



EVALUATION REPORT SITE CONDITIONS – WIND CONDITIONS

PREPARED FOR:
ENERGINET ELTRANSMISSION A/S

ORDER NO.: 14772868

*Report No.: R14772868-0-1, Rev. 1,
2023-12-22*

Wind Farm: Energy Island North Sea
Wind Farms

Evaluation Basis:
IECRE OD-502: Operational Document,
"Project Certification Scheme", Edition 1.0,
2018-10

CLASSIFICATION
CLIENT'S DISCRETION

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DOCUMENT HISTORY

REVISION	RELEASE DATE	AFFECTED PAGE(S)	MODIFICATION
0	2023-11-15	-	Initial Document
1	2023-12-22	5, 7	Addition of evaluation report for the measurement campaign /1.2.16/. Addition of chapter 6 including interfaces to other evaluation modules.

1. DOCUMENTS

1.1 Examined Documents

- /1.1.1/ EMD International A/S: Report
"Site Wind Conditions Assessment Energy Island North Sea",
Doc. No. 230331_22306_A_TS_2 Rev. 2, 2023-05-12, 250 pages
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+009)
- /1.1.2/ EMD International A/S: Document Package
"EMD-WRF data", 4 files
MD5 checksum: 54A878D8BD0D765A91A253378CDA7539
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+002)
- /1.1.3/ EMD International A/S: Document Package
"Filtered and repaired LiDAR data", 3 files pages
MD5 checksum: 554844AF46B232087BF07B04815E1FDD
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+003)
- /1.1.4/ EMD International A/S: Document Package
"FINO3 data", 2 files
MD5 checksum: 2104FFB74522A151A289E8236DED31C2
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+004)
- /1.1.5/ EMD International A/S: Document Package
"Long-term corrected LiDAR data", 4 files
MD5 checksum: 7C60466FCEC9498EE3AF4CCBC3EF4BD4
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+005)
- /1.1.6/ EMD International A/S: Document Package
"Raw buoy data", 43 file
MD5 checksum: F8397A47EEEF0A638A4A758848072490
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+006)
- /1.1.7/ EMD International A/S: Document Package
"Wind resource map", 2 files
MD5 checksum: FC609B2E37A5957E55D92753E53552F3
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+007)

1.2 Noted Documents

- /1.2.1/ 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)
- /1.2.2/ 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. -+011)
- /1.2.3/ 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)
- /1.2.4/ 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)
- /1.2.5/ 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)
- /1.2.6/ 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)
- /1.2.7/ 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)
- /1.2.8/ Energinet: Data Sheet
"Deployment record for Lot 1, North Sea", 1 page
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+015)

- /1.2.9/ Energinet: Data Sheet
"Deployment record for Lot 2, North Sea", 1 page
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+016)
- /1.2.10/ DNV GL: Certificate
"ISO 9001 Management System Certificate Fugro Norway AS",
Doc. No. 10000409040-MSC-NA-NOR, 2020-12-16, 2 pages
(DEWI-OCC Order-No.: 14772868 – Doc. No. -00+038)
- /1.2.11/ 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)
- /1.2.12/ Energinet: Excel-File
"Stations and deployment record - EI", 9318 kB
MD5 checksum: 821C2BD5165DD6F2C886EB606F0602AB
(DEWI-OCC Order-No.: 14772868 - Doc No. -00+040)
- /1.2.13/ Energinet: Document Package
"Buoy predeployment validation reports", 11 files
MD5 checksum: 31C235877CAA7B49E65ED01B63F81E11
(DEWI-OCC Order-No.: 14772868 – Doc. No. -00+041)
- /1.2.14/ Energinet: Document Package
"Instrument certificates and reports", 103 files
MD5 checksum: 4E57DF8944CAB3F13F0B921B83C8A57E
(DEWI-OCC Order-No.: 14772868 – Doc. No. -00+042)
- /1.2.15/ Energinet: Document Package
"Service reports", 50 files
MD5 checksum: BE9419A52E4F80B41BBFD5C3726D065D
(DEWI-OCC Order-No.: 14772868 – Doc. No. -00+043)
- /1.2.16/ DEWI-OCC GmbH: Evaluation Report
Site Conditions – Measurement Campaign for Wind and Metocean Conditions
Doc. No. R14772868-0-5, Rev. 0, 2023-12-22, 7 pages

2. CERTIFICATION SCHEME

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

3. APPLIED STANDARDS AND GUIDELINES

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

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

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

4. SCOPE OF EVALUATION

The wind conditions for the Energy Island North Sea Wind Farm documented in chapter 1 shall be evaluated for conformity with IECRE OD-502 /2.1/ with purpose of use in the design basis for FEED design and respective technical standards /3.1/ and /3.2/

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

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

5. REMARKS

5.1 General and site configuration

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

The documents listed in chapter 1 present the wind conditions for the Energy Island North Sea Wind Farm. The documentation details the wind conditions and relevant input parameters as well as the applied codes and standards to be used for the design basis for FEED design for the offshore wind farm.

Coordinates of the planned wind farm area are given in /1.1.1/. Wind conditions at the site were derived on the basis of LiDAR measurements and model data and are detailed in /1.1.1/ and /1.1.2/ to /1.1.7/. Hydrographic conditions at the wind farm 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

4.3.1 Wind conditions

Wind conditions for the site of the Energy Island North Sea Wind Farm are detailed in /1.1.1/ with background data given in /1.1.2/ to /1.1.7/.

Wind data was derived on the basis of floating LiDAR measurements of two buoys at location. In total 12 months of measurements were derived by the company "Fugro". Independent testing and verification of the LiDAR buoys is documented in /1.2.1/ to /1.2.7/. The availability period of the different buoys and replacement of single buoys is presented in /1.2.8/ and /1.2.9/.

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 /1.2.10/ to /1.2.15/. The evaluation of the measurement campaign is documented in /1.2.16/.

According to /1.1.1/ data was supplemented with secondary data from other measurement sites. Turbulence data is derived from secondary sources instead of in-site measurements.

Other data sources are listed including measurement height, measurement period and measurement length.

Data quality and selection as well as post-processing of data are discussed. According to /1.1.1/ the industry data filter of the LiDAR buoys was replaced by a custom filter. According to the author of /1.1.1/ the industry filter is not suitable for offshore use and testing was executed to ensure that the applied custom filter does not lower the data quality in comparison to the industry filter. The use of a custom filter is therefore acceptable. According to /1.1.1/ verification of the LiDAR buoys not impacted.

For long term correction a meso-scale wind model with 20 years of data was used and a wind model was created. According to /1.1.1/ the wind model is validated with data from 3 long term measurement sites.

Measurement data and data of the meso-scale model is given in /1.1.2/ to /1.1.7/.

A height of 150 m above mean sea level is chosen as reference height. Should the hub height or other relevant assumptions of the final chosen wind turbine deviate from the presented height and assumptions, data shall be reassessed.

Parameters for extreme wind conditions and normal wind conditions as well as information for wind shear and turbulence intensity are given in /1.1.1/. Values for gust are not presented. According to the author of /1.1.1/ on-site measurements are not suitable for derivation. Values for gust can be replaced by other given design values for site specific design, so this can be accepted. According to the author of /1.1.1/ estimated gust values can be provided if required during project progress.

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

6. INTERFACE TO OTHER EVALUATION MODULES

- 6.1 The measurement campaign is evaluated in R14772868-0-5, Rev. 0
- 6.2 The data basis for metocean conditions at the site of the Wind Farm Area and Energy Island (Metocean Assessment Part A) is evaluated in R14772868-0-2, Rev. 0
- 6.3 The data analysis for metocean conditions at the site of the Energy Island (Metocean Assessment Part B) is evaluated in R14772868-0-3, Rev. 0
- 6.4 The data analysis for Metocean conditions at the site of the Wind Farm Area (Metocean Assessment Part C) is evaluated in R14772868-0-4, Rev. 0

7. CONDITIONS

- 6.1. Should the hub height or other relevant assumptions of the final chosen wind turbine deviate from the presented assumptions and height of 150 m above sea level, data shall be reassessed.
- 6.2. If additional on-site measurement data becomes available, wind parameters shall be reassessed.
- 6.3. Values for gust, if used in design, shall be evaluated during the certification.

8. CONCLUSION

The wind conditions for the Energy Island North Sea Wind Farm presented in /1.1.1/ and the associated documents /1.1.2/ to /1.1.7/ submitted for review 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 wind conditions in the design basis for FEED design in the Energy Island North Sea Wind Farm.

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

Bremen, 2023-12-22

Expert in Charge

Dipl.-Geol. Rebecca Ley
DEWI-OCC GmbH