



EVALUATION REPORT SITE CONDITIONS - ICE ASSESSMENT

PREPARED FOR:

ENERGINET ELTRANSMISSION A/S

Order No.: 14772968

Report No.: *R14772968-0-4, Rev. 0,
2024-03-19*

Wind Farm: Energy Island Baltic Sea
Wind Farms

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	2024-03-19	Initial Document

1 DOCUMENTS

1.1 Examined Documents

/1.1.1/ Sweco: Report
"Ice Assessment, Energy Island Baltic Sea Bornholm I and II OWF",
Doc. No. 41007612-001, Rev. 03, 2024-02-16, 99 pages
(DEWI-OCC Order-No.: 14772968 - Doc. No. -00+038)

1.2 Noted Documents

- /1.2.1/ 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.: 14772968 - Doc. No. -00+002)
- /1.2.2/ DNV GL: Report
"ZX898M Independent analysis and reporting of ZX Lidars performance verification
executed by ZX Lidars at the UK Remote Sensing Test Site",
Doc. No. 10159431-R-11, Rev. A, 2019-08-02, 82 pages
(DEWI-OCC Order-No.: 14772968 - Doc. No. -00+024)
- /1.2.3/ DNV: Report
"WS199 Independent performance verification of Seawatch Wind Lidar Buoy at Frøya,
Norway",
Doc. No. 10281716-R-11, Rev. A, 2021-11-03, 44 pages
(DEWI-OCC Order-No.: 14772968 - Doc. No. -00+025)
- /1.2.4/ DNV GL: Report
"ZX993 Independent analysis and reporting of ZX Lidars performance verification
executed by ZX Lidars at the UK Remote Sensing Test Site",
Doc. No. 10189145-R-12, Rev. A, 2020-02-28, 90 pages
(DEWI-OCC Order-No.: 14772968 - Doc. No. -00+026)
- /1.2.5/ DNV: Report
"SWLB044 Independent performance verification of Seawatch Wind Lidar Buoy at Frøya,
Norway",
Doc. No. 10281716-R-12, Rev. B, 2021-11-11, 44 pages
(DEWI-OCC Order-No.: 14772968 - Doc. No. -00+027)
- /1.2.6/ DNV GL: Report "TYPE ZX300 LIDAR Remote Sensing Device Type-specific
Classification Summary", Doc. No. GLGH-4275 18 14741 258-R-0003, Rev. D, 2018-11-
09, 21 pages
(DEWI-OCC Order-No.: 14772968 - Doc. No. -00+028)
- /1.2.7/ Energinet: Excel-File
"Stations and deployment record - EIBS",
MD5 Checksum: D60CA60ED1EEF0DC6156D37CEEF9975D, 55 kB
(DEWI-OCC Order-No.: 14772968 - Doc. No. -00+039)
- /1.2.8/ DEWI-OCC GmbH: Evaluation Report
Site Conditions – Measurement Campaign for Wind and Metocean Conditions
Doc. No. R14772968-0-5, Rev. 1, 2024-03-19, 7 pages

/1.2.9/ DEWI-OCC GmbH: Evaluation Report
Site Conditions – Metocean Conditions Part A
Doc. No. R14772968-0-2, Rev. 0, 2024-03-19, 8 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 Energy Island Baltic Sea wind farms 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 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.

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 Energy Island Baltic Sea Wind Farm site is located in the Baltic Sea off the Coast of Bornholm, Denmark. The number and locations of wind turbines are not yet defined.

The documents listed in chapter 1 present the assessment of sea ice and atmospheric icing for the area of the Energy Island Baltic Sea wind farms. The documentation details the determination of key sea ice design parameters such as frost index, ice thickness, ice flow characteristics and ice properties. Additionally atmospheric icing is addressed. 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 observation reports for the region, on model data and measured data.

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 Energy Island Baltic Sea wind farms are detailed in /1.1.1/.

Long term ice observation reports 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/.

In addition, hindcast model data is used. The utilized model data is provided by the company "DHI" and is compared against local and regional measurements. A description of the model is included in /1.1.1/. 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 metocean data basis is evaluated in /1.2.9/.

Measurement locations for local and on-site measurements are presented in /1.1.1/. On-site measurements were executed by the company "Fugro" /1.2.1/. Independent testing and verification of the utilized buoys are documented in /1.2.2/ to /1.2.6/. The availability period of the different buoys and replacement of single buoys is presented in /1.2.7/. The evaluation of the measurement campaign is documented in /1.2.8/.

According to /1.1.1/ hummocked or ridged ice, compacted slush and rafted ice may occur at the wind farm site. The frost index and the ice thickness for the wind farm sites are presented for a return period of 5, 50 and 100 years. For a return period of 50 years an ice thickness of up to 0.3 m is predicted. Information on ice occurrence distribution, ice floe size, ice floe speed are presented.

Relevant atmosphere and sea water properties are listed.

Formulas and expected values for properties of ice including ice brine volume, porosity, poisson ratio, young's modulus and ice friction coefficient are presented in /1.1.1/. The ice strength is presented as bending strength, tensile strength and strength coefficient for return periods including 1 year, 50 years and 100 years. According to /1.1.1/, the tensile strength may conservatively be assumed to be the same as the bending strength.

Recommendations on vertical and dynamic ice loading for design are included in /1.1.1/. Separate load recommendations are given for ice ridges. According to /1.1.1/, thermal loads shall be considered for structures adjacent to main structures and for jack-up structures. Interaction of ice floes with foundation structures is expected to reduce the movement speed of ice, which shall be taken into consideration for assessing ice movement and ice strength.

According to /1.1.1/, atmospheric icing can be expected at the location of the planned wind farms. Marine and sea spray icing is assumed to reach a thickness of up to 100 mm and a density of 850 kg/m³. Atmospheric icing is assumed to be up to 30 mm thick and have a density of 700 kg/m³.

Lastly /1.1.1/ presents design load cases concerning ice loading to be considered in design.

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 is evaluated in R14772968-0-5, Rev. 1
- 6.2 Wind conditions at the site are evaluated in R14772968-0-1, Rev. 1
- 6.3 The data basis for metocean conditions at the site (Metocean Assessment Part A) is evaluated in R14772968-0-2, Rev. 0
- 6.4 The analysis of metocean conditions at the site (Metocean Assessment Part B) is evaluated in R14772868-0-3, Rev. 0

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 Energy Island Baltic Sea wind farms 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 Energy Island Baltic Sea Wind Farms.

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

Bremen, 2024-03-19

Expert in Charge

Rebecca Ley

DEWI-OCC Offshore and Certification Centre GmbH