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Wind power winners

We present the awards for the best turbines, drivetrains, rotor blades and innovations p22

TURBINES 2.1 – 3.5MW *The utility class forms the main battleground for the world's leading turbine manufacturers*

MEDAL WINNERS

GOLD Nordex N117/2400

The 2.4MW Nordex N117 low-wind model was introduced in 2011 and immediately established a wind industry benchmark. Its mid-2012 commercial ramp-up pushed it perhaps two years ahead of the competition, boosting the company's market share in Germany from around 4% in the first half of 2012 to around 11% a year later.

Technically, the N117 builds on the 2.5MW Gamma platform, the origins of which dates back to the N80/2500 Alpha series of 2000. The combination of 2.4MW rated power and a 117-metre rotor diameter provides a specific power rating of only 223W/m².

A key feature is the slender in-house-developed rotor blade with carbon fibres incorporated in the load-carrying main girders for exceptional stiffness with low mass. The blade weighs less than 11 tonnes.

Nordex focused on maximising yield levels at inland sites with average wind speeds at hub heights of 6–6.5m/s.

Industry standard Nordex's low-wind N177/2400 has stolen a march on the competition

The N117/2400 can produce more than 3,500 full-load hours (40% capacity factor) under these conditions.

The turbine comes with tubular steel and concrete-steel hybrid towers and hub heights up to 141 metres. This configuration enables the development of many inland and forested sites that only a decade ago were not considered viable for wind-power.

SILVER Wind to Energy W2E-120/3fc

German engineering consultancy W2E initially developed this 3MW turbine as the Fuhrländer FL3000. Following that company's insolvency in 2012, W2E took over and finished the work, renaming the turbine as the W2E-120/3fc.

The key innovation in this completed

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TOP TEN TURBINES 2.1–3.5MW *German manufacturers make a clean sweep of the medal table*

Model	IEC class	Power rating	Rotor diameter	Drive system	Hub heights	Noteworthy
Nordex N117/2400 (Germany)	IIIA	2.4MW	117m	HSG, DFIG	Up to 141m, hybrid concrete-steel	Trend-setting product about two years ahead of competition; lightweight blades
W2E-120/3fc (Germany)	IIA	3MW	120.6m	MSG, PMG	Up to 140m, hybrid concrete-steel	Innovative drivetrain combination of W2E Larus Compact with Winergy HybridDrive
Enercon E-101 (Germany)	IIA	3MW	101m	DD, SG	Up to 149m, hybrid concrete-steel	New product family with 2.5MW E-115 model; water-cooled generators, advanced blade manufacturing system, automated production
Vestas V112-3.3 (Denmark)	IB-IIA	3.3MW	112m	HSG, PMG	Up to 137m, hybrid concrete-steel	State-of-the-art design. Optimisation of 3MW model. V105, V117 and V126 versions
GE 2.5-120 (US)	III	2.5MW	120m	HSG, DFIG	Up to 139m, hybrid concrete-steel	Switched from PMG to DFIG in 2012; built-in battery storage (2012), advanced controls and industrial internet capabilities
Repower M114 (Senvion) (Germany)	IIA	3.2MW	114m	HSG, DFIG	Up to 143m, hybrid concrete-steel	Pioneer in the 3MW class;-builds on 2MW and 3.4M104; evolutionary development
Alstom ECO 122 (France)	IIB-IIIA	2.7MW	122m	HSG, DFIG	Up to 139m, hybrid concrete-steel	"Pure torque" drivetrain separates rotor torque and rotor bending moments
Nordex Delta N117/3000 (Germany)	IIA	3MW	117m	HSG, DFIG	Up to 141m, hybrid concrete-steel	Sister model N100/3000 (IEC IA) and latest N131/3000 (IEC IIIA)
Prokon P3000 (Germany)	III	3MW	116m	DD, PMG	Up to 142m, hybrid concrete-steel	Novel design approach, built on 15 years HSG experience; IEC II model planned
Lagerwey N100 (Netherlands)	IIIA	2.5MW	100m	DD, PMG	Up to 135m, in-house developed steel shell tower	Lightweight direct-drive turbine with novel passive air-cooled PMG, designed and built in-house

model is the combination of W2E's patented Larus Compact with Winergy's medium-speed HybridDrive in a compact flanged drive system solution.

Larus Compact comprises a single rotor bearing and a large-diameter shaft coupling that transmits rotor torque to the flanged HybridDrive via an annular array of flexible elastomer elements. Rotor-bending moments are led directly via the rotor bearing and main carrier into the tower.

Winergy claims total system conversion efficiency (gearbox plus generator) to exceed 96.5%. Germany's environment ministry provided financial support to W2E in recognition of the innovative nature of the project.

BRONZE Enercon E-101

The 3MW E-101 builds on Enercon's long experience with direct-drive technology. The company has built 21,500 direct-drive turbines ranging in capacity from the minuscule (30kW) to the mighty (7.5MW). The E101 turbine introduced Enercon's latest thinking on drivetrain technology — a new water-cooled electrically excited synchronous generator, a principle that does not require rare earth metals.

Enercon built an advanced multi-storey facility to manufacture the E-101's blades. The automated production processes, in which unfinished blades in mobile mould vehicles move along pre-determined stations, was derived from Enercon's advanced foundry developed in-house.

The E-101 comes with industry-leading hub heights up to 149 metres. The in-house prefabricated hybrid concrete-steel towers have already been applied in thousands of Enercon turbines. A 2.5MW low-wind E-115 sister model supplements the E-101.

TURBINES 3.6MW+ *The titans of the wind industry, the biggest and most powerful machines now on the market*

MEDAL WINNERS

GOLD Siemens SWT-6.0-154

Now market ready, Siemens commissioned a 6MW direct-drive turbine prototype with 120-metre rotor diameter in 2011. Another prototype followed in 2012, with a rotor diameter of 154 metres. In 2013 two offshore prototypes with the shorter blades were installed in the UK, and a "market-ready" unit with the longer blades at a high-wind onshore test site in Scotland.

The cylindrical-shaped 6MW nacelle looks like a bigger version of Siemens' SWT-3.0-101, the main difference being the helicopter-hoisting platform to the rear of the nacelle. The water-cooled PMG is based on previous designs but with a larger 6.5-metre diameter.

Inside the nacelle a huge cast main carrier forms the central structural element, and to the front there is a remarkably easy internal service hub access via the hollow generator shaft and single rotor bearing inner ring. Two individual power-electronic converters are located inside the nacelle with a medium-voltage transformer.

The first prototype used SWT-3.6-120 rotor blades and hub, but for the SWT-6.0-154 Siemens developed longer 75-metre blades.

Despite the incorporation of converters and transformer in the nacelle, the SWT-6.0-154's head weighs only 360 tonnes, already considered an industry benchmark. Systematic testing and validation, together with an already healthy-looking order book, suggests the SWT-6.0-154 is set to become a worthy successor to Siemens' current offshore turbines.

Siemens SWT-6.0-154 The long-bladed prototype is sited onshore at a test site in Scotland

SILVER Alstom Haliade 150-6MW

The direct-drive Haliade 150-6MW has a 150.8-metre rotor diameter, and the drivetrain comprises a stationary hollow main shaft, a rotor hub with two bearings, and a 7.5-metre medium-voltage air-water cooled inner-rotor PMG. A clever and novel design solution is that the generator rotor part has its own bearing and is connected to the hub via flexible couplings. This Alstom pure torque principle enables full separation between rotor-bending moments, led directly into the support structure, and "pure" rotor torque fed into the generator without constraining the generator air gap.

The slender 73.5-metre GloBlade was developed with LM Wind Power. The power electronic converter and transformer are located in the tower foot to reduce head mass. A prototype was installed in early 2012, an offshore prototype in late 2013 with series production planned in 2014.

BRONZE Gamesa G128-5.0MW

This is the third medal for the Spanish firm that initially started making Vestas-type turbines, and gradually developed them in-house. The G128-4.5MW was the first major full turbine developmenet project for the company.

Gamesa's G128-5.0MW is developed from 2009's G128-4.5MW. Both models feature a tube-shaped CompacTrain drivetrain comprising a main shaft assembly flanged to a two-stage planetary gearbox and PMG drivetrain, pioneered with German engineering group ZF. It is claimed to enhance reliability by removing high-speed mechanical rotating components.

The 4.5MW onshore unit has segmented composite blades, but the 5MW versions for onshore and offshore use have single-piece blades. New is a G132-5.0MW onshore unit with 132-metre rotor and single-piece blades.

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