Belwind Offshore Energy

Annual work report 2017

Offshore wind energy power plant

Belwind

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1 Introduction

The Belwind offshore wind farm is located on the Belgian Continental Shelf, within the Belgian Exclusive Economic zone. The distance from the wind farm to the nearest point at the shore (Zeebrugge) is approximately 46 km (Figure 1).

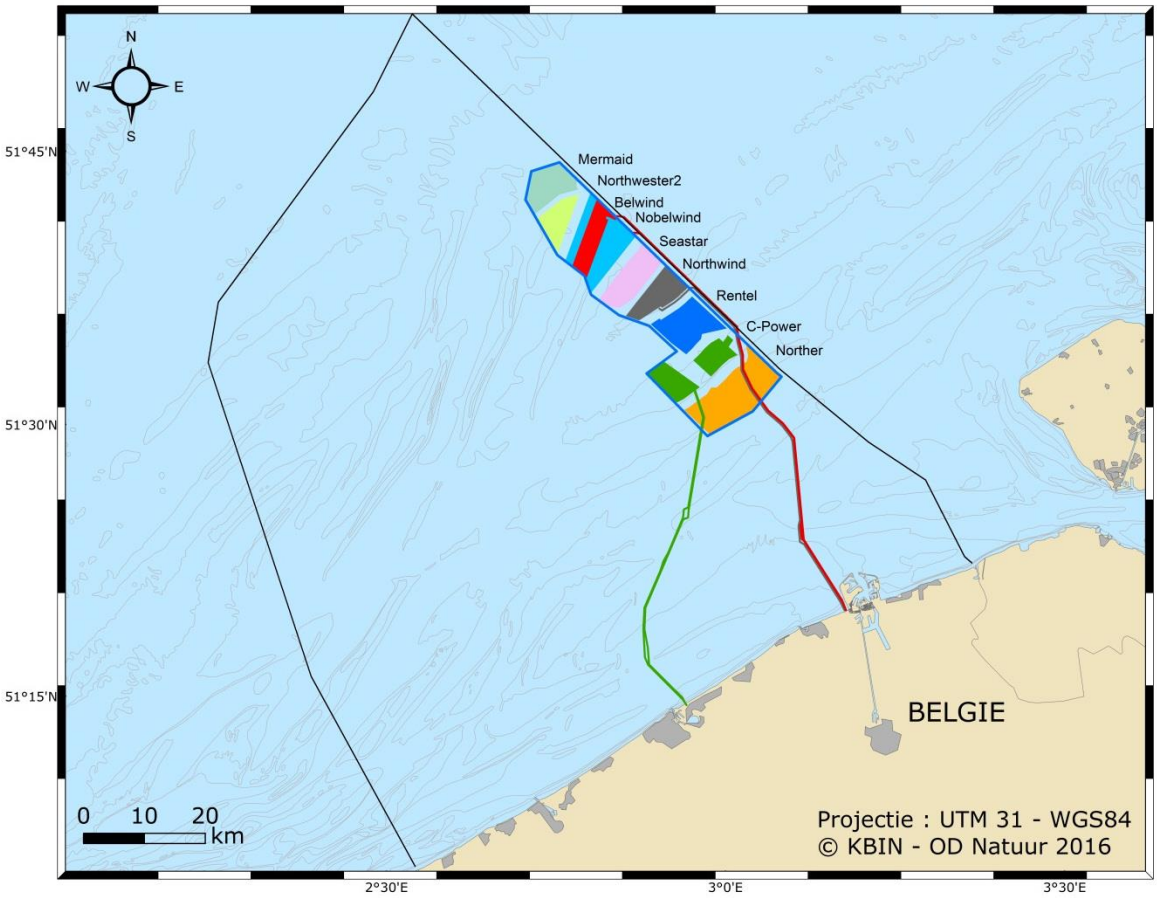


Figure 1: Location offshore wind farm Belwind

2 Project overview

According the authorization for the construction and a license for the operation of a wind farm on the Bligh Bank in the Belgian sea areas article, the wind farm should be constructed in two phases.

Belwind consists of 55 wind turbines of 3 MW each (Vestas V90) and an Offshore High Voltage Station (OHVS). Via a local grid (33 kV) the wind turbines are connected to the OHVS. The energy is transported to shore by a 150 kV submarine cable. Belwind has been erected in 2009 and 2010 and is fully operational since January 2011.

Figure 2: Locations of the wind turbines and the grid connection of Belwind

In 2013 and 2014, the realization of the Belwind Demo project was started. This project consists of the installation of a jacket foundation and a 6 MW windturbine (GE Haliade 6M – rotordiameter 150m) at location L01. The Belwind Demo project received its 33 kV cable installation in 2014 during the summer. Once the cable was connected the commissioning of the Haliade 150 Turbine got on its way. The WTG produces since 2015 green energy via a direct drive concept and had at time of erection the biggest blade rotor size in operation.
In November 2015 the division of Alstom Power has been taking over by GE Renewables.

The development of Phase 2, Belwind 2 or Belwind phase 2, was started in 2014. For the development, a new company was created, named Nobelwind in which funds was found for the pre-development. The shareholders of the Nobelwind are the same shareholders as in Belwind. In line with the Royal Decrees 20/12/2000 (Domain concession), 12/03/2002 (Sea-cable) and 07/09/2003 (Marine Environmental permit), the partial split of the initial domain concession, sea-cable permit and Marine Environmental permit, has been applied by Belwind and Nobelwind. Nobelwind obtained in 2015 the necessary authorization for the realization of the windfarm.

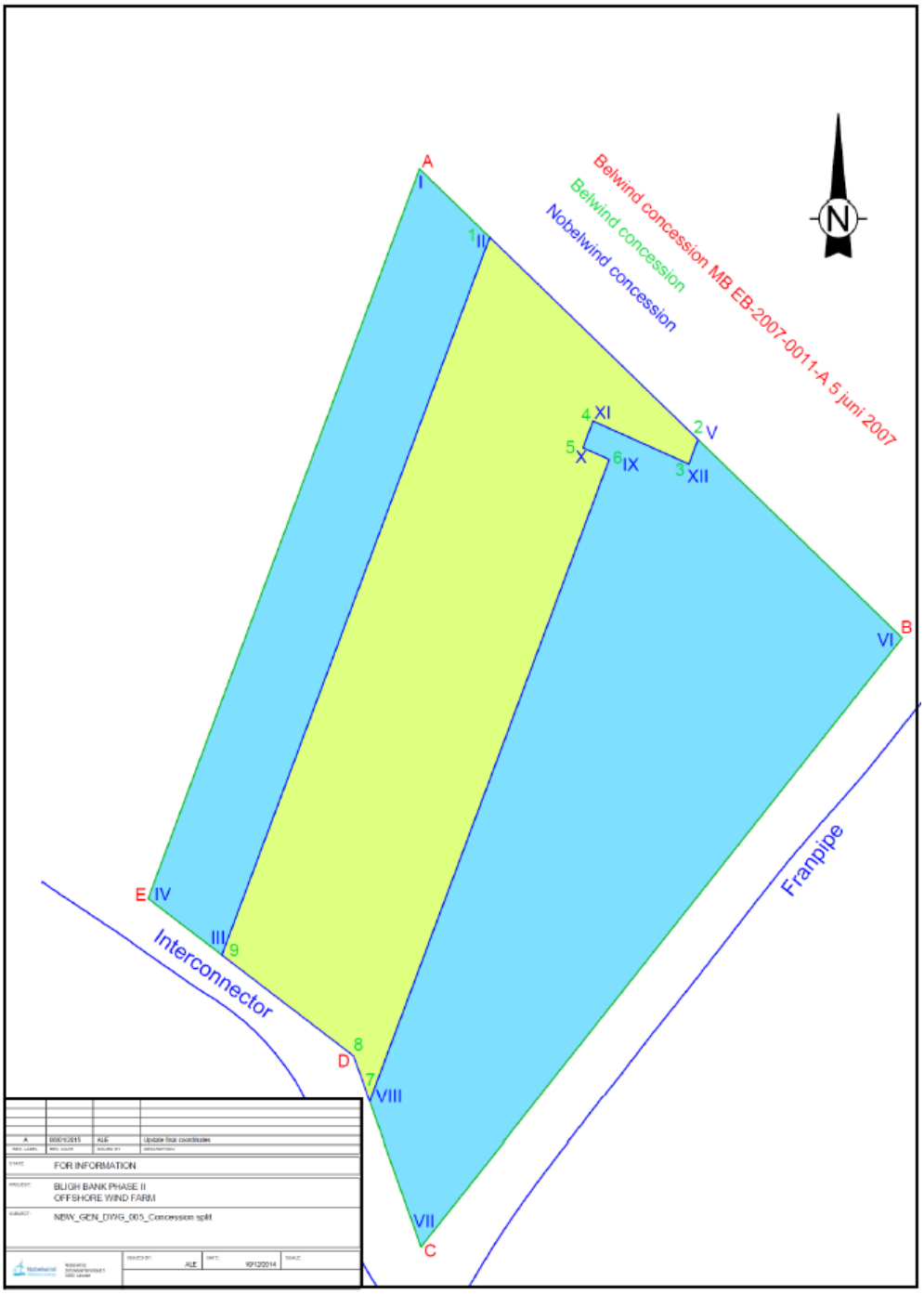


Figure 3: Domain concessions Belwind and Nobelwind

Nobelwind consists of 50 WTG's, type Vestas V112 3,3 MW, total of 165 MW and one OHVS. A 220 kV interconnector cable connects this OHVS with the Northwind OHVS. Energy is transported to land via the existing 220 kV export cable, named Cableco. Construction of Nobelwind started in 2016. The first energy has been produced since January 2017 and Nobelwind is fully operational as of May 2017.

3 Construction works on the Belwind concession

The Nobelwind activities have mostly been performed on the outside of the Belwind concession boundaries. However, the installation of the Nobelwind OHVS with its foundation has been located inside the Belwind concession. For these works a temporary Nobelwind work zone was defined in agreement with the Belwind operations. The Nobelwind OHVS is connected with the already pre-installed 220kV interconnector cable which leads the High Voltage energy via the OHVS of Northwind and a shared Cableco 220kV export cable to shore (Elia substation located in Zeebrugge).

Also, the cables leading to the NBW concession Wind Turbine Generators (WTG`s) have partially been installed in the Belwind concession. These infield cables have been buried by jetting technique and do cross other cables at few locations. These cable crossings are designed with matrasses separating both cables. Between the Belwind OHVS and the Nobelwind OHVS a 33kV cable was installed as a purpose to be able to back-feed either of the windfarm assets in case of a major export cable damage. This seriously mitigates the risk of the WTG`s deteriorating under offshore conditions when not powered. This 33kV coupling cable has been pulled in on the BW OHVS via the spare J-tube which received a new adapted bellmouth for this purpose as the bellmouth was buried under scour protection. Mattresses were installed to prevent damage on the cable during pull-in and the cable was trenched and stone buried near the OHVS.

4 Wind farm annual operations information

Below figures cover the 55 MVOW V90 turbines. The GE Haliade demo project is covered in chapter 5.

4.1 Production

4.1.1 Performance of the wind farm

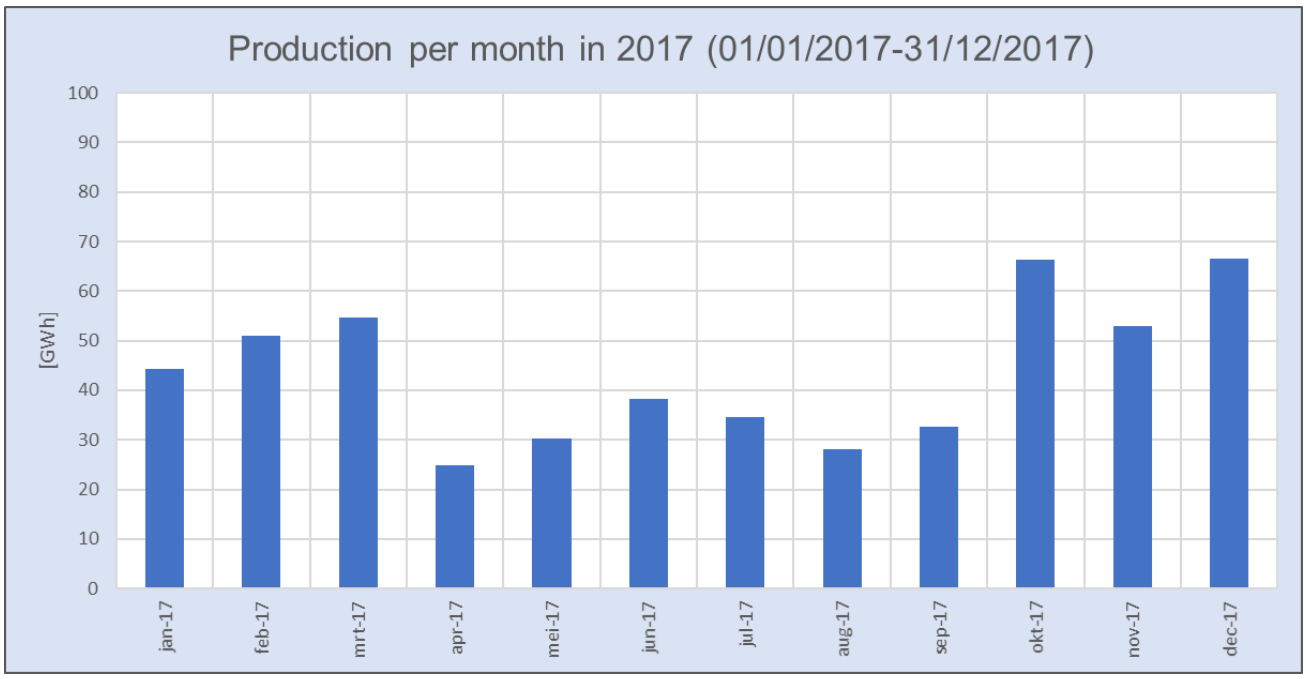


Figure 4: Monthly production V90 2017

4.1.2 Wind rose & energetic wind rose

The displayed wind rose is a graphical representation of the wind speed and direction measured all over the wind farm (see Figure 5). For all wind speed categories, the wind direction WSW prevails.

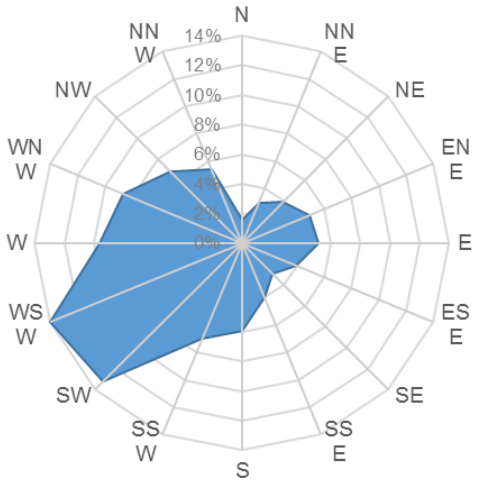


Figure 5: Energetic wind-rose

4.2 Maintenance

4.2.1 Planned Maintenance

MVOW, the service contractor for the Belwind **V90 WTG's**, performed the following planned maintenance and inspections in 2017:

- Annual service: yearly an annual service is done on all the turbines. The annual service takes three full days per turbine. Every component is carefully inspected and made sure it will operate correctly for the next year;
- 7-yearly service: At the end of 2017 49/55 of the V90 turbines received their 7-yearly service.
- Statutory inspections: on regular intervals, the service elevator (3 months), the Acta crane on the transition piece (1year) and the hook-on points (1 year) are inspected and certified by a 3rd party;
- MVOW HV inspections: every year, all the HV equipment on the turbines (transformer and switchgears) is inspected by MVOW;
- HV inspections: every year, MVOW skilled technicians and a third party inspect and certifies the HV installation. The switchgear in the turbines is inspected with ultra-sonic equipment;
- Blade inspections: All blades from all WTG's were inspected by the use of drones. Due to some delay in UK, the inspections started later than expected, being the beginning of April. As the drones and the cameras are constantly evolving and more detailed analyses can be done, MVOW concluded that there was a big amount of blade damages in different categories.

  As soon as the results were available, Belwind and MVOW took immediate actions. A blade repair team was created, vessels were arranged and all equipment was ordered.

  As from the 3rd May of May Bluefort (hotel vessel) is operational for the blade repair campaign. The Bluefort is a ferry, rebuild as a hotel vessel which is anchored just outside the wind farms. On the Bluefort 80 technicians were permanently housed. To get to the turbines, the technicians are transported by CTV. There were 2 CTV's operational, the NOS Advancer and the NOS Assister.

Figure 6: Bluefort

Repairs were executed by:

- **Rope workers:** Rope workers are working on rather small damages and all lightning damages (see Figure 7);
- **Sky climbers:** Sky climbers are used for the bigger damages (see Figure *7* 13).

Figure 7: Rope workers at work on BW

Figure 8: Sky climbers in use

The blade project came to an end in September. In total 27 full blade repairs were done (7x cat 4 and 20x cat 3). As immediate actions were taken, all blade damages are under control.

The maintenance contract of the **electrical installation** with CG is still actual.

Booster station:

CG Holding and Parkwind performed all planned maintenance:

- Yearly mandatory statutory inspections of high voltage installation;
- Yearly maintenance on all low voltage parts of the installation;
- 3 Monthly visual inspection of the high voltage parts of the installation;
- Annual maintenance of Fire detection & Fire Fighting;
- 3 Monthly maintenance on all SCADA systems and IT infrastructure.

Offshore High Voltage Station:

CG Holding and Parkwind performed all planned maintenance:

- Yearly mandatory statutory inspections of high voltage installation carried out by supplier: this inspection was carried out according to legal criteria (AREI) and no major observations were made;
- 3-monthly mandatory statutory inspections of all lifting equipment by supplier: all secondary equipment, cables, chains, slings, hooks and the cranes mechanisms are inspected to see if any aging or damage has occurred to the equipment;

- 3-monthly mandatory statutory inspections of all personal protective equipment by supplier: the inspection focuses on the state of all PPE's used and verifies if all PPE are maintained and used as intended by the manufacturer;
- Yearly inspection and maintenance of the fire detection system this maintenance campaign focuses on testing of the fire detection equipment and fire control cabinet functions;
- Yearly inspection and maintenance of the firefighting this maintenance campaign focuses on the firefighting equipment, e.g. pressure on the firefighting gas and portable fire bottles and test of the release valves and activation push buttons;
- Yearly maintenance of HVAC installation: annual replacement of filters, functional tests of all valves & sensors, inspection of the ice water machine and cleaning of the heat exchange condensers is performed;
- Yearly inspection of diesel fuel system: general inspection of the diesel generator, pumps and valves are focused during this yearly maintenance. The diesel tank and its leak detection is also checked;
- Yearly inspection of life saving equipment (life jackets, life raft, immersion suits and portable fire extinguisher) by supplier;
- Thermal Imaging LV, MV and HV equipment: CG carried out regular inspection using thermal imaging camera;
- Ultrasonic inspection of MV and HV equipment: CG carried out regular inspection using ultra sonic measuring equipment;
- No extra maintenance has been done during 2016 on the bilge water separator, filters will be replaced during de first semester of 2018;
- Due to lack of time in the painting campaign, no painting repairs were performed in 2017 on the BW OHVS. This will be rectified by having the campaign in the first semester of 2018;
- Coupling cable between BW OHVS and NBW OHVS has been pulled in on BW OHVS and is installed in the first quarter of 2017 (see Figure 9).

Figure 9: Coupling cable on Belwind OHVS

On the **foundations**, the following tasks have been performed in 2017 as part of the routine maintenance:

- Inspection, maintenance and recertification of the fall arrest systems in spring;
- Inspection of cathodic protection by several techniques such as drop-cell and ROV stab measurements;
- Survey of cables and scour protection by multi-beam survey;
- Internal foundation inspection, especially focused on corrosion in fall;
- Internal and external NDT-inspections of welds, bearings and boat landing studs;
- ROV inspection of outer submerged foundation to evaluate the marine growth and presence of ropes, fishing nets, rocks or other debris;
- Inspection of paint by qualified paint inspector and subsequent touch-up, especially on the ladders and top platforms;
- Paint repairs if necessary: on some foundations, some of the circumferential welds have been repaired as paint was flaking and not adhered any longer. Smaller repairs were done on the ladders and railing on the topside. A tender process was held to select the best coating contractor for all coating repairs on all Parkwind concessions.

5 The Belwind DEMO project ‘Haliade’ GE

5.1 Production

5.1.1 Performance of the WTG

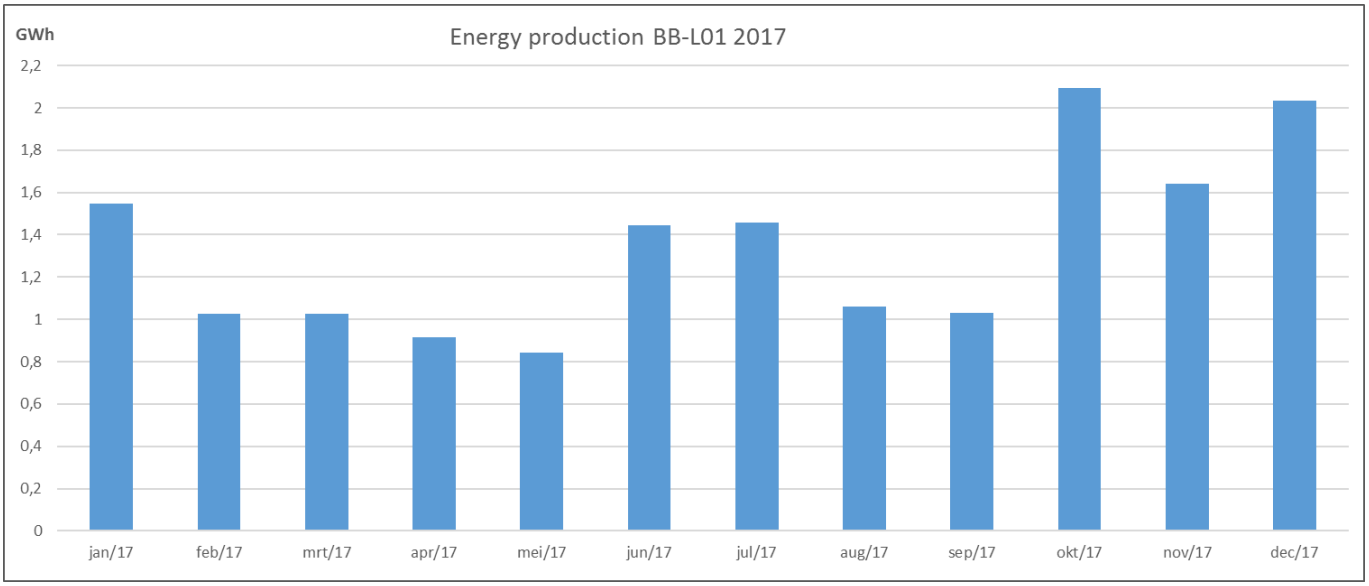


Figure 10: Monthly production GE-Haliade 2017

6 Environmental Research

The MUMM coordinated all the foreseen standard environmental monitoring activities in the field. There was a continuation of the bird assessments, the fish assessments by line fishing and trawl net fishing as further research activities on the fouling organisms on the foundations and scour protection, the seabed and the fauna at the reef balls. In collaboration with scientific organizations, some dedicated programs were also started-up in 2017.

6.1 Bat Monitoring

Like the bat monitoring activities in 2015 and 2016, Belwind facilitated the installation of a bat monitoring equipment on the Belwind OHVS in August 2017. The recorded ultrasonic signals allow for the researchers to diversify the different species and note their presence as passing by or as more local.

Figure 11: Installation of bat recorder system on Belwind OHVS Cable deck

6.2 Fish telemetry installation

Following previous campaigns where the presence of cod was monitored in the Belwind windfarm, a research project "PCAD4D" was set-up that would investigate the effects of a seismic survey on the behavior of Atlantic cod. A full seismic survey is scheduled to take place near to a Dutch wind farm in 2018 during which Belwind would serve as the non-exposed reference location for the acoustic telemetry experiments. These telemetry experiments involve tagging cod with an acoustic tag whose signal can be picked up by installed receivers in Belwind (Figure 12).

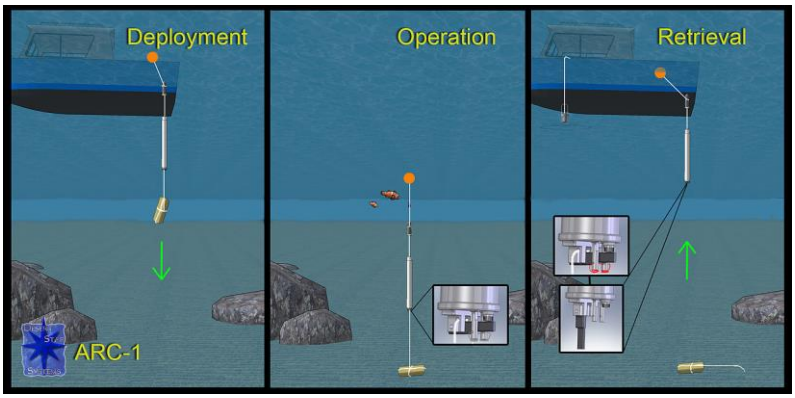


Figure 12:Deployment and retrieval of Fish telemetry devises

During the summer of 2017, different scenarios of receivers and number of fish tagged were explored to gather real life experience in what kind of data can be expected using these scenarios and to get the best possible receiver set-up for the exposure experiments. A network of 8 to 10 fish telemetry receivers was placed around BB C05 and BB F05. The deployment and retrieval of these receivers have been optimized over the last campaigns.

6.3 C-POD installations

Three C-POD underwater noise detectors were installed in the Belwind windfarm to monitor the presence of marine mammals. By detecting the specific ultrasonic underwater sounds, an evaluation of the presence of sea mammals can be done. Parkwind offshore personnel regularly spotted sea mammals in and around Belwind (Figure 13).

Figure 13: Sea mammals (left: bottlenose dolphin; right: seal) roaming at the Belwind wind farm

6.4 Fish track sampling

The fish track sampling campaign, as executed with the research vessel Belgica in Autumn 2017, included two fish tracks in the Belwind domain concession (see Figure 14). The established mitigation measures of the HAZOP in 2016 (see Annual Work Report 2016 for Belwind) were set as standard to assure the highest levels of safety during such high-risk activities in the windfarm for both the research vessel and its personnel as the windfarm assets.

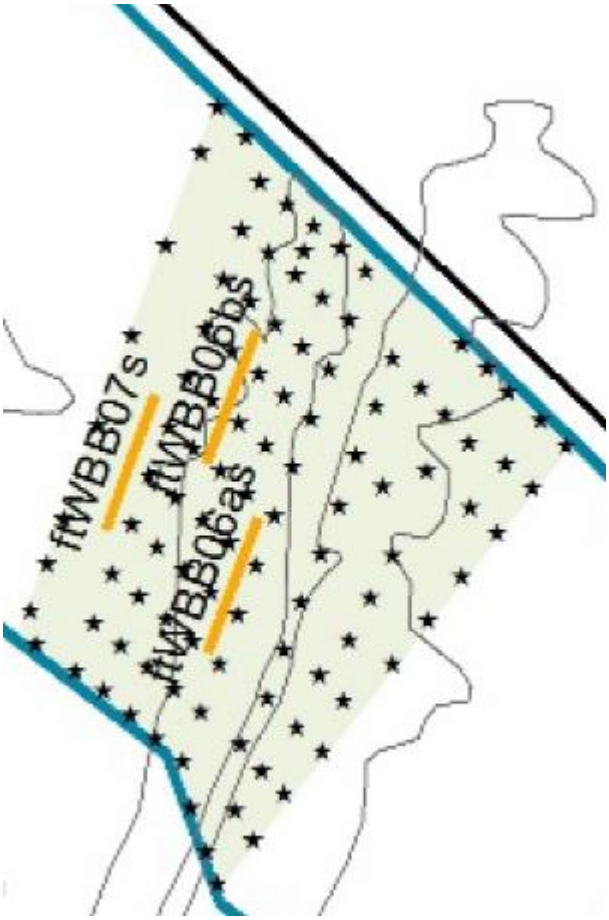


Figure 14: Fish tracks on the Bligh Bank

7 Permit conditions

In compliance with the authorization for the construction and a license for the operation of a wind farm on the Bligh Bank in the Belgian sea areas article, we give an overview of the environmental permit conditions as mentioned in the appendix 1 of the authorization for the construction and a license for the operation of a wind farm (see Table 1).

Table 1: Permit conditions overview

Condition Number	Condition Summary	Current Status
2	Each planned modification must be reported to the Board and will be included in the annual work report.	In February, the Board was informed about the planned new shareholders structure, i.e. Parkwind shall take over all shares of Summit Renewable Energy Belwind.
4	The holder undertakes to find and recover all floating or sunken objects used for its activities which, for any reason, have ended up in the sea during the construction, operation or dismantling stages.	All dropped objects related to Belwind offshore activities (#4) are recorded in the online reporting tool, the SOS system, and notified to the Board. Adequate actions were undertaken for recovery of the GEO XIV anchor lost in August 2017.
14	During construction, all foundations and structures already finished must have a temporary warning light (at the highest point) for shipping and aviation traffic.	No new foundations installed in 2017.
15	The holder must set up the necessary safety systems to assure the signalling of the wind farm and structures at all times.	Since 8 February 2011 all navigation and aviation signalisation are fully operational. All cases of defects or malfunctioning (only Tier 1 events) were reported to the relevant authorities and repaired as soon as possible.
16	All WTG's must be numbered individually at the base of the mast and at the top of the nacelle.	The foundation and the WTGs have been numbered in accordance with the requirements of this condition.
17	All WTGs and transformers must be provided with collection receptacles to prevent liquids from being released in the environment.	The design of the WTG is such that in case of leakage in the nacelle, all fluids are collected in the central part of the nacelle. From here, collection receptacles are installed under the oil pumps and hydraulic systems as standard. In September 2017, an environmental leakage (minor quantity, details see 9.2.1 of this report) occurred and was reported to the relevant authorities (i.e. MUMM and DG Environment).
20	During the operation stage, the availability must be facilitated of a specially equipped intervention vessel (or combination of vessels) for assignments concerning the prevention of shipping traffic accidents and cleaning up sea pollution around and in the wind farm	On 22 January 2011, an agreement was signed with Federal authority responsible for the marine environment. Further clarification regarding the practicalities of the agreement have been clarified in vision text signed by the Secretary of State, DG Environment, MUMM and wind farms C-power, Belwind and Northwind.
21	Once or twice a year, the holder must take part in simulated nautical accidents, emergency towing exercises and pollution combating exercises.	On a regular base Belwind MVOW execute internal emergency exercises (see 9.1.2 of this report).
24	Before laying protective mattresses or other artificial erosion protection on the seabed, the holder must verify and certify that all components chosen can be used without any danger of leaching into the marine environment. The composition of the erosion protection must be presented to the Board for approval. The use of monoliths and slag is hereby prohibited.	No new construction material to be approved in 2017.

Condition Number	Condition Summary	Current Status
29.1	The construction materials and rip-rap must be made of natural materials and must not contain any waste materials or a secondary raw material… the use of slag is prohibited.	No new construction material to be approved in 2017.
31.2	Pile driving activity between 1 January and 30 April will be subject to additional, special monitoring in the amount of EUR 50,000 at most, which is not included in the estimated budget and is completely at the expense of the holder	No piling activities have been performed in 2017.
33.1	The lighting of the turbines for the benefit of shipping and aviation traffic must comply with the conditions set by the competent authorities.	Lights are installed according to the Navigational Aids plan and have been fully operational in the O&M reporting period. Since Nobelwind is built around Belwind, the Navigational Aids Plan of Belwind has been changed into a Navigational Aids Plan of the Bligh Bank, considering the whole zone of Belwind and Nobelwind as one zone.
33.2	Foghorns, which come into operation automatically in the event of a meteorological visibility of less than 2 sea miles, must be placed on the corner turbines.	Fog horns are installed according to the Navigational Aids plan and have been fully operational in the O&M reporting period. See also 33.1.
34	The holder must maintain the farm on a regular basis.	All installations are maintained on a regular basis.
48	A logbook must be kept in which the following is specified for each turbine: ➢ Date, time and all relevant data of incidents that occur which have an impact of the environment, stating the measures taken; and ➢ The recording of hazardous waste materials, the date of removal of the relevant batch of waste, the quantity and the name of the carrier and the recognised waste processor must also be recorded.	We confirm that logbooks have been kept for all turbines since start-up of the first WTG and this has continued during operation.

9 Operations Management

9.1 Health Safety and environment

9.1.1 Proactive safety initiatives

In 2017 some proactive safety initiatives, to avoid unwanted events from happening, were initiated:

Further development and improvement of the online full near miss and hazard observation reporting system. Personnel is encouraged to report all unwanted events using the online reporting tool, the 'SoS' [SafeOffshoreOperations] system. The system facilitates the notification, reporting and follow-up of events.

Existing work procedures were updated and new work procedures were implemented. Some examples are:

- *Visitor procedure*
- *Diving procedure*
- *Work Vessel Coordination Procedure*
- *LOTO procedure*
- *Inspection procedure*
- *Organization of exercises (ongoing)*

Steps were taken in the development of General HSSE Employer Requirements for Contractors during the O&M phase. These HSSE Employer Requirements give a clear overview of what is expected of the Contractor during his work scope regarding training, induction, environmental protection measures, the work vessel coordination procedure, risk assessments and method statements, management of change procedure, etc.

Offshore workplace inspections, on the OHVS and the wind turbines, were executed by the external Service for Prevention and Protection at Work, Securex.

Several trainings were organized to improve safety, such as a VCA-VOL training, ISM / ISPS course, a training on how to use air monitoring equipment in confined spaces, etc.

The ERP BW/NBW was revised. The changes are related to the transition of Nobelwind from a project-phase to an O&M-phase.

9.1.2 Safety Exercises

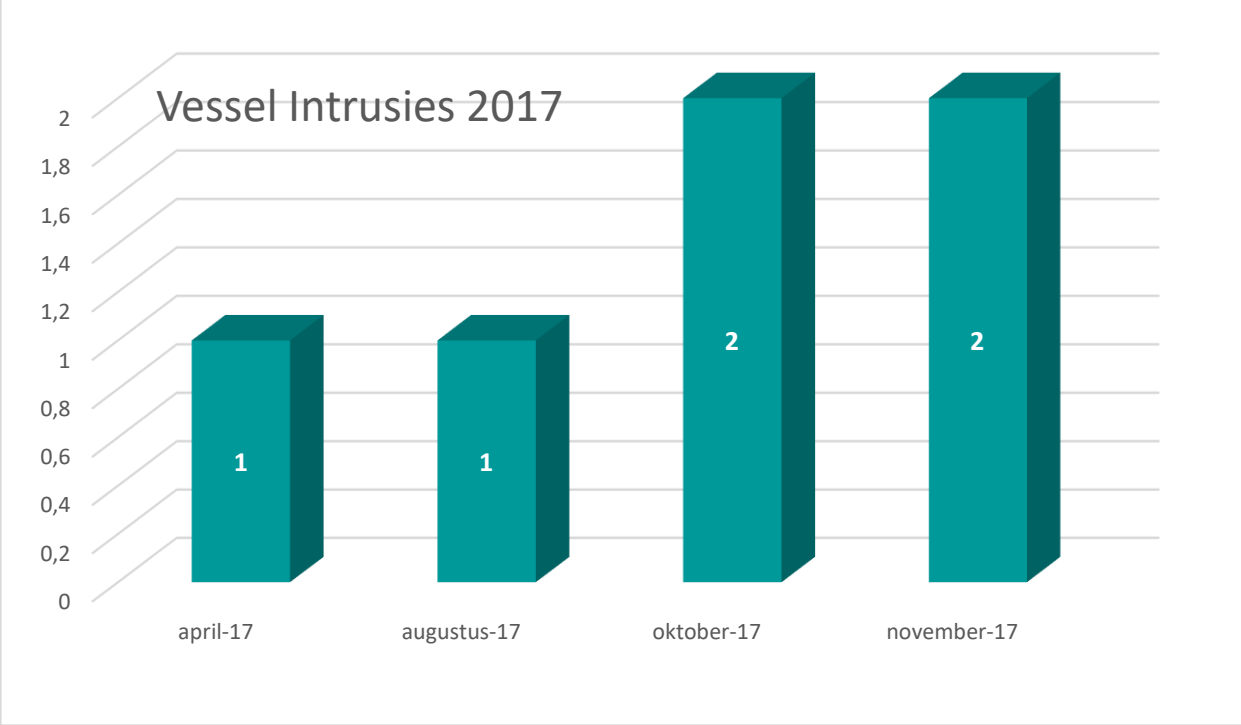
Overview emergency exercises 2017	
WTG	04/07/2017: MHI Vestas – Liquid in eye exercise (Tier 1) evacuation to Esvagt.
	04/07/2017: MHI Vestas – Broken shoulder (Tier1) evacuation to Esvagt.
	04/07/2017: MHI Vestas – Broken Finger (Tier 1) evacuation to Esvagt.
	18/12/ 2017: MHI Vestas - Abandon ship drill (Muster) Esvagt.
	18/12/2017: MHI Vestas - Fire drill (Muster) Esvagt.
	18/12/2017: MHI Vestas - MOB drill (Muster) Esvagt.

9.1.3 Emergency actions (TIER2)

No TIER 2 situations, that need external assistance, were reported in 2017.

9.1.4 Intrusions

In 2017 we had 6 intrusions reported on the Belwind concession. A good monitoring of the wind park will be executed as a direct action.



Vessel	Amount of intrusions
ARM22	3
Cornelis Jannet GO 23	1
Larche	1
Multraship Rescue 2	1

9.2 O&M office Parkwind

O&M team offices are located in the harbor of Ostend.
Esplanadestraat 10B
8400 Oostende

10 Conclusion and outlook

2017 was not the most productive year since the beginning of Belwind, mainly due to less wind than predicted in combination with the blade repair campaign. Where unplanned downtime occurred, the teams managed to keep the unavailability of the turbine to its minimum.

The maintenance routine on all aspects (WTG, civil and electrical) was carried out. Belwind and contractors were challenged a few times with unexpected issues, such as the big amount of blade damages. With the correct lessons learned implemented in both scheduled and unscheduled tasks, it is expected that in 2018 the maintenance routine can continue without any major surprises to overcome.

No big HSSE incidents were recorded and all tasks as mentioned under the operational permits are well managed. The monitoring results of the installed infrastructure show no significant observations for 2017.

Belwind, captured under the Parkwind organization, will keep striving for innovation in terms of maintenance procedures, preventive actions, O&M inspection tools, etc. as it has been doing in the past. This smarter maintenance shall allow Belwind to enlarge its maintenance scope without running the risk of needing a larger OPEX budget. Next to the standard maintenance, it is expected that some issues start showing off after 7 years in operation which might need some more dedicated attention. However, with a strong team as Parkwind it confident that any concerning progress can be tackled adequately and preferably in a proactive matter.