

Identification of Evening Peak Optimised Wind Sites in India

Study by:



On behalf of:



GOVERNMENT OF INDIA
MINISTRY OF NEW
AND RENEWABLE ENERGY



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for Economic Affairs
and Climate Action

on the basis of a decision
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Introduction

To intensify the strategic political dialogue on the proceeding transformation of energy systems in Germany and India, the German Chancellor and the Indian Prime Minister founded the Indo-German Energy Forum (IGEF) in April 2006.

To initiate strategic cooperation projects between the German and Indian governments, IGEF provides a communication platform for networking between research institutions and the private sectors of both countries. IGEF identifies opportunities to accelerate the energy transition of India and thus reduce carbon emissions.

The Indian energy market is transforming. Around-the-clock-tenders for renewable energy open up new possibilities. Large scale wind farms can already compete with the average price for electricity produced by coal (approx. 5 cents/kWh) and can be even cheaper per unit (approx. 3 cents/kWh). Thus, it needs to be evaluated whether wind farms yield enough energy during peak demand times to be a reliant energy source. If this is the case, wind farms could replace energy production with coal-fired power plants in the peak demand time and lower the overall energy production by fossil fuels. Furthermore, newly built wind farms could lead to an even more flexible operation of existing coal-fired power plants and an emerging energy mix, which again leads to fewer CO₂ emissions. On the one hand, this would help India achieve its climate goals for 2030, and on the other hand, it would make the construction of new coal-fired power plants redundant.

The objective of the current study is to identify and describe “peak wind speed generation clusters”, which are areas throughout India,

both onshore and offshore that fulfil the following criteria:

- The wind generation profile of the site is constantly high throughout the year during peak demand hours, especially evening hours 7 to 11 pm.
- The wind sites shall show a high electricity generation profile on an annual average (capacity factor for onshore wind farms $\geq 20\%$ and offshore wind farms $\geq 40\%$).

The Indo-German Energy Forum (IGEF) had previously conducted an initial analysis of the daily and seasonal wind patterns in India to identify regions with strong wind speeds during peak demand hours. IGEF has provided EMD with the georeferenced maps prepared in these previous studies the ratio between mean power during the evening hours (7 to 11 pm) and the annual mean power.

EMD has conducted a detailed analysis of the provided maps and has combined them with wind resource maps from the Global Wind Atlas and with other geo-referenced information, to identify the potential of both onshore and offshore peak wind speed generation clusters in the different states of India.

In addition, Geographic Information System (GIS) data was used to classify each cluster based on variables relevant to wind farm development. The contractor further developed a method for estimating energy costs, which allows the classification of clusters.

Furthermore, the study identifies ten potential sites for wind farms in India, eight of which are onshore and two offshore, and describes them in detail.

Analysis of peak wind speed clusters

2.1 Data sources and methodology

EMD has combined diverse information from different sources for the analysis and classification of the “peak wind speed generation clusters”. Two variables were identified to form the clusters:

- The capacity factor for IEC 3 class wind turbines above 20% for onshore clusters and 40% for offshore clusters (see 2.1.1)
- Peak wind ratio above 1,2 (see 2.1.2)

As a result of this analysis, we found that nearly all states have areas where the conditions of capacity factor and peak wind speed are fulfilled. Further analysis and classification were thus carried out at the state level for the onshore cluster.

Additionally, two offshore clusters were identified: Gujarat and TamilNadu.

2.1.1 Wind resource

The wind resource throughout India was analysed with information obtained from the Global Wind Atlas and following information was downloaded at 100 m height above the ground:

- Wind speed, Weibull A factor and Weibull k factor
- The capacity factor for IEC 1 class wind turbines
- The capacity factor for IEC 2 class wind turbines
- The capacity factor for IEC 3 class wind turbines

The capacity factor for IEC 3 class wind turbines was a criterion to define peak wind speed generation clusters:

- Only areas throughout India with a capacity factor for IEC 3 class wind turbines above 20% were chosen to form part of the onshore peak wind speed generation clusters.
- Only areas throughout India with a capacity factor for IEC 3 class wind turbines above 40% were chosen to form part of the offshore peak wind speed generation clusters.

Furthermore, the IEC class was evaluated based on the mean wind speed and the covered land surface for each IEC class was determined.

- < 7,5 m/s = IEC 3
- 7,5 ... 8,5 m/s = IEC 2
- 8,5 ... 10 m/s = IEC 1
- 10 m/s = IEC S

2.1.2 The ratio of wind speed

IGEF has provided EMD with georeferenced maps with information on the ratio between mean power during the evening hours (7 to 11 pm) and the annual mean power. These maps were prepared in the following study:

[1] Analysis of Daily and Seasonal Variation of Wind Resource in India, Deutsche Windguard, 30 September of 2020 (DWG Project Nr. VC20217 and DWG Report Nr. PE20014.A0).

The following information was integrated into the analysis:

- grid_daily_pattern_RatiosPeakHoursDaily_nonSeasonal - map showing the ratio between the mean power during the defined peak hours compared to the annual mean power
- grid_daily_pattern_ratios_PeakHoursSummer-PeakHoursYear - map showing the ratio in mean power during

the peak hours in the summer season (peak of the peak hours) and the annual mean power during the peak hours

The ratio between the mean power during the defined peak hours compared to the annual mean power, called peak wind ratio in the following analysis, was the second criterion to define peak wind speed generation clusters. Only areas with a peak wind ratio above 1,2 were chosen to be part of the peak wind speed generation clusters.

2.1.3 Site complexity (only onshore)

Site complexity is being evaluated based on satellite surface data using the information of Globcover.

- Cities and water bodies are classified as excluded areas, which are unsuitable for the installation of wind turbines.
- Forests and floodable areas are classified as restricted areas with implications in the cost of energy (higher capex).

The analysis shows that after defining the land surface that complies with “peak wind speed generation” conditions, the additional constraints (cities, lakes) and limitations (forest, floodland) to the installation of wind turbines cause only very small changes to the net surface (less than 1%).

2.1.4 Electrical infrastructure (only onshore)

The electrical infrastructure was evaluated from online material coming from the Center for Study of Science, Technology and Policy (CSTEP).

Georeferenced transmission lines were accessed at:

http://darpan.cstep.in/reatlas/transmission_lines_national.geojson

The GIS analysis of the distance to High Voltage (HV) lines has implications on the cost of energy since an increase in the balance of plant capex was assumed for each km of distance.

Except for Jammu and Kashmir, all states have access to the national electrical grid. States with the lowest grid density are Orissa, West Bengal, and Rajasthan; all other states have an average distance to the nearest HV line of fewer than 10 km.

2.1.5 Project logistics (only offshore)

EMD has researched offshore capabilities in India and has revised the FOWIND study.

[1] Supply chain, port infrastructure and logistics study for offshore wind farm development in Gujarat and Tamil Nadu, Fowind, June 2016

The study clarifies “that no single port estate in India is currently [2016] suitable to facilitate all offshore wind construction activities without some level of adaptation or with the strategic use of multiple port estates” but identifies the following “promising port estates”:

- Hazira and Pipavav (Gujarat)
- Tuticorin (Tamil Nadu)

In addition, the distance to the shoreline was identified.

2.1.6 Capacity density

To determine the potential wind energy generation capacity per square kilometre, literature research was conducted:

[1] Data investigation of installed and output power densities of onshore and offshore wind turbines worldwide, Peter Enevoldsen, Mark Z. Jacobson, 2020, Energy for Sustainable Development

[2] Capacity densities of European offshore wind farms, Deutsche WindGuard, 2018

[3] Two methods for estimating limits to large-scale wind power generation, Lee M. Miller, Nathaniel A. Brunsell, David B. Mechem, Fabian Gans, Andrew J. Monaghan, Robert Vautard, David W. Keith und Axel Kleidon, Proceedings of the National Academy of Sciences, 2015

[1] concludes that the mean (range) installed, and output power densities of onshore wind farms are 20 MW/km² (range: 6 – 48

MW/km²) and of offshore wind farms are 7 MW/km² (range: 3 – 20 MW/km²); [2] informs a similar capacity density for offshore wind farms.

However, [3] alerts that for large scale installations, “the correlation between the amount of energy generated and the number of wind turbines is not linear, as more turbines increasingly slow down the wind”, identifying a maximum of 1,1 MW/km² for the wind capacity density.

In our evaluation, we adopted the conservative value of 1,1 MW/km² both for onshore and offshore wind farms.

2.1.7 Levelized cost of energy (LCOE)

The cost of generation or levelized cost of energy (LCOE) is a concept widely used in the electric power industry to compare different generation solutions. It divides the discounted cash flow (capex and opex) by the discounted flow of energy at the same discount rate. In this way, it determines the "generation cost" for which the income (amounts of energy generated multiplied by LCOE) equals the investment costs: capex, opex and capital cost. It should be noted that the concept of LCOE does not take into consideration the fiscal cost.

$$LCOE = \frac{\sum_{i=1}^n \frac{capex_i + opex_i}{(1+r)^i}}{\sum_{i=1}^n \frac{E_i}{(1+r)^i}}$$

To determine the levelized cost of energy, we made the following assumptions:

- Capex for onshore wind farms = 875 kUSD/MW
- Additional Capex for installations in forest +15%
- Additional Capex for installations in flooded areas +50%
- Additional Capex for connection to the nearest HV line = 4kUSD/MW per km
- Capex for offshore wind farms = 1.600 kUSD/MW
- Opex for onshore wind farms = 11,8 kUSD/MW/year
- Opex for offshore wind farms = 30 kUSD/MW/year
- Cost of capital: 6,3% (equity return 4,5%, interest 9,8%, tax 30%)

2.2 Results of analysis

2.2.1 Peak wind generation capacity

The analysis identifies extensive areas across India that comply with the criteria of a capacity factor above 20% (onshore) / 40% (offshore) and a peak wind speed ratio above 1,2 (“peak wind speed generation” conditions); a total of 736.000 km².

Twelve states with a minimum surface of 1.000 km² have more than 10% of their land surface with peak wind speed generation conditions and are further analysed in this section of the report. Out of the states with less than 1.000 km² surface, Puducherry and Daman and Diu also have more than 10% of their land surface with peak wind speed generation conditions.

Table 1: Surface of states and their net surface with peak wind speed generation conditions

State	Surface [km2]	Net surface [km2]	%
Gujarat	196.244	127.185	65%
Andhra Pradesh	162.968	85.180	52%
Karnataka	191.791	97.633	51%
Tamil Nadu	130.060	64.883	50%
Bihar	94.163	31.034	33%
Maharashtra	307.713	88.962	29%
Uttar Pradesh	240.928	55.123	23%
West Bengal	88.752	16.119	18%
Haryana	44.212	7.680	17%
Madhya Pradesh	308.252	53.131	17%
Rajasthan	342.239	55.294	16%
Orissa	155.707	18.010	12%

The analysis also identifies two offshore clusters off the coasts of Gujarat and Tamil Nadu.

With a capacity density of 1,1 MW/km² for both onshore and offshore wind farms, the net surface with peak wind speed generation conditions translates into 777 GW onshore capacity and 32 GW offshore capacity.

Most of the generation capacity is in IEC class 3 environments.

Existing wind farms are not a limitation to the development of new sites in any state, the highest current wind farm penetration is in Rajasthan with 6,4% of the wind farm potential currently installed.

Table 2: The net surface of offshore clusters with peak wind speed generation conditions

State	Net surface [km2]
Gujarat	9.478
Tamil Nadu	19.871

Table 3: Peak wind speed generation capacities by IEC class

State	Total [GW]	IEC I [GW]	IEC II [GW]	IEC III [GW]
Gujarat – onshore	139,9	0	0,6	139,3
Karnataka	107,4	0,1	0,5	106,8
Maharashtra	97,9	0	0,2	97,6
Andhra Pradesh	93,7	0	0,3	93,4
Tamil Nadu – onshore	71,4	0,2	1,5	69,7
Rajasthan	60,8	0	0	60,8
Uttar Pradesh	60,6	-	-	60,6
Madhya Pradesh	58,4	-	0	58,4
Bihar	34,1	-	-	34,1
Orissa	19,8	-	0	19,8
West Bengal	17,7	-	-	17,7
Haryana	8,4	-	-	8,4
Punjab	2,8	-	-	2,8
Chhattisgarh	1,8	-	0	1,8
Jharkhand	1,1	-	0	1,1
Gujarat - offshore	10,4	-	0,7	9,7
Tamil Nadu - offshore	21,9	0	3,6	18,2

Table 4: Peak wind speed generation capacities vs installed capacities

State	Total [GW]	Installed [GW]	%
Rajasthan	60,8	3,9	6,4%
Maharashtra	97,9	5,1	5,2%
Tamil Nadu	71,4	3,2	4,5%
Andhra Pradesh	93,7	3,9	4,2%
Karnataka	107,4	3,2	3,0%
Madhya Pradesh	58,4	1,7	2,9%
Gujarat	139,9	3,6	2,6%

2.2.2 Capacity factors

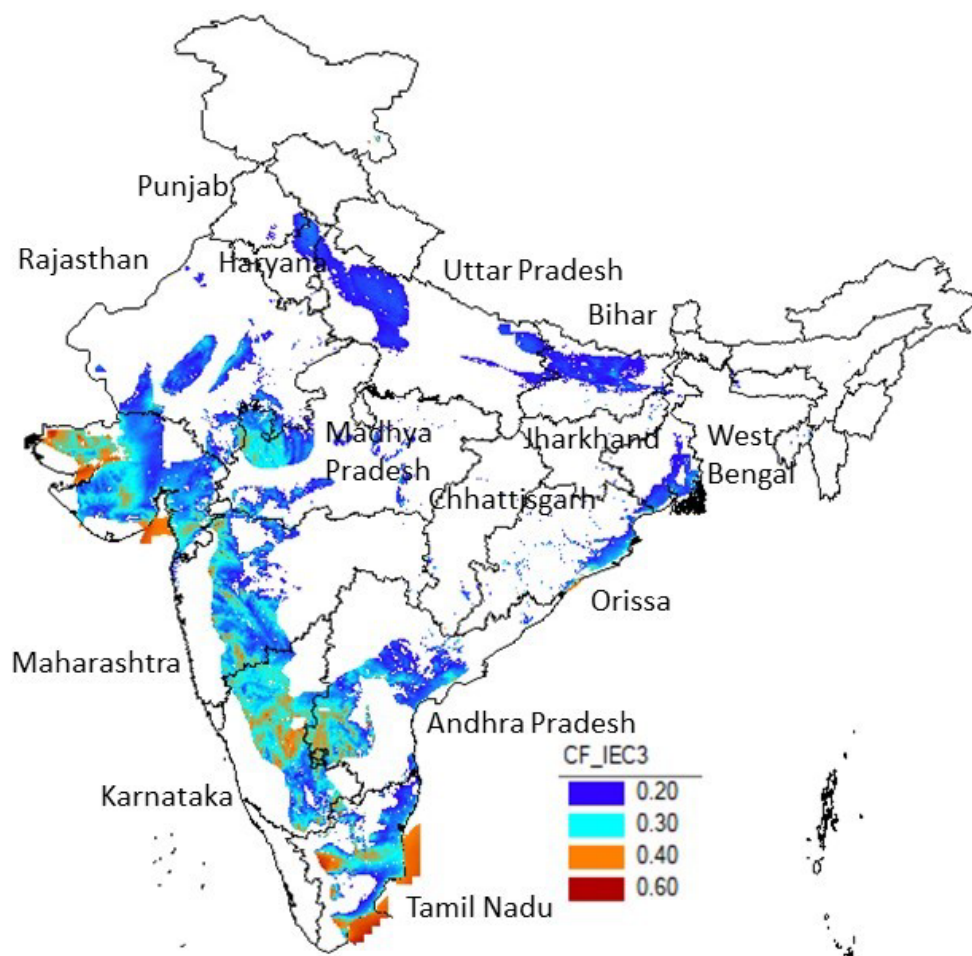
Onshore average capacity factors for IEC class 3 wind turbines above 25% can be found in the

states Karnataka, Tamil Nadu, Gujarat, Andhra Pradesh, and Maharashtra. These are also the states with the highest maximum capacity factors.

Table 5: Capacity factors IEC class 3

State	Mean	Stddev	Min	Max
Tamil Nadu – offshore	45%	4%	40%	61%
Gujarat – offshore	44%	3%	40%	54%
Karnataka	30%	5%	20%	65%
Tamil Nadu – onshore	29%	7%	20%	63%
Gujarat – onshore	28%	5%	20%	69%
Andhra Pradesh	27%	5%	20%	64%
Maharashtra	27%	5%	20%	63%
Madhya Pradesh	25%	4%	20%	53%
Orissa	25%	4%	20%	53%
Rajasthan	24%	3%	20%	57%
Haryana	23%	1%	20%	35%
West Bengal	23%	2%	20%	38%
Uttar Pradesh	21%	1%	20%	28%
Bihar	21%	1%	20%	41%

Figure 1: Capacity factors IEC class 3



2.2.3 Wind speed ratio

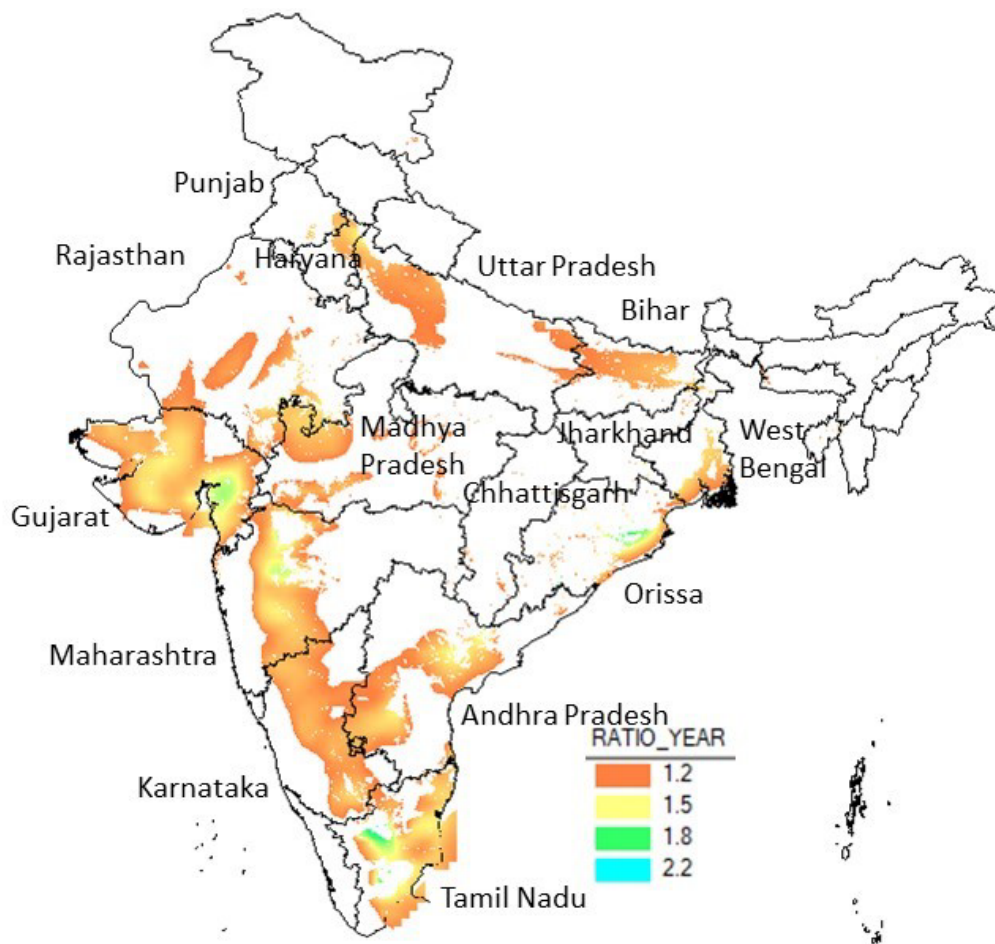
The highest average wind speed ratios can be found in the states Tamil Nadu (on- and offshore), Orissa, Gujarat (on- and offshore),

Haryana, Maharashtra, West Bengal, and Andhra Pradesh. In some of these states, sites with wind speed ratios above 1,8 and 2,0 can be found.

Table 6: Wind speed ratios

State	Mean	Stddev	Min	Max
Tamil Nadu – offshore	1,31	0,05	1,20	1,45
Gujarat – offshore	1,31	0,07	1,20	1,52
Tamil Nadu - onshore	1,39	0,12	1,20	2,12
Orissa	1,37	0,14	1,20	1,94
Gujarat – onshore	1,36	0,09	1,20	1,63
Haryana	1,35	0,05	1,20	1,48
Maharashtra	1,33	0,09	1,20	1,64
West Bengal	1,33	0,07	1,20	1,56
Andhra Pradesh	1,30	0,08	1,20	1,84
Madhya Pradesh	1,29	0,06	1,20	1,45
Karnataka	1,28	0,04	1,20	1,42
Bihar	1,28	0,04	1,20	1,41
Rajasthan	1,27	0,07	1,20	1,51
Uttar Pradesh	1,25	0,05	1,20	1,50

Figure 2: Wind speed ratios



2.2.4 Levelized cost of energy (LCOE)

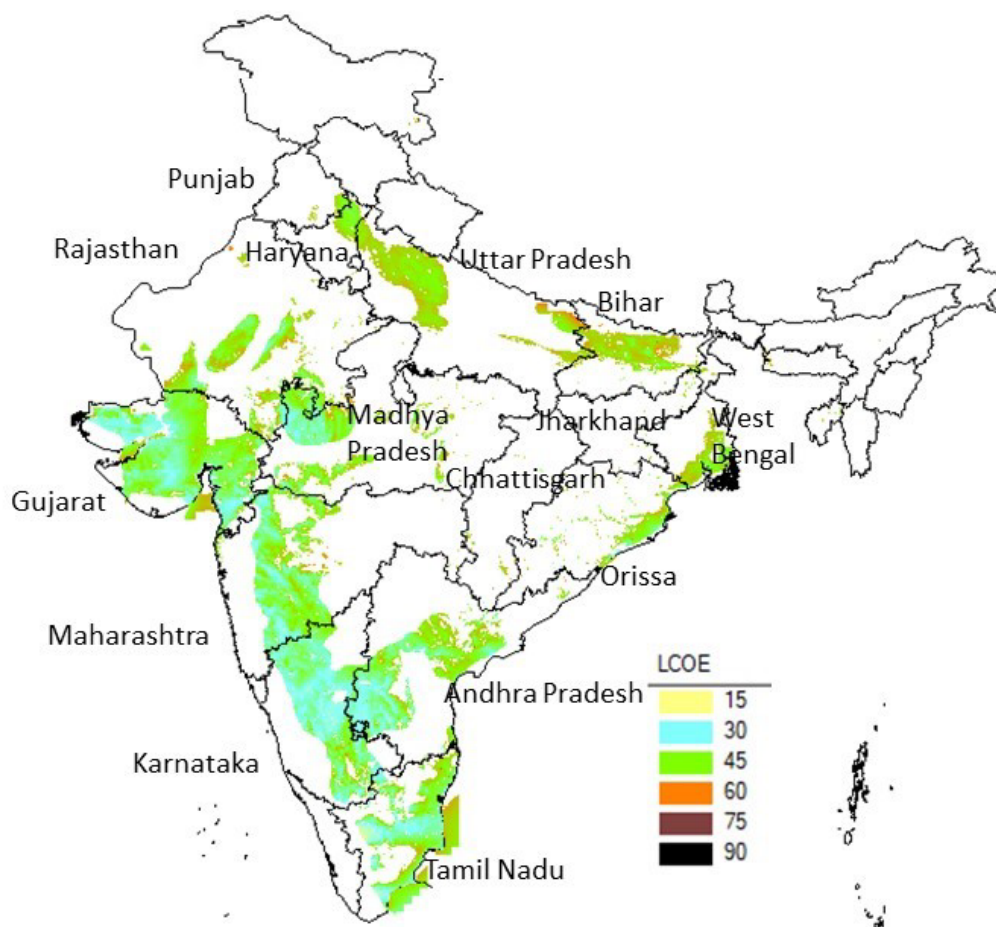
The lowest average Levelized cost of energy (LCOE) can be found in the states of Karnataka,

Tamil Nadu (on- and offshore), Gujarat (on- and offshore), Andhra Pradesh and Maharashtra.

Table 7: Levelized cost of energy (LCOE)

State	Mean	Stddev	Min	Max
Tamil Nadu – offshore	47,9	4,2	34,4	55,8
Gujarat – offshore	49,4	3,8	39,4	55,2
Karnataka	35,7	6,0	15,7	76,2
Tamil Nadu – onshore	38,4	8,1	16,6	76,0
Gujarat – onshore	38,6	6,3	15,0	75,0
Andhra Pradesh	40,3	7,4	16,5	77,4
Maharashtra	40,5	6,4	16,6	81,3
Madhya Pradesh	42,7	6,5	19,4	79,0
Rajasthan	45,7	5,5	18,6	80,0
Orissa	45,8	5,8	20,9	77,3
Haryana	46,0	3,0	30,2	65,0
West Bengal	48,1	3,9	28,9	76,6
Uttar Pradesh	49,2	2,7	39,8	81,6
Bihar	49,6	3,1	25,6	86,3

Figure 3: Levelized cost of energy (LCOE)



2.3 Peak wind speed site analysis

This section describes the results of the detailed analysis of ten potential wind farm sites, eight of them onshore and two offshore. The sites were selected in seven different states in environments that combine high wind speed ratios and high capacity factors, thus low LCOE.

2.4 Data sources and methodology

The detailed site analysis was conducted in windPRO using a combination of mesoscale and microscale modelling. Meso scale modelling was conducted in Weather Research and Forecasting (WRF) and these data were then long term correlated and micromodelled with WASP. Data sources for the models were ERA5 for the wind data, Copernicus Digital Elevation Model DEM GLO-30 for elevation data and GlobCover for roughness data.

To make site assessment comparable, the same IEC class 3 wind turbine model was selected in all ten sites, simulating a wind farm consisting of 12 Vestas V150-4,2 MW with a hub height of 105 m, totalling 50,4 MW in each site. When selecting the individual wind turbine positions, we made sure that these positions were not placed in protected areas (according to Open Street Maps) nor interfered with existing wind turbine positions (as identified in Google Earth).

Wake loss was determined for each wind farm configuration with the N.O. Jensen model applying the DTU default wake decay constant for onshore and offshore wind farms.

The power curve of the V150-4,2 MW was adjusted to the local air density using pressure and temperature measurements from nearby weather stations. To account for additional losses, a lump sum 8% loss factor was applied to the energy production after wake loss.

2.5 Results of analysis

The results of the analysis are presented in ten preliminary energy yield reports that inform the specific input data, the positions of the wind turbines, the energy production forecast, and its daily and seasonal distribution. Heat maps were created in excel format that visualizes the distribution of the energy production and the capacity factors in six-time slots of four hours each and the 12 months of the year.

The representation of the spatial variability of the resource obtained from this modelling is generally very accurate, but it needs to be noted that WRF model output can be subject to high bias and the magnitude of the wind speed must be confirmed in a measurement campaign before any investment decision.

The energy production values and their implication in the energy cost must therefore be interpreted as preliminary. This is especially the case for Saharanpur in Uttar Pradesh; since in this case, no WRF model could be conducted due to the proximity of the Himalayan mountain range. We used modified re-analysis data for the production analysis, with much higher uncertainty than the meso scale data modelled with WRF.

Table 8: Results of site analysis

Report number	Site/ City	State	Production	Capacity factor
21-459-001	Dhenkanal	Orissa	98.090 MWh	22,2%
21-459-002	Chilika	Orissa	139.098 MWh	31,5%
21-459-003	Kharagpur	West Bengal	90.859 MWh	20,6%
21-459-004	Saharanpur	Uttar Pradesh	103.560 MWh	23,5%
21-459-005	Offshore	Gujarat	188.085 MWh	42,6%
21-459-006	Arnod	Gujarat	112.712 MWh	25,5%
21-459-007	Erode	Tamil Nadu	100.780 MWh	22,8%
21-459-008	Offshore	Tamil Nadu	192.133 MWh	43,5%
21-459-009	Harapanahalli	Karnataka	188.728 MWh	42,7%
21-459-010	Proddatur	Andhra Pradesh	203.659 MWh	46,1%

Description of the data sources and tools

The Center for Study of Science, Technology and Policy (CSTEP) is one of India's leading think tanks, with a mission to enrich policymaking with innovative approaches using science and technology for a sustainable, secure, and inclusive society. For additional information: <https://cstep.in/>

Copernicus Digital Elevation Models (DEM) is a set of Digital Elevation Models with global coverage released by the European Space Agency (ESA). Two instances of this dataset are available to the public: a global model at 90m resolution (Copernicus DEM GLO-90) and a near-global model at 30m resolution (Copernicus DEM GLO-30). The Copernicus DEM is a digital surface model (DSM) and it includes all surface structures – like buildings, infrastructure and forests. The Copernicus DEM is derived from an edited DSM named WorldDEM™ with the WorldDEM™ model being based on radar satellite data from the TanDEM-X mission. The WorldDEM model has been infilled on a local basis with other DEMs, such as ASTER, SRTM90, SRTM30, SRTM30plus, GMTED2010, TerraSAR-X Radargrammetric DEM and ALOS World 3D-30m. Produced using Copernicus WorldDEM-30 © DLR e.V. 2010-2014 and © Airbus Defence and Space GmbH 2014-2018 provided under COPERNICUS by the European Union and ESA; all rights reserved. For additional information: <https://spacedata.copernicus.eu/web/cscda/dataset-details?articleId=394198>

ERA5 is a climate reanalysis dataset developed through the Copernicus Climate Change Service (C3S) and processed/delivered by the European Centre for Medium-Range Weather Forecasts ECMWF. The dataset is the successor to the popular but now discontinued ERA-Interim dataset. The ERA5 dataset has several improvements compared to ERA-Interim: A newer modelling system, more observations and higher spatial resolution (31 km) from a native Gaussian modelling grid. For additional

information:

[https://help.emd.dk/mediawiki/index.php?title=ERA5_\(Gaussian_Grid\)](https://help.emd.dk/mediawiki/index.php?title=ERA5_(Gaussian_Grid))

Global Wind Atlas 3.0, is a free, web-based application developed, owned, and operated by the Technical University of Denmark (DTU). The Global Wind Atlas 3.0 is released in partnership with the World Bank Group, utilizing data provided by Vortex, using funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: <https://globalwindatlas.info>

GlobCover is an ESA initiative that began in 2005 in partnership with JRC, EEA, FAO, UNEP, GOFC-GOLD and IGBP. The project aimed to develop a service capable of delivering global composites and land cover maps using input observations from the 300m MERIS sensor onboard the ENVISAT satellite mission. ESA makes available the land cover maps, which cover 2 periods: December 2004 – June 2006 and January – December 2009. For additional information:

http://due.esrin.esa.int/page_globcover.php

WASP is the industry standard for linear flow modelling and energy yield calculation for wind turbines and wind farms. For additional information: <https://www.wasp.dk/>

windPRO is the industry leading software suite for the design and planning of wind farm projects. Successfully used by both large corporations and small entrepreneurs, windPRO is recognized and accepted by banks and authorities worldwide. For additional information: <https://www.emd-international.com/windpro/>

The Weather Research and Forecasting (WRF) Model is a next-generation mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting applications. It features two dynamical cores, a data assimilation system, and a software architecture supporting parallel

computation and system extensibility. The model serves a wide range of meteorological applications across scales from tens of meters to thousands of kilometres. The effort to develop WRF began in the latter 1990s and was a collaborative partnership of the National Center for Atmospheric Research (NCAR), the National Oceanic and Atmospheric Administration (represented by the National

Centers for Environmental Prediction (NCEP) and the Earth System Research Laboratory), the U.S. Air Force, the Naval Research Laboratory, the University of Oklahoma, and the Federal Aviation Administration (FAA). For additional information:

<https://www.mmm.ucar.edu/weather-research-and-forecasting-model>

Annex

4.1 Data source – KMZ Files

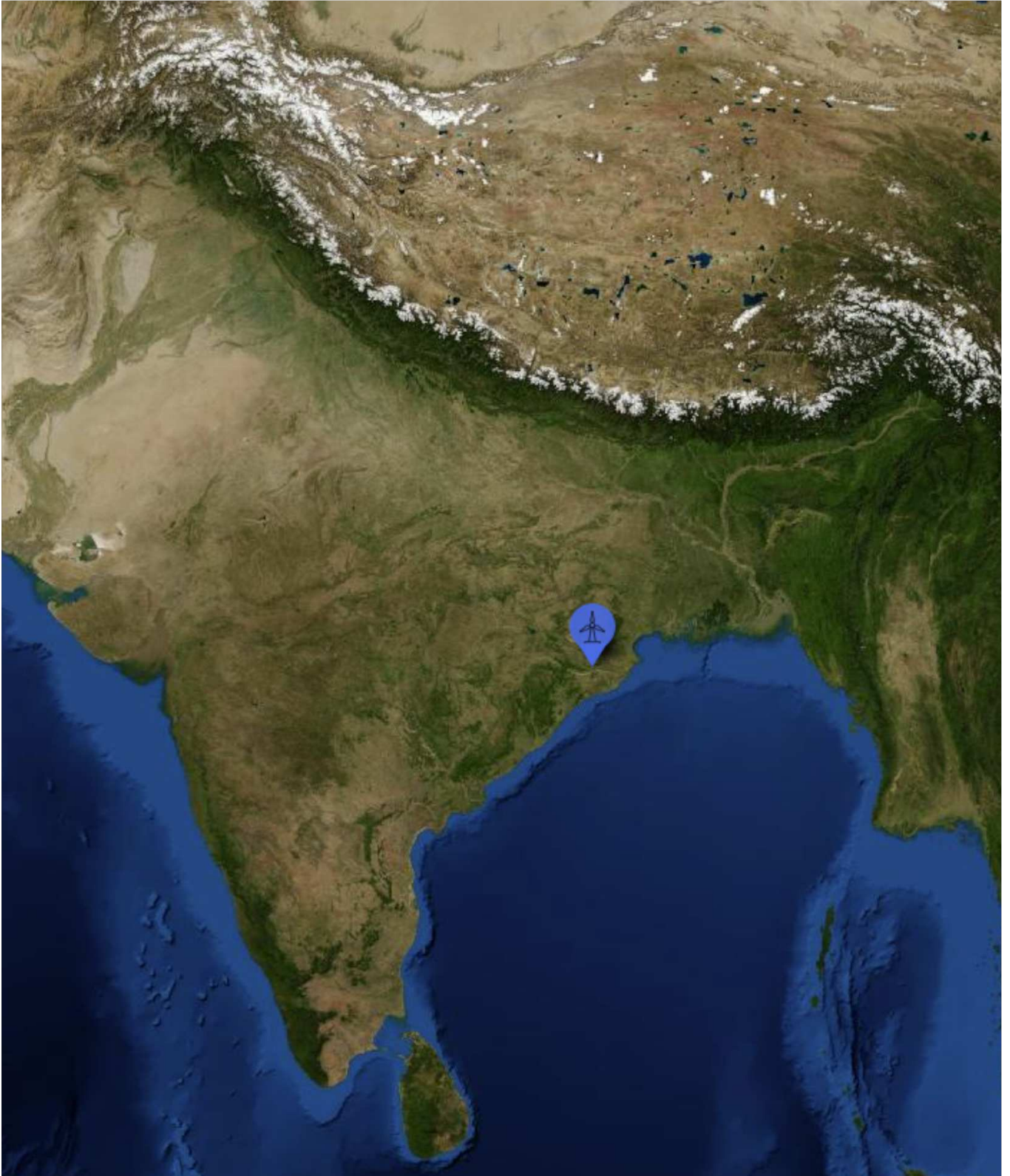
The KMZ files can be downloaded [here](#).

4.2 Preliminary Energy Yield Assessments

The Preliminary Energy Yield Assessments can be downloaded separately [here](#).

Note: Preliminary energy yield assessment based on meso-scale data. Consult with an expert before an investment decision.

Yield Assessment - Dhenkanal, Orissa



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.

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Calculated:
21/2/2022 15:59/3.5.508

PARK - Main Result

Calculation: 22-459-001 Dhenkanal - Orissa

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

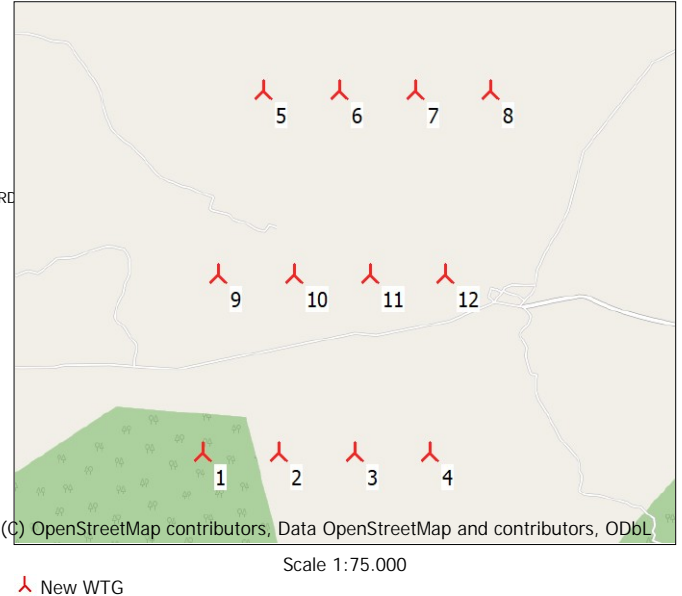
Scaler/wind data

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_N20.679_E085.662 - orissa1
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	24,3	24,0			
From air density settings [hPa]	959,0	993,2	987,6			
Resulting air density [kg/m³]	1,131	1,163	1,158			
Relative to 15°C at sea level [%]	92,3	94,9	94,5	-4,3	-4,3	0,0



Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	Result-8,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Wake loss [%]	Specific results ^{a)}		Wind speed			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	free [m/s]	wake [m/s]	reduced [m/s]
Wind farm	106.619,6	98.090,0	113.318,4	5,9	22,2	8.174,2	1.946	5,1		5,0

^{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			Wind speed	
									Result [MWh/y]	Result-8,0% [MWh/y]	Wake loss [%]	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-OS - 08-2019	16.487,6	15.169	2,1	7,17	7,09	
2 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	8.362,2	7.693	2,4	4,88	4,80	
3 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	8.085,4	7.439	4,1	4,87	4,76	
4 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	7.935,0	7.300	3,3	4,81	4,73	
5 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	11.274,0	10.372	5,9	5,77	5,61	
6 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	7.522,5	6.921	9,3	4,83	4,64	
7 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	7.892,8	7.261	10,0	4,95	4,75	
8 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	7.890,8	7.260	7,5	4,90	4,75	
9 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	8.125,5	7.475	4,8	4,90	4,79	
10 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	7.821,1	7.195	8,4	4,90	4,72	
11 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	7.760,1	7.139	9,1	4,90	4,71	
12 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	7.462,5	6.866	7,7	4,78	4,63	

WTG siting

	Geo [deg]-WGS84	Longitude	Latitude	Z [m]	Row data/Description	Calculation period	
						Start	End
1 New	85,642376° E	20,657362° N	373,3	90,0°, 750,0 m	1/1/2002	1/1/2022	
2 New	85,649574° E	20,657362° N	101,1		1/1/2002	1/1/2022	
3 New	85,656773° E	20,657362° N	80,8		1/1/2002	1/1/2022	
4 New	85,663971° E	20,657362° N	69,0		1/1/2002	1/1/2022	
5 New	85,648143° E	20,689547° N	190,6	90,0°, 750,0 m	1/1/2002	1/1/2022	
6 New	85,655343° E	20,689547° N	77,8		1/1/2002	1/1/2022	
7 New	85,662543° E	20,689547° N	92,6		1/1/2002	1/1/2022	
8 New	85,669743° E	20,689547° N	87,1		1/1/2002	1/1/2022	
9 New	85,643851° E	20,673166° N	98,5	90,0°, 750,0 m	1/1/2002	1/1/2022	
10 New	85,651050° E	20,673166° N	95,2		1/1/2002	1/1/2022	
11 New	85,658250° E	20,673166° N	88,3		1/1/2002	1/1/2022	
12 New	85,665449° E	20,673166° N	74,0		1/1/2002	1/1/2022	

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.

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Mathias Thamhain / mth@emd.dk
Calculated:
21/2/2022 15:59/3.5.508

PARK - Wind Data Analysis

Calculation: 22-459-001 Dhenkanal - OrissaWind 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° (1); Hub height: 105,0

Site coordinates

Geo WGS84

East: 85,642376° E North: 20,657362° N

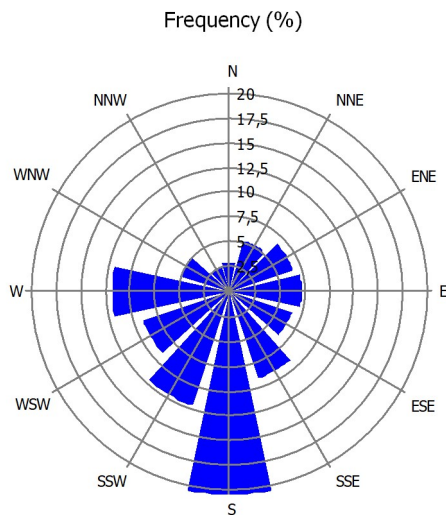
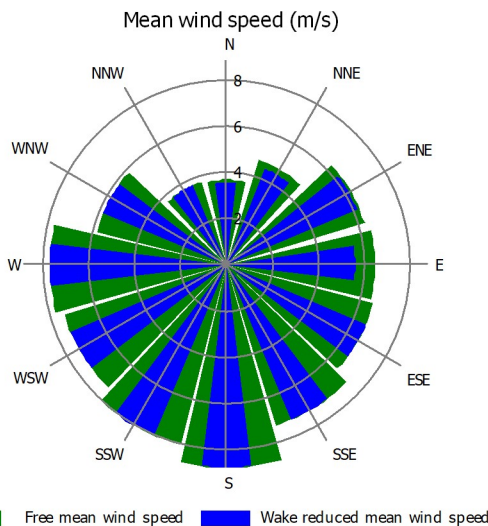
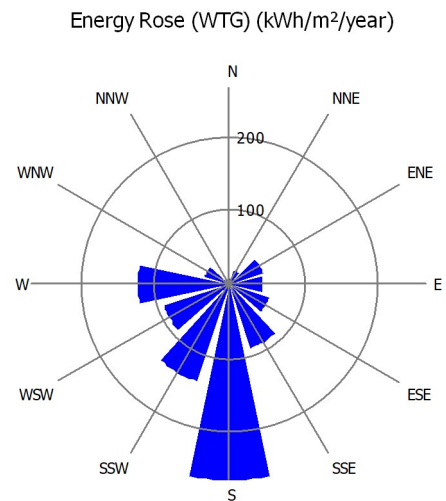
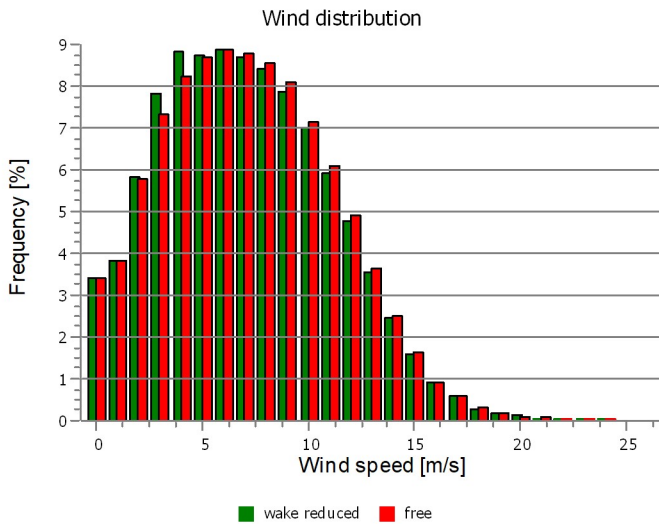
4*VESTAS V150-4.2 4200 150.0 !O! hub: 105,0 m (TOT: 180,0 m) dist: 750 m (5,0 RD) angle: 90° (1)

Masts used

Take nearest

Winddata for site

Sector	Free mean wind speed [m/s]	Wake reduced mean wind speed [m/s]	Frequency [%]
0 N	3,7	3,6	3,0
1 NNE	4,7	4,5	5,3
2 ENE	6,3	6,2	6,8
3 E	6,5	5,6	7,3
4 ESE	6,6	6,6	6,7
5 SSE	7,3	7,3	9,3
6 S	8,8	8,8	20,6
7 SSW	8,1	8,1	12,1
8 WSW	7,4	7,4	9,2
9 W	7,7	7,7	11,9
10 WNW	5,8	5,8	5,2
11 NNW	3,8	3,8	2,6
All	7,2	7,1	100,0



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21/2/2022 15:59/3.5.508

PARK - Time varying AEP

Calculation: 22-459-001 Dhenkanal - Orissa

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	307	443	715	843	822	707	593	515	422	229	177	225	5.995
1	225	372	632	802	792	687	615	540	396	221	154	177	5.613
2	175	290	540	709	705	638	612	522	406	204	135	157	5.093
3	162	232	392	505	526	509	496	434	326	186	116	123	4.008
4	144	182	326	496	531	512	468	436	306	178	110	110	3.800
5	135	140	249	435	503	477	432	414	327	182	122	133	3.547
6	129	123	182	338	451	415	424	386	309	183	137	131	3.207
7	138	94	150	264	346	356	365	339	279	164	114	139	2.748
8	79	69	111	187	289	337	369	342	259	148	74	79	2.342
9	91	81	94	177	275	349	372	381	265	177	83	86	2.430
10	87	81	126	198	242	374	402	387	293	203	112	104	2.608
11	71	83	109	180	284	384	410	392	304	204	114	88	2.623
12	58	96	120	198	265	361	424	379	289	202	105	81	2.579
13	74	103	142	207	279	334	412	403	321	211	104	78	2.667
14	86	115	176	249	324	357	422	414	354	214	100	89	2.901
15	88	141	224	313	382	362	375	379	301	210	100	81	2.957
16	106	194	329	549	583	440	449	404	349	219	107	93	3.823
17	219	322	536	840	855	657	553	545	390	264	195	180	5.555
18	400	568	798	997	1.013	805	667	610	477	332	297	300	7.264
19	536	676	896	1.020	983	799	689	643	473	373	370	398	7.856
20	551	667	880	955	898	776	653	562	479	332	359	429	7.540
21	493	611	866	899	814	692	561	517	416	313	305	396	6.884
22	444	566	810	877	811	652	568	501	390	271	252	323	6.466
23	360	527	760	851	842	646	541	474	376	241	211	282	6.111
Grand Total	5.156	6.776	10.165	13.089	13.814	12.627	11.871	10.919	8.507	5.462	3.951	4.282	106.620

Hour/Month [MW]	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
0	9,9	15,8	23,1	28,1	26,5	23,6	19,1	16,6	14,1	7,4	5,9	7,3	16,4
1	7,2	13,3	20,4	26,7	25,6	22,9	19,8	17,4	13,2	7,1	5,1	5,7	15,4
2	5,6	10,4	17,4	23,6	22,7	21,3	19,7	16,9	13,5	6,6	4,5	5,1	14,0
3	5,2	8,3	12,6	16,8	17,0	17,0	16,0	14,0	10,9	6,0	3,9	4,0	11,0
4	4,6	6,5	10,5	16,5	17,1	17,1	15,1	14,1	10,2	5,7	3,7	3,5	10,4
5	4,4	5,0	8,0	14,5	16,2	15,9	13,9	13,3	10,9	5,9	4,1	4,3	9,7
6	4,2	4,4	5,9	11,3	14,5	13,8	13,7	12,4	10,3	5,9	4,6	4,2	8,8
7	4,5	3,4	4,8	8,8	11,1	11,9	11,8	10,9	9,3	5,3	3,8	4,5	7,5
8	2,6	2,4	3,6	6,2	9,3	11,2	11,9	11,0	8,6	4,8	2,5	2,6	6,4
9	2,9	2,9	3,0	5,9	8,9	11,6	12,0	12,3	8,8	5,7	2,8	2,8	6,7
10	2,8	2,9	4,1	6,6	7,8	12,5	13,0	12,5	9,8	6,5	3,7	3,3	7,1
11	2,3	3,0	3,5	6,0	9,2	12,8	13,2	12,7	10,1	6,6	3,8	2,8	7,2
12	1,9	3,4	3,9	6,6	8,5	12,0	13,7	12,2	9,6	6,5	3,5	2,6	7,1
13	2,4	3,7	4,6	6,9	9,0	11,1	13,3	13,0	10,7	6,8	3,5	2,5	7,3
14	2,8	4,1	5,7	8,3	10,5	11,9	13,6	13,4	11,8	6,9	3,3	2,9	7,9
15	2,8	5,0	7,2	10,4	12,3	12,1	12,1	12,2	10,0	6,8	3,3	2,6	8,1
16	3,4	6,9	10,6	18,3	18,8	14,7	14,5	13,0	11,6	7,1	3,6	3,0	10,5
17	7,1	11,5	17,3	28,0	27,6	21,9	17,8	17,6	13,0	8,5	6,5	5,8	15,2
18	12,9	20,3	25,7	33,2	32,7	26,8	21,5	19,7	15,9	10,7	9,9	9,7	19,9
19	17,3	24,1	28,9	34,0	31,7	26,6	22,2	20,7	15,8	12,0	12,3	12,9	21,5
20	17,8	23,8	28,4	31,8	29,0	25,9	21,0	18,1	16,0	10,7	12,0	13,8	20,7
21	15,9	21,8	27,9	30,0	26,3	23,1	18,1	16,7	13,9	10,1	10,2	12,8	18,9
22	14,3	20,2	26,1	29,2	26,2	21,7	18,3	16,2	13,0	8,8	8,4	10,4	17,7
23	11,6	18,8	24,5	28,4	27,2	21,5	17,5	15,3	12,5	7,8	7,0	9,1	16,7
Grand Total	6,9	10,1	13,7	18,2	18,6	17,5	16,0	14,7	11,8	7,3	5,5	5,8	12,2

PARK - Time varying AEP

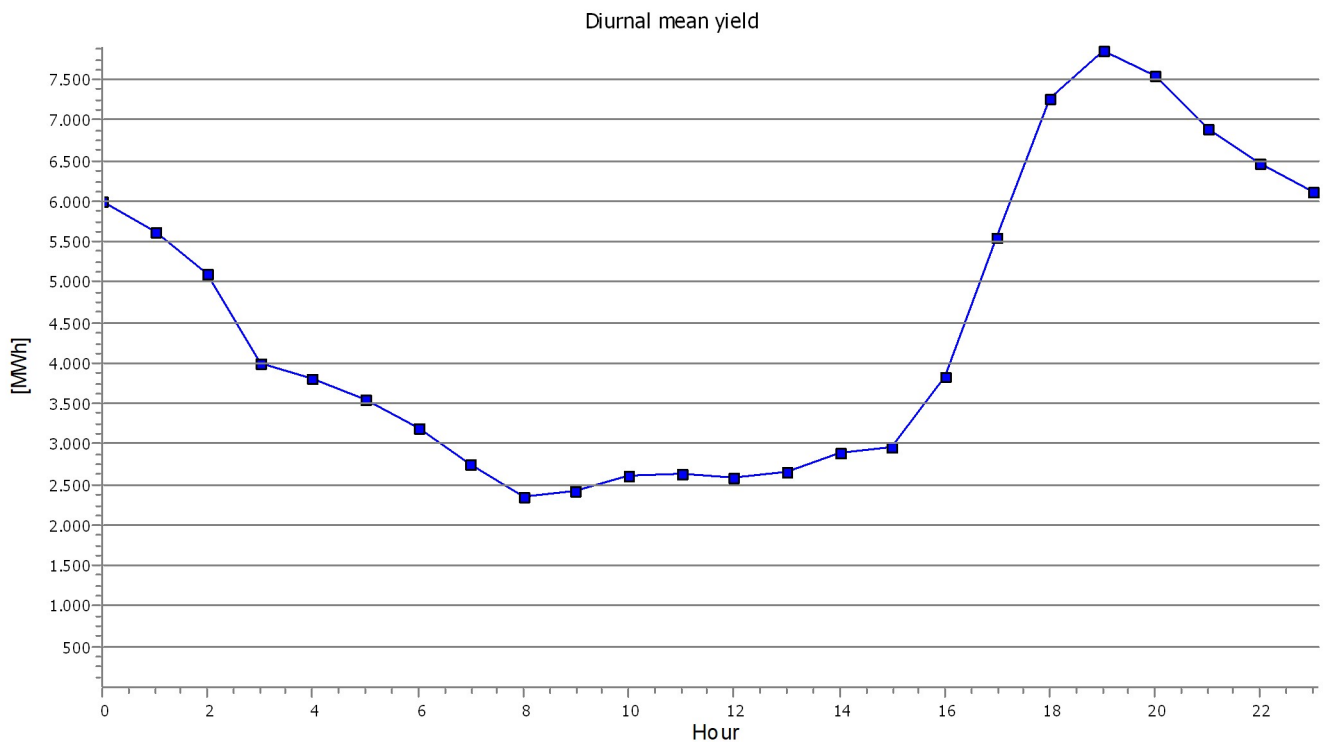
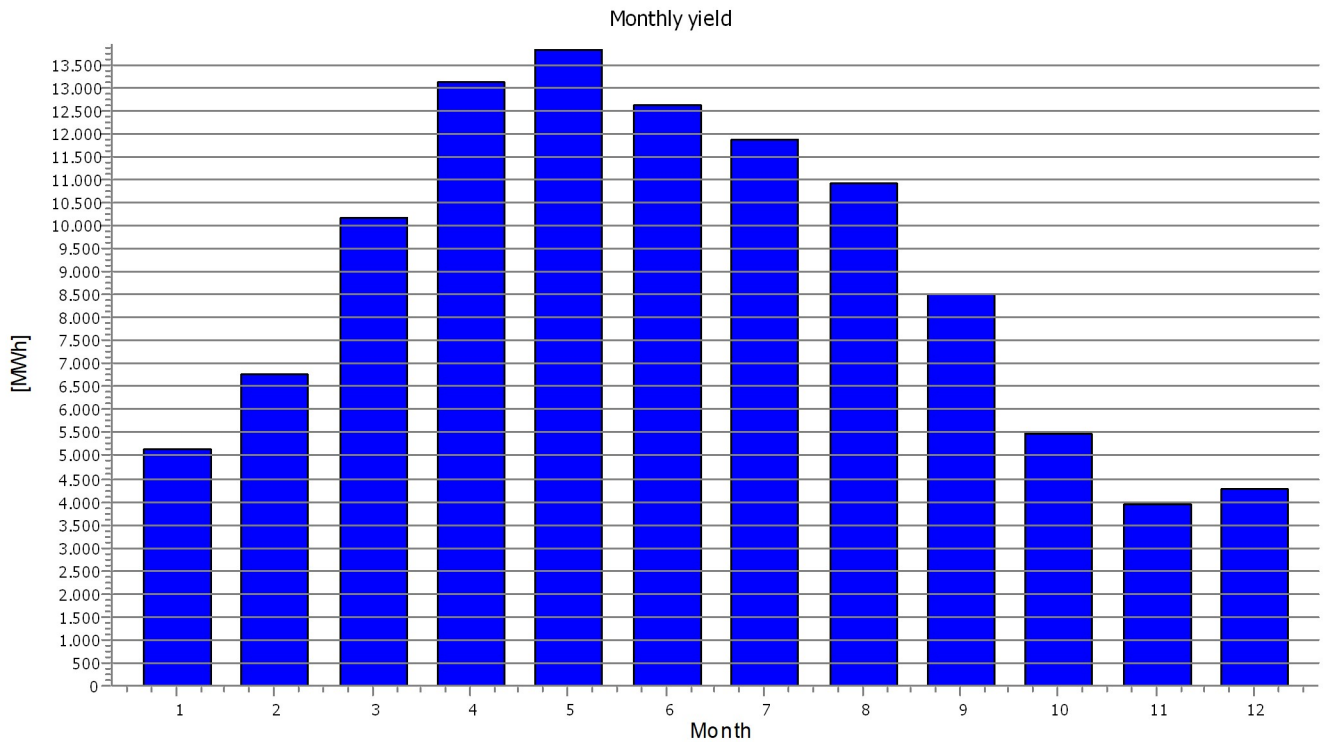
Calculation: 22-459-001 Dhenkanal - Orissa

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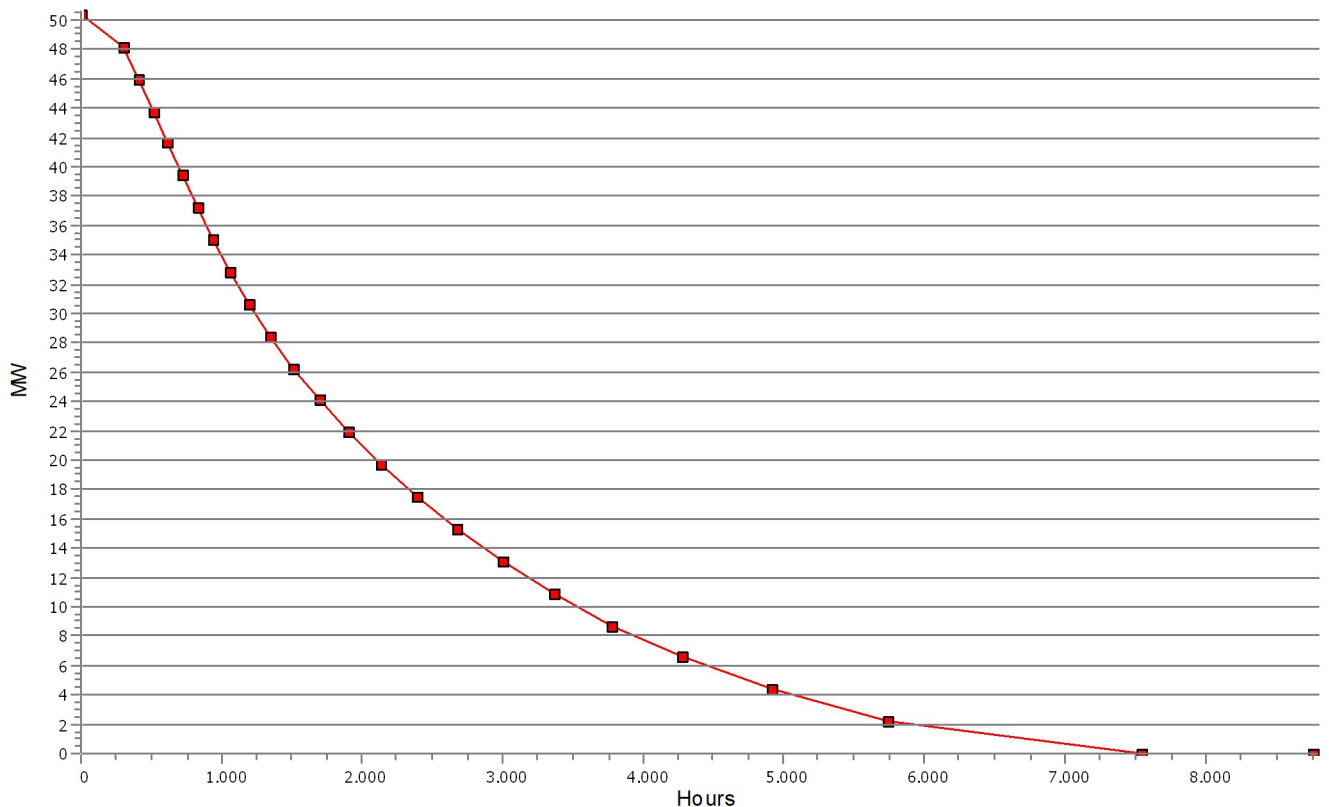
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Windfarm: 50,4 MW based on 12 turbines of type VESTAS V150-4.2 4200 150.0 !O!.

Selection: All new WTGs

Hours	Hours [%]	Hours accumulated	Power [MW]	Power (MW/WTG)
0	0,0	0	50,4	4,2
292	3,3	292	48,2 - 50,4	4,0 - 4,2
115	1,3	407	46,0 - 48,2	3,8 - 4,0
106	1,2	513	43,8 - 46,0	3,7 - 3,8
100	1,1	614	41,6 - 43,8	3,5 - 3,7
102	1,2	716	39,4 - 41,6	3,3 - 3,5
106	1,2	821	37,3 - 39,4	3,1 - 3,3
111	1,3	932	35,1 - 37,3	2,9 - 3,1
125	1,4	1057	32,9 - 35,1	2,7 - 2,9
135	1,5	1191	30,7 - 32,9	2,6 - 2,7
152	1,7	1344	28,5 - 30,7	2,4 - 2,6
166	1,9	1510	26,3 - 28,5	2,2 - 2,4
183	2,1	1693	24,1 - 26,3	2,0 - 2,2
207	2,4	1900	21,9 - 24,1	1,8 - 2,0
228	2,6	2128	19,7 - 21,9	1,6 - 1,8
255	2,9	2383	17,5 - 19,7	1,5 - 1,6
291	3,3	2674	15,3 - 17,5	1,3 - 1,5
319	3,6	2993	13,1 - 15,3	1,1 - 1,3
368	4,2	3361	11,0 - 13,1	0,9 - 1,1
418	4,8	3779	8,8 - 11,0	0,7 - 0,9
499	5,7	4278	6,6 - 8,8	0,5 - 0,7
630	7,2	4909	4,4 - 6,6	0,4 - 0,5
833	9,5	5742	2,2 - 4,4	0,2 - 0,4
1805	20,6	7547	0,0 - 2,2	0,0 - 0,2
1219	13,9	8766	0,0	0,0

Duration curve 50,4 MW WindFarm



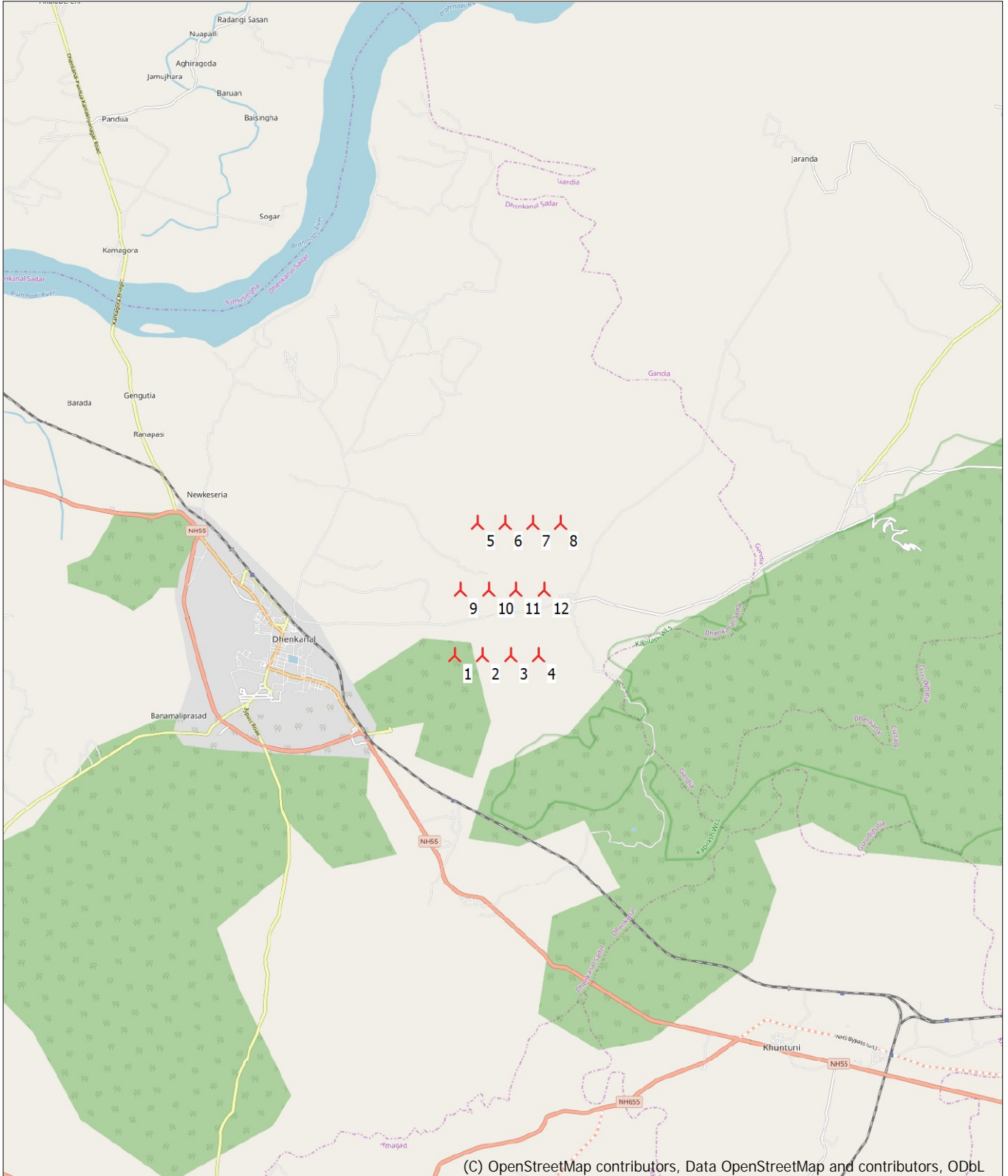
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21/2/2022 15:59/3.5.508

PARK - Map

Calculation: 22-459-001 Dhenkanal - Orissa



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:150.000, Map center Geo WGS84 East: 85,656059° E North: 20,673455° N

 New WTG

Heat Maps - Dhenkanal, Orissa

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	822	521	316	290	1,158	1,712	4,819
2	1,252	515	302	429	1,601	2,183	6,281
3	2,109	862	424	622	2,312	3,025	9,355
4	2,620	1,438	708	909	3,050	3,242	11,967
5	2,607	1,702	1,021	1,164	3,080	3,054	12,628
6	2,324	1,625	1,318	1,291	2,455	2,533	11,546
7	2,117	1,558	1,414	1,482	2,158	2,143	10,873
8	1,849	1,449	1,361	1,428	2,014	1,901	10,002
9	1,430	1,123	1,021	1,155	1,557	1,542	7,829
10	785	660	674	768	1,095	1,079	5,061
11	552	463	363	387	893	1,055	3,713
12	646	488	340	313	897	1,333	4,017
Total	19,112	12,405	9,262	10,239	22,271	24,802	98,090

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	13.1%	8.3%	5.1%	4.6%	18.5%	27.4%	12.9%
2	22.2%	9.1%	5.3%	7.6%	28.4%	38.7%	18.5%
3	33.7%	13.8%	6.8%	10.0%	37.0%	48.4%	24.9%
4	43.3%	23.8%	11.7%	15.0%	50.4%	53.6%	33.0%
5	41.7%	27.2%	16.3%	18.6%	49.3%	48.9%	33.7%
6	38.4%	26.9%	21.8%	21.4%	40.6%	41.9%	31.8%
7	33.9%	24.9%	22.6%	23.7%	34.5%	34.3%	29.0%
8	29.6%	23.2%	21.8%	22.9%	32.2%	30.4%	26.7%
9	23.6%	18.6%	16.9%	19.1%	25.7%	25.5%	21.6%
10	12.6%	10.6%	10.8%	12.3%	17.5%	17.3%	13.5%
11	9.1%	7.6%	6.0%	6.4%	14.8%	17.4%	10.2%
12	10.3%	7.8%	5.4%	5.0%	14.4%	21.3%	10.7%
Total	26.0%	16.9%	12.6%	13.9%	30.3%	33.7%	22.2%

Yield Assessment - Chilika, Orissa



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.

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Mathias Thamhain / mth@emd.dk
Calculated:
21/2/2022 09:08/3.5.508

PARK - Main Result

Calculation: 22-459-002 Chilika - Orissa

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

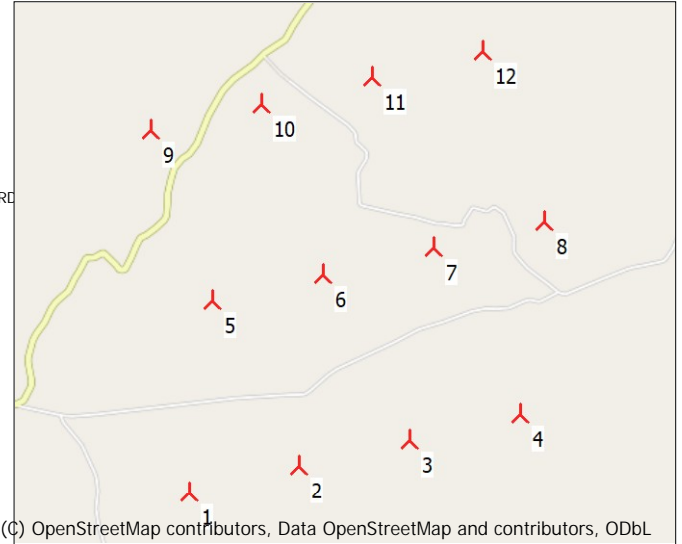
Scaler/wind data

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_N19.632_E085.363 - Chilika
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]	24,7	24,8	24,8			
From air density settings [hPa]	1000,0	1001,0	1000,7			
Resulting air density [kg/m³]	1,170	1,170	1,170			
Relative to 15°C at sea level [%]	95,5	95,5	95,5	-2,9	-2,9	0,0



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

Scale 1:50.000

▲ New WTG

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	Result-8,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Wake loss [%]	Specific results ^{a)}		Wind speed			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	free [m/s]	wake [m/s]	reduced [m/s]
Wind farm	151.192,9	139.097,5	159.069,1	5,0	31,5	11.591,5	2.760	6,2		6,0

^{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			Wind speed	
									Result [MWh/y]	Result-8,0% [MWh/y]	Wake loss [%]	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-OS - 08-2019	13.586,0	12.499	1,5	6,30	6,24	
2 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	13.256,2	12.196	2,2	6,23	6,15	
3 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	13.499,0	12.419	2,1	6,30	6,22	
4 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	13.582,5	12.496	1,3	6,29	6,24	
5 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	12.639,8	11.629	4,1	6,13	5,99	
6 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	12.073,7	11.108	7,3	6,09	5,86	
7 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	12.211,6	11.235	7,9	6,15	5,91	
8 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	12.494,3	11.495	7,0	6,20	5,99	
9 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	12.424,8	11.431	2,3	6,01	5,93	
10 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	12.067,4	11.102	6,0	6,04	5,85	
11 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	11.675,8	10.742	8,9	6,04	5,78	
12 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	11.681,8	10.747	9,4	6,06	5,80	

WTG siting

	Geo [deg]-WGS84	Longitude	Latitude	Z [m]	Row data/Description	Calculation period	
						Start	End
1 New	85,353470° E	19,618173° N	9,7	76,6°, 750,0 m	1/1/2002	1/1/2022	
2 New	85,360428° E	19,619734° N	2,0		1/1/2002	1/1/2022	
3 New	85,367386° E	19,621294° N	5,0		1/1/2002	1/1/2022	
4 New	85,374344° E	19,622855° N	2,6		1/1/2002	1/1/2022	
5 New	85,354939° E	19,629562° N	7,8	76,6°, 750,0 m	1/1/2002	1/1/2022	
6 New	85,361897° E	19,631122° N	2,0		1/1/2002	1/1/2022	
7 New	85,368856° E	19,632683° N	4,7		1/1/2002	1/1/2022	
8 New	85,375814° E	19,634243° N	5,8		1/1/2002	1/1/2022	
9 New	85,351086° E	19,639656° N	1,6	76,6°, 750,0 m	1/1/2002	1/1/2022	
10 New	85,358045° E	19,641217° N	2,0		1/1/2002	1/1/2022	
11 New	85,365004° E	19,642777° N	2,0		1/1/2002	1/1/2022	
12 New	85,371963° E	19,644337° N	3,0		1/1/2002	1/1/2022	

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Mathias Thamhain / mth@emd.dk
Calculated:
21/2/2022 09:08/3.5.508

PARK - Wind Data Analysis

Calculation: 22-459-002 Chilika - Orissa Wind 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: 77° (5); Hub height: 105,0

Site coordinates

Geo WGS84

East: 85,353470° E North: 19,618173° N

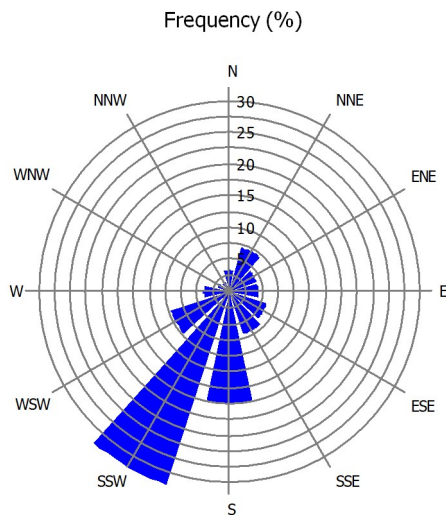
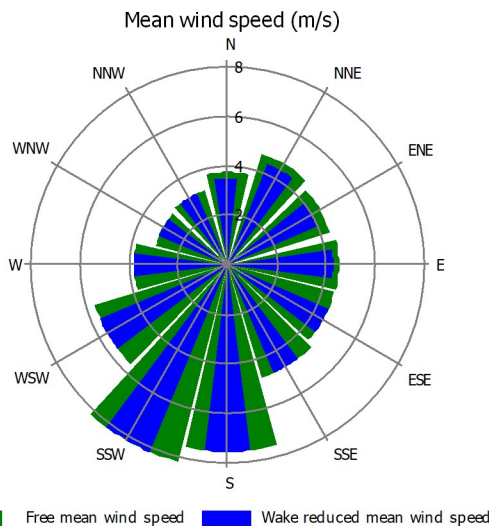
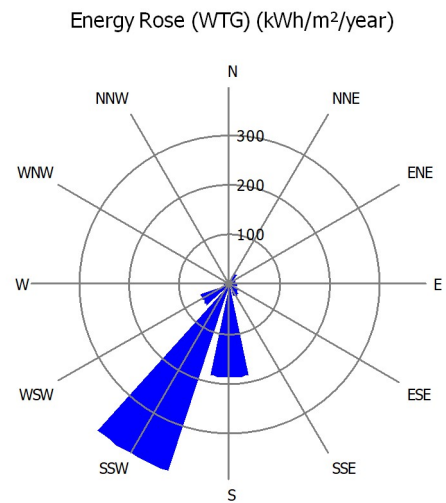
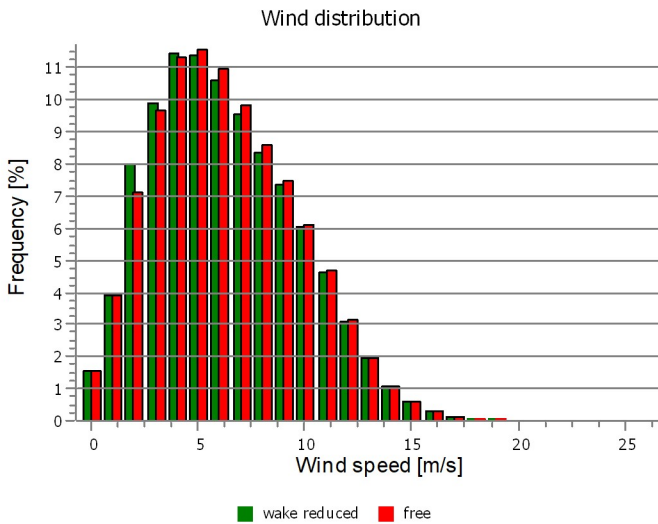
4*VESTAS V150-4.2 4200 150.0 !O! hub: 105,0 m (TOT: 180,0 m) dist: 750 m (5,0 RD) angle: 77° (5)

Masts used

Take nearest

Winddata for site

Sector	Free mean wind speed [m/s]	Wake reduced mean wind speed [m/s]	Frequency [%]	
0 N		3,8	3,5	3,5
1 NNE	4,7	4,4	4,4	7,2
2 ENE	4,4	4,0	4,0	4,5
3 E	4,6	4,3	4,3	4,5
4 ESE	4,5	4,5	4,5	6,1
5 SSE	4,8	4,8	4,8	7,0
6 S	7,6	7,6	7,6	17,7
7 SSW	8,3	8,3	8,3	32,0
8 WSW	5,7	5,7	5,7	9,7
9 W	3,8	3,8	3,8	4,1
10 WNW	3,0	3,0	3,0	2,0
11 NNW	3,2	3,2	3,2	1,6
All	6,3	6,2	6,2	100,0



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Calculated:
21/2/2022 09:08/3.5.508

PARK - Time varying AEP

Calculation: 22-459-002 Chilika - Orissa

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	132	261	630	952	958	844	718	570	419	193	129	128	5.932
1	113	226	579	935	961	805	696	550	388	204	130	132	5.721
2	122	198	552	906	943	758	686	527	386	210	146	144	5.577
3	138	194	524	842	860	664	582	462	344	213	154	155	5.131
4	151	183	491	840	843	667	585	457	331	218	151	166	5.084
5	145	164	465	819	825	677	586	461	342	220	167	186	5.058
6	142	163	422	761	815	641	611	458	324	217	178	177	4.909
7	156	156	393	726	791	623	580	445	326	227	192	197	4.812
8	150	148	385	682	787	629	606	452	320	222	187	203	4.772
9	148	156	367	709	837	629	582	446	334	214	152	174	4.748
10	117	159	412	809	859	649	602	458	344	207	135	149	4.901
11	109	185	454	872	985	712	628	494	373	201	121	115	5.249
12	125	258	604	1.016	1.088	799	707	552	413	213	126	118	6.020
13	200	369	753	1.132	1.176	902	808	690	523	289	154	141	7.136
14	281	501	902	1.210	1.259	1.008	929	832	637	373	213	204	8.347
15	351	562	946	1.226	1.231	1.044	966	887	642	412	271	262	8.800
16	382	582	933	1.174	1.191	1.049	1.008	892	713	426	290	290	8.929
17	373	542	881	1.107	1.119	998	976	912	654	404	299	285	8.550
18	353	522	866	1.085	1.069	949	887	793	616	373	258	268	8.040
19	328	479	848	1.077	1.053	913	820	759	543	320	241	242	7.623
20	275	436	785	1.031	1.001	921	794	692	498	260	204	223	7.121
21	209	393	745	992	950	865	724	639	412	240	172	198	6.538
22	174	320	694	967	945	835	750	616	395	215	147	157	6.215
23	135	294	661	950	970	833	717	573	385	196	130	139	5.982
Grand Total	4.809	7.449	15.291	22.818	23.517	19.413	17.549	14.619	10.663	6.266	4.347	4.453	151.193

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

PARK - Time varying AEP

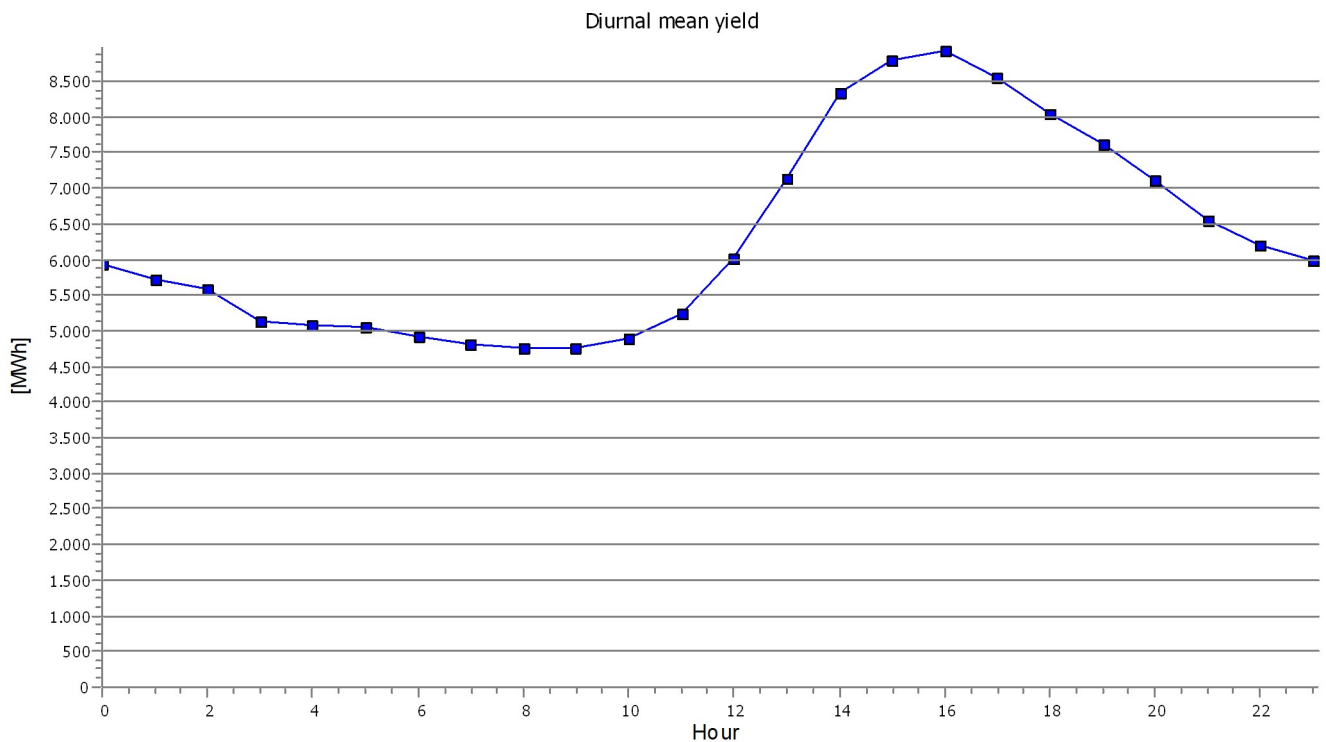
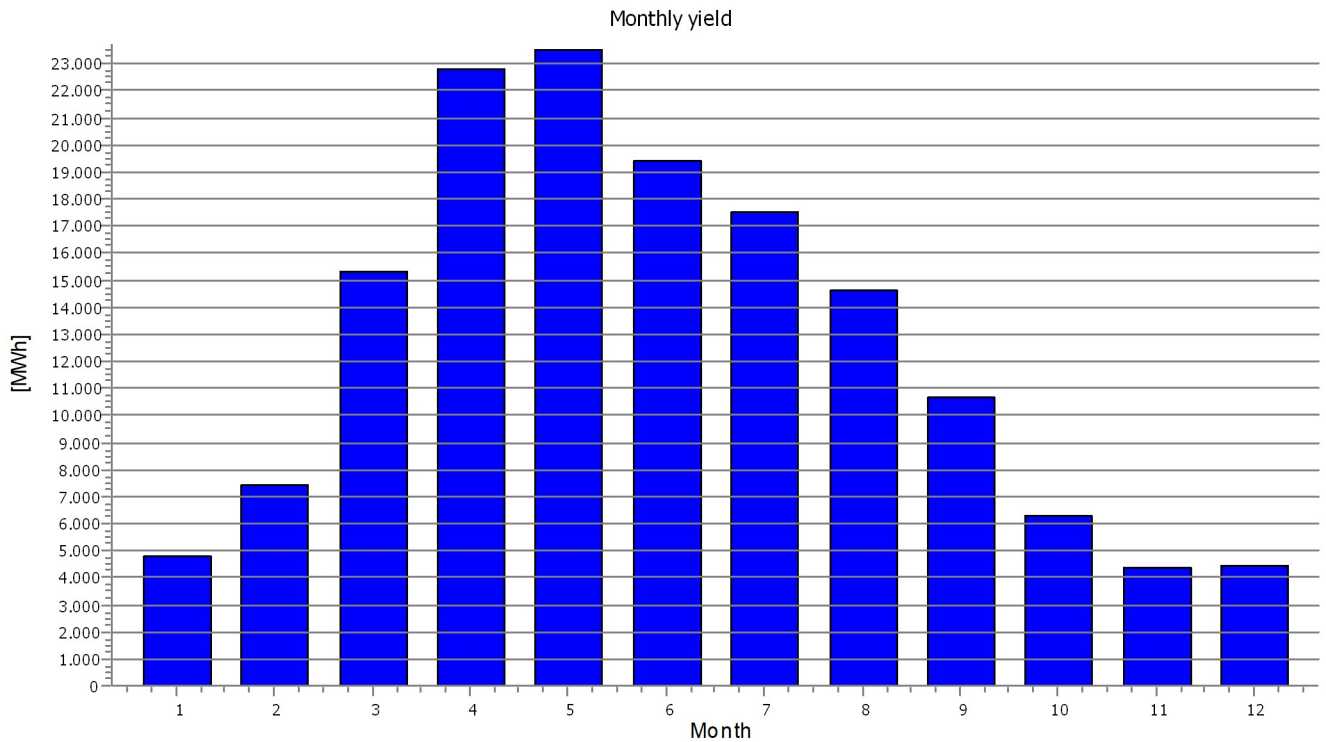
Calculation: 22-459-002 Chilika - Orissa

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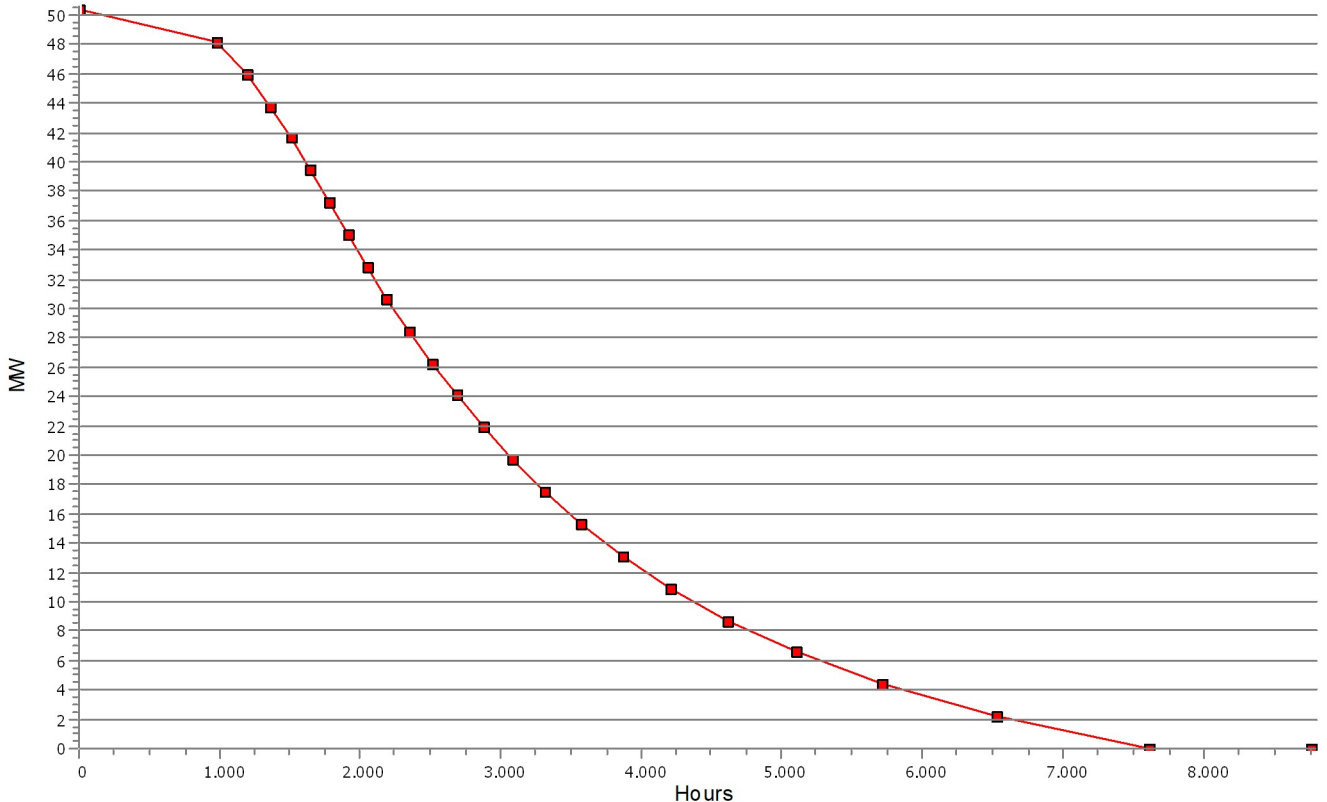
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Windfarm: 50,4 MW based on 12 turbines of type VESTAS V150-4.2 4200 150.0 !O!.

Selection: All new WTGs

Hours	Hours [%]	Hours accumulated	Power [MW]	Power (MW/WTG)
0	0,0	0	50,4	4,2
971	11,1	971	48,2 - 50,4	4,0 - 4,2
222	2,5	1193	46,0 - 48,2	3,8 - 4,0
167	1,9	1359	43,8 - 46,0	3,7 - 3,8
145	1,7	1504	41,6 - 43,8	3,5 - 3,7
138	1,6	1642	39,4 - 41,6	3,3 - 3,5
139	1,6	1780	37,3 - 39,4	3,1 - 3,3
135	1,5	1915	35,1 - 37,3	2,9 - 3,1
136	1,6	2051	32,9 - 35,1	2,7 - 2,9
140	1,6	2191	30,7 - 32,9	2,6 - 2,7
155	1,8	2346	28,5 - 30,7	2,4 - 2,6
166	1,9	2512	26,3 - 28,5	2,2 - 2,4
176	2,0	2688	24,1 - 26,3	2,0 - 2,2
190	2,2	2878	21,9 - 24,1	1,8 - 2,0
205	2,3	3083	19,7 - 21,9	1,6 - 1,8
228	2,6	3312	17,5 - 19,7	1,5 - 1,6
254	2,9	3566	15,3 - 17,5	1,3 - 1,5
300	3,4	3865	13,1 - 15,3	1,1 - 1,3
343	3,9	4209	11,0 - 13,1	0,9 - 1,1
402	4,6	4611	8,8 - 11,0	0,7 - 0,9
489	5,6	5100	6,6 - 8,8	0,5 - 0,7
615	7,0	5715	4,4 - 6,6	0,4 - 0,5
808	9,2	6523	2,2 - 4,4	0,2 - 0,4
1088	12,4	7611	0,0 - 2,2	0,0 - 0,2
1155	13,2	8766	0,0	0,0

Duration curve 50,4 MW WindFarm



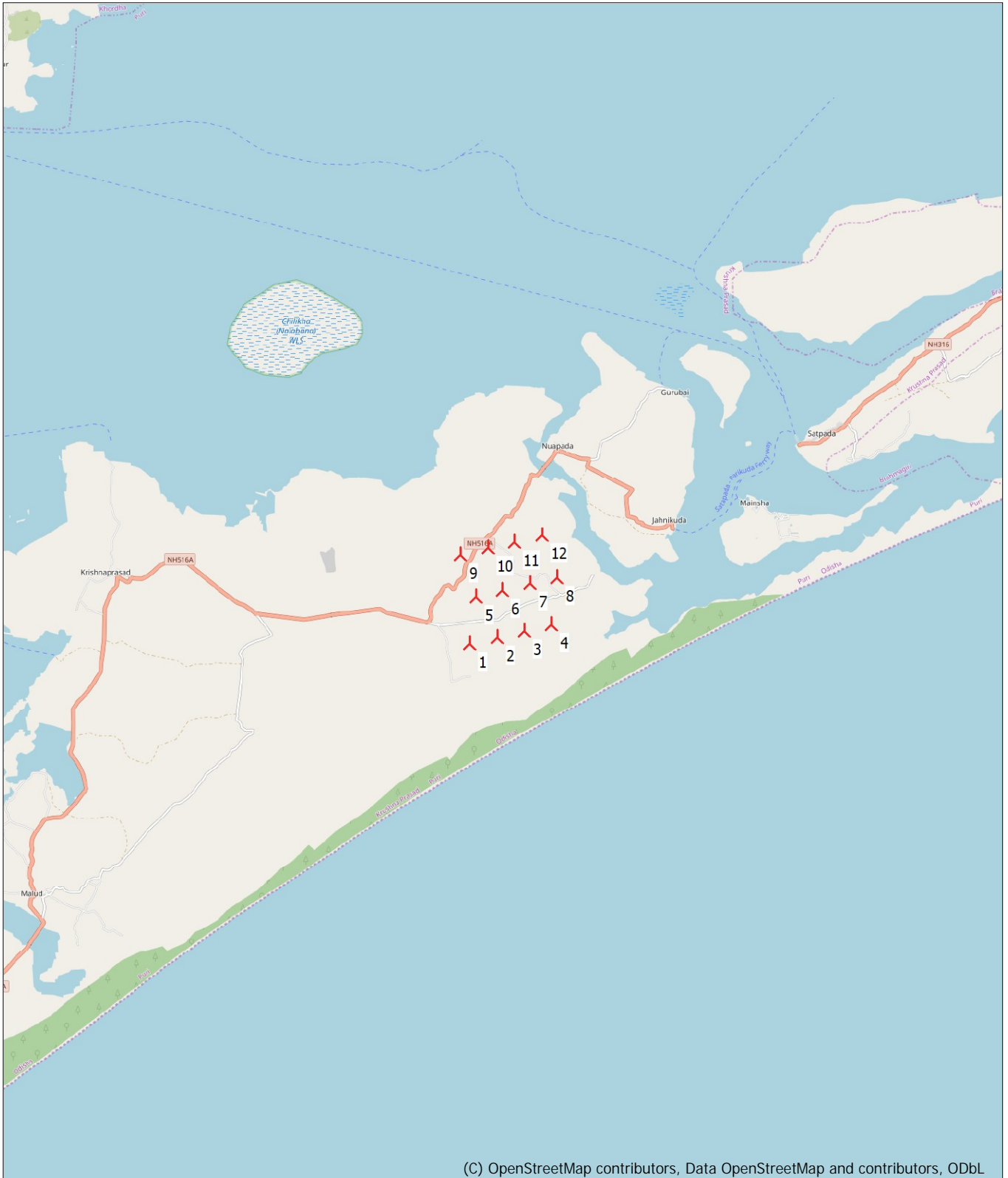
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Calculated:
21/2/2022 09:08/3.5.508

PARK - Map

Calculation: 22-459-002 Chilika - Orissa



Map: EMD OpenStreetMap , Print scale 1:150.000, Map center Geo WGS84 East: 85,363450° E North: 19,631255° N

 New WTG

Heat Maps - Chilika, Orissa

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	464	547	482	880	1,322	730	4,424
2	808	612	597	1,554	1,954	1,327	6,853
3	2,103	1,629	1,488	2,948	3,245	2,655	14,068
4	3,345	2,894	2,826	4,217	4,088	3,624	20,993
5	3,424	3,013	3,191	4,373	4,078	3,558	21,635
6	2,825	2,399	2,409	3,454	3,596	3,178	17,860
7	2,467	2,174	2,225	3,137	3,396	2,746	16,145
8	1,940	1,676	1,702	2,725	3,088	2,318	13,450
9	1,414	1,218	1,261	2,037	2,324	1,555	9,810
10	754	812	776	1,184	1,401	838	5,764
11	514	633	548	702	1,001	600	3,999
12	514	667	590	667	998	660	4,097
Total	20,572	18,274	18,095	27,879	30,491	23,787	1,39,098

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	7.4%	8.7%	7.7%	14.1%	21.2%	11.7%	11.8%
2	14.3%	10.8%	10.6%	27.5%	34.6%	23.5%	20.2%
3	33.7%	26.1%	23.8%	47.2%	51.9%	42.5%	37.5%
4	55.3%	47.8%	46.7%	69.7%	67.6%	59.9%	57.9%
5	54.8%	48.2%	51.1%	70.0%	65.2%	56.9%	57.7%
6	46.7%	39.7%	39.8%	57.1%	59.5%	52.5%	49.2%
7	39.5%	34.8%	35.6%	50.2%	54.3%	43.9%	43.1%
8	31.0%	26.8%	27.2%	43.6%	49.4%	37.1%	35.9%
9	23.4%	20.1%	20.9%	33.7%	38.4%	25.7%	27.0%
10	12.1%	13.0%	12.4%	18.9%	22.4%	13.4%	15.4%
11	8.5%	10.5%	9.1%	11.6%	16.6%	9.9%	11.0%
12	8.2%	10.7%	9.4%	10.7%	16.0%	10.6%	10.9%
Total	28.0%	24.8%	24.6%	37.9%	41.4%	32.3%	31.5%

Yield Assessment - Kharagpur, West Bengal



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.

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Mathias Thamhain / mth@emd.dk
Calculated:
21/2/2022 09:51/3.5.508

PARK - Main Result

Calculation: 22-459-003 Kharagpur WB

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

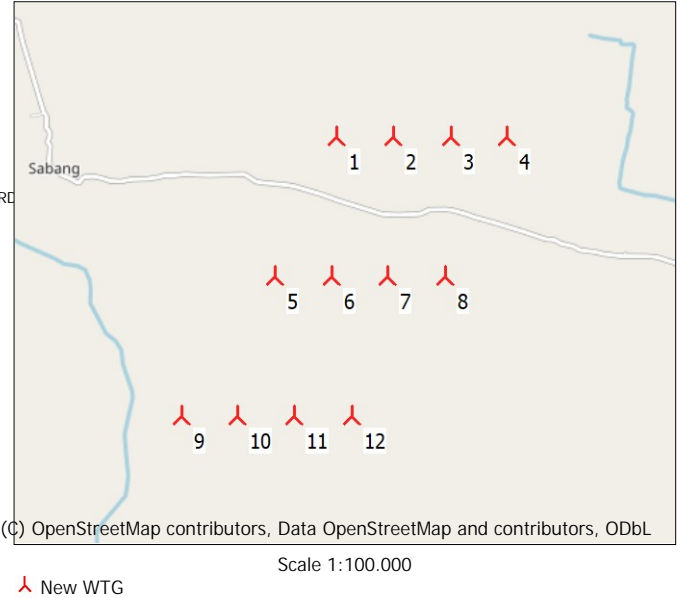
Scaler/wind data

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_N22.143_E087.653 - WB
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]	24,7	24,8	24,7			
From air density settings [hPa]	1000,1	1000,7	1000,3			
Resulting air density [kg/m³]	1,170	1,170	1,170			
Relative to 15°C at sea level [%]	95,5	95,5	95,5	-4,0	-4,0	0,0



Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	Result-8,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Wake loss [%]	Specific results ^{a)}		Wind speed		
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	free [m/s]	wake [m/s]
Wind farm	98.760,1	90.859,3	104.641,5	5,6	20,6	7.571,6	1.803	5,1	4,9

^{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			Wind speed	
									Result [MWh/y]	Result-8,0% [MWh/y]	Wake loss [%]	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-OS - 08-2019	7.984,8	7.346	8,1	5,06	4,91	
2 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	7.999,0	7.359	9,1	5,08	4,91	
3 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	7.918,2	7.285	8,2	5,04	4,89	
4 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	8.354,4	7.686	4,9	5,08	4,99	
5 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	8.116,5	7.467	7,7	5,08	4,93	
6 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	8.057,9	7.413	8,7	5,09	4,91	
7 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	8.008,8	7.368	7,8	5,05	4,89	
8 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	8.439,8	7.765	4,2	5,09	4,99	
9 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	8.540,1	7.857	1,4	5,05	5,01	
10 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	8.508,6	7.828	2,3	5,06	5,00	
11 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	8.324,1	7.658	2,7	5,03	4,95	
12 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	8.508,0	7.827	2,2	5,06	5,00	

WTG siting

	Geo [deg]-WGS84	Longitude	Latitude	Z [m]	Row data/Description	Calculation period	
						Start	End
1 New	87,630730° E	22,181047° N	8,4	90,0°, 750,0 m	1/1/2002	1/1/2022	
2 New	87,638005° E	22,181047° N	9,0		1/1/2002	1/1/2022	
3 New	87,645279° E	22,181047° N	4,8		1/1/2002	1/1/2022	
4 New	87,652554° E	22,181047° N	9,2		1/1/2002	1/1/2022	
5 New	87,622773° E	22,164569° N	9,5	90,0°, 750,0 m	1/1/2002	1/1/2022	
6 New	87,630047° E	22,164569° N	8,9		1/1/2002	1/1/2022	
7 New	87,637322° E	22,164569° N	4,0		1/1/2002	1/1/2022	
8 New	87,644596° E	22,164569° N	8,7		1/1/2002	1/1/2022	
9 New	87,610757° E	22,148034° N	4,1	90,0°, 750,0 m	1/1/2002	1/1/2022	
10 New	87,618030° E	22,148034° N	7,4		1/1/2002	1/1/2022	
11 New	87,625304° E	22,148034° N	3,9		1/1/2002	1/1/2022	
12 New	87,632577° E	22,148034° N	4,9		1/1/2002	1/1/2022	

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Calculated:
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PARK - Wind Data Analysis

Calculation: 22-459-003 Kharagpur WBWind 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° (8); Hub height: 105,0

Site coordinates

Geo WGS84

East: 87,630730° E North: 22,181047° N

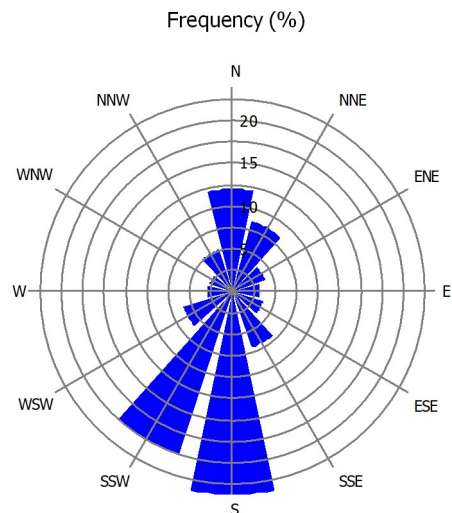
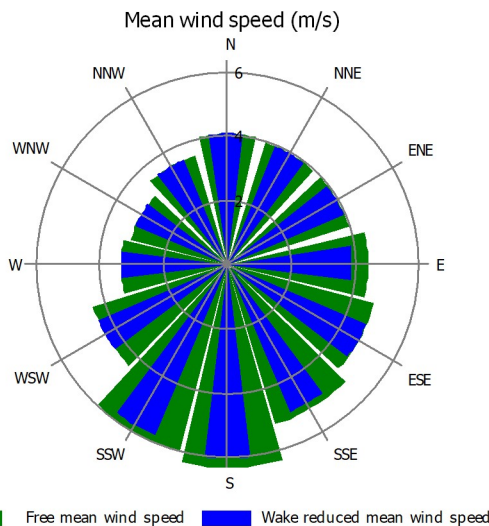
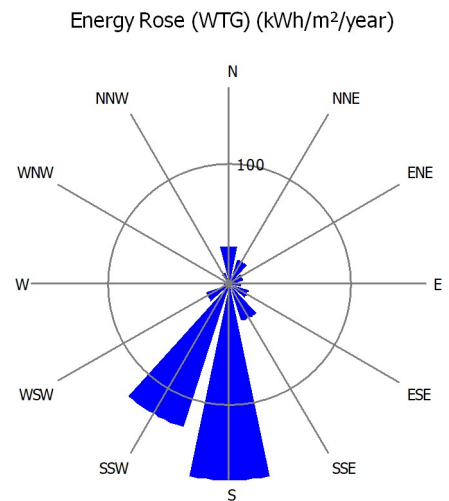
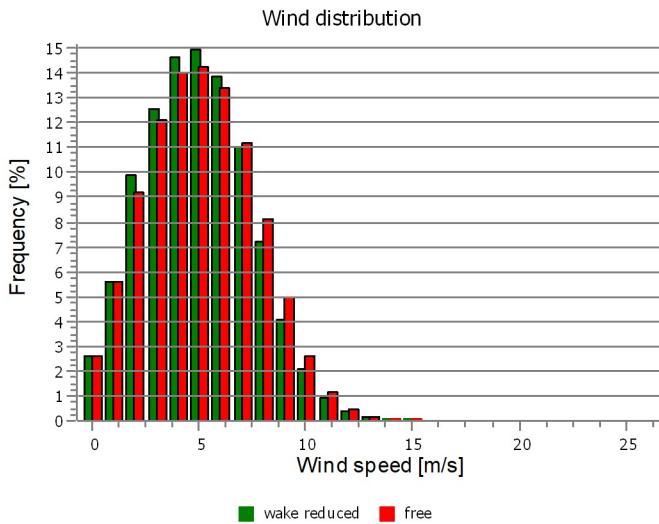
4*VESTAS V150-4.2 4200 150.0 !O! hub: 105,0 m (TOT: 180,0 m) dist: 750 m (5,0 RD) angle: 90° (8)

Masts used

Take nearest

Winddata for site

Sector	Free mean wind speed [m/s]	Wake reduced mean wind speed [m/s]	Frequency [%]
0 N	4,1	4,1	12,1
1 NNE	4,0	4,0	8,6
2 ENE	4,0	4,0	4,1
3 E	4,4	3,9	3,2
4 ESE	4,8	4,7	3,8
5 SSE	5,2	5,0	7,0
6 S	6,3	6,0	23,9
7 SSW	6,0	5,8	20,2
8 WSW	4,4	4,4	6,1
9 W	3,4	3,4	3,0
10 WNW	3,1	3,1	2,8
11 NNW	3,6	3,6	5,2
All	5,1	4,9	100,0



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PARK - Time varying AEP

Calculation: 22-459-003 Kharagpur WB

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	226	254	458	652	659	594	502	411	337	168	164	194	4.619
1	223	239	439	658	674	596	501	421	318	186	173	214	4.641
2	262	237	431	641	638	570	499	407	326	185	201	255	4.653
3	289	251	409	537	537	490	427	357	281	188	222	267	4.254
4	308	261	381	537	513	473	415	345	266	191	238	275	4.203
5	297	236	329	482	471	440	393	319	275	196	240	305	3.983
6	266	201	268	396	457	374	367	293	248	178	227	255	3.530
7	204	133	194	369	419	344	323	266	219	124	131	182	2.909
8	92	70	148	288	381	330	330	265	223	113	74	84	2.397
9	95	72	126	243	352	325	303	271	229	132	67	82	2.296
10	111	77	132	236	309	330	352	298	244	140	89	115	2.435
11	106	80	112	219	368	350	390	327	268	126	88	111	2.546
12	95	73	135	272	407	388	435	343	272	126	82	106	2.734
13	101	80	164	347	490	482	504	434	329	137	72	94	3.234
14	109	99	234	515	655	596	620	527	400	151	70	98	4.073
15	99	123	327	632	721	602	568	513	401	159	76	100	4.321
16	136	193	435	753	833	673	639	537	466	174	88	122	5.050
17	218	300	566	800	847	712	651	627	462	209	143	175	5.708
18	279	378	636	791	806	691	631	569	471	234	158	221	5.867
19	295	377	611	757	732	626	597	573	444	227	177	238	5.654
20	289	335	547	703	709	643	576	522	449	210	164	232	5.378
21	265	305	532	664	640	590	522	481	380	199	168	231	4.978
22	251	272	495	652	637	570	532	449	351	185	158	205	4.758
23	220	264	462	647	662	557	485	403	312	172	155	197	4.537
Grand Total	4.838	4.912	8.571	12.792	13.917	12.347	11.562	9.958	7.969	4.109	3.427	4.360	98.760

Hour/Month [MW]	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
0	7,3	9,1	14,8	21,7	21,2	19,8	16,2	13,3	11,2	5,4	5,5	6,3	12,7
1	7,2	8,5	14,2	21,9	21,7	19,9	16,2	13,6	10,6	6,0	5,8	6,9	12,7
2	8,5	8,5	13,9	21,4	20,6	19,0	16,1	13,1	10,9	6,0	6,7	8,2	12,7
3	9,3	8,9	13,2	17,9	17,3	16,3	13,8	11,5	9,4	6,1	7,4	8,6	11,7
4	9,9	9,3	12,3	17,9	16,5	15,8	13,4	11,1	8,9	6,2	7,9	8,9	11,5
5	9,6	8,4	10,6	16,1	15,2	14,7	12,7	10,3	9,2	6,3	8,0	9,8	10,9
6	8,6	7,2	8,6	13,2	14,7	12,5	11,8	9,5	8,3	5,7	7,6	8,2	9,7
7	6,6	4,8	6,3	12,3	13,5	11,5	10,4	8,6	7,3	4,0	4,4	5,9	8,0
8	3,0	2,5	4,8	9,6	12,3	11,0	10,6	8,6	7,4	3,6	2,5	2,7	6,6
9	3,1	2,6	4,1	8,1	11,3	10,8	9,8	8,7	7,6	4,3	2,2	2,7	6,3
10	3,6	2,8	4,3	7,9	10,0	11,0	11,3	9,6	8,1	4,5	3,0	3,7	6,7
11	3,4	2,9	3,6	7,3	11,9	11,7	12,6	10,6	8,9	4,1	2,9	3,6	7,0
12	3,1	2,6	4,3	9,1	13,1	12,9	14,0	11,1	9,1	4,1	2,7	3,4	7,5
13	3,2	2,9	5,3	11,6	15,8	16,1	16,2	14,0	11,0	4,4	2,4	3,0	8,9
14	3,5	3,5	7,6	17,2	21,1	19,9	20,0	17,0	13,3	4,9	2,3	3,2	11,2
15	3,2	4,4	10,5	21,1	23,3	20,1	18,3	16,6	13,4	5,1	2,5	3,2	11,8
16	4,4	6,9	14,0	25,1	26,9	22,4	20,6	17,3	15,5	5,6	2,9	3,9	13,8
17	7,0	10,7	18,2	26,7	27,3	23,7	21,0	20,2	15,4	6,7	4,8	5,7	15,6
18	9,0	13,5	20,5	26,4	26,0	23,0	20,4	18,4	15,7	7,5	5,3	7,1	16,1
19	9,5	13,4	19,7	25,2	23,6	20,9	19,3	18,5	14,8	7,3	5,9	7,7	15,5
20	9,3	12,0	17,6	23,4	22,9	21,4	18,6	16,8	15,0	6,8	5,5	7,5	14,7
21	8,6	10,9	17,2	22,1	20,6	19,7	16,8	15,5	12,7	6,4	5,6	7,5	13,6
22	8,1	9,7	16,0	21,7	20,6	19,0	17,2	14,5	11,7	6,0	5,3	6,6	13,0
23	7,1	9,4	14,9	21,6	21,4	18,6	15,7	13,0	10,4	5,5	5,2	6,3	12,4
Grand Total	6,5	7,3	11,5	17,8	18,7	17,1	15,5	13,4	11,1	5,5	4,8	5,9	11,3

PARK - Time varying AEP

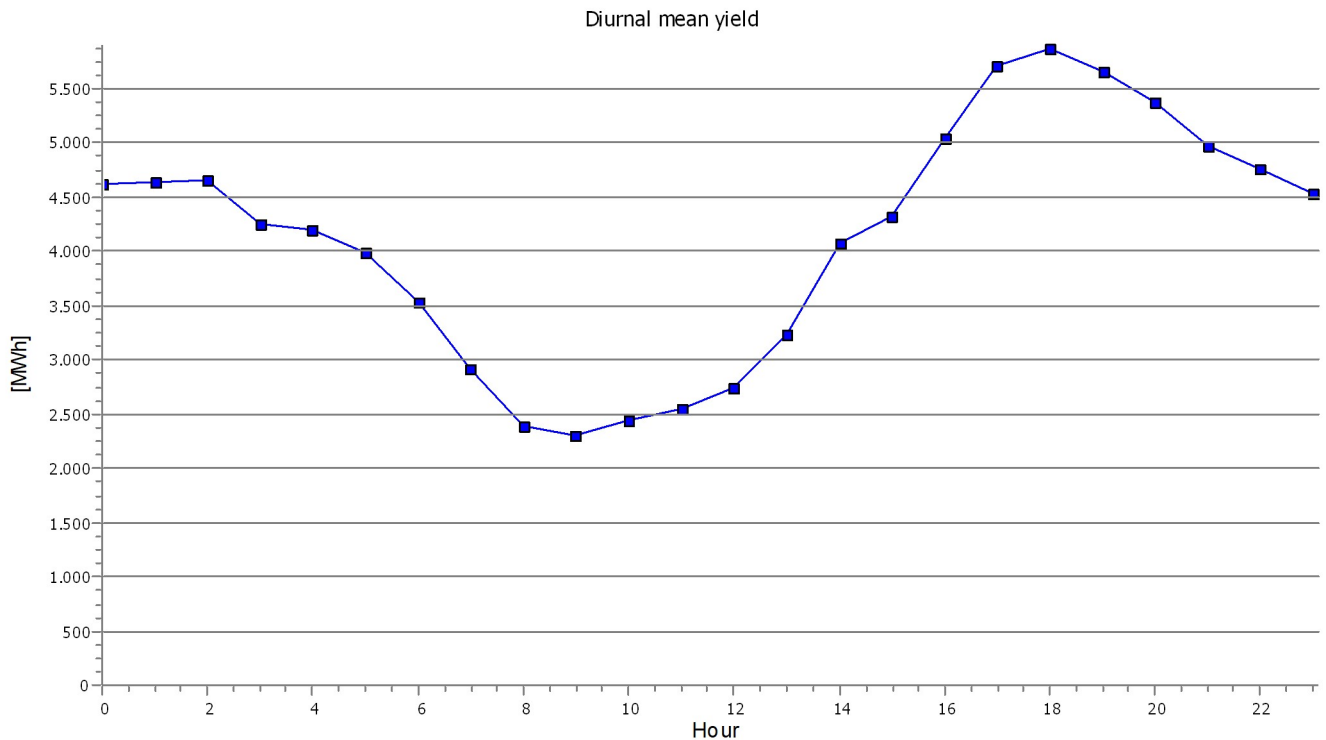
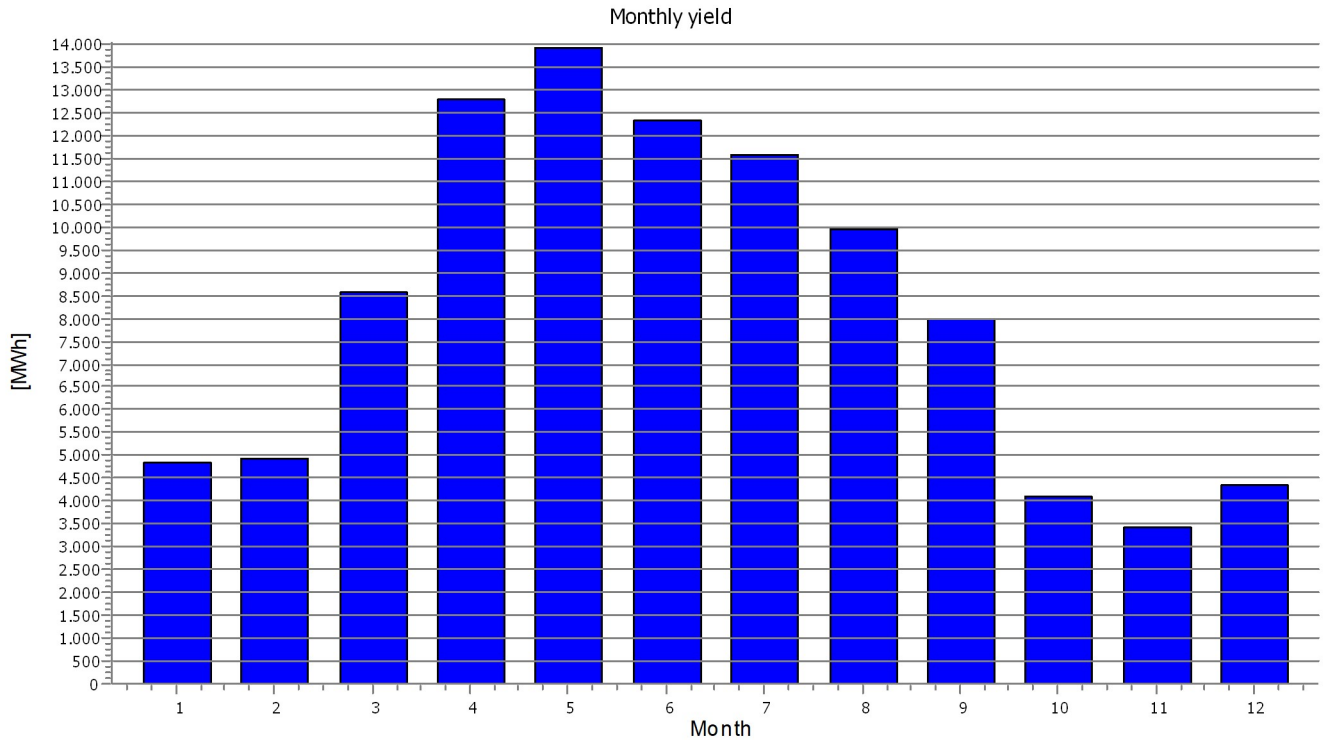
Calculation: 22-459-003 Kharagpur WB

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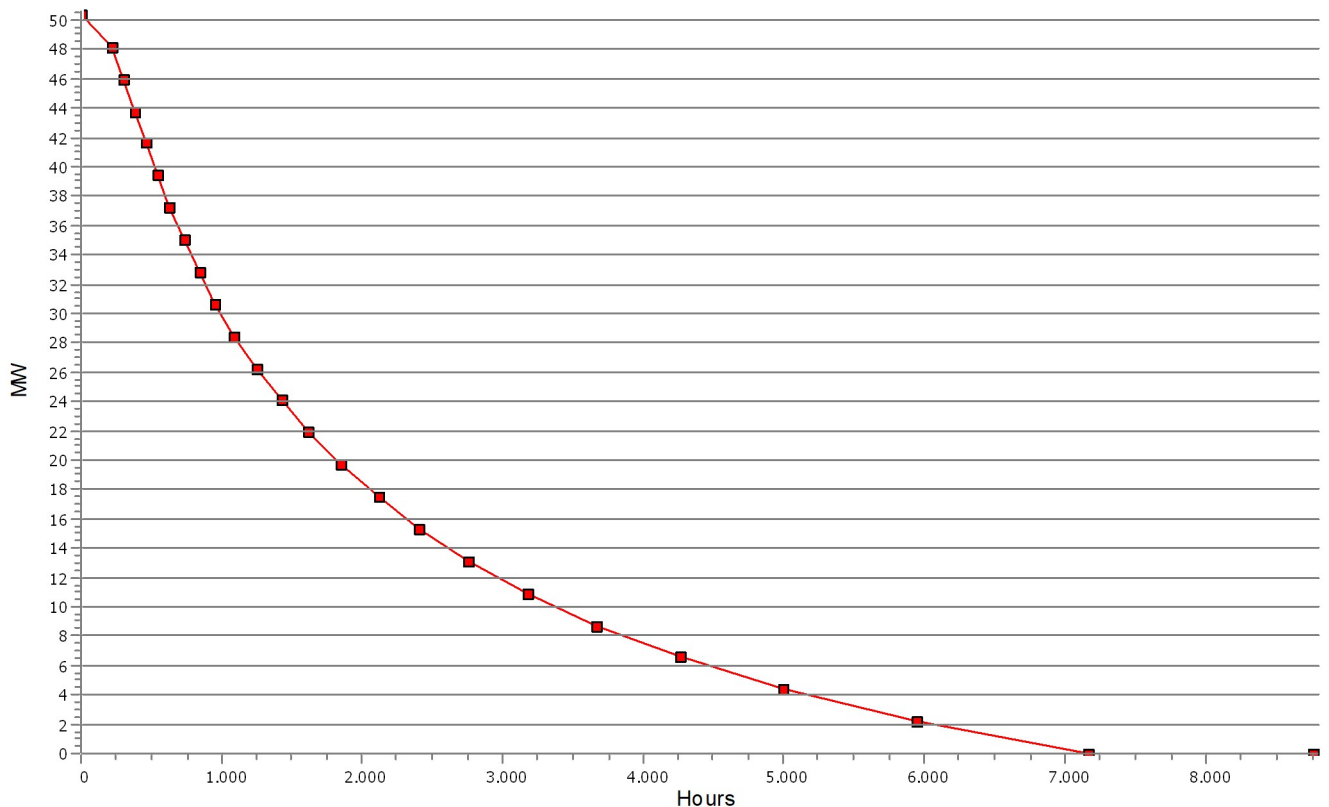
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Windfarm: 50,4 MW based on 12 turbines of type VESTAS V150-4.2 4200 150.0 !O!.

Selection: All new WTGs

Hours	Hours [%]	Hours accumulated	Power [MW]	Power (MW/WTG)
0	0,0	0	50,4	4,2
211	2,4	211	48,2 - 50,4	4,0 - 4,2
86	1,0	297	46,0 - 48,2	3,8 - 4,0
82	0,9	379	43,8 - 46,0	3,7 - 3,8
77	0,9	455	41,6 - 43,8	3,5 - 3,7
86	1,0	541	39,4 - 41,6	3,3 - 3,5
87	1,0	629	37,3 - 39,4	3,1 - 3,3
101	1,1	729	35,1 - 37,3	2,9 - 3,1
107	1,2	836	32,9 - 35,1	2,7 - 2,9
118	1,3	954	30,7 - 32,9	2,6 - 2,7
135	1,5	1089	28,5 - 30,7	2,4 - 2,6
156	1,8	1245	26,3 - 28,5	2,2 - 2,4
174	2,0	1418	24,1 - 26,3	2,0 - 2,2
200	2,3	1619	21,9 - 24,1	1,8 - 2,0
223	2,5	1842	19,7 - 21,9	1,6 - 1,8
268	3,1	2110	17,5 - 19,7	1,5 - 1,6
297	3,4	2408	15,3 - 17,5	1,3 - 1,5
349	4,0	2757	13,1 - 15,3	1,1 - 1,3
419	4,8	3175	11,0 - 13,1	0,9 - 1,1
489	5,6	3664	8,8 - 11,0	0,7 - 0,9
591	6,7	4255	6,6 - 8,8	0,5 - 0,7
738	8,4	4993	4,4 - 6,6	0,4 - 0,5
956	10,9	5949	2,2 - 4,4	0,2 - 0,4
1221	13,9	7169	0,0 - 2,2	0,0 - 0,2
1597	18,2	8766	0,0	0,0

Duration curve 50,4 MW WindFarm



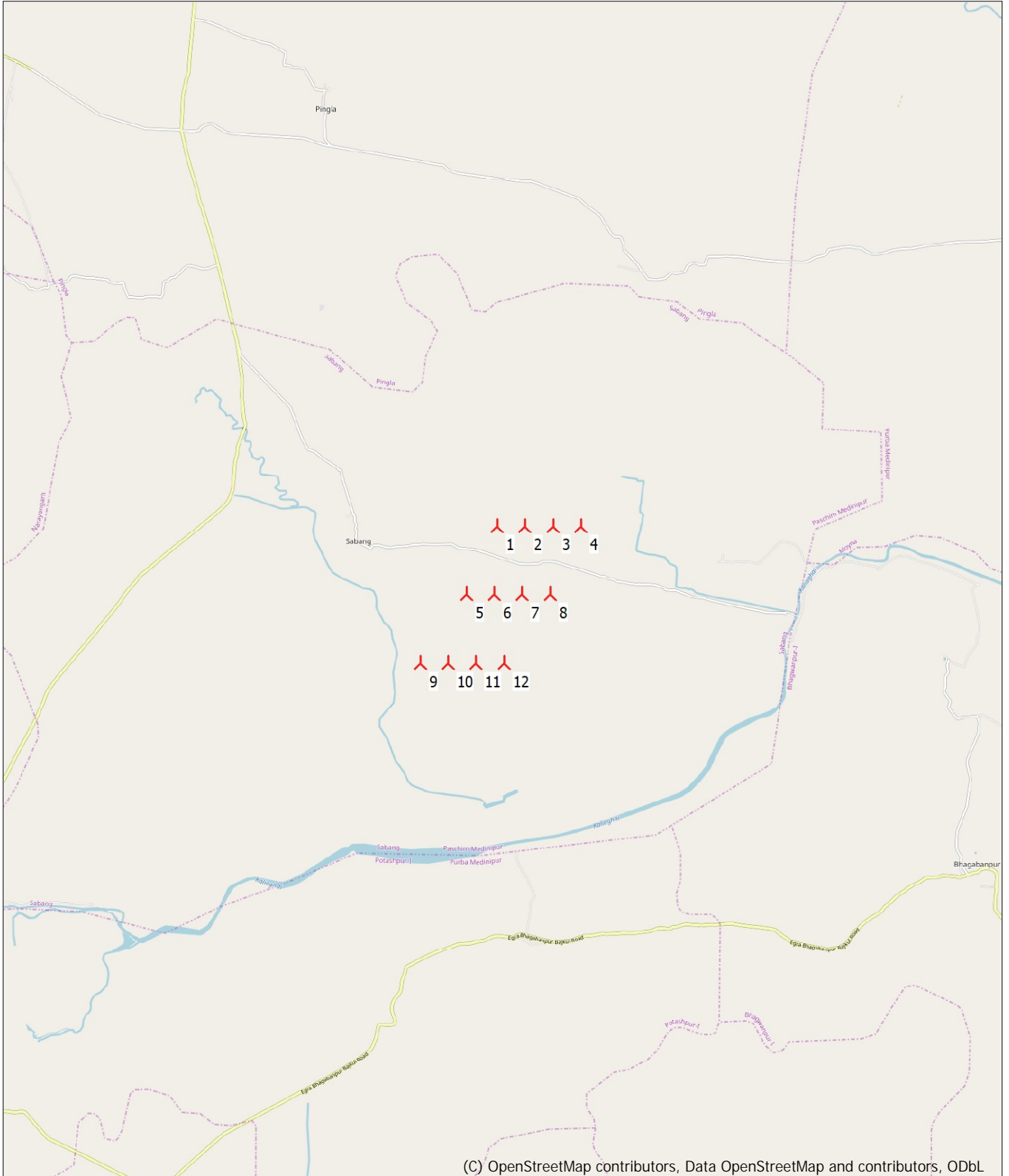
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PARK - Map

Calculation: 22-459-003 Kharagpur WB



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:150.000, Map center Geo WGS84 East: 87,631656° E North: 22,164540° N

 New WTG

Heat Maps - Kharagpur, West Bengal

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	920	989	372	372	855	944	4,451
2	902	764	276	345	1,149	1,083	4,519
3	1,598	1,078	477	791	2,068	1,873	7,885
4	2,289	1,641	908	1,625	2,852	2,453	11,768
5	2,306	1,711	1,297	2,092	2,961	2,436	12,803
6	2,071	1,501	1,228	1,902	2,486	2,171	11,360
7	1,775	1,379	1,264	1,956	2,317	1,946	10,637
8	1,469	1,125	1,068	1,672	2,121	1,707	9,161
9	1,160	927	887	1,290	1,695	1,373	7,331
10	669	635	470	527	776	704	3,780
11	700	769	292	276	522	594	3,152
12	856	937	361	365	697	795	4,011
Total	16,715	13,455	8,901	13,213	20,496	18,080	90,859

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	14.7%	15.8%	5.9%	5.9%	13.7%	15.1%	11.9%
2	16.0%	13.5%	4.9%	6.1%	20.3%	19.2%	13.3%
3	25.6%	17.3%	7.6%	12.7%	33.1%	30.0%	21.0%
4	37.8%	27.1%	15.0%	26.9%	47.2%	40.6%	32.4%
5	36.9%	27.4%	20.8%	33.5%	47.4%	39.0%	34.1%
6	34.2%	24.8%	20.3%	31.5%	41.1%	35.9%	31.3%
7	28.4%	22.1%	20.2%	31.3%	37.1%	31.1%	28.4%
8	23.5%	18.0%	17.1%	26.8%	33.9%	27.3%	24.4%
9	19.2%	15.3%	14.7%	21.3%	28.0%	22.7%	20.2%
10	10.7%	10.2%	7.5%	8.4%	12.4%	11.3%	10.1%
11	11.6%	12.7%	4.8%	4.6%	8.6%	9.8%	8.7%
12	13.7%	15.0%	5.8%	5.8%	11.1%	12.7%	10.7%
Total	22.7%	18.3%	12.1%	18.0%	27.9%	24.6%	20.6%

Yield Assessment - Saharanpur, Uttar Pradesh



Project:
Site Analysis contract 81274134

Description:
Preliminary energy yield assessment with high uncertainties based on re-analysis data. Consult with expert prior to investment decision. This report extract is subject to confidentiality and liability limitation clause of the main report.

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Mathias Thamhain / mth@emd.dk
Calculated:
23/2/2022 23:21/3.5.508

PARK - Main Result

Calculation: 22-459-004 Saharanpur UP

Setup

AEP scaled to a full year based on number of samples
Scaling factor from 22,0 years to 1 year: 0,045

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

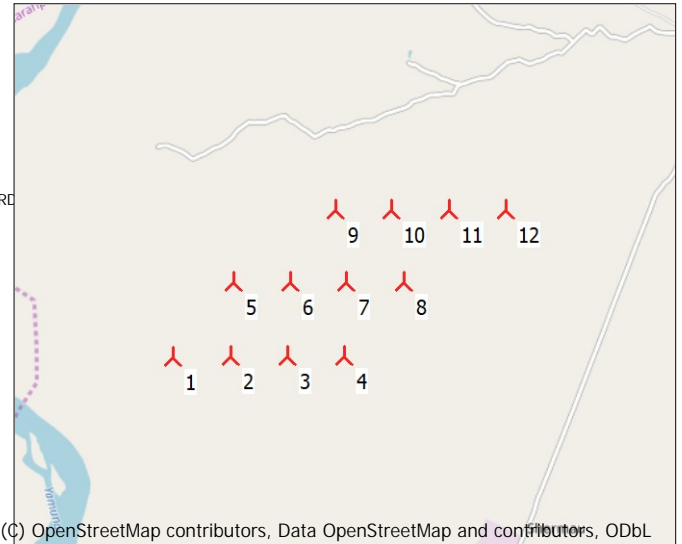
Scaler/wind data

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: 1/1/2000 05:30:00 - 1/1/2022 04:30:00
Meteo object(s): ERA5 (Gaussian Grid)_N29,929732_E077,1875 (UP), 100,00m -
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]	23,1	23,1	23,1			
From air density settings [hPa]	971,9	972,2	972,0			
Resulting air density [kg/m³]	1,143	1,143	1,143			
Relative to 15°C at sea level [%]	93,3	93,3	93,3	-5,4	-5,4	0,0



▲ New WTG

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	Result-8,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Wake loss [%]	Specific results ^{a)}		Wind speed		
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	free [m/s]	wake [m/s]
Wind farm	112.564,7	103.559,5	117.510,5	4,2	23,4	8.630,0	2.055	5,3	5,2

^{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			Wind speed	
									Result [MWh/y]	Result-8,0% [MWh/y]	Wake loss [%]	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-OS - 08-2019	9.545,3	8.782	2,7	5,31	5,24	
2 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	9.411,4	8.658	3,8	5,30	5,20	
3 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	9.199,7	8.464	6,0	5,31	5,15	
4 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	8.942,9	8.228	8,2	5,29	5,11	
5 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	9.356,3	8.608	4,5	5,31	5,19	
6 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	9.374,7	8.625	4,3	5,31	5,18	
7 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	9.360,8	8.612	4,0	5,30	5,18	
8 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	9.172,9	8.439	6,0	5,30	5,16	
9 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	9.535,7	8.773	3,3	5,32	5,23	
10 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	9.522,8	8.761	3,3	5,32	5,22	
11 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	9.481,0	8.723	3,0	5,30	5,22	
12 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	9.661,2	8.888	1,4	5,31	5,26	

WTG siting

	Geo [deg]-WGS84			Z [m]	Row data/Description	Calculation period	
	Longitude	Latitude				Start	End
1 New	77,220240° E	29,873471° N	255,4	90,0°, 750,0 m	1/1/2000	1/1/2022	
2 New	77,228002° E	29,873471° N	255,4		1/1/2000	1/1/2022	
3 New	77,235764° E	29,873471° N	256,1		1/1/2000	1/1/2022	
4 New	77,243525° E	29,873471° N	256,0		1/1/2000	1/1/2022	
5 New	77,228400° E	29,882321° N	256,0	90,0°, 750,0 m	1/1/2000	1/1/2022	
6 New	77,236163° E	29,882321° N	256,0		1/1/2000	1/1/2022	
7 New	77,243926° E	29,882321° N	256,0		1/1/2000	1/1/2022	
8 New	77,251688° E	29,882321° N	257,0		1/1/2000	1/1/2022	
9 New	77,242312° E	29,890946° N	258,1	90,0°, 750,0 m	1/1/2000	1/1/2022	
10 New	77,250075° E	29,890946° N	257,4		1/1/2000	1/1/2022	
11 New	77,257838° E	29,890946° N	256,9		1/1/2000	1/1/2022	
12 New	77,265602° E	29,890946° N	257,6		1/1/2000	1/1/2022	

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Calculated:
23/2/2022 23:21/3.5.508

PARK - Wind Data Analysis

Calculation: 22-459-004 Saharanpur UPWind 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° (11); Hub height: 105,0

Site coordinates

Geo WGS84

East: 77,220240° E North: 29,873471° N

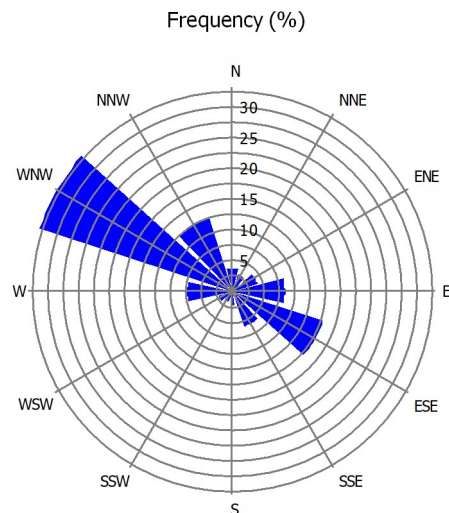
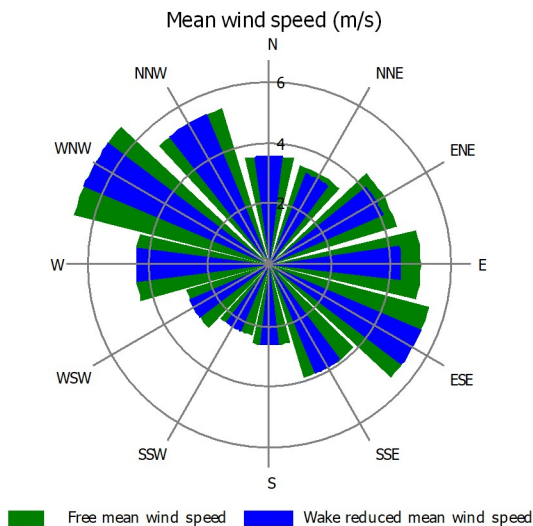
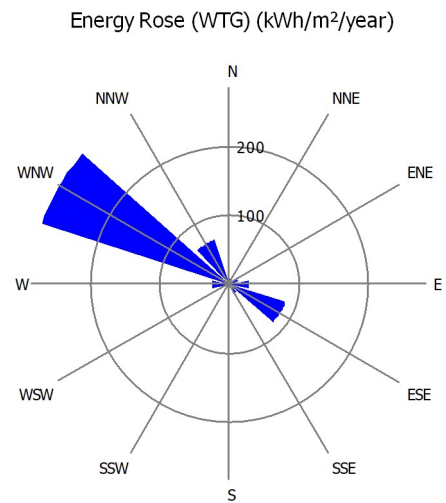
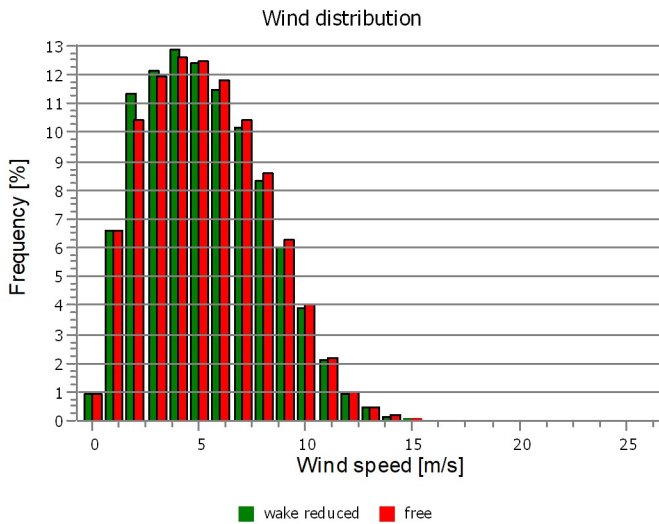
4*VESTAS V150-4.2 4200 150.0 !O! hub: 105,0 m (TOT: 180,0 m) dist: 750 m (5,0 RD) angle: 90° (11)

Masts used

Take nearest

Winddata for site

Sector	Free mean wind speed [m/s]	Wake reduced mean wind speed [m/s]	Frequency [%]
0 N	3,6	3,6	3,8
1 NNE	3,4	3,3	2,9
2 ENE	4,4	4,1	4,2
3 E	5,0	4,4	8,6
4 ESE	5,5	5,5	15,5
5 SSE	3,9	3,9	6,0
6 S	2,7	2,7	2,2
7 SSW	2,4	2,4	1,7
8 WSW	2,9	2,9	2,4
9 W	4,4	4,4	7,3
10 WNW	6,7	6,7	33,0
11 NNW	5,4	5,4	12,5
All	5,3	5,2	100,0



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Calculated:
23/2/2022 23:21/3.5.508

PARK - Time varying AEP

Calculation: 22-459-004 Saharanpur UP

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	610	636	748	705	651	517	325	240	271	303	441	558	6.003
1	595	617	702	662	619	501	316	231	251	272	419	549	5.735
2	589	604	672	637	582	491	316	227	239	249	404	545	5.555
3	541	552	597	587	519	444	290	201	210	216	361	488	5.006
4	521	524	580	565	521	416	293	205	197	194	334	457	4.805
5	507	510	565	546	533	409	292	202	185	181	322	446	4.698
6	505	509	544	519	508	378	282	202	188	175	315	439	4.564
7	495	497	504	407	370	301	237	171	159	154	300	430	4.026
8	424	407	338	254	334	299	234	158	109	78	196	352	3.185
9	240	240	253	268	349	300	250	181	120	54	103	181	2.539
10	201	225	281	312	335	289	247	190	136	65	113	159	2.552
11	219	258	331	334	306	272	239	191	147	85	141	179	2.701
12	256	294	379	356	296	266	229	180	163	112	174	208	2.913
13	295	338	433	392	316	264	221	171	185	150	209	242	3.216
14	334	384	488	449	362	276	216	173	216	188	250	276	3.612
15	370	417	545	494	403	296	196	164	238	231	282	305	3.941
16	384	429	574	533	459	325	186	156	232	227	277	316	4.097
17	481	473	590	573	500	340	180	145	251	283	368	441	4.624
18	636	615	729	652	554	347	181	158	310	385	485	575	5.627
19	715	701	844	790	645	428	227	192	355	441	543	635	6.516
20	727	721	886	845	709	482	283	221	373	443	556	643	6.889
21	702	707	876	835	714	508	325	241	366	415	531	615	6.835
22	666	683	842	804	707	520	342	250	342	374	501	585	6.617
23	635	655	796	757	678	520	344	246	310	332	474	563	6.309
Grand Total	11.648	11.997	14.094	13.276	11.970	9.188	6.250	4.695	5.553	5.607	8.098	10.188	112.565

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

PARK - Time varying AEP

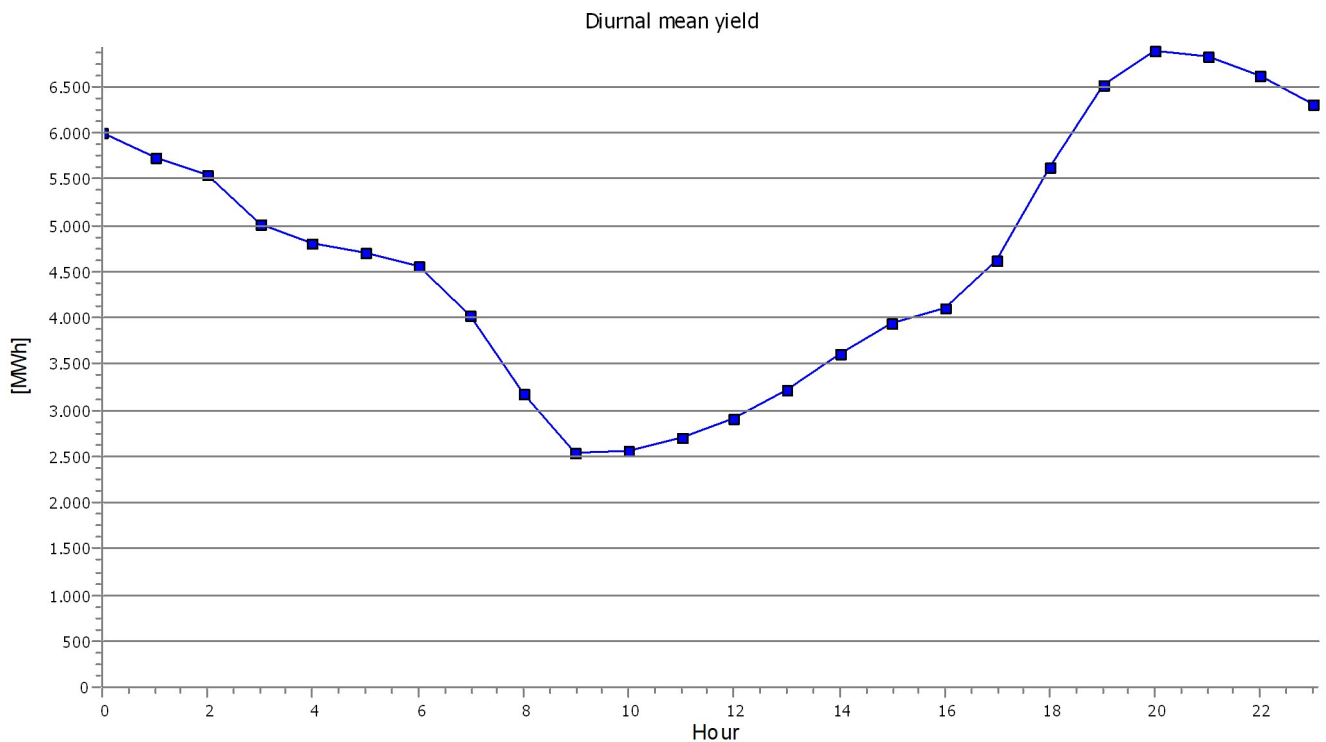
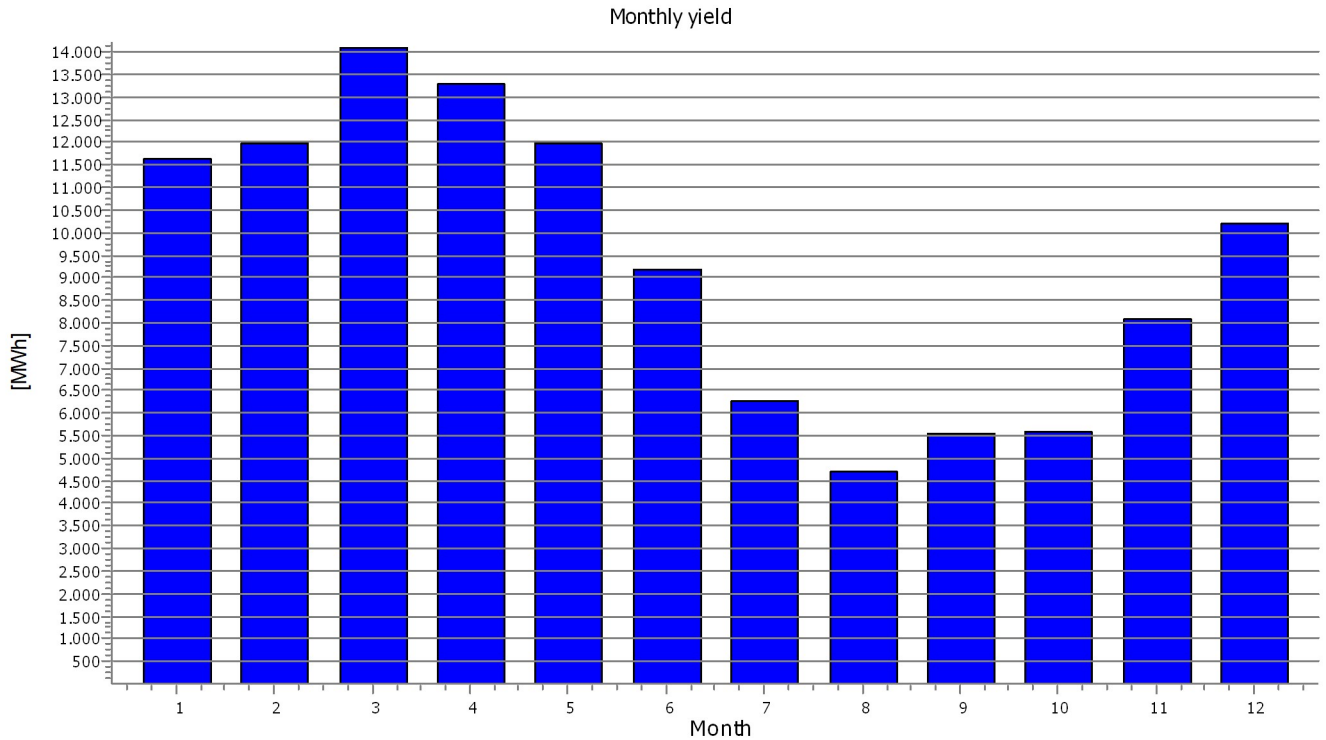
Calculation: 22-459-004 Saharanpur UP

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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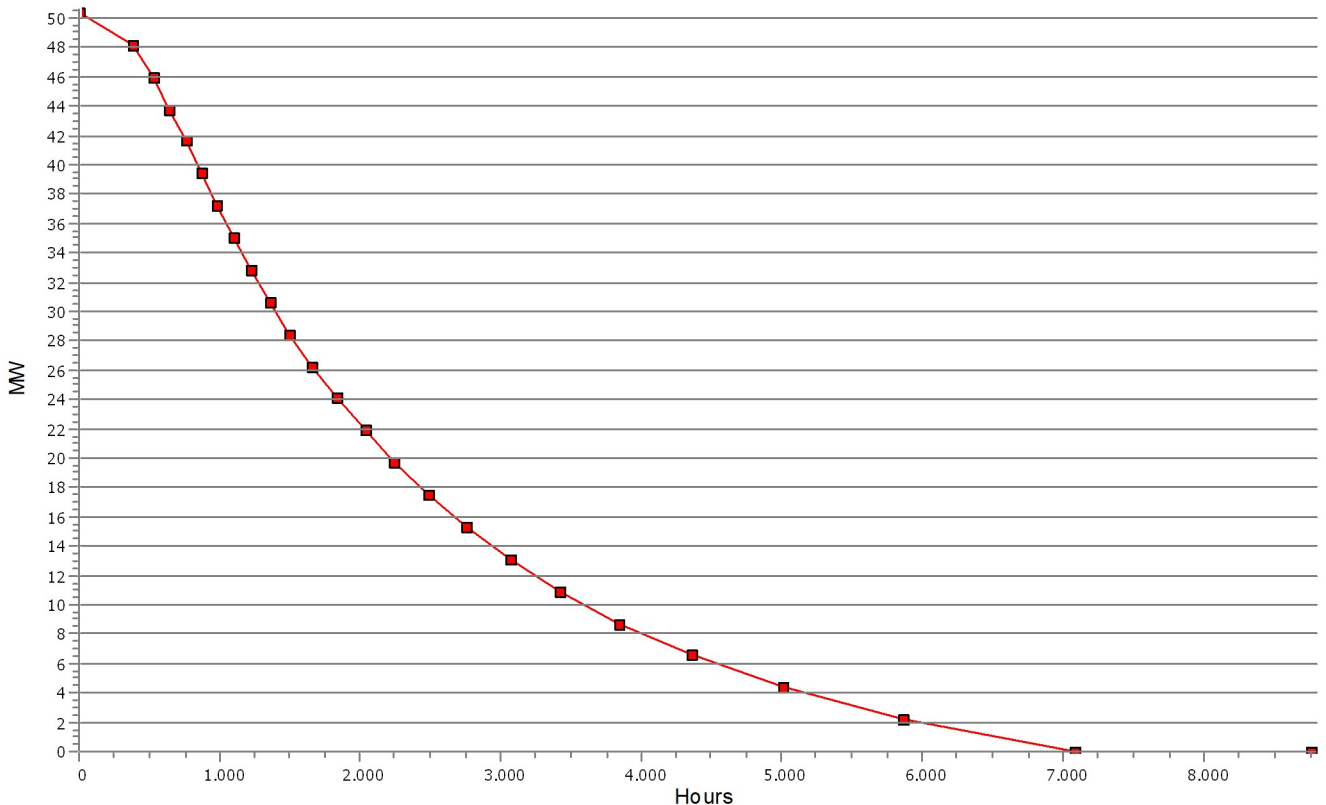
Calculation: 22-459-004 Saharanpur UP

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
386	4,4	386	48,2 - 50,4	4,0 - 4,2
137	1,6	523	46,0 - 48,2	3,8 - 4,0
119	1,4	642	43,8 - 46,0	3,7 - 3,8
114	1,3	756	41,6 - 43,8	3,5 - 3,7
112	1,3	868	39,4 - 41,6	3,3 - 3,5
110	1,3	978	37,3 - 39,4	3,1 - 3,3
119	1,4	1097	35,1 - 37,3	2,9 - 3,1
128	1,5	1225	32,9 - 35,1	2,7 - 2,9
132	1,5	1357	30,7 - 32,9	2,6 - 2,7
141	1,6	1498	28,5 - 30,7	2,4 - 2,6
160	1,8	1658	26,3 - 28,5	2,2 - 2,4
174	2,0	1832	24,1 - 26,3	2,0 - 2,2
197	2,2	2029	21,9 - 24,1	1,8 - 2,0
214	2,4	2243	19,7 - 21,9	1,6 - 1,8
243	2,8	2486	17,5 - 19,7	1,5 - 1,6
270	3,1	2756	15,3 - 17,5	1,3 - 1,5
306	3,5	3062	13,1 - 15,3	1,1 - 1,3
353	4,0	3416	11,0 - 13,1	0,9 - 1,1
428	4,9	3844	8,8 - 11,0	0,7 - 0,9
512	5,8	4355	6,6 - 8,8	0,5 - 0,7
648	7,4	5003	4,4 - 6,6	0,4 - 0,5
860	9,8	5863	2,2 - 4,4	0,2 - 0,4
1225	14,0	7087	0,0 - 2,2	0,0 - 0,2
1679	19,2	8766	0,0	0,0

Duration curve 50,4 MW WindFarm



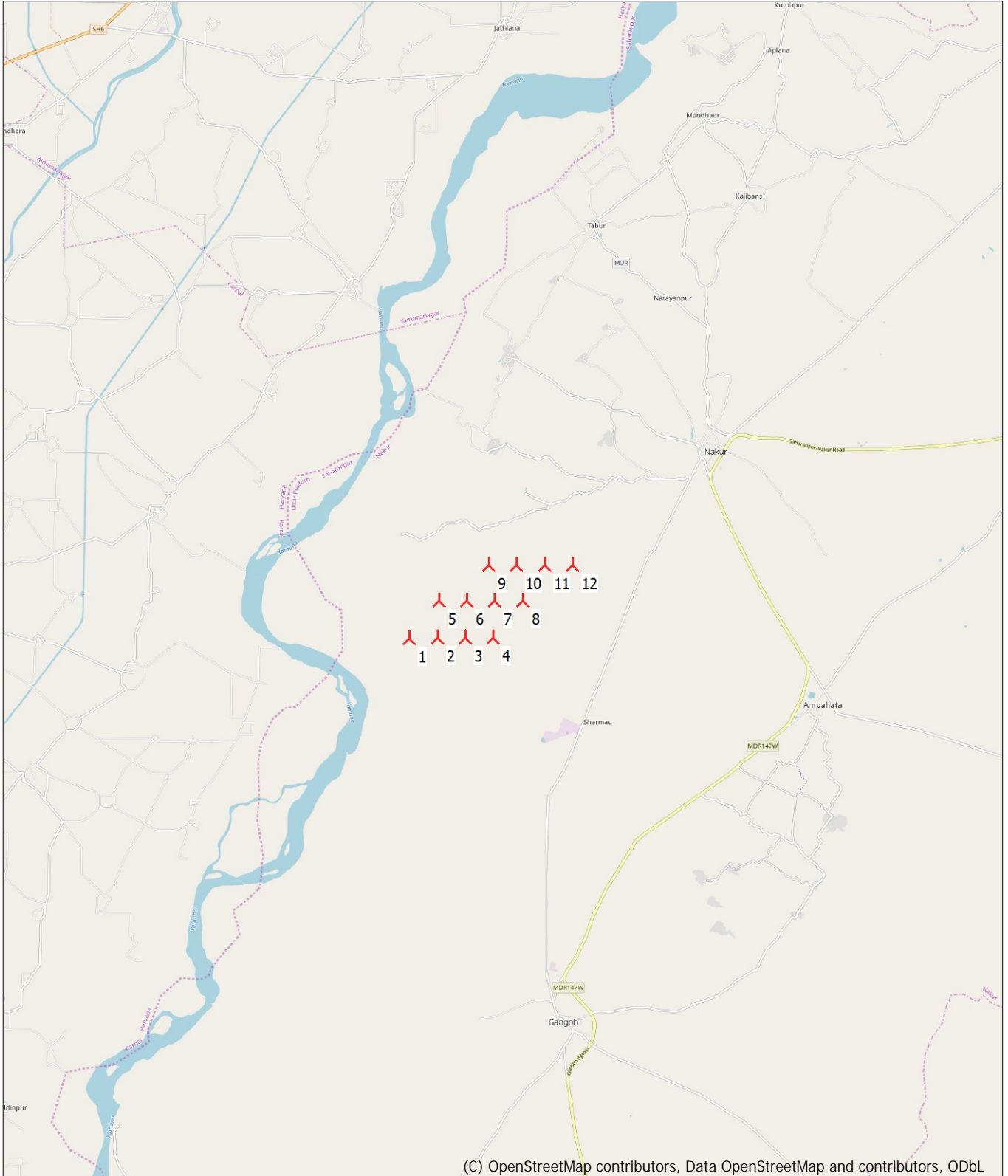
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Site Analysis contract 81274134

Description:
Preliminary energy yield assessment with high uncertainties based on re-analysis data. Consult with expert prior to investment decision. This report extract is subject to confidentiality and liability limitation clause of the main report.

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Mathias Thamhain / mth@emd.dk
Calculated:
23/2/2022 23:21/3.5.508

PARK - Map

Calculation: 22-459-004 Saharanpur UP



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

0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:150.000, Map center Geo WGS84 East: 77,242921° E North: 29,882209° N

 New WTG

Heat Maps - Saharanpur, Uttar 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	2,169	1,875	985	1,148	2,037	2,528	10,741
2	2,235	1,902	1,040	1,318	2,034	2,541	11,069
3	2,481	1,998	1,072	1,654	2,483	3,104	12,793
4	2,350	1,881	1,090	1,559	2,318	2,927	12,125
5	2,185	1,786	1,227	1,279	2,001	2,603	11,080
6	1,823	1,414	1,112	1,042	1,353	1,912	8,656
7	1,125	996	883	794	720	1,186	5,703
8	818	712	656	620	593	876	4,275
9	903	671	476	751	1,069	1,302	5,172
10	922	644	257	619	1,181	1,362	4,986
11	1,487	1,184	523	865	1,554	1,887	7,500
12	1,985	1,650	821	978	1,812	2,214	9,460
Total	20,483	16,712	10,141	12,626	19,155	24,442	1,03,560

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	34.7%	30.0%	15.8%	18.4%	32.6%	40.5%	28.6%
2	39.6%	33.7%	18.4%	23.4%	36.0%	45.0%	32.7%
3	39.7%	32.0%	17.2%	26.5%	39.7%	49.7%	34.1%
4	38.9%	31.1%	18.0%	25.8%	38.3%	48.4%	33.4%
5	35.0%	28.6%	19.6%	20.5%	32.0%	41.6%	29.5%
6	30.1%	23.4%	18.4%	17.2%	22.4%	31.6%	23.9%
7	18.0%	15.9%	14.1%	12.7%	11.5%	19.0%	15.2%
8	13.1%	11.4%	10.5%	9.9%	9.5%	14.0%	11.4%
9	14.9%	11.1%	7.9%	12.4%	17.7%	21.5%	14.3%
10	14.8%	10.3%	4.1%	9.9%	18.9%	21.8%	13.3%
11	24.6%	19.6%	8.7%	14.3%	25.7%	31.2%	20.7%
12	31.8%	26.4%	13.1%	15.7%	29.0%	35.4%	25.2%
Total	27.8%	22.7%	13.8%	17.2%	26.0%	33.2%	23.5%

Yield Assessment - Off-shore, Gujarat



Project:
Site Analysis contract 81274134

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Calculated:
22/2/2022 09:25/3.5.508

PARK - Main Result

Calculation: 22-459-005 Gujarat off-shore

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: 0,050 DTU default offshore
Reference WTG: 4*VESTAS V150-4.2 4200 150.0 IOI hub: 105,0 m (TOT: 180,0 m) dist: 1.200 m (8,0 m)

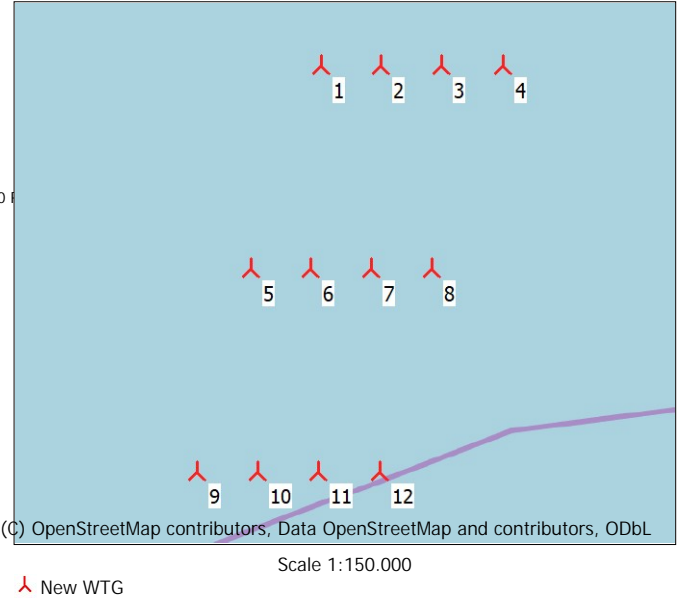
Scaler/wind data

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_N20.899_E072.300 - Gujarat off-shore
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]	24,8	24,8	24,8			
From air density settings [hPa]	1001,1	1001,1	1001,1			
Resulting air density [kg/m³]	1,171	1,171	1,171			
Relative to 15°C at sea level [%]	95,6	95,6	95,6	-2,6	-2,6	0,0



Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	Result-8,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Wake loss [%]	Specific results ^{a)}		Wind speed		
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	free [m/s]	wake [m/s]
Wind farm	204.440,5	188.085,2	208.636,6	2,0	42,6	15.673,8	3.732	7,1	7,1

^{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			Wind speed	
									Result [MWh/y]	Result-8,0% [MWh/y]	Wake loss [%]	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-OS - 08-2019	17.344,5	15.957	0,2	7,13	7,12	
2 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.122,2	15.752	1,5	7,13	7,08	
3 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.022,0	15.660	2,1	7,13	7,06	
4 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	16.960,9	15.604	2,4	7,13	7,05	
5 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.231,7	15.853	0,9	7,13	7,10	
6 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	16.978,0	15.620	2,3	7,13	7,05	
7 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	16.879,1	15.529	2,9	7,13	7,03	
8 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	16.843,9	15.496	3,1	7,13	7,02	
9 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.206,9	15.830	1,0	7,13	7,10	
10 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	16.974,7	15.617	2,4	7,13	7,05	
11 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	16.925,2	15.571	2,7	7,13	7,04	
12 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	16.951,4	15.595	2,5	7,13	7,04	

WTG siting

	Geo [deg]-WGS84	Longitude	Latitude	Z [m]	Row data/Description	Calculation period	
						Start	End
1 New	72,189789° E	20,963363° N	0,0	90,0°, 1.200,0 m	1/1/2002	1/1/2022	
2 New	72,201320° E	20,963363° N	0,0		1/1/2002	1/1/2022	
3 New	72,212852° E	20,963363° N	0,0		1/1/2002	1/1/2022	
4 New	72,224383° E	20,963363° N	0,0		1/1/2002	1/1/2022	
5 New	72,176331° E	20,927194° N	0,0	90,0°, 1.200,0 m	1/1/2002	1/1/2022	
6 New	72,187859° E	20,927194° N	0,0		1/1/2002	1/1/2022	
7 New	72,199388° E	20,927194° N	0,0		1/1/2002	1/1/2022	
8 New	72,210917° E	20,927194° N	0,0		1/1/2002	1/1/2022	
9 New	72,166306° E	20,891016° N	0,0	90,0°, 1.200,0 m	1/1/2002	1/1/2022	
10 New	72,177832° E	20,891016° N	0,0		1/1/2002	1/1/2022	
11 New	72,189357° E	20,891016° N	0,0		1/1/2002	1/1/2022	
12 New	72,200883° E	20,891016° N	0,0		1/1/2002	1/1/2022	

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Calculated:
22/2/2022 09:25/3.5.508

PARK - Wind Data Analysis

Calculation: 22-459-005 Gujarat off-shore Wind data: 1 - 4*VESTAS V150-4.2 4200 150.0 !O! hub: 105,0 m (TOT: 180,0 m) dist: 1.200 m (8,0 RD) angle: 90° (17); Hub height: 105,0

Site coordinates

Geo WGS84

East: 72,189789° E North: 20,963363° N

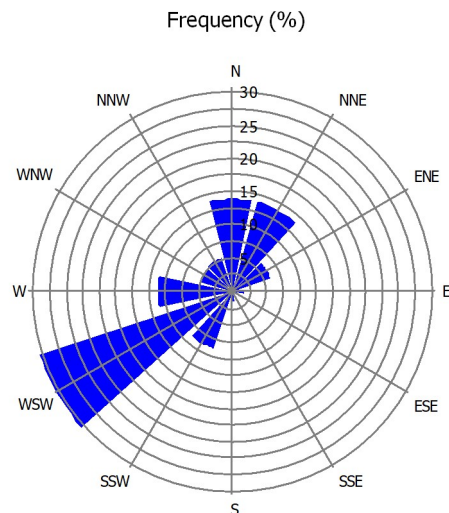
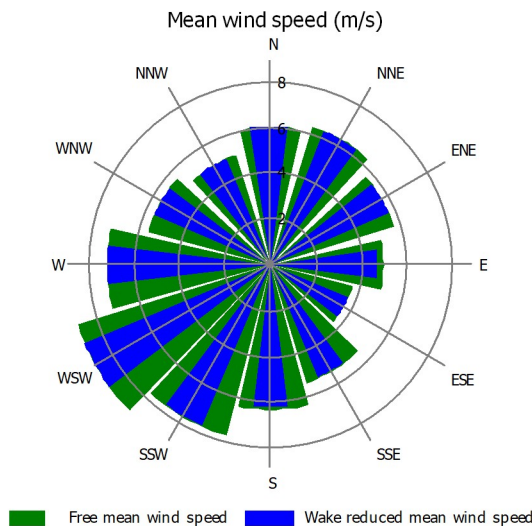
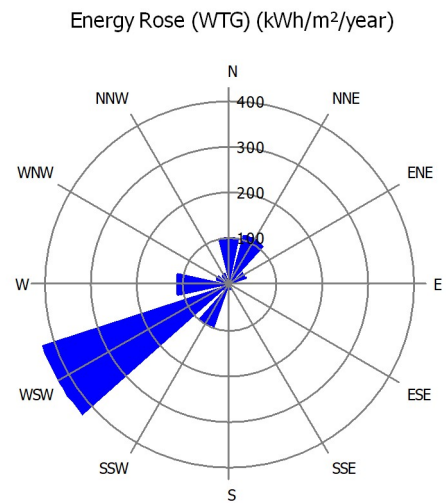
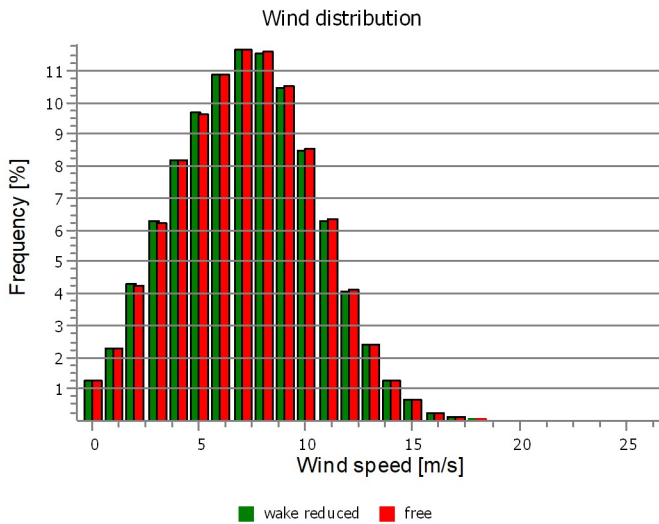
4*VESTAS V150-4.2 4200 150.0 !O! hub: 105,0 m (TOT: 180,0 m) dist: 1.200 m (8,0 RD) angle: 90° (17)

Masts used

Take nearest

Winddata for site

Sector	Free mean wind speed [m/s]	Wake reduced mean wind speed [m/s]	Frequency [%]
0 N	6,1	6,1	14,0
1 NNE	6,3	6,3	14,1
2 ENE	5,7	5,7	6,1
3 E	5,0	4,7	1,7
4 ESE	3,7	3,7	0,4
5 SSE	5,4	5,4	0,6
6 S	6,4	6,2	1,6
7 SSW	7,7	7,7	9,1
8 WSW	8,9	8,9	30,6
9 W	7,2	7,2	11,3
10 WNW	5,6	5,6	5,1
11 NNW	5,1	5,1	5,3
All	7,1	7,1	100,0



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PARK - Time varying AEP

Calculation: 22-459-005 Gujarat off-shore

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	863	765	978	1.011	1.189	1.183	1.307	1.236	803	491	630	796	11.253
1	824	708	892	890	1.046	1.093	1.247	1.191	721	465	599	774	10.449
2	823	664	787	758	899	1.018	1.211	1.128	709	424	555	762	9.738
3	805	630	708	629	767	902	1.128	1.039	643	386	502	715	8.854
4	827	641	621	538	670	867	1.092	1.015	585	333	494	723	8.407
5	828	617	552	439	571	816	1.037	938	556	318	505	772	7.949
6	789	576	460	332	493	739	994	884	497	313	510	727	7.311
7	754	544	413	272	415	671	925	824	455	303	470	712	6.758
8	699	508	366	214	381	645	899	798	413	274	452	673	6.322
9	662	474	336	192	363	645	902	795	377	247	379	608	5.978
10	577	417	308	191	351	665	960	835	377	212	331	544	5.769
11	504	330	243	167	441	727	1.023	903	396	159	243	441	5.578
12	394	278	218	208	522	811	1.096	961	410	123	183	357	5.560
13	367	249	216	262	671	904	1.176	1.058	484	125	160	309	5.982
14	349	243	235	366	863	1.028	1.280	1.151	557	149	143	298	6.663
15	313	239	268	469	977	1.082	1.296	1.199	616	173	145	270	7.047
16	328	271	323	644	1.170	1.188	1.381	1.277	759	217	159	266	7.984
17	360	296	416	826	1.307	1.275	1.418	1.347	831	280	223	294	8.871
18	436	385	551	996	1.371	1.304	1.436	1.367	943	354	264	364	9.770
19	545	482	731	1.167	1.417	1.306	1.431	1.385	988	401	348	474	10.676
20	672	608	904	1.260	1.438	1.338	1.441	1.375	1.006	436	438	608	11.523
21	762	715	1.036	1.278	1.435	1.318	1.402	1.364	950	493	534	733	12.019
22	859	771	1.087	1.230	1.407	1.274	1.396	1.327	902	512	608	792	12.164
23	865	810	1.054	1.127	1.334	1.225	1.342	1.267	817	516	637	823	11.817
Grand Total	15.205	12.222	13.703	15.465	21.499	24.025	28.819	26.662	15.795	7.702	9.510	13.834	204.440

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

PARK - Time varying AEP

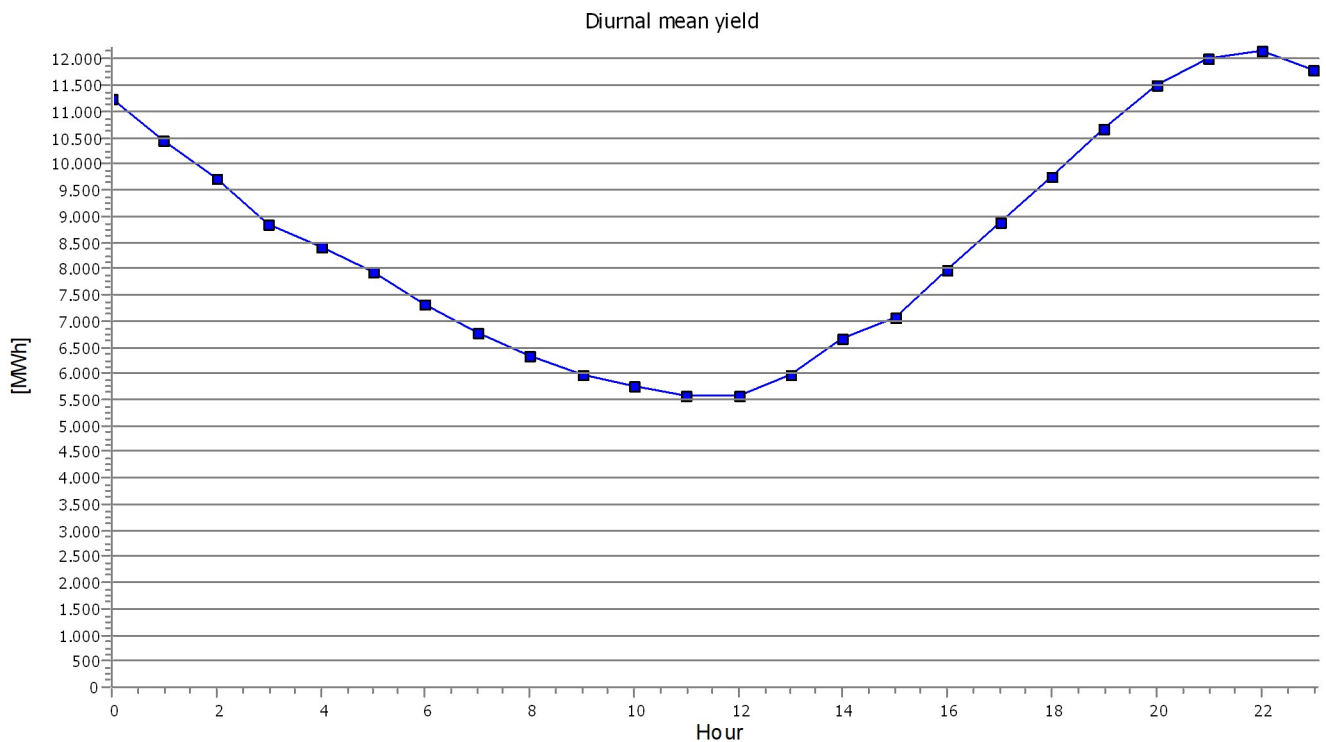
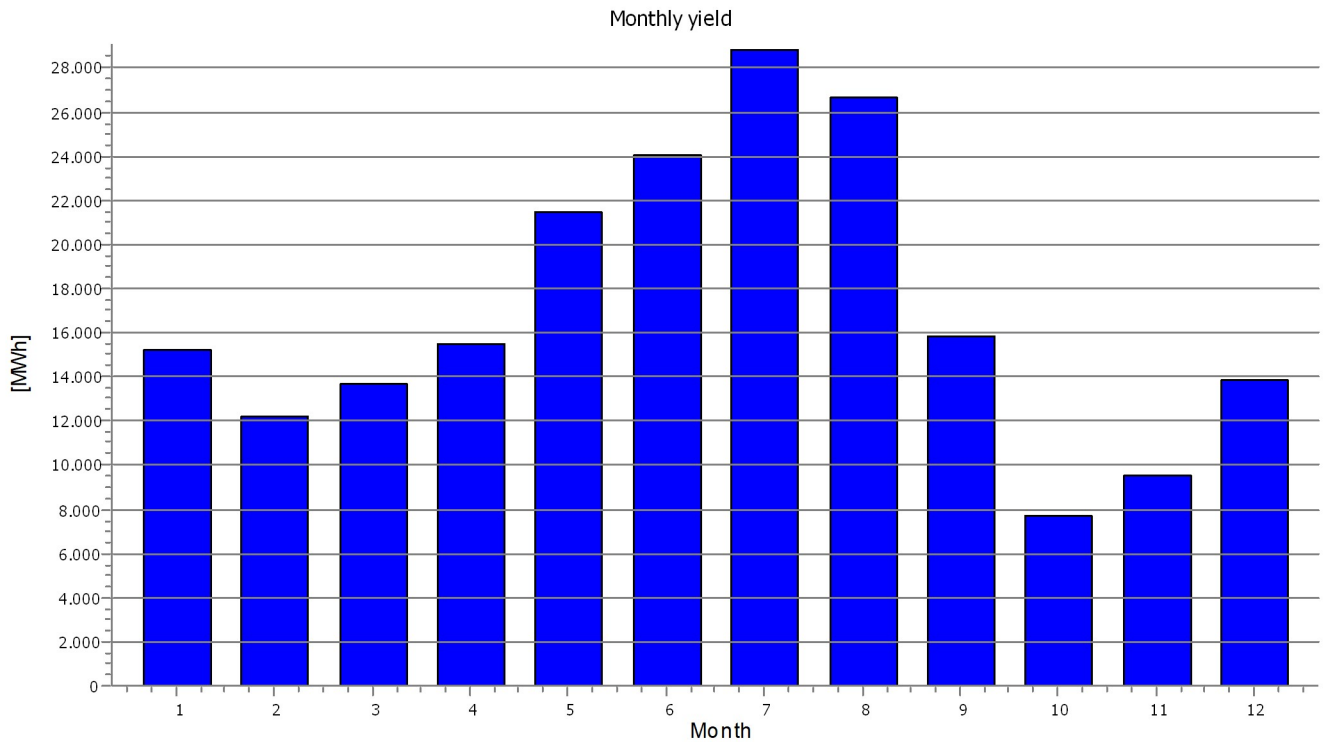
Calculation: 22-459-005 Gujarat off-shore

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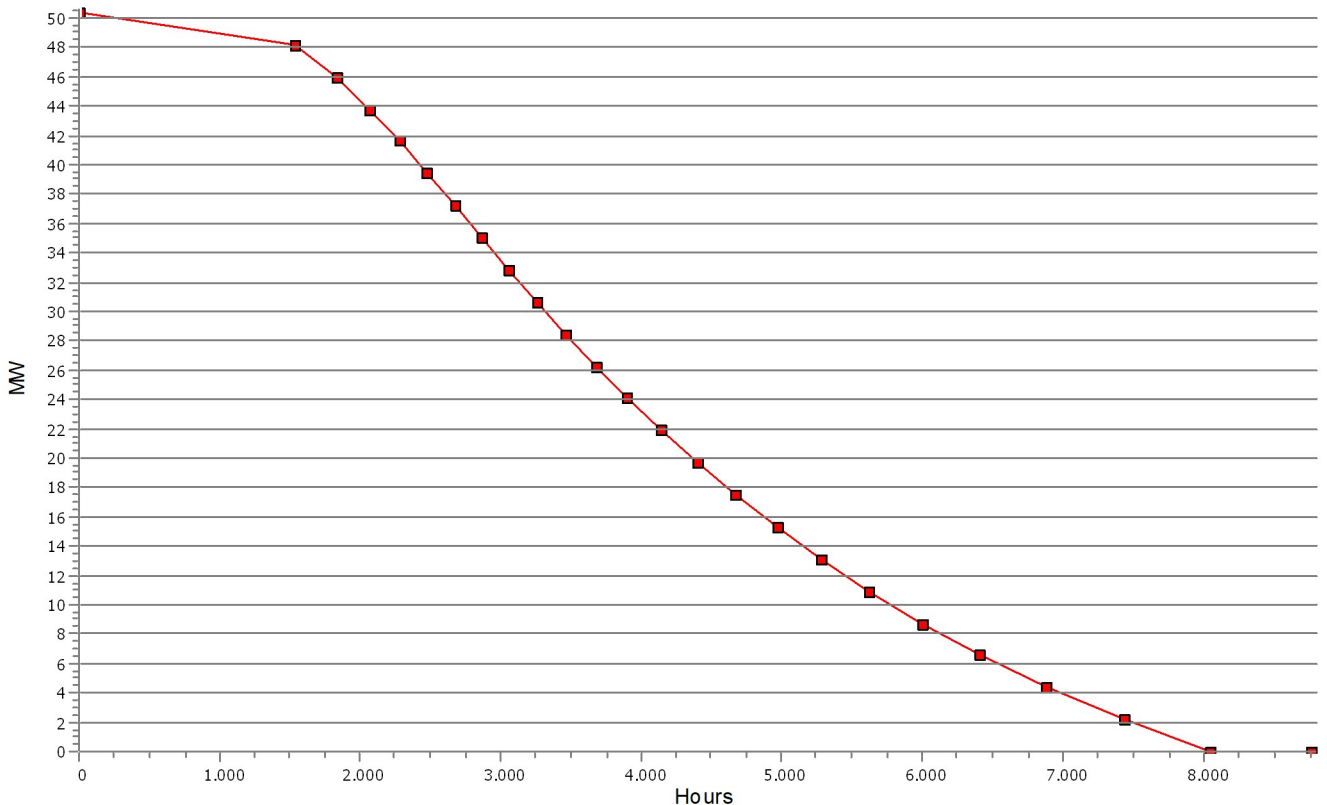
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Windfarm: 50,4 MW based on 12 turbines of type VESTAS V150-4.2 4200 150.0 !O!.

Selection: All new WTGs

Hours	Hours [%]	Hours accumulated	Power [MW]	Power (MW/WTG)
0	0,0	0	50,4	4,2
1529	17,4	1529	48,2 - 50,4	4,0 - 4,2
301	3,4	1830	46,0 - 48,2	3,8 - 4,0
234	2,7	2064	43,8 - 46,0	3,7 - 3,8
221	2,5	2285	41,6 - 43,8	3,5 - 3,7
191	2,2	2476	39,4 - 41,6	3,3 - 3,5
194	2,2	2670	37,3 - 39,4	3,1 - 3,3
190	2,2	2860	35,1 - 37,3	2,9 - 3,1
193	2,2	3053	32,9 - 35,1	2,7 - 2,9
200	2,3	3253	30,7 - 32,9	2,6 - 2,7
205	2,3	3459	28,5 - 30,7	2,4 - 2,6
218	2,5	3677	26,3 - 28,5	2,2 - 2,4
223	2,5	3900	24,1 - 26,3	2,0 - 2,2
245	2,8	4145	21,9 - 24,1	1,8 - 2,0
253	2,9	4399	19,7 - 21,9	1,6 - 1,8
273	3,1	4672	17,5 - 19,7	1,5 - 1,6
292	3,3	4964	15,3 - 17,5	1,3 - 1,5
310	3,5	5274	13,1 - 15,3	1,1 - 1,3
342	3,9	5616	11,0 - 13,1	0,9 - 1,1
375	4,3	5991	8,8 - 11,0	0,7 - 0,9
415	4,7	6406	6,6 - 8,8	0,5 - 0,7
473	5,4	6880	4,4 - 6,6	0,4 - 0,5
554	6,3	7433	2,2 - 4,4	0,2 - 0,4
610	7,0	8044	0,0 - 2,2	0,0 - 0,2
722	8,2	8766	0,0	0,0

Duration curve 50,4 MW WindFarm



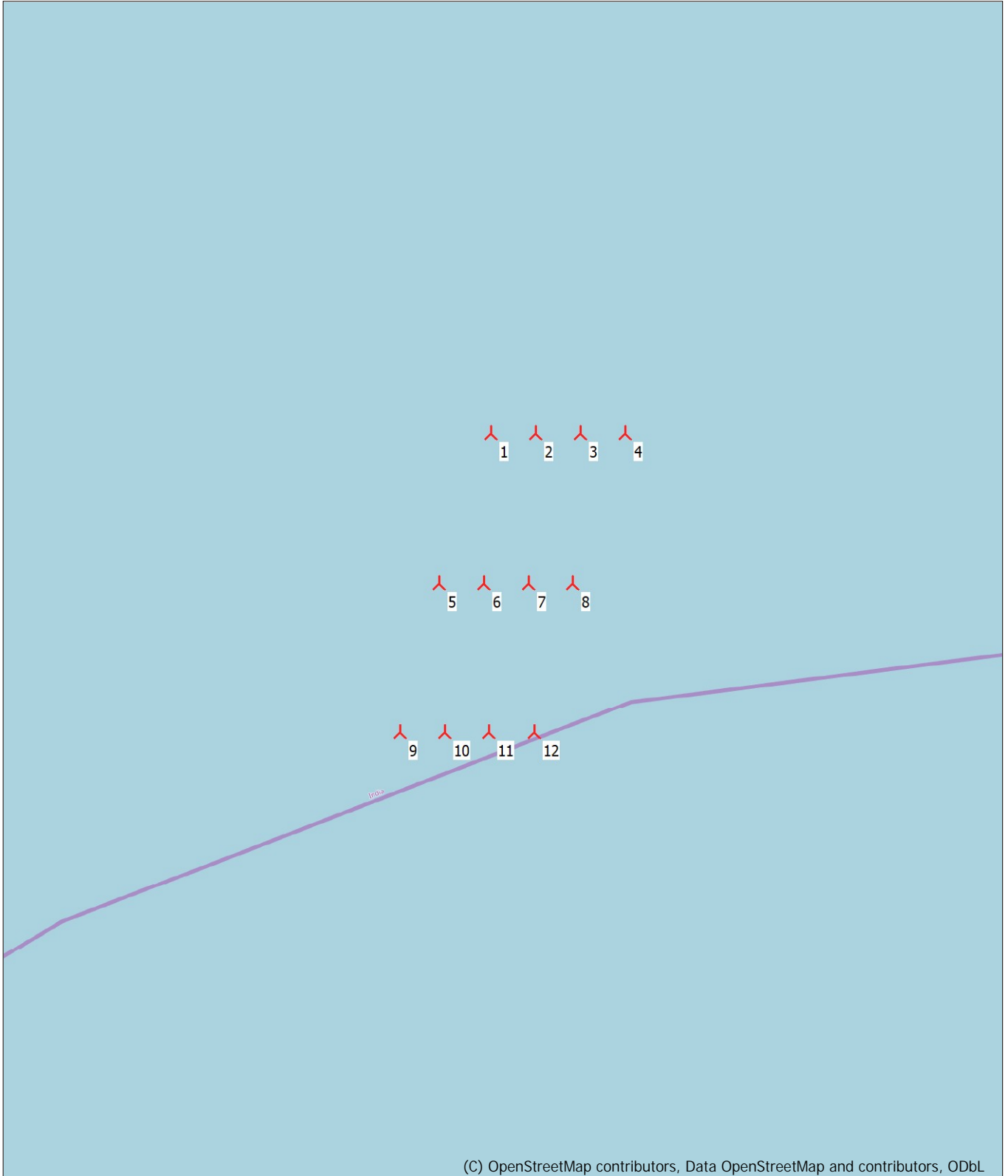
Project:
Site Analysis contract 81274134

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.

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Calculated:
22/2/2022 09:25/3.5.508

PARK - Map

Calculation: 22-459-005 Gujarat off-shore



Map: EMD OpenStreetMap , Print scale 1:150.000, Map center Geo WGS84 East: 72,195345° E North: 20,927190° N

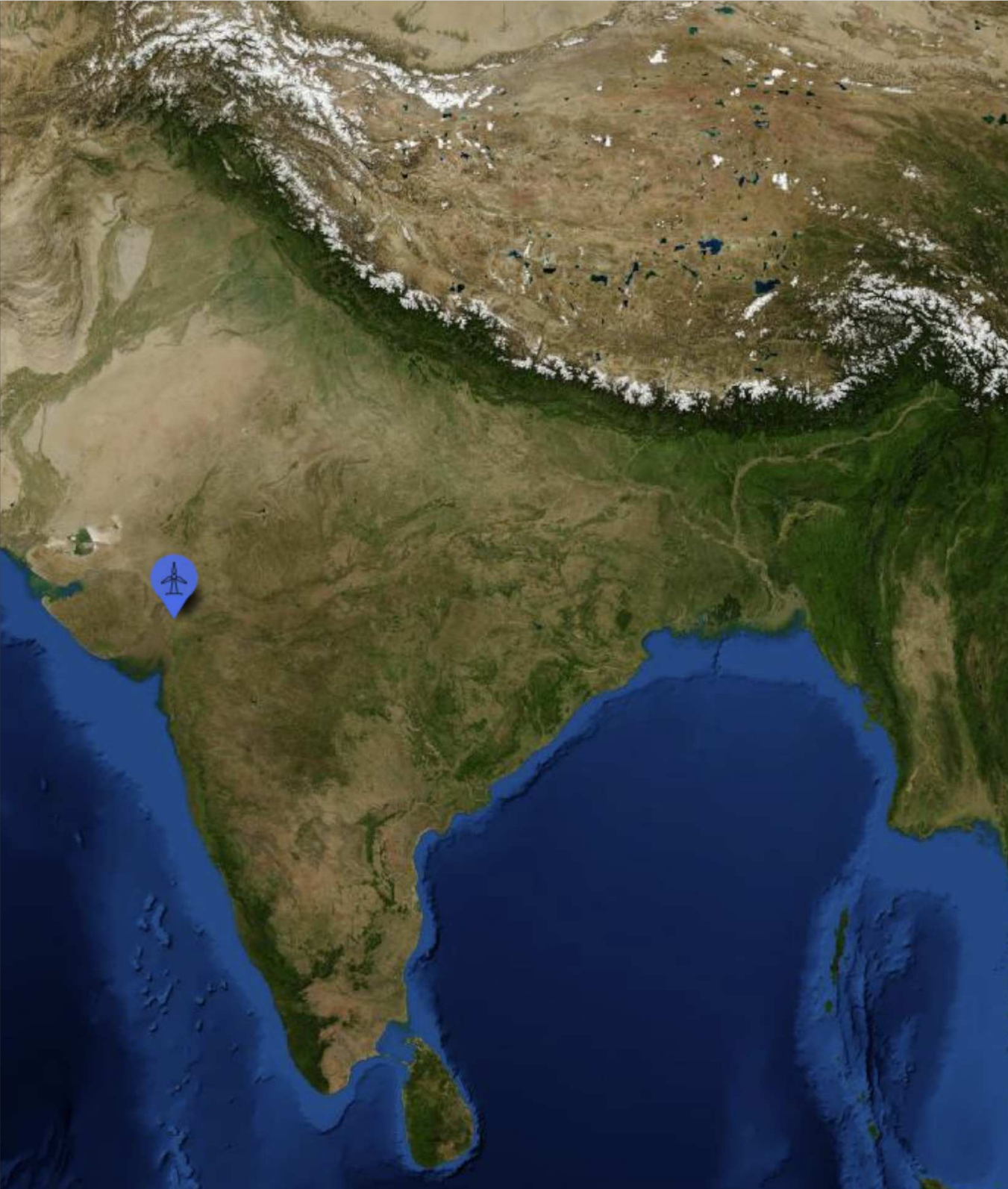
 New WTG

Heat Maps - Off-shore, Gujarat

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	3,050	2,943	2,247	1,309	1,536	2,905	13,989
2	2,546	2,187	1,591	929	1,319	2,672	11,244
3	3,096	1,883	1,153	862	1,858	3,754	12,606
4	3,025	1,454	703	1,201	3,342	4,504	14,228
5	3,590	1,977	1,413	2,790	4,844	5,165	19,779
6	3,860	2,845	2,468	3,519	4,667	4,743	22,103
7	4,502	3,724	3,481	4,461	5,213	5,133	26,514
8	4,226	3,368	3,064	4,020	4,946	4,905	24,529
9	2,646	1,925	1,438	1,902	3,238	3,381	14,532
10	1,626	1,165	820	523	1,152	1,800	7,086
11	2,103	1,820	1,292	581	914	2,040	8,749
12	2,803	2,699	2,085	1,135	1,286	2,719	12,727
Total	37,071	27,991	21,754	23,232	34,316	43,721	1,88,085

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	48.8%	47.1%	36.0%	20.9%	24.6%	46.5%	37.3%
2	45.1%	38.7%	28.2%	16.4%	23.4%	47.3%	33.2%
3	49.5%	30.1%	18.4%	13.8%	29.7%	60.1%	33.6%
4	50.0%	24.0%	11.6%	19.9%	55.3%	74.5%	39.2%
5	57.4%	31.6%	22.6%	44.6%	77.5%	82.6%	52.7%
6	63.8%	47.0%	40.8%	58.2%	77.2%	78.4%	60.9%
7	72.0%	59.6%	55.7%	71.4%	83.4%	82.1%	70.7%
8	67.6%	53.9%	49.0%	64.3%	79.1%	78.5%	65.4%
9	43.7%	31.8%	23.8%	31.5%	53.5%	55.9%	40.0%
10	26.0%	18.6%	13.1%	8.4%	18.4%	28.8%	18.9%
11	34.8%	30.1%	21.4%	9.6%	15.1%	33.7%	24.1%
12	44.8%	43.2%	33.4%	18.2%	20.6%	43.5%	33.9%
Total	50.4%	38.0%	29.6%	31.6%	46.6%	59.4%	42.6%

Yield Assessment - Arnod, Gujarat



Project:
Site Analysis contract 81274134

Description:
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Calculated:
22/2/2022 09:56/3.5.508

PARK - Main Result

Calculation: 22-459-006 Arnod Gujarat

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 (RISO/EMD)
Wake decay constant
Wake decay constant: 0,075 DTU default onshore
Reference WTG: 4*VESTAS V150-4.2 4200 150.0 IOI hub: 105,0 m (TOT: 180,0 m) dist: 750 m (5,0 RD)

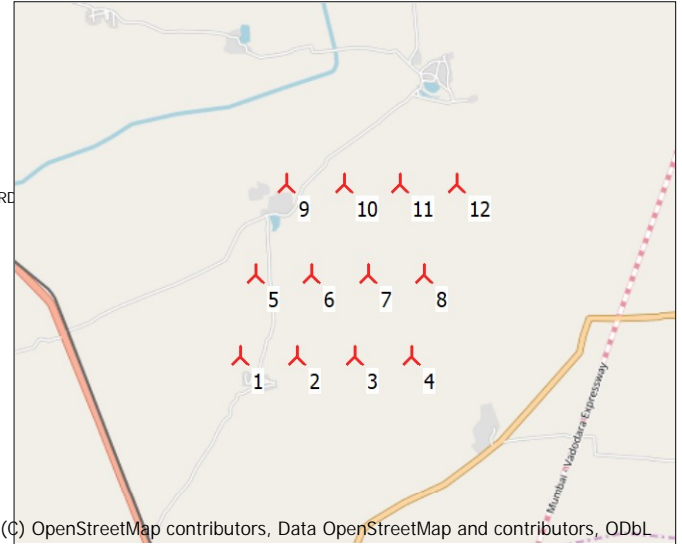
Scaler/wind data

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_N21.920_E072.925 - Gujarat
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]	24,7	24,7	24,7			
From air density settings [hPa]	999,1	999,4	999,3			
Resulting air density [kg/m³]	1,169	1,169	1,169			
Relative to 15°C at sea level [%]	95,4	95,4	95,4	-3,8	-3,8	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 [MWh/y]	Result-8,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Wake loss [%]	Specific results ^{a)}		Wind speed		
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	free [m/s]	wake [m/s]
Wind farm	122.513,4	112.712,4	131.701,1	7,0	25,5	9.392,7	2.236	5,6	5,5

^{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			Wind speed	
									Result [MWh/y]	Result-8,0% [MWh/y]	Wake loss [%]	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-OS - 08-2019	10.486,5	9.648	4,7	5,64	5,51	
2 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	10.407,6	9.575	5,5	5,64	5,48	
3 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	10.544,9	9.701	5,0	5,66	5,51	
4 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	10.610,8	9.762	3,3	5,63	5,53	
5 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	10.428,5	9.594	4,9	5,63	5,50	
6 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	9.956,1	9.160	9,3	5,63	5,40	
7 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	9.835,8	9.049	10,1	5,62	5,37	
8 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	9.936,9	9.142	9,0	5,62	5,39	
9 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	10.541,0	9.698	4,1	5,63	5,54	
10 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	10.057,3	9.253	8,6	5,63	5,43	
11 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	9.825,6	9.040	9,9	5,61	5,38	
12 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	9.882,3	9.092	9,4	5,61	5,40	

WTG siting

	Geo [deg]-WGS84	Longitude	Latitude	Z [m]	Row data/Description	Calculation period	
						Start	End
1 New	72,922955° E	21,913267° N	16,0	90,0°, 750,0 m	1/1/2002	1/1/2022	
2 New	72,930212° E	21,913267° N	16,9		1/1/2002	1/1/2022	
3 New	72,937469° E	21,913267° N	18,0		1/1/2002	1/1/2022	
4 New	72,944727° E	21,913267° N	16,0		1/1/2002	1/1/2022	
5 New	72,924782° E	21,923037° N	16,3	90,0°, 750,0 m	1/1/2002	1/1/2022	
6 New	72,932040° E	21,923037° N	16,0		1/1/2002	1/1/2022	
7 New	72,939297° E	21,923037° N	15,5		1/1/2002	1/1/2022	
8 New	72,946556° E	21,923037° N	15,6		1/1/2002	1/1/2022	
9 New	72,928840° E	21,933603° N	16,0	90,0°, 750,0 m	1/1/2002	1/1/2022	
10 New	72,936099° E	21,933603° N	16,0		1/1/2002	1/1/2022	
11 New	72,943357° E	21,933603° N	15,0		1/1/2002	1/1/2022	
12 New	72,950616° E	21,933603° N	15,2		1/1/2002	1/1/2022	

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Mathias Thamhain / mth@emd.dk
Calculated:
22/2/2022 09:56/3.5.508

PARK - Wind Data Analysis

Calculation: 22-459-006 Arnod GujaratWind 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° (14); Hub height: 105,0

Site coordinates

Geo WGS84

East: 72,922955° E North: 21,913267° 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° (14)

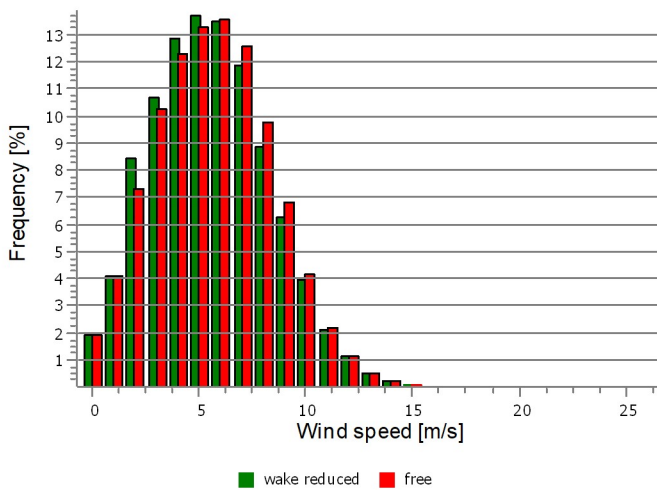
Masts used

Take nearest

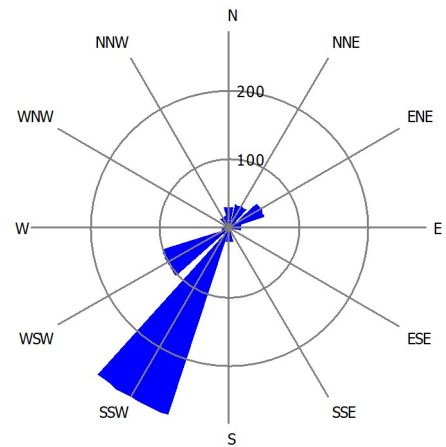
Winddata for site

Sector	Free mean wind speed [m/s]	Wake reduced mean wind speed [m/s]	Frequency [%]
0 N	5,0	4,7	8,4
1 NNE	4,9	4,6	10,3
2 ENE	5,3	5,0	12,1
3 E	5,1	4,5	4,4
4 ESE	3,7	3,7	1,2
5 SSE	3,6	3,6	1,0
6 S	5,4	5,4	3,6
7 SSW	7,5	7,5	26,5
8 WSW	5,7	5,7	16,8
9 W	3,7	3,7	4,7
10 WNW	3,7	3,7	4,6
11 NNW	4,2	4,2	6,3
All	5,6	5,5	100,0

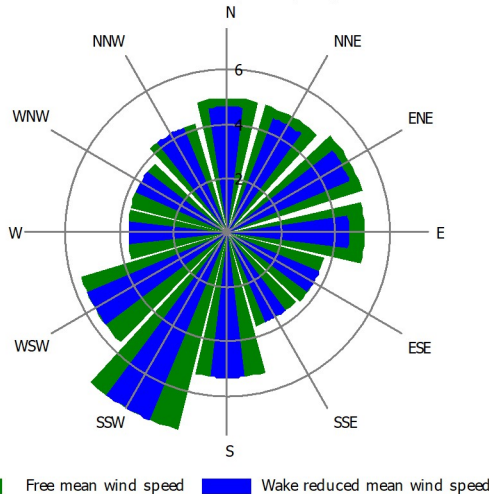
Wind distribution



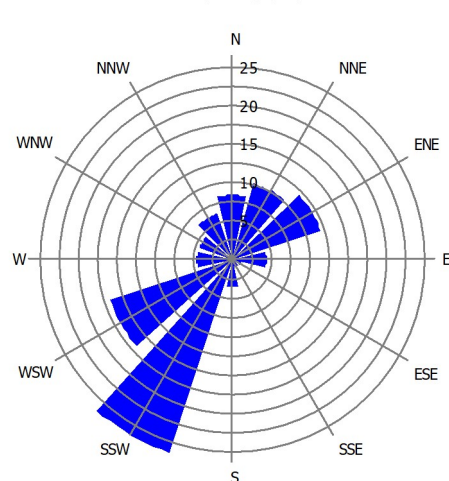
Energy Rose (WTG) (kWh/m²/year)



Mean wind speed (m/s)



Frequency (%)



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Calculated:
22/2/2022 09:56/3.5.508

PARK - Time varying AEP

Calculation: 22-459-006 Arnod Gujarat

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	594	487	502	489	709	817	808	718	443	296	403	515	6.781
1	558	459	451	414	605	677	689	633	371	296	398	508	6.058
2	548	416	392	355	488	600	623	573	351	290	402	506	5.545
3	502	386	353	320	418	487	519	479	281	266	401	470	4.882
4	503	385	324	322	389	454	500	466	238	253	432	480	4.745
5	482	363	315	284	353	439	496	446	243	264	453	515	4.653
6	455	334	277	231	330	395	511	444	218	274	472	491	4.432
7	452	314	249	171	289	401	475	414	193	249	438	471	4.118
8	343	231	138	113	282	424	487	421	188	134	264	344	3.370
9	158	121	94	101	251	437	487	434	195	74	100	146	2.599
10	118	98	88	97	233	456	516	432	194	74	90	119	2.516
11	106	89	81	83	271	495	561	468	204	66	73	93	2.591
12	83	73	66	92	297	528	601	467	191	60	65	76	2.602
13	84	67	61	99	349	591	638	521	229	69	66	72	2.845
14	80	66	64	128	433	702	762	611	264	83	66	73	3.332
15	71	68	82	148	464	752	818	663	282	100	77	74	3.597
16	88	95	100	223	620	896	965	773	352	117	85	87	4.401
17	135	119	152	332	864	1.072	1.073	896	399	141	135	137	5.454
18	278	224	264	506	1.067	1.173	1.124	943	506	222	219	278	6.805
19	426	353	439	717	1.184	1.199	1.164	1.046	591	281	328	427	8.154
20	516	424	535	790	1.180	1.223	1.169	1.040	656	315	386	505	8.739
21	539	461	594	798	1.110	1.138	1.106	996	603	325	407	556	8.634
22	574	470	586	730	1.005	1.037	1.053	913	543	316	406	547	8.180
23	570	501	550	610	878	923	936	805	461	306	402	541	7.482
Grand Total	8.260	6.606	6.756	8.155	14.071	17.315	18.084	15.602	8.197	4.870	6.570	8.029	122.513

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

PARK - Time varying AEP

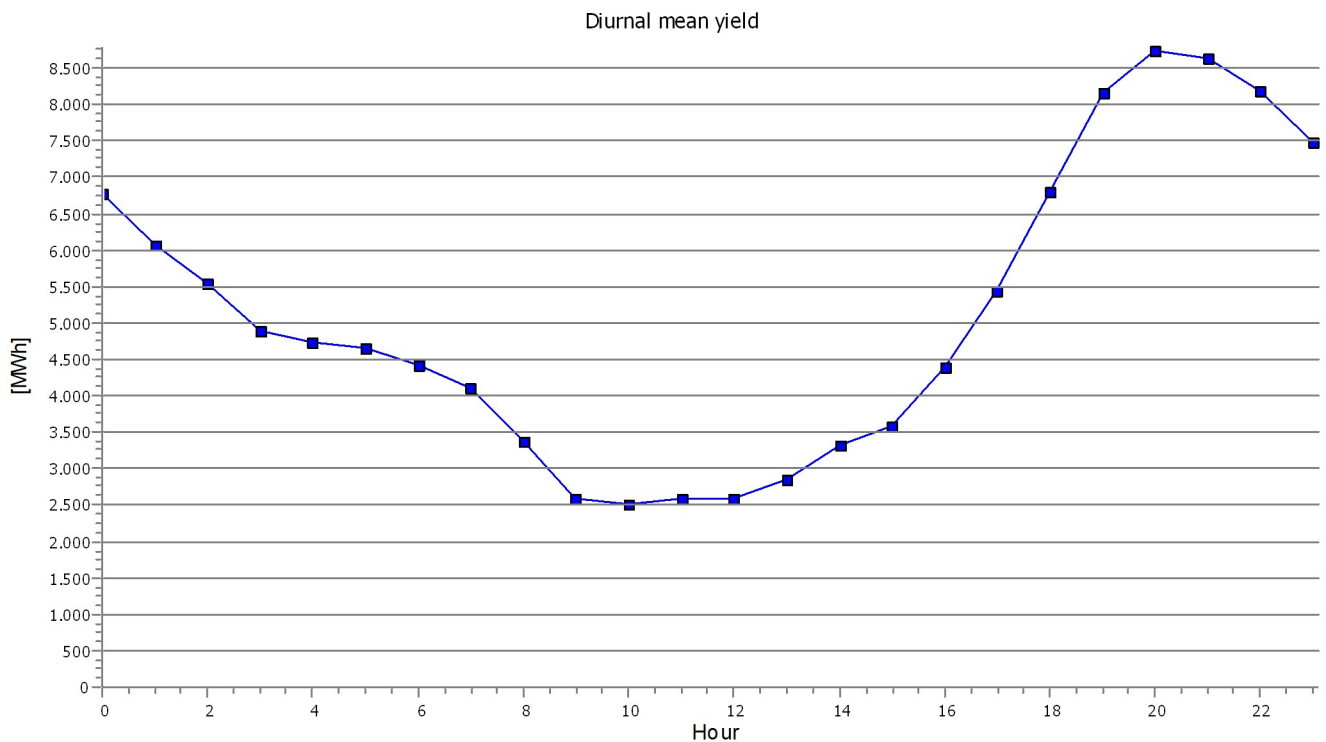
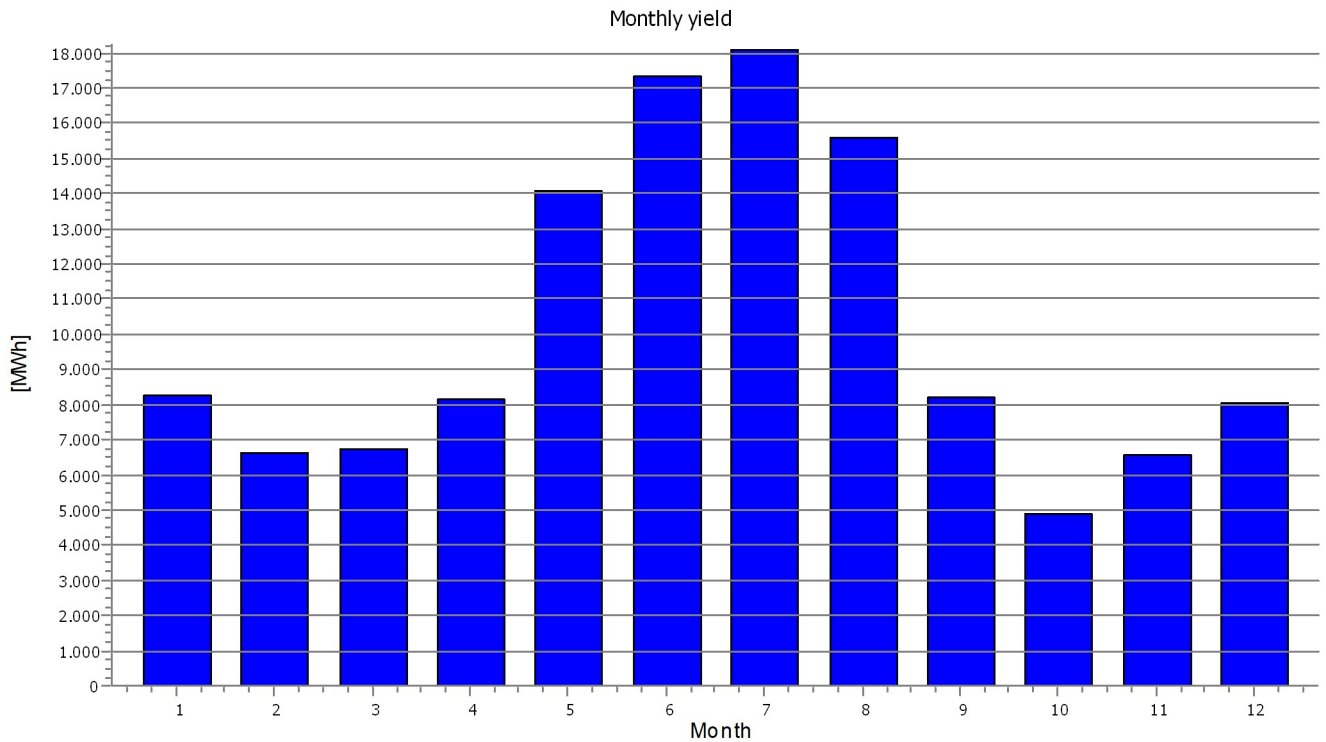
Calculation: 22-459-006 Arnod Gujarat

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.



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.

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Mathias Thamhain / mth@emd.dk
Calculated:
22/2/2022 09:56/3.5.508

PARK - Time varying AEP

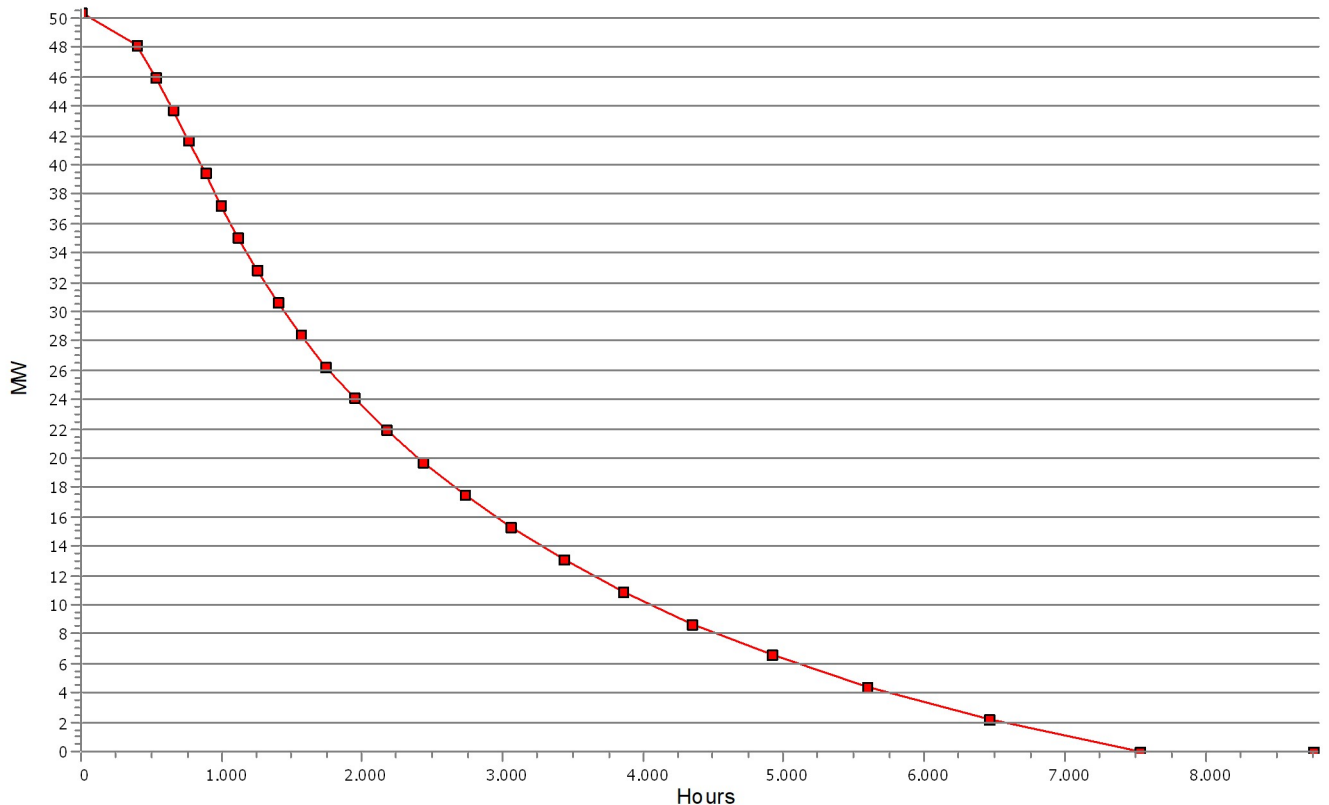
Calculation: 22-459-006 Arnod Gujarat

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
399	4,6	399	48,2 - 50,4	4,0 - 4,2
133	1,5	532	46,0 - 48,2	3,8 - 4,0
120	1,4	653	43,8 - 46,0	3,7 - 3,8
111	1,3	764	41,6 - 43,8	3,5 - 3,7
114	1,3	878	39,4 - 41,6	3,3 - 3,5
117	1,3	995	37,3 - 39,4	3,1 - 3,3
121	1,4	1117	35,1 - 37,3	2,9 - 3,1
134	1,5	1251	32,9 - 35,1	2,7 - 2,9
143	1,6	1393	30,7 - 32,9	2,6 - 2,7
162	1,8	1555	28,5 - 30,7	2,4 - 2,6
180	2,1	1735	26,3 - 28,5	2,2 - 2,4
200	2,3	1935	24,1 - 26,3	2,0 - 2,2
230	2,6	2165	21,9 - 24,1	1,8 - 2,0
260	3,0	2424	19,7 - 21,9	1,6 - 1,8
299	3,4	2723	17,5 - 19,7	1,5 - 1,6
327	3,7	3050	15,3 - 17,5	1,3 - 1,5
379	4,3	3430	13,1 - 15,3	1,1 - 1,3
418	4,8	3848	11,0 - 13,1	0,9 - 1,1
494	5,6	4342	8,8 - 11,0	0,7 - 0,9
572	6,5	4914	6,6 - 8,8	0,5 - 0,7
678	7,7	5592	4,4 - 6,6	0,4 - 0,5
863	9,8	6455	2,2 - 4,4	0,2 - 0,4
1073	12,2	7528	0,0 - 2,2	0,0 - 0,2
1238	14,1	8766	0,0	0,0

Duration curve 50,4 MW WindFarm



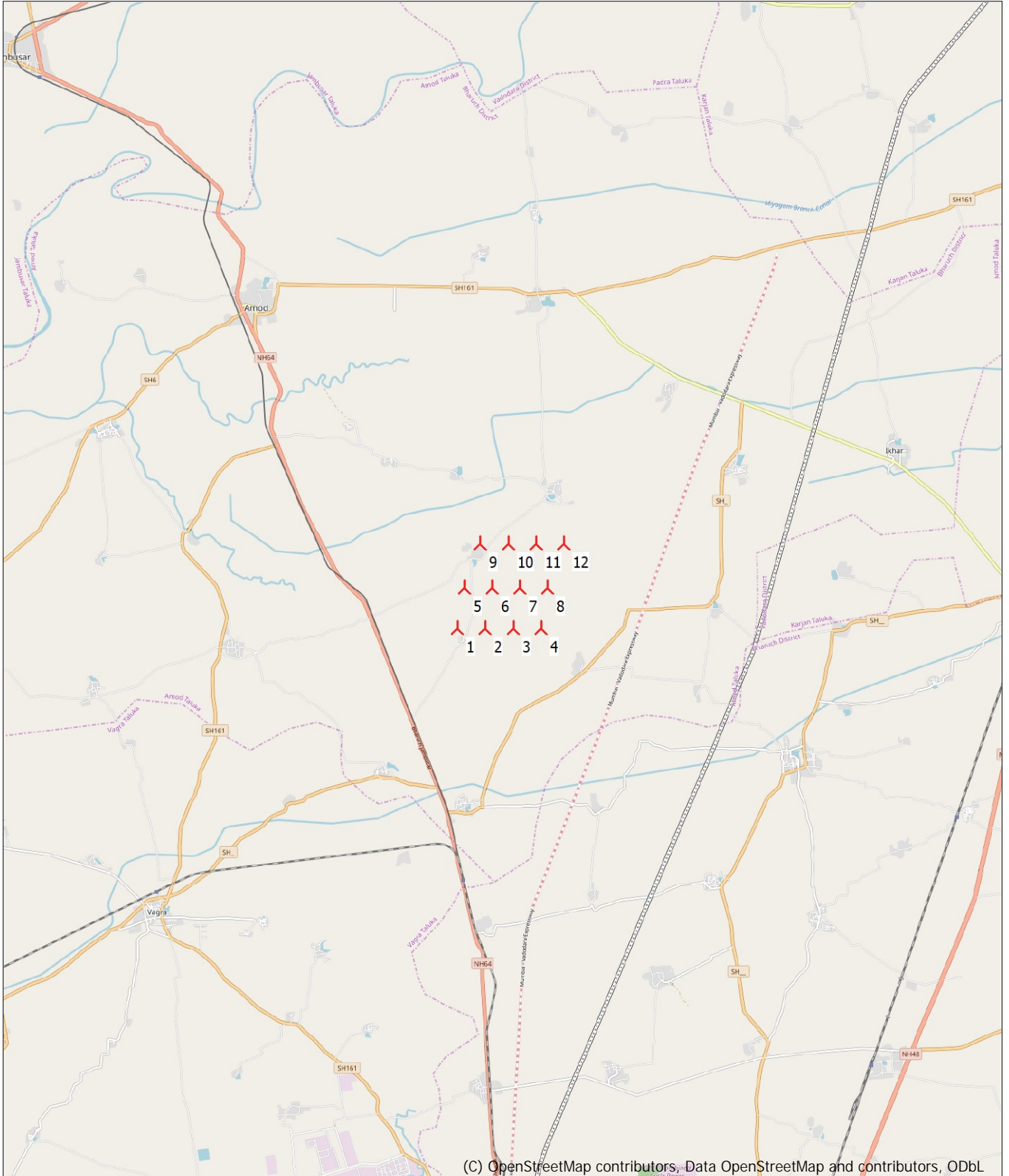
Project:
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Calculated:
22/2/2022 09:56/3.5.508

PARK - Map

Calculation: 22-459-006 Arnod Gujarat



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:150.000, Map center Geo WGS84 East: 72,936785° E North: 21,923435° N

New WTG

Heat Maps - Arnod, Gujarat

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	2,026	1,740	667	292	853	2,023	7,599
2	1,609	1,284	497	252	728	1,708	6,077
3	1,562	1,072	368	251	878	2,084	6,216
4	1,453	928	363	430	1,635	2,694	7,502
5	2,043	1,252	954	1,420	3,436	3,839	12,945
6	2,374	1,554	1,667	2,367	3,993	3,975	15,930
7	2,428	1,824	1,887	2,594	3,980	3,924	16,638
8	2,210	1,628	1,615	2,081	3,365	3,454	14,353
9	1,330	821	719	889	1,701	2,081	7,541
10	1,056	957	320	287	700	1,160	4,480
11	1,475	1,651	486	252	706	1,473	6,044
12	1,839	1,800	645	271	854	1,977	7,386
Total	21,405	16,512	10,189	11,386	22,829	30,392	1,12,712

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	32.4%	27.8%	10.7%	4.7%	13.6%	32.4%	20.3%
2	28.5%	22.7%	8.8%	4.5%	12.9%	30.3%	17.9%
3	25.0%	17.2%	5.9%	4.0%	14.1%	33.4%	16.6%
4	24.0%	15.4%	6.0%	7.1%	27.0%	44.5%	20.7%
5	32.7%	20.0%	15.3%	22.7%	55.0%	61.4%	34.5%
6	39.3%	25.7%	27.6%	39.1%	66.0%	65.7%	43.9%
7	38.9%	29.2%	30.2%	41.5%	63.7%	62.8%	44.4%
8	35.4%	26.0%	25.8%	33.3%	53.9%	55.3%	38.3%
9	22.0%	13.6%	11.9%	14.7%	28.1%	34.4%	20.8%
10	16.9%	15.3%	5.1%	4.6%	11.2%	18.6%	11.9%
11	24.4%	27.3%	8.0%	4.2%	11.7%	24.4%	16.7%
12	29.4%	28.8%	10.3%	4.3%	13.7%	31.6%	19.7%
Total	29.1%	22.4%	13.8%	15.5%	31.0%	41.3%	25.5%

Yield Assessment - Erode, Tamil Nadu



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

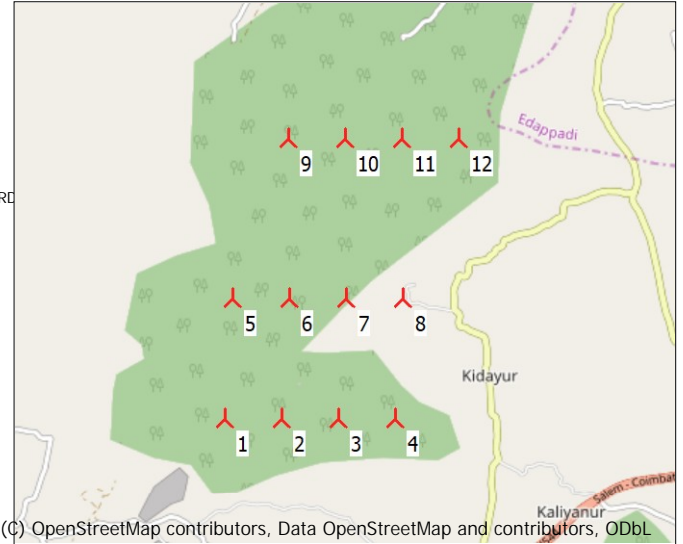
Scaler/wind data

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 [MWh/y]	Result-8,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Wake loss [%]	Specific results ^{a)}		Wind speed		
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	free [m/s]	wake [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

^{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			Wind speed	
									Result [MWh/y]	Result-8,0% [MWh/y]	Wake loss [%]	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-OS - 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-OS - 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-OS - 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-OS - 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-OS - 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-OS - 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-OS - 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-OS - 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-OS - 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-OS - 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-OS - 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-OS - 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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Mathias Thamhain / mth@emd.dk
Calculated:
22/2/2022 10:24/3.5.508

PARK - Wind Data Analysis

Calculation: 22-459-007 Erode Tamil Nadu Wind 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)

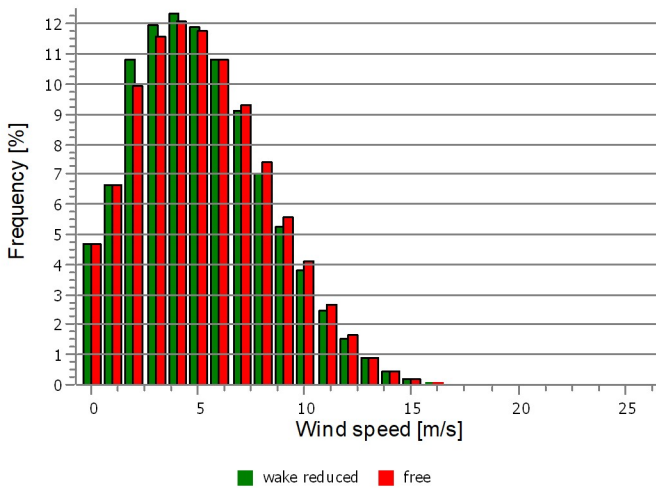
Masts used

Take nearest

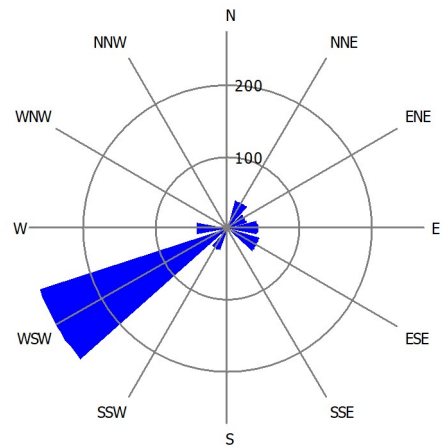
Winddata for site

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

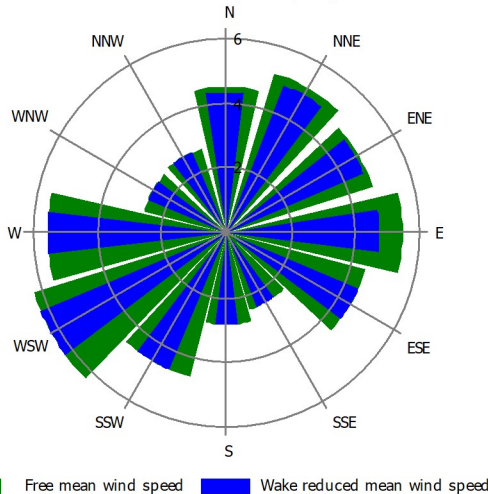
Wind distribution



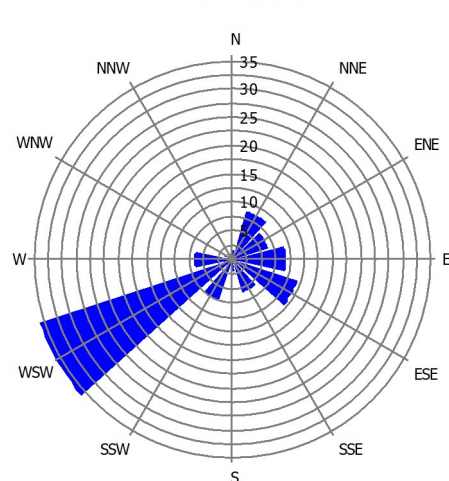
Energy Rose (WTG) (kWh/m²/year)



Mean wind speed (m/s)



Frequency (%)



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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

PARK - Time varying AEP

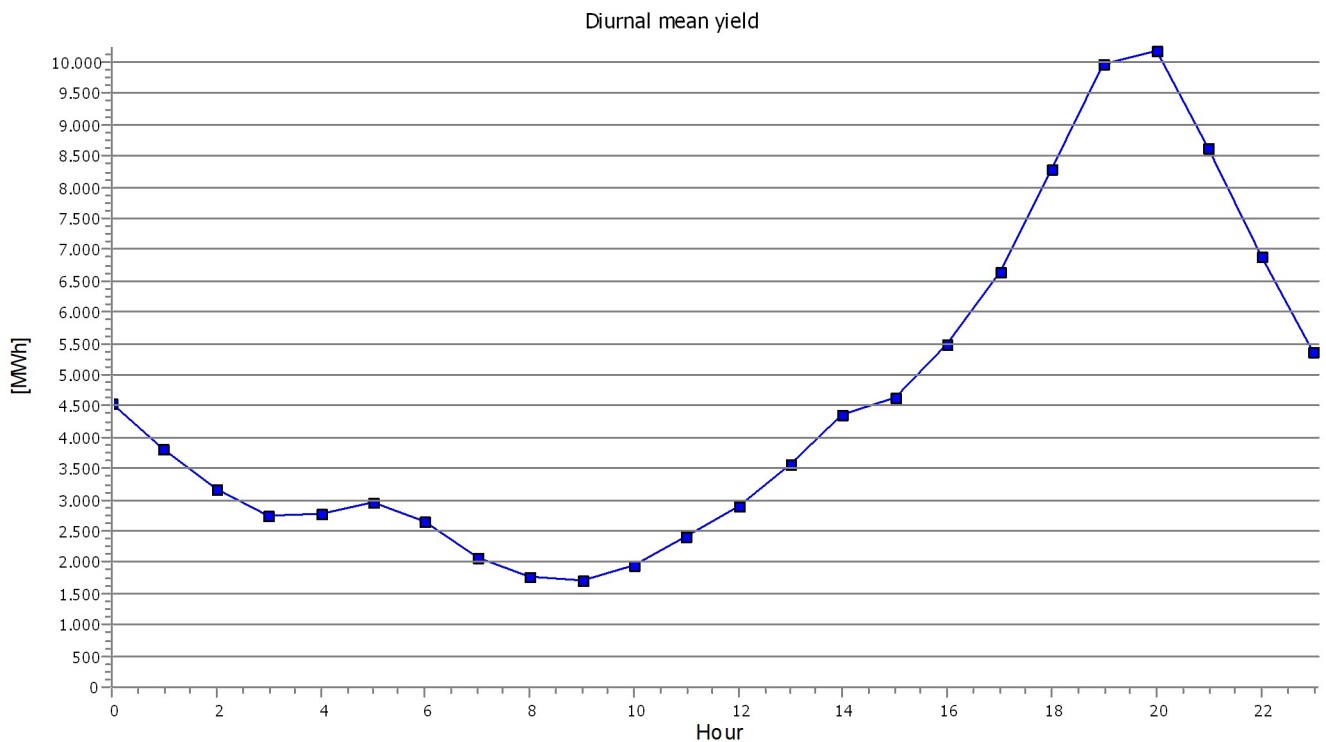
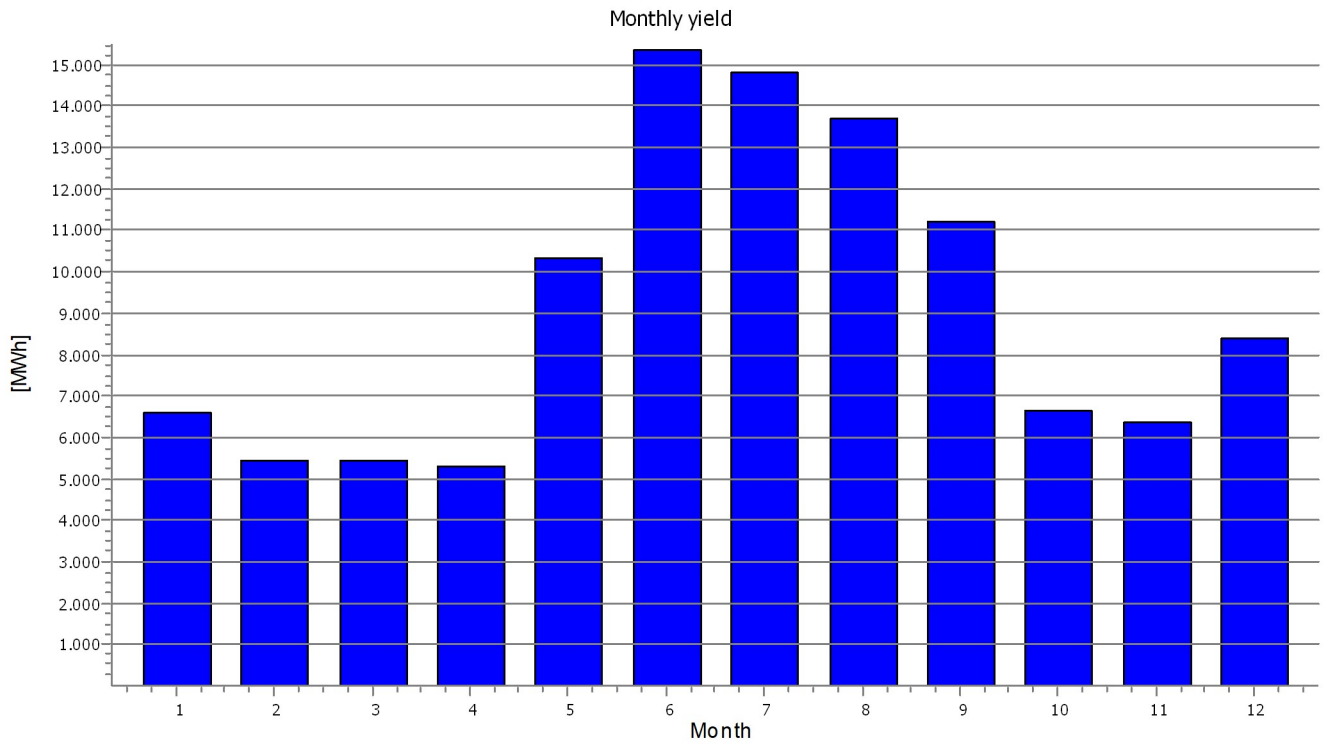
Calculation: 22-459-007 Erode Tamil Nadu

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.



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.

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

PARK - Time varying AEP

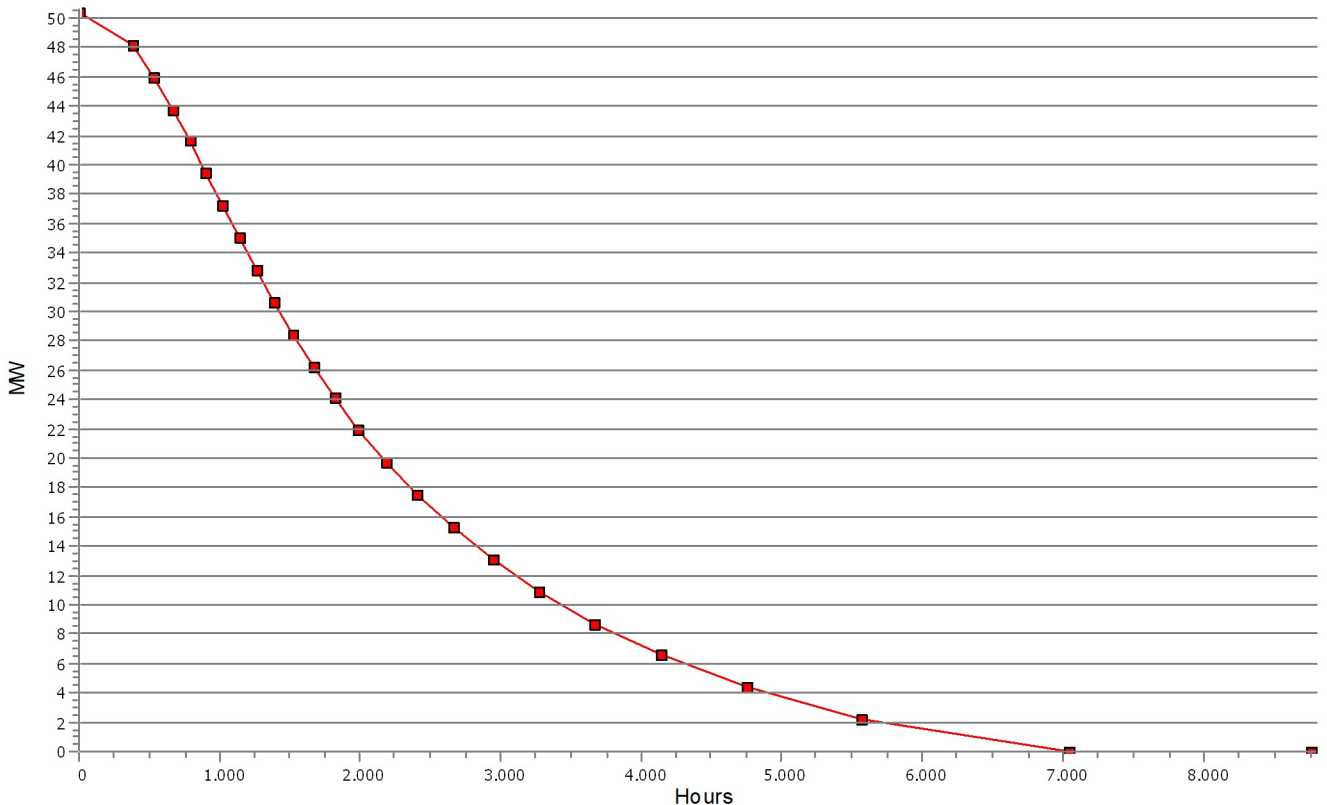
Calculation: 22-459-007 Erode Tamil Nadu

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

Duration curve 50,4 MW WindFarm



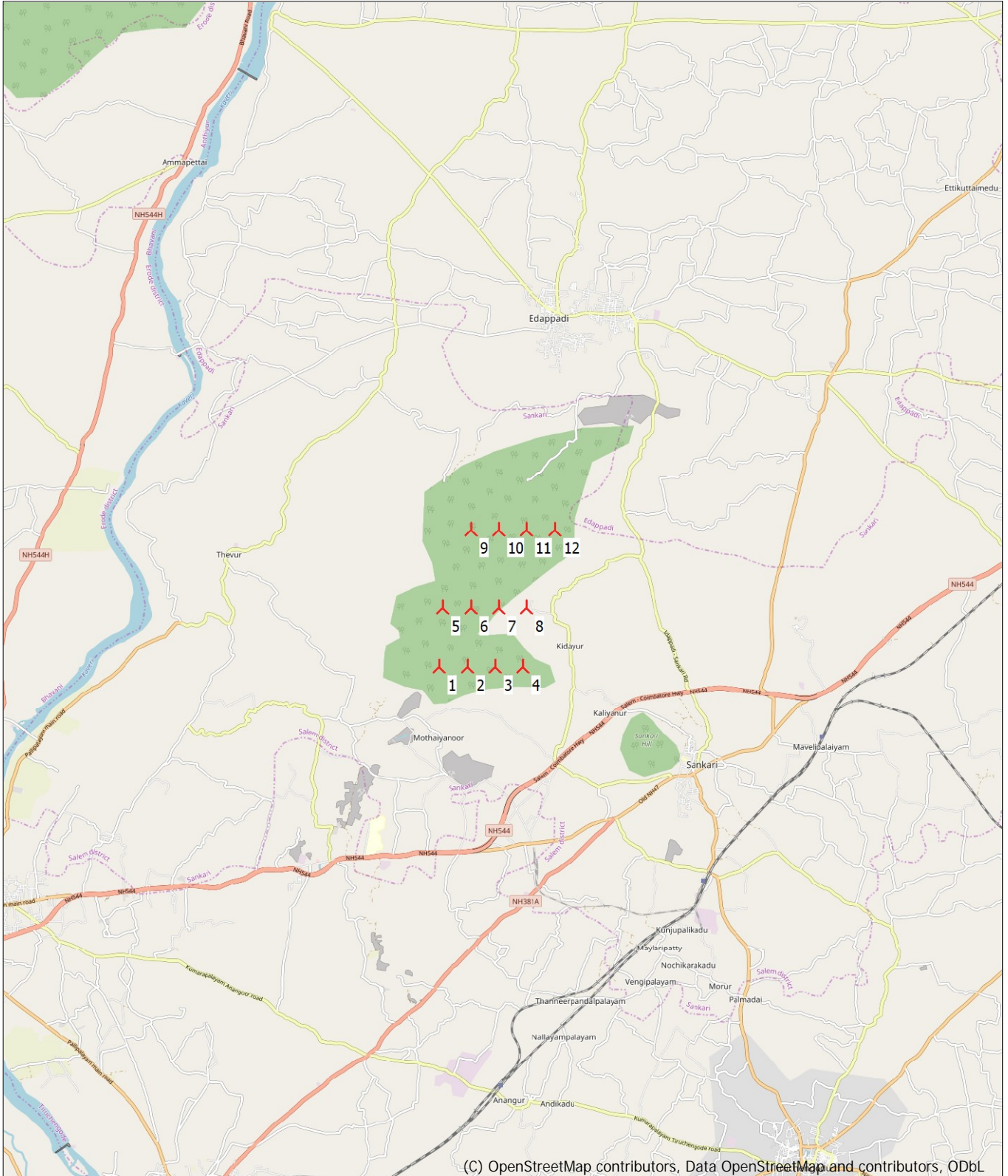
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Site Analysis contract 81274134

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

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%

Yield Assessment - Off-shore, Tamil Nadu



Project:
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Calculated:
22/2/2022 16:11/3.5.508

PARK - Main Result

Calculation: 22-459-008 Tamil Nadu off-shore

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: 0,050 DTU default offshore
Reference WTG: 4*VESTAS V150-4.2 4200 150.0 IOI hub: 105,0 m (TOT: 180,0 m) dist: 1.200 m (8,0 m)

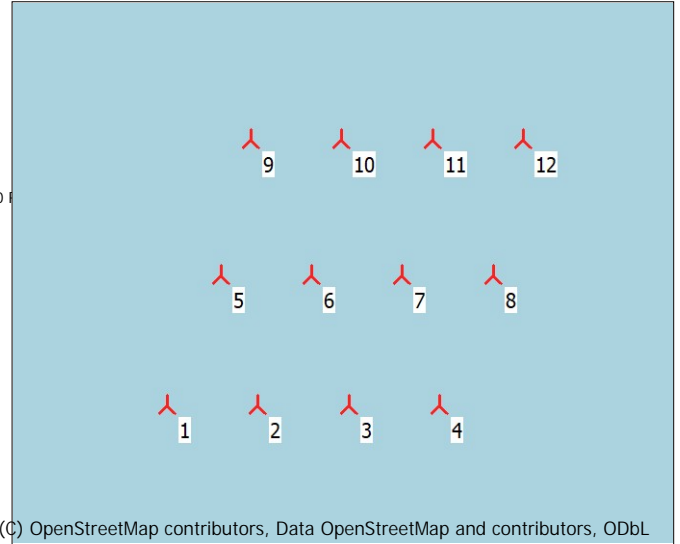
Scaler/wind data

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 03:30:00 - 1/1/2022 03:30:00
Meteo object(s): EmdWrf_N08.910_E078.360 - TN offshore
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]	24,8	24,8	24,8			
From air density settings [hPa]	1001,1	1001,1	1001,1			
Resulting air density [kg/m³]	1,171	1,171	1,171			
Relative to 15°C at sea level [%]	95,6	95,6	95,6	-2,7	-2,7	0,0



▲ New WTG

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	Result-8,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Wake loss [%]	Specific results ^{a)}		Wind speed			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	free [m/s]	wake [m/s]	reduced [m/s]
Wind farm	208.840,1	192.132,9	216.411,3	3,5	43,5	16.011,1	3.812	7,3		7,2

^{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			Wind speed	
									Result [MWh/y]	Result-8,0% [MWh/y]	Wake loss [%]	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-OS - 08-2019	17.557,7	16.153	2,6	7,32	7,23	
2 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.434,9	16.040	3,3	7,32	7,20	
3 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.489,8	16.091	3,0	7,32	7,21	
4 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.662,2	16.249	2,1	7,32	7,24	
5 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.414,3	16.021	3,4	7,32	7,19	
6 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.148,1	15.776	4,9	7,32	7,14	
7 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.127,5	15.757	5,0	7,32	7,13	
8 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.330,7	15.944	3,9	7,32	7,18	
9 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.682,9	16.268	1,9	7,32	7,25	
10 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.389,3	15.998	3,6	7,32	7,19	
11 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.258,4	15.878	4,3	7,32	7,16	
12 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.344,3	15.957	3,8	7,32	7,18	

WTG siting

	Geo [deg]-WGS84	Longitude	Latitude	Z [m]	Row data/Description	Calculation period	
						Start	End
1 New	78,348999° E	8,917634° N	0,0	90,0°, 1.200,0 m	1/1/2002	1/1/2022	
2 New	78,359903° E	8,917634° N	0,0		1/1/2002	1/1/2022	
3 New	78,370807° E	8,917634° N	0,0		1/1/2002	1/1/2022	
4 New	78,381711° E	8,917634° N	0,0		1/1/2002	1/1/2022	
5 New	78,355402° E	8,933014° N	0,0	90,0°, 1.200,0 m	1/1/2002	1/1/2022	
6 New	78,366306° E	8,933014° N	0,0		1/1/2002	1/1/2022	
7 New	78,377210° E	8,933014° N	0,0		1/1/2002	1/1/2022	
8 New	78,388115° E	8,933014° N	0,0		1/1/2002	1/1/2022	
9 New	78,359057° E	8,949072° N	0,0	90,0°, 1.200,0 m	1/1/2002	1/1/2022	
10 New	78,369962° E	8,949072° N	0,0		1/1/2002	1/1/2022	
11 New	78,380867° E	8,949072° N	0,0		1/1/2002	1/1/2022	
12 New	78,391772° E	8,949072° N	0,0		1/1/2002	1/1/2022	

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Mathias Thamhain / mth@emd.dk
Calculated:
22/2/2022 16:11/3.5.508

PARK - Wind Data Analysis

Calculation: 22-459-008 Tamil Nadu off-shore Wind data: 1 - 4*VESTAS V150-4.2 4200 150.0 !O! hub: 105,0 m (TOT: 180,0 m) dist: 1.200 m (8,0 RD) angle: 90° (21); Hub height: 105,0

Site coordinates

Geo WGS84

East: 78,348999° E North: 8,917634° N

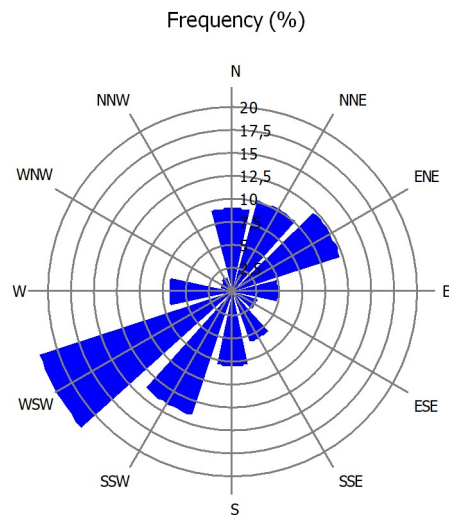
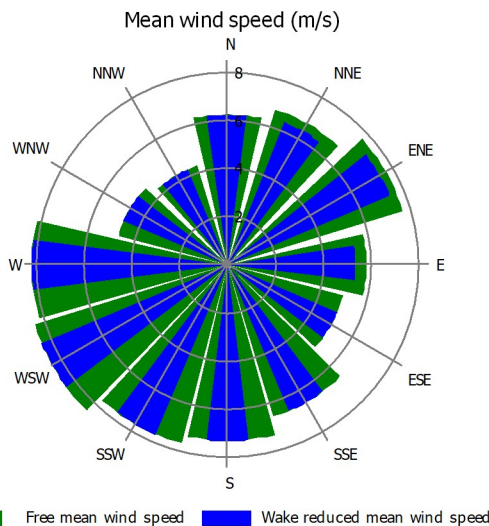
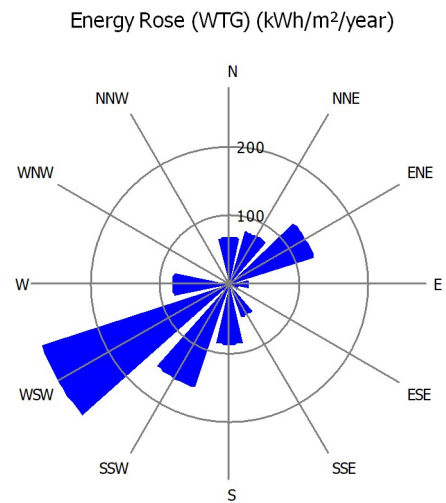
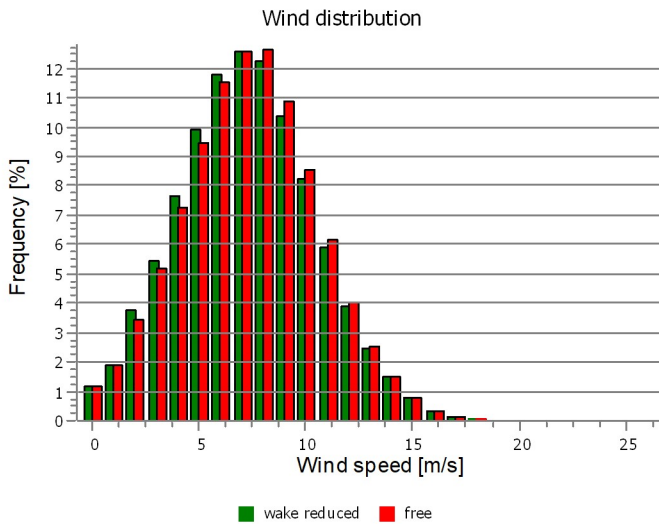
4*VESTAS V150-4.2 4200 150.0 !O! hub: 105,0 m (TOT: 180,0 m) dist: 1.200 m (8,0 RD) angle: 90° (21)

Masts used

Take nearest

Winddata for site

Sector	Free mean wind speed [m/s]	Wake reduced mean wind speed [m/s]	Frequency [%]
0 N	6,3	6,3	9,2
1 NNE	6,8	6,4	10,3
2 ENE	7,7	7,4	12,4
3 E	5,8	5,4	5,0
4 ESE	5,0	5,0	2,8
5 SSE	6,6	6,6	5,8
6 S	7,3	7,3	8,1
7 SSW	7,7	7,7	14,2
8 WSW	8,5	8,5	22,2
9 W	8,2	8,2	6,9
10 WNW	4,7	4,7	1,4
11 NNW	4,3	4,3	1,7
All	7,3	7,2	100,0



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PARK - Time varying AEP

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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

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	867	731	487	416	777	863	845	821	727	538	538	780	8.389
1	808	639	412	351	740	898	866	815	761	519	517	779	8.106
2	670	514	329	263	681	890	881	804	673	436	456	657	7.253
3	571	414	247	231	629	847	820	737	594	366	395	566	6.419
4	510	361	214	213	596	828	763	681	593	353	372	569	6.054
5	548	363	202	190	601	775	779	662	576	360	416	578	6.050
6	644	411	210	191	568	754	730	633	562	363	451	688	6.206
7	639	424	199	144	528	721	703	609	510	312	464	688	5.940
8	599	402	175	103	480	684	622	542	445	291	392	641	5.375
9	568	382	159	93	379	648	612	487	402	232	364	596	4.921
10	556	353	141	97	419	650	594	485	407	213	316	580	4.813
11	504	320	187	202	491	738	677	560	475	273	300	564	5.292
12	532	351	300	398	733	945	911	819	755	440	337	548	7.068
13	607	419	480	656	1.007	1.151	1.162	1.086	988	634	375	593	9.157
14	612	492	614	797	1.165	1.308	1.278	1.225	1.121	776	471	658	10.519
15	763	668	718	911	1.271	1.358	1.352	1.280	1.248	857	520	756	11.702
16	981	830	786	970	1.314	1.396	1.376	1.346	1.234	898	602	859	12.591
17	1.153	1.011	857	989	1.324	1.401	1.401	1.316	1.282	947	636	964	13.280
18	1.190	1.048	884	996	1.335	1.405	1.396	1.332	1.283	916	674	1.015	13.474
19	1.183	1.037	861	908	1.277	1.400	1.369	1.290	1.249	843	657	1.000	13.072
20	1.109	984	808	807	1.188	1.327	1.278	1.239	1.147	777	611	964	12.238
21	1.115	949	723	697	1.090	1.219	1.224	1.141	1.047	681	581	899	11.367
22	1.067	908	651	560	995	1.100	1.088	1.009	909	602	539	882	10.308
23	995	828	566	464	845	981	947	887	832	527	537	835	9.245
Grand Total	18.794	14.841	11.208	11.646	20.432	24.286	23.673	21.806	19.820	13.153	11.521	17.661	208.840

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

PARK - Time varying AEP

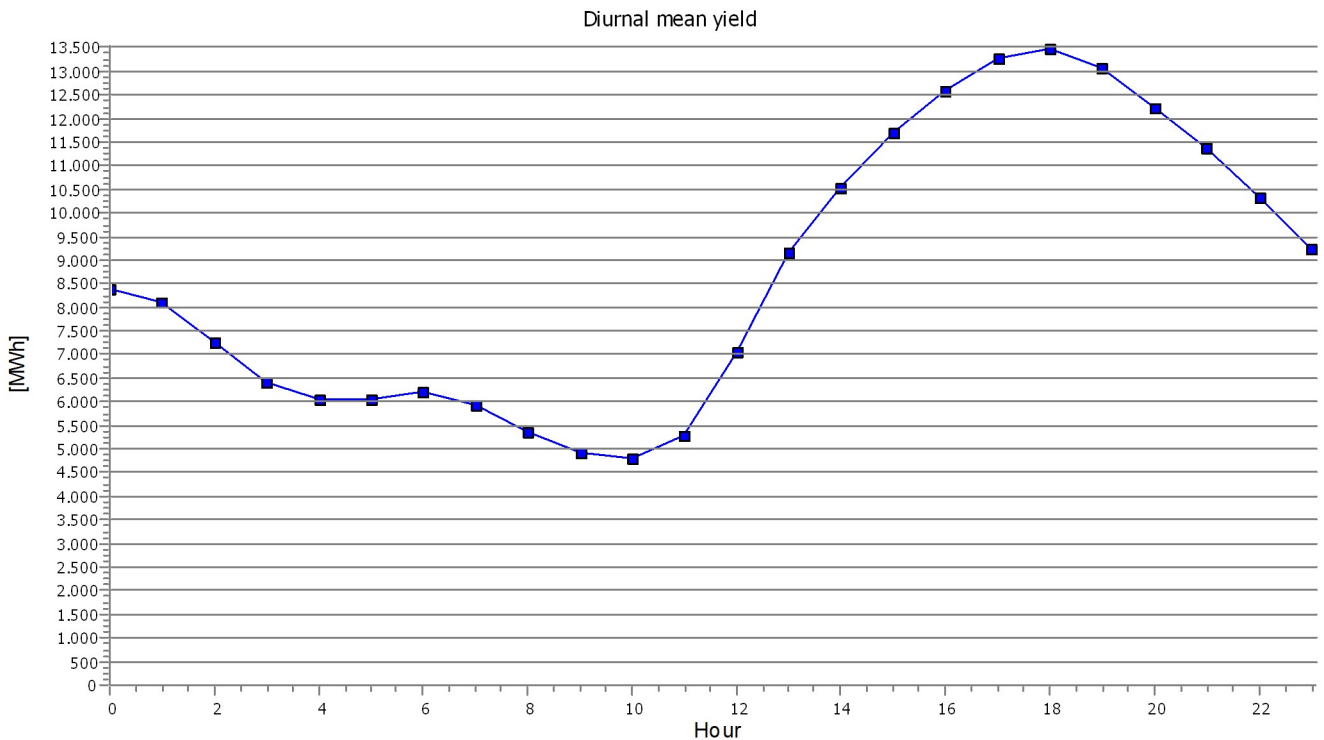
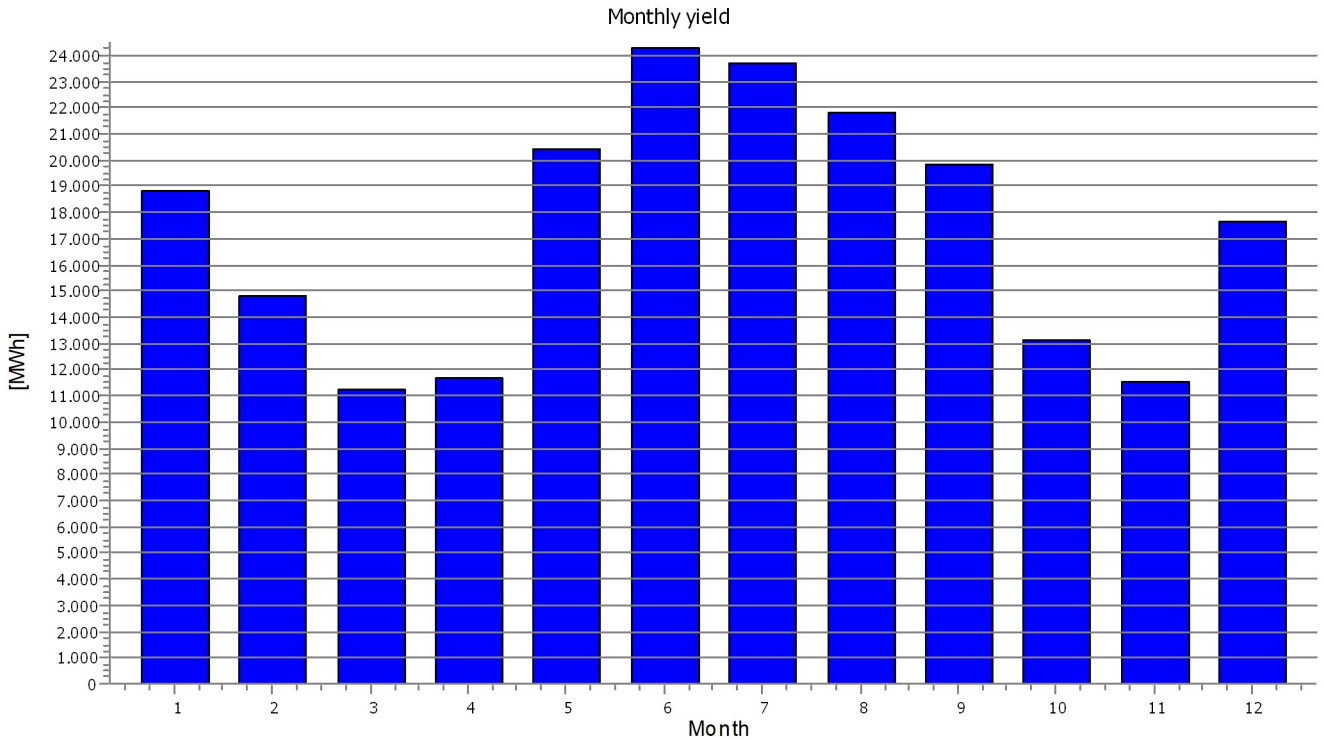
Calculation: 22-459-008 Tamil Nadu off-shore

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.



Project:
Site Analysis contract 81274134

Description:
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Calculated:
22/2/2022 16:11/3.5.508

PARK - Time varying AEP

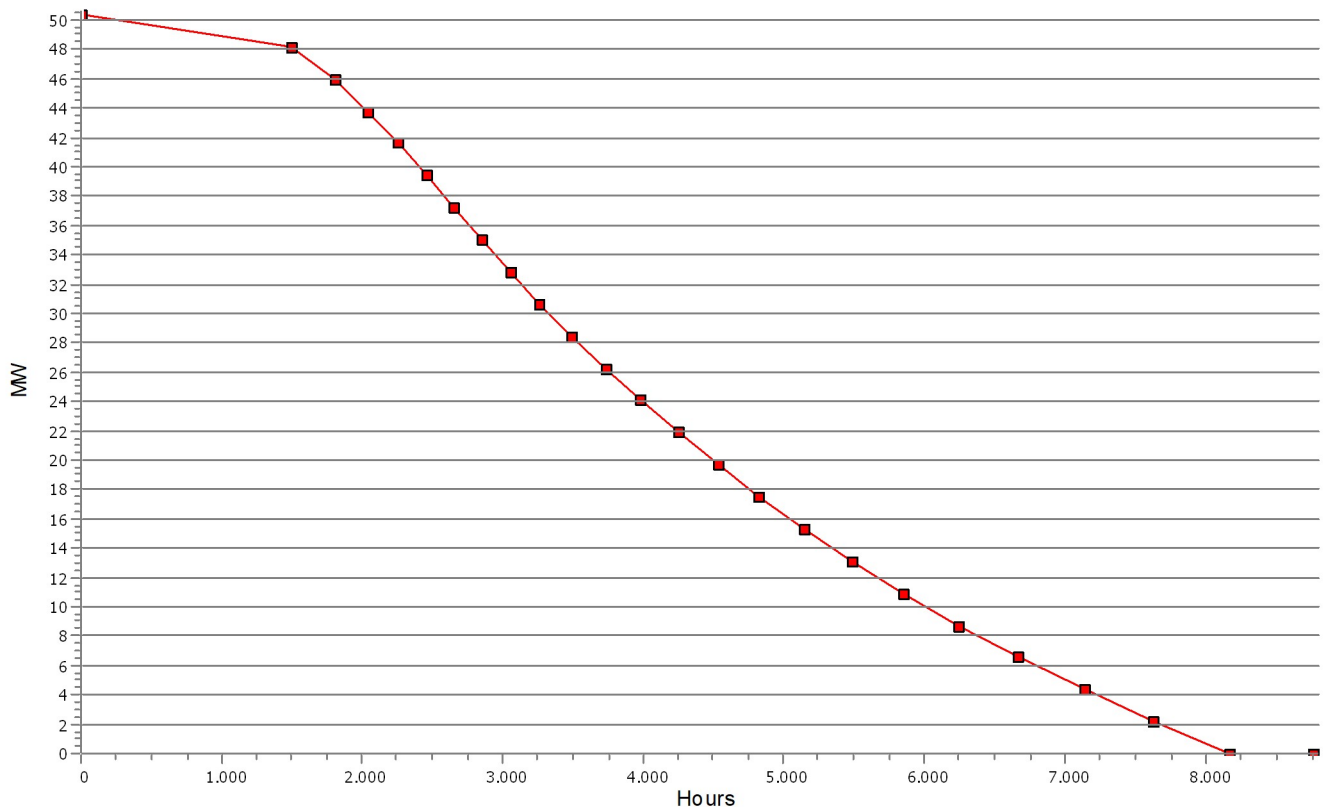
Calculation: 22-459-008 Tamil Nadu off-shore

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
1498	17,1	1498	48,2 - 50,4	4,0 - 4,2
301	3,4	1799	46,0 - 48,2	3,8 - 4,0
237	2,7	2036	43,8 - 46,0	3,7 - 3,8
214	2,4	2249	41,6 - 43,8	3,5 - 3,7
209	2,4	2458	39,4 - 41,6	3,3 - 3,5
192	2,2	2651	37,3 - 39,4	3,1 - 3,3
197	2,2	2848	35,1 - 37,3	2,9 - 3,1
201	2,3	3049	32,9 - 35,1	2,7 - 2,9
214	2,4	3263	30,7 - 32,9	2,6 - 2,7
223	2,5	3485	28,5 - 30,7	2,4 - 2,6
243	2,8	3729	26,3 - 28,5	2,2 - 2,4
246	2,8	3975	24,1 - 26,3	2,0 - 2,2
266	3,0	4241	21,9 - 24,1	1,8 - 2,0
287	3,3	4528	19,7 - 21,9	1,6 - 1,8
294	3,4	4822	17,5 - 19,7	1,5 - 1,6
316	3,6	5138	15,3 - 17,5	1,3 - 1,5
346	3,9	5484	13,1 - 15,3	1,1 - 1,3
369	4,2	5853	11,0 - 13,1	0,9 - 1,1
390	4,4	6242	8,8 - 11,0	0,7 - 0,9
422	4,8	6665	6,6 - 8,8	0,5 - 0,7
467	5,3	7131	4,4 - 6,6	0,4 - 0,5
500	5,7	7631	2,2 - 4,4	0,2 - 0,4
535	6,1	8166	0,0 - 2,2	0,0 - 0,2
600	6,8	8766	0,0	0,0

Duration curve 50,4 MW WindFarm



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Calculated:
22/2/2022 16:11/3.5.508

PARK - Map

Calculation: 22-459-008 Tamil Nadu off-shore



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:150.000, Map center Geo WGS84 East: 78,370386° E North: 8,933353° N

 New WTG

Heat Maps - Off-shore, 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	2,684	2,154	2,049	2,313	4,147	3,943	17,290
2	2,115	1,435	1,341	1,776	3,612	3,375	13,653
3	1,358	758	608	1,943	3,117	2,528	10,312
4	1,160	679	455	2,541	3,553	2,326	10,714
5	2,600	2,110	1,627	3,841	4,830	3,789	18,798
6	3,218	2,832	2,502	4,381	5,153	4,257	22,343
7	3,139	2,736	2,305	4,326	5,098	4,174	21,779
8	2,923	2,378	1,908	4,057	4,861	3,935	20,062
9	2,534	2,062	1,591	3,784	4,644	3,620	18,235
10	1,711	1,277	928	2,491	3,315	2,380	12,100
11	1,753	1,567	1,262	1,567	2,363	2,087	10,599
12	2,560	2,321	2,192	2,352	3,531	3,294	16,248
Total	27,754	22,310	18,769	35,370	48,223	39,706	1,92,133

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	42.9%	34.5%	32.8%	37.0%	66.4%	63.1%	46.1%
2	37.5%	25.4%	23.8%	31.5%	64.0%	59.8%	40.3%
3	21.7%	12.1%	9.7%	31.1%	49.9%	40.5%	27.5%
4	19.2%	11.2%	7.5%	42.0%	58.7%	38.5%	29.5%
5	41.6%	33.8%	26.0%	61.5%	77.3%	60.6%	50.1%
6	53.2%	46.8%	41.4%	72.4%	85.2%	70.4%	61.6%
7	50.2%	43.8%	36.9%	69.2%	81.6%	66.8%	58.1%
8	46.8%	38.1%	30.5%	64.9%	77.8%	63.0%	53.5%
9	41.9%	34.1%	26.3%	62.6%	76.8%	59.9%	50.2%
10	27.4%	20.4%	14.8%	39.9%	53.0%	38.1%	32.3%
11	29.0%	25.9%	20.9%	25.9%	39.1%	34.5%	29.2%
12	41.0%	37.1%	35.1%	37.6%	56.5%	52.7%	43.3%
Total	37.7%	30.3%	25.5%	48.1%	65.5%	54.0%	43.5%

Yield Assessment - Harapanahalli, Karnataka



Project:
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Calculated:
27/2/2022 20:29/3.5.508

PARK - Main Result

Calculation: 22-459-009 Harapanahalli - Karnataka

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

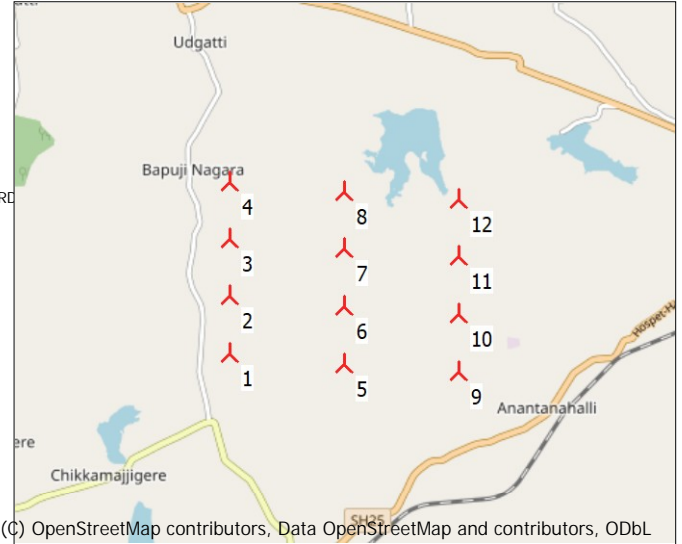
Scaler/wind data

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_N14.779_E075.910 - KA
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]	20,7	20,9	20,8			
From air density settings [hPa]	931,0	934,0	932,3			
Resulting air density [kg/m³]	1,104	1,107	1,105			
Relative to 15°C at sea level [%]	90,1	90,3	90,2	-5,8	-5,8	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 [MWh/y]	Result-8,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Wake loss [%]	Specific results ^{a)}		Wind speed		
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	free [m/s]	wake [m/s]
Wind farm	205.138,9	188.727,8	213.612,0	4,0	42,7	15.727,3	3.745	7,4	7,2

^{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			Wind speed	
									Result [MWh/y]	Result-8,0% [MWh/y]	Wake loss [%]	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-OS - 08-2019	17.241,1	15.862	2,8	7,37	7,26	
2 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.365,7	15.976	3,4	7,43	7,30	
3 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.518,8	16.117	3,3	7,47	7,34	
4 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.626,1	16.216	2,3	7,45	7,36	
5 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.643,4	16.232	2,8	7,48	7,37	
6 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	16.754,8	15.414	5,6	7,37	7,16	
7 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	16.844,0	15.496	5,7	7,40	7,18	
8 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	16.880,0	15.530	5,2	7,38	7,18	
9 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	17.127,3	15.757	1,3	7,27	7,22	
10 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	16.766,9	15.426	4,6	7,33	7,15	
11 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	16.918,0	15.565	5,2	7,40	7,19	
12 Yes	VESTAS	V150-4.2-4.200	4.200	150,0	105,0	EMD	Level 00 - Calculated - Modes PO1 & PO1-OS - 08-2019	16.453,0	15.137	5,2	7,27	7,07	

WTG siting

	Geo [deg]-WGS84	Longitude	Latitude	Z [m]	Row data/Description	Calculation period	
						Start	End
1 New	75,909691° E 14,772227° N	75,909691° E	14,772227° N	613,8	0,0°, 750,0 m	1/1/2002	1/1/2022
2 New	75,909691° E 14,779007° N	75,909691° E	14,779007° N	625,4		1/1/2002	1/1/2022
3 New	75,909691° E 14,785787° N	75,909691° E	14,785787° N	621,8		1/1/2002	1/1/2022
4 New	75,909691° E 14,792567° N	75,909691° E	14,792567° N	616,5		1/1/2002	1/1/2022
5 New	75,923666° E 14,770995° N	75,923666° E	14,770995° N	629,0	0,0°, 750,0 m	1/1/2002	1/1/2022
6 New	75,923666° E 14,777775° N	75,923666° E	14,777775° N	618,0		1/1/2002	1/1/2022
7 New	75,923666° E 14,784555° N	75,923666° E	14,784555° N	614,8		1/1/2002	1/1/2022
8 New	75,923666° E 14,791336° N	75,923666° E	14,791336° N	605,2		1/1/2002	1/1/2022
9 New	75,937642° E 14,770095° N	75,937642° E	14,770095° N	622,2	0,0°, 750,0 m	1/1/2002	1/1/2022
10 New	75,937642° E 14,776875° N	75,937642° E	14,776875° N	621,9		1/1/2002	1/1/2022
11 New	75,937642° E 14,783656° N	75,937642° E	14,783656° N	618,7		1/1/2002	1/1/2022
12 New	75,937642° E 14,790436° N	75,937642° E	14,790436° N	601,0		1/1/2002	1/1/2022

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Calculated:
27/2/2022 20:29/3.5.508

PARK - Wind Data Analysis

Calculation: 22-459-009 Harapanahalli - Karnataka Wind 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: 0° (26); Hub height: 105,0

Site coordinates

Geo WGS84

East: 75,909691° E North: 14,772227° N

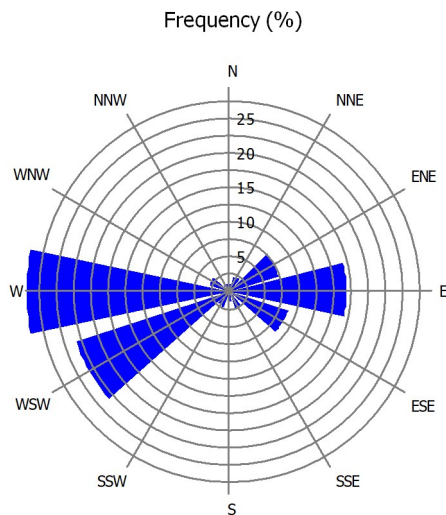
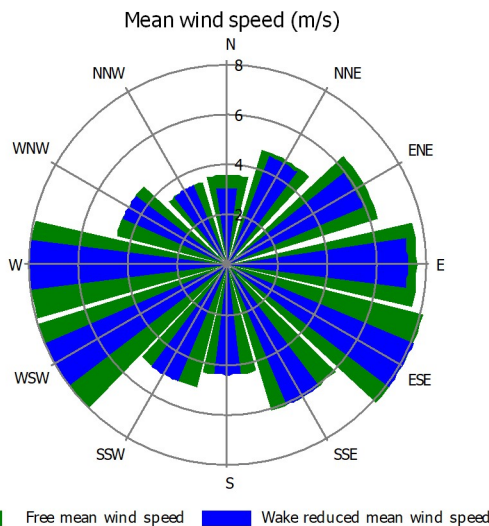
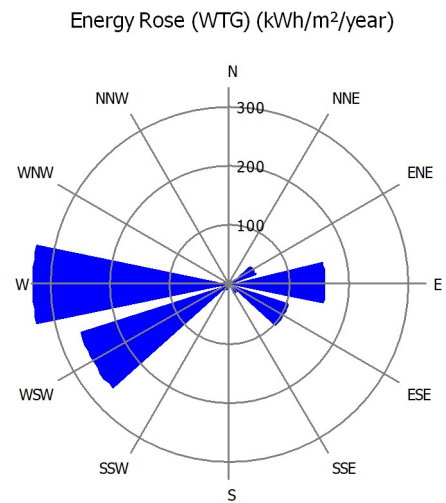
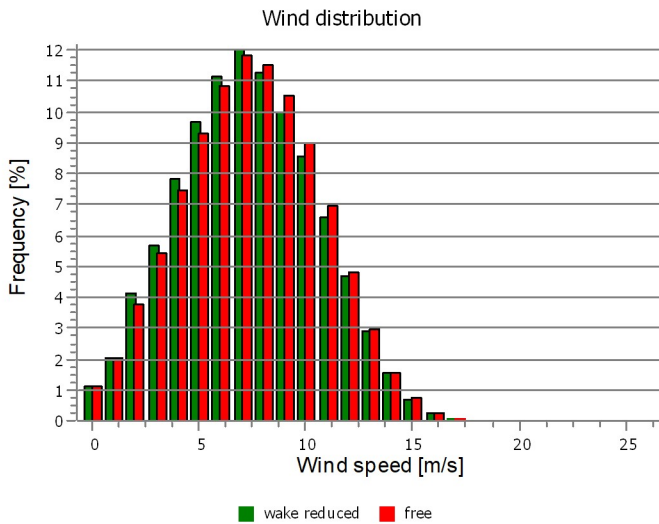
4*VESTAS V150-4.2 4200 150.0 !O! hub: 105,0 m (TOT: 180,0 m) dist: 750 m (5,0 RD) angle: 0° (26)

Masts used

Take nearest

Winddata for site

Sector	Free mean wind speed [m/s]	Wake reduced mean wind speed [m/s]	Frequency [%]
0 N	3,6	3,1	1,2
1 NNE	4,8	4,7	2,2
2 ENE	6,4	5,9	7,5
3 E	7,6	7,2	16,9
4 ESE	8,1	8,1	8,9
5 SSE	6,1	6,1	2,6
6 S	4,4	4,4	1,4
7 SSW	5,1	5,1	2,3
8 WSW	8,0	8,0	23,4
9 W	8,0	8,0	29,4
10 WNW	4,6	4,6	3,0
11 NNW	3,5	3,5	1,2
All	7,4	7,3	100,0



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PARK - Time varying AEP

Calculation: 22-459-009 Harapanahalli - Karnataka

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	1.042	839	727	589	838	998	1.093	948	718	536	835	1.037	10.201
1	1.009	802	584	461	764	964	1.089	936	633	491	810	1.020	9.564
2	992	747	481	378	638	917	1.073	891	604	460	794	1.028	9.002
3	997	729	452	318	547	821	988	824	535	445	773	1.011	8.439
4	995	734	436	347	560	837	1.001	854	530	395	751	955	8.396
5	961	712	406	322	529	846	1.022	843	548	391	703	956	8.239
6	926	667	354	249	459	805	1.014	815	488	355	708	881	7.720
7	851	605	272	178	409	848	1.036	863	500	332	616	815	7.326
8	530	359	142	119	358	823	1.003	877	499	289	535	577	6.111
9	454	310	139	113	329	799	945	809	466	320	527	553	5.763
10	442	330	161	116	314	823	1.004	848	512	350	571	588	6.058
11	410	313	161	97	397	920	1.103	991	617	343	526	569	6.447
12	337	291	180	96	418	998	1.203	1.084	668	328	479	516	6.597
13	313	272	187	108	458	1.050	1.264	1.183	752	343	447	465	6.842
14	320	267	217	130	468	1.090	1.313	1.207	776	351	414	443	6.994
15	287	248	232	153	475	1.071	1.276	1.174	759	359	409	431	6.875
16	316	289	267	210	615	1.155	1.348	1.219	858	410	387	439	7.513
17	390	328	317	326	837	1.269	1.397	1.323	936	493	466	504	8.584
18	581	477	458	552	1.048	1.305	1.417	1.354	1.096	673	614	709	10.285
19	833	668	689	812	1.193	1.316	1.418	1.364	1.149	804	817	925	11.990
20	1.023	843	889	949	1.220	1.297	1.364	1.286	1.094	815	953	1.084	12.818
21	1.026	898	955	920	1.123	1.170	1.213	1.144	903	758	946	1.102	12.159
22	1.028	852	868	772	956	1.011	1.113	969	759	659	895	1.021	10.902
23	1.032	861	798	662	873	970	1.047	899	685	588	860	1.040	10.315
Grand Total	17.095	13.442	10.372	8.975	15.826	24.103	27.746	24.705	17.084	11.288	15.834	18.669	205.139

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

PARK - Time varying AEP

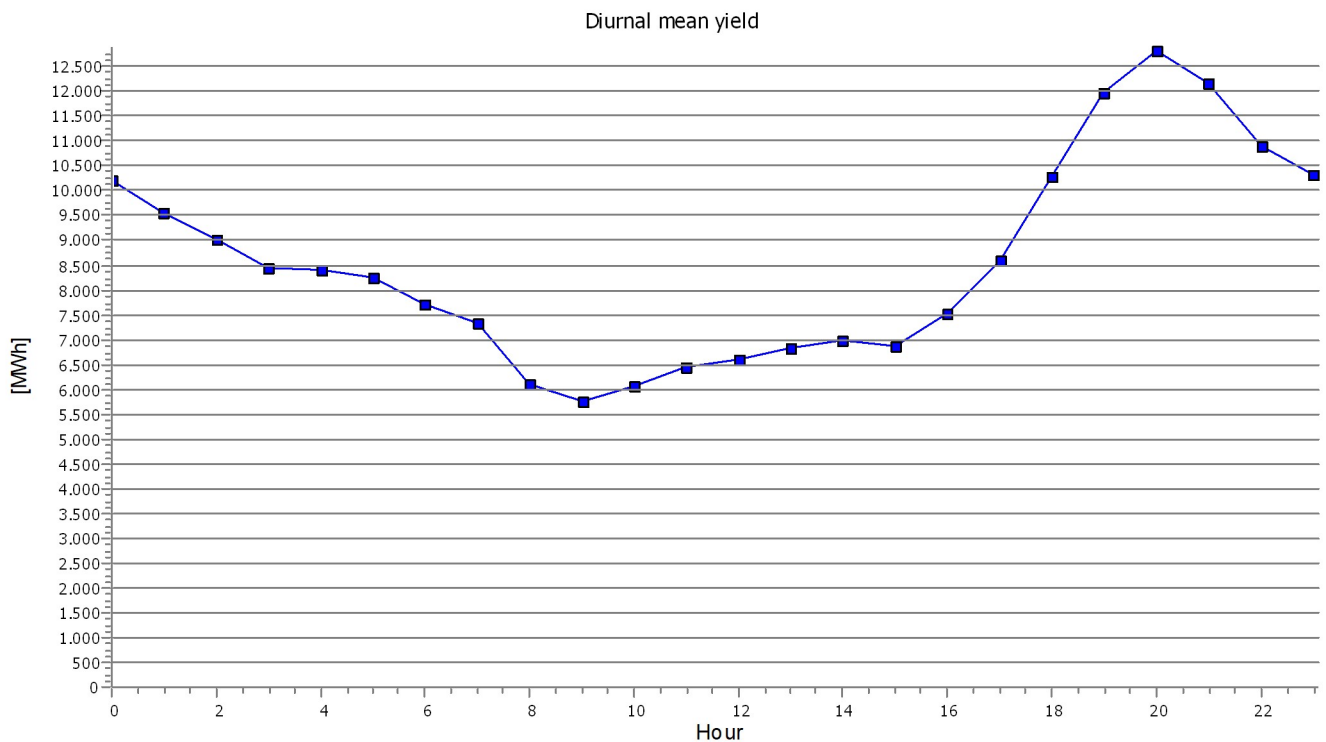
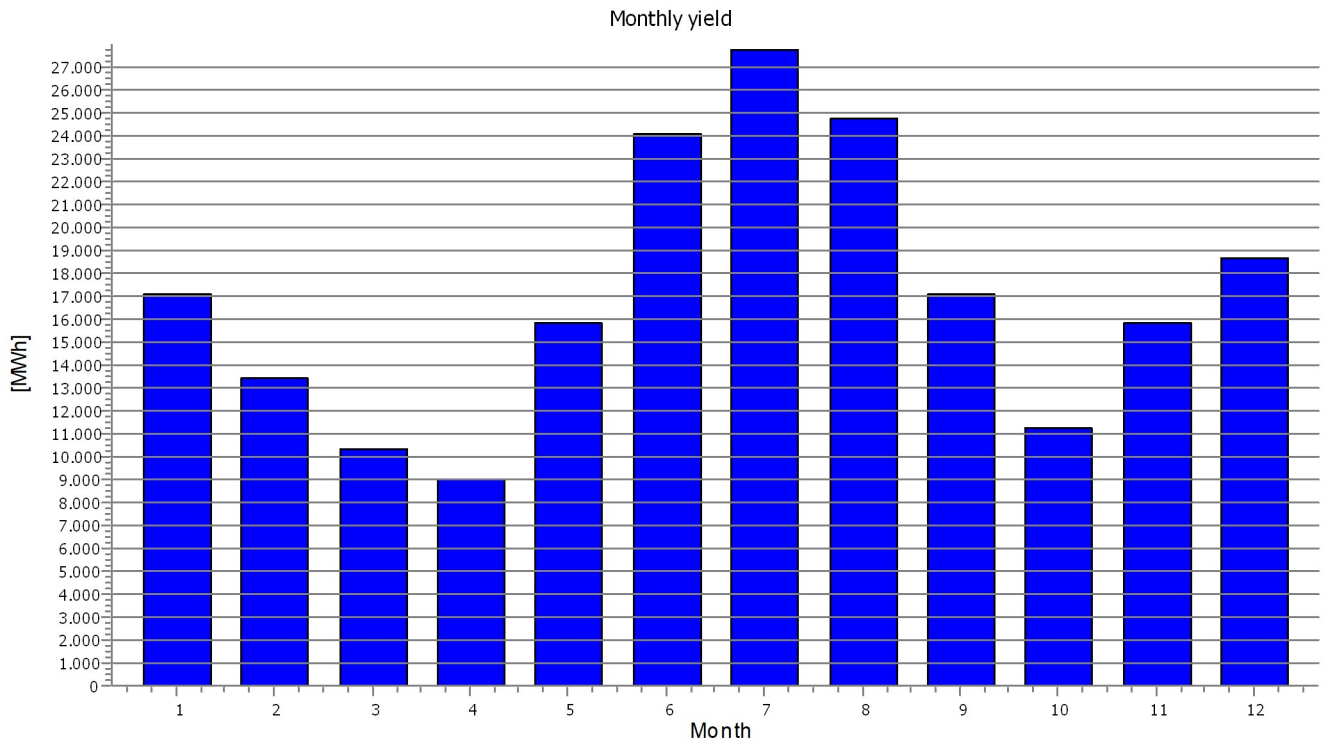
Calculation: 22-459-009 Harapanahalli - Karnataka

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.



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.

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Calculated:
27/2/2022 20:29/3.5.508

PARK - Time varying AEP

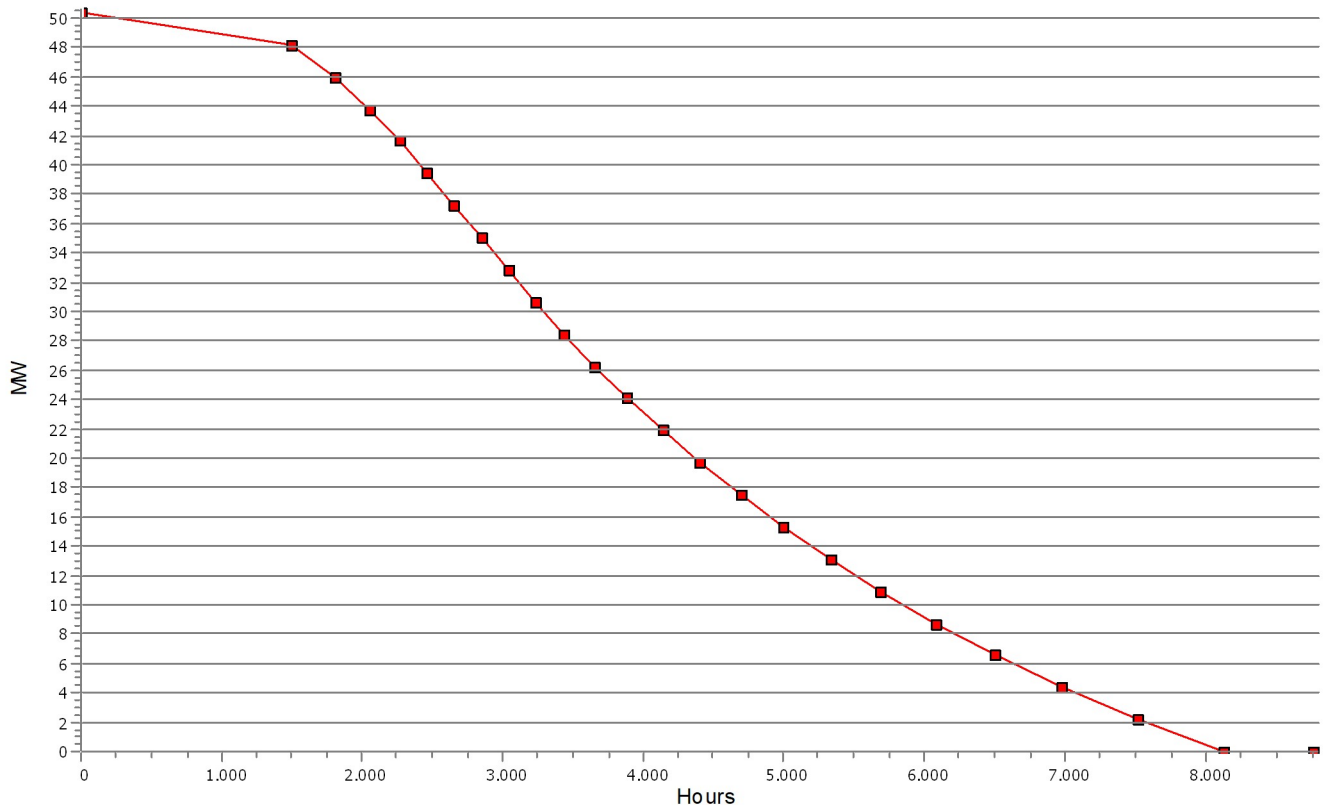
Calculation: 22-459-009 Harapanahalli - Karnataka

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
1490	17,0	1490	48,2 - 50,4	4,0 - 4,2
315	3,6	1805	46,0 - 48,2	3,8 - 4,0
244	2,8	2049	43,8 - 46,0	3,7 - 3,8
219	2,5	2268	41,6 - 43,8	3,5 - 3,7
194	2,2	2462	39,4 - 41,6	3,3 - 3,5
189	2,2	2651	37,3 - 39,4	3,1 - 3,3
192	2,2	2843	35,1 - 37,3	2,9 - 3,1
193	2,2	3035	32,9 - 35,1	2,7 - 2,9
199	2,3	3235	30,7 - 32,9	2,6 - 2,7
204	2,3	3439	28,5 - 30,7	2,4 - 2,6
215	2,5	3654	26,3 - 28,5	2,2 - 2,4
232	2,6	3886	24,1 - 26,3	2,0 - 2,2
251	2,9	4138	21,9 - 24,1	1,8 - 2,0
265	3,0	4402	19,7 - 21,9	1,6 - 1,8
286	3,3	4689	17,5 - 19,7	1,5 - 1,6
310	3,5	4998	15,3 - 17,5	1,3 - 1,5
333	3,8	5331	13,1 - 15,3	1,1 - 1,3
358	4,1	5689	11,0 - 13,1	0,9 - 1,1
385	4,4	6074	8,8 - 11,0	0,7 - 0,9
430	4,9	6503	6,6 - 8,8	0,5 - 0,7
476	5,4	6980	4,4 - 6,6	0,4 - 0,5
541	6,2	7521	2,2 - 4,4	0,2 - 0,4
605	6,9	8126	0,0 - 2,2	0,0 - 0,2
640	7,3	8766	0,0	0,0

Duration curve 50,4 MW WindFarm



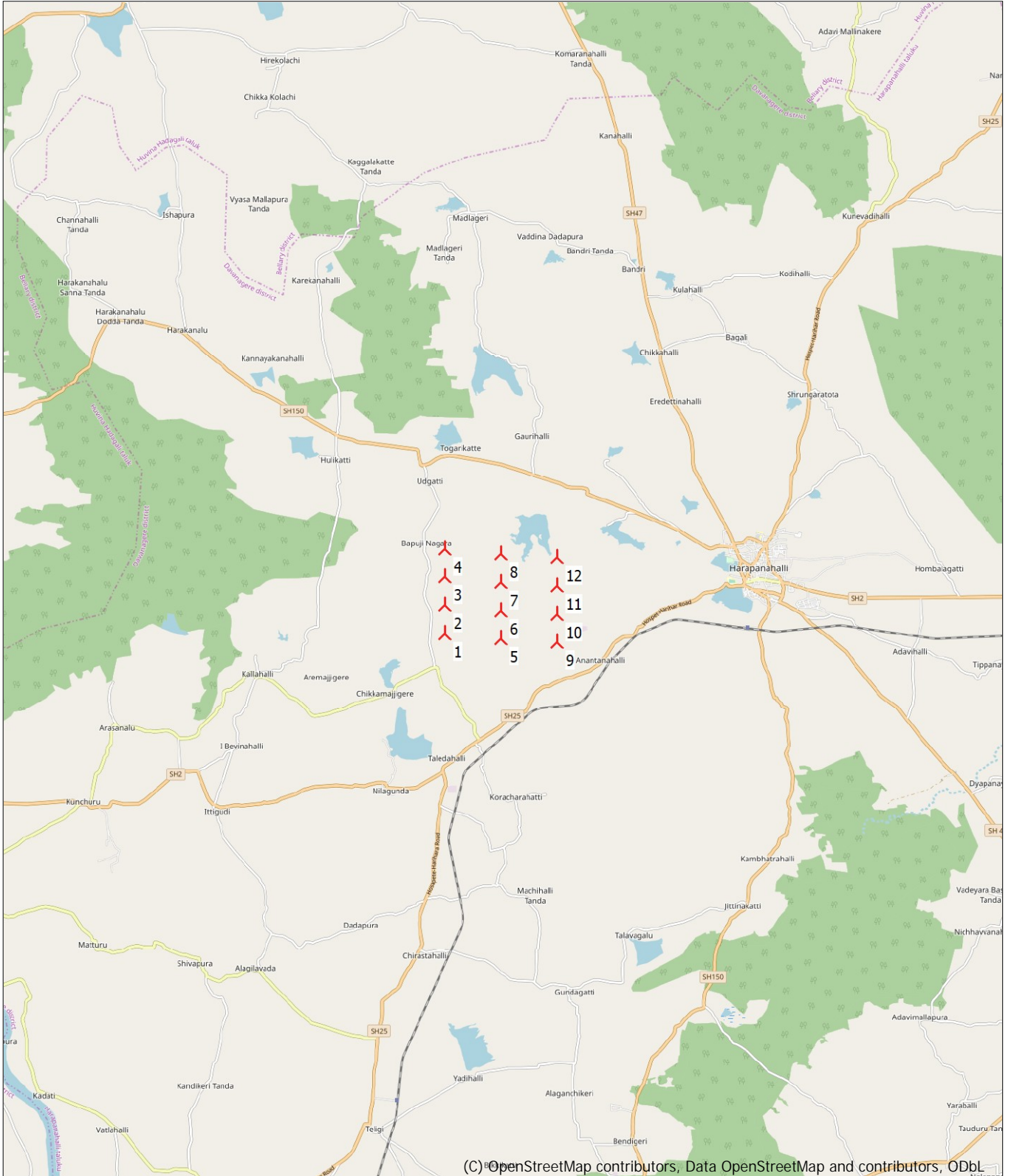
Project:
Site Analysis contract 81274134

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Calculated:
27/2/2022 20:29/3.5.508

PARK - Map

Calculation: 22-459-009 Harapanahalli - Karnataka



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:150.000, Map center Geo WGS84 East: 75,923666° E North: 14,781331° N

New WTG

Heat Maps - Harapanahalli, Karnataka

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	3,717	3,434	1,689	1,156	1,951	3,781	15,727
2	2,867	2,501	1,207	992	1,621	3,178	12,366
3	2,064	1,350	555	751	1,593	3,229	9,542
4	1,606	1,008	409	448	1,747	3,039	8,257
5	2,564	1,801	1,286	1,673	3,398	3,839	14,560
6	3,404	3,069	3,096	3,872	4,642	4,092	22,175
7	3,904	3,747	3,730	4,652	5,134	4,359	25,526
8	3,311	3,106	3,243	4,276	4,839	3,954	22,729
9	2,291	1,900	1,925	2,719	3,715	3,167	15,718
10	1,778	1,354	1,198	1,270	2,190	2,594	10,385
11	2,955	2,556	1,985	1,609	2,101	3,361	14,567
12	3,768	3,319	2,105	1,705	2,372	3,907	17,176
Total	34,229	29,146	22,429	25,123	35,303	42,498	1,88,728

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	59.5%	55.0%	27.0%	18.5%	31.2%	60.5%	41.9%
2	50.8%	44.3%	21.4%	17.6%	28.7%	56.3%	36.5%
3	33.0%	21.6%	8.9%	12.0%	25.5%	51.7%	25.4%
4	26.6%	16.7%	6.8%	7.4%	28.9%	50.2%	22.8%
5	41.0%	28.8%	20.6%	26.8%	54.4%	61.4%	38.8%
6	56.3%	50.8%	51.2%	64.0%	76.7%	67.7%	61.1%
7	62.5%	60.0%	59.7%	74.4%	82.2%	69.7%	68.1%
8	53.0%	49.7%	51.9%	68.4%	77.4%	63.3%	60.6%
9	37.9%	31.4%	31.8%	45.0%	61.4%	52.4%	43.3%
10	28.4%	21.7%	19.2%	20.3%	35.0%	41.5%	27.7%
11	48.9%	42.3%	32.8%	26.6%	34.7%	55.6%	40.1%
12	60.3%	53.1%	33.7%	27.3%	38.0%	62.5%	45.8%
Total	46.5%	39.6%	30.5%	34.1%	48.0%	57.8%	42.7%

Yield Assessment - Proddatur, Andhra Pradesh



Project:
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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 IOI hub: 105,0 m (TOT: 180,0 m) dist: 750 m (5,0 RD)

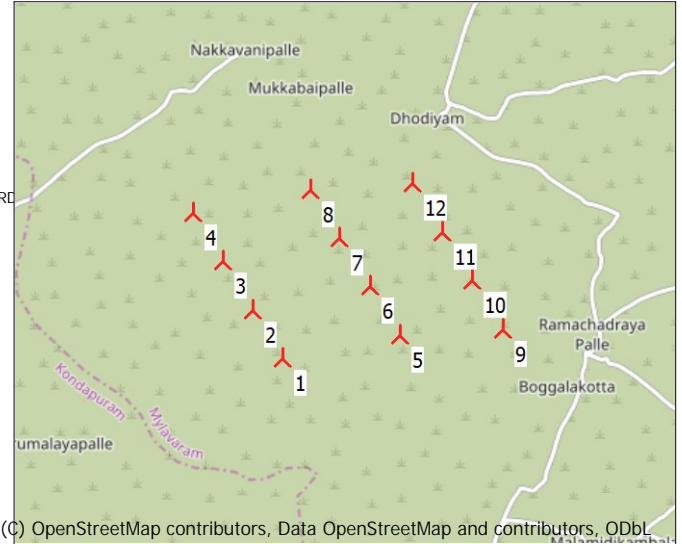
Scaler/wind data

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



Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	Result-8,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Wake loss [%]	Specific results ^{a)}		Wind speed		
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	free [m/s]	wake [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			Wind speed	
									Result [MWh/y]	Result-8,0% [MWh/y]	Wake loss [%]	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-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	Longitude	Latitude	Z [m]	Row data/Description	Calculation period	
						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	

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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

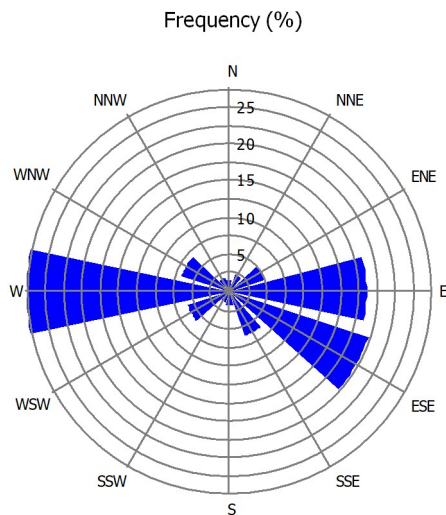
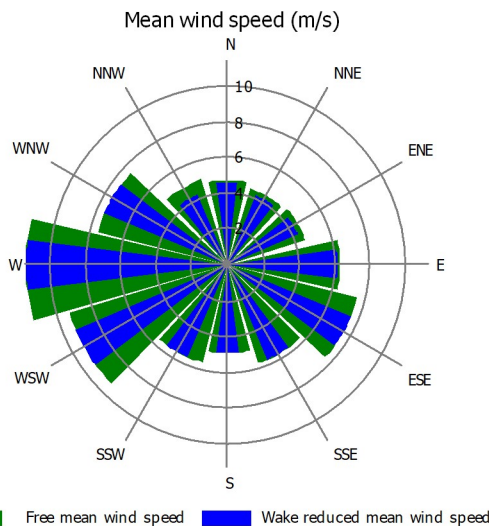
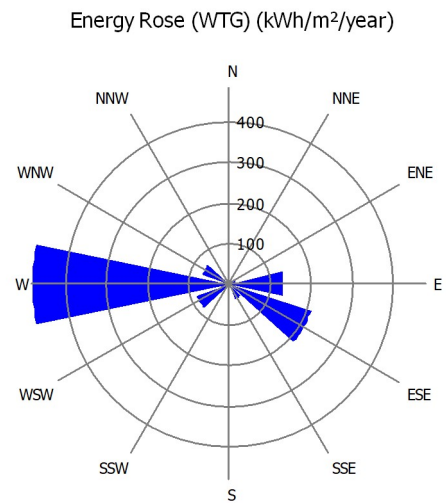
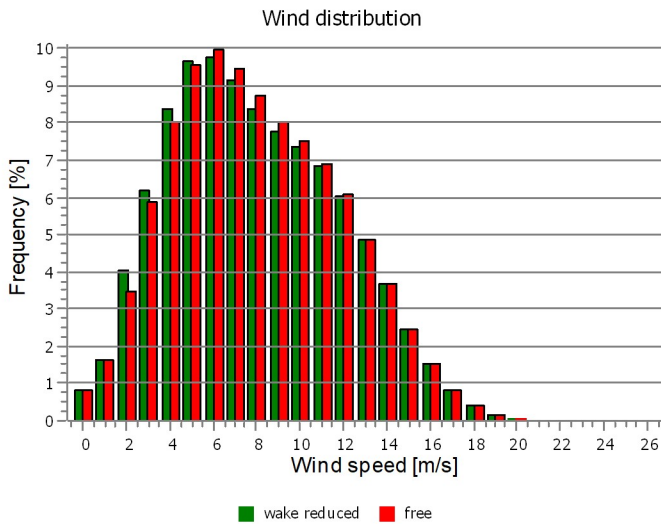
4*VESTAS V150-4.2 4200 150.0 !O! hub: 105,0 m (TOT: 180,0 m) dist: 750 m (5,0 RD) angle: -32° (43)

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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Calculation: 22-459-010 Proddatur AP

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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

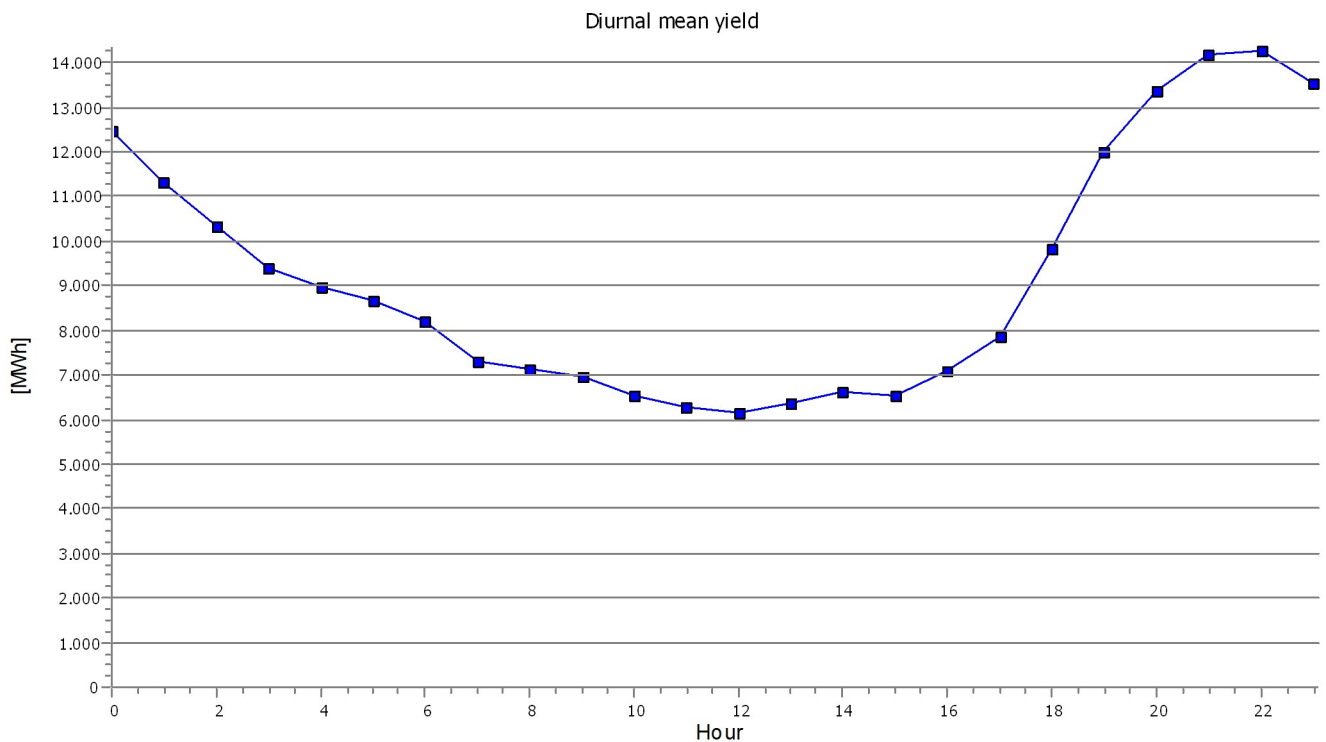
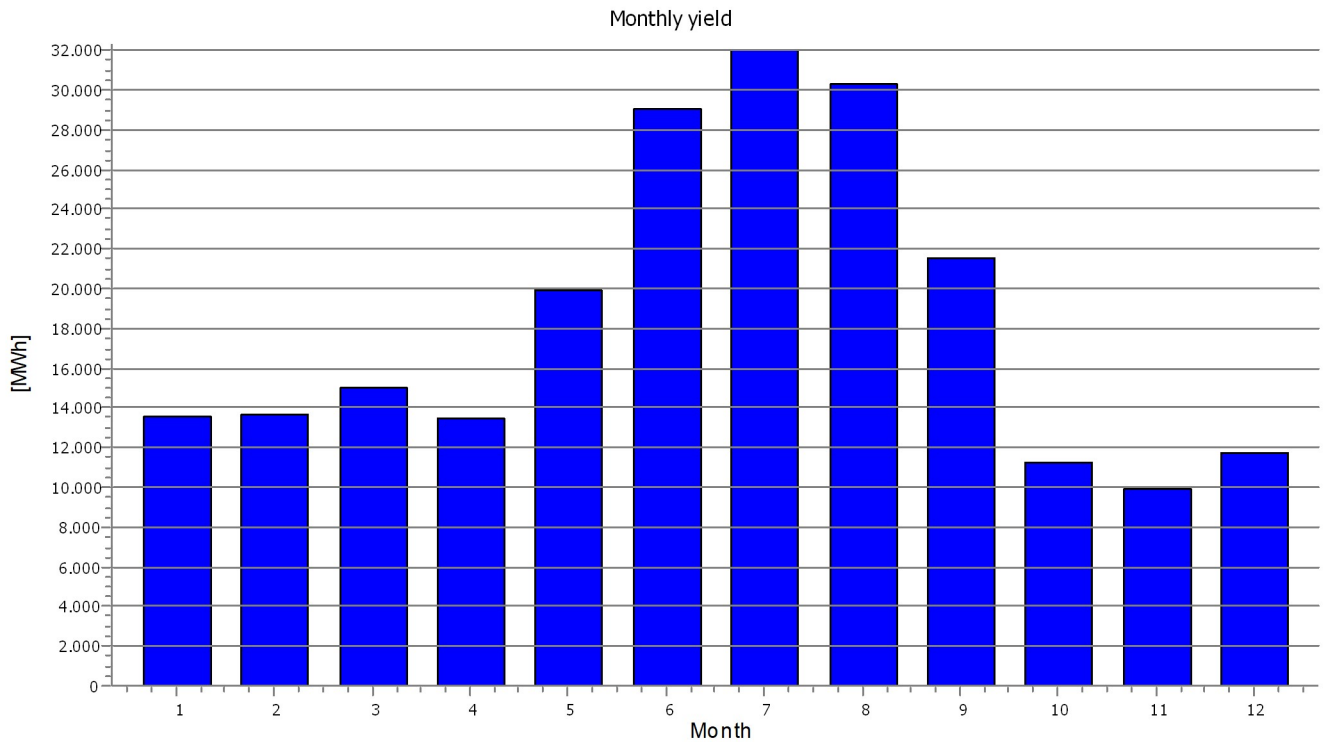
Calculation: 22-459-010 Proddatur AP

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.



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.

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

PARK - Time varying AEP

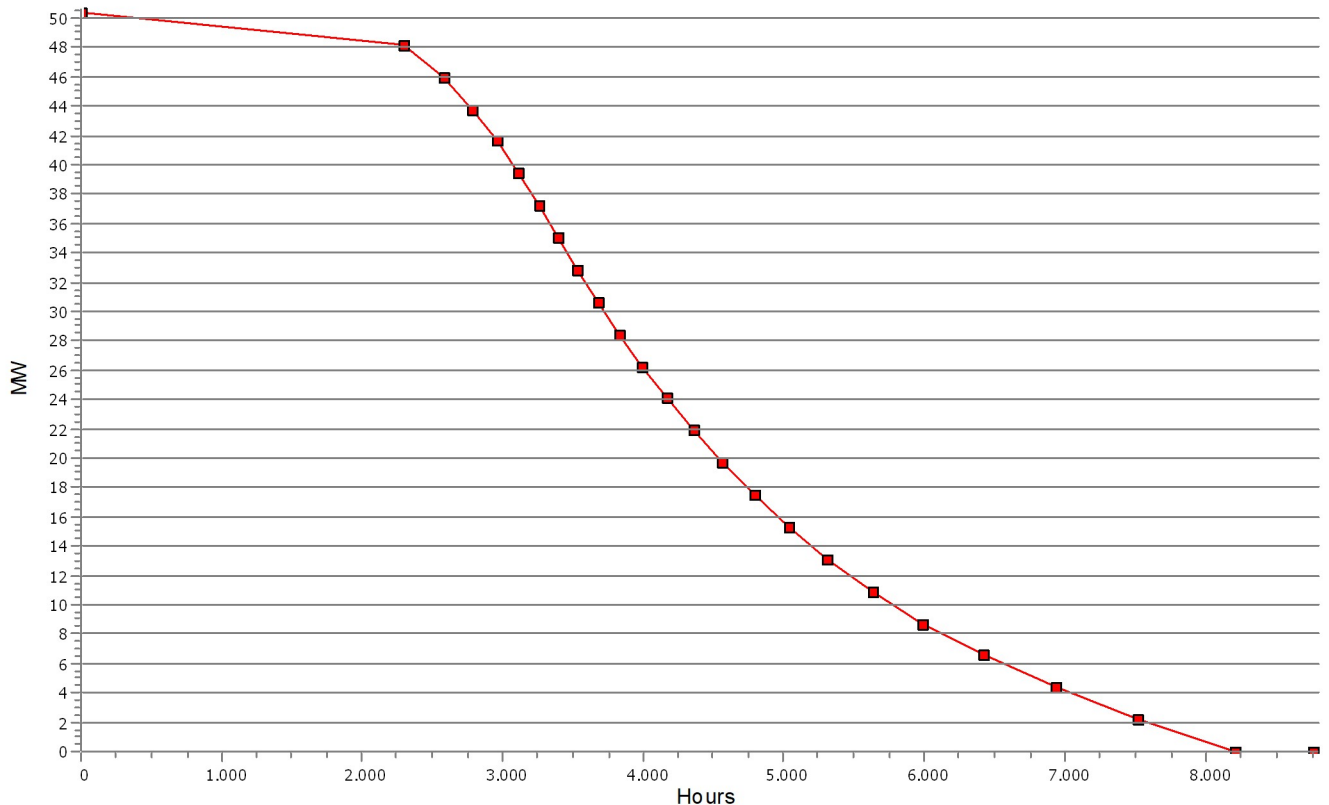
Calculation: 22-459-010 Proddatur AP

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

Selection: All new WTGs

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



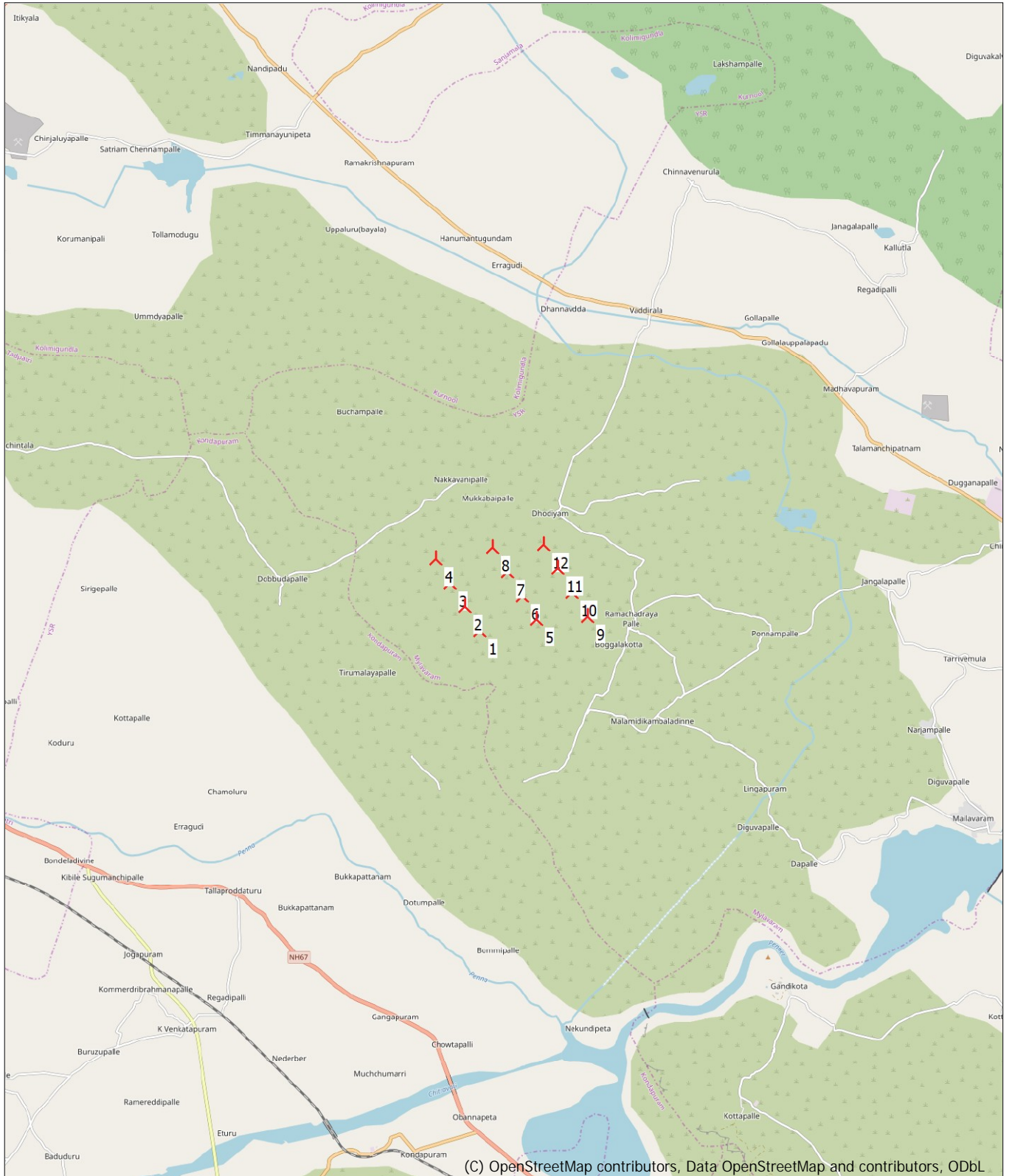
Project:
Site Analysis contract 81274134

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.

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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%

