WIND RESOURCE DEPARTMENT

DOCUMENT REF.: ERITACERXXCAM.0

ENERGY RESOURCE ASSESSMENT AND LAYOUT

CAMPOVAGLIO WIND FARM (ITALY)

DEVELOPER: ACCIONA Energía

JULY 2023

CONTROL

PREPARED	REVISED	APPROVED
Digitally signed by Patricia Garcés Calvo Date: 2023.07.14 11:49:58 +02'00'	Digitally signed by Julián Alberdi Zaragüeta Date: 2023.07.14 12:03:49 +02'00'	Digitally signed by Diego González Oslé Date: 2023.07.14 12:49:59 +02'00'

INDEX OF CONTENTS

INDEX OF TABLES

INDEX OF FIGURES

1. EXECUTIVE SUMMARY

The scope of the current report is to estimate the energy production of Campovaglio wind farm with the N163/6.X (7000) TS159 turbine according to the standard IEC 61400-1 3rd edition 1st Amdt.

This energy assessment is based on ERA5 reanalysis Vortex long-term data series and LES data series which have been adjusted with a wind map calibrated with ACCIONA Energía's met masts within the region.

Since no measurements are available at the site the uncertainty has been considered to be higher than 25%.

1.1. LAYOUT

The layout has been defined by the Wind Resource Department (WRD) of ACCIONA Energía with the constraints included in the point 1.6. It consists of 11 N163/6.X (7000) TS159 turbines (IPITACERXXCAM230620).

Nordex has supplied the power curves, power coefficient and thrust coefficient curves (official document F008-277-A12-R6).

1.2. ENERGY RESOURCE ASSESSMENT

The results of the energy assessment are shown in the next table:

Net energy summary of the wind farm	
Layout code	IPITACERXXCAM230620
Turbine type	NORDEX 163 / 6.X (7.000)
Number of turbines	11
Hub height (m)	159,00
Equivalent net hours	3.427
Capacity factor	0,391
Total power installed (MW)	77,00
Wind farm net output (GWh/year)	263,87

Table 1: Net energy summary of the wind farm

Besides, the gross energy predictions are included:

Gross energy summary of the wind farm	
Layout code	IPITACERXXCAM230620
Turbine type	NORDEX 163 / 6.X (7.000)
Number of turbines	11
Hub height (m)	159
Power installed (MW)	77
Annual average speed in the WF (m/s)	9,07
Annual turbine energy output (MWh)	29.485
Gross full load hours	4.212
Capacity factor	0,481
Wind farm gross output (GWh/year)	324,33

Table 2: Gross energy summary of the wind farm

1.3. ELECTROMAGNETIC INTERFERENCE STUDY

Upon analysis of all the telecommunication services in the area region of the Campovaglio Wind Farm, it can be concluded that it will not cause any severe interference in the radio communications of the area.

As soon as the project turns into an advanced development stage, a complete Electromagnetic Interference (EMI) report should be carried out to analyze in detail the microwave radiolinks and the

terrestrial television in the wind farm area. In order to accomplish the complete EMI report, an on-field measurement survey should be performed.
The Aglientu Seismic Station is 3km from the projected wind farm, and it is recommended to consult the Istituto nazionale nazionale di geofisica e vulcanología (INGV) of Italy.
Finally, although no problem is expected, L'Ente nazionale per l'aviazione civile (ENAC) of Italy must be consulted about the project in order to obtain its approval.

1.4. ENVIROMENTAL FEASIBILITY STUDY, NOISE AND FLICKERING STUDY

Environmental restrictions have been supplied by the Environmental Department in the document Informe viabilidad ambiental Luogosanto 20/05/22 and later, as:

- *Asseto ambientale PPRç*
- *Aree Naturali Subnaturali*
- *Beni Paesagistici PPR*
- *Ricettori sensibili*
- *Siti riproduttivi rapaci idonei*

All of them have been considered to design the current layout.

For future revisions, a noise assessment should be carried out in order to ensure noise levels at the onsite houses did not exceed the standards (45 -55 dBAs night-day).

1.5. IMPORTANT NOTICES AND RECOMMENDATIONS

1) Acciona does not have any information of the presence of other neighbouring wind farms that could change the results of the study. Only small wind turbines located around Campovaglio wind farm without affectation.

2) All direction data is referred to the geographic North Pole, also known as true north (local declination is 3.22° E ± 0.34° (changing by 0.14º E per year).

3) All the hourly calculations are referred to UTC time.

4) All coordinates shown in this report (otherwise it will be specified) are referred to Coordinate System: UTM, Datum: WGS84 and Zone: 32N.

5) The current wind resource assessment does not imply any guarantee of the energy estimation.

6) A site verification visit was carried out by Energy Technology, Environment, Business Development, PM and Civil Engineering Department members. It is important to highlight that the constructability of this wind farm was verified.

7) It has been considered a loss of 5% due to the complexity of the terrain that can affect in terms of high ambient turbulence intensity. This fact should be confirmed once measurements are available.

8) The installation of one met station with sensors at least at 2/3 of hub height and a LIDAR in two different points are necessary in order to reduce the uncertainty in the estimation of the topographic efficiency, the wind shear and the ambient turbulence intensity due to the complex terrain and to obtain Nordex site and turbine approval. Next, recommended positions are shown:

Met stations				
Name	**UTM-X (m)**	**UTM-Y (m)**	**Top sensor high (m)**	**Station Type**
Campovaglio 2	523,193	4,554,927	99.9	Evaluación de recurso
Campovaglio_LIDAR_21	523,193	4,554,927	200	LIDAR
Campovaglio_LIDAR_1	518,000	4,553,886	200	LIDAR
Campovaglio_LIDAR_3	525,633	4,555,263	200	LIDAR

Table 2: Met stations coordinates

1.6. WIND FARM RESTRICTIONS

The following points include the main conditions and restrictions considered for the design of the implementation according to Business Department criteria:

- The distance between wind turbines must be at least 3D (3*163 = 489m) and the distance between alignments of wind turbines must be at least 5D (5*163 = 815m).
- Campovaglio municipal boundary has been considered in order not to site wind turbines out of this limit.
- Environmental restrictions supplied by Environmental department and GIOED Engineering.

In the following table, other constraints given by the QSE and Business Development (BD) specialists of Acciona and taken into account for the layout design are included:

Restriction type	**DESIGN CRITERIA**		
	Local rule (m)	**AE standards (m)**	
Roads	(HH+D/2)*1,1= 265	(HH+D/2)*1,5 =	361
Permanent dwellings	700	(HH+D/2)*2 =	481
Farm buildings (day and night use)	500	(HH+D/2)*1,5 =	361
Farm buildings (day use)	300	(HH+D/2)*1,5 =	361
Rivers	150	(HH+D/2) =	241
Electric lines		(HH+D/2)+10+10 =	261
Beni paesaggistici PPR	300		

Table 3: Restrictions considered for the design

1.7. METHODOLOGY

Next, some clarifications about the methodology of the study are presented:

- Acciona has worked with ERA5 reanalysis series and LES series of the Vortex platform. Data can be seen in Table 5 and Table 6.
- The **variation in wind speed over the wind farm site** has been predicted using a 30 m resolution Vortex Farm. Once the Vortex_ERA5 series is adjusted with the wind speed map of Sardinia (it has been carried out with several met stations located throughout the region at 159m) using 0.1 wind shear, the Vortex Farm has been also adjusted.

- The **air density** has been calculated with the temperature, pressure and relative humidity from Vortex-ERA5 reanalysis node.
- The **wake effects** have been calculated with the Deep array wake Eddy viscosity model (DAWM EV) in Openwind using hourly series (wind speed and direction) from 22 years distribution.
- The **cartography** used for the modeling comes from JAXA (Japan Aerospace Exploration Agency) with 30m resolution.
- The roughness used comes from OW Landcover.
- The **effective turbulence intensity** at turbine positions has been calculated with Sten Frandsen formulae according to the 3rd edition 1st Amdt. of the IEC 61400-1 standard using Turbuopt software with LES data series.

2. REFERENCES

[1] ISO 2533:1975/Add 2: 1997: "*Standard Atmosphere"*

[2] IEC 61400-1, 2nd edition: "Wind Turbine Generator Systems - Part 1: Design Requirements", 1999.

[3] IEC 61400-1, 3rd edition, 1st Amdt: "Wind Turbine Generator Systems – Part 1 Design Requirements", 2010.

[4] IEC 61400-12, 1st edition: "Wind Turbines - Part 12-1: Power performance measurements of electricity producing wind turbines", 2005.

[5] IEC 61400-1, 4th edition, 1st Amdt: "Wind energy Generator Systems – Part 1 Design Requirements", 2018.

[6] FRANDSEN, S. "Turbulence and turbulence-generated fatigue loading in wind turbine clusters." Risø-R-1188, 128 pp, 2003.

[7] GUMBEL, E. J. "Multivariate Extremal Distributions." Bull. Inst. Internat. de Statistique 37, 471-475, 1960a.

[8] Measnet, "Evaluation of Site-Specific Wind Conditions", Version 1, Nov 2009.

[9] Windpro 3.0 User manual, "5-Loads Site compliance and load response", April 2015.

3. SOFTWARE

[1] Meteodyn 5.3.2 (2017) Meteodyn, France. <or Meteodyn Universe 1.0>

[2] Openwind Enterprise Version 01.09.00.3647d. Copyright © 2008-2020 ReCode Inc. & UL Services Group, LLC.

4. APPENDIX 1: TABLES AND FIGURES

Station	Measured period	Coord UTM			Trademark	Lightning rod	Sensor					
		UTM X	UTM Y	Altitude (m)			Type	Model	Load position	Height (m)	Boom length (m)	True north arm orientation
Vortex_LES_Campovaglio_010122_311222_160	01/01/2022 - 31/12/2022	519.893	4.553.216	214			Wind speed	Vortex	1	160,00		
							Direction	Vortex	1	160,00		
							Pressure	Vortex	1	160,00		
							Temperature	Vortex	1	160,00		
							Relative Humidity	Vortex	1	160,00		
							Speed & Dir.	Vortex	2	150,00		
Vortex_ERA5_41.13N_9.24E	31/12/1999 - 14/06/2023	519.872	4.553.231	185			Wind speed	Vortex	1	160,00		
							Direction	Vortex	1	160,00		
							Pressure	Vortex	1	160,00		
							Temperature	Vortex	1	160,00		
							Relative Humidity	Vortex	1	160,00		
							Speed & Dir.	Vortex	2	150,00		
							Speed & Dir.	Vortex	3	120,00		
							Speed & Dir.	Vortex	4	100,00		
							Speed & Dir.	Vortex	5	80,00		
WGS84 Zone 32 N												

Table 4: Met masts main features

Station: Vortex_LES_Campovaglio_010122_311222_160 | From year: 2022 | To year: 2022 | Sensor: 1 | Hub height (159 m)														
Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Long term (%)
	V (m/s)													
2022	9,61	9,98	8,32	9,61	5,91	6,62	6,15	5,33	7,97	5,75	8,62	8,54	7,70	100,0
Average	**9,61**	**9,98**	**8,32**	**9,61**	**5,91**	**6,62**	**6,15**	**5,33**	**7,97**	**5,75**	**8,62**	**8,54**	**7,70**	

Caption:	Own data => 90%	Own data < 90%

Table 5: Monthly wind speed average of the data in Vortex_LES_Campovaglio_010122_311222_160

Station: Vortex_ERA5_41.13N_9.24E | From year: 2000 | To year: 2023 | Sensor: 1 | Hub height (159 m)														
Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Long term (%)
	V (m/s)													
2000	7,87	8,81	7,53	8,97	7,45	6,77	8,31	5,02	7,09	7,44	9,30	9,65	7,85	101,3
2001	9,15	9,90	11,84	9,80	7,01	7,59	6,78	6,24	8,84	5,52	9,26	10,72	8,56	110,5
2002	6,81	10,27	7,59	9,03	8,28	6,01	7,57	6,99	6,68	7,49	8,96	8,57	7,85	101,3
2003	10,36	8,35	6,47	7,93	7,16	4,98	7,23	5,81	6,47	10,02	7,63	9,26	7,64	98,6
2004	9,73	8,92	9,25	8,52	7,57	7,33	6,92	7,07	6,17	6,32	7,75	9,43	7,92	102,2
2005	8,07	9,67	7,29	8,19	7,36	5,43	7,70	7,84	5,76	5,40	8,16	10,24	7,59	97,9
2006	8,70	8,36	9,52	7,73	7,69	5,69	4,88	9,88	6,06	6,49	6,96	7,65	7,47	96,4
2007	9,18	9,38	8,97	5,84	8,48	7,09	8,23	6,63	7,30	5,96	8,69	10,15	7,99	103,1
2008	8,10	7,11	12,28	9,37	7,43	6,87	6,53	6,62	5,73	6,86	8,09	8,48	7,79	100,5
2009	8,22	8,25	9,62	7,59	4,69	7,78	7,89	5,17	6,09	6,03	8,54	11,49	7,61	98,2
2010	9,66	10,96	8,68	6,99	7,88	6,98	5,31	7,49	7,31	8,14	9,70	9,31	8,20	105,8
2011	6,20	7,25	7,89	6,83	6,26	7,59	8,95	5,80	6,28	6,29	7,28	10,76	7,28	93,9
2012	9,09	7,09	6,82	9,24	6,93	7,30	7,36	4,65	5,89	8,79	7,81	10,41	7,62	98,3
2013	10,15	8,56	10,67	8,64	9,36	7,13	4,94	5,05	7,26	6,63	10,38	5,84	7,88	101,7
2014	7,46	9,72	8,32	8,28	8,26	6,42	9,40	7,53	6,43	5,79	7,03	7,78	7,70	99,4
2015	9,43	7,89	10,57	7,11	6,99	5,67	6,94	5,85	7,40	7,72	7,80	4,38	7,31	94,3
2016	10,45	11,16	8,87	8,11	9,54	7,46	6,34	6,28	6,31	7,33	9,05	8,12	8,25	106,5
2017	10,06	8,25	8,43	7,05	6,95	5,46	7,16	5,23	8,07	6,82	8,17	10,14	7,65	98,7
2018	11,34	7,64	10,28	7,44	6,45	5,84	6,74	4,97	6,21	8,28	6,73	9,28	7,60	98,1
2019	8,71	7,78	10,24	8,19	8,59	5,89	6,39	4,84	7,57	7,70	9,68	11,55	8,09	104,4
2020	8,07	10,88	8,48	5,98	7,16	7,94	5,32	7,11	6,69	9,43	6,56	8,94	7,71	99,5
2021	11,37	8,83	6,92	6,80	8,94	6,06	7,04	6,98	6,52	6,15	8,11	9,30	7,75	100,0
2022	8,85	9,09	8,21	9,19	5,70	6,17	5,87	5,13	7,59	5,63	8,21	7,73	7,28	93,9
2023	9,48	6,40	9,48	7,56	6,15	4,04							7,18	92,6
Average	**9,02**	**8,77**	**8,93**	**7,93**	**7,43**	**6,53**	**6,95**	**6,27**	**6,77**	**7,05**	**8,25**	**9,09**	**7,75**	
Caption:					Own data => 90%					Own data < 90%				

Table 6: Monthly wind speed average of the data in Vortex_ERA5_41.13N_9.24E

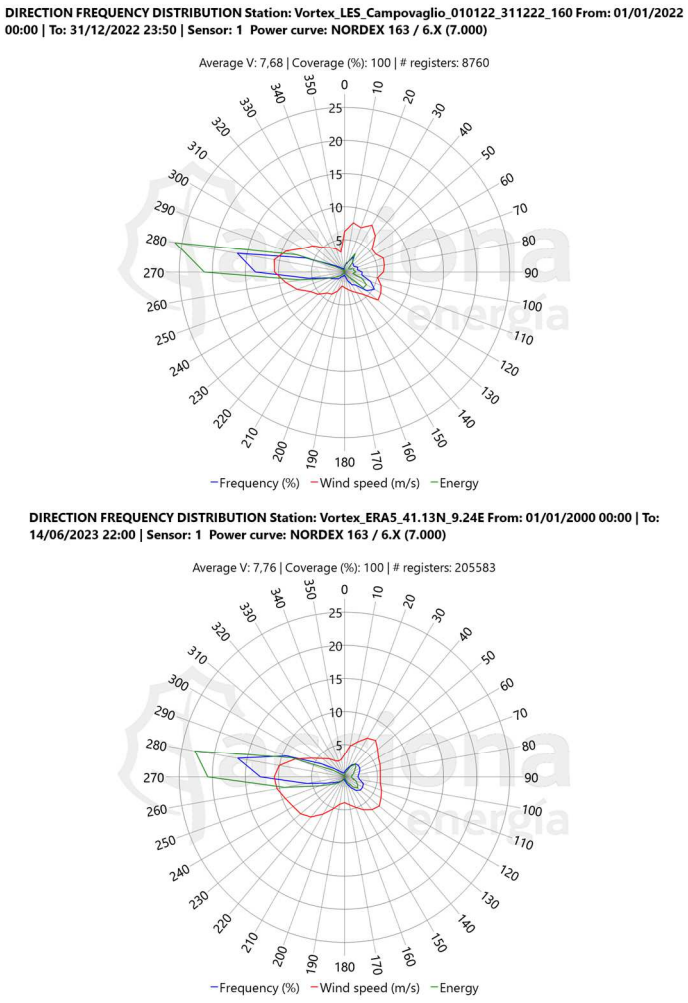
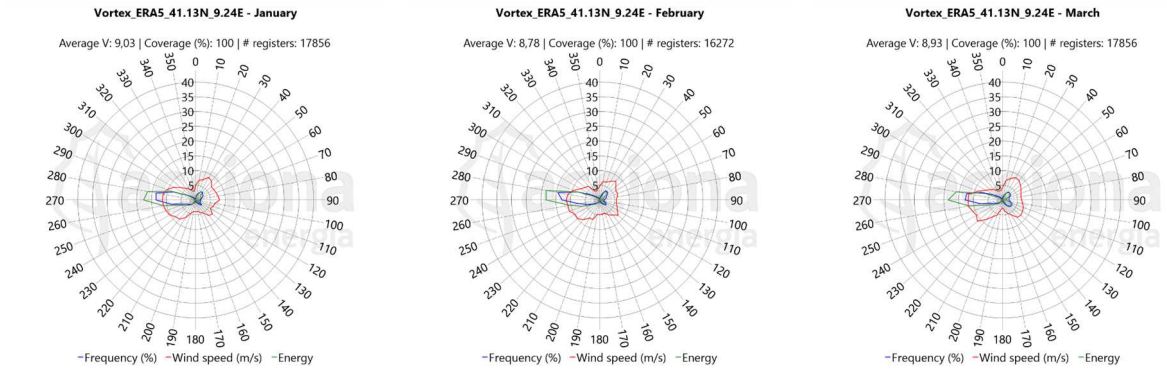


Figure 1: Wind rose: wind speed, frequency and energy



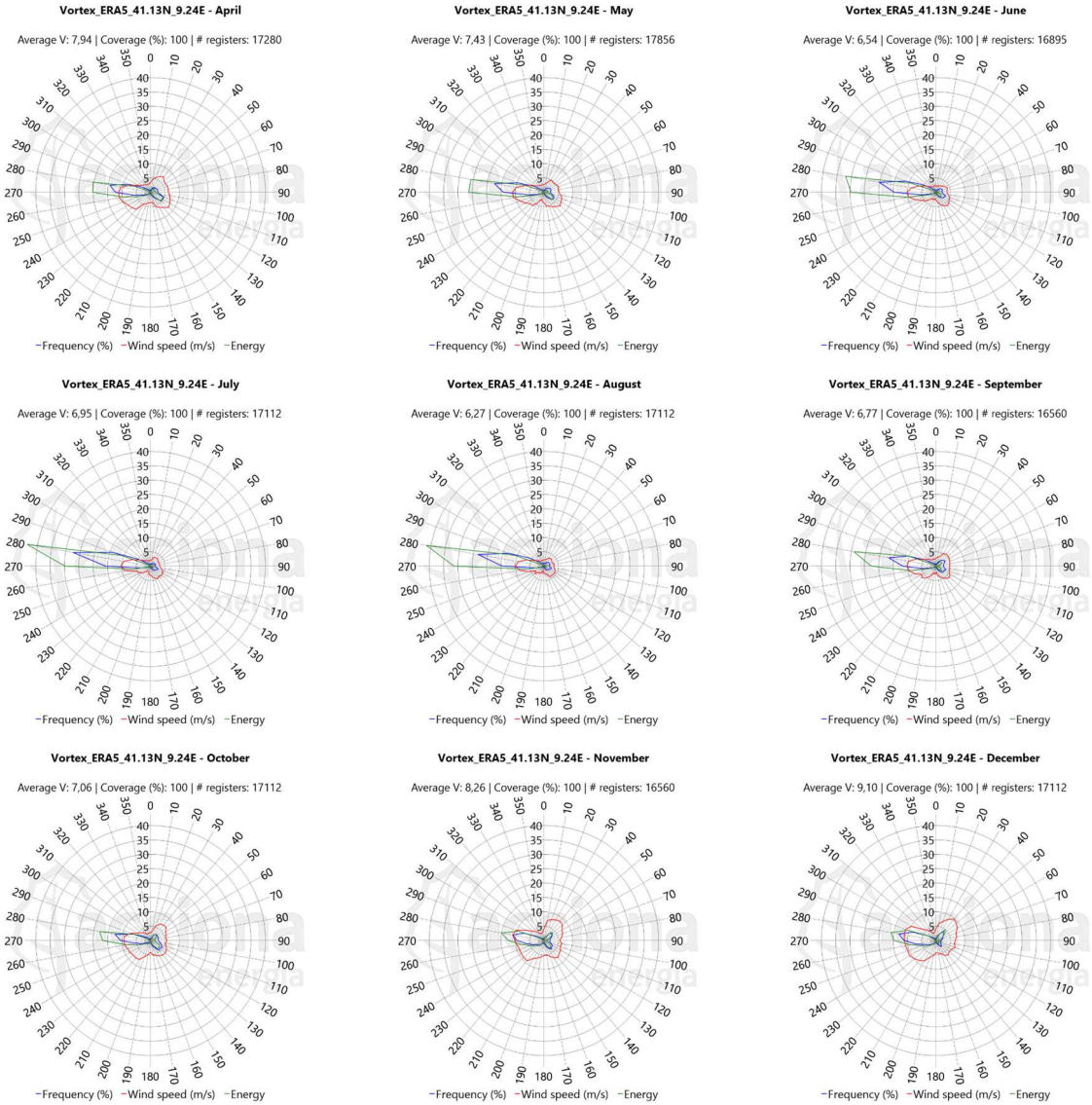
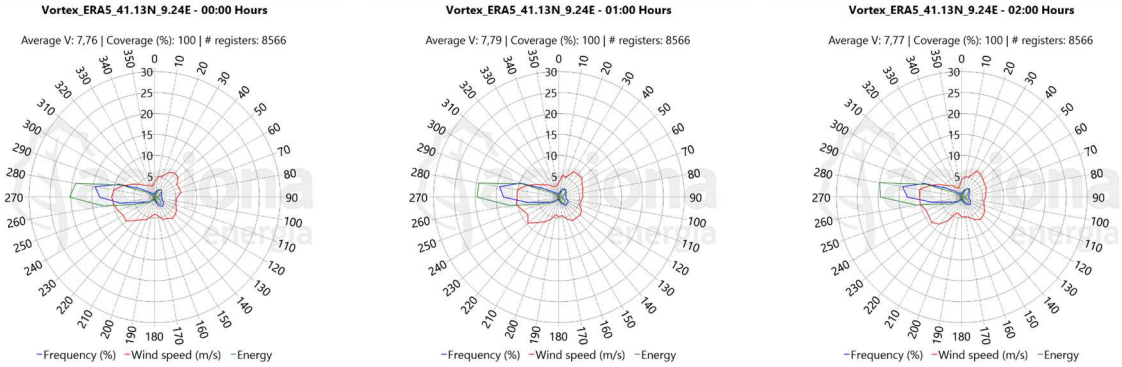


Figure 2: Rosas mensuales de viento y energía_ING Vortex_ERA5_41.13N_9.24E (Jan00-Jun23)



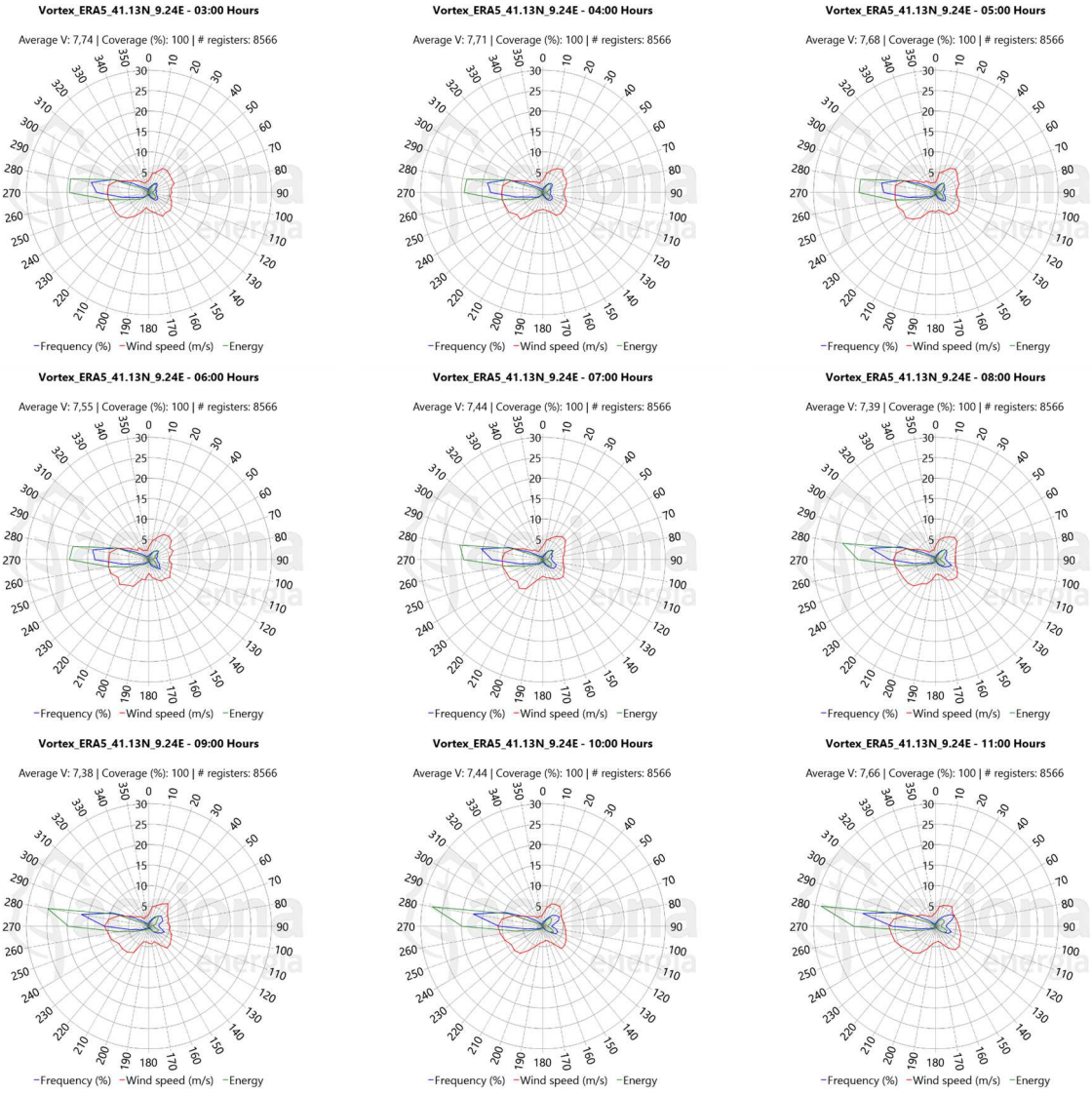
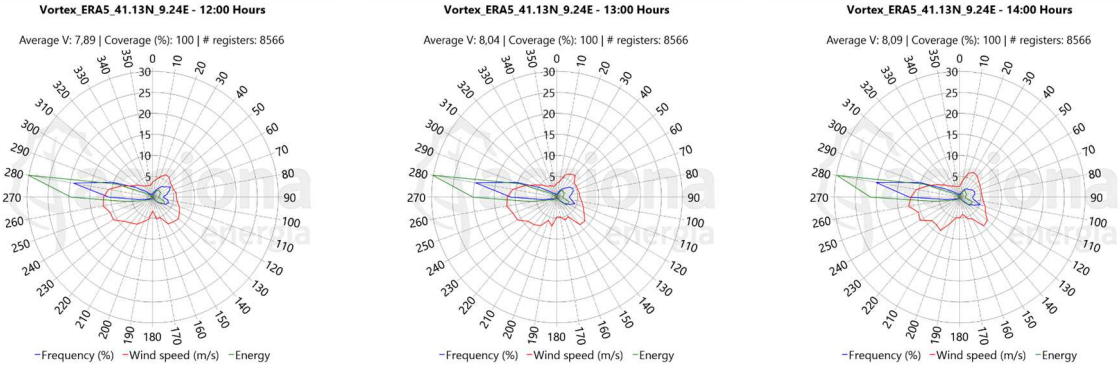


Figure 3: Rosas horarias de viento y energía desde 00h hasta 11h_ING Vortex_ERA5_41.13N_9.24E (Jan00-Jun23)



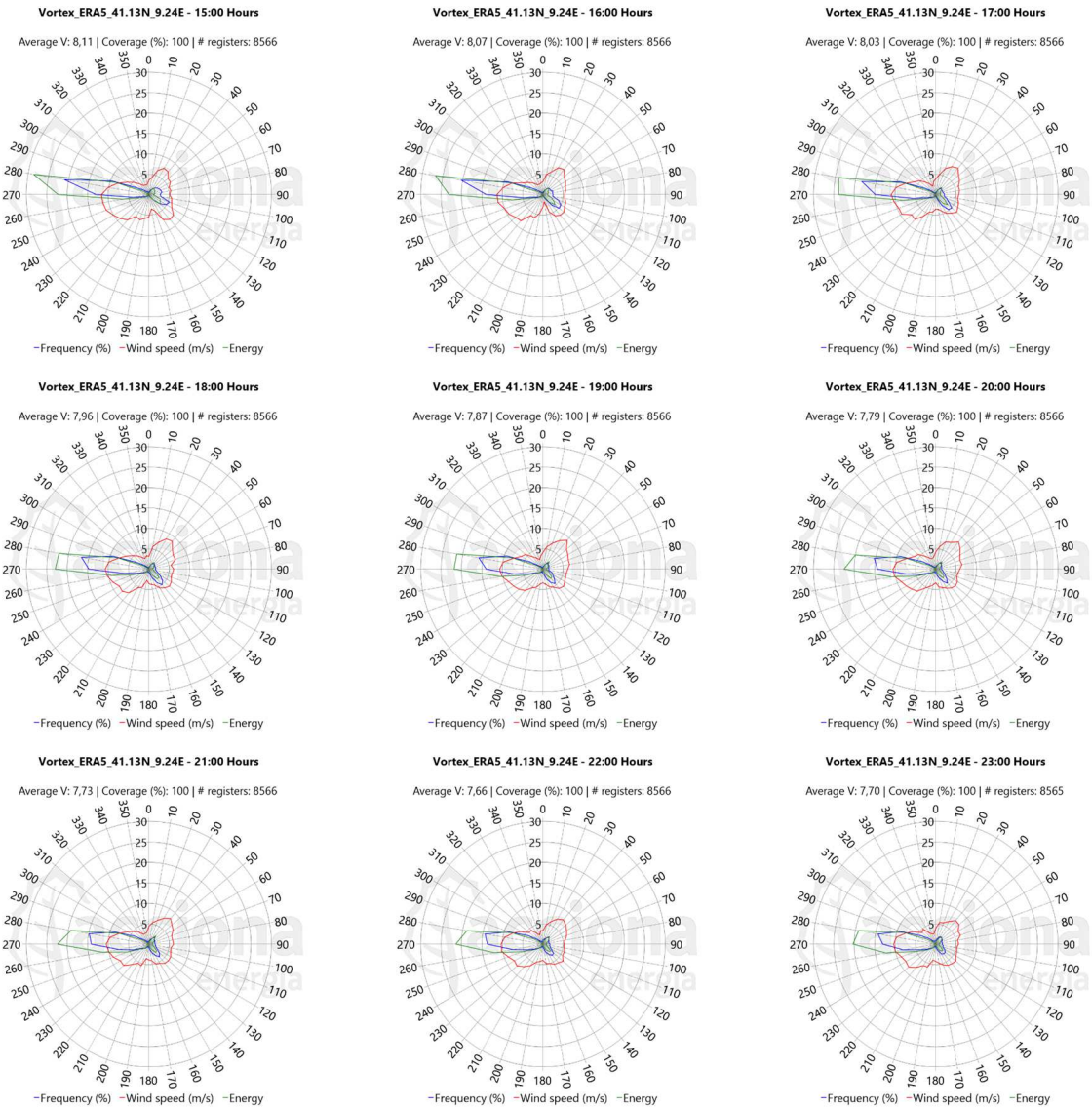


Figure 4: Rosas horarias de viento y energía desde 12h hasta 23h_ING Vortex_ERA5_41.13N_9.24E (Jan00-Jun23)

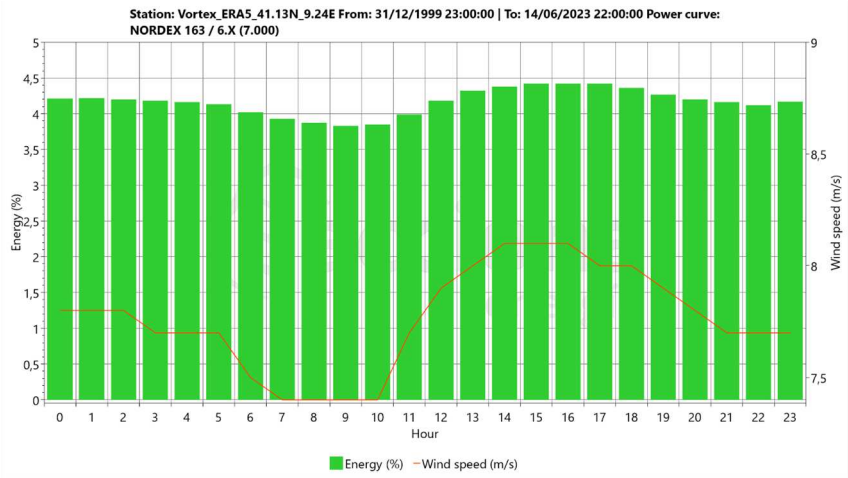


Figure 5: Hourly wind speed and energy variation

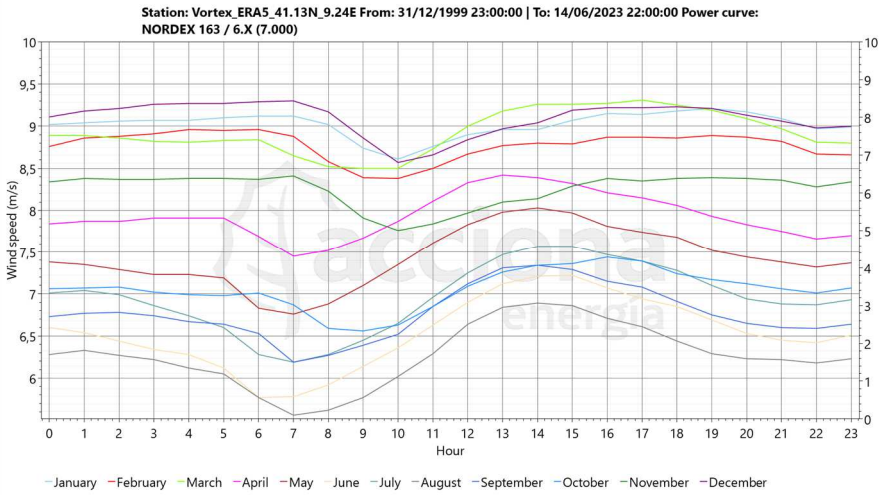


Figure 6: Hourly wind speed variation per months

Vortex_LES_Campovaglio_010122_311222_160 | 01/01/2022 - 31/12/2022							
Pair of sensors	**Sensor height (m)**	**Wind shear**	**# data sets**	**Ave. V sensor 1 (m/s)**	**Ave. V sensor 2 (m/s)**	**Priority**	**Estimated wind shear**
1 - 2	160,00 - 150,00	0,066	8.760	7,68	7,65	1	0,066

Table 7: Wind shear and wind speed analysis at different heights Config. 1 - Vortex_LES_Campovaglio_010122_311222_160

Vortex_ERA5_41.13N_9.24E | 31/12/1999 - 14/06/2023							
Pair of sensors	**Sensor height (m)**	**Wind shear**	**# data sets**	**Ave. V sensor 1 (m/s)**	**Ave. V sensor 2 (m/s)**	**Priority**	**Estimated wind shear**
1 - 2	160,00 - 150,00	0,072	205.584	7,76	7,72	1	0,072

Table 8: Wind shear and wind speed analysis at different heights Config. 2 - Vortex_ERA5_41.13N_9.24E

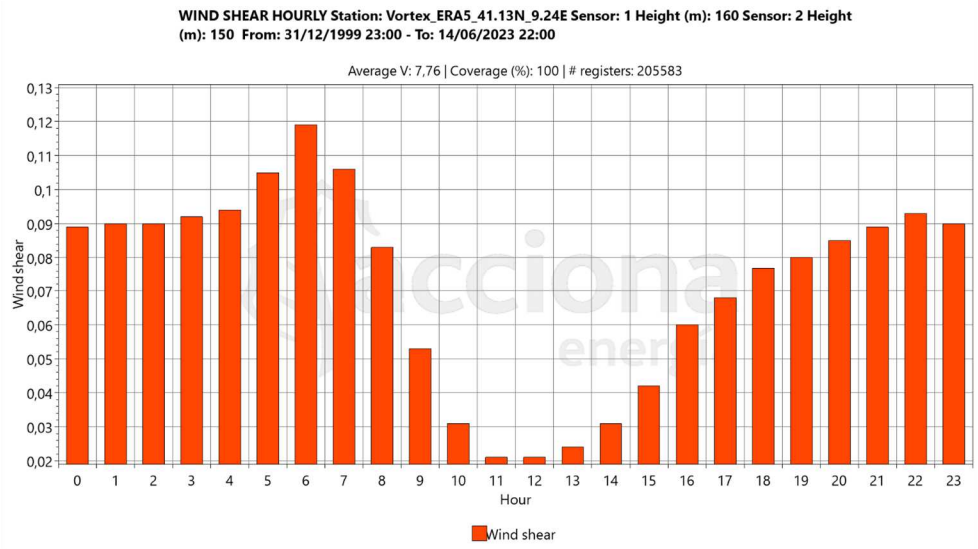


Figure 7: Wind shear calculation Hourly Vortex_ERA5_41.13N_9.24E

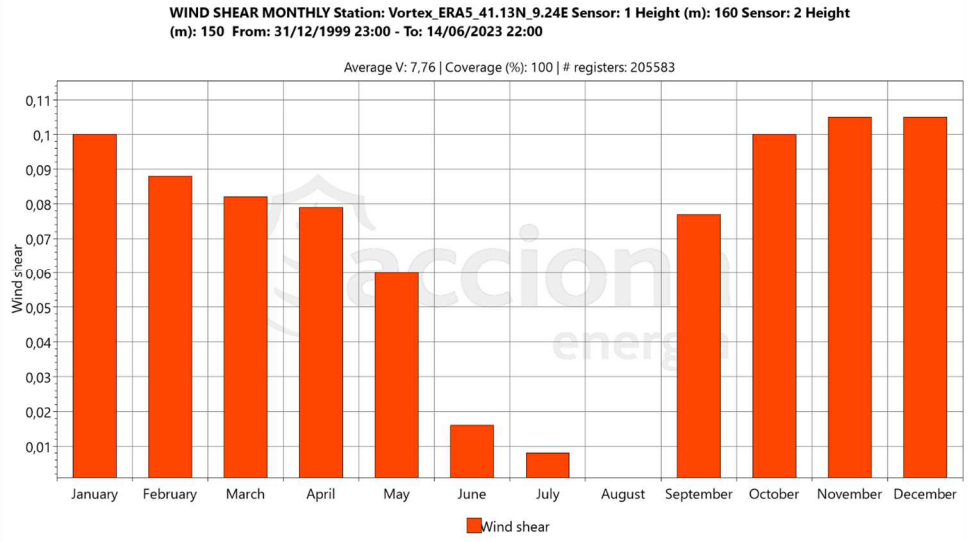


Figure 8: Wind shear calculation Monthly Vortex_ERA5_41.13N_9.24E

Vortex_LES_Campovaglio_010122_311222_160 | Fechas: 01/01/2022 00:00 - 31/12/2022 23:50 | Sensores: 1 - 2														
WS (m/s) (m/s)	**0**	**30**	**60**	**90**	**120**	**150**	**180**	**210**	**240**	**270**	**300**	**330**	**No dir.**	**Total**
1,0	0,224	-0,128	0,000	0,175	0,236	0,177	0,122	0,108	-0,135	-0,538	-0,475	-0,754		**0,040**
2,0	-0,283	-0,057	0,045	0,119	0,201	0,004	0,147	0,044	-0,052	-0,332	-0,250	-0,360		**-0,029**
3,0	-0,119	0,043	0,042	0,158	0,159	0,052	0,107	0,237	0,047	-0,103	-0,124	-0,182		**0,028**
4,0	0,013	0,166	0,129	0,151	0,081	0,110	0,197	0,370	0,218	-0,062	0,004	-0,083		**0,081**
5,0	0,051	0,192	0,130	0,156	0,074	0,206	0,163	0,392	0,322	-0,008	0,028	0,066		**0,096**
6,0	0,086	0,122	0,105	0,168	0,095	0,191	0,094	0,465	0,255	-0,002	-0,021	-0,131		**0,080**
7,0	0,123	0,084	0,139	0,073	0,111	0,236	0,365	0,487	0,261	-0,010	-0,035	0,027		**0,064**
8,0	0,193	0,078	0,087	0,076	0,085	0,240	0,121		0,185	0,028	-0,011	0,061		**0,065**
9,0	0,122	0,102	0,083	0,086	0,067	0,122		0,214	0,145	0,034	-0,023	0,039		**0,055**
10,0	0,106	0,135	0,115	0,098	0,052	0,144		0,202	0,130	0,027	-0,002	0,009		**0,048**
11,0	0,122	0,118	0,072	0,091	0,059	0,011		0,281	0,160	0,034	0,028	0,096		**0,060**
12,0	0,137	0,150	0,156	0,092	0,088	0,131		0,219	0,193	0,037	0,011	0,061		**0,073**
13,0	0,142	0,123	0,092	0,045	0,077	0,122		0,291	0,179	0,034	0,015			**0,067**
14,0	0,164	0,147	0,118	0,099	0,082	0,153		0,276	0,176	0,047	0,016	0,011		**0,076**
15,0		0,128			0,079			0,188	0,184	0,054	0,045			**0,077**
16,0		0,156			0,107				0,133	0,052	0,086	0,152		**0,069**
17,0		0,142		-0,194	0,037			0,189	0,135	0,056	0,083			**0,066**
18,0									0,127	0,062	0,085			**0,067**
19,0										0,072	0,108			**0,078**
20,0										0,073	0,099			**0,078**
21,0										0,062	0,115			**0,068**
22,0										0,068	0,122			**0,074**
23,0										0,054	0,123			**0,061**
24,0										0,079	0,133			**0,095**
25,0										0,068	0,122			**0,090**
26,0										0,072	0,130			**0,086**
27,0										0,080	0,122			**0,094**
28,0										0,131	0,106			**0,114**
29,0										0,074				**0,074**
30,0										0,068				**0,068**
Total:	**0,080**	**0,120**	**0,107**	**0,117**	**0,091**	**0,134**	**0,153**	**0,285**	**0,156**	**0,034**	**0,022**	**-0,069**		0,066
Range:	**0,106**	**0,126**	**0,114**	**0,114**	**0,083**	**0,164**	**0,164**	**0,343**	**0,179**	**0,036**	**0,028**	**-0,003**		0,069
Number of data:	**219**	**547**	**489**	**643**	**1214**	**548**	**158**	**255**	**550**	**3108**	**853**	**176**		**8760**

Table 9: Wind shear by direction and speed range Config. 1 - Vortex_LES_Campovaglio_010122_311222_160

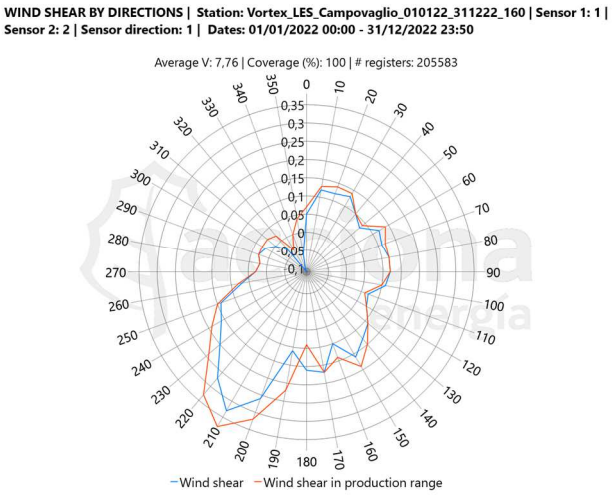


Figure 9: Wind shear by direction and speed range Config. 1 - Vortex_LES_Campovaglio_010122_311222_160

Vortex_ERA5_41.13N_9.24E | Fechas: 31/12/1999 23:00 - 14/06/2023 22:00 | Sensores: 1 - 2														
WS (m/s) (m/s)	**0**	**30**	**60**	**90**	**120**	**150**	**180**	**210**	**240**	**270**	**300**	**330**	**No dir.**	**Total**
0,0	-1,541	-0,480	-0,054	-0,132	-0,347	0,000	-0,244	-1,930	-1,383	-2,357	-1,766	-2,202		**-1,088**
1,0	-0,139	0,186	0,234	0,226	0,092	-0,098	-0,139	-0,062	-0,238	-0,634	-1,022	-0,777		**-0,222**
2,0	0,065	0,173	0,173	0,205	0,046	-0,083	0,076	0,195	0,031	-0,430	-0,680	-0,386		**-0,120**
3,0	0,163	0,173	0,113	0,164	0,088	-0,009	0,141	0,315	0,167	-0,229	-0,444	-0,196		**-0,056**
4,0	0,303	0,236	0,144	0,131	0,092	0,044	0,187	0,447	0,192	-0,111	-0,276	-0,043		**-0,004**
5,0	0,259	0,250	0,198	0,121	0,105	0,106	0,254	0,424	0,171	-0,055	-0,175	0,046		**0,031**
6,0	0,235	0,227	0,181	0,123	0,119	0,155	0,309	0,409	0,164	-0,016	-0,081	0,075		**0,067**
7,0	0,194	0,179	0,150	0,089	0,107	0,196	0,352	0,400	0,159	0,010	-0,031	0,055		**0,077**
8,0	0,158	0,145	0,136	0,079	0,110	0,229	0,420	0,353	0,148	0,027	0,002	0,026		**0,083**
9,0	0,150	0,144	0,102	0,070	0,111	0,255	0,386	0,274	0,155	0,036	0,029	0,062		**0,085**
10,0	0,131	0,127	0,102	0,066	0,127	0,272	0,306	0,287	0,160	0,050	0,046	0,074		**0,093**
11,0	0,085	0,105	0,097	0,081	0,130	0,283	0,318	0,289	0,179	0,059	0,050	0,085		**0,095**
12,0	0,091	0,093	0,096	0,096	0,131	0,277	0,312	0,290	0,182	0,067	0,058	0,097		**0,099**
13,0	0,104	0,095	0,093	0,111	0,137	0,268	0,268	0,269	0,188	0,076	0,057	0,080		**0,101**
14,0	0,091	0,087	0,105	0,100	0,126	0,276	0,463	0,270	0,180	0,079	0,062	0,095		**0,099**
15,0	0,083	0,096	0,088	0,120	0,141	0,258	0,319	0,286	0,179	0,082	0,057	0,060		**0,099**
16,0	0,113	0,093	0,081	0,102	0,142	0,195	0,350	0,269	0,177	0,079	0,061	0,088		**0,092**
17,0		0,089	0,098	0,123	0,113	0,217		0,238	0,179	0,082	0,063	0,074		**0,091**
18,0		0,084	0,103	0,130	0,162	0,189		0,286	0,170	0,083	0,066	0,087		**0,091**
19,0		0,086	0,083	0,137	0,151	0,164		0,239	0,171	0,086	0,070	0,162		**0,092**
20,0	0,078	0,078	0,099	0,133	0,141	0,167		0,290	0,180	0,082	0,068	0,117		**0,087**
21,0	0,075	0,071	0,109	0,140	0,194	0,111		0,261	0,165	0,085	0,068	0,073		**0,086**
22,0		0,071	0,143	0,123	0,154	0,145		0,214	0,162	0,085	0,077			**0,089**
23,0		0,069	0,066	0,136	0,137				0,182	0,088	0,073			**0,091**
24,0			0,131				0,132		0,157	0,090	0,076			**0,089**
25,0									0,168	0,094	0,074			**0,093**
26,0									0,120	0,101	0,082			**0,096**
27,0									0,114	0,101	0,076			**0,095**
28,0										0,087	0,084			**0,087**
29,0									0,106	0,097				**0,098**
30,0								0,156		0,087				**0,104**
31,0										0,101				**0,101**
32,0									0,097	0,098				**0,098**
Total:	**0,150**	**0,141**	**0,130**	**0,111**	**0,114**	**0,180**	**0,260**	**0,305**	**0,168**	**0,050**	**-0,061**	**-0,142**		**0,072**
Range:	**0,181**	**0,137**	**0,126**	**0,102**	**0,116**	**0,197**	**0,302**	**0,314**	**0,171**	**0,053**	**-0,032**	**0,005**		**0,079**
Number of data:	**4861**	**12434**	**16186**	**13494**	**19257**	**11843**	**3252**	**4249**	**11902**	**71893**	**31030**	**5183**		**205584**

Table 10: Wind shear by direction and speed range Config. 2 - Vortex_ERA5_41.13N_9.24E

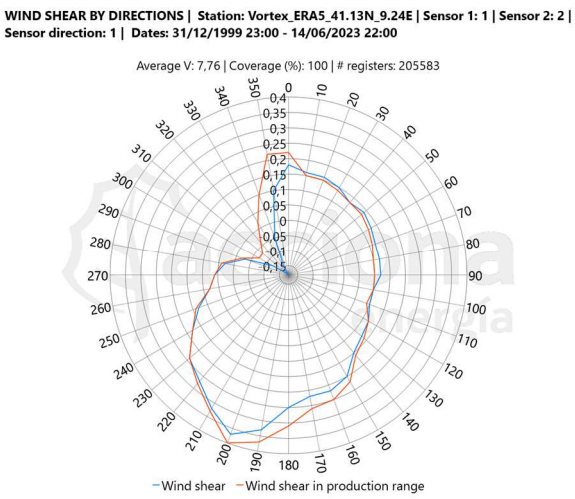


Figure 10: Wind shear by direction and speed range Config. 2 - Vortex_ERA5_41.13N_9.24E

Station: Vortex_ERA5_41.13N_9.24E Date: 01/01/2000 00:00 - 14/06/2023 22:00 | Sensor: 1												
	Temperature			Pressure (mb)	Relative humidity (%)	Density (kg/m³)	WS (m/s)	Energy - NORDEX 163 / 6.X (7.000)				
Calculated temperature (ºC)	Num. hours	Freq. (%)	Ave.	Ave.	Ave.	Ave.	Ave.	Total (kWh)	Average (kWh)	%	Accum. gain (%)	Accum. loss (%)
-1	4	0,002	-0,60	967,70	78	1,235	8,38	15.906	3.977	0,00	0,00	100,00
0	69	0,034	-0,03	969,53	76	1,235	8,07	231.387	3.353	0,04	0,04	99,96
1	222	0,108	1,01	970,93	75	1,232	8,07	677.278	3.051	0,12	0,16	99,84
2	287	0,140	1,97	969,39	76	1,225	10,26	1.322.748	4.609	0,23	0,39	99,61
3	536	0,261	3,06	972,88	71	1,225	9,61	2.118.524	3.953	0,36	0,75	99,25
4	1.352	0,658	4,02	974,37	69	1,222	9,16	5.034.849	3.724	0,86	1,61	98,39
5	2.380	1,158	5,00	972,68	70	1,215	9,20	8.746.109	3.675	1,49	3,10	96,90
6	4.163	2,025	5,99	973,25	71	1,211	8,82	14.416.727	3.463	2,45	5,55	94,45
7	6.823	3,319	6,98	973,47	74	1,207	8,71	22.889.202	3.355	3,90	9,45	90,55
8	10.041	4,884	7,98	974,64	77	1,204	8,91	35.125.049	3.498	5,98	15,43	84,57
9	13.584	6,608	8,96	975,20	79	1,200	9,35	49.528.503	3.646	8,43	23,86	76,14
10	14.956	7,275	9,95	975,41	80	1,196	9,43	54.836.340	3.667	9,33	33,19	66,81
11	13.219	6,430	10,94	975,58	79	1,192	9,21	47.714.031	3.610	8,12	41,31	58,69
12	12.619	6,138	11,95	974,88	79	1,186	8,93	43.940.776	3.482	7,48	48,79	51,21
13	11.384	5,537	12,94	974,02	78	1,181	8,73	39.052.211	3.430	6,65	55,44	44,56
14	10.310	5,015	13,94	974,41	76	1,177	8,09	32.103.837	3.114	5,46	60,90	39,10
15	9.506	4,624	14,94	974,58	75	1,173	7,50	26.192.491	2.755	4,46	65,36	34,64
16	9.688	4,712	15,94	974,66	74	1,169	7,56	26.849.602	2.771	4,57	69,93	30,07
17	9.700	4,718	16,95	974,49	75	1,164	7,52	26.638.725	2.746	4,53	74,46	25,54
18	10.266	4,994	17,96	974,55	74	1,160	7,59	29.186.953	2.843	4,97	79,43	20,57
19	10.166	4,945	18,94	974,56	73	1,155	7,49	28.643.160	2.818	4,87	84,30	15,70
20	9.574	4,657	19,94	974,47	71	1,151	7,33	26.142.502	2.731	4,45	88,75	11,25
21	8.526	4,147	20,95	974,52	69	1,147	6,88	20.696.820	2.428	3,52	92,27	7,73
22	7.738	3,764	21,95	974,52	67	1,143	6,15	15.434.873	1.995	2,63	94,90	5,10
23	7.364	3,582	22,94	974,51	63	1,139	5,62	12.329.433	1.674	2,10	97,00	3,00
24	6.127	2,980	23,93	974,64	59	1,135	4,87	7.352.106	1.200	1,25	98,25	1,75
25	4.935	2,400	24,93	974,66	55	1,132	4,26	4.105.434	832	0,70	98,95	1,05
26	3.540	1,722	25,91	974,57	52	1,128	3,99	2.412.232	681	0,41	99,36	0,64
27	2.793	1,359	26,93	974,70	48	1,124	3,89	1.721.448	616	0,29	99,65	0,35
28	1.826	0,888	27,91	974,43	44	1,120	3,90	1.071.518	587	0,18	99,83	0,17
29	1.049	0,510	28,91	974,33	40	1,117	4,00	606.277	578	0,10	99,93	0,07
30	473	0,230	29,89	973,74	38	1,113	4,00	289.373	612	0,05	99,98	0,02
31	208	0,101	30,84	973,36	34	1,108	3,98	132.892	639	0,02	100,00	0,00
32	101	0,049	31,92	974,09	30	1,106	3,81	54.124	536	0,01	100,00	0,00
33	44	0,021	32,82	973,61	28	1,103	3,57	14.583	331	0,00	100,00	0,00
34	8	0,004	33,86	974,64	20	1,101	5,23	9.647	1.206	0,00	100,00	0,00
35	2	0,001	34,65	972,50	35	1,090	2,90	0	0	0,00	100,00	0,00
TOTAL:	**205.583**	**100,000**	**15,17**	**974,61**	**73**	**1,172**	**7,76**			**100**		

Table 11: Temperature distribution and associated values Config. 2 - Vortex_ERA5_41.13N_9.24E

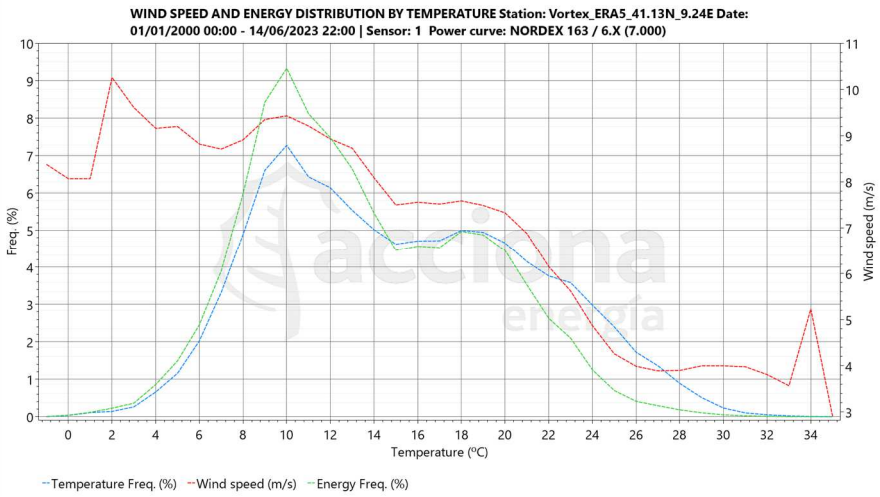


Figure 11: Temperature distribution and associated values Config. 2 - Vortex_ERA5_41.13N_9.24E

Direction														
	0	30	60	90	120	150	180	210	240	270	300	330	No dir.	All directions
Wind speed (m/s)	Repr.	Repr.	Repr.	Repr.	Repr.	Repr.	Repr.	Repr.	Repr.	Repr.	Repr.	Repr.	Repr.	Repr.
0,5		58,000			56,250	79,357	58,424	62,584	66,183			63,333		68,018
1,0		47,747	45,156	46,658	39,071	42,006	41,422	39,758	40,033	51,736	45,155	73,421		43,356
1,5	40,385	35,993	39,372	40,876	29,932	32,422	30,849	31,719	28,584	37,744	38,511	43,140		34,774
2,0	33,729	37,564	35,672	36,317	25,116	21,445	26,236	33,566	26,852	28,696	27,604	31,907		30,691
2,5	28,942	34,502	36,403	27,390	20,815	18,156	16,715	28,150	22,572	25,057	26,153	30,760		27,003
3,0	25,460	29,655	28,173	24,133	17,994	16,994	14,847	20,764	22,967	22,164	22,851	24,767		23,251
3,5	22,518	25,690	25,237	20,508	16,519	10,758	22,733	19,810	19,874	17,743	20,637	22,567		20,796
4,0	25,122	20,208	21,695	18,807	14,785	9,263	15,605	18,098	13,793	16,912	19,875	21,234		18,533
4,5	20,438	19,100	19,610	17,662	14,240	9,968	12,600	20,249	12,571	15,088	16,208	21,844		16,810
5,0	18,869	16,915	17,991	15,279	14,266	8,654	9,536	16,770	15,709	14,471	16,007	14,589		15,602
5,5	17,532	15,588	16,440	14,889	14,000	8,768	12,590	17,094	16,888	14,112	15,531	10,987		14,948
6,0	15,331	15,515	15,516	13,849	12,448	7,960	20,852	13,606	13,417	12,991	13,674	11,918		13,751
6,5	17,106	15,796	14,432	12,498	11,382	8,143		10,540	18,644	12,637	14,262	10,031		13,479
7,0	12,709	14,951	12,908	14,149	10,656	10,531	6,776	11,839	10,138	10,709	12,608	15,551		12,385
7,5	13,622	12,632	12,429	12,311	10,664	6,686	8,111	14,117	13,935	12,374	12,219	13,835		12,217
8,0	12,671	12,864	12,159	12,443	11,254	8,192			10,653	12,662	11,506	11,599		12,052
8,5	11,581	10,163	13,389	13,190	11,087	7,326			11,629	10,419	10,929	14,301		11,261
9,0	9,375	12,052	11,464	9,112	10,981	7,516		12,828	8,556	10,422	10,910	5,895		10,502
9,5	11,080	10,280	11,807	10,379	9,834	5,232		9,700	7,691	9,501	11,239	9,696		9,909
10,0	12,647	12,075	11,471	9,564	11,418	7,148		11,054	14,397	9,649	11,539	12,726		10,573
10,5	12,044	10,299	10,681	11,049	11,325	7,711			11,703	8,681	15,171	11,534		10,369
11,0	11,173	10,950		8,658	10,106	7,475		12,335	8,753	8,488	13,912	8,171		10,101
11,5	12,367	11,556	8,778	10,757	11,485	7,803			10,611	8,938	12,517	7,195		10,329
12,0	13,235	11,876	7,249	9,356	9,664	5,812		13,882	10,575	9,660	12,058	8,052		10,363
12,5	11,197	12,158	8,941	8,090	8,918	4,353		12,192	9,262	9,169	11,028	7,097		9,691
13,0	9,607	10,837	8,182	8,983	8,355	8,543		9,305	10,701	9,879	16,195			10,857
13,5	10,221	9,446	8,367	11,471	9,954	7,467		9,744	11,641	11,371	11,464			10,924
14,0	9,921	9,961	12,719	9,325	9,317	5,446		6,369	10,834	12,492	14,147	12,346		11,836
14,5		10,935	12,353	10,109	9,226				10,721	11,973	15,572			11,890
15,0		9,956			9,368			10,586	11,162	13,869	13,208			12,876
15,5		10,981			11,278				10,182	12,797	10,579			12,097
16,0		10,548			9,445				14,445	13,859	12,973			13,570
16,5		13,177		8,326	11,857			13,434	19,383	13,996	11,169	7,845		14,059
17,0		9,774			9,367				15,656	15,521	10,809			14,897
17,5									9,622	15,511	12,194			14,935
18,0									12,212	15,469	12,618			15,323
18,5									19,011	14,396	12,188			14,559
19,0										14,721	10,902			14,348
19,5										15,478	12,287			15,089
20,0										14,428	13,584			14,479
20,5										15,210	15,243			15,168
21,0										15,820	16,017			15,898
21,5										15,974	9,535			15,941
22,0										15,765	16,332			15,753
22,5										15,428				15,428
23,0										15,339				15,339
23,5										14,903	13,778			14,395
24,0										14,706	12,760			14,385
24,5										14,949	11,506			14,720
25,0										13,939	15,941			14,897
25,5										13,721	14,572			13,975
26,0										12,892				12,892
26,5										13,154	14,063			13,575
27,0										14,648				14,648
27,5														
28,0											15,826			15,826
28,5										12,460				12,460
29,0														
29,5										14,579				14,579
Total:	**24,318**	**22,900**	**25,091**	**24,347**	**18,395**	**25,434**	**33,655**	**30,224**	**23,364**	**15,546**	**18,912**	**31,600**		**21,210**
Productive range:	**18,647**	**17,054**	**18,169**	**15,745**	**12,871**	**9,800**	**16,589**	**17,351**	**13,948**	**13,624**	**15,509**	**19,198**		**14,812**

Table 12: Turbulence intensity by wind speed and direction Config. 1 - Vortex_LES_Campovaglio_010122_311222_160

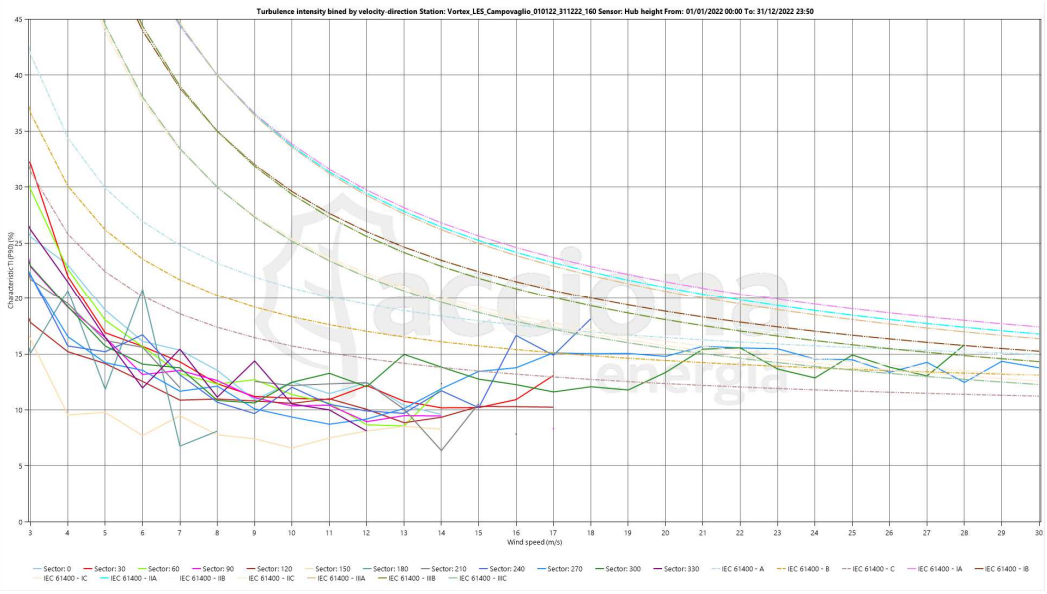


Figure 12: Turbulence intensity by wind speed and direction Config. 1 - Vortex_LES_Campovaglio_010122_311222_160

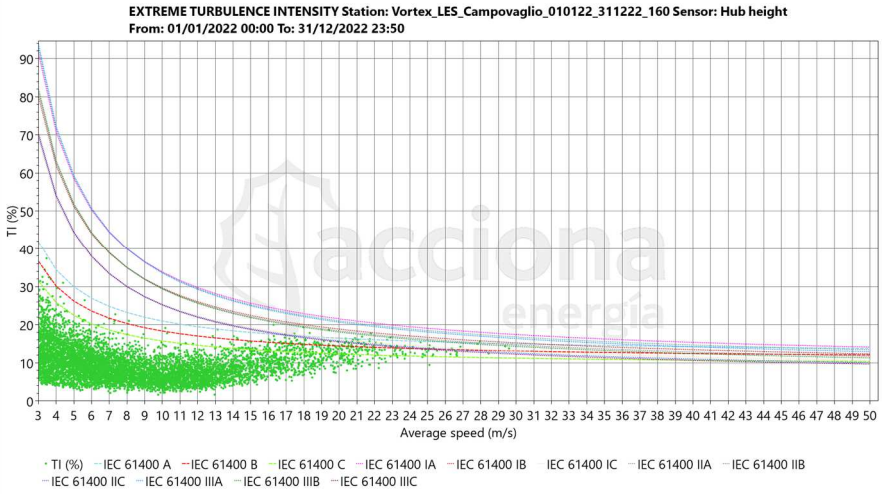


Figure 13: Extreme turbulence intensity Config. 1 - Vortex_LES_Campovaglio_010122_311222_160

Layout: IPITACERXXCAM230620							
Station	**Altitude (m)**	**Height (m)**	**Total height (m)**	**Relative humidity (%)**	**Temperature (ºC)**	**Pressure (mb)**	**Density (kg/m³)**
Vortex_ERA5_41.13N_9.24E	185	159	344	72	15,2	975	1,172
	185	160	345	72	15,2	975	1,172
Turbine	**Altitude (m)**	**Hub height (m)**	**Hub altitude (m)**	**Hub height RH (%)**	**Hub height temperature (ºC)**	**Hub height pressure (mb)**	**Hub height density (kg/m³)**
T01	245	159	404	72	14,8	968	1,165
T02	207	159	366	72	15,0	972	1,170
T03	301	159	460	72	14,4	961	1,159
T04	216	159	375	72	15,0	971	1,169
T05	252	159	411	72	14,7	967	1,165
T06	136	159	295	72	15,5	980	1,178
T07	99	159	258	72	15,7	985	1,182
T08	138	159	297	72	15,5	980	1,177
T09	174	159	333	72	15,3	976	1,173
T10	281	159	440	72	14,6	964	1,162

T11	115	159	274	72	15,6	983	1,180
Wind farm	**197**	**159**	**356**	**72**	**15,1**	**973**	**1,171**

Table 13: Mean air density of the wind farm IPITACERXXCAM230620

N163/7000_IECS_F008_277_A12_R6_M0_113,118,138,159		
Mean density of the site = 1,175kg /m3		
Wind speed (m/s)	**Power (kW)**	**Thrust Coefficient Ct (δ= 1,175kg/m3)**
3	28	0,872
4	260	0,845
5	628	0,820
6	1.145	0,808
7	1.855	0,803
8	2.795	0,791
9	3.954	0,740
10	5.140	0,665
11	6.134	0,573
12	6.700	0,479
13	6.954	0,391
14	7.000	0,317
15	7.000	0,258
16	7.000	0,210
17	7.000	0,174
18	7.000	0,149
19	7.000	0,131
20	6.882	0,117
21	6.331	0,096
22	5.794	0,077
23	5.270	0,062
24	4.760	0,050
25	4.264	0,041
26	3.774	0,035
(3-26 m/s) = 10%		

Table 14: Calculated power curve and trust coefficient for N163/7000_IECS_F008_277_A12_R6_M0_113,118,138,159

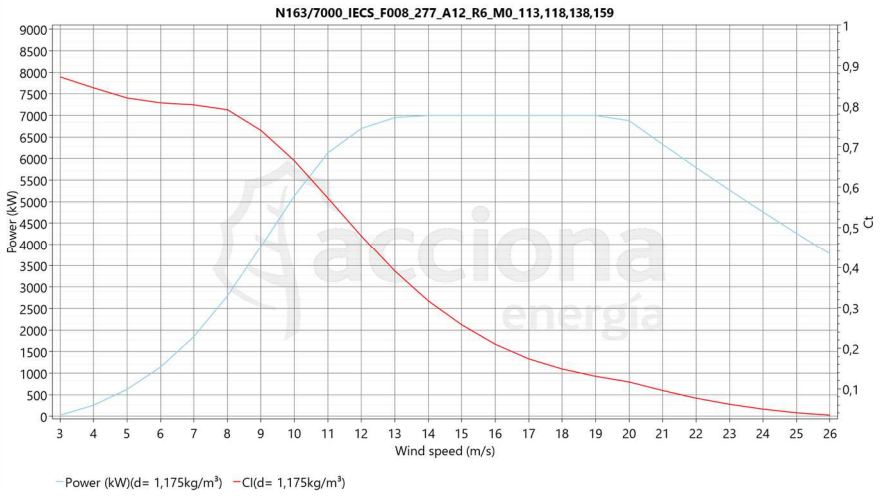


Figure 14: Calculated power curve and trust coefficient for N163/7000_IECS_F008_277_A12_R6_M0_113,118,138,159

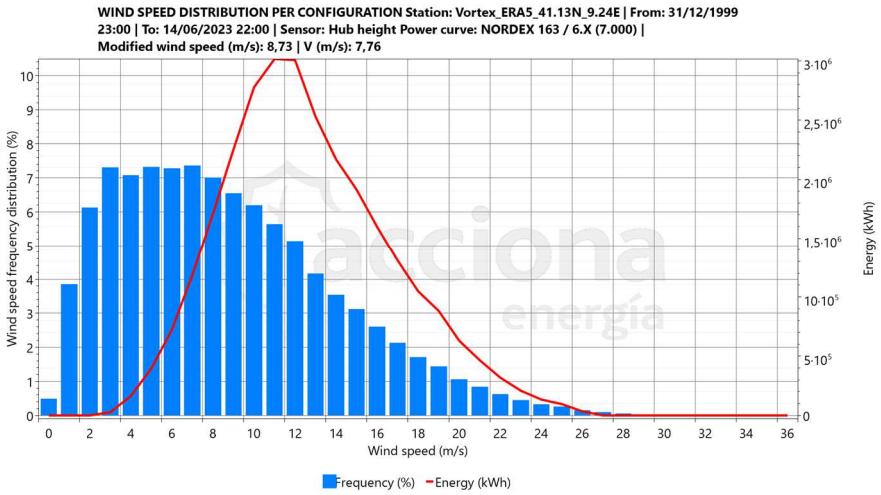


Figure 15: Energy and wind speed frequency distribution Config. 2 - Vortex_ERA5_41.13N_9.24E

WIND SPEED DISTRIBUTION PER CONFIGURATION Station: Vortex_ERA5_41.13N_9.24E | From: 31/12/1999 23:00 | To: 14/06/2023 22:00 | Sensor: Hub height Power curve: NORDEX 163 / 6.X (7.000) | Modified wind speed (m/s): 8,73 | V (m/s): 7,76		
Wind speed (m/s)	**Frequency (%)**	**Energy (kWh)**
0,0	0,495	0
1,0	3,855	0
2,0	6,125	0
3,0	7,309	27.543
4,0	7,071	163.920
5,0	7,325	397.988
6,0	7,286	724.000
7,0	7,360	1.188.133
8,0	7,006	1.710.141
9,0	6,543	2.253.750
10,0	6,192	2.777.867
11,0	5,646	3.016.950
12,0	5,138	3.006.918
13,0	4,161	2.529.145
14,0	3,538	2.168.814
15,0	3,120	1.913.416
16,0	2,606	1.598.143
17,0	2,133	1.308.222
18,0	1,708	1.047.532
19,0	1,438	881.991
20,0	1,052	630.088
21,0	0,841	465.784
22,0	0,629	318.862
23,0	0,452	208.735
24,0	0,320	133.947
25,0	0,254	95.515
26,0	0,151	34.323
27,0	0,101	0
28,0	0,055	0
29,0	0,034	0
30,0	0,025	0
31,0	0,014	0
32,0	0,005	0
33,0	0,004	0
34,0	0,002	0
35,0	0,002	0
36,0	0,001	0
	TOTAL:	**28.601.727**
	EQUIVALENT HOURS:	**4.085,96**

Table 15: Energy and wind speed frequency distribution Config. 2 - Vortex_ERA5_41.13N_9.24E

Project: Campovaglio_ER.0									Layout: IPITACERXXCAM230620			Coordinates: WGS84 Zone 32 N							
Ref.	Turbine	UTM X	UTM Y	Altitude (m)	Hub height (m)	Rotor D (m)	Power (kW)	Distance D	Topography efficiency (%)	Gross production (MWh)	Gross full load hours	Wake effect internal	Wind sector management	Wind velocity management	Net production (MWh)	Net hours	Mean free wind speed (m/s)	Rayleigh velocity (m/s)	Rayleigh effect. wind speed (m/s) ρ=1,225 kg/m³
Vortex_LES_Campovaglio_010122_311222_160		519.893	4.553.216	214	159,00		7.000		100,00	23.977,03	3.425,29						7,68		
Vortex_ERA5_41.13N_9.24E		519.872	4.553.231	185	159,00		7.000		100,00	28.601,72	4.085,96						8,73		
Vortex_ERA5_41.13N_9.24E	T01	517.675	4.553.551	245	159,00	163	7.000	3,2	126,48	30.327,21	4.332,46	97,95	100,00	100,00	24.758,16	3.536,88	9,32	8,61	8,24
	T02	517.974	4.553.969	207	159,00	163	7.000	3,1	129,36	31.016,13	4.430,88	97,39	100,00	100,00	25.175,81	3.596,54	9,59	8,75	8,35
	T03	518.277	4.554.378	301	159,00	163	7.000	3,1	131,33	31.487,87	4.498,27	98,77	100,00	100,00	25.920,89	3.702,98	9,80	9,03	8,54
	T04	520.017	4.553.276	216	159,00	163	7.000	12,6	126,26	30.273,26	4.324,75	97,52	100,00	100,00	24.605,62	3.515,09	9,30	8,56	8,20
	T05	521.463	4.554.904	252	159,00	163	7.000	3,3	129,91	31.149,32	4.449,90	97,60	100,00	100,00	25.338,43	3.619,78	9,65	8,81	8,39
	T06	521.612	4.555.429	136	159,00	163	7.000	3,3	127,98	30.684,90	4.383,56	98,56	100,00	100,00	25.206,17	3.600,88	9,46	8,77	8,35
	T07	522.815	4.553.379	99	159,00	163	7.000	5,2	110,81	26.568,39	3.795,48	98,24	100,00	100,00	21.753,79	3.107,68	8,15	7,70	7,54
	T08	522.653	4.554.209	138	159,00	163	7.000	4,9	115,60	27.718,18	3.959,74	96,50	100,00	100,00	22.293,26	3.184,75	8,47	7,85	7,66
	T09	523.144	4.554.832	174	159,00	163	7.000	4,9	121,76	29.195,38	4.170,77	96,41	100,00	100,00	23.459,44	3.351,35	8,92	8,19	7,93
	T10	524.602	4.554.459	281	159,00	163	7.000	7,8	116,55	27.944,13	3.992,02	96,28	100,00	100,00	22.423,74	3.203,39	8,53	7,88	7,69
	T11	525.606	4.555.239	115	159,00	163	7.000	7,8	116,63	27.964,91	3.994,99	98,38	100,00	100,00	22.929,88	3.275,70	8,54	8,03	7,81
NORDEX 163 / 6.X (7.000)	11			197	159,00	163	7.000	5,4	122,97	324.329,68	4.212,07	97,61	100,00	100,00	263.865,19	3.426,82	9,07	8,38	8,06
Wind farm	11			197				5,4	122,97	324.329,68	4.212,07	97,61	100,00	100,00	263.865,19	3.426,82	9,07	8,38	8,06

Efficiencies - IPITACERXXCAM230620	
Description	Data (%)
Turbine interaction	
Wake effect internal	97,61
Blockage effect	98,86
Availability	
Turbine availability	97,00
Balance of plant availability	99,50
Grid availability	99,50
Electrical efficiencies	
Operational electrical efficiency	97,00
Step up transformers	100,00
MV cable losses	97,70
ST wind farm transformation losses	99,50
HV transport losses and ST sale transformation	99,80
External grid overload	100,00
Turbine performance	
Generic power curve adjustment	100,00
High wind speed hysteresis	100,00
Site specific power curve adjustment	97,20
Suboptimal performance	99,00
Turbine drivetrain and blade degradation	99,50
Flow inclination	100,00
Environmental efficiencies	
Performance degradation icing	100,00
Icing shutdown	100,00
Low Temperature shutdown	100,00
High Temperature shutdown	100,00
Site access	100,00
Terrain complexity	95,00
Performance degradation blade soiling	99,50
Tree growth	100,00
High temperatures derating	100,00
Birds	100,00
Lightning	100,00
High altitude	100,00
Curtailments	
Wind sector management	100,00
Wind velocity management	100,00
Visual and environmental	100,00
Noise reduction	100,00
Grid curtailment	100,00
Supply & Demand power limitation	100,00
Other Efficiencies	
Total	**81,35**

Table 16:Wind farm gross and net energy output IPITACERXXCAM230620

5. APPENDIX 2: EFFECTIVE TURBULENCE INTENSITY ANALYSIS

The Effective turbulence intensity formulae vary depending on the standard IEC 61400-1 edition and are shown below:

$$I_{eff} = \frac{\sigma_{eff}}{V_{hub}} = \frac{1}{V_{hub}}\left\{\left(\left(1 - \sum_{i=1}^{N} p_{wi}\right)\sigma_{Ed}^{m} + \sum_{i=1}^{N}\left[p_{wi}\sigma_{TEd}^{m}\right]\right\}^{1/m}$$

For the 3rd edition:

$$I_{rep} = I_{eff} + 1.28\frac{\sigma_{\sigma}}{V_{hub}}$$

Where:

$$\sigma_{Ed}\ is \begin{cases} \sigma_{charact} = \sigma_{amb} + \sigma_{\sigma}\ in\ 2^{nd} ed. \\ \sigma_{amb}\ in\ 3^{rd}\ ed. \\ \sigma_c = \sigma_{amb} + 1.28\sigma_{\sigma}\ in\ 3^{rd}\ ed.\ 1^{st} amd. \end{cases}$$

$$\sigma_{T_{Ed}}\ is \begin{cases} = \sqrt{\dfrac{V_{hub}^2}{\left(1.5 + \dfrac{0.8d_i}{\sqrt{C_t}}\right)^2} + \sigma_{charact}^2} & in\ 2^{nd}\ ed. \\ = \sqrt{\dfrac{0.9V_{hub}^2}{\left(1.5 + 0.3d_i\sqrt{\dfrac{V_{hub}}{c}}\right)^2} + \sigma_{amb}^2} & in\ 3^{rd}\ ed. \\ = \sqrt{\dfrac{V_{hub}^2}{\left(1.5 + \dfrac{0.8d_i}{\sqrt{C_t}}\right)^2} + \sigma_c^2} & in\ \ 3^{rd}\ ed.\ 1^{st} amd. \end{cases}$$

The next graph represents the turbines in black to which a 5° wake expansion has been applied using the park model (in green). The space between the blue and green lines show the portion of the wake that is not considered as overlap when applying the Frandsen view angle methodology. This methodology is applied for Nordex turbines which have been certified according to the standard IEC 61400-1 3rd edition 1st Amdt (2010).

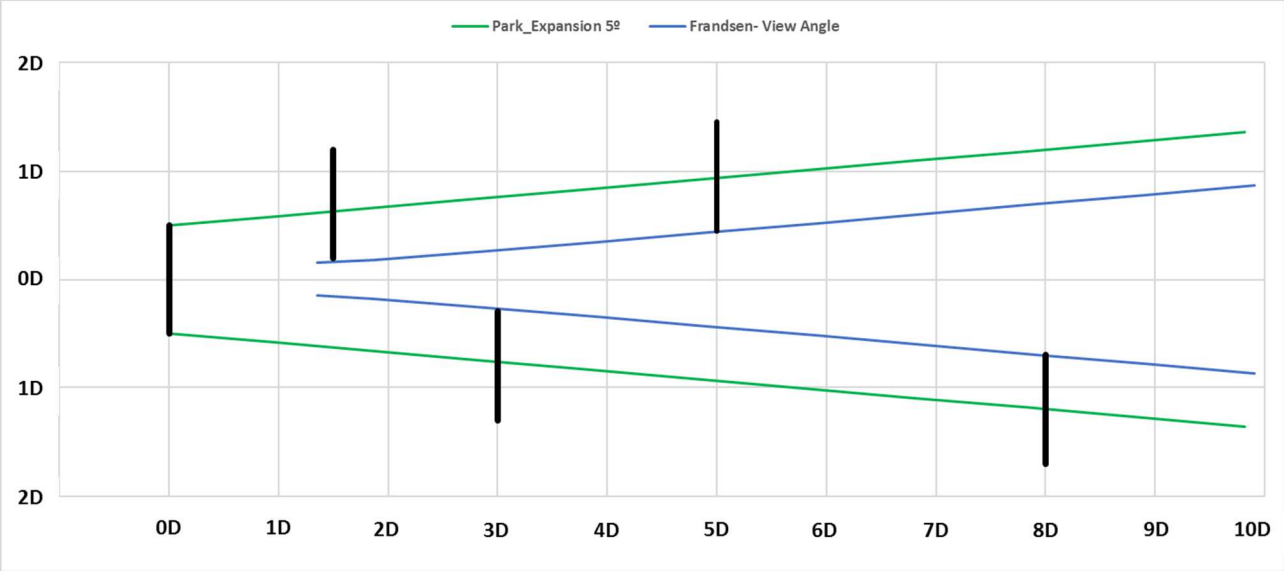


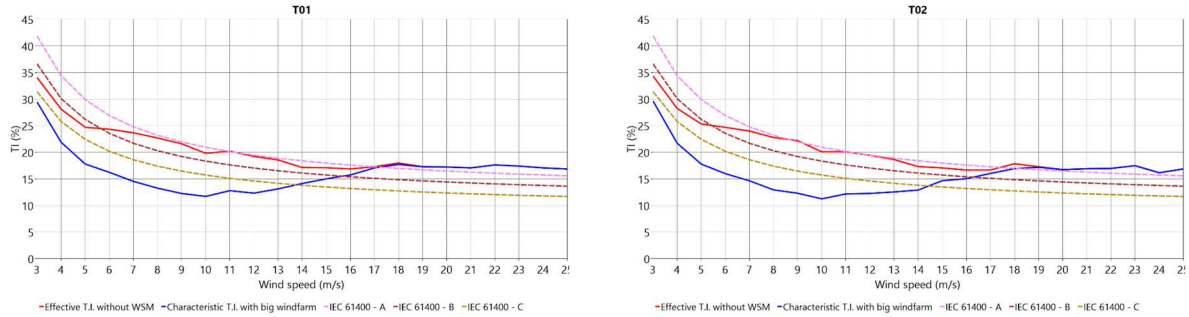
Figure 16: 5° park wake expansion and effective wake using the Frandsen view angle wake model

In the next table, the main parameters used for the effective turbulence intensity analysis are shown:

Turbine	X	Y	Z	FVg factor	Fsigma	Min WS stop	Max WS stop	Min WS curve	Max WS curve	Stop number	Nordex	Wind speed prod factor
T01	517.675	4.553.551	245	1,052	1	3	25	3	25	4	True	1,052
T02	517.974	4.553.969	207	1,077	1	3	25	3	25	4	True	1,077
T03	518.277	4.554.378	301	1,096	1	3	25	3	25	4	True	1,096
T04	520.017	4.553.276	216	1,06	1	3	25	3	25	4	True	1,06
T05	521.463	4.554.904	252	1,088	1	3	25	3	25	4	True	1,088
T06	521.612	4.555.429	136	1,07	1	3	25	3	25	4	True	1,07
T07	522.815	4.553.379	99	0,939	1	3	25	3	25	4	True	0,939
T08	522.653	4.554.209	138	0,966	1	3	25	3	25	4	True	0,966
T09	523.144	4.554.832	174	1,008	1	3	25	3	25	4	True	1,008
T10	524.602	4.554.459	281	0,965	1	3	25	3	25	4	True	0,965
T11	525.606	4.555.239	115	0,969	1	3	25	3	25	4	True	0,969

Table 17: Turbulence intensity calculation parameters

5.1. Effective turbulence intensity without wind sector management



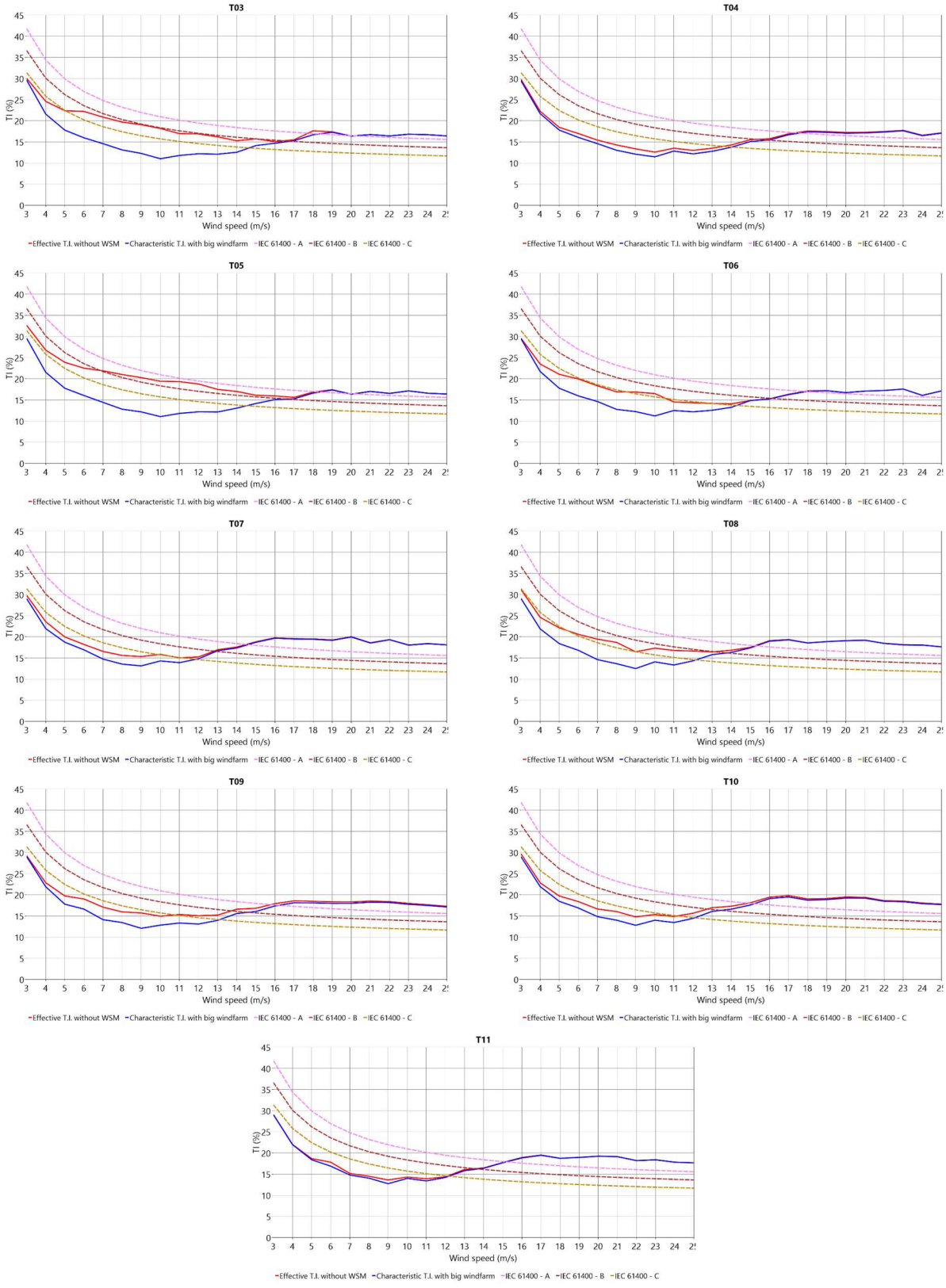


Figure 17: Effective turbulence intensity without WSM or WVM

6. APPENDIX 3: TURBINE COORDINATES. SITE LOCATION AND LAYOUT

Wind farm layout						
IPITACERXXCAM230620						
WGS84 Zone 32 N						
WTG	**UTM X**	**UTM Y**	**Turbine type**	**Hub height (m)**	**Rotor D (m)**	**Power (kW)**
T01	517.675	4.553.551	NORDEX 163 / 6.X (7.000)	159	163	7.000
T02	517.974	4.553.969	NORDEX 163 / 6.X (7.000)	159	163	7.000
T03	518.277	4.554.378	NORDEX 163 / 6.X (7.000)	159	163	7.000
T04	520.017	4.553.276	NORDEX 163 / 6.X (7.000)	159	163	7.000
T05	521.463	4.554.904	NORDEX 163 / 6.X (7.000)	159	163	7.000
T06	521.612	4.555.429	NORDEX 163 / 6.X (7.000)	159	163	7.000
T07	522.815	4.553.379	NORDEX 163 / 6.X (7.000)	159	163	7.000
T08	522.653	4.554.209	NORDEX 163 / 6.X (7.000)	159	163	7.000
T09	523.144	4.554.832	NORDEX 163 / 6.X (7.000)	159	163	7.000
T10	524.602	4.554.459	NORDEX 163 / 6.X (7.000)	159	163	7.000
T11	525.606	4.555.239	NORDEX 163 / 6.X (7.000)	159	163	7.000

Meteorological stations				
Name	**UTM X**	**UTM Y**	**Upper sensor height (m)**	**Met station type**
Vortex_LES_Campovaglio_01 0122_311222_160	519.893	4.553.216	160	Wind assessments
Vortex_ERA5_41.13N_9.24E	519.872	4.553.231	160	Wind assessments

Table 18: Turbine coordinates of IPITACERXXCAM230620

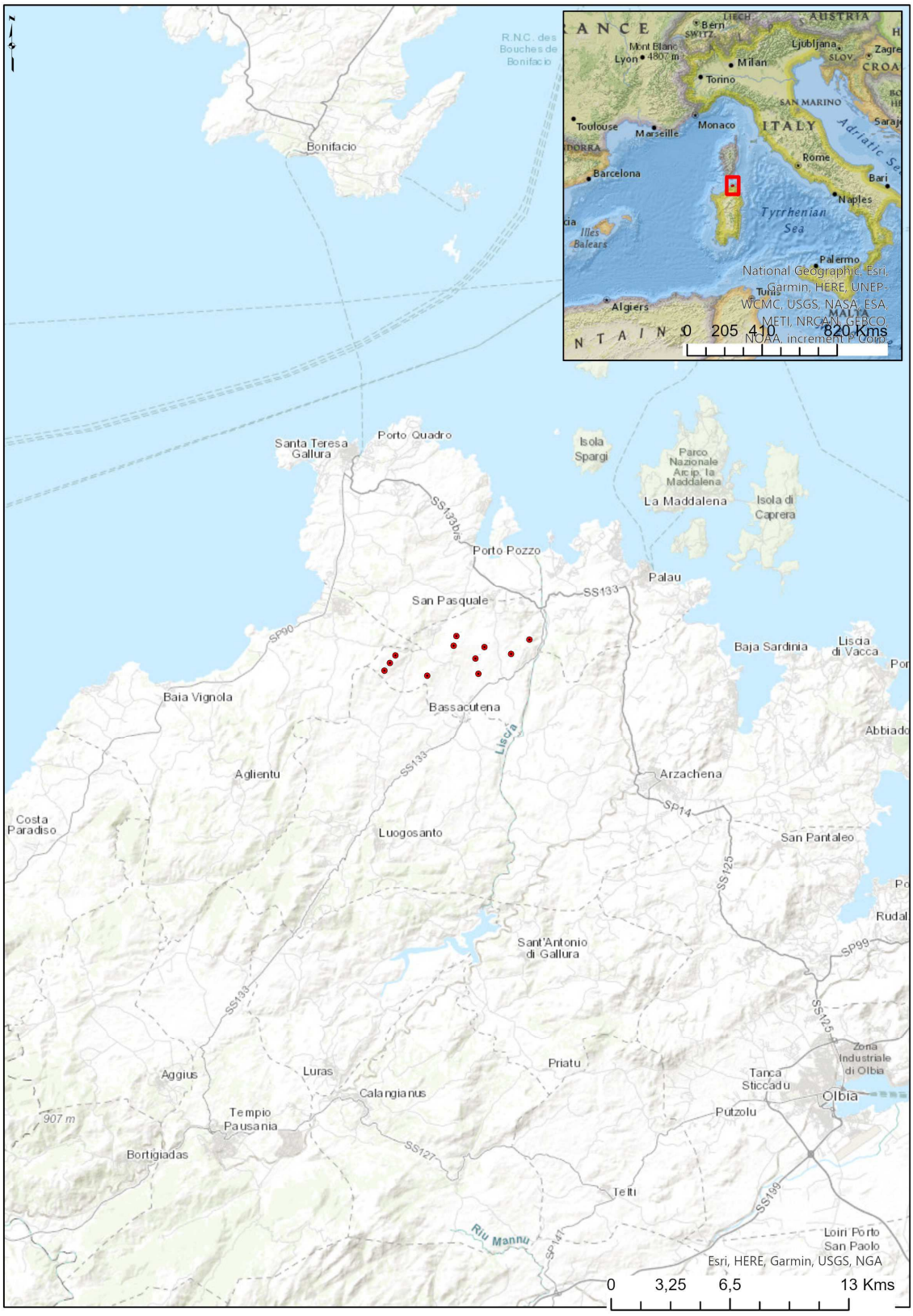
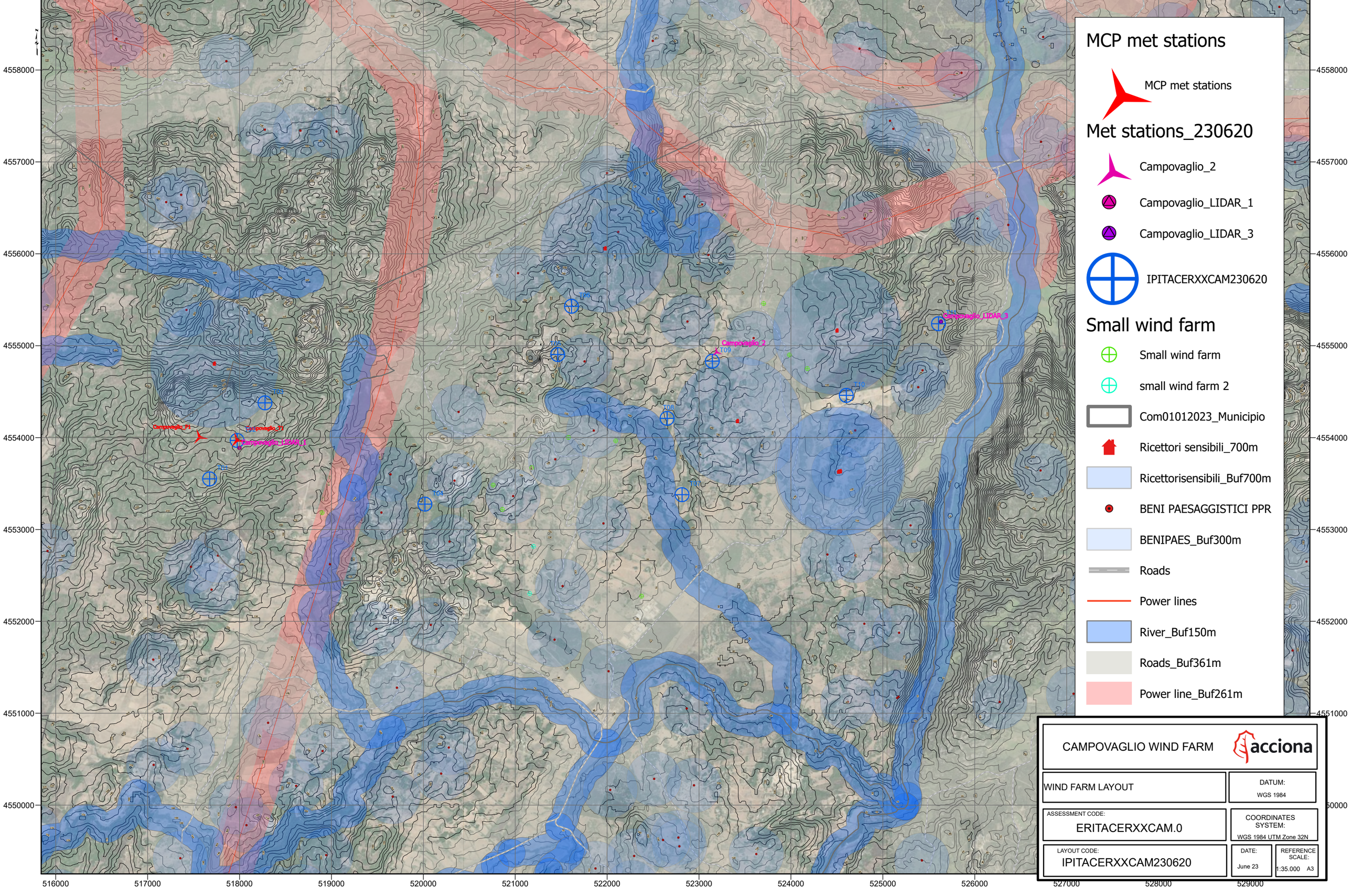


Figure 18: Site location


MCP met stations
MCP met stations
Met stations_230620
Campovaglio_2
Campovaglio_LIDAR_1
Campovaglio_LIDAR_3
IPITACERXXCAM230620
Small wind farm
Small wind farm
small wind farm 2
Com01012023_Municipio
Ricettori sensibili_700m
Ricettorisensibili_Buf700m
BENI PAESAGGISTICI PPR
BENIPAES_Buf300m
Roads
Power lines
River_Buf150m
Roads_Buf361m
Power line_Buf261m
CAMPOVAGLIO WIND FARM
acciona
WIND FARM LAYOUT
DATUM:
WGS 1984
ASSESSMENT CODE:
ERITACERXXCAM.0
COORDINATES SYSTEM:
WGS 1984 UTM Zone 32N
LAYOUT CODE:
IPITACERXXCAM230620
DATE:
June 23
REFERENCE SCALE:
1:35.000 A3
4558000
4557000
4556000
4555000
4554000
4553000
4552000
4551000
4550000
516000
517000
518000
519000
520000
521000
522000
523000
524000
525000
526000
527000
528000
529000