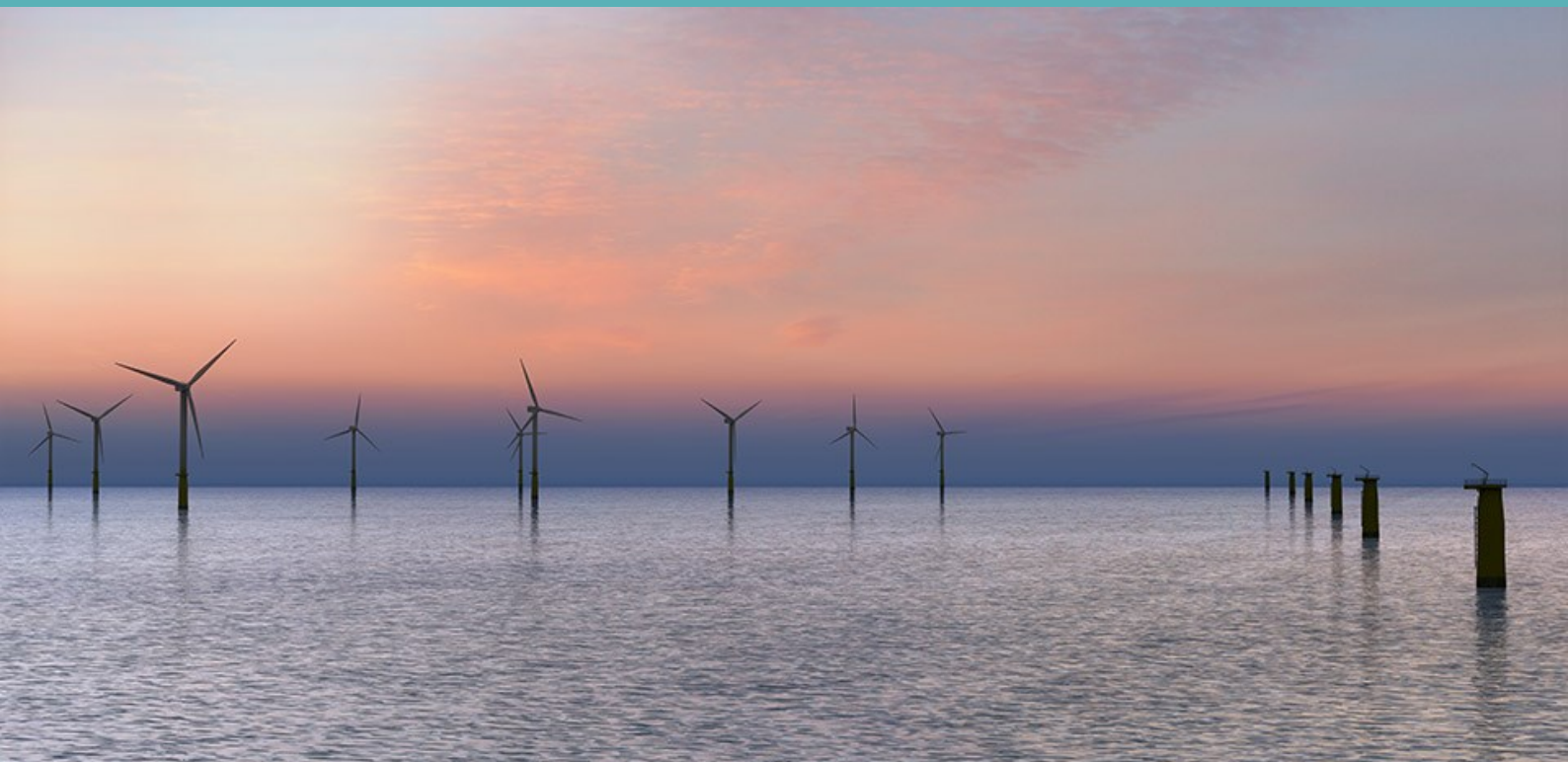


VCE

Vienna Consulting
Engineers ZT GmbH



VCE Offshore Reference Projects





Windfarm Butendiek, North Sea, Germany

Condition Monitoring System . Data Analysis . Web-User Interface

The offshore wind farm Butendiek was developed by the WTG AG and is being operated by Deutsche Windtechnik for the OWP Butendiek GmbH&Co.KG. The wind farm is situated 32km west of the island of Sylt in the North Sea area of Germany. The wind farm comprises a total of 80 wind turbines with an output of 3.6 megawatt each. The network is supplied with a performance of up to 288 MW via a transformer platform.

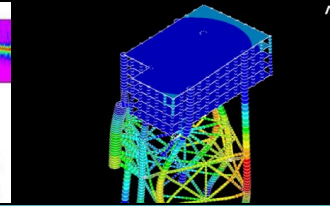
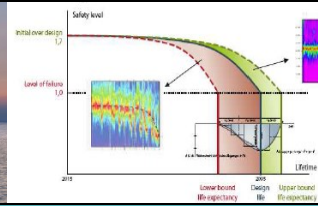
The foundations (mono-piles and transition pieces) of all 80 wind turbines are equipped with a condition monitoring system for permanent condition monitoring and monitoring of the ageing behaviour (fatigue). All measurement data are transmitted to an onshore server, analysed by software routines and all results are made available to the client in a web-user interface.

- Client: Butendiek Offshore Windpark GmbH & Co KG
- Location: Germany
- Service Period: 2017 – current
- Services: Software for data transmission, software for data analysis, web-user interface, support in the preparation of the monitoring reports for the authorities



WIMOS® Services conducted:

- | | | | | |
|------------------------------|--|--|--|--|
| Lifecycle Management: | <input checked="" type="checkbox"/> Condition Assessment | <input checked="" type="checkbox"/> Condition Monitoring | <input type="checkbox"/> Rehabilitation Planning | <input type="checkbox"/> Quality Control |
| | <input checked="" type="checkbox"/> Lifetime Assessment | <input type="checkbox"/> Traffic Analysis | <input checked="" type="checkbox"/> Environmental Influences | <input type="checkbox"/> Risk Assessment |
| Special Measurements: | <input type="checkbox"/> Attendant Monitoring | <input type="checkbox"/> Noise and Vibrancy | <input type="checkbox"/> Deflection Measurements | <input type="checkbox"/> Seismics |



East Anglia ONE

The East Anglia ONE site is located in the southern North Sea within the south-eastern area of the East Anglia Zone, which was identified as part of The Crown Estate Round offshore wind leasing process. The East Anglia ONE site covers an area of approximately 300 km², and it is located approximately 45 km southeast of the town of Lowestoft.

The project will consist of 102 wind turbines (Siemens SWT – 7MW) and associated 3 legged, pre-piled jacket foundations, and an offshore substation (OSS) with a 4 leg jacket construction at water depths generally ranging from 40 to 50m. The minimum design service life shall be 25 years. The planned export cable route is approximately 85 km in length offshore and 37 km onshore, with a landfall at Bawdsey.

EA1 OWF will be fully operational in 2020. Its structures are manufactured on several yards, eg. in Dubai, in Northern Ireland and in Spain.

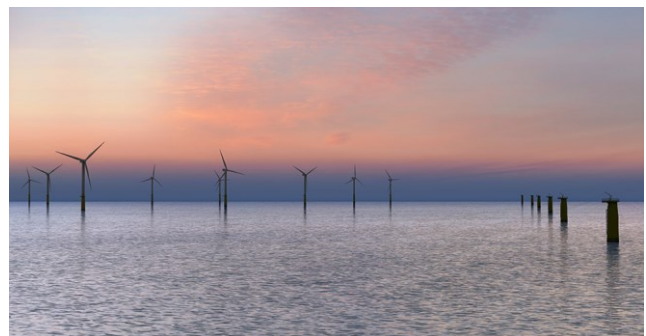
VCE designs, delivers installs and operates a structural health monitoring system (SHMS) with focus on foundation of the WTGs and also the OSS (offshore sub-station). In total 9 WTGs will be equipped with sensors for permanent evaluation of the structures' condition.

All monitoring data is forwarded to a monitoring server at an on-shore station. At this central monitoring unit data from totally 243 sensors gets evaluated on consequently automatically pre-rated.

Furthermore VCE is commissioned to evaluate all monitoring data and to set up reference models of the structures for on-going model update and condition assessment.

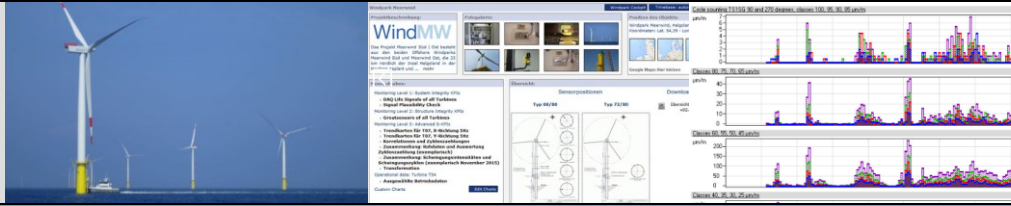
Finally the server-based monitoring software automatically generates a periodic report in order to help the client to assess the condition of the structure sufficiently. This allows data management with reasonable effort. All data is available via web-access at the monitoring server.

- Client: East Anglia One Ltd.
- Location: Southern North Sea
- Service Period: 2017 – ongoing
- Services:



WIMOS® Services conducted:

- | | | | | |
|------------------------------|--|--|--|--|
| Lifecycle Management: | <input checked="" type="checkbox"/> Condition Assessment | <input checked="" type="checkbox"/> Condition Monitoring | <input type="checkbox"/> Rehabilitation Planning | <input type="checkbox"/> Quality Control |
| | <input checked="" type="checkbox"/> Lifetime Assessment | <input type="checkbox"/> Traffic Analysis | <input checked="" type="checkbox"/> Environmental Influences | <input type="checkbox"/> Risk Assessment |
| Special Measurements: | <input type="checkbox"/> Attendant Monitoring | <input type="checkbox"/> Noise and Vibrancy | <input type="checkbox"/> Deflection Measurements | <input type="checkbox"/> Seismics |



Wind Park Meerwind South / East, Germany Condition Monitoring System . Data Analysis . Web-User Interface

The project Meerwind South / East consists of the two offshore wind parks Meerwind South and Meerwind East, which were planned and constructed 23 km north of Helgoland island in the North Sea and are maintained from Helgoland. The wind park comprises a total of 80 wind turbines with an output of 3.6 megawatt each. The network is supplied with a performance of up to 288 MW via a transformer platform.

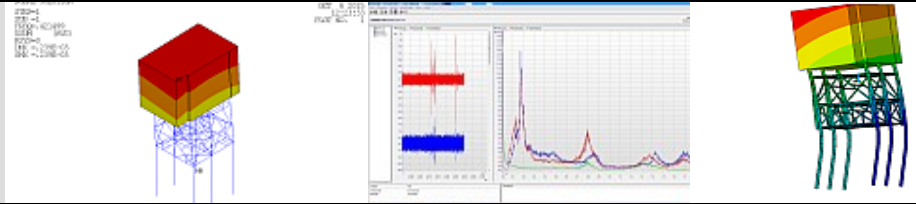
The foundations (mono-piles and transition pieces) of all 80 wind turbines are equipped with a condition monitoring system for permanent condition monitoring and monitoring of the ageing behaviour (fatigue). All measurement data are transmitted to an onshore server, analysed by software routines and all results are made available to the client in a web-user interface.

- Client: Airwerk GmbH
- Location: Germany
- Service Period: 2015 – current
- Services: Software for data transmission, software for data analysis, web-user interface, support in the preparation of the monitoring reports for the authorities



WIMOS® Services conducted:

- | | | | | |
|------------------------------|--|--|--|--|
| Lifecycle Management: | <input checked="" type="checkbox"/> Condition Assessment | <input checked="" type="checkbox"/> Condition Monitoring | <input type="checkbox"/> Rehabilitation Planning | <input type="checkbox"/> Quality Control |
| | <input checked="" type="checkbox"/> Lifetime Assessment | <input type="checkbox"/> Traffic Analysis | <input checked="" type="checkbox"/> Environmental Influences | <input type="checkbox"/> Risk Assessment |
| Special Measurements: | <input type="checkbox"/> Attendant Monitoring | <input type="checkbox"/> Noise and Vibrancy | <input type="checkbox"/> Deflection Measurements | <input type="checkbox"/> Seismics |



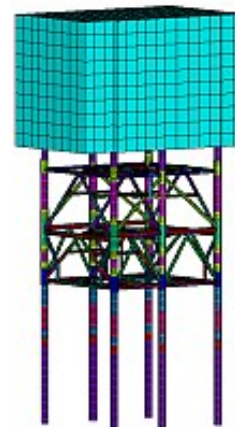
HelWinBeta Platform

The objective of the monitoring system is to identify the performance of the structure and the interrelation of piles and jacket. For this purpose a system identification campaign is proposed. It consists of:

- Measurement of the dynamic response of the platform by a mobile system
- Work out a structural model and perform a dynamic analysis
- Compare measured frequencies with computed frequencies
- Adjust the model to the measured characteristic
- Draw conclusions on performance
- Work out recommendations
- Explain the findings in detail

- Client: TenneT TSO GmbH
- Location: North Sea, Germany
- Service Period: since 2015

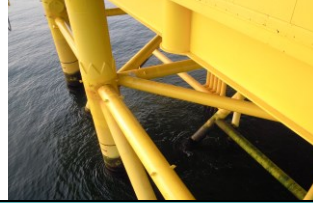
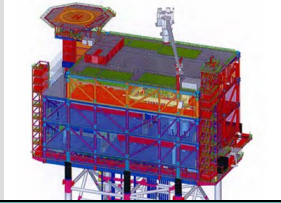
ELEMENTS
222 128



MESH 10-001
PLAT 100 1

WIMOS® Services conducted:

- | | | | | |
|------------------------------|--|--|--|--|
| Lifecycle Management: | <input checked="" type="checkbox"/> Condition Assessment | <input checked="" type="checkbox"/> Condition Monitoring | <input type="checkbox"/> Rehabilitation Planning | <input type="checkbox"/> Quality Control |
| | <input checked="" type="checkbox"/> Lifetime Assessment | <input type="checkbox"/> Traffic Analysis | <input checked="" type="checkbox"/> Environmental Influences | <input type="checkbox"/> Risk Assessment |
| Special Measurements: | <input type="checkbox"/> Attendant Monitoring | <input type="checkbox"/> Noise and Vibrancy | <input type="checkbox"/> Deflection Measurements | <input type="checkbox"/> Seismics |

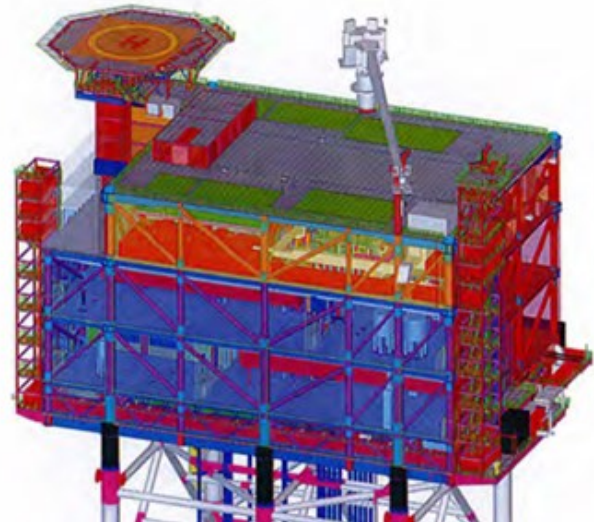


Development of a SHM Concept for DolWinAlpha Platform

The scope of work included the development of a comprehensive monitoring concept for the platform and the drafting of a design document for life-time monitoring. The special focus was on the dynamic behavior of the structure, the welded joints and the grouted joints.

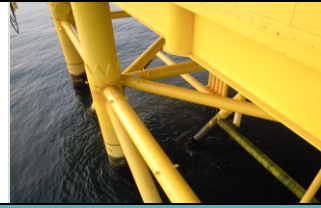
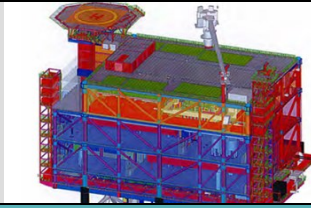
The concept also included the estimation of implementation costs for all monitoring services.

- Client: TenneT TSO GmbH
- Location: North Sea, Germany
- Service Period: 2014



WIMOS® Services conducted:

- | | | | | |
|------------------------------|--|--|--|--|
| Lifecycle Management: | <input checked="" type="checkbox"/> Condition Assessment | <input checked="" type="checkbox"/> Condition Monitoring | <input type="checkbox"/> Rehabilitation Planning | <input type="checkbox"/> Quality Control |
| | <input checked="" type="checkbox"/> Lifetime Assessment | <input type="checkbox"/> Traffic Analysis | <input checked="" type="checkbox"/> Environmental Influences | <input type="checkbox"/> Risk Assessment |
| Special Measurements: | <input type="checkbox"/> Attendant Monitoring | <input type="checkbox"/> Noise and Vibrancy | <input type="checkbox"/> Deflection Measurements | <input type="checkbox"/> Seismics |



Motion Analysis DolWinAlpha Platform

The platform DolWin alpha was experiencing unexpectedly high motions in the topside, even in moderate weather/sea conditions, which are having a detrimental effect on the platform's electrical equipment and may also result in premature fatigue damage.

The scope of work included a motion analysis of DolWin1 platform split up into two phases. In the first phase, measurements of the platform movements were taken and an analysis of the data was performed. Within the second phase, the achieved data was compared with the expected structural response of the platform derived from a dynamic structural model. The final step was to propose a technical solution to reduce the motions.

- Client: TenneT TSO GmbH
- Location: North Sea, Germany
- Service Period: 2015



WIMOS® Services conducted:

- | | | | | |
|------------------------------|--|--|--|--|
| Lifecycle Management: | <input checked="" type="checkbox"/> Condition Assessment | <input checked="" type="checkbox"/> Condition Monitoring | <input type="checkbox"/> Rehabilitation Planning | <input type="checkbox"/> Quality Control |
| | <input checked="" type="checkbox"/> Lifetime Assessment | <input type="checkbox"/> Traffic Analysis | <input checked="" type="checkbox"/> Environmental Influences | <input type="checkbox"/> Risk Assessment |
| Special Measurements: | <input type="checkbox"/> Attendant Monitoring | <input type="checkbox"/> Noise and Vibrancy | <input type="checkbox"/> Deflection Measurements | <input type="checkbox"/> Seismics |



On-board Calibration and Adjustment of Mooring System of AmirKabir Semi-Submersible Drilling Unit in the Caspian Sea

The mooring system of the AmirKabir semi-submersible drilling unit, which is located in the Caspian Sea, was calibrated. Therefore the cable (chain) forces of a total of 8 winches were measured for different loads and compared against the winch load monitoring system. In case of unacceptable deviations the winch system was adjusted to match the cable (chain) force readings.

The services were carried out by the VCE from 26 April to 08 May 2014.

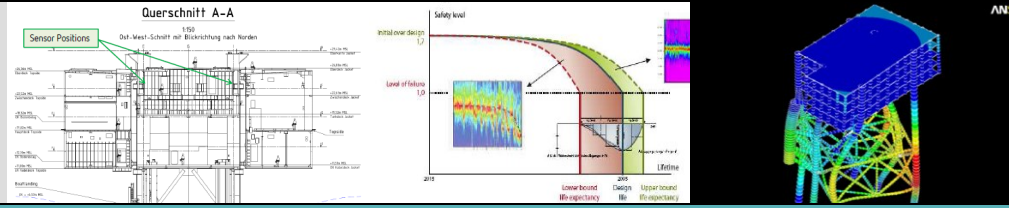
The cable (chain) forces were determined by the BRIMOS® 12.1 based method developed by applying the BRIMOS® Recorder with an external 3D-accelerometer. This equipment has been applied worldwide for measurement of cable forces at more than 7,500 cables since 2001. The recorder captured the vibration behavior of cables with an accuracy better than 0.1 %. The cable force was determined from the geometry of the cable, the cable properties and the fundamental frequencies.

- Client: The North Drilling Company
- Location: Caspian Sea, Azeri Continental Shelf
- Service Period: 2014



WIMOS® Services conducted:

- | | | | | |
|------------------------------|--|--|--|--|
| Lifecycle Management: | <input checked="" type="checkbox"/> Condition Assessment | <input checked="" type="checkbox"/> Condition Monitoring | <input type="checkbox"/> Rehabilitation Planning | <input type="checkbox"/> Quality Control |
| | <input checked="" type="checkbox"/> Lifetime Assessment | <input type="checkbox"/> Traffic Analysis | <input checked="" type="checkbox"/> Environmental Influences | <input type="checkbox"/> Risk Assessment |
| Special Measurements: | <input type="checkbox"/> Attendant Monitoring | <input type="checkbox"/> Noise and Vibrancy | <input type="checkbox"/> Deflection Measurements | <input type="checkbox"/> Seismics |

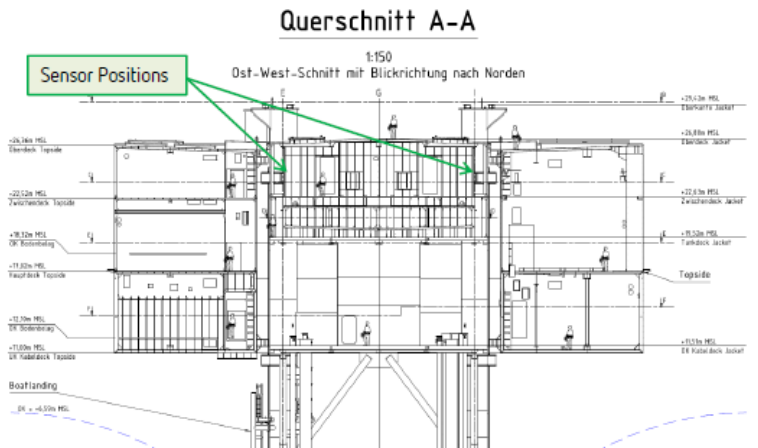


Development of a SHM Concept for OSS Baltic 2

The scope of work included the development of a comprehensive monitoring concept for the platform and the drafting of a design document for life-time monitoring. The special focus was on the dynamic behavior of the structure, the welded joints and the grouted joints.

The concept also included the estimation of implementation costs for all monitoring services.

- Client: Weser Wind GmbH
- Location: Baltic Sea
- Service Period: 2013



WIMOS® Services conducted:

- | | | | | |
|------------------------------|--|--|--|--|
| Lifecycle Management: | <input checked="" type="checkbox"/> Condition Assessment | <input checked="" type="checkbox"/> Condition Monitoring | <input type="checkbox"/> Rehabilitation Planning | <input type="checkbox"/> Quality Control |
| | <input checked="" type="checkbox"/> Lifetime Assessment | <input type="checkbox"/> Traffic Analysis | <input checked="" type="checkbox"/> Environmental Influences | <input type="checkbox"/> Risk Assessment |
| Special Measurements: | <input type="checkbox"/> Attendant Monitoring | <input type="checkbox"/> Noise and Vibrancy | <input type="checkbox"/> Deflection Measurements | <input type="checkbox"/> Seismics |



Development of a SHM Concept for BorWinAlpha Platform

The scope of work included the development of a comprehensive monitoring concept for the platform and the drafting of a design document for life-time monitoring. The special focus was on the dynamic behavior of the structure, the welded joints and the grouted joints.

The concept also included the estimation of implementation costs for all monitoring services.

- Client: TenneT TSO GmbH
- Location: North Sea, Germany
- Service Period: 2014



WIMOS® Services conducted:

- | | | | | |
|------------------------------|--|--|--|--|
| Lifecycle Management: | <input checked="" type="checkbox"/> Condition Assessment | <input checked="" type="checkbox"/> Condition Monitoring | <input type="checkbox"/> Rehabilitation Planning | <input type="checkbox"/> Quality Control |
| | <input checked="" type="checkbox"/> Lifetime Assessment | <input type="checkbox"/> Traffic Analysis | <input checked="" type="checkbox"/> Environmental Influences | <input type="checkbox"/> Risk Assessment |
| Special Measurements: | <input type="checkbox"/> Attendant Monitoring | <input type="checkbox"/> Noise and Vibrancy | <input type="checkbox"/> Deflection Measurements | <input type="checkbox"/> Seismics |



Development of a SHM Concept for OSS Baltic 2

The scope of work included the development of a comprehensive monitoring concept for the platform and the drafting of a design document for life-time monitoring. The special focus was on the dynamic behavior of the structure, the welded joints and the grouted joints.

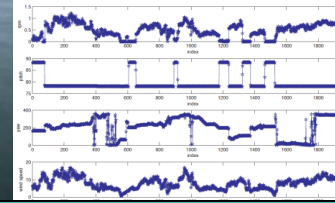
The concept also included the estimation of implementation costs for all monitoring services.

- Client: TenneT TSO GmbH
- Location: North Sea, Germany
- Service Period: 2014



WIMOS® Services conducted:

- | | | | | |
|------------------------------|--|--|--|--|
| Lifecycle Management: | <input checked="" type="checkbox"/> Condition Assessment | <input checked="" type="checkbox"/> Condition Monitoring | <input type="checkbox"/> Rehabilitation Planning | <input type="checkbox"/> Quality Control |
| | <input checked="" type="checkbox"/> Lifetime Assessment | <input type="checkbox"/> Traffic Analysis | <input checked="" type="checkbox"/> Environmental Influences | <input type="checkbox"/> Risk Assessment |
| Special Measurements: | <input type="checkbox"/> Attendant Monitoring | <input type="checkbox"/> Noise and Vibrancy | <input type="checkbox"/> Deflection Measurements | <input type="checkbox"/> Seismics |



Baltic Hub

Structural Condition Monitoring

The project Baltic Hub consists of Baltic Eagle and Wikinger Süd wind farms with approx. 50 wind turbines which are in the German part of the Baltic Sea.

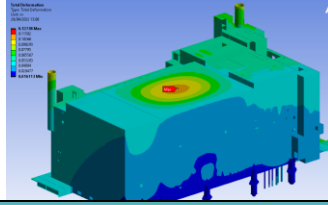
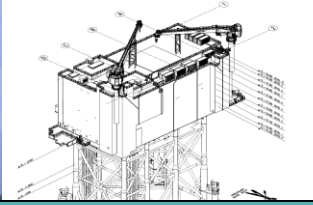
The Mono-pile foundations and transition pieces are provided with a temporary vibration monitoring. This vibration monitoring consists of a single accelerometer and a datalogger. The measurement data are analysed automatically, described comprehensibly and send to the client.

- Client: Baltic Eagle GmbH
- Location: Germany
- Service Period: 2021 – current
- Services: Software for data transmission, software for data analysis, web-user interface, support in the preparation of the monitoring reports for the authorities



WIMOS® Services conducted:

- | | | | | |
|------------------------------|--|--|--|--|
| Lifecycle Management: | <input checked="" type="checkbox"/> Condition Assessment | <input checked="" type="checkbox"/> Condition Monitoring | <input type="checkbox"/> Rehabilitation Planning | <input type="checkbox"/> Quality Control |
| | <input checked="" type="checkbox"/> Lifetime Assessment | <input type="checkbox"/> Traffic Analysis | <input checked="" type="checkbox"/> Environmental Influences | <input type="checkbox"/> Risk Assessment |
| Special Measurements: | <input type="checkbox"/> Attendant Monitoring | <input type="checkbox"/> Noise and Vibrancy | <input type="checkbox"/> Deflection Measurements | <input type="checkbox"/> Seismics |



SHM of 12 TenneT Platforms, North Sea

Structural Health Monitoring System . Data Analysis . Web-User Interface

The 12 transverter platforms of TenneT are situated in the North Sea more than 100km from shore. All 12 platforms to be monitored have a capacity of more than 6.500 MW.

VCE installs on all 12 platforms structural health monitoring systems. The installations take place onshore as well as offshore. The monitoring records platform movements and environmental impacts and compares the data with the condition as designed. All measurement data are transmitted to an onshore server, analysed by software routines and all results are made available to the client in a web-user interface.

- Client: TenneT TSO GmbH
- Location: North Sea, Germany
- Service Period: 2022-current
- Services: Planning and Installation of SHM System, Software for data transmission, software for data analysis, web-user interface, support in the preparation of the monitoring reports for the authorities



WIMOS® Services conducted:

- | | | | | |
|------------------------------|--|--|--|--|
| Lifecycle Management: | <input checked="" type="checkbox"/> Condition Assessment | <input checked="" type="checkbox"/> Condition Monitoring | <input type="checkbox"/> Rehabilitation Planning | <input type="checkbox"/> Quality Control |
| | <input checked="" type="checkbox"/> Lifetime Assessment | <input type="checkbox"/> Traffic Analysis | <input checked="" type="checkbox"/> Environmental Influences | <input type="checkbox"/> Risk Assessment |
| Special Measurements: | <input type="checkbox"/> Attendant Monitoring | <input type="checkbox"/> Noise and Vibrancy | <input type="checkbox"/> Deflection Measurements | <input type="checkbox"/> Seismics |