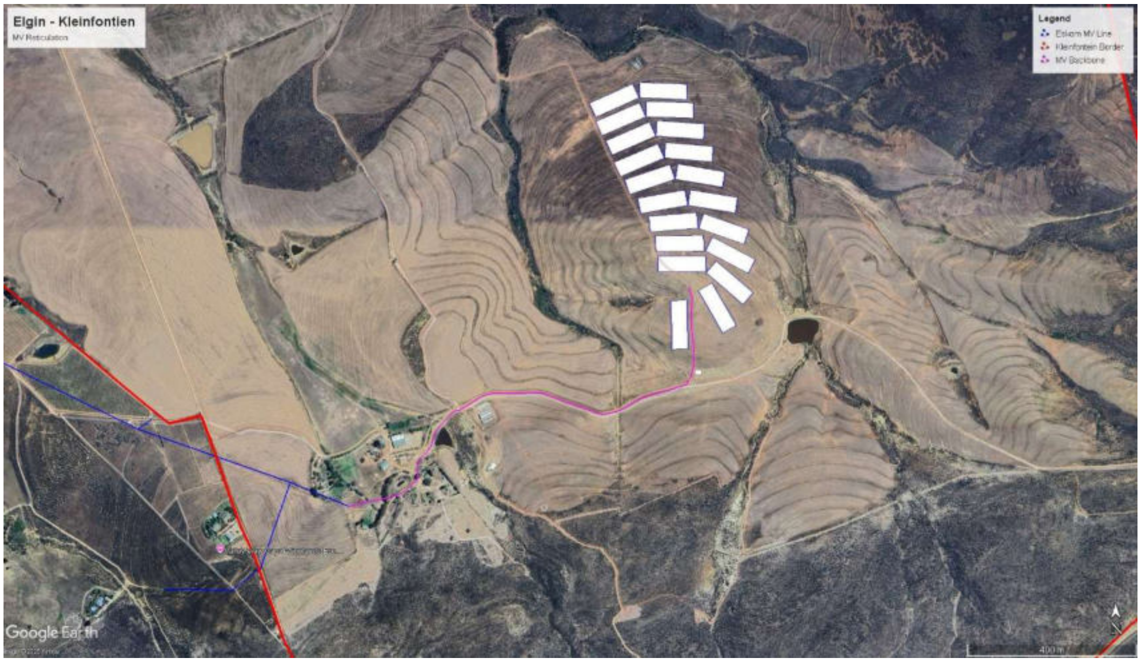


Figure 8: Possible MV Reticulation

In being proactive, and to ensure energy security for the site EFRC is also looking at alternative means of embedded generation to ensure that should the NSP not have this network capacity for the Site, that through alternative means of energy generation that the Site would have enough power to power the 20 broiler houses

Based on the above RenEnergy has looked at several options in order to assist EFRC in its attempt to obtain energy security for the site, and has decided on the below option of implementation based on the fact that there is no available network capacity from the NSP to upgrade the Client's supply point and that no power may be exported to the grid, but ensuring sufficient generation to power the entire site.

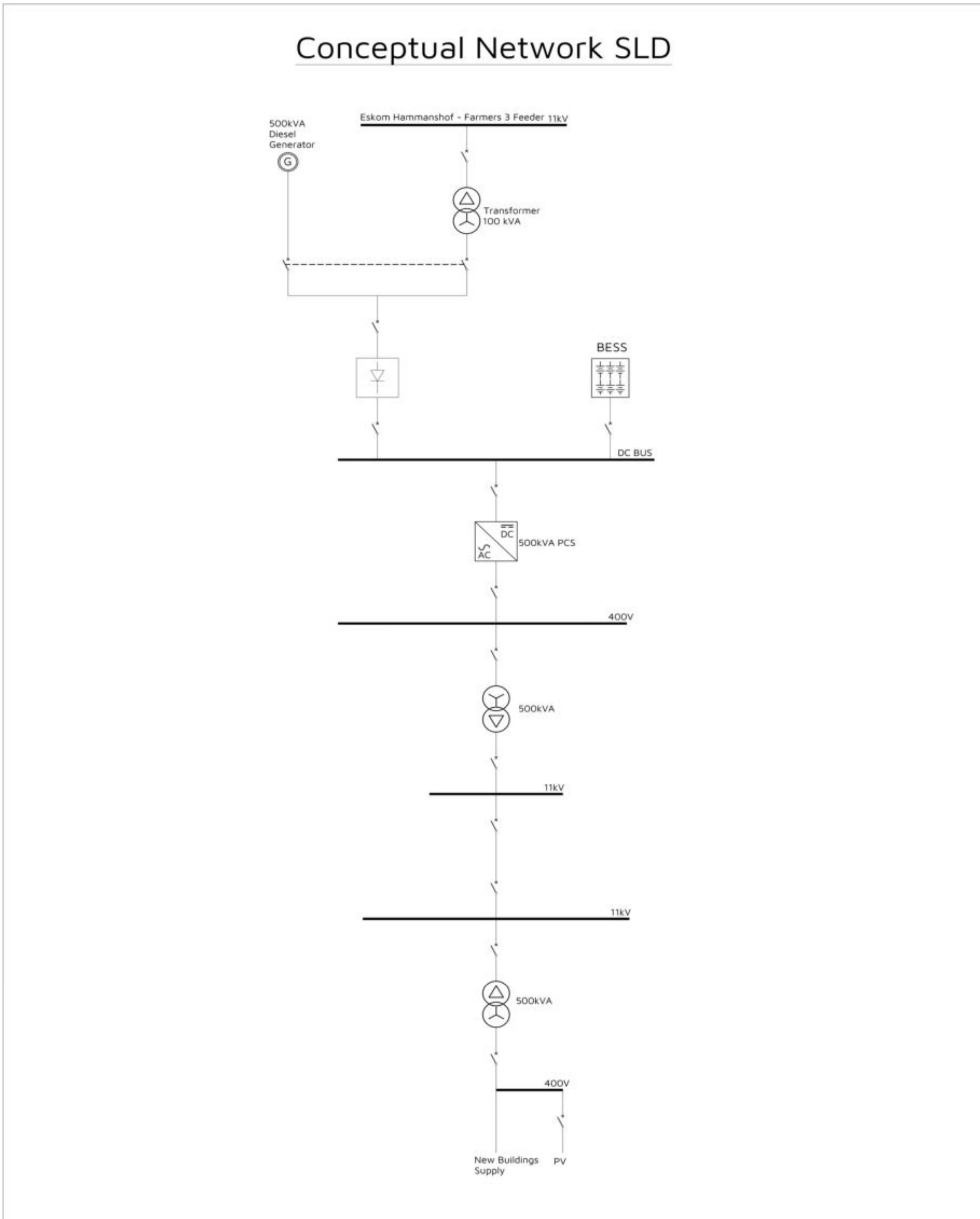


Figure 9: Conceptual Network Diagram for the proposed embedded generation with 100kVA Eskom supply, see annexure A for more detail.

In this option the Eskom 100kVA supply point, the diesel generation, Battery Energy Storage System (BESS) are connected onto a direct current (DC) Bus voltage level, the solar photovoltaic (PV) shall be connected locally at each building via grid tied inverters.

The Eskom 100kVA supply point, the diesel generators (DGs) and Battery Energy Storage System (BESS) and are all connected onto the low voltage (LV) level upstream this voltage is then stepped up to the medium voltage (MV) level to distribute the energy to the buildings which are situated approximately 2km away. The solar PV would be localised and connected to each building and tying into the buildings main supply.

The primary source of energy during the day would be the solar PV, which is localised at the buildings' site, any excess energy produced should flow on the internal Client network before charging the BESS, no export of excess energy generated to the NSP grid network will be allowed, the secondary source of energy would be the BESS, and the tertiary source of energy would be Eskom supply point, whereas the diesel generator would be the last resort in order to ensure energy security for the entire site.

On the DC voltage level, the three energy sources, DG, Eskom and BESS, are combined, the DC voltage is then converted to alternating current (AC) voltage via the Power Conversion System (PCS) to a low voltage (LV) supply, from where it would then be converted to the 11kV medium voltage (MV) level via step-up transformer. From the transformer point a ring main unit (RMU) would be installed from where an overhead line/underground cable would connect in order to distribute the energy to a centralised point where the new buildings are located. Where the buildings are located a step-down transformer will be installed to convert the MV voltage to the LV voltage level, from where the relevant buildings can be supplied from. Each localised grid tied solar PV connection for each building would have to be sized accordingly to ensure the local main electrical infrastructure equipment of the customer is not exceeded.

To realise this solution, the energy delivered by the BESS and the DGs and even the solar PV energy generated downstream from the supply point, should not be exported to the grid, to ensure this a power plant controller shall be installed to take inputs from the intelligent electronic devices (IEDs) and metering equipment to measure, detect and ensure the flow of energy to where it is required. The solution would have to incorporate a rectifier, as the NSP does not have sufficient additional network capacity in the area to provide power to the site. A detailed design would be completed once as part of the Smal Scale Embedded Generation (SSEG) approval process.

The solar PV system size will match the local load or the maximum amount of PV modules that can be installed on the roofs of the individual buildings when they are erected, whichever is the maximum. There is also the option of building an additional MV line to allow supply to the site in case the main backbone requires maintenance or repairs. The 11kV MV line will be installed inside the road reserve as far as possible to limit the registration of any additional servitudes as far as possible. The MV line shall be installed as far as possible to the opposite of the road of where the wet services are located.

This configuration does not allow any energy generated on site to be exported to the grid supply from the NSP, the energy that is generated on site will either be stored in the battery, consumed on site locally and any excess energy generated that cannot be consumed or stored will be curtailed.

Since the solar PV will be installed on the roofs of the buildings being built and due to the sensitivity of the Client's operations on site, the operations and maintenance (O&M)

schedules for the embedded system will be aligned to the Client's operations to ensure that there is limited impact on the development and growth of the chickens.

Based on initial simulations and calculations, the number of buildings that may be required to install solar PV modules on to power the site is estimated to be approximately 7 to 8. This is considering the size of the roof, using the optimal azimuth, allowing space for operations and maintenance teams to access the system on the roof, and the current available module sizes available for installation.

A similar concept has been implemented by RenEnergy before for previous Clients, and Eskom and their Renewable Energy Technical Evaluation Committee (RETEC) has approved similar design concepts in the past. Final sizing of the system will be based on LCOE and ensuring that the energy mix is sufficiently sized to run the plant with minimal support from the grid, this detail will be indicated in the detailed design phase of the project.

Rooftop Solar PV Installation

Below is an indication of what the rooftop solar PV installation would look like if the buildings of the site would be used.

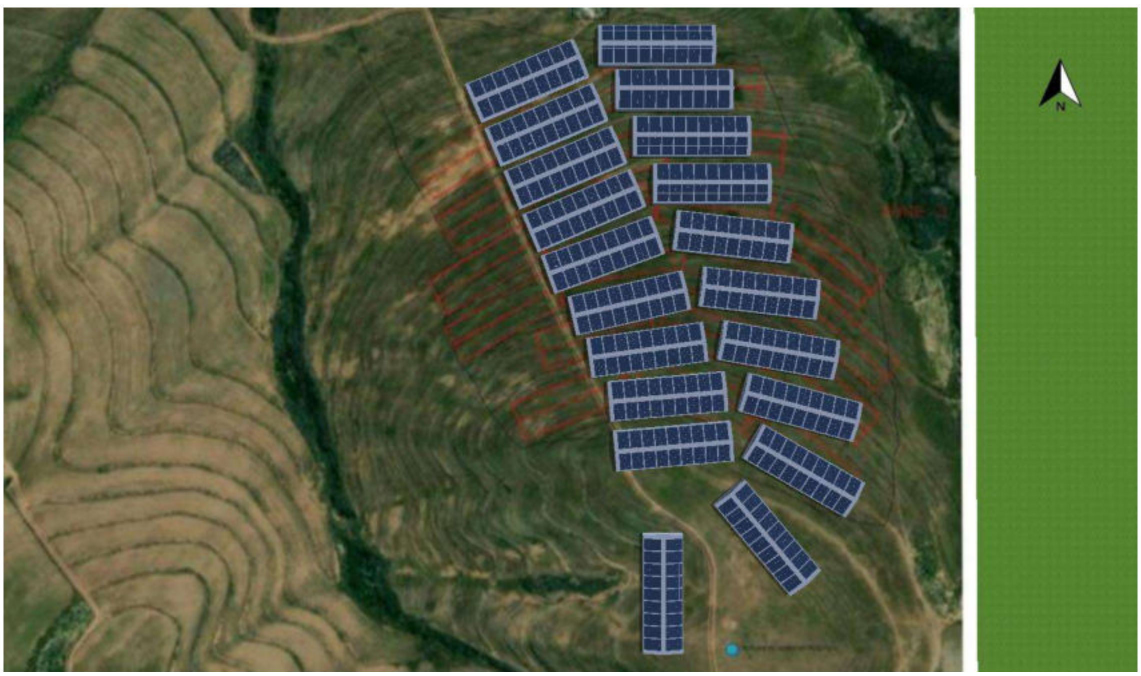


Figure 10: Plan view of the buildings having solar PV modules installed

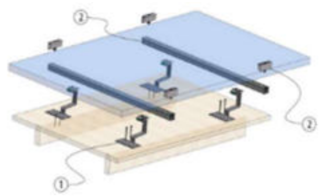
Figure 11: Front aerial view of the buildings having solar PV modules installed

Equipment Selection

Datasheets for all major equipment included in the Datasheets and Warranty Statements Appendix once finalised.

Table 1: Type and Quality of Major Equipment to be installed

SOLAR MODULES		
	Tier 1 module manufacturer Performance warranty: Power: 25 year linear warranty Product: 10 years Positively Tolerance IEC 61215 IEC 61730 ISO9001 ISO14001	Module Name: Canadian Solar/Jinko Solar/ JA Solar/Longi/Yingli
INVERTERS		
	Performance warranty: 5 years (option to extend to 10 years) NRS 097 Compliant Indoor/Outdoor rated	PCS Inverter Name: Sungrow/Huawei/ATESS/Mega revo Total AC output: 500kVA
MOUNTING EQUIPMENT - ROOF MOUNTED SYSTEMS		

	Roof mounted Warranty: 10 years Mounting gear is designed and selected according to module specifications, mechanical loading, wind loading, flexibility and longevity.	Manufacturer: Schletter/Lumax/K2 Mounting type: Non penetrating where possible Total roof loading: [15] kg/m^2 Mounting type: Aluminium Railless IBR Roof Sheeting Type
MONITORING SOFTWARE		
	World leading solar PV monitoring platform and technology supplier. 5-minute interval recording, logging and error	Manufacturer: Meteocontrol/EAS/Higeco/Inaxxess Power curtailment: If required Web interface: Yes Weather station with irradiance sensors
DC CABLES		
	EN 50618, IEC 62930 compliant DC Cables to be included in the installation	Manufacturer: KBE / Zonn
AC CABLES		

 	Steel wired amoured, PVC insulated 600/1000V rated cables with aluminium conductors manufactured to SANS 1507-3 are to be used.	Manufacturer: Aberdare / CBI
BATTERY TECHNOLOGY		
	Warranty: 7 years Powerpack Units Bi-directional battery inverters Powerpack controller coordinating all the operations of the battery system with ability to communicate with external controllers	Manufacturer: Tesla/Huawei/Sungrow/Freedom Won/SolarMD/IES Type: Rechargeable Lithium Ion Powerpack System

Other major equipment to be considered are:

Solar PV ACDB

- The ACDB will used for the connection of the inverters at single location.
- 400V low voltage (LV) Panels in case of string inverters.
- All the AC low voltage switchboards shall be suitable for operation between 380 and 420V Volts, 50 Hz. 3/4 wire system.

- The overall construction of the LV Switchboards shall be factory assembled with fabrication processed on computer numeric controlled type or equivalent machines.
- The 400V LV Panel shall be type tested for short circuit test. All the breakers shall be type tested for short circuit of the required rating as per the inverters.
- The 400V LV Panel shall be provided with necessary protection against overcurrent, earth fault, short circuit current in addition to other basic protections. Cable Sizing

Standards, Codes and Regulations

The design, construction, and operation & maintenance of the plant, the equipment and facilities and the testing and commissioning of the plant will be strictly according to the local rules and regulations. In general, the below listed local regulations will be adhered to in addition to the OSH Act of South Africa as well as the Electrical Machinery Act of South Africa, during the design phase, the definition of the material and equipment and during the construction phase.

- 240-150642762 – Generation Plant Safety Regulations
- ORHVS - Operating Rules for High Voltage Systems
- SANS 10160:2010 Basis of structural design and actions for buildings and industrial structures
- SANS 10161:1980 The design of foundations for buildings
- SANS 10162 The structural use of steel
- SANS 10164 The structure use of masonry
- SANS 10120 Code of practice for use with standardized specifications for civil engineering construction and contract documents.
- SANS 10144:1995 Detailing of steel reinforcement for concrete
- SANS 10145:2000 Concrete masonry construction
- SANS 920:2005 Steel bars for concrete reinforcement
- SANS 10109-1:2009 Concrete floors Part 1. Bases to concrete floors
- SANS 10109-2:2004 Concrete floors Part 2: Finishes to concrete floors
- SANS 10142-1 & 2 The wiring of premises Part 1 and 2.
- SANS 1339 Electric cables - Cross-linked polyethylene (XLPE)-insulated cables for voltages from 3,8/6,6 kV to 19/33kV.
- SANS 10400 The application of the National Building Regulations

- SANS 10292 Earthing of Low voltage (LV) distribution systems
- SANS 2220 Electrical security systems
- The South African National Grid Code for Renewable Power Plants (latest edition)

All electrical installations will comply with the appropriate requirements of IEC 60364 (all parts), IEC 61936-1, SANS 10142-1, SANS 10098-1, SANS 10114-1, SANS 10114-2, South African national, provincial and local legislation. In general, all applicable SANS standards and regulations will be used, in addition to any South African national standards. The main equipment listed below will be, among others, according to the listed standards:

PV Modules

- IEC 61215
- IEC 61730-1
- IEC 61730-2
- IEC 62804
- IEC 62782
- IEC 62716
- IEC 60904
- IEC 61701
- IEC 60068-2-68
- IEC 61853 - 1
- IEC 61853 – 2
- IEC 61853-3
- EN 50380
- CE Certification
- PID free certified performed by reputable third-party laboratories (IEC 62804)
- IEC 61345 - UV test for Photovoltaic (PV) modules
- Facility: ISO 90001 - Quality management system
- Safety class 11 1000V/1500V
- LeTID Report of PERC modules
- UL61730

Module Mounting System

- ASCE 7-10
- ACI 318-14
- ASCE-07-16
- AISI-S100-2016
- AISC-360-16
- ACI 543R-12
- ASTM D1143
- ASTM D3689
- ASTM D3966
- ASTM A792
- ACI 211.1
- ISO 14713
- DIN EN 10346
- DIN EN ISO 1461
- DIN EN 10346
- EN ISO 10683
- ISO 4042
- DIN EN ISO 9223:2012
- DIN EN ISO 14713-1:2010-05
- UL3703
- UBC
- IEC 62817
- IEC 62727
- ISO 9223
- ISO 9224
- EN 1990
- SANS 10160

Inverter

- EMC Compliance
- IEC 61000-3-12
- IEC/EN 61000-3-11
- IEC 61000-3-11
- IEC 61000-6-2
- IEC 61000-6-4
- IEC 62103
- EN 62109-1
- EN 62109-2
- IEC/EN 62109-1
- IEC/EN 62109-2
- IP 66 Test Report
- IEC 61727
- IEC 62116
- IEC 61683 / EN 61683 / DIN EN 61683
- IEC 60068-2-1
- IEC 60068-2-2
- IEC 60068-2-14
- IEC 60068-2-27
- IEC 60068-2-30
- IEC 60068-2-64
- IEC 62446-1
- IEC 62093
- IEC 62981
- IEC 61643-11
- EN 50539-11
- EN 50539-12
- BDEW 2008
- NRS097

Transformer

- IEC 60076
- IEC 60296
- IEC 61558
- IEC 61558
- IEC 62041
- IEC 60137
- IEC 60815
- IEC 60068-3
- IEC 60296
- IEC 60185
- SANS 780

Switchgear

- IEC 62271-200

DC Cable

- EN50618; H1Z2Z2-K; 50363076
- IEC62930; R 5048873
- IEC 60228 Class 5
- RoHS & Reach conform

LV Cable

- SANS 1507/3

MV Cable

- SANS 1339

HV Cable

- IEC 60840
- SANS 60840
- NRS 077

Overhead Lines

- IEC 61089
- SANS 10280
- NRS 033

SCADA

- IEC 61724-1
- IEC 61850-7-420
- IEC 60870-5-101:2003+AMD1:2015 CSV
- IEC 60870-5-104:2006+AMD1:2016 CSV
- The South African Grid Code

BESS

- ANSI/CAN/UL 1974
- IEC 62619
- SAE J2950
- SAE J2997
- EN 50272-3
- IEC 62933
- IEC 62485
- AUS/NZ 5139
- NFPA 855
- GRID CONNECTION CODE FOR BATTERY ENERGY STORAGE FACILITIES (BESF) CONNECTED TO THE ELECTRICITY TRANSMISSION SYSTEM (TS) OR THE DISTRIBUTION SYSTEM (DS) IN SOUTH AFRICA

Annexure A: Conceptual Network SLD

Conceptual Network SLD