Energy & Resources

Energy and resources

- **Definition and importance of energy:**

- Energy is defined as the ability to do work.

- It is measured by multiplying the force applied on an object (measured in Newton) with the distance measured by that object (measured in meter).

- The unit of energy therefore is **Newton-meter** (N-m) called **Joule** (J).

- Its higher units are
- kilo joule (kJ),
- Mega joule (MJ),
- Giga joule (GJ) and
- Exa joule (EJ).

Energy and resources

- When energy is converted into electricity, it is called **power.**

- The unit of measurement of power is J/s (Joule per second), known as **watt** (W).

- 1000 watt is known as **one kilowatt** (kW),
- 10^6 watt is one mega watt (M.W), and
- 10^9 watt is one Giga watt (G.W).

- The electricity consumed in our homes is measured in kilowatt hour (kWh); i.e., one kilowatt load used for one hour.

Energy and resources

- **Energy is required for doing any type of work in life.**

- It is required for
- **cooking,**
- **heating,**
- **cooling,**
- **lighting,** etc in our homes.

- **It is required to run machines and other mechanical equipment in industries.**

- **It is required to run locomotives for transportation**.

- So much so that the amount consumption of energy by a nation is usually considered as **an index of its development**.

- This is because of the fact that almost all our developmental activities are directly or indirectly dependent upon the energy consumption. That is why, there exists wide disparities between the energy consumption of the developed and non-developed countries.

Types of energy sources

- An energy source may be defined as the one that can provide us with adequate amount of energy in a usable form over long periods of time. These sources can be divided into the following major types:
- **(i) Renewable energy sources**
- **(ii) Non-renewable energy sources**
- **(iii) Sustainable energy source**

Renewable energy sources

- These are those energy sources which are either **perpetually available in nature** such as

- **Heat of the sun,**
- **Power of winds,**
- **Power of tidal sea waves,**
- **Thermal energy of the oceans,**
- **Heat persistent under the earth's crust etc.,**

- They are all generated continuously in nature

Non- renewable energy sources

- These are those energy sources which have accumulated in nature over a long span of time (millions of years) and can not be replenished in hundreds of years.

- **These sources are finite in quantity and cannot be reproduced**.

- They are, thus, sure to be exhausted after some years.

- These energy sources include fossil fuels such as

- **coal,**
- **petroleum**
- **natural gas**
- **nuclear fuels like Uranium-235.**

Sustainable energy source

Sustainable energy is a term sometimes **applied to nuclear power**.

The supplies are not exactly renewable, but they will last for a very long time because a great deal of electricity is produced from a small amount of radioactive material

Sources of energy

- **Renewable energies:**

- (1) Solar energy
- (2) Wind energy
- (3) Tidal energy
- (4) Ocean thermal energy
- (5) Geothermal energy
- (6) Hydro-power

- **Non-renewable energies:**

- (7) Biomass energy
- (8) Thermal power
- (9) Nuclear power.

Advantages and disadvantages of various energy types

Energy type	Advantages	Disadvantages
Renewable	Wide availability. Lower running cost. Decentralized power production. Low pollution. Available for foreseeable future.	Unreliable supply. Usually produced in small quantities. Often very difficult to store. Currently per unit cost of energy is more compared to other type.

Advantages and disadvantages of various energy types

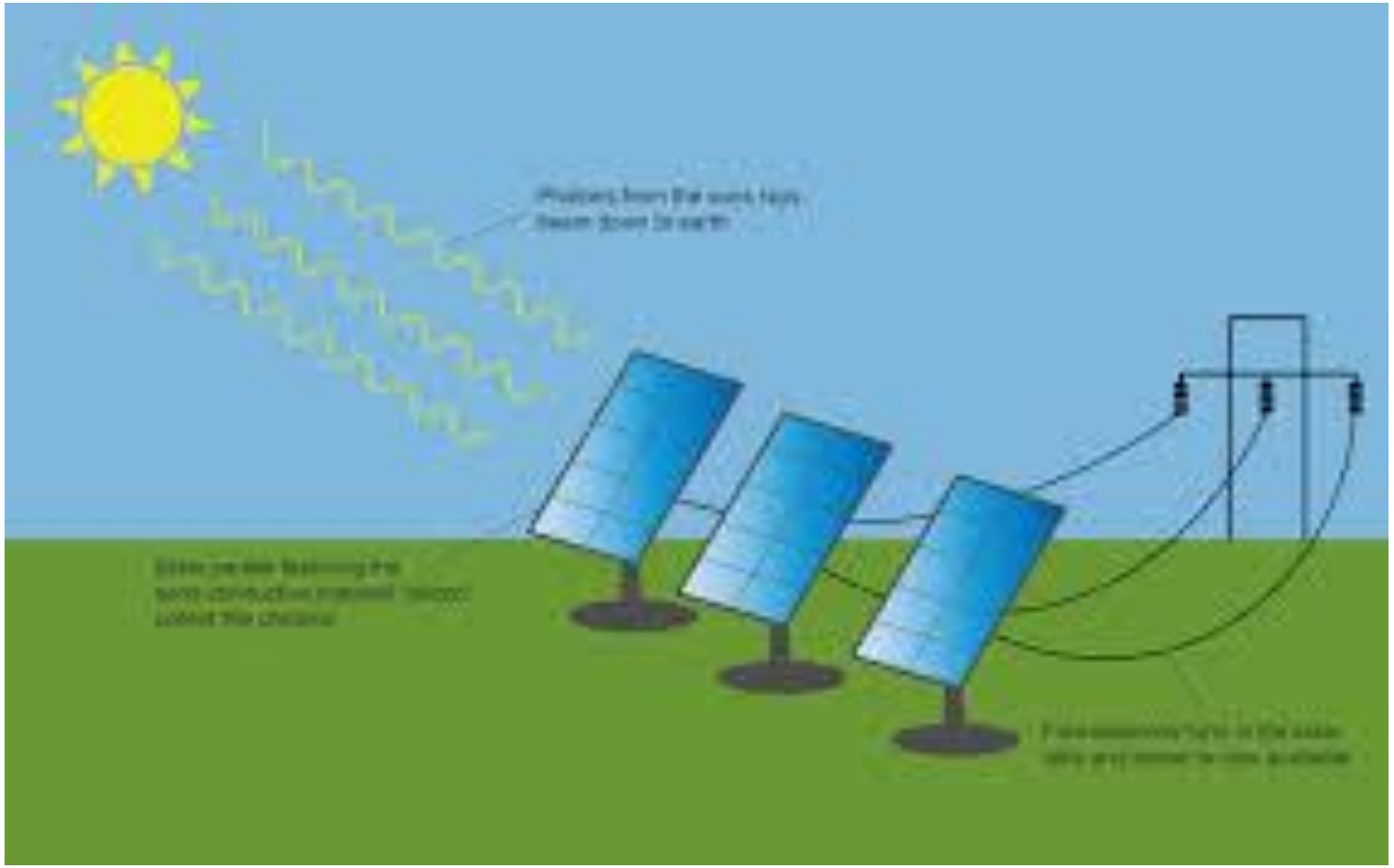
Energy type	Advantages	Disadvantages
Non-renewable	Available in highly concentrated form. Easy to store. Reliable supply. Lower cost per unit of energy produced as the technology is advanced.	Highly polluting. Available only in few places. High running cost. Limited supply and will one day get exhausted.

Advantages and disadvantages of various energy types

Energy type	Advantages	Disadvantages
Sustainable (Nuclear power)	Highly reliable. Produces large amounts of energy with very little carbon dioxide emission. Uses small amount of raw material per unit energy production.	Risk of radioactivity. High waste disposal cost. High capital investment and maintenance cost.

Solar energy

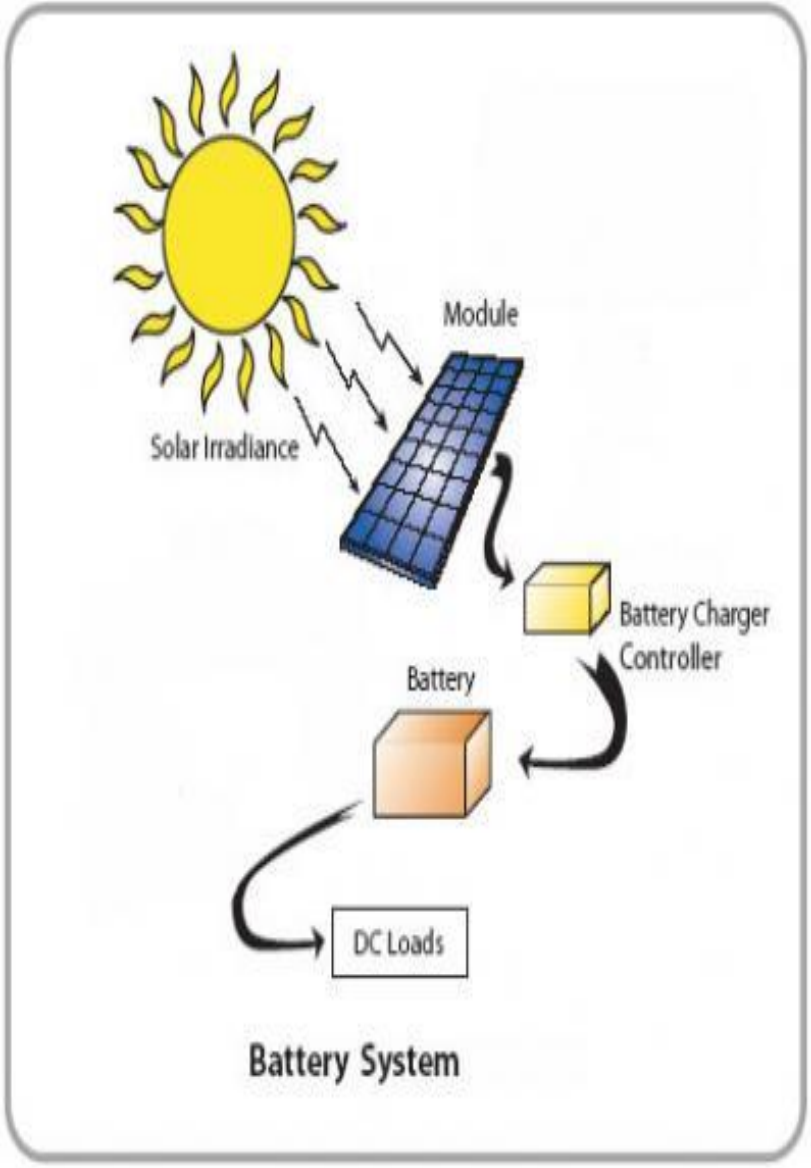
Solar energy

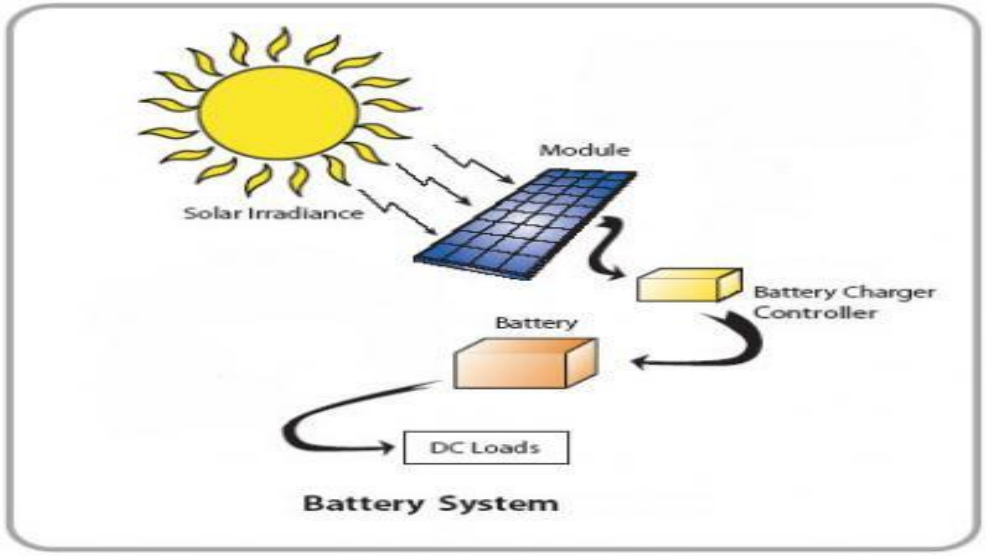


Solar energy

The solar energy is the direct heat and light energy released continuously by the sun, as sun is perpetual source of energy.

The nuclear fusion reactions occurring in side the sun are understood to be releasing enormous quantities of energy in the form of heat and light.



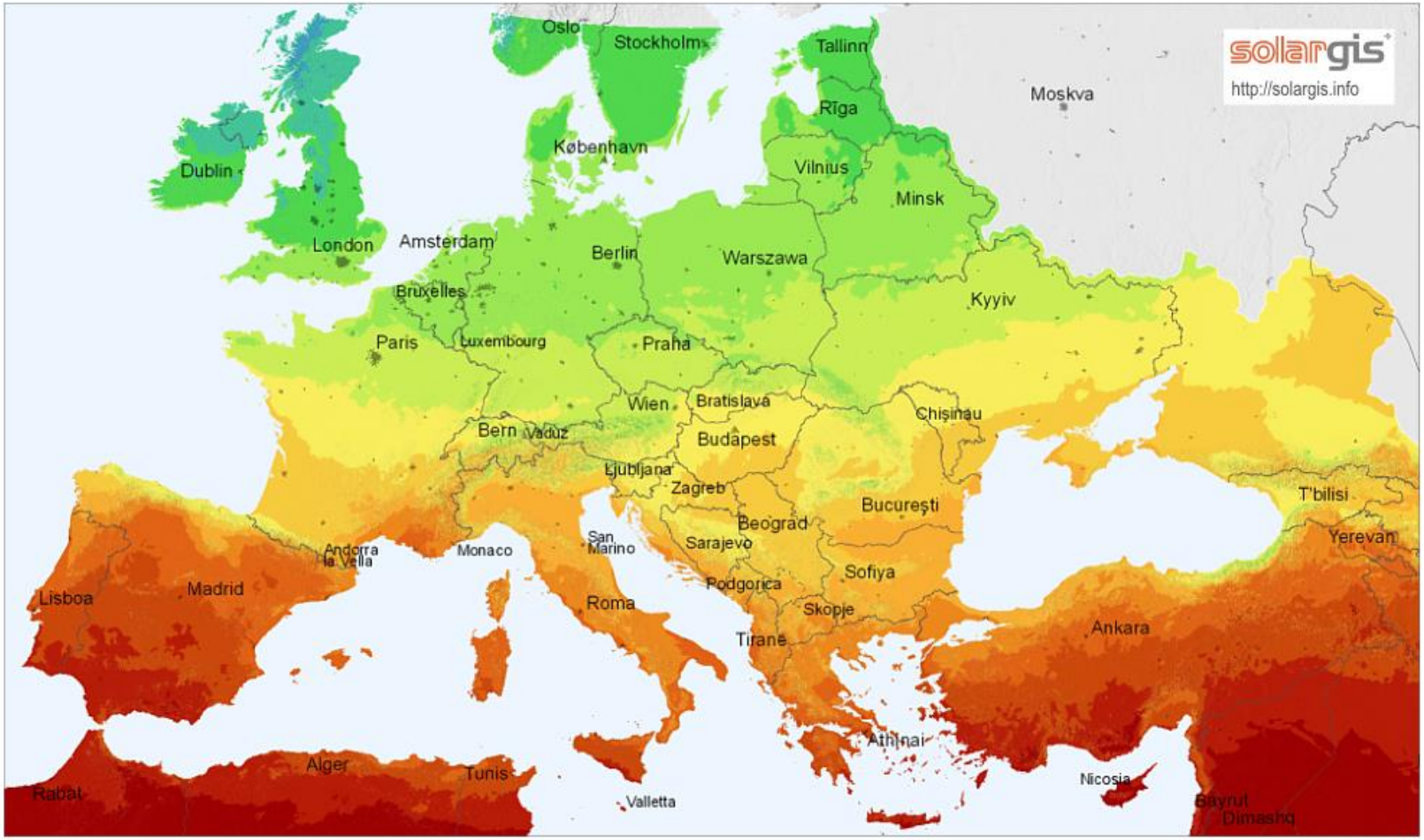


Solar energy

The solar energy, received by the near space surrounding the earth is estimated to be about 1.4 kJ/second/m2. This is known as **solar constant.**

Global horizontal irradiation

Europe

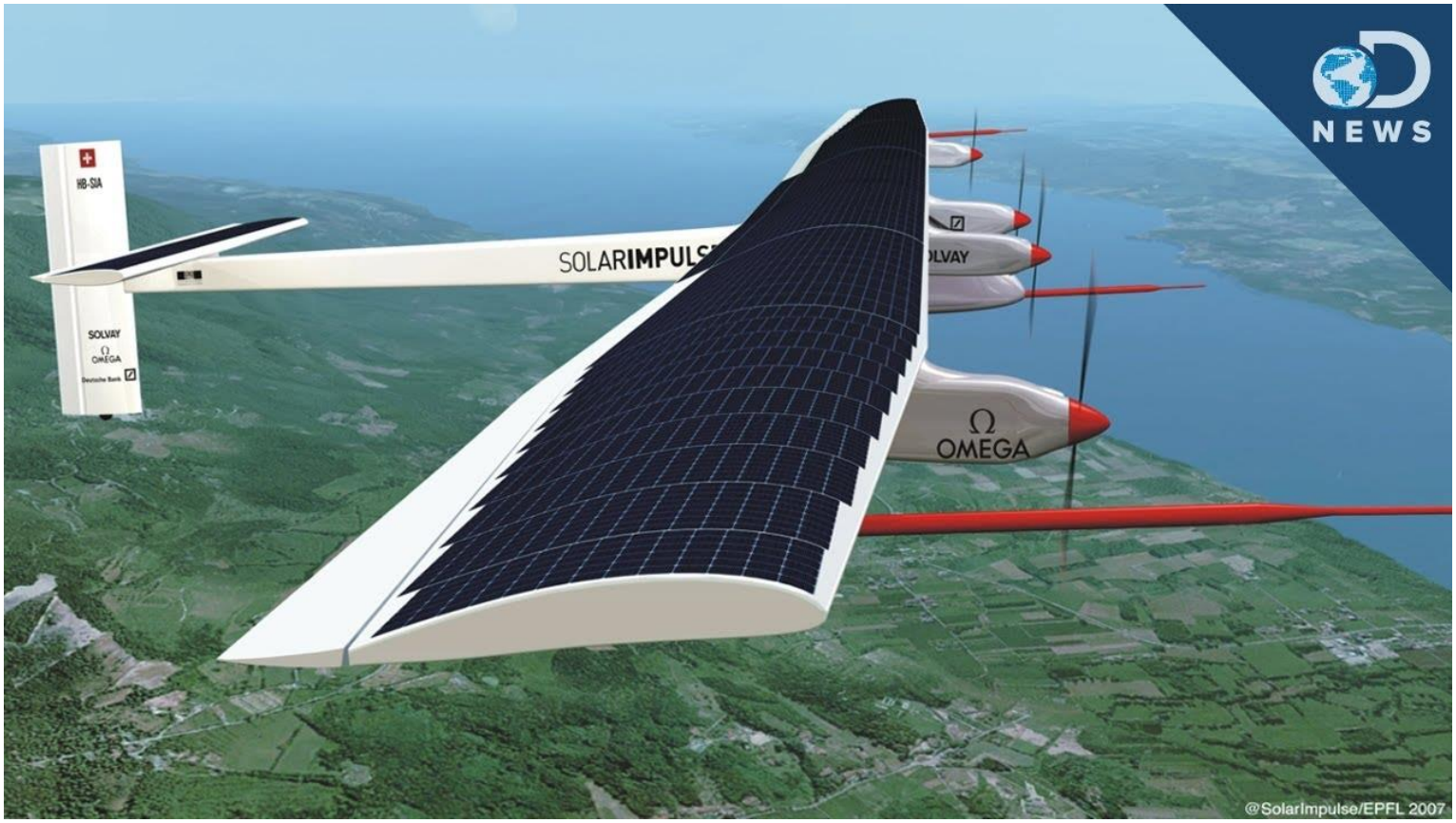


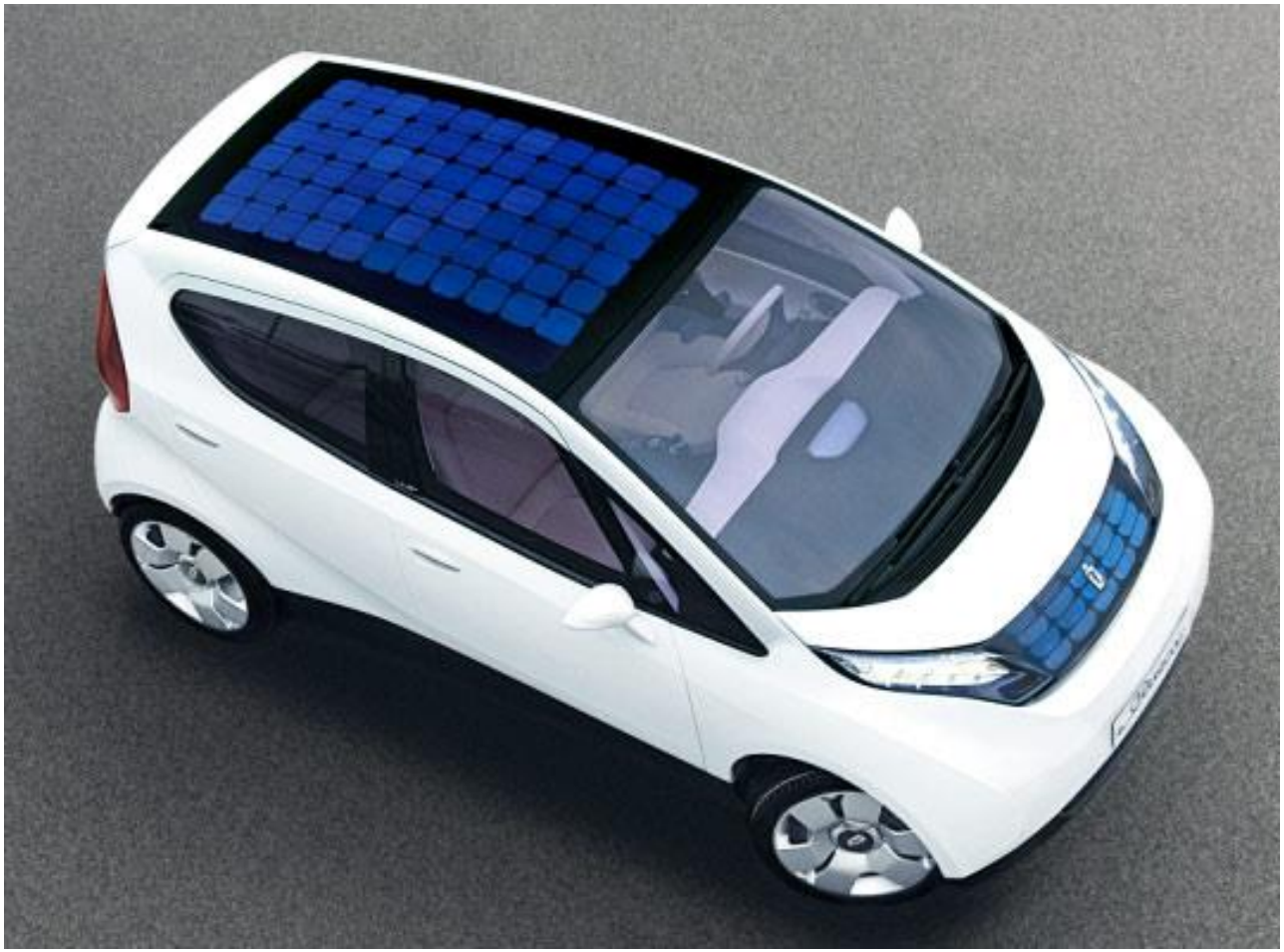
Average annual sum (4/2004 - 3/2010)

< 700 900 1100 1300 1500 1700 1900 > kWh/m^2

0 250 500 km


victorytraffic.en.alibaba.com

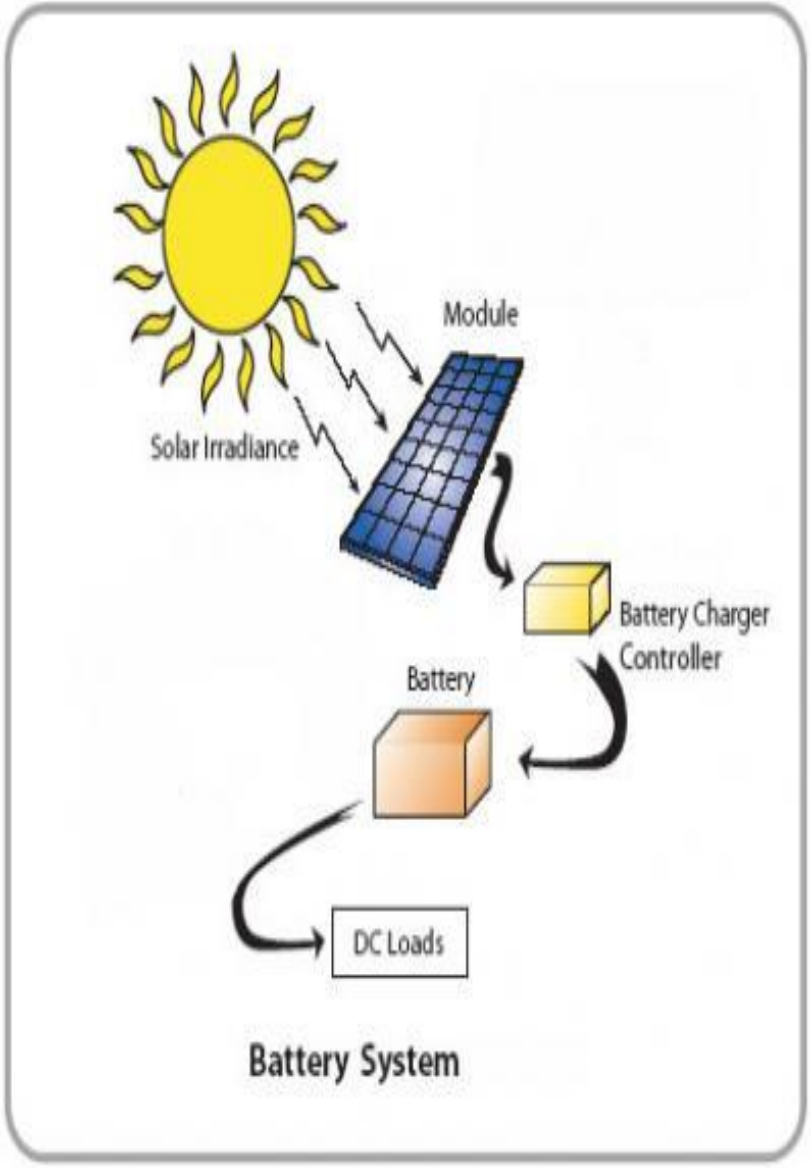

NEWS
HB-SIA
SOLVAR
OMEGA
SOLVAY
OMEGA
@SolarImpulse/EPFL 2007



Solar energy

Solar energy holds a tremendous potential for the future, since the total energy we receive each year from the sun is around **35,000 times** the total energy being used presently by man.

However, about 1/3rd of this total energy is either absorbed by the outer atmosphere, or reflected back into the space, through a process called **albedo.**



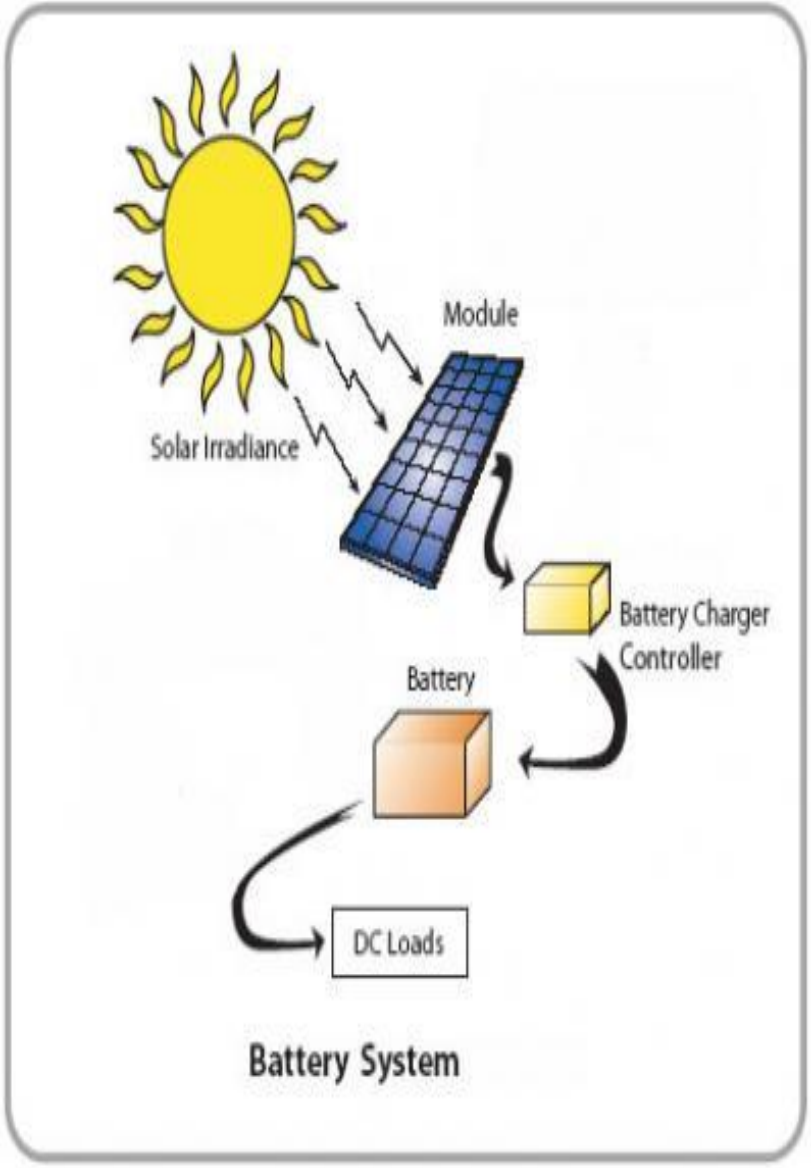
Solar energy

In spite of such a huge amount of solar energy being received on earth, its present utilization is on a very small scale

in homes and to heat up waters of swimming pools.

In homes, it is being used for cooking food in solar cookers,

. Its use in solar water heaters to supply hot water in houses and hotels,
There is an urgent need to increase their use in hotels,
Hospitals
and individual homes\
to replace the usual electric geysers, for obtaining hot waters for bathing and washing purposes.



Solar energy

In future, solar energy can possibly be used **to run cars, power plants, spaceships.**

Disadvantages

Not continuous (During night)
Not workable in cloudy days
Although solar energy is freely available,
the necessary equipment and installations are not free.
The initial cost of setting up a solar energy harnessing system, including a standby heating unit are high
over the long term, solar energy will become **economical,** cost **effective**,
as the prices of fossil fuels increases with their **dwindling** stocks, in future.

Wind Energy

- The **driving force** of the wind is **sun**
- Wind has been used for centuries, as almost a free and a non-polluting source of energy.
- Sailing ships and wind powered grind mills are the early examples
- The high-speed winds, infact, do possess a lot of **kinetic energy** due to their velocity
- The minimum wind speed required for satisfactory working of a wind generator is **15 km/hr.**
- Wind speed increases with height.
- At a given turbine site, the power available ***30m above ground*** is typically **60% greater than at 10m height**.
- That is why windmills need to be located at enough heights.
- The wind energy could also be used to produce hydrogen by the electrolysis of water.
- This combustible gas could then be piped to land and used as a fuel**.**


WIND DIRECTION
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1. Blades
2. Rotor
3. Pitch
4. Brake
5. Low-speed shaft
6. Gear box
7. Generator
8. Controller
9. Anemometer
10. Wind Vane
11. Nacelle
12. High-speed shaft
13. Yaw drive
14. Yaw motor
15. Tower

Wineglass Bay, Tasmania, Australia (42°10′S, 148°18′E).

Wind Energy

A large number of windmills are installed in clusters of hundreds of units, called **WIND FARMS**, which generate power and feed it to the nearest power grid for distribution.

These farms are ideally located in -

1. **Coastal areas,**
2. **Open grasslands,**
3. **Hilly regions,**
4. **Mountain passes and ridges,** etc.,

where the winds are usually strong and steady.

Wind Energy

Wind speed increases with height

The wind energy could also be used to produce hydrogen by the electrolysis of water. This combustible gas could then be piped to land and used as a fuel.

Wind Energy

Disadvantages

1. **Wind is an intermittent source,**
2. **Intermittency of wind depends on the geographic distribution of wind.**
3. **Wind, therefore, generally cannot be used as the sole source of electricity in an area,**
4. **Requires some other backup or standby source of electricity.**
5. **noise pollution**
6. **Kills bird**
7. **interference with TV reception**
8. **aesthetic objections to the shear number of wind turbines**

Biomass energy

Biomass is the organic matter produced by the **plants, animals** and include **wood, cattle dung, agricultural wastes such as crop residues, organic municipal solid waste like paper, food wastes and other non fossil fuel derived materials like textiles, natural rubber, leather etc.**

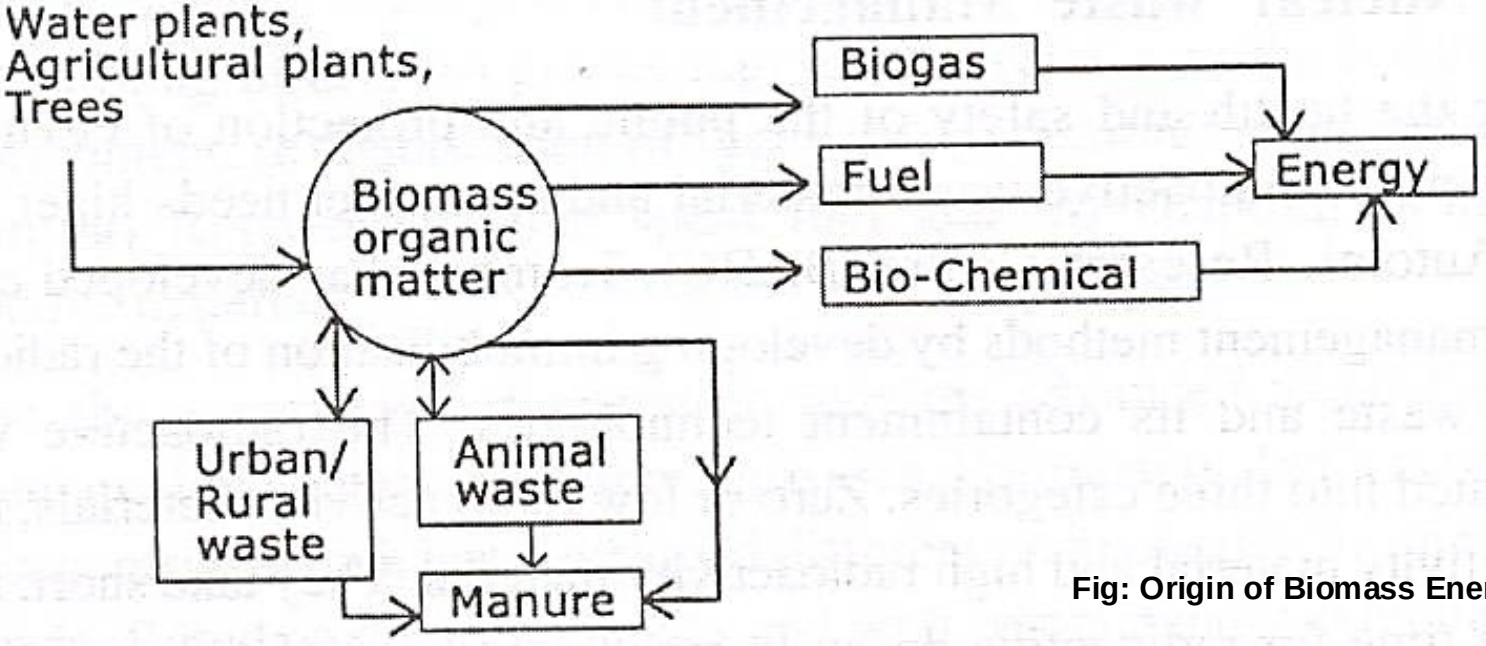


Fig: Origin of Biomass Energy

Biomass energy

Biomass is used on a large scale to obtain energy either by directly **burning** the same or by converting it into more convenient form of

1. **solid fuels** like **manure, dung cakes** etc

2. **liquid fuels like ethanol, biodiesel etc or gas fuels like biogas etc.**

Biomass has infact, provided a major source of energy to human beings, since the early days of human civilization.

The firewood is the best known and most widely used biomass fuel in the world.

Wood alone is being used as a primary source of energy, even in these modern days.

In India dung cakes are made from cattle dung and burnt for cooking.

Biomass energy

The vegetation matter, cow dung and other organic municipal wastes (biomass) can also be converted into gas fuels, like biogas, which can be used as a clean source of energy, for cooking or for producing electricity on a small scale to light the individual homes or group housing flats or even streetlights.

Since the direct burning of biomass produces air pollutants like **CO_2, SO_2, NOx** etc, it is always preferable to convert the biomass into a cleaner gas fuel (biogas).

Production of Biogas and Gobar gas from biomass:

Biogas is produced from
animal dung,
kitchen wastes,
plants like hyacinth, etc and
organic wastes from households and
industries like fish processing, diaries etc.

In India, the biogas is primarily being produced from cattle dung (gobar), and hence this biogas is called the **'Gobar gas'.**

The vegetation matter (biomass), besides being used as a fuel for direct burning to produce heat or electricity, can also be converted into liquid fuels, called biofuels.

These biofuels can some day replace the fossil fuels (i.e. diesel and petrol) to run our locomotives.

The two most common types of biofuels produced from biomass are ethanol and biodiesel.

Ethanol is an alcohol made by fermenting any biomass high in carbohydrates (i.e. sugars, starches, cellulose etc).

Ethanol is at present, is mostly used as a fuel additive to cut down a vehicle's **carbon monoxide** and other **smog** causing emissions.

But flexible fuel vehicles, which would run on mixtures of gasoline and up to 85% ethanol, have been developed in Japan.

Thus, technology is already underway to replace diesel and petrol with such biofuels.

Biodiesels is made by **combining alcohol (usually methanol) with vegetable oil, animal fat etc.**

Biodiesel can be used as an additive to reduce vehicle's emissions (typically by 20%) or in pure form, as a renewable alternative fuel for diesel engines.

Researchers are also developing algae that produce oils, which can be converted to biodiesel.

New ways have also been found to produce ethanol from grasses, trees, barks, sawdust, paper and farming wastes.

The fibrous waste of sugar industry is world's largest potential source of biomass energy.

Ethanol produced from sugarcane molasses is a good automobile fuel.

Another liquid fuel, called the pyrolysis oil, can also be produced from the biomass, through a process called pyrolysis.
Pyrolysis occurs when biomass, is heated in absence of oxygen.
The biomass then turns into liquid, called pyrolysis oil, which can be burnt like petroleum to generate electricity.

Biogas primarily contains

methane-CH_4 (60-79%) and

carbon dioxide-CO_2 (30-35%),

small quantities of nitrogen-N_2 (5%) and

oxygen-O_2 (0 - 0.1%).

The hydrogen sulphide-H_2S gas may also sometimes be present, though rarely.

In this mixture of gases, methane burns easily and hence this biogas can be easily used for cooking,
heating and
for producing electricity.

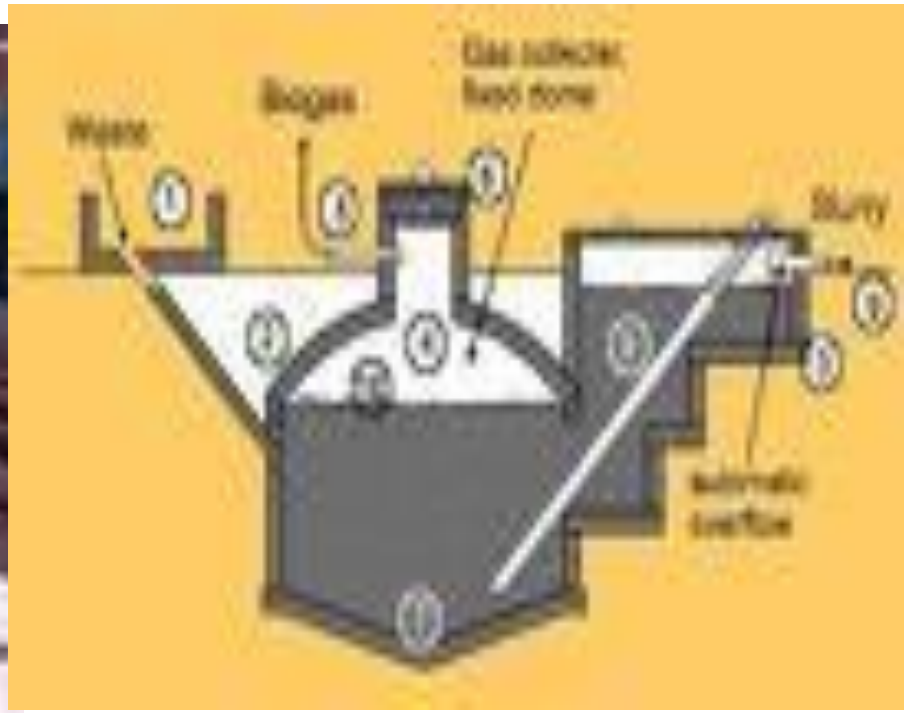
It has been estimated that from 1 tonne (1000 kg) of food waste, one can produce 85 m^3 of biogas.

Once the biogas is produced from the waste biomass, some residue is left, which can be used as an **agricultural fertilizers (manure).**

BIOMASS
ENERGY

Short rotation forestry/ plants


WASARA | CONCEPT


Gas collector
feed zone
Biogas
Slurry

Hydrogen Energy

- The fossil fuels (coal, petroleum and natural gas) based energy sources are getting depleted rapidly and their availability is not promising.
- At present **petroleum fuels** are contributing to the **80%** of energy requirement.
- Hydrogen has been identified as alternative promising energy source.
- Hydrogen can be produced in unlimited quantities from abundant, universally distributed and inexhaustible energy sources.

Hydrogen Energy

The primary energy sources may be
water,
coal,
biomass,
natural gas,
petroleum etc.

Hydrogen is an **intermediate secondary energy source**.

Using Hydrogen fuel in transportation sector is presently in planning and development stage only.

Hydrogen can be used economically and commercially around **2020.**

It has been established that hydrogen can meet all the energy needs of world in the coming years.

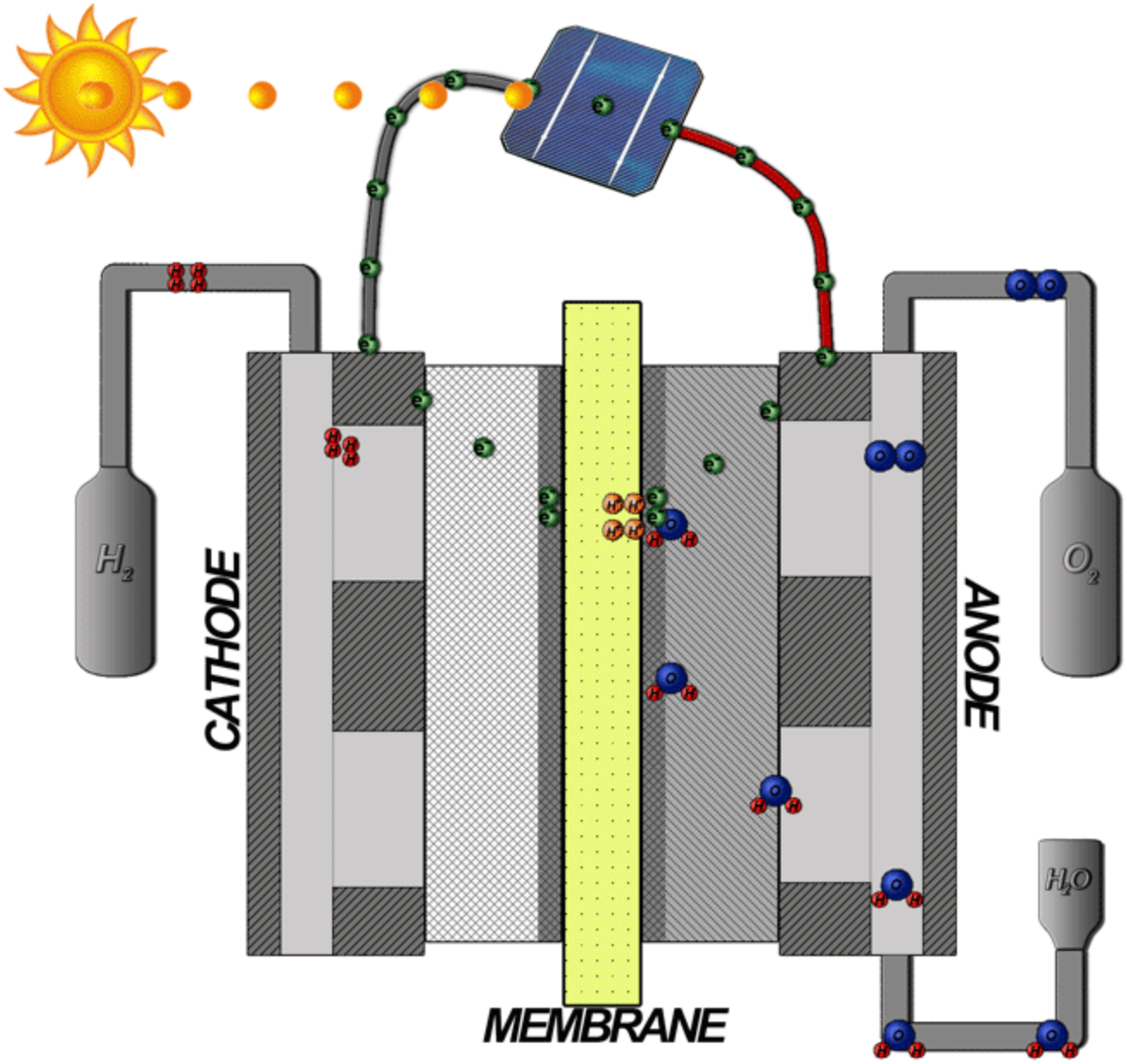
Hydrogen Energy

Hydrogen can be produced commercially by

1. **Electrolysis of water,**
2. **Steam reforming of hydrocarbons,**
3. **Liquefaction of natural gas,**
4. **Cracking of ammonia,**
5. **By reaction of coal at high temperatures.**

Hydrogen can be produced without pollution by electrolysis of water,

Water electrolysis would be a major hydrogen production of the future.



Water Splitting for the generation of Hydrogen

Hydrogen Energy

Advantages

The merits of hydrogen as an alternative future fuel are

(1) It can be produced by several alternative methods.

(2) It can be produced from fossil fuels, water, biomass etc.

(3) Hydrogen is a renewable energy source.

(4) Hydrogen has high energy density as compared to fossil fuels.

(5) Hydrogen is an environmentally friendly and clean fuel. The end product is water

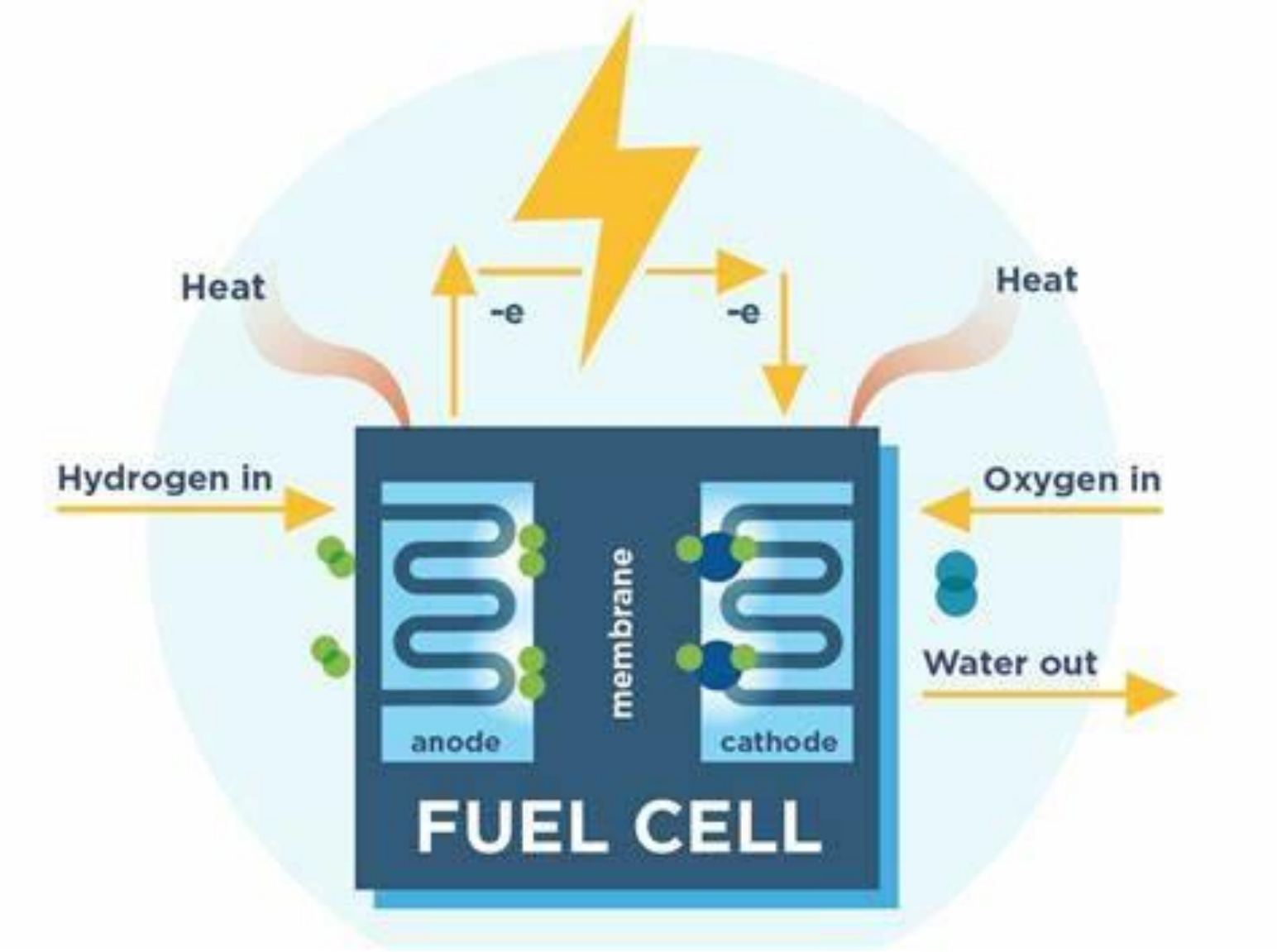
(6) Hydrogen can be transported by pipeline, just like natural gas.

Hydrogen Energy

Hydrogen is used in

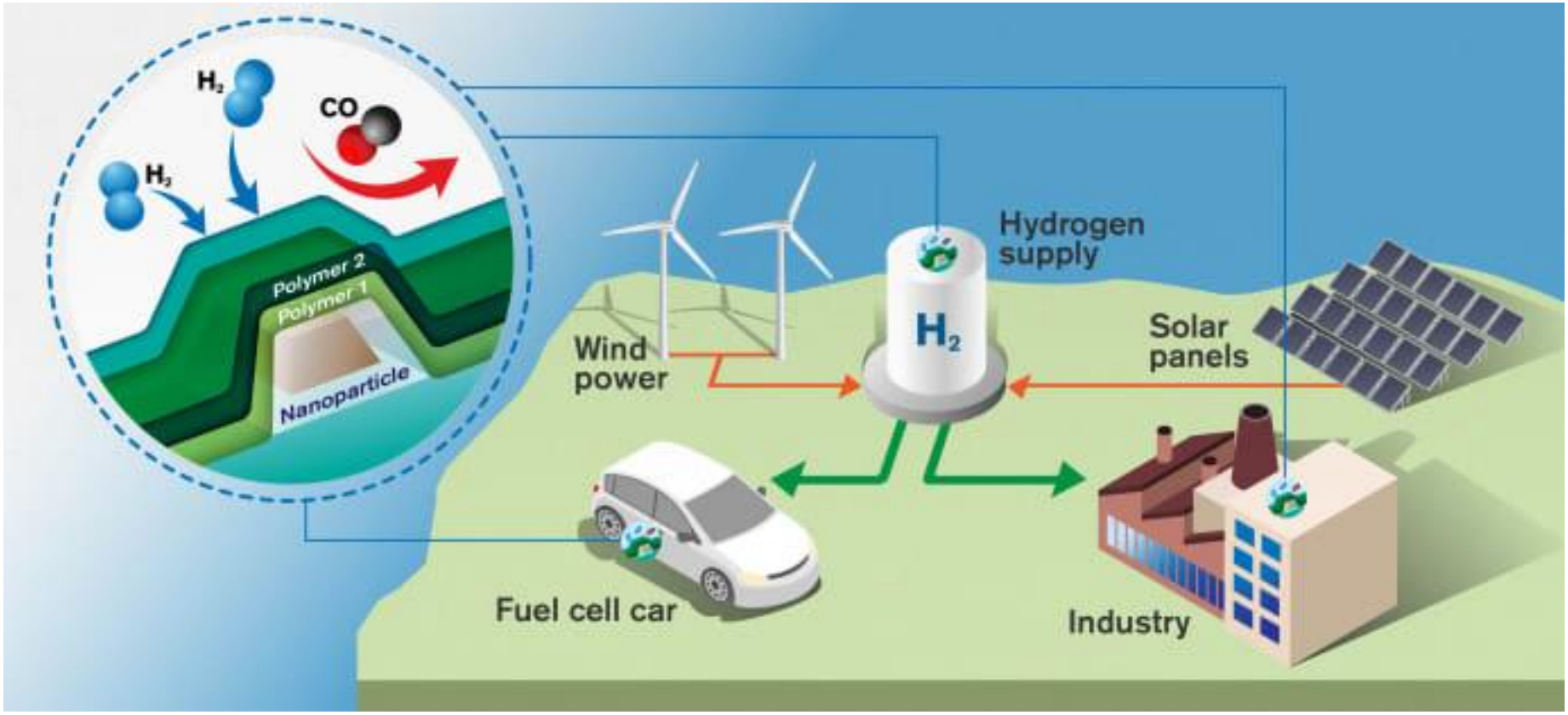
1. Synthesis of ammonia (NH_3), methanol (CH_3OH), urea
2. As reducing agent in metallurgy etc.
3. It is used as high thrust fuel in rockets.
4. In future, hydrogen will be an intermediate fuel for transportation.

Utilization of Hydrogen Energy



Limitation of Hydrogen Energy

The limitation is that ***hydrogen is a gas at normal temperature and pressure***, hence it is difficult to **store and transport**. Hydrogen is an **explosive gas** and care is necessary against leakage and explosion.



Thermal Energy

- Thermal power plants develop electricity by using the heat energy produced by ***burning of the fossil fuels like coal, oil and natural gas***.
- The heat produced by burning of such a fuel is used to heat up and boil water ***to produce steam***, which in turn, is moved in pipes to ***turn the turbines***, coupled with generators to produce electricity.
- These fuels are non-renewable and their supply shall last only for a finite period.
- The power generated from the use of these fuels is, hence known as non-renewable energy.

Environmental impacts of Thermal power plants

- 1. Use of coal in thermal power production causes generation of huge quantities of flyash waste.
- 2. The burning of coal emits air pollutants like particulate matter and gases like sulphur dioxide, oxides of nitrogen carbon dioxide etc.
- 3. Drilling and extraction of oil may cause leaks and accidental fires causing severe pollution of the land, sea and air.
- 4. During refining of crude oil, several solid wastes like grease are produced which damages the environment.

Environmental impacts of thermal power plants

- 5. The high-ash fuels used makes flue-gas dust control a difficult problem.
- 6. The hot water disposed into the river cause an increase in the temperature of a river which leads to Oxygen depletion of the river water. Oxygen deficiency can be seriously detrimental to aquatic life.
- 7. Thermal power plants can have impacts on soil and groundwater. The soil quality, can be adversely affected by dust sediment, particularly in the near vicinity of the plant. The seriousness of ground-level pollution depends on the heavy-metal content of the dust. The chemistry of the soil can be altered by acidic precipitation (acid rain) characterized mainly by the acid formers SO2 and NOx. Under unfavorable conditions, acidification can pass from the soil to both the groundwater and surface waters.

Environmental impacts of thermal power plants

- 8. Adverse effects of thermal power plants on human health can derive from the direct impact of noxious gases on the organism and/or their indirect impact via the food chain and changes in the environment. Especially in connection with high levels of fine particulates, noxious gases like S2 and NOx can lead to respiratory diseases.
- 9. The personnel working in power plants are exposed to substantial noise nuisance.
- 10. The landscape is affected by construction of the roads needed for delivering operating media and disposing of residues.

Energy Conservation

- Energy conservation means to reduce the quantity of energy that is used for different purposes.
- This practice may result in increase of financial capital, enevironmental value, national and personal security, and human comfort.
- Individuals and organizations that are direct consumers of energy may want to conserve energy in order to reduce energy costs and promote economic, political and environmental sustainability.
- Industrial and commercial users may want to increase efficiency and thus maximize profit.

Energy Conservation

- On a larger scale, energy conservation is an important element of energy policy. In general, energy conservation reduces the energy consumption and energy demand per capita. This reduces the rise in energy costs, and can reduce the need for new power plants, and energy imports. The reduced energy demand can provide more flexibility in choosing the most preferred methods of energy production.
- By reducing emissions, energy conservation is an important method to prevent climate change. Energy conservation makes it easier to replace non-renewable resources with renewable energy. Energy conservation is often the most economical solution to energy shortages.

Tips to Save Energy

- Turning the lights off whenever you leave a room.
- Using energy saving light bulbs in rooms.
- Turning the heating down or off in rooms that are not being used regularly.
- Ensuring the window and door seals are in good condition in air-conditioned rooms.
- Using sun light to dry clothes in the summer rather than mechanical cloth drier.
- Choosing low energy rating appliances for cooking, washing and refrigerating.
- Making sure that hot water boilers and pipes are well insulated.