

## 1.1 Objective of Solar Training

This solar training is intended to provide the advanced practical knowledge required for the safe, code-compliant design and installation of photovoltaic (PV) systems, with a focus on both grid and off-grid solar electric systems. This training also provides effective use of energy modeling software such as HOMER and RETScreen for easy technical design and financial engineering of renewable energy technologies. The goal of this training is to create unique and specialized practical concepts needed to work on all PV systems, including system components, system sizing, site analysis, PV module criteria, mounting solutions, over-current protection, grounding, safety, and commissioning. The university's curriculum and practices are conducted to conform to the requirements of ISO/IEC 17024.

### Course Content

Training Courses	Course Content
<b>Component of Lecture course</b>	
Occupational Health Safety and Environment	This topic provides trainees with the requisite knowledge to adopt safe and good working habits. The topics include on-site risk assessment; work hazards; site safety; first aid
Fundamentals of Solar Energy	This topic covers the knowledge on basics of the Solar PV system. Topics discussed are but not limited to the following: Electricity from Solar Energy; Feature of Solar PV System; Site selection, Solar Home Systems (SHS), Centralized System, solar thermal systems including concentrated solar power systems (CSP)
Solar Radiation	This topic provides broad knowledge on solar energy and some of the topics discussed are solar Insolation; Peak Sun Hour (PSH); Tilt Angle and examples of effect by various tilt angle; No-Shade Time
Electrical Basics and circuit theory	This topic covers the knowledge on basic electricity and basic calculation skill of electrical circuit. Topics include AC and DC circuits; Ohm's Law, Power Law; Kirchhoff's Law; Power and Energy; Peak load and Daily Power consumption; Voltage Drop; Calculation of Voltage Drop; Specification of Voltage Drop
PV Cells and Modules	The topics discussed in this section broadly covers the physics of PV cell; PV module; Type of PV Module; I-V and P-V Curve; Characteristic of IV Curve; Series & Parallel Connection; Output of PV Module; Bypass Diodes & Blocking Diodes; Effect of shadow
Batteries	The topics discussed in this section broadly covers Type of Lead-acid Batteries; Profile of Battery Voltage; Indicator of State of Charge; Charging

	Efficiency; Cycle Life, Capacity; Discharge Rate; Maintenance of Electrolyte; Maintenance of Electrode; Maintenance of Cell Voltage; Battery capacity specifications; effects of temperature; Series, Parallel and Inter-Connection
Charge Controllers	The topics discussed in this section cover Function of Charge Controller; Type of Charge Controller; Status of the charge controller, Setpoint voltage; Connecting Sequence, etc.
Inverters	Topics treated under inverters include the various type of inverters (eg. Square wave, pure sine wave, etc), output waveform, surge related issues
Applying Energy Efficiency Techniques and Load Assessment	This topic provides knowledge on techniques needed to reduce electrical demand. These solutions mostly passive in nature can reduce demand to reduce the capacity of the system to be sized. Topics include an overview of passive solar design systems (eg. Orientation, thermal mass, insulation, ventilation, window shading, and sun control, etc.); overview of active solar systems
System Design	This topic provides in-depth calculations required to conduct system component sizing. Design criteria and the required specification are analyzed. Topics handled are assessing end-user services and energy demand; resource assessment and selection, site assessment; system configuration; Determining the load requirements of the system; Determining the losses of the subsystem, e.g. battery efficiency, regulator efficiency, and cable losses; Determining the size; Load estimation, inverter sizing, battery sizing, charge controller sizing, PV sizing, wiring sizing
System inspection, monitoring, and Maintenance	This topic covers the knowledge of inspection, monitoring, and Maintenance. Topics discussed are System Parameters; Measuring equipment; Status of Charge Controller; Status of the system; Measuring points (Centralized); Specific Gravity; Daily Usage Time of loads (SHS); Peak load & Total load (Centralized)
Testing and commissioning of the system	This topic aids knowledge in system commissioning. The topic covers discussion areas such as final installation checklist; Visual inspection; verification of code compliance; electrical system verification testing; system functioning testing; verification of

	array power and energy production against standard test conditions (STC); derating factor components
Fault Finding and Trouble Shooting	This topic covers general knowledge of troubleshooting. Topics to be discussed include; IV and PV Curve; Characteristic of IV Curve; Series & Parallel Connection; Effect of shadow; short circuit faults and open circuit faults.
Introduction to <b>HOMER</b> , <b>Pvsyst</b> , <b>SEQUEL</b> (A Solver for circuit Equations with User-defined Elements) and <b>RetScreen</b> Softwares	These software tools are decision-making tools that reduce the cost of pre-feasibility studies; <ul style="list-style-type: none"> <li>• disseminating knowledge to help trainees make better decisions; and by</li> <li>• training people to better analyze the technical and financial viability of possible projects.</li> </ul>
Procurement and quality management & customer care	This topic covers the knowledge on Procurement and quality management principles. The trainer will explain the specifications of the main components and measuring instruments to be used in a PV project and how to read the datasheet of materials. <ul style="list-style-type: none"> <li>• Trainee will better understand the standards for selection, choices, and financial implication in the procurement of solar system devices.</li> <li>• Trainees will acquaint themselves with quality management principles and customer care relations.</li> </ul>
Knowledge evaluation	Trainees will be examined in theoretical and practical skills
<b>Component of Practical work (hands-on)</b>	<b>Course Content</b>
How to use measuring instruments	This topic covers the skills on how to use measuring instruments. The trainer explains the specification of measuring instruments and how to use them. After the explanation, the trainee will measure the parameters using the instruments individually and record the data into the datasheet
Measuring of an electrical circuit	This topic reviews the circuit laws and voltage drop learned in the basics of electricity. The trainees will calculate the values at the designated points by using circuit laws, and then trainees will measure the values at the same points to confirm if both values are the same.
Performance check of Charge Controller	This topic reviews the functions and operation conditions of the charge controller. Trainees are tooled to check the protective function of the charge controller by using test instruments. It is important to understand how switches change when the

	charge controller has reached high voltage disconnect (HVD) or low voltage disconnect (LVD).
Inspection of PV system	This topic reviews the inspection method of a PV system. Trainees are provided the requisite skills to check the PV system by measuring the system parameters during operation. It is important to understand the meaning of system parameters.
Monitoring of existing PV system	This topic covers the monitoring method of the existing PV system. The trainees will be instructed how to conduct monitoring using the monitoring sheet. The trainees will conduct monitoring of the existing PV system at the site and evaluate the system status from monitoring results.
Measuring of I-V curve	This topic covers the measurement of the I-V curve and what are the parameters that affect the I-V curve. The trainees are instructed to measure I-V curve using a test instrument and record the data into a datasheet. After measuring, the trainees will arrange and process the data
Measuring of PV module output	This topic covers the characteristic of PV output. The trainees will measure PV output by changing the direction and tilt angle of the PV module and understand how PV output changes by those effects
Conducting continuity test of wiring	This test is done to make sure there is continuity in the cable to be used for the connection.
System connection sequence	Connection sequence is important to avoid damage to trainees and system components.
System connection	For example, a simple standalone Solar System like street lighting components are connected and installed