



EVALUATION REPORT SITE CONDITIONS - METOCEAN CONDITIONS PART A

PREPARED FOR:

ENERGINET ELTRANSMISSION A/S

Order No.: 14772868

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2024-07-09

Wind Farm: Energy Island North Sea
Wind Farms

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DOCUMENT HISTORY

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0	2023-12-22	Initial Document
1	2024-06-28	Update of references /1.2.13/, /1.2.16/ and /1.2.17/.
2	2024-07-09	Editorial changes.

1 DOCUMENTS

1.1 Examined Documents

- /1.1.1/ DHI: Report
"Energy Island North Sea Metocean Assessment Part A: Data Basis – Measurements and Models Establishment of bathymetry, measurements, and hindcast",
Doc. No. 4500087261, Rev. 1.1, 2023-11-20, 163 pages
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+044)

1.2 Noted Documents

- /1.2.1/ DANAK: Certificate
"Accreditation for testing DS/EN ISO/IEC 17025:2017 DHI A/S", 2019-06-24, 2 pages
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+020)
- /1.2.2/ Fugro: Report
"SWLB measurements at Energy Islands Project Measurement Plan, All Lots",
Doc. No. C75486_Project_Measurement_Plan_All_Lots 05 Rev. 5, 2022-04-06, 53 pages
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+012)
- /1.2.3/ DNV GL: Report
"Independent performance verification of Seawatch Wind Lidar Buoy at Frøya, Norway",
Doc. No. 10281716-R-2 Rev. B, 2021-05-07, 45 pages
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+010)
- /1.2.4/ DNV: Report
"Independent performance verification of Seawatch Wind Lidar Buoy at the LEG offshore platform",
Doc. No. 10298247-R-1 Rev. A, 2021-07-09, 43 pages
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+011)
- /1.2.5/ DNV: Report
"Independent analysis and reporting of ZX Lidars performance verification executed by ZX Lidars at the UK Remote Sensing Test Site",
Doc. No. 10284581-R-61-A Rev. A, 2021-10-05, 38 pages
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+013)
- /1.2.6/ DNV GL: Report
"Independent analysis and reporting of ZX Lidars performance verification executed by ZX Lidars at the UK Remote Sensing Test Site",
Doc. No. 10284581-R-1 Rev. A, 2021-02-17, 82 pages
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+014)
- /1.2.7/ DNV: Report
"WS191 Independent performance verification of Seawatch Wind Lidar Buoy at Frøya, Norway",
Doc. No. 10332389-R-4 Rev. A, 2022-04-04, 37 pages
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+017)
- /1.2.8/ DNV: Report
"ZX862 Independent analysis and reporting of ZX Lidars performance verification executed by ZX Lidars at the UK Remote Sensing Test Site",
Doc. No. 10284581-R-84-A Rev. A, 2021-11-12, 38 pages
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+018)

- /1.2.9/ Energinet: Data Sheet
"Deployment record for Lot 1, North Sea", 1 page
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+015)
- /1.2.10/ Energinet: Data Sheet
"Deployment record for Lot 2, North Sea", 1 page
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+016)
- /1.2.11/ DNV GL: Certificate
"ISO 9001 Management System Certificate Fugro Norway AS",
Doc. No. 10000409040-MS-NA-NOR, 2020-12-16, 2 pages
(DEWI-OCC Order-No.: 14772868 – Doc. No. -00+038)
- /1.2.12/ Fugro: Report
"SWLB measurements at Energy Islands Project Measurement Plan, All
Lots",
Doc. No. C75486_Project_Measurement_Plan_All_Lots 09, Rev. 9, 2023-
05-30, 56 pages
(DEWI-OCC Order-No.: 14772868 – Doc. No. -00+039)
- /1.2.13/ Energinet: Excel-File
"Stations and deployment record - EINS",
MD5 checksum: D7ED6B74294B9BEA11E246CD9BA6F4B1, 79 kB
(DEWI-OCC Order-No.: 14772868 – Doc. No. -00+047)
- /1.2.14/ Energinet: Folder
"Buoy predeployment validation reports", 11 files
MD5 checksum: 31C235877CAA7B49E65ED01B63F81E11
(DEWI-OCC Order-No.: 14772868 – Doc. No. -00+041)
- /1.2.15/ Energinet: Folder
"Instrument certificates and reports", 103 files
MD5 checksum: 4E57DF8944CAB3F13F0B921B83C8A57E
(DEWI-OCC Order-No.: 14772868 – Doc. No. -00+042)
- /1.2.16/ Energinet: Folder
"Service reports",
MD5 checksum: F751DC01543860C133EFFBAF40EA631D, 11 files
(DEWI-OCC Order-No.: 14772868 – Doc. No. -00+048)
- /1.2.17/ DEWI-OCC GmbH: Evaluation Report
Site Conditions – Measurement Campaign for Wind and Metocean
Conditions
Doc. No. R14772868-0-5, Rev. 1, 2024-06-27, 7 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

/3.3/ DNV-RP-C205: Recommended Practice, "Environmental Conditions and Environmental Loads", Edition September 2019, amended September 2021

4 SCOPE OF EVALUATION

The metocean conditions data basis (Metocean Conditions Assessment Part A) for the Energy Island North Sea wind farm area and island area documented in chapter 1 shall be evaluated for conformity with IECRE OD-502 /2.1/ with consideration of the additional standards listed in chapter 3.

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 marine conditions, wind conditions, soil conditions and electrical conditions are not subject of this evaluation report.

5 REMARKS

5.1 General

The Energy Island North Sea Wind Farm site is located in the North Sea off the Coast of Jutland, Denmark. The number and locations of wind turbines as well as the exact location and extent of the island are not yet defined.

The documents listed in chapter 1 present the data basis for the metocean conditions assessment for the Energy Island North Sea wind farm area and island area. The documentation details the site bathymetry, the data basis for the analysis of water levels, current conditions, and waves 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 and energy island area is given in /1.1.1/. The metocean data base is established on the base of a hindcast model which is compared against local buoy measurements and existing regional measurements. The responsible company "DHI" holds an accreditation for testing according to DS/EN ISO/IEC 17025 /1.2.1/.

Measurements and models are presented in /1.1.1/.

An analysis and interpretation of metocean conditions at the project site and determination of design values are not part of the scope of the documents in chapter 1.

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 Energy Island North Sea wind farm area and energy island area are given in /1.1.1/ 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

The data basis for hydrographic conditions for the site of the Energy Island North Sea wind farm area and island area is detailed in /1.1.1/.

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 /1.2.3/ to /1.2.8/. The availability period of the different buoys and replacement of single buoys is presented in /1.2.9/ and /1.2.10/. 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 /1.2.11/ to /1.2.16/. The evaluation of the measurement campaign is documented in /1.2.17/.

A description of the bathymetry at the site is included based on a survey executed at the site during 2022, using a multi-beam echosounder, data has a resolution of 5 m. According to /1.1.1/ water depths range from 25 to 35 m relative to mean sea level (MSL) in the artificial island area. Water depths reach up to 50 m relative to MSL in the wind farm area. Maps of the bathymetry and depth profiles are included in /1.1.1/.

Water levels at the island and wind farm area were derived from a local hydrodynamic model. According to /1.1.1/ the site is located close to an amphidromic point, so tidal ranges are small.

The applied model is described and according to /1.1.1/ it is validated against local and regional measurements. Local and regional measurement positions are given. A sensitivity study for the model is included in /1.1.1/.

Current conditions at the site are based on measurements and a local hindcast model, supplemented by a regional hydrodynamic model.

Local and regional locations of current measurements are given.

A sensitivity study is presented in /1.1.1/ for the local hindcast model. The validation of the local and the regional hindcast model against measurement data is included in /1.1.1/.

Current speeds for different depths are presented and a recommendation for normal and extreme current is given and currents are given as depth-averaged and near-surface currents.

Wave characteristics are derived based on a local spectral wave model calibrated on local measurements according to /1.1.1/.

Locations of local and regional wave climate measurements are given.

The applied wave model, a sensitivity study for the model, the model setup and a validation of wave parameters are presented. Possible wave spectra are discussed and a recommendation for an appropriate wave spectrum is given in /1.1.1/.

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

5.2.3 Other site conditions

The data basis for other site conditions for the Energy Island North Sea wind farm area and island area are detailed in /1.1.1/. They are separated into other atmospheric conditions and other oceanographic conditions.

Given information for atmospheric conditions includes rainfall, air temperature, humidity, solar radiation, lightning and visibility.

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

Under consideration of all remarks, other site conditions as detailed in /1.1.1/ are suitable for further analysis and for application in the design basis.

5.2.4 Climate change

The Metocean Assessment Part A /1.1.1/ includes information on how to address climate change and sea level rise at the Energy Island North Sea wind farm area and island area for the project lifetime. Information is based on a literature study and modelling of sea level rise.

According to /1.1.1/ a sea level rise of 0.8 m by the year 2113 is expected.

Under consideration of all remarks information on climate change is suitable for application in the design basis.

6 INTERFACE TO OTHER EVALUATION MODULES

- 6.1 The measurement campaign is evaluated in R14772868-0-5
- 6.2 Wind conditions at the site are evaluated in R14772868-0-1
- 6.3 The analysis of metocean conditions at the island site (Metocean Assessment Part B) is evaluated in R14772868-0-3
- 6.4 The analysis of metocean conditions at the offshore wind farm site (Metocean Assessment Part C) is evaluated in R14772868-0-4

7 CONDITIONS

- 7.1 Design parameters for marine conditions, 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.

8 CONCLUSION

The metocean conditions data basis (Metocean Conditions Assessment Part A) for the Energy Island North Sea wind farm area and island area 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 metocean conditions data basis in the design basis for the Energy Island North Sea wind farm and artificial island.

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

Bremen, 2024-07-09

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