Solar PV System Installation and Maintenance

Level IV

Learning Guide -28

Unit of Competence	**Compile and Produce Solar PV Installation Detailed Report**
Module Title	**Compiling and Producing Solar PV Installation Detailed Report**
LG Code	**EIS PIM4 M08 LO1-LG28**
TTLM Code	**EIS PIM4 TTLM 0920v1**

LO1: Prepare to develop a solar PV installation report

ADRA ETHIOPIA

Instruction Sheet	Learning Guide:-28

This learning guide is developed to provide you the necessary information, knowledge, skills and attitude regarding the following content coverage and topics:

- OHS processes and procedures for a given work area are identified, obtained and understood.
- Established techniques for report writing are reviewed are adopted in accordance with organization policies.
- The scope of the report is evaluated and report parameters established using a formal evaluation/survey processes.
- Criteria from other related works impacting on the report are determined from other sources.
- Source and availability of information is identified.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:-

- Identify, obtain and understand OHS processes and procedures for a given work area,
- Review and adopt established techniques for report writing in accordance with organization policies.
- Evaluate the scope of the report and use formal evaluation/survey processes
- Determine criteria from other related works impacting on the report from other sources.
- Identify source and availability of information.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks

Information Sheet 1	Identifying, obtaining and understanding OHS processes and procedures

1.1 OHS on site

When collecting data on site, the same OHS procedures as for installations apply.

1.1.1 General OHS Management

Occupational health and safety must be managed systematically . The best system will depend on the nature and size of the business, however, there are a number of aspects to be considered as a basis for any sound occupational health and safety management system.

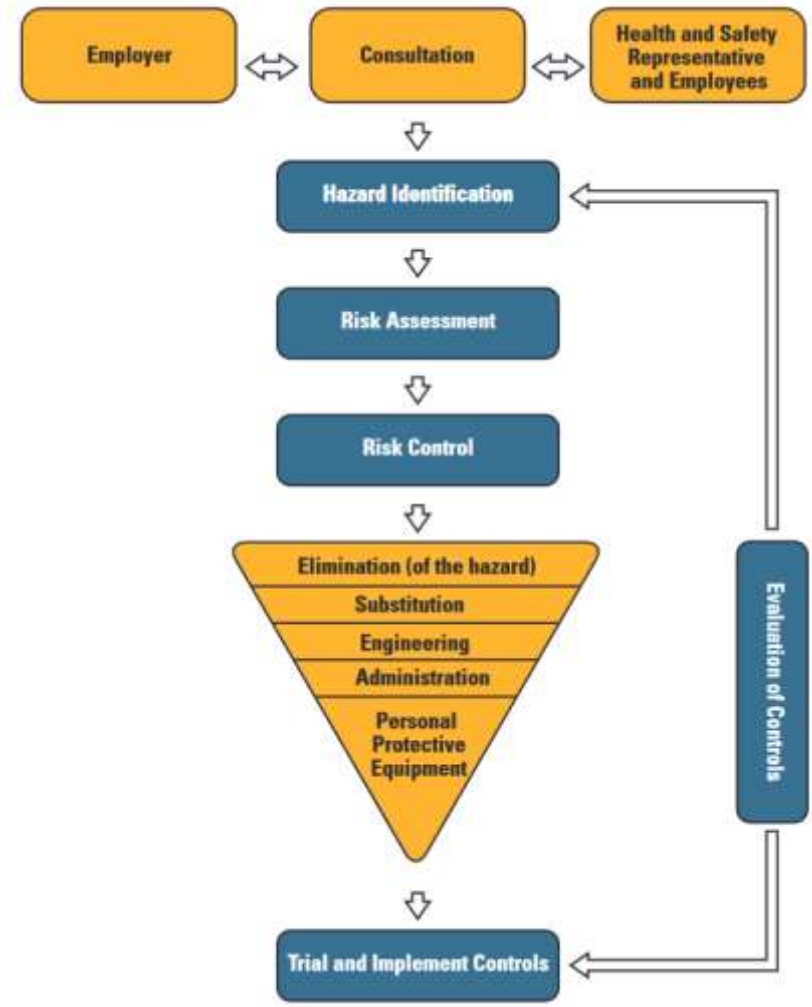


Figure 1: The hazard management approach (Worksafe Victoria, 2006)

Common hazards or risks in office work generally come from psychosocial effects and hazardous manual handling, for example:

- repetitive work, like computer use
- sitting for long periods
- poorly designed workstations
- lifting, handling and moving office equipment and supplies
- tripping on objects on the floor or power cords
- workplace bullying, harassment and occupational violence
- work-related stress

Involving your employees in health and safety issues can result in a safer workplace. That is why consultation is an important part of risk management. In certain situations employers must consult about health and safety issues with employees and health and safety representatives (HSRs) if they have them.

1.1.2 Risk management process

The general procedure for risk management is the following:

- Find the hazards in your workplace.
- Assess the risks associated with those hazards. You do not have to do a formal risk assessment if there is already information about the risk and how to control it.
- Control the risks.
- Monitor and review your risk controls. Revise the controls if they are not working.

In the specific case of identification of hazards in the office the following types of hazards can occur:

- **Mechanical hazards**, such as filing cabinets that tend to tip when heavily laden top drawers are open; tripping hazards.
- **Physical hazards**, like glare or reflections from screens; hot components of photocopiers; poorly designed chairs that do not provide the user with adequate back support; poorly designed jobs and tasks that demand prolonged work in a fixed posture.

- **Chemical hazards**, such as vapours in the atmosphere – for example, paint, solvents or airborne particles like photocopier toner.
- **Psychological hazards**, like the need to perform excessive workloads under pressure, lack of satisfaction from a job where there is inadequate recognition of work performed or repetitive work and insufficient task variety.
- **Electrical hazards** such as damaged electrical cords or overloaded power points that may lead to the risk of electric shock.

- **Checking records of injuries and incidents**

Many Occupational Health and Safety Acts require employers to maintain a written record of dangerous occurrences in the workplace and to keep information and records relating to the health and safety of employees of the employer. Some employers have included the reporting of pain and symptoms, as well as small incidents not resulting in injury in their injury and accident reporting procedure. Your workplace should have such a system and should use the data to identify possible hazards and areas of concern.

Check injury records, first aid reports and workers compensation claim forms for information about the work tasks, the area in which work is performed, the activity being undertaken at the time of injury, factors thought to be related to the incident and the type of symptoms or injury reported. Check particularly for reports of pain in the back, neck, shoulders and upper limbs; cuts or bruising; trip and fall incidents; and headache and vision problems.

1.1.3 Risk Mitigation Strategies

Employers and employees both have to contribute to avoid hazards at the work space.

- Examples of employer duties:
  - ✓ For your employees, you must provide and maintain a working environment that is safe and free of risks to health, so far as is reasonably practicable. Employees may include contractors and agency staff.
  - ✓ Give your employees the necessary information, instruction, training or supervision to enable them to do their work in a way that is safe and without risks to health.
  - ✓ Ensure that the conduct of your business does not endanger other people (including visitors, the public and other workers).

- ✓ Report notifiable incidents to Work Safe

- **Examples of employee duties:**
  - ✓ Take reasonable care for your health and safety in the workplace. You must also take reasonable care for the health and safety of others who may be affected by what you do or don't do.
  - ✓ Cooperate with your employer about any action they take to comply with the OHS Act or Regulations. For example, use equipment properly, follow safe work policies and procedures and attend training.
  - ✓ Don't intentionally or recklessly interfere with or misuse anything at the workplace to support health, safety and welfare.

Self-Check - 1	Written Test

Instruction: Follow the below selected instruction

Answer all the questions listed below. Use the Answer sheet provided in the next page:

N°	Questions and answers
1	Many Occupational Health and Safety Acts require employers to maintain a written records
	True or false:
2	Employers and employees both have not to contribute to avoid hazards at the work space
	True or false:
3	Take reasonable care for your health and safety in the workplace.
	True or false

Note: Satisfactory rating - 4 points **Unsatisfactory - below 4 points**

Information Sheet 2	Reviewing and adopting establishing techniques for report writing

2.1 Purpose of Report writing

Part of finalising a solar PV project is writing a report, or system documentation. There should be meaningful documentation for every photovoltaic system. But even though documentation forms an essential part of a PV system installation in daily practice we often encounter poorly documented systems. In many cases there is a "documentation", but on closer inspection the document turns out to be a collection of all sorts of documents, in which you first have to search around for 10 minutes to at least find out which solar modules were actually installed.

A good documentation that serves its actual purpose, providing information on the system fast, should contain certain documents in any case and should also contain a "data sheet" of the photovoltaic system as a cover page on which you can find the most important information - without long searching - at first glance. How such a documentation should look like is the content of this and the following chapters. The system documentation is written by the installer, it should be carefully archived, and a copy should be handed over to the client. The documentation basically contains all information on the PV system, which components were used, how the system is connected, the data sheets and manuals as well as initial testing and measuring results.

- **The documentation serves several purposes:**
  - ✓ The installer can quickly look up the components that were used in case of a component failure or when a question arises. After several years one forgets which components were used so written documentation is helpful.
  - ✓ Data sheets and manuals might not be available on the internet anymore after several years but should be saved if needed for repair or maintenance in the future.
  - ✓ If clients change to another installer for maintenance or repairs, they know what was installed and can hand it over to the new installer.
  - ✓ All information is available at one place, e.g. serial numbers of components that are needed for a warranty claim or to get help from the manufacturer with an error.

- ✓ If the system is extended in the future, the documentation of wiring diagrams and components used helps to plan the expansion.
- ✓ The client and installer both sign the documentation and the condition at that the system was handed over which then serves as a basis in case a legal conflict comes up.

2.2 Writing technique

The purpose of a report or in our case solar system documentation is to conserve the information for a later use. That means that the report needs to contain all important information in a structured way so that other persons in the future can easily find and review information.

When writing a report considers the following:

- ✓ **Use short language:**

Use no more words than are necessary to express what you mean. It is sometimes tempting to choose a roundabout way of saying something because an unadorned statement may seem too naked. Try to remember that you are wasting your own, your company's and your reader's time, if you use too many words. While it may sometimes be tactful to dress up unpalatable facts in a cloak of excess words, most technical writing demands that you make your point as concisely as possible. Here are a few examples of how very wordy statements can be pruned:

- ✓ **Be clear:**

Take care to use words which have the precise meaning you intend to convey, and, when you have the choice, choose words which are most easily understood. Avoid words with vague meanings. It is usually better to use concrete rather than abstract nouns and to use verbs rather than nouns. Doing so will often make you're meaning clearer and help you make your point more strongly.

For example:

The train has been subject to delay. = The train was delayed.

The retention of the receipt is desirable.= Please keep the receipt.

- ✓ **Avoid misunderstandings:**

Make sure that there is no alternative way to interpret the information you are giving. Always ask yourself: how would a person who has no background knowledge on the project read this? Example: The inverter installed is the Phocos Any grid. Missing information which size is installed? The data sheet has information on different inverter sizes. Better: The inverter installed is the Phocos Any grid PSW-H (5 kW).

- ✓ **Make it easy to read:**

A system documentation is a working tool so it needs to be practical in the first place. Make it easy to read and not unnecessarily long.

- ✓ **Structure the report:**

Use a list of content and split the information into sections to make it easy to find concrete information.

Self-Check - 2	Written Test

Instruction: Follow the below selected instruction

The following are true or false items, write true if the statement is true and write false if the statement is false.

N°	Questions and answers
1	PV system documentation should have minimum 20 pages of text.
	True or false:
2	The purpose of PV system documentation is to keep important information on the system for later.
	True or false:
3	Not Use a list of content and split the information into sections to make it easy to find concrete information.
	True or false:

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

Information Sheet 3	Evaluating the scope of the report and establishing report parameters

3.1 Establishing a procedure for report writing

At this point I would like to point out that documentation is not a luxury that can be renounced. After all, a solar power system should perform its service over a period of 20-30 years. The probability that there will not be a single system failure within this period is relatively low. Be it an insulation fault or a reduced yield in parts of the system. Whenever work has to be carried out on the system, it is important to have documentation at hand that provides the most important information about the system.

It should also be noted that the preparation of meaningful documentation involves an effort that the installer must charge for. It is not enough to quickly copy the data sheets and the manuals together and call it documentation. Any price advantages achieved by sloppy documentation will be paid twice or three times over in the course of 20-30 years of system operation. If no documentation is available later, the plans must then be painstakingly compiled. For small solar home system with one or two modules it seems not necessary to keep an accurate string plan. But as soon as several modules in 3-5 kWp systems or even bigger are connected as multiple strings, a string plan becomes helpful. The position of the individual module strings can be determined afterwards with some effort in the absence of documentation. But the determination of further data of the system can also become very complicated and cost-intensive afterwards. In order to be able to write a complete and useful documentation in an efficient way, it is advisable to already collect the necessary information from the beginning of the project. The goal is that in the end all data is already saved in one place and only needs to be put together in a report.

- **The following aspects should be part of the procedure for report writing:**
  - ✓ Who is responsible for the report? There should be a responsible person or team from the beginning of the project
  - ✓ Where is the data collected? Having a file structure, whether it is digital or for hardcopies is essential and helps to keep the overview
  - ✓ How does the information flow? Make sure to get information during planning process from all parties involved, establish an information flow for the project

3.2 Minimum requirements for PV system documentations

The system user should be provided as a minimum with the information as described in of BS EN 62446 Grid connected photovoltaic systems — Minimum requirements for system documentation, commissioning tests and inspection. The following provides a summary of the information required:

- **System specific information:**
  - ✓ Basic system information (parts used, rated power, installation dates etc)
  - ✓ System designer information
  - ✓ System installer information
  - ✓ Wiring diagram, to include information on:
    - ➢ Module type & quantities
    - ➢ String configurations
    - ➢ Cable specifications – size and type.
    - ➢ Over-current protective device specifications (where fitted) - type and ratings.
  - ✓ Array junction box locations (where applicable).
  - ✓ d.c. isolator type, location and rating
  - ✓ Array over-current protective devices (where applicable) – type, location and rating
  - ✓ Details of all earth / bonding conductors – size and connection points.
  - ✓ Details of any connections to an existing Lightning Protection System (LPS).
  - ✓ Details of any surge protection device installed (both on a.c. and d.c. lines) to include location, type and rating.
  - ✓ AC isolator location, type and rating.
  - ✓ AC overcurrent protective device location, type and rating.
  - ✓ Residual current device location, type and rating (where fitted).

- **Datasheets:**
  - ✓ Module datasheets
  - ✓ Inverter datasheets
  - ✓ Mounting system datasheet
  - ✓ Charge Controller datasheet (if applicable)
  - ✓ Battery datasheet (if applicable)

- **Operation and maintenance information, to include:**
  - ✓ Procedures for verifying correct system operation.
  - ✓ A checklist of what to do in case of a system failure.
  - ✓ Emergency shutdown / isolation procedures.
  - ✓ Maintenance and cleaning recommendations (if any).
  - ✓ Considerations for any future building works related to the PV array (e.g. roof works).

- **Warranty and testing information:**
  - ✓ Warranty documentation for PV modules and inverters - to include starting date of warranty and period of warranty.
  - ✓ Documentation on any applicable workmanship or weather-tightness warranties.
  - ✓ Test results and commissioning data

Furthermore, the following is recommended to add as well:

Component manuals:

- ✓ Installation manuals of all components, especially modules, inverters, charge controllers and batteries

- **PV System Design:**
  - ✓ System design and yield simulation if available

3.3 Report structure

As mentioned, the main purpose of a PV System report is to provide information fast and easy. So a “system data sheet” that summarises all important information should be the first element of the report. After the data sheet follow the detailed information with the system design, all component data sheets, manuals, single line diagrams and plans, O&M info, testing reports and protocols and warranty documents. All these documents can add up to a large number of pages so add a list of content to help any future users to find information easily. For smaller PV installation projects, the procedure is usually a bit easier. Different project reports can be combined. If the same type of modules and charge controllers is used all the time, it is enough to save one copy of the respective data sheets and manuals. But for every project should exist a summary of the components used and the wiring plan

but it can be kept very short, as long as it fulfils its purpose. If one of the following report templates is used, the report structure will be different.

3.4 Report templates by dena

The German organisation dena has a checklist for a proper system documentation and templates for the commissioning of the battery system and the solar array. dena is short for Germany Energy Agency. As Agency for Applied Energy Transition dena helps achieve energy and climate policy objectives by developing solutions and putting them into practice, both nationally and internationally. The templates below are taken from dena and can be used for all kinds of solar PV installations.

3.4.1 Checklist creation of documentation document by dena

Dena uses this checklist for the creation of PV system documentations:

Table 1: Checklist creation of documentation by dena

Documentation Components	Remarks	✔
Part 1: System Description / Overview		
• Short, generally understandable plant / function description in text form Structure of the plant / sub systems, components, module array (location, fastening, alignment), inverter Plant operation (irradiation, power generation, consumption, grid feed-in -> short operating principle) Monitoring (data acquisition, sensor technology, large display, internet) • Maintenance/servicing		
• Overview sheet Plant data/Special features • Plant capacity- PV modules (number, type, etc) – size module – surface – number of strings – inverter – grid connection – Commissioning date – annual energy yield – CO2 savings p.a. – etc.		
• Material delivery • Parts lists/ delivery note with exact description of all		

Documentation Components	Remarks	✔
system components (quantity, nominal data, manufacturer, etc.)		
• Plans Single-pole circuit diagram (module arrangement, interconnection, potential equalization, lightning protection if necessary, surge arrester, circuit breaker, mains connection, energy meter, monitoring, etc.) General plan with location of the module fields, inverters etc. (assignment to roof areas) Please mark components on the plans, number them if necessary, and provide them with nominal data.		
• Images • Charts • Photos	Optional Optional	
Part 2: Warnings and safety instructions		
• Description of possible risks Significant potential hazards- high (no load) voltages – working on the inverter – etc.		
• Overview signs, boards, stickers List of the indications provided (named, typed and place of affixing)		
Part 3: Operation and maintenance		
• Description Plant operation Commissioning - Shutdown – Operating status – inverter display Reference to inverter operating manual		
• Behaviour in the event of faults, failure Contact details of important contact persons – Fault report. Note on independent fault rectification – Possible sources of error/ rectification – Safety regulations.		
• Service/Maintenance log		

Documentation Components	Remarks	✔
Part 4: Solar generator		
• PV Modules Module layout with module number Module parts list (description, ID, flasher values, if necessary, module number) • Module datasheets, further information if necessary • Certificates • Warranties • Installation and maintenance instructions		
• Mounting system • Description of mounting system, production information if necessary – Datasheets. • Certificates, if applicable • Drawings, if applicable		
• Images • Photos		
Part 5: Inverter		
• Drawing Installation location/ mounting/ arrangement of inverter • list of serial numbers, if applicable, if not on a delivery list and/or plan • datasheets, further information if necessary • Certificates – CE declaration of conformity • Certificates of harmless Release device • Installation and operating instructions • Guarantees and warranties/ Guarantee and warranty conditions – if necessary, extension of guarantee		
Part 6: Data acquisition and visualisation		
• Brief description • Wiring diagram monitoring (data logger, digital input, interface, large display, energy meter,		

Documentation Components	Remarks	✔
modem, telephone system, remote monitoring internet) • Connection diagram Pin assignment • Installation and operating instructions: Data logger/ large display • Printout of the Software User Manual		

Part 7: Contact documents		
• Commissioning/ acceptance protocol • Feed-in and grid connection contract • If necessary, expert/approvals (proof of statistics etc.)		
Part 8: Planning and installation		
• Design results • Simulation results • Site plan of the building/ orientation • Roof supervision/orientation • Construction drawings • Circuit diagrams etc. • Plans cable laying, fuses, switches • Cable lists (cable types, cross-sections)		

3.4.2 Battery Acceptance Record template by dena

The following protocol can be used to record the commissioning process of a battery bank.

Table 2: battery bank format

Project name:	
1. General information	
Plant operator:	
	Name, first name
	Street

	Place
	Phone (private and business)
Location of the plant: (if not identical with address of the plant operator)	
	Street
	Place
Plumber:	
	Name
	Street
	Place
	Tel.
Commissioning:	
	Name
	Company
Commissioning date:	

2. Technical plant data			
Nominal capacity:	Ah (C) for		V
Battery type:			
	(chemistry, manufacturer, type)		
Number of strands:			
Number of cells per string:			
Operating voltage:			V
		( )	

Battery backup:			
	(manufacturer, type)	(max. current)	
Grounding:			
	(positive pole, negative pole, isolated)		
Battery connection cable:			mm²
	(manufacturer, type, length)	(cross section)	
Filling the battery:			
	(date, time)		

Exam results (please confirm or comment by ticking off the box)

	Torque of pole screws/ pole nuts and all other connections audited
	Minimum distances to walls and other cells are maintained
	Battery placed and battery tray (if applicable) are installed according to manufacturer's instructions

Remarks:

Commissioning measurement report	
Editor:	
Date/time:	
Room temperature:	

	✔
For liquid electrolyte batteries: Equalizing charge performed and completed	
For gel batteries: Full charge performed and completed	
Measurement of the cell voltages 2 hours after completion of the full or equalisation charge	

Cell	Cell voltage (V)	Electrolyte density (kg/L)	Electrolyte temperature (°C)	Cell	Cell voltage (V)	Electrolyte density (kg/L)	Electrolyte temperature (°C)
1				13			
2				14			
3				15			
4				16			
5				17			
6				18			
7				19			
8				20			
9				21			

If there is not enough space, please add another sheet.

Remarks:

3.4.3 Changes

The following changes (technical and/or financial) have been made to the planning template:

Table 3: planning template

Change	Planning template	actual installation

(If there is not enough space here, please enclose further changes on a separate sheet)

Justification of the amendments:

3.4.4 Photo documentation

Please enclose photos of the following components or component groups and views:

- General view of the battery
- Close-up of the pole screw connections
- Close-up of the battery fuses

3.4.5 Briefing

An instruction of the system operator in the operation and maintenance of the battery is on _____
through
Operating instructions were handed over to the operator.

7.note / comment

3.4.6 .Plant documentation

Document folder:	☐completely transferred	
	☐incomplete, the following documents are to be submitted later up until:	

9.Acceptance of the battery		☐flawless
		☐with the following shortcomings that still need to be remedied up to:
		date
	Shortcomings:	

The battery is fully functional. All country-specific and local requirements as well as the requirements of DENA are met.

Place	Date	Signature (company stamp of the bidder with overall responsibility)
Place	Date	Signature of the plant operator

Table 4: PV Generator Acceptance Record template by dena

Project name:	
General information	
Plant operator:	
	Name, first name
	Street
	Place
	Phone (private and business)
Location of the plant: (if not identical with address of the plant operator)	
	Street
	Place
Plumber:	

	Name
	Street
	Place
	Tel.
Commissioning:	
	Name
	Company
Commissioning date:	

Technical plant data		
Generator power:		kWp
Module type/ string no.:		
	(manufacturer, type)	

Number of modules:		
Inverter/ string no..:		
	(manufacturer, type, serial number)	
Warranty extension WR:		
	(possible/ not possible, years)	
Operating voltage: (AC side)	L1: L2: L3:	V
Surge diverter:		(V=)
	(manufacturer, type)	(rated voltage)
Lightning protector:		
	(yes / no, kind)	
Module connection cable:		( ) mm²
	(manufacturer, type)	(cross section)
DC main line:		( ) mm²
	(manufacturer, type)	(cross section)

AC voltage page		
Emergency stop switch/fuse:		
	(manufacturer, type)	
Generator junction box:		
	(manufacturer, type)	
Generator assembly:		
	(place and type)	
Data acquisition:		
	(Description, manufacturer, type)	
Remarks:		

Commissioning measurement report		
Editor:		
Date/time:		
Weather:		
Irradiation/ temperature:		

			Uoc (V)		
Complete system					
Sub-plant	string no.	Number of modules / type	ΔU_{oc} (V)	Isc (A)	U_{mpp} (V)

Note:

- U_{oc}= generator no-load voltage
- ΔU_{oc}= Open circuit voltage for each string
- Isc= string current in short circuit
- U_{mpp}= voltage in MPP

Grounding resistance of the earth of the house:		Ω
Insulation resistance of the PV generator, DC string cable:		MΩ
DC main cable:		MΩ
Remarks:		

Changes

The following changes (technical and/or financial) have been made to the planning template:

Change	Planning template	actual installation

(If there is not enough space here, please enclose further changes on a separate sheet)

Justification of the amendments:

Photo documentation

Please enclose photos of the following components or component groups and views:

- General view of the house with recognizable PV generator
- Close-up of the PV generator with elevation and Module Cabling
- Close-up of the generator connection box (closed)
- Close-up of the generator connection box (open)
- Close-up of the DC side disconnection point

- Close-up of the inverter
- Close-up feed meter / reference meter

Briefing

An instruction of the system operator in the operation and maintenance of the battery is on _____
through
Operating instructions were handed over to the operator.

7.note / comment

Plant documentation

Document folder:

	completely transferred
	incomplete, the following documents are to be submitted later up until:

Acceptance of the PV system

	flawless
	With the following shortcomings that still need to be remedied:

The PV system is fully functional.

Place Date Signature (company stamp of the bidder with overall responsibility)
Place Date Signature of the plant operator

Acceptance Report template by RAL

This acceptance record is a document that can be used as basis to document

- **Acceptance Record**

Minimum Requirements of the Acceptance Record According to the RAL Quality Label "Photovoltaic Installations" RAL GZ 966

General Information

Client

_____

Name, given name

_____

Street& no.

_____

Postal code, location

_____

Phone

_____

Fax

_____

Email

Location of the photovoltaic power plant

(If not identical with clients address)

_____

Street, no.

_____

Postal code, location

Installer / contact

_____

Name of the installing company

_____

Street& no.

_____

Postal code, location

_____

Phone

_____

Fax

_____

Email

Date of hand-over

_____

Time, date

Other involved companies, planners and subcontractors according to annex

Technical Specifications of the Photovoltaic Installation

Type of the plant: Grid-connected ☐

Off-grid ☐

Hybrid ☐

Other, please specify ☐

_____

_____

Nominal power of the PV-array (STC) P_{PV}: _____ kW_p

Modules (manufacturer, model, quantity, nominal power):

_____O

see annex

Inverter (manufacturer, model, quantity, nominal AC power):

_____O

see annex

Number of strings per inverter, number of modules per string:

_____O

see annex

Potential equalisation / grounding: realisation, location, comments:

_____O

see annex

Outside lightning protection available: Yes ☐ No ☐

If yes: realisation, location, comments:

_____O

see annex

String fuses, string diodes (if applicable) (manufacturer, type, voltage, amperage):

Over-voltage protection DC and AC (if existing) (manufacturer, type, nominal voltage,):

Module cables, main DC cables (manufacturer, type, cross-section area for each cable type):

DC-isolator (switch) (manufacturer, type, voltage/amperage):

Residual current protection AC (RCD-switch) (if applicable) (manufacturer, type):

AC fuses (manufacturer, type, voltage/amperage):

Monitoring system (if existing): Yes ☐ No ☐
(manufacturer, type, model, measured values):

Grounding resistance of the ground electrode OK / rejected (measurement see annex)
Isolation resistance of the PV array OK / rejected (measurement see annex)
Isolation resistance of DC-main cable: OK / rejected (measurement see annex)
(Delete as appropriate)
Comments:

Visual Checks, Verification against Quotation

Mounting without visible damages to plant, roof and building OK / rejected
Mounting system, perforations, sealing OK / rejected
Cabling, cable path OK / rejected
Inverter, inverter function OK / rejected
Function of protection devices OK / rejected
Feed-in test at the meter OK / rejected
Function of the monitoring system (if applicable)OK / rejected
Cleanness (waste, location of the installation was left cleanly) OK / rejected
Installation in accordance with quotation / contract OK / rejected
(Delete as appropriate)
Comments:

Reasonability Check:

Plant is fully operational: ☐ Yes ☐ No

Ambient temperature:_____ °C(± 5 °C) ☐ ☐ ☐

Irradiation:_____ W/m^2(± 200 W/m^2) cloudy sun / clouds bright sun

Power output DC:_____ W(± 10%, e.g. display inverter)

Power output AC:_____ W(± 10%, e.g. display inverter)

Comments:

Measured Values

☐ customer's meter or ☐ meter of the electricity utility (ESCOM)

Meter number feed-in meter: .....,actual meter count: .....kWh

Meter number PV generation meter: .....,actual meter count:.....kWh

Inverter Type, No.	**Open circuit voltage V_{OC} in V Generator / String 1 / 2 / 3 ...**	**Short circuit amperage I_{SC} in A String 1 / String 2 / String 3 ...**

If not sufficient, please add own sheet in annex.

PV plants with return current diodes: Please provide for each string the voltage reduction $V_{SC,\ D}$ at the diode (short circuit). PV plants with string fuses: Please provide for each string the voltage reduction $V_{SC,\ D}$ at the fuse including contacts (short circuit). Comments:

Deficiencies, Rework Requirement, Comments

Deficiencies and eventually to be performed reworks have to be noted with rework schedule:

Documentation

Documentation complete: ☐ Yes No ☐

Complete documentation was handed over to the client: Yes ☐ No ☐

Declaration of conformity:

Yes ☐ No ☐

Technical drawings of string design, and the PV array, connection to the inverters:

Yes ☐ No ☐

For all components:

Supporting documents, operation manuals, mounting manuals, data sheets, certificates and guarantees: Yes ☐ No ☐

List with serial numbers of the modules, flash list: Yes ☐ No ☐

Protocols of measurements: Yes ☐ No ☐

Service contact information (phone, fax, mobile phone numbers):Yes ☐ No ☐

Documented Customer Dialogue according RAL (Site Evaluation):Yes ☐ No ☐

Proof of client's instruction according RAL: Yes ☐ No ☐

Any other protocol prepared during the planning and installation phase Yes ☐ No ☐

Comments:

Client Instruction

The client's instructions/requests were implemented and the client understood the main function of the plant: Yes ☐ No ☐

Comments:

Signatures

The signatures serve as acceptance that the plant is free of defects with the exception of the deficiencies and rework requirements listed herein

Location, date _____

Signature client _____

Signature installer / planner _____

Appendix

_____

_____

_____

3.5 Selecting and adapting a report template

Which template to select and use depends on the size and scope of the PV system. Of course, a small PV solar home system of 200 W does not require the same documentation as a 10 or 30 kWp system. Every installer can decide which template to choose and how much time to invest in the documentation. But the overall goal should be to collect and document enough information to make any future repairs or maintenance work as easy as possible. So an installer should always plan ahead and rather invest a day in a good documentation right after the installation than many days when there is a failure a few years later and the information has to be found from scratch. Furthermore, a good documentation for the client should be seen as part of the work that needs to be performed as part of the installation process.

Self-Check - 3	Written Test

Instruction: Follow the below selected instruction

Answer all the questions listed below. Use the Answer sheet provided in the next page:

N°	Questions and answers
1	Warranty documentation for PV modules and inverters - to include starting date of warranty and period of warranty.
	True or false
2	Which template to select and use not depends on the size and scope of the PV system.
	True or false
3	Every installer can decide which template to choose and how much time to invest in the documentation
	True or false

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

Information Sheet 4	Determining Criteria from other related works

4.1 Civil works

Was any kind of civil works carried out in the process of the installation? If so, also include information on anything that was done. If in the future the PV System will be changed or extended the user will need to know what was done. For larger systems also keep any information on statics:

a) System statics of the mounting structure used
b) Soil expertise for ground-mounted plants
c) Test statics, in which the proof is provided that the building can absorb the additional loads caused by the PV system, taking into account the wind and snow load zone at the system location.

a) System statics of the mounting structure used

- **Roof mounting**

The solar array of a PV system can be mounted on rooftops, generally with a few inches gap and parallel to the surface of the roof. If the rooftop is horizontal, the array is mounted with each panel aligned at an angle. If the panels are planned to be mounted before the construction of the roof, the roof can be designed accordingly by installing support brackets for the panels before the materials for the roof are installed. The installation of the solar panels can be undertaken by the crew responsible for installing the roof. If the roof is already constructed, it is relatively easy to retrofit panels directly on top of existing roofing structures.

b) Ground-mounted

Ground-mounted PV systems are usually large, utility-scale photovoltaic power stations. The PV array consists of solar modules held in place by racks or frames that are attached to ground-based mounting supports.

- **Ground-based mounting supports include:**
  - ✓ **Pole mounts**, which are driven directly into the ground or embedded in concrete.
  - ✓ **Foundation mounts**, such as concrete slabs or poured footings

- ✓ **Ballasted footing mounts**,

such as concrete or steel bases that use weight to secure the solar module system in position and do not require ground penetration. This type of mounting system is well suited for sites where excavation is not possible such as capped landfill and simplifies decommissioning or relocation of solar module systems.

- **Mounting as a shade structure**

PV panels as external shading device in zero-energy building, Singapore

Solar panels can also be mounted as shade structures where the solar panels can provide shade instead of patio covers. The cost of such shading systems are generally different from standard patio covers, especially in cases where the entire shade required is provided by the panels. The support structure for the shading systems can be normal systems as the weight of a standard PV array is between 3 and 5 pounds/ft^2. If the panels are mounted at an angle steeper than normal patio covers, the support structures may require additional strengthening. Other issues that are considered include:

- ✓ Simplified array access for maintenance.
- ✓ Module wiring may be concealed to maintain the aesthetics of the shading structure.
- ✓ Growing vines around the structure must be avoided as they may come in contact with the wiring.

- **Soil expertise for ground-mounted plants**

Applications include:

- ✓ Determining accurate soiling losses for PV performance guarantees
- ✓ Monitoring soiling losses to enable detection of other system-level issues
- ✓ Optimizing washing schedules for best return-on-investment
- ✓ Determining typical soiling rates for forecasting models
- ✓ Collecting pre-construction prospecting data at new sites

4.2 Domestic electricity

Whenever a PV system is added to an existing wiring system, e.g. in grid-connected systems or backup-systems, the existing electrical installation is usually changed. Plans, single line diagrams and a detailed documentation of what was done should be included in the report. See Figure 2 for an example of a single line diagram that was done to update the buildings wiring plans after a PV system installation. Also, if a lightning protection system is added, the planning should be added to the report as well.

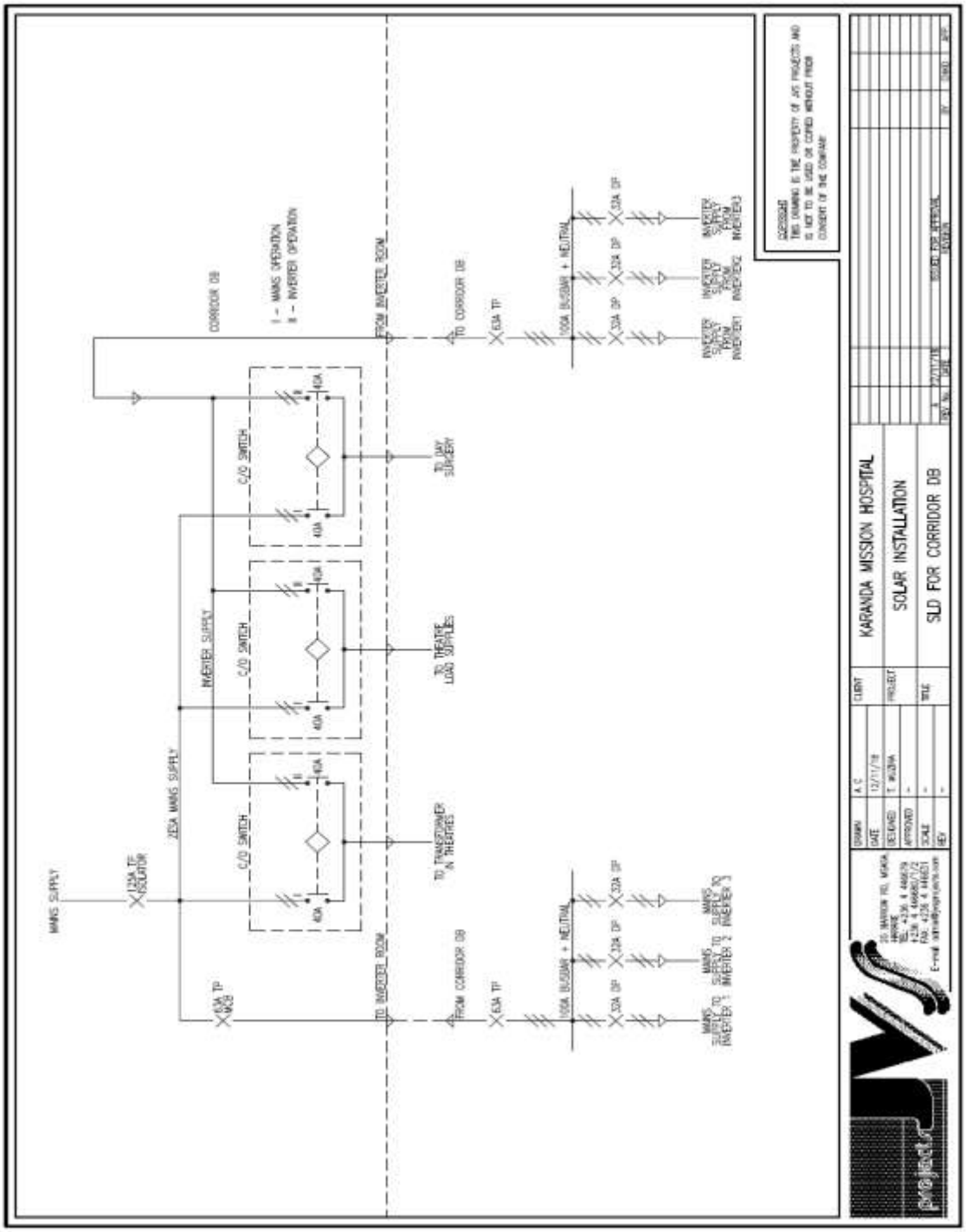


Figure 3 : Single Line Diagram for Karanda Hospital, Corridor DB

Self-Check - 4	Written Test

Instruction: Follow the below selected instruction

The following are true or false items, write true if the statement is true and write false if the statement is false.

N°	Questions and answers
1	Statement: Other related works that are not specifically solar photovoltaic can be ignored in the report.
	True or false:
2	Statement: Information on statics should be included in the report.
	True or false:
3	Ground-mounted PV systems are usually large, utility-scale photovoltaic power stations.
	True or false:

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

Information Sheet 5	Identifying source and availability of information

5.1 Identifying source and availability of information

In the following table is a list of the information needed for the report and a reference where to usually get it from. Depending on the company structure, system size and management structure, the information can have different sources from case to case.

Table 5: Identifying source and availability of information

Information	Source	Notes
• Basic system information (parts used, rated power, installation dates etc)	• Project manager • Project planner	
• System designer information	• Project planner	
• System installer information	• System installer • Project manager	
• Wiring diagram, to include information on: Module type & quantities • String configurations Cable specifications – size and type. • Over-current protective device specifications (where fitted) - type and ratings. Array junction box locations (where applicable). d.c. isolator type, location and rating . Array over-current protective devices (where applicable) – type, location and rating . Details of all earth / bonding conductors – size and connection points.	• System installer • Installing electrician • Planning team	

Information	Source	Notes
• Details of any connections to an existing Lightning Protection System (LPS). • Details of any surge protection device installed (both on a.c. and d.c. lines) to include location, type and rating. • AC isolator location, type and rating. • AC over current protective device location, type and rating. • Residual current device location, type and rating (where fitted).		
Datasheets: • Module datasheets • Inverter datasheets • Mounting system datasheet • Charge controller datasheet • (if applicable) • Battery datasheet (if applicable)	• Internet research, usually websites of manufacturers	• Make sure to download the correct model and generation. • For example, the SMA Sunny Island inverter from 2015 probably has a different manual than the one from 2020.
Component Manuals: • Module manuals • Inverter manuals • Mounting system manual • Charge controller manual (if applicable) • Battery manual (if applicable)	• Internet research, usually websites of manufacturers	• Make sure to download the correct model and generation. • Sometimes manuals are for more than one model and contains

Information	Source	Notes
		info on several components of the same manufacturer.
Operation and maintenance information, to include: Procedures for verifying correct system operation. • A checklist of what to do in case of a system failure. • Emergency shutdown / Isolation procedures. • Maintenance and cleaning recommendations (if any). • Considerations for any future building Works related to the PV array (e.g. roof works).	• Project manager • Project planner • Installation team	• Usually this information is not written down in the planning phase. The person who writes the import needs to interview the project planner, manager or installation team to get the information.
Warranty and testing information: • Warranty documentation for PV modules and inverters - to include starting date of warranty and period of warranty. • Documentation on any applicable workmanship or weather-tightness warranties. • Test results and commissioning data •	• Warranty Documents: • Internet research, usually websites of manufacturers • Request from manufacturer • Documentation on workmanship, test results: • Installation	• Standard warranty documents and certificates of compliance are available on the internet or can be requested from the manufacturer. • Test results from testing and commissioning need to be documented by the installers. It is

Information	Source	Notes
	team	important to inform the team early to note down any testing results in writing and to pass them on to the report writer.

Self-Check - 5	Written Test

Answer all the questions listed below. Use the Answer sheet provided in the next page:

N°	Questions and answers
1	Module datasheets is found on Internet research, usually websites of manufacturers
	True or false
2	The source of System installer information is on the System installer & Project manager
	True or false

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

Solar PV System Installation and Maintenance

Level IV

Learning Guide -29

Unit of Competence	**Compile and Produce Solar PV Installation Detailed Report**
Module Title	**Compiling and Producing Solar PV Installation Detailed Report**
LG Code	**EIS PIM4 M08 LO2-LG29**
TTLM Code	**EIS PIM4 TTLM 0920v1**

LO2: Develop solar PV installation report

Instruction Sheet	Learning Guide:-29

This learning guide is developed to provide you the necessary information, knowledge, skills and attitude regarding the following content coverage and topics:

- Report is developed to include scenarios/requirements established in consultation with appropriate person(s), and regulatory requirements.
- Report is developed in collaboration with all relevant personnel.
- Competent persons are identified to assist in the compilation of the report.
- Report is reviewed against all inputs and adjusted to rectify any anomalies.
- Report is compiled in accordance with organization policies and procedures.
- research report information is compiled and analysed

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:-

- Develop a report to include scenarios/requirements established in consultation with appropriate person(s), and regulatory requirements.
- Develop report in collaboration with all relevant personnel.
- Identify competent persons to assist in the compilation of the report.
- Review report against all inputs and adjust to rectify any anomalies.
- Compile report in accordance with organization policies and procedures.
- Compile and analyse research report information

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks

Information Sheet 1	Developing report include scenarios/requirements

1.1 Developing report include scenarios/requirements activities

The following chapter describes how to write or compile the necessary parts of a PV system documentation.

1.2 System data sheet

The system data sheet or system description is one of the most important parts of a system documentation. It includes all essential info at one sight. It should be kept as short as possible, 1-2 pages only, and clearly structured. Here is an example for a system description of a 14.3 kWp back-up system near Harare in Zimbabwe:

- **KARANDA Hospital Project**

PV/battery system Installation overview

Overview

The Karanda hospital has currently 3 diesel generators, an unreliable grid connection and a battery back-up system for the administration office.

Main objective

Support the hospital with reliable back up-power for up to 4hours in the three new theatres. Support the hospital power consumption with solar power and reduce the diesel generator fuel consumption in case of a main supply power failure.

Technical overview

- **Inverter/battery**

3 x 5kW/48Volt inverters are connected to a 1000Ah (C5), 2Volt x 24 cell lead acid battery bank. The battery bank is designed to carry all 3 theatre peak loads for a back-up time of 4hours. The total back up load was estimated at 4kW. Therefore, the battery capacity is 16kWh in order for the back-up to be guaranteed for 4hours. The battery has at optimal conditions a storage capacity of 22kWh at full charge, at a discharge rate of 5hours and to a depth of discharge of 50%.

The inverters connect on AC separately to a source and to a load. Each inverter will be given one phase from the buildings main electrical supply system. The theatres are supplied via their individual DB-boards from the inverters AC output. A change over switch in the Distribution board allows for the reconnection to the mains supply in case of an inverter/battery system failure.

- **Solar MPPT**

The inverter has an integrated MPPT that controls the solar panels output to the Batteries.

- **Solar array**

The 14.31kWp or 54 x 265Wp solar array are split up on the East and the West facing roof. 18 x 265Watt solar panels on the West roof and 36 x 265Watt solar panels on the East facing roof. Each inverters MPPT connects to an individual array of 16 x 265Watt solar panels. The total of 54 solar panels are connected in strings of 3 x 265Watt solar panels. Two strings are paralleled with y-Connectors directly on the roof. Therefore 6 panels are connected together on the roof and connect to a 32A fuse holder with a 25A fuse within the PV/DC combiner box. The combiner box connects via the surge protection device and the DC disconnect switch to the DC/MPPT input terminal of the inverter.

- **Roof mounting**

The roof mounting consists of a short rail system and are mounted on the East and the West facing roof. The solar panels are secured to a short rail with middle and end clamps to the IBR roof sheet. The cables are covered in weather resistant conduit when exposed to sunlight. Underneath the solar panels the solar cable are attached to the short rails with cable ties. The solar cable is installed to not touch the solar panel bottom surface and not to touch the IBR roof sheeting. The minimum bending radius of the solar cables was observed.

- **Inverter/battery room**

Figure 4: position of inverter room

The installation room has a floor size of 3x5meter and houses the 3 inverters, the batteries on a supporting steel frame, a sub distribution board for AC, 3 DC combiner boxes for the solar array and DC fuse boxes between the batteries and the inverter. The inverter room is locked at all times and will only be accessed by authorised and trained technical personnel.

- **Remote monitoring**

A monitoring system (Raspberry Pie) is connected to the inverters and allows for remote access of the data via the satellite internet connection of the hospital. The monitoring includes values of the PV system output, the battery performance and the load provided by the inverters.

1.3 PV System Design

It makes sense to also include the initial PV system design to the report. The wiring charts and construction plans that were created in the planning phase are an essential part of the documentation but also the sizing calculation and any yield simulations, especially when done with PV planning software should be included. Most PV software has a function to print a report which can be simply attached to the report. If any planning decision must be reviewed later or if the client wants to find out if the projected yield of the system equals the actual yield, it is necessary to have access to the initial simulations.

1.4 Warranty information

In case those components fail, it is recommended to document information on warranty conditions. In most cases only the 2-year manufacturer guarantee applies. But module manufacturers e.g. give an extended warranty of up to 20 years. It is also possible to purchase an extended warranty from inverter manufacturers. In any case, the conditions and any additional information should be written down. Most manufacturers provide a warranty certificate for the components, these should be saved for all components.

When a component fails and warranty should be claimed, the manufacturers will ask for the serial numbers. It is very important to note down the serial numbers of all components. The installer does not have to travel to the site of the installation then but can look up the serial number and report the warranty case to the manufacturer remotely. Especially for project in remote areas a complete and well-thought documentation can save a lot of costs.

1.5 Data sheets and manuals

Data sheets and installation manuals of all components should be saved. Solar systems are meant to last 10 or 20 or even 25 years. It is not guaranteed that the data sheets are available on the internet over 10 years so they should be downloaded at the time of the project implementation. Data sheets often contain info on several component sizes of the same type. It should be made sure that the report contains information on the specific type of component that was used. Use the templates presented in LG28 to make sure to not forget any details.

1.6 Single line diagrams and plans

Single line diagrams of the PV system installation and all related wiring should be included in the report as well as drawings of the PV system location.

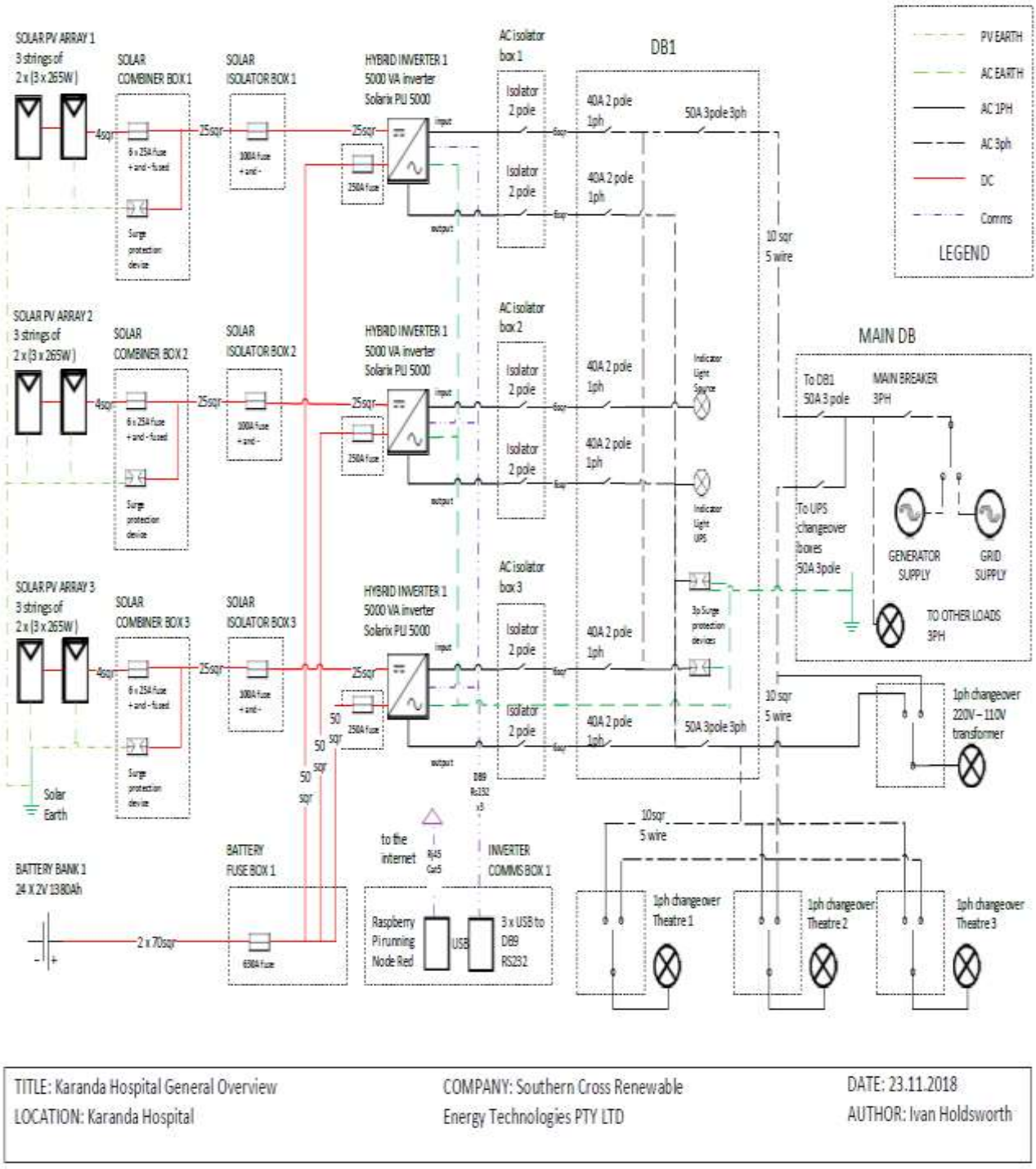


Figure 5: Single line diagram of a PV system

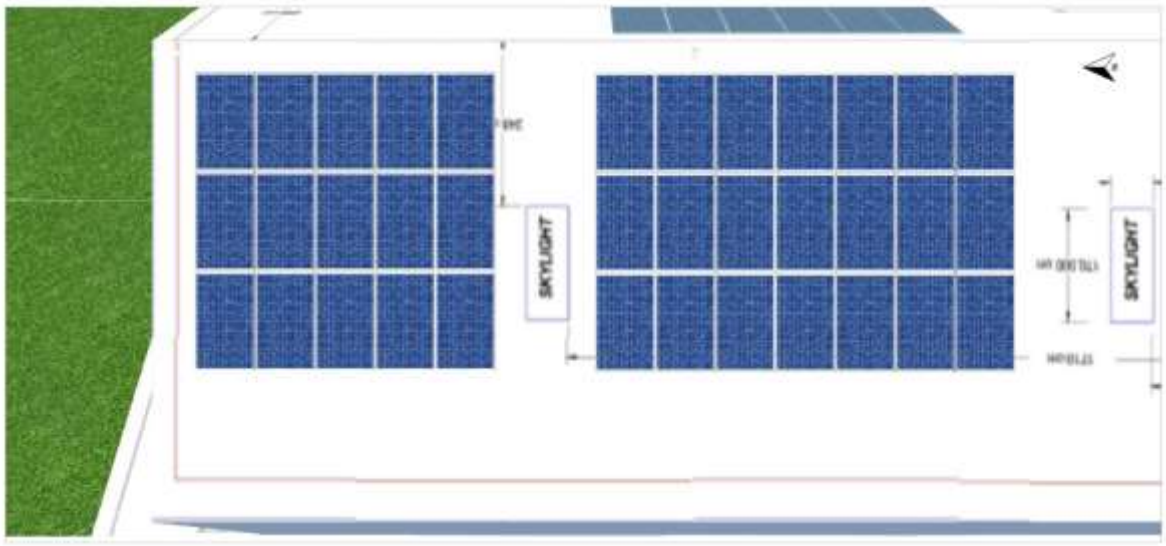


Figure 6: Roof drawing, excerpt from PV SOL report

1.7 Maintenance information

The report should include information on maintenance procedures, especially when another team than the installing team is doing the maintenance or when the client should take over basic maintenance tasks. Please see the next chapter (information sheet 2 of LG29) for more details and templates on maintenance information.

1.8 Testing reports

In order to prove that the system was fully functional at the time of commissioning, measuring protocols of the following components should be included:

- PV modules (voltage and amperage of the single modules, strings)
- Batteries (voltage of single batteries, battery bank)

The easiest is to use one of the templates introduced in LG28.

1.9 Photos

Photos should be included in every PV system report. The photos serve several purposes. On the hand they create legal safety for the installer. If there is an argument after the installation because the client discovered damages at the house or the installation, the photos can be used to check the condition of the site at the time of the installation. Photos should be taken before starting an installation and after finalising it. The second purpose of taking pictures is to remember the site. If after a few years the client calls and has a problem, the pictures help the installer to remember the place. Before driving to the client's

place, as much information as possible must be collected. Many problems can even be solved by the client himself, e.g. if it is changing the programming of a charge controller or checking cable connections. But the client needs very clear instructions what to do.

Self-Check – 1	Written Test

Instruction: Follow the below selected instruction

For each of the following question choose the best answer and circle the letter of your choice.

N°	Questions and answers	
1	How should the system description or system data sheet in a report be done?	
	A – As long and detailed as possible	B – Always in the local language
	C – Short and clear with all important information	D – Handwritten to be flexible
2	What is the system description good for?	
	A – To provide clients and installer with all necessary info on the system	B – To confuse competitors
	C – To make the client happy	D – It has no actual purpose

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

Information Sheet 2	Developing report in collaboration with all relevant personnel

2.1 Developing report in collaboration with all relevant personnel

The system report also serves the purpose to provide information on operation, maintenance and safety. Firstly, it is used by the solar installer who is doing the maintenance and necessary repairs of the system. Secondly, also the system user needs the report in case he takes over smaller maintenance tasks or needs to switch off the system in emergency. It should be made sure that the descriptions are clear and easy to understand. In the following exampled for maintenance procedures and instructions for the client are inserted.

2.2 Operation and Maintenance Info

Depending on the size of the PV system, the maintenance instructions can be more or less detailed. Here is an example for a maintenance manual for the 14.3 kWp back-up system near Harare in Zimbabwe. It is part of the documentation that was handed over to the client but can also be printed as a single manual. This way, the person responsible for the maintenance can get his/ her own copy.

Table 6: Contact information of the installers

Local Project Management, Installation and Service:	
Sunergy Zimbabwe 26 Cambridge Road Avondale Harare, Zimbabwe Mr. Dave Mathews Tel: +263 (4) 333213 Cell: +263 77 240 0655 davem@trivade.co.zw www.solarenergy.co.zw	**JVS Projects** 22 Harrow Road Msasa Harara, Zimbabwe Mr. Steve Harris Tel: +263 242 446679-82 steveh@jvsprojects.com http://www.jvsprojects.com

Project management: **maxx-solar energy PTY Ltd.** 604 Buitenkloof Studios 8 Kloof Street Cape Town, 8001 Ms. Antje Klauss-Vorreiter Tel: +27 (0) 21 813 6561 antje@maxx-energy.co.za http://maxx-solar-energy.co.za/	**Supervision:** **Southern Cross Renewable Energies** 16 Culross Street Bryanston 2194, Johannesburg South Africa Mr. Mathias Weber Phone: +27 (21) 820-4888 mathias@sc-ret.co.za www.sc-ret.com

- **Maintenance Schedule**

Daily	Switch on Display at Reception
Monthly	Inspection of solar panels and cleaning (if necessary) (Fill protocol)
Quarterly	Carry out small battery maintenance (to pick out at 5 random batteries) Report to installation company
Semi annual	Carry out full battery maintenance (all batteries)

- **Reports**

In order to guarantee the longest possible lifetime and reliability of the system, it is necessary to carry out maintenance carefully. Many system faults can be prevented by maintenance and battery failure can be predicted and avoided by interpreting the battery

voltage and acid levels. For this reason, frequent reporting to the installation company is essential.

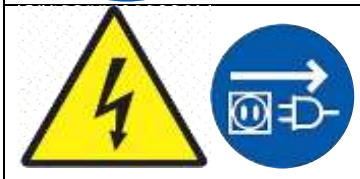
- **Maintenance Equipment**

To keep on site:

- ✓ Goggles
- ✓ Funnel
- ✓ Rubber gloves
- ✓ measuring protocol template
- ✓ Distilled water (approx. 20 ltr per year)

- **To bring for maintenance:**
  - ✓ Voltmeter
  - ✓ Water

Table 7: Security Notice Security Notice

	When maintaining batteries wear gloves, eye protection and rubber boots in any case!
	If eyes, skin or clothes get in contact with battery acid, immediately rinse with a lot of water! Identify water source before in case of emergency.
	When cleaning the modules, use fall prevention, e.g. harnesses
	Beware of electrical shocks! Live cables! Always disconnect for maintenance, isolate PV for voltage measurements.

- **Maintenance Instructions**

The following instructions are basic guidelines on how to execute maintenance measurements on the PV system. The section is split into maintenance of solar panels (on the roof) and maintenance of batteries and other components (battery room). For detailed instructions please consult the manufacturer manuals. Disconnect system when carrying out maintenance.

Cleaning Modules

Detailed cleaning instructions are available in the manufacturer manual. The instructions below sum up the basic procedure and what to consider when cleaning the modules.

Cleaning frequency and documentation

Check Voltage and Amperage of the PV system at all three inverters, use the ▼ and ▲ buttons to navigate through the inverter menu. Note down the results in the Module inspection sheet (Annex.1). Visually inspect the solar modules if they need cleaning. If you need to clean them note down voltage and amperage after cleaning as well.

Before Cleaning

DISCONNECT PANELS BEFORE CLEANING. To avoid electric shocks, disconnect PV

Table 8: Modules before cleaning.

• Open the lids of all three combiner boxes. When entering the battery room, they are located on the left-hand side.	

• Open the breakers, take out fuses and put into your pocket to prevent somebody from accidentally switching on again.	

Cleaning procedure

- **When to clean**
  - ✓ Cleaning of the panels should be carried out in the early morning when the panels are cool to avoid thermal shock.
  - ✓ Check monthly if cleaning is necessary, more often when it has been very dry or dusty.

- **How to clean**
  - ✓ All dust and especially bird droppings must be removed
  - ✓ Use deionized or harvested rainwater at ambient temperature and a sponge, microfiber cloth or a soft brush to wipe away the dirt
  - ✓ A rubber squeegee is recommended to remove excess water

- **To avoid**
  - ✓ Use of high-pressure hoses or cleaners is not permitted as these may damage the panel, laminate or cells.
  - ✓ Do not lean on the panels while cleaning. Use a broom with a soft cloth around it to clean the panels that are difficult to reach.
  - ✓ Do not scrub with force, avoid scratching the surface of the panels
  - ✓ Do not use detergents!!!

Safety instructions

- ✓ Make sure you are safe during cleaning.
- ✓ Use a harness or scaffolding for your personal safety

- ✓ Do not stand below the panels when water is running down the panels
- ✓ Caution! Roof is slippery when wet!

Why is cleaning necessary?

The more sunlight, the more electricity generation. When the PV modules are dirty or covered in dust less sunlight gets through. Less light reaches the cell, so the electricity yield is less. To get the most out of the PV system (most electricity and most saving on Diesel and ZESA!), the panels should be kept clean. Nevertheless, when there is no water in the dry season priorities should be set and no water should be wasted for cleaning panels in times of drought.

2.3 Battery maintenance

Make sure the batteries are fully charge when maintaining to get accurate and comparable results.

Battery maintenance includes:

- ✓ Visual check
- ✓ Checking connections
- ✓ Measuring acid level
- ✓ Refill distilled water (if necessary)

Detailed instructions below.

Important: Batteries can be dangerous and cause severe harm. Even if you are experienced, don't underestimate what can happen and especially wear eye protection and gloves.

Preparation

Material required:

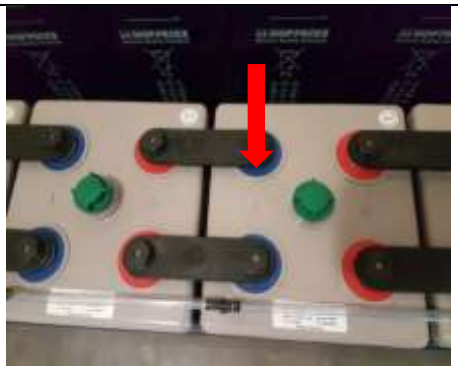
- ✓ Bucket of water or access to running water for emergency
- ✓ Distilled water
- ✓ Cup (to refill water and as drainer)
- ✓ Gloves and goggles
- ✓ Funnel (plastic)
- ✓ Acid level measuring kit
- ✓ Report paper and pen

Procedure

Bold printed steps are part of the small maintenance procedure to be carried out every 3 months. The normal printed are carried out only every 6 months or only if necessary (e.g. refilling distilled water).

Table 9: Procedure Bold printed steps

Steps	Explanation
• Bypass PV system on AC DB board	
• Disconnect PV at combiner boxes by opening switches	
• Switch off all three inverters. Power switch at inverter.	
• Measure voltage of PV generator at combiner boxes and note down result	
• Visual check: Are the batteries clean and are there any visible damages / burnt poles.	Wipe with a damp cloth if necessary. Beware of short circuits. NEVER wipe with a dry cloth because of static charge.
• Check connections: Tighten loose connections on the DC side	Don't over tighten! Use a wrench to check if connections are loose. If not loose, do not tighten any further to prevent damage at battery terminals.
• Personal Safety: Identify nearest water source or bring a bucket of water in case of emergency.	When in touch with acid, immediately rise skin or eye. Use a lot of water too make sure the acid is washed off.
• Put on safety goggles and gloves.	If the eyes get in touch with the battery acid, the eye is burnt, and a loss of eyesight is the consequence. One drop is enough to blind you!!
• Measure voltage level of 5 (all) cells. Note down values on report sheet.	Template in Annex. Measuring of all cells half a year.

• Remove the cap of the battery	
• Measure acid level of 5 (all) cells using the measuring kit:	Measure all cells every 6 months Carefully insert the hydrometer into cell, not pushing down on the top of the plates. Carefully draw liquid into the hydrometer and avoid "bumping" the hydrometer. Be careful the float is not flooded (too much liquid) or sticking to the sides of the glass tube. Obtain a reading by looking directly at the float. Repeat measuring to reconfirm reading.
• RECORD the cell number and result.	Template in Annex. If it is very warm or very cold correct the specific gravity for temperature. If the ambient temperature is fairly consistent and original gravities are taken when the batteries are put into service temperature correction is not as critical and only necessary if problems arise. Make sure electrolyte is not hot if just taken out of service. Let it reach room temperature. Use the thermometer to check room temperature and electrolyte temperature.

• Check electrolyte level: Refill necessary if the liquid is closer to the minimum level than maximum level (rule of thumb).	The scale can be found on the batteries. Each battery has to be checked individually. 
• To refill, put the funnel in the opening and pour distilled water into the battery until the max. level is reached. Use a cup to pour the distilled water from to prevent over-filling the battery.	**Only use distilled water to fill up.** Never fill over maximum level and never let liquid drop below minimum. Both will damage the batteries.
• Close the lid of the battery.	
• Safely rinse and pack away the measuring and filling equipment.	
• Switch the inverters back on.	
• Re-connect the PV system by closing the fuses and close lids of the combiner boxes.	
• Switch off AC bypass.	

- **Inverter Settings**

These are the current inverter settings (as per 23rd Nov 2018). No changes must be made unless advised by Sunergy/jvs projects.

Setting number: 01 to 38

01-SBU02-60A03-UPS04-SdS05-USE06-LIE (restart enable)07-EEE (restart enable)09-50Hz11-2A12-48V13-53V16-C50-Solar First18-Alarm On19-ESP20-LON22-AON23-bYE-Bypass enable26-57.6V27-53.5V29-42V31-SbE-Solar power enable32-120min33-EEN34-61.2V35-360min36-450min37-40days38-disable

2.4 Operation and Maintenance Templates

If the client is responsible for maintenance tasks on the system, templates for the documentation of measurements and tasks performed should be attached to the report. When the client has a template to use as a basis, it will be easier to perform all tasks correctly. The same template should of course also be used when the installation company takes over the maintenance. Again, the forms in the following were created for the 14.3 kWp system near Harare.

Table 10: Example for a Module Inspection Sheet

Year:_____

Module Inspection Sheet

Month	Date	Voltage in V before			Amperage in A before			Modules cleaned (Y/N?) When? Date, time.	Voltage in V after			Amperage in A after			Inspected by:
		Inv. 1	Inv. 2	Inv. 3	Inv. 1	Inv. 2	Inv. 3		Inv. 1	Inv. 2	Inv. 3	Inv. 1	Inv. 2	Inv. 3	
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Table 11: Example for liquid lead battery maintenance sheet

Inspection Protocol

Name of inspector		Room temperature		Charge mode (float, boost,..)		PV Generator voltage in V (at combiner box)	1-1: 1.2: 1.3:	2.1: 2.2: 2.3:	3.1: 3.2: 3.3:
Date, time		Total voltage battery bank in V		State of charge in %					

Cell number	Cell voltage in V	Electrolyte density in kg/l	Electrolyte temperature in °C	Electrolyte level (okay/ n.okay)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

Notes:

Self-Check - 2	Written Test

Instruction: Follow the below selected instruction

For each of the following question choose the best answer and circle the letter of your choice.

N°	Questions and answers	
1	Why must information on operation and maintenance be included in the report?	
	A – It is a legal requirement	B – Installers or clients should know what O&M measurements to carry out and how
	C – It does not have to be included	D – Because solar installers do not know how to do proper maintenance
2	How should the maintenance instructions be written?	
	A – Extra complicated so that only professionals understand	B – Clearly and easy to understand
	C – instructions don't have to be written down	D – Very long

Note: Satisfactory rating - 4 points **Unsatisfactory - below 4 points**

Information Sheet 3	Identifying competent persons for compilation of the report

3.1 Identifying competent persons for compilation of the report

Typically, the project manager writes the report or appoints a person to take over the task. In smaller companies it is usually somebody who was involved in the planning and implementation of the project. That makes it easier for the person to write down the details about the project and find the necessary information. If another person takes over the report writing who wasn't involved in the project, it is necessary to make sure that the person receives all relevant information on the project. One way to do that is to use a report template along which the report writer can request the information from the installer or planner. It is possible to collaborate on the report and ask several people to fill in different parts of information, but one person should be always responsible. It is recommended to gather the information for the report already throughout the project and not only at the end because some information might be lost after completion of the project.

3.2 General Principles (Drawn from the CRIRSCO Template)

The reports should name a Competent Person who takes responsibility for the disclosure. Securities regulators can have specific requirements for disclosure in a "Technical Report" which is prepared by Qualified Persons (e.g. Canada) or Competent Persons elsewhere. Most large mining companies have Competent Persons Reports to support their annual declarations of Mineral Resources and Mineral Reserves. These reports sometimes take the format of strategic business plans.

- The Competent Person must discuss any material aspect for which the presence or absence of comment could affect the public perception or value of the mineral occurrence.
- Mineral Reserves are estimates with attendant uncertainty. The Competent Person should provide a balanced discussion of risks and opportunities accompanying statements of Mineral Resources and Mineral Reserves.
- The report should be supported adequately by text, figures, tables, sections, and maps to demonstrate competence by conveying material information in a transparent manner.
- There should be consistency between financial reports and technical studies: Financial reports take into account Mineral Resources and Mineral Reserves and are

based on assumptions concerning commodity prices, exchange rates, and other parameters of significance.

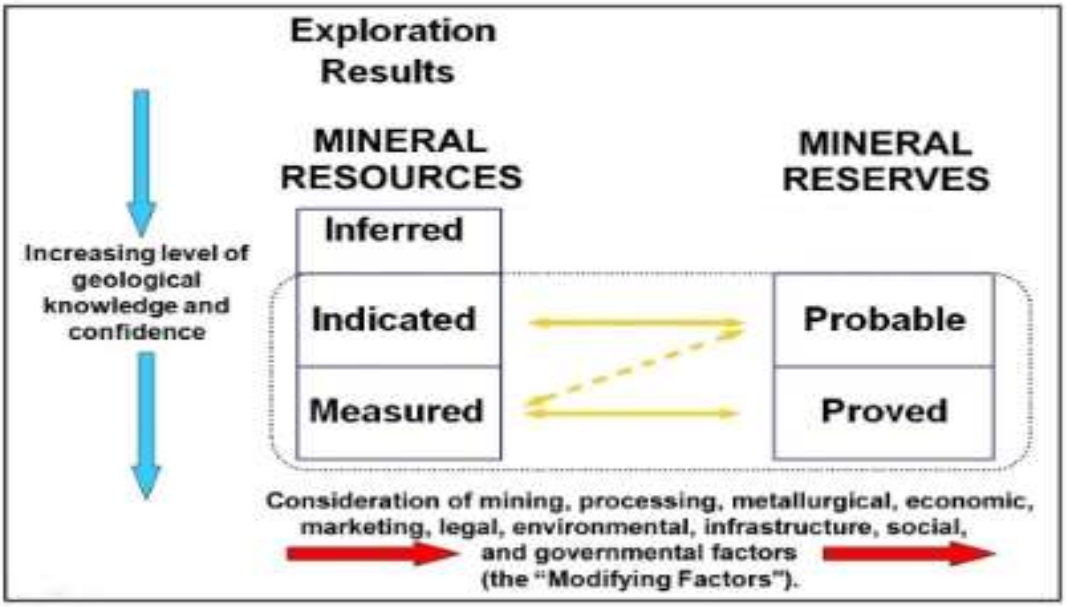


Figure 7: exploration results of mineral resources

Disclosure should be comparable with that made by other entities, as for example resources and reserves using the CRIRSCO Template

- ✓ Specify type of CP report and time available for preparation
- ✓ Describe dates for site visits by CPs and their activities on site-If no site visit, state why not needed or not made and risk to conclusions
- ✓ Describe sections for which each CP is responsible
- ✓ Describe ownership; vet ownership by third party legal opinion
- ✓ Obtain opinion(s) that payments due surface and mineral rights holders and other stakeholders have been made
- ✓ Specify risk of change in legal regime
- ✓ Ensure maps are up to date and legible (at least with 200% "zoom")

Self-Check - 3	Written Test

Instruction: Follow the below selected instruction

The following are true or false items, write true if the statement is true and write false if the statement is false.

N°	Questions and answers
1	Only one person at a time can work on the report.
	True or false:
2	The person creating the report should have a management degree.
	True or false:
3	It is recommended to gather the information for the report already throughout the project
	True or false

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

Score = _____

Rating=_____

Information Sheet 4	Reviewing report against all inputs

4.1 Reviewing report against all inputs

In the course of a project it might happen that component types, locations of components or other details of the planning change. For that reason, it is necessary to not only copy the initial planning into the report but to verify the information:

- Have any components changed?
- Is the wiring on site as planned or has anything changed?
- Could the components be installed at the planned location?
- Did any unforeseen changes or challenges occur?
- Are there any facts or information that could only be confirmed after the installation?
- Did anything else happen that should be noted in the report?

All information should be reviewed if it is true, coherent, and complete. Most projects follow the same basic scheme but sometimes there are special circumstances, e.g. a Diesel generator that was integrated in the system or an unusual type of battery. Those specialties might not be considered in a standard report template but should be nevertheless mentioned in the report and any additional information that might be required should be noted down.

- **This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications**

Test Procedure Documentation

A detailed test procedure should be published before test commencement. This test procedure includes all specific requirements and agreements for test execution and data reduction. All parties to the test must have a sufficient opportunity to review and approve this test procedure. It is recommended that the test procedure contain the following sections:

- ✓ Purpose
- ✓ Guarantee values and basis for guarantee or performance prediction
- ✓ Test schedule
- ✓ Parties to the test and respective roles and responsibilities for details of installation, operation, and data analysis, including responsibility for:

- Calibrations
- Ongoing data quality
- Cleaning of sensors
- Cleaning of array
- Detection of system issues
- Resolution of system issues
- Determination of curtailment (if applicable)
- Analysis of data
- Writing/review of final report
- Any other relevant roles.

- ✓ Plant operating requirements
- ✓ Instrumentation
- ✓ Pre-Test Uncertainty Analysis
- ✓ Detailed data treatment and reduction methods
- ✓ Criteria for a successful test
- ✓ Instrumentation cut-sheets and calibration certificates
- ✓ Historical meteorological data as an appendix.

- **Test Report**

The final test report will include both the Test Procedure (either explicitly or by reference) as well as the following items

Description of the party doing the test

- ✓ Description of the site being tested, including latitude, longitude, and altitude.
- ✓ Description of the system being tested, specifically including Table B-2, which describes all of the inputs to the model.
- ✓ Description of the historical meteorological data that were used for the initial prediction.
- ✓ A summary of the initial performance prediction that was made based on the historical data
- ✓ A summary of the definition of the meteorological data taken during the test
- ✓ A summary of the definition of the system output data collected during the test
- ✓ The raw data that were collected during the test, including note of which data, if any, were flagged for removal.
- ✓ An explanation of why data (if any) were removed.
- ✓ A list of any deviations from the test procedure and why these were taken.

Self-Check - 4	Written Test

Instruction: Follow the below selected instruction

The following are true or false items, write true if the statement is true and write false if the statement is false.

N°	Questions and answers
1	After completion the report should be double-checked for correctness and completeness.
	True or false:
2	One should always stick to the report template.
	True or false:

Note: Satisfactory rating - 4 points **Unsatisfactory - below 4 points**

Information Sheet 5	Compiling report.

5.1 Compiling report.

In this chapter we look at how to compile a report and how to save it properly.

5.2 Digital or hard copy

There is the option to save a report either as hard copy or as digital copy. Both variants have advantages. A hard copy is easy to use and independent from data loss when a computer breaks. On the other hand, a hard copy needs space and the more installations an installer finished, the more documentations need to be stored. Digital copies on the other hand last a long time, don't need space in the office and automatic searching makes it easy to find information. But digital information also needs to be saved somewhere. One has to think of a filing system for the information and safety copies on an external hard drive should be made.

For larger and important projects, is recommended to keep both, a digital and a hard copy, in order to make sure that the information is not lost. For clients it is usually better to get a hard copy. One the one hand, it is a nice gesture from the installer to hand over the complete copy of the documentation at the end of a project. It leaves the client with a good feeling and builds trust in the installer. In case of a problem or if he wants to extend the system, chances are high that he contacts the same installer again and not a competitor. On the other hand, he can keep the documentation with the PV system and doesn't have to search for long whenever there is a problem or emergency with the system. Sometimes clients also would like to have a digital copy of the documents, especially when the client is a company or when many people were involved in the project on the client's side. Then a digital copy should be also supplied to the client.

5.3 Format of the report

Depending on the size of the project and the number of documents, the report might be quite long. When printing it out, it usually makes sense to split it into different chapter and to add page separators between the chapters. E.g. one section for the data sheets, another section for measuring results and another section can be added for maintenance reports.

All pages should be punched and combined in an arch file. In that way pages can be added or removed. This is useful when for example a component must be replaced after a few years or wiring plans are changed because the client decides to re-wire his house. The amended plans can then easily be added to the documentation.

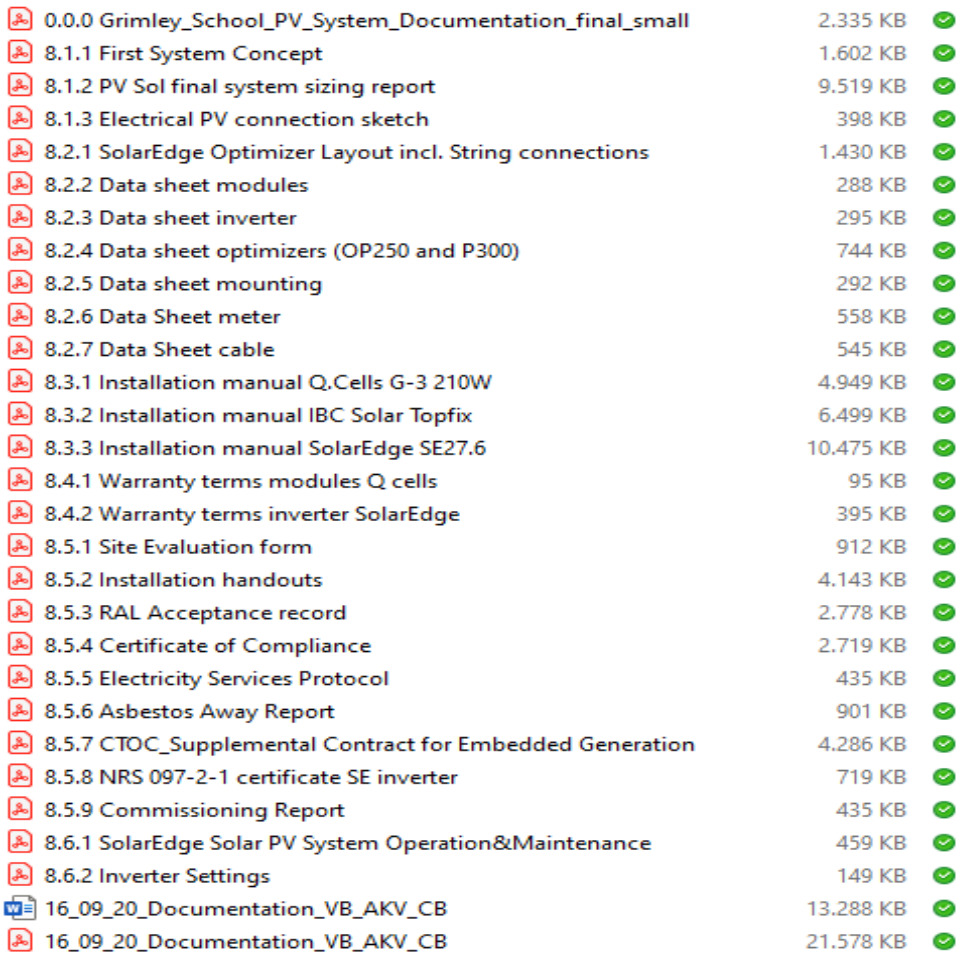


Figure 8: Digital PV System Documentation

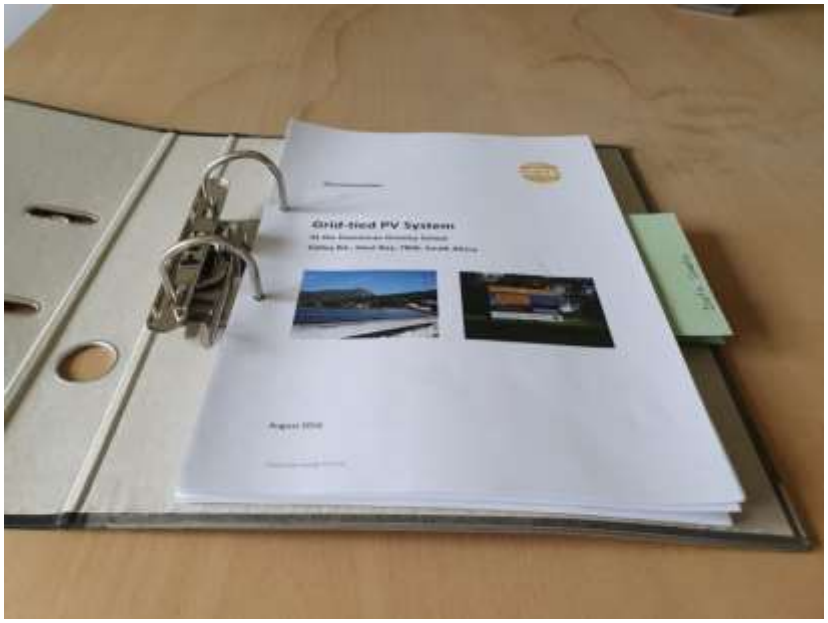


Figure 9: PV System documentation in an arch file with separators for the chapters

Self-Check - 5	Written Test

Instruction: Follow the below selected instruction

For each of the following question choose the best answer and circle the letter of your choice.

N°	Questions and answers	
1	What should be considered when printing a PV system documentation?	
	A – It should be printed on recycling paper	B – It should be printed in colour
	C – It should be structured in chapters	D – It should not be longer than 60 pages
2	Why does it make sense to put a report in an arch file?	
	A – An arch file is very big and can be found easily in the office	B – Pages can be added when components are replaced in the future
	C – One should not use an arch file	D – Pages can be taken out to hide mistakes

Note: Satisfactory rating - 2 points **Unsatisfactory - below 2points**

Information Sheet 6	Compiling research report information.

6.1 Compiling research report information

If any research was done in relation with the project, the research results should also be saved in a written report. The research report should consist of:

a) A cover sheet with the name of the researcher and topic of the research
b) A short summary
c) A list of content
d) The research results
e) A bibliography or list of sources that were used to compile the report

- **The Title or topic**

The title is your readers' first contact with the report. Its aim is to inform them of the report's contents. It should be brief, but it must contain enough information to distinguish it from other, similar reports. Try to write it using ordinary English grammar, rather than the 'headline' style that is sometimes adopted; for example, a good title might be A comparative survey of computer programs for business using the PC rather than PC business program comparison survey

- **The Summary**

The purpose of the summary is to give a brief overview of the whole report, not just of the conclusions and recommendations. Although it is placed immediately after the title, it is written last, after the rest of the report has been completed. It is not necessary to give detailed information in the summary - it is sufficient to give an indication of the kind of information that can be found in the report. For a short report, a summary of about 100-150 words is enough; for a major research report, a summary may be as long as one page. It certainly should not be longer than this. As a general rule, the shorter the

Collecting information for your research paper can be challenging when you are unsure how to get started or how to organize a plan to compile what you need. There are a few areas to focus on that may make the task easier for you. At the same time you can break up the task to make things easier for you during the process. The following tips are a few hints to help you get started with research for your topic.

- **The List of Contents**

the list of contents is there to help your reader find specific information in the report quickly. It is usual to present it as a list of headings with corresponding page numbers. In a long report, or if the material is complex, it is helpful to split the report into sections which are also presented in the list of contents. The sections should be given informative subheadings that should be chosen with as much care as the main title of the report.

- **Think about Your Topic and Information You Will Need to Support It**

Once you have decided on a good topic to write about you can start thinking about what information you need to collect. This is a great way to start planning your research. You can think about details you need to mention in your paper, where the information should be mentioned and which sources you may need to use. Your thesis statement and other parts of you research paper should be considered to help you understand what details you need.

- **Make a List of Resources You Need to Use**

Once you have had a chance to start thinking about details you want to mention, next is to consider making a list of references to use that will provide such data. This can help you plan your research and how to use your time. Many research papers need a considerable amount of information in order for overall content to make sense to the reading audience. Such sources should be unique and include multiple sources to help make your paper interesting. Aside from using the internet, consider encyclopedias, other reference books and even quotes from people you can interview related to your topic.

- **Make an Outline to Help You Collect Information**

An outline can help you break up your research paper. This is an easy way to look at the whole picture to give you a better idea of how to collect your data. The outline includes sections your research paper is made up of. As you collect data you would take notes and include them in the section you have created within your outline. You can take your time researching your topic and you can do it out of order and mark off sections as you complete them. At the same time your content is organized and structure within the outline, making the writing process easier to get started.

- **Steps to a Successful Research Report**
  - ✓ Choose a topic. It should be a subject he can understand and one that interests him.
  - ✓ Make a plan. Create a calendar together to map out the process.
  - ✓ Check with the teacher
  - ✓ Conduct research and take notes
  - ✓ Outline the project
  - ✓ Write the report
  - ✓ Edit and reread the report.

Self-Check - 6	Written Test

Instruction: Follow the below selected instruction

The following are true or false items, write true if the statement is true and write false if the statement is false.

N°	Questions and answers
1	Collecting information for your research paper can be challenging when you are unsure how to get started or how to organize a plan .
	True or false:
2	A research report does not necessary Make a List of Resources You Need to Use
	True or false:
3	The list of contents is there not to help your reader find specific information in the report quickly.
	True or false

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

Solar PV System Installation and Maintenance

Level IV

Learning Guide -30

Unit of Competence	**Compile and Produce Solar PV Installation Detailed Report**
Module Title	**Compiling and Producing Solar PV Installation Detailed Report**
LG Code	**EIS PIM4 M08 LO3-LG30**
TTLM Code	**EIS PIM4 TTLM 0920v1**

LO3: Obtain approval for final solar PV installation report

Instruction Sheet	Learning Guide:-30

This learning guide is developed to provide you the necessary information, knowledge, skills and attitude regarding the following content coverage and topics:

- Report is presented and discussed with person(s) of higher authority.
- Alterations to the report resulting from the presentation/discussion are negotiated with person(s) of higher authority within the constraints of Organization policy.
- Final report is presented and approval obtained from.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:-

- Present report and discuss with person(s) of higher authority.
- Negotiate alterations to the report resulting from the presentation/discussion with person(s) of higher authority within the constraints of Organization policy.
- Present final report and obtain approval.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks

Information Sheet 1	Presenting and discussing report with higher authority

1.1 Presenting and discussing report with higher authority

Because the report is an important part of the project implementation process, it is necessary to discuss it internally and with the client. In this chapter is explained what must be discussed.

1.2 Discussing the report with the client

The report should be a useful tool for the client to understand his own PV system so he should also be involved in the report approval process. Before handing over the final report the client should be asked if he has any additional requirements or things he would like to get with the report.

1.3 Discussing report internally

Internal reporting involves the compilation of financial and operational information on a frequent basis, which is distributed to those within an organization who can use it to improve performance. Internal reports are not shared with anyone outside of the firm. After compiling the report it should be reviewed by at least one person who was involved in the project implementation process to make sure that all information is correct and nothing is missing. Especially when it is a complex project, mistakes can happen so the four-eye-principle to verify the information is recommended.

Once a second person who is competent to give a qualified opinion has approved the report the management should have a final look and approve the report if all is correct. Especially in bigger projects, the report and the information included might have legal consequences or is of importance if it gets to a legal dispute so it should be approved by a higher authority. One important area of internal reporting is financial reporting. Financial reports are used to monitor a company's financial health and can inform decisions which need to be made about the direction in which a company will be taken. For example, an internal report could reveal that one division spends a lot of money without generating very much revenue and managers could discuss how to make that division more efficient or consider the possibility of closing that division altogether.

Self-Check - 1	Written Test

Instruction: Follow the below selected instruction

The following are true or false items, write true if the statement is true and write false if the statement is false.

N°	Questions and answers
1	The report should be checked after the 4-eye-principle.
	True or false:
2	The client should not be involved in the report writing process.
	True or false:

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

Information Sheet 2	Negotiating alterations to the report resulting from presenting to Higher authority

2.1 Introduction

Negotiations involve two or more parties who come together to reach some end goal through compromise or resolution that is agreeable to all those involved. One party will put its position forward, while the other will either accept the conditions presented or counter with its own position. The process continues until both parties agree to a resolution.

2.2 The information that follows outlines seven steps you can use to negotiate successfully.

- Gather Background Information
- Assess your arsenal of negotiation tactics and strategies
- Create Your Negotiation Plan
- Engage in the Negotiation Process
- Closing the Negotiation
- Conduct a Postmortem
- Create Negotiation Archive

The stages in a Negotiation Lifecycle are depicted in this chart (Exhibit 1). It is not always a given that negotiations should happen, especially if the status quo is fine or other alternatives exist. But if needs exist for opposing parties to reach a mutual solution, engage dutifully in each step in the lifecycle.

Figure 10: negotiation lifecycle

When discussing the report with higher authorities, it is necessary to know where all the information in the report comes from and to be able to answer any questions. When changes to the report are proposed, always evaluate if the change will benefit the understanding of the installation process and if might it be useful in the future. The report should not be overloaded with unnecessary information and a logical structure should be kept at any times.

After discussing with higher authorities, like the project manager or the client or any other parties, their view should be considered, and the report altered if necessary. When altering the report, add the new information to the chapters where they belong to or add new chapters if necessary.

Self-Check - 2	Written Test

Instruction: Follow the below selected instruction

The following are true or false items, write true if the statement is true and write false if the statement is false.

N°	Questions and answers
1	Everything the client proposes must be added to the report.
	True or false:
2	All changes that are discussed with higher authority should be added at the end of the report.
	True or false:
3	The report should not be overloaded with unnecessary information and a logical structure should be kept at any times.
	True or false

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

Information Sheet 3	Presenting final report and obtaining approval from appropriate person

3.1 Handover and instruction

When the report is finalised, one copy (digital or hard copy) is kept by the installer and another copy is handed over to the client. It is recommended to hand over the report to the client as a hard copy. The handover of the documentation is the very last step in the process of a PV system installation.

- **The report should be talked through with the client and the client should be briefed on:**
  - ✓ who to contact in case of questions and emergency,
  - ✓ the basic functioning of the system (to not accidentally destroy or limit the functioning e.g. by covering the modules because he doesn't know that they are producing the electricity),
  - ✓ maintenance procedures,
  - ✓ emergency switch-off procedure,
  - ✓ where to find what in the documentation.

3.2 Client Approval

When the handover of the report is finished, it is recommended to let the client sign a handover protocol. A handover protocol is a legal protection document for the PV system installer. The client signs that everything is in order, that he was instructed by the installer on the use of the system, that the system worked at the time of the handover and that the client received the complete documentation. In case a problem occurs later, the client cannot blame the installer because he signed that he witnessed the handover of a working system. Also, the document protects the installer from being held liable for damages he did not cause. It sometimes happens that clients discover a damage in their house, e.g. a broken window or holes in the wall and they try to blame the PV installer for it. For that reason, an installer should always take photos of the site before and after the installation and have the handover protocol signed to avoid any problems later. But of course, this document should not be used as an excuse to install a bad quality system that is doomed to fail sooner or later.

Customer Briefing

Minimum requirements for a Customer Instruction according to the RAL Quality Label "Photovoltaic Installations" RAL GZ 966, Adapted by DGS Thuringia for South Africa

The following was discussed with the customer

- ☐ Functionality and operation of the entire system have been explained to the customer.
- ☐ The customer has been informed about the basic functionality of the main components (modules, inverter, cabling, main DC insulator/switch, protection equipment, meters etc.).
- ☐ The customer has been informed about the location of the main components of the installation (modules, inverter, cabling, main DC switch, protection equipment, meters etc.).
- ☐ User manuals have been delivered to the customer (especially for inverter and modules).If applicable:
- ☐ The customer has been informed about the location of the monitoring systems and informed about its function.

Service contact details

- ☐ Service contact details at visible locations on critical components, e.g. inverter, data recorder, battery bank, etc.

Relevant operations and necessary actions were explained

- ☐ Normal operation: The plant is working (producing energy and feeding in) with sufficient radiation, respective display on the inverter.
- ☐ Sufficient radiation, but the inverter does not work, showing malfunction reports or switching on and off or indicating errors etc.
- ☐ **In case of malfunction the customer should:**
  - ✓ Switch off the PV plant (DC insulator/switch, fuses).
  - ✓ Inspect for obvious faults such as loose connections, brittle cables or physical damage to any component.
  - ✓ Contact the installer (see service phone number).

System tests and inspections

The installation contractor shall be responsible for annual inspection of the installation. All maintenance activities listed in the user's manual shall be adhered to.

- ☐ It is recommended to check plant yield and report at least on a monthly basis (if not constantly monitored).
- ☐ Where possible, dirt (leaves, bird droppings etc.) shall be removed from PV-modules by washing.

The following annual inspections should be performed:

- ✓ Changes to the configuration or set-up of plant / PV array / roof (e.g. after thunderstorms etc.)
- ✓ Functional testing for the integrity of all protective equipment (eg. earthing, lightning protectors, etc.)
- ✓ Visual inspection of all components for physical damage, including panels, cables, connectors, mounting brackets, etc.

Monitoring system (if applicable)

- ☐ The monitoring system is installed and working.
- ☐ The customer was informed how to use the monitoring system.
- ☐ The operating manual was handed to the customer.
- ☐ The customer was duly trained to perform plausibility check of the yields.
- ☐ The customer was trained to assess essential values that may indicate malfunctions.

Signed by customer		**Signed by installer**
Location:		**Location:**
Date:		**Date:**
Name:		**Name:**
Capacity:		**Capacity:**
Signature:		**Signature:**

Self-Check - 3	Written Test

Instruction: Follow the below selected instruction

Answer all the questions listed below. Use the Answer sheet provided in the next page:

N°	Questions and answers
1	The handover of the documentation is the very last step in the process of a PV system installation
	True or false
2	A handover protocol is not a legal protection document for the PV system installer.
	True or false
3	When the handover of the report is finished, it is recommended to let the client sign a handover protocol.
	True or false

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

List of reference materials

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