Ocean Thermal Energy Conversion (OTEC)

•**Ocean Thermal Energy Conversion** (**OTEC**) uses the ocean thermal gradient between cooler deep and warmer shallow or surface seawaters to run a heat engine and produce useful work, usually in the form of electricity. OTEC can operate with a very high capacity factor and so can operate in base load mode.

•Ocean Thermal Energy Conversion (OTEC) technology uses a turbine generator to create renewable energy from the temperature difference between cold, deep seawater circulating in the ocean and surface seawater warmed by the sun. In order to produce power with the low temperature range, a working fluid with low boiling point is used.

•The amount of energy created is dependant on the amount of water available to cool or heat the working fluid.

•The Okinawa OTEC project has a maximum capacity of 100kW, but since it does not always have access to the maximum capacity due to other seawater users, will often produce less electricty.

•This is due to the previous use of water by local industries and the Okinawa Deep Seawater Research Center, and does not hinder the project's goal of demonstration and testing.

•Ocean thermal energy conversion (OTEC) is a process or technology for producing energy by harnessing the temperature differences (thermal gradients) between ocean surface waters and deep ocean waters.

•Energy from the sun heats the surface water of the ocean. In tropical regions, surface water can be much warmer than deep water. This temperature difference can be used to produce electricity and to desalinate ocean water. Ocean Thermal Energy Conversion (OTEC) systems use a temperature difference (of at least 77° Fahrenheit) to power a turbine to produce electricity. Warm surface water is pumped through an evaporator containing a working fluid. The vaporized fluid drives a turbine/generator.

•The vaporized fluid is turned back to a liquid in a condenser cooled with cold ocean water pumped from deeper in the ocean. OTEC systems using seawater as the working fluid can use the condensed water to produce desalinated water.

Principles of OTEC Plant Operation

•OTEC or ocean thermal energy thermal conversion is a technology which converts solar radiation absorbed by the oceans to electric energy. The ocean's can be considered as the world's largest solar energy collector as it covers two third of the earth surface.

•The working principle of an OTEC plant is that it uses the warm water to heat and vaporize a liquid (working fluid) and this working fluid develops pressure which forces it to evaporate and the expanding vapour runs through a heat engine like turbine, generator, and it is condensed back into a liquid by cold water brought up from depth and the cycle is repeated.

•There are basically three types of OTEC power plant:

1. Closed cycle
2. Open cycle
3. Hybrid cycle

•Most of the electricity we use comes from heat engines of one kind or another. A heat engine is a machine that cycles between two different temperatures, one hot and one cold, usually extracting heat energy from a fuel of some kind.

•In a steam engine or a steam turbine, for example, coal heats water to make hot, high-pressure steam, which is then allowed to expand and cool down to a lower temperature and pressure, pushing a piston and turning a wheel as it does so.

•The greater the temperature difference between the hot steam and the cooled water vapor it becomes, the more energy can be extracted

Advantages and disadvantages

Advantage

•OTEC sounds immensely attractive: it's clean, green renewable energy that doesn't involve burning fossil fuels, producing large amounts of greenhouse gases, or releasing toxic air pollution. By helping to reduce our dependence on fuels such as petroleum, OTEC could also help to reduce the "collateral" damage the world suffers from an oil-dependent economy—including wars fought over oil and water pollution from tanker spills.

• It could also provide a very useful source of power for tropical island states that lack their own energy resources, effectively making them self-sufficient. As we've already considered, open-cycle OTEC can play a useful part in providing pure, usable water from ocean water.

•OTEC can also be used to produce fuels such as hydrogen; the electricity it generates can be used to power an electrolysis plant that would split seawater into hydrogen and oxygen, which could be bottled or piped ashore and then used to power such things as fuel cells in electric cars.

•The waste cooling water used by an OTEC plant can also be used for **aquaculture** (growing fish and other marine food such as algae under controlled conditions), refrigeration, and air conditioning.

Disadvantages

•The biggest problem with OTEC is that it's relatively inefficient.

•The laws of physics say that any practical heat engine must operate at less than 100 percent efficiency; most operate well below—and OTEC plants, which use a relatively small temperature difference between their hot and cold fluids, have among the lowest efficiency of all: typically just a few percent.

•OTEC plants have to work very hard (pump huge amounts of water) to produce even modest amounts of electricity, which brings problems.

Wave and Tidal Wave

•A tidal wave is a **shallow water wave** caused by the **gravitational interactions** between the Sun, Moon, and Earth.

•A tidal wave is a regularly reoccurring shallow water wave caused by effects of the gravitational interactions between the Sun, Moon, and Earth on the ocean.

•**Tidal power** harnesses the energy from the tidal force and wave action in order to generate electricity. Unlike other primary energy flows, it is a predictable source of energy because tides occur at expected times.

• This predictability has an advantage over wind and solar power since the sun may or may not shine on a particular day and the wind doesn't always blow the expected amount.

• Tidal power is still not a dispatchable source of electricity as it is available when nature provides it, not necessarily when it is needed.

•Tidal power is not a widely used energy resource at the moment because its costs outweigh the advantages. Previously only very specialized locations were able to support these technologies.

•However, recent improvements are making tidal power much more cost effective and adaptable to a wider range of locations. If support for tidal power continues to increase the industry will likely grow

Working principle of Tidal power plants

•Tide or wave is periodic rise and fall of water level of the sea. Tides occur due to the attraction of sea water by the moon. Tides contain large amount of potential energy which is used for power generation.

•When the water is above the mean sea level, it is called flood tide. When the water level is below the mean level it is called ebb tide.

•The ocean tides rise and fall and water can be stored during the rise period and it can be discharged during fall.

• A dam is constructed separating the tidal basin from the sea and a difference in water level is obtained between the basin and sea.

During high tide period, water flows from the sea into the tidal basin through the water turbine. The height of tide is above that of tidal basin. Hence the turbine unit operates and generates power, as it is directly coupled to a generator.

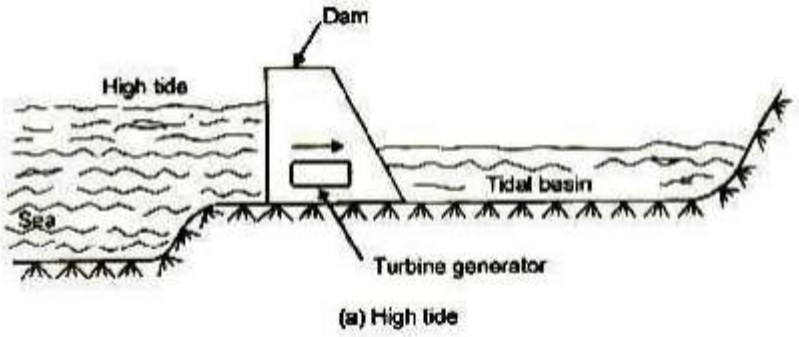

Figure: High tide