

SAURYAJYOTI RENEWABLES PVT LIMITED

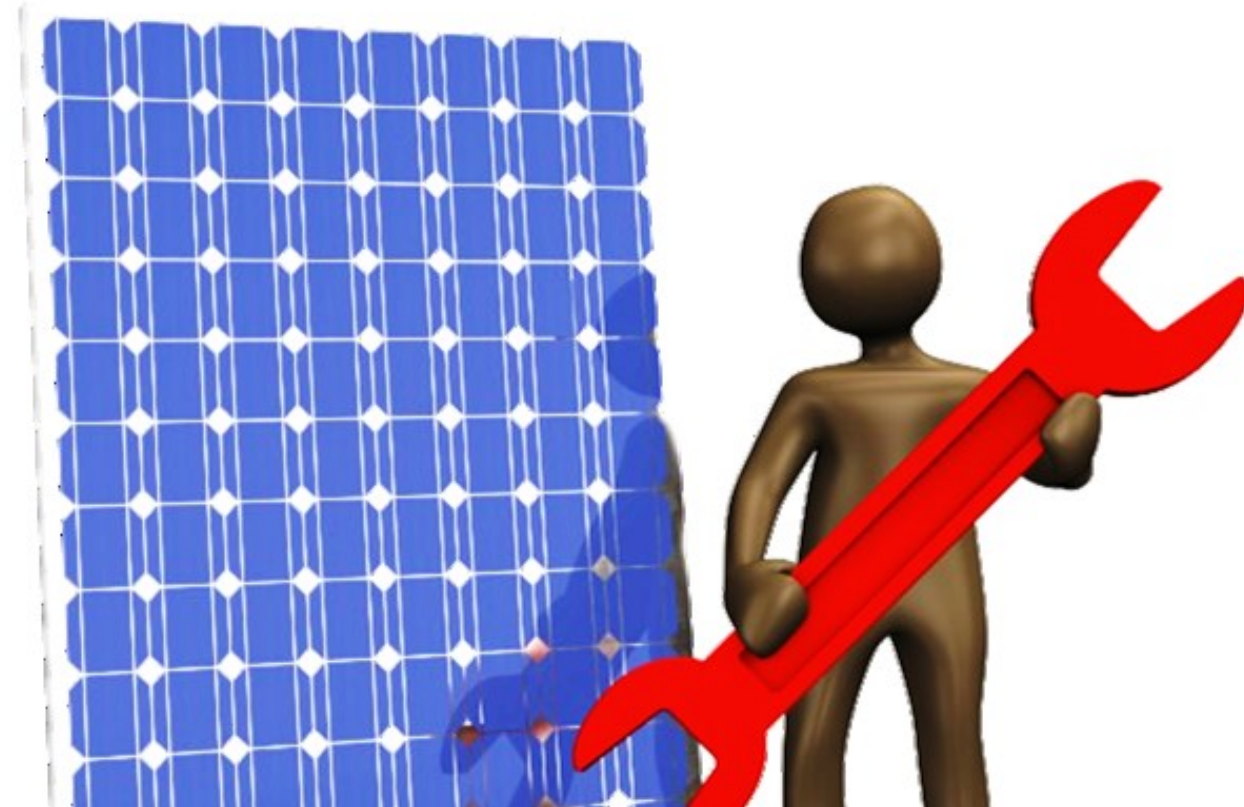
(RENEWABLE DIVISION OF M/S GANAPATI PRODUCTS)



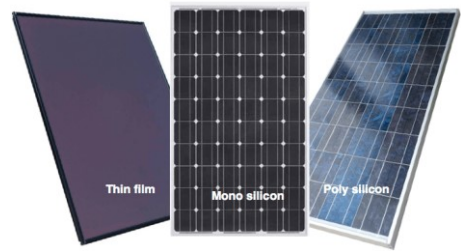
PV INSTALLATION & QUALITY
ASSURANCE BEST PRACTICES

PV INSTALLATION & QUALITY ASSURANCE BEST PRACTICES

- ❖ Effective and simple designs are best
- ❖ Equipment selection
- ❖ Installation work day & efficiency concepts
- ❖ Site prep and install processes (ground prep with clips and roof layout marking essentials)



SYSTEM COMPONENTS



PV Modules



Module Mounting Structures (MMS)



DC Cables



Strings Junction Box (SJB)



Inverters



Lightning Arrestors



Earth Pits



AC Distribution Box (ACDB)



AC Cables

EFFECTIVE AND SIMPLE DESIGNS ARE BEST

- Goals = increase productivity and profitability
- Less complicated designs result in faster installations
- Typically more reliable performance

How?

- Avoid mini array “islands” (an array with only one or two modules)

Why?

- Lots of penetrations per module
- Lots of cabling and conduit runs
- More design challenges depending on inverters used
- More complications in predicting system performance

EFFECTIVE AND SIMPLE DESIGNS ARE BEST

How?

- Avoid overly challenging sites

Why?

- A skipped opportunity is a lot cheaper than a site that costs you money
- Liability on challenging roof types from leaks or damaged materials or excessive engineering and equipment costs
- Time spent to close the sale, design and build this one system could have been used on three other conventional sites. aka “opportunity cost”
- Reduced safety issues and mistakes.

EQUIPMENT SELECTION

Goals?

- Cost, be sure to include labor with your calcs
 - Installation speed / productivity
 - Reliability & performance
 - Reduced callbacks
 - Referrals
 - Safety
-
- Modules
 - Inverters
 - Solar Structure / Racking
 - BOS

EQUIPMENT SELECTION: MODULES

Modules

- Reliability
- Warranty
- Price
- Efficiency?
- kWh per KW or per square foot
- Crystalline Silicon poly vs mono / thin film

EQUIPMENT SELECTION: INVERTERS

Inverters

- Reliability
- Warranty
- Price
- Efficiency?
- String / Central inverter vs Micro inverter?
- Hybrid inverter string with optimizers
- Which is best?

EQUIPMENT SELECTION: RACKING

Solar Structure / Racking

- ✓ Reliability
- ✓ Warranty
- ✓ Price
- ✓ Efficiency?
- ✓ Physically
- ✓ Tested at manufacturer - system approach
- ✓ Briefly it includes–Mechanical–Bonding/Grounding
- ✓ CABLE MANAGEMENT (& CONDUIT management)
- ✓ Include cable management and essential accessories
- ✓ Install quickly with few tools
- ✓ Effective total solution that manages overall costs
- ✓ Roof attachments and flashing typically used

EQUIPMENT SELECTION: BOS

BOS balance of systems (everything else)

- ✓ Junction boxes
- ✓ Flashings (stay away from rubber boot based)
- ✓ Wire splices
- ✓ Sub panels
- ✓ Meter mounts
- ✓ Switch gear
- ✓ DC disconnects needed? Odd site or PV location?
- ✓ Conduit supports? Conduit bonding clamp

INSTALLATION WORK DAY: EFFICIENCY

Industry standard, a PV install in one day is typical

How?

- ✓ Good design
- ✓ Right equipment helps, especially if its mostly pre assembled
- ✓ Man hours per kw is still important
- ✓ eg: nine person crew installing 5kw in one day is likely more expensive than three person crew taking two days...

INSTALLATION WORK DAY: PLAN AND COMMUNICATE

Planning ahead of time and communicating with homeowner is essential.

Before work starts communicate a plan with your team.

–Even drawing out pv stringing on a scrap can be a timesaver.

Set clear goals

–“By 10 am break all racking footings should be in”

–“before lunch all racking should be installed and leveled”

–“we should be laying glass after lunch and testing the system by 3pm...”

Complete as much work as possible at your warehouse or on the ground

–module wire management with wire clips

–prefabricate sub panels

INSTALLATION WORK DAY: PLAN AND COMMUNICATE

Misc

Work like a machine (or an assembly line)

- ✓ One person drills and applies sealant to holes, another follows with L feet/standoffs and flashings
- ✓ If there is a bottleneck redirect or rotate to other items then resume assembly line

Try to stay out of the house (garage) if you can

- ✓ Gear can usually be installed quicker and more readily serviced

Installation Quality

Why does quality matter?

- ✓ Performance
- ✓ Safety
- ✓ Liability
- ✓ Pride & morale
- ✓ Reliability
- ✓ Service costs / call backs
- ✓ Referrals

Installation Quality

Check quality while you work and when system is completed...

- It's best to maintain quality as you work rather than returning to correct something
- If documentation is needed, it may be best to collect while installation is underway
- Sometimes a 2nd opinion can provide a better solution
- It's best to promote high quality not just pick on mistakes
 - ✓ Friendly competition and positive reinforcement can promote productivity and morale. Take pride in your work.

Common Tools & Equipment's Used

☐ TOOLS



Srew Drivers



Hammer



Measuring Tape



Megohm meter



Crimping Tool Set



Angle Finder



Battery Maintenance Kit



Compass



Wire Cutter



Nut Drivers



Flashlight



Cutting Piler



Wire Stripper



Cleaning Brush



Battery water filler

☐ EQUIPMENT



Clamp Meter



Pyranometer



Hydrometer



Multimeter

☐ SAFETY TOOLS



Some observations from Site – DUST Effect

a) Dust observed on PV Modules?



Cleaned Modules



Cleaning Required Shortly
(No significant financial impact)



Cleaning required (Significant financial impact)

The table alongside shows the impact of dust in month of 'December' on a 10 kW system

*Rs. 5.14 is the Tariff Rate (per unit price) considered for calculation for a domestic consumer.

For a commercial consumer, the rate is doubled (Rs. 10/-)

b) Effect of Dust on PV Modules



PV Module	Actual Monthly Energy Generation
Uncleaned Modules 	1,143 kWh
Cleaned Modules 	1,443 kWh

Table 1: Effect of dust on PV Modules

Units Generated	1,143 Units (Uncleaned)	1,443 Units (Cleaned)
Units Gained - (1,443 - 1,143)	300 Units	
Monthly Savings - (300 × 5.14*)	Rs.1,620	
Daily Saving - (Rs 1,620 ÷ 30)	Rs.54 / day	
Annual Saving - (54 × 365)	Rs.19,500 /year	

Financial analysis of dust on PV Modules

Some observations from Site – MODULE SHADING



a) Shading observed on PV Module?



Modules being used to dry chilies



Shading on PV modules due to surrounding objects

PV Module	% of Array Shaded	Power Loss due to Shade
Shaded Modules 	13%	44%
Unshaded Modules 	–	–

Power loss due to shading on modules

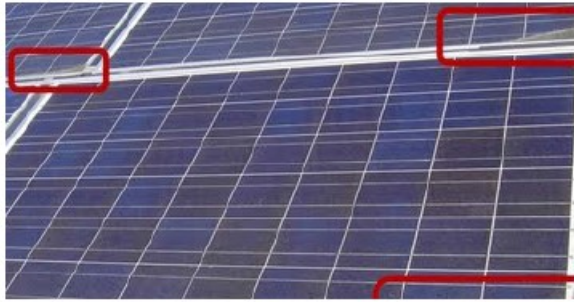
Daily Generation	4.2 Units (Shaded)	7.5 Units (Unshaded)
Units Gained = (7.5 – 4.2)	3.3 Units	
Daily Savings = (3.3 × 5.14*)	Rs.17 /day	
Monthly Saving = (Rs 17 × 30)	Rs.510 / month	
Annual Saving = (510 × 12)	~ Rs.6,100 /year	

Financial analysis of shading on PV Modules

*Assumption: Rs. 5.14/kWh is the power tariff rate of an average residential customer

Some observations from Site – PHYSICAL INTEGRITY OF PV MODULES

a) Physical Integrity observed?



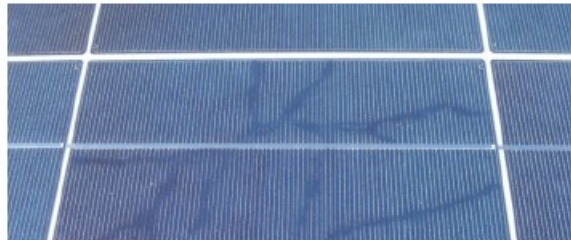
Moisture Condensation



Tiny Hairline Cracks



Corrosion



Delamination



Damaged Module



Never climb on modules



Never sit or stand on PV modules

Some observations from Site – PHYSICAL INTEGRITY OF INVERTERS



LED Green - Indicating correct operation of inverter

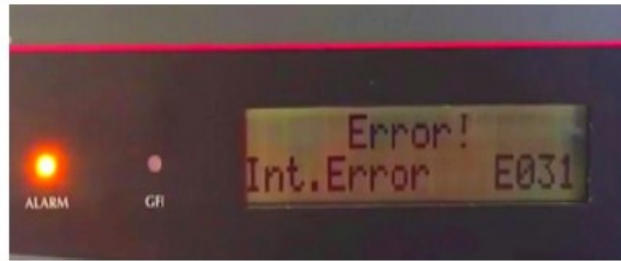


- Check the inverter's display screen, which is the primary indicator of a possible problem with the inverter. The inverter can detect and display inverter warnings and faults.



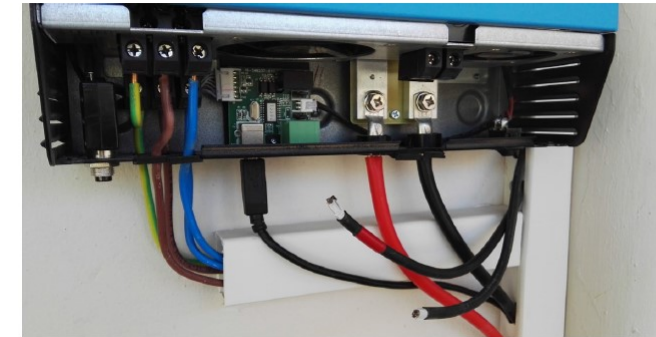
Figure 81: Inverter damage - Burn out

- Visually check or inspect the inverter for external damage.



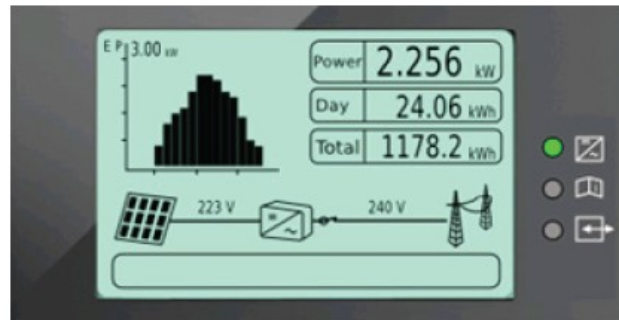
LED Red - Indicating incorrect operation of inverter

- Check for loose or disconnected wires



Disconnected wire from inverter base

- Check inverter display and record all input and output voltages readings.



Inverter display screen



Dust accumulation on Inverter

- Check for noise levels of inverter through an audio check. If you notice that inverter is producing a large humming sound, then contact your service provider. Refer (Unit 3 Advanced Section).
- Inspect, clean or replace the filters (By trained personnel only).

Some observations from Site – PHYSICAL INTEGRITY OF BOS



Cables are tied using cable tie



Blown fuse



Incorrect cables connection looped tightly



Incorrect cables connection looped loosely



Properly insulated



Incorrect - Conduits are damaged



Incorrect - Cable conduit are not closed



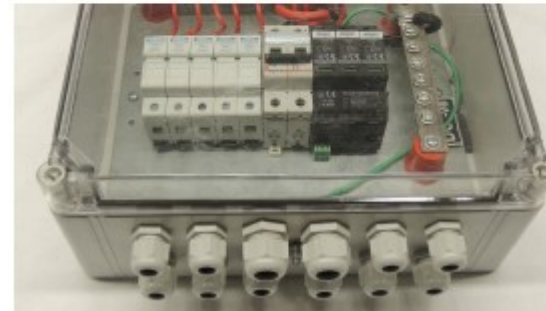
Correct cabling connection



Improper insulation

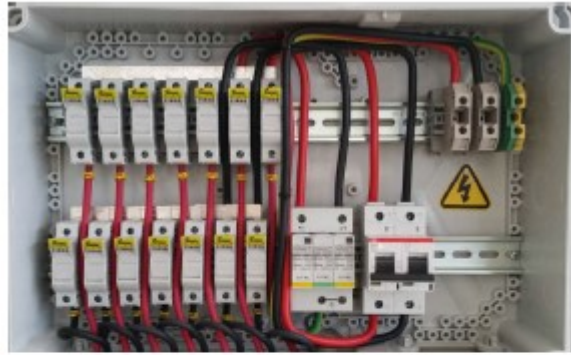


Correct - Conduits are in proper condition

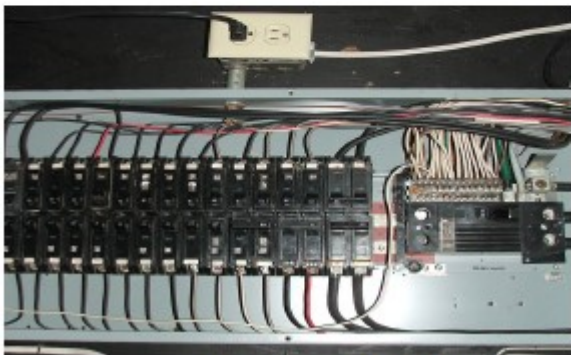


Correct- Cable conduit are closed

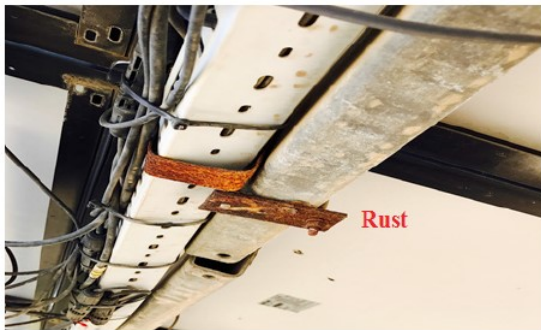
Some observations from Site – STRUCTURE & EARTHING



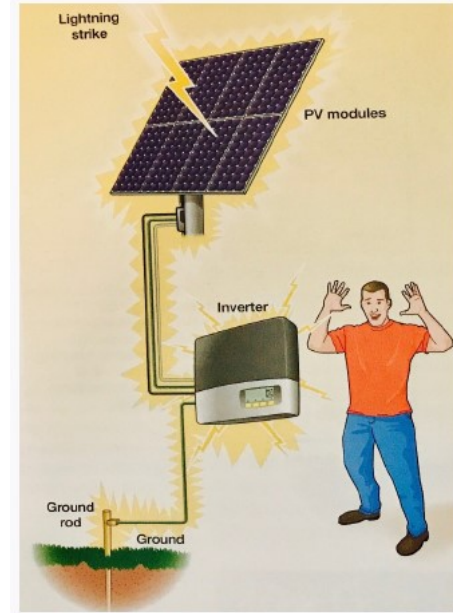
Cables are labelled properly



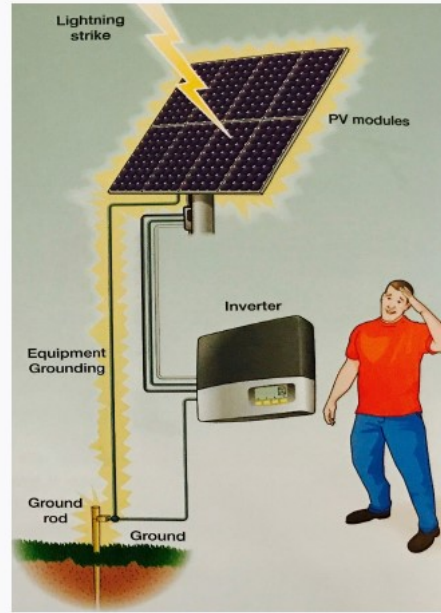
Cables are not labelled properly



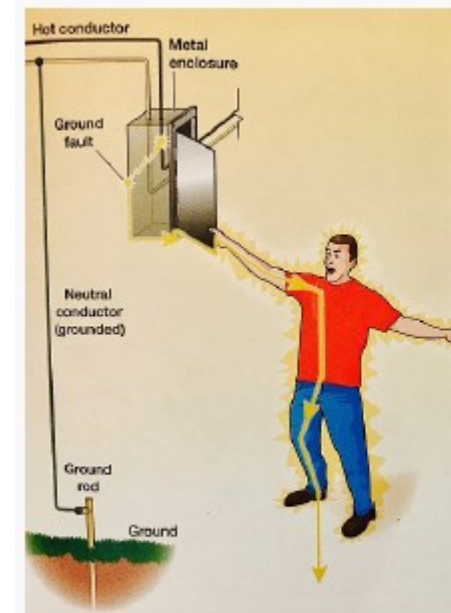
Rusting of Mounting structure



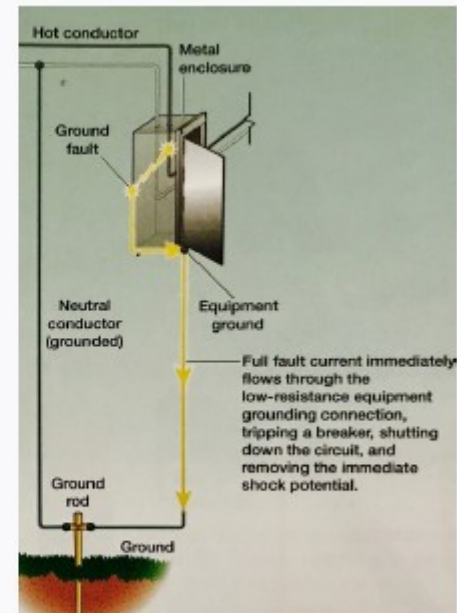
Poor Lightning Protection



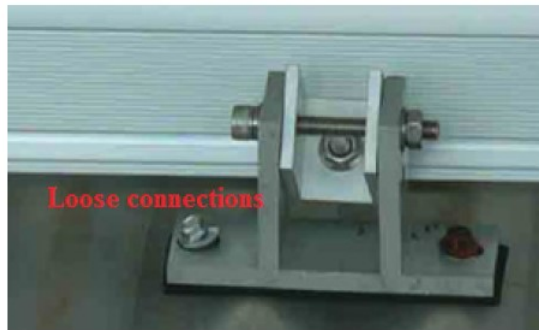
Good Lightning Protection



No Equipment Grounding



Proper Equipment Grounding



Loosed clamps



Good Installation



Bad Installation

Some observations from Site – INVERTER READINGS



Inverter display screen showing units generated by PV system



Net metering display screen showing units consumed by consumer

Some observations from Site – SAFETY NORMS



Incorrect practice - Without safety helmet



Correct practice - With safety helmet



PVC Gloves



Cotton Gloves



Incorrect practice - Without safety gloves



Correct practice - With safety gloves



Incorrect practice - Normal glasses



Correct practice - Safety glasses



Incorrect practice - Without face shield



Correct practice - With face shield



Incorrect practice - Without safety shoes



Correct practice - With safety shoes