OFFwind Highlights No. 17 – JANUARY 2026

CASE STUDY – KORSNÄS FINLAND BOTTOM FIXED WIND FARM

Korsnäs is likely to be the first large scale offshore wind farm in Finland. This Highlight tries to summarize the present state and key features of the future farm which is likely to be established 2030-2040.

Furthermore, based on offshore projects implemented, a preliminary indicative estimation of the likely Levelized Cost of Energy from the Korsnäs wind farm has been made.

Area location and introduction

The OFFwind project has selected 2 case study areas within the Interreg Aurora Program area, to serve as examples of future large-scale offshore wind establishments in the Norwegian Sea outside Northern Norway, and in the Sea and Gulf of Bothnia of the Baltic Sea. The Norwegian and Sea area "Nordavind D" outside Troms is suitable for floating turbines and the "Korsnäs" area in the Sea of Bothnia for fixed bottom turbines. This document focuses on the Korsnäs case study. The Northern Norway case is described in another case study document.

Figure 1. *Some of the offshore wind areas being considered in the Sea and Gulf of Bothnia. The Korsnäs case study area is indicated with a red arrow.*

In 2022 Metsähallitus organised an international competitive tendering for development of the Korsnäs offshore wind area, and in December 2022 Metsähallitus and Vattenfall signed a contract for development and construction of this first large scale offshore wind park in Finland.

Key features of the Korsnäs area and offshore park

Total area:	274 km2
Distance from land:	15-30 km
Water depth:	Mainly 10-30 m
Wind speed at 100 m:	Around 9,3 m/s
Wind speed at 200 m:	Around 10 m/s
Number of turbines:	Max 150
Turbine capacity:	Max 25 MW
Turbine hight:	Max 350 m
Total capacity:	Max 2,5 GW
Annual production:	Max 7 TWh
Turbine distance:	1-2 km

Level ice thickness h_i^{50} :	0,77 m
Wind speed V_w^{50}:	21,9 m/s
Wind gust speed. V_G^{50}:	27,4 m/s
Maximum ice speed, V_i:	0,55 m/s
Wave height, H_w^{50}:	7,6 m
Maximum sea level:	1,44 m, H_{SL}^{max}
Minimum sea level:	- 1,03 m, H_{SL}^{min}

Power transmission from the turbines to one or more sea based power stations in the park will be done with 3 phase AC submarine power cables. From the sea based power station(s) at least 2 cabels will transmit the power to the mainland. 2 alternative power cable routes to the mainland will be evaluated, and 1 power station will be built where the submarine cable reaches the mainland. From there the electricity will be transfered by 1–2 new 400 kV overhead power transmission lines to the Fingrid power station in Toby, Korsholm (60 km), and/or south to the planned new power station in Åback, Kristinestad (61-73 km).

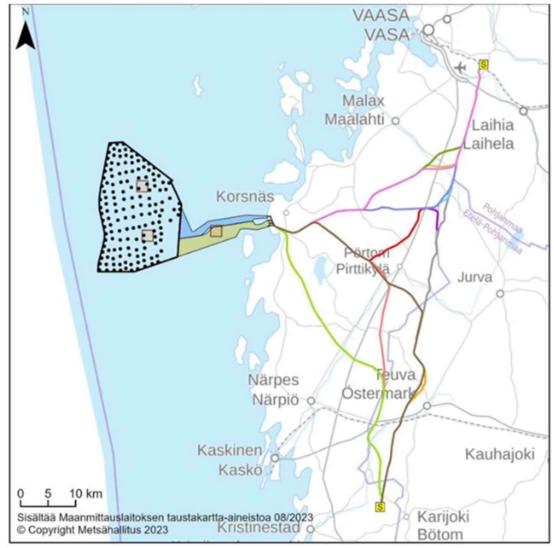

Figure 2. *Map of the offshore area, the two alternative routes for the sea cables to the mainland, and the different alternative power line routes to the 2 connection points to the national grid. Source: Forststyrelsen & Vattenfall, Korsnäs havsvindkraftspark och sjökabelsträckningar, MKB-program 2024.*

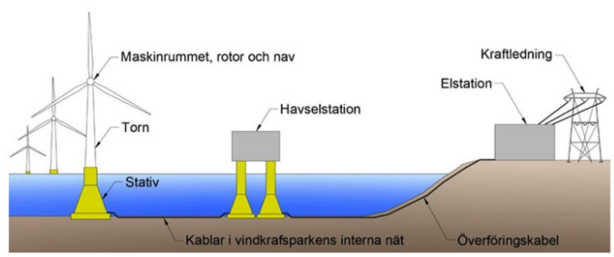

Figure 3. *Illustration of a possible power transmission system from the sea to the mainland. Source: Forststyrelsen & Vattenfall, Korsnäs havsvindkraftspark och sjökabelsträckningar, MKB-program 2024.*

Possible turbine concept

Offshore wind energy is a new developing industrial sector. The turbine size is continuously growing now - with 20-25 MW turbines being developed, prototyped and tested. It is difficult to predict which size turbines will be available and used when the first phase of the Korsnäs offshore park is developed. However, for this case study, the IEA 22 MW Reference wind turbine concept (RWT), developed within IEA Wind Task 55 REFWIND, was selected. The turbine is illustrated in Figure 4.

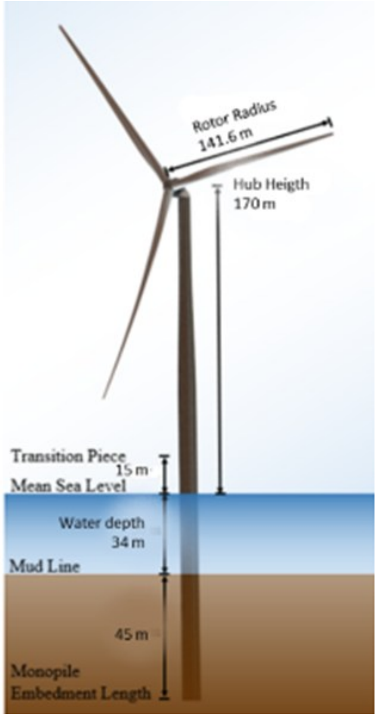

***Figure 4**. Illustration of IEA 22 MW Reference monopile wind turbine. Open source* [*https://github.com/IEAWindTask37/IEA-22-280-RWT*](https://github.com/IEAWindTask37/IEA-22-280-RWT)

The IEA 22 MW RWT has a hub height of 170 m, with a 5.614 m vertical distance between the rotor apex and tower top. The tower is assumed to start 15 m above mean sea level, and its length is therefore 149.3 m. The monopile concept is designed for a water depth of 34 m and its length in the seabed is 45 m, giving a total length of 94 m to reach the tower base. The assembly also includes a transition piece, of a total mass of 100 t, which is located between the tower and monopile 15 m above mean sea level. The hub height of 170 m leaves a clearance of 30 m between mean sea level and blade tip.

Conceptual design of the gravity-based reinforced concrete foundation

Gravity-Based Foundations (GBFs) are a favoured choice for offshore wind turbines in ice-infested waters due to their inherent stability and ability to withstand heavy ice-induced forces. These structures rely on their substantial weight and broad base area to remain securely anchored on the seabed, effectively resisting the horizontal pressures exerted by moving ice. This design significantly reduces the risk of displacement or structural failure, ensuring the reliable operation of wind turbines in harsh icy conditions. GBFs are most suitable for shallow to medium water depths (10–50 meters), where ice loads are particularly severe. In deeper waters exceeding 50 meters, the size and cost of GBFs increase substantially, making them less viable.

The conceptual design of the gravity-based reinforced concrete foundation is shown in ***Figure 5*** and key parameters provided in ***Table 1.***

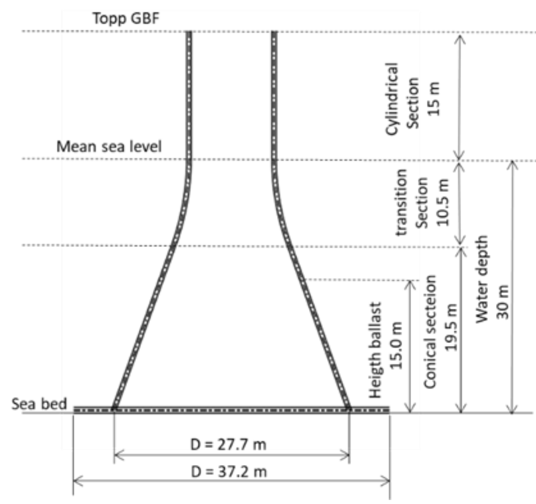

***Figure 5.** Conceptual design of gravity-based reinforced concrete foundation (GBF).*

Parameter	Value
Power rating [MW]	22
Rotor diameter [m]	283
Number of blades	3
Cut-in wind speed [m/s]	3
Rated wind speed [m/s]	11
Cut-out wind speed [m/s]	25
Hub height [m]	170
RNA mass [t]	1208

Tower top diameter [m]	6
Tower base diameter [m]	10
Steel Tower mass [t]	1574
Water depth [m]	30.0
Volume of ballast [m^3]	16242
Mass of ballast [t]	32483
Volume concrete [m^3]	2531
Mass of concrete [t]	6327

Table 1*. Key parameters for proposed design of 22 MW offshore wind turbine with gravity-based reinforced concrete foundation.*

Power Transmission from the Korsnäs Offshore Wind Farm

The transmission voltage in the cables connecting the turbines to the sea-based substations depends on the voltage level at the turbines but is likely to be **66-132 kV.** The diameter of these cables can be **120 -300 mm** and the weight **20-100 kg/m.**

At the sea-based substation(s), the power from the turbines will be collected and the voltage increased to **HVAC** to minimise the losses during the transmission to the mainland. A sea-based substation is estimated to require an **area of around 2000m^2 and be around 65 meters high from sea level.**

Another new substation will be built where the sea cables reach land, and the HVAC power is transferred to aerial power lines and connected to the national power grid. This power station is estimated to **require a land area of 4-8 hectares**. It is also possible that some of the nearest turbines will be connected directly to the substation on land.

Figure 6. *Example of Offshore Wind Farm – Onshore Substation. Source: LAM Associates Ltd, UK, Building Services Consulting Engineers, www.lamassociates.co.uk*

Connection to the national power grid

Different countries have different approaches to the connection of offshore wind power to the national transmission system – see *Figure 7.* For example, in the UK, the wind farm developers are responsibility to design, procure, and constructing the transmission infrastructure required for the offshore wind farm. In Germany the point of connection is at a sea-based substations, and in Denmark and the Netherlands, wind farm developers only need to bring the power to a sea-based substation owned by the National Transmission System Operator (TSO).

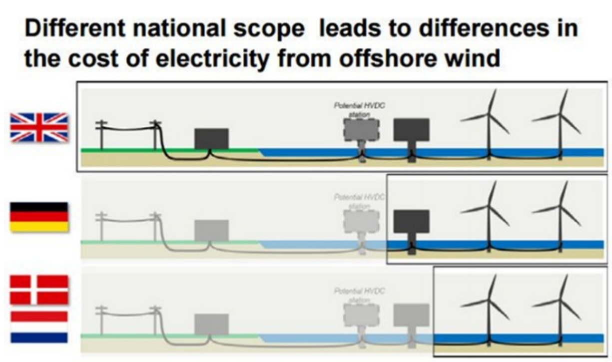

Figure 7. *Different countries have different connection points for offshore wind power to the national power grid. Source: Ørsted*

At present the approach in Finland is very similar to that in UK, which means that the developer must bring the power 60-70 kilometres to the substations in Toby and/or Kristinestad with all the costs this involves. However, the national legislation is changing, and if other power generating actors connect to the land substation in Korsnäs after 1.1.2026, the established 400 kV HVAC power line(s) built to Toby and/or Kristinestad can be sold to Fingrid, the National Transmission System Operator (TSO).

Hydrogen as a complement to HVAC power transmission.

The future national hydrogen grid is currently planned to go near Korsnäs – See ***Figure 8*** below.

To combine power production and transmission with hydrogen production and supply may have some advantages.

Hydrogen can be produced and stored when the electricity price is low.

Hydrogen **might be stored in the Korsnäs mine** located less than 10 kilometers north from the planned onshore substation

The hydrogen might be used in **gas turbines for balancing power** generation or supplied to the future **national hydrogen grid**.

Figure 8. *Preliminary route alternatives for a national hydrogen network in Finland.*
Korsnäs indicated with the red arrow. Source: Gasgrid

Figure 9. *The land-based substation will be located around 25 km from the planned hydrogen network. The old mine is located around 10 km away from the substation*
Source: Vasabladet

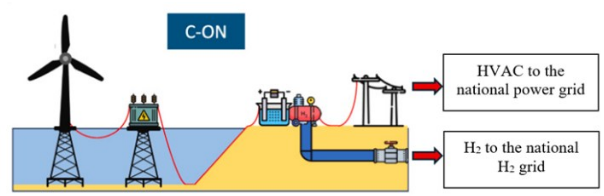

Figure 10. *Concept picture of possible HVAC supply to the national power grid and hydrogen supply from an offshore wind park. In the case of Korsnäs, the hydrogen could possibly be supplied to the nearby future national hydrogen grid shown in Figure 8. Source of concept picture: Applied Energy, Volume 397, 1 November 2025.*

Connection to a new future HVDC cable going through the Sea of Bothnia

There are several new offshore wind farms being developed in the Sea of Bothnia. In the future it may be feasible to connect these farms to a HVDC cable crossing the Sea of Bothnia and connecting many offshore wind farms. For example, on the Swedish side there are currently 10 offshore wind farms with a production of 122 TWh/a being planned.

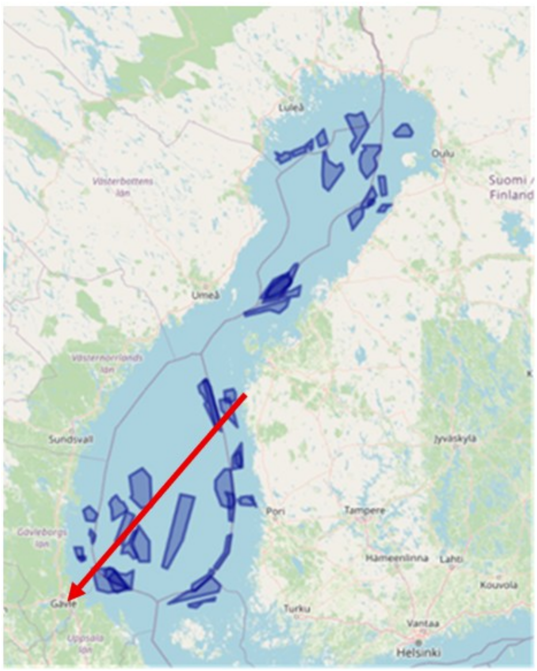

Figure 11. *A HVDC sea cable between Korsnäs and Sweden connecting 10-12 offshore wind farms may be feasible in the future.*

Economics and feasibility

Offshore wind is a relatively new developing industrial sector which depends on many factors, and the costs are likely to change as the industry evolves. Therefore, predicting the future costs of offshore wind power is very challenging, and the cost predictions vary considerably, so **the costs and feasibility presented here for the Korsnäs case must be seen as only indicative estimates with a high level of uncertainty involved.**

However, studying the costs of already implemented offshore wind farms gives an indication of what the likely costs in Korsnäs could be.

The US National Renewable Energy Laboratory, NREL, provides in their report *“2022 Cost of Wind Energy Review" (December 2023*), a cost summary table for fixed bottom 600 MW, 50 x 12 MW monopile turbines wind park located 50 km from shore at a water dept of 34 m.
The costs of this reference park are summarized below.

CAPEX	4640 $/kW
OPEX	108 $/kW
Interest rate	6,48 %
Energy production	4295 MWh/MW/yr
Total LCOE	**95 $/MWh**

The global weighted average LCOE values derived from the individual power plants commissioned in the year 2023, as stated by the the International Renewable Energy Agency IRENA, where:

Offshore wind	7,5 US₵/kWh
Biomass	7,2 “
Geothermal	7,1 “
Hydropower	5,7 “
Onshore wind	3,3 “

Source: IRENA “Renewable power Generation Costs in 2023”

In their *“Renewable Power Generation Costs in 2024”* report, IRENA states that the **global weighted average costs** of electricity from newly commissioned utility-scale renewable power technologies in 2023 - 2024 decreased 4 % for offshore wind power and 3 % for onshore wind power. The capacity factors in 2024 were 42 % offshore and 34 % for onshore wind. However, **in the EU the weighted average LCOE for offshore wind was as follows for new offshore farms.**

2022	0,084 $/kWh
2023	0,073 $/kWh
2024	0,080 $/kWh

It should be noted that "high interest" countries face higher capital costs, inflating the share of financing costs in LCOE.

John Constable and Professor Gordon Hughes have in their report *"The Cost of Offshore Wind Power: Blindness and Insight"* September 2020, summarized the results of auditing the accounts of on the capital and operating costs of 350 onshore and offshore wind farms in the United Kingdom, a set which covers the majority of the larger wind farms (> 10 MW capacity) built and commissioned between 2002 and 2019.

Although the report covers relatively small and early established farms, the results below for the offshore farms are of some interest – see below.

CAPEX	4490 GBP/kW
OPEX yr 1	184 GBP/kW
OPEX yr 15	426 GBP/kW
Capacity Factor	40-45 %

In this study it was found that OPEX increased 5,9 % annually and that the Capacity Factor steadily declined after 5 years of operation.

The current costs of offshore wind power have been summarized in OFFwind *Highlight 7 – The Cost of Offshore Wind Power*, and the likely future costs in Offwind *Highlight 14 – Future Costs of Offshore Wind Power*. Please see these publication for more information on costs.

Levelized cost of energy (LOCE) from the Korsnäs wind farm.

Since many important factors still are to be decided for the Korsnäs offshore wind farm, an energy cost estimate is, at this stage, very indicative. The technology and construction processes used, the connection point to the national grid, the current capital costs, the level of subsidies, etc., when the park is built, will largely influence the levelized cost of energy.

However, based on implemented similar type of offshore parks so far (by 2024), the Levelized Cost of Energy seems to be between 0,07- 0,12 €/kWh. Of the LCOE of offshore wind power, around 97,5% originates from the CAPEX and 2,5 % from the OPEX, so the capital costs are very important for the LCOE.

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