



COMUNE DI
ESTERZILI



COMUNE DI
ESCALAPLANO



PROVINCIA DEL
SUD SARDEGNA



REGIONE AUTONOMA
DELLA SARDEGNA

PROGETTO DEFINITIVO PER LA REALIZZAZIONE DI UN PARCO EOLICO
DENOMINATO " ESTERZILI/ESCALAPLANO " COMPOSTO DA 11
AEROGENERATORI DA 5,6 MW PER UNA POTENZA COMPLESSIVA DI
61,60 MW SITO NEI COMUNI DI ESTERZILI ED ESCALAPLANO (SU), CON
OPERE DI CONNESSIONE



ETANRG

Proponente:
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Progettazione:
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LEONARDO
Engineering srl

Elaborato	EE.PD.RTN.09	VALUTAZIONE RISORSA EOLICA ED ANALISI				
Cod. pratica	Data	Consegna	Formato	Scala	Livello progettuale	
EE_01	18/12/2023		A4	-	Progetto definitivo	

REVISIONI	Rev.	Data	Descrizione	Elaborato	Controllato	Approvato
	01	Dicembre 2023	Prima emissione	G. Donnarumma	V. Vanacore	M. Afeltra

PARK - Main Result

Calculation: V.162-5.6-119

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

Calculation performed in UTM (north)-WGS84 Zone: 32
At the site centre the difference between grid north and true north is: 0,2°

Power curve correction method
New windPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>
Air density calculation method
Height dependent, temperature from climate station
Station: CAPO BELLAVISTA
Base temperature: 17,3 °C at 138,0 m
Base pressure: 1013,3 hPa at 0,0 m
Air density for Site center in key hub height: 633,5 m + 50,0 m = 1,135 kg/m³ -> 92,6 % of Std
Relative humidity: 0,0 %

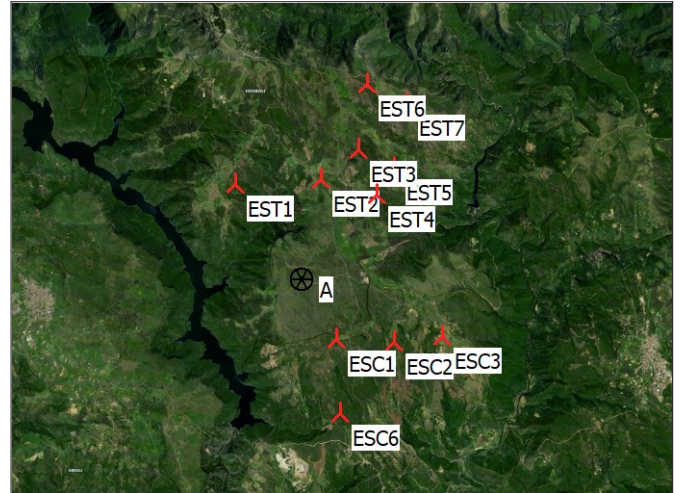
Wake Model Parameters
Wake decay constant 0,090 DTU default onshore
Hub height independent

Omnidirectional displacement height from objects

Wake calculation settings
Angle [°] Wind speed [m/s]
start end step start end step
0,5 360,0 1,0 0,5 30,5 1,0

Wind statistics IT Torre anemometrica h 60 mt - 60.00 m.wvs

WAsP version WAsP 12 Version 12.08.0032



New WTG

Scale 1:200.000
Site Data

Key results for height 50,0 m above ground level

Terrain UTM (north)-WGS84 Zone: 32

Easting	Northing	Name of wind distribution	Type
A 528.458	4.394.223	Site data: WAsP (3)	WAsP (WAsP 12 Version 12.08.0032)

Wind energy [kWh/m²]	Mean wind speed [m/s]	Equivalent roughness
2.277	5,6	0,4

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Wake loss [%]	Specific results ^{a)}			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	183.620,4	165.258,4	187.263,8	1,9	30,6	15.023,5	2.683	6,6

^{a)} Based on Result-10,0%

Calculated Annual Energy for each of 11 new WTGs with total 61,6 MW rated power

WTG type	Links	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator Name	Annual Energy			
									Result [MWh/y]	Result-10,0% [MWh/y]	Wake loss [%]	Free mean wind speed [m/s]
1 A	Yes	VESTAS	V162-5.600	5.600	162,0	119,0	EMD	Level 0 - Calculated - Modes 0/0-0S - 03-2019	16.437,6	14.794	2,6	6,56
2 A	Yes	VESTAS	V162-5.600	5.600	162,0	119,0	EMD	Level 0 - Calculated - Modes 0/0-0S - 03-2019	15.538,8	13.985	2,6	6,30
3 A	Yes	VESTAS	V162-5.600	5.600	162,0	119,0	EMD	Level 0 - Calculated - Modes 0/0-0S - 03-2019	16.677,4	15.010	2,1	6,59
4 A	Yes	VESTAS	V162-5.600	5.600	162,0	119,0	EMD	Level 0 - Calculated - Modes 0/0-0S - 03-2019	18.903,8	17.013	2,5	7,21
5 A	Yes	VESTAS	V162-5.600	5.600	162,0	119,0	EMD	Level 0 - Calculated - Modes 0/0-0S - 03-2019	16.648,2	14.983	1,0	6,55
6 A	Yes	VESTAS	V162-5.600	5.600	162,0	119,0	EMD	Level 0 - Calculated - Modes 0/0-0S - 03-2019	17.546,1	15.791	1,1	6,80
7 A	Yes	VESTAS	V162-5.600	5.600	162,0	119,0	EMD	Level 0 - Calculated - Modes 0/0-0S - 03-2019	18.837,5	16.954	3,5	7,27
8 A	Yes	VESTAS	V162-5.600	5.600	162,0	119,0	EMD	Level 0 - Calculated - Modes 0/0-0S - 03-2019	15.628,9	14.066	1,3	6,27
9 A	Yes	VESTAS	V162-5.600	5.600	162,0	119,0	EMD	Level 0 - Calculated - Modes 0/0-0S - 03-2019	15.210,9	13.690	2,0	6,20
10 A	Yes	VESTAS	V162-5.600	5.600	162,0	119,0	EMD	Level 0 - Calculated - Modes 0/0-0S - 03-2019	16.102,0	14.492	1,7	6,38
11 A	Yes	VESTAS	V162-5.600	5.600	162,0	119,0	EMD	Level 0 - Calculated - Modes 0/0-0S - 03-2019	16.089,3	14.480	0,6	6,32

WTG siting

UTM (north)-WGS84 Zone: 32

Easting	Northing	Z [m]	Row data/Description
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1 New	530.448	4.396.456	640,0 VESTAS V162 5600 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (199)
2 New	528.975	4.396.868	645,1 VESTAS V162 5600 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (200)
3 New	529.954	4.397.646	788,4 VESTAS V162 5600 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (201)
4 New	531.226	4.398.871	880,8 VESTAS V162 5600 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (202)
5 New	530.192	4.399.372	875,8 VESTAS V162 5600 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (203)

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PARK - Main Result

Calculation: V.162-5.6-119

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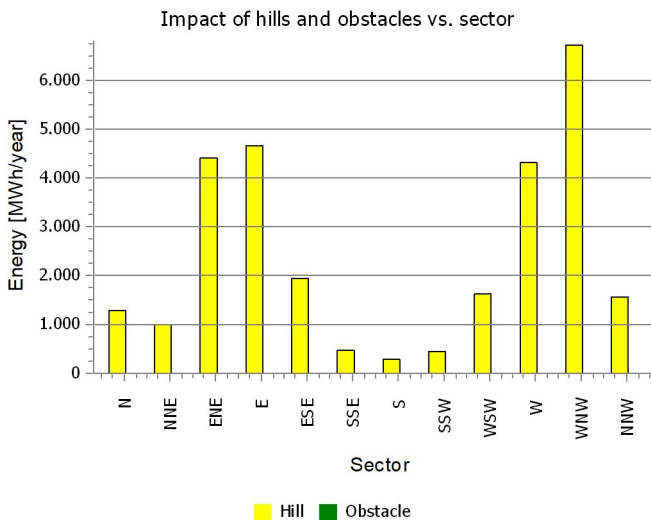
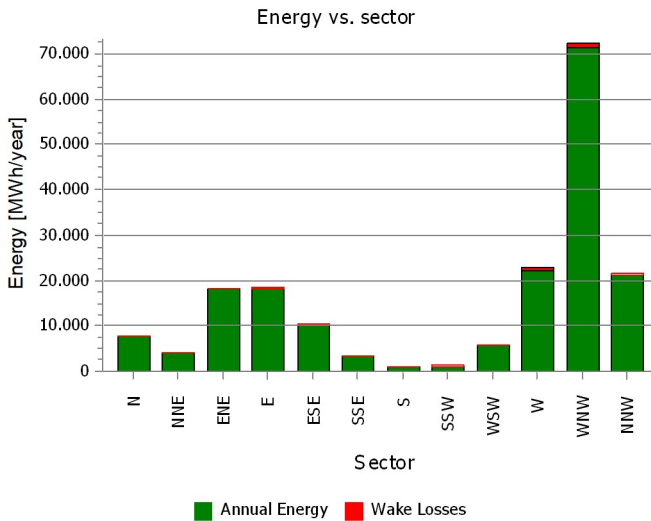
UTM (north)-WGS84 Zone: 32

	Easting	Northing	Z	Row data/Description
			[m]	
6 New	526.710	4.396.718	656,0	VESTAS V162 5600 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (204)
7 New	530.912	4.397.183	800,0	VESTAS V162 5600 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (205)
8 New	529.398	4.392.646	600,0	VESTAS V162 5600 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (206)
9 New	530.924	4.392.562	560,0	VESTAS V162 5600 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (207)
10 New	532.216	4.392.710	610,2	VESTAS V162 5600 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (208)
11 New	529.497	4.390.670	491,6	VESTAS V162 5600 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (209)

PARK - Production Analysis

Calculation: V.162-5.6-119 WTG: All new WTGs, Air density varies with WTG position 1,101 kg/m³ - 1,143 kg/m³
Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	6.582,5	3.036,2	13.861,4	13.977,3	8.435,8	2.854,9	815,5	795,3	4.117,7	18.459,5	65.562,6	20.015,0	158.513,7
+Increase due to hills	[MWh]	1.296,9	1.000,9	4.420,6	4.648,4	1.929,6	470,9	290,4	432,4	1.617,9	4.334,1	6.728,9	1.579,2	28.750,1
-Decrease due to wake losses	[MWh]	250,3	94,0	263,7	549,4	286,3	78,9	76,7	76,9	121,5	539,3	1.032,4	273,9	3.643,3
Resulting energy	[MWh]	7.629,0	3.943,2	18.018,3	18.076,3	10.079,1	3.246,9	1.029,1	1.150,7	5.614,1	22.254,3	71.259,1	21.320,2	183.620,4
Specific energy	[kWh/m ²]													810
Specific energy	[kWh/kW]													2.981
Increase due to hills	[%]	19,7	33,0	31,9	33,3	22,9	16,5	35,6	54,4	39,3	23,5	10,3	7,9	18,14
Decrease due to wake losses	[%]	3,2	2,3	1,4	2,9	2,8	2,4	6,9	6,3	2,1	2,4	1,4	1,3	1,95
Utilization	[%]	33,0	29,7	27,8	32,1	36,5	40,5	37,5	36,8	28,0	22,1	19,8	25,2	24,0
Operational	[Hours/year]	602	252	653	771	581	330	186	170	354	862	2.079	936	7.777
Full Load Equivalent	[Hours/year]	124	64	293	293	164	53	17	19	91	361	1.157	346	2.981



PARK - Power Curve Analysis

Calculation: V.162-5.6-119 WTG: 1 - VESTAS V162 5600 162.0 IO!, Hub height: 119,0 m

Name: Level 0 - Calculated - Modes 0/0-0S - 03-2019
Source: Manufacturer

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type	Generator type	Specific power kW/m ²
26/03/2019	EMD	10/08/2017	23/07/2019	24,0	Pitch	User defined	Variable	0,27

Document no. 0081-5098 V02.

HP curve comparison - Note: For standard air density

Vmean	[m/s]	5	6	7	8	9	10
HP value Pitch, variable speed (2013)	[MWh]	10.249	15.343	20.152	24.357	27.855	30.619
VESTAS V162 5600 162.0 IO! Level 0 - Calculated - Modes 0/0-0S - 03-2019	[MWh]	10.407	15.624	20.487	24.625	27.889	30.245
Check value	[%]	-2	-2	-2	-1	0	1

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m²) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.

For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see the windPRO manual.

The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.

Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

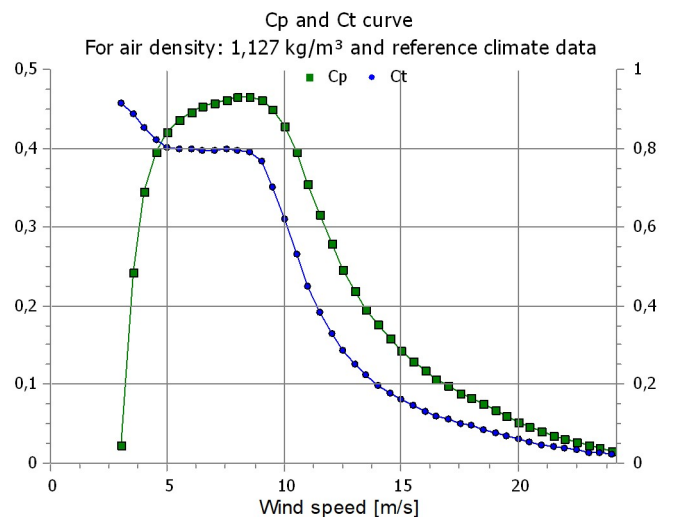
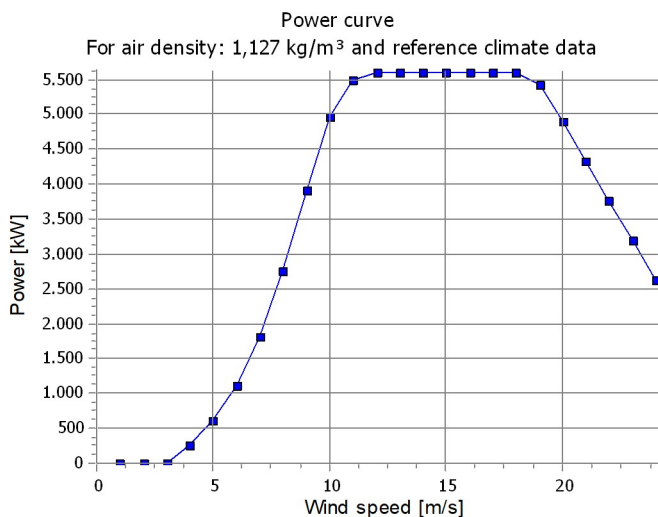
Original data, Air density: 1,225 kg/m³

Wind speed [m/s]	Power [kW]	Cp	Wind speed [m/s]	Ct curve
3,0	27,0	0,08	3,0	0,91
3,5	144,0	0,27	3,5	0,89
4,0	289,0	0,36	4,0	0,85
4,5	464,0	0,40	4,5	0,82
5,0	669,0	0,42	5,0	0,80
5,5	919,0	0,44	5,5	0,80
6,0	1.220,0	0,45	6,0	0,80
6,5	1.574,0	0,45	6,5	0,80
7,0	1.990,0	0,46	7,0	0,80
7,5	2.467,0	0,46	7,5	0,80
8,0	3.010,0	0,47	8,0	0,80
8,5	3.617,0	0,47	8,5	0,79
9,0	4.257,0	0,46	9,0	0,77
9,5	4.834,0	0,45	9,5	0,70
10,0	5.256,0	0,42	10,0	0,62
10,5	5.482,0	0,38	10,5	0,53
11,0	5.578,0	0,33	11,0	0,45
11,5	5.598,0	0,29	11,5	0,38
12,0	5.600,0	0,26	12,0	0,33
12,5	5.600,0	0,23	12,5	0,29
13,0	5.600,0	0,20	13,0	0,25
13,5	5.600,0	0,18	13,5	0,22
14,0	5.600,0	0,16	14,0	0,20
14,5	5.600,0	0,15	14,5	0,18
15,0	5.600,0	0,13	15,0	0,16
15,5	5.600,0	0,12	15,5	0,15
16,0	5.600,0	0,11	16,0	0,13
16,5	5.600,0	0,10	16,5	0,12
17,0	5.600,0	0,09	17,0	0,11
17,5	5.600,0	0,08	17,5	0,10
18,0	5.600,0	0,08	18,0	0,10
18,5	5.568,0	0,07	18,5	0,09
19,0	5.418,0	0,06	19,0	0,08
19,5	5.179,0	0,06	19,5	0,07
20,0	4.894,0	0,05	20,0	0,06
20,5	4.609,0	0,04	20,5	0,05
21,0	4.329,0	0,04	21,0	0,05
21,5	4.043,0	0,03	21,5	0,04
22,0	3.764,0	0,03	22,0	0,04
22,5	3.488,0	0,02	22,5	0,03
23,0	3.203,0	0,02	23,0	0,03
23,5	2.914,0	0,02	23,5	0,03
24,0	2.616,0	0,01	24,0	0,02

Power, Efficiency and energy vs. wind speed

Data used in calculation, Air density: 1,127 kg/m³ New windPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Cp	Interval [m/s]	Energy [MWh]	Acc. Energy [MWh]	Relative [%]
1,0	0,0	0,00	0,50- 1,50	0,0	0,0	0,0
2,0	0,0	0,00	1,50- 2,50	0,0	0,0	0,0
3,0	7,0	0,02	2,50- 3,50	55,9	55,9	0,3
4,0	256,0	0,34	3,50- 4,50	247,4	303,3	1,8
5,0	610,7	0,42	4,50- 5,50	548,3	851,6	5,2
6,0	1.117,2	0,45	5,50- 6,50	903,9	1.755,5	10,7
7,0	1.824,3	0,46	6,50- 7,50	1.291,4	3.046,9	18,5
8,0	2.761,3	0,46	7,50- 8,50	1.667,2	4.714,0	28,7
9,0	3.906,2	0,46	8,50- 9,50	1.956,0	6.670,1	40,6
10,0	4.964,6	0,43	9,50-10,50	2.026,6	8.696,7	52,9
11,0	5.492,5	0,36	10,50-11,50	1.826,4	10.523,0	64,0
12,0	5.595,5	0,28	11,50-12,50	1.489,6	12.012,6	73,1
13,0	5.600,0	0,22	12,50-13,50	1.164,9	13.177,5	80,2
14,0	5.600,0	0,18	13,50-14,50	896,6	14.074,1	85,6
15,0	5.600,0	0,14	14,50-15,50	682,0	14.756,1	89,8
16,0	5.600,0	0,12	15,50-16,50	513,1	15.269,2	92,9
17,0	5.600,0	0,10	16,50-17,50	382,2	15.651,4	95,2
18,0	5.599,6	0,08	17,50-18,50	281,2	15.932,5	96,9
19,0	5.418,0	0,07	18,50-19,50	198,6	16.131,1	98,1
20,0	4.894,0	0,05	19,50-20,50	131,1	16.262,2	98,9
21,0	4.329,0	0,04	20,50-21,50	82,9	16.345,1	99,4
22,0	3.764,0	0,03	21,50-22,50	51,0	16.396,2	99,7
23,0	3.203,0	0,02	22,50-23,50	30,3	16.426,5	99,9
24,0	2.616,0	0,02	23,50-24,50	11,1	16.437,6	100,0



Project:

ESTERZILI -ESCALAPLANO 23

Licensed user:

Abn wind energy s.r.l.

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Calculated:

24/02/2024 14:36/4.0.424

PARK - Terrain

Calculation: V.162-5.6-119 Site Data: A - Site data: WAsP (3)

Obstacles:

0 Obstacles used

Roughness:

Terrain data files used in calculation:

C:\Users\HP\Desktop\WP ESTERZILI_21\05_new 2022\ROUGHNESSLINE_ONLINEDATA_0.wpo

Min X: 521.245, Max X: 541.305, Min Y: 4.368.647, Max Y: 4.428.793, Width: 20.060 m, Height: 60.146 m

Orography:

Terrain data files used in calculation:

C:\Users\HP\Desktop\WP ESTERZILI_21\05_new 2022\CONTOURLINE_ONLINEDATA_0.wpo

Min X: 522.980, Max X: 539.474, Min Y: 4.380.241, Max Y: 4.411.221, Width: 16.494 m, Height: 30.980 m

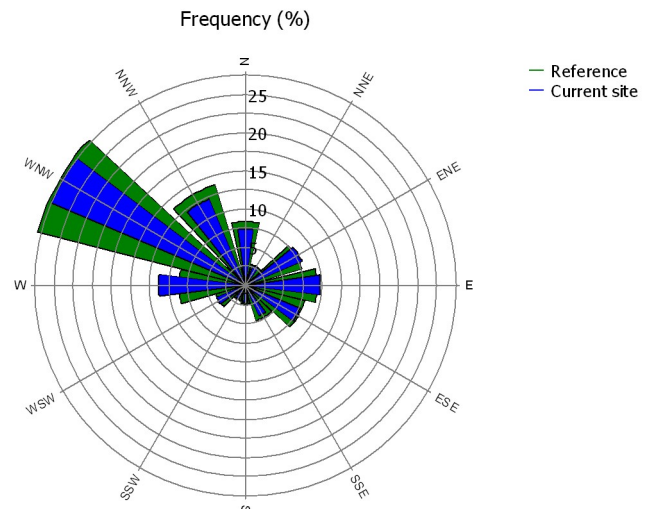
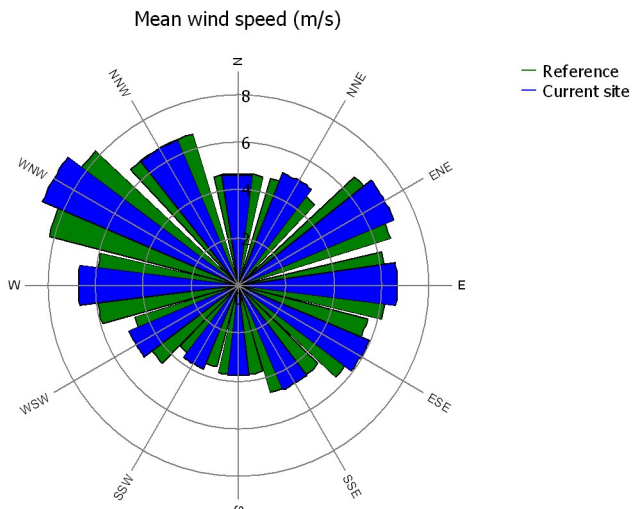
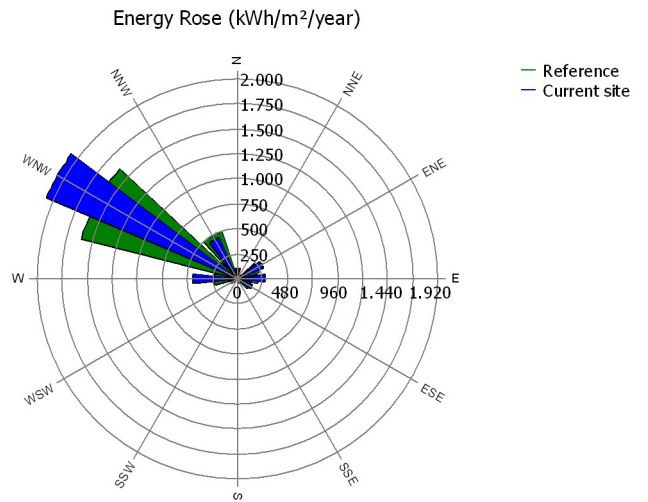
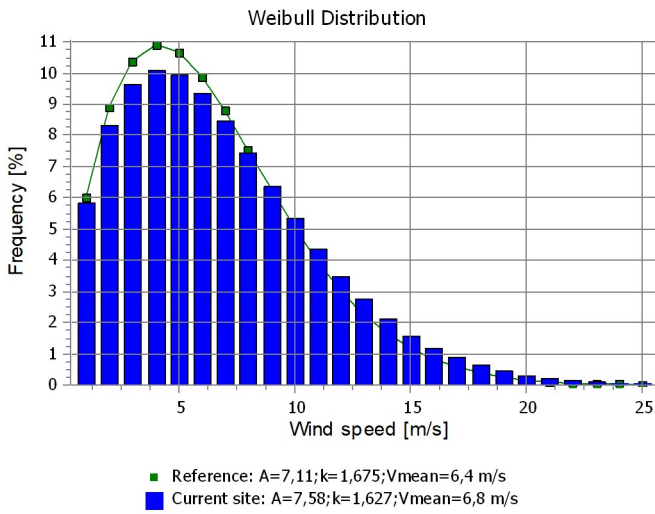
PARK - Wind Data Analysis

Calculation: V.162-5.6-119 Wind data: A - Site data: WasP (3); Hub height: 119,0

Site coordinates
UTM (north)-WGS84 Zone: 32
East: 528.458 North: 4.394.223
Wind statistics
IT Torre anemometrica h 60 mt - 60.00 m.wws

Weibull Data

Sector	Current site			Frequency [%]	Reference: Roughness class 1		
	A- parameter [m/s]	Wind speed [m/s]	k- parameter		A- parameter [m/s]	k- parameter	Frequency [%]
0 N	5,17	4,61	1,682	7,5	5,22	1,637	8,4
1 NNE	5,62	5,06	1,553	2,8	5,18	1,528	2,8
2 ENE	7,99	7,08	2,033	8,0	7,53	2,061	7,7
3 E	7,51	6,65	2,104	9,8	6,96	2,116	9,4
4 ESE	6,70	5,94	2,045	7,8	6,30	2,065	8,0
5 SSE	5,34	4,73	2,162	4,4	5,28	2,142	4,8
6 S	4,26	3,77	2,162	2,3	4,22	2,150	2,5
7 SSW	4,27	3,79	1,885	2,0	3,97	1,895	2,1
8 WSW	5,49	4,96	1,486	4,1	5,03	1,497	3,9
9 W	7,49	6,71	1,619	11,4	6,62	1,625	8,7
10 WNW	10,07	8,93	1,893	27,6	9,25	1,925	28,0
11 NNW	7,38	6,61	1,623	12,3	7,41	1,655	13,8
All	7,58	6,79	1,627	100,0	7,11	1,675	100,0



PARK - Wind Data Analysis

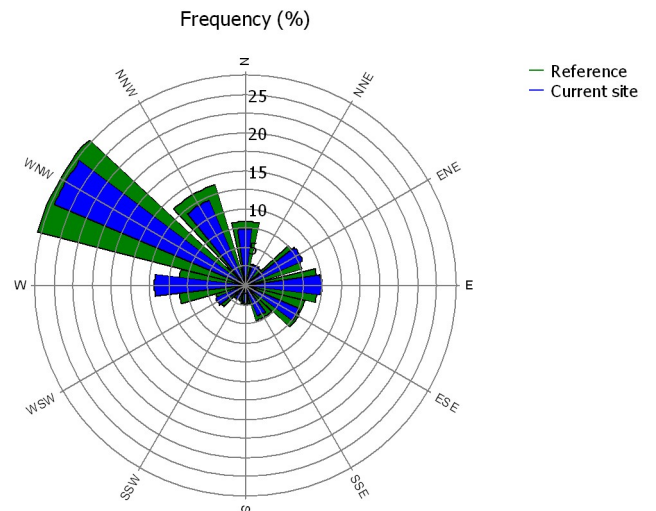
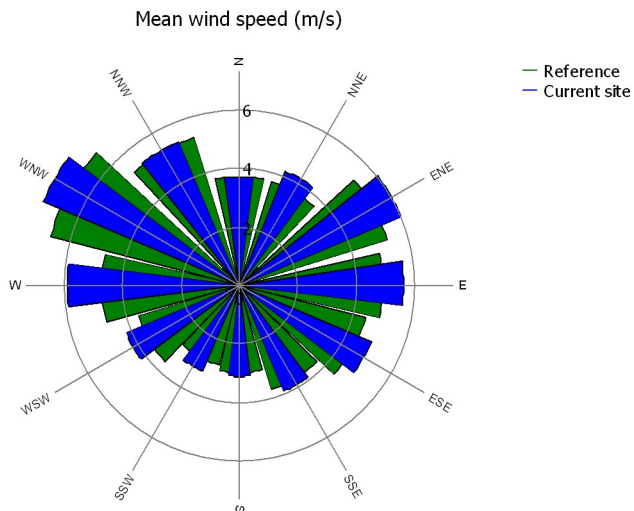
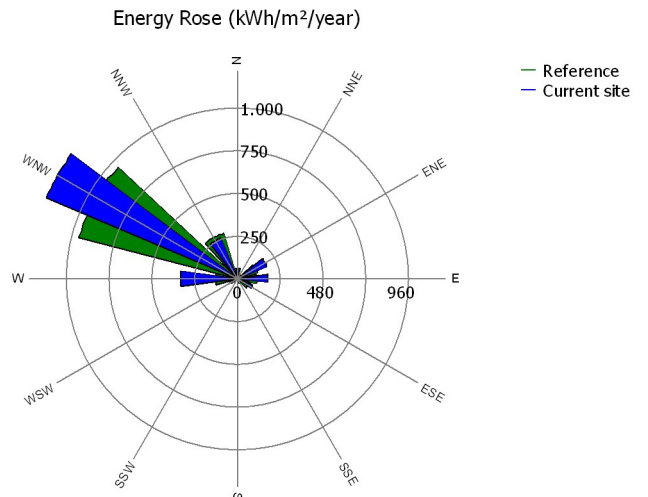
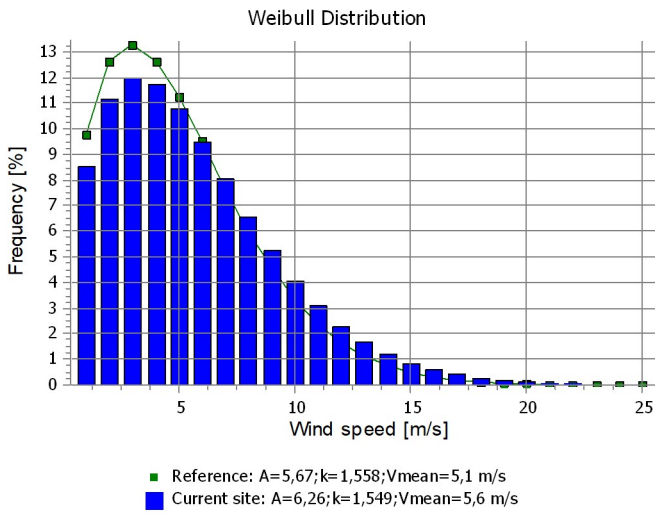
Calculation: V.162-5.6-119 Wind data: A - Site data: WasP (3); Hub height: 50,0

Site coordinates
UTM (north)-WGS84 Zone: 32
East: 528.458 North: 4.394.223

Wind statistics
IT Torre anemometrica h 60 mt - 60.00 m.wws

Weibull Data

Sector	Current site			Frequency [%]	Reference: Roughness class 1		
	A- parameter [m/s]	Wind speed [m/s]	k- parameter		A- parameter [m/s]	k- parameter	Frequency [%]
0 N	4,15	3,72	1,576	7,4	4,13	1,521	8,4
1 NNE	4,63	4,20	1,455	2,9	4,09	1,424	2,8
2 ENE	6,79	6,02	1,908	8,1	5,99	1,916	7,7
3 E	6,34	5,62	1,963	9,9	5,54	1,967	9,4
4 ESE	5,53	4,91	1,912	7,7	5,01	1,920	8,0
5 SSE	4,42	3,92	2,025	4,3	4,20	1,994	4,8
6 S	3,51	3,11	2,021	2,2	3,36	1,998	2,5
7 SSW	3,59	3,19	1,779	2,0	3,15	1,764	2,1
8 WSW	4,61	4,20	1,393	4,2	3,97	1,393	3,9
9 W	6,56	5,89	1,553	11,9	5,24	1,514	8,7
10 WNW	8,20	7,30	1,771	27,2	7,50	1,775	28,0
11 NNW	5,92	5,34	1,521	12,1	5,87	1,541	13,8
All	6,26	5,63	1,549	100,0	5,67	1,558	100,0



PARK - Park power curve

Calculation: V.162-5.6-119

Wind speed [m/s]	Power													
	Free WTGs [kW]	Park WTGs [kW]	N [kW]	NNE [kW]	ENE [kW]	E [kW]	ESE [kW]	SSE [kW]	S [kW]	SSW [kW]	WSW [kW]	W [kW]	WNW [kW]	NNW [kW]
0,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3,5	1.314	1.170	1.142	1.142	1.208	1.132	1.161	1.216	1.143	1.144	1.208	1.132	1.161	1.216
4,5	4.585	4.348	4.296	4.294	4.411	4.282	4.338	4.425	4.299	4.297	4.411	4.283	4.338	4.422
5,5	9.203	8.818	8.727	8.728	8.919	8.711	8.804	8.942	8.737	8.734	8.921	8.713	8.804	8.937
6,5	15.798	15.162	15.014	15.013	15.328	14.990	15.139	15.365	15.028	15.024	15.332	14.992	15.139	15.358
7,5	24.780	23.800	23.571	23.570	24.055	23.535	23.763	24.110	23.595	23.587	24.057	23.539	23.764	24.099
8,5	36.296	34.917	34.599	34.591	35.274	34.541	34.867	35.356	34.631	34.617	35.278	34.547	34.867	35.338
9,5	49.098	47.729	47.489	47.402	48.081	47.349	47.651	48.182	47.488	47.404	48.091	47.353	47.651	48.183
10,5	58.263	57.643	57.616	57.493	57.817	57.498	57.564	57.864	57.539	57.427	57.788	57.484	57.562	57.890
11,5	61.276	61.164	61.156	61.134	61.194	61.136	61.152	61.201	61.141	61.121	61.192	61.135	61.153	61.206
12,5	61.594	61.591	61.591	61.590	61.592	61.591	61.589	61.592	61.590	61.588	61.591	61.591	61.589	61.592
13,5	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600
14,5	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600
15,5	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600
16,5	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600
17,5	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600	61.600
18,5	61.248	61.283	61.296	61.292	61.273	61.309	61.273	61.266	61.288	61.278	61.267	61.303	61.275	61.281
19,5	56.969	57.061	57.078	57.083	57.037	57.085	57.066	57.031	57.078	57.083	57.037	57.085	57.066	57.031
20,5	50.699	50.787	50.804	50.808	50.764	50.811	50.792	50.759	50.804	50.808	50.764	50.811	50.792	50.759
21,5	44.473	44.547	44.561	44.564	44.528	44.566	44.551	44.523	44.561	44.564	44.528	44.566	44.551	44.523
22,5	38.368	38.425	38.436	38.439	38.410	38.440	38.428	38.407	38.436	38.439	38.410	38.440	38.428	38.407
23,5	32.054	32.103	32.112	32.115	32.090	32.116	32.106	32.087	32.112	32.115	32.090	32.116	32.106	32.087
24,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Description:

The park power curve is similar to a WTG power curve, meaning that when a given wind speed appears in front of the park with same speed in the entire wind farm area (before influence from the park), the output from the park can be found in the park power curve. Another way to say this: The park power curve includes wake losses, but do NOT include terrain given variations in the wind speed over the park area.

Measuring a park power curve is not as simple as measuring a WTG power curve due to the fact that the park power curve depends on the wind direction and that the same wind speed normally will not appear for the entire park area at the same time (only in very flat non-complex terrain). The idea with this version of the park power curve is not to use it for validation based on measurements. This would require at least 2 measurement masts at two sides of the park, unless only a few direction sectors should be tested, AND non complex terrain (normally only useable off shore). Another park power curve version for complex terrain is available in windPRO.

The park power curve can be used for:

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

Note:

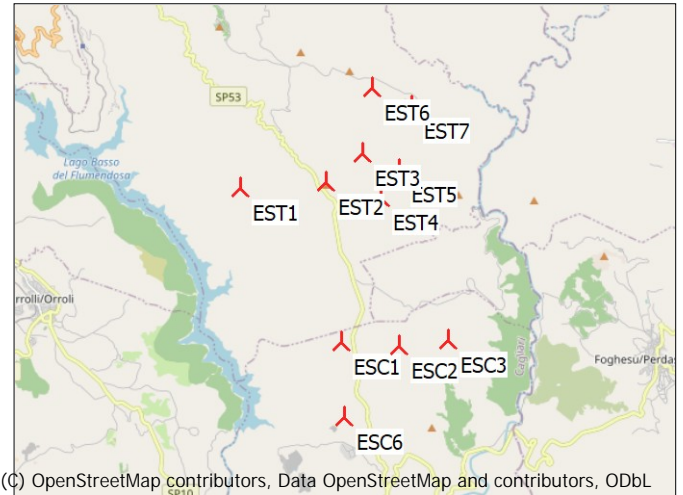
From the >Result to file< the >Wind Speeds Inside Wind farm< is also available. These can (e.g. via Excel) be used for extracting the wake induced reductions in measured wind speed.

PARK - WTG distances

Calculation: V.162-5.6-119

WTG distances

	Z	Nearest WTG	Z	Horizontal distance	Distance in rotor diameters
	[m]		[m]	[m]	
1	640,0	7	800,0	863	5,3
2	645,1	3	788,4	1.251	7,7
3	788,4	7	800,0	1.064	6,6
4	880,8	5	875,8	1.149	7,1
5	875,8	4	880,8	1.149	7,1
6	656,0	2	645,1	2.270	14,0
7	800,0	1	640,0	863	5,3
8	600,0	9	560,0	1.528	9,4
9	560,0	10	610,2	1.300	8,0
10	610,2	9	560,0	1.300	8,0
11	491,6	8	600,0	1.979	12,2
Min	491,6		560,0	863	5,3
Max	880,8		880,8	2.270	14,0



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

Scale 1:200.000

 New WTG

Project:

ESTERZILI -ESCALAPLANO 23

Licensed user:

Abn wind energy s.r.l.

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Daniele Vinaccia / vinaccia@abnwindenergy.it

Calculated:

24/02/2024 14:36/4.0.424

PARK - Wind statistics info

Calculation: V.162-5.6-119

Main data for wind statistic

File	C:\Users\HP\Desktop\WP ESTERZILI_21\05_new 2022\IT Torre anemometrica h 60 mt - 60.00 m.wvs
Name	Torre anemometrica h 60 mt - 60.00 m
Country	Italy
Source	USER
Mast coordinates	UTM (north)-WGS84 Zone: 32 East: 528.458 North: 4.394.223
Created	02/02/2022
Edited	02/02/2022
Sectors	12
WASP version	WASP 12 Version 12.6.0.28
Coordinate system	UTM (north)-WGS84 Zone: 32
Displacement height	None

Additional info for wind statistic

Source data	Torre anemometrica h 60 mt
Data from	13/06/2008
Data to	01/12/2012
Measurement length	53,6 Months
Recovery rate	89,5 %
Effective measurement length	48,0 Months

Note

To get the most correct calculation results, wind statistics shall be calculated with the SAME model and model parameters, as currently chosen in calculation. For WASP versions before 10.0, the model is unchanged, but thereafter more model changes affecting the wind statistic is seen. Likewise WASP CFD should always use WASP CFD calculated wind statistics.

Project:

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Calculated:

24/02/2024 14:36/4.0.424

PARK - Wind statistics info

Calculation: V.162-5.6-119

Main data for wind statistic

File	C:\Users\HP\Desktop\WP ESTERZILI_21\05_new 2022\IT Torre anemometrica h 60 mt - 60.00 m.wvs
Name	Torre anemometrica h 60 mt - 60.00 m
Country	Italy
Source	USER
Mast coordinates	UTM (north)-WGS84 Zone: 32 East: 528.458 North: 4.394.223
Created	02/02/2022
Edited	02/02/2022
Sectors	12
WASP version	WASP 12 Version 12.6.0.28
Coordinate system	UTM (north)-WGS84 Zone: 32
Displacement height	None

Additional info for wind statistic

Source data	Torre anemometrica h 60 mt
Data from	13/06/2008
Data to	01/12/2012
Measurement length	53,6 Months
Recovery rate	89,5 %
Effective measurement length	48,0 Months

Note

To get the most correct calculation results, wind statistics shall be calculated with the SAME model and model parameters, as currently chosen in calculation. For WASP versions before 10.0, the model is unchanged, but thereafter more model changes affecting the wind statistic is seen. Likewise WASP CFD should always use WASP CFD calculated wind statistics.

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Calculated:

24/02/2024 14:36/4.0.424

PARK - Wind statistics info

Calculation: V.162-5.6-119

Main data for wind statistic

File	C:\Users\HP\Desktop\WP ESTERZILI_21\06_NEW 2023\IT Torre anemometrica h 60 mt - 60.00 m.wws
Name	Torre anemometrica h 60 mt - 60.00 m
Country	Italy
Source	USER
Mast coordinates	UTM (north)-WGS84 Zone: 32 East: 528.458 North: 4.394.223
Created	11/06/2023
Edited	11/06/2023
Sectors	12
WASP version	WASP 12 Version 12.08.0032
Coordinate system	UTM (north)-WGS84 Zone: 32
Displacement height	None

Additional info for wind statistic

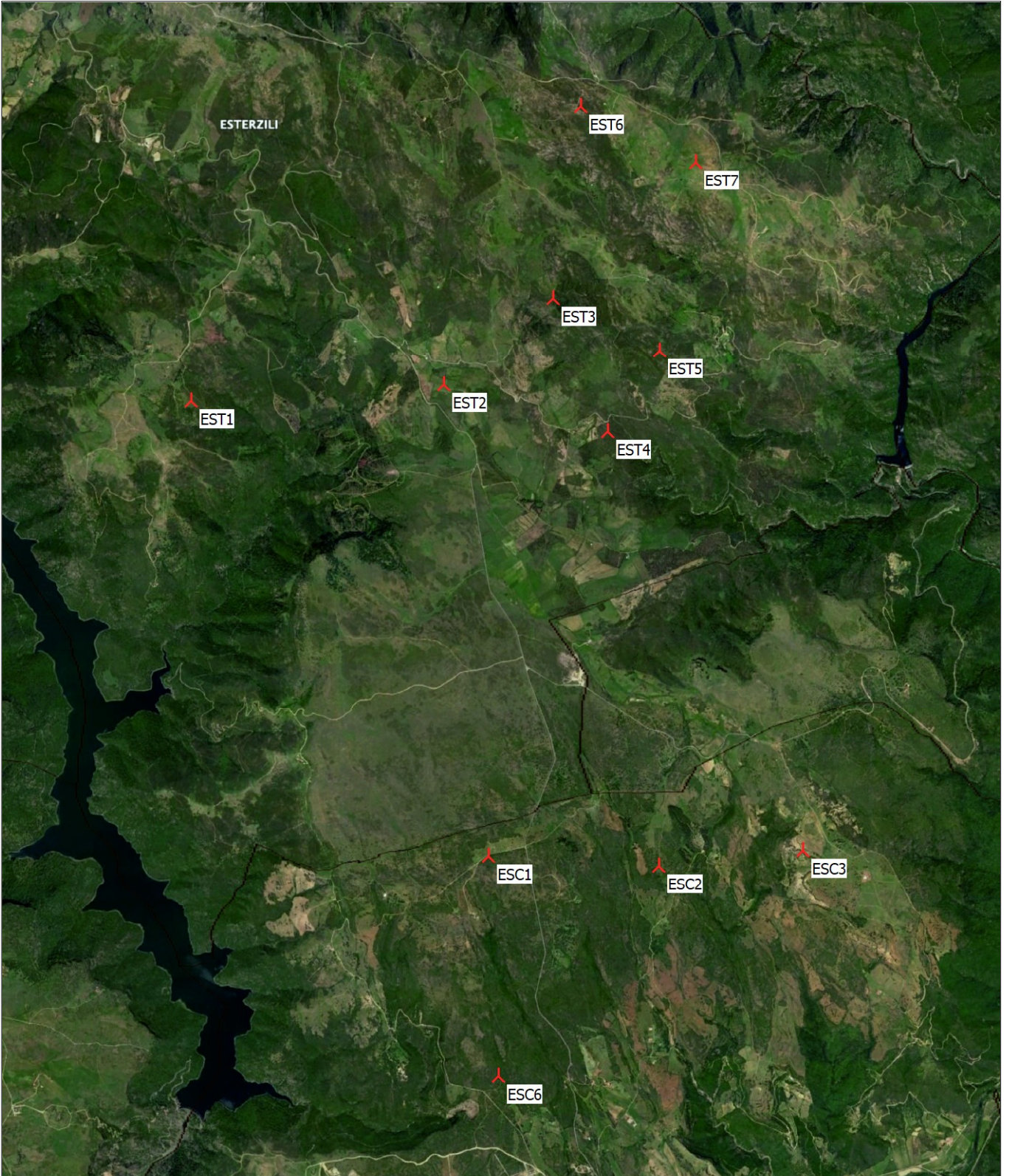
Source data	Torre anemometrica h 60 mt
Data from	13/06/2008
Data to	01/12/2012
Measurement length	53,6 Months
Recovery rate	89,5 %
Effective measurement length	48,0 Months

Note

To get the most correct calculation results, wind statistics shall be calculated with the SAME model and model parameters, as currently chosen in calculation. For WASP versions before 10.0, the model is unchanged, but thereafter more model changes affecting the wind statistic is seen. Likewise WASP CFD should always use WASP CFD calculated wind statistics.

PARK - Map

Calculation: V.162-5.6-119



0 500 1000 1500 2000 m

Map: SAT ESCALAPLANO-ESTERZILI , Print scale 1:50.000, Map center UTM (north)-WGS84 Zone: 32 East: 529.463 North: 4.395.021
New WTG