

This is an English translation of the executive summary of a Statnett report from November 2023 titled Development of offshore grid (Norwegian: Utvikling av nett til havs). In the case of any uncertainties or discrepancies from a direct translation, the Norwegian text is the prevailing authoritative version.

Executive summary

We need to develop cost-effective and sustainable solutions for offshore wind to be realized

The development of offshore wind and offshore grid is a necessary part of the energy transition in Europe when several thousand TWh of fossil energy must be replaced with renewable energy. Norway needs new renewable power generation to cover the growing power demand, both for energy transition and to enable new industry.

Statnett assumes a growth of Norwegian power consumption between 50-160 TWh until 2050. The availability of affordable priced power will determine how big the growth will be. Norway has good potential for offshore wind power production with large sea areas and favourable wind conditions. Today's challenge is that offshore wind has high development costs. The grid connection costs make up a significant part of the total costs. We need solutions that reduce these as much as possible if offshore wind is to become a competitive energy source in Norway.

Statnett's task is to facilitate a sustainable and socio-economically rational connection of the offshore wind. The grid costs both at sea and on land are possible to reduce through good planning and by geographically distributing offshore wind along the coast to achieve a regional balance between production and consumption. In a separate report from February 2023¹, Statnett pointed to several areas on land that are suitable for connecting offshore wind.

To develop a sustainable offshore grid, we have carried out a double materiality analysis together with the industry and the Norwegian Ministry of Energy's Collaboration Forum for offshore wind. Here we have identified which factors have the greatest impact on climate, nature and environment and social conditions. Based on the analysis, we have defined the following overall measures for further planning the offshore grid:

- Consider greenhouse gas emissions in a comprehensive cradle-to-grave perspective
- Consider knowledge of local natural and environmental conditions when choosing design and route
- Establish good dialogue and early involvement of stakeholders

For the most socio-economic and sustainable development, it is important to see the various steps for development of offshore wind in a long term and holistic perspective. This way, we can utilise the areas as best as possible and find long-term rational solutions. For both radial and hybrid solutions, we must consider whether technical solutions etc. should be prepared for a future connection with other offshore wind farms and consumption offshore. Statnett recommends starting with the development of the offshore wind areas that are closest to the industrial hubs on land, as this will reduce onshore and offshore grid development costs, in addition to reducing the environmental impact. It appears economically rational to build hybrid grid solutions from the wind development zone *Sørvest F* in the North Sea. Such solutions will connect the offshore wind both to Norway and at least one other country. A prerequisite for this conclusion is that the consequences on price and for the power system are acceptable. Statnett is investigating these consequences to provide an

¹ Tilknytning av nye havvindområder til land, 15th February 2023

updated knowledge base ahead of the government's announcement of new offshore wind areas that are assumed to be in 2025.

Large amounts of unregulated power generation – both on land and at sea – will have a major impact on system operation, both locally and across national borders. Regardless of Norway's investment in offshore wind, there is a need for the development of several technical, regulatory and market measures. Consumption must adapt to the power production, and the power system must be able to handle more frequent and larger flow changes.

Grid has long lead times - We have started planning and development to be able to connect offshore wind in time

Offshore grid is on critical path for the development of offshore wind. The ministry for energy has asked Statnett to start an investigation of possible hybrids in Sørvest F. Statnett will investigate and develop several alternative hybrid projects in order to identify the best solutions and be able to realize two hybrid connections by 2040. As part of this, we have strengthened our cooperation with our European sister companies around the North Sea by entering into five MoUs (memorandum of understanding) with Elia (Belgium), TenneT (Germany), Amprion (Germany), Energinet (Denmark) and National Grid Venture (Great Britain). By doing this, we will be developing a portfolio of possible options for future political decisions.

Statnett has started development of a coordinated grid solution for the connection of offshore wind at Utsira Nord (a wind development zone outside Haugesund, which is part of *Vestavind F*). It may become relevant with several such coordinated grid solutions, meshed domestic grid at sea or HVDC connections of offshore wind where Statnett becomes the developer and owner of the domestic offshore grid.

Statnett will assess alternative offshore grid solutions for offshore wind for the announcement in 2025

Norway has announced its first two offshore wind farms and has the ambition to announce 30 GW of offshore wind by 2040. In September 2023, the Government initiated investigations into three wind development zones which are relevant for announcement in 2025: *Sørvest F*, *Vestavind F* and *Vestavind B*. Before the areas can be announced, they must be opened, and a strategic impact assessment must be carried out. In connection to this, Statnett will by November 2024 contribute to assessing grid solutions and the impact on the power system. Statnett will promote solutions which contribute to speed, cost-efficiency, sustainability and a holistic power system development.

Sørvest F is an extension of the Sørlige Nordsjø II zone and is suitable for bottom fixed offshore wind. NVE (the Norwegian regulating authority) has estimated a potential of up to 11.5 GW of offshore wind in this area. The area is far from land and close to other countries' sea areas. *Sørvest F* is therefore relevant for connection to both Norway and Europe. Such hybrids grid solutions provide power flows to Norway and can at the same time facilitate for socially profitable trade. Compared to a radial, hybrid solutions can result in a lower need for subsidies. Statnett will present updated profitability analyses of hybrids in a separate delivery in connection with the ongoing strategic impact assessment for the area.

The preliminary assessment is that a first hybrid to *Sørvest F* should be linked at the Southern part of Norway. Along with the development of Eastern Corridor 2 (a new power line between the South of Norway to Grenland) this will give increased power to Grenland. Several locations between Stavanger and the Eastern part of Norway are relevant for further development of *Sørvest F*.

For a development of any radial connections to the Southern North Sea, it appears more rational to connect these towards areas that are closer to land, such as Sørvest A, E or Sønnavind A.

Vestavind F is an extension of the Utsira Nord zone, has a depth of approximately 265 meters and is suitable for floating offshore wind. The government has already presented a possible expansion of the existing fields at Utsira Nord to 2.25 GW. Vestavind F also contains new areas, so that the total capacity can be around 3-5 GW.

Our recommendation is that expansions in Vestavind F are initially connected radially to Haugalandet. The assessments indicate that the area can accommodate a connection of approximately 2.7 GW offshore wind provided an upgrade of the entire grid at Haugalandet and a reinforcement of Sauda-Samnanger. A further increase of offshore wind connected to Haugalandet requires flexibility in the consumption or new grid reinforcements.

A new wind production area in the southern part of Vestavind F can be connected to the Stavanger area. Vestavind F is located approximately 50 km from existing transmission grid and is the closest identified offshore wind area to Stavanger. A radial connection must be assessed in relation to possible hybrid connections from Sørvest A-F to Stavanger.

A new wind production area in the northern part of Vestavind F can be connected with a long radial towards the Bergen area. As of now, Statnett does not want to recommend this as a long-term solution, as there are other areas closer to Bergen.

Vestavind B is a new area for floating offshore wind approximately 60 km northwest of Øygarden outside Bergen. Statnett is planning a new station here that will be suitable as a connection point. Statnett has, in connection with the evaluation of *Trollvind*, considered that connection to this area is beneficial, partly due to the power situation in Bergen.

The Bergen area has a strong consumption growth along the coast. Thus, connection of offshore wind here is positive. With a strong transmission grid between Western Norway and Eastern Norway, a significant part of power production from offshore wind will also flow towards Eastern Norway and Grenland.

Combined offshore wind and electrification of petroleum should always be considered for offshore electrification. Platforms that are electrified from shore have the capacity to connect twice as much offshore wind as the power requirement offshore without increasing the transmission capacity to land. With such a solution the platforms are supplied with 100 % offshore wind 50-60 % of the time, while any surplus power is transported onshore. During the remainder of time, the platform will be partially supplied from land. In total, the power demand from land is reduced by over 2/3 and the connections provide a net flow of power towards land.

Predictable and good framework conditions must be in place to obtain profitable investments

There is currently a high cost level for offshore wind and offshore grids due to high demand and high commodity prices – especially for floating offshore wind. We expect that the current price level for electricity will decrease and that the capacity of suppliers will increase. To realize large volumes of offshore wind in Norway, it is necessary that the cost level is reduced so that the developments are competitive in the power market. This also requires predictable and functioning framework conditions, including how costs and revenues for grid and infrastructure will be divided. Predictability reduces the risk and thus the costs for the investors.

We expect that offshore wind in the North Sea will be connected to land with both radial and hybrid grid solutions, and that some of these will eventually be developed into meshed grid solutions. Meshed grid solutions can link several offshore wind farms together, link offshore wind production and offshore consumption or link offshore wind production to countries with multiple connections. To ensure a rational grid development, there should be a separation of ownership for grids and production offshore - as onshore.

In Germany, the Netherlands and Denmark, all or part of the offshore grid will be built and financed by the TSOs. This reduces the risk and costs for developers of offshore wind power production, and can lead to increased volume and thus lower power prices. This challenges the profitability of offshore wind in Norway, where offshore grids are to be financed by the offshore wind developers. The authorities should consider whether Norway should establish more equal framework conditions as our neighbouring countries.

There is also a need to conclude on offshore market design, including how congestion income for meshed grid at sea shall be distributed. Statnett and RME recommend the creation of offshore bidding zones to provide optimal utilization of both transmission capacity and the available production resources. Statnett also recommends that income from congestion rents in an offshore meshed grid should be included as part of the income base for the TSOs and thus contribute to reducing costs for tariff customers.