

MEMO

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Subject: Borssele Wind Resource Assessment – Proposed revisions based on Verification Comment Sheet

To: Frank van Erp, Ruud de Bruijne; RVO

Introduction

RVO 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. The wind resource assessment report was submitted to RVO in May 2015. DNV GL has subsequently carried out a verification process of the Wind Resource Assessment and has requested clarification of a few points, as specified in their Verification Comment Sheet (VCS reference: 644235-VCS-09-Rev00, dated 2015-09-02). This memo presents the corresponding revisions to the WRA report.

Summary of relevant Verification Comments

2 (TQ).	The main conclusion from the study is that 'the mean wind speed at a hub height of 100 m MSL at the Borssele zone centre is 9.6 +/- 0.5 m/s.' Please re-phrase the conclusion.
3 (A).	Section 3.4.3 RVO metocean studies. DNV GL has noted that it is written: The mean wind speed at 100 m is found by Deltares to be 9.26 m/s, which is 0.3 m/s lower than the wind speed found in this assessment. ... In the approval letter for Zone Borssele Sites DNV GL has written that 'Upper bounds parameters (conservative parameters) can be applied directly for design without further justification.'
4 (TQ).	Section 3.5 Borssele wind climate. The way uncertainties are added together is not understood. [...] However the long term variation depends on the period considered. By looking at Figure 26, 3.5% seems to be the variation from year to year. During 20 years, the uncertainty of the mean wind speed seems only to be $3.5\%/\sqrt{20}=0.8\%$. Please

	reconsider.
5 (A).	Section 4.6 Figure 28. Figure 28 is not a frequency plot, but a probability plot. When a smooth line is used, it is not straight-forward to figure out what the percentage means. The area in a frequency plot should be 'one' so the unit on the second axis has to be 's/m', It is suggested to change the figure in the next revision.
6 (TQ).	<p>Section 4.9 Extreme Wind Speed.</p> <p>a) DNV GL has noted that it is written <i>'It should be noted that accuracy of the estimates from both data sources is unknown, as both involve assumptions regarding the suitability of off-site or modelled data.'</i></p> <p>b) It is not clear from the section what is the 50 year wind speed to be used for design.</p> <p>c) Furthermore DNV GL is aware that other nearby offshore wind farms have been designed for much higher extreme wind speeds than U_{hub} 10 min 50 year 41 m/s.</p> <p>DNV GL find 41 m/s to be a too low value extreme wind speed.</p> <p>... It shall also be noted that it is confusing that the extreme wind speeds presented in the metocean report are different from the extreme wind speed presented in the present report. Please rewrite section 4.9.</p>

Revisions

2 (TQ).

Samenvatting

Original text	Revised text
De gemiddelde windsnelheid op ashoogte van 100m MSL in het centrum van de Borssele site is 9.6 ± 0.5 m/s .	De gemiddelde lange termijn windsnelheid op ashoogte van 100m MSL in het centrum van de Borssele site is 9.6 ± 0.5 m/s (± standaard deviatie).

Executive Summary

Original text	Revised text
The mean wind speed at a hub height of 100 m MSL at the Borssele zone centre is 9.6 ± 0.5 m/s .	The long-term mean wind speed at a hub height of 100 m MSL at the Borssele zone centre is 9.6 ± 0.5 m/s (± standard deviation).

Section 3.5 (p. 22)

Original text	Revised tekst
The calculated mean wind speed at the Borssele zone is shown in Table 16, along with the associated uncertainty in terms of wind speed.	The calculated long-term mean wind speed at the Borssele zone is shown in Table 16, along with the associated uncertainty in terms of wind speed.

Conclusion (p. 43)

Original text	Revised tekst
The calculated mean wind speed at 100 m at the Borssele wind farm zone centre is 9.6 ± 0.5 m/s (± standard deviation).	The calculated long-term mean wind speed at 100 m at the Borssele wind farm zone centre is 9.6 ± 0.5 m/s (± standard deviation).

3 (A).

Section 3.4.3 (p. 20-21)

Original text	Revised text
The mean wind speed at 100 m is found by Deltares to be 9.26 m/s, which is 0.3 m/s lower than the wind speed found in this assessment.	The mean wind speed at 100 m is found by Deltares to be 9.26 m/s (Table 3.6 in [8] [9] [10] [11]), which is 0.3 m/s lower than the wind speed found in this assessment.

Section 3.4.3 (p. 21)

Original text	Revised tekst
	<p><i>[extra text to be added after the 2nd bullet point]:</i></p> <p>The Deltares reports also shows the upper bounds of the wind speed estimate at 100 m to be 10.04 m/s (Table 3.7 in [8] [9] [10] [11]), which can be seen as 95% upper bounds estimates given in Table 3.6. Within this context, the wind speed found in this Ecofys assessment is below this upper bound.</p>

Original text:

Table 14 – Calculated mean wind speed at Borssele wind farm zone and the associated uncertainty, using the other wind measurements as the primary source.

	Ecofys (this study)	Deltares [8] [9] [10] [11]
Mean wind speed at 100 m at zone centre [m/s]	9.6 (Table 12)	9.26
Extreme wind speed (50-year return) at 100 m at zone centre [m/s]	43-46 (Table 19)	36* * hourly
Weibull scale factor (k)	2.19 (Figure 27)	2.09
Power law exponent	0.085 ± 0.03 (Figure 17)	0.08 ± 0.03
Dominant wind direction	SW (Figure 29)	SW

Revised text:

Table 14 – Calculated mean wind speed at Borssele wind farm zone and the associated uncertainty, using the other wind measurements as the primary source.

	Ecofys (this study)	Deltares [8] [9] [10] [11]	Deltares 95% upper bound [8] [9] [10] [11]
Mean wind speed at 100 m at zone centre [m/s]	9.6 (Table 12)	9.26	10.04
Extreme wind speed (50-year return) at 100 m at zone centre [m/s]	43-46 (10-minute) (Table 19)	36 (hourly) 40 (10-minute)*	45 (hourly) 49 (10-minute)*
Weibull scale factor (k)	2.19 (Figure 27)	2.09	2.09
Power law exponent	0.085 ± 0.03 (Figure 17)	0.08 ± 0.03	0.11
Dominant wind direction	SW (Figure 29)	SW	n/a

* 20150216_SDB_Deltares_Metocean study for the Borssele Wind Farm Zone Site I_Tables_F.xls; Sheet 'Extreme Wind Speeds'; cell S80 (Extreme 600s mean wind speed, U100, OMNI direction)

4 (TQ).

Section 3.5 (p. 22)

Original text	Revised text
The combined uncertainty in the calculated Borssele wind climate is shown in Table 15.	The combined uncertainty in the calculated Borssele wind climate is shown in Table 15. The uncertainty definitions are given in Appendix F, and explained in Sections 3.1, 3.2 and 3.3.

5 (A).

Section 4.6 (p. 35)

Original text	Revised text
Figure 27 – Frequency distributions of the calculated wind speed at 100 m at the centre of the Borssele zone, with the fitted Weibull curve.	Figure 27 –Probability plot of the calculated wind speed at 100 m at the centre of the Borssele zone, with the fitted Weibull curve.
Figure 28 – Frequency distributions of the mast-top measurements at the offshore masts.	Figure 28 – Probability plot of the mast-top measurements at the offshore masts.

6 (TQ).

[see also response to Question 3. for revisions in Table 14]

Section 4.9 (p. 40)

Original text	Revised text
	<i>[extra text to be added after Table 20]:</i> These estimates can be compared to the detailed extreme wind climate estimates in the Deltares reports ([8] [9] [10] [11]) and accompanying Excel tables. The primary comparisons show that the estimates in this report are below the upper bounds found by Deltares (see Table 14).

Section 4.9 (p. 40)

Original text	Revised text
<p>The 50-year extreme 10-minute wind speed can be directly compared to the IEC design class of the wind turbine [13]. The estimates based on the KNW mesoscale data (41 m/s) are slightly below the limits for Class II wind turbines ($V_{ref} = 42.5$ m/s), whereas the estimates derived from the Meteomast IJmuiden measurements (43-46 m/s) are above this limit and below the threshold for a Class I wind turbine ($V_{ref} = 50$ m/s). It should be noted that accuracy of the estimates from both data sources is unknown, as both involve assumptions regarding the suitability of off-site or modelled data. Considering a conservative estimate of the extreme wind speeds, Ecofys recommends Class I wind turbines for the Borssele zone.</p>	<p>The 50-year extreme 10-minute wind speed can be directly compared to the IEC design class of the wind turbine [13]. The estimates based on the KNW mesoscale data (41 m/s) are slightly below the extreme wind speed limit for Class II wind turbines ($V_{ref} = 42.5$ m/s), whereas the estimates derived from the Meteomast IJmuiden measurements (43-46 m/s) are above this limit and below the extreme wind speed threshold for a Class I wind turbine ($V_{ref} = 50$ m/s). The accuracy of the estimates from both data sources is unknown, as both involve assumptions regarding the suitability of off-site or modelled data.</p> <p>It should be noted that, in order to obtain a project specific approval, it has to be shown that the rotor nacelle assembly loads due to wind & waves do not exceed type approved loads.</p>