Innovation is in the air…

At a recent gathering of renewable energy advocates in Cape Town, an innovative wind turbine prototype was launched, amidst much excitement and enthusiasm along with serious interest by some of the bigger players in the renewable energy arena.

After six years of intensive R&D, the first prototype of the turbine was unveiled on the rolling hills of Baskop private nature reserve in Scarborough, just outside Cape Town. Standing a mere six metres high, with twin turbines spinning in the mild breeze, the 3kW prototype appears to be the solution to the global wind turbine/farm challenges.

Originally from Germany, creator and designer of the PowerWing™ technology, Rolf Seeliger, was impressed by the magnitude of the wind farm industry in Europe, in Germany particularly – considered one of the leading wind turbine and wind energy producers in the world. He saw the potential for implementing the same industry in South Africa.

He says, "In the wind turbine industry, the precept of 'bigger is better' is the norm. When you see these turbines from a distance you cannot appreciate the scale of each unit; some with tower heights of 100m." He adds, "To put that into perspective, each one is the height of a 30-storey building." Rolf saw an opening in the green energy market for more compact, high efficiency wind turbines – and the associated cost benefits associated with transporting and installing smaller components and units.

With international patents pending, the PowerWing™ machine that was launched is a 3kW machine and Rolf adds, "This technology is fully scalable up to megawatt utility capacity."

__Rolf Seeliger__ next to the PowerWing™ prototype, which stands a mere six metres high. With lower tower heights, the PowerWing™ technology is highly suited for floating offshore wind farms, as well as closer positioning to urban areas.

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PowerWing™ benefits

"The PowerWing (PW) single skin SUPERVORTEXX blades for large wind turbine applications can be made using GRP or Carbon Fibre composites, using single-sided moulds. Blades for smaller wind turbines can be injection moulded using a variety of suitable thermoplastic polymers or pressure cast aluminium," he explains.

The distinctive SUPERVORTEXX design – viz partial airfoil blade – combines aerodynamic lift with flow resistance/deflection features, enabling high blade efficiencies, extreme rigidity and exceptionally lightweight blades, with low inertia. Rolf adds, "Being a single skin construction, they are simple to manufacture and substantially more cost effective in comparison to conventional dual-skin moulded rotor blades. Additionally, blade transportation costs and installation costs will be greatly reduced."

Currently 5MW conventional rotor blades are 61m long, weigh 16 tons each and are individually shipped on low-bed trailers to site. These blades have complex airfoil chords required to produce the aerodynamic lift to effectively convert/transfer the kinetic wind energy into rotational power. Owing to their weight they have a very high own inertia to overcome.

(The wind turbine industry is presently engaged in developing 10MW turbines and studying the feasibility of 20MW turbines, with the associated increase in size of blades and transport and installation logistical challenges.)

In most cases complex planetary gearboxes are used to increase the slow rotor rotation speeds from between five to 15rpm to between 500 to 1500rpm on the generator side. Blades are made with glass-reinforced fibreglass, using complex opposing halves moulds, in a time consuming and costly process.

Rolf continues, "Traditional blades range between 10 to 15% of the total wind-turbine cost, with a 5MW wind-turbine costing about €5-million, excluding foundation, installation and transport costs. In this case, each blade would cost up to €250 000."

Surface area

He explains that PW partial airfoil blades work on the principle of airflow pressure differential/deflection in combination with conventional aerodynamic lift principles, employed solely by the vast majority of wind-turbine manufacturers. "PW blades are substantially shorter and have a greater surface area per blade. The biggest blade surface areas are positioned towards the centre of the rotor swept area, resulting in greater kinetic power extraction, giving the rotors smaller diameters than conventional rotors, yet affording them substantially more blade surface area."

Typically, conventional three-blade rotors have between six to 9% blade surface area of the total rotor swept area, with the largest blade area being closest to the rotor hub.

In *(Fig.1)*, the principal power extraction potential of conventional rotors used by the industry is clearly illustrated, where a rotor with 27m diameter can potentially produce 225kW and a rotor with 54m diameter, 1000kW.

"The industry's standard approach is that with every doubling of rotor diameter a fourfold power output should be achieved. This approach completely ignores the role that the total blade surface area has in relationship to the total rotor swept area, namely, if the blade surface area is 10% of the rotor swept area, then 90% of the total cubic airflow *(Fig.2)* and available kinetic energy passing through the rotor disc area, is not harvested. The approach is, that the more power output required from a wind turbine, then the bigger the rotor diameter must be," Rolf explains. By comparison, a four-blade PW rotor enables up to 40% surface area, and an eight-blade PW rotor up to 70% blade surface area, making it possible to harvest the vast majority of the available kinetic energy flowing through the rotor, with substantially smaller rotor diameters. This critical feature makes the PW concept highly suitable for the more dominant low-wind geographic regions of the world.

PW rotors are pivot-mounted onto the head assembly utilising the generator as counter weights. This configuration allows for passive rotor tilt furling (reduction of rotor angle against the airflow) during gale force winds or gusts, thus eliminating the need for complex sensors and control motors used in conventional wind turbines.

Compared with conventional rotors, PW rotors are positioned downwind relative to the generator/tower axis and are self-steering into the wind, eliminating the need for complex electric motor blade pitch and rotor steering control systems. Additionally, in the unlikely event of a blade failure, a major safety feature is that the PW blades cannot strike the mast/tower. The rotors are coupled directly to permanent magnet generators, do not require gearboxes and have a low cut-in wind speed (<1.5m/sec) with no cut-out wind speed.

Application

PW turbines can be configured into multiple stacked arrays on a single tilt-up and swivel mast/tower construction. By using a basic twin-rotor unit and multiplying it on a single appropriately dimensioned tower, costs can be reduced and manufacturing simplified. For example, if one PW twin-rotor unit generates 2MW output and an output of 4MW is required, then two stacks of twin-rotor units on a single tower can be configured. Rolf adds, "Additionally this type of configuration allows for closer positioning of PW turbines in a given wind farm area. The low inertia, high efficiency PW rotors are minimally affected by turbulent airflow in comparison to conventional wind-turbines. These require clean non-turbulent airflow to enable the effective functioning of the aerodynamic lift blades. Smaller rotor diameter PW wind turbines could also be used as infill turbines in existing wind farms thereby utilising the existing infrastructure and reducing wind farm costs further."

__Fig 1:__ The principal power extraction potential of conventional rotors used by the industry is shown. In this graphic a rotor with 27m diameter can potentially produce 225kW and a rotor with 54m diameter, 1000kW.

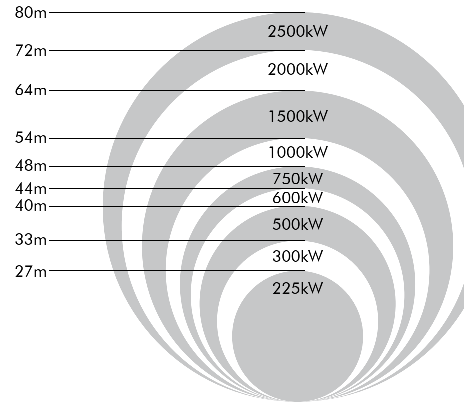
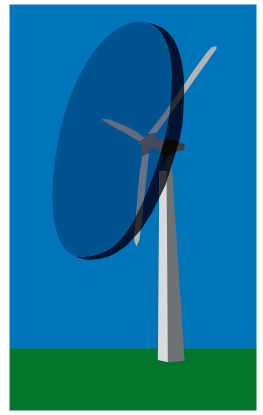


__Fig 2:__ The industry standard continues to ignore the fact that the total blade surface area is a critical factor in relationship to the total rotor swept area; that is, if the blade surface area is 10% of the rotor swept area, then 90% of the total cubic airflow and available kinetic energy passing through the rotor disc area is not contributing to energy transfer.



PW rotors operate noiselessly, making them ideal for urban and inner city areas, where, in the latter case, building rooftops are ideally suited owing to substantially smaller rotor diameters and the multiple stackable array system requiring lower overall mast heights.

According to Rolf, "PW Synergy2 twin, counter rotating wind turbine systems (which eliminate any gyroscopic effect), can be configured with twin, quad or more rotors to suit the prevailing wind conditions in any given region."

Rolf concludes, "Locally we are embarking on the 'MetroWind' Project, to bring small scale wind turbine arrays into urban areas, utilising existing power distribution infrastructures. Parallel to this we are commercialising the technology into the African markets and are seeking potential venture partners to be a part of accelerating the roll-out of this unique technology."◆

Update

After successfully exhibiting at the recent Wind Power Expo held at the CTICC in May, considerable international interest has been shown in the PowerWing™ technology.

Currently, with a view to commercialising the PowerWing™ technology, the company is in discussions with a leading German generator manufacturing company, as well as a well-established Korean multinational company, involved in the manufacture of renewable energy systems.