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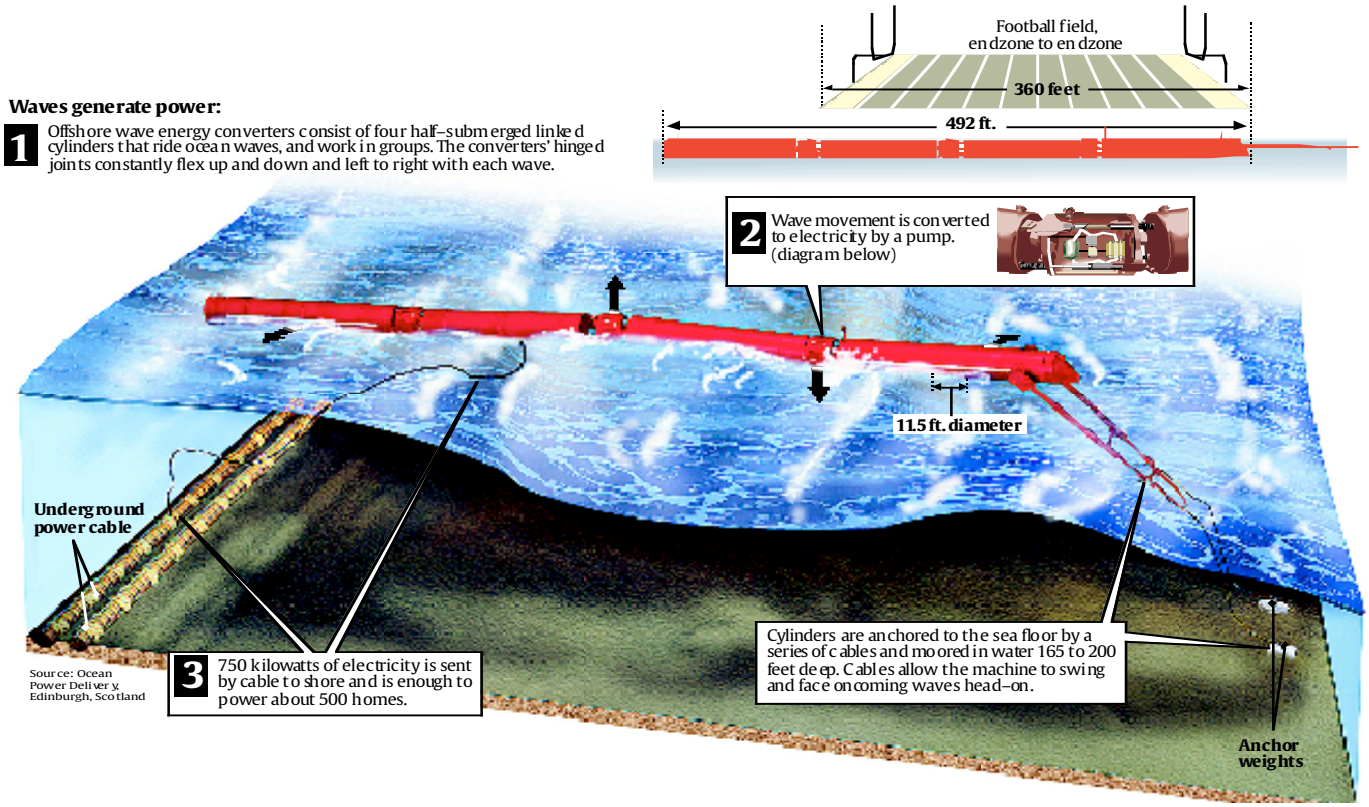
Catch a wave, throw a switch

Marine power projects take advantage of waves, tides and currents to create energy used to generate electricity. Here is one of the technologies used to harness wave and tide power.



By Paul Davidson
USA TODAY

Any wiped-out surfer knows all too well the back-breaking power of the ocean's waves.

Now, a fledgling industry is harnessing the incessant motion of waves, tides and currents to create the world's newest form of renewable energy.

After sputtering along for nearly a decade, marine power appears poised to join the alternative energy juggernaut, though the technologies are still in the early stages and have no guarantee of success. Developers are using an array of contraptions — from spinning turbines to bobbing buoys and undulating, snakelike cylinders — to convert ocean or river movements into electricity.

The world's first commercial wave farm is scheduled to launch this summer off Portugal's coast. The first pilot tidal generator in the USA revved up in New York City's East River last December. And the USA's first utility-scale wave project, off Oregon beaches, won preliminary federal approval this year. All told, the Federal Energy Regulatory Commission has cleared 21 preliminary permits, and about 35 are pending for wave and tidal projects, largely off the West Coast and shores of Florida and New England.

Widespread use of marine energy is about a decade

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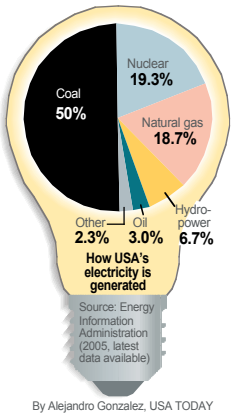
away, says Roger Bedard, ocean energy leader for the Electric Power Research Institute. In 50 years or so, he says, 20% of offshore wave energy could be tapped practically. That, combined with tidal energy, could constitute 10% of all U.S. power sources.

Prototype wave-power machines have been around for a century, but interest in marine energy picked up during the 1970s oil embargo, only to recede when oil prices fell. Driving the new push is a scramble for green energy, such as wind, solar and biomass, amid growing concerns about global warming and expected federal limits on fossil fuel plants' carbon dioxide emissions. About half the states require utilities to mix traditional power with some alternative energy.

Marine energy has some distinct advantages over its chief rival, wind power. Water is 850 times denser than air, allowing tidal turbines, for instance, to produce about 40 times more power than windmills with similar gear. That will ultimately mean smaller equipment at lower costs, Bedard says.



By Alejandro Gonzalez, USA TODAY

And though tidal, wave and wind strengths all fluctuate, marine energy is far more predictable than wind. Tidal flows -- bay or river currents that shift several times daily based on the moon's gravitational pull — can be forecast years in advance. Satellite images foretell wave heights, which trace wind patterns, days ahead. That lets utilities use generators more efficiently.

"If I know it's not always there, I can make certain other plants are there to back it up," says Hal LaFlash, Pacific Gas & Electric's renewable-energy director.

PG&E this year filed applications to study wave power off the California coast, becoming the first major U.S. utility to do so. It's also considering a tidal project in the strait under the Golden Gate Bridge.

Another selling point for marine energy is its low profile. Water turbines moored to the seabed are hidden from nearby communities. And while the sometimes- mammoth machines that harness wave energy bounce on the ocean's surface, they are barely visible several miles offshore. By contrast, some environmental groups have opposed wind farms as an eyesore.

Developers have wave power down to a science. In Oregon, for instance, wave heights average about 11 1/2 feet in the winter, enough to generate sufficient electricity per yard of wave-crest length to power about 38 homes. Waves, and power potential, are higher on the West Coast than the East Coast.

In December, Verdant Power placed a water turbine on the bed of New York's East River. Tidal flows of about 6 feet per second spin the turbine blades, which turn a shaft that powers a generator. Cables along the river floor connect the devices to the power grid.

The 35-kilowatt turbine is generating electricity for a small grocery store and parking garage on nearby Roosevelt Island. Four more turbines are scheduled to be added this month. After an 18-month trial, Verdant hopes to install some 200 turbines that will produce up to 10 megawatts of electricity, enough to power 7,500 homes, says Verdant Chief Financial Officer Kevin Lynch.

Ocean Renewable Power plans a much larger turbine array in the Gulf Stream off the Florida coast. Unlike tidal flows, an ocean current is constant and can host enough turbines to power a few hundred thousand homes, says company CEO Chris Sauer.

Others are testing the harsher waters of the open seas. Early next year, Ocean Power Technologies plans to install a 50-ton buoy in 150-foot-deep waters off the coast of Reedsport, Ore. As waves knock the buoy to and fro, hydraulic fluid is pumped through a cylinder, which drives a generator. If the test is successful, 13 buoys will be added by late 2008. Plans call for an array of some 300 eventually, generating electricity to power nearly 40,000 homes.

"As a young guy in Australia, I did a lot of surfing, and you get used to the mechanical force in the waves that toss you around, and you realize there's an enormous amount of energy out there," says CEO George Taylor.

Portugal project

Ocean Power Delivery of Scotland has tested a much larger device in the Orkney Islands. Its 380-foot-long "sea snake" contains seven cylinders linked by hinges that undulate with the waves' motions, tripping hydraulic pumps that turn motors. It plans to install three machines, at about $13.5 million, this summer near northern Portugal, and eventually an array of 30 to light 15,000

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Portuguese homes. PG&E plans to consider the device for California.

Unlike wind power, which must be zapped from states such as Wyoming and Kansas to larger cities, clogging transmission lines and losing energy along the way, marine energy farms can be near coastal population centers.

"Because of its location, it will be relatively easy to integrate into our system," says Kevin Watkins, vice president of the Pacific Northwest Generating Cooperative, which has agreed to buy power from Ocean Power Technologies.

Europe is further ahead than the USA. It's testing a variety of prototypes, including a "wave dragon" that scoops water into a basin, then releases it to turn turbines. Even big players are jumping in. General Electric has taken a small stake in Ocean Power Delivery.

"We've done our due diligence, and we think this has promise," says Kevin Walsh, who heads renewable energy for GE Energy Financial Services.

Yet, marine energy also faces choppy waters. Projects cost about 13 cents to 35 cents per kilowatt hour of electricity, at least twice the cost of wind. Mass production, Bedard says, eventually should drive down costs below wind.

"It's about where wind was 25 years ago," Bedard says, adding that water turbines will develop more quickly, having borrowed from the advances of windmills.

Regulatory obstacles

Equipment has yet to be tested for long periods in punishing surroundings, says analyst Brandon Owens of Cambridge Energy Research Associates. Ocean Power Technologies had to suspend a trial in Hawaii to install more durable shock absorbers. The company, which is preparing its initial public offering of stock, lost $7.1 million on $1.7 million in revenue last year, according to a filing with the Securities and Exchange Commission.

"It's a harsh environment, and these things are difficult to build and maintain," Owens says.

There are also regulatory hurdles. It took Verdant Power four years to get approvals for its New York pilot program from agencies such as FERC, the Coast Guard and the U.S. Fish and Wildlife Service. Getting a commercial license takes eight years. Verdant must spend more than $2 million on sonar gear to study the turbines' effect on fish. Lynch says there is none because the blades rotate at just 32 revolutions per minute. PG&E plans to study the effect of wave devices on kelp farming, crabbing, even surfing. The machines do rob energy from waves, but the effect on wave heights is minuscule, Bedard say.

The Ocean Renewable Energy Coalition's Sam O'Neill says agencies are unfairly subjecting marine energy to the same scrutiny as hydroelectric dams.

A bill to be introduced by Rep. Jay Inslee, D-Wash., would streamline approvals, earmark $50 million a year for marine energy research, and provide the same tax credits as other renewables. "We have to give them a level playing field," he says. "This is the most concentrated energy on the planet."

Powered by water

Other electricity–producing devices that use the energy of currents or waves:

PowerBuoy

What it is: A floating buoyike structure with an onboard electrical generator and a computer that monitors wave severity and controls electricity output.
How it works: A pistonlike device at the buoy's bottom rises and falls with ocean waves. The piston's movement drives a generator that produces electricity, which is sent by cable to shore.
Power generation: 40 kilowatts, enough to power 31 homes; larger units are planned.
Placement: Designed for mooring in water 100 to 200 feet deep, 1 to 5 miles offshore.
Deployed: Tests in Atlantic City; Oahu, Hawaii; Santona, Spain; Reedsport, Ore.
Company: Ocean Power Technologies, Pennington, N.J.

Underwater turbine

What it is: Underwater windmill that uses currents to produce electricity.
How it works: Flowing water rotates the turbine blades, which turn the generator that produces electricity, which is cabled to shore. The turbine can swivel to take advantage of incoming/outgoing tides. Blades rotate about 32 times per minute.
Power generation: 35 kilowatts; A 10–megawatt field would power approximately 7,600 homes[1].
Deployed: One unit tested in New York's East River, near Roosevelt Island.
Company: Verdant Power, New York, N.Y.

Wave Dragon

What it is: An offshore floating platform with an "overtopping-type" energy converter.
How it works: Ocean waves are channeled over a barrier and into a reservoir. Water is released through outlets with turbines that spin and generate electricity, which is sent by cable to shore.
Power generation: Three models: 4, 7, and 11 megwatts
Deployed: Platform to be tested off the coast of Wales this year.
Company: Wave Dragon, Copenhagen, Denmark

1 — units are intended to work in fields, not as a stand-alone single unit. They are clustered together in tens or hundreds to form a field. Deeper or faster water currents yield higher power generation per unit.

Source: The companies By Robert W. Ahrens, USA TODAY

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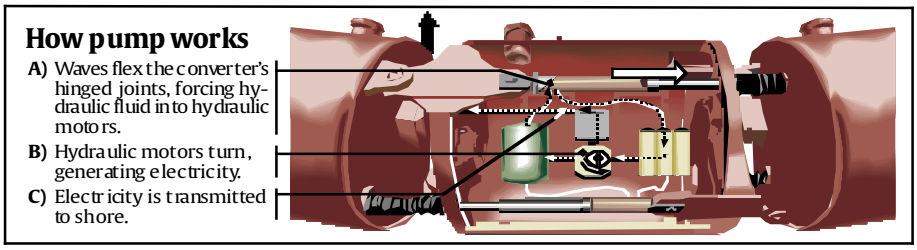

Objectives

Students will:

- Read the article "Catch a wave, throw a switch."
- Analyze the article through discussion.
- Navigate a reputable website for information on renewable energy and its sources.
- Identify and organize information by using a mind map.
- Describe in writing a current renewable energy technology.

Preparation

Each student will need:

- A copy of the article, discussion questions and lesson for "Catch a wave, throw a switch."
- Internet access.

20 minutes – Read and discuss it

In groups of three or four, read the article and discuss the questions.

- Marine power is one of seven types of renewable resources which can be replenished in a short period of time. What advantages does marine power have over wind power, another renewable resource?
- Why have some environmental groups denounced wind power?
- What are the obstacles for wave power?
- The opposite of a renewable resource is fossil fuel which provides energy from limited sources which will eventually dwindle. Three main fossil fuels are coal, oil and natural gas. What products do we use regularly that receive energy from fossil fuel? (Name at least five products.)
- If the world ran out of fossil fuel tomorrow, name three ways your life would be affected.
- How could wave power take away some of our dependence on fossil fuel?

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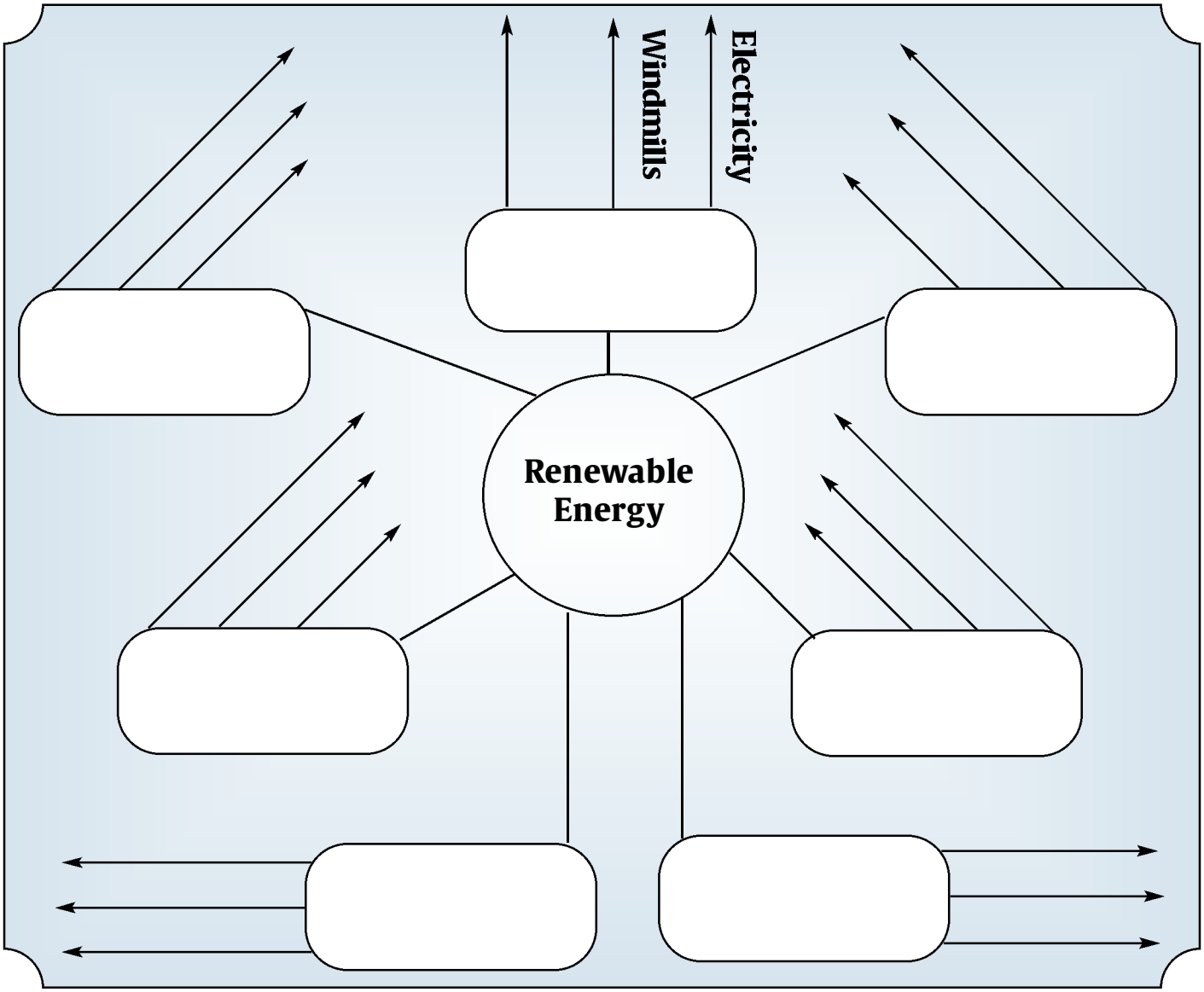
45 minutes – Analyze it: Mindmapping our Renewable Resources

Renewable resources can be replenished in a short amount of time. There are seven renewable energy sources currently being explored and utilized. Go to the National Renewable Energy Laboratory's website(http://www.nrel.gov/learning/re_basics.html) and then list the seven energies below in the rectangles. On the lines attached to the rectangles, list some of the sources of this energy and/or some of the technologies that use it.



10 minutes – Apply it

Of the technologies listed in your mindmap, choose the one technology you consider the most interesting or promising and write a paragraph describing the technology. Include the name of the technology, which power source it utilizes, what the technology does and why you believe it is promising. Be sure to list the limitations of the technology as well as its benefits/advantages. **Be prepared to share this information in class.**