PCREEE
Pacific Centre for Renewable Energy and Energy Efficiency
SE4ALL Centre of Excellence to Promote Sustainable Energy Markets, Industries and Innovation

UNIDO UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

GNSEC

Unlocking MG for sustainable development

7.2 O & M

Suva, Fiji

June 26th-30th, 2023

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CONTENTS

1. Session objectives
2. Operation and Maintenance
3. Typical O&M tasks

1. SESSION OBJECTIVES

SESSION OBJECTIVES

i) Discuss key aspects for to consider during the O&M phase of mini-grids.

ii) Share relevant experiences during mini-grid O&M

1. OPERATION AND MANTEINANCE

OPERATION AND MAINTENANCE

O & M Levels

Surveillance level:
Basic maintenance duties to be performed by the beneficiaries of local service e.g. schools or hospitals technicians, porters.

Preventive maintenance level:
Duties to be performed by the professional maintenance contractor.

Supervision – Evaluation level:
Duties to be performed by the premise administrator or a subcontracted technical evaluator

The O&M Plan must always be:

- adapted to the plant implemented and to the site hosting it
- prepared by or with assistance of qualified professional (s)

Reference list of contents

1. Cover – with title, authors, date, and revision tracking registry
2. Identification of roles and staff for Basic Maintenance and Professional contractors – with copies of contracts in annex
3. PV plant description – project as-built
4. Task check-lists – specifying responsibility, frequency for each task
5. Protocol for Basic Maintenance (operating ranges, templates for O&M Book, Troubleshooting)
6. Monitoring plan – specifying parameters, data logging, data downloading and management

EXAMPLE MAINTENANCE GUIDE

INSTALATION COMPONENT	TASK	PERIODICITY
PHOTOVOLTAIC MODULES	General cleaning	1 TIME YEAR
	Review of the of the damages affecting the safety and protection of the modules	SEMI ANNUAL
	Complete review of the installation of photovoltaic modules: degradation, yellow marks, …	SEMI ANNUAL
	Review and tighten terminals and electrical connections.	SEMI ANNUAL
	Review the status of the protection diodes and junction boxes.	SEMI ANNUAL
	Making measurements of open circuit voltage and load current of each string independently.	SEMI ANNUAL
	Thermography of all modules of Photovoltaic Plant	SEMI ANNUAL
	Field measurement of the IV curve / PV strings 10% Plant	SEMI ANNUAL
	Review of the status of the PV modules to the original project, keeping records updated Flash Report	SEMI ANNUAL
INVERTER	Complete review of the inverters mechanical state: IGBT, UPS, Cards, etc	ANNUAL
	General cleaning: blown and vacuuming.	ANNUAL
	Complete revision of inverter operation: IGBT, UPS, cards, checking AC and DC parameters, power factor, THD, etc..	ANNUAL
	Review of the status of the inverter output connections on the stretch of AC	ANNUAL
	Review of the external conditions in which the inverter is installed (humidity, ventilation, etc..). Cleaning air filters	SEMI ANNUAL
	Review of operating temperatures lower than specified by the manufacturer.	ANNUAL
	Review that there´s not abnormal noise and vibrations	SEMI ANNUAL
	Review correct identification of inverters	SEMI ANNUAL
	Thermography	ANNUAL

EXAMPLE MAINTENANCE GUIDE

INSTALATION COMPONENT	TASK	PERIODICITY
	Measurement of the efficiency AC / DC inverters (characterization of the power curve 1 inverter on each plant)	ANNUAL
FIXED STRUCTURE OR SOLAR TRACKERS	Complete revision of the metal structure (grid, turnbuckles, ..) and foundations	SEMI ANNUAL
	Review and correct the alignment of the modules and metal structure	SEMI ANNUAL
	Visual inspection of the state of the foundations and welding	SEMI ANNUAL
	Visual inspection of all parts of the metal structure or trackers, modules anchoring elements	SEMI ANNUAL
	Review the coupling torque of the screws	ANNUAL
	Review correct identification of trackers and fixed structures	SEMI ANNUAL
	Complete mechanical review	SEMI ANNUAL
	Review of the proper operation of all functions of the control system trackers	SEMI ANNUAL
LV ELECTRICAL INSTALATION	Full Review of LV installation: wiring, including ground wires, connections, pipes, switchboards, transformers and meters	SEMI ANNUAL
	Measuring voltages and currents in electrical switchboard	SEMI ANNUAL
	Review of the electrical connections and conectors between panels	SEMI ANNUAL
	Thermography of all the modules, connections, splices and protections.	ANNUAL
	Checking of the supply voltage, electrical protection assay	SEMI ANNUAL
	Review rodents presence. Application of rodent treatment if necessary	SEMI ANNUAL
	Revision the lack of heating or vibrations	SEMI ANNUAL
	Review the properly identification of components and electrical hazard stickers	SEMI ANNUAL
	Check the voltage drop and insulation resistance in the system with lower PR	SEMI ANNUAL
HV ELECTRICAL INSTALLATION	Review rodents presence. Application of rodent treatment if necessary	SEMI ANNUAL
	Complete checking of the whole HV installation	ANNUAL
	Cleaning the components of the HV installation (Clean power transformers, switchgear, busbars and insulators)	SEMI ANNUAL
	Thermography of the switchboards, connections, splices and protections.	ANNUAL
	Checking the optical and acustic indicators	SEMI ANNUAL

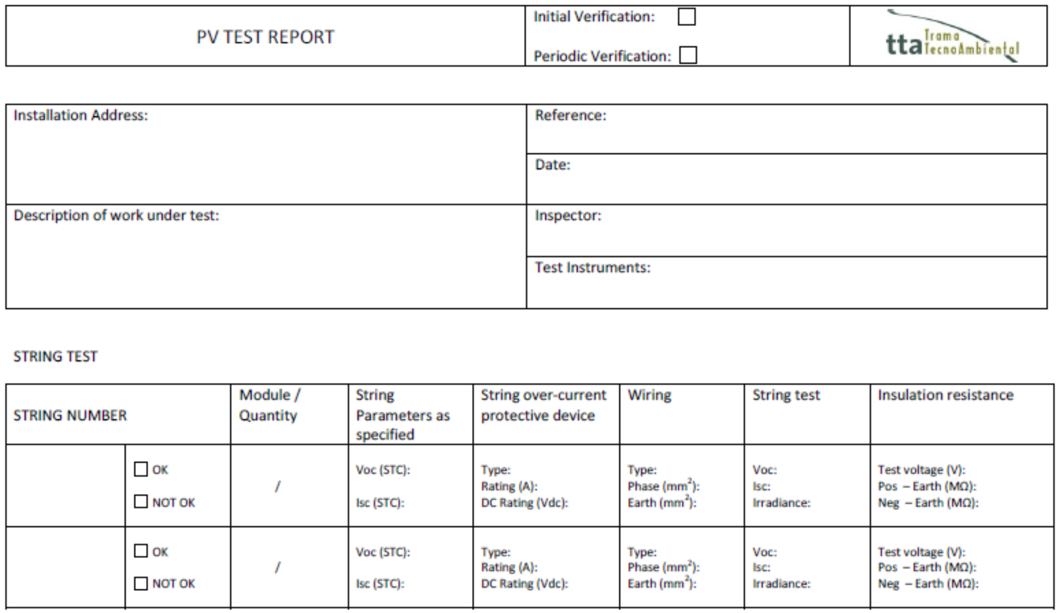
EXAMPLE MAINTENANCE GUIDE

INSTALATION COMPONENT	TASK	PERIODICITY
	Global review of the HV electrical instalation : Checking ground resistance, insulation resistance between conductors, measuring voltajes of step and touch, interlocks, supply voltage, electrical protection assay	ANNUAL
	Review the properly identification of components and electrical hazard stickers	SEMI ANNUAL
MONITORING SYSTEM	Complete review of the elements of the monitoring system installation (wiring, signal converters, switchgear…)	SEMI ANNUAL
	Review of rodents presence. Application rodent treatment if necessary	SEMI ANNUAL
SECURITY SYSTEM	Complete review of the proper working of the security system of the photovoltaic plant, and proper communication (access to cameras and videos, sending alarms) with CRA.	SEMI ANNUAL
	Review of rodents. Application rodent treatment if necessary	SEMI ANNUAL
	Making false penetration testing around the perimeter and simulate alarms	SEMI ANNUAL
	Complete review of the elements of the security system installation	SEMI ANNUAL
	Review of the correct sharpness of the cameras	SEMI ANNUAL
	Cleaning of all the cameras (outer glass, protective housings, etc.)	SEMI ANNUAL
	Revision of the no vegetation in the fenced area	MONTHLY
BUILDINGS AND STORE	Complete review of the existing buildings	SEMI ANNUAL
	Cleaning the buildings and store building.	SEMI ANNUAL
	Review of rodents presence. Application rodent treatment if necessary	SEMI ANNUAL
	Review the correct working of the access doors, opening and closing system	SEMI ANNUAL
	Review of the structural state of the different buildings. Control of the presence of cracks, leaks and / or structural defects	SEMI ANNUAL
	Review of the state of the foundations of building	SEMI ANNUAL
	Review the existence and proper placement of signs and warnings	SEMI ANNUAL
	Review and replacement of existence of safety equipment of the Transformation Centers (extinguisher, gloves, sidewalks, poles, etc.)	SEMI ANNUAL
	Review proper state lighting, ventilation, air conditioning, painting, cleaning air filters	SEMI ANNUAL
	Review of the spare stock	MONTHLY

EXAMPLE MAINTENANCE GUIDE

INSTALATION COMPONENT	TASK	PERIODICITY
	Review of the lack of storage not permitted inside buildings HV installations	MONTHLY
LANDS, ACCESS, ROADS AND DRAINS	Complete review of the land, access, roads and drains of the Plant	SEMI ANNUAL
	Clearing or herbicide application	ANNUAL
	Cleaning of waste and materials intern or external to the actual installation and removal to the waste dump.	MONTHLY
METHEOROLOGIC STATION	Complete review of the weather station sensors, wiring and connections, piping, electrical components, datalogger, switchgears…	SEMI ANNUAL
	Calibration of cells and Pyranometers	EACH TWO YEARS
	Radiation sensors cleaning	**WEEKLY**
PERIMETER FENCE AND OTHERS	Review of doors, locks, hinges, plain and perimeter fence posts so that it is in perfect operation..	SEMI ANNUAL
	Compliance with environmental obligations	ANNUAL

TEMPLATE EXAMPLES

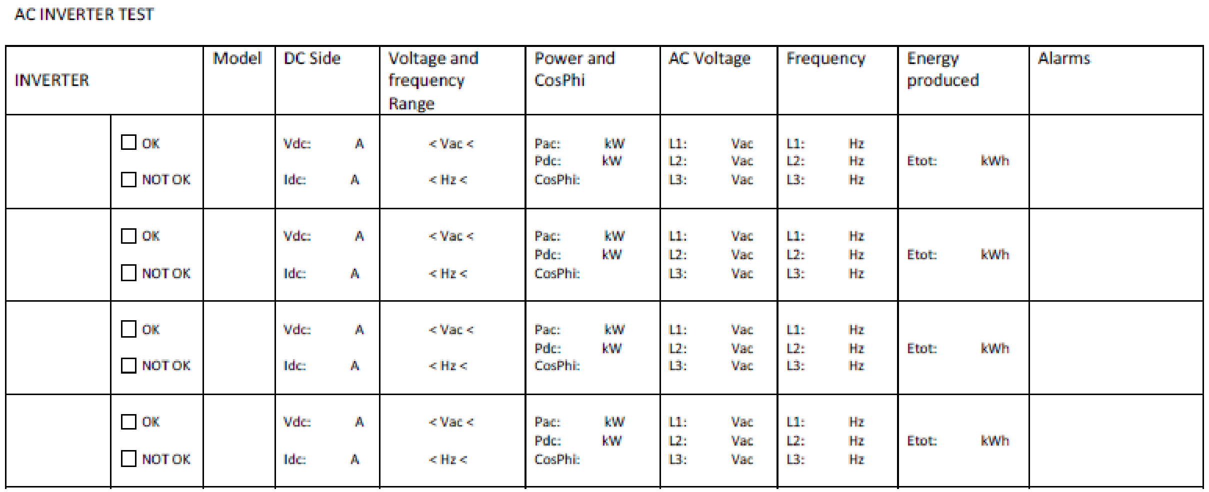


PV TEST REPORT	Initial Verification: ☐ Periodic Verification: ☐	tta Trama TecnoAmbiental

Installation Address:	Reference:
	Date:
Description of work under test:	Inspector:
	Test Instruments:

STRING TEST

STRING NUMBER		Module / Quantity	String Parameters as specified	String over-current protective device	Wiring	String test	Insulation resistance
	☐ OK ☐ NOT OK	/	Voc (STC): Isc (STC):	Type: Rating (A): DC Rating (Vdc):	Type: Phase (mm^2): Earth (mm^2):	Voc: Isc: Irradiance:	Test voltage (V): Pos – Earth (MΩ): Neg – Earth (MΩ):
	☐ OK ☐ NOT OK	/	Voc (STC): Isc (STC):	Type: Rating (A): DC Rating (Vdc):	Type: Phase (mm^2): Earth (mm^2):	Voc: Isc: Irradiance:	Test voltage (V): Pos – Earth (MΩ): Neg – Earth (MΩ):



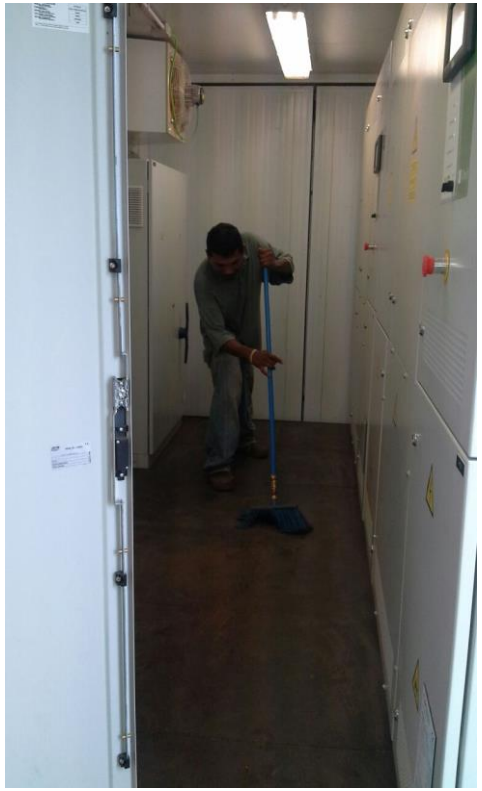
AC INVERTER TEST

INVERTER		Model	DC Side	Voltage and frequency Range	Power and CosPhi	AC Voltage	Frequency	Energy produced	Alarms
	☐ OK ☐ NOT OK		Vdc: A Idc: A	< Vac < < Hz <	Pac: kW Pdc: kW CosPhi:	L1: Vac L2: Vac L3: Vac	L1: Hz L2: Hz L3: Hz	Etot: kWh	
	☐ OK ☐ NOT OK		Vdc: A Idc: A	< Vac < < Hz <	Pac: kW Pdc: kW CosPhi:	L1: Vac L2: Vac L3: Vac	L1: Hz L2: Hz L3: Hz	Etot: kWh	
	☐ OK ☐ NOT OK		Vdc: A Idc: A	< Vac < < Hz <	Pac: kW Pdc: kW CosPhi:	L1: Vac L2: Vac L3: Vac	L1: Hz L2: Hz L3: Hz	Etot: kWh	
	☐ OK ☐ NOT OK		Vdc: A Idc: A	< Vac < < Hz <	Pac: kW Pdc: kW CosPhi:	L1: Vac L2: Vac L3: Vac	L1: Hz L2: Hz L3: Hz	Etot: kWh	

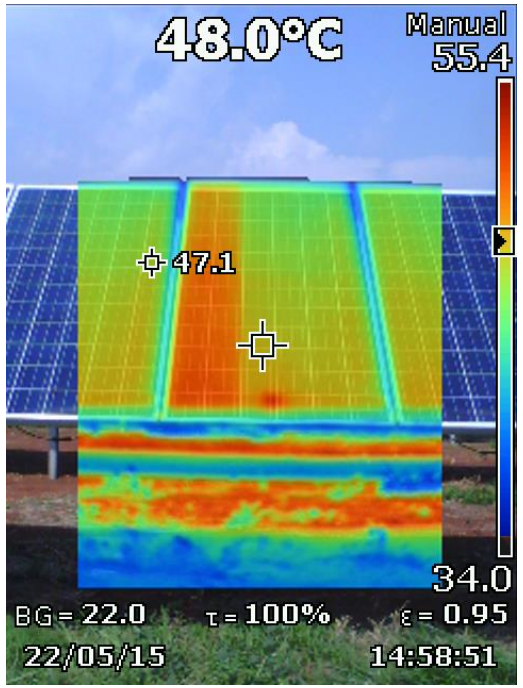
2. TYPICAL O&M TASKS

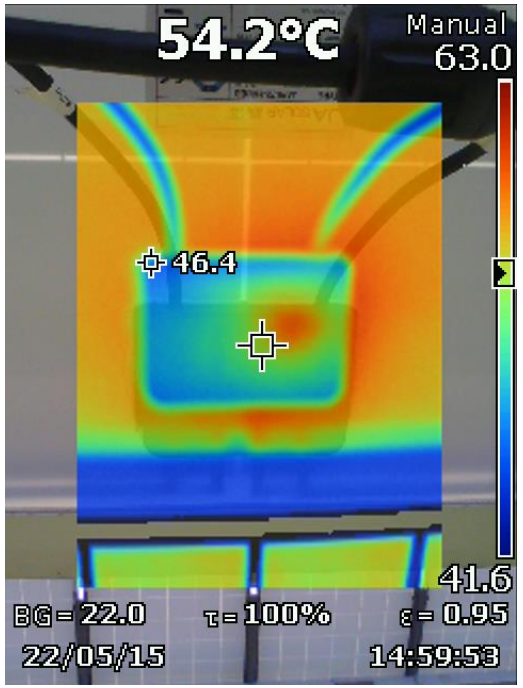
OPERATION AND MAINTENANCE TASKS

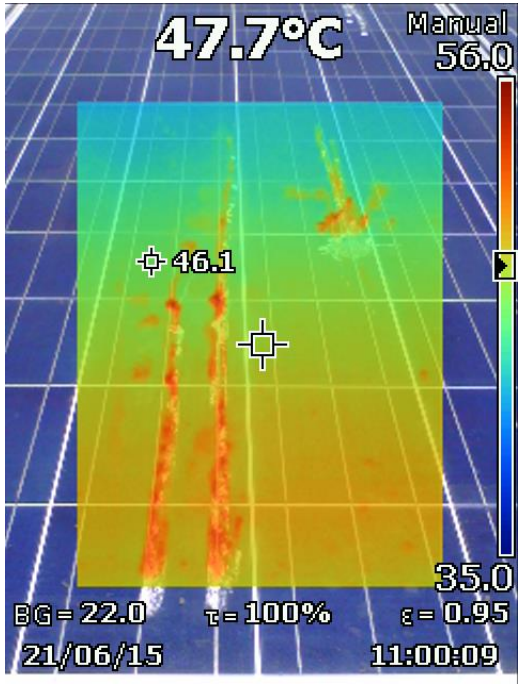
OPERATION AND MAINTENANCE TASKS



OPERATION AND MAINTENANCE TASKS







BATTERY CARE

- Regular maintenance and care increases the reliability and service life of your battery system
- Document all maintenance work and measurement results

  they may be necessary for future warranty claims
- Semi-yearly maintenance work
  - Measure the voltage of the battery system in trickle charge mode
  - Measure the individual voltages of the cells/blocks in trickle charge mode
  - Measure the electrolyte density of a few cells/blocks
  - Measure the electrolyte temperature of a few cells/blocks
  - Check/balance the electrolyte level of the cells
  - Measure the room temperature

- Regular maintenance and care increases the reliability and service life of your battery system
- Document all maintenance work and measurement results,

  they may be necessary for future warranty claims
- Yearly maintenance work
  - All maintenance and inspection work performed during the semi-yearly interval
  - Visual inspection of all screw and cable connections
  - Check all screw connections using a torque wrench
  - Visual inspection of the battery frame or battery cabinets
  - Check the ventilation and exhaust system
  - Check all components associated with the battery
- Never clean with a feather duster or synthetic fiber cloth

Vinaka!

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