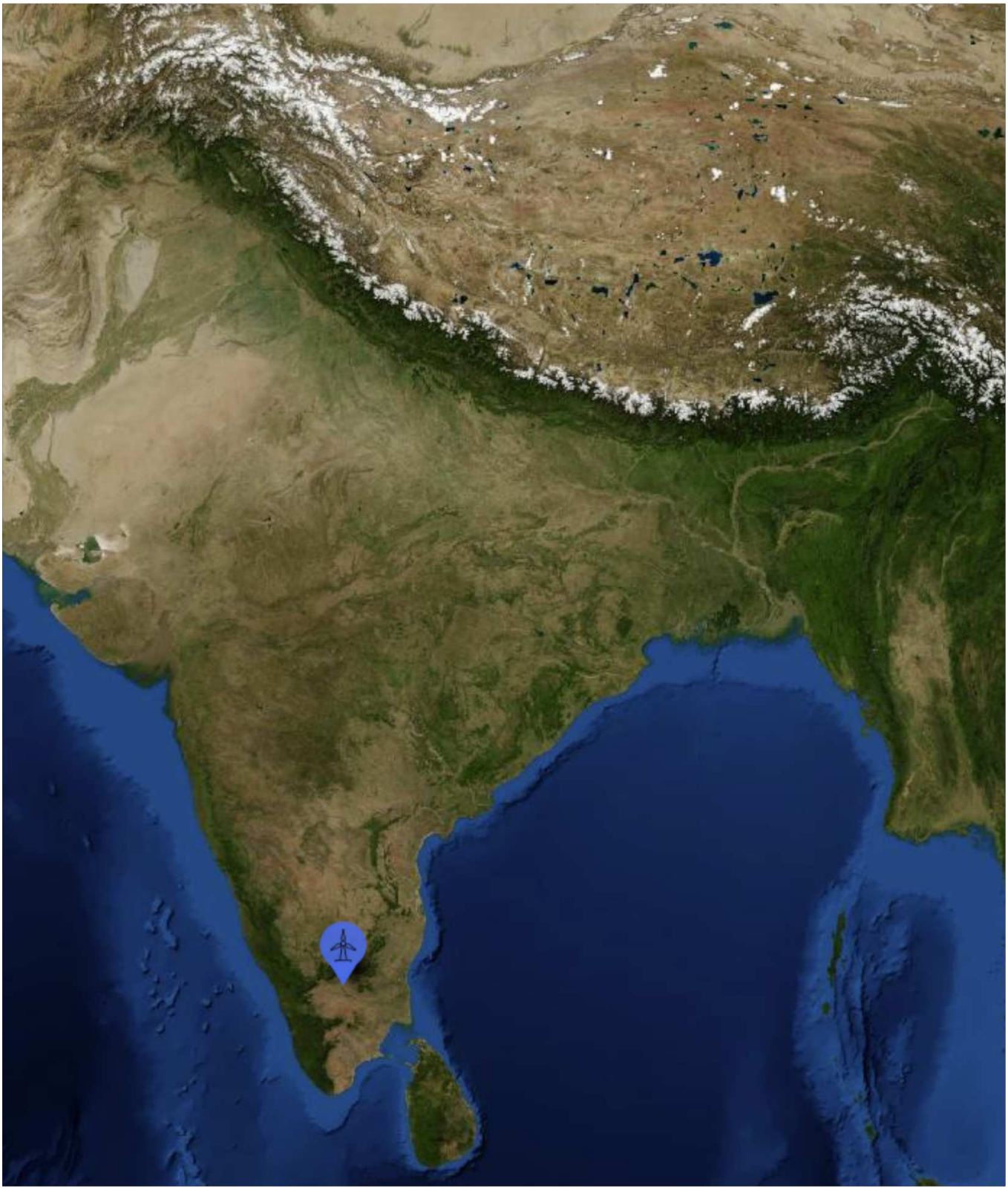
Yield Assessment - Erode, Tamil Nadu



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:
EMD SUR SRL
Dr. Tomas de Anchorena 648 PB 2
AR-C1170ACL Ciudad Autónoma de Buenos Aires
+54 911 5491 6161
Mathias Thamhain / mth@emd.dk

Calculated:
22/2/2022 10:24/3.5.508

PARK - Main Result

Calculation: 22-459-007 Erode Tamil Nadu

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: 43
At the site centre the difference between grid north and true north is: -0,8°

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 !O! hub: 105,0 m (TOT: 180,0 m) dist: 750 m (5,0 RD

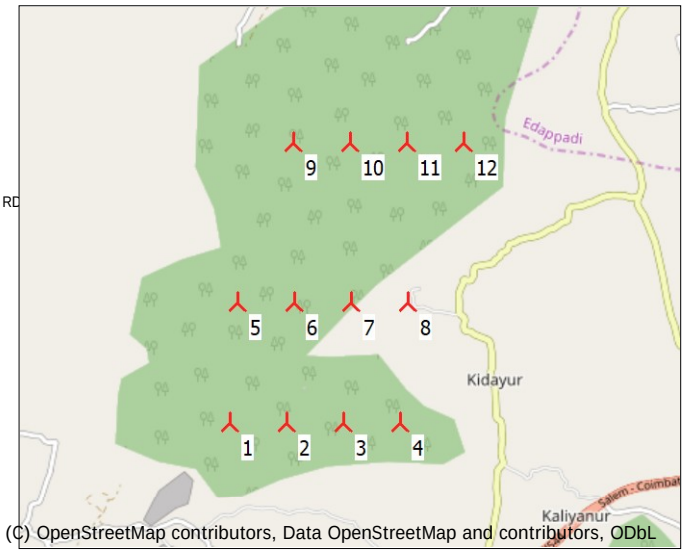
Scaler / wind data

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_N11.521_E077.816 - Erode TN
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]	21,2	22,6	21,9			
From air density settings	[hPa]	939,9	962,8	951,4			
Resulting air density	[kg/m³]	1,112	1,134	1,123			
Relative to 15°C at sea level	[%]	90,8	92,6	91,7	-6,1	-6,1	0,0



(C) OpenStreetMap contributors, Data OpenStreetMap and contributors, ODbL

Scale 1:100.000

New WTG

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK	Result-8,0%	GROSS (no loss) Free WTGs	Wake loss	Specific results¤) Capacity factor	Mean WTG result	Full load hours	Wind speed free	wake reduced
	[MWh/y]	[MWh/y]	[MWh/y]	[%]	[%]	[MWh/y]	[Hours/year]	[m/s]	[m/s]
Wind farm	109.543,4	100.779,9	115.087,9	4,8	22,8	8.398,3	2.000	5,2	5,0

¤) 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 Result [MWh/y]	Result-8,0% [MWh/y]	Wake loss [%]	Wind speed free [m/s]	reduced [m/s]
1	Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-0S - 08-2019	9.311,9	8.567	4,4	5,21	5,10
2	Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-0S - 08-2019	8.630,9	7.940	5,5	5,02	4,90
3	Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-0S - 08-2019	8.327,2	7.661	4,9	4,93	4,82
4	Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-0S - 08-2019	10.175,4	9.361	2,1	5,36	5,31
5	Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-0S - 08-2019	9.813,8	9.029	4,0	5,34	5,23
6	Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-0S - 08-2019	10.628,8	9.778	5,8	5,64	5,48
7	Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-0S - 08-2019	6.509,4	5.989	7,5	4,48	4,33
8	Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-0S - 08-2019	6.990,7	6.431	7,4	4,61	4,47
9	Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-0S - 08-2019	10.014,5	9.213	2,8	5,36	5,29
10	Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-0S - 08-2019	10.858,8	9.990	4,4	5,65	5,53
11	Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-0S - 08-2019	11.712,0	10.775	5,4	5,92	5,77
12	Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-0S - 08-2019	6.569,9	6.044	5,2	4,46	4,36

WTG siting

		Geo [deg]-WGS84 Longitude	Latitude	Z [m]	Row data/Description	Calculation period Start	End
1	New	77,805880° E	11,499571° N	437,7	90,0°, 750,0 m	1/1/2002	1/1/2022
2	New	77,812749° E	11,499571° N	397,5		1/1/2002	1/1/2022
3	New	77,819619° E	11,499571° N	398,8		1/1/2002	1/1/2022
4	New	77,826488° E	11,499571° N	438,0		1/1/2002	1/1/2022
5	New	77,806797° E	11,513810° N	499,5	90,0°, 750,0 m	1/1/2002	1/1/2022
6	New	77,813667° E	11,513810° N	547,5		1/1/2002	1/1/2022
7	New	77,820536° E	11,513810° N	360,8		1/1/2002	1/1/2022
8	New	77,827406° E	11,513810° N	340,8		1/1/2002	1/1/2022
9	New	77,813550° E	11,532758° N	480,6	90,0°, 750,0 m	1/1/2002	1/1/2022
10	New	77,820420° E	11,532758° N	532,2		1/1/2002	1/1/2022
11	New	77,827290° E	11,532758° N	539,9		1/1/2002	1/1/2022
12	New	77,834160° E	11,532758° N	339,0		1/1/2002	1/1/2022

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PARK - Wind Data Analysis

Calculation: 22-459-007 Erode Tamil NaduWind 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: 90° (18); Hub height: 105,0

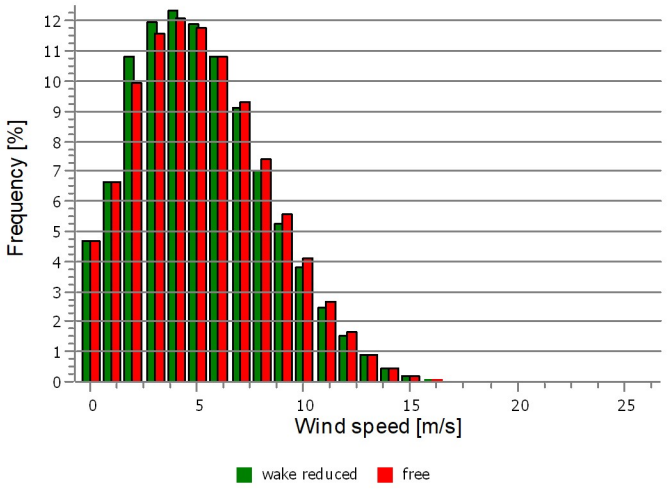
Site coordinates

Geo WGS84
East: 77,805880° E North: 11,499571° 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: 90° (18)
Masts used
Take nearest

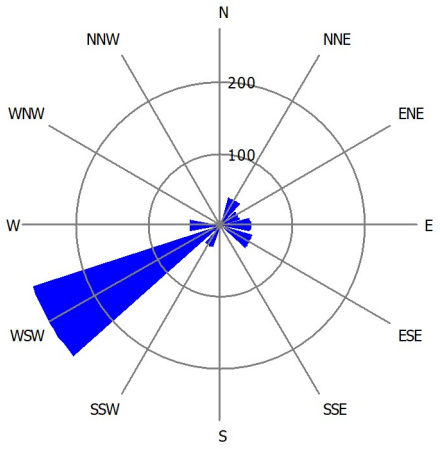
Winddata for site

Sector	Free mean wind speed [m/s]	Wake reduced mean wind speed [m/s]	Frequency [%]
0 N	4,6	4,4	1,7
1 NNE	5,2	4,9	8,9
2 ENE	4,8	4,7	6,7
3 E	5,5	4,8	9,5
4 ESE	4,5	4,5	12,1
5 SSE	2,5	2,5	6,0
6 S	2,9	2,9	2,0
7 SSW	4,6	4,6	7,6
8 WSW	6,3	6,3	35,8
9 W	5,6	5,6	6,7
10 WNW	2,7	2,7	1,7
11 NNW	2,7	2,7	1,2
All	5,2	5,1	100,0

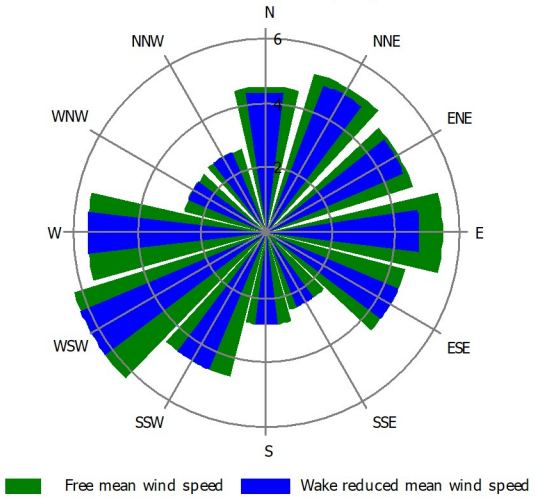
Wind distribution



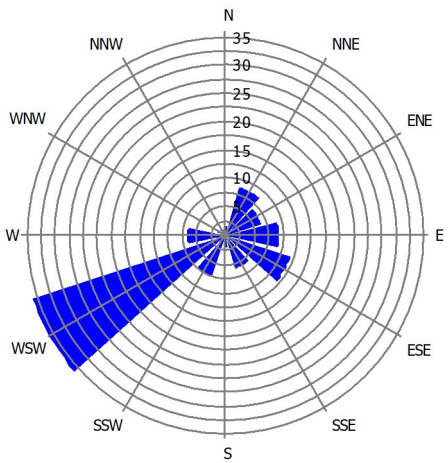
Energy Rose (WTG) (kWh/m²/year)



Mean wind speed (m/s)



Frequency (%)



PARK - Time varying AEP

Calculation: 22-459-007 Erode Tamil Nadu

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	242	224	255	284	496	624	581	559	479	276	231	286	4.539
1	153	143	160	218	446	534	520	511	401	246	227	260	3.820
2	139	95	105	143	318	456	459	415	344	187	211	291	3.164
3	154	93	89	113	241	373	371	337	249	154	237	335	2.745
4	188	98	80	111	213	354	365	345	212	137	279	403	2.784
5	223	97	62	92	208	385	373	344	238	134	311	481	2.946
6	243	82	49	72	175	306	352	297	186	121	329	453	2.665
7	251	90	30	36	95	205	249	190	120	85	294	437	2.082
8	183	80	25	21	76	199	227	177	111	75	244	338	1.757
9	176	77	23	20	81	232	210	175	120	90	216	299	1.720
10	147	62	30	27	90	341	304	222	167	106	205	259	1.960
11	117	67	35	26	154	478	431	329	235	111	188	246	2.417
12	114	77	46	30	190	594	562	426	299	149	180	224	2.891
13	126	86	61	43	265	704	687	567	419	213	177	214	3.564
14	144	105	90	68	375	841	814	701	544	287	182	215	4.366
15	119	111	115	104	476	851	815	742	579	333	183	206	4.633
16	169	165	154	192	682	931	881	811	702	396	184	228	5.495
17	247	240	232	307	823	1.032	966	973	825	478	248	279	6.650
18	414	399	415	441	954	1.142	1.102	1.081	1.031	607	317	403	8.306
19	643	652	742	679	1.007	1.198	1.189	1.195	1.072	630	415	547	9.969
20	787	789	893	760	936	1.150	1.102	1.098	992	589	462	628	10.185
21	713	724	805	645	763	950	867	876	774	497	418	594	8.625
22	562	530	567	484	656	798	766	719	625	399	345	435	6.888
23	357	353	364	364	589	678	633	600	498	326	272	339	5.374
Grand Total	6.611	5.439	5.426	5.281	10.309	15.358	14.827	13.689	11.221	6.624	6.355	8.402	109.543

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

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EMD SUR SRL
Dr. Tomas de Anchorena 648 PB 2
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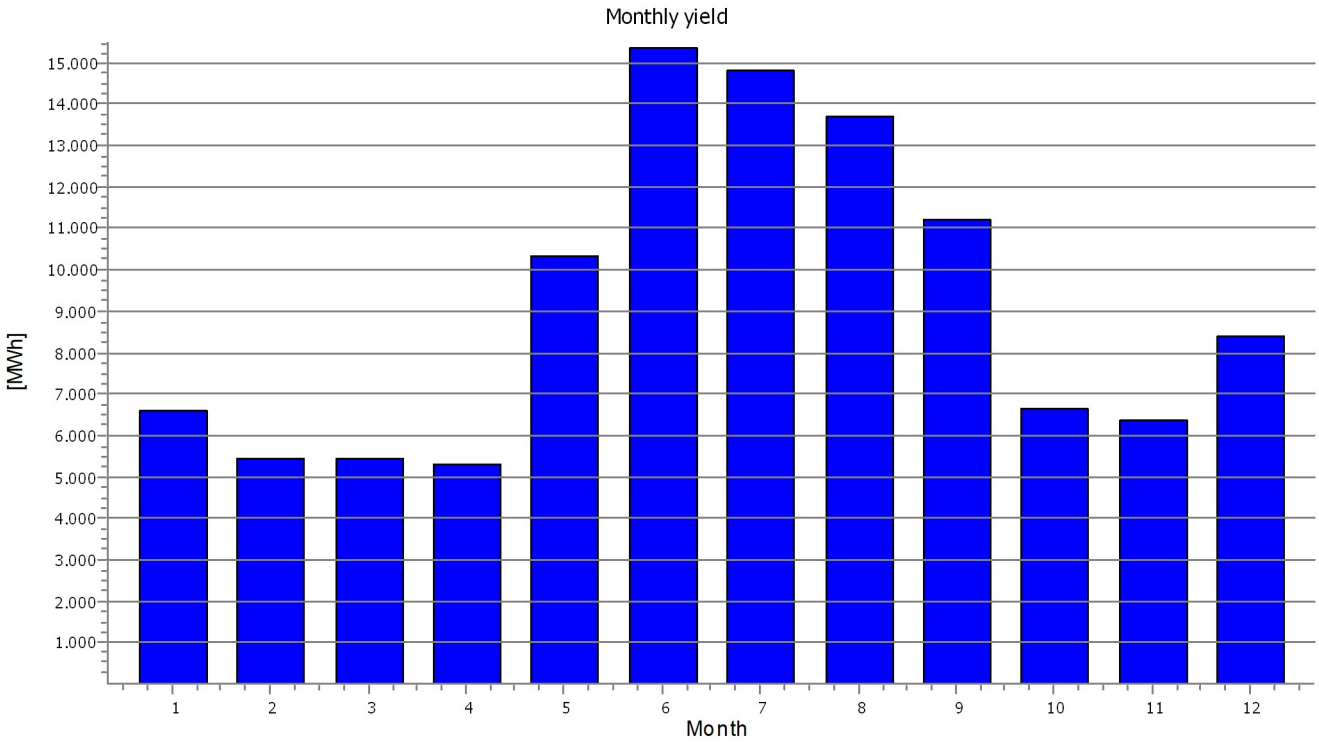
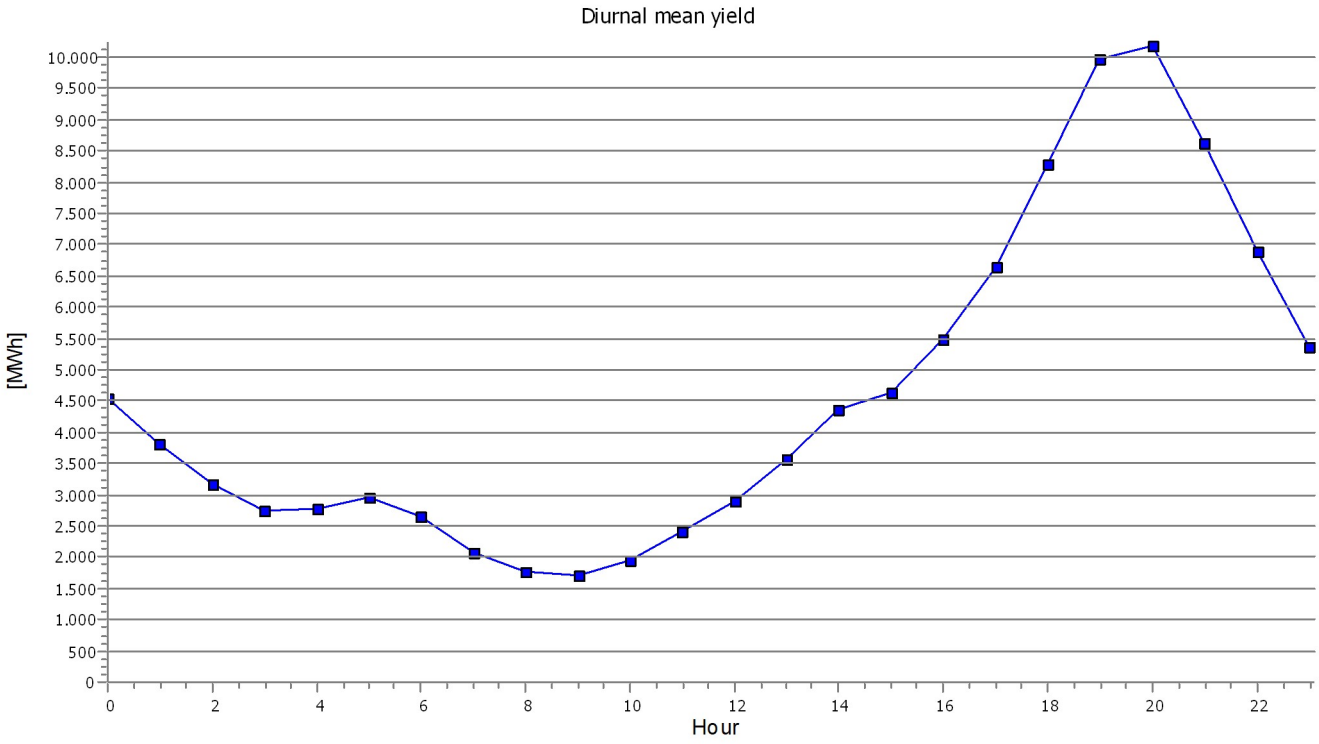


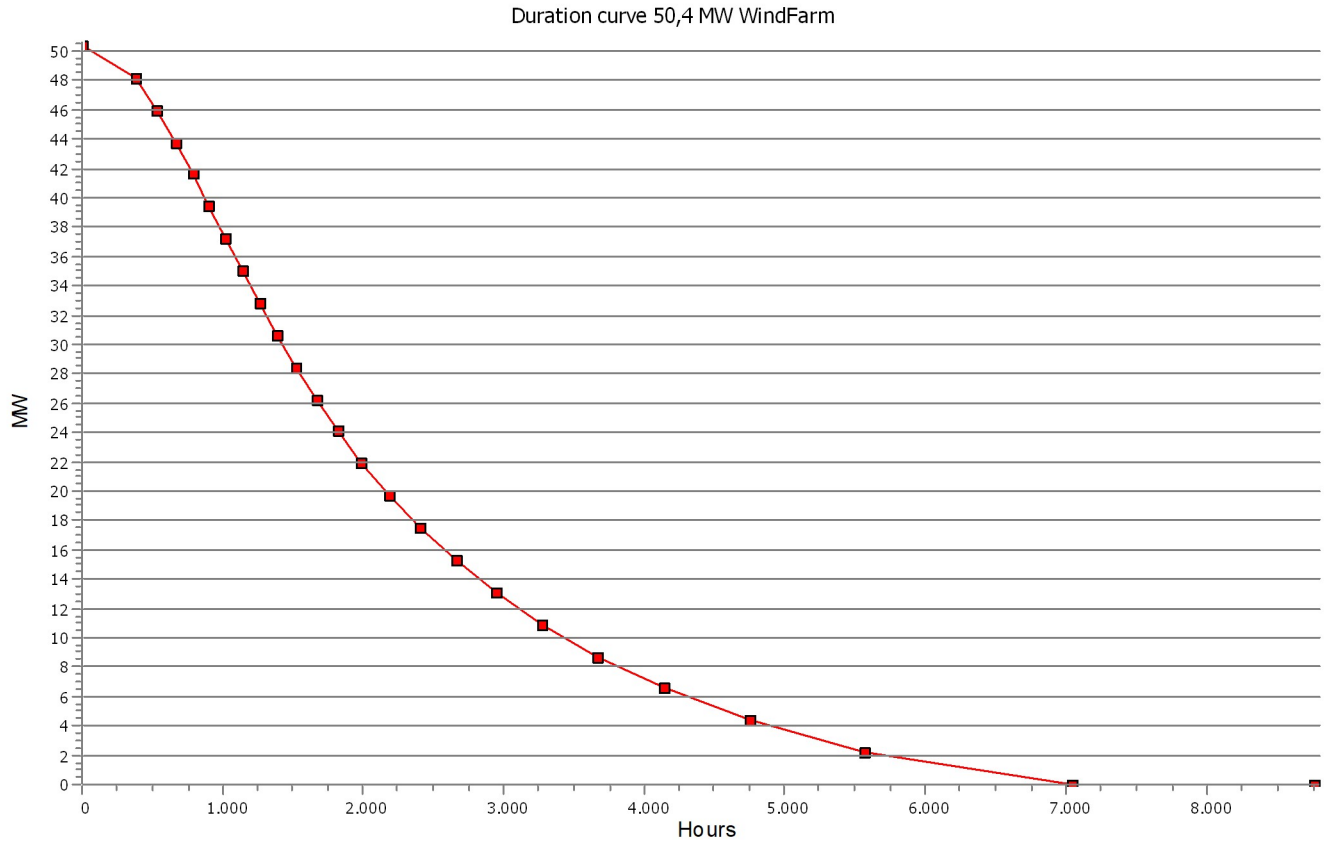


PARK - Time varying AEP

Calculation: 22-459-007 Erode Tamil Nadu

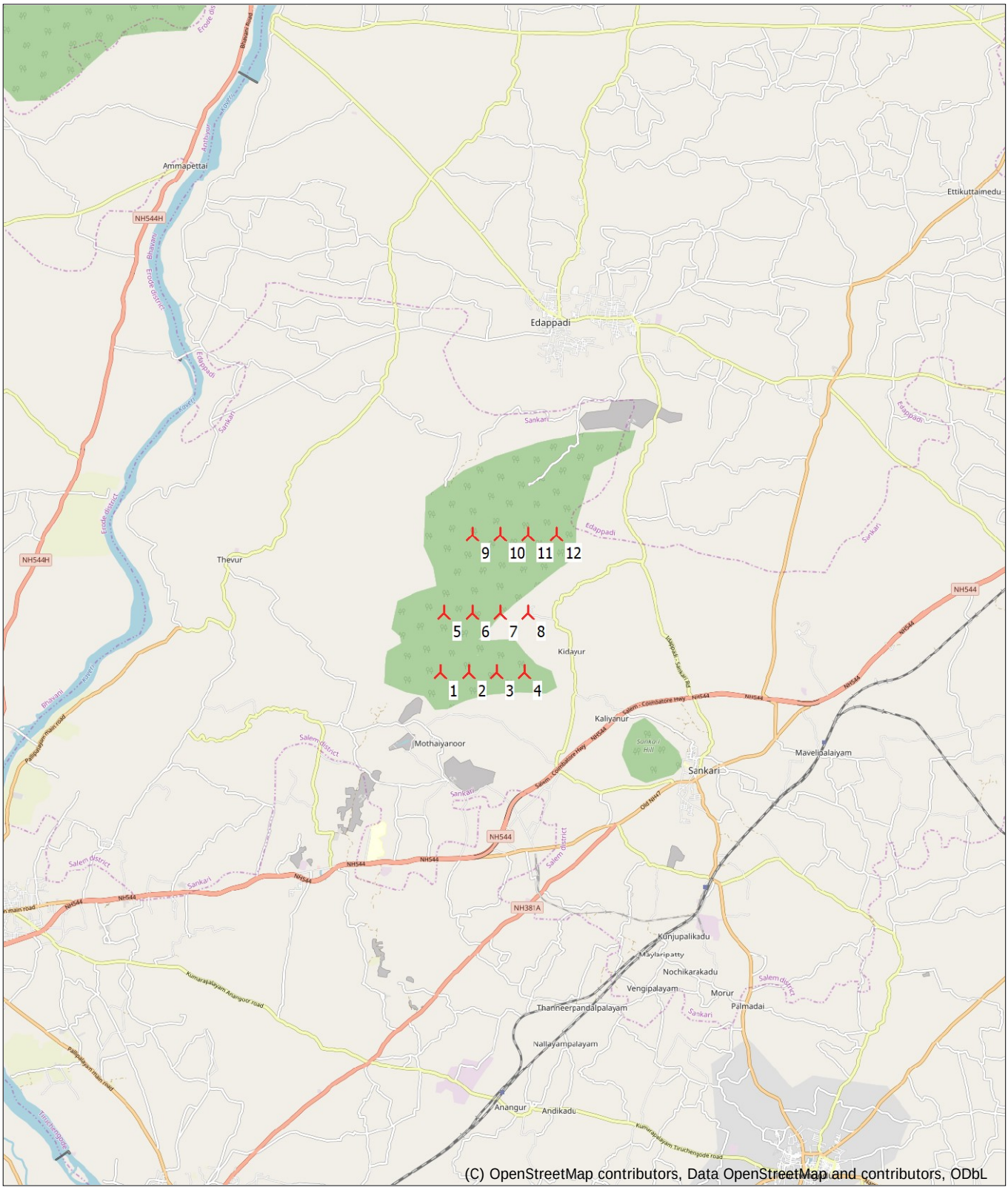
Windfarm: 50,4 MW based on 12 turbines of type VESTAS V150-4.2 4200 150.0 !O!.
Selection: All new WTGs

Hours	Hours [%]	Hours accumulated	Power [MW]	Power (MW/WTG)
0	0,0	0	50,4	4,2
387	4,4	387	48,2 - 50,4	4,0 - 4,2
149	1,7	535	46,0 - 48,2	3,8 - 4,0
131	1,5	667	43,8 - 46,0	3,7 - 3,8
121	1,4	788	41,6 - 43,8	3,5 - 3,7
112	1,3	900	39,4 - 41,6	3,3 - 3,5
117	1,3	1017	37,3 - 39,4	3,1 - 3,3
120	1,4	1137	35,1 - 37,3	2,9 - 3,1
122	1,4	1259	32,9 - 35,1	2,7 - 2,9
126	1,4	1385	30,7 - 32,9	2,6 - 2,7
136	1,6	1521	28,5 - 30,7	2,4 - 2,6
144	1,6	1665	26,3 - 28,5	2,2 - 2,4
153	1,7	1818	24,1 - 26,3	2,0 - 2,2
167	1,9	1985	21,9 - 24,1	1,8 - 2,0
197	2,2	2182	19,7 - 21,9	1,6 - 1,8
220	2,5	2402	17,5 - 19,7	1,5 - 1,6
257	2,9	2659	15,3 - 17,5	1,3 - 1,5
286	3,3	2946	13,1 - 15,3	1,1 - 1,3
329	3,8	3274	11,0 - 13,1	0,9 - 1,1
393	4,5	3668	8,8 - 11,0	0,7 - 0,9
470	5,4	4138	6,6 - 8,8	0,5 - 0,7
610	7,0	4748	4,4 - 6,6	0,4 - 0,5
816	9,3	5564	2,2 - 4,4	0,2 - 0,4
1483	16,9	7047	0,0 - 2,2	0,0 - 0,2
1719	19,6	8766	0,0	0,0



PARK - Map

Calculation: 22-459-007 Erode Tamil Nadu



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:150.000, Map center Geo WGS84 East: 77,820020° E North: 11,516164° N

New WTG

Heat Maps - Erode, Tamil Nadu

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	633	832	574	463	1,355	2,226	**6,082**
2	511	337	264	349	1,340	2,204	**5,004**
3	561	203	103	287	1,420	2,419	**4,992**
4	698	286	87	226	1,489	2,073	**4,859**
5	1,381	636	369	1,202	3,189	2,708	**9,485**
6	1,829	1,150	1,150	2,751	3,959	3,291	**14,129**
7	1,777	1,231	1,078	2,648	3,807	3,099	**13,641**
8	1,676	1,082	830	2,242	3,734	3,029	**12,594**
9	1,355	695	582	1,693	3,339	2,658	**10,323**
10	793	439	351	903	1,942	1,666	**6,094**
11	833	1,116	785	664	1,071	1,377	**5,846**
12	1,078	1,632	1,051	790	1,341	1,837	**7,730**
Total	**13,126**	**9,638**	**7,226**	**14,217**	**27,987**	**28,586**	**1,00,780**

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	10.1%	13.3%	9.2%	7.4%	21.7%	35.6%	**16.2%**
2	9.1%	6.0%	4.7%	6.2%	23.7%	39.0%	**14.8%**
3	9.0%	3.2%	1.6%	4.6%	22.7%	38.7%	**13.3%**
4	11.5%	4.7%	1.4%	3.7%	24.6%	34.3%	**13.4%**
5	22.1%	10.2%	5.9%	19.2%	51.0%	43.3%	**25.3%**
6	30.2%	19.0%	19.0%	45.5%	65.5%	54.4%	**38.9%**
7	28.4%	19.7%	17.3%	42.4%	60.9%	49.6%	**36.4%**
8	26.8%	17.3%	13.3%	35.9%	59.8%	48.5%	**33.6%**
9	22.4%	11.5%	9.6%	28.0%	55.2%	43.9%	**28.4%**
10	12.7%	7.0%	5.6%	14.5%	31.1%	26.7%	**16.3%**
11	13.8%	18.4%	13.0%	11.0%	17.7%	22.8%	**16.1%**
12	17.3%	26.1%	16.8%	12.6%	21.5%	29.4%	**20.6%**
Total	**17.8%**	**13.1%**	**9.8%**	**19.3%**	**38.0%**	**38.8%**	**22.8%**