Energy innovation into a headwind

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The public authorities in Japan are putting all their efforts into establishing a new industry based on floating offshore wind turbines. In Norway we have already developed the technology they need. So

researchers are asking why Norway isn't making the same efforts here at home.

Groups of well-dressed men and women are swarming inside an enormous exhibition centre in Stavanger. Together, they represent the backbone of the Norwegian economy. They possess know-how which is exported all over the world. Outside, taxi drivers are waiting with the broadest smiles they will have this year, and Sola airport is setting new records in the number passengers cleared every half-hour through security. The ONS oil and energy exhibition and conference is underway.

From Fukushima to Forus

In a small auditorium deep in the heart of one of the exhibition halls, an unassuming Japanese professor in a slightly over-sized suit is speaking in hushed tones into a crackling microphone. He is talking about something very different from oil. He describes the typhoon which had only recently ravaged the seas offshore the melted-down nuclear reactor at Fukushima – an event which had almost prevented him from travelling to Stavanger. And about how he will create a green industry based on the know-how derived from the Norwegian offshore industry combined with the forces contained in the typhoon. He is talking about floating wind turbines. His audience appears to consist of a school class, a small group of wind power enthusiasts, and a casual journalist.

The gently-spoken but assertive Japanese professor is Tomoaki Utsunomiya from the University of Kyoto. He and his team have recently constructed, tested and assembled a floating wind turbine located off the east coast of Japan which is now generating 100 kW. And all in just 18 months. His team have achieved this with a combination of political will and technological investment. Following the Fukushima disaster, nuclear energy no longer represents a realistic option for

electricity generation in Japan. The authorities are planning to scale up the turbines and establish their own industry involving several floating wind farms located along the coast in areas where wind can provide enough energy to entirely replace Fukushima's nuclear generation capacity.

This is wonderful news for Norwegian wind power enthusiasts. However, at the same time our own politicians behave as though they are entirely satisfied with the high levels of production of green energy Norway generates from hydropower.

Norway has the technology

Wind energy researcher John Olav Giæver Tande is sitting in his office in Gløshaugen, Trondheim's very own technology think tank. He is a Director at the NOWITECH Research Centre, coordinating our own Norwegian efforts to develop offshore wind power.

He is full of praise for the Japanese efforts to develop giant floating wind turbines designed to generate electricity from wind blowing across the world's oceans. He is also calling for political action to promote similar efforts here in Norway.

The reason for this is that Norwegian technologists already possess the know-how which the Japanese are currently working so hard to develop. We have the world's most advanced offshore oil and gas industry, combined with global expertise in the field of maritime operations. In 2009 Hydro and Statoil installed "Hywind" – the world's first full-scale wind turbine in the sea off the island of Karmøy. This turbine has surprised technologists by generating more energy than anticipated. It also continued to operate at full capacity even during the Dagmar hurricane which ravaged the Norwegian coast in December 2011. Statoil is currently planning a pilot wind farm, based on Hywind project

technology, consisting of between three and six offshore turbines.

"We have the know-how", says Tande, "and because we have the Norwegian Petroleum Fund at our disposal are in the unique position of possessing the resources to put this knowledge to good use", he adds. "Norwegian politicians should now be recognising their opportunity to assist us in creating a new export industry linked to offshore wind technology. We are already one step ahead of the Japanese, and have a chance to grab an important share of tomorrow's market" says Tande.

The enormous force of new knowledge

In the space of just four years, Trondheim's research centres have produced tremendous results in the field of offshore wind technology, not only in relation to specific technological solutions, but also simulation tools aimed at providing increasingly accurate computational data. Research is being carried out into models, materials, substructures, grid hook-ups, and the operations and control systems of our future floating wind turbines. Furthermore, the centres have established an educational programme for researchers which has attracted attention throughout Europe.

"At the moment we have about 50 students working on their PhDs in the field of wind energy", says Tande. "Education is the key to any future success. No education, no innovation", he adds.

One of the most important challenges in the field of wind energy is to reduce costs.

"It's no secret that floating wind turbines are expensive", says Tande. "But we believe it is possible to make such wind farms profitable in the long term", he adds. "This is why our research is targeted at reducing costs. All our efforts are dedicated to developing new and innovative

solutions. An important starting point in this work is the reference turbine we have developed".

"It is a pure simulation model, and functions as a complete description of a large-scale wind turbine. Researchers can use the model as a platform for testing a variety of new designs, including those for rotor blades, generators, substructures and control systems", says Tande. "The next step is to carry out full scale physical tests of these innovations", he says.

"Our researchers have now received funding from the Research Council of Norway to establish a small floating test turbine, and we are planning to have this installed at a location offshore Mid-Norway during 2014.

We are very pleased to have received this funding, and the turbine will provide us with a research infrastructure unique in the world", says Tande.

Positive growth

To date, offshore wind power has seen only relatively low levels of development compared with the onshore sector. However, the industry is enjoying rapid growth. Europe is leading the way with plans to increase current offshore production capacities of 4 GW to 40 GW (gigawatts) by 2020, and aims to achieve as much as 150 GW by 2030. This represents an annual production of about 500 TWh, corresponding to four times Norway's electricity consumption.

"We have good reason to believe that accomplishing the last great leap will require power from floating turbines operating in deep water far out at sea", says Tande. "Added to this will be major contributions from China, Japan, Korea and the USA", he says. He also believes that Norwegians have more than enough reasons to invest in the development of climate-friendly technology.

"We have become experts at boasting about producing the 125 TWh of electricity Norway consumes in the form of environmentally-friendly hydropower", says Tande. "But we mustn't forget that each year we export 2500 TWh of fossil energy to other countries. This should also be included on the other side of the climate ledger", he adds.

It costs less to pollute in Europe

However, the fly in the ointment for all those aiming to generate more energy from renewables is the quota system which forms the basis of European climate policy. A European directive requires Norway to increase its energy production from renewables by almost 10 per cent by 2020.

"Of course, if we replace fossil energy with renewables, this will reduce our CO2 emissions. It's as simple as that", says Tande. "The quota system was intended to assist in achieving this.

However, current low quota prices make it look as though the best has become the enemy of the good", he adds. "The quota system has ended up making investment in renewable energy options unprofitable in techno-economic terms", says Tande.

He goes on to explain. "The system is rooted on a fixed number of quotas – that is, a stipulated volume of emissions. One quota is equivalent to one tonne of CO2. If this emissions volume is reduced, the quota price falls. It is just like a sale of goods. In simple terms we can compare the quotas to 100 cartons of milk. If a lot of milk consumers choose to drink water instead, milk producers are left with a surplus. The shopkeeper then has to reduce the price of milk in order to sell it. In other words, the milk will continue to be produced and then sold at spot price for as long as there are still customers willing to buy it".

He continues. "When we look at this in terms of energy, it means that all green energy producers entering the market are effectively contributing to bringing down quota prices. This is true even if they have in fact supplied the additional energy which the EU is asking for".

"The answer is simple", says Tande. "Politicians must reduce the number of quotas available in order to make it expensive to pollute", he adds. "Such a proposal was recently put before the EU Parliament, but unfortunately it was voted down. Nevertheless, I remain confident that a solution will be found. Otherwise the situation will become too ridiculous", he says.

Cicero Strategy Director Knut Alfven agrees with Tande in many respects.

"The problem is not that we have quotas", says Alfsen. "But that we have too many of them".

He believes that we are setting our sights too low when it comes to reducing emissions, and that the current quota system is holding progress back.

"Our lack of ambition is a consequence of a failure to coordinate our energy policy measures on a global scale", he says. "Taken together with recent economic downturns, this has contributed to very low European quota prices", he adds. "Such low prices, added to major uncertainties and the future regulation of climate gas emissions in Europe and elsewhere, hold back investment in innovative low carbon technologies, including offshore turbine systems", says Alfsen.

He believes that we must look at new options when it comes to our future international climate agreements. According to Alfsen, such agreements are essential for building a foundation for research,

development and the implementation of "green solutions". He believes that Norway's emissions reduction measures lack ambition and that the current quota system is holding progress back.

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Electrify the Norwegian shelf

In contrast, major investment is being made in renewable energy in Japan – and entirely independently of quota systems. Plans are underway for an offshore wind farm to replace the reactor at Fukushima as a producer of electricity. Japan has taken opened the door to a new era, stipulating a high and fixed price for all electricity, regardless of whether the source is coal or wind power.

In Norway, however, neither any shortage of power we may have, nor our political will, are great enough to force electricity prices up. If we are to succeed in building an industry based on floating wind turbines, we must find other ways of achieving it. One idea is to use the turbines to electrify the offshore oil and gas sector – letting the oil industry, which has grown fat on the back of fossil fuels, pay for the development of a new renewable industry.

The man behind this proposal is Magnus Korpås. He is a Research Director at SINTEF, and an expert on the energy market and the integration of new energy sources into existing distribution systems. He believes that floating wind farms are just what the oil industry needs to

make it more environmentally friendly. The key here is electrification.

"It is very likely that CO2 emissions from the Norwegian shelf will increase in the years to come unless we do something about it", says Korpås. If Norway is to achieve anything approaching climate-friendly status, we have to reduce our domestic emissions volumes. Everyone knows that the offshore sector has to take this seriously", he adds.

Energy-consuming oil production

The reason for this is that many fields currently in production require increasing amounts of energy to maintain production. They are located further out to sea, in deeper waters, and often require so-called "pressure support" – energy which they consume to maintain well stability during production. The solution is for Norway either to buy its way out of the problem by purchasing quotas, or to take effective action.

"I am in no doubt that the smartest thing to do is really tackle the problem itself", says Korpås.

The medicine he prescribes involves using floating wind turbines to supply oil platforms with their green electricity requirements. Moreover, any surplus energy from the wind farms can be transferred onshore via cables for use as a reserve source when the wind isn't blowing.

"In this way, each platform will become a producer of green energy. This will reduce both offshore sector CO2 emissions and increase our levels of green energy production", says Korpås.

According to Korpås, the majority of our platforms are located in areas ideally suited to the installation of floating wind turbines when it comes to both water depth and wind conditions. A powerful symbiosis, you might say", he adds.

Achieving this won't be easy. However, according to computations taken from a study completed by Sintef Energy Research for the northern North Sea, it is an entirely realistic proposition in the long term. The figures show that oil and gas platforms could represent an important initial market for electricity produced from floating wind turbines.

The best of both worlds

The office of marine resource researcher Arne Fredheim is just a stone's throw or two from Rockheim, Trondheim's museum of popular music. He is currently working on another aspect of the wind turbine story – plans for a project he calls AquaWind. His vision rocks almost as much as the museum's futuristic chameleon facade.

"Once you have set aside a large area of ocean for the installation of a wind farm, we believe you can also exploit such areas for other purposes", he says. "What could be more natural than to start thinking in terms of marine resource exploitation?", he says.

This suggestion appears to run contrary to efforts made so far by the Japanese and other countries in connection with offshore wind farms. There have been massive protests from professional fishermen who work in the areas where wind farms are now being installed. But according to Fredheim there is no need for any conflict.

"Those of us working on such proposals are neither for nor against marine resource exploitation in and around offshore wind farms", he says. "Our job is to demonstrate what is possible in terms of technology. And that is quite a lot, even in the short term", he adds.

Artificial habitats

One of AquaWind's plans is to build artificial reefs in locations where floating turbines have been installed. An artificial reef can act as a habitat for various species such as seaweeds and shellfish. This in turn will provide excellent living conditions for spawn from a variety of species, and act as a basis for promoting population growth and diversity.

"The idea of creating artificial reefs is not new", says Fredheim. "Both the Japanese and Koreans have previous experience with this idea", he says. "What is new is the creation of such reefs in and around wind farms", he says.

It may be possible to exploit of the enormous turbine anchor lines as foundations for the cultivation of seaweeds and shellfish. This will represent an ideal environment for many species, including fish. However, the opposite may be true for the fishermen, who will be required to keep their distance from the giant turbines.

"However, as we all know fish swim all over the sea, and it might be possible that fishing in such areas could be favourable. Or perhaps the opposite will be the case? Fish may learn that they will be relatively safe in these areas, and will therefore be attracted to life in around the turbines", says Fredheim.

New fisheries technology

Even if floating wind farms represent a risk to the fishermen, researchers believe that it will be possible to develop special vessels which will allow fishing to take place in these environments. The same applies to fishing gear. By developing customised gear – pots and suchlike – fishing may be entirely possible in such areas.

"Another possibility is to exploit the areas below the turbines for aquaculture", says Fredheim. "Not necessarily for fish, but perhaps for

the cultivation of other benthic species. Both lobsters and shellfish can be cultivated provided we develop the right gear", he says.

From Trondheim to Tokyo

Outside the Norwegian embassy in Tokyo, the cherry trees are in full bloom. Per Christer Lund at Innovation Norway works here as an energy advisor, specialising in technology transfer and networking. Over the phone he told Gemini the following;

"The proof of the pudding is in the eating. Norway has demonstrated that it is a world leader in the construction of floating installations designed to withstand extreme marine weather conditions", he says. "The Japanese are keeping a close eye on developments in Norway, and this is a big issue for those of us working to promote Norwegian technology here in Japan. We have to broaden our horizons and adopt a global view", he says. "There is a big market for renewable energy out there, and we already have the technology", says Lund.

Provided by SINTEF