



MER Windmolenpark Elzenburg - de Geer te Oss

Bijlage 7
Energieopbrengst

projectnummer 0408379.00
definitief
4 september 2017

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Leeswijzer

In dit bijlagerapport zijn de resultaten van de energieopbrengstberekeningen in WindPro (Antea Group, 2017) opgenomen. De resultaten hebben als basis gediend voor de effectbeschrijving in hoofdstuk 14 in het MER.

datum vrijgave
04-9-2017

beschrijving revisie
definitief

goedkeuring
Bastian van Dijk

vrijgave
Johan van de Heijning

MER Windmolenpark Elzenburg - de Geer te Oss

Bijlage 7

projectnummer 0408379.00

4 september 2017

Gemeente Oss



Project:

Windpark Oss (Elzenburg)

Licensed user:

Antea Group
 Beneluxweg 125 Postbus 40
 NL-4900 AA OOSTERHOUT
 0513 634045
 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 11:29/3.1.597

PARK - Main Result

Calculation: Variant 1A Elz Hoed en Schil Lagerwey

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1.234 kg/m³ to 1.234 kg/m³
 Air density relative to standard 100,7 % to 100,8 %
 Hub altitude above sea level (asl) 101,4 m to 106,8 m
 Annual mean temperature at hub alt. 9,3 °C to 9,4 °C
 Pressure at WTGs 1.000,3 hPa to 1.000,9 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:100m Mixed farmland 0,065

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 99,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

	Wind energy [kWh/m ²]	Mean wind speed [m/s]	Equivalent roughness
A 167.269 422.465 Site data: WASP (4) WASP (WASP 11 Version 11.04.0026)	2.665	6,7	1,9



Scale 1:25.000

▲ New WTG

⊗ Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			Mean wind speed @hub height [m/s]
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	
Wind farm	76.259,2	68.633,3	84.665,5	90,1	28,2	6.239,4	2.476	6,7

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 11 new WTGs with total 27,7 MW rated power

WTG type	Links Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy		Park		Free mean wind speed [m/s]
									Result [MWh]	Result-10,0% [MWh]	Efficiency [%]	Free mean wind speed [m/s]	
1 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	6.849,7	6.165	88,78	6,76	
2 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.304,1	6.574	94,97	6,75	
3 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	6.969,8	6.273	88,46	6,83	
4 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	6.850,0	6.165	88,73	6,76	
5 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.001,2	6.301	92,46	6,70	
6 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	6.664,7	5.998	86,26	6,76	
7 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.236,2	6.513	91,83	6,83	
8 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	6.821,0	6.139	89,96	6,70	
9 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.021,7	6.320	91,99	6,72	
10 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	6.875,2	6.188	90,32	6,71	
11 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	6.665,8	5.999	87,09	6,73	

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description

	X [m]	Y [m]	Z [m]	Row data/Description
1 New	166.475	422.658	4,7	LAGERWEY L100-2.5MW 2520 100.0 !O! hub: 99,0 m (TOT: 149,0 m) (79)
2 New	166.051	422.508	4,9	LAGERWEY L100-2.5MW 2520 100.0 !O! hub: 99,0 m (TOT: 149,0 m) (80)
3 New	166.932	423.038	5,3	LAGERWEY L100-2.5MW 2520 100.0 !O! hub: 99,0 m (TOT: 149,0 m) (81)
4 New	167.700	422.562	4,3	LAGERWEY L100-2.5MW 2520 100.0 !O! hub: 99,0 m (TOT: 149,0 m) (82)

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Project:

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Koen Wilmer / koen.wilmer@anteagroup.com

Calculated:

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PARK - Main Result

Calculation: Variant 1A Elz Hoed en Schil Lagerwey

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Dutch Stereo-RD/NAP 2008

	X (east)	Y (north)	Z	Row data/Description
			[m]	
5 New	166.452	422.255	7,8	LAGERWEY L100-2.5MW 2520 100.0 !O! hub: 99,0 m (TOT: 149,0 m) (83)
6 New	167.315	422.571	5,3	LAGERWEY L100-2.5MW 2520 100.0 !O! hub: 99,0 m (TOT: 149,0 m) (84)
7 New	166.552	423.051	4,1	LAGERWEY L100-2.5MW 2520 100.0 !O! hub: 99,0 m (TOT: 149,0 m) (85)
8 New	167.265	422.182	3,8	LAGERWEY L100-2.5MW 2520 100.0 !O! hub: 99,0 m (TOT: 149,0 m) (86)
9 New	167.629	422.160	5,3	LAGERWEY L100-2.5MW 2520 100.0 !O! hub: 99,0 m (TOT: 149,0 m) (87)
10 New	166.867	422.219	7,6	LAGERWEY L100-2.5MW 2520 100.0 !O! hub: 99,0 m (TOT: 149,0 m) (88)
11 New	166.905	422.624	2,4	LAGERWEY L100-2.5MW 2520 100.0 !O! hub: 99,0 m (TOT: 149,0 m) (89)

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 Calculated:
 6-2-2017 11:32/3.1.597

PARK - Main Result

Calculation: Variant 1A Elz Hoed en Schil Vestas

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,234 kg/m³ to 1,235 kg/m³
 Air density relative to standard 100,7 % to 100,8 %
 Hub altitude above sea level (asl) 96,8 m to 102,0 m
 Annual mean temperature at hub alt. 9,4 °C to 9,4 °C
 Pressure at WTGs 1.000,8 hPa to 1.001,5 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:100m Mixed farmland 0,065

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 94,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²]

Mean wind speed [m/s]

Equivalent roughness

2.575

6,7

1,9



New WTG

Site Data

Scale 1:25.000

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	91.299,5	82.169,6	106.457,4	85,8	24,7	7.470,0	2.165	6,7

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 11 new WTGs with total 38,0 MW rated power

Links	Valid	WTG type Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
									Result [MWh]	Result-10,0% [MWh]		
1 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-0S - 01-2016	8.204,5	7.384	84,43	6,68
2 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-0S - 01-2016	9.024,6	8.122	93,29	6,66
3 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-0S - 01-2016	8.253,8	7.428	83,07	6,75
4 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-0S - 01-2016	8.052,0	7.247	83,00	6,67
5 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-0S - 01-2016	8.550,8	7.696	89,72	6,62
6 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-0S - 01-2016	7.726,3	6.954	79,68	6,67
7 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-0S - 01-2016	8.865,1	7.979	89,05	6,75
8 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-0S - 01-2016	8.131,1	7.318	85,58	6,61
9 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-0S - 01-2016	8.469,0	7.622	88,43	6,64
10 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-0S - 01-2016	8.218,9	7.397	85,98	6,63
11 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-0S - 01-2016	7.803,5	7.023	81,21	6,65

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description

1	New	166.467	422.656	4,9	VESTAS	V112-3.45	3450	112,0	!O! hub: 94,0 m (TOT: 150,0 m) (1)
2	New	166.040	422.510	4,1	VESTAS	V112-3.45	3450	112,0	!O! hub: 94,0 m (TOT: 150,0 m) (20)
3	New	166.950	423.029	4,6	VESTAS	V112-3.45	3450	112,0	!O! hub: 94,0 m (TOT: 150,0 m) (21)
4	New	167.697	422.565	4,3	VESTAS	V112-3.45	3450	112,0	!O! hub: 94,0 m (TOT: 150,0 m) (22)
5	New	166.462	422.245	8,0	VESTAS	V112-3.45	3450	112,0	!O! hub: 94,0 m (TOT: 150,0 m) (23)

To be continued on next page...

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Koen Wilmer / koen.wilmer@anteagroup.com

Calculated:

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PARK - Main Result

Calculation: Variant 1A Elz Hoed en Schil Vestas

...continued from previous page

Dutch Stereo-RD/NAP 2008

	X (east)	Y (north)	Z	Row data/Description
			[m]	
6 New	167.295	422.585	4,9	VESTAS V112-3.45 3450 112.0 !O! hub: 94,0 m (TOT: 150,0 m) (24)
7 New	166.548	423.059	4,3	VESTAS V112-3.45 3450 112.0 !O! hub: 94,0 m (TOT: 150,0 m) (25)
8 New	167.267	422.183	3,8	VESTAS V112-3.45 3450 112.0 !O! hub: 94,0 m (TOT: 150,0 m) (26)
9 New	167.628	422.161	5,3	VESTAS V112-3.45 3450 112.0 !O! hub: 94,0 m (TOT: 150,0 m) (27)
10 New	166.865	422.215	7,5	VESTAS V112-3.45 3450 112.0 !O! hub: 94,0 m (TOT: 150,0 m) (28)
11 New	166.903	422.616	2,8	VESTAS V112-3.45 3450 112.0 !O! hub: 94,0 m (TOT: 150,0 m) (29)

Project:

Windpark Oss (Elzenburg)

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 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 13:21/3.1.597

PARK - Main Result

Calculation: Variant 1B Elz Hoed en Schil Nordex

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,228 kg/m³ to 1,229 kg/m³
 Air density relative to standard 100,3 % to 100,3 %
 Hub altitude above sea level (asl) 147,0 m to 151,9 m
 Annual mean temperature at hub alt. 9,0 °C to 9,1 °C
 Pressure at WTGs 994,8 hPa to 995,4 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:150m Closed farmland 0,066

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 144,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²]

3.868

Mean wind speed [m/s]

7,6

Equivalent roughness

1,9



Scale 1:20.000

New WTG

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	107.723,6	96.951,3	116.232,1	92,7	41,9	12.118,9	3.672	7,6

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 8 new WTGs with total 26,4 MW rated power

Links	WTG type		Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact. Type-generator					Result	Result-10,0%		
1 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.156,2	11.841	90,45	7,62
2 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.856,5	12.471	95,42	7,63
3 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.722,8	12.350	93,17	7,69
4 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.739,5	12.366	94,82	7,58
5 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.389,7	12.051	93,02	7,56
6 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.381,5	12.043	91,67	7,63
7 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.135,0	11.822	90,13	7,62
8 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.342,5	12.008	92,78	7,54

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.467	422.656	4,9	NORDEX N131/3300 DE 3300 131,0	!-! hub: 144,0 m (TOT: 209,5 m) (12)
2 New	166.036	422.509	4,1	NORDEX N131/3300 DE 3300 131,0	!-! hub: 144,0 m (TOT: 209,5 m) (13)
3 New	166.986	423.194	3,3	NORDEX N131/3300 DE 3300 131,0	!-! hub: 144,0 m (TOT: 209,5 m) (14)
4 New	167.509	422.155	6,3	NORDEX N131/3300 DE 3300 131,0	!-! hub: 144,0 m (TOT: 209,5 m) (15)
5 New	166.446	422.236	7,9	NORDEX N131/3300 DE 3300 131,0	!-! hub: 144,0 m (TOT: 209,5 m) (16)
6 New	167.460	422.659	5,0	NORDEX N131/3300 DE 3300 131,0	!-! hub: 144,0 m (TOT: 209,5 m) (17)
7 New	166.967	422.696	3,0	NORDEX N131/3300 DE 3300 131,0	!-! hub: 144,0 m (TOT: 209,5 m) (18)
8 New	166.946	422.194	4,5	NORDEX N131/3300 DE 3300 131,0	!-! hub: 144,0 m (TOT: 209,5 m) (19)

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 Calculated:
 6-2-2017 11:41/3.1.597

PARK - Main Result

Calculation: Variant 1B Elz Hoed en Schil Enercon

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings
 Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,229 kg/m³ to 1,230 kg/m³
 Air density relative to standard 100,3 % to 100,4 %
 Hub altitude above sea level (asl) 138,0 m to 142,9 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 995,9 hPa to 996,5 hPa

Wake Model Parameters
 Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data
 Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 135,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

	Wind energy [kWh/m ²]	Mean wind speed [m/s]	Equivalent roughness
A 167.269 422.465 Site data: WASP (4) WASP (WASP 11 Version 11.04.0026)	3.634	7,5	1,9



▲ New WTG

⊗ Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Park efficiency [%]	Specific results ^{a)}			Mean wind speed @hub height [m/s]
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	
Wind farm	108.735,5	97.862,0	118.143,6	92,0	33,2	12.232,7	2.913	7,5

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 8 new WTGs with total 33,6 MW rated power

Links	WTG type			Power, rated	Rotor diameter	Hub height	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact.	Type-generator					Result	Result-10,0%		
1 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.250,8	11.926	89,59	7,47
2 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.075,4	12.668	95,09	7,48
3 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.962,2	12.566	92,76	7,54
4 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.837,0	12.453	94,24	7,43
5 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.564,6	12.208	92,84	7,42
6 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.408,6	12.068	90,35	7,48
7 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.240,2	11.916	89,34	7,47
8 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.396,7	12.057	92,10	7,39

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.475	422.658	4,7	ENERCON E-126 EP4 4200 127,0	!O! hub: 135,0 m (TOT: 198,5 m) (116)
2 New	166.051	422.508	4,9	ENERCON E-126 EP4 4200 127,0	!O! hub: 135,0 m (TOT: 198,5 m) (117)
3 New	166.987	423.202	3,2	ENERCON E-126 EP4 4200 127,0	!O! hub: 135,0 m (TOT: 198,5 m) (118)
4 New	167.515	422.156	6,2	ENERCON E-126 EP4 4200 127,0	!O! hub: 135,0 m (TOT: 198,5 m) (119)
5 New	166.430	422.233	7,9	ENERCON E-126 EP4 4200 127,0	!O! hub: 135,0 m (TOT: 198,5 m) (120)
6 New	167.464	422.652	4,9	ENERCON E-126 EP4 4200 127,0	!O! hub: 135,0 m (TOT: 198,5 m) (121)
7 New	166.974	422.696	3,0	ENERCON E-126 EP4 4200 127,0	!O! hub: 135,0 m (TOT: 198,5 m) (122)
8 New	166.952	422.209	4,1	ENERCON E-126 EP4 4200 127,0	!O! hub: 135,0 m (TOT: 198,5 m) (123)

Project:

Windpark Oss (Elzenburg)

Licensed user:

Antea Group
 Beneluxweg 125 Postbus 40
 NL-4900 AA OOSTERHOUT
 0513 634045
 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 11:44/3.1.597

PARK - Main Result

Calculation: Variant 2A Elz Hoed Lagerwey

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings
 Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,234 kg/m³ to 1,234 kg/m³
 Air density relative to standard 100,7 % to 100,8 %
 Hub altitude above sea level (asl) 101,4 m to 106,8 m
 Annual mean temperature at hub alt. 9,3 °C to 9,4 °C
 Pressure at WTGs 1.000,3 hPa to 1.000,9 hPa

Wake Model Parameters
 Terrain type Wake decay constant
 HH:100m Mixed farmland 0,065

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data
 Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 99,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²] 2.665
 Mean wind speed [m/s] 6,7
 Equivalent roughness 1,9



New WTG

Scale 1:20.000
 Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	42.951,4	38.656,2	45.826,7	93,7	29,2	6.442,7	2.557	6,7

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 6 new WTGs with total 15,1 MW rated power

Links	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact.							Result [MWh]	Result-10,0% [MWh]		
1 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.099,8	6.390	92,03	6,76
2 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.420,4	6.678	96,48	6,75
3 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.144,3	6.430	94,35	6,70
4 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.184,8	6.466	94,76	6,70
5 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.113,1	6.402	93,44	6,71
6 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	6.988,9	6.290	91,32	6,73

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.475	422.658	4,7	LAGERWEY L100-2.5MW	2520	100,0	!O!	hub: 99,0 m (TOT: 149,0 m) (90)
2 New	166.051	422.508	4,9	LAGERWEY L100-2.5MW	2520	100,0	!O!	hub: 99,0 m (TOT: 149,0 m) (91)
3 New	166.452	422.255	7,8	LAGERWEY L100-2.5MW	2520	100,0	!O!	hub: 99,0 m (TOT: 149,0 m) (92)
4 New	167.265	422.182	3,8	LAGERWEY L100-2.5MW	2520	100,0	!O!	hub: 99,0 m (TOT: 149,0 m) (93)
5 New	166.867	422.219	7,6	LAGERWEY L100-2.5MW	2520	100,0	!O!	hub: 99,0 m (TOT: 149,0 m) (94)
6 New	166.905	422.624	2,4	LAGERWEY L100-2.5MW	2520	100,0	!O!	hub: 99,0 m (TOT: 149,0 m) (95)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 Beneluxweg 125 Postbus 40
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 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 11:43/3.1.597

PARK - Main Result

Calculation: Variant 2A Elz Hoed Vestas

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,234 kg/m³ to 1,235 kg/m³
 Air density relative to standard 100,7 % to 100,8 %
 Hub altitude above sea level (asl) 96,4 m to 102,0 m
 Annual mean temperature at hub alt. 9,4 °C to 9,4 °C
 Pressure at WTGs 1.000,8 hPa to 1.001,5 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:100m Mixed farmland 0,065

Displacement heights from objects

Wake calculation settings

Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 94,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²] Mean wind speed [m/s] Equivalent roughness
 2.575 6,7 1,9



Scale 1:20.000

New WTG

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			Mean wind speed @hub height [m/s]
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	
Wind farm	52.335,0	47.101,5	57.576,6	90,9	26,0	7.850,2	2.275	6,6

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 6 new WTGs with total 20,7 MW rated power

Links	WTG type		Type-generator	Power rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact.							Result [MWh]	Result-10,0% [MWh]		
1 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	8.608,2	7.747	88,66	6,68
2 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	9.217,0	8.295	95,32	6,66
3 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	8.779,0	7.901	92,17	6,62
4 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	8.746,6	7.872	92,03	6,61
5 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	8.629,3	7.766	90,28	6,63
6 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	8.354,8	7.519	86,93	6,65

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z [m] Row data/Description

1 New	166.469	422.660	4,8	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (35)
2 New	166.039	422.505	3,9	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (36)
3 New	166.462	422.250	8,0	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (37)
4 New	167.266	422.188	4,2	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (38)
5 New	166.865	422.219	7,5	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (39)
6 New	166.910	422.617	2,4	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (40)

Project:

Windpark Oss (Elzenburg)

Licensed user:

Antea Group
 Beneluxweg 125 Postbus 40
 NL-4900 AA OOSTERHOUT
 0513 634045
 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 11:46/3.1.597

PARK - Main Result

Calculation: Variant 2B Elz Hoed Nordex

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,228 kg/m³ to 1,229 kg/m³
 Air density relative to standard 100,3 % to 100,3 %
 Hub altitude above sea level (asl) 147,0 m to 152,0 m
 Annual mean temperature at hub alt. 9,0 °C to 9,1 °C
 Pressure at WTGs 994,8 hPa to 995,4 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings

Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 144,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²]

Mean wind speed [m/s]

Equivalent roughness

3.868

7,6

1,9



Scale 1:20.000

New WTG

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	68.203,1	61.382,8	72.413,6	94,2	42,4	12.276,6	3.720	7,6

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 5 new WTGs with total 16,5 MW rated power

Links	WTG type		Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact. Type-generator					Result [MWh]	Result-10,0% [MWh]		
1 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.389,3	12.050	92,03	7,62
2 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.928,8	12.536	95,92	7,63
3 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.595,4	12.236	94,43	7,56
4 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.597,5	12.238	93,34	7,62
5 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.692,2	12.323	95,22	7,54

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.462	422.657	5,0	NORDEX N131/3300 DE 3300 131,0	!-! hub: 144,0 m (TOT: 209,5 m) (30)
2 New	166.038	422.508	4,0	NORDEX N131/3300 DE 3300 131,0	!-! hub: 144,0 m (TOT: 209,5 m) (31)
3 New	166.446	422.233	8,0	NORDEX N131/3300 DE 3300 131,0	!-! hub: 144,0 m (TOT: 209,5 m) (32)
4 New	166.967	422.692	3,0	NORDEX N131/3300 DE 3300 131,0	!-! hub: 144,0 m (TOT: 209,5 m) (33)
5 New	166.946	422.195	4,5	NORDEX N131/3300 DE 3300 131,0	!-! hub: 144,0 m (TOT: 209,5 m) (34)

Project:

Windpark Oss (Elzenburg)

Licensed user:

Antea Group
 Beneluxweg 125 Postbus 40
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 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 11:47/3.1.597

PARK - Main Result

Calculation: Variant 2B Elz Hoed Enercon

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,229 kg/m³ to 1,230 kg/m³
 Air density relative to standard 100,3 % to 100,4 %
 Hub altitude above sea level (asl) 138,0 m to 142,9 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 995,9 hPa to 996,5 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings

Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 135,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²]

3.634

Mean wind speed [m/s]

7,5

Equivalent roughness

1,9



New WTG

Scale 1:20.000

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			Mean wind speed @hub height [m/s]
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	
Wind farm	69.002,5	62.102,3	73.568,7	93,8	33,7	12.420,5	2.957	7,4

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 5 new WTGs with total 21,0 MW rated power

Links	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
								Result [MWh]	Result-10,0% [MWh]		
1 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.512,9	12.162	91,37	7,47
2 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.182,0	12.764	95,81	7,48
3 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.791,2	12.412	94,38	7,42
4 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.724,0	12.352	92,61	7,47
5 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.792,4	12.413	94,82	7,39

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.475	422.658	4,7	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (124)
2 New	166.051	422.508	4,9	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (125)
3 New	166.427	422.233	7,9	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (126)
4 New	166.974	422.696	3,0	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (127)
5 New	166.952	422.209	4,1	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (128)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 0513 634045
 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 11:49/3.1.597

PARK - Main Result

Calculation: Variant 3A Hoed en Schil Lagerwey

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings
 Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,234 kg/m³ to 1,234 kg/m³
 Air density relative to standard 100,7 % to 100,7 %
 Hub altitude above sea level (asl) 101,5 m to 106,1 m
 Annual mean temperature at hub alt. 9,3 °C to 9,4 °C
 Pressure at WTGs 1.000,3 hPa to 1.000,9 hPa

Wake Model Parameters
 Terrain type Wake decay constant
 HH:100m Mixed farmland 0,065

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data
 Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 99,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

				Wind energy [kWh/m ²]	Mean wind speed [m/s]	Equivalent roughness
A	167.269	422.465	Site data: WASP (4)	2.665	6,7	1,9



New WTG

Scale 1:20.000
 Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	55.913,6	50.322,3	61.521,6	90,9	28,5	6.290,3	2.496	6,7

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 8 new WTGs with total 20,2 MW rated power

Links	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact.							Result [MWh]	Result-10,0% [MWh]		
1 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.016,1	6.315	89,29	6,82
2 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	6.872,1	6.185	88,89	6,76
3 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	6.725,6	6.053	87,10	6,76
4 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.352,5	6.617	94,39	6,79
5 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	6.838,1	6.154	91,18	6,66
6 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.068,3	6.361	92,50	6,72
7 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.099,5	6.390	93,82	6,69
8 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	6.941,4	6.247	89,98	6,76

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.945	422.951	5,9	LAGERWEY L100-2.5MW	2520	100,0	!O!	hub: 99,0 m (TOT: 149,0 m) (96)
2 New	167.527	422.565	5,4	LAGERWEY L100-2.5MW	2520	100,0	!O!	hub: 99,0 m (TOT: 149,0 m) (97)
3 New	167.141	422.583	3,9	LAGERWEY L100-2.5MW	2520	100,0	!O!	hub: 99,0 m (TOT: 149,0 m) (98)
4 New	166.546	422.949	2,5	LAGERWEY L100-2.5MW	2520	100,0	!O!	hub: 99,0 m (TOT: 149,0 m) (99)
5 New	167.011	422.203	2,7	LAGERWEY L100-2.5MW	2520	100,0	!O!	hub: 99,0 m (TOT: 149,0 m) (100)
6 New	167.397	422.166	5,9	LAGERWEY L100-2.5MW	2520	100,0	!O!	hub: 99,0 m (TOT: 149,0 m) (101)
7 New	166.604	422.247	7,0	LAGERWEY L100-2.5MW	2520	100,0	!O!	hub: 99,0 m (TOT: 149,0 m) (102)
8 New	166.737	422.614	7,1	LAGERWEY L100-2.5MW	2520	100,0	!O!	hub: 99,0 m (TOT: 149,0 m) (103)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 Beneluxweg 125 Postbus 40
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 0513 634045
 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 11:48/3.1.597

PARK - Main Result

Calculation: Variant 3A Hoed en Schil Vestas

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,234 kg/m³ to 1,235 kg/m³
 Air density relative to standard 100,8 % to 100,8 %
 Hub altitude above sea level (asl) 96,1 m to 101,0 m
 Annual mean temperature at hub alt. 9,4 °C to 9,4 °C
 Pressure at WTGs 1.001,0 hPa to 1.001,6 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:100m Mixed farmland 0,065

Displacement heights from objects

Wake calculation settings

Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 94,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

	Wind energy [kWh/m ²]	Mean wind speed [m/s]	Equivalent roughness
A 167.269 422.465 Site data: WASP (4) WASP (WASP 11 Version 11.04.0026)	2.575	6,7	1,9



New WTG

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	67.127,1	60.414,4	77.231,7	86,9	25,0	7.551,8	2.189	6,7

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 8 new WTGs with total 27,6 MW rated power

Links	WTG type		Power, rated	Rotor diameter	Hub height	Power curve Creator	Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]	
	Valid	Manufact.						Type-generator	Result			Result-10,0%
1 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	8.408,2	7.567	84,81	6,74
2 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	8.082,4	7.274	83,24	6,68
3 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	7.824,0	7.042	80,68	6,67
4 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	9.100,9	8.191	92,85	6,70
5 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	8.184,2	7.366	87,26	6,58
6 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	8.550,2	7.695	89,17	6,64
7 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	8.649,2	7.784	91,57	6,60
8 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	8.328,1	7.495	85,90	6,67

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.940	422.954	5,6	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (41)
2 New	167.527	422.560	5,1	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (42)
3 New	167.131	422.584	3,9	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (43)
4 New	166.538	422.954	2,1	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (44)
5 New	166.992	422.204	2,3	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (45)
6 New	167.396	422.174	6,0	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (46)
7 New	166.589	422.234	5,4	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (47)
8 New	166.742	422.606	7,0	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (48)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 Calculated:
 6-2-2017 11:50/3.1.597

PARK - Main Result

Calculation: Variant 3B Hoed en Schil Nordex

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,228 kg/m³ to 1,229 kg/m³
 Air density relative to standard 100,3 % to 100,3 %
 Hub altitude above sea level (asl) 147,1 m to 149,5 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 995,1 hPa to 995,4 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings

Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 144,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²] Mean wind speed [m/s] Equivalent roughness
 3.868 7,6 1,9



New WTG

Site Data

Scale 1:20.000

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			Mean wind speed @hub height [m/s]
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	
Wind farm	81.595,7	73.436,1	87.104,0	93,7	42,3	12.239,4	3.709	7,6

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 6 new WTGs with total 19,8 MW rated power

Links	WTG type		Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact. Type-generator					Result [MWh]	Result-10,0% [MWh]		
1 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.848,1	12.463	94,05	7,69
2 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.801,2	12.421	95,30	7,58
3 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.690,0	12.321	95,25	7,55
4 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.337,0	12.003	91,37	7,63
5 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.486,5	12.138	92,57	7,62
6 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.432,8	12.090	93,55	7,53

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z [m] Row data/Description

1 New	167.010	423.209	3,2	NORDEX N131/3300 DE 3300 131,0	!- hub: 144,0 m (TOT: 209,5 m) (49)
2 New	167.591	422.163	5,1	NORDEX N131/3300 DE 3300 131,0	!- hub: 144,0 m (TOT: 209,5 m) (50)
3 New	166.591	422.231	5,5	NORDEX N131/3300 DE 3300 131,0	!- hub: 144,0 m (TOT: 209,5 m) (51)
4 New	167.348	422.681	4,0	NORDEX N131/3300 DE 3300 131,0	!- hub: 144,0 m (TOT: 209,5 m) (52)
5 New	166.802	422.723	3,1	NORDEX N131/3300 DE 3300 131,0	!- hub: 144,0 m (TOT: 209,5 m) (53)
6 New	167.091	422.198	3,9	NORDEX N131/3300 DE 3300 131,0	!- hub: 144,0 m (TOT: 209,5 m) (54)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 Calculated:
 6-2-2017 11:51/3.1.597

PARK - Main Result

Calculation: Variant 3B Hoed en Schil Enercon

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,229 kg/m³ to 1,230 kg/m³
 Air density relative to standard 100,3 % to 100,4 %
 Hub altitude above sea level (asl) 138,5 m to 142,2 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 996,0 hPa to 996,4 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 135,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²]

3.634

Mean wind speed [m/s]

7,5

Equivalent roughness

1,9



New WTG

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			Mean wind speed @hub height [m/s]
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	
Wind farm	82.681,3	74.413,1	88.481,4	93,4	33,7	12.402,2	2.953	7,5

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 6 new WTGs with total 25,2 MW rated power

Links	WTG type			Power, rated	Rotor diameter	Hub height	Power curve Creator	Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact.	Type-generator						Result	Result-10,0%		
1 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD	Level 0 - official - 0 s - 4200kW - 08/2015	14.132,0	12.719	93,97	7,54
2 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD	Level 0 - official - 0 s - 4200kW - 08/2015	13.910,8	12.520	94,88	7,42
3 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD	Level 0 - official - 0 s - 4200kW - 08/2015	13.900,8	12.511	95,32	7,41
4 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD	Level 0 - official - 0 s - 4200kW - 08/2015	13.468,5	12.122	90,64	7,48
5 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD	Level 0 - official - 0 s - 4200kW - 08/2015	13.732,8	12.360	92,58	7,48
6 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD	Level 0 - official - 0 s - 4200kW - 08/2015	13.536,3	12.183	93,33	7,38

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description

	X [m]	Y [m]	Z [m]	Row data/Description
1 New	167.025	423.208	3,5	ENERCON E-126 EP4 4200 127,0 !O! hub: 135,0 m (TOT: 198,5 m) (129)
2 New	167.587	422.144	5,3	ENERCON E-126 EP4 4200 127,0 !O! hub: 135,0 m (TOT: 198,5 m) (130)
3 New	166.607	422.234	7,2	ENERCON E-126 EP4 4200 127,0 !O! hub: 135,0 m (TOT: 198,5 m) (131)
4 New	167.343	422.680	4,0	ENERCON E-126 EP4 4200 127,0 !O! hub: 135,0 m (TOT: 198,5 m) (132)
5 New	166.822	422.733	3,9	ENERCON E-126 EP4 4200 127,0 !O! hub: 135,0 m (TOT: 198,5 m) (133)
6 New	167.085	422.179	3,6	ENERCON E-126 EP4 4200 127,0 !O! hub: 135,0 m (TOT: 198,5 m) (134)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 11:53/3.1.597

PARK - Main Result

Calculation: Variant 4A Hoed Vestas

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings
 Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,234 kg/m³ to 1,235 kg/m³
 Air density relative to standard 100,8 % to 100,8 %
 Hub altitude above sea level (asl) 96,4 m to 101,1 m
 Annual mean temperature at hub alt. 9,4 °C to 9,4 °C
 Pressure at WTGs 1.001,0 hPa to 1.001,5 hPa

Wake Model Parameters
 Terrain type Wake decay constant
 HH:100m Mixed farmland 0,065

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data
 Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

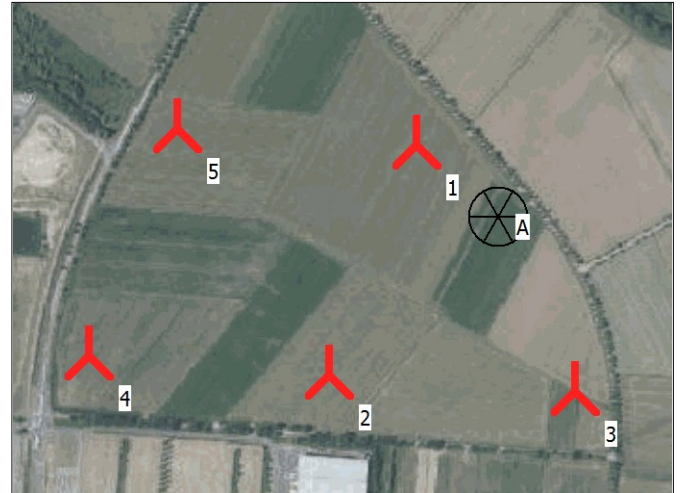
WASP version WASP 11 Version 11.04.0026

Key results for height 94,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

				Wind energy [kWh/m ²]	Mean wind speed [m/s]	Equivalent roughness
A	167.269	422.465	Site data: WASP (4)	2.575	6,7	1,9



Scale 1:12.500

New WTG

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			Mean wind speed @hub height [m/s]
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	
Wind farm	43.262,6	38.936,3	47.816,6	90,5	25,7	7.787,3	2.257	6,6

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 5 new WTGs with total 17,3 MW rated power

WTG type	Links	Valid	Manufact.	Type-generator	Power rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
										Result [MWh]	Result-10,0% [MWh]		
1 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016		8.307,6	7.477	85,65	6,67
2 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016		8.450,8	7.606	90,07	6,58
3 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016		8.821,3	7.939	92,02	6,64
4 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016		8.852,4	7.967	93,67	6,60
5 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0	EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016		8.830,4	7.947	91,05	6,67

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	167.134	422.585	4,0	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (56)
2 New	166.989	422.204	2,4	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (57)
3 New	167.397	422.179	5,9	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (58)
4 New	166.591	422.234	5,5	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (59)
5 New	166.737	422.611	7,1	VESTAS V112-3.45	3450	112,0	!O!	hub: 94,0 m (TOT: 150,0 m) (60)

Project:

Windpark Oss (Elzenburg)

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 Calculated:
 2-2-2017 11:27/3.1.597

PARK - Main Result

Calculation: Variant 4A Hoed Lagerwey

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,234 kg/m³ to 1,234 kg/m³
 Air density relative to standard 100,7 % to 100,7 %
 Hub altitude above sea level (asl) 101,7 m to 106,1 m
 Annual mean temperature at hub alt. 9,3 °C to 9,4 °C
 Pressure at WTGs 1.000,3 hPa to 1.000,9 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:50m Mixed farmland 0,075

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind statistics NL Eindhoven, 1970-76.wws

WAsP version WAsP 11 Version 11.04.0026



New WTG

Site Data

Key results for height 99,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

				Wind energy [kWh/m ²]	Mean wind speed [m/s]	Equivalent roughness
A	166.948	422.479	Site data: WAsP (4)	3.063	7,1	1,9
			WAsP (WAsP 11 Version 11.04.0026)			

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	39.700,9	35.730,8	42.160,5	94,2	32,3	7.146,2	2.836	7,1

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 5 new WTGs with total 12,6 MW rated power

Links	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact.							Result	Result-10,0%		
1 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.865,0	7.079	92,23	7,11
2 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.756,5	6.981	93,50	7,01
3 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	8.008,7	7.208	95,01	7,07
4 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.982,6	7.184	95,31	7,04
5 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	8.088,1	7.279	94,79	7,12

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	167.141	422.583	3,9	LAGERWEY L100-2.5MW 2520 100.0 !O!	hub: 99,0 m (TOT: 149,0 m) (104)
2 New	167.011	422.203	2,7	LAGERWEY L100-2.5MW 2520 100.0 !O!	hub: 99,0 m (TOT: 149,0 m) (105)
3 New	167.397	422.166	5,9	LAGERWEY L100-2.5MW 2520 100.0 !O!	hub: 99,0 m (TOT: 149,0 m) (106)
4 New	166.604	422.247	7,0	LAGERWEY L100-2.5MW 2520 100.0 !O!	hub: 99,0 m (TOT: 149,0 m) (107)
5 New	166.737	422.614	7,1	LAGERWEY L100-2.5MW 2520 100.0 !O!	hub: 99,0 m (TOT: 149,0 m) (108)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 Calculated:
 6-2-2017 11:55/3.1.597

PARK - Main Result

Calculation: Variant 4B Hoed Nordex

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,228 kg/m³ to 1,229 kg/m³
 Air density relative to standard 100,3 % to 100,3 %
 Hub altitude above sea level (asl) 147,1 m to 150,1 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 995,0 hPa to 995,4 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 144,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

	X (east)	Y (north)	Name of wind distribution	Type	Wind energy [kWh/m ²]	Mean wind speed [m/s]	Equivalent roughness
A	167.269	422.465	Site data: WASP (4)	WASP (WASP 11 Version 11.04.0026)	3.868	7,6	1,9



New WTG

Scale 1:10.000

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean wind speed @hub height [m/s]	Full load hours [Hours/year]	Mean wind speed [m/s]
Wind farm	41.849,2	37.664,3	43.306,5	96,6	43,4	7,6	3.804	7,6

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 3 new WTGs with total 9,9 MW rated power

Links	WTG type		Power, rated	Rotor diameter	Hub height	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact. Type-generator					Result	Result-10,0%		
1 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.959,9	12.564	97,08	7,55
2 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.967,7	12.571	95,88	7,62
3 A	Yes	NORDEX N131/3300 DE-3.300	3.300	131,0	144,0	EMD Level 0 - official - 3300 kW - 07/2015	13.921,7	12.529	96,96	7,53

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.597	422.231	6,1	NORDEX N131/3300 DE 3300 131.0	!-! hub: 144,0 m (TOT: 209,5 m) (61)
2 New	166.802	422.722	3,1	NORDEX N131/3300 DE 3300 131.0	!-! hub: 144,0 m (TOT: 209,5 m) (62)
3 New	167.091	422.198	3,9	NORDEX N131/3300 DE 3300 131.0	!-! hub: 144,0 m (TOT: 209,5 m) (63)

Project:

Windpark Oss (Elzenburg)

Licensed user:

Antea Group
 Beneluxweg 125 Postbus 40
 NL-4900 AA OOSTERHOUT
 0513 634045
 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 11:57/3.1.597

PARK - Main Result

Calculation: Variant 4B Hoed Enercon

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,229 kg/m³ to 1,230 kg/m³
 Air density relative to standard 100,3 % to 100,4 %
 Hub altitude above sea level (asl) 138,6 m to 142,2 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 996,0 hPa to 996,4 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings

Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 135,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²]
 3.634

Mean wind speed [m/s]
 7,5

Equivalent roughness
 1,9



New WTG

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	42.399,4	38.159,5	43.921,5	96,5	34,5	12.719,8	3.029	7,4

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 3 new WTGs with total 12,6 MW rated power

Links	WTG type		Power, rated	Rotor diameter	Hub height	Power curve Creator	Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]	
	Valid	Manufact.						Type-generator	Result			Result-10,0%
1 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD	Level 0 - official - 0 s - 4200kW - 08/2015	14.165,6	12.749	97,13	7,41
2 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD	Level 0 - official - 0 s - 4200kW - 08/2015	14.224,1	12.802	95,89	7,48
3 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD	Level 0 - official - 0 s - 4200kW - 08/2015	14.009,8	12.609	96,59	7,38

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.607	422.234	7,2	ENERCON E-126 EP4 4200 127,0 !O!	hub: 135,0 m (TOT: 198,5 m) (135)
2 New	166.822	422.733	3,9	ENERCON E-126 EP4 4200 127,0 !O!	hub: 135,0 m (TOT: 198,5 m) (136)
3 New	167.085	422.179	3,6	ENERCON E-126 EP4 4200 127,0 !O!	hub: 135,0 m (TOT: 198,5 m) (137)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 11:58/3.1.597

PARK - Main Result

Calculation: Variant 5A Omgeving Vestas

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,234 kg/m³ to 1,235 kg/m³
 Air density relative to standard 100,8 % to 100,8 %
 Hub altitude above sea level (asl) 98,6 m to 101,0 m
 Annual mean temperature at hub alt. 9,4 °C to 9,4 °C
 Pressure at WTGs 1.001,0 hPa to 1.001,3 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:100m Mixed farmland 0,065

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 94,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²] Mean wind speed [m/s] Equivalent roughness
 2.575 6,7 1,9



New WTG

Scale 1:20.000

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	35.787,3	32.208,6	38.797,6	92,2	26,6	8.052,1	2.334	6,7

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 4 new WTGs with total 13,8 MW rated power

Links	WTG type		Power rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]	
	Valid	Manufact.					Type-generator	Result [MWh]			Result-10,0% [MWh]
1 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0 EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	9.122,6	8.210	91,92	6,74
2 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0 EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	8.794,7	7.915	90,35	6,68
3 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0 EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	9.009,9	8.109	95,40	6,60
4 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0 EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	8.860,1	7.974	91,40	6,67

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.943	422.989	5,2 VESTAS V112-3.45 3450 112.0 !O! hub: 94,0 m (TOT: 150,0 m) (64)
2 New	167.143	422.614	4,6 VESTAS V112-3.45 3450 112.0 !O! hub: 94,0 m (TOT: 150,0 m) (65)
3 New	166.588	422.233	5,2 VESTAS V112-3.45 3450 112.0 !O! hub: 94,0 m (TOT: 150,0 m) (66)
4 New	166.737	422.606	7,0 VESTAS V112-3.45 3450 112.0 !O! hub: 94,0 m (TOT: 150,0 m) (67)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 NL-4900 AA OOSTERHOUT
 0513 634045
 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 11:59/3.1.597

PARK - Main Result

Calculation: Variant 5A Omgeving Lagerwey

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings
 Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,234 kg/m³ to 1,234 kg/m³
 Air density relative to standard 100,7 % to 100,7 %
 Hub altitude above sea level (asl) 102,9 m to 106,1 m
 Annual mean temperature at hub alt. 9,3 °C to 9,4 °C
 Pressure at WTGs 1.000,3 hPa to 1.000,7 hPa

Wake Model Parameters
 Terrain type Wake decay constant
 HH:100m Mixed farmland 0,065

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data
 Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 99,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²] Mean wind speed [m/s] Equivalent roughness
 2.665 6,7 1,9



New WTG

Scale 1:20.000
 Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	29.221,0	26.298,9	30.863,9	94,7	29,8	6.574,7	2.609	6,8

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 4 new WTGs with total 10,1 MW rated power

Links	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact.						Result [MWh]	Result-10,0% [MWh]		
1 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD Level 0 - - Standard mode - 04-2013	7.417,2	6.676	94,36	6,82
2 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD Level 0 - - Standard mode - 04-2013	7.242,3	6.518	93,79	6,76
3 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD Level 0 - - Standard mode - 04-2013	7.310,4	6.579	96,61	6,69
4 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD Level 0 - - Standard mode - 04-2013	7.251,1	6.526	94,00	6,76

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.957	422.992	5,0	LAGERWEY L100-2.5MW 2520 100.0	!O!	hub: 99,0 m (TOT: 149,0 m) (109)
2 New	167.141	422.583	3,9	LAGERWEY L100-2.5MW 2520 100.0	!O!	hub: 99,0 m (TOT: 149,0 m) (110)
3 New	166.604	422.247	7,0	LAGERWEY L100-2.5MW 2520 100.0	!O!	hub: 99,0 m (TOT: 149,0 m) (111)
4 New	166.737	422.614	7,1	LAGERWEY L100-2.5MW 2520 100.0	!O!	hub: 99,0 m (TOT: 149,0 m) (112)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 12:00/3.1.597

PARK - Main Result

Calculation: Variant 5B Omgeving Nordex

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,228 kg/m³ to 1,229 kg/m³
 Air density relative to standard 100,3 % to 100,3 %
 Hub altitude above sea level (asl) 147,1 m to 149,8 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 995,1 hPa to 995,4 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings

Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 144,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²] Mean wind speed [m/s] Equivalent roughness
 3.868 7,6 1,9



New WTG

Scale 1:20.000

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	55.608,2	50.047,4	58.205,4	95,5	43,3	12.511,9	3.791	7,6

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 4 new WTGs with total 13,2 MW rated power

Links	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact.							Result [MWh]	Result-10,0% [MWh]		
1 A	Yes	NORDEX	N131/3300 DE-3.300	3.300	131,0	144,0	EMD	Level 0 - official - 3300 kW - 07/2015	13.884,6	12.496	96,58	7,55
2 A	Yes	NORDEX	N131/3300 DE-3.300	3.300	131,0	144,0	EMD	Level 0 - official - 3300 kW - 07/2015	13.883,5	12.495	95,53	7,60
3 A	Yes	NORDEX	N131/3300 DE-3.300	3.300	131,0	144,0	EMD	Level 0 - official - 3300 kW - 07/2015	13.779,9	12.402	94,58	7,62
4 A	Yes	NORDEX	N131/3300 DE-3.300	3.300	131,0	144,0	EMD	Level 0 - official - 3300 kW - 07/2015	14.060,3	12.654	95,47	7,69

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.592	422.238	5,8	NORDEX N131/3300 DE 3300	131,0	!-!	hub: 144,0 m (TOT: 209,5 m) (69)
2 New	167.231	422.479	5,1	NORDEX N131/3300 DE 3300	131,0	!-!	hub: 144,0 m (TOT: 209,5 m) (70)
3 New	166.797	422.723	3,1	NORDEX N131/3300 DE 3300	131,0	!-!	hub: 144,0 m (TOT: 209,5 m) (71)
4 New	167.005	423.209	3,2	NORDEX N131/3300 DE 3300	131,0	!-!	hub: 144,0 m (TOT: 209,5 m) (72)

Project:

Windpark Oss (Elzenburg)

Licensed user:

Antea Group
 Beneluxweg 125 Postbus 40
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 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 12:02/3.1.597

PARK - Main Result

Calculation: Variant 5B Omgeving Enercon

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,229 kg/m³ to 1,230 kg/m³
 Air density relative to standard 100,3 % to 100,4 %
 Hub altitude above sea level (asl) 138,3 m to 142,2 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 996,0 hPa to 996,5 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings

Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 135,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²] 3.634

Mean wind speed [m/s] 7,5

Equivalent roughness 1,9



New WTG

Scale 1:20.000
 Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	56.469,1	50.822,2	59.208,0	95,4	34,5	12.705,5	3.025	7,5

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 4 new WTGs with total 16,8 MW rated power

Links	WTG type		Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact. Type-generator					Result [MWh]	Result-10,0% [MWh]		
1 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.099,8	12.690	96,68	7,41
2 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.026,3	12.624	95,05	7,45
3 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.005,9	12.605	94,53	7,47
4 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.337,1	12.903	95,25	7,54

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description

	X [m]	Y [m]	Z [m]	Row data/Description
1 New	166.607	422.234	7,2	ENERCON E-126 EP4 4200 127,0 !O! hub: 135,0 m (TOT: 198,5 m) (138)
2 New	167.244	422.466	5,7	ENERCON E-126 EP4 4200 127,0 !O! hub: 135,0 m (TOT: 198,5 m) (139)
3 New	166.813	422.733	3,4	ENERCON E-126 EP4 4200 127,0 !O! hub: 135,0 m (TOT: 198,5 m) (140)
4 New	167.021	423.203	3,3	ENERCON E-126 EP4 4200 127,0 !O! hub: 135,0 m (TOT: 198,5 m) (141)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 12:04/3.1.597

PARK - Main Result

Calculation: Variant 6A 3 x langs N329 Vestas

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings
 Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,234 kg/m³ to 1,234 kg/m³
 Air density relative to standard 100,8 % to 100,8 %
 Hub altitude above sea level (asl) 99,2 m to 101,0 m
 Annual mean temperature at hub alt. 9,4 °C to 9,4 °C
 Pressure at WTGs 1.001,0 hPa to 1.001,2 hPa

Wake Model Parameters
 Terrain type Wake decay constant
 HH:100m Mixed farmland 0,065

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data
 Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 94,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

	X (east)	Y (north)	Name of wind distribution	Type	Wind energy [kWh/m ²]	Mean wind speed [m/s]	Equivalent roughness
A	167.269	422.465	Site data: WASP (4)	WASP (WASP 11 Version 11.04.0026)	2.575	6,7	1,9



New WTG

Scale 1:20.000

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	27.578,2	24.820,4	29.068,7	94,9	27,4	8.273,5	2.398	6,7

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 3 new WTGs with total 10,4 MW rated power

Links	WTG type		Power-rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]	
	Valid	Manufact.					Type-generator	Result [MWh]			Result-10,0% [MWh]
1 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0 EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	9.367,3	8.431	94,36	6,74
2 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0 EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	9.165,6	8.249	97,03	6,60
3 A	Yes	VESTAS	V112-3.45-3.450	3.450	112,0	94,0 EMD	Level 0 - Calculated - Modes 0 & 0-OS - 01-2016	9.045,3	8.141	93,29	6,67

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.945	422.992	5,2 VESTAS V112-3.45 3450 112.0	!O! hub: 94,0 m (TOT: 150,0 m) (73)
2 New	166.589	422.234	5,4 VESTAS V112-3.45 3450 112.0	!O! hub: 94,0 m (TOT: 150,0 m) (74)
3 New	166.737	422.609	7,0 VESTAS V112-3.45 3450 112.0	!O! hub: 94,0 m (TOT: 150,0 m) (75)

Project:

Windpark Oss (Elzenburg)

Licensed user:

Antea Group
 Beneluxweg 125 Postbus 40
 NL-4900 AA OOSTERHOUT
 0513 634045
 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 6-2-2017 12:05/3.1.597

PARK - Main Result

Calculation: Variant 6A 3 x langs N329 Lagerwey

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,234 kg/m³ to 1,234 kg/m³
 Air density relative to standard 100,7 % to 100,7 %
 Hub altitude above sea level (asl) 104,0 m to 106,1 m
 Annual mean temperature at hub alt. 9,3 °C to 9,4 °C
 Pressure at WTGs 1.000,3 hPa to 1.000,6 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:100m Mixed farmland 0,065

Displacement heights from objects

Wake calculation settings

Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 99,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

					Wind energy [kWh/m ²]	Mean wind speed [m/s]	Equivalent roughness
A	167.269	422.465	Site data: WASP (4)	WASP (WASP 11 Version 11.04.0026)	2.665	6,7	1,9



New WTG

Scale 1:20.000

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	22.305,9	20.075,3	23.141,8	96,4	30,3	6.691,8	2.655	6,8

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 3 new WTGs with total 7,6 MW rated power

Links	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact.							Result	Result-10,0%		
1 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.554,3	6.799	96,11	6,82
2 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.399,9	6.660	97,79	6,69
3 A	Yes	LAGERWEY	L100-2.5MW-2.520	2.520	100,0	99,0	EMD	Level 0 - - Standard mode - 04-2013	7.351,7	6.617	95,30	6,76

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.957	422.992	5,0	LAGERWEY L100-2.5MW 2520 100.0	!O!	hub: 99,0 m (TOT: 149,0 m) (113)
2 New	166.604	422.247	7,0	LAGERWEY L100-2.5MW 2520 100.0	!O!	hub: 99,0 m (TOT: 149,0 m) (114)
3 New	166.737	422.614	7,1	LAGERWEY L100-2.5MW 2520 100.0	!O!	hub: 99,0 m (TOT: 149,0 m) (115)

Project:

Windpark Oss (Elzenburg)

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 Calculated:
 6-2-2017 12:07/3.1.597

PARK - Main Result

Calculation: Variant 6B 3 x langs N329 Nordex

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,228 kg/m³ to 1,229 kg/m³
 Air density relative to standard 100,3 % to 100,3 %
 Hub altitude above sea level (asl) 147,2 m to 149,4 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 995,1 hPa to 995,4 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings

Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 144,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²]

3.868

Mean wind speed [m/s]

7,6

Equivalent roughness

1,9



New WTG

Scale 1:20.000

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	42.259,7	38.033,7	43.666,1	96,8	43,8	12.677,9	3.842	7,6

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 3 new WTGs with total 9,9 MW rated power

Links	WTG type		Power, rated	Rotor diameter	Hub height	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact.					Type-generator	Result		
1 A	Yes	NORDEX	N131/3300 DE-3.300	3.300	131,0	144,0 EMD Level 0 - official - 3300 kW - 07/2015	14.058,7	12.653	97,82	7,55
2 A	Yes	NORDEX	N131/3300 DE-3.300	3.300	131,0	144,0 EMD Level 0 - official - 3300 kW - 07/2015	13.969,6	12.573	95,90	7,62
3 A	Yes	NORDEX	N131/3300 DE-3.300	3.300	131,0	144,0 EMD Level 0 - official - 3300 kW - 07/2015	14.231,4	12.808	96,63	7,69

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.589	422.236	5,4	NORDEX N131/3300 DE 3300	131,0	!-!	hub: 144,0 m (TOT: 209,5 m) (76)
2 New	166.797	422.720	3,2	NORDEX N131/3300 DE 3300	131,0	!-!	hub: 144,0 m (TOT: 209,5 m) (77)
3 New	167.005	423.209	3,2	NORDEX N131/3300 DE 3300	131,0	!-!	hub: 144,0 m (TOT: 209,5 m) (78)

Project:

Windpark Oss (Elzenburg)

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 Calculated:
 6-2-2017 12:08/3.1.597

PARK - Main Result

Calculation: Variant 6B 3 x langs N329 Enercon

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings
 Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,229 kg/m³ to 1,230 kg/m³
 Air density relative to standard 100,3 % to 100,4 %
 Hub altitude above sea level (asl) 138,3 m to 142,2 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 996,0 hPa to 996,5 hPa

Wake Model Parameters
 Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data
 Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 135,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²]
3.634

Mean wind speed [m/s]
7,5

Equivalent roughness
1,9



New WTG

Site Data

Scale 1:20.000

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	42.973,2	38.675,9	44.452,0	96,7	35,0	12.892,0	3.070	7,5

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 3 new WTGs with total 12,6 MW rated power

Links	WTG type		Power, rated	Rotor diameter	Hub height	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact. Type-generator					Result	Result-10,0%		
1 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.287,9	12.859	97,97	7,41
2 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.191,0	12.772	95,78	7,47
3 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.494,2	13.045	96,30	7,54

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.607	422.234	7,2	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (142)
2 New	166.813	422.733	3,4	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (143)
3 New	167.021	423.203	3,3	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (144)

Project:

Windpark Oss (Elzenburg)

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 Calculated:
 4-7-2017 11:54/3.1.597

PARK - Main Result

Calculation: VKA 1a Enercon 126

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,229 kg/m³ to 1,230 kg/m³
 Air density relative to standard 100,4 % to 100,4 %
 Hub altitude above sea level (asl) 138,7 m to 141,0 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 996,1 hPa to 996,4 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings

Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 135,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²]

Mean wind speed [m/s]

Equivalent roughness

3.634 7,5 1,9



Scale 1:20.000

New WTG

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	69.982,2	62.984,0	73.788,3	94,8	34,2	12.596,8	2.999	7,5

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 5 new WTGs with total 21,0 MW rated power

Links	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact.	Type-generator					Result [MWh]	Result-10,0% [MWh]		
1 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.840,6	12.457	94,91	7,40
2 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.263,0	12.837	96,46	7,47
3 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.160,0	12.744	94,51	7,52
4 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.595,5	12.236	92,03	7,46
5 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.123,0	12.711	96,31	7,42

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.667	422.287	6,0	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (206)
2 New	166.233	422.541	5,1	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (207)
3 New	166.702	422.989	3,7	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (208)
4 New	167.051	422.612	4,1	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (209)
5 New	167.401	422.235	5,5	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (210)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 Calculated:
 4-7-2017 12:54/3.1.597

PARK - Main Result

Calculation: VKA 1b Enercon 126

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,229 kg/m³ to 1,230 kg/m³
 Air density relative to standard 100,4 % to 100,4 %
 Hub altitude above sea level (asl) 138,7 m to 141,0 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 996,1 hPa to 996,4 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings

Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 135,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²]
 3.634

Mean wind speed [m/s]
 7,5

Equivalent roughness
 1,9



New WTG

Scale 1:20.000
 Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	56.593,1	50.933,8	59.001,7	95,9	34,6	12.733,4	3.032	7,5

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 4 new WTGs with total 16,8 MW rated power

Links	WTG type		Power, rated	Rotor diameter	Hub height	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact. Type-generator					Result	Result-10,0%		
1 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.082,1	12.674	96,56	7,40
2 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.540,4	13.086	97,05	7,52
3 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.784,9	12.406	93,32	7,46
4 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.185,8	12.767	96,74	7,42

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.667	422.287	6,0	ENERCON E-126 EP4 4200 127,0 !O!	hub: 135,0 m (TOT: 198,5 m) (202)
2 New	166.702	422.989	3,7	ENERCON E-126 EP4 4200 127,0 !O!	hub: 135,0 m (TOT: 198,5 m) (203)
3 New	167.051	422.612	4,1	ENERCON E-126 EP4 4200 127,0 !O!	hub: 135,0 m (TOT: 198,5 m) (204)
4 New	167.401	422.235	5,5	ENERCON E-126 EP4 4200 127,0 !O!	hub: 135,0 m (TOT: 198,5 m) (205)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 Calculated:
 4-7-2017 12:58/3.1.597

PARK - Main Result

Calculation: VKA 2a Enercon 126

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings
 Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,229 kg/m³ to 1,230 kg/m³
 Air density relative to standard 100,4 % to 100,4 %
 Hub altitude above sea level (asl) 137,9 m to 141,0 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 996,1 hPa to 996,5 hPa

Wake Model Parameters
 Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data
 Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 135,0 m above ground level

Terrain	Dutch Stereo-RD/NAP 2008	X (east)	Y (north)	Name of wind distribution	Type	Wind energy [kWh/m ²]	Mean wind speed [m/s]	Equivalent roughness
A	167.269	422.465	Site data: WASP (4)	WASP (WASP 11 Version 11.04.0026)	3.634	7,5	1,9	



New WTG

Scale 1:20.000
 Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	69.461,5	62.515,4	73.745,1	94,2	34,0	12.503,1	2.977	7,5

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 5 new WTGs with total 21,0 MW rated power

Links	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact.	Type-generator					Result [MWh]	Result-10,0% [MWh]		
1 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.785,8	12.407	94,53	7,40
2 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.935,6	12.542	95,50	7,40
3 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.554,3	12.199	91,38	7,48
4 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.038,2	12.634	93,90	7,52
5 A	Yes	ENERCON	E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.147,6	12.733	95,68	7,47

WTG siting

Dutch Stereo-RD/NAP 2008
 X (east) Y (north) Z Row data/Description [m]

1 New	166.667	422.287	6,0	ENERCON E-126 EP4 4200 127.0 !O!	hub: 135,0 m (TOT: 198,5 m) (193)
2 New	167.177	422.251	4,9	ENERCON E-126 EP4 4200 127.0 !O!	hub: 135,0 m (TOT: 198,5 m) (194)
3 New	166.955	422.704	3,0	ENERCON E-126 EP4 4200 127.0 !O!	hub: 135,0 m (TOT: 198,5 m) (195)
4 New	166.519	422.958	2,9	ENERCON E-126 EP4 4200 127.0 !O!	hub: 135,0 m (TOT: 198,5 m) (196)
5 New	166.233	422.541	5,1	ENERCON E-126 EP4 4200 127.0 !O!	hub: 135,0 m (TOT: 198,5 m) (197)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 0513 634045
 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 4-7-2017 13:00/3.1.597

PARK - Main Result

Calculation: VKA 2b Enercon 126

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,229 kg/m³ to 1,230 kg/m³
 Air density relative to standard 100,4 % to 100,4 %
 Hub altitude above sea level (asl) 137,9 m to 141,0 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 996,1 hPa to 996,5 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings

Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 135,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

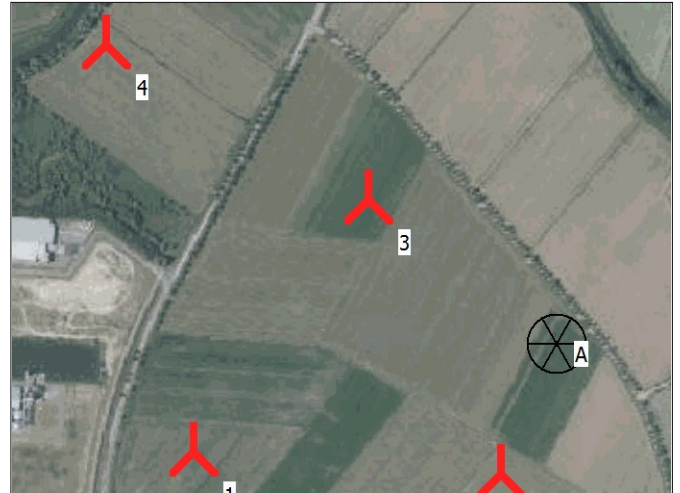
A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²]
 3.634

Mean wind speed [m/s]
 7,5

Equivalent roughness
 1,9



New WTG

Scale 1:12.500

Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	56.384,4	50.746,0	58.958,0	95,6	34,5	12.686,5	3.021	7,4

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 4 new WTGs with total 16,8 MW rated power

Links	WTG type		Power, rated	Rotor diameter	Hub height	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact. Type-generator					Result	Result-10,0%		
1 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.026,8	12.624	96,18	7,40
2 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.009,1	12.608	96,00	7,40
3 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.838,1	12.454	93,29	7,48
4 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.510,4	13.059	97,06	7,52

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description

	X [m]	Y [m]	Z [m]	Row data/Description
1 New	166.667	422.287	6,0	ENERCON E-126 EP4 4200 127,0 !O! hub: 135,0 m (TOT: 198,5 m) (198)
2 New	167.177	422.251	4,9	ENERCON E-126 EP4 4200 127,0 !O! hub: 135,0 m (TOT: 198,5 m) (199)
3 New	166.955	422.704	3,0	ENERCON E-126 EP4 4200 127,0 !O! hub: 135,0 m (TOT: 198,5 m) (200)
4 New	166.519	422.958	2,9	ENERCON E-126 EP4 4200 127,0 !O! hub: 135,0 m (TOT: 198,5 m) (201)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 4-7-2017 13:02/3.1.597

PARK - Main Result

Calculation: OA a Enercon 126

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings

Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,229 kg/m³ to 1,230 kg/m³
 Air density relative to standard 100,4 % to 100,4 %
 Hub altitude above sea level (asl) 137,9 m to 141,0 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 996,1 hPa to 996,5 hPa

Wake Model Parameters

Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings

Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data

Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 135,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²]

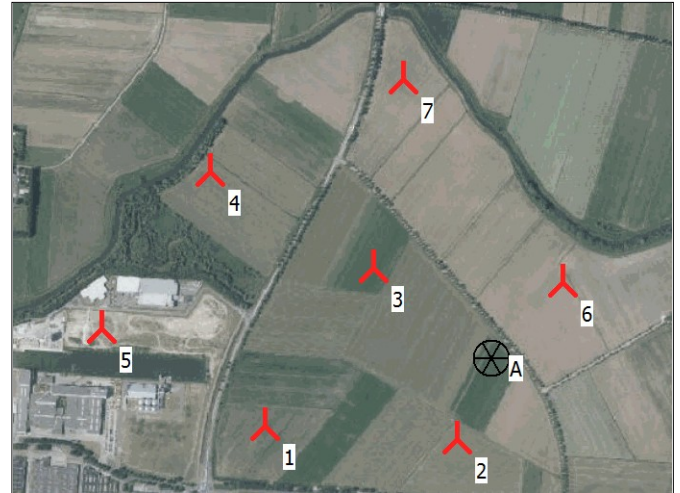
3.634

Mean wind speed [m/s]

7,5

Equivalent roughness

1,9



Scale 1:20.000

▲ New WTG

⊗ Site Data

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Park efficiency [%]	Specific results ^{a)}			Mean wind speed @hub height [m/s]
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	
Wind farm	95.390,8	85.851,7	103.641,7	92,0	33,3	12.264,5	2.920	7,5

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 7 new WTGs with total 29,4 MW rated power

Links	WTG type		Power, rated	Rotor diameter	Hub height	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact. Type-generator					Result	Result-10,0%		
1 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.582,8	12.224	93,14	7,40
2 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.606,8	12.246	93,25	7,40
3 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.194,6	11.875	88,96	7,48
4 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.745,9	12.371	91,95	7,52
5 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.034,8	12.631	94,91	7,47
6 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.486,4	12.138	90,82	7,48
7 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.739,4	12.365	91,31	7,54

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.667	422.287	6,0	ENERCON E-126 EP4 4200 127,0	!O! hub: 135,0 m (TOT: 198,5 m) (169)
2 New	167.177	422.251	4,9	ENERCON E-126 EP4 4200 127,0	!O! hub: 135,0 m (TOT: 198,5 m) (170)
3 New	166.955	422.704	3,0	ENERCON E-126 EP4 4200 127,0	!O! hub: 135,0 m (TOT: 198,5 m) (171)
4 New	166.519	422.958	2,9	ENERCON E-126 EP4 4200 127,0	!O! hub: 135,0 m (TOT: 198,5 m) (172)
5 New	166.233	422.541	5,1	ENERCON E-126 EP4 4200 127,0	!O! hub: 135,0 m (TOT: 198,5 m) (175)
6 New	167.458	422.667	5,0	ENERCON E-126 EP4 4200 127,0	!O! hub: 135,0 m (TOT: 198,5 m) (176)
7 New	167.033	423.202	3,4	ENERCON E-126 EP4 4200 127,0	!O! hub: 135,0 m (TOT: 198,5 m) (177)

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 4-7-2017 13:04/3.1.597

PARK - Main Result

Calculation: OA b Enercon 126

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings
 Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,229 kg/m³ to 1,230 kg/m³
 Air density relative to standard 100,4 % to 100,4 %
 Hub altitude above sea level (asl) 137,9 m to 141,0 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 996,1 hPa to 996,5 hPa

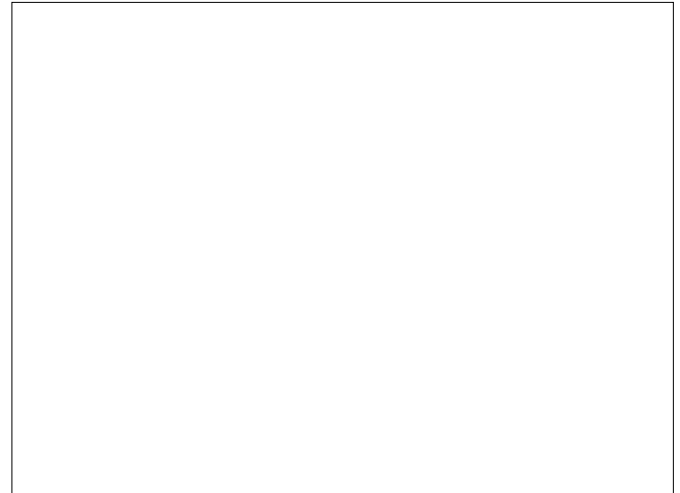
Wake Model Parameters
 Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data
 Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026



New WTG

Scale 1:20.000

Site Data

Key results for height 135,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

					Wind energy [kWh/m ²]	Mean wind speed [m/s]	Equivalent roughness
A	167.269	422.465	Site data: WASP (4)	WASP (WASP 11 Version 11.04.0026)	3.634	7,5	1,9

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			Mean wind speed @hub height [m/s]
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	
Wind farm	82.640,1	74.376,1	88.854,7	93,0	33,7	12.396,0	2.951	7,5

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 6 new WTGs with total 25,2 MW rated power

Links	WTG type		Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact. Type-generator					Result [MWh]	Result-10,0% [MWh]		
1 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.823,7	12.441	94,79	7,40
2 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.680,4	12.312	93,75	7,40
3 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.478,4	12.131	90,87	7,48
4 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.218,1	12.796	95,10	7,52
5 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.541,0	12.187	91,18	7,48
6 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.898,5	12.509	92,37	7,54

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description

1 New	166.667	422.287	6,0	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m)	(178)		
2 New	167.177	422.251	4,9	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m)	(179)		
3 New	166.955	422.704	3,0	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m)	(180)		
4 New	166.519	422.958	2,9	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m)	(181)		
5 New	167.458	422.667	5,0	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m)	(182)		
6 New	167.033	423.202	3,4	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m)	(183)		

Project:

Windpark Oss (Elzenburg)

Licensed user:

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 0513 634045
 Koen Wilmer / koen.wilmer@anteagroup.com
 Calculated:
 4-7-2017 13:06/3.1.597

PARK - Main Result

Calculation: OA c Enercon 126

Wake Model N.O. Jensen (RISØ/EMD)

Calculation Settings
 Air density calculation mode Individual per WTG
 Result for WTG at hub altitude 1,229 kg/m³ to 1,230 kg/m³
 Air density relative to standard 100,4 % to 100,4 %
 Hub altitude above sea level (asl) 137,9 m to 141,0 m
 Annual mean temperature at hub alt. 9,1 °C to 9,1 °C
 Pressure at WTGs 996,1 hPa to 996,5 hPa

Wake Model Parameters
 Terrain type Wake decay constant
 HH:150m Mixed farmland 0,059

Displacement heights from objects

Wake calculation settings
 Angle [°] Wind speed [m/s]
 start end step start end step
 0,5 360,0 1,0 0,5 30,5 1,0

Wind data
 Wind statistics Weight [%]
 NL Eindhoven, 1970-76.wws 72
 DE Dusseldorf, 1970-79.wws 28

WASP version WASP 11 Version 11.04.0026

Key results for height 135,0 m above ground level

Terrain Dutch Stereo-RD/NAP 2008

X (east) Y (north) Name of wind distribution Type

A 167.269 422.465 Site data: WASP (4)

WASP (WASP 11 Version 11.04.0026)

Wind energy [kWh/m²] Mean wind speed [m/s] Equivalent roughness
 3.634 7,5 1,9



New WTG

Site Data

Scale 1:20.000

Calculated Annual Energy for Wind Farm

WTG combination	Result [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) [MWh/y]	Park efficiency [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	69.914,3	62.922,8	74.004,5	94,5	34,2	12.584,6	2.996	7,5

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 5 new WTGs with total 21,0 MW rated power

Links	WTG type		Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator Name	Annual Energy		Park Efficiency [%]	Free mean wind speed [m/s]
	Valid	Manufact. Type-generator					Result [MWh]	Result-10,0% [MWh]		
1 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.962,2	12.566	95,74	7,40
2 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.949,7	12.555	95,60	7,40
3 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	13.658,5	12.293	92,08	7,48
4 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.266,6	12.840	95,43	7,52
5 A	Yes	ENERCON E-126 EP4-4.200	4.200	127,0	135,0	EMD Level 0 - official - 0 s - 4200kW - 08/2015	14.077,2	12.670	93,56	7,54

WTG siting

Dutch Stereo-RD/NAP 2008

X (east) Y (north) Z Row data/Description [m]

1 New	166.667	422.287	6,0	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (184)
2 New	167.177	422.251	4,9	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (185)
3 New	166.955	422.704	3,0	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (186)
4 New	166.519	422.958	2,9	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (187)
5 New	167.033	423.202	3,4	ENERCON E-126 EP4 4200 127,0	!O!	hub: 135,0 m (TOT: 198,5 m) (188)

Over Antea Group

Van stad tot land, van water tot lucht; de adviseurs en ingenieurs van Antea Group dragen in Nederland sinds jaar en dag bij aan onze leefomgeving. We ontwerpen bruggen en wegen, realiseren woonwijken en waterwerken. Maar we zijn ook betrokken bij thema's zoals milieu, veiligheid, assetmanagement en energie. Onder de naam Oranjewoud groeiden we uit tot een allround en onafhankelijk partner voor bedrijfsleven en overheden. Als Antea Group zetten we deze expertise ook mondiaal in. Door hoogwaardige kennis te combineren met een pragmatische aanpak maken we oplossingen haalbaar én uitvoerbaar. Doelgericht, met oog voor duurzaamheid. Op deze manier anticiperen we op de vragen van vandaag en de oplossingen van de toekomst. Al meer dan 60 jaar.

Contactgegevens

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