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Skilling India in Electronics

Participant Handbook

Sector
Electronics

Sub-Sector
Solar Electronics

Occupation
Installation

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SOLAR PANEL INSTALLATION TECHNICIAN

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Prime Minister of India


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COMPLIANCE TO
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I would like to take the opportunity to thank everyone who contributed in developing this Handbook for the QP Solar Panel Installation Technician.

The Handbook is the result of tireless pursuit to develop an effective tool for imparting the Skill Based training in the most effective manner.

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CEO

Electronics Sector Skills Council of India

About this Book

This Participant Handbook is designed to enable training for the specific Qualification Pack (QP). Each National Occupational (NOS) is covered across Unit/s.

Key Learning Objectives for the specific NOS mark the beginning of the Unit/s for that NOS. The symbols used in this book are described below.

Symbols Used


Key Learning Outcomes


Steps


Time


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Unit Objectives

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1. Basics of Electricity and Solar Energy

Key learning Outcomes

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

- Measure voltage, current and power of solar photovoltaic modules
- Identify the components of solar photovoltaic system
- Identify types of solar photovoltaic systems
- Define solar cell parameters
- List the types of connections of solar photovoltaic panels
- Explain the main factors affecting the output of solar photovoltaic modules

UNIT 1.1: Basics of Electricity and Power Generation System

Unit Objectives

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

- Measure voltage, current, power and energy
- Define Ohm's law
- Explain the difference between alternating current (AC) and direct current (DC)
- Identify the use of multimeter
- Explain the power generation system

1.1.1 Introduction to Electricity

Electricity is a natural force that comes into existence whenever there is a flow of electric charge between two components. When working with circuits, there is need for the users to be aware about some of the basic concepts of electricity, otherwise an incorrect connection in a circuit may cause high damage to people and the circuit components.

The main terms associated with electricity are as follows:

- Current
- Voltage
- Power
- Energy

Current

When electrons inside any material move, flow of electricity takes place. This flow is called current. It is measured in ampere.

Voltage

In an electrical circuit, the current flows only when there is a voltage source. Voltage is the force pushing electrons through the wire.

Power

When electricity flows in an electrical circuit, it results in some work done. For example, when electricity flows in a fan, the blades of the fan rotate and when the electricity flows in a refrigerator, it cools things inside. Thus, when electricity flows through an appliance, it results in some work done.

Electrical power is the rate at which an electric circuit transfers electrical energy. Electrical power is similar to mechanical power and can be considered as the rate at which electrical work is done. It is measured in watts (one joule per second) and represented as *P*. Electric power in watts is also called wattage. Consider the formula:

P= work done per unit time = VQ/t = VI

Where P is the electric power in watts determined when an electric current represented by I in amperes with a charge *Q* in coulombs passes through an electrical potential difference denoted by V in time t seconds.

Electric power is produced by electric generators in an electric power generation unit called a grid. This power is further supplied to residential and commercial location. It can also be produced by other sources such as electric batteries. The energy delivered and consumed by electric utilities is measured using an electricity meter.

Energy

If the electrical power is the rate or speed of work done, then electrical energy is the total amount of work done in a given time period. It is product of power of electrical appliance and duration of its usage. Consider the following equation to determine electrical energy:

Electrical Energy (E) = Power (P) x Duration of Energy usage (T) = Power (Watt) x Time (hour)

$$E\ (Wh) = P\ (W) \times T\ (h)$$

$$\text{Power} = \text{Energy} / \text{Time}$$

1.1.2 Ohm's Law

According to Ohm's law, current flowing through a conductor is directly proportional to the voltage across the conductor. The mathematical equation of Ohm's law is as follows:

$$I = V/R$$

Where,

I is current flowing through the conductor,

V is the potential difference or voltage across the conductor, and

R is proportionality constant, known as the resistance of the conductor.

Problem Statement: A fan works on 24V DC and while running it takes 3A current. Calculate the DC power consumed by the fan?

Solution: The fan is a DC fan and the current flowing through the fan, I_{dc} is 3A. The voltage of the fan, V_{dc} is 24V. Then DC power consumed by the fan is:

$$P_{dc} = I_{dc} \times V_{dc}$$

$$P_{dc} = 3 \times 24 = 72 \text{ watts}$$

1.1.3 Electrical Circuit

The interconnection of various electrical components is called electrical circuit. The basic components of a circuit are:

- Power source such as a battery
- Wire running from the hot side to a load
- Wire running from the load to the power source
- Switch to open or close the circuit

The load will operate when the circuit is closed or complete. The following figures show an open and a close circuit:

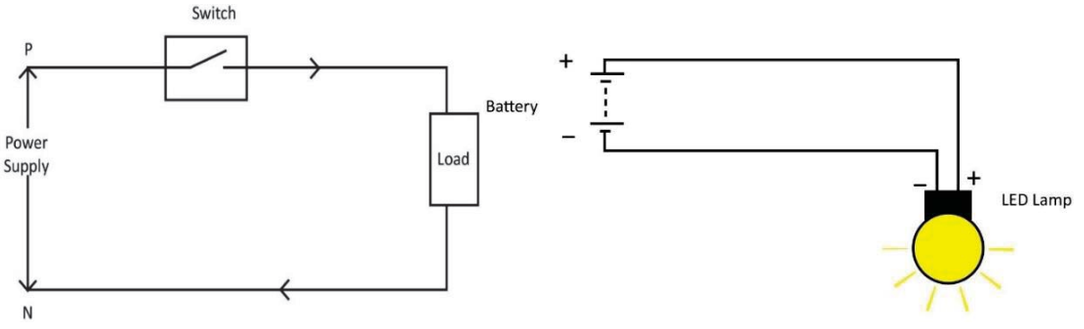


Fig. 1.1.1: An open and a close circuit

In an electrical circuit, power flows in two forms:

- DC power
- AC Power

DC Circuit and AC Circuit

DC power flows in a DC circuit. A DC circuit is a circuit in which current flows in only one direction. The direction of current does not change with time.

In AC circuit, current flows in both the directions; clockwise and counter clockwise. For time period 0 to T/2 current flows in clock wise direction and for time period T/2 to T, the charge flow reverses to counter clockwise direction. It is not only the direction but the value of current that keeps changing with time.

The AC current changes its direction 50 times in one second which means the power supply has 50 Hertz frequency. The following figure shows the voltage-time relationship between AC and DC:

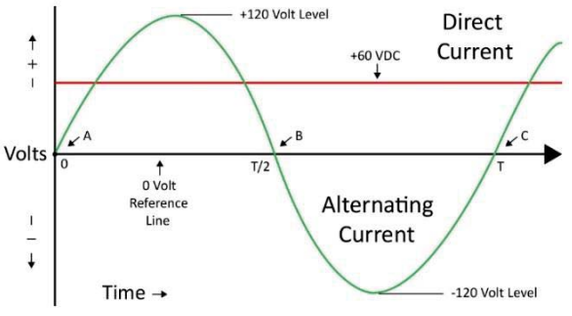


Fig. 1.1.2: Voltage-Time relationship for AC and DC

Most of the home appliances such as light bulbs and TV, fans operate on AC power at 220 volts. Solar panels and batteries produce DC power. Appliances such as DC CFL lights, DC LED lights and DC fans can run on DC power by connecting them to solar panels or batteries. These are incapable of running on AC power supplied from the national grid.

Series and Parallel Circuit

Complex circuits, in which more than one load is connected, may be either in series or in parallel or a combination of both. The basic working of the circuits is explained as follows:

- In a series circuit, all the components are connected as a chain and the current flowing through the components is same all over the circuit. There is only one path in the circuit in which the current can flow. So, the current passes through each and every component. Opening or breaking any point of a series circuit causes the whole circuit to stop functioning and the entire circuit needs to be replaced.
- In a parallel circuit, two or more components are connected in parallel. All the components have the same voltage across them. The current flow varies across the components. If any point of the circuit gets damaged, only that part needs to be replaced.

The following figure shows a series and a parallel circuit:

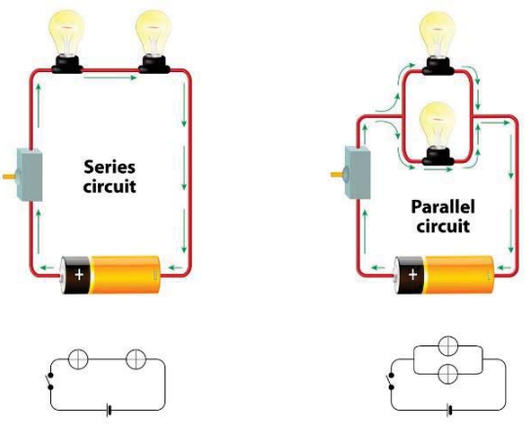


Fig. 1.1.3: Series and parallel circuits

Typically circuit breakers and fuses are in series with the load and multiple loads are in parallel.

1.1.4 Measurement of Electrical Parameters

There are many types of measuring tools available such as voltmeter, ammeter and multimeter, which can measure voltage, current, power and energy. Among these, one of the most versatile measuring tools is called multimeter.

Measurement Voltage, Current and Resistance

A multimeter can be used for measuring voltage, current and resistance. It can also be used for fault detection in small circuits or to find out the broken wires in a circuit.

It can be of two types:

- Analog Multimeter
- Digital Multimeter

The following image shows the different types of multimeters:

Analog Multimeter

It consists of a needle which points at the scale built on it for giving the measured value.

Digital Multimeter

It is an electronic meter which displays the measured values in digital form.

Fig. 1.1.4: Types of multimeters

Usually, a standard multimeter can measure the following electrical quantities:

- DC Voltage
- AC Voltage
- DC Current
- AC Current
- Resistance

Measurement of DC Voltage and Current

Voltage can be measured by directly connecting the voltage meter or the multimeter to the terminals of the voltage source. To measure the voltage using the multimeter, it should be used in voltmeter mode. The range selector knob of the meter should point towards the sign, volts or 'V'.

Current can be measured by connecting the current meter or the multimeter to the terminals of voltage source, provided the current is controlled by appropriate value of resistance or load in path. Multimeter should be in current mode to measure current. The range selector knob of the meter should point towards sign, amperes or 'A'.

Appropriate precaution should be taken to position the knob or the probe properly for:

- Expected range of voltage or current level
- AC or DC form
- Position of the red probe for AC or DC current measurement
- Position of the red probe for AC or DC voltage measurement

The following figure shows measurement of DC voltage using multimeter:

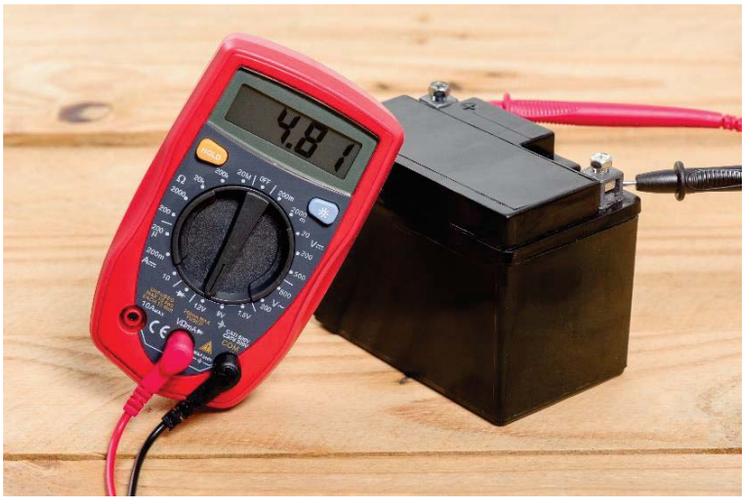


Fig. 1.1.5: Measurement of DC voltage

Measurement of AC Voltage and Current

In principle, the procedure for measurement of both DC and AC, current and voltage are similar. For measurement of AC voltage by using a multimeter, it is essential to select the AC form (~) with the range selector knob on the multimeter. It is also essential to check the position of the red probe, as it should be kept in voltage or current mode in the multimeter as per the measuring parameter.

The red and black probes are to be connected to phase and neutral points in the circuit, respectively. The following figure shows measurement of AC current using multimeter:

Fig. 1.1.6: Measurement of AC current

Measurement of Resistance

Resistance measurement is an important part in the field of electricity. The flow of current in a circuit depends on its resistance. Thus, it is very important to know the value of resistance in a circuit.

For measurement of resistance using a multimeter, the range selector knob should be first placed on the 'Resistance' mode or Ohms mode, which is normally shown on a multimeter with Ω symbol.

The following figure shows measurement of resistance using a multimeter:

Fig. 1.1.7: Measurement of resistance

Measurement of Electrical Power

Current and voltage can be measured by using an ammeter and a voltmeter respectively. The output power in an electric circuit can be measured using the formula:

Power = Voltage x Current

Measurement of Electrical Energy

Electrical energy is the power consumed by a load during a specified time period. The product of power and time gives the value of electrical energy consumed by the load in watt-hour.

The meters available for measurement of energy are called energy meter. As the unit of energy is watt-hour, the meters are also called watt-hour meter. The following image show a meter:

Fig. 1.1.8: Energy meter

1.1.5 Power Generation System

There are different processes, such as chemical, photo-voltaic, and electromechanical, with which energy is transformed into an electrical form to generate electrical power. This transformation or conversion process happens at a power station or a power plant. A power station has generators and a rotating machine that converts mechanical power into electric power.

Typically, electricity is generated using fossil fuels such as coal, oil, and natural gas. Nuclear power is also used to generate electricity but nowadays renewable source of energy are such as solar, wind, wave and hydroelectric are becoming popular choice. The fuel cost and the efficiency of the power station determines the operating costs of generating electrical energy.

The following image shows the electric power being generated at a plant and supplied to the customer or end user:

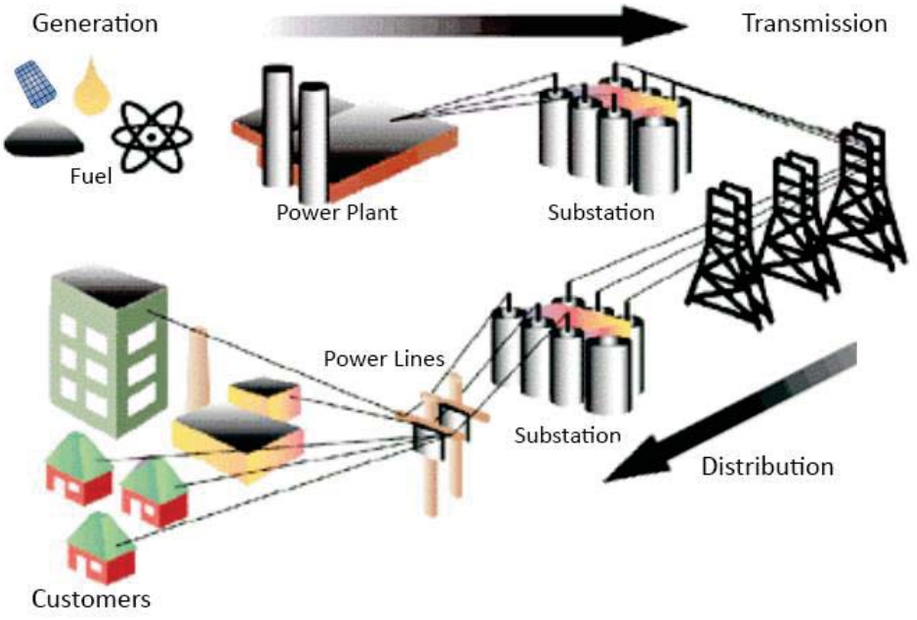


Fig. 1.1.9: Electric power supply from generating plant to end users

Activity

1. Fill in the following table for various DC loads.

Name of DC Load	Voltage across load Vdc (Volts)	Current Through the Load, Idc (Ampere)	Power Consumed by the load, Pdc (Watt)
Fan	12	2.5	-
LED	-	0.5	1.5
TV	-	3.3	80
Refrigerator	48	-	500
Motor	36	-	746

2. Fill the following table on estimation of electrical energy consumed by electrical appliances.

Type of appliance	Power of the appliance	Daily duration of usage of appliance	Electrical energy consumed
Tube Light	40 W	4 hours	= ..... Wh
Tube Light	40 W	..... hours	= 400 Wh
Fan 1	60 W	12 hours	= ..... Wh
Fan 2	30 W	12 hours	= ..... kWh
TV	150 W	2 hours	= ..... Wh
Cooler	200 W	10 hours	= ..... kWh
Computer	..... W	2 hours	= 400 Wh
LED Light	5 W	..... hours	= 20 Wh
AC	1.5 kW	10 hours	= ..... kWh
AC	1.5 kW	..... hours	= 7.5kWh
Unknown Appliance	..... W	10 hours	= 500Wh
Unknown Appliance	..... W	5 hours	=10 kWh

Activity

Solve the following problems.

Problem 1.0: What does electric power depend on? An electrical appliance is connected to 48V which results in 3A current through the load. What is the power consumed by the load?

Problem 2.0: For a 75W lamp, a voltage of 220V is applied. What is the value of the resultant current?

Problem 3.0: An electrical bulb consumes energy at the rate of 40 W per hour and is used for 12 hours. What is the energy consumed by the bulb?

Problem 4.0: Consider two bulbs, A and B with same power of 100 W. Bulb A is used for 12 hours and Bulb B is used for 25 hours. Which bulb will consume more energy? Assuming utilities charges of Rs. 6, what would be the cost of electricity consumed by the bulbs?

UNIT 1.2: Renewable Energy and Solar Energy System

Unit Objectives

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

- Identify renewable energy sources
- Define the fundamentals of solar energy
- Explain the basic working of a solar energy system
- List the advantages and disadvantages of solar energy system

In this modern world, energy has become an integral part of everyone's daily life. Energy is required in one form or the other. This energy to be used must come from somewhere. Normally, the energy to be used is supplied in the form of diesel, petrol, coal, LPG, CNG and electricity.

In India, people do not get sufficient amount of energy. There is a huge shortage of energy supply. There are around 5, 90,000 villages in India and 700 million people live in rural India. Most households in rural India do not get sufficient electricity, which hinders the growth of rural India both at the social and economic front. There is either lack of sufficient infrastructure to supply energy to all or sufficient fuel is not available at a reasonable cost. Therefore, there are efforts to use infinite or renewable energy sources.

1.2.1 Renewable Energy

The renewable or natural energy sources are continuously produced by natural processes and forces occurring in the environment. These energy sources are also available in a distributed manner around everyone, which means that the required energy can be generated where there is a need. The following figure shows some renewable energy sources:

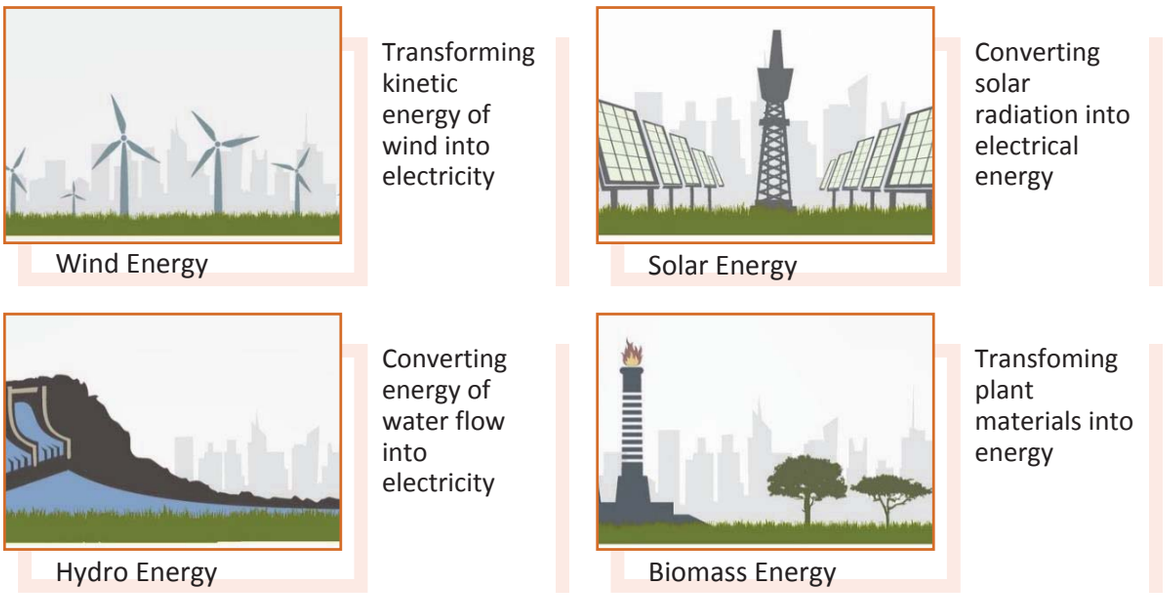


Fig. 1.2.1: Sources of renewable energy

These sources are available in variable form or available occasionally in cycles and can be harnessed during their specific cycle. For instance, solar radiation energy is available in day-night cycle. Any amount of solar energy can be harnessed without affecting the availability of solar energy for the next day, and therefore, it is termed renewable energy source.

Similarly, wind energy and hydro energy are renewable energy sources and can be harnessed in any amount and cannot be depleted. If the balance is made between consumption of biomass energy and growth of biomass, then biomass energy can also be considered as renewable energy.

Solar Energy

The sun is the main, natural source of energy on Earth. The energy received from the sun by the earth is in the form of electromagnetic radiations. Then, this energy gets converted into various forms of renewable energy. On reaching the earth, some of the energy from the solar radiations:

- Is reflected back
- Gets absorbed in the atmosphere
- Reaches earth surface without any conversion
- Is converted into wind energy and biomass energy
- Is used in water evaporation, thus causing rain, and is available in the form of hydro energy

The amount of energy from the sun that reaches Earth is very large as compared to what is being produced from fossil fuels. In 2013, the annual energy consumption from all possible sources including electricity, coal, gas, diesel, petrol and biomass was 567 Exa joules or 157,481 TWh and total electricity consumption was 70 Exa joules or 19,504 TWh. The availability of total solar energy source is 3,850,000 Exa joules, which is many thousand times more than is consumed annually.

TIP

Exa joule = 1000,000,000,000,000,000 joules

1 Joule= 1 Ws (watt-second)

1Wh = 3600 Ws= 3600 J

1kWh = 3600KJ = 3600,000 J

Power Unit	Equivalent Unit
1 Watt	1 joule-second = 1W
1 kilowatt	1000 watt or 1000 W
1Megawatt	1,000,000 W
1Gigawatt	1,000,000,000 W

1.2.2 Solar Energy System

India is blessed with a large amount of sunlight. Solar radiation is received in a range of 4 to 7 kWh/m2 /day. Such amount of radiation is good enough to generate electricity to fulfil electricity requirement of an entire region using this technology. Importantly, the energy can be generated in any area, where there is a need, by installing the solar energy system.

The solar power system works as follows:

- The solar radiation hits the solar cells and gets transformed into DC energy.
- The DC energy is converted to AC energy with the help of an inverter.
- The generated AC electricity is identical to the power that is provided by the utility companies. The AC electricity can be supplied to gadgets such as computers and lights directly.
- The generated electricity can also be transmitted to the national electricity grid and from there may be supplied all over the country.

The following image shows the conversion of solar energy into electricity:

Fig. 1.2.2: Basic solar energy conversion process

A solar energy system or a PV system is a power setup devised to supply the available solar power in the form of electricity. In this system, a solar panel is the main component. It is constructed in such a manner that it absorbs the sunlight as an energy source and uses it to supply electricity or provide heating.

Solar panel has to be placed in the sun to generate electricity. It is very simple to use but it is very expensive. The basic unit of a solar panel is called a solar cell or PV cell. It is made of silicon which is also used in computer chips. Though there is greater availability of silicon, but solar cells are manufactured in a clean environment leading to high production cost.

A PV cell is made from two types of silicon, monocrystalline and polycrystalline. When these two silicons receive solar energy, they develop a voltage difference across themselves. Current flows when this cell is connected to an electric circuit. So, the solar panels in the solar power comprise of solar PV cells fitted into a frame. The cells are made from two kinds of silicon, which are monocrystalline and polycrystalline.

A PV system is can be said to be comprised of several PV modules. A PV module is a packaged collection of generally 6 × 10 PV cells, connected. It forms the PV display of a PV system that produces and provides solar energy to applications in both residential and commercial areas. The rating of the modules is done as per their DC output under STC. The range of this output is generally from 100 to 365 watts. Several PV cells are connected to form a PV module, then encapsulated in a glass frame which is mounted according to the requirement. The produce a defined voltage, the cells are wired in series or parallel in a module. For example, a 12V panel produce around 16V in sun shine hours and charge a 12V battery. The following image shows the parts of a solar panel:

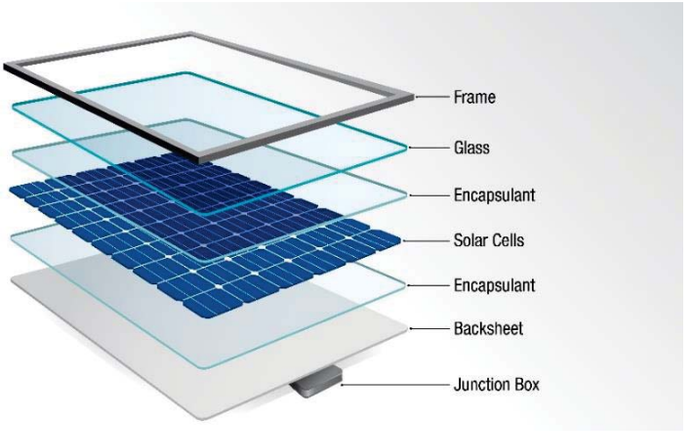


Fig. 1.2.3: Parts of a solar panel

Solar PV modules are the most important part of the system. They are also called the power generators of the system. In addition to PV modules, a PV system also includes various other parts. The following figure shows the other parts of a solar PV system:

Batteries	For those PV systems which are required to operate at night or during the absence of sunlight, storage of energy is important. Batteries are used to store electricity.
Charge Controller	The PV module output depends on the intensity of sunlight and the temperature of the cell. Charge controllers or regulators are the components which control the DC output and deliver that to the grid, batteries, and/or loads and ensures smooth operation of the PV system.
Inverter	For applications that are run by AC power, the DC/AC inverters are required to be installed in PV systems.
Mounting Structures	They are required to fix the PV modules and to ensure that the modules are directed towards the sun.
Load	The household appliances and equipment that require to be powered by the PV solar system are called load.

Fig. 1.2.4: Parts of a solar PV system

The following image shows different components of a solar energy system:

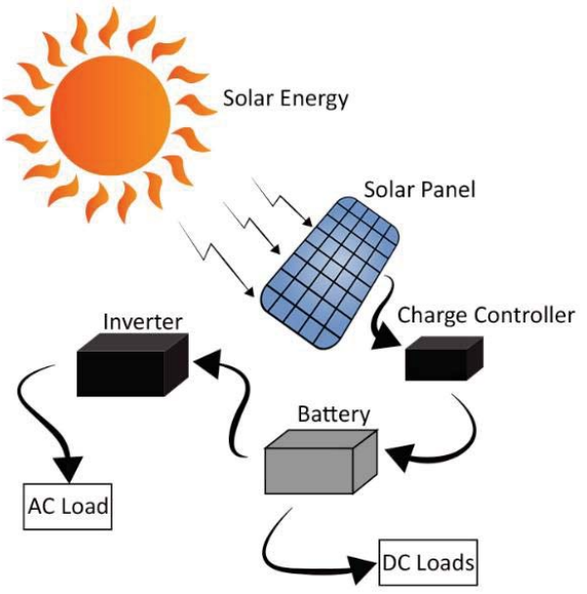


Fig. 1.2.5: Components of a solar energy system

1.2.3 Types of Solar Energy Systems

A solar energy or solar PV system can be of several types depending on the way the energy is generated and used.

PV systems could be a simple PV module and load, for example, in the case of a water pump motor where the usage of water pump may be restricted just to sun shine hours when solar energy is available. It can be a complex system to power a residential building or a house where the power requirement is in the day as well as in the night when there is no solar energy. This kind of system may require a back-up generator, run AC/DC loads, and even store power.

Based on the system configuration, PV systems are classified as:

Fig. 1.2.6: Main types of PV systems

The basic principle behind PV systems remain same but different types of systems provide energy solution for different requirements.

Standalone Solar PV System

These systems are self-sufficient. They are independent of any other source of energy to supply electricity to appliances or load. Since the standalone solar PV systems are independent of any other energy source, they invariably use some means to store energy, typically in the form of batteries. Since batteries are used, it is important to use electronic devices such as a charge controller to protect

them. Also, for conversion of DC electricity from PV modules and battery into AC electricity, an inverter must be used.

The examples of standalone solar PV systems include solar lantern, solar PV home lighting system and solar PV water pumping system. The following figure shows a standalone solar PV system:

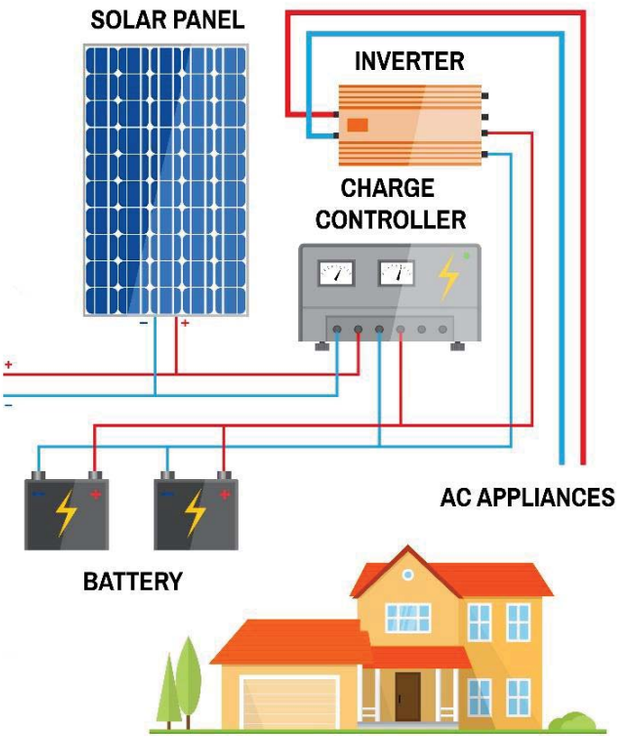


Fig. 1.2.7: Stand-alone solar PV system

Grid-connected Solar PV System

In this type of PV system, the system is connected with a nearby, available electricity grid. In this way, the generated electricity is fed into the grid. No battery storage is used in this case. However, conversion of DC electricity into AC electricity is required before feeding to the grid.

A typical arrangement of grid-connected solar PV system is shown in the following image:

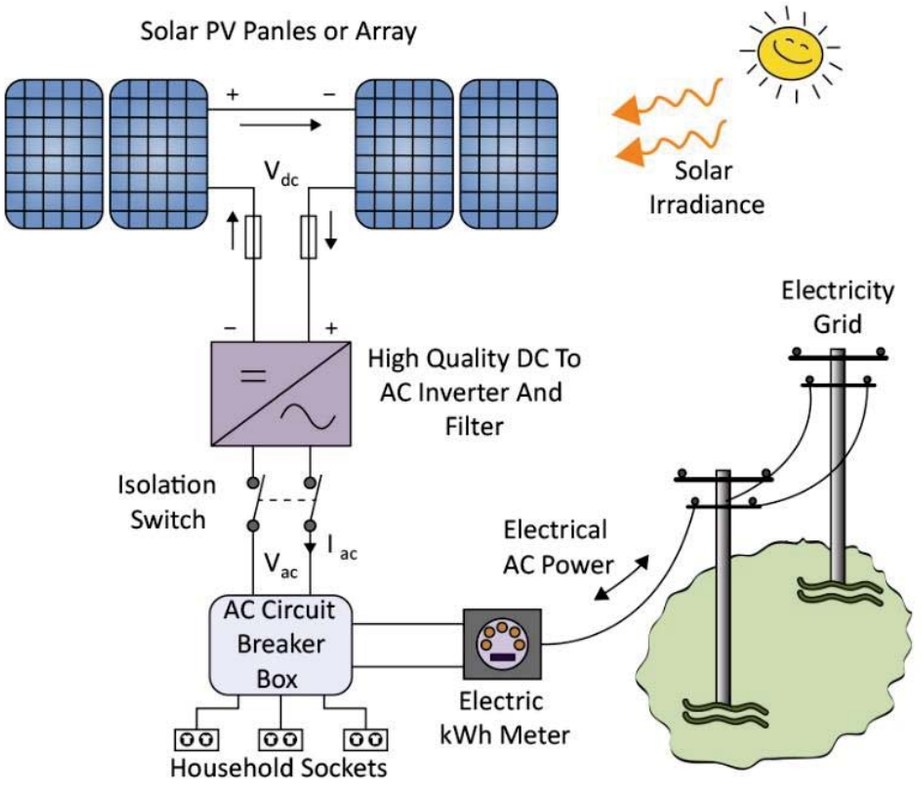


Fig. 1.2.8: Grid-connected solar PV system

Electricity grid voltage and frequency are well defined and, therefore, the PV electricity can be fed to electricity grid only after proper power conditioning, that is converting PV generated electricity to appropriate voltage and frequency level.

Therefore, in grid-connected solar PV system, the inverter not only performs the function of DC to AC conversion but also performs the function of grid synchronization, which is related to adjusting the generated PV energy to appropriate voltage and frequency level. This type of PV system is used in India for large scale solar PV power plants.

Hybrid Solar PV System

In some cases, an auxiliary source of energy such as a diesel generator is used in addition to solar PV modules and/or grid. This needs to be done when solar PV modules are not designed to supply the full energy required by the load (may be due to cost reason). In such cases, auxiliary source of solar PV systems are used, called as hybrid solar PV system.

The following figure shows a hybrid solar PV system:

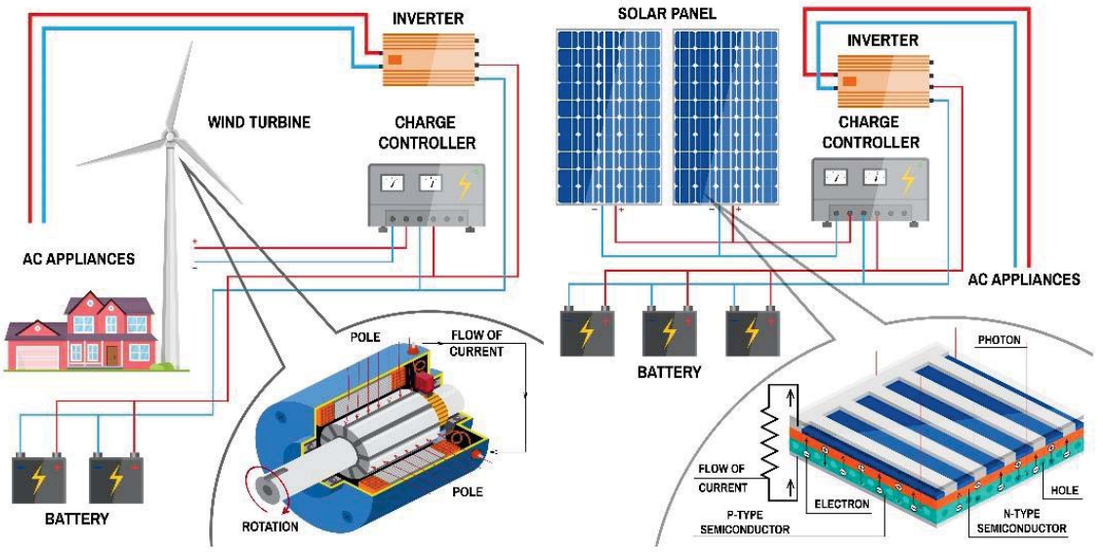


Fig. 1.2.9: Hybrid solar PV system

1.2.4 Advantages and Disadvantages of Solar Energy System

The following figure shows the advantages and disadvantages of solar energy system:

Advantages	Disadvantages
● It is clean and non-polluting.	● Solar power cannot be obtained in night time.
● It is renewable energy.	● Solar cells (or) solar panels are very expensive.
● Solar cells do not produce noise and are totally silent.	● Energy has to be stored in batteries.
● They require very little maintenance.	● Air pollution and weather can affect the production of electricity.
● They are long lasting sources of energy which can be used almost anywhere.	● They need large area of land to produce efficient power supply.
● They have long life time.	
● There is no fuel cost or fuel supply problems.	

Fig. 1.2.10: Advantages and disadvantages of solar energy system

Activity

Answer the following questions.

1. List two renewable energy sources.

2. Mention three demerits of solar energy system.

3. Draw a flow diagram for solar energy conversion process.

UNIT 1.3: Solar Cells

Unit Objectives

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

- Describe how solar cells generate electricity
- List the parameters of solar cells
- Explain solar cell technologies
- Identify the factors affecting electricity generated by a solar cell

1.3.1 Solar Cell

Solar cell is a semiconductor device which directly converts sunlight into electricity by photovoltaic effect. Hence, they are also called photovoltaic cell. The following image shows a typical silicon solar cell:

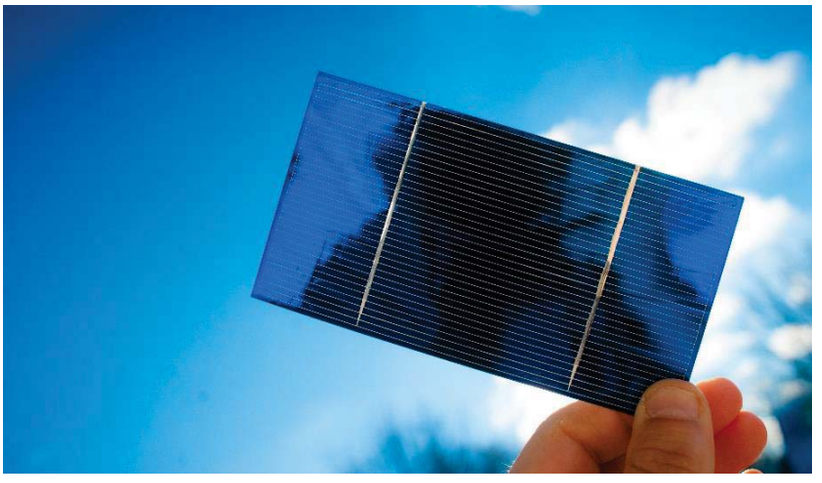


Fig. 1.3.1: Solar cell

Solar cell is the basic block of solar photovoltaic technology. It is a device that directly converts sunlight into electricity without any other intermediate conversion step. Input to solar cells is energy in the form of solar radiation and output from the solar cells is energy in the form of electricity.

The electricity generated by a solar cell depends upon some factors as listed in the following figure:

•Intensity of light	•The higher is the intensity of sunlight, the more is the electricity generated by a solar cell.
•Area of the cell (A)	If area of a solar cell is increased, the current generated by it increases.
•Angle at which light falls on it (Θ)	The power generated by a solar cell is optimum when sunlight falling on it is perpendicular to its front side.

Fig. 1.3.2: Factors affecting electricity generated by a solar panel

Besides these factors, conversion efficiency (Ŋ), amount of light (Pin) and operating temperature (T) also effect the electricity generation.

Parameters of Solar Cell:

A solar cell converts sunlight into electricity. There are several parameters of solar cells that determine the effectiveness of conversion of sunlight into electricity. The list of these parameters is as follows:

Short circuit current (I_{sc})	It is the maximum current that can be produced by a solar cell without affecting its construction. The higher the I_{sc}, better is the cell. It is measured in ampere (A) or milli-ampere (mA). The value of this maximum current depends on the cell technology, cell area, amount of solar radiation failing on th cell, angle of cell and so on.
Open circuit voltage (V_{oc})	It is the maximum voltage that can be produced by a solar cell when there is no load connected to it. The higher the V_{oc}, the better is the cell. It is measured in volts (V) or sometimes in milli-volts (mV).
Maximum power point (P_m)	It is the maximum power that a solar cell produces under the STC. The higher the P_m, the better is the cell. It is given in terms of watt (W). A solar cell can operate at many current and voltage combinations. But it will produce maximum power only when operating at certain current and voltage. This maximum power point is denoted as P_m. Typically, the maximum power point for a I-V curve of solar cells occurs at the 'knee' or 'bend' of the curve. $$\mathbf{P_m \text{ or } P_{max} = I_m \, X \, V_m}$$
Current at maximum power point (I_m)	This is the current which solar cell will produce when operating at maximum power point. The I_m will always be lower than Isc. It is given in terms of ampere (A) or milli-ampere (mA).
Voltage at maximum power point (Vm)	This is the voltage which solar cell will produce when operating at maximum power point. The V_m will always be lower than V_{oc}. It is given in terms of volt (V) or milli-volt (mV).
Fill factor (FF)	FF is the ratio of the areas covered by Im-Vm rectangle to the area covered by Isc- Voc rectangle whose equation is given below. Typical FF values range from 0.5 to 0.82. $$\mathbf{FF = I_m \, x \, V_m \, / \, I_{sc} \, x \, V_{oc}}$$ $$\mathbf{FF = P_m / \, I_{sc} \, x \, V_{oc}}$$
Efficiency (ŋ)	It is defined as the maximum output power (P_m or P_{max}) divided by the input power (P_{in}). The efficiency of a cell is given in terms of percentage (%), which means that the given percentage of input radiation power is converted into electrical power. $$\mathbf{\eta = P_m \, / \, P_{in}}$$

Fig. 1.3.3: Parameters of solar cell

The following graph shows solar cell I-V curve based on the parameters explained:

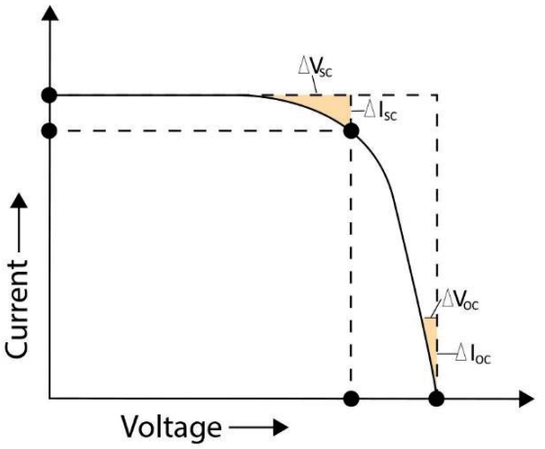


Fig. 1.3.4: Solar cell I-V curve

1.3.2 Solar Cell Technologies

The solar cell technology is named after the material used. The materials used in solar cells have different properties. Hence, different types of solar cells have different values for parameters such as efficiency, short circuit current density, fill factor (FF) and open circuit voltage. The following table lists commercial cell technologies, materials and efficiency:

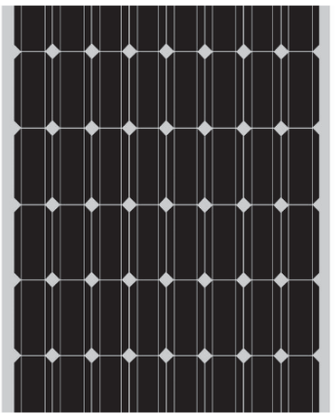
Commercial Solar Cells Technology, Material and Efficiency			
Solar photovoltaic technology	**Solar cell type**	**Material Used**	**Efficiency (?) in per cent**
Crystalline Silicon (c-Si) solar cell	Mono-crystalline silicon Poly or multicrystalline Si (mc-Si)	Mono-crystalline silicon Multi-crystalline silicon	14-16 14-16
Thin film solar cell	Amorphous Si (a-Si) Cadmium telluride (CdTe) Copper-Indium-Gallium-Selenide (CIGS)	Amorphous silicon Cadmium and tellurium Copper, Indium, Gallium, Selenium	6-9 8-11 8-11
Multi-junction solar cell	GaInP/GaAs/Ge Gallium indium phosphide/Gallium arsenide/ Germanium	Gallium (Ga), Arsenic (Ar), Indium (In), Phosphorus (P), Germanium (Ge)	30-35

The following table lists commonly available commercial solar cells along with η, area (A), maximum current density (J_{sc}), V_{oc} and FF:

Typical Solar Cell Parameters of Commercial Solar Cells with Available Cell Areas					
Solar Cell Type	Efficiency (?)	Cell area (A) (in cm2)	Output voltage (Voc) (in V)	Output current (Jsc) (in mA/cm2)	Fill factor (FF) (in %)
Mono-crystalline silicon	14-17 %	5-156	0.55-0.68	30-38	70-78
multi-crystalline silicon	14-16 %	5-156	0.55-0.65	30-35	70-76
Amorphous silicon	6-9 %	5-200	0.70-1.1	8 – 015	60-70
Cadmium telluride	8-11 %	5-200	0.80-1.0	15-25	60-70
Copper-indium-Gallium-Selenide	8-11 %	5-200	0.50-0.7	20-30	60-70
Gallium indium Phosphide / Gallium arsenide/Germanium	30-35 %	1-4 cm2	1.0-2.5	15-35	70-85

In the market, a wide variety of solar cells are available. These cells are made by using different materials such as mono crystalline, poly crystalline and non-crystalline.

The following figure shows different types of solar cells:



Monocrystalline cells contain pure silicon that are in cylindrical shape.

To lower the cost and optimize the performance of a monocrystalline cell, four sides of the cylinder are cut out to make silicon wafers. It provides the monocrystalline solar panels their appearance.

These cells can be easily recognized from their uniform look and even, coloured external surface because of high-purity silicon contents.

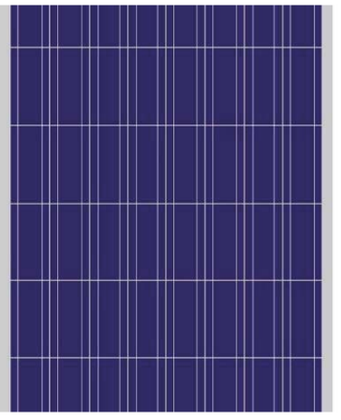
These cells are highly efficient and must be mounted in a rigid frame to ensure protection.

Polycrystalline (or Multi-crystalline) cells are comprised of several small crystals called crystallite.

The raw silicon is melted and kept in square mould. Then, it is cooled and sliced to make square wafers.

Polycrystalline solar panels are of rectangular shape without having any rounded edges.

These cells are less efficient and less expensive than mono crystalline cells but like the latter, require to be mounted in a rigid frame.



Amorphous cells are formed by placing a thin film of non crystalline (amorphous) silicon onto a wide range of surfaces. Due to the amorphous nature, these are flexible.

Amorphous silicon cells usually have low efficiency but are eco-friendly as they do not utilize harmful heavy metals such as cadmium or lead.

The power output of amorphous cells reduces over time, specially during the first few months, after that they are generally stable. The specified output of the amorphous cells should be one that is generated after the stabilization stage.

Fig. 1.3.5: Different types of solar cells

Activity

Answer the following questions.

1. The current density of a solar cell having an area of 100 cm^2 at STC is given as 35 mA/cm2. Find the output current of a solar cell.

2. A solar cell having an area of 100 cm2 gives 3.1 A current at maximum power point and 0.5 V at maximum power point at STC. The cell gives 3.5 A short circuit current and 0.6 V open circuit voltage. What is the maximum power point of the solar cell? Also, find out the efficiency of solar cell.

3. Calculate the output power from a solar cell if its efficiency (in %) is 30,24,19,16 and 12, input power density is 1000 W/m2, and area of the solar cell is 100 cm2.

4. Mention the basic difference between monocrystalline and polycrystalline solar cell.

UNIT 1.4: Photovoltaic (PV) Panels

Unit Objectives

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

- Identify the working process of PV panels
- Describe the solar panel array configurations
- Identify the factors affecting generation of electricity of a solar PV module
- Describe the function of blocking diode and bypass diode

1.4.1 How PV Panel Works?

A solar panel consists of several solar cells assembled together for converting solar energy into electricity. A solar cell is a two-terminal power generating device in which one is positive terminal and the other is negative terminal. Solar cells are comprised of silicon which is a semi-conductor (it has properties of both metals and an electrical insulator.) The following image shows the cross section of a solar panel:

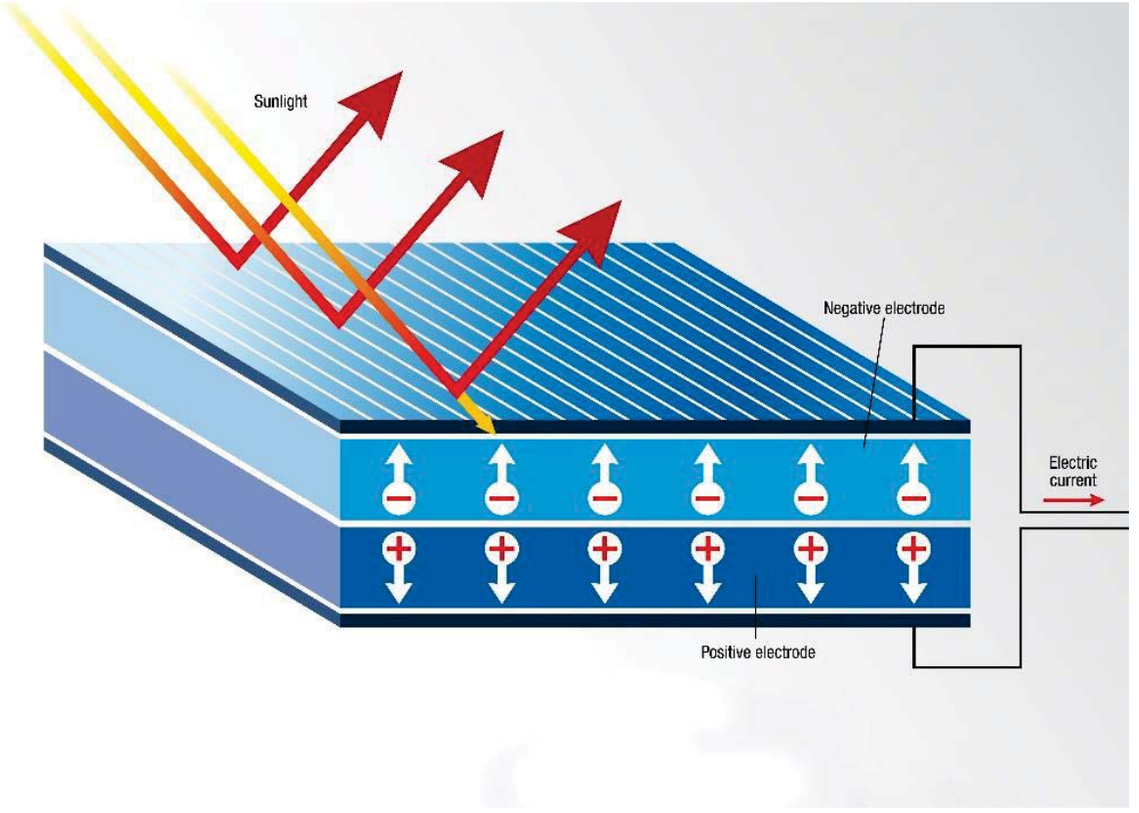


Fig. 1.4.1: Cross section of a solar panel

The solar panel works on the principle of photoelectric effect, the emission of electrons from a material when it is exposed to light. The working of a solar panel is explained as follows:

Sunlight is made up of minute particles known as photons which are emitted from the sun.

When they strike the silicon atoms of a solar cell, their energy is transferred to the loose electrons, dislodging them from the atoms.

The photons are simlar to the white ball in a pool game, which transfers its energy to the coloured balls it hits.

After freeing the electrons,a solar cell needs to direct these free electrons into electric current.

An electric imbalance has to be created inside the cell.

This will serve as a slant, down which the electrons can move in the same direction.

This imbalance is brought about with the help of the internal composition of silicon.

The silicon atoms are tightly packed together.

When little quantity of some other element is put into this structure, two kinds of silicon are formed: n-type having spare electrons and p-type having holes due to missing electrons.

When these two types of silicon are placed adjacent to each other within a solar cell, the spare electrons from the n- type silicon cross over to occupy the space in the p-type silicon.

An electric field is created inside the cell as the n-type silicon gets a positive charge and the p-tyope silicon gets a negative charge.

This imbalance is maintained by silicon as being a semiconductor, it can do the work of an insulator.

When the photons from the sunlight knock off the electrons from the silicon atoms, the electric field makes them flow in a systematic manner.

This produces electric current which is used to operate appliances, satellites and various other objects.

Fig. 1.4.2: Working of solar panel

1.4.2 Panel Construction

A solar panel used for electricity generation in rural areas consists of several solar cells. The solar cells may be of round, square or some other shape. Irrespective of the size of solar cell, they produce half a volt. The size of a cell determines the amount of amperes that the cell can produce. Thus, larger the cell more amperes it can produce.

A cell has a limitation of producing half a volt and hence, many cells are assembled in a series connection to produce enough voltage for charging a 12 V battery. This requires 30 to 36 cells on a panel to ensure that voltage requirement of 12 V is accomplished.

Similarly, panels in tropical area should have at least 33 cells as less than that is not sufficient to charge a 12 V battery in such areas. Panels with 34 to 36 cells, or higher, are optimum in tropical area but are expensive.

1.4.3 PV Solar Panels Array Configurations

Sometimes, the power requirement is more than the power that a single solar PV panel can produce. For increasing the power generation, panels are connected in any one of the three ways:

- Series connections
- Parallel connections
- Series-parallel connections

Series-Connected Panels

In case the requirement for voltage is more than that a panel can produce, then extra panels are connected in series. Hence, for example, if a panel can provide 12 V, then two such panels in a series connection can provide 24 V. Similarly, three panels of 12 V each, connected in series will provide a total of 36 V.

The amperes provided by the solar in a series connection remains the same as that provided by a single panel since the same electricity flows through all the panels. In other words, every panel raises the electrical pressure but the flow remains the identical as that of a single panel. Since the power in watts is equal to the volts time's amperes, therefore, the power increases with the number of panels.

The following figure shows the solar cells connected in series:

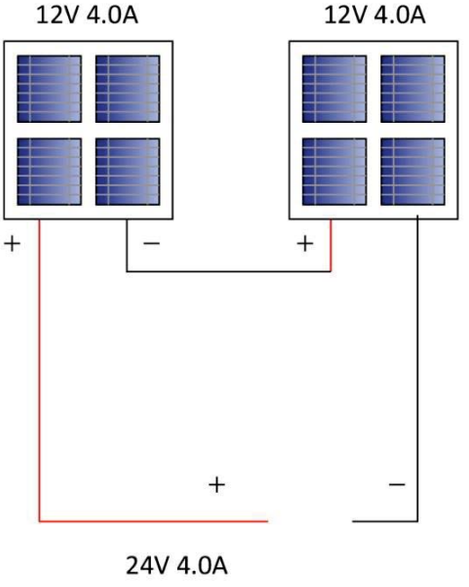


Fig. 1.4.3: Solar cells - series connection

In case the PV panels connected in series are of different voltage and current (amperage), then the total voltage is calculated by totalling their individual voltages. However, the minimum ampere capacity will be the criteria for the current available at maximum.

In a series connection, if a panel can produce 2A and another panel in series can produce 3A, then the result is a current of a little over 2A from the combined panels. Therefore, to get maximum current in series-connected panels which are of different ampere capacity, then the ampere ratings of the panels should match. Moreover, since amperes are affected by the size of the PV cells, it should be ensured that panels in a series connection should be of the same size.

Parallel-Connected Panels

Panels are connected in parallel, when a single panel produce sufficient voltage but not enough current. If one panel generates 2A in bright sunlight, two panels in parallel will generate 4A. For each of the 2A panels that are connected in parallel, an extra 2A current will be generated in bright sunlight. With panels that are in parallel connection, the voltage remains same as that of a single panel but the amperage increases with every additional panel connected in parallel.

TIP

Two panels in parallel produce the same power as two panels in series, but the voltage and amperage are different.

The following figure shows solar cells connected in parallel:

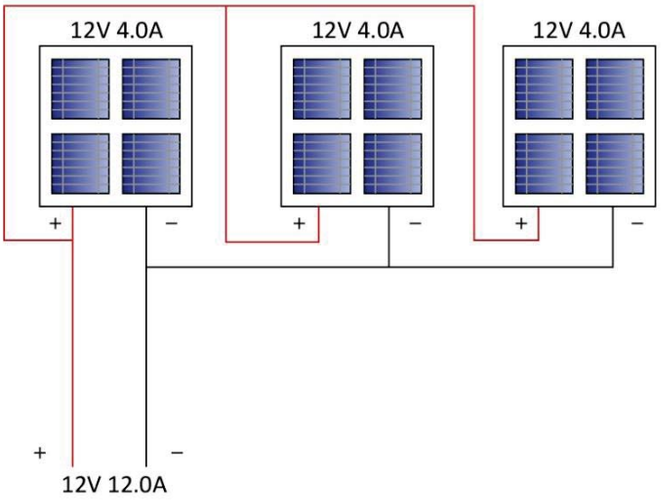


Fig. 1.4.4: Solar cells - parallel connection

If PV panels having different voltage and current levels are connected in parallel, their currents must be totalled similar to that when panels with same characteristics are connected in parallel. Hence, if one panel generates 3A and the other 2A, a total of 5A will be produced.

However, the available voltage from the panels connected parallel at maximum power will be limited by the smaller voltage of the two panels. If a panel with output16V is connected in parallel with the one with output of 17V, it results in a voltage a little greater 16V. Thus, for getting the most out of the parallel-connected panels, the panels should have identical characteristics of voltage and same number of cells.

Series-Parallel Connections

Solar PV systems that power large appliances such as refrigerators, generally use a 24V battery in place of a 12V battery. Some appliances even use 48V batteries. Since solar panels are usually designed to charge 12V batteries, two panels are required be connected in series to charge a 24V battery and four panels need to be connected in series for providing charge to a 48V battery. If amperes more than one panel can produce are required, the panels should be connected in parallel as well. The combination of series and parallel connections may be extended to:

- As high a voltage as needed by adding more panels in series.
- As high amperage as needed by adding more panels in parallel.

There are many ways of connecting a large number of panels to get the desired voltage and current. The following figure lists two ways of making series-parallel connection:

Connect the panels in series until the desired voltage is reached and then connect more sets of panels that are connected in series, in parallel until the amperage is reached.

Connect panels in parallel to get the desired amperes, then connect more sets of panels that are connected parallelly, in series to get the voltage required.

Fig. 1.4.5: Two ways of making a series-parallel connection

1.4.4 Blocking Diode and Bypass Diode

A diode is a specialized electronic component with two terminals known as the anode and the cathode. It has asymmetric conductance, which means that it conducts mainly in one direction. It has very less resistance, ideally zero, to the flow of current in one direction whereas it has high resistance, ideally infinite, in the other direction. Diodes are usually made up of semiconductor materials such as germanium, silicon or selenium.

Diodes may have same characteristics, but their functionalities depend on the way they are used. The diodes which play important roles in the functioning of solar panels are:

- Blocking diode
- Bypass diode

Blocking Diodes

The following diagram shows a simple setup, with two panels wired in series charging a battery (for simplicity no controller is shown) and a blocking diode connected in series with the two panels:

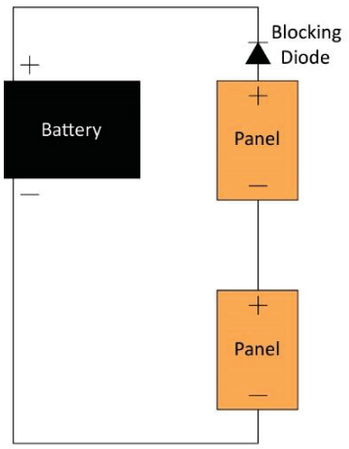


Fig. 1.4.6: Blocking Diode

During sunshine hours, battery is charged as long as the voltage generated by the two solar panels is greater than the specified voltage of the battery. However, in the absence of sunshine, while no voltage is being generated by the panels, a flow of current is caused through the panels by the voltage of the battery in the opposite direction. This would result in the discharge of the battery, if there is no blocking diode in the circuit. Blocking diodes are useful for a system that uses solar panels for charging the battery. They are generally used in the construction of solar panels.

By-Pass Diodes

If one of the solar panels in the preceding diagram is shaded, the panel will not be able to produce significant power and it will also possess a high resistance which will block the flow of power generated by the un-shaded panel. The following diagram shows working of by-pass diodes:

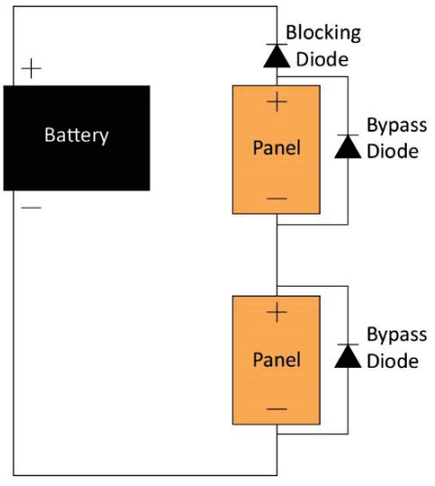


Fig. 1.4.7: By-pass diode

In this case, when one panel is shaded, the current generated by the un-shaded panel will flow through the by-pass diode so that it can avoid the high resistance of the shaded panel. If the panels are not connected in series that will allow production of high voltage, by-pass diodes will not be of any use. They are most efficient whereas string inverter or a maximum power point tracking (MPPT) controller involves series connected panels for producing voltages that are greater than the minimum input voltage. Some solar panels are formed with cells grouped together, each group consisting of a built- in by-pass diode. Shading of a panel may be caused by a branch of a tree, debris or snow.

1.4.5 Factors Affecting Electricity Output of PV Panels

The following figure lists the factors that affect output of PV panels:

Effect of panel area	•The larger the solar panel, the more electricity is produced. If the amount of surface covered by the panels is made twice as large, the electricity output is also doubled.
Effect of sun's brightness	•The more sunlight that falls on the panel, the more electricity is produced. If there is shade on it, the electricity output falls greatly.
Effect of panel direction	•To get the most electricity from a solar panel, it must be facing the sun.
Effect of heat	•Solar panels work best when kept cool. The hotter the panel, the less power it provides.
Mounting of Panels	•Because solar panels are constantly exposed to wind and weather, it is important that their mounting is secure and resistant to corrosion or loosening. •Mounting panels on a roof is usually cheaper than mounting them on a pole. But if the roof is shaded or facing the wrong way, a pole must be used.

Fig. 1.4.8: Factors affecting output of PV panels

1.4.6 Getting Maximum Electricity from a Panel

It is always preferred to get as much electricity as possible from the PV panels as they are expensive. To get maximum electricity:

- **Ensure that the panels receive the brightest sunlight**
  - Even if a small part of a solar panel is shaded, it loses most of its electricity output. Hence, it is important that the panels are placed at such a location where the sunshine will be available on them for at least 6 hours (09:00 to 15:00).
  - It must be considered that over the year the position of the sun shifts from north to south as well as during the day from east to west.
  - The position of trees and buildings to the north and south of the panel must be considered to make sure that they will not cause any shade on the panels at any time of year.
- **Ensure that the panels are facing towards the sun**
  - The panels produce maximum electricity when they point towards the sun directly.
  - The movement of the panels is not practical in most of the places. If the panels are fixed in such a way that they face the direction where the brightest sun is located, then they produce maximum electricity.

  The following figure lists two examples of mounting the solar panel:

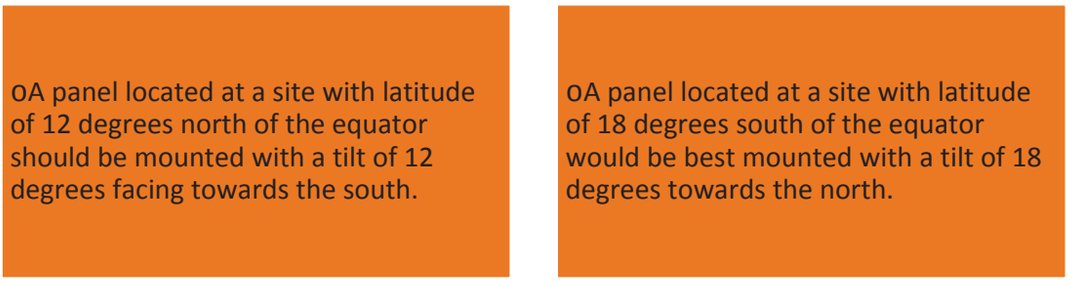


Fig. 1.4.9: Examples of mounting the solar panel at a particular latitude

  - A panel that is mounted on the equator is required to have a tilt of 5 degrees towards any direction. A small tilt (5 to 10 degrees) is always needed for allowing the rain wash off any dirt from the panel. In tropical regions where the latitude is 15degree or less, high accuracy in pointing the panel towards the equator is not needed.
  - At latitudes that are higher than 15 degrees, the panels are required to be pointed carefully towards the equator for receiving the maximum power output.
- **Ensure that the panel is kept as cool as possible**
  - As the solar panels are required to be in the bright sun, it is hard to prevent them from getting hot. Hence, they are mounted in such a way that the flow of air can reach to both sides of the panels.
  - The panels must not be mounted directly on the roof but at least at a gap of 10 cm above the roof, to allow air flow around the panels and cool them.

Activity

Answer the following questions.

1. A solar PV string is rated for V_{mp} = 400 V and Imp = 8A. Design a series-parallel connected solar PV array to generate 16 kW DC power. What will be the DC output voltage and current on the array?

2. A Solar PV string is rated for V_{mp} = 460 V and Imp = 100A. Design a series-parallel connected solar PV array to generate 46 kW DC power. What will be the DC output voltage and current of the array?

UNIT 1.5: Electrical Power System

Unit Objectives

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

- Explain an electric grid
- Identify the components of electrical power system
- List the type of power system

Electrical power system is a system of various electrical components interconnected to generate, transfer and utilize electric power. If this system supplies power to homes and industries in a region of a considerable area, it is called as grid. The grid is divided into the following sections:

- Centralized generators that supply the power. These may be located far from highly populated areas and transmit large amount of electricity in to the transmission lines.
- Transmission lines that carries the high voltage electricity power from the generating stations to the substations.
- Substations where high voltage electricity is converted in to lower voltage electricity.
- Distribution lines that feeds the lower voltage electricity power to nearby homes and industries.
- Distributed generation which is located at or near the location of load. It can be connected to the distribution lines of the utility, or it can just provide power to a standalone load.

The following figure shows an electric grid:

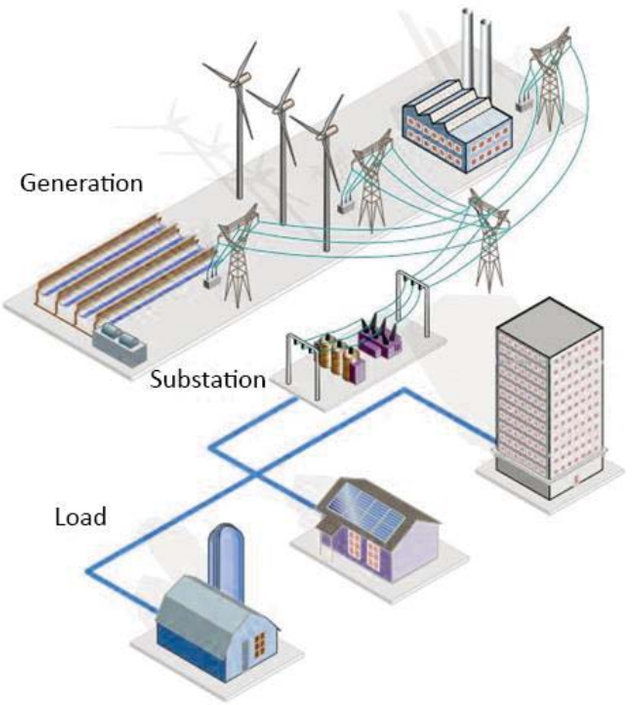


Fig. 1.5.1: An electric grid

Smaller electrical power systems are generally found in residential and commercial buildings, small industries, and hospitals. These systems usually rely on three-phase AC power which is considered as the standard for transmission and dissemination of large-scale power over the world. There are some specialized power systems which do not depend on three-phase AC power. These specialized power systems are used in aircrafts, electric rail systems and automobiles.

Components of Electrical Power System

Several components together form a power system. The basic components of an electrical power system are:

- Supplies
- Loads
- Conductors
- Capacitors and reactors
- Power electronics
- Protective devices
- Supervisory Control and Data Acquisition (SCADA) systems

Supplies

The electrical power system may utilize one or more than one sources of power to generate electricity. DC power is mainly supplied by batteries, solar PV cells and fuel cells. AC power is usually supplied with the help of a turbo generator. There are several techniques used to spin the rotor of the turbine such as by means of falling water that is hydro power, with the help of steam heated using fossil fuel or nuclear energy, and using wind energy.

The phases of power generated by AC generators depends on how the electric poles are fed. Higher the number of phases, higher will be the efficiency of the power system. But it also leads to an increase in the infrastructure requirements for the system. An electricity grid connects a number of loads and generators operating at the similar number of phases (commonly three-phase) and frequency (commonly at 50 or 60 Hz).

Loads

Power systems are capable of supplying and transferring electricity to loads varying from any small household equipment to large industrial machines. Majority of the loads have a requirement of a certain voltage level.

For AC devices, with specific voltage, it is also important to consider the specified frequency level and the number of phases. For example, the home appliances, generally operates at single-phase power with frequency of 50 or 60 Hz and a specified voltage range of 110 - 260 volts.

Each device has a wattage specifying the quantity of power it expends at any instant of time.

Total quantity of power utilized by the loads connected to a power system = Quantity of power generated by the supplies – Quantity of power loss during the transmission.

Conductors

Conductors are used to carry the power from the power generating stations to the load center. Conductors, in an electric grid may be categorized as a part of:

- The transmission system which allows high voltage power (generally more than 69 kV) of huge amount to be carried from the power stations to different load centers.
- The distribution system which carries low voltage power (usually less than 69 kV) of smaller amounts from the load centers to residential buildings and industry.

Few of the considerations on which the choice of conductors depends are cost, transmission losses and tensile strength of the metal.

Capacitors and Reactors

Capacitors are usually put near inductive loads with the purpose to reduce the present demand of electricity on the power system. The reactors that consume the reactive power are used to control the voltage over long distance transmission lines.

Note:

In an AC power system, most of the loads are inductive which means that the current is behind the voltage as the loads resist the changes in current. The difference in the phases of current and voltage results in the generation of reactive power.

Reactive power is an imaginary power that does not perform any measurable work but it is transmitted back and forth in every cycle, between the load and the source of reactive power. Reactive power may be supplied by adjusting the generator excitation. It is cheaper to provide it through capacitors.

Power Electronics

Semi-conductor based devices that are used as power electronics components are able to switch the huge amount of power especially in the range of few hundred watts and several hundred megawatts. The power electronics is basically used for:

- Rectification
- Conversion of AC power to DC power

Hence, every digital equipment having an AC source that may be an adapter which plugs into the wall or any other component which is internal to the equipment is based on power electronics. It is also important for a power source which needs to produce an AC output but inherently produces a DC output. High-voltage Direct current (HVDC) is high-powered power electronics that is used in the conversion of AC to DC power over a long-distance transmission. HVDC systems are used by many industrial and residential photovoltaic installations.

Protective Devices

Power systems are equipped with protective devices that helps to protect the system from any damage during power failures. A fuse is the most common protective device. If the amount of current passing through the fuse surpasses the threshold limit of the fuse, the material of the fuse melts and interrupts the circuit. There are few limitations with fuses, which are:

- Fuse cannot be reset, it can only be replaced
- Replacement of fuse at a remote site is inconvenient
- Unavailability of a spare fuse
- Fuse allows current flow so it may be hazardous for man

It is possible to reset the circuit breakers after they have interrupted current flow. Mini circuit breakers are used in modern systems using less than 10 kW. In higher powered systems, protective relays initiate a trip after detecting a fault.

SCADA systems

SCADA stands for Supervisory Control and Data Acquisition. In large power applications, it is used to:

- Switch on the generators
- Control the generator output
- Switch in/out system elements for maintenance purpose

The following figure lists the components of a SCADA system:

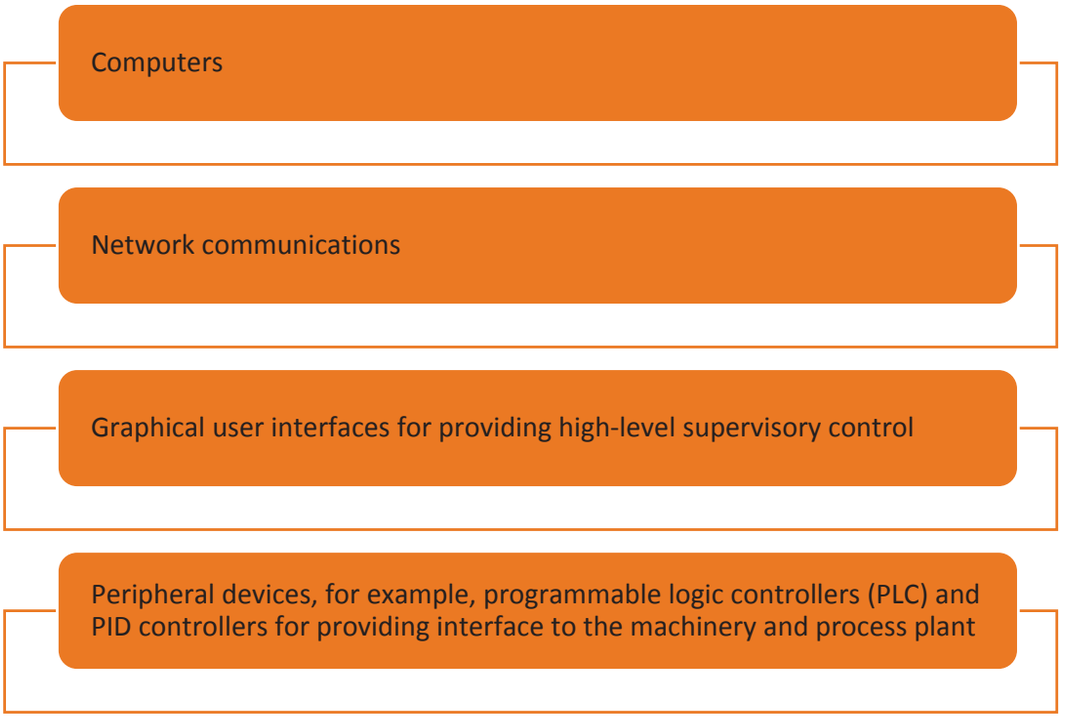


Fig. 1.5.2: Components of the SCADA system

Types of Power System

Though different power systems have common components, but they vary widely in their design and working procedure. The power system can be categorized as:

- Residential power systems
- Commercial power systems

The following figure shows the electric power systems:

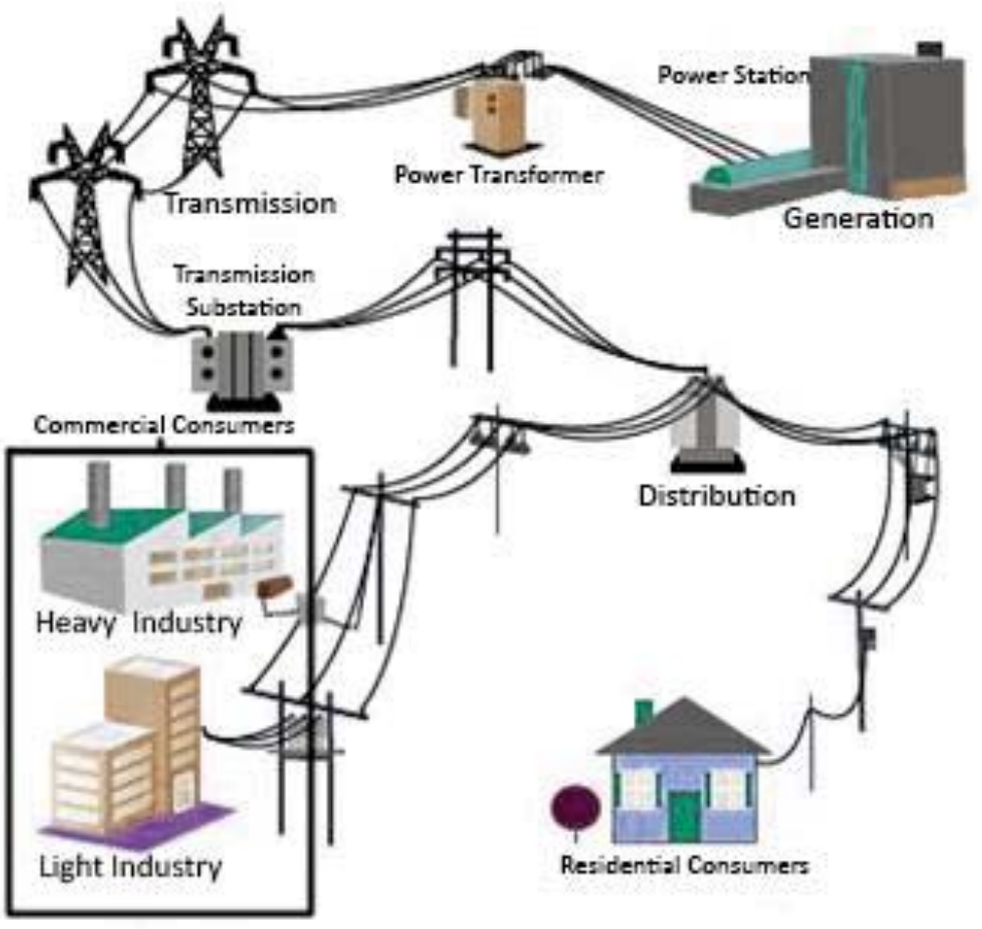


Fig. 1.5.3: Electric power systems

The following figure lists the characteristics of residential and commercial power system:

Residential Power Systems	Commercial Power Systems
•Receive electricity from the distribution lines having low voltage, that run past the dwelling. •Operating voltage ranges between 110 and 260 volts. •Majority of the residential wiring are of single phase with 120 Volts, consisting of positive, negative, and neutral wires. •Some appliances, such as air conditioner, refrigerators, dryers and washers use a two phase circuit with 240 Volts. •Residual current devices (RCDs) are installed, for safety reasons, on the appliance circuits as well as on the lighting circuits. •Wiring is usually hidden from users within the walls and attic crawl spaces. •Protective earths are run in combination with lighting circuits allowing the metallic lamp holders to be grounded. •Incorporating microgenerators especially photovoltaic cells.	•High-rise buildings and shopping centers require power larger than residential systems. •Large commercial installations require a well ordered system of sub-panels, which are separatd from the main distribution board. •Wiring uses a three-phase design and run through conduits or ceiling rafters where it is easily accessible to service. In three phase electrical systems, there are two smaller legs running 120 Volts each and wider leg running 208 Volts. •Commercial wiring often has a higher level of insulation, known as TTHT (Thermoplastic, high-heat resistant, nylon coated) to protect the electrical wiring from corrosive gases and liquids. •HVAC unit connected to it must be adequately supplied.

Fig. 1.5.4: Residential and commercial power systems

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2. Components for Solar PV System

Key learning Outcomes

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

- List the types of PV modules and their characteristics
- Identify the batteries used in PV system
- Describe standard parameter of battery
- Recognize functions of a charge controller
- List the types of charge controllers
- List the types of inverters
- Explain mounting structures

UNIT 2.1: Solar PV Modules

Unit Objectives

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

- Identify the characteristics of PV modules
- Evaluate the rating of a PV module

2.1.1 Solar PV Modules

The basic component of a solar PV system, a solar cell, is able to generate a very small quantity of electricity as compared to the electricity needs. For example, single solar cell can generate daily electricity in the range of 6Wh to 10Wh while daily residential and commercial requirements are much higher. Also, a crystalline silicon solar cells with an area of 10 × 10 square cm, can generate 1.5 Wattpeak (Wp) output power approximately, with open circuit voltage (V_{oc}) 0.6 V and short circuit current (I_{sc}) 3.5 A approximately. Therefore, to generate more electricity, solar cells are connected in combination of series and parallel to form a PV module. The following image shows a solar PV module:

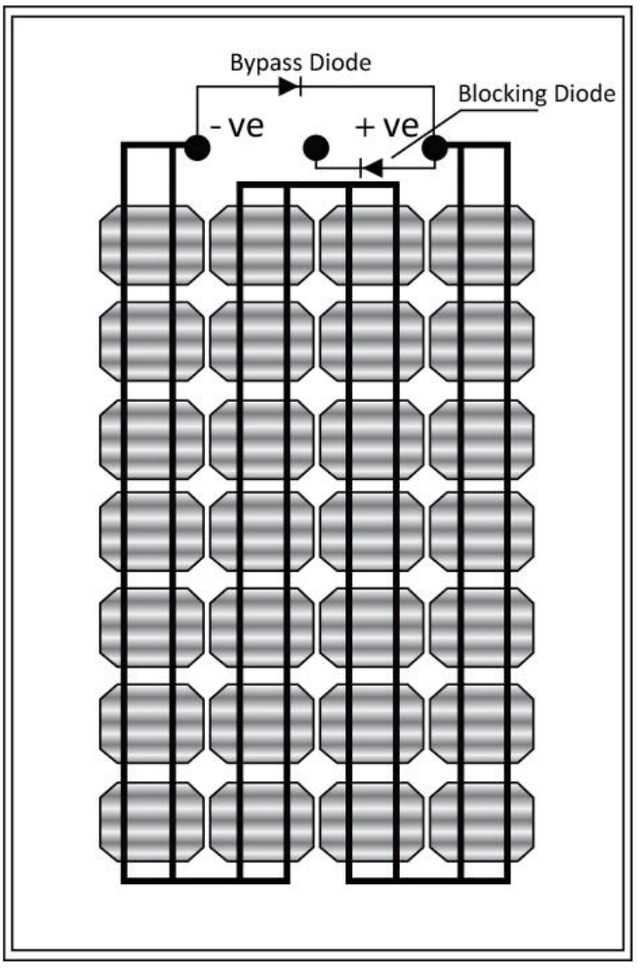


Fig 2.1.1: Solar PV module

The amount of the output current from a PV module is directly proportional to the solar irradiance. The output of solar PV module can be increased by connecting more solar cells in a parallel connection. The solar cell voltage primarily depends on its temperature not on the solar irradiance. PV modules, when formed by connecting the solar cells in series can operate at different voltages. The number of solar cells and the way they are connected in a PV module determines the current and voltage that the modules can provide, and the average energy they can produce every day. PV modules are very important part of PV systems.

TIP

Irradiance means the solar energy received per unit area in form of electromagnetic radiation.

2.1.2 Characteristics of Solar PV Modules

Like solar cells, the solar PV modules are named after the type of solar cells used in manufacturing them. The following figure lists some commonly available PV modules:

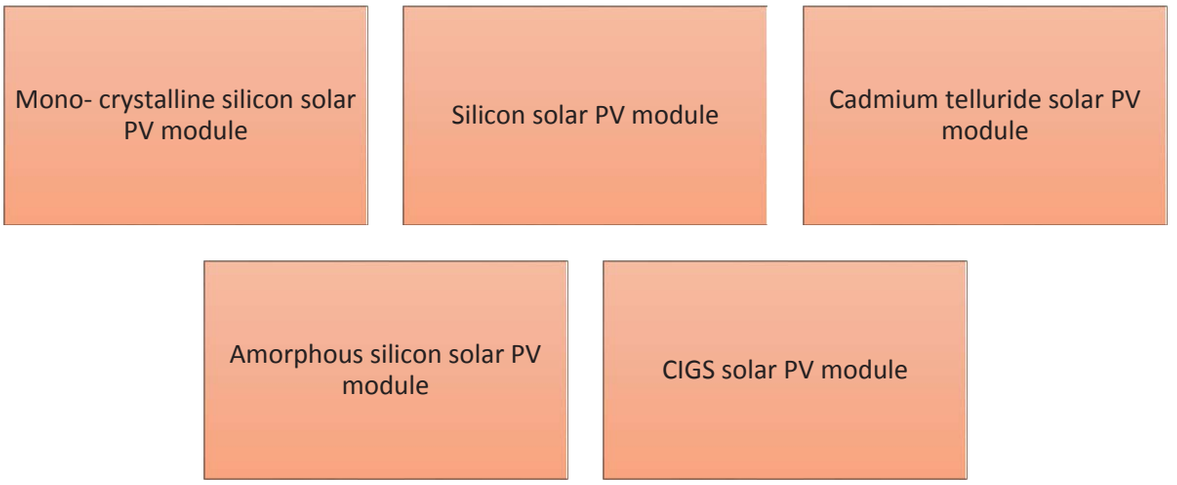


Fig. 2.1.2: Some commonly available PV modules

Mono-crystalline silicon solar PV module and multi-crystalline solar PV module are the most commonly manufactured and used PV modules.

The following table shows the efficiency of different PV modules:

Module Type	Efficiency
Advanced crystalline silicon modules	more than 18%
Commercial modules of mono-crystalline silicon solar cells	12 to 16%
Modules of poly-crystalline silicon solar cells	11% to 13%
Amorphous silicon modules	between 4% and 8%
Copper, Indium and Selenium (CIS) modules	11%
Commercial CIS modules	below 10%
Modules having gallium arsenide solar cells built for space applications	more than 20% and up to 30%

The performance warranty of most of the crystalline silicon commercial modules is a minimum of 20 years. Depending on climate and region, the energy pay-back time ranges from 2 years to 6 years. Most amorphous silicon modules available in the market have a stable efficiency level ranging from 4- 8%. The estimated energy pay-back time of amorphous silicon modules is 1-3 years.

TIP

EPBT= E_{input}/E_{saved}, where

EPBT is energy pay-back time

E_{input} specifies the amount of input energy for the life cycle of a module. It comprises of energy required for manufacturing and installing activities, energy required for module to operate and then finally to decommission it.

E_{saved} is the annual saving of energy from the electricity produced by the PV module.

Some important features of PV modules are listed as follows:

- A solar cell converts radiation energy into electrical energy when sunlight falls on it. Since solar cell is the basic component of a PV module, it generates electricity only when sunlight falls on it. Thus, in absence of sunshine or at night, there is no output energy from a PV module.
- The amount of electricity which a PV module can generate, depends on its physical size. Large size of the module enables large amount of electricity generation.
- PV modules are mainly characterized in terms of their power rating, which is known as 'peak power' rating denoted by 'Wp'. The Wp rating is maximum power rating that a PV module can provide under best condition, called standard test condition. The PV modules are available in Wp rating starting from 1 Wp to 300 Wp.

TIP

Commonly available Wp rating of PV modules are 3 Wp, 10 Wp, 18 Wp, 36 Wp, 50 Wp, 75 Wp, 150 Wp, 175 Wp, 220 Wp, and 300 Wp.

- Electricity generated from a PV module is DC in nature. The conventional electricity supply available is AC in nature. All the appliances such as TV, CFL, tube light, refrigerator, washing machine and so on run on AC. Therefore, if solar PV electricity has to be used, it must be first converted into AC. To convert DC electricity into AC electricity, an additional device called inverter is used.
- Since PV modules generate electricity only during day time, the batteries store electricity to be utilized by the load especially in the night for a seamless supply. Several devices such as LED bulbs, DC fans, DC water pumps and so on can directly be operated using DC electricity.
- Even other devices such as mobile phone, computer and refrigerator can also be run directly on DC. So, if we are using DC appliances, the use of inverter can be avoided. Also, the use of DC appliances is not very common.
- For large energy generation, many PV modules are connected. The interconnection of these modules is called PV module array.
- The I-V characteristics of a solar PV module is a graph in which different values of current (I) for different voltage (V) is plotted on Y-axis and X-axis respectively. A typical I-V characteristic curve of a solar PV module is shown in the following figure:

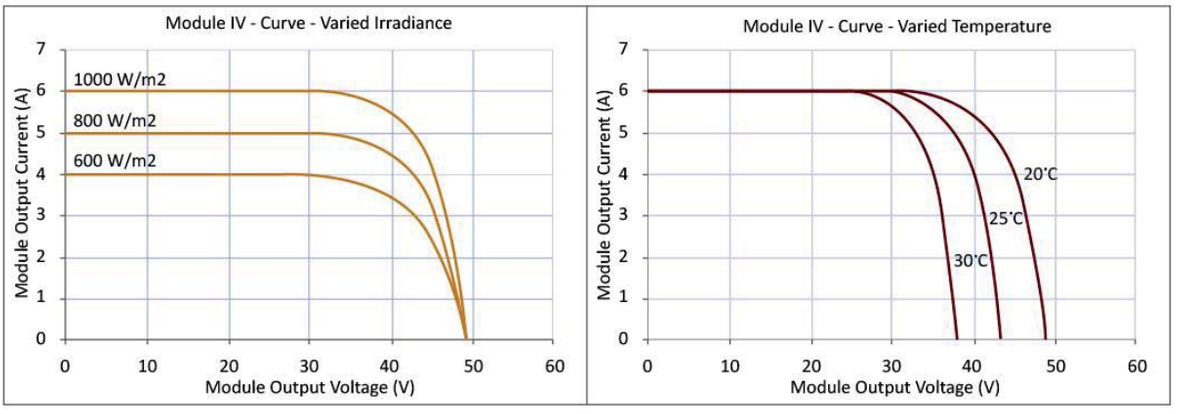


Fig. 2.1.3: I-V curve of a solar PV module

- A P-V curve is plotted between power of a solar PV module on Y-axis and voltage of a PV module on X-axis. The following figure shows a typical P-V curve of a solar PV module:

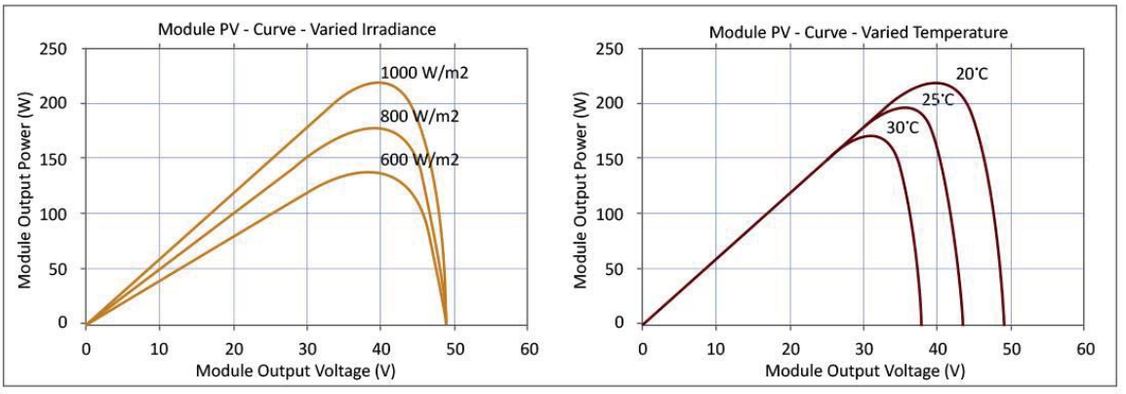


Fig. 2.1.4: P-V curve of a solar PV module

2.1.3 Rating of PV Modules

PV modules are rated by the manufacturers, generally at standard test conditions (STC). The STC rating for temperature is 25°C, irradiance is 1000W/m2 and sunlight spectrum is AM [air mass] 1.5G[global]. The solar irradiation is corresponding to the condition when solar radiation travels 1.5 times the thickness of the earth's atmosphere. Therefore, this irradiation is called Air Mass 1.5. However, the real energy produced by PV modules installed in a field is a consequence of varied operating temperatures, sunlight spectra and irradiances. Hence, it is important to rate the PV modules after analysing them at diverse temperatures and irradiances.

The International Electrotechnical Commission (IEC) Technical Committee 82 Working Group 2(IEC/TC82/WG2) has framed one of the most pertinent PV standards. It is the IEC 61853 standard with the title Photovoltaic Module Performance Testing and Energy Rating (IEC, 2011).

It is comprised of four sections:

IEC 61853-1	It specifies the measurement of temperature and irradiance and power rating of a PV module. It specifies the need for assessing the performance of a PV module as per its power rating at different temperatures and irradiances.
IEC 61853-2	It specifies the measurement of the incidence angle, spectral response and the operating temperature. It specifies about the testing methods used for the measurement of the effect of changing angles of incidence and sunlight spectra. It also describes the estimation of the speed of wind, the temperature of the module from irradiance as well as the ambient temperature.
IEC 61853-3	It specifies the rating of energy level of PV modules. It specifies the calculations involved in this rating in watt-hours.
IEC 61853-4	It specifies the standard time span and weather conditions which are ideal for calculating the energy rating.

Fig. 2.1.5: IEC rating of PV module

Electrical parameters are determined at STC. Rated specifications of a PV module are determined from the maximum power point (MPP) of the I-V curve of PV module. The PV modules are sealed to protect them against moisture, pollution, corrosion and weathering. In this way, the performance specifications of the modules can be guaranteed.

Activity

1. Some PV Module Parameters are given in the following table. Fill in the blanks by estimating the other PV module parameters. Assume Vm = 0.85 x Voc and Im = 0.93 x Isc. All the parameters are given at STC.

Voc (Volts)	Vm (Volts)	Isc (ampere)	Im (ampere)	Cell area (cm2)	Pm(watt)
21		5.0		145	
	13.5	2.0		55	
	14.5		0.8	30	
19			1.5	50	
	14.2		3.2	100	
	15	5.7		160	

2. Fill in the blanks in the following table for IV characteristics of solar panel.

Sr. No.	Current I (A)	Voltage, V (V)	Power, P (W)= I x V
1	0.00	0.58	
2	0.01	0.58	
3	0.39		0.22
4	0.79	0.57	
5	1.19	0.56	
6		0.55	0.88
7	1.99	0.54	
8	2.39	0.53	
9	2.79		1.47
10	3.19	0.51	
11		0.46	1.65

UNIT 2.2: Batteries in a PV System

Unit Objectives

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

- Define the function of batteries in a PV module
- List the types of batteries
- Perform the installation of a battery
- Explain battery maintenance

2.2.1 Introduction to Batteries

Batteries, an electrical storage medium, are integral part of a standalone solar PV system. The battery stores electricity generated which can be used later. They are important because without energy storage, a solar PV system will not be able to deliver the energy to the load when there is no sunlight. In case of a standalone system, electrical energy for running appliances in non-sunshine hours is needed whereas in a grid-connected PV system, energy storage is not required. In other words, it supplies electricity at night or in absence of sunlight when the solar panel is not able to produce electricity or power.

The battery is an expensive component and has a shortest life among the PV system components. The battery gets damaged when maintained poorly or not used properly. A typical battery used in the PV system is shown in the following figure:

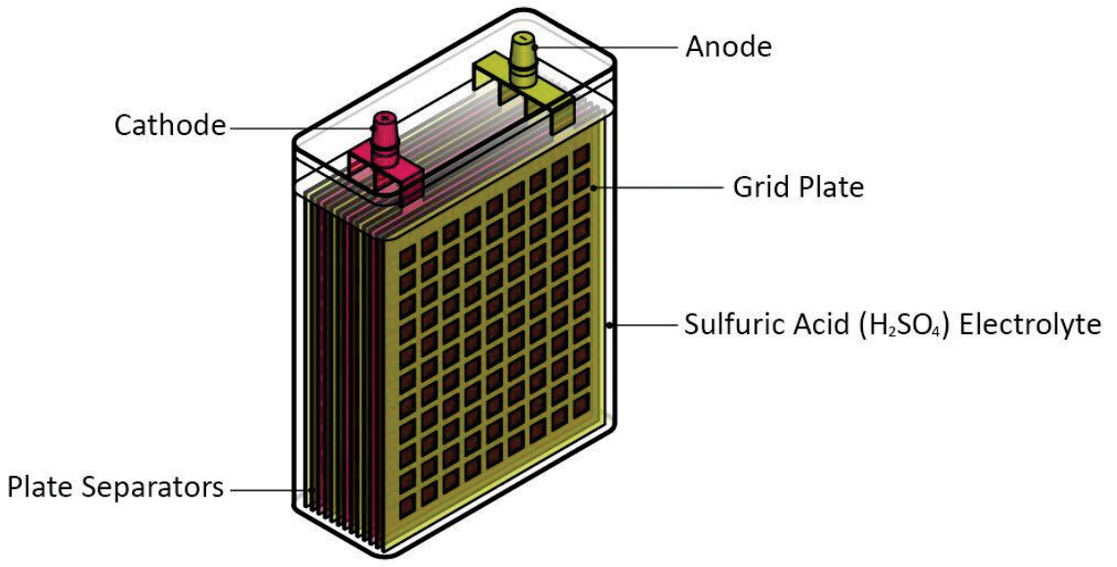


Fig. 2.2.1. Batteries

2.2.2 Components of Batteries

The components of a battery are listed in the following figure:

Anode

- It is generally referred as positive terminal, positive node or positive lead.
- It is the electrode which gives up electrons to the external circuit, as a result of which the electrode is oxidized during the discharging reaction.

Cathode

- It is generally referred as negative terminal or negative node.
- It is the electrode which gains electrons from the external circuit, as a result of which the electrode is reduced during the discharging reaction.

Electrolyte

- It is a medium which provides conductivity to ions between anode and cathode. One can say that an electrolyte is a medium through which current flows internally in a battery.
- An electrolyte is typically a liquid, such as water or other solvents which can dissolve salts, acids or alkalis.

Salt bridge

- It is a porous material used to keep the two electrodes connected but yet separated from each other; otherwise the chemical reaction would stop.
- It is also referred as separator.

Fig. 2.2.2: Components of a battery

2.2.3 Types of Batteries

There are variety of batteries available in the market for different types of applications. Each battery type is more suited for one type of application.

The following figure shows the classification of batteries:

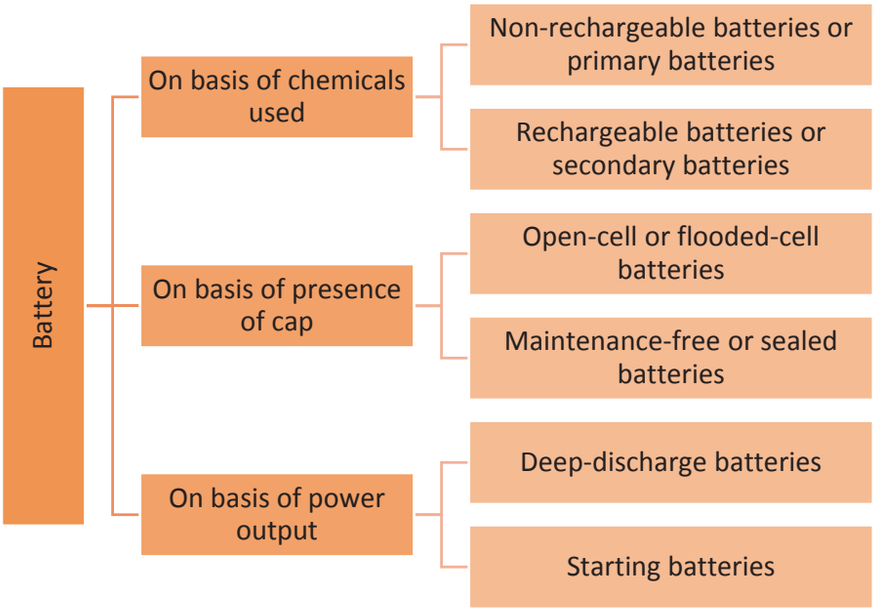


Fig. 2.2.3: Classification of batteries

Few of the primary and secondary batteries are listed in the following figure:

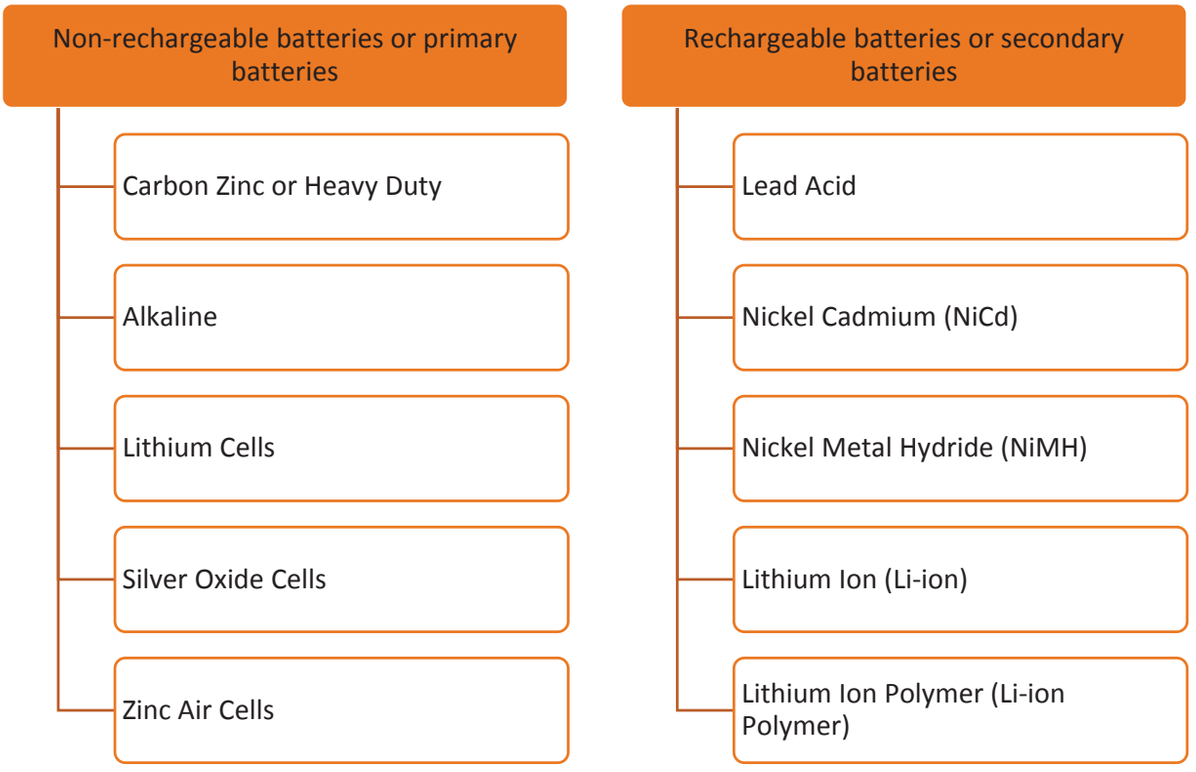


Fig. 2.2.4: Primary and secondary batteries

Other types of batteries are:

Open-cell or flooded-cell batteries	•Have removable caps on top •Facilitates testing the cells and adding water when needed
Maintenance-free or sealed batteries	•Are sealed and can be maintained only at a factory •Does not have filler caps though have a smooth top •Used for a PV system •Does not last as long as open-cell batteries if maintained properly
Deep-discharge battery	•Best-suited for most PV because they are specially designed to deliver a high percentage of their power without any damage • 80% of the power stored in a deep-discharge battery can be regularly used without damage
Starting battery	•Used for vehicles •Is designed to provide high power for a short time to start an engine •Are easily damaged by using a high percentage of the electricity stored in them

Fig. 2.2.5: Different types of batteries

Battery is the component of a PV system which requires careful handling and maintenance. The liquid level in the battery must be checked regularly to ensure correct level is maintained. The ionized distilled water or the purest form of water must be added if water level in the cell is low.

2.2.4 Parameters of Batteries

The standard parameters of a battery specified by the manufacturers are listed in the following figure:

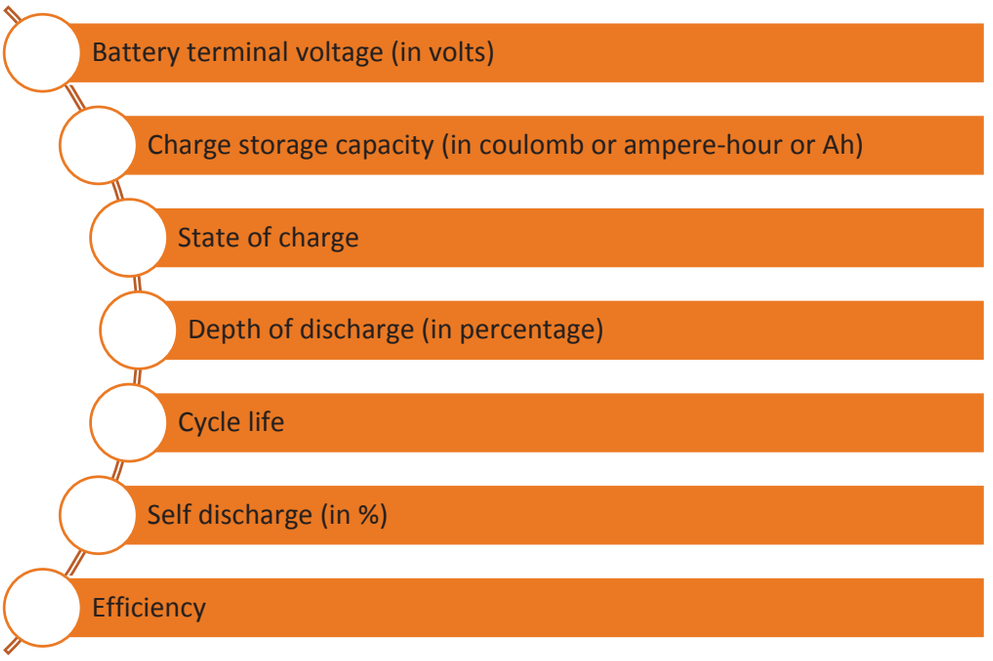


Fig. 2.2.6: Standard parameters of batteries

Battery Terminal Voltage

Batteries supply electrical energy to the load connected across its terminals. The electrical energy transfer from the battery to load is possible only when there is voltage difference between the two terminals. Thus, a battery's terminal voltage is the voltage difference between its two terminals or electrodes. The voltage difference between its terminals is the driving force for the current to flow.

For a given appliance, an appropriate level of terminal voltage must be available, otherwise the device does not work. The supply requirement may vary from 1.5V to 6V to 12V. Some devices may also need higher voltages. Thus, battery terminal voltage is one of the important parameters that determines the choice of the battery. For solar PV system applications, there are batteries which are available with 6V and 12V ratings.

Each battery is made up of cells. The terminal voltage of cells is determined by the components they are made up of. The battery terminal voltage changes with the condition of battery. It increases when the battery gets charged and decreases when it gets discharged.

The following figure lists different voltage terminologies associated with battery:

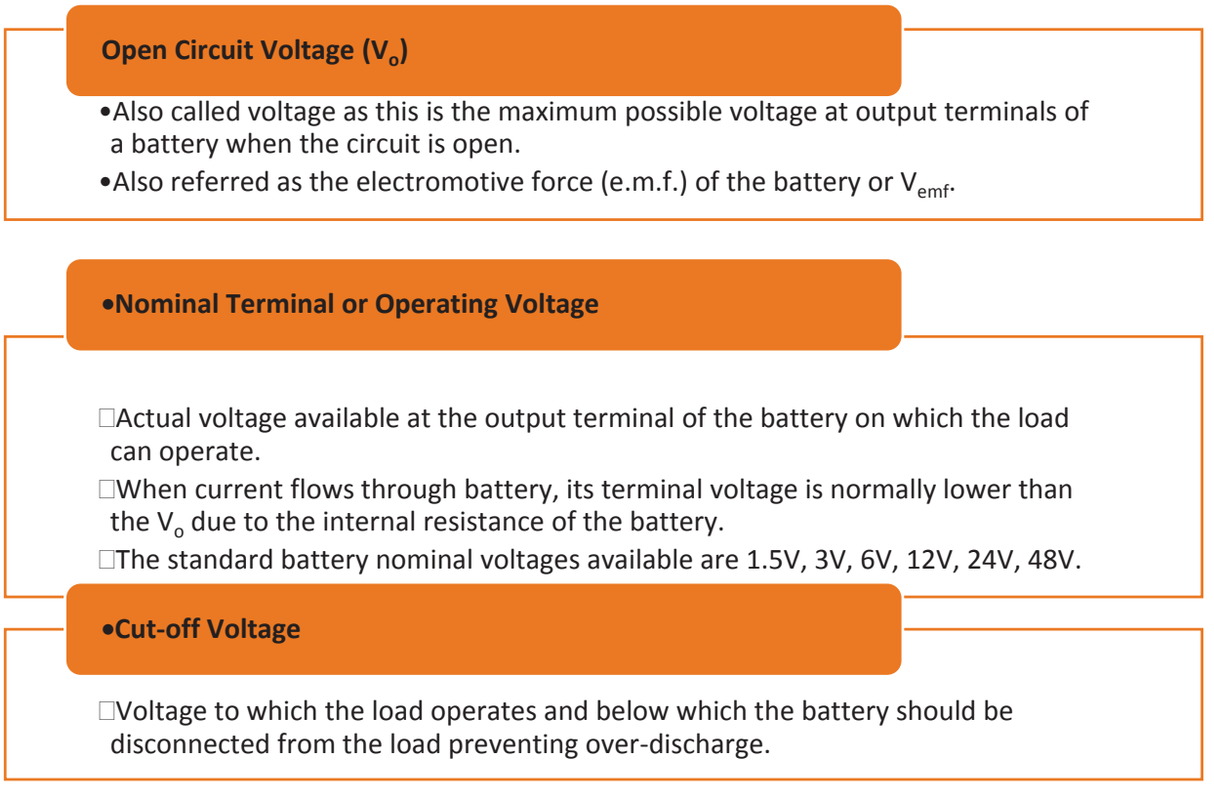


Fig. 2.2.7: Different voltage terminologies associated with a battery

Battery Storage Capacity

The capacity of a battery refers to its charge storage capacity and is expressed in terms of ampere-hour (Ah). One Ah is the amount of charge delivered when constant current of one ampere (A) is used for one hour (h). The capacity of a battery is given by the expression:

Capacity (C) = Current (A) X Hour (h)

The capacity of non-rechargeable batteries normally varies in few mAh to several Ah. The capacity of rechargeable batteries can vary from few Ah to thousands of Ah.

State of Charge (SOC)

SOC of a battery refers to the percentage of its capacity that can be used. For example, a battery having 100 Ah rating but depleted by 20 Ah will have an SOC measurement of 80%. The ratio of the quantity of energy currently saved in the battery to its given rated capacity is known as the battery state of discharge (BSOC or SOC). A 500 Ah capacity rated battery will have 400 Ah of energy saved in the SOC is 80%. A simple way of measuring the BSOC of a battery is to measure its voltage and compare it with the voltage of a battery that is fully charged.

Depth of Discharge (DOD)

The depth of discharge (DOD) of a battery ascertains the amount of power of the battery that can be used. For example, if the manufacturer of a battery marks its DOD as 25%, then the load can utilize only 25% of its capacity.

Almost all batteries, especially the ones used for renewable energy appliances, get their rating as per their capacity. However, the real energy that can obtained from the battery, especially for lead acid batteries, is much less than the given rated capacity. This happens because taking out the entire capacity from the battery can reduce its lifetime considerably. The amount of the battery capacity that can be utilized from the battery is called its DOD. If a battery has its rated capacity as 500Ah and DOD of 20%, then it can give 500 x .2= 100 Ah of energy.

Percentage of maximum capacity of the battery is the percentage of its capacity that has been discharged. A discharge of minimum 80% DOD is known as deep discharge.

Therefore, normally, deep discharge batteries are preferred for PV applications. The batteries used for solar PV applications have high DoD, about 50%. In practice, there is no battery for which the allowable DoD is 100%. Normally, the batteries used for starting, lighting and ignition applications, for instant, the car batteries, have small DoD, about 10% to 20%. The Li-ion batteries have DoD of 80% to 90%.

Cycle Life

Cycle life is defines as the number of cycles a battery or cell carries out before capacity reaches 80% 80% of its original capacity.

Every cycle of charge and discharge of the cell is linked to a simultaneous conversion cycle of the active chemicals within the cell. This is accompanied by gradual degradation of the chemicals in the cells that is not visible to the user. The degradation could be a consequence of undesirable and unavoidable chemical reactions within the cell or an alteration in the morphology of the electrode particles due to growth of dendrites and crystal. The cell capacity is reduced or the effective resistance within the cell may rise as the volume of the active chemicals in the cell could diminish over time.

The cell does not die after the cycle life is over but its gradual degradation carries on. It works normally but its capacity decreases considerably as compared to when it was new.

Self-Discharge Rate

The rate at which a cell gets discharged while not in use, because of undesirable chemical reactions inside it, is called its self-discharge rate. It depends on the temperature and components of the cell. The following table lists the self-discharge rates per month for some batteries:

Type	Self-Discharge Rate/month
Lead Acid	4% to 6%
Alkaline	2%-3%
Primary Lithium Metal	10%
Nickel Based	10%-15%
Lithium ion	1%-2%

Battery Efficiency

The charging voltage for any rechargeable battery is greater than the discharging voltage.

- Charging voltage = battery electromotive force (e.m.f.) + voltage drop because of the internal resistance of the battery
- Discharging voltage = battery electromotive force (e.m.f.) – voltage drop due to the internal resistance of the battery

The discharged energy is always less than the charging energy of the battery due to its internal resistance. Typically, a lead-acid battery is 80% to 90% efficient in doing charge transfer. The expression for the charge transfer efficiency is as follows:

Ampere-hour/Charge transfer efficiency = Discharged energy (Ah) X 100 / Charging Energy (Ah)

2.2.5 Batteries Used in PV System

The batteries used for PV system:

- Must be rechargeable
- Must allow deep discharge
- Should have long life span
- Should be easily serviced
- Have high capacities and low self-discharge rate

Lead Acid Battery

Lead acid battery is the most common battery that is used in PV applications. The name comes from the main components in the battery which are lead and sulphuric acid.

The following figure lists some characteristics of lead-acid batteries which make it a good choice for PV applications:

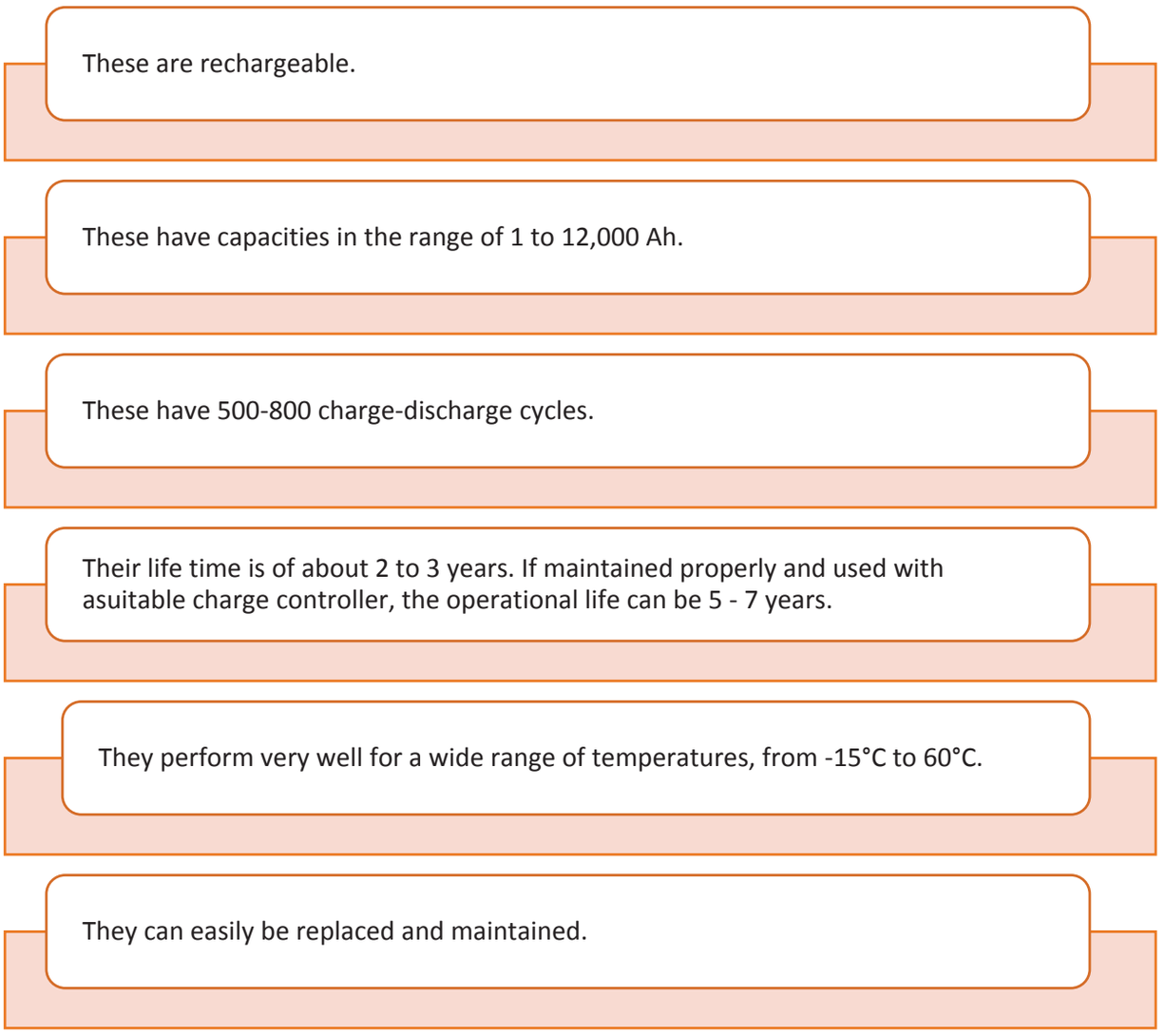


Fig. 2.2.8: Characteristics of a lead-acid battery

The most commonly used lead-acid battery is the car battery. A car battery is designed to provide a high current for a short duration for starting the engines. They are sometimes used for small photovoltaic systems because of their low cost but their operational life in solar PV applications is likely to be short. Hence, the car batteries are not suitable for deep discharge cycle that is experienced by the batteries in PV systems.

Flooded Tubular Plate Design

The most common lead- acid battery used in PV systems is of flooded tubular plate design, having low antimony plates. Longer operational life may be achieved if the maximum DOD is limited. If the batteries are wrongly treated, it will lead to a shorter lifetime. Flat plate lead-acid batteries are often used as stationary batteries for the stand-by applications. However, these batteries do not allow deep cycling. Hence, these are not the best choice for most of the PV applications.

Sealed Lead-Acid Battery

A sealed lead-acid battery is designed mainly to avoid spillage problems and the need to top up the electrolyte. Some of this type batteries are sold specifically to be used in the PV systems. They are attractive for applications in the remote regions where visit to the site is a problem. Sealed lead acid batteries are considerably more expensive and generally less resistant to extreme temperatures than the conventional flooded batteries.

Nickel Cadmium Batteries

The nickel-cadmium battery (NiCd or NiCad) is a rechargeable battery which has porous plaques of nickel hydroxide as positive plates of the electrodes and porous plaques of cadmium hydroxide as negative plates of the electrodes.

The following figure lists two types of NiCd batteries:

Sintered Plate NiCd Batteries	Pocket Plate NiCd batteries
•These suffer from memory effect, in which the useful capacity of the battery appears to drop after it has been discharged over many cycles or if it is discharged at low rates. •These batteries are not, therefore, attractive for use in PV systems.	•These can be used in PV systems because they have additives in their plates to prolong their operational life and to minimize the memory effect. •These are highly resistant to extremes of temperature and can safely be taken down to less than 10% SOC. •Their main disadvantage is their high cost as compared to lead-acid batteries.

Fig. 2.2.9: Types of NiCd batteries

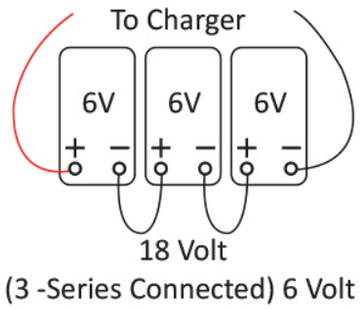
Comparison between Lead Acid Batteries and Nickel Cadmium Batteries

The following table lists the comparison between lead acid batteries and nickel cadmium batteries based on their performance and prices:

Battery type		Lead-acid		NiCd
Cycle time		600 to 1500 cycles		1500 to 3500 cycles
Efficiency	[Ah extracted/Ah restored]	83 to > 90%		71%
Self discharge rate		3 to 10%/month		6 to 20%/month
Range of operation		-15 to +50°C		-40 to +45°C
Investment cost	[€/kWh capacity]	160	- 200	690 - 1590
Specific energy cost	[€/kWh from battery]	0.11	- 0.33	0.20 - 1.06

2.2.6 Connection of Batteries in a Photovoltaic System

In a PV system, the batteries can be connected in series, parallel or in both. The following figure shows the connections of the batteries:



Series Connection

Batteries are connected together in series when the required PV system voltage is higher than the individual battery terminal voltage.

Negative terminal of one battery is connected to the positive terminal of the other.

The positive terminal of the first one and the negative terminal of the last one are used to obtain high voltage.

Connecting the batteries in series increases the voltage.

Ideally, it is desired that the terminal voltage of all the series connected batteries is same.

Parallel Connection

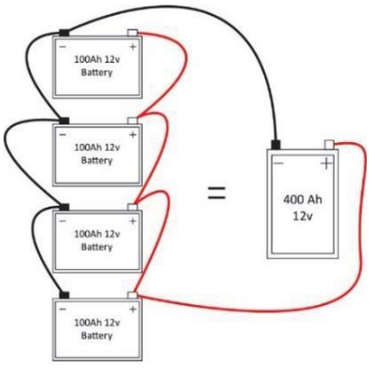
Batteries are connected in parallel when high current is required.

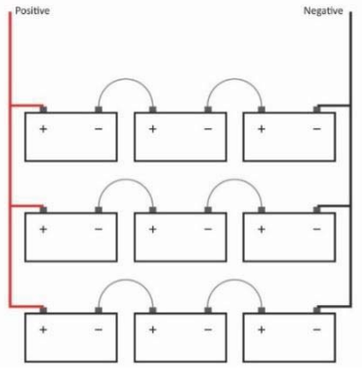
Same type of terminals are connected together at one point.

The positive terminal of all the batteries is connected as one and negative terminal of all the batteries are connected together as one.

The capacity of each battery is additive.

Connecting the batteries in parallel increases the capacity but the voltage remains same, which is equal to the voltage of a single battery.





Mixed Connection

Combinations of series and parallel connection are used.

This type of connection is used when both voltage and current/capacity requirement increases the standard values of available batteries.

Depending on the voltage requirement, the calculated numbers of batteries are connected in series and depending upon the current/capacity requirement, the numbers of such series combinations are connected in parallel combinations.

Fig. 2.2.10: Different connections of the batteries

2.2.7 Maintenance of Batteries

Batteries can be used for a longer period if they are properly maintained. To keep the battery in a good condition, the following actions should be taken:

Keep the battery clean	•If the top of the battery is dirty, corrosion will soon be a problem and electricity will begin to leak from the battery connections through the dirt. •To clean the battery, use only fresh water and a rag.
Test each cell with the hydrometer	•All the cells should measure about the same when tested with the hydrometer. •If one or more cells measure very differently from the others, the battery is probably beginning to fail.
Keep the battery cells full of electrolyte	•The battery cells should be checked at least once a month and special, high-purity water added if the liquid is below the correct level. •If water has to be added often to one or two cells but not the rest of the cells, the battery is failing and it will have to be replaced soon.
Equalization of a battery	•Sometimes the battery can be repaired by deliberate overcharging. This is called an equalizing charge. •To equalize the cells in a battery, give them a slow, controlled overcharge.

Fig. 2.2.11: Actions to be taken to maintain the battery

Activity

1. Fill in the following table on capacity, discharge rate and current of battery.

Capacity	Discharge Duration	Current Produced
50 Ah	10 h	5.....
120 Ah	..... h	4 A
250.....	20 h	12500 mA
.....	12 h	30 A
450 Ah	15 h	.....
1200 mAh	....h	10

2. If you have 12 V battery of capacity 500 Ah, then calculate the power of battery and the amount of energy stored in the battery. Assume battery duration is 10 hours.

UNIT 2.3: Charge Controller

Unit Objectives

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

- List the functions of charge controller
- Identify the types of charge controller
- Explain different charge controller technologies
- Explain the maintenance of a charge controller

The PV panels can overcharge the battery by forcing too much electricity into it. Hence, a charge controller is required. The battery gets hot and loses water rapidly when it is overcharged. This may cause damage to the battery. A charge controller controls the charge by working similar to a valve on a rainwater collection system which prevents overflowing of the water tank.

2.3.1 Defining Charge Controller

The charge controller must be connected between the battery and PV panels. The voltage of battery is constantly under a check. A controller restricts extra charge from getting into the battery if a high voltage indicates full battery. The following image shows charge controller in a PV system:

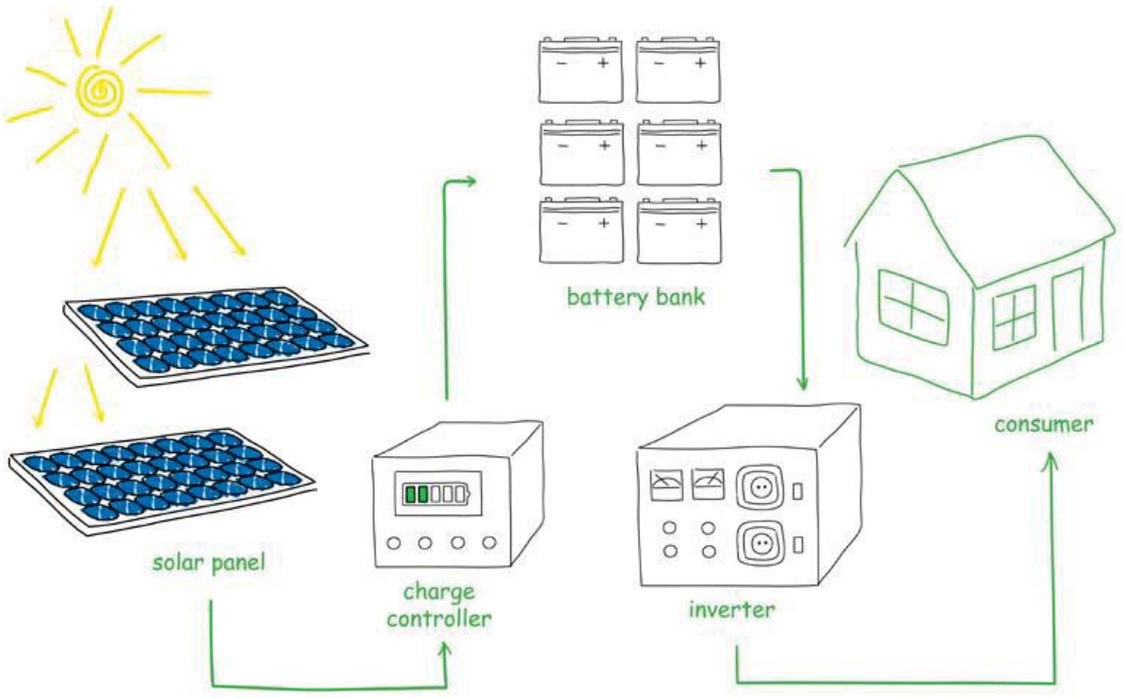


Fig. 2.3.1: Charge controller

Charge controller performs functions such as:

- Charging the battery.
- Giving an indication when battery is fully charged.
- Monitoring the battery voltage and when it is minimum, cutting off the supply to the load switch to remove the load connection.
- Ensuring the load is cut off from the battery supply in case of overload (the load is in a switch-off state).

The following figure shows the functions of a charge controller:

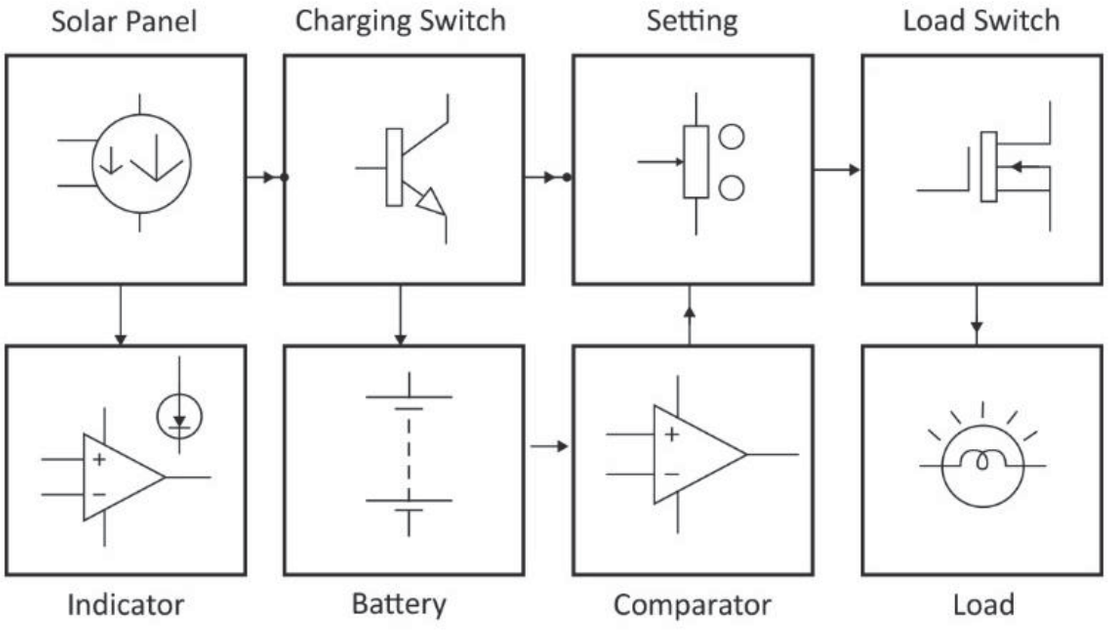


Fig. 2.3.2: Functions of a charge controller

2.3.2 Charge Controllers - Types

The main types of charge controllers are mentioned in the following figure:

Series Charge Controller

- A switch shutting the electricity flow off from the panel to the battery when full charge is attained.
- Switching usually done using magnetic switch known as a relay. Other switching transistors may also be used.

Parallel Charge Controller

- It is a parallel connection along with panels placed side to side with their output wires.
- The panel wires are short restricting any extra electricity to the bettery when a full battery is sensed.

Discharge Controller

- Restricts appliances from intake of excess electricity from the battery to avoid discharging it.
- It should be connected between the appliances and battery. It works by keeping the battery's voltage under a constant check.
- During a low voltage, it shows a battery is completely drained.

Combined Charge & Discharge Controllers

- They are put together in a same box and can be distinguished by looking their respective connections.
- If the connections lead to the panels, the controller box consists of a charge controller. If the box connections lead to the appliances, the controller box consist of a discharge controller.

Fig. 2.3.3: Types of Charge Controllers

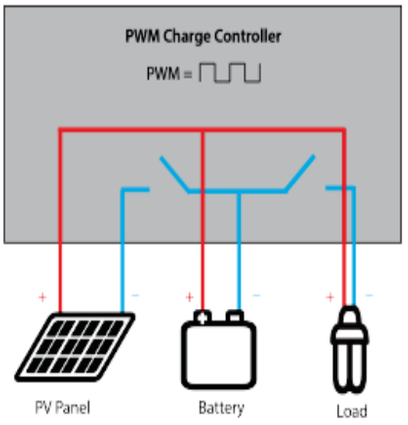
The following image shows a combined charge controller:

Fig. 2.3.4: Combined charge controller

2.3.3 Charge Controller Technologies

A basic charge controller ceases to charge a battery when they go beyond a set upper limit of voltage level and begins to recharge when the battery voltage goes back, down that level. With technological advancements in electronics, charge rates can be adjusted as per the battery level allowing maximum charge capacity. The following figure lists the technologies used by the charge controllers:

Pulse Width Modulation (PWM) Charge Controller

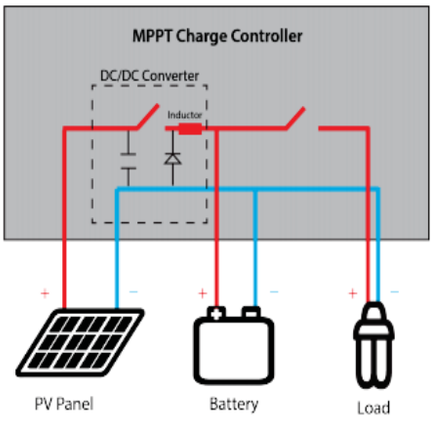


PWM charge controllers function by matching the panel voltage to the voltage of the battery and in the process bring down the output voltage of the panel.

It comes into action when the battery is full. At the time of charging, it allows current as much as the panels can generate to reach the target.

Once the battery reaches the target voltage, the battery is disconnected from the charge controller from the panel ensuring the efficient charging of the battery and protecting it from being overcharged.

Maximum Power Point Tracking (MPPT) Charge Controller



MPPT charge controller is based on the latest technology and aims at getting the utmost benefit from the solar panel. It functions as per the panel voltage and transforms the excess voltage of the panel into current. This gives a boost to the solar panel's output.

MPPT charge controllers have an indirect connection with the PV system and the battery bank as it is linked to a DC/DC voltage converter. This converter changes the extra PV voltage into additional current without any loss of power.

MPPT controllers do using an adaptive algorithm which follows the MPP of the PV array and then adjusts the input voltage to manage the efficient amount of power for the system.

Fig. 2.3.5: Charge controller technologies

2.3.4 Terminologies Related to Charge Controller

For a charge controller to operate, various voltage and current levels are defined. These levels are listed in the following figure:

Nominal System Voltage	•Voltage at which charge controller and battery operate in PV system.
Nominal Load Current	•Maximum load current that charge controller should be able to handle.
Nominal PV Array Current	•Maximum PV array current that charge controller should be able to handle. •A safety factor of 1.25 is used to account for variation in short circuit current at non STC.
Charge Regulator Set Points	•It senses a battery's voltage (or SoC) to decide either to disconnect the source (PV array in this case) to prevent overcharging or to disconnect the load (from the battery output) to prevent deep discharging. •Majorly used in cases of unpredictable loads and the batteries for minimizing initial cost (optimized/undersized). There are set algorithm threshold values, decisions upon which are taken.
Voltage Regulation Set Point (VR)	•A battery's maximum voltage up to which it hold its charge capacity. •At a threshold level, the controller either regulates the current received by the battery or disconnects it from the source.
Voltage Regulation Hysteresis (VHR)	•It is the difference between VR and the voltage at which the controller reconnects the battery to the PV source and starts charging. • VRH determines the effectiveness of a controller charging the battery.
Low Voltage Disconnect (LVD)	• Minimum battery's voltage that states its discharge but not deep discharge. It is also referred as DoD of battery (depth of discharge). • Battery load is disconnected by charge controller the moment voltage reaches its LVD, to avoid deep discharge.
Low Voltage Disconnect Hysteresis (LVDH)	•Difference between battery voltage and LVD value, where load battery terminals are reconnected to the load. •Low LVDH will make the load switched on and off more frequently, which can adversely affect the battery hence the LVDH is not very low.

Fig. 2.3.6: Voltage and current levels of a charge controller

The following figure shows the charge regular set points:

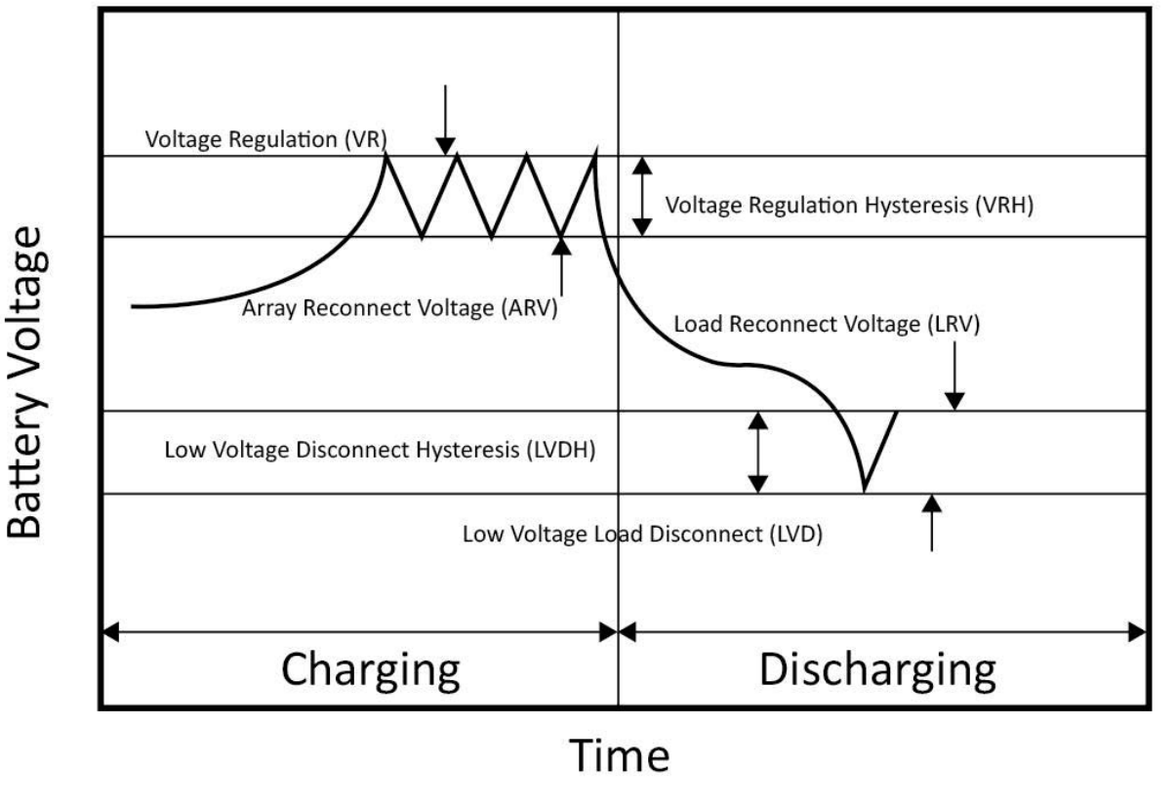


Fig. 2.3.7: Charge regular set points

Charge controllers are available for various rating of nominal system voltage and PV array current. Typical rating of 12V, 6A rated PWM charge controller is shown in the following figure:

Nominal System Voltage	12V
Nominal PV array current	6A
Nominal load current	6A
Regulation voltage	14V
Low voltage disconnect	11V
Low Voltage reconnect	13V
Type of charging	Series PWM
Temperature	-20' C to 55'C
Self-consumption	10mA maximum

Fig 2.3.7: Specifications of a PWM charge controller

Features of Charge Controller

The features of a charge controller are as follows:

- Type of switching and control: Switching may be series type or shunt or parallel type. The control algorithm used by a charge controller may be PWM type or MPPT type.
- Temperature compensation: It alters the charge regulation voltage as per the battery temperature.
    - Raises the regulation voltage when the battery temperature is very low. This improves its capability to charge the battery.
    - Lowers the regulation voltage when the temperature of the battery is high. It helps to reduce the loss of electrolyte and overcharging of the battery.
    - Lead acid battery has the standard temperature compensation coefficient of -5Mv/°C.

  Few charge controllers have the provision of equalization functions, both manual and automatic. Charge regulation voltage is regularly raised for a fixed span of time to equalize the battery cells. Flooded, and vented batteries usually get the equalisation charge.
- Indications for system status and operating information: The set points of the charge controller specify the voltage levels of the controller to perform regulate and control functions. These are important parameters affecting the life of the battery and the system efficiency.

  Few charge controllers have battery voltage sense leads to oppose the aftereffect of voltage drop on the charge regulation set points. The following image shows battery voltage sensing of a charge controller:

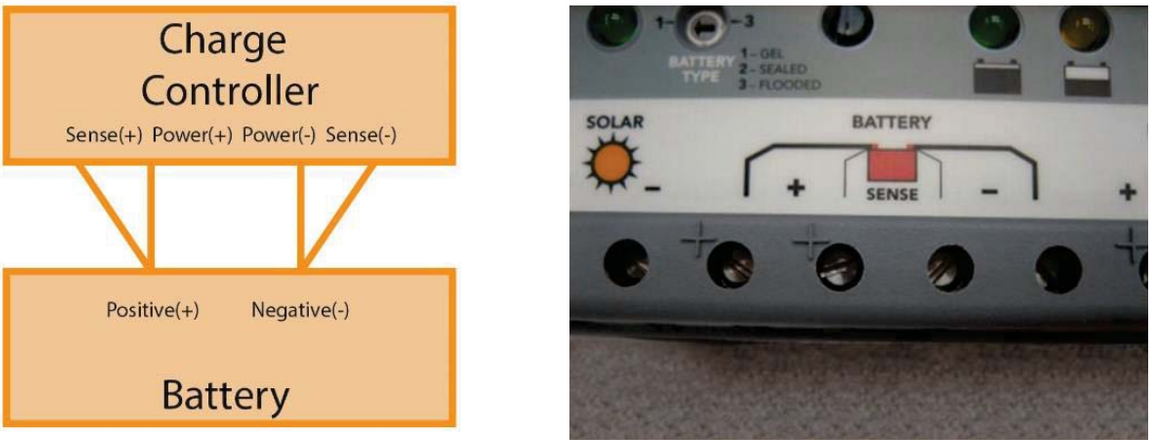


Fig. 2.3.8: Battery voltage sensing of a charge controller

2.3.5 Wiring and Maintenance of Controller

Connecting the correct wires to the right terminals is very important. Incorrect wiring of the controller prevents it from working and the battery may be damaged due to this. For wiring and maintenance of the charge controllers, the key points as shown in the following figure need to be followed:

The controller should be wired in the circuit as per the instructions provided by the supplier of the controller in the manual.

- The battery's positive should be connected to battery's positive terminal on the controller followed by a panel's positive terminal being connected to the controller.
- In some cases, a controller has a panel connected before the battery or vice versa in other cases.

The controller should be strongly mounted in a cool place away from sun, safe from rain and close to the battery.

- A controller should be placed where indicators are visible. Problems may be caused de to long wires between the battery and controller as measurement of charge from a distance is difficult.
- A wire should range between 1m-2m between a battery nas controller.

Ensure installation of an earthing system and that all intallation steps are duly followed.

- Lightening is the major damaging agent of semiconductor switches. A circuit to disperse generated electricity from lightening is included in charge controllers of good-quality.
- Controllers must be equipped with a wire earther properly using an earling rod (burried) so that electricty as a result of lightening can go down in the ground without causing any harm to the controller.
- A mount or PV panel frame is essentialy required in some installations for an earth connection.

Avoid changing controller adjustments.

- The adjustments indicate a full or discharged.
- Without appropriate equipment or techniques, adjustments can't be correct.
- Any change in adjustments without proper equipment/techniques, it may result in a battery's damage or decreased life span.

Ensure a correct wiring.

- Incorrect wiring can cause serious damage to controllers.
- Other factors are water, insects, heat, and animals.
- Carefully add new appliances to ensure a controller handles extra power without damaging itself.
- In case of a serious damage to controller, consider replacing with a good quality controller.

Fig. 2.3.9: Key points for wiring and maintenance of the charge controllers

Activity

Complete the following table to obtain missing quantities:

Solar Panel Wattage (W)	Solar Panel operating voltage	Battery bank voltage	Battery bank current	Battery bank current +25%	MPPT Ratings
1000	24	24	41.67	51	24V, 51A
3000	36	36			
4800	48	36			

UNIT 2.4: Inverters

Unit Objectives

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

- List the basic functions of inverters
- Identify the types of inverters
- Evaluate the efficiency of inverters

2.4.1 Defining Inverter

Most of the appliances use AC power while PV modules produce DC Power. Also, in standalone solar photovoltaic systems the energy stored in batteries is in the form of DC power. Therefore, the transition of DC power to AC power is required before it is used for running appliances. Transition of DC Power into AC power can be obtained using devices called DC to AC converters or DC/AC converters or inverters. The following figure shows the basic workflow of an inverter:

Fig. 2.4.1: Basic workflow of an inverter

The inverter's main functions are listed in the following figure:

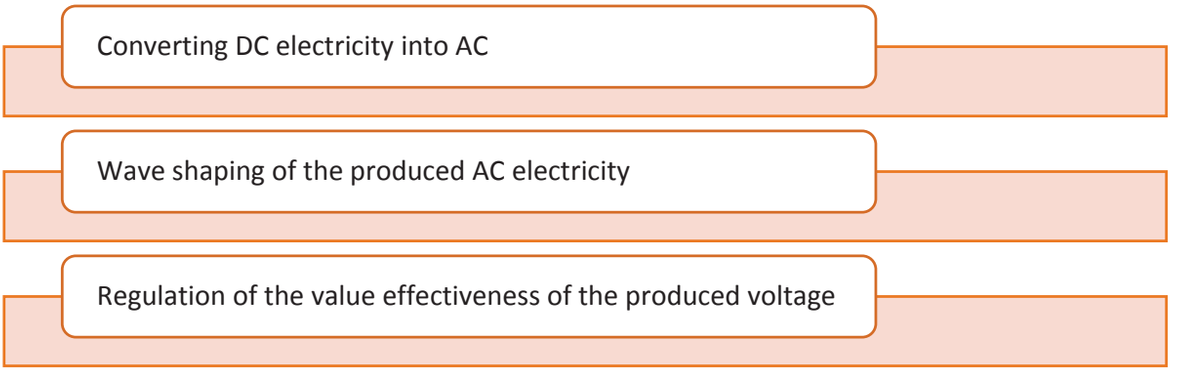


Fig. 2.4.2: Basic functions of an inverter

Inverters for PV Applications

Inverters operating in a solar PV system, constantly nears MPP (maximum power point). The high-switching- frequency inverters with a 20 kHz or higher frequency, is possible because of switch- mode semiconductor power devices. Low power inverters use power MOSFETs and bipolar transistors whereas, thyristors are utilized in high-power inverters. If run at a frequency up to 50 kHz, IGBT (Insulated-gate bipolar transistor) have the capacity of handling several hundred kW; delivering an AC production wave in the form of pure sinusoidal one, along with a little filter at the output. Thus, the process restricts the large, energy-consuming and expensive power filters.

Inverters, used for PV applications, have the following:

- Reliability
- Efficiency characteristics

Solar inverters have some unique functions modified to work with PV arrays. These include highest power point tracking and anti-islanding safety. Islanding indicates a state wherein a distributed generator (DG) persists powering an area when the grid power is not available from the utility.

Solar micro-inverters are not same as the regular inverters. Each solar panel has a single micro-inverter connected to it. The total efficiency of the system can be enhanced due to this. The collective output from all the micro-inverters is supplied to the electrical grid.

2.4.2 Types of Solar Inverters

The solar inverters play as a significant interface between the solar PV and load. Depending on whether battery is used in the PV system or not, the solar inverters can be classified in three categories:

- Standalone Inverters
- Grid Tie Inverters
- Battery Backup Grid-tie Inverters

Standalone/Off-Grid Inverters

They are normally used in standalone PV power systems. In standalone system, there is no backup of power for energy storage. Therefore, this type of inverter has battery backup to supply the power to the load in case of non-sunshine hours.

The standalone inverters are called so because there is no need to attach them to the solar panels. They receive DC power from batteries. PV arrays are used to charge the batteries. Some standalone inverters are coupled with the battery chargers to refill the battery. Since the standalone inverters are detached from the utility grid they do not need anti- islanding safety.

The following image represents a block diagram of a standalone inverter:

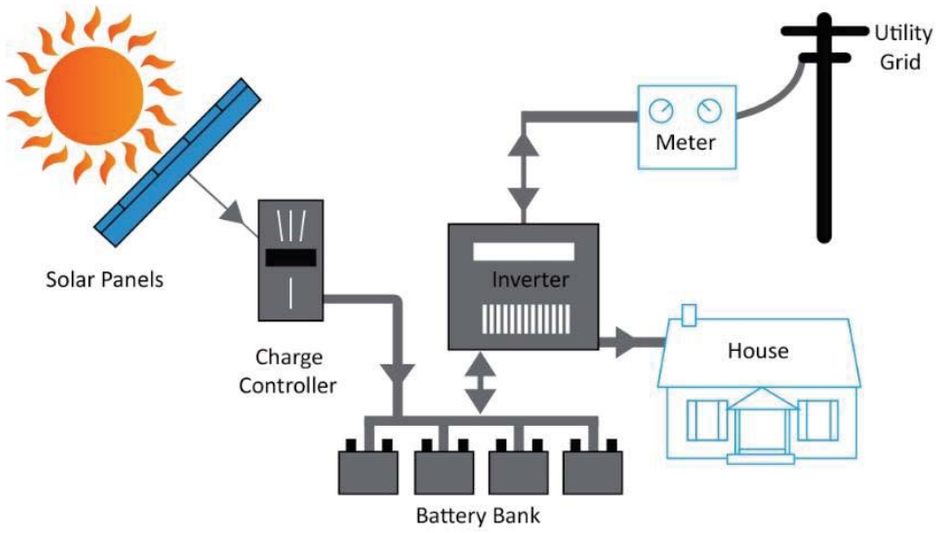


Fig. 2.4.3: Block diagram of a standalone inverter

Grid Tie Inverters

These inverters are connected to grid and do not have battery back-up. They have special circuitry to match inverter output voltage and frequency with that of grid. Grid is used as battery backup when power generated by PV array is insufficient. These inverters also have inbuilt MPPT to extract maximum amount of power from the PV array.

When the sun is shining and PV array is generating more power than usage, then the extra power after meeting the load is supplied to the grid. If PV array power is less than the load requirement, then some power is drawn from the grid to make up the shortage of power.

The grid tie inverters are set up in such a way that they turn off automatically at times of power loss to provide protection from any harm. Thus, at such times these inverters do not supply emergency power. Homes, which are powered by utility grid, should utilize grid tie inverters to get benefit from net metering. Grid tie inverters need anti- islanding protection in their system. The following image represents a block diagram of a grid tied inverter:

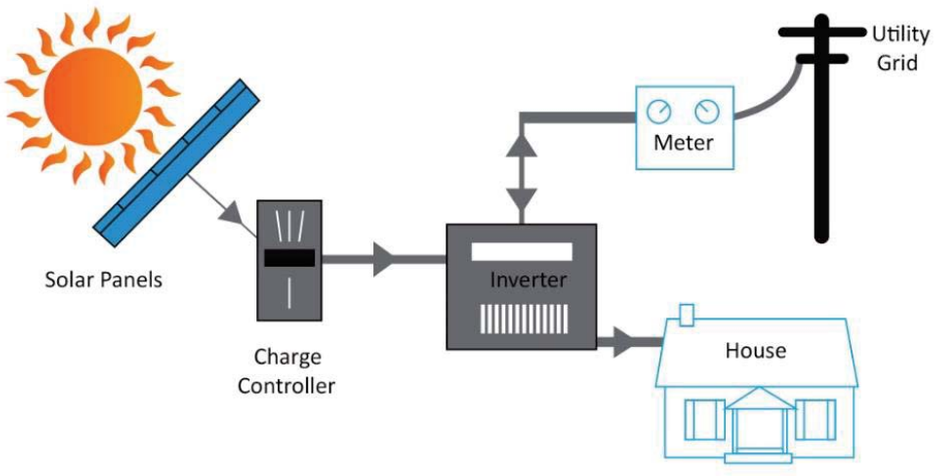


Fig. 2.4.4: Block diagram of a grid tie inverter

Battery Backup Grid-tie Inverter

Grid-ties inverters also have battery backup like standalone inverters. The battery backup inverters are designed to draw energy from batteries and regulate that with its on-board charger. They supply the extra energy to the utility grid. These inverters can provide AC power to chosen areas where energy is needed at times of power interruptions. They need to install anti-islanding protection. A battery backup grid-tie inverter is shown in the following image:

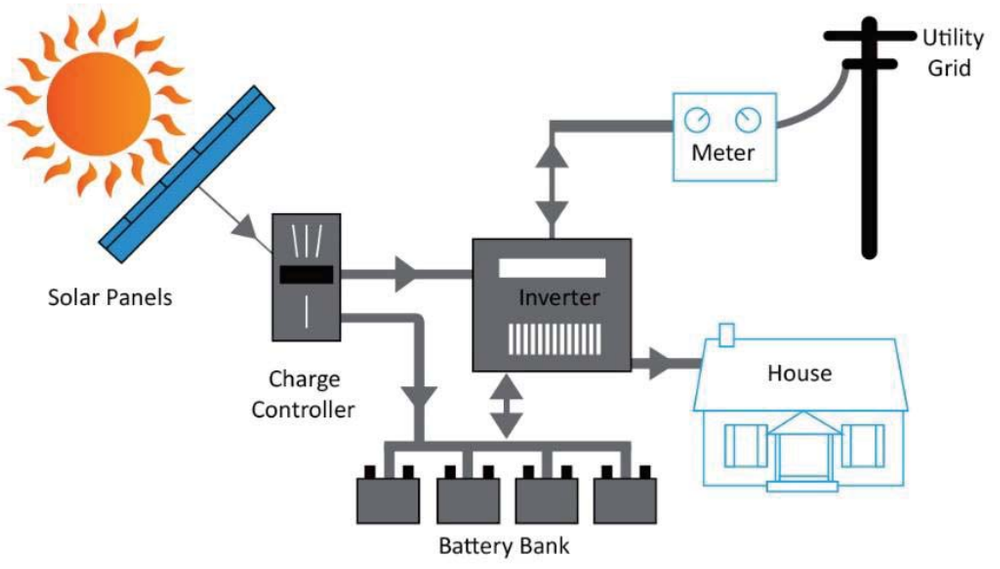


Fig. 2.4.5: Block diagram of a battery backup grid-tie inverter

2.4.3 Efficiency of Inverters

The competence of an inverter is typically demarcated by its design operating power. In general, efficiency of the inverters ranges from:

- Partial load at 85% - 95% (typically10%)
- Full load at 90% to 96%

In a PV system, the size of a grid-connected inverter is calculated using the efficiency characteristics of the inverter as well as its overload capability. Ideal system performance can be achieved by using an inverter that has a rating in the range of 70% -90% as nominal rating of the solar PV array that depends on the performance of inverter and the climate involved.

For grid-tied operation, inverters should:

- Match the necessary equipment considering the quality of output voltage and current waveforms.
- Avoid production of electrical noise that may hinder TV's/Radio's reception.
- Be turned off during a grid's failure ensuring safety of engineers present to repair the grid.

In stand-alone PV systems, battery supplies energy to the inverter. Hence, partial load operation of the inverter can be curtailed by sizing the inverter to match loads.

Activity

1. Complete the following table for a DC/DC Converter:

I/P Voltage	I/P Current	I/P Power	O/P Voltage	O/P Current	O/P Power	Power Loss	Efficiency (%)
50	3		40	3			
	3	300		3	230		

2. Input DC power of an inverter is 300W. The efficiency of the inverter is given 97%. What is the output of AC power?

UNIT 2.5: Mounting Structures

Unit Objectives

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

- Identify the need of mounting structures
- List different types of mounting systems

PV mounting systems are also known as solar module racking. These are utilized to get the solar panels attached to locations such as surfaces of roofs, exterior of buildings or the ground. Retrofitting of solar panels on roofs or as a section of a building (known as BIPV) can be done with the help of these mounting systems.

2.5.1 Importance for Mounting Structures

The importance of mounting structures is listed in the following figure:

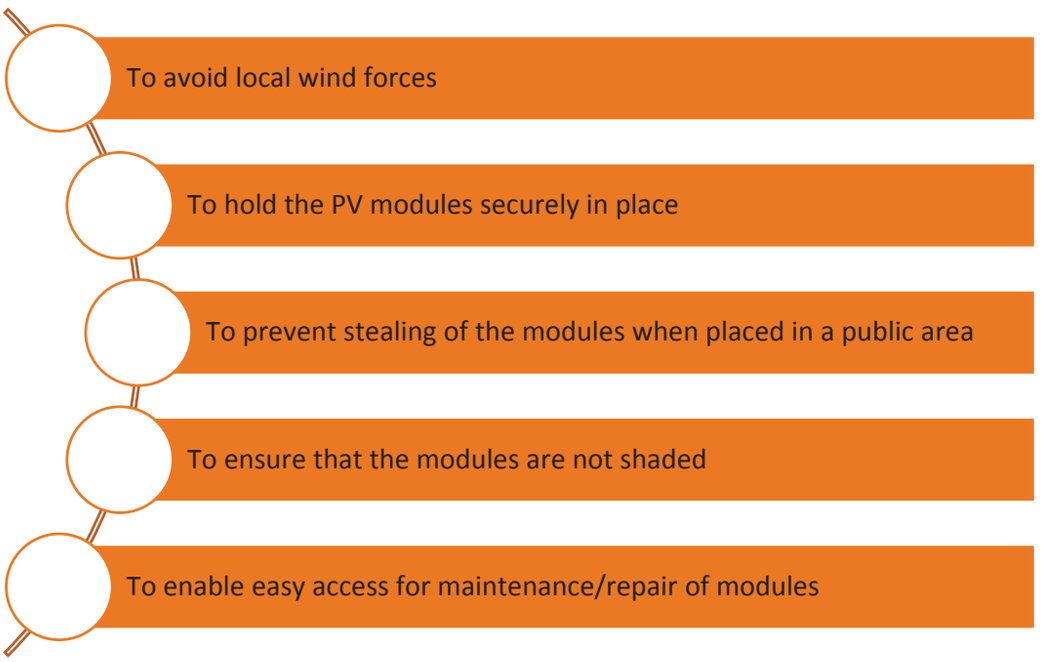


Fig. 2.5.1: Aim of mounting structures

Special mounting structures that can serve as PV modules as well as building elements are developed for integration in buildings. PV modules on the roofs of houses, in the facades of buildings, warning signage, outdoor lighting and telephone box's roof are some common examples. The structural cost must be low. In most PV applications, the configuration is less profitable due to extra cost borne for placement of PV modules on sun tracking system.

2.5.2 Types of Mounting Structures

Solar panel mounting structures or systems are made of aluminium, galvanized iron (GI) and mild steel (MS) material. The following image shows the basic solar panel mounting systems:

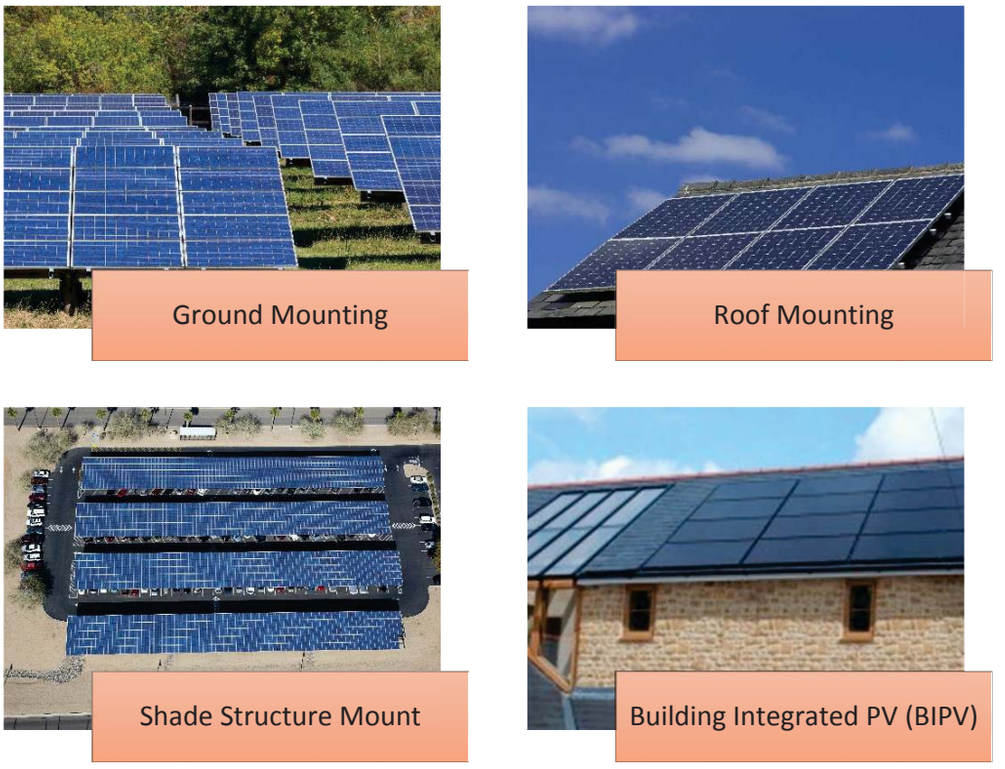


Fig. 2.5.2: Basic solar panel mounting systems

The following table lists some common types of PV array mounting systems:

Structure	Description	Image
Ground-mounted PV arrays	• They are used for larger PV systems or where the rooftop installations are not practical. • They can use racks, poles and other foundations for supporting the arrays. • They are usually more vulnerable to damage than rooftop arrays, but the constraints for their orientation and location is less as compared to the rooftop installations.	

Structure	Description	Image
Integrated mount	• They have panels attached directly to rafters and replace roofing materials. • They require modules are integrated into the exterior of the building or roofing Sometimes these systems are referred to building integrated PV.	
Stand-off mount/Flush mount	• They use standoffs attached to the roof for supporting rails on which the PV modules are mounted. • They allow sufficient gap to provide air flow as solar panels usually need air flow to give best performance. • They are recommended and popular mounts for residential purposes.	
Standard panel fixture	• They allow panels to be fixed in the customer place as it is. • There is no requirement of adjustments in these fixtures.	
Non- standard panel fixtures	• They require pictorial representation of customer place where the panel is to be installed. • They require the panel fixture be designed separately as per the customer roof model.	

Structure	Description	Image
Ballasted mounting systems	• They are used in flat roof commercial projects. • They are dependent on the weight of the array, racking system and material such as concrete paver to fix the array to the roof or ground. • They do not require penetration to roof or ground.	
Roof top	• They are very popular for installing solar PV arrays. • They offer less physical protection and limited access to the PV array for safety. • They generally provide better sun exposure. • They do not occupy space on the ground. Hence the ground may be needed for other purposes. • They must be secured structurally and any attachment and penetration must be weather sealed properly. • They should not be blocked from sun by any shades.	

Structure	Description	Image
Direct mount	• They allow panels to be attached directly to the roof. • They are cheap and easy to install.	
Pole mount	• They are generally used with manufactured racks that are mounted on the top or attached to the side of a steel pole. • They are popular for off-grid residential photovoltaic systems, as the weight of PV array is balanced over the pole, seasonal adjustments can be easily done. • They are very common in small applications having one or two modules where the entire system mounted on a single pole. • They offer better cooling for the panels as compared to roof mounting.	
Rack mounting structure	• They are used for non-tracking system at ground level. • They are also used in large commercials or utility scale arrays.	

Structure	Description	Image
Sun-tracker systems	• They follow the sun daily. • They are generally mounted on poles and allow the system to receive greater amount of solar energy. • They allow tracking to enhance the summer gain by 30% or more, but in winter the gain is 15% or less. • They allow tracking in two axes to achieve maximum performance. • They can also be of single-axis to provide simplicity and reliability.	
Shade structure	• They work as patio covers to provide shade. • For example, carports can have solar panels and cover as many parking spots as the project requires. These carports could have the provision of electric vehicle charging stations as an added benefit to the cars parked there.	

Activity

Choose the correct alternative.

1. Which of the following mounting structures does not need any penetration to the roof or ground?

   a. Ballasted Mounting b. Rack Mounting c. Pole Mounting

2. Which of the following options is a purpose of mounting systems?

   a. Regulating temperature b. Resisting wind force c. Protecting PV modules from dust

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3. Role of a Solar Panel Installation Technician

Unit 3.1 – Responsibilities of a Solar Panel Installation Technician

Unit 3.2 – Installation Prerequisites

Unit 3.3 – Site Analysis

Unit 3.4 – Installation and Maintenance of Solar Panel

Key learning Outcomes

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

- Recognize the roles of a solar panel installation technician
- Identify prerequisites for installing a solar PV system
- Construct the design of the solar PV system
- Analyse the size and calculation of the components
- Evaluate the location for installation
- Analyze the customer's requirements
- Identify the suitable mounting structures
- Assemble and fix the mounting structure
- Execute setting up connection between different components of the PV system
- Perform troubleshooting of PV system

UNIT 3.1: Responsibilities of a Solar Panel Installation Technician

Unit Objectives

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

- Identify the attributes needed to work as a solar panel installation technician
- Recognize the roles of a solar panel installation technician
- Identify the technical responsibilities of a solar panel installation technician

Solar panel installation technician, also known as panel installer, is responsible for installing solar panels at the customers' premises. Essential skills required to install solar panel are:

- Work in a standing position for long hours
- Have physical capacity to deal with the weight of a solar panel
- Be willing to work in an outdoor setting at various locations like fields, roof tops, both urban and rural

Fig. 3.1.1: Attributes of a panel installer

The following image shows solar panel installation technicians installing panels.

Fig. 3.1.2: Solar panel installation technicians

The role of a solar panel installation technician is listed as follows:

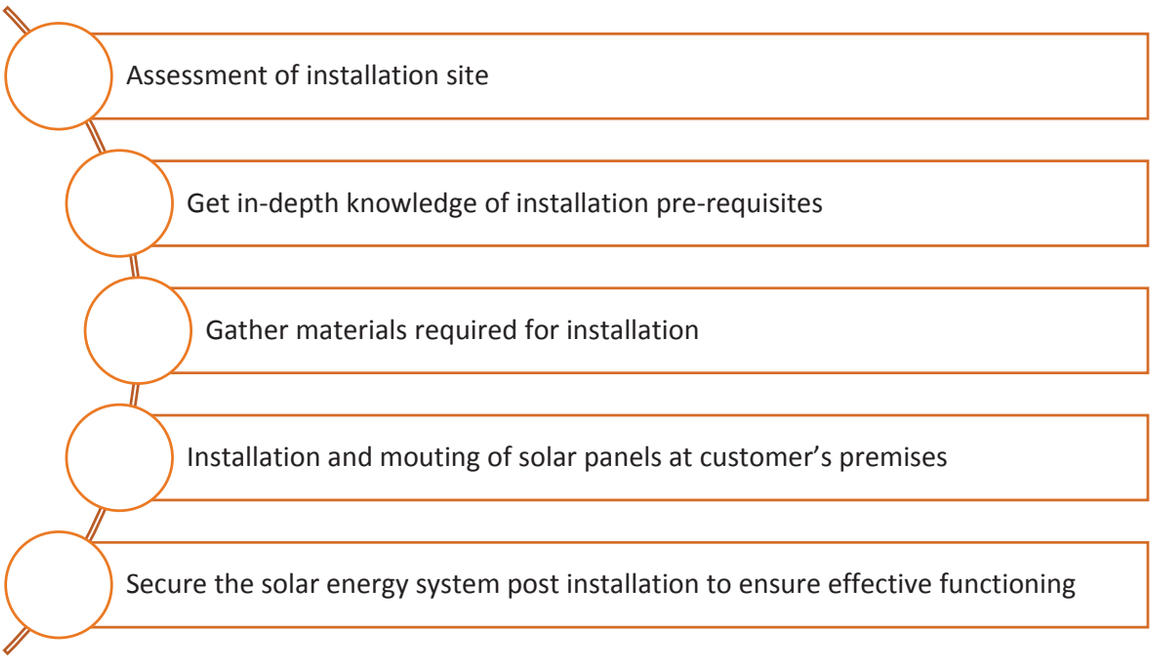


Fig. 3.1.3: Key roles of a panel installer

Apart from the key technical responsibilities of the installation, the solar panel installation technician or the panel installer also needs to:

- Ensure number of modules and panels are as per the voltage requirement.
- Ensure proper handling of panels and other materials.
- Assess precautionary measures to be taken.
- Ensure effective functioning of the system post-installation.
- Manage wastes and workplace safety.
- Deliver quality work as per standards despite constraints.
- Ensure customer satisfaction and get a feedback on standards of work.

UNIT 3.2: Prerequisites for Solar Panel Installation

Unit Objectives

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

- Identify required tools and equipment
- Construct the design of the solar PV system
- Analyse the size and calculation of the components
- Identify the wiring requirements

3.2.1 Tools and Equipment for Solar Panel Installation

For a solar panel installation, there are certain tools required for site assessments and installation. The panel installer must have the knowledge of different tools needed for analyzing site condition, mounting and installing solar panel. To mount solar panels, the panel installer need to gather the required equipment and consumables.

The tools required for site assessment are:

- Tape measure of 50-100 ft.
- Solar Pathfinder that will help in evaluating the solar energy potential of a site)
- Maps for calculating the latitude and magnetic declination of the location
- Digital camera to capture the location for future use.

Some other materials, such as a blanket and cardboard, are also required to keep the PV modules from being live during the installation process. Some tools are required especially for installing and maintaining the battery system. They are listed in the following figure:

Small flashlight

- Used to view the electrolyte level

Baking soda

- used as a neutralizer for any acid spill

Funnel

- used to fill electrolyte in the battery

Distilled water

- used as electrolyte for the battery

Fig. 3.2.1: Tools required for installing and maintaining the battery system

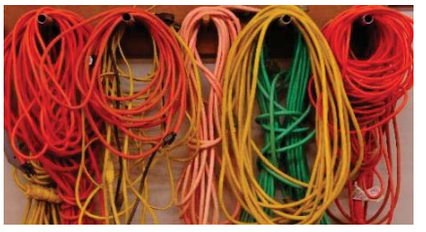
To prepare the location for installing solar panel, some electrical and mechanical tools and equipment are needed.

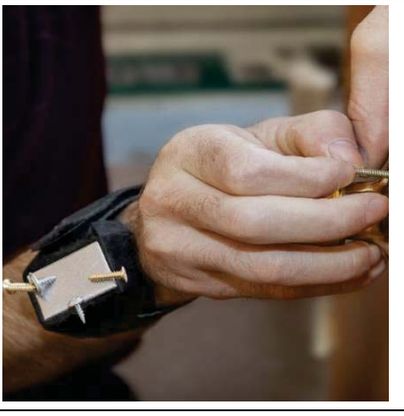
The following table lists the tools and equipment required for solar panel installation:

Tool and equipment	Description	Image
Angle finder	Used to find degree of bend and precision angle	
Torpedo level	Used to measure vertical, horizontal and diagonal planes	
Fish tape	Used for routing wiring through the walls and electrical conduits	
Chalk line	Used to mark straight lines on flat surfaces, where a hand does not reach	
Cordless drill	• Used to drive screws into various substrates without damaging them • Are available in hammer drill configuration with a clutch • Uses rechargeable batteries	
Drill bits	• Used to remove material for creating different kinds of holes in different materials • Are attached to a drill to cut through the work object by rotating it • Available in various shapes and sizes	

Tool and equipment	Description	Image
Hole saw	• Is a saw blade of ring shape • Creates a hole in the work object without having to cut up the core	
Hole punch	• Creates holes in sheets of paper which are used in a binder or folder • Used on sheet metal, like aluminium siding or metal air ducts	
Torque wrench	• Used where the screw and bolt tightening is important • Applies a specific torque to a fastener such as a nut or bolt • Acts usually as a socket wrench that comes with special internal mechanisms	
Nut driver	• Used to tighten the nuts and bolts • Consists of a socket attached to a shaft and cylindrical handle • Sizes of 7/16”, ½”, 9/16” are used for PV modules	
Wire strippers	Used to strip the insulation part from electric wires	
Crimpers	Used to crimp, which is binding two pieces of metal by deforming one or both of them such that they hold each other	

Tool and equipment	Description	Image
Needle-nose pliers	• Used to bend, re-position and snip wire • Help in reaching areas where fingers or any other tool/instrument is less likely to reach	
Lineman's pliers	• Used to grip, twist, bend and cut wire and cable • Have a gripping joint at their snub nose and cutting edge in their craw	
Slip-joint pliers	Are pliers with adjustable pivot point or fulcrum which increases the size range of their jaws	
Wire cutter	Used for cutting wires. Both small and large wire cutters are needed for PV installation	
Multimeter	Used to measure resistance, current and voltage	
Hacksaw	Used for cutting metal as well as plastic pipe and plastic conduit	

Tool and equipment	Description	Image
Tape measure	• A ruler made of ribbon or cloth, fibre glass or plastic or metal strip • Consists of linear-measurement markings • Measures long length and around curves or corners • Can be easily carried in pocket or toolkit	
Heavy duty extension cords	• Flexible electrical power cables, also known as flex. They are attached to a plug at one end and one/multiple sockets at the other end • Used in case of high voltage power supply for heavy work operations like power supply of large drilling machines on construction sites	
Caulking gun	• Holds a cartridge or tube filled with glue type material and is used to seal gaps/cracks • Has caulk made of silicone or latex, and is used to bind a wide range of materials like metal, glass, wood and ceramic • Used to seal joints or seams in various structures and piping	
Fuse Pullers	Used to insert and remove electrical fuses from housing	
Clamp meter	Used to measure the vector sum of the currents, which depends on their phase relationship, flowing in all the conductors passing through the probe	

Tool and equipment	Description	Image
Reciprocating saw	• Used to cut objects with push-and-pull ("reciprocating") motion of the blade • Contains a large blade and a handle which allows the saw to be used comfortably on vertical surfaces	
Conduit bender	Used in conjunction with a long lever to bend angles in conduit where the electric wires are placed	
Magnetic wristband	• Is a band worn on the wrist that has magnetic mechanism to hold the tools on the wrist band while you work. • Can hold nails, fasteners, drill bits, small tools and wrenches	
C-clamps	Used to hold a wood or metal work object by turning the screw from the bottom of a frame until it reaches the required state of pressure or release	

Tool and equipment	Description	Image
Stud finder	Used to locate framing studs that are typically behind the final walling surface (usually drywall)	
Pry bar	Consists of a metal bar with a single curved end and flattened points, usually with a small fissure on one or both ends for removing nails	
Refractometer	Used for the battery system to measure refraction of light through the liquid. The index of refraction is calculated from the material composition.	
Hydrometer	Used to measure the gravity of a battery's electrolyte	
Voltmeter	Used to measure potential difference between two points in the electric circuit	

3.2.2 Design of the Solar PV System

Each household has different electrical equipment leading to different requirements of electricity supply. The installation technician should take care of these varying requirements while designing solar PV systems. Each solar PV system is custom designed to meet the requirement of the customer.

The design of a solar PV system requires calculation of, the values of different components such as solar PV modules, battery, charge controller and inverter, required to make the complete PV system which is capable of supplying electricity to the connected load as required. The following figure lists the steps for designing a PV system:

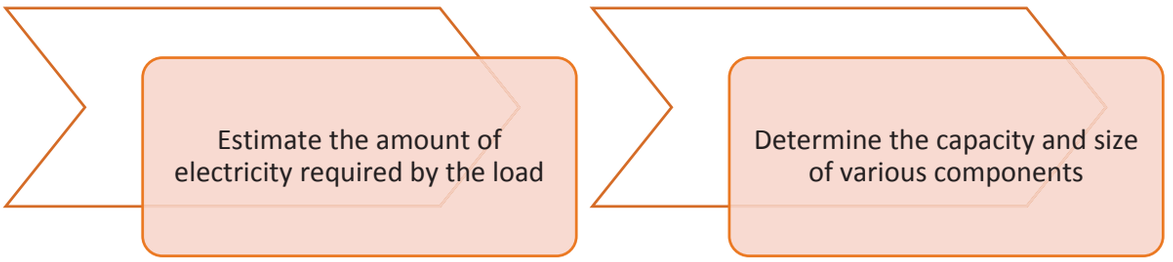


Fig. 3.2.2: Steps involved to design of a PV system

To design a solar PV system, following information is required:

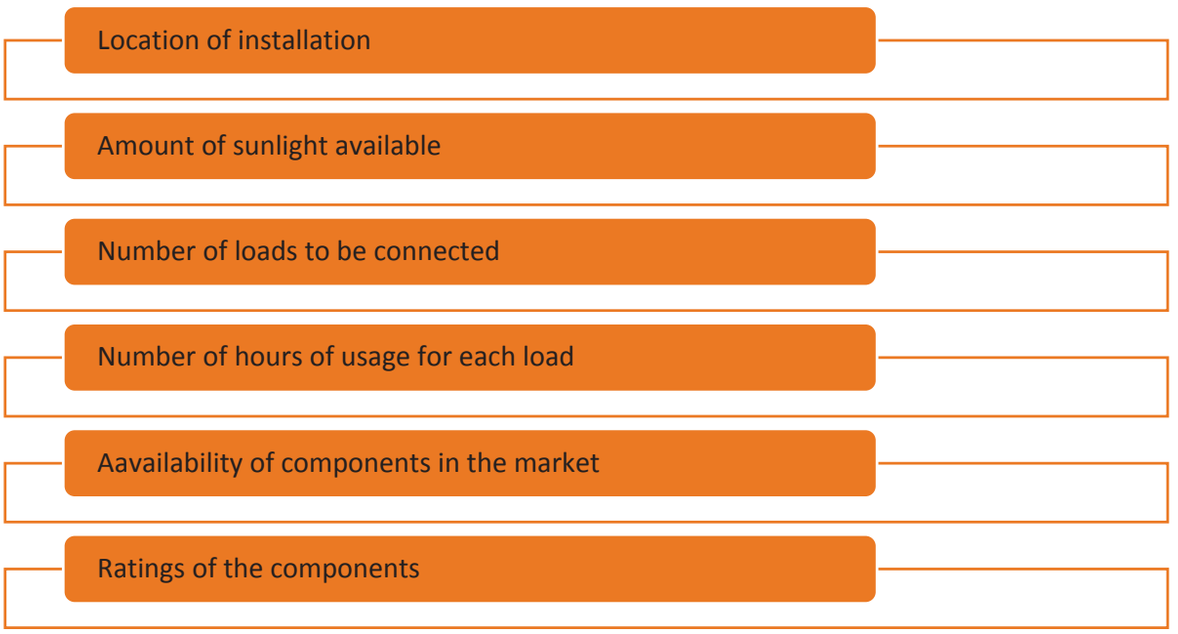


Fig. 3.2.3: Information needed to design a solar PV system

The design can be of two types:

- Approximate Design
- Precise Design

Since many parameters come into play in the design of solar PV systems, most of the time it is acceptable to create an approximate design. As the name suggest, this design may not be 100% correct. The approximate design is useful when your system size is not too large.

However, if the system is in several 10s of kW or 100s of kW, it is advisable to create a precise design where all the parameters that affect the performance of the PV system are considered.

Approximate Design of a SPV System

An approximate design is based on certain assumptions and parameters, neglecting the impact of temperature and radiation.

The energy flow diagram is useful in designing a solar PV system. During the sunshine hours, energy flows from the PV source to the battery through electronic circuitry through the power converters units like maximum power point tracking (MPPT) charge controller which is controlled by electronic circuits. When the load is operating, the energy flows from the battery to the load through the electronic circuitry (mainly charge controller, and through inverter in the case of AC loads). The following figure represents solar PV system's energy flow diagram:

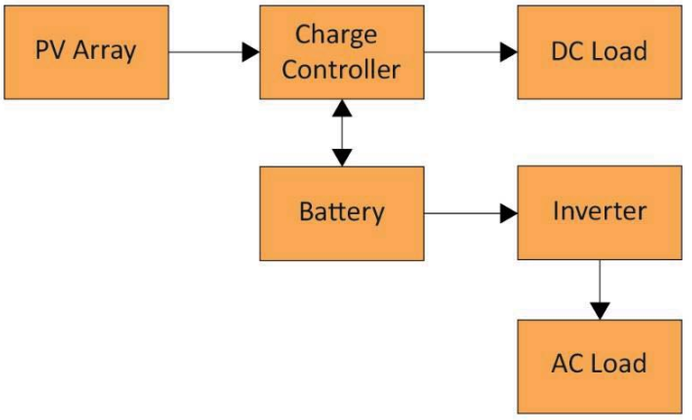


Fig.3.2.4: Energy flow diagram

The design of a standalone PV system proceeds in the reverse direction of the energy flow. The following figure lists steps for approximate design of solar PV systems:

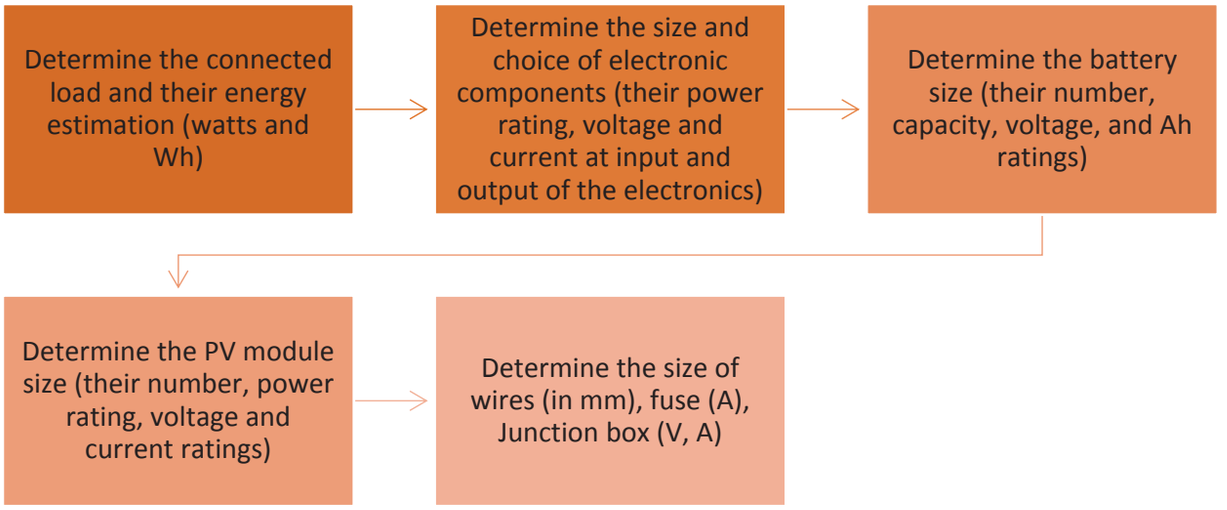


Fig. 3.2.5: Steps for approximate design of solar PV systems

3.2.3 Sizing and Calculation of the Components

After estimating the energy requirement of the load, choose the components suitable for the PV system. The determination of capacity of these components depends on the total voltage and current of the loads.

Capacity of Inverter:

The inverter should be selected in such a way that it can supply the desired power to the load. Hence, the desired output power of the inverter must be equal to the total connected power of the load. In practice, it is good to choose an inverter with a power capacity higher than the total connected load. The efficiency of the inverter can be calculated as:

$$\text{Efficiency } (\eta) = (\text{Output Power}/\text{Input Power}) \times 100\%$$

The efficiency of the inverter helps in estimating the required input power to the inverter. The following table shows the required capacity for the inverter:

Load	**Inverter**		
Total Wattage of Load	Efficiency (%)	Output (W)	Input (VA)
565	93	565	(565×100)/93 =607.52 VA =610 VA

Selection of Charge Controller

The charge controller is selected as per the required input and output voltage and current of the load and the battery. It should be able to handle the currents and voltages that are likely to be flowing in the system. The following table shows the parameters required for selecting a charge controller:

Energy (Wh)	**Wattage (W)**	**Voltage (V)**	**Maximum Current (A)**
3420	565	12	48

To pass the maximum current, a charge controller must have sufficient ampere capacity. It is calculated by splitting the panel's peak-watt rate to 12V. For instance, a 100 Wh panel connected to a controller must have a charging capacity of 8.33A (100 ÷ 12).

Majority of appliances require more amperes in order to start rather than keep running. For instance, electrical motors require thrice the amount of ampere to keep running. Hence, a discharge controller should have sufficient ampere capacity that enable passing maximum current load, inclusive of extra current used for starting.

Battery Size for PV System

A battery is required since appliances utilize electricity at a wide-range of time and at different rates as compared to the output produced by a panel. To work properly, a system's battery must fall under the category of deep-discharge. At the same time, the battery must have the storage capacity to operate such appliances at all times despite bad weather. To have a battery that lasts long, it must be charged regularly. A large battery, which has the capacity to operate appliances for five days at a stretch without the need to recharge, must be installed.

Voltage and ampere-hour rate should be known before hand while purchasing a battery. A home based solar PV system should be 12V or 24V. The following points should be considered at the time of buying:

- The watt-hour capacity needed in the battery should be five times the total appliance watt-hours per daytime.
- The inverter and DC-DC converters will have some losses because they will have less than 100% efficiency. Therefore, batteries should be selected in such a way that they should not only supply the power and energy required by the load, but can also supply the loss of energy in inverter and/or DC to DC converters. In other words, the loss occurring at converter must be compensated by the battery.
- The size of the battery must be large enough so that the appliances will use one-fifth of its full charge in one day.

The following figure lists the steps for calculating battery size:

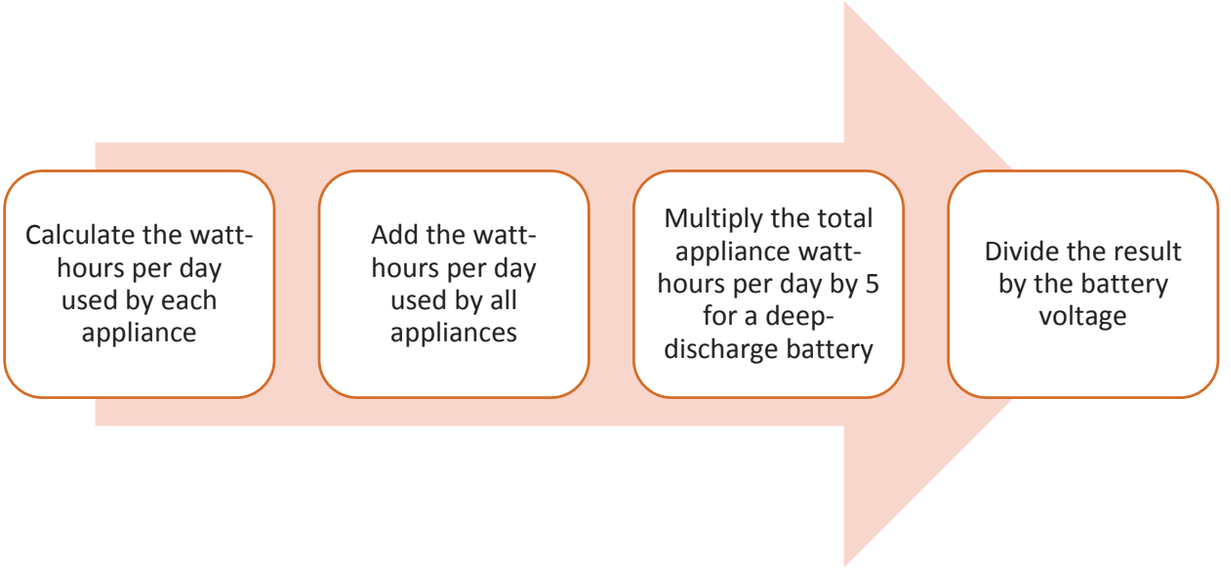


Fig. 3.2.6: Steps for calculating battery size

To determine the size and number of batteries needed, the parameters of the batteries to be considered. For example, if the DoD is 50%, only 50% of the total charge stored in the battery can be used. In solar PV system, normally the deep discharge batteries are used with DoD in the range of 50% to 60%.

The following table shows the actual battery capacity calculation:

Energy	System Voltage	Battery Capacity	DOD (%)	Actual Battery Capacity
3420 Wh	12V	3420/12= 285Ah	50	285/0.5 = 570Ah

PV Module Size

The solar PV module must supply enough energy to the battery, so that battery can supply enough energy to the inverter, to supply enough energy to the load as per the requirement.

The following table shows the required energy from solar PV module when the efficiency of the battery is 95%:

Total Energy (Wh)	Battery Efficiency (%)	Energy from Solar PV Module
3420	95	3420/0.95= 3600Wh

To estimate the requirement for the number of PV modules, the availability of solar radiation at the location where PV system is being installed must be considered. Typical daily solar radiation in India varies from 4-7 kWh/m²/day. For example, the daily solar radiation at the location where the system will be installed is 4.5kWh/m²/day. The estimated solar PV module wattage is shown in the following table:

Energy from Solar PV Module	No. of Sunshine Hours	Solar PV Module Wattage
3600	4.5	3600/4.5= 800 Watts

The following figure lists the steps to calculate the peak-watt capacity required in a system:

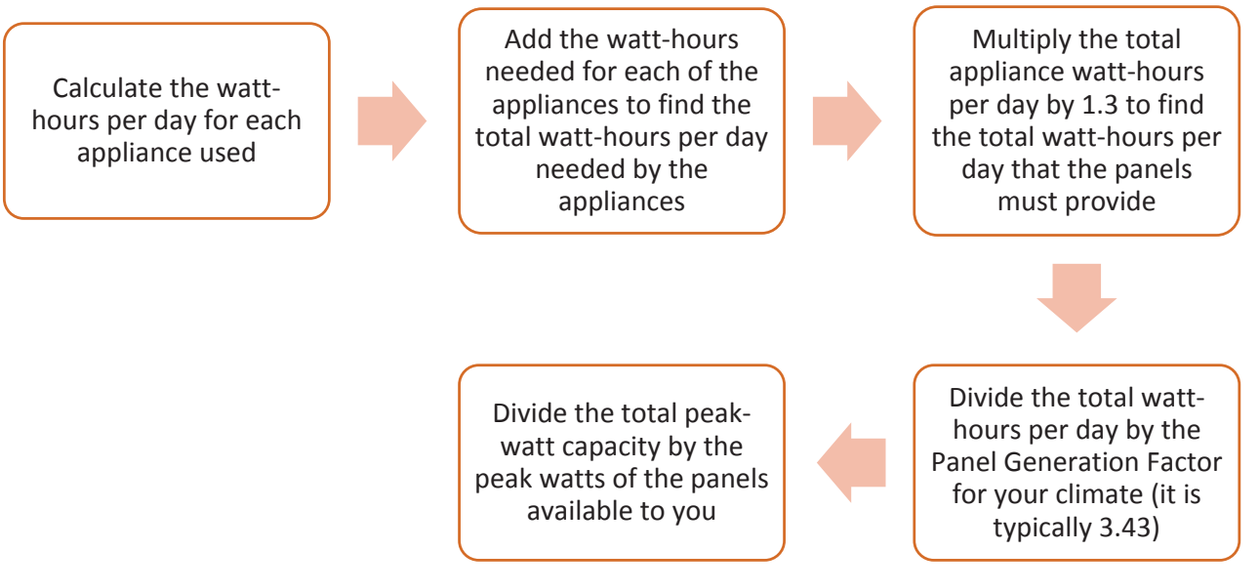


Fig. 3.2.7: Steps to find the peak-watt capacity

Panel Generation Factor

A small panel of 1Wp shall provide 3.43Wh/day (120 ÷ 35) as 35Wp is the average daily energy produced in tropical climate that produces 12Wh/day. The Panel Generation Factor for the said climate would be 3.43. The Panel Generation Factor varies with climate.

Adjusting the Panel Generation Factor as per Climate

The system's size should fit even the cloudiest season to give its services all through the year. The following guidelines must be adhered to for estimating a panel output of different climates:

Climate Class 1	Sunnier than the tropical coastal climate with many days of clear skies and few cloudy periods longer than four days. A desert location may be in this class. For this climate, use a Panel Generation Factor of 3.86.
Climate Class 2	A tropical coastal climate with most days partly cloudy. Fully cloudy periods are usually no more than five days long. For this climate, use a Panel Generation Factor of 3.43.
Climate Class 3	Cloudy periods of five to seven days occur regularly but are typically followed by three or more clear days. For this climate, use a Panel Generation Factor of 3.0.
Climate Class 4	Cloudy periods of ten or more days occur regularly and fully clear days are unusual. For this climate, use a Panel Generation Factor of 2.57.

Fig. 3.2.8: Guidelines for estimating the panel output

Fuse and Junction Box Selection

Fuses and junction box are components that are also required for PV system installation. Fuses, wires and junction boxes should be chosen for the maximum possible currents and voltages that are likely to occur in the system. Mainly, the parameter used for choosing these products is current. Normally, a standalone system will have a DC side as well as an AC side. Therefore, the maximum voltage and current for both DC and AC sides must be considered. This estimation of maximum current is useful in deciding the appropriate components, fuses, junction boxes and wires.

3.2.4 Wiring Requirements

In any electrical system, wires are needed to connect power supply and load together. The choice of wires which includes choice of materials for wires, diameter of wires, and so on, plays an important role. The appropriate choice of wires is even more important in the case of solar PV applications, because a part of the system may be working on DC current and another part on AC current.

The appropriate choice of wires is important because:

- This will reduce the electrical losses in wires. Since solar PV power is expensive, it is important to minimize the power losses in wires as much as possible.
- This will help to avoid shock hazards and fire hazards in PV systems.

- This will help the system to perform better. If all the components in PV system are chosen sufficiently but appropriate wire is not available, the system may not perform as per the expectations. For example, if large current is flowing in a certain part of your PV system and wire that you have chosen is very thin, there may be lot of power loss in the thin wire, it may heat up and even burn. There may even be fire in the system and the whole system will stop working. In the worst case, the entire PV system may get destroyed.

Electrical wires are made up of metals because metals are the most electrically conductive materials. Wires are mostly made of metals such as silver, copper and aluminum. Copper wire is generally used as it is cheap and available.

Generally, wires are coated with any insulating material like polyvinyl chloride (PVC), nylon, and polyester, to prevent shock hazards and energy loss through unwanted current conduction and avoid short circuit between two wires running together.

When a bunch of wires run side by side wherein the wires may be bonded, twisted or braided together, it is referred as 'cables' or wire cable'.

The following image shows different types of wires:

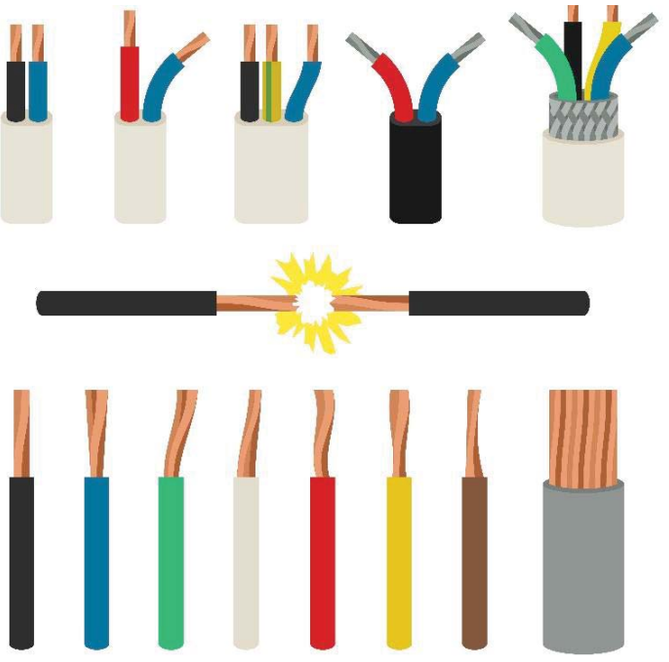


Fig. 3.2.9: Different types of wires

Voltage Loss in Wires

The voltage desirable to drive electricity in a wire is known as the voltage drop of the wire. It is important to choose appropriate conductor with low resistance to minimize voltage loss in DC wires and cables in PV systems. Wires with low resistance are of large diameter. But large diameter wires mean more material, which means large diameter wires are more expensive than small diameter wires of the same material. There is a trade-off between cost and resistance of wires. Therefore, some cost optimization of wire with respect to their resistance is required.

To avoid a greater voltage loss, the wiring rules as listed in the following figure should be considered:

- The length of wire should be as short as possible as per the required purpose.
- The voltage drop-in should not exceed 0.5V and 1V in a 12V system and a 24V system, repectively.
- A wire less than 2.5mm square in length should not be in PV system wiring.

Fig. 3.2.10: Wiring rules to minimize voltage loss

Types of Wires

Wires can be divided into the following four categories, depending on their structures and applications. The following figure shows different categories of wires:

Single-stranded

Multi-stranded

Single-core

Multi-core

Fig. 3.2.11: Different categories of wires

Solar Cable

A cable utilized for interconnection of solar panels or other electrical components in the generation of photovoltaic power is known as a solar cable.

The features of a solar cable are as follows:

- Designed as UV and weather resistant
- Laid outside and used between large temperature range
- Maximum DC voltage permissible is 1.8kV for single-core cables. DC rating should be Uo1.5kVDC from phase to ground with a temperature range of -40 °C to +90 °C ambient, a 25-year service life against thermal ageing 120 °C on the conductor.

- Should have a double insulation for protection against ground faults and short circuits
- The cable's cut-away needs to be proportionate so that 1% loss during economical operations is restricted.

MC4 extension cable and an electrical extension cord is quite similar. It has a female and male connector at each end, respectively. These cables are available in various lengths from 8 feet to 100 feet. The following image shows a solar cable with connectors:

Fig. 3.2.12: Solar cable with connectors

The use of an extension cable is not viable because the distance travelled by the wire in a solar panel set-up of a house or a cabin is normally very long. Therefore, in such cases the panels are connected to a combiner box with the help of an extension cable. This approach allows the use of cheaper wiring in an electrical conduit to cater to long distances; which in turn lead to less cost than MC4 cables.

Consider a 20 feet wire needs to go through the electrical equipment and two modules. A 50 foot extender cable shall suit the situation.

As per the combiner box location, one side of the panel string may have a greater distance than the opposite side.

Solar Cable Connectors

The following image shows a solar PV cable connector:

Fig. 3.2.13: A solar PV cable connector

A PV module is designed with a junction box at the back. An installer attaches wires directly to the junction box when modules are wired together. The recent PV modules have been added with MC connectors that appear from the junction box. The MC connectors are weatherproof, safe and reliable.

The following table lists the connectors:

Type	Description	Image
Solar line 1	• A common connector on modules, it has been available since mid-1990s and presently manufactures too. • Rubbery ends of each connector fit the ridges. It is essential that no gaps exist for a good connection. • Abbreviated as: MC1 or MC3 (for 3-millimeter connector)	
Solar line 2	• Built into modules from mid-2000 and are common today • Rigid plastic, and on being engaged, it clicks together • As per 2008 National Electric Code (NEC), connectors that lock and click must be used when PV modules are installed in accessible locations. • Installer has an option of attaching an optional piece to the solar line 2 connectors, which provide a provision to lock. A special tool is required to unlock connectors. • Abbreviated as: MC2, MC2L (L for locking) and MC4 (for 4mm connector)	

Size of Wires

More volts (electrical pressure) are needed to push a certain amount of amperes (current) across a wire in a smaller wire with less diameter. More panels and batteries should be installed to get a higher voltage, which includes extra cost. In large diameter wires, the voltage required to drive electricity through wires is low whereas the wire's cost is high. The best wire size will compensate the cost of a large wire with a low voltage and the extra panel cost from smaller diameter wires that are relatively cheaper.

More voltage is required to push certain amperes through a longer wire. In order to get an increased voltage, more panels and batteries should be installed, bearing extra cost. Short wires save cost and reduce the scope of power loss.

The following figure lists the steps to find the correct size of wire:

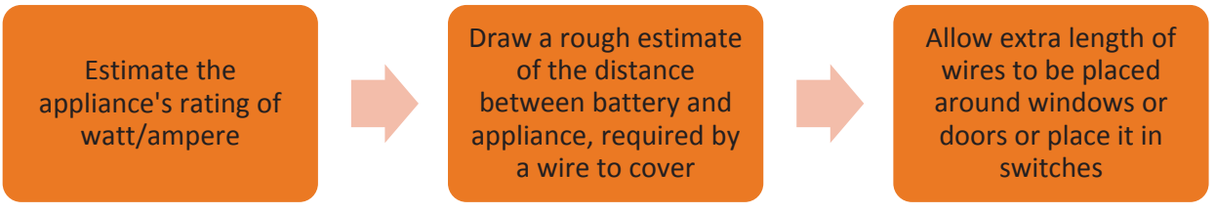


Fig. 3.2.14: Steps for finding the required size of wire

The watt or ampere rating is usually shown on the label, although sometimes it can only be found on specification sheets packed with the appliance. The amperes used by an appliance can also be measured while it is in use with an ammeter.

Activity 

A house has the following DC loads rated at 12 V.

- Three 40W lights
- A 50W fan

All the loads are to be powered simultaneously using two parallel connected modules. Each module has a peak current of 2.5A and short circuit current of 3.5A. Choose the proper Charge Controller.

Activity

1. A household has 3 CFL lamp of 12 watt each, used for 6 hours per day, and a fan of 50 watt used for 10 hours per day. Estimate the total daily energy consumed by the households. All the loads use AC power.

2. A household has only DC loads. There are 5 LED lamps of 5 watt each and two DC fans of 30 watt each. There is also a TV that works on DC power and consumes 80 watt. All loads are operated for two hours per day. Estimate the total energy consumed in a day by all the loads.

UNIT 3.3: Site Analysis

Unit Objectives

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

- Recognize the key tasks involved in site analysis
- Evaluate the location for installation
- Analyse the customer's requirements
- Identify the suitable mounting structures

Site analysis is an initial segment of urban and architectural process of designing, purely dedicated to a study of historical, geographical, legal, climatic and infrastructural background of a particular site. Before installing a solar energy system, site analysis must be carried out to evaluate the feasibility and efficiency of the system.

PV arrays are attached on the rooftops, ground or other structures providing adequate solar access along with protection and support. The conditions on site and its results typically dictate an appropriate approach to use and indicate a location for mounting a system. The following figure lists the key tasks involved in site analysis:

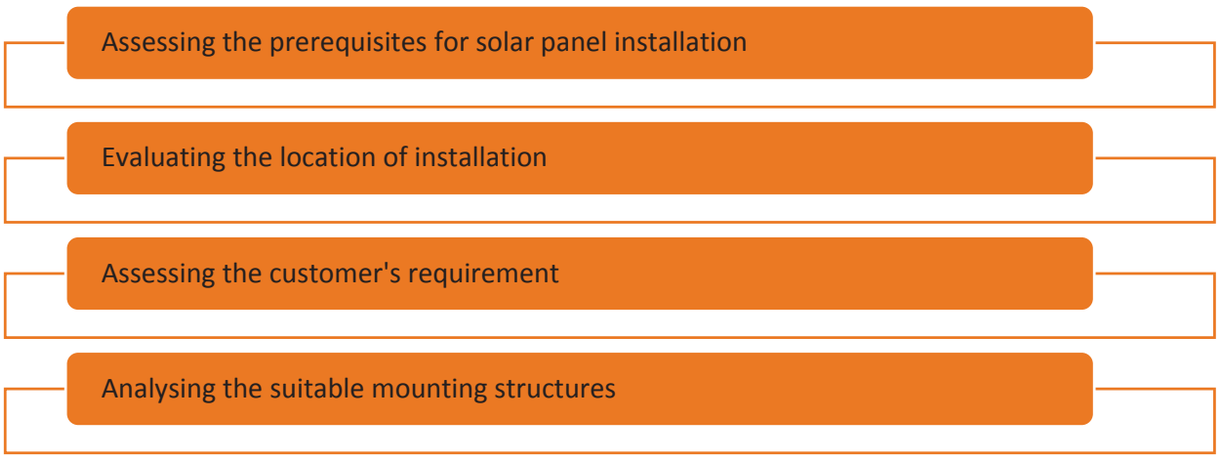


Fig. 3.3.1: Key tasks involved in site analysis

3.3.1 Assessing the Prerequisites for Installing Solar Panel

Before starting the installation of solar panels, it must be ensured that the requirements for the installations are available. These requirements may include:

- Tools and equipment needed for the installation
- Cables to be used in the installation
- Structure materials needed for mounting
- Adequate number of proper PV system components
- Construction of the site where solar panels will be mounted.

The finest practices for solar energy system installation require a system optimization for solar energy production along with structural considerations. The following figure lists the elements that need to be optimized in a solar energy system:

- Roof orientation and panel orientation
  - Follow the sun's path in the sky to understand if an object casts a shadow over the solar photovoltaic panels; due to which operating efficiency of the unit will suffer.
- Roof slope
  - Type of solar mount structures
  - Associated safety issues
- Shading
  - Placement of solar panel with respect to shading from trees, chimneys and vents.
- Setback requirements
  - Local building rules and regulations
  - Issues with regard to installer/maintenance
  - Accessibility during an emergency
  - Pressure from wind load
- Type of roof
  - Shape (flat or sloped)
  - Material (clay tile, asphaltic shingle, metal, shake)
  - Placement and connections of panels
- Panel array layout
  - Panel layout (landscape or portrait)
  - Number of panels required

Fig. 3.3.2: Elements to be optimized for better installation of solar energy system

Trusses or rafters must be thoroughly inspected before installing a solar energy system. The spacing, condition and size must be assessed. It is difficult to inspect trusses even though analyzing a rafter's integrity is simple and direct. Truss cannot be repaired or modified without the assistance of a structural engineer. An assembly of pieces of wood connected along with steel plates forming a combined structural member is known as a truss. A truss resembles a common beam which supports load in an open space. The major variance in both is that every piece of a truss in tension, resists force, whereas a solid beam flexes when stressed. The construction must be strong enough to hold the panel for a long period, may be 20-25 years.

3.3.2 Evaluating the Location of Installation

Location for the solar energy system is one of the most important consideration. Whether the installing of the solar panel will be fruitful is dependent on the location. Earthquake loads and wind loads must be considered where applicable. The solar panel must be installed in a way that:

- The panels get sunlight for the maximum period
- The panels are kept out of any shade throughout the year
- The system can avoid obstruction such as trees, buildings and antennas, or soiling such as leaves and bird droppings because every small and partial shading of the module will cause a reduced system output. The presence of water and snow in the installation should also be considered as it can also affect the solar panels and the mounting structures.
- The sunlight falls perpendicularly on the panels so that they can absorb the maximum energy.

The following image shows solar panels in a snowy region:

Fig. 3.3.3: Solar panels in a snowy region

For example, the module should be facing true south in northern latitudes and true north in southern latitudes for best power production.

3.3.3 Assessing the Customer's Requirement

The panel installer should enquire customers about the purpose of the installation. Assessing their requirements and their preferences, the installer should suggest a type of PV systems that the customers may opt for. The customers must be informed of the following:

- The estimated cost for the installation
- The materials required for the installation
- Any civil construction that must be undertaken for the installation of the panels so that the panels get maximum solar energy.
- Remove all factors that restrain the sunlight to reach solar unit, for example trim branches or unnecessary item.
- Time required for the total process of installing the system

The types of load that will be attached to the PV system must also be assessed. It will help to identify the requirements of installation. The equipment, lights and appliances, power-driven using a PV solar system comprise PV system's electric loads. Loads that are energy-efficient give economic efficiency to an overall system. The following table lists the power consumption of some commonly used appliances:

DC	Wattage	AC	Wattage
Fluorescent light	5-15	Fluorescent light	7-25
Stereo player	40	Stereo player	100
Television (25cm, colour)	45	Computer	50
Refrigerator	50-70	Television (48 cm, colour)	60-85
Ceiling Fan	20	Refrigerator (100 L)	90-150
		Cooler	200-300
		Microwave oven	450-750
		Power drill	450-1000
		Toaster	900-1100
		Coffee Maker	850-1500
		Air Conditioner	3000-4000

3.3.4 Analyzing Suitable Mounting Structures

The location, civil constructions and other requirements decide the suitability of a mounting structure. Ground mount structures are preferred for larger systems. Sometimes rooftop mount structures are preferred so that the ground can be used for other purposes.

A PV array's layout may have a substantial effect on operating temperatures and natural cooling such as:

- Considering passive cooling of the modules, there are chances of a horizontal layout having some benefit over vertical layout.
- A landscape unit allows more uniform cooling as air tends to be under a module for a shorter time frame before it escapes.
- A mounting placed 3 inches atop a roof is considered coolest.

Mounting PV arrays on rooftop areas are restricted by the following factors:

- Necessary space for service and installation
- Fire cod's ventilation and pathway
- Setbacks by wind load
- Required space for other tools/equipment

Sloped roofs need fall important protection systems or personal fall arrest systems for maintenance workers and installers. Photovoltaic arrays may be:

- Roof mounted on a sloping or a flat roof
- Ground free standing

Suitability of installation of a PV system's roof construction should be ensured. The following figure lists some major aspects to evaluate while conducting a site survey for roof-mounted PV arrays:

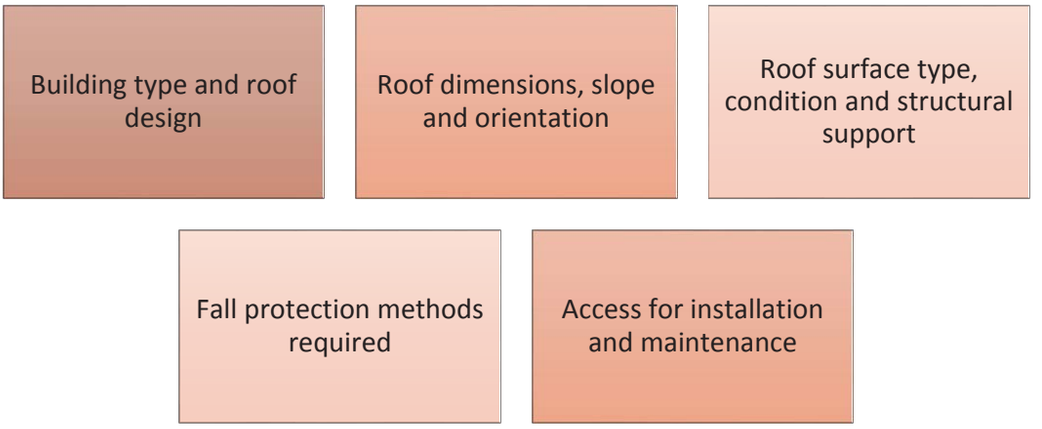


Fig. 3.3.4: Some key items to evaluate during a site survey for roof-mounted PV arrays

The following figure lists some key inspection points for the site survey for ground mounted PV array:

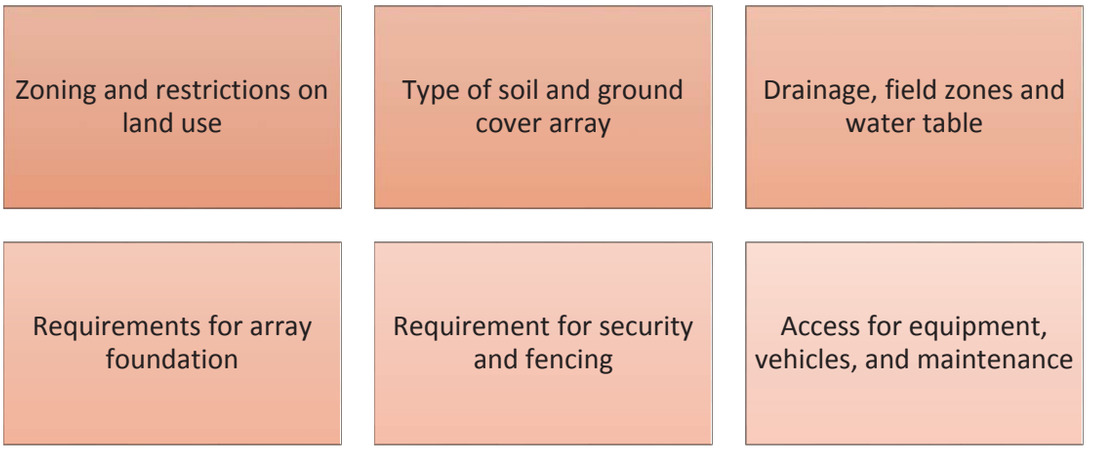


Fig. 3.3.5: Some key items to evaluate during a site survey for ground-mounted PV arrays

Activity 

Create a checklist for prerequisites of panel installation.

Activity

Look at the devices on the table. Note their wattage ratings labelled on them. Calculate the energy consumed if they run for 8 hours.

Components:

- CFL (20W)
- Phone charger (4W)
- Laptop (50W)
- Lamp (60W)

UNIT 3.4: Installation and Maintenance of Solar Panel

Unit Objectives

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

- Identify the steps of solar panel installation
- Assemble and fix the mounting structure
- Execute setting up connection between different components of the PV system
- Perform the troubleshooting of a PV system

Installation is a process in which the different components are connected in a systematic order to make a perfect working solar PV system to meet predefined demands. Based on the requirements of the customer, different types and different number of components are used in a PV system.

Solar modules require to be installed firmly on metallic structures to get it permanently fixed. The mounting structures depend on the size and application of the system. For example:

- For smaller systems, such as solar home systems, mounting structures used are simple enough.
- Pole mounting module structures are used for solar streetlights, solar pumps and solar-powered signal lighting,
- For bigger systems, such as solar power plants, larger array mounting structures are used.

Before starting the installation procedure, the panel installer needs to measure the value of the parameters of the panels that include:

- Short circuit current
- Open circuit voltage
- Maximum Current
- Maximum Voltage
- Maximum power (at STC) or Peak Power Output

3.4.1 Installation of Solar Panel

The following figure lists the steps of solar panel installation:

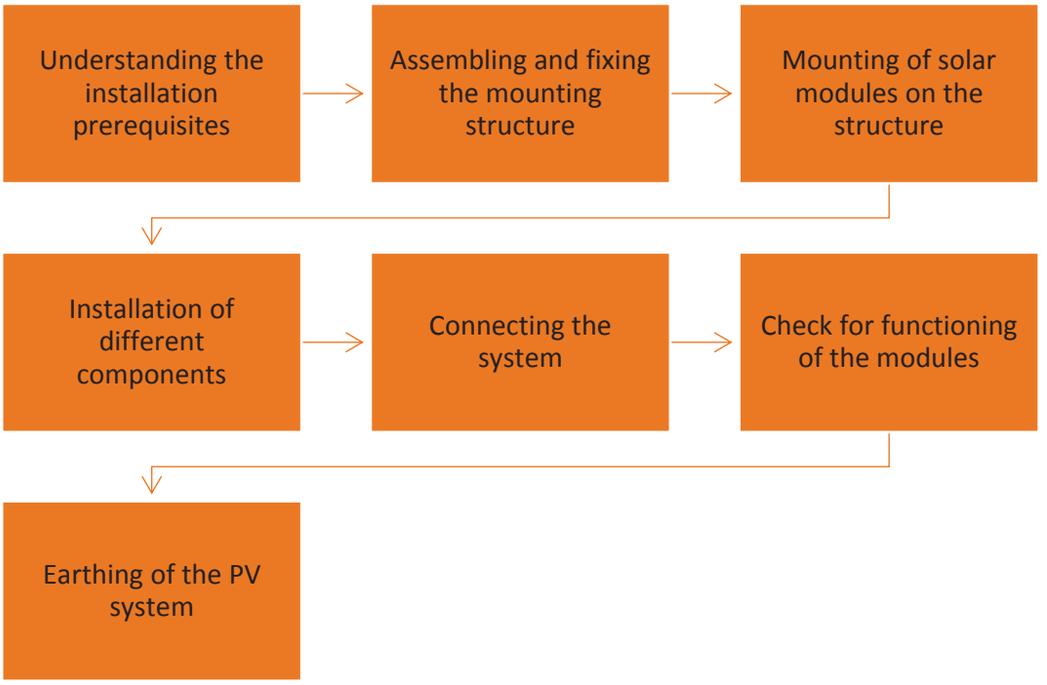


Fig. 3.4.1: Steps for installing solar panel

3.4.2 Understanding Installation Prerequisites

The PV technician must understand the prerequisites of the panel installation. He/she needs to:

- understand the requirement of the customer
- ensure availability of required equipment during installation
- certify the module is defect-free prior to installation
- undertake specified measures like corrosion resistance, fire resistance during module's installation

3.4.3 Assembling and Fixing the Mounting Structure

To mount the panels, the installer should determine the mounting method – whether it will be ground mount or roof mount. While mounting the solar modules, the installer should consider certain guidelines to ensure the maximum output from the solar modules.

The following figure lists the guidelines to ensure maximum output:

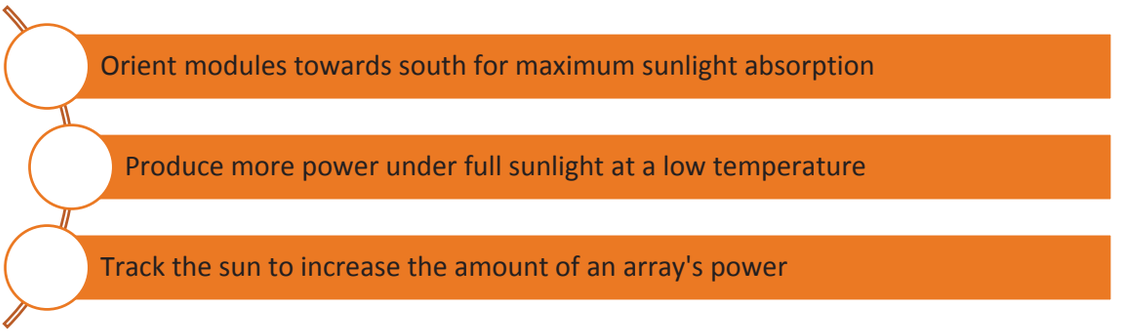


Fig. 3.4.2: Some guidelines for ensuring maximum output

Due to the movement of the earth, there is a difference of angle at which the earth's surface receives the sun's rays over a year. At any particular place on earth, this variation in angle in one year may be up to 45 degrees. The following figure lists the facts that should be considered while installing solar panels:

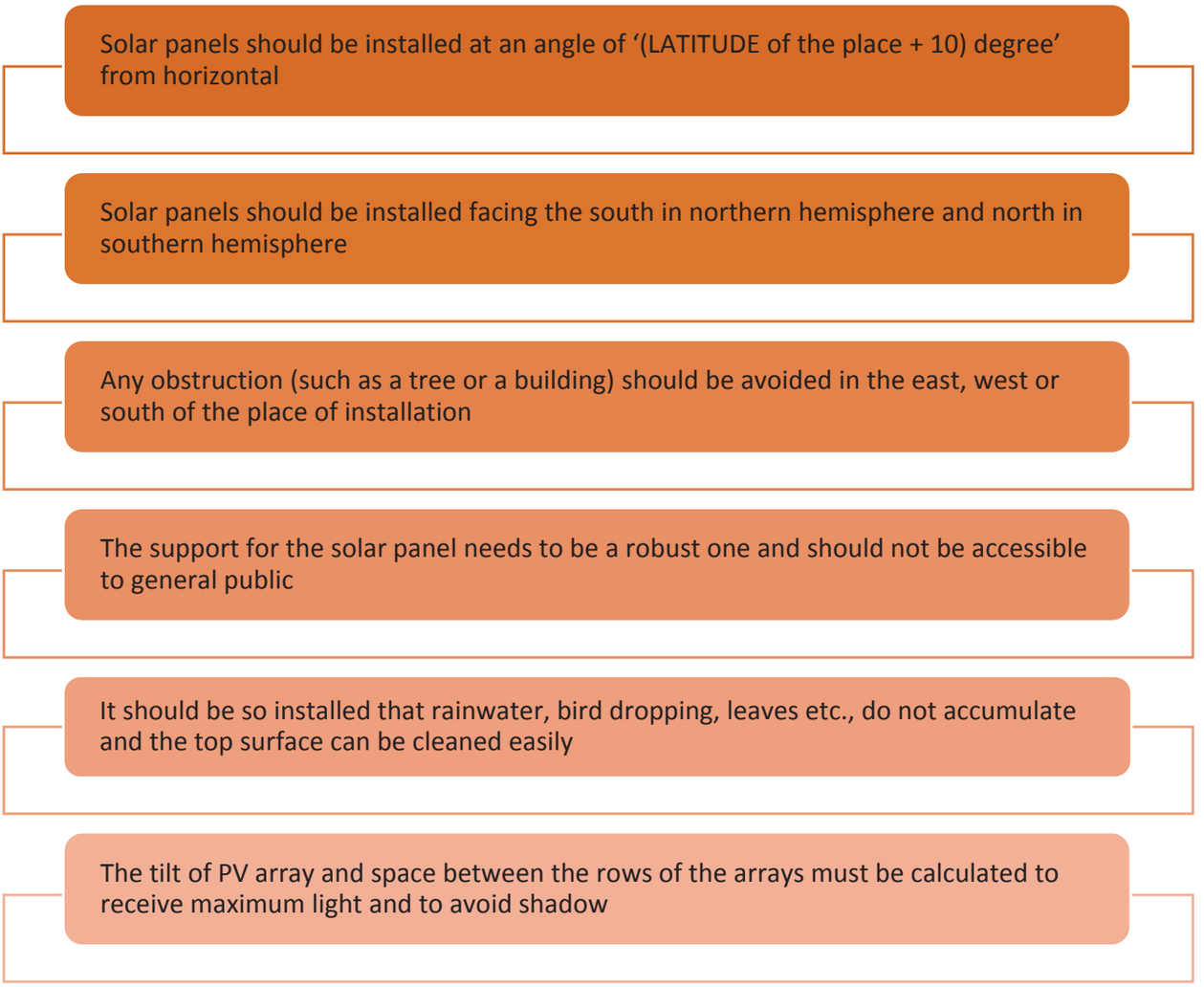


Fig. 3.4.3: Facts to be considered while installing solar panels

Precautions for Installing Structure and Mounting of PV Modules

In a PV system, depending on the requirement, the numbers of modules connected in a parallel and serial combination result in PV array. The array is kept in a sequence according to the number of modules in series and parallel, and accordingly, the structure for the array is designed and mounted on that structure. Following precautions must be taken:

- Mechanical structures should be designed keeping in mind the wind load data of the site where the solar photovoltaic system is being installed so that it can withstand that much wind load. There are standard norms that are followed to design a structure for the given wind load.
- The appropriate material should be used for mounting structure. Normally, the PV modules are supposed to last for 25 years; therefore, the PV structure should also be lasting for 25 years. Galvanized iron or aluminum steel structure can be used. Precaution must be taken to use the appropriate thickness of galvanization.
- Stainless steel bolts should be used to avoid any rusting during the lifetime of the system.
- All the connection should be tightly made to avoid any shorts and sparking.
- Different rated PV modules should not be connected in series and parallel combination.

3.4.4 Installation of PV System Components

After fixing the mounting structures as per the customer requirements, the PV technician needs to install the solar panels and other components such as battery, inverter and controllers.

Installation of PV Modules

PV modules come in a well-packaged form. To have safe a installation, the technician needs to find an appropriate place so that the dust settling on these components may be avoided.

The installer must:

- Carefully unpack the solar panel.
- Carefully handle the panels without damaging any panel.
- Mount the modules in either horizontal or vertical orientation above the fixture along with mounting rails with the help of bolts and nuts. In a vertical installation, the junction box's module clamp should point downward. The support module mounting structure, nuts and bolts, and clamps should adhere to all customary norms.
- Ensure that there is enough space between the two modules bearing in mind the linear thermal expansion of the module frames.
- Provide suitable ventilation for cooling under a module and to allow any condensation or moisture to dissipate.

The roof installation of solar module may affect the fire proofing of the house construction. The following figure lists some probable solutions for fire proofing:

Leave enough space between the modules so that fire fighting personnel can access the place in case of fire.

Place a fireman's switch around the PV module in the DC current line. Solar modules can be mounted on the rails using pre- drilled mounting holes which are located at the back of module frame

Fig. 3.4.4: Some probable solutions for fire proofing

Precautions for Installing PV Modules

The following figure lists some precautions that are required to be taken by the installer during the installation:

- Monitor module Voc and Isc and check that they are within specified limits before installing the module.
- The installation of modules should be done in dry weather condition using dry tools to avoid risk of electric shock.
- Use mounting system recommended by manufacturer. Use predrilled mounting holes. Additional holes drilled in the frame may avoid the warranty.
- Modules should not be stepped on during installation. No heavy or sharp edge items should be placed on them to avoid damage to the glass cover.
- Ensure accessibility of the roof structure after modules are installed for maintenance. Preassembled & prewired modules may be used for roof areas difficult to access.
- The corners and edges of frameless modules are particularly sensitive and are subjected to high level of breakage risk during installation.
- When installing multiple modules on a support structure, lay out all modules before fastening to ensure they are aligned, leaving gaps between them.
- Use an opaque material to cover the module during installation to avoid generation of any current.
- Do not disassemble or disturb a module's part.

Fig. 3.4.5: Precautions for installing PV modules

Installation of Inverter

While installing the inverter, the PV installation technician must ensure that:

- The inverters are installed in a location where faultless operation is guaranteed. The following figure lists some factors that are to be considered:

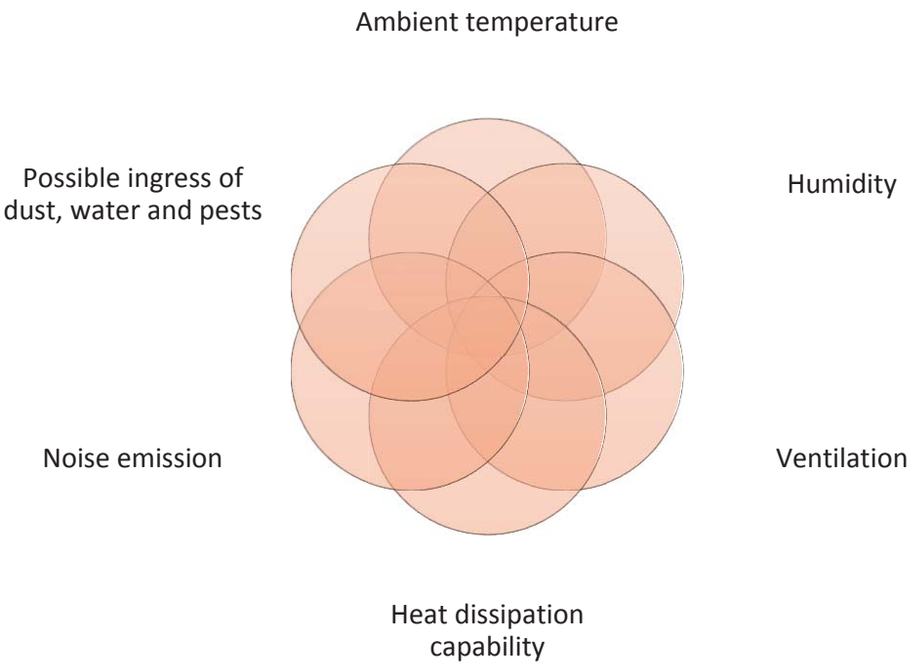


Fig. 3.4.6: Factors for installation of inverters

- The inverters must be easily accessible with sufficient space around them, for maintenance and servicing.
- The inverter mounted on the ground or a wall should be at a height convenient for reading its display.
- The inverter for large power application is mounted on ground and is securely bolted to the concrete floor.
- The inverter for small power application is mounted on a wall and is securely bolted to the wall.
- Ensure adequate open space is provided around ventilation panels for heat dissipation.

Installation of Battery

The panel installer must consider the factors listed in the following figure for the installation of the battery:

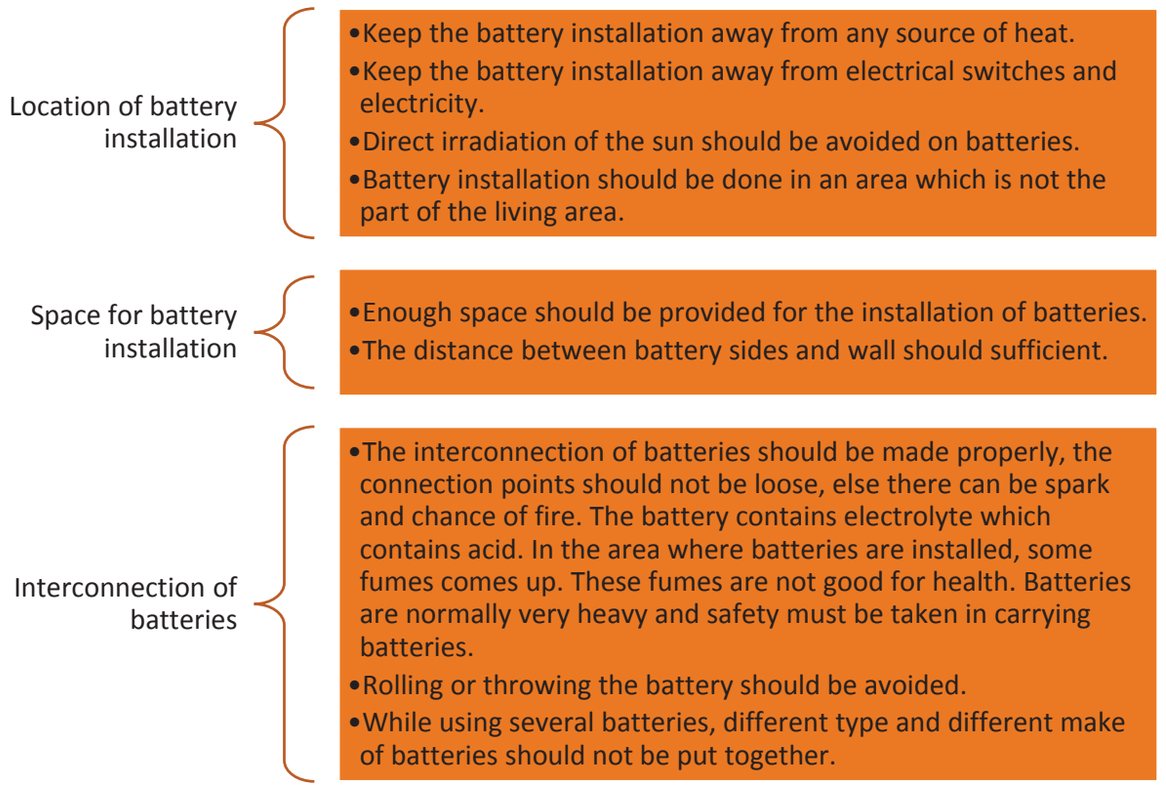


Fig. 3.4.7: Factors for installation of the battery

Installation of DC and AC Power Distribution Boxes

The installer should ensure:

- The DC and AC distribution boxes are located near the inverter.
- The array output wires from the combiner box are routed to the DC distribution box along the shortest route.
- The installation of wiring to the DC or the AC isolator switch and surge protection devices is ground fault and short circuit proof.
- For DC voltages > 50V, the two pole DC isolator switch has at least 5mm gap between the contacts to enable safe and reliable isolation.
- The plate of the DC isolator clearly states the DC voltage level of operation.
- The inverter input should be isolated when connecting to the DC distribution box and inverter output should be isolated when connecting to the AC distribution box.
- The AC distribution box may be combined with the load distribution box. If separate, it should be located near the load distribution box.
- The DC PV energy meter is installed inside the DC distribution box and the AC PV energy meter is installed inside the AC distribution box.
- The DC and the AC distribution box enclosures are connected to the ground.

3.4.5 Connecting the System

Cables are used to connect multiple PV modules in combination to generate the desired voltage and current. For carrying out the interconnection the panel installer must:

- Check the maximum system voltage as per the installation and follow adjustment measures accordingly to match output requirement.
- Use recommended cable to generate maximum voltage.
- Use recommended material of solar cable and plugs for electrical connection.
- Ensure that junction box is covered.

For cabling, the following rules listed in the following figure must be followed:

Required length of cable shall be cut and terminals to be crimped.

Wire size shall be increased as the length of the cable increases.

All exposed wiring must be in conduits/capping-casing. DC and AC cables should be installed in separate conduits or enclosures and labelled.

Wiring through roofing must be water proof. Cables should be laid in shadow areas where possible and they should not impede rain water run-off.

Where the wiring is through flammable materials, like thatched roof, they must be in a metal conduit.

For roof mounted installations, fix cables to the roof supports using suitable fastenings.

Cables, fasteners and cable ties should be weather resistant.

Cables should stay away from lightning conductors.

Avoid sharp edges and mechanical damage to cable insulation.

Use proper recommended tools and follow cable termination guidelines.

Cable termination should be either crimped or soldered to suit terminal design.

Fig. 3.4.8: Rules for cabling

Interconnection of Components

The panel installer needs to connect the PV modules with other components such as junction box, controller and battery, and then check the functioning of the modules.

Interconnection of Junction Box and PV Module

The installer must follow the following steps for connecting the junction box to the PV module:

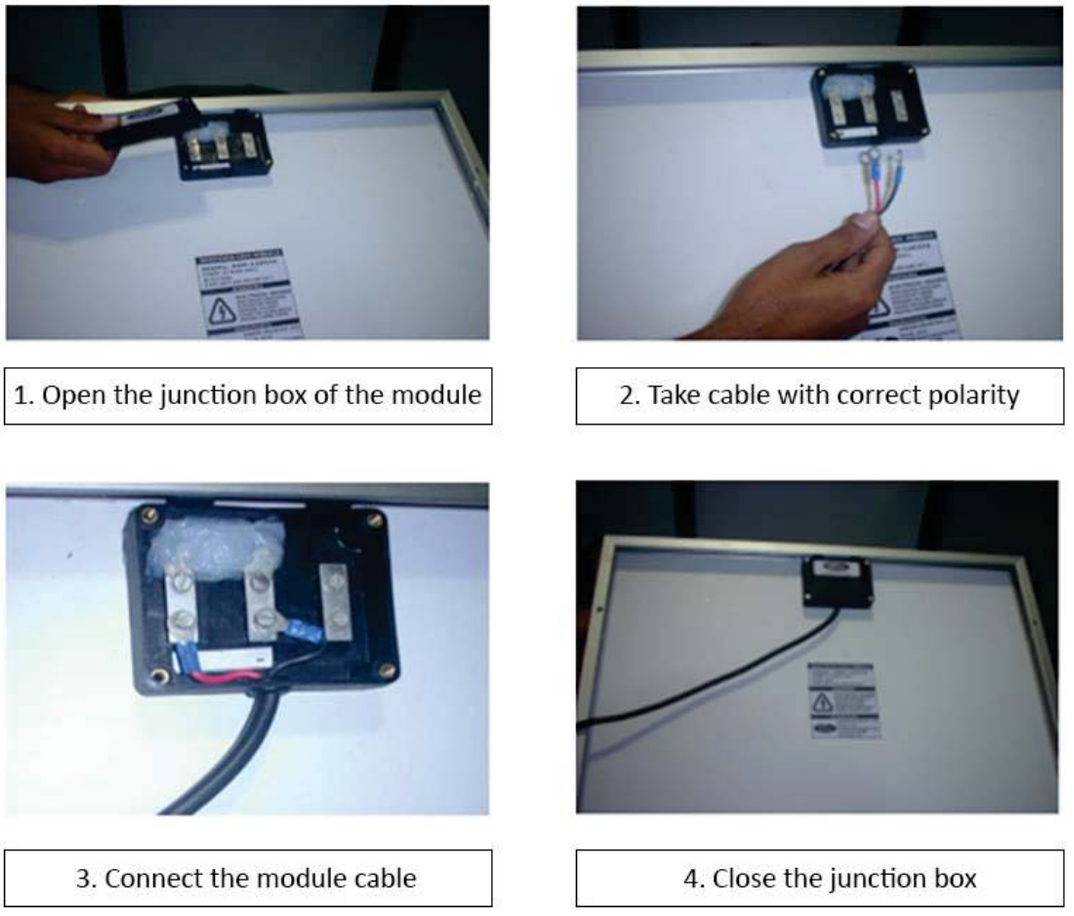


Fig. 3.4.9: Steps for connecting the junction box to the PV module

Install spare fuse to avoid any short circuits as per company policy

Interconnection of Charge Controller and PV Module

For interconnections between solar modules and charge controllers, some general installation guidelines must be followed:

- Minimum wire length must be used to avoid DC voltage drop.
- No wires are loosely connected.
- Different size of conductor for series and parallel connections and from junction box to the battery must be used to avoid the system's voltage from dropping.

The following figure lists the steps of interconnection of a charge controller and a PV module:

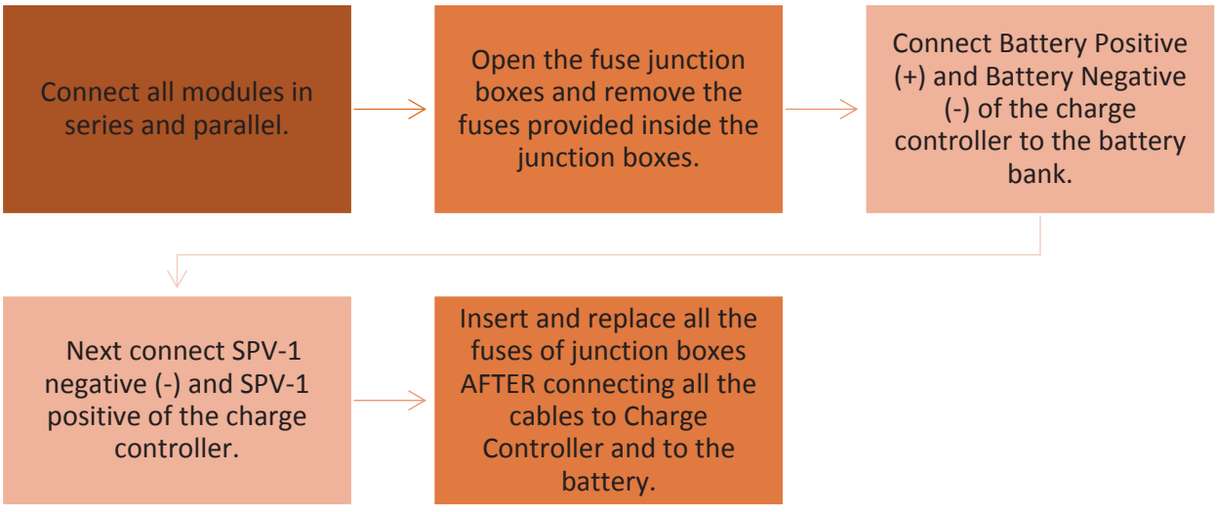


Fig. 3.4.10: Steps to interconnect charge controller and PV module

- Battery connections must be given first to charge controller. The charge controller will be damaged if the solar PV Array is connected first and then the battery bank.
- Switch OFF MCB of Charge Controller before any connection.
- Switch ON MCB of the Charge Controller when all the connections are thoroughly checked and fuses are replaced in the junction boxes.
- Do not short negative terminals of the system.
- All the positive (+) and negative (-) wires will run separately from the junction boxes.

Precautions for Interconnecting the Components

The panel installer must:

- Ensure that modules with similar MPP currents are interconnected in a series string to avoid losses due to mismatching of modules.
- Interconnect module connectors under open circuit.
- For modules without connectors, use suitable clamp terminals, strain relief and waterproof cable feed-though when connecting cables into the module junction box. Ensure that the junction box cover is sealed and watertight.
- Not disconnect module connectors under load.
- Before disconnecting module connectors, turn off the inverter and trip the DC circuit breaker to isolate load. The module connectors can be disconnected under open circuit voltage.
- Measure string open circuit voltage before connecting in parallel with other strings.
- Ensure that the measurement of string I/V characteristics ensures that string MPP voltages and currents are matched within specified limits.

- Ensure that the string open circuit voltages are matched within specified limits.
- Ensure that fuses, blocking diodes and DC surge/lighting protection devices are installed and wired inside the combiner box.
- When connecting DC main cable into the combiner box, ensure that combiner box is isolated from PV string/array to avoid high risk of arc because of DC power input.
- Ensure ease of access for interconnections and maintenance of string/array combiner boxes while installing the boxes.
- When connecting DC main cable into inverter DC input, ensure that the inverter DC input is isolated using a DC circuit breaker.

3.4.6 Checking for Functioning of the Modules

A panel installer needs to check the functioning of the PV modules after setting up the connections between the system components and the panels. He/she needs to:

- Visually check the system after installation is complete
  - Check that all modules and system components are secured by bolts.
  - Check that all wiring connections are properly made as per diagrams and instructions.
  - Ensure all essential parts are grounded properly. Ensure all disconnects and circuit breakers are turned off and all fuses have been removed out of their holders.
  - Check the polarity of all PV strings and PV array, both at combiner boxes and at inverters.
  - Check open circuit voltages of all PV strings and PV array. The string open circuit voltages should be within specified tolerance.
- Ration the voltage through the circuit where shorting link is to be installed.
  - Only if this voltage is zero, install shorting link across the PV output's load side circuit while disconnect is open.
  - Do not insert a fuse/disconnect breakers towards the battery/inverter during these steps.
  - Then attach a PV string fuse in the first-string fuse holder.
  - Shut associated disconnect.
  - Measure the short circuit current, then open the disconnect.
  - Move the fuse to each circuit string and re-do the procedure. Every time, measure the current. The string short circuit currents should be as per the specified tolerance.
  - Remove the shorting link and open the disconnect on PV output circuit.
- Check that all the source string fuses are installed.
  - Estimate the PV array's open circuit voltage.
  - Ensure that the open circuit voltage is close to the lowest individual string open circuit voltage, measured and within specified tolerance.
- If the ground fault protection device trips in any of the above tests, ensure there is only one grounding point and follow troubleshooting procedure to find ground fault.
- Connect the inverter, PV array and the utility source by closing output disconnects/circuit breakers prior to the input disconnect/circuit breakers.
  - The inverter will remain off for some time with its input voltage close to a PV array open circuit voltage and an AC output current of zero.

- When the inverter begins delivering power to load/grid, the inverter output AC current as well as the DC input voltage and current will reach maximum power values.
- Monitor inverter output current using clamp-on current probe. Record inverter output AC Current, voltage and frequency. These should be within specified limits.
- Monitor inverter DC input voltage and current. Ensure they are within maximum power specification.

3.4.7 Earthing of the PV system

The panel installer must ensure the proper earthing of the PV system to protect the system from lightening. The following figure lists the reasons for earthing or grounding:

Equipment and system grounding is required to provide earth as a common reference point for various voltages, to restrict voltages because of lightning/accidental contact/line surges with lines having a high voltage and to provide current path for operation of over-current protection devices.

Equipment grounding maintains protection from shock which are a result of ground fault. It is an obligation in all PV systems.

Fig. 3.4.11: Reasons for grounding the PV system

The grounding consists of the grounding electrode, the grounded conductor and the grounding conductor.

The following figure lists the rules for grounding of PV system:

- The grounded conductor is grounded at one point via the grounding electrode and the grounding conductors connect all equipment enclosures to the grounding electrode via the grounded conductor.
- The equipment chassis is connected to grounding electrode via grounding conductor.
- The PV array, the combiner box, the inverter, the DC and the AC distribution boxes require grounding.
- The grounding conductor must not be fused or switched.
- Array support structure should have equipotential bonding and grounding arrangements for safe conduction of capacitive discharge currents to ground.
- All grid-connected PV systems have DC voltage well over 50V and require system ground. DC system grounding is done by connection of a negative conductor on ground at a single point.
- The single point ground is located near the PV array for battery system protection from voltage surges.
- AC system can use the same grounding electrode.
- If two separate electrodes are used for DC and AC systems, they need to be bound together.
- Jumpers can be installed for system and equipment grounding conductors to maintain ground continuity if one of the equipment is removed from the system.
- Ground fault detector and interrupter (GFDI) is used to isolate grounded negative conductor from ground under ground fault condition.
- GFDI also isolates undergrounded positive conductor. Most grid-tied inverters provide inbuilt fault protection for ground. If not, an external fault protection for ground is required.

Fig. 3.4.12: Some rules for grounding of PV system

3.4.8 Maintenance of PV System

Maintenance refers to fixing any sort of mechanical, plumbing or electrical work so that the component or equipment or system does not go out of order or break.

Maintenance can be of many different types. The following figure lists two basic type of maintenance:

Unscheduled Maintenance	Scheduled Maintenance
• Performed when there is a sudden fault or damage to the system or its components • Involves repair or replacement of components of the system	• Performed as a routine check up to maintain the components of a system so that the system and its components are in proper working condition • Done periodically

Fig. 3.4.13: Scheduled and unscheduled maintenance

The PV system and its components require less maintenance as compared to other power systems, although a few periodic maintenance tasks should be performed on the PV system components.

While performing maintenance for PV components it is must to refer to the component specification sheet or the catalogue provided by the supplier, so that the installer is:

- properly familiar with the component
- aware of the necessary precautions to be taken while maintaining the component.

The associated components of a PV system, such as batteries and charge controller, need to be maintained:

- Once a fortnight the surface of the panels should be wiped clean with a wet rag to remove dust, fallen leaves, bird dropping, etc.
- Only water is to be used and no other cleaning agent.
- With solar panel secondary battery maintenance becomes minimum. Still general periodical maintenance of battery should be carried out in the usual manner and as per the maintenance manual.

3.4.9 Troubleshooting of PV System Components

A variety of problem solving and troubleshooting techniques are applied for repair of failed systems, processes or products. It is a reasonable, methodical search for the cause of a problem/issues for the purpose of a resolution and so that the module/process/system can be made functional again. Proper working of the PV system would be possible if during the initial phase of installation, a high quality and a proper designed system is installed, and, if regular maintenance of the system and its components, is done.

The following figure lists the probable reasons of fault in a PV system:

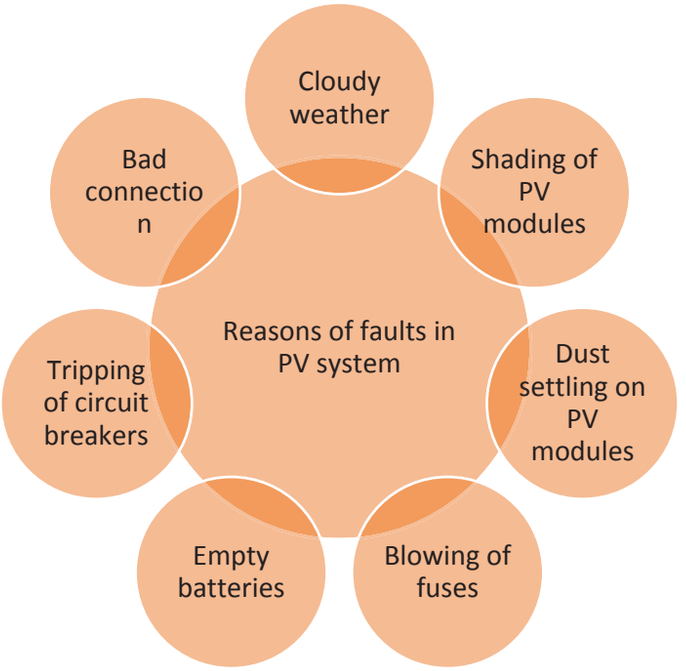


Fig. 3.4.14: Probable reasons of faults in the PV system

Basic troubleshooting starts with visual inspection of different components. A PV technician should be able to:

- Check the PV array for partial shading or dirt.
- Check all fuses and the circuit breaker.
- Check the junction boxes, the distribution boxes and wiring for loose connections and/or corrosion.
- Check the PV modules and batteries for proper series-parallel configurations.
- Check system wiring using multimeter for proper polarity and continuity.
- Check the meters installed in the system for proper voltage and current readings.

The solar PV power source is a reliable source of electrical energy. However, there may be rare instances when the solar PV power source is not able to drive the connected equipment. The diagnosis of the problem in such situations starts with the battery. A panel installer must:

- Check the voltage of the battery bank.
  - If the voltage of the battery bank is correct as indicated in the charge controller, the problem may be due to:

Inverter is tripped	Switch/load MCB is tripped	Load fuse is blown off

Fig. 3.4.15: Checking the battery to resolve the issue

- If none of the above faults is observed then analyze the exact gravity of electrolyte present in the battery's secondary cells. There may be two cases that are listed in the following figure:

Specific gravity is above the level as specified in the maintenance manual.

- Battery is in order and the problem would be either with the charge controller or the load.
- Disconnect the load from charge controller and connect it directly to the battery.
- If the equipment operates, the defect may be with the charge controller.
- Disconnect the charge controller and check as per troubleshooting instructions given in the manual supplied with it.
- If the problem is not solved, inform the manufacturer/supplier.

Specific gravity of the electrolyte is below the specified level and red LED is glowing.

- Loads may be drawing more current from the battery than required.
  - In such case, battery is bound to get discharged, even if SPV Panel is functioning properly.
  - This would result in frequent tripping of the load.
  - To avoid this, get the load equipment checked and replace any defective components.
- The SPV Panel may not be producing required power for which the Power Source has been designed.
  - Check for any loose connection/breakage of wire in SPV module interconnections.
  - If there is no such loose connection, clean the SPV Modules with soft cloth.
  - Whenever there is bright sunshine, measure the voltage and current of each module after disconnecting the wire.
  - If any of the SPV modules gives low voltage/current output during bright sunlight inform the manufacturer/Supplier with module serial number along with the measurement taken, for necessary investigations.
- Failure of blocking diode
  - If it is failed in short circuit mode, voltage across its terminal will be zero in place of 0.7 V while charging current flows through it.
  - When it fails in open circuit mode, the current will not flow through the diode.
  - The diode may be checked as per standard method of checking of diode by removing from the circuit.

Fig. 3.4.16: Steps to diagnose the problem

3.4.10 Troubleshooting faults in a PV System

The following table lists some fault symptoms along with their possible reasons:

Symptom	Probable cause	Action
No output	• Break of conductor • Corrosion of cable • Loose or improper connection	• Replace cable • Check polarity and connection of wires • Ensure wires are non-corrosive
	• Defective connector • Loose connection • Corrosion of connector • Improper fixing of the connector	• Replace the connector • Adjust the connector properly
	• Damaged junction box	• Send for servicing to the factory
	• Charge controller fails	• Replace the charge controller
	• Some internal problem	• Send to factory for exchange in warranty period
Output voltage okay, but no output current	• Internal damage of cell • Interconnection problem	• Return to factory within the warranty period
No charging indication on the Charge controller	• Shading of the SPV module • Dirt on panels	• Remove the shades or change the location of the module and ensure maximum sunlight falls on the module. • Clear the particles on the module
	• Broken module	• Replace
	• Electronic failure of charge controller	• Replace
	• Break of conductor • Corrosion of cable • Loose or improper connection	• Replace cable • Verify the wire connections are tight, corrosion free and of correct polarity.

Symptom	Probable cause	Action
Output voltage for less duration	• Shading of the SPV module • Dirt on panels • Improper installation	• Remove the shades or change the location of the module and ensure maximum sunlight falls on the module. • Place the module in such a way that direct sunlight falls on the module for more hours. • Clear the particles on the module
	• Broken module	• Replace
	• Electronic failure of charge controller	• Replace
	• Conductor has broken • Corrosion of cable • Loose or improper connection	• Replace cable • Verify that the wire connections are tight, corrosion free and of correct polarity.
	• Insufficiently charged battery • Acid leak from battery • Low capacity • Battery terminal broken	• Charge the battery to full charge condition and check the output duration. • Replace battery
No voltage across blocking diode	• Diode failed in short circuit mode	• Replace diode
Voltage high across blocking diode	• Diode failed in open circuit mode	• Replace diode

Activity

Create a maintenance schedule checklist for a PV system.

Practical

There is a sudden shut down and loss of energy in a PV system. Troubleshoot the problem.

Tools:

- Clamp meter
- Screw drivers (or 11-in-1)
- Notepad
- Pencil
- Spare GFDI fuses
- Multimeter

Practical

Measure the current of the PV module with a clamp accessory.

Tool:

- Digital Multimeter (DMM)
- Current Output Clamp
- Voltage Output Clamp

Practical

Wire and install a 1-kilowatt standalone PV system.

Components:

- 1/2" galvanized electrical conduit
- Copper grounding wire
- Concrete
- 4 x 4 posts
- 40-amp charge controller
- 24-volt 110-watt PV panels (8)
- 1/2" copper rod
- Electrical cable
- 12-volt, 255-amp sealed batteries (4)
- 5500-watt power inverter
- Nylon rope
- Angle brackets
- Angle finder
- Fuse combiner box
- Solar breaker
- Circuit breaker

Practical

The output of the PV system is low. Troubleshoot the problem.

Components:

- PV system with low output
- Faulty PV module
- 381 voltmeter
- 381 clamp meter
- DC ammeter

Practical

Perform the maintenance activities of a PV system.

Component:

- Piece of cloth
- Electrolyte (ionized distilled water)
- Grease
- Torque wrench
- Baking powder solution
- Water
- PV system battery with corroded terminal

Practical

Battery state of charge (SOC) is constantly below 1.5V. Troubleshoot the issue.

Components:

- Faulty battery
- Wrench
- Distilled water
- Multimeter

Practical

Perform a test for the earthing and lightning protection.

Components:

- Ohmmeter
- DC voltmeter

Practical

Set up a cable connection for PV modules and other components in the PV system.

Components:

- MC4 connector
- Cable trench or tray
- Flat head screw driver
- Class 2 SPD
- Cable
- 3 core, 5 core cables
- Wire stripper
- Spare fuse

Practical

Install roof attachment for a flat roof mounting systems.

Components:

- Rails
- Clamps
- Purlins (supports boards or rafters, rests on principals, horizontal beam running lengthwise with the roof)
- PV modules
- Bolts

Practical

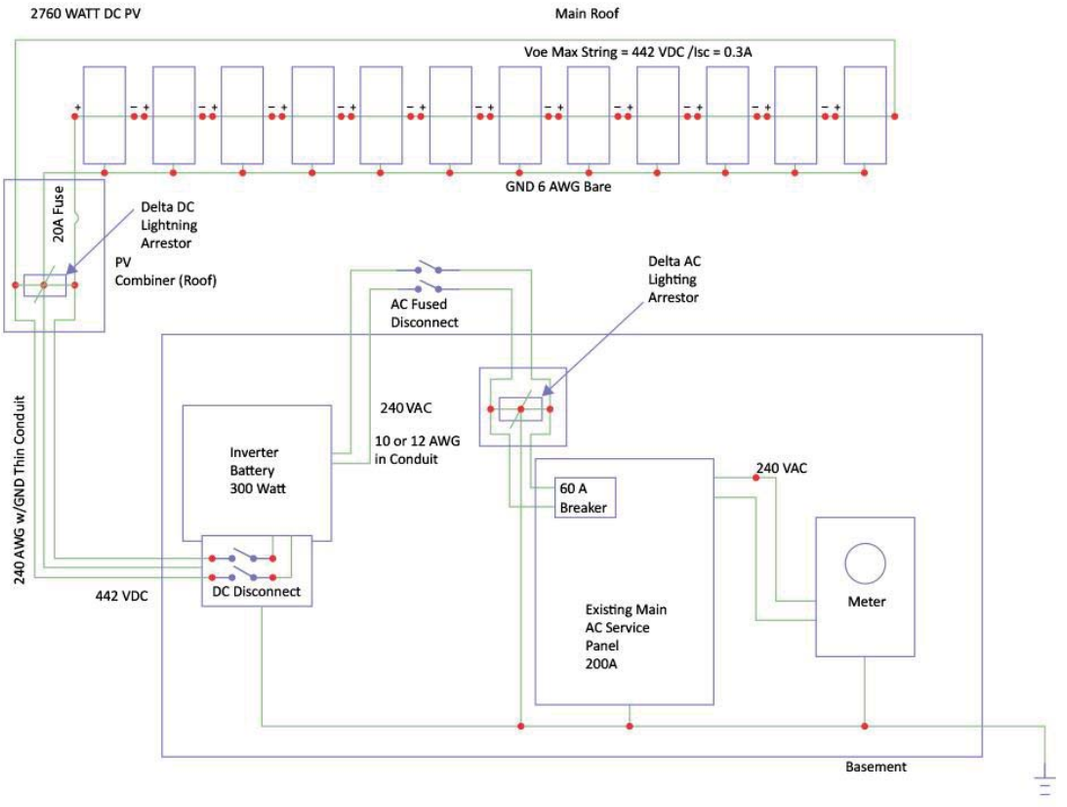
Install roof attachment for a slope roof mounting systems.

Components

- Hooks
- Screws
- Drill
- Hanger bolt
- Array structure
- Corrosion protection
- Weather protection
- Flange (strengthens or attaches a work piece to maintain position on a rail, is a projecting flat rim, collar, or rib structure on a work piece)
- Rubber seal
- PV modules
- Bolts and nuts

Practical

Install a commercial grid-tied PV system as per the specification given in the diagram.



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4. Work Ethics and Workplace Safety

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Unit 4.1 – Work Ethics

Unit 4.2 – Workplace Safety

Unit 4.3 – Soft Skills

Key learning Outcomes

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

- Explain work ethics
- Interact with supervisor
- Interact with colleagues
- Evaluate the practices of working in a team
- Implement quality and safety procedure
- Recognize the potential sources of accidents
- List the general safety guidelines
- Recognize safety measures and precautions
- Explain communication skills
- Develop effective listening skills
- Manage a conflict
- Explain the importance of personality development

UNIT 4.1: Work Ethics

Unit Objectives

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

- Describe work ethics
- List the factors for creating strong work ethics
- Interact with supervisor
- Interact with colleagues
- Evaluate the practices of working in a team
- Implement quality and safety procedure
- Execute work effectively

4.1.1 Defining Work Ethics

Work ethics means the right and the wrong way of doing your job. Work ethics would mean the following:

- Following timelines
- Working as per standards and guidelines
- Following the rules and policies of the organization

Work ethics is essential for an organization to achieve its objectives. Every individual in the workplace, from the CEO to the entry-level workers, need to possess strong work ethics for the company to scale new heights. A panel installer should be aware of work ethics to complete his/her work effectively. The following figure lists some factors that help to create strong work ethics.

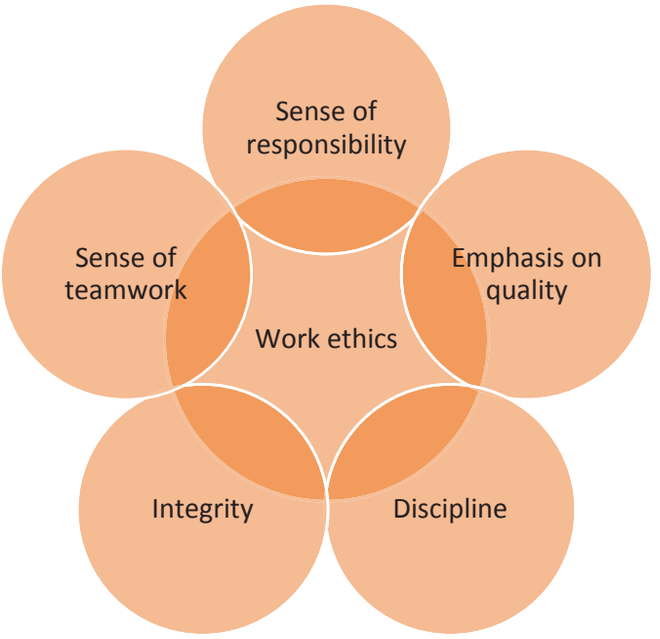

Fig. 4.1.1: Certain factors for creating strong work ethics

Integrity

An employee should display integrity in all spheres of the job. This enables the person to develop:

- Trustworthy association with clients
- Good interaction with colleagues and supervisors

Sense of Responsibility

The quality and quantity of the work an employee produces depends largely on the person's sense of responsibility. The employee will be punctual and complete all tasks on time if he/she takes responsibility for the work. This involves:

- Completing the work effectively
- Following quality and safety procedures
- Adhering to health and safety norms
- Ensuring waste management and disposal procedures and standards
- Achieving work standards

Emphasis on Quality

Employees with good work ethics are concerned about the quality of their work. They go beyond what is needed to complete their task and secure their job. They put in their best efforts to effectively perform their assigned tasks. The employee should:

- Ensure quality of materials
- Ensure proper handling of materials
- Ensure that only company recommended quality materials are used unless specified otherwise by the customer
- Ensure that the quantity of modules/panels match the voltage requirement of the system

Discipline

The daily tasks can only be completed if the employees are totally committed towards their work. A strong sense of discipline keeps them focussed on their goals. Their dedication and discipline enables them to finish their assignments on time. The employee should:

- Be aware of the timelines
- Minimize absenteeism
- Plan the day's activities and the complete work plan for each installation

Sense of Teamwork

The employees as a team, work together to achieve company goals. An employee possessing a strong sense of teamwork assists a team to meet its objectives and produce high quality work. He/she knows the value of respect and cooperation. Thus, an employee needs to:

- Work as a team member for achieving smooth workflow and and satisfying the customer
- Communicate the constraints and quality requirements to the team
- Build team coordination

4.1.2 Interacting with Supervisor

A supervisor can guide an employee to work efficiently. The employee must be able to communicate with the supervisor in a proper way. The following figure highlights and lists the points on which a panel installer must interact with the supervisor:

Fig. 4.1.2: Interacting with a supervisor

The panel installer needs to understand the work requirements, the instructions of the supervisor and the standard working procedures to carry out the work efficiently. Work requirement is a document which has the date, location and the details of a task, which must be done. It is the record of the task which must be performed. The panel installer should be able to understand the assigned task and its requirements.

Understanding work requirement involves the factors listed in the following figure:

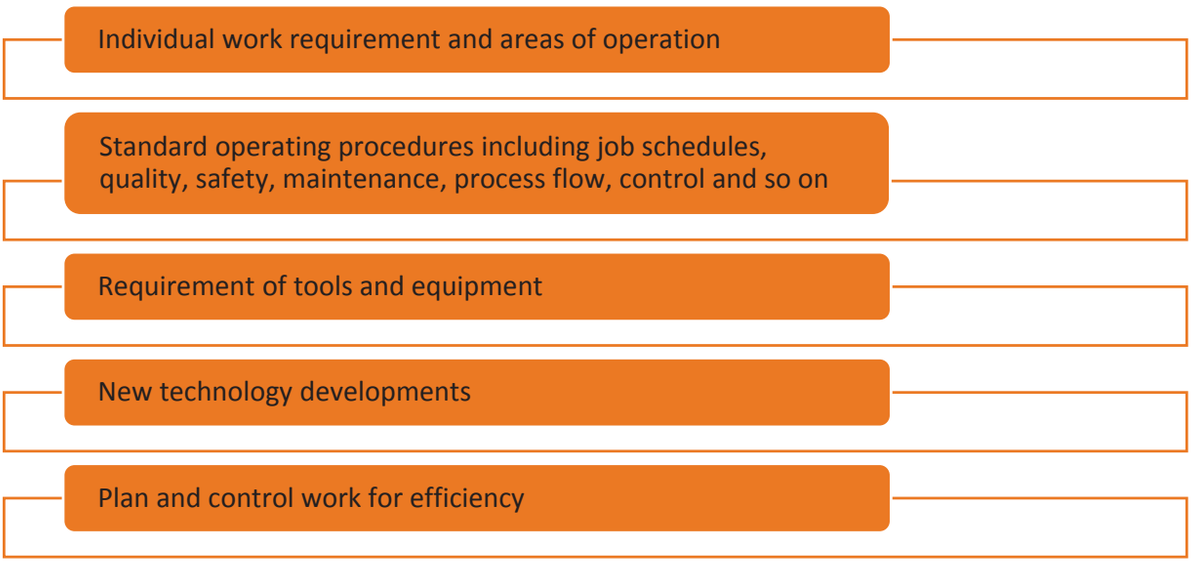

Fig. 4.1.3: Understanding work requirement

4.1.3 Reporting Structure

All businesses must organize the work they do. A clear structure makes it easier to see which part of the business does what work and enables effective communication across the business structure. The following figure lists the ways to structure a business:

By function	By product or activity	By area	By customer	By process
• Arranging the business according to what work each section or department does	• Organizing business according to the different products made	• Organizing business as per the geographical or regional structure	• Organizing the business as per the different needs of different customer groups	• Arranging the business according to the stages the products have to go through as they are made

Fig. 4.1.4: Ways to structure a business

A panel installer should be aware of the reporting structure so that the incidents can be reported to the correct stakeholder.

The following figure shows a basic reporting structure:

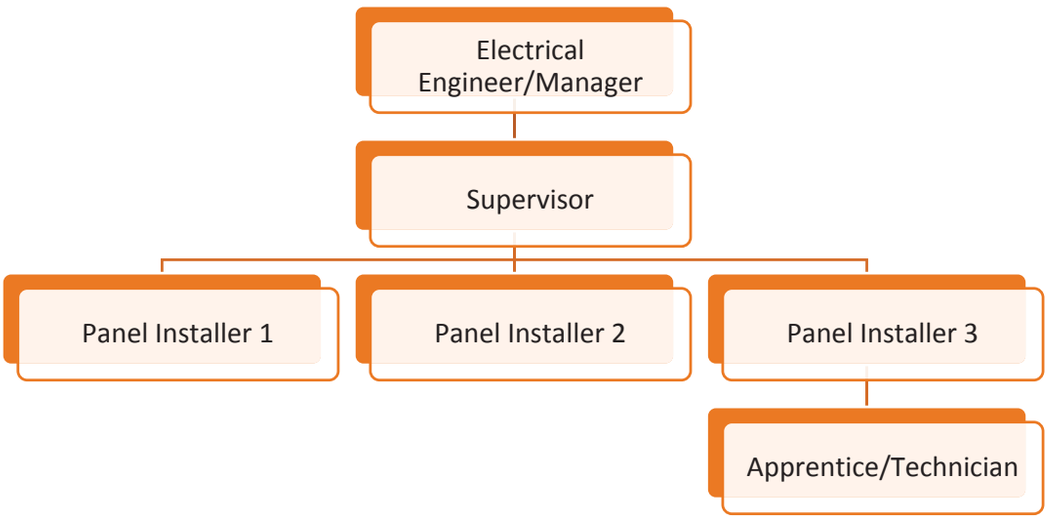

Fig. 4.1.5: A basic reporting structure

4.1.4 Interacting with Colleagues

Sense of harmony and unity is the key to a healthy and competitive environment in an organization or a workplace. Higher the rank in an organization, the bigger the responsibilities get and the more complex the problems become.

The work group is united by the goals and missions of the organization. But, at times, issues such as varied viewpoint, creates an unhealthy work environment. A panel installer needs to interact with his/her colleagues to carry out the installation work. The following figure lists the reasons for having a good relationship with colleagues:

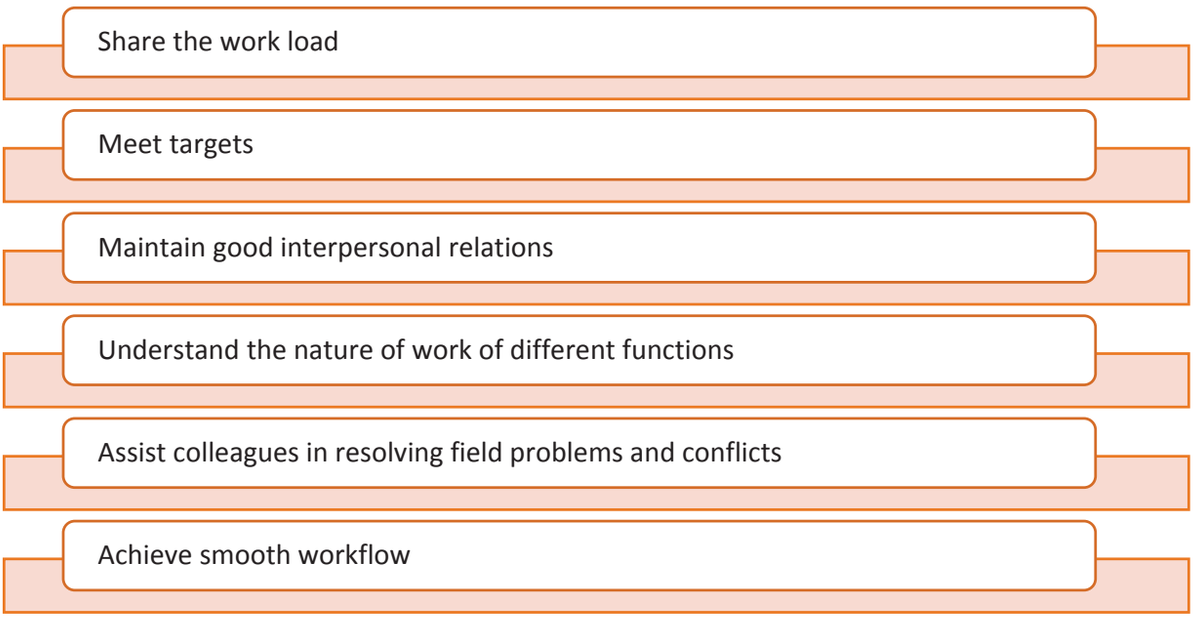

Fig. 4.1.6: Reasons for having a good relationship with colleagues

4.1.5 Following Quality and Safety Procedures

For an organization, it is very important to maintain quality standards. A quality standard is an account of the specifications, distinct features, necessities and varied guidelines related to a product or service so as to meet its purpose and quality level. A panel installer must ensure the quality of materials is maintained in accordance to the company work standards. The following figure highlights some of the key points to be followed by a panel installer to ensure quality:

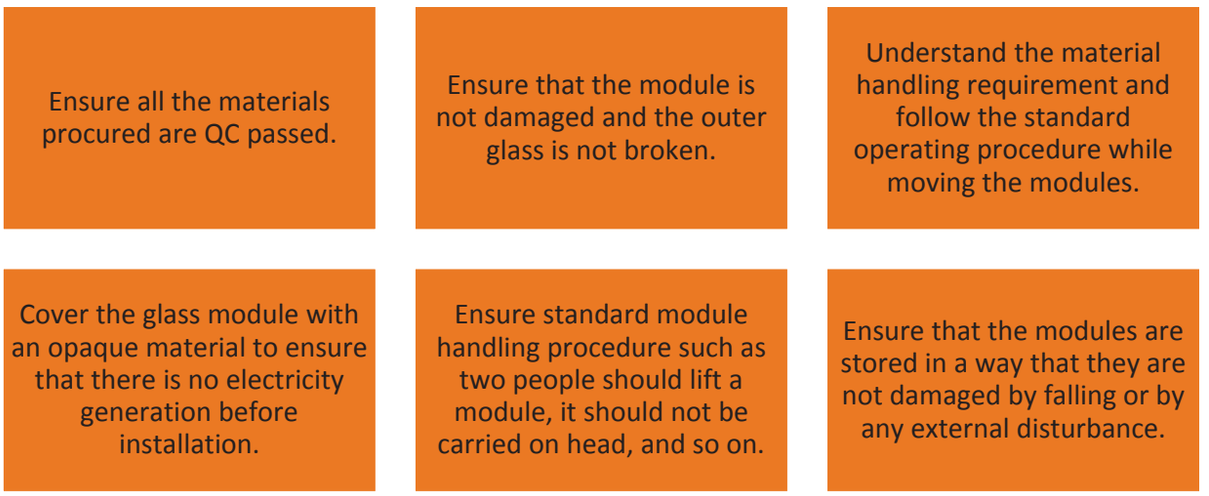

Fig. 4.1.7: Ensuring quality standards

The PV panel installer should follow the safety procedures to ensure own safety as well as that of others. He/she must be aware of the type of accidents or hazards that can take place while working and the probable actions to be taken. The following figure lists some of the safety procedures that should be followed by a panel installer while working with solar panels:

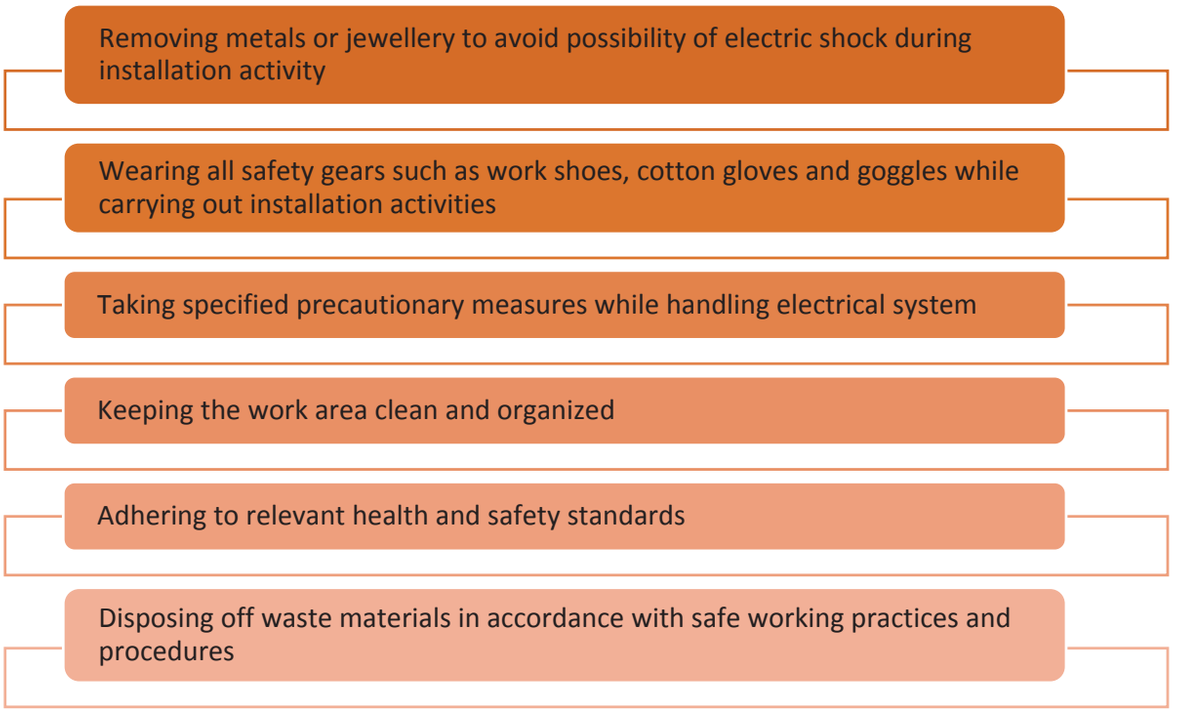

Fig. 4.1.8: The safety procedures

4.1.6 Completing the Work Effectively

The panel installer must be aware of the timelines of work. He/she not only does the scheduled tasks, that is to install and maintain the PV system, but also does the following tasks to complete the work:

- Clean the work area after completing the installation activity.
- Remove all the used tools and consumables from the installation area.
- Fill in the job completion form and get the signature of the customer.
- Inform the customer about maintenance of the solar panels and the procedure for their cleaning.
- Follow company standards in documentation of the performed installation activities.

4.1.7 Working as a Team

A panel installer employee cannot do all the work by himself. Hence, he/she needs to work in a team. The following figure lists some practices to be followed by a panel installer while working in a team:

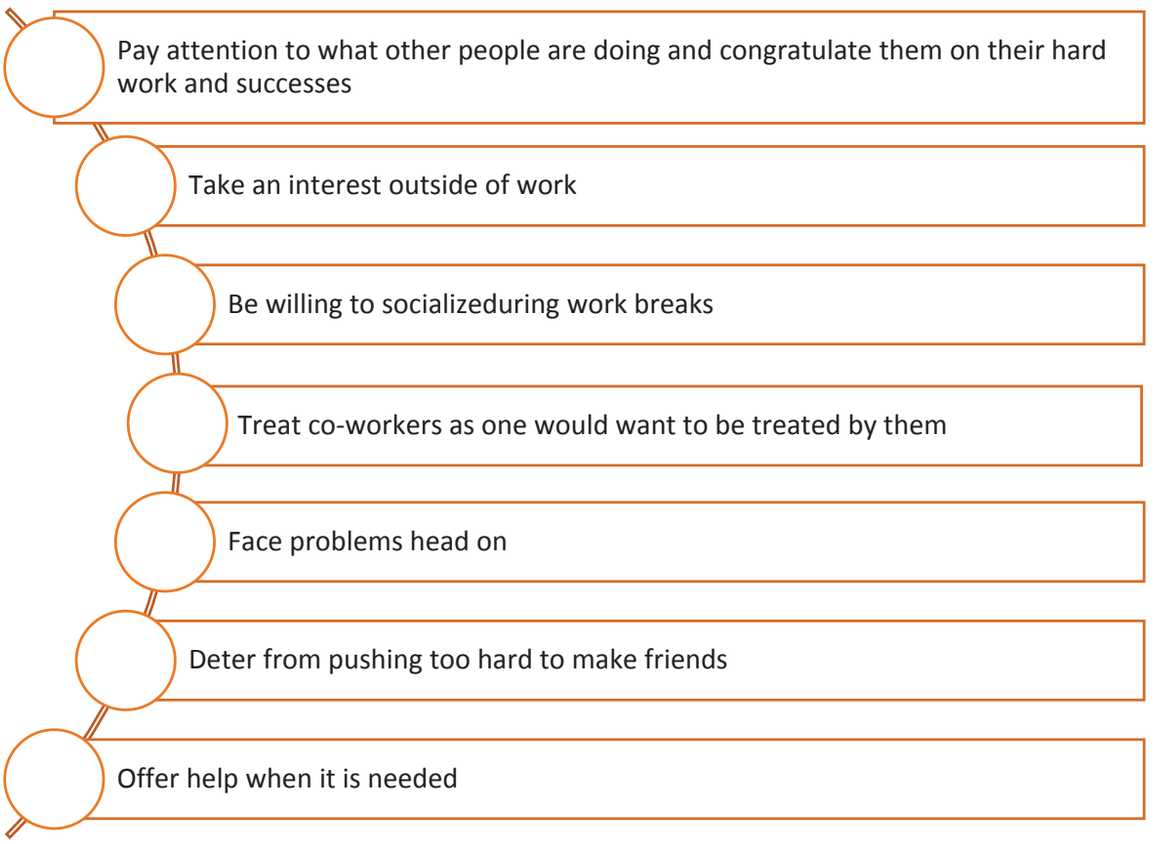

Fig. 4.1.9: Practices to be followed while working in a team

4.1.8 Understanding Organizational Work Policies and its Processes

Working effectively in an organization requires awareness of the work policies and the standard work processes. The following figure lists the general work policies and procedures in an organization:

- Setup the production equipment and supplies before executing the job orders.
- Operate the equipment safely and effectively for production processing.
- Ensure that the equipment is well maintained and is in a good and safe working condition.
- Inspect the equipment to identify any replacements, malfunctions and repairs.
- Perform regular equipment maintenance to ensure production capacity and quality.
- Provide assistance to junior operators in their assigned responsibilities.
- Repair and clean the equipment when needed.
- Work under the guidance of sthe upervisor to perform and complete the assigned duties in a timely manner.
- Evaluate equipment performance and recommend improvements.
- Operate trucks and other industrial vehicles to transfer the production equipment between the warehouse and the working area.
- Follow safety procedures and company policies for equipment operation.
- Recommend process improvements to enhance operational efficiency and safety.
- Contribute to waste management programmes.
- Identify and report unsafe operations to the supervisor immediately.
- Maintain the work area to keep it clean, safe and organized.

Fig. 4.1.10: General work policies and procedures in an organization

UNIT 4.2: Workplace Safety

Unit Objectives

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

- Recognize the potential sources of accidents
- Classify the safety policies
- Identify the responsibilities of managers and employees regarding safety
- List the general safety guidelines
- Recognize the safety measures and precautions

Working is good for health and people are also becoming aware of the fact that a healthy workforce is profitable for the employers as well. A safe, healthy and positive work environment can boost the morale and work-life balance of the employees and, as a result, be beneficial for the business.

Health refers to the general well being of a person. A healthy person, who in this case is a panel installer, is free from all diseases and has a sense of mental, physical and social well being. A healthy panel installer can:

- Help to prevent absence from work
- Improve work performance
- Demonstrate work responsibility
- Reduce accidents and work-related ill health

Just as an installation of a safe PV system takes place according to a building's code and standards, similarly, a panel installer's safety is also important. Few of the safety considerations are:

- Work area
- Equipment involved and usage of tools
- Forms of personal protection
- Safety hazards information

PV system installation involves various safety hazards mainly as a result of an electric shock or a fall from a rooftop. A significant/theoretical understanding of electrical systems and respective safety hazards associated with it is essential in order to work safely with PV systems.

4.2.1 Potential Sources of Accidents

A panel installer must be aware of the potential sources of accidents so that he/she can avoid them or ensure minimizing their impact at the workplace. The installer needs to:

- Spot and report potential hazard timely.
- Follow rules related to hazardous materials as per the company's policy.
- Handle all equipment and tools with care.
- Avoid mishaps that may be a result of dangerous gases, chemicals or sharp tools; and potential hazards that may be an outcome of probable injuries like minor burns or cuts.

The following figure lists the types of hazards:

Fig. 4.2.1: Types of Hazards

Safety Hazards

Death or any type of illness or injury caused due to unsafe conditions are categorized under safety hazards. The following figure lists some instances of safety hazards:

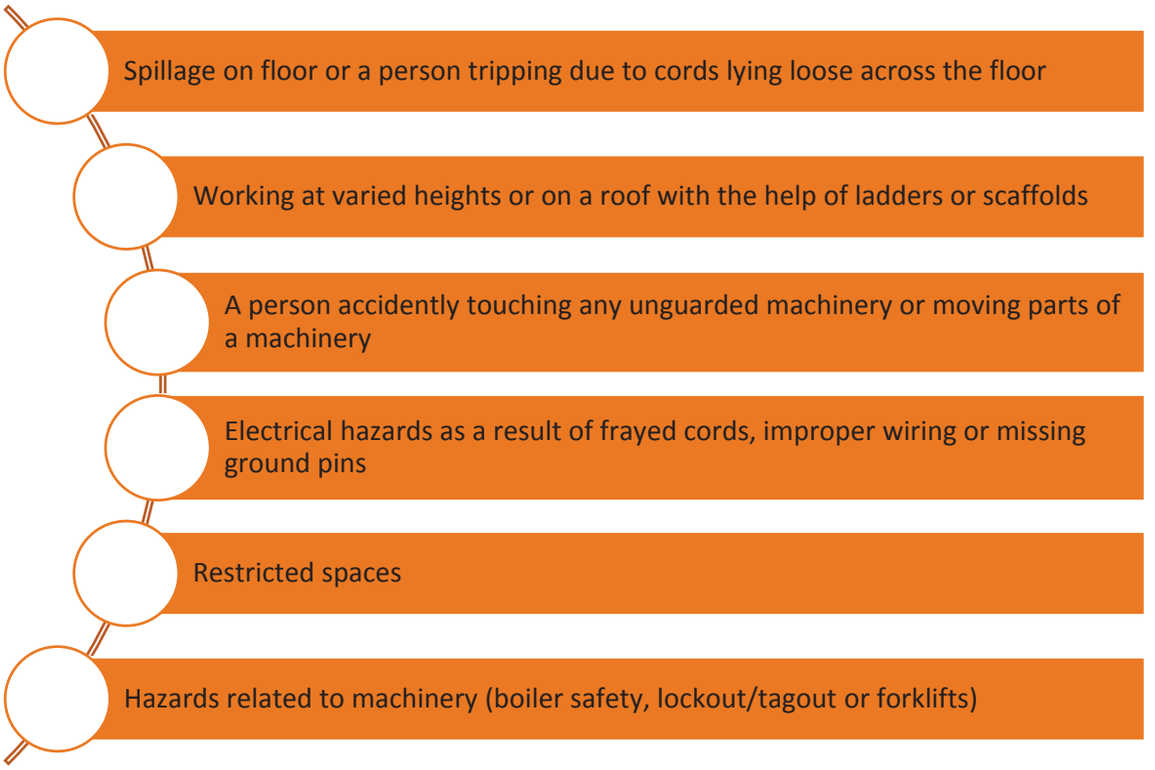

Fig. 4.2.2: Instances of safety hazards

Biological Hazards

Any biological substance that may threaten health of humans as a result of toxins or viruses are known as biological hazards. A person may be exposed to biological hazards in the following cases:

- Schools, colleges and universities
- Day care facilities,
- Hospitals, laboratories and nursing homes
- Outdoor occupations

The following figure lists the types of ill- health effects caused by biological hazards:

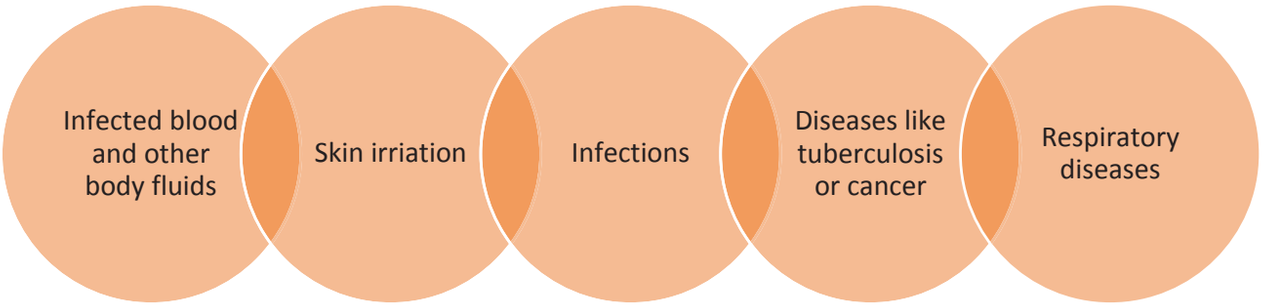

Fig. 4.2.3: Types of ill-health effects caused by biological hazards

Physical Hazards

An occupational hazard caused by environmental factors is termed as a physical hazard. It includes hazards such as:

- Radiation caused by radio waves, microwaves or EMFs
- Sunlight/ultraviolet rays exposure
- Extreme temperatures, be it hot or cold
- Noise pollution

Ergonomic Hazards

Ergonomic hazards occur due to single/multiple factors within the working environment that pose a threat to the musculoskeletal system of an individual. An uncomfortable workstation leading to wrong sitting postures, repetitive movement of a body part causing sprain or strain, muscle sores, etc., are categorized under ergonomic hazards. The following figure lists some instances that may cause ergonomic hazards:

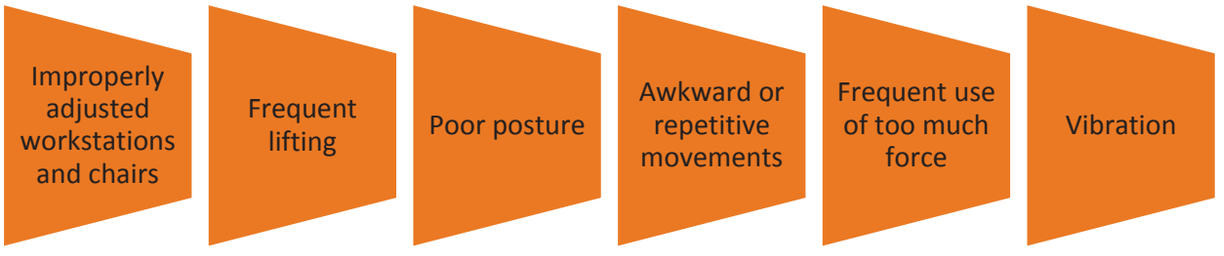

Fig. 4.2.4: Instances that may cause ergonomic hazards

Chemical Hazards

Exposure to chemicals at a workplace is the main cause of chemical hazards. Exposure to chemicals can be due to working around items that involve chemical preparations in any state solid, liquid or gas. Not all chemicals pose a threat, but there may be workers who are sensitive to even the mildest or non-toxic forms of chemical that is termed healthy. A person can be exposed to chemicals by inhalation of fumes, ingestion or poisoning.

The following figure lists some chemicals that one should be aware of:

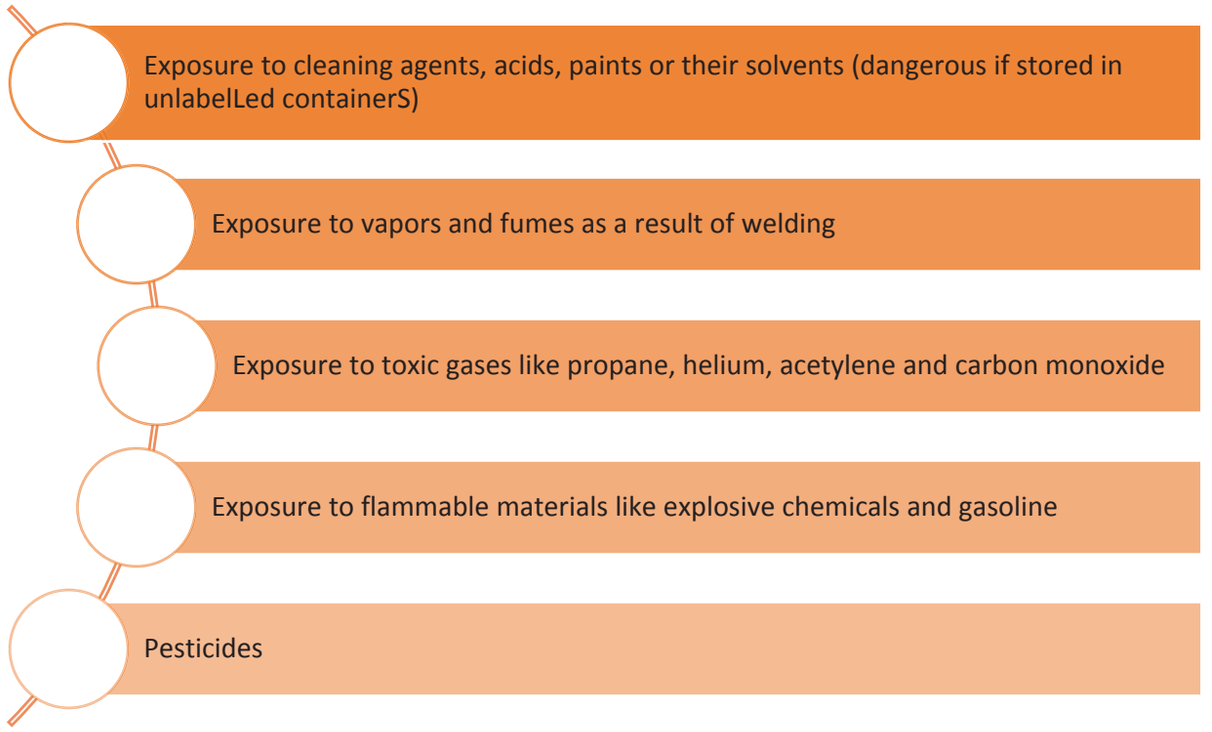

Fig. 4.2.5: Some chemicals that can cause hazards

4.2.2 Safety Policies

A health and safety policy is a written declaration made by an employer. It states the company's commitment for safeguarding the health and safety of the workers and also is an assurance to the public. It is a signed document made by the management related to the health and safety of the employees. A workplace requires a health and safety policy for the following reasons:

- To show complete commitment towards their health and safety of employees
- To prove to the employees that safety performance and work performance are in harmony with each other
- To give a clear statement of the company's objectives, principles, plans, ideas and procedures
- To increase buy-in through all divisions of the company
- To provide a definite outline of the accountability of the organization for the health and safety of the workers and also give a clear idea of the responsibility of the employer and the employees.
- To abide by the Occupational Health and Safety Act
- To define practices and processes to be adhered at the workplace to avoid injuries and diseases

In an organization, there are several policies followed by the employees. As a part of the organization, a panel installer must follow the safety policies. The following figure lists some of them:

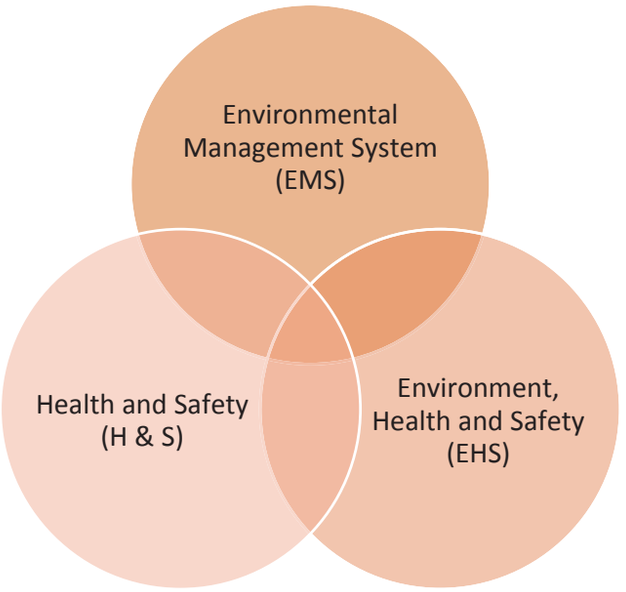

Fig. 4.2.6: Some safety policies

EHS Policy

The following figure highlights some important points from EHS policy guidelines:

- Provide a conducive work environment for all employees, ensuring their health and safety while taking all relevant steps to protect the environment.
- Protect the environment by conserving natural resources through elimination of waste generation and prevention of environmental pollution.
- Protect the health and safety of all employees, visitors, contractors or suppliers at the plant.
- Comply with all applicable regulatory requirements legally that relate to occupational and environmental health and safety.
- Make continual improvements in protecting environment and occupational health and safety performance by improving processes, introducing and investing in new technologies and upgrading competence and awareness of the employees.

Fig. 4.2.7: Some important points from EHS policy

EMS Policy

To minimize the risk of 'environmental impacts', some objectives and targets are set. The following points to the list of the primary objectives and goals set at ISO14001- certified plants.

- Minimization of wastes and enhancement of recycling rate
- Advancement of energy and resource conservation
- Adequate supervision of chemical substances
- Promotion of environmentally friendly products

The following table lists some other objectives and targets of EMS policy:

Aspect	Objectives	Targets
Use of paper	Reduction in use of paper	Reduction in use of paper by 25% within a year
Consumption of electricity	Reduction in the consumption of electricity	Reduction in the consumption of electricity by 20% within 1 year (based on current year consumption)
Use of cleaning material	Reduction in the use of hazardous cleaning material	Reduction in the usage of cleaning material by 25% within a year
Use of hazardous chemicals such as solder paste, epoxy potting and tin-lead solder	Increased use of environmental friendly alternative chemicals	Reduction in the usage of these chemicals by 5% within a year

H&S Policy

The following figure lists some of the objectives and key measures of health and safety policy:

Priority Actions	Measures/Key Performance Indicators
Make workplace free from injuries and illnesses	
• Improve workstation ergonomics • Reduce manual handling slips, trips and falls • Provide EHS training, safety audits and participation	• Number of incidents/accidents and near misses • First aid incidents • Number of days lost
Improve Occupational Health and Safety Assessment Series (OHSAS) knowledge throughout the organization	
• Provide EHS training, as per defined needs, of at least 6 hours to each employee • Improve OHSAS knowledge by employee participation	• Number of hours of training given to each employee in a year • Number of suggestions received from workers to improve workplace safety besides internal audit findings and safety audit findings

Responsibilities towards Safety Policies

All the members in an organization have their own responsibilities to ensure workplace safety. There is a safety committee in an organization. All the workers and managers as well as the safety committee members need to carry out their responsibilities related to safety. The following figure highlights the responsibilities towards safety policies:

Safety Committee Responsibilities	•Detect unsafe conditions and work practices by inspecting the facility regularly •Participate actively in health and safety training programmes and evaluate the programme's effectiveness •Plan improvements to existing procedures, health and safety rules, and plan safety promotions/incentives •Assessing personal protective equipment (PPE) needs •Overseeing emergency response preparedness and tests •Performing job safety analysis and serving as a resource for questions on safety •Immediately investigate workplace accidents
Responsibilities of Managers	•Familiarize employees with the OHS program, ensuring its effective implementation in the plant and enforce all company safety rules consistently and fairly •Beware of all safety considerations on introduction of a new process/procedure, machine/material to the workplace and providing safety training to employees before assigning duties •Give maximum support to programmes and committees that promote health and safety •Review and complete all reports related to an accident/incident, when required, to ensure fulfilment of all requirements so that appropriate action is taken to prevent recurrence •See that all injuries, even minor ones, are treated immediately and referred to a medical facility, if necessary •Inspect the work area regularly to look out for unsafe conditions and work practices and ensuring that unsafe or harmful conditions found in the course of inspections or incident investigations are remedied without delay •Conduct risk assessments for potential hazards from ergonomic hazards, violence at the workplace or emergencies to minimizing risks. •Conduct a safety orientation for all new employees, as well as for existing employees who are learning a new role and including the risks associated with the role •Ensure that all employees are healthy at work
Responsibilities of Workers	•Work with care and attention at all times and wear protective equipment as needed or required •Operate equipment/machinery after receiving the proper instructions •Report minor/major injuries/symptoms to the manager to enable action towards prevention and take possible remedy action to ensure that no one gets hurt •Encourge co-workers to work safely and assist them to have a safe working environment by suggesting actions to improve the effectiveness of the programme on health and safety •Maintain equipment in good, safe working order and check the usage of guards and safety devices on equipment as per the standards •Adhere to all safety rules and regulations •Take necessary steps to improve health and attendance as every employee has an obligation to meet the attendance requirements of the job; When an employee shows extraordinarily long absences, the rest of the team can be placed in a compromising position and conditions could become unsafe

Fig. 4.2.8: Responsibilities towards safety policies

4.2.3 General Safety Guidelines

An employee should obey some general guidelines as listed in the following figure to ensure a safe and healthy workplace:

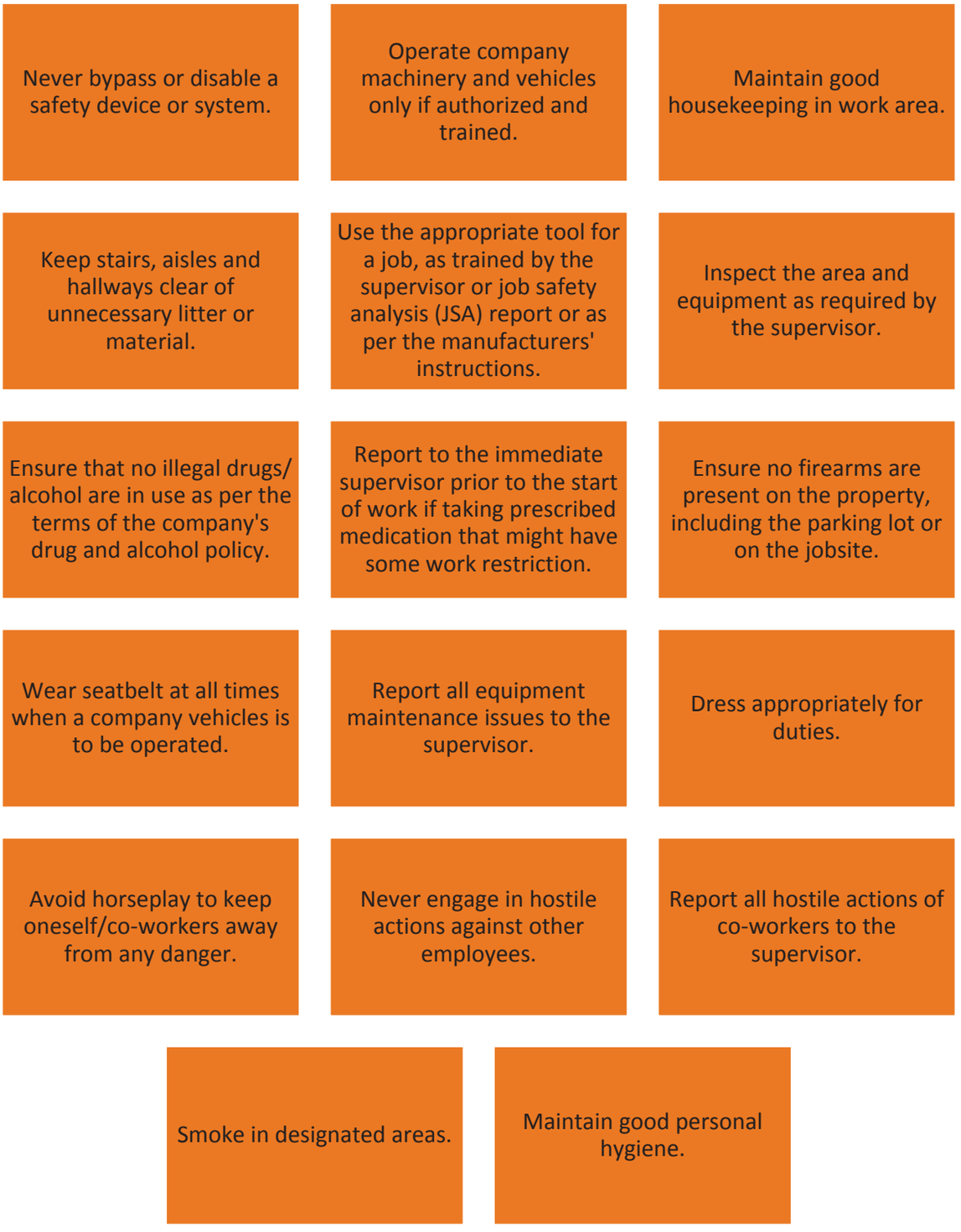

Fig. 4.2.9: General safety guidelines

4.2.4 Safety Measures and Precautions

Safety procedures and measures are dependent on the type of work. There may be a need for electrical safety, fire safety or mechanical safety for a panel installer. The following figure lists the general measures an employee should be aware of to ensure safety:

Daily safety instructions

- Take safety measures to prevent accidents.
- Ensure zero accidents while at work.
- Avoid damaging components caused by negligence in electrostatic discharge (ESD) procedure.
- Ensure no loss for company due to safety negligence.
- Ensure proper maintainance of machine and work process for achieving quality output as per the company standards.

Before starting work

- Plan and discuss requirement of work to be done.
- Consider potential hazards and measures to be taken.
- Confirm permission to isolate (use a permit system if relevant).
- Isolate the electrical equipment or circuit.
- Place a "DANGER, DO NOT OPERATE" tag.
- Put up safety barriers when required.
- Use the correct earthing equipment.
- Cover and insulate a nearby live apparatus.
- Check test instruments and get authorization to do the work.

When working

- Use safety observers when required.
- Always wear PPE.
- Never rely on memory.
- Connect the earth and neutral conductors first.
- Check the isolation points before resuming work after a break.
- Check and clean the tools that are used regularly.
- Use non-conducting tape measures.

After completion of work

- Check if tools are left after work completion.
- Remove own earthing equipment.
- Notify all personnel involved that the equipment will be energized.
- Hand in the work permit (if relevant).
- Remove "DANGER, DO NOT OPERATE" tags.
- Switch off all machineries.
- Remove and store all PPE properly.

Fig. 4.2.10: General safety measures for an employee

Electrical Safety

One of the most potential causes of an accident may be an electric shock for working professionals on site. The precautions are of utmost importance when it comes to the job role of a solar panel installer.

To ensure electrical safety, the panel installer needs to check the following points:

- Adequate wiring
- Appropriate electrical equipment used along with its correct label and capacity
- Working and good condition of equipment
- Listing of current breaks for the circuit breaker
- Unexposed electrical parts
- Overhead power-lines to be out of contact range from work area
- Proper insulation of wires
- Double insulated or grounded electrical systems and tools
- No overloaded circuits
- Removal of damaged power tools/equipment
- Usage of appropriate PPE by employees
- Usage of appropriate tools by employees
- Labelled and correct usage of chemicals
- Ladders do not conduct electricity
- Dry area without any standing water
- Securely installed equipment
- Equipment is not exposed to possible overheating due to poor air circulation or covering of the ventilation device.

Fig. 4.2.11: Ensuring electric safety

Some electrical safety points while installation and maintenance of a PV system are mentioned in the following figure:

Handling PV modules exposed to sunlight	• Read the warnings mentioned at the back side of the PV modules for handling them. • As PV modules produce electricity when they are exposed to sunlight, precautions should be taken so that the person carrying or handling the PV modules does not get a shock. • Also, the positive and negative terminals of the PV modules should be kept away from each other to avoid the shorting of terminals when the PV module is under sunlight.
Handling batteries in PV system	• Always remember to disconnect the batteries before moving or handling them. • Avoid shorting the terminals of batteries to avoid severe damage. • While checking the battery voltage with multimeter, always check if the multimeter is in voltage mode. If the multimeter in current mode is connected to the battery terminals, then the short circuit to the battery terminals will take place. This can result in severe damages and also cause fire.
Safe distance from exposed electrical conductors	• Knowledge of the location of an exposed electrical conductor helps in keeping a safe distance from it, but at the same time, knowing the potential in that conductor is also very important.
Undertake proper work practice in wet or damp locations containing electricity	• Working area selection is a must for electrical safety which involves checking the location for sufficient space, conducting material around and also, if the place is wet or damp.
The proper lockout/tag-out procedures for electrical equipment and systems	• Lockout/tag-out procedure is always required for electrical equipment and systems to ensure that only one person is responsible for the operation of the equipment or system.
Cleaning, adjusting, or repairing equipments without unplugging them from mains	• Unplugging from live mains is essential before doing maintenance work or handling live conductors or equipment to ensure electrical safety else it may lead to severe accidents.

Fig. 4.2.12: Some electrical safety points while installation and maintenance of a PV system

Fire Safety

It is essential to ensure safety from fire whether a professional is working onsite or offsite. To ensure fire safety, the panel installer should do the following:

- In case of fire, the glass of the nearest manual call point must be broken and people must be alerted. Alternatively, emergency phone numbers must be dialled to give information about the location of the fire or a fire bell must be used.
- An attempt must be made to extinguish fire with the help of available firefighting equipment.
- If familiar with the plant/machinery/equipment affected by fire, try to avoid spread of fire or isolate it.
- Avoid using water to extinguish fire in case the source of fire is from electrical power. Instead switch the mains off.
- Hose reel and hydrants must not be used at any other time except in case of a fire.
- "No Smoking" signboard must be put up and adhered to at all times.
- A fire drill is normally carried out every six months. It is important to educate and train people to be ready for firefighting during a fire.

Fire Drill

A fire drill is a practice of the procedure of evacuating a building in case of an emergency. The following points should be kept in focus while conducting a fire drill:

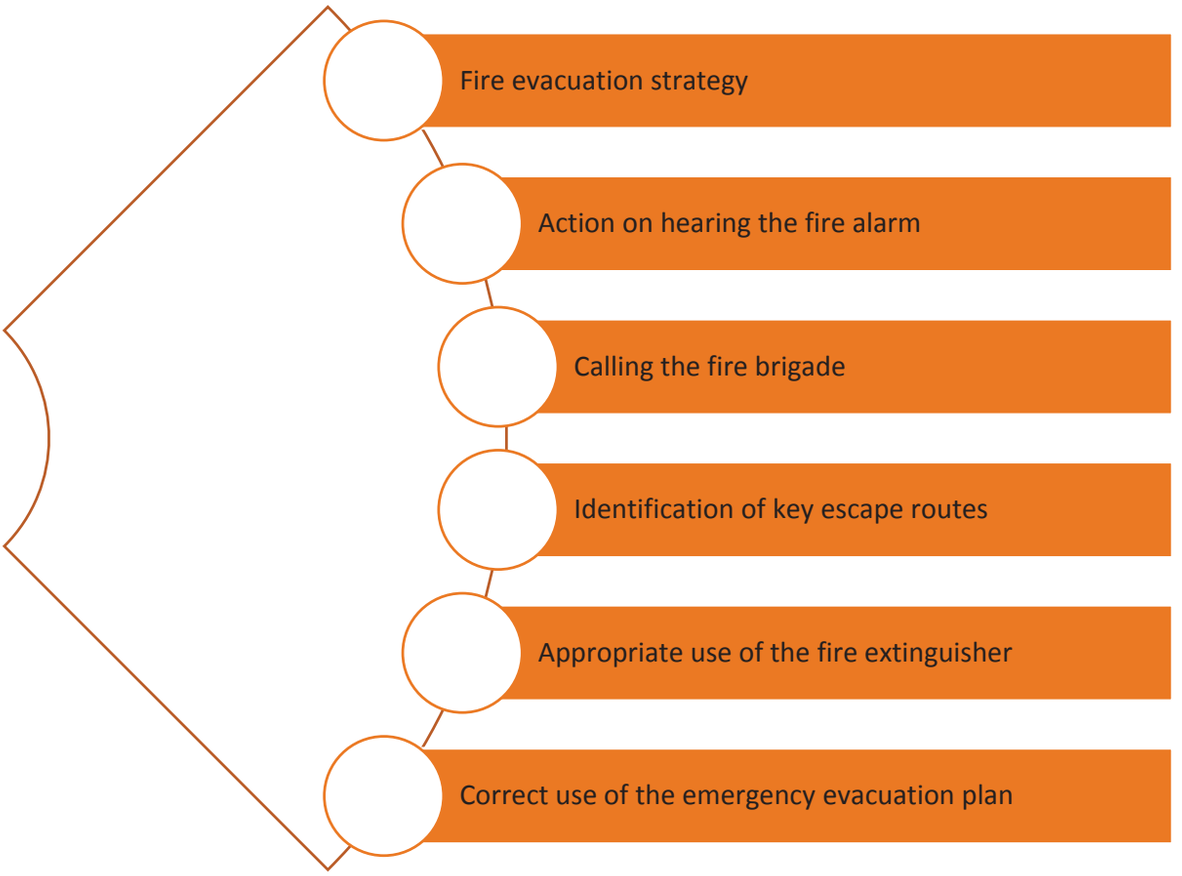

Fig. 4.2.13: Key points of a fire drill

After completion of the drill, one should:

- Record the total evacuation time.
- Silence the alarms.
- Bring the fire alarm system back to its normal operating condition.
- Re-evaluate and discuss concerns arising during the fire drill.
- Keep records and notes of the fire drill and update the evacuation checklist report.

Mechanical Safety

While installation of a PV system, mechanical safety for the onsite working professional is the key point to be considered. The working professional should carry mechanical safety equipment while installing the PV modules on the rooftop. There may be a few minor hazards which include burns, or cuts from sharp tools.

Site Safety

The panel installer should make a site safety plan and abide by the following guidelines to ensure jobsite safety:

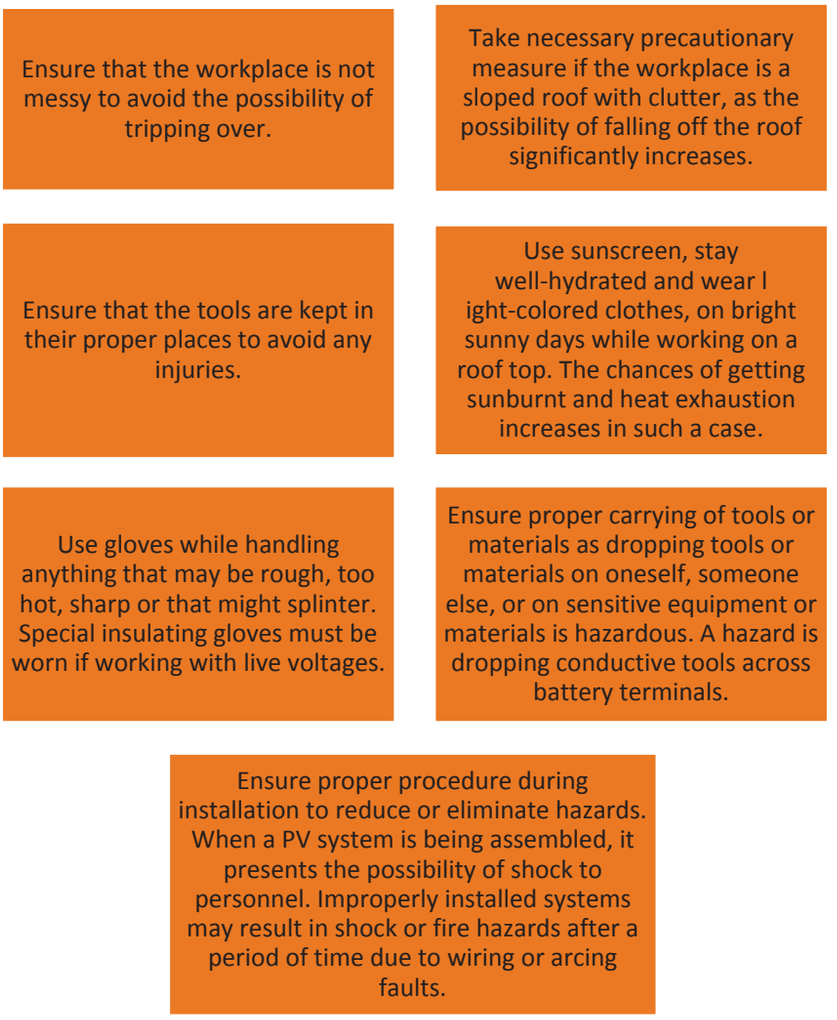

Fig. 4.2.14: Ensuring site safety

Safety Regarding Battery Installation

A panel installer needs to install the battery in a PV system and requires to maintain it. The following figure lists the possible hazards and the precautions to be taken during battery installation:

Sulphuric Acid

The battery contains sulphuric acid that could cause burns and other injury. Sulphuric acid flows out if a battery is damaged.

- For this purpose, appropriate precaution by the means of wearing apron, wearing gloves and protective glasses should be taken.
- In case of contact with sulphuric acid, wash thoroughly with water and consult a doctor for treatment.

Gas

There is a possibility of an explosive gas being generated in a battery.

- Combustibles flame or spark must be avoided in the battery room.
- A battery room must be equipped with a fire extinguisher.
- All the tools required during an installation must be wrapped using an insulated electrical tape to reduce the scope of short circuit.
- Tools, sundries and other conductive things should not be left on the battery.

Electrical Shock

A system including multiple cells may create high voltage.

- During the installation of a battery, danger of electrical impact must be avoided.

Fig. 4.2.15: Ensuring safety during battery installation

Use of Safety Gears and PPE

PPE are specially made to protect workers from:

- Injuries caused by impacts of electricity
- Electrical hazards
- Heat and chemicals
- Other occupational safety hazards

The following figure lists the PPE used at workplace:

Fig. 4.2.16: PPE

PPE is the last measure of control when worker exposure to the safety hazards cannot be eliminated by feasible work practices or engineering control.

The following figure lists some responsibilities of employer and the employee regarding use of PPE:

Responsibilities of employer	Responsibilities of employee
• Assess hazards at the workplace • Provide PPE • Determine the use the PPE • Ensure protective helmet for employees at all times to avoid head injuries	• Use PPE as per the instructions received in the training • Inspect condition of PPE regularly • Maintain PPE and keep it in a clean/reliable condition

Fig. 4.2.17: Responsibilities regarding PPE

Protective clothes refer to clothing designed especially to protect workers from potential hazards. Lab coats and ballistic vests worn by electricians, scientists and law enforcement officials respectively fall under this category. The different iems of the PPE can either be worn individually or in complete sets.

The following figure highlights different types of protections:

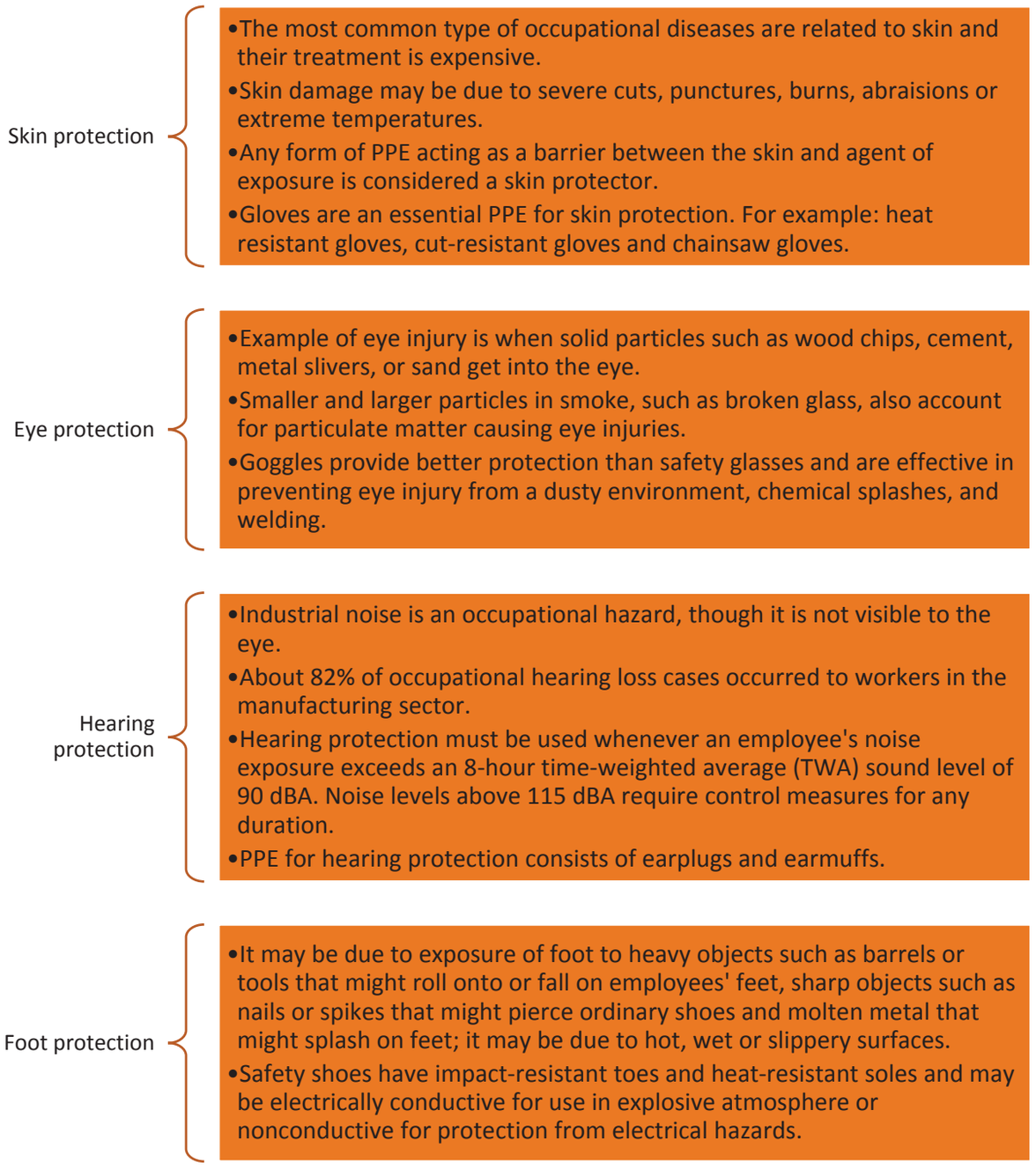

Fig. 4.2.18: Types of protection

4.2.5 Reporting Incidents

Reporting any accident or hazard to the supervisor is very important. A panel installer should know the reporting procedure.

TIP

Incident reporting procedure is a procedure for reporting incidents. It is essential, so that all near misses/accidents/dangerous occurrences/occupational diseases do not go unnoticed and that preventive measure can be taken to prevent similar reccurrences.

The following figure lists the types of incidents:

Dangerous occurrence

Any occurrence that poses a threat to the safety of people at a workplace and there is imminent risk of death or serious injury to someone

First aid

The provision of initial care for an illness or injury and is usually performed by non-expert, but trained personnel to a sick or injured person until definitive medical treatment can be accessed

Hazard

A source/situation, potentially a harm in terms of human injury or ill-health, damage to property, damage to the environment or a combination of these

Hazard identification

The process of recognizing that a hazard exists and defining its characteristics

Illness

Any physical or mental ailment, disorder, defect or morbid condition, which can be of sudden or gradual development and also includes the aggravation, acceleration, exacerbation or reoccurrence of any pre-existing disease

Incident

Any unplanned event resulting in or having a potential for injury, ill health, damage or other loss

Injury

Any physical or mental damage to the body caused by exposure to a hazard

Lost time injury

A work related injury which results in a person being absent from work for at least one full shift

Medical treatment injury

A work related injury which results in treatment provided by a qualified health professional

Near miss

An incident that does not produce an injury or disease but has the potential to do so

Risk

The likelihood and consequence of an injury or harm occurring

System failure

Systematic processes that fail to manage the task, activity, process or problem

Fig. 4.2.19: Types of incidents to be reported to a supervisor

The following figure lists the incident reporting procedure:

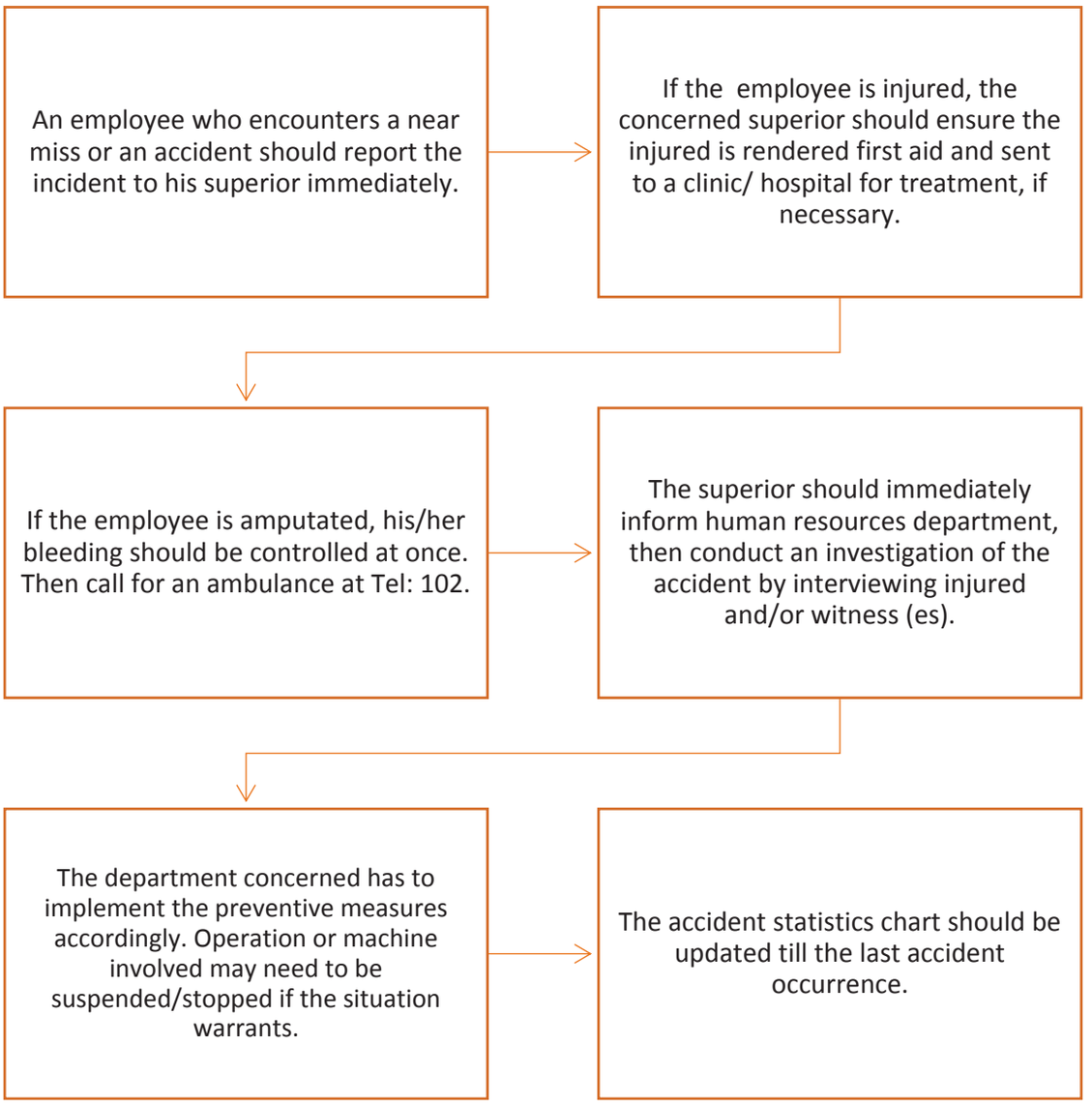

Fig. 4.2.20: Incident reporting procedure

4.2.6 Housekeeping

Good housekeeping is an observable proof of management and their concerne for health and safety of an employee on a daily basis. A workplace well in order adds to the safe working environment and minimizes obstacles that are a threat to health and safety.

The following figure lists the purpose of housekeeping:

Fig. 4.2.21: Purpose of housekeeping

UNIT 4.3: Soft Skills

Unit Objectives

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

- Explain communication skills
- Develop effective listening skills
- List the barriers to listening
- Manage a conflict
- Explain the importance of personality development

4.3.1 Understanding Communication Skills

"You can have brilliant ideas, but if you can't get them across, your ideas won't get you anywhere."
–Lee Iacocca

Communication is a skill, which is essential in today's world, where there is ever-increasing importance on the ability to communicate and the need to work with others. The nature of work has changed. It demands faster communication, prompt action and good interpersonal relations. Also, as one climbs up the career ladder, having excellent communication skills is a must.

It is the exchange of thoughts, ideas, opinions, suggestions, feedback and so on. For any communication to be complete, it is important to get feedback or a response to whatever is communicated.

In communication, the sender of a message sends it through a medium. The message then reaches the receiver, who then replies to it.

The basic communication process is shown in the following figure:

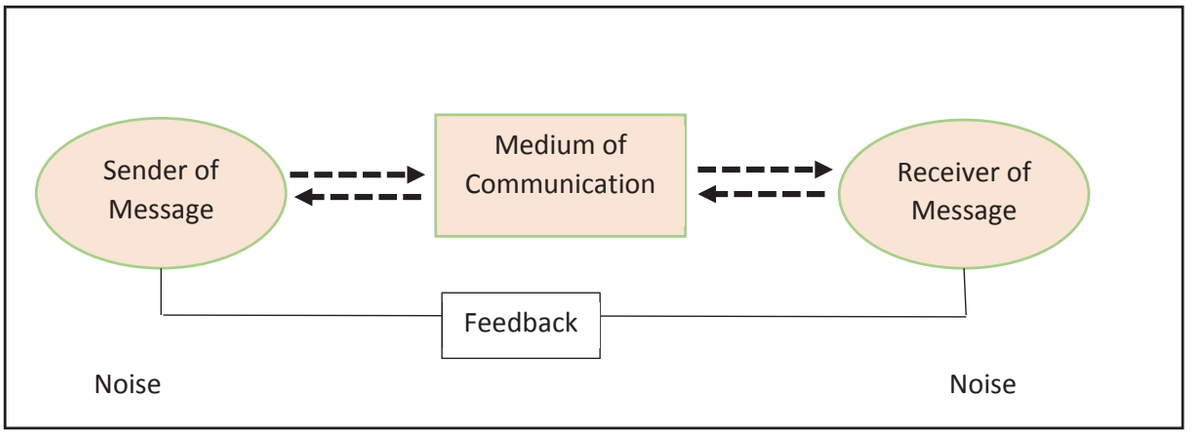

Fig. 4.3.1: The communication process

The skill to effectively communicate is the most effective as well as powerful tool to be successful in personal and/or professional life. A lot of people find it challenging to interacting with friends, peers and family members. Conflict and emotion are a part of communication which are inclusive in all types of interaction.

Effective communication:

- Empowers a person to influence others.
- Is usually seen as a display of one's ability and intelligence.

Five Components of Communication

A person's communication should include five important components listed in the following figure:

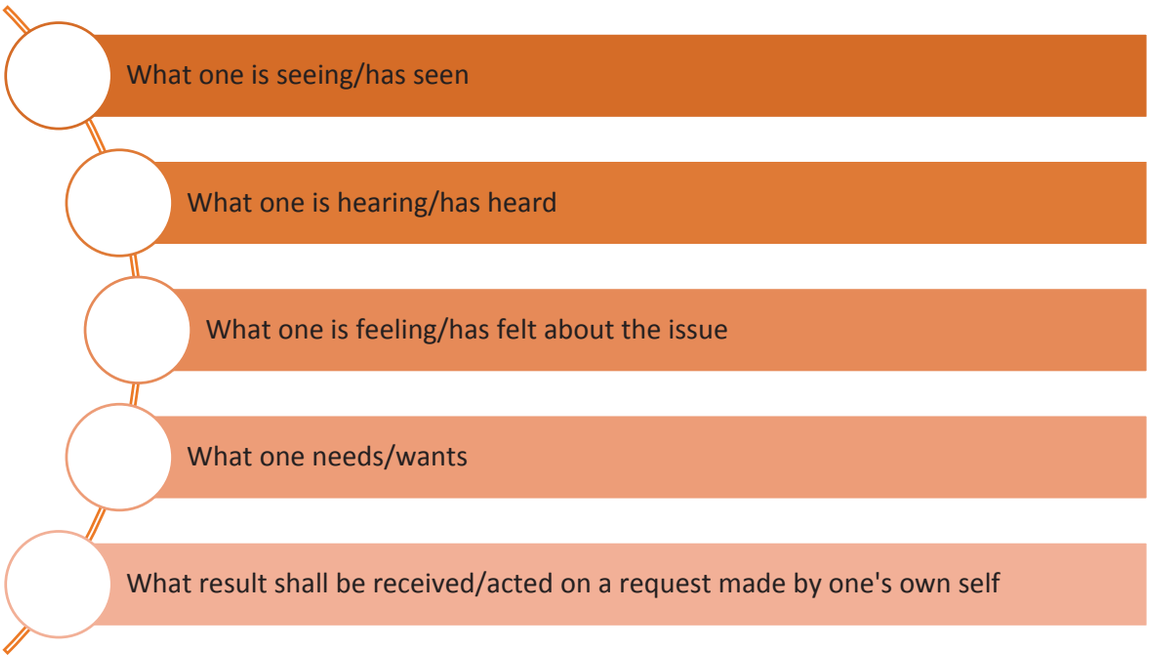

Fig. 4.3.2: Components of a message

The following figure shows how past experiences shape communication style:

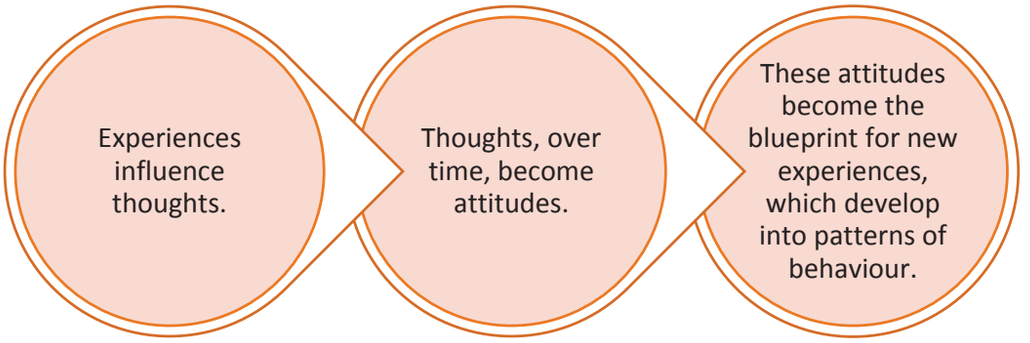

Fig. 4.3.3: Experiences shaping communication style

Effective Listening

Effective communication depends on active and effective listening. There is a difference between 'listening' and 'hearing'.

- Active listening means to understand the meaning behind the sentences and words.
- It leads to understanding the facts and ideas.
- It also means to listen to non-verbal clues in the conversation.
- As one goes up the career ladder, the listening skills should become even better. Managers generally spend 65 to 90 percent of their time listening.
- Listening skills can be consciously developed. Some ways to develop the skill are as shown in the following figure:

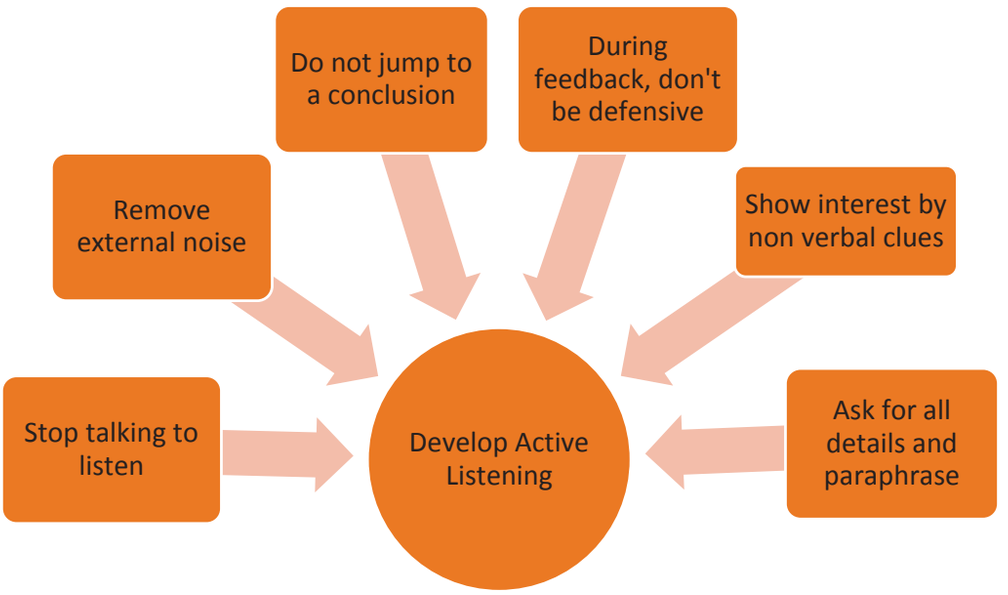

Fig. 4.3.4: Developing listening skills

The following figure lists the steps to effective listening:

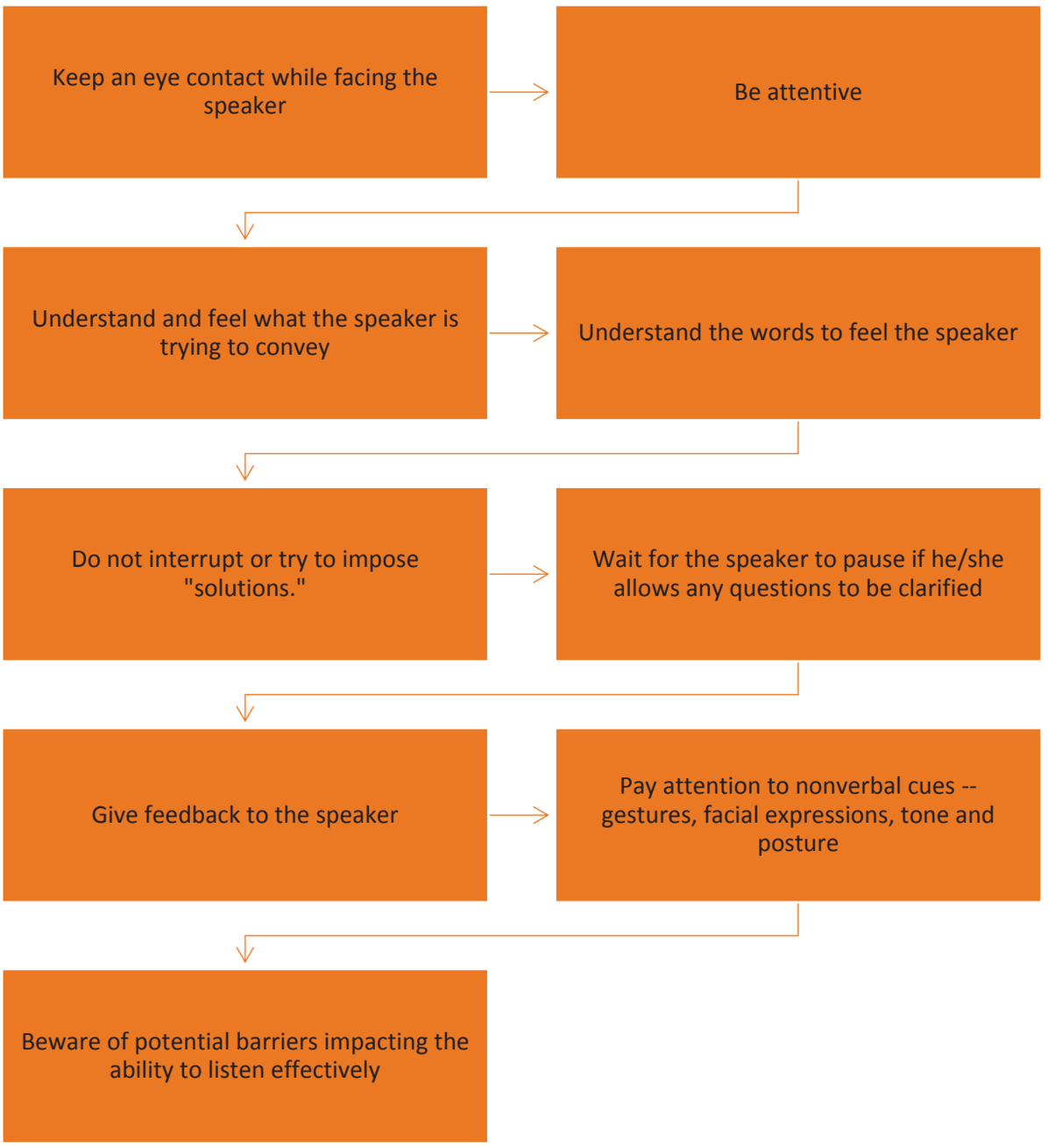

Fig. 4.3.5: Steps to effective listening

Barriers to Listening

Sometimes people have a barrier that impedes their listening skills. Awareness of a barrier is the first step in being able to overcome it. The following figure shows some barriers to listening:

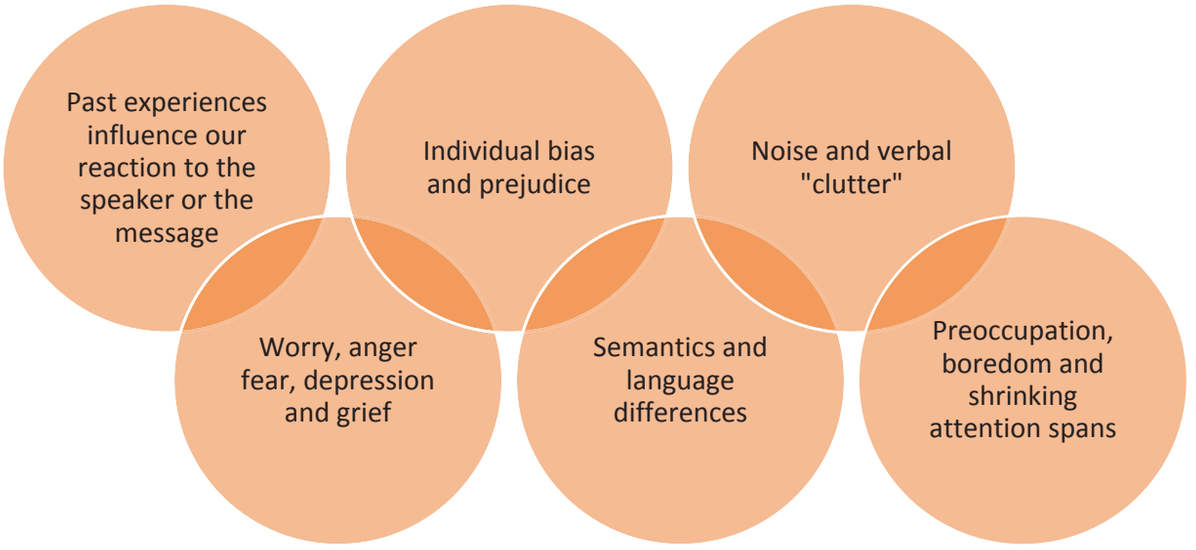

Fig. 4.3.6: Some barriers to listening

Types of Communication

The various forms of communication are listed as follows:

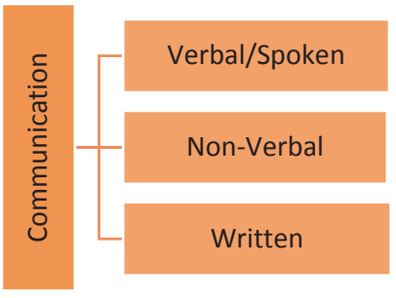

Fig. 4.3.7: Different types of communication

- Verbal Communication – it mainly consists of spoken words.
- Non-verbal communication – it mainly consists of gestures, facial expressions and hand movements.
- Written communication – it is mainly a written form of communication such as, reports, analysis, e-mails and so on.

In non-verbal communication, it is important to show proper gestures, otherwise the person can be misunderstood. The following figure lists some of the steps for non-verbal communication:

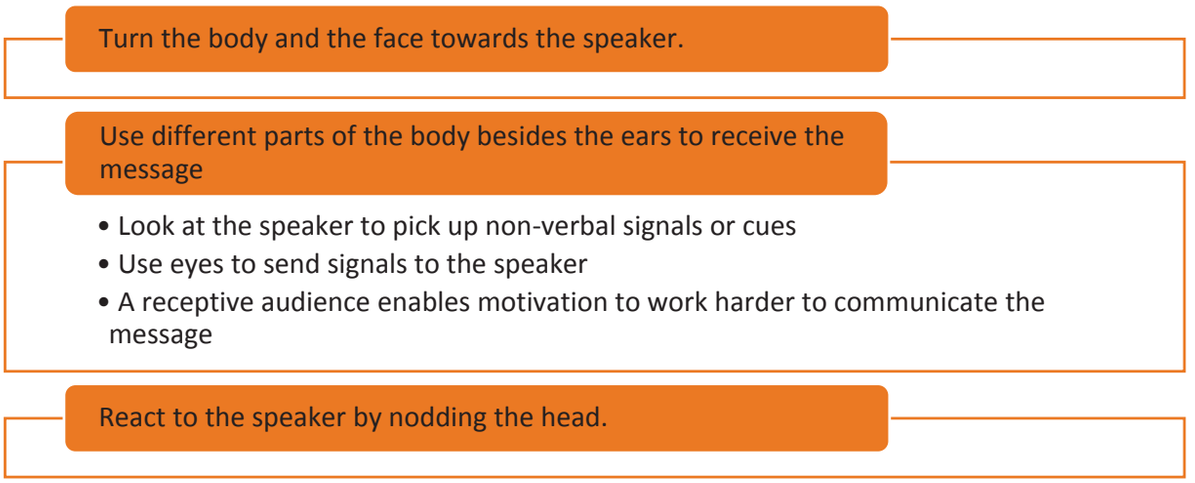

Fig. 4.3.8: Few steps for non-verbal communication

Acknowledgment

Acknowledgment to a conversation is very important. A person should keep the following points in mind:

- Acknowledge after listening as to what the speaker says, whether there is an agreement on the conversation or not. Expressing own point of view at this point is not essential.
- Acknowledge the speaker's thoughts and feelings as it does not mean that they are agreed with.
- Acknowledge after listening to what the speaker says, allows the latter to feel a sense of satisfaction of being understood.

Emotional Obstacles

Emotions act as barriers to effective communication. The following figure lists some of the emotional obstacles:

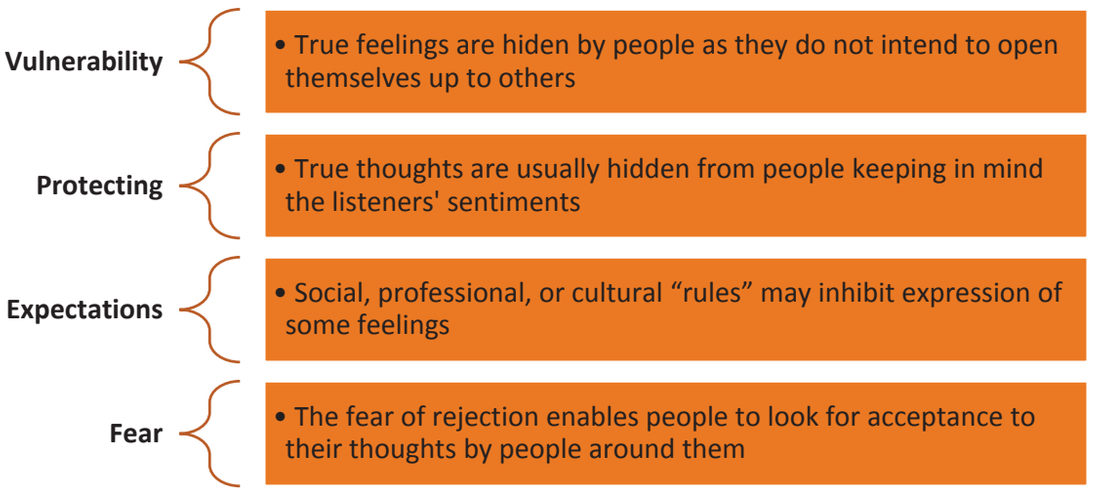

Fig. 4.3.9: Emotional Obstacles

Communicating Long or Emotional Messages

While communicating long or emotional messages, a person must:

- Explain the need of the conversation. The other people/listeners will attend to it better if they have a basic understanding of the conversation.
- Communicate own thoughts and feelings using 'I' as it gives a personal tag to the conversation.
- Avoid any verbal attacks on people. In order to disagree or criticize, being polite at all times is essential. Also, disrespectful tone and actions in a conversation describes the behaviour of a person.
- Specify needs and expectations in positive terms.

Managing a Conflict

In a workplace, conflicts are a very common issues. An employee must have the ability to manage the conflicts. The following figure lists some key points to be followed while managing conflicts:

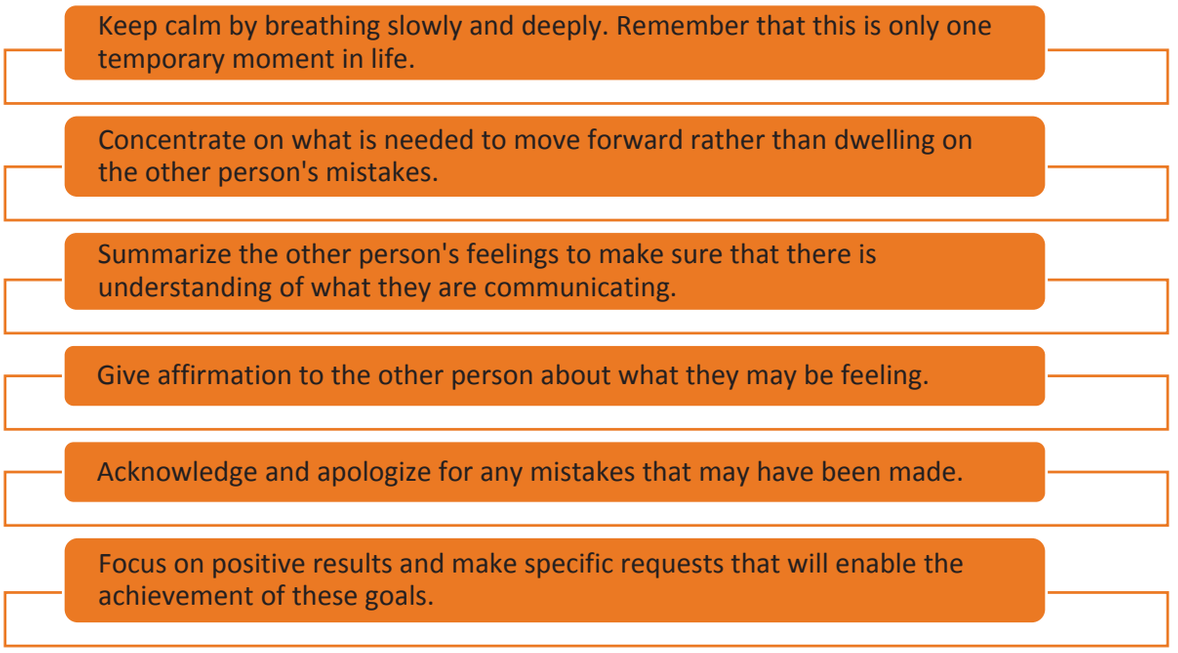

Fig. 4.3.10: Managing conflict

4.3.2 Personality Development

Personality developments involves developing of interpersonal skill. It is required for:

- Cordially working with others
- Effective communication skills
- Receiving and giving feedback
- Working well in teams or groups

Howard Gardner described interpersonal skill as one of the multiple intelligences; interpersonal intelligence or the ability to be able to understand and work effectively with others. It focusses on presenting work, decision making, ensuring group effectiveness and running meetings.

Benefits of Interpersonal Skills

The following figure lists the benefits of developing interpersonal skills:

Fig. 4.3.11: Benefits of developing interpersonal skills

Interpersonal skills involve body language and effective expression. The following figure lists some body language and expressions:

Body Language	Effective Expression
• Gestures • Facial expressions • Eye contact • Posture • Tone of voice	• 'I' Statements - ownership • Matching non-verbal & verbal • Questions • Overcome barriers • Positive language • Ask for feedback

Fig. 4.3.12: Some body language and expressions

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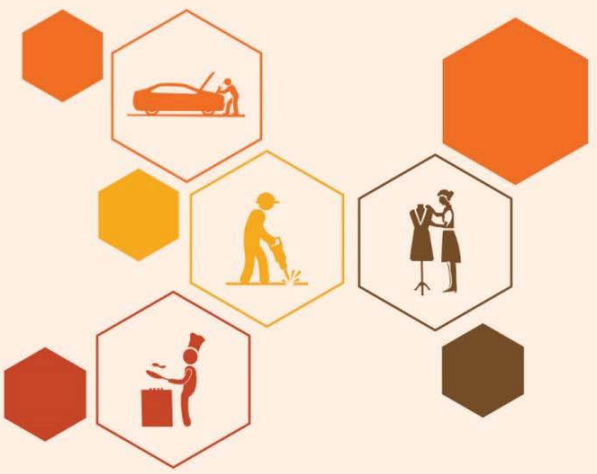
Transforming the skill landscape

ESSCI

5. Employability & Entrepreneurship Skills



Key Learning Outcomes

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

1. Explain the meaning of health
2. List common health issues
3. Discuss tips to prevent common health issues
4. Explain the meaning of hygiene
5. Discuss the purpose of Swacch Bharat Abhiyan
6. Explain the meaning of habit
7. Discuss ways to set up a safe work environment
8. Discuss critical safety habits to be followed by employees
9. Explain the importance of self-analysis
10. Discuss motivation with the help of Maslow's Hierarchy of Needs
11. Discuss the meaning of achievement motivation
12. List the characteristics of entrepreneurs with achievement motivation
13. List the different factors that motivate you
14. Discuss the role of attitude in self-analysis
15. Discuss how to maintain a positive attitude
16. List your strengths and weaknesses
17. Discuss the qualities of honest people
18. Describe the importance of honesty in entrepreneurs
19. Discuss the elements of a strong work ethic
20. Discuss how to foster a good work ethic
21. List the characteristics of highly creative people
22. List the characteristics of highly innovative people
23. Discuss the benefits of time management
24. List the traits of effective time managers
25. Describe effective time management technique
26. Discuss the importance of anger management
27. Describe anger management strategies
28. Discuss tips for anger management
29. Discuss the causes of stress
30. Discuss the symptoms of stress
31. Discuss tips for stress management
32. Identify the basic parts of a computer
33. Identify the basic parts of a keyboard
34. Recall basic computer terminology
35. Recall the functions of basic computer keys
36. Discuss the main applications of MS Office
37. Discuss the benefits of Microsoft Outlook
38. Discuss the different types of e-commerce
39. List the benefits of e-commerce for retailers and customers
40. Discuss how the Digital India campaign will help boost e-commerce in India
41. Describe how you will sell a product or service on an e-commerce platform
42. Discuss the importance of saving money
43. Discuss the benefits of saving money

44. Discuss the main types of bank accounts
45. Describe the process of opening a bank account
46. Differentiate between fixed and variable costs
47. Describe the main types of investment options
48. Describe the different types of insurance products
49. Describe the different types of taxes
50. Discuss the uses of online banking
51. Discuss the main types of electronic funds transfers
52. Discuss the steps to prepare for an interview
53. Discuss the steps to create an effective Resume
54. Discuss the most frequently asked interview questions
55. Discuss how to answer the most frequently asked interview questions
56. Discuss basic workplace terminology
57. Discuss the concept of entrepreneurship
58. Discuss the importance of entrepreneurship
59. Describe the characteristics of an entrepreneur
60. Describe the different types of enterprises
61. List the qualities of an effective leader
62. Discuss the benefits of effective leadership
63. List the traits of an effective team
64. Discuss the importance of listening effectively
65. Discuss how to listen effectively
66. Discuss the importance of speaking effectively
67. Discuss how to speak effectively
68. Discuss how to solve problems
69. List important problem solving traits
70. Discuss ways to assess problem solving skills
71. Discuss the importance of negotiation
72. Discuss how to negotiate
73. Discuss how to identify new business opportunities
74. Discuss how to identify business opportunities within your business
75. Explain the meaning of entrepreneur
76. Describe the different types of entrepreneurs
77. List the characteristics of entrepreneurs
78. Recall entrepreneur success stories
79. Discuss the entrepreneurial process
80. Describe the entrepreneurship ecosystem
81. Discuss the purpose of the Make in India campaign
82. Discuss key schemes to promote entrepreneurs
83. Discuss the relationship between entrepreneurship and risk appetite
84. Discuss the relationship between entrepreneurship and resilience
85. Describe the characteristics of a resilient entrepreneur
86. Discuss how to deal with failure
87. Discuss how market research is carried out
88. Describe the 4 Ps of marketing

89. Discuss the importance of idea generation
90. Recall basic business terminology
91. Discuss the need for CRM
92. Discuss the benefits of CRM
93. Discuss the need for networking
94. Discuss the benefits of networking
95. Discuss the importance of setting goals
96. Differentiate between short-term, medium-term and long-term goals
97. Discuss how to write a business plan
98. Explain the financial planning process
99. Discuss ways to manage your risk
100. Describe the procedure and formalities for applying for bank finance
101. Discuss how to manage your own enterprise
102. List important questions that every entrepreneur should ask before starting an enterprise

UNIT 5.1: Personal Strengths & Value Systems

Unit Objectives

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

1. Explain the meaning of health
2. List common health issues
3. Discuss tips to prevent common health issues
4. Explain the meaning of hygiene
5. Discuss the purpose of Swacch Bharat Abhiyan
6. Explain the meaning of habit
7. Discuss ways to set up a safe work environment
8. Discuss critical safety habits to be followed by employees
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26. Discuss the importance of anger management
27. Describe anger management strategies
28. Discuss tips for anger management
29. Discuss the causes of stress
30. Discuss the symptoms of stress
31. Discuss tips for stress management

5.1.1 Health, Habits, Hygiene: What is Health?

As per the World Health Organization (WHO), health is a "State of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity." This means being healthy does not simply mean not being unhealthy – it also means you need

to be at peace emotionally, and feel fit physically. For example, you cannot say you are healthy simply because you do not have any physical ailments like a cold or cough. You also need to think about whether you are feeling calm, relaxed and happy.

Common Health Issues

Some common health issues are:

- Allergies
- Asthma
- Skin Disorders
- Depression and Anxiety
- Diabetes
- Cough, Cold, Sore Throat
- Difficulty Sleeping
- Obesity

Prevent Health Issues

Taking measures to prevent ill health is always better than curing a disease or sickness. You can stay healthy by:

- Eating healthy foods like fruits, vegetables and nuts
- Cutting back on unhealthy and sugary foods
- Drinking enough water everyday
- Not smoking or drinking alcohol
- Exercising for at least 30 minutes a day, 4-5 times a week
- Taking vaccinations when required
- Practicing yoga exercises and meditation

How many of these health standards do you follow? Tick the ones that apply to you.

1. Get minimum 7-8 hours of sleep every night. ☐
2. Avoid checking email first thing in the morning and right before you go to bed at night. ☐
3. Don't skip meals – eat regular meals at correct meal times. ☐
4. Read a little bit every single day. ☐
5. Eat more home cooked food than junk food. ☐
6. Stand more than you sit. ☐
7. Drink a glass of water first thing in the morning and have at least 8 glasses of water through the day. ☐

8. Go to the doctor and dentist for regular check-ups. ☐
9. Exercise for 30 minutes at least 5 days a week. ☐
10. Avoid consuming lots of aerated beverages. ☐

What is Hygiene?

As per the World Health Organization (WHO), "Hygiene refers to conditions and practices that help to maintain health and prevent the spread of diseases." In other words, hygiene means ensuring that you do whatever is required to keep your surroundings clean, so that you reduce the chances of spreading germs and diseases.

For instance, think about the kitchen in your home. Good hygiene means ensuring that the kitchen is always spick and span, the food is put away, dishes are washed and dustbins are not overflowing with garbage. Doing all this will reduce the chances of attracting pests like rats or cockroaches, and prevent the growth of fungus and other bacteria, which could spread disease.

How many of these health standards do you follow? Tick the ones that apply to you.

1. Have a bath or shower every day with soap – and wash your hair with shampoo 2-3 times a week. ☐
2. Wear a fresh pair of clean undergarments every day. ☐
3. Brush your teeth in the morning and before going to bed. ☐
4. Cut your fingernails and toenails regularly. ☐
5. Wash your hands with soap after going to the toilet. ☐
6. Use an anti-perspirant deodorant on your underarms if you sweat a lot. ☐
7. Wash your hands with soap before cooking or eating. ☐
8. Stay home when you are sick, so other people don't catch what you have. ☐
9. Wash dirty clothes with laundry soap before wearing them again. ☐
10. Cover your nose with a tissue/your hand when coughing or sneezing. ☐

See how healthy and hygienic you are, by giving yourself 1 point for every ticked statement! Then take a look at what your score means.

Your Score

0-7/20: You need to work a lot harder to stay fit and fine! Make it a point to practice good habits daily and see how much better you feel!

7-14/20: Not bad, but there is scope for improvement! Try and add a few more good habits to your daily routine.

14-20/20: Great job! Keep up the good work! Your body and mind thank you!

We have already discussed the importance of following good hygiene and health practices for ourselves. But, it is not enough for us to be healthy and hygienic. We must also extend this standard to our homes, our immediate surroundings and to our country as a whole.

Swachh Bharat Abhiyan

The 'Swachh Bharat Abhiyan' (Clean India Mission) launched by Prime Minister Shri Narendra Modi on 2nd October 2014, believes in doing exactly this. The aim of this mission is to clean the streets and roads of India and raise the overall level of cleanliness. Currently this mission covers 4,041 cities and towns across the country. Millions of our people have taken the pledge for a clean India. You should take the pledge too, and do everything possible to keep our country clean!

What are Habits?

A habit is a behaviour that is repeated frequently. All of us have good habits and bad habits. Keep in mind the phrase by John Dryden: "We first make our habits, and then our habits make us." This is why it is so important that you make good habits a way of life, and consciously avoid practicing bad habits.

Some good habits that you should make part of your daily routine are:

- Always having a positive attitude
- Smiling! Make it a habit to smile as often as possible
- Making exercise a part of your daily routine
- Making time for family and friends
- Reading motivational and inspirational stories
- Going to bed early and waking up early

Some bad habits that you should quit immediately are:

- Skipping breakfast
- Smoking, drinking alcohol and doing drugs
- Snacking frequently even when you are not hungry
- Spending more money than you can afford
- Eating too much fattening and sugary food
- Worrying about unimportant issues
- Staying up late and waking up late

- Following healthy and hygienic practices every day will make you feel good mentally and physically.
- Hygiene is two-thirds of health – so good hygiene will help you stay strong and healthy.

5.1.2: Safety: Tips to Design a Safe Workplace

Every employer is obligated to ensure that his workplace follows the highest possible safety protocol. When setting up a business, owners must make it a point to:

- Use ergonomically designed furniture and equipment to avoid stooping and twisting
- Provide mechanical aids to avoid lifting or carrying heavy objects
- Have protective equipment on hand for hazardous jobs
- Designate emergency exits and ensure they are easily accessible
- Set down health codes and ensure they are implemented
- Follow the practice of regular safety inspections in and around the workplace
- Ensure regular building inspections are conducted
- Get expert advice on workplace safety and follow it

Non-Negotiable Employee Safety Habits

Every employer is obligated to ensure that his workplace follows the highest possible safety protocol. When setting up a business, owners must make it a point to:

- Immediately report unsafe conditions to a supervisor
- Recognize and report safety hazards that could lead to slips, trips and falls
- Report all injuries and accidents to a supervisor
- Wear the correct protective equipment when required
- Learn how to correctly use equipment provided for safety purposes
- Be aware of and avoid actions that could endanger other people
- Take rest breaks during the day and some time off from work during the week

- Be aware of what emergency number to call at the time of a workplace emergency
- Practice evacuation drills regularly to avoid chaotic evacuations

5.1.3 Self-Analysis – Attitude, Achievement Motivation

To truly achieve your full potential, you need to take a deep look inside yourself and find out what kind of person you really are. This attempt to understand your personality is known as self-analysis. Assessing yourself in this manner will help you grow, and will also help you to identify areas within yourself that need to be further developed, changed or eliminated. You can better understand yourself by taking a deep look at what motivates you, what your attitude is like, and what your strengths and weaknesses are.

What is Motivation?

Very simply put, motivation is your reason for acting or behaving in a certain manner. It is important to understand that not everyone is motivated by the same desires – people are motivated by many, many different things. We can understand this better by looking at Maslow's Hierarchy of Needs.

Maslow's Hierarchy of Needs

Famous American psychologist Abraham Maslow wanted to understand what motivates people. He believed that people have five types of needs, ranging from very basic needs (called physiological needs) to more important needs that are required for self-growth (called self-actualization needs). Between the physiological and self-actualization needs are three other needs – safety needs, belongingness and love needs, and esteem needs. Theseneeds are usually shown as a pyramid with five levels and are known as Maslow's Hierarchy of Needs.

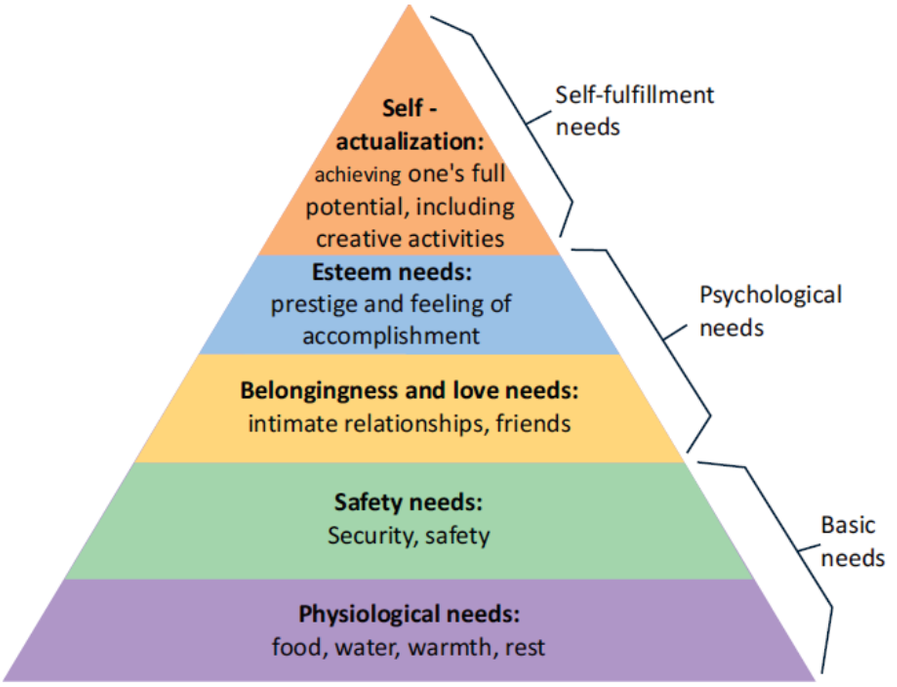

Fig 6.1.1: Maslow's Hierarchy of Needs

As you can see from the pyramid, the lowest level depicts the most basic needs. Maslow believed that our behaviour is motivated by our basic needs, until those needs are met. Once they are fulfilled, we move to the next level and are motived by the next level of needs. Let's understand this better with an example.

Rupa comes from a very poor family. She never has enough food, water, warmth or rest. According to Maslow, until Rupa is sure that she will get these basic needs, she will not even think about the next level of needs – her safety needs. But, once Rupa is confident that her basic needs will be met, she will move to the next level, and her behaviour will then be motivated by her need for security and safety. Once these new needs are met, Rupa will once again move to the next level, and be motivated by her need for relationships and friends. Once this need is satisfied, Rupa will then focus on the fourth level of needs – her esteem needs, after which she will move up to the fifth and last level of needs – the desire to achieve her full potential.

Understanding Achievement Motivation

We now know that people are motivated by basic, psychological and self-fulfilment needs. However, certain people are also motivated by the achievement of highly challenging accomplishments. This is known as Achievement Motivation, or 'need for achievement'. The level of motivation achievement in a person differs from individual to individual. It is important that entrepreneurs have a high level of achievement motivation – a deep desire to accomplish something important and unique. It is equally important that they hire people who are also highly motivated by challenges and success.

What Motivates You?

What are the things that really motivate you? List down five things that really motivate you. Remember to answer honestly!

I am motivated by:

_____

_____

_____

_____

Characteristics of Entrepreneurs with Achievement Motivation

Entrepreneurs with achievement motivation can be described as follows:

- Unafraid to take risks for personal accomplishment
- Love being challenged
- Future-oriented
- Flexible and adaptive
- Value negative feedback more than positive feedback
- Very persistent when it comes to achieving goals
- Extremely courageous
- Highly creative and innovative
- Restless - constantly looking to achieve more
- Feel personally responsible for solving problems

Think about it:

- How many of these traits do you have?
- Can you think of entrepreneurs who display these traits?

What is Attitude?

Now that we understand why motivation is so important for self-analysis, let's look at the role our attitude plays in better understanding ourselves. Attitude can be described as your tendency (positive or negative), to think and feel about someone or something. Attitude is the foundation for success in every aspect of life. Our attitude can be our best friend or our worst enemy. In other words:

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tendency (positive or negative), to think and feel about someone or something. Attitude is the foundation for success in every aspect of life. Our attitude can be our best friend or our worst enemy. In other words:

"The only disability in life is a bad attitude."

When you start a business, you are sure to encounter a wide variety of emotions, from difficult times and failures to good times and successes. Your attitude is what will see you through the tough times and guide you towards success. Attitude is also infectious. It affects everyone around you, from your customers to your employees to your investors. A positive attitude helps build confidence in the workplace while a negative attitude is likely to result in the demotivation of your people.

How to Cultivate a Positive Attitude?

The good news is attitude is a choice. So, it is possible to improve, control and change our attitude, if we decide we want to!

The following tips help foster a positive mindset:

- Remember that you control your attitude, not the other way around
- Devote at least 15 minutes a day towards reading, watching or listening to something positive
- Avoid negative people who only complain and stop complaining yourself
- Expand your vocabulary with positive words and delete negative phrases from your mind
- Be appreciative and focus on what's good in yourself, in your life, and in others
- Stop thinking of yourself as a victim and start being proactive
- Imagine yourself succeeding and achieving your goals

What Are Your Strengths and Weaknesses?

Another way to analyse yourself is by honestly identifying your strengths and weaknesses. This will help you use your strengths to your best advantage and reduce your weaknesses.

Note down all your strengths and weaknesses in the two columns below. Remember to be honest with yourself!

Strengths	Weaknesses

- Achievement motivation can be learned.
- Don't be afraid to make mistakes.
- Train yourself to finish what you start.
- Dream big.

5.1.4 Honesty & Work Ethics: What is Honesty?

Honesty is the quality of being fair and truthful. It means speaking and acting in a manner that inspires trust. A person who is described as honest is seen as truthful and sincere, and as someone who isn't deceitful or devious and doesn't steal or cheat. There are two dimensions of honesty – one is honesty in communication and the other is honesty in conduct.

Honesty is an extremely important trait because it results in peace of mind and builds relationships that are based on trust. Being dishonest, on the other hand, results in anxiety and leads to relationships full of distrust and conflict.

Qualities of Honest People

Honest individuals have certain distinct characteristics. Some common qualities among honest people are:

1. They don't worry about what others think of them. They believe in being themselves – they don't bother about whether they are liked or disliked for their personalities.
2. They stand up for their beliefs. They won't think twice about giving their honest opinion, even if they are aware that their point of view lies with the minority.
3. They are think skinned. This means they are not affected by others judging them harshly for their honest opinions.
4. They forge trusting, meaningful and healthy friendships. Honest people usually surround themselves with honest friends. They have faith that their friends will be truthful and upfront with them at all times.
5. They are trusted by their peers. They are seen as people who can be counted on for truthful and objective feedback and advice.

Importance of Honesty in Entrepreneurs

One of the most important characteristics of entrepreneurs is honesty. When entrepreneurs are honest with their customers, employees and investors, it shows that they respect those that they work with. It is also important that entrepreneurs remain honest with themselves.

Let's look at how being honest would lead to great benefits for entrepreneurs.

- **Honesty and customers:** When entrepreneurs are honest with their customers it leads to stronger relationships, which in turn results in business growth and a stronger customer network.
- **Honesty and employees:** When entrepreneurs build honest relationships with their employees, it leads to more transparency in the workplace, which results in higher work performance and better results.

- **Honesty and investors:** For entrepreneurs, being honest with investors means not only sharing strengths but also candidly disclosing current and potential weaknesses, problem areas and solution strategies. Keep in mind that investors have a lot of experience with start-ups and are aware that all new companies have problems. Claiming that everything is perfectly fine and running smoothly is a red flag for most investors.
- **Honesty with oneself:** The consequences of being dishonest with oneself can lead to dire results, especially in the case of entrepreneurs. For entrepreneurs to succeed, it is critical that they remain realistic about their situation at all times, and accurately judge every aspect of their enterprise for what it truly is.

What are Work Ethics?

Being ethical in the workplace means displaying values like honesty, integrity and respect in all your decisions and communications. It means not displaying negative qualities like lying, eating and stealing.

Workplace ethics play a big role in the profitability of a company. It is as crucial to an enterprise as high morale and teamwork. This is why most companies lay down specific workplace ethic guidelines that must compulsorily be followed by their employees.

These guidelines are typically outlined in a company's employee handbook.

Elements of a Strong Work Ethic

An entrepreneur must display strong work ethics, as well as hire only those individuals who believe in and display the same level of ethical behaviour in the workplace. Some elements of a strong work ethic are:

- **Professionalism**: This involves everything from how you present yourself in a corporate setting to the manner in which you treat others in the workplace.
- **Respectfulness**: This means remaining poised and diplomatic regardless of how stressful or volatile a situation is.
- **Dependability**: This means always keeping your word, whether it's arriving on time for a meeting or delivering work on time.
- **Dedication**: This means refusing to quit until the designated work is done, and completing the work at the highest possible level of excellence.
- **Determination**: This means embracing obstacles as challenges rather than letting them stop you, and pushing ahead with purpose and resilience to get the desired results.
- **Accountability**: This means taking responsibility for your actions and the consequences of your actions, and not making excuses for your mistakes.
- **Humility**: This means acknowledging everyone's efforts and had work, and sharing the credit for accomplishments.

How to Foster a Good Work Ethic?

As an entrepreneur, it is important that you clearly define the kind of behaviour that you expect from each and every team member in the workplace. You should make it clear that you expect employees to display positive work ethics like:

- **Honesty**: All work assigned to a person should be done with complete honesty, without any deceit or lies.
- **Good attitude**: All team members should be optimistic, energetic, and positive.
- **Reliability**: Employees should show up where they are supposed to be, when they are supposed to be there.
- **Good work habits**: Employees should always be well groomed, never use inappropriate language, conduct themselves professionally at all times and so on.
- **Initiative**: Doing the bare minimum is not enough. Every team member needs to be proactive and show initiative.
- **Trustworthiness**: Trust is non-negotiable. If an employee cannot be trusted, it's time to let that employee go.
- **Respect**: Employees need to respect the company, the law, their work, their colleagues and themselves.
- **Integrity**: Each and every team member should be completely ethical and must display above board behaviour at all times.
- **Efficiency**: Efficient employees help a company grow while inefficient employees result in a waste of time and resources.

- Don't get angry when someone tells you the truth and you don't like what you hear.
- Always be willing to accept responsibility for your mistakes.

5.1.5 Creativity & Innovation: What is Creativity?

Creativity means thinking outside the box. It means viewing things in new ways or from different perspectives, and then converting these ideas into reality. Creativity involves two parts: thinking and producing. Simply having an idea makes you imaginative, not creative. However, having an idea and acting on it makes you creative.

Characteristics of Highly Creative People

Some characteristics of creative people are:

- They are imaginative and playful
- They see issues from different angles
- They notice small details
- They have very little tolerance for boredom
- They detest rules and routine
- They love to daydream
- They are very curious

What is Innovation?

There are many different definitions of innovation. In simple terms, innovation means turning an idea into a solution that adds value. It can also mean adding value by

implementing a new product, service or process, or significantly improving on an existing product, service or process.

Characteristics of Highly Innovative People

Some characteristics of highly innovative people are:

- They embrace doing things differently
- They don't believe in taking shortcuts
- They are not afraid to be unconventional
- They are highly proactive and persistent
- They are organized, cautious and risk-averse

- Take regular breaks from your creative work to recharge yourself and gain fresh perspective.
- Build prototypes frequently, test them out, get feedback, and make the required changes.

5.1.6 Time Management: What is Time Management?

Time management is the process organizing your time, and deciding how to allocate your time between different activities. Good time management is the difference between working smart (getting more done in less time) and working hard (working for more time to get more done).

Effective time management leads to an efficient work output, even when you are faced with tight deadlines and high pressure situations. On the other hand, not managing your time effectively results in inefficient output and increases stress and anxiety.

Benefits of Time Management

Time management can lead to huge benefits like:

- Greater productivity
- Better professional reputation
- Higher chances for career advancement
- Higher efficiency
- Reduced stress
- Greater opportunities to achieve goals

Not managing time effectively can result in undesirable consequences like:

- Missing deadlines
- Substandard work quality
- Stalled career
- Inefficient work output
- Poor professional reputation
- Increase in stress and anxiety

Traits of Effective Time Managers

Some traits of effective time managers are:

- They begin projects early
- They set daily objectives
- They modify plans if required, to achieve better results
- They are flexible and open-minded
- They inform people in advance if their help will be required
- They know how to say no
- They break tasks into steps with specific deadlines
- They continually review long term goals
- They think of alternate solutions if and when required
- They ask for help when required
- They create backup plans

Effective Time Management Techniques

You can manage your time better by putting into practice certain time management techniques. Some helpful tips are:

- Plan out your day as well as plan for interruptions. Give yourself at least 30 minutes to figure out your time plan. In your plan, schedule some time for interruptions.
- Put up a "Do Not Disturb" sign when you absolutely have to complete a certain amount of work.
- Close your mind to all distractions. Train yourself to ignore ringing phones, don't reply to chat messages and disconnect from social media sites.
- Delegate your work. This will not only help your work get done faster, but will also show you the unique skills and abilities of those around you.
- Stop procrastinating. Remind yourself that procrastination typically arises due to the fear of failure or the belief that you cannot do things as perfectly as you wish to do them.
- Prioritize. List each task to be completed in order of its urgency or importance level. Then focus on completing each task, one by one.
- Maintain a log of your work activities. Analyse the log to help you understand how efficient you are, and how much time is wasted every day.
- Create time management goals to reduce time wastage.

- Always complete the most important tasks first.
- Get at least 7 – 8 hours of sleep every day.
- Start your day early.
- Don't waste too much time on small, unimportant details.
- Set a time limit for every task that you will undertake.
- Give yourself some time to unwind between tasks.

5.1.7 Anger Management: What is Anger Management?

Anger management is the process of:

1. Learning to recognize the signs that you, or someone else, is becoming angry
2. Taking the best course of action to calm down the situation in a positive way

Anger management does not mean suppressing anger.

Importance of Anger Management

Anger is a perfectly normal human emotion. In fact, when managed the right way, anger can be considered a healthy emotion. However, if it is not kept in check, anger can make us act inappropriately and can lead to us saying or doing things that we will likely later regret. Extreme anger can:

- **Hurt you physically**: It leads to heart disease, diabetes, a weakened immune system, insomnia, and high blood pressure.
- **Hurt you mentally**: It can cloud your thinking and lead to stress, depression and mental health issues.
- **Hurt your career**: It can result in alienating your colleagues, bosses, clients and lead to the loss of respect.
- **Hurt your relationships**: It makes it hard for your family and friends to trust you, be honest with you and feel comfortable around you.

This is why anger management, or managing anger appropriately, is so important.

Anger Management Strategies

Here are some strategies that can help you control your anger:

Strategy 1: Relaxation

Something as simple as breathing deeply and looking at relaxing images works wonders in calming down angry feelings. Try this simple breathing exercise:

1. Take a deep breath from your diaphragm (don't breathe from your chest)
2. Visualize your breath coming up from your stomach
3. Keep repeating a calming word like 'relax' or 'take it easy' (remember to keep breathing
4. deeply while repeating the word)
5. Picture a relaxing moment (this can be from your memory or your imagination)
6. Follow this relaxation technique daily, especially when you realize that you're starting to feel angry.

Strategy 2: Cognitive Restructuring

Cognitive restructuring means changing the manner in which you think. Anger can make you curse, swear, exaggerate and act very dramatically. When this happens, force yourself to replace your angry thoughts with more logical ones. For instance, instead of thinking 'Everything is ruined' change your mindset and tell yourself 'It's not the end of the world and getting angry won't solve this'.

Strategy 3: Problem Solving

Getting angry about a problem that you cannot control is a perfectly natural response. Sometimes, try as you may, there may not be a solution to the difficulty you are faced with. In such cases, stop focusing on solving the problem, and instead focus on handling and

facing the problem. Remind yourself that you will do your best to deal with the situation, but that you will not blame yourself if you don't get the solution you desire.

Strategy 4: Better Communication

When you're angry, it is very easy to jump to inaccurate conclusions. In this case, you need to force yourself to stop reacting, and think carefully about what you want to say, before saying it. Avoid saying the first thing that enters your head. Force yourself to listen carefully to what the other person is saying. Then think about the conversation before responding.

Strategy 5: Changing Your Environment

If you find that your environment is the cause of your anger, try and give yourself a break from your surroundings. Make an active decision to schedule some personal time for yourself, especially on days that are very hectic and stressful. Having even a brief amount of quiet or alone time is sure to help calm you down.

Tips for Anger Management

The following tips will help you keep your anger in check:

- Take some time to collect your thoughts before you speak out in anger.
- Express the reason for your anger in an assertive, but non-confrontational manner once you have calmed down.
- Do some form of physical exercise like running or walking briskly when you feel yourself getting angry.
- Make short breaks part of your daily routine, especially during days that are stressful.
- Focus on how to solve a problem that's making you angry, rather than focusing on the fact that the problem is making you angry.

- Try to forgive those who anger you, rather than hold a grudge against them.
- Avoid using sarcasm and hurling insults. Instead, try and explain the reason for your frustration in a polite and mature manner.

5.1.8 Stress Management: What is Stress?

We say we are 'stressed' when we feel overloaded and unsure of our ability to deal with the pressures placed on us. Anything that challenges or threatens our well-being can be defined as a stress. It is important to note that stress can be good and bad. While good stress keeps us going, negative stress undermines our mental and physical health. This is why it is so important to manage negative stress effectively.

Causes of Stress

Stress can be caused by internal and external factors.

Internal causes of stress

- Constant worry
- Rigid thinking
- Unrealistic expectations
- Pessimism
- Negative self-talk
- All in or all out attitude

External causes of stress

- Major life changes
- Difficulties with relationships
- Having too much to do
- Difficulties at work or in school
- Financial difficulties
- Worrying about one's children and/or family

Symptoms of Stress

Stress can manifest itself in numerous ways. Take a look at the cognitive, emotional, physical and behavioural symptoms of stress.

Cognitive Symptoms	Emotional Symptoms
• Memory problems • Concentration issues • Lack of judgement • Pessimism • Anxiety • Constant worrying	• Depression • Agitation • Irritability • Loneliness • Anxiety • Anger

Physical Symptoms	Behavioural Symptoms
• Aches and pain • Diarrhoea or constipation • Nausea • Dizziness • Chest pain and/or rapid heartbeat • Frequent cold or flu like feelings	• Increase or decrease in appetite • Over sleeping or not sleeping enough • Withdrawing socially • Ignoring responsibilities • Consumption of alcohol or cigarettes • Nervous habits like nail biting and pacing

Tips to Manage Stress

The following tips can help you manage your stress better:

- Note down the different ways in which you can handle the various sources of your stress.
- Remember that you cannot control everything, but you can control how you respond.
- Discuss your feelings, opinions and beliefs rather than reacting angrily, defensively or passively.

- Practice relaxation techniques like meditation, yoga or tai chi when you start feeling stressed.
- Devote a part of your day towards exercise.
- Eat healthy foods like fruits and vegetables. Avoid unhealthy foods especially those containing large amounts of sugar.
- Plan your day so that you can manage your time better, with less stress.
- Say no to people and things when required.
- Schedule time to pursue your hobbies and interests.
- Ensure you get at least 7-8 hours of sleep.
- Reduce your caffeine intake.
- Increase the time spent with family and friends.

- Force yourself to smile even if you feel stressed. Smiling makes us feel relaxed and happy.
- Stop yourself from feeling and thinking like a victim. Change your attitude and focus on being proactive.

UNIT 5.2: Digital Literacy: A Recap

Unit Objectives

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

1. Identify the basic parts of a computer
2. Identify the basic parts of a keyboard
3. Recall basic computer terminology
4. Recall the functions of basic computer keys
5. Discuss the main applications of MS Office
6. Discuss the benefits of Microsoft Outlook
7. Discuss the different types of e-commerce
8. List the benefits of e-commerce for retailers and customers
9. Discuss how the Digital India campaign will help boost e-commerce in India

5.2.1 Computer and Internet basics: Basic Parts of a Computer

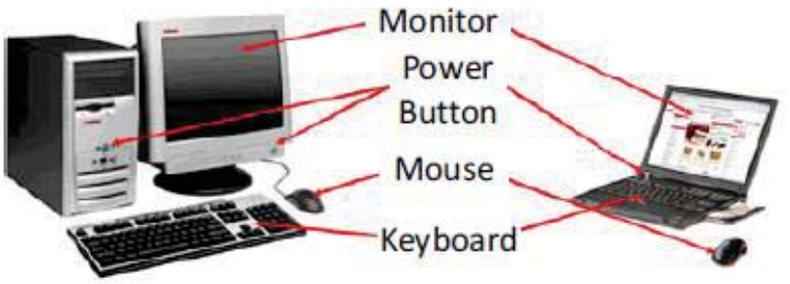


Fig.6.2.1. Parts of a Computer

- **Central Processing Unit (CPU)**: The brain of the computer. It interprets and carries out program instructions.
- **Hard Drive**: A device that stores large amounts of data.
- **Monitor**: The device that contains the computer screen where the information is visually displayed.
- **Mouse**: A hand-held device used to point to items on the monitor.
- **Speakers**: Devices that enable you to hear sound from the computer.
- **Printer**: A device that converts output from a computer into printed paper documents.

Basic Parts of a Keyboard

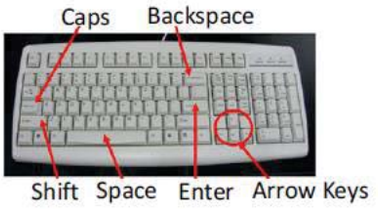


Fig.6.2.2. Parts of a Keyboard

- **Arrow Keys**: Press these keys to move your cursor.
- **Space bar**: Adds a space.
- **Enter/Return**: Moves your cursor to a new line.
- **Shift**: Press this key if you want to type a capital letter or the upper symbol of a key.
- **Caps Lock**: Press this key if you want all the letters you type to be capital letters. Press it again to revert back to typing lowercase letters.
- **Backspace**: Deletes everything to the left of your cursor.

Basic Internet Terms

- **The Internet:** A vast, international collection of computer networks that transfers information.
- **The World Wide Web:** A system that lets you access information on the Internet.
- **Website:** A location on the World Wide Web (and Internet) that contains information about a specific topic.
- **Homepage:** Provides information about a website and directs you to other pages on that website.
- **Link/Hyperlink:** A highlighted or underlined icon, graphic, or text that takes you to another file or object.
- **Web Address/URL:** The address for a website.
- **Address Box:** A box in the browser window where you can type in a web address.

- When visiting a .com address, there no need to type http:// or even www. Just type the name of the website and then press Ctrl + Enter. (Example: Type 'apple' and press Ctrl + Enter to go to www.apple.com)
- Press the Ctrl key and press the + or - to increase and decrease the size of text.
- Press F5 or Ctrl + R to refresh or reload a web page.

5.2.2 MS Office and Email: About MS Office

MS Office or Microsoft Office is a suite of computer programs developed by Microsoft. Although meant for all users, it offers different versions that cater specifically to students, home users and business users. All the programs are compatible with both, Windows and Macintosh.

Most Popular Office Products

Some of the most popular and universally used MS Office applications are:

- **Microsoft Word**: Allows users to type text and add images to a document.
- **Microsoft Excel**: Allows users to enter data into a spreadsheet and create calculations and graphs.
- **Microsoft PowerPoint**: Allows users to add text, pictures and media and create slideshows and presentations.
- **Microsoft Outlook**: Allows users to send and receive email.
- **Microsoft OneNote**: Allows users to make drawings and notes with the feel of a pen on paper.
- **Microsoft Access**: Allows users to store data over many tables.

Why Choose Microsoft Outlook?

A popular email management choice especially in the workplace, Microsoft Outlook also includes an address book, notebook, web browser and calendar. Some major benefits of this program are:

- **Integrated search function**: You can use keywords to search for data across all Outlook programs.
- **Enhanced security**: Your email is safe from hackers, junk mail and phishing website email.
- **Email syncing**: Sync your mail with your calendar, contact list, notes in One Note and…your phone!
- **Offline access to email:** No Internet? No problem! Write emails offline and send them when you're connected again.

- Press Ctrl+R as a shortcut method to reply to email.
- Set your desktop notifications only for very important emails.
- Flag messages quickly by selecting messages and hitting the Insert key.
- Save frequently sent emails as a template to reuse again and again.
- Conveniently save important emails as files.

5.2.3 E-Commerce: What is E-Commerce?

E-commerce is the buying or selling of goods and services, or the transmitting of money or data, electronically on the internet. E-Commerce is the short form for "electronic commerce."

Examples of E-Commerce

Some examples of e-commerce are:

- Online shopping
- Online auctions
- Online ticketing
- Electronic payments
- Internet banking

Types of E-Commerce

E-commerce can be classified based on the types of participants in the transaction. The main types of e-commerce are:

- **Business to Business (B2B)**: Both the transacting parties are businesses.
- **Business to Consumer (B2C)**: Businesses sell electronically to end-consumers.
- **Consumer to Consumer (C2C):** Consumers come together to buy, sell or trade items to other consumers.
- **Consumer-to-Business (C2B)**: Consumers make products or services available for purchase to companies looking for exactly those services or products.
- **Business-to-Administration (B2A)**: Online transactions conducted between companies and public administration.
- **Consumer-to-Administration (C2A)**: Online transactions conducted between individual and public administration.

Benefits of E-Commerce

The e-commerce business provides some benefits for retailers and customers.

Benefits for retailers

- Establishes an online presence
- Reduces operational costs by removing overhead costs
- Increases brand awareness through the use of good keywords
- Increases sales by removing geographical and time constraints

Benefits for customers

- Offers a wider range of choice than any physical store
- Enables goods and services to be purchased from remote locations
- Enables consumers to perform price comparisons

Digital India Campaign

Prime Minister Narendra Modi launched the Digital India campaign in 2015, with the objective of offering every citizen of India access to digital services, knowledge and information. The campaign aims to improve the country's online infrastructure and increase internet connectivity, thus boosting the e-commerce industry.

Currently, the majority of online transactions come from tier 2 and tier 3 cities. Once the Digital India campaign is in place, the government will deliver services through mobile connectivity, which will help deliver internet to remote corners of the country. This will help the e-commerce market to enter India's tier 4 towns and rural areas.

E-Commerce Activity

Choose a product or service that you want to sell online. Write a brief note explaining how you will use existing e-commerce platforms, or create a new e-commerce platform, to sell your product or service.

- Before launching your e-commerce platform, test everything.
- Pay close and personal attention to your social media.

UNIT 5.3: Money Matters

Unit Objectives

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

1. Discuss the importance of saving money
2. Discuss the benefits of saving money
3. Discuss the main types of bank accounts
4. Describe the process of opening a bank account
5. Differentiate between fixed and variable costs
6. Describe the main types of investment options
7. Describe the different types of insurance products
8. Describe the different types of taxes
9. Discuss the uses of online banking
10. Discuss the main types of electronic funds transfers

5.3.1 Personal Finance – Why to Save? Importance of Saving

We all know that the future is unpredictable. You never know what will happen tomorrow, next week or next year. That's why saving money steadily through the years is so important. Saving money will help improve your financial situation over time. But more importantly, knowing that you have money stashed away for an emergency will give you peace of mind. Saving money also opens the door to many more options and possibilities.

Benefits of Saving

Inculcating the habit of saving leads to a vast number of benefits. Saving helps you:

- **Become financially independent**: When you have enough money saved up to feel secure you can start making your choices, from taking a vacation whenever you want, to switching careers or starting your own business.
- **Invest in yourself through education**: Through saving, you can earn enough to pay up for courses that will add to your professional experience and ultimately result in higher paying jobs.
- **Get out of debt**: Once you have saved enough as a reserve fund, you can use your savings to pay off debts like loans or bills that have accumulated over time.
- **Be prepared for surprise expenses:** Having money saved enables you to pay for unforeseen expenses like sudden car or house repairs, without feeling financially stressed.
- **Pay for emergencies**: Saving helps you deal with emergencies like sudden health issues or emergency trips without feeling financially burdened.
- **Afford large purchases and achieve major goals**: Saving diligently makes it possible to place down payments towards major purchases and goals, like buying a home or a car.
- **Retire**: The money you have saved over the years will keep you comfortable when you no longer have the income you would get from your job.

- Break your spending habit. Try not spending on one expensive item per week, and put the money that you would have spent into your savings.
- Decide that you will not buy anything on certain days or weeks and stick to your word.

5.3.2 Types of Bank Accounts, Opening a Bank Account

Types of Bank Accounts

In India, banks offer four main types of bank accounts. These are:

- Current Accounts
- Savings Accounts
- Recurring Deposit Accounts
- Fixed Deposit Accounts

Current Accounts

Current accounts offer the most liquid deposits and thus, are best suited for businessmen and companies. As these accounts are not meant for investments and savings, there is no imposed limit on the number or amount of transactions that can be made on any given day. Current account holders are not paid any interest on the amounts held in their accounts. They are charged for certain services offered on such accounts.

Saving Accounts

Savings accounts are meant to promote savings, and are therefore the number one choice for salaried individuals, pensioners and students. While there is no restriction on the number and amount of deposits made, there are usually restrictions on the number and amount of withdrawals. Savings account holders are paid interest on their savings.

Recurring Deposit Accounts

Recurring Deposit accounts, also called RD accounts, are the accounts of choice for those who want to save an amount every month, but are unable to invest a large sum at one time. Such account holders deposit a small, fixed amount every month for a pre-determined period (minimum 6 months). Defaulting on a monthly payment results in the account holder being charged a penalty amount. The total amount is repaid with interest at the end of the specified period.

Fixed Deposit Accounts

Fixed Deposit accounts, also called FD accounts, are ideal for those who wish to deposit their savings for a long term in return for a high rate of interest. The rate of interest offered depends on the amount deposited and the time period, and also differs from bank to bank. In the case of an FD, a certain amount of money is deposited by the account holder for a fixed period of time. The money can be withdrawn when the period expires. If necessary, the depositor can break the fixed deposit prematurely. However, this usually attracts a penalty amount which also differs from bank to bank.

Opening a Bank Account 

Opening a bank account is quite a simple process. Take a look at the steps to open an account of your own:

Step 1: Fill in the Account Opening Form

This form requires you to provide the following information:

- Personal details (name, address, phone number, date of birth, gender, occupation, address)
- Method of receiving your account statement (hard copy/email)
- Details of your initial deposit (cash/cheque)
- Manner of operating your account (online/mobile banking/traditional via cheque, slip books)

Ensure that you sign wherever required on the form.

Step 2: Affix your Photograph

Stick a recent photograph of yourself in the allotted space on the form.

Step 3: Provide your Know Your Customer (KYC) Details

KYC is a process that helps banks verify the identity and address of their customers. To open an account, every individual need to submit certain approved documents with respect to photo identity (ID) and address proof. Some Officially Valid Documents (OVDs) are:

- Passport
- Driving License
- Voters' Identity Card
- PAN Card
- UIDAI (Aadhar) Card

Step 4: Submit All your Documents

Submit the completed Account Opening Form and KYC documents. Then wait until the forms are processed and your account has been opened!

- Select the right type of account.
- Fill in complete nomination details.
- Ask about fees.
- Understand the rules.
- Check for online banking – it's convenient!
- Keep an eye on your bank balance.

5.3.3 Costs: Fixed vs Variable: What are Fixed and Variable Costs?

Fixed costs and variable costs together make up a company's total cost. These are the two types of costs that companies have to bear when producing goods and services. A fixed cost does not change with the volume of goods or services a company produces. It always remains the same.

A variable cost, on the other hand, increases and decreases depending on the volume of goods and services produced. In other words, it varies with the amount produced.

Differences Between Fixed and Variable Costs

Let's take a look at some of the main differences between fixed and variable costs:

Criteria	Fixed Costs	Variable Costs
Meaning	A cost that stays the same, regardless of the output produced.	A cost that changes when the
Nature	Time related.	Volume related.
Incurred	Incurred irrespective of units being produced.	Incurred only when units are produced
Unit cost	Inversely proportional to the number of units produced	Remains the same, per unit.
Examples	Depreciation, rent, salary, insurance and tax	Material consumed, wages, commission on sales and packing expenses

- When trying to determine whether a cost is fixed or variable, simply ask the following question: Will the particular cost change if the company stopped its production activities? If the answer is no, then it is a fixed cost. If the answer is yes, then it is probably a variable cost.

5.3.4 Investment, Insurance and Taxes: Investment

Investment means that money is spent today with the aim of reaping financial gains at a future time. The main types of investment options are as follows:

- **Bonds:** Bonds are instruments used by public and private companies to raise large sums of money – too large to be borrowed from a bank. These bonds are then issued in the public market and are bought by lenders.

- **Stocks:** Stocks or equity are shares that are issued by companies and are bought by the general public.
- **Small Savings Schemes:** Small Savings Schemes are tools meant to save money in small amounts. Some popular schemes are the Employees Provident Fund, Sukanya Samriddhi Scheme and National Pension Scheme.
- **Mutual Funds:** Mutual Funds are professionally managed financial instruments that invest money in different securities on behalf of investors.
- **Fixed Deposits:** A fixed amount of money is kept aside with a financial institution for a fixed amount of time in return for interest on the money.
- **Real Estate:** Loans are taken from banks to purchase real estate, which is then leased or sold with the aim of making a profit on the appreciated property price.
- **Hedge Funds:** Hedge funds invest in both financial derivatives and/or publicly traded securities.
- **Private Equity:** Private Equity is trading in the shares of an operating company that is not publicly listed and whose shares are not available on the stock market.

Insurance

There are two types of insurance – Life Insurance and Non-Life or General Insurance.

Life Insurance

Life Insurance deals with all insurance covering human life.

Life Insurance Products

The main life insurance products are:

- **Term Insurance:** This is the simplest and cheapest form of insurance. It offers financial protection for a specified tenure, say 15 to 20 years. In the case of your death, your family is paid the sum assured. In the case of your surviving the term, the insurer pays nothing.
- **Endowment Policy:** This offers the dual benefit of insurance and investment. Part of the premium is allocated towards the sum assured, while the remaining premium gets invested in equity and debt. It pays a lump sum amount after the specified duration or on the death of the policyholder, whichever is earlier.
- **Unit-Linked Insurance Plan (ULIP):** Here part of the premium is spent on the life cover, while the remaining amount is invested in equity and debt. It helps develop a regular saving habit.
- **Money Back Life Insurance:** While the policyholder is alive, periodic payments of the partial survival benefits are made during the policy tenure. On the death of the insured, the insurance company pays the full sum assured along with survival benefits.
- **Whole Life Insurance:** It offers the dual benefit of insurance and investment. It offers insurance cover for the whole life of the person or up to 100 years whichever is earlier.

General Insurance

General Insurance deals with all insurance covering assets like animals, agricultural crops, goods, factories, cars and so on.

General Insurance Products

The main general insurance products are:

- **Motor Insurance:** This can be divided into Four-Wheeler Insurance and Two-Wheeler insurance.
- **Health Insurance:** The main types of health insurance are individual health insurance, family floater health insurance, comprehensive health insurance and critical illness insurance.
- **Travel Insurance:** This can be categorised into Individual Travel Policy, Family Travel Policy, Student Travel Insurance and Senior Citizen Health Insurance.
- **Home Insurance:** This protects the house and its contents from risk.
- **Marine Insurance:** This insurance covers goods, freight and cargo against loss or damage during transit by rail, road, sea and/or air.

Taxes

There are two types of taxes – Direct Taxes and Indirect Taxes.

Direct Tax

Direct taxes are levied directly on an entity or a person and are non-transferrable. Some examples of Direct Taxes are:

- **Income Tax:** This tax is levied on your earning in a financial year. It is applicable to both, individuals and companies.
- **Capital Gains Tax:** This tax is payable whenever you receive a sizable amount of money. It is usually of two types – short term capital gains from investments held for less than 36 months and long term capital gains from investments held for longer than 36 months.
- **Securities Transaction Tax:** This tax is added to the price of a share. It is levied every time you buy or sell shares.
- **Perquisite Tax:** This tax is levied is on perks that have been acquired by a company or used by an employee.
- **Corporate Tax:** Corporate tax is paid by companies from the revenue they earn.

Indirect Tax

Indirect taxes are levied on goods or services. Some examples of Indirect Taxes are:

- **Sales Tax:** Sales Tax is levied on the sale of a product.
- **Service Tax:** Service Tax is added to services provided in India.
- **Value Added Tax:** Value Added Tax is levied at the discretion of the state government. The tax is levied on goods sold in the state. The tax amount is decided by the state.
- **Customs Duty & Octroi:** Customs Duty is a charge that is applied on purchases that are imported from another country. Octroi is levied on goods that cross state borders within India.
- **Excise Duty:** Excise Duty is levied on all goods manufactured or produced in India

- Think about how quickly you need your money back and pick an investment option accordingly.
- Ensure that you are buying the right type of insurance policy for yourself.
- Remember, not paying taxes can result in penalties ranging from fines to imprisonment.

5.3.5 Online Banking, NEFT, RTGS etc.: What is Online Banking?

Internet or online banking allows account holders to access their account from a laptop at any location. In this way, instructions can be issued. To access an account, account holders simply

Internet banking can be used to:

- Find out an account balance
- Transfer amounts from one account to another
- Arrange for the issuance of cheques
- Instruct payments to be made
- Request for a cheque book
- Request for a statement of accounts
- Make a fixed deposit

Electronic Funds Transfers

Electronic funds transfer is a convenient way of transferring money from the comfort of one's own home, using integrated banking tools like internet and mobile banking. Transferring funds via an electronic gateway is extremely convenient. With the help of online banking, you can choose to:

- Transfer funds into your own accounts of the same bank.
- Transfer funds into different accounts of the same bank.
- Transfer funds into accounts in different bank, using NEFT.
- Transfer funds into other bank accounts using RTGS.
- Transfer funds into various accounts using IMPS.

NEFT

NEFT stands for National Electronic Funds Transfer. This money transfer system allows you to electronically transfer funds from your respective bank accounts to any other account, either in the same bank or belonging to any other bank. NEFT can be used by individuals, firms and corporate organizations to transfer funds between accounts.

In order to transfer funds via NEFT, two things are required:

- A transferring bank
- A destination bank

Before you can transfer funds through NEFT, you will need to register the beneficiary who will be receiving the funds. In order to complete this registration, you will require the following information:

- Recipient's name
- Recipient's bank's name
- Recipient's account number
- Recipient's bank's IFSC code

RTGS

RTGS stands for Real Time Gross Settlement. This is a real-time fund transfer system which enables you to transfer funds from one bank to another, in real time or on a gross basis. The transferred amount is immediately deducted from the account of one bank, and instantly credited to the other bank's account. The RTGS payment gateway is maintained by the Reserve Bank of India. The transactions between banks are made electronically. RTGS can be used by individuals, companies and firms to transfer large sums of money. Before remitting funds through RTGS, you will need to add the beneficiary and his bank account details via your online banking account. In order to complete this registration, you will require the

- Name of the beneficiary
- Beneficiary's account number
- Beneficiary's bank address
- Beneficiary's bank's IFSC code

IMPS

IMPS stands for Immediate Payment Service. This is a real-time, inter-bank, electronic funds transfer system used to transfer money instantly within banks across India. IMPS enables users to make instant electronic transfer payments using mobile phones through both, Mobile Banking and SMS. It can also be used through ATMs and online banking. IMPS is available 24 hours a day and 7 days a week. The system features a secure transfer gateway and immediately confirms orders that have been fulfilled.

- Register for IMPS with your bank
- Receive a Mobile Money Identifier (MMID) from the bank
- Receive a MPIN from the bank

To transfer money through IMPS, the you need to:

Once you have both these, you can login or make a request through SMS to transfer a particular amount to a beneficiary.

For the beneficiary to receive the transferred money, he must:

1. Link his mobile number with his respective account
2. Receive the MMID from the bank

In order to initiate a money transfer through IMPS, you will need to enter the following information:

1. The beneficiary's mobile number
2. The beneficiary's MMID
3. The transfer amount
4. Your MPIN

As soon as money has been deducted from your account and credited into the beneficiary's account, you will be sent a confirmation SMS with a transaction reference number, for future reference.

Differences Between NEFT, RTGS & IMPS

Criteria	NEFT	RTGS	IMPS
Settlement	Done in batches	Real-time	Real-time
Full form	National Electronic Fund Transfer	Real Time Gross Settlement	Immediate Payment Service
Timings on Monday – Friday	8:00 am – 6:30 pm	9:00 am – 4:30 pm	24x7
Timings on Saturday	8:00 am – 1:00 pm	9:00 am – 1:30 pm	24x7
Minimum amount of money transfer limit	₹1	₹2 lacs	₹1
Maximum amount of money transfer limit	₹10 lacs	₹10 lacs per day	₹2 lacs
Maximum charges as per RBI	Up to 10,000 – ₹2.5 above 10,000 – 1 lac – ₹5 above 1 – 2 lacs ₹15 above 2 – 5 lacs ₹25 above 5 – 10 lacs ₹25	above 2 – 5 lacs ₹25 above 5 – 10 lacs ₹50	Up to 10,000 – ₹5 above 10,000 – 1 lac – ₹5 above 1 – 2 lacs – ₹15

- Never click on any links in any e-mail message to access your online banking website.
- You will never be asked for your credit or debit card details while using online banking.
- Change your online banking password regularly.

UNIT 5.4: Preparing for Employment & Self Employment

Unit Objectives

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

1. Discuss the steps to prepare for an interview
2. Discuss the steps to create an effective Resume
3. Discuss the most frequently asked interview questions
4. Discuss how to answer the most frequently asked interview questions
5. Discuss basic workplace terminology

5.4.1 Interview Preparation: How to Prepare for an Interview?

The success of your getting the job that you want depends largely on how well your interview for that job goes. Therefore, before you go in for your interview, it is important that you prepare for it with a fair amount of research and planning. Take a look at the steps to follow in order to be well prepared for an interview:

1. **Research the organization that you are having the interview with.**
   - Studying the company beforehand will help you be more prepared at the time of the interview. Your knowledge of the organization will help you answer questions at the time of the interview, and will leave you looking and feeling more confident. This is sure to make you stand out from other, not as well informed, candidates.
   - Look for background information on the company. Ty and find an overview of the company and its industry profile.
   - Visit the company website to get a good idea of what the company does. A company website offers a wealth of important information. Read and understand the company's mission statement. Pay attention to the company's products/services and client list. Read through any press releases to get an idea of the company's projected growth and stability.
   - Note down any questions that you have after your research has been completed.
2. **Think about whether your skills and qualifications match the job requirements.**
   - Carefully read through and analyse the job description.
   - Make a note of the knowledge, skills and abilities required to fulfil the job requirements.
   - Take a look at the organization hierarchy. Figure out where the position you are applying for fits into this hierarchy.
3. **Go through the most typical interview questions asked, and prepare your responses.**
   - Remember, in most interviews a mix of resume-based, behavioural and case study questions are asked.
   - Think about the kind of answers you would like to provide to typical questions asked in these three areas.
   - Practice these answers until you can express them confidently and clearly.

4. **Plan your attire for the interview.**
   - It is always safest to opt for formal business attire, unless expressly informed to dress in business casual (in which case you should use your best judgement)
   - Ensure that your clothes are clean and well-ironed. Pick neutral colours – nothing too bright or flashy.
   - The shoes you wear should match your clothes, and should be clean and suitable for a n interview.
   - Remember, your aim is to leave everyone you meet with the impression that you are a professional and highly efficient person.
5. **Ensure that you have packed everything that you may require during the interview.**
   - Carry a few copies of your resume. Use a good quality paper for your resume print outs.
   - Always take along a notepad and a pen.
   - Take along any information you may need to refer to, in order to fill out an application form.
   - Carry a few samples of your work, if relevant.
6. **Remember the importance of non-verbal communication.**
   - Practice projecting confidence. Remind yourself to smile and make eye contact. Practice giving a firm handshake.
   - Keep in mind the importance of posture. Practice sitting up straight. Train yourself to stop nervous gestures like fidgeting and foot-tapping.
   - Practice keeping your reactions in check. Remember, your facial expressions provide a good insight into your true feelings. Practice projecting a positive image.
7. **Make a list of questions to end the interview with.**
   - Most interviews will end with the interviewer(s) asking if you have any questions. This is your chance to show that you have done your research and are interested in learning more about the company.
   - If the interviewer does not ask you this question, you can inform him/her that you have some queries that you would like to discuss. This is the time for you to refer to the notes you made while studying the company.
   - Some good questions to ask at this point are:
     - What do you consider the most important criteria for success in this job?
     - How will my performance be evaluated?
     - What are the opportunities for advancement?
     - What are the next steps in the hiring process?
   - Remember, never ask for information that is easily available on the company website.

- Ask insightful and probing questions.
- When communicating, use effective forms of body language like smiling, making eye contact, and actively listening and nodding. Don't slouch, play with nearby items, fidget, chew gum, or mumble.

5.4.2 Preparing an Effective Resume: How to Create an Effective Resume?

A resume is a formal document that lists a candidate's work experience, education and skills. A good resume gives a potential employer enough information to believe the applicant is worth interviewing. That's why it is so important to create a résumé that is effective. Take a look at the steps to create an effective resume:

Step 1: Write the Address Section

The Address section occupies the top of your resume. It includes information like your name, address, phone number and e-mail address. Insert a bold line under the section to separate it from rest of your resume.

Example:

Khyati Mehta
Breach Candy, Mumbai – India
Contact No: +91 2223678270
Email: jasmine.watts@gmail.com

Step 2: Add the Profile Summary Section

This part of your resume should list your overall experiences, achievements, awards, certifications and strengths. You can make your summary as short as 2-3 bullet points or a s long as 8-10 bullet points.

Example:

Profile Summary

- A Floor Supervisor graduated from University of Delhi having 6 years of experience in managing a retail outlet.
- Core expertise lies in managing retail staff, including cashiers and people working on the floor.

Step 3: Include Your Educational Qualifications

When listing your academic records, first list your highest degree. Then add the second highest qualification under the highest one and so on. To provide a clear and accurate picture of your educational background, it is critical that include information on your position, rank, percentage or CPI for every degree or certification that you have listed.

If you have done any certifications and trainings, you can add a Trainings & Certifications section under your Educational Qualifications section.

Example:

Educational Qualifications
<Enter qualification> <enter date of qualification> from <enter name of institute> with <enter percentage or any other relevant scoring system>.

Step 4: List Your Technical Skills

When listing your technical skills, start with the skills that you are most confident about. Then add the skills that you do not have as good a command over. It is perfectly acceptable to include just one skill, if you feel that particular skill adds tremendous value to your résumé. If you do not have any technical skills, you can omit this step.

Example:

Technical Skills
• *<Enter your technical skill here, if applicable>*

Step 5: Insert Your Academic Project Experience

List down all the important projects that you have worked on. Include the following information in this section:

- Project title
- Contribution
- Organization
- Description
- Platform used

Example:

Academic Projects
Project Title: *<Insert project title>*
Organization: *<Insert the name of the organization for whom you did the project>*
Platform used: *<Insert the platform used, if any>*
Contribution: *<Insert your contribution towards this project>*
Description: *<Insert a description of the project in one line>*

Step 6: List Your Strengths

This is where you list all your major strengths. This section should be in the form of a bulleted list.

Example:

Strengths
• Excellent oral, written and presentation skills
• Action-oriented and result-focused
• Great time management skills

Step 7: List Your Extracurricular Activities

It is very important to show that you have diverse interests and that your life consists of more than academics. Including your extracurricular activities can give you an added edge over other candidates who have similar academic scores and project experiences. This section should be in the form of a bulleted list.

Example:

< Insert your extracurricular activity here. E.g.: Member of, _____ played (name of sport) at _____ level, won (name of prize/award) for _____>

Step 8: Write Your Personal Details

The last section of your résumé must include the following personal information:

- Date of birth
- Nationality
- Gender & marital status
- Languages known

Example:

Personal Details

• Date of birth:	25th May, 1981
• Gender & marital status:	Female, Single
• Nationality:	Indian
• Languages known:	English, Hindi, Tamil, French

- Keep your resume file name short, simple and informational.
- Make sure the resume is neat and free from typing errors.
- Always create your resume on plain white paper.

5.4.3 Interview FAQs

Take a look at some of the most frequently asked interview questions, and some helpful tips on how to answer them.

Q1. Can you tell me a little about yourself?

Tips to answer:

- Don't provide your full employment or personal history.
- Offer 2-3 specific experiences that you feel are most valuable and relevant.
- Conclude with how those experiences have made you perfect for this specific role.

Q2. How did you hear about the position?

Tips to answer:

- Tell the interviewer how you heard about the job – whether it was through a friend (name the friend), event or article (name them) or a job portal (say which one).
- Explain what excites you about the position and what in particular caught your eye about this role.

Q3. What do you know about the company?

Tips to answer:

- Don't recite the company's About Us page.
- Show that you understand and care about the company's goals.
- Explain why you believe in the company's mission and values.

Q4. Why do you want this job?

Tips to answer:

- Show that you are passionate about the job.
- Identify why the role is a great fit for you.
- Explain why you love the company.

Q5. Why should we hire you?

Tips to answer:

- Prove through your words that you can not only do the work, but can definitely deliver excellent results.
- Explain why you would be a great fit with the team and work culture.
- Explain why you should be chosen over any other candidate.

Q6. What are your greatest professional strengths?

Tips to answer:

- Be honest – share some of your real strengths, rather than give answers that you think sound good.
- Offer examples of specific strengths that are relevant to the position you are applying for.
- Provide examples of how you've demonstrated these strengths.

Q7. What do you consider to be your weaknesses?

Tips to answer:

- The purpose of this question is to gauge your self-awareness and honesty.
- Give an example of a trait that you struggle with, but that you're working on to improve.

Q8. What are your salary requirements?

Tips to answer:

- Do your research beforehand and find out the typical salary range for the job you are applying for.
- Figure out where you lie on the pay scale based on your experience, education, and skills.
- Be flexible. Tell the interviewer that you know your skills are valuable, but that you want the job and are willing to negotiate.

Q9. What do you like to do outside of work?

Tips to answer:

- The purpose of this question is to see if you will fit in with the company culture.
- Be honest – open up and share activities and hobbies that interest and excite you.

Q10. If you were an animal, which one would you want to be?

Tips to answer:

- The purpose of this question is to see if you are able to think on your feet.
- There's no wrong answer – but to make a great impression try to bring out your strengths or personality traits through your answer.

Q11: What do you think we could do better or differently?

Tips to answer:

- The purpose of this question is to see if you have done your research on the company, and to test whether you can think critically and come up with new ideas.
- Suggest new ideas. Show how your interests and expertise would help you execute these ideas.

Q12: Do you have any questions for us?

Tips to answer:

- Do not ask questions to which the answers can be easily found on the company website or through a quick online search.
- Ask intelligent questions that show your ability to think critically.

- Be honest and confident while answering.
- Use examples of your past experiences wherever possible to make your answers more impactful.

5.4.4 Work Readiness – Terms & Terminologies: Basic Workplace Terminology

Every employee should be well versed in the following terms:

- **Annual leave:** Paid vacation leave given by employers to employees.
- **Background Check:** A method used by employers to verify the accuracy of the information provided by potential candidates.
- **Benefits:** A part of an employee's compensation package.
- **Breaks:** Short periods of rest taken by employees during working hours.
- **Compensation Package:** The combination of salary and benefits that an employer provides to his/her employees.
- **Compensatory Time (Comp Time):** Time off in lieu of pay.
- **Contract Employee:** An employee who works for one organization that sells said employee's service to another company, either on a project or time basis.
- **Contract of Employment:** When an employee is offered work in exchange for wages or salary, and accepts the offer made by the employer, a contract of employment exists.
- **Corporate Culture:** The beliefs and values shared by all the members of a company, and imparted from one generation of employees to another.
- **Counter Offer/Counter Proposal:** A negotiation technique used by potential candidates to increase the amount of salary offered by a company.
- **Cover Letter:** A letter that accompanies a candidate's resume. It emphasizes the important points in the candidate's resume and provides real examples that prove the candidate's ability to perform the expected job role.
- **Curriculum Vitae (CV)/Resume:** A summary of a candidate's achievements, educational work experience, skills and strengths.
- **Declining Letter:** A letter sent by an employee to an employer, turning down the job offer employer to the employee.
- **Deductions:** Amounts subtracted from an employee's pay and listed on the employee's pay slip.
- **Discrimination:** The act of treating one person not as favourably as another person.
- **Employee:** A person who works for another person in exchange for payment.
- **Employee Training:** A workshop or in-house training that an employee is asked to attend by his or her superior, for the benefit of the employer.
- **Employment Gaps:** Periods of unemployed time between jobs.
- **Fixed-Term Contract:** A contract of employment which gets terminated on an agreed-upon date.
- **Follow-Up:** The act of contacting a potential employer after a candidate has submitted his or her resume.
- **Freelancer/Consultant/Independent Contractor:** A person who works for him or herself for temporary jobs and projects with different employers.
- **Holiday**: Paid time-off from work.
- **Hourly Rate**: The amount of salary or wages paid for 60 minutes of work.
- **Internship**: A job opportunity offered by an employer to a potential employee, called an at the employer's company for a fixed, limited time period.

- **Interview**: A conversation between a potential employee and a representative of an order to determine if the potential employee should be hired.
- **Job Application**: A form which asks for a candidate's information like the candidate's name, details and work experience. The purpose of a candidate submitting a job application, is to show that candidate's interest in working for a particular company.
- **Job Offer**: An offer of employment made by an employer to a potential employee.
- **Job Search Agent**: A program that enables candidates to search for employment opportunities by selecting criteria listed in the program, for job vacancies. background, made by the and pitches intern, to work employer, in address, contact
- **Lay Off**: A lay off occurs when an employee is temporarily let go from his or her job, due to the employer not having any work for that employee.
- **Leave**: Formal permission given to an employee, by his or her employer, to take a leave of absence from work.
- **Letter of Acceptance**: A letter given by an employer to an employee, confirming the offer of employment made by the employer, as well as the conditions of the offer.
- **Letter of Agreement**: A letter that outlines the terms of employment.
- **Letter of Recommendation**: A letter written for the purpose of validating the work skills o f a person.
- **Maternity Leave**: Leave taken from work by women who are pregnant, or who have just given birth.
- **Mentor**: A person who is employed at a higher level than you, who offers you advice and guides you in your career.
- **Minimum wage**: The minimum wage amount paid on an hourly basis.
- **Notice**: An announcement made by an employee or an employer, stating that the employment contract will end on a particular date.
- **Offer of Employment**: An offer made by an employer to a prospective employee that contains important information pertaining to the job being offered, like the starting date, salary, working conditions etc.
- **Open-Ended Contract**: A contract of employment that continues till the employer or terminates it.
- **Overqualified**: A person who is not suited for a particular job because he or she has too m any years of work experience, or a level of education that is much higher than required f or the job, or is currently or was previously too highly paid.
- **Part-Time Worker**: An employee who works for fewer hours than the standard number of hours normally worked.
- **Paternity Leave**: Leave granted to a man who has recently become a father.
- **Recruiters/Head-hunters/Executive Search Firms**: Professionals who are paid by employers to search for people to fill particular positions.
- **Resigning/Resignations**: When an employee formally informs his or her employer that he or she is quitting his or her job.
- **Self-Employed**: A person who has his or her own business and does not work in the capacity of an employee.
- **Time Sheet**: A form that is submitted to an employer, by an employee, that contains the number of hours worked every day by the employee.

UNIT 5.5: Understanding Entrepreneurship

Unit Objectives

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

1. Discuss the concept of entrepreneurship
2. Discuss the importance of entrepreneurship
3. Describe the characteristics of an entrepreneur
4. Describe the different types of enterprises
5. List the qualities of an effective leader
6. Discuss the benefits of effective leadership
7. List the traits of an effective team
8. Discuss the importance of listening effectively
9. Discuss how to listen effectively
10. Discuss the importance of speaking effectively
11. Discuss how to speak effectively
12. Discuss how to solve problems
13. List important problem solving traits
14. Discuss ways to assess problem solving skills
15. Discuss the importance of negotiation
16. Discuss how to negotiate
17. Discuss how to identify new business opportunities
18. Discuss how to identify business opportunities within your business
19. Explain the meaning of entrepreneur
20. Describe the different types of entrepreneurs
21. List the characteristics of entrepreneurs
22. Recall entrepreneur success stories
23. Discuss the entrepreneurial process
24. Describe the entrepreneurship ecosystem
25. Discuss the purpose of the Make in India campaign
26. Discuss key schemes to promote entrepreneurs
27. Discuss the relationship between entrepreneurship and risk appetite
28. Discuss the relationship between entrepreneurship and resilience
29. Describe the characteristics of a resilient entrepreneur
30. Discuss how to deal with failure

5.5.1 Concept Introduction (Characteristic of Entrepreneur, types of firms / types of enterprises)

Entrepreneurs and Entrepreneurship

Anyone who is determined to start a business, no matter what the risk, is an entrepreneur. Entrepreneurs run their own start-up, take responsibility for the financial risks and use creativity, innovation and vast reserves of self-motivation to achieve success. They dream big and are determined to do whatever it takes to turn their idea into a viable offering. The aim of a n entrepreneur is to create an enterprise. The process of creating this enterprise is known as entrepreneurship.

Importance of Entrepreneurship

1. Entrepreneurship is very important for the following reasons:
2. It results in the creation of new organizations
3. It brings creativity into the marketplace
4. It leads to improved standards of living
5. It helps develop the economy of a country

Characteristics of Entrepreneurs

All successful entrepreneurs have certain characteristics in common.

They are all:

- Extremely passionate about their work
- Confident in themselves
- Disciplined and dedicated
- Motivated and driven
- Highly creative
- Visionaries
- Open-minded
- Decisive

Entrepreneurs also have a tendency to:

- Have a high-risk tolerance
- Thoroughly plan everything
- Manage their money wisely
- Make their customers their priority
- Understand their offering and their market in detail
- Ask for advice from experts when required
- Know when to cut their losses

Examples of Famous Entrepreneurs

Some famous entrepreneurs are:

- Dhirubhai Ambani (Reliance)
- Dr. Karsanbhai Patel (Nirma)
- Azim Premji (Wipro)
- Anil Agarwal (Vedanta Resources)

Types of Enterprises

As an entrepreneur in India, you can own and run any of the following types of enterprises:

Sole Proprietorship

In a sole proprietorship, a single individual owns, manages and controls the enterprise. This type of business is the easiest to form with respect to legal formalities. The business and the owner have no separate legal existence. All profit belongs to the proprietor, as do all the losses the liability of the entrepreneur is unlimited.

Partnership

A partnership firm is formed by two or more people. The owners of the enterprise are called partners. A partnership deed must be signed by all the partners. The firm and its partners have no separate legal existence. The profits are shared by the partners. With respect to losses, the liability of the partners is unlimited. A firm has a limited life span and must be dissolved when any one of the partners dies, retires, claims bankruptcy or goes insane.

Limited Liability Partnership (LLP)

In a Limited Liability Partnership or LLP, the partners of the firm enjoy perpetual existence as well as the advantage of limited liability. Each partner's liability is limited to their agreed contribution to the LLP. The partnership and its partners have a separate legal existence.

- Learn from others' failures.
- Be certain that this is what you want.
- Search for a problem to solve, rather than look for a problem to attach to your idea.

5.5.2 Leadership & Teamwork: Leadership and Leaders

Leadership means setting an example for others to follow. Setting a good example means not asking someone to do something that you wouldn't willingly want to do yourself. Leadership is about figuring out what to do in order to win as a team, and as a company. Leaders believe in doing the right things. They also believe in helping others to do the right things. An effective leader is someone who:

- Creates an inspiring vision of the future.
- Motivates and inspires his team to pursue that vision.

Leadership Qualities That All Entrepreneurs Need

Building a successful enterprise is only possible if the entrepreneur in charge possesses excellent leadership qualities. Some critical leadership skills that every entrepreneur must have are:

1. **Pragmatism:** This means having the ability to highlight all obstacles and challenges, in order to resolve issues and reduce risks.
2. **Humility:** This means admitting to mistakes often and early, and being quick to take responsibility for your actions. Mistakes should be viewed as challenges to overcome, not opportunities to point blame.
3. **Flexibility:** It is critical for a good leader to be very flexible and quickly adapt to change. It is equally critical to know when to adapt and when not to.
4. **Authenticity:** This means showing both, your strengths and your weaknesses. It means being human and showing others that you are human.
5. **Reinvention:** This means refreshing or changing your leadership style when necessary. To do this, it's important to learn where your leadership gaps lie and find out what resources are required to close them.
6. **Awareness:** This means taking the time to recognize how others view you. It means understanding how your presence affects those around you.

Benefits of Effective Leadership

Effective leadership results in numerous benefits. Great leadership leads to the leader successfully:

- Gaining the loyalty and commitment of the team members
- Motivating the team to work towards achieving the company's goals and objectives
- Building morale and instilling confidence in the team members
- Fostering mutual understanding and team-spirit among team members
- Convincing team members about the need to change when a situation requires adaptability

Teamwork and Teams

Teamwork occurs when the people in a workplace combine their individual skills to pursue a common goal. Effective teams are made up of individuals who work together to achieve this common goal. A great team is one who holds themselves accountable for the end result.

1. **Unity of purpose:** All the team members should clearly understand and be equally committed to the purpose, vision and goals of the team.
2. **Great communication skills:** Team members should have the ability to express their concerns, ask questions and use diagrams, and charts to convey complex information.
3. **The ability to collaborate:** Every member should feel entitled to provide regular feedback on new ideas.
4. **Initiative:** The team should consist of proactive individuals. The members should have the enthusiasm to come up with new ideas, improve existing ideas, and conduct their own research.
5. **Visionary members:** The team should have the ability to anticipate problems and act on these potential problems before they turn into real problems.

6. **Great adaptability skills:** The team must believe that change is a positive force. Change should be seen as the chance to improve and try new things.
7. **Excellent organizational skills:** The team should have the ability to develop standard work processes, balance responsibilities, properly plan projects, and set in place methods to measure progress and ROI.

- Don't get too attached to your original idea. Allow it to evolve and change.
- Be aware of your weaknesses and build a team that will complement your shortfalls.
- Hiring the right people is not enough. You need to promote or incentivize your most
- talented people to keep them motivated.
- Earn your team's respect.

5.5.3 Communication Skills: Listening & Speaking the Importance of Listening Effectively

Listening is the ability to correctly receive and understand messages during the process of communication. Listening is critical for effective communication. Without effective listening skills, messages can easily be misunderstood. This results in a communication breakdown and can lead to the sender and the receiver of the message becoming frustrated or irritated. It's very important to note that listening is not the same as hearing. Hearing just refers to sounds that you hear. Listening is a whole lot more than that. To listen, one requires focus. It means not only paying attention to the story, but also focusing on how the story is relayed, the way language and voice is used, and even how the speaker uses their body language. The ability to listen depends on how effectively one can perceive and understand both, verbal and non-verbal cues.

How to Listen Effectively?

To listen effectively you should:

- Stop talking
- Stop interrupting
- Focus completely on what is being said
- Nod and use encouraging words and gestures
- Be open-minded
- Pay attention to the tone that is being used
- Pay attention to the speaker's gestures, facial expressions and eye movements
- Not try and rush the person
- Not let the speaker's mannerisms or habits irritate or distract you

- Think about the speaker's perspective
- Be very, very patient

The Importance of Speaking Effectively

How successfully a message gets conveyed depends entirely on how effectively you are able to get it through. An effective speaker is one who enunciates properly, pronounces words correctly, chooses the right words and speaks at a pace that is easily understandable.

Besides this, the words spoken out loud need to match the gestures, tone and body language used. What you say, and the tone in which you say it, results in numerous perceptions being formed. A person who speaks hesitantly may be perceived as having low self-esteem or lacking in knowledge of the discussed topic. Those with a quiet voice may very well be labelled as shy. And those who speak in commanding tones with high levels of clarity, are usually considered to be extremely confident. This makes speaking a very critical communication skill.

How to Speak Effectively?

To speak effectively you should:

- Incorporate body language in your speech like eye contact, smiling, nodding, gesturing etc.
- Build a draft of your speech before actually making your speech.
- Ensure that all your emotions and feelings are under control.
- Pronounce your words distinctly with the correct pitch and intensity. Your speech should be crystal clear at all times. Use a pleasant and natural tone when speaking. Your audience should not feel like you are putting on an accent or being unnatural in any way.
- Use precise and specific words to drive your message home. Ambiguity should be avoided at all costs.
- Ensure that your speech has a logical flow.
- Be brief. Don't add any unnecessary information.
- Make a conscious effort to avoid irritating mannerisms like fidgeting, twitching etc.
- Choose your words carefully and use simple words that the majority of the audience will have no difficulty understanding.
- Use visual aids like slides or a whiteboard.
- Speak slowly so that your audience can easily understand what you're saying. However, be careful not to speak too slowly because this can come across as stiff, unprepared or even condescending.
- Remember to pause at the right moments.

- If you're finding it difficult to focus on what someone is saying, try repeating their words in your head.
- Always maintain eye contact with the person that you are communicating with, when speaking as well as listening. This conveys and also encourages interest in the conversation.

5.5.4 Problem Solving & Negotiation Skills: What is a Problem?

As per The Concise Oxford Dictionary (1995), a problem is, "A doubtful or difficult matter requiring a solution"

All problems contain two elements:

1. Goals
2. Obstacles

The aim of problem solving is to recognize the obstacles and remove them in order to achieve the goals.

How to Solve Problems?

Solving a problem requires a level of rational thinking. Here are some logical steps to follow when faced with an issue:

Step 1: Identify the problem

Step 2: Study the problem in detail

Step 3: List all possible solutions

Step 4: Select the best solution

Step 5: Implement the chosen solution

Step 6: Check that the problem has really been solved

Important Traits for Problem Solving

Highly developed problem solving skills are critical for both, business owners and their employees. The following personality traits play a big role in how effectively problems are solved:

Being open minded

Not panicking

Asking the right questions

Having a positive attitude

Being proactive

Focusing on the right problem

How to Assess for Problem Solving Skills?

As an entrepreneur, it would be a good idea to assess the level of problem solving skills of potential candidates before hiring them. Some ways to assess this skill are through:

1. Application forms: Ask for proof of the candidate's problem solving skills in the application form.
2. Psychometric tests: Give potential candidates logical reasoning and critical thinking tests and see how they fare.

3. Interviews: Create hypothetical problematic situations or raise ethical questions and see how the candidates respond.
4. Technical questions: Give candidates examples of real life problems and evaluate their thought process.

What is Negotiation?

Negotiation is a method used to settle differences. The aim of negotiation is to resolve differences through a compromise or agreement while avoiding disputes. Without negotiation, conflicts are likely to lead to resentment between people. Good negotiation skills help satisfy both parties and go a long way towards developing strong relationships.

Why Negotiate?

Starting a business requires many, many negotiations. Some negotiations are small while others are critical enough to make or break a start-up. Negotiation also plays a big role inside the workplace. As an entrepreneur, you need to know not only know how to negotiate yourself, but also how to train employees in the art of negotiation.

How to Negotiate?

Take a look at some steps to help you negotiate:

Step 1: Pre-Negotiation Preparation	Agree on where to meet to discuss the problem, decide who all will be present and set a time limit for the discussion.
Step 2: Discuss the problem	This involves asking questions, listening to the other side, puttingyour views forward and clarifying doubts.
Step 3: Clarify the Objective	Ensure that both parties want to solve the same problem and reach the same goal.
Step 4: Aim for a Win-Win Outcome	Try your best to be open minded when negotiating. Compromise and offer alternate solutions to reach an outcome where both parties win.
Step 5: Clearly Define the Agreement	When an agreement has been reached, the details of the agreement should be crystal clear to both sides, with no scope for misunderstandings.
Step 6: Implement the Agreed Upon Solution	Agree on a course of action to set the solution in motion

- Know exactly what you want before you work towards getting it
- Give more importance to listening and thinking, than speaking
- Focus on building a relationship rather than winning
- Remember that your people skills will affect the outcome
- Know when to walk away – sometimes reaching an agreement may not be possible

5.5.5 Business Opportunities Identification: Entrepreneurs and Opportunities

"The entrepreneur always searches for change, responds to it and exploits it as an opportunity."
Peter Drucker
The ability to identify business opportunities is an essential characteristic of an entrepreneur.

What is an Opportunity?

The word opportunity suggests a good chance or a favourable situation to do something offered by circumstances.

Common Questions Faced by Entrepreneurs

A critical question that all entrepreneurs face is how to go about finding the business opportunity that is right for them.

- Some common questions that entrepreneurs constantly think about are:
- Should the new enterprise introduce a new product or service based on an unmet need?
- Should the new enterprise select an existing product or service from one market and offer it in another where it may not be available?
- Should the enterprise be based on a tried and tested formula that has worked elsewhere?

It is therefore extremely important that entrepreneurs must learn how to identify new and existing business opportunities and evaluate their chances of success.

When is an Idea an Opportunity?

An idea is an opportunity when:

- It creates or adds value to a customer
- It solves a significant problem, removes a pain point or meets a demand
- Has a robust market and profit margin
- Is a good fit with the founder and management team at the right time and place

Factors to Consider When Looking for Opportunities

Consider the following when looking for business opportunities:

- Economic trends
- Changes in funding
- Changing relationships between vendors, partners and suppliers
- Market trends
- Changes in political support
- Shift in target audience

Ways to Identify New Business Opportunities

1. **Identify Market Inefficiencies**
   When looking at a market, consider what inefficiencies are present in the market. Think about ways to correct these inefficiencies.

2. **Remove Key Hassles**
   Rather than create a new product or service, you can innovatively improve a product, service or process.
3. **Create Something New**
   Think about how you can create a new experience for customers, based on existing business models.
4. **Pick a Growing Sector/Industry**
   Research and find out which sectors or industries are growing and think about what opportunities you can tap in the same.
5. **Think About Product Differentiation**
   If you already have a product in mind, think about ways to set it apart from the existing ones.

Ways to Identify Business Opportunities Within Your Business

1. **SWOT Analysis**

   An excellent way to identify opportunities inside your business is by creating a SWOT analysis. The acronym SWOT stands for strengths, weaknesses, opportunities, and threats. SWOT analysis framework:

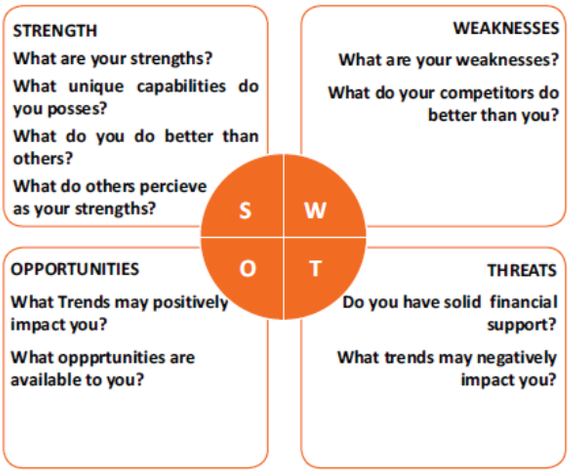


Fig.5.5.1. SWOT Analysis

   Consider the following when looking for business opportunities:
   By looking at yourself and your competitors using the SWOT framework, you can uncover opportunities that you can exploit, as well as manage and eliminate threats that could derail your success.

2. **Establishing Your USP**

   Establish your USP and position yourself as different from your competitors. Identify why customers should buy from you and promote that reason.

Opportunity Analysis

Once you have identified an opportunity, you need to analyse it.

To analyse an opportunity, you must:

- Remember, opportunities are situational.
- Avoid the latest craze.

- Look for a proven track record.
- Love your idea.

5.5.6 Entrepreneurship Support Eco-System: Who is an Entrepreneur?

An entrepreneur is a person who:

- Does not work for an employee
- Runs a small enterprise
- Assumes all the risks and rewards of the enterprise, idea, good or service

Types of Entrepreneurs

There are four main types of entrepreneurs:

1. **The Traditional Entrepreneur:** This type of entrepreneur usually has some kind of skill – they can be a carpenter, mechanic, cook etc. They have businesses that have been around for numerous years like restaurants, shops and carpenters. Typically, they gain plenty of experience in a particular industry before they begin their own business in a similar field.
2. **The Growth Potential Entrepreneur:** The desire of this type of entrepreneur is to start an enterprise that will grow, win many customers and make lots of money. Their ultimate aim is to eventually sell their enterprise for a nice profit. Such entrepreneurs usually have a science or technical background.
3. **The Project-Oriented Entrepreneur:** This type of entrepreneur generally has a background in the Arts or psychology. Their enterprises tend to be focus on something that they are very passionate about.
4. **The Lifestyle Entrepreneur:** This type of entrepreneur has usually worked as a teacher or a secretary. They are more interested in selling something that people will enjoy, rather than making lots of money.

Characteristics of an Entrepreneur

Successful entrepreneurs have the following characteristics:

- They are highly motivated
- They are creative and persuasive
- They are mentally prepared to handle each and every task
- They have excellent business skills – they know how to evaluate their cash flow, sales and revenue
- They are willing to take great risks
- They are very proactive – this means they are willing to do the work themselves, rather than wait for someone else to do it
- They have a vision – they are able to see the big picture
- They are flexible and open-minded
- They are good at making decisions

Entrepreneur Success Stories

Dhiru Bhai Ambani

Dhirubhai Ambani began his entrepreneurial career by selling “bhajias” to pilgrims in Mount Girnar on weekends. At 16, he moved to Yemen where he worked as a gas-station attendant, and as a clerk in an oil company. He returned to India with Rs. 50,000 and started a textile trading company. Reliance went on to become the first Indian company to raise money in global markets and the first Indian company to feature in Forbes 500 list.

Dr. Karsanbhai Patel

Karsanbhai Patel made detergent powder in the backyard of his house. He sold his product door-to door and offered a money back guarantee with every pack that was sold. He charged Rs.3 per kg when the cheapest detergent at that time was Rs.13 per kg. Dr. Patel eventually started Nirma which became a whole new segment in the Indian domestic detergent market.

The Entrepreneurial Process

Let’s take a look at the stages of the entrepreneurial process.

Stage 1: Idea Generation. The entrepreneurial process begins with an idea that has been thought of by the entrepreneur. The idea is a problem that has the potential to be solved.

Stage 2: Germination or Recognition. In this stage a possible solution to the identified problem is thought of.

Stage 3: Preparation or Rationalization. The problem is studied further and research is done to find out how others have tried to solve the same problem.

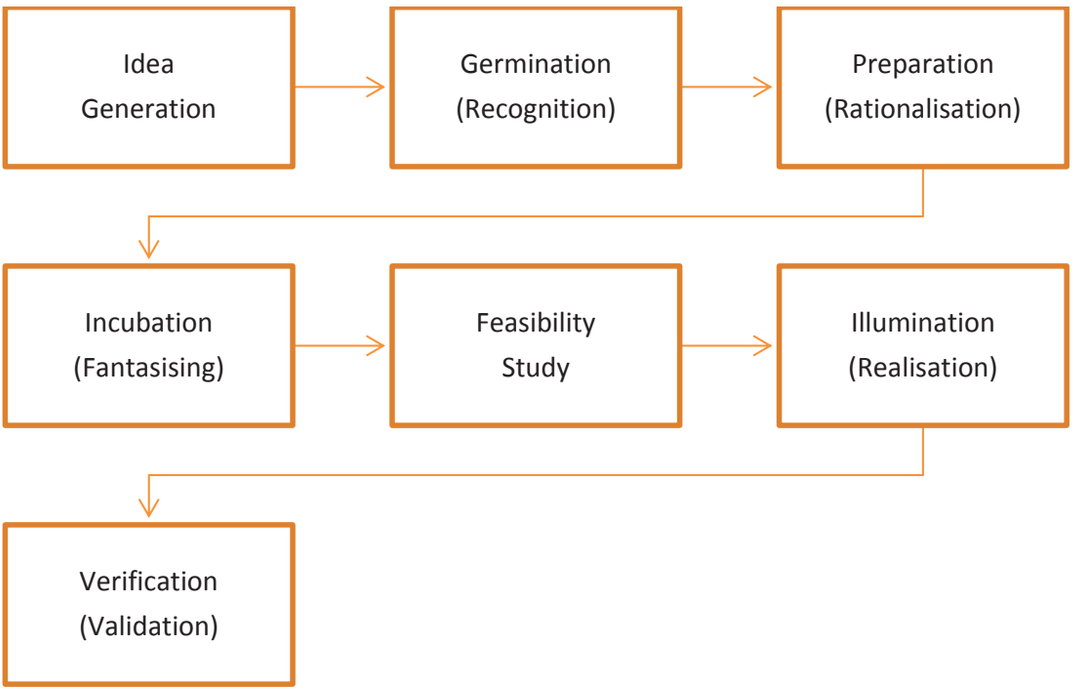
Stage 4: Incubation or Fantasizing. This stage involves creative thinking for the purpose of coming up with more ideas. Less thought is given to the problem areas.

Stage 5: Feasibility Study: The next step is the creation of a feasibility study to determine if the idea will make a profit and if it should be seen through.

Stage 6: Illumination or Realization. This is when all uncertain areas suddenly become clear. The entrepreneur feels confident that his idea has merit.

Stage 7: Verification or Validation. In this final stage, the idea is verified to see if it works and if it is useful.

Take a look at the diagram below to get a better idea of this process.



Introduction to the Entrepreneurship Ecosystem

The entrepreneurship support ecosystem signifies the collective and complete nature of entrepreneurship. New companies emerge and flourish not only because of the courageous, visionary entrepreneurs who launch them, but they thrive as they are set in an environment or 'ecosystem' made of private and public participants. These players nurture and sustain the new ventures, facilitating the entrepreneurs' efforts. An entrepreneurship ecosystem comprises of the following six domains:

1. **Favourable Culture:** This includes elements such as tolerance of risk and errors, valuable networking and positive social standing of the entrepreneur.
2. **Facilitating Policies & Leadership:** This includes regulatory framework incentives and existence of public research institutes.
3. **Financing Options:** Angel financing, venture capitalists and micro loans would be good examples of this.
4. **Human Capital:** This refers to trained and untrained labour, entrepreneurs and entrepreneurship training programmes, etc.
5. **Conducive Markets for Products & Services:** This refers to an existence or scope of existence of a market for the product/service.
6. **Institutional & Infrastructural Support:** This includes legal and financing advisers, telecommunications, digital and transportation infrastructure, and entrepreneurship networking programmes.

These domains indicate whether there is a strong entrepreneurship support ecosystem and what actions should the government put in place to further encourage this ecosystem.

The six domains and their various elements have been graphically depicted.

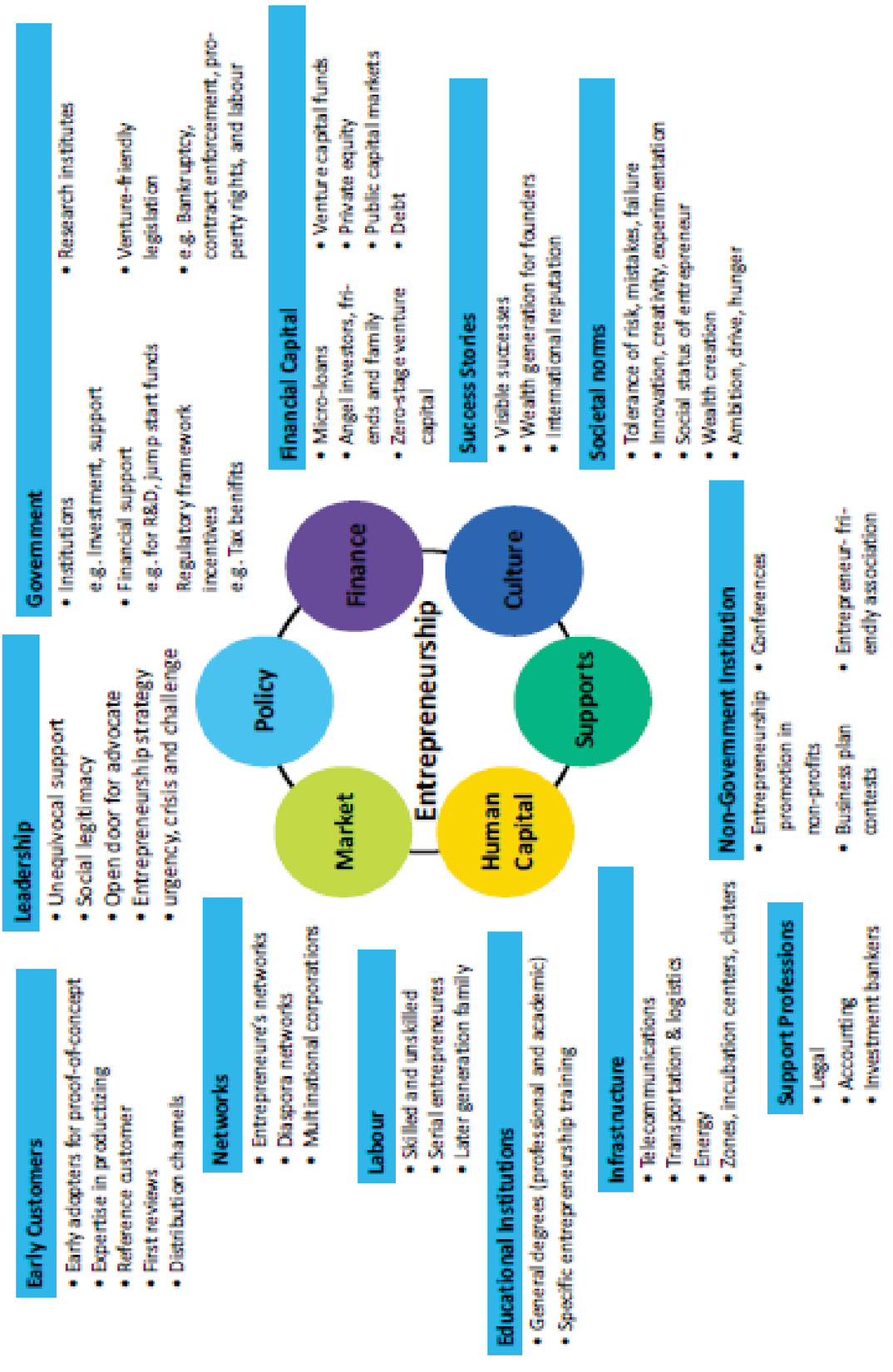


Fig.5.5.2. Entrepreneurship at a Glance

Every entrepreneurship support ecosystem is unique and all the elements of the ecosystem are interdependent. Although every region's entrepreneurship ecosystem can be broadly described by the above features, each ecosystem is the result of the hundred elements interacting in highly complex and particular ways.

Entrepreneurship ecosystems eventually become (largely) self-sustaining. When the six domains are resilient enough, they are mutually beneficial. At this point, government involvement can and should be significantly minimized. Public leaders do not need to invest a lot to sustain the ecosystem. It is imperative that the entrepreneurship ecosystem incentives are formulated to be self-liquidating, hence focussing on sustain ability of the environment.

Make in India Campaign

Every entrepreneur has certain needs. Some of their important needs are:

- To easily get loans
- To easily find investors
- To get tax exemptions
- To easily access resources and good infrastructure
- To enjoy a procedure that is free of hassles and is quick
- To be able to easily partner with other firms

The Make in India campaign, launched by Prime Minister Modi aims to satisfy all these needs of young,aspiring entrepreneurs. Its objective is to:

- Make investment easy
- Support new ideas
- Enhance skill development
- Safeguard the ideas of entrepreneurs
- Create state-of-the-art facilities for manufacturing goods

Key Schemes to Promote Entrepreneurs

The government offers many schemes to support entrepreneurs. These schemes are run by various Ministries/Departments of Government of India to support First Generation Entrepreneurs. Take a look at a few key schemes to promote entrepreneurship:

Sl.	Name of the Scheme
1.	Pradhan Mantri MUDRA Yojana - Micro Units Development and Refinance Agency (MUDRA),
2.	STAND UP INDIA
3.	Prime Minister Employment Generation Programme (PMEGP)
4.	International Cooperation
5.	Performance and Credit Rating
6.	Marketing Assistance Scheme
7.	Reimbursement of Registration Fee for Bar Coding
8.	Enable Participation of MSMEs in State/District level Trade Fairs and Provide Funding Support
9.	Capital Subsidy Support on Credit for Technology up gradation
10.	Credit Guarantee Fund for Micro and Small Enterprise (CGFMSE)
11.	Reimbursement of Certification Fees for Acquiring ISO Standards

12. Agricultural Marketing
13. Small Agricultural Marketing
14. Mega Food Park
15. Adivasi Mahila Sashaktikaran Yojana

1. **Pradhan Mantri MUDRA Yojana**, - Micro Units Development and Refinance Agency (MUDRA),

Description

Under the aegis support of Pradhan Mantra MUDRA Yojana, MUDRA has already created its initial products/schemes. The interventions have been named 'Shisha', 'Kishore' and 'Taren' to signify the stage of growth/development and funding needs of the beneficiary micro unit/entrepreneur and also provide a reference point for the next phase of graduation/growth to look forward to:

a. Shisha: Covering loans up to Rs. 50,000/-
b. Kishor: Covering loans above Rs. 50,000/- and up to Rs.5 lakh
c. Tarun: Covering loans above Rs. 5 lakh to Rs.10 lakh

Who can apply?

Any Indian citizen who has a business plan for a non-farm sector income generating activity such as manufacturing, processing, trading or service sector and whose credit need is less than Rs.10 lakh can approach either a Bank, MFI, or NBFC for availing of MUDRA loans under Pradhan Mantri Mudra Yojana (PMMY).

2. Stand Up India

Description

The objective of the Standup India scheme is to facilitate bank loans between Rs.10 lakh and Rs.1 crore to at least one Schedule Caste (SC) or Scheduled Tribe (ST) borrower and at least one woman borrower per bank branch for setting up a Greenfield enterprise. This enterprise may be in manufacturing, services or the trading sector. In case of non-Individual enterprises at least 51% of the shareholding and controlling stake should be held be either an SC/ST or Woman Entrepreneur.

Who can apply?

ST, SC &Women

3. Prime Minister Employment Generation Programme (PMEGP)

Description

The Scheme is implemented by Khadi and Village Industries Commission (KVIC), as the nodal agency at the National level. At the State level, the Scheme is implemented through State KVIC Directorates, State Khadi and Village Industries Boards (KVIBs) and District Industries Centres (DICs) and banks. The Government subsidy under the Scheme is routed by KVIC through identified banks for eventual distribution to the beneficiaries/entrepreneurs in their bank accounts.

Nature of assistance

The maximum cost of the project/unit admissible under manufacturing sector is Rs.25 lakh and under business/service sector is Rs.10 lakh. Levels of funding under PMEGP

Categories of beneficiaries under PMEGP	Beneficiary's contribution (of project cost)	Rate of Subsidy (of project cost)
Area (location of project/unit)		Urban Rural
General Category	10%	15% 25%
Special (including SC / ST / OBC / Minorities / Women, Ex-servicemen, Physically handicapped, NER, Hill and Border areas, etc.	05%	25% 35%

The balance amount of the total project cost will be provided by Banks as term loan as well as working capital.

Who can apply?

Any individual, above 18 years of age. At least VIII standard pass for projects costing above Rs.10 lakh in the manufacturing sector and above Rs.5 lakh in the business/service sector. Only new projects are considered for sanction under PMEGP. Self Help Groups (including those belonging to BPL provided that they have not availed benefits under any other Scheme), Institutions registered under Societies Registration Act,1860; Production Co-operative Societies, and Charitable Trusts are also eligible. Existing Units (under PMRY, REGP or any other scheme of Government of India or State Government) and the units that have already availed Government Subsidy under any other scheme of Government of India or State Government are NOT eligible.

4. International Cooperation

Description

The Scheme would cover the following activities:

a. Deputation of MSME business delegations to other countries for exploring new areas of technology infusion/upgradation, facilitating joint ventures, improving market of MSMEs products, foreign collaborations, etc.
b. Participation by Indian MSMEs in international exhibitions, trade fairs and buyer-seller meets in foreign countries as well as in India, in which there is international participation.
c. Holding international conferences and seminars on topics and themes of interest to the MSME.

Nature of assistance

IC Scheme provides financial assistance towards the airfare and space rent of entrepreneurs. Assistance is provided on the basis of size and the type of the enterprise.

Who can apply?

a. State/Central Government Organisations;
b. Industry/Enterprise Associations; and

c. Registered Societies/Trusts and Organisations associated with the promotion and development of MSMEs

5. Performance and Credit Rating for Micro and Small Enterprises

Description

The objective of the Scheme is to create awareness amongst micro & small enterprises about the strengths and weaknesses of their operations and also their credit worthiness.

Turn Over	Fee to be reimbursed by Ministry of MSME
Up to Rs.50 lacs	75% of the fee charged by the rating agency subject to a ceiling Rs. 15,000/-
Above Rs.50 lacs to Rs.200 Lacs	75% of the fee charged by the rating agency subject to a ceiling of Rs.30,0001-
Above Rs.200 lacs	75% of the fee charged by the rating agency subject

Nature of assistance

Who can apply?

Any enterprise registered in India as a micro or small enterprise is eligible to apply.

6. Marketing Assistance Scheme

Description

The assistance is provided for the following activities:

a. Organizing exhibitions abroad and participation in international exhibitions/trade fairs
b. Co-sponsoring of exhibitions organized by other organisations/industry associations/agencies
c. Organizing buyer-seller meets, intensive campaigns and marketing promotion events

Nature of assistance

Financial assistance of up to 95% of the airfare and space rent of entrepreneurs. Assistance is provided on the basis of size and the type of the enterprise. Financial assistance for co-sponsoring would be limited to 40% of the net expenditure, subject to maximum amount of Rs.5 lakh.

Who can apply?

MSMEs, Industry Associations and other organizations related to MSME sector.

7. Reimbursement of Registration Fee for Bar Coding

Description

The financial assistance is provided towards 75% reimbursement of only one-time registration fee and 75% of annual recurring fee for first three years paid by MSEs to GS1 India for using bar coding.

Nature of assistance

Funding support for reimbursement of 75% of one time and recurring bar code registration fees.

Who can apply?

All MSMEs with EM registration.

8. Enabling Participation of MSMEs in State/District Level Trade Fairs and Provide Funding Support

Description

Provide marketing platform to manufacturing MSMEs by enabling their participation in state/district level exhibitions being organized by state/district authorities/associations.

Nature of assistance

1. Free registration for participating in trade fairs
Note: *The selection of participants would be done by the MSME-DIs post the submission of application.*

2. Reimbursement of 50% of to and fro actual fare by shortest distance/direct train (limited to AC II tier class) from the nearest railway station/bus fare to the place of exhibition and 50% space rental charges for MSMEs (General category entrepreneurs).

3. For Women/SC/ST entrepreneurs & entrepreneurs from North Eastern Region Govt. of India will reimburse 80% of items listed above in Point (2).

Note: The total reimbursement will be max. Rs. 30,000/- per unit for the SC/ST/Women/Physically Handicapped entrepreneurs, while for the other units the max. limit will be Rs. 20,000/- per person per MSME unit.

Note: *The participant is required to submit follow-up proofs post attending the event to claim reimbursement. The proofs can be submitted after logging in online under the section "My Applications" or directly contacting a DI office.*

Who can apply?

All MSMEs with EM registration.

9. Capital Subsidy Support on Credit for Technology Upgradation

Description

MSMEs can get a capital subsidy (~15%) on credit availed for technology upgradation.

Nature of assistance

Financial assistance for availing credit and loan.

Who can apply?

1. Banks and financial institutions can apply to DC-MSME for availing support.
2. MSMEs need to directly contact the respective banks for getting credit and capital subsidy.

How to apply?

If you are a financial institution, click on the "Apply Now" button or else you can also directly contact the Office of DC-MSME. You can view the contact details of Office of DC-MSME. If you are an MSME, directly contact the respective banks/financial institutions as listed in the scheme guidelines.

10. Provision of Collateral Free Credit for MSMEs

Description

Banks and financial institutions are provided funding assistance under this scheme so that they can in turn lend collateral free credit to MSMEs.

Nature of assistance

Funding support to banks and financial institutions for lending collateral-free credit to MSMEs.

Who can apply?

Banks and financial institutions can apply to office of DC-MSME/MSME-DIs for availing support. MSMEs need to directly contact the respective banks for getting credit.

11. Reimbursement of certification fees for acquiring ISO standards

ISO 9000/ISO 14001 Certification Reimbursement.

Description

The GoI assistance will be provided for one-time reimbursement of expenditure to such MSME manufacturing units which acquire ISO 18000/ISO 22000/ISO 27000 certification.

Nature of assistance

Reimbursement of expenditure incurred on acquiring ISO standards.

Who can apply?

MSMEs with EM registration.

12. Agricultural Marketing

Description

A capital investment subsidy for construction/renovation of rural godowns . Creation of scientific storage capacity and prevention of distress sale.

Nature of assistance

Subsidy @ 25% to farmers, 15% of project cost to companies.

Who can apply?

NGOs, SHGs, companies, co-operatives.

13. Small Agricultural Marketing

Description

Business development description provides venture capital assistance in the form of equity, and arranges training and visits of agri-preneurs

Farmers' Agriculture Business Consortium

Business development description provides venture capital assistance in the form of equity, and arranges training and visits of agri-preneurs.

Nature of assistance

Financial assistance with a ceiling of Rs.5 lakh.

Who can apply?

Individuals, farmers, producer groups, partnership/propriety firms, SGHs, agri-preneurs, etc.

14. Mega Food Park

Description

Mechanism to link agricultural production and market to maximize value addition, enhance farmer's income, create rural employment.

Nature of assistance

One-time capital grant of 50% of project cost with a limit of Rs.50 crore.

Who can apply?

Farmers, farmer groups, SHGs.

15. Adivasi Mahila Sashaktikaran Yojana

Description

Concessional scheme for the economic development of ST women.

Nature of assistance

Term loan at concessional rates up to 90% of cost of scheme.

Who can apply?

Scheduled Tribes Women.

- Research the existing market, network with other entrepreneurs, venture capitalists, angel investors, and thoroughly review the policies in place to enable your entrepreneurship.
- Failure is a stepping stone and not the end of the road. Review yours and your peers' errors and correct them in your future venture.
- Be proactive in your ecosystem. Identify the key features of your ecosystem and enrich them to ensure self-sustainability of your entrepreneurship support ecosystem.

5.5.7 Risk Appetite & Resilience: Entrepreneurship and Risk

Entrepreneurs are inherently risk takers. They are path-makers not path-takers. Unlike a normal, cautious person, an entrepreneur would not think twice about quitting his job (his sole income) and taking a risk on himself and his idea.

An entrepreneur is aware that while pursuing his dreams, assumptions can be proven wrong and unforeseen events may arise. He knows that after dealing with numerous problems, success is still not guaranteed. Entrepreneurship is synonymous with the ability to take risks. This ability, called risk-appetite, is an entrepreneurial trait that is partly genetic and partly acquired.

What is Risk Appetite?

Risk appetite is defined as the extent to which a company is equipped to take risk, in order to achieve its objectives. Essentially, it refers to the balance, struck by the company, between possible profits and the hazards caused by changes in the environment (economic ecosystem, policies, etc.). Taking on more risk may lead to higher rewards but have a high probability of losses as well. However, being too conservative may go against the company as it can miss out on good opportunities to grow and reach their objectives. The levels of risk appetite can be broadly categorized as “low”, “medium” and “high.” The company’s entrepreneur(s) have to evaluate all potential alternatives and select the option most likely to succeed. Companies have varying levels of risk appetites for different objectives.

The levels depend on:

- The type of industry
- Market pressures
- Company objectives

For example, a start-up with a revolutionary concept will have a very high risk appetite. The start-up can afford short term failures before it achieves longer term success. This type of appetite will not remain constant and will be adjusted to account for the present circumstances of the company.

Risk Appetite Statement

Companies have to define and articulate their risk appetite in sync with decisions made about their objectives and opportunities. The point of having a risk appetite statement is to have a framework that clearly states the acceptance and management of risk in business. It sets risk taking limits within the company. The risk appetite statement should convey the following:

- The nature of risks the business faces.
- Which risks the company is comfortable taking on and which risks are unacceptable.
- The nature of risks the business faces.
- Which risks the company is comfortable taking on and which risks are unacceptable.
- How much risk to accept in all the risk categories.
- The desired trade-off between risk and reward.
- Measures of risk and methods of examining and regulating risk exposures.

Entrepreneurship and Resilience

Entrepreneurs are characterized by a set of qualities known as resilience. These qualities play an especially large role in the early stages of developing an enterprise. Risk resilience is an extremely valuable characteristic as it is believed to protect entrepreneurs against the threat of challenges and changes in the business environment.

What is Entrepreneurial Resilience?

Resilience is used to describe individuals who have the ability to overcome setbacks related to their life and career aspirations. A resilient person is someone who is capable of easily and quickly recovering from setbacks. For the entrepreneur, resilience is a critical trait.

Entrepreneurial resilience can be enhanced in the following ways:

- By developing a professional network of coaches and mentors
- By accepting that change is a part of life
- By viewing obstacles as something that can be overcome

Characteristics of a Resilient Entrepreneur

The characteristics required to make an entrepreneur resilient enough to go the whole way in their business enterprise are:

- A strong internal sense of control
- Ability to diversify and expand
- Strong social connections
- Survivor attitude
- Skill to learn from setbacks
- Cash-flow conscious habits
- Ability to look at the bigger picture
- Attention to detail

- Cultivate a great network of clients, suppliers, peers, friends and family. This will not only help you promote your business, but will also help you learn, identify new opportunities and stay tuned to changes in the market.
- Don’t dwell on setbacks. Focus on what the you need to do next to get moving again.
- While you should try, and curtail expenses, ensure that it is not at the cost of your growth.

5.5.8 Success & Failures: Understanding Successes and Failures in Entrepreneurship

Shyam is a famous entrepreneur, known for his success story. But what most people don't know, is that Shyam failed numerous times before his enterprise became a success. Read his interview to get an idea of what entrepreneurship is really about, straight from an entrepreneur who has both, failed and succeeded.

Interviewer: Shyam, I have heard that entrepreneurs are great risk-takers who are never afraid of failing. Is this true?

Shyam: Ha ha, no of course it's not true! Most people believe that entrepreneurs need to be fearlessly enthusiastic. But the truth is, fear is a very normal and valid human reaction, especially when you are planning to start your own business! In fact, my biggest fear was the fear of failing. The reality is, entrepreneurs fail as much as they succeed. The trick is to not allow the fear of failing to stop you from going ahead with your plans. Remember, failures are lessons for future success!

Interviewer: What, according to you, is the reason that entrepreneurs fail?

Shyam: Well, there is no one single reason why entrepreneurs fail. An entrepreneur can fail due to numerous reasons. You could fail because you have allowed your fear of failure to defeat you. You could fail because you are unwilling to delegate (distribute) work. As the saying goes, "You can do anything, but not everything!" You could fail because you gave up too easily – maybe you were not persistent enough. You could fail because you were focusing your energy on small, insignificant tasks and ignoring the tasks that were most important. Other reasons for failing are partnering with the wrong people, not being able to sell your product to the right customers at the right time at the right price… and many more reasons!

Interviewer: As an entrepreneur, how do you feel failure should be looked at?

Shyam: I believe we should all look at failure as an asset, rather than as something negative. The way I see it, if you have an idea, you should try to make it work, even if there is a chance that you will fail. That's because not trying is failure right there, anyway! And failure is not the worst thing that can happen. I think having regrets because of not trying, and wondering 'what if' is far worse than trying and actually failing.

Interviewer: How did you feel when you failed for the first time?

Shyam: I was completely heartbroken! It was a very painful experience. But the good news is, you do recover from the failure. And with every subsequent failure, the recovery process gets a lot easier. That's because you start to see each failure more as a lesson that will eventually help you succeed, rather than as an obstacle that you cannot overcome. You will start to realize that failure has many benefits.

Interviewer: Can you tell us about some of the benefits of failing?

Shyam: One of the benefits that I have experienced personally from failing is that the failure made me see things in a new light. It gave me answers that I didn't have before. Failure can make you a lot stronger. It also helps keep your ego in control.

Interviewer: What advice would you give entrepreneurs who are about to start their own enterprises?

Shyam: I would tell them to do their research and ensure that their product is something that is actually wanted by customers. I'd tell them to pick their partners and employees very wisely and cautiously. I'd tell them that it's very important to be aggressive – push and market your product as aggressively as possible. I would warn them that starting an enterprise is very expensive and that they should be prepared for a situation where they run out of money. I would tell them to create long term goals and put a plan in action to achieve that goal. I would tell them to build a product that is truly unique. Be very careful and ensure that you are not copying another start-up. Lastly, I'd tell them that it's very important that they find the right investors.

Interviewer: That's some really helpful advice, Shyam! I'm sure this will help all entrepreneurs to be more prepared before they begin their journey! Thank you for all your insight!

- Remember that nothing is impossible.
- Identify your mission and your purpose before you start.
- Plan your next steps – don't make decisions hastily.

UNIT 5.6: Preparing to be an Entrepreneur

Unit Objectives

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

1. Discuss how market research is carried out
2. Describe the 4 Ps of marketing
3. Discuss the importance of idea generation
4. Recall basic business terminology
5. Discuss the need for CRM
6. Discuss the benefits of CRM
7. Discuss the need for networking
8. Discuss the benefits of networking
9. Discuss the importance of setting goals
10. Differentiate between short-term, medium-term and long-term goals
11. Discuss how to write a business plan
12. Explain the financial planning process
13. Discuss ways to manage your risk
14. Describe the procedure and formalities for applying for bank finance
15. Discuss how to manage your own enterprise
16. List important questions that every entrepreneur should ask before starting an enterprise

5.6.1 Market Study / The 4 Ps of Marketing / Importance of an IDEA: Understanding Market Research

Market research is the process of gathering, analysing and interpreting market information on a product or service that is being sold in that market. It also includes information on:

- Past, present and prospective customers
- Customer characteristics and spending habits
- The location and needs of the target market
- The overall industry
- Relevant competitors

Market research involves two types of data:

- Primary information. This is research collected by yourself or by someone hired by you.
- Secondary information. This is research that already exists and is out there for you to find and use.

Primary research

Primary research can be of two types:

- Exploratory: This is open-ended and usually involves detailed, unstructured interviews.
- Specific: This is precise and involves structured, formal interviews. Conducting specific

Secondary research

Secondary research uses outside information. Some common secondary sources are:

- **Public sources:** These are usually free and have a lot of good information. Examples are government departments, business departments of public libraries etc.
- **Commercial sources:** These offer valuable information but usually require a fee to be paid. Examples are research and trade associations, banks and other financial institutions etc.
- **Educational institutions:** These offer a wealth of information. Examples are colleges, universities, technical institutes etc.

The 4 Ps of Marketing

The 4 Ps of marketing are Product, Price, Promotion and Place. Let's look at each of these 4 Ps in detail.

Product

A product can be:

- A tangible good
- An intangible service

Whatever your product is, it is critical that you have a clear understanding of what you are offering, and what its unique characteristics are, before you begin with the marketing process.

Some questions to ask yourself are:

- What does the customer want from the product/service?
- What needs does it satisfy?
- Are there any more features that can be added?
- Does it have any expensive and unnecessary features?
- How will customers use it?
- What should it be called?
- How is it different from similar products?
- How much will it cost to produce?

Price

Once all the elements of Product have been established, the Price factor needs to be considered. The Price of a Product will depend on several factors such as profit margins, supply, demand and the marketing strategy.

Some questions to ask yourself are:

• What is the value of the product/service to customers?	• Is the customer price sensitive?
• Do local products/services have established price points?	• Should discounts be offered?
	• How is your price compared to that of your competitors?

Promotion

Once you are certain about your Product and your Price, the next step is to look at ways to promote it. Some key elements of promotion are advertising, public relations, social media marketing, email marketing, search engine marketing, video marketing and more.
Some questions to ask yourself are:

- Where should you promote your product or service?
- What is the best medium to use to reach your target audience
- When would be the best time to promote your product?
- How are your competitors promoting their products?

Place

According to most marketers, the basis of marketing is about offering the right product, at the right price, at the right place, at the right time. For this reason, selecting the best possible location is critical for converting prospective clients into actual clients.

Some questions to ask yourself are:

- Will your product or service be looked for in a physical store, online or both?
- What should you do to access the most appropriate distribution channels?
- Will you require a sales force?
- Where are your competitors offering their products or services?
- Should you follow in your competitors' footsteps?
- Should you do something different from your competitors?

Importance of an IDEA

Some questions to ask yourself are:
Ideas are the foundation of progress. An idea can be small or ground-breaking, easy to accomplish or extremely complicated to implement. Whatever the case, the fact that it is an idea gives it merit. Without ideas, nothing is possible. Most people are afraid to speak out their ideas, out for fear of being ridiculed. However, if are an entrepreneur and want to remain competitive and innovative, you need to bring your ideas out into the light.
Some ways to do this are by:

- Establishing a culture of brainstorming where you invite all interested parties to contribute
- Discussing ideas out loud so that people can add their ideas, views, opinions to them
- Being open minded and not limiting your ideas, even if the idea who have seems ridiculous
- Not discarding ideas that you don't work on immediately, but instead making a note of them and shelving them so they can be revisited at a later date.

- Keep in mind that good ideas do not always have to be unique.
- Remember that timing plays a huge role in determining the success of your idea.
- Situations and circumstances will always change, so be flexible and adapt your idea accordingly.

5.6.2 Business Entity Concepts: Basic Business Terminology

If your aim is to start and run a business, it is crucial that you have a good understanding of basic business terms. Every entrepreneur should be well versed in the following terms:

- Accounting: A systematic method of recording and reporting financial transactions.
- Accounts payable: Money owed by a company to its creditors.
- Accounts Receivable: The amount a company is owed by its clients.
- Assets: The value of everything a company owns and uses to conduct its business.
- Balance Sheet: A snapshot of a company's assets, liabilities and owner's equity at a given moment.
- Bottom Line: The total amount a business has earned or lost at the end of a month.
- Business: An organization that operates with the aim of making a profit.
- Business to Business (B2B): A business that sells goods or services to another business.
- Business to Consumer (B2C): A business that sells goods or services directly to the end user.
- Capital: The money a business has in its accounts, assets and investments. The two main types of capital are debt and equity.
- Cash Flow: The overall movement of funds through a business each month, including income and expenses.
- Cash Flow Statement: A statement showing the money that entered and exited a business during a specific period of time.
- Contract: A formal agreement to do work for pay.
- Depreciation: The degrading value of an asset over time.
- Expense: The costs that a business incurs through its operations.
- Finance: The management and allocation of money and other assets.
- Financial Report: A comprehensive account of a business' transactions and expenses.
- Fixed Cost: A one-time expense.
- Income Statement (Profit and Loss Statement): Shows the profitability of a business during a period of time.
- Liabilities: The value of what a business owes to someone else.
- Marketing: The process of promoting, selling and distributing a product or service.
- Net Income/Profit: Revenues minus expenses.
- Net Worth: The total value of a business.
- Payback Period: The amount of time it takes to recover the initial investment of a business.
- Profit Margin: The ratio of profit, divided by revenue, displayed as a percentage.

- Return on Investment (ROI): The amount of money a business gets as return from an investment.
- Revenue: The total amount of income before expenses are subtracted.
- Sales Prospect: A potential customer.
- Supplier: A provider of supplies to a business.
- Target Market: A specific group of customers at which a company's products and services are aimed.
- Valuation: An estimate of the overall worth of the business.
- Variable Cost: Expenses that change in proportion to the activity of a business.
- Working Capital: Calculated as current assets minus current liabilities.
- Business Transactions: There are three types of business transactions. These are:
  - Simple Transactions – Usually a single transaction between a vendor and a customer. For example: Buying a cup of coffee.
  - Complex Transactions – These transactions go through a number of events before they can be completed. For example: Buying a house.
  - Ongoing transactions – These transactions usually require a contract. For example: Contract with a vendor.

Basic Accounting Formulas

Take a look at some important accounting formula that every entrepreneur needs to know.

1. **The Accounting Equation**: This is value of everything a company owns and uses to conduct its business.

Formula: Assets = Liability + Owner's Equity

2. **Net Income**: This is the profit of the company.

Formula: Net Income = Revenues – Expenses

3. **Break-Even Point**: This is the point at which the company will not make a profit or a loss. The total cost and total revenues are equal.

Formula: Break-Even = Fixed Costs/Sales Price – Variable Cost per Unit

4. **Cash Ratio**: This tells us about the liquidity of a company.

Formula: Cash Ratio = Cash/Current Liabilities

5. **Profit Margin:** This is shown as a percentage. It shows what percentage of sales are left over after all the expenses are paid by the business.

Formula: Profit Margin = Net Income/Sales

6. **Debt-to-Equity Ratio:** This ratio shows how much equity and debt a company is using to finance its assets, and whether the shareholder equity can fulfil obligations to creditors if the business starts making a loss.

Formula: Debt-to-Equity Ratio = Total Liabilities/Total Equity

7. **Cost of Goods Sold**: This is the total of all costs used to create a product or service, which has been sold.

Formula: Cost of Goods Sold = Cost of Materials/Inventory – Cost of Outputs

8. **Return on Investment (ROI)**: This is usually shown as a percentage. It calculates the profits of an investment as a percentage of the original cost.

Formula: ROI = Net Profit/Total Investment * 100

9. **Simple Interest**: This is money you can earn by initially investing some money (the principal).

Formula:
A = P(1 + rt); R = r * 100
Where:
A = Total Accrued Amount (principal + interest)
P = Principal Amount
I = Interest Amount
r = Rate of Interest per year in decimal; r = R/100
t = Time Period involved in months or years

10. **Annual Compound Interest**: The calculates the addition of interest to the principal sum of a loan or deposit.

Formula:
A = P (1 + r/n) ^ nt:
Where:
A = the future value of the investment/loan, including interest
P = the principal investment amount (the initial deposit or loan amount)
r = the annual interest rate (decimal)
n = the number of times that interest is compounded per year
t = the number of years the money is invested or borrowed for

5.6.3 CRM & Networking: What is CRM?

CRM stands for Customer Relationship Management. Originally the expression Customer Relationship Management meant managing one's relationship with customers. However, today it refers to IT systems and software designed to help companies manage their relationships.

The Need for CRM

The better a company can manage its relationships with its customers, the higher the chances of the company's success. For any entrepreneur, the ability to successfully retain existing customers and expand the enterprise is paramount. This is why IT systems that focus on addressing the problems of dealing with customers on a daily basis are becoming more and more in demand.

Customer needs change over time, and technology can make it easier to understand what customers really want. This insight helps companies to be more responsive to the needs of their customers. It enables them to modify their business operations when required, so that their customers are always served in the best manner possible. Simply put, CRM helps companies recognize the value of their clients and enables them to capitalize on improved customer relations.

Benefits of CRM

CRM has a number of important benefits:

- It helps improve relations with existing customers which can lead to:
  - Increased sales

- Identification of customer needs
- Cross-selling of products

- It results in better marketing of one's products or services
- It results in better marketing of one's products or services
- It enhances customer satisfaction and retention
- It improves profitability by identifying and focusing on the most profitable customers

What is Networking?

In business, networking means leveraging your business and personal connections in order to bring in a regular supply of new business. This marketing method is effective as well as low cost. It is a great way to develop sales opportunities and contacts. Networking can be based on referrals and introductions, or can take place via phone, email, and social and business networking websites.

The Need for Networking

Networking is an essential personal skill for business people, but it is even more important for entrepreneurs. The process of networking has its roots in relationship building. Networking results in greater communication and a stronger presence in the entrepreneurial ecosystem. This helps build strong relationships with other entrepreneurs. Business networking events held across the globe play a huge role in connecting like-minded entrepreneurs who share the same fundamental beliefs in communication, exchanging ideas and converting ideas into realities. Such networking events also play a crucial role in connecting entrepreneurs with potential investors. Entrepreneurs may have vastly different experiences and backgrounds but they all have a common goal in mind – they all seek connection, inspiration, advice, opportunities and mentors. Networking offers them a platform to do just that.

Benefits of Networking

Networking offers numerous benefits for entrepreneurs. Some of the major benefits are:

- Getting high quality leads
- Increased business opportunities
- Good source of relevant connections
- Advice from like-minded entrepreneurs
- Gaining visibility and raising your profile
- Meeting positive and enthusiastic people
- Increased self-confidence
- Satisfaction from helping others
- Building strong and lasting friendships

- Use social media interactions to identify needs and gather feedback.
- When networking, ask open-ended questions rather than yes/no type questions.

5.6.4 Business Plan: Why Set Goals?

Setting goals is important because it gives you long-term vision and short-term motivation. Goals can be short term, medium term and long term.

Short-Term Goals

- These are specific goals for the immediate future.

Example: Repairing a machine that has failed.

Medium-Term Goals

- These goals are built on your short-term goals.
- They do not need to be as specific as your short-term goals.

Example: Arranging for a service contract to ensure that your machines don't fail again.

Long-Term Goals

These goals require time and planning.
They usually take a year or more to achieve.

Example: Planning your expenses so you can buy new machinery

Why Create a Business Plan?

A business plan is a tool for understanding how your business is put together. It can be used to monitor progress, foster accountable and control the fate of the business. It usually offers a 3-5year projection and outlines the plan that the company intends to follow to grow its revenues. A business plan is also a very important tool for getting the interest of key employees or future investors.
A business plan typically comprises of eight elements.

Executive Summary

The executive summary follows the title page. The summary should clearly state your desires as the business owner in a short and business like way. It is an overview of your business and your plans. Ideally this should not be more than 1-2 pages.
Your Executive Summary should include:

- The Mission Statement: Explain what your business is all about.

Example: Nike's Mission Statement

Nike's mission statement is "To bring inspiration and innovation to every athlete in the world."

- Company Information: Provide information like when your business was formed, the names and roles of the founders, the number of employees, your business location(s) etc.
- Growth Highlights: Mention examples of company growth. Use graphs and charts where possible.
- Your Products/Services: Describe the products or services provided.
- Financial Information: Provide details on current bank and investors.
- Summarize future plans: Describe where you see your business in the future.

Business Description

The second section of your business plan needs to provide a detailed review of the different elements of your business. This will help potential investors to correctly understand your business goal and the uniqueness of your offering.
Your Business Description should include:

- A description of the nature of your business
- The market needs that you are aiming to satisfy
- The ways in which your products and services meet these needs
- The specific consumers and organizations that you intend to serve
- Your specific competitive advantages

Market Analysis

The market analysis section usually follows the business description. The aim of this section is to showcase your industry and market knowledge. This is also the section where you should lay down your research findings and conclusions.

Your Market Analysis should include:

- Your industry description and outlook
- Information on your target market
- The needs and demographics of your target audience
- The size of your target market
- The amount of market share you want to capture
- Your pricing structure
- Your competitive analysis
- Any regulatory requirements

Organization & Management

This section should come immediately after the Market Analysis.
Your Organization & Management section should include:

- Your company's organizational structure
- Details of your company's ownership
- Details of your management team
- Qualifications of your board of directors
- Detailed descriptions of each division/department and its function
- The salary and benefits package that you offer your people

Service or Product Line

The next section is the service or product line section. This is where you describe your service or product, and stress on their benefits to potential and current customers. Explain in detail why your product of choice will fulfil the needs of your target audience.
Your Service or Product Line section should include:

- A description of your product/service
- A description of your product or service's life cycle
- A list of any copyright or patent filings
- A description of any R&D activities that you are involved in or planning

Marketing & Sales

Once the Service or Product Line section of your plan has been completed, you should start on the description of the marketing and sales management strategy for your business.

Your Marketing section should include the following strategies:

- **Market penetration strategy:** This strategy focuses on selling your existing products or services in existing markets, in order to increase your market share.
- **Growth strategy:** This strategy focuses on increasing the amount of market share, even if it reduces earnings in the short-term.
- **Channels of distribution strategy:** These can be wholesalers, retailers, distributers and even the internet.
- **Communication strategy:** These can be written strategies (e-mail, text, chat), oral strategies (phone calls, video chats, face-to-face conversations), non-verbal strategies (body language, facial expressions, tone of voice) and visual strategies (signs, webpages, illustrations).

Your Sales section should include the following information:

- **A salesforce strategy:** This strategy focuses on increasing the revenue of the enterprise.
- **A breakdown of your sales activities:** This means detailing out how you intend to sell your products or services – will you sell it offline or online, how many units do you intend to sell, what price do you plan to sell each unit at, etc.

Funding Request

This section is specifically for those who require funding for their venture.

The Funding Request section should include the following information:

- How much funding you currently require.
- How much funding you will require over the next five years. This will depend on your long-term goals.
- The type of funding you want and how you plan to use it. Do you want funding that can be used only for a specific purpose, or funding that can be used for any kind of requirement?
- Strategic plans for the future. This will involve detailing out your long-term plans – what these plans are and how much money you will require to put these plans in motions.
- Historical and prospective financial information. This can be done by creating and maintaining all your financial records, right from the moment your enterprise started, to the present day. Documents required for this are your balance sheet which contains details of your company's assets and liabilities, your income statement which lists your company's revenues, expenses and net income for the year, your tax returns (usually for the last three years) and your cash flow budget which lists the cash that came in, the cash that went out and states whether you had a cash deficit (negative balance) or surplus (positive balance) at the end of each month.

Financial Planning 

Before you begin building your enterprise, you need to plan your finances. Take a look at the steps for financial planning:

Step 1: Create a financial plan. This should include your goals, strategies and timelines for accomplishing these goals.

Step 2: Organize all your important financial documents. Maintain a file to hold your investment details, bank statements, tax papers, credit card bills, insurance papers and any other financial records.

Step 3: Calculate your net worth. This means figure out what you own (assets like your house, bank accounts, investments etc.), and then subtract what you owe (liabilities like loans, pending credit card amounts etc.) the amount you are left with is your net worth.

Step 4: Make a spending plan. This means write down in detail where your money will come from, and where it will go.

Step 5: Build an emergency fund. A good emergency fund contains enough money to cover at least 6 months' worth of expenses.

Step 6: Set up your insurance. Insurance provides long term financial security and protects you against risk.

Risk Management

As an entrepreneur, it is critical that you evaluate the risks involved with the type of enterprise that you want to start, before you begin setting up your company. Once you have identified potential risks, you can take steps to reduce them. Some ways to manage risks are:

- Research similar business and find out about their risks and how they were minimized.
- Evaluate current market trends and find out if similar products or services that launched a while ago are still being well received by the public.
- Think about whether you really have the required expertise to launch your product or service.
- Examine your finances and see if you have enough income to start your enterprise.
- Be aware of the current state of the economy, consider how the economy may change over time, and think about how your enterprise will be affected by any of those changes.
- Create a detailed business plan.

Ensure all the important elements are covered in your plan.

Scrutinize the numbers thoroughly.

Be concise and realistic.

Be conservative in your approach and your projections.

Use visuals like charts, graphs and images wherever possible.

5.6.5 Procedure and Formalities for Bank Finance: The Need for Bank Finance

For entrepreneurs, one of the most difficult challenges faced involves securing funds for start-ups. With numerous funding options available, entrepreneurs need to take a close look at which funding methodology works best for them. In India, banks are one of the largest funders of start-ups, offering funding to thousands of start-ups every year.

What Information Should Entrepreneurs Offer Banks for Funding?

When approaching a bank, entrepreneurs must have a clear idea of the different criteria that banks use to screen, rate and process loan applications. Entrepreneurs must also be aware of the importance of providing banks with accurate and correct information. It is now easier than ever for financial institutions to track any default behaviour of loan applicants. Entrepreneurs looking for funding from banks must provide banks with information relating to their general credentials, financial situation and guarantees or collaterals that can be offered.

General Credentials

This is where you, as an entrepreneur, provide the bank with background information on yourself. Such information includes:

- Letter(s) of Introduction: This letter should be written by a respected business person who knows you well enough to introduce you. The aim of this letter is set across your achievements and vouch for your character and integrity.
- Your Profile: This is basically your resume. You need to give the bank a good idea of your educational achievements, professional training, qualifications, employment record and achievements.
- Business Brochure: A business brochure typically provides information on company products, clients, how long the business has been running for etc.
- Bank and Other References: If you have an account with another bank, providing those bank references is a good idea.
- Proof of Company Ownership or Registration: In some cases, you may need to provide the bank with proof of company ownership and registration. A list of assets and liabilities may also be required.

Financial Situation

Banks will expect current financial information on your enterprise. The standard financial reports you should be prepared with are:

- Balance Sheet
- Cash-Flow Statement
- Business Plan
- Profit-and-Loss Account
- Projected Sales and Revenues
- Feasibility Study

Guarantees or Collaterals

Usually banks will refuse to grant you a loan without security. You can offer assets which the bank can seize and sell off if you do not repay the loan. Fixed assets like machinery, equipment, vehicles etc. are also considered to be security for loans.

The Lending Criteria of Banks

Your request for funding will have a higher chance of success if you can satisfy the following lending criteria:

- Good cash flow
- Adequate security
- Good reputation
- Adequate shareholders' funds
- Experience in business

The Procedure

To apply for funding the following procedure will need to be followed.

1. Submit your application form and all other required documents to the bank.
2. The bank will carefully assess your credit worthiness and assign ratings by analysing your business information with respect to parameters like management, financial, operational and industry information as well as past loan performance.
3. The bank will make a decision as to whether or not you should be given funding.

- Get advice on funding options from experienced bankers.
- Be cautious and avoid borrowing more than you need, for longer than you need, at an interest rate that is higher than you are comfortable with.

5.6.6 Enterprise Management - An Overview: How to Manage Your Enterprise?

To manage your enterprise effectively you need to look at many different aspects, right from managing the day-to-day activities to figuring out how to handle a large-scale event. Let's take a look at some simple steps to manage your company effectively.

Step 1: Use your leadership skills and ask for advice when required.

Let's take the example of Ramu, an entrepreneur who has recently started his own enterprise. Ramu has good leadership skills – he is honest, communicates well, knows how to delegate work etc. These leadership skills definitely help Ramu in the management of his enterprise. However, sometimes Ramu comes across situations that he is unsure how to handle. What should Ramu do in this case? One solution is for him to find a more experienced manager who is willing to mentor him. Another solution is for Ramu to use his networking skills so that he can connect with managers from other organizations, who can give him advice on how to handle such situations.

Step 2: Divide your work amongst others – realize that you cannot handle everything yourself.

Even the most skilled manager in the world will not be able to manage every single task that an enterprise will demand of him. A smart manager needs to realize that the key to managing his enterprise lies in his dividing all his work between those around him. This is known as delegation. However, delegating is not enough. A manager must delegate effectively if he wants to see results. This is important because delegating, when done incorrectly, can result in you creating even more work for yourself. To delegate effectively, you can start by making two lists. One list should contain the things that you know you need to handle yourself. The second list should contain the things that you are confident can be given to others to manage and handle. Besides incorrect delegation, another issue that may arise is over-delegation. This means giving away too many of your tasks to others. The problem with this is, the more tasks you delegate, the more time you will spend tracking and monitoring the work progress of those you have handed the tasks to. This will leave you with very little time to finish your own work.

Step 3: Hire the right people for the job.

Hiring the right people goes a long way towards effectively managing your enterprise. To hire the best people suited for the job, you need to be very careful with your interview process. You should ask potential candidates the right questions and evaluate their answers carefully. Carrying out background checks is always a good practice. Running a credit check is also a good idea, especially if the people you are planning to hire will be handling your money. Create a detailed job description for each role that you want filled and ensure that all candidates have a clear and correct understanding of the job description. You should also have an employee manual in place, where you put down every expectation that you have from your employees. All these actions will help ensure that the right people are approached for running your enterprise.

Step 4: Motivate your employees and train them well.

Your enterprise can only be managed effectively if your employees are motivated to work hard for your enterprise. Part of being motivated involves your employees believing in the vision and mission of your enterprise and genuinely wanting to make efforts towards pursuing the same. You can motivate your employees with recognition, bonuses and rewards for achievements. You can also motivate them by telling them about how their efforts have led to the company's success. This will help them feel pride and give them a sense of responsibility that will increase their motivation. Besides motivating your people, your employees should be constantly trained in new practices and technologies. Remember, training is not a one-time effort. It is a consistent effort that needs to be carried out regularly.

Step 5: Train your people to handle your customers well.

Your employees need to be well-versed in the art of customer management. This means they should be able to understand what their customers want, and also know how to satisfy their needs. For them to truly understand this, they need to see how you deal effectively with customers.

This is called leading by example. Show them how you sincerely listen to your clients and the efforts that you put into understand their requirements. Let them listen to the type of questions that you ask your clients so they understand which questions are appropriate.

Step 6: Market your enterprise effectively.

Also, hire a marketing agency if you feel you need help in this area. Now that you know what is required to run your enterprise effectively, put these steps into play, and see how much easier managing your enterprise becomes!

- Get advice on funding options from experienced bankers.
- Be cautious and avoid borrowing more than you need, for longer than you need, at an interest rate that is higher than you are comfortable with.

5.6.7 20 Questions to Ask Yourself Before Considering Entrepreneurship

1. Why am I starting a business?
2. What problem am I solving?
3. Have others attempted to solve this problem before? Did they succeed or fail?
4. Do I have a mentor or industry expert that I can call on?
5. Who is my ideal customer?
6. Who are my competitors?
7. What makes my business idea different from other business ideas?
8. What are the key features of my product or service?
9. Have I done a SWOT analysis?
10. What is the size of the market that will buy my product or service?
11. What would it take to build a minimum viable product to test the market?
12. How much money do I need to get started?
13. Will I need to get a loan?
14. How soon will my products or services be available?
15. When will I break even or make a profit?
16. How will those who invest in my idea make a profit?
17. How should I set up the legal structure of my business?
18. What taxes will I need to pay?
19. What kind of insurance will I need?
20. Have I reached out to potential customers for feedback?

- It is very important to validate your business ideas before you invest significant time, money and resources into it.
- The more questions you ask yourself, the more prepared you will be to handle to highs and lows of starting an enterprise.

Footnotes:

1. A mentor is a trusted and experienced person who is willing to coach and guide you.
2. A customer is someone who buys goods and/or services.
3. A competitor is a person or company that sells products and/or services similar to your products and/or services.
4. SWOT stands for Strengths, Weaknesses, Opportunities and Threats. To conduct a SWOT analysis of your company, you need to list down all the strengths and weaknesses of your company, the opportunities that are present for your company and the threats faced by your company.
5. A minimum viable product is a product that has the fewest possible features, that can be sold to customers, for the purpose of getting feedback from customers on the product.
6. A company is said to break even when the profits of the company are equal to the costs.
7. The legal structure could be a sole proprietorship, partnership or limited liability partnership.
8. There are two types of taxes – direct taxes payable by a person or a company, or indirect taxes charged on goods and/or services.
9. There are two types of insurance – life insurance and general insurance. Life insurance overs human.

- life while general insurance covers assets like animals, goods, cars etc

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