OCEAN ENERGY

WHAT IS OCEAN ENERGY?

Oceans occupy more than 70 percent of the earth's surface and are an important source of energy that can provide us with enormous amounts of electrical energy.[1]

Waves, tides, ocean currents, salinity gradient and temperature differential are the main forms of ocean energy which can be used to produce electricity. However, many ocean energy technologies are still in the research and development stage and are not yet fully commercialized. Some of the most promising ocean technologies include:[2]

WAVE ENERGY

Wave energy uses converters to collect the energy stored in ocean waves and produce electricity.[3] Rated power output ranges from 70 kW to a few MW for a single system. Multiple units are installed to build wave power farms.[2]

Wave devices may typically be categorized either by position or by wave movement response:

Shoreline devices

Whether attached to or installed in the shoreline, these devices do not require long power cables underwater and are easier to set up and maintain.

Near-shore devices

Near-shore devices are installed at medium water depths (20 - 25 m) and mounted at ranges of up to 500 m from the shore.

Offshore systems

Offshore systems harness the more efficient wave resources that are available in deep waters (over 25 m).[2]

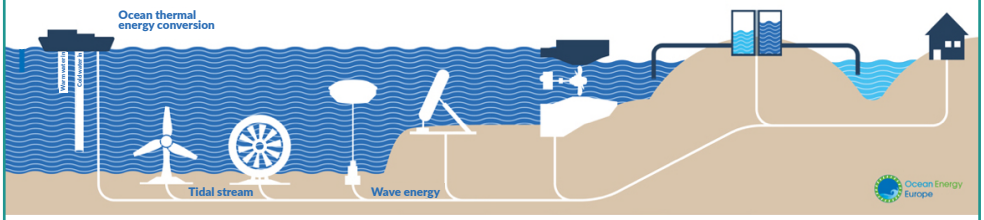


Figure 1: Different ocean energy technologies (https://www.oceanenergy-europe.eu/ocean-energy/)

TIDAL ENERGY

There are two main types of tidal energy that determine the type of technology for electricity generation:

Tidal array technologies harness the potential energy produced by the difference in height between high and low tides. Dams are used as a containment element to extract tidal energy from different ranges.

Tidal stream technology (or current) absorbs the kinetic energy generated by the horizontal movement of water from currents streaming in and out of coastal environments (such as seashores).[2,4]

Tidal energy uses the following technologies:[2]

Horizontal axis turbines

These machines have two or three blades positioned horizontally to form a rotor. The dynamic action of the water current causes the rotor to rotate and generates electricity.

Vertical axis turbines

Typically, two or three blades are fixed along a vertical shaft to construct a rotor that generates electricity with the flow of water that falls perpendicular to the marine current.

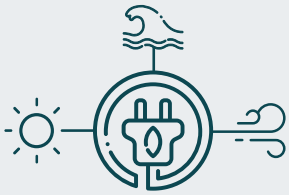
Oscillating hydrofoil

This device works in the water like an airplane wing, generating energy from a vertical oscillation.

KEY FACTS

532 MW

Total global ocean energy capacity in 2018[3]



Similar to geothermal energy, **ocean energy works well with other renewable energy sources** by generating electricity at different times. It can contribute to the maintenance of an electricity grid that depends on increasing numbers of variable renewables.[6]

Through 2050 the ocean energy industry is expected to develop 100 GW of production capacity in Europe, providing **10% OF EUROPE'S ELECTRICITY** and serving **76 MILLION HOUSEHOLDS**.[6]

Conventional technology is being used in tidal reservoirs; nevertheless, worldwide there are only two large-scale projects operating.

The 240 MW "La Rance" dam in France has been generating power since 1966, whereas **the 254 MW "Sihwa" dam (South Korea)** has been in operation since 2011. Additionally, several smaller projects in Japan, Canada and Russia have been launched.[5]

OCEAN THERMAL ENERGY (OTEC)

OTEC system uses the difference in temperature between the surface and deep water in a heat exchange cycle to generate electricity. Tropical areas are best suited for utilizing this source of energy.[2] Figure 2 shows a closed OTEC system with all components.

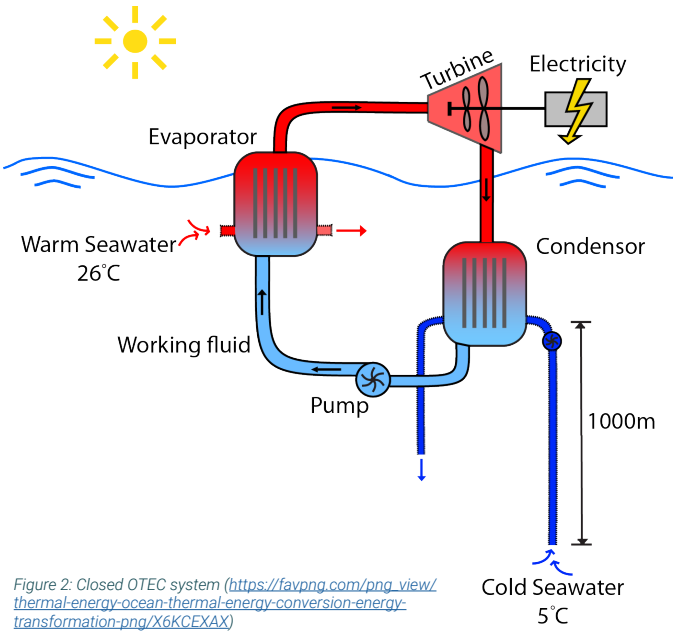


Figure 2: Closed OTEC system (https://favpng.com/png_view/thermal-energy-ocean-thermal-energy-conversion-energy-transformation-png/X6KCEXAX)

SALINITY GRADIENTS

Using the pressure-retarded reverse osmosis method and related conversion techniques, energy associated with the salinity gradient can be harnessed at the mouth of rivers where freshwater combines with saltwater.[5]

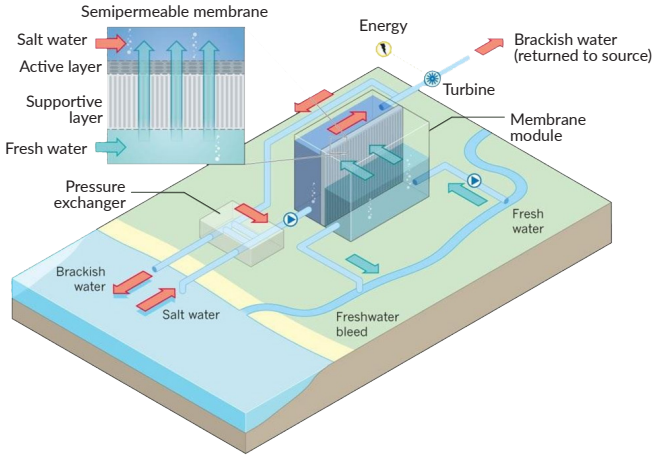


Figure 3: Schematic diagram of a PRO plant run on river water vs sea water. (https://www.semanticscholar.org/paper/Osmotic-power-with-Pressure-Retarded-Osmosis%3A-and-%E2%80%93-Helfer-Lemckert/b8dd88f4ea819997eaf8a3378a94d0eed35b1829)

APPLICABILITY OF OCEAN ENERGY

- The best wave power areas are places with strong winds. Areas off the United States' northwest and northeast coasts have great ocean energy potential.
- The European countries participating in ocean energy research and development are France, Portugal, Ireland, UK and Denmark followed by other countries around the globe such as Australia, Canada, USA and South Africa. These are the countries with extreme waves and winds, high tides and rivers that flow into the oceans providing the necessary gradient of salinity for energy generation.[7]

Figure 4: La Rance tidal power plant, France (https://www.edf.fr/en/the-edf-group/industrial-provider/renewable-energies/marine-energy/tidal-power)

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