

## SPECIALIZED POWER SYSTEMS INSTALLATION

UNIT CODE: 0714 451 11A

TVETCDACC UNIT CODE: ENG/CU/TLE/CR/02/5/MA

### Relationship to Occupational Standards

This unit addresses the unit of competency: Install Specialized Power Systems.

**Duration of Unit:** 190 hours

### Unit Description

This unit specifies competences required for installing specialized power systems. These include preparing power supply electrical drawings, performing electrical installation system sizing, setting up telecommunication mains utility power supply system, setting up telecommunication solar power supply system, setting up telecommunication ups system and testing electrical power supply system

### Summary of Learning Outcomes

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

| S/NO | LEARNING OUTCOME                        | DURATION (HRS) |
|------|-----------------------------------------|----------------|
| 1.   | Install Solar power supply systems      | 40             |
| 2.   | Set up Telecommunication UPS systems    | 30             |
| 3.   | Install Power Factor Correction Systems | 30             |
| 4.   | Install HVAC systems                    | 60             |
| 5.   | Test electrical power supply system     | 20             |
|      | <b>TOTAL HOURS</b>                      | 190            |

### Learning Outcomes, Content and Suggested Assessment Methods

| Learning Outcome                                      | Content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Suggested Assessment Methods                                                                                                                                                                            |
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| 1. Set up Telecommunication Solar power supply system | <ul style="list-style-type: none"><li>1.1.Solar Power Fundamental Concepts<ul style="list-style-type: none"><li>1.1.1. Solar Radiation</li><li>1.1.2. Photovoltaic Effect</li><li>1.1.3. Solar Panel Characteristics</li><li>1.1.4. Solar Inverter Operation</li></ul></li><li>1.2.Preparing Solar Power Supply Equipment and Materials<ul style="list-style-type: none"><li>1.2.1. Solar Panel Selection<ul style="list-style-type: none"><li>1.2.1.1.Understanding Solar Panel Ratings: Watts, Voltage, Amperes</li></ul></li></ul></li></ul> | <ul style="list-style-type: none"><li>1. Written assessment</li><li>2. Oral assessment</li><li>3. Practical</li><li>4. Project</li><li>5. Third party report</li><li>6. Portfolio of evidence</li></ul> |

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|  | <ul style="list-style-type: none"> <li>1.2.1.2.Choosing the Right Solar Panel Type: monocrystalline, polycrystalline, amorphous</li> <li>1.2.2. Solar Inverter Selection <ul style="list-style-type: none"> <li>1.2.2.1.Understanding Inverter Ratings: Watts, Voltage, Frequency</li> <li>1.2.2.2.Choosing the Right Inverter Type: on-grid, off-grid, hybrid</li> </ul> </li> <li>1.2.3. Battery Bank Selection <ul style="list-style-type: none"> <li>1.2.3.1.Understanding Battery Bank Capacity (Ah, kWh)</li> <li>1.2.3.2.Choosing the Right Battery Type: lead-acid, lithium-ion</li> </ul> </li> <li>1.2.4. Cable Selection <ul style="list-style-type: none"> <li>1.2.4.1.Choosing the Right Cable Type</li> <li>1.2.4.2.Cable Sizing based on Load Requirements and Voltage Drop</li> </ul> </li> <li>1.2.5. Mounting Structure Selection: <ul style="list-style-type: none"> <li>1.2.5.1.Choosing the Right Mounting Structure: roof-mounted, ground-mounted</li> <li>1.2.5.2.Tracking Systems: Single-Axis Tracker, Dual-Axis Tracker</li> <li>1.2.5.3.Erection of Support Structures</li> <li>1.2.5.4.Inclination and Orientation <ul style="list-style-type: none"> <li>I. Determining Optimal Tilt Angle and Azimuth</li> </ul> </li> </ul> </li> </ul> |  |
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|  | <p>II. Adjusting the Mounting Structure</p> <p>1.3.Installing Solar Panels</p> <p>1.3.1. Securing Solar Panels with Clamps and Bolts</p> <p>1.3.2. Weatherproofing</p> <p>1.3.3. Interconnecting Solar Panels</p> <p>1.3.3.1.Connecting Solar Panels in Series and Parallel</p> <p>1.3.3.2.Using MC4 Connectors</p> <p>1.3.3.3.Cable Laying and Termination</p> <p>1.3.4. Cable Routing</p> <p>1.3.4.1.Planning Cable Routes procedures</p> <p>1.3.4.2.Securing Cables</p> <p>1.3.5. Cable Termination</p> <p>1.3.5.1.Stripping and Tinning Cable Ends</p> <p>1.3.5.2.Crimping Connectors</p> <p>1.3.5.3.Connecting Cables to Solar Panels, Inverters, and Batteries</p> <p>1.3.6. Installing Solar Panel Combiner Boxes</p> <p>1.3.7. Combiner Box Selection: Box Size and Rating</p> <p>1.3.7.1.Combiner Box Installation</p> <p>1.3.7.2.Mounting the Combiner Box</p> <p>1.3.7.3.Connecting Solar Panels to the Combiner Box</p> <p>1.3.7.4.Connecting the Combiner Box to the Inverter</p> <p>1.4.Installing Solar System Protection Systems</p> |  |
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|                                        | <ul style="list-style-type: none"> <li>1.4.1. Sizing and installation of DC Circuit Breakers and Fuses</li> <li>1.4.2. Surge Protection Devices (SPDs)</li> <li>1.5.Installing Solar System Inverters and Battery Banks <ul style="list-style-type: none"> <li>1.5.1. Connecting Batteries in Series and Parallel</li> <li>1.5.2. Ventilation and Cooling systems</li> <li>1.5.3. Connecting the Inverter to Solar Panels, Batteries, and AC Load</li> <li>1.5.4. Configuring Inverter Settings</li> </ul> </li> <li>1.6.Solar Power System Testing <ul style="list-style-type: none"> <li>1.6.1. Pre-Commissioning Tests <ul style="list-style-type: none"> <li>1.6.1.1.Insulation Resistance Test</li> <li>1.6.1.2.Continuity Test</li> <li>1.6.1.3.Earth Resistance Test</li> <li>1.6.1.4.Open-circuit tests</li> <li>1.6.1.5.Short-circuit tests</li> <li>1.6.1.6.Voltage and current tests</li> </ul> </li> <li>1.6.2. Commissioning Procedures <ul style="list-style-type: none"> <li>1.6.2.1.Energizing the System</li> <li>1.6.2.2.Load Testing</li> <li>1.6.2.3.Performance Monitoring</li> </ul> </li> </ul> </li> <li>1.7.Preparing Documentation <ul style="list-style-type: none"> <li>1.7.1. As-built drawings</li> <li>1.7.2. Test reports</li> </ul> </li> </ul> |                                                                                                                                                                              |
| 2. Set up Telecommunication UPS system | <ul style="list-style-type: none"> <li>2.1.Introduction to UPS Systems <ul style="list-style-type: none"> <li>2.1.1. Definition and purpose of a UPS system.</li> <li>2.1.2. Importance in telecommunication systems</li> <li>2.1.3. Types of UPS System <ul style="list-style-type: none"> <li>2.1.3.1.Standby (offline), Line-interactive, and Online double conversion UPS systems.</li> </ul> </li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>1. Written assessment</li> <li>2. Oral assessment</li> <li>3. Practical</li> <li>4. Project</li> <li>5. Third party report</li> </ul> |

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|  | <p>2.1.3.2. Application cases for each in telecommunications.</p> <p>2.2. Telecommunication system power requirements</p> <p>2.2.1. Power Supply Systems in Telecommunication</p> <p>2.2.1.1. AC vs. DC power in telecom systems.</p> <p>2.2.1.2. Voltage and current considerations</p> <p>2.2.2. Load Analysis</p> <p>2.2.2.1. Calculating total load requirements</p> <p>2.2.2.2. UPS sizing</p> <p>2.3. UPS System Components</p> <p>2.3.1. UPS Unit</p> <p>2.3.1.1. Inverter, rectifier, and battery charger functions.</p> <p>2.3.1.2. Power capacity rating (kVA or kW).</p> <p>2.3.2. Batteries</p> <p>2.3.2.1. Types: Lead-acid, Lithium-ion, or Nickel-Cadmium (NiCd).</p> <p>2.3.2.2. Battery banks and their configuration.</p> <p>2.3.2.3. Battery runtime and backup capacity calculations.</p> <p>2.3.3. Monitoring and Control Interfaces</p> <p>2.3.3.1. LCD display</p> <p>2.3.3.2. Alarms</p> <p>2.3.3.3. Network interfaces for remote monitoring.</p> <p>2.4. Installing the UPS System</p> <p>2.4.1. UPS Placement</p> <p>2.4.1.1. Factors to consider when choosing an optimal UPS location</p> | <p>6. Portfolio of evidence</p> |
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|  | <ul style="list-style-type: none"> <li>2.4.1.2. Rack-mounting and standalone installations.</li> <li>2.4.2. Electrical Connections <ul style="list-style-type: none"> <li>2.4.2.1. Main AC supply to UPS termination.</li> <li>2.4.2.2. System load termination</li> <li>2.4.2.3. Grounding UPS system</li> </ul> </li> <li>2.4.3. Battery bank Installation <ul style="list-style-type: none"> <li>2.4.3.1. Battery banks configurations.</li> <li>2.4.3.2. Verification of battery bank health.</li> </ul> </li> <li>2.5. Testing and Commissioning <ul style="list-style-type: none"> <li>2.5.1. Initial System Checks <ul style="list-style-type: none"> <li>2.5.1.1. Verification of input voltage, load capacity, and system settings.</li> <li>2.5.1.2. UPS Error codes and warnings.</li> </ul> </li> <li>2.5.2. Load Testing <ul style="list-style-type: none"> <li>2.5.2.1. Simulated power failure test</li> <li>2.5.2.2. Load performance and battery discharge rates.</li> </ul> </li> <li>2.5.3. System Configuration <ul style="list-style-type: none"> <li>2.5.3.1. Remote monitoring and alert settings configuration</li> <li>2.5.3.2. UPS integration to existing telecom network management systems</li> </ul> </li> </ul> </li> <li>2.6. Maintenance and Troubleshooting <ul style="list-style-type: none"> <li>2.6.1. Routine Maintenance <ul style="list-style-type: none"> <li>2.6.1.1. Battery health monitoring.</li> <li>2.6.1.2. Cleaning Ventilation.</li> </ul> </li> <li>2.6.2. Troubleshooting Common Issues <ul style="list-style-type: none"> <li>2.6.2.1. UPS not switching to battery mode.</li> <li>2.6.2.2. Overload and temperature warnings.</li> </ul> </li> </ul> </li> </ul> |  |
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|                                            | 2.6.2.3.Degraded battery performance.<br>2.7.Documentation and Reporting<br>2.7.1. Installation Report<br>2.7.2. Maintenance Logs<br>2.7.2.1.Tracking performance<br>2.7.2.2.Service dates<br>2.7.2.3.Battery replacements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                   |
| 3. Install Power Factor Correction Systems | 3.1.Fundamentals of Power Factor & PFC Systems<br>3.1.1. Introduction to Power Factor<br>3.1.1.1.Understanding real, reactive, and apparent power<br>3.1.1.2.Definition and importance of power factor (PF)<br>3.1.1.3.Causes and effects of poor power factor<br>3.1.1.4.Effects of low power factor on electrical systems<br>3.1.1.5.Power factor measurement methods<br>3.1.1.6.Industrial and commercial applications<br>3.1.2. Power Factor Correction (PFC) Concepts<br>3.1.2.1.Types of power factor correction: passive, active, hybrid<br>3.1.2.2.Components of PFC systems: capacitor banks, reactors, controllers<br>3.1.2.3.Fixed vs. automatic PFC<br>3.1.2.4.Harmonic distortion and filtering techniques<br>3.1.2.5.Selection criteria for PFC systems | 7. Written assessment<br>8. Oral assessment<br>9. Practical<br>10. Project<br>11. Third party report<br>12. Portfolio of evidence |

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|  | <p>3.1.3. Safety Procedures &amp; Compliance</p> <p>3.1.3.1. Electrical safety regulations (IEC, IEEE, NEC)</p> <p>3.1.3.2. PPE and handling high-voltage capacitors</p> <p>3.1.3.3. Lockout/Tagout (LOTO) and earthing procedures</p> <p>3.2. Power Factor Correction System Installation</p> <p>3.2.1. Site Survey &amp; System Sizing</p> <p>3.2.1.1. Load analysis and reactive power calculation</p> <p>3.2.1.2. Selection of capacitor banks based on demand</p> <p>3.2.1.3. Harmonics analysis and mitigation techniques</p> <p>3.2.2. Installation of PFC Equipment</p> <p>3.2.2.1. Mounting capacitor banks and reactors</p> <p>3.2.2.2. Wiring capacitor bank</p> <p>3.2.2.3. Electrical wiring and busbar connections</p> <p>3.2.2.4. Integrating controllers and protection devices</p> <p>3.2.3. Testing &amp; Initial Commissioning</p> <p>3.2.3.1. Checking voltage, current, and power factor levels</p> <p>3.2.3.2. Verifying automatic switching of capacitor banks</p> <p>3.2.3.3. Identifying and troubleshooting installation issues</p> <p>3.3. Maintenance &amp; Troubleshooting</p> <p>3.3.1. Detecting capacitor degradation and failures</p> |  |
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|                                | <p>3.3.2. Identifying harmonic interference problems</p> <p>3.3.3. Ensuring long-term reliability of PFC systems</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                |
| <p>4. Install HVAC systems</p> | <p>4.1.Fundamentals of HVAC Systems</p> <p>4.1.1. Introduction to HVAC Systems</p> <p>4.1.1.1.Basics of heating, ventilation, and air conditioning</p> <p style="padding-left: 40px;">I. Psychrometric principles</p> <p style="padding-left: 40px;">II. Heat transfer mechanisms</p> <p>4.1.1.2.Types of HVAC systems: split, packaged, VRF, ductless</p> <p>4.1.1.3.Applications in residential, commercial, and industrial setups</p> <p>4.1.2. HVAC Components &amp; Working Principles</p> <p>4.1.2.1.Refrigeration cycle overview</p> <p>4.1.2.2.Compressors, condensers, evaporators, expansion valves</p> <p>4.1.2.3.Types of Ducts, air handling units, filters, fans</p> <p>4.1.2.4.Refrigerants and their environmental impact</p> <p>4.1.3. Safety Procedures &amp; Regulations</p> <p>4.1.3.1.Personal protective equipment (PPE)</p> <p>4.1.3.2.Handling refrigerants &amp; compliance with EPA guidelines</p> | <ol style="list-style-type: none"> <li>1. Written assessment</li> <li>2. Oral assessment</li> <li>3. Practical</li> <li>4. Project</li> <li>5. Third party report</li> <li>6. Portfolio of evidence</li> </ol> |

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|  | <p>4.1.3.3. Electrical safety and lockout/tagout (LOTO) procedures</p> <p>4.2. HVAC Installation Techniques</p> <p>4.2.1. Reading blueprints and schematics</p> <p>4.2.2. Selecting appropriate HVAC units</p> <p>4.2.3. Mounting indoor and outdoor units</p> <p>4.3. Ductwork &amp; Piping</p> <p>4.3.1. Designing and installing duct systems</p> <p>4.3.2. Leak testing and vacuuming procedures</p> <p>4.3.3. Insulation and sealing techniques</p> <p>4.3.4. Copper tubing, pipe bending, and brazing</p> <p>4.3.5. Charging refrigerants and pressure testing</p> <p>4.4. Electrical Wiring &amp; Controls</p> <p>4.4.1. Electrical Connections</p> <p>4.4.1.1. Wiring diagrams and control circuit installation</p> <p>4.4.1.2. Connecting thermostats and relay and sensors</p> <p>4.4.1.3. Checking voltage, current, and electrical continuity</p> <p>4.4.2. Ventilation &amp; Air Balancing</p> <p>4.4.2.1. Adjusting airflows and testing pressure differences</p> <p>4.4.2.2. Filter installation and replacement</p> <p>4.4.2.3. Identifying airflow obstructions and fixing leaks</p> <p>4.5. System Testing &amp; Commissioning</p> <p>4.5.1. System Start-up &amp; Performance Testing</p> |  |
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|                                        | <ul style="list-style-type: none"> <li>4.5.1.1. Checking operational efficiency</li> <li>4.5.1.2. Troubleshooting common startup issues</li> <li>4.5.1.3. Analyzing system parameters and making adjustments</li> <li>4.5.2. HVAC Troubleshooting &amp; Repairs <ul style="list-style-type: none"> <li>4.5.2.1. Diagnosing electrical, mechanical, and refrigerant issues</li> <li>4.5.2.2. Common fault codes and diagnostic tools</li> <li>4.5.2.3. Fixing airflow, compressor, and coil problems</li> </ul> </li> <li>4.5.3. Documentation &amp; Customer Handover <ul style="list-style-type: none"> <li>4.5.3.1. Creating HVAC installation reports</li> <li>4.5.3.2. Explaining system operation to clients</li> <li>4.5.3.3. Maintenance best practices and service scheduling</li> </ul> </li> </ul> |                                                                                                                                                                                                                |
| 5. Test electrical power supply system | <ul style="list-style-type: none"> <li>5.1. Electrical Safety <ul style="list-style-type: none"> <li>5.1.1. Safety Regulations and Standards: NEC, IEC</li> <li>5.1.2. Personal Protective Equipment (PPE)</li> <li>5.1.3. Electrical Shock Hazards</li> <li>5.1.4. Lockout/Tagout Procedures</li> </ul> </li> <li>5.2. Test Equipment <ul style="list-style-type: none"> <li>5.2.1. Multimeter</li> <li>5.2.2. Clamp Meter</li> <li>5.2.3. Megger</li> <li>5.2.4. Power Quality Analyzer</li> <li>5.2.5. Oscilloscope</li> </ul> </li> <li>5.3. Electrical tests <ul style="list-style-type: none"> <li>5.3.1. Visual inspection: purpose and procedure</li> <li>5.3.2. Insulation Resistance Test</li> </ul> </li> </ul>                                                                                   | <ul style="list-style-type: none"> <li>1. Written assessment</li> <li>2. Oral assessment</li> <li>3. Practical</li> <li>4. Project</li> <li>5. Third party report</li> <li>6. Portfolio of evidence</li> </ul> |

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|  | <ul style="list-style-type: none"> <li>5.3.2.1.Purpose and Significance</li> <li>5.3.2.2.Test Procedure</li> <li>5.3.2.3.Interpretation of Results</li> <li>5.3.3. Continuity Test <ul style="list-style-type: none"> <li>5.3.3.1.Purpose and Significance</li> <li>5.3.3.2.Test Procedure</li> <li>5.3.3.3.Interpretation of Results</li> </ul> </li> <li>5.3.4. Earth Resistance test <ul style="list-style-type: none"> <li>5.3.4.1.Purpose and Significance</li> <li>5.3.4.2.Test Procedure</li> <li>5.3.4.3.Interpretation of Results</li> </ul> </li> <li>5.3.5. Voltage and Current Measurements <ul style="list-style-type: none"> <li>5.3.5.1.Measuring Voltage and Current Levels</li> <li>5.3.5.2.Verifying Phase Sequence</li> <li>5.3.5.3.Power Factor</li> </ul> </li> <li>5.3.6. Protection System Testing <ul style="list-style-type: none"> <li>5.3.6.1.Testing Overcurrent and Overvoltage Protection</li> <li>5.3.6.2.Response of protection systems</li> <li>5.3.6.3.Testing Earth Fault Protection</li> </ul> </li> <li>5.3.7. Transformer Testing <ul style="list-style-type: none"> <li>5.3.7.1.Voltage Ratio Test</li> <li>5.3.7.2.Winding Resistance Test</li> <li>5.3.7.3.Insulation Resistance Test</li> <li>5.3.7.4.Load Test</li> </ul> </li> <li>5.3.8. Cable Testing <ul style="list-style-type: none"> <li>5.3.8.1.Cable Fault Location</li> <li>5.3.8.2.Cable Impedance Measurement</li> </ul> </li> </ul> |  |
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|  | 5.3.8.3.Cable Insulation<br>5.3.9. Functional Testing<br>5.3.10. Documentation and Reporting of electrical tests<br>5.3.10.1. Importance of tests documentation<br>5.3.10.2. Test checklists<br>5.3.10.3. Creating Test Report |  |
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### Suggested Methods of delivery

1. Practical
2. Project
3. Demonstration
4. Group discussion
5. Direct instruction
6. Field visits
7. Industry visits
8. Case studies

### Recommended Resources for 25 trainees

| S No.    | Item                         | Specifications for Purchase                 | Quantity | Recommended Ratio (Item: Trainee) |
|----------|------------------------------|---------------------------------------------|----------|-----------------------------------|
| <b>A</b> | <b>Tools &amp; Equipment</b> |                                             |          |                                   |
| 1        | Laptops/Desktop Computers    | 8GB RAM, 256GB SSD, CAD software compatible | 10 pcs   | 1:3                               |
| 2        | Drawing Tools                | Includes T-squares, protractors, rulers     | 25 sets  | 1:1                               |
| 3        | Plotter/Printer              | Wide-format, high-resolution for CAD prints | 2 pcs    | 1:13                              |
| 4        | Digital Multimeters          | Auto-ranging, backlit display               | 5 pcs    | 1:5                               |
| 5        | Power Factor Meters          | Measures 0.5-1.0 power factor               | 5 pcs    | 1:5                               |
| 6        | Cable Cutters                | Insulated, ergonomic handle                 | 10 pcs   | 1:3                               |
| 7        | Cable Strippers              | Adjustable for different wire gauges        | 10 pcs   | 1:3                               |

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| 8        | Crimping Tools                      | High-quality, suitable for insulated terminals     | 10 pcs    | 1:3         |
| 9        | Torque Wrenches                     | Adjustable torque range, calibrated                | 2 sets    | 1:13        |
| 10       | Spanners and Socket Sets            | Includes standard and metric sizes                 | 2 sets    | 1:13        |
| <b>B</b> | <b>Reference Materials</b>          |                                                    |           |             |
| 11       | Electrical Symbols Reference Charts | Comprehensive symbols for schematic reference      | 25 pcs    | 1:1         |
| 12       | Paper and Pencils/Erasers           | For drafting, includes erasers and HB pencils      | 25 sets   | 1:1         |
| 13       | Whiteboard and Markers              | Magnetic whiteboard, assorted color markers        | 1 set     | 1 per class |
| <b>C</b> | <b>Electrical Materials</b>         |                                                    |           |             |
| 14       | Cables and Wires                    | Assorted gauges for electrical training            | As needed | As needed   |
| 15       | Electrical Panels and Enclosures    | Weatherproof, lockable                             | 5 sets    | 1:5         |
| 16       | Conduit and Trunking                | Assorted sizes for wire management                 | As needed | As needed   |
| 17       | Cable Ties, Connectors, and Lugs    | Variety pack for secure electrical connections     | As needed | As needed   |
| 18       | Safety Labels and Tags              | Assorted electrical hazard labels                  | 25 pcs    | 1:1         |
| 19       | DC Cables                           | Proper gauge for low voltage applications          | As needed | As needed   |
| 20       | Battery Banks                       | Rechargeable, assorted capacities                  | 5 sets    | 1:5         |
| 21       | Solar Panel Mounts and Brackets     | Adjustable for solar panel installation            | 5 sets    | 1:5         |
| 22       | Scaffolding                         | Modular, adjustable height for safe access         | 2 sets    | 1:13        |
| <b>D</b> | <b>Testing &amp; Measurement</b>    |                                                    |           |             |
| 23       | Multimeters                         | Digital, auto-ranging with multiple test functions | 10 pcs    | 1:3         |
| 24       | Projector                           | High-resolution for presentations                  | 1 pc      | 1 per class |
| 25       | Insulation Resistance Testers       | 500V, accurate insulation resistance measurement   | 5 pcs     | 1:5         |

|          |                             |                                                       |           |           |
|----------|-----------------------------|-------------------------------------------------------|-----------|-----------|
| 26       | Distribution Boards         | With circuit breakers for demonstration purposes      | 5 pcs     | 1:5       |
| 27       | Switchgear                  | Assorted for learning different control methods       | As needed | As needed |
| 28       | Power Meters                | Monitors electrical parameters                        | 5 pcs     | 1:5       |
| 29       | Solar Irradiance Meter      | Measures solar panel exposure accurately              | 5 pcs     | 1:5       |
| 30       | DC Disconnect Switch        | Safety switch for DC power                            | 5 pcs     | 1:5       |
| 31       | Battery Tester              | Measures voltage and charge level                     | 5 pcs     | 1:5       |
| 32       | Ladders                     | Adjustable, anti-slip steps                           | 5 pcs     | 1:5       |
| 33       | UPS Units                   | Backup power, 1000VA capacity                         | 5 pcs     | 1:5       |
| 34       | Power Distribution Units    | With surge protection                                 | 5 pcs     | 1:5       |
| 35       | Batteries                   | Assorted types for various testing needs              | As needed | As needed |
| 36       | Racks/Cabinets              | Secure storage for equipment                          | As needed | As needed |
| 37       | Inverters                   | 1000W, pure sine wave                                 | 5 pcs     | 1:5       |
| 38       | Solar Panels                | Assorted, rated 200W or higher                        | As needed | As needed |
| 39       | Charge Controllers          | For battery charging regulation                       | 5 pcs     | 1:5       |
| <b>E</b> | <b>Documentation</b>        |                                                       |           |           |
| 40       | Manufacturer's Catalogues   | Latest catalogs of electrical components              | 5 pcs     | 1:5       |
| 41       | Electrical Design Standards | Includes IEEE, IEC guidelines                         | 5 pcs     | 1:5       |
| 42       | Electrical Codebooks        | National Electrical Code, BS7671                      | 5 pcs     | 1:5       |
| 43       | EMCA Act                    | Environmental guidelines for electrical installations | 5 pcs     | 1:5       |
| 44       | OSHA                        | Safety guidelines for electrical systems              | 5 pcs     | 1:5       |
| 45       | Cable Sizing Charts         | For selecting correct cable gauge                     | 5 pcs     | 1:5       |

|    |                                  |                                           |        |     |
|----|----------------------------------|-------------------------------------------|--------|-----|
| 46 | Cable Specification Catalogs     | Specifications for different cable types  | 5 pcs  | 1:5 |
| 47 | Electrical Load Data Sheets      | Load calculations and examples            | 5 pcs  | 1:5 |
| 48 | Specification Sheets             | Manufacturer's specs for key components   | 5 pcs  | 1:5 |
| 49 | Electrical Utility Standards     | Guidelines from utility providers         | 5 pcs  | 1:5 |
| 50 | Site Layout Diagrams             | Electrical schematics for practice        | 5 sets | 1:5 |
| 51 | Solar Power System Sizing Guides | Guides for sizing solar installations     | 5 pcs  | 1:5 |
| 52 | Battery Storage Design Manuals   | Guidelines for setting up battery storage | 5 pcs  | 1:5 |