NONRENEWABLE RESOURCES

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COAL, PETROLEUM, AND GAS

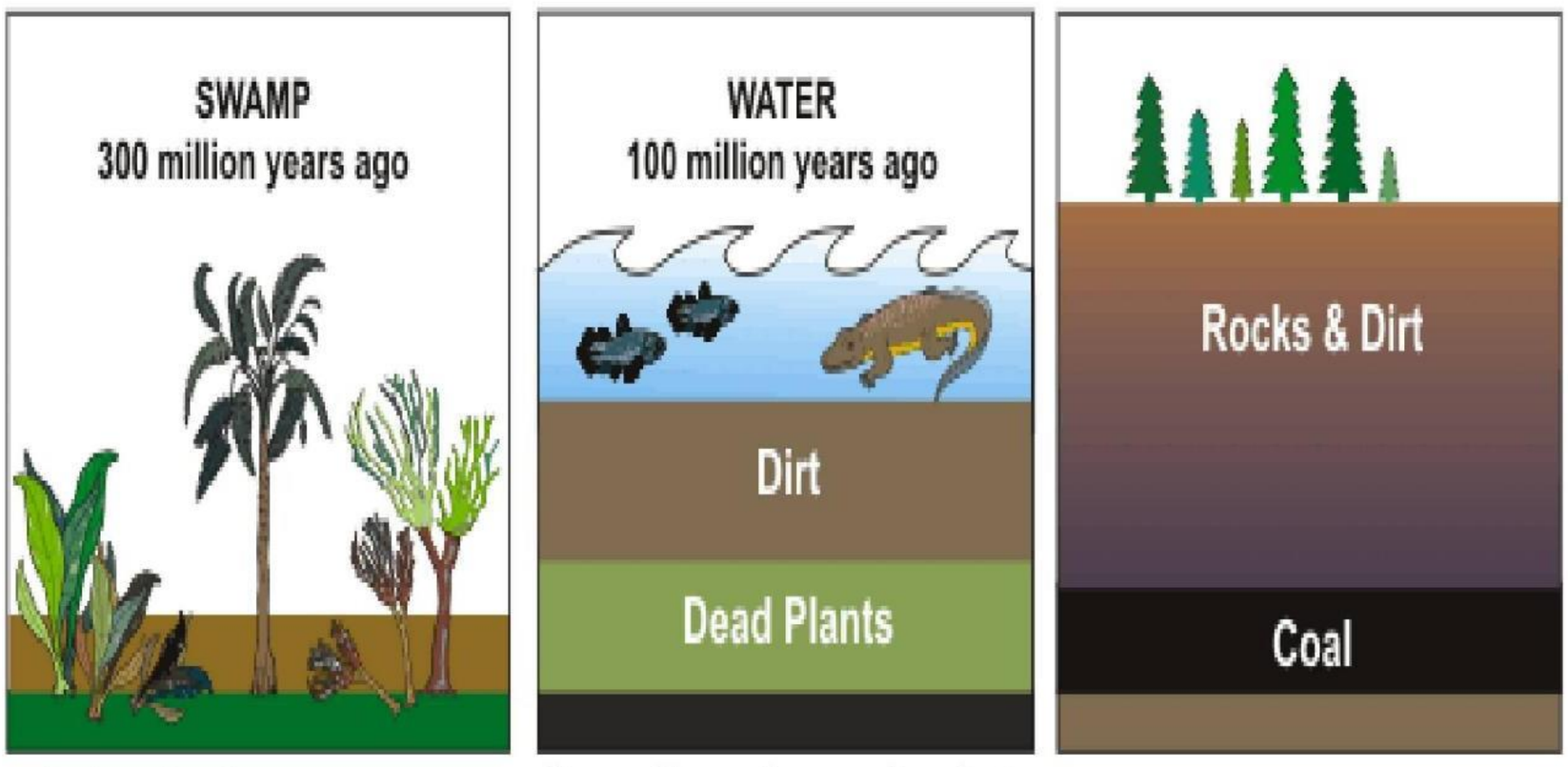
Coal, petroleum, and natural gas are considered nonrenewable because they can not be replenished in a short period of time. These are called fossil fuels.

Availability of Coal and lignite

- Available in Bihar, Jharkhand, Orissa, MP, Chhattisgarh and West Bengal.
- Imported from : Australia and Indonesia.
- Annual consumption : 400 million tonnes of coal which contributes to 300 million tonnes of carbon emission
- Lignite reserves : 1200 Million tonnes – May last for another century.

- Types of Coal – Peat, Lignite, Bituminous Coal & Anthracite Coal. Carbon content in different types of coal.

HOW IS COAL MADE ???



Before the dinosaurs, many giant plants died in swamps.

Over millions of years, the plants were buried under water and dirt.

Heat and pressure turned the dead plants into coal.

Peat

- First stage of transformation.
- Contains **less than 40 to 55 per cent carbon == more impurities.**
- Contains sufficient volatile matter and **lot of moisture** [more smoke and more pollution].
- Left to itself, it burns like **wood**, gives less heat, emits more smoke and leaves a **lot of ash.**

Lignite

- **Brown coal.**
- Lower grade coal.
- **40 to 55 per cent carbon.**
- Intermediate stage.
- Dark to black brown.
- Moisture content is high (over 35 per cent).
- It undergoes **SPONTANEOUS COMBUSTION**

[Bad. Creates fire accidents in mines]

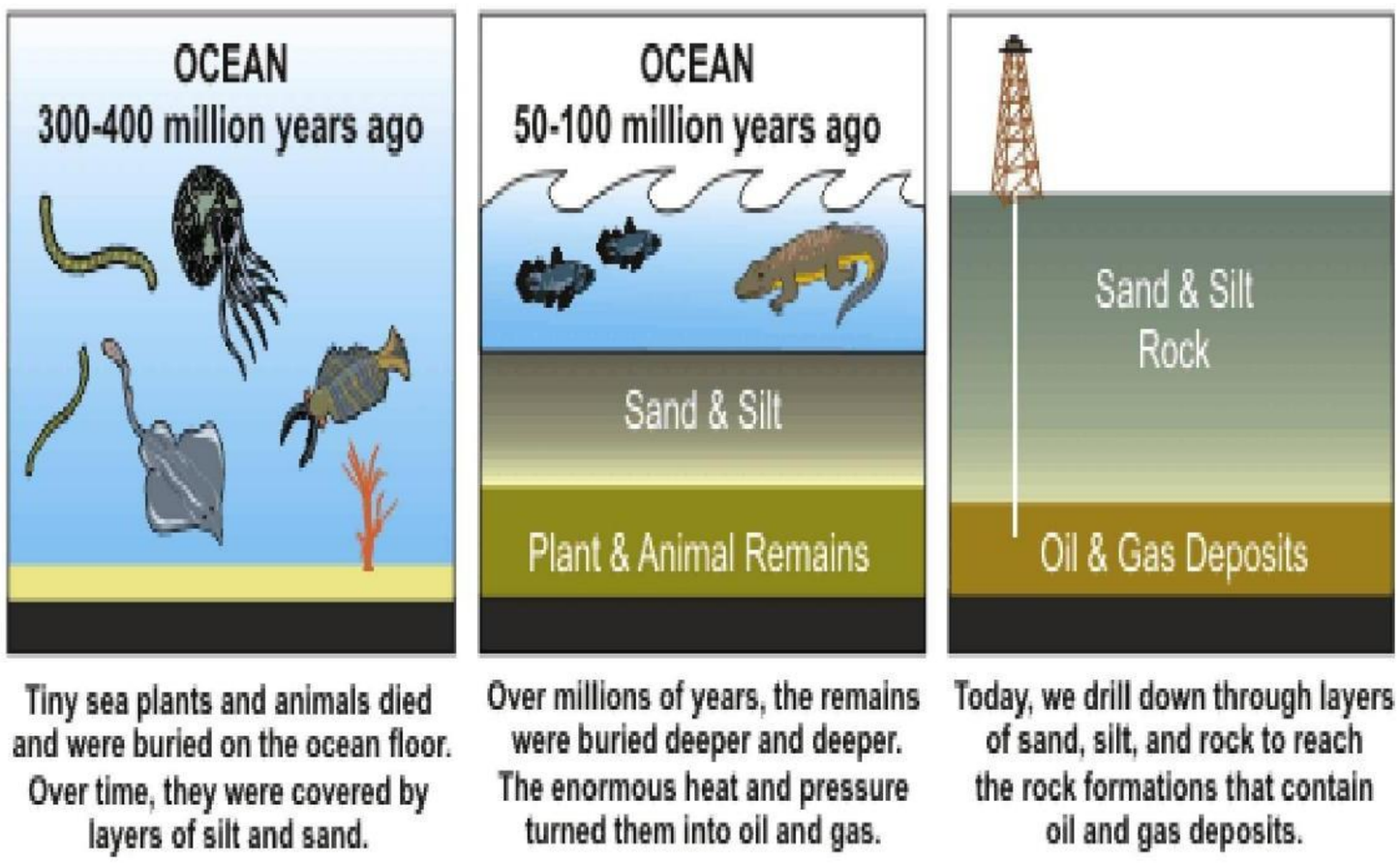
Bituminous coal

- Soft coal; most widely available and used coal.
- Derives its name after a liquid called bitumen.
- **40 to 80 per cent carbon.**
- Moisture and volatile content (15 to 40 per cent)
- Dense, compact, and is usually of black colour.
- **Does not have traces of original vegetable material.**
- Calorific value is **very high** due to high proportion of carbon and low moisture.
- Used in production of **coke and gas**.

Anthracite

- **Best quality**; hard coal.
- **80 to 95 per cent carbon**.
- Very little volatile matter.
- Negligibly small proportion of moisture.
- Semi-metallic lustre.
- **Ignites slowly** == less loss of heat == highly efficient.
- Ignites slowly and burns with a nice short **blue flame. [Complete combustion == Flame is BLUE == little or no pollutants. Example: LPG]**
- In India, it is found only in Jammu and Kashmir and that too in small quantity.

HOW ARE OIL AND GAS MADE ???



Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of silt and sand.

Over millions of years, the remains were buried deeper and deeper. The enormous heat and pressure turned them into oil and gas.

Today, we drill down through layers of sand, silt, and rock to reach the rock formations that contain oil and gas deposits.

Burn Fuel → heat water to make steam → steam turns turbines → turbines turn generators → electrical power sent around country

Is it renewable?

Fossil fuels are not a renewable energy resource.

- Once we've burned them all, there isn't any more, and our consumption of fossil fuels has nearly doubled every 20 years since 1900.
- In the case of Oil, we also use it to make plastics and many other products.

Power Plant

- Energy provides the power to progress.
- The natural resources of a country may be big but they can only be turned into wealth if they are developed, adopted, and exchanged for the other goods. This cannot be achieved without energy.
- The availability of enough energy and its proper use in any country can result in its people rising to the highest standard of living.
- The development of the power generation industry is a sign of growing gross national products which reflects the prosperity of the people. The lack of it and insufficient measure can throttle the whole economic activity and well being of the country.
- Continuous efforts have been made to develop the power plants in a country in different sections such as hydro, thermal, nuclear, solar, wind and tidal to meet the present as well as future power demand.

What is a Power Plant?

- It is a system where electric power is generated by using energy resources such as solid fuels, liquid fuels, natural gas, hydro, nuclear, solar, wind, tidal, etc.

Sources of Energy:

- Solid fuels
- Liquid fuels
- Natural gas
- Hydropower
- Nuclear power
- Solar power
- Wind power
- Tidal power
- Geothermal energy
- Hydrogen energy
- Biomass energy
- Wave energy.

Types of Power plants

- According to the nature of the load:

Base load power plant and Peak load power plant

- Base load power plant: A base load power plant is a **power station** that usually provides a continuous supply of electricity throughout the year with some minimum power generation requirement. Base load power plants will only be turned off during periodic maintenance, upgrading, overhaul or service. Base load power plant has the character of slow demand response, a mechanism to match generation with the load it supplies.

- **Base load** is the minimum level of electricity demand required over a period of 24 hours. It is needed to provide power to components that keep running at all times (also referred as **continuous load**).
- **Peak load** is the time of high demand. These peaking demands are often for only shorter durations. In mathematical terms, peak demand could be understood as the difference between the base demand and the highest demand. Now going back to the examples of **household loads**: microwave oven, toaster and television are examples of peak demand, whereas refrigerator and HVAC systems are examples of base demand.

Types of power plants (cont.)

- According to the fuel used:
  - Hydropower plant
  - Steam power plant
    - Condensing power plant
    - Non-condensing power plant
  - Diesel power plant
  - Nuclear power plant
  - Gas-turbine power plant
- According to the non-conventional power generation: Geothermal power plant, Tidal power plant, Solar power plant, Wind power plant and Biogas power plant
- According to the service: Fixed power plant and Mobile power plant
  - FPP- In a fixed location and distributes power.
  - MPP- **Mobile Power Plant** is a type of electric **power plant**, which provides electricity for a temporary purpose. The **power plant** that is, generally the thermal **power plant,** mounted on the transport vehicles and serves the electricity in the remote and required locations at a far distance from the transmission **power** lines

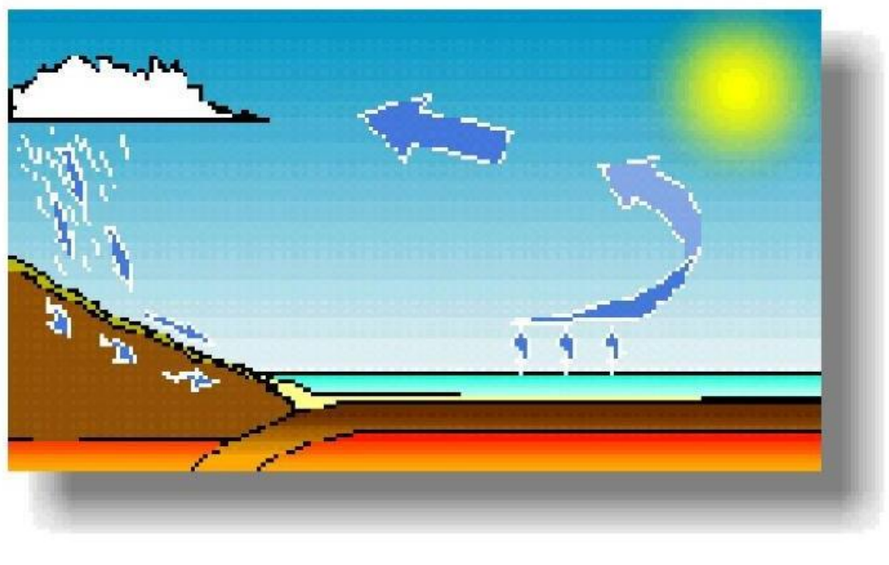
Factors to be considered for the location of any **type of power plant (Contd.)**

- Availability of labour: Plenty of skilled labourers at cheap rate should be available.
- Type of community and public attitude.
- Economic impacts such as local tax, transmission and distribution,
- Effects of pollution.
- Solid waste management.
- Public health and safety concerns.
- The required size of the plant
- Nearness to the load centres to reduce the transmission cost.
- Environmental impact assessment
- Study of wind direction and speed, humidity and temperature at the site.
- Reliability in operation
- The type of load to be taken by the power plant.
- Plant life.
- Future development.

Hoover Dam on the Colorado river

- Hydro-electric power stations can produce a great deal of power very cheaply. The huge "Hoover Dam", on the Colorado river, supplies much of the electricity for the city of Las Vegas.

Water Cycle



Sun evaporates water from the sea and lakes, which forms clouds and falls as rain in the mountains, keeping the dam supplied with water.

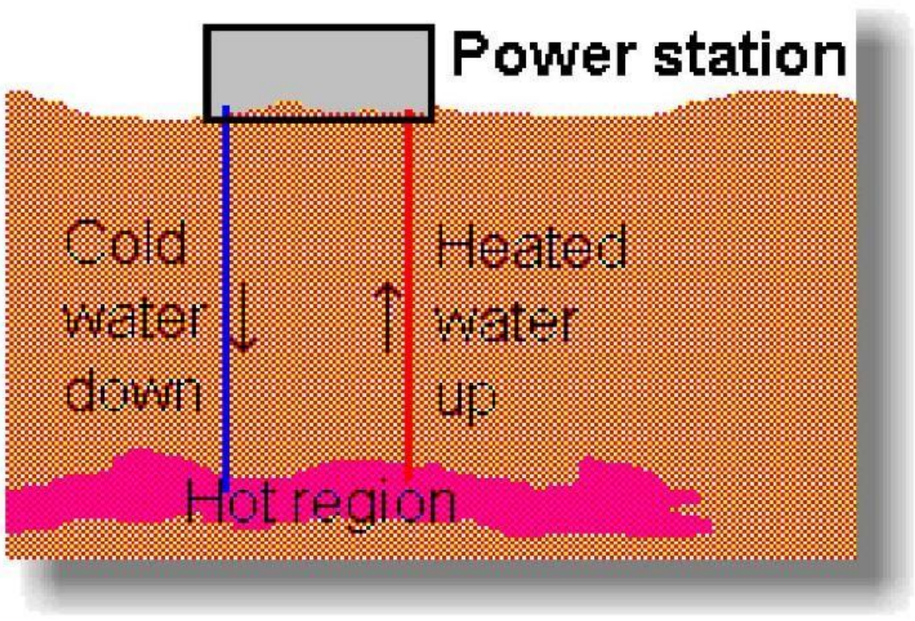
HYDEL ENERGY CYCLE

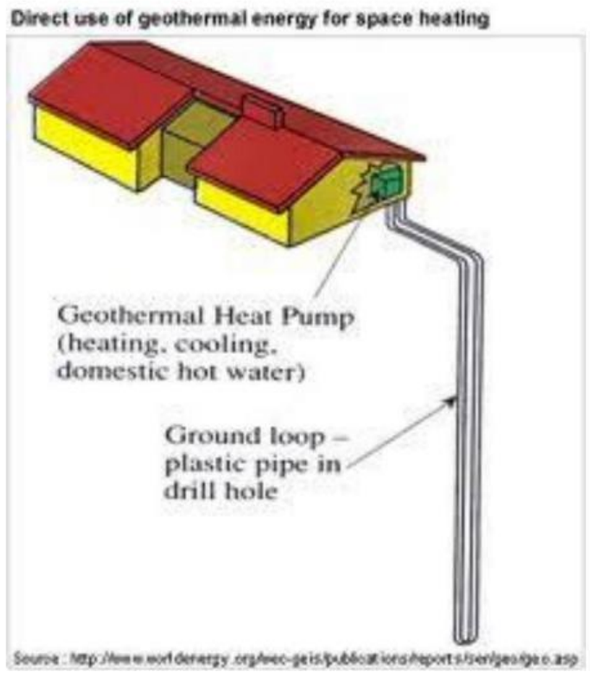
- **Solar heat** → Evaporation → Heat variation in terrains
  Temperature gradients → Wind energy → Rain →
  Hydrocycle → **Hydel energy** →

GEOTHRMAL ENERGY

- The name "geothermal" comes from two Greek words: "geo" means "Earth" and "thermal" means "heat".
- Geothermal Energy is the energy from heat inside the Earth.
- In India, it is available at JK, MP

How it works ?





Advantages

- Geothermal energy does not produce any pollution, and does not contribute to the greenhouse effect.
- The power stations do not take up much room, so there is not much impact on the environment.
- No fuel is needed.
- Once you've built a geothermal power station, the energy is almost free.
- It may need a little energy to run a pump, but this can be taken from the energy being generated.

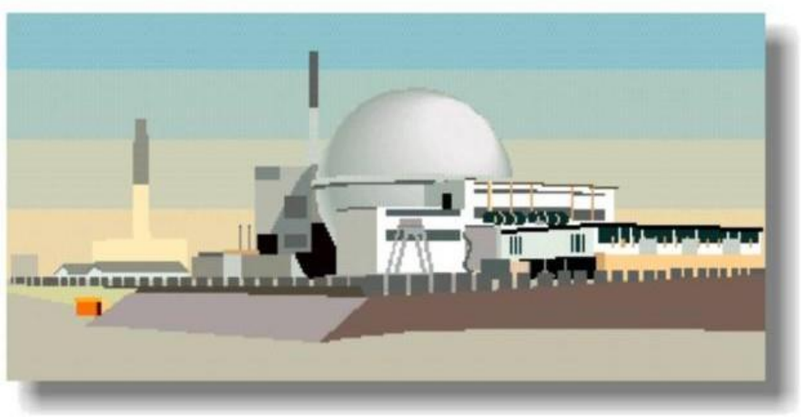
Disadvantages

- Limited site to build a geothermal power station.
- Hot rocks of a suitable type are needed at a depth where we can drill down to them.
- Hazardous gases and minerals may come up from underground, and can be difficult to safely dispose of.

Is it renewable?

- Geothermal energy is renewable.
- The energy keeps on coming, as long as we don't pump too much cold water down and cool the rocks too much.

NUCLEAR ENERGY



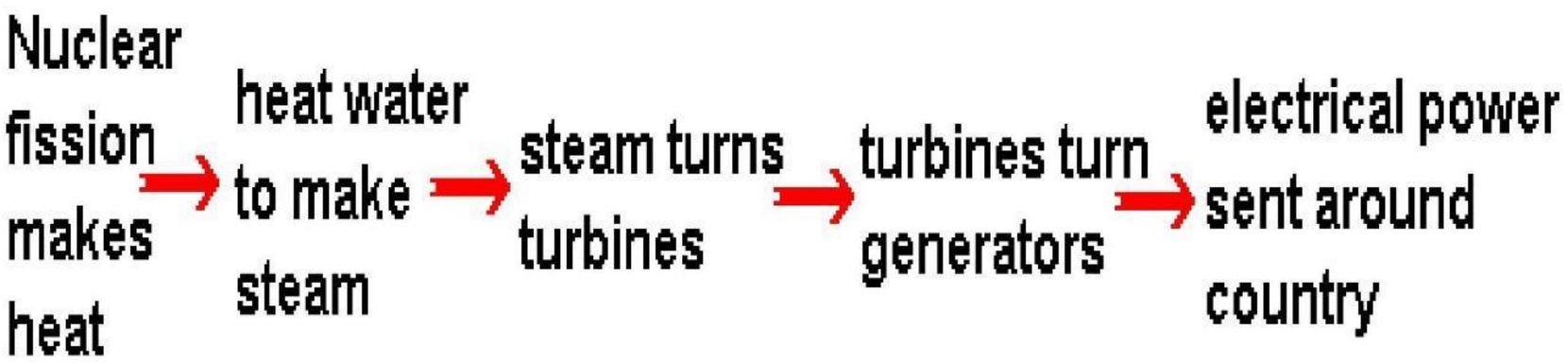
The first large-scale nuclear power station opened at Calder Hall in Cumbria, England, in 1956.

Nuclear fission uses uranium to create energy.

Nuclear energy is a nonrenewable resource because once the uranium is used, it is gone!

ADVANTAGES

- Nuclear power costs about the same as coal, so it's not expensive to make.
- Does not produce smoke or carbon dioxide, and hence does not contribute to the greenhouse effect.
- Produces huge amounts of energy from small amounts of fuel.
- Produces small amounts of waste.
- Nuclear power is reliable.



- The reactor uses Uranium rods as fuel, and the heat is generated by nuclear fission.

- Carbon dioxide gas /Water/Liquid metal is pumped through the reactor to take the heat away, and the hot gas /fluid then heats water to make steam.

- The steam drives turbines which drive generators.

IS IT RENEWABLE?

- Nuclear energy from Uranium is not renewable.

- Once we've dug up all the Earth's uranium and used it, there isn't any more.

- we can use "fast breeder" reactors to convert uranium into other nuclear fuels whilst also getting the energy from it.

Why Alternate fuels?

- Growth in population, rapid industrialization, demand more energy
- Energy demand is met mainly from the sources like coal, petroleum and natural gas
- Increase in price of petroleum and depletion of fossil fuels.
- **Increasing environmental concerns due to greenhouse gas (GHG) emissions**.
- **Focus is on to recover energy from waste materials, including materials that are not biodegradable (biomass, municipal solid waste, industrial waste, agriculture waste and other low grade fuels).**
- A fuel source which is economical and sustainable in nature is biofuels
- **Biofuels can be produced from a variety of bio-feedstocks, they are renewable, sustainable, biodegradable** (80.4 to 91.2% biodegradation after 30 days, whereas the petro diesel reached only 24.5% biodegradation. The degradation is caused by biological activity, particularly by enzyme action leading to significant changes in the material's chemical structure) **carbon neutral for the whole life cycle and environmentally friendly; they encourage green industries and agriculture and are applicable as motor fuels, without or with slight engine modifications**.
- Several biofuels, including bioethanol, biomethanol, biodiesel and biohydrogen, appear to be attractive options for the future of the transport sector
- As per 2018 statistics globally, roughly 25% of energy came from renewable sources.
- **As of 27 November 2020, 38% of India's installed electricity generation capacity is from renewable sources (136 GW out of 373 GW)**
- Greenhouse-gas emissions from biofuels, such as **ethanol and biodiesel**, **may be lower than many researchers have estimated**, according to a study in 2011. The findings could further fuel a debate over whether biofuels actually reduce greenhouse-gas emissions compared to gasoline, and if so, by how much.

INTRODUCTION

- All renewable energy (except tidal and geothermal power), ultimately comes from the sun
- Flow of air around the earth, possess kinetic energy which is called wind energy
- About 1 to 3 percent of the solar energy falling on the earth surface gets converted to wind energy
- A Windmill captures wind energy and then uses a generator to convert it to electrical energy.

- **The conversion of wind energy to electrical energy is one of the most successful renewable energy technology**
- **The kinetic energy of a moving body is proportional to its mass (or weight).**
- **The kinetic energy in the wind thus depends on the density of the air, i.e. its mass per unit of volume.**
- **In other words, the "heavier" the air, the more energy is received by the turbine.**
- **All over the world the annual wind market is growing with over 30% rate.**

Advantages of Wind Park or Wind Farms

1.Renewable – meaning that the source of energy is not depleted when it is used. So, as we use wind energy we don't decrease the amount of wind available; whereas in the case of fossil fuels, it leads to depletion of resources.

2.Low-cost energy – Although wind turbines have high upfront costs, the energy they produce is cheap.

3.Clean energy – Generating energy using wind turbines does not emit any greenhouse gases.

Disadvantages of Wind Park or Wind Farms

1.Onshore wind is an intermittent source of energy, as **turbines cannot generate electricity on demand**, but only when the wind is blowing, and at sufficient strength.
2.When wind strength is insufficient for turbines to operate, the fossil-fuel-based power supply is needed as a backup, which can temporarily increase greenhouse gas emissions.
3.As per some research, people who live or work in close proximity have experienced symptoms that **include decreased quality of life, annoyance, stress, sleep disturbance, headache, anxiety, depression, and cognitive dysfunction**. However, many researchers have differing opinions.
4.Wind turbine syndrome and wind farm syndrome are terms for the alleged adverse human health effects related to the proximity of wind turbines. Wind turbine syndrome has been characterized as pseudoscience.
5.Wind Parks need to be spread over more land than other power stations and need to be built in wild and rural areas, which can lead to industrialization of the countryside

How is wind Created?

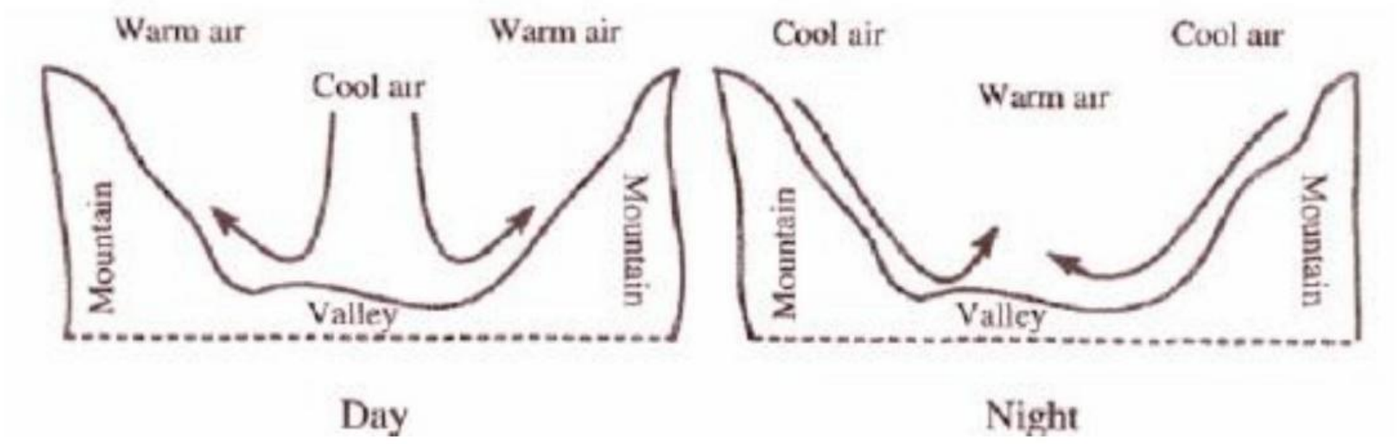
The earth's winds are caused by pressure differences across the earth's surface due to uneven heating

Local Winds: During the day the air over the land is heated more than the air over the sea.

Opposite effect happens during the night

Day pattern: Wind blows from sea to land

Night pattern: Wind blows from land to sea

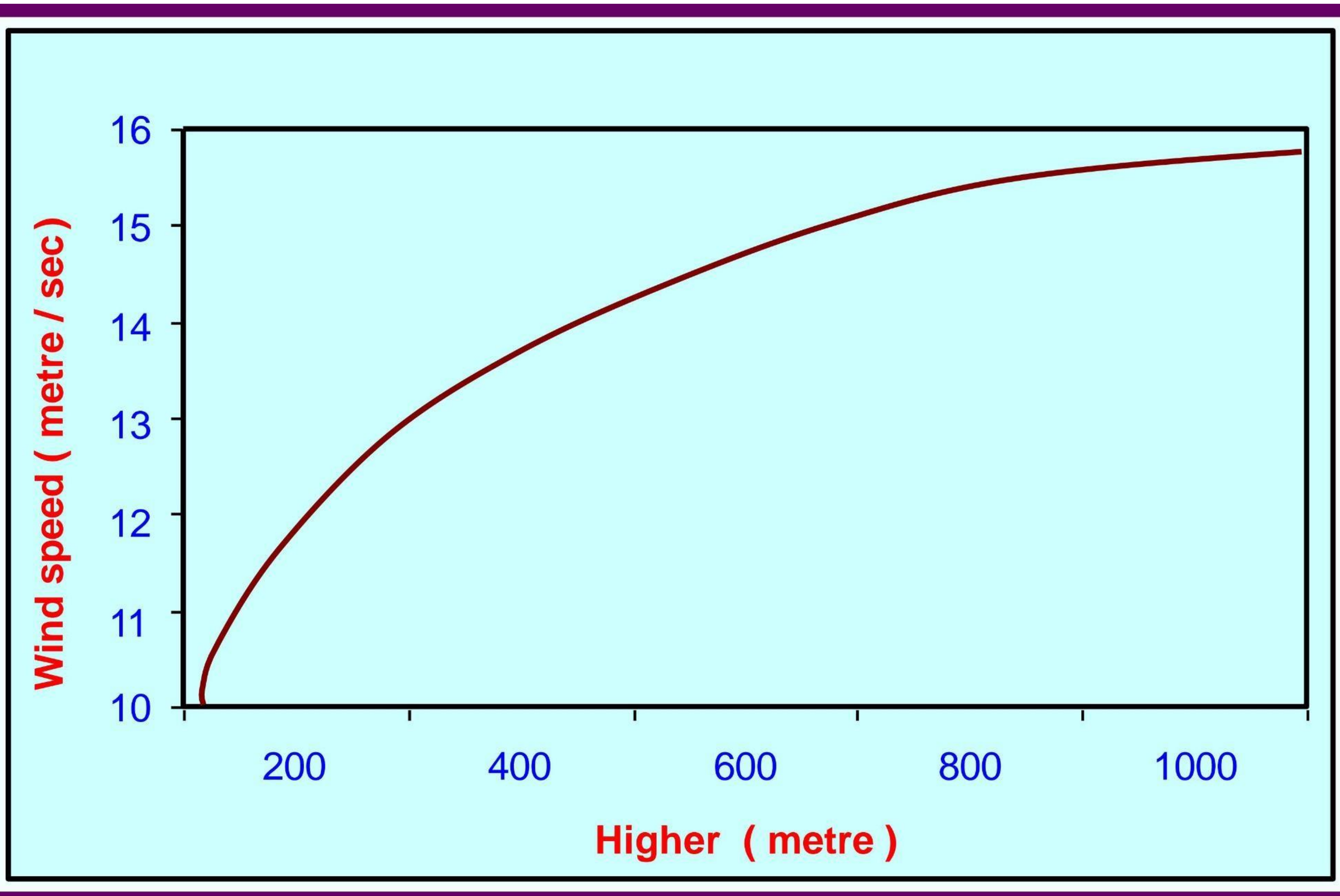


How is wind Created ?

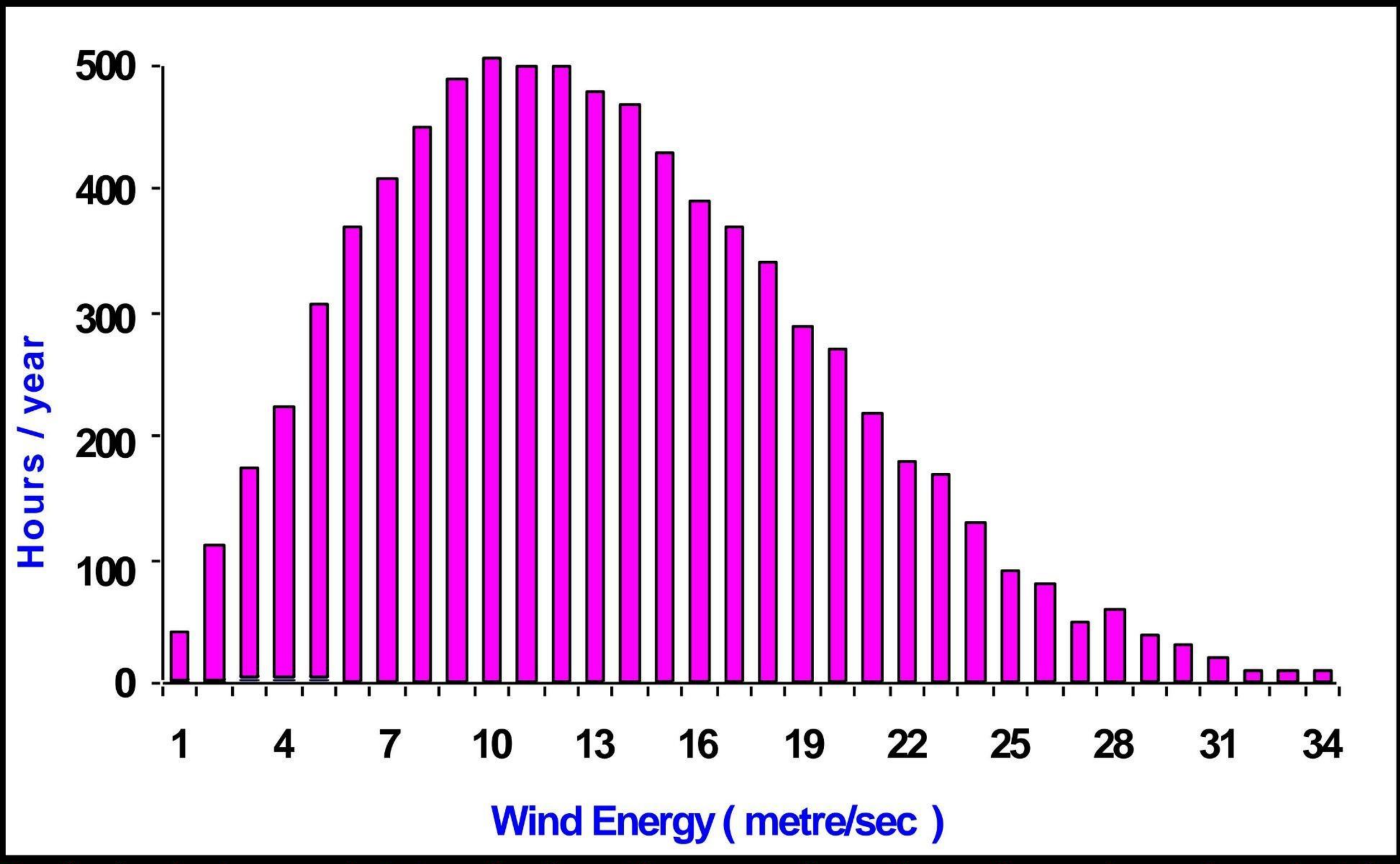
Global Winds: Occur due to greater heating of the air near the equator than the poles. Thus wind blows from the poles to the equator

Large ocean and land masses also affect the wind pattern

It is important to understand these wind patterns for the evaluation of potential wind sites



A typical vertical Variation in the wind speed (wind speed of 10 mete / sec is considered at 10 metre height from the ground)



Typical wind speed data of a location as a function of number of probable hours of a given speed in a year (wind speed histogram). This type of data for stations in India can be obtained from meteorology centres.

$A = \pi r^2$ Power in the Wind

•Kinetic energy of the wind flowing across a wind turbine is used to derive electrical energy from wind.

- P = ½ ρV³A in watts
- Where,
- P = power,
- ρ = air density,
- A = swept area of blades given by Area formula $A = \pi r^2$
- where r is the radius of the blades.
- V = velocity of the wind.

•If wind speed increases by a factor of two, the power output would increases by a factor of eight.

- Power is proportional to the area.

•The large wind turbine will convert more power from the wind. Wind power also depends **on the cube of the wind speed & also proportional to the area**

Power in the Wind

$P = \frac{1}{2} \rho V^3 A$ in watts

P – Power V – wind velocity

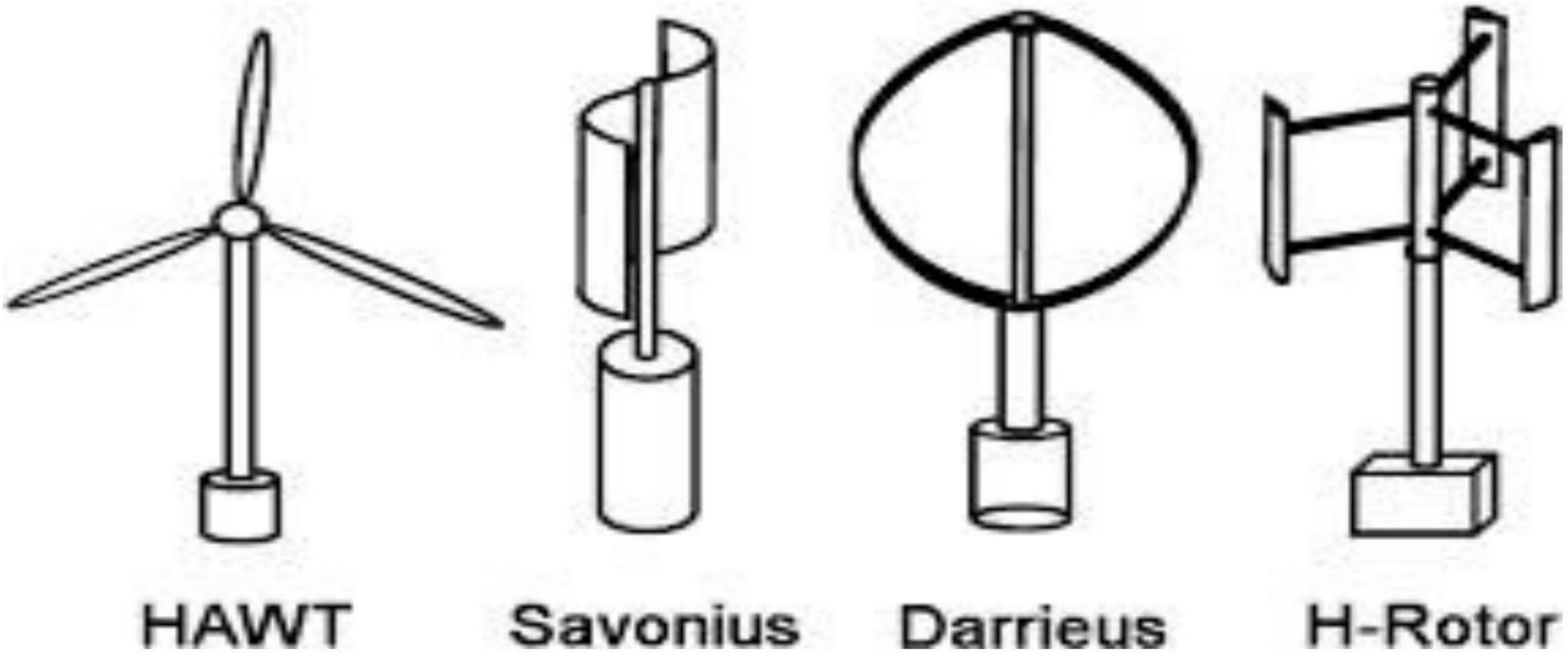
ρ- density of air A – Swept area

- Power depends on the cube of the wind speed & also proportional to the area.
- Under standard temperature (25°C) and pressure (760 mm of Hg), the air density is considered as 1.22 kg/m³. a simple formula for the power can be written as: $P = 0.6\ V^3\ A$ watt
- ρ- density of air = 1.23 kg/m³
- $P = 0.6\ V^3 A$

Conversion of Wind Power: Wind Turbine

- Wind turbine converts the energy of the wind into electrical energy.
- Converts airflow into mechanical motion and gives the electrical power.
- There are several types of wind turbines convert useful energy they are,

1) Propeller type
2) Multi type
3) Savonius
4) Darreius



The tip speed ratio is given by dividing the speed of the tips of the turbine blades by the speed of the wind – for example if a 20 mph wind is blowing on a wind turbine and the tips of its blades are rotating at 80 mph, then the tip speed ration is 80/20 = 4.

Savonius-Wind-Turbine

Darrieus-Wind-Turbine

H-Type wind turbine

Efficiency of Wind Power Conversion Cp

- Higher the change in the kinetic energy, larger will be the power conversion
- This efficiency term in wind energy technology is referred as coefficient of performance.

- **The coefficient of performance. Cp, is defined as; actual power output from a wind machine divided by the available wind power (=0.6V³A) or**

$$Cp = P(\text{ real }) / P(\text{ ideal })$$

$$Cp = P(\text{ real }) / 0.6\ V^3\ A$$

- **The actual wind turbines convert wind energy at lower efficiency than given by the Betz limit, due to various losses (drag on the blade, swirl imparted to airflow by the rotor, etc.).**

This is true for all wind turbine designs.

The practical wind turbines have Cp which is less than Betz limit.

- **(** According to **Betz's law**, no **turbine** can capture more than 16/27 (59.3%) of the kinetic energy in **wind**. The factor 16/27 (0.593) is known as **Betz's** coefficient. Practical utility-scale **wind turbines** achieve at peak 75–80% of the **Betz limit)**.

•The tip speed ratio (λ) is defend as the ratio of the speed of rotor blade tip to the undisturbed wind speed

- the undisturbed wind speed is the speed of wind away from the machine
- Tip speed ratio, $\lambda = \omega \times R / V$
- $\omega \rightarrow$ angular speed R $\rightarrow$ radius of rotor

•The efficiency of wind turbines increases with the increase in wind speed but decreases again at high speeds

TYPES OF WIND TURBINES

- Mainly the rotor of the wind turbines can be divided in two categories

1)Rotor based on aerodynamic lift

2) Rotor based on aerodynamic drag

- Lift is a force that is generated due to motion of a solid object in the fluid
- Drag is the force that resists the movement of a solid object through a fluid

Wind machines based on drag force :

- The wind machines that use drag force provide high torque but at low rpm.
- These machines are suitable for water pumping and grinding.

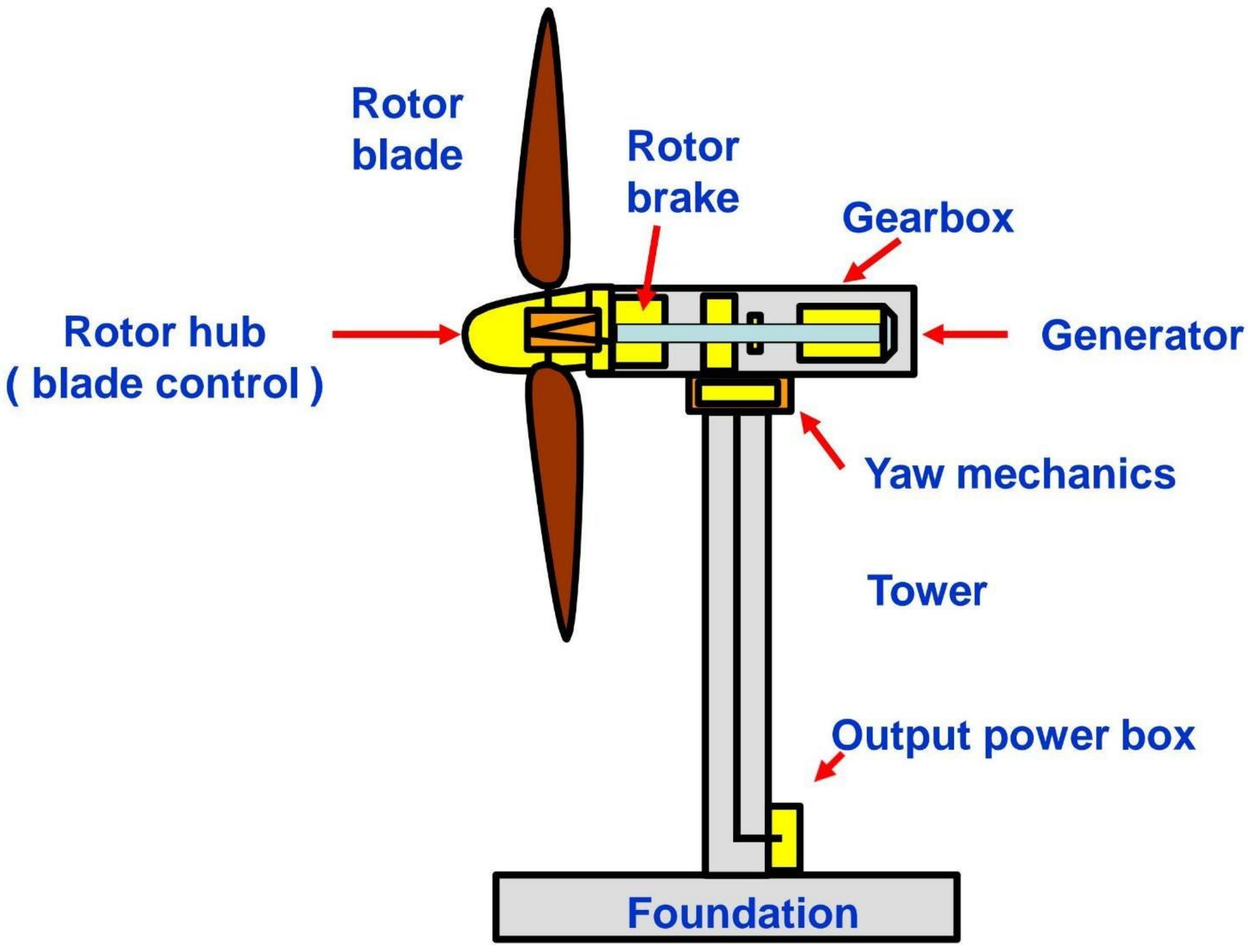
Wind machines based on lift force :

- The characteristics of lift force based machine is low to medium torque but at high rpm.

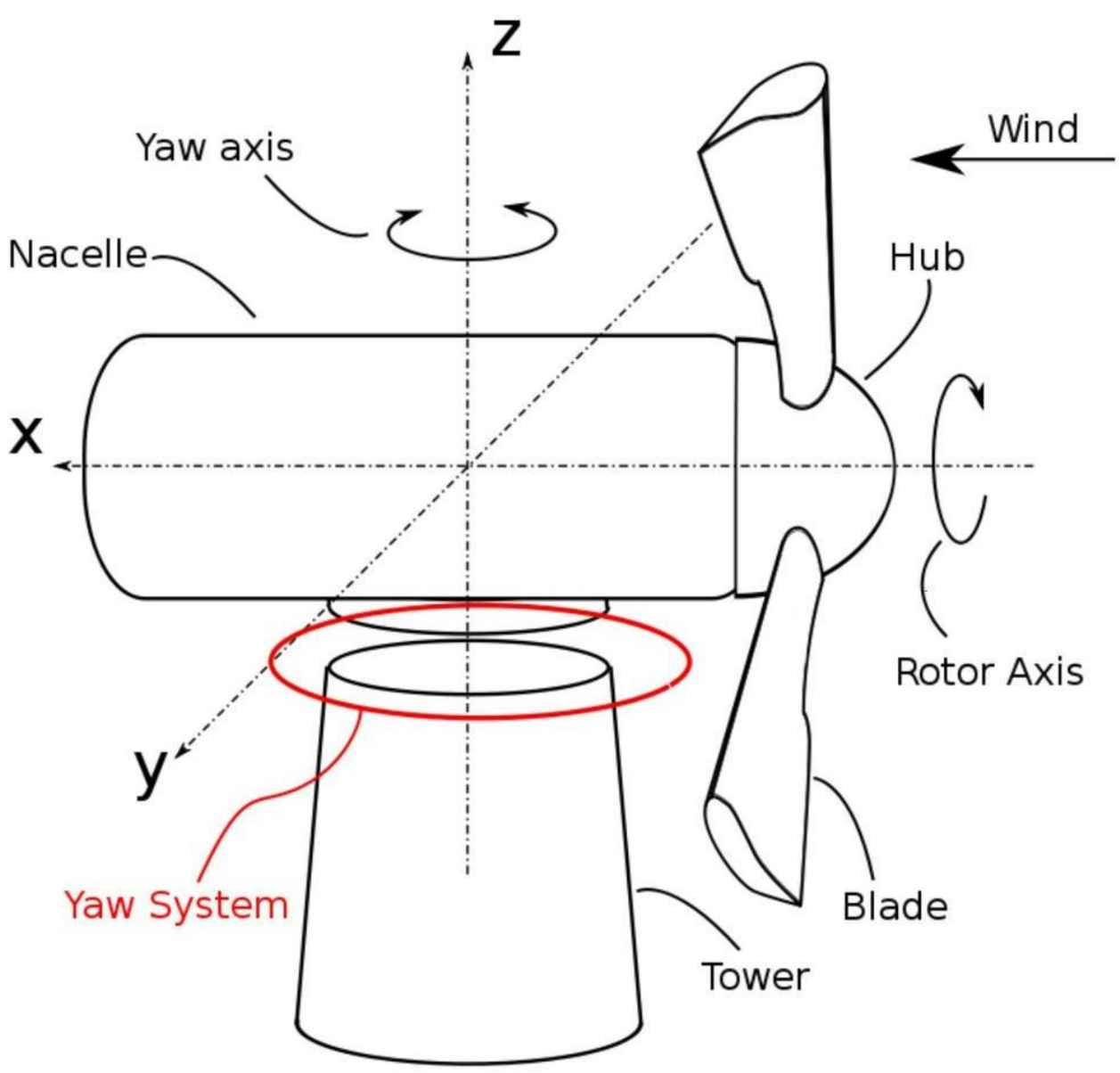
COMPONENTS OF A WIND TURBINE

- The main components of a wind turbine for electricity generation are: rotor, transmission system, generator, yaw and control system.

- Apart from the rotor, most of the components are kept inside the 'nacelle' shown in Fig which is designed to rotate (yaw) according to wind speed direction.



Schematic diagram of a typical wind turbine for powe generation and typical components



ROTOR

- The rotor converts kinetic energy of the wind flow to mechanical energy (movement of rotor).
- With the technology advancing, the rotor size is increasing.
- Very large wind turbine with 4-5 MW power rating have rotor diameter in the range of about 100 metres or even higher.
- The rotors can be of three blades or of two blades.
- In case of two blades the solidity (percentage area of the blades as compared to the swept area by the blades) is less and has 2 to 3% lesser efficiency.
- The blades can be constructed from glass reinforced plastic, wood, carbon fibre reinforced plastic, steel and aluminium.
- The requirement of the blade material is low weight, high stiffnes and high fatigue strength.
- The glass reinforced plastic is suitable from the material point of view and used commonly.

Generator

- A generator converts mechanical motion of the rotor to electrical energy.
- It works on the principle of electromagnetic induction. When a conducting coil rotates in a magnetic field, voltage is generated across the coil terminal, which becomes source of power.
- A generator of a grid connected wind machine is required to produce the frequency which is same as grid frequency (50 Hz in India).
- Generator can be a synchronous generator or asynchronous generator. A synchronous generator provides constant frequency output power but does not allow rotor speed variation.

An induction generator can supply constant frequency output power while allowing some variation in the rotor speed.

Yaw System

- The horizontal axis turbines have yaw system that turns the rotor according to the wind direction.
- A rotor swept area should be moving perpendicular to the wind direction.
- The yaw system is also used to cut off the rotor from the wind in case of very strong wind.

Annual Energy Production Approximate

How much energy will be generated in a year by a 100 kW rated power in a machine

- **Number of hours in a year – 8760 hours**

Rated power of the wind machine =

100 X 8760= 876000 kWh

The capacity factor = 30%

Annual energy = 876000 X 0.3

production = 262800 kWh

Estimation of the annual energy output of wind machine using capacity factor is an approximate finding and annual output

Actual rated power of the turbine rating should be

= power rating / capacity factor

= 2.28 / 0.30

= 7.6 kW – 8 kW

Thus, at 8 kW rated power wind turbine will provide desired annual energy under given situation.

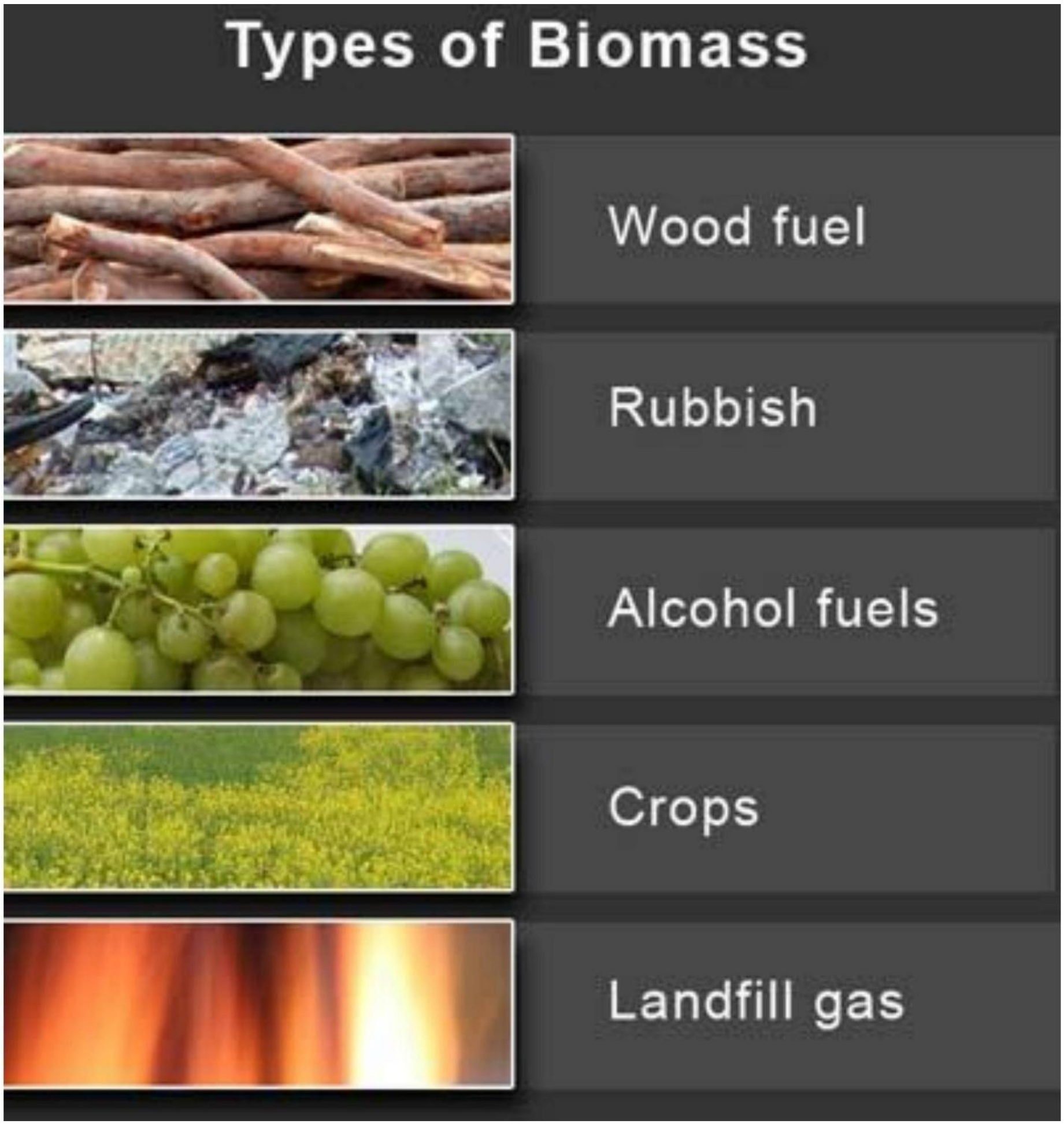
The cost of a wind turbine of per kW basis runs between Rs 30000 and Rs 50000.

OVERVIEW OF BIOMASS

- Biomass is a renewable energy source that is derived from living or recently living organisms.
- Biomass includes biological material, not organic material like coal.
- Energy derived from biomass is mostly used to generate electricity or to produce heat.
- Thermal energy is extracted by means of combustion, torrefaction, pyrolysis, and gasification

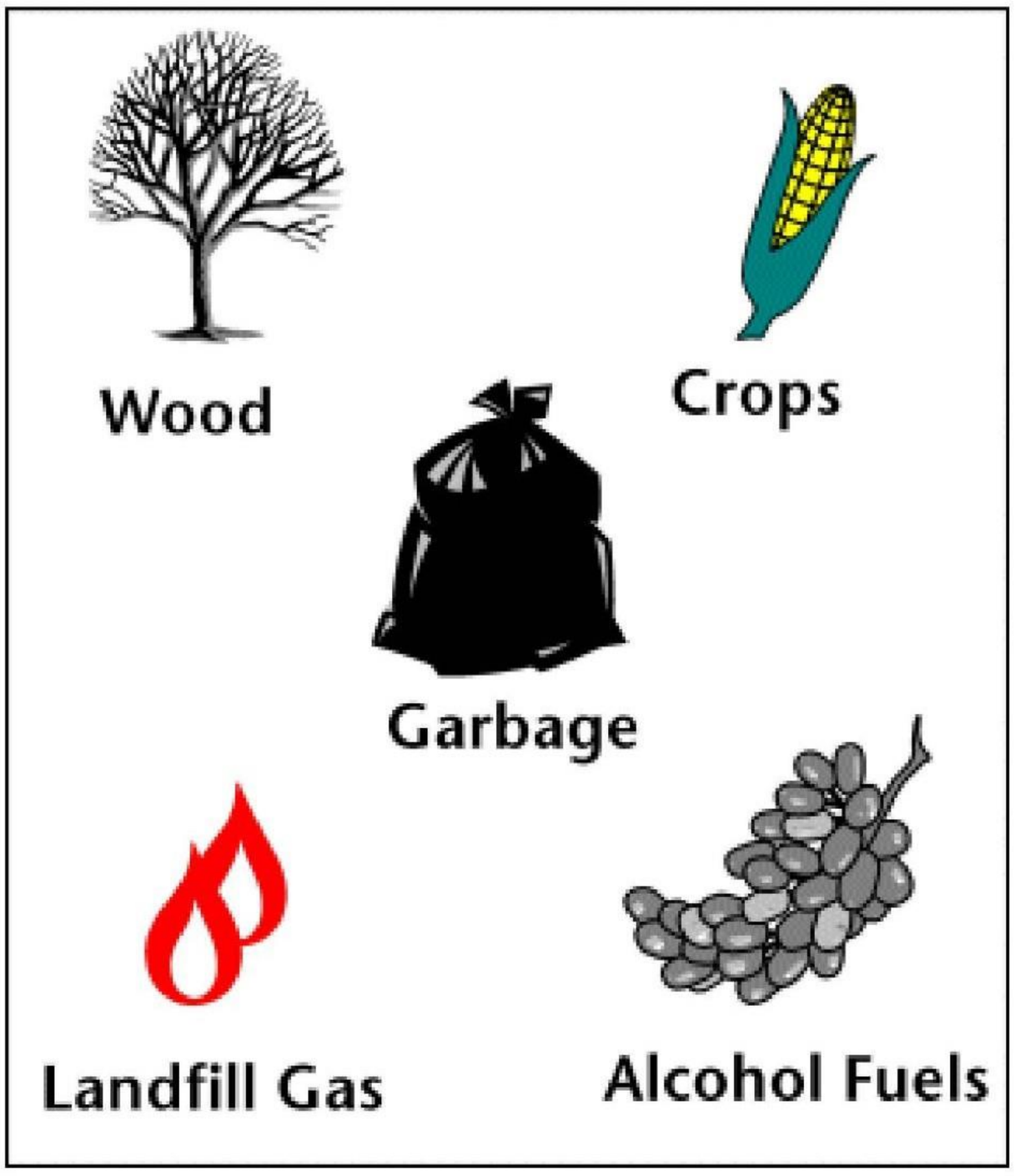
(Torrefaction of biomass, e.g., wood or grain, is a mild form of pyrolysis at temperatures typically between 200 and 320 °C. Torrefaction changes biomass properties to provide a better fuel quality for combustion and gasification applications. Torrefaction produces a relatively dry product, which **reduces or eliminates its potential for organic decomposition)**

- Biomass can be chemically and biochemically treated to convert it to a energy-rich fuel.



http://www.coralreefmedia.com/types-of-biomass.jpg

Types of Biomass



Technology

- Biomass technology today serves many markets that were developed with fossil fuels and modestly reduces their use

- Uses - Industrial process heat and steam, Electrical power generation, Transportation fuels (ethanol and biodiesel) and other products.

- Primary focus of the Biomass Program – development of advanced technologies.

Current Focus

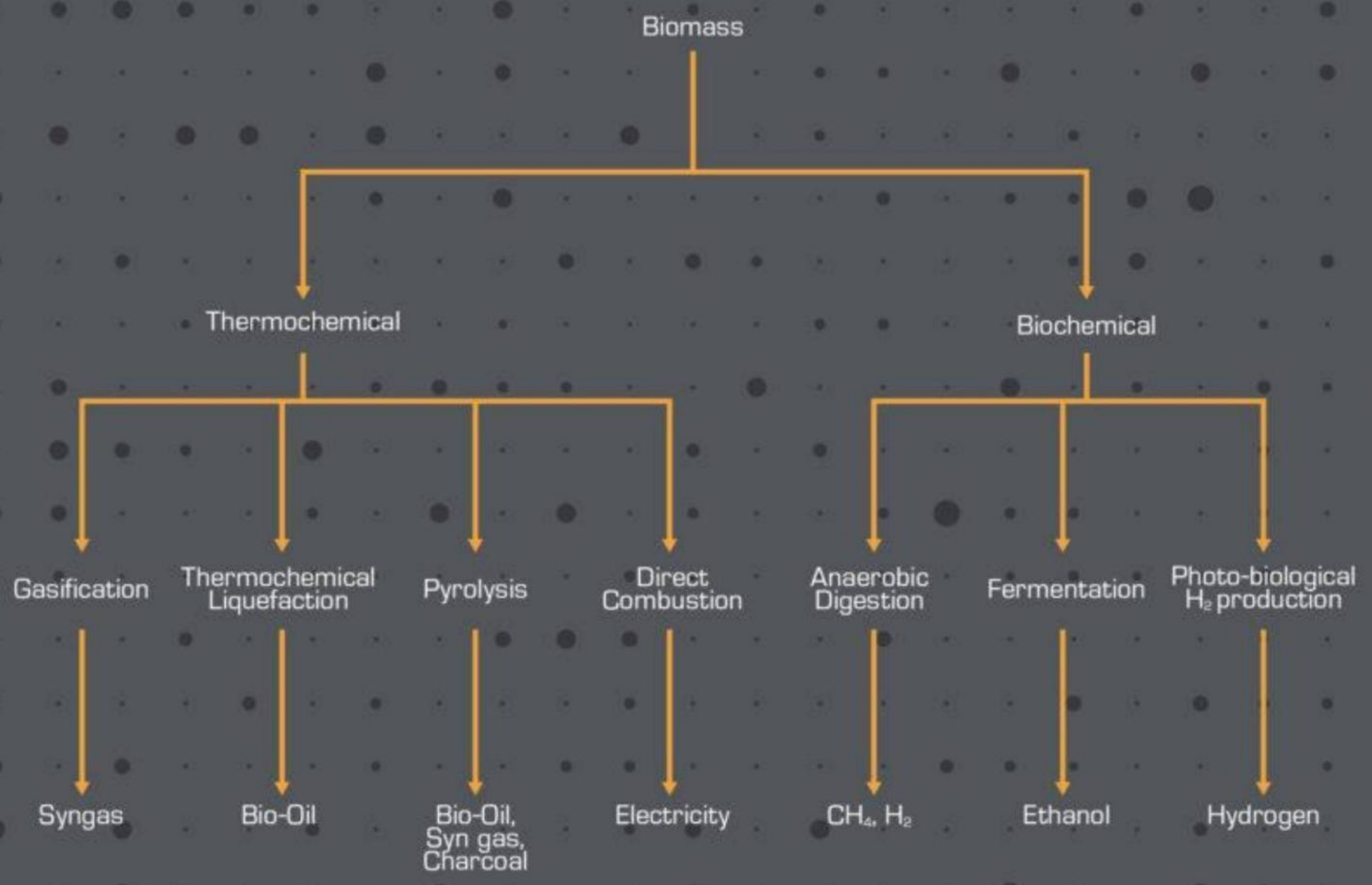
- **Sugar Platform Technology:**

Sugar platform bio-refineries breaks down biomass into different types of component sugars for fermentation or other biological processing into various fuels and chemicals.

- **Thermochemical Platform Technology**

On the other hand, thermochemical bio-refineries transform biomass into synthesis gas (hydrogen and carbon monoxide) or pyrolysis oil.

NEXUS PMG



Bio-refinery

- A facility that integrates biomass conversion processes and equipment to produce fuels, power, and chemicals from biomass.

- Analogous to today's petroleum refineries

- It is based on “Sugar Platform“ and “Thermochemical Platform“

Sugar platform biorefineries breaks down biomass into different types of component sugars for fermentation or other biological processing into various fuels and chemicals.

On the other hand, thermochemical biorefineries transform biomass into synthesis gas (hydrogen and carbon monoxide) or pyrolysis oil.

The thermochemical biomass conversion process is complex, and uses components, configurations, and operating conditions that are more typical of petroleum refining. Biomass is converted into syngas, and syngas is converted into an ethanol-rich mixture.

However, syngas created from biomass contains contaminants such as tar and sulphur that interfere with the conversion of the syngas into products. These contaminants can be removed by tar-reforming catalysts and catalytic reforming processes. This not only cleans the syngas, it also creates more of it, improving process economics and ultimately cutting the cost of the resulting ethanol

Biorefineries – They help in utilizing the optimum energy potential of organic wastes and may also resolve the problems of waste management and GHGs emissions.

Biomass wastes can be converted, through appropriate enzymatic/chemical treatment, into either gaseous or liquid fuels.

The pre-treatment processes involved in biorefining generate products like paper-pulp, high fructose corn syrup (HFCS), solvents, acetate, resins, laminates, adhesives, flavour chemicals, activated carbon, fuel enhancers, undigested sugars etc. which generally remain untapped in the traditional processes. The suitability of this process is further enhanced from the fact that it can utilize a variety of biomass resources, whether plant-derived or animal-derived.

Gasification Technology

- Gobar gas Production
- Biogas
- Synthesis gas

Gasification

- A process that uses heat, pressure, and steam to convert materials directly into a gas composed primarily of carbon monoxide and hydrogen.

- Gasification technologies rely on four key engineering factors

1. Gasification reactor atmosphere (level of oxygen or air content).
2. Reactor design.
3. Internal and external heating.
4. Operating temperature.

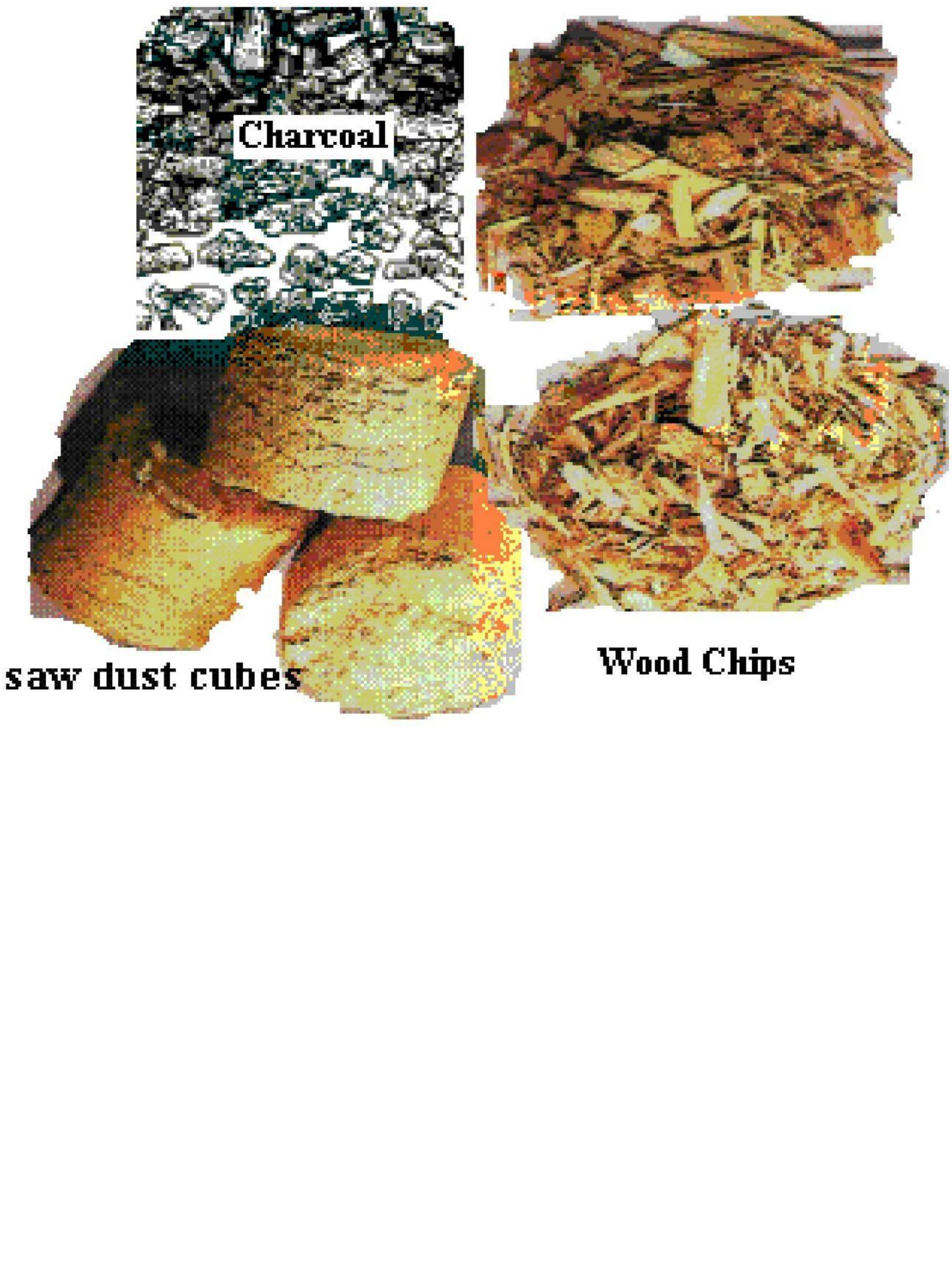
Gasification

- **Typical raw materials** - coal, petroleum-based materials, and organic materials.

- The feedstock is prepared and fed, in either dry or slurried form, into a sealed reactor chamber called a **gasifier**.

- The feedstock is subjected to high heat, pressure, and either an oxygen-rich or oxygen-starved environment within the gasifier.

Raw Materials for Gasification

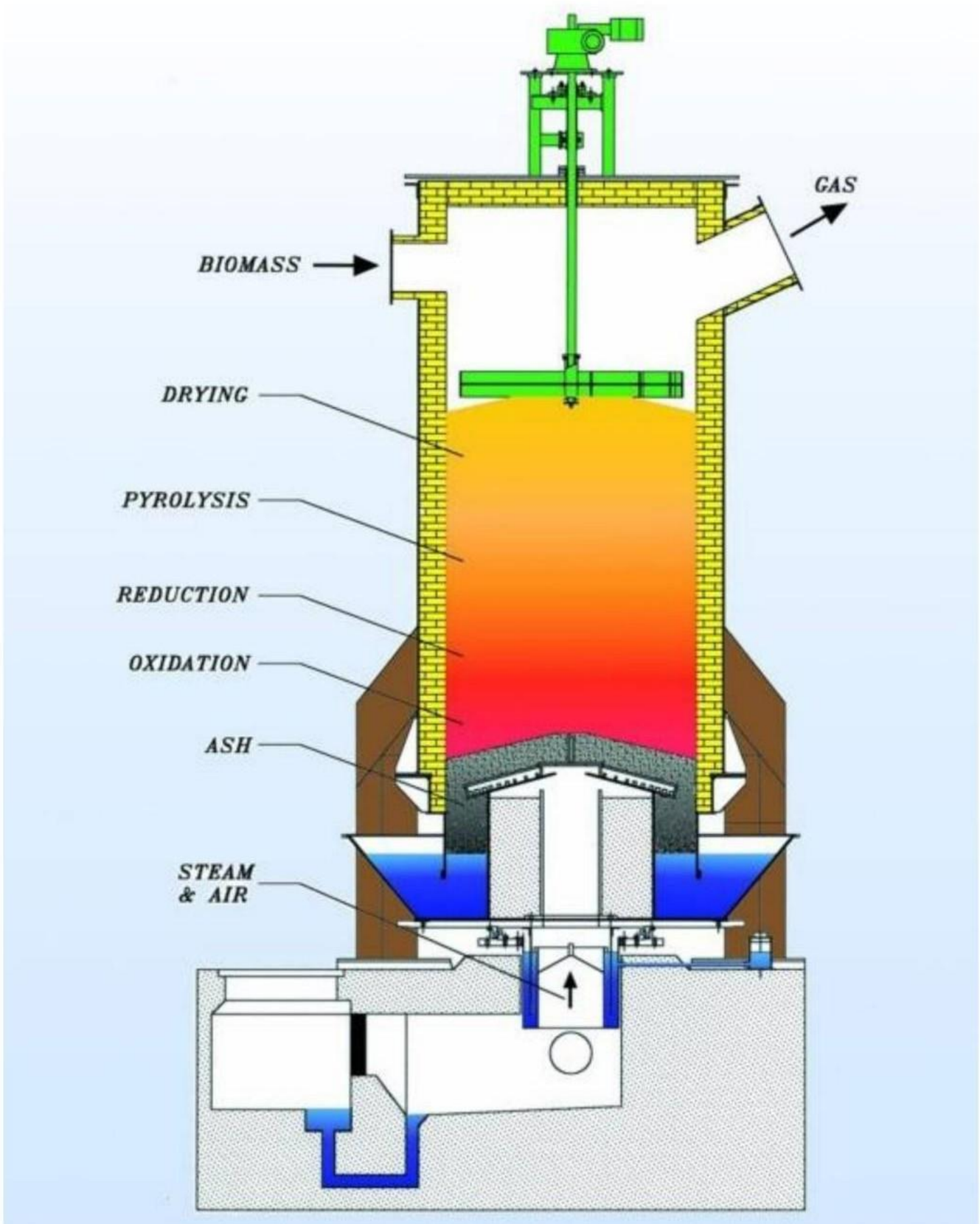


Gasification

- **Products of gasification :**
  * Hydrocarbon gases (also called syngas).
  * Hydrocarbon liquids (oils).
  * Char (carbon black and ash).

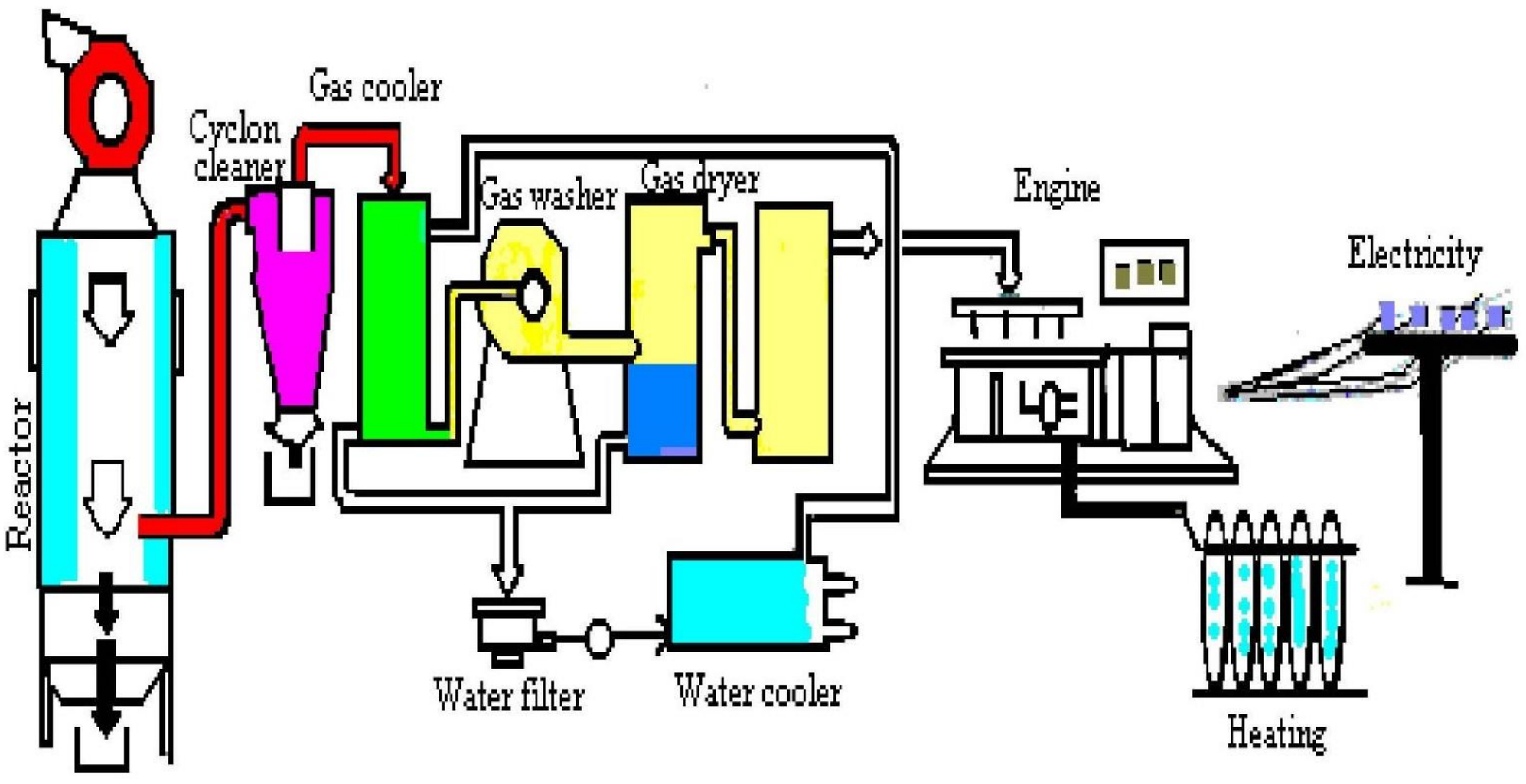
- **Syngas** is primarily carbon monoxide and hydrogen (more than 85 percent by volume) and smaller quantities of carbon dioxide and methane

Gasification



http://www.volund.dk/var/volund/storage/images/media/gallery/technical_illustrations/gasification_illustration/4324-4-eng-GB/gasification_illustration.jpg

Gasifier Plant



Stages in Gasification

- The dehydration or drying process occurs at around 100 °C. Typically the resulting steam is mixed into the gas flow and may be involved with subsequent chemical reactions, notably the water-gas reaction if the temperature is sufficiently high.

- Pyrolysis. Pyrolysis is essentially the thermal decomposition of organic matter under inert atmospheric conditions or in a limited supply of air, leading to the release of volatiles and formation of char. The *pyrolysis* (or devolatilization) process occurs at around 200–300 °C. Volatiles are released and char is produced, resulting in up to 70% weight loss for coal. The process is dependent on the properties of the carbonaceous material and determines the structure and composition of the char, which will then undergo gasification reactions.

- Cracking. Cracking is defined as **a process, wherein complex organic molecules namely long chain hydrocarbons or kerogens are broken down into smaller molecules namely light hydrocarbons.**

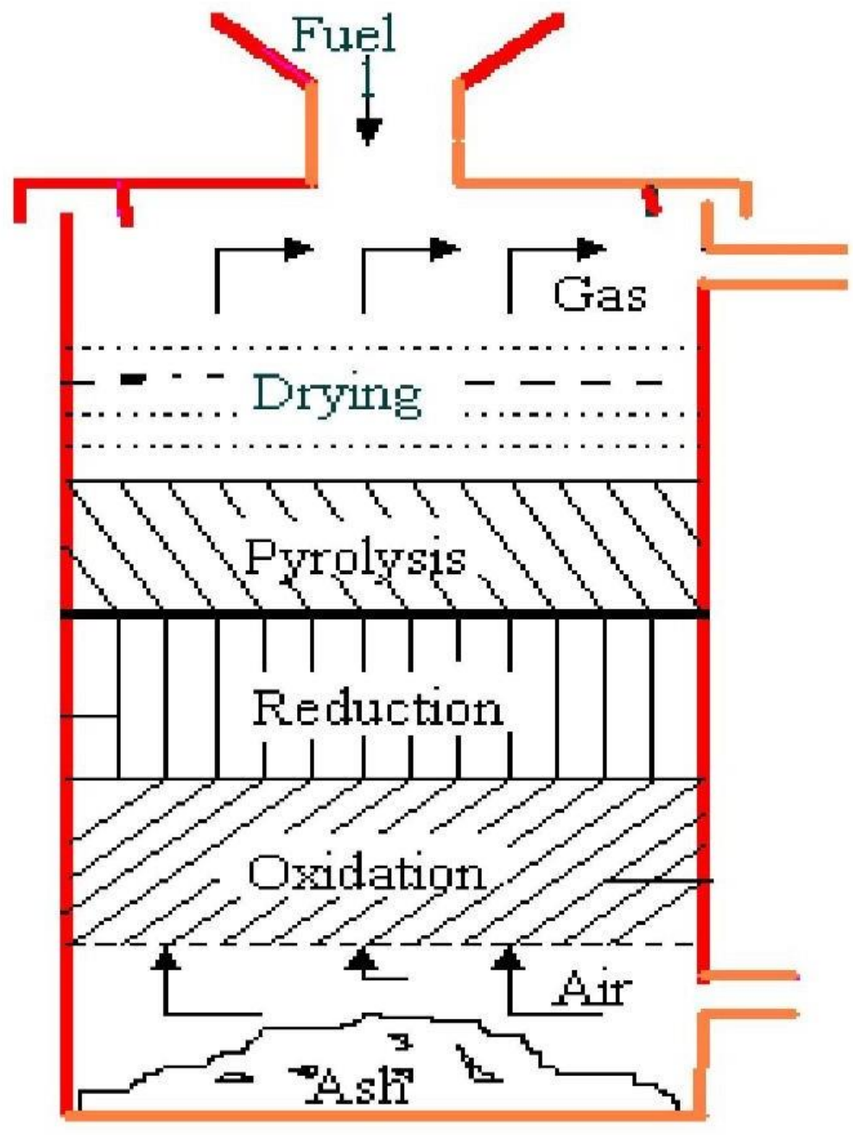
- Reduction. Reduction is the process of stripping oxygen atoms off combustion products of hydrocarbon (HC) molecules, **so as to return the molecules to forms that can burn again.** Reduction is the direct reverse process of combustion.

- Combustion :**The combustion process occurs as the volatile products and some of the char react with oxygen to primarily form carbon dioxide and small amounts of carbon monoxide, which provides heat for the subsequent gasification reactions.**

- Drying-Pyrolysis&Cracking-Reduction-Oxidation

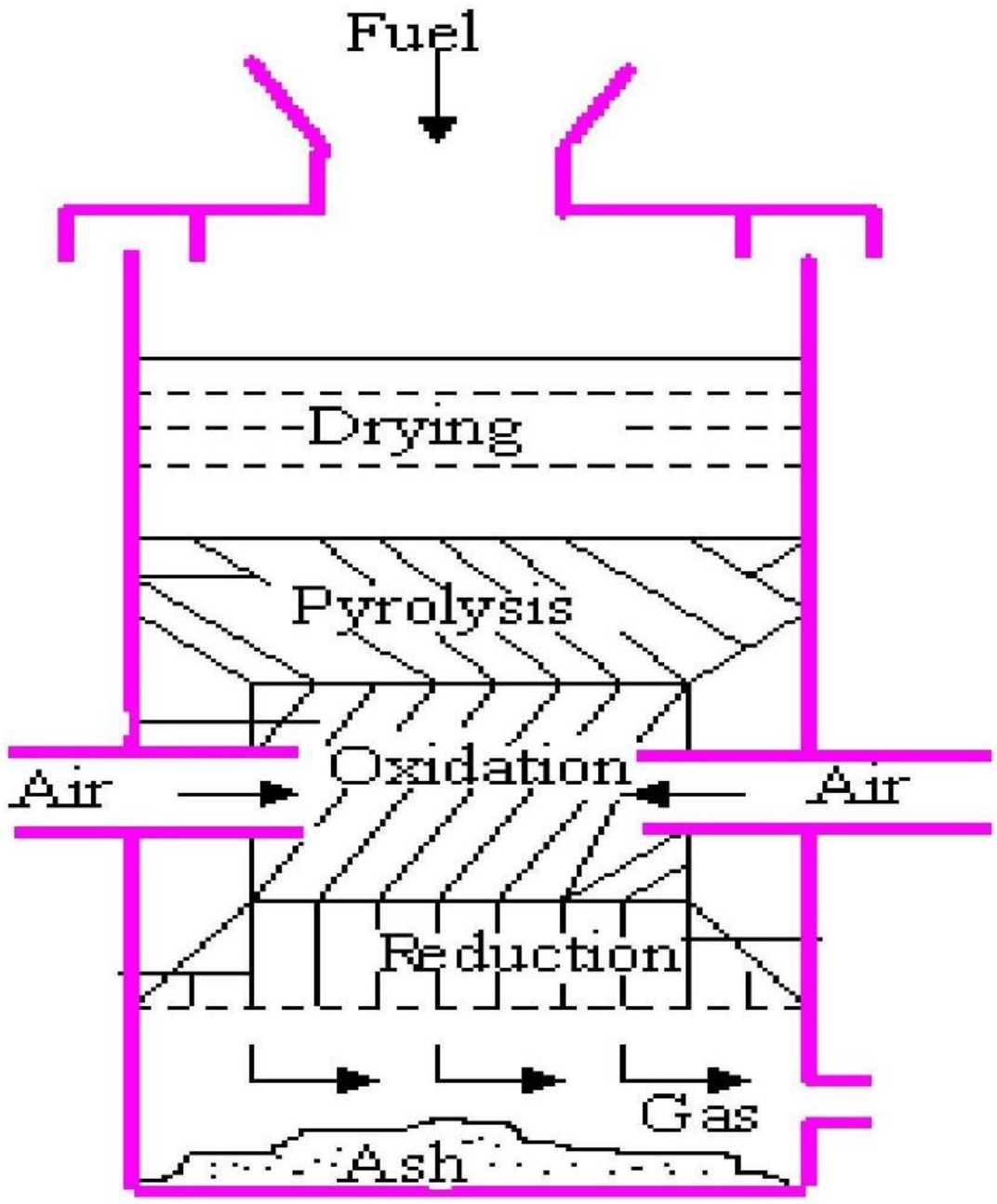
Types of Gasifiers

- Updraft Gasifier



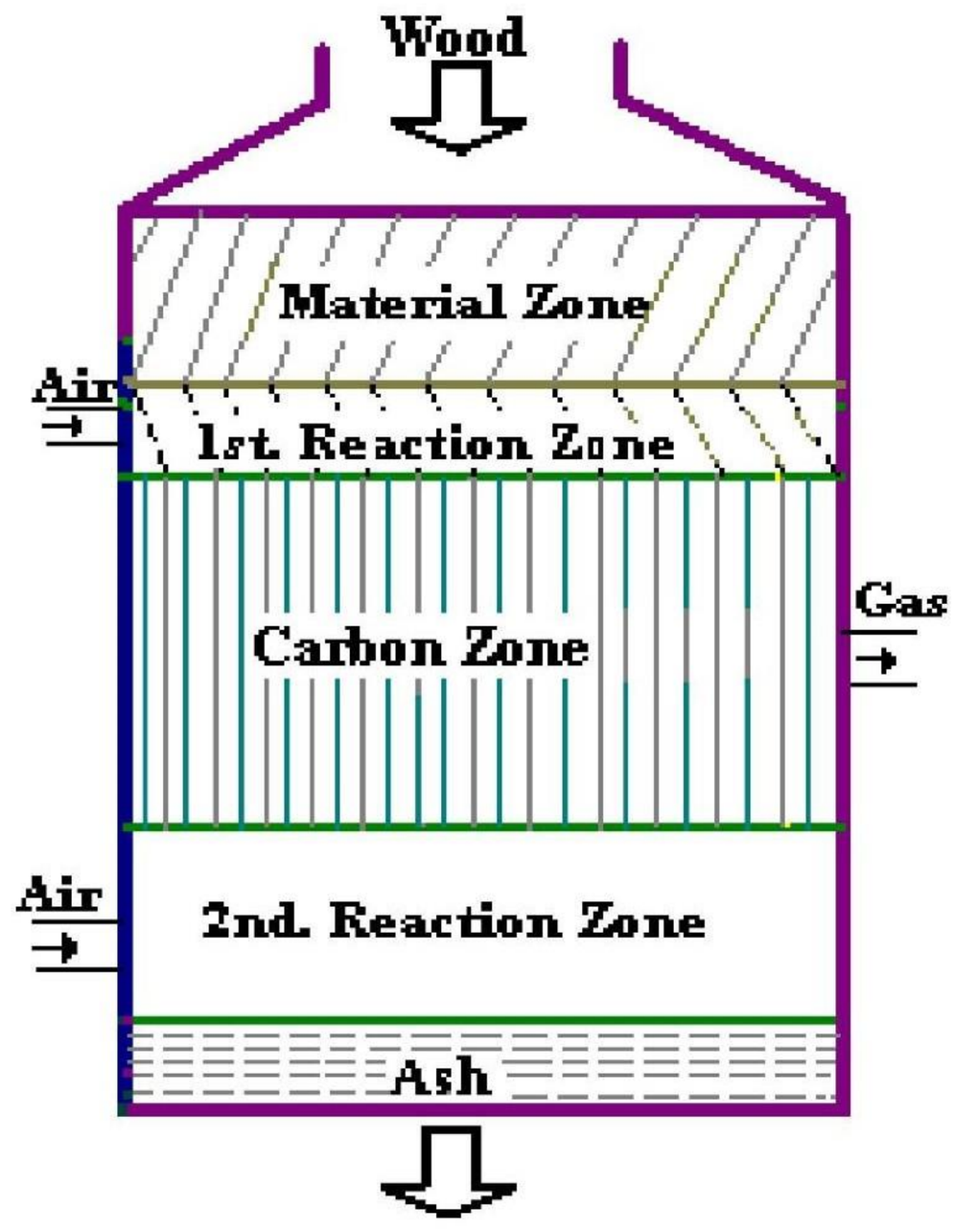
Types of Gasifiers

- Downdraft Gasifier



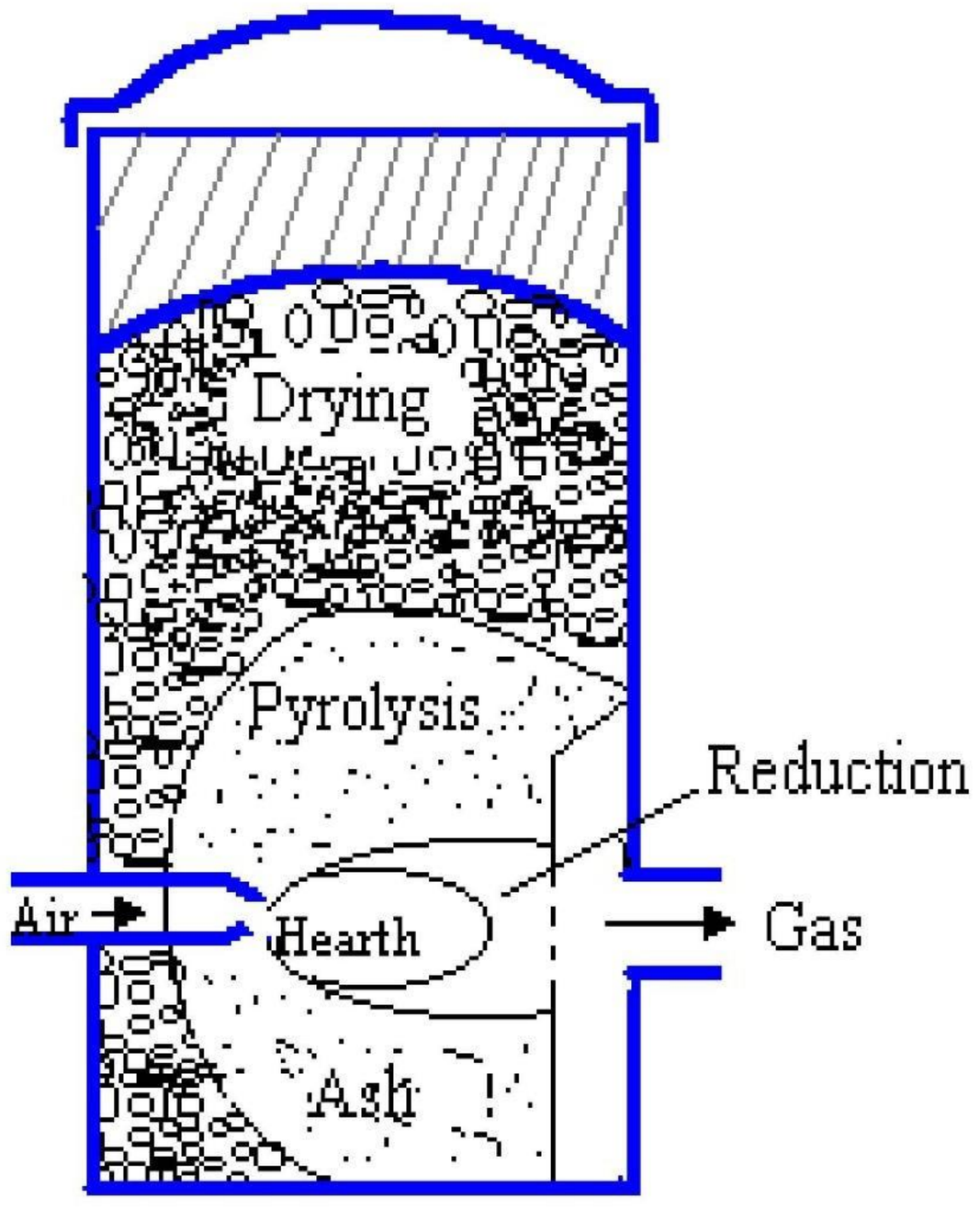
Types of Gasifiers

- Twin-fire Gasifier



Types of Gasifiers

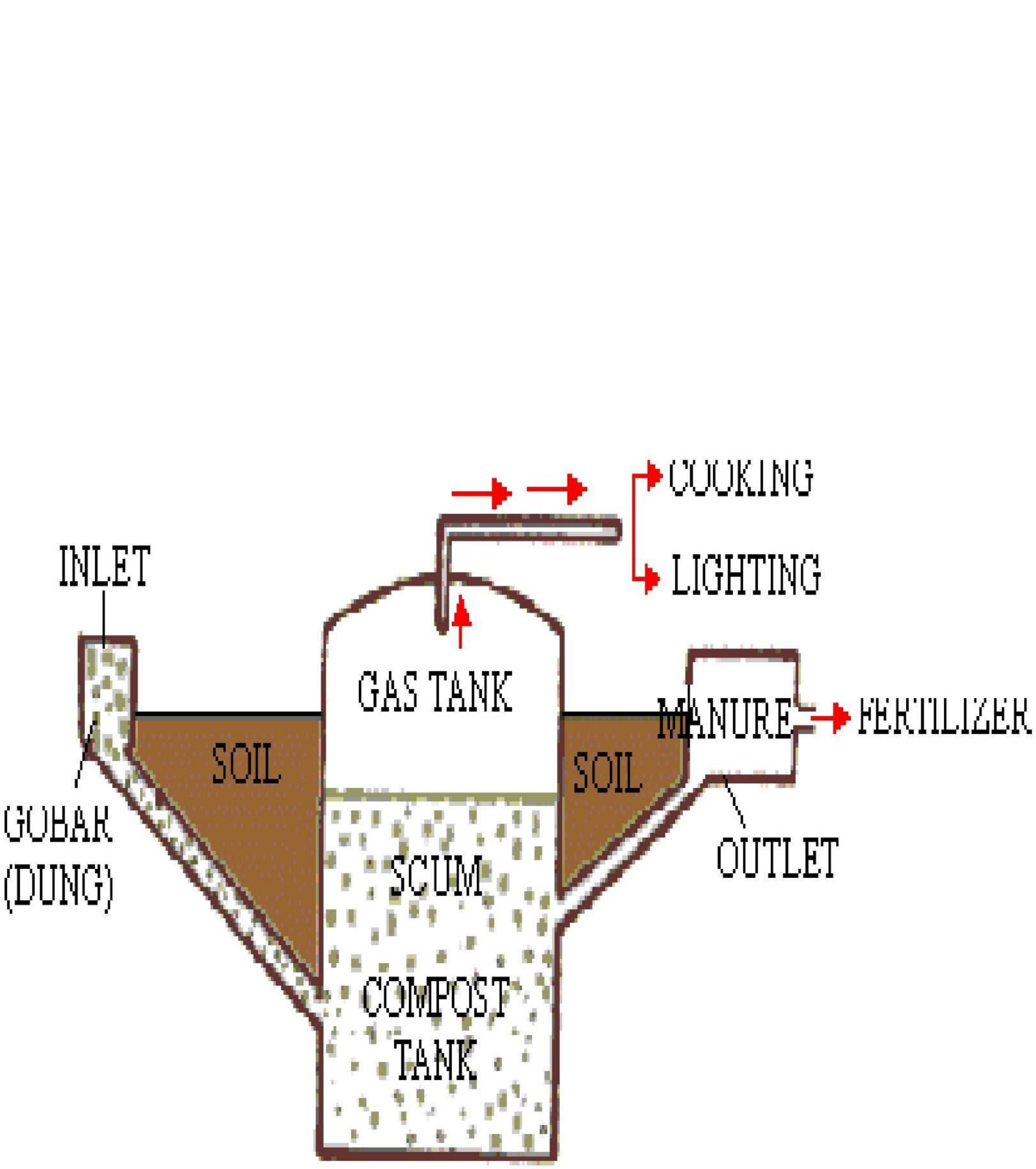
- **Crossdraft gas producers**



Gobar gas

- Gobar gas production is an **anaerobic process**

- Fermentation is carried out in an air tight, closed cylindrical concrete tank called a **digester**

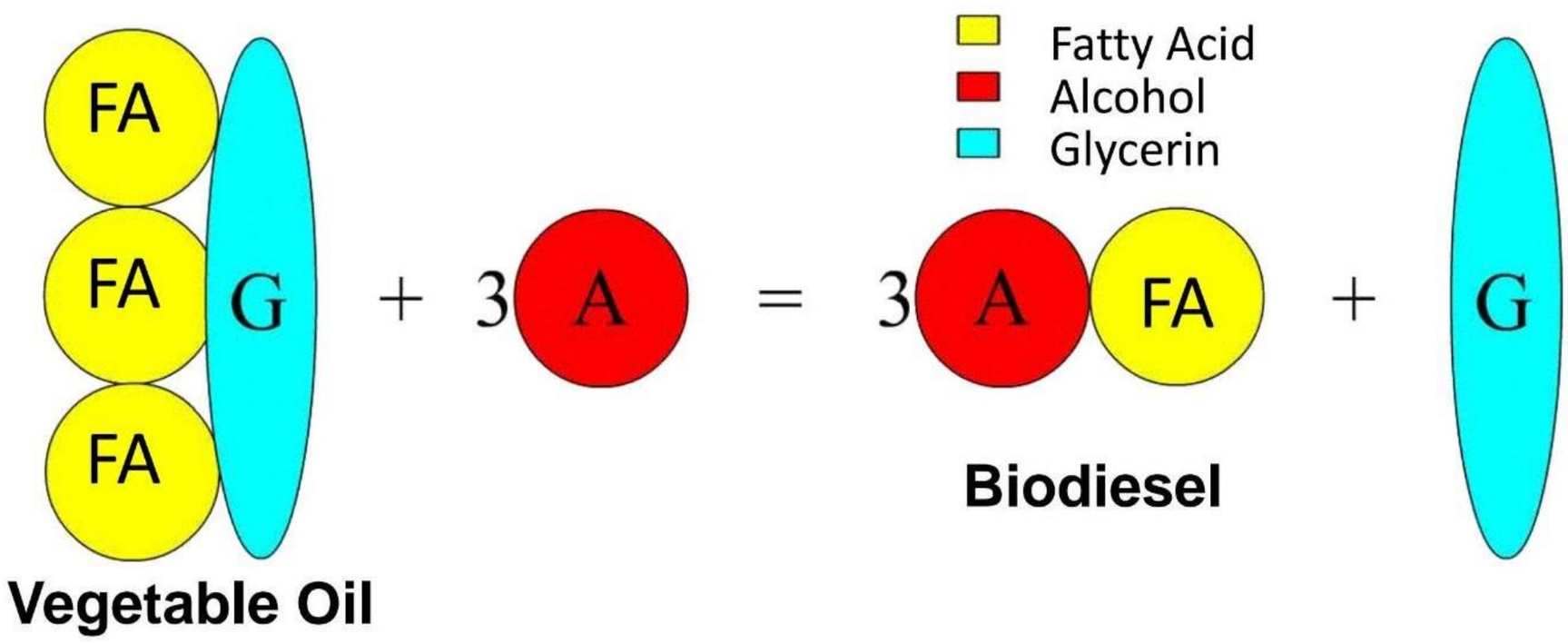


Factors to be considered in location of Bio-gas plant

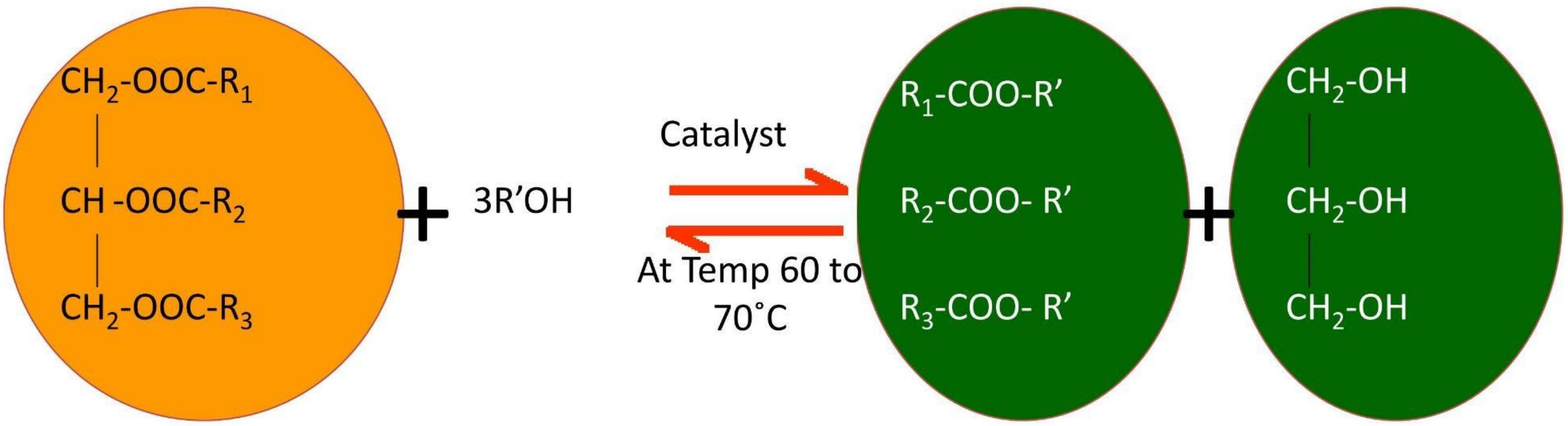
- It **should** be nearer **to** the intended **place** of gas use (eg. home or farm).
- It **should** also be nearer **to** the cattle shed/ stable for easy handling of raw materials.
- The water table **should** not be very high.
- Availability of feedstock.

What is Biodiesel?

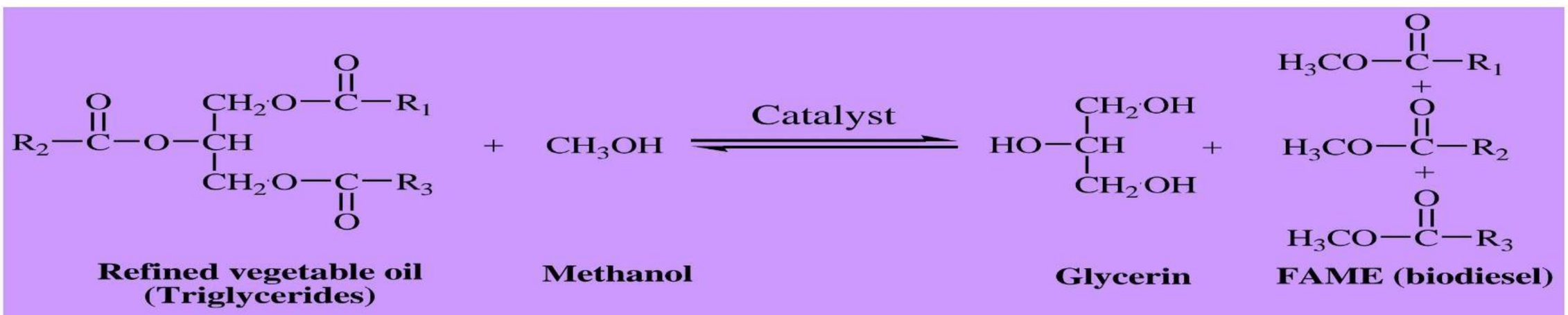
- **Alternative fuel for diesel engines**
- **Made from vegetable oil or animal fat**
- **Lower emissions, High flash point (>300F), Safer**
- **Biodegradable, Essentially non-toxic.**
- **Chemically, biodiesel molecules are mono-alkyl esters produced usually from triglyceride esters**



Mechanism of Transesterification Reaction



Triglyceride + **Alcohol** ⇌ **Esters** + **glycerol**



Scheme 1 (Reaction scheme for transesterification of lipids)

IMPORTANCE OF BIODIESEL

- Environment friendly
- Clean burning
- Renewable fuel
- No engine modification
- Increase in engine life
- Biodegradable and non-toxic
- Easy to handle and store

RAW MATERIALS

- Rapeseed, the major source (>80%)
- Sunflower oil (10%, Italy and Southern France)
- Soybean oil (USA & Brazil)
- Palm oil (Malaysia)
- Linseed, olive oils (Spain)
- Cottonseed oil (Greece)
- Beef tallow (Ireland), lard, used frying oil (Austria), Jatropha (Nicaragua & South Americas), Guang-Pi (China)

Benefits of Biodiesel

- - High cetane number (average 45,8-56,9 units)
- - High flash point (above +100)
- - Good lubricating property
- - Absence of sulfur and aromatic hydrocarbons
- - Low toxicity of emissions
- - Virtually complete bio-degradability (99% biodiesel is destroyed in water or soil in 28 days)
- - Zero balance of greenhouse gases

BASIC REACTION

CH_2COOR' | $CHCOOR''$ | CH_2COOR'''	3 ROH	Catalyst ⟶	CH_2OH | $CHOH$ | CH_2OH	R'COOR + R''COOR + R'''COOR
60 Kg Oil	6.78 Kg Alcohol	0.60Kg NaOH	6.5 Kg Glycerin	58 Kg Biodiesel

WHY BIODIESEL IMPORTANT FOR RAILWAYS

Indian Rail has very large available land and Bio-diesel will help Railways to :

*** Improve upon emission norms**

*** Eventually reduce diesel cost**

*** Contribute to Environment protection**

Biodiesel Challenges

- Cold Weather Operation (Chemistry)
- Producing enough feedstock oil to replace a large portion of petroleum (biology, chemistry, physics, economics)
- Engine and emissions optimization (chemistry, physics)

Bioethanol

- Ethanol is extensively used in Brazil for cars.
- Currently in India we use it as a blended fuel. It was made mandatory in 2003 in nine states and four union territories, and later extended to other parts of the country based on the availability of ethanol; but this is not implemented due to shortage of ethanol
- Technology to develop Ethanol from agro residues has to be exploited.
- Bioethanol can be produced from three classes of vegetative sources.
    - ➢starch from grain, corn and tubers like cassava
    - ➢sugar plants (sugar beet or sugar cane)
    - ➢cellulose plants (trees and biomass)

Replacing fossil fuels with so-called **biofuels**, such as bioethanol, is one way of reducing greenhouse gas emissions from the transport sector, which is responsible for a considerable proportion of total CO_2 emissions

BENEFITS OF BIOETHANOL

- Less dependence on crude oil
- It is a renewable fuel.
- Increase octane number (a standard measure of the performance of motor fuel)
- Reduces air pollution, cleaner environment due to cleaner combustion ➔ lower net carbon dioxide emissions .
- Helping in the emergence of a new market
- Expanded market opportunity in the agricultural field

WHAT ARE THE RAW MATERIALS FOR BIOETHANOL?

There are in general three groups of raw material:

1). Sugar : Beet, Sugar Cane, Sweet Sorghum and Fruits.

2). Starchy Material such as corn, wheat, rice, potatoes, cassava, sweet potatoes etc.

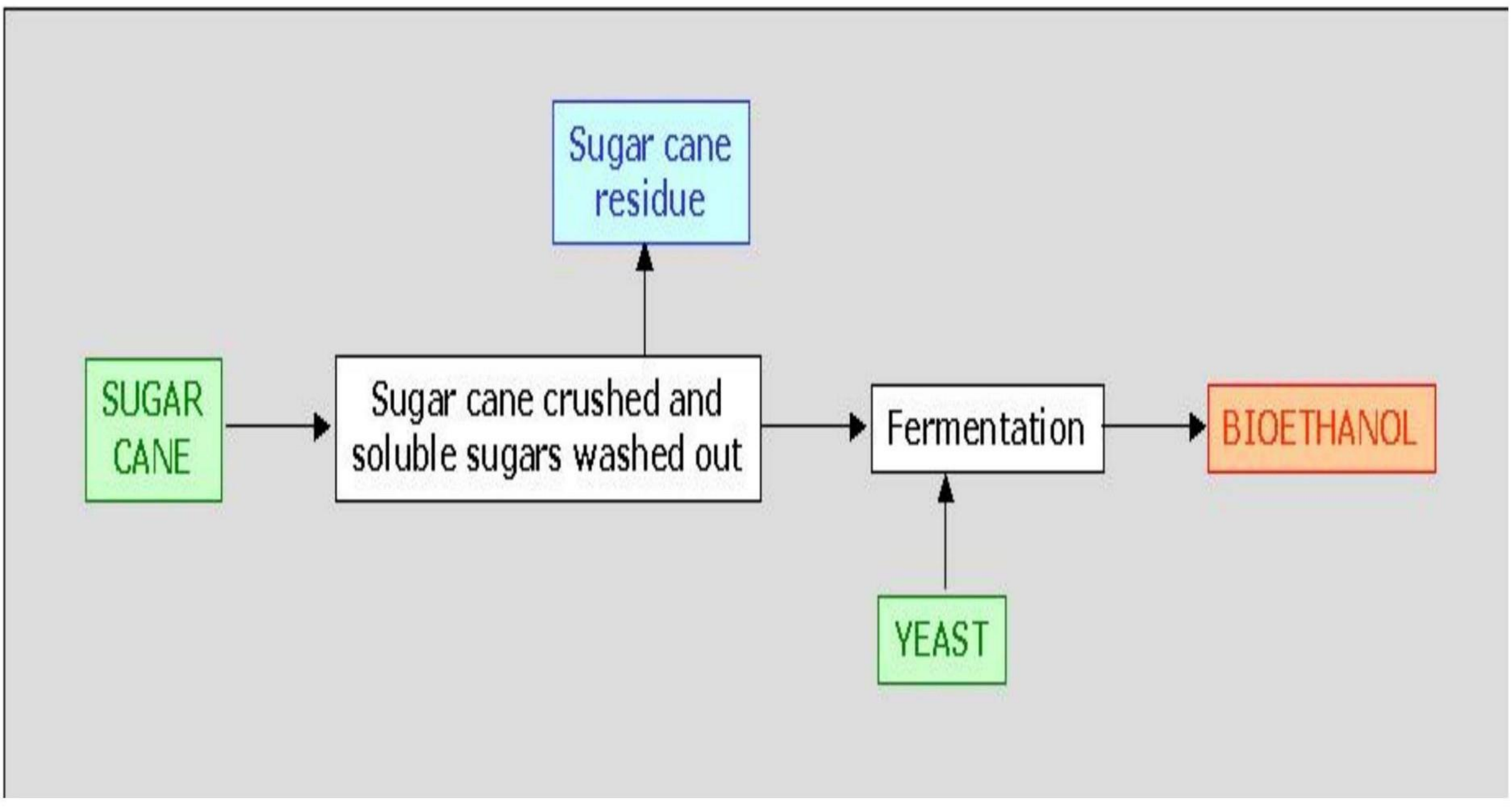
3). Cellulose materials like wood, used paper, crop residues etc.

STEPS FOR ETHANOL PRODUCTION

- Fermentation Process
- Distillation Process
- Dehydration Process

http://www.zeochem.ch/information/pdfs/ETHANOL%20Pocess.pdf

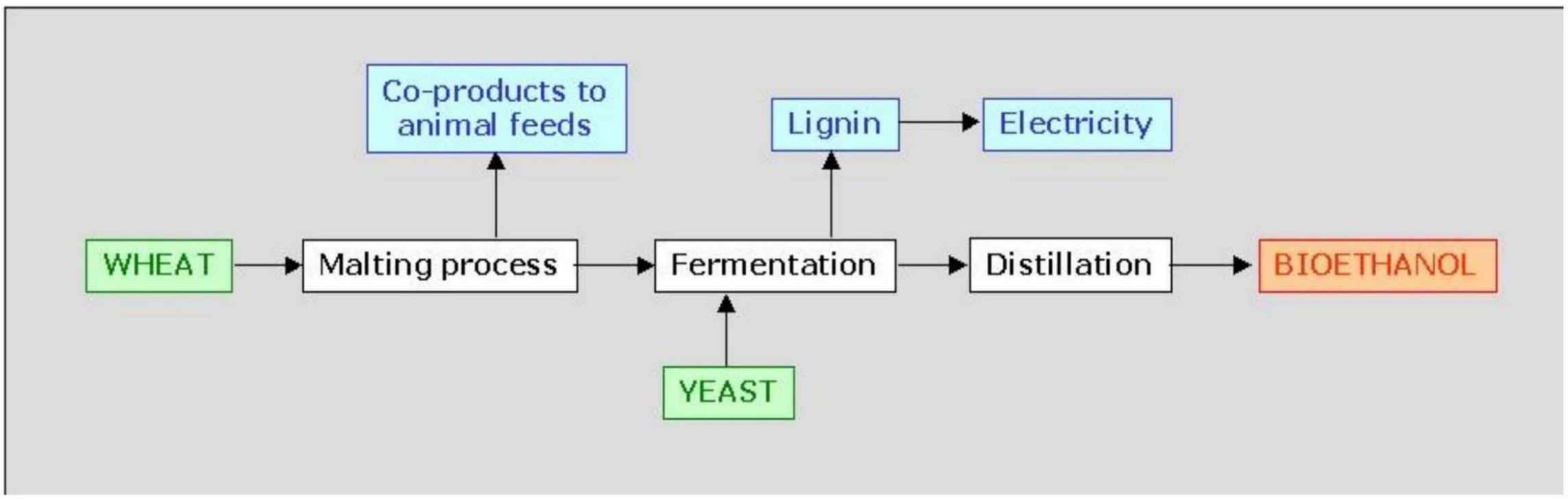
Sugar cane



*Source : sajeewa.wikispaces.com/file/view/bioethanol.**ppt***

Conversion of Starch to sugar and then sugar to ethanol

Wheat



- Ethanol is produced at 10-15% concentration and the solution is distilled to produce ethanol at higher concentrations

*Source : sajeewa.wikispaces.com/file/view/bioethanol.**ppt***

Bioethanol from Molasses

- The molasses is diluted with water until a concentration of 8-10% sugar is obtained in solution.
- To discourage bacterial growth, this is acidified with a little sulphuric acid.
- A nutritive solution of ammonium salts is added.
- The dilute solution obtained as above is taken in big fermentation tanks and some yeast is added (5% by volume).
- Distillation
- Dehydration

Sugarbeet

Yield : 70'000 kg/ha

Water : 77% m/m
Sugars: 17% m/m
Non-sugars: 4% m/m

Slicing

Slicing of sugarbeet into chips

Diffusion

Extraction of sweet juice
Separation of pulps

Fermentation

Conversion of sugars into alcohol
Production of ethanol at 8-10% m/m

Distillation

Separation of alcohol and stillage
Production of hydrated ethanol at 95% m/m

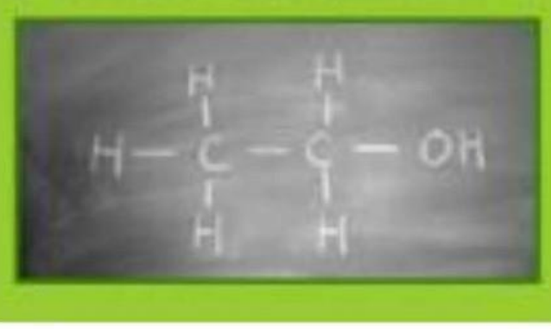
Dehydration

Alcohol rectification

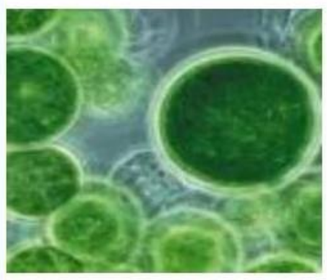
Ethanol

Anhydrous ethanol (7'400 l/ha)

Density: 0,795 kg/l
Energy content: 26,8 MJ/kg
Purity: 99,7% m/m (min.)
Water content: 0,3% m/m (max.)
European Norm: EN 15376



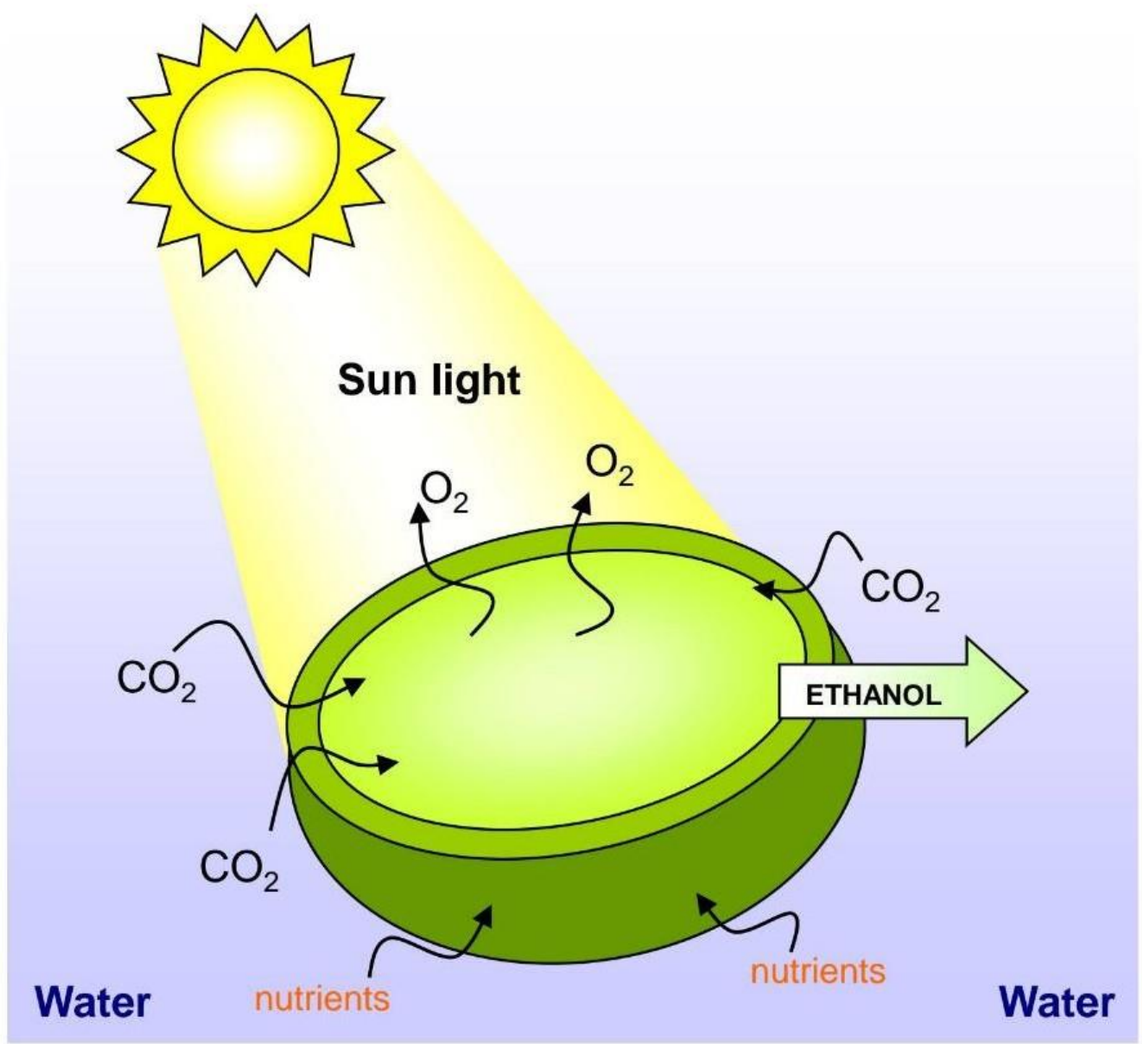
http://www.biofuels-platform.ch/en/infos/bioethanol.php



“BIOETHANOL FROM NON-CONVENTIONAL SOURCES”

Bioethanol production from non-conventional sources

Microalgae as a feedstock for bioethanol production

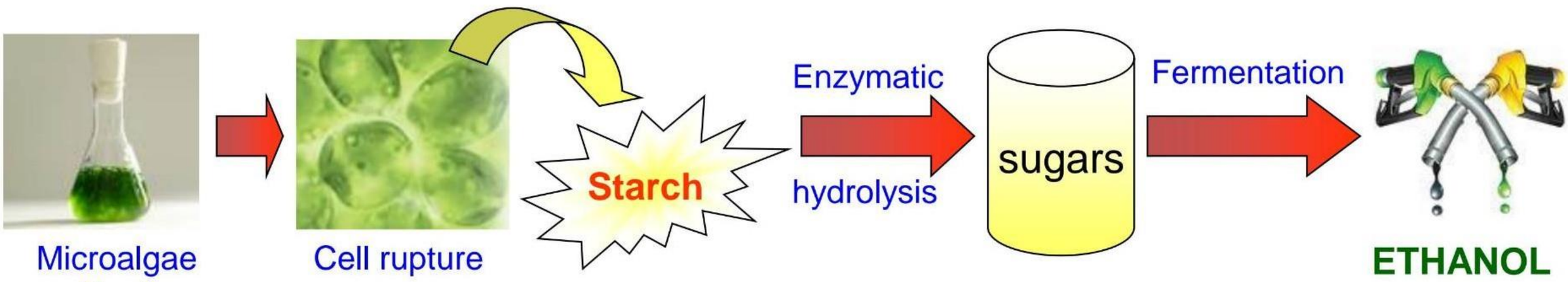


The microalgae Chlorella vulgaris, particularly, has been considered as a promising feedstock for bio-ethanol production

Bioethanol production from non-conventional sources

Microalgae as a feedstock for bioethanol production

Technology under development



Some algal species are able to conduct self-fermentation

CONCLUSION

- Biomass is a potential alternative to fossil fuels but it is not very viable.
- There are many problems in the development and transportation of it and carbon is a byproduct of processing of biomass, just like it is a byproduct of fossil fuels.
- They are better alternative energy sources.

SOURCES AND EFFECTS OF WATER POLLUTANTS ON HUMAN HEALTH, QUALITY STANDARDS FOR DRINKING WATER AND WASTEWATER TREATMENT

Need:

A person on an average can survive without food for days, but cannot survive without water.

Water is the basic need of any living being. But sadly this basic need is soon nearing its end.

Thanks to the high amounts of water consumption, the availability is decreasing

- Water is one among the most abundantly found natural resources.
- Without water life on earth is impossible.
- Water is an essential substance for all living organism
- Green plants need water for photosynthesis and animals need water for drinking, bathing, washing, etc. Water is also known as the **elixir of life**.

Availability

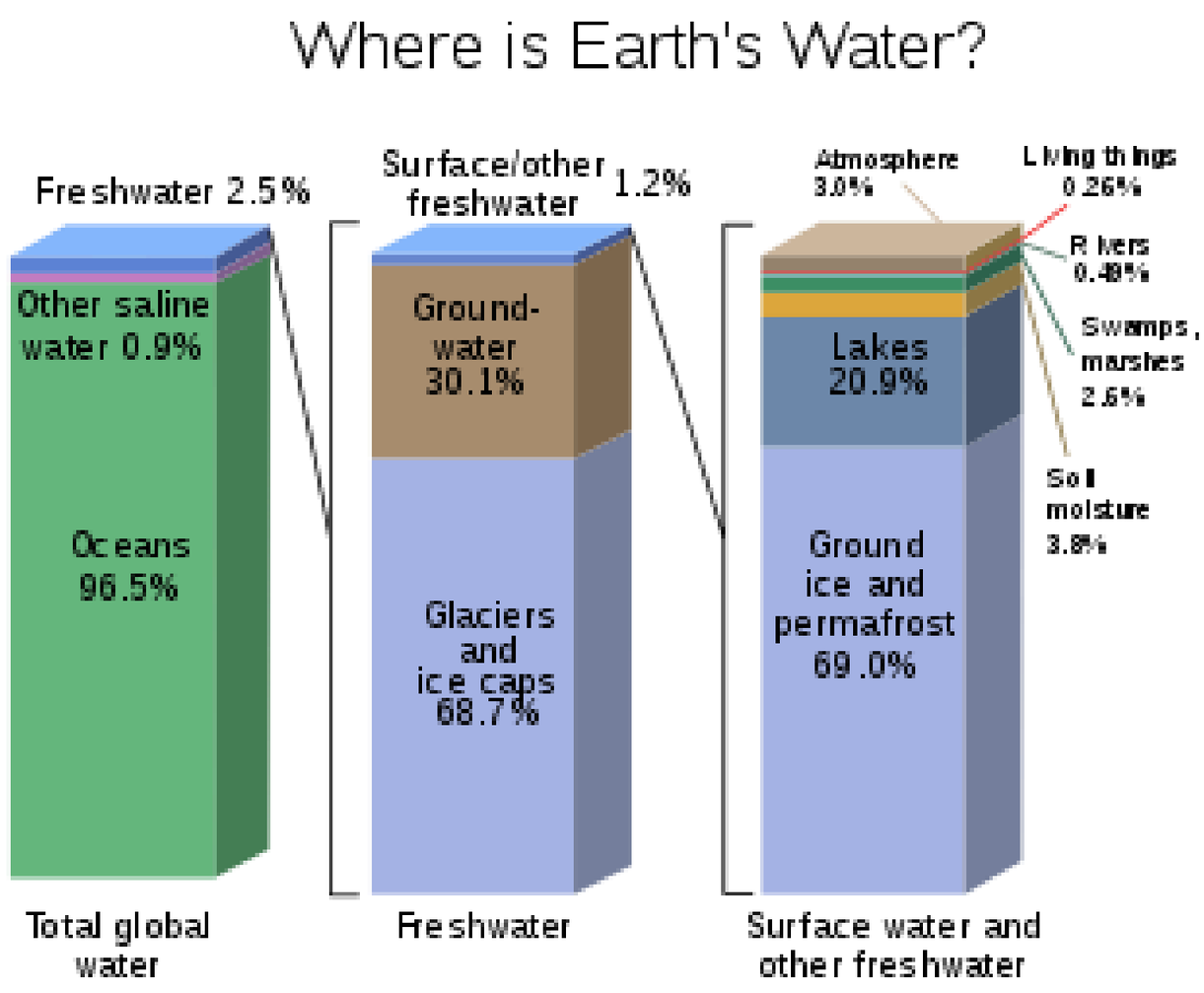
The total volume of water on Earth is estimated at 1.386 billion km³ (333 million cubic miles), with [97.5% being salt water and 2.5% being fresh water.](#)
Of the fresh water, only 0.3% is in liquid form on the surface.[
As the oceans cover roughly 71% of the area of Earth and reflect blue light, [Earth](#)appears blue from space, and is often referred to as the *blue [planet](#)*and the *[Pale Blue Dot](#)*.

It is a prime natural resource which is found on and under the ground.

Most of the water (about 97.5%) is in the seas and oceans as salt water. This water is too salty to be used for drinking and irrigation.

Thus, only 2.5% is available to us as fresh water. Out of this approximately 70% is locked up in the mountains or glacier.

So, about only 30% of the fresh water is easily available to us in the form of groundwater, river, lake, stream, soil moisture, and water vapor for our need of water consumption.



SOURCES


Natural Sources of Water
Oceans
Lakes
Ponds
Rivers
Streams

Sources -contd

•***Rainwater:*** Rain is the main source of water. It is considered to be the purest form of natural water. The rainwater also brings with it, the smoke and dust particles present in the atmosphere. Therefore, the first shower of rain contains many impurities.

•***Oceans and seas***: Almost 97% of all water is in the oceans. But this water is too salty to be used for drinking, farming, and irrigation.

•***River and lakes***: A part of rainwater falling on the earth's surface runs down the slope of the land in the form of rivers and streams. In some rivers, water also flows in by melting of ice on the mountains.

•***Groundwater***: When it rains, a part of it seeps through a layer of soil. This water reaches solid rocks where it gets collected as groundwater. Groundwater can be obtained by drilling wells or sinking tube well to reach the water table.

Water Consumption

All living organisms need water to stay alive. But human beings depend on water more than plants and animals. In our day-to-day activities, we do water consumption for different purposes such as:

Domestic uses: We need water for drinking, cleaning, cooking, washing, and some other activities. Each person may use an average of about 260 Liters of water a day in the house for different activities

Industrial uses: Our industries use a large amount of water at different stages of production, from the use of water as a raw material to generate electricity. The uses vary from industry to industry.

Water consumption -contd

Agriculture uses: farmers depend largely on the water in the form of rainfall for higher production of crops. If there is not sufficient rainfall c
Farmers use different irrigation methods to water the plants.

Water for recreation and transport: People still depend on water transportation to carry heavy and bulky products as machinery, coal, grain,
People build most of their recreation areas along lakes, rivers, and seas. They enjoy water sports such as swimming, fishing, and sailing.

WATER CYCLE

The circulation of water from Earth’s surface to the atmosphere and back to earth is called water cycle. It is a cyclical process which repeats itself again and again. The different stages of the water cycle are as follows:

Evaporation: It takes place when the sun heats up water in river, lakes or ocean and turns it into vapor or steam. The water vapor leaves the rivers, lakes, and oceans and goes into the air. About 90% evaporation is provided by the ocean, sea, lakes, and river. The remaining 10% is contributed by plant transpiration. Water vapor is water particles in gaseous form.

Water cycle - contd

Formation of a cloud: When warm air rises, it expands and cools. Cool air cannot hold as much water vapor in it as warm air; therefore some of the vapor condenses onto tiny dust particles floating in the air and form tiny water droplets around dust particles. These water droplets join together, they become a visible cloud.

Condensation: When water vapors enter the air, the air cools and the water vapor changes back into liquid droplets, forming clouds. This process of change of water vapor into liquid droplets is called condensation.

Precipitation: It occurs when the clouds become saturated with water vapor and heavy with water, the water falls back to the Earth in the form of rain, hail, or snow.

WATER POLLUTION

Water pollution is defined as any adverse change in composition and the condition of the water which tend to lower its quality and cause health hazard or makes it unfit for domestic use.

Classification of water pollutants :

1) Oxygen demanding wastes
2) Disease causing agents
3) Synthetic organic wastes
4) Plant nutrients
5) Inorganic chemicals and minerals
6) Sediments
7) Radioactive substances
8) Thermal discharges
9) Oil

SOURCES AND EFFECTS OF

WATER POLLUTION

1) Sewage and domestic waste
2) Industrial wastes and effluents
3) Insecticides and pesticides
4) Detergents and fertilizers
5) Siltation
6) Thermal pollution
7) Radioactive materials

SEWAGE AND DOMESTIC WASTES

- Nearly 75% of water pollution is due to sewage and domestic wastes.
- Biological oxygen demand (BOD)- The amount of oxygen consumed by microbiological action when 1000ml sample of water containing known amount of oxygen is incubated for 5 days.
- Water having DO content below 8.0 mg/l is considered as polluted. Heavily polluted water have DO content below 4.0 mg/l.
- Chemical oxygen demand (COD) - It is the oxygen required by organic substance in order to oxidise them by a strong chemical oxidant.

INDUSTRIAL WASTES AND EFFLUENTS

- The industrial wastes and their effluents include poisonous materials like acids, alkalis, salts, phenols, cyanides, zinc, insecticides which makes water toxic and deoxygenated and eventually do not support aquatic life.

- MERCURY- Minamata disease.

- OILS- Oil reduce rate of oxygen uptake by water, retards light intensity by 90%.

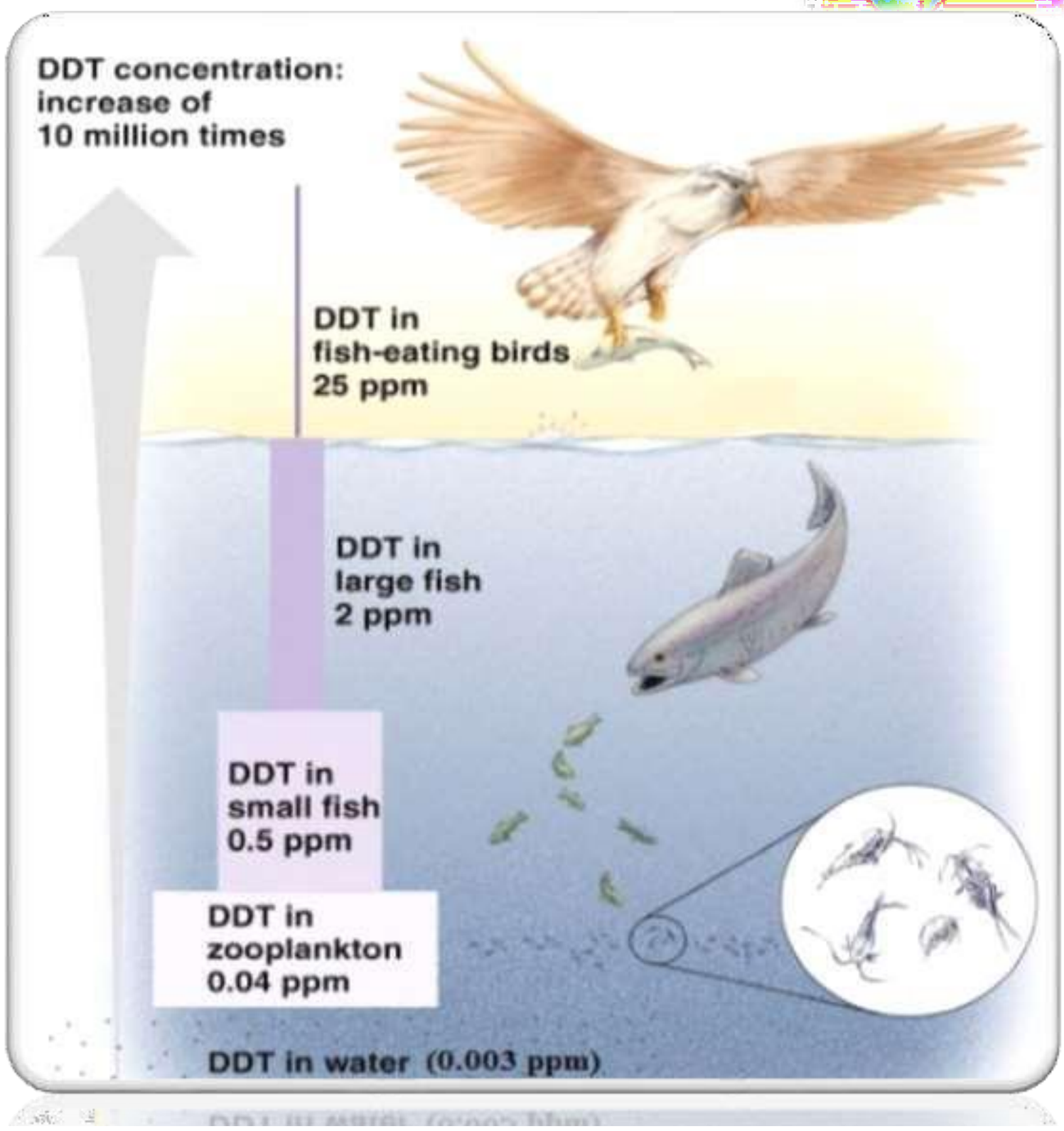
- BLACK FOOT DISEASE (Arsenic), ASBESTOSIS (Asbestos), BERYLLIOSIS (Beryllium), ITAI- ITAIdisease (Cadmium).

- The most common cause of blue baby syndrome is water contaminated with nitrates.
- After a baby drinks formula made with nitrate-rich water, the body converts the nitrates into nitrites. These nitrites bind to the hemoglobin in the body, forming methemoglobin, which is unable to carry oxygen.
- (Underdeveloped fecal organisms in babies convert nitrate to nitrite in the gastrointestinal tract. Nitrates are not toxic to the body but if converted into nitrite, it may lead to blue baby syndrome. Nitrate and nitrite convert hemoglobin to methemoglobin, which cannot carry oxygen. It leads to low blood oxygen levels and blue baby syndrome)
- Nitrates are most common in drinking water in farming communities that use well water. This contamination is due to the use of fertilizers and manure.
- Infants younger than 3 months are at highest risk for blue baby syndrome, but it can also occur in other populations.

INSECTICIDES AND PESTICIDES

- They are biologically active chemicals are used for pest control. These include DDT (dichloro diphenyl trichloroethane), aldrin etc.

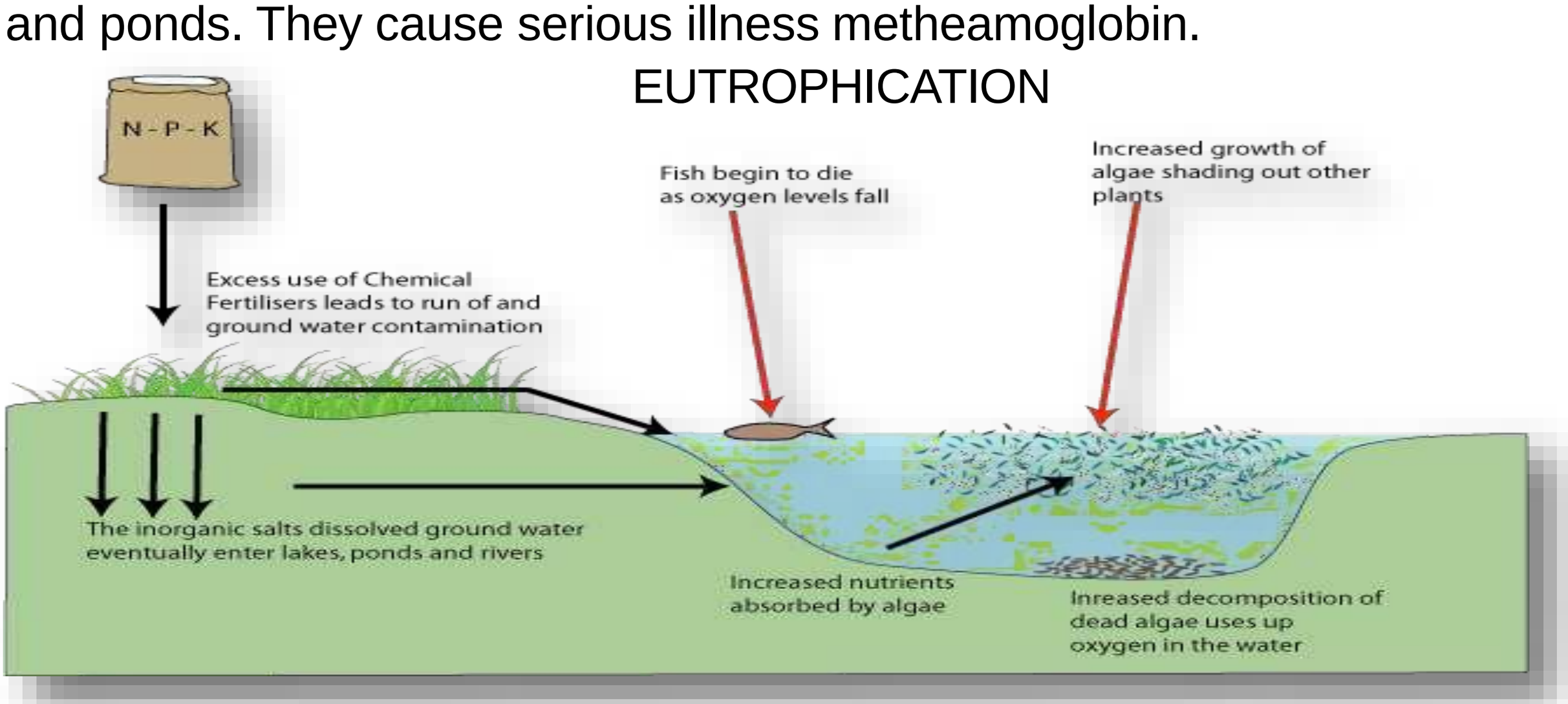
Increased accumulation of these toxic substance in the food chain at high level is called **BIOLOGICAL MAGNIFICATION**.



DETERGENTS AND FERTILIZERS

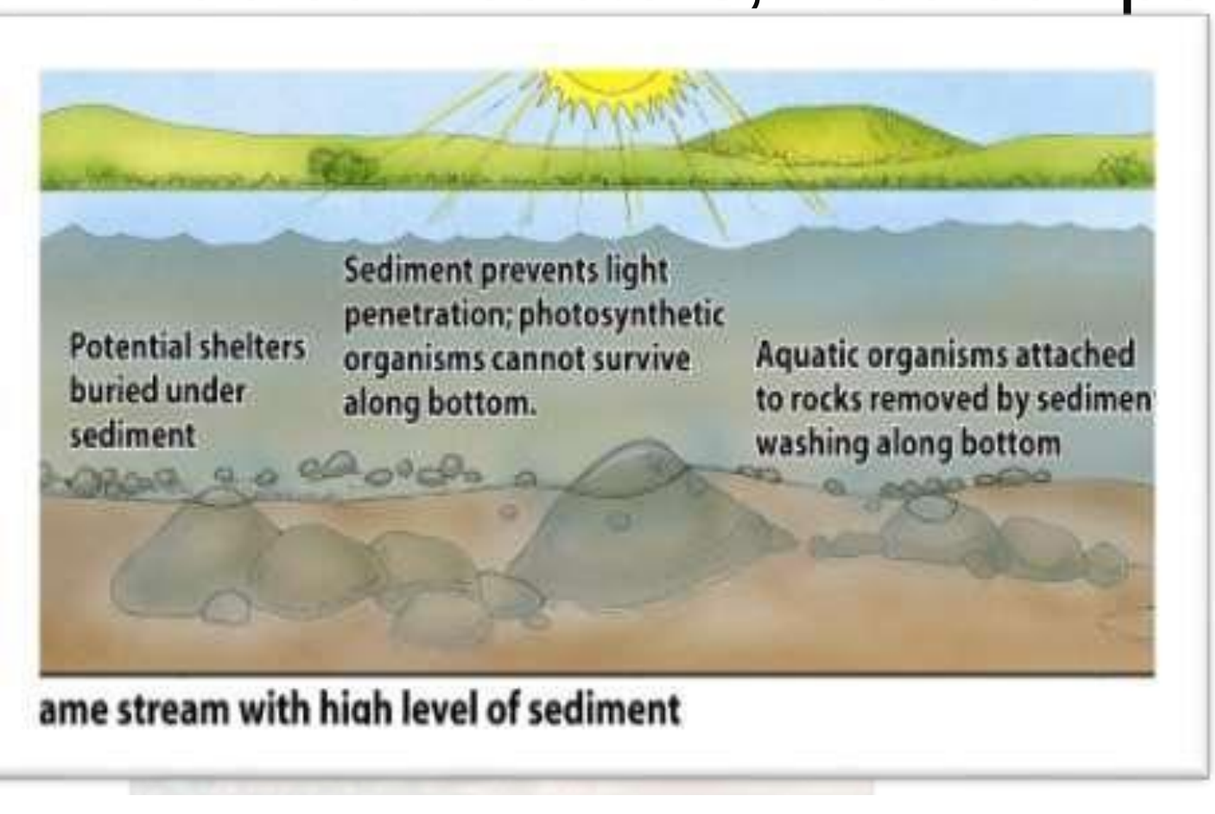
- Detergents are used as cleaning agent and derived from surfactant (10% - 30%, alkyl benzene sulphonate), builder (10% to 15%, sodium phosphate) and other ingredients.
- Fertilizers such as nitrates and phosphates are used to improve crop yield reach through irrigation, rainfall and drainage into rivers and ponds. They cause serious illness metheamoglobin.

EUTROPHICATION

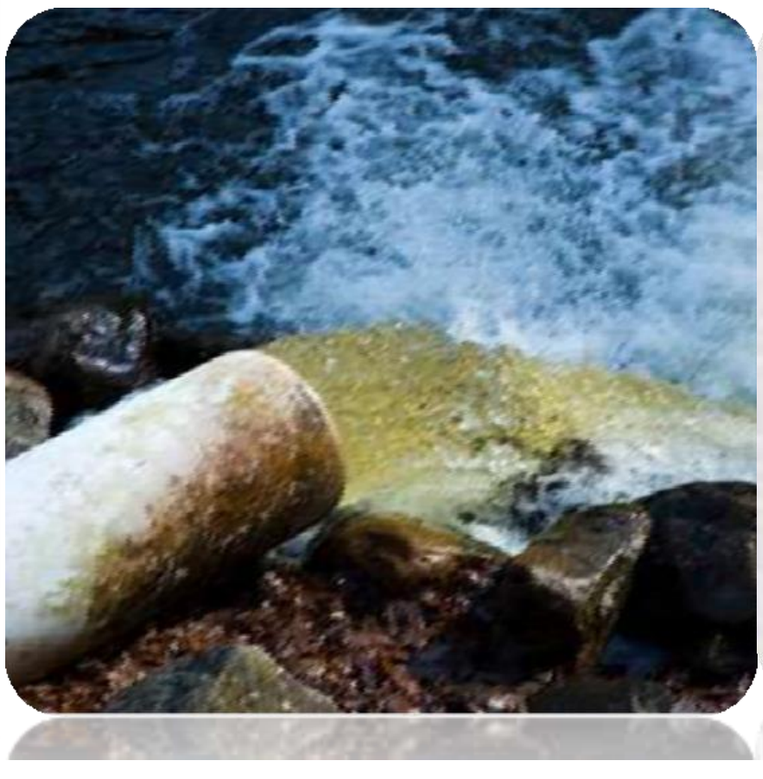


OTHER SOURCES

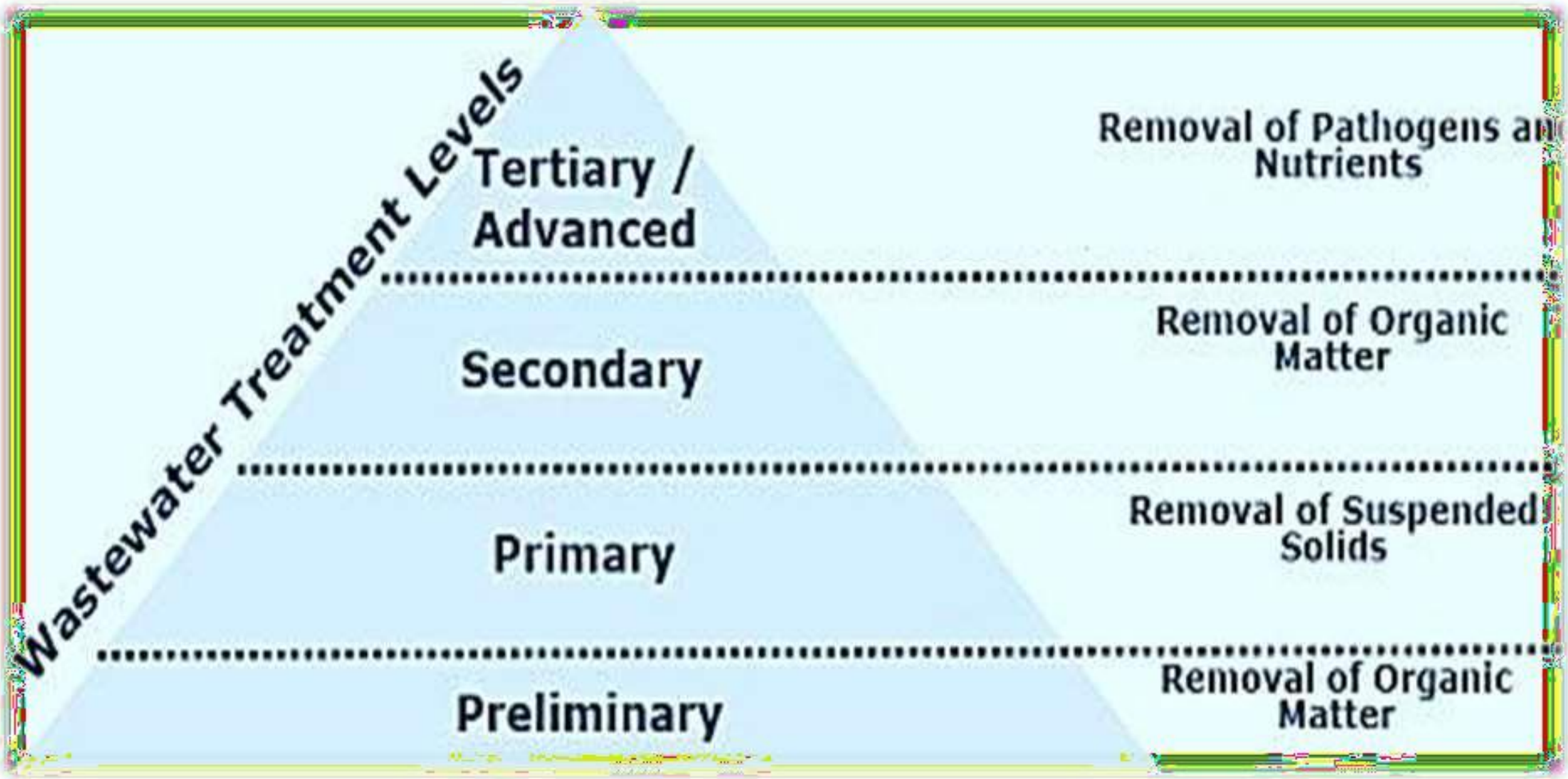
- **SILTATION** :- Seen in hilly streams and creates turbidities.
- **THERMAL POLLUTION**:- Heated waste water from power plants and industries which raises the temperature of water to a harmful level.
- **RADIOACTIVE MATERIALS** :- Radioactive pollutants get their way into water streams from various sources such as nuclear reactors, nuclear power plants and nuclear test.



ame stream with high level of sediment



The sewage treatment process are conveniently classified as



THANKYOU