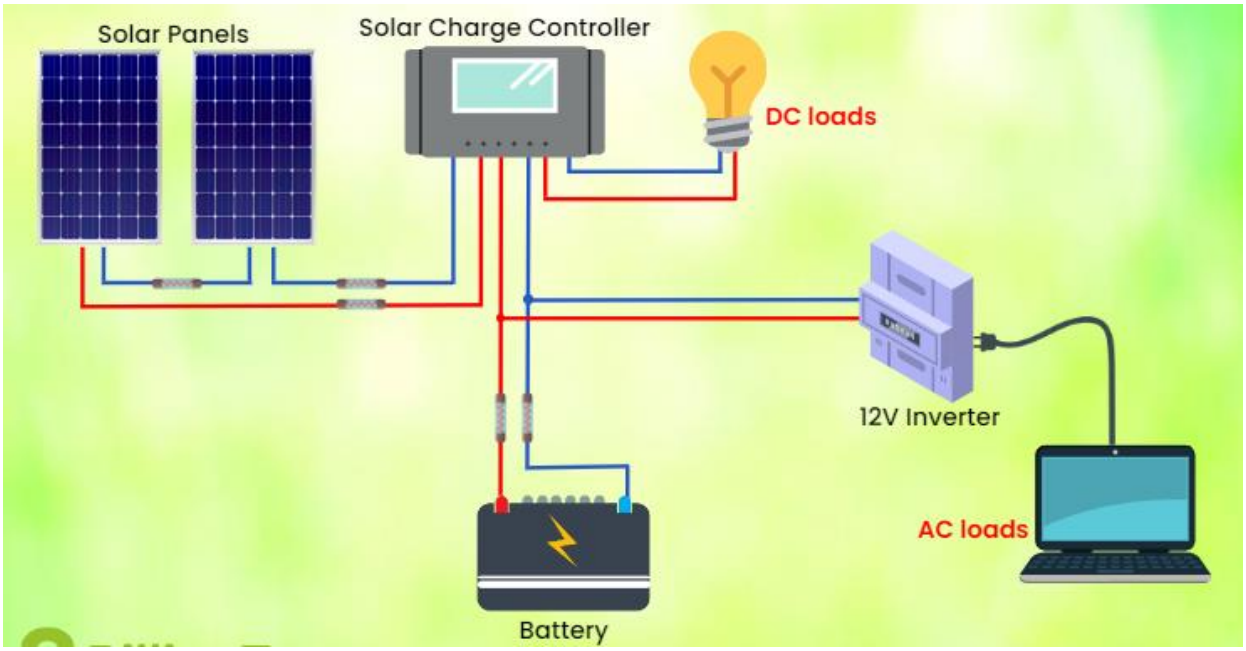
19MEZ402 Solar Photovoltaics Fundamentals And Technology

UNIT 2-STAND ALONE PV SYSTEMS

Connecting PV modules to both a battery and a load

Connecting PV modules to both a battery and a load in a solar energy system is a standard approach to ensure that power is available even when the PV modules are not generating electricity (e.g., at night or during cloudy periods). Here's a detailed look at how this system works and what needs to be considered



1. System Components:

- **PV Modules:** Generate DC electricity from sunlight.
- **Battery:** Stores excess energy generated by the PV modules for use when solar energy is insufficient.
- **Charge Controller:** Regulates the charging of the battery and ensures it is not overcharged or excessively discharged.
- **Inverter (optional for AC loads):** Converts the DC electricity from the battery or PV modules to AC if the load requires it.

- **Load:** The device or system that consumes the electricity, which can be either DC or AC.

2. Basic Connection Setup:

The typical connection of PV modules to a battery and load involves several key steps:

A. PV Modules to Charge Controller:

- The PV modules are connected to a charge controller, which manages the power flow to the battery. The charge controller ensures that the battery is charged at the correct voltage and current and prevents overcharging.

B. Battery to Load:

- The load can be connected directly to the battery, with the charge controller managing the distribution of power. The charge controller allows the load to draw power from the battery when the PV modules are not producing enough electricity.

C. Inverter for AC Loads (if necessary):

- If the load requires AC power, an inverter is added between the battery and the load. The inverter converts the DC power from the battery to AC power suitable for the load.

3. System Operation:

Daytime (High Solar Input):

- **Direct Load Supply:** During periods of strong sunlight, the PV modules generate electricity, which can be used directly to power the load.
- **Battery Charging:** Any excess power generated by the PV modules is stored in the battery for later use.

Nighttime or Cloudy Conditions (Low Solar Input):

- **Load Supplied by Battery:** When the PV modules generate little or no power, the battery supplies power to the load, ensuring continuous operation.
- **Automatic Switching:** The charge controller automatically switches the load to battery power when solar input is insufficient.

4. Types of Charge Controllers:

- **PWM (Pulse Width Modulation) Charge Controllers:**
  - **Simple and Cost-Effective:** They regulate the voltage by reducing it to the battery's level, which can lead to energy loss.
  - **Best for Smaller Systems:** Suitable for small, cost-sensitive systems where efficiency is less critical.
- **MPPT (Maximum Power Point Tracking) Charge Controllers:**
  - **Higher Efficiency:** MPPT controllers optimize the power output from the PV modules by adjusting the electrical operating point, leading to greater energy harvest.
  - **Ideal for Larger Systems:** Recommended for larger, more complex systems where maximizing efficiency is important.

5. Key Considerations:

- **Battery Sizing:** The battery should be sized to store enough energy to power the load during periods of low solar generation.
- **Load Demand:** Ensure that the load does not exceed the capacity of the battery and the PV system.
- **Energy Management:** Implementing energy management strategies, such as load prioritization or load-shedding, can help in managing power supply effectively.

6. Applications:

- **Off-Grid Solar Systems:** Ideal for remote areas where grid power is unavailable.
- **Hybrid Solar Systems:** Often used in conjunction with other power sources (e.g., generators) to ensure continuous power supply.
- **Residential Solar Power Systems:** Used in homes to provide backup power and reduce reliance on the grid.

This configuration allows for a reliable and continuous power supply, taking advantage of solar energy during the day while storing excess energy for use at night or during periods of low sunlight.