



Netherlands Enterprise Agency

# Offshore wind energy Netherlands Site data Borssele wind farm zone



Recommended Locations for Borssele Metocean Buoy 1 and 2  
Ecofys

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# MEMO

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**Subject: Borssele – Recommended locations for floating LiDAR**  
**To:** Frank van Erp, Ruud de Bruijne; RVO

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## Introduction

RVO has commissioned Ecofys to provide a wind resource assessment for the Borssele offshore wind farm zone, as part of its plan to provide a detailed information package for the sites to all participants in the tender for concessions. This preliminary assessment will be based on off-site wind measurements and mesoscale model data. RVO has separately ordered an on-site wind measurement campaign using two floating LiDARs.

The first (Lot 1) will last at least 12 months and is intended as the primary basis for the Borssele zone wind climate assessment. The Lot 1 location should measure undisturbed wind speeds, taking into consideration the proximity of the Borssele zone to the Belgian offshore wind farms. The second campaign (Lot 2) will be located close to the Belgian border in order to validate the level of wake effects from those offshore wind farms. This memo relates to the recommended positions for the two floating LiDARs.

## **Lot 1 - Key criteria**

The recommendation for the Lot 1 floating LiDAR position are based on two key criteria:

1. A representative site for a wind resource assessment for Sites 1, 2, 3 & 4
2. Undisturbed wind speeds, minimising wake effects from the Belgian wind farms

Additionally, the position should be located outside of any safety buffers for subsea cables or pipelines, as outlined by RVO<sup>1</sup>.

### **1. Representative wind resource assessment**

For on-site wind measurements at simple sites, MEASNET guidelines recommend a maximum 10 km distance from the measurement location and all wind turbines<sup>2</sup>. At this distance, the uncertainty in horizontal extrapolation is minimised. A circle with a radius of 10 km would be smaller than the Borssele zone, so no location would fully meet this recommendation. However, if this circle was centred over the zone, it would cover most of the planned wind farm area.

The calculated wind climate for the Borssele zone (shown in Figure 1) and other independent offshore wind atlases (presented in the wind resource assessment report<sup>3</sup>) all indicate a stronger gradient perpendicular to the coast, with little change parallel to the coast. This indicates that the optimal location for the Lot 1 floating LiDAR would be roughly central in the zone, along the axis perpendicular to the coast. This will minimise the overall uncertainty in extrapolation to all four sites.

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<sup>1</sup> RVO, 15 January 2015, "Site Studies Wind Farm Zone Borssele - Starting points & Assumptions Wind Farm Zone Borssele"

<sup>2</sup> MEASNET, November 2009, "Evaluation of Site-Specific Wind Conditions - Version 1"

<sup>3</sup> Ecofys, 26 May 2015, "Borssele Offshore Wind Farm Zone - Wind Resource Assessment"

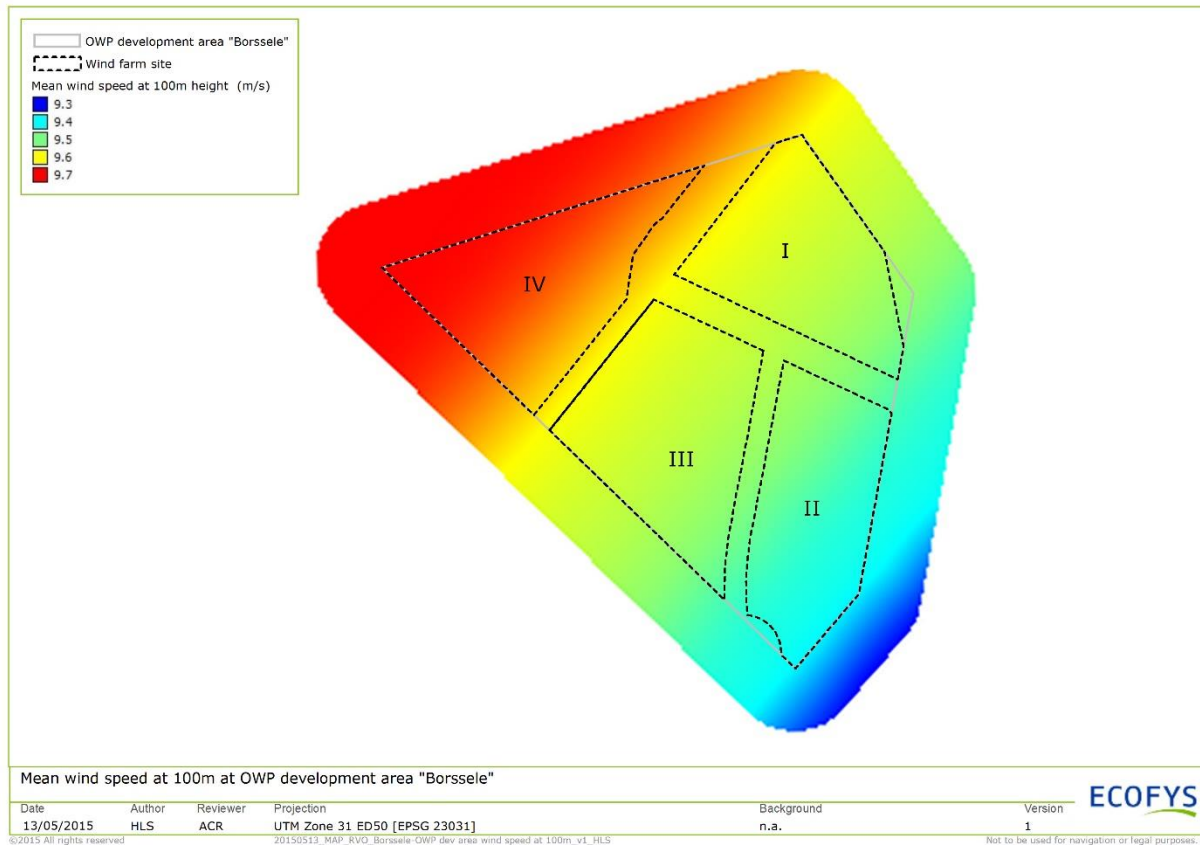


Figure 1 – 100 m mean wind speed map over Borssele wind farm zone.

## 2. Wake effects

The Lot 1 floating LiDAR should be located in undisturbed wind. Most of the zone is downwind of several large offshore wind farms in Belgium, in the dominant wind direction (SW). These effects can be quite significant; ECN has estimated that the wake losses from the Belgian wind farms will amount to about 4% across the full Borssele zone<sup>4</sup>. Therefore, the floating LiDAR must be located at a sufficient distance away from these wind farms.

There are few measurements of the extent of wake effects from offshore wind farms. However, there are some general guidelines which can be applied.

First, the IEC standard for power curve measurements considers that wind measurements are overly disturbed within 20 rotor diameters of any wind turbine<sup>5</sup>. For the Belgian offshore wind farms, this means a distance of roughly 2.5 km downwind.

<sup>4</sup> ECN, June 2014, "Quick scan wind farm efficiencies of the Borssele location," ECN-E--14-050

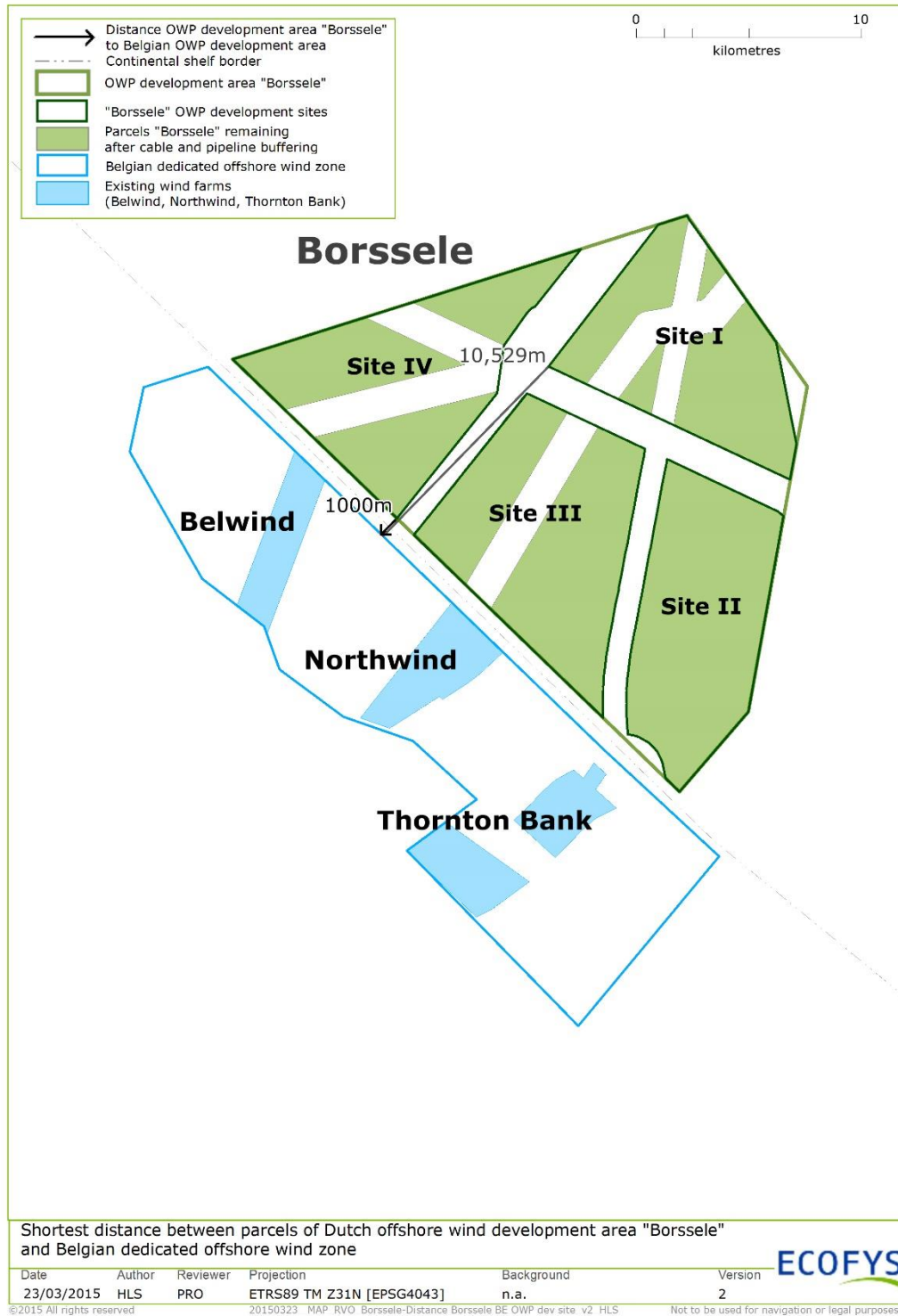
<sup>5</sup> IEC, December 2005, "Wind turbines – Part 12-1: Power performance measurements of electricity producing wind turbines", IEC 61400-12-1 Edition 1.0

Also, DTU has calculated the downstream effects of large offshore wind farms based on several models.<sup>6</sup> They found that wind speeds are expected to recover to about 98% of their initial value approximately 6-8 km downstream of an offshore wind farm.

Thus, a distance of at least 8 km from the Belgian wind farms would allow mostly free-stream wind measurements, while maintaining sufficient proximity to the wind farms for the comparison with Lot 2 (future) measurements (location still to be determined). The sites within the Borssele zone are located at a minimum distance of 1-10 km from the Belgian wind farms, as shown in Figure 2.

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<sup>6</sup> Risø, October 2007, "Summary report: The shadow effect of large wind farms: measurements, data analysis and modelling" Risø-R-1615(EN)



**Figure 2 – Borssele and Belgian wind farm zones. The minimum distance between the Borssele sites and the Belgian wind farms is between 1-10 km**

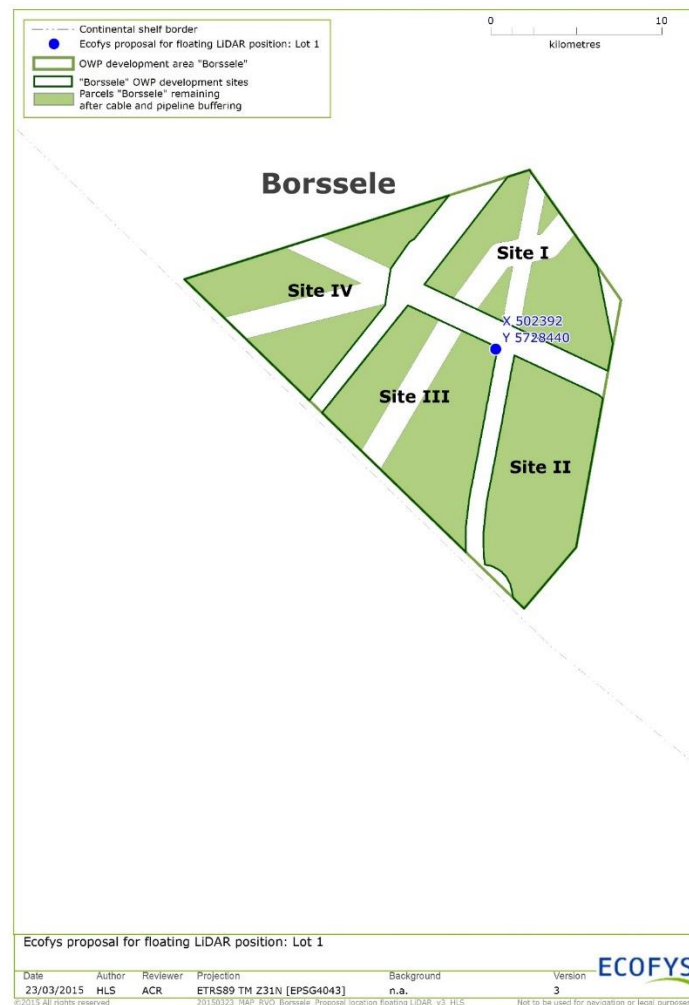


## Lot 1 – Recommended location

Based on the analysis described above, Ecofys recommends a location that is roughly central in the Borssele zone, along the axis perpendicular to the coast, while maintaining a distance of at least 8 km from the Belgian offshore wind farms. In addition, the location must not be within any safety buffers for subsea cables or pipelines. For this reason, a location is proposed that is 100 m from the safety buffers on the northeast corner of Site III, as shown in Figure 3. Ecofys believes that the identified location is the best balance of all above factors. The coordinates are provided in Table 1.

**Table 1 – Coordinates of Ecofys proposal for Borssele Lot 1 floating LiDAR location**

Easting (UTM ETRS89 zone 31)	Northing (UTM ETRS89 zone 31)	Longitude (WGS84)	Latitude (WGS84)
502,392	5,728,440	3° 2.0772'	51° 42.4140'



**Figure 3 – Ecofys proposal for floating LiDAR position – Lot 1 Borssele**

## Lot 2 – Key Criteria

The goal of the second floating LiDAR campaign (Lot 2) is to validate the level of wake effects from the offshore wind farms in Belgium. In order to have sufficient data in the wind farm wakes, it is important to consider that the dominant winds are from the southwest, as shown in the wind rose in Figure 4<sup>7</sup>.

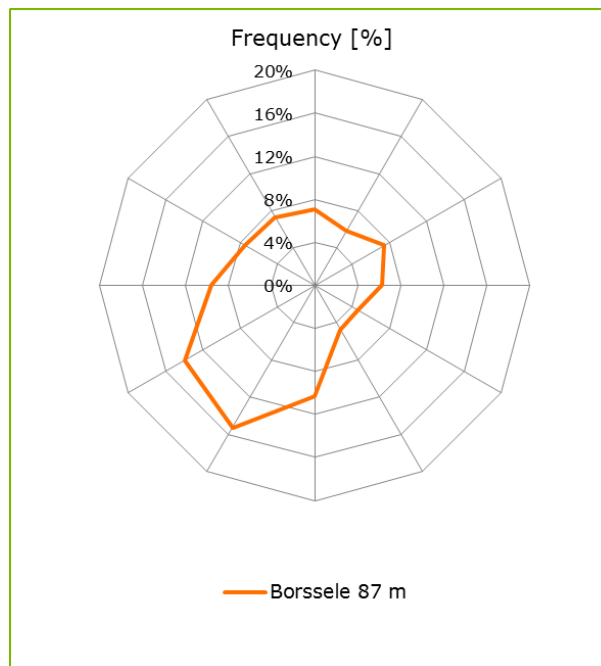


Figure 4 - Wind rose at 100 m at the centre of the Borssele zone: wind direction frequency per sector. The predominant winds are from the southwest.

## Lot 2 – Recommended Location

The optimal location for the Lot 2 buoy would be downstream of the Northwind offshore wind farm for southwesterly winds, in line with the Lot 1 buoy. It will then be possible to compare near-wake wind speeds (from the Lot 2 buoy) to far-wake wind speeds (from the Lot 1 buoy) to determine the effect of the Belgian wind farms.

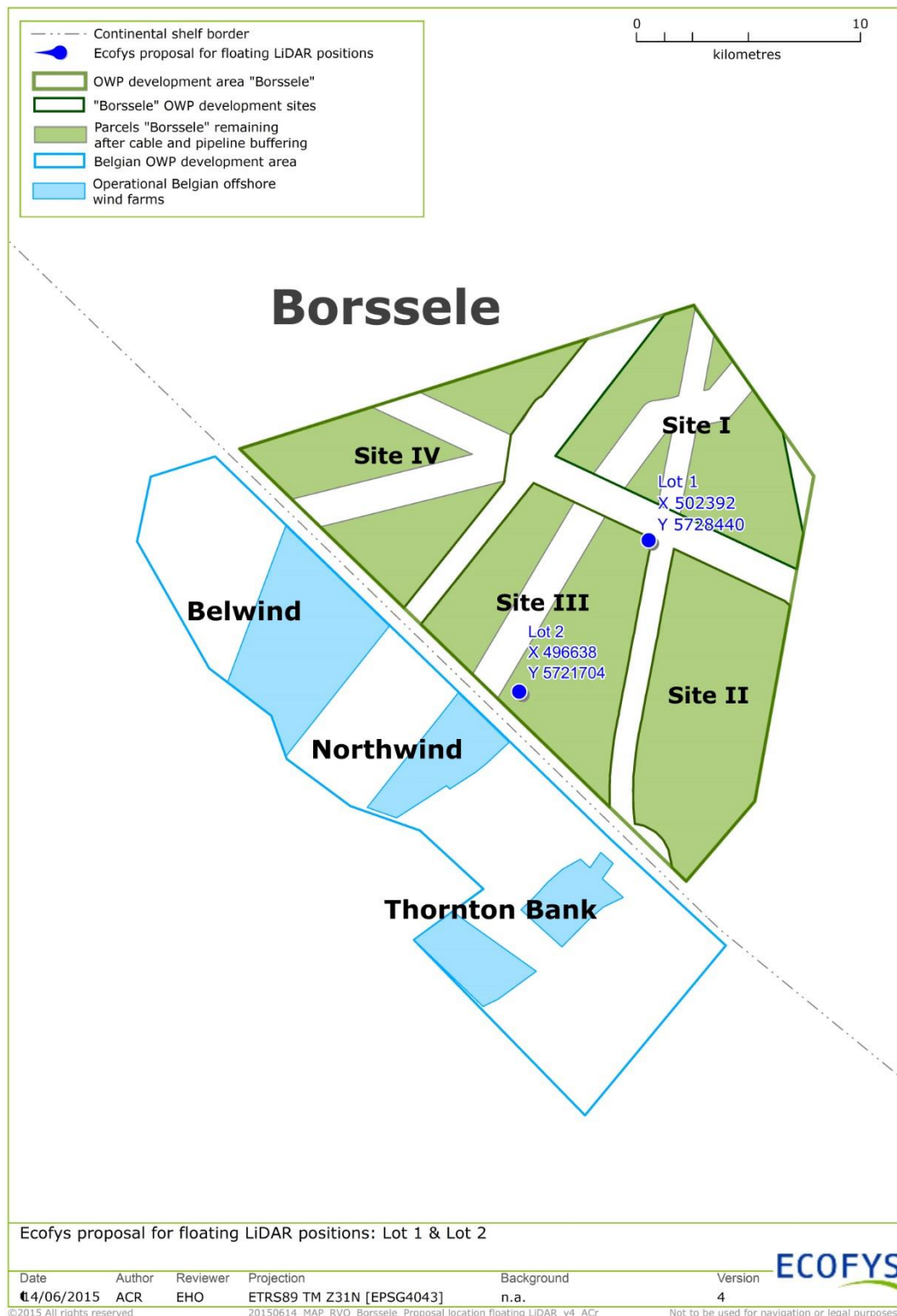
Ecofys recommends placing the buoy about 2 km from the wind farm, since this will provide a reasonable assessment of the scale of wake effects close to the wind farms. The identified location for Lot 2 is shown in Figure 5 and the coordinates are provided in Table 2.

**Table 2 – Coordinates of Ecofys proposal for Borssele Lot 2 floating LiDAR location**

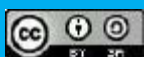
Easting (UTM ETRS89 zone 31)	Northing (UTM ETRS89 zone 31)	Longitude (WGS84)	Latitude (WGS84)
496,638	5,721,704	2° 57.0846'	51° 38.7780'

<sup>7</sup> Ecofys, 26 May 2015, "Borssele Offshore Wind Farm Zone - Wind Resource Assessment"





**Figure 5 – Ecofys proposals for floating LiDAR position – Lot 1 & Lot 2 Borssele**



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