

**Our Ocean Backyard — *Santa Cruz Sentinel* columns by Gary Griggs, Director, Institute of Marine Sciences, UC Santa Cruz.**

**#16 November 22, 2008**

**Wave power—part 1**



*The wave motor built by the Armstrong Brothers was located on the cliff near Natural Bridges.*

There is something about oil and nuclear energy that generates strong reactions. My last two columns--which addressed our remaining petroleum and uranium reserves and the time and costs required to develop those energy sources--produced more emails than any others I've written over the past six months.

The objective of my column is to raise awareness and not to champion a particular point of view. But I don't write the headlines, which may sometimes imply a point of view I did not intend.

After the energy crises of the 1970s had passed, many people lost interest in alternative energy sources. But the recent rise in the price of crude oil and the increased awareness of climate change as a consequence of burning fossil fuels have refocused public attention on the need to develop renewable energy resources. To provide some perspective, renewable sources provided about 18 percent of the energy consumed globally in 2006, but only 7 percent of that used in the United States. In 2007, PG&E, our power provider, delivered 25% of their electricity from renewable sources (13% hydroelectric and 12% renewable).

With the exception of nuclear, geothermal and tidal power, almost every other source of energy being considered today, including fossil fuels, has its origin in the sun. Fossil fuels, whether coal, oil or natural gas, are stored hydrocarbons formed initially through photosynthesis, which means they store ancient or fossil solar energy. Hydroelectric power is produced by capturing stream flow, which is the result of precipitation, which depends on evaporation of water heated by the sun. Waves are generated by wind, which ultimately has its origin in atmospheric pressure differences driven primarily by latitudinal differences in solar heating.

It is important to look carefully at each of these renewable or sustainable sources to understand the nature and magnitude of the energy available and to consider what may be involved in trying to harness any of these sources. I will also try to summarize the progress that has already been made in developing these sources.

Waves are the most obvious manifestation of ocean energy--ask any surfer about the energy in a large wave. The amount of energy moving through the oceans as waves is impressive.

The energy in a wave is proportional to the square of its height. A wave 2 meters high represents an energy flow of about 25 kilowatts (34 horsepower) for each meter of wave front, enough to light 250 100-watt light bulbs; a wave twice as high contains 4 times as much energy. A single wave 1.2 meters high striking the west coast of the United States may release as much as 50 million horsepower. Calculating how much energy is available is the easy part, but how do we harness any of this energy?

The Armstrong brothers, two local entrepreneurs, actually built what has been called a “wave motor” out on West Cliff Drive near Natural Bridges in 1898. One of the two shafts is still visible on the rock terrace below the bike path just south of Chico Avenue, although it now has a large circular concrete cap over it. You can, very carefully, walk down onto the terrace and hear and sometimes feel the wave surge underneath the cap at high tide.

Although the Armstrong brothers didn’t actually generate any power, they did figure out a way to use the energy in waves to pump water. Taking advantage of a cave and perhaps a natural blowhole, they drilled two large-diameter vertical shafts from the cliff top down into the cave. Two 6-foot-diameter, 600-pound pistons were placed in the shafts, and as the waves surged in at high tide, they pushed the pistons up. As the pistons dropped back down under the force of gravity, they pumped seawater up a pipe into a water tank at the top of a derrick.

Following the 1897-1898 drought, tourists who came to Santa Cruz were faced with clouds of choking dust as they took their scenic buggy rides along the cliffs. The Armstrong brothers were hired to solve the problem, and with a tank full of salt water high above the cliffs they were able to pipe the water into horse-drawn water tanks that were used to water down the coastal wagon road. Hardly a solution to our energy needs, but an interesting use of wave power nonetheless.

There are now experimental wave energy plants in Japan, Norway, Britain, Sweden, Russia, and India. Portugal has the first commercial wave power project. Although the first phase is only producing 2.25 megawatts of power--enough to supply 1,500 households--the Portuguese project aims to expand 10-fold over the next several years.

There are now dozens of research firms working on the technology for harnessing wave power, with names like *Pelamis*, *Anaconda*, *IWave*, *Gyrowave*, *Aegir Dynamo*, *Dexa Converter*, *Synchware Power Resonator*, *Wave Blanket* and *Limpet*.

More on harnessing ocean energy in the next column.