OCEAN POWER

Ocean power is one of the newest and least understood categories of renewable energy technologies. This category includes both tidal generating systems and wave power. Both types of power are limited in their applications: tidal power is only viable in locations with strong tidal differentials and wave power is only viable in areas with strong wave energy. Additionally, wave and tidal energy are currently the most expensive types of renewable energy, with net lifetime operational losses relative to existing sources of power at present.[1]

Tidal power is reminiscent of hydropower. As with hydropower, there are two types of tidal power generating systems: one that stores potential energy and one that uses kinetic energy. Tidal barrages store the flooding tide behind a dam-like barrage, and as it is released on the ebb tide, it turns a turbine to produce electricity. Tidal stream generators use the energy of moving tidal water, just as run-of-river hydropower uses the kinetic energy of flowing stream water.[2] Commercial tidal power systems are in place in Nova Scotia, France, and South Korea, and demonstration projects exist in New York's East River and Maine's Western Passage and Cobscook Bay.[3]

Wave power systems use the oscillatory motion of waves to generate electricity. Commercial deployment of wave energy is still very limited, but there are various engineering systems in development, including point absorber buoys, surface attenuators, oscillating wave surge converters, oscillating water column devices, overtopping devices, submerged pressure differential devices, and floating in-air converters.[4] The DOE and Oregon State University began construction of two experimental wave power sites 6 nautical miles off the coast of Oregon in 2021.[5] Technologies being tested at the PacWave North and PacWave South facilities include point absorbers, attenuators, oscillating water columns, and hybrid devices.[6]

Since ocean power is still so new, little is known about its environmental impacts,[7] which may include the following:[8, 9]

- Collision risk: Sea birds, bats, mammals, turtles, fish, could experience collisions with wave energy structures or rotating tidal turbines. Collision risk could be enhanced if

[1] Project Drawdown. "Ocean power." https://drawdown.org/solutions/ocean-power
[2] Project Drawdown. "Ocean power." https://drawdown.org/solutions/ocean-power
[3] Wikipedia. "Tidal power." https://en.wikipedia.org/wiki/Tidal_power
[4] Wikipedia. "Wave power." https://en.wikipedia.org/wiki/Wave_power
[5] https://pacwaveenergy.org
[6] Department of Energy. "PacWave." https://www.energy.gov/eere/water/pacwave
[7] USFWS. "Energy technologies and impacts: Hydrokinetic energy." https://www.fws.gov/ecological-services/energy-development/hydrokinetic.html
[8] Copping, Andrea E. et al. 2020. Potential environmental effects of marine renewable energy development: The state of the science." *Journal of Marine Science and Engineering* 8. DOI:10.3390/jmse8110879
[9] Oregon State University. 2014. "Wave-energy decides might affect the natural environment: Scientists plan research to better understand effects."

animals are attracted to tidal turbines, wave power structures, lights on the structures, or forage species that are drawn to the structures.

- Effects of underwater noise: Anthropogenic noise created by energy generation devices may affect species that use echolocation and sound for communication, including marine mammals. Impacts may range from auditory masking, stress, behavioral changes, acoustic responses or injuries, and, in extreme cases, barotrauma or death.
- Effects of electromagnetic fields (EMF) on animals: EMFs could alter the feeding and orientation behavior of some marine species. The most susceptible species are likely to be those, like salmon, that use the Earth's magnetic fields to migrate to their spawning grounds, and sharks, skates, and rays, which locate prey by detecting the electricity created by prey movements.
- Changes in benthic and pelagic habitats: Structures in the water may attract marine life by creating an artificial reef and growth substrate for fouling organisms or by acting as fish aggregating devices.
- Changes in oceanographic processes: Wave and tidal power devices may alter sediment movement, currents, and stratification of the water column, with downstream impacts on larval dispersal and delivery of food particles to benthic filter feeders.
- Entanglement of animals with mooring systems: Marine mammals may collide or become entangled in wave power devices. Alternatively, mammals may be forced to alter their migration patterns in order to avoid structures or devices.

Environmental effects of ocean power are likely to be highly site-specific, and they will also vary with the type and design of each device.[10]

- Fishery friendliness: Because ocean power devices are located in marine and estuarine environments, their impacts to fisheries are serious considerations that need to be evaluated at both site-specific and cumulative scales. Since ocean power technologies are still so new, little is known about these impacts, but they may include: collision of fish with turbines or wave energy devices; effects of underwater anthropogenic noise on species that rely on acoustics for communicating and migrating; impacts of EMFs on species that rely on magnetic detection and electric currents for feeding and migration; impacts to fish community composition, trophic relations, and distributions by creation of artificial reef and fish aggregating effects; and changes to habitats and hydrographic processes resulting from alteration of wave energy and water flow, which could affect larval dispersal and delivery of food to the benthos.
- Co-benefits: None.
- Environmental externalities: Little is known about the impacts of ocean power to marine mammals, turtles, and sea birds, but potential impacts include collision, entanglement, alteration of migration and feeding, and acoustic impacts.
- Policy catalysts: Wave and tidal energy can be promoted through research funding, demonstration, and lead-by-example projects.
- More information:

[10] Oregon State University. 2014. "Wave-energy decides might affect the natural environment: Scientists plan research to better understand effects."

- Drawdown: Ocean power
- U.S. Energy Information Administration: Tidal power
- U.S. Energy Information Administration: Wave power
- Wikipedia: Tidal power
- Wikipedia: Wave power
- Department of Energy: PacWave

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