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Renewable Energy Fact Sheet

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Ocean Energy

Using the oceans' tides, waves, and heat to generate electricity

Key Facts

- The oceans' tides, waves, current, and heat can be used to generate electricity. These resources are renewable, because the moon's gravity drives tides, and winds create waves. Covering 70 percent of the Earth's surface, the oceans collect significant amounts of heat from the sun.
- A tidal dam with a capacity of 240 megawatts (MW) has operated in France since 1966; a 100 MW tidal dam has generated power in China since 1987; and a 20 MW tidal dam has operated in Canada since 1984. Several other, smaller ocean energy systems are also in use around the world. Theoretically, ocean waves could produce more than 2 million MW of electricity, according to the US Department of Energy.
- The best locations for harnessing wave power are regions with the strongest winds. Areas off the Northwest and Northeast coasts of the United States have good potential for ocean energy.

Ocean Energy Technologies

- *Tidal dams:* A dam, or barrage, built across a narrow bay or river mouth can harness tidal energy. As the tide flows in or out, creating uneven water levels on opposite sides of the barrage, the barrage gates open and water flows through turbines to generate electricity. The La Rance station in France, an industrial-sized tidal power station with a capacity of 240 MW, supplies 90 percent of Brittany's electricity. South Korea plans to build a 260 MW tidal dam, scheduled for completion in 2009. For a tidal dam to be feasible, the difference between high and low tides must be more than 16 feet. Forty sites worldwide have such strong tides, including locations in the northeastern and northwestern United States.
- *Tidal fences:* Chains of turnstiles, or tidal fences, can reach across channels between islands or from an island to the mainland. Tidal fences sit on the ocean's surface and rotate with the tides. Some tidal currents move at 6 to 9 miles per hour, generating the same amount of energy as winds with much higher velocities. The Philippines is planning to construct a tidal fence between two of its islands.
- *Tidal turbines:* Underwater turbines, similar to wind turbines, can also harness tidal and ocean current energy. In water moving between 4 and 5.5 miles per hour, a 50-foot diameter water turbine could generate as much energy as a 200-foot diameter wind turbine. The European Union has located 106 sites in Europe where tidal turbines could be constructed. Tidal turbines should be close to shore, in water 60 to 100 feet deep, in order to produce constant, base-load power. On June 7, 2005, the United Kingdom announced a $5 million grant to build a submerged, propeller-driven tidal stream generator off the coast of Scotland by 2006. This system will be connected to the electric grid and have an electrical capacity of 1 MW.
- *Wave technologies:* Surface waves and pressure variations below the ocean's surface can generate intermittent power. Floating buoys, platforms, or submerged devices, placed in deep water, generate electricity using the bobbing motion of the ocean's waves. A Portuguese corporation ordered three wave energy converters in May 2005, with a total of 2.5 MW of electrical capacity. These devices, shaped like 130-foot long pencils, will float perpendicular to the ocean floor, bobbing up and down to produce electricity. Facilities built along the coast also can extract energy from breaking waves. Wave energy systems have already been installed in Norway, Scotland, Japan, Australia and Indonesia.

- *Ocean thermal energy conversion (OTEC)*: The heat stored in the ocean can be used to generate electricity. OTEC technologies use the warm water at the ocean's surface to vaporize a working fluid, such as ammonia, which boils at a much lower temperature than water. The expanding vapor from the boiling working fluid drives a low-pressure turbine attached to a generator and produces electricity. The vapor is then returned to liquid form by exposure to cold, deep-sea water. OTEC provides consistent base load power. It works best when the temperature difference between the water at the ocean's surface and the ocean's floor is at least 35°F. Such conditions exist in tropical coastal regions, near Hawaii and Guam, for example.

Benefits

- *Pollution prevention:* Harnessing ocean energy does not create greenhouse gases or other pollutants.
- *Offshore location:* Most ocean energy technologies do not occupy valuable land area.
- *Jobs and security:* Ocean energy could be produced domestically, providing jobs for Americans and helping to reduce energy security concerns associated with depending on foreign countries for oil and natural gas.

Cost

- Ocean energy facilities have no fuel costs, but to date their capital costs are high, particularly in deep-sea regions, because most of these technologies are relatively new and immature. The cost of harnessing wave energy has fallen significantly and wave power generation may be economically feasible within the next decade, according to the European Union. Experience with demonstration projects and technological advances will reduce the construction costs of ocean energy power generation.

Issues

- *Accessibility:* Ocean energy technologies cannot be built everywhere; they require specific water depths, significant wave activity, or large differences between the heights of high and low tides.
- *Transmission infrastructure:* Deep-sea systems require new transmission lines to carry electricity from off shore to consumers on land. Coastal systems usually require new power lines as well.
- *Environmental impacts:* Tidal dams that block river mouths may impede sea life migration and lead to the buildup of silt, as seen behind other dams along rivers. Tidal fences may block migratory sea life. Careful site selection can mitigate these problems. Tidal turbines, coastal wave energy generators, and technologies to harness ocean currents do not block migratory paths and have limited environmental impacts once constructed.

For More Information

European Union ATLAS Program http://europa.eu.int/comm/energy_transport/atlas/htmlu/wave.html
European Union ATLAS Program http://europa.eu.int/comm/energy_transport/atlas/htmlu/tidal.html
National Renewable Energy Laboratory http://www.nrel.gov/clean_energy/ocean.html
Practical Ocean Energy Management Systems http://www.poemsinc.org/home.html
DOE Efficiency and Renewable Energy http://www.eere.energy.gov/consumerinfo/factsheets/nb1.html

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