

**The Economist, March 2006....**

**Energy technology: Wind turbines that rotate about a vertical axis, rather than the usual horizontal one, could have a number of benefits**

WIND turbines are springing up in all sorts of places around the world, from China to California, but most of them have the same basic design: the blades rotate about a horizontal axis, as in an old-fashioned windmill. Such turbines can generate electricity at a cost not much higher than non-renewable, fossil-fuel sources—provided the wind is blowing, that is. But if proponents of a rival design are to be believed, electricity can be generated from wind even more cheaply, using turbines that rotate about a vertical axis, like a playground roundabout.

TMA, a company based in Cheyenne, Wyoming, announced in November that its first vertical-axis wind turbine (VAWT) would soon be ready for commercial production. The TMA system has two sets of vertical blades. The two inner blades, each shaped like a half-cylinder, catch the wind and rotate about a central axis, while the three outer blades, shaped like aircraft wings, are fixed. The interaction between the two sets of blades causes a drop in pressure in front of the rotating blades' leading edges, which further increases the rate of rotation. TMA claims that its system harvests 43-45% of the wind's available energy; conventional propeller-style turbines, in contrast, have efficiencies of 25-40%.

In winds of more than 80kph (50mph), furthermore, the blades and gearboxes of conventional turbines cannot cope with the strain, and they have to be shut down. TMA says its vertical-axis design can still work even at wind speeds as high as 110kph, however. The ability to harvest high-speed winds is particularly valuable, since each doubling of wind speed results in an eightfold increase in available energy. TMA also claims that its design is quieter and less visually obtrusive than conventional turbines.

A British consortium, Eurowind Developments, which includes VT Group, a shipbuilding and engineering company, and Mott Macdonald, a consultancy, believes VAWTs could be the best design for giant offshore turbines. Such a turbine, with a capacity of ten megawatts, would be able to power around 10,000 homes. Today's largest horizontal-axis turbines produce around five megawatts, and are proving difficult to scale up. Each blade has to be more than 60 metres long, and the bigger the blade, the greater the stress it experiences as it turns: the blade's own weight compresses it at the top of the cycle and stretches it at the bottom. As a result, blades must be made and transported in one piece, which is expensive. Reinforcing the blade to enable it to withstand these forces further increases cost and reduces efficiency.

The blades of a VAWT, in contrast, do not have to undergo this repeated stretching and compression. Nor does their cross-section vary from top to bottom, which makes them cheaper to manufacture than windmill blades, the shape of which must be painstakingly engineered. VAWT blades can also be made in pieces and joined together on site. So vertical-axis designs should enable wind turbines to be scaled up more easily, resulting in cheaper electricity, even for VAWT designs of similar efficiency to conventional turbines. "If we can build a ten megawatt turbine for only

slightly more than other companies build five megawatt turbines, then the efficiency question goes out of the window," says Steven Peace of Eurowind.

Neither TMA nor Eurowind has yet proved the technology in commercial deployments, however, and the mainstream wind industry remains sceptical about the benefits of VAWTS, in large part because the idea is not new. Simple VAWTS, with a couple of sails pushed around by the wind, have been around for centuries, and were being used in Persia thousands of years ago. In 1922 a Finnish engineer, S. J. Savonius, improved on this primitive design, and devised a turbine based on two half-cylinder blades, as TMA uses. In 1931 a Frenchman, Georges Darrieus, patented a wind turbine that operates on an entirely different principle with two thin, curved blades fixed to a central axis, in a design often compared to an egg-beater.

Turbines based on the Savonius design are already used for small-scale generation in remote locations. Even large-scale VAWTS have been tried before. In the early 1990s the British government funded a trial in Carmarthen Bay in Wales, which culminated in the construction of a 500 kilowatt, 35-metre turbine. But it failed after six months because of a manufacturing fault, and the trial was wound up shortly afterwards. The project's final report concluded that VAWTS had no applications on land, but they should be reconsidered "if offshore wind energy becomes more attractive".

That day has now come, so it might be time to give the technology another look. Nigel Crowe, director of the British Wind Energy Association, says the use of horizontal-axis turbines has as much to do with historical factors as technological merit. "Why do we use horizontal axis turbines? Why do we use VHS, not Betamax?" he asks. "They are the ones that got accepted first, and got established in the marketplace. The industry now is going through some major changes. Maybe the goalposts have moved a bit and maybe it is the right time to look again." With plans afoot to build wind farms off the coast of Britain and elsewhere, the fortunes of the VAWT may be about to take a turn for the better.

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## TMA's vertical axis wind turbine introduces competitive advantage

*Design creates pull on the back side, contributing to 40%+ wind conversion efficiencies; doesn't kill birds; runs more quietly; and doesn't need to be installed as high, blending better with landscape. Generating costs estimated at 3.5 cents per kilowatt-hour, surpassing conventional energy sources.*

by [Sterling D. Allan](#)

*Pure Energy Systems News* - Exclusive Interview, Breaking  
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CHEYENNE, WYOMING, USA -- Terra Moya Aqua Inc. (TMA) is ready to go into production of a new vertical-axis wind turbine design that resolves some of the shortcomings that have plagued the traditional propeller design.

While many of the new design features are superior to the familiar propeller, Ron Taylor, who is the inventor of the new vertical design, as well as founder, Chief Operations Officer, and chairman of the board for Terra Moya Aqua Inc., is modest in his approach. He does not see his vertical turbine supplanting the existing propeller infrastructure, but rather views it as supplementing the field.

Ten years in the making, with seven iterations, and countless hours in a wind tunnel being tested by a premier wind engineering firm, as well as years of data collected from prototypes installed just outside of Cheyenne (one of the more windy locations in the U.S.), the TMA design is now ready for commercialization.



Earlier versions of the TMA vertical axis turbine. TMA is not releasing the most current photos, due to the patent-pending status of some of its aspects.



While the various propeller designs now in use harness from 20 to 28% of the wind's power, with some newer designs edging to between 30% and 40%, Taylor says that TMA's design captures over 40% of the wind's power, all across the profile, from low- to very high-speed winds. Depending on the harsh Wyoming weather, a production prototype is expected to be completed in 5-7 months, at which time they will then launch full-scale manufacturing.

### **Power from Push and Pull**

Perhaps the most fascinating feature of this new design is the fact that it not only gathers energy from the push on the front side, but actually is pulled forward on the back side through a lift effect, similar to the principle that causes lift on a wing. "The back pressure creates a vortex that pulls it around, turning drag into lift," says Taylor.

The result is that the turbine spins just slightly faster than the wind speed -- 1/100ths faster on average, beginning with winds of about 5 miles per hour.

This facet is the "technology breakthrough" that makes it unique, according to Taylor.

This is the crux of their design, and of the approximate sixty claims between the two U.S. patents awarded and a third pending, and numerous international patents secured as well. "We have received notice of the acceptance of the 2nd USA Patent from our attorney but have yet to receive the printed version with the number," said Taylor. "Our patent attorney is very pleased with how broad our patent protection is."

### **Trial and Error**

Earlier designs had 7-8 rotors on them, but in wind tunnel testing, they found that the wind tended actually to blow around the turbine – much as water flows a rock in a stream – rather than through it. This is a case, the inventor confirms, in which "less is more." Their present design has only two rotor blades with three directional foils.

The independent Fort Collins wind-engineering company, Cermak Peterka, Perterson, Inc., that tested TMA's various design iterations, is considered one of the most competent in the world. For example, the company's track record includes running the wind analysis on the WTC Twin Towers prior to their construction. ([Ref](#)) TMA also used some of the same software used by large automobile and airline manufacturers such as G.M. or Boeing, for data collection on materials stress and wind flow.

As a result of implementing changes based on these professional analyses, TMA's latest vertical turbine performs eight times better than their first.

## Ready to Come out of the Chute

Taylor said that his company has taken a very low-key approach in the development of their technology. "We would rather under-promise and over-deliver [than the other way around]," he said. Now they are ready for the spotlight, which has landed on them since a story that was released on Friday by the *Casper Star Tribune* was immediately picked up by the *Associated Press*. Their phone has been ringing non-stop.



**Ronald J. Taylor**  
Inventor of the design, as well as founder, Chief Operations Officer, and chairman of the board for Terra Moya Aqua Inc.

## Cost is Below Conventional Energy

Taylor says that the energy generation cost for their turbine comes in at around 2.5 to 3.5 cents per kilowatt hour, depending on the regimen, comparable to the most efficient propeller designs available. He arrives at this figure by taking into consideration the power curves, cost of construction, and all testing and design work. However, he might be overly modest in saying that. Just this year wind power reached the benchmark of becoming competitive with conventional energy generation, which is in the range of 4-6 cents/kw-h -- nearly twice as expensive as the number Taylor gave. ([Ref.](#))

Taylor said that were it not for the production tax credits that wind turbines receive, there would not be nearly as many built, and they would not be as competitive with commercial generation systems. He doesn't think that the TMA turbine will require a tax credit in order to be competitive, especially in higher wind areas.

## Handles High Wind Speeds

The optimal speed for harvesting wind energy, between 28 and 33 mph, is the same in both the traditional propeller design and the TMA design. However, TMA's vertical axis design can generate electricity from winds as high as 70 mph, while the propeller designs typically can only generate energy into the low 50's. This means that the TMA design can go into areas of stronger winds beyond the tolerances of the propeller designs.

In propeller turbines, the pitch of the blades must be changed depending on the wind speed. At lower speeds, the blades are more flat, and become more angled with higher winds, catching less of the wind's capacity. Once the wind speed surpasses a propeller's top speed, it is designed to be braked to a stop. This eliminates damage from outward-thrusting centrifugal forces which the props are not designed to handle.

The TMA vertical axis design, on the other hand, doesn't have to be braked to a stop.

"We do not have to change the angle of our rotors," said Taylor. He said their fixed configuration works equally well at low and high speeds. Once the wind goes above 70 mph, the rotor is disengaged from the generator and gear box so as to not damage them, and is left spinning freely and harmlessly at close to the speed of the wind. The diameter of the rotating vertical axis turbine is much less than of the propeller design.

Taylor said the TMA turbine will begin to spin with winds of around 5 mph, at which point it is just free-wheeling. It begins powering a trickle charge as the gearing system engages when the wind speeds reach between 8 and 10 mph.

The TMA design is rated by structural engineers to handle winds of 156 mph without any damage to the structure. This is just below a category "F3" tornado wind speed. ([Ref](#)) Subjected to winds of 180 - 212 in early testing under controlled conditions, an earlier prototype withstood this force, with the only consequence being that a lock collar loosened by 1/8 of an inch.

In the 1960's, 108 mph winds wrecked an array of propeller turbines in Spain. TMA's prototype near Cheyenne was recently subjected to winds of 104 mph and "kept on going," said Taylor. "We do not take down the turbine in storm conditions as it is designed to handle nearly any situation. Obviously a hurricane or direct hit from a major tornado will do damage to anything man can build, but we are satisfied with the durability of the TMA turbine in most extreme wind conditions."

The ability of the TMA turbines to generate electricity during stronger winds offers a tremendous power advantage. The physics of wind power is such that for every doubling of wind speed, there is an eight-fold increase in the amount of wind power. Given the wind-speed limitations in presently-available horizontal-turbine technologies, the region of mid 50 mph to 70 mph will essentially be held exclusively by the TMA technology. This is double the 28-33 mph optimal range for prop turbines, and offers the promise of eight times the power output capacity in windier regions.

### **Kind to the Birds; More Quiet**

One of the primary environmental drawbacks of the propeller wind turbines is that they kill birds. The tips of the blades spin much faster than the wind speed, chopping through the air sometimes at speeds of 200 mph. The birds generally just don't see them coming.

The TMA vertical axis design probably "looks like a building to the bird," said Taylor. "We've never seen a dead bird at our test site." Likely this is because birds don't normally fly into solid walls.

He notes that his company has been able to secure permission to install their turbine in several California counties where propeller turbines are banned because of the known bird carnage. Also, because of their lower speed, the TMA turbines produce much less noise than the propeller counterpart.

## Blends Better into the Environment

Another advantage of spinning at the speed of the wind, is that the damage to the TMA vertical axis rotors from particulates carried by moving air is negligible. A side benefit from this, which is very important to many people, is that the device can be painted to better blend in with its environment. Not being chipped by wind-driven sand or other small fragments of matter, the paint will last longer. Because it stands much shorter, about half the height of a comparable propeller design, the TMA's visible impact on the landscape is much smaller as well.

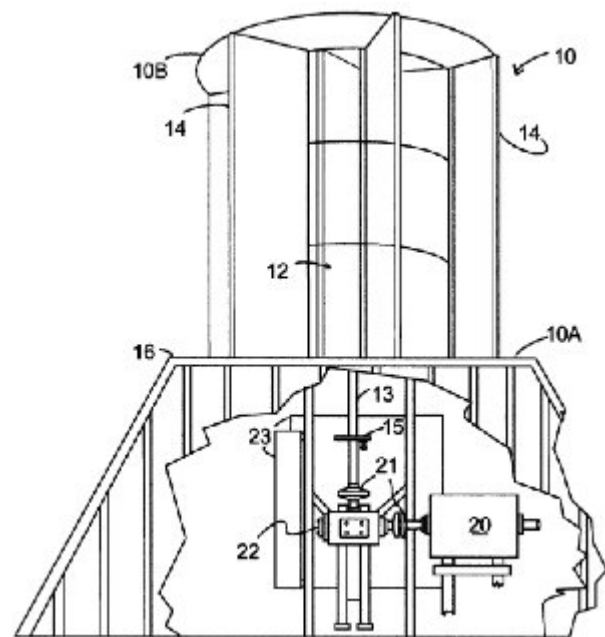
## Serviceability and EMF

An advantage of vertical-axis wind turbines in general is that the generator can be situated on the ground for ease of access and service. It is also can be protected better from the elements that can wear on the gears and generator.

Some other advantages of the TMA system, as listed on the company website are

- no field of magnetic resonance
- no interference with aircraft navigation or communication
- no ground resonance

In other words, there is "no electronic, magnetic or radar interference for aircraft navigation equipment." ([Ref](#))



**Fig. 1;** US Patent 6,015,258 (January 18, 2000)  
[Wind turbine \(pdf\)](#)

## Scalability

Finally, Taylor says the TMA design scales very well, performing "proportionately better." Still, he does not see a need to go to a huge size, but intends to design these turbines for output of between 1 kilowatt and 1 megawatt. A 1 kW turbine would stand around 18' feet high, including the control systems under the rotor area. This is in the low range to handle home power supplementation, and is small enough to be permitted in most residential zoned areas. The municipal-grade 1 MW turbine would be about 220 feet high, half the size of a comparable propeller system. The production prototype will be a 25 kW machine and stand approximately 34 feet tall. Now that the hard work of research and development is over, and the process of production commenced, Taylor calls this project an "overnight success story. It only took us ten years to get there."

## About the Company

TMA is not a publicly-traded company, and therefore cannot solicit investments. Those who do invest in the company are give a full understanding of the technology prior to doing so, and are brought in under non-disclosure, non-compete agreements. TMA will be farming out the manufacturing through licensing contracts. The company presently has four to five fabricators lined up, with trained people ready to build their designated turbine components. "Turbine material lists are finalized, and the bidding processes have been completed or are in the final stages. TMA also has multiple purchasers for the product once the first model's power curve and performance is confirmed by actual operation of the full scale model."

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### SOURCES:

- Phone interview with Ron Taylor, inventor, founder, COO, chairman of the board for Terra Moya Aqua Inc (Nov. 7, 2005). Taylor reviewed the story Nov. 8, am, and his corrections have been integrated.
- <http://www.tmawind.com> - company website.
- <http://www.otcbb.com/profiles/NVHG.htm> - Nevada Holding Group, Inc. absorbed into TMA. (See "more" button under *Business Summary*).
- <http://www.cppwind.com> - wind engineering company website
- [Wind turbine \(pdf\)](#) - US Patent 6,015,258 (January 18, 2000)
- [Cheyenne firm's wind turbines get makeover](#) - (*Casper Star Tribune*; Nov. 5, 2005)
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- <http://www.cbsnews.com/stories/2005/11/05/ap/tech/mainD8DMFFN05.shtml>

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