

CURRICULUM FOR THE TRAINING AND CERTIFICATION OF PHOTOVOLTAIC INSTALLERS

A Course for Integration into Electrical Installation Grade II Skill Level



SYLLABI AND REGULATIONS



MOE



European Union



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PREFACE

Solar energy is among the alternative sources of energy that has been identified as a suitable option for providing modern energy services to Puntland. However, utilization of solar as a major source of energy continues to be hampered by the lack of adequate technical capacity and the lack of a structured training programme that can develop and deliver skilled personnel with knowledge and skills suited for the industry. In order to address these issues, a training needs assessment was carried out which led to the development of a curriculum within the MoE aimed at addressing these challenges.

Training Needs Assessment (TNA) Survey

The objectives of the TNA were:

- i) Review of institutional and policy framework for vocational training in the fields of electrical / electronic trades
- ii) Review of existing vocational technical training curriculum (mainly domestic electrical installation) and level of knowledge and skills acquired by graduates of these curricula
- iii) Assess technical training infrastructure for electrical technology.
- iv) Assess technical training implementation capacity.
- v) Review PV curricula available and the training experiences on PV systems and applications in Puntland.
- vi) Assess both formal and informal training undertaken by training institutions, NGOs and the private sector in the field of PV.
- vii) Identify PV systems that are appropriate for Puntland.

Methodology

A participatory approach was used where stakeholders were identified and discussions held.

Data and information gathering was made through visits to the field where institutions, dealers and end users were met and discussions held with responsible persons.

Where possible, joint meetings involving several stakeholders were held and scheduled interviews used to guide in data gathering.

In addition to field data gathering, a review of the country data and information relating to TVET, socio-economic situation, energy sector and PV market was carried out. The relevant documents were provided by ADRA and the Ministry of Education in Puntland.

In relation to this, the following documents were reviewed:

- i) A Socio-economic Baseline Survey Report, ADRA, 2008.
 - ii) The Puntland, Local Economic Development (LED) study report of 2006 on promotion of employment through training for the Ministry of Education.
 - iii) Curriculum for Electrical Installation courses, skills level Grade II and Grade III, UNESCO, 2007.
- The data and information gathered was analyzed and the results are presented in form of a report.

TNA Findings

The training needs assessment revealed that;

- i) MoE through TVET department favours establishment of a structured PV course in VTCs.
- ii) A structure to implement the TVET objectives exists at MoE.
- iii) TVET institutions are few and donor dependant.
- iv) TVET institutions can be facilitated to offer PV courses.
- v) TVET's have no implementation capacity for PV courses.
- vi) No harmonized PV curriculum exist.
- vii) No accredited PV course.
- viii) PV is widely used as a source of power for different reasons.
- ix) Existing electrical installation course a good foundation for PV course.
- x) Integrating PV course into Electrical Installation preferred.

Recommendation

Based on the TNA findings, it was recommended that;

- i) There is need to strengthen TVET institutional framework
- ii) VTCs to be facilitated to offer PV courses.
- iii) The number of TVET institutions should be increased and more training levels introduced for scalability.
- iv) The course should be optional, that is either stand alone or integrated.
- v) Grade II & III courses should be developed for easy integration into the Electrical Installation course.
- vi) The minimum entry requirement for the stand alone course should be electrical installation course grade III.
- vii) Welding is a detailed course best run on its own.
- viii) Industrial attachment should be given emphasis.
- ix) The course treatment and weighting should be 40% for theory and 60% for the CATs and practical.
- x) Stakeholders should create more awareness.
- xi) The curriculum needs to be translated into Somali.

Topic	Sub-topic	Time (hrs)
Unit 1: Basic Electricity II	<ul style="list-style-type: none"> ➤ Determination of resistance of metal conductors ➤ Factors that affect the resistance of a material ➤ Connection of simple electrical circuits ➤ Measurement of resistance ➤ Effects of temperature on resistance 	8
Unit 2: Solar Energy II	<ul style="list-style-type: none"> ➤ Defining terms and their units of measurement ➤ Solar energy and its conversion ➤ Methods of solar energy harvesting 	6
Unit 3: Solar Cells & Modules	<ul style="list-style-type: none"> ➤ Defining terms used with cells and modules ➤ Defining a P-N junctions ➤ Identifying of the terminals of a P-N junction diode ➤ Verifying solar module performance ➤ Measuring module quantities ➤ Explaining the construction of various types of modules ➤ Performing tests on a solar module 	7
Unit 4: Batteries II	<ul style="list-style-type: none"> ➤ Classify batteries and state key performance differences between the classes ➤ State two most common battery technologies in the market and major differences ➤ Describe lead acid battery construction and packaging ➤ Explain the operation of lead acid batteries ➤ Explain factors that affect the performance of lead acid batteries ➤ Specify batteries for solar systems ➤ Measure total voltage and current of cells connected in series and parallel ➤ Demonstrate various charging methods ➤ Carry out maintenance on a battery 	16
Unit 5: Charge Controllers II	<ul style="list-style-type: none"> ➤ Types of charge controllers ➤ Explaining the performance of two common types of charge controllers ➤ Specifying and selecting charge controllers ➤ Selecting charge controllers 	4
Unit 6: Power Inverters II	<ul style="list-style-type: none"> ➤ Operation of power inverters ➤ Testing power inverters ➤ Diagnosing faults in a power inverters ➤ Repairing faults in power inverters 	4
Unit 7: Solar PV System Sizing II	<ul style="list-style-type: none"> ➤ Explain sizing and the need for sizing a solar system ➤ Explain terminologies used with solar systems. ➤ Determine the daily load energy demand for given system specifications ➤ State and apply special considerations in determining sizing load energy demand for cycling or intermittent loads ➤ Determining the right size of equipment, cables and accessories ➤ Size a typical solar system given all the necessary data ➤ Record the planned system specification ➤ Make a drawing of the planned solar system ➤ Estimate materials for the planned system ➤ Cost the planned installation 	10
	<ul style="list-style-type: none"> ➤ Plan PV installation work 	4

Unit 8: Review of PV System Installation	<ul style="list-style-type: none"> ➤ List the main tools used in PV system installation and testing ➤ Choose an appropriate module/array mounting structure ➤ Properly locate and mount PV components - module, battery, Inverter, Charge Controller ➤ Interconnect PV components to complete a PV system installation 	
Unit 9: Review of PV System Inspection, Testing and Commissioning	<ul style="list-style-type: none"> ➤ Carrying out Visual and mechanical inspection on a completed solar system ➤ Carrying out testing on a completed systems ➤ User Training ➤ System commissioning 	3
Unit 10: Review of PV System Maintenance	<ul style="list-style-type: none"> ➤ Carrying out electrical wiring maintenance tasks ➤ Carrying out PV system Components maintenance tasks ➤ Planning a maintenance schedule 	4
Unit 11: Review of PV System Troubleshooting and Repairs	<ul style="list-style-type: none"> ➤ Carry out a step by step system trouble shooting ➤ Identifying faulty PV components and take appropriate action ➤ Identify common faults and carry out simple repairs ➤ Carry out fault diagnosis using modern equipment in-built programme menus and error codes 	4
Unit 12: Review of Packaged Systems & Hybrid Systems	<ul style="list-style-type: none"> ➤ Explain rationale behind packaged systems ➤ Explain the four most common packaged systems ➤ Select appropriate packaged systems for the four common packaged systems ➤ Explain hybrid systems and determine where they are suitable ➤ Carry out routine maintenance of hybrid systems 	8
Unit 13: Review of Health, Safety and Environment	<ul style="list-style-type: none"> ➤ Identify health and safety hazards in handling PV systems and Components ➤ Mitigate risks in handling PV systems and Components ➤ Mitigate Environmental hazards in handling PV systems and Components ➤ Identifying Health and safety hazards when handling and disposing materials used in PV solar installation systems ➤ Risk mitigation ➤ Environmental hazards and mitigation 	8
Unit 14: Attachment	<ul style="list-style-type: none"> ➤ Work experience ➤ Interaction skills 	60
Total Time Allocation		146

ABBREVIATIONS/ACRONYMS

AC	Alternating Current
ACP	African Caribbean Pacific
ADRA	Adventist Development Relief Agency
C.C	Charge Controller/Regulator.
DC	Direct Current
EC	European Commission
EU	European Union
HTI	Hargeisa Technical Institute
IDPs	Internally Displaced Persons
KEREA	Kenya Renewable Energy Association
kWhr	Kilowatt hour
MOE	Ministry of Education
NGOs	Non Governmental Organizations
PV	Photovoltaic
SELP	Somali Energy and Livelihood Project
TNA	Training Needs Assessment
TVET	Technical Vocational Education Training
USAID	United States Agency of International Development.
VTC	Vocational Training Centre

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1 Introduction

1.1 Background

Solar energy is among the alternative sources of energy that have been identified as suitable options for providing modern energy services to Puntland. This is mainly because the solar energy resource in Puntland is very good, ranging between 5 and 7 kWhrs/m²/day and also because the electricity infrastructure in Puntland is very limited in terms of capacity and coverage and other alternatives are expensive.

In view of the above, ADRA with the support of EC, USAID and other donors has been supporting initiatives aimed at stimulating the use of solar PV for electricity. These initiatives have included promotion campaigns, demonstration systems and training of solar technicians. As a result, the PV market has been growing steadily.

The PV training courses that have offered in the past have been on hard-hoc basis and short - limited to one or two weeks. These courses were found to be inadequate in imparting adequate knowledge and skills to the trainees to enable them to competently provide solar PV services that include sizing, installation, maintenance and repair. Besides being inadequate, these courses were donor dependent and therefore not sustainable in the long term.

The Ministry of Education recognizes the potential of solar energy in the provision of electricity to households and institutions in Puntland. More importantly, the solar business creates more opportunities for employment creation, both direct and through self-employment, and income generation. This is in line with the TVET policy of the Government.

The TVET policy allows this Ministry to review and expand curriculum to cover new skills areas taking into account market trends. The PV market in Puntland has a huge potential and is growing. This curriculum is therefore timely.

This curriculum has developed within the guidelines established within the Ministry of Education Puntland policy document on Technical Vocational Education and Training (TVET). It has been designed for institutions that have the capacity to effectively administer the course and have workshop facilities equipped with the necessary equipment to provide practical training during the course duration.

The PV installation course covered under this Curriculum assumes that the trainee has acquired basic knowledge in electrical and solar PV installation. This means that the trainee has undertaken or is pursuing Electrical Installation Course Grade III.

However, the course has been structured in such a manner that practicing electricians and technicians, who may have attained higher qualifications in the electrical engineering field can still undergo the training and acquire the same skill level of PV installation. The course may therefore be offered as a stand-alone course.

1.2 General Objectives

The general objectives of this curriculum are:

- a) To provide a standardized course for solar PV installers that is accredited within the MOE – TVET system.
- b) To develop practical skills and attitudes among the participants to enable them to offer solar products and services that meet basic technical and performance standards.
- c) To impart basic technology knowledge and practical skills to the trainees to enable them size, install, maintain, troubleshoot and repair small PV systems.
- d) To guide VTCs in delivering an up to-date standard PV course that imparts the trainees with knowledge and skills suited for the solar PV industry.
- e) To guide the VTCs in the acquisition of suitable resource materials for the course.
- f) To introduce entry-level PV technology knowledge and skills to those aspiring to pursue technical career in the solar energy industry.

1.3 Curriculum Structure and Duration

1.3.1 Structure

The course comprises of 12 units covering technical aspects of solar PV, 1 unit covering environmental and safety and 1 unit covering the attachment. Throughout the course duration, the teacher will involve the trainees through practical exercises and demonstrations as appropriate.

1.3.2 Duration

The course duration is 146 hours.

1.3.3 Entry Requirements

The minimum entry requirements for this course are:

- a) Education
Primary School level (Grade 8) of Education
- b) Professional Training

When offered as Integrated Course Unit:

- Electrical Installation Course Grade III or equivalent.
- Solar PV Installation Course Skill Level Grade III.

When offered as a Stand-alone Course:

- Basic qualification in the field of electrical installation grade III or equivalent for practicing technicians.
- Solar PV Installation Course Skill Level Grade III

1.3.4 Testing and Certification

The mode of assessing, testing and certification of TVET Electrical Installation Course shall apply to this course. The Ministry of Education shall set and administer the theoretical exam which shall carry a weighting of 40% of the total exam mark and TVET Institutions shall administer the CAT exam and assess the practical competencies which shall carry a weighting of 20% and 40% of the total exam mark respectively. TVET shall then forward the marks to MoE to aggregate and certify the qualified trainees.

1.4 Implementation Guidelines

1.4.1 As a Unit Integrated into the Electrical Installation Grade III Skill Level

This PV Curriculum course has principally been designed for integrated into the Electrical Installation Course Grade III. It should be offered as a Unit in Section 4 of Electrical Installation Grade III Skill Level.

1.4.2 As a Stand-alone Course

Practicing electricians and technicians, who may have attained the minimum requirement or higher qualifications in the electrical engineering field can still undergo the training and acquire the same skill level of PV installation. The course may therefore be offered as a stand-alone course.

When offered as a stand-alone course, it may be conducted full-time or part-time provided that the course content is covered adequately.

2 Detailed Course Units and Allocated Time

UNIT 1: BASIC ELECTRICAL II (8 HOURS)

The aim of this unit is to help the trainee gain the knowledge and skills and also understand the rationale behind using specific instruments for specific measurements during a simple electrical installation job. It also helps the trainee to interpret simple circuit diagrams and use them to carry out basic electrical installation work that meets the recommended standards in Puntland.

1.1 Specific Objectives

At the end of the topic, the trainee should be able to;

- a) define common terms used in electrical energy
- b) determine the resistance of metal conductors
- c) calculate voltage drops in conductors
- d) carry out energy and power consumption of appliances in electrical circuits
- e) describe series and parallel electrical circuits and their characteristics

1.2 Trainee's Learning Activities – Sub Topics

1.2.1 Defining Electrical Energy Terminology

- i) Work
- ii) Energy
- iii) Power
- iv) Watt hours
- v) Ampere hours

1.2.2 Energy and power consumption calculations.

1.2.3 Determining resistance of conductors

- i) Measurement of resistance
- ii) Resistivity and calculation of resistance.

1.2.4 Voltage drop calculations

1.2.5 Describe series and parallel electrical circuits and their characteristics

UNIT 2: SOLAR ENERGY II (6 HOURS)

The aim of this unit is to help the trainee differentiate between the sun as the source of solar energy and the other sources of energy (renewable and non-renewable) available. It also helps the trainee to understand the most common uses of solar energy and how it is radiated onto the earth's surface and what affects its strength as it enters the earth's surface.

2.1 Specific Objectives

At the end of the topic, the trainee should be able to:

- a) State facts about the Sun
- b) define terms that are commonly used in solar energy
- c) explain solar energy conversion
- d) state various methods of solar energy harvesting

2.2 Trainee's Learning Activities – Sub Topics

2.2.1 Facts about the Sun

- i) Distance from the earth
- ii) Surface temperature
- iii) Mass
- iv) Diameter
- v) Amount of energy it radiates

2.2.2 Defining terms and their units of measurement

- i) Solar constant
- ii) Direct and diffuse radiation
- iii) Insolation or irradiation
- iv) Irradiance
- v) Peak sun hours

2.2.3 Solar energy and its conversion

- i) sun as a source of energy
- ii) solar to heat (thermal)
- iii) solar to electricity

2.2.4 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)

UNIT 3: SOLAR CELLS & MODULES/PANELS (7 HOURS)

The aim of this unit is to help the trainee understand the principals of operation of a solar cell and how they are interconnected in a solar PV module/panel, differentiate between different types of modules/panels and have an in-depth understanding of their principals of operation and factors that affect performance. It prepares and equips the trainee with the knowledge and skills required in identifying the correct module/panel through carrying out the necessary tests required in confirming that the module/panel conforms to the manufacturer's specifications.

3.1 Specific Objectives

At the end of this topic, the trainee should be able to:

- a) define various terms used with cells and modules
- b) define the p-n junction
- c) identify the terminals of a p-n junction diode
- d) connect the P-N junction diode circuit
- e) verify the performance of solar modules in various connection modes
- f) measure module electrical quantities
- g) explain the construction of various types of solar modules
- h) perform tests on a solar module

3.2 Trainees' Learning Activities – Sub Topics

3.2.1 Defining terms used with cells and modules/panel

- i) Solar cell
- ii) Solar module
- iii) Solar panel
- iv) Solar array
- v) Open circuit voltage
- vi) Short circuit current
- vii) Peak power
- viii) Maximum power current and voltage

3.2.2 Defining a P-N junctions

- i) Formation of the junction
- ii) Depletion layer
- iii) Forward bias

3.2.3 Identifying of the terminals of a P-N junction diode

- i) Anode
- ii) Cathode

3.2.4 Connecting a diode in a circuit

- i) Polarity
- ii) Voltage levels
- iii) establish transistor

3.2.5 Verifying solar module performance

- i) Parallel connection
 - The need for interconnecting modules
 - Resultant parameters (voltages and currents)
 - Parameter calculations

- ii) Series connection
 - The need for interconnecting modules
 - Resultant parameters (voltages and currents)
 - Parameter calculations

3.2.6 Measuring module quantities

- i) Short circuit Current (I_{sc})
- ii) Open Circuit Voltage (V_{oc})
- iii) Current at Maximum Power (I_{pmax})
- iv) Voltage at maximum Power (V_{pmax})
- v) Maximum power (P_{max})
- vi) Module rating (standard test conditions)

3.2.7 Explaining the construction of various types of modules

- i) Solar cells interconnection to build voltage
- ii) Module construction -
 - Encapsulation and sealing for environment protection
 - Mechanical strength (glass)
 - Mounting frame
- iii) Module laminate

3.2.8 Performing tests on a solar module

- i) Open circuit tests
- ii) Short circuit tests
- iii) Interpretation of results - module status

UNIT 4: BATTERIES II (16 HOURS)

The aim of this unit is to help the trainee understand the need of energy storage and differentiate between different types of batteries and have an in-depth understanding of their performance characteristics under different circumstances. It equips the trainee with the knowledge and skills required in identifying the most suitable battery suited for solar PV installation work.

4.1 Specific Objectives

At the end of this topic, the trainee should be able to:

- a) Classify batteries and state key performance differences between the classes.
- b) State two most common battery technologies & maintenance procedures.
- c) Have in-depth understanding of the lead acid battery & various charging methods.
- d) Connect cells in series and parallel & measure total voltage and current.
- e) Demonstrate various charging methods

4.2 Trainee's Learning Activities – Sub Topics

4.2.1 Classifying batteries stating key performance differences between them

- i) Starter, Lighting and Ignition (SLI) Batteries
 - Application
 - Performance
- ii) Standby Batteries
 - Application
 - Performance

- iii) Traction Batteries
 - Application
 - Performance
- iv) Solar Batteries
 - Application
 - Performance

4.2.2 Stating common storage battery Technologies

- i) Alkaline
 - Alkali (usually potassium hydroxide) used as the electrolyte
 - Examples (Nickel Cadmium)
 - Performance
 - Cycle life
 - Self discharge
 - Maintenance
 - Limitation
 - Cost
- ii) Lead Acid
 - Acid (usually sulphuric acid) used as the electrolyte
 - Examples - normal car battery
 - Performance
 - Cycle life
 - Self discharge
 - Maintenance

4.2.3 Describing Lead acid Battery construction

- i) Active material
 - +ve plate
 - -ve plate
 - Electrolyte
 - Tubular and Flat plates
 - AGM
- ii) Other materials
 - Separators
 - Casing
- iii) Packaging
 - Vented or flooded
 - Sealed/immobilized electrolyte
 - Advantages and disadvantages of both types of packaging

4.2.4 Explaining the operation of Lead acid battery

- i) Discharging process
- ii) Active material utilization
 - +ve plate
 - -ve plate
 - Sulphuric acid
 - Over-discharging effects such as sulphation
- iii) Charging process

- iv) Active material reconstitution
 - +ve plate
 - -ve plate
 - Sulphuric acid
 - Over-charging effects such as water loss
- v) Chemical reaction equation
 - To use the equation to explain performance characteristics of lead acid battery.

4.2.5 Explaining factors that affect the performance of a Lead acid battery

- i) Battery Capacity
 - Effect of temperature
 - Effect of rate of discharge current
- ii) Service life
 - Effect of depth of discharge
 - Effect of rate of discharge
 - Effect of overcharging
 - Effect of over discharging
- iii) Other factors that affect battery performance
 - Maintenance
 - storage

4.2.6 Specifying and selecting solar batteries for solar systems

- i) Standard features
 - cycle life
 - charging efficiency
 - low self discharge
 - large electrolyte volume
- ii) Selecting solar batteries
 - Standard features above have to be considered
 - Vented flooded preferable over sealed
 - Shallow cycle (SLI) reasonable for small systems
 - Medium cycle for larger systems - Modified car batteries for solar use.
 - Deep cycle for critical applications
 - Deep cycle for large expensive systems
 - Price
- iii) Use of battery testing instruments
 - Voltmeter
 - Hydrometer
- iv) State of charge tests
 - Voltage tests
 - Electrolyte specific gravity tests using hydrometer
 - Interpretation of results

4.2.7 Measuring various parameters for different batteries' cells connection modes

- i) Series
 - Total voltage
 - Total current
- ii) Parallel
 - Total voltage
 - Total current

4.2.8 Demonstrating of various charging methods

4.2.9 Carrying out maintenance on battery cells

Unit 5: CHARGE CONTROLLERS II (4 HOURS)

The aim of this unit is to help the trainee understand the need of a charge controller/regulator in a solar PV system, differentiate between the functions carried out by a C.C in a PV circuit and have an in-depth understanding of their principals of operation and factors that affect performance. It prepares and equips the trainee with the knowledge and skills required in identifying the correct C.C through carrying out the necessary tests required in confirming that the C.C conforms to the manufacturer's specifications.

5.1 Specific Objectives

At the end of this topic, the trainee should be able to:

- a) Describe the two common types of charge controllers
- b) Explain performance characteristics of two common types of charge controllers
- c) Specify charge controllers
- d) Select appropriate charge controllers

5.2 Trainee's Learning Activities – Sub Topics

5.2.1 Types of charge controllers

- i) Series Controller
 - Description
 - Performance
 - Accuracy in regulation
 - Efficiency
- ii) Shunt Controller
 - Description
 - Performance
 - Accuracy in regulation
 - Efficiency

5.2.2 Explaining the performance of two common types of charge controllers

5.2.3 Specifying charge controllers

- i) Standard features of charge controllers
 - Low battery voltage disconnect (LVD)
 - Reversed polarity protection
 - Low battery disconnect alarm
 - Proper settings for batteries to be used in the system
 - Voltage and current ratings
- ii) Other features
 - Type - series or shunt
 - Short circuit protection
 - Overload protection
 - High battery voltage disconnect (HVD)
 - Metering (Voltage, Current, energy)
 - Alarms (HVD, LVD)
 - Lighting and surge protection
- iii) Other considerations
 - Environment of use - outdoor or indoor, humidity, temperature etc.

5.2.4 Selecting charge controllers

- i) Standard features should be incorporated
- ii) Application - high specs for critical applications
- iii) Cost of the PV system - high specs for expensive systems justifiable
- iv) Price of Controller

Unit 6: POWER INVERTERS II (4 HOURS)

The aim of this unit is to help the trainee understand the need of a power inverter in a DC circuit, differentiate between the 2 main types of power inverters and have an in-depth understanding of their performance characteristics under different load conditions. It equips the trainee with the knowledge and skills required in identifying the most suitable inverter suited for specific solar PV system design.

6.1 Specific objectives

At the end of the topic, the trainee should be able to:

- a) Explain the operation of power inverters
- b) Test a power inverter
- c) Diagnose faults in a charge controller
- d) Repair faults in a charge controller

6.2 Trainee's Learning Activities – Sub Topics

6.2.1 Operation of power inverters

- i) Types of Inverters and their performance
 - Square Wave
 - Efficiency
 - Harmonics
 - output voltage regulation
 - Problem loads/appliances
 - Modified Square Wave
 - Efficiency
 - Harmonics
 - output voltage regulation
 - Problem loads/appliances
 - Sine Wave
 - Efficiency
 - Harmonics
 - Output voltage regulation
 - Problem loads/appliances

6.2.2 Testing power inverters

- i) Safety observation

6.2.3 Diagnosing faults in an Inverter

6.2.4 Repairing faults in an Inverter

Unit 7: SOLAR PV SYSTEM SIZING II (10HOURS)

The aim of this unit is to help the trainee understand the need of solar PV system sizing under different conditions. It equips the trainee with the knowledge and skills required in determining the power consumption demand of a PV system through calculating the AC and DC loads, determining the module/panel, C.C, battery and power inverter sizes through calculation, and determining the system cable sizes through interpreting the cable chart.

7.1 Specific objectives

At the end of the topic, the trainee should be able to:

- a) Explain sizing the need for sizing a solar system & the terminologies used.
- b) Design a solar PV system based on the client's specification.
- c) State and apply special considerations in designing for cycling or intermittent loads.
- d) Estimate materials for a planned system & cost the planned installation.

7.2 Trainee's Learning Activities – Sub Topics

7.2.1 Explaining sizing and 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

7.2.2 Explaining terminologies for solar system technology

- i) Module outputs and specifications
- ii) Daily energy requirement
- iii) Autonomy
- iv) Battery capacity
- v) Depth of discharge
- vi) Insolation
- vii) Tracking

7.2.3 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

7.2.4 Special considerations in determining sizing load energy demand for cycling or intermittent loads

- i) Operating nature of intermittent loads and duty cycle
- ii) Special considerations in refrigeration
- iii) Special considerations in radio communication

7.2.5 Determining the right size of equipment – factors to consider

- i) Module
- ii) Cables and accessories
- iii) Charge controller
- iv) Inverter
- v) Battery

7.2.6 Step – by – step sizing of solar systems

- i) Total load power) and daily energy demand
- ii) Systems voltage
- iii) Systems current hours (amphr)
- iv) autonomy
- v) Battery capacity
- vi) Insolation determination
- vii) Module charging current and number of modules
- viii) Load current (ac and DC) calculation
- ix) Choice of modules, battery, charge controllers inverters
- x) Choice of cables and accessories; the voltage drop limitations

7.2.7 Recording specifications of the planned installation**7.2.8 Drawing of the planned installation****7.2.9 Estimating materials of the planned installation****7.2.10 Cost the planned installation**

- i) Material costs
- ii) Labour costs
- iii) Contingency costs

Unit 8: REVIEW OF PV SYSTEM INSTALLATION (4 HOURS)

The aim of this unit is to help the trainee understand and adapt the correct procedure required in the installation of solar PV systems. It equips the trainee with the knowledge and skills required in planning installation work, interpreting drawings, mounting components and ensuring that the right tools and instruments are used on the right job with the correct purpose.

8.1 Specific Objective

At the end of the topic, the trainee should be able to:

- a) Plan PV installation work
- b) List the main tools used in PV system installation and testing
- c) Choose an appropriate module/array mounting structure.
- d) Properly locate, mount PV & interconnect PV components to complete an installation.

8.2 Trainee's Learning Activities – Sub Topics**8.2.1 Planning PV installation work**

- i) Importance of planning the work
- ii) System completeness
- iii) PV components working condition
- iv) Tools and instruments
- v) Documents and manuals
- vi) Scheduling
- vii) PV system installation check list

8.2.2 Key Tools and Instruments for PV installation

- i) Multimeter (with at least 10A DC current rating)
- ii) Compass
- iii) Hydrometer
- iv) Inclinator (or angle of tilt template and spirit level)
- v) Set of Spanners
- vi) Set of Screw drivers
- vii) Claw hammer
- viii) Drill/wall punch
- ix) Cable Stripper
- x) Measuring Tape

8.2.3 Choosing an appropriate PV modules support structure

- i) Choice of mounting structure
 - Roof
 - Ground
 - Pole
- ii) Orientation
- iii) Tilt
- iv) Fixing
- v) Module interconnection - for more than one module
- vi) Mounting basic PV components of a provided circuit diagram on model boards
- vii) Installing the fittings and associated accessories and loads
- viii) Interconnecting the system

8.2.4 Locating and mounting PV components - module, battery, Inverter, Charge Controller

- i) Module/panel
 - Location
 - fixing
- ii) Charge Controller
 - Location
 - Fixing
- iii) Inverter
 - Location
 - Fixing
- iv) Battery
 - Location
 - Battery box
 - Safe handling
 - Fuses and Circuit breakers
 - Battery line fuse
 - Inverter fuse

8.2.5 System interconnection

- i) Cable terminations
- ii) Module / array to charge controller
 - safety
 - sequence

- iii) Charge controller to battery through the battery fuse
- iv) Battery to Inverter through the Inverter fuse
- v) Connection to consumer unit or distribution board
 - dc loads
 - ac loads

Unit 9: REVIEW OF PV SYSTEM INSPECTION, TESTING & COMMISSIONING (3 HOURS)

The aim of this unit is to help the trainee understand and adapt the correct procedure required in the inspection, testing and commissioning of solar PV systems. It equips the trainee with the knowledge and skills required to carry out inspection, testing and commissioning using the right tools and drawings for the system.

9.1 Specific objectives

At the end of the topic, the trainee should be able to:

- a) Developing inspection, testing & commissioning plans and procedures for PV systems.
- b) Carry out visual and mechanical inspection of a PV system.
- c) Commission a completed solar PV system & fill out a commissioning sheet.
- d) Carry out user training

9.2 Trainee's Learning Activities – Sub Topics

9.2.1 Carrying out Visual and mechanical inspection on a completed solar system

- i) Completeness of the installation
- ii) All necessary PV components
- iii) Protection fuses/circuit breakers
- iv) Module or array orientation
- v) Module or array tilt
- vi) Battery location for ventilation and safety
- vii) Battery electrolyte levels (if flooded)
- viii) Firmness of cable terminations and connections
- ix) Firmness of components and equipment mounting
- x) Neatness

9.2.2 Carrying out testing on a completed systems

- i) Polarity test (special emphasis on DC systems)
- ii) Earthing tests
- iii) Insulations tests
- iv) Continuity tests
- v) Module or array tests
 - Purpose and instrument selection and settings
 - Weather condition
 - Current tests (short circuit) test
 - Voltage (open circuit) test
 - Interpreting the results
- vi) Battery Tests
 - Purpose and instruments selection and settings
 - Voltage tests
 - Electrolyte specific gravity tests
 - Interpreting the results

- vii) Charge Regulator tests
 - Purpose and instruments selection and settings
 - Voltage tests
 - Interpreting the results
- viii) Inverter tests
 - Purpose and instruments selection and settings
 - Input Voltage test
 - Output voltage test
 - Interpreting the results
- ix) Loads and other appliances tests
 - As prescribed by the manufacturer

9.2.3 System commissioning

- i) Definition and purpose of system commissioning
- ii) Step-by-step commissioning procedure

9.2.4 End User Training

- i) Importance of user training
- ii) User training topics
 - System design and performance expectations review
 - Purpose of each installed component
 - Status indicators and their purpose
 - How to operate each component and equipment
 - User maintenance functions
 - The use of provided manuals and forms
 - How to deal with breakdowns
 - Energy conservation

Unit 10: REVIEW OF PV SYSTEM MAINTENANCE (4 HOURS)

The aim of this unit is to help the trainee understand the importance of maintenance and adapt the correct procedure required in the maintenance of solar PV systems. It equips the trainee with the knowledge and skills required in planning maintenance work and ensuring that the right tools and instruments are used during maintenance.

10.1 Specific Objectives

At the end of the topic, the trainee should be able to:

- a) Carry out electrical wiring maintenance tasks
- b) Carry out PV system components maintenance tasks
- c) Plan maintenance work

10.2 Trainee's Learning Activities – Sub Topics

10.2.1 Carrying out electrical wiring maintenance Tasks

- i) Neatness
- ii) Firmness of installed accessories and fittings
- iii) Cables and conduits condition

10.2.2 Carrying out PV system Components maintenance tasks

- i) Array maintenance
 - Cleaning
 - Mechanical checks
 - Integrity of cable terminations
 - Electrical tests
- ii) Battery Maintenance
 - Cleaning
 - Integrity of cable terminations and corrosion protection
 - Topping up (if flooded)
 - Specific gravity checks
 - Voltage test
- iii) Charge Regulator test
 - Dusting
 - Integrity of cable terminations
 - Status indicators checks
 - Voltage tests
- iv) Inverters
 - Dusting
 - Integrity of cable terminations
 - Status indicators checks
 - Voltage tests
- v) Loads and installed equipment
 - As per manufacturers recommendations

10.2.3 Planning a maintenance schedule

- i) Planning and scheduling maintenance work.

Unit 11: REVIEW OF PV SYSTEM TROUBLE SHOOTING AND REPAIRS (4 HOURS)

The aim of this unit is to help the trainee learn the techniques required in trouble shooting and repair of solar PV systems. It equips the trainee with the knowledge and skills required in choosing the tools to carry out maintenance and identifying faulty components and faults in the system wiring, and how to repair/replace the identified faulty components.

11.1 Specific Objectives

At the end of the topic, the trainee should be able to

- a) Carry out a step by step faulty diagnosis of the system and take appropriate action.
- b) Identify common faults and carry out simple repairs.
- c) Carry out fault diagnosis using modern equipment in-built programme menus and error codes.

11.2 Trainee's Learning Activities – Sub Topics

11.2.1 System troubleshooting

- i) Step-by-step troubleshooting
 - User Interview
 - System components status indicators
 - Protective devices condition
 - System commissioning tests
 - Components test

11.2.2 Identifying faulty PV components

- i) Single Modules
- ii) Single module in an array
- iii) Single Battery
- iv) Single battery in battery bank
- v) Charge controller
- vi) Inverter
- vii) Fuses/circuit breakers
- viii) Broken wire or bad connections
- ix) Compact Fluorescent lamps

11.2.3 Common faults and simple Repairs

- i) Common faults
 - Wiring faults such as broken wire, loose connection etc.
 - Excessive system use
 - Component failure
 - Operation of wiring protective devices
 - Operation of component/equipment protective devices
- ii) Simple repairs
 - Components soldering and repairs
 - Components replacement
 - System wiring protective devices failure
 - Resetting of component/equipment protective devices

11.2.4 Carrying out fault diagnosis using modern equipment in-built programme menus and error codes

- i) Understanding in-built programme menus and error codes in charge controllers, Inverters and other modern electronic devices
- ii) Fault diagnosis using in-built programme menus and error codes

Unit 12: REVIEW OF PACKAGED SYSTEMS & HYBRID SYSTEMS (8 HOURS)

The aim of this unit is to help the trainee understand the difference between different types of packaged and hybrid systems and their principals of operation. It equips the trainee with the knowledge and skills required in choosing the most suitable system for usage in specific areas and how to carry out maintenance and repair work.

12.1 Specific Objectives

At the end of the topic, the trainee should be able to

- a) Understand the rationale behind packaged systems and explain the four most common.
- b) Select an appropriate packaged system.
- c) Explain hybrid systems and determine where they are suitable
- d) Carry out routine maintenance of hybrid systems.

12.2 Trainee's Learning Activities – Sub Topics

12.2.1 Rationale for packaged systems

12.2.2 Explaining the four most common packaged systems

- i) Solar Lanterns
- ii) Solar Refrigerators
- iii) Solar Pumps
- iv) Solar street lighting

12.2.3 Selecting appropriate packaged systems for the four common packaged systems – factors to consider

- i) Solar Lanterns
 - Hours of lighting
 - Type of bulb
 - Extra features
 - Robustness
- ii) Solar street lights
 - Illumination level
 - Height of pole
 - Daily duration of use
 - Selecting suitable packages using local insolation and manufacturer's data
- iii) Solar Refrigerators
 - Storage requirement
 - Temperature requirement
 - Ambient temperatures
 - Selecting suitable packages using local insolation and manufacturer's data
- iv) Solar Pumps
 - Daily water requirement
 - Pumping head (static) determination
 - Selecting suitable pumping packages using local insolation and manufacturer's data

12.2.4 Explain hybrid systems and determine where they are suitable

- i) Definition of hybrid systems
- ii) Characteristics of hybrid systems
- iii) Suitability of hybrid systems
- iv) PV hybrid systems

12.2.5 Maintenance of PV hybrid systems

Unit 13: REVIEW OF HEALTH, SAFETY & ENVIRONMENT (8 HOURS)

The aim of this unit is to help the trainee understand the impact of solar PV components to the environment and the necessary measures required to avoid environmental degradation through the disposal of PV components. It equips the trainee with the knowledge and skills required in disposing of solar PV components and be able to mitigation against environmental risk.

13.1 Specific Objectives

At the end of the topic, the trainees should be able to

- a) Identify health and safety hazards in handling PV systems and Components
- b) Mitigate risks in handling PV systems and Components
- c) Mitigate Environmental hazards in handling PV systems and Components

13.2 Trainee's Learning Activities – Sub Topics

13.2.1 Identifying Health and safety hazards when handling and disposing materials used in PV solar installation systems

- i) Battery acid
- ii) Acidic fumes from batteries on charge
- iii) Electric shocks
- iv) Electrocution
- v) Fires and explosion risks
- vi) Safety at work and site

13.2.2 Risk mitigation

- i) Protective wear
- ii) Use of appropriate tools and instruments
- iii) Restrictions
- iv) Danger and warning notices
- v) User training
- vi) Proper designs and professional installations

13.2.3 Environmental hazards and mitigation

- i) The battery lead hazard
- ii) Lead hazard risk mitigation

Unit 14: ATTACHMENT (60HOURS)

The aim of this unit is to help the trainee build confidence in tackling challenges that exist in the solar PV industry. It equips the trainee with the knowledge and skills required when working in different kinds of environment.

14.1 Specific Objectives

At the end of the topic, the trainees should be able to;

- a) Confidently work in the field with minimal supervision.
- b) Interact confidently in all areas related to solar installation.

14.2 Trainee's Learning Activities – Sub Topics

- i) Work experience
- ii) Interaction skills

3. APPENDICES

Tools and Equipment

Basic tools and equipment requirements for basic PV training courses are listed below. The quantities are the recommended minimum meant for every 6 trainees.

Item No.	Quantity	Description
1	Lot	Tools provided for under electrical installation Grade II skills level
2	6	PV Modules assorted sizes and ratings
3	2 each	Module Mounting Structures – roof, pole, ground
4	3	Charge Controller 12V c/w indicators
5	2 each	Inverter 200W - 1000W, 12V, Modified sine wave and pure sine wave
6	3 each	Batteries 12V, 50 to 100 AH. One set sealed/gel and the other flooded c/w accessories such as terminals and battery water
7	3	Inclinometer
8	3	Compass
9	3	Hydrometer
10	3	Multimeter – 20A DC
11	3 each	Various Lamp fittings and accessories –Liner Fluorescent tube, Compact Fluorescent, incandescent and LED types
12	3 each	Fuse and Holder of various ratings (surface mount types)
13		
14	10m each	4 to 10 sq.mm. cable lengths, single core in colors yellow, red and black
15	3 each	Fused Isolators, single and double pole
16	0.5m	Cable samples - 6 to 70 sq.mm. mounted on demo board
17	1 packet each	Cable Lugs and crimps 2.5mm to 10mm
18	3	Practice boards (3/4 inch block board, 4ft by 4 ft)
19	3	Earth rods and clamps
20	1 roll	Wiring cable 2.5 mm twin
21	Lot	Electrical wiring (surface) accessories – clips, screws, etc.
22	2	Packaged Solar Water pumping systems
23	2	Packaged Street Light systems
24	2	Packaged Refrigeration Systems
25	4	Solar Lanterns, 2 LED and 2 compact fluorescent lamps
26	1	PV&Wind&Diesel (or petro) Generator Packaged System

Reference Materials

- i) Solar electric systems for Africa by Mark Hankins, revised edition
- ii) Rural lighting by IT Power Ltd
- iii) The solar entrepreneur's hand book by Geoff Stapleton, Larith Gunaratne and Peter JM Konics
- iv) Photovoltaics Design and Installation Manual by Solar Energy International (SEI).

3. APPENDICES

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Qalabka iyo Agabka

Qalabka iyo agabka asaasiga u ah tababarka koorsadan ID hoos ayeey ku taxan yihiin, talo ahaan waa inta ugu yare e lix latababare ku soo aadi karta

Item No.	Quantity	Description
1	Lot	Tools provided for under electrical installation Grade II skills level
2	6	PV Modules assorted sizes and ratings
3	2 each	Module Mounting Structures – roof, pole, ground
4	3	Charge Controller 12V c/w indicators
5	2 each	Inverter 200W - 1000W, 12V, Modified sine wave and pure sine wave
6	3 each	Batteries 12V, 50 to 100 AH. One set sealed/gel and the other flooded c/w accessories such as terminals and battery water
7	3	Inclinometer
8	3	Compass
9	3	Hydrometer
10	3	Multimeter – 20A DC
11	3 each	Various Lamp fittings and accessories –Liner Fluorescent tube, Compact Fluorescent, incandescent and LED types
12	3 each	Fuse and Holder of various ratings (surface mount types)
13		
14	10m each	4 to 10 sq.mm. cable lengths, single core in colors yellow, red and black
15	3 each	Fused Isolators, single and double pole
16	0.5m	Cable samples - 6 to 70 sq.mm. mounted on demo board
17	1 packet each	Cable Lugs and crimps 2.5mm to 10mm
18	3	Practice boards (3/4 inch block board, 4ft by 4 ft)
19	3	Earth rods and clamps
20	1 roll	Wiring cable 2.5 mm twin
21	Lot	Electrical wiring (surface) accessories – clips, screws, etc.
22	2	Packaged Solar Water pumping systems
23	2	Packaged Street Light systems
24	2	Packaged Refrigeration Systems
25	4	Solar Lanterns, 2 LED and 2 compact fluorescent lamps
26	1	PV&Wind&Diesel (or petro) Generator Packaged System

13.2 Waxqabadka Latababaraha – Casharada

13.2.1 Qeexida caafimaadka iyo ka badbaadinta qatarta markaad hayso ama aad tuureso qalab la nacay ee ID

- i) Asiidka bateriga
- ii) Qiiqa asiidka marka la dabeynayo bateriga
- iii) Shoog koronto
- iv) Dab bixiyaha
- v) Qatarta dab ama qarax
- vi) Badbaadada shaqada iyo goobta

13.2.2 Qatarta oo la xadido/yareeyo

- i) Dhar/lebis ku daafaca(u qalma shaqada)
- ii) Isticmaal qalabka ku haboon shaqada
- iii) Sharci wax kala xadeeya
- iv) Isticmaal calaamadaha tilmaamaya digniinta iyo qatarta
- v) Isticmaal/ku dhaqan tababarka
- vi) Naqshad saxan iyo rakibaad xirfadeysan

13.2.3 Qatarta cimilada iyo fududeynteeda

- i) Qatarta leadka batariga
- ii) Qatarta Leadka sidii loo fududeyn lahaa

CUTUBKA 14: KU XIRNAAN MEHERAD (60 saac)

Ujeedada cutubkan waxay latababaraha ka caawineysaa dhisida kalsoonidiisa iyo isagoo si dhaba oo fudud u ogaan kara caqabadaha ka jira goobaha ay yaalaan ID. Midaan waxay ardeyga bareysaa aqoon iyo xirfad uu ku ogaada in marxalada shaqadu ka duwan tahay mida kale.

14.1: Ujeedooyinka gaar - ahaaneed

Dhammaadka mawduucan/hawshan,latababaruhu waa inuu:

- a) Kalsooni u shaqeyn isagoo goobta shaqada ka helaya caawinaada ugu yar.

14.2: Waxqabadka Latababaraha (Casharada)

- iii) Waayo aragnima shaqo
- iv) Xirfadle soo jiidashao leh

CUTUBKA 12: DIB U EEGID HABABKA ISKU-XIRXIRKA IYO ISKU-DHAFKA (8 saac)

Ujeedada cutubkani waa in latababaruhu bartaa farqiga u dhexeeya noocyada kala duwan ee xir-xiritaanka/xafidaada iyo habka isku-dhafka ah, iyo xeerarkooda muhiimka ah. Ardeygu waxuu cutubkan ku baranayaa aqoon iyo xirfad uu ku doorto habka ugu wanaagsan ee qalabka loo geyn karo goob cayiman isla markaana lagu soo dayactiri karo qalabka iyadoon la soo qaadin.

12.1 Ujeedooyinka gaar - ahaneed

Dhammaadka mawduucan/hawshan, tababartuhu waa inuu:

- a) Fahmaa xaalada isbedeli karta ee habka xir-xirida/xafidaada
- b) Qeexi karaa afarta nooc ee caanka ku ah habka xir-xirida/xafidaada
- c) Sharxi karaa habka isku-dhafka iyo marka la adeegsado
- d) Dayactiri karaa habka xir-xiritaanka/xafidaada.

12.2 Waxqabadka latababaha – Casharada

12.2.1 Hab sameynta dab bixiyaha.

12.2.2 Sharax afarta dab sameeyaha

- i) Dab sameeyaha
- ii) Dab badalaha
- iii) Dab keydiyaha
- iv) Dab gudbiyaha

12.2.3 Sharax habka isku-dhafka iyo markuu haboon yahay

- i) Waamaxay habka - iskudhafka ah ee ID
- ii) Wanaaga iyo xumaanta ee habka - iskudhafka
- iii) Jiritaanka ID isku - dhaf
- iv) Doorashada ID isku - dhaf

12.2.4 Dayactirka ID ee habka isku-dhafka

- i) Nadaamka/habka dayactirka
- ii) Ka taxadarka hab kale
- iii) Qalabka iyo agabka dayactirka

CUTUBKA 13: DIB U EEGID CAAFIMAADKA, BADBAADADA & CIMILADA (8 saac)

Ujeedada cutubkani waa in latababaruhu ku fahmaa/bartaa saameynta qalabka ID ay ku yeelan karaan cimilada iyo xisaabtan muhiim ah oo looga hor tagayo in cimilada ay duleeyan qalabka la tuuro/xumaada ee ID. Ardayga waxuu cutubkan ku baranayaa aqoon iyo xirfad muhiim ah si qalabka la tuurayo oo xumaadaa loo gelayo iyo sidii loo yareen lahaa qatarta ku iman karta cimilada.

13.1 Ujeedooyinka gaar - ahaaneed

Dhammaadka mawduucan/hawshan, latababaruhu waa inuu:

- a) Qeexi karaa caafimaadka iyo ka badbaadida qatarta iyadoo la hayo qalab ka mida ID
- b) Yareenta qatarta iyadoo lagu dhex jiro qalabka ama habka ID
- c) Yareenta qatarta cimilada kaga iman karta ID

CUTUBKA 11: DIB U EEGID HABKA CILAD BAARISTA IYO DAYACTIRKA ID (4 saac)

Ujeedada cutubkani waa in latababaruha ku bartaa xeeladaha cilad barista iyo dayactirka dhamaan qalabka lleysdabeyaha. Ardeyga waxuu cutubkan ka baranayaa aqoon iyo xirfad uu ku kala doorto/ku xusho qalabka iyo agabka uu isticmaalayo waqtiga dayactirka, waxuuna si fudud u kala qeexi doonaa ciladaha ku yimaada qalabka iyo habka loo xiray waayarada korontada hadey cilad gasho, isla markaasna waxuu awood u yeelanayaa inuu dayactiro ama bedelo sheygii haleysan.

11.1 Ujeedooyinka gaar - ahaaneed

Dhammaadka mawduucan/hawshan, latababaruha waa inuu:

- a) Awoodaa/garanayo habkay u kala horeyso cilad baarista
- b) Qeexi karaa ciladaha ku yimaada qalabka ID, qaatana goaan u qalma
- c) Qeexi karaa ciladaha joogtada ah iyo sida ugu fudud ee loo alin karo

11.1 Waxqabadka Latababaraha – Casharada

11.1.1 Habka cilad baarista

Kala horeynta cilad - baarista

- i) Wareysi isticmaalaha
- ii) Habka adeegsiga hagayaasha la socda qalabka
- iii) Daafaca xaalada / jawiga aaladu ku sugan tahay
- iv) Habka tijaabinta shaqo gelinta
- v) Tijaabinta qalabkoo dhan

11.1.2 Ka qeex qalabka ID ee si wacan u shaqeyn

- i) Hal modules/Banal
- ii) Hal module/banal oo dibada yaala
- iii) Bateri (hal)
- iv) Hal batari oo ku jira santuuqa batariga
- v) Dabeyn suge / hubiye
- vi) Tamar - Bedele
- vii) Faynuusyo/wareeg/maayad jare
- viii) Keybal goan ama isku- xir xun
- ix) Nalal

11.1.3 Ciladaha joogtada ah iyo sida ugu fudud ee loo xaliyo

- i) Ciladaha joogtada ah
 - Ciladaha waayarada sida waayar goay, ama six un loo xiray iwm.
 - Adeegsi hab siyaado/xad-dhaaf ah
 - Qeybaha oo cilad ku timaado
 - Hawgal ku wajahan wayarada daafacooda
 - Hawlgal ku wajahan qeybaha qalabka
- ii) Dayactir fudud
 - Meelaha qalabku isaga alxaman yahay iyo dayactirkooda
 - Qalab la bedelayo
 - Habka shaqada wayarada oo cilad ay ku timaado

11.1.4 dabeeyaha.

- i) Celed bixinta Dab keydiya
- ii) Ilaalinta habka dab keydiyaha uu dabka u siideynayo
- iii) Khalad sixida dabeeyaha

CUTUBKA 10: DIB U EEGID HABKA DAYACTIRKA ID (4 saac)

Ujeedada cutubkani waa in latababaru barto/fahmo muhiimada ay leedahay dayactirka ileys – danabeyaha iyo waxa loo adeegsado si loo dayactiro, halkaas ardaygu waxuu ka helayaa aqoon iyo xirfad uu si fudud ugu qorsheesan karo dayactirka ID qalabka iyo agabka ugu haboon isticmaalka dayactirka ID

10.1 Ujeedooyinka gaar - ahaaneed

Dhammaadka mawduucan/hawshan, latababaruhu waa inuu:

- a) Awoodaa Fullinta hawsha dayactirka keybalada korontada
- b) Awoodaa Fullinta hawsha dayactirka illeys - danabeyaha
- c) Sameeyaa qorshe shaqo dayactir

10.2 Waxqabadka Latababaraha – Casharada

10.2.1 Shaqo dayactir keybalada korontada

- i) Hubinta tayada aan habeysneyn
- ii) Firmness of installed accessories and fittings
- iii) Hubinta keybalada korontada iyo gudbiyayaasha

10.2.2 Shaqo dayactir dhamaan qalabka ID

- i) Dayactirka banalka
 - Nafaad
 - Hubinta makaanik ahaan
 - Isku dhaf keybalo dhamaad ah
 - Hubin koronto ahaan
- ii) Dayactirka batariga
 - Nadaafad
 - Isku dhaf keybalo dhamaad ah iyo ka taxadar tifmid
 - In la dhayo haduu hoorayo
 - Hubin soo jiidasho gaar - ahaaneed
 - Hubin Foltejka
- iii) Dayactir Dabeeyaha
 - Nadaafad
 - Isku dhaf keybalo dhamaad ah
 - Marxalada hubinta calaamadaha digayaasha
 - Hubin Foltejka
- iv) Dayactirka tamarbedelaha
 - Nadaafad
 - Isku dhaf keybalo dhamaad ah
 - Marxalada hubinta calaamadaha digayaasha
 - Hubin folteej
- v) Qalabka dayactirka, isku xir-xirka iyo xamuulka iyadoo la raacayo tala bixinta soo saarayaasha

10.2.3 Qorsheyn/shaqo dayactir

Qorsheyn jadwal shaqo oo ku wajahan dayactir

8.2.5 Habkii oo la xiriiriyo

- i) Keybalka oo la soo diyaariyo
- ii) Banalka oo tagu sharxo dabeeyaha
 - Badbaadada
 - Hab isku xiriirsan
- iii) Dabeeyaha oo lagu xirayo batariga isagoo loo marsiinayo fayuuska
- iv) Batariga oo lagu xiro tamarbedelaha isagoo loo marinayo fayuuska
- v) Ku xirid qeybta isticmaalka ama qeybinta
 - Xamuul DC
 - Xamuul AC

csd

CUTUBKA 9: DIB U EEGID HABKA HUBINT, TIJAABINTA & HAWGELINTA EE ID (3 saac)

Ujeedada cutubkani waa in latababaru barto/fahmo hubinta, tijaabinta iyo shaqo gelinta ileysdanabeyah. Ardaygu waxuu cutubkan ka helayaa/baranayaa aqoon ku saabsan siduu u xulan lahaa una isticmaali lahaa qalabka ku haboon shaqada uu qabanayo oo ah hubin, tijaabin iyo hawlgelinta dhamaan qalabka ileysdanabeyuhu ka kooban yahay iyagoo isku xir – xiran.

9.1 Ujeedooyinka gaar - ahaaneed

Dammaadka mawduucan/hawshan, latababaruhu waa inuu:

- a) Horumarinta tijaabooyinka & qorsho hawgelineed .
- b) Garanayo Hubin arag-ahaaneed qalabkoo dhan
- c) U diyaarin karo tijaabo iyo shaqo bilaabid

9.2 Waxqabadka Latababaraha – Casharada

9.2.1 Hubin aragti ahaan iyo farsamo

- i) Dhameynta isku xir - xirka
- ii) Qalabka muhiimka ah oo dhan
- iii) Hubinta fuyuuska/qulquljaha
- iv) Banalka oo loo xiray jiho
- v) Banalka oo loo xiray jan-jeer
- vi) Goobta la dhigayo batariga oo hawo iyo badbaado leh
- vii) Heerka electrolyte ee batariga(haduu fatahayo)
- viii) Adeega isku xirnaanta keebalada halkey isaga yimaadaan
- ix) Adeega isku xirnaanta dhamaan qalabkia
- x) In loo habeeyo qaab tayo leh

8.2 Waxqabadka Latababaraha – Casharada

8.2.1 Qorsho shaqo lagu xir-xirayo ID

- i) Muhiimada qorshaha shaqada
- ii) Habkii oo aan dhameystirneen
- iii) Xaalada shaqo ee qalabka ID
- iv) Qalab iyo agab
- v) Shax, Hagayaal iyo dukumanti
- vi) Jadwal
- vii) Hubinta listiga ee habka xir – xirida ID

8.2.2 Qalabka iyo agabka loo isticmaalayo xir-xirida id

- i) Multimeter (with at least 10A DC current rating)
- ii) Compass
- iii) Hydrometer
- iv) Inclinator (or angle of tilt template and spirit level)
- v) Set of Spanners
- vi) Set of Screw drivers
- vii) Claw hammer
- viii) Drill/wall punch
- ix) Cable Stripper
- x) Measuring Tape

8.2.3 Doorashada goobta ku haboon rakibaada banalka ID

- i) Dooro qaabka rakibaada
 - Sakxada sare
 - Dhulka
 - Cirif
- ii) Jiho / meel
- iii) Janjeer
- iv) Xirid
- v) Banal la xiriira in ka badan hal banal

8.2.4 Dhigid iyo rakibaad qalabka ID oo dhan(banal,batari,tamar-bedele iyo dabeeye)

- i) Banalka qoraxda
 - Goobta
 - Xirid
- ii) Dabeeye
 - Goobta
 - Xirid
- iii) Tamar - Bedele
 - Goobta
 - Xirid
- iv) Bateri/Keydiye
 - Goobta
 - Santuuq Batari
 - Qaadid taxadar leh

7.1 Ujeedooyinka gaar - ahaaneed

Dhamaadka mawduucan/hawshan, latababaruhu waa inuu:

- Waa inuu Sharxaa baahida qalabka doorashada goobta
- Waa inuu dhameystirtaa xogta doorashada, xisaabi karaa energy iyo power uu heli karo.
- Aqrin / xulan karaa kebalada ku haboon

7.2 Waxqabadka Latababaraha (Casharada)

7.2.1 Habkuu u shaqeeyo dabeeyaha

- Sugida/hubinta iyo ogaanshaha shaqada socota
 - Baahida dabeeyaha
 - Dab xad-dhaaf ah
 - Dab laaan
 - Aqoonsiga Calaamadaha
 - Digayaal
 - Cabirid
- Xaafidaada shaqada
 - Bateri
 - Qalabka
 - Xamuul dheeraad ah
 - Maayad hoose
 - Kala rogida kuwa lidka isku ah
 - Iftiinka iyo mawjada danabka
- Shaqooyinka kale
 - Ku haboon xiriir ama isku ekaan qalabka kale midkood

7.2.2 Doorashada/ciyimaada dabeeyaha.

7.2.3 Xiriirinta dabeeyaha.

7.2.4 Hubinta/tijaabinta dabeeyaha.

- Hubin/tijaabin cilad dhulka ah
- Hubinta/Tijaabinta maayada
- Hubin/Tijaabinta xamuul siyaado ah
- Hubin/Tijaabin Dabeyn siyaado ah
- Hubin/Tijaabin wax I

CUTUBKA 8: DIB U EEGID HABKA XIR-XIRKA ID (4 saac)

Ujeedada cutubkani waa siduu latababaruhu ku fahmi lahaa/baranlahaa dhab ahaan talaabooyinka saxda ah ee la qaadayo marka la doonayo in laxir-xiro ileys-danabeye. Cutubkani waxuu ardeyga ku baranayaa aqoon iyo farsamo gaaarsiisa siduu si sahlan u xir-xiri lahaa (ID) iasgoo raacaya shaxda alaabta kala furfuran una adeegsanayo qalab ku haboon isticmaalka iyo shaqada uu qabanayo isgoo hadana u kala hormarinaya sidey tahay.

8.1 Ujeedooyinka gaar - ahaaneed

Dhammaadka mawduucan/hawshan, latababaruhu waa inuu:

- Waa inuu garanayo qorshaha shaqada xir – xiritaanka (ID)
- Qori/taxi karaa magacyada qalabka loo baahan yahay (xir-xiritanka iyo tijaabinta (ID)
- Choose an appropriate module/array mounting structure.
- Goobta ku haboon, fur – furista iyo xir – xitaanka dhaman qalabka ID

6.1 Ujeedooyinka gaar - ahaaneed

Dhammaadka mawduucan/hawshan,latababaruhu waa inuu:

- In uu kala qeexi karo farqiga kala duwan ee Batariga uu isticmaalayo.
- Waa inuu sharxi karaa baahida bateriga la dabeyn karo.
- Waa inuu kala gartaa qalabka kala duwan ee lagu tijaabiyo bateriga
- Waa inuu barto tijaabinta batarigoo ku jira marxalada dabeynta
- Waa inuu garanayo bateriga ku haboon shaqada lleysdanabeeyaha
- Dayactirka bateriyada ku shaqeeya qoraxda

6.2 Waxqabadka Latababaraha (Casharada)

6.2.1 Qeexida ereyada gaarka u ah Bateriga

- Gundhiga / asal ahaan Bateriga
- Unug
- Keydiye / Bateri
- Muga iyo cabirka Ambeyerka
- Xubnaha gudaha ee Bateriga
- Agabka elagtroniga ah iyo soo jiidashadooda gaarka ah

6.2.2 Sharaxa baahida ku aadan awooda la keydiyo

- Tamarta qoraxda aan joogtada ahayn
- Baahida tamarta habeenkii iyo jawiga liita
- Habkiyoo wada dhacay (shaqadii wada gabay)
- Bateriyada ladabeyo iyo kuwa aan ladabeynkarin

6.2.3 Tijaabinta Keydiyaha / Bateriga

Marxalada tijaabinta dabeynta

- Tijaabinta Voltajka
- Tijaabin soojidasho gaar – ahaaneed lana isticmaalayo hydrometer
- Tarjumid/qeexid maxsuulkii soo baxay

6.2.4 Xulashada Bateriga qoraxda ku shaqeeya

- Arimaha si gaar ah u quseeya
 - Jiritaankiisa soo noq – noqda (cubooneysiin)
 - Qaade electrolyte baaxad weyb
- Duleel fatahaya oo ka wanaagsan mid kor ka daboolan
- Wareeg aan gun dheereyn kuna xiran hab aan weyneyn.
- Wareeg dhexe oo ku xiran hab balaaran – In bateriga gaariga loo habeeyo qaab loogu isticmaalo tamarta qoraxda.
- Qiimaha

CUTUBKA 7: Cabirka ilays danabeyahay II (10saac)

Ujeedada cutubkani waa in latababaru barto/fahmo baahida lleys – danabeyuha eek ala doorashada marxalado kala duwan. Ardaygu waxuu cutubkan ka helayaa/baranayaa aqoon ku saabsan isticmaalka awooda loo baahan yahay kuna saleysan habka lleysdanabeynta isagoo u maraya xisaabinta xamuulka AC iyo DC, Waxuu ka baaraandegayaa module/panel, C.C, bateri iyo tamar beadlaha isagoo adeegsanaya xisaab , waxaa kaloo u fududaaneysa doorashada kebalada uu rabo.

2.2.3 Adeegsiga ugu caansan ee awoodda Cadceedda.

- i) Iftiinka
- ii) Kulaylka
- iii) Qalajinta
- iv) Biyo soo saaridda
- v) Isgaarsiinta
- vi) Qaboojinta
- vii) Kuwo kale

3.2.4 Awoodda cadceedda ee Dhulkadushiisa

Waxyaalaha saameeya awoodda cadceedda ee ina soo gaadha.

3.2.5 Cabiraadda awoodda Cadceedda *Tamarta Cadceedda ee meel Carifan

- i) Habka meterka (Pyranometer)
- ii) Diiwaaninta

CUTUBKA 4: Dab keydiye II (16 saac)

Ujeedada cutubkani waa in latababaraha ka caawinayaa siduu ku fahmi lahaa faaidooyinka ay leedahay awood keydinta iyo in uu kala qeexi karo farqiga u dhexeeya noocyada kala duwan ee keydiyayaasha iyo isagoo si dhaba u fahmi doona calaamadaha iyadoo lagu dhex jiro shaqooyin iyo marxalado kala duwan. Latababaruhu isagoo haysta qalab iyo aqoon ku filan waxuu kala dooran karaa batega ugu haboon shaqada laga qabanayo lleysdanabeyaha.

4.1 Ujeedooyinka gaar - ahaaneed

Dhammaadka mawduucan/hawshan, latababaruhu waa inuu:

CUTUBKA 5: kaydiye Dabeeyaha II (4 saac)

Ujeedada cutubkani waa in latababaruhu baro/fahmo muhiimada uu dabeeyuhu u leeyahay shaqooyinka quseeya ID, kalasocid shaqada uu qabanayo dabeyaha iyo maayada qulquleysa ID iyo isagoo si hoose u fahmi doona xeerarkooda shaqo iyo waxyaalaha saameynta ku yeesha cutubkan waxuu ardayga barayaa aqoon iyo xirfad uu ku cayimi karo dabeyaha ku haboon isagoo kaashanaya tijaabooyin muhiim ku ah iyo warbixinta uu wato.

5.1 Ujeedooyinka gaar - ahaaneed

Dhammaadka Mawduucan/hawshan, latababaruhu waa inuu:

- a) Qeexi/sharaxi karaa habkuu u shaqeeyo dabeyn sugaha.
- b) Sharaxaa baahida/isticmaalka dabeeyaha ee shaqada ID quseesa .
- c) Hubin karaa oo hawgeliyaa dabeyaha.

CUTUBKA 6: Awood is dhexmariyaha II (4 saac)

Ujeedada cutubkani waa in uu latababaruhu barto/fahmo baahida tamar bedeluhu u leeyahay maayada tooska ah, kala soocida farqiga u dhexeeya labada nooc ee tamar bedelayaasha iyo isagoo si hufan u fahmi doona waxay ku kala duwan yihiin markii la saaro xamuul. cutubkan waxuu ardayga barayaa aqoon iyo xirfad uu ku cayimi karo tamar bedelaha ku haboon isagoo kaashanaya tijaabooyin muhiim ku ah iyo warbixinta uu wato.

6.1 Ujeedooyinka gaar - ahaaneed

Dhammaadka mawduucan/hawshan, latababaruhu waa inuu:

- a) Qeexaa habka shaqo ee tamar bedelaha
- b) Sharaxaa labada nooc ee tamar bedelayaasha, wanaag iyo xumaan waxay leeyihiin
- c) Qeexaa habka terminals iyo tamarbedelaha loogu xiro ID .

Hubin/Tijaabin karaa oo hawgeliyaa Tamar bedelaha.

2.2.6 Calaamadaha loo isticmaalo Shaxanada Korontada *Danabka**2.2.7 Mareeg fudud ee Koronto iyo Cabirkeeda. ;**

- i) Maayad
- ii) Cadaadis
- iii) Caabbi
- iv) Ohom beeg

2.2.8 Kalasocidda maayadda toosan iyo maayadda talantaaliga ah.

- i) Maayad toos aht
- ii) Maayad talantaali aht

2.2.9 Howl hooso

- i) Sida tuubooyinka loo leexiyo
- ii) Daare demiye , bareeso , guluub haye, santuukha iskuxira .
- iii) Taranki iyo fiilo ururin

CUTUBKA 3: TAMARTA QORAXDA (3 saac)

Ujeedada cutubkani waa in ardaygu kala saaro Awoodda Cadceedda iyo tawoodaha kale , waxaa kale oo latababaruhu baranayaa waxyaalaha loo adeegsado Awoodda Cadceedda siday Tamartaasi ku soo gaadho dhulka dushiisa iyo saamaynta ay leedahay.

- i) Ujeedooyinka gaar - ahaaneed

Dhammaadka mawduucan?hawshan,latababaruhu waa inuu::

- a) Sharax gaaban ka bixin karaa Ilaha Awoodda dhaqan ahaan loo adeegsado e
- b) Sharaxaa ilaha awooda dib loo isticmaalikaro.
- c) Sheegaa Adeegsiyada ugu Caansan ee awooda Cadceedda.
- d) Sheegaa awoodda cadceedda ee dhulka dushiisa iyo waxyaalaha saameeya.
- e) Cabiraa Xaddiga awoodda cadceedda ee meel uu garanaayo.

2.2 Waxqabadka latababaraha (Casharad)**2.2.1 Ilaha awoodeed ee lagu dhaqmo**

- i) Saliid
- ii) Dhuxul
- iii) Neefta noolaha ka timid
- iv) Batroolka Neeftiisa
- v) Kuwo kale.

2.2.2 Ilaha ay ka rimaado awooda dib loo isticmaalikaro.

- i) Qoraxda r
- ii) Dabaysha
- iii) Biyaha
- iv) Kulka dhulka l
- v) Neefta ka tinid Noolaha.

1.2.5 Aqoonta Qalab gacmeedka.

- i) Qalabka wax lagu gooyo
- ii) Qalabka wax lagu cabbiro
- iii) Qalabka wax lagu dalooliyo
- iv) Qalabka wax lagu soofeeyo

1.2.6 Farsamada Hoosada

- i) Adeegsiga saxan ee qalab gacmeedka

CUTUBKA 2: Awood Ilays Danabeyaha (6 saac)

Ujeedada cutubkani waa in ardaygu kala saaro Awoodda Cadceedda iyo tawoodaha kale , waxaa kale oo latababaruhu baranayaa waxyaalaha loo adeegsado Awoodda Cadceedda siday Tamartaasi ku soo gaadho dhulka dushiisa iyo saamaynta ay leedahay.

- a) Xubnaha ay mareegi ka koobantahay.
- b) Xaddiyada asaasiga ah ee Korontada iyo halbeegyada lagu cabiro.
- c) Xeerka Ohom iyo Cabbiraada Korontada .
- d) Siday ushaqeeyaan Saacadaha Korontada lagu Cabiro.
- e) Jaantus maregeed oo fudud iyo Calaamadihiisa.
- f) Maayad toos ah iyo Maayad talantaali ah.
- g) Sida loogu rakibo gidaarka loona hubiyo qalabka korontada.

1.2 Waxqabadka Latababaraha (Casharada)**1.2.1 Qeexida Korontada.**

- i) Waa maxay korantadu ama Danabku.
- ii) Ilaha tamarta ka dhalato.
- iii) Siday mareegtu u dhexmarto maayaddu.

1.2.2 Sharaxaada qaybaha mareegeed.

- i) Dabdhaliye.
- ii) Gudbiyeyaal.
- iii) Daare demiyeyaal.
- iv) Rarka.

1.2.3 Sharaxaadda Xaddiyada asaasiga ah ee korontada iyo Halbeegyadooda

- i) Maayad iyo Ambeer.
- ii) Cadaadis iyo Foolt.
- iii) Caabbi iyo Ohom.
- iv) Tamar iyo waat.
- v) Awood iyo juul.

1.2.4 Xeerka Ohom

- i) Waxaa toos isula kordha maayada iyo fooltiga.

2.2.5 Howlgalka qalabka cabirka ee korontada.

- i) Amber beeg
- ii) Maayad cadaadis, ohom beeg
- iii) Sawirka Degdega (current, voltage and resistance)
- iv) Awood beeg
- v) Beeg badnaale
- vi) Cadaadis beeg
- vii) Tamar beeg

2 Fahfaahinta koorsada Labaad ee korontada qoraxda laga dhaliyo.

CUTUBKA 1: AQOONTA ASAASIGA AH EE KORONTADA GARADE II (8 saac)

Ujeedada cutubkani waxay tahay in ardaygu barto aasaaska korontada si uu u helo faham uu ku adeegsankaro shaqada loo tababarayo iyo uu ardaygu fahmo sida loo akhriyo shaxda mareegaha fudud.

1.1 Ujeedooyinka gaar - ahaaneed

Dhammaatka mawduucan/hawshan latabaaruhu waa in uu;

- a) Qeex caafimaadka, badbaadada iyo qatarta goobta shaqada.
- b) Isticmaal qalabka ku haboon cabirka,calaamadeynta,goynta, daloolinta, adhada, soofeynta & qaabeynta.
- c) Isku xir-xirida &qaabka isticmaalka screws, rivets.
- d) Qeex saameynta kulka ku sameeyo ashiyaada kala duwan.
- e) Fahmida qalabka & xulashada qalabka loo isticmaalayo shaqada

1.2 Waxqabadka la tababaraha (Casharada)

1.2.1 Caafimaadka iyo amaanka

- i) Waa inuu taxadaraa ardaygu marka laga shaqaynayo hoosada.
- ii) Waa inuu ardaygu isticmaalo huga hoosada.
- iii) Waa inuu ardaygu ogyahay saamaynta uu yeelanayo dareeraha ku daata hoosada.

1.2.2 Miis howleedka

- i) Isticmaalka qabatada.
- ii) Isticmaalka qalqabka cabirka.
- iii) Isticmaalka qalabka goynta.
- iv) Sida wax loo dalooliyo.
- v) Soofaynta.

1.2.3 Iskuxirka iyo rakibaada

- i) Rakibidda iyo iskuxirka qalabka iyado la adeegsanayo boolal iyo ribidhoAsse.
- ii) Qaabaynta iyo siday isugu xirmaan qaybuhu.

1.2.4 Saamaynta kulku ku leeyahay alaabta

- i) Fidid.
- ii) Ururid.
- iii) Xoogayn.

1.3.4 Imtixaanka iyo Aqoonsiga

Koorsadan waxa ay ku xadeysan tahay habka qiimeynta, imtixaanidda iyo aqoonsiga ee koorsada TVET ee Wasaaradda Waxbarashada. Wasaaradda Waxbarashada ayaa dejineysa, qaadeysana imtixaanka qoraalka ah, kaas oo u dhigmi doona 40% ee wadarta guud ee lagu gudbi karo, ururrada TVET waxa ay qaadi doonaan imtixaanka CAT, waxa ayna qiimeyn ku sameyn doonaan heerka aqoonta dhanka farsamada, taas oo iyaduna qayb ahaan u dhigmi doonta 20% iyo 40% ee wadarta guud ee imtixaamka, sida ay u kala horreeyaan. TVET markaa waxa ay dhibcaha u gudbin doontaa Wasaaradda Waxbarashada si la isugu daro, loona siiyo aqoonsi ardada ku guuleysata.

1.4 Habraaca Fulinta

1.4.1 Cutubkan waxa uu xiriir la leeyahay heerka saddexaad Korontada.

Manhajkan koorsada PV waxa guud ahaan loogu talo-galey in uu qayb ka noqdo Heerka III ee koorsada Xiridda Korontada. Waa in loo bixiyaa sidii cutub ku jira Waaxda 4 ee Xiridda Korontada Heerka III.

1.4.2 Marka uu Yahay Koorso Iskeed u Taagan

Xirfadleyaasha korontada iyo farsamo-yaqaannada, iyada suuro-gal tahay in ay buuxsheen shuruudaha ugu yar ama shahaadooyin sare ee injineernimo ka sitaan korontada, waa ay ka qayb-geli karaan, yeelan karaanna xirfad heerkeedu gaarsiisan tahay xiridda PV. Sidaa darteed, koorsadu waa mid iskeed isu taagi karta oo si gaar ah loo bixin karo.

Marka loo qaadanayo sidii koorso gaar ah, waxa lagu bixinayaa full-time ama part-time, shuruudduna tahay in nuxurka koorsada dhammaanteed la wada maro.

Ujeedooyinka Guud

Ujeedooyinka Guud ee Manhajkan waa:

- In koorso mideysan la siiyo dadka ka shaqeynaya xiridda PV, taas oo ka sharciyeysan nidaamka TVET ee Wasaaradda Waxbarashada.
- In kor loo qaado xirfadda farsamo iyo tan aragti ee ka-qayb-galeyaasha si ay awood ugu yeeshaan bixinta qalab iyo adeeg waafaqsan heerarka farsamo iyo hawl-fulin ee loo baahan yahay.
- In dadka la tababarayo la siiyo aqoonta aasaasiga ah ee tiknolojiyadda iyo xirfadda farsamo ay ku cabbiri karaan, xiri karaan, hagaajin karaan, cillad bixin karaan, dayactiri karaanna small PV systems.
- In lagu hoggaansho VTC-yada in siiyaan dadka la tababarayo koorso PV oo casri ah, kuna dheehan aqoon iyo xirfad kaafin karta hawlaha tamarta qorraxda ee PV.
- In lagu hoggaansho VTC-yada in ay bartaan wax walba oo loogu baahan yahay bixinta koorsada.
- Dadka daneynaya in ay shaqo nolol-dhalin ka dhigtaan hawlaha tamarta qorraxda in la siiyo aqoon tiknolojiyadeed iyo xirfad ay ku hawl-galaan oo heer aasaasi ah.

1.3 Qaab-Dhismeedka iyo Muddada Manhajka

1.3.1 Qaab-Dhismeedka

Koorsadu waxa ay ka kooban tahay 1 cutub oo daboolaya aqoonta aasaasiga ah, 13 cutub oo ku saabsan farsamada qorraxda ee PV, 1 cutub oo ku saabsan degaanka iyo bad-baadada iyo 1 cutub oo lifaaq ah. Inta koorsadu socoto, macallinku waxa uu aradada ku hawl-gelinayaa leyli farsamo gacanta laga qabanayo iyo weliba bandhig hadba sida loo baahdo.

1.3.2 Muddada

Koorsadu waxa ay soconaysaa 272 saac.

1.3.3 Shuruudaha Gelidda

Shuruudaha ugu hooseeya ee koorsadan waa:

- Heer Aqoon
Shahaado waxbarasho heer dugsi dhexe (Grade 8)
- Tababar Xirfadeed

Markay ay tahay Koorso isku dhafan oo dhameystiran:

- Korsada Laydh Gelinta Heerka III ama mid u dhigma.
- Aqoonta Koorsada ILEYSDANABEYNTA ee Heerka III.

Markay ay tahay Koorso gaar ah oo iskeeda u taagan:

- Basic qualification in the field of electrical installation grade III or equivalent for practicing technicians.
- Solar PV Installation Course Skill Level Grade III

1.1: HORDHAC

Tamarta qorraxdu waxa ay ka mid tahay ilaha tamar ee loo aqoonsadey in ay ku habboon yihiin in laga dhaliyo tamar danab lagu adeegsado Puntland. Sababta ugu weyn waxa ay tahay iyada oo awoodda tamarta ileyska qorraxdu Puntland aad u wanaagsan yahay, una dhexeeyo 5 illaa 7 kWhrs/m²/maalintiiba iyo weliba iyada oo tamarta danabka hadda laga helo Puntland uu aad u kooban yahay marka laga hadlo dhanka awoodda iyo ku-baahsanaanta degaannada, isla markaana qaababka kale ee tamarta danabka loo dhalin karo ay yihiin kuwo qaali ah.

Sidaa darteed, ADRA oo kaashaneysa EC, USAID iyo deeq-bixiyeyaal kale, waxa ay taageero siineysaa hal-abuurka ah in tamarta qorraxda loo adeegsado dhalinta tamarta danabka. Taageeradan waxa ay isugu jirtaa ololeyaal loogu talo-galey in dadka lagu dhiiri-geliyo hal-abuurkan, demonstration systems, iyo tababarro la siinayo dad ka shaqeeya farsamadan. Arrimahaa dartood, maalinba maalinta ka dambeysa suuq-geynta PV waa ay sii kobceysay.

Tababbarada PV ee la qabtey illaa iyo hadda waxa ay ahaayeen kuwo deg-deg lagu qabtey, isla markaana ku kooban hal ama laba asbuuc. Waxa la ogaadey in tababbaradaasu aanay gaarsiisneyn heerka loo baahan yahay ee soo saari kara farsamo-yaqaanno leh aqoon iyo xirfad si habboon ku buuxsha baahida adeegga tamarta danabka PV, sida cabbiraadda, xir-xiridda, hagaajinta iyo dayactirka. Intaa waxa dheer, tababbaradaas waxa ay ahaayeen kuwo ku tiirsan dhaqaalaha laga helo deeq-bixiyeyaasha, sidaa awgeedna ma lahayn jiritaan waara muddo dheer.

Wasaaradda Waxbarashu waa ay aqoonsan tahay fursadda weyn ee la xiriirta in tamarta qorraxda laga dhaliyo awoodda danabka lagu isticmaalo Puntland heer guri illaa iyo hay'adaha dawladda. Intaa waxa ka muhiimsan, ganacsiga tamarta qorraxdu waxa uu dhaliyaa fursado shaqo-abuur fara badan, si toos ah ama si dadbanba. Arrintaasi waa mid waafaqsan qorshaha TVET ee dawladda.

Qorshaha TVET waxa uu u oggolaanayaa wasaaraddan in ay dib-u-eegid ku sameyso, isla markaana ballaarisno manhajka si loogu biiriyo xirfado cusub ayada oo la eegayo hadba baahida ka jirta suuqa. Suuqa uu PV ku haysto Puntland waa mid aad u baaxad weyn. Sidaa awgeed, manhajkan wa mid ku habboon wakhtiga hadda ah.

Dejinta manhajkan waxa la waafajiyey nidaamka siyaasadda u deggan Wasaaradda Waxbarashada ee Puntland dhanka Waxbarashada Technical Vocational Education and Training (TVET) . Waxa loogu talo-galey ururrada awood u leh in ay si habboon u baxshaan tababarka, isla markaana leh agab waxbarasho ay u dhan yihiin qalabka loogu baahan yahay fulinta tababarro farsamo.

Tababbarka PV ee xir-xirka ee ku jira manhajkan waxa uu ka filayaa qofka la tababaray in uu aqoon aasaasi ah u leeyahay xiridda dabka korontada iyo tan qorraxda. Taa waxa loola jeedaa in qofka la tababaray uu qaatay amaba ku guda jiro Koorsada Xiridda Dabka Heerka III.

Hase yeeshee, koorsada waxa ay ku saleysan tahay qaab ah in farsamo-yaqaannada dabka, oo laga yaabo in ay yihiin injineero sita shahaado jaamacadeed ee korontada, in ay haddana ka qayb-geli karaan tababbarka, isla markaana yeelan karaan xirfad gaarsiisan xiridda PV. Sidaa darteed, koorsadu waa mid iskeed isu taagi karta oo si gaar ah loo bixin karo.

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AC	Alternating Current
ACP	African Caribbean Pacific
ADRA	Adventist Development Relief Agency
C.C	Charge Controller/Regulator.
DC	Direct Current
EC	European Commission
EU	European Union
HTI	Hargeisa Technical Institute
IDPs	Internally Displaced Persons
KEREA	Kenya Renewable Energy Association
kWhr	Kilowatt hour
MOE	Ministry of Education
NGOs	Non Governmental Organizations
PV	Photovoltaic
SELP	Somali Energy and Livelihood Project
TNA	Training Needs Assessment
TVET	Technical Vocational Education Training
USAID	United States Agency of International Development.
VTC	Vocational Training Centre

Cutubka9: Habka Tamarta Qoraxda (ID) loo Xusho	<ul style="list-style-type: none"> ➤ Faahfaahinta lagu Doorto intuu laegyahay awooda (ID) ➤ Waxyaalaha loo eego Xulashada iyo Xadidka m, keydiyayaasha, Tamarbedelayaasha iyo CC Iyadoo loo eegayo Cimilada ➤ Dhameystirka iyo Xisaabinta Baahida Tamarta iyo Awooda aad u Baahan tahay ➤ Ka Baarandigida, Xulashada iyo Isticmaalka of module, battery, Inverter and charge controller ➤ Isticmaalka Keybalka iyo doorashada Xargaha 	3
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Cutubka11: Habka Hubinta, Tijaabinta iyo hawgelinta (ID)	<ul style="list-style-type: none"> ➤ Hubinta Muuqaal ahaaneed ➤ Isku xirka iyo tijaabinta Koronto ahaaneed Qalabka (ID) oo dhan ➤ Tijaabinta Qalabka loo isticmalayo Tamarta ➤ Tusida iyo Barida Isticmaalaha Qalabka (ID) ➤ Tababarida, Tijaabinta iyo hawgelinta ee Qalabka (ID) 	4
Cutubka12: Habka Dayactirka Qalabka (ID)	<ul style="list-style-type: none"> ➤ Hawsha Dayactirka Wayarada Korontada ➤ Hawsha Dayactirka Xubnaha Qalabka (ID) ➤ Dayactirka Keydiyaha ➤ Tijaabinta Keydiye Buuxshaha ➤ Tijaabinta Tamar-Bedelaha ➤ Qorsheynta Dayactirka ➤ Qalabkii la isku-Xirxiray iyo Rarka uu Qaadi karo 	8
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Maxsuulki ka soo baxay u kuurgelidii baahida tababarka muhiimka ah

- i) Wasaarada waxbarashada qeybteeda TVET iney asaasto qaab koorsooyinka ID looga her geliyo VTCs.
- ii) Ujeedooyinka wasaarada waxbarashada eek u wajahan TVET waa in loo sameeyaa qaab/muuqaal shaqogelin/dadargelin.
- iii) TVET hada jira waa yaryihiin, waxayna ku taagan yidiin deeq ay helaan.
- iv) TVET (macadyada) waxay sahli karaan soo bandhigida koorsooyinka ID.
- v) TVET ma laha awood shaqaale u qaas ah koorsooyinka ID.
- vi) Koorsooyinka ID kuma haboona manhajka hada jira.
- vii) Koorsooyinka ID ma aha mid la garanayo.
- viii) ID si baahsan ayaa tamar ahaan loo isticmaalaa iyo xaalado kala duwan.
- ix) Manhajka Koorsooyinka korantada ee hada jira waxuu asaas wacan u noqon kartaa Koorsooyinka/ barashada ID.

Waxaa la doortay in la isku dhex daro koorsooyinka korantada iyo mida ID

Talo soo jeedin.

- i) Waxaa loo bahan yahay in la sameeyo qaab dhismeed awood leh oo ku wajahan TVET
- ii) VTC waa iney si sahlan u soo bandhigaan koorsooyinka ID.
- iii) TVET waa in la badiyaa oo la sameeyaa tababaro badan oo soobandhiga for scalability.
- iv) Koorsooyinka waa in ay ahaataa mid la doortay, hadey tahay mid iskeed u taagan ama mid ku lifaaqan koorsooyinka kale.
- v) Koorsooyinka Gareedka II & III waa in loo abuuraa si sahlan oo ay isu dhex geli karaan koorsooyinka korantada.
- vi) Ugu yaraan baahida gelitaanka koorsooyinka goonida u taagan waa iney ahaato koorsooyinka korantada heerka III
- vii) Alxanka waa kooso faahfaahin badan u baahan, kuna haboon iney gooni u istaagto..
- viii) Ku lamaaninta warshadaha waa in la siiyaa muhiimad.
- ix) koorsooyinka 40% qoraal 60% ay ahaataa CATs iyo shaqo gacanta laga qabya.
- x) Maamulayaasha gzoobaha kala duwan waa iney sameeyaan wacyi gelin
- xi) Manhajka waxuu u baahan yahay in soomali lagu tarjumo.

HORDHAC

Tamarta qoraxda waxay ku jirta kuwa lagu bedelan karo keydadka/khayraadka tamarta ee hadda jira, isla markaana la cadeeyen in ay tahay habka ugu wanaagsan ee Puntland loogu heli karo adeega tamar casri ah. Si kastaba ha ahaatee, adeegsiga tamarta qoraxda oo ah keyd tamar kan uguweyn waxa hirgelintii si joogta dib ugu dhigay la'aanshaha aqoon farsamo oo ku haboon iyo iyada oo aysan jirin tababar qorsho agaasiman leh oo keeni karay shakhsi xifad iyo aqoon xambaarsan oo ku haboon farsamadaa and warshadda. Si hadaba xaaladan loo bandhigo, waxa la qabtay cilmi baaris lagu oqaanayo tababarka loo baahan yahay, keentay in MoE diyaariso manhajka.

U kuurgelida nooca tababarka loo baahan yahay

Ujeedooyinka waa:

- i) Dib u eeg hay'adaha iyo qaabka shaqo ee siyaasada ee loo dejiyey tababarka mihnadaha ee xirfadaha korontada iyo electronicada
- ii) Dib u eeg tababarka mihnadaha farsamada ee hadda jira (qaar ahaan farsamada korantadeena) iyo heerka aqoonta iyo xirfada ay heleen kuwii qalin jebiyey ee lagu tababaray manhajkaa
- iii) U kuurgal tababarka farsamo lagmamarmaanka u ah hawlaha bulshada ee tecnolojada korontada
- iv) U kuurgal awooda fulinta tababarka farsamo
- v) Dib u eeg manhajka PV ee la heli karo iyo khibradaha tababarada habka PV iyo sida loogu isticmaalilahaa/ adeesan karo Puntland
- vi) U kuurgal tababarada tooska ah iyo kuwa aan tooska ahayn ay qabteen hay'adaha, NGOyada iyo qeybaha ganacsatada ee maadada PV
- vii) Kala qeex ama caddee hababka PV ugu haboon Puntland.

Habka Gudbinta

Xilligii tababarka waxa la adeegsaday habka kawa qeybgalka taasoo ay khuseeyayaashu/ka qeybgalayaashu ay doodaha ka qeybqaateen, kuna soo bandhigeen aaraddooda.

Xog iyo warbixin ururin baa la sameeyey iyadoo la booqday meelaha ay ku kulmaan bulshada, ganacsatada iyo kuwa isticmaala; doodana lala yeeshay dad xil kas ah oo waxaas ku shaqaya.

Sidoo kale, meelihi ay suurta gashay waxa lagu qabtay kulamo wadajir ah kana qeybgaleen dad kala duwan lana yeeshay wareysiyo iyadao la adeegsayo hagaha lagu ururiyo xogta.

Xog ururintaa waxaa barbar socday, dib u eegis lagu sameeyey xogo iyo warbixino la xidhiidhay TVETka, xaalada habka dhagan-dhaqaale, qeybta tamarta iyo suuqa PV. ADRA iyo Wasaaradda Waxbarashadu waxa ay keeneen qoraalo la xidhiidha arrintan.

Qoraalada la soo bandhigay dibna loo eegay waxa ka mid ahaa:

- i) A Socio-economic Baseline Survey Report, ADRA, 2008.
- ii) The Puntland, Local Economic Development (LED) study report of 2006 on promotion of employment through training for the Ministry of Education.
- iii) Curriculum for Electrical Installation courses, skills level Grade II and Grade III, UNESCO, 2007. Xoghii iyo warbixinaddii la soo ururiyey natiooyinkii ka soo baxayna waxa loo diyaariyey qaab warbixin ama report.

MAHADCELIN

Diyaarinta muqararkan iyo hagayaashan dejintoodu suuragal ma noqoteen haddii aan la helin taageerada iyo dadaalka Waaxda farsamada iyo Tababaradda ee Wasaaradda Wxabarashada. Iyada oo ay horseedeyso diyaarinta qormadan, Wasaaraddu waxay si buuxda ugu heshay qormada daneeyayaal badan. Hawshan waxa maal geliyey Midowga Yurub ACP ee Awooda Tamarta, iyadoo la sii mariyey ADRA. Maalgelintanu muhiim bay u ahayd fulinta hawshan.

Koox khabiiri Puntland ah oo ay lashaqynayaan Rencon Associates Ltd, ahna Shirkada la talinta dibu Cosbooneysiinta Tamarta, ayaa isu soo ururisay qormada, iyagoo raaceya tilmaamaha ay ka helaan shaqaalaha mashruuca tamarta ee ADRA. Khibrada farsamo ay kasbadeen kooxdan khabiirada ah wuxuu ahaa mid aad u qiimo badan.

Si loogu diyaar garoobo qorista manhajka, qorayaashu waxay adeegsadeen keyd agabo iyo biroyin oo ay badanaa ka heleen keydad kala duwan ee Waaxada Manaahijta iyo Tababarada, Wasaarada Waxbarashad Puntland; Solar PV artisian; Dugsiyada Farsamada Gacanta; kuwa ka shaqeyta solar PV iyo Deeq bixiyeyaasha.

Kuwa mutan in si khaas ah loo xuso biiradoodii si firfircooned, isla markaana la adeegsadeen agabkooda waxa ka mid ah:

Dugsiga Farsamada Gacanta ee Galkaio
 Dugsiga Farsamada Gacanta ee Garowe
 Dugsiga Farsamada Gacanta ee Bosaaso
 UNESCO
 GOLIS
 DIAKONIA
 ENIA

Kenya Renewable Energy Association (KERECA) and International Finance Corporation
 Ministry of Energy and Mineral Development and Germany Technical Cooperation (Uganda).
 Botswana Power Corporation and United Nations Development Programme (Botswana).
 Mahad balaaran baan gaarsiineynaa dhamman kuwii kale ee wax nagu biiriyey si loo diyaariyo qormadan

Abdi Farah Said

Minister of Education
 Puntland State of Somalia

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MANHAJKA BARASHADA IYO ISKUXIR-XIRKAKORONTADA QORAXDA LAGA DHALIYO

Tabarkan waxa ku lifaaqan manhajka Korontada



MUQARARKA ILEYS QOREXEEDKA



MOE



European Union

