

**Course:** **Certificate in Implementing Photovoltaic Systems for Solar Power Generation (Level 2)**

**Guided Learning Hours: 30**

**Pre-requisite:** **Certificate in Implementing Photovoltaic Systems for Solar Power Generation (Level 1) or any other introductory course in photovoltaic systems design & installation**

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### **Abstract**

This unit will provide individuals with a basic photovoltaic background, with the technical and practical knowledge required to design and install complex photovoltaic systems to meet real world applications.

In order to ensure that the learner fully understands the concepts relating to photovoltaic design and installation, the course content was structured to maximize the contact hours allocated for practical work. Currently, 80% of the course involves hands on, practical training.

This unit will focus on the NEC Article 690 wiring codes and its understanding and practices, together with proper commissioning and hand over procedures as well as AHJ inspection requirements and procedures. PV systems installation will cover various stand-alone battery based systems and a look at grid –tie systems array sizing. Learning will take place through a combination of lectures and laboratory sessions

### **Target Audience**

Individuals and technicians wishing to learn about renewable energy, solar power generation, design and installation of photovoltaic systems for small to medium size residential and commercial use.

## Learning Outcomes

On completion of this course, learners will be able to:

1. Install panels on various roof layouts using different racking methods
  2. Install and maintain batteries, inverters, charge controllers and enclosures.
  3. Prepare photovoltaic system drawings for electrical inspection and approval.
  4. Install Hybrid systems.
  5. Install Grid-Tie systems.
  6. Install grounding and lightning protection.
  7. Commission and Hand over.
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## Course Content

### 1. Install panels on various roof layouts using different racking methods

*Racking systems:* Types of racking systems (Ground, Pole, Roof); Selection criteria; Design, installation and maintenance.

*Safety:* Personal protective equipment; Use of ladders and scaffolding; Use of personal fall arrest systems; Principle and operation of various lifting devices (hoists).

### 2. Install and maintain batteries, inverters, charge controllers and enclosures

*Batteries:* Types of batteries (AGM, Flooded); Selection and sizing of battery banks and installations; Wiring and testing of batteries; Battery maintenance, Battery box /enclosures.

*Charge Controllers:* Types of charge controllers (PWM and MPPT); Selection and sizing of Charge controllers; Installation of charge controllers; Protection of charge controllers.

*Inverters:* Types of inverters (stand alone, grid-tie, Synchronous, multimode); Battery Charging features, Selection and Sizing of inverters; Installation and protection of inverters.

*Enclosures:* Types of enclosures; Selection and installation of various enclosures; Installation and overcurrent protection use.

### **3. Prepare photovoltaic system drawings for electrical inspection and approval**

*National Electric Code:* Codes of practice relating to photovoltaic systems (local, international); Purpose of the NEC code, Article 690; Application of the NEC 690 and other articles to photovoltaic systems to select systems components and installation.

*Approval process for PV systems:* Government regulations and required standard (British (BS) & North American (NEC) Standards); Authority having Jurisdiction (AHJ); Site Visit; Preparing approval documents.

### **4. Install Hybrid Systems**

*Back up photovoltaic systems:* Secondary power source; System integration (Wind and Solar); Transfer switching (manual, automatic); Design and installation of backup systems.

*Generators:* Types, selection and sizing.

### **5. Install Grid-Tie Systems**

*String Sizing:* Environmental considerations; Photovoltaic module specifications; Calculations; Combiner box.

*Photovoltaic Array:* Sizing of module array; Grid-tie inverters, connections and requirements; PUC interconnection agreements; Incentives and subsidies (country specific).

### **6. Install Grounding and Lightning Protection**

*Grounding:* Systems and equipment grounding (module array, inverters, charge controllers); Laws governing grounding protection (NEC requirements).

*Lightning Protection:* Installation and use of surge arresters.

### **7. Commission and Hand Over**

*Commissioning and Hand Over:* Regulations governing commissioning and hand over procedures; Testing, verification and documentation of photovoltaic systems installation and performance;

## Assessment Criteria

In order to achieve Learning Outcome...	The Learner must...
1. Install panels on various roof layouts using different racking methods	1.1 Describe different types of roof mounts systems 1.2 Install a PV array unto a ground mount racking system 1.3 Install a PV array unto a pole mount racking system 1.4 Apply safety equipment when working at heights
2. Install and maintain batteries, inverters, charge controllers and enclosures	2.1 Determine and size a battery bank to meet a specific load requirement 2.2 Select the appropriate battery types for a particular application' 2.3 Install and wire a battery bank 2.4 Describe battery bank maintenance 2.5 Describe and select the various types of charge controllers and inverters for a particular application 2.6 Install and wire combiner box, charge controllers and inverters 2.7 Select, install and wire fuses, circuit breakers in enclosures
3. Prepare photovoltaic system drawings for electrical inspection and approval	3.1 Describe the permitting process for PV installation AHJ approval 3.2 Prepare documents for site plan, systems wiring diagrams, listing of approved component for submission 3.3 Be able to reference and apply NEC Article 690 to PV systems design and installation 3.4 Apply local wiring codes
4. Install Hybrid Systems	4.1 Select suitable components for a standby generator for used with a photovoltaic system. 4.2 Install a standalone photovoltaic system in conjunction with a backup generator

5. Install Grid-Tie Systems	5.1 Demonstrate the ability to size photovoltaic array strings
6. Install Grounding and Lightning Protection	6.1 Select and install the proper method of grounding protection for various photovoltaic systems based on NEC guidelines 6.2 Select and install the proper lightning arrestor to provide protection for various photovoltaic systems
7. Commission and Hand Over	7.1 Conduct performance and verification testing of an installed photovoltaic system 7.2 Follow the required handover procedure for a an installed photovoltaic system

### **Essential Learning Resources:**

Learners will need access to a wide range of publications relating to renewable energy, photovoltaic systems and solar panels. Various manufacturer products specifications and reference data would also be beneficial to learners. Site visits to PV system installations will be encouraged during the delivery of this course.

### **Textbooks and Manuals**

Photovoltaics: Design and Installation Manual  
ISBN-10: 0865715203  
Publisher: Solar Energy International

### **Websites**

<http://www.solarabcs.org/about/publications/reports/expedited-permit/>  
<http://www.homepower.com/>