EE3014 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

UNIT V - HYBRID RENEWABLE ENERGY SYSTEMS

5.2- RANGE AND TYPE OF HYBRID SYSTEMS

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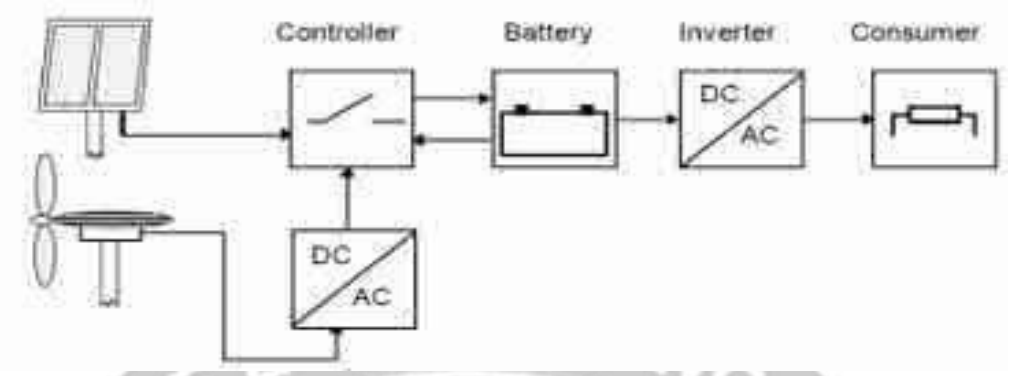
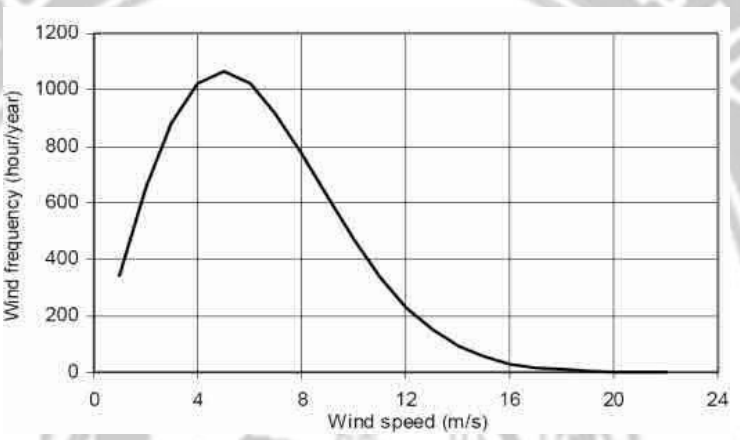
Hybrid System Characteristics

Although hybrid energy systems are open, they can have the characteristics of a closed system if a subsystem with the function of ‐monitoring‖ is introduced as a feedback between output (consumer) and input (controller). As inputs of particular hybrid system cannot be changed. However, the load may be changed. With a backup system as another energy sourcethe system can be designed as a partial closed-loop feedback system. There are various possiblyto make combination of different energy sources. Selection of energy source for hybrid system is mainly depends upon availability at the place where it going to stabilized. In general in India solar energy is available almost all the places and infrastructure for power generation is rugged. Hence need low maintenance so it is smart to choose to have PV one of the energy sources in hybrid system. Wave and tidal energy available only at sea shore and need large capital investment and more maintenance, therefore not compatible for household hybrid system. But can be use in large power hybrid system. Corrosion because of seawater is a major drawback. Wind energy source is also a good choice but more preferable for open land hybrid system and status of wind throughout the year is also important. India has monsoon climate hence has enough potential of wind energy. Biomass energy is good option but it needs regular feeding to continuously operate. Biomass with grid hybrid system is broadly used in sugar mill in India. In residential applications, biomass can be used for space heating or for cooking. Businesses and industry use biomass for several purposes including space heating, hot water heating, and electricity generation.

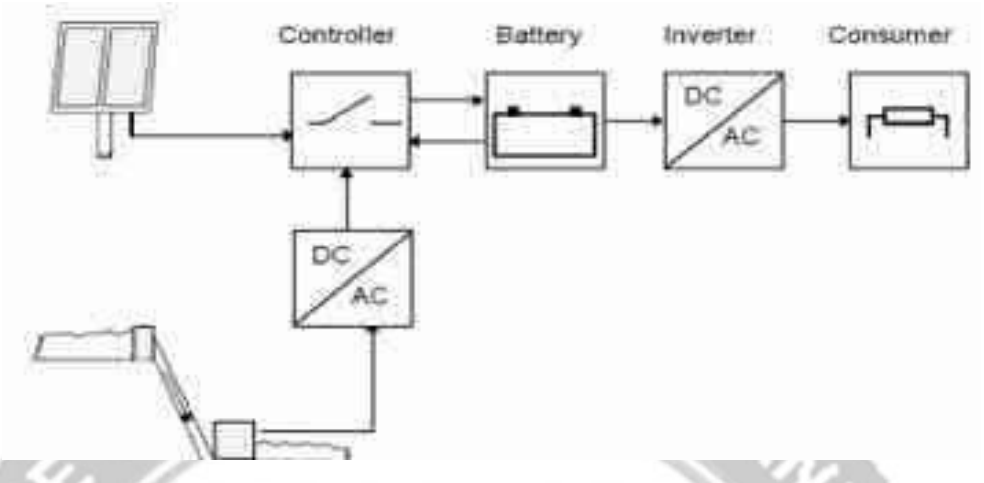
Wind/PV Hybrid System





A typical hybrid energy system consists of solar and wind energy sources. The principle of an open loop hybrid system of this type is shown in Figure. The power produced by the wind generators is an AC voltage but have variable amplitude and frequency that can then be transformed into DC to charge the battery. The controller protects the battery from overcharging or deep discharging. As high voltages can be used to reduce system losses, an inverter is normally in traduced to transform the low DC voltage to an AC voltage of 230V of frequency 50 Hz. The hybrid PV-wind generator system has been designed to supply continuous power of 1.5 kW and should have the following capabilities: Maximizes the electric power produced by the PV panels or by the wind generator by detecting and tracking the point of maximum power stores the electric energy in lead-acid batteries for a stable repeater operation. Control of the charge and discharge processes of the batteries protects wind generator from over speeding by connecting a dummy load to its output.

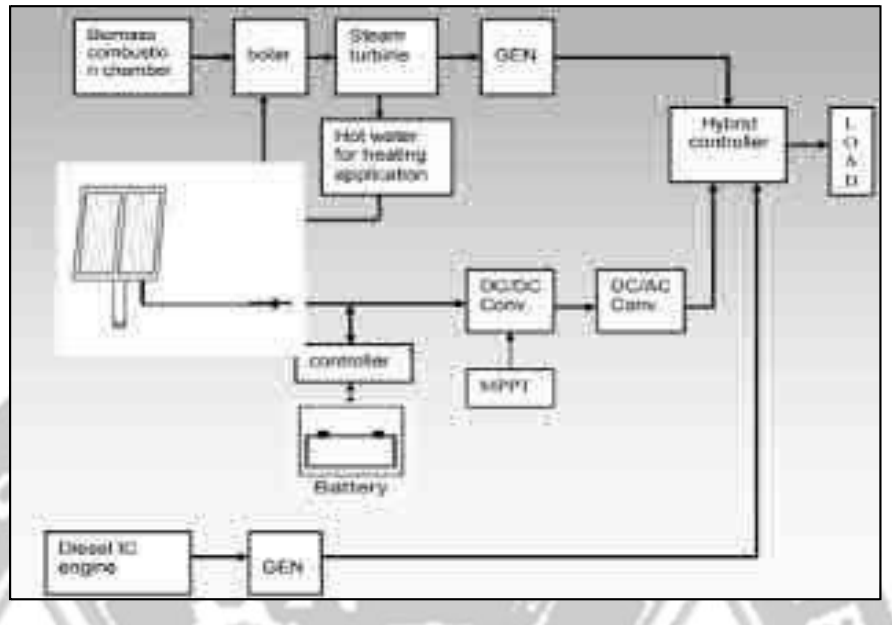
PV/Hydro Hybrid System



The block diagram of hybrid system, which combines PV with hydro system, is shown above. In this system there is a small reservoir to store the water. This type of hybrid system sometimes depends upon the geographical condition where the water at some height is available. System capacity is depends upon at the water quantity and solar radiation. The power supplied by falling water is the rate at which it delivers energy, and this depends on the flow rate and water head. The local water flow and head are limited at this project site, and a relatively simple hydro energy component is used in the project. Hydropower available is may be of runoff river type hence produces variable amplitude and frequency voltage. It can be use to charge the battery after converting it into DC.

Biomass-PV-Diesel Hybrid System

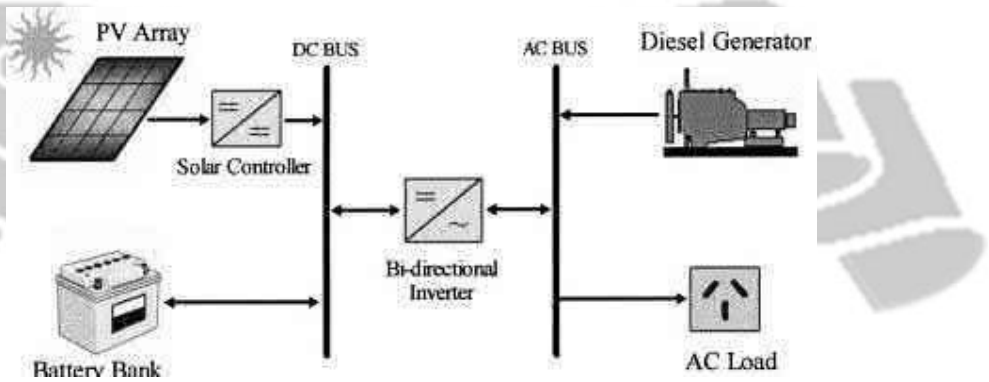
Biomass is matter usually thought of as garbage. Some of it is just substance lying around -- dead trees, tree branches, yard clippings, leftover crops, wood chips and bark and sawdust from lumber mills. It can even include used tires and livestock manure. The waste wood, tree branches and other scraps are gathered together in big trucks. The trucks bring the waste from factories and from farms to a biomass power plant. Here the biomass is dumped into huge hoppers. This is then fed into a furnace where it is burned. The heat is used to boil water in the boiler, and the energy in the steam is used to turn turbines and generators. Other applicationof Biomass is that it can also be tapped right at the landfill with burning waster products. When garbage decomposes, it gives off methane gas. Pipelines are put into the landfills and the methane gas can be collected. It is then used in power plants to make electricity.



In hybrid system diesel energy is only work as a backup source. When the demand on its peak, the available sources are insufficient for that then the diesel back is required. There is a controller, which maintains the energy balance during the load variation. It assigns the priority among the energy sources. It also maintains the synchronizing the voltage signal coming from the different sources. Suppose the instantaneous magnitude of voltage signal coming from PV sources is differ from that of coming from other source say biomass. Hence it causes the local circulating power flow.

Hybrid PV diesel system

A photovoltaic diesel hybrid system ordinarily consists of a PV system, diesel gensets and intelligent management to ensure that the amount of solar energy fed into the system exactly matches the demand at that time. Basically the PV system complements the diesel gensets. It can supply additional energy when loads are high or relieve the genset to minimize its fuel consumption.



In the future, excess energy could optionally be stored in batteries, making it possible for the hybrid system to use more solar power even at night. Intelligent management of various system components ensures optimal fuel economy and minimizes CO_2 emissions.

Advantages of a photovoltaic diesel hybrid system

In contrast to power supply systems using diesel gensets, and despite their higher initial cost, PV systems can be amortized in as little as four to five years, depending on the site and system size, and they have low operating costs. In addition, PV systems are flexible and can be expanded on a modular basis as the energy demand grows. Compared to pure gensets systems, a photovoltaic diesel hybrid system provides numerous advantages:

- Lower fuel costs
- Reduced risk of fuel price increases and supply shortages
- Minimal CO_2 .

Components of photovoltaic diesel hybrid system

PV inverters

PV inverters are the central components of the fuel Save Solution. Designed specifically to be used in weak utility grids, they are suitable for high voltage and frequency fluctuations. They also remain extremely productive in harsh ambient conditions such as heat, moisture, salty air, among others. A centralized PV system contains only one string into a central point where direct current is converted to alternating current. In a decentralized PV system, the PV power is divided into many strings, which are converted into alternating current by several inverters.

PV array

The solar power is generated in the PV modules, which can be mounted on the ground or on a roof, depending on local conditions. Inverters are compatible with all PV module types and technologies currently available on the market.

Fuel save Controller

The fuel save controller provides the perfect interface between the gensets, PV systems and loads, managing demand-based PV feed-in into the diesel-powered grid. As the central component of the fuel save solution, it ensures maximum security with reduced fuel costs and minimizes CO_2 emissions.

Diesel Genset

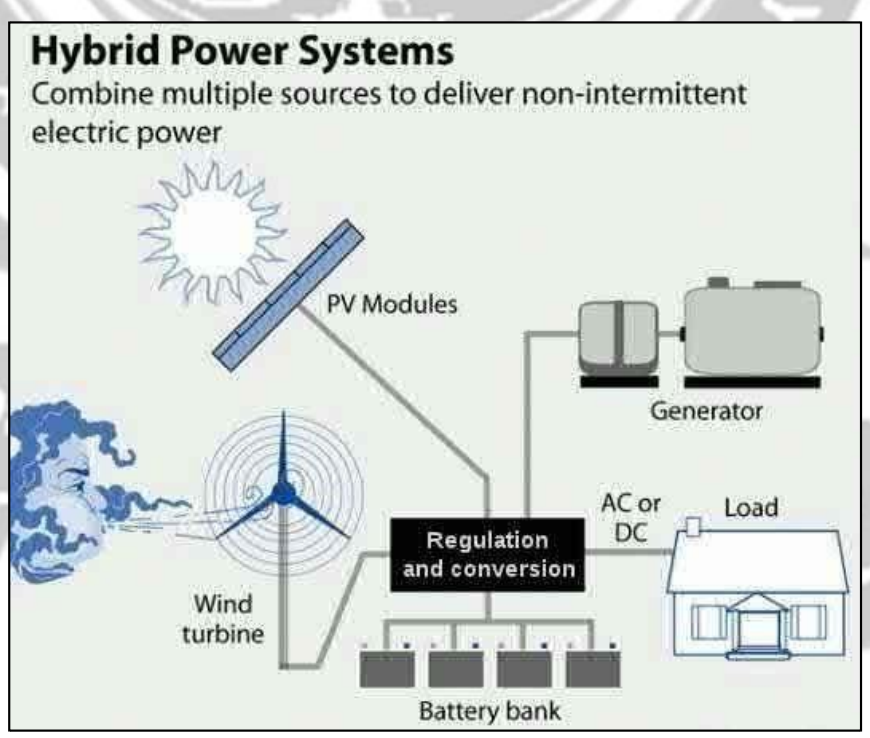
In grid-remote regions, pure diesel systems often provide the energy for industrial applications. They constitute the local grid, ensuring a constant power supply to all connected users. Because the gensets require a constant fuel supply, they are often the system‘s highest operating cost. In regions with weak utility grids, diesel gensets often serve as a backup during grid power outages.

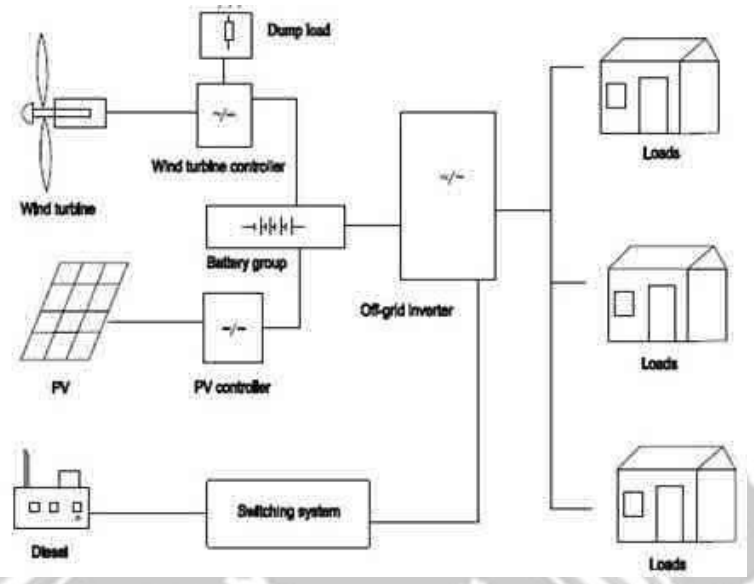
Optional storage batteries

To boost the efficiency of the entire energy supply system, it is advisable to include a storage battery. When solar irradiation is insufficient or energy is needed after dark, the storage battery supplies the required energy, ensuring optimal hybrid system operation.

PV/SOLAR THERMAL/GRID-CONNECTED HYBRID SYSTEM

The hybrid system that combines wind, solar, and diesel power generation system has become popular because of its advantages over either single system. The main advantages of hybrid systems are fuel saving lower atmospheric contamination, savings in maintenance, silent systems, and connection to other power supplies which enable higher service quality than traditional single-source generation systems. The main components of hybrid systems are: the power sources, the storage devices, the power management center, and monitor and control devices. There are two main advantages of the system compared to others. First, the energy ofthe proposed system is used wisely and efficiently by monitoring the load power and the available renewable energy to define the quantity of needed power and to select the best available source. Secondly, additional batteries are used as a dumped load in the system, which can be used if there is a shortage in the renewable energy source to minimize the usage of the diesel engine. In addition, a wireless monitoring system will be used to help in self- troubleshooting and a fast alarm system, which will minimize maintenance efforts.





Hybrid Solar Wind Diesel Power Generation system has different schematics that each has its own advantages and implementation. In the scheme illustrated in Figure, the battery is charged directly from the photovoltaic (PV) module and the wind turbine where each has itsown charge controller. The load receives its required power from all energy sources via an inverted to convert the DC to AC. The battery is charged in similar way to the first scheme but the only difference is that the load receives its required power via the battery not others. Also, there is no dump load in this case.

The charge controller receives the power from the energy sources (PV module and the wind turbine) and delivers the power to the battery if it is not fully charged, to the dump load if the battery is fully charged. If the battery is not fully charged and the output power from the renewable energy sources is not satisfactory, the diesel engine is turned on to supply the load with the needed power until the battery is fully charged again. The sensors are used for controlling the power flow among the system devices and elements, and troubleshooting purposes. For wind turbine, if the wind sensor reading does not match the proper amount of energy produced by wind turbine, the controller will send a command to the generator housed in the wind turbine to shut off. For the PV module, if the light intensity sensor reading does not match the amount of power produced by the PV module, the controller will send a command to the disconnect the PV module from the charge controller. The system will take the power input from both the wind turbine and solar panel and send them to the charge controller. The charge controller will direct the power to the battery or the dump load battery based on battery voltage input.

When the battery voltage sensor inputs data that the battery is full, the charge controller will switch to dump load. However, when the battery is undercharged, the diesel engine will be switched on to supply the load with the power needed until the battery is charged again.

Moreover, the other sensors will be used for the troubleshooting purpose. For example, the system will be able to identify problem in the wind turbine or the solar panel. Such as when the wind speed and the light intensity sensors reading do not match with the input power given to the system that is read by the voltage and current sensors. Furthermore, the fuel level sensor will sense the diesel engine is running out of fuel.