

**Lecture 5. Energy in the chemical industry.
Types of energy. Secondary energy resources.
Energy problems in the chemical industry and
their solutions**

- What is Energy?

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**“Energy is a property of matter
that can be converted into work,
heat or radiation.**

The different forms of energy:

Energy can be obtained in number of way. It may be in the form of

(1) **Chemical energy** - due to chemical reaction, (Biomass, petroleum, natural gas, propane and coal are examples of stored chemical energy).

(2) **Electrical energy** - due to flow of electron, (Lightning and electricity are examples of electrical energy).

(3) **Heat energy** - due to thermal vibration, (Geothermal energy is an example of thermal energy).

(4) **Light energy** - due to radiation of light

(5) **Mechanical energy** – due to moving parts, (Compressed springs and stretched rubber bands are examples of stored mechanical energy).

(6) **Nuclear energy** - due to nuclear reaction, (The nucleus of a uranium atom is an example of nuclear energy).

Category of energy resource

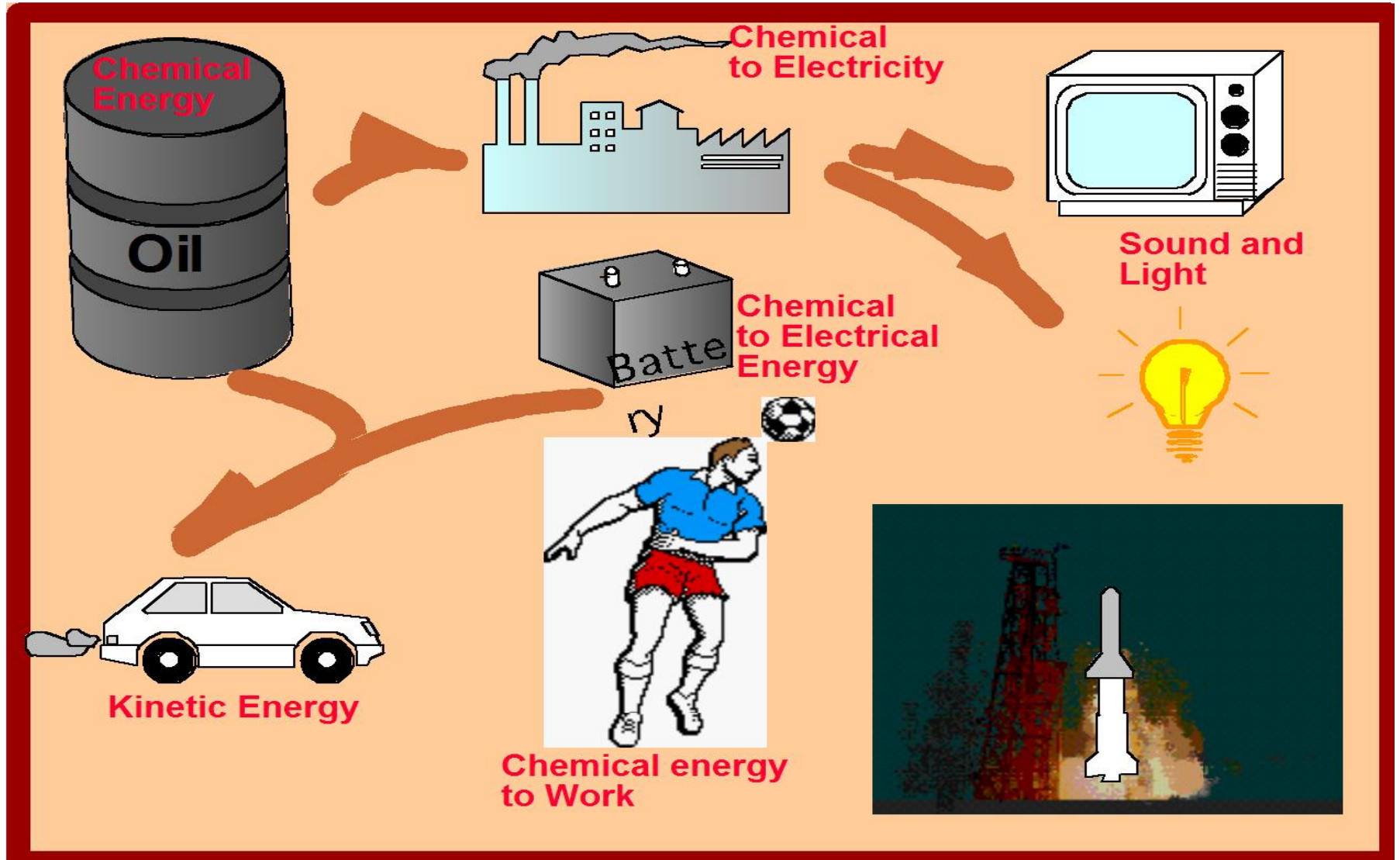
On the basis of availability, the energy resources are broadly categories as,

- Primary energy resources
- Secondary energy resources

Primary energy: All energy originates from natural sources such as coal, solar, wind, hydro are called primary energy resources.

Secondary energy: The energy converted from primary energy sources. For example, the solar energy can be converted into electricity

Energy Transformations

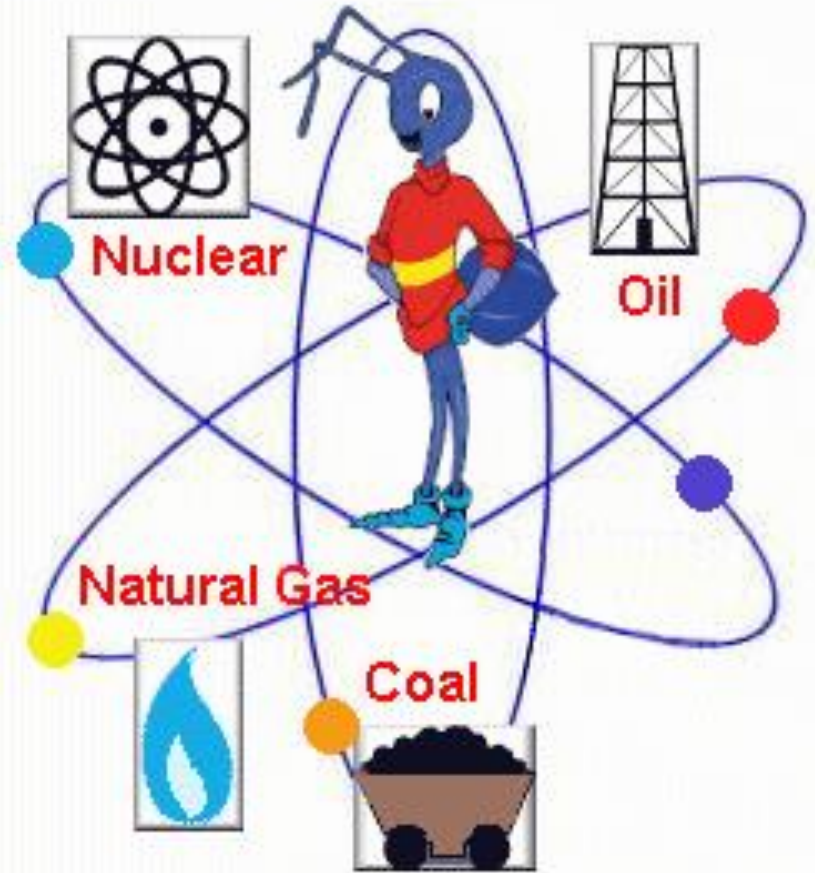


Types of Energy sources

- 1. Conventional energy sources (or) Non-renewable energy sources;**
- 2. Non-Conventional energy sources (or) Renewable energy sources**

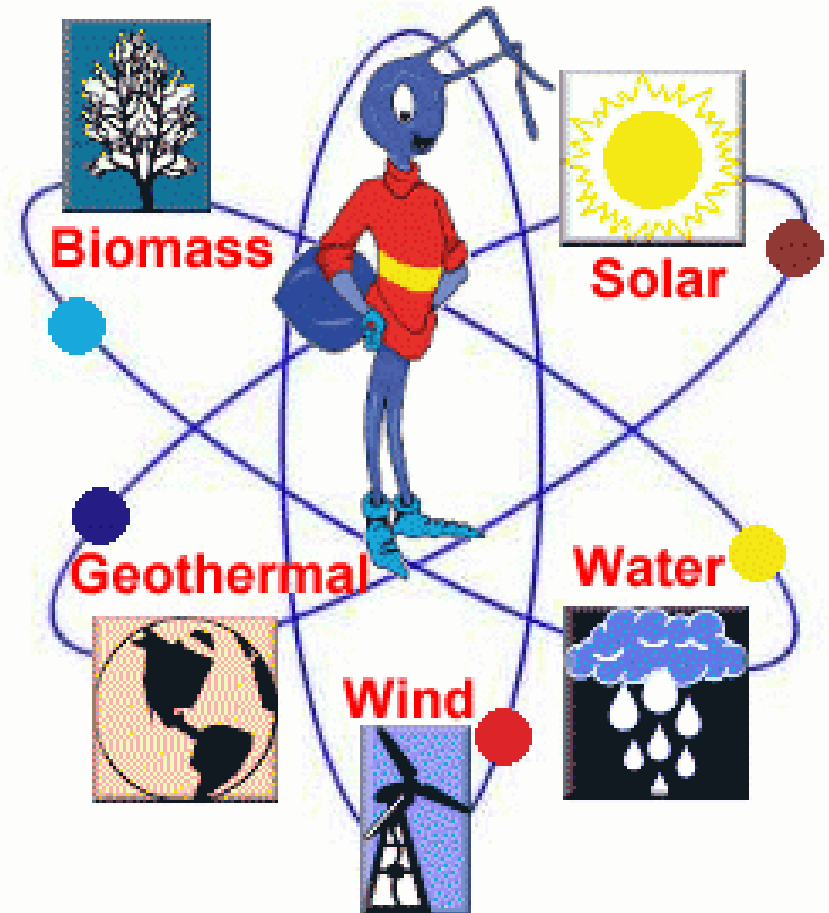
Conventional energy sources (or) Non-renewable energy sources

Non-renewable energy is the conventional fossil fuels such as coal, oil and gas, which are likely to deplete with time.



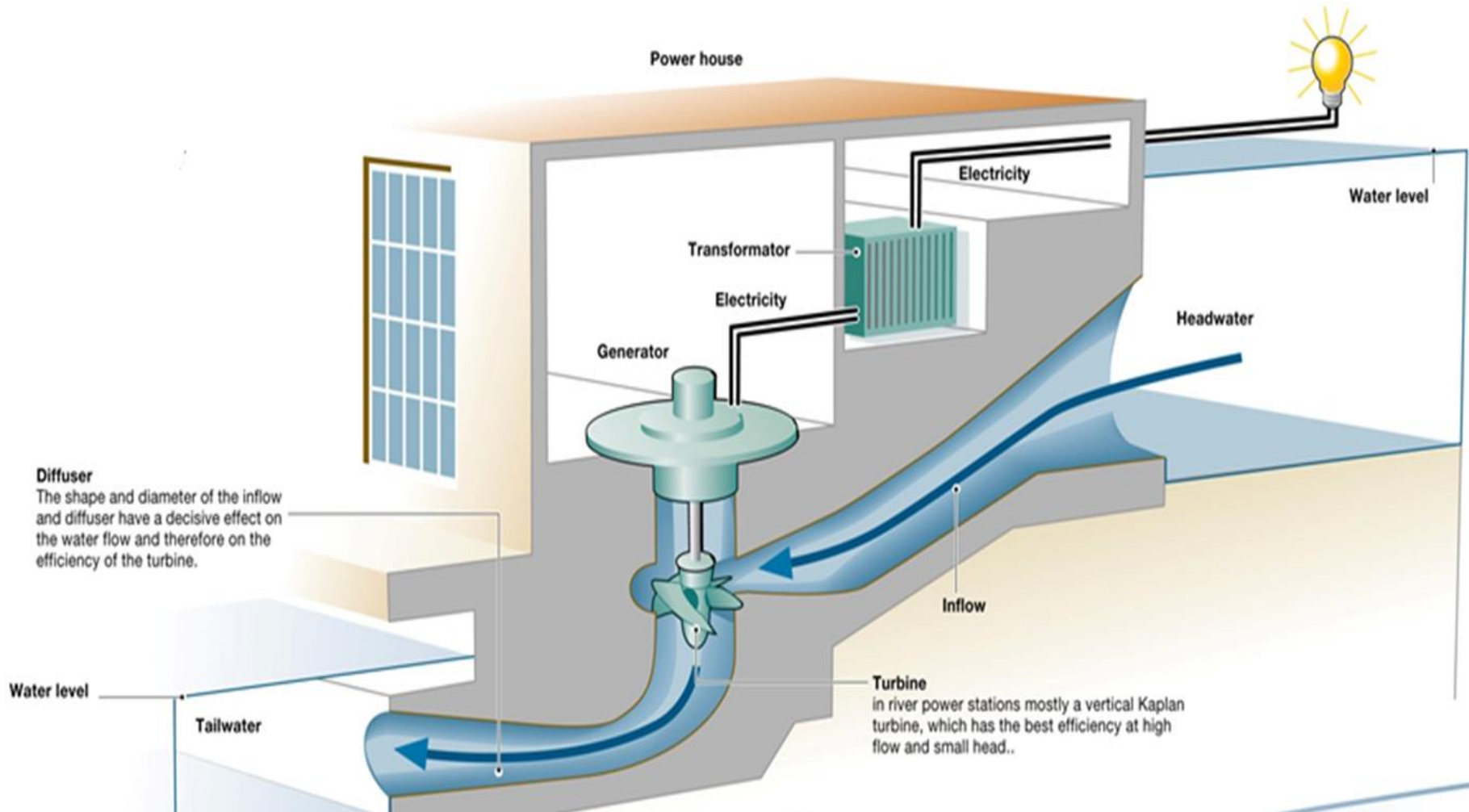
Non-Conventional energy sources (or) Renewable energy sources

Renewable energy is energy obtained from sources that are essentially inexhaustible. Examples of renewable resources include wind power, solar power, geothermal energy, tidal power and hydroelectric power.



Hydroelectric power plants use running water to spin a turbine and generate electricity.

Hydroelectricity is very economical, with costs per kilowatt-hour similar to coal.

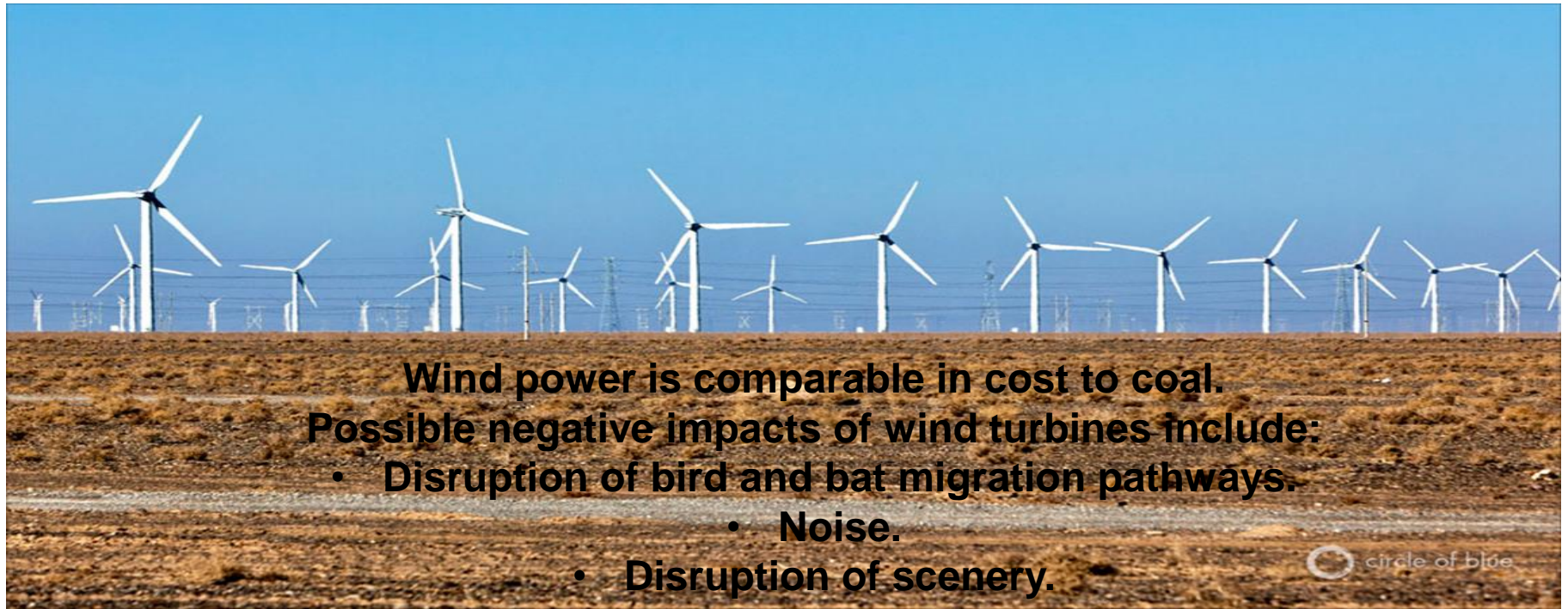


The construction of the dam has major ecological impacts.

- Regular flooding downstream stops, preventing deposition of silt and nutrients.
 - The reservoir can experience sedimentation, where particles of soil in the river settle to the bottom of the reservoir.
 - The ecosystem immediately behind the dam becomes flooded.
 - River water, when stopped, warms faster and begins to evaporate.
 - Fish and other organisms can no longer move upstream.
- Another issue with dams is that they produce a constant, steady stream of electricity that cannot be easily adjusted to meet demand.
 - Some dams have pumped storage, where water will be sent and stored during low-demand times, then returned back through the dam's turbines when demand is higher.

Wind energy is similar to hydroelectricity, except that moving air provides the force to spin the generator.

- Wind turbines are able to orient themselves to face the oncoming wind.
- As the air passes through, the blades rotate.
- These are attached to a shaft, which connects to the turbine.
- A single wind turbine can generate 1-7 megawatts of energy per year, not enough for a large population.
- Wind farms are large numbers of wind turbines clustered together.



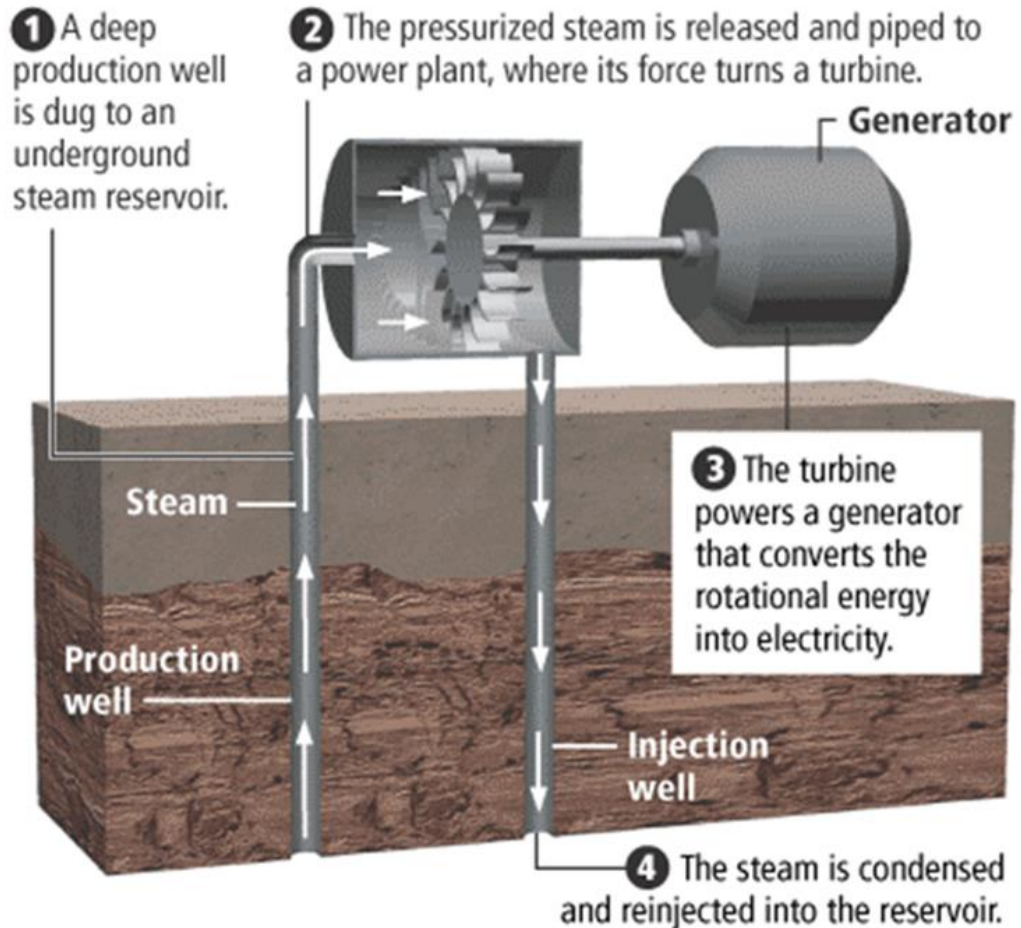
Wind power is comparable in cost to coal.

Possible negative impacts of wind turbines include:

- **Disruption of bird and bat migration pathways.**
 - **Noise.**
 - **Disruption of scenery.**

Geothermal Energy

- **Geothermal power, like nuclear and coal, works by boiling water to steam.**
 - Naturally-occurring heat from the Earth is used in place of fuel.
- **At a geothermal plant, two wells are drilled.**
 - One injects cold water towards the underground heat.
 - The second directs steam to the turbine.



Source: U.S. Department of Energy

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Solar Energy

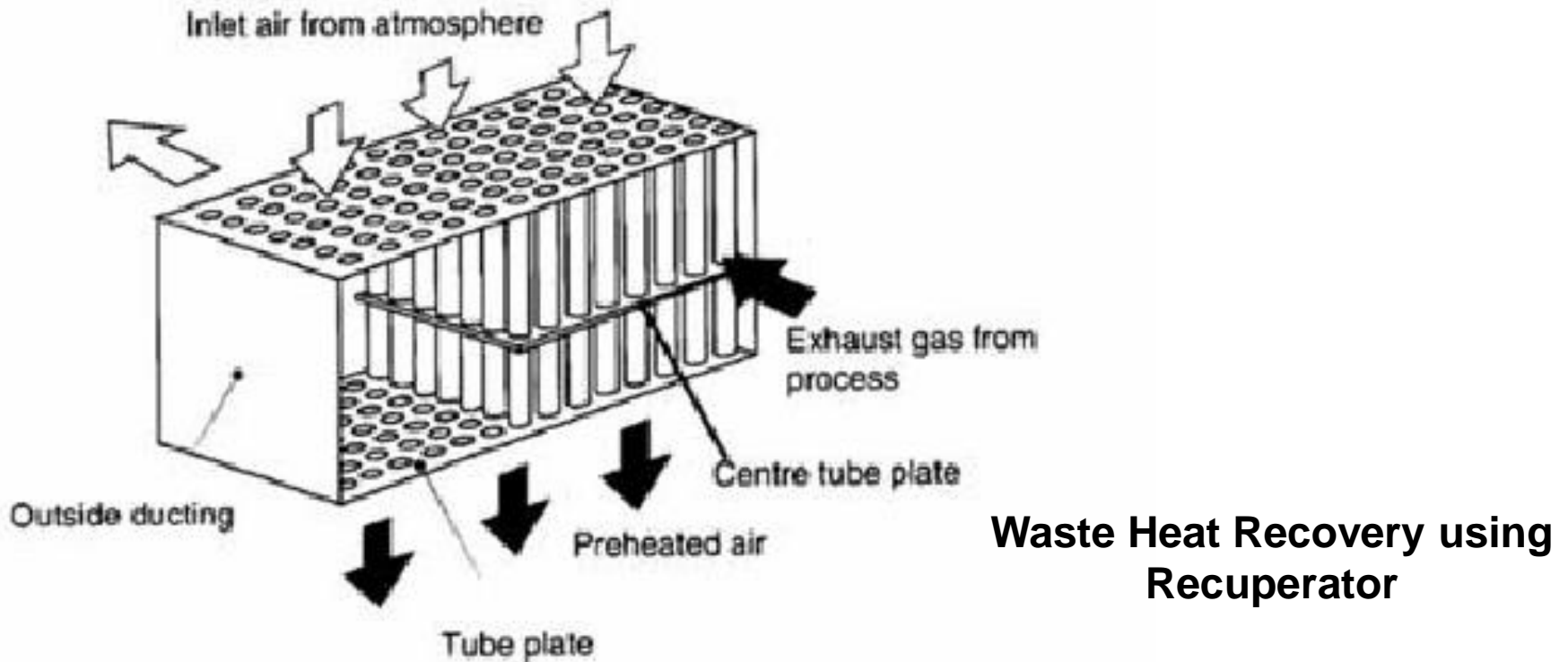
- An enormous amount of energy (over 1,000 watts per square meter) hits the Earth every day.
 - This energy is very diffuse, spread out across the entire surface area of the planet.
- Two separate technologies have been developed to convert solar energy into electricity.

The use of secondary energy resources

- Waste heat is heat generated in a process by way of fuel combustion or chemical reaction, which is then “dumped” into the environment and not reused for useful and economic purposes. The essential fact is not the amount of heat, but rather its “value”. The mechanism to recover the unused heat depends on the temperature of the waste heat gases and the economics involved.

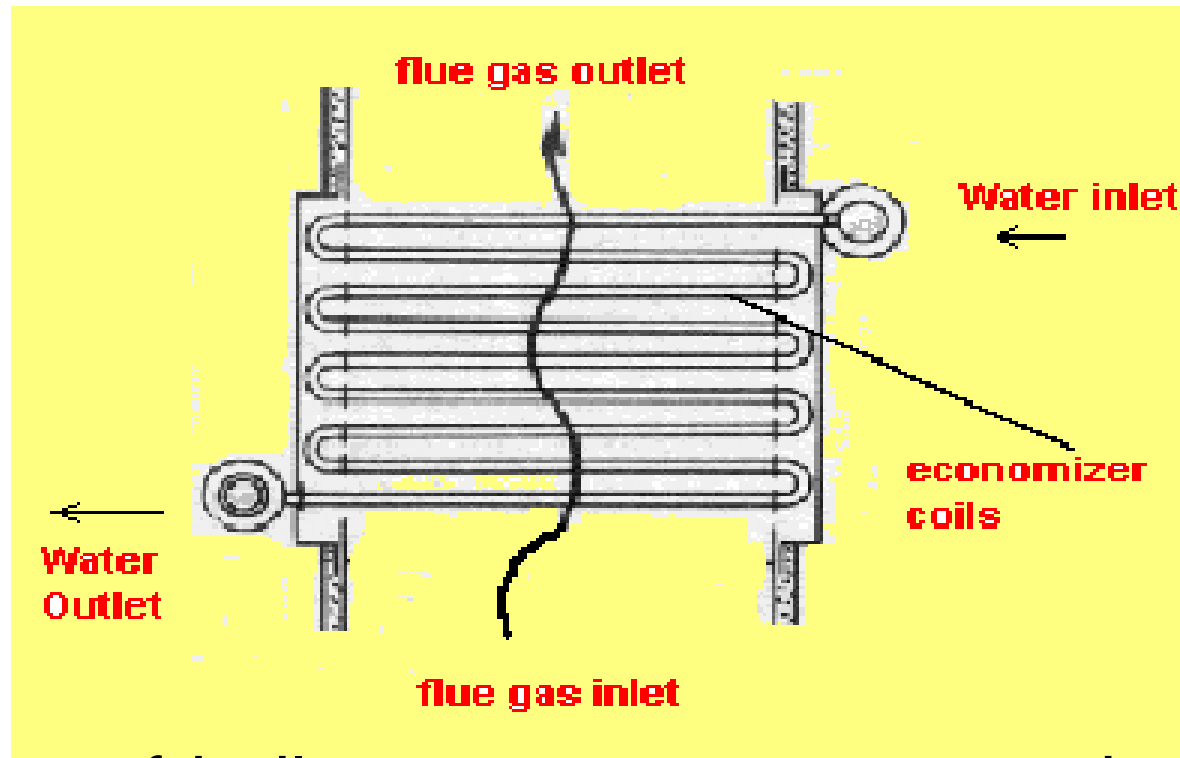
- Large quantities of hot flue gases are generated from boilers, kilns, ovens and furnaces. If some of the waste heat could be recovered then a considerable amount of primary fuel could be saved. The energy lost in waste gases cannot be fully recovered. However, much of the heat could be recovered and adopting the following measures can minimize losses.

The use of secondary energy resources



- In a recuperator, heat exchange takes place between the flue gases and the air through metallic or ceramic walls. Ducts or tubes carry the air for combustion to be preheated, the other side contains the waste heat stream.

Economizer



In the case of boiler systems, an economizer can be provided to utilize the flue gas heat for pre-heating the boiler feed water. On the other hand, in an air pre-heater, the waste heat is used to heat combustion air. In both the cases, there is a corresponding reduction in the fuel requirements of the boiler.