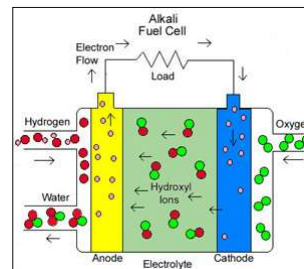
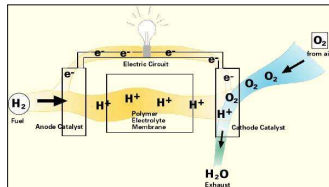


### Hydrogen Energy

- ❖ Hydrogen - potential fuel for motive power, the energy needs of buildings and portable electronics.
- ❖ Use of Hydrogen is primarily through Fuel Cells.
- ❖ Fuel cells promises to check some of the disadvantages of fossil fuels like environmental impact, efficiency, etc.
- ❖ The principle of the fuel cell was discovered by German scientist Christian Friedrich Schönbein in 1838.
- ❖ Based on his work, the first fuel cell was demonstrated by Welsh scientist and barrister Sir William Robert Grove.
- ❖ Most important design features in a fuel cell are:
  - ✓ Electrolyte substance
  - ✓ Fuel that is used (Most common fuel is hydrogen)
  - ✓ Anode catalyst.
  - ✓ Cathode catalyst.



Reference: [http://www.vpmthane.org/publication-aenrgysource/Alternate\\_Energy\\_ebook.pdf](http://www.vpmthane.org/publication-aenrgysource/Alternate_Energy_ebook.pdf)

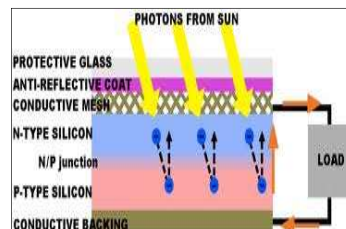
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### Solar Energy

- ❖ The simplest definition of solar energy is the energy from sun.
- ❖ The sun can be regarded as a huge furnace, in which, Hydrogen atoms fuse into Helium at immensely high temperature.
- ❖ The sun is continuously radiating energy for billions of years and will provide solar energy as long as it continues to shine. This makes solar energy a most important renewable energy resource.
- ❖ The emergence of interest in solar energy utilization took place in 1970 due to rising cost of energy from convectional means.
- ❖ Solar energy is the most attractive way to generate energy because the amount of solar radiations received by earth surface per minute is greater than energy utilization by entire population in one year.
- ❖ Absorption, Reflection, Scattering of incident radiation.
- ❖ Direct, reflected, diffused and global solar radiations



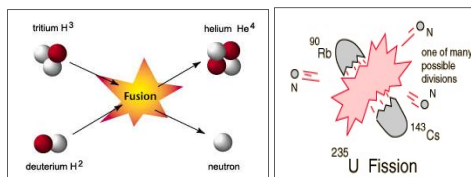
Reference: Solar Energy Fundamental and Modeling Techniques by Zekai Sen **Photovoltaic Cell**

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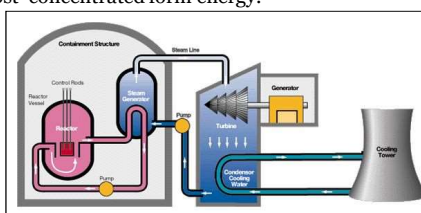
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## Nuclear Energy



- ❖ The nucleus of atom is source of nuclear energy.
- ❖ When the nucleus splits (fission), nuclear energy is released in the form of heat energy and light energy.
- ❖ Nuclear energy is also released when nuclei collide at high speeds and join (fusion).
- ❖ The sun's energy is produced from a nuclear fusion reaction in which hydrogen nuclei fuse to form helium nuclei.
- ❖ Nuclear energy is the most concentrated form energy.



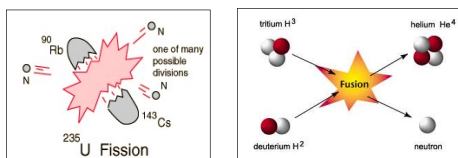
Reference: [http://revisionworld.com/gcse/physics/radioactivity/nuclear-fission &docid](http://revisionworld.com/gcse/physics/radioactivity/nuclear-fission-&docid)

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## Nuclear fission and nuclear fusion



### Nuclear Fission:

- ❖ Fission may be defined as the process of splitting **an atomic nucleus into fission fragments**
- ❖ The fission fragments are generally in the form of smaller atomic nuclei and neutrons
- ❖ Large amounts of energy can be produced by fission
- ❖ Fission produces large amount of heat energy and it is this heat, that is captured by nuclear power plants to produce electricity

### Nuclear Fusion:

- ❖ Fusion is a nuclear reaction whereby **two light atomic nuclei fuse or combine to form a single larger, heavier nucleus.**
- ❖ The fusion process generates tremendous amounts of energy; refer back to Einstein's equation.
- ❖ For fusion to occur, a large amount of energy is needed to overcome the electrical charges of the nuclei and fuse them together
- ❖ Fusion reactions do not occur naturally on our planet but are the principal type of reaction found in stars, like SUN.

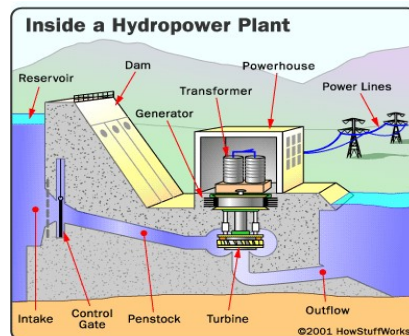
Reference : [www.southerncompany.com](http://www.southerncompany.com)

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## Hydro energy



- ❖ Hydropower is our most mature and largest source of renewable power, producing about 10 percent of the India's electricity.
- ❖ Hydro-power plants convert the energy of **flowing water into electricity**.
- ❖ The most common form of hydro-power uses a dam on a river to retain a large reservoir of water. Water is released through turbines to generate electrical power.
- ❖ Hydropower plants produce **no emissions but can affect water quality** and wildlife habitats. Therefore, hydropower plants are now being designed and operated to minimize impact on the rivers.
- ❖ In India, hydro power potential has been estimated to be about **41100 MW**.

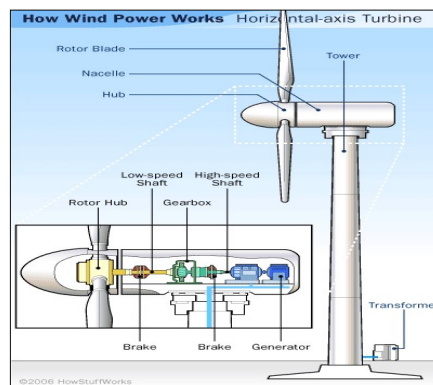
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## Wind energy

- ❖ Wind energy has been used for many centuries to sail vessels, pump water, and grind corn. Today's wind turbines, wind mills, are a much more efficient technology to use wind energy.
- ❖ It is free, abundant, **non-polluting**, inexhaustible and no depletion of scarce resources.
- ❖ Operating cost of a wind mill is virtually zero.
- ❖ But serious flaw in this energy resource is its **unreliability due to non-continuous wind flow**.

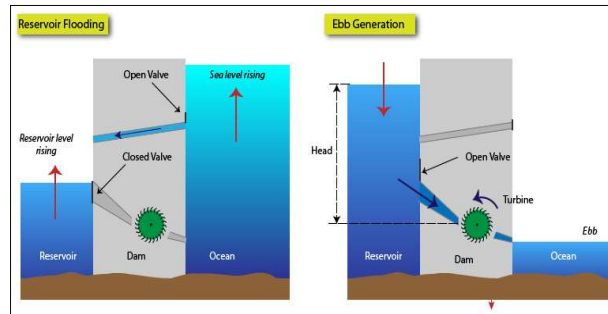


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## Tidal energy



- ❖ Gravitational forces between the moon, sun and the earth cause rising and lowering of oceanic waters around which results in Tidal waves. The moon exerts more than twice as great a force on the tides as the sun because it is much closer to the earth.
- ❖ To harness the tidal energy, a dam is built across the mouth of a bay. It will have large gates in it and low head hydraulic turbines should also be installed in it. By opening the gates at time of high tide, water is stored in the tidal basin and the gates are closed. After the tide has receded, the water is allowed to flow back to ocean through water turbines in the dam.
- ❖ In India, 7400 MW could be generated in gulf of Cambay and 1200 MW in Gulf of Kutch.

