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Economic Cooperation**

# Rooftop Solar PV System Designers and Installers

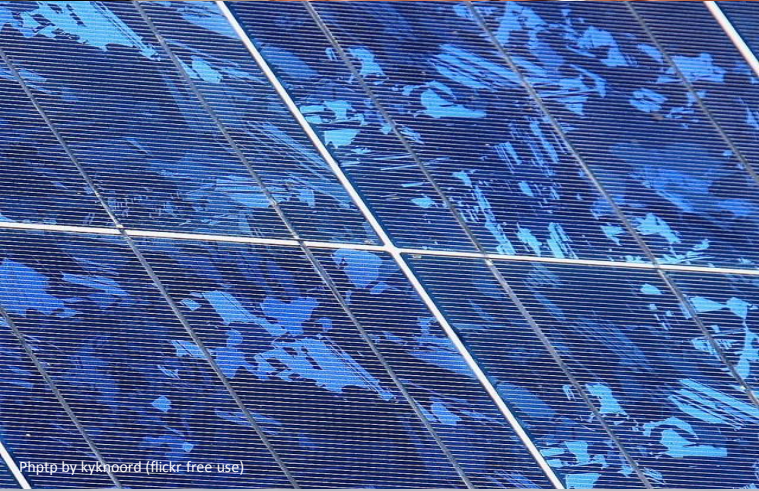
## Training Curriculum

APEC Secretariat

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# Maintenance and Inspection



*Training of PV Designer and Installer*



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# Maintenance and Inspection



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As with any piece of equipment, performing regular maintenance and inspection of components will help ensure system performance and minimize disruption due to component failure. Solar power systems are safe when operating correctly however there are potentially dangerous hazards associated with some system components.



# Why Maintenance



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A rooftop solar PV system require regular inspection and maintenance because:

- It is a potentially dangerous, high voltage electrical generator and require regular inspection and maintenance to remain safe
- It is also an investment for the owner, to ensure maximum electricity production and longevity, the system require regular inspection and maintenance





# Who is Responsible



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While there are a few things that the owner can do, regular maintenance and inspection should be done by **trained technicians** with the right tools

Each new installation of a rooftop solar PV system should be accompanied by a follow up visit within 30 days of commissioning. Ideally, the installer also scheduled an inspection and maintenance visit between 11-12 months after commissioning

The first month and first year visits are designed to ensure that the installation is safe and performing as expected



# What Needs to be Done



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During an inspection and maintenance visit, the first priority by the technician must be SAFETY, The second and third priorities by the technician must be SAFETY and SAFETY



The following parts of the solar PV system must be checked:

- Inverter(s)
- Solar PV
- All wiring
- Combiner box
- Grounding



# What Needs to be Done



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A consistent and comprehensive set of procedures must be defined and strictly followed

Starting at the main utility distribution box, to the inverter, checking the grounding system, going up to the rooftop, and then back to the inverter

Visual inspection, data collection and instrumentation helps the technician to write a complete report of the system's performance and if necessary make adjustments

Tools such as infrared camera, calibrated multimeter, handheld pyranometer and others are indispensable



Disconnect Procedure:

Loads off => AC output disconnected => DC input disconnected

SOLAR PV PANELS CANNOT BE TURNED OFF

It continues to produce electricity as long as there is sunlight

Basic Safety Concerns at a Solar PV Installation Site:

- Falling from height
- Electrical burns
- Electric shock and/or electrocution
- Falling objects
- General construction site hazards



Sequence:

Start at the main AC distribution box from the utility connection => Grid Inverter => Battery Inverter (if installed) => Battery (if installed) => Combiner box(es) (if installed) => Solar Panels

What to check:

- Visual inspection
- Voltage and current
- Fastener torque values
- Hot spots
- Environmental conditions

## Main AC Distribution Box

- Visually check for issues
- Check voltage from inverter
- Check temperatures with IR camera or if using contactless thermometer:
  - Check circuit breaker body temperature
  - Check incoming cable connection temperature
  - Check output cable connection temperature
  - Check busbar temperature
- Turn off utility power and inverter input
- Check cable connector fasteners for torque values
- Observe environmental conditions
  - Water damage
  - Direct sunlight or exposure to weather
  - Other potential damage

## Grid Inverter

- Visually check for issues
- Check voltage from inverter
- Check temperatures with IR camera or if using contactless thermometer:
  - Check AC disconnect circuit breakers and its cable connectors
  - Check DC circuit connectors
  - Check DC disconnect circuit breakers and its cable connectors
- Ensure that utility power and solar PV DC input are off
- Check cable connector fasteners for torque values
- Check mounting structure and bracket
- Observe environmental conditions
  - Water damage
  - Direct sunlight or exposure to weather
  - Other potential damage

## Battery Inverter

- Visually check for issues
- Check voltage from inverter
- Check voltage from batteries
- Check temperatures with IR camera or if using contactless thermometer:
  - Check AC disconnect circuit breakers and its cable connectors
  - Check DC circuit connectors
  - Check DC disconnect circuit breakers and its cable connectors
- Ensure that utility power and battery DC input are off
- Check cable connector fasteners for torque values
- Check mounting structure and bracket
- Observe environmental conditions
  - Water damage
  - Direct sunlight or exposure to weather
  - Other potential damage

## Battery Bank

- Check temperatures with IR camera or if using contactless thermometer:
  - Check battery banks
  - Check fuses
- Ensure that utility power and battery DC output are off
- Visually check for issues
- Wait 30-45 minutes to check battery voltages:
  - Each battery bank
  - Individual batteries
- Check battery rack and DC distribution box
- Check cable connector fasteners for torque values
- Observe environmental conditions
  - Water damage
  - Direct sunlight or exposure to weather
  - Other potential damage

## Combiner box

- Visually check for issues
- Check temperatures with IR camera or if using contactless thermometer:
  - Check all fuses and circuit breakers
  - Check all cable connectors
- Check voltages and current:
  - Each string
  - Total array
- Ensure that utility power and Solar PV DC input are off
- With heavy blankets, cover the solar PV panel array from sunlight
- Check cable connector fasteners for torque values
- Observe environmental conditions
  - Water damage
  - Direct sunlight or exposure to weather
  - Other potential damage



## Solar Panels

- Visually check for issues such as discoloration, cracks, fungus, etc
- Check temperatures with IR camera or if using contactless thermometer:
  - Surface temperature
  - Rear junction box
- Ensure that utility power and Solar PV DC input are off
- With heavy blankets, cover the solar PV panel array from sunlight
- Check mounting brackets and fasteners
- Check all fasteners for torque values and that locking connectors are properly connected
- Observe environmental conditions
  - Water damage
  - Solar panel mounting and shading
  - Roof structure
  - Other potential damage

## Suggested Periodic Maintenance Schedule

- Solar panel cleaning => **At least 3 times per year** (2 times during dry season) in rural areas. At least once every 4 weeks in high pollution urban areas or dry and dusty conditions. Key indicator: more than 5% of energy production loss
- Visual inspection and physical measurements => At least 1 time per year
- Power and energy output monitoring => Monthly report from daily data collection
- System performance monitoring => Automatic daily data collection and immediate warning/alerts set up during commissioning

# Inspection Visual Guide



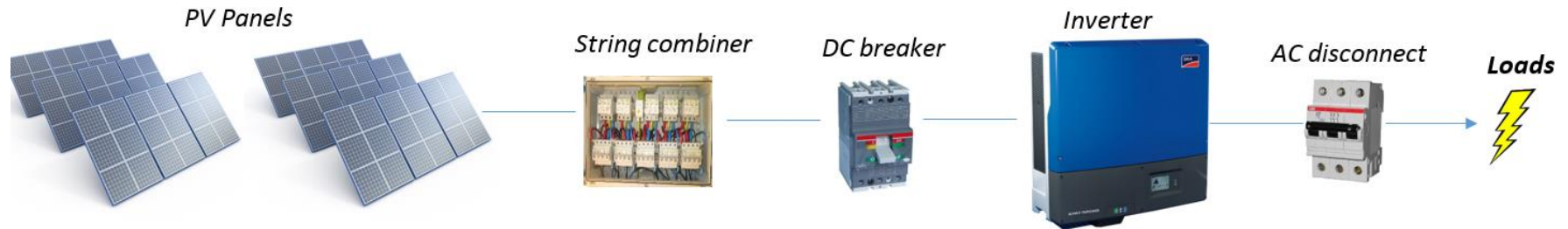
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## General Inspection:

- Check all cables for damage
- Check all breakers and fuses for hot spots
- Check all cable connectors for proper torque values
- Check for proper voltages at all connection points
- Check all fuses and breakers for proper values

## General Inspection:

- Check for signs of animal infestation and damage
- Check for proper air flow and access
- Check all mounting points for loose fasteners
- Check for environmental damage (dirt, wate, etc)
- Check for recent changes or replaced parts



PV Panels

String combiner

DC breaker

Inverter

AC disconnect

Loads

- Check junction box
- Check for damaged cable
- Perform Voc (each module)
- Perform Isc (each module)
- Clean PV module
- Check all connectors
- Inspect for PV quality (“snail-track”, cracked glass, delamination, discoloration)
- Inspect all mounting brackets and fasteners

- Test Voc to test quality connection and how much voltage is produced per string
- Test for Isc per each string array
- Inspect for loose connection, cracked housing, broken/burnt component, unbundled and disorganised cable, unsecure connection, animal inside

- Perform V(AC) and I(AC)
- Test and check functionality and inverter settings
- Inspect for loose connections, corrosion, proper installation
- Check ventilation for blockage
- Check mounting hardware and fasteners





# Asia-Pacific Economic Cooperation

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