



WIND ENERGY PRODUCTION

INTRODUCTION

The wind characteristics in the selected location can be represented statistically as a Weibull distribution function that is the wind speed distribution probability function for such a long time period to be representative for all the climate cycles.

$$f(x) = \frac{k}{c} \left(\frac{x}{c}\right)^{k-1} \exp\left[-\left(\frac{x}{c}\right)^k\right] \quad (k > 0, x > 0, c > 1)$$

This Distribution is defined by two parameters that can be edited in the GUI:

K: Is the parameter that defines the Distribution shape and is a function of the wind speed standard deviation.

c: Is the parameter that defines the maximum value position and is a function of the wind speed mean value.

Based on this information the average wind speed is calculated. This value is shown in the GUI when the parameters *K* and *c* are specified:

$$s = \frac{c}{(0.568 + 0.433/K)^{\left(\frac{1}{K}\right)}}$$

In order to simplify this process, it has been added a database with the default values for all the locations generated with Meteonorm¹. These default values can be seen in Table 1.

¹ "Meteonorm," 2015. [Online]. Available: <http://www.meteonorm.com>.



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Table 1 Default Weibull parameters for each location available in RenewIT Tool, source Meteonorm¹.

City	Weibull parameters		Mean wind speed
	k[-]	c [m/s]	(m/s)
ALM	1.28	2.96	2.74
AMS	1.82	5.3	4.71
ATH	1.31	3.08	2.84
BBU	1.28	2.85	2.64
BCN	1.3	3.01	2.78
BEG	1.29	2.87	2.65
BER	1.68	4.59	4.10
BGO	1.64	4.01	3.58
BOD	1.2	2.64	2.48
BRU	1.64	4.13	3.69
BTS	1.66	4.03	3.60
BUD	1.25	2.74	2.55
CLJ	1.08	2.16	2.10
CPH	1.84	5.64	5.01
DOK	1.71	4.45	3.97
DUN	1.84	5.4	4.79
EDI	2.02	9.26	8.20
FRA	1.58	3.7	3.32
GDN	1.51	3.51	3.16
HAM	1.4	3.09	2.81
HEL	1.63	3.82	3.42
INN	1.03	1.85	1.83
KBP	1.55	3.58	3.22
KSC	1.37	3.05	2.79
KUN	1.64	4.06	3.63
LIS	1.45	4.27	3.87
LLA	1.62	3.73	3.34
LON	1.61	3.83	3.43
LWO	1.38	3.2	2.92
LYS	1.59	3.68	3.30
MAD	1.46	4.03	3.65
MAN	1.97	7.79	6.90
MEL	1.73	4.38	3.90
MIL	1.01	1.54	1.53
MRS	1.52	4.64	4.18
MSQ	1.59	3.69	3.31
MUN	1.59	3.78	3.39
NAP	1.09	2.17	2.10
NTE	1.34	3	2.75



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OPO	1.6	5.63	5.04
OSL	1.37	2.98	2.72
PAR	1.61	3.8	3.40
PRG	1.38	3.08	2.81
RIX	1.19	2.57	2.42
ROM	1.11	2.19	2.11
RVK	1.64	4.06	3.63
SDR	1.62	3.77	3.37
SJJ	1.03	1.57	1.55
SKG	1.05	1.89	1.85
SKP	1.02	1.73	1.72
SOF	1.39	3.06	2.79
SPU	1.36	3.39	3.10
STK	1.62	3.8	3.40
SVQ	1.04	1.76	1.73
TIA	1.08	2.07	2.01
TRN	1.97	7.46	6.61
VAL	1.63	3.86	3.45
VAR	1.37	3.37	3.08
VAS	1.08	2.3	2.23
VIE	1.59	3.7	3.32
WAW	1.67	4.13	3.69
ZAG	1.04	1.68	1.65
ZRH	1.06	2.08	2.03

Finally, knowing the wind speed distribution and the wind turbine power curve, the wind energy generated can be calculated. In the RenewIT tool two different wind turbine size have been considered: small size (50 kW)² and medium size (600 kW)³.

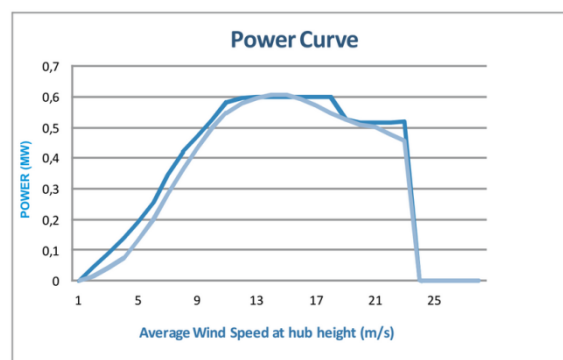


Figure 1 Sample of a wind power curve of a wind turbine of 600 kW³.

² AEOLUS-H 50kW. AEOLUS wind turbine 2015.

³ BONUS-600 kW. Repowering Solutions 2012.



OTHER ASSUMPTIONS

Changes in the wind speed for the height differences between the wind turbine rotor and the anemometer

The vertical profile of the wind speed depends very much on the terrain, the thermal conditions of the environment. The modeling of this is complex and demands a lot of knowledge of the location. The project has considered that the wind speed is already the one at the wind turbine rotor.

Changes in the wind speed for the differences in the height above sea level between the wind turbine site and the meteorological station

When wind data is used from a meteorological station, one must be sure that its height above sea level is very similar to the one of the site. If this is not true, the data will not be representative enough. As in the previous point, the modeling of this effect is too complex for this tool.

Shadow effects between wind turbines

The objective of the project is not modeling a wind park, but modelling on-site renewables by the use of some wind turbines. Therefore, they will be sited without shadows effects between them.