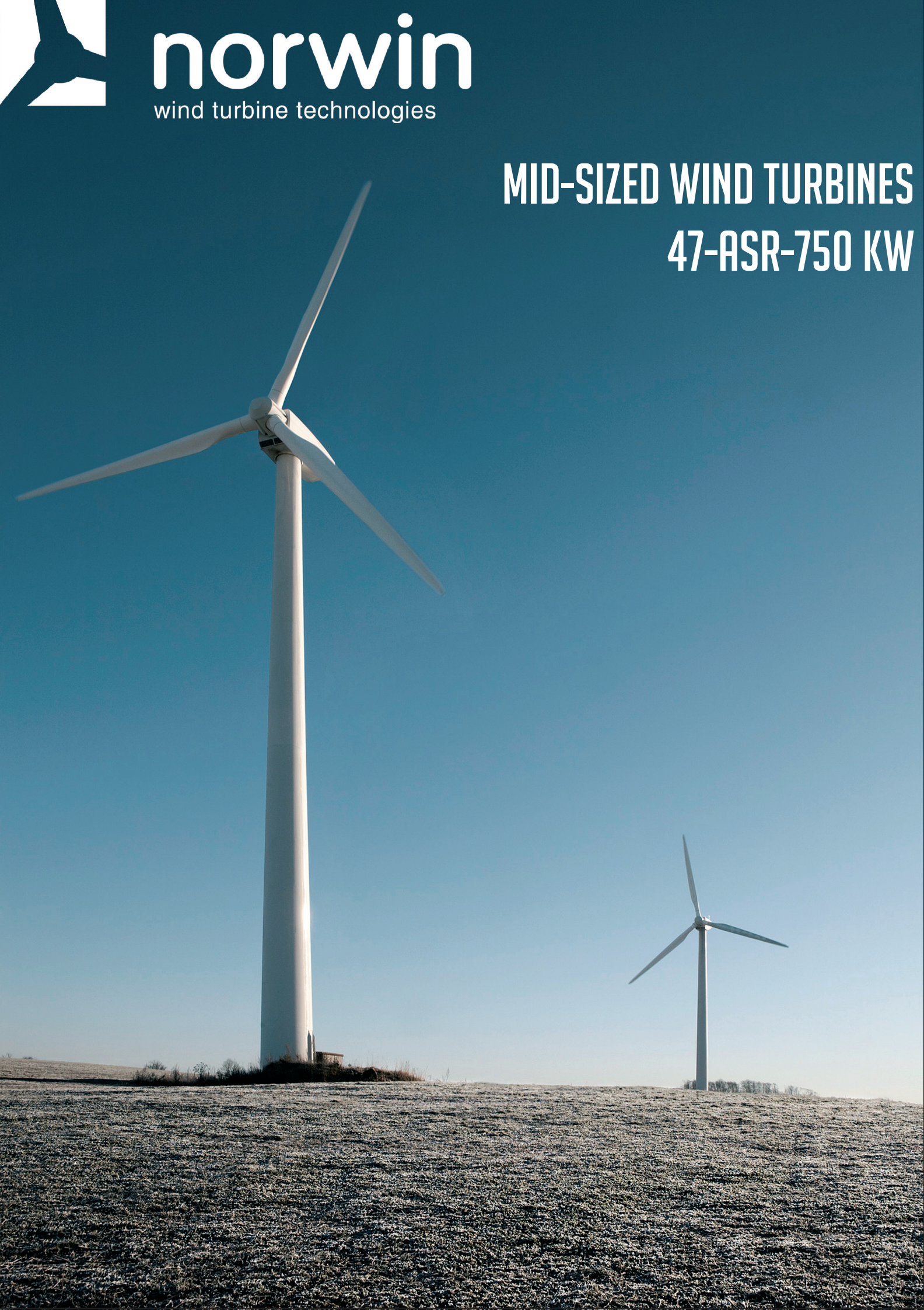
norwin
wind turbine technologies

MID-SIZED WIND TURBINES
47-ASR-750 KW



Norwin 47-ASR-750 kW

This ASR regulated wind turbine is designed for high wind speeds and turbulence and has a proven reliability from operation during many years in Denmark. With the IEC Class IB and IIA compliance and certificate from DNV the turbines fulfill requirements for installation almost anywhere. For lower wind classes a new 54m rotor is available.

ASR – Active Stall Regulation

The ASR system means that the blades are turned to obtain optimal operational conditions both at low and high speed. The system combines the advantages of pitching at lower wind speeds while utilizing the stall properties at high loads. This means that power fluctuations, which are common for normal pitch regulation, are avoided.

Nacelle and Cooling

The glass fiber nacelle provides standing height for service. Noise reduction ventilating ducts are integrated. Cooling and ventilation are controlled for nacelle, gearbox, and generator.

Rotor – Reliability from LM

The LM21P blade made by LM Windpower is mounted on extenders mounted on the hub. All blades act simultaneously when pitching. The hub is mounted to the forged flange of the main shaft with bolts.

Braking System

The mechanical safety brake is mounted on the high-speed shaft of the gearbox. A 'fail safe' spring type disk brake is activated instantly in case of emergency.

Heavy loads on the gearbox during braking are avoided by using the pitch system for aerodynamic braking.

Yaw System

The yaw system is a combination of a yaw brake and active yaw drives. The connection between the nacelle and the tower is through a four point ball bearing. The yaw drives are electrical driven standard units consisting of an electrical motor with brake included, a helical and a planetary gear. Apart from the brakes in the yaw drives, a hydraulic actuated disk brake system is installed. The yaw drives are actuated through soft starters, to equalize the torque between the motors, and to prevent a high peak torque in the starting situation.

Main Frame

The main frame is a relatively flat low-weight welded design, providing direct access from the tower.

Shaft, Bearing and Gearbox

The rotor, shaft and gearbox arrangement is designed to be highly flexible for movements in the yaw and tilt directions. The main shaft is connected to the main frame at the front with a roller bearing and a bearing truss. The main bearing absorbs the axial loads of the rotor. The rear bearing is integrated in the Winergy gearbox, which on both sides is connected to the main frame with a support including a rubber element. This

way the system is supported in three places, making the forces run smoothly from the rotor and into the tower. A large cooler with external fan cools the gear oil and the oil is, in parallel, passing through an off-line filter to secure clean oil.

Generator

The generator is mounted on the main frame behind the gear opposite the main shaft and connected to the gear via a flexible coupling. The standard generator is a closed asynchronous double-wound, induction generator.

Blade Turning System

The blade turning mechanism is placed inside the hub. The actuator is a hydraulic cylinder that, during normal operation, is supplied by a hydraulic power package through a proportional valve, placed in the nacelle. In emergency situations an accumulator system placed in the hub will make the supply.

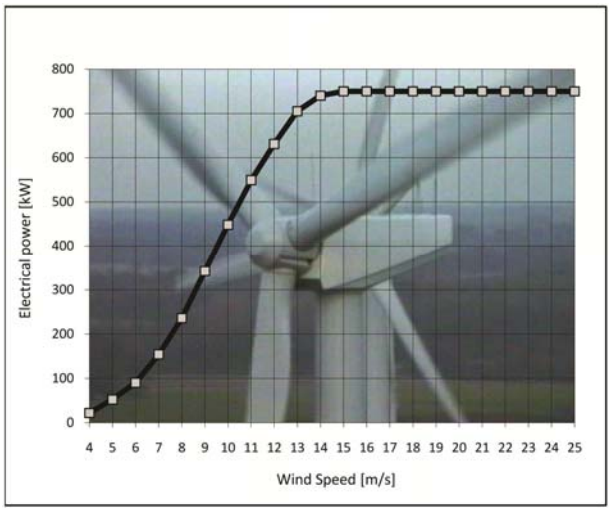
Controller

The main control panel is placed partly at the bottom of the tower partly in the nacelle. With the possibility of adjusting selected parameters, authorized personnel can change operational limits of the turbine directly on the front panel or by remote surveillance.

TECHNICAL DATA
NORWIN 47-ASR-750 kW

Nominal electric power:	200/750 kW
Power regulation:	Active Stall Regulation (ASR)
IEC wind class:	IB and IIA
Rotor diameter:	47 m
Rotor speed:	25.2 rpm at full load
Rotor:	Three blades placed upwind of tower
Swept area:	1735 m²
Tilt angle:	4°
Coning angle:	3.0° forward
Blades make:	LM21P
Tip speed:	63 m/s at full load
Pitch angle:	ASR control
Pitch bearings:	Slew rings (4 point ball bearing)
Air brake, normal:	Blade pitch to -20°
Air brake, emergency:	Blade pitch to -85° fail safe position
Nominal pitch speed:	7.5°/second
Mechanical brake:	Fail-safe type disk brake
Brake torque:	1.8 times of nominal torque
RPM max. value:	1600 (50 Hz) or 1920 (60 Hz), observed on the high-speed shaft
Generator:	Closed, asynchronous, 6/4-pole, induction, IP54
Generator speed:	1000/1500 (50 Hz) or 1200/1800 (60 Hz) rpm at sync. speed
Loss in generator:	3% at nominal power
Generator cut-in:	Thyristor controlled gradual cut-in
Grid connection:	50 Hz - 690 V or 60 Hz - 690 V
Yaw motors:	4 pcs. with electrical brakes built in
Yaw brakes:	4 pcs. hydraulic brakes of disk brake type
Yaw bearing:	Slew ring (4 point ball bearing)
Tower type:	Conical steel tower (40-65m hub height)
Controller:	PLC or microprocessor based
Cut-in wind speed:	3-4 m/s
Cut-out wind speed:	25 m/s, based on 5-min. average
Mass of blade:	6600 kg (total 3 pieces)
Mass of hub:	8000 kg
Mass of nacelle:	24000 kg
Mass tota, excl. tower:	38600 kg
Reference noise level:	100 dBA

POWER CURVE AND ENERGY PRODUCTION
NORWIN 47-ASR-750 kW

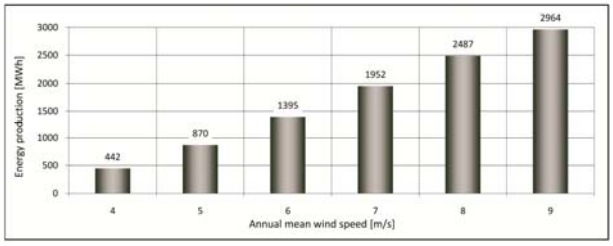


The power curve is for our 750 kW turbine, with a rotor diameter of 47 m, two stage generator and featuring Active Stall Regulation. A system that among others compensate for the natural variations of the stall level due to variations in air density and pollution of the blades.

The power curve is valid for: 1.225 kg/m3 air density, clean blades, undisturbed horizontal inflow and 10% average turbulence.

Wind speed [m/s]	Elect. power [kW]	Thrust coeff. Ct
3	3	0.80
4	22	0.88
5	52	0.85
6	90	0.83
7	154	0.79
8	236	0.75
9	342	0.70
10	448	0.64
11	549	0.58
12	631	0.51
13	705	0.45
14	740	0.40
15	750	0.36
16	750	0.31
17	750	0.28
18	750	0.26
19	750	0.23
20	750	0.21
21	750	0.19
22	750	0.18
23	750	0.17
24	750	0.16
25	750	0.15

The annual energy production is calculated for different annual mean wind speed in hub height. A Rayleigh wind speed distribution and 100 % availability is assumed.



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