**Solar Electric Technician Training**

**Module 1: Introduction to solar electric system**

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| **Objectives:** By the end of this session, learners will be able to:   * Introduction of solar energy and photovoltaics. * Introduce solar radiation and related parameters  (watt peak, irradiance, insolation, peak sun hour). * Discuss variations in solar radiation due to season and time of the day. * Describe how solar radiation is measured. * Discuss components of solar PV systems, and their types. * Discuss applications of solar PV systems: Solar streetlights, solar water pumps (SWP), solar rooftop (SRT) systems, solar mini-grids (SMG), grid-connected and off-grid systems, hybrid systems. * Explain the specifications of solar modules, charge controllers, inverters, batteries, water pump, pump controller, mounting structures, and balance of system (BOS). * List electric protection equipment and explain their uses. | **Instructor:** *[Name]* |
| **Session duration:**   * 12 hours (Theory) |

| **Trainers’ activities** | **Learners’ activities** | **Teaching aids** | **Time** |
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| **Introduction to energy sources, solar energy and photovoltaics** | | | **60’** |
| **Session kick-off:**  Introduce the session objectives and agenda and ask questions as:   * What are the sources of energy? * What are the major types of energy sources? * What is the source of electricity used at households? * Have you heard about solar, wind, biomass, geothermal energy sources? | Learner's brainstorm and list energy sources they know.  Learners categorized the listed energy sources as renewable and non-renewable.  Learners raise hands if familiar and briefly share knowledge or experiences | Slides/Powerpoint presentation for module 1 (P1), white boards or metacards | 10’ |
| Gives overview of solar energy, its importance and basic of photovoltaics via illustrated talk and explanation on**:**   * Definition of solar energy. * The conversion of solar energy. * The working principles of solar cell and solar energy, which are utilized to produce useful energy from the sun. | Learners take notes and ask questions and engage in discussion | Slides/Powerpoint presentation for module 1 (P1), white boards or metacards | 20’ |
| Trainers further gives illustrated talk and explanation on:   * Definition of photovoltaics. * Semi-conductor (silicon, number, size and connections) * Cell voltage (1000 watt/m² = 0.6V, 100 cm²= 3 A and 12V battery = 1.5 times more cell Volt) * Panel body (Frame, white coated) * Types of photovoltaics modules: * Monocrystalline * Polycrystalline * Thin-Film * Half-cut cell | Learners take notes, ask questions and engage in discussion | Slides/Powerpoint presentation for module 1 (P1), white boards or metacards | 30’ |
| **Solar radiation and related parameters (Watt peak, Irradiance, Insolation and Peak sun hours)** | | | **90’** |
| Trainers explains the key solar parameters and their significance via illustrated talk and explanation on:   * Definition of solar radiation. * Types of solar radiation. * Infrared light * Visible light * Ultraviolet light * How it is collected and converted into useful energy source? | Learners take notes, ask questions and engage in discussion | Slides/Powerpoint presentation for module 1 (P1), white boards or metacards | 30’ |
| Explain different parameters of solar radiation.   * Watt peak * Irradiance (Watt/m2) * Insolation (Watt-hour/m2/day) * Peak sun hour | Learners take notes, ask questions and engage in discussion | Slides/Powerpoint presentation for module 1 (P1), white boards or metacards | 60’ |
| **Discuss variations in solar radiation due to season and time of day** | | | **60’** |
| Trainers explain how time of day and season affect solar radiation via illustrated talk on   * How solar radiation varies with respect to time of day? * How solar radiation varies with respect to season change? | Learners take notes, ask questions and engage in discussion | Slides/Powerpoint presentation for module 1 (P1), white boards or metacards | 30’  30’ |
| **Describe how solar radiation is measured.** | | | **45’** |
| Trainers explains solar radiation via illustrated talk on  **Measurement of radiation**:   * Direct solar radiation * Diffuse solar radiation * Global solar radiation   Trainers introduces **measurement tools covering**:   * Pyranometer * Pyrheliometer * Solar radiator * Mobile app: Sun’s path tool   Ask learners to download the mobile app and demonstrate how it to use it | * Install the app. * Learn to use app. * Learners observe demonstration and ask questions about the measurement process | Slides/Powerpoint presentation for module 1 (P1), white boards or metacards | 20’  25’ |
| **Discuss components of solar PV systems and their types** | | | **120’** |
| Trainers gives illustrated talk on **components of solar PV system and their types** covering:   * Solar PV modules * Monocrystalline * Polycrystalline * Half-cut cell * Charge controller * PWM * MPPT * Inverter * Off-grid inverter * On-grid inverter * Hybrid inverter * Battery * Flooded lead acid * VRLA * Li-ion * Water pump * Surface pump * Submersible pump * Pump controller * VFD controller * Mounting structure * Ground mount * Roof mount * Balance of system (BoS) * Wires and cables * Combiner box * Fuses, MCBs, MCCBs, etc. * Installation accessories. | Learners take notes, ask questions and engage in discussion | Slides/Powerpoint presentation for module 1 (P1), white boards or metacards | 15’ for each |
| **Discuss applications of solar PV systems** | | | **120’** |
| Ask question:   * Have you seen any solar panels installed in your location? * What were those systems installed for? | * Learners brainstorm potential applications of solar PV systems in their own communities | Slides/Powerpoint presentation for module 1 (P1), white boards or metacards | 15’ |
| Trainers gives illustrated talk on **application of solar PV systems covering:**   * Solar streetlight * Solar water pump * Solar rooftop * Solar mini-grid * Solar off-grid * Solar grid-connected * Solar hybrid   Assign the group exercise for identifying the | * Participants in the discussion. | Slides/Powerpoint presentation for module 1 (P1), white boards or metacards | 15’ for each |
| **Explain the specifications of solar PV components. (Refer to the specifications which is provided in Media folder.)** | | | **120’** |
| Walkthrough the detailed **specifications of solar PV components** covering:   * Solar PV module: walk through specs such as Voc, Isc, Vmpp and Impp of any solar modules. * Charge controller: Explains charge controller types and parameters like MPPT efficiency, volage, Max current. * Inverter: Explain inverters focussing on parameters like input voltage range, output range and efficiency. * Battery: Discuss Parameters like DoD, Voltage and efficiency. * Water pump: Explain the parameters like flow rate, head and efficiency * Pump controller: Discuss parameters like Max PV range. * Mounting structure * BoS: Wires and cables, Fuses, MCBs, MCCBs, etc.   Assign the homework to mark the key parameters from the provided datasheets of components | * Learners examine sample specifications/datasheets and identify important characteristics. * Read spec sheets and mark the key parameters. * Review material specifications and design types * Read datasheets, mark parameters like **Voc, Vmpp, DoD** for each component | Print out of Specifications of each component. | 15’ for each |
| **List electrical protection equipment and explain their uses** | | | **105’** |
| Ask question:   * What is protection? * What is protection equipment? * Why is it important? * List the electrical protection equipment. | * Learners try to answers and engage in discussions on the importance of protection devices in solar systems. * Participate in the review and clarify doubts |  | 15’ |
| Trainer gives illustrated talk and explanation on **electrical protection equipment and their uses covering:**   * Fuse * MCBs * MCCBs * Switches * Earthing protection * Lightning Arrestor (LA) | * Engage in a hands-on session to inspect and read spec sheets of wires and fuses. | Slides/Powerpoint presentation for module 1 (P1), white boards or metacards | 90’ |
| **Total time** | | | **720’** |