The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Pelamis: A Shot in the Dark?

Posted by Prof. Goose on June 1, 2006 - 9:32pm
Topic: Alternative energy
Tags: eu, kyoto, pelamis, wave energy [list all tags]

[editor's note, by Prof. Goose] This is a guest post by lads.

Pelamis is a greek word that means sea serpent. I guess it is the best definition for what I was shown today, a metal serpent riding the waves, harvesting its energy.

A presentation of the pilot project was held here at school, directed to the Hydraulic Engineering students, but open to the general public. The speakers were from Enersis, the company promoting this first full materialization of such technology. I couldn't miss it.

What you see in this picture is a cylindrical metal structure with 150 meters long by 3 meters wide; sitting still onshore it resembles a 5 carriege high-speed train. It weights 400 tons, and uses another 300 tons of ballast on the sea floor to keep it in place. It is supposedly the best present technology for harnessing the waves' energy.

Pelamis

Background

Every state of the EU ratified the Kyoto protocol, but only two are now below the emission levels agreed, moreover the majority of the states is increasing or failing to reduce its emissions. This is posing a huge financial problem, especially for smaller states; from 2012 onwards CO_2 credits must be bought, blowing away the budget of these states. This is the main problem that the Enersis folks to compels us to invest heavily on renewable energy. They didn't mention any problems on fossil fuels, but showed some concern with present prices.

A major expansion of renewable energy is therefore needed to minimize the consequences of not complying with Kyoto. But the current forms of renewable energy do not have that expanding potential: the sites for wind energy projects are disappearing (mountain tops are already filled with turbines, and natural reserves also take their toll), geothermal and tidal are also restricted; as for hydroelectric the expansion limits seem already to be reached.

As for the waves they present a vast resource, the restrictions might be way over our needs, this must be the way to go. Moreover larger cities tend to be located in coastal areas, facilitating the connection with the delivery grid. Wave intensity can also be predicted with 4/5 days antecedence, making it easier to accommodate peak output periods to the grid.

At this point they forgot to talk about offshore wind energy; on purpose? I don't know, but the final paragraphs will tell more.

Brief History of Pelamis

It started in 1998 when Ocean Power Delivery Ltd (OPD) was founded in Edimburgh to develop the concept of Pelamis, a Wave Energy Converter (WEC). From then on OPD managed to get funds from venture capital companies, developing at first a 1:7 scale prototype and then moving to a full scale machine that has been under testing in the European Marine Energy Centre in Orkney.

Enersis is a Portuguese renewable energy company, that has been investing in the wind sector since 1998; in 2003 it started considering the hypothesis of wave energy. After some pre-agreements in 2004, in the beginning of 2005 it signed the contract for the first Pelamis production units that will be deployed off Póvoa do Varzim still this year. This project will start with 3 Pelamis units, each with a max production capacity of 750 Kw, totalizing 2250 Kw.

How does it work?

My knowledge of hydraulics and mechanics is very slim, but I'll try to give you an idea.

As usual wave energy is actually solar energy, the sun heats the air masses generating wind, on the oceans the winds cause disturbances on the sea surface originating waves. Waves generated at different parts of the ocean interact with each other adding and creating vast fronts of motion, with immense energy.

Previous ocean WEC projects have failed because of the extreme conditions that can be experienced at high sea. At a site with a mean wave amplitude of 2 meters, waves of 20 meters can be experienced during extreme weather conditions. Pelamis' success comes from the fact of not being designed to maximize energy output, but to survive the high sea fare. The key factor to achieve survival was the concept of the moorings that keep Pelamis in place, rightly oriented to the wave motion; when waves become stronger Pelamis pierces through the wave, avoiding stronger movements.

When a wave passes through Pelamis it "serpents", the 4 sections sway, both horizontally and vertically, this motion actions hydraulic jacks located at the 3 junctions pumping high pressurized oil that put the electric generators at work. This way the pulsating movement of the wave is transformed in a continuous energy flux.

Pelamis sways both horizontally and vertically

Pelamis can be tuned to accommodate the specific conditions of the operating site, maximizing the energy output without compromising the survival of the equipement. This is accomplished by varying the length of each section.

If you want a deeper understanding of this technology please visit the links I furnish below.

Pelamis' Power Convertion Module

The Aguçadoura I Project

Aguçadoura is the name of the nearest village of the deploy site, by so chosen for the name of this pilot project. It is starting with 3 Pelamis units totaling 2250 Kw, and will expand to 5 units sometime in the future. The transportation of these first units to Portugal has begun, as so the final assembling in the shipyards of Peniche, with deployment occurring still this year. These units are tuned to start working at wave heights of 0.6 meters, reaching peak production at 5.5 meters; they are expected to work 2800 hours per year (this is quite close to onshore wind). The life expectancy of Pelamis is somewhat unknown, but 15 years was given as a low estimate (in my view this might be optimistic, we are talking of a semi-submerged steel structure).

This first 3 unit project has a cost of € 8.5 million (to get a better idea a 3000 Kw wind turbine costs here around € 1.2 million - at this point my red light started flashing). The electricity produced by this project will cost the triple of current energy produced in Wind farms (I don't see how this can be so low from the previous numbers).

It seems that other companies are watching closely this project, if it succeeds, you may see Pelamis wave farms in the North Sea (UK and Holland), California or Australia.

Enersis is already planning the Aguçadoura II project, a wave farm with a total of 38 Pelamis. Once Aguçadoura II is operational Pelamis will become fully commercial. From this point on, Enersis expects a period of 7 to 10 years of refinement and development that will lead the monetary costs of the energy produced to the levels of Wind energy.

Future development focus on using materials other than steel, resistant to corrosion (in this chapter seagulls are a headache), and on increasing power capacity. Pelamis with 1000 Kw are being designed, and 2000 Kw can be possible; this is achieved by increasing the length of the Pelamis, but wavelength will put a limit to that.

Conclusions

To start my conclusions I will write here my interaction with the Enersis technician that made the technical presentation, during the Q&A session:

Q: What is the Energy Profit Ratio (EPR) of a project like this?

A: I don't know, I have never done that kind of accounting, but adding the costs of materials, production, paint, etc, I can say it's pretty high, like that of Wind.

Q: Offshore wind energy seems to be bound to EPR figures near those of Uranium. Now imagine I win the Euromillions and I want to invest, what will make me choose Pelamis instead of an Offshore Wind project?

A: Look, I think EPR is a very bad way to evaluate an energy project because of the immense market distortions we have right now...

The guy then started talking about coal, and how the price of electricity from coal at the power plant was half of that at the grid end. He suddenly started talking to someone else, and avoided me thereafter. The room was emptying, I left.

First Conclusion: these guys don't have a clue of what EPR Pelamis has (I also doubt they have a clue of what EPR is).

This project is a *Shot In The Dark*, like Ozzy says. It has a lot of engineering to it and at first sight it might seem to have a bright future, but EPR must be know in order to evaluate it against similar projects. We must not forget that waves are raised by the wind; wave energy will mostly be redundant to offshore wind energy. This is enforced by comments made by the Enersis people indicating that the southern portuguese coast wasn't useful for wave farms - this is where the wind blows weaker in the western european coast. Since we live in a finite resource world we should use those resources the best way possible.

There are of course different characteristics to wave energy, you can yield waves form winds hundreds of miles way (the highest waves that reach Europe's west coast are formed in the North Atlantic), also wave motion is somewhat smoother than wind, which tens to blow in bursts. But still the intermittent characteristics prevail.

I believe we should wait for the Aguçadoura II to be completed to take final conclusions, by that time Offshore Wind will also be more mature, making comparisons easier. This kind of project should be take forward only if its EPR is above that of Wind Energy. If the EPR of Pelamis is found to be over 1 it can be considered only in situations where Wind energy cannot be directly yielded.

To know more:

Ocean Power Delivery

Slideshow (I strongly recommend this one)

Interactive Model

Videos

Wikipedia

Thanks once again to the TOD editing team for letting me share my views with the oil drummers.