RV College of Engineering®

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# Tidal Energy

## UNIT 4

# Introduction



- Tidal power, also called **TIDAL ENERGY**, is a form of **HYDROPOWER** which converts the energy of tides into the useful form of power, mainly in electricity.
- Tides are the waves caused due to gravitational pull of the moon and sun.
- Ocean tides are the periodic rise and fall of ocean water level occurs twice in each lunar day.
- During one lunar day the ocean water level rises twice and fall twice.

# Introduction



- Time interval between a consecutive low tide and high tide is 6.207 hrs.
- Tidal range is the difference between the consecutive high tide and low tide.
- During high tide, the water flow into the dam and during low tide water flow out which result in moving the turbine.
- Although not yet widely used, tidal power has potential for future electricity generation. Tides are more predictable than wind energy and solar power.

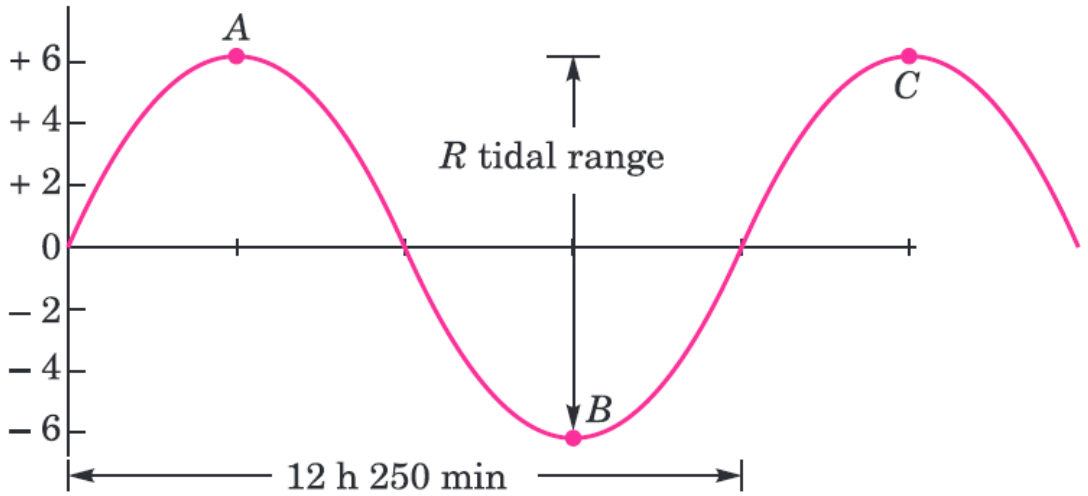



**Fig. 9.7.** The tides of sea.

The difference between high and low water levels is called the *range* of the tide. The *tidal range* $R$ is defined as :

$R$ = water elevation at high tide—water elevation at low tide.

# Basic Working Principle

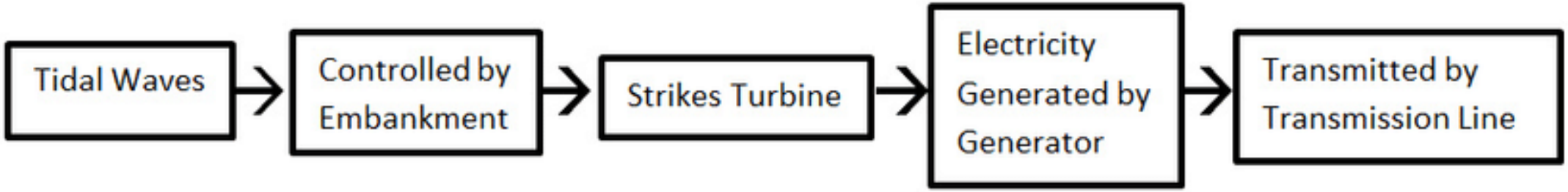


Tides are produced mainly by the gravitational attraction of the moon and the sun on the water of solid earth and the oceans. About 70% of the tide producing force is due to the moon and 30% to the sun. The moon is thus the major factor in the tide formation.

Surface water is pulled away from the earth on the side facing the moon, and at the same time the solid earth is pulled away from the water on the opposite side. Thus high tides occur in these two areas with low tides at intermediate points. As the earth rotates, the position of a given area relative to the moon changes, and so also do the tides. There are thus a periodic succession of high and low tides.

# Block Diagram





# Tidal Energy Project in India



- West Bengal Renewable Energy Development Agency in sunderbans.
- The Indian state of Gujarat is planning to host South Asia's first commercial-scale tidal power station. The company Atlantis Resources is to install a 50MW tidal farm in the Gulf of Kutch on India's west coast, with construction starting early in 2012. later on it is decided to increase the capacity up to 250MW plants.

## Tidal plants in Kerala

- Situated near the breakwaters of Vizhinjam Port which is about 20 km from Thiruvananthapuram city. The station started its commercial operation in 1991. This oscillating water column (OWC) produces about 150 kw of power.

# Tidal Energy Project in India

- India has reportedly decided to not proceed with the proposed tidal power station developments in states of Gujarat and West Bengal.
- The reason behind it was financial challenges in the implementation of those projects.
- Based on the studies, there's an estimated potential of about 8000 MW of tidal energy, with 7,000 MW within the Gulf of Khambhat, 1,200 MW within the Gulf of Kutch in Gujarat, and about 100 MW within the Gangetic delta in Sunderbans in West Bengal.

# Tidal Energy Projects



## History

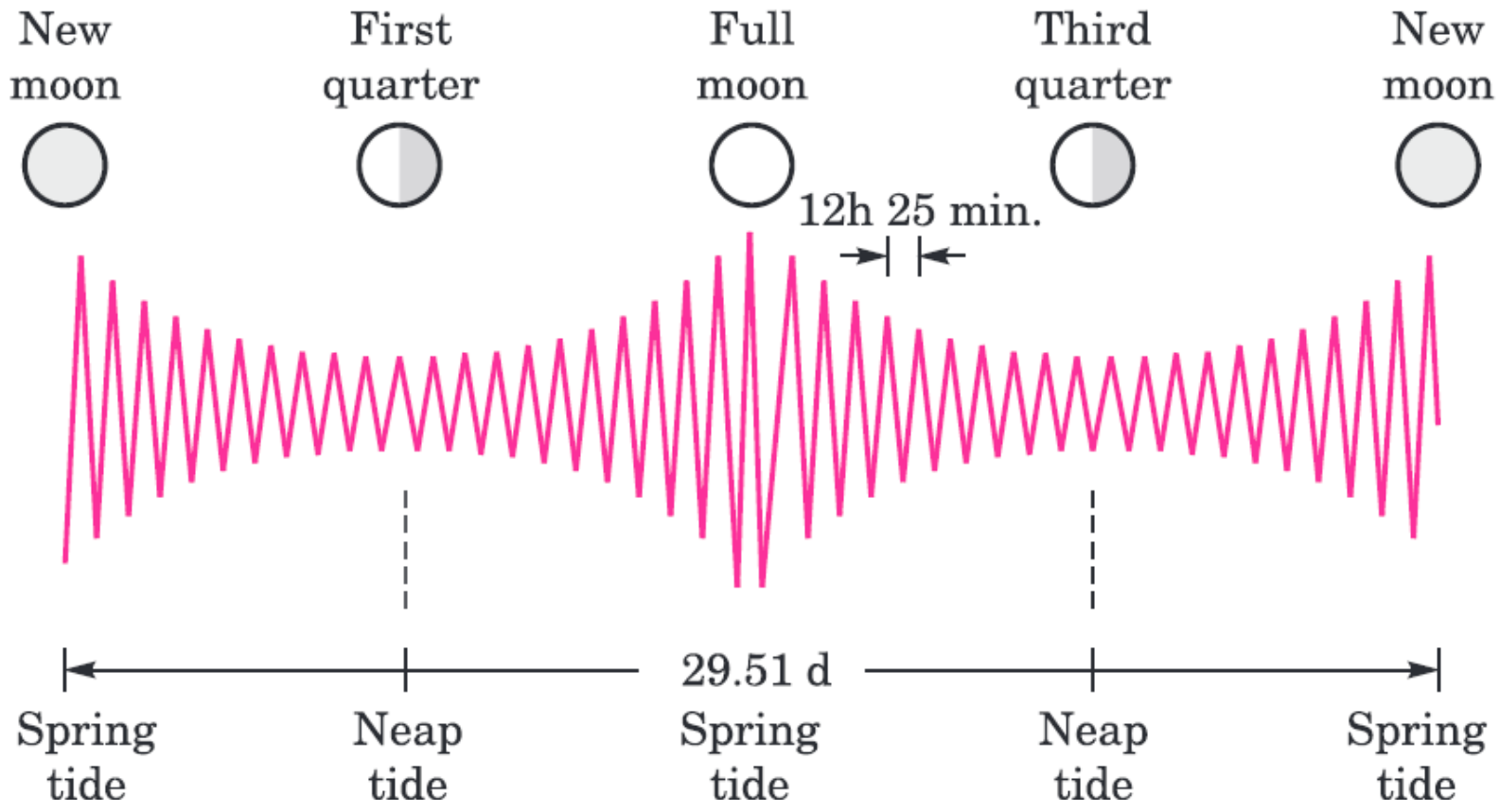
- The first tidal power station was the Rance tidal power plant built over a period of 6 years from 1960 to 1966 at La Rance, France. It has 240 MW installed capacity.
- also the world's second biggest tidal power station.

- With a peak rating of 240 Megawatts, generated by its 24 turbines, it supplies 0.012% of the power demand of France. With a capacity factor of approximately 40%, it supplies an average 96 Megawatts, giving an annual output of approximately 600GWh. The barrage is 750 m (2,461 ft) long, from Brebis point in the west to Briantais point in the east. The power plant portion of the dam is 332.5 m (1,091 ft) long. The tidal basin measures 22.5 $km^2$ (9 sq mi).

# Introduction



Because of the changing positions of the moon and sun relative to the earth, the range varies continuously. There are however, some characteristic features of this variation.



# Tidal Phenomenon



(1) The tides are a periodical phenomenon but no two tides in any cycle are alike. Since the relative positions of sun and moon and their distances from earth are continuously changing, the tides are also influenced accordingly. Of the two high tides in a single day, one tide is higher than the other. In any month, the tides on the full moon and no moon days are particularly higher than the rest, as on these days sun's and moon's attraction acts in a directly additive manner. These are termed as the spring tides. In any year, the tides that occur at the time of versnal and autumnal equinoxes will we even higher due to the relative location of the sun and earth. Thus the tidal range $R$ shown in the figure varies from time to time. Generally, a long time mean value of $R$ is designated as mean tidal range at any particular place.

# Tidal Phenomenon

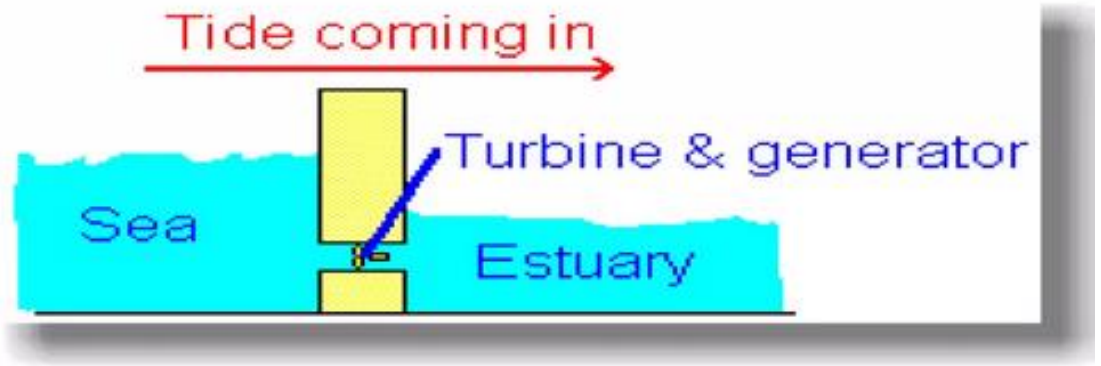


(2) The mean tidal range varies from place to place. The shape of the tidal cycle depends upon the interaction of the sea with the coast line. Where the coast line offers a resonating influence, the tidal range gets accentuated, at the other places, the land may produce a dampening effect on the tidal phenomenon. For instance, in land locked seas, the tidal phenomenon is always much subdued. Because of this interacting effect, the tidal range (as well as the tidal period) varies from place to place. For example; the mean tidal range on the west coast of India is as high as 7 to 8 meters near the gulf of Kutch, whereas it is only one meter or so near Kerala, down south. Bay of Fundy (Canada) has one of the greatest tidal ranges in the world *i.e.*, of 20 m, whereas the Adiatic sea at the Zara has virtually static water with the range being only of a few cm. Thus the tidal phenomenon is a unique feature of every coast line.

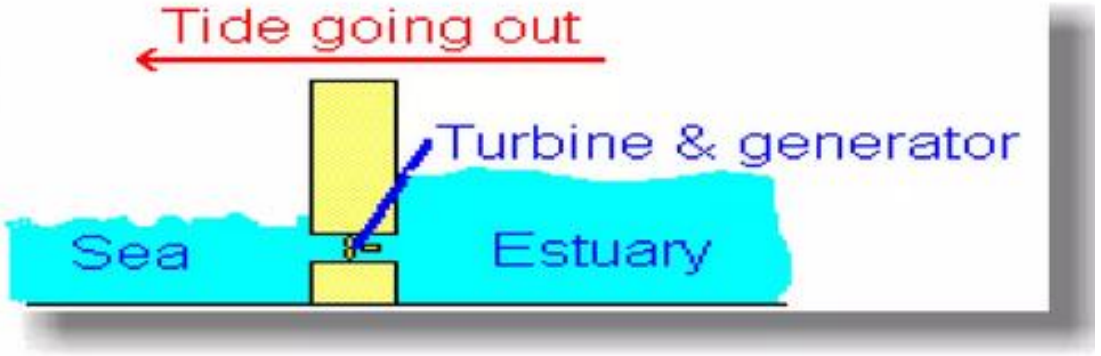
(3) In spite of their complexity, the tides are amenable to mathematical analysis. As a result the exact time and the water level for a high tide as low tide can be forecast with great accuracy.

# TIDES:-

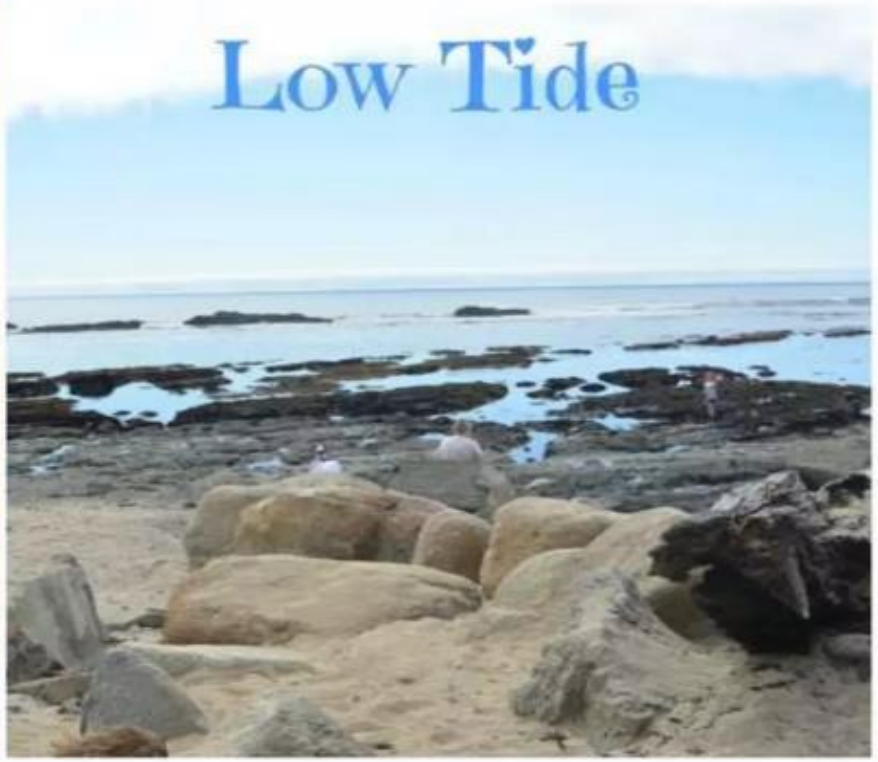
- This tidal electricity generation works as the tides comes in and again when it goes out.




- The turbine is driven by the power of the sea in both direction.



# Types of tides

# Main parts of TPP:-

- A tidal power plant consists of three main parts:
- The first being the barrage itself, holding the water back during high tide.
- The second part is the sluice gate that let water through the third part,
- The third part consist turbine and generator, resulting in electricity generation.

# Introduction



## 1. Tidal Barrage

- A **tidal barrage** is a dam-like structure used to capture the energy from masses of water moving in and out of a bay or river due to tidal forces.

## 2. Sluice Gate

- The sluice gates are left open during high tide and closed during low tide to create a water level differential, creating a potential difference that powers the turbine when the water is released.

# 3. Tidal Stream Generator

- Tidal stream generators are very similar to wind turbines except their below the water surface instead of above or on land.
- The turbine and generator converts the movement of water coming from change in tide, the kinetic energy, into electricity.
- Water is 830 times denser than air and therefore can generate electricity at lower speeds than wind turbines.

# 3. Tidal Stream Generator

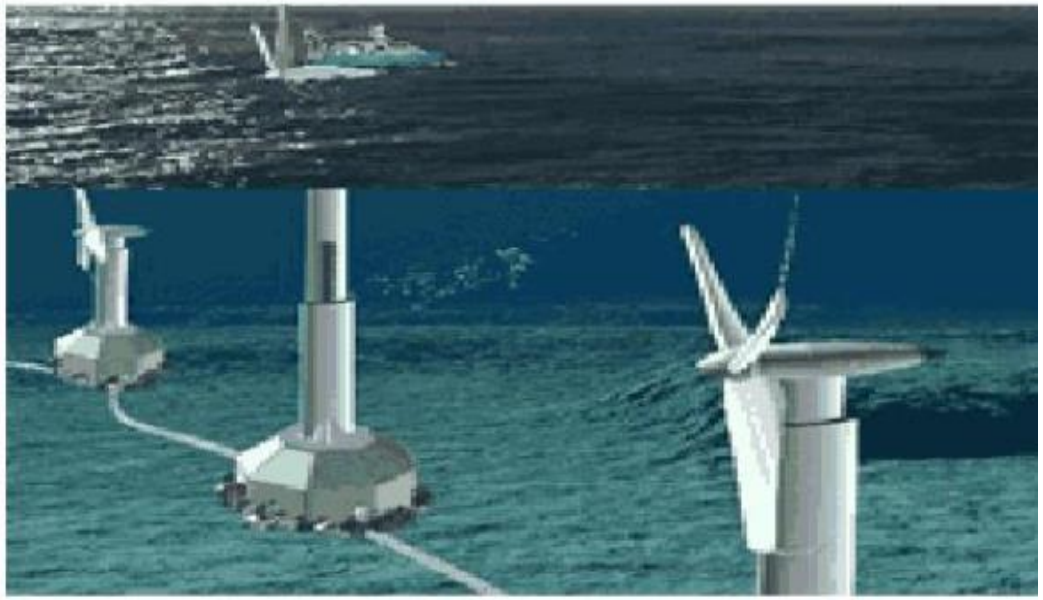
- **Axial turbines**
- **Vertical and horizontal axis cross flow turbines**

# Introduction



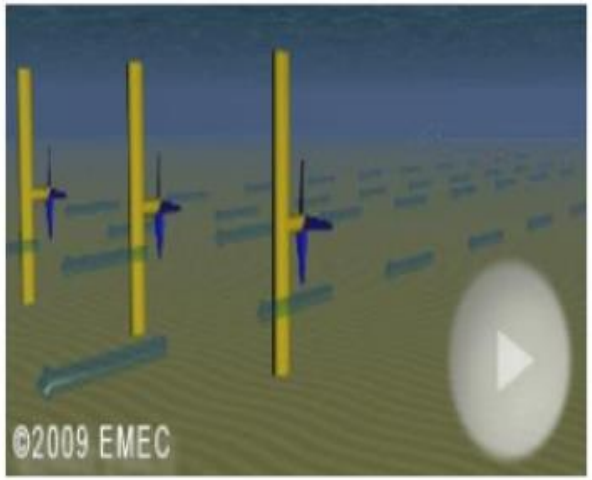
## Axial turbines

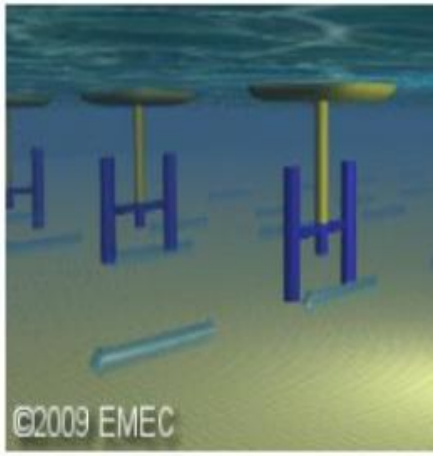
- These are close in concept to traditional windmills operating under the sea.



## Vertical and horizontal axis cr flow turbines

- These turbines that can be deployed either vertically or horizontally.

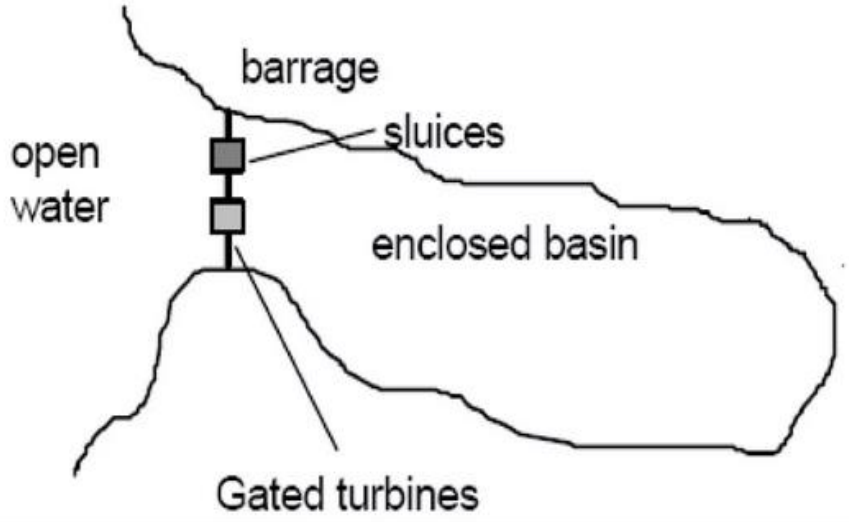


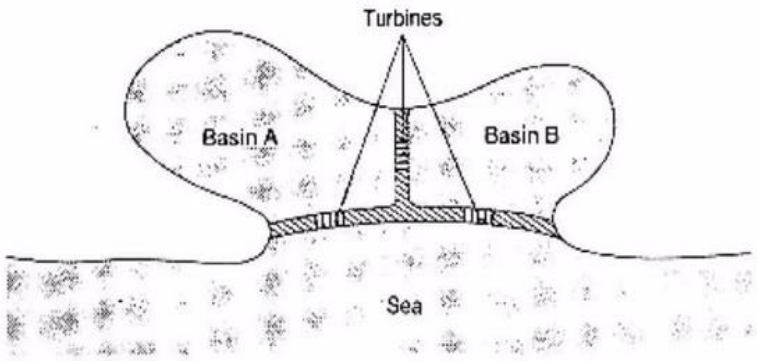
# Introduction



**Single Basin Scheme:** This scheme has one barrage and one water storage basin, one way system, the incoming tide is allowed to fill the basin through sluice ways during the tide and the impounded water is used to generate electricity by letting the water flow from basin to the sea through the turbines during single basin schemes is intermittent generation power.




**Double Basin Scheme:** In the double basin scheme, there are two basins on the landward side with the powerhouse located at the interconnecting waterway between the two basins



## Advantages of Tidal Energy

- It is an inexhaustible source of energy.
- Tidal energy is environment friendly energy and doesn't produce greenhouse gases.
- As 71% of Earth's surface is covered by water, there is scope to generate this energy on large scale.
- Efficiency of tidal power is far greater as compared to coal, solar or wind energy. Its efficiency is around 80%.
- Tidal Energy doesn't require any kind of fuel to run.
- The life of tidal energy power plant is very long.
- The large density of water, almost 1000 times greater than in air, results in very large amounts of energy to get out of the tidal currents even if the speed is low.

## Disadvantages of Tidal Energy

- Cost of construction of tidal power plant is high.
- There are very few ideal locations for construction of plant and they too are localized to coastal regions only.
- Intensity of sea waves is unpredictable and there can be damage to power generation units.
- Influences aquatic life adversely and can disrupt migration of fish.
- The actual generation is for a short period of time. The tides only happen twice a day so electricity can be produced only for that time.
- Usually the places where tidal energy is produced are far away from the places where it is consumed. This transmission is expensive and difficult.

# Major tidal plants in world

| Rank | Station | Country | Location | Capacity (MW) |
|---|---|---|---|---|
| 1 | Sihwa Lake Tidal Power Station | South Korea | 37°18'47"N 126°36'46"E | 254 |
| 2 | Rance Tidal Power Station | France | 48°37'05"N 02°01'24"W | 240 |
| 3 | Annapolis Royal Generating Station | Canada | 44°45'07"N 65°30'40"W | 20 |
| 4 | Jiangxia Tidal Power Station | China | 28°20'34"N 121°14'25"E | 3.9 |
| 5 | Kislaya Guba Tidal Power Station | Russia | 69°22'37"N 33°04'34"E | 1.7 |

# Economics



- Tidal energy is not cost competitive because it is generally not commercially available.
- When selecting a spot to set up a tidal energy station it is important to make sure that it will be economically feasible.
- To set up a tidal facility with an average annual output of 1050 MW would cost about 1.2 billion dollars, not including maintenance and running costs.
- This is far more expensive than coal and oil.

# Introduction

## FUTURE?

- In a society with increasing energy needs, it is becoming more and more important to have alternative sources of power to keep up with the ever growing energy demand.
- The capacity of tidal energy exceeds that of coal and oil and is renewable.
- The Department of Energy has shown great interest in regards to tidal power as the perfect energy source for the future.