Chapter 2. Offshore wind energy development in the Belgian part of the North Sea & anticipated impacts: an update

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Cable laying vessel in the Belwind wind farm Photo RBINS / MUMM

2.1. Context

The European Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market, imposes upon each Member State a target figure of the contribution of the production of electricity from renewable energy sources that should have been achieved in 2010. For Belgium, this target figure was 6 % of the total energy consumption. In January 2008, the European Commission launched its new Climate Plan, and a new target for Belgium was set at 13 % by 2020. Offshore wind farms in the Belgian part of the North Sea (BPNS) are expected to make an important contribution to achieve that goal.

With the Royal Decree of 17 May 2004 a zone in the Belgian part of the North Sea (BPNS) was reserved for the production of electricity. It is located between two major shipping routes: the north and south traffic separation schemes (TSS). The total surface area of this dedicated zone is 263.7 km² (Figure 1).

Prior to installing a wind farm, a developer must obtain (1) a domain concession in the zone reserved for wind energy development and (2) an environmental permit. Without an environmental permit, a project developer is not allowed to build and exploit a wind farm, even if a domain concession was granted.

When a project developer applies for an environmental permit an administrative procedure, mandatory by law, starts. That procedure has several steps, including a public hearing during which the public can express any objections. Later on during the permit procedure, the Management Unit of the North Sea Mathematical Models (MUMM) of the Royal Belgian Institute of Natural Sciences renders advice on the possible environmental impact of the future project to the Minister responsible for the marine environment. MUMM's advice includes an environmental impact assessment, based on an environmental impact study that is set up by the project developer. The Minister then grants or denies the environmental permit in a duly motivated decree.

The environmental permit includes a number of terms and conditions intended to minimize or mitigate the impact of the project on the marine ecosystem. Furthermore, as required by law, the permit imposes a monitoring programme to assess the effects of the project on the marine environment. The environmental monitoring is a legal obligation and is the responsibility of the federal government. The monitoring has two goals:

- to enable the authorities to mitigate or even halt the activities in case of extreme damage to the marine ecosystem;
- to understand and evaluate the impact of offshore wind farms on the different aspects of the marine environment and consequently support the future policy regarding offshore wind farms.

The monitoring is lead by MUMM, but MUMM collaborates with other institutes that each have their expertise of the marine environment. The costs of the monitoring program are paid by the permit holders.

At present, three companies have been granted a domain concession and an environmental permit to build and exploit an offshore wind farm: C-Power in 2004, Belwind in 2008 and Northwind (formerly Eldepasco) in 2009. C-Power had its permit revised in 2006 and 2008, and the monitoring programme was adapted accordingly (Table 1).

C-Power and Belwind have already started their construction activities at the Thorntonbank and Bligh Bank, respectively, while Northwind's construction activities (72 turbines of 3MW) on the Bank zonder Naam were postponed till September 2012. More detailed information on those three wind farm projects can be found via www.c-power.be, www.belwind.eu & www.eldepasco.be.

Three other projects, Norther, Rentel and Seastar, were granted only a domain concession so far (Figure 1). The Norther project is located in the southern part of the wind energy zone. Rentel, obtained a concession in between C-Power and Northwind (Figure 1). Seastar, in between Belwind and Northwind, was granted a concession in March 2010, but this has been withdrawn. The Norther project recently applied for an environmental permit and that application is currently under consideration (Table 1).

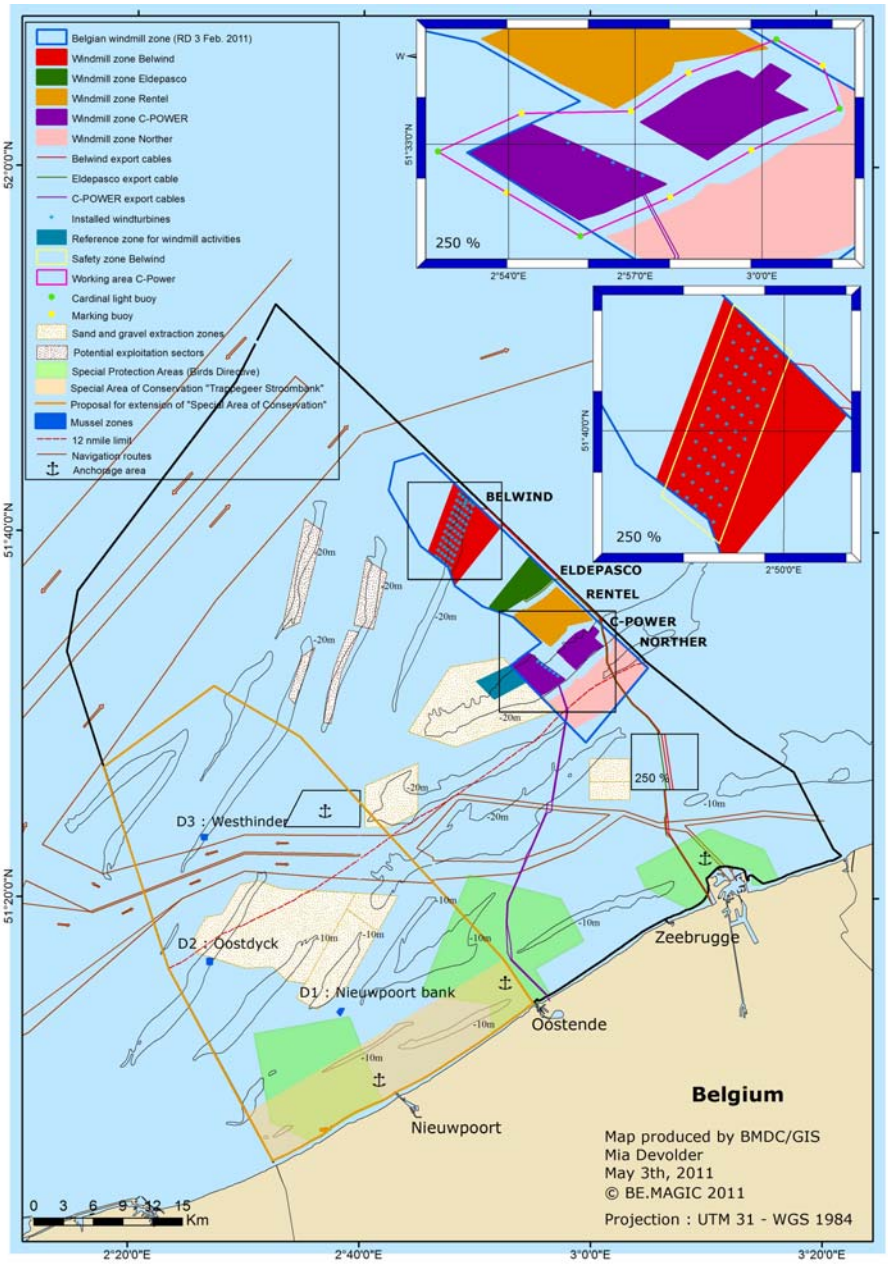

Figure 1. Zone reserved for the production of renewable energy by the Royal Decree of 17 May 2004 (http://www.mumm.ac.be/EN/Management/Atlas)

Table 1.
Overview of the dates when the projects were granted a domain concession and an environmental permit.

Project	Concession obtained	Permit application	Permit obtained
C-Power	27/06/03	17/6/2003 22/9/2005 -	14/04/2004 10/05/2006 25/04/2008
Belwind	5/6/2007	19/6/2007	20/2/2008
Eldepasco	15/5/2006	12/12/2008	19/11/2009
Norther	5/10/2009	10/5/2011	-
Rentel	4/6/2009	No application yet	
Seastar	24/3/2010[1]	No application yet	

[1] The concession of Seastar has been withdrawn.

2.2. Ongoing wind farm projects

2.2.1. C-Power

The C-Power project is located on the Thorntonbank (Figure 1). This is a sandbank located 27 km of the Belgian coast. Water depth in the concession area varies between 18 and 24 m. The sub sea power cable comes ashore near Ostend.

The C-Power concession is divided in two sub-areas (A and B). Across the two sub-areas 54 turbines will be installed. Phase I (30,5 MW), a pilot phase, consists of six turbines that were installed on row D of sub-area A and the first 150 kV offshore cable (Figure 2). The six 5MW Repower turbines are operating since the 10th of May 2009. Phase II and phase III will each consist of 24 turbines of 6.15 MW. The installed capacity of the entire wind farm will be 325 MW.

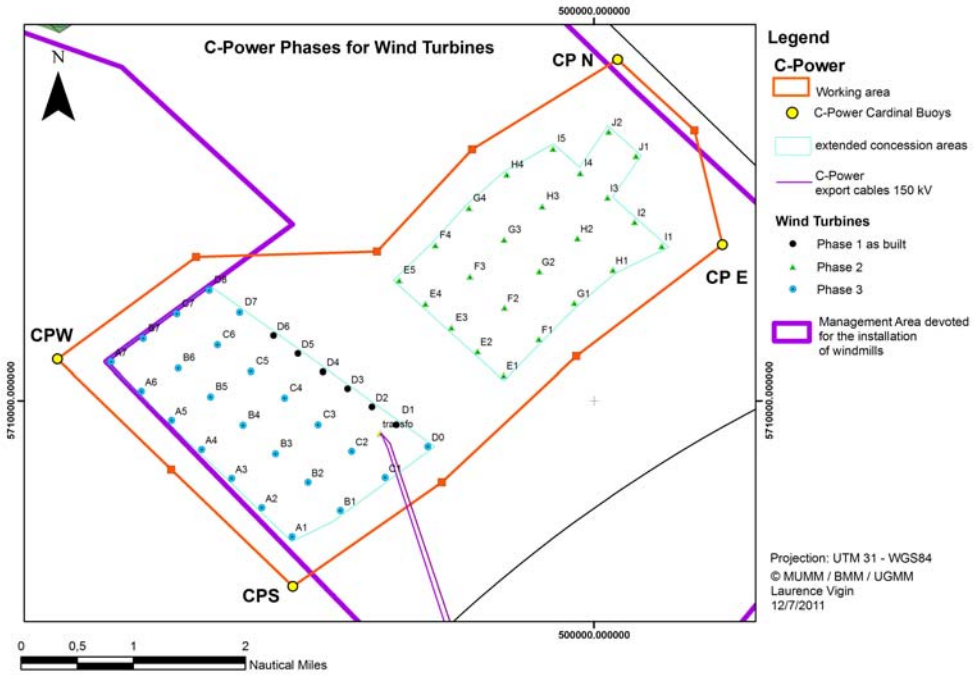

Figure 2. Layout of the C-Power project.

C-Power used gravity based foundations (GBF) for their phase I. These GBFs are hollow, concrete structures that are filled with sand, upon installation on the seabed. More detailed information can be obtained from Peire *et al.* (2009) and Brabant & Degraer (2010).

The foundation type for the phase II and III turbines is different from the pilot phase since jacket foundations, instead of the GBFs, will be installed. These foundations consist of a steel jacket with four legs (Figure 3). The foundations are installed using the pre-piling concept: four pin-piles are driven into the seabed and the legs of the foundation are grouted on the pre-piles. The piles vary in length depending on the water depth at their location and are in the range of 21.0 to 49.5 m.

The phase II of C-Power is located in sub-area B and consists of 24 wind turbines and an offshore high voltage station (OHVS) (Figure 2). C-Power is currently installing the 24 foundations of phase II (area B). Before the pre-piling of the pin piles started, bottom surveys were conducted in 2010 and the seabed needed to be prepared. This seabed preparation consisted of two steps: bulk dredging to remove the loose “sand dunes” and precision dredging, i.e. removal of approximately one meter of the bottom layer to create a flat surface. The total volume to be dredged for the seabed preparation is estimated to be 275.000 m³ for area B (phase II) and 240.000 m³ for area A (phase III), and an additional 4.640 m³ for the OHVS foundation. The dredged sediments are being disposed on three temporary disposal locations in sub-area A of the C-Power concession, situated in the gullies between the large dunes of the Thorntonbank and also used for the disposal of sediments during the construction of the first phase (Van den Eynde *et al.*, 2010).

Pre-piling started on March 30th 2011. Since the weather in the first half of 2011 was very good, piling of Phase II ended on June 12th and pin piles of the phase III turbines are currently being installed. Phase III will consist of 24 turbines and the installation of a second 150 kV export cable. The installation of the phase II turbines, the OHVS, the second export cable and the phase III jacket foundations is scheduled for 2012.

Figure 3. Photo of a jacket foundation of C-Power (Photo RBINS / MUMM).

2.2.2. Belwind

The Belwind project is situated on the Bligh Bank at about 40 km of the Belgian coast (Figure 1 & 4). The water depth in the concession area varies between 15 and 40m. Once finalized, the park will consist of 110 turbines and OHVS, with a total installed capacity of 330 MW. The construction of the park is divided in two phases.

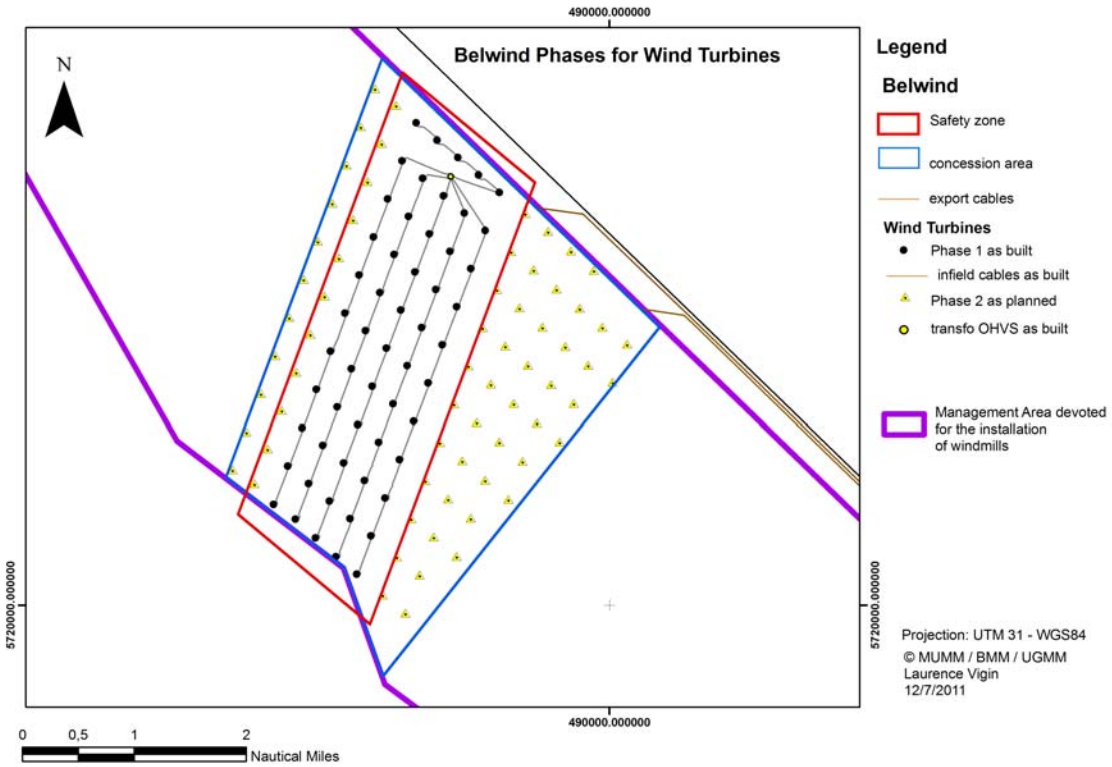

Figure 4. Lay out of the Belwind project.

In 2010, Belwind completed the first phase of their wind farm: 55 Vestas V90-3MW turbines, an OHVS, infield cables and an export cable. The piling of the monopiles (MP) started in September 2009 and the last of the 56 MPs was installed on February 5th 2010. On every monopile a transition piece (TP) was installed. The TP makes the connection between the MP and the wind turbine. All 55 wind turbines and the OHVS were installed in 2010. After they were commissioned, the 55 wind turbines started producing energy on January 13th, 2011 (Figure 5).

Figure 5. Phase I wind turbines on the Bligh Bank (Photo RBINS / MUMM).

The wind turbines are connected with the OHVS by infield cables. The OHVS has five decks, each deck has a surface of 250m² (Figure 6), and has a total weight of about 1150 tons.

Figure 6. Offshore high voltage station (OHVS) on the Bligh Bank (Photo RBINS / MUMM).

The 33 kV generated power is transformed by the OHVS to 150 kV and exported to shore by an export cable. A crucial step during the deployment of the export cable was the crossing of the 'Scheur', the main shipping route to Zeebrugge. The total length of the cable is 52km. The sub sea cable comes ashore at Zeebrugge (Figure 7).

Figure 7. Preparation of the beach pull in of the export cable at Zeebrugge (Photo Belwind).

2.3. Anticipated environmental impacts

With the construction and exploitation of the above described projects a new offshore activity started in the BPNS. While offshore wind farms help to achieve the goals set by 2001/77/EC on the promotion of electricity produced from renewable energy and help in the struggle against climate change, the construction and exploitation of offshore wind farms will also have certain impacts on the marine environment, which can be neutral, positive and/or negative for the marine ecosystem.

The environmental impact assessments (MUMM, 2004 & 2007) anticipated a variety of possible impacts. Some of those impacts are already being revealed during the first years of environmental monitoring (Degraer *et al.*, 2010), e.g.:

- Increased erosion of the natural sandy sediments around wind turbine foundations because of accelerating currents next to the foundations;
- Increased turbidity during the construction of the wind farms;
- Increased underwater noise pressure, generated during the construction and exploitation phases and the associated impact on marine mammals and fish;
- Colonisation of the introduced hard substrata (i.e. foundations) by epifouling organisms and its consequent stepping-stone effect on invasive species;
- Attraction of fish by the introduced hard substrata;
- Changes within the soft-substratum macro- and epibenthos and fish as a result of e.g. fisheries displacement, altered sediment characteristics and organic enrichment of the sandy sediments by (local) deposition of organic matter produces by the hard substrate epifauna;
- Altered spatio-temporal distribution, densities and migration routes of seabirds and marine mammals;
- Altered public perception of offshore wind farms.

With the monitoring programme, MUMM and its partners (1) assess the extent of the anticipated impacts on the different aspects of the marine ecosystem and (2) aim at revealing the processes behind the impacts. The first objective is basically tackled through the baseline monitoring, focusing on the a *posteriori*, resultant impact quantification, while the second monitoring objective is covered by the targeted or process monitoring, focusing on the cause-effect relationships of a priori selected impacts. As such, the baseline monitoring deals with observing rather than understanding impacts and hence leads to area-specific results, which might form a basis for halting activities. Targeted monitoring on the other hand deals with the understanding of the processes behind the impacts of a selected set of hypothesized cause-effect relationships highly relevant to the wind energy sector. This step is not only

a pre-requisite for effective regulatory application, but also permits (1) current and future impact mitigation, (2) better prediction of future impacts, as well as (3) moving away from site-specific observations to more generic knowledge. More details on this topic can be found in Degraer & Brabant (2009) and Degraer *et al.* (2010).

In 2009, we reported on the lessons learnt and recommendations from the first two years of environmental monitoring (Degraer and Brabant, 2009). The integrated Degraer *et al.* (2010) report focused on the natural spatio-temporal variability and the evaluation of the early and localized environmental impacts at the C-Power and Belwind sites. This report targets a selection of major findings from the baseline and targeted monitoring.

2.4. References

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