How is wave power used

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Wave power is the capture of energy of wind waves to do useful work - for example, electricity generation, water desalination, or pumping water. A machine that exploits wave power is a wave energy converter (WEC).

Waves are generated primarily by wind passing over the sea''s surface and also by tidal forces, temperature variations, and other factors. As long as the waves propagate slower than the wind speed just above, energy is transferred from the wind to the waves. Air pressure differences between the windward and leeward sides of a wave crest and surface friction from the wind cause shear stress and wave growth.[1]

Wave power as a descriptive term is different from tidal power, which seeks to primarily capture the energy of the current caused by the gravitational pull of the Sun and Moon. However, wave power and tidal power are not fundamentally distinct and have significant cross-over in technology and implementation. Other forces can create currents, including breaking waves, wind, the Coriolis effect, cabbeling, and temperature and salinity differences.

As of 2023, wave power is not widely employed for commercial applications, after a long series of trial projects. Attempts to use this energy began in 1890 or earlier,[2] mainly due to its high power density. Just below the ocean''s water surface the wave energy flow, in time-average, is typically five times denser than the wind energy flow 20 m above the sea surface, and 10 to 30 times denser than the solar energy flow.[3]

In 2000 the world''s first commercial wave power device, the Islay LIMPET was installed on the coast of Islay in Scotland and connected to the UK national grid.[4] In 2008, the first experimental multi-generator wave farm was opened in Portugal at the Agu?adoura wave park.[5] Both projects have since ended. For a list of other wave power stations see List of wave power stations.

Wave energy converters can be classified based on their working principle as either:[6][7]

The first known patent to extract energy from ocean waves was in 1799, filed in Paris by Pierre-Simon Girard and his son.[8] An early device was constructed around 1910 by Bochaux-Praceique to power his house in Royan, France.[9] It appears that this was the first oscillating water-column type of wave-energy device.[10] From 1855 to 1973 there were 340 patents filed in the UK alone.[8]

Modern pursuit of wave energy was pioneered by Yoshio Masuda''s 1940s experiments.[11] He tested various concepts, constructing hundreds of units used to power navigation lights. Among these was the concept of extracting power from the angular motion at the joints of an articulated raft, which Masuda proposed in the 1950s.[12]

The oil crisis in 1973 renewed interest in wave energy. Substantial wave-energy development programmes were launched by governments in several countries, in particular in the UK, Norway and Sweden.[3] Researchers re-examined waves'' potential to extract energy, notably Stephen Salter, Johannes Falnes, Kjell Budal, Michael E. McCormick, David Evans, Michael French, Nick Newman, and C. C. Mei.

Salter''s 1974 invention became known as Salter''s duck or nodding duck, officially the Edinburgh Duck. In small-scale tests, the Duck''s curved cam-like body can stop 90% of wave motion and can convert 90% of that to electricity, giving 81% efficiency.[13] In the 1980s, several other first-generation prototypes were tested, but as oil prices ebbed, wave-energy funding shrank. Climate change later reenergized the field.[14][3]

The world''s first wave energy test facility was established in Orkney, Scotland in 2003 to kick-start the development of a wave and tidal energy industry. The European Marine Energy Centre(EMEC) has supported the deployment of more wave and tidal energy devices than any other single site.[15] Subsequent to its establishment test facilities occurred also in many other countries around the world, providing services and infrastructure for device testing.[16]

The ?10 million Saltire prize challenge was to be awarded to the first to be able to generate 100 GWh from wave power over a continuous two-year period by 2017 (about 5.7 MW average).[17] The prize was never awarded. A 2017 study by Strathclyde University and Imperial College focused on the failure to develop "market ready" wave energy devices - despite a UK government investment of over ?200 million over 15 years.[18]

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