**Solar Electric Technician Training**

**Module 6: Testing and commissioning (T & C)**

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| **Objectives:** By the end of this session, learners will be able to:   * Perform testing and commissioning of installed system components by using standard templates, technical manuals, and defined standard procedures. * Verify the integrity of wiring (single phase and three phase). * Check PV modules, mounting structures, batteries, charge controller, inverter, water pump, pump controller, fuses, busbars, etc. for functioning. * Check the connection of components including earthing and protection devices. * Check the net metering function, anti-islanding function and installed metering system to meet the regulatory and technical requirements. | **Instructor:** *[Name]* |
| **Session duration:**   * 7 hours (Theory) * 29 hours (Practical) |

| **Trainers' activities** | **Learners’ activities** | **Teaching aids** | **Time** |
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| **Perform testing and commissioning of selected site for different types of solar photovoltaics (SPV) systems.** | | | **1080’** |
| **Introduction**   * Begin the session by briefly explaining session objectives and emphasizing the importance of testing and commissioning. * Provide a brief recap the key components involved in solar photovoltaics (SPV) installation and wiring.   **Testing**   * Discuss the tools and equipment necessary for testing and commissioning * Outline the detailed process for testing SPV system and its wiring. * Demonstrates the full testing process on a sample SPV system, explaining each step in detail. * Give opportunity to participants to perform the testing on a sample SPV system in small groups, with supervision and feedback. | * Listen attentively, take notes, and ask questions for clarification. * Actively participate in discussions. * Take notes, ask questions, and engage in discussions. * Observe the demonstration, take notes, and ask questions. * Execute testing tasks on the system, ensuring proper procedure and safety. | * Whiteboard, markers, and presentation slides * SPV system workstations and testing equipment. | 30’  60'  60'  60’  180’ |
| **Commissioning**   * Demonstrate the commissioning process on a sample SPV system, focusing on critical checkpoints. * Provide the opportunity for participants to perform the commissioning process on a sample SPV system in small groups, with supervision and feedback. | * Observe demonstration, ask questions, and take notes. * Execute the commissioning tasks, documenting findings and ensuring adherence to procedure. | * SPV System Workstations, * Commissioning tools | 60'  180’ |
| **Troubleshooting during T & C**   * Discuss common issues encountered during testing and commissioning, such as wiring faults, component failures, and incorrect settings. * Give assignment with simulation setup (issues) and ask to resolve the issues. | * Participate in discussion, ask questions, and participate in troubleshooting exercises. * Diagnose and resolve issues, applying troubleshooting strategies, and documenting actions taken. | * Troubleshooting guides, case study and handouts * Simulation setup * Diagnostic tools | 60’  180’ |
| **Documentation**   * Discuss the importance of proper documentation and introduce standard formats. * Guide learners in documenting the results of their testing and commissioning activities using standard templates. | * Take notes, ask questions, and practice completing documentation using provided templates. * Complete documentation accurately, reflecting the results of the testing and commissioning. | * Documentation templates * Reporting guidelines * Example reports | 60’  120’ |
| **Review**   * Summarize key points from the session and facilitate a discussion on challenges faced during the exercises. | * Participate in discussion, share insights |  | 30’ |

| **Trainer’s activities** | **Learners’ activities** | **Teaching aids** | **Time** |
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| **Check the integrity of wiring (single phase and three phase).** | | | **240’** |
| * Provide overview of session objectives and importance of wiring integrity in SPV systems. * Explain common wiring faults (e.g., loose connections, incorrect polarity) and potential hazards (e.g., short circuits, grounding issues) in SPV systems. * Provide real or simulated examples of faulty wiring for learners/participants to identify issues. | * Listen, take notes, and ask questions for clarification. * Participate in discussion, ask questions, and share experiences with wiring issues. * Inspect provided samples, identify faults, and discuss findings with peers and trainer. | * Whiteboard, markers, and presentation slides * Faulty Wiring samples, diagrams of common faults * Wiring fault samples, inspection tools | 30’ |
| **Wiring connection:**   * Demonstrate how to inspect wiring connections for continuity, correct polarity, and secure fittings. * Provide opportunity to learners to inspect wiring connections in small groups, to identifying continuity, polarity, and secure fittings. | * Observe the demonstration, ask questions, and take notes. * Inspect wiring connections, document findings, and discuss results with the trainer. | * Continuity testers, Polarity check tools, connection samples * SPV wiring setups, inspection tools | 60’ |
| Give assignment to learners to use testing equipment to verify wiring integrity in small groups. | * Test wiring circuits, document results, and discuss any issues encountered. | * Testing equipment, SPV circuit setups | 135’ |
| **Review**   * Summarize key points from the session and facilitate a discussion on challenges faced during the exercises. | * Participate in discussion, share insights |  | 15’ |
| **Check PV modules, mounting structures, batteries, charge controller, inverter, water pump, pump controller, fuses, busbars, etc. for functioning.** | | | **360’** |
| Demonstrate and assign testing and commissioning of PV modules functioning:   * PV module soiling * PV module interconnection * PV module voltage and current * PV junction box | * Observe the demonstration, ask questions, and take notes. * Perform the testing. | * Multimeter * Assignment (E1) * T&C document | 45’ |
| Demonstrate and assign testing and commissioning of mounting structure:   * Ground clearance (grasses, bushes) * Rust and eroded structure * Tightening of nuts and bolts | * Observe the demonstration, ask questions, and take notes. * Perform the testing. | * Screwdriver * Assignment (E1) * T&C document | 45’ |
| Demonstrate and assign testing and commissioning of charge controller:   * Dust/soiling * Wire connection * Setting of system | * Observe the demonstration, ask questions, and take notes. * Perform the testing. | * Assignment (E1) * T&C document | 45’ |
| Demonstrate and assign testing and commissioning of inverter:   * Dust/soiling * Wire connection: input and output connections * Mounting of inverter * Setting of system | * Observe the demonstration, ask questions, and take notes. * Perform the testing. | * Assignment * T&C document | 45’ |
| Demonstrate and assign testing and commissioning of batteries:   * Dusting/soiling * Wire connection * Water level (if required) * Mounting of batteries | * Observe the demonstration, ask questions, and take notes. * Perform the testing. | * Assignment * T&C document | 45’ |
| Demonstrate and assign testing and commissioning of water pump functioning:   * Check water intake section if any debris * Wire connection * Pump fitting: pipeline, check valve, gates, joints, etc. | * Observe the demonstration, ask questions, and take notes. * Perform the testing. | * Assignment (E1) * T&C document | 45’ |
| Demonstrate and assign testing and commissioning of pump controller functioning:   * Mounting of pump controller * Wire connection * Setting of system * Dusting/soiling | * Observe the demonstration, ask questions, and take notes. * Perform the testing. | * Assignment (E1) * T&C document | 45’ |
| Demonstrate and assign testing and commissioning of Balance of System (BoS):   * Dusting/soiling of BoS equipment * Rusting in busbars * Wire connections * Conditions of cable trays, conduits, etc. | * Observe the demonstration, ask questions, and take notes. * Perform the testing. | * Assignment (E1) * T&C document | 45’ |
| **Check the connection of components including earthing and protection devices.** | | | **240’** |
| Demonstrate and assign testing and commissioning of BoS:   * Earth resistance * Wire connections of body and component earthing * Check connectivity of protection devices: MCB, SPDs, fuses, etc. | * Observe the demonstration, ask questions, and take notes. * Perform the testing. | * Assignment (E1) * T&C document | 240’ |
| **Check the net metering function, anti-islanding function and installed metering system to meet the regulatory and technical requirements.** | | | **360’** |
| Give illustrated talk on net metering:   * Function of net metering * Importance of net metering * Regulatory and technical requirement for installing net metering | * Participate in discussion. |  | 120’  120’  120’ |
| **Total time** | | | **2160’** |