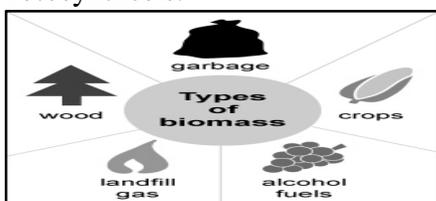
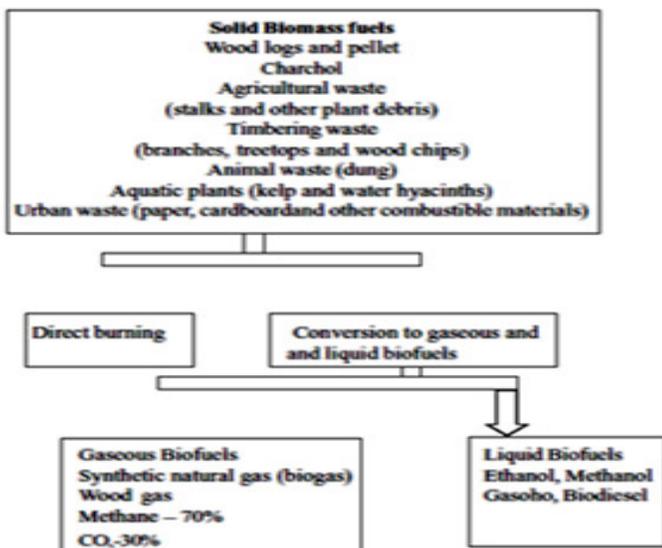


## 30B. RENEWABLE SOURCES OF ENERGY-II

- These energy resources can be used with minimal environmental degradation. Its for these reasons there is growing interest in renewable energy resources.
  - Biomass is a renewable energy resource derived from plants and animal waste.
  - The energy from biomass is released on burning or breaking the chemical bonds of organic molecules formed during photosynthesis.



- Biomass represents an indirect form of solar energy.
- Biomass fuels can be used directly or they can be transformed into more convenient form and then used.
- Energy from biomass is the oldest fuel used by humans. More than one million people in the world still use wood as primary source of energy for cooking.
- **Sources of biomass**



- Biomass can be burnt directly as a source for cooking, heating, lighting, generating steam, for industrial use for producing electricity.
- Can be used to generate gaseous fuels (gasification).
- Can be converted into alcohol (liquid biofuels) by distillation.
- Methane and biogas can be produced from urban wastes in landfills and sewage at waste water treatment plants.
- Manure from livestock and other organic waste is converted by microorganisms in digestion chamber to form methane (CH<sub>4</sub>), which is burned to produce electricity, used in fuel cell, or used as fuel for vehicles.
- Molasses obtained from sugarcane is fermented to produce ethanol that can be used in automobiles.
- **Uses of Biomass**
  - Traditional use of biomass is more than its use in modern application. In the developed world biomass is important for applications such as combined heat and power generation.
  - Biomass fuels used in India account for about one third of the total fuel used in the country, and it amount to 90% of the rural households.
  - Bricks can be used as fuel in place of coal in traditional chulhas and furnaces or in a gasifier.
- **Advantages of Biomass Energy**
  - Burning of biomass does not increase atmospheric CO<sub>2</sub> as biomass was formed by atmospheric CO<sub>2</sub> and the same amount of carbon dioxide is released on burning.

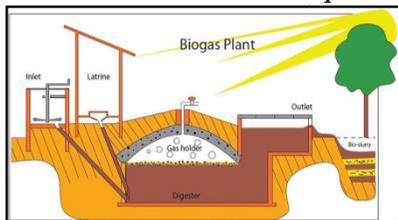
- Biomass is renewable and free from net CO<sub>2</sub> emissions and is abundantly available on the earth in the form of firewood, agricultural residues, cattle dung, city garbage etc.
- Bio-energy, in the form of biogas, which is derived from biomass, is supposed to be one of the key energy resources for global sustainable development.

• **Bagasse as Biofuel**

- Bagasse, is the leftover of sugar cane after it is crushed and its juice extracted, is used to generate electricity.
- About 3500 MW of power can be generated from bagasse in the existing 453 sugar mills in the country.
- Around 270 MW of power has already been commissioned and more is under construction.

• **Biogas plant**

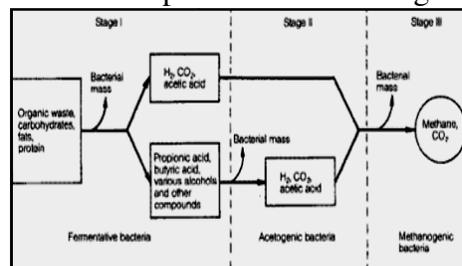
- The biogas plant consists of two components:
  - (i) Digester (or fermentation tank) and
  - (ii) a gas holder.
- The digester is a cube-shaped or cylindrical waterproof container with an inlet into which the fermentable mixture is introduced in the form of liquid slurry.



- The gas holder is normally an airproof steel container that floats like a ball on the fermentation mix, cuts off air to the digester (anaerobiosis) and collects the gas generated.
- The gas holder is equipped with a gas outlet, while the digester is provided with an overflow pipe to lead the sludge out into a drainage pit.
- Any biodegradable substance can be fermented anaerobically (in absence of

oxygen) by methane-producing (methanogenic) bacteria.

- Cow dung or faeces are collected and put in a biogas digester or fermenter (a large vessel in which fermentation can take place).
  - A series of chemical reactions occur in the presence of methanogenic bacteria (CH<sub>4</sub> generating bacteria) leading to the production of CH<sub>4</sub> and CO<sub>2</sub>.
- Methanogenesis is a microbial process, involving many complexes, and differently interacting species, but most notably, the methane-producing bacteria.
  - The biogas process consists of three stages; hydrolysis, acidification and methane formation.
  - Figure shows the process of Methanogenesis



- **Potential of biogas in India**
- This is **equivalent to 6.6 crore domestic LPG cylinders**. This is equivalent to 5% of the total LPG consumption in the country today.
- **Petro crops (Plants)**
  - There is a need for alternative energy providing sources that can be regenerated.
  - Recent researches suggest that hydrocarbon producing plants can become alternative energy sources, which can be inexhaustible and ideal for liquid fuel.
  - Petro plants/petrocrops can be grown on land which are unfit for agriculture and not covered with forests.
  - Plant species that produce substances/products can be extracted in an economically viable way.

- Plant species belong to the families Asclepiadaceae, Asteraceae, Anacardiaceae Euphorbiaceae, Convolvulaceae, Caprifoliaceae, Lamiaceae, and Moraceae.
- *Jatropha curcas* is an important petro-plant
- Biocrude is obtained by tapping the latex, followed by coagulation, or by extraction of the dry biomass using a suitable solvent in cases where latex tapping is not possible.
- Biocrude is a complex mixture of liquids, terpenoids, triglycerides, phytosterols waxes, and other modified isoprenoid compounds.
- Hydro cracking of biocrude can convert it into several useful products like gasoline (automobile fuel), gas oil and kerosene.

- **Some potential Petro-crop species are**

- ❖ *Calotropis*
- ❖ *Euphorbia*
- ❖ *Jatropha curcas*
- ❖ *Pittosporum*
- ❖ *Parthenium*

- **GEOTHERMAL ENERGY**

- It is natural heat from the interior of the earth that can be used to generate electricity as well as to heat up buildings.
- The core of the earth is very hot and it is possible to make use of this geothermal energy.
- These are areas where there are volcanoes, hot springs, and geysers, and methane under the water in the oceans and seas.
- In 1943 geothermal hot water was used for the first time in Iceland.
- At present in 21 countries the internal heat of earth is used to produce electricity.
- Geothermal resource falls into three major categories:

- i) Geopressurized zones,
- ii) hot-rock zones and
- iii) Hydrothermal convection zones. Of

- **Geothermal energy in India**

- In India, Northwestern Himalayas and the western coast are considered geothermal areas.
- The Geological Survey of India has already identified more than 350 hot spring sites.
- The Puga valley in the Ladakh region has the most promising geothermal field. An experimental 1-kW generator is under operation in this area.
- It is being used mainly for poultry farming, mushroom cultivation, and Pashmina-wool processing, all of which need higher temperature.

- **Environmental Impact of Geothermal Energy\**

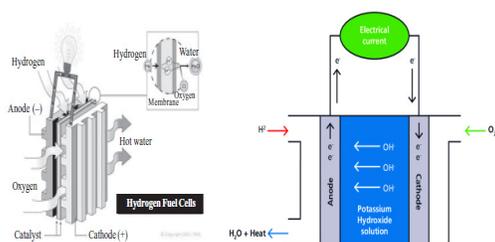
- Geothermal energy can pose several environmental problems which includes on-site noise, emissions of gas and disturbance at drilling sites, disposal sites, roads and pipelines and power plants during its development.
- The steam contains hydrogen sulphide gas, which has the odour of rotten eggs, and cause air pollution. The minerals in the steam are also toxic to fish and they are corrosive to pipes, and equipment, requiring constant maintenance



- **HYDROGEN ENERGY**

- Hydrogen gas is being considered as the fuel for the future.
- When hydrogen gas burns in the air or in fuel cells, it combines with oxygen gas to produce non-polluting.

- Water vapour and fuel cells directly convert hydrogen into electricity. Widespread use of hydrogen as fuel would greatly reduce the problem of air pollution and danger of global warming because there will not be any CO<sub>2</sub> emission.
- Obtaining a large amount of pure hydrogen for commercial purposes is a problem because hydrogen is present in combination with other elements such as oxygen, carbon and nitrogen.
- Figure shows structure and function of fuel cell



- Hydrogen and phosphoric acid are the most common type of fuel cells.
  - Fuel cells that run on methanol, ethanol, and natural gas are also available.
  - A fuel cell consists of an electrolyte sandwiched between two electrodes.
  - Oxygen passes over one electrode and hydrogen over the other, and they react electrochemically to generate electricity, water, and heat.
  - Traditional methods generating electricity require combustion of fuel and the resultant heat is used to produce steam to run turbines which generate electricity.
  - It involves loss of heat and thus not very efficient.
  - On the other hand in chemical fuel cells, chemical energy is converted directly into electricity, thus are more efficient and do not produce harmful gases.
- **Basic components of a hydrogen-burning fuel cell are:**
    - Oxygen and hydrogen are added to the fuel cell in an electrolyte solution.

- The reactants remain separated from one another and, upon ionization, migrate through the electrolyte solution from one electrode to another.
- The flow of electrons from the negative to the positive electrode is diverted along its path into an electrical motor, supplying current to keep the motor running.
- In order to maintain this reaction, hydrogen and oxygen are added as needed.
- When hydrogen is used in a fuel cell, waste products are only oxygen and water.
- Using natural gas methane (CH<sub>4</sub>) in fuel cells produces some pollutants.

- **Fuel cell technology in India**

- Fuel cells have efficiency levels up to 55% as compared to 35% of conventional power plants.
- The emission of green house gases is significantly low CO<sub>2</sub> as only water vapor is emitted.
- Fuel cell systems are excellent options for small-scale decentralized power generation.
- Fuel cells can supply combined heat and power to buildings, hospitals, airports and military installations at remote locations.

- **Fuel Cell Technology and Environment**

- Fuel cells are efficient and clean energy producer.
- Fuel cells have been used in space flights and being introduced in electric vehicles for reducing urban air pollution.
- Fuel cell powered vehicles have very high-energy conversion efficiency, and near-zero pollution.
- Fuel-cell-powered EV's (electric vehicles) score over battery operated EV's in terms of increased efficiency and easier and faster refueling.



### Check Yourself

#### CHECK YOUR SELF

1. Name the energy released from biomass.
  - a. Mechanical
  - b. Nuclear
  - c. Thermal
  - d. Chemical
2. What is baggasse?
  - a. Petro crops
  - b. Dry twig and grasses
  - c. Cattle dung
  - d. Left over of sugar cane after crushed and juice extract in sugar mills.
3. Name the plant which yield biocrude and obtained biofuel.
  - a. Jatropha
  - b. Lantana
  - c. Ficus
  - d. Mangifera
4. Name the energy which is obtained from hot springs.
  - a. Geothermal
  - b. Mechanical
  - c. Hydel
  - d. Thermal
5. Geothermal energy can impact the environment in causing:
  - a. Noise pollution
  - b. Air pollution
  - c. Water pollution
  - d. Air and noise pollution

Ans: 1.d    2.d    3.a    4.a    5.d



#### Stretch Yourself

1. What is bagasse?
2. Define petro crops with examples.
3. Hydrogen is known as fuel of future. What does it mean?
4. Name the most promising geothermal energy field in India



#### Test Yourself

1. Why do we consider biomass as indirect form of solar energy?
2. Describe the working of a hydrogen fuel cell?
3. Give advantages and disadvantages of geothermal energy.
4. Do you find any limitation of geothermal energy? If yes, describe it.
5. What is biocrude? Explain it with example.