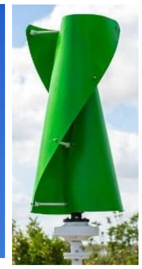
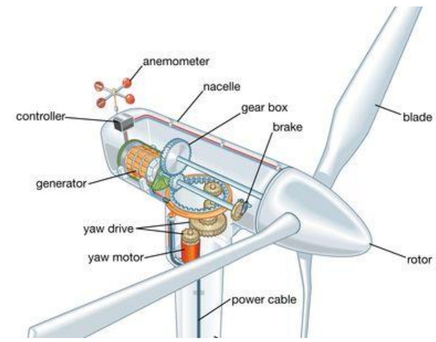
But what to do if there is a month of cloudy days? Better to make free electricity in all weather conditions by adding a wind generator. Visit the Facebook group "Wind/Solar Power, DIY Generators hobbiest and parts". https://www.facebook.com/groups/1178190098902934/



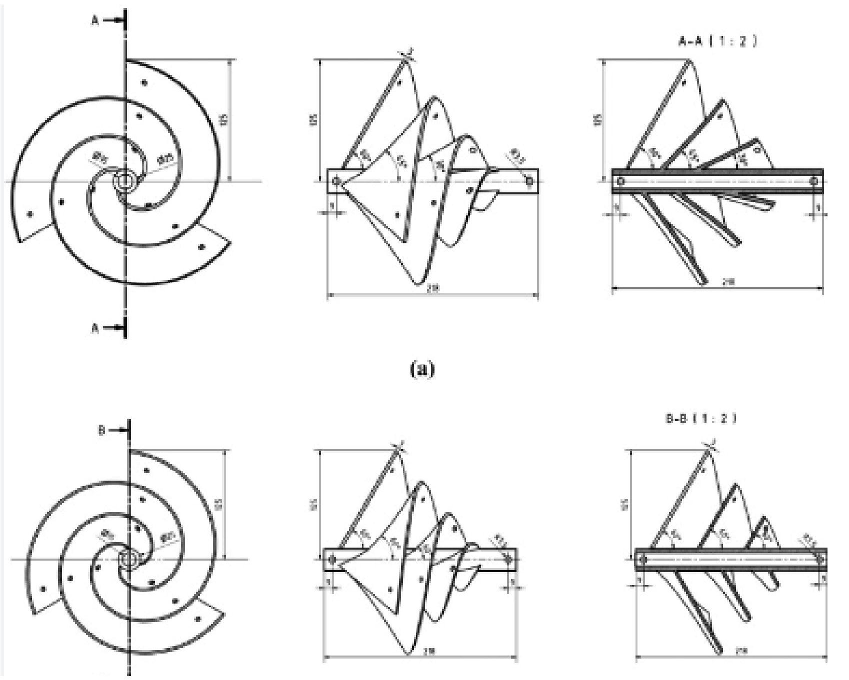

Wind power generation is accomplished by a device that catches the force of the wind and turns a shaft on an electricity generator. These in the past have either a horizontal (shaft being parallel to the wind direction) or vertical orientation with the shaft being perpendicular to the wind direction.

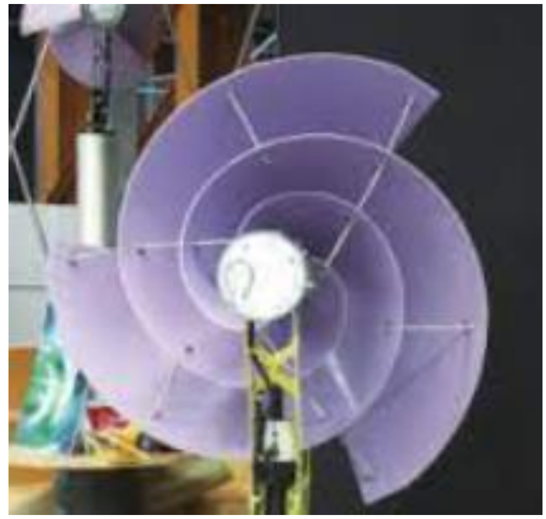
The most common is the old type of wind turbine is horizontal axis where shaft is horizontal. As shown to the right. Requires the works to be at top of tower which makes maintenance problematic, but a vertical power generator can have works on the ground making maintenance easier.

Horizontal blades have to be curved and twisted and tapered.
Vertical can have much simpler blade geometry and can be straight.
Noise is related to tip speed so **Horizontal is nosier** vertical much quitter.
Virtual is omnidirectional no yaw system is needed, so vertical perform better in gusty or turbulent winds and less noisy. So until present the horizontal type has allegedly been considered the most efficient bur further research indicates that this is because the horizontal types have not been fully developed have been and the plans and method lost. Vertical turbines dating back to BC from ancient Persia had a "super charger" on them. Take the letter K and the shape is the top-down view. Each of the legs and back of the letter K are walls and then the interaction of the legs and the back is where the vertical axis turbine is. The air enters and gets compressed before it enters the vertical axis turbine. Only part of the turbine is exposed to the incoming air to maximize air flow and pressure. Some if these still exist today. I've never seen a study or attempt at a modern reproduction of this method.

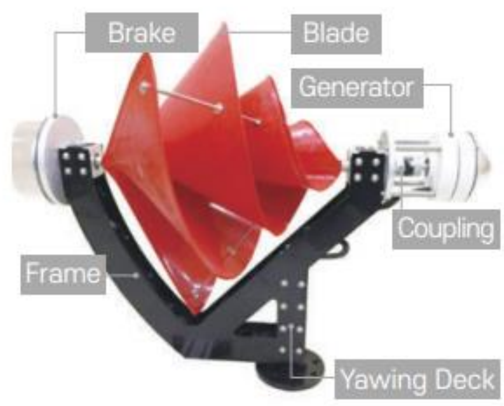
Very interesting is the Archimedes Liam F1 a horizontal axis turbine with a spiral rotor developed by a Dutch company inspired by the Archimedes screw and the nautilus shell. Unlike normal blades functioning by lift (horizontal turbines, Darrieus) or drag (Savonius), the spiral collects the kinetic energy of the wind on a surface always perpendicular to the flow direction, managing to nullify output air speed and, according to the developers, promising efficiency up to 80%, while the standard generators do not go beyond 25-50% in production. Other advantages are the good reactivity (minimum speed of 0.9 m/s) and the ability of the rotor to self-align.





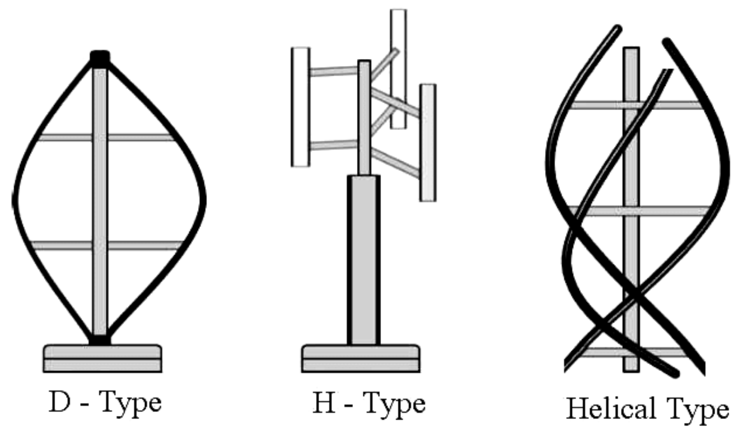
is bird and bat friendly and has a beautiful design, suitable for urban and rural areas.
The AWM comes in two sizes:

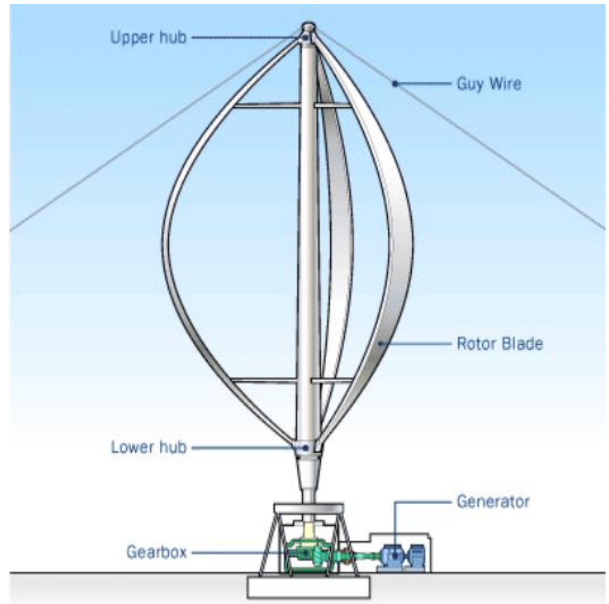
02 The 0.75 meter diameter with a rated power of 100 w/h and a maximum of 150 w/h.



Darrieus wind turbines are lift based

that

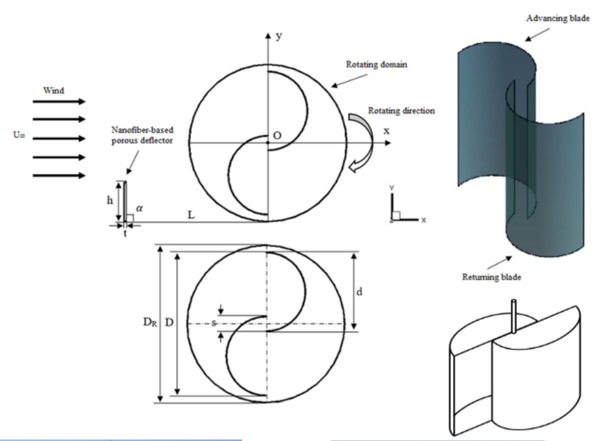


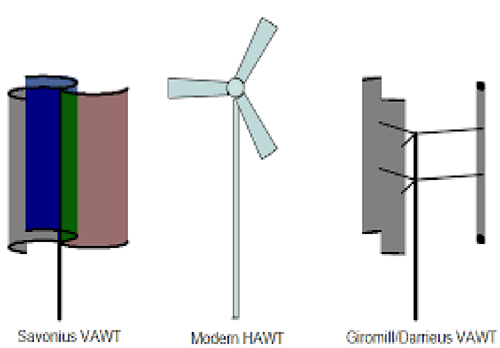


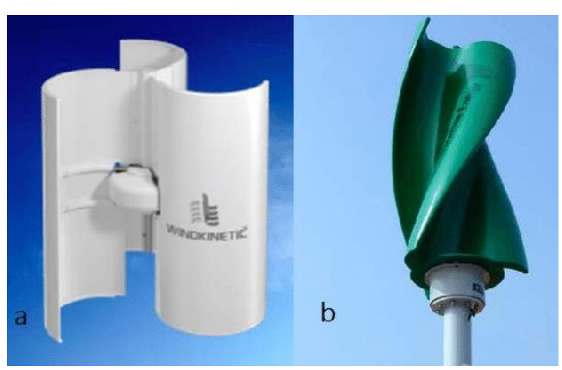
orientation means that an addition to capturing some energy from the upwind blade you also capture some from the downwind blade. 80% of power generated by upwind blade and 20% from down wind blades. And so vertical axis are all a lot less efficient than the standard horizontal axis. **More separation between up wind and downwind sides gives better quality on downwind side**. But this adds other problems.

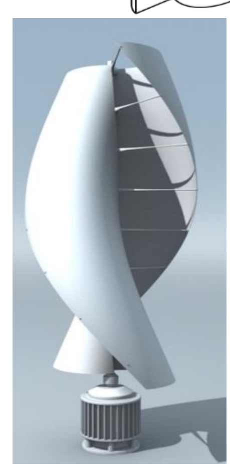
Savonius type machines are drag based

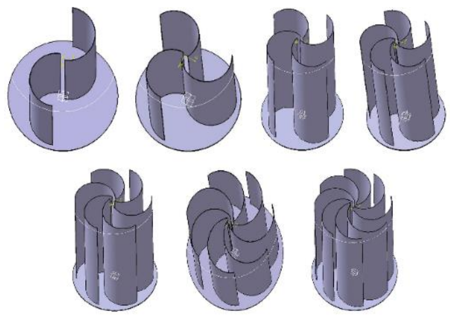
the returning blade drag is fighting the advancing blades so are less efficient. Can only reach half the Betz limit which is the maximum theoretical power that a horizontal turbine can extract. But is the Betz limit may not be applicable with all designs? Many are wildlife and people friendly ands quiet with a very small foot print and much lower cost to build and maintain but are less efficient although being more cost efficient in many applications. They are a win win choice for many homeowners. Hare some of the many designs.

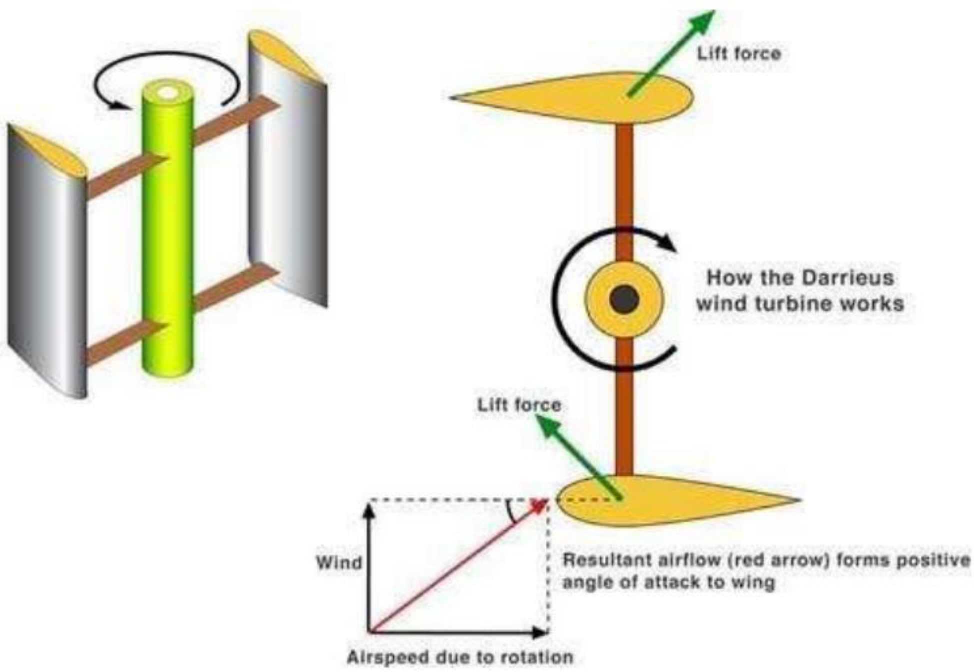




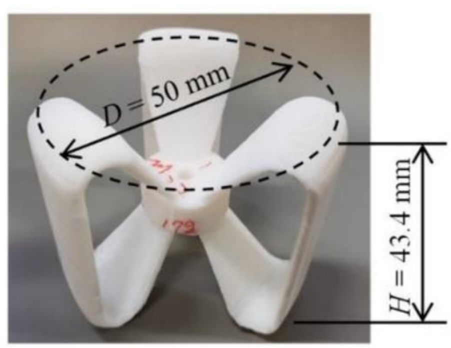




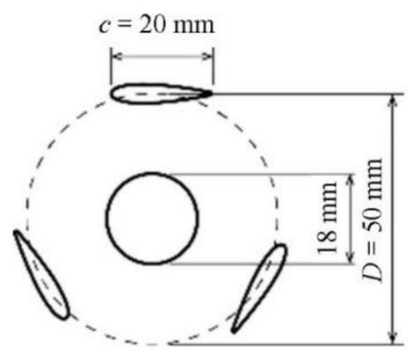



Lift force
How the Darrieus
wind turbine works
Lift force
Wind
Resultant airflow (red arrow) forms positive
angle of attack to wing
Airspeed due to rotation

(a)


D = 50 mm
H = 43.4 mm

(b)

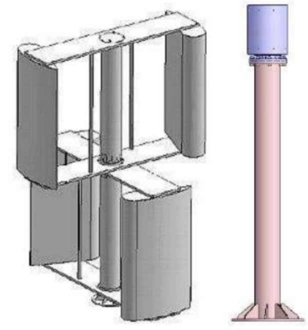

c = 20 mm
18 mm
D = 50 mm

(c)

Darrieus vertical axis turbines principle of operation. The resultant of the wind speed and the air speed due to rotation forms a positive angle of attack of the lift force to the wing.

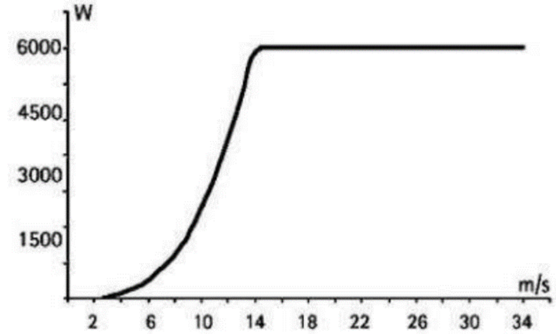
THE DARRIEUS AERODYNAMIC CONCEPT In 1931 the French engineer George J. M. Darrieus introduced the Darrieus Vertical Axis Wind Turbine. The Darrieus type of machine consists of two or more flexible airfoil blades, which are attached to both the top and the bottom of a rotating vertical shaft. The wind blowing over the airfoil contours of the blade creates an aerodynamic lift and actually pulls the blades along. Although nowhere near as much research has been carried out on these types of machine when compared with the horizontal axis machines, both the USA and Canada did have large research programs working on the Darrieus design in the 1970's and 1980's. This work culminated with the construction of a 4.2 MW machine designated as “Eole C” at Cap Chat, Québec, Canada.

There were a number of commercial wind farms built in the USA using the Darrieus design, most of which were built by The Flow Wind Corporation. The machines proved to be efficient and reliable. However there was a problem with fatigue on the blades. The airfoil blades were designed to flex, allowing for the extra centrifugal forces in high wind and blade speeds. The flexing of the blades led to premature fatigue of the blade material, leading to a number of blade failures. The vertical axis turbines built and tested in the 1970’s and 1980’s, used a symmetrical airfoil blade profile. Their theory was that, if the airfoil is symmetric then it will provide lift from both sides of the airfoil, therefore generating lift through more of the 360º path of the blades rotation. It was also believed at the time, that lift would only be created by the blade while traveling into the direction of the wind flow and that the drag created by the opposing blade traveling down wind was an undesirable although unavoidable effect. A symmetrical airfoil is not the most efficient approach at providing lift. A design goal was to maximize lift at the same time as utilizing the inevitable drag created by the opposing blade. There have been a number of attempts using hinged blades attached to the end of the cross arm, therefore allowing the aerofoil section of blade to maintain its optimum angle of attack through the maximum portion of its arced rotation. An optimal blade profile and optimal fixing angle for the blade to the cross arm could achieve the same goal. The wind flowing over the high lift and low drag blade profile, coupled with the blade areas solidity, gives the machine the initial power needed to overcome its inertia. Once momentum has been established, the forward movement of the blade through the air creates its own local wind flow over its contours, creating a varying amount of lift throughout the full 360º of its rotation. In its down wind stroke, the curved underside of the blade acts like the sail of a yacht therefore creating usable torque throughout its rotation. The stalling of the blades at the top and bottom of their arc of rotation is also useful, as it regulates the speed of the blades rotation, implying that the blades accelerate up to a point of equilibrium at which they will not increase their speed no matter how hard the wind blows. The more constant and predictable loadings on a vertical axis turbine blade, coupled with there not being any need for the blades to twist or taper, not only contribute to the possibility of scale increase, but will also enables their production in sections using mechanical mass production techniques.



ROPATEC VERTICAL WIND TURBINE INTRODUCTION The Ropatec wind rotors developed in Italy are neither proper Darrieus nor Savonius but a hybrid design. The wind rotors are made from airfoil sections like those of an airplane wing. A central panel between the wings referred to as the turtle back, acts as a diffuser and directs the wind flow toward the wings, turning the wind rotor at low wind speed. Figure 12. Hybrid Darrieus and

Savonius Ropatec vertical axis wind generator. Figure 13. Ropatec rotors without turtle shell diffuser and the columnar tower with the generator on top.



The Ropatec wind rotor is a vertically driven wind rotor that could be described as a hybrid building upon the Savonius and Darrieus principles. The WRE.060 model is associated with the MSP-Controller, an innovative CPU controlled charge regulator at 48 Volts with an incorporated SMD DC/AC inverter with 4,500 VA continuous output. A central pole referred to as the axis has the electrical generator bolted to the top. The axis and generator are inserted into the wind rotor assembly and the generator is bolted to the inner tube. When the wind rotor turns, it also turns the generator. The wind rotor will start to turn in a light breeze of about 7 km/hr or 4 knots. The maximum rpm is reached in winds of 50 km/hr or27 knots. The wind rotor has a distinctive shape that creates an aerodynamic braking effect causing it to stall at high wind speeds. Winds stronger than 50 km/hr will not increase the wind rotor speed beyond its maximum rotational speed of 90 rpm. The wind rotor is rated to produce power in winds up to 230 km/hr, the central wind speeds of a Category 2 hurricane or cyclone. It is designed for a maintenance free operation of 15 years.

The Ropatec design possesses the following characteristics: 1. A low cut in wind speed at 2 m/s at every position. 2. Its operation is independent of the wind direction. 3. It is a low maintenance system. 4. It generates low noise even at high wind velocities. 5. It does not require a cut off wind speed. 6. It possesses an aerodynamically auto regulated rotational speed. 7. Its nominal power output is achieved at wind speeds of 14 m/s and higher. 8. It is not associated with an electromagnetic field built-up. 9. It has storm suitability up to 56 m/s, with practical experience up to 75 m/s. 10. It has a reliable, long product life time The system can produce electricity directly or is expandable to a hybrid system including photovoltaic modules and/or diesel generator sets. TECHNICAL SPECIFICATIONS OF WindRotor WRE.060 WindRotor Rated output on axis (at 14 m/s) 6 kW Cut in wind speed 2 m/s Rated wind speed 14 m/s Rotor speed control Aerodynamically auto regulated Over speed control Not required Maximum revolutions/minute 90 rpm at14 m/s Cut off wind speed None Rotor weight 700 kg Rotor blade type Vertical Axis Wind Turbine (VAWT) Rotor diameter 3.3 m Swept area 14.52 m² (3.3 m x 4.4 m) Gear box type No gear box, direct driven generator Brake system Not required Generator Generator type Permanent excited multi pole Electrical transmission Brushless MSPController Battery charger 48 VDC Output MSP on grid 2x 215VAC/ 230 VAC / 50Hz – 60 Typical performance Average wind 5 m/s Annual energy output 3.051 MW.hr Sea level, Weibull K 2 Average wind 7 m/s Annual energy output 7.608 MW.hr.

VERTICAL AXIS WIND TURBINE, SOLWIND DESCRIPTION The vertical axis wind turbine by Solwind in New Zealand is designed to start up at 1.5 m/s and start producing power at a wind speed of just 3.7 m/s and produce their rated output at 10 m/s. These turbines are extremely quiet in operation. This is due to their special design where the blades do not create the usual coning noise that occurs with conventional horizontal axis wind turbines when the blades pass close to the mast at each revolution. The blades are always at the same distance from the mast. The blades are made from composite fiber glass, stainless steel and lightweight aluminum, making them extremely strong yet flexible and easy to handle

A new Low Speed Magnetic Levitation Alternator (MLA), featuring only one moving part is used. This keeps the wearing components to a minimum, and so prolongs the longevity of the wind turbine. At high wind speeds the turbine will start to stall, causing the machine to slow down at around 27 m/s. In the stalling mode, the turbine will automatically maintain its output speed. This Darrieus based design lends itself to taking the wind from any direction and does not need a yawing mechanism.

GENERATOR The generator is a low speed Magnetic Levitation Alternator (MLA). The output is 3/6 phase up to 415 volt AC. A 3 /6 phase rectifier pack with regulator shunt type is available to suit the end user voltage such as 12 / 24 / 48 / 120 / 240 / 600 volts DC or any voltage required. The generator is base mounted at the foot of the mast, and requires no slipping assembly, no dolly bearing assembly, no brush assembly and has no power cables running up the mast. MAST ASSEMBLY The stayed single pole mast assemblies have been designed for erection with out the aid of any extra lifting gear for remote area operation. A complete self contained power generation system is accommodated within the base of the mast which will mean that only the 230/415 Volts AC will need to be connected to the end user via an underground or poled cable. The mast requires no guide wires and provides a smaller ground footprint than the stayed single pole mast assembly. The mast is constructed from high tensile steel, and come in standard lengths of 6.5 meters for easy handling. The maximum design wind speed is 190 km/hr. For coastal locations stainless steel fasteners are used throughout. EUROWIND WIND TURBINE DESIGN The concept aims at utilizing an innovative and unique adaptation which allows the turbine to be mounted on industrial chimneys and other similar tall structures without inhibiting their normal use. The rotor blade design features an asymmetrical airfoil section selected for its high lift and low drag characteristics and is mounted to its supporting cross arm at a critical angle to optimize its performance. The blades are not twisted and their edges are parallel, unlike the twisted tapering blades of horizontal wind turbines. The simple, regular shape of the blade coupled with the lower blade stresses experienced by vertical axis turbines allow the blades to be produced mechanically in sections by extrusion or pultrusion. A directly coupled slow speed alternator eliminates the need for separate generator sets, gearboxes and clutches.

Figure 17. Eurowind wind mill designs. Figure 18. Large Eurowind modular vertical wind mill concept. The main features of the Eurowind turbines designs are: 1. The turbine is self starting. 2. Vertical axis turbines are omni directional and do not require pointing in the direction of the wind. 3. The lower blade rotational speeds imply lower noise levels. 4. Perceived as being more aesthetically pleasing. 5. The increased blade configuration solidity and torque assists the machine in self starting. 6. Elimination the risk of the blades reaching equilibrium during start-up rotation by using 3 blades or more. 7. Reduced cyclic loading and power pulsation and fluctuation by using more than 2 blades 8. Easy access to all mechanical and structural elements of the machine. 9. A direct drive, permanent magnet generator is used and there are no gear boxes with the machine having only one moving part. These machines have been adapted for use in the marine environment such as at harbors, on barges or oil rigs.

VENTURI WIND TURBINES INTRODUCTION In horizontal axis wind turbines the blades rotate and describe a circular surface. The rotor extracts the energy from the air flowing through this rotor surface and has a theoretical maximum efficiency of 59 according to Betz's law. In the Venturi turbine concept, the rotor blades are attached to the hub at both ends. When rotating, a spherical surface is generated. Because of this aerodynamic behavior, Venturi effect turbines create a wind flow pattern that converges first, like rapids in a river. Within the sphere, a low pressure area is generated which attracts the air in front of the rotor towards the sphere. After the rotor has absorbed energy from the air, the energy poor air is swung radically outwards through the Venturi planes and is carried away by the surrounding airflow. The air flowing through the turbine and the air surrounding the rotor are used more effectively, resulting into the efficiency of the Venturi turbine being higher than the efficiency of conventional wind turbines. DESCRIPTION Venturi turbines create a wind flow pattern that converges first like rapids in a river. This is induced by the unique aerodynamic Venturi characteristics. Therefore the turbine experiences a higher wind speed than other wind turbines would observe. This enables the Venturi turbine to generate electricity at very low wind speeds. Little gusts can be utilized for electricity generation where conventional turbines would use these to start rotating. At inland locations, this characteristic enables the Venturi turbine to generate power during 80 to 90 percent of the time. Other turbines rotate just 50 percent of the time because they are designed for windy locations. Windy locations geographically cover only a small part of the land surface such as at mountain passes and sea sides.

When conventional wind turbines are placed inland, energy production is low and down times are long because they will rotate only about half of the time. Also, they are too noisy when they run. At such a location, the Venturi turbine will produce 2-3 times as much energy and down times are short. Wind tunnel measurements at the Technical University of Delft have shown that a three blade Venturi Turbine has a measured efficiency of 85 percent, which is 40 percent higher than the theoretical maximum efficiency of 59 percent in Betz's law.

ADVANTAGES OF VENTURI TURBINES REDUCED SOUND EFFECT The tips of conventional wind turbines are the main noise generators. Compared with it, the sound generated by a small Venturi turbine is virtually non existent because it does not have such a tip. Also, there is no gearbox and the number of blades reduces the speed of rotation. LOW DOWN TIME The six bladed rotor induces a high start up moment. This enables the turbine to run almost continuously, unless there is really no wind. The Venturi effect enables the Venturi turbine to generate a higher level of power at lower wind speeds, which is essential at an inland wind regime, where most of the applications will be found. This also minimizes the down periods to 10 to 20 percent of time where conventional turbines are known to stand still for 50 percent of the time. This results in a more constant power supply to a consuming system or a battery than conventional wind turbines would be able to deliver under the same circumstances. At lower wind speeds the Venturi turbine will potentially generate three times more energy than comparable small wind turbines simply because the Venturi turbine will run and absorb energy from gusts while other wind turbines will require these gusts for their start up. This is of crucial importance for inland locations. ATTRACTIVE DESIGN AND STYLING Rotors create visual apprehension. Because the running small wind turbine is visually associated with a transparent sphere, this unrest is reduced and is recognized as attractive and pleasing to the eye. The Venturi turbine is a fun object to be placed at locations that are meant to catch the eye, like billboards or attraction park entrances. HIGH RELIABILITY Because the blades of the Venturi turbine are attached to the hub at both ends, the feet of the blade and the flexible blade itself are subjected to non fluctuating tensile stresses only. Wind gusts and gyroscopic effects barely influence it. This way of rotor construction is so robust that it practically excludes the failure of the blades. In case a blade would fail, it is still attached to the turbine at its other end. The generator is integrated into the central hub of the Venturi turbine. The magnetic field is induced by permanent magnets. The generator dimensions are matched to the rotor characteristics thus making an expensive and problem prone gearboxes obsolete. COST EFFECTIVENESS Whist the theoretical background of the blade configuration is very complex, the manufacturing is utterly simple because the blade can be laser cut from a plate. Because normally the blades constitute a large part of the cost because special tooling like a mould is required, the Venturi turbine can be economically produced at relatively low volumes. The cantilevered construction of conventional blades cause the foot of the blade to be subjected to strongly alternating bending moments caused by fluctuating wind gusts and gyroscopic effects. Additionally the unsupported tip end causes the blade as a whole to vibrate. The alternating stress loads are the main cause of blade failure. TECHNICAL SPECIFICATIONS Data Cut-in wind speed 2 m/s Survival wind speed 40 m/s Rotor speed control Not needed Rated output at 10 m/s 100 W Maximum output at 17 m/s 500 W Maximum rotational speed at 40 m/s 2,100 rpm Total weight 30 kg Number of rotor blades 6 Rotor blade type Flat blade polyester Rotor diameter 1.1 m Swept area 1 m_ Rotor Volume 1 m3 Brake system Electrical brake Gear box type No gear box, direct driven Generator Electrical transmission Four phase brushless Type Permanent magnet generator Battery charger Output battery charger 12/24 VDC Typical yearly output at sea level Average windspeed 4 m/s 100 kW.hr Average windspeed 5 m/s 200 kW.hr Average windspeed 6 m/s 350 kW.hr Average windspeed 7 m/s 450 kW.hr

TURBY WIND TURBINE DESIGN DESCRIPTION This design is advocated for construction in an urban environment. The vibrations, high noise levels and the low efficiency characterizing the Darrieus turbine are caused by the flow of air around the blade. The angle of attack of the apparent wind is kept below 20 degrees. The rotational speed of the turbine is for all parts of the blades is constant. In a Darrieus turbine the distance between blade and shaft varies, accordingly, the blade speed also varies. On the blade parts near the shaft the self generated head wind is low, whereas at the curve of the blade, at the greatest distance from the shaft, its reaches a maximum. The low blade speed close to the shaft results in an angle of attack of the apparent wind that over large parts of a revolution exceeds the allowable limit with stall as a consequence. Figure 22. Turby three bladed vertical axis turbine. There are moments of laminar flow and moments of turbulence resulting in intermittent lift power and drag on the blades and this causes vibrations. The contribution of these blade parts to the driving force of the turbine is negligible. In the curve of the blade, the speed of the headwind is high. The angle of attack of the apparent wind is small, with the consequence that the component of the lift force in the direction of the rotation also nears zero. These parts of the blades do not contribute to the driving force. However given their high speed they do generate a high level of noise. This explains why the Darrieus turbine vibrates heavily, makes a lot of noise and has a low efficiency. The blades of the Turby concept are designed with a fixed distance to the vertical shaft. To reduce the inevitable vibrations due to the change of the angle of attack between + 20 and – 20 degrees resulting in a change of the mechanical stress in the blade two times per revolution, its developers chose an odd number of 3 blades of a helical shape, making all changes occur gradually. Figure 23. Turby triple blade wind turbine design on top of a building. TECHNICAL SPECIFICATIONS Operation Cut-in wind speed 4 m/s Rated wind speed 14 m/s Cut-out wind speed 14 m/s Survival wind speed 55 m/s Rated rotational speed 120 - 400 rpm Rated blade speed 42 m/s Rated power at 14 m/s 2.5 kW Turbine Overall height 2890 Weight (inc. blades) 136 kg Base flange Diameter 250 Bolt circle 230 Bolt holes 6 x M10 Rotor Diameter 1999 Height 2650 Rotorblades Number 3 Material composite Weight (3 blades) 14 kg Converter Type 4 -quadrants AC-DC-AC Rated power 2.5 kW Peak power 3.0 kW Output 220-240 V 50 Hz 60 Hz under development Weight 15 kg Integrated functions Control Maximum Power Point tracker Start Starting is achieved by the generator in motor operation. Brake Electrical, short circuiting of the generator. Protection Grid failure, anti islanding, system faults, short circuit, mechanical faults, vibrations, blade rupture, imbalance. Overspeed protection Two independent detection systems each triggering an independent brake action: 1. Generator frequency measurement in the converter. 2. Generator voltage measurement on the generator terminals. Generator Type, rated voltage, rated voltage 250 V 6.3 A, 3 phase synchronous permanent magnet Peak brake current, rated power 60 A, 2.5 kW During 250 ms Overload 20 percent 120 min 50 percent 30 min 100 percent 10 min

POLES DESIGNS Two different mast types depending on the required height can be considered. Up to 6 m height, spring supported masts. From 7.5 m and higher, freestanding tubular masts are used. Both types could be either made of stainless steel or galvanized steel. HELICAL WIND TURBINES DESCRIPTION The Windside Wind Turbine developed in Finland is a vertical wind turbine whose design is based on sailing engineering principles. The turbine rotor is rotated by two spiral formed vanes. It is intended for both inland and marine environments. Designs are for use in wind speeds of up to 60 m/s. Figure 26. Helical wind turbine with generator at its base. Figure 27. Manufacturing of helical wind blades. The generator is at right. These designs for battery charging are a unique and ecological solution for energy production in harsh environments under cold or hot conditions, violent storms, as well as low wind speeds. These turbines generate almost no noise and are safe to use in population centers, public spaces, parks, wildlife parks and on top of buildings. They are also aesthetically appealing and in many cases have been used to combine art and functionality. QUIETREVOLUTION QR5 WIND TURBINE DESCRIPTION The QR5 is a wind turbine designed in response to increasing demand for wind turbines that work well in the urban environment, where wind speeds are lower and wind directions change frequently. It possesses a sophisticated control system that takes advantage of gusty winds with a predictive controller that learns about the site's wind conditions over time to further improve the amount of energy generated. If the control system determines that sufficient wind exists for operation, the turbine is actively spun up to operating conditions at which point it enters the lift mode and starts extracting energy from the wind. It will self-maintain in a steady wind of 4.0-4.5 m/s. The turbine will brake in high wind events of speeds over 12 m/s and shut down at continuous speeds over 16 m/s. The blade tip speed is much lower than on a similarly rated horizontal axis wind turbine so less noise is produced. The helical blade design results in a smooth operation that minimizes vibration and further reduces acoustic noise. It is constructed using a light and durable carbon fiber structure and is rated at 6kW and has an expected output of 9,600 kWhr per year at an average annual wind speed of 5.9 m/s. This would provide 10 percent of the energy for a 600 m2 office building. Its design life is 25 years.

QUIETREVOLUTION QR5 WIND TURBINE DESCRIPTION The QR5 is a wind turbine designed in response to increasing demand for wind turbines that work well in the urban environment, where wind speeds are lower and wind directions change frequently. It possesses a sophisticated control system that takes advantage of gusty winds with a predictive controller that learns about the site's wind conditions over time to further improve the amount of energy generated. If the control system determines that sufficient wind exists for operation, the turbine is actively spun up to operating conditions at which point it enters the lift mode and starts extracting energy from the wind. It will self-maintain in a steady wind of 4.0-4.5 m/s. The turbine will brake in high wind events of speeds over 12 m/s and shut down at continuous speeds over 16 m/s. The blade tip speed is much lower than on a similarly rated horizontal axis wind turbine so less noise is produced. The helical blade design results in a smooth operation that minimizes vibration and further reduces acoustic noise. It is constructed using a light and durable carbon fiber structure and is rated at 6kW and has an expected output of 9,600 kWhr per year at an average annual wind speed of 5.9 m/s. This would provide 10 percent of the energy for a 600 m2 office building. Its design life is 25 years.

It is directly incorporated into the mast. The helical design of the blades captures turbulent winds and eliminates vibration. As a safety feature, it is designed with a high tensile wire running through all its component parts, to minimize the risk of any broken parts being flung from the structure in the unlikely event of structural failure. TECHNICAL SPECIFICATIONS Physical dimensions 5m high x 3.1m diameter Generator Direct drive, mechanically integrated, weather sealed 6 kW permanent magnet generator Power control Peak power tracking constantly optimizes turbine output for all sites and wind speeds Operation mode Max wind speed: 16m/s; Min wind speed: 4m/s Design lifetime 25 years Rotor construction Carbon fiber and epoxy resin blades and connection arms Brake and shutdown Overspeed braking above 14 m/s wind speed Auto shutdown in high wind speeds above 16m/s Roof mounting Minimum recommended height above buildings: 3 m Tower mounting Minimum mast height: 9m to bottom of blades Remote monitoring Event log can be accessed via PC. Remote monitoring stores operation and kW hours of electricity generated.

VERTICAL AXIS WIND TURBINES © M. Ragheb 3/21/2015 had these references 1. Cliff Kuang, "Farming in the Sky," Popular Science, Vol. 273, No. 3, pp. 43-47, September 2008. 2. John O. Dabiri, "Potential Order-of-magnitude Enhancement of Wind Farm Power Density via Counter-rotating Vertical-axis Wind Turbine Array," Journal of Renewable and Sustainable Energy, Volume 3, Issue 4, July 19, 2011. 3. Kevin Bullis, "Will Vertical Turbines Make More of the Wind?" Technology Review, April 8, 2013.

Home Wind Turbine Notes

Compared to home solar panels which one just plug in and they give us battery charging on bright days with little hassle, while wind turbines are mechanical machines which take many hours to design, engineer and build and do require occasional maintenance. Both need a charge controller to properly charge and protect batteries.

Although the large horizontal axis wind turbines (HAWT) used to generate commercial power are claimed to be the most efficient they are very costly and expensive to maintain. Unless one has large acreage they are too expensive. HAWTs are not recognized as a viable option to harness the energy of the wind in urban areas, where the wind is less intense, much more chaotic and turbulent.

VAWTs, e.g., good performance under the weak and unstable wind, no noise and safety concerns, and aesthetically sound for integration in urban areas. there is considerable wind in the urban areas with a significant potential for power, viz. road dividers, side of railway tracks, top and around the high-rise buildings. The development of an efficient wind energy system closer to the point of use meets the local power demand, minimizes the use of diesel/gas-based electricity generation, reduces the strain on the existing grid infrastructure, incorporates the sustainability in the cities, supports the local economy, and addresses the environmental concerns.

Horizontal Axis Wind Turbine (HAWT) is relatively ineffective in urban situations and face local resistance due to noise, aesthetic, visual and public safety concerns [13]. Alternatively, Vertical Axis Wind Turbine (VAWT) has been predicted as a potential solution for the implementation of WTs in urban and semi-urban areas [14], [15]. The VAWTs have a relatively low environmental impact and better adaptable characteristics to the unsteady wind of urban terrains. These turbines can produce electricity from any direction with low cut-in wind speed and are relatively simple in design to integrate with urban buildings and infrastructure.

VARIABLE GEOMETRY VERTICAL AXIS MACHINES P. J. Musgrove in 1975 led a research project at Reading University in the UK whose purpose was to attempt to rationalize the geometry of the blades by straightening out the blades of a Darrieus type wind turbine. This led to the design of a straight bladed vertical axis wind turbine designated as the H rotor blade configuration. At the time it was thought that a simple H blade configuration could, at high wind speeds, overspeed and become unstable. It was thus proposed that a reefing mechanism be incorporated into the machine design thus allowing the blades to be feathered in high winds. These earlier machines with feathering blades were known as Variable Geometry Vertical Axis Wind Turbines. There were a number of these designs which had different ways of feathering their blades. During the late 1970's there was an extensive research program carried out. This included wind tunnel tests and the building of a few prototype machines in the 40-100 kW range. This work culminated in a final reefing arrowhead blade design for a large 25 meter, 130 kW rated machine, located in Carmarthen Bay in South Wales. This machine known as the VAWT 450, was built by a consortium of Sir Robert McAlpine and Northern Engineering Industries (Vertical Axis Wind Turbines Limited) in 1986.

H ROTOR STRAIGHT BLADED VERTICAL MACHINE From the research carried out in the UK during the 1970-1980 time frame it was established that the elaborate mechanisms used to feather the blades were unnecessary. The drag/stall effect created by a blade leaving the wind flow would limit the speed that the opposing blade in the wind flow could propel the whole blade configuration forward. The fixed straight bladed or H Rotor configuration was therefore self regulating in all wind speeds reaching its optimal rotational speed, early after its cut in wind speed.

There have been a few commercial companies producing H rotor wind turbines since the 1980's. However turbine designs were aimed at niche areas of the small wind turbine market. Due to the lower and more predictable stress loading on the blades of vertical axis wind turbines, they are the ideal type of machine for large scale electricity production. This potential for use for economic multi megawatt electricity production has not as yet been exploited. This is due partly due to earlier design failures and partly due to their slightly lower blade efficiency. IMPULSE AND AERODYNAMIC VERTICAL TURBINES, TIP SPEED RATIO (TSR) Aerodynamic wind turbines can be divided into two main classes: horizontal axis wind turbines and vertical axis turbines. Large wind turbines up to a rated power of 5 MW are horizontal axis engines, much like the traditional Dutch windmills. This familiarity has given the development of horizontal turbines a higher priority than that of vertical turbines. Modern horizontal axis wind turbines have a high efficiency but their capital cost is high. They have to be directed in the direction of the wind, either manually or by the use of a sensor based yaw-control mechanism, adding to their design complexity and cost. Vertical axis turbines do not need such a control system; and can catch the wind from all directions. Vertical axis wind turbines designs can be either impulse (drag) or lift (aerodynamic) devices. According to Betz's equation, an aerodynamic turbine has a theoretical efficiency of 59 percent and an impulse type engine only 19-40 percent. Not all the energy in the wind can be extracted because if it were possible, the wind speed behind the turbine will be zero thus clogging any flow through the rotor. Part of the wind will flow through the rotor and part around it. The ratio of these two components determines the efficiency of the turbine. It might appear counter intuitive that devices covering the whole swept area have such a low efficiency. However the ancient mariners have long realized that "Sailing before the wind' is far less energetic than "Close hauled" or "Half wind." Without slip, the maximum rotor speed would be about the same speed as the wind speed. An example is the three cup anemometers commonly used for measuring wind speed.

THE SAVONIUS IMPULSE CONCEPT The Savonius turbine is a vertical axis machine which uses a rotor that was introduced by Finnish engineer S. J. Savonius in 1922. In its simplest form it is essentially two cups or half drums fixed to a central shaft in opposing directions. Each cup or drum catches the wind and so turns the shaft, bringing the opposing cup or drum into the flow of the wind. This cup or drum then repeats the process, so causing the shaft to rotate further and completing a full rotation. This process continues all the time the wind blows and the turning of the shaft is used to drive a pump or a small generator. These types of windmills are also commonly used for wind speed instruments such as the anemometer. Modern Savonius machines have evolved into fluted bladed devices, which have a higher efficiency and less vibration than the older twin cup or drum machines. Figure 10. Evolution of the Savonius design for water pumping from half drums into the fluted spiral bladed design.

Comments I am the co-founder of Southwest Wind power - The company is gone but we studied countless designs over the years. We produced over 170,000 wind turbines like the AIR and Skystream - There are so many challenges with the vertical axis even if someone figured out the aerodynamics - Blade fatigue was always a big issue. Lower bearing issues when they did not use upper guy-wires. Even on a roof, you still get noise. - Last is finance. They are so unconventional that all financial institutions will not touch them. Comment 3 s. There was a recent study [at the University of Warwick, I think] that performed thousands of hours of simulations and they demonstrated that VAWTs work much better than HAWTs in denser arrays, so the generating capacity per square kilometre of wind farm foot print can (potentially) be much higher. I think VAWTs are likely to become more common in the future. Comment 3 One way to possibly increase the efficiency of VAWT systems could be by changing the surface structure of the blades to be more like a golf ball which uses the aerodynamics to increase some lift, reduce drag and effectively increase distance but that last factor doesn't much matter as much as the first two. Presumably, this could add to efficiency on the leading and trailing winds when applied relationally to the blade shape dynamics.

One recommendation to your VT - place you VT into the tube to protect the VT against strong wind. You can than pull the tube down to “open” the VT. In case of emergency you put the tube up and your VT is save. Because the blades of VT you can not adjust according to wind.r I have a plan in my head for a vertical axis turbine that gets round the problem of the blades rotating into wind and robbing efficiency. My idea involves a drum with blades that fold flush to the drum but come out for half a revolution to catch the wind. The timing of the blade actuation would be cam based. The positioning of the cam would be provided by a wind vane that always faced the wind thus ensuring the blades were always open at the right time.

There was a company in the UK called VAWT lead by Dr Ian Mays which eventually became the extremely successful Renewable Energy Systems. They built several large scale prototypes which were thoroughly tested in the field including in Carmarthen Bay and the Isles of Scilly. The big issue that resulted in stopping research was fatigue. It appears that VAWTs have a much worse fatigue environment than HAWTs. The British Library probably holds copies of the research reports.

The major advantage of VAWTs are the low wind speeds required to start turning and produce energy vs the higher wind speeds requirement for HAWTs.

One “efficiency” you didn’t mention. A v.a.w.t. can be Having worked in the small wind industry, selling over 2,000 small wind turbines, installing and servicing some 200 of them and living on a small wind turbine in my backyard the past 13 years, I'm very familiar with both HAWT and VAWT turbines. Some 10 years ago, an independent engineering firm did studies on various VAWT and HAWT turbines, at the same location, on the same tower heights and found HAWT's produce: 4-8x more energy than VAWT's, of comparable turbine ratings. Their study found that VAWT's were generating enough power to offer a: 80-160-yr. ROI while the average HAWT turbine offered: 20-25-yr. ROI. Most everyone loves the look and idea of VAWT's but they're simply yard art, they produce virtually no energy which is why the large, commercial wind turbines, never use them. In most cases, 1x 350W solar panel will far out-produce any VAWT, at a small fraction of the price.

much shorter, which costs less money, therefore giving you more bang for the buck. They can also produce power at lower wind speeds.

My Solar Energy professor explained that what matters in renewables is the Power-to-Cost ratio (Watts/$). Simplicity and cost are very important especially for the homeowner.

what your thoughts are on the Archimedes Screw type of Wind Turbines that seem to fall somewhere between the HAWT and VAWT?

I think application is an important part of the equation of which is better. If you're saying a small HAWT cannot work in a backyard of a residential development, but a VAWT can, then vertical is better. If we're saying we need maximum efficiency and we are deploying an industrial one in the middle of a farm or ocean, then horizontal is better.

There is a company that want to and is in the final stages of going to implementation of vawt installed on the middle part of highways to collect the wind energy produced by cars. The amount of energy isn't high, but it is more than enough to power lighting for the highway and more. If this is implemented and other micro energy producers are implemented, then we will reduce our overall need for electricity from the bigger scale energy sources.

Slightly less efficient, but not massively so (30% v. 40%) BUT usable in many more contexts. I really like the idea of putting them along the centre barrier of motorways, picking up the energy from the traffic movement, and they're probably more suitable for domestic use - quieter, smaller and if mass-produced, could be much cheaper. So we need them to enter the mainstream market.

I'm not a great mech designer, but it seems simple enough to design a pivot on the VAWP blades so they lock with the wind direction (i.e. max push force obtained from wind) and pivot to show minimum resistance on the "into the wind" return path.

Rosie, have you considered a 90 degree non-motivated rotating blade on a VAWT? It would allow the blade to catch wind on one side, but not the other. So it would rotatate to catch the wind on one side, then rotate back as it comes to the other side to let the wind pass with little resistance, maximizing rotational velocity and minimizing turbulance. It would need a cushion mechanism to let the blade rotate with minimum noise and impact. So the smaller yaws of the blades would basically replace the larger yaw of the head, but could potentially be more effective than the HAWT.

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My invention: A cheap east to build VAWT with half cylinders open at one end to ease air flow. anchored by "spokes" to the vertical shaft. The connection to the half cylinders has an adjustable spring that allows a much larger radius from current designs. The spring flexes in high winds to slow speed of the main shaft (auto braking), and permits much higher velocity at lower wind speeds (it also allows a much larger integral of area to "catch" the wind).

Medians on freeways. Urban industrial rooftops or plant towers. Commercial buildings. Also the lack of transmission loss. Being closer to existing infrastructure is a huge factor beyond simple efficiency.

@sanjuansteve

2 years ago

I think VAWTs mounted horizontally at the top corners of tall, oceanfront buildings is one great application for them as the wind direction is generally constant and the horizontal mounting takes advantage of the vortices.

@geoffhenderson8837

8 months ago

A couple of points missed by Rosie: VAWTs have actually operated with greater efficiency than VAWTs. In the 1980s (when I was working in Altamont Pass, California) the Flowind 250 kW VAWTs achieved the greatest specific output (units of kWh/sq.m) of the turbines in the Pass - and it wasn't because of better wind speed. It was normalised for wind speed and attributed to the "troposkein" (skipping rope) shape of the blades which formed a closed shape on the central tower. This eliminates the tip vortex which is a significant source of drag on turbines with open ends (as on all HAWTs and constant radius VAWTs). The troposkein blades were favoured in the 1980s for large VAWTs because in theory they eliminate bending in the blades, though only from centrifugal loading. Which brings us to the second point: the biggest drawback of VAWTs is that the aerodynamic bending loads on their blades fully reverse every revolution (think of the upwind blade being blown towards the tower, whereas the downwind blade is being blown away from the tower). Given fatigue's well-known role as a major design driver, this is a big drawback. Also their slower tipspeed (about half that of HAWTs), which gives them the low noise advantage, doubles the torque on the shaft, driving up the cost of the gearbox.

I have a vertical axis turbine(s) on the peak of my roof laying horizontally slightly offset front or back of the peak . Works great for all wind angles and the wind ramps up in speed towards the turbine(s) from the pitch of the roof. Pus i have the added benefits of the vortex that happens on the opposite side of the peak. The peak runs east to west. In the summer the wind comes mainly from the south and winter from the north. Depending of time of year, i will have the rig biased to either the north side of the peak, or the south, grabbing onto the vortices.

One of the big killers of VAWT is the simple fact that the force acting on the blade (lift design) is only there during aprox ½ of each rotation. During the retreating and advancing portion of the rotation the lift is nullified. One way to possibly over come this is to use some type of variable pitch system.. maybe… look up voith drive (water tractor propeller system) it uses a constantly changing pitch system to maximize thrust in that case but something similar could be adapted to a VAWT

Although efficiency is a key parameter, I believe more important is energy/dollar. If the efficiency is 30% lower, but the cost is 50% lower, it may still be viable solution. Also, one should also add cost of "noise" and damage to the environment, e.g. killing birds

@RexAlfieLee

2 years ago (edited)

Just a thought on complicating the VAWT. 1/ A shield shaped like an upside down tick that curves around one side of the turbine but on the depth dimension it would be as deep as the vertical turbine is long. 2/ This shield diverts the wind away from the interfering side towards the wind capture side. 3/ The tail would need to be long enough for the wind to hold the shield with the point into the wind. I believe the tail of the tick would need to be straight but am open to other opinions. 3/ The shield would be attached the same upright as the turbine blades but connected to that pole above & below the turbine so that it spins freely on its own bearings. 4/ The length would keep the point of the tick directed into the wind & the attachment bearings would allow the shield & turbine to freely catch the wind from whichever direction. 5/ The negative forces now become positive.

Ingredient scoop VAWT's need over done connecting rods where vertical bladed ones are connected at 2 points rather than one, this also means that you can have a dual generator setup far easier, and a dual generator will add structure to the rotational parts. The efficiency thing is the same reason we have the engines we have today

Great presentation. I'm sure a VAWT that is more efficient can be designed. Another place to put them, besides medians on freeways could be airport runways, to capture the non-stop jet engine wind blast that is going from 6 am to midnight at virtually every major airport in the world. I'm sure you could capture wind and power not just airports but some part of surrounding communities as well.

Could you put a mesh around it, to prevent birds from hitting the blades?

In a class called the "History of Science and Technology" in the assigned book they had some vertical axis turbines dating back to BC from ancient Persia. However they had a "super charger" on them. I don't know if you came across this in your research. I will try to describe this with words the best I can. Take the letter K and the shape is the top down view of what I am going to describe. Each of the legs and back of the letter K are walls and then the interaction of the legs and the back is where your vertical axis turbin is. The air enters and gets compressed before it enters the vertical axis turbine. Only part of the turbine is exposed to the incoming air to maximize air flow and pressure. Some if these still exist today. I've never seen a study or attempt at a modern reproduction of this method. I would curious if it could and how high it could boost efficiency of a vertical turbine.

There are now a number of papers that have shown that a set of counter rotating VAWTs can be packed much more densely than HAWTS, and so achieve better land use efficiency. They are counter rotating to make better use of turbulence cause by upstream turbines, thus boosting the energy efficiency of the grid as a whole, even though each individual turbine still has lower efficiency than a HAWT.

hat if you put multiple blades of various diameters stacked in one after the other inside the turbine?

One efficiency only available to Vertical Axis Wind Turbines is in the use of magnets. You put polar opposite magnets in the base and the turbine, and can get close to a frictionless bearing. I've seen these for marine applications, where noise, vibration and maintenance are the key issues, Horizontal Axis Turbines are generally prohibitive to sleep on a sailboat and are almost always missed in favour of solar, but getting the real estate for the amount of solar on a small boat is a pain, especially with sails up. I'm hoping VAWT keeps developing well.

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Power test china wind turbine 12v VAWT Vevor 600 watt permanent magnet motor lantern vertical axis is unable to reach more than 6 watts of power because of its type of rotor. At 292 RPM gave 13.2 V at 0.48 A at 6.2 W * At 106 RPM 12.5 V .05 A 0.6 W AT 195 RPM 12.76 V 0.18 A 2.4 W *** AT 209 RPM 12.93 V 0.27A 3.4 W. AT 248 RPM 13.2 V 0.37A 4.8 W *** AT 278 RPM 13.14 A 5.9 W**

*** * * * * * ***

Test 300 watt 12v permanent magnet motor for vawt wind turbine DIY generatore eolico [#windturbine](#) Model 300 300 W 3 phase. 94 RPM 2.23 V * 103 RPM 22 V *** 200 RPM 5.5 V ** 230 RPM 6.02 V ** 252 RPM 7.08 V ** 300 RPM 7.97 V *** 398 RPM 10.8 V ** 482 RPM 13.6 V ** 636 RPM 17.5 V ** 704 RPM 19.47 ** 800 RPM 22.26 V ** DID BATTER CHARGE TEST AND C ONCLUDED YES IT DJOES HAVE FULL 300 WATTS GENERATION. BOUGHT ON AMAZON Test by Alberto Conticelli posted on Wind/Solar Power. DIY Generators hobbiest and parts.**

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- 【Strong Wind Resistance】The horizontal rotation brings small wind pressure so that it can resist a super typhoon.Due to its compact shape, low starting wind speed, and large windward area, the wind turbine can generate electricity at lower wind speeds.Drawing on the design principle of aircraft wings and the horizontal plane rotation, noise can be reduced to a level that cannot be measured in the natural environment.
- 【Low Starting Wind Speed】Its starting wind speed is lower than other wind turbines, and the rising arc of power generation is gentle, so it can generate more power than others within a certain range.Designed with three-phase AC PMG, it boasts low torque, high-power tracking
-
- intelligent microprocessor that can effectively regulating the current and voltage. It obviously increases wind energy utilization and annual power generation.
- 【Stable And Low Noise】With dual bearings, the fan movement is more stable. Low vibration and low noise. In addition, with its compact shape, it has the lowest starting wind speed and a larger windward area, enabling it to generate electricity at lower wind speeds.
- 【 Easy Installation】All things you need for installation are included. Humanized and convenient flange design, easy to install and maintain.

- 【Applicable Scene】It is ideally suited for boats, gazebos, cabins or mobile homes, as well as for green windmills, home, corporate and industrial energy supplem.

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Started wind speed: 1.3 m/s   Cut-in wind speed: 2.5 m/s
Rated Wind Speed: 11 m/s   Max Wind Speed: ≤40 m/s
The instantaneous maximum wind speed≤45m/s   Blades quantity:3 （3 different colors）
Rotor Diameter of Blades: 0.6m   Blades height(m): 0.8m
Speed regulation: The wind engle automatically   Rated Voltage: 12 V
Rated Power: 400 W   Max Power: 450 W
Enerator protection grade: IP67 Work environment temperature: 25~+45℃
Product assembly weight (Kg) <10Kg   Over speed protection: Electromagnetic brake
Feature: Low vibration,Low start wind speed Blade material: Glass fiber
Generator: Maglev generator Design service life: 10~15 years
Package includes: 1 x Wind Power Turbine Generator 1 x Controller 3* Blade （White，Red，Blue）
A bag of screws to connect the main body A bag of screws for connecting the bracket blades

Technical Details

Manufacturer	MuChaIOAK
Part Number	563413
Item Weight	28.7 pounds
Product Dimensions	34.25 x 15.35 x 8.46 inches
Country of Origin	China
Item model number	/
Color	White, Red, Blue
Power Source	ac
ASIN	B0CN15JR66
Best Sellers Rank	#1,199,016 in Patio, Lawn & Garden (See Top 100 in Patio, Lawn & Garden) #2,910 in Solar & Wind Power Parts & Accessories
Date First Available	November 9, 2023

MuChaIOAK Turbine Generator Kit, Portable Vertical Helix Wind Power, Turbine Generator Kit With Charge Controller for Marine RV Home Industrial Energy, 400W 12V 3 Blade $209.99