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Welbergweg 49
NL-7556 PE Hengelo
0031742489940

Calculated:
12-1-2018 10:59/3.1.617

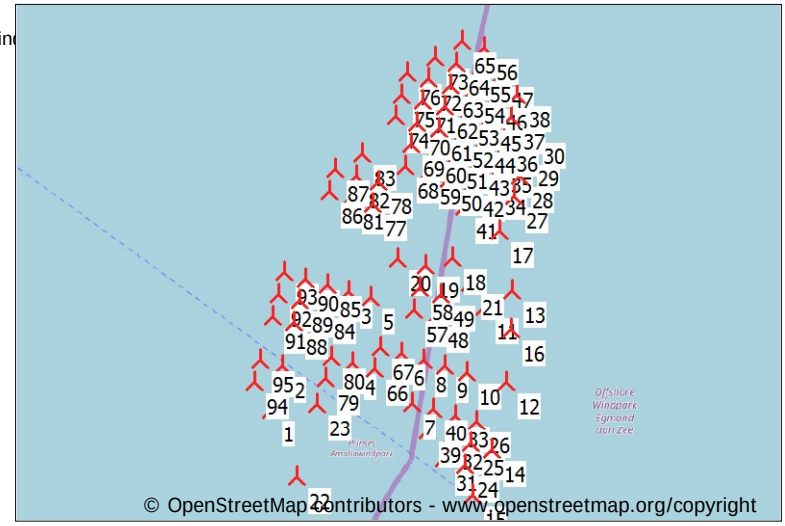
Loss&Uncertainty - Main result

Calculation: HKN 95x V164 HH 107m (met bestaande windparken)

Main data for PARK

PARK calculation 3.1.617: HKN 95x V164 HH 107m (met bestaande win

Count	95
Rated power	760,0 MW
Mean wind speed	9,6 m/s at hub height
Sensitivity	1,2 %AEP / %Mean Wind Speed
Expected lifetime	20 Years



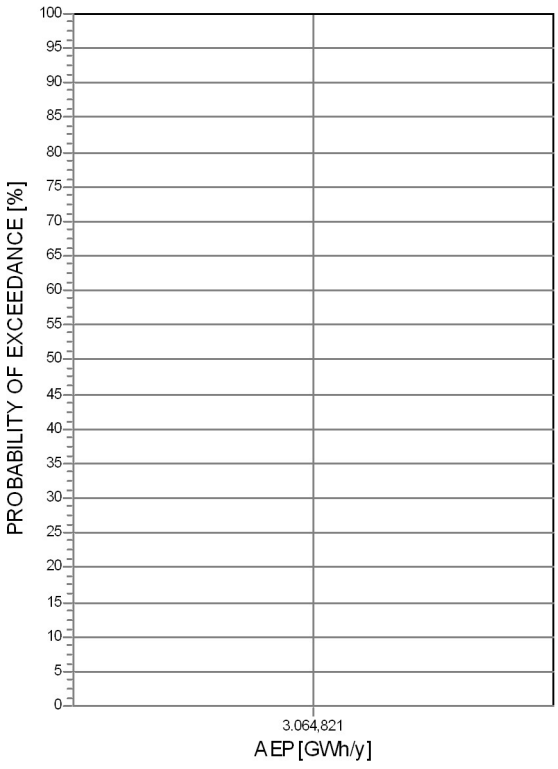
Scale: 400.000

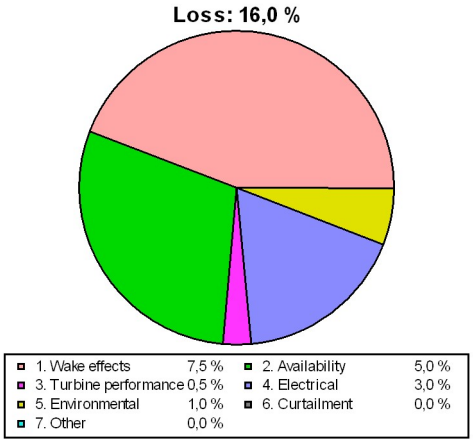
RESULTS

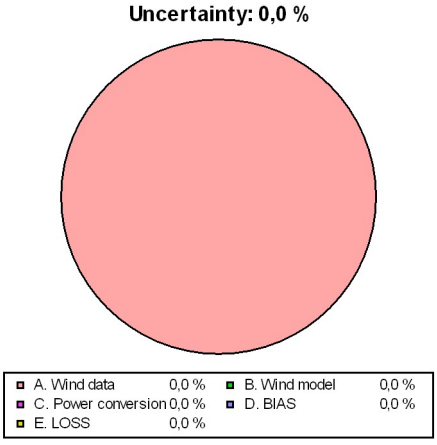
		P50
NET AEP	[GWh/y]	3.064,8
Capacity factor	[%]	46,0
Full load hours	[h/y]	4.033

Result details

	P50		Uncertainty
GROSS AEP *)	3.650,0 GWh/y		0,0 %
Bias correction	0,0 GWh/y	0,0 %	0,0 %
Loss correction	-585,2 GWh/y	-16,0 %	0,0 %
Wake loss		-7,5 %	
Other losses		-9,2 %	
NET AEP	3.064,8 GWh/y		0,0 %







*) Calculated Annual Energy Production before any bias or loss corrections
Assumptions: Uncertainty and percentiles (PXX values) are calculated for the expected lifetime

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Loss&Uncertainty - Assumptions and results

Calculation: HKN 95x V164 HH 107m (met bestaande windparken)

ASSUMPTIONS

LOSS

		Method *)	Loss [%]	Loss [GWh/y]	Std dev**) [%]	Comment
1.	Wake effects					
	Wake effects, all WTGs	Calculation	7,5	273,7	0,0	
2.	Availability					
	Turbine availability	Estimate	5,0	182,5	0,0	
3.	Turbine performance					
	High wind hysteresis	Estimate	0,5	18,2	0,0	
4.	Electrical					
	Electrical losses	Estimate	3,0	109,5	0,0	
5.	Environmental					
	Performance degradation not due to icing	Estimate	0,5	18,2	0,0	
	Performance degradation due to icing	Estimate	0,5	18,2	0,0	
6.	Curtailment					No input
7.	Other					No input
	LOSS, total		16,0	585,2	0,0	

UNCERTAINTY

		Method *)	Std dev, wind speed [%]	Std dev, AEP [%]	Comment
A.	Wind data				
	Wind measurement/Wind data				
	Long term correction				
	Year-to-year variability				
	Future climate				
	Other wind related				
B.	Wind model				
	Vertical extrapolation				
	Horizontal extrapolation				
	Other wind model related				
C.	Power conversion				
	Power curve uncertainty				
	Metering uncertainty				
	Other AEP related uncertainties				
D.	BIAS, total uncertainty			0,0	
E.	LOSS, total uncertainty			0,0	
	UNCERTAINTY, total (1y average)			0,0	
	UNCERTAINTY, total (20y average)			0,0	

VARIABILITY

Years	Variability (std dev) [%]	Total std dev [%]
1	0,00	0,0
5	0,00	0,0
10	0,00	0,0
20	0,00	0,0

RESULTS

AEP versus exceedance level / time horizon

PXX [%]	1 y [MWh/y]	5 y [MWh/y]	10 y [MWh/y]	20 y [MWh/y]
50	3.064.821	3.064.821	3.064.821	3.064.821
75	3.064.821	3.064.821	3.064.821	3.064.821
84	3.064.821	3.064.821	3.064.821	3.064.821
90	3.064.821	3.064.821	3.064.821	3.064.821
95	3.064.821	3.064.821	3.064.821	3.064.821

*) Calculation means that a calculation method available in the windPRO software is used. This still typically involve a user judgement and user data where the quality of those decides the accuracy. If calculation method is used, the values will often be different from turbine to turbine, here the average is shown, but at page "WTG results" the individual turbine results are shown.
**) For totals the std dev refers to the full AEP, otherwise std dev refers to the bias or loss component which is a fraction of the total AEP.

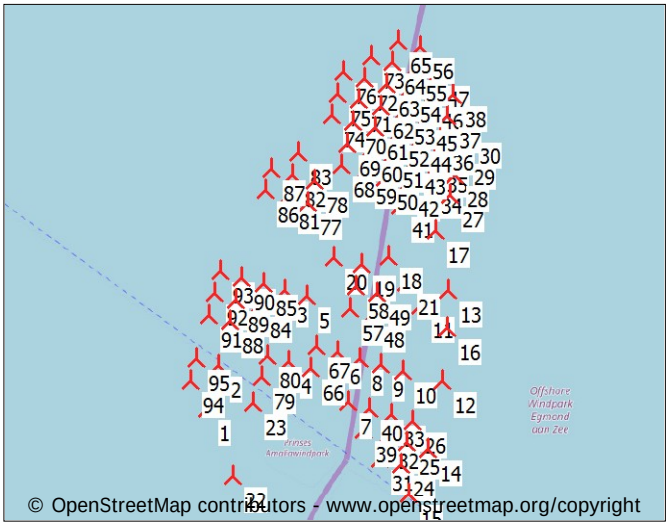
Loss&Uncertainty - WTG results

Calculation: HKN 95x V164 HH 107m (met bestaande windparken)

Main data for PARK

PARK calculation 3.1.617: HKN 95x V164 HH 107m (met bestaande windparken)

Count	95	
Rated power	760,0	MW
Mean wind speed	9,6	m/s at hub height
Sensitivity	1,2	%AEP / %Mean Wind Speed
Expected lifetime	20	Years



Scale: 400.000

Expected AEP per WTG including bias, loss and uncertainty evaluation

	Description	Calculated GROSS*) [MWh/y]	Bias [%]	20 years averaging Loss [%]	Unc. [%]	P50 [MWh/y]
	Layer: 86#8000kW VESTAS 24000m/48000m					
1	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (3)	38.380,8	0,0	12,5	0,0	33.564,8
2	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (4)	38.382,7	0,0	14,3	0,0	32.876,2
3	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (10)	38.396,7	0,0	15,8	0,0	32.345,5
4	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (13)	38.400,8	0,0	16,6	0,0	32.038,7
5	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (14)	38.405,1	0,0	15,5	0,0	32.459,7
6	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (18)	38.416,7	0,0	16,4	0,0	32.128,5
7	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (21)	38.425,5	0,0	16,1	0,0	32.222,9
8	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (22)	38.427,9	0,0	15,9	0,0	32.318,8
9	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (26)	38.436,1	0,0	15,7	0,0	32.392,5
10	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (29)	38.446,5	0,0	15,1	0,0	32.639,3
11	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (30)	38.452,9	0,0	14,8	0,0	32.749,0
12	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (33)	38.469,8	0,0	14,0	0,0	33.079,9
13	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (34)	38.471,7	0,0	14,1	0,0	33.062,9
14	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (35)	38.464,7	0,0	14,3	0,0	32.976,4
15	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (37)	38.459,2	0,0	12,1	0,0	33.798,2
24	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (32.1)	38.451,7	0,0	14,3	0,0	32.941,3
25	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (32.2)	38.455,1	0,0	16,2	0,0	32.223,5
26	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (32.3)	38.458,8	0,0	15,9	0,0	32.357,0
27	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (31.1)	38.456,6	0,0	15,5	0,0	32.506,2
28	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (31.2)	38.459,0	0,0	16,4	0,0	32.160,0
29	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (31.3)	38.462,8	0,0	16,4	0,0	32.153,5
30	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (31.4)	38.463,6	0,0	15,7	0,0	32.431,3
31	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (28.1)	38.443,1	0,0	14,9	0,0	32.713,1
32	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (28.2)	38.441,1	0,0	16,5	0,0	32.096,1
33	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (28.3)	38.447,1	0,0	16,7	0,0	32.043,8
34	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (27.1)	38.445,8	0,0	17,4	0,0	31.749,8
35	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (27.2)	38.449,4	0,0	18,4	0,0	31.391,7
36	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (27.3)	38.447,4	0,0	18,4	0,0	31.387,8
37	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (27.4)	38.450,8	0,0	17,6	0,0	31.671,7
38	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (27.5)	38.450,9	0,0	16,0	0,0	32.284,6
39	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (25.1)	38.433,1	0,0	16,3	0,0	32.152,8
40	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (25.2)	38.437,6	0,0	16,8	0,0	31.986,6
41	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (24.1)	38.432,9	0,0	16,0	0,0	32.295,1
42	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (24.2)	38.435,7	0,0	17,8	0,0	31.593,6
43	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (24.3)	38.434,5	0,0	19,1	0,0	31.095,0
44	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (24.4)	38.437,2	0,0	19,2	0,0	31.045,1
45	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (24.5)	38.438,1	0,0	19,2	0,0	31.066,1
46	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (24.6)	38.439,2	0,0	18,2	0,0	31.433,6
47	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (24.7)	38.437,4	0,0	16,3	0,0	32.165,4

To be continued on next page...

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Loss&Uncertainty - WTG results

Calculation: HKN 95x V164 HH 107m (met bestaande windparken)

...continued from previous page

	Description	Calculated GROSS*) [MWh/y]	Bias [%]	Loss [%]	20 years averaging Unc. [%]	P50 [MWh/y]
48	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (23.1)	38.430,2	0,0	16,1	0,0	32.242,7
49	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (23.2)	38.429,2	0,0	16,9	0,0	31.944,3
50	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (20.1)	38.425,0	0,0	17,7	0,0	31.619,5
51	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (20.2)	38.425,0	0,0	19,3	0,0	31.019,1
52	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (20.3)	38.427,0	0,0	19,5	0,0	30.929,0
53	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (20.4)	38.427,2	0,0	19,3	0,0	31.024,6
54	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (20.5)	38.425,3	0,0	18,6	0,0	31.275,9
55	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (20.6)	38.426,8	0,0	17,3	0,0	31.777,1
56	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (20.7)	38.424,2	0,0	15,0	0,0	32.661,6
57	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (19.1)	38.419,7	0,0	16,1	0,0	32.224,9
58	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (19.2)	38.420,8	0,0	16,4	0,0	32.121,6
59	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (17.1)	38.417,3	0,0	17,5	0,0	31.709,4
60	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (17.2)	38.417,6	0,0	18,9	0,0	31.153,0
61	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (17.3)	38.418,2	0,0	19,0	0,0	31.130,3
62	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (17.4)	38.417,3	0,0	18,7	0,0	31.247,3
63	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (17.5)	38.418,2	0,0	18,1	0,0	31.480,7
64	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (17.6)	38.418,6	0,0	16,9	0,0	31.926,0
65	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (17.7)	38.413,5	0,0	14,5	0,0	32.861,4
66	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (16.1)	38.408,0	0,0	16,4	0,0	32.103,7
67	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (16.2)	38.408,9	0,0	16,2	0,0	32.190,7
68	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (15.1)	38.407,2	0,0	16,9	0,0	31.909,9
69	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (15.2)	38.408,0	0,0	17,5	0,0	31.677,6
70	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (15.3)	38.410,5	0,0	17,8	0,0	31.570,8
71	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (15.4)	38.407,7	0,0	17,9	0,0	31.549,2
72	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (15.5)	38.409,2	0,0	17,0	0,0	31.872,5
73	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (15.6)	38.405,1	0,0	15,1	0,0	32.623,6
74	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (12.1)	38.400,5	0,0	15,4	0,0	32.469,2
75	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (12.2)	38.401,6	0,0	15,4	0,0	32.475,0
76	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (12.3)	38.397,2	0,0	14,3	0,0	32.909,0
77	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (11.1)	38.397,4	0,0	15,4	0,0	32.487,1
78	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (11.2)	38.400,0	0,0	16,3	0,0	32.135,9
79	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (9.1)	38.392,3	0,0	15,3	0,0	32.529,3
80	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (9.2)	38.395,3	0,0	15,6	0,0	32.409,2
81	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (8.1)	38.392,2	0,0	15,3	0,0	32.512,0
82	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (8.2)	38.393,5	0,0	16,1	0,0	32.194,0
83	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (8.3)	38.394,1	0,0	14,9	0,0	32.687,4
84	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (7.1)	38.391,5	0,0	16,2	0,0	32.166,4
85	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (7.2)	38.390,7	0,0	16,0	0,0	32.242,5
86	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (6.1)	38.386,3	0,0	13,8	0,0	33.098,2
87	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (6.2)	38.388,9	0,0	13,8	0,0	33.101,8
88	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (5.1)	38.383,2	0,0	15,0	0,0	32.627,9
89	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (5.2)	38.386,1	0,0	16,4	0,0	32.100,9
90	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (5.3)	38.385,4	0,0	15,4	0,0	32.468,7
91	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (2.1)	38.377,9	0,0	13,7	0,0	33.131,6
92	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (2.2)	38.380,5	0,0	14,3	0,0	32.882,1
93	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (2.3)	38.378,5	0,0	13,3	0,0	33.266,7
94	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (161)	38.378,9	0,0	12,6	0,0	33.557,0
95	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (162)	38.377,9	0,0	13,2	0,0	33.308,4
	Layer: 9 Vestas V164 extra					
16	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (38)	38.472,7	0,0	13,8	0,0	33.182,2
17	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (39)	38.456,5	0,0	14,3	0,0	32.943,1
18	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (40)	38.431,0	0,0	15,6	0,0	32.437,4
19	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (41)	38.422,3	0,0	16,2	0,0	32.207,9
20	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (42)	38.408,0	0,0	15,1	0,0	32.598,3
21	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (43)	38.444,4	0,0	15,6	0,0	32.462,2
22	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (44)	38.387,6	0,0	11,7	0,0	33.886,0
23	VESTAS V164-8.0MW 8000 164.0 !O! hub: 107,0 m (TOT: 189,0 m) (45)	38.390,5	0,0	14,3	0,0	32.898,6
	PARK	3.649.994,6	0,0	16,0	0,0	3.064.820,7