Solar Generation for Remote Borefields

Hybrid System Manual

Written by Team Power

# Safety

Personal safety and the safety of the equipment should be first priority when starting the system, running maintenance checks or shutting down the system for replacement procedures or decommissioning. When visiting the borefield the following personal protective equipment (PPE) must be worn to ensure the safety of the visitor.

* Boots
* Ear plugs (during diesel generator operation)
* Gloves
* Hard hats
* Sunscreen

The list above is only a guide to the PPE required for site visits and should be altered depending on the purpose of the visit. All visitors to the borefield who are undertaking maintenance checks should follow the maintenance procedure outlined in section 3 and become familiar with the technology at the site prior to visits. This would include any extra information outlined by the manufacture of each technology of the overall system.

# Start-up Procedure

**PV Module (DC) Connection**

**CAUTION**: Before connecting to PV modules, please install separately a DC circuit breaker between inverter and PV modules.

Step 1: Check the input voltage of PV array modules.

Step 2: Disconnect the circuit breaker.

Step 3: Check correct polarity of connection cable from PV modules and PV input connectors. Then, connect positive pole (+) of connection cable to positive pole (+) of PV input connector. Connect negative pole (-) of connection cable to negative pole (-) of PV input connector.

Step 4: Make sure the wires are securely connected.

**Battery Connection**

**CAUTION**: Before connecting to batteries, please install separately a DC circuit breaker between inverter and batteries.

Step 1: Check the nominal voltage of batteries.

Step 2: Make sure the wires are securely connected

**Inverter start up tests (hard hat, gloves, and eye protection recommended)**

**CAUTION**: It's very important for system safety and efficient operation to use appropriate cable for AC connection.

Step 1: Be sure that the inverter is off before proceeding with this section.

Step 2: Test the continuity of all DC fuses to be installed in the DC string combiner box, install all string fuses, and close fused switches in combiner box.

Step 3: Check open circuit voltage at DC disconnect switch to ensure it is within proper limits according to the manufacturer’s installation manual.

Step 4: If installation contains additional DC disconnect switches then voltage check on each switch working from the PV array to the inverter DC disconnect switch closing each switch after the test is made except for the final switch before the inverter (it is possible that the system only has a single DC switch).

Step 5: At this point consult the inverter manual and follow proper start-up procedure (all power to the inverter should be off at this time).

Step 6: Confirm that the inverter is operating

Step 7: Confirm that the operating voltage is within proper limits according to the manufacturer’s installation manual.

Step 8: After recording the operating voltage at the inverter close any open boxes related to the inverter system.

Step 9: Confirm that the inverter is producing the expected power output on the supplied meter.

**Diesel Generator start up**

The 138 kVA three phase Cummins diesel generator consist of an internal start up mechanism and require only the push of the START button on the main generator console. Refer to generator manual for more information.

# Refuelling the Diesel Generator

The fuel level in the diesel generator should be monitor during every site visit. However, the length of operation of the generator will become consist during the lifetime of the project and therefore an accurate schedule can be drafted. For the safest outcome, refuelling of the diesel generator should be done when the generator is not in operation and cold. The diesel generator is intended to be in operation only during the night when the PV system and the battery bank are unable to provide sufficient power to the pumps hence refuelling should take place during the day when the PV is operating and the generator has had time to cool.

# Maintenance Procedures

The following section outlines the maintenance procedure for the PV array, battery bank, inverter, boost converter and diesel generator. These steps are only a guideline for generic technologies and more precise maintenance procedures should be obtained by the supplier. It should also be noted that these maintenance procedures are in no particular order.

**PV**

* Although solar cells are made to be self-cleaning, that is, rain water should wash away dust or dirt on the panel any build-up of dust or bird droppings should be cleaned using water with small amounts of soap
* Solvents should never be used to clean the panels
* The area around the solar panels should be checked for possible shading hazards. Any objects that could cause shading should be removed
* Panel mountings should be checked for corrosion
* Telemetry system for the solar panels should be checked regularly to monitor the performance of the panels.

**Battery Bank**

* Check and clean battery terminals
* Ensure batteries are receiving sufficient cooling
* Perform electrical tests on strings of batteries to ensure voltages across string are kept within 5 % of each other.

**Inverter**

* The inverter housing and vents should be cleaned regularly to remove dust build up
* Housing should be clear of insects and spiders
* Electrical connections should be checked and kept clean
* Electrical operation of the inverter should be tested on a regular basis

**Boost**

* Procedure similar to that of the inverter

**Diesel Generator**

* Check all connections both electrical and mechanical
* Check all metallic frames and the diesel tank for corrosion
* Test the generator of performance

# Shut down Procedure

The shutdown procedure for the hybrid system essentially follows the reverse order of the start-up procedure. Disconnecting the PV array from the system involves firstly turning off the AC isolator located next to the inverter for that PV array and then turning off the DC isolator which is also located next to the inverter. The diesel generator can be shut down by pressing the stop button on the generator console.