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TNO report

TNO 2019 R11357 | Final report

Yield assessment Wind Farm Hollandse Kust noord
Scoping analysis for three different wind turbine types

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Copy no	
No. of copies	
Number of pages	38 (incl. appendices)
Number of appendices	3
Sponsor	
Project name	HKN Tender -Yield assessment WFS HKN
Project number	060.41570

Summary

RVO assigned ECN part of TNO to calculate the potential energy yield (P50[1]) for the wind farm zone Hollandse Kust Noord (HKN) Wind Farm Site V that will be tendered in 2019. The yield is determined for 3 different wind turbine types, using wind conditions for HKN as can be found on the RVO website. The wind turbine models are based on state of the art design analysis of turbines that are assumed to be available on the market at the time of installation of the wind farms at HKN in 2023.

The wind turbine characteristics are based on nominal power and rotor diameters that have been agreed on with RVO. The power and thrust curves of the wind turbines, which are required for the wind farm yield analysis, have been calculated with the ECN rotor design tool BOT.

A wind turbine lay-out has been designed by ECN for each of the three wind turbine models. The lay-outs are aiming for optimal spacing of the turbines with respect to yield, taking into account the restrictions that the installed capacity is maximized at 760 MW and that the wind turbines should be completely inside the boundary of the site (i.e. it is not allowed that rotor blades cross the site boundary).

The energy yields of the three wind farm designs have been determined with ECNs wind farm design tool FARMFLOW.

The resulting gross yield has been reduced by:
- The wind farm wake losses
- A fixed value for the assumed time fraction of non-availability of the wind turbines
- Electrical losses in the wind farm electrical collection system
- Curtailment losses due to a restricted transmission capacity to the offshore transmission system of 700 MW.

The resulting capacity factors[2] of the wind farms designs show a nearly linear relation with the rotor power density[3]. The net capacity factor, i.e. after subtracting all losses, varies between 46.7% for the wind turbine model with the highest rotor power density, and 52.4% for the model with the lowest rotor power density.

[1] P50 is the “best estimate” of the energy yield, suggesting that the estimated yield may be exceeded with 50% probability.
[2] The capacity factor is the non-dimensional ratio between the average generated power in a given period and the installed (rated) power.
[3] The rotor power density is the ratio between the rated power of a wind turbine and its rotor swept area.

Contents

1 Introduction

This report describes the work done and the results of a scoping analysis of the energy yield of the wind farm zone Hollandse Kust Noord (HKN). The work is performed by assignment of Rijksdienst voor Ondernemend Nederland, RVO.

The terms of reference for the project are as follows:
- The results are used for the development of the tender criteria for the HKN wind farm zone.
- These criteria will include the energy yield and capacity factor of the wind farm.
- In order to have characteristic values, RVO has assigned ECN to perform yield analysis calculations of the HKN wind farm zone for 3 different wind turbine types, which should be based on commercially available models where RVO indicated to use the geometries as indicated in Table 1-1.

Table 1-1 Wind turbine characteristics

Wind turbine Model	Nominal power	Rotor diameter	Hub height	Total height
	[MW]	[m]	[m]	[m]
A	9.5	174	117	204
B	10	193	126.5	223
C	12	220	140	250

The characteristic data required to perform the yield analysis are the power and the axial thrust curve. ECN determined the power and thrust curve with ECN's Blade Optimisation Tool, BOT [2].

The wind resource data applied in the analysis are based on reports and data supplied on RVO's website https://offshorewind.rvo.nl/windwaternh [7].

After the wind farm gross yield has been calculated including losses due to internal wake effects and wake effects from the existing wind farms OWEZ and Prinses Amalia, only the following additional losses have been taken into account:

- Wind turbine availability (flat rate value of 96%).
- Curtailment due to OWF overplanting from 700 MW to 760 MW, with 700 MW being the guaranteed transmission capacity.

2 Wind resources

2.1 Introduction

The wind resources applied in this study is based on the wind resources supplied by RVO which is described in a report [3]. The wind resources vary slightly over the HKN area, see Figure 2-1 which is copied from [3].

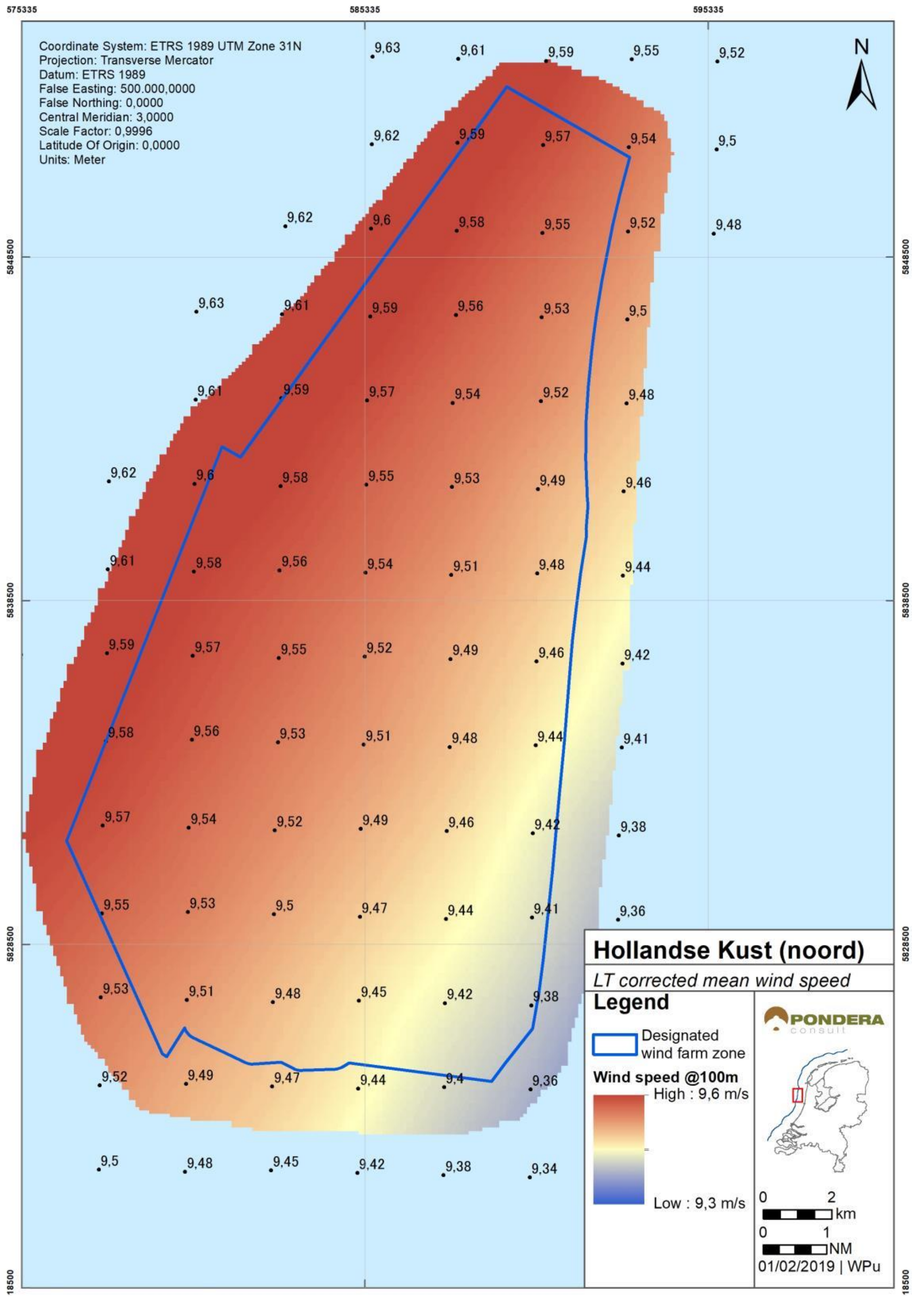

Figure 2-1 The average wind speed distribution over the HKN area at 100 m height, according to [3]

Because the average wind speed at the centre location of site V differs less than 0.15 m/s with all other locations in this site, only the wind rose data at the centre of the site is used throughout the wind farm zone. Table 2-1 shows the wind rose data for the reference height of 100 m above mean sea level (msl).

Table 2-1 Input data from Wind Resource Assessment for HKN Wind Farm Zone, centre location of site V, at 100 m above mean sea level (msl)

Direction	Frequency	Weibull A	Weibull k	Power law exponent
[°]	[%]	[m/s]	[-]	[-]
0	6.093	9.05	2.38	0.0362
30	5.690	8.97	2.57	0.0366
60	6.785	9.51	2.70	0.0459
90	7.128	9.55	2.62	0.0571
120	5.231	8.93	2.48	0.1034
150	5.059	9.32	2.36	0.1107
180	7.418	11.07	2.29	0.1031
210	13.010	12.82	2.48	0.1101
240	15.510	12.65	2.57	0.0946
270	11.200	11.45	2.34	0.0667
300	9.169	10.37	2.34	0.0526
330	7.708	9.95	2.26	0.0385

2.2 Wind resource at hub height

The wind turbines used in the analysis are described in Appendix A. As a general principle it is assumed that the hub height corresponds to a minimum distance of 30 m between the rotor blades and the mean sea level (msl). This results in a hub height of 117 m for turbine type A, 126.5 m for type B and 140 m for type C. By means of the power law exponent the wind resource data from [3] at heights of 100, 120 and 160 m have been interpolated to the hub heights of the three turbine types. The interpolated wind resource data at hub height is listed in Table 2-2.

The air density ρ at the OWEZ met mast at 116 m height is 1.2255 kg/m^3 according to [3]. A corrected air density for the hub heights of the three turbine types has been calculated with the following equation:

$$\rho = \frac{p_0 M}{RT}\left(1 - \frac{Lh}{T_0}\right)^{gM/RL}$$

Where:

- p_0 is sea level standard atmospheric pressure (101325 Pa)
- M is molar mass of dry air (0.0289644 kg mol^{-1})
- R is ideal (universal) gas constant (8.31447 J mol^{-1} K^{-1})
- T is the air temperature at altitude h in K
- T_0 is sea level standard temperature (288.15 K)

- L is the temperature lapse rate (0.0065 K m^{-1})
- g is the earth-surface gravitational acceleration (9.80665 ms^{-2})

The corrected air densities are also listed in Table 2-2.

Table 2-2 Interpolated wind resource data for the hub heights of turbine types A, B and C

Direction	Frequency	A (117 m) ρ = 1.2254 kg/m^3		B (126.5 m) ρ = 1.2243 kg/m^3		C (140 m) ρ = 1.2227 kg/m^3	
		Weibull A	Weibull k	Weibull A	Weibull k	Weibull A	Weibull k
[°]	[-]	[m/s]	[-]	[m/s]	[-]	[m/s]	[-]
0	6.093	9.102	2.38	9.128	2.38	9.163	2.38
30	5.690	9.022	2.57	9.048	2.57	9.083	2.56
60	6.785	9.579	2.70	9.614	2.70	9.659	2.70
90	7.128	9.636	2.62	9.681	2.62	9.741	2.62
120	5.231	9.076	2.47	9.149	2.47	9.244	2.47
150	5.059	9.438	2.36	9.568	2.36	9.680	2.36
180	7.418	11.251	2.29	11.343	2.29	11.466	2.29
210	13.010	13.044	2.48	13.158	2.48	13.309	2.47
240	15.510	12.839	2.57	12.935	2.57	13.062	2.56
270	11.200	11.570	2.34	11.628	2.34	11.702	2.34
300	9.169	10.456	2.34	10.499	2.34	10.555	2.34
330	7.708	10.010	2.26	10.040	2.26	10.083	2.26

The wake effects in a wind farm are influenced by the ambient turbulence intensity, which makes it important to have a good estimate of the turbulence intensity distribution as well. The turbulence intensity distribution in this study is based on accurate measurements from the met mast IJmuiden Ver at 92 m height. Because the wind farm zone HKN is much closer to coast, a higher turbulence intensity is expected for eastern wind directions. Since no accurate measurements of the turbulence intensity per sector are available, the influence of the distance to coast is based on an educated guess. The average turbulence intensity distributions as measured at IJmuiden Ver and as estimated for the HKN wind farm zone are shown in Figure 2-2.

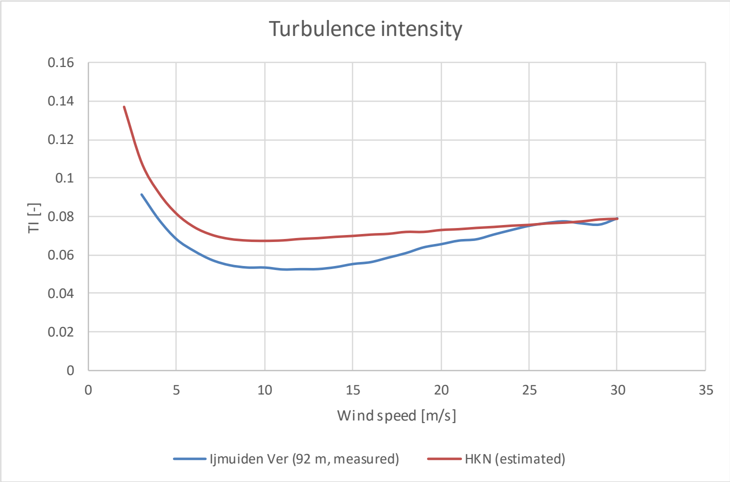

Figure 2-2 Turbulence intensity distribution measured at Ijmuiden Ver at 92 m height and estimated for the wind farm zone HKN

3 Wind turbine characteristics

The wind farm yield analysis has been performed for 3 wind turbine types. In consultation with RVO the following general wind turbine geometries are the basis for the wind turbine designs.

Table 3-1 General characteristics of wind turbines A, B and C.

Wind turbine Model	Nominal power	Rotor diameter	Rotor Power Density
	[MW]	[m]	[W/m^2]
A	9.5	174	400
B	10	193	342
C	12	220	316

TNO designed the three rotors using the Blade Optimisation Tool[4] BOT [2]. The results of the designs are the aerodynamic properties, the power curve and the axial thrust curve as a function of the ambient wind speed at hub height.

The input for the designs is a set of commonly used aerodynamic profiles, DUWIND profiles at the inner part and NACA profiles at the outer part of the blade. It is assumed that the hub height corresponds to a minimum distance of 30 m between the rotor blades and the mean sea level:

$$H_{hub} = 30 + \frac{1}{2} D_{rotor} \text{ [m]}.$$

The resulting power and thrust curves of the blades are shown in Appendix A.

[4] Version 2016-1

4 Wind farm design

4.1 Introduction

Three wind farm designs have been created for three different wind turbine types. The nominal power of each design is as close as possible to the maximum allowed nominal power of 760 MW.

Table 4-1 General characteristics of the wind farm designs

Wind turbine model	# wind turbines	WF nominal power
	[#]	[MW]
A	80	760
B	76	760
C	63	756

The site description and boundaries are taken from Project and Site description, especially Appendix C, see [8].

4.2 Design strategy

The wind farm is designed only taking into account the available space. No restriction e.g. due to water depth has been applied. What has also not been considered is minimizing the number of cable crossing to existing infrastructure.

The main wind farm design strategy applied is to position wind turbines evenly distributed in the space, with slightly closer spacing at positions of higher average wind speed and at positions where large sectors of free wind exists (i.e. at the site boundaries). The turbines are positioned completely inside the allowable boundaries on the coordinates given in [8].

The designs are reported in detail in Appendix B.

5 Wake and yield analysis

The wake analysis, performed with the FARMFLOW[5] [10] model, resulted in the following gross yields and wake effects, cf. Table 5-1. In each analysis a wind farm is modelled with the wind turbine model, A, B or C, always together with the Prinses Amalia and OWEZ wind farms. The characteristics of the wind turbines can be found in Appendix A and the wind turbine locations in Appendix B.

Table 5-1 Results of wake and yield analysis

Turbine model	Gross yield	Yield including wakes	Normalized yield (WF A = 100%)	Capacity factor
	[GWh]	[GWh]	[%]	[%]
A	3637.6	3269.6	100.0	49.1
B	3804.4	3465.8	106.0	52.0
C	4007.2	3656.2	111.8	55.2

For each design the losses due to wake effects for all individual turbines in the wind farm are shown in Figure 5-1, Figure 5-2 and Figure 5-3.

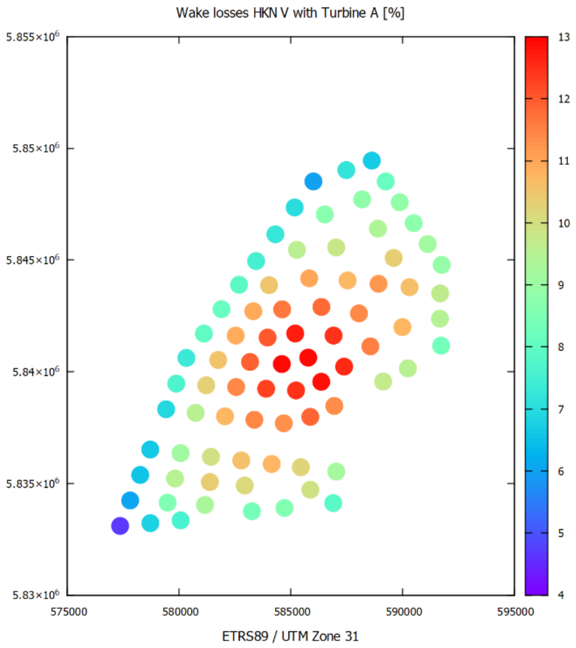

Figure 5-1 Wake losses in percentage for wind farm design with wind turbines type A

[5] Version 3.1.1

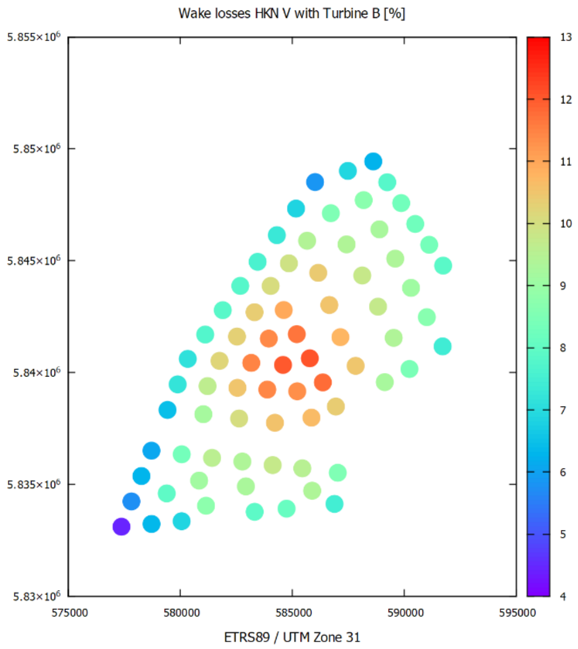

Figure 5-2 Wake losses in percentage for wind farm design with wind turbines type B

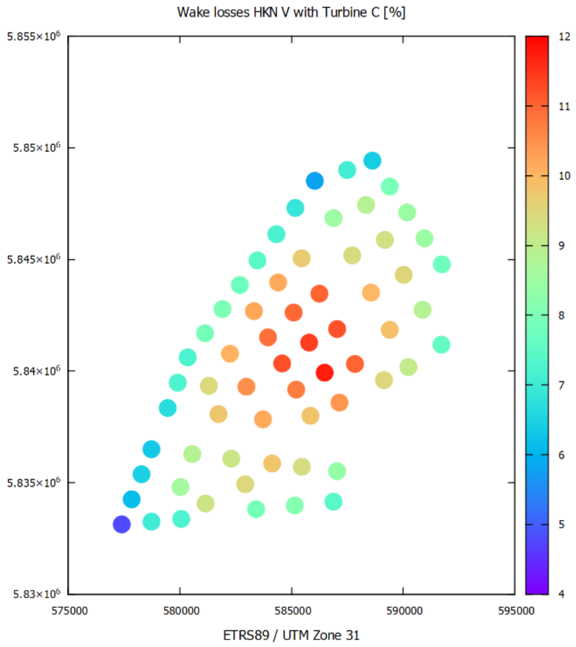

Figure 5-3 Wake losses in percentage for wind farm design with wind turbines type C

6 Losses analysis

6.1 Introduction

On top of the wind farm wake losses it is agreed to take the following additional losses into account:

- Losses due to availability of the wind turbines, further referred to as “availability losses”
- Losses in the array cabling
- Losses due to curtailment to the limited transport capacity of the cable connection to the onshore grid.

6.2 Availability losses

Due to the fact that no detailed information is available about the availability of the wind turbines comparable to the types used in this work, and no information on the wind farm electrical design, a fixed or lumped value of 4% is prescribed for the time-weighted availability losses.

6.3 Array cable losses

For calculating the array cable losses a radial collection system has been the designed for each of the three wind farm layouts, consisting of two cable types (300mm^2 Cu and 800mm^2 Cu tre-foil). Cable distances between turbines have been determined using the shortest distance with 10% overlength. The unavailability of the array cables is assumed to be included in the total wind farm unavailability.

Table 6-1: Array cable losses, assuming 96% availability of wind turbines

Wind turbine Model	Array cable losses
	[%]
A	0.57
B	0.59
C	0.63

6.4 Curtailment losses

To determine the curtailment losses due to a limitation of the temperature of the high-voltage electrical transmission cable a simulation model of the cable temperature has been created. The model is created on the basis of information supplied by TenneT, see [9]. The input for the model is the wind farm power matrix and wind time series for each of the sites of HKN, as supplied via the RVO website.

The wind power matrix is the directional dependent power curve of the wind farm as calculated with the FARMFLOW tool. The wind time series used for the simulations consist of 15 years hourly data. The wind speeds are extrapolated with the wind shear power law exponent as given in Figure 6-1 to the hub heights of the wind turbine types used in this work.

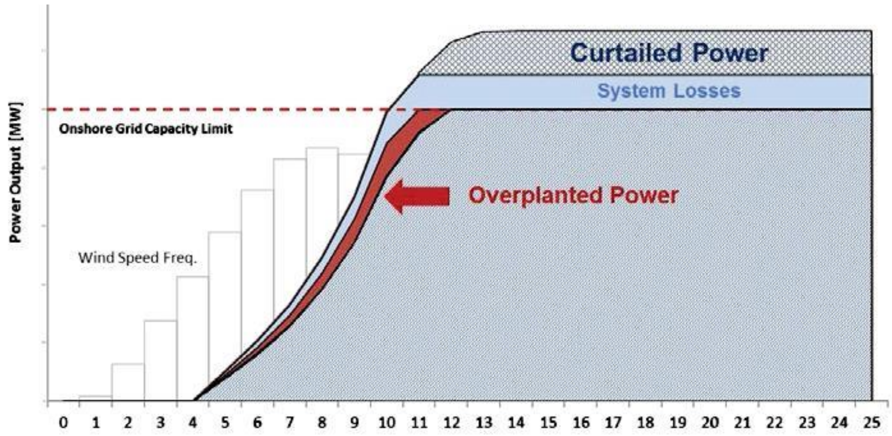

Figure 6-1: Principal of capacity optimization (Source Global offshore wind conference 2014)

The wind farm output power is created from the Wind Farm Power matrix. First the internal array losses, aerodynamic and electrical losses and the losses due to availability have been applied.

In the model it is assumed that when the cable temperature increases above the temperature limit, the power of the wind farm is reduced to 700 MW. The loss is assumed to be the difference between the power that could be generated and the power that can be transported to the onshore grid.

As illustrated in Figure 6-2 TNO has modelled the 220kV export transmission system and simulated the following curtailment strategy (at a 1 hour time resolution):

a. immediate limitation of Wind Power Plant power to 700 MW when export cable temperature reaches 90 ˚C
b. this reduction is lifted as soon as the export cable temperature drops below 90 ˚C minus a hysteresis of 5 ˚C.

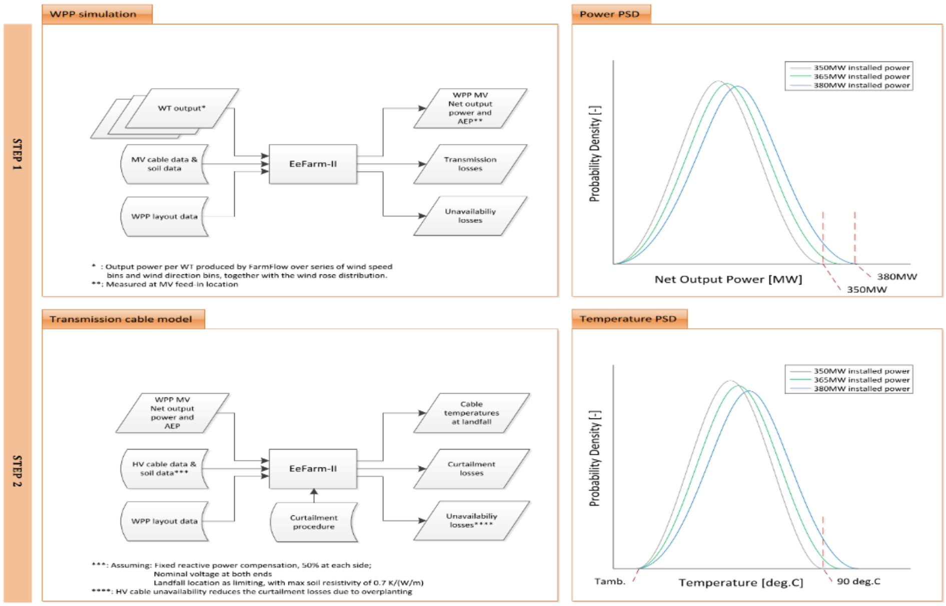

Figure 6-2: Schematic overview of procedure to determine the losses due to curtailment

In Figure 6-2, step 1 illustrates the procedure to determine the WPP (wind power plant) power output (probability density) and the effect of immediate curtailment. Step 2 illustrates the procedure in which wind time series are used to generate a WPP power output time series, which is fed through a thermal model of a transmission cable section to simulate the cable temperature. The lower right figure illustrates the probability density of this cable temperature and curtailment above a certain level.

The static cable thermal model [5] has been implemented in ECN's software tool EeFarm[6] [6]. The cable rating was tuned so that the conductor temperature is just below 90 ˚C (87 ˚C) for constant input power of 700 MW. As for HKN no soil data and detailed cable data is available at the moment, the cable dynamic characteristics were set in accordance with the TenneT HKZ overplanting position paper [9], cf. Figure 6-3.

[6] Version 2.

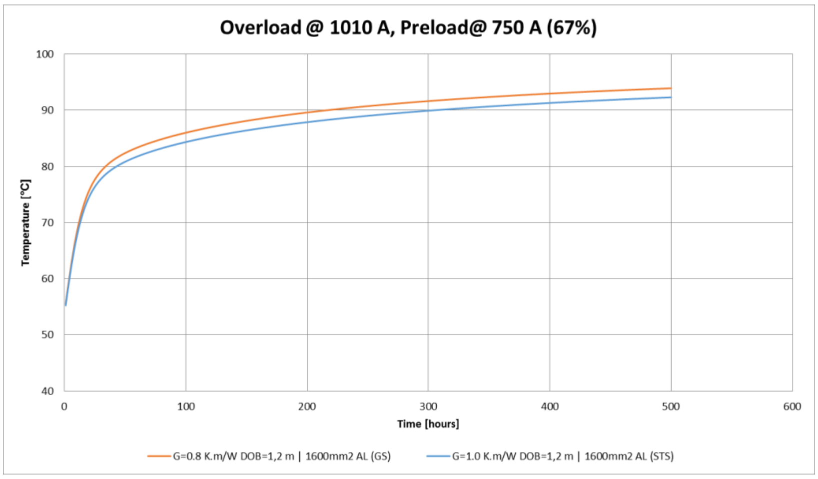

Figure 6-3: Development of temperature of conductor with overload of 1010 A (380 MW) and preload of 750 A, copied from [9], figure 4

6.4.1 *Resulting curtailment losses*

The resulting curtailment losses for the wind farms are shown in Table 6-2.

Table 6-2: Curtailment losses for worst-case scenario, assuming 96% availability of wind turbines

Wind turbine Model	Curtailment losses
	[%]
A	0.42
B	0.42
C	0.41

7 Results

The net energy yield for the wind farm zone Hollandse Kust Noord (HK noord) Wind Farm Site V are determined for three turbine types and wind farm designs. The gross energy yield, determined on the basis of the power curve of the wind turbine in the ambient wind conditions assumed for the sites are reduced by the following losses:

1. Wake effects
2. Availability of the turbines and intra array electrical system
3. Curtailment due to overplanting of approximately 60 MW

The summary of results is presented in Table 7-1 and the detailed results of the wake loss analysis is shown in Appendix C.

Table 7-1 Results of wake and yield analysis and including electrical and curtailment losses

Turbine Model	Gross Yield	After Wake losses	After unavailability losses	After electrical losses	After curtailment losses	WF Net Capacity factor
	[GWh]	[GWh]	[GWh]	[GWh]	[GWh]	[%]
A	3637.6	3269.6	3138.9	3121.1	3108.0	46.7
B	3804.4	3465.8	3327.3	3307.6	3293.7	49.4
C	4007.2	3656.2	3510.0	3487.9	3473.6	52.4

8 Conclusion

ECN has analysed 3 different scenarios for the wind farm zone Hollandse Kust Noord Wind Farm Site V to be tendered in 2019. The wind conditions applied are based on the wind conditions that RVO provides on their website [4].
For each scenario the wind turbine characteristics, i.e. power and thrust curve are determined using the rotor blade optimisation tool BOT. A layout has been designed and the performance has been evaluated using ECN's FARMFLOW tool to determine the gross yield and wake losses.

The resulting energy yield is converted into a capacity factor, being the ratio of the actual predicted generated power divided by the installed rated power of the scenario considered. This ratio depends to a large extend on the rotor power density, and follows a decreasing slope of approximately 7% per 100 W/m^2 rotor power density increase (see Figure 8-1).

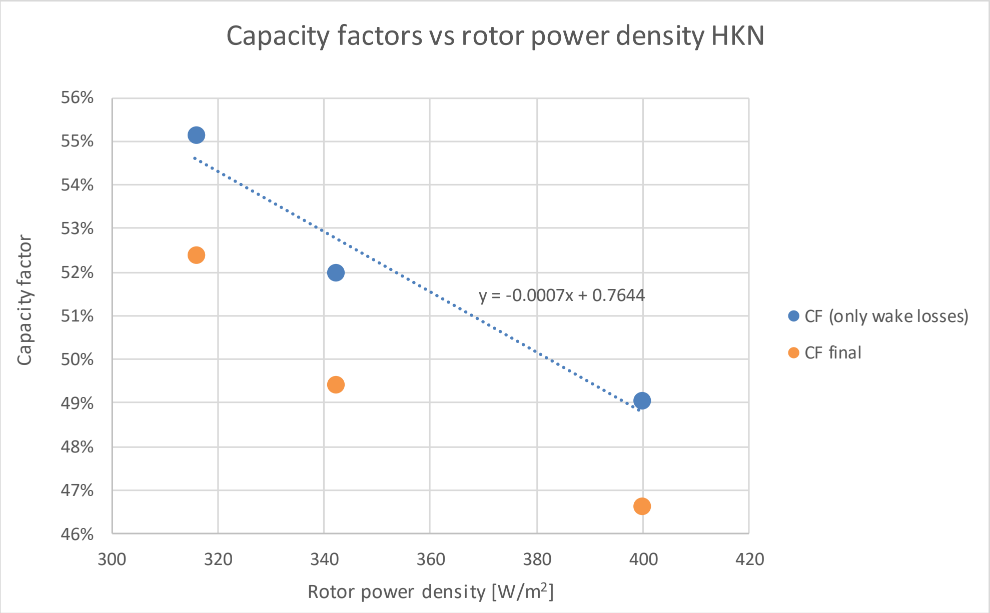

Figure 8-1: Wind farm capacity factors versus rotor power density, blue dots capacity factor after wake losses and orange dots capacity factor after all losses taken into account in this study.

9 References

[1] Submarine Power Cables, section 3.1.3, 2009.

[2] E.T.G. Bot and O. Ceyhan. Blade Optimisation Tool, BOT, 2011.

[3] A. Oldroyd, H. Hussin, W. Pustjens, P. Rooijmans, E. Holtslag, L. Garcia, R. Verzijlbergh, and E. Wiegant. Wind Resource Assessment for Hollandse Kust (noord) Wind Farm Zone. Report by Oldbaum, Document No. HKN_20190312_OBL_WRA-HKN_V5_OF, March 2019.

[4] Floriane Dubonnet, Maziar Golestani, Rodolfo Bolaños, Hans Fabricius Hansen, Palle Martin Jensen, and Sara Jackson. Wind Farm Zone Hollandse Kust (zuid) & Hollandse Kust (noord).Metocean Study; September 2017.

[5] A. Papadopoulos, S. Rodrigues, T. Todorcevic, R Teixeira Pinto, and P. Bauer. Collection and Transmission Losses of Offshore Wind Farms for Optimization Purposes. In *In proceedings of the IEEE ECCE USA*, 2015.

[6] J.T.G. Pierik. EeFarm II Description, testing and application, 2009.

[7] RVO. General information Hollandse kust (zuid) Wind Farm Zone https://offshorewind.rvo.nl/generalnh, 2019.

[8] R. Van Lanen, G. Cutler and T. Moekotte.Site studies Hollandse Kust (noord) Wind Farm Zone, 2019.

[9] TenneT TSO, Memorandum Overplanting ONL 15-083-T11_Overplanting_PP versie 3, 29 februari 2016

[10] E.T.G. Bot. FarmFlow validation against full scale wind farms, 2015.

A Wind turbine characteristics

A.1 Turbine A: 9.5 MW – 174 m

Table 9-1 Power and thrust coefficients curve for wind turbine A, a 9.5 MW wind turbine with a 174 m rotor diameter

Power and thrust coefficients curve for standard air density (1.225 kg/m^3)						
V [m/s]	P [kW]	C_t [-]		V [m/s]	P [kW]	C_t [-]
3.0	12	0.885		14.5	9500	0.276
3.5	88	0.885		15.0	9500	0.248
4.0	219	0.885		15.5	9500	0.223
4.5	417	0.885		16.0	9500	0.202
5.0	659	0.880		16.5	9500	0.183
5.5	953	0.862		17.0	9500	0.167
6.0	1290	0.843		17.5	9500	0.153
6.5	1684	0.831		18.0	9500	0.141
7.0	2148	0.824		18.5	9500	0.130
7.5	2683	0.817		19.0	9500	0.120
8.0	3293	0.810		19.5	9500	0.111
8.5	3981	0.802		20.0	9500	0.103
9.0	4747	0.792		20.5	9500	0.096
9.5	5588	0.778		21.0	9500	0.089
10.0	6475	0.758		21.5	9500	0.083
10.5	7365	0.725		22.0	9500	0.078
11.0	8175	0.677		22.5	9500	0.073
11.5	8825	0.614		23.0	9500	0.069
12.0	9224	0.542		23.5	9500	0.065
12.5	9408	0.469		24.0	9500	0.061
13.0	9477	0.407		24.5	9500	0.057
13.5	9497	0.354		25.0	9500	0.053
14.0	9500	0.311				

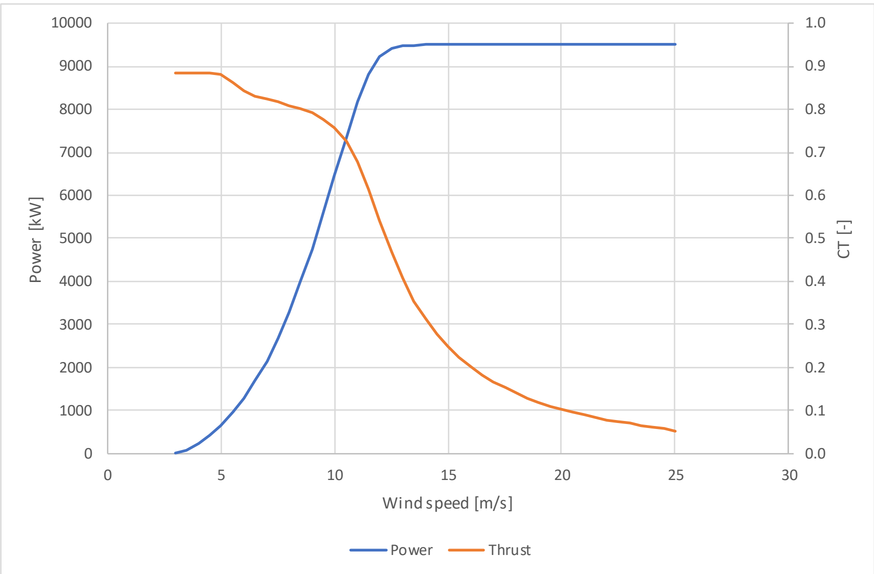

Figure 9-1 Power and thrust coefficients curve for wind turbine A, a 9.5 MW wind turbine with a 175 m rotor

A.2 Turbine B: 10.0 MW – 193 m

Table 9-2 Power and thrust coefficients curve for wind turbine B, a 10.0 MW wind turbine with a 193 m rotor diameter

Power and thrust coefficients curve for standard air density (1.225 kg/m^3)						
V [m/s]	P [kW]	C_t [-]		V [m/s]	P [kW]	C_t [-]
3.0	88	0.863		14.5	9996	0.235
3.5	217	0.828		15.0	9999	0.211
4.0	394	0.798		15.5	9999	0.190
4.5	615	0.796		16.0	10000	0.172
5.0	891	0.796		16.5	10000	0.157
5.5	1227	0.797		17.0	10000	0.143
6.0	1631	0.797		17.5	10000	0.131
6.5	2108	0.797		18.0	10000	0.120
7.0	2665	0.797		18.5	10000	0.111
7.5	3305	0.797		19.0	10000	0.103
8.0	4025	0.796		19.5	10000	0.095
8.5	4812	0.780		20.0	10000	0.088
9.0	5644	0.743		20.5	10000	0.082
9.5	6502	0.707		21.0	10000	0.077
10.0	7357	0.671		21.5	10000	0.072
10.5	8159	0.636		22.0	10000	0.067
11.0	8836	0.599		22.5	10000	0.063
11.5	9339	0.543		23.0	10000	0.059
12.0	9661	0.459		23.5	10000	0.056
12.5	9842	0.391		24.0	10000	0.052
13.0	9932	0.339		24.5	10000	0.050
13.5	9973	0.297		25.0	10000	0.047
14.0	9990	0.263				

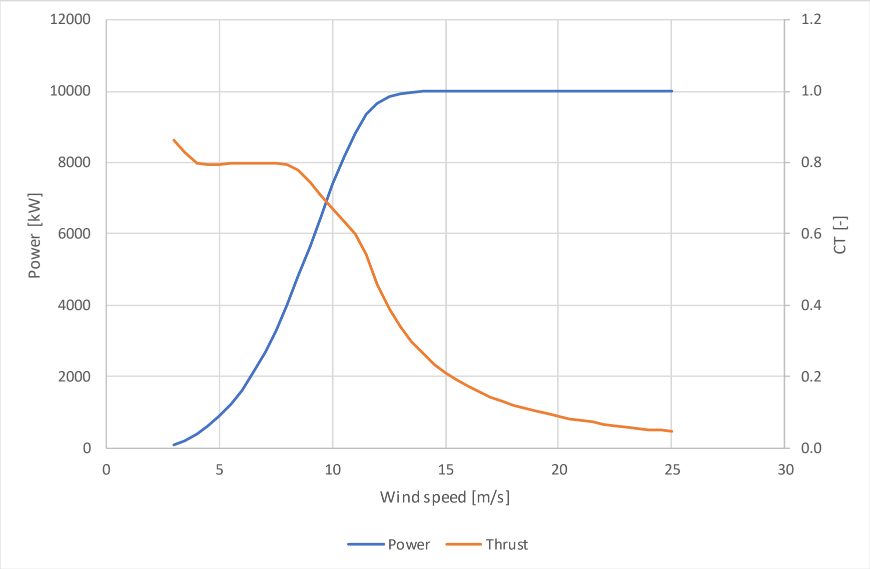

Figure 9-2 Power and thrust coefficients curve for wind turbine B, a 10.0 MW wind turbine with a 193 rotor diameter

A.3 Turbine C: 12.0 MW – 220 m

Table 9-3 Power and thrust coefficients curve for wind turbine C, a 12.0 MW wind turbine with a 167 m rotor diameter

Power and thrust coefficients curve for standard air density (1.225 kg/m³)					
V [m/s]	P [kW]	C_t [-]	V [m/s]	P [kW]	C_t [-]
3.0	9	0.846	14.5	12000	0.220
3.5	185	0.891	15.0	12000	0.198
4.0	425	0.899	15.5	12000	0.179
4.5	739	0.840	16.0	12000	0.163
5.0	1114	0.816	16.5	12000	0.149
5.5	1566	0.816	17.0	12000	0.136
6.0	2109	0.816	17.5	12000	0.125
6.5	2749	0.816	18.0	12000	0.115
7.0	3496	0.816	18.5	12000	0.107
7.5	4358	0.816	19.0	12000	0.099
8.0	5343	0.816	19.5	12000	0.092
8.5	6453	0.816	20.0	12000	0.086
9.0	7665	0.816	20.5	12000	0.080
9.5	8894	0.812	21.0	12000	0.075
10.0	10014	0.729	21.5	12000	0.070
10.5	10899	0.652	22.0	12000	0.066
11.0	11482	0.576	22.5	12000	0.062
11.5	11793	0.480	23.0	12000	0.058
12.0	11929	0.410	23.5	12000	0.055
12.5	11978	0.356	24.0	12000	0.052
13.0	11994	0.312	24.5	12000	0.049
13.5	11998	0.276	25.0	12000	0.047
14.0	12000	0.246			

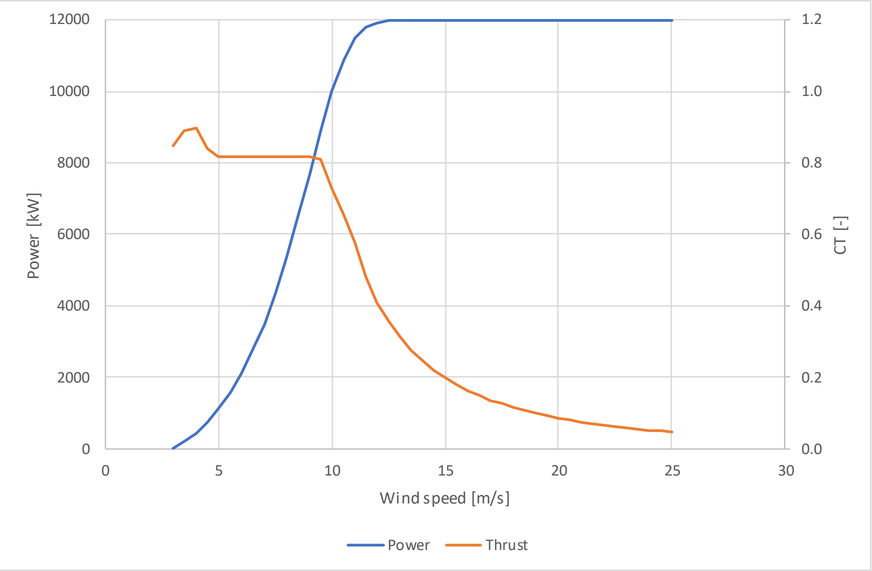

Figure 9-3 Power and thrust coefficients curve for wind turbine C, a 12.0 MW wind turbine with a 220 m rotor diameter

A.4 Vestas V80: 2.0 MW – 80 m (Prinses Amalia wind farm)

Table 9-4 Power and thrust coefficients curve for the Vestas V80 wind turbine of the Prinses Amalia wind farm, a 2.0 MW wind turbine with a 80 m rotor diameter

Power and thrust coefficients curve for standard air density (1.225 kg/m^3)		
V [m/s]	P [kW]	C_t [-]
4.0	58	0.751
5.0	149	0.779
6.0	277	0.791
7.0	461	0.813
8.0	696	0.809
9.0	985	0.788
10.0	1303	0.740
11.0	1607	0.656
12.0	1824	0.539
13.0	1939	0.392
14.0	1982	0.308
15.0	1994	0.247
16.0	1997	0.203
17.0	1999	0.169
18.0	2000	0.143
19.0	2000	0.122
20.0	2000	0.105
21.0	2000	0.092
22.0	2000	0.080
23.0	2000	0.071
24.0	2000	0.063
25.0	2000	0.057

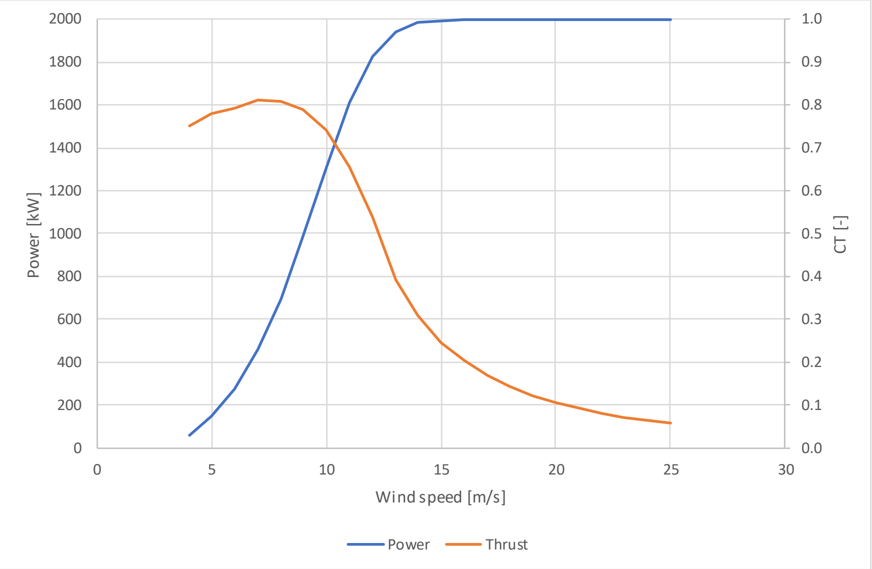

Figure 9-4 Power and thrust coefficients curve for the Vestas V80, a 2.0 MW wind turbine with a 80 m rotor diameter (Prinses Amalia)

A.5 Vestas V90: 3.0 MW – 90 m (OWEZ)

Table 9-5 Power and thrust coefficients curve for the Vestas V90 wind turbine of the OWEZ wind farm, a 3.0 MW wind turbine with a 90 m rotor diameter

V [m/s]	P [kW]	C_t [-]
4.0	77	0.845
5.0	190	0.826
6.0	353	0.825
7.0	581	0.824
8.0	886	0.824
9.0	1272	0.800
10.0	1696	0.712
11.0	2106	0.615
12.0	2489	0.531
13.0	2797	0.461
14.0	2951	0.382
15.0	2993	0.305
16.0	2999	0.248
17.0	3000	0.205
18.0	3000	0.172
19.0	3000	0.147
20.0	3000	0.126
21.0	3000	0.110
22.0	3000	0.096
23.0	3000	0.085
24.0	3000	0.075
25.0	3000	0.067

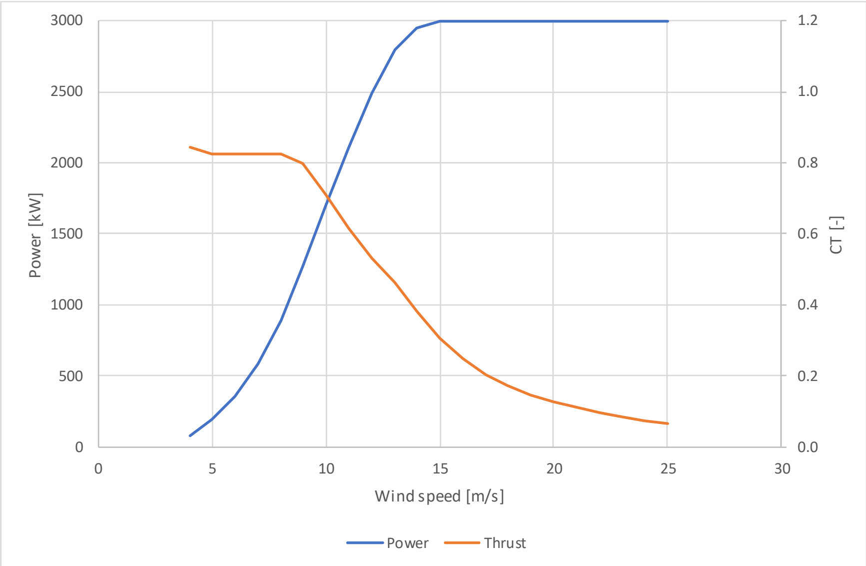

Figure 9-5 Power and thrust coefficients curve for the Vestas V90, a 3.0 MW wind turbine with a 90 m rotor diameter (OWEZ)

B Wind turbine coordinates for all scenarios including OWFs Amalia and OWEZ

B.1 Site V, wind turbine type A

Table 9-6 Coordinates of the wind farm design for Site V using wind turbine type A, with a hub height of 117 m

Wind turbine	X	Y	Wind turbine	X	Y
#	[m]	[m]	#	[m]	[m]
1	588630.2	5849451.8	41	583964.2	5841531.0
2	589255.6	5848518.8	42	584602.0	5840348.5
3	589881.0	5847585.7	43	585239.9	5839166.1
4	590506.4	5846652.6	44	585877.8	5837983.6
5	591131.8	5845719.6	45	581902.6	5842804.2
6	591757.2	5844786.5	46	581116.8	5841712.5
7	587489.6	5849027.7	47	582540.5	5841621.7
8	588196.7	5847717.9	48	580330.9	5840620.8
9	588903.9	5846408.0	49	581754.6	5840530.0
10	589611.0	5845098.2	50	583178.3	5840439.3
11	590318.1	5843788.3	51	580740.7	5838165.9
12	591689.7	5843509.4	52	582057.1	5838008.9
13	591679.8	5842376.9	53	583373.5	5837852.0
14	590000.0	5842000.0	54	584690.0	5837695.0
15	591732.4	5841168.6	55	579877.6	5839471.8
16	588932.3	5843939.6	56	581218.2	5839395.4
17	586017.3	5848520.5	57	582558.8	5839318.9
18	586527.0	5847044.0	58	583899.3	5839242.5
19	587036.7	5845567.4	59	579424.2	5838322.8
20	587546.4	5844090.9	60	578713.0	5836520.3
21	588056.0	5842614.4	61	580071.7	5836358.6
22	588565.7	5841137.9	62	581430.4	5836196.8
23	590245.5	5840153.5	63	582789.1	5836035.1
24	589138.8	5839563.9	64	584147.9	5835873.4
25	585177.9	5847354.3	65	585455.2	5835729.9
26	585280.6	5845459.2	66	587036.7	5835532.4
27	586373.5	5842902.1	67	578263.3	5835380.4
28	586920.0	5841623.6	68	577813.5	5834240.6
29	587391.0	5840232.3	69	577363.8	5833100.7
30	584314.4	5846154.7	70	578717.8	5833225.0
31	585827.1	5844180.7	71	580071.8	5833349.2
32	583450.9	5844955.1	72	581164.6	5834042.6
33	584034.2	5843874.5	73	582943.5	5834907.0
34	584617.4	5842793.9	74	579823.3	5835222.6
35	585200.7	5841713.3	75	581383.4	5835064.8
36	585783.9	5840632.7	76	579489.1	5834141.6
37	586367.2	5839552.2	77	583266.4	5833758.6
38	586950.4	5838471.6	78	584721.2	5833903.8
39	582688.4	5843895.9	79	586903.5	5834121.4
40	583326.3	5842713.4	80	585878.9	5834718.1

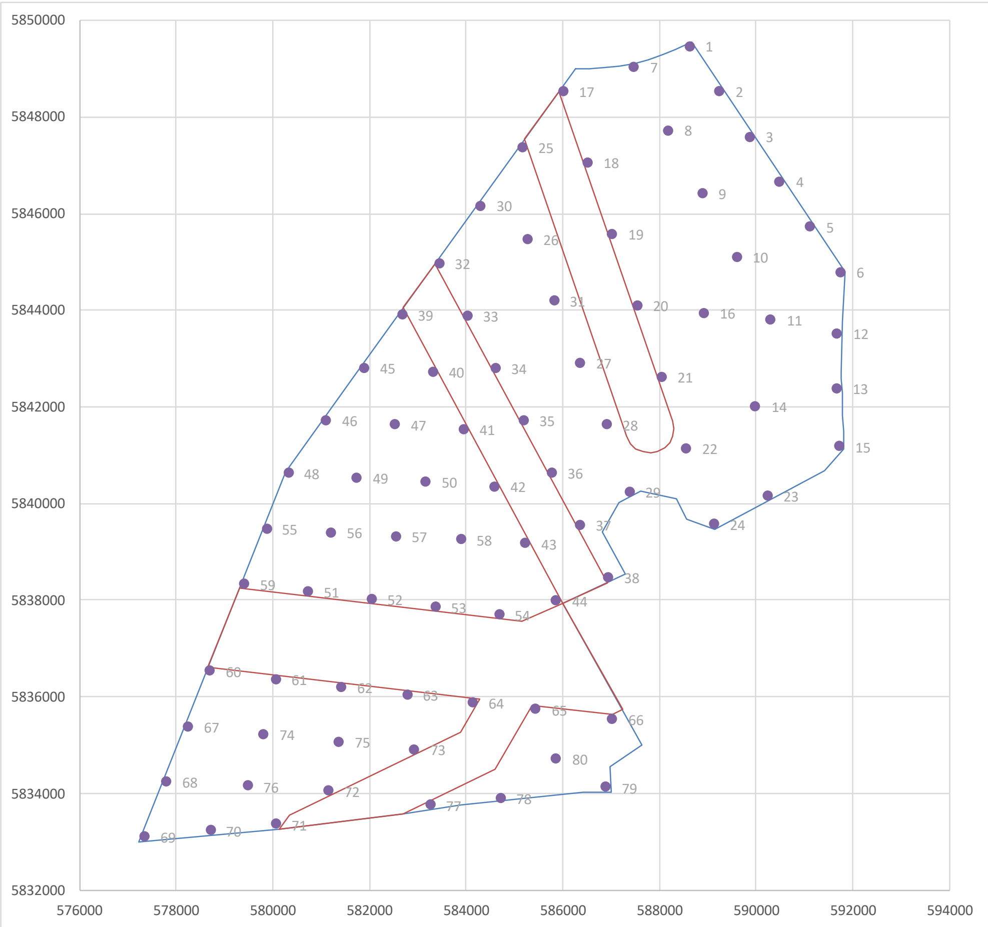

Figure 9-6 Wind farm design for Site V using wind turbine type A

B.2 Site V, wind turbine type B

Table 9-7 Coordinates of the wind farm design for Site V using wind turbine type B, with a hub height of 126.5 m

Wind turbine	X	Y	Wind turbine	X	Y
#	[m]	[m]	#	[m]	[m]
1	588626.4	5849440.3	39	583958.2	5841522.0
2	589250.6	5848509.1	40	584593.7	5840344.0
3	589874.8	5847577.8	41	585229.2	5839166.0
4	590499.0	5846646.5	42	585864.7	5837987.9
5	591123.2	5845715.3	43	581904.6	5842790.7
6	591747.4	5844784.0	44	581122.0	5841703.5
7	587491.7	5849018.4	45	582540.1	5841612.7
8	588196.9	5847710.8	46	584232.9	5837759.1
9	588902.2	5846403.1	47	580339.3	5840616.2
10	589607.4	5845095.5	48	581757.5	5840525.4
11	590312.7	5843787.8	49	583175.6	5840434.7
12	591018.0	5842480.2	50	582634.5	5837949.7
13	591723.2	5841172.6	51	581036.0	5838140.2
14	586027.9	5848518.9	52	579888.5	5839473.5
15	586730.3	5847126.2	53	581223.6	5839396.6
16	587432.7	5845733.4	54	582558.8	5839319.7
17	588135.1	5844340.7	55	583894.0	5839242.8
18	588837.4	5842947.9	56	579437.6	5838330.8
19	589539.8	5841555.2	57	578719.2	5836510.0
20	590242.2	5840162.5	58	580072.4	5836348.9
21	589138.1	5839574.3	59	581425.7	5836187.8
22	585174.9	5847333.9	60	582779.0	5836026.7
23	585671.0	5845896.9	61	584132.3	5835865.7
24	586167.0	5844459.8	62	585458.0	5835720.0
25	586663.0	5843022.8	63	587038.7	5835522.5
26	587159.0	5841585.8	64	578272.2	5835377.2
27	587839.0	5840302.7	65	577825.3	5834244.4
28	584318.5	5846144.1	66	577378.3	5833111.6
29	584857.6	5844886.4	67	578722.6	5833234.9
30	583462.1	5844954.4	68	580066.8	5833358.3
31	584044.2	5843875.9	69	581158.3	5834050.1
32	584626.3	5842797.5	70	582936.9	5834914.4
33	585208.3	5841719.1	71	580850.0	5835173.5
34	585790.4	5840640.7	72	579400.0	5834600.0
35	586372.5	5839562.3	73	583327.6	5833777.9
36	586954.5	5838483.9	74	584754.0	5833919.0
37	582687.3	5843878.0	75	586893.6	5834130.8
38	583322.7	5842700.0	76	585896.4	5834720.8

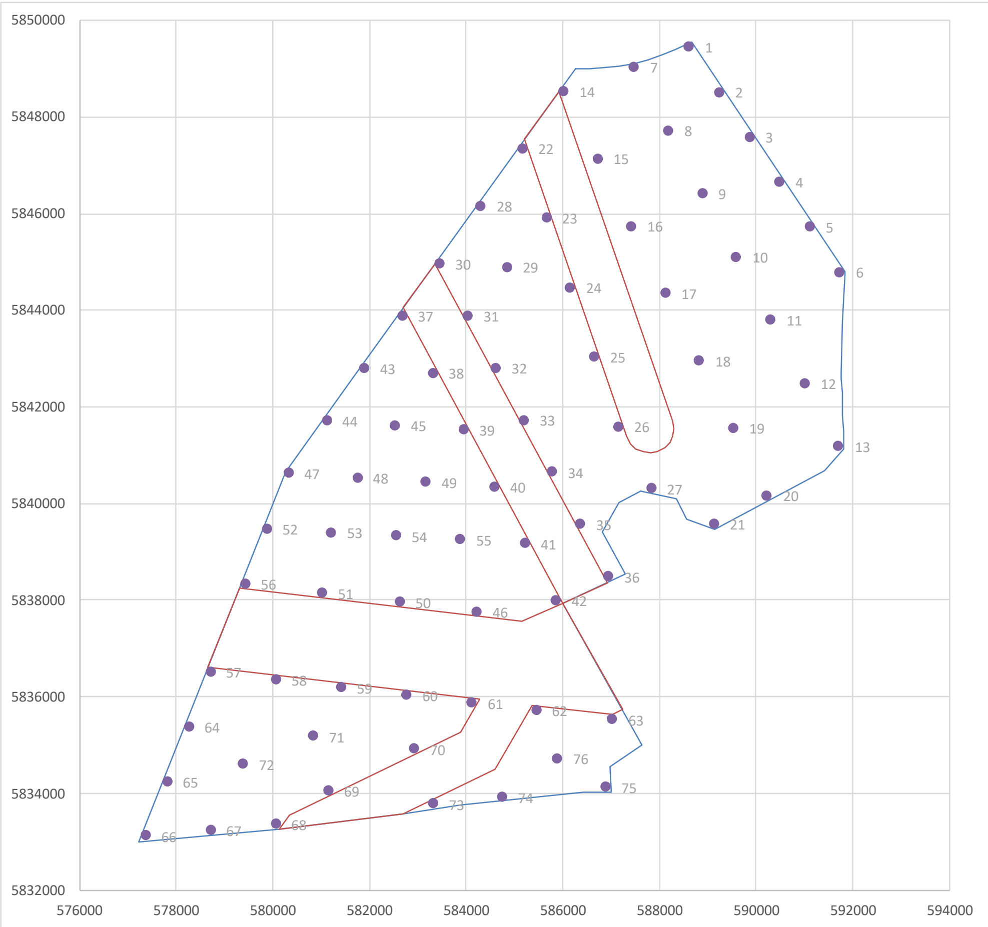

Figure 9-7 Wind farm design for Site V using wind turbine type B

B.3 Site V, wind turbine type C

Table 9-8 Coordinates of the wind farm design for Site V using wind turbine type C, with a hub height of 140 m

Wind turbine	X	Y		Wind turbine	X	Y
#	[m]	[m]		#	[m]	[m]
1	588621.2	5849423.9		33	583949.8	5841509.2
2	589399.2	5848263.1		34	584581.8	5840337.5
3	590177.3	5847102.2		35	585213.9	5839165.8
4	590955.4	5845941.4		36	585846.0	5837994.1
5	591733.5	5844780.5		37	581907.5	5842771.6
6	587494.7	5849005.1		38	581129.4	5841690.7
7	588337.8	5847439.7		39	582245.4	5840775.9
8	589180.8	5845874.3		40	582981.2	5839293.5
9	590023.9	5844308.9		41	583722.2	5837833.6
10	590867.0	5842743.6		42	580351.3	5840609.7
11	591710.1	5841178.2		43	581300.0	5839335.3
12	586043.0	5848516.7		44	581731.6	5838070.9
13	586881.9	5846848.4		45	579903.9	5839475.9
14	587720.8	5845180.1		46	579456.6	5838342.1
15	588559.7	5843511.8		47	578727.9	5836495.3
16	589398.6	5841843.5		48	580556.9	5836278.3
17	590237.5	5840175.3		49	582302.8	5836071.1
18	589137.2	5839589.1		50	584131.9	5835854.0
19	585170.7	5847304.9		51	585462.1	5835706.0
20	585454.4	5845049.2		52	587041.7	5835508.6
21	584324.3	5846129.1		53	578284.9	5835372.6
22	586249.0	5843463.9		54	577841.9	5834249.8
23	587043.6	5841878.6		55	577398.9	5833127.1
24	587840.1	5840316.3		56	578729.3	5833249.1
25	583478.0	5844953.3		57	580059.8	5833371.2
26	584403.6	5843966.9		58	581149.4	5834060.8
27	585097.1	5842618.9		59	582927.5	5834924.8
28	585790.7	5841270.8		60	580028.0	5834800.0
29	586484.3	5839922.8		61	583414.7	5833805.2
30	587146.0	5838585.6		62	585147.2	5833974.6
31	582685.6	5843852.6		63	586879.6	5834144.1
32	583317.7	5842680.9				

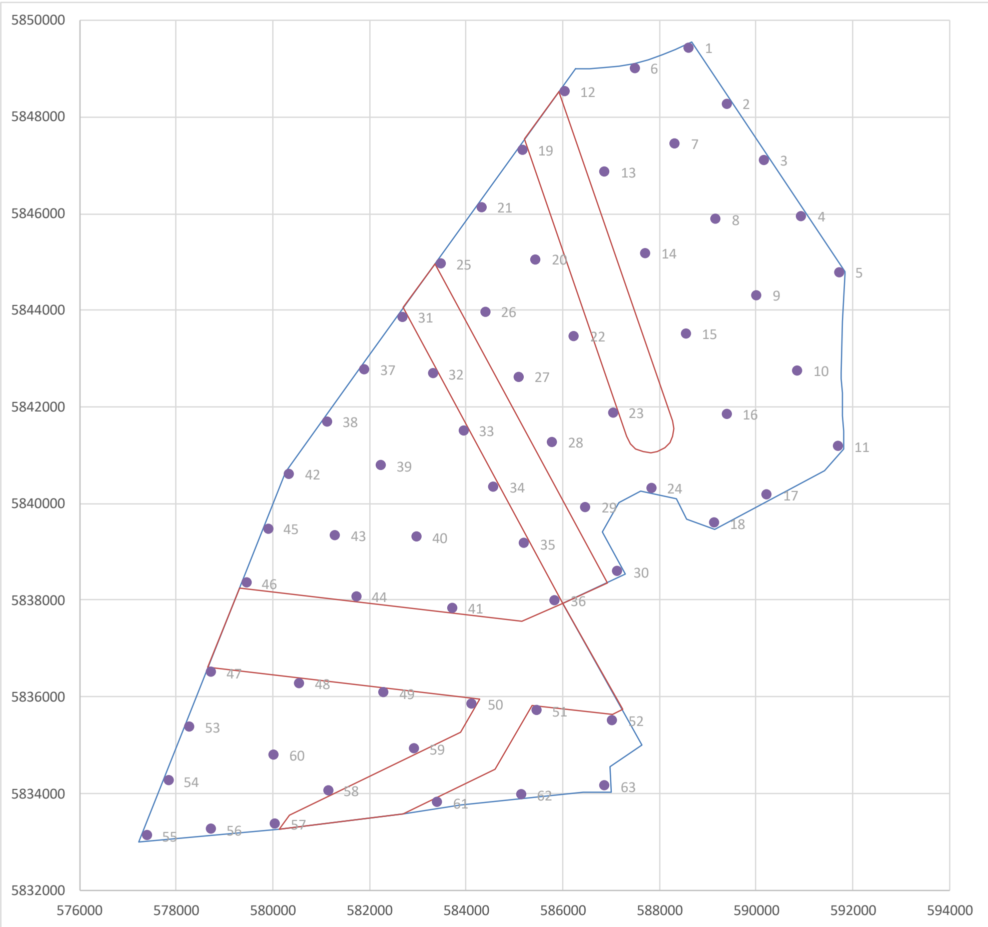

Figure 9-8 Wind farm design for Site V using wind turbine type C

B.4 Prinses Amalia wind farm

Table 9-9 Coordinates of the wind turbines installed at the Prinses Amalia wind farm, with a hub height of 59 m

Wind	X	Y	Wind	X	Y
#	[m]	[m]	#	[m]	[m]
1	584,022.0	5,829,007.0	33	581,523.0	5,827,499.0
2	583,071.0	5,829,056.0	34	582,005.1	5,827,235.0
3	583,532.0	5,828,757.0	35	582,488.1	5,826,971.0
4	583,994.0	5,828,458.0	36	582,970.0	5,826,707.0
5	584,455.0	5,828,159.0	37	583,452.0	5,826,443.0
6	582,103.0	5,829,063.0	38	583,935.0	5,826,179.0
7	582,570.0	5,828,772.0	39	584,417.0	5,825,915.0
8	583,037.0	5,828,481.0	40	584,900.0	5,825,651.0
9	583,503.0	5,828,191.0	41	580,531.1	5,827,405.0
10	583,970.0	5,827,900.0	42	581,019.1	5,827,150.0
11	584,437.0	5,827,608.0	43	581,506.1	5,826,895.0
12	584,904.0	5,827,318.0	44	581,993.0	5,826,640.0
13	585,371.0	5,827,027.0	45	582,481.0	5,826,385.0
14	581,585.1	5,828,734.0	46	582,968.0	5,826,130.0
15	582,057.0	5,828,452.0	47	583,455.0	5,825,875.0
16	582,529.0	5,828,170.0	48	583,942.0	5,825,620.0
17	583,002.0	5,827,888.0	49	584,430.0	5,825,365.0
18	583,474.0	5,827,606.0	50	580,527.1	5,826,802.0
19	583,946.0	5,827,323.0	51	581,019.1	5,826,556.0
20	584,418.0	5,827,041.0	52	581,511.0	5,826,310.0
21	584,890.0	5,826,759.0	53	582,002.1	5,826,064.0
22	585,362.0	5,826,477.0	54	582,494.0	5,825,818.0
23	581,068.1	5,828,385.0	55	582,986.0	5,825,571.0
24	581,545.0	5,828,111.0	56	583,478.0	5,825,325.0
25	582,024.0	5,827,839.0	57	580,547.1	5,826,228.0
26	582,500.0	5,827,566.0	58	581,043.1	5,825,990.0
27	582,978.0	5,827,293.0	59	581,539.1	5,825,752.0
28	583,455.0	5,827,020.0	60	582,035.1	5,825,515.0
29	583,932.0	5,826,747.0	61	581,523.0	5,827,499.0
30	584,410.0	5,826,473.0	62	582,005.1	5,827,235.0
31	584,887.0	5,826,200.0	63	582,488.1	5,826,971.0
32	581,041.1	5,827,763.0			

B.5 OWEZ wind farm

Table 9-10 Coordinates of the wind turbines installed at the OWEZ wind farm, with a hub height of 70 m

Wind	X	Y		Wind	X	Y
#	[m]	[m]		#	[m]	[m]
1	597,181.1	5,826,380.1		19	595,384.1	5,829,940.1
2	596,756.1	5,826,863.1		20	594,959.1	5,830,424.1
3	596,339.1	5,827,338.1		21	594,534.1	5,830,908.1
4	595,914.1	5,827,822.1		22	598,548.1	5,827,853.1
5	595,490.1	5,828,305.1		23	598,119.1	5,828,338.1
6	595,065.1	5,828,789.1		24	597,695.1	5,828,826.1
7	594,633.1	5,829,281.1		25	597,038.1	5,829,572.1
8	594,208.1	5,829,764.1		26	596,560.1	5,830,116.1
9	593,783.1	5,830,248.1		27	596,135.1	5,830,600.1
10	593,366.1	5,830,739.1		28	595,710.1	5,831,084.1
11	592,933.1	5,831,216.1		29	595,285.1	5,831,568.1
12	592,508.1	5,831,700.1		30	598,868.1	5,828,998.1
13	598,189.1	5,826,748.1		31	598,446.1	5,829,486.1
14	597,764.1	5,827,232.1		32	597,796.1	5,830,224.1
15	597,339.1	5,827,715.1		33	597,312.1	5,830,776.1
16	596,914.1	5,828,199.1		34	596,887.1	5,831,260.1
17	596,234.1	5,828,973.1		35	596,462.1	5,831,744.1
18	595,809.1	5,829,457.1		36	596,037.1	5,832,228.1

C Simulation results

C.1 Wind turbine type A

Turbine	X	Y	Annual yield	Capacity factor	Efficiency
	[m]	[m]	[MWh]	[-]	[%]
1	588630.2	5849451.8	42219.4	0.507	93.37
2	589255.6	5848518.8	41550.8	0.499	91.89
3	589881.0	5847585.7	41220.5	0.495	91.16
4	590506.4	5846652.6	41273.3	0.496	91.27
5	591131.8	5845719.6	41097.4	0.494	90.88
6	591757.2	5844786.5	41206.0	0.495	91.12
7	587489.6	5849027.7	41977.8	0.504	92.83
8	588196.7	5847717.9	41247.8	0.495	91.22
9	588903.9	5846408.0	40998.4	0.492	90.66
10	589611.0	5845098.2	40556.1	0.487	89.69
11	590318.1	5843788.3	40426.9	0.485	89.40
12	591689.7	5843509.4	40862.4	0.491	90.36
13	591679.8	5842376.9	40952.4	0.492	90.56
14	590000.0	5842000.0	40367.3	0.485	89.27
15	591732.4	5841168.6	41472.4	0.498	91.71
16	588932.3	5843939.6	40163.1	0.482	88.82
17	586017.3	5848520.5	42526.0	0.511	94.04
18	586527.0	5847044.0	41304.3	0.496	91.34
19	587036.7	5845567.4	40796.8	0.490	90.22
20	587546.4	5844090.9	40391.5	0.485	89.32
21	588056.0	5842614.4	40081.3	0.481	88.64
22	588565.7	5841137.9	40025.2	0.481	88.51
23	590245.5	5840153.5	40928.1	0.491	90.51
24	589138.8	5839563.9	40843.2	0.490	90.32
25	585177.9	5847354.3	42059.7	0.505	93.01
26	585280.6	5845459.2	40906.4	0.491	90.46
27	586373.5	5842902.1	39897.8	0.479	88.23
28	586920.0	5841623.6	39596.7	0.475	87.57
29	587391.0	5840232.3	39555.9	0.475	87.47
30	584314.4	5846154.7	41945.9	0.504	92.76
31	585827.1	5844180.7	40267.6	0.484	89.05
32	583450.9	5844955.1	41838.7	0.502	92.52
33	584034.2	5843874.5	40491.2	0.486	89.54
34	584617.4	5842793.9	39973.8	0.480	88.40
35	585200.7	5841713.3	39492.6	0.474	87.33
36	585783.9	5840632.7	39390.9	0.473	87.11
37	586367.2	5839552.2	39407.9	0.473	87.15
38	586950.4	5838471.6	40091.5	0.481	88.66
39	582688.4	5843895.9	41658.8	0.500	92.13
40	583326.3	5842713.4	40288.0	0.484	89.09
41	583964.2	5841531.0	39796.8	0.478	88.01
42	584602.0	5840348.5	39389.9	0.473	87.11
43	585239.9	5839166.1	39598.7	0.476	87.57

Turbine	X	Y	Annual yield	Capacity factor	Efficiency
	[m]	[m]	[MWh]	[-]	[%]
44	585877.8	5837983.6	39865.2	0.479	88.16
45	581902.6	5842804.2	41563.0	0.499	91.91
46	581116.8	5841712.5	41615.6	0.500	92.03
47	582540.5	5841621.7	40304.7	0.484	89.13
48	580330.9	5840620.8	41918.3	0.503	92.70
49	581754.6	5840530.0	40477.6	0.486	89.51
50	583178.3	5840439.3	39845.0	0.478	88.11
51	580740.7	5838165.9	40924.0	0.491	90.50
52	582057.1	5838008.9	40377.7	0.485	89.29
53	583373.5	5837852.0	40064.2	0.481	88.60
54	584690.0	5837695.0	40125.3	0.482	88.73
55	579877.6	5839471.8	41771.8	0.502	92.38
56	581218.2	5839395.4	40570.5	0.487	89.72
57	582558.8	5839318.9	40067.7	0.481	88.61
58	583899.3	5839242.5	39674.1	0.476	87.74
59	579424.2	5838322.8	42110.2	0.506	93.12
60	578713.0	5836520.3	42240.7	0.507	93.41
61	580071.7	5836358.6	41107.8	0.494	90.91
62	581430.4	5836196.8	40727.2	0.489	90.07
63	582789.1	5836035.1	40454.9	0.486	89.46
64	584147.9	5835873.4	40371.9	0.485	89.28
65	585455.2	5835729.9	40610.5	0.488	89.81
66	587036.7	5835532.4	41067.8	0.493	90.82
67	578263.3	5835380.4	42268.4	0.508	93.47
68	577813.5	5834240.6	42492.7	0.510	93.97
69	577363.8	5833100.7	43123.3	0.518	95.36
70	578717.8	5833225.0	42156.4	0.506	93.23
71	580071.8	5833349.2	41804.5	0.502	92.45
72	581164.6	5834042.6	41038.9	0.493	90.75
73	582943.5	5834907.0	40651.2	0.488	89.90
74	579823.3	5835222.6	40934.2	0.492	90.52
75	581383.4	5835064.8	40543.3	0.487	89.66
76	579489.1	5834141.6	41371.3	0.497	91.49
77	583266.4	5833758.6	41460.0	0.498	91.69
78	584721.2	5833903.8	41345.0	0.496	91.43
79	586903.5	5834121.4	41669.3	0.500	92.15
80	585878.9	5834718.1	40741.6	0.489	90.10
All			3269592.7	0.491	90.38

C.2 Wind turbine type B

Turbine	X	Y	Annual yield	Capacity factor	Efficiency
	[m]	[m]	[MWh]	[-]	[%]
1	588626.4	5849440.3	46939.4	0.535	93.77
2	589250.6	5848509.1	46163.6	0.527	92.22
3	589874.8	5847577.8	45919.6	0.524	91.73
4	590499.0	5846646.5	45944.0	0.524	91.78
5	591123.2	5845715.3	45900.5	0.524	91.69
6	591747.4	5844784.0	46130.9	0.526	92.16
7	587491.7	5849018.4	46621.6	0.532	93.14
8	588196.9	5847710.8	45707.8	0.521	91.31
9	588902.2	5846403.1	45444.0	0.518	90.78
10	589607.4	5845095.5	45393.6	0.518	90.68
11	590312.7	5843787.8	45525.1	0.519	90.94
12	591018.0	5842480.2	45727.0	0.522	91.35
13	591723.2	5841172.6	46366.0	0.529	92.62
14	586027.9	5848518.9	47152.4	0.538	94.20
15	586730.3	5847126.2	45808.5	0.523	91.51
16	587432.7	5845733.4	45372.8	0.518	90.64
17	588135.1	5844340.7	45182.7	0.515	90.26
18	588837.4	5842947.9	45195.9	0.516	90.29
19	589539.8	5841555.2	45375.6	0.518	90.65
20	590242.2	5840162.5	45849.6	0.523	91.59
21	589138.1	5839574.3	45447.8	0.518	90.79
22	585174.9	5847333.9	46648.2	0.532	93.19
23	585671.0	5845896.9	45357.8	0.517	90.61
24	586167.0	5844459.8	44861.0	0.512	89.62
25	586663.0	5843022.8	44808.9	0.511	89.51
26	587159.0	5841585.8	44687.6	0.510	89.27
27	587839.0	5840302.7	44821.6	0.511	89.54
28	584318.5	5846144.1	46418.1	0.530	92.73
29	584857.6	5844886.4	45114.1	0.515	90.12
30	583462.1	5844954.4	46266.9	0.528	92.43
31	584044.2	5843875.9	45039.1	0.514	89.97
32	584626.3	5842797.5	44592.4	0.509	89.08
33	585208.3	5841719.1	44233.7	0.505	88.37
34	585790.4	5840640.7	44030.1	0.502	87.96
35	586372.5	5839562.3	44181.3	0.504	88.26
36	586954.5	5838483.9	44881.1	0.512	89.66
37	582687.3	5843878.0	46168.6	0.527	92.23
38	583322.7	5842700.0	44885.2	0.512	89.67
39	583958.2	5841522.0	44365.9	0.506	88.63
40	584593.7	5840344.0	44061.4	0.503	88.02
41	585229.2	5839166.0	44402.7	0.507	88.70
42	585864.7	5837987.9	44731.3	0.510	89.36
43	581904.6	5842790.7	46149.7	0.526	92.19
44	581122.0	5841703.5	46200.0	0.527	92.29
45	582540.1	5841612.7	44918.5	0.512	89.73
46	584232.9	5837759.1	44791.1	0.511	89.48

Turbine	X	Y	Annual yield	Capacity factor	Efficiency
	[m]	[m]	[MWh]	[-]	[%]
47	580339.3	5840616.2	46512.5	0.531	92.92
48	581757.5	5840525.4	44959.9	0.513	89.82
49	583175.6	5840434.7	44332.8	0.506	88.56
50	582634.5	5837949.7	45050.3	0.514	90.00
51	581036.0	5838140.2	45469.6	0.519	90.83
52	579888.5	5839473.5	46468.6	0.530	92.83
53	581223.6	5839396.6	45252.9	0.516	90.40
54	582558.8	5839319.7	44815.4	0.511	89.53
55	583894.0	5839242.8	44351.2	0.506	88.60
56	579437.6	5838330.8	46843.0	0.534	93.58
57	578719.2	5836510.0	47031.1	0.537	93.95
58	580072.4	5836348.9	45903.3	0.524	91.70
59	581425.7	5836187.8	45281.6	0.517	90.46
60	582779.0	5836026.7	45380.2	0.518	90.66
61	584132.3	5835865.7	45192.1	0.516	90.28
62	585458.0	5835720.0	45308.4	0.517	90.51
63	587038.7	5835522.5	45805.2	0.523	91.50
64	578272.2	5835377.2	46929.9	0.535	93.75
65	577825.3	5834244.4	47197.3	0.538	94.29
66	577378.3	5833111.6	47849.3	0.546	95.59
67	578722.6	5833234.9	46897.1	0.535	93.69
68	580066.8	5833358.3	46643.0	0.532	93.18
69	581158.3	5834050.1	45681.0	0.521	91.26
70	582936.9	5834914.4	45427.8	0.518	90.75
71	580850.0	5835173.5	45501.9	0.519	90.90
72	579400.0	5834600.0	46094.9	0.526	92.08
73	583327.6	5833777.9	46107.6	0.526	92.11
74	584754.0	5833919.0	46006.0	0.525	91.91
75	586893.6	5834130.8	46334.4	0.529	92.56
76	585896.4	5834720.8	45384.6	0.518	90.66
All			3465797.7	0.520	91.10

C.3 Wind turbine type C

Turbine	X	Y	Annual yield	Capacity factor	Efficiency
	[m]	[m]	[MWh]	[-]	[%]
1	588621.2	5849423.9	59548.5	0.566	93.63
2	589399.2	5848263.1	58576.6	0.557	92.10
3	590177.3	5847102.2	58231.8	0.554	91.56
4	590955.4	5845941.4	58234.1	0.554	91.56
5	591733.5	5844780.5	58679.3	0.558	92.26
6	587494.7	5849005.1	59119.0	0.562	92.95
7	588337.8	5847439.7	57963.0	0.551	91.13
8	589180.8	5845874.3	57698.1	0.549	90.72
9	590023.9	5844308.9	57574.3	0.547	90.52
10	590867.0	5842743.6	57984.3	0.551	91.17
11	591710.1	5841178.2	58785.3	0.559	92.43
12	586043.0	5848516.7	59930.5	0.570	94.23
13	586881.9	5846848.4	58210.0	0.553	91.52
14	587720.8	5845180.1	57641.3	0.548	90.63
15	588559.7	5843511.8	57261.9	0.544	90.03
16	589398.6	5841843.5	57349.6	0.545	90.17
17	590237.5	5840175.3	57838.6	0.550	90.94
18	589137.2	5839589.1	57598.7	0.548	90.56
19	585170.7	5847304.9	59246.3	0.563	93.15
20	585454.4	5845049.2	57468.4	0.546	90.35
21	584324.3	5846129.1	59039.1	0.561	92.82
22	586249.0	5843463.9	56625.7	0.538	89.03
23	587043.6	5841878.6	56489.0	0.537	88.82
24	587840.1	5840316.3	56623.0	0.538	89.03
25	583478.0	5844953.3	58876.0	0.560	92.57
26	584403.6	5843966.9	57156.3	0.543	89.86
27	585097.1	5842618.9	56650.4	0.539	89.07
28	585790.7	5841270.8	56376.3	0.536	88.64
29	586484.3	5839922.8	56161.7	0.534	88.30
30	587146.0	5838585.6	56986.5	0.542	89.60
31	582685.6	5843852.6	58702.2	0.558	92.29
32	583317.7	5842680.9	57122.4	0.543	89.81
33	583949.8	5841509.2	56713.6	0.539	89.17
34	584581.8	5840337.5	56486.1	0.537	88.81
35	585213.9	5839165.8	56792.5	0.540	89.29
36	585846.0	5837994.1	57387.8	0.546	90.23
37	581907.5	5842771.6	58541.7	0.557	92.04
38	581129.4	5841690.7	58606.5	0.557	92.14
39	582245.4	5840775.9	57220.9	0.544	89.97
40	582981.2	5839293.5	56946.8	0.541	89.53
41	583722.2	5837833.6	57153.1	0.543	89.86
42	580351.3	5840609.7	59027.5	0.561	92.81
43	581300.0	5839335.3	57614.3	0.548	90.58
44	581731.6	5838070.9	57409.4	0.546	90.26
45	579903.9	5839475.9	59004.5	0.561	92.77
46	579456.6	5838342.1	59366.9	0.564	93.34

Turbine	X	Y	Annual yield	Capacity factor	Efficiency
	[m]	[m]	[MWh]	[-]	[%]
47	578727.9	5836495.3	59590.2	0.567	93.69
48	580556.9	5836278.3	57978.6	0.551	91.16
49	582302.8	5836071.1	57784.5	0.549	90.85
50	584131.9	5835854.0	57397.1	0.546	90.24
51	585462.1	5835706.0	57665.7	0.548	90.67
52	587041.7	5835508.6	58302.7	0.554	91.67
53	578284.9	5835372.6	59508.9	0.566	93.56
54	577841.9	5834249.8	59707.9	0.568	93.88
55	577398.9	5833127.1	60580.5	0.576	95.25
56	578729.3	5833249.1	59143.3	0.562	92.99
57	580059.8	5833371.2	59016.1	0.561	92.79
58	581149.4	5834060.8	57746.1	0.549	90.79
59	582927.5	5834924.8	57596.6	0.548	90.56
60	580028.0	5834800.0	58146.3	0.553	91.42
61	583414.7	5833805.2	58622.3	0.557	92.17
62	585147.2	5833974.6	58441.7	0.556	91.89
63	586879.6	5834144.1	58907.8	0.560	92.62
All			3656156.2	0.552	91.24