From IMAges 7
November 2009

Harnessing the **waves** and tides

New Zealand is rich in potential sources of wave and tidal energy according Margot Gerritsen, who spoke at the NZIMA Energy, Wind and Water programme workshop earlier this year. She discussed her work with Jenny Rankine.

Tory Strait and French Pass in the Marlborough Sounds and the Hokianga and Kaipara Harbours are all potential energy sites, says Gerritsen, a professor in the Department of Energy Resources Engineering at Stanford University in California.

A tidal power generation project has been proposed for the Kaipara, where currents move at up to three metres per second in a deep channel. Full tidal assessments involve radar observations, two-dimensional computer modelling to rank sites, three-dimensional modelling for design optimisation and risk analysis, as well as studies of possible effects on marine life and harbour floors. This has yet to be completed for the other sites.

Gerritsen has helped develop a computer model exploring the impact of tidal turbines, and hopes to extend it to their design. "They look just like a beefed-up wind turbine: the drag and friction forces are much larger in water and so they need to be a lot stronger." Cavitation, the formation and collapse of vapour bubbles in water with pressure changes, is also a problem for tidal turbines.

Gerritsen's computational mathematics has several other applications. She has developed a computer model of coastal erosion, for example the way in which sand in the Kaipara and Hokianga Harbours moves from the harbour to the ever-changing sandbar in the estuary. "I'm also interested in the transport of nutrients, which is very important for fishing. Nutrients may well up from the bottom to the top layers of the sea; this can show fishing boats when they should fish where, and when they should not, because they may be overfishing."

When she worked at the University of Auckland in New Zealand in the late 1990s, Gerritsen used computer modelling to help design spinnakers, mainsails and jibs for Team New Zealand's America's Cup yacht. "It requires a lot of mathematics; like turbine design you need to understand how air flows past a sail." She is now collaborating with international sail making company Doyle Sails and has worked on the unique no-rigging design of the 88m luxury clipper yacht, the *Maltese Falcon*.

Another application is the application of efficient numerical schemes to the recovery of oil from existing fields. "Pumping is not efficient for very long. You can inject carbon dioxide or other gases to increase the pressure in the reservoir, which helps get more oil out. A lot of the oil being produced now is very, very sticky, like peanut butter in the rock, and very hard to extract. One method is to burn some of the oil to heat and "soften" the oil. It's an optimisation problem working out where to inject the gas or where to burn. We build computer models to simulate the flow of gas and oil through the reservoir."

She and more than six other researchers have been working with multinational oilfield services corporation Schlumberger. "We use laboratory experimentation to validate the model. You can mimic a rock using very small glass beads, for example, and observe the flows." The team also uses CT scanners to look inside rock cores from the actual field.

In 2007 Gerritsen started Smart Energy, a podcast blog site that discusses energy issues and policies for the public and policy makers. "A lot of people don't like having new energy systems built close to where they live; NIMBY (not in my back yard) is very strong. It's hard to convince people that we always have to choose between the lesser of several evils, and that energy has to be paid for in different ways."

See also

Gerritsen's blog site - www.smartenergyshow.com

The no-rigging yacht - www.symaltesefalcon.com/about.asp

Top: Wave power buoy. Above: Gerritsen on her Triumph Bonneville with students in her department.

$$P=\left(\frac{15^2 20}{2}\right)=112.5\text{MW}$$

"There is an eternality about math questions, a feeling that you're really getting to the bottom of something." *John Conway*