COMFREY WIND FARM - WIND RESOURCE ASSESSMENT

REVISION CONTROL				
REVISION	DATE	BY		DESCRIPTION
1	26/09/2014	José Miguel Jáuregui		First draft
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PREPARED	REVISED	
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This document can not be made public or be the objet of public presentations in other circumstances different from the scope of Comfrey wind farm project.

Three and a half years of measurements have been used to obtain the results and calculations presented in this report; should the measurement period change, Nayxa informs that the results obtained might slightly change.

1. GENERAL DESCRIPTION

In this report an estimation of Comfrey wind farm energy production is presented. Comfrey wind farm is located near the town of Comfrey within the limits of Brown and Cottonwood counties, state of Minnesota, USA.

Three different wind turbines are going to be assessed within this report, the Vestas V110-2000 at 80 meter height, the Vestas V100-2000 at 80 meter height and the General Electric GE103-1700 at 80 meter height.

The Vestas V110-2000 model is classified as IEC IIIA, the Vestas V100-2000 as IIB and the General Electric model GE103-1700 is designed to fulfil the specifications of IIIB IEC standards. All three models are designed to face low rate wind regimes and eventually be placed in medium wind regimes to exploit the maximum of these conditions.

The project consists of 16 wind turbines Vestas V110-2000 / Vestas V100-2000 or 18/19 General Electric GE103-1700. The project has a power limitation of 31.5 MWs and therefore this limitation should be taken into account when doing the energy calculation. The four strategies described here will be compared in terms of energy produced, so the client can make the best decision for the project.

Wind field modelization and energy calculation have been estimated with the help of commercial software WAsP and WindFarmer, from Danish Laboratory Riso and Garrad Hassan Partners respectively. The terrain studied in this project is very flat therefore there is no special need for CFD software to be used.

2. SITE ANALYSIS

Comfrey wind farm is located near the town of Comfrey within the limits of Brown and Cottonwood counties, state of Minnesota, USA. In the following pages situation maps and pictures of the wind farm and surroundings are presented.

The wind farm is located in a gentle area surrounded by very flat terrain. The terrain studied in this project is very flat therefore there is no special need for CFD software to be used. According to measurements and observations from nearby stations and meteorological models, winter periods seem to be quite hard and cold and frequent and continuous icing occurs during these periods..

Savage vegetation in the area is very scattered with a majority of cultivated crops and some pasture/hays. There are also some trees at the bank of the rivers, lakes and water channels draining from and onto them. A roughness map has been implemented in order to include vegetation in WAsP calculations.

Wind turbines are located in sites with an altitude range of 341 to 351 meters. The Ruggedness Index (RIX) equals to 0 in all position, being this, an indicator of the non-complexity of the terrain. If the RIX value is ~0%, all of the slopes of the terrain are less steep than 0.3 and the wind flow is likely to be attached, i.e. follow the terrain surface. This situation is generally within the performance envelope of WAsP.

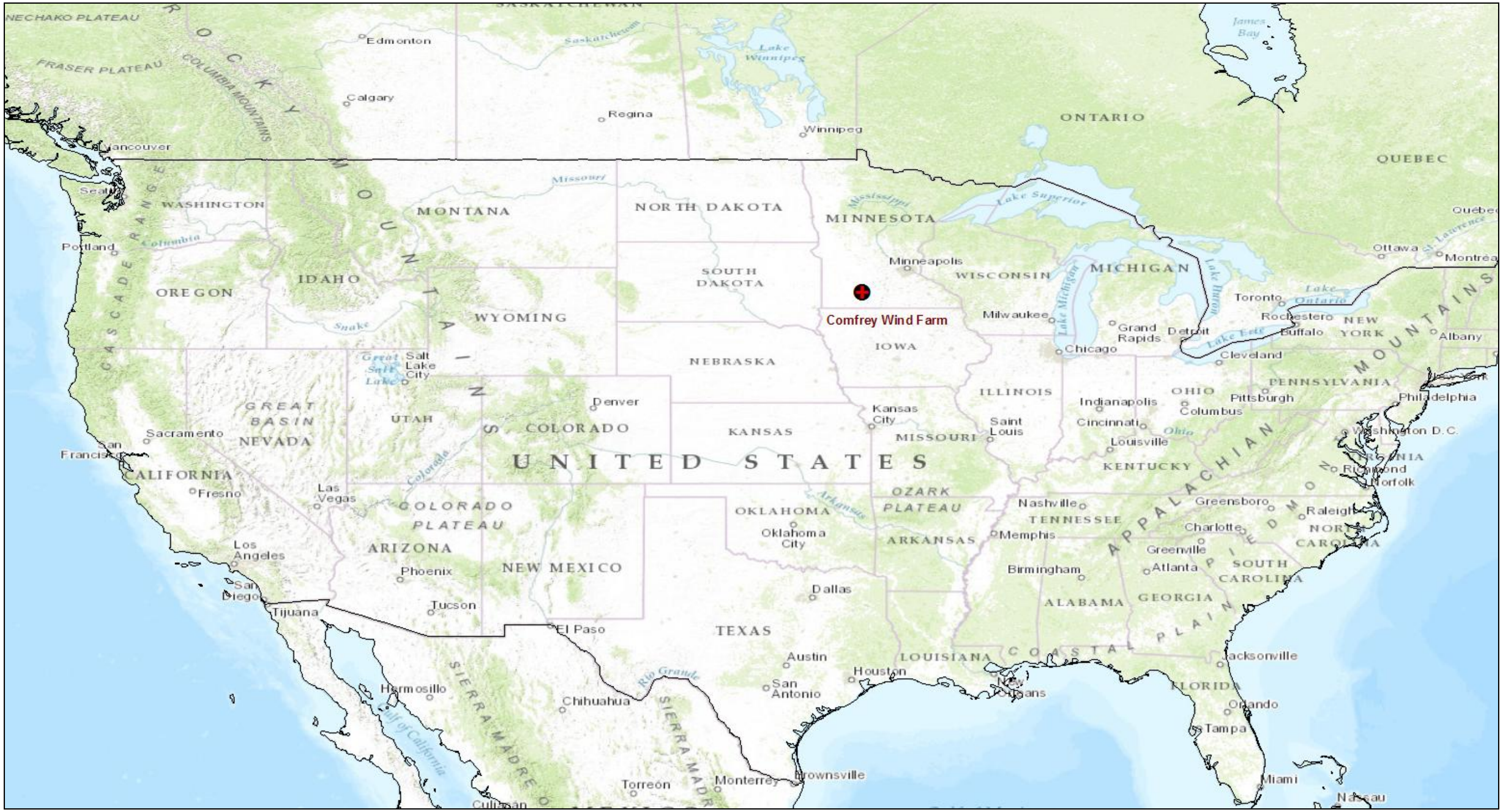


Figure 1. Situation map of Comfrey wind farm.

Figure 2. Comfrey wind farm detail 1,Vestas layouts and met mast location source Google Earth.

Figure 3. Comfrey wind farm, 18 General Electric wind turbines layout and met mast location, source Google Earth.

Figure 4. Comfrey wind farm, 19 General Electric wind turbines layout and met mast location, source Google Earth.

3. TERRAIN DESCRIPTION

3.1 DENSITY AND HEIGHT

The air kinetic energy going through the rotor section is directly proportional to the third power of wind speed and linearly proportional to the air density; this is why air density is an important parameter in wind energy calculations.

Wind Turbines at Comfrey wind farm are situated within a height range of 10 meters; therefore only minor density factor correction should be applied to each wind turbine. Hub height should be added to air density calculation. This is done with the help of WindFarmer software which corrects the power curve of the wind turbine and adapts it to each particular condition.

The mean site specific air density should be calculated with the standard 1 formula, taken from IEC 61.400-12-1. The temperature sensor from Comfrey met mast cannot be used due to device/software failure.

Instead, temperature data from the nearby NOAA weather station located in the town of Springfield will be used. This station is located at a distance of approximately 10 miles from the project. This station indicates a mean annual temperature of 6.94ºC (44.49ºF) which has been corroborated with different world data bases (WorldClim or NASA among others). 30 years of measurements have been taken into account, considering this period representative of the long term behaviour of the local weather.

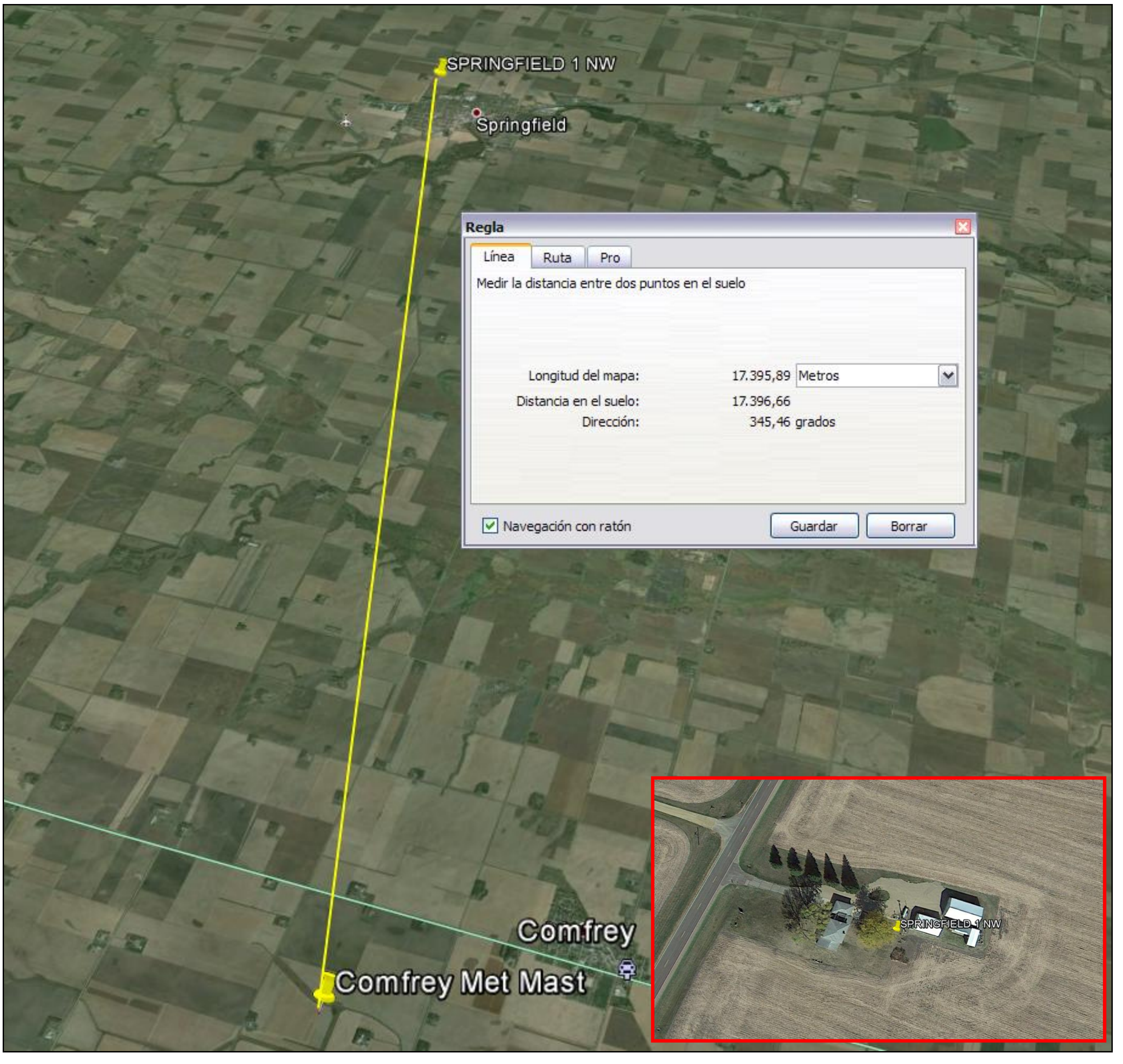


Figure 5. Situation and distance from Springfield NOAA station and Comfrey met mast.

Pressure data from different organisms covering a time period of 20 years will be used to calculate the mean annual pressure of Comfrey wind farm. Relative humidity data from worldwide databases, covering a time period of 20 years will also be used to calculate the mean annual relative humidity at Comfrey wind farm.

The annual mean air pressure at surface level has been determined to be 972.832 mbar taking into account NASA and NCAR data. The annual mean relative humidity of air is determined to be 70.02% taking into account NCAR and Wisconsin University data.

Using all this information, the selected hub height, and the formula on this page, a mean annual density value of 1.2001 Kg/m³ at 428 meters (hub height + mean altitude) is obtained.

$$\rho = \frac{1}{T}\left(\frac{B}{R_0} - \phi P_w\left(\frac{1}{R_0} - \frac{1}{R_w}\right)\right) \qquad \text{(F.1)}$$

where

B is the barometric pressure [Pa];

T is the absolute temperature [K];

ϕ is the relative humidity (range 0 to 1);

R_0 is the gas constant of dry air [287,05 J/kgK];

R_w is the gas constant of water vapour [461,5 J/kgK];

P_w is the vapour pressure [Pa].

$$P_w = 0{,}0000205 \exp(0{,}0631846 \cdot T) \qquad \text{(F.2)}$$

Standard 1. IEC standard for air density calculation.

3.2 TERRAIN OROGRAPHY AND ROUGHNESS

Orography and roughness have been studied with the help of Google Earth software and several international data bases. On the next page, the topographic map and the roughness map used for Comfrey wind farm calculations are presented. A perimeter of 12.5 kilometres1 7.7 miles, around the wind farm has been used to build the map. Official topography from the *USGS National Elevation Dataset* has been used.

The wind farm is located in a gentle area surrounded by very flat terrain. The slope map of area will also be presented, showing that there are not complex zones within the wind farm terrains or in the surroundings of Comfrey wind farm. Slopes in the range 1-3º are spotted in the vicinity of the wind turbines, being these values of no big importance.

In the land use/roughness map, it can be seen that savage vegetation in the area is very scattered with a majority of cultivated crops and some pasture/hays. There are also some trees at the bank of the rivers, lakes and water channels draining from and to them.

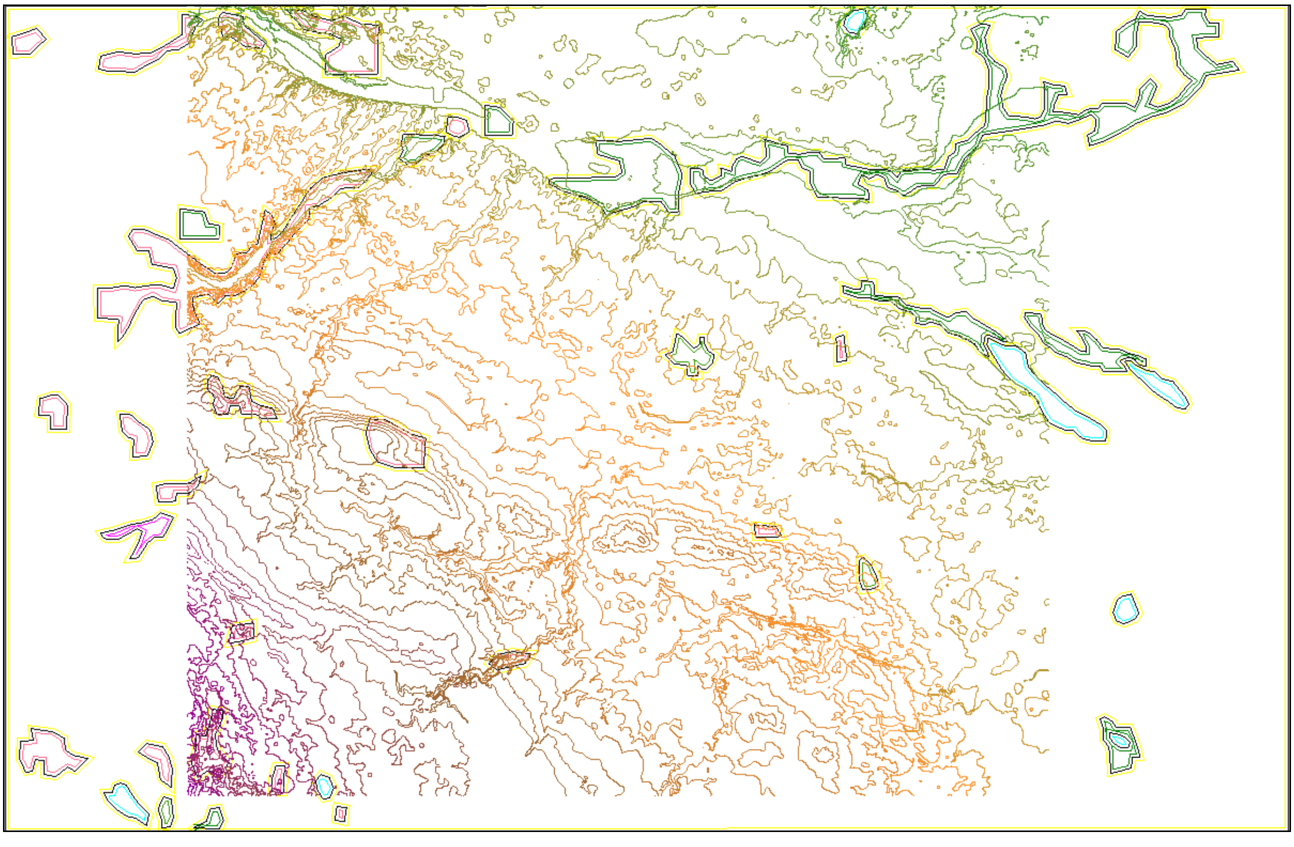


Figure 6. Comfrey elevation and roughness map.

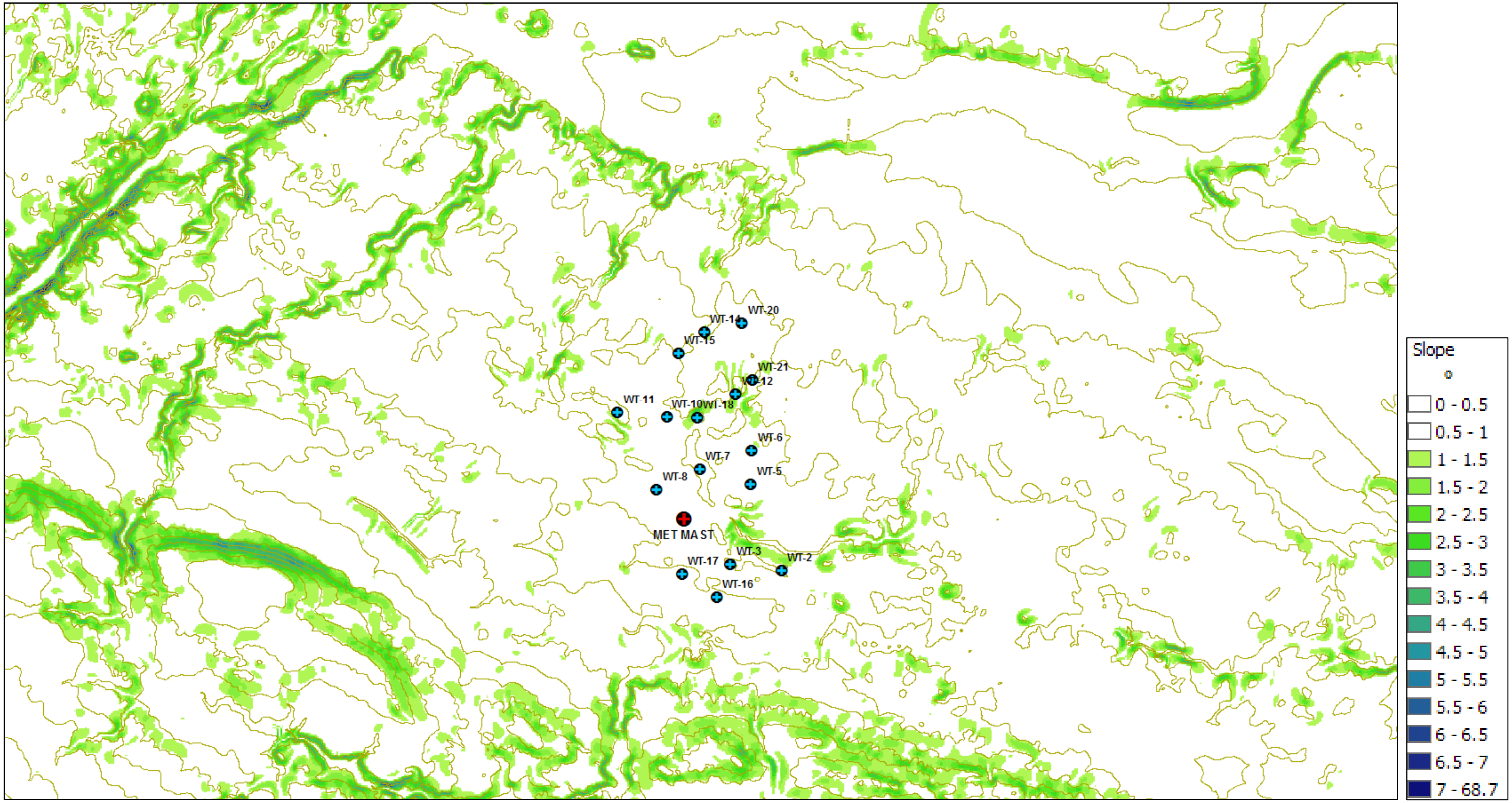


Figure 7. Comfrey wind farm, slope map.

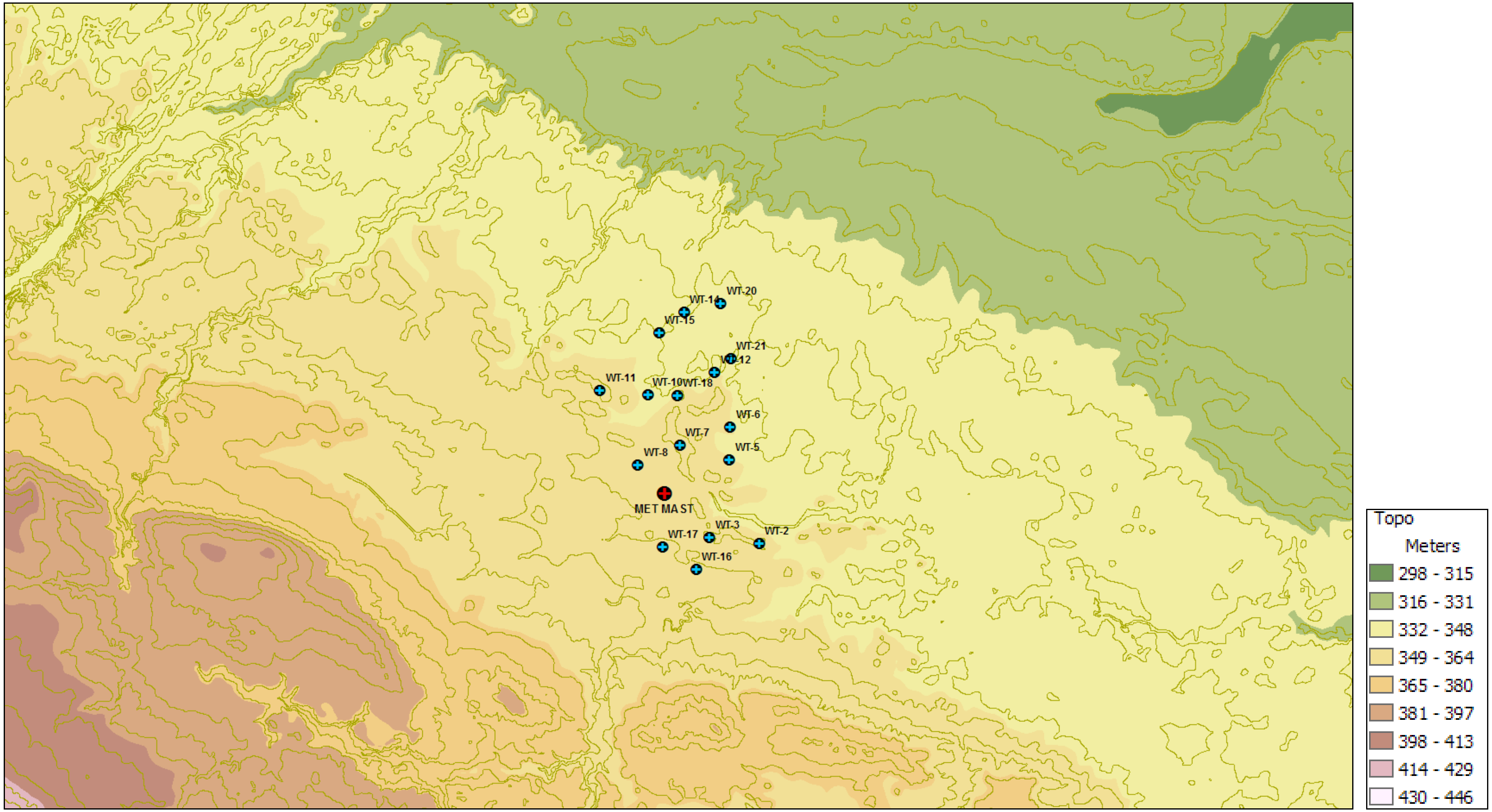


Figure 8. Comfrey wind farm and surroundings, topographic map.

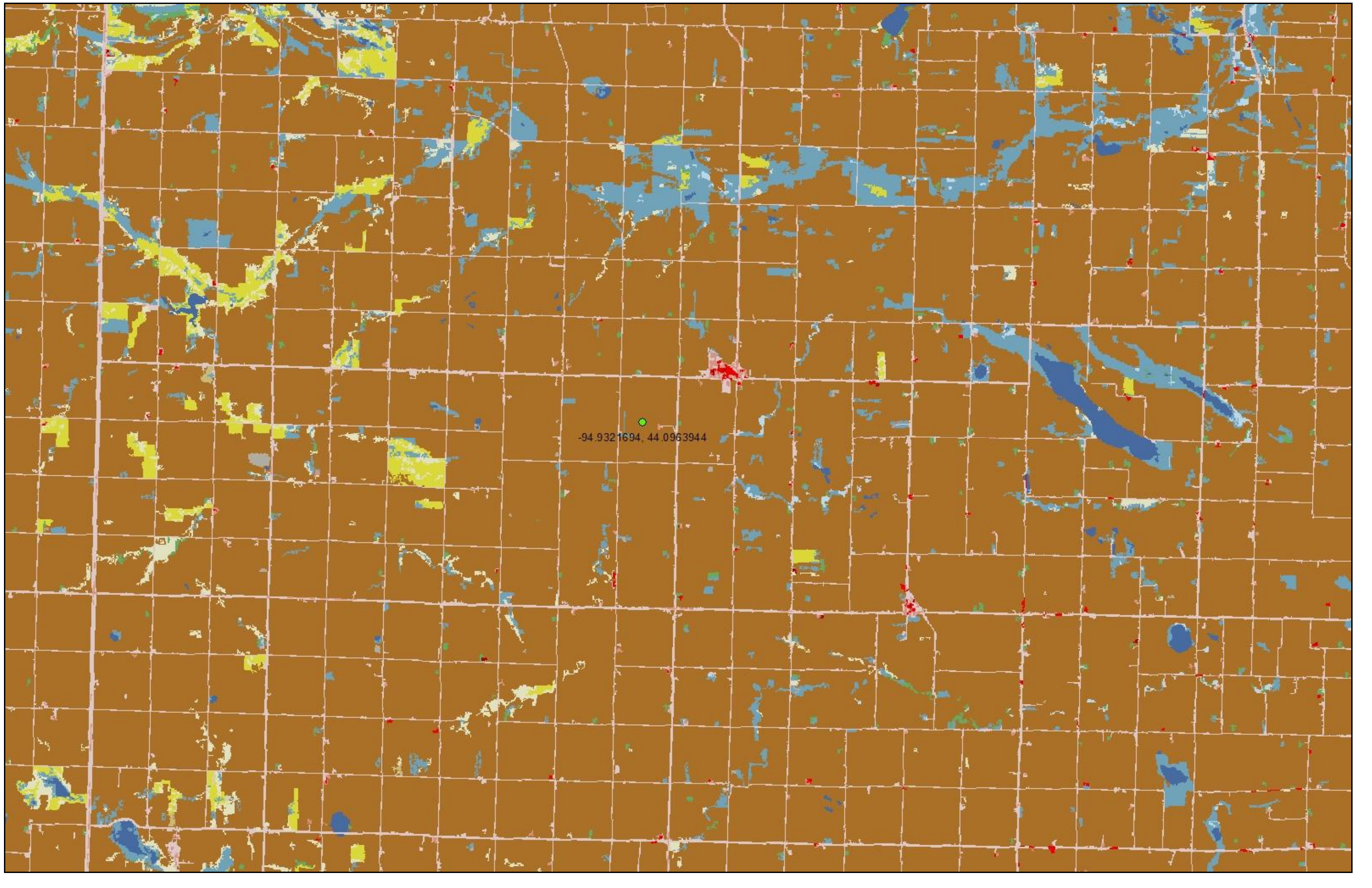


Figure 9. Comfrey wind farm and surroundings, roughness map.

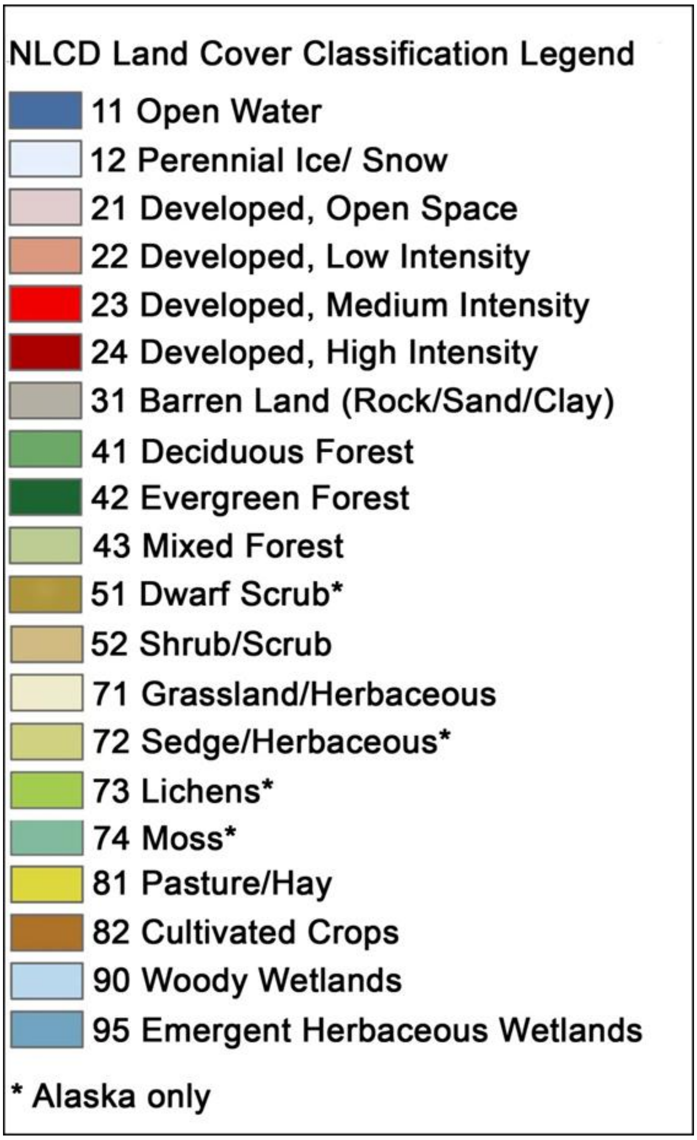


Figure 10. Roughness map legend, NLCD American National Land Cover Database.

At this point distances among Comfrey wind turbines are going to be shown. Generally a minimum recommended distance of 3 rotor diameters in the least prevailing wind direction and a distance of 7 diameters in the prevailing wind direction are required. The different layouts will be studied.

This recommendation is followed in this project. A table with the distance among each wind turbine can be seen in the next pages. Figures with affections among wind turbines will also be presented for the different layouts studied, showing that the main wind directions are respected in all the cases. It is possible to observe in the different plots that the affections caused by the different wind turbines do not affect excessively the neighbour turbines.

The wake lost will not reach important values among the wind turbines and the wake turbulence will be kept under acceptable values.

DISTANCE	WTG1	WTG2	WTG3	WTG4	WTG5	WTG6	WTG7	WTG8	WTG9	WTG10	WTG11	WTG12	WTG13	WTG14	WTG15	WTG16
WTG1	0	8.49	15.06	20.27	21.38	24.36	31.34	37.39	29.96	41.11	39.44	11.41	16.21	28.62	41.11	31.60
WTG2	8.49	0	13.56	18.92	16.36	17.11	26.18	31.00	27.96	38.29	35.59	5.78	7.94	24.59	39.58	30.39
WTG3	15.06	13.56	0	5.47	8.73	15.44	17.52	24.85	15.02	26.06	24.50	19.31	18.47	13.98	26.45	17.04
WTG4	20.27	18.92	5.47	0	8.99	16.78	14.83	22.86	9.69	20.93	19.95	24.61	23.10	10.40	21.00	11.58
WTG5	21.38	16.36	8.73	8.99	0	7.81	10.01	16.40	13.71	22.49	19.31	21.14	17.39	8.42	24.93	16.94
WTG6	24.36	17.11	15.44	16.78	7.81	0	12.01	14.25	20.41	27.04	22.67	20.14	14.41	13.54	30.70	23.84
WTG7	31.34	26.18	17.52	14.83	10.01	12.01	0	8.24	11.89	15.27	10.66	30.55	25.77	4.90	19.72	15.20
WTG8	37.39	31.00	24.85	22.86	16.40	14.25	8.24	0	19.69	19.46	13.96	34.38	28.55	13.13	25.15	22.75
WTG9	29.96	27.96	15.02	9.69	13.71	20.41	11.89	19.69	0	11.35	11.51	33.46	30.79	7.48	11.63	3.48
WTG10	41.11	38.29	26.06	20.93	22.49	27.04	15.27	19.46	11.35	0	5.51	43.48	39.81	14.12	6.30	11.11
WTG11	39.44	35.59	24.50	19.95	19.31	22.67	10.66	13.96	11.51	5.51	0	40.44	36.16	11.02	11.52	12.86
WTG12	11.41	5.78	19.31	24.61	21.14	20.14	30.55	34.38	33.46	43.48	40.44	0	6.79	29.54	45.09	36.00
WTG13	16.21	7.94	18.47	23.10	17.39	14.41	25.77	28.55	30.79	39.81	36.16	6.79	0	25.68	42.25	33.74
WTG14	28.62	24.59	13.98	10.40	8.42	13.54	4.90	13.13	7.48	14.12	11.02	29.54	25.68	0	17.19	10.94
WTG15	41.11	39.58	26.45	21.00	24.93	30.70	19.72	25.15	11.63	6.30	11.52	45.09	42.25	17.19	0	9.51
WTG16	31.60	30.39	17.04	11.58	16.94	23.84	15.20	22.75	3.48	11.11	12.86	36.00	33.74	10.94	9.51	0

DISTANCE	WTG1	WTG2	WTG3	WTG4	WTG5	WTG6	WTG7	WTG8	WTG9	WTG10	WTG11	WTG12	WTG13	WTG14	WTG15	WTG16
WTG1	0	7.72	13.69	18.43	19.43	22.15	28.49	33.99	27.23	37.37	35.85	10.37	14.74	26.01	37.38	28.73
WTG2	7.72	0	12.33	17.20	14.87	15.56	23.80	28.18	25.42	34.81	32.36	5.26	7.21	22.35	35.98	27.62
WTG3	13.69	12.33	0	4.97	7.94	14.04	15.93	22.59	13.65	23.69	22.28	17.55	16.79	12.71	24.04	15.49
WTG4	18.43	17.20	4.97	0	8.17	15.25	13.48	20.79	8.81	19.03	18.14	22.38	21.00	9.45	19.09	10.53
WTG5	19.43	14.87	7.94	8.17	0	7.10	9.10	14.91	12.46	20.45	17.55	19.22	15.81	7.65	22.66	15.40
WTG6	22.15	15.56	14.04	15.25	7.10	0	10.92	12.95	18.55	24.58	20.61	18.31	13.10	12.31	27.91	21.67
WTG7	28.49	23.80	15.93	13.48	9.10	10.92	0	7.49	10.81	13.88	9.69	27.77	23.43	4.45	17.92	13.82
WTG8	33.99	28.18	22.59	20.79	14.91	12.95	7.49	0	17.90	17.69	12.69	31.26	25.95	11.94	22.86	20.68
WTG9	27.23	25.42	13.65	8.81	12.46	18.55	10.81	17.90	0	10.32	10.46	30.42	27.99	6.80	10.57	3.16
WTG10	37.37	34.81	23.69	19.03	20.45	24.58	13.88	17.69	10.32	0	5.01	39.53	36.19	12.84	5.73	10.10
WTG11	35.85	32.36	22.28	18.14	17.55	20.61	9.69	12.69	10.46	5.01	0	36.76	32.87	10.02	10.47	11.69
WTG12	10.37	5.26	17.55	22.38	19.22	18.31	27.77	31.26	30.42	39.53	36.76	0	6.17	26.85	40.99	32.73
WTG13	14.74	7.21	16.79	21.00	15.81	13.10	23.43	25.95	27.99	36.19	32.87	6.17	0	23.35	38.41	30.67
WTG14	26.01	22.35	12.71	9.45	7.65	12.31	4.45	11.94	6.80	12.84	10.02	26.85	23.35	0	15.62	9.94
WTG15	37.38	35.98	24.04	19.09	22.66	27.91	17.92	22.86	10.57	5.73	10.47	40.99	38.41	15.62	0	8.65
WTG16	28.73	27.62	15.49	10.53	15.40	21.67	13.82	20.68	3.16	10.10	11.69	32.73	30.67	9.94	8.65	0

Table 1. Distances among wind turbines, Vestas V100-2000 and V110-2000 respectively.

DISTANCE	WTG1	WTG2	WTG3	WTG4	WTG5	WTG6	WTG7	WTG8	WTG9	WTG10	WTG11	WTG12	WTG13	WTG14	WTG15	WTG16	WTG17	WTG18
WTG1	0	5.66	4.13	14.92	15.72	21.03	19.67	20.74	29.31	34.19	30.16	40.52	38.18	5.43	10.51	27.48	41.36	32.27
WTG2	5.66	0	8.25	15.26	14.62	19.68	20.75	23.65	30.43	36.30	29.08	39.91	38.29	11.08	15.74	27.78	39.92	30.68
WTG3	4.13	8.25	0	11.60	13.16	18.36	15.88	16.62	25.41	30.09	27.14	37.18	34.56	5.61	7.70	23.87	38.43	29.50
WTG4	14.92	15.26	11.60	0	3.85	7.47	5.69	11.30	15.20	21.60	15.59	25.62	23.33	16.90	14.96	12.67	26.88	18.12
WTG5	15.72	14.62	13.16	3.85	0	5.31	8.48	14.99	17.01	24.12	14.58	25.30	23.79	18.75	17.93	13.57	25.68	16.55
WTG6	21.03	19.68	18.36	7.47	5.31	0	8.73	16.29	14.40	22.20	9.41	20.32	19.37	23.90	22.43	10.09	20.39	11.24
WTG7	19.67	20.75	15.88	5.69	8.48	8.73	0	7.59	9.72	15.92	13.31	21.84	18.74	20.53	16.88	8.17	24.20	16.44
WTG8	20.74	23.65	16.62	11.30	14.99	16.29	7.59	0	11.66	13.83	19.81	26.25	22.01	19.56	13.99	13.14	29.81	23.14
WTG9	29.31	30.43	25.41	15.20	17.01	14.40	9.72	11.66	0	8.00	11.55	14.82	10.35	29.66	25.02	4.75	19.14	14.76
WTG10	34.19	36.30	30.09	21.60	24.12	22.20	15.92	13.83	8.00	0	19.11	18.89	13.55	33.38	27.71	12.75	24.42	22.09
WTG11	30.16	29.08	27.14	15.59	14.58	9.41	13.31	19.81	11.55	19.11	0	11.02	11.17	32.48	29.89	7.26	11.29	3.38
WTG12	40.52	39.91	37.18	25.62	25.30	20.32	21.84	26.25	14.82	18.89	11.02	0	5.35	42.21	38.65	13.71	6.12	10.78
WTG13	38.18	38.29	34.56	23.33	23.79	19.37	18.74	22.01	10.35	13.55	11.17	5.35	0	39.26	35.11	10.70	11.18	12.49
WTG14	5.43	11.08	5.61	16.90	18.75	23.90	20.53	19.56	29.66	33.38	32.48	42.21	39.26	0	6.59	28.68	43.77	34.96
WTG15	10.51	15.74	7.70	14.96	17.93	22.43	16.88	13.99	25.02	27.71	29.89	38.65	35.11	6.59	0	24.93	41.02	32.75
WTG16	27.48	27.78	23.87	12.67	13.57	10.09	8.17	13.14	4.75	12.75	7.26	13.71	10.70	28.68	24.93	0	16.69	10.62
WTG17	41.36	39.92	38.43	26.88	25.68	20.39	24.20	29.81	19.14	24.42	11.29	6.12	11.18	43.77	41.02	16.69	0	9.24
WTG18	32.27	30.68	29.50	18.12	16.55	11.24	16.44	23.14	14.76	22.09	3.38	10.78	12.49	34.96	32.75	10.62	9.24	0

Table 2. Distances among wind turbines, GE103-1700, 18 WTGs.

DISTANCE	WTG1	WTG2	WTG3	WTG4	WTG5	WTG6	WTG7	WTG8	WTG9	WTG10	WTG11	WTG12	WTG13	WTG14	WTG15	WTG16	WTG17	WTG18	WTG19
WTG1	0	5.66	4.13	14.92	15.72	21.03	19.67	20.74	29.31	34.19	30.16	36.59	40.52	38.18	5.43	10.51	27.48	41.36	32.27
WTG2	5.66	0	8.25	15.26	14.62	19.68	20.75	23.65	30.43	36.30	29.08	35.54	39.91	38.29	11.08	15.74	27.78	39.92	30.68
WTG3	4.13	8.25	0	11.60	13.16	18.36	15.88	16.62	25.41	30.09	27.14	33.48	37.18	34.56	5.61	7.70	23.87	38.43	29.50
WTG4	14.92	15.26	11.60	0	3.85	7.47	5.69	11.30	15.20	21.60	15.59	21.89	25.62	23.33	16.90	14.96	12.67	26.88	18.12
WTG5	15.72	14.62	13.16	3.85	0	5.31	8.48	14.99	17.01	24.12	14.58	21.04	25.30	23.79	18.75	17.93	13.57	25.68	16.55
WTG6	21.03	19.68	18.36	7.47	5.31	0	8.73	16.29	14.40	22.20	9.41	15.86	20.32	19.37	23.90	22.43	10.09	20.39	11.24
WTG7	19.67	20.75	15.88	5.69	8.48	8.73	0	7.59	9.72	15.92	13.31	18.91	21.84	18.74	20.53	16.88	8.17	24.20	16.44
WTG8	20.74	23.65	16.62	11.30	14.99	16.29	7.59	0	11.66	13.83	19.81	24.47	26.25	22.01	19.56	13.99	13.14	29.81	23.14
WTG9	29.31	30.43	25.41	15.20	17.01	14.40	9.72	11.66	0	8.00	11.55	14.02	14.82	10.35	29.66	25.02	4.75	19.14	14.76
WTG10	34.19	36.30	30.09	21.60	24.12	22.20	15.92	13.83	8.00	0	19.11	19.99	18.89	13.55	33.38	27.71	12.75	24.42	22.09
WTG11	30.16	29.08	27.14	15.59	14.58	9.41	13.31	19.81	11.55	19.11	0	6.47	11.02	11.17	32.48	29.89	7.26	11.29	3.38
WTG12	36.59	35.54	33.48	21.89	21.04	15.86	18.91	24.47	14.02	19.99	6.47	0	5.14	7.93	38.74	35.77	11.33	5.35	5.66
WTG13	40.52	39.91	37.18	25.62	25.30	20.32	21.84	26.25	14.82	18.89	11.02	5.14	0	5.35	42.21	38.65	13.71	6.12	10.78
WTG14	38.18	38.29	34.56	23.33	23.79	19.37	18.74	22.01	10.35	13.55	11.17	7.93	5.35	0	39.26	35.11	10.70	11.18	12.49
WTG15	5.43	11.08	5.61	16.90	18.75	23.90	20.53	19.56	29.66	33.38	32.48	38.74	42.21	39.26	0	6.59	28.68	43.77	34.96
WTG16	10.51	15.74	7.70	14.96	17.93	22.43	16.88	13.99	25.02	27.71	29.89	35.77	38.65	35.11	6.59	0	24.93	41.02	32.75
WTG17	27.48	27.78	23.87	12.67	13.57	10.09	8.17	13.14	4.75	12.75	7.26	11.33	13.71	10.70	28.68	24.93	0	16.69	10.62
WTG18	41.36	39.92	38.43	26.88	25.68	20.39	24.20	29.81	19.14	24.42	11.29	5.35	6.12	11.18	43.77	41.02	16.69	0	9.24
WTG19	32.27	30.68	29.50	18.12	16.55	11.24	16.44	23.14	14.76	22.09	3.38	5.66	10.78	12.49	34.96	32.75	10.62	9.24	0

Table 3. Distances among wind turbines, GE103-1700, 19 WTGs.

Figure 11. Affections among wind turbines, Vestas V100/110 16 WTGs layout.

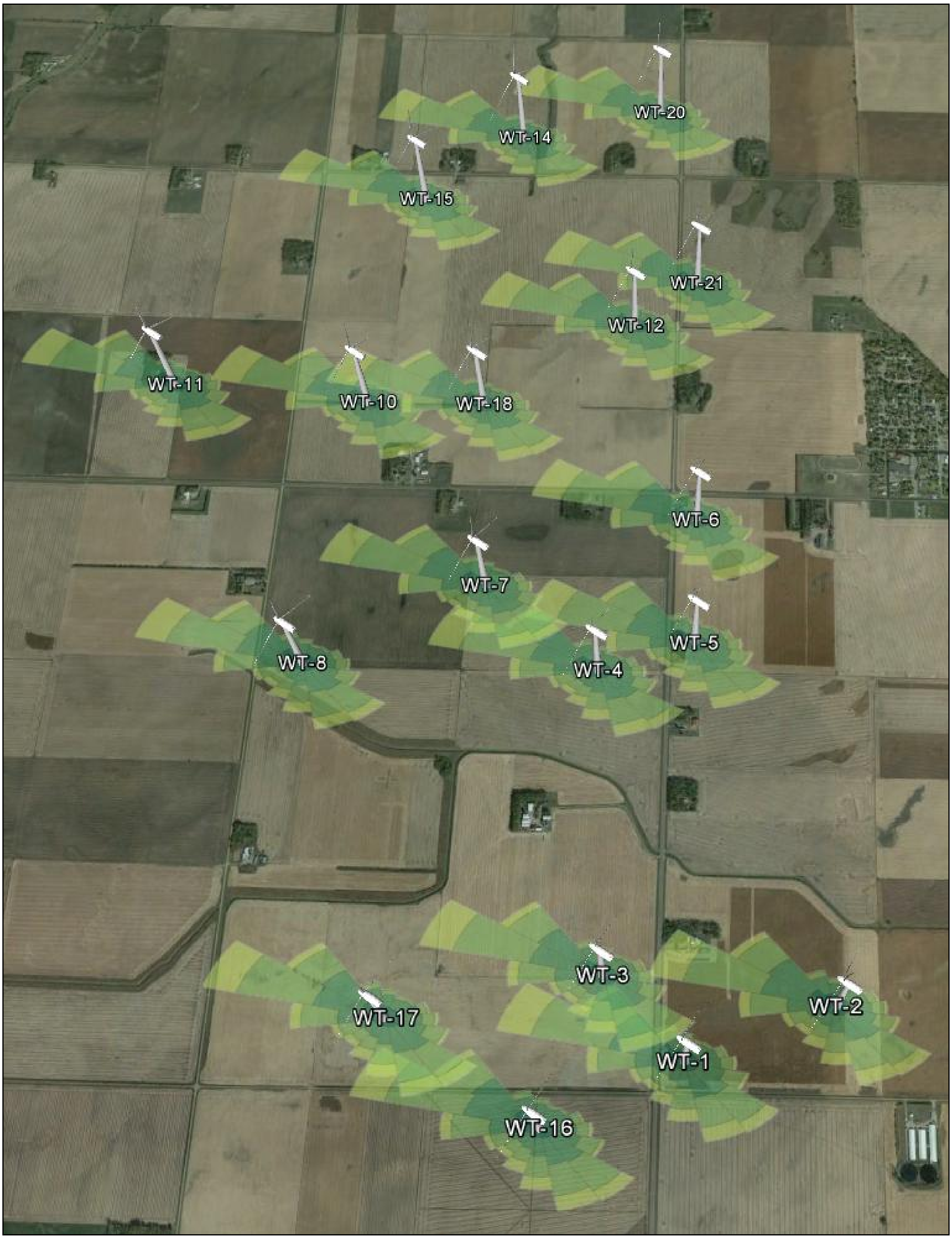


Figure 12. Affections among wind turbines, GE103 18 WTGs layout.

Figure 13. Affections among wind turbines, GE103 19 WTGs layout.

3.3 WIND FARM LAYOUT

In the following table Comfrey wind farm possible lay-outs are presented. The reference system used is NAD83 Time zone 15N. The three options considered are presented.

Turbine	Project Position	Hub [m]	Rotor [m]	Model	Power (Kw)	UTM X [m]	UTM Y [m]	Height (m)	RIX %
COMFREY WIND FARM V100/110-2000									
Ae1	WT-2	80	100	V100-2000	2000	346941	4883555	350	0
Ae2	WT-3	80	100	V100-2000	2000	346099	4883663	350	0
Ae3	WT-5	80	100	V100-2000	2000	346440	4884975	348	0
Ae4	WT-6	80	100	V100-2000	2000	346450	4885522	347	0
Ae5	WT-7	80	100	V100-2000	2000	345603	4885222	350	0
Ae6	WT-8	80	100	V100-2000	2000	344899	4884883	349	0
Ae7	WT-10	80	100	V100-2000	2000	345073	4886072	346	0
Ae8	WT-11	80	100	V100-2000	2000	344253	4886153	350	0
Ae9	WT-12	80	100	V100-2000	2000	346198	4886457	346	0
Ae10	WT-14	80	100	V100-2000	2000	345685	4887470	341	0
Ae11	WT-15	80	100	V100-2000	2000	345258	4887122	345	0
Ae12	WT-16	80	100	V100-2000	2000	345883	4883127	351	0
Ae13	WT-17	80	100	V100-2000	2000	345321	4883506	351	0
Ae14	WT-18	80	100	V100-2000	2000	345563	4886063	350	0
Ae15	WT-20	80	100	V100-2000	2000	346298	4887616	342	0
Ae16	WT-21	80	100	V100-2000	2000	346466	4886680	345	0

Turbine	Project Position	Hub [m]	Rotor [m]	Model	Power (Kw)	UTM X [m]	UTM Y [m]	Height (m)	RIX %
COMFREY WIND FARM GE103-1700									
Ae1	WT-1	80	103	GE103-1700	1715	346393	4883357	350	0
Ae2	WT-2	80	103	GE103-1700	1715	346941	4883555	350	0
Ae3	WT-3	80	103	GE103-1700	1715	346099	4883663	350	0
Ae4	WT-4	80	103	GE103-1700	1715	346062	4884858	350	0
Ae5	WT-5	80	103	GE103-1700	1715	346440	4884975	348	0
Ae6	WT-6	80	103	GE103-1700	1715	346450	4885522	347	0
Ae7	WT-7	80	103	GE103-1700	1715	345603	4885222	350	0
Ae8	WT-8	80	103	GE103-1700	1715	344899	4884883	349	0
Ae9	WT-10	80	103	GE103-1700	1715	345073	4886072	346	0
Ae10	WT-11	80	103	GE103-1700	1715	344253	4886153	350	0
Ae11	WT-12	80	103	GE103-1700	1715	346198	4886457	346	0
Ae12	WT-14	80	103	GE103-1700	1715	345685	4887470	343	0
Ae13	WT-15	80	103	GE103-1700	1715	345258	4887122	341	0
Ae14	WT-16	80	103	GE103-1700	1715	345883	4883127	345	0
Ae15	WT-17	80	103	GE103-1700	1715	345321	4883506	351	0
Ae16	WT-18	80	103	GE103-1700	1715	345563	4886063	351	0
Ae17	WT-20	80	103	GE103-1700	1715	346298	4887616	350	0
Ae18	WT-21	80	103	GE103-1700	1715	346466	4886680	342	0

Turbine	Project Position	Hub [m]	Rotor [m]	Model	Power (Kw)	UTM X [m]	UTM Y [m]	Height (m)	RIX %
COMFREY WIND FARM GE103-1700									
Ae1	WT-1	80	103	GE103-1700	1715	346393	4883357	350	0
Ae2	WT-2	80	103	GE103-1700	1715	346941	4883555	350	0
Ae3	WT-3	80	103	GE103-1700	1715	346099	4883663	350	0
Ae4	WT-4	80	103	GE103-1700	1715	346062	4884858	350	0
Ae5	WT-5	80	103	GE103-1700	1715	346440	4884975	348	0
Ae6	WT-6	80	103	GE103-1700	1715	346450	4885522	347	0
Ae7	WT-7	80	103	GE103-1700	1715	345603	4885222	350	0
Ae8	WT-8	80	103	GE103-1700	1715	344899	4884883	349	0
Ae9	WT-10	80	103	GE103-1700	1715	345073	4886072	346	0
Ae10	WT-11	80	103	GE103-1700	1715	344253	4886153	350	0
Ae11	WT-12	80	103	GE103-1700	1715	346198	4886457	346	0
Ae12	WT-13	80	103	GE103-1700	1715	346075	4887112	343	0
Ae13	WT-14	80	103	GE103-1700	1715	345685	4887470	341	0
Ae14	WT-15	80	103	GE103-1700	1715	345258	4887122	345	0
Ae15	WT-16	80	103	GE103-1700	1715	345883	4883127	351	0
Ae16	WT-17	80	103	GE103-1700	1715	345321	4883506	351	0
Ae17	WT-18	80	103	GE103-1700	1715	345563	4886063	350	0
Ae18	WT-20	80	103	GE103-1700	1715	346298	4887616	342	0
Ae19	WT-21	80	103	GE103-1700	1715	346466	4886680	345	0

Table 4. Comfrey wind farm lay-outs studied in this assessment.

4. WIND RESOURCE MEASUREMENT

4.1. DESCRIPTION

The meteorological mast used to carry out the energy assessment of Comfrey wind farm is an 80 meter height mast located in the following NAD83 T15N coordinates: 345.340 – 4.884.394. Measurements are available from 03/12/2010 to 23/07/2014. The following information from Comfrey wind farm has been received:

- Comfrey meteorological mast wind data.
- Meteorological mast description and measurement levels.
- Calibration certificates of the anemometers are not available.

The met mast is located within the limits of the wind farm. Being the wind farm located in a very flat terrain, the results derived from the met mast will be considered as representative of the wind regime and therefore of the energy produced.

The reference period is going to be selected from 1st March 2011 to 28th February 2014. It's strongly recommended to take blocks of entire years to build the reference period. Three years of data are available which will provide the results with manageable uncertainty.

In the next tables the information about all the sensors installed and the calibrations applied is presented.

WIND RESOURCE ASSESSMENT AND SITE ASSESSMENT DEPARTMENT

MET MAST NAME / ID	INSTALLATION DATE
COMFREY MET MAST	15/08/2007

SITE DESCRIPTION	
COMPANY / OWNER	COMFREY WIND FARM LLC
UTM-X / LONGITUDE	345.340 / 94.9321694 W
UTM-Y / LATITUDE	4.884.394 / 44.0963944 N
REFERENCE SYSTEM	NAD 83
UTM TIME ZONE	T15 N
HEIGHT	352 meters (1155 feet)
TOWN	Comfrey
MET MAST HEIGHT	80 meters (256 feet)
MET MAST MAKE	
REGION	Cottonwood county (Minnesota)
COUNTRY	USA
MET MAST ID	183
TERRAIN / VEGETATION TYPE	Cultivated crops

EQUIPMENT LIST						
SENSOR - MAKE	HEIGTH	CHANNEL	ALIAS	ORIENTATION	CAL / OFFSET	SERIAL Nº / CALIBRATION
NRG 40 anemometer	80	A1	80_1	315º		
NRG 40 anemometer	80	A2	80_2	135º		
NRG 200P wind vane	80	V1		230º		
NRG 40 anemometer	60	A3	60_1	315º		
NRG 40 anemometer	60	A4	60_2	135º		
NRG 200P wind vane	60	V2		230º		
NRG 40 anemometer	40	A5	40_1	135º		
NRG 40 anemometer	40	A6	40_2	315º		
NRG 200P wind vane	40	V3		230º		
Temperature						
BATTERY VOLTAGE	PV HEIGHT	ORIENTATION	LOGGER HEIGHT	NIGHT LIGHT	DAY LIGHT	SAFETY LINE / WIRE (SI/NO)
				n/a	n/a	
REMARKS	WIND VANES	ANEMOMETERS	LOGGER MODEL	LOGGER SERIAL	LIGHTNING KIT	DIRECTION DEVIATION (SI/NO)
	3	6	NRG		n/a	SI

EQUIPMENT MEASUREMENT PERIOD					
SENSOR - MAKE	HEIGTH	CHANNEL	START MEASUREMENT PERIOD	FAILURE	END MEASUREMENT PERIOD
NRG 40 anemometer	80	A1	15/08/2007	YES	01/04/2014
NRG 40 anemometer	80	A2	15/08/2007	NO	23/07/2014
NRG 200P wind vane	80	V1	15/08/2007	NO	23/07/2014
NRG 40 anemometer	60	A3	15/08/2007	NO	23/07/2014
NRG 40 anemometer	60	A4	15/08/2007	NO	23/07/2014
NRG 200P wind vane	60	V2	15/08/2007	NO	23/07/2014
NRG 40 anemometer	40	A5	15/08/2007	NO	23/07/2014
NRG 40 anemometer	40	A6	15/08/2007	YES	04/03/2012
NRG 200P wind vane	40	V3	15/08/2007	NO	23/07/2014
Temperature		ANALOG	15/08/2007	YES	15/08/2007

Table 5. Comfrey met mast description sheet.

Met Mast	UTM X	UTM Y	Time zone	Ref. system	Elevation	Measurement levels	Start mesurement	End measurement
COMFREY	345.340	4.884.394	T15N	NAD83	352	80-80-60-60-40-40	15-08-2007	23-07-2014

Table 6. Available met masts.

Met Mast	Sensor type	Serial number	Make	Height	Start mesurement	End measurement	Slope	Offset	Calibration	Slope apllied	Offset applied
COMFREY MET MAST											
COMFREY	anemometer		NRG 40	80	15-08-2007	01-04-2014				0.76500	0.35000
COMFREY	anemometer		NRG 40	80	15-08-2007	23-07-2014				0.76500	0.35000
COMFREY	anemometer		NRG 40	60	15-08-2007	23-07-2014				0.76500	0.35000
COMFREY	anemometer		NRG 40	60	15-08-2007	23-07-2014				0.76500	0.35000
COMFREY	anemometer		NRG 40	40	15-08-2007	23-07-2014				0.76500	0.35000
COMFREY	anemometer		NRG 40	40	15-08-2007	04-03-2012				0.76500	0.35000
COMFREY	wind vane		NRG 200P	80	15-08-2007	23-07-2014		50º			-50º
COMFREY	wind vane		NRG 200P	60	15-08-2007	23-07-2014		50º			-50º
COMFREY	wind vane		NRG 200P	40	15-08-2007	23-07-2014		50º			-50º
COMFREY	Temperature			3	15-08-2007	23-07-2014					

Table 7. Comfrey met mast equipment list and calibration applied.

COMFREY MET MAST	Wind speed 80 meters (m/s)	Wind speed 60 meters (m/s)	Wind speed 40 meters (m/s)	Wind shear
Mean	7.78	7.47	6.67	0.215

Table 8. Comfrey met mast measurement levels wind speed, reference period.

4.2 DATA FILTERING AND AVAILABILITY

191,232 10-minute wind data have been processed and analysed. The selection of the reference time period (1st March 2011 to 28th February 2014) and the filtering process imply the final use of 154,832 10-minute data, and a general availability of 98.10% is met in the reference period.

In the annexes the daily availability of each anemometer is presented along with all the problems detected in the meteorological mast. Colourful maps are also presented showing the amount of available daily data of each sensor during the whole measurement campaign.

No artificial exterior generation of wind data in order to fill gaps, has been done. Only data from the different anemometers at the met mast has been used in order to fill measurements of anemometers at equal and different levels.

In the next page it is possible to observe a table with the monthly availability, number of data and mean wind speed of each anemometer. The data are used to verify the consistency of the measurements. The anemometer known as 40_2 will not be considered due to the fact of his early failure.

These data will be taken into account to implement this energy assessment, constituting a reference period of measurement of 3 years.

CONFREY MET MAST																	
YEAR	MONTH	V80_1	D/A %	Data	V80_2	D/A %	Data	V60_1	D/A %	Data	V60_2	D/A %	Data	V40_1	D/A %	Data
2010	JANUARY	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
	FEBRUARY	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
	MARCH	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
	APRIL	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
	MAY	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
	JUNE	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
	JULY	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
	AUGUST	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
	SEPTEMBER	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
	OCTOBER	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
	NOVEMBER	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
	DECEMBER	8.26	58.96	2632	8.21	57.46	2565	7.52	56.14	2506	7.64	58.71	2621	6.87	60.57	2704
2011	JANUARY	7.63	96.46	4306	7.61	96.46	4306	7.02	96.46	4306	7.03	96.46	4306	6.50	96.46	4306
	FEBRUARY	9.86	90.92	3666	9.85	90.92	3666	9.19	90.92	3666	9.14	90.92	3666	8.25	90.92	3666
	MARCH	7.58	100.00	4464	7.60	100.00	4464	7.09	100.00	4464	7.09	100.00	4464	6.55	100.00	4464
	APRIL	8.39	100.00	4320	8.31	100.00	4320	8.02	100.00	4320	7.96	100.00	4320	7.42	100.00	4320
	MAY	8.34	100.00	4464	8.33	100.00	4464	8.01	100.00	4464	7.89	100.00	4464	7.34	100.00	4464
	JUNE	7.28	100.00	4320	7.29	100.00	4320	6.96	100.00	4320	6.78	100.00	4320	6.32	100.00	4320
	JULY	5.86	100.00	4464	5.90	100.00	4464	5.52	100.00	4464	5.41	100.00	4464	4.86	100.00	4464
	AUGUST	5.83	100.00	4464	5.90	100.00	4464	5.46	100.00	4464	5.37	100.00	4464	4.71	100.00	4464
	SEPTEMBER	6.51	100.00	4320	6.44	100.00	4320	6.12	100.00	4320	5.94	100.00	4320	5.34	100.00	4320
	OCTOBER	8.35	100.00	4464	8.58	100.00	4464	8.13	100.00	4464	7.99	100.00	4464	7.16	100.00	4464
	NOVEMBER	8.82	100.00	4320	8.91	100.00	4320	8.46	100.00	4320	8.39	100.00	4320	7.54	100.00	4320
	DECEMBER	8.69	95.88	4280	8.61	95.88	4280	8.12	95.90	4281	8.07	95.90	4281	7.22	95.90	4281
2012	JANUARY	9.48	93.26	4163	9.70	90.37	4034	9.00	92.72	4139	9.15	90.66	4047	7.97	96.51	4308
	FEBRUARY	8.07	86.66	3494	8.18	86.66	3494	7.71	86.66	3494	7.78	86.73	3497	6.99	86.66	3494
	MARCH	8.49	94.15	4203	8.82	94.15	4203	8.21	94.62	4224	8.38	94.62	4224	7.56	95.59	4267
	APRIL	8.28	100.00	4320	8.59	100.00	4320	8.14	100.00	4320	8.16	100.00	4320	7.29	100.00	4320
	MAY	8.18	100.00	4464	8.35	100.00	4464	8.02	100.00	4464	7.98	100.00	4464	7.23	100.00	4464
	JUNE	7.14	100.00	4320	7.22	100.00	4320	7.07	100.00	4320	7.09	100.00	4320	6.39	100.00	4320
	JULY	5.76	100.00	4464	5.65	100.00	4464	5.53	100.00	4464	5.58	100.00	4464	4.73	100.00	4464
	AUGUST	6.11	100.00	4464	6.03	100.00	4464	5.83	100.00	4464	5.89	100.00	4464	4.96	100.00	4464
	SEPTEMBER	6.83	100.00	4320	6.72	100.00	4320	6.64	100.00	4320	6.58	100.00	4320	5.77	100.00	4320
	OCTOBER	8.26	100.00	4464	8.26	100.00	4464	8.03	100.00	4464	8.06	100.00	4464	7.35	100.00	4464
	NOVEMBER	7.88	100.00	4320	7.92	100.00	4320	7.59	100.00	4320	7.70	100.00	4320	7.01	100.00	4320
	DECEMBER	7.53	93.66	4181	7.52	94.00	4196	6.89	100.00	4464	7.28	94.47	4217	6.40	100.00	4464
2013	JANUARY	8.56	85.13	3800	8.61	85.13	3800	8.23	85.13	3800	8.33	85.13	3800	7.64	85.13	3800
	FEBRUARY	7.63	97.00	3911	7.60	97.02	3912	7.38	97.12	3916	7.44	97.67	3938	6.93	97.17	3918
	MARCH	7.86	94.51	4219	7.78	94.51	4219	7.63	94.65	4225	7.67	94.65	4225	7.10	94.69	4227
	APRIL	8.51	89.51	3867	8.48	89.51	3867	8.30	89.58	3870	8.33	89.58	3870	7.55	89.86	3882
	MAY	7.61	100.00	4464	7.46	100.00	4464	7.44	100.00	4464	7.47	100.00	4464	6.65	100.00	4464
	JUNE	6.88	100.00	4320	6.81	100.00	4320	6.72	100.00	4320	6.77	100.00	4320	5.91	100.00	4320
	JULY	6.50	100.00	4464	6.40	100.00	4464	6.32	100.00	4464	6.32	100.00	4464	5.39	100.00	4464
	AUGUST	5.72	100.00	4464	5.64	100.00	4464	5.59	100.00	4464	5.63	100.00	4464	4.77	100.00	4464
	SEPTEMBER	7.10	100.00	4320	7.18	100.00	4320	6.79	100.00	4320	6.94	100.00	4320	5.86	100.00	4320
	OCTOBER	7.81	100.00	4464	7.86	100.00	4464	7.48	100.00	4464	7.55	100.00	4464	6.66	100.00	4464
	NOVEMBER	9.34	100.00	4320	9.42	100.00	4320	8.89	100.00	4320	9.02	100.00	4320	8.15	100.00	4320
	DECEMBER	7.86	96.46	4306	7.80	96.48	4307	7.52	96.46	4306	7.62	96.46	4306	6.97	96.46	4306
2014	JANUARY	10.18	100.00	4464	10.15	100.00	4464	9.70	100.00	4464	9.77	100.00	4464	8.99	100.00	4464
	FEBRUARY	9.22	100.00	4032	9.16	100.00	4032	8.69	100.00	4032	8.85	100.00	4032	8.06	100.00	4032
	MARCH	8.47	100.00	4464	8.44	100.00	4464	8.13	100.00	4464	8.21	100.00	4464	7.57	100.00	4464
	APRIL	17.00	0.07	3	8.90	97.38	4207	8.76	97.45	4210	8.69	97.45	4210	8.03	97.55	4214
	MAY	0.00	0.00	0	7.54	100.00	4464	7.29	100.00	4464	7.38	100.00	4464	6.75	100.00	4464
	JUNE	0.00	0.00	0	7.21	100.00	4320	6.92	100.00	4320	7.07	100.00	4320	6.43	100.00	4320
	JULY	0.00	0.00	0	7.45	100.00	3240	7.21	100.00	3240	7.27	100.00	3240	6.57	100.00	3240
	AUGUST	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
	SEPTEMBER	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
	OCTOBER	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
	NOVEMBER	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
	DECEMBER	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
TOTAL		7.79	97.36	169543	7.80	97.48	185592	7.46	97.68	185943	7.49	97.53	185744	6.75	97.81	186373

Table 9. Comfrey monthly wind data with no filling process implemented.

4.3 SENSOR FUNCTIONALITY

As it will be explained in the present point, no problems regarding anemometer consistency at Comfrey met mast have been spotted.

Once the measurements have been cleaned, a decision has to be made in terms of the measurements chosen to calculate the wind shear and estimate this important parameter for wind turbine operation. The hub height in this project is chose to be 80 meters; therefore no extrapolation will be needed in order to calculate the wind distribution at hub height. Nevertheless it is important to calculate the wind shear.

The pair of anemometers situated at 80-40 meters and orientated towards 135º, have been chosen based on 2 criteria:

- There must be a minimum distance between the anemometers selected to calculate the wind shear.
- This pair of anemometers is the best option to represent the wind shear across the wind turbine rotor.

These anemometers will be known as the shear anemometers from now on and the wind vanes associated with them will be known as the shear wind vanes.

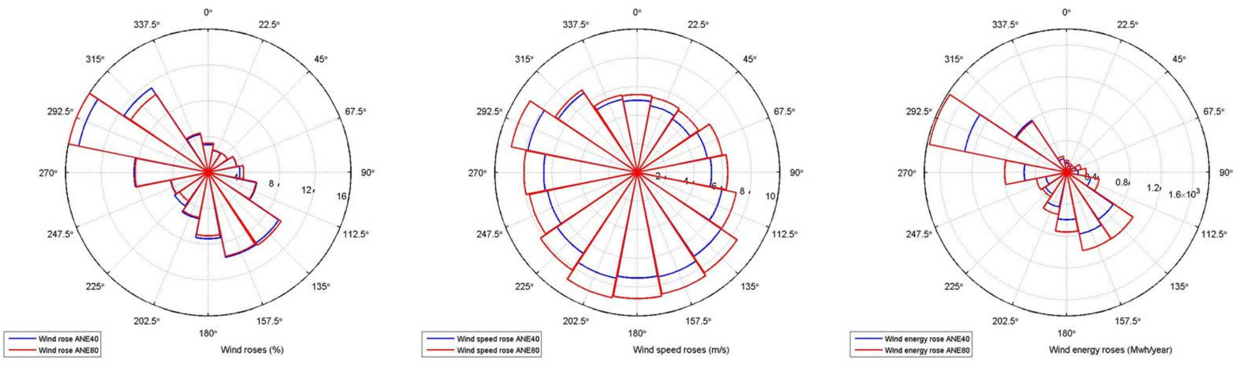


Figure 14. 80_1 and 40_1 meter wind rose, wind speed rose and wind energy rose.

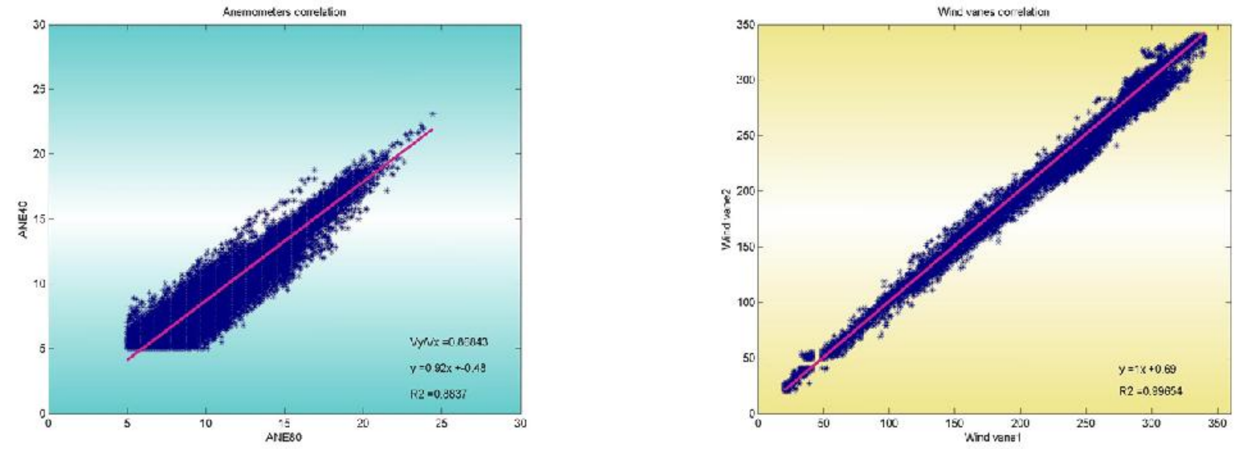


Figure 15. 80_1 and 40_1 meter anemometer correlation, reference period.

Sector	Slope	Offset	R^2	Nº Points
1	0.998	-0.628	0.900	2132
2	1.004	-0.750	0.857	1488
3	0.909	-0.232	0.834	1521
4	0.887	-0.224	0.890	2296
5	0.871	-0.248	0.904	2667
6	0.971	-0.927	0.881	5205
7	0.966	-1.066	0.878	10892
8	0.946	-0.892	0.878	11466
9	0.906	-0.662	0.854	8525
10	0.851	-0.004	0.881	5884
11	0.785	0.591	0.814	4745
12	0.918	-0.649	0.884	4304
13	0.944	-0.827	0.878	9067
14	0.971	-0.746	0.947	17768
15	0.878	0.041	0.890	11404
16	1.071	-1.051	0.816	3104
Global	**0.918**	**-0.478**	**0.884**	**102468**

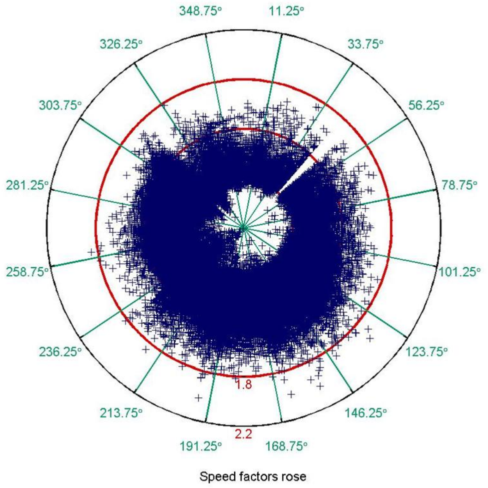


Figure 16. Wind direction sector correlation and anemometer measurement comparison.

It can be seen that the correlation between the anemometers selected is good enough. Some scatter can be observed between both anemometers due to the fact that these anemometers are not yet cleaned from the shadow effects of the met mast. In fact the anemometer 40_1 will not be cleaned due to the early failure of the 40_2 anemometer.

The fact that the anemometers are not calibrated and the existence of a high wind shear value between both levels also contribute to this scatter, not revealing however malfunctioning of any of the anemometers.

In the next plot, the distribution of the wind direction difference º between the two wind vanes installed at the meteorological mast, at 80 and 40 meters respectively, is presented. This plot along with the wind vanes correlation figure shown in the previous page, show no difference between both wind vanes. Due to the lack of offset between both wind vanes, it will be possible to identify perfectly the main wind directions.

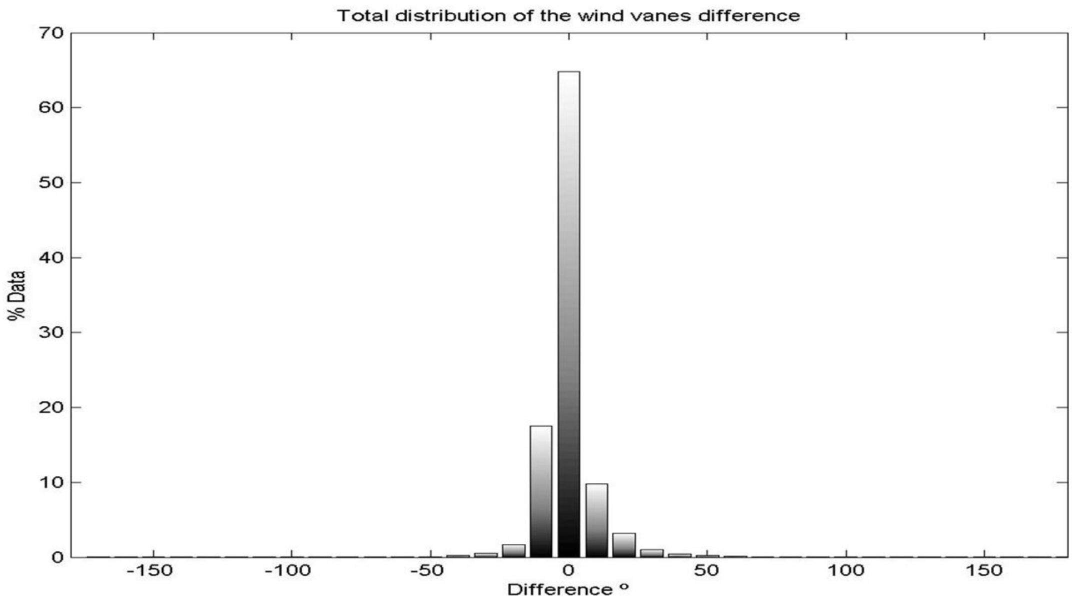


Figure 17. Distribution of the wind vane difference, reference period.

The next two plots are intended to study the evolution of the main anemometers and wind vanes during the measurement period and observe possible drifts, trends or degradation of any sensor. The two shear anemometers show no temporal drift and their performance has been coherent and accurate.

The performance of the shear wind vanes shows a similar behavior with no temporal drifts or degradations. It can be concluded that the measurement conditions at Comfrey met mast show consistency in time. The lack of MEASNET calibration can be described as the main default of the measurement campaign.

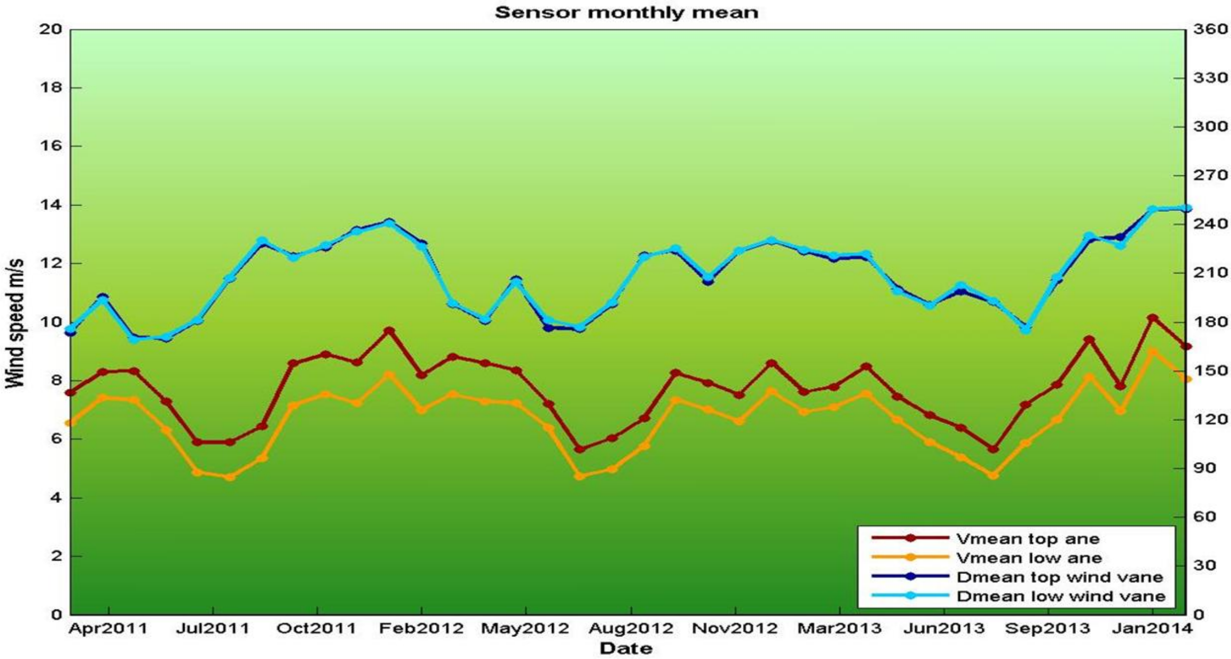


Figure 18. Monthly means of the sensors, reference period.

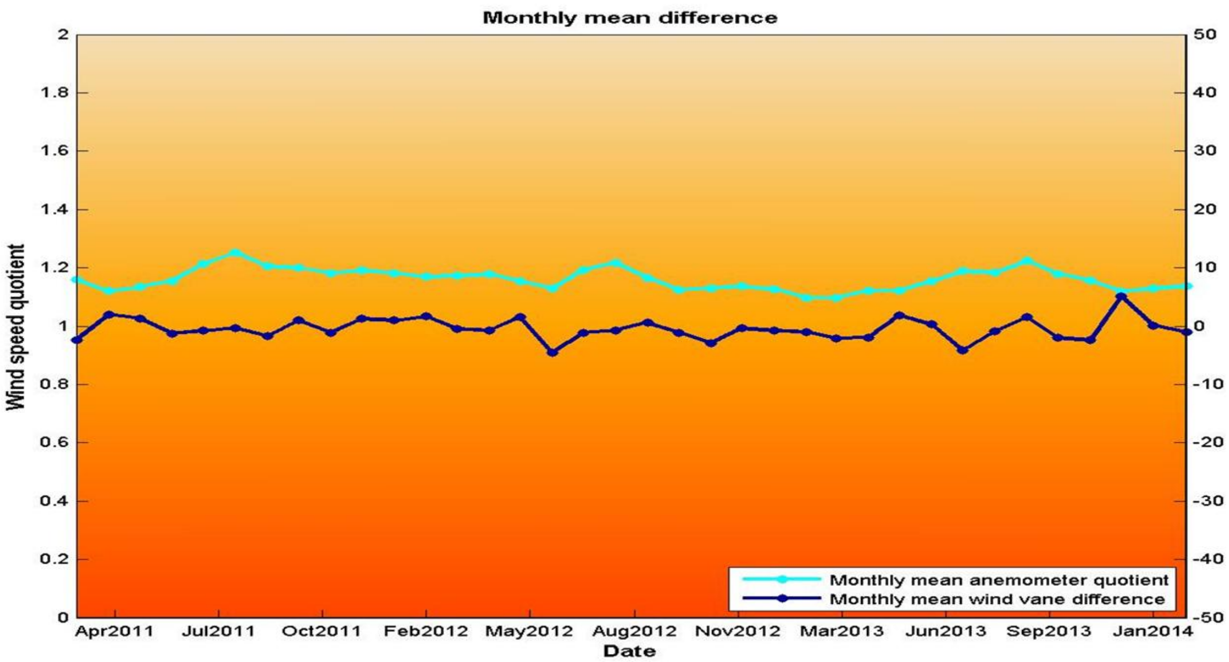


Figure 19. Difference of the monthly means of the sensors, reference period.

4.4 WIND SHEAR

Wind shear in the reference period is analysed with the 80_2 and 40_1 anemometers, meeting a mean value of 0.215. This is quite a high value, meaning that it will be necessary to demand an opinion to the wind turbine manufacturers about this fact. The wind shear is an important parameter affecting the validation of the site conditions for an effective operation of the wind turbines. This validation is done by the wind turbine manufacturer.

In order to calculate the wind shear a series of calculations are made, following a logarithmic law and supposing a neutral behavior of the atmosphere boundary layer. There are not measurements available to characterize the different types of atmosphere stability (stable/neutral/unstable) and therefore corrections to the wind shear are not possible.

Data are divided into 16 wind direction sectors according to the highest wind vane and the logarithmic law is applied to each set of data. Different calculations are done in order to remove the affection of low wind speeds and outliers. In the next page a linear and a rose plot of the values met are presented.

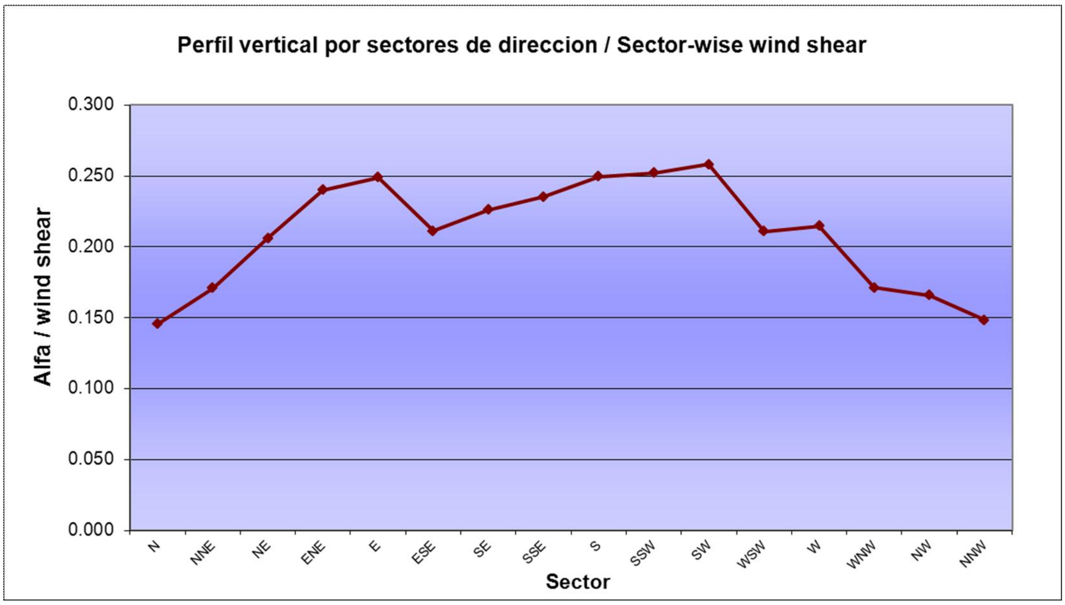


Figure 20. Sector wise wind shear, 80_2 and 40_1 meter anemometers, reference period.

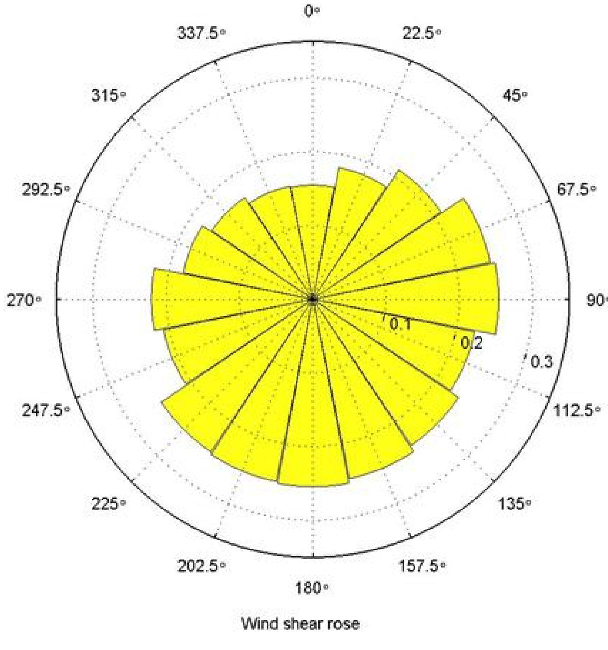


Figure 21. Wind shear rose, reference period.

4.5 MET MAST AFFECTION

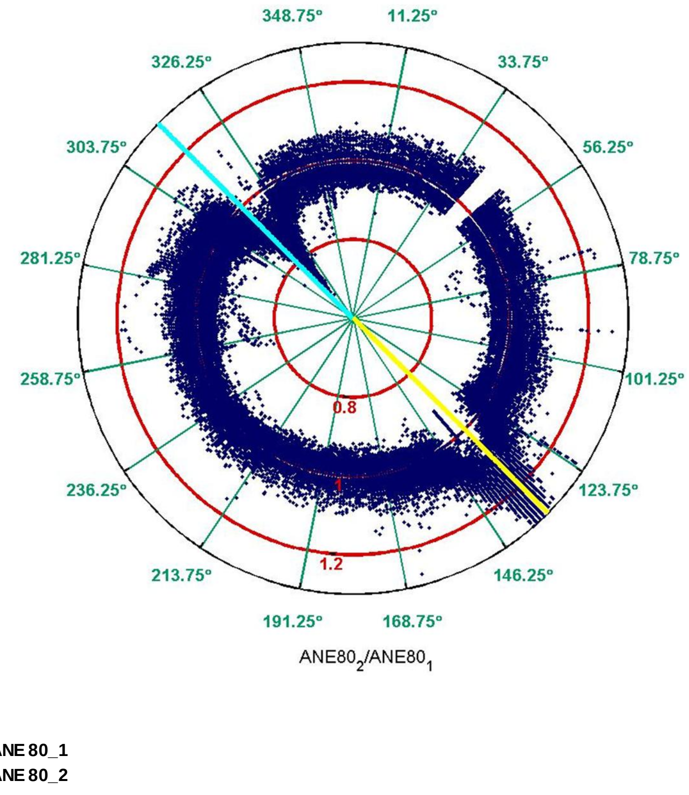
The measurements of Comfrey met mast have been made with double coverage at 80, 60 and 40 meters, situating 2 NRG 40 anemometers orientated towards 135º and 315º. This is made with the aim of removing the met mast affection and be able to build a clean dataset of wind data. This procedure will be performed on the anemometers placed at 80 and 60 meters, but only the plots describing this process at 80 meters will be shown.

The anemometer 80_2 will be considered as the main anemometer, due to the fact that it is still working and presents higher availability than the 80_1 anemometer. In the following plot the wind speed measurements of the 80_2 anemometer are divided and subtracted respectively by the 80_1 anemometer and represented as a function of the wind direction.

There are two situations where the wind speed of the two anemometers is quite different. These two events represent the mast shadow, wind affecting sectors 7 and 15 respectively. In order to remove this problem the anemometers have been combined to a single dataset, using the wind data from directions undisturbed by the mast.

On the next page the results of the correlation between both anemometers is shown. It can be observed that the correlation is very good and therefore a consistent series of data will be obtained at 80 meters height.

The dataset obtained from the combination of the 2 anemometers placed at 80 meters will be used to estimate the net energy produced by the wind turbines of Comfrey wind farm.



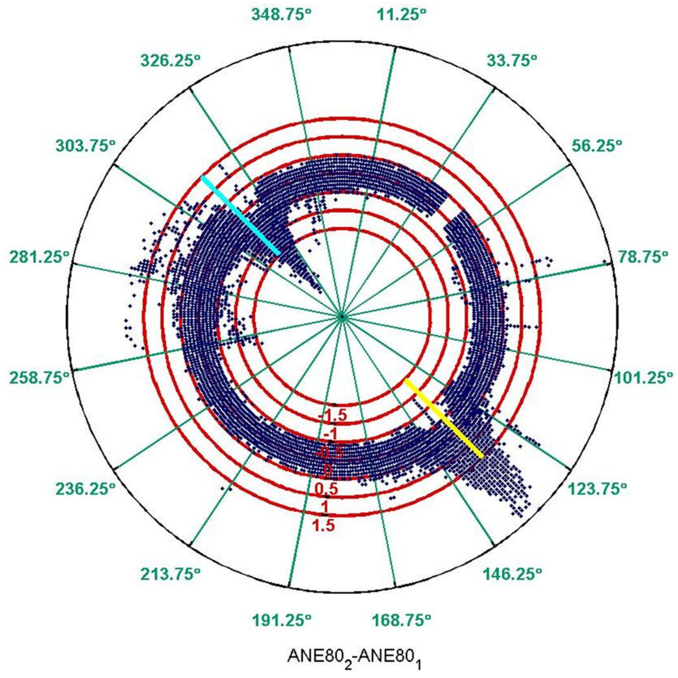


Figure 22. Quotient and difference of the 80 meter anemometers, placed at Comfrey met mast.

Sector	ANE 1 m/s	ANE2 m/s	FREQ. %	QUOTIENT
1	5.48	5.55	3.20	0.988
2	5.35	5.36	2.50	0.998
3	5.33	5.30	2.62	1.005
4	6.08	6.08	3.23	1.001
5	6.35	6.30	3.90	1.008
6	7.04	6.98	5.32	1.009
7	8.42	7.65	9.69	1.101
8	8.72	8.65	9.30	1.007
9	8.90	8.97	6.85	0.992
10	9.04	9.13	5.10	0.990
11	8.44	8.46	3.97	0.997
12	7.93	7.93	4.53	0.999
13	8.04	8.05	8.32	0.999
14	9.03	9.01	16.60	1.002
15	6.99	7.51	10.55	0.931
16	5.50	5.69	4.32	0.967
Global	**7.802**	**7.789**	**100**	**1.002**

Sector	Slope	Offset	R^2	Nº Points
1	0.998	0.080	0.993	3664
2	0.994	0.034	0.994	2793
3	0.991	0.013	0.994	3011
4	0.990	0.053	0.993	3977
5	0.984	0.058	0.995	5005
6	0.992	-0.004	0.994	7382
7	0.922	-0.119	0.956	14419
8	1.003	-0.098	0.997	14196
9	1.014	-0.064	0.998	10307
10	1.012	-0.025	0.999	7550
11	1.005	-0.030	0.999	5650
12	1.001	-0.015	0.997	6368
13	0.989	0.097	0.996	12125
14	0.982	0.149	0.997	25717
15	0.983	0.660	0.955	14134
16	1.020	0.062	0.985	5078
Global	**0.988**	**0.075**	**0.979**	**141376**

Table 10. Sector wise result of the division and the correlation between the 80 meter anemometers, placed at Comfrey met mast.

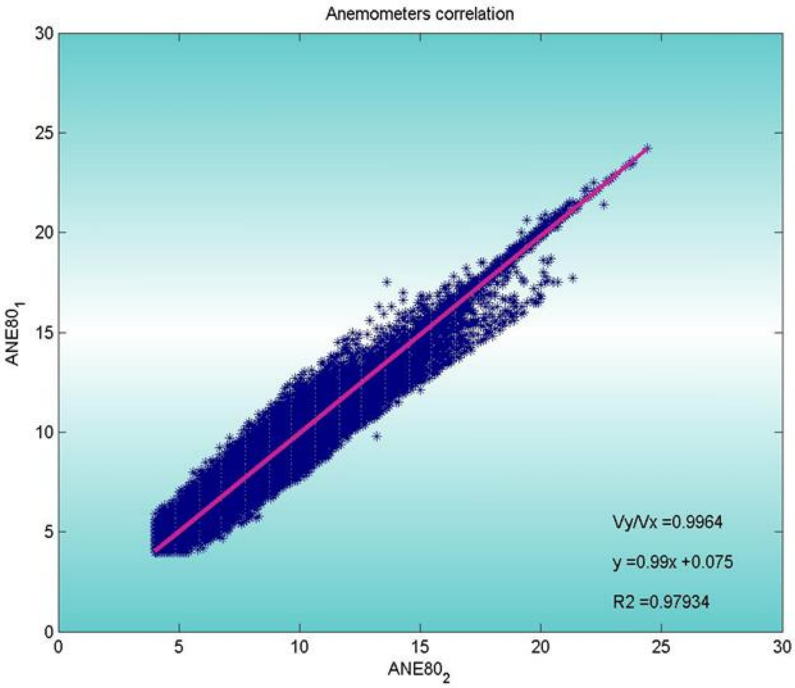


Figure 23. Correlation of the 80 meter anemometers, placed at Comfrey met mast.

4.6 WIND STATISTICS

Within the next pages, statistical roses obtained at the meteorological mast will be presented; hourly and monthly plots will also be shown in order to identify the wind regime affecting Comfrey wind farm.

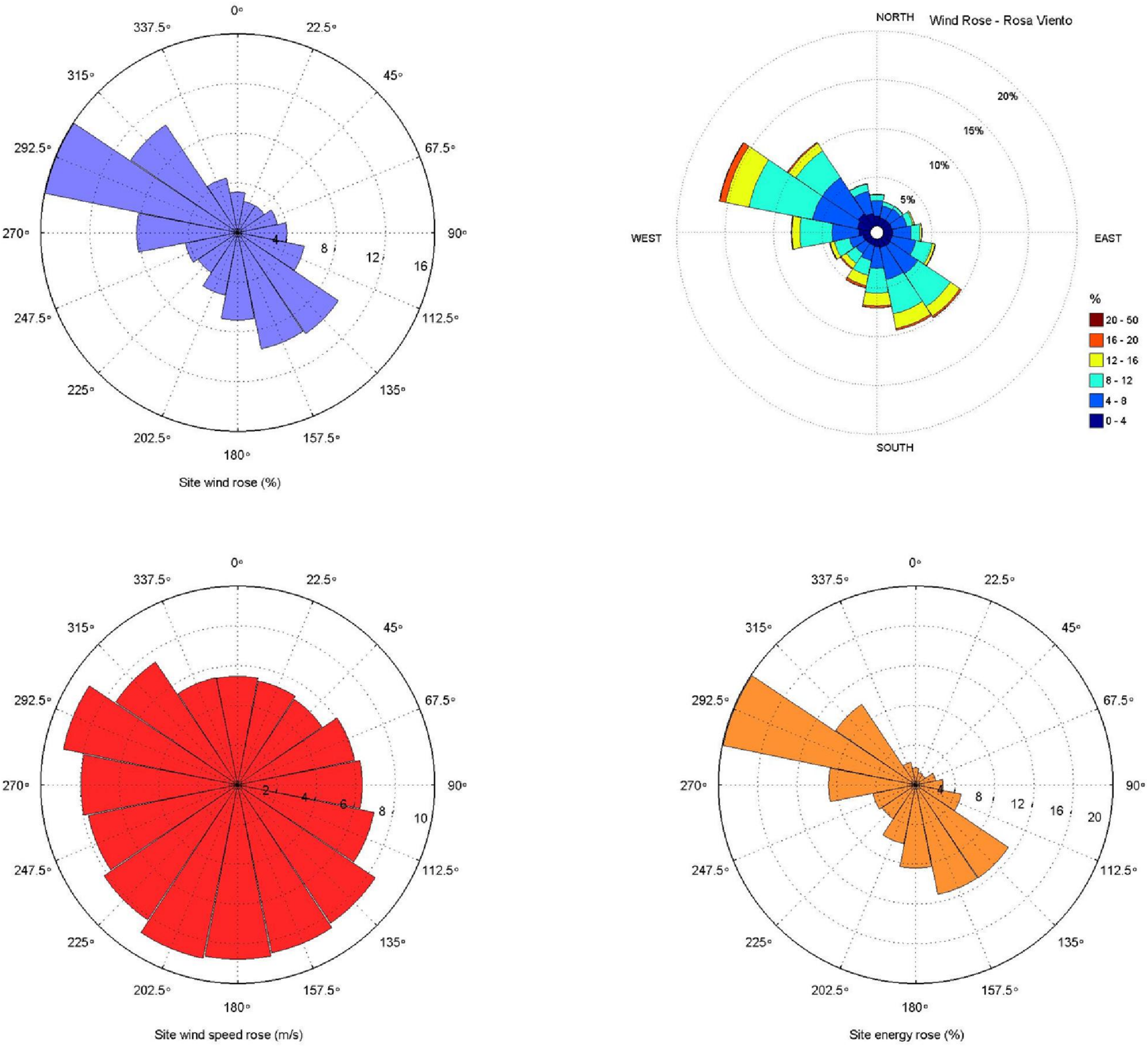


Figure 24. Wind rose, wind rose with speed intervals, wind speed rose and wind energy rose at 80 meters Comfrey met mast.

In these plots it can be noticed that main wind speed directions come from the northwest and southeast, with some secondary wind coming from the south and west. The most energetic directions would be the northwest and southeast ones.

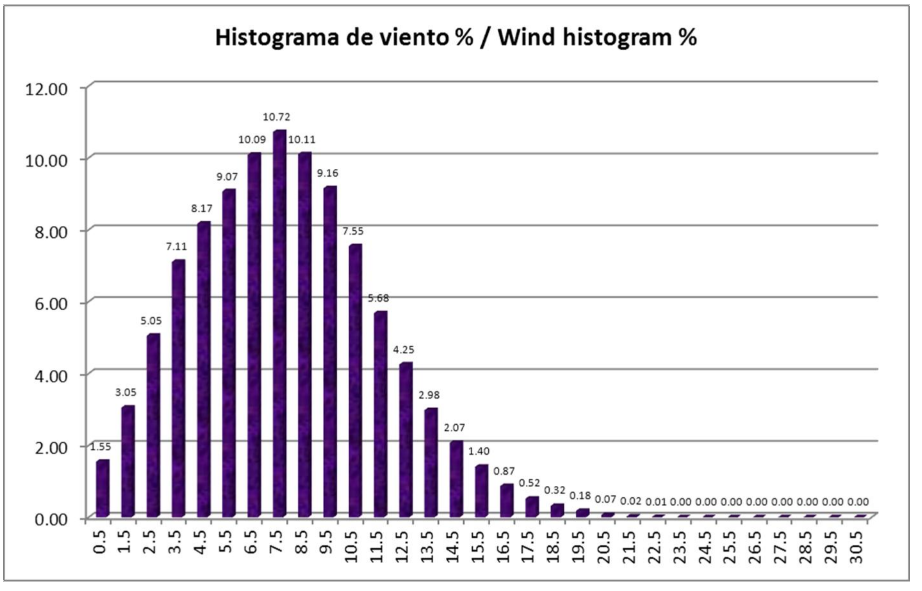


Figure 25. Wind histogram at 80 meters height.

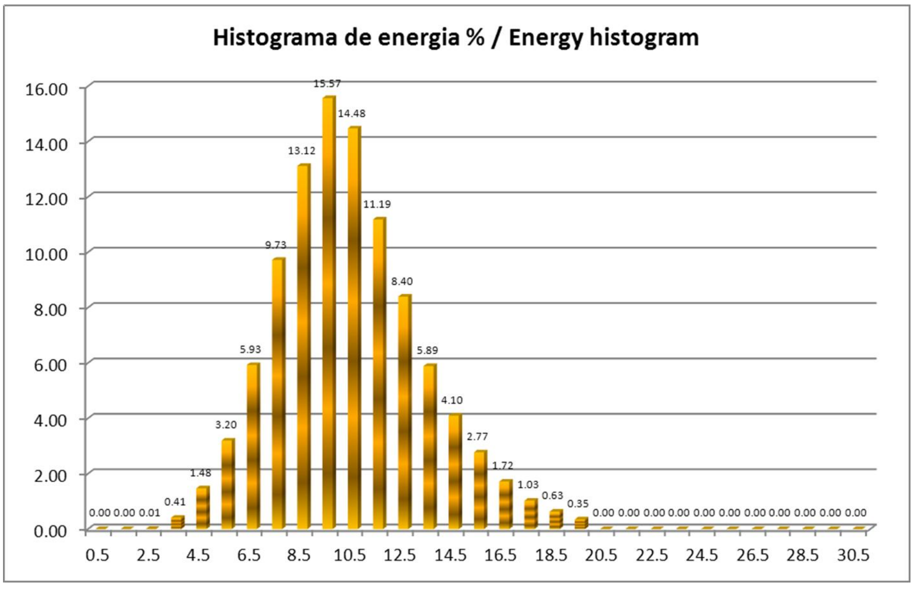
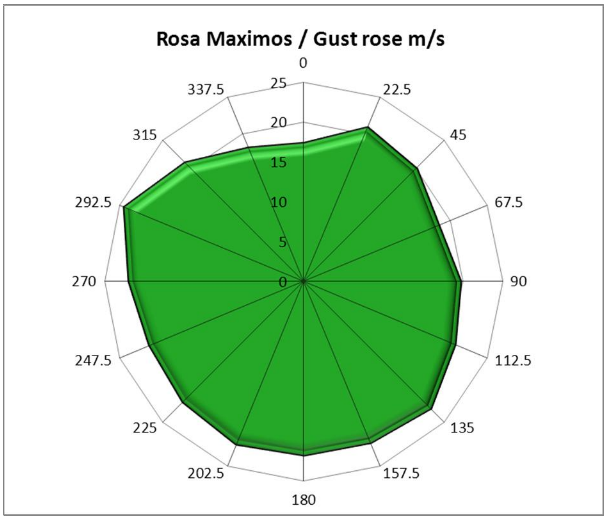


Figure 26. Energy histogram at 80 meters height.

In these plots the wind frequency histogram and the energy histogram are shown in order to identify the wind regime of Comfrey wind farm.



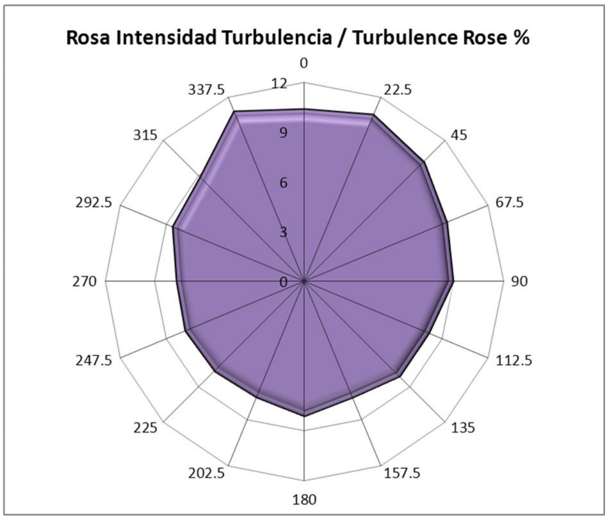


Figure 27. Wind speed gust rose and turbulence intensity rose at 80 meters.

In these plots the wind frequency histogram and the energy histogram are shown in order to identify the wind regime of Comfrey wind farm.

It can be observed that the highest wind speed gusts come from the main wind directions while the highest ambient turbulence arises from the least important directions. In the next page hourly and monthly plots will also be shown in order to identify the temporal wind regime affecting Comfrey wind farm

It can be seen that the monthly energy statistics are strongly polarised by the epoch of the year, being summer months the least energetic months. Therefore summer seems to be the best time for building the wind farm and do important maintenance works.

In the hourly plots it can be seen that wind energy production decreases during the day, meaning that these periods might be the best for carrying out maintenance works at the wind farm.

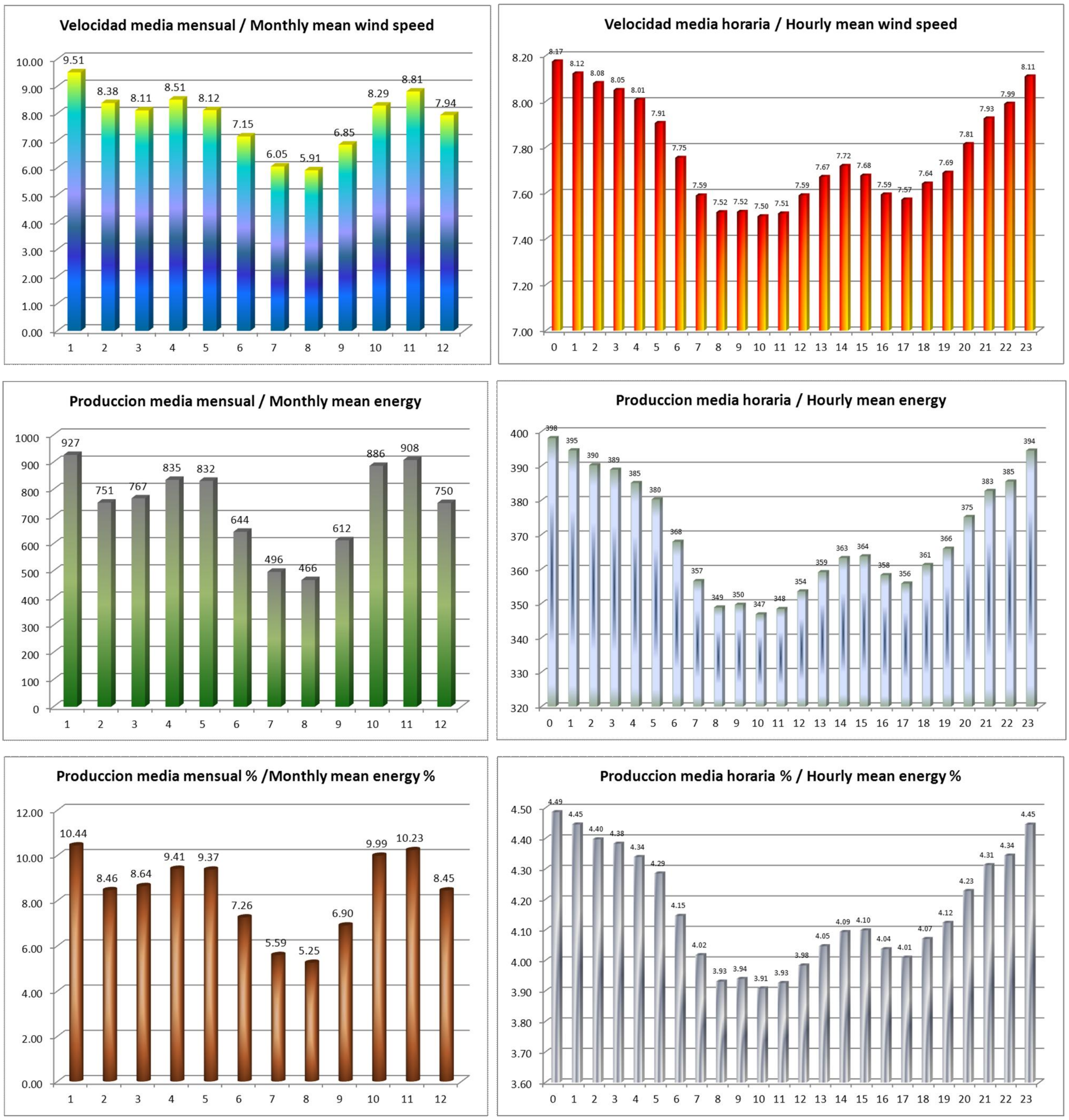


Figure 28. Monthly and hourly statistics of wind speed and energy productions

5. REFERENCE PERIOD

In wind resource assessment it is essential to define a reference period which becomes the most representative one of the general wind conditions of the wind farm. It is strongly recommended to select entire blocks of years to constitute the reference period, especially at sites with different wind regimes depending on the season.

In this case 43 months of measurement are available, so the only possibility is to select three years of data. Some minor changes in the long term energy produced by a wind farm might be met if only three years of measurements are taken into account; this is why the MCP procedure (measure/correlation/prediction) becomes extremely important in order to evaluate the long term wind energy production accurately.

Mean wind speed at Comfrey measurement mast taking into account a period of three years is 7.78 m/s at 80 meters.

In the following point a correlation between Comfrey meteorological mast and MERRA reanalysis data will be implemented with the goal of reducing uncertainty in wind energy calculation. Correlation will result in a wind energy factor of 0.990 for achieving a long term result.

The selection of the reference time period (1st March 2011 to 28th February 2014) is done with the help of the reference data and taking into account availability criteria and representativeness of the short term data.

Met Mast	UTM X	UTM Y	Time zone	Ref. system	Elevation	Measurement levels	Start mesurement	End measurement	Reference Period	Availability Ref. Per. %
COMFREY	345.340	4.884.394	T15N	NAD83	352	80-80-60-60-40-40	15-08-2007	23-07-2014	01/03/2011 -> 28/02/2014	98.10

Table 11. Met mast data, reference period.

In the next plot the wind distributions at hub height representing the reference period that will be used in the wind assessment software will be shown.

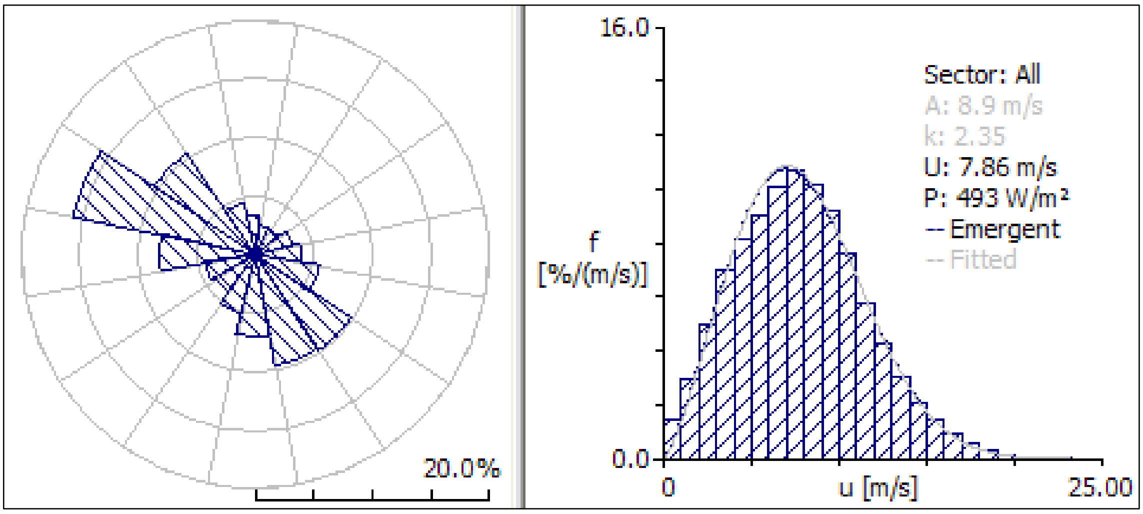


Figure 29. Wind distribution at 80 meters.

MONTH / MES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	DAY / DIA																														
Jan-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Feb-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Mar-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Apr-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
May-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jun-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jul-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Aug-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Sep-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Oct-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Nov-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Dec-10	####	####	144	144	144	144	144	144	144	47	0	0	0	0	0	11	144	144	144	144	144	144	144	122	0	0	125	144	144	23	0
Jan-11	0	130	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Feb-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	69	0	0	141	144	144	144	144	144	####	####	####
Mar-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	138	78	144	144	144	144	144	144	144	144	144	33	144
Jan-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	79	0	67	144	144	144	144	144	144	144
Feb-12	144	138	0	0	0	125	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	66	0	####	####
Mar-12	0	48	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jan-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	56	0	0	0	0
Feb-13	50	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####	####	####
Mar-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	129	0	64	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-13	144	144	144	144	144	144	144	144	43	0	0	83	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-13	144	144	138	0	137	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jan-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Feb-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####	####	####
Mar-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-14	144	144	87	91	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	72	####	####	####	####	####	####	####	####
Aug-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Sep-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Oct-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Nov-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Dec-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####

0% datos | 1% - 50% datos | 51% - 99% datos | 100% datos | #### sin datos | > 100% datos

Table 12. Final daily availability at hub height achieved with all sensors and correlations among them.

In this table the daily availability of the reference period is presented. The availability of the wind data at hub height in the reference period is calculated and meets a value of 98.10%. Nayxa always recommends availability values over 97%.

6. MCP

Within the scope of extending the wind speed and wind energy calculation from 3 years of measurements to a longer period, a long term correlation, MCP, of Comfrey data is necessary. MCP is the abbreviation for Measure-Correlate-Predict techniques, which is widely in use for establishing long-term wind statistics, using limited wind data from the current site and long-term data from a more-or-less nearby site.

The general methodology of the MCP process proceeds as follows:

- Collect wind data at the predictor site for a period of time as long as possible.

- Identify a reference site, for which high quality, long term records exist, in the vicinity of the predictor site, and which has a similar exposure to main winds - this is hereafter referred to as the ‘reference’ site.

- Obtain wind data from the reference site for the same time period as for the predictor site -this period is hereafter referred to as the ‘concurrent period’.

- Establish a relationship, if statistically possible, between the data from the reference and predictor sites for the concurrent period.

- Obtain wind data from the reference site for a historic period of 10 to 20 years duration - this period is hereafter referred to as the ‘historic’ period.

- Apply the relationship determined above to the historic data from the reference site to ‘predict’ what the winds would have been at the predictor site over that period. Note that this is a prediction of the winds that would have been observed had measurements been made at the predictor site for the same period as the historic data, rather than a prediction of winds that will be observed in future.

6.1 CORRELATION COMFREY – MERRA REANALYSIS

NASA's Modern Era Retrospective-analysis for Research and Applications (MERRA) is intended to be a full reanalysis of the satellite era. In general, the data provided will support science research and applications such as wind energy. MERRA reanalysis data is chosen to accomplish the MCP. The node with the best correlation is located at the global WGS84 coordinates 44.0ºN and 95.33ºW. The period March 1994 to February 2014 has been selected to carry out the MCP procedure.

A wind index correlation is going to be assessed; the wind speed factor between common period and MERRA total period will be calculated. At a second step wind energy sensitivity with respect to wind speed will be found; in the last step, an energy correction factor will be worked out, regardless wind direction sector linear correlation

It is extremely important that the reference data do not show an artificial temporal tendency and therefore they only represent the natural variability of the wind throughout the time. The temporal behaviour of the reference data will be analysed in the next pages through the assessment of the historical reference data period.

In the following plot the monthly mean wind speed of the reference data is presented along with the tendency line in red; no time dependant tendency is observed. In reanalysis data such as MERRA, more input data are added with the time being. It is therefore not difficult to find artificial tendencies throughout time, not being this, the case though.

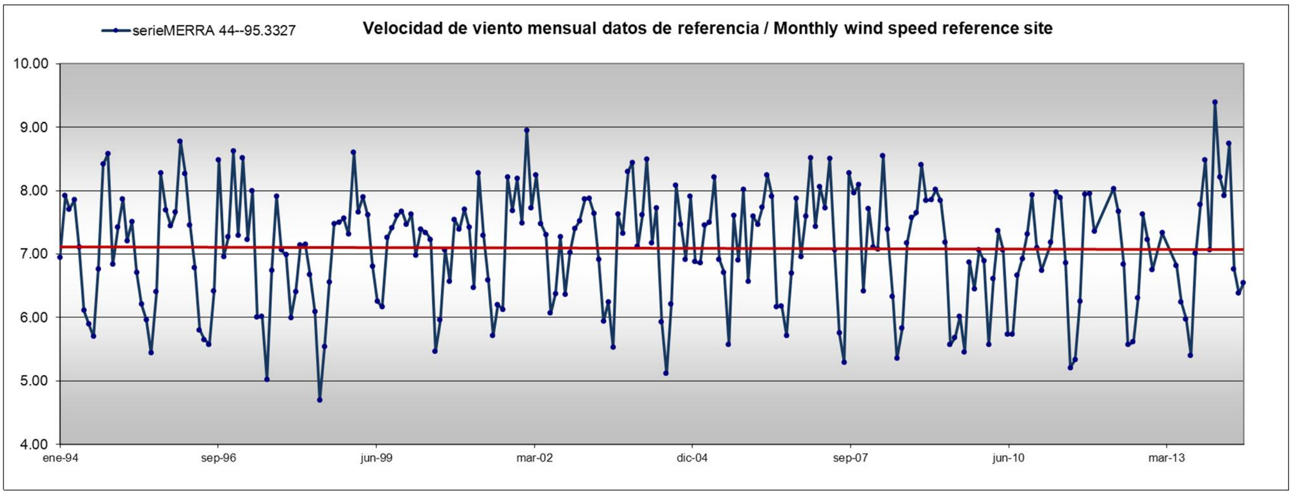


Figure 30. Monthly wind speed at MERRA node.

In the following plot the yearly mean wind speed of the reference data is presented along with the mean wind speed of the data (red line) and the mean wind speed of the reference data in the common period with the site data (green line).

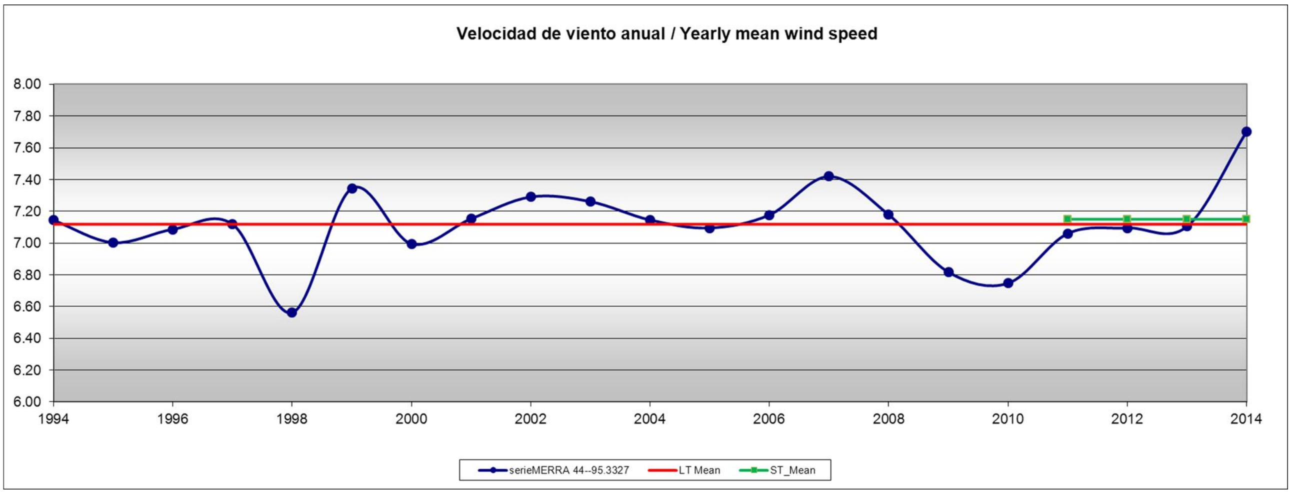


Figure 31. Yearly wind speed MERRA and MERRA mean wind speed in the reference period.

A wind index correlation is going to be assessed between the site and the reference data; the wind speed factor between the common period and the MERRA total measurement period will be calculated. At a second step wind energy sensitivity with respect to wind speed will be found; in the last step, an energy correction factor will be worked out, regardless wind direction sector linear correlation

Firstly, the common period of the site and reference data is going to be analysed. Monthly wind speed values of the reference data and the site data are shown in the next plot. The monthly linear correlation between both sources of data will also be plotted.

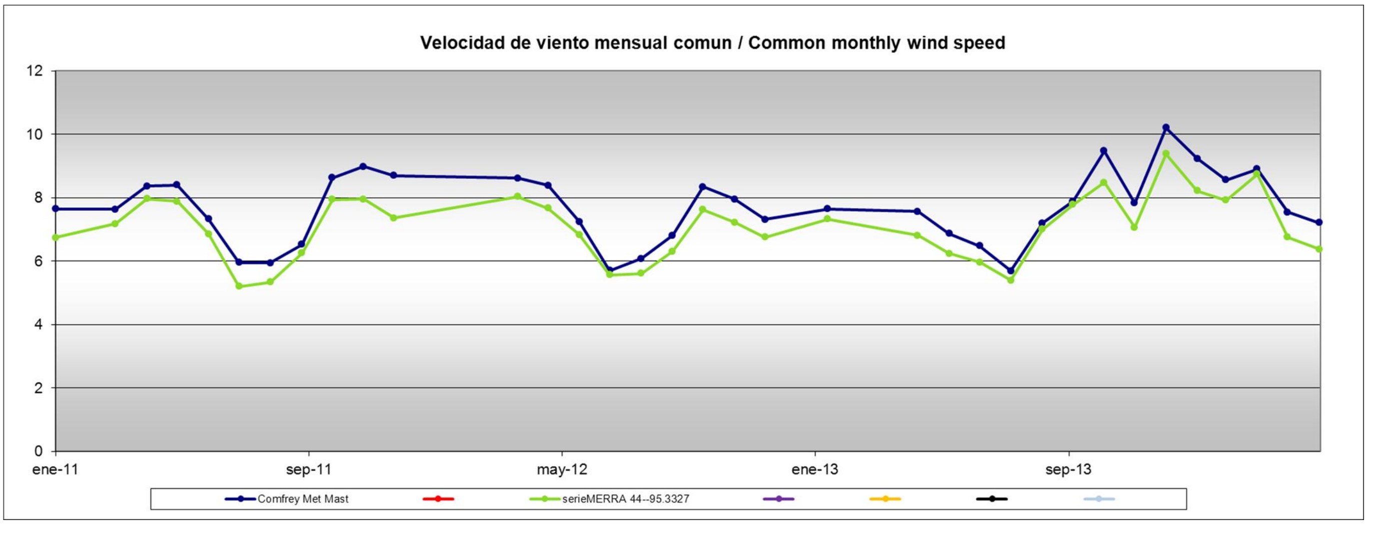


Figure 32. Monthly wind speed from Comfrey and MERRA data.

a) It can be seen that Comfrey met mast wind speed and the reference station follow a very similar tendency in the common period of measurements.

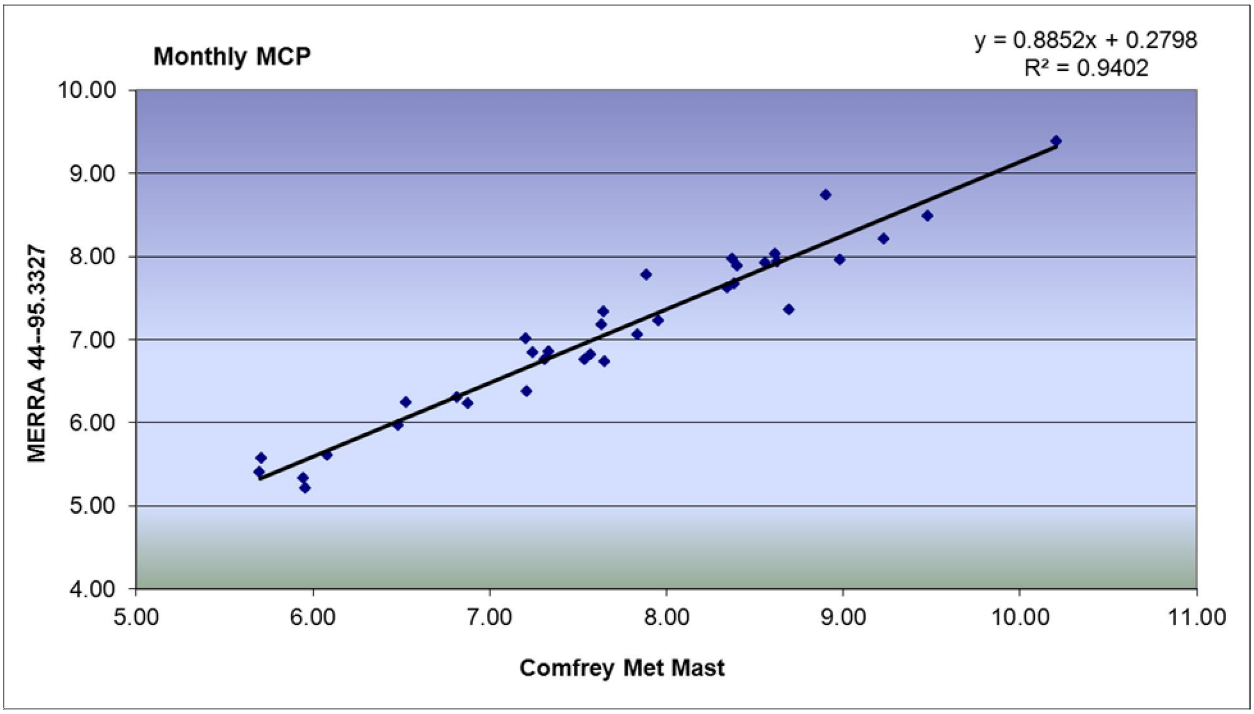


Figure 33. Global monthly wind speed correlation of Comfrey and MERRA data.

b) A mean adjustment factor r^2 of 0.9402 in monthly mean wind speed is obtained in the correlation reference data/site data, which is an indicator of the excellent relation between both datasets.

These last two statements allow us to conclude that a correlation can be implemented between these two sources of data and therefore it will be possible to extend in time the site measurements.

In the last plots shown, it can be seen that according to the reference data, the measurement campaign at Comfrey wind farm has been carried out in a very slightly windier epoch than the historical period. Wind speed in the period March 2011 to February 2014 is about 0.7% higher than the mean historical wind speed. The wind energy produced in the same period is around 1% higher than the mean historical wind speed

Correction factors have been obtained for long term wind speed and long term wind energy production resulting in:

LT wind speed	**7.10**
Meas. Period wind speed	**7.15**
LT wind speed factor	0.993
Sensitivity	**1.42**
LT energy factor	0.990

Table 13. Long term applied factors.

A factor of 0.990 will be applied to correct the energy calculation obtained from the site data and a factor of 0.993 will be used to correct the wind speed. These new values of wind speed and energy yield will be representative of a period of time equal to the measurement/simulation period of the reference station, i.e. 20 years.

7. WIND TURBINE

Three different wind turbines are going to be assessed within this report, the Vestas V100-2000 at 80 meter height, the Vestas V110-2000 at 80 meter height and the General Electric GE103-1700 at 80 meter height.

The Vestas V110-2000 model is classified as IEC IIIA, the Vestas V100-2000 as IIB and the General Electric model GE103-1700 is designed to fulfil the specifications of IIIB IEC standards. All three models are designed to face low rate wind regimes and eventually place in medium wind regimes to exploit the maximum of these conditions.

The project consists of 16 wind turbines Vestas V110-2000 / Vestas V100-2000 or 18/19 General Electric GE103-1700. The project has a power limitation of 31.5 MWs and therefore this limitation should be taken into account when doing the energy calculation. The four strategies described here will be compared in term of energy produced, so the client can make the best decision for the project.

The Danish and American manufacturers Vestas and General Electric are world references in wind turbine building and assembling. The technique reliability of both manufacturers is guaranteed by their years of experience in the wind energy sector.

In the next plots the wind turbine power curves at standard density and at Comfrey density (1.2001 kg/m^3) are shown. The corrected power curves will be the basis for wind energy calculation and site assessment study.

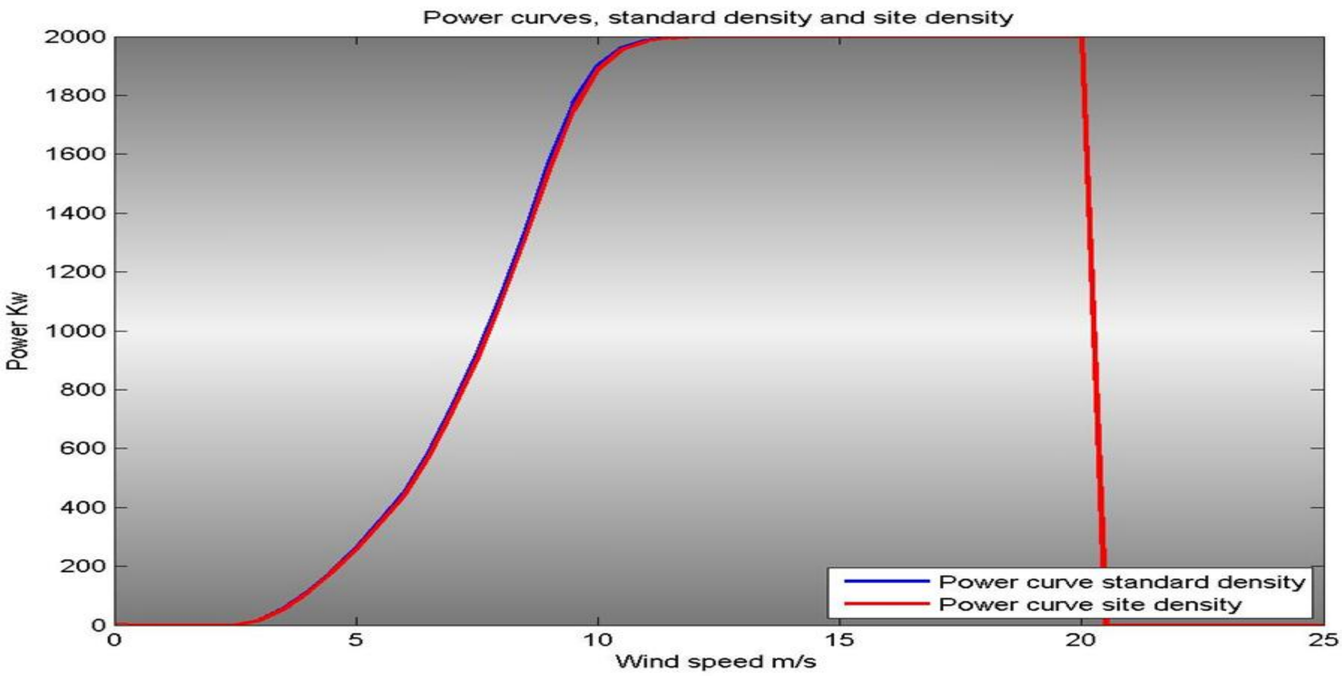


Figure 34. Vestas V100-2000 standard and site power curve.

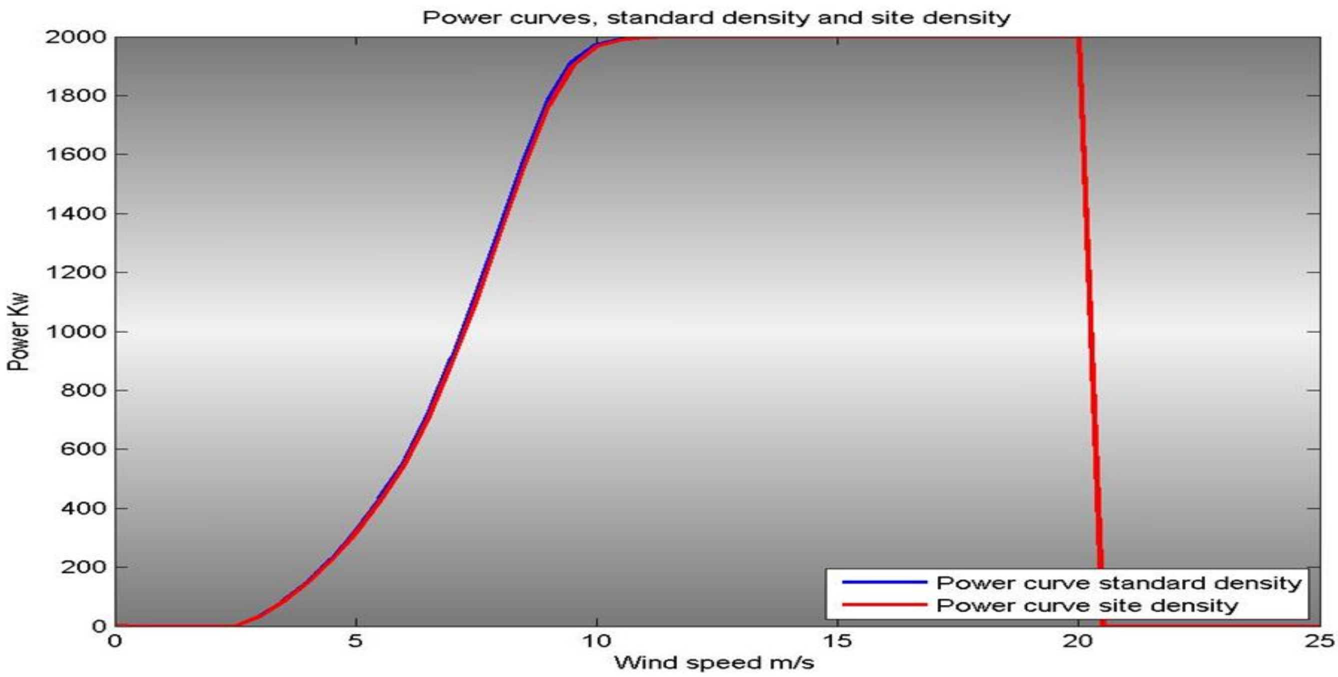


Figure 35. Vestas V110-3000 standard and site power curve.

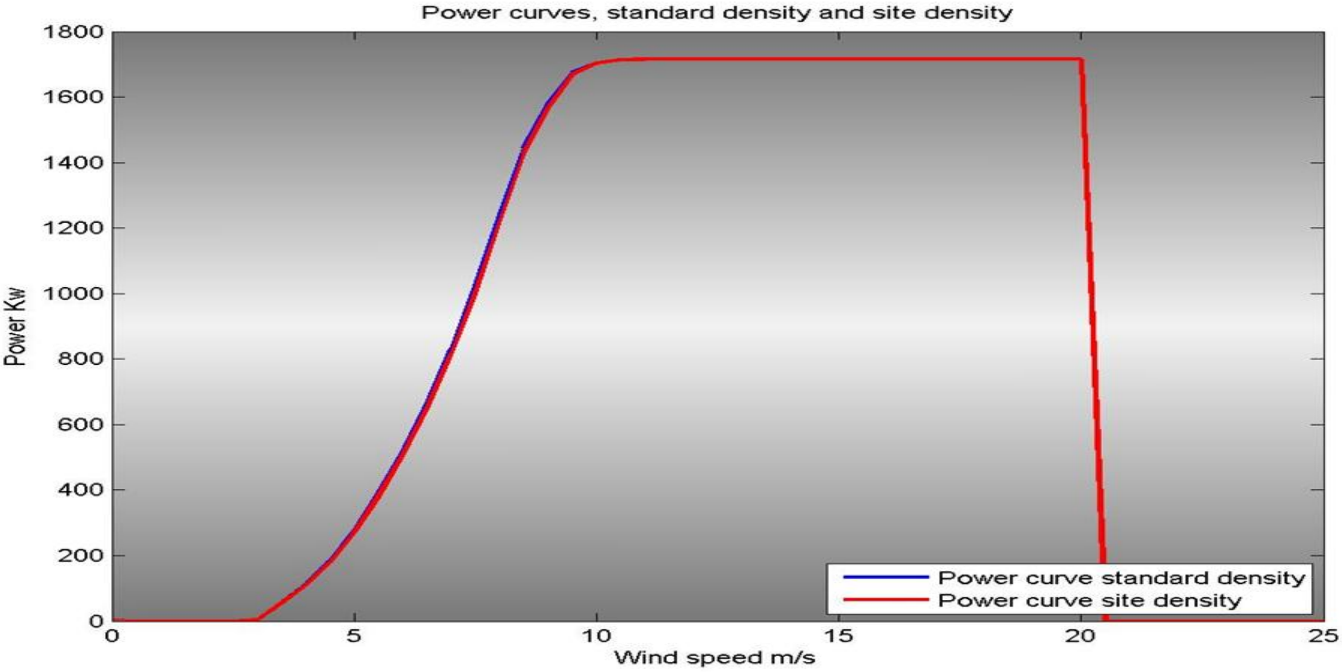


Figure 36. General Elecric GE103-1700 standard and site power curve.

V(m/s)	P(kW)	Ct	V(m/s)	P(kW)	Ct
Air Density = 1.225 Kg/M^3			Air Density = 1.2001 Kg/M^3		
0	0	0.000	0	0	0.000
1	0	0.000	1	0	0.000
2	0	0.000	2	0	0.000
3	16	0.878	3	15	0.878
4	113	0.884	4	110	0.884
5	261	0.824	5	256	0.824
6	448	0.798	6	438	0.798
7	741	0.804	7	726	0.804
8	1119	0.794	8	1096	0.794
9	1577	0.735	9	1547	0.738
10	1901	0.594	10	1886	0.603
11	1986	0.434	11	1984	0.445
12	2000	0.320	12	1999	0.328
13	2000	0.245	13	2000	0.251
14	2000	0.194	14	2000	0.198
15	2000	0.156	15	2000	0.159
16	2000	0.128	16	2000	0.131
17	2000	0.107	17	2000	0.109
18	2000	0.091	18	2000	0.092
19	2000	0.078	19	2000	0.080
20	2000	0.067	20	2000	0.069
21	0	0.000	21	0	0.000
22	0	0.000	22	0	0.000
23	0	0.000	23	0	0.000
24	0	0.000	24	0	0.000
25	0	0.000	25	0	0.000
26	0	0.000	26	0	0.000
27	0	0.000	27	0	0.000
28	0	0.000	28	0	0.000
29	0	0.000	29	0	0.000
30	0	0.000	30	0	0.000

Table 14. Power and Ct curve, V100-2000 at air density 1.225 and density 1.2001 kg/m^3

V(m/s)	P(kW)	Ct	V(m/s)	P(kW)	Ct
Air Density = 1.225 Kg/M^3			Air Density = 1.2001 Kg/M^3		
0	0	0.000	0	0	0.000
1	0	0.000	1	0	0.000
2	0	0.000	2	0	0.000
3	33	1.004	3	31	1.005
4	149	0.951	4	145	0.951
5	321	0.901	5	314	0.901
6	554	0.897	6	542	0.898
7	909	0.868	7	890	0.870
8	1354	0.813	8	1328	0.818
9	1788	0.677	9	1764	0.686
10	1973	0.490	10	1966	0.502
11	1998	0.350	11	1997	0.359
12	2000	0.262	12	2000	0.268
13	2000	0.203	13	2000	0.207
14	2000	0.162	14	2000	0.165
15	2000	0.131	15	2000	0.133
16	2000	0.108	16	2000	0.110
17	2000	0.091	17	2000	0.093
18	2000	0.077	18	2000	0.079
19	2000	0.067	19	2000	0.068
20	2000	0.058	20	2000	0.059
21	0	0.000	21	0	0.000
22	0	0.000	22	0	0.000
23	0	0.000	23	0	0.000
24	0	0.000	24	0	0.000
25	0	0.000	25	0	0.000
26	0	0.000	26	0	0.000
27	0	0.000	27	0	0.000
28	0	0.000	28	0	0.000
29	0	0.000	29	0	0.000
30	0	0.000	30	0	0.000

Table 15. Power and Ct curve, V110-2000 at air density 1.225 and density 1.2001 kg/m^3

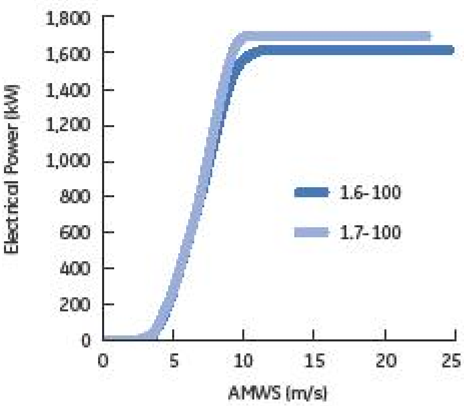
V(m/s)	P(kW)	Ct	V(m/s)	P(kW)	Ct
Air Density = 1.225 Kg/M^3			Air Density = 1.2001 Kg/M^3		
0	0	0.000	0	0	0.000
1	0	0.000	1	0	0.000
2	0	0.000	2	0	0.000
3	3	0.960	3	3	0.940
4	112	0.890	4	109	0.872
5	275	0.870	5	269	0.852
6	515	0.810	6	504	0.794
7	829	0.800	7	811	0.784
8	1240	0.800	8	1215	0.784
9	1579	0.690	9	1567	0.676
10	1704	0.490	10	1704	0.480
11	1715	0.350	11	1715	0.343
12	1715	0.260	12	1715	0.255
13	1715	0.200	13	1715	0.196
14	1715	0.160	14	1715	0.157
15	1715	0.130	15	1715	0.127
16	1715	0.110	16	1715	0.108
17	1715	0.090	17	1715	0.088
18	1715	0.080	18	1715	0.078
19	1715	0.060	19	1715	0.059
20	1715	0.060	20	1715	0.059
21	0	0.000	21	0	0.000
22	0	0.000	22	0	0.000
23	0	0.000	23	0	0.000
24	0	0.000	24	0	0.000
25	0	0.000	25	0	0.000
26	0	0.000	26	0	0.000
27	0	0.000	27	0	0.000
28	0	0.000	28	0	0.000
29	0	0.000	29	0	0.000
30	0	0.000	30	0	0.000

Table 16. Power and Ct curve, GE103-1700 at air density 1.225 and density 1.2001 kg/m^3


GE Power & Water
Renewable Energy
GE's 1.6-100 and 1.7-100
Best-in-class capacity factor
ecomagination
imagination at work

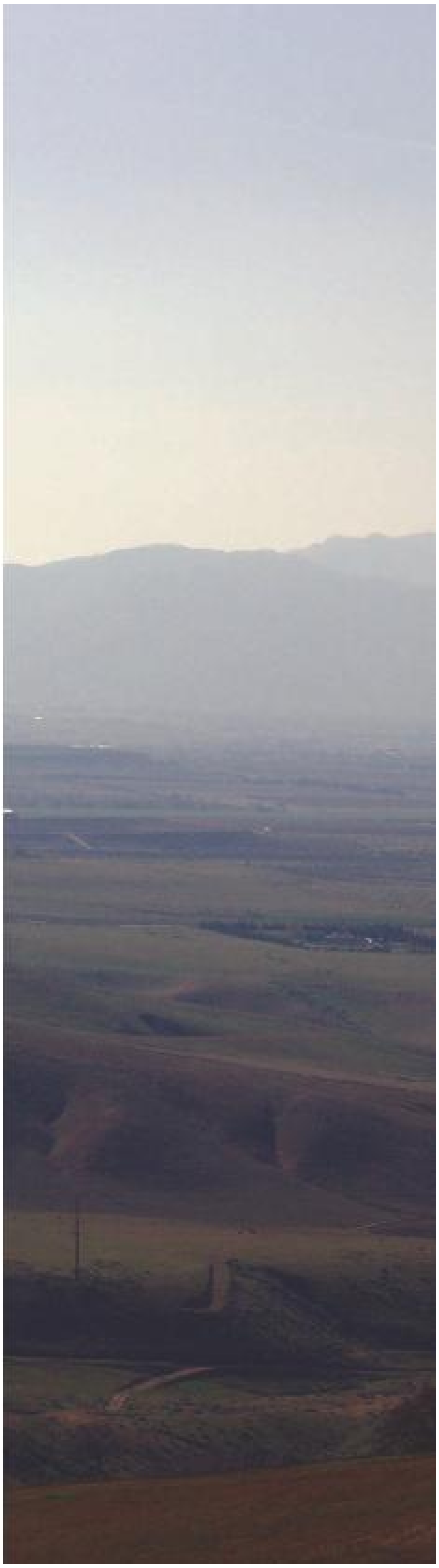
1.6-100 and 1.7-100 Specifications

Power Curve Improvement



Highest capacity factor in its class

- **Value.** Best in Class Capacity Factor, 54% (1.6-100) and 53% (1.7-100) @ 7.5 m/s
- **Reliability.** GE fleet at 98%+ availability
- **Experience.** 21,000+ wind turbines installed globally
- **Finance-ability.** Evolutionary design using "proven technology" from GE 1.5 MW and 2.5 MW platforms




Best-in-class capacity factor
1.6-100 wind turbine, Tehachapi, California, U.S.A.
7

Vestas.

2 MW PLATFORM

Wind. It means the world to us.™

V110-2.0 MW™
Facts & figures

POWER REGULATION

Power regulation	Pitch regulated with variable speed

OPERATING DATA

Rated power	2,000 kW (50/60 Hz)
Cut-in wind speed	3 m/s
Rated wind speed	11.5 m/s
Cut-out wind speed	20 m/s
Wind class	IEC IIIA
Operating temperature range:	standard turbine: -20°C to 40°C low temperature turbine: -30°C to 40°C

SOUND POWER

Max 107.5 dB*

(Mode 0, 10 m above ground, hub height 80 m, air density 1.225 kg/m³)

* for further information on noise limits please contact Vestas

ROTOR

Rotor diameter	110 m
Swept area	9,503 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Generator type	4-pole (50 Hz)/6-pole (60 Hz) doubly fed generator, slip rings

GEARBOX

Type	two helical stages and one planetary stage

BLADE DIMENSIONS

Length	54 m
Max. chord	3.9 m

TOWER

Type	tubular steel tower
Hub heights*	95 m and 125 m (50 Hz) 80 m and 95 m (60 Hz)

* Tower heights are preliminary and subject to change

NACELLE DIMENSIONS

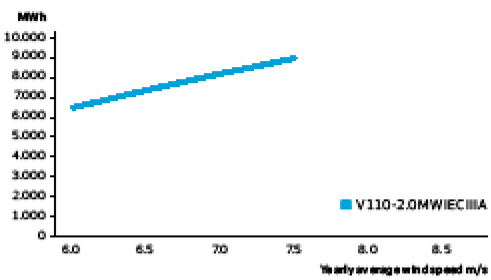
Height for transport	4 m
Height installed (incl. CoolerTop®)	5.4 m
Length	10.4 m
Width	3.5 m

HUB DIMENSIONS

Max. transport height	3.4 m
Max. transport width	4 m
Max. transport length	4.2 m

Max. weight per unit for transportation	70 metric tonnes

ANNUAL ENERGY PRODUCTION



Assumptions
One wind turbine, 100% availability, 0% losses, k factor = 2,
Standard air density = 1.225, wind speed at hub height

V100-1.8/2.0 MW™
Facts & figures

POWER REGULATION	Pitch regulated with variable speed

OPERATING DATA

Rated power	1,800/2,000 kW (50/60 Hz*)
Cut-in wind speed	3 m/s
Rated wind speed	12 m/s
Cut-out wind speed	20 m/s
Wind class	IEC S (IEC IIIA average wind/ IEC IIA extreme wind) IEC IIB (50/60 Hz)
Operating temperature range	standard turbine: -20 °C to 40 °C. low temperature turbine: -30 °C to 40 °C

* The rated power for V100 IEC IIIA 60 Hz is limited to 1950 kW in North America

SOUND POWER

Max 105 dB*

(Mode 0, 10 m above ground, hub height 80 m, air density 1.225 kg/m³)

* for further information on noise limits please contact Vestas

ROTOR

Rotor diameter	100 m
Swept area	7,854 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Generator type	4-pole (50 Hz)/6-pole (60 Hz) doubly fed generator, slip rings

GEARBOX

Type	two helical stages and one planetary stage

BLADE DIMENSIONS

Length	49 m
Max. chord	3.9 m

TOWER

Type	tubular steel tower
Hub heights	80 m, 95 m and 120 m (IEC IIIA)

NACELLE DIMENSIONS

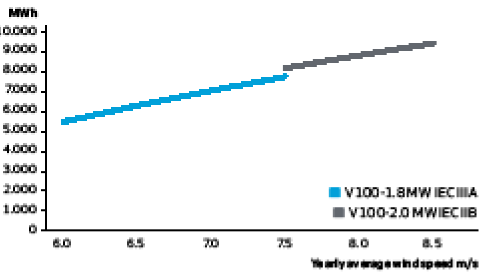
Height for transport	4 m
Height installed (incl. CoolerTop®)	5.4 m
Length	10.4 m
Width	3.5 m

HUB DIMENSIONS

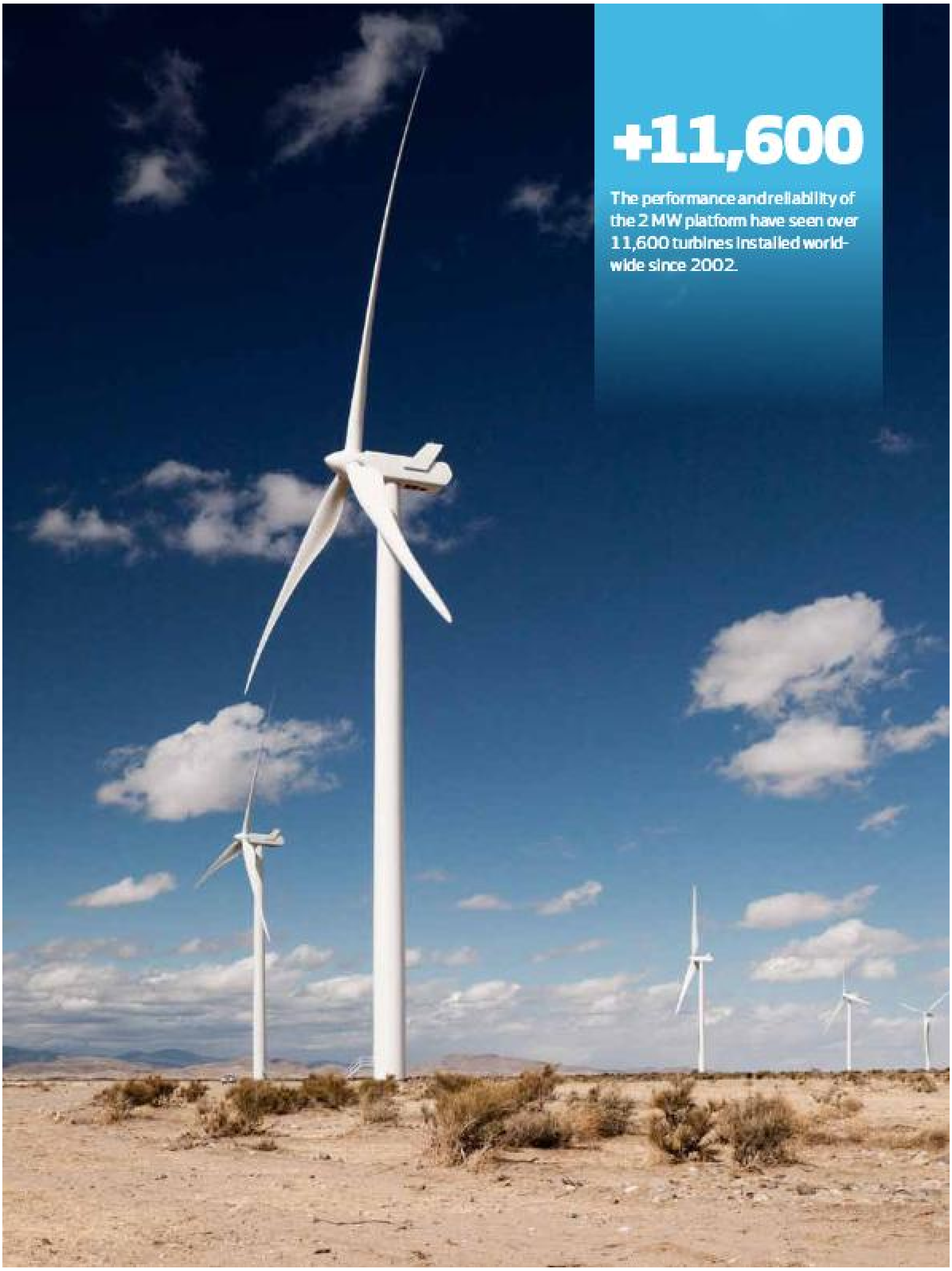
Max. transport height	3.4 m
Max. transport width	4 m
Max. transport length	4.2 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS



Assumptions
One wind turbine, 100% availability, 0% losses, k factor = 2, Standard air density = 1.225, wind speed at hub height


+11,600
The performance and reliability of the 2 MW platform have seen over 11,600 turbines installed world-wide since 2002.

8. ENERGY CALCULATION

The energy production study is going to be presented within the following pages. Once the wind speed distribution is obtained at hub height, Matlab, WAsP and WindFarmer software are used to estimate wind energy production of Comfrey wind farm.

With the help of WAsP and wind data from Comfrey met mast, the wind field map for a perimeter of 5 kilometres around the wind farms is obtained. The resolution chosen for this calculation is 5 meters. Once the wind turbines of Comfrey wind farm have been placed another WAsP simulation is run with the precise wind turbine positions to estimate the energy produced.

Once the wind resource is calculated in WAsP, WindFarmer is used to correct the energy produced in three different aspects; firstly it calculates the wind distribution for every wind turbine position, secondly it uses a non-linear wake model known as Eddy Viscosity model and thirdly it corrects the wind turbine power curve for every turbine position.

Within the following pages, production tables and maps will be presented. Energy production for each wind turbine will be shown as well and wind flow maps and wind turbines in three dimensions.

Wake losses have been calculated using the Eddy Viscosity model from Garrad Hassan and Partners; it is a non-linear model which improves older linear models. It is included within the software WindFarmer.

An adaptation factor is included which stands for the different conditions a wind turbine may face different from the ideal ones (conditions of the power curve measurement certification). Losses due to icing, blades dirt, hysteresis and occasional issues are also included within this adaptation factor. Possible affecting conditions related to the complexity of the terrain are also taken into account.

This factor has been set to 5% emphasized by the fact that wind turbines will be facing long episodes of icing due to the cold climatic conditions affecting Comfrey wind farm.

An availability factor of 3% losses is included; this factor accounts for the general percentage of wind turbines operation contractually guaranteed. Electrical losses are also included and quantified as another 3% of general loss.

There is an output power limitation of 31.5 MWs at the wind farm that needs to be respected. Calculations have been made in order to estimate this loss and convert it to energy that the wind farm will not be able to produce. The power limitation factor accounts for this issue at each scenario.

The model factor takes into account the potential errors made in the wind field modelization at the meteorological mast. Its values depends on a number of factors, such as the Weibull distribution of the wind at the site, the number of meteorological masts installed or small variations in the calculated versus real air density.

In the following page, the production table along with the loss factors are going to be shown. Several plots including wind speed maps in two and three dimensions will also be shown.

Turbine	Project Position	Hub [m]	Rotor [m]	Model	Power (Kw)	COORD. X [m]	COORD. Y [m]	Height (m)	RIX %	Wind Speed [m/s]	Gross Energy MWh/year	Wake Losses %	Adaptation Factor Loss %	Electrical Losses %	Unavaila-bility %	Model Factor	Power Limitation Factor	Long-Term Factor	Net Energy MWh/year	Net hh.ee.
COMFREY WIND FARM V100-2000																				
Ae1	WT-2	80	100	V100-2000	2000	346941	4883555	350	0	7.75	8951	2.32	5	3	3	1.0017	0.9947	0.990	7654	3827
Ae2	WT-3	80	100	V100-2000	2000	346099	4883663	350	0	7.73	8926	2.57	5	3	3	1.0017	0.9947	0.990	7610	3805
Ae3	WT-5	80	100	V100-2000	2000	346440	4884975	348	0	7.74	8937	4.00	5	3	3	1.0017	0.9947	0.990	7493	3747
Ae4	WT-6	80	100	V100-2000	2000	346450	4885522	347	0	7.74	8932	4.30	5	3	3	1.0017	0.9947	0.990	7463	3731
Ae5	WT-7	80	100	V100-2000	2000	345603	4885222	350	0	7.76	8966	3.40	5	3	3	1.0017	0.9947	0.990	7571	3785
Ae6	WT-8	80	100	V100-2000	2000	344899	4884883	349	0	7.73	8917	2.06	5	3	3	1.0017	0.9947	0.990	7647	3824
Ae7	WT-10	80	100	V100-2000	2000	345073	4886072	346	0	7.72	8911	4.20	5	3	3	1.0017	0.9947	0.990	7454	3727
Ae8	WT-11	80	100	V100-2000	2000	344253	4886153	350	0	7.75	8954	1.79	5	3	3	1.0017	0.9947	0.990	7703	3851
Ae9	WT-12	80	100	V100-2000	2000	346198	4886457	346	0	7.74	8942	4.00	5	3	3	1.0017	0.9947	0.990	7498	3749
Ae10	WT-14	80	100	V100-2000	2000	345685	4887470	341	0	7.70	8878	3.11	5	3	3	1.0017	0.9947	0.990	7522	3761
Ae11	WT-15	80	100	V100-2000	2000	345258	4887122	345	0	7.74	8930	3.10	5	3	3	1.0017	0.9947	0.990	7567	3783
Ae12	WT-16	80	100	V100-2000	2000	345883	4883127	351	0	7.73	8921	2.56	5	3	3	1.0017	0.9947	0.990	7607	3803
Ae13	WT-17	80	100	V100-2000	2000	345321	4883506	351	0	7.72	8915	2.01	5	3	3	1.0017	0.9947	0.990	7650	3825
Ae14	WT-18	80	100	V100-2000	2000	345563	4886063	350	0	7.80	9035	4.70	5	3	3	1.0017	0.9947	0.990	7513	3757
Ae15	WT-20	80	100	V100-2000	2000	346298	4887616	342	0	7.75	8954	2.32	5	3	3	1.0017	0.9947	0.990	7656	3828
Ae16	WT-21	80	100	V100-2000	2000	346466	4886680	345	0	7.76	8959	3.80	5	3	3	1.0017	0.9947	0.990	7530	3765
Wind turbine results								348	0	7.74	8939	3.14	5	3	3	1.0017	0.9947	0.990	7571	3786
Capacity factor %		43.21%		Mean Total Loss %		14.67	Gross and Net wind farm energy yield (MWh/year)				143028								121138	

Table 17. P50 production and losses of Comfrey wind farm, Vestas V100-2000.

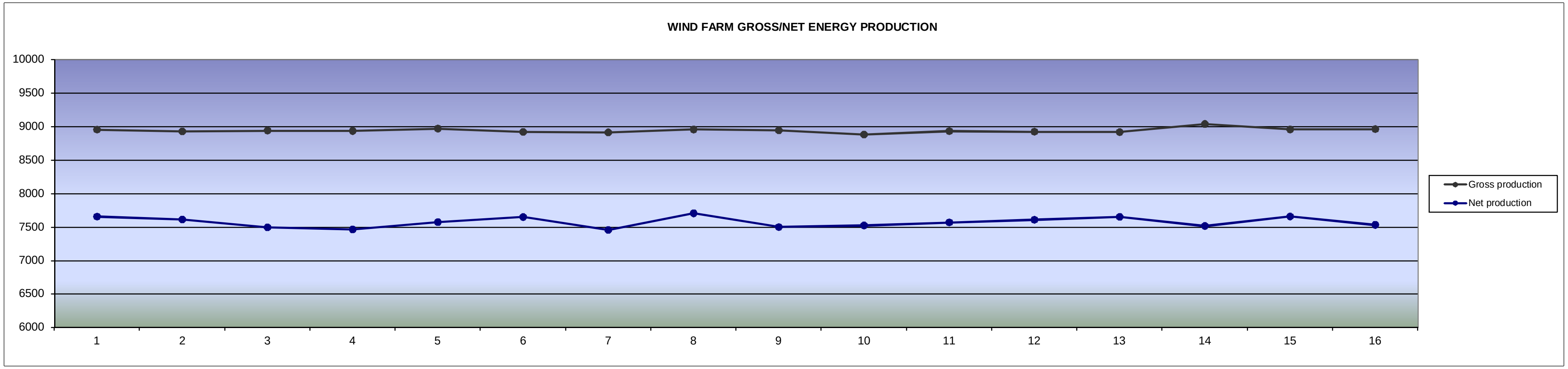


Figure 37. P50 gross and net production of Comfrey wind farm, Vestas V100-2000.

Turbine	Project Position	Hub [m]	Rotor [m]	Model	Power (Kw)	COORD. X [m]	COORD. Y [m]	Height (m)	RIX %	Wind Speed [m/s]	Gross Energy MWh/year	Wake Losses %	Adaptation Factor Loss %	Electrical Losses %	Unavaila-bility %	Model Factor	Power Limitation Factor	Long-Term Factor	Net Energy MWh/year	Net hh.ee.
COMFREY WIND FARM V110-2000																				
Ae1	WT-2	80	110	V110-2000	2000	346941	4883555	350	0	7.75	9717	2.42	5	3	3	1.0017	0.9939	0.990	8292	4146
Ae2	WT-3	80	110	V110-2000	2000	346099	4883663	350	0	7.73	9692	2.77	5	3	3	1.0017	0.9939	0.990	8237	4119
Ae3	WT-5	80	110	V110-2000	2000	346440	4884975	348	0	7.74	9703	4.20	5	3	3	1.0017	0.9939	0.990	8110	4055
Ae4	WT-6	80	110	V110-2000	2000	346450	4885522	347	0	7.74	9698	4.40	5	3	3	1.0017	0.9939	0.990	8087	4043
Ae5	WT-7	80	110	V110-2000	2000	345603	4885222	350	0	7.76	9730	3.70	5	3	3	1.0017	0.9939	0.990	8181	4090
Ae6	WT-8	80	110	V110-2000	2000	344899	4884883	349	0	7.73	9683	2.27	5	3	3	1.0017	0.9939	0.990	8278	4139
Ae7	WT-10	80	110	V110-2000	2000	345073	4886072	346	0	7.72	9679	4.50	5	3	3	1.0017	0.9939	0.990	8061	4031
Ae8	WT-11	80	110	V110-2000	2000	344253	4886153	350	0	7.75	9720	1.90	5	3	3	1.0017	0.9939	0.990	8345	4172
Ae9	WT-12	80	110	V110-2000	2000	346198	4886457	346	0	7.74	9707	4.30	5	3	3	1.0017	0.9939	0.990	8104	4052
Ae10	WT-14	80	110	V110-2000	2000	345685	4887470	341	0	7.70	9646	3.30	5	3	3	1.0017	0.9939	0.990	8148	4074
Ae11	WT-15	80	110	V110-2000	2000	345258	4887122	345	0	7.74	9695	3.30	5	3	3	1.0017	0.9939	0.990	8189	4095
Ae12	WT-16	80	110	V110-2000	2000	345883	4883127	351	0	7.73	9688	2.77	5	3	3	1.0017	0.9939	0.990	8234	4117
Ae13	WT-17	80	110	V110-2000	2000	345321	4883506	351	0	7.72	9683	2.20	5	3	3	1.0017	0.9939	0.990	8284	4142
Ae14	WT-18	80	110	V110-2000	2000	345563	4886063	350	0	7.80	9795	5.00	5	3	3	1.0017	0.9939	0.990	8110	4055
Ae15	WT-20	80	110	V110-2000	2000	346298	4887616	342	0	7.75	9716	2.40	5	3	3	1.0017	0.9939	0.990	8293	4147
Ae16	WT-21	80	110	V110-2000	2000	346466	4886680	345	0	7.76	9723	4.00	5	3	3	1.0017	0.9939	0.990	8146	4073
Wind turbine results								348	0	7.74	9705	3.34	5	3	3	1.0017	0.9939	0.990	8194	4097
Capacity factor %		46.77%		Total Loss %		14.95	Gross and Net wind farm energy yield (MWh/year)				155275								131098	

Table 18. P50 production and losses of Comfrey wind farm, Vestas V110-2000.

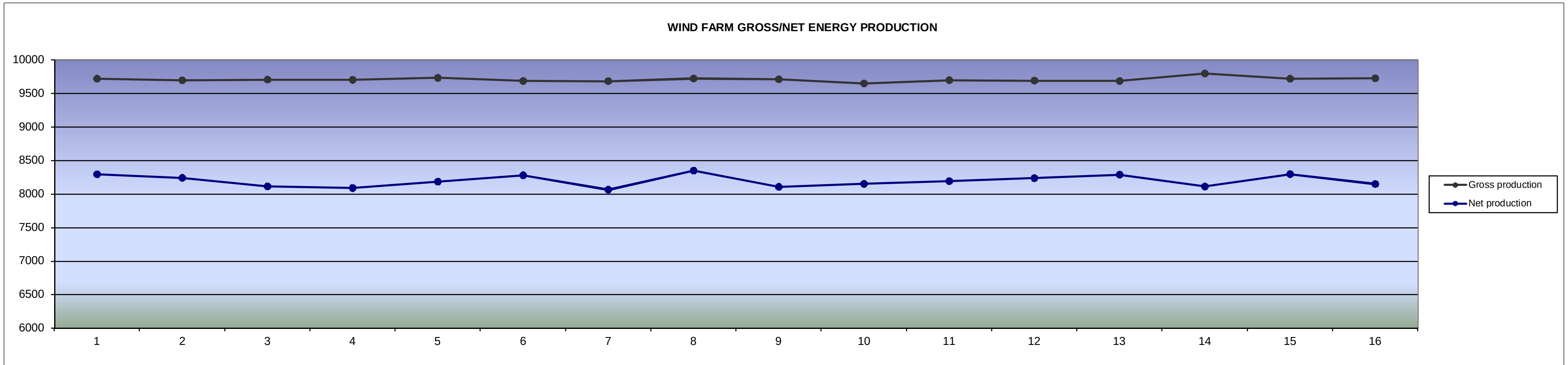


Figure 38. P50 gross and net production of Comfrey wind farm, Vestas V110-2000.

Turbine	Project Position	Hub [m]	Rotor [m]	Model	Power (Kw)	COORD. X [m]	COORD. Y [m]	Height (m)	RIX %	Wind Speed [m/s]	Gross Energy MWh/year	Wake Losses %	Adaptation Factor Loss %	Electrical Losses %	Unavaila-bility %	Model Factor	Power Limitation Factor	Long-Term Factor	Net Energy MWh/year	Net hh.ee.
COMFREY WIND FARM GE103-1700																				
Ae1	WT-1	80	103	GE103-1700	1715	346393	4883357	350	0	7.70	8486	4.70	5	3	3	1.0017	1.000	0.990	7094	4137
Ae2	WT-2	80	103	GE103-1700	1715	346941	4883555	350	0	7.72	8513	2.64	5	3	3	1.0017	1.000	0.990	7291	4251
Ae3	WT-3	80	103	GE103-1700	1715	346099	4883663	350	0	7.70	8492	5.00	5	3	3	1.0017	1.000	0.990	7074	4125
Ae4	WT-4	80	103	GE103-1700	1715	346062	4884858	350	0	7.72	8515	5.30	5	3	3	1.0017	1.000	0.990	7068	4121
Ae5	WT-5	80	103	GE103-1700	1715	346440	4884975	348	0	7.71	8501	5.00	5	3	3	1.0017	1.000	0.990	7081	4129
Ae6	WT-6	80	103	GE103-1700	1715	346450	4885522	347	0	7.71	8496	4.20	5	3	3	1.0017	1.000	0.990	7145	4166
Ae7	WT-7	80	103	GE103-1700	1715	345603	4885222	350	0	7.73	8524	4.70	5	3	3	1.0017	1.000	0.990	7126	4155
Ae8	WT-8	80	103	GE103-1700	1715	344899	4884883	349	0	7.70	8484	2.09	5	3	3	1.0017	1.000	0.990	7312	4264
Ae9	WT-10	80	103	GE103-1700	1715	345073	4886072	346	0	7.69	8481	4.10	5	3	3	1.0017	1.000	0.990	7140	4164
Ae10	WT-11	80	103	GE103-1700	1715	344253	4886153	350	0	7.72	8515	1.65	5	3	3	1.0017	1.000	0.990	7376	4301
Ae11	WT-12	80	103	GE103-1700	1715	346198	4886457	346	0	7.71	8503	3.90	5	3	3	1.0017	1.000	0.990	7176	4184
Ae12	WT-14	80	103	GE103-1700	1715	345685	4887470	343	0	7.67	8452	2.93	5	3	3	1.0017	1.000	0.990	7214	4206
Ae13	WT-15	80	103	GE103-1700	1715	345258	4887122	341	0	7.71	8494	2.89	5	3	3	1.0017	1.000	0.990	7253	4229
Ae14	WT-16	80	103	GE103-1700	1715	345883	4883127	345	0	7.70	8488	2.78	5	3	3	1.0017	1.000	0.990	7257	4232
Ae15	WT-17	80	103	GE103-1700	1715	345321	4883506	351	0	7.69	8484	2.23	5	3	3	1.0017	1.000	0.990	7300	4257
Ae16	WT-18	80	103	GE103-1700	1715	345563	4886063	351	0	7.77	8579	4.70	5	3	3	1.0017	1.000	0.990	7172	4182
Ae17	WT-20	80	103	GE103-1700	1715	346298	4887616	350	0	7.72	8511	2.09	5	3	3	1.0017	1.000	0.990	7335	4277
Ae18	WT-21	80	103	GE103-1700	1715	346466	4886680	342	0	7.73	8517	3.50	5	3	3	1.0017	1.000	0.990	7221	4211
Wind turbine results								348	0	7.71	8502	3.58	5	3	3	1.0017	1.000	0.990	7202	4199
Capacity factor %		47.94%		Mean Total Loss %	14.58	Gross and Net wind farm energy yield (MWh/year)					153035								129637	

Table 19. P50 production and losses of Comfrey wind farm, General Electric GE103-1700, 18 WTGs.

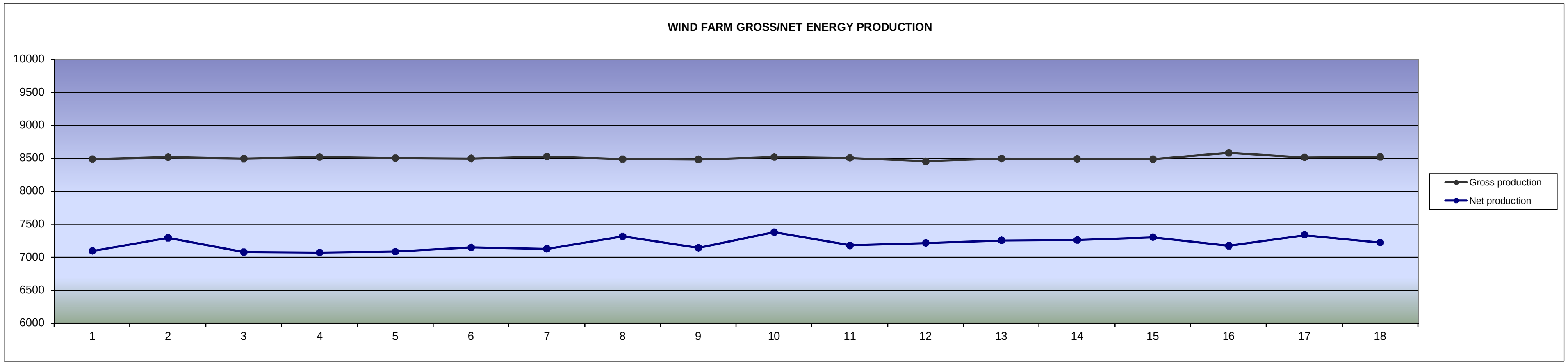


Figure 39. P50 gross and net production of Comfrey wind farm, General Electric GE103-1700, 18 WTGs.

Turbine	Project Position	Hub [m]	Rotor [m]	Model	Power (Kw)	COORD. X [m]	COORD. Y [m]	Height (m)	RIX %	Wind Speed [m/s]	Gross Energy MWh/year	Wake Losses %	Adaptation Factor Loss %	Electrical Losses %	Unavaila-bility %	Model Factor	Power Limitation Factor	Long-Term Factor	Net Energy MWh/year	Net hh.ee.
COMFREY WIND FARM GE103-1700																				
Ae1	WT-1	80	103	GE103-1700	1715	346393	4883357	350	0	7.70	8486	4.70	5	3	3	1.0017	0.9842	0.990	6982	4071
Ae2	WT-2	80	103	GE103-1700	1715	346941	4883555	350	0	7.72	8513	2.65	5	3	3	1.0017	0.9842	0.990	7174	4183
Ae3	WT-3	80	103	GE103-1700	1715	346099	4883663	350	0	7.70	8492	5.00	5	3	3	1.0017	0.9842	0.990	6962	4059
Ae4	WT-4	80	103	GE103-1700	1715	346062	4884858	350	0	7.72	8515	5.30	5	3	3	1.0017	0.9842	0.990	6956	4056
Ae5	WT-5	80	103	GE103-1700	1715	346440	4884975	348	0	7.71	8501	5.00	5	3	3	1.0017	0.9842	0.990	6969	4064
Ae6	WT-6	80	103	GE103-1700	1715	346450	4885522	347	0	7.71	8496	4.20	5	3	3	1.0017	0.9842	0.990	7032	4100
Ae7	WT-7	80	103	GE103-1700	1715	345603	4885222	350	0	7.73	8524	4.80	5	3	3	1.0017	0.9842	0.990	7005	4084
Ae8	WT-8	80	103	GE103-1700	1715	344899	4884883	349	0	7.70	8484	2.09	5	3	3	1.0017	0.9842	0.990	7196	4196
Ae9	WT-10	80	103	GE103-1700	1715	345073	4886072	346	0	7.69	8481	4.20	5	3	3	1.0017	0.9842	0.990	7019	4093
Ae10	WT-11	80	103	GE103-1700	1715	344253	4886153	350	0	7.72	8515	1.73	5	3	3	1.0017	0.9842	0.990	7253	4229
Ae11	WT-12	80	103	GE103-1700	1715	346198	4886457	346	0	7.71	8503	4.30	5	3	3	1.0017	0.9842	0.990	7029	4099
Ae12	WT-13	80	103	GE103-1700	1715	346075	4887112	343	0	7.68	8468	6.40	5	3	3	1.0017	0.9842	0.990	6827	3981
Ae13	WT-14	80	103	GE103-1700	1715	345685	4887470	341	0	7.67	8452	4.10	5	3	3	1.0017	0.9842	0.990	7003	4084
Ae14	WT-15	80	103	GE103-1700	1715	345258	4887122	345	0	7.71	8494	3.30	5	3	3	1.0017	0.9842	0.990	7105	4143
Ae15	WT-16	80	103	GE103-1700	1715	345883	4883127	351	0	7.70	8488	2.78	5	3	3	1.0017	0.9842	0.990	7143	4165
Ae16	WT-17	80	103	GE103-1700	1715	345321	4883506	351	0	7.69	8484	2.23	5	3	3	1.0017	0.9842	0.990	7185	4189
Ae17	WT-18	80	103	GE103-1700	1715	345563	4886063	350	0	7.77	8579	4.80	5	3	3	1.0017	0.9842	0.990	7050	4111
Ae18	WT-20	80	103	GE103-1700	1715	346298	4887616	342	0	7.72	8511	2.55	5	3	3	1.0017	0.9842	0.990	7181	4187
Ae19	WT-21	80	103	GE103-1700	1715	346466	4886680	345	0	7.73	8517	4.40	5	3	3	1.0017	0.9842	0.990	7032	4100
Wind turbine results								348	0	7.71	8500	3.92	5	3	3	1.0017	0.9842	0.990	7058	4115
Capacity factor %		46.98%		**Mean Total Loss %**		16.50	**Gross and Net wind farm energy yield (MWh/year)**				161503								134103	

Table 20. P50 production and losses of Comfrey wind farm, General Electric GE103-1700, 19 WTGs.

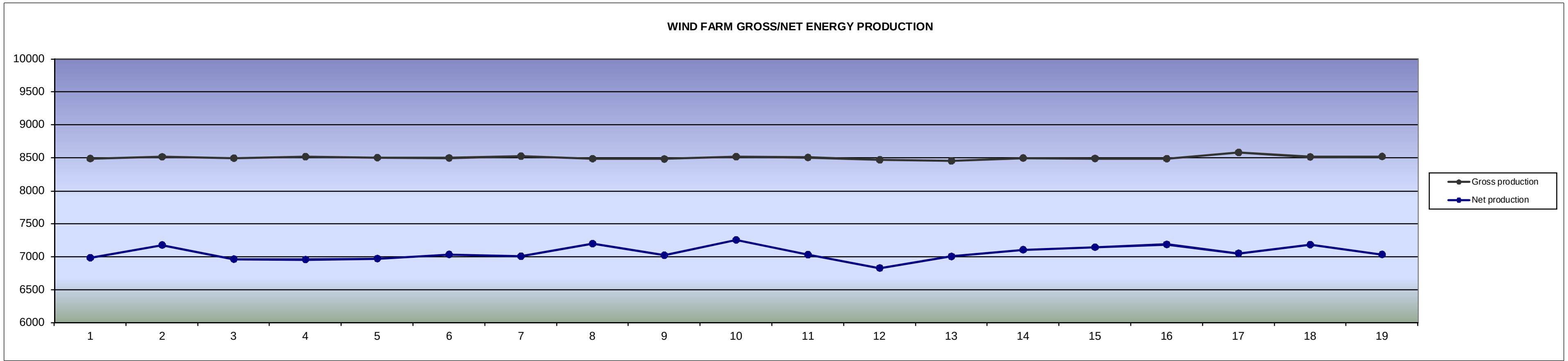


Figure 40. P50 gross and net production of Comfrey wind farm, General Electric GE103-1700, 19 WTGs.

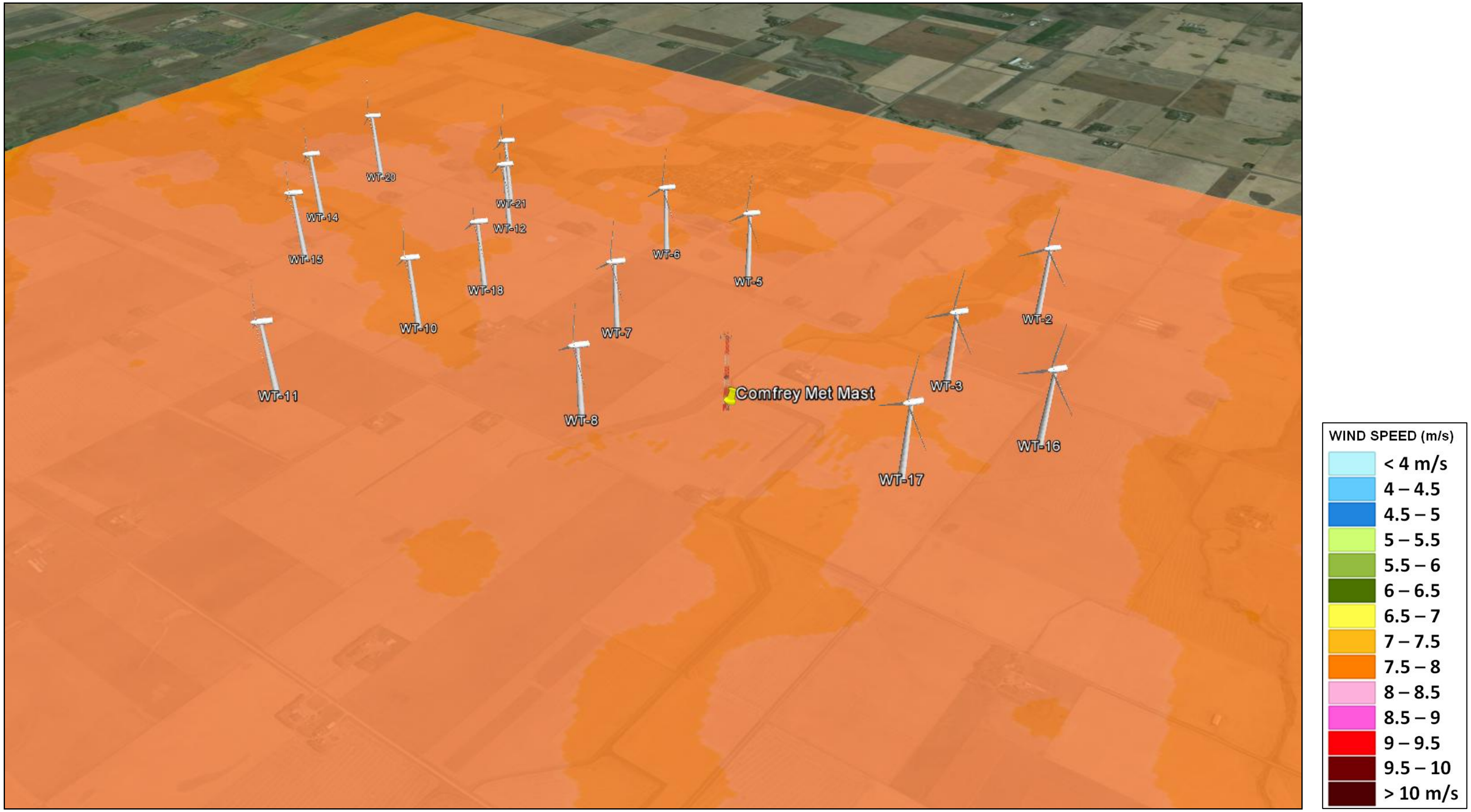


Figure 41. Comfrey wind speed map, V100-2000, V110-2000 layout.

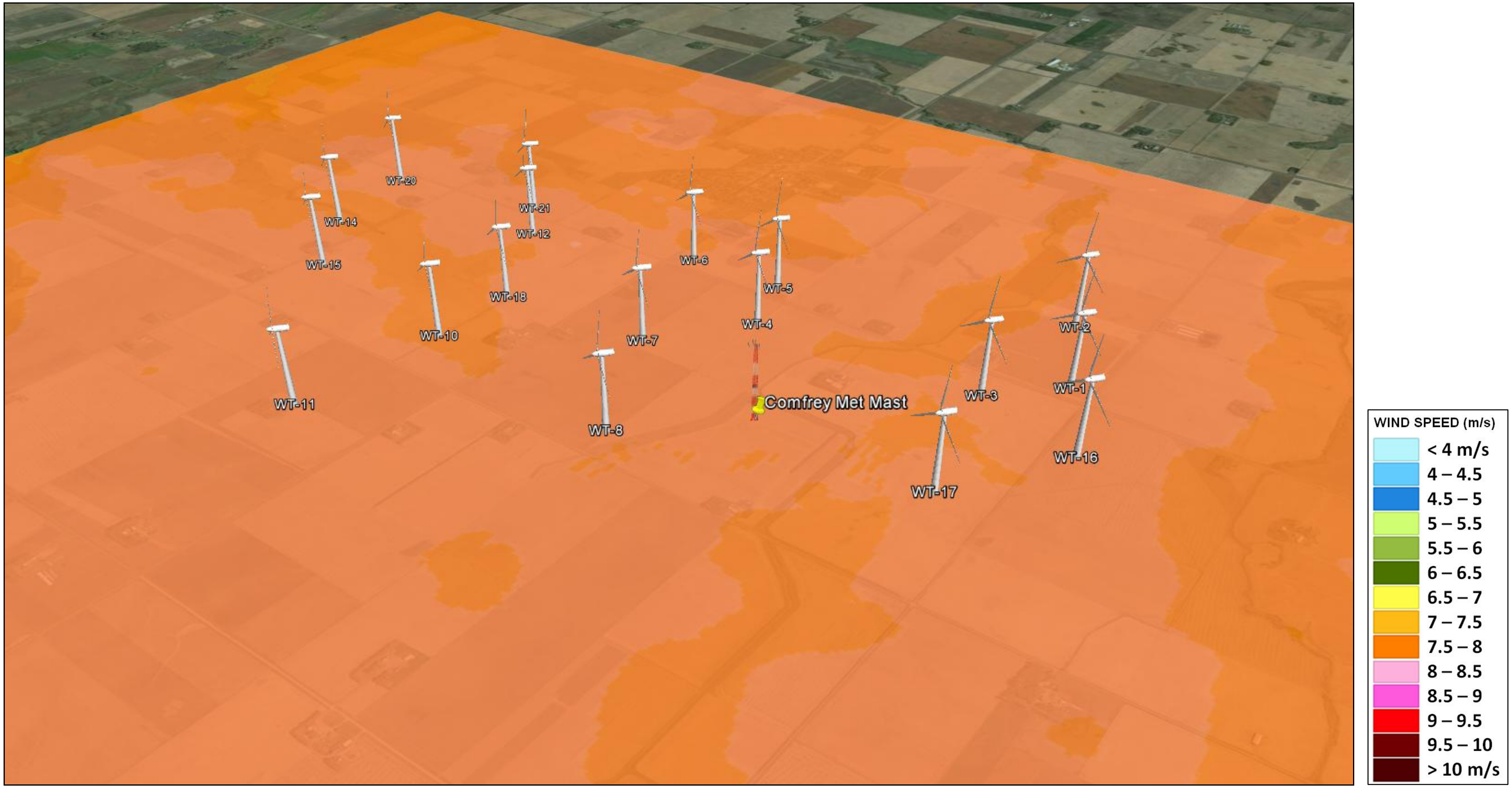


Figure 42. Comfrey wind speed map, GE103-1700 layout, 18 WTG.

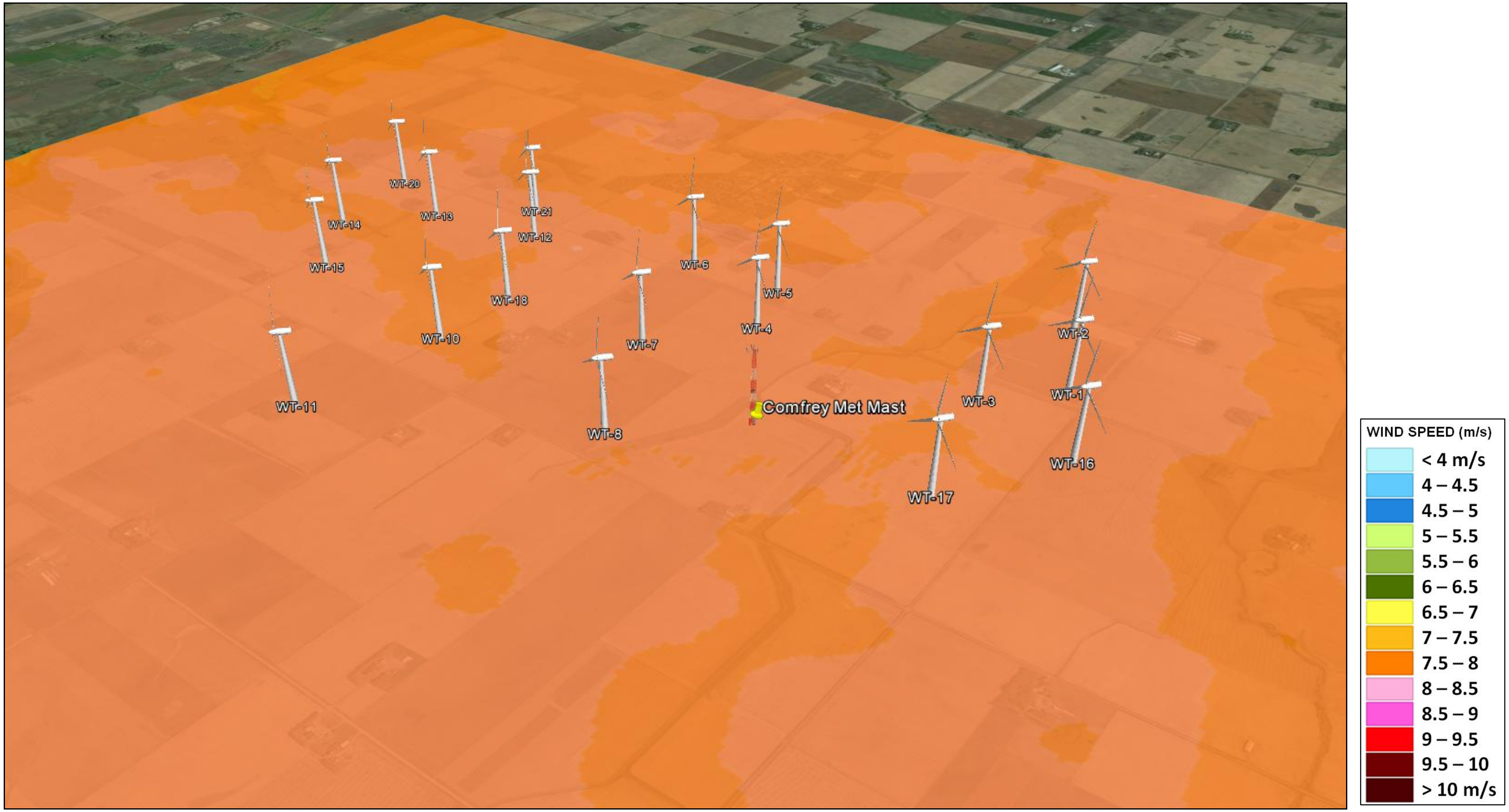


Figure 43. Comfrey wind speed map, GE103-1700 layout, 19 WTG.

9. UNCERTAINTY ANALYSIS

UNCERTAINTY ANALYSIS 1 YEAR

Wind	Anemometer calibration and mounting	5
	Filtering and filling in	1
	Variability 1 year	6
	MCP	0.79
	Variability measurement period	1.06
	Wind shear	1
	Other	0
	Wind uncertainty	**8.0**
Sensitivity		**1.4221**
Production	Wind uncertainty	11.4
	Horizontal modelling	1
	Density	1
	Power curve	3
	Wake model	1
	Topographic map	1
	Other	0
	Production uncertainty	**12.0**
Quantile		
0.75	net eq. Hours P50	3786
	std. deviation	454
	net eq. hours 75% upper-limit	4309
	net eq. hours 75% lower-limit	3263
Quantile		
0.9	net eq. Hours P50	3786
	std. deviation	454
	net eq. hours 90% upper-limit	4533
	net eq. hours 90% lower-limit	3039
Quantile		
0.75	net energy MWh P50	7571
	std. deviation	908
	net energy MWh 75% upper-limit	8616
	net energy MWh 75% lower-limit	6526
Quantile		
0.9	net energy MWh P50	7571
	std. deviation	908
	net energy MWh 90% upper-limit	9065
	net energy MWh 90% lower-limit	6077

UNCERTAINTY ANALYSIS 10 YEAR

Wind	Anemometer calibration and mounting	5
	Filtering and filling in	1
	Variability 1 year	1.9
	MCP	0.79
	Variability measurement period	1.06
	Wind shear	1
	Other	0
	Wind uncertainty	**5.7**
Sensitivity		**1.4221**
Production	Wind uncertainty	8.1
	Horizontal modelling	1
	Density	1
	Power curve	3
	Wake model	1
	Topographic map	1
	Other	0
	Production uncertainty	**8.9**
Quantile		
0.75	net eq. Hours P50	3786
	std. deviation	335
	net eq. hours 75% upper-limit	4172
	net eq. hours 75% lower-limit	3400
Quantile		
0.9	net eq. Hours P50	3786
	std. deviation	335
	net eq. hours 90% upper-limit	4338
	net eq. hours 90% lower-limit	3234
Quantile		
0.75	net energy MWh P50	7571
	std. deviation	671
	net energy MWh 75% upper-limit	8342
	net energy MWh 75% lower-limit	6800
Quantile		
0.9	net energy MWh P50	7571
	std. deviation	671
	net energy MWh 90% upper-limit	8674
	net energy MWh 90% lower-limit	6468

Table 21. Comfrey wind farm uncertainty analysis for the model V100-2000.

UNCERTAINTY ANALYSIS 1 YEAR		
Wind	Anemometer calibration and mounting	5
	Filtering and filling in	1
	Variability 1 year	6
	MCP	0.79
	Variability measurement period	1.06
	Wind shear	1
	Other	0
	Wind uncertainty	8.0
Sensitivity	1.4221	
Production	Wind uncertainty	11.4
	Horizontal modelling	1
	Density	1
	Power curve	3
	Wake model	1
	Topographic map	1
	Other	0
	Production uncertainty	12.0
Quantile		
0.75	net eq. Hours P50	4097
	std. deviation	492
	net eq. hours 75% upper-limit	4662
	net eq. hours 75% lower-limit	3532
Quantile		
0.9	net eq. Hours P50	4097
	std. deviation	492
	net eq. hours 90% upper-limit	4906
	net eq. hours 90% lower-limit	3288
Quantile		
0.75	net energy MWh P50	8194
	std. deviation	983
	net energy MWh 75% upper-limit	9325
	net energy MWh 75% lower-limit	7063
Quantile		
0.9	net energy MWh P50	8194
	std. deviation	983
	net energy MWh 90% upper-limit	9811
	net energy MWh 90% lower-limit	6577

UNCERTAINTY ANALYSIS 10 YEAR		
Wind	Anemometer calibration and mounting	5
	Filtering and filling in	1
	Variability 1 year	1.9
	MCP	0.79
	Variability measurement period	1.06
	Wind shear	1
	Other	0
	Wind uncertainty	5.7
Sensitivity	1.4221	
Production	Wind uncertainty	8.1
	Horizontal modelling	1
	Density	1
	Power curve	3
	Wake model	1
	Topographic map	1
	Other	0
	Production uncertainty	8.9
Quantile		
0.75	net eq. Hours P50	4097
	std. deviation	363
	net eq. hours 75% upper-limit	4514
	net eq. hours 75% lower-limit	3680
Quantile		
0.9	net eq. Hours P50	4097
	std. deviation	363
	net eq. hours 90% upper-limit	4694
	net eq. hours 90% lower-limit	3500
Quantile		
0.75	net energy MWh P50	8194
	std. deviation	726
	net energy MWh 75% upper-limit	9029
	net energy MWh 75% lower-limit	7359
Quantile		
0.9	net energy MWh P50	8194
	std. deviation	726
	net energy MWh 90% upper-limit	9388
	net energy MWh 90% lower-limit	7000

Table 22. Comfrey wind farm uncertainty analysis for the model V110-2000.

	UNCERTAINTY ANALYSIS 1 YEAR			UNCERTAINTY ANALYSIS 10 YEAR	
Wind	Anemometer calibration and mounting	5	Wind	Anemometer calibration and mounting	5
	Filtering and filling in	1		Filtering and filling in	1
	Variability 1 year	6		Variability 1 year	1.9
	MCP	0.79		MCP	0.79
	Variability measurement period	1.06		Variability measurement period	1.06
	Wind shear	1		Wind shear	1
	Other	0		Other	0
	Wind uncertainty	**8.0**		**Wind uncertainty**	**5.7**
Sensitivity		**1.4221**	**Sensitivity**		**1.4221**
Production	Wind uncertainty	11.4	Production	Wind uncertainty	8.1
	Horizontal modelling	1		Horizontal modelling	1
	Density	1		Density	1
	Power curve	3		Power curve	3
	Wake model	1		Wake model	1
	Topographic map	1		Topographic map	1
	Other	0		Other	0
	Production uncertainty	**12.0**		**Production uncertainty**	**8.9**
Quantile			**Quantile**		
0.75	net eq. Hours P50	4199	0.75	net eq. Hours P50	4199
	std. deviation	504		std. deviation	372
	net eq. hours 75% upper-limit	4779		net eq. hours 75% upper-limit	4627
	net eq. hours 75% lower-limit	3619		net eq. hours 75% lower-limit	3771
Quantile			**Quantile**		
0.9	net eq. Hours P50	4199	0.9	net eq. Hours P50	4199
	std. deviation	504		std. deviation	372
	net eq. hours 90% upper-limit	5028		net eq. hours 90% upper-limit	4811
	net eq. hours 90% lower-limit	3370		net eq. hours 90% lower-limit	3587
Quantile			**Quantile**		
0.75	net energy MWh P50	7202	0.75	net energy MWh P50	7202
	std. deviation	864		std. deviation	638
	net energy MWh 75% upper-limit	8196		net energy MWh 75% upper-limit	7936
	net energy MWh 75% lower-limit	6208		net energy MWh 75% lower-limit	6468
Quantile			**Quantile**		
0.9	net energy MWh P50	7202	0.9	net energy MWh P50	7202
	std. deviation	864		std. deviation	638
	net energy MWh 90% upper-limit	8623		net energy MWh 90% upper-limit	8251
	net energy MWh 90% lower-limit	5781		net energy MWh 90% lower-limit	6153

Table 23. Comfrey wind farm uncertainty analysis for the model GE103-1700, 18 WTGs.

UNCERTAINTY ANALYSIS 1 YEAR		
Wind	Anemometer calibration and mounting	5
	Filtering and filling in	1
	Variability 1 year	6
	MCP	0.79
	Variability measurement period	1.06
	Wind shear	1
	Other	0
	Wind uncertainty	8.0
Sensitivity		1.4221
Production	Wind uncertainty	11.4
	Horizontal modelling	1
	Density	1
	Power curve	3
	Wake model	1
	Topographic map	1
	Other	0
	Production uncertainty	12.0
Quantile		
0.75	net eq. Hours P50	4115
	std. deviation	494
	net eq. hours 75% upper-limit	4683
	net eq. hours 75% lower-limit	3547
Quantile		
0.9	net eq. Hours P50	4115
	std. deviation	494
	net eq. hours 90% upper-limit	4927
	net eq. hours 90% lower-limit	3303
Quantile		
0.75	net energy MWh P50	7058
	std. deviation	847
	net energy MWh 75% upper-limit	8032
	net energy MWh 75% lower-limit	6084
Quantile		
0.9	net energy MWh P50	7058
	std. deviation	847
	net energy MWh 90% upper-limit	8451
	net energy MWh 90% lower-limit	5665

UNCERTAINTY ANALYSIS 10 YEAR		
Wind	Anemometer calibration and mounting	5
	Filtering and filling in	1
	Variability 1 year	1.9
	MCP	0.79
	Variability measurement period	1.06
	Wind shear	1
	Other	0
	Wind uncertainty	5.7
Sensitivity		1.4221
Production	Wind uncertainty	8.1
	Horizontal modelling	1
	Density	1
	Power curve	3
	Wake model	1
	Topographic map	1
	Other	0
	Production uncertainty	8.9
Quantile		
0.75	net eq. Hours P50	4115
	std. deviation	364
	net eq. hours 75% upper-limit	4534
	net eq. hours 75% lower-limit	3696
Quantile		
0.9	net eq. Hours P50	4115
	std. deviation	364
	net eq. hours 90% upper-limit	4714
	net eq. hours 90% lower-limit	3516
Quantile		
0.75	net energy MWh P50	7058
	std. deviation	625
	net energy MWh 75% upper-limit	7777
	net energy MWh 75% lower-limit	6339
Quantile		
0.9	net energy MWh P50	7058
	std. deviation	625
	net energy MWh 90% upper-limit	8086
	net energy MWh 90% lower-limit	6030

Table 24. Comfrey wind farm uncertainty analysis for the model GE103-1700, 19 WTGs.

In the previous tables the Comfrey uncertainty analysis has been presented. The uncertainty analysis is divided in two different sections, variables affecting directly wind speed measurement and variables affecting directly wind energy production.

Anemometers uncertainty is set to 5%; NRG anemometers have been installed at Comfrey met mast, and Measnet calibration certificates are not available. This issue penalizes very much the uncertainty calculation.

Wind shear uncertainty is set to 1% due to the fact that although the met mast is installed at hub height, measurements of the whole rotor are not available.

Horizontal modelling uncertainty is set to 1% due to the fact that the wind farm is located in very flat terrain with RIX=0 for each wind turbine position and the met mast location.

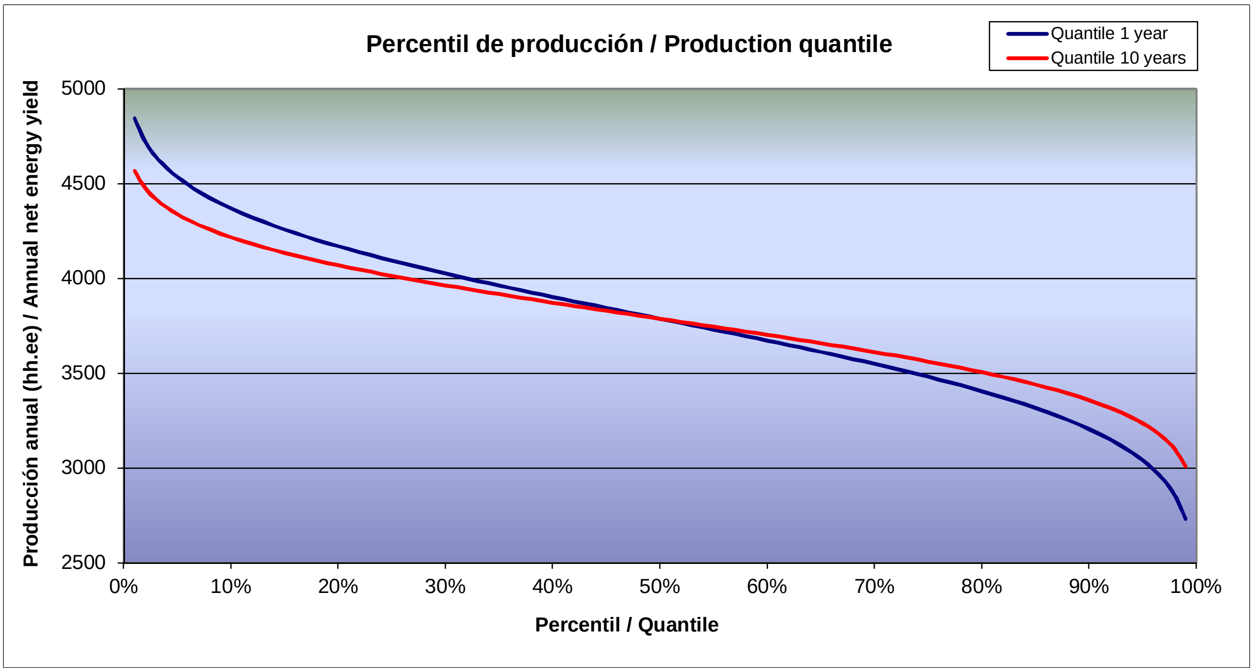


Figure 44. Comfrey production quantile for the Vestas V100-2000 model.

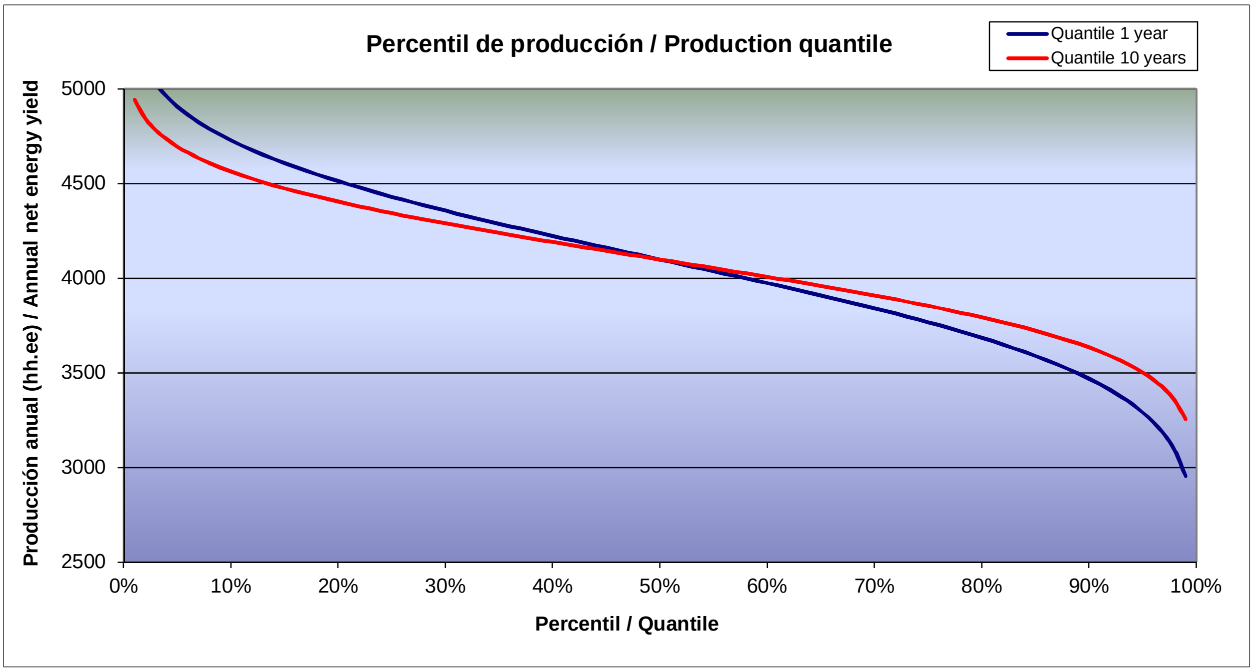


Figure 45. Comfrey production quantile for the Vestas V110-2000 model.

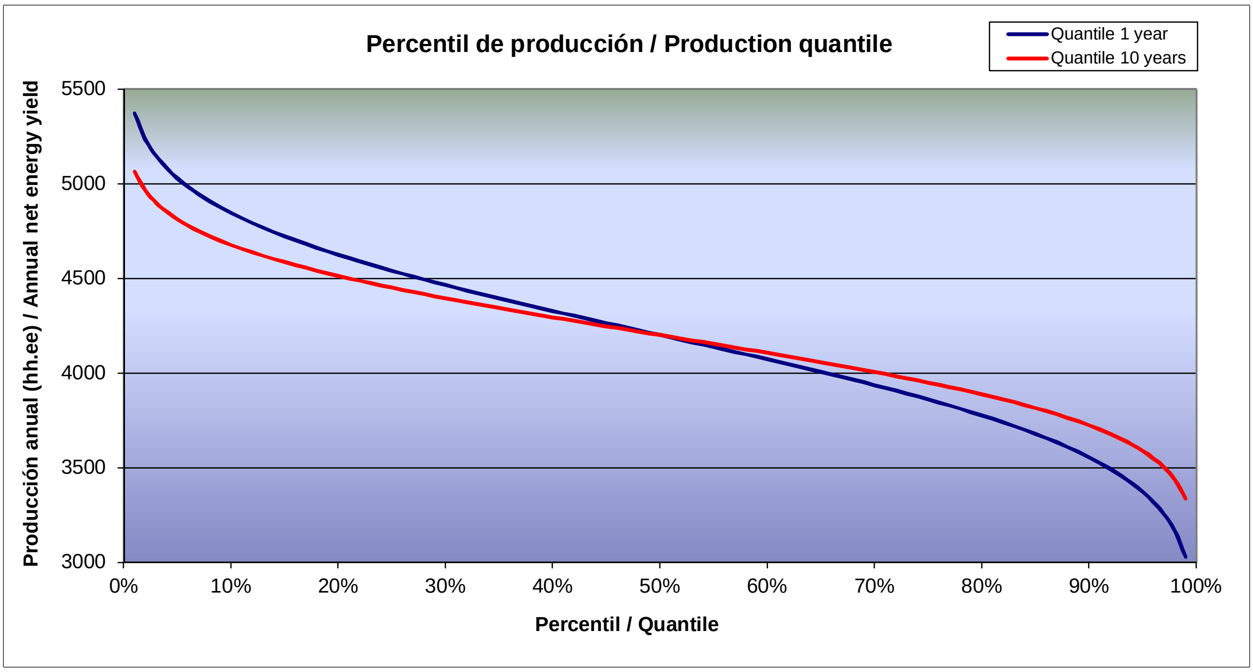


Figure 46. Comfrey production quantile for the General Electric GE103-1700 model, 18 WTGs.

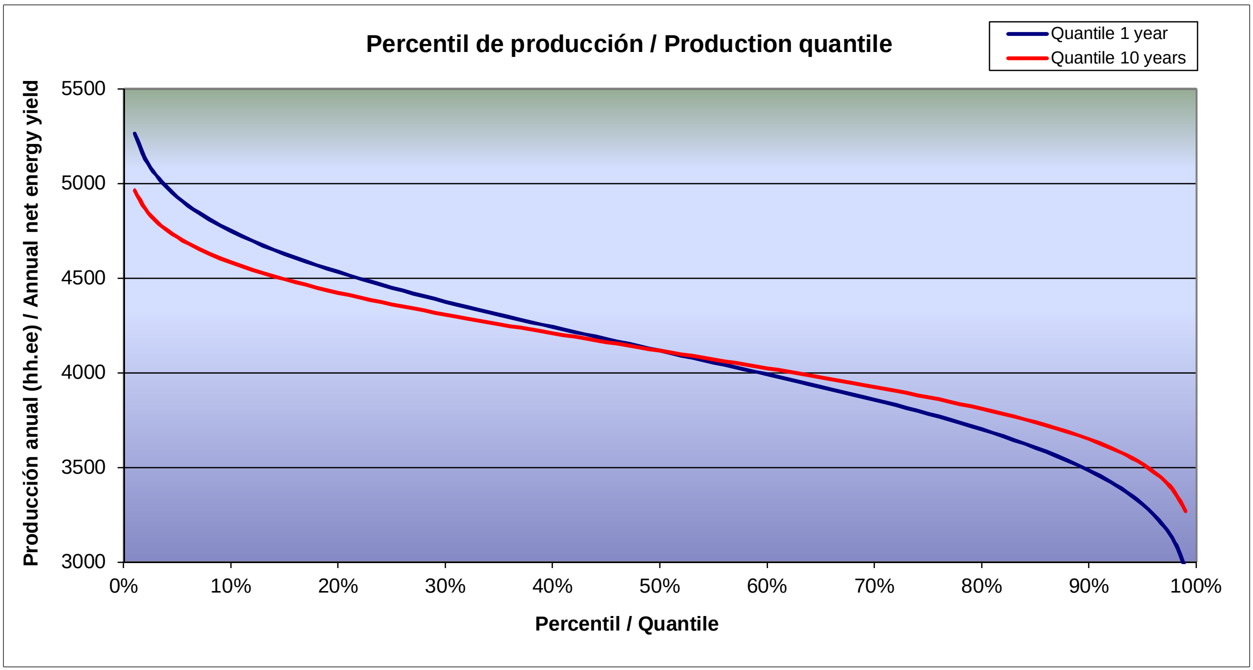


Figure 47. Comfrey production quantile for the General Electric GE103-1700 model, 19 WTGs.

10. CONCLUSIONS

Within this project wind data from Comfrey met mast has been analysed; data from the MERRA reanalysis project has also been processed and taken into account. Gross and Net energy produced have been calculated bearing in mind general losses usually taken into account in wind energy.

Data quality from Comfrey met mast suffers from the fact that the anemometers do not have serial number, therefore they can't be traced. It is also very important that there are no calibration certificates available. Generic NRG 40 calibrations have been taken into account.

A power curve correction according to the particular air density for each wind turbine position and wind turbine model has been carried out; this implies that each wind turbine has its own particularized power curve, adapted to its performance conditions.

An MCP correlation has been implemented between Comfrey met mast and the four closest MERRA nodes; It is been concluded that measurements at Comfrey have been taken in slightly windier epoch than the historical period.

Nearby wind farms have not been spotted and knowledge of existing wind farms is not available; therefore additional wake losses to Comfrey wind farm have not been modelled. The wind shear factor has been estimated to meet a mean value of 0.215.

An exhaustive uncertainty analysis of wind energy production has been presented; the most important sources of uncertainty have been included; there might be other sources of uncertainty but their values are negligible compared to all the issues considered.

A complex topographical study of Comfrey wind farm and surroundings has been carried out with the aim of predicting the wind turbine behaviour in this particular wind farm; different maps with terrain slope and topographic issues have been presented.

Energy production at 80 meters using the Vestas V100-2000, the Vestas V110-2000 and the General Electric GE103-1700 models respectively has been calculated.

11. REFERENCES

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[7]. Power curve and Ct information of wind turbines V110-2000, V100-2000 and GE103-1700.

ANNEXES

12. ANNEX

QUALITY CONTROL MEASUREMENT CAMPAIGN

MET MAST	PERIOD
COMFREY	DECEMBER 2010 - JULY 2014

FAILURES - PROBLEMS

Nº	DATE	SENSOR	DESCRIPTION
1	03/12/2010 11:20 - 04/12/2010 18:40	WIND VANES 80, 60	Icing
2	04/12/2010 18:40 - 05/12/2010 08:30	WIND VANE 80	Icing
3	10/12/2010 07:30 - 16/12/2010 22:00	ANE 80_1	Icing
4	10/12/2010 07:30 - 17/12/2010 09:20	ANE 80_2	Icing
5	10/12/2010 07:30 - 17/12/2010 19:00	ANE 60_1	Icing
6	10/12/2010 07:30 - 16/12/2010 23:30	ANE 60_2	Icing
7	10/12/2010 07:30 - 16/12/2010 09:40	ANE 40_1	Icing
8	10/12/2010 07:30 - 16/12/2010 18:40	ANE 40_2	Icing
9	24/12/2010 20:20 - 27/12/2010 03:00	ALL	Icing
10	30/12/2010 03:50 - 02/01/2011 02:10	ALL	Icing
11	02/01/2011 02:10 - 02/02/2010 14:50	WIND VANE 40	Icing
12	20/02/2011 11:30 - 23/02/2011 00:20	ALL	Icing
13	18/11/2011 22:30 - 20/11/2011 23:30	WIND VANES 80, 60	Icing
14	30/12/2011 04:10 - 30/12/2011 22:30	ALL	Icing
15	22/01/2012 10:40 - 24/01/2012 12:40	ANE 80_1	Icing
16	22/01/2012 10:40 - 25/01/2012 10:00	ANE 80_2	Icing
17	22/01/2012 10:40 - 24/01/2012 16:50	ANE 60_1	Icing
18	22/01/2012 13:10 - 25/01/2012 10:40	ANE 60_2	Icing
19	22/01/2012 13:10 - 25/01/2012 20:30	WIND VANE 80	Icing
20	22/01/2012 13:10 - 24/01/2012 22:50	WIND VANE 60	Icing
21	22/01/2012 13:10 - 23/01/2012 15:10	WIND VANE 40	Icing
22	02/02/2012 23:00 - 06/02/2012 03:30	ALL	Icing
23	28/02/2012 11:00 - 02/03/2012 21:00	ANE 80_1, ANE 80_2	Icing
24	28/02/2012 11:00 - 02/03/2012 15:50	ANE 60_1, ANE 60_2	Icing
25	28/02/2012 11:00 - 02/03/2012 13:30	ANE 40_1, ANE 40_2	Icing
26	04/03/2012 12:50 - 05/03/2012 09:50	WIND VANES 60, 40	Icing
27	04/03/2012 00:20 - 23/07/2014 11:50	ANE 40_2	Failure
28	09/12/2012 12:50 - 11/12/2012 20:40	WIND VANE 40	Icing
29	17/12/2012 03:00 - 19/12/2012 02:00	ANE 80_1	Icing
30	17/12/2012 03:00 - 18/12/2012 23:20	ANE 80_2	Icing
31	17/12/2012 03:00 - 18/12/2012 19:50	ANE 60_2	Icing
32	16/12/2012 03:10 - 18/12/2012 22:00	WIND VANES 80, 60	Icing
33	27/01/2013 09:20 - 01/02/2013 15:30	ALL	Icing
34	10/02/2013 08:00 - 10/02/2013 12:10	ALL	Icing
35	11/02/2013 15:30 - 12/02/2013 06:50	WIND VANES 80, 60	Icing

QUALITY CONTROL MEASUREMENT CAMPAIGN

MET MAST	PERIOD
COMFREY	DECEMBER 2010 - JULY 2014

FAILURES - PROBLEMS

Nº	DATE	SENSOR	DESCRIPTION
36	15/03/2013 21:30 - 17/03/2013 14:10	ALL	Icing
37	09/04/2013 07:00 - 12/04/2013 10:00	ALL	Icing
38	03/12/2013 22:50 - 05/12/2013 01:00	ALL	Icing
39	05/12/2013 01:00 - 05/12/2013 11:30	WIND VANES 80, 40	Icing
40	01/04/2014 00:30 - 23/07/2014 11:50	ANE 80_1	Failure
41	03/04/2014 14:30 - 04/04/2014 08:50	ALL	Icing
42			
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Table 25. Comfrey met mast failures and problems.

	DAY / DIA																														
MONTH / MES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Jan-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Feb-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Mar-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Apr-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
May-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jun-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jul-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Aug-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Sep-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Oct-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Nov-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Dec-10	####	####	144	144	144	144	144	144	144	47	0	0	0	0	0	11	144	144	144	144	144	144	144	122	0	0	125	144	144	23	0
Jan-11	0	130	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Feb-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	69	0	0	141	144	144	144	144	144	####	####	####
Mar-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	138	78	144	144	144	144	144	144	144	144	144	32	144
Jan-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	64	0	67	144	144	144	144	144	144	144
Feb-12	144	138	0	0	0	122	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	66	0	####	####
Mar-12	0	27	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	18	0	131	144	144	144	144	144	144	144	144	144	144	144	144
Jan-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	56	0	0	0	0
Feb-13	50	144	144	144	144	144	144	144	144	117	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####	####	####
Mar-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	129	0	58	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-13	144	144	144	144	144	144	144	144	43	0	0	80	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-13	144	144	137	0	137	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jan-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Feb-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####	####	####
Mar-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-14	3	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
May-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jun-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jul-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Aug-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Sep-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Oct-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Nov-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Dec-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####

0% datos | 1% - 50% datos | 51% - 99% datos | 100% datos | #### sin datos | > 100% datos

Table 26. Comfrey 80_1 anemometer, daily availability.

	DAY / DIA																														
MONTH / MES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Jan-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Feb-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Mar-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Apr-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
May-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jun-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jul-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Aug-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Sep-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Oct-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Nov-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Dec-10	####	####	144	144	144	144	144	144	144	45	0	0	0	0	0	0	90	144	144	144	144	144	144	122	0	0	125	144	144	23	0
Jan-11	0	130	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Feb-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	69	0	0	141	144	144	144	144	144	####	####	####
Mar-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	138	78	144	144	144	144	144	144	144	144	144	32	144
Jan-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	64	0	0	82	144	144	144	144	144	144
Feb-12	144	138	0	0	0	122	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	66	0	####	####
Mar-12	0	27	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	18	2	144	144	144	144	144	144	144	144	144	144	144	144	144
Jan-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	56	0	0	0	0
Feb-13	50	144	144	144	144	144	144	144	144	118	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####	####	####
Mar-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	129	0	58	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-13	144	144	144	144	144	144	144	144	43	0	0	80	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-13	144	144	138	0	137	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jan-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Feb-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####	####	####
Mar-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-14	144	144	87	88	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	72	####	####	####	####	####	####	####	####
Aug-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Sep-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Oct-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Nov-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Dec-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####

0% datos | 1% - 50% datos | 51% - 99% datos | 100% datos | #### sin datos | > 100% datos

Table 27. Comfrey 80_2 anemometer, daily availability.

	DAY / DIA																														
MONTH / MES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Jan-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Feb-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Mar-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Apr-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
May-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jun-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jul-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Aug-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Sep-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Oct-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Nov-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Dec-10	####	####	144	144	144	144	144	144	144	47	0	0	0	0	0	0	29	144	144	144	144	144	144	122	0	0	125	144	144	23	0
Jan-11	0	130	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Feb-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	69	0	0	141	144	144	144	144	144	####	####	####
Mar-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	138	78	144	144	144	144	144	144	144	144	144	33	144
Jan-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	64	0	43	144	144	144	144	144	144	144
Feb-12	144	138	0	0	0	122	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	66	0	####	####
Mar-12	0	48	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jan-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	56	0	0	0	0
Feb-13	50	144	144	144	144	144	144	144	144	122	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####	####	####
Mar-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	129	0	64	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-13	144	144	144	144	144	144	144	144	43	0	0	83	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-13	144	144	137	0	137	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jan-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Feb-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####	####	####
Mar-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-14	144	144	87	91	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	72	####	####	####	####	####	####	####	####
Aug-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Sep-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Oct-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Nov-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Dec-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####

0% datos | 1% - 50% datos | 51% - 99% datos | 100% datos | #### sin datos | > 100% datos

Table 28. Comfrey 60_1 anemometer, daily availability.

	DAY / DIA																														
MONTH / MES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Jan-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Feb-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Mar-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Apr-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
May-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jun-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jul-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Aug-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Sep-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Oct-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Nov-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Dec-10	####	####	144	144	144	144	144	144	144	45	0	0	0	0	0	2	144	144	144	144	144	144	144	122	0	0	125	144	144	23	0
Jan-11	0	130	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Feb-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	69	0	0	141	144	144	144	144	144	####	####	####
Mar-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	138	78	144	144	144	144	144	144	144	144	144	33	144
Jan-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	79	0	0	80	144	144	144	144	144	144
Feb-12	144	138	0	0	0	125	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	66	0	####	####
Mar-12	0	48	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	18	23	144	144	144	144	144	144	144	144	144	144	144	144	144
Jan-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	56	0	0	0	0
Feb-13	50	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####	####	####
Mar-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	129	0	64	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-13	144	144	144	144	144	144	144	144	43	0	0	83	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-13	144	144	137	0	137	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jan-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Feb-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####	####	####
Mar-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-14	144	144	87	91	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	72	####	####	####	####	####	####	####	####
Aug-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Sep-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Oct-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Nov-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Dec-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####

0% datos | 1% - 50% datos | 51% - 99% datos | 100% datos | #### sin datos | > 100% datos

Table 29. Comfrey 60_2 anemometer, daily availability.

	DAY / DIA																														
MONTH / MES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Jan-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Feb-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Mar-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Apr-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
May-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jun-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jul-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Aug-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Sep-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Oct-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Nov-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Dec-10	####	####	144	144	144	144	144	144	144	45	0	0	0	0	0	85	144	144	144	144	144	144	144	122	0	0	125	144	144	23	0
Jan-11	0	130	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Feb-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	69	0	0	141	144	144	144	144	144	####	####	####
Mar-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	138	78	144	144	144	144	144	144	144	144	144	33	144
Jan-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	79	53	144	144	144	144	144	144	144	144
Feb-12	144	138	0	0	0	122	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	66	0	####	####
Mar-12	0	91	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jan-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	56	0	0	0	0
Feb-13	50	144	144	144	144	144	144	144	144	124	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####	####	####
Mar-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	129	0	66	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-13	144	144	144	144	144	144	144	144	43	0	0	95	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-13	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-13	144	144	137	0	137	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jan-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Feb-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####	####	####
Mar-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-14	144	144	87	95	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-14	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	72	####	####	####	####	####	####	####	####
Aug-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Sep-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Oct-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Nov-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Dec-14	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####

0% datos | 1% - 50% datos | 51% - 99% datos | 100% datos | #### sin datos | > 100% datos

Table 30. Comfrey 40_1 anemometer, daily availability.

	DAY / DIA																														
MONTH / MES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Jan-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Feb-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Mar-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Apr-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
May-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jun-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jul-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Aug-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Sep-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Oct-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Nov-10	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Dec-10	####	####	144	144	144	144	144	144	144	45	0	0	0	0	0	31	144	144	144	144	144	144	144	122	0	0	125	144	144	23	0
Jan-11	0	130	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Feb-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	69	0	0	141	144	144	144	144	144	####	####	####
Mar-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Apr-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
May-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Jun-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Jul-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Aug-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Sep-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Oct-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Nov-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	####
Dec-11	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	138	78	144	144	144	144	144	144	144	144	144	33	144
Jan-12	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	79	53	144	144	144	144	144	144	144	144
Feb-12	144	138	0	0	0	125	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	66	0	####	####
Mar-12	0	63	144	3	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Apr-12	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
May-12	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jun-12	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Jul-12	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Aug-12	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Sep-12	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Oct-12	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Nov-12	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Dec-12	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####

0% datos | 1% - 50% datos | 51% - 99% datos | 100% datos | #### sin datos | > 100% datos

Table 31. Comfrey 40_2 anemometer, daily availability.