DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

19EE711 SOLAR AND WIND ENERGY

UNIT III-SOLAR RESOURCE

Based on other criterion like configuration, connection with Grid, storage etc.:

1. Stand–alone PV system
2. Grid Interactive PV System
3. Hybrid solar PV system

8.1. Stand-alone PV system:

Important features:

- Stand–alone Solar systems are designed to operate independent of the electric utility grid, and are generally designed and sized to supply certain DC and/or AC electrical loads.
- PV panels are connected in series/parallel to obtain the desired DC voltage and also to sustain the connected load while simultaneously charging the batteries to give the required backup power.
- The charge controller regulates the current output and prevents the voltage level from exceeding the maximum value for charging the batteries.
- During the sunshine hours, the load is supplied with DC power while simultaneously charging the battery.
- Battery bank sizing depends on a number of factors, such as the duration of an uninterrupted power supply required to the load when there is less or no radiation from the sun.
- The battery bank while giving back up facility results in around 20–30 % power loss due to heat when in operation.
- When designing a solar PV system with a battery backup, the

designer must take this loss into account and also should plan a location with adequate space and ventilation for safe housing of the battery racks.

- Normally when Grid is close by, people will not go for a Standalone system with full battery backup since utility supply on Grid itself will serve as power backup when there is no adequate Sunshine. Only a small battery backup is normally provided as contingency to support essential loads.
- But in case of remote locations where nearby Grid access is not there Standalone PV systems must have battery backup except for direct online systems.

- Further, the solar and wind power outputs can fluctuate on an hourly or daily basis. The stand−alone system must, therefore, have some means of storing energy, which can be used to supply the load during the periods of low or no power output as and when required.
- The major application of stand−alone power systems are in remote areas where utility lines are uneconomical to install due to terrain, the '***right of way***' difficulties or the environmental concerns. Even without these constraints, building new transmission lines is expensive in far off areas.

Stand alone systems can be designed and configured in different ways with or without control functions like charge controller or MPPT, with or without battery backup etc based on user requirements and budget. This has become possible due to the enormous development in the field of Electronics and Computers which takes care of all complex monitoring and control functions. To understand and appreciate the versatility of such PV systems in terms of their capabilities, we will study one system with battery backup and several other control features.

Standalone PV system with battery backup and some additional features:

Figure−22 below shows a Standalone PV system with battery backup along with several features/ important subsystems like MPPT, Battery Charger etc.In such a stand−alone PV power system the peak power tracker senses the voltage and current outputs of the array and continuously adjusts the operating point using the switching Regulator to extract the maximum power under the given climatic conditions. The output of the array goes through this regulator to the inverter, which converts DC into AC. The array output in excess of the load requirement is used to charge the battery. The battery charger is usually a DC–DC buck converter. When the sun is not available, the battery discharges to the inverter to power the loads. The battery discharge diode D_b is to prevent the battery from being charged when the charger is opened after a full charge or for other reasons. The array diode D_a is to isolate the array from the battery, thus keeping the array from acting as load on the battery when it is not generating power.

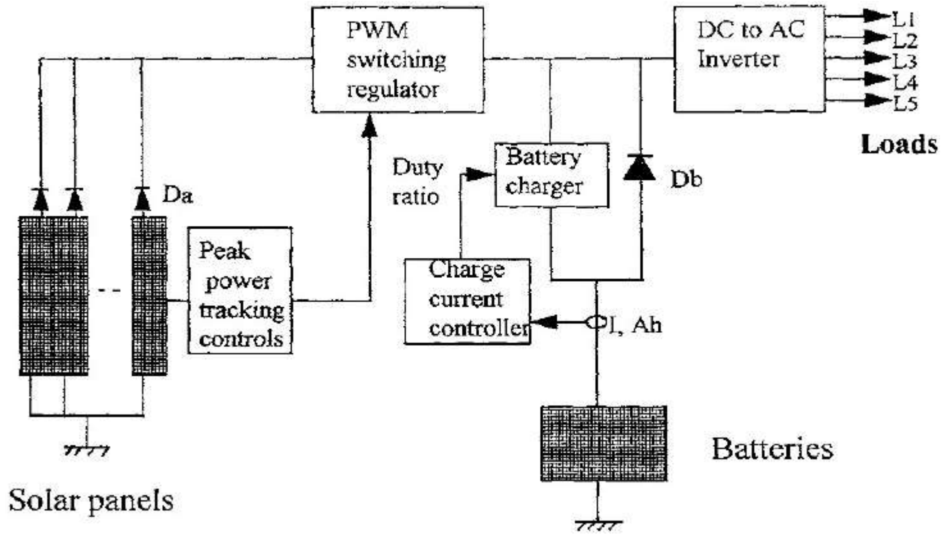

Figure-22: Photovoltaic stand-alone power system with battery backup and other subsystems like battery charger, Charge controller, MPPT etc.

8.2. Grid interactive PV systems:

Important features:

- A **Grid-connected Photo Voltaic (PV) system** is a Solar PV Power generating system that is connected to the utility Grid. A grid–connected PV system consists of a Grid Interface system apart from the normal solar panels, Inverters and a power conditioning unit. They range from small residential and commercial roof top systems to large utility–scale Solar Power Stations.. A grid–connected system will include an integrated battery system as well but of a very small capacity to serve as a backup for essential monitoring and control functions.
- Grid–connected or utility–interactive PV systems are designed to operate in parallel and interconnected with the electric utility grid. The most important subsystem in grid–connected PV systems is

Power Conditioning Unit (PCU). It generally includes MPPT, charge controller and most importantly the grid interface unit apart from the Inverter. Apart from the inverter, the PCU mainly consists of a Grid interface between the PV system, AC output circuits and the

electric utility network, typically at an on−site distribution panel or service entrance.

- This allows the AC power produced by the PV system to either supply on− site electrical loads or to back−feed the grid when the PV system output is greater than the on−site load demand. At night and during other periods when the electrical loads are greater than the PV system output, the balance of power required by the loads is received from the electric utility.
- This interface also automatically stops supplying power to the grid when the utility grid is not energized. This safety feature is required in all grid− connected PV systems, and ensures that the PV system will not continue to operate and feed back into the utility grid when the grid is down for service or repair.
- The grid interface also incorporates synchronization circuitry that allows the production of sinusoidal waveforms in synchronization with the electrical service grid.

- One of the important and useful feature of a grid−connected system is net metering. Net meters have a capability to record consumed or generated power in an exclusive summation format. The recorded power registration is the net amount of power consumed—the total power used minus the amount of power that is produced by the solar power system and fed into the grid.Net meters are supplied and installed by utility companies that provide Grid− connection service systems. Net metered solar PV power plants are subject to specific contractual agreements and are subsidized by state governmental agencies.