



New in Norway: floating wind turbines

| by Annemieke van Roekel

Compared to other European countries, Norway has very little installed wind power capacity. But this is about to change. Two different prototypes of a floating wind turbine will soon be tested in the North Sea, off the south-west coast. Near the island of Utsira a consortium of companies want to build Europe's first floating wind park.

Although large scale development of offshore wind parks in Europe has yet to begin, expectations are high for the next decade. By the end of 2007, Europe had around 1,100MW of installed offshore wind capacity in five countries: Denmark, UK, the Netherlands, Sweden and Ireland. This is expected to grow to 20,000MW by 2020.

The North Sea is regarded as a favourable region for offshore wind parks in Europe. High wind speeds create conditions where more kilowatts can be generated in comparison to onshore parks. If the wind speed doubles, electricity production increases eightfold.

At the same time, weather and wave conditions on the North Sea are rough, especially during the winter. Along the Norwegian North Sea coast, average wind velocity of 10 metres per second and waves more than 5 metres high are not unusual.

Norway has another problem as well: it has vast deep sea areas, and not much shallow water. That's why the country is now developing deep-water wind technology. There is an advantage to wind parks in deep water: they can hardly be seen from the shore, so there is less public resistance.

The Norwegian wind power company Sway is taking on the multiple challenges of developing offshore wind power in Norway. It is creating windmills that can float on strong waves and tidal currents. 'Our calculations show that a floating system is cheaper compared to a construction that is built directly on the sea floor,' Eystein Borgen, chief executive of Sway, says. 'The forces acting upon floating anchor systems are not as strong in comparison to those acting on steady constructions, as the water provides much of the stability.' Sway has patented a floating wind turbine concept that is now being tested in a Dutch wind laboratory. Borgen expects one 5MW prototype to be operational in 2010. A final decision from the authorities about this pilot is expected around the summer of 2008. Sway will invest around €30 million in realising the prototype.

Empty bottle |

The principle of Sway's floating wind turbine concept can be compared to an empty bottle with a layer of sand at the bottom, Borgen explains. The floating tower is hollow and contains a heavy mass of rock in the base. The tower measures 186 metres, of which 96 metres are below the surface. A tension leg connecting the tower to the anchor allows the system to rotate. Unlike a conventional windmill, the rotor is placed on the leeward side of the tower. Water depths of 300 metres or more are suitable for the Sway system.

Sway plans to use a 5MW turbine to go on top of the floating mast; the rotor has a diameter of about 120 metres and if wind speeds exceed 25 metres per second the rotor is automatically turned off. While 5MW doesn't seem a modest choice for North Sea conditions, Borgen says that 'the harsh wave conditions demand a heavy design for the tower anyhow, so from an economic perspective we might as well use a powerful turbine'.

Another prototype of a floating wind park is developed by StatoilHydro and the concept has been tested in a laboratory in Trondheim. This 5MW Hywind prototype may soon be tested in the North Sea near Karmøy Island, between Stavanger and Haugesund. 'By developing floating wind turbines, we can make use of our knowledge from the oil and gas industry,' Øistein Johannessen of StatoilHydro says. 'By combing the well known Spar technology (a type of sea-based oil platform with a heavy counterweight at the bottom, ed.) with wind turbines, we hope to be able to develop wind turbines that can operate in water depths of up to 700 metres. There are still major technical and commercial challenges that have to be solved.' An investment decision for the pilot is expected in 2008, and the Norwegian state has, through Enova, granted about €7 million (59 million Norwegian kroner) for a planned pilot demonstration. Enova, which is part of the Norwegian Ministry of Petroleum and Energy, has as its main mission to achieve national energy policy goals by way of financial incentives.



Windmills on Utsira

The Norwegian telecommunication and power generating company Lyse wants to use floating windmills to realise a 25MW demonstration farm south-east of the island of Utsira. This tiny island is located 15 kilometres from the Norwegian south-western coast and can only be reached by a 1.5 hour boat trip from the marine town of Haugesund. 'Our choice largely depends on the technical results of the two prototypes,' Tore Tagholdt, senior wind advisor at

The mayor of Utsira has not seen one dead bird yet

Lyse, says. The 25MW wind park should be built around 2012. Tagholdt stresses the long-term planning that is involved in this kind of project. Lyse asked for a concession and is now waiting for permission from the Norwegian Department for Water and Wind Resources to carry out a technical and environmental study. Costs for infrastructure, including a transformer station on Utsira and a high voltage cable from Utsira to the mainland, amount to €6-8 million (50-70 million Norwegian kroner).

Lyse, which is owned by 16 municipalities and specialises in telecommunication and hydro-electric power production (accounting for 6% of Norway's total electricity production), also has plans for a large-scale follow-up of a floating wind park at another deep-sea location, 17km west from Utsira. In about ten years, the 56 floating windmills would have a total installed power capacity of 280MW. Another plan to realise a traditional 1000MW offshore wind park near the border with Denmark was recently announced by Lyse. 'This southern North Sea wind power plant is located in an area with water depths of around 60 metres, where the windmills will be built on the sea floor. We also investigated the possibilities for a traditional offshore park north of Utsira but the sea floor turned out to be too rocky,' Tagholdt says.

Lyse's onshore plans for wind parks, all located in southwest Norway, amount to 600MW. Norway had 333MW of installed wind power capacity by the end of 2007.

Cheap hydropower |

The reason why Norway is behind the rest of Europe in realising wind parks has to do with the abundant and cheap hydropower available in the country. A few dozen national energy companies produce almost 99% of the country's electricity, almost all of it hydropower. Electricity prices are low for households as well as companies. However, subsidised power may come to an end due to pressure from the European Union. Although Norway is not a member, they have to comply with certain rules in order to guarantee trade and small Norwegian communities are already feeling the effects. As the government has to increase the rates for electricity, some big consumers, such as metal companies, are moving to other countries where the electricity rates remain low, like Iceland.

Norway imports only a small fraction of its electricity from other European countries, such as Germany. 'Norway prefers not to import electricity, especially not when it is produced in coal power plants. This is one of the reasons to start developing wind parks. Wind electricity could also be interesting as we can export it to surrounding countries,' says Tagholt. It all comes down to finance. At the moment, Norway doesn't use its own gas power plant near Haugesund due to cheap import fees for electricity and high gas prices.

Consequently, one of the first wind parks in Norway, built in 2002 on the island of Havøygavlen, north-east of Hammerfest in Finnmark county, wouldn't have been realised without foreign investments from the Dutch energy company Nuon. Norwegian energy companies involved

By 2010 oil heaters will be forbidden throughout Norway

in the 40MW project in Finnmark were Norsk Miljøkraft and Norsk Hydro, which merged with Statoil in 2007 to StatoilHydro. The 45 million wind park was partly financed within the system of green certificates. The phasing out of this tax incentive on renewables, along with Nuon's strategic decision to concentrate its core activities in three countries (the Netherlands, Germany and Belgium), was behind the company's decision to sell most of its foreign wind parks, including the one in Finnmark, a spokeswoman from Nuon confirms. To date, Nuon owns one 108MW offshore park near the Dutch coast and is investigating more offshore options. One of the main reasons for Nuon to invest in offshore wind power is the high kWh production compared to onshore locations.

The main obstruction to building in this busy part of the North Sea is shipping safety. Wind parks could impede navigation and affect radar. In addition, some Norwegian wind parks have had an adverse effect on wildlife, particularly eagles. Wind parks therefore have to be severely tested before they can be built.

But the mayor of Utsira, Jarle Nilsen, hasn't seen one dead bird yet near the onshore wind-hydrogen park on his island. As for Utsira's inhabitants, wind energy is not a new phenomenon. A few years ago, an innovative wind-hydrogen test facility was built on the island, which combines wind power and production of hydrogen gas from the surplus electricity produced.

The combination of wind as a renewable energy source and hydrogen as an energy carrier makes it possible for isolated communities to function independently of a grid connection at zero-emission level. That's why other communities in the North Sea area are considering copying the concept that is being tested on Utsira. Using hydrogen also solves the problem of the instability of wind and the lack of power produced when wind speed drops.



The StatoilHydro hydrogen plant at Utsira.



Ten households |

On the ferry to Utsira, passengers can see the two 600kW Enercon wind turbines rise up from the rocky, desolate north-eastern part of the island. StatoilHydro is the owner of the plant, consisting of two windmills, a water electrolyser that produces hydrogen and oxygen, and a fuel cell and gas engine that convert electricity back from hydrogen when wind power is insufficient. At optimum performance, the electricity generated by the wind turbines would theoretically be enough for all 240 inhabitants of Utsira. In practice, one windmill delivers electricity to ten households isolated in an autonomous grid; the other windmill delivers straight to the ordinary grid.

A maximum of 12 cubic metres of hydrogen are stored in a pressure vessel at 200 bars, sufficient for two days of electricity consumption for the ten households. The fuel cell produces 10kW, but most electricity from hydrogen is produced by the ICE gas generator that has been specially adapted for the use of hydrogen gas. The two wind turbines are well adapted to the high wind levels on the island and can stand wind velocities up till 32 metres per second. Over 26 metres per second, the blades automatically adapt their position to catch less wind, but they still produce power. Over 32 metres per second, when hurricane levels are reached, the system switches off and the blades completely turn out of the wind.

The mayor hopes the floating wind park near Utsira's coast will be approved of by the Norwegian national authorities. 'We have received positive responses from the people involved,' Tagholdt says. 'Local fishermen don't see the floating wind park as a threat as the importance of the fishing grounds in this area has been slowly decreasing. That the five wind turbines south-east of Utsira will be visible from the island could even increase social acceptance as it might be an interesting tourist attraction.'

The plans for a floating wind park are compatible with the mayor's dreams to make Utsira one of the first zero-emission communities in Norway by 2020. Norway's smallest community is now investigating the possibilities and hopes to make a decision this summer. 'A zero-emission island would make some historical sense too, as Utsira is the oldest meteorological station in Norway. The average temperature has risen two degrees since 1868, when the weather was first monitored here. One of our main challenges to cut emissions would be transport: the car park, farmer's tractors and the ferry. We could possibly use the hydrogen that is produced by the wind turbine on our island as a fuel for hybrid cars. These types of cars would fit perfectly here as the speed limit on all Utsira's roads is 30kph and the engine in that case would only use electricity and no fossil fuels,' Nilsen says.

Heating would also fit in the community's sustainable plans, although it wouldn't be easy as electric heating is common and prices are low. By 2010, oil heaters will be forbidden throughout Norway. On Utsira, quite a few households already make use of heat pumps, which extracts heat from the ground or open water. 'We would like to be a demonstration island for new technologies to show to the other 400 Norwegian communities the possibilities of low-energy options,' Nilsen adds. Utsira is Norway's smallest community, but, as it seems, not with the smallest ambitions. ■



A worker of StatoilHydro checks the meters inside the Utsira hydrogen plant.