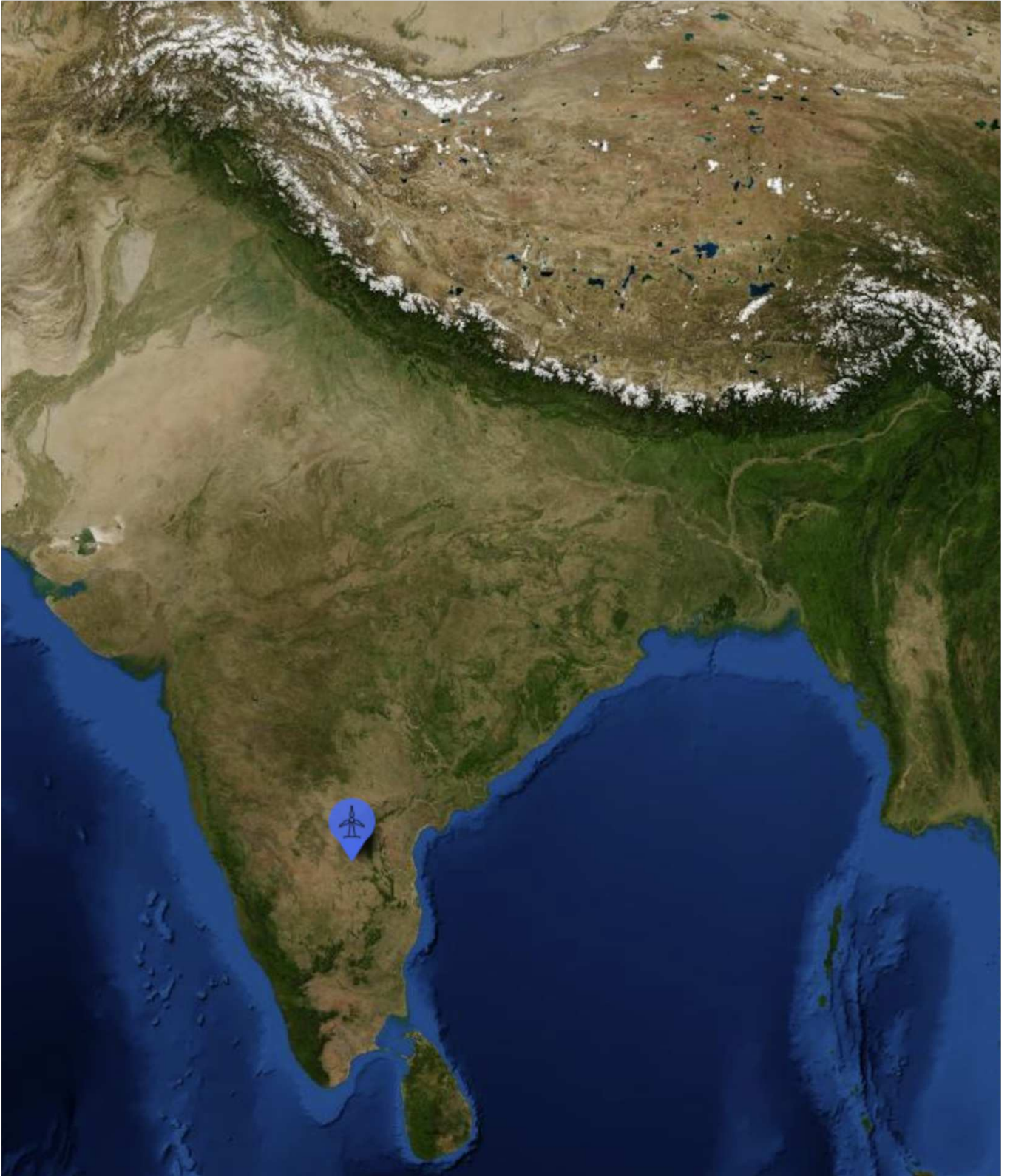


Yield Assessment - Proddatur, Andhra Pradesh



Project:

Site Analysis contract 81274134

Description:

Preliminary energy yield assessment based on meso-scale data. Consult with expert prior to investment decision. This report extract is subject to confidentiality and liability limitation clause of the main report.

Licensed user:

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Mathias Thamhain / mth@emd.dk

Calculated:

27/2/2022 18:34/3.5.508

PARK - Main Result

Calculation: 22-459-010 Proddatur AP

Setup

AEP scaled to a full year based on number of samples
Scaling factor from 20,0 years to 1 year: 0,050

Calculation performed in UTM (north)-WGS84 Zone: 44

At the site centre the difference between grid north and true north is: -0,7°

Wake

Wake Model: N.O. Jensen (RISØ/EMD)

Wake decay constant

Wake decay constant: 0,075 DTU default onshore

Reference WTG: 4*VESTAS V150-4.2 4200 150,0 IO! hub: 105,0 m (TOT: 180,0 m) dist: 750 m (5,0 RD)

Scaler / wind data

Name EMD Default Measurement Mast Scaler

Terrain scaling Measured Data Scaling (WASP Stability / A-Parameter)

Micro terrain flow model WASP IBZ from Site Data

Used period 1/1/2002 04:30:00 - 1/1/2022 04:30:00

Meteo object(s) EmdWrf_N14.901_E078.220 - AP

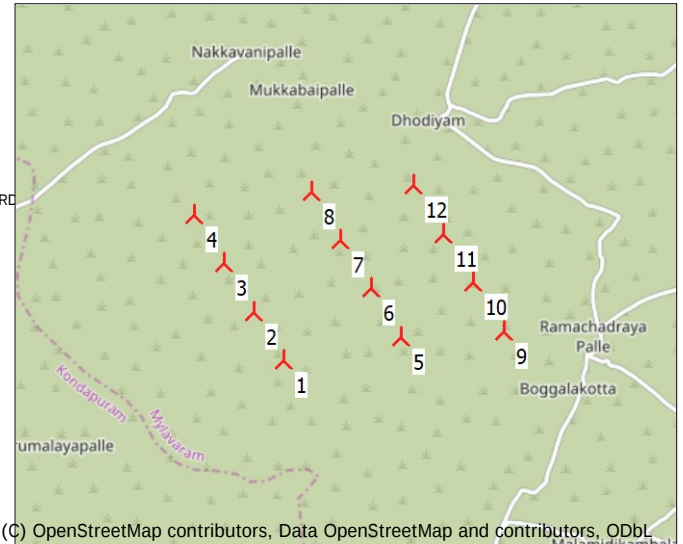
Displacement height Omnidirectional from objects

WASP version WASP 11 Version 11.06.0028

Power correction

Power curve correction (adjusted IEC method, improved to match turbine control)

	Min	Max	Avg	Corr.	Neg. corr.	Pos. corr.
				[%]	[%]	[%]
Air density						
From air density settings	[°C]	22,4	22,9	22,7		
From air density settings	[hPa]	959,4	968,6	963,9		
Resulting air density	[kg/m³]	1,131	1,140	1,135		
Relative to 15°C at sea level	[%]	92,3	93,0	92,7	-3,3	-3,3
						0,0



New WTG

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK	Result-8,0%	GROSS (no loss) Free WTGs	Wake loss	Specific results ^{a)}		Full load hours	Wind speed	
					Capacity factor	Mean WTG result		free	wake reduced
	[MWh/y]	[MWh/y]	[MWh/y]	[%]	[%]	[MWh/y]	[Hours/year]	[m/s]	[m/s]
Wind farm	221.368,4	203.658,9	229.907,4	3,7	46,1	16.971,6	4.041	7,9	7,8

a) Based on Result-8,0%

Calculated Annual Energy for each of 12 new WTGs with total 50,4 MW rated power

WTG type	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy		Wake loss [%]	Wind speed	
									Result	Result-8,0%		free	reduced
									[MWh/y]	[MWh/y]		[m/s]	[m/s]
1 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019		19.099,5	17.572	1,4	8,00	7,93
2 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019		18.817,3	17.312	3,2	8,06	7,92
3 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019		18.642,0	17.151	3,9	8,05	7,87
4 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019		18.886,4	17.375	4,0	8,14	7,97
5 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019		18.200,1	16.744	3,6	7,84	7,67
6 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019		18.286,8	16.824	5,2	7,96	7,71
7 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019		17.753,7	16.333	5,7	7,81	7,55
8 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019		17.767,3	16.346	5,1	7,77	7,55
9 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019		18.057,6	16.613	2,5	7,72	7,60
10 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019		18.365,0	16.896	3,6	7,90	7,72
11 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019		18.828,2	17.322	3,5	8,06	7,87
12 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019		18.664,4	17.171	2,8	7,95	7,80

WTG siting

	Geo [deg]-WGS84		Z [m]	Row data/Description	Calculation period	
	Longitude	Latitude			Start	End
1 New	78,209610° E	14,900829° N	369,3	-31,7°, 750,0 m	1/1/2002	1/1/2022
2 New	78,205940° E	14,906586° N	368,5		1/1/2002	1/1/2022
3 New	78,202269° E	14,912342° N	365,9		1/1/2002	1/1/2022
4 New	78,198598° E	14,918099° N	369,7		1/1/2002	1/1/2022
5 New	78,223929° E	14,903579° N	316,7	-31,7°, 750,0 m	1/1/2002	1/1/2022
6 New	78,220259° E	14,909335° N	330,0		1/1/2002	1/1/2022
7 New	78,216588° E	14,915092° N	318,0		1/1/2002	1/1/2022
8 New	78,212917° E	14,920849° N	311,5		1/1/2002	1/1/2022
9 New	78,236532° E	14,904338° N	287,1	-31,7°, 750,0 m	1/1/2002	1/1/2022
10 New	78,232862° E	14,910094° N	302,2		1/1/2002	1/1/2022
11 New	78,229191° E	14,915851° N	311,0		1/1/2002	1/1/2022
12 New	78,225520° E	14,921608° N	302,2		1/1/2002	1/1/2022

Project:

Site Analysis contract 81274134

Description:

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Calculated:

27/2/2022 18:34/3.5.508

PARK - Wind Data Analysis

Calculation: 22-459-010 Proddatur APWind data: 1 - 4*VESTAS V150-4.2 4200 150.0 !O! hub: 105,0 m (TOT: 180,0 m) dist: 750 m (5,0 RD) angle: -32° (43); Hub height: 105,0

Site coordinates

Geo WGS84

East: 78,209610° E North: 14,900829° N

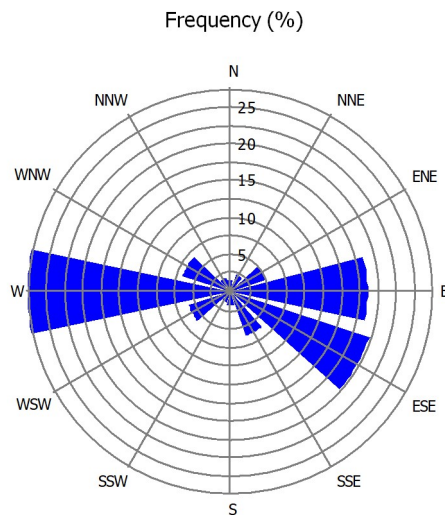
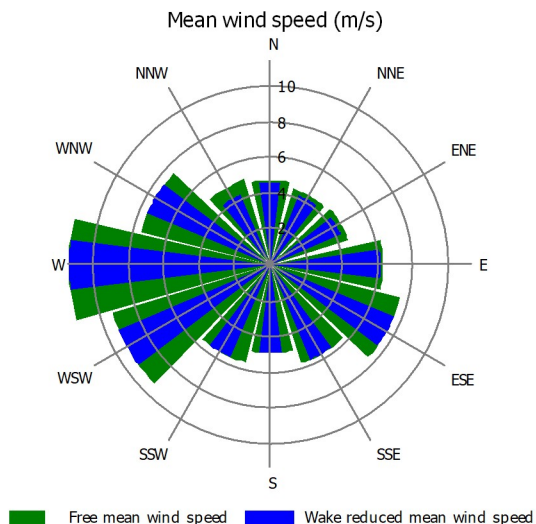
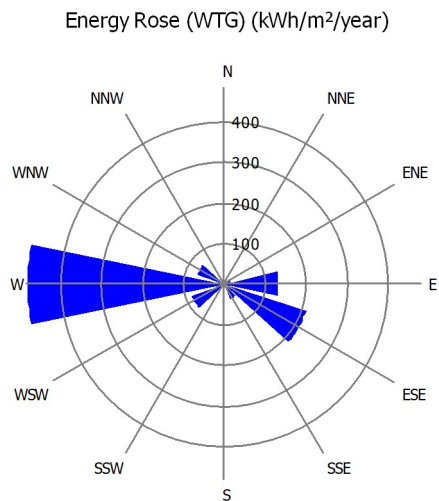
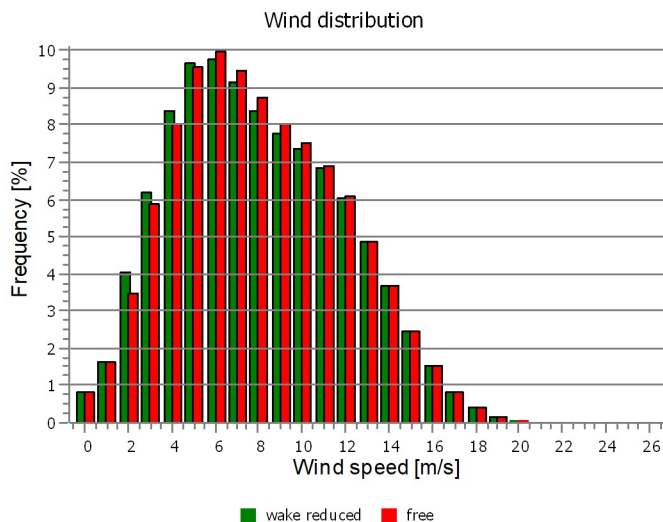
4*VESTAS V150-4.2 4200 150.0 !O! hub: 105,0 m (TOT: 180,0 m) dist: 750 m (5,0 RD) angle: -32° (43)

Masts used

Take nearest

Winddata for site

Sector	Free mean wind speed [m/s]	Wake reduced mean wind speed [m/s]	Frequency [%]	
0 N	4,8	4,7	1,7	
1 NNE	4,5	4,2	2,4	
2 ENE	4,6	4,3	5,0	
3 E	6,4	6,2	18,7	
4 ESE	7,6	7,6	19,9	
5 SSE	5,8	5,8	6,4	
6 S	5,0	5,0	1,9	
7 SSW	5,7	5,7	1,6	
8 WSW	9,4	9,4	5,9	
9 W	11,4	11,4	27,6	
10 WNW	7,6	7,6	6,8	
11 NNW	5,0	4,3	2,0	
All	8,0	7,9	100,0	



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Calculated:

27/2/2022 18:34/3.5.508

PARK - Time varying AEP

Calculation: 22-459-010 Proddatur AP

Windfarm: 50,4 MW based on 12 turbines of type VESTAS V150-4.2 4200 150.0 !O!.

Selection: All new WTGs

Calculated mean yield per month and hour [MWh]. The result includes wake losses and any curtailment losses.

Values are scaled to a full year, see correction factors at main result page.

Hour/Month [MWh]	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
0	1.011	1.010	1.149	992	1.163	1.363	1.425	1.366	1.061	614	555	763	12.472
1	777	807	943	850	1.153	1.380	1.426	1.399	1.060	574	398	569	11.335
2	582	585	711	711	1.135	1.397	1.449	1.422	1.112	521	291	423	10.338
3	451	443	547	554	1.077	1.374	1.442	1.408	1.096	486	226	309	9.415
4	362	387	477	563	1.078	1.362	1.426	1.385	1.060	445	189	228	8.961
5	318	340	453	572	1.047	1.319	1.385	1.351	1.054	429	178	212	8.658
6	255	291	356	514	1.031	1.272	1.387	1.354	1.026	403	163	164	8.216
7	165	172	210	377	1.006	1.257	1.335	1.288	921	332	121	111	7.294
8	104	109	167	323	969	1.295	1.386	1.322	933	308	115	93	7.124
9	136	124	148	249	862	1.267	1.383	1.321	900	300	132	121	6.946
10	175	154	159	181	677	1.161	1.324	1.244	814	282	192	173	6.537
11	216	197	180	109	565	1.081	1.254	1.173	740	272	249	235	6.271
12	241	253	232	117	442	1.015	1.216	1.103	668	271	290	286	6.135
13	294	306	291	148	399	985	1.192	1.100	681	309	342	324	6.371
14	334	349	351	200	389	974	1.185	1.099	686	327	354	358	6.606
15	311	333	370	235	389	955	1.150	1.073	659	336	365	374	6.551
16	376	412	431	338	460	968	1.172	1.062	672	400	390	405	7.086
17	482	491	536	451	488	1.026	1.217	1.092	669	431	485	493	7.861
18	800	785	824	640	565	1.082	1.276	1.131	766	555	643	771	9.840
19	1.108	1.077	1.146	893	720	1.168	1.329	1.201	868	664	834	1.000	12.007
20	1.269	1.230	1.297	1.038	897	1.292	1.383	1.277	953	711	903	1.109	13.361
21	1.322	1.288	1.377	1.130	1.052	1.345	1.427	1.348	1.029	768	916	1.168	14.169
22	1.320	1.275	1.375	1.167	1.152	1.371	1.427	1.367	1.071	779	855	1.105	14.264
23	1.189	1.185	1.286	1.115	1.204	1.362	1.413	1.365	1.054	695	718	967	13.552
Grand Total	13.598	13.604	15.018	13.467	19.920	29.073	32.011	30.251	21.550	11.214	9.903	11.761	221.368

Hour/Month [MW]	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
0	32,6	36,1	37,1	33,1	37,5	45,4	46,0	44,1	35,4	19,8	18,5	24,6	34,2
1	25,1	28,8	30,4	28,3	37,2	46,0	46,0	45,1	35,3	18,5	13,3	18,3	31,1
2	18,8	20,9	22,9	23,7	36,6	46,6	46,7	45,9	37,1	16,8	9,7	13,6	28,3
3	14,5	15,8	17,6	18,5	34,7	45,8	46,5	45,4	36,5	15,7	7,5	10,0	25,8
4	11,7	13,8	15,4	18,8	34,8	45,4	46,0	44,7	35,3	14,3	6,3	7,3	24,6
5	10,3	12,1	14,6	19,1	33,8	44,0	44,7	43,6	35,1	13,8	5,9	6,8	23,7
6	8,2	10,4	11,5	17,1	33,3	42,4	44,7	43,7	34,2	13,0	5,4	5,3	22,5
7	5,3	6,1	6,8	12,6	32,4	41,9	43,1	41,5	30,7	10,7	4,0	3,6	20,0
8	3,4	3,9	5,4	10,8	31,3	43,2	44,7	42,6	31,1	9,9	3,8	3,0	19,5
9	4,4	4,4	4,8	8,3	27,8	42,2	44,6	42,6	30,0	9,7	4,4	3,9	19,0
10	5,7	5,5	5,1	6,0	21,9	38,7	42,7	40,1	27,1	9,1	6,4	5,6	17,9
11	7,0	7,0	5,8	3,6	18,2	36,0	40,5	37,8	24,7	8,8	8,3	7,6	17,2
12	7,8	9,0	7,5	3,9	14,3	33,8	39,2	35,6	22,3	8,8	9,7	9,2	16,8
13	9,5	10,9	9,4	4,9	12,9	32,8	38,5	35,5	22,7	10,0	11,4	10,4	17,5
14	10,8	12,5	11,3	6,7	12,5	32,5	38,2	35,5	22,9	10,5	11,8	11,6	18,1
15	10,0	11,9	11,9	7,8	12,5	31,8	37,1	34,6	22,0	10,8	12,2	12,1	17,9
16	12,1	14,7	13,9	11,3	14,8	32,3	37,8	34,2	22,4	12,9	13,0	13,1	19,4
17	15,5	17,5	17,3	15,0	15,7	34,2	39,2	35,2	22,3	13,9	16,2	15,9	21,5
18	25,8	28,1	26,6	21,3	18,2	36,1	41,2	36,5	25,5	17,9	21,4	24,9	27,0
19	35,7	38,5	37,0	29,8	23,2	38,9	42,9	38,7	28,9	21,4	27,8	32,3	32,9
20	40,9	43,9	41,8	34,6	28,9	43,1	44,6	41,2	31,8	23,0	30,1	35,8	36,6
21	42,6	46,0	44,4	37,7	33,9	44,8	46,0	43,5	34,3	24,8	30,5	37,7	38,8
22	42,6	45,5	44,4	38,9	37,2	45,7	46,0	44,1	35,7	25,1	28,5	35,6	39,1
23	38,3	42,3	41,5	37,2	38,8	45,4	45,6	44,0	35,1	22,4	23,9	31,2	37,1
Grand Total	18,3	20,2	20,2	18,7	26,8	40,4	43,0	40,7	29,9	15,1	13,8	15,8	25,3

PARK - Time varying AEP

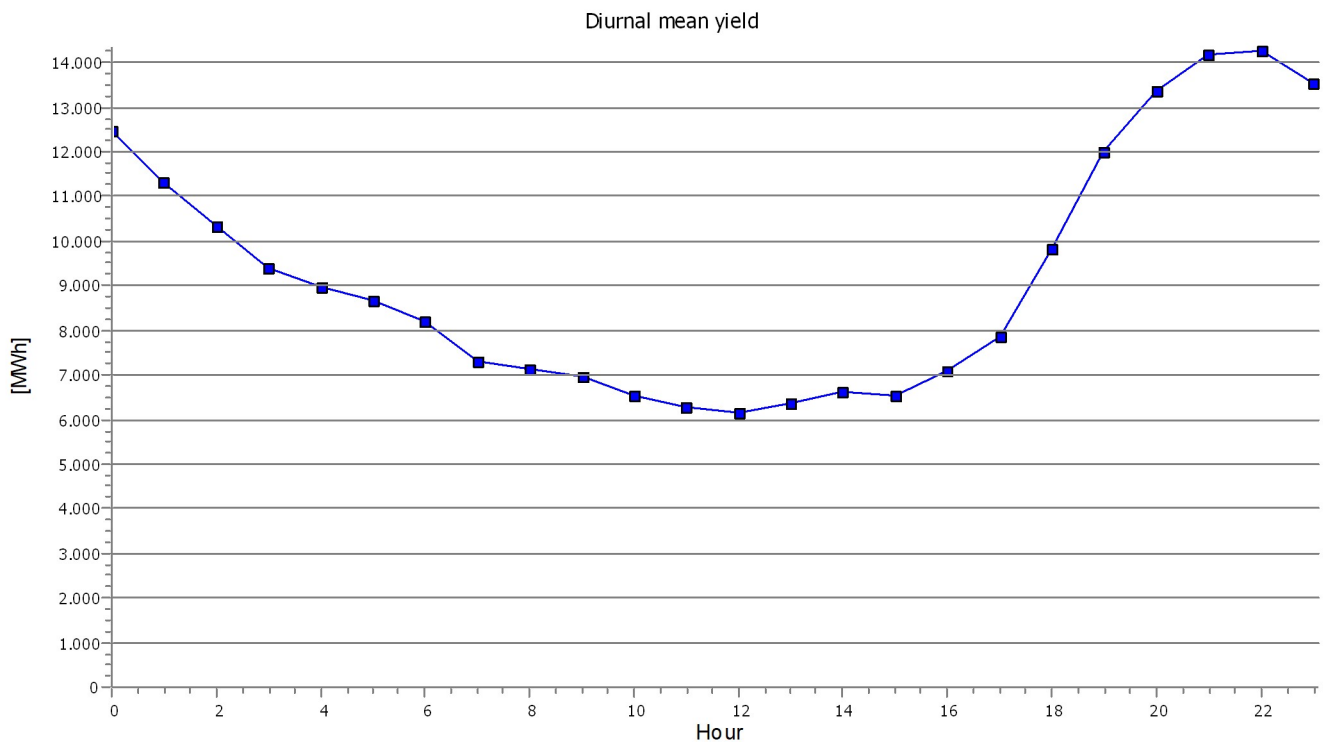
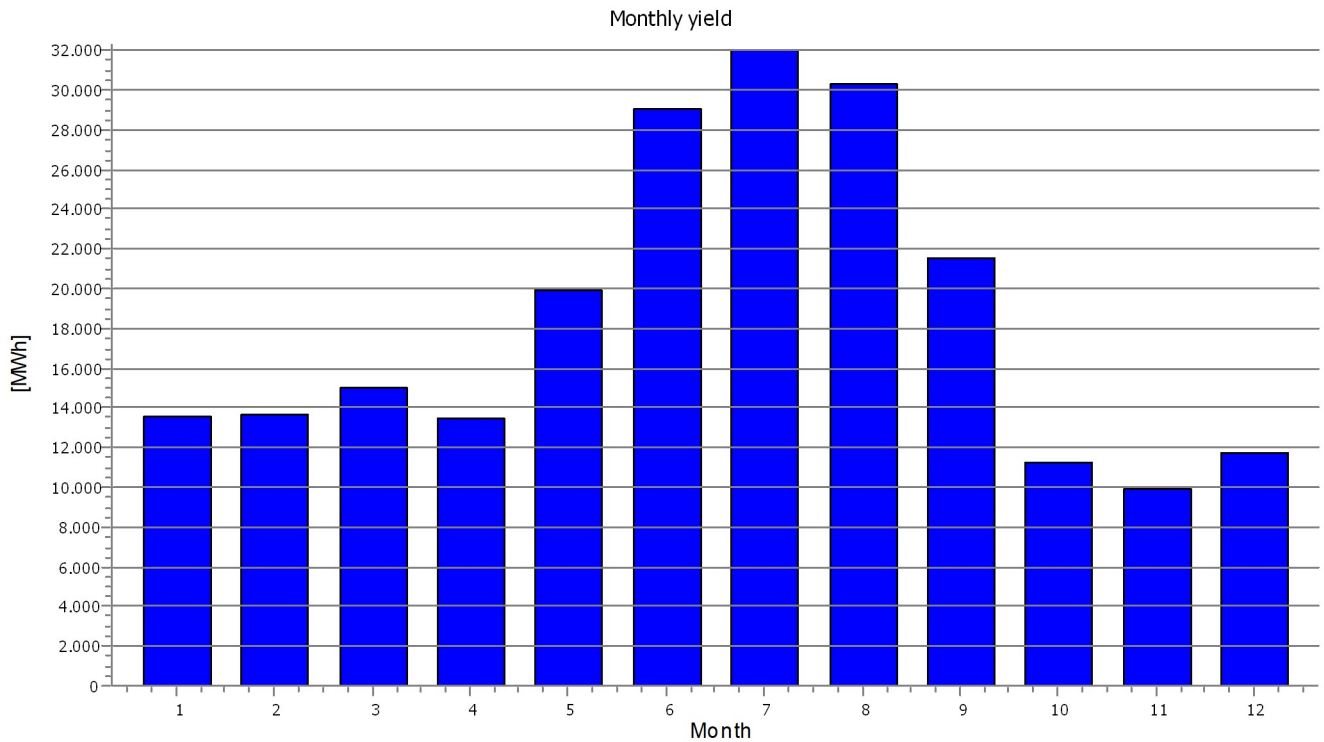
Calculation: 22-459-010 Proddatur AP

Windfarm: 50,4 MW based on 12 turbines of type VESTAS V150-4.2 4200 150.0 !O!.

Selection: All new WTGs

Calculated mean yield per month and hour [MWh]. The result includes wake losses and any curtailment losses.

Values are scaled to a full year, see correction factors at main result page.



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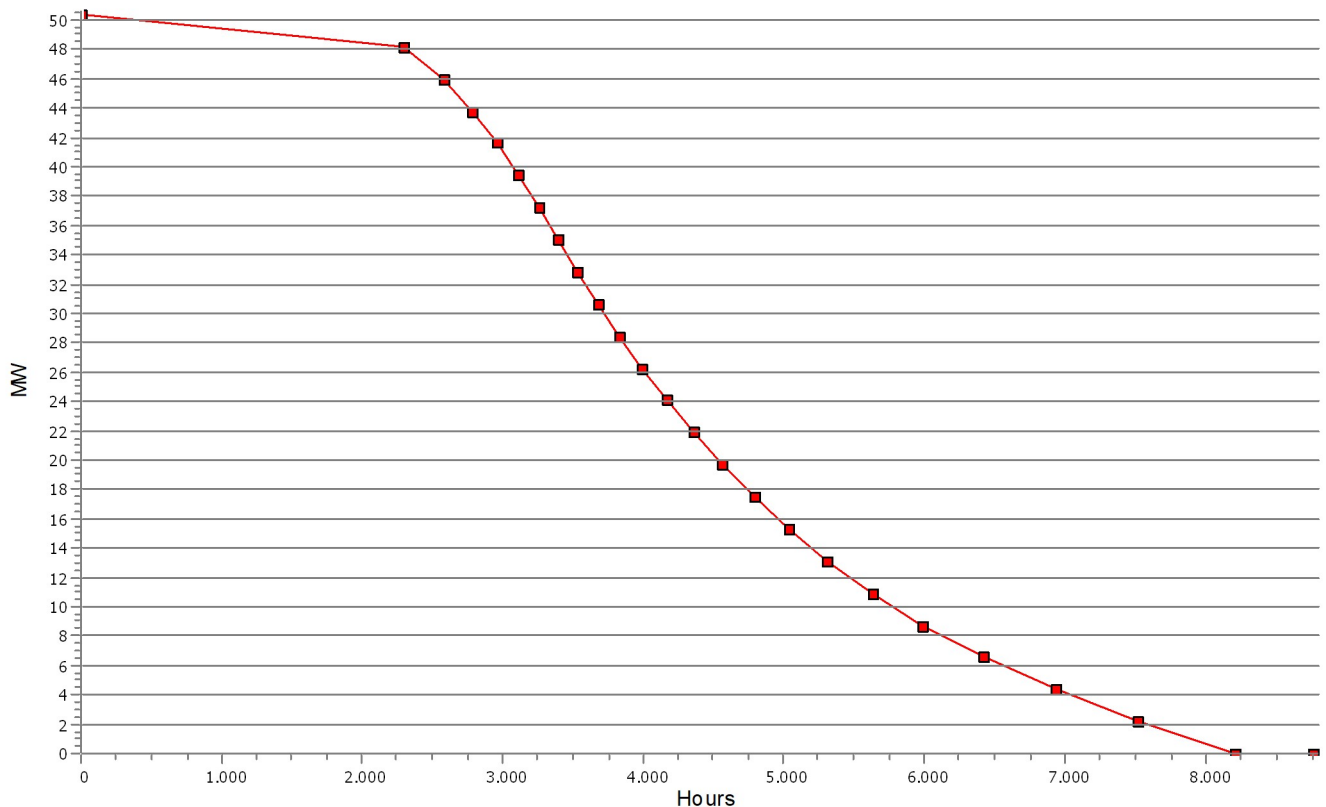
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Windfarm: 50,4 MW based on 12 turbines of type VESTAS V150-4.2 4200 150.0 !O!.

Selection: All new WTGs

Hours	Hours [%]	Hours accumulated	Power [MW]	Power (MW/WTG)
0	0,0	0	50,4	4,2
2294	26,2	2294	48,2 - 50,4	4,0 - 4,2
287	3,3	2580	46,0 - 48,2	3,8 - 4,0
205	2,3	2786	43,8 - 46,0	3,7 - 3,8
170	1,9	2956	41,6 - 43,8	3,5 - 3,7
152	1,7	3108	39,4 - 41,6	3,3 - 3,5
144	1,6	3252	37,3 - 39,4	3,1 - 3,3
138	1,6	3390	35,1 - 37,3	2,9 - 3,1
142	1,6	3532	32,9 - 35,1	2,7 - 2,9
149	1,7	3681	30,7 - 32,9	2,6 - 2,7
151	1,7	3832	28,5 - 30,7	2,4 - 2,6
163	1,9	3995	26,3 - 28,5	2,2 - 2,4
174	2,0	4169	24,1 - 26,3	2,0 - 2,2
190	2,2	4359	21,9 - 24,1	1,8 - 2,0
202	2,3	4561	19,7 - 21,9	1,6 - 1,8
225	2,6	4786	17,5 - 19,7	1,5 - 1,6
245	2,8	5031	15,3 - 17,5	1,3 - 1,5
277	3,2	5307	13,1 - 15,3	1,1 - 1,3
320	3,7	5628	11,0 - 13,1	0,9 - 1,1
362	4,1	5990	8,8 - 11,0	0,7 - 0,9
429	4,9	6418	6,6 - 8,8	0,5 - 0,7
510	5,8	6928	4,4 - 6,6	0,4 - 0,5
594	6,8	7522	2,2 - 4,4	0,2 - 0,4
688	7,9	8211	0,0 - 2,2	0,0 - 0,2
556	6,3	8766	0,0	0,0

Duration curve 50,4 MW WindFarm



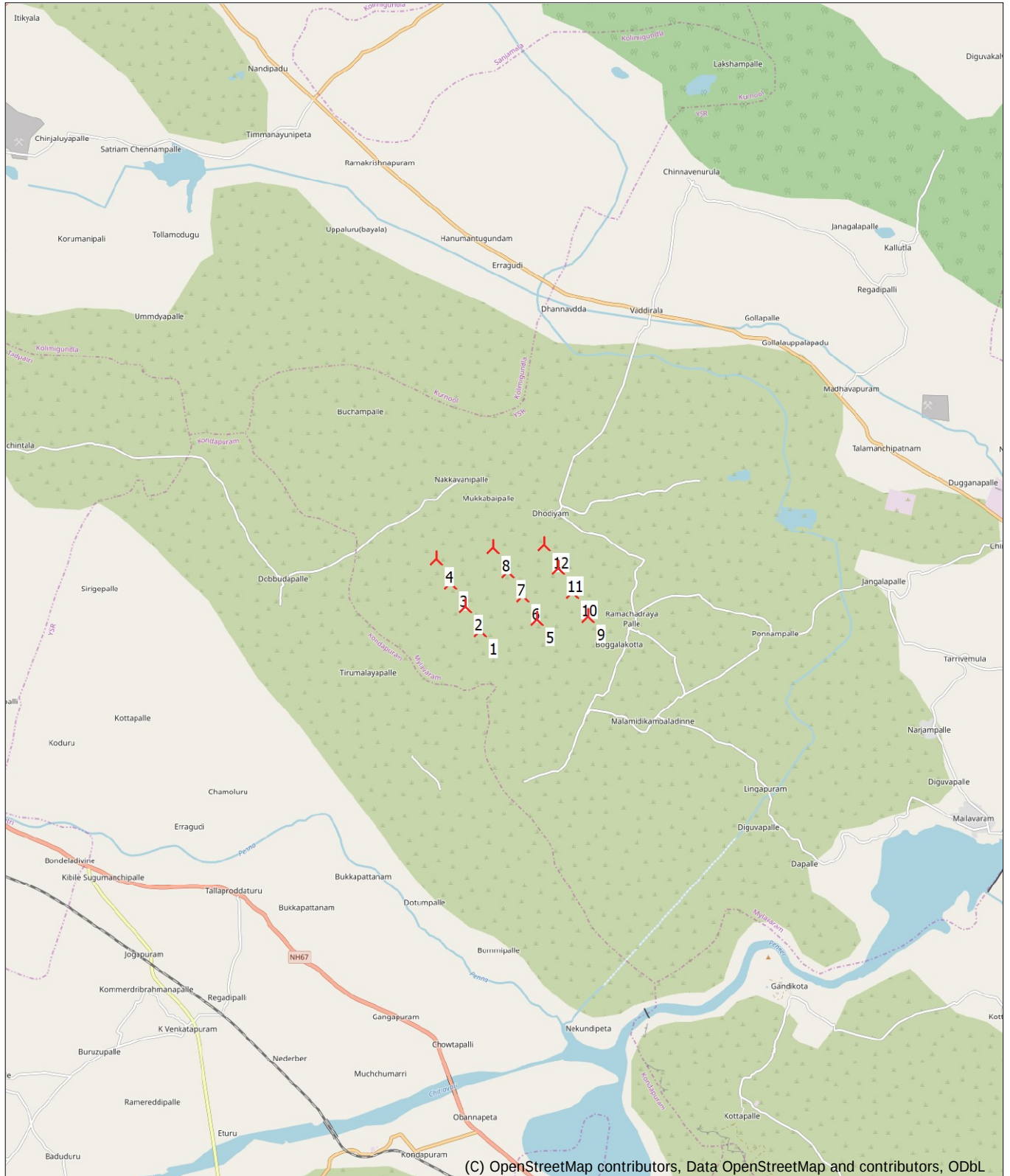
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Calculated:
27/2/2022 18:34/3.5.508

PARK - Map

Calculation: 22-459-010 Proddatur AP



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:150.000, Map center Geo WGS84 East: 78,217565° E North: 14,911218° N

New WTG

Heat Maps - Proddatur, Andhra Pradesh

AEP [MWh]							
Hour/Month	00:00 - 04:00	04:00 - 08:00	08:00 - 12:00	12:00 - 16:00	16:00 - 20:00	20:00 - 00:00	TOTAL
1	2,595	1,012	581	1,085	2,544	4,692	12,510
2	2,617	1,095	537	1,142	2,545	4,579	12,515
3	3,082	1,376	603	1,144	2,703	4,909	13,816
4	2,858	1,863	794	644	2,136	4,095	12,389
5	4,166	3,829	2,828	1,489	2,055	3,960	18,327
6	5,073	4,793	4,420	3,616	3,904	4,941	26,747
7	5,282	5,091	4,920	4,364	4,595	5,198	29,450
8	5,147	4,947	4,656	4,026	4,127	4,929	27,831
9	3,983	3,736	3,115	2,478	2,736	3,778	19,826
10	2,020	1,481	1,069	1,144	1,887	2,717	10,317
11	1,353	599	633	1,243	2,163	3,121	9,111
12	1,899	657	573	1,235	2,455	4,001	10,820
Total	40,075	30,478	24,728	23,610	33,850	50,919	2,03,659

Capacity factor [Per cent]							
Hour/Month	00:00 - 04:00	04:00 - 08:00	08:00 - 12:00	12:00 - 16:00	16:00 - 20:00	20:00 - 00:00	TOTAL
1	41.5%	16.2%	9.3%	17.4%	40.7%	75.1%	33.4%
2	46.4%	19.4%	9.5%	20.2%	45.1%	81.1%	37.0%
3	49.3%	22.0%	9.6%	18.3%	43.2%	78.5%	36.8%
4	47.3%	30.8%	13.1%	10.6%	35.3%	67.7%	34.1%
5	66.7%	61.3%	45.2%	23.8%	32.9%	63.4%	48.9%
6	83.9%	79.3%	73.1%	59.8%	64.6%	81.7%	73.7%
7	84.5%	81.5%	78.7%	69.8%	73.5%	83.2%	78.5%
8	82.4%	79.2%	74.5%	64.4%	66.0%	78.9%	74.2%
9	65.9%	61.8%	51.5%	41.0%	45.2%	62.5%	54.6%
10	32.3%	23.7%	17.1%	18.3%	30.2%	43.5%	27.5%
11	22.4%	9.9%	10.5%	20.6%	35.8%	51.6%	25.1%
12	30.4%	10.5%	9.2%	19.8%	39.3%	64.0%	28.9%
Total	54.5%	41.4%	33.6%	32.1%	46.0%	69.2%	46.1%