

MEMO

Prepared: Anthony Crockford, Helen Pater 09-02-2016

Approved: Erik Holtslag 09-02-2016

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Subject: Hollandse Kust Zuid – Recommended locations for floating LiDAR

To: Frank van Erp, Ruud de Bruijne; RVO

Introduction

RVO will provide a detailed information package for the Hollandse Kust Zuid offshore wind farm sites to all participants in the tender for concessions. RVO will order an on-site wind measurement campaign using two floating LiDARs. Ecofys has been asked to recommend suitable locations for these floating LiDARs within the Hollandse Kust Zuid zone.

Key criteria

The recommendations for the floating LiDAR positions are based on the following criteria:

1. A representative site for a wind resource assessment for Sites I, II, III & IV
2. Undisturbed wind speeds, minimising wake effects from the nearby Eneco Luchterduinen wind farm
3. The positions should be located outside of any safety buffers for shipping lanes, subsea cables or pipelines
4. Each area should be defined as a 1.5 km x 1.5 km square, with a minimum separation of 0.5 km between the two areas.

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 turbines¹. At this distance, the uncertainty in horizontal extrapolation is minimised. A circle with a radius of 10 km would be smaller than the Hollandse Kust Zuid zone, so no location would fully meet this recommendation. However, if this circle is centred over the zone, it would cover most of the planned wind farm area.

¹ MEASNET, November 2009, "Evaluation of Site-Specific Wind Conditions - Version 1"

The expected wind climate for the Hollandse Kust zone will have a stronger gradient perpendicular to the coast, with little change parallel to the coast. This indicates that the optimal locations for the floating LiDARs 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.

2. Wake effects

The 129 MW Eneco Luchterduinen wind farm is located in the northern corner of the Hollandse Kust Zuid zone. The floating LiDARs should be located in undisturbed wind, so they 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 turbine². For the Eneco Luchterduinen wind farm, this means a distance of 2.24 km downwind.

Also, DTU has calculated the downstream effects of large offshore wind farms based on several models.³ 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 Eneco Luchterduinen wind farm would allow mostly free-stream wind measurements.

3. Other constraints

A minimum distance of 500 m was kept from all subsea pipelines and cables, and the floating LiDARs are placed outside of any shipping lanes. These constraints are shown in Figure 1. The proposed floating LiDAR locations are also shown for reference.

² IEC, December 2005, "Wind turbines – Part 12-1: Power performance measurements of electricity producing wind turbines", IEC 61400-12-1 Edition 1.0

³ Risø, October 2007, "Summary report: The shadow effect of large wind farms: measurements, data analysis and modelling" Risø-R-1615(EN)

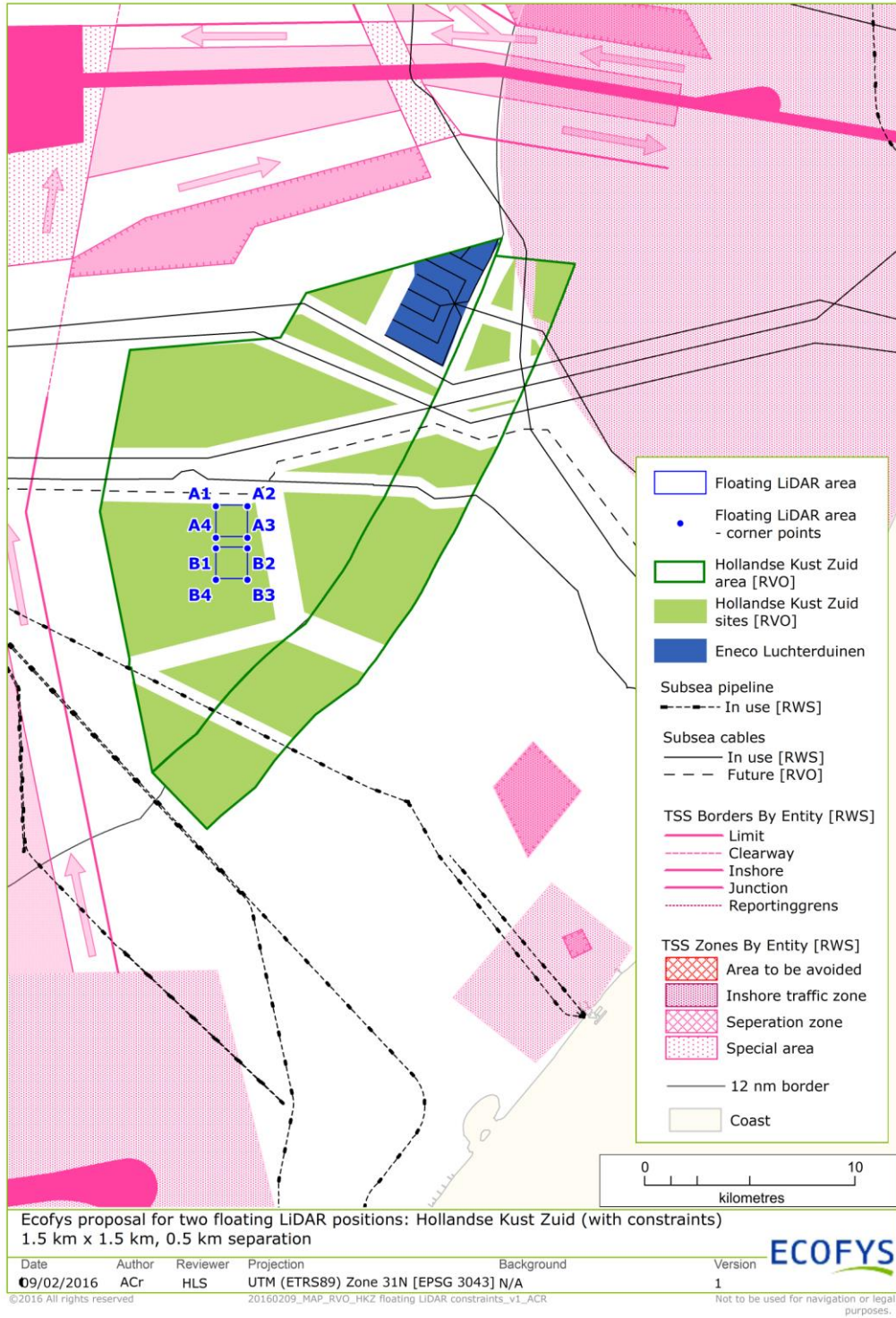


Figure 1 – Constraints around proposed site for floating LiDAR positions for Hollandse Kust Zuid

Recommended locations

Based on the analysis described above, Ecofys recommends a location that is roughly central in the Hollandse Kust Zuid zone, along the axis perpendicular to the coast, while maintaining a distance of at least 8 km from the Eneco Luchterduinen offshore wind farms, and outside any other constrained areas. For this reason, the proposed locations are in the eastern section of Site II, as shown in Figure 2. Ecofys believes that the identified location is the best balance of all above factors. The coordinates of the corner points are provided in Table 1.

Table 1 – Coordinates of Ecofys proposal for floating LiDAR locations

Corner point	Easting (UTM ETRS89 zone 31N)	Northing (UTM ETRS89 zone 31N)
A1	568,500	5,797,000
A2	570,000	5,797,000
A3	570,000	5,795,500
A4	568,500	5,795,500
B1	568,500	5,795,000
B2	570,000	5,795,000
B3	570,000	5,793,500
B4	568,500	5,793,500

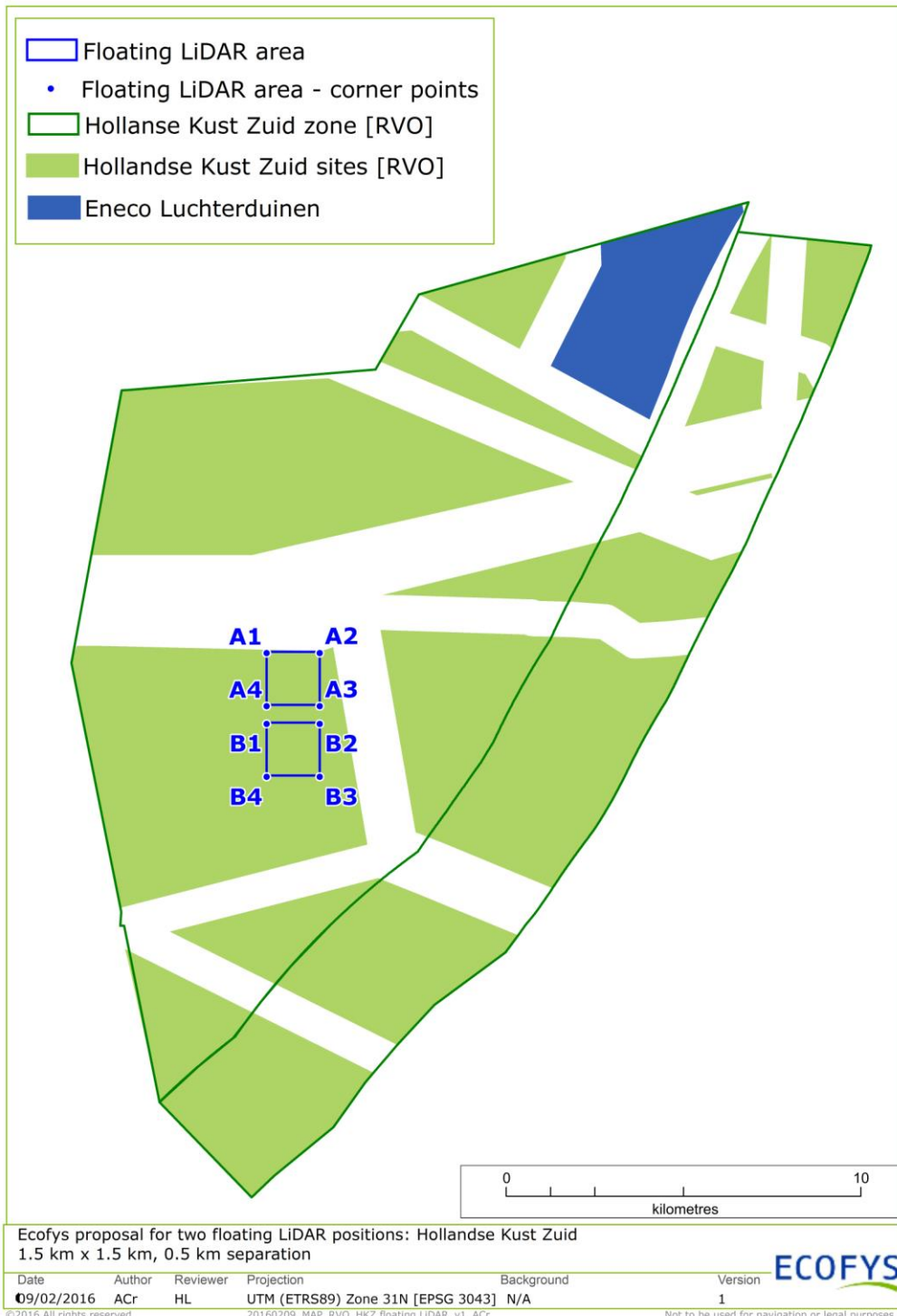


Figure 2 – Ecofys proposal for floating LiDAR positions – Hollandse Kust Zuid