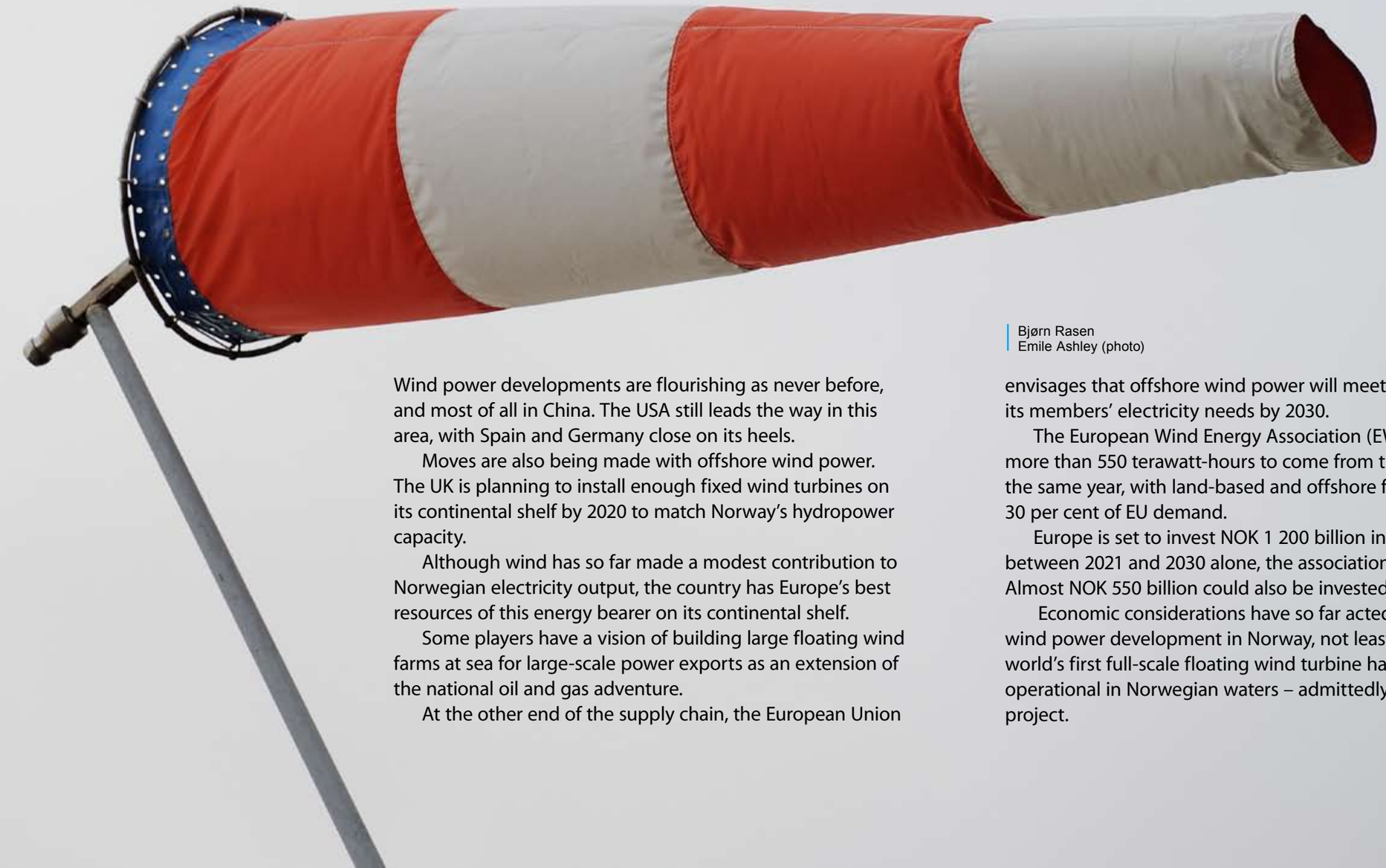
THE WAY THE WIND IS BLOWING



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Emile Ashley (photo)

Wind power developments are flourishing as never before, and most of all in China. The USA still leads the way in this area, with Spain and Germany close on its heels.

Moves are also being made with offshore wind power. The UK is planning to install enough fixed wind turbines on its continental shelf by 2020 to match Norway's hydropower capacity.

Although wind has so far made a modest contribution to Norwegian electricity output, the country has Europe's best resources of this energy bearer on its continental shelf.

Some players have a vision of building large floating wind farms at sea for large-scale power exports as an extension of the national oil and gas adventure.

At the other end of the supply chain, the European Union envisages that offshore wind power will meet 17 per cent of its members' electricity needs by 2030.

The European Wind Energy Association (EWEA) expects more than 550 terawatt-hours to come from this source in the same year, with land-based and offshore farms meeting 30 per cent of EU demand.

Europe is set to invest NOK 1 200 billion in wind power between 2021 and 2030 alone, the association estimates. Almost NOK 550 billion could also be invested in 2011-20.

Economic considerations have so far acted as a brake on wind power development in Norway, not least offshore. The world's first full-scale floating wind turbine has now become operational in Norwegian waters – admittedly as a pilot project.

- Norway's output of primary energy sources consists mainly of hydropower and petroleum. Oil and gas account for 90 per cent of the energy volume, according to Statistics Norway (SSB).
- Annual Norwegian hydropower output lies close to 120 TWh. That meets some 50 per cent of total national energy consumption, the SSB reports. Total theoretical hydropower generation is estimated at 600 TWh by the Norwegian Water Resources and Energy Directorate (NVE), with the realistic potential put at 205 TWh.
- According to the state-owned Enova company, Norway's offshore wind power potential is 14 000 TWh. But Sintef and the Norwegian University of Science and Technology (NTNU) say the realistic annual figure – in 20-25 years from now – is 25 TWh.
  The latter figure corresponds to energy consumption by installations on the NCS. Scientists believe it could quadruple to 100 TWh by 2050, the year Norway is officially due to be carbon neutral.

NO CHEAP OPTION ⇨

NAILING DOWN THE ANSWERS

A number of technical hindrances lie astride the road leading from the world's first full-scale floating wind turbine to large wind farms far out to sea.

Photo: Øyvind Hagen, Statoil

How do you get a nail to stand upright on the open sea? This question is posed in the latest issue of *Gemini*, a magazine from Norway's Sintef research institute in Trondheim.

It is intended to illustrates the problems associated with installing floating wind turbines some distance from land in tough conditions of wind, wave and salt spray.

These challenges and the way such units are to be maintained have been studied by a team from Sintef and the Norwegian University of Science and Technology (NTNU).

The "nail" in this case is pounded by waves as it bobs up and down, and carries a head weighing several hundred tonnes with a propeller attached which rotates and swings in the wind.

Questions the scientists want to find good answers to include how they can prevent the technology rusting away under the impact of the salt water, which gets in everywhere.

Weight

One solution being studied by Chapdrive, which has developed a system for hydraulic power transmission in wind turbines, involves halving the weight of the nacelle housing the machinery.

The technological hurdles facing future floating turbines are different from those for the wind power units placed in shallow water closer to the coast. These are basically land turbines installed in the sea, and have been designed for dry conditions rather than the salt spray of a turbulent sea.

The Sintef/NTNU scientists also point to the challenge of stabilising a turbine mounted on a floater. Gusts of wind striking the rotors out at sea create much wear and tear.

Another unclarified issue is how the turbine tower will behave when wind and current pull in different directions. Nor have any of the questions related to actual installation in stormy seas been resolved.

Expensive

Once a turbine is in place, people must be able to board it for maintenance and repair. A helideck like those found on petroleum platforms could be too expensive.

But access via ship also poses clear challenges and means a greater share of planned maintenance must be done in weather windows. That in turn demands careful monitoring from land.

Using satellite transmission for remote diagnosis is mentioned as a possible solution, but would require the development of technology for building robust and stable turbines.

Last but not least, getting the power to shore requires the construction of a cost-effective infrastructure for the transmission cables.

The Sintef/NTNU team emphasis the need to see the NCS as a whole. That calls for coordination with possible electricity deliveries to petroleum installations and new cables to Norway, the UK or continental Europe.

A completely new grid of the type involved here could take several decades to build. And a national effort would be required for Norway to become a major exporter of offshore wind power.

That includes the development of a licensing system and the production of zoning plans for wind farms.

Hywind

Statoil's Hywind project, the world's first full-scale floating wind turbine, represents a first cautious step in that direction.

This pilot project became operational north-west of Stavanger in September in order to test the impact of wind and wave forces on the structure.

Hywind combines known wind power and petroleum technologies, and the long-term aim is to install turbines further out to sea where the wind potential will be much greater than near the coast.

In a longer perspective, Statoil is hoping to reduce costs so that floating wind power can be competitive in the energy market.

This structure comprises a steel cylinder filled with ballast, which has a draft of 100 metres and is attached to the seabed by three mooring lines. The tower extends 80 metres above the sea.

Statoil is investing about NOK 400 million in Hywind, which will deliver power through a transmission cable to a local grid operator.

The project has received roughly NOK 60 million in support from Enova, the state-owned Norwegian company charged with promoting greater use of renewable energy. ❇

NO CHEAP OPTION

Offshore wind power is not economically viable – at least for the moment.

Harnessing one megawatt of wind power is currently twice as expensive on the NCS as in a land-based development.

The Lyse study (see box) puts the cost of offshore wind power at NOK 38-64 million per MW. That compares with an estimated NOK 14 million on land.

Generally speaking, it would cost about 30-35 million per MW to develop offshore wind power on the NCS compared with a land-based price of NOK 15 million.

Lyse's calculations also indicate that offshore costs will be three times those on land when the necessary investment in platform modifications is included.

"It's not economic to develop offshore wind power today," says Mette Kristine Kanestrøm, manager for this activity at Lyse Produksjon. "We'll need subsidies to get started in Norway, but developments should become viable in the longer term."

She adds that the financial challenge has increased in recent years because costs in general have risen by 20-30 per cent.

The Norwegian government wants NCS installations to get more of their power from shore or offshore wind farms. Most of them obtain their electricity today from diesel or gas turbines.

Lyse has based its study on 11 fixed wind turbines located in 70 metres of water close to the Ula, Gyda and Ekofisk fields. This case envisages the use of five-MW wind turbines to supplement gas-fired power generated directly on the installations.

"Five MW is the realistic level with today's technology," explains Ms Kanestrøm. "Installing more powerful units would boost the cost per MW."

Winds in this area have an average speed of 10.7 metres per second and blow fairly constantly. The turbines would stand still only a few days of the year.

Lyse believes that its 11 proposed units could realistically supply the three fields mentioned above with 40-45 per cent of their power needs.

The utility estimates that the annual climate benefit would be a cut of 120 000 tonnes in the 490 000 tonnes of carbon dioxide emitted today by the gas turbines on Ula, Gyda and Ekofisk.

Developing one MW without having to put in a cable to land is expected to cost NOK 49 million, including necessary modifications on the installations.

Put another way, it would cost NOK 2.5 billion to reduce carbon emissions from these three fields by 25 per cent.

Lyse has also looked at a solution where gas turbines on the installations are removed. That could be achieved with a 30-unit wind farm and a cable from land to supply power in calm periods.

In this case, the price tag would be NOK 64 million per MW when developed and an overall capital expenditure of almost NOK 10 billion.

A final example involves 175 wind turbines and cables to send surplus electricity to land. That cuts the price per MW to NOK 38 million, but the investment would be more than NOK 33 billion.

"The most realistic option for getting started is to install isolated generating units on the NCS without transmission cables to land," concludes Ms Kanestrøm.

"Possible links between land and turbines must be dimensioned for later expansion. And if we're going to make a big commitment offshore, we should also think of export cables to other countries. ❇

The feasibility of installing wind turbines on parts of the NCS to cut greenhouse gas emissions and their cost has been studied by power utility Lyse for the NPD. This work forms part of the Climate Cure 2020 report, which includes a discussion of new or amended policy instruments in Norwegian climate policy. Particular attention is paid to measures which can help to meet the goal of reducing annual emissions by 15-17 million tonnes up to 2020. Read more (in Norwegian only) at *www.klimakur2020.no*.

MAKING HASTE SLOWLY

Things take time, says Lyse chief executive Eimund Nygaard, and does not believe that offshore wind power will be available on a large scale until after 2020.

He draws comparisons with the petroleum industry when describing the process leading up to wind farms which really provide a genuine alternative to other energy bearers.

"There are several common features. Just deciding to install a transmission cable takes several years. Building and installing turbines and a grid aren't done just like that for a billion kroner or two.

"This is an extremely capital-intensive process, and not a job which a company like Lyse could take on by itself."

As when gas is discovered, Mr Nygaard points out, a market must exist before development takes place. He envisages owner constellations similar to those found in the petroleum industry which could develop wind power for large-scale export.

Norway currently has excess capacity for electricity generation and could be left with the power unless it has an international market for such deliveries.

"This must be done on a large scale, and that calls for political willingness," says Mr Nygaard. "The politicians must act. We've got more than enough plans."

State-owned Statnett, which is currently planning the next-generation central grid for Norway, has also called for assurances about a wind power commitment.

Auke Lont, the company's chief executive, recently submitted proposals for a new grid development which says that NOK 20-45 billion needs to be spent on this work over the next decade. ❇