Lecture 24: Tidal Energy & Biomass

Course: MECH-422 – Power Plants

Instructor: Kashif Liaqat

Term: Fall 2021

BUITEMS – DEPARTMENT OF MECHANICAL ENGINEERING

Tidel Energy

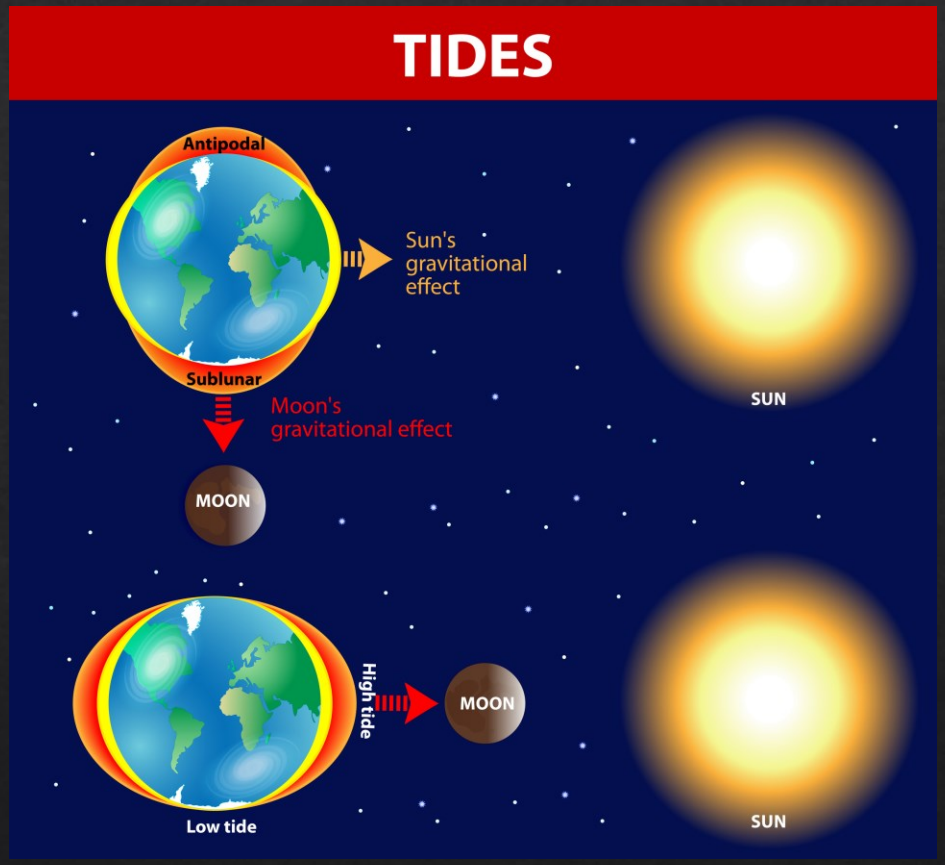
What is tidal energy?

- Tidal power facilities harness the energy from the rise and fall of tides.
- Two types of tidal plant facilities.
  - Tidal barrages
  - Tidal current turbines
- Ideal sites are located at narrow channels and experience high variation in high and low tides.

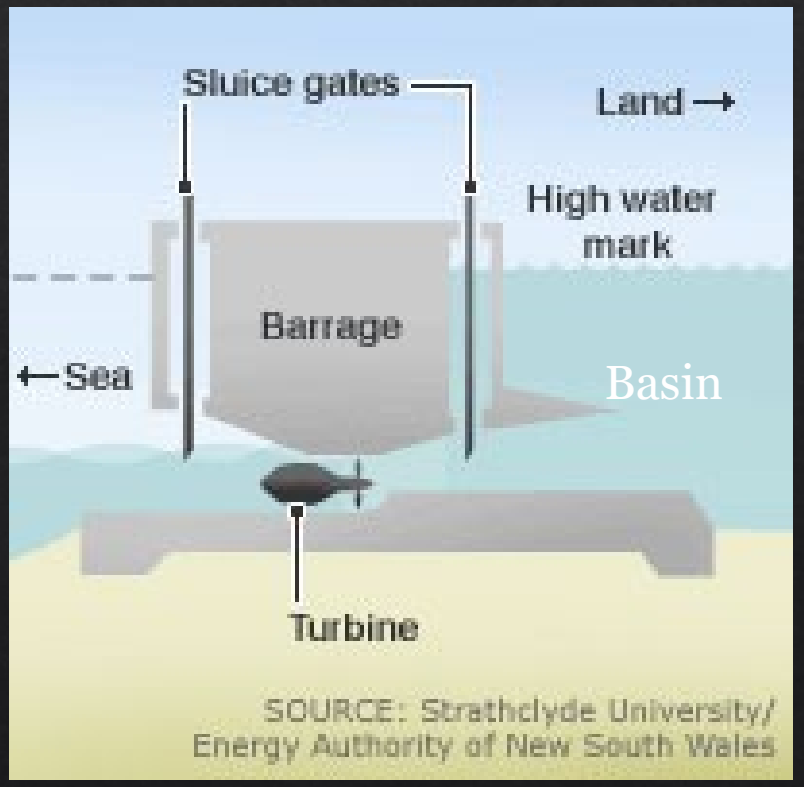
How Tides are formed

Tides are very long waves that move across the oceans.

They are caused by the gravitational forces exerted on the earth by the moon, and to a lesser extent, the sun.



Tidal Barrage



- Utilize potential energy
- Tidal barrages are typically dams built across an estuary or bay.
- consist of turbines, sluice gates, embankments, and ship locks.

Current sites of tidal barrages

- **La Rance**, Brittany, France
  - The first and largest tidal barrage power plant
  - Constructed between 1961 and 1967.
  - Situated on the Rance River.
  - Contains 24 reversible 10 MW bulb turbines generating a capacity of 240 MW and a net power output of 480 GWh per year.
  - Two- way generation system and pumped storage.
- **Annapolis Tidal Generation Facility** on the **Bay of Fundy**, Canada
  - Constructed between 1981 and 1984.
  - Generating capacity of 20 MW and a net output of 30 GW h per year.
  - Further development is being considered in the Bay of Fundy.

Tidal current turbines

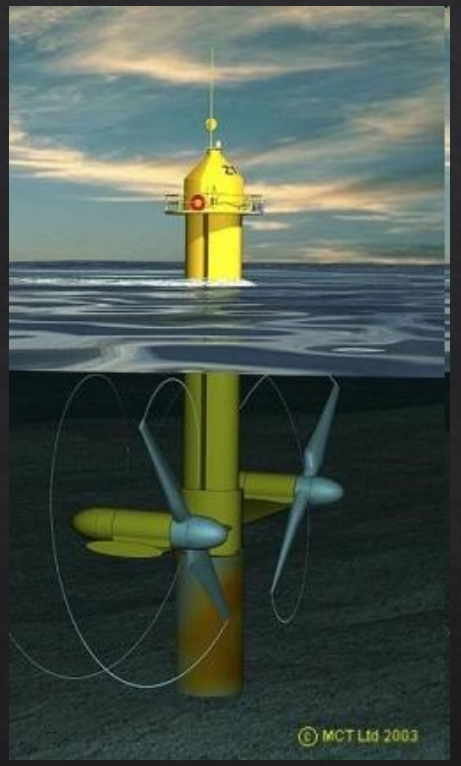
- Extracts kinetic energy from moving water generated by tides.
- Operate during flood and ebb tides.
- Consists of a rotor, gearbox, and a generator. These three parts are mounted onto a support structure. There are three main types:
  - Gravity structure
  - Piled structure
  - Floating structure

•Located in Orkney, Scotland. Comprises an area of 975 km2 and 70 islands.

•Orkney Islands could generate 18,000 GW h per year.

•Operational since 2005.

Tidal power facilities



An attenuator wave energy converter. (By P123 – Own work, Public Domain, https://commons. wikimedia.org/w/index.php?curid=4859717)

Biomass Energy

Biomass

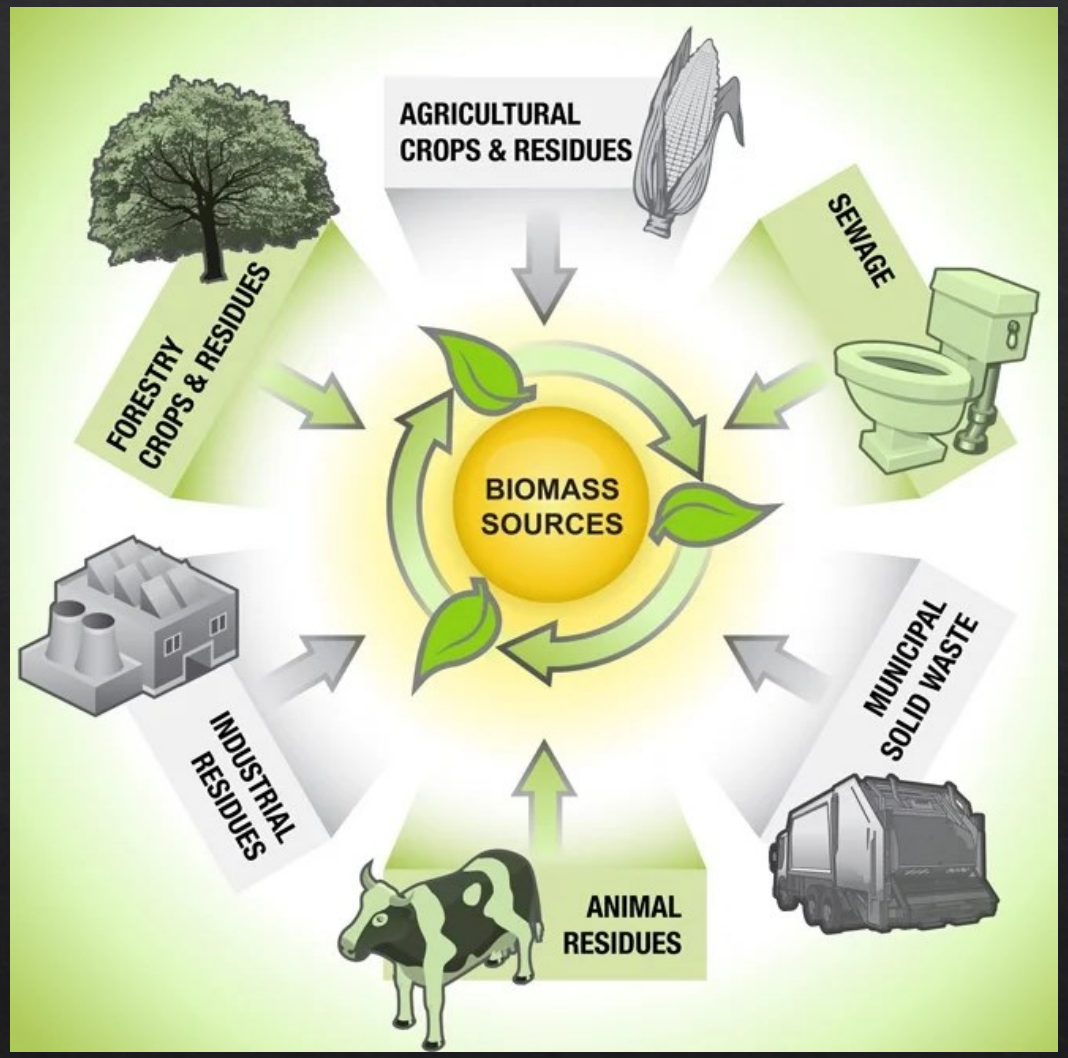
- Biomass is the material derived from plants that use sunlight to grow which include plant and animal material such as wood from forests, material left over from agricultural and forestry processes, and organic industrial, human and animal wastes.
- Biomass energy is a type of renewable energy generated from biological (such as, anaerobic digestion) or thermal conversion (for example, combustion) of biomass resources.

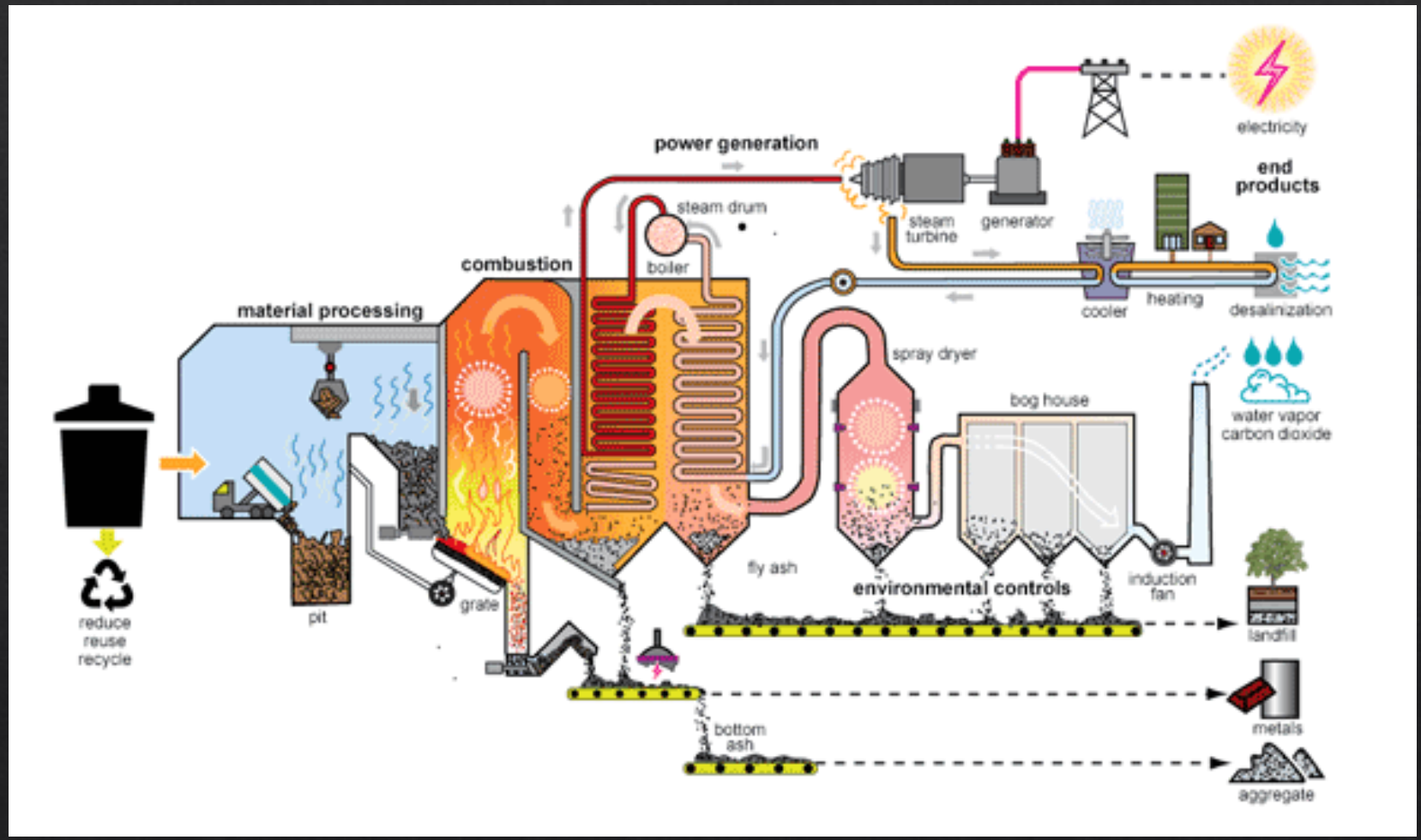
Sources

- Biomass comes from a variety of sources which include:
  - Wood from natural forests and woodlands
  - Forestry plantations
  - Forestry residues
  - Agricultural residues such as straw, stover, cane trash and green agricultural wastes
  - Agro-industrial wastes, such as sugarcane bagasse and rice husk
  - Animal wastes
  - Industrial wastes, such as black liquor from paper manufacturing
  - Sewage
  - Municipal solid wastes (MSW)
  - Food processing wastes

Biomass

- In nature, if biomass is left lying around on the ground it will break down over a long period of time, releasing carbon dioxide and its store of energy slowly.
- By burning biomass its store of energy is released quickly and often in a useful way.
- So converting biomass into useful energy imitates the natural processes but at a faster rate.


AGRICULTURAL
CROPS & RESIDUES
SEWAGE
FORESTRY
CROPS & RESIDUES
BIOMASS
SOURCES
INDUSTRIAL
RESIDUES
MUNICIPAL
SOLID WASTE
ANIMAL
RESIDUES


power generation
electricity
end products
steam drum
steam turbine
generator
boiler
combustion
material processing
heating
cooler
desalinization
spray dryer
bog house
water vapor
carbon dioxide
fly ash
environmental controls
induction fan
landfill
reduce
reuse
recycle
pit
grate
metals
bottom ash
aggregate

Applications of Biomass

- Biomass systems range from small stoves used in homes for heating or cooking to large power plants used by centralized utilities to produce electricity.

- In residential applications, biomass can be used for space heating or for cooking.
  - Wood is the most common source of fuel, although many different materials are used.
  - New designs for woodstoves can improve the efficiency of the cooking or heating system, decreasing the amount of fuel that is needed.

- Industry and businesses use biomass for several purposes including space heating, hot water heating, and electricity generation.
  - Many industrial facilities, such as sugar mills, naturally produce organic waste.

End of Lecture!