EVALUATION REPORT SITE CONDITIONS - ICE ASSESSMENT - HESSELØ SOUTH

PREPARED FOR:

ENERGINET ELTRANSMISSION A/S

Order No.: 15626318

Report No.: *R15626318-0-4, Rev. 0, 2025-01-24*

Wind Farm: Hesselø South

CLASSIFICATION

CLIENT'S DISCRETION

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DOCUMENT HISTORY

REVISION	RELEASE DATE	MODIFICATION
0	2025-01-24	Initial Document

1 DOCUMENTS

1.1 Examined Documents

/1.1.1/ C2WIND ApS: Report
"Hesselø South Offshore Wind Farm - Sea Ice Site Condition Assessment",
Doc. No. 24021-04-04, Rev. 4, 22.10.2024, 109 pages
(DEWI-OCC Order-No.: 15626318 - Doc No. -00c+156)

1.2 Noted Documents

/1.2.1/ SWECO Deltares: Report
"Kattegat and Hesselø South - Site Metocean Conditions Assessments - Part A: Measurements and Hindcast Data Basis",
Doc. No. 41011328A, Rev. 4, 16.01.2025, 105 pages
(DEWI-OCC Order-No.: 15626203 - Doc No. -00c+152)

/1.2.2/ SWECO Deltares: Report
"Kattegat and Hesselø South - Site Metocean Conditions Assessments - Part C: Analyses and Design Parameters for Hesselø South",
Doc. No. 41011328C, Rev. 3, 22.01.2025, 143 pages
(DEWI-OCC Order-No.: 15626203 - Doc No. -00c+154)
Plus Appendix (DEWI-OCC Order-No.: 15626203 - Doc No. 00c+095 -142)

/1.2.3/ DEWI-OCC GmbH: Evaluation Report
Site Conditions – Metocean Conditions Hesselø South
Doc. No. R15626318-0-3, Rev. 0, 2025-01-24, 9 pages

2 CERTIFICATION SCHEME

/2.1/ IECRE OD-502: Operational Document, "Project Certification Scheme", Edition 1.0, 2018-10-11

3 STANDARDS AND GUIDELINES

The conformity evaluation was carried out based on the following standards and guidelines:

/3.1/ IEC 61400-3-1: "Wind energy generation systems - Part 3-1: Design requirements for fixed offshore wind turbines", Edition 1.0, 2019-04

/3.2/ IEC 61400-1: "Wind energy generation systems - Part 1: Design requirements", Edition 4.0, 2019-02

4 SCOPE OF EVALUATION

The ice assessment for the offshore wind farm Hesselø South documented in /1.1.1/ shall be evaluated for conformity with IECRE OD-502 /2.1/ with consideration of the additional standards listed in chapter 3 with the purpose of use in the design basis for FEED design.

The document /1.1.1/ shall be reviewed for completeness, correctness and consistency.

Wind conditions, marine conditions, soil conditions, electrical conditions and other site conditions are not subject of this evaluation report.

5 REMARKS

5.1 General

The offshore wind farm Hesselø South is located 40 km northwest off the north coast of Zealand and approximately 50 km east of the Djursland peninsular. The number and locations of wind turbines are not yet defined.

The document /1.1.1/ presents the assessment of sea ice for the area of the offshore wind farm Hesselø South. The documentation details the determination of key sea ice design parameters such as sheet ice thickness, days with ice coverage, ich ridge parameters, ice strength coefficient as well as ice drift direction and speed. Load cases concerning sea ice are discussed. In /1.1.1/, relevant input parameters to be used for the design basis for FEED design for the offshore wind farm area are presented.

The location of the planned wind farm area is given in /1.1.1/. The ice assessment is based on ice observations for the region, on temperatures, on model data, wind statistics and public papers.

Wind conditions and hydrographical conditions for design of wind turbine generators (WTG) at the site, results of the geophysical and geotechnical campaigns, electrical network conditions and other site conditions are not part of this report.

5.2 Site Conditions

5.2.1 Ice Conditions

Ice conditions for the site of the offshore wind farm Hesselø South are detailed in /1.1.1/.

Sea ice observations and meteorological observations from various sources are available for the general region of the wind farm and for several locations close to the wind farm site and are used as basis for assessment in /1.1.1/.

Locations for sea ice observations and relevant time frames with an occurrence of sea ice are listed. The number of days with competent sea ice of several categories of thickness is calculated from that data.

Measurements and time series for air temperature and sea surface temperature are presented.

In addition, hindcast model data is used regarding wind and current data to determine wind-ice drift direction and velocity. The utilized model data is provided by the company “SWECO” and is the same as described and used in the metocean assessment /1.2.1/ and /1.2.2/. Presentation of hindcast models, presentation of measurement data at the project site and validation of models and measurements are not part of the scope of this report. The hindcast model and metocean conditions are evaluated in /1.2.3/.

In /1.1.1/ the sheet ice thickness is determined based on a thermal ice grow model. Assumptions for the model and input parameters such as thermal conductivity of ice, freezing temperature of saline water, sea and air temperatures are outlined. The maximum sheet ice thickness for past years with an occurrence of sea ice as well as a 50-year sheet ice thickness are calculated and presented. The ice assessment /1.1.1/ distinguishes between various subcategories of ice sheet cover depending on the stage of ice development. Days of occurrence for different ice thickness bins are determined for past winters and a value for occurrence for one year is calculated.

The ice assessment further determines parameters of ice ridges, such as the layer ice thickness, the ice strength coefficient for 1 year and the average ice strength coefficient.

To determine the vertical and horizontal forces acting on the support structure, ice parameters such as flexural strength of the ice, Young’s modulus, Poisson’s ratio and coefficients of kinetic friction are discussed. Additionally, the occurrence frequency of different ice action speeds is presented.

The ice assessment /1.1.1/ presents and discusses relevant design load cases concerning ice loading to be considered in design.

Lastly, the effects of climate change are investigated. According to /1.1.1/ climate change will not cause the sea ice conditions to be more severe than predicted from hindcast and observations.

Under consideration of all remarks, the ice assessment as detailed in /1.1.1/ is suitable for application in the design basis for FEED design.

6 INTERFACE TO OTHER EVALUATION MODULES

6.1 The measurement campaign at the offshore wind farms Kattegat and Hesselø South is evaluated in R15626203-0-1

6.2 The wind conditions at the offshore wind farm Hesselø South are evaluated in R15626203-0-2

6.3 Metocean conditions for the offshore wind farm Hesselø South are evaluated in R15626203-0.2

7 CONDITIONS

7.1 Design parameters for wind conditions, hydrographical conditions, soil conditions and electrical conditions shall be presented in additional expertises and will be evaluated separately.

8 CONCLUSION

The ice assessment for the offshore wind farm Hesselø South documented in /1.1.1/ was found plausible and in conformity with IECRE OD-502 /2.1/ and the respective technical standards /3.1/ and /3.2/.

There are no objections against the application of the ice assessment in the design basis for FEED design for the offshore wind farm Hesselø South.

Changes in the ice assessment shall be approved by DEWI-OCC GmbH; otherwise this report loses its validity.

Bremen, 2025-01-24

Expert in Charge

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