Muhsen A. Mansour
Abdusalam

# SELECTION OF A WIND TURBINE USING THE WIND DATA ANALYSIS

**A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF APPLIED SCIENCES OF NEAR EAST UNIVERSITY**

**By**
**Muhsen A. Mansour Abdusalam**

**In Partial Fulfillment of the Requirements for the Degree of Master in Mechanical Engineering**

**NICOSIA, 2017**

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**Approval of Director of Graduate School of**

**Applied Sciences**

**Prof. Dr. Nadire ÇAVUŞ**

**We certify this thesis is satisfactory for the award of the degree of Master in Mechanical Engineering**

**Examining Committee in Charge:**

I hereby declare that, all the information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last Name :

Signature :

Date:

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I would like to especially thank my thesis advisor, Assist. Prof. Dr. Hüseyin ÇAMUR, for his useful guidance and supporting me with valuable information and discussions that assisted me in working through many problems.

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**To my parents ...**

## ABSTRACT

Wind energy, which is among the most promising renewable energy resources, is used throughout the world as an alternative to fossil fuels. The aim of this study is to establish the meteorological basis for the assessment of wind energy resources in Cyprus and to provide suitable data for evaluating the potential wind power. Moreover, the objective of the present study is to estimate available wind power of five cities in Northern part of Cyprus, namely, Dipkarpaz, Girne, Güzelyurt, Lefkoşa and Mağusa using the wind data collected from meteorological department. For this purpose, wind speed data, collected for a one-year period between January-December 2016, were evaluated. The results concluded that the annual mean wind speed is ranging between 2.47 and 4.58 m/s. Furthermore, the results showed that Mağusa is the most suitable location for harnessing the wind power, while Dipkarpaz has been identified as the second most suitable site.



***Keyword:*** Northern part of Cyprus; wind energy; wind speed; density; wind power

## ÖZET

En umut verici yenilenebilir enerji kaynakları arasında yer alan rüzgar enerjisi, tüm dünyada fosil yakıtlara alternatif olarak kullanılmaktadır. Bu çalışmanın amacı, Kıbrıs'taki rüzgar enerjisi kaynaklarının değerlendirilmesi için meteorolojik temel oluşturmak ve potansiyel rüzgar enerjisini değerlendirmek için uygun veri sağlamaktır. Ayrıca, bu çalışmanın amacı meteoroloji dairesinden alinan rüzgar verilerini kullanarak Kıbrıs'ın kuzeyindeki beş kentin, yani Dipkarpaz, Girne, Güzelyurt, Lefkoşa ve Mağusa'nın, mevcut rüzgar gücünü tahmin etmektir. Bu amaçla, ocak-Aralık 2016 tarihleri arasındaki bir yıllık dönem için elde edilen rüzgar hızı verileri değerlendirilmiştir. Çalışma sonunda yıllık ortalama rüzgar hızının 2.47 ila 4.58 m/s arasında değiştiği sonucuna varılmıştır. Ayrıca, sonuçlar Mağusa'nın rüzgar enerjisi kullanmak için en uygun yer olduğunu, Dipkarpaz'ın en uygun ikinci alan olarak tespit edildiğini göstermiştir.



***Anahtar Kelimeler:*** Kuzey Kıbrıs Türk Kesimi; rüzgar enerjisi; rüzgar hızı; yoğunlu; rüzgr enerjisi

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| | |
|---|---|
| $\dot{m}$ | Mass flow rate [kg/s] |
| $P_{Available}$ | Available wind power [W] |
| $\rho$ | Density [kg/m$^3$] |
| $Q$ | Volume flow [m$^3$/s] |
| $v$ | Wind speed [m/s] |

# CHAPTER 1
# INTRODUCTION

## 1.1 Background

Wind energy can be considered as a clean and environmentally preferable source of energy (Shu et al., 2015; Ozay & Celiktas, 2016). It can be established certain superiorities in comparison with traditional energy sources. Wind energy is known as a renewable and environmental friendly energy source. Utilization of wind energy as an energy source such as electric power (Alodat & Anagreh, 2011) has been growing rapidly in the whole world due to consumption of the limited fossil fuels, environmental pollution and global warming (Shu et al., 2015). Therefore, it has become one of the lowest-priced renewable energy sources.

Wind energy does not have a transportation problem and does not require a high technology to utilize (İlkili & Türkbay, 2010; Al Zohbi et al., 2015; Masseran, 2015).

The advantage of wind energy can be considered as: cleanliness, low cost, and abundance in everywhere on the world (İlkili & Türkbay, 2010).

Wind energy can be converted into different type of energy such as mechanical energy or electrical energy. The kinetic energy in wind is converted into mechanical energy, which is then converted into electrical energy. Wind electricity generation systems convert wind energy into electricity by means of wind turbines (İlkili & Türkbay, 2010). According to the Betz Theorem, the amount of energy obtained by converting wind energy to mechanical energy is proportional to the third power of wind speed (Gourieres & Gourieres, 1982; İlkili & Türkbay, 2010). The technology converting wind energy to other energy types are more economical comparing to other conversion systems.

## 1.2 Research Aims

The purposes of this work are

1. To examine the seasonal and diurnal evolution of wind speeds across Northern Part of Cyprus.
2. To investigate the wind characteristics and available energy produced by different type of wind turbine.

3. To find the optimum location and best type of wind turbine that can be used in Northern Part of Cyprus.

### 1.3 Thesis Outlines

Chapter 1 provides a description of wind energy and the aims of this work. In chapter 2 explains the fundamental concept of wind turbine in terms of horizontal wind turbine and vertical axis wind turbine. The characteristics of wind speed in different location in Northern Part of Cyprus and the available power obtained from the wind energy is discussed in chapter 3. The final conclusion on the current study is described in chapter 4.

# CHAPTER 2
# WIND TURBINE

The wind turbine can be classified according to the turbine generator configuration, airflow path relative to the turbine rotor, turbine capacity, the generator-driving pattern, the power supply mode and the location of turbine installation.

## 2.1 Brief history of wind power

In the period from $7^{th}$ to $10^{th}$ century, the first wind powers were used which was located between Iran and Afghanistan (Ngo & Natowitz, 2016). They were used for pumping the water of grinding wheat. They had vertical axis and low efficiency because of the drag component of these turbines (Kishore, 2015). Moreover, to work properly, the part rotating in the opposite direction compared to the wind, had to be protected by a wall (see Figure 2.1).

**Figure 2.1:** Persian Windmills (Kishore, 2015)

Observably, it can be used only in places with a main wind direction, because there is no way to follow the variations.

The first windmills built in Europe and inspired by the Middle Eastern ones had the same problem, but they used a horizontal axis (Todkar et al., 2017). So they substitute the drag with the lift force, making their inventors also the unaware discoverer of aerodynamics (Todkar et al., 2017).

During the following centuries, many modifies were applied for the use in areas where the wind direction varies a lot: the best examples are of course the Dutch windmills, used to drain the water in the lands taken from the sea with the dams, could be oriented in wind direction in order to increase the efficiency as shown in Figure 2.2.

**Figure 2.2** Dutch Windmill (Nelson, 2014)

The wind turbines used in the USA during the 19th century and until the the 20th century were mainly used for irrigation (Olah et al., 2011). They had a high number of steel-made blades and represented a huge economic potential because of their large quantity: about 8 million were built all over the country (see Figure 2.3).

**Figure 2.3** American multi blade Windmill (Yogi & Kreith, 2007)

The first attempt to generate electricity was made at the end of the 19th century, and they become more and more frequent in the first half of the following century. Almost all those models had a horizontal axis, but in the same period (1931) Georges Jean Marie Darrieus designed one of the most famous and common type of VAWT (see Figure 2.4), that still bears his name (Paraschivoiu, 2013).

**Figure 2.4** Darrieus wind Turbine (Paraschivoiu, 2013)

The recent development led to the realization of a great variety of types and models, both with vertical and horizontal axis, with a rated power from the few kW of the beginning to the 6 MW and more for the latest constructions.

## 2.2 Turbine Classification

Wind turbines can be separated into two types based on the axis on which the turbine rotates. Turbines that rotate around a horizontal axis, known as Horizontal Axis Wind Turbine (HAWT) are more common than Vertical-Axis Wind Turbines (VAWT) that rotate around a vertical axis (Steeby, 2012).

Most commercial wind turbines today belong to the horizontal-axis type, in which the rotating axis of the blades are parallel to the wind stream (Tong, 2010). The advantages of

this type of wind turbines include the high turbine efficiency, high power density, low cut-in wind speed and low cost per unit power output.

Several typical vertical-axis wind turbines are shown in Figure 2.5. The blades of vertical – axis wind turbines rotate with respect to their vertical axes that are perpendicular to the ground. A significant advantage of vertical-axis wind turbines is that the turbine can accept wind from any direction and thus no yaw control is needed. Since the wind generator, gearbox, and other main turbine components can be set up on the ground, it greatly simplifies the wind tower design and construction, and consequently reduces the turbine cost. However, the vertical axis wind turbines must use an external energy source to rotate the blades during initialization (Rivkin & Silk, 2013). Because the axis of the wind turbine are supported only on one end at ground, its maximum practical height is thus limited. Due to the lower wind power efficiency, vertical-axis wind turbines today make up only a small percentage of wind turbines (Gipe, 2004).

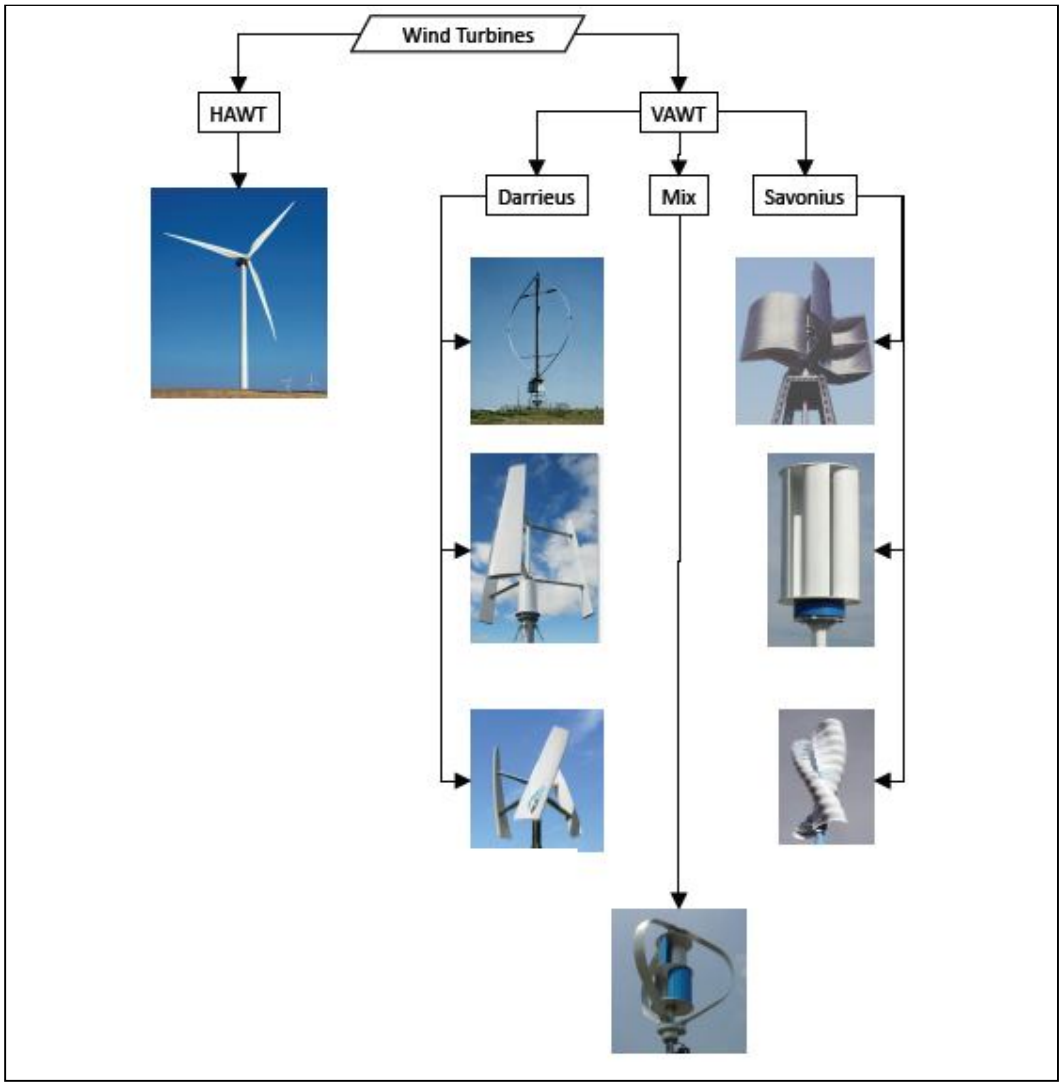


**Figure 2.5:** Wind turbine types

### 2.2.1 Horizontal Axis Wind Turbines

Horizontal-axis wind turbines (HAWT) have its rotating shaft fixed horizontally with high tower to utilize high wind speeds. Small turbines are pointed by a simple wind vane, while large turbines generally use a wind sensor coupled with a servo motor. Most of the horizontal-axis wind turbines have a gear box to control the shaft speed and turns the slow rotation of the blades into a quicker rotation that is more suitable to drive a generator (Tong, 2010) as shown in Figure 2.6.

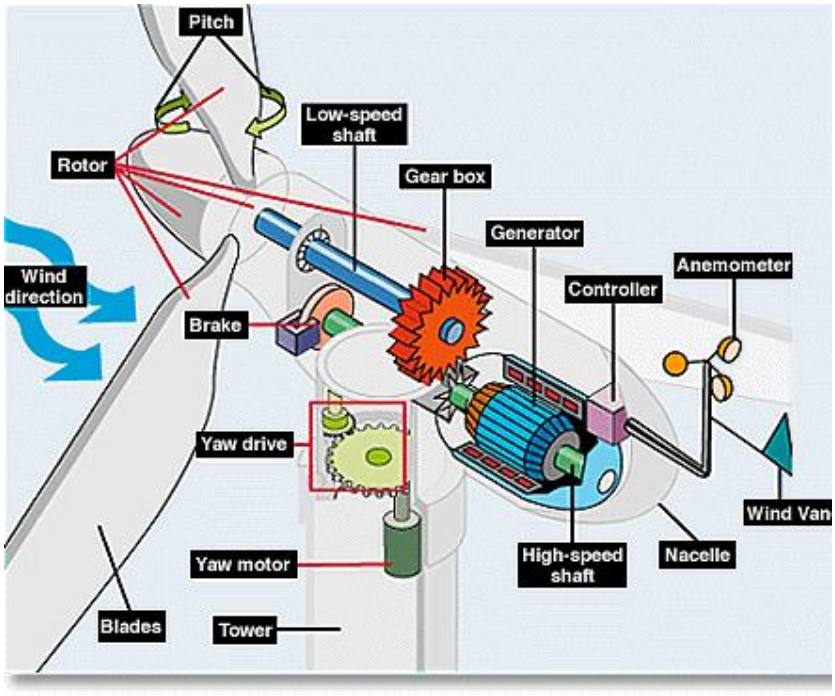


**Figure 2.6:** Components of a Horizontal-Axis Wind Turbine (Hau & Hau, 2006)

A gear box is used to control the angular speed of the generator to be able to get a constant output power at different air speeds, there are also designs that use direct drive of an annular generator (Castellano, 2012). Some models operate at constant speed, but more energy can be collected by variable-speed turbines which use a solid-state power converter to interface to the transmission system. All turbines have a safety system which shut down the turbine if it was running over the designed speed or when the vibrations exceed the safe range (Hau & Hau, 2006).

#### 2.2.1.1 Types of HAWT

There are two types of horizontal axis wind turbines

A. Horizontal upwind: the generator shaft is positioned horizontally and the wind hits the blade before the tower. Turbine blades are made stiff to prevent the blades from being pushed into the tower by high winds, and the blades are placed at a

considerable distance in front of the tower and are sometimes tilted up a small amount (Masters, 2013; Chiras et al., 2010).

B. Horizontal downwind: the generator shaft is positioned horizontally and the wind hits the tower first and then the blade. Horizontal downwind does not need an additional mechanism for keeping it in line with the wind, and in high winds the blades can be allowed to bend, which reduces their swept area and thus their wind resistance. The horizontal downwind turbine is also free of turbulence problems (Masters, 2013; Chiras et al., 2010).

#### 2.2.1.2 Advantages and Disadvantages of Horizontal Axis Wind Turbine

The advantages of using this type of turbine (Farret & Simões, 2017; Daim, 2013; Wu et al., 2011; Ali, 2017) are following

- Their tall towers allow wind turbine blades to access strong wind. If we increase the height of wind turbine blades to every 10 meters, we will get 20% more speed and 34% more power output.
- The efficiency of this type of wind turbine is more as compare to vertical axis wind turbine because blades are perpendicular to wind. With this direction, they have more capability to receive wind impact.
- These turbines have variable blade pitch. By this behavior, blades get the optimum angle of attack which allows the blades to adjust it for greater control to get maximum wind energy.

Because of getting high attitude, tower needs massive construction to support heavy blades and its other components like gearbox and electricity. Tower height makes wind turbine visible across many areas which will create disturbance to view the landscape. Horizontal axis wind turbines designed on downwind failed due to fatigue and failure when turbine blades pass through the shadow of tower. Horizontal axis wind turbines need yaw control mechanism for turning their blades to get maximum wind energy Farret & Simões, 2017; Daim, 2013; Wu et al., 2011; Ali, 2017).

Horizontal axis wind turbines need yawing or braking devices when the speed of wind is enough. If such type of situations where we don't stop wind turbines it can destroy itself also. Due to the movements of turbine blades, cyclic stresses generate because one of the blades of turbine faces minimum wind energy and other at the same time faces maximum

which will create twists and crack the blade quickly Farret & Simões, 2017; Daim, 2013; Wu et al., 2011; Ali, 2017).

### 2.2.2 Vertical Axis Wind Turbines

Vertical-axis wind turbines (or VAWTs) have the main rotor shaft arranged vertically (Ledec et al,. 2011). One of the major advantages of the vertical-axis wind turbines is that it does not need to be pointed to the wind, it catches the wind from any position. It also does not need a high tower which makes it much cheaper than the horizontal-axis wind turbine (Paraschivoiu, 2002).

With a vertical-axis wind turbine, the generator and gearbox can be placed near the ground, not required a tower to hold all of these equipments (Figure 2.7). However, drag force may be created when the blade rotates into the wind (Paraschivoiu, 2002).

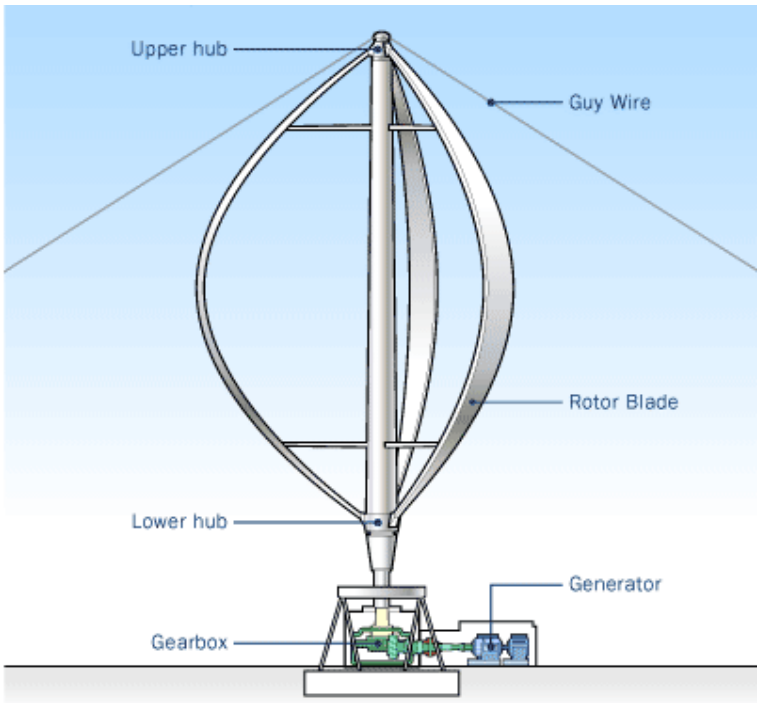


**Figure 2.6:** A Vertical-Axis Wind Turbine ((Paraschivoiu, 2002)

It is difficult to mount vertical-axis turbines on towers, so they are commonly mounted over the ground or at the top of a building. The wind speed is lower at the lower altitudes because of the buildings and other facilities which block the wind and that is the reason vertical axis-wind turbines are common at low altitudes, where it can work efficiently at low wind speeds.

#### 2.2.2.1 Advantages and Disadvantages of Vertical Axis Wind Turbine

**A. Advantages:**

1. The generator, gearbox and other components may be placed on the ground, so the tower doesn't need to support it, and it is more accessible for maintenance (Rivkin & Silk, 2013; Casper. 2007; Hunter & Elliot, 2005).
2. Relative cost of production, installation and transport compared to horizontal axis turbines (Rivkin & Silk, 2013; Casper. 2007; Hunter & Elliot, 2005).
3. The turbine doesn't need to be pointed into the wind to be effective. This is an advantage on sites where the wind direction is highly variable (Rivkin & Silk, 2013; Casper. 2007; Hunter & Elliot, 2005).
4. Hilltops, ridge lines and passes can have higher and more powerful winds near the ground than higher up because due to the speed up the effect of winds moving up a slope. In these places, vertical axis turbines are suitable (Rivkin & Silk, 2013; Casper. 2007; Hunter & Elliot, 2005).
5. The blades spin at slower speeds than the horizontal turbines, decreasing the risk of injuring birds (Rivkin & Silk, 2013; Casper. 2007; Hunter & Elliot, 2005).
6. It is significantly quieter than the horizontal axis wind turbine. As a result, vertical axis wind turbines work well on rooftops, making them particularly useful in residential and urban environments. They may also be built in locations where taller structures are prohibited by law (Rivkin & Silk, 2013; Casper. 2007; Hunter & Elliot, 2005).
7. They are particularly suitable for areas with extreme weather conditions, like in the mountains where they can supply electricity to mountain huts (Rivkin & Silk, 2013; Casper. 2007; Hunter & Elliot, 2005).

**B. Disadvantages**

1. They are less efficient than horizontal axis wind turbines. Most of them are only half as efficient as the horizontal ones because of the additional drag that they have

as their blades rotate into the wind (Rivkin & Silk, 2013; Casper. 2007; Hunter & Elliot, 2005).

2. Airflow near the ground and other objects can create turbulent flow, which can introduce issues of vibration. This can include noise and bearing wear which may increase the maintenance or shorten the service life (Rivkin & Silk, 2013; Casper. 2007; Hunter & Elliot, 2005).

### 2.3 Available wind power

Estimation of the available energy in the wind at a site, in which the wind turbine is proposed to be located, is one of the preliminary steps in the planning of a wind energy project. The available power of the free-air stream that flows through the cross-sectional area $A_R$, at constant velocity v, is:

$$P_{Available} = \frac{1}{2}\dot{m}v^2 = \frac{1}{2}\rho Q v^2 = \frac{1}{2}\rho A_R v^3 \qquad (2.1)$$

where ρ is the density of air, Q is the volume flow passing through the given cross section, $A_R = \pi D^2/4$ is a rotor cross-sectional area, where D is the turbine rotor diameter.

Eq. (2.1) demonstrates that the factors influencing the available power in the wind stream are the area of the wind rotor, the air density, and the wind velocity. Effect of the wind velocity on the

wind power value is more prominent owing to its cubic relationship. The determination of the wind conditions at the intended site of the wind turbine setting is an important task because small changes in wind velocity can result in significant variation in energy production. Because the wind velocity varies, it is necessary to know the frequency distribution and to give the information on the number of hours for which the velocity is within a specific range (Mathew, 2006).

Providing reliable wind data should be the first step in any wind turbine investments. Knowing the mean annual wind speed is not enough to provide a precise energy calculation even if the mean annual wind velocity is determined on the basis of measurements taken over decades (Hau, 2013; Chang et al., 2003). It also requires information on how frequently the individual wind speeds of the spectrum can be expected at a given location.

# CHAPTER 3
# WIND CHARACTERISCS IN CYPRUS

## 3.1 Environment Descriptions and Data Collection

Cyprus is geographically predisposed to winds from the Mediterranean. Cyprus is situated at latitude 35 ° North and longitude 33 ° East, surrounded by the Eastern Mediterranean Sea. The surface winds over Cyprus are controlled by local surface effects, such as the temperature contrast between land and open sea (land and sea breezes), the differential heating of land (anabatic and catabatic winds) and the constraints imposed by topography.

The mean wind speeds in the Cyprus are generally below 10 m/s for most of the year. Strong winds with mean speeds exceeding 10 m/s over land areas occur in association with a weather system, such as an active surface trough or squall line.

Wind speed data collected from meteorological department located in the Lefkoşa. In general, there are many devices that can be used to measure the wind energy of any locations such as cup anemometer, wind speed meter, wind speed sensor. In this study, cup anemometer is used to measure the wind and it is located at a height of 10m. Table 3.1 gives a description of the stations including geographical coordinates, altitude, measuring height and period of record.

**Table 3.1.** Details of each station used in the analysis

| Station name | Coordinates | | Measuring Height[m] | Period records |
|---|---|---|---|---|
| | Latitude [°N] | Longitude [°E] | | |
| Dipkarpaz | 35° 37' 36 | 34° 24' 31 | 10 | 2016 |
| Girne | 35° 20’ 25 | 33° 19’ 08 | 10 | 2016 |
| Güzelyurtt | 35° 11’ 53 | 32° 59’ 38 | 10 | 2016 |
| Lefkoşa | 35° 10’ 08 | 33° 21’ 33 | 10 | 2016 |
| Mağusa | 35° 06’ 54 | 33° 56’ 33 | 10 | 2016 |

### 3.2 Daily Wind Speed and Seasonal Variations

Wind speeds are different for months and seasons vary. Figure 3.1-3.5 show daily wind speed for different months in a different location in the Northern Part of Cyprus. For example, it is seen in Figure 3.1 that December has a maximum of around 11 m/s wind speed, while February has around 9 m/s wind speed. In spring season (March, April, and May), March has the maximum wind speed comparing to April and May. In addition, in summer season (June, July, and August), the highest wind speed occurs in June, while the wind speeds are ranging between 2 and 5 m/s in July and August. Also, it is observed from Figure 3.1 that November and October have maximum wind speed in Autumn season. Moreover, it is noticed that daily wind speed for Dipkarpaz and Mağusa vary between 0 and 13 m/s as shown in Figure 3.1 and 3.5, respectively. While, the wind speeds in other location are varied between 0 and 8 m/s (Figures 3.2, 3.3 and 3.4).

In general, it can be concluded that Dipkarpaz and Mağusa have maximum wind speed during the year comparing to Girne, Güzelyurtt, and Lefkoşa.

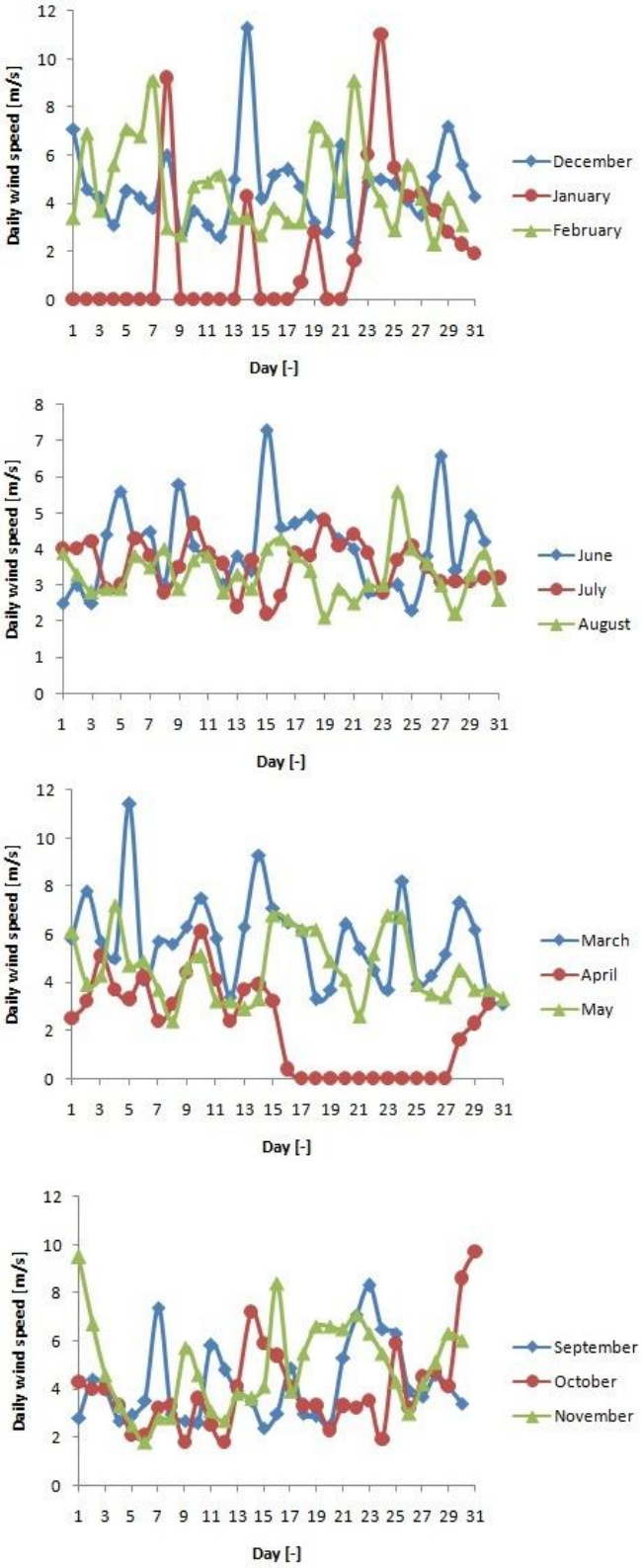


**Figure 3.1:** Daily wind speed in Dipkarpaz

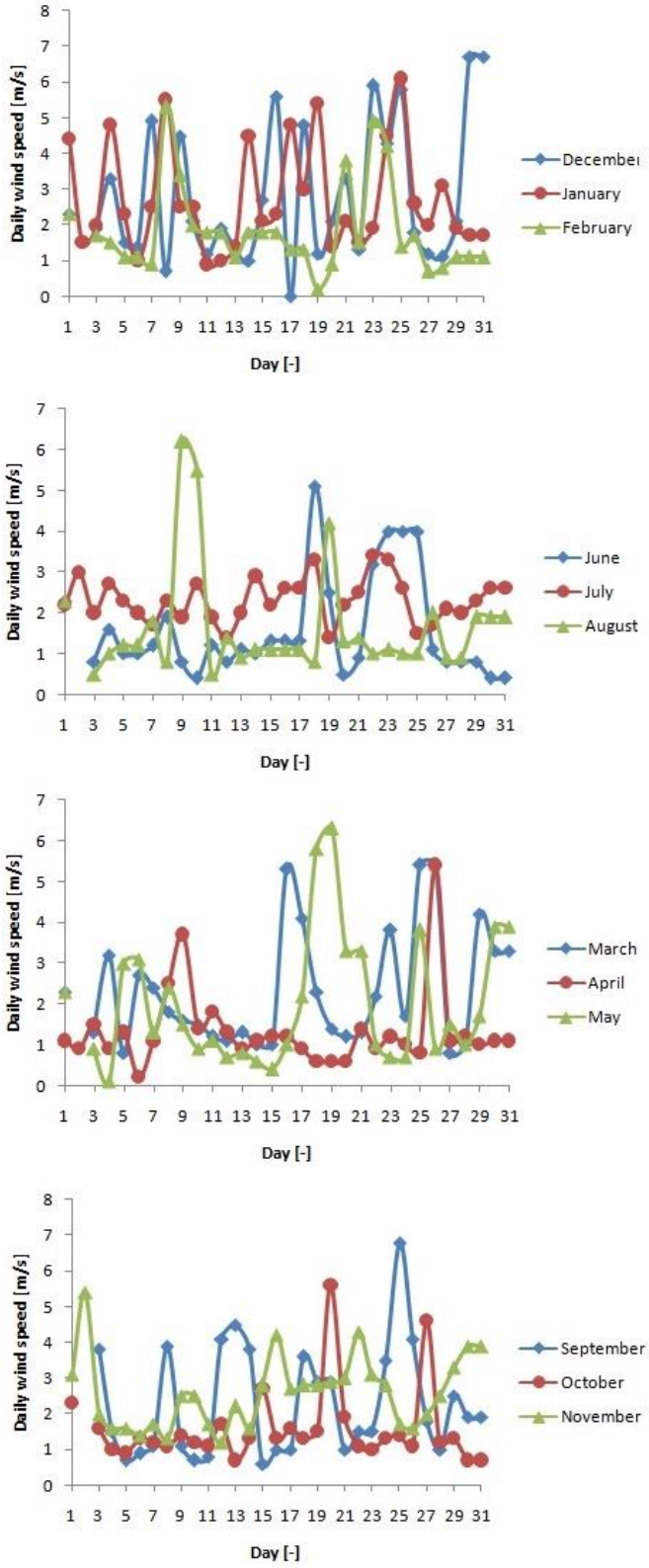


**Figure 3.2:** Daily wind speed in Girne

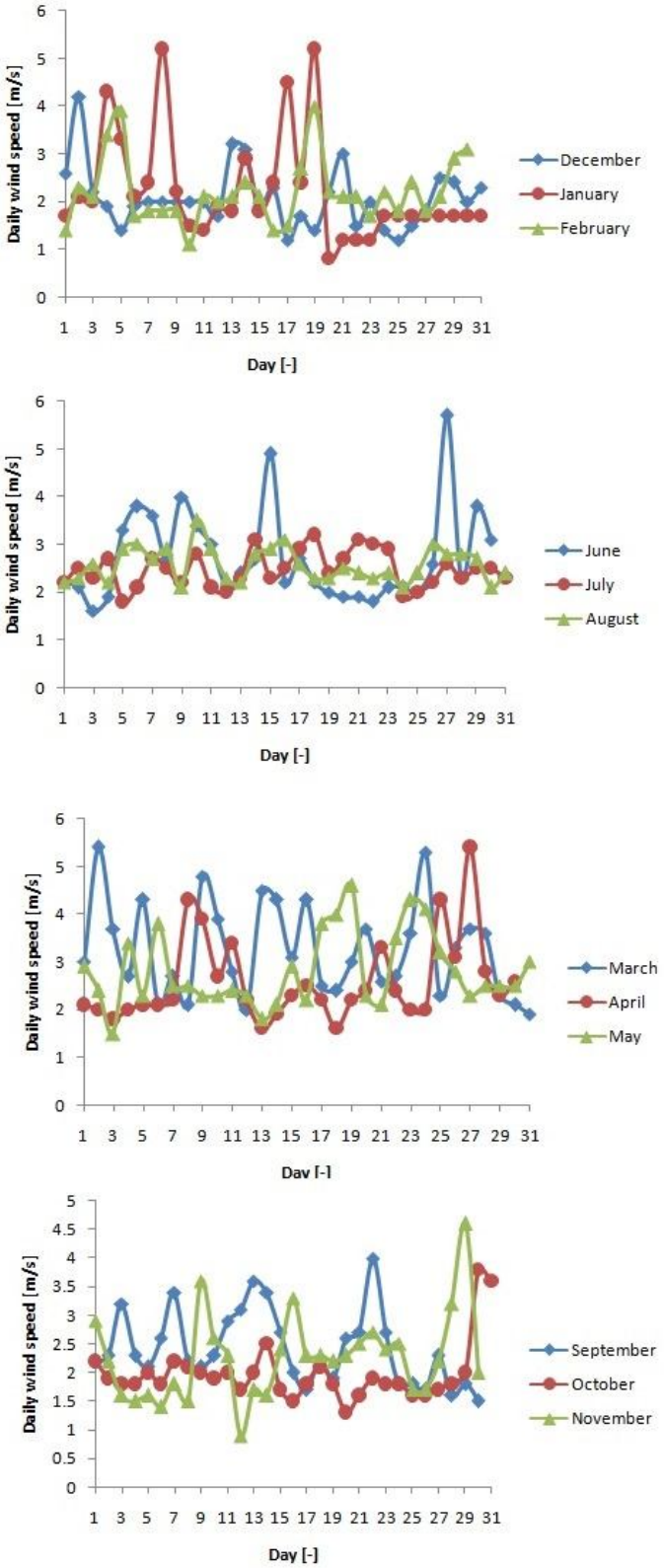


**Figure 3.3:** Daily wind speed in Güzelyurtt

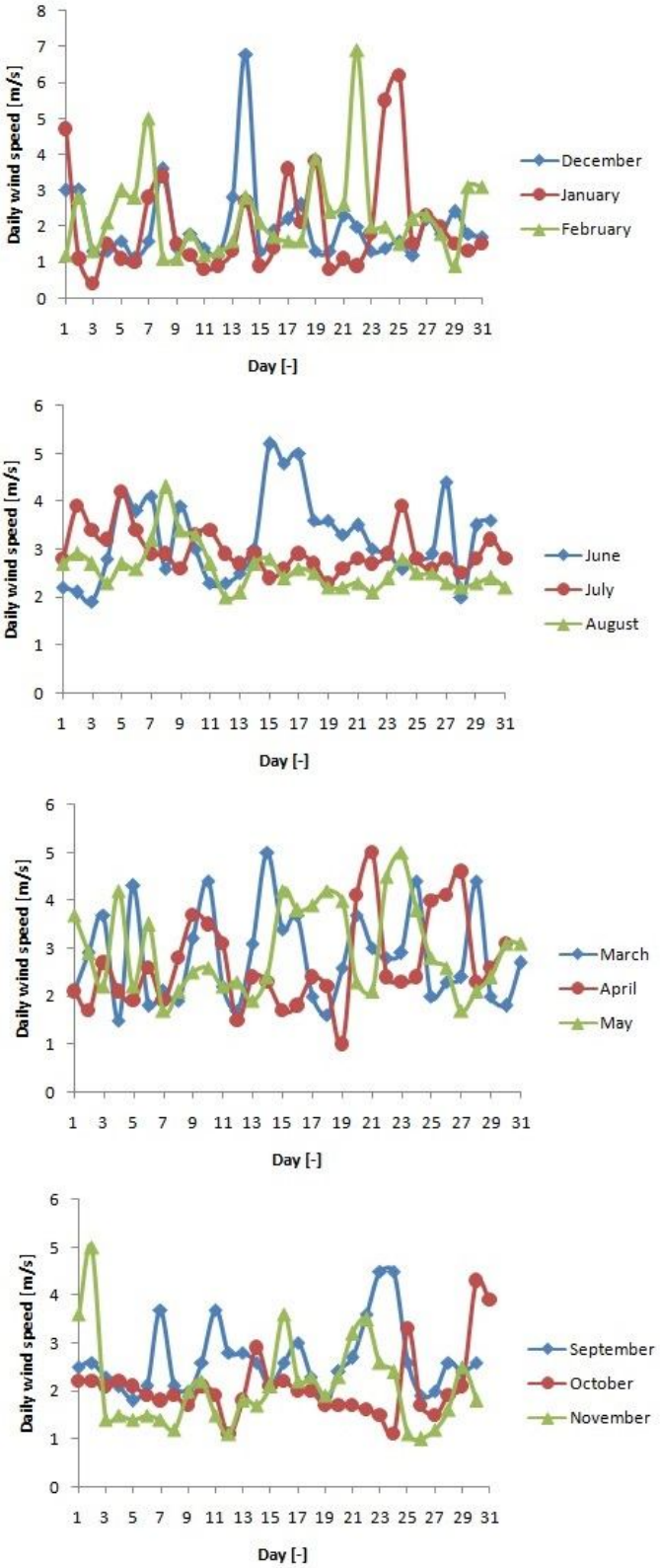


**Figure 3.4:** Daily wind speed speed in Lefkoşa

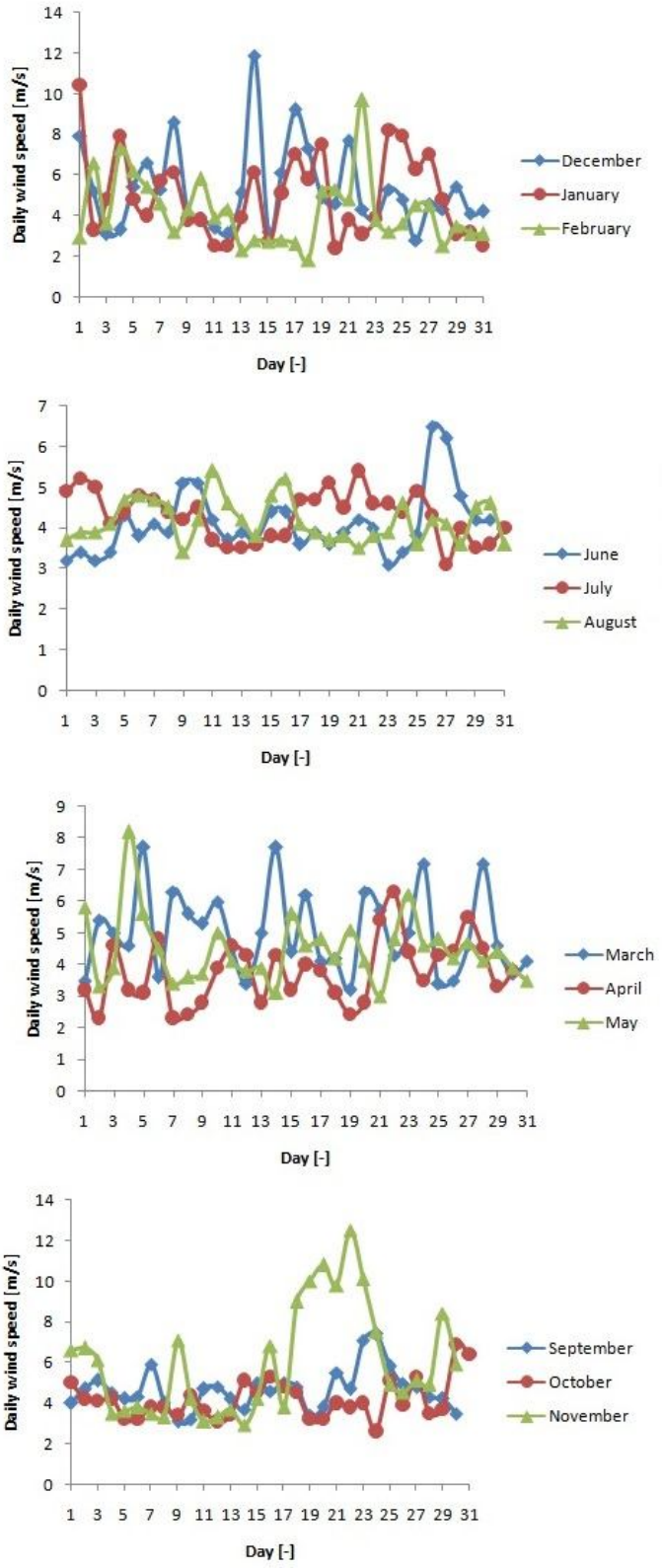


**Figure 3.5:** Daily wind speed in Mağusa

The daily time-evolution of wind velocity is quite important for the integration of wind power into the overall energy supply. Figure 3.6 shows the daily time variation of the season daily wind speed for five stations which represent different climate regimes for four seasons (winter, spring, summer and Autumn). From the graph it reveals that wind speeds are varying between 2 and 8 m/s in Mağusa and Dipkarpaz. Also, it is noticed that Girne, Güzelyurtt and Lefkoşa have the lowest wind speed compared to Mağusa and Dipkarpaz. Moreover, it is observed that the maximum wind speeds are occurred in winter and spring in Mağusa and Dipkarpa, respectively.

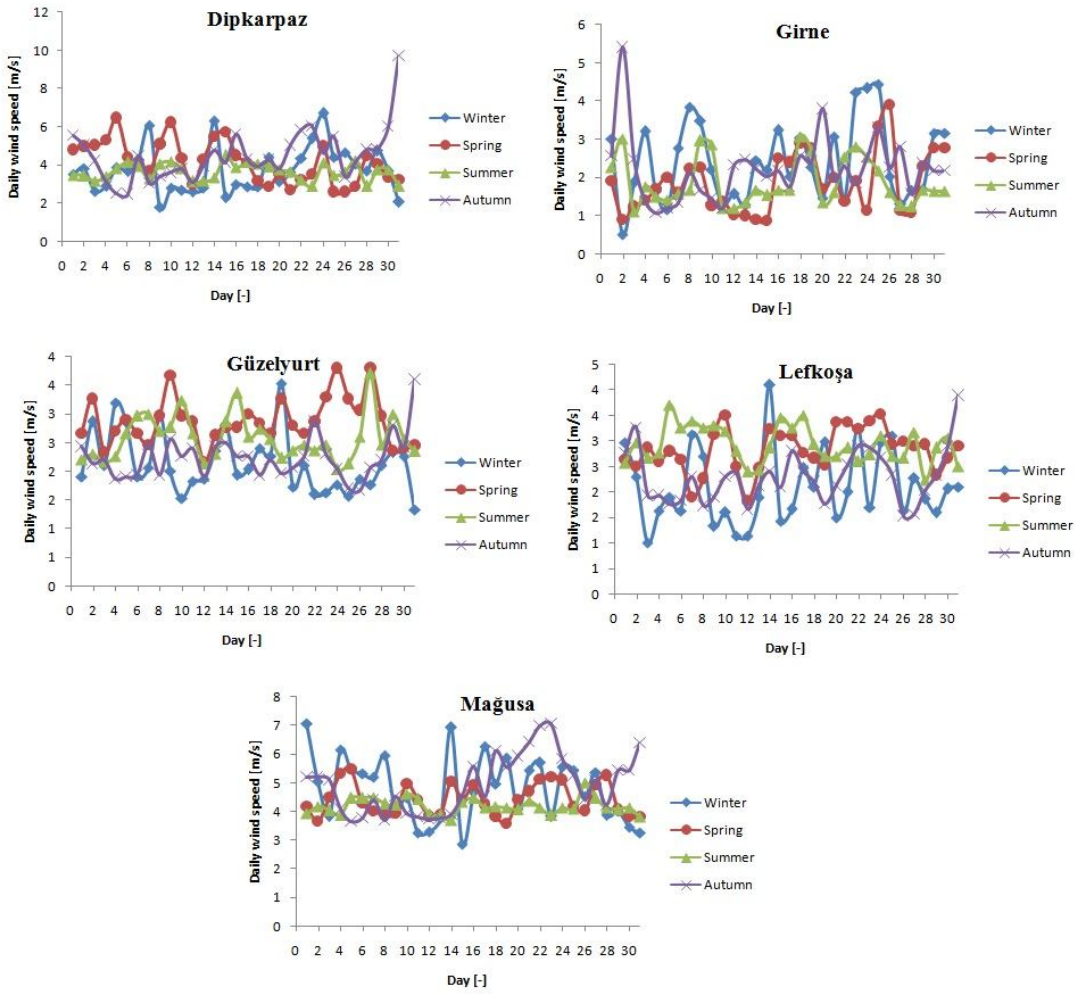


**Figure 3.6:** Daily seasonally wind speed in five different locations in Cyprus

### 3.2 Hourly Wind Speed and Seasonal Variations

The daily time-evolution of wind velocity is quite important for the integration of wind power into the overall energy supply. Figure 3.7 to 3.12 show the daily time variation of the mean hourly wind speed for five locations which represent different climate regimes for four seasons and 12 months.

It is seen in Figures 3.7 to 3.12 that December and February has a maximum wind speed around 5m/s in Dipkarpaz. While, in Girne and Lefkoşa, the maximum wind speed occurs in December, and February respectively. Moreover, It is observed that January has a maximum of 3.5 m/s wind speed in Güzelyurtt. Figure 3.11 and 3.12 show that December has a maximum wind speed of 6 m/s in Mağusa. In general, in winter, the maximum occurs early in the afternoon, while the minimum occurs during the night or early in the morning.

Furthermore, Figures 3.7 to 3.12 show hourly average wind speed for spring (March, April, and May) and average wind speed varies in the range 2–7 m/s. It is seen in that maximum average wind speeds arises in March for Dipkarpaz, Girne, Güzelyurtt, Lefkoşa, and Mağusa.

Additionally, it observed from the figures that June has maximum wind speed in five stations in terms of Dipkarpaz, Girne, Güzelyurtt and Lefkoşa. Whereas, the maximum wind speed occurs in July and August in Mağusa. From the graphs, it reveals that during the summer, the diurnal variation in the coastal areas has a maximum which occurs late in the afternoon and a minimum which occurs in most cases between 5 and 6 a.m. In contrast, in the building areas (Lefkoşa), the maximum occurs in the afternoon at 2 p.m. and a minimum which occurs in between 3 and 4 a.m. During autumn, it is seen in Figures that maximum average wind speeds occur in September (Girne, Güzelyurtt, and Lefkoşa) and November (Dipkarpaz and Mağusa).

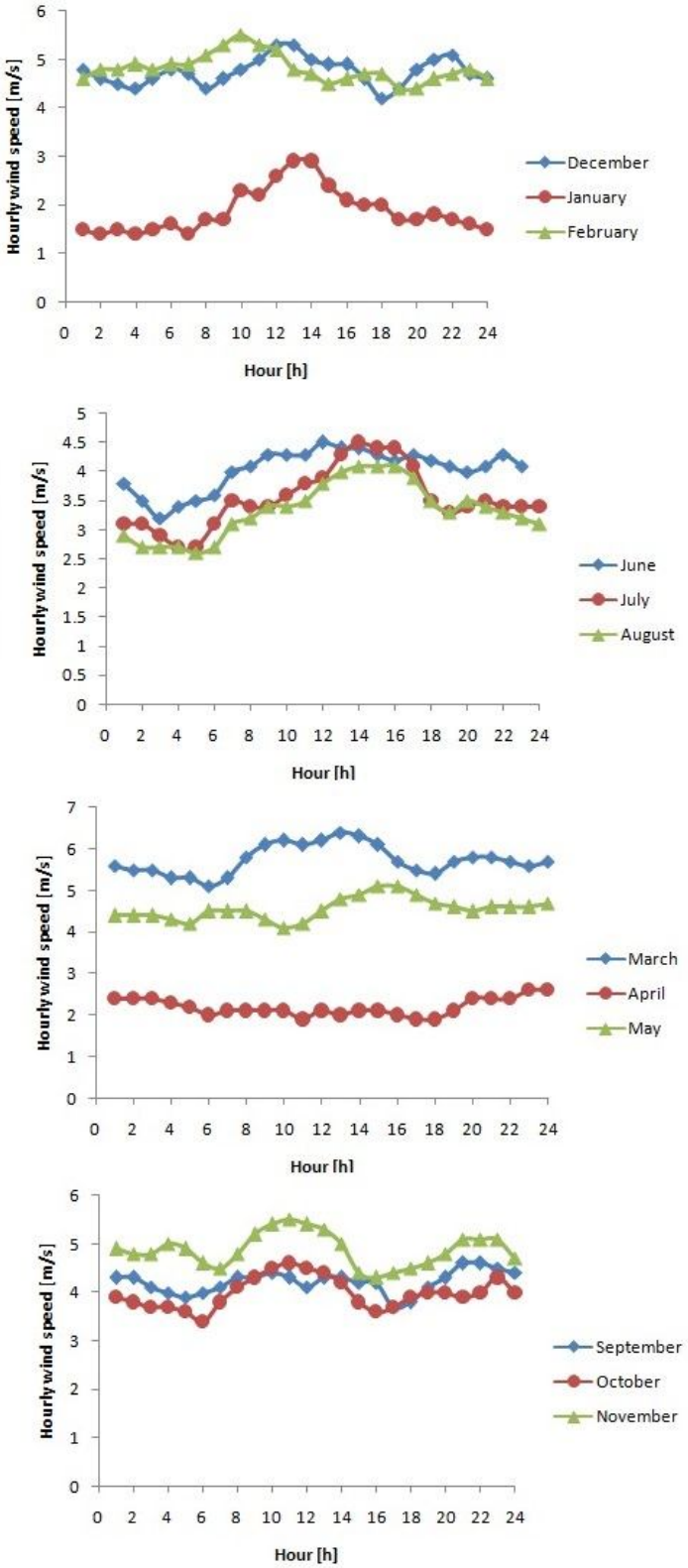


**Figure 3.7:** Hourly wind speed in Dipkarpaz

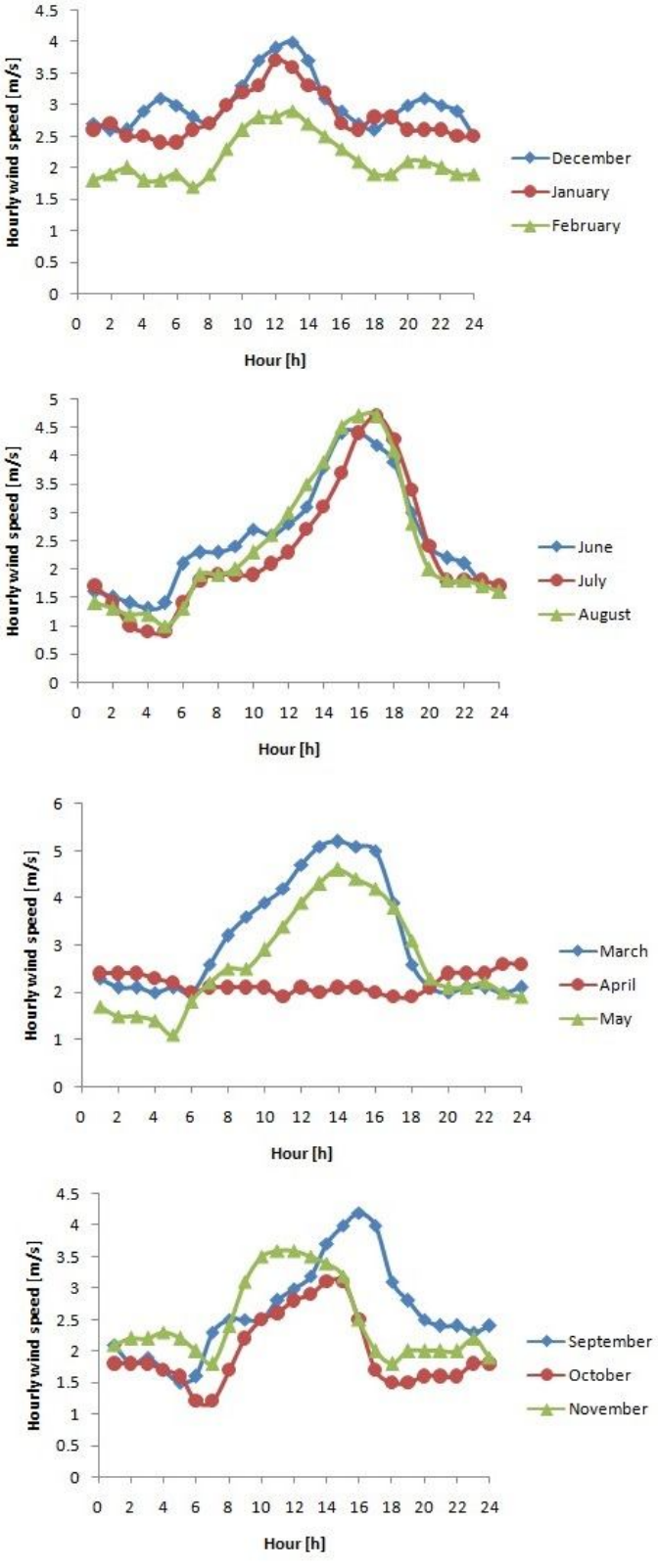


**Figure 3.8:** Hourly wind speed in Girne

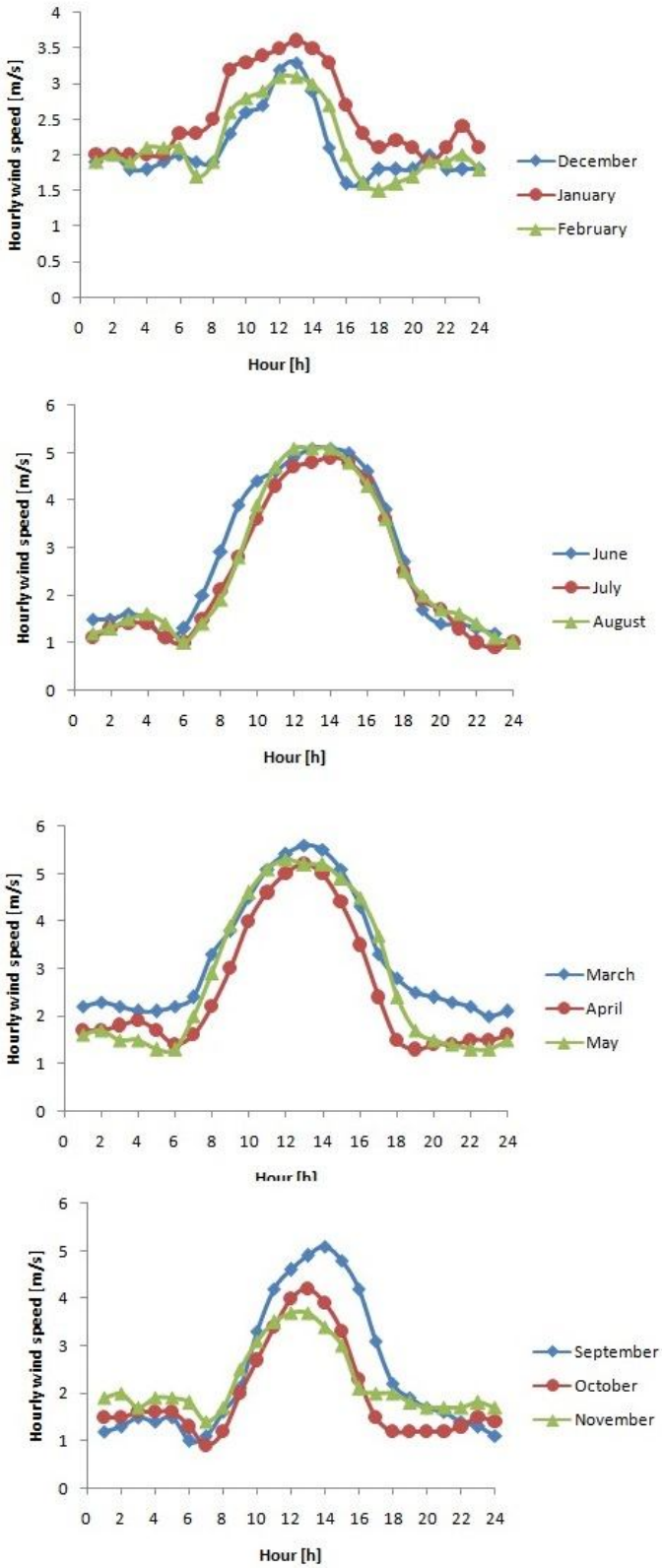


**Figure 3.9:** Hourly wind speed in Güzelyurtt

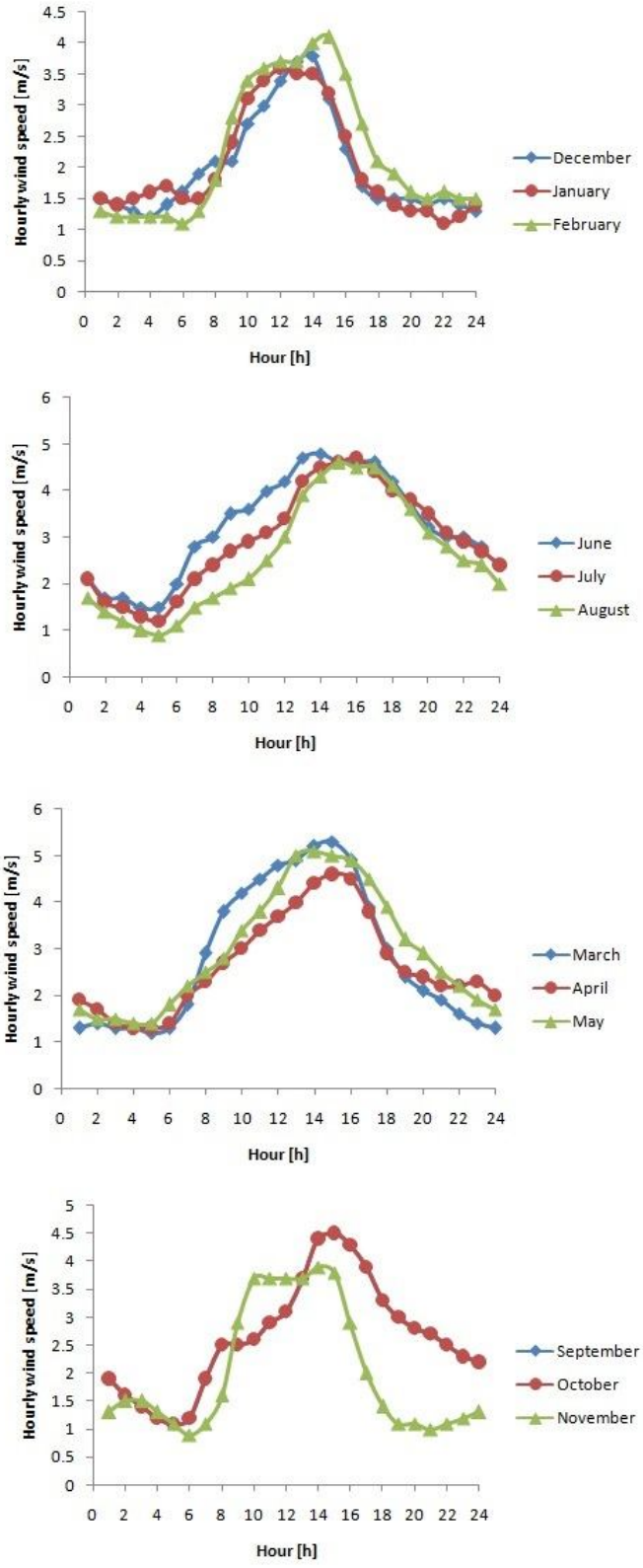


**Figure 3.10:** Hourly wind speed in Lefkoşa

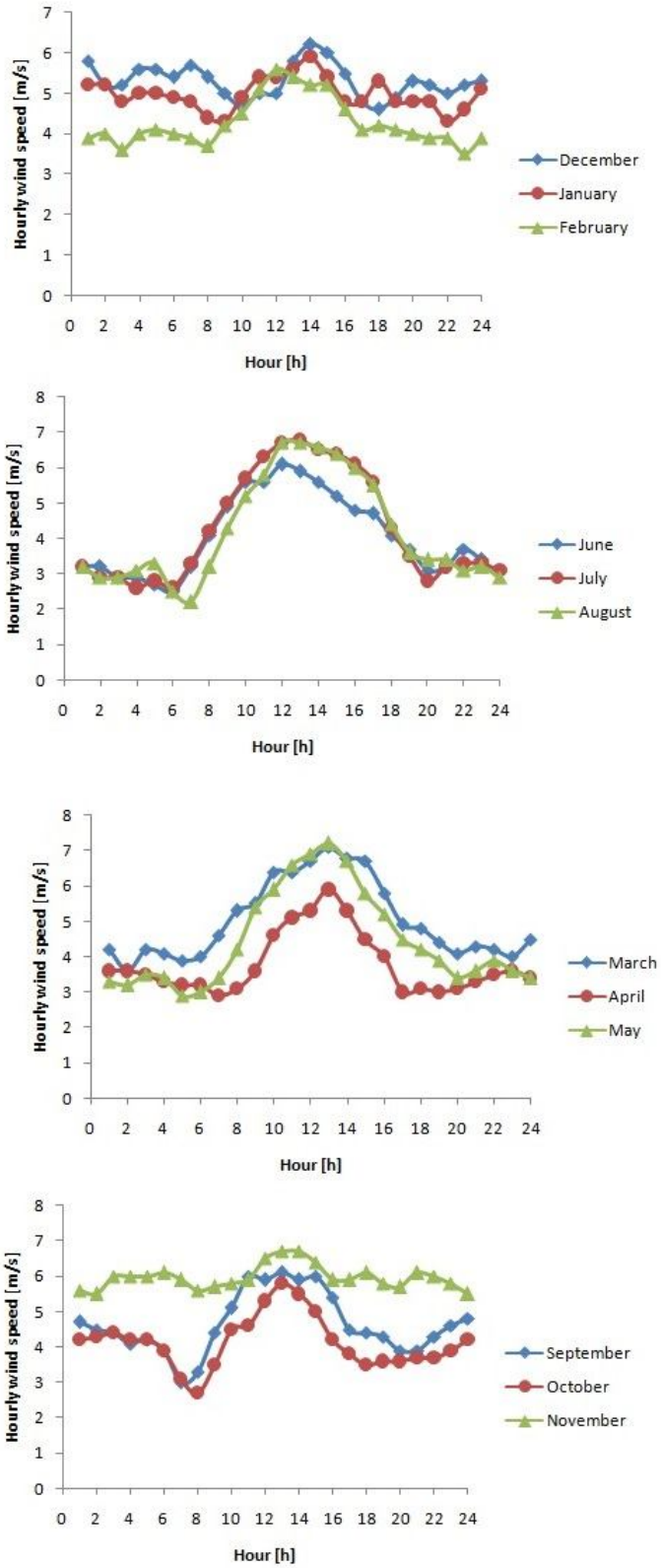


**Figure 3.11:** Hourly wind speed in Mağusa

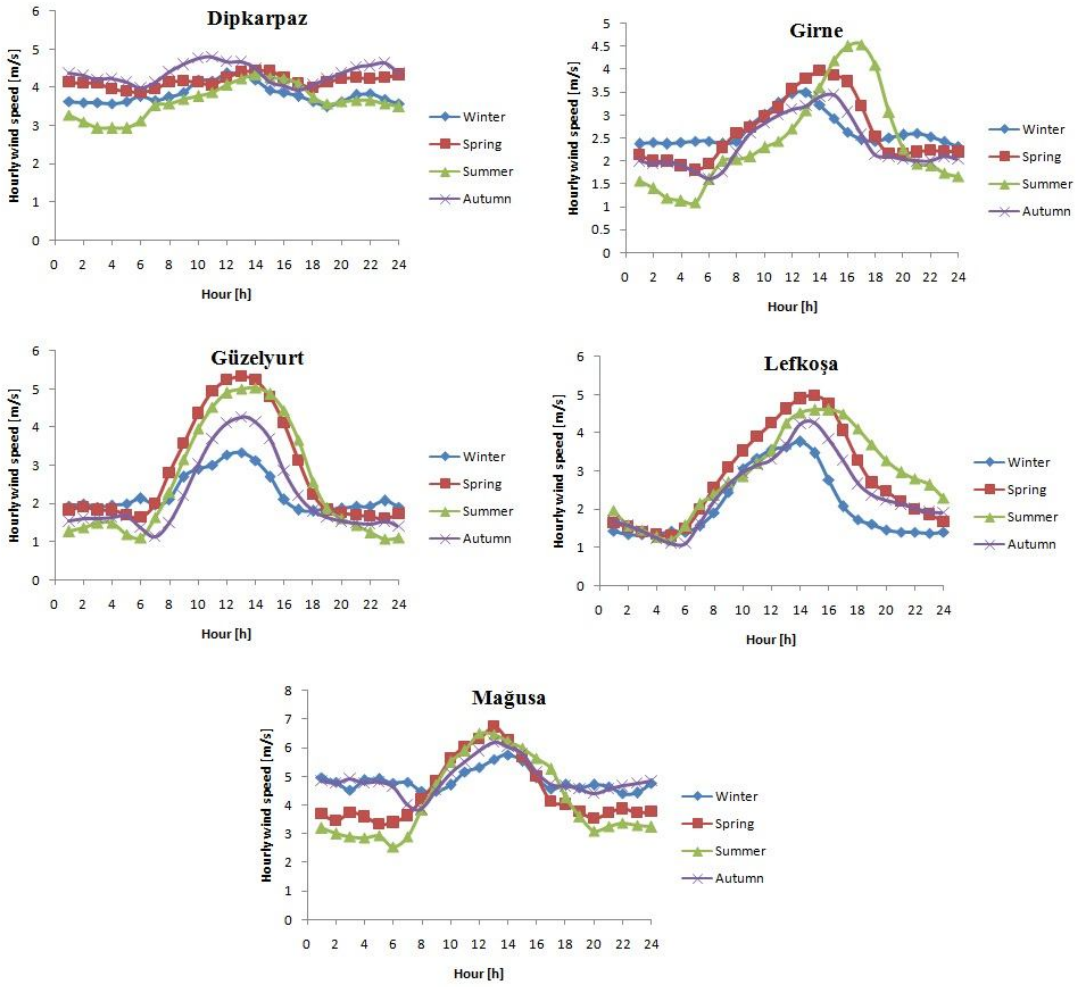


**Figure 3.12:** Hourly seasonally wind speed in five different locations in Cyprus

### 3.4 Daily Available Power at Five Sites in Cyprus

The graphical representation of the daily average available wind power data of 5 cities in Northern Part of Cyprus is illustrated in Figures 3.13-3.17. The unit of average available wind power is assigned as $W/m^2$. It is noticed that maximum available wind power occurs in winter season at Dipkarpaz, Girne and Lefkoşa. While the maximum available wind power occurs in spring and autumn season at Güzelyurtt and Mağusa, respectively.

In general, Mağusa has maximum daily average available wind power compared to another cities for 2016 and it is followed by Dipkarpaz, Girne, Lefkoşa and N Güzelyurtt in terms of the daily average available wind power.

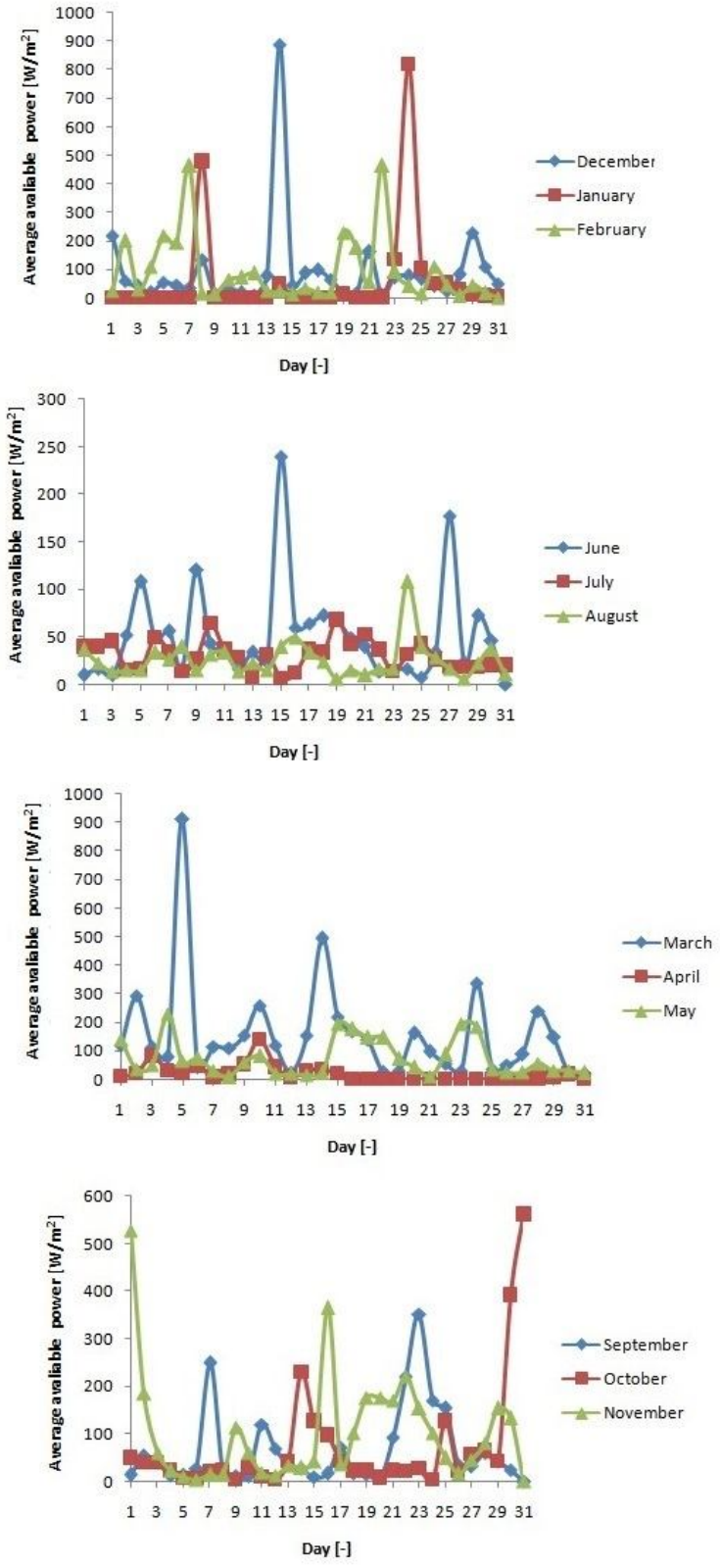


**Figure 3.13:** Daily available wind power in Dipkarpa

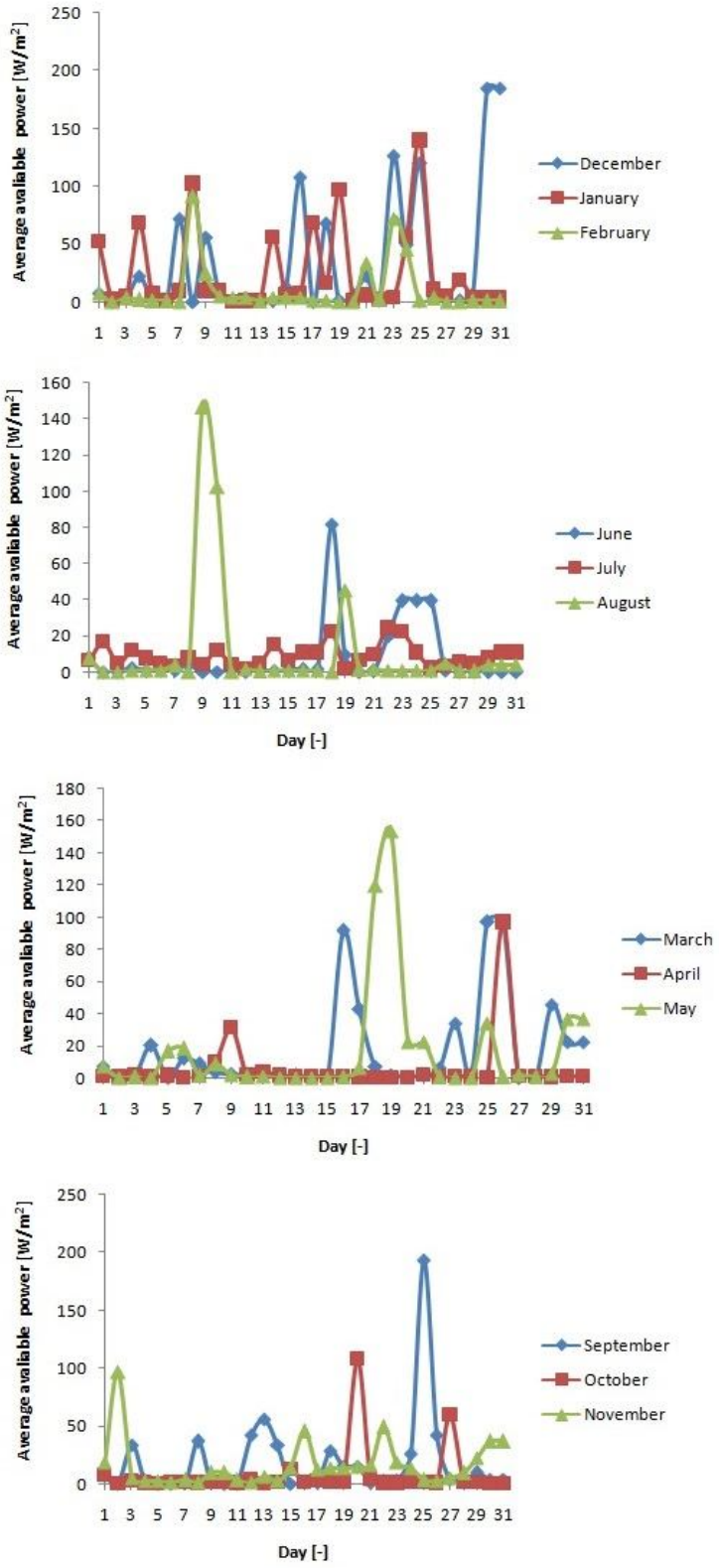


**Figure 3.14:** Daily available wind power in Girne

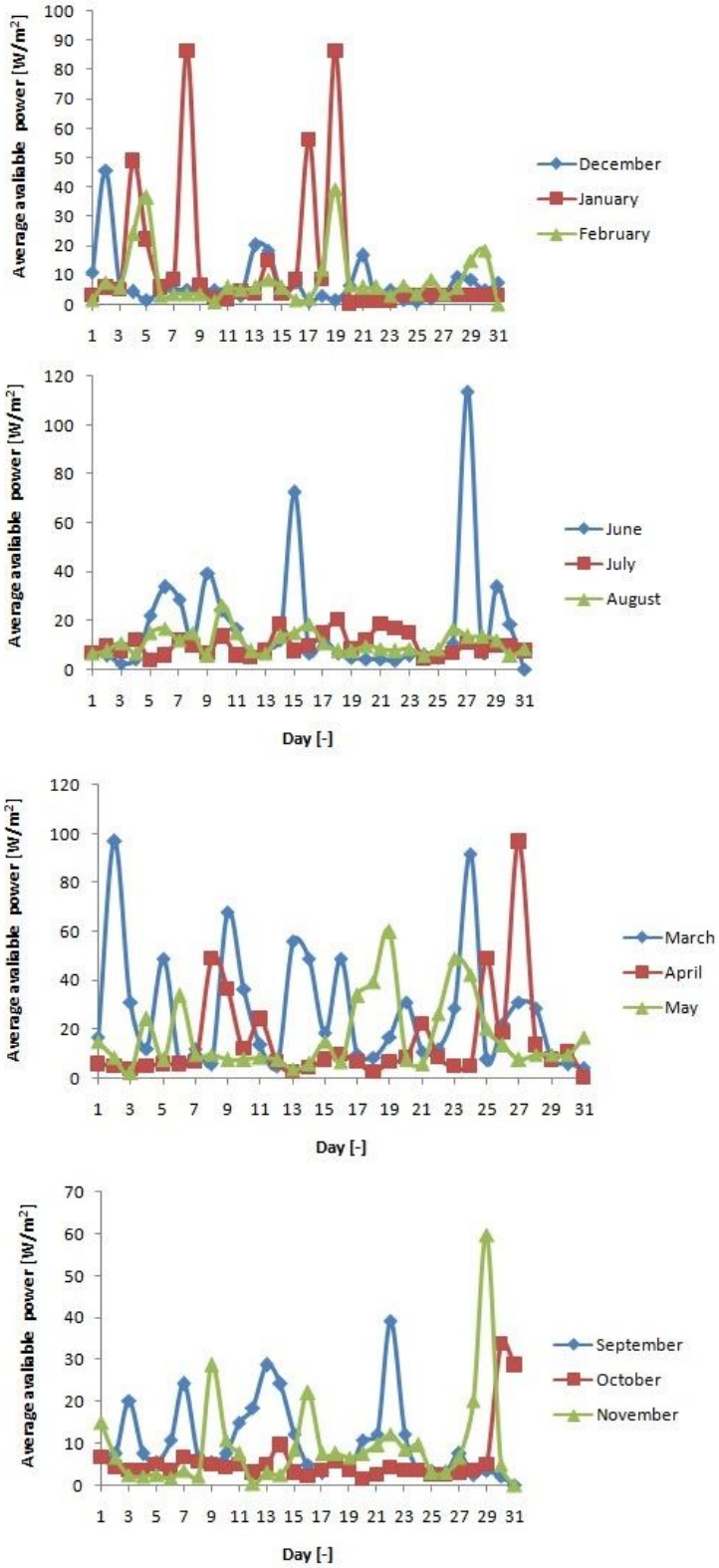


**Figure 3.15:** Daily available wind power in Güzelyurtt

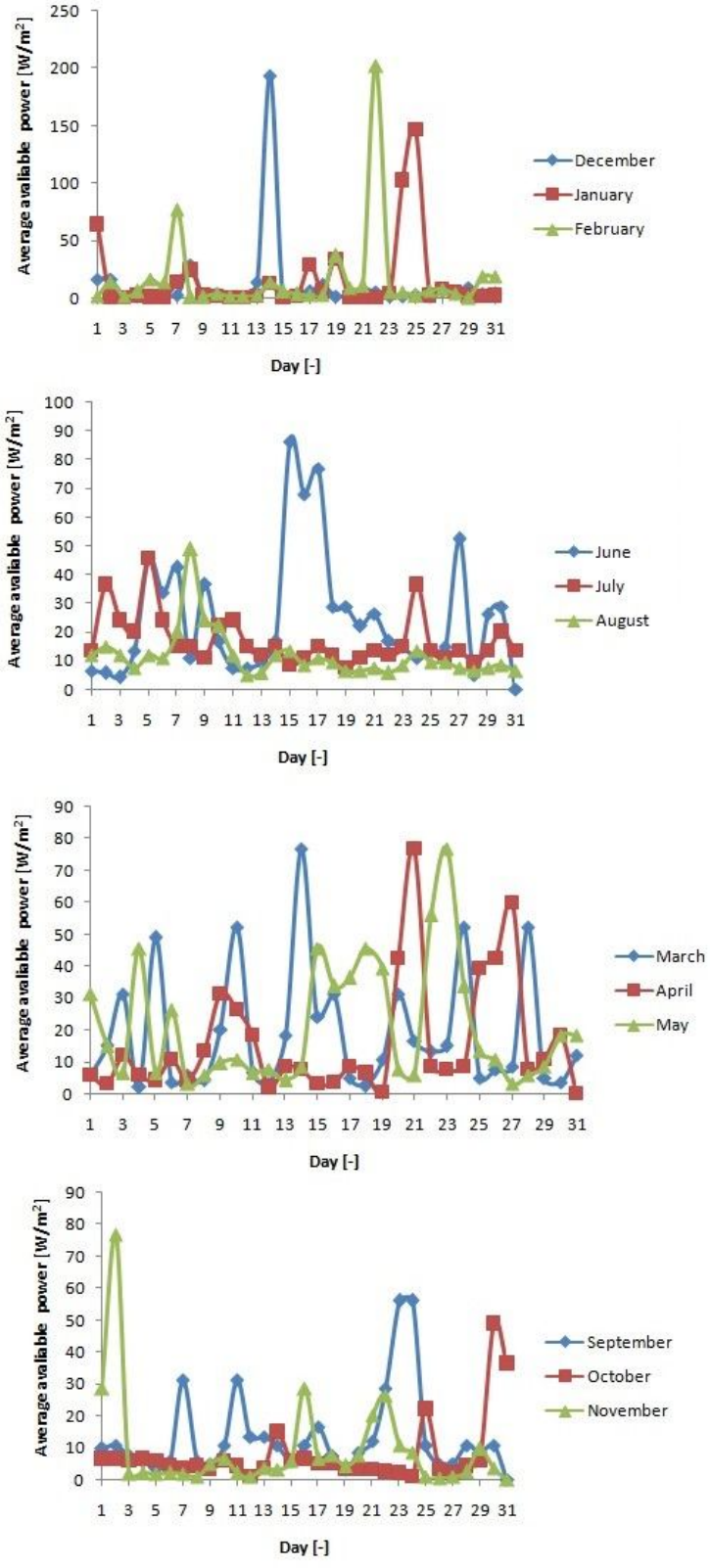


**Figure 3.16:** Daily available wind power in Lefkoşa

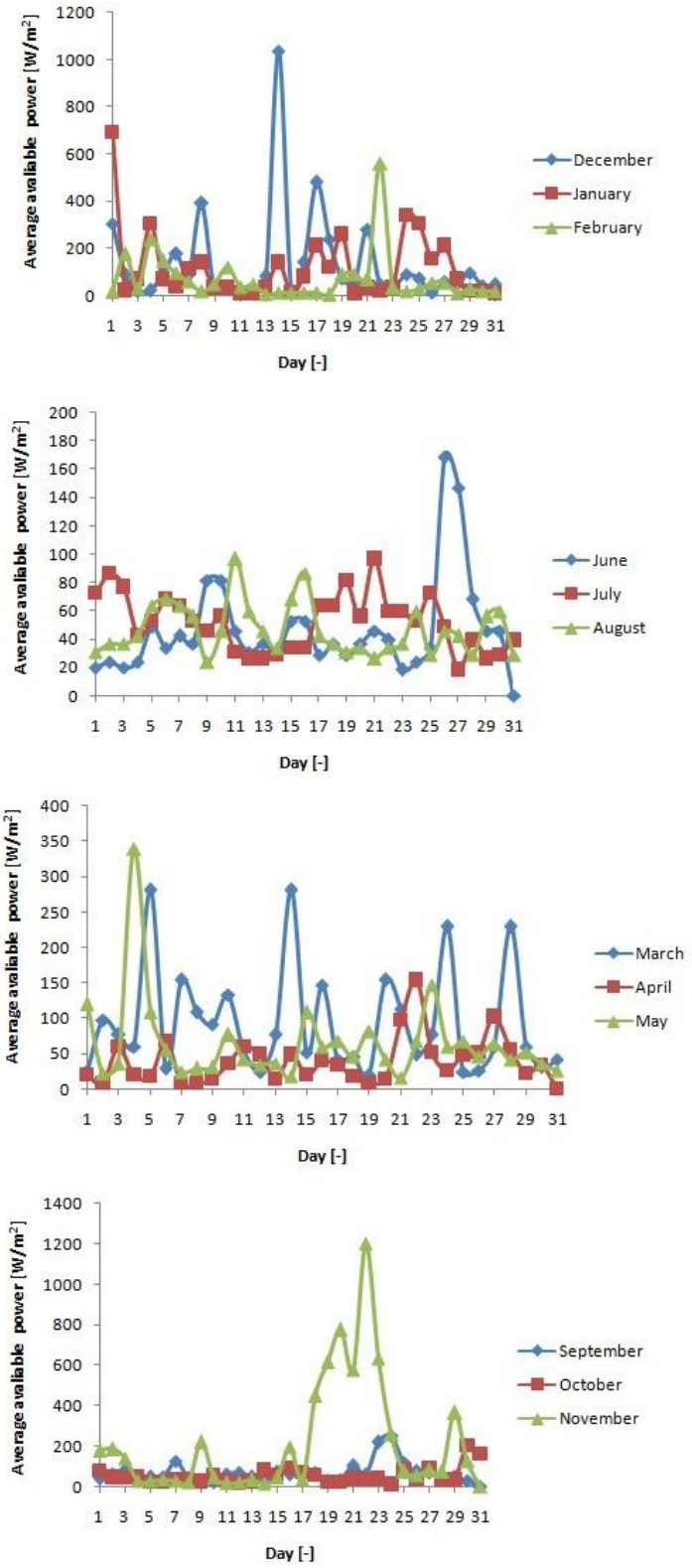


**Figure 3.17:** Daily available wind power in Mağusa

### 3.5 Optimum Location for Producing Electricity Using Wind Turbine

Mean monthly wind speed in five studied sites during the period from January to December 2016 is shown in Figure 3.18 and Table 3.2. Also, Figure 3.19 illustrates the mean monthly wind speed in percent for each month at different locations. It can be seen that the highest monthly mean wind speed of 5.74 m/s (12%) occurred in March in Dipkarpaz, while the lowest mean wind speed of 1.57 m/s ( occurred in October in Girne. Generally, it is found that the mean annual wind speed in the period from January to December 2016 was in the range of 1.5 to 6 m/s. Moreover, it noticed that Dipkarpaz and Mağusa have maximum wind speed compared to other locations as shown in Figure 3.19.

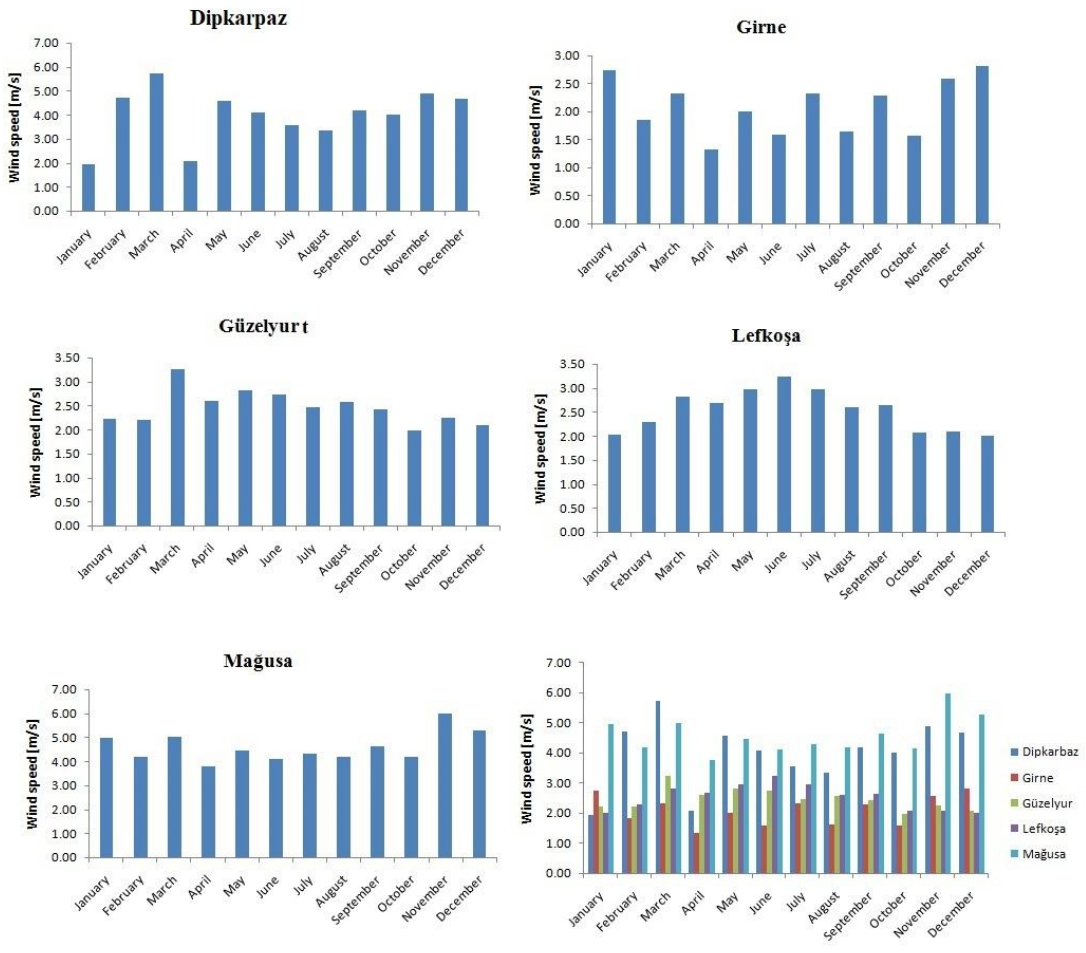


**Figure 3.18:** Average monthly wind speed in m/s at different five locations

**Table 3.2.** Average monthly wind speed in m/s at five locations

| Location | January | February | March | April | May | June |
|---|---|---|---|---|---|---|
| Dipkarpaz | 1.95 | 4.73 | 5.74 | 2.09 | 4.57 | 4.07 |
| Girne | 2.74 | 1.85 | 2.33 | 1.32 | 2.00 | 1.58 |
| Güzelyurt | 2.23 | 2.20 | 3.25 | 2.59 | 2.81 | 2.74 |
| Lefkoşa | 2.02 | 2.28 | 2.83 | 2.68 | 2.97 | 3.25 |
| Mağusa | 4.96 | 4.19 | 5.01 | 3.78 | 4.47 | 4.11 |
| **Location** | **July** | **August** | **September** | **October** | **November** | **December** |
| Dipkarpaz | 3.56 | 3.35 | 4.20 | 4.01 | 4.90 | 4.67 |
| Girne | 2.32 | 1.63 | 2.29 | 1.57 | 2.58 | 2.82 |
| Güzelyurt | 2.47 | 2.57 | 2.42 | 1.98 | 2.25 | 2.08 |
| Lefkoşa | 2.96 | 2.59 | 2.64 | 2.07 | 2.09 | 2.01 |
| Mağusa | 4.31 | 4.17 | 4.64 | 4.17 | 5.99 | 5.27 |

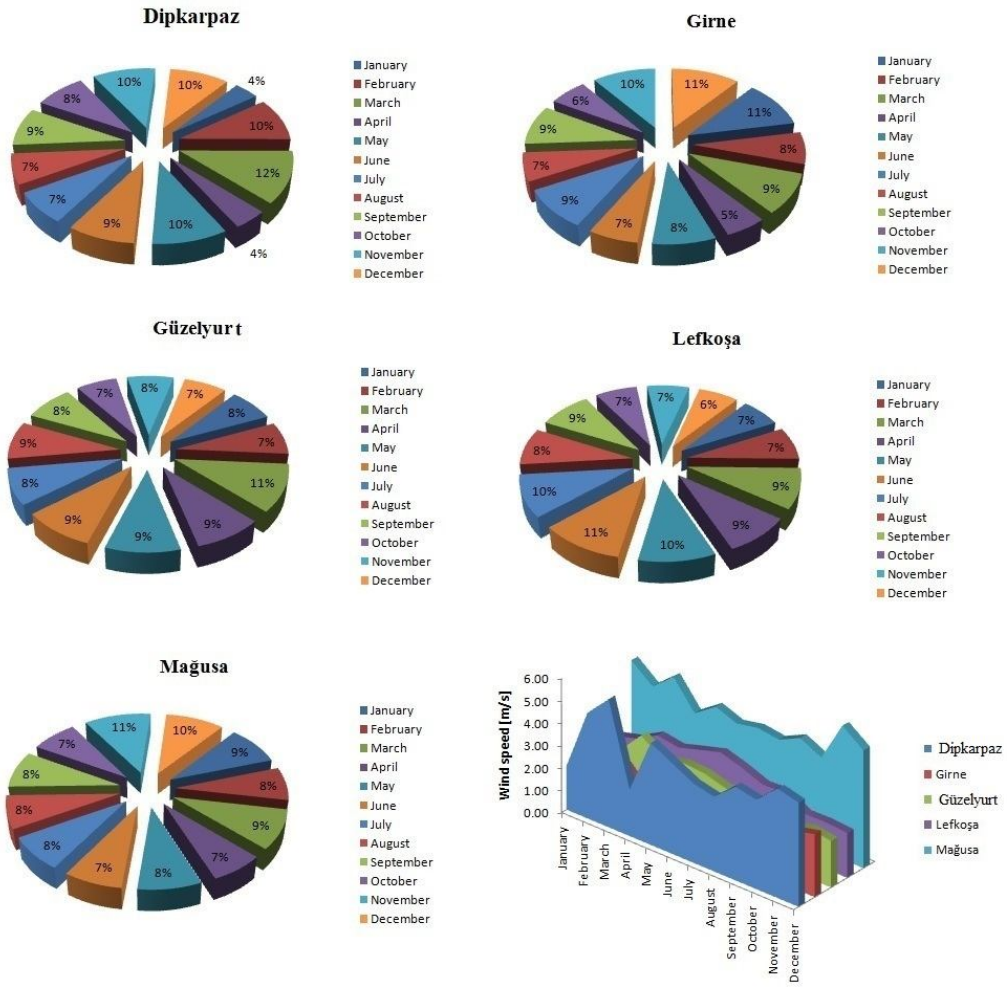


**Figure 3.19:** Average monthly wind speed in percent at different five locations

Figures 3.20 and 3.21 show the comparison of mean monthly wind power for different locations in Cyprus over a period of January to December 2016 at 10m height. It is noticed that Mağusa has the highest monthly average wind power compared to another cities which it occurs in November (134 W/m$^2$). The monthly average wind power variation over a long-term data during the January to December 2016 at different station is given in Table 3.3. It is observed that the average monthly wind power are ranging between 2 and 20 W/m$^2$. Additionally, the maximum wind power was Dipkarpaz and Mağusa with value of 134 and 118 W/m$^2$ on November and March as shown in Figure 3.21 and Table 3.3

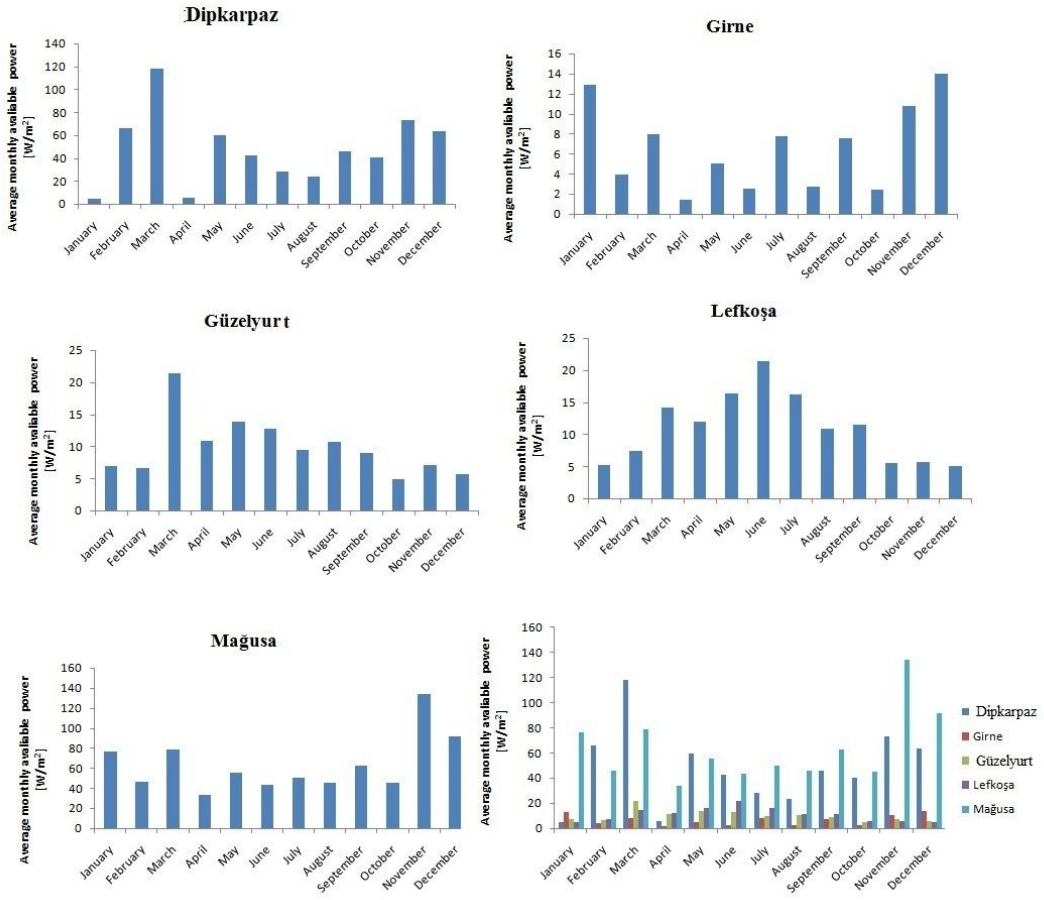


**Figure 3.20:** Average monthly available wind power in $W/m^2$ at different five locations

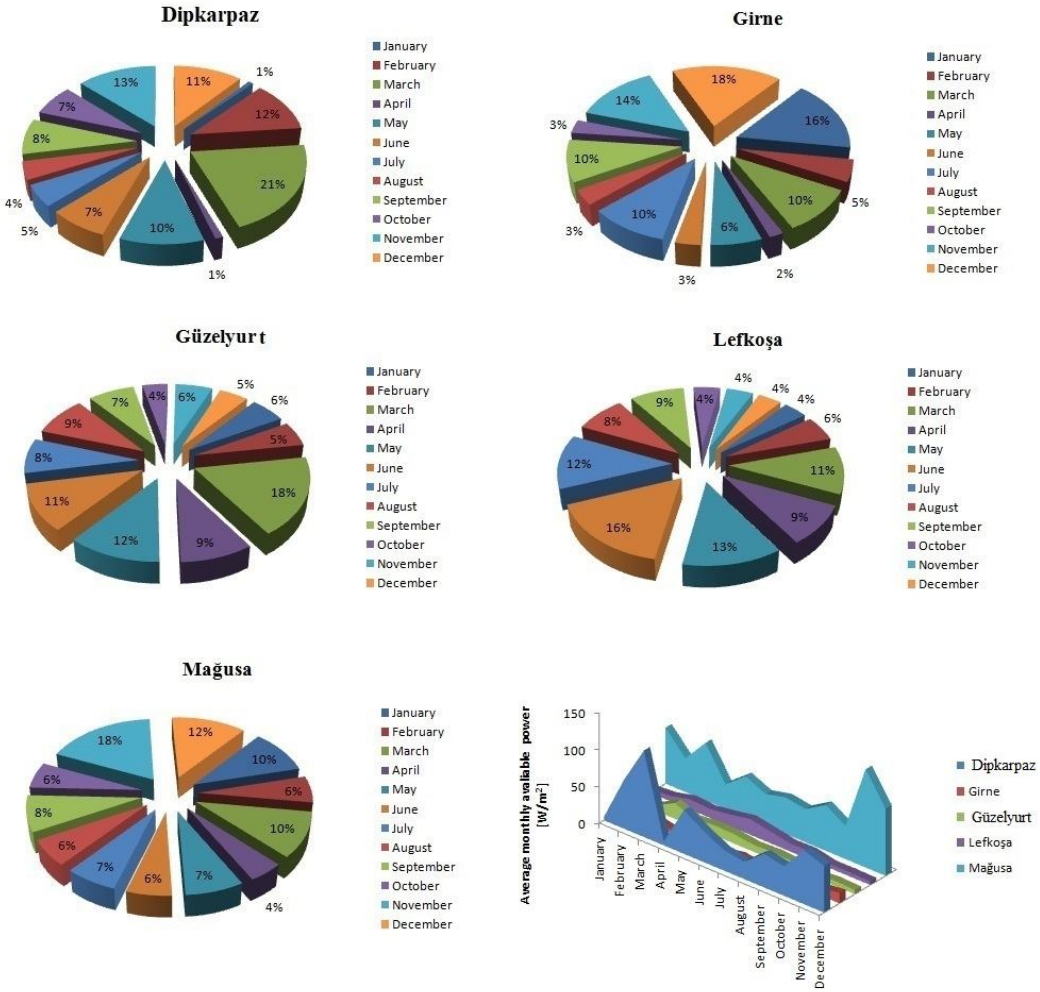


**Figure 3.21:** Average monthly available wind power in percent at different five locations

**Table 3.3.** Average monthly available wind power in $W/m^2$ at five locations

| Locations | January | February | March | April | May | June |
|---|---|---|---|---|---|---|
| Dipkarpaz | 5 | 66 | 118 | 6 | 60 | 42 |
| Girne | 13 | 4 | 8 | 1 | 5 | 2 |
| Güzelyurt | 7 | 7 | 21 | 11 | 14 | 13 |
| Lefkoşa | 5 | 7 | 14 | 12 | 16 | 21 |
| Mağusa | 76 | 46 | 79 | 34 | 56 | 43 |
| **Locations** | **July** | **August** | **September** | **October** | **November** | **December** |
| Dipkarpaz | 28 | 23 | 46 | 40 | 73 | 64 |
| Girne | 8 | 3 | 8 | 2 | 11 | 14 |
| Güzelyurt | 9 | 11 | 9 | 5 | 7 | 6 |
| Lefkoşa | 16 | 11 | 11 | 6 | 6 | 5 |
| Mağusa | 50 | 45 | 62 | 45 | 134 | 92 |

### 3.6. Wind Power of Selecting Turbines

The comparison between the leading manufacturers of wind turbines is shown in Table 3.4 3.5 (appendix 1). In order to determine the number of wind turbines that could be installed in each site, the two following conditions should be esteemed:

- if the wind direction is parallel to the diameter of the wind turbine, the distance between the wind turbines should be 6 to 9 times the diameter of the wind turbine.
- if the wind direction is perpendicular to the diameter of the wind turbine, the distance between the wind turbines should be 3 to 5 times the diameter of the wind turbine.

**Table 3.4:** Comparison of horizontal wind turbine

| name | rated power [kW] | rated wind speed [m/s] | cut-in wind speed [m/s] | cut-out wind speed [m/s] | Rotor diameter [m] | Height of the mast [m] |
|---|---|---|---|---|---|---|
| Ampair - 0.1 to o.3 kw | 0.1 | 20 | 3.5 | None | 0.928 | Variable |
| Ampair - 0.1 to o.3kw | 0.3 | 12.6 | 3 | None | 1.2 | Variable |
| Aircon -10 KW | 10 | 11 | 2.5 | 32 | 144 | 12/18/24/30 |
| Atlantis windkraft -0.3 to o.6 kw | o.3 | 10 | 3 | None | 1.5 | 3/6/9/12 |
| Atlantis windkraft -0.3 to o.6 kw | 0.6 | 10 | 3 | None | 2 | 3/6/9/12 |
| Eclectic Energy - 0.4 kw | 0.4 | 16 | 2 | None | 1.1 | Variable |
| Fortis wind energy - 0.8 to 10 kw | 0.8 | 14 | 3 | No | 2.2 | 12,18 |
| Eoltec - 6 to 250 kw | 6 | 12 | 4 | None | 5.6 | 18/24/30 |
| Eoltec - 6 to 250 kw | 25 | 12 | 3 | None | 10 | 18/24/32 |
| Fortis montana - 0.8 to 10 kw | 5.6 | 17 | 2.5 | No | 5 | 18 |
| F0rtis wind energy 0.8 to 10 kw | 1.4 | 16 | 2.5 | None | 3.12 | 12,-24 |
| Fuhrlander 30 to 2700 kw | 30 | 12 | 2.5 | 25 | 13 | 18 -27 |
| Fortis wind energy - 0.8 to 10 kw | 10 | 12 | 3 | No | 7 | 18-36 |
| Gaia -wind A/S -11 kw | 11 | 10 | 3 | 25 | 13 | 18 |
| Fuhrlander 30 to 2700 kw | 100 | 13 | 2.5 | 25 | 21 | 35 |
| Iskra wind turb - 5 kw | 5 | 11 | 3 | 60 | 5.4 | 12 to 30 |
| Gazelle wind turb Ltd - 20 kw | 20 | 13 | 4 | 20 | 22 | 12.5 to 20 |
| Jonica lmpianti - 20 kw | 20 | 12.5 | 3.5 | 37.5 | 8 | 12--18 |
| Marlec Engineering Co Ltd - 0.025 to 0.34 kw | 0.025 | 10 | 2.6 | None | 0,500 | Variable up to 6,5 |
| Marlec Engineering Co Ltd - 0.025 to 0.34 kw | 0.09 | 10 | 2.6 | None | o.913 | Variable up to 6,5 |
| Marlec Engineering Co Ltd - 0.025 to 0.34 kw | 0.09 | 10 | 2.6 | it furls at 15 m/s but no real cut out | 0.91 | up to 6.5 |
| Proven Energy products Ltd - 0.6 to 15 kw | 0.6 | 10 | 2.5 | None | 2.55 | 5.5 |
| Pitchwind Systems AB - 20 to 30 | 30 | 15 | 2 | None | 14 | 20 / 62 |
| Proven Energy products Ltd - 0.6 to 15 kw | 6 | 12 | 2.5 | None | 5.5 | 9-/---15 |
| Proven Energy products Ltd - 0.6 to 15 kw | 15 | 12 | 2.5 | None | 9 | 15--/--20 |
| Renewable Devices Swift turb s - 1.5 kw | 1.5 | 12 | 4 | 17 | 2 | 5 |

**Table 3.4:** Continued

| name | rated power [kW] | rated wind speed [m/s] | cut-in wind speed [m/s] | cut-out wind speed [m/s] | Rotor diameter [m] | Height of the mast [m] |
|---|---|---|---|---|---|---|
| Surface power Technologies - 0.46 kw | 0.46 | 12.6 | 3 | None | 1.4 | 7+ |
| TH Rijswijk, Univ of Applied Sciences - 5 to 5.5 kw | 5 | 10.5 | 2.75 | >10.5 | 5 | 6---/--18 |
| Sviab - of 0.75 kw | 0.75 | 12 | 2.5 | None | 2.4 | 7---/--11 |
| Travere lndustries - 0.9 to 50 kw | 0.9 | 10 | 2.3 | 60 | 2.4 | 12 |
| Travere lndustries - 0.9 to 50 kw | 1.6 | 10 | 2.5 | 60 | 3.2 | 12 |
| Travere lndustries - 0.9 to 50 kw | 2.1 | 8 | 2.5 | 60 | 6 | 12 |
| Travere lndustries - 0.9 to 50 kw | 3 | 12 | 2.8 | 60 | 3.6 | 12 |
| Tulipower - 2.5 kw | 2.5 | 10 | 3 | 18 | 5 | 12.5 |
| Travere lndustries - 0.9 to 50 kw | 5.5 | 10 | 3 | 60 | 6 | 12 |
| Wind Energy Solutions (WES) - 2 to 250 kw | 2.5 | 8.5 | 3 | 20 | 5 | 6 or 12 |
| windsave - 1 kw | 1 | 12 | 2.9 | 15 | 1.75 | …….. |

**Table 3.5:** Comparison of vertical wind turbine

| name | rated power [kW] | rated wind speed [m/s] | cut-in wind speed [m/s] | cut-out wind speed [m/s] | Rotor diameter [m] | Height of the mast [m] |
|---|---|---|---|---|---|---|
| Ecofys - 3 kw | 3 | 14 | 3.5 | 20 | 2.8 | Variable 1-12 |
| Eurowind smaii turb Ltd - 1.3 to 30 kw | 1.3 | 12 | 3 to 4 | 28 to 32 | 2.25 | site dependent |
| Eurowind small turb Ltd - 1.3 to 30 kw | 5 | 12 | 3 to 4 | 28 to 32 | 4.25 | site dependent |
| Eurowind small turb Ltd - 1.3 to 30 kw | 19 | 12 | 3 to 4 | 28 to 32 | 8.25 | site dependent |
| Eurowind small turb Ltd - 1.3 to 30 kw | 10.8 | 12 | 3 to 4 | 255 | 6.25 | site dependent |
| Eurowind small turb Ltd - 1.3 to 30 kw | 30 | 12 | 3 to 4 | 28 to 32 | 10.25 | site dependent |
| YO Windside production Ltd -1 to 8 kw | 8 | 20 | 2 | None | 2 | Not relevant |
| YO Windside production Ltd -1 to 8 kw | 1 | 18 | 2 | None | 1 | Not relevant |
| Ropatec S.p.a - 0.75 to 6 kw | 0.75 | 14 | 2 | None | 1.5 | Not relevant |
| Ropatec S.p.a - 0.75 to 6 kw | 3 | 14 | 2 | None | 3.3 | Not relevant |
| Ropatec S.p.a - 0.75 to 6 kw | 6 | 14 | 2 | None | 3.3 | Not relevant |
| Rugged renewables - 0.4 kw | 0.4 | 12 | 4.5 | DK | 0.8 | …… |
| Venturi Wind b.v.(i.o.) - 0.11 to 0.50 kw | 0.5 | 17 | 2 | None | 1.1 | 11 |
| Turby B.V - 2.5 kw | 2.5 | 14 | 4 | 14 | 1.99 | 6 ---7.5 |
| VR & Tech - 2.5 to 100 kw | Minimum 10* | 8 | 4 | None | 4 | …… |
| VR & Tech - 2.5 to 100 kw | Minimum 2.5* | 8 | 4 | None | 2 | Not relevant |
| VR & Tech - 2.5 to 100 kw | Minimum 25* | 8 | 4 | None | 6 | ……. |
| Wind dam - 2 kw | 2 | 12 | 2 | None | 2.56 | DK |
| Wind dam - 4 kw | 4 | 12 | 2.5 | None | 2.56 | DK |
| Windwall B.V . - 2.9 to 60 kw | 2.9 | 10.5 | 4 | 20 | 2 | n . A. |
| Windwall B.V. - 2.9 to 60 kw | 2.9 | 10.5 | 4 | 20 | 2 | n.a. |
| XCO2 - 6 KW | 6 | 12.5 | 4.5 | 16 | 3.1 | 5.1 |

### 3.4 Wind frequency distribution

The direction of the wind for each month was recorded during the investigated year (2016). Eight directions were considered and the wind frequencies for these directions at different locations are presented in Figures 3.21-3.25. Increasing wind frequency was used as an indicator of the main direction.

As mentioned before, Mağusa has the maximum values of mean monthly wind speed. Therefore, the dominant direction of the wind for the region was found to be southwest (SW) in winter and spring seasons, while the second direction from which the wind blows mostly was determined as the south (S) direction during summer. In autumn season, the wind direction with the greatest frequency for September and October is W, while wind direction with the greatest frequency is NE for November as shown in Figure 3.25. In addition, the wind direction with the greatest frequency is W during October and E for Dipkarpaz.

Additionally, it can be seen from Figure 3.23 that during winter, wind direction with the greatest frequency is E for Güzelyurt. In spring Season, wind direction with the greatest frequency wind direction with the greatest frequency in March and April is E and W in May for Güzelyurt. For Güzelyurt, wind direction with the greatest frequency is NW during summer. The wind direction with the greatest frequency is NW during September and E during October and November for Güzelyurt.

Most of the wind blows in the East (E), North East(NE) and South (S) direction at Girne which depends on the season as shown in Figure 3.22. Moreover, the data from the present location of Lefkoşa indicates that South-West (SW) has the greatest frequency in all seasons (Figure 3.24).

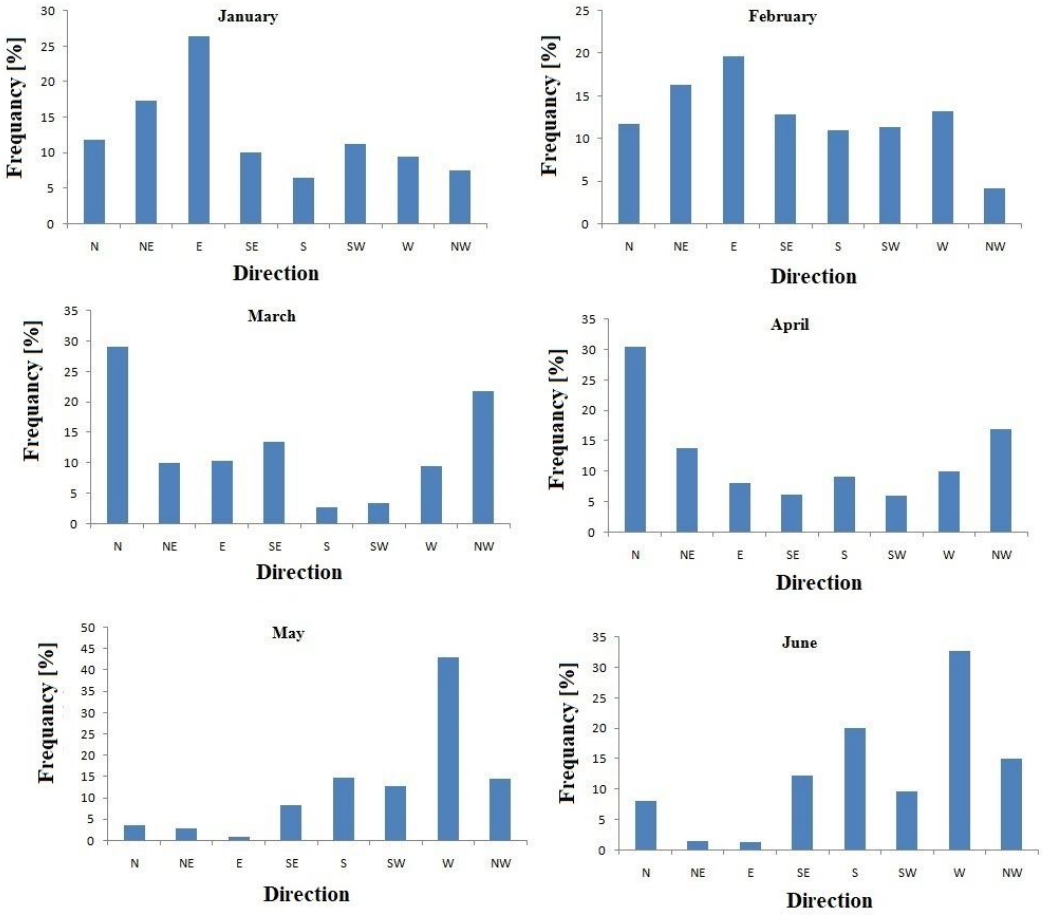


**Figure 3.21:** Average monthly frequency at Dipkarpaz

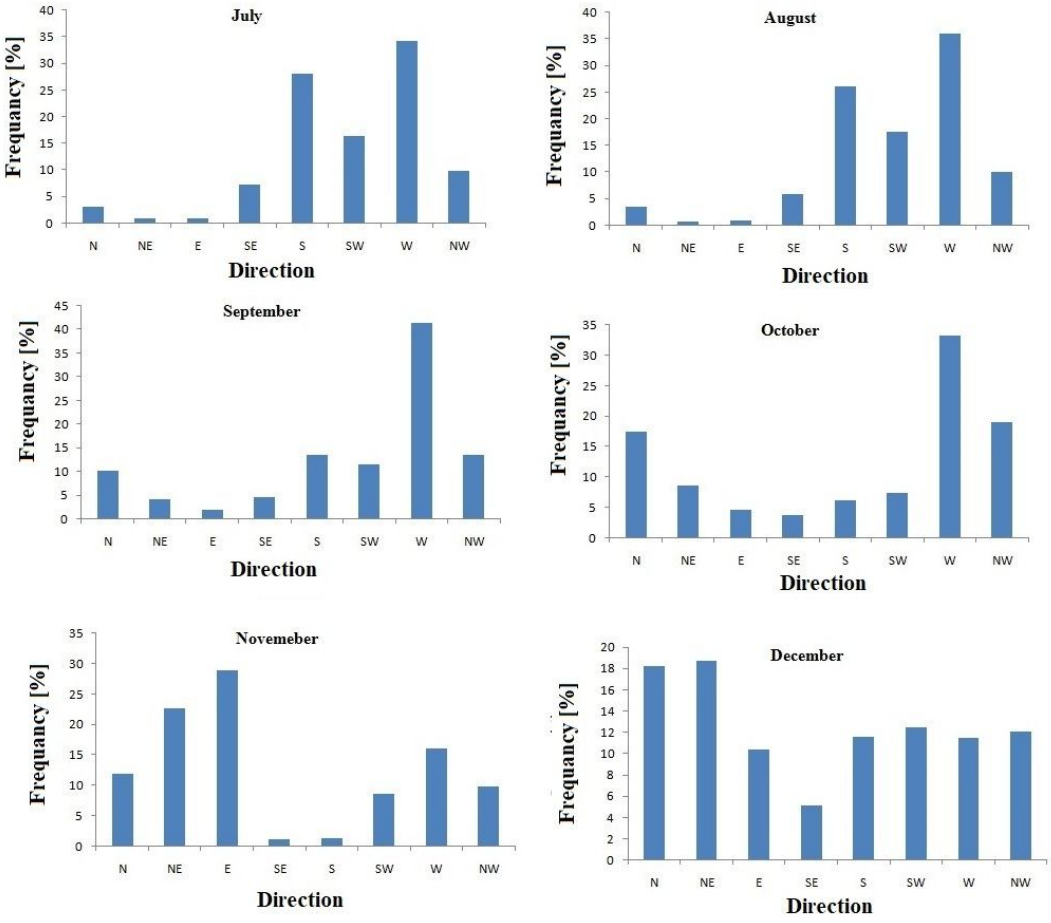


**Figure 3.21:** Continued

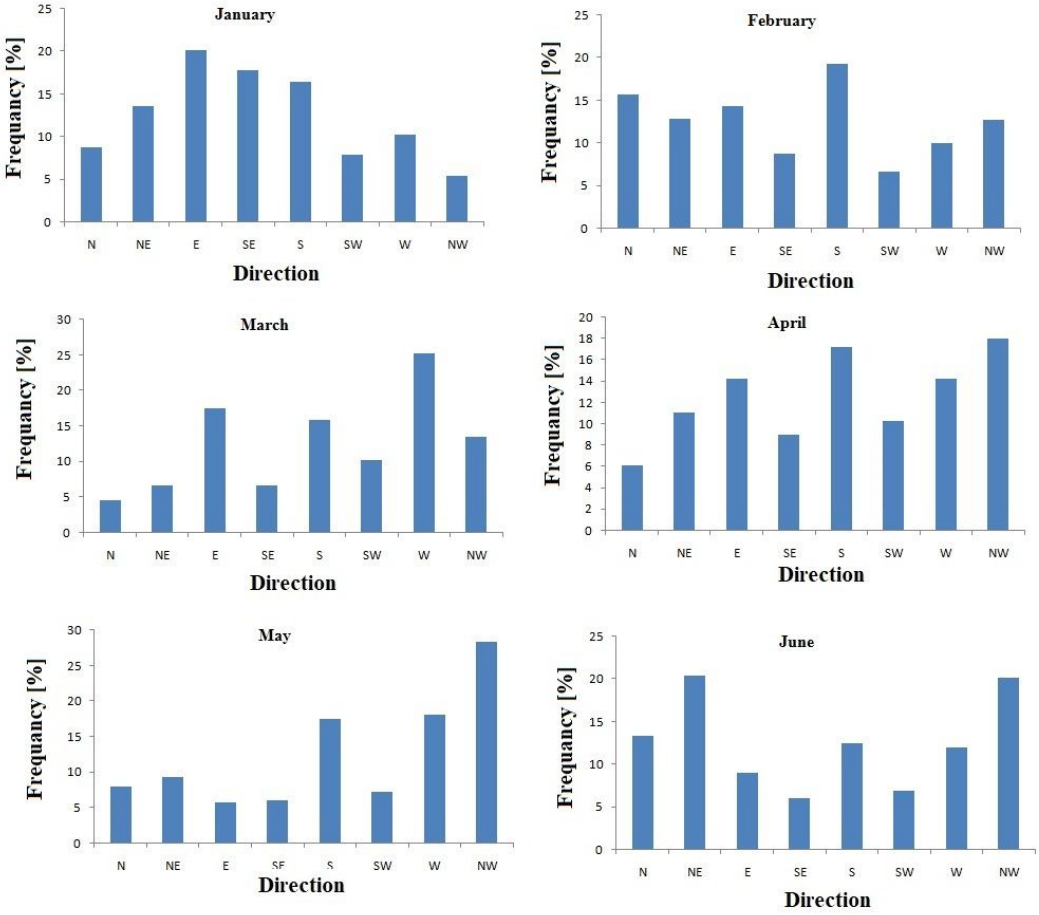


**Figure 3.22:** Average monthly frequency at Girne

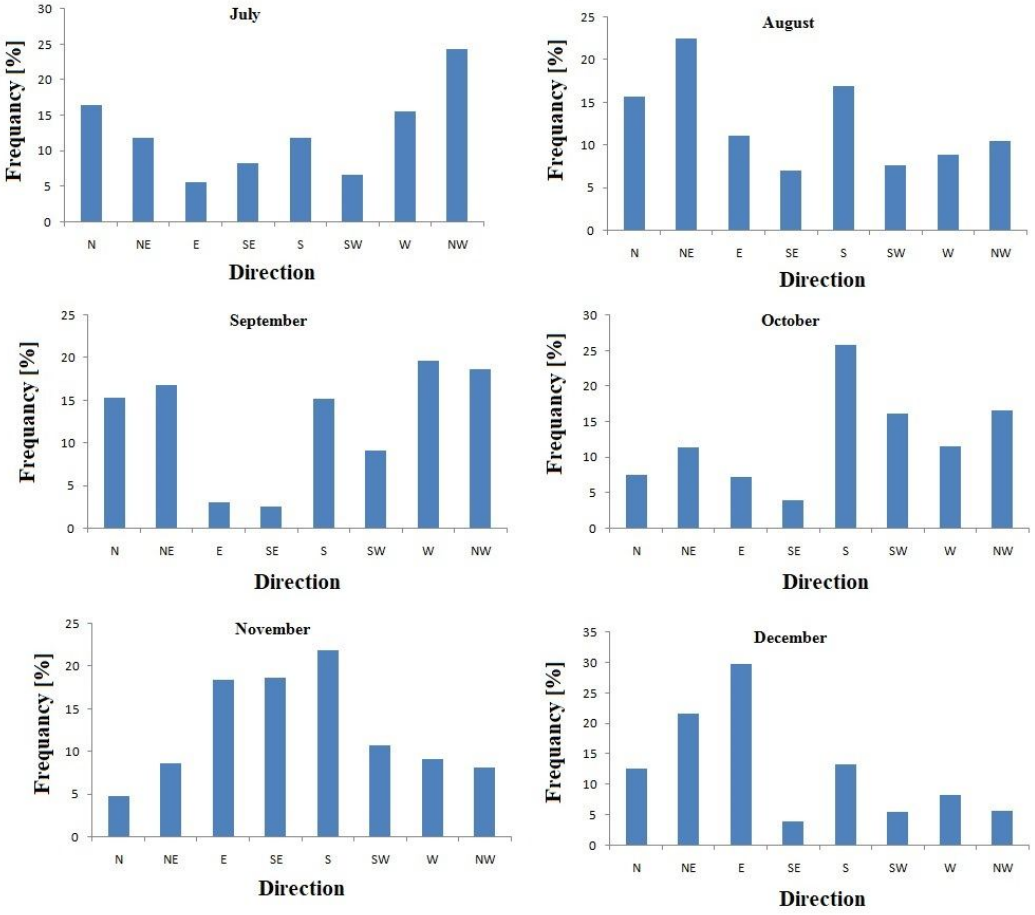


**Figure 3.22:** Continued

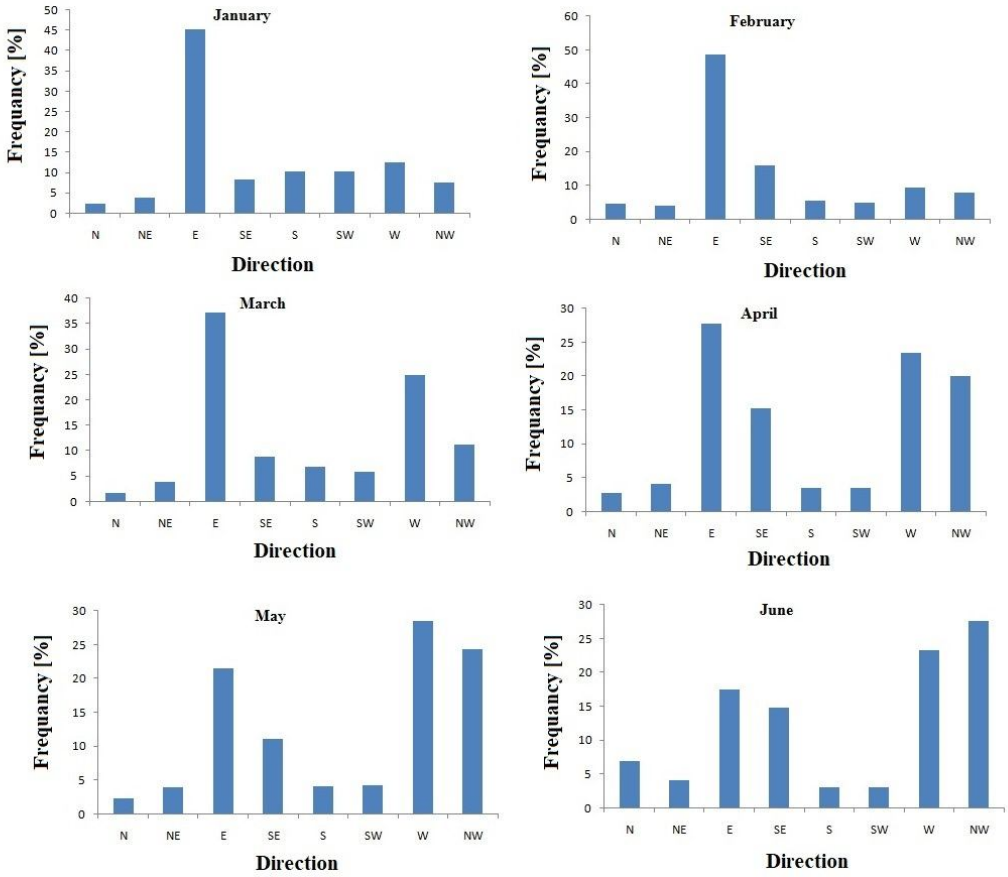


**Figure 3.23:** Average monthly frequency at Güzelyurt

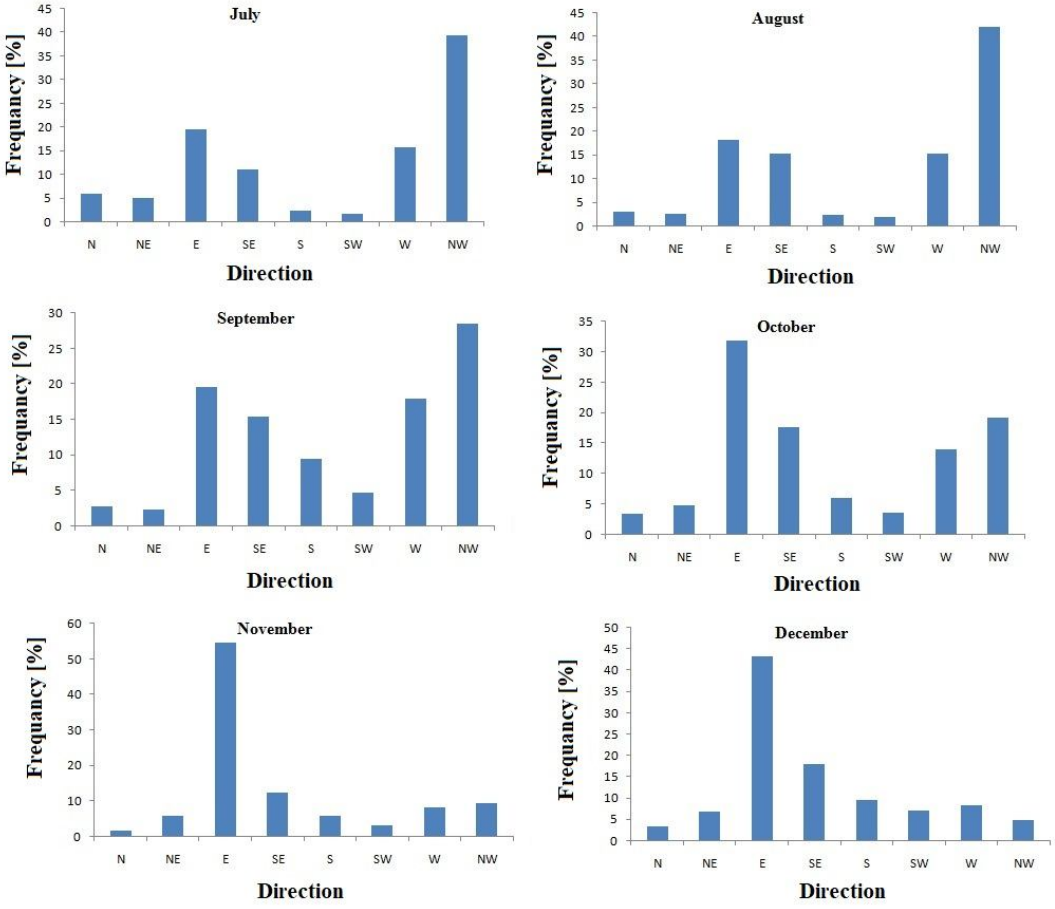


**Figure 3.23:** Continued

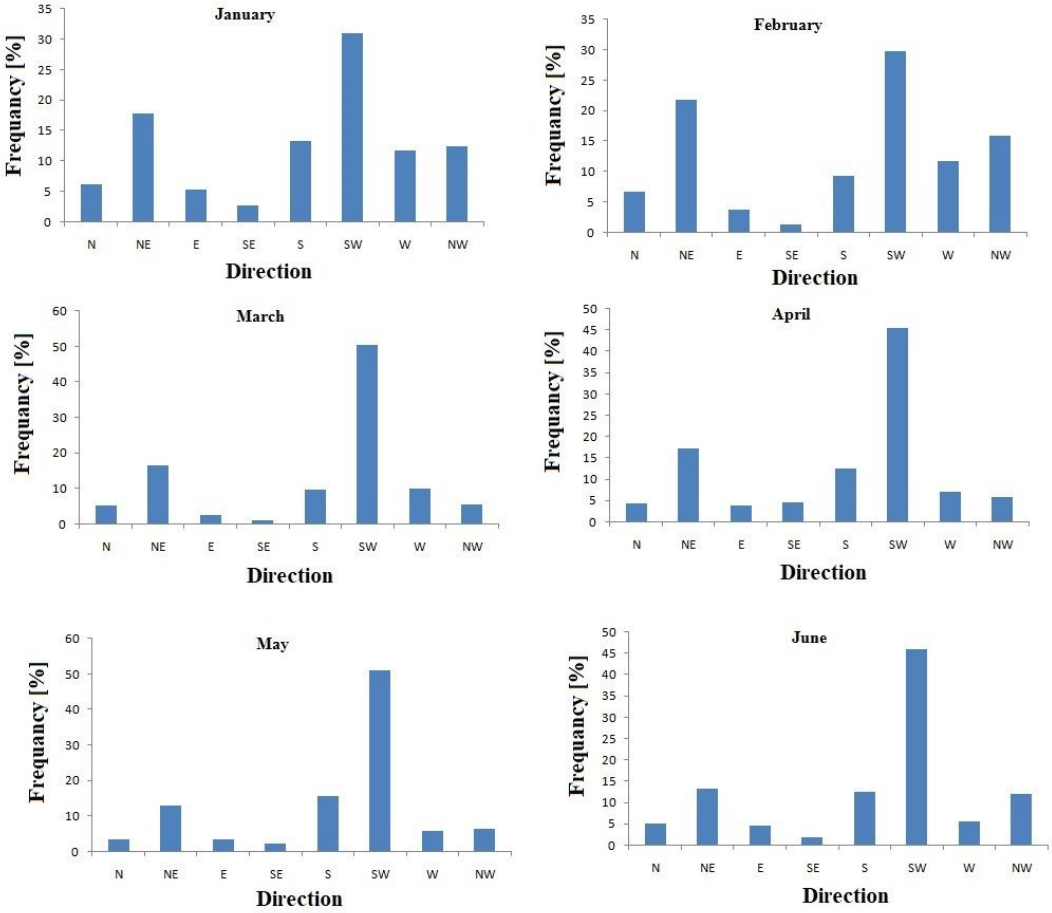


**Figure 3.24:** Average monthly frequency at Lefkoşa

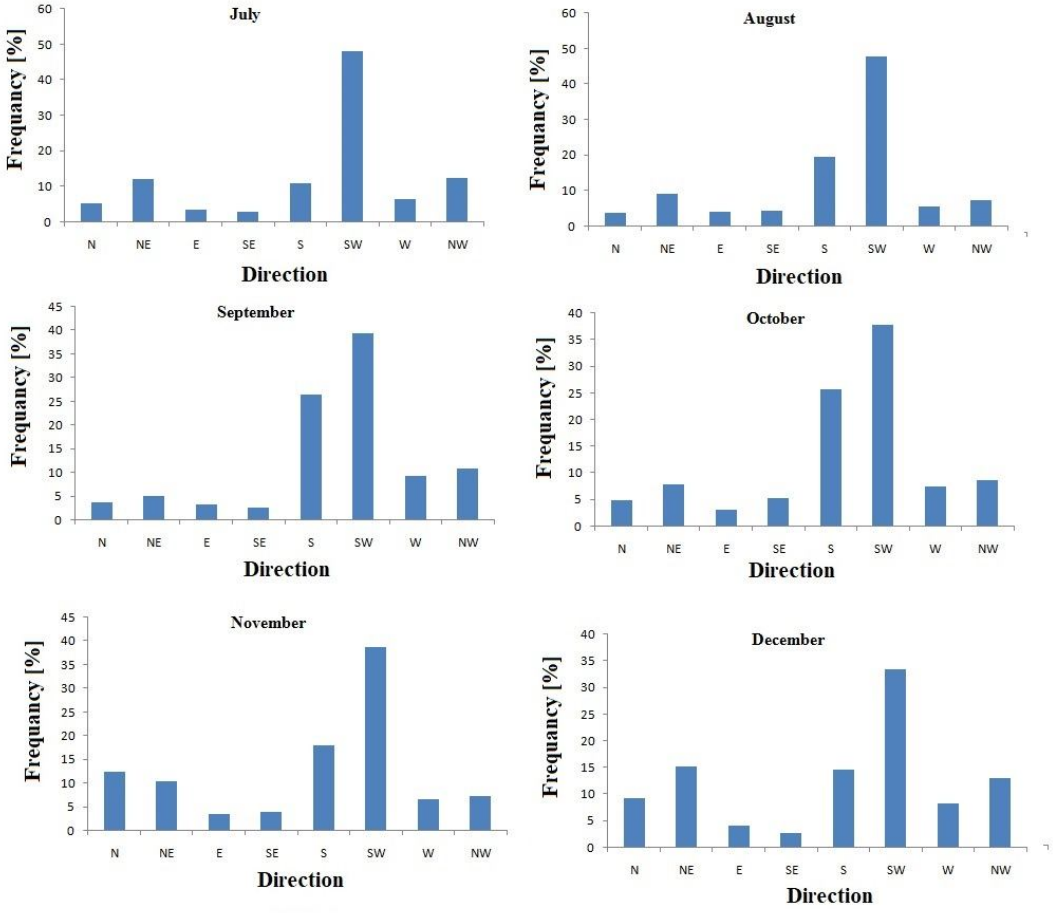


**Figure 3.24:** Continued

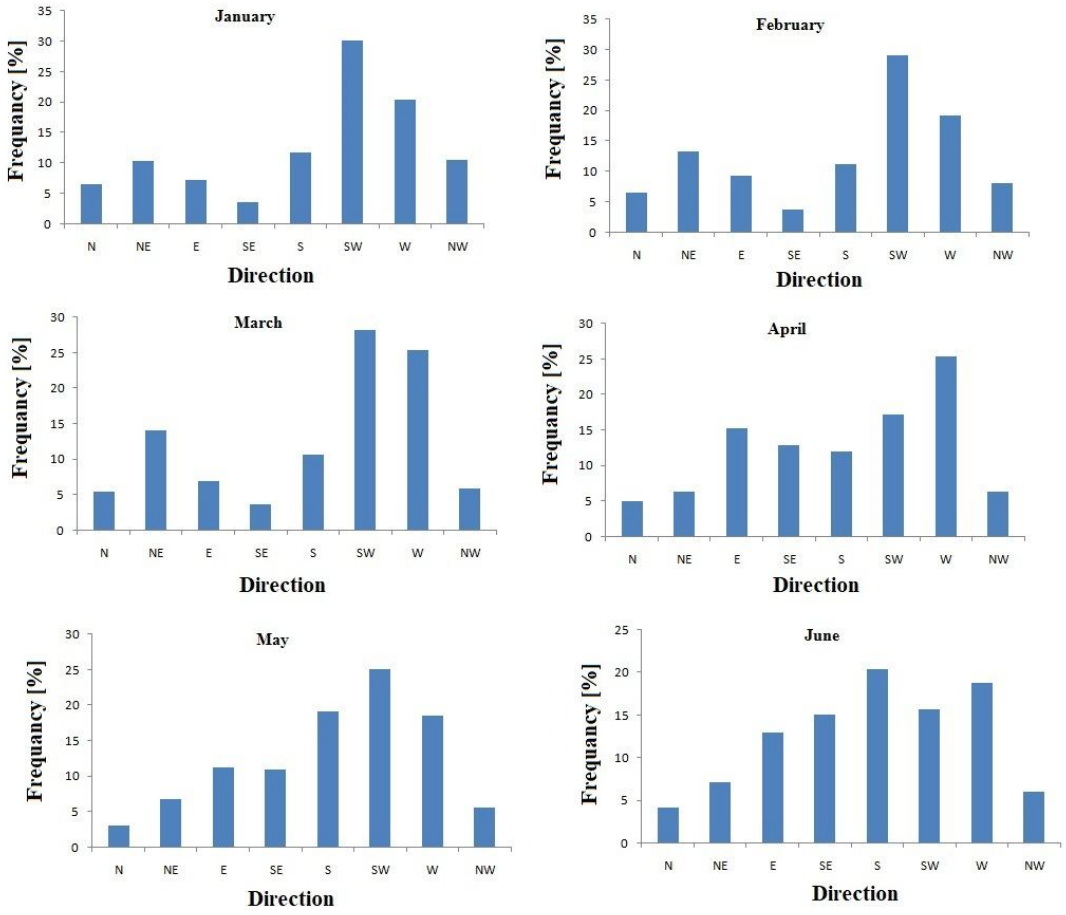


**Figure 3.25:** Average monthly frequency at Mağusa

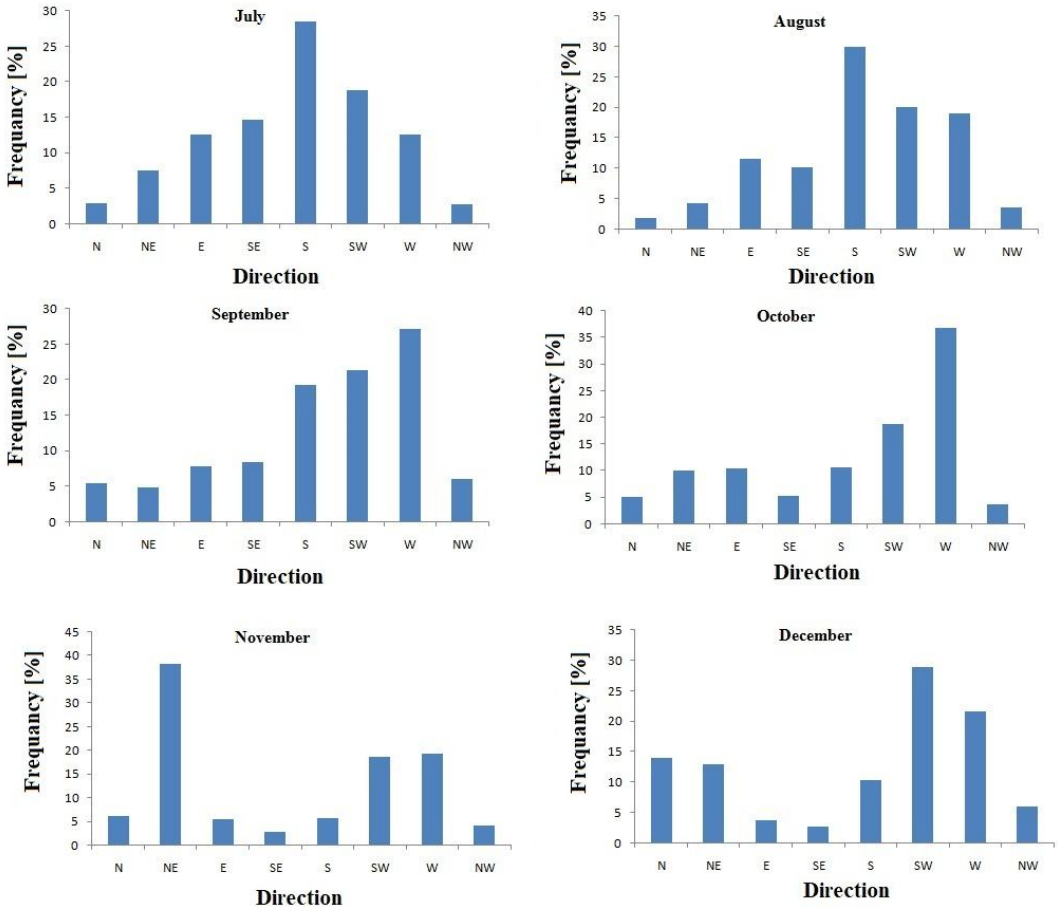


**Figure 3.25:** Continued

# CHAPTER 4
# CONCLUSION

## 4.1 Conclusions

To consider renewable energy technologies as drivers of sustainable economic growth as well as environmental solutions must be considered. The aim of this study is to find the meteorological basis for the assessment of wind energy resources in Cyprus and to provide suitable data for evaluating the potential wind power. Hence, in the present study average hourly and daily wind speed data of five cities, namely, Dipkarpaz, Girne, Güzelyurtt, Lefkoşa and Mağusa, in Northern part of Cyprus were analyzed over one year period from January to December 2016. The significant findings are summarized below

- In wind speed analysis of the monthly average wind speed over one year period data belonging to five cities in Cyprus, Dipkarpaz and Mağusa have the largest average wind speed values.
- The wind data of Mağusa showed that the maximum monthly wind speed occurs in the month of November while the month of April has the lowest mean wind speed. In addition, the highest mean wind speed value with 4.88 m/s is determined in the autumn season, while the lowest value is in the summer season with 4.19 m/s.
- The wind directions were found to be diverse for the selected sites. However, comparing to the other sites, the wind directions (blowing from) for Dipkarpaz and Mağusa were found to be consistent in the West direction with the wind speed frequency of 43.01% and 36.82%, respectively.
- It can be concluded that, while the overall prospects for the exploitation of wind energy in the Cyprus do not appear to be very good, there are three areas which stand out as prospective locations for wind farms namely, Dipkarpaz and Mağusa.

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# APPENDIX 1

## CATALOGUE OF EUROPEAN URBAN WIND TURBINE MANUFACTURERS

# Catalogue of European Urban Wind Turbine Manufacturers








Supported by the
European Commission under the
**Intelligent Energy - Europe**
Programme




# Aircon

## HAWT - 10 kW


Contact name: Aircon GmbH & Co.KG
Address: Nessestraße 27, 26789 Leer
Telephone: +49 491 454 44 84
Country : **Germany**


### Aircon 10 references

| Site | Use | Country |
|---|---|---|
| Nordhausen | University | Germany |
| Bremerhaven | University | Germany |
| Hamburg | Greenpeace building | Germany |
| Warnungs | Solartechn. Hubert Kuhn | Austria |
| Sopelana | Zero CO2/ Environmental assoc | Spain |

### Aircon 10/ 10 kW

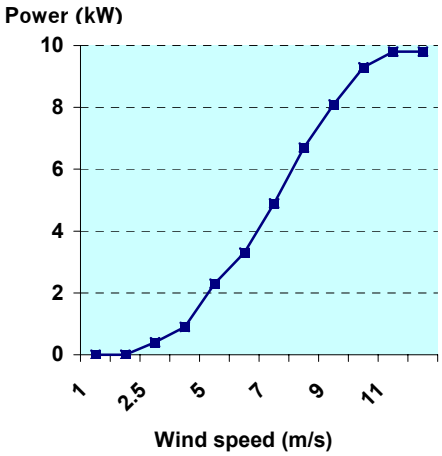
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 10 | kW |
| 2) Rated wind speed | 11 | m/s |
| 3) Cut-in wind speed | 2,5 | m/s |
| 4) Cut-out wind speed | 32 | m/s |
| 5) Maximum wind speed the turbine can withstand | 190 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 144 | kg |
| 7) Rotor diameter | 7,1 | m |
| 8) Rotor height (for VAWT only) | | m |
| 9) Swept area | 39,6 | $m^2$ |
| 10) Height of the mast | 12/18/24/30 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 130 | At rated wind speed |
| 12) Gear box type | Gearless | |
| 13) Brake system | Pitch-control + generator overload regulation | |
| 14) Number of blades | 3 | |
| 15) Blades material | Composite fibre glass | |
| 16) Output voltage | 400 | V |
| 17) Minimum operation temperature | - 20 | °C |
| 18) Maximum operation temperature | + 40 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | < 40 | DB |
| 20) Lifetime | > 20 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Azimut motor | |
| 24) Upwind or downwind | Upwind turbine | |

### Calculated power curve

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 2,5 | 0,4 |
| 4 | 0,9 |
| 5 | 2,3 |
| 6 | 3,3 |
| 7 | 4,9 |
| 8 | 6,7 |
| 9 | 8,1 |
| 10 | 9,3 |
| 11 | 9,8 |
| 11,5- 25 | 9,8 |

### Power curve:



# Ampair

## HAWT – 0,1 to 0,3 kW


Contact name: George Durrant
Address: The Doughty Building, Crow Arch Lane, Ringwood, Hampshire, BH24 1NZ
Telephone: +44 (0) 1425 480 780
Country: **United Kingdom**


### Ampair 0,1 kW references

| Site | Use | Country |
|---|---|---|
| Regis Road Recycling Centre, Camden, London | Electricity generation | UK |
| | | |

### Ampair Pacific Hawk / 0,1 kW

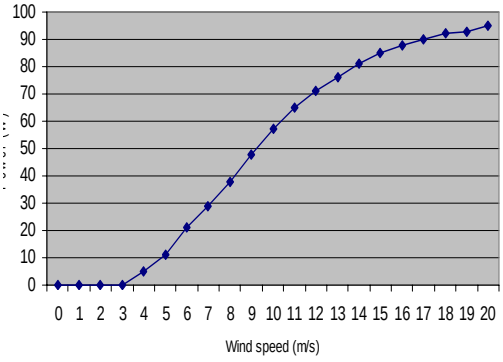
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 0,1 | kW |
| 2) Rated wind speed | 20 | m/s |
| 3) Cut-in wind speed | 3,5 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | Storm-proof | km/h |
| DIMENSIONS | | |
| 6) Nacelle and rotor weight | 12,6 | kg |
| 7) Rotor diameter | 0,928 | m |
| 8) Rotor height (for VAWT only) | - | m |
| 9) Swept area | 0,68 | $m^2$ |
| 10) Height of the mast | Variable | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | DK | At rated wind speed |
| 12) Gear box type | None | |
| 13) Brake system | Inductors | |
| 14) Number of blades | 6 | |
| 15) Blades material | Glass filled polypropylene | |
| 16) Output voltage | 12 / 24 | V |
| 17) Minimum operation temperature | - 30 | °C |
| 18) Maximum operation temperature | High temperatures not a problem | °C |
| 19) Acoustic levels at a distance of 20 m? at nacelle? (wind = 5 m/s) | 20 at nacelle in strong winds | DB |
| 20) Lifetime | 10 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Wind vane, free yaw | |
| 24) Upwind or downwind | Upwind | |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 05 |
| 5 | 11 |
| 6 | 21 |
| 7 | 29 |
| 8 | 38 |
| 9 | 48 |
| 10 | 57 |
| 11 | 65 |
| 12 | 71 |
| 13 | 76 |
| 14 | 81 |
| 15 | 85 |
| 16 | 88 |
| 17 | 90 |
| 18 | 92 |
| 19 | 93 |
| 20 | 95 |

### Power curve



# Ampair

## HAWT – 0,1 to 0,3 kW


Contact name: George Durrant
Address: The Doughty Building, Crow Arch Lane, Ringwood, Hampshire, BH24 1NZ
Telephone: +44 (0) 1425 480 780
Country: **United Kingdom**


### Ampair 0,3 kW references

| Site | Use | Country |
|---|---|---|
| None available yet | | |
| | | |

### Ampair Pacific Hawk / 0,3 kW

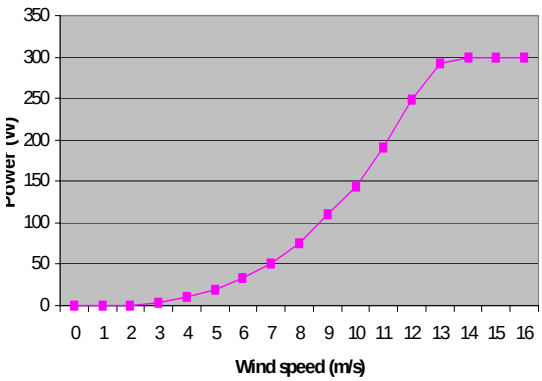
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 0,3 | kW |
| 2) Rated wind speed | 12,6 | m/s |
| 3) Cut-in wind speed | 3 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | 180 | km/h |
| DIMENSIONS | | |
| 6) Nacelle and rotor weight | 12 | kg |
| 7) Rotor diameter | 1,2 | m |
| 8) Rotor height (for VAWT only) | - | m |
| 9) Swept area | 1.13 | $m^2$ |
| 10) Height of the mast | Variable | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | DK | At rated wind speed |
| 12) Gear box type | None | |
| 13) Brake system | Blade pitch control | |
| 14) Number of blades | 3 | |
| 15) Blades material | Glass filled polypropylene | |
| 16) Output voltage | 12 / 24, or grid-connected | V |
| 17) Minimum operation temperature | Perhaps - 20 | °C |
| 18) Maximum operation temperature | Perhaps + 35 | °C |
| 19) Acoustic levels at a distance of 20 m? at nacelle ? (wind = 5 m/s) | Not dB tested yet | DB |
| 20) Lifetime | 10 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Wind vane, free yaw | |
| 24) Upwind or downwind | Upwind | |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 4 |
| 4 | 10 |
| 5 | 20 |
| 6 | 34 |
| 7 | 51 |
| 8 | 76 |
| 9 | 110 |
| 10 | 144 |
| 11 | 192 |
| 12 | 248 |
| 13 | 293 |
| 14 | 300 |
| 15 | 300 |
| 16 | 300 |

### Power curve



# ATLANTIS Windkraft

## HAWT from 0,3 kW to 0,6 kW.

**WB 15 / 0,3 kW**


Contact name: Kottwitz Raimund
Address: Holzstr. 10, 31556 Wölpinghausen
Telephone: +49 5037 988 03
Country : **Germany**


### Atlantis WB 15 references

| Site | Use | Country |
|---|---|---|
| Berlin | About 20 projects in Berlin ( 7 schools, 1 high school, 4 practical education centres, ... ). | Germany |
| | | |

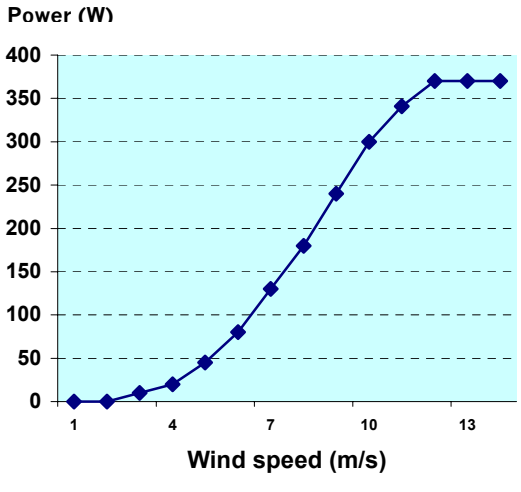
### Technical information

| | | Unit |
|---|---|---|
| 1) Rated power | 0,3 | kW |
| 2) Rated wind speed | 10 | m/s |
| 3) Cut-in wind speed | 3 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | No limit | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 23 | kg |
| 7) Rotor diameter | 1,5 | m |
| 8) Rotor height (for VAWT only) | | m |
| 9) Swept area | 1,8 | $m^2$ |
| 10) Height of the mast | 3/6/ 9/12 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | | At rated wind speed |
| 12) Gear box type | | |
| 13) Brake system | | |
| 14) Number of blades | | 3 |
| 15) Blades material | | Composite fibre glass |
| 16) Output voltage | 12 – 24 | V |
| 17) Minimum operation temperature | Tested in arctic | °C |
| 18) Maximum operation temperature | + 90 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 78 | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | Wind vane |
| 24) Upwind or downwind | | |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 10 |
| 4 | 20 |
| 5 | |
| 6 | 80 |
| 7 | |
| 8 | 180 |
| 9 | |
| 10 | 300 |
| 11 | |
| 12 | 370 |
| 13 | |
| 14 | 370 |

### Power curve:



# ATLANTIS Windkraft

## HAWT from 0,3 kW to 0,6 kW.


Contact name: Kottwitz Raimund
Address: Holzstr. 10, 31556 Wölpinghausen
Telephone: +49 5037 988 03
Country : **Germany**


### Atlantis WB 20 references

| Site | Use | Country |
|---|---|---|
| Berlin | About 20 projects in Berlin: 7 schools, 1 high school, 4 practical education centres, ... | Germany |
| | | |

## WB 20/ 0,6 kW

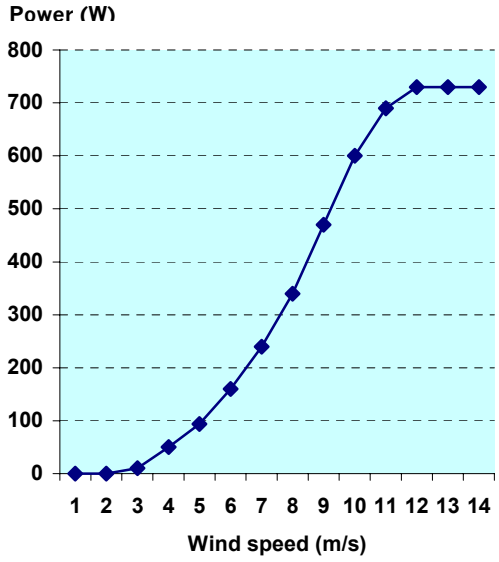
## Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 0,6 | kW |
| 2) Rated wind speed | 10 | m/s |
| 3) Cut-in wind speed | 3 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | No limit | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 37 | kg |
| 7) Rotor diameter | 2 | m |
| 8) Rotor height (for VAWT only) | | m |
| 9) Swept area | 3,14 | $m^2$ |
| 10) Height of the mast | 3/6/ 9/12 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | | At rated wind speed |
| 12) Gear box type | | |
| 13) Brake system | | |
| 14) Number of blades | | 4 |
| 15) Blades material | | Carbon fibre |
| 16) Output voltage | 24- 48 | V |
| 17) Minimum operation temperature | Tested in arctic | °C |
| 18) Maximum operation temperature | + 90 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 78 | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | Wind vane |
| 24) Upwind or downwind | | |

## Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 10 |
| 4 | 50 |
| 5 | |
| 6 | 160 |
| 7 | |
| 8 | 340 |
| 9 | |
| 10 | 600 |
| 11 | |
| 12 | 730 |
| 13 | |
| 14 | 730 |

## Power curve:



# Eclectic Energy

## HAWT – 0,4 kW


| | |
|---|---|
| Contact name: | Peter Anderson |
| Address: | Edwinstowe House, High Street, Edwinstowe, Nottinghamshire NG21 9PR |
| Telephone: | +44 (0) 162 382 15 35 |


### D400 – 0,4 kW references

| Site | Use | Country |
|---|---|---|
| Nottingham University | Testing / monitoring | UK |
| Building Research Establishment (BRE), Watford | Testing / Monitoring | UK |
| | | |

### Stealth Gen D400 / 0,4 kW

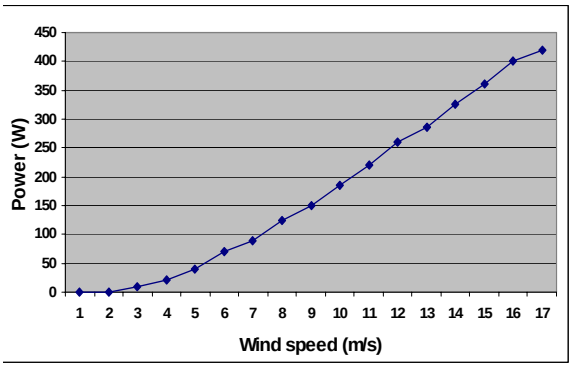
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 0,4 | kW |
| 2) Rated wind speed | 16 | m/s |
| 3) Cut-in wind speed | 2 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | 130 | km/h |
| DIMENSIONS | | |
| 6) Nacelle and rotor weight | 15 | kg |
| 7) Rotor diameter | 1,1 | m |
| 8) Rotor height (for VAWT only) | - | m |
| 9) Swept area | 0,95 | $m^2$ |
| 10) Height of the mast | Variable | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 1 200 | At rated wind speed |
| 12) Gear box type | None | |
| 13) Brake system | Electrical | |
| 14) Number of blades | 5 | |
| 15) Blades material | Glass reinforced nylon | |
| 16) Output voltage | 12/24/48/150 | V |
| 17) Minimum operation temperature | -20 | °C |
| 18) Maximum operation temperature | 120 | °C |
| 19) Acoustic levels at a distance of 20 m? at nacelle? (wind = 5 m/s) | 3 above background | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Wind vane, free yaw | |
| 24) Upwind or downwind | Upwind | |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 10 |
| 4 | 20 |
| 5 | 40 |
| 6 | 70 |
| 7 | 90 |
| 8 | 125 |
| 9 | 150 |
| 10 | 185 |
| 11 | 220 |
| 12 | 260 |
| 13 | 285 |
| 14 | 325 |
| 15 | 360 |
| 16 | 400 |

### Power curve:



# Ecofys

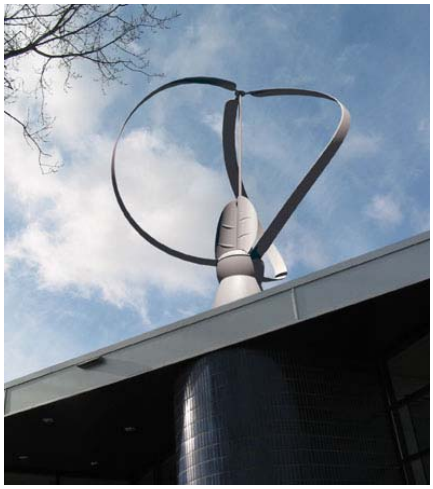
## VAWT 3 kW.


Contact name: Geert Timmers
Address: PO Box 8408, 3503 RK Utrecht
Telephone: +31-30 3808300
Country : Netherlands


### Neoga references: no references

| Site | Use | Country |
|---|---|---|
| | | |
| | | |
| | | |

## Neoga 3 kW



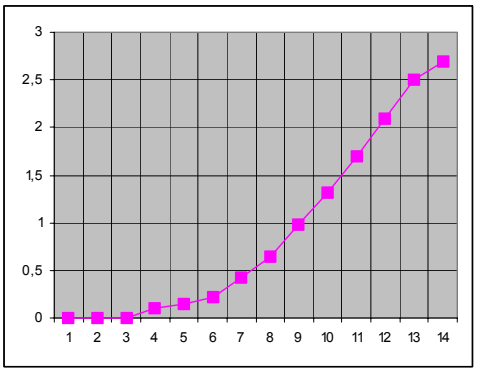
## Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 3 | kW |
| 2) Rated wind speed | 14 | m/s |
| 3) Cut-in wind speed | 3,5 | m/s |
| 4) Cut-out wind speed | 20 | m/s |
| 5) Maximum wind speed the turbine can withstand | Not available | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 200 | kg |
| 7) Rotor diameter | 2,8 | m |
| 8) Rotor height (for VAWT only) | 4 | m |
| 9) Swept area | 5,5 | $m^2$ |
| 10) Height of the mast | Variable 1-12 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 300 | At rated wind speed |
| 12) Gear box type | No gear box | |
| 13) Brake system | Electrical brake + disc brake | |
| 14) Number of blades | 5 | |
| 15) Blades material | Aluminium | |
| 16) Output voltage | 230 | V |
| 17) Minimum operation temperature | - 30 | °C |
| 18) Maximum operation temperature | + 50 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | Not available | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Independent of wind direction | |
| 24) Upwind or downwind | Not applicable | |

## Calculated power curve

| Wind speed (m/s) | Power* (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 100 |
| 5 | |
| 6 | 220 |
| 7 | 420 |
| 8 | 650 |
| 9 | 980 |
| 10 | 1320 |
| 11 | 1700 |
| 12 | 2100 |
| 13 | 2500 |
| 14 | 2700 |
| 15 | |

## Power curve



# Eoltec

## HAWT from 6 kW to 250 kW.

Contact name: Thomas Schulthess
Address: 455, promenade des Anglais, 06299 Nice
Telephone: +33 6 85 30 35 05
Country : **France**

### Eoltec Sirocco 6 kW references

| Site | Use | Country |
|---|---|---|
| Nice | Demonstration turbine connected to the grid | France |
| Orkney Island | Extreme winds test site | UK |
| | Hybrid electrification stand-alone or grid-tied, water pumping, heating,... | 4 continents |

### Sirocco/ 6 kW

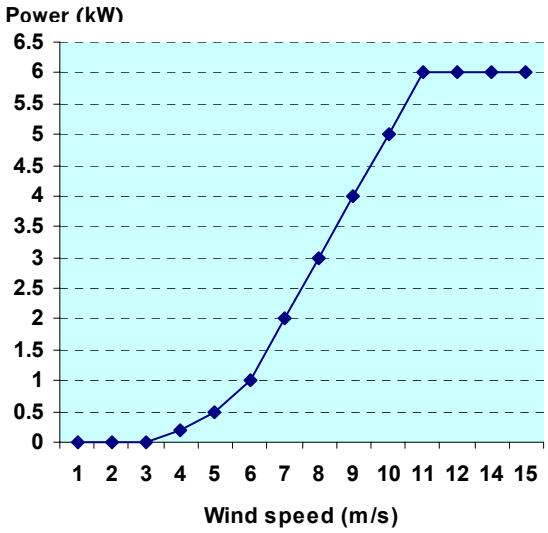
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 6 | kW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 4 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | 216 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight (+ generator) | 202 | kg |
| 7) Rotor diameter | 5,6 | m |
| 8) Rotor height (for VAWT only) | | m |
| 9) Swept area | 24,7 | $m^2$ |
| 10) Height of the mast | 18/24/30 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 245 | At rated wind speed |
| 12) Gear box type | | |
| 13) Brake system | Optional remote control at tower base | |
| 14) Number of blades | 2 | |
| 15) Blades material | Composite fibre glass | |
| 16) Output voltage | 230 | V |
| 17) Minimum operation temperature | - 40 | °C |
| 18) Maximum operation temperature | + 50 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 65 | DB |
| 20) Lifetime | 25 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Wind vane | |
| 24) Upwind or downwind | Upwind turbine | |

### Calculated power curve

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 0,2 |
| 5 | 0.5 |
| 6 | 1.1 |
| 7 | 1.8 |
| 8 | 2.7 |
| 9 | 3.8 |
| 10 | 5 |
| 11 | 5.7 |
| 12 | 6 |
| 13 | 6 |
| 14 | 6 |
| 15 | 6 |
| Inland site, altitude 300 m, 18 m tower<br>Rayleigh distribution (k= 2)<br>Shear ratio 0,143 / Turbulence factor 10 % | |

### Power curve:



# Eoltec

## HAWT from 6 kW to 250 kW.

Contact name: Thomas Schulthess
Address: 455, promenade des Anglais, 06299 Nice
Telephone: +33 6 85 30 35 05
Country : **France**

### Eoltec Wind runner 25 kW references

| Site | Use | Country |
|---|---|---|
| Orkney Island | Prototype | UK |

## Wind Runner/ 25 kW

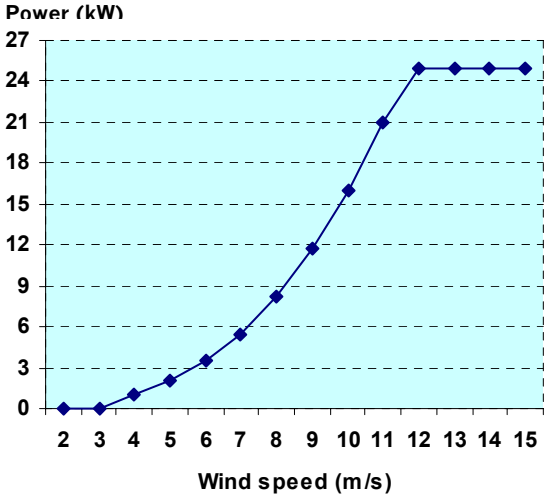
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 25 | kW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 3 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | 216 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight (+ generator) | 620 | kg |
| 7) Rotor diameter | 10 | m |
| 8) Rotor height (for VAWT only) | | m |
| 9) Swept area | 78,6 | $m^2$ |
| 10) Height of the mast | 18/24/32 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 140 | At rated wind speed |
| 12) Gear box type | none – direct drive | |
| 13) Brake system | Optional remote control (blades stalling) | |
| 14) Number of blades | 2 | |
| 15) Blades material | Composite fiber glass | |
| 16) Output voltage | 400 | V |
| 17) Minimum operation temperature | - 40 | °C |
| 18) Maximum operation temperature | + 50 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 65 | DB |
| 20) Lifetime | 25 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Wind vane | |
| 24) Upwind or downwind | Upwind turbine | |

### Calculated power curve

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0.5 |
| 4 | 1 |
| 5 | 2 |
| 6 | 3.5 |
| 7 | 5.5 |
| 8 | 8.2 |
| 9 | 11.7 |
| 10 | 16 |
| 11 | 21 |
| 12 | 25 |
| 13 | 25 |
| 14 | 25 |
| 15 | 25 |

### Power curve:



# Eurowind Small Turbines Ltd

## VAWT – from 1,3 kW to 30 kW


Contact name: Steven Peace
Address: 38 Kings Avenue, Newhaven, East Sussex BN9 0NA
Telephone: +44 (0) 12 73 61 23 83
Country: **United Kingdom**


### Eurowind 1,3 kW references

| Site | Use | Country |
|---|---|---|
| Unknown | Prototype | UK |
| | | |

**Eurowind / 1,3 kW**

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 1,3 | kW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 3 to 4 | m/s |
| 4) Cut-out wind speed | 28 to 32 | m/s |
| 5) Maximum wind speed the turbine can withstand | 255 | km/h |
| DIMENSIONS | | |
| 6) Nacelle and rotor weight | DK | kg |
| 7) Rotor diameter | 2,25 | m |
| 8) Rotor height (for VAWT only) | 2 | m |
| 9) Swept area | 4,5 | $m^2$ |
| 10) Height of the mast | Site dependent | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | DK | At rated wind speed |
| 12) Gear box type | | DK |
| 13) Brake system | | DK |
| 14) Number of blades | | 3 |
| 15) Blades material | | Composite fibre glass |
| 16) Output voltage | 24 – 240 | V |
| 17) Minimum operation temperature | Not known | °C |
| 18) Maximum operation temperature | Not known | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | Dk | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | Not necessary |
| 24) Upwind or downwind | | N/a |

### Calculated power curve

**Not available**

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

### Power curve

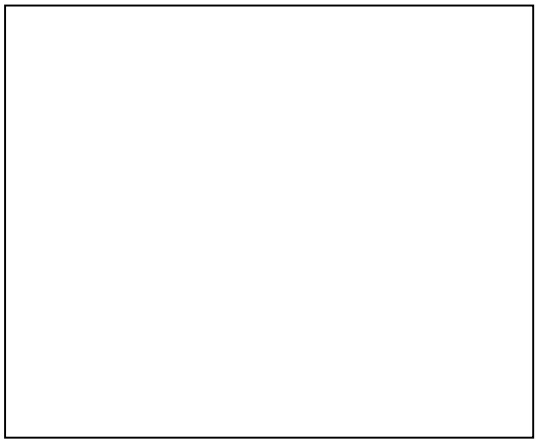
**Not available**

# Eurowind Small Turbines Ltd

## VAWT – from 1,3 kW to 30 kW


Contact name: Steven Peace
Address: 38 Kings Avenue, Newhaven, East Sussex BN9 0NA
Telephone: +44 (0) 12 73 61 23 83
Country : **United Kingdom**


**Eurowind / 5 kW**



### Eurowind 5 kW references

| Site | Use | Country |
|---|---|---|
| | | |
| | | |

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 5 | kW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 3 to 4 | m/s |
| 4) Cut-out wind speed | 28 to 32 | m/s |
| 5) Maximum wind speed the turbine can withstand | 255 | km/h |
| DIMENSIONS | | |
| 6) Nacelle and rotor weight | DK | kg |
| 7) Rotor diameter | 4,25 | m |
| 8) Rotor height (for VAWT only) | 4 | m |
| 9) Swept area | 17 | $m^2$ |
| 10) Height of the mast | Site dependent | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | DK | At rated wind speed |
| 12) Gear box type | DK | |
| 13) Brake system | DK | |
| 14) Number of blades | 3 | |
| 15) Blades material | Composite fibre glass | |
| 16) Output voltage | 24 – 240 | V |
| 17) Minimum operation temperature | Not known | °C |
| 18) Maximum operation temperature | Not known | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Not necessary | |
| 24) Upwind or downwind | N/a | |

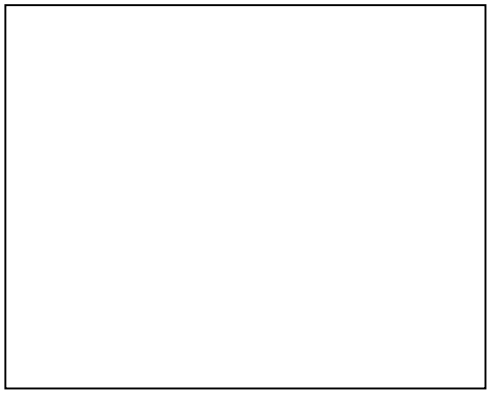
### Calculated power curve

**Not available**

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | |
| 2 | |
| 2,5 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

### Power curve

**Not available**

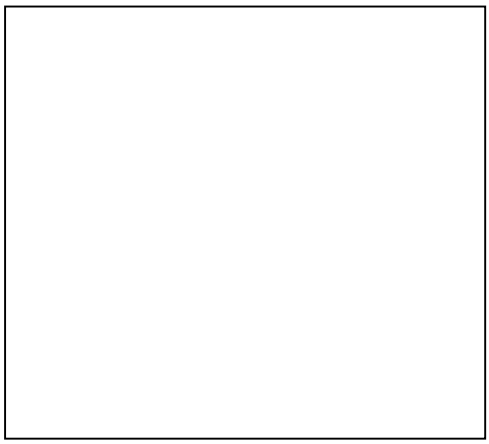


# Eurowind Small Turbines Ltd

## VAWT – from 1,3 kW to 30 kW


Contact name: Steven Peace
Address: 38 Kings Avenue, Newhaven, East Sussex BN9 0NA
Telephone: +44 (0) 12 73 61 23 83
Country: **United Kingdom**


**Eurowind / 10,8 kW**



### Eurowind 10,8 kW references

| Site | Use | Country |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 10,8 | kW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 3 to 4 | m/s |
| 4) Cut-out wind speed | 28 to 32 | m/s |
| 5) Maximum wind speed the turbine can withstand | 255 | Km/h |
| DIMENSIONS | | |
| 6) Nacelle and rotor weight | DK | kg |
| 7) Rotor diameter | 6,26 | m |
| 8) Rotor height (for VAWT only) | 5 | m |
| 9) Swept area | 37 | $m^2$ |
| 10) Height of the mast | Site dependent | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | DK | At rated wind speed |
| 12) Gear box type | DK | |
| 13) Brake system | DK | |
| 14) Number of blades | 3 | |
| 15) Blades material | Composite fibre glass | |
| 16) Output voltage | 24 – 240 | V |
| 17) Minimum operation temperature | DK | °C |
| 18) Maximum operation temperature | DK | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | DK | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Not necessary | |
| 24) Upwind or downwind | N/a | |

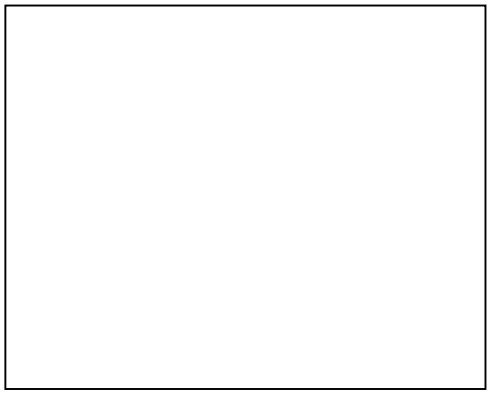
### Calculated power curve

**Not available**

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | |
| 2 | |
| 2,5 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

### Power curve

**Not available**



# Eurowind Small Turbines Ltd

## VAWT – from 1,3 kW to 30 kW


Contact name: Steven Peace
Address: 38 Kings Avenue, Newhaven, East Sussex BN9 0NA
Telephone: +44 (0) 12 73 61 23 83
Country: **United Kingdom**


### Eurowind 19 kW references

| Site | Use | Country |
|---|---|---|
| No references available yet | | |
| | | |

**Eurowind / 19 kW**

**Photo Montage**

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 19 | kW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 3 to 4 | m/s |
| 4) Cut-out wind speed | 28 to 32 | m/s |
| 5) Maximum wind speed the turbine can withstand | 255 | Km/h |
| DIMENSIONS | | |
| 6) Nacelle and rotor weight | DK | kg |
| 7) Rotor diameter | 8,25 | m |
| 8) Rotor height (for VAWT only) | 8 | m |
| 9) Swept area | 66 | $m^2$ |
| 10) Height of the mast | Site dependent | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | DK | At rated wind speed |
| 12) Gear box type | DK | |
| 13) Brake system | DK | |
| 14) Number of blades | 3 | |
| 15) Blades material | Composite fibre glass | |
| 16) Output voltage | 24 – 240 | V |
| 17) Minimum operation temperature | DK | °C |
| 18) Maximum operation temperature | DK | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | DK | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Not necessary | |
| 24) Upwind or downwind | N/a | |

### Calculated power curve

**Not available**

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

### Power curve

**Not available**

# Eurowind Small Turbines Ltd

## VAWT – from 1,3 kW to 30 kW


Contact name: Steven Peace
Address: 38 Kings Avenue, Newhaven, East Sussex BN9 0NA
Telephone: +44 (0) 12 73 61 23 83
Country: **United Kingdom**


### Eurowind 30 kW references

| Site | Use | Country |
|---|---|---|
| No references available yet | | |
| | | |

**Eurowind / 30 kW**

**Photo Montage**

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 30 | kW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 3 to 4 | m/s |
| 4) Cut-out wind speed | 28 to 32 | m/s |
| 5) Maximum wind speed the turbine can withstand | 255 | Km/h |
| DIMENSIONS | | |
| 6) Nacelle and rotor weight | DK | kg |
| 7) Rotor diameter | 10,25 | m |
| 8) Rotor height (for VAWT only) | 10 | m |
| 9) Swept area | 102,5 | $m^2$ |
| 10) Height of the mast | Site dependent | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | DK | At rated wind speed |
| 12) Gear box type | DK | |
| 13) Brake system | DK | |
| 14) Number of blades | 3 | |
| 15) Blades material | Composite fibre glass | |
| 16) Output voltage | 24 – 240 | V |
| 17) Minimum operation temperature | DK | °C |
| 18) Maximum operation temperature | DK | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | DK | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Not necessary | |
| 24) Upwind or downwind | N/a | |

### Calculated power curve

**Not available**

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

### Power curve

**Not available**

# Fortis Wind Energy

## HAWT from 0,8 kW to 10 kW.


Contact name: Johan Kuikman
Address: Botanicuslaan 14, 9751 AC Haren
Telephone: +31 – 50 5340104
Country : **Netherlands**


## Espada / 0,8 kW

### Espada references

| Site | Use | Country |
|---|---|---|
| Xingang Nat. Machinery Corp. | Technology transfer | China |
| Windsund, Sunderland | Offshore application | UK |
| Brussel | Ecole Royale Miltaire | Belgium |
| Galeforce | Stand alone application | UK |

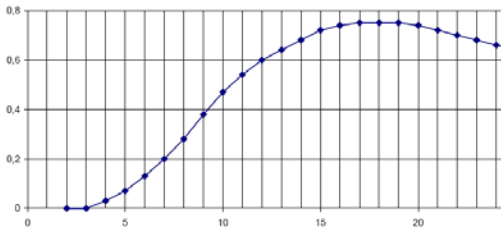
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 0,8 | kW |
| 2) Rated wind speed | 14 | m/s |
| 3) Cut-in wind speed | 3 | m/s |
| 4) Cut-out wind speed | No | m/s |
| 5) Maximum wind speed the turbine can withstand | 60 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 52 | kg |
| 7) Rotor diameter | 2,2 | m |
| 8) Rotor height (for VAWT only) | --- | m |
| 9) Swept area | 3,80 | $m^2$ |
| 10) Height of the mast | 12 – 18 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 1000 | At rated wind speed |
| 12) Gear box type | No brake system | |
| 13) Brake system | Short circuit in generator | |
| 14) Number of blades | 2 | |
| 15) Blades material | Composite fibre glass | |
| 16) Output voltage | 12 - 240 | V (DC) |
| 17) Minimum operation temperature | - 30 | °C |
| 18) Maximum operation temperature | + 50 | °C |
| 19) Acoustic levels at a distance of 20 m ? (wind = 10 m/s) | < 60 | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Wind vane | |
| 24) Upwind or downwind | Upwind | |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 0,03 |
| 5 | 0,07 |
| 6 | 0,13 |
| 7 | 0,20 |
| 8 | 0,28 |
| 9 | 0,38 |
| 10 | 0,47 |
| 11 | 0,57 |
| 12 | 0,66 |
| 13 | 0,74 |
| 14 | 0,78 |
| 15 | 0,8 |

### Power curve



# Fortis Wind Energy

## HAWT from 0,8 kW to 10 kW.


Contact name: Johan Kuikman
Address: Botanicuslaan 14, 9751 AC Haren
Telephone: +31-50 5340104
Country : Nethrelands


### Passaat references

| Site | Use | Country |
|---|---|---|
| Dieren | Stand alone electricity | Netherlands |
| Split | Roof university building | Croatia |
| Lapan | Rural electrification | Indonesia |
| Trontheim | Radio repeaters | Norway |

## Passaat 1,4 kW

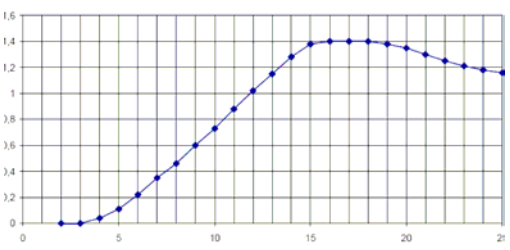
## Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 1,4 | kW |
| 2) Rated wind speed | 16 | m/s |
| 3) Cut-in wind speed | 2,5 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | 60 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 75 | kg |
| 7) Rotor diameter | 3,12 | m |
| 8) Rotor height (for VAWT only) | --- | m |
| 9) Swept area | 7,65 | $m^2$ |
| 10) Height of the mast | 12 - 24 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 775 | At rated wind speed |
| 12) Gear box type | | No gear box |
| 13) Brake system | | Short circuit of generator |
| 14) Number of blades | | 3 |
| 15) Blades material | | Composite fibre glass |
| 16) Output voltage | 24-240 | V (DC) |
| 17) Minimum operation temperature | - 30 | °C |
| 18) Maximum operation temperature | + 50 | °C |
| 19) Acoustic levels at a distance of 20 m ? (wind = 10 m/s) | < 60 | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | Wind vane |
| 24) Upwind or downwind | | Upwind |

## Calculated power curve

| Wind speed (m/s) | Power* (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0,001 |
| 4 | 0,040 |
| 5 | 0,110 |
| 6 | 0,220 |
| 7 | 0,350 |
| 8 | 0,460 |
| 9 | 0,600 |
| 10 | 0,730 |
| 11 | 0,880 |
| 12 | 1,020 |
| 13 | 1,150 |
| 14 | 1,280 |
| 15 | 1,400 |
| *power on axis, sea level, temp. 15°C | |

## Power curve



# Fortis Montana

## HAWT from 0,8 kW to 10 kW.


Contact name: Johan Kuikman
Address: Botanicuslaan 14, 9751 AC Haren
Telephone: +31 – 50 5340104
Country : Netherlands


### Montana references

| Site | Use | Country |
|---|---|---|
| Stompetoren | Demonstration at installation company | Netherlands |
| Waregem | On the roof of industrial building | Belgium |
| Perugia | Plasto Work and Wind Engineering | Italy |
| CREST | Stand alone electricity | Greece |

**Montana 5,6 kW**

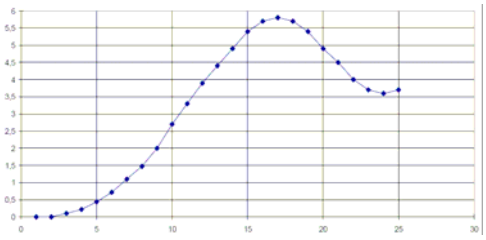
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 5,6 | kW |
| 2) Rated wind speed | 17 | m/s |
| 3) Cut-in wind speed | 2,5 | m/s |
| 4) Cut-out wind speed | No | m/s |
| 5) Maximum wind speed the turbine can withstand | 60 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 170 | kg |
| 7) Rotor diameter | 5 | m |
| 8) Rotor height (for VAWT only) | --- | m |
| 9) Swept area | 19,6 | $m^2$ |
| 10) Height of the mast | 18 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 450 | At rated wind speed |
| 12) Gear box type | | No gear box |
| 13) Brake system | | Short circuit at generator |
| 14) Number of blades | | 3 |
| 15) Blades material | | Composite fibre glass |
| 16) Output voltage | 24 - 400 | V (DC) |
| 17) Minimum operation temperature | - 30 | °C |
| 18) Maximum operation temperature | + 50 | °C |
| 19) Acoustic levels at a distance of 20 m ? (wind = 10 m/s) | < 60 | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | Wind vane |
| 24) Upwind or downwind | | Upwind |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0,10 |
| 4 | 0,22 |
| 5 | 0,44 |
| 6 | 0,72 |
| 7 | 1,10 |
| 8 | 1,43 |
| 9 | 2,00 |
| 10 | 2,70 |
| 11 | 3,30 |
| 12 | 3,90 |
| 13 | 4,40 |
| 14 | 4,90 |
| 15 | 5,40 |

### Power curve



# Fortis Wind Energy

## HAWT from 0,8 kW to 10 kW.


Contact name: Johan Kuikman
Address: Botanicuslaan 14, 9751 AC Haren
Telephone: +31-50 5340104
Country : Netherlands


**Alize, 10 kW**

### Alize references

| Site | Use | Country |
|---|---|---|
| Dronrijp | Farm | Netherlands |
| Lutjegast | Farm | Netherlands |
| Opende | Farm | Netherlands |
| St. Cruz de la Palma | Desalination plant | Spain, Canary Islands |

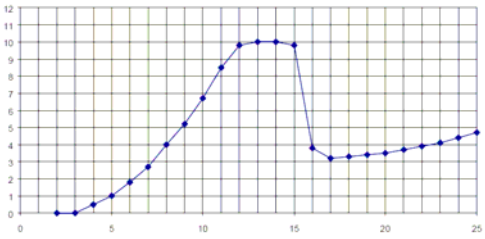
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 10 | kW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 3 | m/s |
| 4) Cut-out wind speed | No | m/s |
| 5) Maximum wind speed the turbine can withstand | 60 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 285 | kg |
| 7) Rotor diameter | 7 | m |
| 8) Rotor height (for VAWT only) | --- | m |
| 9) Swept area | 38,5 | $m^2$ |
| 10) Height of the mast | 18 – 36 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 300 | At rated wind speed |
| 12) Gear box type | No gear box | |
| 13) Brake system | Short circuit of generator | |
| 14) Number of blades | 3 | |
| 15) Blades material | Composite fibre glass | |
| 16) Output voltage | 120 - 400 | V (DC) |
| 17) Minimum operation temperature | - 30 | °C |
| 18) Maximum operation temperature | + 50 | °C |
| 19) Acoustic levels at a distance of 20 m ? (wind = 10 m/s) | < 60 | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Wind vane | |
| 24) Upwind or downwind | Upwind | |

### Calculated power curve

| Wind speed (m/s) | Power* (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 0,4 |
| 5 | 1,0 |
| 6 | 1,8 |
| 7 | 2,8 |
| 8 | 3,9 |
| 9 | 5,2 |
| 10 | 6,8 |
| 11 | 8,5 |
| 12 | 9,8 |
| 13 | 10,0 |
| 14 | 10,0 |
| 15 | 10,0 |

### Power curve



# Fuhrländer

## HAWT from 30 kW to 2 700 kW.


Contact name: Carina Demuth / A. Kloos
Address: Auf der Höhe 4, 56477 Waigandshain
Telephone: +49 266 49 96 60
Country : **Germany**


### Fürländer FL30 references

| Site | Use | Country |
|---|---|---|
| Zistersdorf | Government | Austria |
| Cody / Wyoming | Privat Ranch | USA |
| Köln | Public Services | Germany |
| | | |

**FL 30/ 30 kW**

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 30 | kW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 2,5 | m/s |
| 4) Cut-out wind speed | 25 | m/s |
| 5) Maximum wind speed the turbine can withstand | 55 | m/s |
| DIMENSIONS | | |
| 6) Rotor weight | 640 | kg |
| 7) Rotor diameter | 13 | m |
| 8) Rotor height (for VAWT only) | | m |
| 9) Swept area | 133 | $m^2$ |
| 10) Height of the mast | 18/27 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 70 | At rated wind speed |
| 12) Gear box type | Spur gear/planet gears | |
| 13) Brake system | Disk brake+ Mech tip brake | |
| 14) Number of blades | 3 | |
| 15) Blades material | Glass Fibre Composite | |
| 16) Output voltage | 400 | V |
| 17) Minimum operation temperature | -20°C | °C |
| 18) Maximum operation temperature | + 50°C | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 93 | DB |
| 20) Lifetime | | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | Yes | |
| 23) Yaw control system | 1 gearbox motors | |
| 24) Upwind or downwind | | |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |
| 16 | |
| 17 | |
| 18 | |
| | |

### Power curve

# Fuhrländer

## HAWT from 30 kW to 2 700 kW.


Contact name: Carina Demuth / A. Kloos
Address: Auf der Höhe 4, 56477 Waigandshain
Telephone: +49 266 49 96 60
Country : **Germany**


### Fuhrländer FL 100 references

| Site | Use | Country |
|---|---|---|
| Rennerod | Company " Spedition Pracht" | Germany |
| Iwata /Shizuoka | Iwata Factory | Japan |
| Vilemov | Orthodox Akademie | Czech Republic |
| Boston | IBEW Local | USA |

**FL 100/ 100 kW**

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 100 | kW |
| 2) Rated wind speed | 13 | m/s |
| 3) Cut-in wind speed | 2,5 | m/s |
| 4) Cut-out wind speed | 25 | m/s |
| 5) Maximum wind speed the turbine can withstand | 67 | m/s |
| DIMENSIONS | | |
| 6) Rotor weight (incl. hub) | 2 300 | kg |
| 7) Rotor diameter | 21 | m |
| 8) Rotor height (for VAWT only) | | m |
| 9) Swept area | 346 | $m^2$ |
| 10) Height of the mast | 35 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 47 | At rated wind speed |
| 12) Gear box type | Combined spur gear/planet gears | |
| 13) Brake system | Disc brake + rotor tip brake + parking brake system + aerodynamic safety system "stall" | |
| 14) Number of blades | 3 | |
| 15) Blades material | Glass Fibre Composite | |
| 16) Output voltage | 400 | V |
| 17) Minimum operation temperature | -20°C | °C |
| 18) Maximum operation temperature | + 50°C | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 95 | DB |
| 20) Lifetime | 25 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | Yes | |
| 23) Yaw control system | Wind vane | |
| 24) Upwind or downwind | Upwind | |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |
| 16 | |
| 17 | |
| 18 | |

### Power curve

# Gaia-Wind A/S

## HAWT 11 kW.


Contact name: Jesper Andersen
Address: Håndværkervej 1, 8840 Rødkærsbro
Telephone: +45 87 76 22 00
Country : **Denmark**


**Gaia 11 kW references**: have not provided any references

| Site | Use | Country |
|---|---|---|
| | | |
| | | |

**Gaia/ 11 kW**

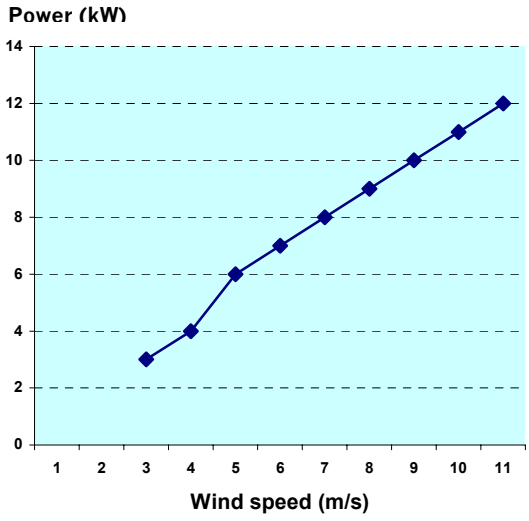
## Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 11 | kW |
| 2) Rated wind speed | 10 | m/s |
| 3) Cut-in wind speed | 3 | m/s |
| 4) Cut-out wind speed | 25 | m/s |
| 5) Maximum wind speed the turbine can withstand | 65 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 208-248 | kg |
| 7) Rotor diameter | 13 | m |
| 8) Rotor height (for VAWT only) | Not relevant | m |
| 9) Swept area | 132 | $m^2$ |
| 10) Height of the mast | 18 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 56 | At rated wind speed |
| 12) Gear box type | Compact shaft mounted gear | |
| 13) Brake system | Disc brake | |
| 14) Number of blades | 2 | |
| 15) Blades material | Composite fiber glass | |
| 16) Output voltage | 380-400 | V |
| 17) Minimum operation temperature | - 20 | °C |
| 18) Maximum operation temperature | + 50 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 45 Db at 59 meters | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | Yes | |
| 23) Yaw control system | Wind vane | |
| 24) Upwind or downwind | Downwind turbine | |

## Calculated power curve

| Wind speed (m/s) | Power(kW) |
|---|---|
| 1 | |
| 2 | |
| 3 | 3 |
| 4 | 4 |
| 5 | 6 |
| 6 | 7 |
| 7 | 8 |
| 8 | 9 |
| 9 | 10 |
| 10 | 11 |
| 11 | 12 |

## Power curve:



# Gazelle Wind Turbines Ltd

## HAWT – 20 kW


Contact name: Ken Chaplin
Address: Stargate Ind Est, Ryton, Tyne & Wear, NE40 3 EX
Telephone: +44 (0) 191 413 00 12
Country: **United Kingdom**


**Gazelle / 20 kW**

### Gazelle 20 kW references

| Site | Use | Country |
|---|---|---|
| Southport Eco Centre, | Electricity generation for building | UK |
| Montagne Jeunesse Eco Factory, Swansea | Electricity generation for building | UK |
| Sunderland Enterprise Park, Sunderland | Electricity generation for building | UK |

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 20 | kW |
| 2) Rated wind speed | 13 | m/s |
| 3) Cut-in wind speed | 4 | m/s |
| 4) Cut-out wind speed | 20 | m/s |
| 5) Maximum wind speed the turbine can withstand | DK | km/h |
| DIMENSIONS | | |
| 6) Nacelle and rotor weight | 1600 | kg |
| 7) Rotor diameter | 11 | m |
| 8) Rotor height (for VAWT only) | - | m |
| 9) Swept area | 95 | $m^2$ |
| 10) Height of the mast | 12,5 to 20 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 106 | At rated wind speed |
| 12) Gear box type | | None |
| 13) Brake system | | - |
| 14) Number of blades | | 3 |
| 15) Blades material | | Carbon fibre epoxy |
| 16) Output voltage | 400 | V |
| 17) Minimum operation temperature | DK | °C |
| 18) Maximum operation temperature | DK | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | DK | DB |
| 20) Lifetime | 20 to 25 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | Yes |
| 23) Yaw control system | | Free yaw |
| 24) Upwind or downwind | | Downwind |

### Calculated power curve

**Not available**

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

### Power curve

**Not available**

# Iskra Wind Turbines

## HAWT – 5 kW


Contact name: John Balson
Address: 261, Woodborough Road, St Anns, Nottingham, NG3 4 JZ
Telephone: +44 (0) 115 841 32 83
Country: **United Kingdom**


### Iskra 5 kW references

| Site | Use | Country |
|---|---|---|
| The Turbine, Shireoaks Business Innovation Centre, Worksop | Electricity generation for building | UK |
| Westergate Business Centre, Brighton | Electricity generation for building | UK |
| Hockerton Housing Project, Hockerton | Electricity generation for homes and visitor centre | UK |

**Iskra / 5 kW**

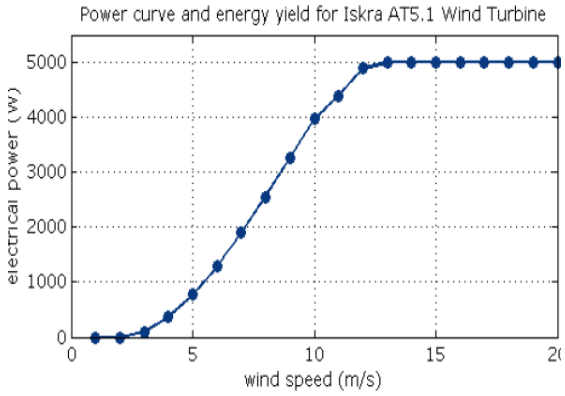
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 5 | kW |
| 2) Rated wind speed | 11 | m/s |
| 3) Cut-in wind speed | 3 | m/s |
| 4) Cut-out wind speed | 60 | m/s |
| 5) Maximum wind speed the turbine can withstand | 216 | km/h |
| DIMENSIONS | | |
| 6) Nacelle and rotor weight | 280 | kg |
| 7) Rotor diameter | 5.4 | m |
| 8) Rotor height (for VAWT only) | - | m |
| 9) Swept area | 22.9 | $m^2$ |
| 10) Height of the mast | 12 to 30 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 200 | At rated wind speed |
| 12) Gear box type | | None |
| 13) Brake system | | Electro-dymamic |
| 14) Number of blades | | 3 |
| 15) Blades material | | Composite fibre glass |
| 16) Output voltage | Variable | V |
| 17) Minimum operation temperature | -20 | °C |
| 18) Maximum operation temperature | +50 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | DK | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | Tail vane |
| 24) Upwind or downwind | | Upwind |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 96 |
| 4 | 367 |
| 5 | 771 |
| 6 | 1284 |
| 7 | 1901 |
| 8 | 2547 |
| 9 | 3253 |
| 10 | 3965 |
| 11 | 4397 |
| 12 | 4888 |
| 13 | 5000 |
| 14 | 5000 |
| 15 | 5000 |

### Power curve:



# Jonica Impianti

## HAWT of 20 kW.


Contact name: Nicola De Luca
Address: Via Poerio 226, 74020 Lizzano
Telephone: +39 099 955 12 08
Country : **Italy**


### Jonica Impianti 20 kW references

| City (Province) | Use | Country |
|---|---|---|
| Lizzano (Taranto) | Jonica Impianti factory | Italy |
| Perarolo di Cadore (Belluno) | Industrial area | Italy |
| Pos al Pago (Belluno) | Industrial area | Italy |
| Quero (Belluno) | Industrial area | Italy |
| Colle Salvetti (Livorno) | AGIP Service station | Italy |

**Jonica Impianti/ 20 kW**

### Technical information

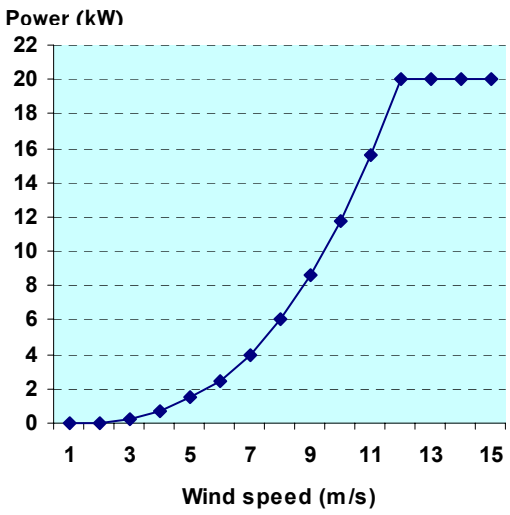
| POWER | | Unit |
|---|---|---|
| 1) Rated power | 20 | KW |
| 2) Rated wind speed | 12,5 | m/s |
| 3) Cut-in wind speed | 3,5 | m/s |
| 4) Cut-out wind speed | 37,5 | m/s |
| 5) Maximum wind speed the turbine can withstand | 153 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight (blades) | 100 | Kg |
| 7) Rotor diameter | 8 | m |
| 8) Rotor height (for VAWT only) | | m |
| 9) Swept area | 50,3 | $m^2$ |
| 10) Height of the mast | 12/18 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 200 | At rated wind speed |
| 12) Gear box type | | Not present |
| 13) Brake system | | Aerodynamic with pitch control |
| 14) Number of blades | | 3 |
| 15) Blades material | | Composite fiber glass |
| 16) Output voltage | 380 | V |
| 17) Minimum operation temperature | - 20 | °C |
| 18) Maximum operation temperature | + 50 | °C |
| 19) Acoustic levels at a distance of 50 m (wind = 9 m/s) | 50 | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | Wind vane |
| 24) Upwind or downwind | | Upwind turbine |

### Calculated power curve

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0,.25 |
| 4 | 0,.50 |
| 5 | 1, 5 |
| 6 | 2, 5 |
| 7 | 4 |
| 8 | 6 |
| 9 | 8, 6 |
| 10 | 11, 8 |
| 11 | 15, 6 |
| 12 | 20 |
| 13 | 20 |
| 14 | 20 |
| 15 | 20 |

Sea level, Raleygh distrib k = 2
Tower height= 18 m, Shear coef = 0,14
Turbulence factor = 15%

### Power curve:



# Marlec Engineering Co Ltd

## HAWT – From 0,025 kW to 0,34 kW


Contact name: Teresa Auciello
Address: Rutland House, Trevithick Rd, Corby, Northants NN17 5XY
Telephone: +44 (0) 1536 201 588
Country: **United Kingdom**


### Rutland 503 – 0,025 kW references

| Site | Use | Country |
|---|---|---|
| Elliott Durham Comprehensive School, Nottingham | Educational | UK |
| Sandy Upper School and Community Sports College | Educational | UK |
| Cromwell Park Primary School, Huntingdon | Educational | UK |

### Rutland 503 / 0,025 kW

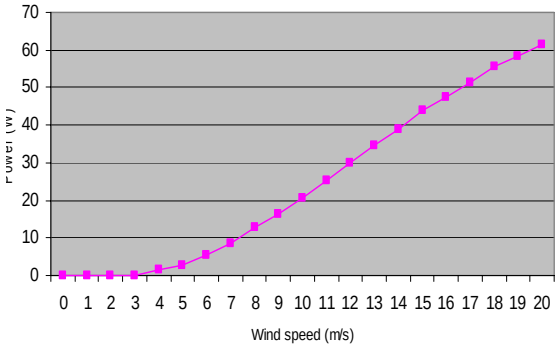

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 0, 025 | kW |
| 2) Rated wind speed | 10 | m/s |
| 3) Cut-in wind speed | 2,6 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | > 137 | km/h |
| DIMENSIONS | | |
| 6) Nacelle and rotor weight | 3 | kg |
| 7) Rotor diameter | 0,500 | m |
| 8) Rotor height (for VAWT only) | - | m |
| 9) Swept area | 0,196 | $m^2$ |
| 10) Height of the mast | Variable up to 6,5 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | DK | At rated wind speed |
| 12) Gear box type | | None |
| 13) Brake system | | DK |
| 14) Number of blades | | 6 |
| 15) Blades material | | Glass reinforced plastic |
| 16) Output voltage | 12 or 24 | V |
| 17) Minimum operation temperature | -25 | °C |
| 18) Maximum operation temperature | DK | °C |
| 19) Acoustic levels at a distance of 20 m? at nacelle? (wind = 5 m/s) | DK | DB |
| 20) Lifetime | 15 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | Wind vane |
| 24) Upwind or downwind | | Upwind |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 1 |
| 4 | 2 |
| 5 | 4 |
| 6 | 6 |
| 7 | 10 |
| 8 | 14 |
| 9 | 20 |
| 10 | 26 |
| 11 | 28 |
| 12 | 36 |
| 13 | 39 |
| 14 | 44 |
| 15 | 56 |

### Power curve:



# Marlec Engineering Co Ltd

## HAWT – From 0,025 kW to 0,34 kW


Contact name: Teresa Auciello
Address: Rutland House, Trevithick Rd, Corby, Northants NN17 5XY
Telephone: +44 (0) 1536 201 588
Country : **United Kingdom**


### Rutland 910-3 – 0,09 kW references

| Site | Use | Country |
|---|---|---|
| Hagbourne Primary School, Oxon | Educational and Electricity generation | UK |
| A43 roadside | Traffic signals | UK |
| Tokyo | Street lighting | Japan |

## Rutland 910-3 / 0,09 kW

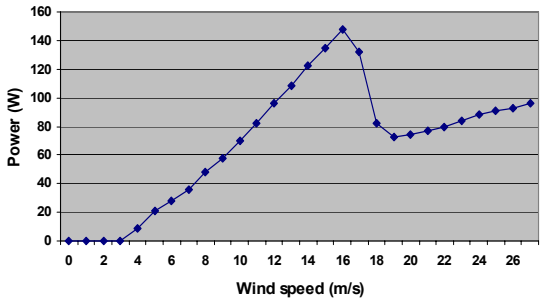
## Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 0,09 | kW |
| 2) Rated wind speed | 10 | m/s |
| 3) Cut-in wind speed | 2,6 | m/s |
| 4) Cut-out wind speed | It furls at 15 m/s but no real cut out | m/s |
| 5) Maximum wind speed the turbine can withstand | > 137 | km/h |
| DIMENSIONS | | |
| 6) Nacelle and rotor weight | 17 | kg |
| 7) Rotor diameter | 0,910 | m |
| 8) Rotor height (for VAWT only) | - | m |
| 9) Swept area | 0,655 | $m^2$ |
| 10) Height of the mast | Up to 6,5 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | DK | At rated wind speed |
| 12) Gear box type | | None |
| 13) Brake system | | DK |
| 14) Number of blades | | 6 |
| 15) Blades material | | Glass reinforced plastic |
| 16) Output voltage | 12 or 24 | V |
| 17) Minimum operation temperature | Artic | °C |
| 18) Maximum operation temperature | Sahara | °C |
| 19) Acoustic levels at a distance of 20 m? at nacelle? (wind = 5 m/s) | DK | DB |
| 20) Lifetime | 15 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | Wind vane |
| 24) Upwind or downwind | | Upwind |

## Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 2 |
| 4 | 14 |
| 5 | 21 |
| 6 | 28 |
| 7 | 44 |
| 8 | 50 |
| 9 | 66 |
| 10 | 83 |
| 11 | 87 |
| 12 | 92 |
| 13 | 121 |
| 14 | 138 |
| 15 | 159 |

## Power curve:



# Marlec Engineering Co Ltd

## HAWT – From 0,025 kW to 0,34 kW


Contact name: Teresa Auciello
Address: Rutland House, Trevithick Rd, Corby, Northants NN17 5XY
Telephone: +44 (0) 1536 201 588
Country : **United Kingdom**


### Rutland 913 – 0,09 kW references

| Site | Use | Country |
|---|---|---|
| Rutland Water | Water level monitoring | UK |
| Southampton | Sailing boat | UK |
| | Street lighting | Taiwan |
| A6006 road sign | Safety sign | UK |

### Rutland 913/ 0,09 kW

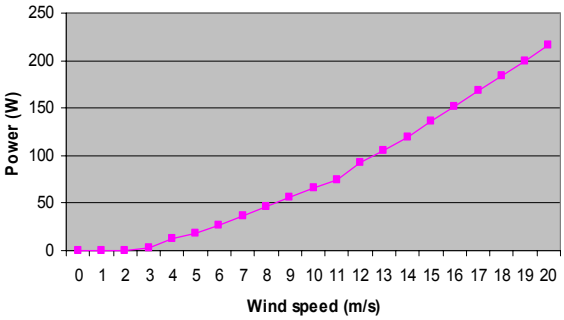

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 0,09 | kW |
| 2) Rated wind speed | 10 | m/s |
| 3) Cut-in wind speed | 2,6 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | > 137 | Km/h |
| DIMENSIONS | | |
| 6) Nacelle and rotor weight | 13 | Kg |
| 7) Rotor diameter | 0,913 | m |
| 8) Rotor height (for VAWT only) | - | m |
| 9) Swept area | 0,655 | $m^2$ |
| 10) Height of the mast | Variable up to 6,5 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | DK | At rated wind speed |
| 12) Gear box type | None | |
| 13) Brake system | DK | |
| 14) Number of blades | 6 | |
| 15) Blades material | Glass reinforced plastic | |
| 16) Output voltage | 12 or 24 | V |
| 17) Minimum operation temperature | -25 | °C |
| 18) Maximum operation temperature | DK | °C |
| 19) Acoustic levels at a distance of 20 m? at nacelle? (wind = 5 m/s) | DK | DB |
| 20) Lifetime | 15 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Wind vane | |
| 24) Upwind or downwind | Upwind | |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 2 |
| 4 | 14 |
| 5 | 21 |
| 6 | 28 |
| 7 | 44 |
| 8 | 50 |
| 9 | 66 |
| 10 | 83 |
| 11 | 87 |
| 12 | 92 |
| 13 | 121 |
| 14 | 138 |
| 15 | 159 |

### Power curve:



# OY Windside Production Ltd

## VAWT from 1 kW to 8 kW.

**WS-4B & 4C/ 1-2 kW**


Contact name: Risto Joutsiniemi
Address: Niemenharjuntie 85, 44800 Pihtipudas
Telephone: +358 208 350 700
Country : **Finland**


### Oy Windside WS-4B/4C references

| Site | Use | Country |
|---|---|---|
| Doncaster | Earth Centre | England |
| Helsinki | Arabianranta | Finland |
| Chicago | Millenium Park | U.S.A |
| Yurigaoka, Fukuoka | Sports centre | Japan |
| Oulu | In a Park wind art work Synergia | Finland |

### Technical information

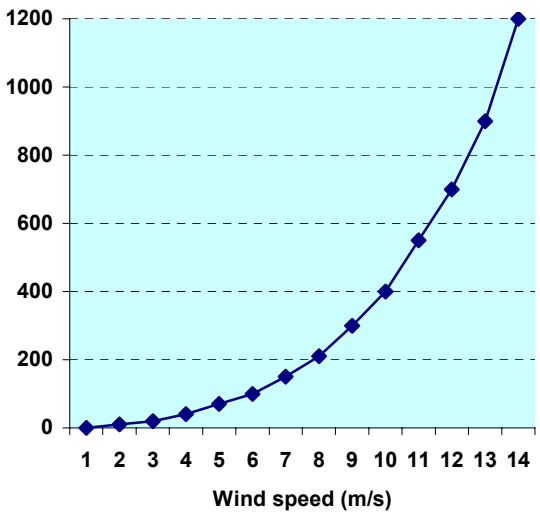
| POWER | | Unit |
|---|---|---|
| 1) Rated power | 1 | KW |
| 2) Rated wind speed | 18 | m/s |
| 3) Cut-in wind speed | 2 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | 144 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 400 | Kg |
| 7) Rotor diameter | 1 | m |
| 8) Rotor height (for VAWT only) | 4 | m |
| 9) Swept area | 4 | $m^2$ |
| 10) Height of the mast | Not relevant | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 170 - 400 | At rated wind speed |
| 12) Gear box type | | No gear box |
| 13) Brake system | | Disk brake |
| 14) Number of blades | | 2 |
| 15) Blades material | | Composite fibre glass |
| 16) Output voltage | 0 - 200 | V |
| 17) Minimum operation temperature | - 60 | °C |
| 18) Maximum operation temperature | + 80 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 0 | DB |
| 20) Lifetime | 100 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | Yes |
| 23) Yaw control system | | Not needed |
| 24) Upwind or downwind | | |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 10 |
| 3 | 20 |
| 4 | 40 |
| 5 | 70 |
| 6 | 100 |
| 7 | 150 |
| 8 | 210 |
| 9 | 300 |
| 10 | 400 |
| 11 | 550 |
| 12 | 700 |
| 13 | 900 |
| 14 | 1 200 |

In battery charging the electricity production will be changing according to the voltage level chosen by the client. 3-phase Generator 25 Ampers

### Power curve



# OY Windside Production Ltd

## VAWT from 1 kW to 8 kW.


Contact name: Risto Joutsiniemi
Address: Niemenharjuntie 85, 44800 Pihtipudas
Telephone: +358 208 350 700
Country : **Finland**


### Oy Windside WS-12 references

| Site | Use | Country |
|---|---|---|
| Raisio | Shopping centre | Finland |
| | | |
| | | |

**WS-12/ 8 kW**

### Technical information

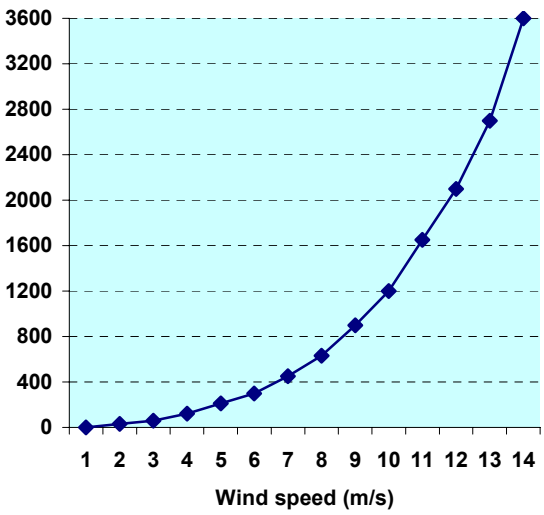
| POWER | | Unit |
|---|---|---|
| 1) Rated power | 8 | kW |
| 2) Rated wind speed | 20 | m/s |
| 3) Cut-in wind speed | 2 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | 216 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 3000 | kg |
| 7) Rotor diameter | 2 | m |
| 8) Rotor height (for VAWT only) | 6 | m |
| 9) Swept area | 12 | $m^2$ |
| 10) Height of the mast | Not relevant | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 100 - 300 | At rated wind speed |
| 12) Gear box type | | No gear box |
| 13) Brake system | | Disk brake |
| 14) Number of blades | | 2 |
| 15) Blades material | | Aluminium |
| 16) Output voltage | 0 - 200 | V |
| 17) Minimum operation temperature | - 60 | °C |
| 18) Maximum operation temperature | + 80 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 0 | DB |
| 20) Lifetime | 100 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | Yes |
| 23) Yaw control system | | Not needed |
| 24) Upwind or downwind | | |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 30 |
| 3 | 60 |
| 4 | 120 |
| 5 | 211 |
| 6 | 300 |
| 7 | 450 |
| 8 | 630 |
| 9 | 900 |
| 10 | 1 200 |
| 11 | 1 650 |
| 12 | 2 100 |
| 13 | 2 700 |
| 14 | 3 600 |

In battery charging the electricity production will be changing according to the voltage level chosen by the client.

### Power curve



# Pitchwind Systems AB

## HAWT from 20 kW to 30 kW


Contact name: Lars Akeson
Address: PO Box 89, 44 322 Lerum
Telephone: +46 708 237 219
Country : **Sweden**


### Pitchwind 30 kW Grid connected references

| Site | Use | Country |
|---|---|---|
| | | |
| | | |
| | | |

## Pitchwind/ 30 kW Grid

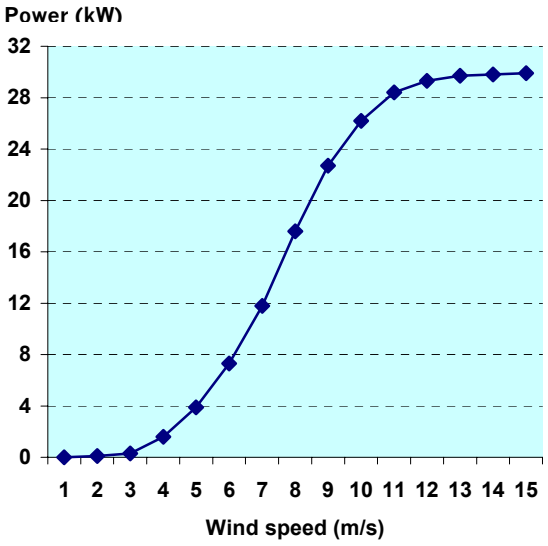
## Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 30 | kW |
| 2) Rated wind speed | 15 | m/s |
| 3) Cut-in wind speed | 2 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | 250 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 550 | kg |
| 7) Rotor diameter | 14 | m |
| 8) Rotor height (for VAWT only) | | m |
| 9) Swept area | 154 | $m^2$ |
| 10) Height of the mast | 20 / 62 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 81 | At rated wind speed |
| 12) Gear box type | | None |
| 13) Brake system | | Pitch by electrical actuator at service parking brake |
| 14) Number of blades | | 2 |
| 15) Blades material | | Steel polyster |
| 16) Output voltage | 380 – 500 | V |
| 17) Minimum operation temperature | - 40 | °C |
| 18) Maximum operation temperature | + 40 | °C |
| 19) Acoustic levels at a distance of 30m from tower base (wind speed 5 m/s & rotor speed = 48 rpm) | 50 | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | Wind wheels |
| 24) Upwind or downwind | | Upwind |

## Calculated power curve

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | 0 |
| 2 | 0,1 |
| 3 | 0,3 |
| 4 | 1,6 |
| 5 | 3,9 |
| 6 | 7,3 |
| 7 | 11,8 |
| 8 | 17,6 |
| 9 | 22,7 |
| 10 | 26,2 |
| 11 | 28,4 |
| 12 | 29,3 |
| 13 | 29,7 |
| 14 | 29,8 |
| 15 | 29,9 |

## Power curve:



# Proven Energy Products Ltd

## HAWT – From 0,6 kW to 15 kW


Contact name: David Watson
Address: Wardhead Park, Stewarton, Ayrshire, KA3 5 LH, Scotland
Telephone: +44 (0) 1560 485 570
Country : **United Kingdom**


### Proven WT 600 references

| Site | Use | Country |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

## Proven WT 600/ 0,6 kW

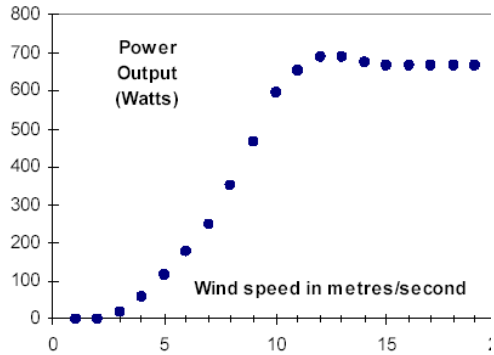
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 0,6 | KW |
| 2) Rated wind speed | 10 | m/s |
| 3) Cut-in wind speed | 2,5 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | 234 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 70 | Kg |
| 7) Rotor diameter | 2,55 | m |
| 8) Rotor height (for VAWT only) | | m |
| 9) Swept area | 5,11 | $m^2$ |
| 10) Height of the mast | 5,5 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | | At rated wind speed |
| 12) Gear box type | | |
| 13) Brake system | | |
| 14) Number of blades | | 3 |
| 15) Blades material | | Polypropylene / P.U. |
| 16) Output voltage | 14 / 24/ 48 | V |
| 17) Minimum operation temperature | Artic circle | °C |
| 18) Maximum operation temperature | South America | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 21 at 20 m<br>35 at mast | DB |
| 20) Lifetime | 20-25 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | |
| 24) Upwind or downwind | | Downwind |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 15 |
| 4 | 60 |
| 5 | 110 |
| 6 | 190 |
| 7 | 260 |
| 8 | 350 |
| 9 | 480 |
| 10 | 600 |
| 11 | 660 |
| 12 | 700 |
| 13 | 700 |
| 14 | 700 |
| | |

### Power curve:



# Proven Energy Products Ltd

## HAWT – From 0,6 kW to 15 kW


Contact name: David Watson
Address: Wardhead Park, Stewarton, Ayrshire, KA3 5 LH, Scotland
Telephone: +44 (0) 1560 485 570
Country : **United Kingdom**


### Proven WT 6 000/ 6 kW

### Proven WT 6 000 references

| Site | Use | Country |
|---|---|---|
| | | |
| | | |
| | | |

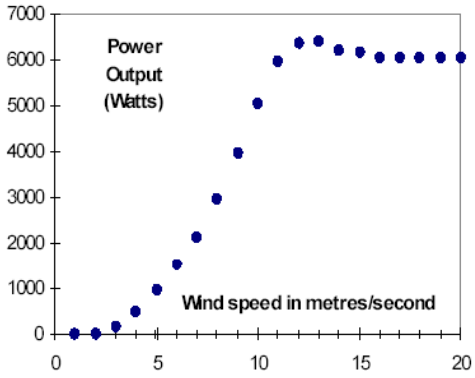
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 6 | KW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 2,5 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | 234 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 539 | Kg |
| 7) Rotor diameter | 5,5 | m |
| 8) Rotor height (for VAWT only) | | m |
| 9) Swept area | 23,76 | $m^2$ |
| 10) Height of the mast | 9 / 15 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | | At rated wind speed |
| 12) Gear box type | | |
| 13) Brake system | | |
| 14) Number of blades | | 3 |
| 15) Blades material | | Wood/ Epoxy / P.U. |
| 16) Output voltage | 48 to 300 | V |
| 17) Minimum operation temperature | Artic circle | °C |
| 18) Maximum operation temperature | South America | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 45 dB at mast<br>36 dB at 20 m | DB |
| 20) Lifetime | 20-25 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | |
| 24) Upwind or downwind | | Downwind |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 100 |
| 4 | 450 |
| 5 | 1 000 |
| 6 | 1 500 |
| 7 | 2 050 |
| 8 | 3 000 |
| 9 | 4 000 |
| 10 | 5 000 |
| 11 | 6 000 |
| 12 | 6 200 |
| 13 | 6 250 |
| 14 | 6 150 |
| | |

### Power curve:

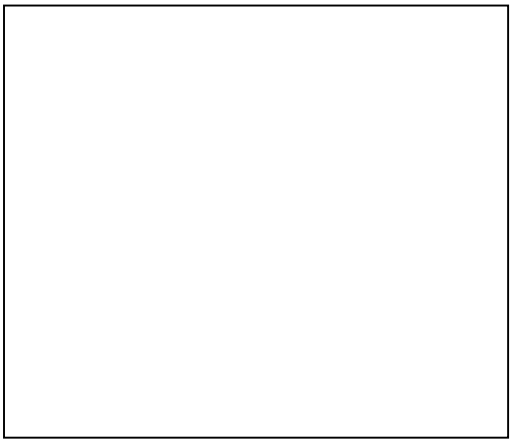


# Proven Energy Products Ltd

## HAWT – From 0,6 kW to 15 kW


Contact name: David Watson
Address: Wardhead Park, Stewarton, Ayrshire, KA3 5 LH, Scotland
Telephone: +44 (0) 1560 485 570
Country : **United Kingdom**


### Proven WT 15 000/ 15 kW



### Proven WT 15 000 references

| Site | Use | Country |
|---|---|---|
| | | |
| | | |

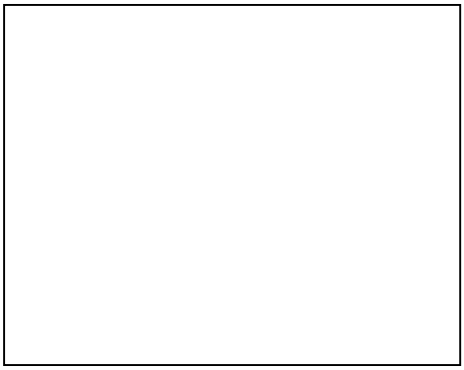
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 15 | KW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 2,5 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | 234 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 1 100 | Kg |
| 7) Rotor diameter | 9 | m |
| 8) Rotor height (for VAWT only) | | m |
| 9) Swept area | 63,62 | $m^2$ |
| 10) Height of the mast | 15 /20 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | | At rated wind speed |
| 12) Gear box type | | |
| 13) Brake system | | |
| 14) Number of blades | | 3 |
| 15) Blades material | | Glass Epoxy |
| 16) Output voltage | 48 DC or 230 AC or 240 AC | V |
| 17) Minimum operation temperature | Artic circle | °C |
| 18) Maximum operation temperature | South America | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 65 dB at mast 48 dB at 20 m | DB |
| 20) Lifetime | 20-25 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | |
| 24) Upwind or downwind | | Downwind |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 300 |
| 4 | 1 200 |
| 5 | 2 200 |
| 6 | 4 000 |
| 7 | 5 500 |
| 8 | 7 500 |
| 9 | 10 000 |
| 10 | 12 500 |
| 11 | 15 000 |
| 12 | 16 000 |
| 13 | 16 000 |
| 14 | 16 500 |

### Power curve:



# Renewable Devices Swift Turbines

## HAWT – 1,5 kW


Contact name:
Address: Bush Estate, Edinburgh, EH26 OPH
Telephone: +44 (0) 131 535 33 01
Country : **United Kingdom**


**Swift Rooftop/ 1,5 kW**

### Swift Rooftop 1,5 kW references

| Site | Use | Country |
|---|---|---|
| Fife School / Collidean | Primary school (rooftop) | England |
| | | |
| | | |

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 1,5 | KW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 4 | m/s |
| 4) Cut-out wind speed | 17 | m/s |
| 5) Maximum wind speed the turbine can withstand | 223 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 15 | Kg |
| 7) Rotor diameter | 2 | m |
| 8) Rotor height (for VAWT only) | | m |
| 9) Swept area | 3,14 | $m^2$ |
| 10) Height of the mast | 5 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | | At rated wind speed |
| 12) Gear box type | | |
| 13) Brake system | | |
| 14) Number of blades | | 5 |
| 15) Blades material | | Moulded carbon fibre |
| 16) Output voltage | 60 DC | V |
| 17) Minimum operation temperature | DK | °C |
| 18) Maximum operation temperature | DK | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | DK | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | Wind vane |
| 24) Upwind or downwind | | Upwind |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

### Power curve:

# Ropatec S.p.a.

## VAWT from 0,75 kW to 6 kW.


Contact name: Hannes Riegler
Address: Via Siemens 19
Telephone: +39 0471 568 180
Country : **Italy**


### Ropatec WRE.007 references

| Site | Use | Country |
|---|---|---|
| Near Bristol | Battery charging for a LNG-station | England |
| | Demonstration unit on a rooftop | Korea |
| Ihoshy | Energy supply for a radio station | Madagascar |
| Hammerfest | Battery charging | Norway |

**WRE.007 / 0,75 kW**

### Technical information

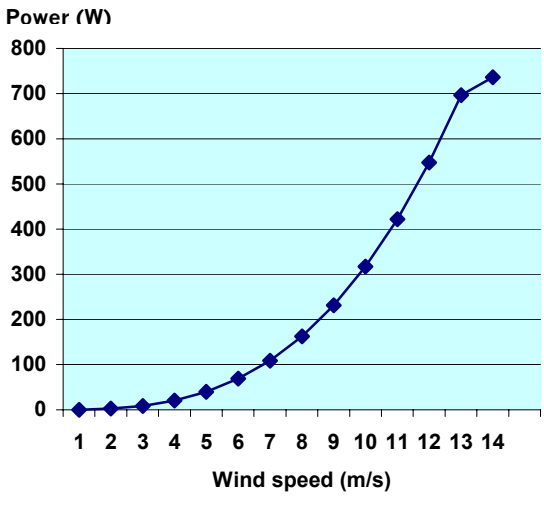
| | | Unit |
|---|---|---|
| 1) Rated power | 0,75 | kW |
| 2) Rated wind speed | 14 | m/s |
| 3) Cut-in wind speed | 2 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | > 150 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 150 | kg |
| 7) Rotor diameter | 1,5 | m |
| 8) Rotor height (for VAWT only) | 1,5 | m |
| 9) Swept area | 2,25 | $m^2$ |
| 10) Height of the mast | Not relevant | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 350 | At rated wind speed |
| 12) Gear box type | No gear box – direct driven | |
| 13) Brake system | None | |
| 14) Number of blades | 2 | |
| 15) Blades material | Aluminium | |
| 16) Output voltage | 200 | V |
| 17) Minimum operation temperature | - 30 | °C |
| 18) Maximum operation temperature | + 50 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | Not audible | DB |
| 20) Lifetime | 15/20 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Independent of wind direction | |
| 24) Upwind or downwind | Upwind turbine | |

### Calculated power curve

| Wind speed (m/s) | Power* (W) |
|---|---|
| 1 | 0,32 |
| 2 | 2,54 |
| 3 | 8,56 |
| 4 | 20,28 |
| 5 | 39,62 |
| 6 | 68,46 |
| 7 | 108,71 |
| 8 | 162,28 |
| 9 | 231,05 |
| 10 | 316,94 |
| 11 | 421,85 |
| 12 | 547,68 |
| 13 | 696,33 |
| 14 | 736,27 |
| 15 | |

*power on axis, sea level, temp. 15°C

### Power curve:



# Ropatec S.p.a.

## VAWT from 0,75 kW to 6 kW.


Contact name: Hannes Riegler
Address: Via Siemens 19
Telephone: +39 0471 568 180
Country : **Italy**


### Ropatec WRE.30 references

| Site | Use | Country |
|---|---|---|
| Monte Cimone | Research station | Italy |
| Foggia | Support for electrical pumps | Italy |
| Sennes | Refuge | Italy |
| Marchetti | Refuge | Italy |

**WRE.030 / 3 kW**

### Technical information

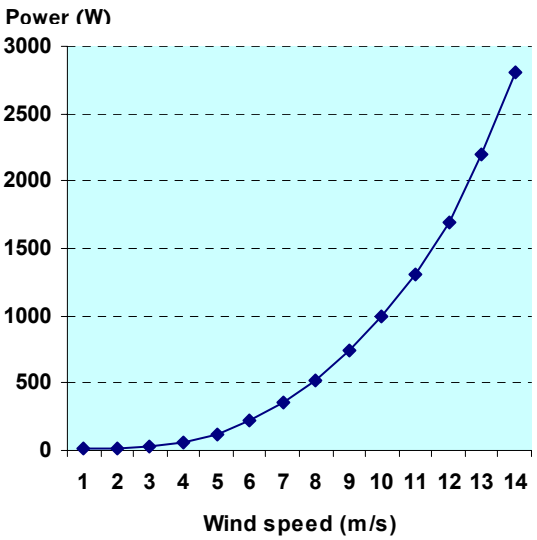
| POWER | | Unit |
|---|---|---|
| 1) Rated power | 3 | kW |
| 2) Rated wind speed | 14 | m/s |
| 3) Cut-in wind speed | 2 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | > 150 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | ~430 | kg |
| 7) Rotor diameter | 3,3 | m |
| 8) Rotor height (for VAWT only) | 2,2 | m |
| 9) Swept area | 7,26 | $m^2$ |
| 10) Height of the mast | Not relevant | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 100 to 120 | At rated wind speed |
| 12) Gear box type | No gear box – direct driven | |
| 13) Brake system | Not required | |
| 14) Number of blades | 2 | |
| 15) Blades material | Aluminium | |
| 16) Output voltage | 0 - 220 | V |
| 17) Minimum operation temperature | - 30 | °C |
| 18) Maximum operation temperature | + 50 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | Not audible | DB |
| 20) Lifetime | 15/20 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Independent of wind direction | |
| 24) Upwind or downwind | Upwind turbine | |

### Calculated power curve

| Wind speed (m/s) | Power* (kW) |
|---|---|
| 1 | 0,01 |
| 2 | 0,02 |
| 3 | 0,03 |
| 4 | 0,06 |
| 5 | 0,12 |
| 6 | 0,22 |
| 7 | 0,35 |
| 8 | 0,52 |
| 9 | 0,74 |
| 10 | 1 |
| 11 | 1,3 |
| 12 | 1,7 |
| 13 | 2,2 |
| 14 | 2,8 |
| 15 | |

* electrical output, sea level, temp. 15°C

### Power curve:



# Ropatec S.p.a.

## VAWT from 0,75 kW to 6 kW.


Contact name: Hannes Riegler
Address: Via Siemens 19
Telephone: +39 0471 568 180
Country : **Italy**


### Ropatec WRE.060 references

| Site | Use | Country |
|---|---|---|
| Valley of Aoste | Water heating system | Italy |
| Hallau | On-grid system | Switzerland |
| Townsville | Demonstration unit | Australia |
| | | |

## WRE.060 / 6 kW

## Technical information

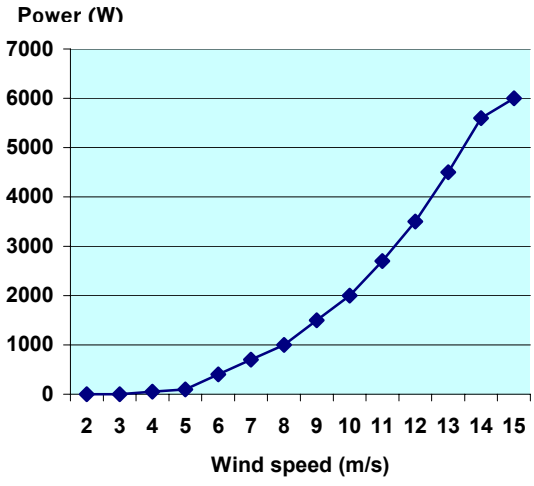
| POWER | | Unit |
|---|---|---|
| 1) Rated power | 6 | kW |
| 2) Rated wind speed | 14 | m/s |
| 3) Cut-in wind speed | 2 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | > 150 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 750 | kg |
| 7) Rotor diameter | 3,3 | m |
| 8) Rotor height (for VAWT only) | 4,4 | m |
| 9) Swept area | 14,52 | $m^2$ |
| 10) Height of the mast | Not relevant | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 110 | At rated wind speed |
| 12) Gear box type | No gear box – direct driven | |
| 13) Brake system | None | |
| 14) Number of blades | 2 | |
| 15) Blades material | Aluminium | |
| 16) Output voltage | 220 | V |
| 17) Minimum operation temperature | - 30 | °C |
| 18) Maximum operation temperature | + 50 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | Not audible | DB |
| 20) Lifetime | 15/20 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Independent of wind direction | |
| 24) Upwind or downwind | Upwind turbine | |

## Calculated power curve

| Wind speed (m/s) | Power*( kW) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0.05 |
| 4 | 0.10 |
| 5 | 0.25 |
| 6 | 0.40 |
| 7 | 0.70 |
| 8 | 1 |
| 9 | 1.5 |
| 10 | 2 |
| 11 | 2.7 |
| 12 | 3.5 |
| 13 | 4.5 |
| 14 | 5.6 |
| 15 | 6 |

* electrical output, sea level, temp. 15°C

## Power curve:



# Rugged renewables

## VAWT – 0,4 kW


Contact name: Ken England

Address: Gear House, unit 3, Saltmeadows road, Gateshead, NE8 3 AH

Telephone: +44 (0) 191 478 51 11

Country : **England**


### EMAT references

| Site | Use | Country |
|---|---|---|
| | | |
| | | |
| | | |

**0,4 kW**

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 0,4 | kW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | ~4,5 | m/s |
| 4) Cut-out wind speed | DK | m/s |
| 5) Maximum wind speed the turbine can withstand | 170 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 50 | kg |
| 7) Rotor diameter | 0,8 | m |
| 8) Rotor height (for VAWT only) | 2,5 | m |
| 9) Swept area | n/a | $m^2$ |
| 10) Height of the mast | | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | | At rated wind speed |
| 12) Gear box type | | |
| 13) Brake system | | |
| 14) Number of blades | | 2 |
| 15) Blades material | | Aluminium |
| 16) Output voltage | | V |
| 17) Minimum operation temperature | - 40 | °C |
| 18) Maximum operation temperature | + 100 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | Silent | DB |
| 20) Lifetime | 20 to 30 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | n/a |
| 24) Upwind or downwind | | n/a |

### Calculated power curve

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | |
| 2 | |
| 2,5 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

### Power curve

# Surface Power Technologies

## HAWT – 0,46 kW


Contact name: John Quinn
Address: Castlebar, Co.Mayo
Telephone: +353 (0) 8795 45117
Country: **Ireland**


**SP 460W / 0,46 kW**

### SP 460 – 0,46 kW references

| Site | Use | Country |
|---|---|---|
| Dorset | Home Electricity | England |
| Cork | Home Electricity | Ireland |
| Orkney Island | Home Electricity | Scotland |
| Donegal | Home Electricity | Ireland |

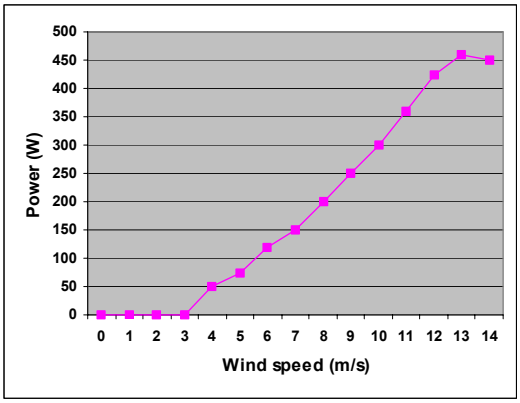
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 0,46 | kW |
| 2) Rated wind speed | 12,5 | m/s |
| 3) Cut-in wind speed | 3 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | 216 | km/h |
| DIMENSIONS | | |
| 6) Nacelle and rotor weight | 17 | kg |
| 7) Rotor diameter | 1,4 | m |
| 8) Rotor height (for VAWT only) | - | m |
| 9) Swept area | 1,96 | $m^2$ |
| 10) Height of the mast | 7+ | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | DK | At rated wind speed |
| 12) Gear box type | None | |
| 13) Brake system | Electromagnetic | |
| 14) Number of blades | 3 | |
| 15) Blades material | Composite fibre glass | |
| 16) Output voltage | 12 | V |
| 17) Minimum operation temperature | DK | °C |
| 18) Maximum operation temperature | DK | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | Silent | DB |
| 20) Lifetime | 30 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Wind vane | |
| 24) Upwind or downwind | Upwind | |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 50 |
| 5 | 75 |
| 6 | 120 |
| 7 | 150 |
| 8 | 200 |
| 9 | 250 |
| 10 | 300 |
| 11 | 360 |
| 12 | 425 |
| 13 | 460 |
| 14 | 450 |

### Power curve:



# Sviab

## HAWT of 0,75 kW


Contact name: Lars Wikberg
Address: Vettershaga, 76010 Bergshamra
Telephone: +46 176 26 42 24
Country : **Sweden**


### Sviab VK 240 references

| Site | Use | Country |
|---|---|---|
| Orraids Ltd | Radio communication | Canada |
| Phuket | Test station | Thaïland |
| National Swedish Building Research | Test station | Antarctic |
| ASEA/ABB | Test station | New Zealand |

### Sviab VK 240 / 0,75 kW

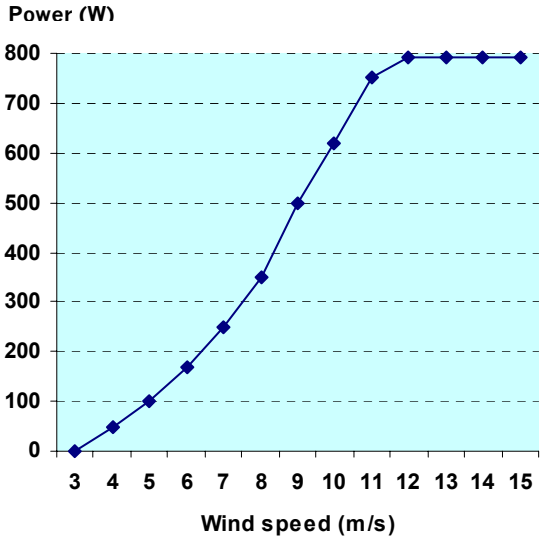
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 0,75 | kW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 2,5 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | 216 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 18 | kg |
| 7) Rotor diameter | 2,4 | m |
| 8) Rotor height (for VAWT only) | | m |
| 9) Swept area | 4,91 | $m^2$ |
| 10) Height of the mast | 7 / 11 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 270-1000 | At rated wind speed |
| 12) Gear box type | Answer not provided | |
| 13) Brake system | Answer not provided | |
| 14) Number of blades | 3 | |
| 15) Blades material | Polyuréthane | |
| 16) Output voltage | 12 – 24 | V |
| 17) Minimum operation temperature | - 40 | °C |
| 18) Maximum operation temperature | + 50 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | Answer not provided | DB |
| 20) Lifetime | Answer not provided | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | No | |
| 23) Yaw control system | Answer not provided | |
| 24) Upwind or downwind | Answer not provided | |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 50 |
| 5 | 100 |
| 6 | 170 |
| 7 | 250 |
| 8 | 350 |
| 9 | 500 |
| 10 | 620 |
| 11 | 750 |
| 12 | 790 |
| 13 | 790 |
| 14 | 790 |
| 15 | 790 |

### Power curve:



# TH Rijswijk, University of Applied Sciences

## HAWT 5 – 5,5 kW


Contact name: Eize de Vries
Address: Lange Kleiweg 80, 2288 GK Rijswijk
Telephone: +31· 70 3401516
Country : Netherlands


### No references

| Site | Use | Country |
|---|---|---|
| | | |
| | | |
| | | |

### TH Rijswijk / 5 kW

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 5 | kW |
| 2) Rated wind speed | 10,5 | m/s |
| 3) Cut-in wind speed | 2,75 | m/s |
| 4) Cut-out wind speed | >10,5 | m/s |
| 5) Maximum wind speed the turbine can withstand | Not available | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 175 | kg |
| 7) Rotor diameter | 5 | m |
| 8) Rotor height (for VAWT only) | --- | m |
| 9) Swept area | 19,6 | $m^2$ |
| 10) Height of the mast | 6 – 18 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | Not available | At rated wind speed |
| 12) Gear box type | | No gear box |
| 13) Brake system | | Not available |
| 14) Number of blades | | 3 |
| 15) Blades material | | Glass fibre reinforced epoxy composite |
| 16) Output voltage | 400 | V |
| 17) Minimum operation temperature | · 20 | °C |
| 18) Maximum operation temperature | + 50 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | Not available | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | Yes |
| 23) Yaw control system | | Wind vane |
| 24) Upwind or downwind | | Upwind |

### Calculated power curve n.a.

| Wind speed (m/s) | Power* (W) |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

### Power curve

# Travere Industries

## HAWT from 0,9 kW to 50 kW.


Contact name: Adrien Orieux
Address: 27 bis imp. Pichon, 83 140 Six Fours
Telephone: +33 4 94 10 10 29
Country : **France**


### Travere 0,9 kW references

| Site | Use | Country |
|---|---|---|
| Corsica | Radio station | France |
| Guadeloupe | Dwelling | Overseas Departments |
| South of France | Dwelling | France |
| | Dwelling | Morocco |

**TI/2.4/0.9 *( 0.9Kw/h )***

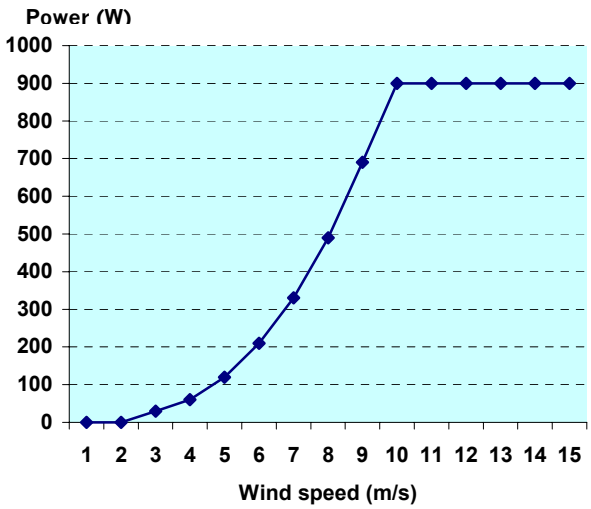
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 0.9 | kW |
| 2) Rated wind speed | 10 | m/s |
| 3) Cut-in wind speed | 2.3 | m/s |
| 4) Cut-out wind speed | 60 | m/s |
| 5) Maximum wind speed the turbine can withstand | 216 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight (+ generator) | 50 | kg |
| 7) Rotor diameter | 2.4 | m |
| 8) Rotor height (for VAWT only) | 0.2 | m |
| 9) Swept area | 4.52 | $m^2$ |
| 10) Height of the mast | 12 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 750 | At rated wind speed |
| 12) Gear box type | None | |
| 13) Brake system | Electronic | |
| 14) Number of blades | 2 | |
| 15) Blades material | Carbon composite | |
| 16) Output voltage | 55 | V |
| 17) Minimum operation temperature | -20 | °C |
| 18) Maximum operation temperature | 80 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | <40 | DB |
| 20) Lifetime | 25 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | Yes | |
| 23) Yaw control system | *"Variable stall"* commanded centrifugal system / Rudder | |
| 24) Upwind or downwind | Upwind | |

### Calculated power curve

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0,03 |
| 4 | 0.60 |
| 5 | 0,12 |
| 6 | 0,21 |
| 7 | 0,33 |
| 8 | 0,49 |
| 9 | 0,69 |
| 10 | 0,90 |
| 11 | 0,90 |
| 12 | 0,90 |
| 13 | 0,90 |
| 14 | 0,90 |
| 15 | 0,90 |
| Altitude 300 m, Tower height = 10 m<br>Shear coeff = 0,11 ; Weibull K = 2<br>Turbulence factor = 10 % | |

### Power curve:



# Travere Industries

## HAWT from 0,9 kW to 50 kW.


Contact name: Adrien Orieux
Address: 27 bis imp. Pichon, 83 140 Six Fours
Telephone: +33 4 94 10 10 29
Country : **France**


### Travere 1.6 kW references

| Site | Use | Country |
|---|---|---|
| Ciotat | University | France |
| | University | India |
| South of France | Dwellings + pumping | France |
| South Pacific | Dwellings | Overseas Departments |

**TI/3.2/1.6 *( 1.6Kw/h )***

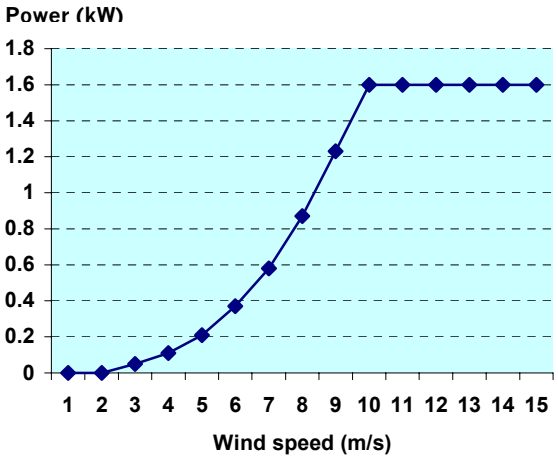
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 1.6 | kW |
| 2) Rated wind speed | 10 | m/s |
| 3) Cut-in wind speed | 2.5 | m/s |
| 4) Cut-out wind speed | 60 | m/s |
| 5) Maximum wind speed the turbine can withstand | 216 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight (+ generator) | 60 | kg |
| 7) Rotor diameter | 3.2 | m |
| 8) Rotor height (for VAWT only) | 0.3 | m |
| 9) Swept area | 8.04 | $m^2$ |
| 10) Height of the mast | 12 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 600 | At rated wind speed |
| 12) Gear box type | | No |
| 13) Brake system | | Electronic |
| 14) Number of blades | | 2 |
| 15) Blades material | | Carbon composit |
| 16) Output voltage | 220 to 380 | V |
| 17) Minimum operation temperature | -20 | °C |
| 18) Maximum operation temperature | 80 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | <40 | DB |
| 20) Lifetime | 25 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | Yes |
| 23) Yaw control system | | *"Variable stall"* commanded centrifugal system / Rudder |
| 24) Upwind or downwind | | Upwind |

### Calculated power curve

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0,05 |
| 4 | 0,11 |
| 5 | 0,21 |
| 6 | 0,37 |
| 7 | 0,58 |
| 8 | 0,87 |
| 9 | 1,23 |
| 10 | 1,60 |
| 11 | 1,60 |
| 12 | 1,60 |
| 13 | 1,60 |
| 14 | 1,60 |
| 15 | 1,60 |
| Altitude 300 m ; Tower height = 10 m | |
| Shear coeff = 0,11 ; Weibull K = 2 | |
| Turbulence factor = 10 % | |

### Power curve:



# Travere Industries

## HAWT from 0,9 kW to 50 kW.


Contact name: Adrien Orieux
Address: 27 bis imp. Pichon, 83 140 Six Fours
Telephone: +33 4 94 10 10 29
Country : **France**


**TI/3.6/3 *( 3Kw/h )***

### Travere 3 kW references

| Site | Use | Country |
|---|---|---|
| North | Grid connection | France |
| | Direct heating | Turkey |
| North | Grid connection | France |
| North | Grid connection | France |

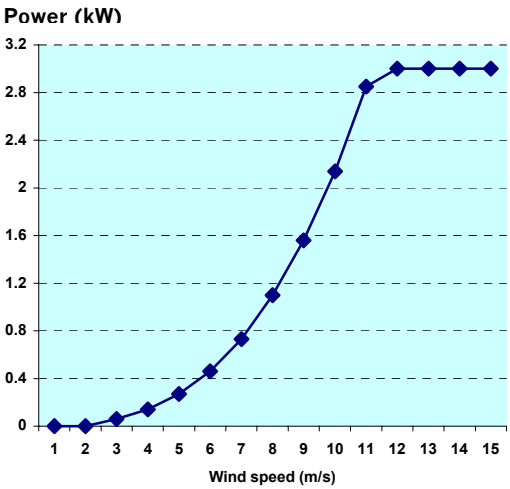
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 3 | kW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 2.8 | m/s |
| 4) Cut-out wind speed | 60 | m/s |
| 5) Maximum wind speed the turbine can withstand | 216 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight (+ generator) | 60 | kg |
| 7) Rotor diameter | 3.6 | m |
| 8) Rotor height (for VAWT only) | 0.6 | m |
| 9) Swept area | 10.18 | $m^2$ |
| 10) Height of the mast | 12 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 550 | At rated wind speed |
| 12) Gear box type | | No |
| 13) Brake system | | Electronic |
| 14) Number of blades | | 2 |
| 15) Blades material | | Carbon composit |
| 16) Output voltage | 220 to 380 | V |
| 17) Minimum operation temperature | -20 | °C |
| 18) Maximum operation temperature | 80 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | <40 | DB |
| 20) Lifetime | 25 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | Yes |
| 23) Yaw control system | | *"Variable stall"* commanded centrifugal system / Rudder |
| 24) Upwind or downwind | | Upwind |

### Calculated power curve

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0.06 |
| 4 | 0.14 |
| 5 | 0.27 |
| 6 | 0.46 |
| 7 | 0.73 |
| 8 | 1.10 |
| 9 | 1.56 |
| 10 | 2.14 |
| 11 | 2.85 |
| 12 | 3.00 |
| 13 | 3.00 |
| 14 | 3.00 |
| 15 | 3.00 |
| Altitude = 300 m ; Tower height = 10 m | |
| Shear coeff = 0,11 ; Weibull K = 2 | |
| Turbulence factor = 10 % | |

### Power curve:



# Travere Industries

## HAWT from 0,9 kW to 50 kW.


Contact name: Adrien Orieux
Address: 27 bis imp. Pichon, 83 140 Six Fours
Telephone: +33 4 94 10 10 29
Country : **France**


### Travere 2.1 kW references

| Site | Use | Country |
|---|---|---|
| Off shore | Platform Total Energie | Nigeria |
| Center | Habitation | France |
| South | Pumping + Dwelling | France |
| Center | Grid connexion | France |

**TI/6/2.1 *( 2.1Kw/h )***

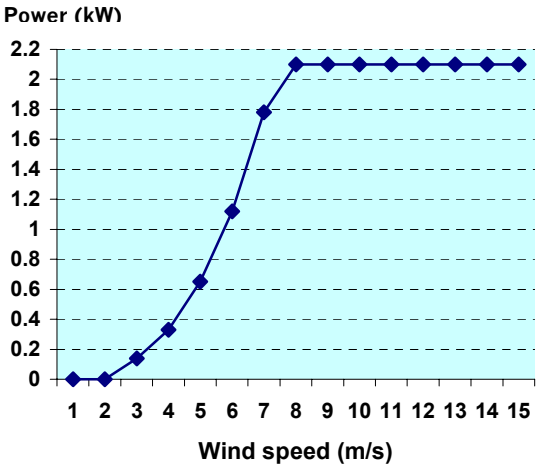
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 2.1 | kW |
| 2) Rated wind speed | 8 | m/s |
| 3) Cut-in wind speed | 2.5 | m/s |
| 4) Cut-out wind speed | 60 | m/s |
| 5) Maximum wind speed the turbine can withstand | 216 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight (+ generator) | 60 | kg |
| 7) Rotor diameter | 6 | m |
| 8) Rotor height (for VAWT only) | 0.9 | m |
| 9) Swept area | 28.27 | $m^2$ |
| 10) Height of the mast | 12 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 440 | At rated wind speed |
| 12) Gear box type | | No |
| 13) Brake system | | Electronic |
| 14) Number of blades | | 2 |
| 15) Blades material | | Carbon composite |
| 16) Output voltage | 220 to 380 | V |
| 17) Minimum operation temperature | -20 | °C |
| 18) Maximum operation temperature | 80 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | <40 | DB |
| 20) Lifetime | 25 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | Yes |
| 23) Yaw control system | | *"Variable stall"* commanded centrifugal system / Rudder |
| 24) Upwind or downwind | | Upwind |

### Calculated power curve

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0,14 |
| 4 | 0,33 |
| 5 | 0,65 |
| 6 | 1,12 |
| 7 | 1,78 |
| 8 | 2,10 |
| 9 | 2,10 |
| 10 | 2,10 |
| 11 | 2,10 |
| 12 | 2,10 |
| 13 | 2,10 |
| 14 | 2,10 |
| 15 | 2,10 |
| Altitude = 300 m ; Tower height = 10 m | |
| Shear coeff = 0,11 ; Weibull K = 2 | |
| Turbulence factor = 10 % | |

### Power curve:



# Travere Industries

## HAWT from 0,9 kW to 50 kW.


Contact name: Adrien Orieux
Address: 27 bis imp. Pichon, 83 140 Six Fours
Telephone: +33 4 94 10 10 29
Country : **France**


**TI/6/5.5 *( 5.5Kw/h )***

### Travere 5.5 kW references

| Site | Use | Country |
|---|---|---|
| Aude | EDF-GDF | France |
| Pacific | Dwelling | Overseas Departments |
| | CETMEF/ Ligth House | France |
| South/Addrar | Pumping | Algéria |

## Technical information

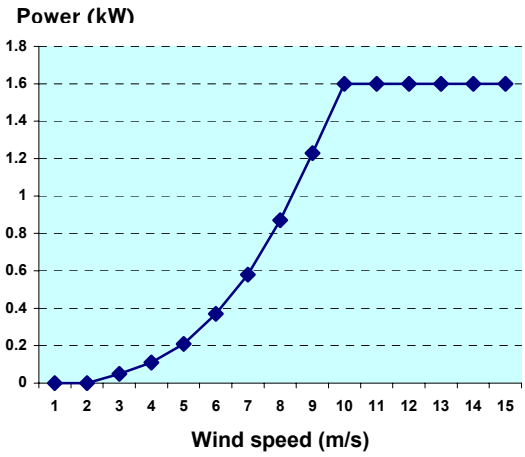
| POWER | | Unit |
|---|---|---|
| 1) Rated power | 5.5 | kW |
| 2) Rated wind speed | 10 | m/s |
| 3) Cut-in wind speed | 3 | m/s |
| 4) Cut-out wind speed | 60 | m/s |
| 5) Maximum wind speed the turbine can withstand | 216 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight (+ generator) | 60 | kg |
| 7) Rotor diameter | 6 | m |
| 8) Rotor height (for VAWT only) | 0.9 | m |
| 9) Swept area | 28.27 | $m^2$ |
| 10) Height of the mast | 12 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 240 | At rated wind speed |
| 12) Gear box type | | No |
| 13) Brake system | | Electronic |
| 14) Number of blades | | 2 |
| 15) Blades material | | Carbon composite |
| 16) Output voltage | 220 to 380 | V |
| 17) Minimum operation temperature | -30 | °C |
| 18) Maximum operation temperature | 80 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | <40 | DB |
| 20) Lifetime | 25 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | Yes |
| 23) Yaw control system | | *"Variable stall"* commanded centrifugal system / Rudder |
| 24) Upwind or downwind | | Upwind |

## Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0.16 |
| 4 | 0.38 |
| 5 | 0.74 |
| 6 | 1.29 |
| 7 | 2.04 |
| 8 | 3.05 |
| 9 | 4.34 |
| 10 | 5.50 |
| 11 | 5.50 |
| 12 | 5.50 |
| 13 | 5.50 |
| 14 | 5.50 |
| 15 | 5.50 |

Altitude = 300 m ; Tower height = 10 m ; Shear coeff = 0,11 ; Weibull K = 2 ; Turbulence factor = 10 %.

## Power curve:



# Tulipower

## HAWT 2,5 kW


Contact name: Hans Duivenvoorden
Address: Van der Palmkade 44, 1051 RE Amsterdam
Telephone: +31 – 6 19618369
Country : Netherlands


### Tulipower references

| Site | Use | Country |
|---|---|---|
| Boxtel | Environmental Information Centre | Netherlands |
| Elst | Installer company, demonstration | Netherlands |
| Zevenbergen | Turbine distributor, demonstration | Netherlands |
| | | |

**Tulipower / 2,5 kW**

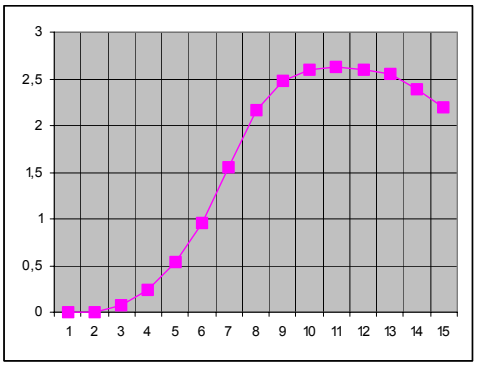
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 2,5 | KW |
| 2) Rated wind speed | 10 | m/s |
| 3) Cut-in wind speed | 3 | m/s |
| 4) Cut-out wind speed | 18 | m/s |
| 5) Maximum wind speed the turbine can withstand | 42,5 | m/s |
| DIMENSIONS | | |
| 6) Total weight | 200 | Kg |
| 7) Rotor diameter | 5 | M |
| 8) Rotor height (for VAWT only) | ... | M |
| 9) Swept area | 19,6 | $m^2$ |
| 10) Height of the mast | 12,5 | M |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 140 | At rated wind speed |
| 12) Gear box type | | No gear box |
| 13) Brake system | | spring powered electro magnetic brake |
| 14) Number of blades | | 3 |
| 15) Blades material | | Composite fibre glass |
| 16) Output voltage | 230 | V |
| 17) Minimum operation temperature | - 20 | °C |
| 18) Maximum operation temperature | + 40 | °C |
| 19) Acoustic levels at a distance of 20 m ? (wind = 5 m/s) | < 35 | DB |
| 20) Lifetime | 15 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | Yes |
| 23) Yaw control system | | Independent of wind direction |
| 24) Upwind or downwind | | Upwind |

### Calculated power curve

| Wind speed (m/s) | Power* (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 68 |
| 4 | 243 |
| 5 | 530 |
| 6 | 958 |
| 7 | 1553 |
| 8 | 2159 |
| 9 | 2474 |
| 10 | 2595 |
| 11 | 2625 |
| 12 | 2598 |
| 13 | 2552 |
| 14 | 2382 |
| 15 | 2192 |

### Power curve



# Turby B.V.

## VAWT 2,5 kW


Contact name: Dick Sidler
Address: Heuvelenweg 18, 7241 HZ Lochem
Telephone: +31 · 6·55822169
Country : Netherlands


### Turby 2,5 kW references

| Site | Use | Country |
|---|---|---|
| Amsterdam | Proof public building (former school) | Netherlands |
| TIburg | Roof flat building | Netherlands |
| Den Haag | Roof town hall | Netherlands |
| Delft | Technical University | Netherlands |

### Turby 2,5 kW

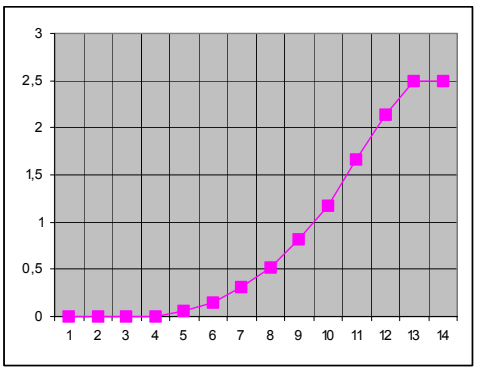
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 2,5 | kW |
| 2) Rated wind speed | 14 | m/s |
| 3) Cut-in wind speed | 4 | m/s |
| 4) Cut-out wind speed | 14 | m/s |
| 5) Maximum wind speed the turbine can withstand | 55 | m/s |
| DIMENSIONS | | |
| 6) Rotor weight | 135 | kg |
| 7) Rotor diameter | 1,99 | m |
| 8) Rotor height (for VAWT only) | 2,88 | m |
| 9) Swept area | 5,3 | $m^2$ |
| 10) Height of the mast | 6 – 7,5 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 400 | At rated wind speed |
| 12) Gear box type | | No gears |
| 13) Brake system | | Electrical brake system |
| 14) Number of blades | | 3 |
| 15) Blades material | | Carbon epoxy composite |
| 16) Output voltage | 230 | V |
| 17) Minimum operation temperature | · 20 | °C |
| 18) Maximum operation temperature | + 40 | °C |
| 19) Acoustic levels at a distance of 20 m ? wind = 10 m/s) | 45 | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | | No |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | Independent |
| 24) Upwind or downwind | | Both |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 6 |
| 5 | 56 |
| 6 | 155 |
| 7 | 310 |
| 8 | 527 |
| 9 | 812 |
| 10 | 1171 |
| 11 | 1659 |
| 12 | 2136 |
| 13 | 2500 |
| 14 | 2500 |
| 15 | -- |

### Power curve



# Venturi Wind b.v.(i.o.)

## VAWT from 0,11 kW to 0,50 k W


Contact name: D.P. Elzinga
Address: Stationsweg 18–7429 AD Deventer-Colmschate
Telephone: +31 0570-510246
Country : Netherlands


### Venturi 110-500 references

| Site | Use | Country |
|---|---|---|
| Waalwijk | Test battery charging | Netherlands |
| Beek & Donk | Test battery charging | Netherlands |
| Deventer | Test battery charging + grid con. | Netherlands |

## Venturi 110-500

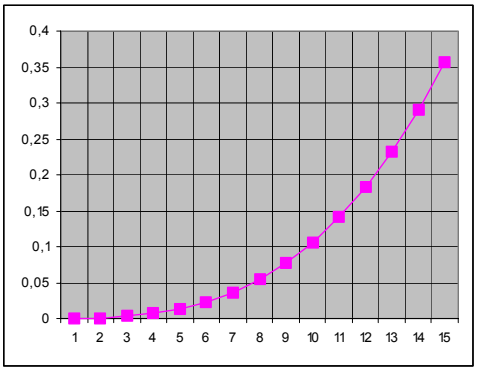
## Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 0,5 | kW |
| 2) Rated wind speed | 17 | m/s |
| 3) Cut-in wind speed | 2 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | >145 | km/h |
| DIMENSIONS | | |
| 6) Rotor weight | 30 | Kg |
| 7) Rotor diameter | 1,1 | m |
| 8) Rotor height (for VAWT only) | 1,3 | m |
| 9) Swept area | 1 | $m^2$ |
| 10) Height of the mast | 11 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 803 | At rated wind speed |
| 12) Gear box type | | None |
| 13) Brake system | | Electrical |
| 14) Number of blades | | 6 |
| 15) Blades material | | Flat blade polyester |
| 16) Output voltage | 100 | V |
| 17) Minimum operation temperature | -25 | -°C |
| 18) Maximum operation temperature | 50 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | Not audible | DB |
| 20) Lifetime | 15 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | Vane |
| 24) Upwind or downwind | | Upwind |

## Calculated power curve

| Wind speed (m/s) | Power* (W) |
|---|---|
| 1 | 0 |
| 2 | 0,7 |
| 3 | 3 |
| 4 | 7 |
| 5 | 13 |
| 6 | 23 |
| 7 | 36 |
| 8 | 54 |
| 9 | 77 |
| 10 | 106 |
| 11 | 141 |
| 12 | 183 |
| 13 | 232 |
| 14 | 290 |
| 15 | 357 |

## Power curve



# VR & Tech

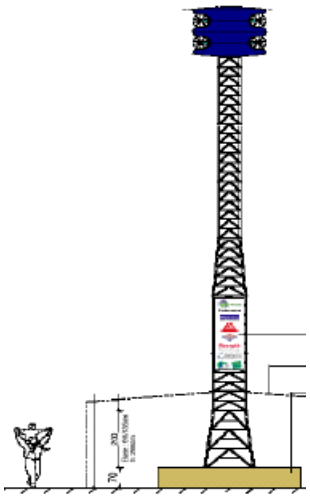
## VAWT from 2,5 kW to 100 kW.


Contact name: Alain Van Ranst
Address: Rue Trou du Sart 5 C-D 5 380 Fernelmont
Telephone: +32 (0) 81 22 42 14
Country : **Belgium**


### VR & Tech Telecom tower / 2 m references

| Site | Use | Country |
|---|---|---|
| Namur | Industrial use in the field of telecom | Belgium |
| | | |
| | | |

**Telecom Tower / 2 m**



### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | Minimum 2,5* | kW |
| 2) Rated wind speed | 8 | m/s |
| 3) Cut-in wind speed | 4 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | No limit | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight (+ generator) | Variable * | kg |
| 7) Rotor diameter | 2 | m |
| 8) Rotor height (for VAWT only) | ~2 or 3 | m |
| 9) Swept area | Variable * | $m^2$ |
| 10) Height of the mast | Not relevant | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 800 | At rated wind speed |
| 12) Gear box type | | Direct drive |
| 13) Brake system | | Electronic constant braking |
| 14) Number of blades | | 9 |
| 15) Blades material | | Fibre glass and Epoxy |
| 16) Output voltage | 400 | V |
| 17) Minimum operation temperature | n.a | °C |
| 18) Maximum operation temperature | 100 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 40 | DB |
| 20) Lifetime | 15 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | None |
| 24) Upwind or downwind | | Not applicable |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

Each project is different because the manufacturer stick several TARP to create a single WARP tower and integrate a mix of renewable energies (solar, CHP) in the same WARP tower.

### Power curve :

* The rated power and the rotor weight vary accordingly with the number of stacked “TARP” modules vertically piled along the tower. 1 TARP corresponds to ~2,5 kW and a same tower can be designed with more than 10 TARPS depending on the energy needs.

# VR & Tech

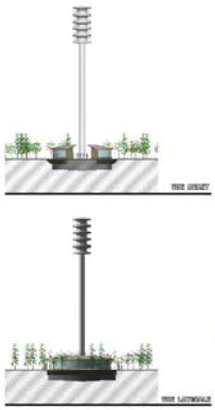
## VAWT from 2,5 kW to 100 kW.


Contact name: Alain Van Ranst
Address: Rue Trou du Sart 5 C-D 5 380 Fernelmont
Telephone: +32 (0) 81 22 42 14
Country : **Belgium**


### VR & Tech House tower/ 4 m references

| Site | Use | Country |
|---|---|---|
| Bastogne | Training centre in renewable energies | Belgium |
| | | |
| | | |

## House tower / 4 m



## Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | Minimum 10* | kW |
| 2) Rated wind speed | 8 | m/s |
| 3) Cut-in wind speed | 4 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | No limit | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight (+ generator) | Variable * | kg |
| 7) Rotor diameter | 4 | m |
| 8) Rotor height (for VAWT only) | ~4 or 5 | m |
| 9) Swept area | Variable | $m^2$ |
| 10) Height of the mast | | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 800 | At rated wind speed |
| 12) Gear box type | | Direct drive |
| 13) Brake system | | Electronic constant braking |
| 14) Number of blades | | 9 |
| 15) Blades material | | Fibre glass and Epoxy |
| 16) Output voltage | 400 | V |
| 17) Minimum operation temperature | n.a | °C |
| 18) Maximum operation temperature | 100 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 40 | DB |
| 20) Lifetime | 15 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | None |
| 24) Upwind or downwind | | Not applicable |

## Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

Each project is different because the manufacturer stick several TARP to create a single WARP tower and integrate a mix of renewable energies (solar, CHP) in the same WARP tower.

## Power curve:

* The rated power and the rotor weight vary accordingly with the number of stacked “TARP” modules vertically piled along the tower.

# VR & Tech

## VAWT from 2,5 kW to 100 kW.

Contact name: Alain Van Ranst
Address: Rue Trou du Sart 5 C-D 5 380 Fernelmont
Telephone: +32 (0) 81 22 42 14
Country : **Belgium**

### VR & Tech House tower/6 m references

| Site | Use | Country |
|---|---|---|
| Andenne | Food industry (Interagri) | Belgium |
| | | |
| | | |

## House tower / 6 m


## Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | Minimum 25* | kW |
| 2) Rated wind speed | 8 | m/s |
| 3) Cut-in wind speed | 4 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | No limit | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight (+ generator) | Variable* | kg |
| 7) Rotor diameter | 6 | m |
| 8) Rotor height (for VAWT only) | Minimum 6 | m |
| 9) Swept area | Variable* | $m^2$ |
| 10) Height of the mast | | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 800 | At rated wind speed |
| 12) Gear box type | | Direct drive |
| 13) Brake system | | Electronic constant braking |
| 14) Number of blades | | 9 |
| 15) Blades material | | Fibre glass and epoxy |
| 16) Output voltage | 400 | V |
| 17) Minimum operation temperature | n.a | °C |
| 18) Maximum operation temperature | 100 | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 40 | DB |
| 20) Lifetime | 15 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | None |
| 24) Upwind or downwind | | Not applicable |

## Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

Each project is different because the manufacturer stick several TARP to create a single WARP tower and integrate a mix of renewable energies (solar, CHP) in the same WARP tower.

## Power curve :

* The rated power and the rotor weight vary accordingly with the number of stacked “TARP” modules vertically piled along the tower.

# Wind Energy Solutions (WES)

## HAWT from 2 kW to 250 kW


Contact name: Marcel Kloesmeijer
Address: De Weel, 1736 KB Zijdewind
Telephone: +31 – 226 425150
Country : Netherlands


### WES$^5$ Tulipo references

| Site | Use | Country |
|---|---|---|
| Elst | Installer company, demonstration | Netherlands |
| Zevenbergen | Turbine distributor, demonstration | Netherlands |
| | | |

### WES$^5$ Tulipo / 2,5 kW

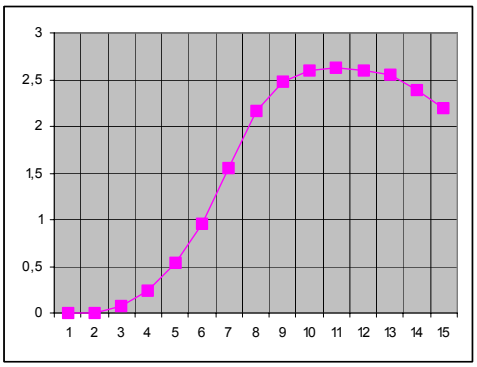
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 2,5 | kW |
| 2) Rated wind speed | 8,5 | m/s |
| 3) Cut-in wind speed | 3 | m/s |
| 4) Cut-out wind speed | 20 | m/s |
| 5) Maximum wind speed the turbine can withstand | 35 | m/s |
| DIMENSIONS | | |
| 6) Total weight | 200 | kg |
| 7) Rotor diameter | 5 | m |
| 8) Rotor height (for VAWT only) | --- | m |
| 9) Swept area | 19,6 | $m^2$ |
| 10) Height of the mast | 6 or 12 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 140 | At rated wind speed |
| 12) Gear box type | | No gear box |
| 13) Brake system | | spring powered electro magnetic brake |
| 14) Number of blades | | 3 |
| 15) Blades material | | Glass reinforced epoxy |
| 16) Output voltage | 400 | V |
| 17) Minimum operation temperature | - 20 | °C |
| 18) Maximum operation temperature | + 40 | °C |
| 19) Acoustic levels at a distance of 20 m ? (wind = 5 m/s) | < 35 | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | | Y |
| 22) Use of an asynchronous generator | | Y |
| 23) Yaw control system | | Active yaw control |
| 24) Upwind or downwind | | Upwind |

### Calculated power curve

| Wind speed (m/s) | Power* (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 68 |
| 4 | 243 |
| 5 | 530 |
| 6 | 958 |
| 7 | 1553 |
| 8 | 2159 |
| 9 | 2474 |
| 10 | 2595 |
| 11 | 2625 |
| 12 | 2598 |
| 13 | 2552 |
| 14 | 2382 |
| 15 | 2192 |

### Power curve



# Winddam

## VAWT – 2 kW


| | |
|---|---|
| Contact name: | Julie Trevithick |
| Address: | 1 Riverside House, Heron Way, Truro,TR1 2 XN |
| Telephone: | +44 (0) 180 387 39 56 |
| Country: | **United Kingdom** |


### Winddam 2 kW references

| Site | Use | Country |
|---|---|---|
| Moss Side Industrial Estate | Testing | UK |
| | | |
| | | |

**AWT(1)2000/ 2 kW**

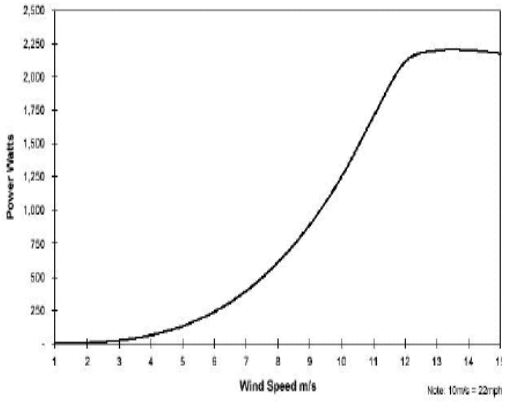
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 2 | kW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 2 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | 234 | Km/h |
| DIMENSIONS | | |
| 6) Nacelle and Rotor weight | DK | Kg |
| 7) Rotor diameter | 2.56 | m |
| 8) Rotor height (for VAWT only) | 2 | m |
| 9) Swept area | 5.12 | $m^2$ |
| 10) Height of the mast | DK | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 108 | At rated wind speed |
| 12) Gear box type | | None |
| 13) Brake system | | Mechanical |
| 14) Number of blades | | 5 |
| 15) Blades material | | Resin Composite |
| 16) Output voltage | 12/24/48/120/ 240 | V |
| 17) Minimum operation temperature | DK | °C |
| 18) Maximum operation temperature | DK | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | Silent | DB |
| 20) Lifetime | 25+ | Years |
| 21) Is the machine self-starting | | DK |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | N/A |
| 24) Upwind or downwind | | N/A |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 35 |
| 4 | 75 |
| 5 | 110 |
| 6 | 250 |
| 7 | 400 |
| 8 | 600 |
| 9 | 850 |
| 10 | 1250 |
| 11 | 1750 |
| 12 | 2100 |
| 13 | 2200 |
| 14 | 2200 |
| 15 | 2150 |
| | |

### Power curve:



# Winddam

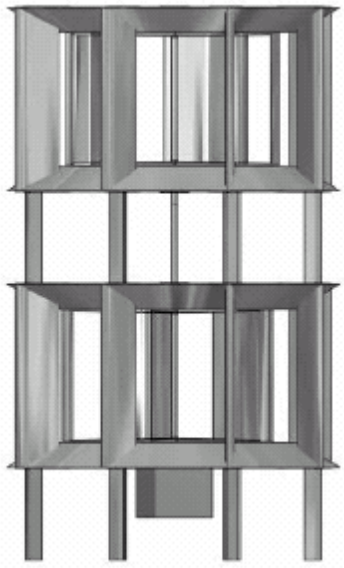
## VAWT – 4 kW


| | |
|---|---|
| Contact name: | Julie Trevithick |
| Address: | 1 Riverside House, Heron Way, Truro,TR1 2 XN |
| Telephone: | +44 (0) 180 387 39 56 |
| Country: | **United Kingdom** |


### Winddam 2 kW references

| Site | Use | Country |
|---|---|---|
| DK | | |
| | | |
| | | |
| | | |

**AWT(2)2x2000/ 4 kW**



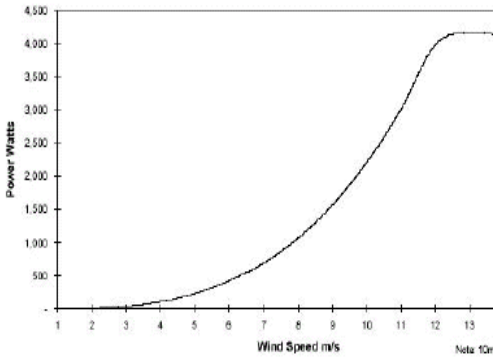
### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 4 | kW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 2.5 | m/s |
| 4) Cut-out wind speed | None | m/s |
| 5) Maximum wind speed the turbine can withstand | 234 | Km/h |
| DIMENSIONS | | |
| 6) Nacelle and Rotor weight | DK | Kg |
| 7) Rotor diameter | 2.56 | m |
| 8) Rotor height (for VAWT only) | 2 x 2 | m |
| 9) Swept area | 2 x 5.12 | $m^2$ |
| 10) Height of the mast | DK | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 200 | At rated wind speed |
| 12) Gear box type | | None |
| 13) Brake system | | Mechanical |
| 14) Number of blades | | 2 x 3 |
| 15) Blades material | | Resin Composite |
| 16) Output voltage | 12/24/48/120/240 | V |
| 17) Minimum operation temperature | DK | °C |
| 18) Maximum operation temperature | DK | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | Whisper | DB |
| 20) Lifetime | 25+ | Years |
| 21) Is the machine self-starting | | DK |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | N/A |
| 24) Upwind or downwind | | N/A |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | Tiny |
| 4 | 100 |
| 5 | 205 |
| 6 | 400 |
| 7 | 665 |
| 8 | 1000 |
| 9 | 1540 |
| 10 | 2205 |
| 11 | 3000 |
| 12 | 4000 |
| 13 | 4150 |
| 14 | 4110 |
| 15 | 4000 |

### Power curve:



# Windsave

## HAWT – 1 kW


Contact name: Graham Reed
Address: 27 Woodside place, Glasgow G3 7QL
Telephone: +44 (0) 141 353 68 41
Country : **United Kingdom**


### WS 1000 1 kW references

| Site | Use | Country |
|---|---|---|
| Burbank | | England |
| Livingston | | England |
| Teesside | | England |
| Glasgow | | Scotland |

**WS 1000/ 1 kW**

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 1 | KW |
| 2) Rated wind speed | 12 | m/s |
| 3) Cut-in wind speed | 2,9 | m/s |
| 4) Cut-out wind speed | 15 | m/s |
| 5) Maximum wind speed the turbine can withstand | 216 | Km/h |
| DIMENSIONS | | |
| 6) Rotor weight | | Kg |
| 7) Rotor diameter | 1,75 | m |
| 8) Rotor height (for VAWT only) | | m |
| 9) Swept area | 2,41 | $m^2$ |
| 10) Height of the mast | | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | | At rated wind speed |
| 12) Gear box type | | |
| 13) Brake system | | |
| 14) Number of blades | | 3 |
| 15) Blades material | | Polyamide Glass Reinforced |
| 16) Output voltage | 240 | V |
| 17) Minimum operation temperature | Not tested | °C |
| 18) Maximum operation temperature | Not tested | °C |
| 19) Acoustic levels at a distance of 20 m ? at nacelle ? (wind = 5 m/s) | 30 DB at 4m/s | DB |
| 20) Lifetime | 10 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | Wind vane |
| 24) Upwind or downwind | | Upwind |

### Calculated power curve

| Wind speed (m/s) | Power (W) |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | 1 000 |
| 13 | |
| 14 | |
| 15 | |

### Power curve:

# WindWall B.V.

## VAWT from 2,9 kW to 60 kW.


Contact name: Rob Roelofs
Address: De Eiken 5D, 7491 HP Delden
Telephone: +31 – 74 2434885
Country : Netherlands


### WW2000 references

| Site | Use | Country |
|---|---|---|
| Zwolle | Roof high school | Netherlands |
| Den Haag | Office building (Siemens) | Netherlands |
| Den Haag | Office building (government) | Netherlands |
| Rotterdam | Erasmus MC (University Medical Centre) | Netherlands |

### WW2000 / 2,9 kW

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 2,9 | kW |
| 2) Rated wind speed | 10,5 | m/s |
| 3) Cut-in wind speed | 4 | m/s |
| 4) Cut-out wind speed | 20 | m/s |
| 5) Maximum wind speed the turbine can withstand | 55 | m/s |
| DIMENSIONS | | |
| 6) Rotor weight | 3000 | kg |
| 7) Rotor diameter | 2 | m |
| 8) Rotor height (for VAWT only) | 5 (horizontal) – 15 (vertical) | m |
| 9) Swept area | 10 | $m^2$ |
| 10) Height of the mast | n.a. | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | 500 | At rated wind speed |
| 12) Gear box type | No gears | |
| 13) Brake system | Electrical + disc brake system | |
| 14) Number of blades | 6 | |
| 15) Blades material | Aluminium | |
| 16) Output voltage | 400 | V |
| 17) Minimum operation temperature | - 20 | °C |
| 18) Maximum operation temperature | + 40 | °C |
| 19) Acoustic levels at nacelle ? (wind = 5 m/s) | 74 | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | Yes | |
| 22) Use of an asynchronous generator | Yes | |
| 23) Yaw control system | Independent | |
| 24) Upwind or downwind | Downwind | |

### Calculated power curve

| Wind speed (m/s) | Power* (W) |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 1% |
| 5 | |
| 6 | |
| 7 | |
| 8 | 50% |
| 9 | |
| 10 | 100% |
| 11 | 100% |
| 12 | 100% |
| 13 | 100% |
| 14 | 100% |
| 15 | 100% |

### Power curve

# XCO2

## VAWT – 6 kW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### EMAT references

| Site | Use | Country |
|---|---|---|
| Southwark Bridge Rd, London | Pilot installation – due 12 / 2005 | UK |
| Temple Meads Roundabout, Bristol | Pilot installation – due 1 / 2006 | UK |
| | | |

**XCO2 / 6 kW**

### Technical information

| POWER | | Unit |
|---|---|---|
| 1) Rated power | 6 | kW |
| 2) Rated wind speed | ~ 12,5 | m/s |
| 3) Cut-in wind speed | 4,5 | m/s |
| 4) Cut-out wind speed | 16 | m/s |
| 5) Maximum wind speed the turbine can withstand | DK | Km/h |
| DIMENSIONS | | |
| 6) Nacelle and rotor weight | DK | kg |
| 7) Rotor diameter | 3,1 | m |
| 8) Rotor height (for VAWT only) | 5 | m |
| 9) Swept area | 15,5 | $m^2$ |
| 10) Height of the mast | 5-10 | m |
| OTHER INFORMATION | | |
| 11) Maximum rpm | DK | At rated wind speed |
| 12) Gear box type | | None |
| 13) Brake system | | DK |
| 14) Number of blades | | 3 |
| 15) Blades material | | Carbon fibre |
| 16) Output voltage | 48 dc or 240 ac | V |
| 17) Minimum operation temperature | -40 | °C |
| 18) Maximum operation temperature | 100 | °C |
| 19) Acoustic levels at a distance of 20 m? at nacelle ? (wind = 5 m/s) | Silent | DB |
| 20) Lifetime | 20 | Years |
| 21) Is the machine self-starting | | Yes |
| 22) Use of an asynchronous generator | | No |
| 23) Yaw control system | | n/a |
| 24) Upwind or downwind | | n/a |

### Calculated power curve

**Not available**

| Wind speed (m/s) | Power (kW) |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

### Power curve