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MINISTRY OF SKILL DEVELOPMENT
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SCGJ | SKILL COUNCIL FOR GREEN JOBS

Participant Handbook

Sector
Green Jobs

Sub-Sector
Renewable Energy

Occupation
Solar PV Installation

Reference ID: **SGJ/Q0103, Version 1.0**
NSQF Level 4

Solar PV Installer (Civil)

Published by

RACHNA SAGAR PVT. LTD.
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First Edition, July 2017
ISBN: 978-93-86620-57-6
Printed in India

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> Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission.

Shri Narendra Modi
Prime Minister of India

Certificate

COMPLIANCE TO QUALIFICATION PACK – NATIONAL OCCUPATIONAL STANDARDS

is hereby issued by the

SKILL COUNCIL FOR GREEN JOBS

for

SKILLING CONTENT : PARTICIPANT HANDBOOK

Complying to National Occupational Standards of
Job Role/ Qualification Pack: '**Solar PV Installer (Civil)**' QP No. '**SGJ/ Q 0103 NSQF Level 4**'

Date of Issuance: 10/05/2016
Valid up to*: 01/10/2018

**Valid up to the next review date of the Qualification Pack or the 'Valid up to' date mentioned above (whichever is earlier)*

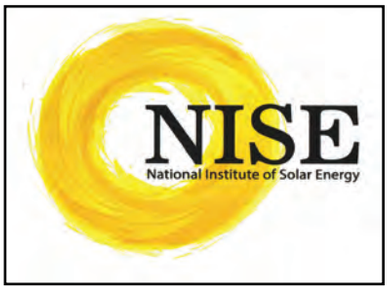
Authorised Signatory
(Skill Council for Green Jobs)

Acknowledgements

ADS Projects & Systems Pvt Ltd

Clean Energy Access Network

Kirti Solar Limited



National Institute of Solar Energy

PowerXP Consultants Pvt Ltd

United States Agency for International Development

About this book

Government of India is aiming towards a capacity of about 100,000 MW to come from Solar Energy by the year 2022. This includes a capacity of 40,000 MW to come up on the rooftops of various buildings and houses spread throughout the country. The Ministry of New and Renewable Energy and State Governments are looking for a pool of trained manpower to effectively undertake this work. Alongside, industry operating in the Solar Photovoltaic domain is offering a huge opportunity for the skilled manpower to undertake civil works and electrical works for installing solar rooftop systems.

Considering the huge technically trained manpower requirement to meet this ambitious goal, Skill Council for Green Jobs is targeting a special skilling course for civil/mechanical works of Rooftop Solar PV Installations, named Solar PV Installer – Civil, who specializes in civil and mechanical installations of Solar Photovoltaic Systems.

This Participant book is designed to enable theoretical and practical training on Rooftop Solar PV Installation as per Solar PV Installer (Civil) Qualification Pack, SGJ/Q0103 and is available for free download at **www.greenskillcouncil.in/NOS.**

The book is designed considering the minimum education qualification to be ITI/Diploma. However, as part this book, efforts have been made to revise their knowledge of electrical and civil concepts required for this job. The contents of this book are in simple language, without going into too much theoretical details and calculations. It is envisaged that this training manual will provide the participants with the knowledge and skills required for Installing a rooftop Solar Photovoltaic system, complying with all applicable codes, standards, and safety requirements; and enable them to actively participate in the growing solar rooftop market. The Skill Council for Green Jobs is thankful to the valuable contributions made by:

- National Institute of Solar Energy
- USAID PACE-D Program
- Clean Access Energy Network
- ADS Global Knowledge Academy
- Smart Brains

On behalf of Skill Council for Green Jobs, the book has been coordinated, compiled and co-authored by Mr. Tanmay Bishnoi, Head – Standards & Research and Ms Geetika Chauhan, Technical Associate.

Units and symbols used in the book have been listed below.

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1. Basics of Solar Energy and Electrical Energy

SGJ/N0101

Key Learning Outcomes

At the end of this module, you will be able to:

1. Explain the basic concept of solar energy.
2. Explain the basic electrical terms like current, voltage, resistance and explain the relationship between using Ohm's Law.
3. Differentiate between series and parallel connections between a combination of resistors
4. Identify the typical measuring instruments used to measure variables in an electrical circuit
5. Explain the terms power and energy, along with the relationship between them
6. Differentiate between Alternating Current (AC) and Direct Current (DC)

UNIT 1.1: An Introduction: Energy from the Sun

Unit Objectives

At the end of this unit, you will be able to:

1. Know about energy from the sun
2. Know about what is solar photovoltaic
3. Know about other sources of renewable energy

1.1.1 The Sun

The sun is like a sphere which contains hot gases. Due to nuclear fusion reactions happening at the core, the internal temperature of sun reaches over 20 million degree Kelvin. Because of nuclear reaction hydrogen is converted into helium (noble gas). Heat energy is transferred from inner layer to outer layer by the process of convection and then radiated into the space. The inner core of sun is not directly visible due to layer of hydrogen atom. The temperature of outer surface (called as photosphere) is about 6400 Kelvin.

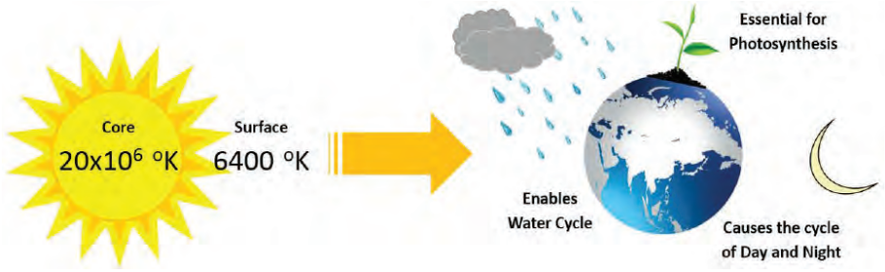

Fig 1.1.1 Utilization of the energy from the sun

The Earth has access to this energy 365 days a year for almost 8 hours per day (on an average). Let us try to understand how nature uses this tremendous power:

- The entire ecosystem on earth exists because of the sun's energy, which is also called 'Solar Energy'.
- This is absorbed by plants and trees which is then used by animals, birds and humans in the form of food.
- The sun plays an important role in maintaining the kind of climate Earth has. It enables the water cycle. That is why we have access to water for our daily uses from rivers, lakes and the seas.

Temperature is measured in Kelvin (K) and Centigrade (C). It is explained using the following relation:

$$K = C + 273$$

Where K = Temperature measured in Kelvin or K

C = Temperature measure in Centigrade or °C

For example, if Temperature is 25 °C

$K = C + 273$

$K = 25 + 273$

$K = 298$

1.1.2 What form of Energy do we Get from the Sun?

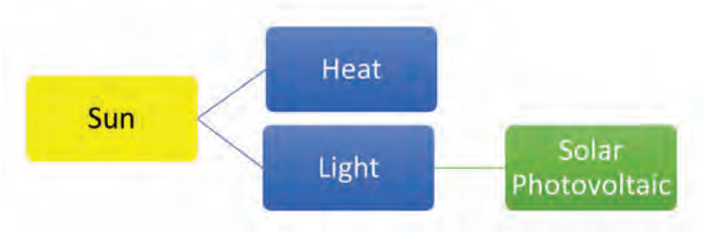

Fig 1.1.2 Components of the energy from the sun

The rays of the sun mainly has two components: Heat and Light.

The Light component of the Sun's power can be used to produce electricity.

The technology available to convert solar energy into electrical energy is called 'Solar Photovoltaics'.

1.1.3 What is Solar Photovoltaic?

The Solar PV Panel is manufactured from Silicon. The process can be seen in the figure depicted below.

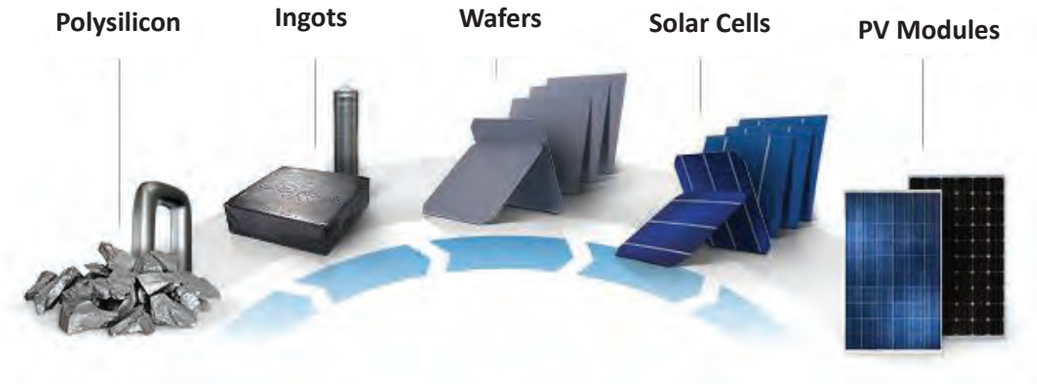

Fig 1.1.3 Manufacturing of a solar PV panel from Silicon

Solar photovoltaic (PV) technology: It refers to the direct conversion of sunlight energy into electrical energy.

Solar pv cell: It is defined as the semiconductor device that directly converts sunlight energy into DC (direct current) electricity.

Solar PV module: It is defined as the series connected assembly of solar PV cells to generate dc electricity.

Solar PV array: It is defined as the connected (series/ parallel or both) assembly of solar PV modules to generate DC electricity.

1.1.4 Other Sources of Renewable Energy

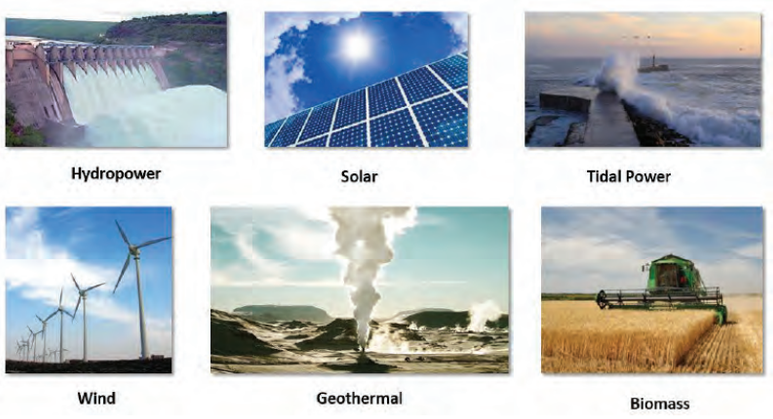

Fig 1.1.4 Various sources of renewable energy

Main advantages of Renewable Energy are:

1. It is an inexhaustible source of energy, which means, it will always be available naturally in the environment.
2. It reduces negative impact on the environment since it doesn't pollute the surroundings like conventional energy sources (coal, petroleum, etc.) do.
3. It is an additional source of electricity to the overall resources of the country.
4. Renewable energy sources can be harnessed in areas which don't have access to national grid or poor access to national grid electricity.

Notes

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2. Basics of Solar Photovoltaic (PV) Systems

SGJ/N0101

UNIT 2.3: Types of Solar Photovoltaic Systems

Unit Objectives

At the end of this unit, you will be able to:

1. Identify and differentiate between the types of solar photovoltaic systems

2.3.1 Types of Solar PV Systems

The types of Solar PV Systems can be broadly categorized as follows:

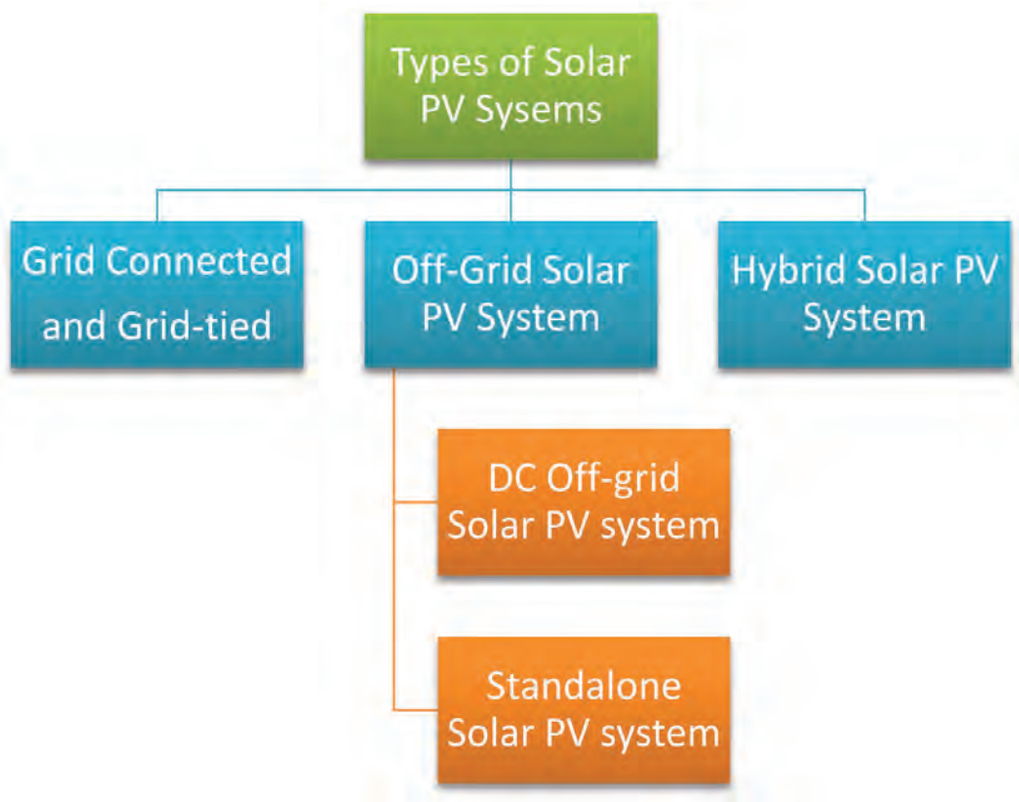

Fig. 2.3.1 Types of solar photovoltaic rooftop systems

Grid-tied PV System

- Works only with grid supply
- Capable of feeding unutilised solar energy to the grid
- Cannot be used for charging batteries directly from solar energy
- Cheaper than an AC off-grid system and saves on electricity bill
- But does not provide backup

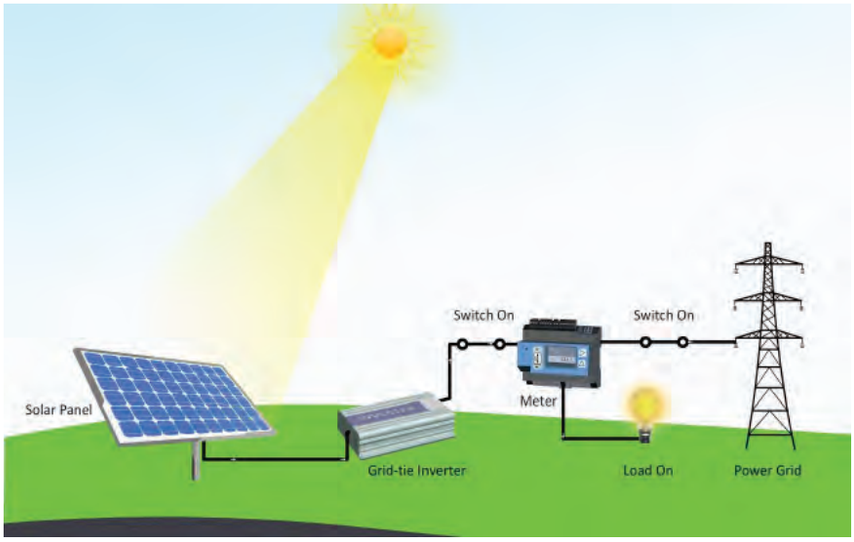

Fig. 2.3.2 Grid-tied system

DC Off-grid Solar PV System

- DC Systems are designed for loads on different voltage ranges e.g. 12V, 24V, 48V.
- DC Power from solar panels is stepped down by the charge controller to provide regulated DC output to the Load
- There is no Standard Voltage in DC based systems
- Stepping UP/Down of Voltages in DC Power is difficult
- Transmission Losses in DC are high
- DC Power can be easily stored in batteries
- Suitable for off grid Solar PV Systems as power is to be stored for usage at night
- For operating during the day, a DC load, like fan, etc. can also be connected to a Solar Panel directly without a battery
- Hence, Off Grid Solar PV System can be with battery bank or without battery bank depending on the requirement and need of the customer.

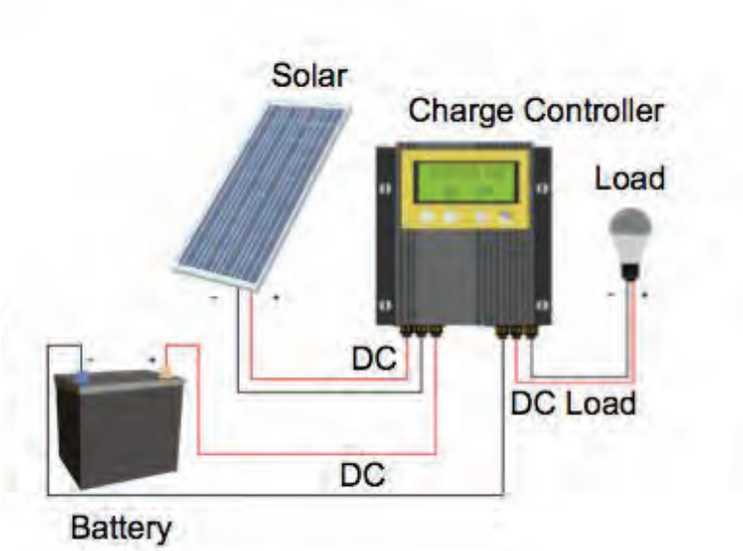

Fig. 2.3.3 DC Off-Grid Solar PV system with battery bank

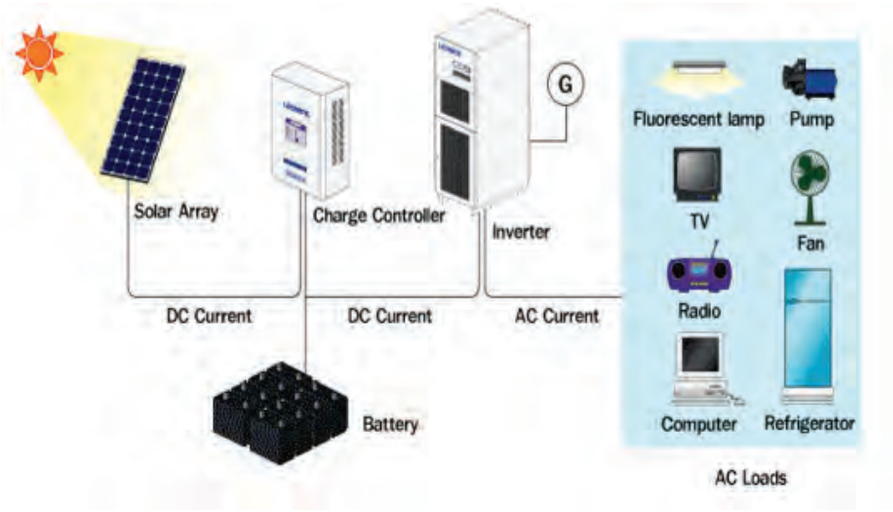

Fig. 2.3.4 Stand-alone Solar PV System

Hybrid Solar PV System

There is another category of Solar PV system which can be grid connected as well as have a battery bank. This type of system is called a Hybrid Solar PV System.

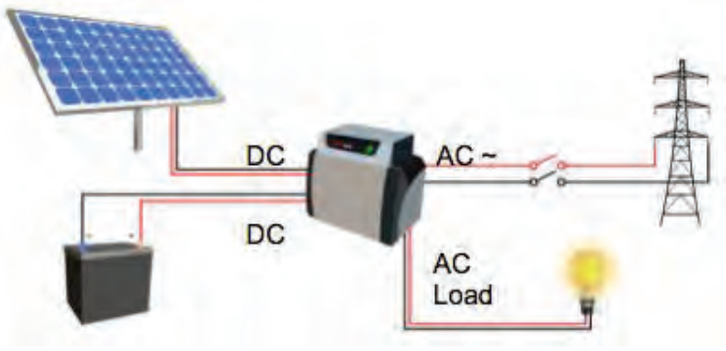

Fig. 2.3.5 Hybrid Solar PV System

Tips

Solar PV system is selected depending on the load requirements of the client, central/state policy regulations and budget

Exercise

1. Identify different components of a Solar PV system
2. Draw the schematic diagram for different types of Solar PV systems