

13.1.0 SOLAR INSTALLATION SYSTEMS

13.1.01 Introduction

The solar system module unit is designed to equip the trainee with knowledge skills and attitudes necessary to understand and install solar installation systems.

Trainees will appreciate prior knowledge and skills acquired in Electrical Installation I of this course.

13.1.02 General Objectives

By the end of module unit, the trainee should be able to:

- a) understand the basic principles of solar systems
- b) acquire relevant skills for installation solar systems
- c) create awareness in the application of solar systems
- d) interpret solar system data to determine the solar sizes
- e) observe safety rules and standards when installing solar system panels
- f) institute quality control measures while installing solar systems
- g) prepare, maintenance schedules and maintain solar systems

13.1.03 Module Unit Summary and Time Allocation

Solar Installation Systems

Code	Sub-Module Unit	Sub Sub-Module Unit	Time Hrs
13.1.1	Solar Installation Systems Fundamentals	<ul style="list-style-type: none">• Solar energy and its conversion• Terms used with solar systems• Methods of solar energy harvesting• Applications	10
13.1.2	Solar (Photo Voltaic) System	<ul style="list-style-type: none">• Parts of a photovoltaic• Functions of each part of a voltaic system• layout of the photo voltaic system	8
13.1.3	Solar Systems' Accessories	<ul style="list-style-type: none">• Types of accessories• Types of cable joints	10

		<ul style="list-style-type: none"> • Wiring systems • Choice of wiring systems • Tests performed on completed installation • Regulations governing solar installations 	
13.1.4	Maintenance And Servicing Of Solar Systems	<ul style="list-style-type: none"> • Procedure for maintenance • Repair and trouble shooting 	4
13.1.5	Solar System Sizing	<ul style="list-style-type: none"> • Terminologies • Sizing a solar system • Daily load energy demand • Equipment, cables and accessories sizing • Application of solar data 	12
Total Time			44

13.1.1 SOLAR SYSTEMS BASICS

Theory

13.1.1T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) explain solar energy and its conversion
- b) define various terms used with solar energy
- c) state various methods of solar energy harvesting
- d) list applications of solar energy

Competence

The trainee should have the ability to:

- i) Identify various forms of solar energy
- ii) Harvest solar energy
- iii) Utilize solar energy in various forms

Content

13.1.1T1 Solar energy and its conversion:

- i) Sun as a source of energy
- ii) Conversion of solar to chemical energy (photosynthesis)
- iii) Solar to heat (thermal)

- iv) Solar to electricity
- v) Solar to biomass

13.1.1T3 Definition of terminologies:

- i) Radiation
- ii) Direct and indirect radiation
- iii) Insolation

13.1.1T4 Methods of solar energy harvesting:

- i) Solar module (solar cells)
- ii) Parabolic reflectors
- iii) Dish reflectors
- iv) Box reflectors
- v) Flat plate collectors (water heating)

13.1.1T5 Applications of solar energy:

- i) Crop drying
- ii) Cooking
- iii) Water heating
- iv) Electricity
- v) Space heating
- vi) Green houses

Practice

13.1.1P0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) perform solar energy harvesting using various methods
- b) apply solar energy in day – to – day life

Content

13.1.1P1 Solar energy harvesting:

- i) Solar module (solar cells)
- ii) Parabolic reflectors
- iii) Dish reflectors
- iv) Box reflectors
- v) Flat plate collectors (water heating)

13.1.1P2 Applications of solar energy:

- i) Crop drying
- ii) Cooking
- iii) Water heating
- iv) Electricity
- v) Space heating
- vi) Green houses

Suggested Learning

Resources

- i) Solar energy equipment and apparatus
- ii) Solar module (solar cells)
- iii) Parabolic reflectors
- iv) Dish reflectors
- v) Box reflectors
- vi) Flat plate collectors (water heating)
- vii) Charts for solar installations
- viii) Field visits to solar homes

13.1.2 SOLAR INSTALLATION SYSTEMS

Theory

13.1.2T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) list the various parts of a photovoltaic systems
- b) explain the functions of each part of a voltaic system
- c) illustrate the layout of a photo voltaic system

Competence

The trainee should have the ability to:

- a) identify the various parts of a photo voltaic system
- b) read and interpret solar system drawings
- c) install solar systems

Content

13.1.2T1 Parts of a photovoltaic system.

- i) Module array
- ii) Charge controller
- iii) Battery
- iv) Inverter
- v) Wires and accessories
- vi) Loads

13.1.2T2 Functions of parts of Photo Voltaic Systems

- i) Charge controller
- ii) Battery
- iii) Inverter
- iv) Wires and accessories

- v) Loads
- 13.1.2T3 Solar system lay out
 - i) Block diagram
 - ii) Schematic diagrams.

Practice

- 13.1.2P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
 - a) Identify various components of a photo voltaic systems
 - b) Read and interpret a solar system layout.
 - c) Install a photo voltaic (solar system) using the right tools.

Content

- 13.1.2P1 Components of a photo voltaic system
 - i) Module array
 - ii) Charge controller
 - iii) Battery
 - iv) Inverter
 - v) Wires and accessories
 - vi) Loads
- 13.1.2P2 Solar system lay out
 - i) Block diagram
 - ii) Schematic diagrams.
- 13.1.2P3 Installation of a solar system

Suggested Learning Resources

- i) Solar module

- ii) Charge controllers
- iii) Inverter
- iv) Lead- acid cells
- v) Solar batteries
- vi) Various accessories and wires
- vii) Manila papers (Charts)
- viii) Tools
- ix) Solar system service kit

13.1.3 SOLAR SYSTEMS' ACCESSORIES

Theory

- 13.1.3T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
 - a) describe various types of accessories.
 - b) describe various types of cable joints
 - c) list various types of wiring systems for a solar systems
 - d) explain factors that are considered when choosing a wiring system
 - e) outline the tests, in the right procedures on a complete installation
 - f) apply various electrical regulations governing solar installations.

Competence

The trainee should have the ability to:

- i) identify the accessories for a photo voltaic system
- ii) perform cable joints
- iii) install electrical circuit using various types of wiring systems
- iv) test solar electrical systems in the right sequence
- v) apply electrical regulations and standards in the photo voltaic installation work

Content

- 13.1.3T1 Types of accessories
 - i) Ac and dc switches
 - ii) Socket outlets
 - iii) Lamp holders
 - iv) Ceiling roses
 - v) Patresses
 - vi) Consumer control units
 - vii) Consumer control units
- 13.1.3T2 Types of cable joints
 - i) Telegraphic joint
 - ii) T Joint Married joint
 - iii) Bell hangers joint
- 13.1.3T3 Wiring systems for P.V systems
 - i) sheathed wiring systems

- ii) Tough rubber sheath,
- iii) polyvinyl chloride(PVC) sheath,
- iv) polychloroprene (PCP)

13.1.3T4 Factors that are considered when choosing a wiring system

- i) Cost
- ii) Durability
- iii) Safety
- iv) Aesthetics
- v) Nature of building

13.1.3T5 Tests procedures for an installation:

- i) Physical inspection
- ii) Electrical tests
- iii) Ring continuity tests
- iv) Effectiveness of the earth tests
- v) Insulation tests
- vi) Polarity tests

13.1.3T6 Electrical regulations governing solar installations

Practice

- 13.1.3P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
 - a) make various types of cable joints and terminations
 - b) select suitable wiring systems and install P.V systems

- c) perform in the right procedure, tests in a complete solar installation
- d) carry out quality control checks

Content

- 13.1.3P1 make of cable joints and terminations
 - i) joints
 - ii) Telegraph
 - iii) Scarf
 - iv) Britannia
 - v) Bell hanger's
 - vi) T Joint
 - vii) Married
 - viii) Termination
s
 - ix) Loop
 - x) Claw
 - xi) Spade
 - xii) Crimped
 - xiii) Lug
 - xiv) crimping
- 13.1.3P2 Wiring systems for solar systems
 - i) sheathed wiring systems
 - ii) tough rubber sheath
 - iii) polyvinyl chloride(PVC) sheath
 - iv) polychloroprene (PCP)
 - v) regulations and standards for P.V installations
 - vi) conduit wiring systems for P.V systems

- vii)PVC conduit wiring systems
- 13.1.3P3 Tests procedures for an installation
 - i) Physical inspection
 - ii) Electrical tests
 - iii) Polarity
 - iv) Earthing
 - v) Insulation
 - vi) Ring continuity
- 13.1.3P4 Electrical regulations governing solar installations
- 13.1.3P5 Quality control checks for solar systems installations
 - i) Material selection
 - ii) Selection of tools and equipment
 - iii) Measuring, marking out and fixing of components and equipment and application of acceptable tolerance
 - iv) Termination techniques
 - v) Testing of the completed installation
 - vi) Compliance with the set standards
 - vii) Good quality finish and appearance

Suggested Learning Resources

- vi) Assorted accessories
- vii) Chalk board
- viii) Text books

- ix) Instruments
- x) Resource persons
- xi) Manuals

13.1.4 MAINTENANCE AND SERVICING OF SOLAR SYSTEMS

Theory

13.1.4T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) explain the procedures for solar system maintenance
- b) outline trouble shooting and repair procedures of a solar system.

Competence

The trainee should have the ability to:

- i) install a photo voltaic system
- ii) test a photo voltaic system
- iii) service and maintain photo voltaic system

Content

- 13.1.4T1 Solar system maintenance procedure,
- i) Battery maintenance
 - ii) cleaning,
 - iii) topping up electrolyte level,

- iv) checking the state of charge,
- v) equalizing charge
- vi) Module maintenance:
- vii) dusting and testing modules
- viii) Checking of connections
- ix) System records and manuals

13.1.4T1 Trouble shooting procedures:

- i) Module condition
- ii) Battery condition
- iii) Control and Protection devices
- iv) Lamp conditions

Practice

13.1.4P0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) test a solar system for proper operation
- b) service and maintain a solar system for proper operation

Content

- 13.1.4P1 Testing a solar system for proper operation
- i) Checking / testing the outputs of a module – Voltage, current and power
 - ii) Checking parameters of a charge controller

- iii) Checking for loose connections
- 13.1.4P2 Servicing and maintaining a solar system
 - i) Battery –
 - ii) topping up
 - iii) electrolyte level
 - iv) charge level
 - v) Module cleaning.
 - vi) Checking for loose connections
 - vii) Checking all other connections,
 - viii) charge controller,
 - ix) inverter,
 - x) loads
 - xi) Checking for burnt out lamps and replacing the same
 - xii) Applying current electrical regulations and codes of practice in all areas of tests and inspection

Suggested Learning Resources

- i) Solar system tool kit
- ii) Solar Battery
- iii) Solar Module
- iv) Solar energy inverter
- v) Solar system service kit.

13.1.5 SOLAR SYSTEM SIZING

Theory

13.1.5T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) explain terminologies used with solar systems.
- b) explain the need for sizing a solar system
- c) determine the daily load energy demand for any system specifications
- d) determining the right size of equipment, cables and accessories
- e) size a typical solar system given all the necessary data.

Competence

The trainee should have the ability to:

- i) Identify the right wires, accessories, cables and apparatus for a solar system.

Content

13.1.5T1 Terminologies for solar system technology

- i) Module outputs and specifications
- ii) Daily energy requirement
- iii) Number of battery storage days
- iv) Battery capacity

- v) Depth of discharge/depth of charge
 - vi) Insolation
 - vii) tracking
- 13.1.5T2 Need for sizing
- i) Need for the right size of the module
 - ii) Need for the right charge controller
 - iii) Need for the battery
 - iv) Need for the right size of fuse and circuit breaker
- 13.1.5T3 Determination of daily energy demand as
- i) Energy due to lamps
 - ii) Energy due to other loads
 - iii) Power required to cater for the losses
 - iv) Total daily energy demand
- 13.1.5T4 Determining the right size of equipment:
- i) Module
 - ii) Cables and accessories factors to consider:
 - iii) Charge controller – Factors to consider:
 - iv) Inverter factors to consider
 - v) Battery.
- 13.1.5T5 Step – by – step sizing of solar systems
- vi) Total daily energy demand
 - vii) Systems voltage
 - viii) Systems current hours
 - ix) Insolation effect
 - x) Autonomy effect
 - xi) Tracking effect
 - xii) Choice of modules, battery charge controllers inverters
 - xiii) Choice of cables and accessories.
- Practice*
- 13.1.5P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to size typical solar system.
- Content*
- 13.1.5P0 Needs of an installations
- i) Need for sizing
 - ii) Daily energy demand
- Suggested teaching and learning resources*
- i) Drawing board
 - ii) Calculator
 - iii) Catalogues
 - iv) Data for solar equipment