Chapter 2. Introduction: offshore wind energy development in the Belgian part of the North Sea & anticipated impacts

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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 be achieved in 2010. For Belgium, this target figure is 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 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, MUMM 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 report 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 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 certain expertise of the marine environment. The costs of the monitoring program are paid by the permit holders.

At this time, three companies have been granted environmental permits to build and exploit an offshore wind farm: C-Power in 2004, Belwind in 2008 and Eldepasco in 2009. C-Power had its permit revised in 2006 and 2008, and the monitoring programme was adapted accordingly (Table 1). Eldepasco will be located on the 'Bank zonder Naam'. This is a sandbank located at mid-distance between the C-Power concession on the Thorntonbank and the Belwind concession on the Bligh Bank (Figure 1). Whilst C-Power and Belwind have already started their construction activities, Eldepasco's construction activities will not start before 2011. More information on those projects can be found on following websites: www.c-power.be, http://meewind.nl/belwind/ & www.eldepasco.be

In 2009 two new projects were granted a domain concession. The Norther project is located in the southern part of the wind energy zone, the other one, Rentel, obtained a concession in between C-Power and Eldepasco (Figure 1). A third project, Seastar, was granted a concession in March 2010. As to now, neither of these projects have applied for an environmental permit yet (Table 1).

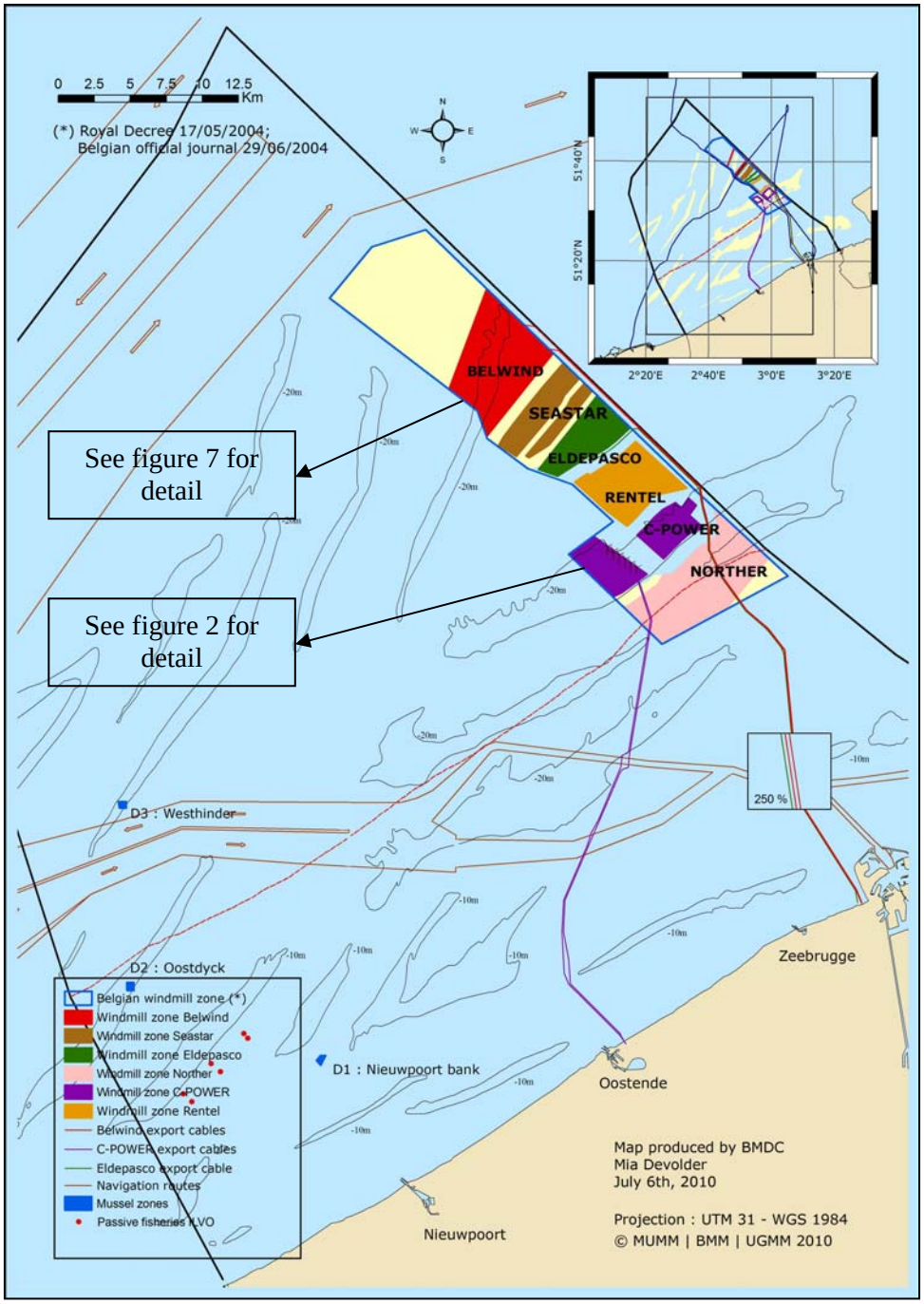

Figure 1. Zone reserved for the production of electricity by the Royal Decree of 17 May 2004.

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	No application yet	
Rentel	4/6/2009	No application yet	
Seastar	24/3/2010	No application yet	

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 56 turbines will be installed. During phase I, six turbines were installed on row D of sub-area A (Figure 2).

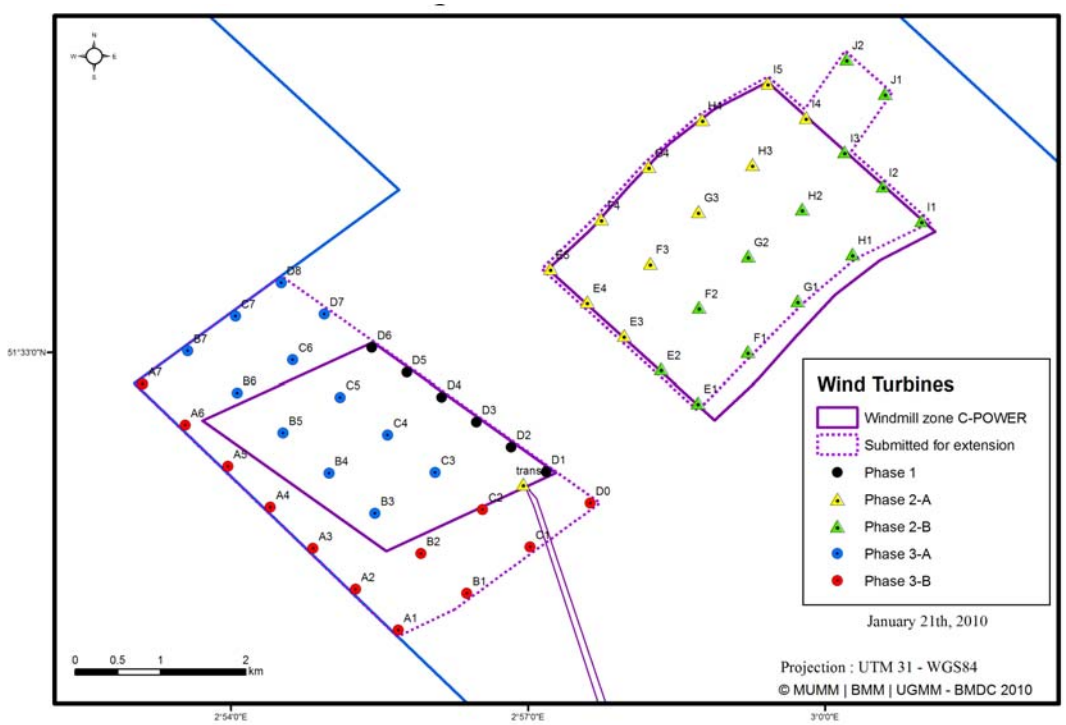

Figure 2. Layout of the C-Power project.

Because pile driving at first seemed to be difficult on the Thorntonbank, C-Power decided to build gravity based foundations (GBF) for their phase I. These GBFs are hollow, concrete structures that are filled with sand, once they sit on the seabed. Due to its weight, the GBF remains stable. The GBFs were constructed in the port of Ostend and then shipped to the Thorntonbank (Figure 3).

Because the Thorntonbank is a sandbank characterised by large dynamic dunes, there is a necessity to level the seabed at the wind turbine location before the GBF can be placed. A foundation pit was dredged to remove the loose sand and to create a flat surface on dense seabed. This sand was dumped at three temporary disposal areas, within the concession area, situated in the gullies between the large dunes of the Thorntonbank. A foundation bed of about 1 m thick and about 30 m diameter was laid in the foundation pit before the GBF was lowered. That foundation bed consists of a filter layer and a gravel layer. Crushed gravel is used for both layers. The diameter of the gravel used for the gravel layer (10 to 80 mm) is slightly bigger than what is used for the filter layer (0 to 63 mm).

The six GBF were set in place in 2008. The temporarily stored sand was re-used as (1) backfill material to increase the stability of the structures, (2) backfill of the temporary trench that was dredged for the cable-crossing of the sea-lane and (3) infill of the foundations.

Finally, a scour protection was laid around each GBF. This is a layer of gravel and rocks that should prevent the erosion of the backfill sediment by water currents accelerating around the structures (Figure 4). This scour protection consists of a filter and an armour layer. The crest diameter of those layers is different for every GBF. The filter layer crest diameter varies between 48.5 m and

62.5 m. The armour layer goes on top of the filter layer and the crest diameter varies between 44 m and 58 m. The filter layer is minimum 0.60 m thick and consists of crushed gravel with a diameter of 10 to 80 mm. The armour is 0.70 m thick and consists of quarried rock. The weight of those rocks ranges from 10 to 200 kg (Peire *et al.*, 2009).

Figure 3. Transport of a GBF from the port of Ostend to the Thorntonbank (Peire *et al.*, 2009)

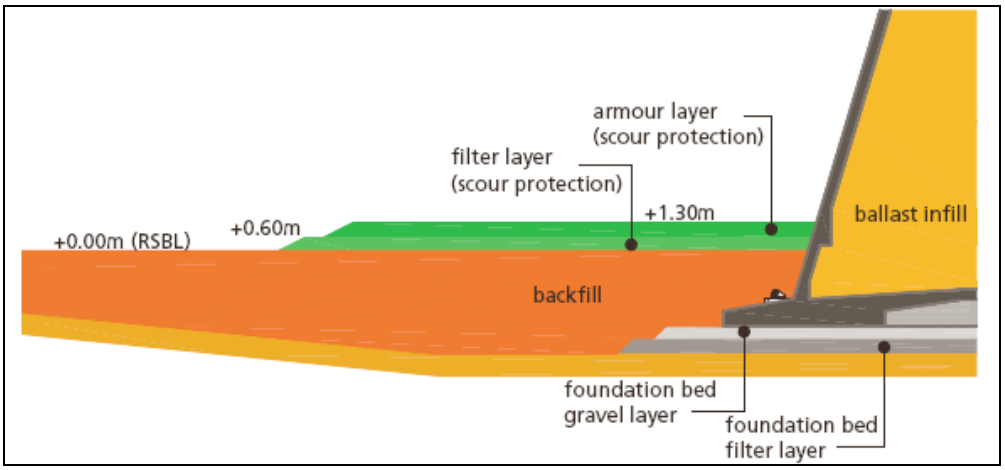

Figure 4. Lay-out of the GBF installation (Peire *et al.*, 2009).

C-Power installed the first six turbines (Repower, 5MW), i.e. phase I of the project, in summer of 2008 (Figure 5). In the first months of 2009, C-Power commissioned and started the phase I of the project. All six turbines were producing electricity on the 10th of May 2009 (Figure 6).

In 2010 bottom surveys are conducted in preparation of construction phase II, which is scheduled for 2011. C-Power will possibly use another type of foundation for the construction of phase II, but a final decision has yet to be taken.

Figure 5. Installation of a turbine on the Thorntonbank (Photo RBINS).

Figure 6. C-Power phase-I on the Thorntonbank produces electricity since May 2009 (Photo RBINS).

2.2.2. Belwind

The Belwind project is situated on the Bligh Bank at about 40 km of the Belgian coast (Figure 7). Water depth in the concession area varies between 15 and 40 m. The sub sea cable comes ashore at Zeebrugge.

Belwind will operate 110 Vestas V90-3MW turbines with a total capacity of 330 MW. Construction of the park is divided in two phases. Belwind started with the construction of phase I, 55 turbines and 1 offshore high voltage station (OHVS), in September 2009.

Instead of gravity based foundations (GBF) Belwind will use monopiles (MPs). The MPs are driven into the seabed with a hammer (Figure 8).

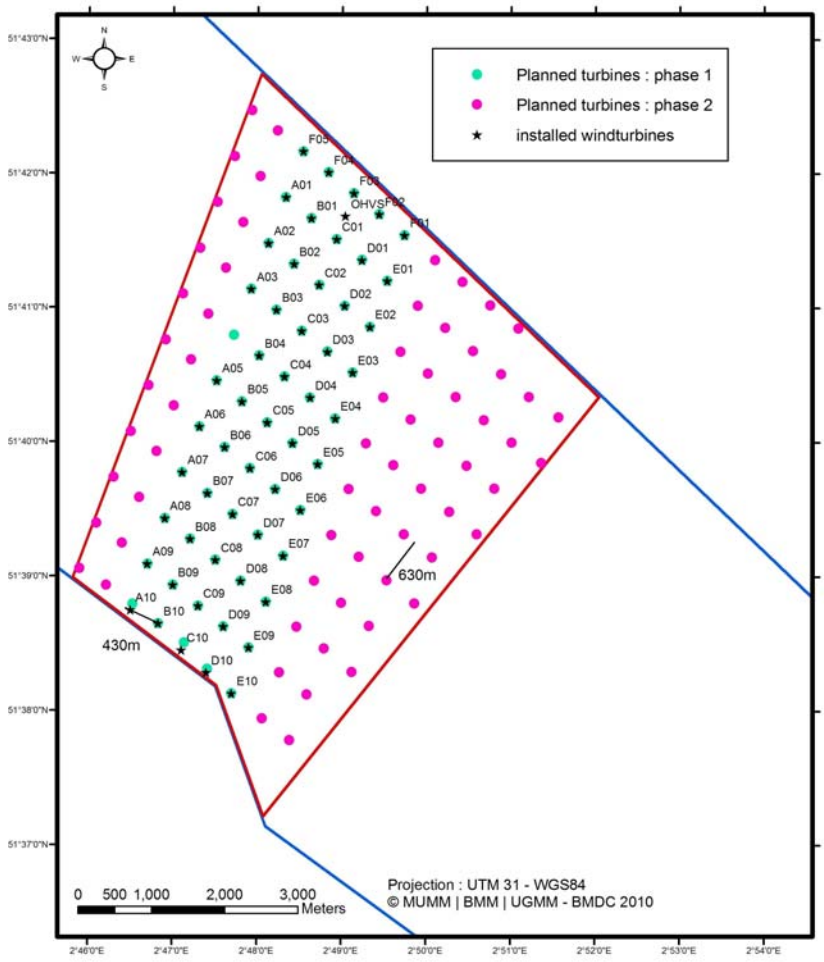

Figure 7. Lay out of the Belwind project (situation 1/2/2010).

Figure 8. The piling vessel Svanen, with a monopile ready to be lifted and piled and the red and white hammer central in the image (Photo RBINS).

In total 56 MPs needed to be installed. The first one was driven into the seabed on September 8th 2009. The 56th, and last, monopile was installed on February 5th 2010.

The MPs were towed out the port of Zeebrugge, one by one, with a tug vessel. The ends of the monopiles were closed with plugs. During the transport to the Bligh Bank, two of the 56 monopiles sank due to damaged hydraulics in the plugs (Figure 9) and had to be recovered. The incidents occurred on October 24th and November 7th. After the second incident the local port authorities suspended the transport permits until an investigation into the causes was done. This resulted in a re-design of the plugs. Furthermore, additional safety measures were implemented, for instance the sea state for which the transport of MPs was allowed, was reduced from 1.5m significant wave height to 1m significant wave height. After the investigation and the re-design the transport of MPs started again on 12 December. The above mentioned incidents together with bad weather conditions during the end of November and beginning of December, explain why only one MP was installed in November (Figure 10).

Figure 9. Two monopiles sank during the transport from the port of Zeebrugge to the Bligh Bank. MP C05, which was lost on October 24th, remained partially above the water surface (Photo Belwind).

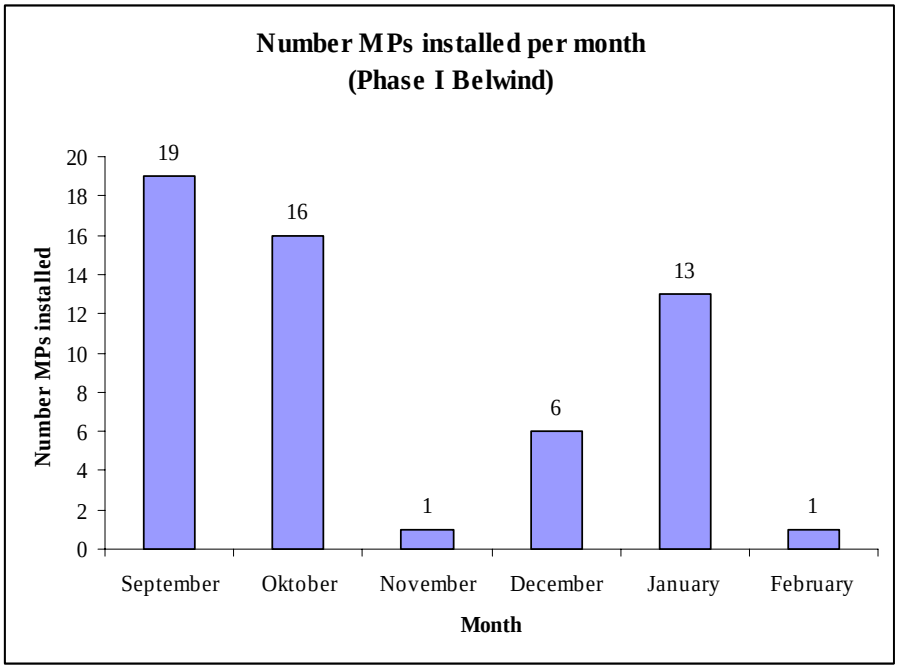

Figure 10. Number of MPs installed per month for the phase I of the Belwind project (2009-2010).

On every monopile a transition piece (TP) was installed. The TP makes the connection between the MP and the wind turbine (Figure 11). In 2010, Belwind will install 55 wind turbines and one offshore high voltage station. In the first months of 2010, several wind turbines were already installed (Figure 12). After the infield cables and the land cable are laid, the phase I of the project should be operational by the end of 2010.

Figure 11. Installed MPs with transition pieces (yellow) on the Bligh Bank (Photo RBINS).

Figure 12. Wind turbines on the Bligh Bank, installed in the first months of 2010 (Photo RBINS).

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 achieving 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 positive and/or negative for the marine ecosystem.

The environmental impact assessments (MUMM, 2004 & 2007) revealed a variety of possible impacts, e.g.:

- Erosion around wind turbine foundations by accelerating currents next to the foundations;
- Increased turbidity during the construction of the wind farms;
- Underwater noise generated during construction and exploitation phase and the associated impact on marine mammals and fish;
- Colonisation of the introduced hard substrata (i.e. foundations) by epifauna and the possible stepping-stone effect for 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 soft substrata by the hard substratum epifauna;
- Impact of wind farms on the distribution, densities and migration routes of seabirds and marine mammals;
- Public perception of offshore wind farms.

With the monitoring programme, MUMM and its partners will assess the extent of the anticipated impacts on the different aspects of the marine ecosystem and will try to reveal the processes behind the impacts. In 2009, we reported on the lessons learnt and recommendations from the first two years of environmental monitoring (Degraer & Brabant, 2009). This year's report targets the first scientific results on the natural spatio-temporal variability and the evaluation of the early and localized environmental impacts at the C-Power and Belwind sites.

2.4. Acknowledgement

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2.5. References

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