GOVERNMENT POLYTECHNIC,DHENKANAL

LECTURE NOTES

ON

RENEWABLE ENERGY

6TH SEMESTER ELECTRICAL ENGINNERING

PREPARED BY-

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MOHANTY

-: Introduction of Renewable Energy:-

Renewable Energy:-

↳ It is an useful energy that is collected from renewable resources which are naturally replenished on a human time scale.

↳ It include carbon neutral sources like sunlight, wind, rain, tides, waves and geothermal heat.

Fossil fuel:-

→ Fossil fuels are energy sources that form naturally via the long-term decomposition of plants and animals. Fossil fuels like petroleum, coal and natural gas have satisfied human energy demands since the Industrial revolution.

↳ The major types of fossil fuels used are

1. coal
2. Natural Gas
3. oil.

1. coal:-

↳ coal is a solid fuel that is composed primarily of carbon.

↳ Depending on its carbon composition coal can be classified into -

(i) Lignite
(ii) Sub-bituminous
(iii) Bituminous
(iv) Anthracite.

↳ The vast majority of coal burned in the united states is bituminous or sub-bituminous.

↳ coal can be extracted via underground mining or strip mining from the surface (some time called mountain top removal)

② Natural gas:-

↳ Natural gas is gaseous fuel. Natural gas extraction can occur during coal mining or oil drilling. Natural gas can also be extracted from oil shales via hydraulic fracturing or fracking.

↳ It is a naturally occurring hydrocarbon gas mixture consisting primarily of methane, but higher alkanes and some small percentage of carbon dioxide, nitrogen, hydrogen sulfide or helium.

③ Oil:-

* crude oil is a liquid fuel that can be refined to create gasoline, kerosene, propane, jet fuel, paint and plastics. It can be found in pure liquid from in oil deposits or mixed with viscous sand and rock in tar sands.

Uses of Fossil fuels:-

↳ Fossil fuels have powered countless sectors of human activity for decades uses for fossil fuel.

↳ It includes

- Electricity generation.
- Home heating.
- Transportation fuel
- Plastics.

• Electricity generation:-

Coal and natural gas power the majority of power plants around the world. They compete with nuclear power, water power, solar power and wind power. All of the which produce lower carbon emission than fossil fuel use - but remain the dominant fuel sources around the world.

- Home heating:-

↳ Natural gas (a by product of coal mining) powers many home heating system, hot water heaters, and gas stoves. In recent years, concern about in home burning of nitrogen oxides (found in natural gases) has led some consumer advocacy groups to purpose shifting from gas appliances to electric.

- Transportation fuel:-

Gasoline and diesel, both petroleum products currently Power most products, consumers, vehicles, aircraft are Powered by jet fuel which is similar in composition to Kerosene.

- Plastic:-

Plastics are created from oil. Plastics manufacturing was initially a by product of oil refined for electricity and transist, but now 300 million tons of plastics are Produced every year. According to the united states environmental protection Agency (EPA), the burning of fossil fuels causes community health risks, pollution and global warming. The environmental impacts of fossil fuels includes:-

(1) Air pollution.
(2) Water pollution.
(3) Global warming.

(1) Air Pollution:-

The burning of fossil fuels Perticularly coal, can release harmful chemicals like Sulfur dioxide and carbo monoxide in to the air. The health effect of air pollution include severe asthama, which has been observed in regions downward of coal Power plants.

(2) Water Pollution:-

The sulfur dioxide released from untreated coal smoke can mix with other elements and produce acid rain, and oil spills poison marine ecosystem while water pollution is not unique to fossil fuels (even so-called clean energy sources like nuclear can pollute water), unregulated fuel spillage pollutes water and endangers plants, animals and human health.

(3) Global Warming:-

Methane and carbon dioxide emissions stemming from electricity plants, gasoline-burning vehicles, comes manufacturing and other industrial processes trap heat in Earth's atmosphere, leading to a surge in global temperature in recent decades.

Importants of Renewable Sources of Energy:-

↳ The importance of renewable source of energy are they differ from fossil fuels principally in their diversity, abundance and potential for use any where on the planet, but above all in that they produce neither green house gasses which cause climate change - nor polluting emission.

↳ Renewable energy sources also produce clean energy.

↳ Hydropower is the most widely used renewable power source, with the global hydroelectric for more than 18% of the worlds total installed power generation capacity and more than 54% of the global renewable power generation capacity.

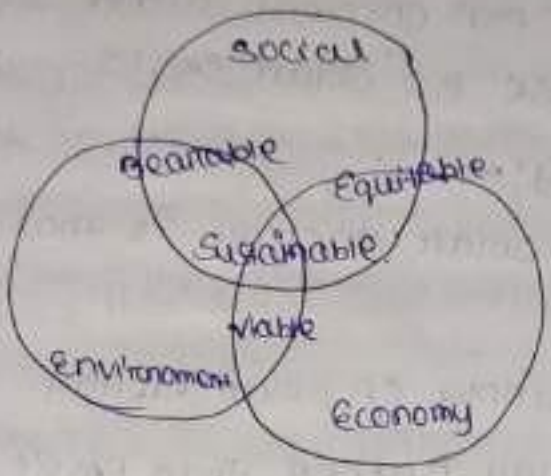
↳ Biomass provides most of the renewable heat in industrial process renewable electricity also can provide heat reducing energy element in industrial process is key to substituting fossil fuels with renewables, as in building

1.

↳ As the renewable sources are fast growing, the cheapest and do much less damage to nature and wasted life surrounding their ~~areas~~ sites as opposed to fossil fuels.

↳ Some important benefits are ion creation, no climate change, clean air, etc.

Sustainable design and development:-



↳ Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This is generally considered to be a balance between economics, environmental and social factors.

↳ If development can produce good economic and social benefits and not damage the environment or even enhance the environment then it could be called sustainable development.

↳ There are three key principles for sustainable development are -
(i) Economic
(ii) Environmental
(iii) Social.

Types of renewable energy sources:-

There are some types of renewable energy.
(i) Solar energy.
(ii) Wind energy.
(iii) Hydroelectric.

(iv) Ocean energy.
(v) Geothermal energy.
(vi) Biomass energy
(vii) Hydrogen.

(i) Solar energy:—

↳ Solar energy is energy from sunlight and converting it into heat, electricity or hot water.
↳ Photovoltaic (PV) system can convert direct sunlight into electricity through the use of solar cells.

Benefits of solar energy:—

↳ one of the benefits of solar energy is that sunlight is endless.
↳ There is a limitless supply of solar energy.
↳ Relying on solar energy rather than fossil fuels also helps us improve public health and environmental condition.
↳ Solar energy could eliminate energy costs, and reduce our energy bills.

Advantages:—

↳ It is a renewable energy source.
↳ It has low maintenance costs.

Disadvantages:—

↳ Cost is very high.
↳ It uses a lot of space.
↳ Solar energy storage is expensive.

(ii) Wind energy:—

↳ Wind farms capture the energy of wind flow by using turbines and converting it into electricity.
↳ There are many systems to convert wind energy.
↳ commercial grade wind-powered generating systems can power many different organizations.
↳ single wind turbines are used to help supplement pre-existing energy organisations.

Benefits of wind energy:-

↳ wind energy is a clean energy source which means that it doesn't pollute the air like other forms of energy.

↳ wind energy doesn't produce carbon dioxide or release any harmful products that can cause environmental degradation are negatively effect human health like smog, acid rain etc.

↳ Investment in wind energy technology can also open up new avenues for jobs and training, as the turbines on farms need to be serviced and maintained to keep running

Advantages:-

↳ wind energy reduces carbon emmissions when used instead of fossil fuels.

↳ wind energy is cost effective.

Disadvantages:-

↳ wind turbines can damage the habits of birds and marine life.

↳ Wind farms can be expensive to construct.

(iii) Hydroelectric energy:-

→ Dams are what people most associate with when it comes to hydroelectric power.

↳ water flows through the dams turbine to produce electricity known as pumped-storage hydropower.

↳ Run of river hydropower uses a channel to funnel water through rather than powering it through a dam.

Benefits of Hydroelectric energy:-

↳ Hydroelectric power is very versatile and can be generated using both large-scale projects and small scale projects like underwater turbines and lower dams on small rivers and streams.

↳ It does not generate pollution, and therefore is a much more environmentally friendly energy option for our environment.

(IV) Geothermal Energy:-

↳ Geothermal heat is heat that is trapped beneath the earth's crust from the formation of the earth 4.5 billion years ago and radio active decay.

↳ Some time large amounts of this heat escape naturally, but all at once, resulting in familiar occurrences such as volcanic eruptions and geysers.

↳ This heat can be captured and used to produce geothermal energy by using steam that comes from the heated water pumping below the surface.

Benefits of geothermal energy:-

↳ It is not as common as other types of renewable sources, but it has a significant potential for energy supply.

(V) Biomass energy:- (Benefits):-

↳ The use of biomass in energy production creats carbon dioxide that is put into the air, but the regeneration of plants consumes the same amount of carbon dioxide, which is said to creat a balanced atmosphere.

↳ Biomass can be used in many different ways in our daily lives.

↳ These days people can improve the environment with ~~greener~~ greener energy solution (Renewable energy)

Biomass energy:-

↳ It is a renewable energy derived from biomass.

↳ Biomass is organic matter that comes from recently living plants and organism.

↳ This can be done by burning biomass or harnessing methane gas which is produced by the natural decomposition of organic materials in ponds or even landfills.

(VI) Hydrogen Energy:-

↳ It needs to be combined with other elements, such as oxygen to make water as it does not occur naturally as a gas on its own.

↳ When hydrogen is separated from another element it can be used for both element it can be used for both fuel and electricity.

Benefits of hydrogen energy:-

↳ It can be used as clean burning fuel which leads to less pollution and cleaner environment.

↳ It can also be used for fuel cell which is similare to batteries and can be used for powering an electric motor.

Limitation to renewable energy:-

↳ There's only enough renewable energy on earth for a billion years.

↳ The electricity generation capacity is still not large length.

↳ Low efficiency level.

↳ Take a lot of space to install.

↳ Require a high upfront capital quality.

↳ Expensive storage costs.

↳ Expensive set up and output could be affected by drought.

↳ In hydro generators need enough rain to fill dams for their supply or flowing.
↳ In wind energy the turbines need wind to turn their blades.
↳ In solar energy solar pannels need clear skies and sunshine to get the heat needed to generate electricity.

Renewable energy sources - policies of India:-

As its name we can known about its working it means that variety types of policies. To produce the energy by using renewable energy sources like, Sun, solar, wind, tidal, geothermal etc.

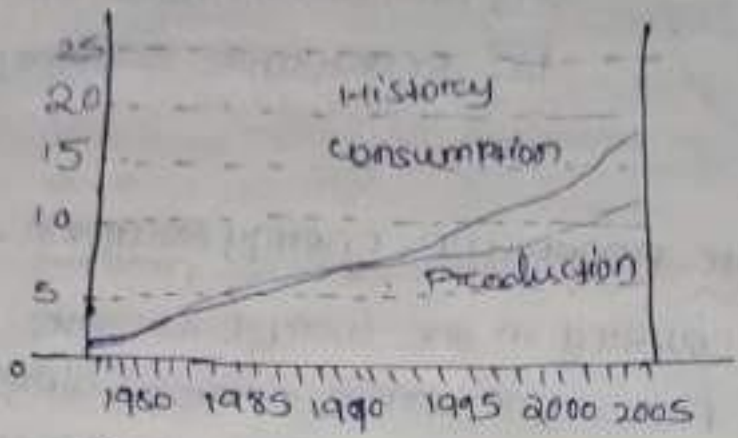
Some following points i.e;

Current energy scenario in India:-

↳ India ranks sixth in the world in total energy consumption
↳ India has increased installed power capacity from 1362 mw To over 1,62,160 mw since independence.
↳ India has electrified more than 50,000 village.
↳ India is a development largest economy in the world, In terms of purchasing power.
↳ The demand for energy how grown at an average of 36% per annum over the past few years.
↳ The rapid increase in use of energy has created problems of demand and supply.
↳ More than 80,000 villages are yet to be electric field.

↳ Around 44% of households, the central government, to the electricity. ... preferring the

It indicates that India has had a -ve among others, ... -ilization balance for decades :-



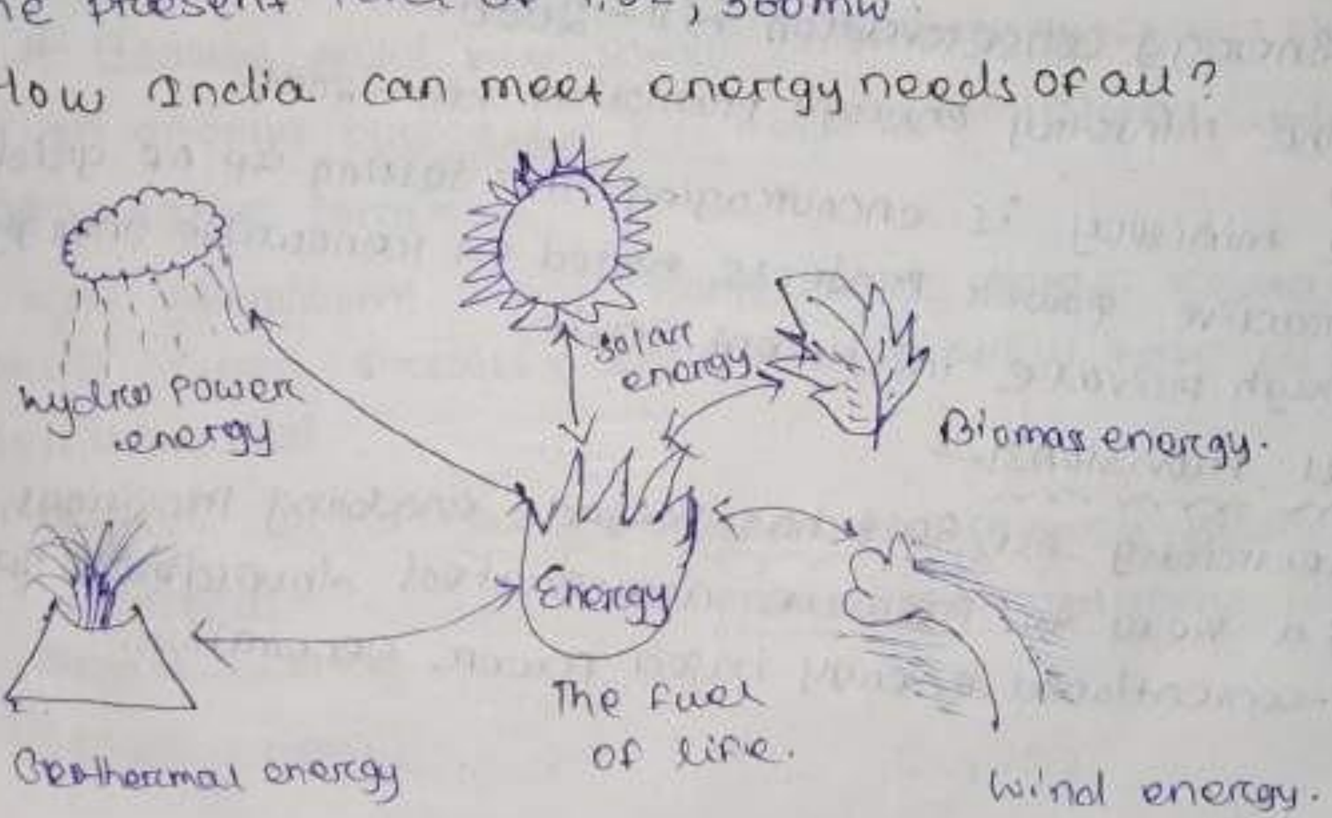
[India's energy Balance]

Power for All by 2012

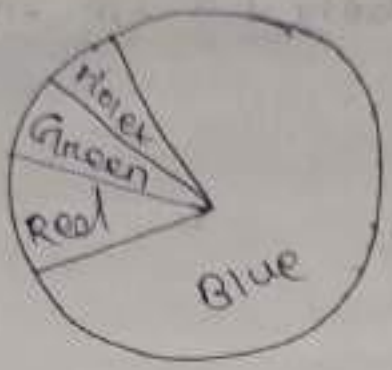
↳ The Government of india has an ambitions missions of power for all by 2012.

↳ This mission would require that the installed generation capacity should more than 2,00,000 mw by 2012 from the present level of 1,02,366mw

How India can meet energy needs of all?



Power in India:-



[B] Thermal power (63%)
[R] Hydro power (21%)
[G] Nuclear power (3%)
[V] Renewable sources (8%)

Policies of India for Renewable energy sources:-

↳ India is the only country in the world to have an exclusive ministry for renewable energy development, The ministry of non-Conventional energy sources (MNES).

↳ India has Pioneered in the world in any administrative actions of RE promotion such as:-

1) Electricity Regularity commission - 1991
2) Mandatory environmental audits for power Project s - 1992.
3) Energy conservation bill - 2000.
4) The ministry energy promotion bill - 2005.

⇒ The ministry is encouraging the setting up of grid interactive power projects based on renewable energy through private investment Route.

Legal Provisions:-

→ Electricity Act, 2003 has several enabling Provisions, with a view to promote accelerated development of non-conventional energy based power generation.

↳ Under the electricity act 2003, the central government from time to time, is responsible for preparing the national electricity policy, in consultation, among others, with the state. Governments for the optimal utilization of all resources, including renewable sources of energy.

Renewable energy Sources - Potential of India:-

↳ India utilizes twelve primary hydro electric power plants: Bihar, Punjab, ~~Maharashtra~~ Uttaranchal, Karnataka, Uttarpradesh, Sikkim, Jammu and Kashmir, Gujarat and Andhrapradesh.

↳ India has the 5th largest wind power installed capacity in the world.

↳ The ten machines near Okha in the Provinence of Gujarat were some of the first wind turbines installed in India.

↳ 140mw solar thermal hybrid power plant will be consentrated in Rajasthan raising india into the second position in the were in utilization of solar thermal.

↳ A 500kw grid interactive biomass gassifier linked to an energy plantation has been commissioned under a demostration projects.

↳ Grid interactive solar photovolatic solar photo volatic power projects aggregating 2100kw have so far been installed.

Estimated potential of renewable energy sources:-

Source	Approximate potential in MWs
Biomass energy	19,500
Solar energy	20,000

Wind energy	45,000
Small hydropower	15,000
Other RE sources	60,000

Total estimated potential is around 1,49,500 mw.

Chapter-2 :- Solar energy :-

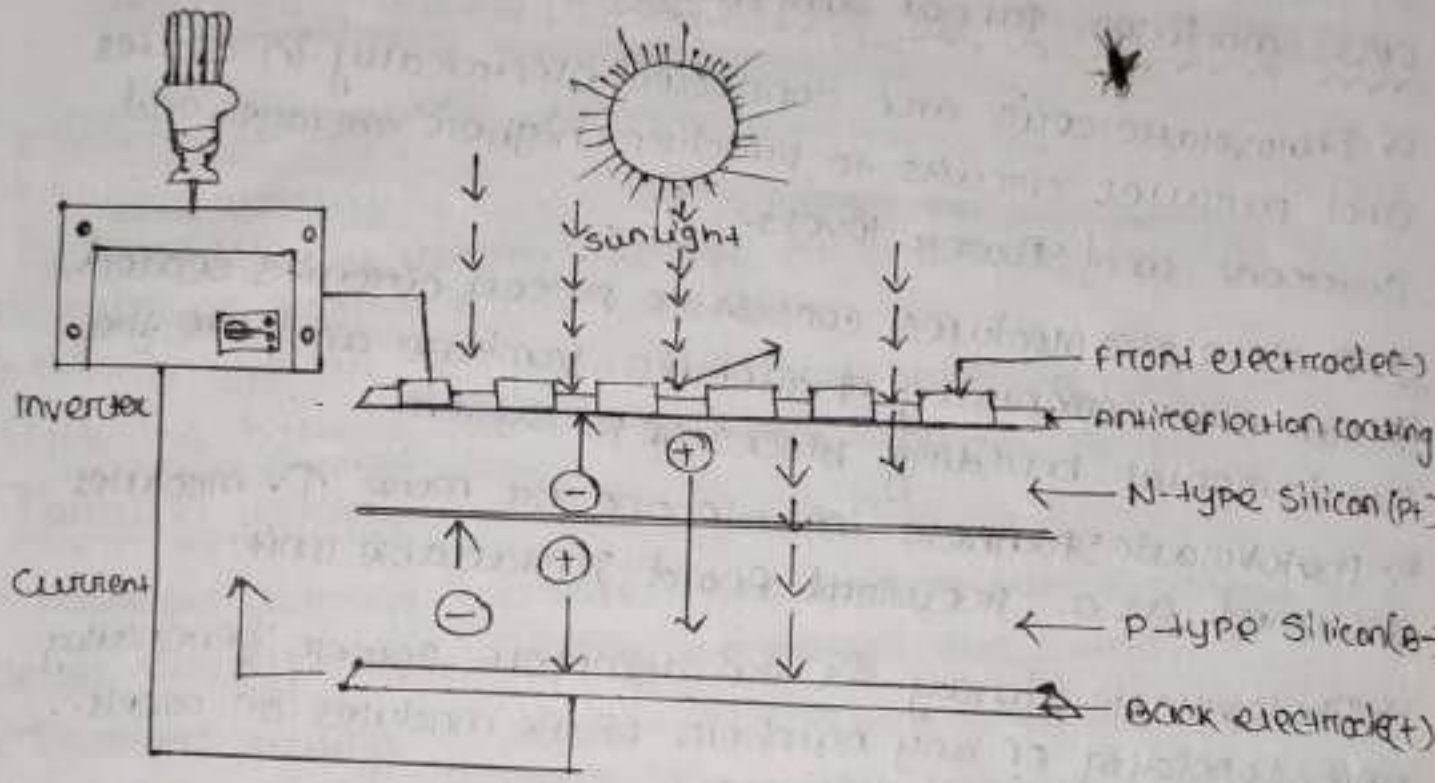
Working Principle of Solar Photo-voltaic System:-

↳ Solar photovoltaic system use cells to convert sunlight into electricity.

↳ The PV cell consists of one or two layers of a semi conducting material, usually silicon.

↳ When light shines on the cell it creats an electric field across the layer causing electricity to flow.

↳ The greater the intensity of the light, the greater the flow of electricity.



↳ PV cells are referred to in terms of the amount of energy they generate in full sunlight; known as Killowatt peak (KWP).

↳ The Solar cell is the basic building block of Solar PV technology. Most people are familiar with PV Solar cells that power calculators.

→ These cells are wired together to form a module (PV Solar Panel)

→ The PV modules gather Solar energy in the form of Sunlight and convert it into DC-electricity.

↳ An inverter can convert this DC power into AC power when PV modules are joined together to form a PV Solar Panel system.

↳ Large PV system can be integrated into buildings to generate electricity.

Photovoltaic cell concept:-

↳ A photovoltaic cell also known as a solar cell is an electronic components that generates electricity when exposed to photons, or particles of light.

↳ A photovoltaic cell is a specialized semiconductor diode that converts visible light into direct current.

cells, modules, panel and array:-

↳ Photovoltaic cells are connected electrically in series and parallel circuits to produce higher voltages and current and power levels.

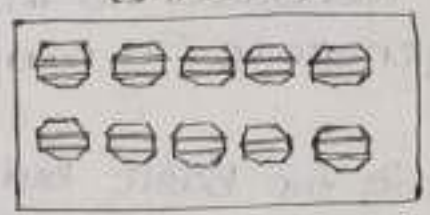
↳ Photovoltaic modules consist of PV cell circuits sealed in an environmentally protective laminate and are the fundamental building blocks of PV system.

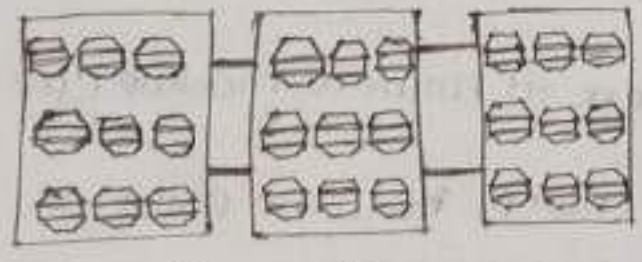
↳ Photovoltaic Panels include one or more PV modules assumed as a prewired field installable unit.

↳ Photovoltaic array is the complete power generating unit, consisting of any number of PV modules or panels.

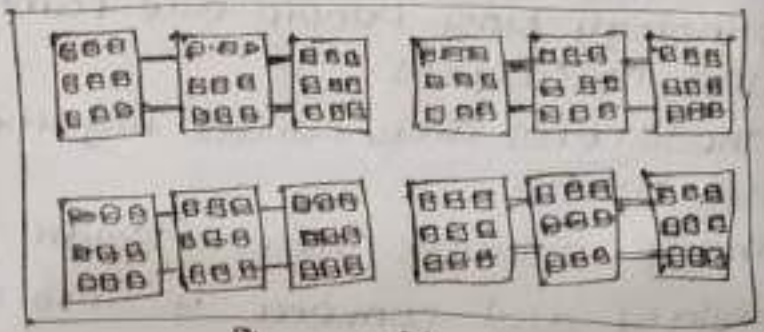
Photovoltaic cell

Module





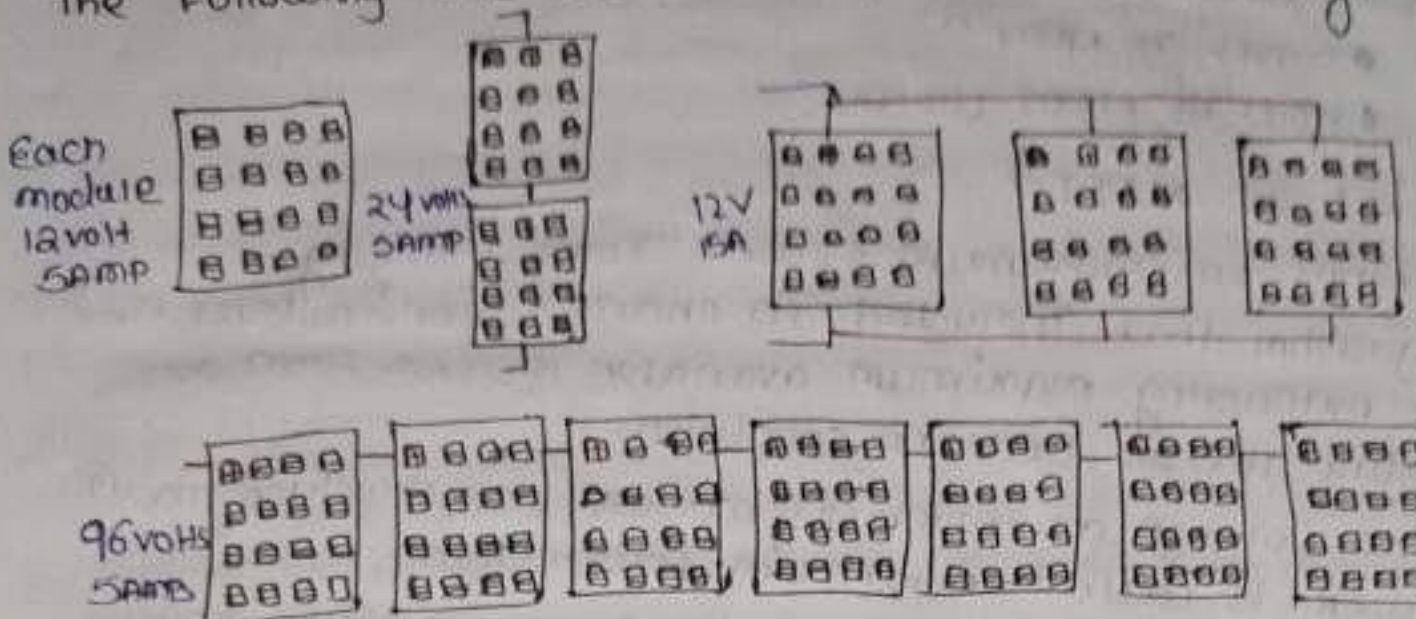
(Panel)



(Array)

Series and Parallel wiring:-

The following the series and parallel wiring.



Series wiring:-

→ Series wiring is when the voltage of a solar ~~array~~ array is increase by wiring the +ve of one solar module to the negative of another solar module.

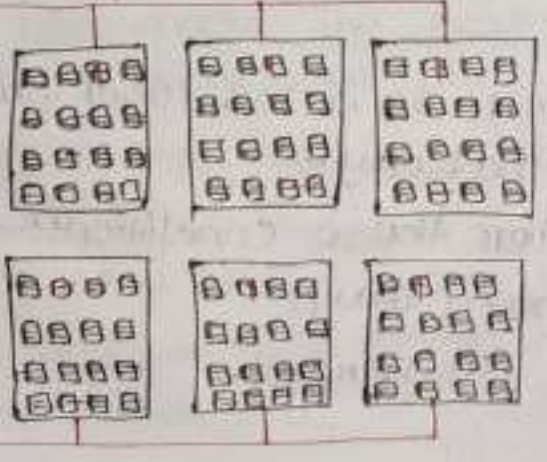
→ This is similar to installing batteries in flashlight. As you slide the battery into the flashlight tube the voltage increases.

Parallel wiring:-

→ Parallel wiring increases the current (amps) output of a solar array while keeping the voltage the same.

↳ Parallel wiring is when the +ve of multiple modules are connected together and all the negative for the same modules are connected together.

Series Parallel combination:-



Maximum Power Point tracking (MPPT):-

Basics of MPPT Solar charge controller:-

- what is MPPT?
- How it is MPPT works?

- what is MPPT?

↳ MPPT or maximum power Point tracking is algorithm that included in charge controllers used for extracting maximum available power from PV module under certain condition.

↳ the voltage at which PV module can produce maxm power is called maximum power Point.

↳ Maximum Power varies with solar radiation, ambient temperature and solar cell temperature.

↳ Typical PV module produces power with maximum power voltage of around 17V measured at a cell temperature of 25°C it can drop to around 15V on a very hot day and it can also rise to 18V on a very cold day.

- How it is works?

↳ The major principle of MPPT is to extract the maxm available power from PV module by making them operate at the most efficient voltage.

↳ That is to say: MPPT checks output of PV modules, comprises it to battery voltage then fixes what is the best power that PV module can produce to charge the battery and converts it to the best voltage to get maxm current into battery.

↳ It can also supply power to a DC load which is connected directly to the battery.

MPPT is most effective under these conditions:-

* cold weather, cloudy or hazy days.
* when battery is deeply discharged.

There are two main types of solar energy technology
(i) photovoltaic cell
(ii) concentrating solar energy (CSP)

Again it depends what type of panels you use
→ This is because as panels get large (in watts) they are also become a little bit more efficient
→ A 1 KW system using 250W panels will require about 1.7 square meters of roof to be installed.

Hot body:—

Hot body means any object which get heated up by either internal or external mechanism. ~~(Caused by nuclear reaction)~~

Ex:- In case of sun, the sun is hot due to the internal mechanism (called fusion reaction).
While in the case of earth, it absorbes heat from sun ray and becomes hot.

→ Now one of the characteristics of a hot body is it emits heat energy in the form of radiation.
→ The radiations from the sun is being absorbed by the earth (called Insolation) and it re-radiates back when the earth is termed as terrestrial radiation or earths radiation.
→ Earth's surface is not homogeneous and it varies from one area to another.
→ Due to earth's rotation and revolution with a tilted axis also made the heating effect of sun rays variable with both space and time.
→ The total heating up of the earth surface is variable.
→ Every part of the earths from morning to night radiates heat back depending upon the intensity of heat it receives from the sun. And this re-radiation of heat

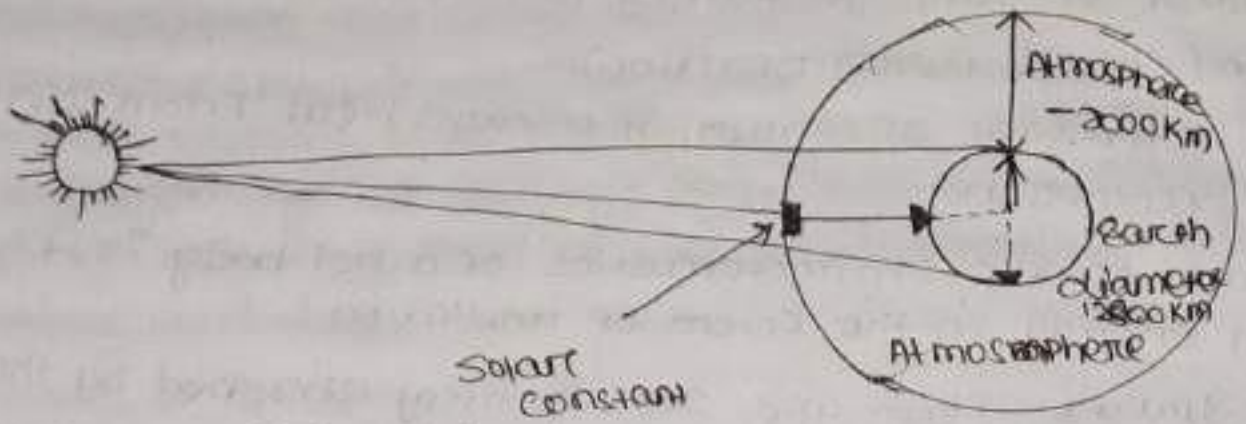
is called terrestrial radiation or earth's radiation.

→ So terrestrial radiation is happening all the time and it varies from space to space and time to time leads to the formation of energy deficit zones and energy surplus zones.

→ Energy deficit zones is having -ve value of terrestrial radiation. This is a continuous process and will stop when sun stops its radiation.

Extraterrestrial irradiation:— The Solar constant:—

The intensity of solar irradiation directly outside the earth's atmosphere on a horizontal surface is almost constant at around 1,360 W/m^2 so called "Solar constant"



Entry point into atmosphere:
Intensity ~ 1360 W/m2

Irradiation: —[W/m2]

The intensity of solar radiation hitting a surface which is the sum of the contributions of all wave lengths within the ~~on~~ spectrum, expressed in units of watts per m^2 of a surface.

Solar collector:—

→ A solar thermal collector heat by absorbing sunlight. A collector is a device for capturing solar radiation.

→ Solar radiation is energy in the form of electromagnetic radiation from the infrared (long) to the electroviolet (short) wavelength.

→ There are two types
(1) PV (photovoltaic)
(2) ST (solar thermal)

PV (photovoltaic) :-

Photovoltaic solar panel

→ PV converts sunlight into electricity using a semiconductor material (normal silicon).
→ when light strikes the cell a portion is absorbed within the semiconductor material knocking electrical load and allowing them to flow.
→ The results in an electric current and thus electricity production.
→ PV panels primarily absorbs the visible portion of the light spectrum.
→ PV panels are normally connected to an inverter to convert from DC to AC and subsequently the electricity is fed into the power ~~grid~~ grid.

ST (solar thermal) :-

Apricus evaluated tube collector solar water heater.
→ Solar thermal panels are referred to by a number of different names such as solar water heater, Solar hot water panel, Solar hot water collector, Solar thermal panel or solar thermal collector. These terms all described the same generic device.
→ Solar water heaters works by absorbing sunlight and converting it into usable heat.
→ A simply analogy is to thing about a black coloured object sitting in the summer sun.
→ over time it can become very hot from absorbing

-the sunlight. Solar water heaters work in the same way by using material that are specially designed to maximise the efficiency of heat absorption.
→ High quality absorber coating, as used by abrius product, are able to absorb up to 95% of the energy in sunlight throughout the spectral range.
→ Below is an example of quality absorber from coating manufacture Rimon that absorbs 95% of available sunlight and only radiates (emits) about 4% of the absorbed energy as heat.
→ The key areas to look at are the yellow which represents solar radiation and the light blue which is how much of that sunlight is absorbed by the coating.

Solar thermal and photovoltaic working together:-
→ Solar thermal and PV should not be seen as competing technologies or products as they perform different functions and as shown below can be installed together to provide a well balanced solar energy harnessing system.
→ electricity can be used for almost any application, and so is a universal energy source
→ Heat is required for hot water and space heating which represent a large percentage of a household's total energy requirements.

Application:-

① Battery chargers:-
→ A solar charger that employees solar energy to supply electricity devices or batteries they are generally portable.

→ Solar charges can charge 12v dc or 24v dc battery bank upto 48v and hundreds of ampere hours capacity.
→ Such type of solar charger setups generally use an intelligent charge controller.

③ Domestic lights:-

The building regulations compliance guide currently stipulates that 75% of fixed light internal fittings in new domestic construction should use low energy lamps.

Lamps:-

→ Tungsten incandescent lamps, as mentioned above have now largely been phased out from general domestic use.
→ Usually with an output of 60w or 100w and giving a warm yellowish light.
→ Tungsten halogen lights also produce a bright warm light and are often used in recessed fittings.

Fittings:-

→ Lighting design needs to be considered both in term of the general level of illuminance required and in term of the relevant working plane.
→ For example compare an office where there is a uniform general level of illuminance to a museum. where everything is in darkness except the brilliant lit display objects.

④ Street light:-

→ A street light or street lamp is a raised source of light often mounted on a lamp column or pole either on the side of the road or within the median, or suspended on a wire above the road to provide illumination.
→ Street lighting can provide safety benefits at mid block and intersection locations and can also improve safety for pedestrians, particularly at crossing points.

Midblock:-

→ The Provision of midblock street lighting increases safety by making road features such as, road alignment kerbs, footpaths, street furnitures, surface condition and other road users.

→ The object that may be on the road visible to both vehicular and pedestrian traffic.

Intersection:-

Providing street light at intersection locations can reduce night time crashes by making the intersection features visible to both vehicular and pedestrian traffic.

④ Water Pumping:-

→ The Pumping of water is a basic and practical technique, far more practical than scooping it up with one's hands or fitting it in a hand held bucket.

→ This is true whether the water is drawn from a fresh source, moved to a needed location, purified or used for irrigation, washing etc.

→ Stream, river, pond or lake is often pumped to higher ground for irrigation, livestock, cooking, cleaning or other uses by humans, who quite naturally need fresh water.

⑤ Solar Cookers:-

→ A solar cooker is a device which uses the energy of direct sunlight to heat, cook and other food material.

→ Many sololar cookers currently in use are relatively inspensive low-tech devices, and advanced, large scale solar cookers can cook for hundreds of people.

→ Because they use on fuel and cost nothing to operate, many nonprofit organisations are promoting their use worldwide in order to help reduce fuel costs and air pollution.

Sem Elec...

⑥ Solar Pond :-

→ A solar pond is a pool of saltwater which collects and stores solar thermal energy.

→ The saltwater naturally from a vertical salinity gradient also known as a 'halocline' in which low salinity water floats on top of high salinity water.

→ The layers of salt solutions in concentration with depth below a certain depth, the solution.

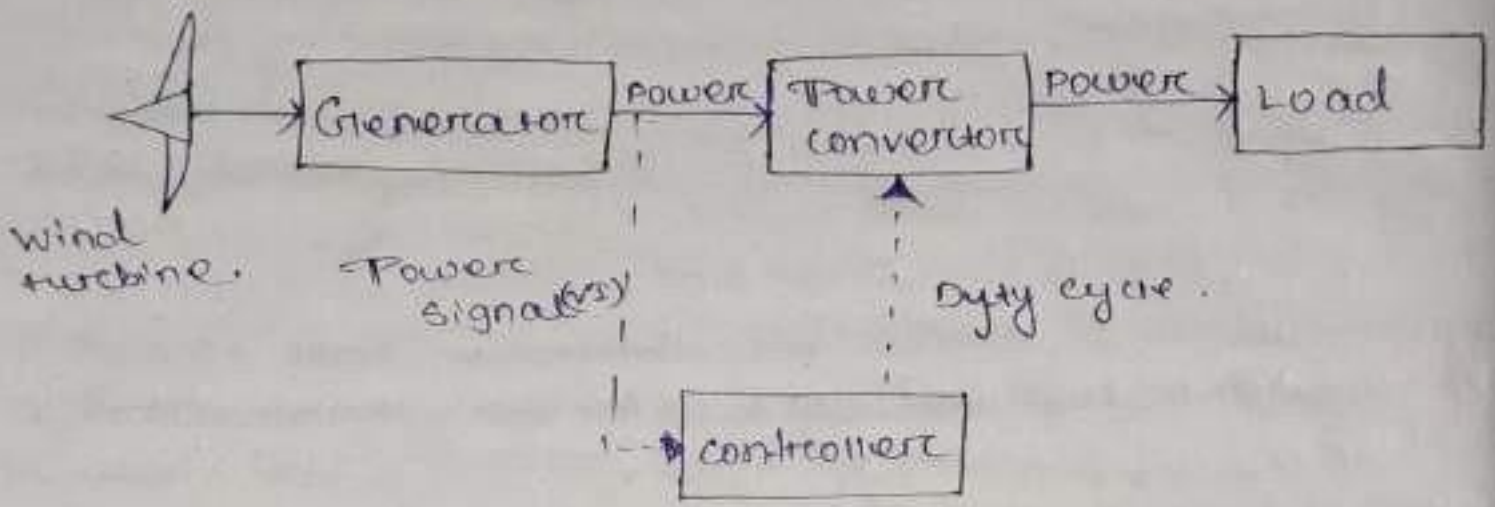
Chapter-3 :WIND Energy :—

Introduction:—

→ wind energy is one of the energy sources in the world, several countries in the world using the wind as one of its energy sources.

→ It can be used for generating electricity for specific uses. the wind it has kinetic energy can be converted to mechanical energy to drive a turbine which converts the mechanical energy to electricity.

Wind energy conversion:—



→ wind energy (or, wind power) describes the process by which wind is used in generate electricity.

→ wind turbines convert the kinetic energy in the wind into mechanical power.

→ This mechanical power, converted to the electrical power by the help of a generator.

Types of wind turbines:—

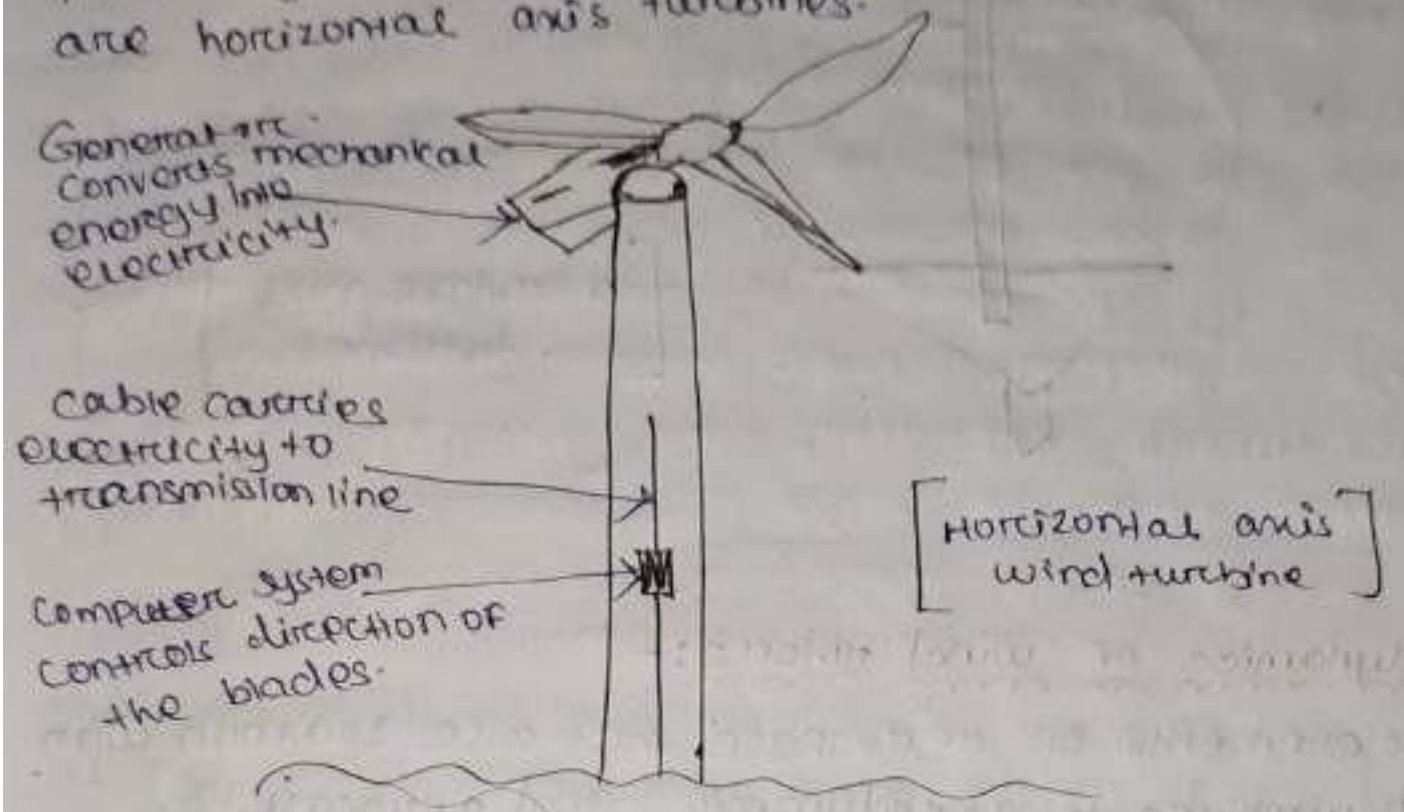
There are two basic types of wind turbines: —

1) Horizontal axis turbines.
2) Vertical axis turbines.

1) Horizontal axis turbines:—

→ Horizontal axis turbines have blades likes aeroplane propellers, and they commonly have three blades.

→ The largest horizontal axis turbines are as tall as 20 storey buildings and have blades more than 100 feet long.
→ Taller turbines with longer blades generate more electricity.
→ Nearly all of the wind turbines currently in use are horizontal axis turbines.



[Horizontal axis wind turbine]

② Vertical axis turbines:-
→ Vertical axis turbine look like egg beaters.
→ That blades that are attached to the top and the bottom of a vertical rotor.
→ The most common type of vertical axis turbine the Darrieus wind turbine named after the georgeus Darrieus who patented the designrt in 1931 looks like a giant two bladed egg beater.
→ Some versions of the vertical axis turbine are 100 feet tall and 50 feet wide.
→ Very few vertical axis wind turbines are in use today because they do not perform as well as horizontal axis turbines.

increasing the efficiency of the system.

→ A renewable energy is the energy that is collected from renewable sources which are naturally replenished at a human time frame such as sunlight, wind, rain, tide waves and geothermal heat.

→ Renewable energy often provides energy in four important areas: electricity generation air and water heating, cooling transport and rural off-grid energy services.

Need for hybrid system:-

→ The WRF 3D-VAR system uses only climatological background error covariances.

→ Flow dependant covariance through ensemble as needed.

→ Hybrid combiness climatological and flow-dependant background error covariances.

→ If can be adopted to an existing 3D-VAR system.

→ Hybrid can be robust formal size ensembles.