



**EVALUATION REPORT
SITE CONDITIONS -
METOCEAN CONDITIONS -
HESSELØ SOUTH**

PREPARED FOR:

ENERGINET ELTRANSMISSION A/S

Order No.: 15626318

Report No.: *R15626318-0-3, Rev. 0,
2025-01-24*

Wind Farm: Hesselø South

CLASSIFICATION
CLIENT'S DISCRETION

KEY TO DOCUMENT CLASSIFICATION

STRICTLY CONFIDENTIAL	For recipients only
CONFIDENTIAL	May be shared within client's organization
UL INTERNAL ONLY	Not to be distributed outside UL
CLIENT'S DISCRETION	Distribution at the client's discretion
FOR PUBLIC RELEASE	No restriction

DOCUMENT HISTORY

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

1 DOCUMENTS

1.1 Examined Documents

- /1.1.1/ 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)
- /1.1.2/ SWECO Deltares: Report '
"Kattegat and Hesselø South - Site Metocean Conditions Assessments Part D: Reverification of Data Basis",
Doc. No. 41011328D, Rev. 2, 04.12.2024, 54 pages
(DEWI-OCC Order-No.: 15626203 - Doc No. -00c+149)
- /1.1.3/ 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 Noted Documents

- /1.2.1/ DNV: Certificate
"Fugro Norway AS - ISO 9001 Management System Certificate",
Doc. No. 10000409040-MSC-NA-NOR, Rev. -, 2023-09-28, 2 pages
(DEWI-OCC Order-No.: 15626203 - Doc No. -00c+150)
- /1.2.2/ fugro Norway: Report
"SWLB measurements - Danish Offshore Wind 2030
Project Measurement Plan, All Lots",
Doc. No. C75516/C75517/C75518_Project_Measurement_Plan_All_Lots 09, Rev. 9,
2023-11-25, 50 pages
(DEWI-OCC Order-No.: 15626318 – Doc. No. -00c+043)
- /1.2.3/ fugro Norway: Data File
"Stations and deployment record",
Doc. No. EE676023543A63074826A562B18A2FD3, 71 KB
(DEWI-OCC Order-No.: 15626318 – Doc. No. -00c+044)
- /1.2.4/ Energinet: Folder
"Buoy drawings and moorings"
3 files
(DEWI-OCC Order-No.: 15626318 - Doc No. -00c+001 - +003)
- /1.2.5/ Energinet: Folder
"Buoy pre-deployment verification reports"
3 files
(DEWI-OCC Order-No.: 15626318 - Doc No. -00c+004 - +006)

- /1.2.6/ Energinet: Folder
"Instrument Certificates"
30 files
(DEWI-OCC Order-No.: 15626318 - Doc No. -00c+007 - +036)
- /1.2.7/ Energinet: Folder
"Service Reports"
6 files
(DEWI-OCC Order-No.: 15626318 - Doc No. -00c+037 - +042)
- /1.2.8/ DEWI-OCC GmbH: Evaluation Report
"Site Conditions – Measurement Campaign for Wind and Metocean
Conditions – Kattegat & Hesselø South"
Doc. No. R15626203-0-1, Rev. 0, 2024-12-20, 6 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 metocean conditions for the offshore wind farm Hesselø South, consisting of the data basis (part A) reverification of the data basis (part D) and the analysis (Part C) documented in chapter 1.1 shall be evaluated for conformity with IECRE OD-502 /2.1/ and respective technical standards /3.1/ and /3.2/ with the purpose of use in the design basis for FEED design.

The documents in 1.1 shall be reviewed for completeness, correctness and consistency.

The analysis and interpretation as well as presentation of design parameters for wind conditions, soil conditions and electrical 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 documents listed in chapter 1 present the data basis for the metocean conditions assessment and the data analysis and determination of design values for the offshore wind farm Hesselø South. The documentation details the site bathymetry, the data basis for the analysis of water levels, current conditions and waves as well as the results of the assessment for water levels, current conditions and wave climate as well as wind conditions for the purpose of correlation of wind and waves.

Additionally, other atmospheric and oceanographic conditions and information on expected climate change and sea level rise is included.

The location of the planned wind farm area is given in /1.1.1/ and /1.1.3/. The metocean assessment is established on the base of hindcast models which are compared against local buoy measurements and existing regional measurements.

Measurements and models are presented in /1.1.1/. A reverification of the data basis with slightly longer on-site measurements is available in /1.1.2/. The analysis and interpretation of metocean conditions at the project site and determination of design values is presented in /1.1.3/.

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

5.2 Site Conditions

5.2.1 Wind conditions

Wind conditions for the site of the offshore wind farm Hesselø South are given in /1.1.1/ and /1.1.3/ for correlation with hydrographical conditions only. Wind conditions for use in the design basis and design of the WTG are not part of this report.

5.2.2 Hydrographic conditions – data basis

The data basis for hydrographic conditions for the offshore wind farm Hesselø South is detailed in /1.1.1/. Document /1.1.2/ presents a reverification of the data on the basis of longer on-site measurements.

Hydrographic data was derived on the basis of hindcast modelling, correlated with on-site measurements and regional measurements.

Measurements of wind conditions, water levels, wave data and current data at the project site were executed by the company “Fugro” /1.2.2/. Independent testing and verification of the utilized buoys is documented in /1.2.5/. The availability period of the different buoys and replacement of single buoys is presented in /1.2.3/. Measurement positions are listed in /1.1.1/

The company “Fugro” is not recognized by IECRE as a testing laboratory for wind and metocean measurements. The qualification of the testing laboratory and the involved personnel as well as the quality of the measurement campaign were therefore confirmed by DEWI-OCC on the basis of the additional documentation /1.2.2/ to /1.2.7/. The evaluation of the measurement campaign is documented in /1.2.8/.

The bathymetry at the site is included in the modelling based on surveys executed at the site during 2021 and 2023, supplemented by publicly available datasets of the European Marine Observation and Data Network. An overview of the bathymetry is included in /1.1.1/.

Hydrodynamic data including water levels, temperature, salinity, current directions and current velocities was derived from a hydrodynamic model.

The applied model is described and according to /1.1.1/, it is validated against various measurement locations in or close to the area of the offshore wind farm Hesselø South and it's neighboring wind farm Kattegat. Measurement positions are given. A comparison between modelled and measured water levels and current velocities is included in /1.1.1/. The method to determine vertical current profiles is presented.

Wave characteristics are derived based on a local numerical wave model with water level and current data used from the hydrodynamic modelling.

The model was calibrated on regional and local observations according to /1.1.1/. Locations wave climate measurements are given.

General information on the applied wave model, the model setup and a validation of wave parameters are presented.

The selection of three reference locations for the metocean conditions in the wind farm area is described in /1.1.1/.

In /1.1.2/ a longer set of on-site measurement data is used to confirm the verification of the metocean data. According to /1.1.2/ the reverification does not change any conclusion made in /1.1.1/.

Under consideration of all remarks, hydrographic conditions as detailed in /1.1.1/ are suitable for application in the design basis for FEED design.

5.2.3 Hydrographic conditions – data analysis and design parameters

Hydrographic conditions for the offshore wind farm Hesselø South are detailed in /1.1.3/.

Results are presented for three reference locations across the project area. The selection of reference locations is discussed in the metocean data basis (see chapter 5.2.2). The location “HS-1” is chosen for the presentation of design values in /1.1.3/.

Water levels, currents and waves for the wind farm area were determined from the hydrodynamic modeling described in /1.1.1/.

Tidal water levels are presented in /1.1.3/ with reference to mean sea level (MSL). Extreme water levels are given for various return periods including 1 year and 50 years. Maps of water level distribution across the wind farm area are shown.

Normal and extreme current conditions are presented. Current roses are given for total currents at different depths. Information on vertical profiles of current speed is included in /1.1.3/ as well as an overview of extreme current speeds near the surface, at mid-depth and near the seabed for various return periods including 1 year and 50 years. Maps of current speed distribution across the wind farm area are shown.

Wave characteristics are presented in /1.1.3/ for normal and extreme conditions. Wave roses are presented for total waves. Various scatter diagrams are given. An overview of the extreme significant wave height, the peak wave period, the maximum wave height and the maximum crest height for various return periods including 1 year and 50 years are included in /1.1.3/. Maps of wave characteristics across the wind farm area are shown.

Applicable wave spectra are discussed and a recommendation for an appropriate wave spectrum is given in /1.1.3/. Information regarding the consideration of braking waves is included.

Under consideration of all remarks, hydrographic conditions as detailed in /1.1.3/ are suitable for application in the design basis for FEED design.

5.2.4 Other site conditions

The data basis for other site conditions for the offshore wind farm Hesselø South is described in /1.1.1/. Results for other site conditions are given in /1.1.3/ and are separated into other atmospheric conditions and other oceanographic conditions.

Given information for atmospheric conditions includes air temperature, pressure, humidity and solar radiation as well as lightning.

Given information for oceanographic conditions includes seawater temperature, salinity, water density and marine growth.

Under consideration of all remarks, other site conditions as detailed in /1.1.3/ are suitable for further analysis and for application in the design basis for FEED design.

5.2.5 Climate change

The metocean conditions data basis /1.1.1/ includes information on how to address climate change and sea level rise at the offshore wind farm Hesselø South for the project lifetime. Information is based on different projections.

According to /1.1.1/ a sea level rise 16 cm by 2050 and 30 cm by 2070 can be expected.

Under consideration of all remarks, information on climate change 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 R15626318-0-2
- 6.3 Sea ice conditions at the offshore wind farm Hesselø South are evaluated in R15626318-0-4

7 CONDITIONS

- 7.1 Design parameters for wind conditions, soil conditions and electrical conditions shall be presented in additional expertises and will be evaluated separately.
- 7.2 When additional measurements are available, the results and validation, especially for the long-term site conditions, shall be reassessed and updated.
- 7.3 As recommended in /1.1.3/, further study of current speeds should be undertaken for detailed design.

8 CONCLUSION

The metocean conditions for the offshore wind farm Hesselø South documented in /1.1.1/, /1.1.2/ and /1.1.3/ were 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 metocean conditions in the design basis for FEED design for the offshore wind farm Hesselø South.

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

Bremen, 2025-01-24

Expert in Charge

Rebecca Ley

DEWI-OCC Offshore and Certification Centre GmbH