Sustainable change through education, engineering and communication

GSES® global sustainable energy solutions

Trouble Shooting and Fault Finding

Training • Consulting • Engineering • Publications



LARGER GRID CONNECT SOLAR SYSTEM

Fault Detection

- Faults and failures in the system can range from being very minor, such as temporary ground fault due to rain, to serious issues, such as output from the plant failing to synchronise with the grid in terms of voltage, PF or frequency.

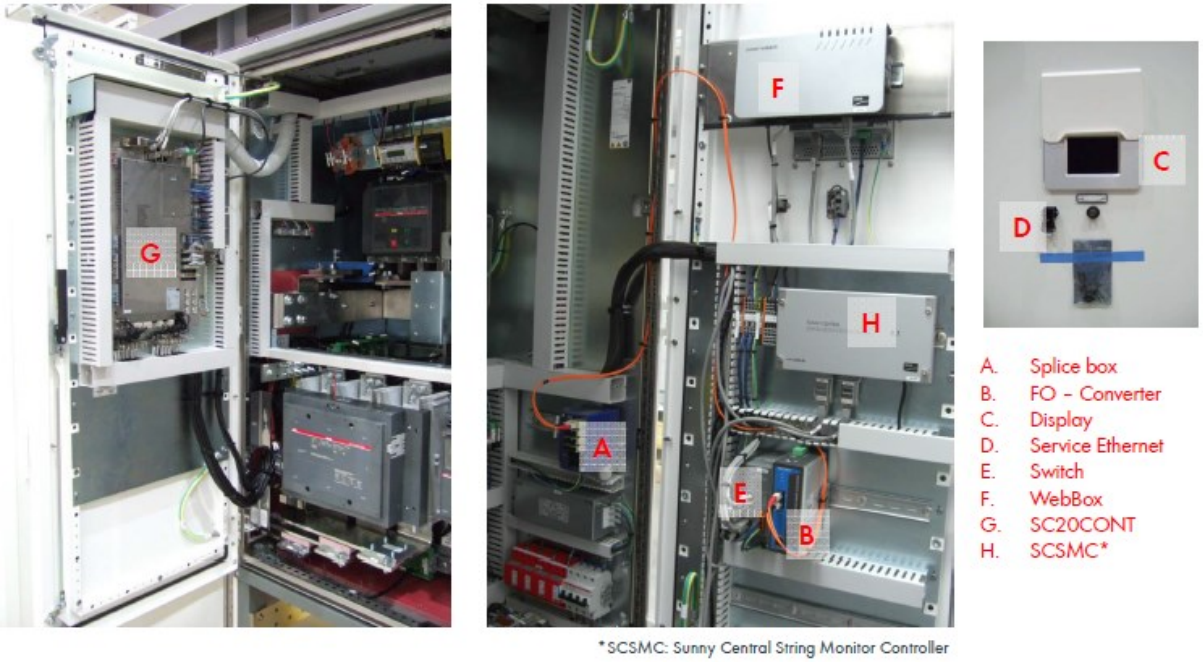
- It is important that operations personnel are notified in some way of the fault or failure so that appropriate action can be taken based on the severity of issue.

- String monitoring remains the convention, but as systems become increasingly larger, the level and type of monitoring may change over time.
  - String faults will be detected by string monitoring which are basically current transformers, and are typically built into string combiner boxes.
  - DC isolation is also built into string combiner boxes, and often has the ability to remote trip as signalled by the SCADA system.

Fault Detection

Monitoring provided at the inverter level will provide the majority of fault detection capability. These days most utility scale inverters are embedded with monitoring capability which includes:

- **Monitoring voltage, current, power and energy** (daily, monthly, lifetime) for the array that they are connected to.
- Keeping a **fault log**, including residual current levels and ground fault detection.
- Providing **active inverter comparison** (where inverter output is compared in real time against pre-defined tolerances).
- Showing **communication (comms) status** (i.e. any comms dropouts, length of time without comms, etc.).
- Showing **inverter attenuation level** based on SCADA or network control.



Inside an SMA Sunny Central CP inverter with string monitoring equipment.
Source: SMA Solar Technology AG

Fault Detection

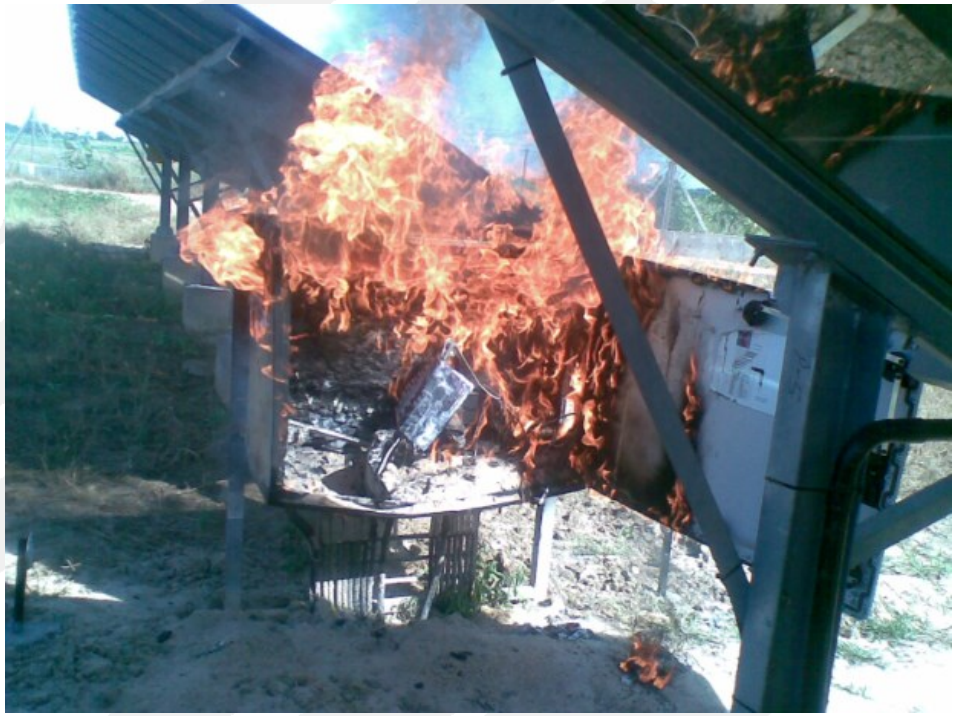
The operational personnel may be notified of a fault or failure in the system via either of the following ways:

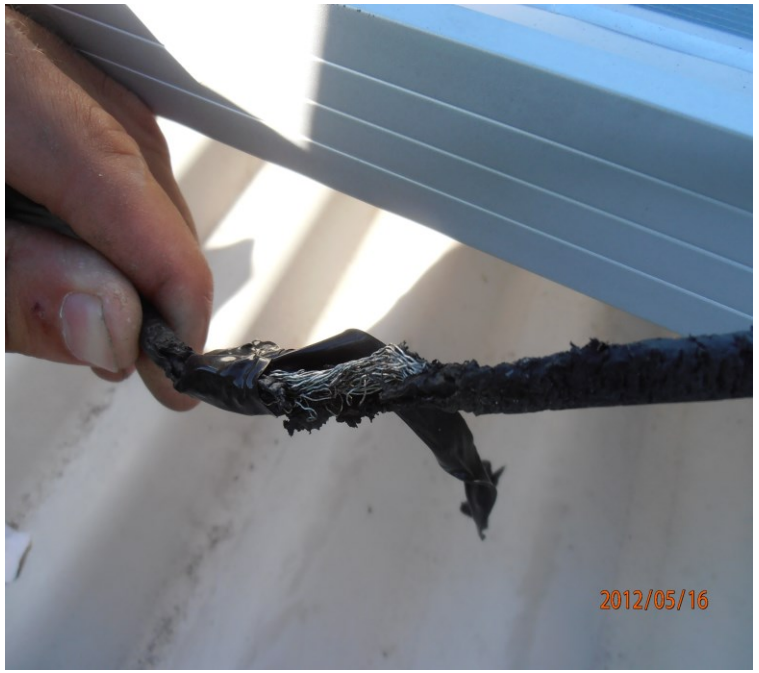
- An alarm or error report sent from the monitoring system
- Routine inspection conducted by maintenance personnel
- Performance analysis of the power plant
- An alarm or error report sent from a third party such as network service provider.

LOOKING AT COMPONENTS

Trouble shooting

- It is difficult writing a comprehensive fault finding document when there can be great variations in the number of inverters and array layouts in a system .





Training

- You should be trained by supplier or manufacture on how to fault find-their particular products—PARTICULARLY INVERTERS and ANY MONITORING
- Rest of system can be generic

System Faults

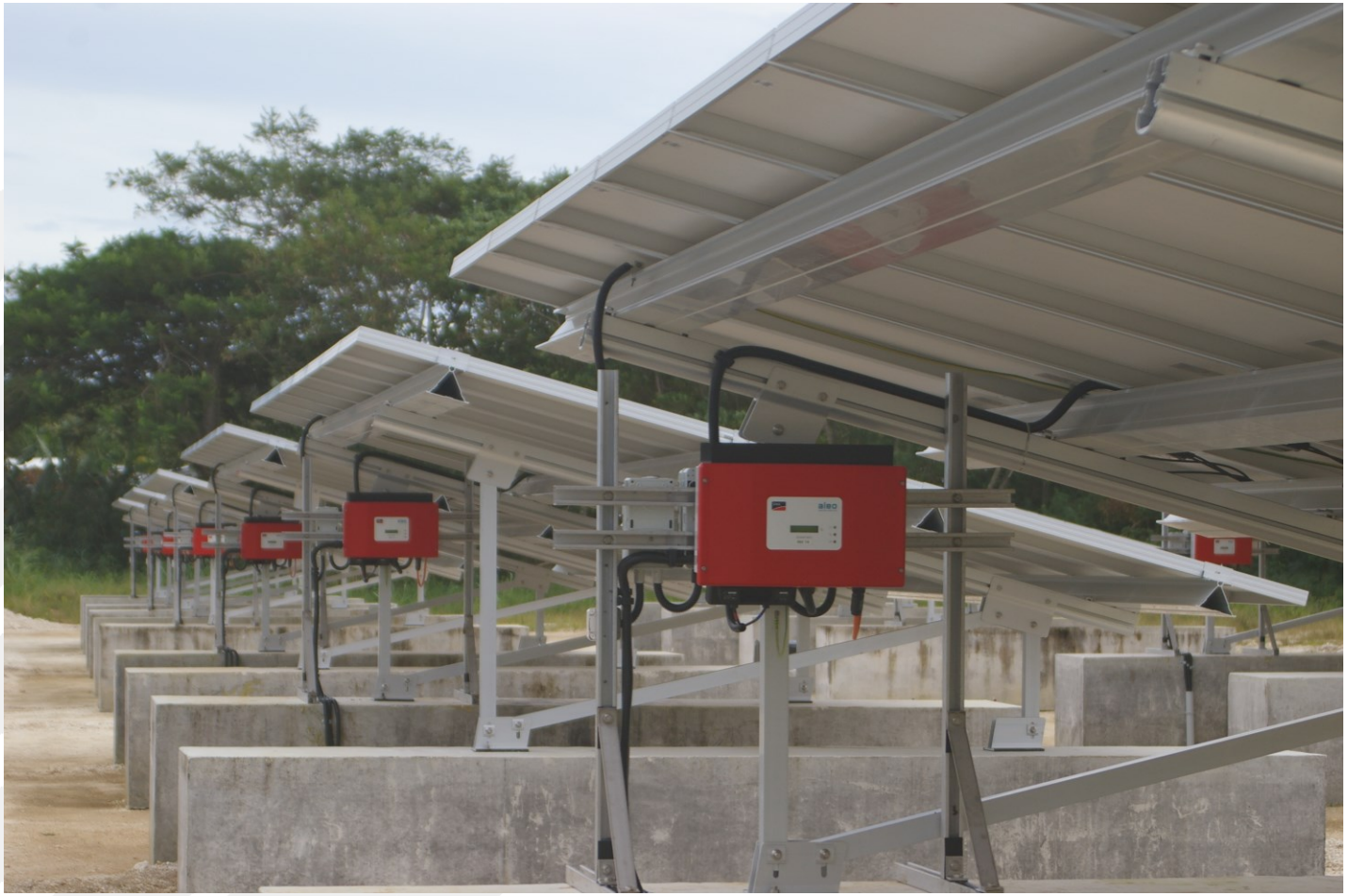
- Easier to talk basic systems first--
- If it is small system then you will notice that there ism a fault when the system is not working or it is underperforming, that is not providing the kWh that was expected.
- Larger systems it will be a case where part of the system is not working and your indicator will be underperforming system

What do you do?

- If it is large system then you might be able to identify which part of the system is underperforming through monitoring.
- Might be able to identify data collected from either large inverter based system that it is one or more strings have failed or under preforming
- If it is multiple inverters in the system –
  - there might be central data source that provides data from each of the inverters
  - These inform you that one or more inverters are not producing energy or under performing.

What if there is no central monitoring?

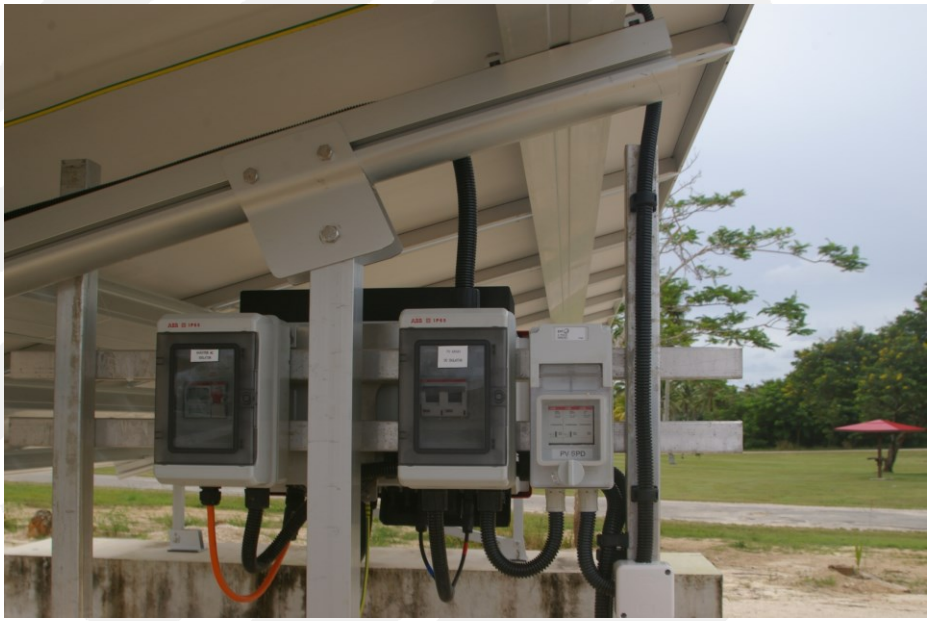
- Visually inspect each inverter.

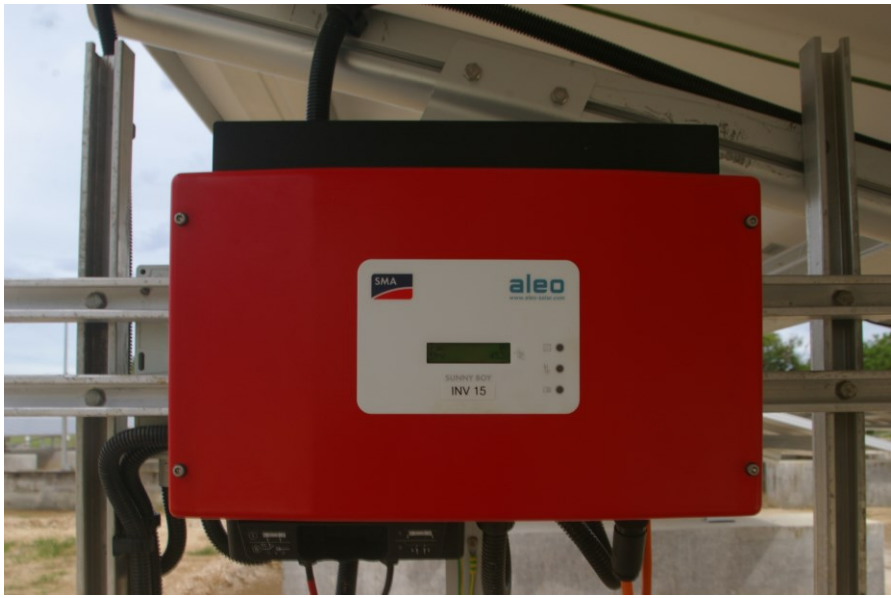


System (or part) Not Working

EASIER NOW JUST TO TALK AS IF ONE SYSTEM

- equipment fault .
- System not operating at that exact point of time due to the inverter not being connected to the grid.





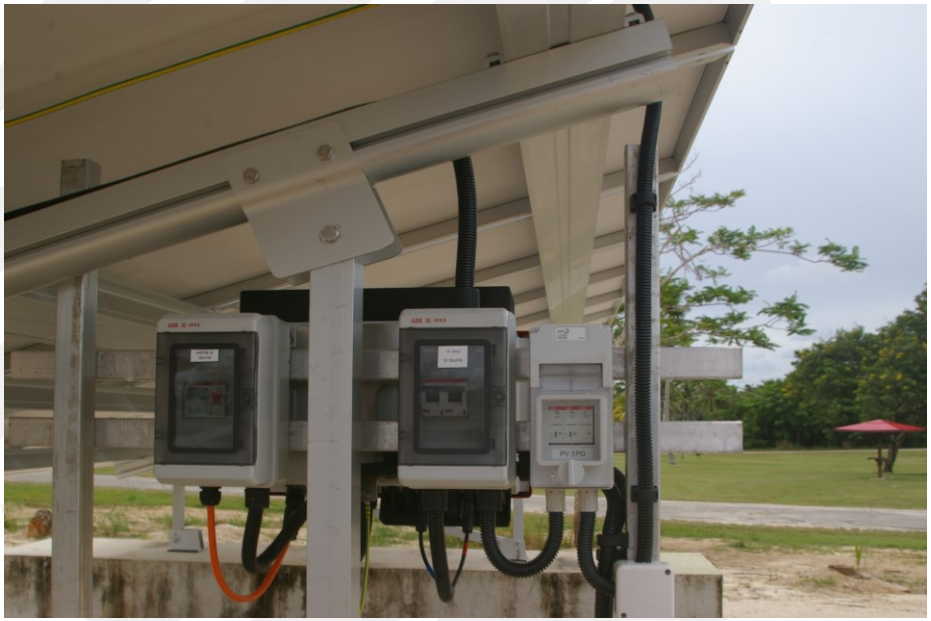
What to do when if system is not working?

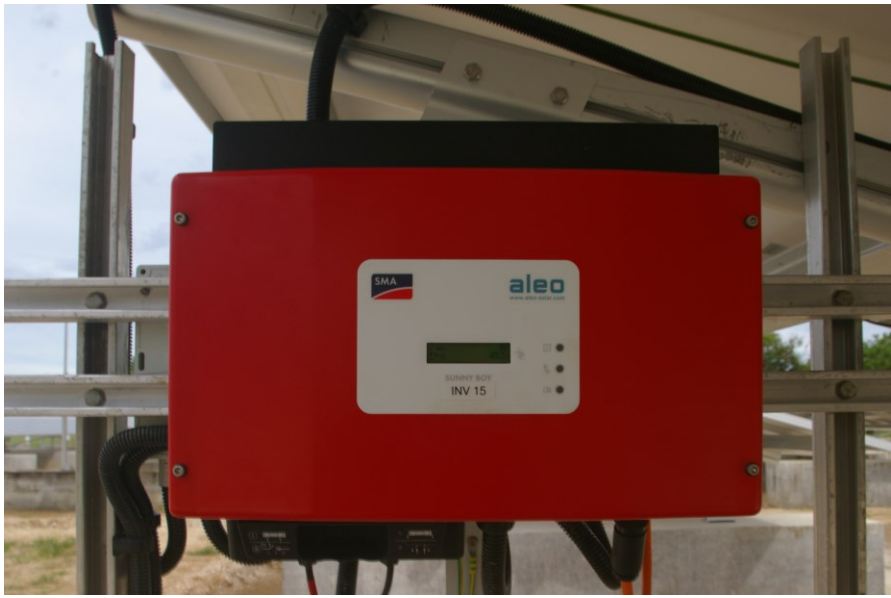
- visit should occur during daylight hours
- Have sufficient hours to do proper testing
- check
  - array d.c. main switch
  - array a.c main switch
  - breaker at the point of attachment to the grid supply (If exists)
- If all the breakers and switches are on, then undertake a visual check of the inverter. Make sure there has not been a failure

Voltage Measurements

At Input/Output terminals of inverter:

- Check d.c voltage
- Check a.c voltage





No a.c. at inverter – all switches on etc-

systematically check all the way back to the point of supply to find the fault. This will involve measuring whether a.c voltage is present :

- at the meters; then
- on the inverter side followed by the supply side of the array a.c mains switch; then
- at the point of attachment to the grid supply.

No d.c. input at inverter – all switches on etc-

systematically check all the way back to the point of supply to find the fault. This will involve measuring whether d.c voltage is present :

- at the d.c main switch; then
- At the array junction box; then
- The solar array.

If there is no d.c. voltage at the junction box (for single strings) or there is no voltage at junction box for one string in multiple strings arrays then the fault is in the string. The fault will be either:

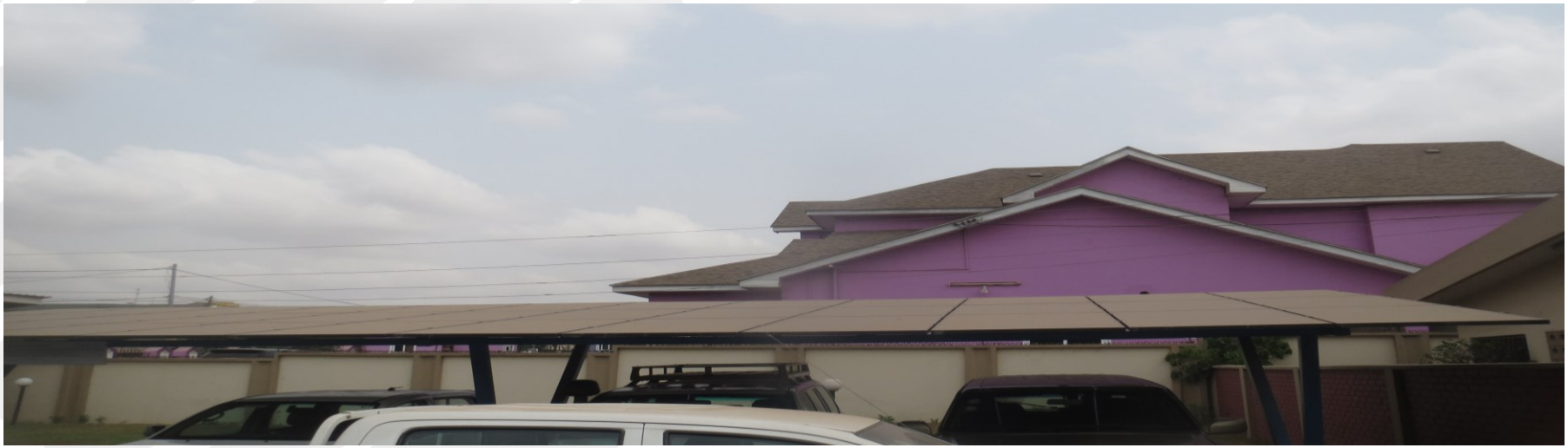
- cable disconnected or plug failure if plugs are used in connecting the string;
- loose connection within the junction box;
- failed bypass diode; or
- failed module

System Underperforming

- You are expecting more from their system than the system can actually deliver.
- poor system design such that the PV array operates at voltages outside the voltage window of the inverter and the inverter disconnects from the grid for long periods.
- from unstable grids such that the grid operates for long periods outside the a.c. voltage window and the inverter disconnects from the grid for long periods
- partial failure of some of the array
- Poor matching between the array and inverter so that the inverter is operating very inefficiently.

If the system is under-performing but it is working when you first arrive:

- visually inspect the system- check if there are trees that may have grown or some other object installed that shades the modules or whether the modules are covered in dirt or bird droppings;
- measure the current coming from the array either using the meter on the inverter or with a clamp meter.



If there is no shading problem but the current is lower then expected then:

- if it is a single string array then the string will need to be tested as described above- but this time looking for why the string is providing less current- it could be one faulty module.
- If there are multiple strings then systematically turn off each string and see whether the current changes. If one of the strings is not providing power then there will be no change in the current when that string has been turned off.

Trouble shooting inverters

- If there is d.c. voltage and a.c. voltage at the inverter terminal (and the solar power is sufficient) but the inverter is not on then the inverter has possibly failed.
- Refer to the manual on the inverter as supplied by the manufacturer

- Grid voltage too high or too low - check the grid and contact electricity distributor if fault is consistent.
- Grid frequency out of range: check the grid and contact electricity distributor if fault is consistent.
- d.c. voltage from array too low: follow advice provided earlier in the section with respect to insufficient modules or temperature problem.

Trouble shooting inverters
General Faults

- d.c. voltage too high - NOTE: This could damage the inverter. Immediately disconnect the array (turn off d.c. array main switch) and investigate why?
- line impedance too high; check that none of the connections on a.c. side are loose then possibly contact electricity distributor if fault persists.
- For transformerless inverters: Leakage current is too high, need to investigate why there is happening- refer to manual for that inverter.