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Executive Summary

Orbit TVET College is located at Brits in the Madibeng municipality. To ensure a continuous working environment with little impact on schooling activities, the school is embarking on a phased renewable energy programme to generate and supply energy power. The school has selected key buildings critical to school operations that must be powered on phase 1.

The energy analysis illustrated that phase1 of the solar system could be a 50 kW three phase inverter, 80 kWh battery and a 54 kW photovoltaic (PV) array. This will power 6 buildings in the first phase. A power management system must be installed with remote controlled (programmable) smart circuit breaker that will be used to block power to low priority buildings and power priority 1 buildings. The inventor, battery and PV array must be scalable up to 200kW. The inverter must come with a smart grid meter to monitor usage and quality of energy from the grid.

To ensure monitoring and reporting the system should have a data logger for continuous capturing inverter, battery, grid and PV data. It should also be able to log and report warnings, faults, and errors. All data to be cloud based in a remote server for 24-hour remote monitoring via an app with a dashboard for critical data collection, reporting and monitoring of the system.

The installation should be compatible to applicable PV standards, with standard warranty of more than 3 years, and PV GreenCard certified.

Phase 2 of the project will include generator integration, ensuring that lower priority buildings have solar power during loadshedding and to increase energy savings.

1. Introduction

The aim of this proposal is to present an energy solution to address the challenges introduced by rampant loadshedding and high electricity cost at Orbit TVET College (Brits Campus). The intermittent levels of loadshedding affects critical operations and learning at the institution. The scope of this project covers providing power to critical loads (lights and plugs) in a phased approach according to the schools prioritization requirements outlined below.

2. Scope of Work

2.1. Building layout

The image below depicts the layout of Orbit TVET college, also illustrating the roof layout. This is not as clear, however interested parties can visit the facility to clarify the roof type and direction.

A. Administration Block
B. Cafeteria and staff offices
C. Student support center
D. Staff room and staff resources center
E. Simulation Room
F. Classrooms
G. Classrooms
H. Classrooms
I. Electrical Infrastructure construction workshop
J. Civil engineering workshop
K. Multi-purpose hall
L. Electro technics workshop & classrooms
M. Electronic workshop

Figure 1: Orbit College building layout

The electrical supply comes in through the main distribution board (DB), which is then distributed to the above listed buildings. Each building is equipped with its own three phase distribution board supplied for by the main DB.

2.2. Supplementary energy strategy

Over the past 3 years South Africa has seen rampant load shedding and high electricity cost. This has affected critical schooling operations. For this reason, Orbit TVET college is looking to have supplementary energy in the form of solar power.

The scope of work for this project is to provide 50kW inverter, battery and a 54 kW solar array to supplement the main power distribution board which is powering the entire facility. The priority of the supplementary power is to critical loads in line with the schools priority.

Powering of critical loads and allocating power to prioritised building shall be done using smart controllers. The system's inverter and battery will be housed next to the main DB, while available roof may be used (taking into consideration the north) to fit the Photovoltaic (PV) array.

The system should be scalable such that more PV panels, batteries or inverter can be added to make the system bigger such that it can cover a higher load.

2.3. Building priority

The supplementary energy priority is outlined below. This indicates the buildings that need to have a higher need to have electricity with or without loadshedding.

Priority 1

- Multi-purpose hall (building K)
- Administration Block (building A)
- Classrooms (building H)
- Cafeteria and staff offices (building H)
- Simulation Room (Building E)
- Staff room and staff resources center (building B)

Priority 2

- Student support center (Building C)
- Classrooms (Building F)
- Classrooms (Building G)
- Electrical Infrastructure construction workshop (Building G)
- Civil engineering workshop (Building K)
- Electro technics workshop & classrooms (Building L)
- Electronic workshop (Building M)

2.4. System design and equipment requirements

The scope of work for the supplementary power supply should comply to the illustrated system design.

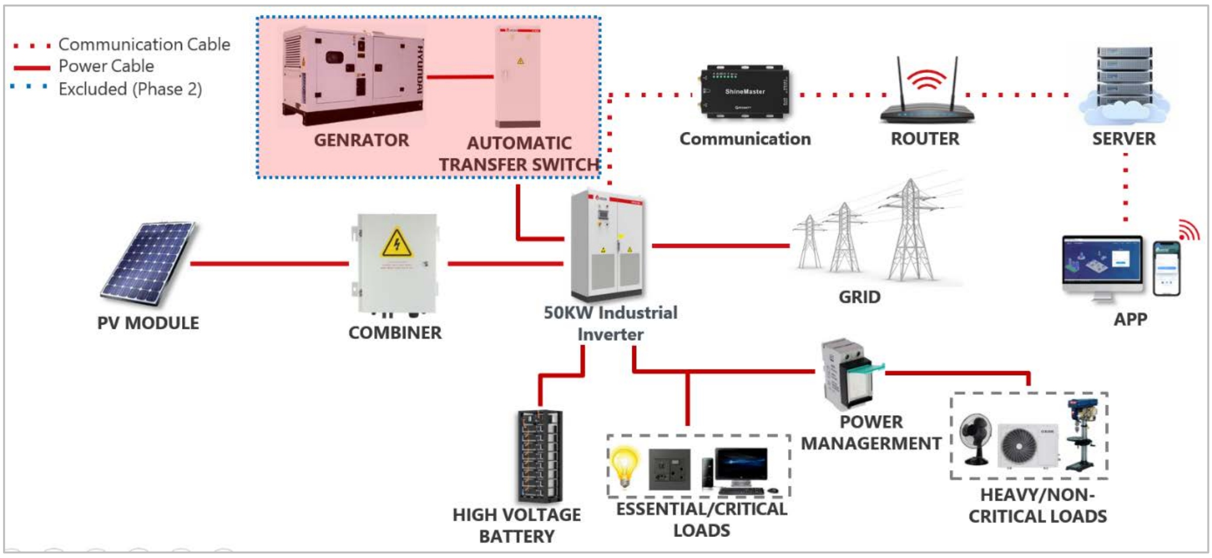

Figure 2: Supplementary power system design

The supplementary power system should have the following characteristics:

A. 50kW hybrid inverter

A single unit transformer-based hybrid inverter with the following characteristics:

- Scalable to increase the capacity of the system to 50kW by connecting more units (upgradable)
- Transformer based inverter to handle inductive and capacitive loads
- Hybrid inverter with capability of powering non-critical loa ds
- Connect to a solar array of 90kW
- Stable power supply with less than 20ms on/off grid switching
- Suitable for commercial and industrial use
- Connectable through an automatic transfer switch to an existing generator and an on/off dry contact
- Large scale three phase application
- High DC bus to allow higher charge and discharge power with lower current
- Compatible with high voltage batteries like (Freedom Won batteries, Pylontech, or equivalent)
- Configurable discharge current for smaller batteries
- Compliant protection and earthing for safety
- NRS approved
- Comes with inverter compatible grid smart metering

B. Automatic Transfer switch (Phase 2)

The school has an existing diesel generator which should be connected to the system. A compatible three phase automatic transfer switch should be connected and have the following characteristics:

- Compatible to both generator and inverter in terms of voltage, current, frequency, breaker (grid, output) current
- Lightning protection Type II
- Protection degree IP20 or better
- Relative humidity 0-95% non-condensing

C. **Solar array**

A 54 kW solar array (using Super High Power monocrystalline) to be installed optimally (north facing) in the available roof space. The solar array and mounting system should have the following characteristics:

- Use super high voltage monocrystalline photovoltaic (PV) panel greater than 500 W per panel
- PV Module efficiency of not less than 21 %
- Greater than 10 year product warranty
- PV panel brand must be from a tier 1 manufacturer
- Mounting system compatible with IBR roof
- All panels to be earthed accordingly
- Mounting system must be compliant to solar installation standards and in line with the load bearing capacity of the roof
- Mounting of solar panels should optimally use the available roof space and ensure that most panels are north facing as much as possible
- A combiner box to reduce the string to 1 or that compatible to the inverter's MPPT

D. **High voltage batteries**

The required battery storage to provide backup power during loadshedding and when there is no sunlight is a 80 kWh battery package. This needs to be provided as a single unit or single stack. The high voltage battery must have the following characteristics:

- High Energy Capacity of 80 kWh
- 80% DoD Energy must be equal to or greater than 60 kWh
- Current capacity 2 000 Ah
- Maximum continuous charge and discharge current 2 000 A
- Maximum continuous charge and discharge power 80 kW
- Round trip efficiency 96-97%
- On-board management comprehensive battery management system and internal trip protection
- On, Off Buttons and manual reset to enable human interface
- Visual display indicating the state of charge (0 to 100%) and error warnings
- USB Plug (equivalent communication port) for Programming and data access with PC
- Protection Shunt Trip Circuit Breaker sized to suit max current, can be tripped by BMS in the event of a critical fault

- Equipped with Battery Management System (BMS) to communicate with inverter and remote monitoring
- Protection for overcurrent, cell under and over voltage, temperature, weak cell detection and other critical events
- Battery Chemistry of the battery must be Lithium Iron Phosphate (LiFePO4)
- Large format ultra-heavy-duty prismatic cells of 200Ah each and 3,2V nominal voltage, fully sealed in plastic casing with bolt on electrode connections
- Battery Cooling through Natural Convection (with negligible heat generation inside the battery)
- Real time data logging and transmission via WiFi to online portal for key battery information and remote monitoring
- Warranty 10 years or 4 000 cycles (or more) for average 80% DoD, and max 90% DoD

E. Power management

Power management in this installation will be used to allow power to high priority buildings and limit power to low priority buildings during loadshedding. Furthermore, it will be used for separation of critical and non-critical loads in high priority buildings. This will ensure that electricity is adequately prioritized and used.

This uses circuit breaker remote control system for facilities energy management via Wi-Fi. To ensure optimal operation, the system is programmed and works independently of any human interface. Should the facilities energy priority changes, the system may be reprogrammed to operate accordingly. Smart breakers will also be used to monitor high consuming breakers to monitor high consuming components apart from the standard circuit breaker operation. The power management systems must have the following components:

- Main server located in the building
- Switches (formerly known as hub)
- Internet access
- Routers
- Equivalently rated smart circuit breakers for low priority buildings (to provide power and cut power)
- Equivalently rated smart circuit breakers for critical and non-critical loads

The power management systems must have the following characteristics:

- Switching off low priority buildings during loadshedding
- Switching off non-critical loads during loadshedding
- Powering critical loads
- Powering high priority buildings
- Perform the normal circuit breaker function

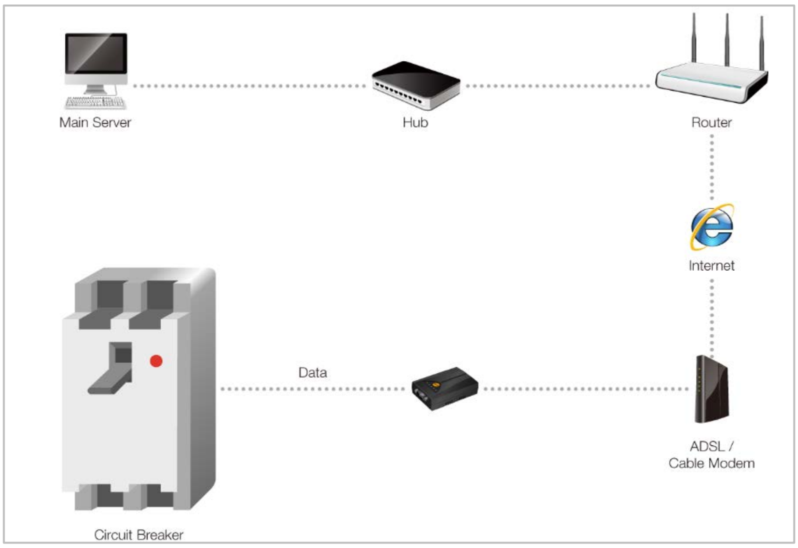

Figure 3: circuit breaker remote control

F. Communication and monitoring

Communication and monitoring of critical system components will be done through the inverter. Critical data collection, reporting and monitoring of the system should have the following capabilities:

- Data Logger for overall system monitoring
- Collect operational data from different units (inverter, battery, PV input)
- Log and reporting of warning, faults and errors
- Cloud storage of data in a remote server
- Responsive to future upgrade requirements
- App with dashboard for remote monitoring (online through a phone or PC)
- Monitoring data available 24 hours a day
- Refresh rate not greater than 5 minutes

G. Grid interface, caballing, labelling and general

The inverter must be connected to the grid. Therefore, the following must be observed:

- Connection to the grid must be done in accordance to set standards and ensure that grid voltage matches the rated output voltage of the inverter
- The phase sequence of grid connection should be correct, and the tightening torque meets the requirements
- The positive and negative poles of DC input connection should be correct, and the tightening torque meets the requirements
- Communication wiring shall be correct and keep a certain distance from the other cables.
- All cables must be marked accordingly and clearly
- All cables must march the rated current in line with set standards
- The insulation protection covers must be correctly fitted and reliable.
- All the danger warning label must be clearly labelled, firm and fixed.

- All useless conductive parts shall betide with insulating ties
- There are no tools, parts, conductive dust or other foreign matters left inside the cabinet.
- There is no condensation of moisture or ice in the cabinet

H. Installation and fitment requirements

The scale of the project and the equipment involved the movement and mounting of heavy weight equipment that requires heavy lifting and precision. As such the bidder needs to observe the following:

- Foundation requirement
- Clearance space in line with relevant standards and manuals to ensure adequate ventilation
- Cable trenching requirements
- Wiring and cable size specifications
- Ventilation requirements
- Ventilation equipment (if required)
- Other protection requirements

I. Separation of critical and non-critical loads

The college's critical requirement is power availability for lighting and plugs. For the purpose of this project those are classified as critical load, while other items are non-critical loads. Critical loads will always have power with priority of power supply starting with solar, grid and lastly battery. Non-critical loads will be powered from access solar power, and the grid.

Installation of the inverter system will only happen at the main circuit breaker. Therefore, backup power will power all the sub-DBs are if power was coming directly from the grid. To enable the classification of critical and non-critical loads, standard circuit breakers currently in place will be replaced with smart circuit breakers. A power management system will be designed and programmed to control the circuit breakers. Critical load circuit brakers will be able to draw power all the time. While non-critical load circuit breaks will only have electricity when grid power and there is excess solar power.

J. Power Prioritization

The power prioritization requirement is to be set as follows:

1. Solar
2. Grid
3. Battery
4. Generator

This prioritization will ensure that solar power is used as often as possible. When there is no solar, grid power must be used before battery power can be used. This is not the most cost-effective way to use the battery, however it does ensure that there is battery power during loadshedding. When the battery has been depleted, and there is no solar power, only then can the generator provide power to the system.

3. Applicable standards

The installation must be compliant with the following standards and specifications:

- National energy
- Electricity regulation act
- NRS 097-2-1:2010
- NRS 097-2-3:2014
- SAS 10142

4. Warranty Clause

4.1. Standard Warranty

The Product will be free from defects in materials and workmanship for a period of thirty six (36) months from the date of installation, but no more than sixty-five (65) months from the date of manufacture of the Product (whichever comes first). Failure to adhere to warranty conditions may result in warranty being void.

5. Briefing clarification

Question 1:

No.	Question	Answer
1.	Specification was requested regarding the batteries and inverter.	It was stated in the briefing that the detailed scope of work would be provided and updated on the document on E-tender
2.	In which building should solar panels be installed	It was stated that the bidder should look at the top view of the campus and propose the best location for the solar panels in line with true North. Simulation results should be presented as part of the proposal.
3.	Would the college be willing to cut trees in order to maximise on the energy generation	Bidders are open to making that proposal for the school to consider. Where feasible, that can be considered.
4.	What solar panel brand should be used?	The BOQ states Canadian solar. However, any solar panel manufactured by a tier 1 manufacturer can be used.
5.	Do all the building have COCs	We cannot answer that at the current moment. However, the school will make provision for that before installation.