Solar PV System Technician Course

Introduction

Solar PV Technician play a vital role in the installation and maintenance of Solar PV System and Electrical appliances. The increased use of solar energy has maximize the demand of Solar PV Technician having the skills to install and maintain solar photovoltaic systems, thus, meeting the ever-growing demand of industry. This course has been design and developed to achieve its objectives of providing appropriate skills.

Overall course objective

The aim of this program is to produce employable Solar PV Technicians who could provide intermediate installation and maintenance services of Solar PV System, including off-grid solar photovoltaic (PV) system installation. In addition, this program aims to prepare unemployed youth to find employment in the construction industries or to enable them in becoming successful as entrepreneur.

Course competencies

After completion of training the trainees will be able to:
Develop professionalism associated with the solar PV technician trade;

- Maintain Safety;
- Interpret Drawings and Layout Electrical Wiring;
- Maintain Tools & Equipment;
- Install Wiring;
- Perform Installations and Assembling of Electrical Appliance / items;
- Load Calculation for the Solar PV System;
- Identify and Install Solar PV Modules for domestic use;
- Identify and install OFF-Grid and ON-Grid PV system;
- Identify and Install Solar PV Modules for large buildings;
- Install and repair Solar PV components such as Batteries, Charge Controllers, lights, Inverters, UPS etc;
- Perform Distribution of Electrical Supply;

- Perform Preventive and Corrective Maintenance;
- Perform Quality Checks; and
- Maintain Documentation.
- Establish business related to his profession.

Job opportunities

The pass out of this course would be able to:

- Work in small & medium construction units as Solar PV Technician
- Work as building electrician in an electrical outfit / company / organization
- Work as building electrician with construction contractor
- Be self employed by having his own electrical / wiring workshop

Trainee entry level

Individuals who wish to enter this course of study have to comply against the following criteria:

- ✓ Grade 10 (Matric) or equivalent;
- ✓ Comfort level of English language and mathematics;
- ✓ Satisfactory completion of appropriate admission assessment test.

Minimum qualification of trainer

Trainers who wish to offer this program should meet one of the following requirements:

- B.Sc. Eng/B.Tech (Electrical, Electronics) and 2 years of relevant work experience; or
- M.Sc. Electronics and 2 years of relevant work experience; or
- Diploma of Associate Engineer (DAE-Electrical, Electronics) and 5 years relevant work experience; or
- Certificate as Building Electrician with 8 years relevant work experience

Trainers offering this program must be computer literate and be conversant with the delivery of competency-based education and all legislative requirements applicable to carry out training and assessment, if any, must be complied with.

Teaching strategies in a competency-based environment

Training in the course is based on defined competency standards, which are industry oriented.

The traditional role of a trainer changes and shifts towards the facilitation of training. A trainer encourages and assists trainees to learn for themselves. Trainees are likely to work in groups (pairs) and all doing something different. Some are doing practical tasks in the workshop, some writing, some not even in the classroom or workshop but in another part of the building using specialist equipment, working on computers doing research on the Internet or the library. As trainees learn at different pace they might well be at different stages in their learning, thus learning must be tailored to suit individual needs.

The following facilitation methods (teaching strategies) are generally employed:

- **Direct Instruction Method:** This might be effective when introducing a new topic to a larger group of trainees in a relative short amount of time. In most cases this method relies on one-way communication, hence there are limited opportunities to get feedback on the trainee's understanding.

- **Discussion Method:** This allows trainees to actively participate in sharing knowledge and ideas. It will help the trainer to determine whether trainees understand the content of the topic. On the other hand, there is a possibility of straying off topic under discussion and some trainees dominating others on their views.

- **Small Group Method:** Pairing trainees to help and learn from each other often results in faster knowledge/skill transfer than with the whole class. The physical arrangement of the classroom/workshop and individual assessment may be challenging. Analogy method should be in corporate.

- **Problem Solving Method:** This is a very popular teaching strategy for the training. Trainees are challenged and are usually highly motivated when they gain new knowledge and skills by solving problems (Contingency skills). Trainees develop critical thinking skills and the ability to adapt to new learning situations (Transfer skills). It might be time consuming and because trainees sometimes work individually, they may not learn all the things that they are expected to learn.

- **Research Method:** This is used for workshops and laboratory tasks, field experiments, and case studies. It encourages trainees to investigate and find answers for themselves and to critically evaluate information. It however requires a lot of time and careful planning of research projects for the trainee.

Medium of instructions

- Urdu, local languages and/or English

Sequence and delivery of the modules

The curriculum for Solar PV System Technician consists of eight (8) modules. The delivery of the modules (sequence) is suggested as follows:

- **Module 1:** introduction to Renewable energy (15 Hours)
- **Module 2:** Safety (30 Hours)
- **Module 3:** Basic Electricity Concept (145 Hours)
- **Module 4:** Solar PV System (105 Hours)
- **Module 5:** Components of Solar PV System (125 Hours)
- **Module 6:** Maintenance, Troubleshooting and Procurement of PV System (55 Hours)
- **Module 7:** Design of PV system (73 Hours)
- **Module 8:** Entrepreneurship (50 Hours)

Learning units within these modules can be delivered interchangeably as stand-alone modules or in an integrated approach.

Duration of the course

The proposed curriculum is composed of 8 modules, which will be delivered over 600 hours i.e. six (6) months.
The distribution of training hours is as follows:

a) Total Training hours = 600 Hours

b) Theory =120 Hours (20%)

c) Practical = 480 Hours (80%)

Introduction

Learning Unit	Learning Outcomes	Learning Elements	Duration (Hours)
Introduction	• Give a self-introduction one by one. • Introduce the background and purpose of this training • Explain the purpose and schedule of this training	• Background • Present Issue of Solar power • Purpose of this training • Schedule & Announcements	2 Hours

Module -1 [Introduction to Renewable Energy]

Learning Unit	Learning Outcomes	Learning Elements	Duration (Hours)
LU-1: Renewable Energy	• Know energy generation process • Know Solar energy generation process • Know Wind energy generation process • Know Bio-Fuel energy generation process • Know Geo Thermal energy generation process • Know Tidal energy generation process	• Introduction to renewable energy sources • Solar energy • Wind energy • Bio-fuel energy • Geo thermal energy • Tidal energy	15 Hours

Module -2 [Safety]

Learning Unit	Learning Outcomes	Learning Elements	Duration (Hours)
LU-1: **Risk Management**	• Conduct a comprehensive assessment of associated physical reputation, emotional, financial, and facilities risk • Provide a realistic assessment of risks along the risk management • Select the most appropriate mitigating actions for each risk • Define the term personal protective equipment and clothing • Apply the protection procedures for electric shock • Understand the Use of tools and its safety	• Risk • Risk assessment and risk control • Electrical risk and basic electrical safety • PPE(Personal Protective Equipment) • First aid treatment against electric shock • Maintaining tool safety	20 Hours
LU-2: **Hazards**	• Define the term hazard. • Identify the different types of hazards. • Describe electricity hazards. • Describe the procedures for reporting hazards. • Describe the different ways of controlling hazards • Perform hazard reporting	• Physical hazards • Electrical Hazards • Chemical Hazards • Controlling Hazards • Training and education • Administrative Control • Procedures for reporting hazards	10 Hours

Module -3 [Basic Electricity Concept]

Learning Unit	Learning Outcomes	Learning Elements	Duration (Hours)
LU-1: **Basic Electricity**	• Know the basics of electricity and basic calculations related to electrical circuit • Know the units (V, A, W, Wh) and use of circuit laws such as "Ohm's Law" and "Kirchhoff's Laws" • Know terms of voltage drop and how to calculate it in a small PV system • Measure the parameters using the instruments individually and record the data into the data sheet • Calculate the values at the designated points by using circuit laws, and then measure the values at the same points to confirm if both values are the same	• Voltage, Current, Resistance, Power • AC and DC • Ohm's Law • Kirchhoff's Voltage Law • Kirchhoff's Current Law • Power and Energy • Peak load and Daily Power consumption • Voltage Drop • Calculation of Voltage Drop • Specification of Voltage Drop	55 Hours
LU-2: **Electrical Wiring System**	• Collect job documentation (e.g. drawing, map, history) • Locate electrical points as per drawing • Know the tools used in electrical wiring • Understand the different types of wiring • Perform different types of Electrical wiring networks • Know measurement of PVC pipes of different sizes • Perform fixing of all pipes and ducts • Understand the process of earthing and its need	• Types of job documents • Importance of Job Documents • Electrical symbols used in building maps and wiring • Tools used in electrical wiring • Types of wiring • Different Electrical wiring Circuits • Measurement of PVC pipes and PVC ducts • Earthing	90 Hours

Module 4 [Solar PV System]

Learning Unit	Learning Outcomes	Learning Elements	Duration (Hours)
LU-1: **Solar PV System Basics**	• Understand the basics of Solar PV system. • Know the type and feature of PV module • Demonstrate knowledge on solar energy • know electricity generation from solar PV system • Know the electrical characteristic Current and voltage • Understand the basic PV system • Describe Series & parallel connections • Demonstrate the effects of shadow on PV panels • Know the meaning of technical terms such as Insolation, Peak Sun Hours and Irradiance • Describe Connection of Cell to module and module to Array • Understand the no-shade time and effect of tilt angle	• Electricity from Solar Energy • Photovoltaic Effect • PV Cell types • Feature of Solar PV System • Electrical Characteristics of PV Cell • Series & Parallel Connection • Peak Sun Hour • Irradiance • Tilt Angle/Azimuth • Insolation • Example of effect by various tilt angle • No-Shade Time • Effect of shadow • PV Cell Interconnection • Module Interconnection and Array Design	60 Hours

LU-2: **Solar Energy Application**	• Understand the meaning of PV system parameters • Understand applications of PV systems such as Solar Home System, solar water pumps, solar fan, solar hybrid and other DC consumers • Understand the load Calculations • Know the interconnections among different power sources • Set the power source priorities • Know about solar cabling and its colors • Know the Off- Grid solar PV system • Know the On- Grid solar PV system	• Peak load and daily power consumption • Load analysis • Application of solar PV system • Solar hybrid system • Solar cabling and electrical Connections of PV modules • SHS (Solar Home System) • Off- Grid solar system and its components • On-Grid solar system and its components	45 Hours

Module-5 [Components of Solar PV System]

Learning Unit	Learning Outcomes	Learning Elements	Duration (Hours)
LU-1: **Batteries**	• Know basics of batteries • Describe the type and features of lead-acid battery • Know the battery capacity, life cycle, how to read capacity and how the life cycle is pre-determined • Understand the maintenance and usage method of battery • Perform battery liquid change operation process • Understand the battery calculation	• Battery or no battery storage • Battery /Battery bank • Type of Lead-acid Batteries • Battery Charging Efficiency • Battery life Cycle, Discharge Rate • Maintenance of Electrolyte • Maintenance of Electrode • Battery connections (Series and Parallel) • Battery calculation with respect to load	25 Hours

LU-2: **Charge Controller**	• Know the basics of charge controller • Describe the types, features and function of charge controller • Perform set point voltage such as HV and LV of charge controller • Check the protective function of C/C by using test instruments • Understand the switching function of C/C when reaches HV or LV	• Charge controller • Types of Charge Controllers • Function of Charge Controller • Set point voltage • Connecting Sequence • Other functions of Charge Controller	15 Hours
LU:3 **DC Light**	• Know basics of DC Light • Know the types and features of DC Lights such as CFL, CCFL, halogen light and LED	• Types of DC lights • Types of AC lights • Compact Fluorescent Light • DC Fluorescent Light	5 Hours
LU-4 **Inverter**	• Know the basic principle of Inverter • Describe the Basic circuitry of inverter • Operation of inverter • Describe the types and features of inverter for SHS • Understand the parameters settings • Maintain and repair of inverter	• Inverter types • Inverter for SHS • Operation and Working principal of inverter • Output Waveform • Components of inverter • Inverter Parameter Settings • Parallel operation of inverters	40 Hours
LU-5 **Uninterruptible power supply (UPS)**	• Know the operation and Working principal of 'UPS' • Basic circuitry of UPS • Perform UPS assembling and Maintenance process • Perform UPS installation for SHS	• UPS for SHS • Components of UPS • Assembling of UPS • UPS installation	40 Hours

Module-6 [Maintenance, Troubleshooting and Procurement of PV System]

Learning Unit	Learning Outcomes	Learning Elements	Duration (Hours)
LU-1: Maintenance	• Know the basic procedure of Maintenance • Describe the general maintenance of PV system	• General Maintenance of PV system	10 Hours
LU-2: Inspection & Monitoring	• Know the basic techniques of Inspection and Monitoring • Understand the necessity of inspection and how to inspect PV system • Analyze PV system condition using the system parameters • Conduct monitoring using the monitoring sheet for an existing PV system • Demonstrate how to read data sheet of materials	• Necessity of inspection • Inspection techniques • Quality inspection • PV Measuring equipment • Use of Irradiance meter • Use of infrared camera • Use Light meter • Use of solar power meter • Use of lux meter • Multi meter • Status of system • Load power measurement • Measuring points • Daily Usage Time of load (SHS) • Peak load & Total load • Discoloration	20 Hours

LU:3 Troubleshooting	• Know procedure of troubleshooting • Describe the normal troubles and causes of troubles occurring in each PV system • Demonstrate the right troubleshooting procedure • Describe the causes and the countermeasures • Explain how to check and countercheck the causes of troubles	• Troubleshooting of PV system	20 Hours
LU:4 Procurement	• Know Procurement process • Know the specifications of PV panels and components	• PV panel selection • PV component selection	5 Hours

Module-7 [Design of PV system]

Learning Unit	Learning Outcomes	Learning Elements	Duration (Hours)
LU-1: Design of PV System	• Know the basic parameters for designing a PV system • Know methods of collecting data • Know data interpretation • Use a simple software for PV system design • Prepare BOM(Bill of Material) for a basic PV system • Explain what data is needed to design and how to design a PV system	• Basic system design • Site selection • Planning • Installation and commissioning • PV system design software • Project	73 Hours

Module-8 [Entrepreneurship]

Learning Unit	Learning Outcomes	Learning Elements	Duration (Hours)
L.U-1 **Starting a Business**	• Demonstrate an understanding of the practices required to start a business • Define entrepreneurship and be able to recognize and describe the characteristics of an entrepreneur • Identify business opportunities in the field of solar PV • Write a business plan for a business in your community • Identify and explain the purpose and contents of a business plan • Choose a product and describe the process leading to distribution	• Entrepreneurship • Business opportunities • Business plan • Product distribution	15 Hours
LU – 2 **Managing a business**	• Demonstrate an understanding of managing a business. • Formulate short and long term business goals • Demonstrate effective verbal written and visual communication skills • Demonstrate business meeting skills • Working as a team, role- play situations that an entrepreneur might face and dealing with customers or employees • Identify professional and explore their benefits	• Business goals • Verbal communication • Written communication • Visual communication • Business meeting skills • Business dealings • Organization's benefits	15 Hours

L.U-3 Marketing a Business	• Demonstrate an understanding of marketing and promoting a business • Describe methods of market research and identifying target markets • Describe and apply the concepts of a marketing mix (the 4Ps of marketing: product, price, place and promotion) • Compare and contrast the promotional tools and techniques used to sell products, services, images and ideas • Describe the impact of supply and demand on a product or business • Identify direct and indirect competition on a business • Conduct market research by developing a survey and presenting the results • Create a promotional campaign using a variety of media • Write a marketing plan for a product	• Target markets • Marketing mix (4ps concept) • Business promotion technique • Impact of supply and demand • Business competition • Market survey • Business promotion campaign	10 Hours
LU-4 Financial Concepts and Application in Business	• Demonstrate and understanding of financial concepts and applications • Identify essential financial reports and understand their purposes (i.e., budget, balance sheet and income statement) • Develop a budget for a simulated business or project	• Essential financial reports • Budget plans	10 Hours