

# **MODULE : ENERGY TECHNOLOGIES**

## **Lesson 6 : Other technologies**

# Outline

- Nuclear Power
- Geothermal power
- Ocean power
- Piezoelectricity

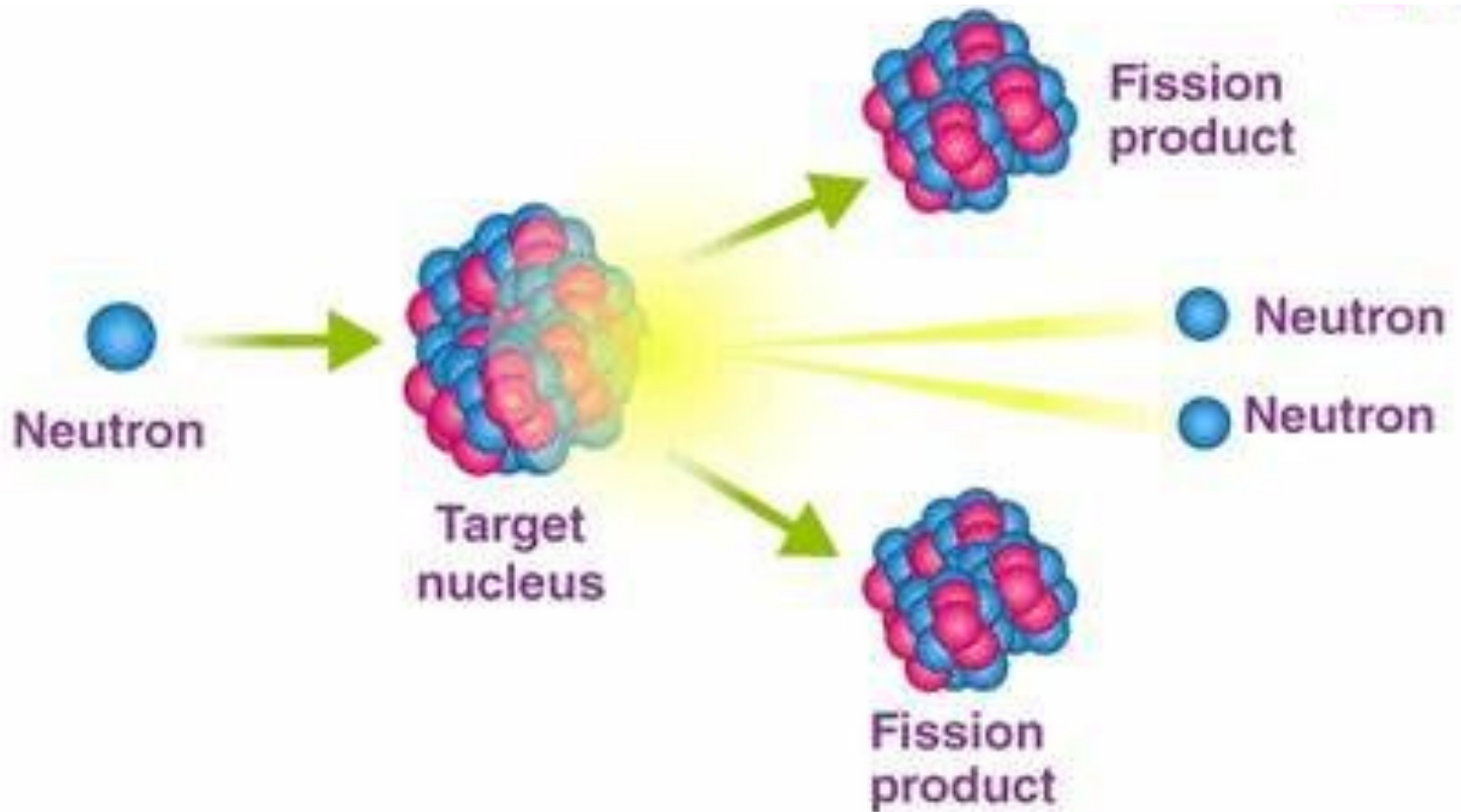
# Nuclear Power

- Nuclear power plants are also thermal power plants which use steam turbine technology
- In contrast to fossil fuel/bio mass fired steam power plants, the heat is generated by nuclear reaction of radioactive material like Uranium.
- Since the radioactive elements are not refurbished it doesn't come under renewable category but carbon emission is low as renewables
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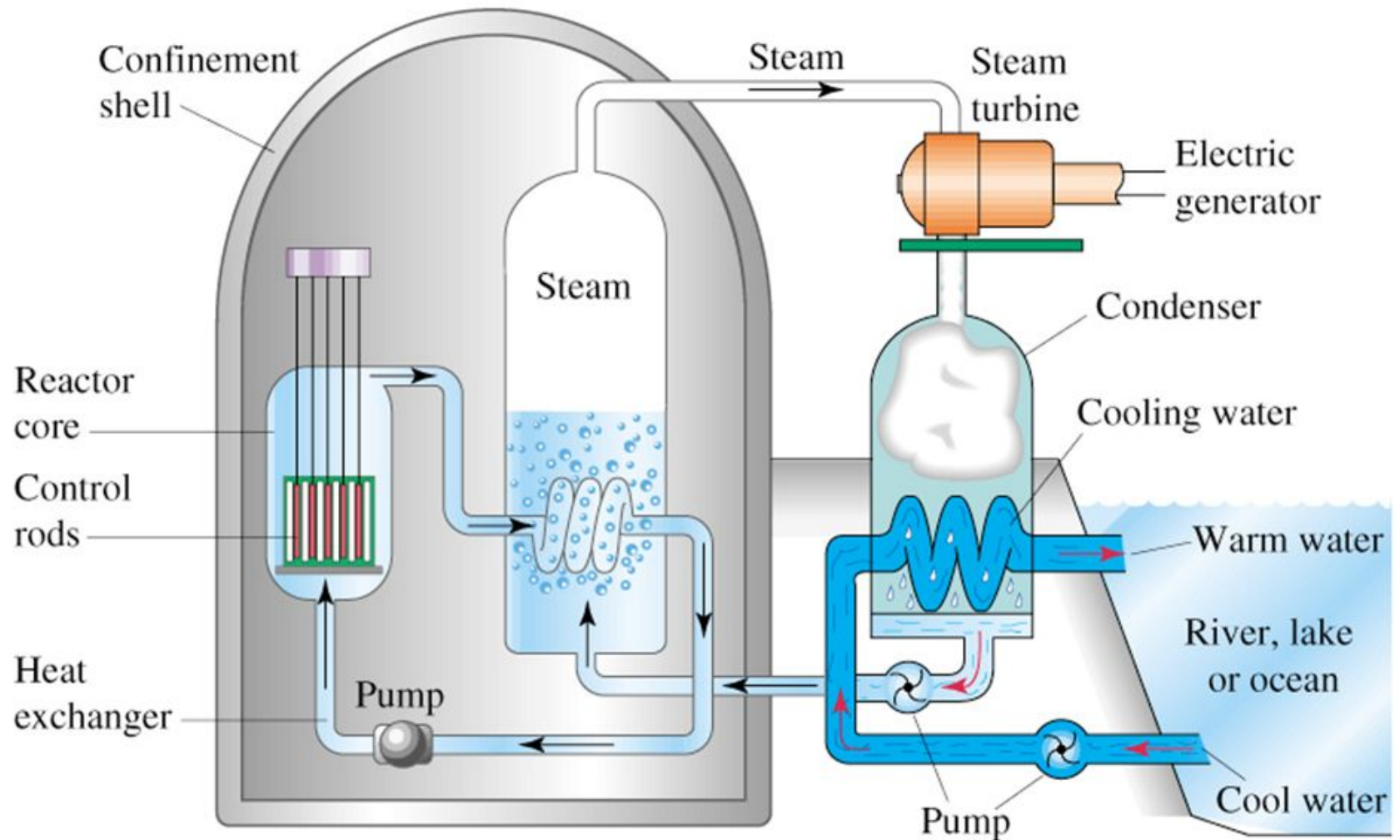
# Heat generation by Nuclear reaction

- In a nuclear reaction, a radioactive atom is hit by a free neutron and is split into more atoms/neutrons. There are two types of reactions
  - a. Nuclear fission (the one used mostly in nuclear plants)
  - b. Nuclear fusion (which occurs in solar energy production)
- As a result a large amount of energy is dissipated as heat is absorbed by the water flowing through the nuclear reactor (chamber in which the reaction takes place)
- the heated water coming out of the reactor is sent to a boiler where the heat is used to generate steam

# Nuclear fission



# Fission reactor of a power plant

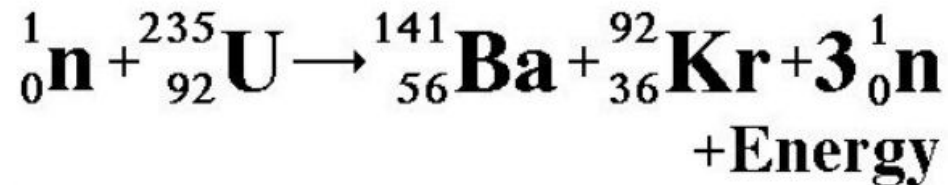


# Fission reactor of a power plant



# Energy output of nuclear fission

Equation for nuclear fission of Uranium will be as follows.



Amount of energy emitted can be calculated from the mass defect (difference between output and input masses) using the energy equation of Einstein;  **$E = mc^2$**

where,  $E$  = energy output,

$m$  = mass defect

$c$  = velocity of light



# Energy output of nuclear fission

Mass of  $_{92}\text{U}^{235}$  = 235.0439 a.m.u.

Mass of  $_0\text{n}^1$  = 1.0087 a.m.u.

Total mass = 236.0526 a.m.u.

Mass of  $_{56}\text{Ba}^{141}$  = 140.9129 a.m.u.

Mass of  $_{36}\text{Kr}^{92}$  = 91.8973 a.m.u.

Mass of  $3\text{ }_0\text{n}^1$  = 3.0261 a.m.u.

Total mass = 235.8373 a.m.u.

Mass defect = 0.2153 a.m.u.

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# Energy output of nuclear fission

Energy released in fission of 1 gm of  ${}_{92}\text{U}^{235}$

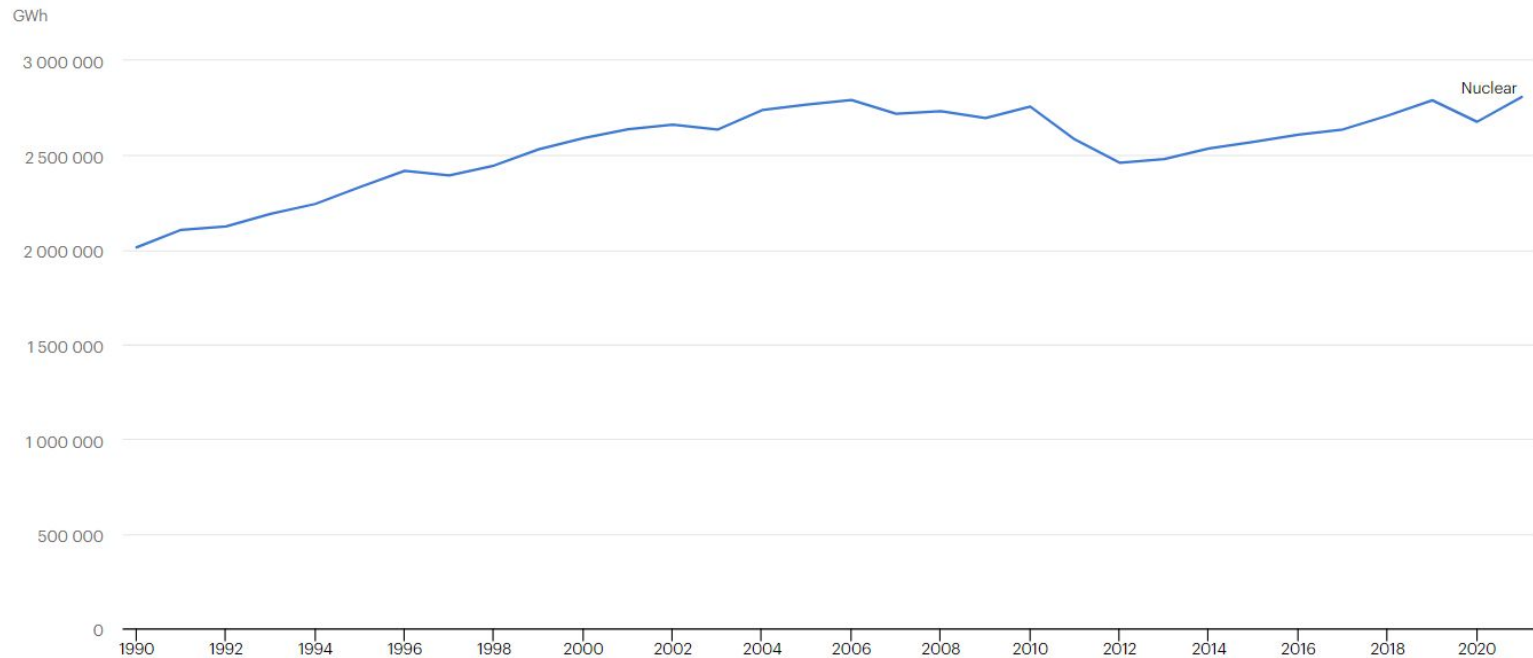
$$= \frac{6.023 \times 10^{23} \times 200}{235} \times 1.6 \times 10^{-13} \text{ J or W - s}$$

$$= \frac{6.023 \times 10^{23} \times 200 \times 1.6 \times 10^{-13}}{235 \times 1000} \text{ kW s}$$

$$= \frac{6.023 \times 10^{23} \times 200 \times 1.6 \times 10^{-13}}{235 \times 1000 \times 3600} \text{ kWh}$$

$$= 2.278 \times 10^4 \text{ kWh}$$

# Global nuclear power generation



# Pros and Cons

## Pros

- High energy output from a small amount of fuel
- Low carbon emission

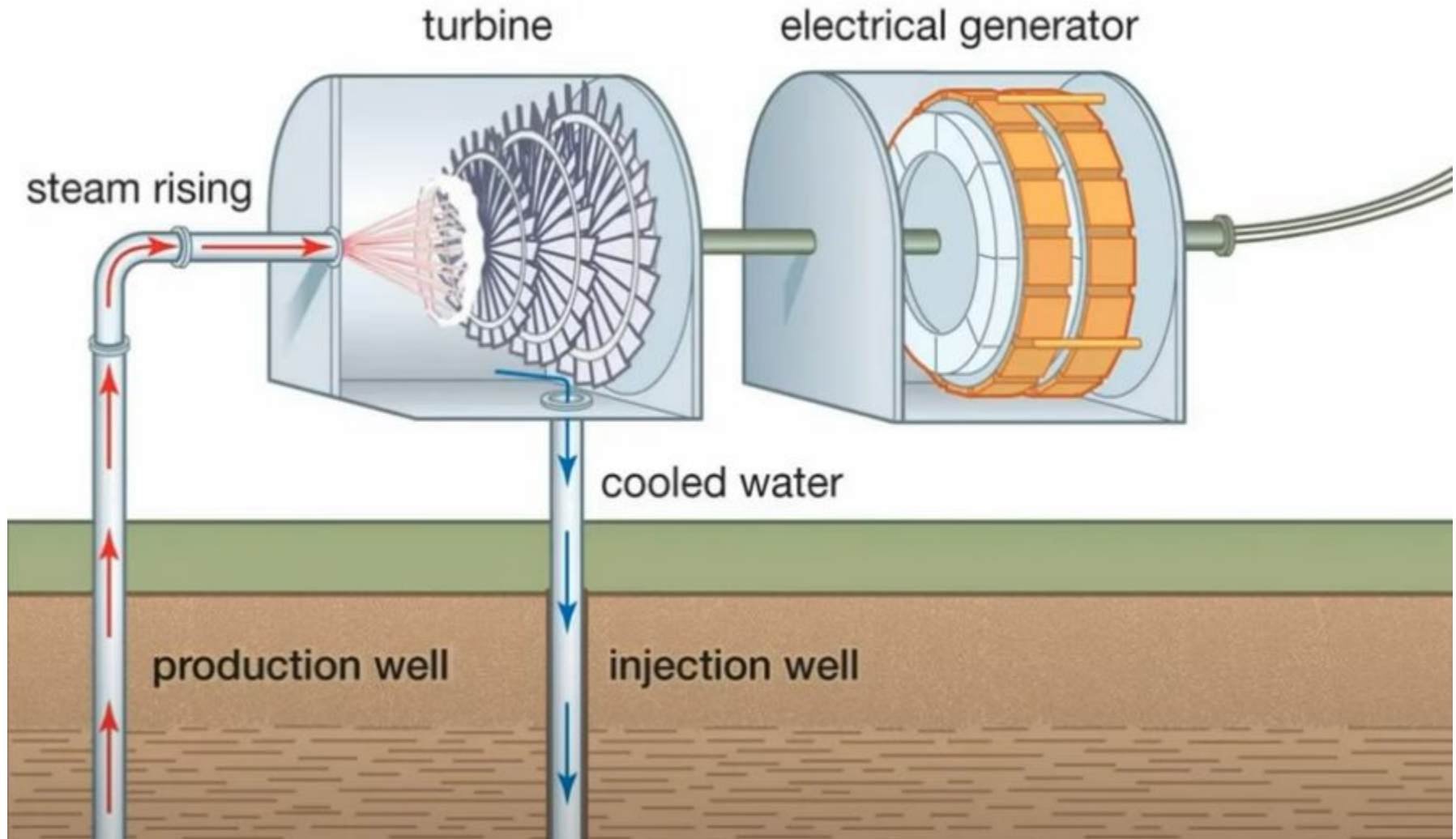
## Cons

- Safety issues
- Need of continuous operation (suits only for base load)

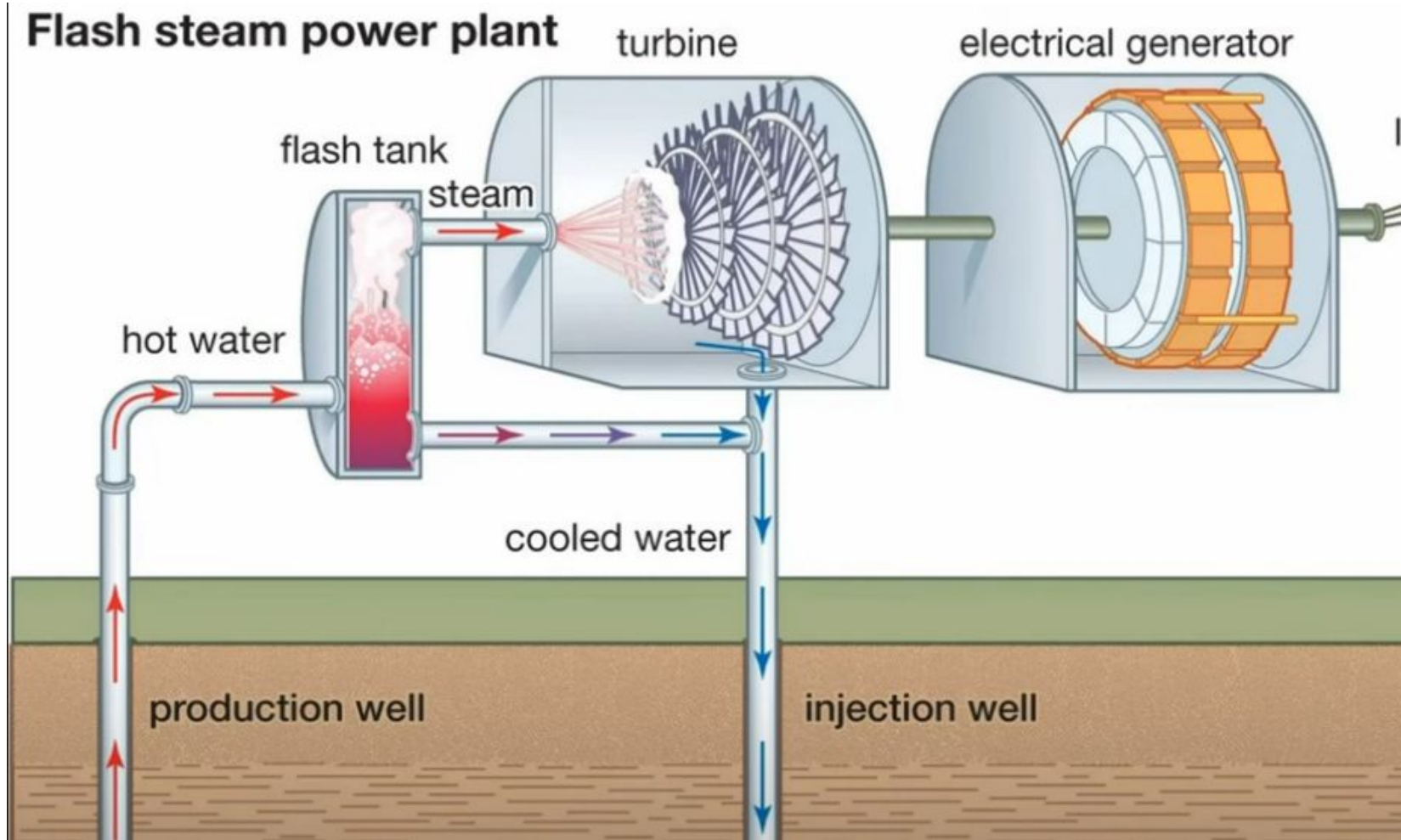
# Geothermal Power

- Another type of thermal (steam turbine) power plant where heat is obtained from the earth crust
- When underground water get in contacts with high amount of heat generated in earth crust it comes out as either hot water or steam.
- Falls under renewable energy category
- Can be categorized into 3 types
  - a. Dry steam
  - b. Flash steam
  - c. Binary cycle

# Dry steam Power plant

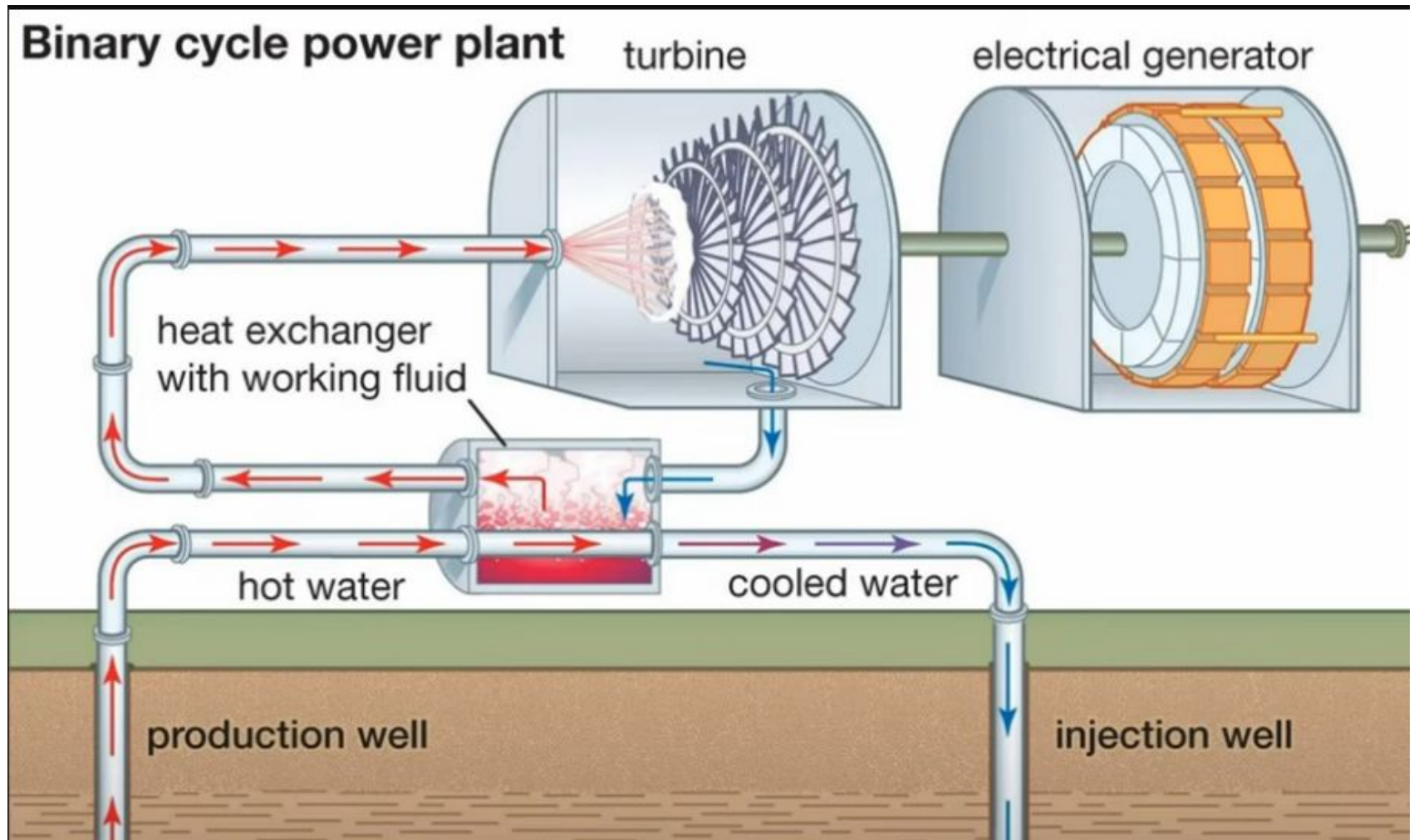


# Flash steam power plant





# Binary cycle power plant

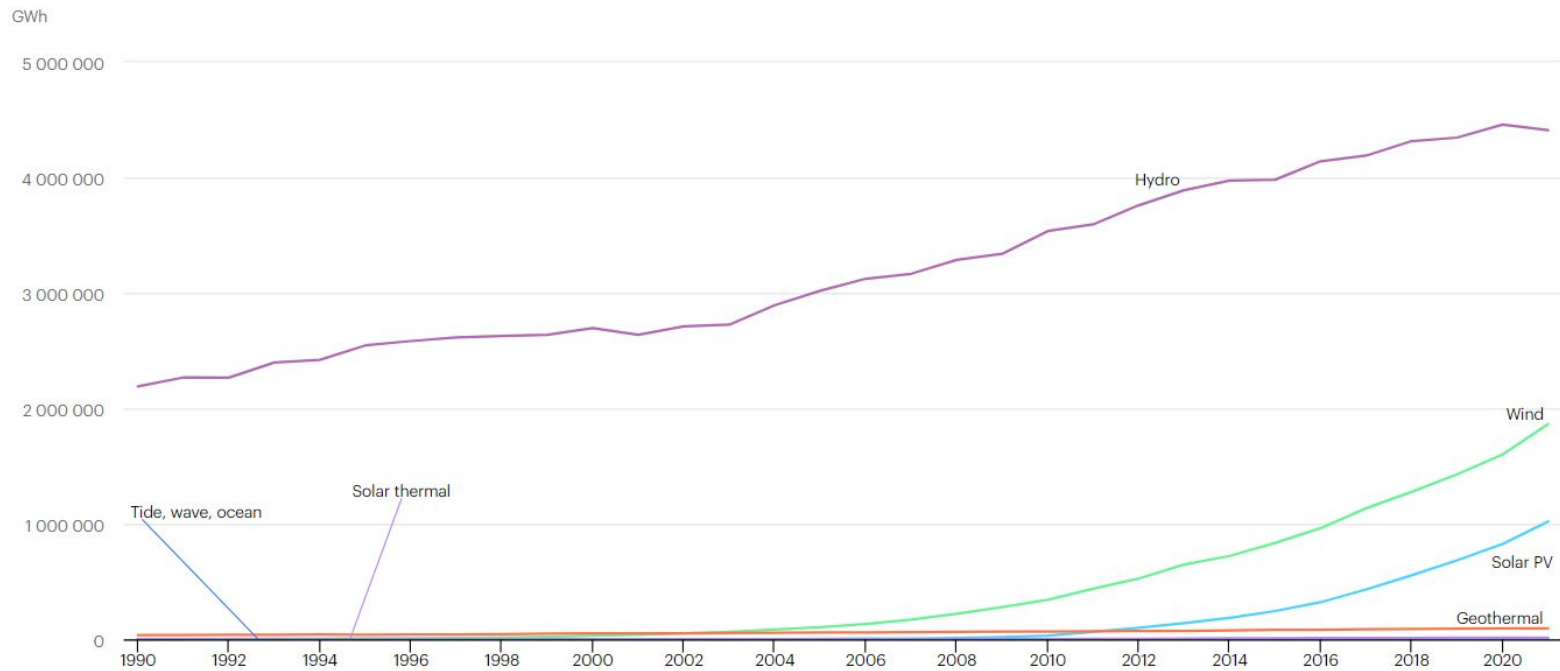


# Comparison of 3 types

## Types of Geothermal Power Plants



# Global share of geothermal power



# Pros and Cons

- Reliable power output
  - No issue in fuel supply (like in biomass)
  - Massive potential
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- Location-specific
  - High construction cost
  - Can generate earthquakes (in extreme cases)

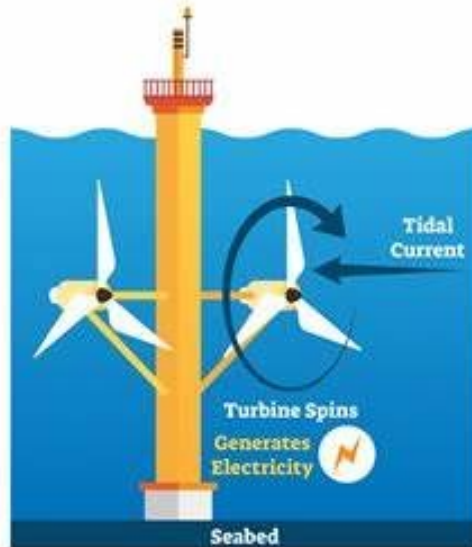
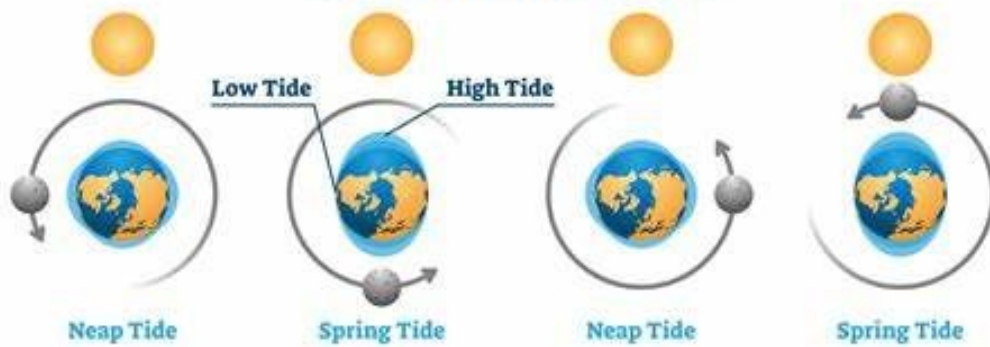
# Ocean power generation

The following technologies fall under ocean power generation

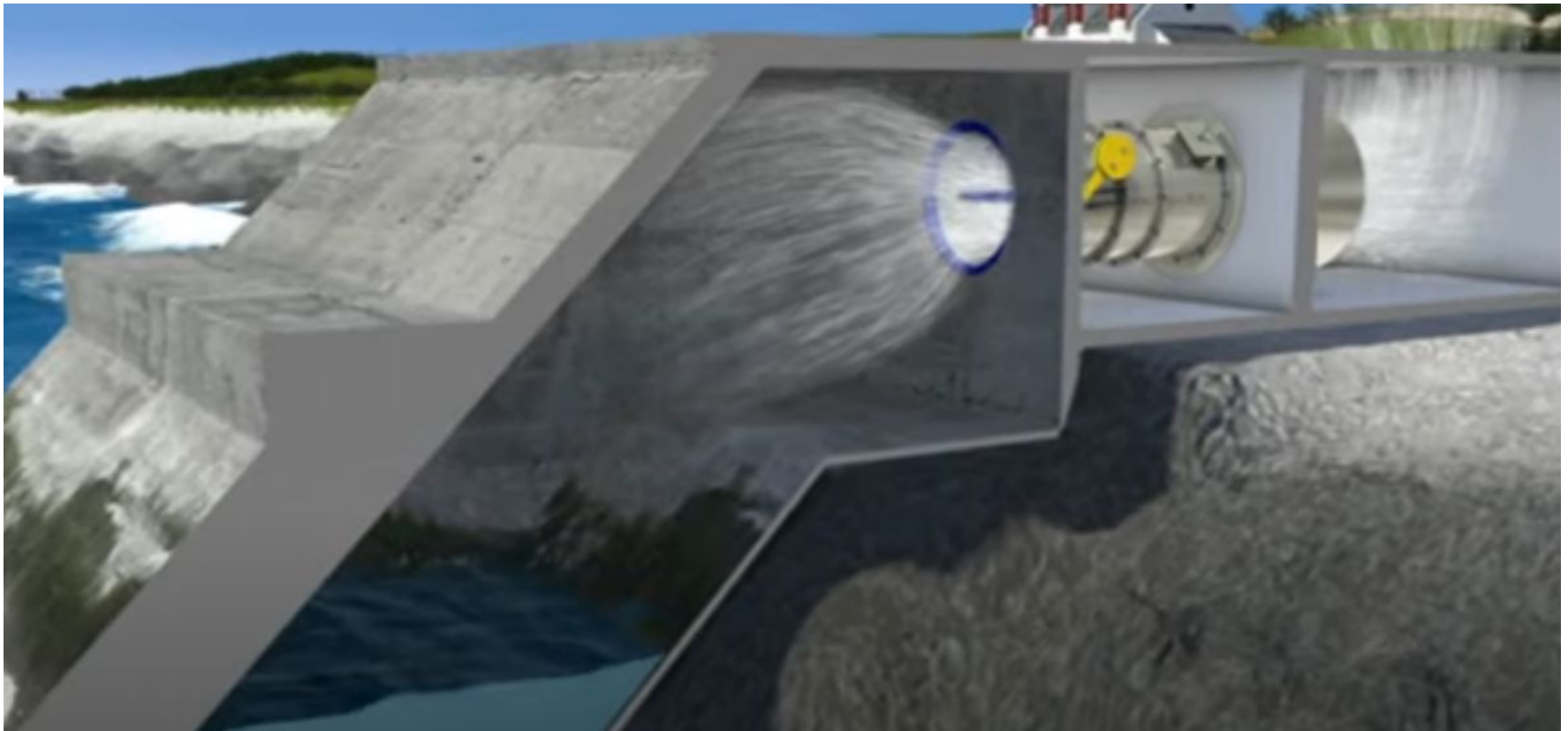
1. tidal power
2. wave power
3. ocean thermal energy conversion (OTEC)

All these technologies are considered as emerging technologies whose commercial viability is still under research and have very little contribution to the world energy generation.

# Tidal power

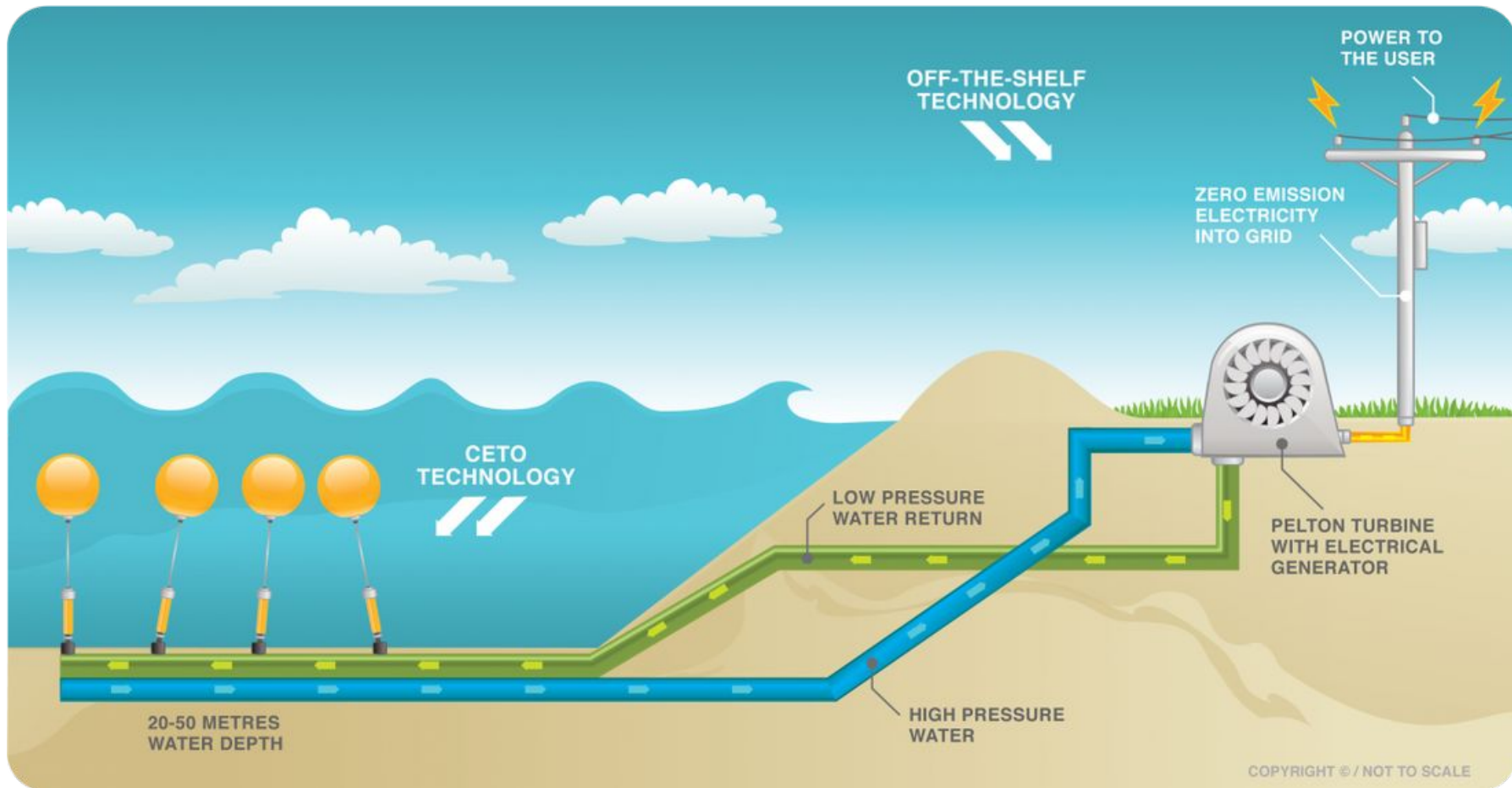


# Wave Power



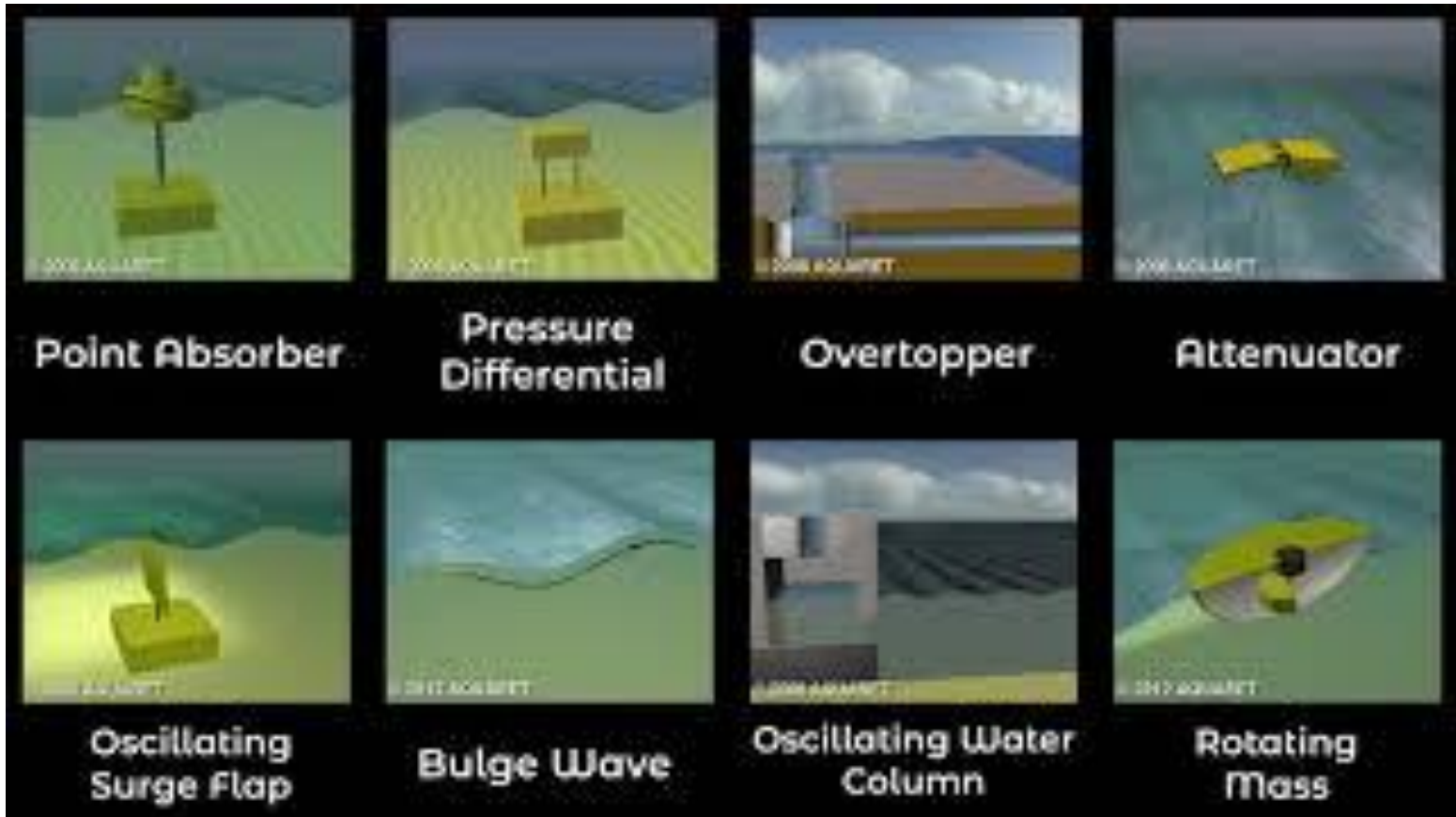


# Wave Power

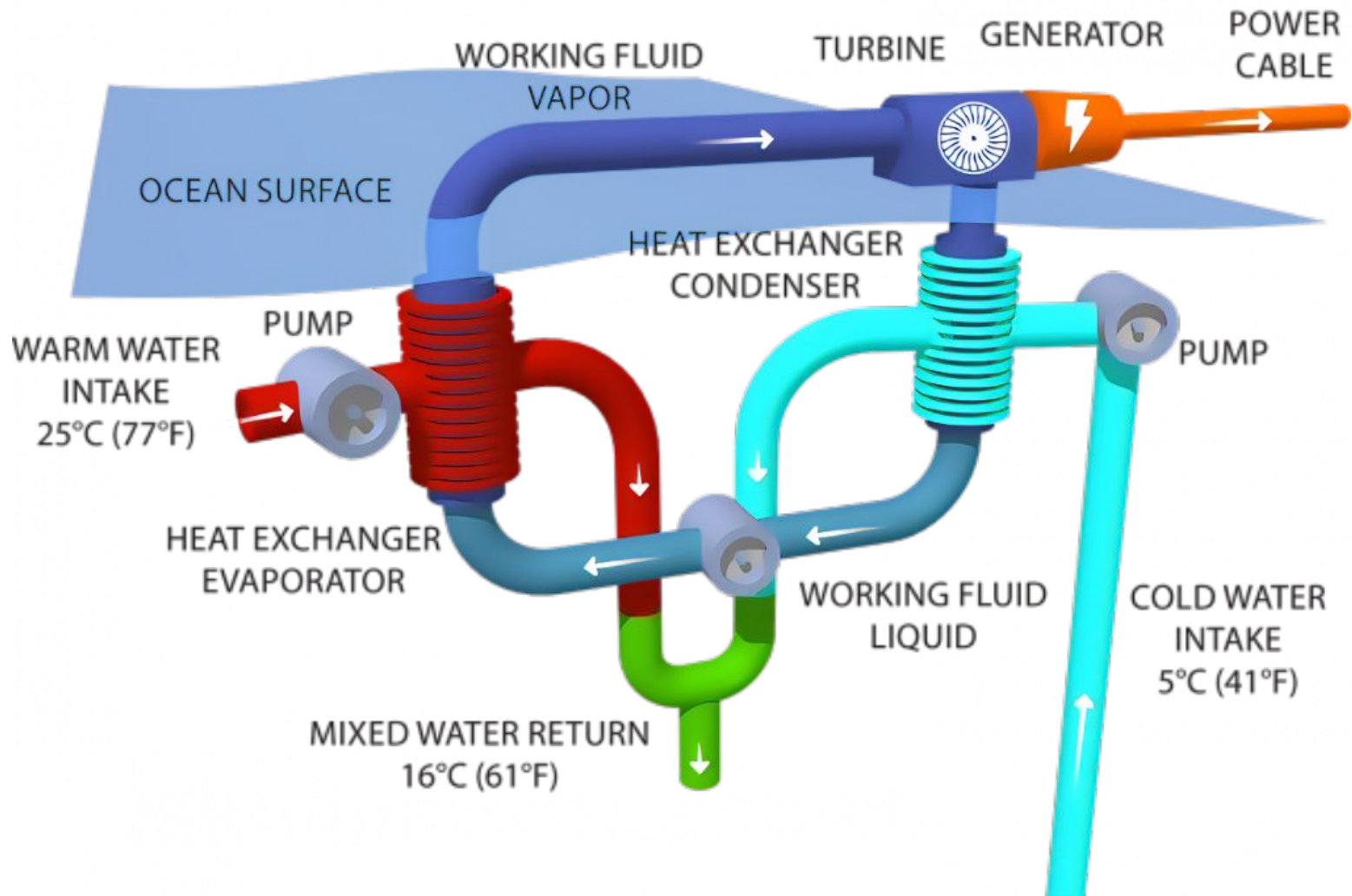




# Wave Power



# OTEC



# Pros and Cons

- Reliability high
- Only possible in countries with ocean
- Maintenance is difficult
- high possibility of being damaged

# Piezoelectricity

- This is not a source of energy but a mechanism to convert mechanical stress into electrical energy
- There are certain material like ceramic, crystal which are known as piezoelectric materials which are used to fabricate a piezoelectric cell
- Such a cell generate a voltage when a mechanical force is applied on it can be used to charge a battery by applying the force continuously

# Piezoelectricity

