The experience of a multipole wind turbine manufacturer

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ENERCON Sales-Tech. Support
Topics of the presentation

- Introduction to ENERCON
- ENERCON production facilities
- First concept of ENERCON wind turbines
- Main exchanges in our history:
  - New concept of ENERCON wind turbines
  - Remote Management & Communication system
  - New rotor blade design
  - Introduction of the concrete tower type
  - Customer relation management
- Impact on Grid Codes
ENERCON GmbH - Introduction
Since 1984...

1984
- Founding of ENERCON GmbH

1991
- Development of ENERCON's gearless generator design

1993-1998
- New production facilities in Magdeburg, India, Brazil, as well as serial production of E-30, E-40, E-66 and installation of first desalination plant

2004
- Installation of first E-70 with 2 MW and new rotor blade design

2005
- Commissioning of E-20 / E-53 prototypes, further development of E-112 to E-126

2006
- New precast concrete tower facility in Emden

2007
- New production site in Portugal and installation of E-126 (6 MW) prototype

2008
- Launching and christening E-Ship 1
ENERCON
Own experience from serial production

Generator

Rotor blades

Hub (mechanical components)

Tower (steel / concrete)

Electronics components

Foundation

Grid connection
ENERCON production facilities worldwide
Germany/Portugal/Turkey/Sweden/India/Brazil

**Sweden (Malmö)**
*ENERCON Windtower Production A.B.*
- Tower production

**Germany (Aurich / Emden / Magdeburg)**
- Head office (Aurich)
- Research & Development
- Production

**Portugal (Viana do Castelo)**
- Rotor blade production, concrete towers,
- E-modules and generators
- Production & assembly E-82

**Turkey (Izmir)**
*ENERCON AERO Turkey*
- E-40/E-48, E-70/E-82
- Rotor blade production

**Brazil (São Paulo/Fortaleza)**
*Wobben Windpower Ltda.*
- E-40/E-48 production
- E-70 rotor blade production

**India (Daman)**
*ENERCON India Ltd.*
- E-30/E-33 and E-40/E-48 production
ENERCON production facilities worldwide
Germany/Portugal/Turkey/Sweden/India/Brazil

Rotor blade production
8 facilities worldwide

Generator production
5 facilities worldwide

Electronics
4 facilities worldwide

Tower production
5 facilities worldwide

Assembly
5 facilities worldwide

Total production area
approx. 450,000 m²
(from 2008)

= approx. 47 SOCCER PITCHES
ENERCON technology
ENERCON old concept on E15 / E17 / E32

~ Variable speed
~ 1985 - 1989: 45 units

~ Variable speed
~ Compact design
~ 1987- 1994: 156 units

~ Variable speed
~ Pitch regulation
~ 1989- 1993: 187 units
ENERCON’s target:

- Create one reliable and robust wind turbine concept that can be easily
  - increase the power output
  - everytime updated with the most demanding Grid Codes

- New concept of Wind turbine: direct drive, no gearbox and own generator

![Diagram of wind turbine components]

- Hub
- Drivetrain
- Gearbox
- Brake
- Generator

- Stator Carrier
- Hub
- Bearings
- Generator
- Rotor
- Stator
- Axial Pin
Main exchanges
Wind turbine concept (I): Gearless drive and variable speed

- Generator:
  - Stator
  - Rotor
- Rectifier
- Control cabinet
- Excitation
- Pitch Drives
- Yaw Drives

ENERCON GmbH 2009
Main exchanges
Wind turbine concept (I): Full scale power electronics
The **power electronic devices** play a major role in the actual ENERCON wind energy converters.
Main exchanges
Wind turbine concept (I): Advantages

- Direct Drive Concept
  No Gearbox
- Variable speed operation
- Slow machine rotation means low wear
- Low machine stress due to high level of speed variability
- Yield-optimised blade design and WEC control
- High hub heights for increased steady yield
- Full scale power electronics for power plant capabilities
- FACTS Capabilities meet the most advanced grid codes and connection requirements
Off-times of Wind Turbines in Germany
Data from failures in the components


Can be expect ~50% less down-time due to failures with ENERCON turbines!
The ENERCON SCADA SYSTEM:

- Developed by ENERCON was launched in 1998
- Used in more than 13,000 wind turbines worldwide.
- Data acquisition, remote monitoring, and open-loop and closed-loop control for wind farms.
- It enables the customer and ENERCON Service to monitor the operating state and to analyse stored operating data.
- Authorised users may use it to modify the operating parameters of the wind turbines and the grid connection.

Improvements in the last years:
- Fibre-optics cabling instead of copper cables;
- OPC interface with LINUX OS (reliable and more user-friendly);
- SCADA Interfaces with different protocols used by customers and System operators (connection to dispatch centers);
Higher efficiency due to the modified blade design:
- The wind turbines reach a maximum Cp of 0.516 (51.6%) (highest Cp ever measured)
- Less noise emission due to optimised blade tips
- Longer service life due to reduced stress
- Transport facilitated due to streamlined blade design

Production features: Vacuum infusion and sandwich technique
Main exchanges
Introduction of concrete tower type (IV)

Installation inside concrete towers

- Higher tower heights compared to a steel tower;
- Less vibrations and oscillations as the steel tower and as a result slightly higher energy yield;
- Smoother running of the wind turbine, no drone (resonating body);
- No corrosion effects;
- Less maintenance;
- Less dependance on the steel;
- Higher availability due to more ENERCON production facilities;
Main exchanges
Customer Relation Managment (V)

Concept of partnership Customer-ENERCON Service during the time life of the Wind Turbines means:

**ENERCON PartnerKonzept (EPK)**

- ENERCON guarantee of at least 97 % technical availability of the Wind Farm;
- Profit-oriented cost structure (calculable operating costs);
- Term of contract up to 15 years;
- Remote control (24 h) by ENERCON SCADA;
- Predictive Maintenance (Visual, Electric and Greasing);
- Unscheduled maintenance (Faults);
- Reparation;
- Maintenance and Repairs only done by ENERCON Service teams;

More than 90% of the O&M contracts are EPK contracts (full maintenance)!
### Results of the 2008 survey on service

<table>
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<tr>
<th>Manufacturer</th>
<th>Enercon</th>
<th>Repower Systems</th>
<th>Vestas</th>
<th>Nordex</th>
<th>Siemens</th>
<th>GE Energy</th>
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<td>New Energy magazine. April 2009. No. 2</td>
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**Manufacturer:**
- **Enercon**
- **Repower Systems**
- **Vestas**
- **Nordex**
- **Siemens**
- **GE Energy**

**Weighting:**
- W = 6
- R = 4
- N = 6

**Unscheduled or service maintenance or repairs:**
- Poor [2.20]
- Satisfactory [2.62]

**Quality of work performed:**
- Good [2.26]
- Satisfactory [2.62]

**Results:**
- Average score range: 2.00 to 5.00
- Higher scores indicate better service satisfaction

**Source:** New Energy magazine. April 2009. No. 2
Impact on the grid codes
ENERCON technology

ENERCON wind energy technology for efficient power feed

✓ Intelligent and flexible grid management system;
  ✓ Active power control
  ✓ Wide voltage and frequency ranges;
  ✓ Power-frequency control
  ✓ Reactive power management

✓ ENERCON first company to obtain certification for WECs with power plant properties
  ✓ Support to the grid during short circuits, bottlenecks and other grid faults;

✓ WEC and Grid connection monitoring through ENERCON SCADA;
ENERCON’s Overview

**Productions:**
- Rotor blades

**Planning:**
- Site planning
- Planning permission process
- Grid codes
- Feasibility & financing

**Installation period and service:**
- Transport and installation
- Access roads
- Foundation
- Grid connection
- Maintenance & repair

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**Expert consulting & customer care**

**Highly qualified employees**

**Years of experience**

**High quality**

**Minimized supplier risk**

**Engineering & development**

**Logistics & installation**

**Long-term partnership**

**Customer-oriented service**
Thanks for your attention!