Project:
GB_Project

Description:
Demo from youtube (user: ReNewAbility Academy) using United Kingdom farm site

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Calculated:
2026-03-17 1:05 PM/4.2.285

PARK - Main Result

Calculation: 5 Old WTG and 2 New WTG

Wake Model N.O. Jensen (RISØ/EMD) Park 2 2018

Calculation performed in UTM (north)-WGS84 Zone: 30
At the site centre the difference between grid north and true north is: 1.1°

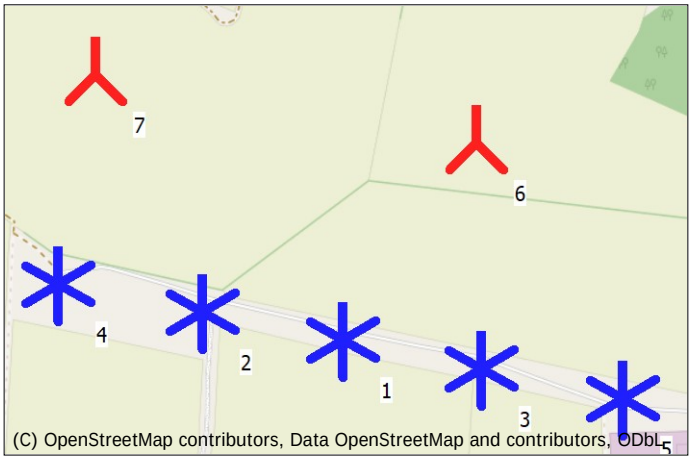
Power curve correction method
New windPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>
Air density calculation method
Height dependent, temperature from climate station
Station: OXFORD V4 2025
Base temperature: 10.1 °C at 91.1 m
Base pressure: 1013.3 hPa at 0.0 m
Air density for Site center in key hub height: 0.0 m + 50.0 m = 1.238 kg/m³ -> 101.0 % of Std
Relative humidity: 0.0 %

Wake Model Parameters
Wake decay constant 0.090 DTU default onshore
Hub height independent

Omnidirectional displacement height 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



Scale 1:10,000

New WTG Existing WTG

Resource file(s)

C:\Users\w0485009\2026_Winter_Cdrive\WindPRO\Week01\EMD-GASP_51.6209_-1.6540_20_20_0.siteres

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Wake loss [%]	Specific results¤) Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	65,963.1	69,522.3	5.1	43.5	9,423.3	3,813	7.4
New WTGs only	50,529.6	52,477.6	3.7	53.4	25,264.8	4,679	8.6
Existing park WTGs only	15,433.5	17,044.6	9.5	27.1	3,086.7	2,374	6.9
Existing park WTGs without new WTGs	16,007.0	17,044.6	6.1		3,201.4		
Reduction for existing park WTGs caused by new	573.5						

¤) Based on wake reduced results and any curtailments.

Calculated Annual Energy for each of 2 new WTGs with total 10.8 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 Result [MWh/y]	Wake loss [%]	Free mean wind speed [m/s]
6 A	Yes	VESTAS	V162-6.2-6,200	6,200	162.0	119.0	EMD	PO6200/PO6200-0S - 2024-10	27,182.3	5.0	8.46
7 A	No	ENERCON	E-160 EP5-4,600	4,600	160.0	119.9	EMD	Mode 00 - OM 0 s (4600 kW)	23,347.2	2.1	8.65

Annual Energy results includes shown losses. For expected NET AEP (expected sold production), see report Loss & Uncertainty.

Calculated Annual Energy for each of 5 existing park WTGs with total 6.5 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 Calculated prod. without new WTGs [MWh/y]	After New WTGs [MWh/y]	Decrease due to new WTGs [MWh %]	Wake loss [%]
1 A	No	BONUS	1.3 MW-1,300/250	1,300	62.0	50.0	EMD	Level 1 - calculated - - 08-2002	3,182.4	3,053.51	128.9 4.0	11.3
2 A	No	BONUS	1.3 MW-1,300/250	1,300	62.0	50.0	EMD	Level 1 - calculated - - 08-2002	3,235.6	3,095.08	140.5 4.3	10.7
3 A	No	BONUS	1.3 MW-1,300/250	1,300	62.0	50.0	EMD	Level 1 - calculated - - 08-2002	3,112.8	3,012.54	100.3 3.2	10.8
4 A	No	BONUS	1.3 MW-1,300/250	1,300	62.0	50.0	EMD	Level 1 - calculated - - 08-2002	3,435.3	3,319.70	115.6 3.4	5.4
5 A	No	BONUS	1.3 MW-1,300/250	1,300	62.0	50.0	EMD	Level 1 - calculated - - 08-2002	3,040.9	2,952.69	88.2 2.9	9.2

New WTGs refers to both new WTGs and existing WTGs that are not treated as Park WTG.

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PARK - Main Result

Calculation: 5 Old WTG and 2 New WTG

WTG siting

		British TM-OSGB36/Airy (GB/IE)			
		Easting	Northing	Z [m]	Row data/Description
1	Exist	424,115	191,390	109.3	BONUS 1.3 MW 1300-250 62.0 !O! hub: 50.0 m (TOT: 81.0 m) (1)
2	Exist	423,930	191,427	112.1	BONUS 1.3 MW 1300-250 62.0 !O! hub: 50.0 m (TOT: 81.0 m) (2)
3	Exist	424,300	191,353	107.9	BONUS 1.3 MW 1300-250 62.0 !O! hub: 50.0 m (TOT: 81.0 m) (3)
4	Exist	423,738	191,463	113.3	BONUS 1.3 MW 1300-250 62.0 !O! hub: 50.0 m (TOT: 81.0 m) (4)
5	Exist	424,488	191,315	106.0	BONUS 1.3 MW 1300-250 62.0 !O! hub: 50.0 m (TOT: 81.0 m) (5)
6	New	424,293	191,652	103.2	VESTAS V162-6.2 6200 162.0 !O! hub: 119.0 m (TOT: 200.0 m) (1)
7	New	423,787	191,740	113.4	ENERCON E-160 EP5 4600 160.0 !O! hub: 119.9 m (TOT: 199.9 m) (2)

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PARK - Reference WTGs

Calculation: 5 Old WTG and 2 New WTG

Wake Model N.O. Jensen (RISØ/EMD) Park 2 2018

Calculation performed in UTM (north)-WGS84 Zone: 30
At the site centre the difference between grid north and true north is: 1.1°

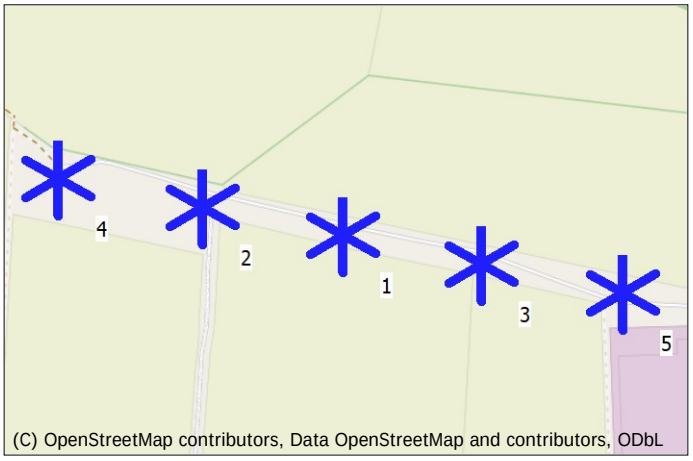
Power curve correction method
New windPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>
Air density calculation method
Height dependent, temperature from climate station
Station: OXFORD V4 2025
Base temperature: 10.1 °C at 91.1 m
Base pressure: 1013.3 hPa at 0.0 m
Air density for Site center in key hub height: 0.0 m + 50.0 m = 1.238 kg/m³ -> 101.0 % of Std
Relative humidity: 0.0 %

Wake Model Parameters
Wake decay constant 0.090 DTU default onshore
Hub height independent

Omnidirectional displacement height 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



Scale 1:10,000
New WTG Existing WTG

Resource file(s)

C:\Users\w0485009\2026_Winter_Cdrive\WindPRO\Week01\EMD-GASP_51.6209_-1.6540_20_20_0.siteres

Calculated Annual Energy for reference WTGs

			Specific results					
Calculated prod. without new WTGs	GROSS (no loss) Free WTGs	Wake loss	Capacity factor	Mean WTG result	Full load hours	Mean wind speed @hub height	Actual wind corrected energy	Goodness Factor
[MWh/y]	[MWh/y]	[%]	[%]	[MWh/y]	[Hours/year]	[m/s]	[MWh/y]	[%]
16,007.0	17,044.6	6.1	28.1	3,201.4	2,463	6.9	0.0	

Calculated Annual Energy for each of 5 reference WTGs with total 6.5 MW rated power

	Links	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Power curve Creator	Name	Calculated prod. without new WTGs	Goodness Factor
					[kW]	[m]	[m]			[MWh/y]	[%]
1	A	No	BONUS	1.3 MW-1,300/250	1,300	62.0	50.0	EMD	Level 1 - calculated - - 08-2002	3,182.4	0
2	A	No	BONUS	1.3 MW-1,300/250	1,300	62.0	50.0	EMD	Level 1 - calculated - - 08-2002	3,235.6	0
3	A	No	BONUS	1.3 MW-1,300/250	1,300	62.0	50.0	EMD	Level 1 - calculated - - 08-2002	3,112.8	0
4	A	No	BONUS	1.3 MW-1,300/250	1,300	62.0	50.0	EMD	Level 1 - calculated - - 08-2002	3,435.3	0
5	A	No	BONUS	1.3 MW-1,300/250	1,300	62.0	50.0	EMD	Level 1 - calculated - - 08-2002	3,040.9	0

WTG siting

British TM-OSGB36/Airy (GB/IE)

	Easting	Northing	Z [m]	Row data/Description	Production source	Statistical basis for normalized production: [Months]
1	424,115	191,390	109.3	BONUS 1.3 MW 1300-250 62.0 !O! hub: 50.0 m (TOT: 81.0 m) (1)		
2	423,930	191,427	112.1	BONUS 1.3 MW 1300-250 62.0 !O! hub: 50.0 m (TOT: 81.0 m) (2)		
3	424,300	191,353	107.9	BONUS 1.3 MW 1300-250 62.0 !O! hub: 50.0 m (TOT: 81.0 m) (3)		
4	423,738	191,463	113.3	BONUS 1.3 MW 1300-250 62.0 !O! hub: 50.0 m (TOT: 81.0 m) (4)		
5	424,488	191,315	106.0	BONUS 1.3 MW 1300-250 62.0 !O! hub: 50.0 m (TOT: 81.0 m) (5)		

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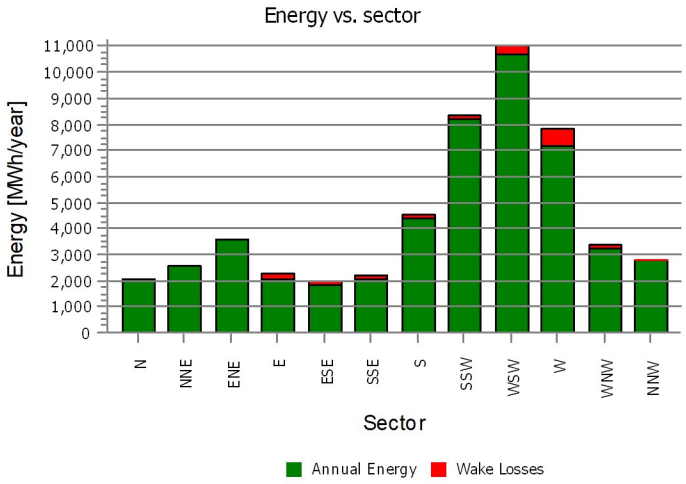
PARK - Production Analysis

Calculation: 5 Old WTG and 2 New WTG WTG: All new WTGs, Air density varies with WTG position 1.216 kg/m³ - 1.225 kg/m³

Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	2,080.5	2,583.7	3,558.5	2,289.4	1,937.4	2,177.0	4,546.7	8,355.1	11,035.7	7,816.3	3,338.6	2,758.6	52,477.6
-Decrease due to wake losses	[MWh]	0.0	0.0	0.0	210.1	131.7	137.4	164.5	197.2	332.9	645.6	128.8	0.0	1,948.1
Resulting energy	[MWh]	2,080.5	2,583.7	3,558.5	2,079.3	1,805.8	2,039.7	4,382.2	8,157.9	10,702.8	7,170.8	3,209.8	2,758.6	50,529.5
Specific energy	[kWh/m²]													1,241
Specific energy	[kWh/kW]													4,679
Decrease due to wake losses	[%]	0.0	0.0	0.0	9.2	6.8	6.3	3.6	2.4	3.0	8.3	3.9	0.0	3.71
Utilization	[%]	32.1	32.9	33.9	27.1	28.4	28.2	15.3	16.4	20.5	23.3	28.4	30.2	22.2
Operational	[Hours/year]	445	519	648	456	362	379	702	1,108	1,508	1,250	680	526	8,584
Full Load Equivalent	[Hours/year]	193	239	329	193	167	189	406	755	991	664	297	255	4,679



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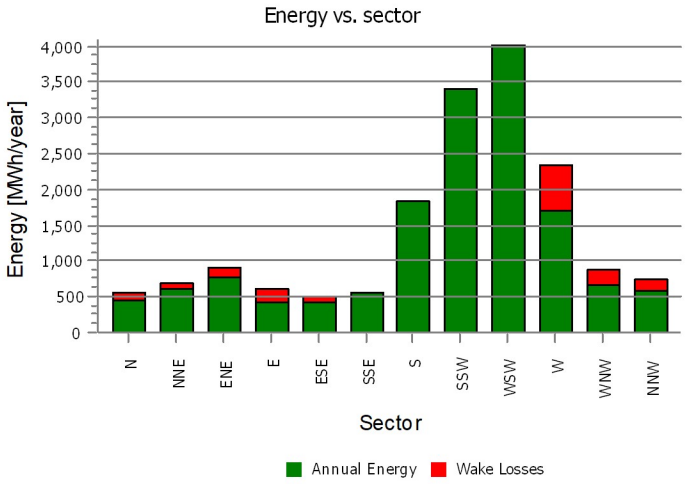
PARK - Production Analysis

Calculation: 5 Old WTG and 2 New WTG WTG: All existing WTGs, Air density varies with WTG position 1.216 kg/m³ - 1.225 kg/m³

Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	553.3	696.6	909.6	616.0	503.6	557.9	1,837.5	3,407.6	4,016.8	2,335.8	866.0	743.9	17,044.6
-Decrease due to wake losses	[MWh]	102.1	97.7	136.9	202.7	76.3	0.0	0.0	0.0	0.0	646.1	201.3	148.0	1,611.1
Resulting energy	[MWh]	451.1	599.0	772.8	413.3	427.4	557.9	1,837.5	3,407.6	4,016.8	1,689.7	664.7	595.9	15,433.5
Specific energy	[kWh/m²]													1,022
Specific energy	[kWh/kW]													2,374
Decrease due to wake losses	[%]	18.5	14.0	15.0	32.9	15.1	0.0	0.0	0.0	0.0	27.7	23.2	19.9	9.45
Utilization	[%]	31.6	34.2	35.6	25.4	33.0	39.4	25.1	26.8	31.4	25.5	27.8	30.5	28.9
Operational	[Hours/year]	387	457	567	389	307	329	614	980	1,316	1,074	583	454	7,457
Full Load Equivalent	[Hours/year]	69	92	119	64	66	86	283	524	618	260	102	92	2,374



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Calculated:
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PARK - Power Curve Analysis

Calculation: 5 Old WTG and 2 New WTG WTG: 6 - VESTAS V162-6.2 6200 162.0 !O!, Hub height: 119.0 m

Name: PO6200/PO6200-0S - 2024-10
Source: Vestas

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type	Generator type	Specific power kW/m²
2024-10-31	EMD	2021-09-28	2024-11-27	24.0	Pitch	User defined	Variable	0.30

Document no.: 0107-3707 V03
Datum: 2024-10-31

HP curve comparison - Note: For standard air density

Vmean	[m/s]	5	6	7	8	9	10
HP value Pitch, variable speed (2013)	[MWh]	10,466	15,919	21,177	25,852	29,785	32,927
VESTAS V162-6.2 6200 162.0 !O! PO6200/PO6200-0S - 2024-10	[MWh]	10,659	16,214	21,489	26,011	29,569	32,113
Check value	[%]	-2	-2	-1	-1	1	3

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see the windPRO manual.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

Original data, Air density: 1.225 kg/m³

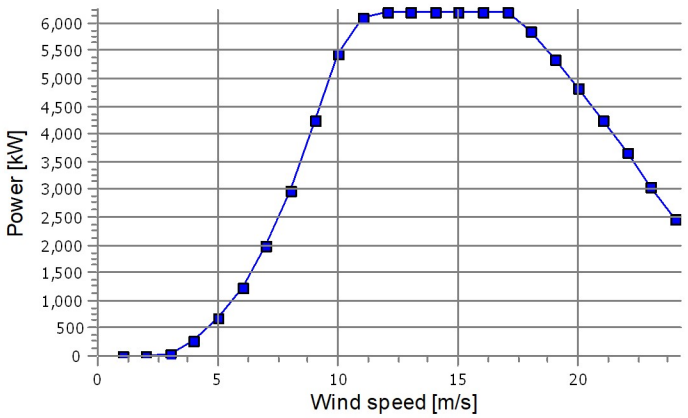
Wind speed [m/s]	Power [kW]	Cp	Wind speed [m/s]	Ct curve
3.0	34.0	0.10	3.0	0.91
3.5	150.0	0.28	3.5	0.88
4.0	292.0	0.36	4.0	0.85
4.5	467.0	0.41	4.5	0.84
5.0	676.0	0.43	5.0	0.82
5.5	927.0	0.44	5.5	0.81
6.0	1,229.0	0.45	6.0	0.81
6.5	1,584.0	0.46	6.5	0.81
7.0	2,000.0	0.46	7.0	0.81
7.5	2,476.0	0.46	7.5	0.80
8.0	3,017.0	0.47	8.0	0.80
8.5	3,626.0	0.47	8.5	0.79
9.0	4,284.0	0.47	9.0	0.78
9.5	4,917.0	0.45	9.5	0.72
10.0	5,483.0	0.43	10.0	0.66
10.5	5,882.0	0.40	10.5	0.58
11.0	6,114.0	0.36	11.0	0.50
11.5	6,176.0	0.32	11.5	0.43
12.0	6,197.0	0.28	12.0	0.37
12.5	6,200.0	0.25	12.5	0.32
13.0	6,200.0	0.22	13.0	0.28
13.5	6,200.0	0.20	13.5	0.25
14.0	6,200.0	0.18	14.0	0.22
14.5	6,200.0	0.16	14.5	0.20
15.0	6,200.0	0.15	15.0	0.18
15.5	6,200.0	0.13	15.5	0.16
16.0	6,200.0	0.12	16.0	0.15
16.5	6,200.0	0.11	16.5	0.14
17.0	6,186.0	0.10	17.0	0.12
17.5	6,077.0	0.09	17.5	0.11
18.0	5,853.0	0.08	18.0	0.10
18.5	5,590.0	0.07	18.5	0.09
19.0	5,348.0	0.06	19.0	0.08
19.5	5,095.0	0.05	19.5	0.07
20.0	4,825.0	0.05	20.0	0.06
20.5	4,538.0	0.04	20.5	0.05
21.0	4,251.0	0.04	21.0	0.05
21.5	3,954.0	0.03	21.5	0.04
22.0	3,664.0	0.03	22.0	0.04
22.5	3,367.0	0.02	22.5	0.03
23.0	3,064.0	0.02	23.0	0.03
23.5	2,763.0	0.02	23.5	0.03
24.0	2,451.0	0.01	24.0	0.02

Power, Efficiency and energy vs. wind speed

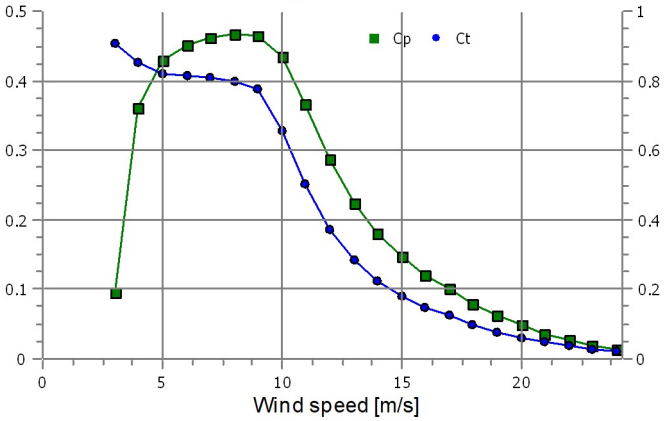
Data used in calculation, Air density: 1.217 kg/m³ New windPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Cp	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	0.0	0.00	0.50- 1.50	0.0	0.0	0.0
2.0	0.0	0.00	1.50- 2.50	0.0	0.0	0.0
3.0	32.4	0.10	2.50- 3.50	35.2	35.2	0.1
4.0	289.4	0.36	3.50- 4.50	182.2	217.5	0.8
5.0	671.2	0.43	4.50- 5.50	498.3	715.8	2.6
6.0	1,220.7	0.45	5.50- 6.50	1,015.8	1,731.5	6.4
7.0	1,986.7	0.46	6.50- 7.50	1,734.4	3,465.9	12.8
8.0	2,997.0	0.47	7.50- 8.50	2,581.5	6,047.5	22.2
9.0	4,254.2	0.47	8.50- 9.50	3,374.4	9,421.9	34.7
10.0	5,449.8	0.43	9.50-10.50	3,782.3	13,204.2	48.6
11.0	6,096.0	0.37	10.50-11.50	3,573.3	16,777.5	61.7
12.0	6,195.0	0.29	11.50-12.50	2,953.2	19,730.7	72.6
13.0	6,200.0	0.23	12.50-13.50	2,277.0	22,007.8	81.0
14.0	6,200.0	0.18	13.50-14.50	1,689.0	23,696.7	87.2
15.0	6,200.0	0.15	14.50-15.50	1,214.1	24,910.8	91.6
16.0	6,200.0	0.12	15.50-16.50	848.9	25,759.6	94.8
17.0	6,188.0	0.10	16.50-17.50	574.3	26,333.9	96.9
18.0	5,853.0	0.08	17.50-18.50	366.3	26,700.2	98.2
19.0	5,348.0	0.06	18.50-19.50	219.4	26,919.5	99.0
20.0	4,825.0	0.05	19.50-20.50	127.2	27,046.7	99.5
21.0	4,251.0	0.04	20.50-21.50	71.0	27,117.7	99.8
22.0	3,664.0	0.03	21.50-22.50	38.2	27,155.9	99.9
23.0	3,064.0	0.02	22.50-23.50	19.8	27,175.7	100.0
24.0	2,451.0	0.01	23.50-24.50	6.6	27,182.3	100.0

Power curve
For air density: 1.217 kg/m³ and reference climate data



Cp and Ct curve (only Cp is air density corrected)
For air density: 1.217 kg/m³ and reference climate data



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Calculated:
2026-03-17 1:05 PM/4.2.285

PARK - Wind Data Analysis

Calculation: 5 Old WTG and 2 New WTG Wind data: A - Resource file(s); Hub height: 119.0

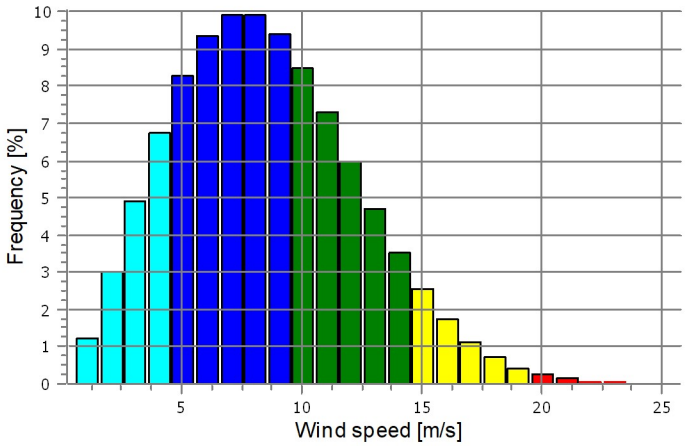
Site coordinates
British TM-OSGB36/Airy (GB/IE)
East: 424,293 North: 191,652
VESTAS V162-6.2 6200 162.0 !O! hub: 119.0 m (TOT: 200.0 m) (1)

Resource file
C:\Users\w0485009\2026_Winter_Cdrive\WindPRO\Week01\EMD-GASP_51.6209_-1.6540_20_20_0.siteres

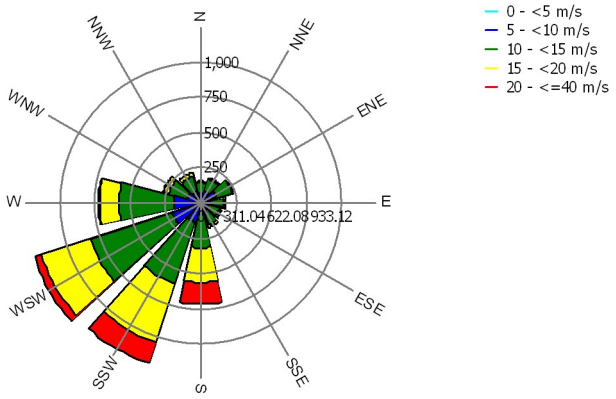
Weibull Data

Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	7.87	6.98	2.363	5.2
1 NNE	8.13	7.22	2.569	6.0
2 ENE	8.43	7.53	2.990	7.5
3 E	8.20	7.26	2.343	5.3
4 ESE	8.53	7.57	2.514	4.2
5 SSE	8.95	7.95	2.669	4.5
6 S	10.69	9.47	2.007	8.3
7 SSW	11.53	10.23	2.455	13.0
8 WSW	10.77	9.58	2.681	17.4
9 W	9.49	8.43	2.539	14.5
10 WNW	8.12	7.20	2.234	8.0
11 NNW	8.45	7.49	2.434	6.2
All	9.55	8.46	2.320	100.0

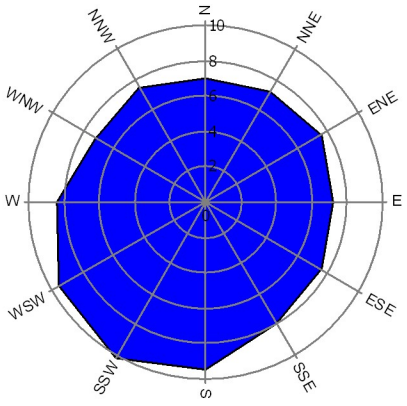
Weibull Distribution



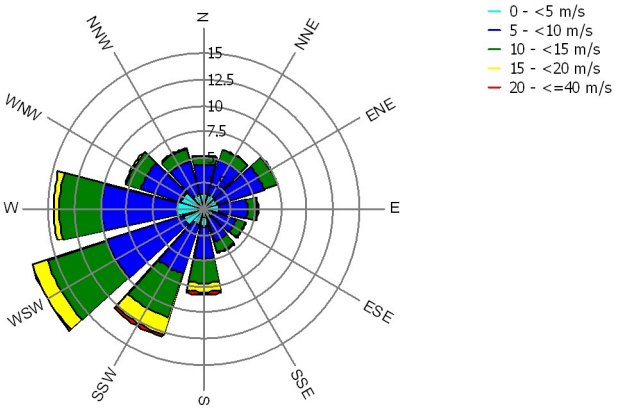
Energy Rose (kWh/m²/year)



Mean wind speed (m/s)



Frequency (%)



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Calculated:
2026-03-17 1:05 PM/4.2.285

PARK - Wind Data Analysis

Calculation: 5 Old WTG and 2 New WTG Wind data: A - Resource file(s); Hub height: 119.9

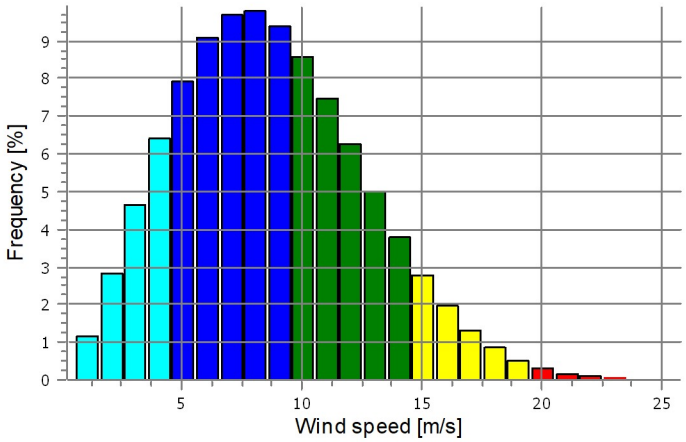
Site coordinates
British TM-OSGB36/Airy (GB/IE)
East: 423,787 North: 191,740
ENERCON E-160 EP5 4600 160.0 !O! hub: 119.9 m (TOT: 199.9 m) (2)

Resource file
C:\Users\w0485009\2026_Winter_Cdrive\WindPRO\Week01\EMD-GASP_51.6209_-1.6540_20_20_0.siteres

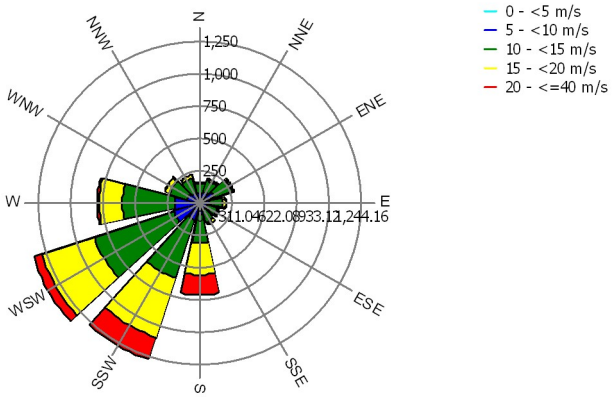
Weibull Data

Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	8.03	7.11	2.370	5.2
1 NNE	8.28	7.36	2.578	6.1
2 ENE	8.80	7.86	3.012	7.6
3 E	8.45	7.49	2.338	5.4
4 ESE	8.65	7.68	2.524	4.2
5 SSE	8.91	7.92	2.654	4.4
6 S	10.72	9.50	2.009	8.1
7 SSW	11.89	10.55	2.517	12.9
8 WSW	11.05	9.83	2.699	17.7
9 W	9.73	8.63	2.504	14.6
10 WNW	8.30	7.35	2.275	7.9
11 NNW	8.55	7.59	2.468	6.1
All	9.76	8.65	2.335	100.0

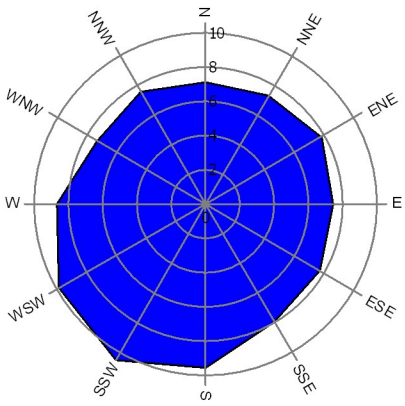
Weibull Distribution



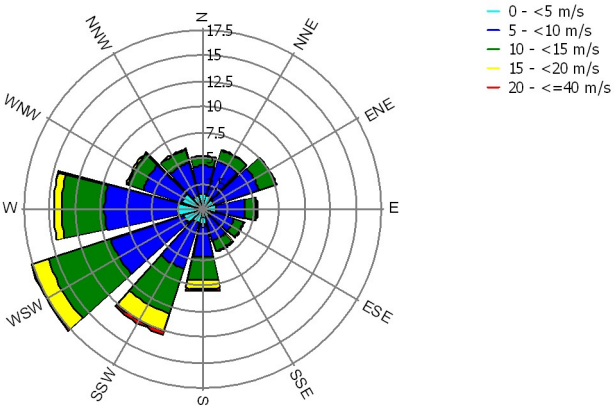
Energy Rose (kWh/m²/year)



Mean wind speed (m/s)



Frequency (%)



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Calculated:
2026-03-17 1:05 PM/4.2.285

PARK - Wind Data Analysis

Calculation: 5 Old WTG and 2 New WTG Wind data: A - Resource file(s); Hub height: 50.0

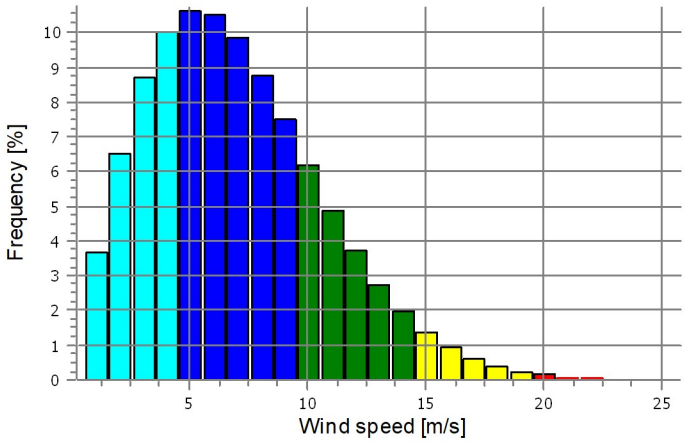
Site coordinates
British TM-OSGB36/Airy (GB/IE)
East: 424,115 North: 191,390
BONUS 1.3 MW 1300-250 62.0 !O! hub: 50.0 m (TOT: 81.0 m) (1)

Resource file
C:\Users\w0485009\2026_Winter_Cdrive\WindPRO\Week01\EMD-GASP_51.6209_-1.6540_20_20_0.siteres

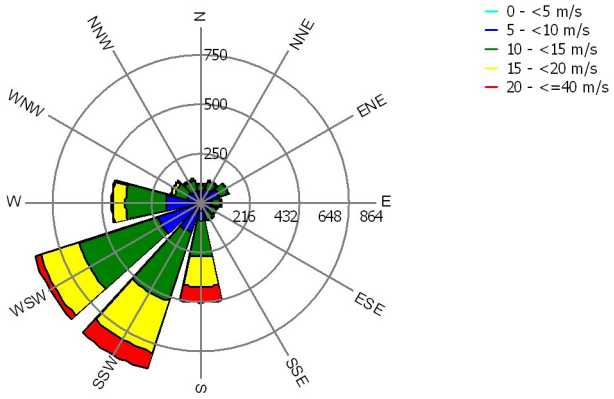
Weibull Data

Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]
0 N	6.27	5.57	1.891	5.2
1 NNE	6.55	5.80	2.065	6.2
2 ENE	6.86	6.08	2.461	7.6
3 E	6.53	5.80	1.916	5.2
4 ESE	6.69	5.92	2.047	4.1
5 SSE	6.82	6.04	2.133	4.4
6 S	9.14	8.12	1.818	8.2
7 SSW	9.96	8.82	2.146	13.2
8 WSW	9.14	8.10	2.246	17.7
9 W	7.61	6.74	2.039	14.4
10 WNW	6.16	5.50	1.715	7.7
11 NNW	6.62	5.87	1.951	6.0
All	7.82	6.94	1.913	100.0

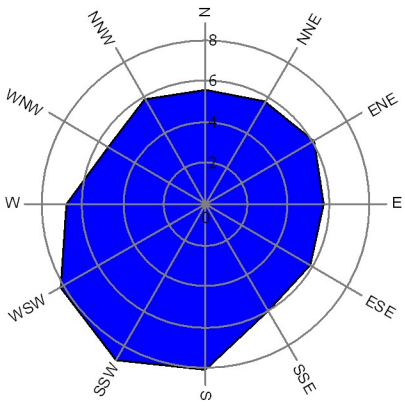
Weibull Distribution



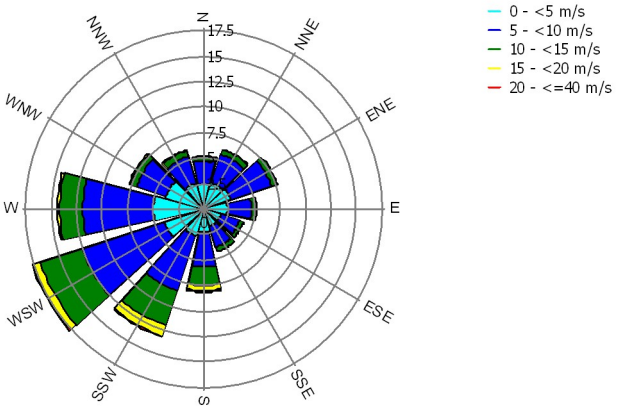
Energy Rose (kWh/m²/year)



Mean wind speed (m/s)



Frequency (%)



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Calculated:
2026-03-17 1:05 PM/4.2.285

PARK - Park power curve

Calculation: 5 Old WTG and 2 New WTG

Wind speed [m/s]	Power Free WTGs [kW]	Park WTGs [kW]	N [kW]	NNE [kW]	ENE [kW]	E [kW]	ESE [kW]	SSE [kW]	S [kW]	SSW [kW]	WSW [kW]	W [kW]	WNW [kW]	NNW [kW]
0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.5	42	40	42	42	42	9	25	42	42	42	42	42	42	42
3.5	429	377	395	403	402	299	362	403	406	413	412	297	343	386
4.5	1,262	1,098	1,150	1,181	1,185	921	1,033	1,121	1,136	1,175	1,174	908	1,042	1,132
5.5	2,521	2,224	2,321	2,378	2,385	1,874	2,098	2,274	2,302	2,371	2,371	1,863	2,114	2,288
6.5	4,297	3,807	3,980	4,070	4,080	3,231	3,606	3,874	3,922	4,038	4,036	3,223	3,647	3,931
7.5	6,646	5,913	6,179	6,307	6,315	5,074	5,629	6,004	6,071	6,240	6,229	5,063	5,695	6,111
8.5	9,478	8,514	8,858	9,017	9,017	7,413	8,204	8,690	8,757	8,944	8,904	7,388	8,244	8,776
9.5	12,418	11,405	11,729	11,899	11,896	10,209	11,178	11,748	11,789	11,925	11,857	10,056	11,067	11,658
10.5	14,768	13,969	14,166	14,316	14,319	12,850	13,806	14,416	14,433	14,498	14,453	12,689	13,599	14,117
11.5	16,098	15,597	15,679	15,789	15,800	14,571	15,418	16,022	16,031	16,053	16,053	14,606	15,273	15,651
12.5	16,770	16,443	16,543	16,604	16,614	15,641	16,322	16,758	16,760	16,765	16,768	15,682	16,233	16,533
13.5	17,100	16,915	17,006	17,032	17,040	16,416	16,855	17,098	17,099	17,100	17,100	16,429	16,812	17,005
14.5	17,235	17,151	17,205	17,214	17,217	16,905	17,128	17,235	17,235	17,235	17,235	16,907	17,112	17,206
15.5	17,280	17,250	17,273	17,275	17,276	17,160	17,244	17,280	17,280	17,280	17,280	17,160	17,240	17,273
16.5	17,295	17,286	17,293	17,293	17,294	17,260	17,285	17,295	17,295	17,295	17,295	17,260	17,283	17,293
17.5	17,177	17,207	17,177	17,177	17,177	17,168	17,175	17,218	17,221	17,220	17,235	17,234	17,197	17,177
18.5	16,690	16,750	16,690	16,690	16,690	16,688	16,691	16,769	16,775	16,774	16,802	16,802	16,730	16,690
19.5	16,195	16,250	16,195	16,195	16,195	16,195	16,197	16,266	16,272	16,271	16,296	16,296	16,230	16,195
20.5	15,638	15,696	15,638	15,638	15,638	15,638	15,640	15,715	15,721	15,720	15,747	15,742	15,674	15,638
21.5	15,054	15,110	15,054	15,054	15,054	15,054	15,056	15,131	15,137	15,136	15,163	15,149	15,086	15,054
22.5	9,867	9,907	9,867	9,867	9,867	9,867	9,869	9,941	9,947	9,945	9,971	9,877	9,867	9,867
23.5	9,263	9,302	9,263	9,263	9,263	9,263	9,265	9,335	9,341	9,340	9,365	9,273	9,263	9,263
24.5	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500
25.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Description:
The park power curve is similar to a WTG power curve, meaning that when a given wind speed appears in front of the park with same speed in the entire wind farm area (before influence from the park), the output from the park can be found in the park power curve. Another way to say this: The park power curve includes wake losses, but do NOT include terrain given variations in the wind speed over the park area.
Measuring a park power curve is not as simple as measuring a WTG power curve due to the fact that the park power curve depends on the wind direction and that the same wind speed normally will not appear for the entire park area at the same time (only in very flat non-complex terrain). The idea with this version of the park power curve is not to use it for validation based on measurements. This would require at least 2 measurement masts at two sides of the park, unless only a few direction sectors should be tested, AND non complex terrain (normally only useable off shore). Another park power curve version for complex terrain is available in windPRO.

The park power curve can be used for:

1. Forecast systems, based on more rough (approximated) wind data, the park power curve would be an efficient way to make the connection from wind speed (and direction) to power.
2. Construction of duration curves, telling how often a given power output will appear, the park power curve can be used together with the average wind distribution for the Wind farm area in hub height. The average wind distribution can eventually be obtained based on the Weibull parameters for each WTG position. These are found at print menu: >Result to file< in the >Park result< which can be saved to file or copied to clipboard and pasted in Excel.
3. Calculation of wind energy index based on the PARK production (see below).
4. Estimation of the expected PARK production for an existing wind farm based on wind measurements at minimum 2 measurement masts at two sides of wind farm. The masts must be used for obtaining the free wind speed. The free wind speed is used in the simulation of expected energy production with the PARK power curve. This procedure will only work suitable in non complex terrains. For complex terrain another park power curve calculation is available in windPRO (PPV-model).

Note:
From the >Result to file< the >Wind Speeds Inside Wind farm< is also available. These can (e.g. via Excel) be used for extracting the wake induced reductions in measured wind speed.

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PARK - Costs

Calculation: 5 Old WTG and 2 New WTG

Cost model: Wind Onshore mid end cost

	Cost	Unit	Cost index	Replace every [years]	Park cost [GBP]	Cost per WTG [GBP]	Cost per MW [GBP]	Cost per MWh [GBP]	Percent of all [%]
Development Expenditures									
Development	2.50	% of CAPEX		0	383,386	191,693	35,499	0.38	1.6
Permitting, EIA etc.	1.00	% of CAPEX		0	153,355	76,677	14,199	0.15	0.6
Capital Expenditures									
Turbines	1.00	Factor	No in-/decrease	0	9,342,624	4,671,312	865,058	9.24	39.0
Foundations	1.00	Factor	No in-/decrease	0	889,091	444,545	82,323	0.88	3.7
Internal roads	1.00	Factor	No in-/decrease	0	151,067	75,533	13,988	0.15	0.6
Internal grid	1.00	Factor	No in-/decrease	0	143,580	71,790	13,294	0.14	0.6
Turbine transport	35.29	kGBP/MW	No in-/decrease	0	453,688	226,844	42,008	0.45	1.9
Turbine installation	35.29	kGBP/MW	No in-/decrease	0	453,688	226,844	42,008	0.45	1.9
Crane pads	21.18	kGBP/MW	No in-/decrease	0	272,213	136,106	25,205	0.27	1.1
Main grid	52.94	kGBP/MW	No in-/decrease	0	680,532	340,266	63,012	0.67	2.8
Land purchase	70.59	kGBP/MW	No in-/decrease	0	907,376	453,688	84,016	0.90	3.8
Neighbour compensation	52.94	kGBP/MW	No in-/decrease	0	680,532	340,266	63,012	0.67	2.8
Purchase of old WTGs	52.94	kGBP/MW	No in-/decrease	0	680,532	340,266	63,012	0.67	2.8
Finance cost	17.65	kGBP/MW	No in-/decrease	0	226,844	113,422	21,004	0.22	0.9
Contingencies	35.29	kGBP/MW	No in-/decrease	0	453,688	226,844	42,008	0.45	1.9
Insurances	0.00	kGBP/MW	No in-/decrease	0	0	0	0	0.00	0.0
Operating Expenditures									
Service, per MW	9,882.23	GBP/MW	No in-/decrease		2,540,653	1,270,326	235,246	2.51	10.6
Service, per MWh	1.06	GBP/MWh	No in-/decrease		1,273,592	636,796	117,925	1.26	5.3
Land rent, per MW	4,941.12	GBP/MW	No in-/decrease		1,270,326	635,163	117,623	1.26	5.3
Land rent, per MWh	0.35	GBP/MWh	No in-/decrease		424,531	212,265	39,308	0.42	1.8
Other, per MW	4,941.12	GBP/MW	No in-/decrease		1,270,326	635,163	117,623	1.26	5.3
Other, per MWh	0.35	GBP/MWh	No in-/decrease		424,531	212,265	39,308	0.42	1.8
Abandonment Expenditures									
Abandonment	70.59	kGBP/MW	No in-/decrease		907,376	453,688	84,016	0.90	3.8
Total					23,983,530	11,991,765	2,220,697	23.73	100.0

COE	23.73	GBP/MWh
LCOE	27.98	GBP/MWh

Cost model input

	Value	Unit
Discount rate	2.5	%
Number of WTGs	2	
Energy yield	50,530	MWh
Cap. factor	53.4	%
Total rated power	10.8	MW
Cabling length	514	m
Road length	514	m
Operation years	20	
Project start year	2027	

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Calculated:
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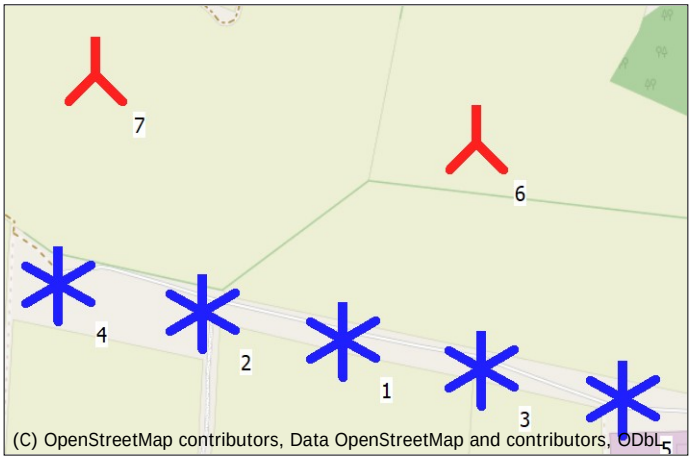
PARK - WTG distances

Calculation: 5 Old WTG and 2 New WTG

WTG distances

	Z [m]	Nearest WTG	Z [m]	Horizontal distance [m]	Distance in rotor diameters (max)	Distance in rotor diameters (min)
1	109.3	3	107.9	189	3.0	3.0
2	112.1	1	109.3	189	3.0	3.0
3	107.9	1	109.3	189	3.0	3.0
4	113.3	2	112.1	195	3.1	3.1
5	106.0	3	107.9	191	3.1	3.1
6	103.2	3	107.9	299	4.8	1.8
7	113.4	4	113.3	282	4.5	1.8
Min	103.2		107.9	189	3.0	1.8
Max	113.4		113.3	299	4.8	3.1



Scale 1:10,000

New WTG Existing WTG

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Calculated:
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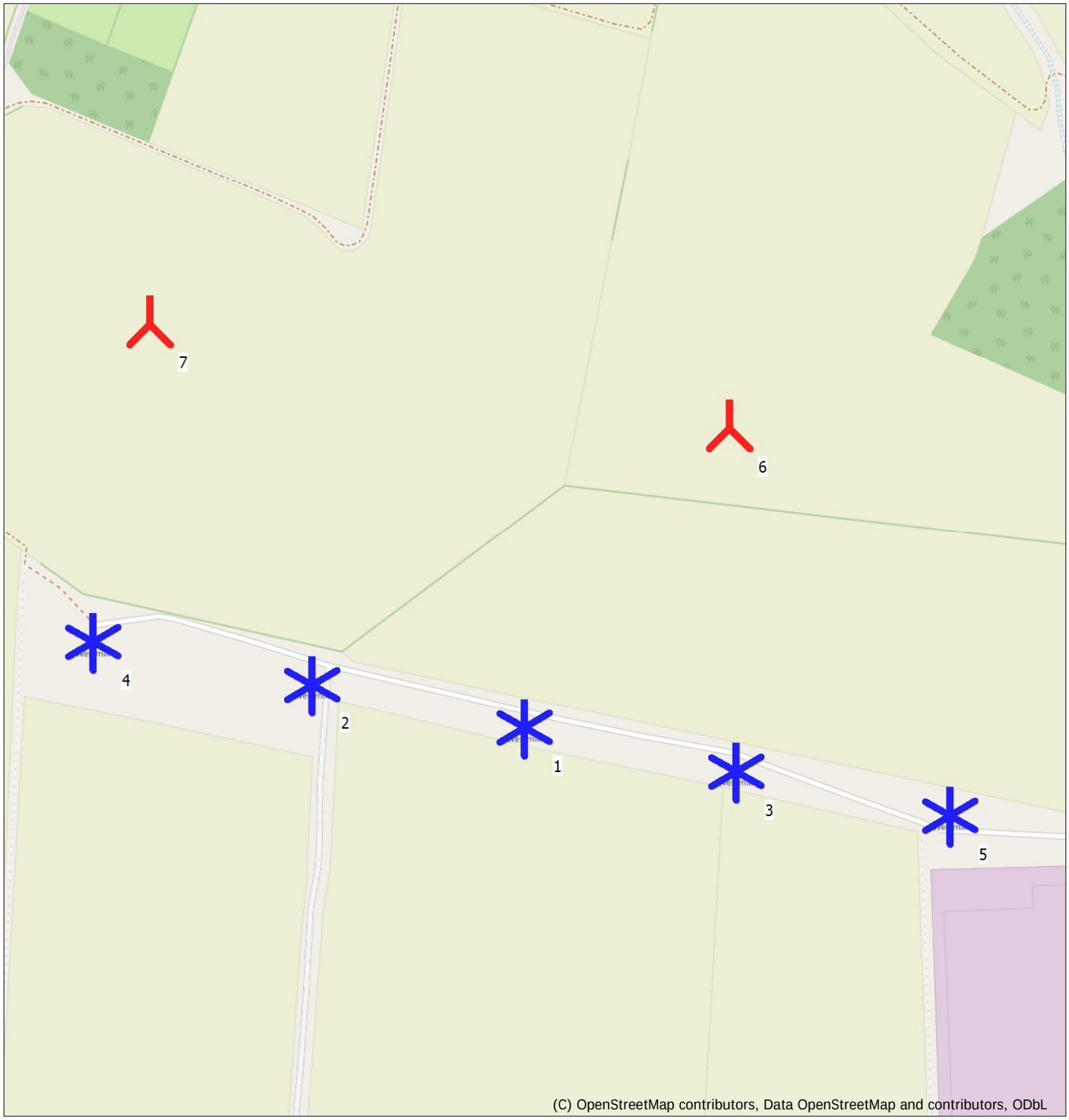
PARK - Map

Calculation: 5 Old WTG and 2 New WTG



Map: EMD OpenStreetMap , Print scale 1:5,000, Map center British TM-OSGB36/Airy (GB/IE) East: 424,113 North: 191,527

New WTG Existing WTG