



COMUNE DI  
SERRI

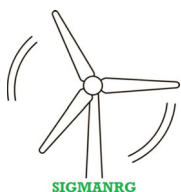


PROVINCIA DEL  
SUD SARDEGNA



REGIONE AUTONOMA  
DELLA SARDEGNA

PROGETTO PARCO EOLICO " SERRI "  
13 WTG - POTENZA 93,60 MW  
COMUNE DI SERRI (SU)



Proponente:  
SIGMANRG SRL  
Via Pietro Cossa n 5  
20122 Milano (MI)

Antonino Apreda

Progettazione:  
LEONARDO ENGINEERING SRL  
Viale Lamberti snc  
81100 Caserta

Ing Giovanni Savarese



LEONARDO  
Engineering srl



Elaborato		SEPDRTN09		VALUTAZIONE RISORSA EOLICA ED ANALISI		
Cod pratica	Data	Consegna	Formato	Scala	Livello progettuale	
SE_01	19/03/2024		A4	-	Progetto definitivo	

REVISIONI	Rev	Data	Descrizione	Elaborato	Controllato	Approvato
	01	Aprile 2024	Prima emissione	G.Donnarumma	V.Vanacore	M.Afeltra

Project:

**Serri**

Licensed user:

**LEONARDO ENGINEERING S.r.l.**

Viale Lamberti nr. snc  
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Giovanni Savarese/gsavarese2015@gmail.com

Calculated:

27/03/2024 19:36/4.0.424

## PARK - Main Result

### Calculation: Valutazione risorsa Eolica

#### 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: 0,1°

#### 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: FONNI V3 2014

Base temperature: 10,7 °C at 1029,0 m

Base pressure: 1013,3 hPa at 0,0 m

Air density for Site center in key hub height: 522,7 m + 119,0 m = 1,142 kg/m³ -> 93,3 % 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 EMD-ConWx Meso Data, EUROPE [SAMPLE]\_N39,71\_E009,17 (22) - 150.00 m.wws

#### WAsP version

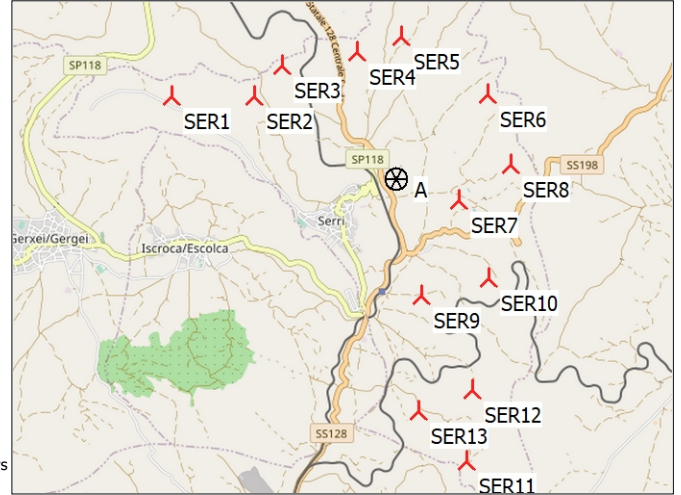
WAsP 12 Version 12.09.0032

### Key results for height 119,0 m above ground level

#### Terrain Geo [deg]-WGS84

Longitude	Latitude	Name of wind distribution	Type	Wind energy [kWh/m²]	Mean wind speed [m/s]	Equivalent roughness
A 9,154186° E	39,706658° N	Site data: WAsP (24)	WAsP (WAsP 12 Version 12.09.0032)	3.000	6,4	2,5

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



▲ New WTG

Scale 1:100.000

⊗ Site Data

### 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»			
					Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	249.357,2	224.421,5	258.900,6	3,7	27,4	17.263,2	2.398	6,7

\*) Based on Result-10,0%

### Calculated Annual Energy for each of 13 new WTGs with total 93,6 MW rated power

Links	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy			Free mean wind speed [m/s]	
	Valid	Manufact.	Type-generator						Result [MWh/y]	Result-10,0% [MWh/y]	Wake loss [%]		
SER1	A	Yes	VESTAS	V162-7.2-7.200	7.200	162,0	119,0	EMD	Level 0 & OS - Calculated - PO7200 - 07-2022	20.432,7	18.389	2,3	6,95
SER10	A	Yes	VESTAS	V162-7.2-7.200	7.200	162,0	119,0	EMD	Level 0 & OS - Calculated - PO7200 - 07-2022	20.300,9	18.271	4,1	6,95
SER11	A	Yes	VESTAS	V162-7.2-7.200	7.200	162,0	119,0	EMD	Level 0 & OS - Calculated - PO7200 - 07-2022	19.169,4	17.252	4,0	6,69
SER12	A	Yes	VESTAS	V162-7.2-7.200	7.200	162,0	119,0	EMD	Level 0 & OS - Calculated - PO7200 - 07-2022	18.278,8	16.451	3,5	6,49
SER13	A	Yes	VESTAS	V162-7.2-7.200	7.200	162,0	119,0	EMD	Level 0 & OS - Calculated - PO7200 - 07-2022	19.988,0	17.989	3,0	6,85
SER2	A	Yes	VESTAS	V162-7.2-7.200	7.200	162,0	119,0	EMD	Level 0 & OS - Calculated - PO7200 - 07-2022	20.717,0	18.645	3,7	7,04
SER3	A	Yes	VESTAS	V162-7.2-7.200	7.200	162,0	119,0	EMD	Level 0 & OS - Calculated - PO7200 - 07-2022	19.365,3	17.429	3,9	6,71
SER4	A	Yes	VESTAS	V162-7.2-7.200	7.200	162,0	119,0	EMD	Level 0 & OS - Calculated - PO7200 - 07-2022	16.571,5	14.914	4,8	6,18
SER5	A	Yes	VESTAS	V162-7.2-7.200	7.200	162,0	119,0	EMD	Level 0 & OS - Calculated - PO7200 - 07-2022	17.628,4	15.866	3,6	6,34
SER6	A	Yes	VESTAS	V162-7.2-7.200	7.200	162,0	119,0	EMD	Level 0 & OS - Calculated - PO7200 - 07-2022	19.238,4	17.315	4,0	6,70
SER7	A	Yes	VESTAS	V162-7.2-7.200	7.200	162,0	119,0	EMD	Level 0 & OS - Calculated - PO7200 - 07-2022	17.956,3	16.161	4,0	6,43
SER8	A	Yes	VESTAS	V162-7.2-7.200	7.200	162,0	119,0	EMD	Level 0 & OS - Calculated - PO7200 - 07-2022	19.199,9	17.280	4,3	6,71
SER9	A	Yes	VESTAS	V162-7.2-7.200	7.200	162,0	119,0	EMD	Level 0 & OS - Calculated - PO7200 - 07-2022	20.510,5	18.459	2,8	6,94

### WTG siting

#### Geo [deg]-WGS84

	Longitude	Latitude	Z [m]	Row data/Description
SER1	New 9,119441° E	39,716365° N	633,1	VESTAS V162-7.2 7200 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (1)
SER10	New 9,168457° E	39,694946° N	550,0	VESTAS V162-7.2 7200 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (10)
SER11	New 9,165030° E	39,673279° N	495,2	VESTAS V162-7.2 7200 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (11)

To be continued on next page...

## PARK - Main Result

### Calculation: Valutazione risorsa Eolica

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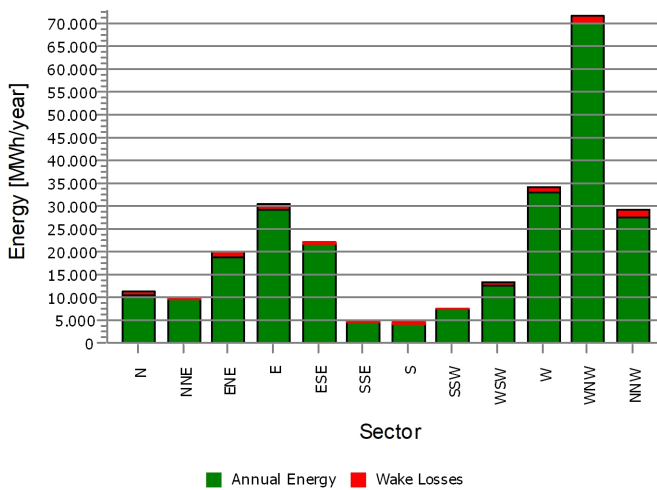
		Geo [deg]-WGS84		Z	Row data/Description
		Longitude	Latitude	[m]	
SER12	New	9,165793° E	39,681664° N	497,9	VESTAS V162-7.2 7200 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (12)
SER13	New	9,157612° E	39,679140° N	540,0	VESTAS V162-7.2 7200 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (13)
SER2	New	9,132161° E	39,716365° N	603,7	VESTAS V162-7.2 7200 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (2)
SER3	New	9,136555° E	39,720095° N	540,0	VESTAS V162-7.2 7200 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (3)
SER4	New	9,147951° E	39,721759° N	479,9	VESTAS V162-7.2 7200 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (4)
SER5	New	9,154896° E	39,723496° N	493,8	VESTAS V162-7.2 7200 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (5)
SER6	New	9,168311° E	39,716634° N	547,7	VESTAS V162-7.2 7200 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (6)
SER7	New	9,163819° E	39,704208° N	496,8	VESTAS V162-7.2 7200 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (7)
SER8	New	9,171903° E	39,708325° N	520,5	VESTAS V162-7.2 7200 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (8)
SER9	New	9,157998° E	39,692782° N	560,0	VESTAS V162-7.2 7200 162.0 !O! hub: 119,0 m (TOT: 200,0 m) (9)

## PARK - Production Analysis

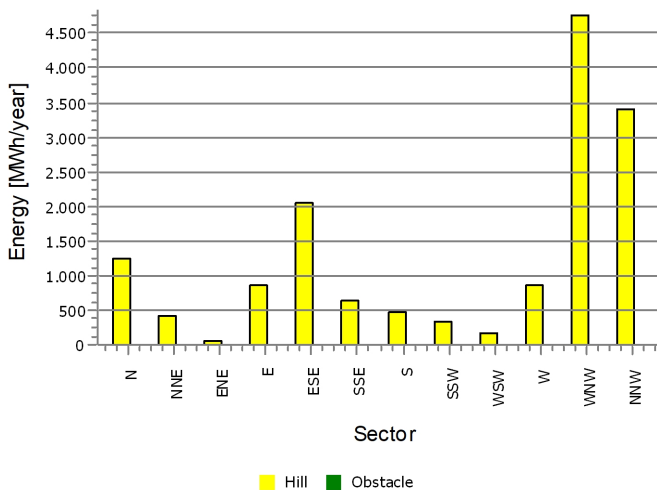
**Calculation:** Valutazione risorsa Eolica **WTG:** All new WTGs, Air density varies with WTG position 1,130 kg/m<sup>3</sup> - 1,147 kg/m<sup>3</sup>  
**Directional Analysis**

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]	9.879,1	9.665,8	19.774,2	29.575,4	20.210,3	4.175,3	4.073,2	7.325,6	13.186,3	33.183,8	66.990,8	25.600,5	243.640,4
+Increase due to hills [MWh]	1.252,7	405,4	65,8	849,6	2.042,3	624,6	473,9	345,7	170,7	850,8	4.761,2	3.417,6	15.260,2
-Decrease due to wake losses [MWh]	646,8	362,7	923,1	1.142,8	669,6	278,7	271,9	247,5	759,4	1.218,4	1.610,0	1.412,5	9.543,4
<b>Resulting energy [MWh]</b>	<b>10.485,0</b>	<b>9.708,5</b>	<b>18.916,9</b>	<b>29.282,2</b>	<b>21.583,0</b>	<b>4.521,3</b>	<b>4.275,2</b>	<b>7.423,8</b>	<b>12.597,6</b>	<b>32.816,1</b>	<b>70.142,0</b>	<b>27.605,5</b>	<b>249.357,2</b>
Specific energy [kWh/m <sup>2</sup> ]													931
Specific energy [kWh/kW]													2.664
Increase due to hills [%]	12,7	4,2	0,3	2,9	10,1	15,0	11,6	4,7	1,3	2,6	7,1	13,3	6,26
Decrease due to wake losses [%]	5,8	3,6	4,7	3,8	3,0	5,8	6,0	3,2	5,7	3,6	2,2	4,9	3,69
Utilization [%]	34,3	29,8	18,9	28,9	33,9	30,5	29,7	27,8	25,3	24,6	25,7	33,0	27,0
Operational [Hours/year]	425	316	451	697	831	351	308	383	531	937	1.672	968	7.870
Full Load Equivalent [Hours/year]	112	104	202	313	231	48	46	79	135	351	749	295	2.664

Energy vs. sector



Impact of hills and obstacles vs. sector



## PARK - Power Curve Analysis

**Calculation:** Valutazione risorsa Eolica **WTG:** SER1 - VESTAS V162-7.2 7200 162.0 !O!, Hub height: 119,0 m  
**Name:** Level 0 & OS - Calculated - PO7200 - 07-2022  
**Source:** Manufacturer

Source/Date	Created by	Created	Edited	Stop wind speed	Power control	CT curve type	Generator type	Specific power
				[m/s]				kW/m <sup>2</sup>
01/07/2022	EMD	25/02/2022	06/10/2022	25,0	Pitch	User defined	Variable	0,35

Based Vestas Document no.: 0114-3777 V03.

### HP curve comparison - Note: For standard air density

Vmean	[m/s]	5	6	7	8	9	10
HP value Pitch, variable speed (2013)	[MWh]	10.666	16.581	22.477	27.862	32.495	36.267
VESTAS V162-7.2 7200 162.0 !O! Level 0 & OS - Calculated - PO7200 - 07-2022	[MWh]	10.658	16.674	22.641	27.985	32.399	35.755
Check value	[%]	0	-1	-1	0	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/m<sup>2</sup>) 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/m<sup>3</sup>

Wind speed	Power	Cp	Wind speed	Ct curve
[m/s]	[kW]		[m/s]	
3,0	42,0	0,12	3,0	0,93
3,5	113,0	0,21	3,5	0,87
4,0	254,0	0,31	4,0	0,85
4,5	426,0	0,37	4,5	0,83
5,0	633,0	0,40	5,0	0,81
5,5	883,0	0,42	5,5	0,81
6,0	1.189,0	0,44	6,0	0,81
6,5	1.549,0	0,45	6,5	0,81
7,0	1.969,0	0,45	7,0	0,81
7,5	2.449,0	0,46	7,5	0,81
8,0	2.994,0	0,46	8,0	0,80
8,5	3.607,0	0,47	8,5	0,80
9,0	4.277,0	0,46	9,0	0,79
9,5	4.914,0	0,45	9,5	0,73
10,0	5.519,0	0,44	10,0	0,67
10,5	6.098,0	0,42	10,5	0,62
11,0	6.647,0	0,40	11,0	0,57
11,5	7.015,0	0,37	11,5	0,51
12,0	7.158,0	0,33	12,0	0,44
12,5	7.189,0	0,29	12,5	0,38
13,0	7.198,0	0,26	13,0	0,34
13,5	7.200,0	0,23	13,5	0,30
14,0	7.200,0	0,21	14,0	0,26
14,5	7.200,0	0,19	14,5	0,23
15,0	7.200,0	0,17	15,0	0,21
15,5	7.200,0	0,15	15,5	0,19
16,0	7.200,0	0,14	16,0	0,17
16,5	7.200,0	0,13	16,5	0,16
17,0	7.200,0	0,12	17,0	0,14
17,5	7.200,0	0,11	17,5	0,13
18,0	7.200,0	0,10	18,0	0,12
18,5	7.191,0	0,09	18,5	0,11
19,0	7.113,0	0,08	19,0	0,10
19,5	6.956,0	0,07	19,5	0,09
20,0	6.682,0	0,07	20,0	0,08
20,5	6.305,0	0,06	20,5	0,07
21,0	5.865,0	0,05	21,0	0,06
21,5	5.397,0	0,04	21,5	0,06
22,0	4.928,0	0,04	22,0	0,05
22,5	4.459,0	0,03	22,5	0,04
23,0	3.984,0	0,03	23,0	0,04
23,5	3.514,0	0,02	23,5	0,03
24,0	3.049,0	0,02	24,0	0,03
24,5	2.598,0	0,01	24,5	0,02
25,0	2.202,0	0,01	25,0	0,02

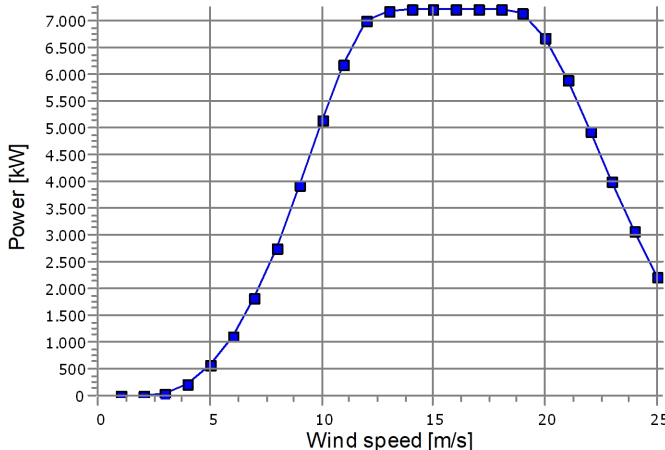
### Power, Efficiency and energy vs. wind speed

Data used in calculation, Air density: 1,130 kg/m<sup>3</sup> New windPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed	Power	Cp	Interval	Energy	Acc. Energy	Relative
[m/s]	[kW]		[m/s]	[MWh]	[MWh]	[%]
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	30,3	0,10	2,50-3,50	40,4	40,4	0,2
4,0	223,1	0,30	3,50-4,50	204,4	244,8	1,2
5,0	576,3	0,40	4,50-5,50	506,1	750,8	3,7
6,0	1.088,5	0,43	5,50-6,50	910,3	1.661,1	8,1
7,0	1.808,1	0,45	6,50-7,50	1.384,2	3.045,3	14,9
8,0	2.753,8	0,46	7,50-8,50	1.864,7	4.910,0	24,0
9,0	3.923,4	0,46	8,50-9,50	2.263,0	7.173,0	35,1
10,0	5.116,3	0,44	9,50-10,50	2.456,9	9.629,9	47,1
11,0	6.175,4	0,40	10,50-11,50	2.409,7	12.039,6	58,9
12,0	6.982,7	0,35	11,50-12,50	2.141,1	14.180,7	69,4
13,0	7.180,7	0,28	12,50-13,50	1.723,2	15.903,9	77,8
14,0	7.199,3	0,23	13,50-14,50	1.309,5	17.213,4	84,2
15,0	7.200,0	0,18	14,50-15,50	972,3	18.185,7	89,0
16,0	7.200,0	0,15	15,50-16,50	710,5	18.896,2	92,5
17,0	7.200,0	0,13	16,50-17,50	512,6	19.408,8	95,0
18,0	7.200,0	0,11	17,50-18,50	366,1	19.774,9	96,8
19,0	7.113,0	0,09	18,50-19,50	256,0	20.030,9	98,0
20,0	6.682,0	0,07	19,50-20,50	170,2	20.201,1	98,9
21,0	5.865,0	0,05	20,50-21,50	106,2	20.307,3	99,4
22,0	4.928,0	0,04	21,50-22,50	63,1	20.370,4	99,7
23,0	3.984,0	0,03	22,50-23,50	36,0	20.406,4	99,9
24,0	3.049,0	0,02	23,50-24,50	19,6	20.426,0	100,0
25,0	2.202,0	0,01	24,50-25,50	6,7	20.432,7	100,0

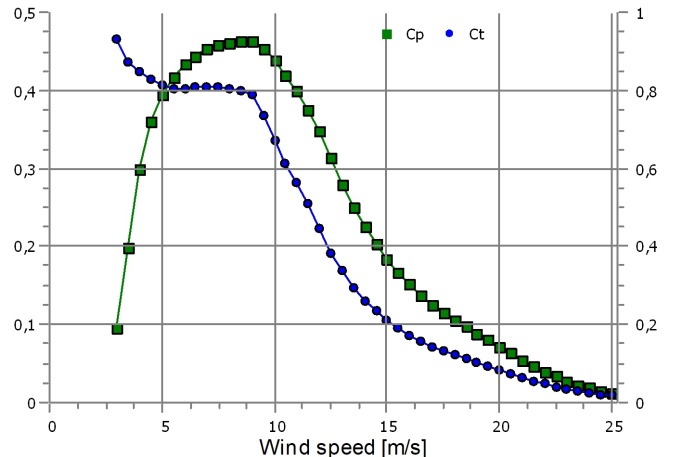
Power curve

For air density: 1,130 kg/m<sup>3</sup> and reference climate data



Cp and Ct curve

For air density: 1,130 kg/m<sup>3</sup> and reference climate data



Project:  
**Serri**

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Viale Lamberti nr. snc  
IT-81100 Caserta (CE)

Giovanni Savarese/gsavarese2015@gmail.com  
Calculated:  
27/03/2024 19:36/4.0.424

## **PARK - Terrain**

**Calculation:** Valutazione risorsa Eolica **Site Data:** A - Site data: WAsP (24)

### **Obstacles:**

0 Obstacles used

### **Roughness:**

Terrain data files used in calculation:

C:\Users\Asus\Documents\windPRO Data\Projects\ROUGHNESSLINE\_ONLINEDATA\_1.wpo  
Min X: 507.626, Max X: 515.231, Min Y: 4.391.382, Max Y: 4.399.099, Width: 7.605 m, Height: 7.717 m

### **Orography:**

Terrain data files used in calculation:

C:\Users\Asus\Documents\windPRO Data\Projects\CONTOURLINE\_ONLINEDATA\_0.wpo  
Min X: 506.409, Max X: 516.396, Min Y: 4.390.394, Max Y: 4.400.367, Width: 9.986 m, Height: 9.973 m

## PARK - Wind Data Analysis

**Calculation:** Valutazione risorsa Eolica **Wind data:** A - Site data: WASP (24); Hub height: 50,0

### Site coordinates

Geo WGS84

East: 9,154186° E North: 39,706658° N

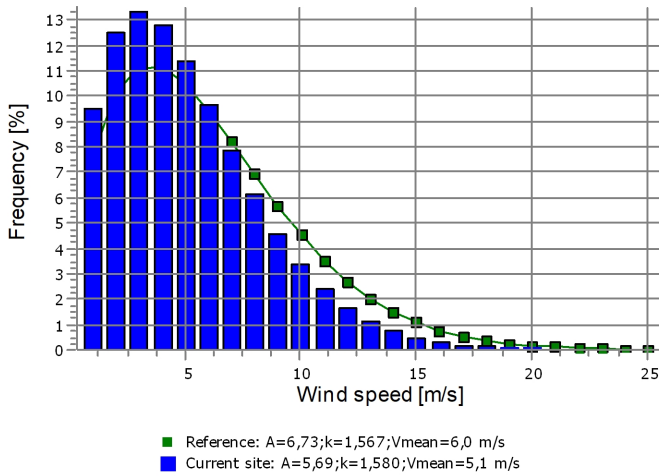
### Wind statistics

IT EMD-ConWx Meso Data, EUROPE [SAMPLE]\_N39,71\_E009,17 (22) - 150.00 m.w.w.s

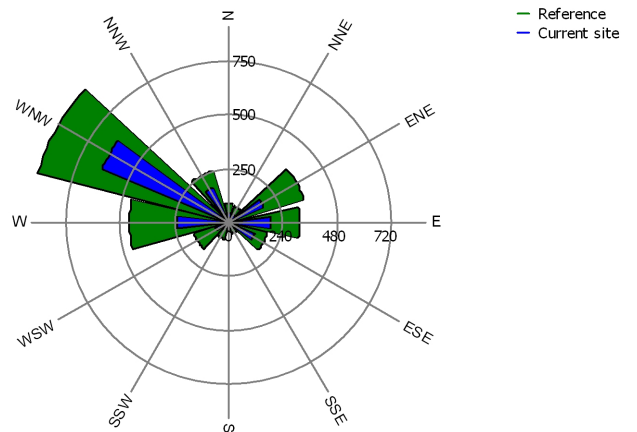
### Weibull Data

Sector	Current site				Reference: Roughness class 1			
	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]	A- parameter [m/s]	k- parameter	Frequency [%]	
0 N	4,95	4,40	1,881	5,2	5,78	1,881	5,9	
1 NNE	5,02	4,47	1,752	3,7	6,27	1,834	4,1	
2 ENE	7,04	6,32	1,568	5,2	8,66	1,545	5,7	
3 E	6,91	6,12	2,021	8,6	8,09	2,021	8,9	
4 ESE	5,21	4,63	1,775	11,3	6,04	1,799	10,5	
5 SSE	3,34	3,14	1,209	4,8	4,21	1,299	4,8	
6 S	3,38	3,15	1,248	4,0	3,97	1,209	3,7	
7 SSW	3,71	3,42	1,303	4,4	4,88	1,283	4,7	
8 WSW	4,26	3,92	1,334	6,0	5,66	1,311	6,6	
9 W	5,95	5,34	1,576	11,4	7,38	1,549	11,4	
10 WNW	7,08	6,30	1,811	22,5	8,17	1,799	20,8	
11 NNW	5,63	5,00	1,865	13,0	6,28	1,814	12,8	
All	5,69	5,11	1,580	100,0	6,73	1,567	100,0	

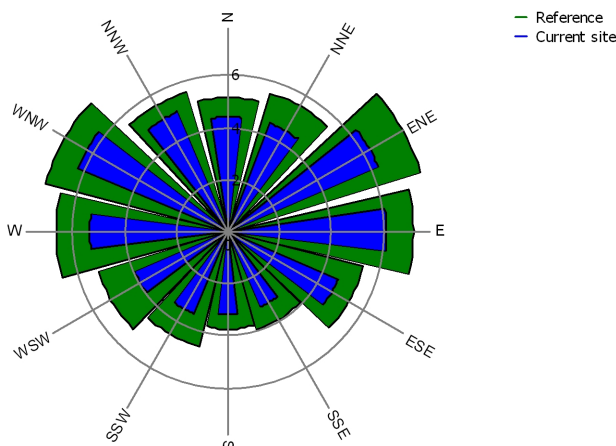
Weibull Distribution



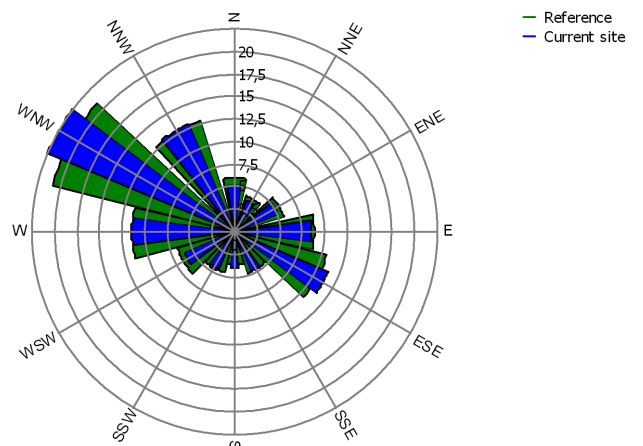
Energy Rose (kWh/m<sup>2</sup>/year)



Mean wind speed (m/s)



Frequency (%)



## PARK - Wind Data Analysis

**Calculation:** Valutazione risorsa Eolica **Wind data:** A - Site data: WASP (24); Hub height: 119,0

### Site coordinates

Geo WGS84

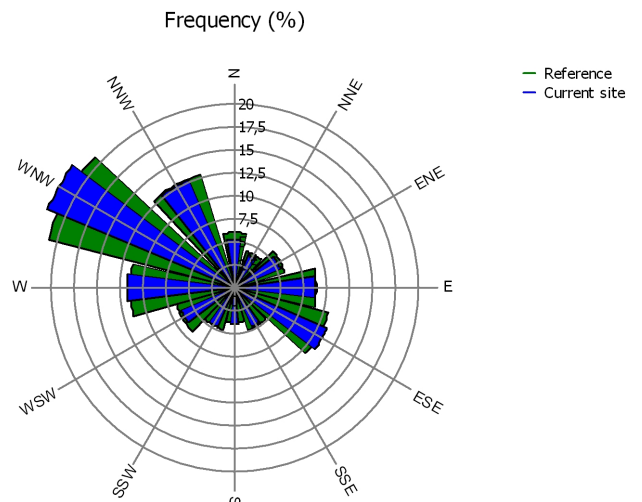
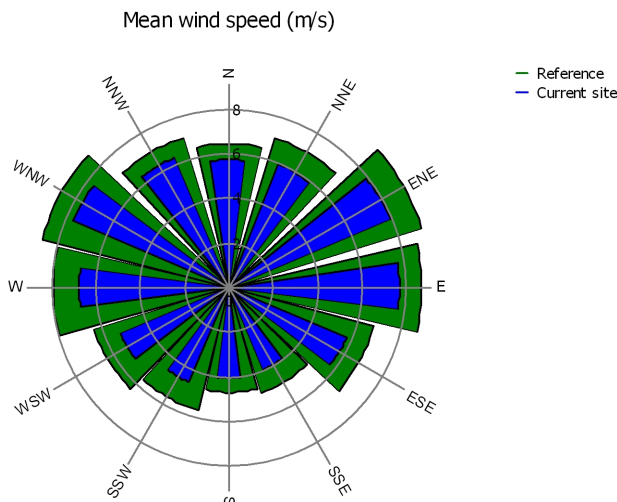
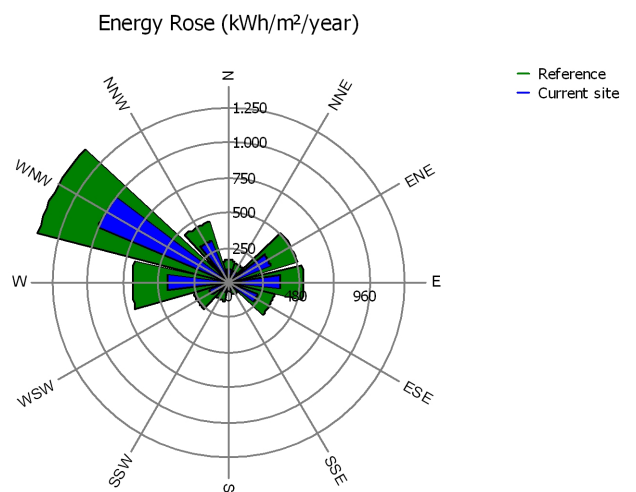
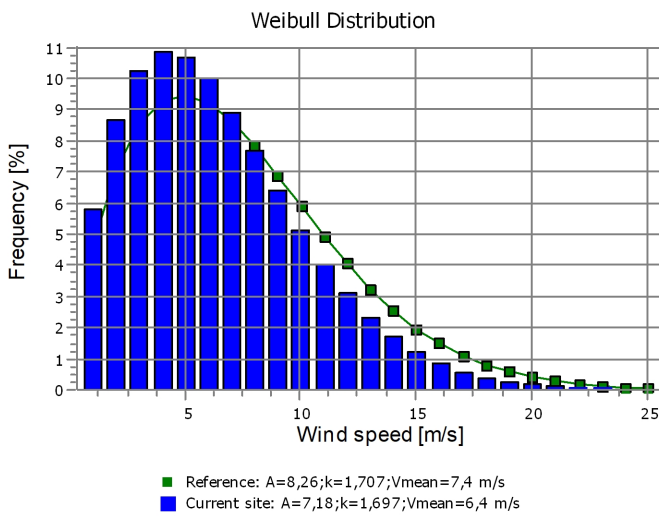
East: 9,154186° E North: 39,706658° N

### Wind statistics

IT EMD-ConWx Meso Data, EUROPE [SAMPLE]\_N39,71\_E009,17 (22) - 150.00 m.w.w.s

### 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	6,44	5,71	2,002	5,3	7,27	2,022	5,9
1 NNE	6,70	5,94	1,881	3,8	7,89	1,972	4,1
2 ENE	8,82	7,88	1,670	5,4	10,15	1,659	5,7
3 E	8,67	7,68	2,197	8,7	9,80	2,197	8,9
4 ESE	6,45	5,73	1,873	10,9	7,60	1,934	10,5
5 SSE	4,30	3,99	1,271	4,6	5,35	1,393	4,8
6 S	4,40	4,06	1,307	3,9	5,06	1,294	3,7
7 SSW	5,03	4,60	1,377	4,6	6,16	1,379	4,7
8 WSW	5,82	5,29	1,428	6,3	6,97	1,423	6,6
9 W	7,56	6,75	1,697	11,7	8,87	1,684	11,4
10 WNW	8,58	7,61	1,939	22,0	9,79	1,955	20,8
11 NNW	7,13	6,32	1,994	12,7	7,90	1,953	12,8
All	7,18	6,41	1,697	100,0	8,26	1,707	100,0





## PARK - Park power curve

**Calculation:** Valutazione risorsa Eolica

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	1.313	1.131	1.076	1.164	1.011	1.112	1.193	1.104	1.071	1.163	1.033	1.120	1.193	1.104
4,5	5.051	4.549	4.402	4.636	4.250	4.515	4.713	4.471	4.393	4.635	4.273	4.519	4.713	4.477
5,5	10.614	9.778	9.540	9.922	9.290	9.727	10.048	9.649	9.523	9.920	9.310	9.725	10.048	9.657
6,5	18.665	17.260	16.868	17.503	16.456	17.180	17.703	17.034	16.833	17.497	16.495	17.181	17.705	17.045
7,5	29.573	27.427	26.824	27.800	26.197	27.305	28.105	27.084	26.779	27.791	26.255	27.304	28.109	27.100
8,5	43.514	40.486	39.633	41.014	38.736	40.308	41.449	40.016	39.579	41.001	38.808	40.307	41.456	40.032
9,5	59.545	56.162	55.087	56.733	54.014	55.860	57.383	55.724	55.072	56.735	54.067	55.854	57.375	55.716
10,5	74.205	71.482	70.594	71.959	69.611	71.135	72.538	71.227	70.627	71.956	69.585	71.132	72.533	71.217
11,5	87.046	85.051	84.395	85.383	83.624	84.762	85.841	84.878	84.427	85.396	83.586	84.765	85.857	84.892
12,5	92.923	92.380	92.214	92.466	91.894	92.237	92.648	92.422	92.284	92.474	91.779	92.236	92.650	92.388
13,5	93.554	93.521	93.515	93.526	93.492	93.513	93.539	93.526	93.519	93.528	93.468	93.506	93.539	93.524
14,5	93.600	93.599	93.599	93.599	93.598	93.599	93.600	93.600	93.600	93.600	93.598	93.599	93.600	93.600
15,5	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600
16,5	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600
17,5	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600
18,5	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600	93.600
19,5	90.428	90.604	90.658	90.574	90.719	90.622	90.540	90.625	90.658	90.574	90.720	90.622	90.540	90.625
20,5	81.965	82.313	82.419	82.253	82.540	82.348	82.187	82.353	82.419	82.253	82.540	82.348	82.187	82.353
21,5	70.161	70.507	70.612	70.447	70.732	70.542	70.381	70.547	70.611	70.447	70.732	70.542	70.381	70.547
22,5	57.967	58.231	58.311	58.186	58.403	58.258	58.136	58.262	58.311	58.186	58.403	58.258	58.136	58.262
23,5	45.682	45.884	45.945	45.849	46.015	45.904	45.811	45.907	45.945	45.849	46.015	45.904	45.811	45.907
24,5	33.774	33.921	33.966	33.896	34.017	33.936	33.868	33.939	33.966	33.896	34.017	33.936	33.868	33.939
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:

- 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.
- 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.
- Calculation of wind energy index based on the PARK production (see below).
- 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:

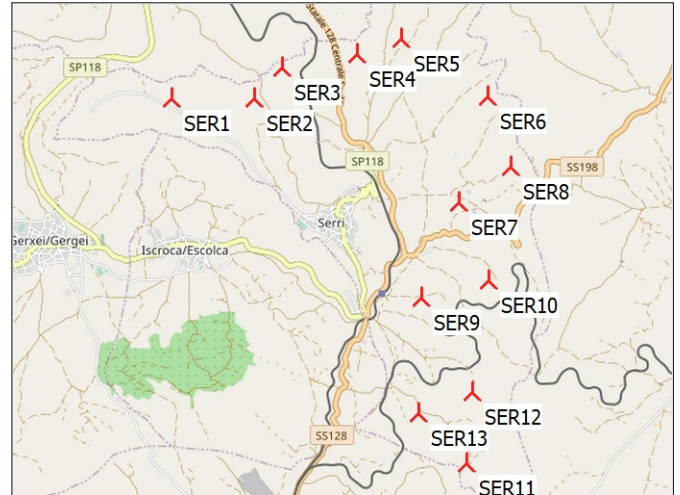
From the >Result to file< the >Wind Speeds Inside Wind farm< is also available. These can (e.g. via Excel) be used for extracting the wake induced reductions in measured wind speed.

## PARK - WTG distances

**Calculation:** Valutazione risorsa Eolica

### WTG distances

	Z	Nearest WTG	Z	Horizontal distance	Distance in rotor diameters
	[m]		[m]	[m]	
SER1	633,1	SER2	603,7	1.090	6,7
SER10	550,0	SER9	560,0	928	5,7
SER11	495,2	SER13	540,0	910	5,6
SER12	497,9	SER13	540,0	755	4,7
SER13	540,0	SER12	497,9	755	4,7
SER2	603,7	SER3	540,0	560	3,5
SER3	540,0	SER2	603,7	560	3,5
SER4	479,9	SER5	493,8	626	3,9
SER5	493,8	SER4	479,9	626	3,9
SER6	547,7	SER8	520,5	972	6,0
SER7	496,8	SER8	520,5	830	5,1
SER8	520,5	SER7	496,8	830	5,1
SER9	560,0	SER10	550,0	928	5,7
<b>Min</b>	<b>479,9</b>	<b>479,9</b>	<b>560</b>	<b>560</b>	<b>3,5</b>
<b>Max</b>	<b>633,1</b>	<b>603,7</b>	<b>1.090</b>	<b>1.090</b>	<b>6,7</b>



Scale 1:100.000

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

📍 New WTG

Project:

**Serri**

Licensed user:

**LEONARDO ENGINEERING S.r.l.**

Viale Lamberti nr. snc  
IT-81100 Caserta (CE)

Giovanni Savarese/gsavarese2015@gmail.com

Calculated:

27/03/2024 19:36/4.0.424

## PARK - Wind statistics info

**Calculation:** Valutazione risorsa Eolica

### Main data for wind statistic

**File** \\...\01\_File\_Programma\EMD-ConWx Meso Data, EUROPE [SAMPLE]\IT EMD-ConWx Meso Data, EUROPE [SAMPLE]\_N39,71\_E009,17 (22) - 150.00 m.wws  
**Name** EMD-ConWx Meso Data, EUROPE [SAMPLE]\_N39,71\_E009,17 (22) - 150.00 m  
**Country** Italy  
**Source** USER  
**Mast coordinates** Geo WGS84 East: 9,170000° E North: 39,710000° N  
**Created** 22/03/2024  
**Edited** 25/03/2024  
**Sectors** 12  
**WAsP version** WAsP 12 Version 12.09.0032  
**Coordinate system** UTM (north)-WGS84 Zone: 32  
**Displacement height** None

### Additional info for wind statistic

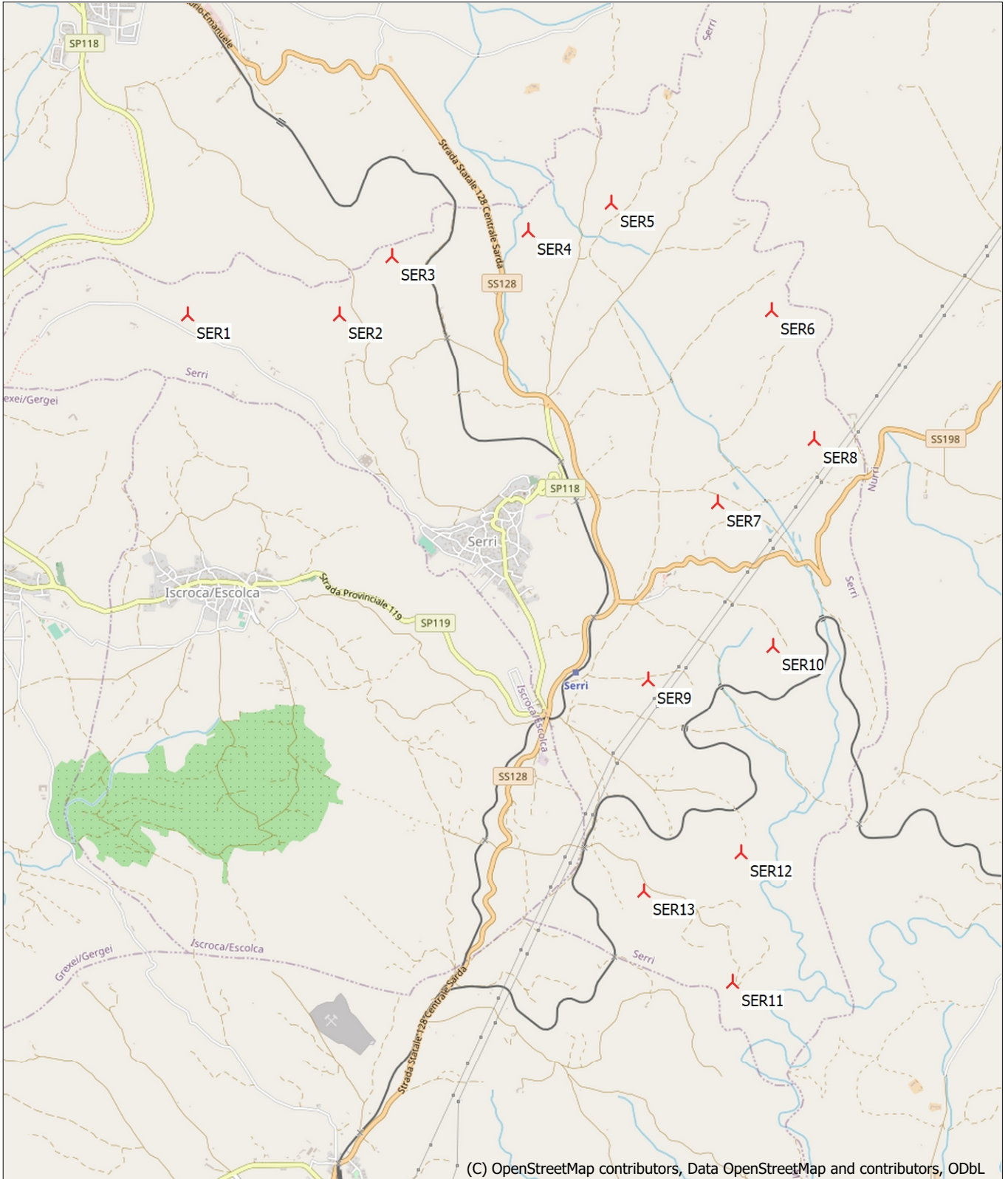
**Source data** EMD-ConWx Meso Data, EUROPE [SAMPLE]\_N39,71\_E009,17 (22)  
**Data from** 01/01/2018  
**Data to** 01/01/2019  
**Measurement length** 12,0 Months  
**Recovery rate** 100,0 %  
**Effective measurement length** 12,0 Months

### 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:** Valutazione risorsa Eolica



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

0 500 1000 1500 2000 m

Map: EMD OpenStreetMap , Print scale 1:40.000, Map center Geo WGS84 East: 9,145672° E North: 39,698387° N

New WTG