



The power of the waves

Ocean energy: an inexhaustible source of energy for the future.

The ocean is one gigantic energy storage system: With an estimated 80,000 TWh per year, it represents an incredible potential for diversifying renewable energy sources and reducing CO₂ emissions.

Current estimates place most of that potential in wave energy. But the challenges are not to be underestimated.

The major appeal of wave energy is that it is virtually inexhaustible and, unlike volatile wind and solar power, is permanently available. Although still in its infancy, wave energy could one day make a significant contribution to a stable, reliable and sustainable power grid.

Different technologies and principles

Four different system concepts are currently under exploration: In regions with strong ocean currents or pronounced tides, such as the coasts of the United Kingdom, Canada, and France, the goal is to use underwater turbines to convert tidal current kinetic energy into electricity.

Osmotic power plants (salinity gradient power plants) use the difference in salinity between fresh water and seawater. These are built, for example, where rivers flow into the sea, and use the hydration energy of the salt ions. This form of energy is also known as „blue gold“.

In tropical regions, thermal power plants that use the temperature difference between warm surface water and cold deep water to generate electricity (Ocean Thermal Energy Conversion, or OTEC) are becoming increasingly popular. A 2020 study by the International Renewable Energy Agency (IRENA) estimated the global energy potential of these systems, similar to heat pumps, at 44,000 TWh per year. However, we still need significant technological advances to make such systems economically viable.

The potential of wave energy, however, seems more tangible: its global theoretical capacity is estimated at 29,500 TWh per year, roughly equivalent to our entire global electricity consumption.

Promising technologies

Five principles are currently attracting attention for the use of wave energy: Point absorbers are floating devices that use vertical wave motion to generate electricity. Oscillating Water Columns (OWCs) compress and decompress the air above a column of water, using wave motion to drive a turbine. Attenuators are elongated devices that lie in the same direction as the waves, using their up and down motion. Overtopping devices, on the other hand, direct water down a ramp into a reservoir and use the difference in elevation to generate electricity, similar to small hydroelectric plants. Companies such as CalWave in California are successfully using the oscillating attenuators principle to harvest the energy of underwater wave movement with submersible metal platforms.

Major challenges

Wave energy systems still have many challenges to overcome. Such systems are being tested and developed at a small number of test sites around the world. In addition to cost and economics, grid integration must also be addressed. The impact of these systems on marine ecosystems is not yet fully understood and requires further investigation. Possible negative effects must be minimized and sustainable solutions developed.

▼ CorPower Ocean from Sweden uses point absorbers in its wave farm to harvest wave energy. Image: ©CorPower Ocean



In addition, many countries have implemented complex approval procedures and extensive regulatory requirements, which have slowed expansion and dampened the excitement seen in previous years. Many companies working in this exciting field have not survived.

Extreme environmental conditions

Shaft power systems must withstand harsh environmental conditions such as storms and saltwater corrosion. Temperature fluctuations, shock, and vibration also stress components. Difficult access requires high system reliability and durability.

The development of robust and low-maintenance materials and designs is therefore essential. Renowned research partners in California and Australia rely on Bachmann electronic for the control of their systems. The developers particularly appreciate the versatility and robust design of the components and the openness of the M200 and M100 controller and I/O systems. Another invaluable advantage for researchers is that they can use M-Target for Simulink® to generate software applications directly from Simulink® and input them directly to the controller during testing.

Industrialization requires stable conditions

Wave energy is on a promising path, but one that still requires considerable research and development efforts. Without a clear political framework and support, such a complex technology cannot be brought to series production.

Some island nations, such as the Faroe Islands, Orkney Islands and Tahiti, have already set their own targets: they want to become completely reliant on renewable ocean energy by 2030 and so end the import of expensive fossil fuels by ship.

If it can overcome the technical, economic and regulatory hurdles, wave energy could make an important contribution to a sustainable energy supply and help reduce dependence on fossil fuels. Cooperation between science, industry and politics is crucial to take full advantage of this potential. Bachmann is ready and waiting!



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CONTACT

*Michael Kocher
Key Account Manager*

*T: +43 5522 3497-0
info@bachmann.info*