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Power of the Tides

By Michael Sandstrom

Harnessing just 0.1% of the potential renewable energy of the ocean could produce enough electricity to power the whole world. Scientists studying the issue say tidal power could solve a major part of the complex puzzle of balancing a growing population's need for more energy with protecting an environment suffering from its production and use.

There are three different ways to tap the ocean for electricity: tidal power (free-flowing or dammed hydro), wave power, or oceanic thermal energy.

Tidal power (also known as hydrokinetic) uses the rise and fall of the tides to produce electricity. Dammed hydro power (technically similar to instream hydro power) makes use of huge dams that trap water as the tides go in and cause turbines to spin as the water is released. However, this method is damaging to the shoreline and the animals that inhabit it.

Wave power is harnessed by machines that move up and down as the waves flow by them, using pistons to turn generators. Since these wave machines are portable, they could provide a source of power in the open ocean to generate electricity for ships, desalination plants, power plants, and lighthouses. Portugal plans to build a 2.25 megawatt wave farm.1 There are, however, still many difficulties that make wave power less feasible than free-flow tidal power for large-scale energy production, including unpredictable storm waves, loss of ocean space, and the difficulty of transferring electricity to shore.

Oceanic thermal energy is produced by the temperature difference existing between the surface water and the water at the bottom of the ocean, which allows a heat engine to make electricity. However, it has a low overall efficiency (less than 7%) and works well only in the tropics.

Benefits of Free-flow Tidal Power

Free-flow tidal power is fast emerging as the preferred technology for tapping ocean power. Since it is underwater, it produces power whether the tide ebbs or flows, generating vastly more power in a highly predictable manner, while providing economic efficiency and environmental benefits. The turbines can be placed in the ocean or any river with a constant current over two meters per second. It has one of the lowest impacts on the environment of any means of energy production, according to a 168-page report released in 2006 by the Electric Power Research Institute (an independent, nonprofit center for energy and environmental research). Tidal power is also one of the most reliable renewable energy resources. Scientists know the movement of the tides for the next 1000 years, which means that power companies can accurately predict exactly how much power they will get and when.

Open Hydro Turbine for generating free-flow tidal power

tidal turbines are somewhat better for the environment than the heavy metals used to make solar cells.[3] Since the sun only shines on average for half a day, solar is not always as predictable due to cloud coverage.

Although tidal and wind share the same basic mechanics for generating electricity, wind turbines can only operate when there is sufficient wind and they are sometimes considered aesthetically unappealing. Moreover, water is 1,000 times denser than air, which means that the potential for generating each unit of energy per meter is much greater than wind power can ever be. A tidal current turbine gains over four times as much energy per meter squared of rotor as a wind turbine.[4]

Current Drawbacks to Tidal Power

COST: The absence of mass production at this early stage means turbines are still relatively expensive to build and install. In order for the cost to come down, both the governmental and corporate sectors must invest in them. Although the U.S. government has recently approved a $7.5 million grant for the research of marine technologies, this sum pales in comparison to the $38 million grant Ireland is directing toward tidal research.[5]

Another reason for the sluggish interest by U.S. companies is that a large-scale, $4.5 million, tidal project recently failed.[6] A tidal company, Verdant Power, installed six turbines in the East River in New York—the first grid-connected, free-flow tidal project in the U.S. However, faulty design and an underestimate of the strength of the current caused the turbines to be damaged and removed. The failure, however, demonstrates how much potential

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power there is in the flow of water and the lessons learned will help improve the next generation of turbine models. In April, Verdant Power received a $2.2 million grant from the Ontario government to install a 15-megawatt turbine array in the St. Lawrence River.[7]

AVAILABILITY/RELIABILITY: There is a short period during high and low tides when the incoming flow is balanced by the outgoing flow and little or no power is generated. This short window, however, compares favorably to the amount of down time associated with solar or wind.

IMPACTS ON AQUATIC ECOSYSTEM: While it is still uncertain what effect a large scale free-flow tidal power plant would have on aquatic life over time, the tests conducted so far indicate that fish and marine animals can avoid the slow moving turbines.[8] Dammed hydropower, on the other hand, uses rapidly spinning turbines which create strong suction at the intake valves, causing serious injuries to aquatic animals trapped in the dam.

Noise generation has been posed as a possible threat, yet hydro-acoustic testing shows that the sound carries just far enough to warn large fish and whales not to come too close to the turbines.[9] Other possible environmental concerns include motor oil leakage from the moving parts of the turbine and disturbance of the sea-floor bottom (especially during installation). However, studies show that the base of a turbine can actually serve as an artificial reef, attracting both sea-floor dwellers and fish.[10]

Tidal Power Progress

Hammerfest, Norway is currently the only place on earth that has a working free-flow tidal-powered turbine connected to the grid. Installed in 2003, it has ten-meter long blades and produces 300kW of electricity, enough to heat and light 35 Norwegian homes.[11] Because of the success of this single turbine, there are plans underway to install another 19 nearby next year. In Northern Ireland, the world's largest tidal turbine was recently installed. Capable of producing 1.2 megawatts of power, it will begin operating later this year, providing power to over one thousand Irish families.[12]

If the United States would install an array of turbines along the Northeast coast, not only would it be the first of its kind in this country, but it could spark huge investment interest globally. There are currently four sites in the Northeast that have been approved (with a fifth pending) by the Federal Energy Regulatory Committee (FERC) on which tidal plants could be built now. If turbines were placed at these sites, the energy yield would be 889 mega watts of power, 1.25% more than is produced at an average coal plant.[13] This would mean more than 850,000 tons of carbon dioxide would be prevented from entering into the atmosphere each year.

Tidal power is still in its infancy; it needs more research and development to make it efficient and more workable. Tidal power alone cannot provide enough energy to supply all of the United States, especially in the middle of the country. However, used in conjunction with other alternative energy sources, it can help eliminate the need for petroleum and nuclear-based power plants, thus reducing the level of green house gases and preventing the accumulation of radioactive waste.

Future Large-Scale Generation Feasibility in the Northeast

	Aesthetics	Safety	Economics
Nuclear Grade: F	— Large centralized plants	— Health and terrorism threat, cannot be placed in or near population center, waste storage issues.	— Most expensive energy source
Wind Grade: B	— NIMBY (Not In My Backyard) Issues, farms disrupt natural landscape	— Safe, migratory bird problems	— Affordable installation, expensive transmission from source
Solar Grade: B-	— Debatable	— Minimal hazardous waste	— Expensive
Tidal Grade: A	— Invisible Systems completely submerged and silent	— Environmentally benign	— Affordable, close to load, about 50% more efficient than coal and oil

Scorecard of Power Generation in the Northeast
(Courtesy of Elizabeth Murphy of Natural Currents)

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