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**Lockheed Martin's Michael Garcia, left, Alan Miller and Ted Rosario look over a model of a pipe developed for capturing ocean thermal energy.**

# OCEAN POWER

## *Hawaii is the incubator for a new source of energy*

**BY KATE GALBRAITH**
New York Times

LOCKHEED MARTIN is best known for building stealth fighters, satellites and other military equipment. But since late 2006 the company has taken on a different kind of enterprise — generating renewable power from the ocean.

The technology is still being developed in the laboratory, but if it succeeds on a large scale, it could eventually become an important tool in the nation's battle against global warming and dependency on foreign oil.

Lockheed and a few other companies are pursuing ocean thermal energy conversion, which uses the difference in temperature between the ocean's warm surface and its chilly depths to generate electricity.

Experts say that the waters off Hawaii and Puerto Rico, as well as near United States military bases on islands like Diego Garcia in the Indian Ocean or Guam in the Pacific, would be good sites for developing this type of energy.

Hawaii and many other islands rely on imported oil to generate most of their electricity, which is expensive, and last year's spikes in oil prices have reinvigorated their search for homegrown alternatives.

"The vagaries of petroleum impact Hawaii far more than any other state," said Theodore Peck, an energy administrator in the state's Department of Business, Economic Development and Tourism. Generating energy from the ocean's temperature variations, he added, is "a natural for Hawaii."

The Navy also is interested in the technology and in the next few months plans to award a contract to explore it, said Whit DeLoach, a spokesman for the Naval Facilities Engineering Command. As of last year, he said, the Navy had spent slightly more than $1 million to research the technology for Diego Garcia.

IN THE APPROACH that Lockheed is pursuing (with another company, Makai Ocean Engineering), the water on the ocean's surface is used to heat a pressurized liquid, usually ammonia, which boils at a temperature slightly below that of warm seawater. That liquid becomes gas, which powers a turbine generator. Cold water is then pumped from the ocean's depths through a giant pipe to condense the gas back into a liquid, and the cycle is repeated.

An important advantage of this method of producing energy is that it could run all the time, unlike solar plants, which cannot work at night, or wind turbines, which stop in calm conditions.

But the technology is expensive and can work in only a limited number of places, like the tropics, where there is a large difference in temperature between the ocean's layers. This excludes many major population centers, although proponents hope that Florida and the Gulf Coast could also be markets. (Other types of ocean energy being explored would harness the tides and waves.)

Meanwhile, Lockheed is developing a test cold-water pipe — to be 13 feet in diameter and 40 feet long — in a laboratory in Sunnyvale, Calif.

Last year, Gov. Linda Lingle of Hawaii announced a partnership between Lockheed and the Industrial Technology Research Institute in Taiwan to build a test plant in Hawaii.

Lockheed says it hopes to obtain financing for the project from the Defense and Energy Departments, as well as from the private sector; if enough is available, the company says it would like to have the platform working by 2013. A Japanese engineering company, Xenesys, is also exploring ocean thermal energy for Cuba and Tahiti, among other countries.

LOCKHEED and the federal government have worked on this type of energy before, after the 1970s oil crises. In 1979, a 50-kilowatt test project was briefly run off the coast of Hawaii's Big Island. Financing for ocean-energy projects was slashed significantly by the Reagan administration, and Lockheed abandoned its pursuit of the technology in the mid-1980s.

Proponents say that since the last attempt to develop it, the technology has improved enormously. Offshore oil platforms similar to the platforms needed for the ocean energy system have become more sophisticated, for example in their ability to withstand hurricanes and to moor in deeper water.

In theory the technology could, among other uses, provide substantial amounts of power to Hawaii and other warm-water sites and also be used in floating power plants making industrial products like ammonia. However, such goals are distant.

Skeptics say that the technology is highly inefficient because it requires large amounts of energy to pump the cold water through the system.

PATRICIA TUMMONS, who edits the newsletter Environment Hawaii, said a major question about the technology was "just how economical it can be."

Robert Varley, who is helping to lead Lockheed's efforts, estimated that just 3.5 percent of the potential energy from the warm water pumped might actually be used. "In reality that doesn't matter — the fuel is free," he said.

But building and operating the platform will be costly. Harry Jackson, the president of Ocees International, an engineering firm based in Honolulu also working on the technology, estimated that a test plant of the size Hawaii is planning — which is still far smaller than commercial scale — would cost $150 million to $250 million.

Some environmental groups are cautiously embracing the technology as one of many approaches that could help reduce fossil fuel consumption and thus combat climate change.

"The environmental impacts associated with it would be probably a lot less than other sorts of power," said Henry Curtis, executive director of Life of the Land, an environmental group in Hawaii.

Still, the technology would not leave its surroundings unscathed. A huge amount of cold water would have to be pumped up from the depths. If that water, which is rich in nutrients, is discharged into a different part of the ocean, it could confuse fish and alter the balance of the ecosystem.

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**Henry Curtis,** *Life of the Land executive director, about ocean thermal energy conversion*