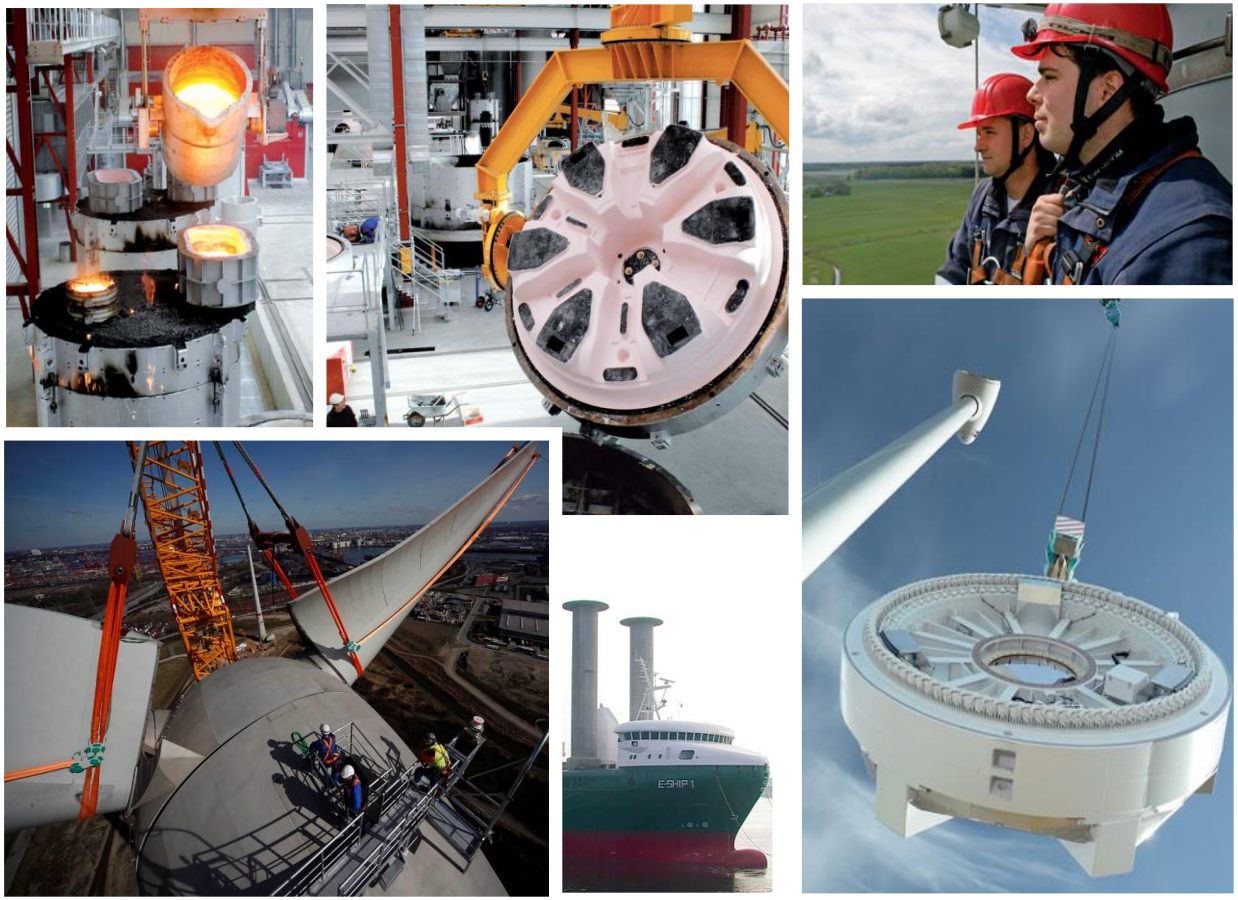
Innovative Wind & Hybrid Systems for Mines & Remote Microgrids.

Adrienne Downey, ENERCON Canada

26.06.2013, Toronto



Privately owned, multinational, state-of-the art wind turbine manufacturer

Guaranteed technical availability

- 97% per annum
- Reimbursement for lost yield
- Steady yield provides planning and financial security

EPK Coverage

- All maintenance service and repair costs
- Cost of main components and transportation
- Reduced uncertainty against unforeseeable events

Above average contract periods

- Contract periods ranging from 12 – 15 years
- EPK follow up package available for 15 – 20 years

ENERCON Projects across Canada

Challenges faced by Renewable Energy Projects in Remote Areas

Exposure: Storms, Wind, Ice, Marine & Saltwater

Local supply chain & construction services available

Cold Climate Operation < -40°C

Site Logistics for Component Shipping, Cranes

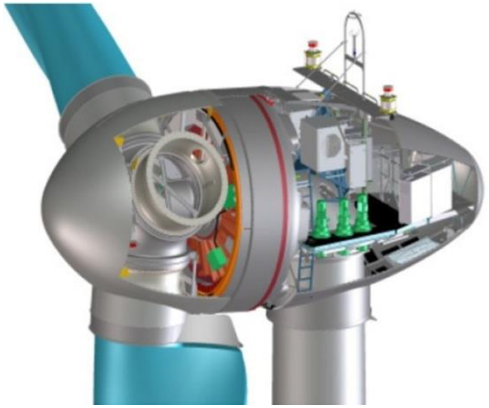
Site Logistics for Component Shipping, Cranes

Grid? Stabilization & Integration (f, V):
Event Ridethroughs UV/OV, Distances & Reactive Power Losses

Data acquisition & remote monitoring systems

O&M:
Personnel, Training, Dedication & Availability of Maintenance Teams, Replacement Parts

Turbine Design: Based on Robust Platforms



V_{avg} of 7.0 m/s
@100m

Gross AEP MWh/a

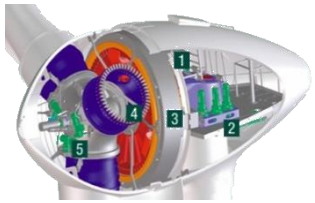
10,000
8,000
6,000
4,000
2,000

E-66
E-66/E-70
E-82
E-101
E-115
E-92

- Robust platforms with +21,0000 WECs installed worldwide
- Continuous improvement in annual energy yield
- Turbine options for IEC class I, II and III regimes
- Turbine capacities: 800kW-7.5MW

1995	1999	2002	2003	2005	2009	2010	2011	2013	2014
E-66	**E-66**	**E-66**	**E-70**	**E-82**	**E-82**	**E-82**	**E-101**	**E-92**	**E-115**
1.5 MW	**1.8 MW**	**2.0 MW**	**2.3 MW**	**2.0 MW**	**2.3 MW**	**3.0 MW**	**3.0 MW**	**2.3 MW**	**2.5 MW**
Ø: 66 m	Ø: 70 m	Ø: 70 m	Ø: 71 m	Ø: 82 m	Ø: 82 m	Ø: 82 m	Ø: 101 m	Ø: 92 m	Ø: 115 m

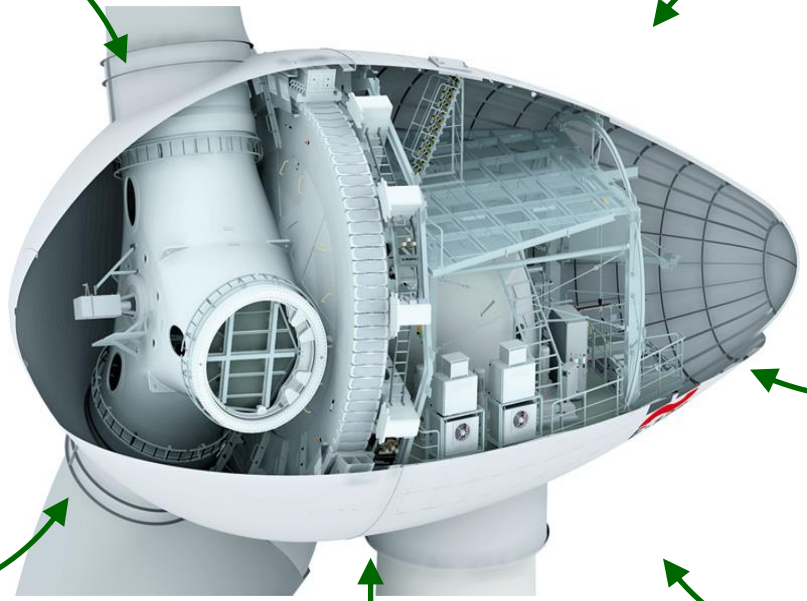
Turbine Design: Incorporating Proven Technologies



Direct Drive Generator
18+ years

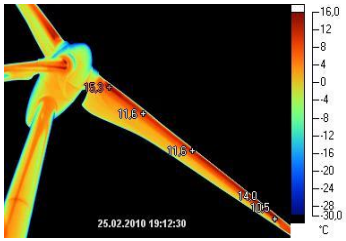
Rotor Blade
8+ years

Full scale Inverters
18+ years



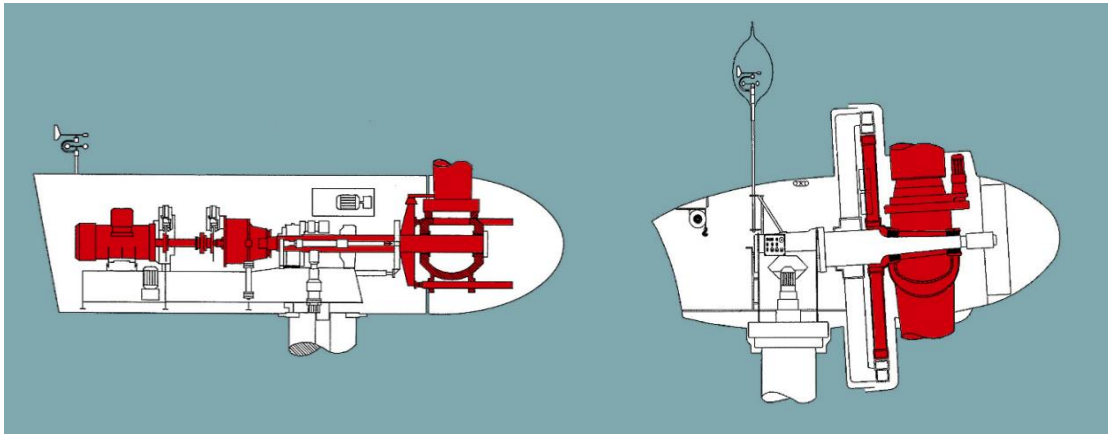
Cast Components

Concrete Towers



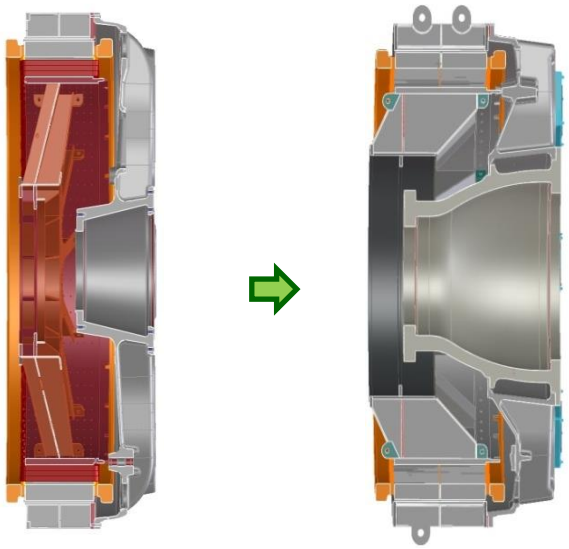
De-icing systems

Storm Control



Conventional geared generator

Direct drive synchronous generator



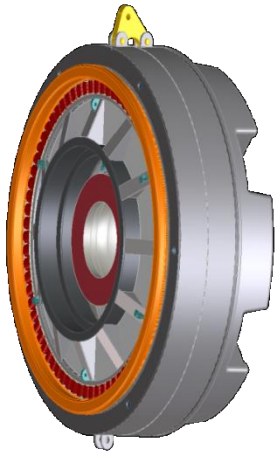
E-82 generator

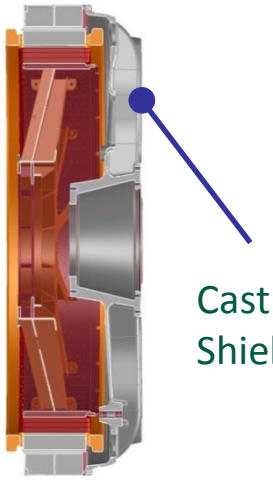
E-101 generator

Maximize Yield

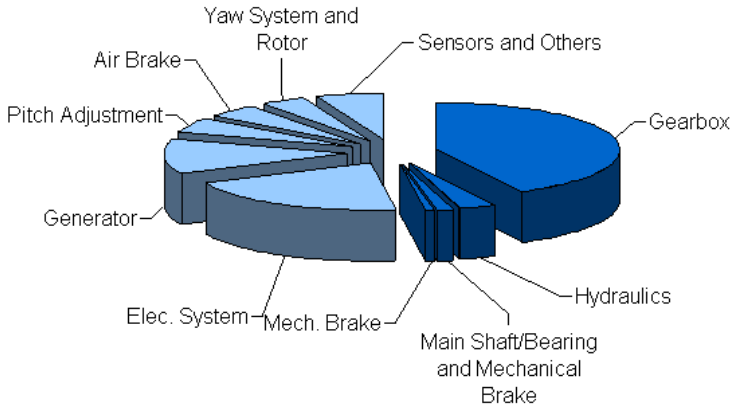
- Higher yield due to reduced losses – no drive train losses
- Generate power at variable rpm
- Very low cut-in wind speed 2-2.5m/s
- 20 years of revolutions by an ENERCON generator are done in 3 months by a geared turbine

Direct Drive Generator





Minimized downtime due to mechanical failure.
(Statistical Basis: 4,737 turbines in Germany with 16,988h accumulated downtime, Q3, 2008)



Mechanical failures non-applicable to ENERCON designs

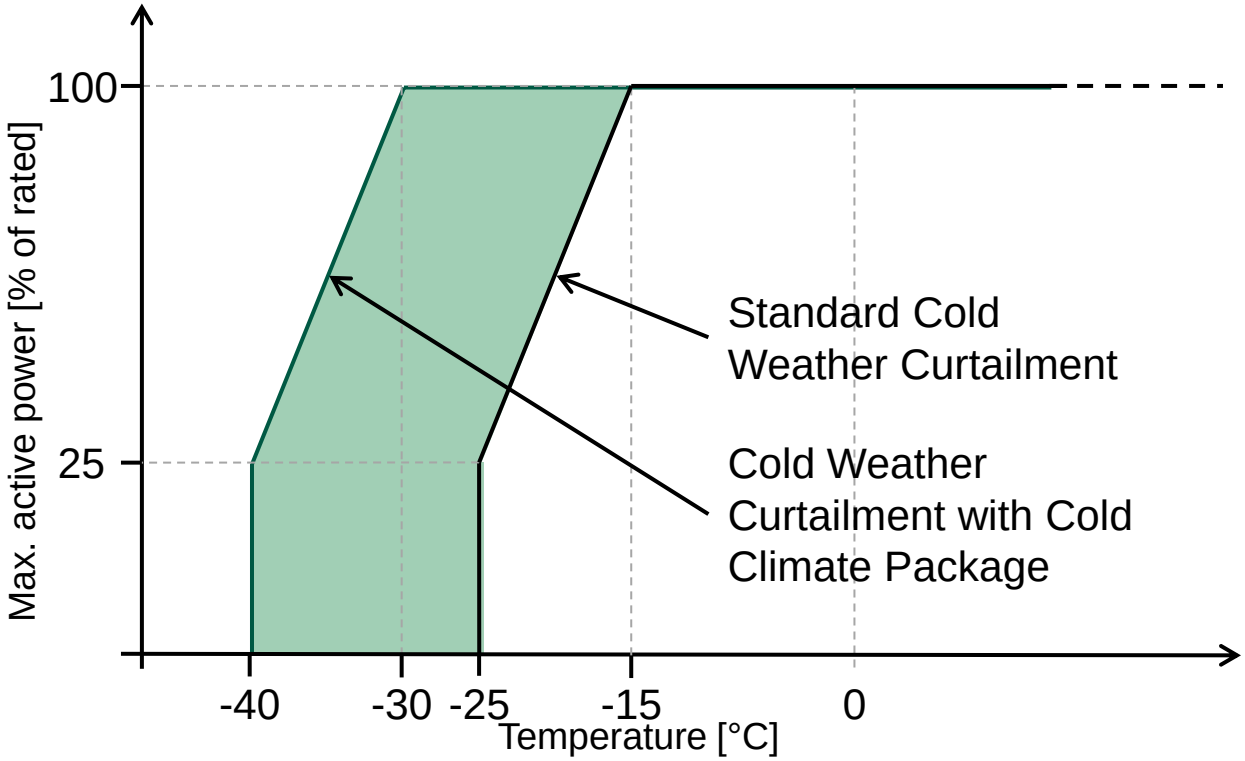
High Reliability

- Fewer rotating components – reduced abrasion and dynamic stresses
- Minimum of lubricant required
- Low speed operation - reduced vibration of the nacelle
- Low stable operating temperatures, High efficiency at low temperatures

The Result: Peace of mind

- Failure rate less than 1 in 7,200 turbines/year ~0.014% failure rate

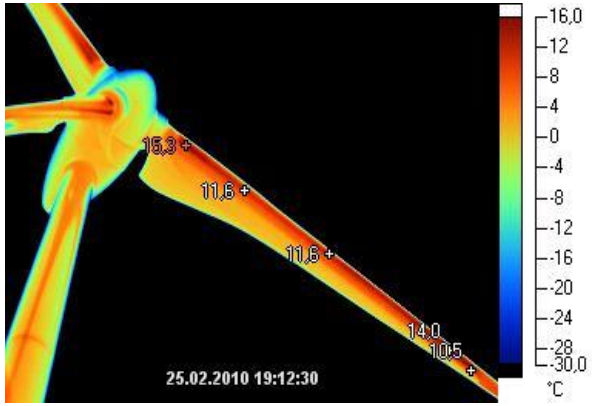
- WEC output needs to be limited at low temperatures to avoid damage
- Operation at 100% or rated active power down to -30°C possible
- Modified Components and Consumables (Castings, Tower design & mettalurgy for cold operation, Lubricants)

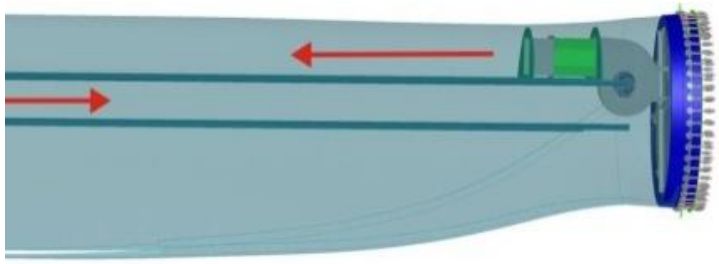


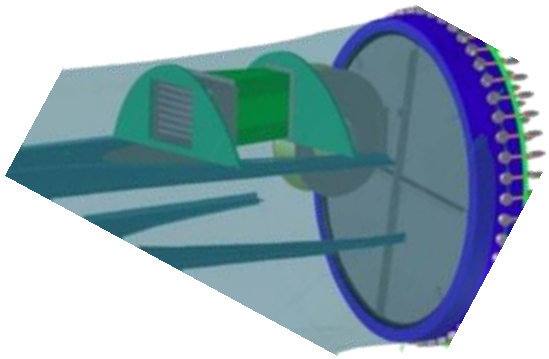
Blade de-icing system

Without de-icing system

With de-icing system

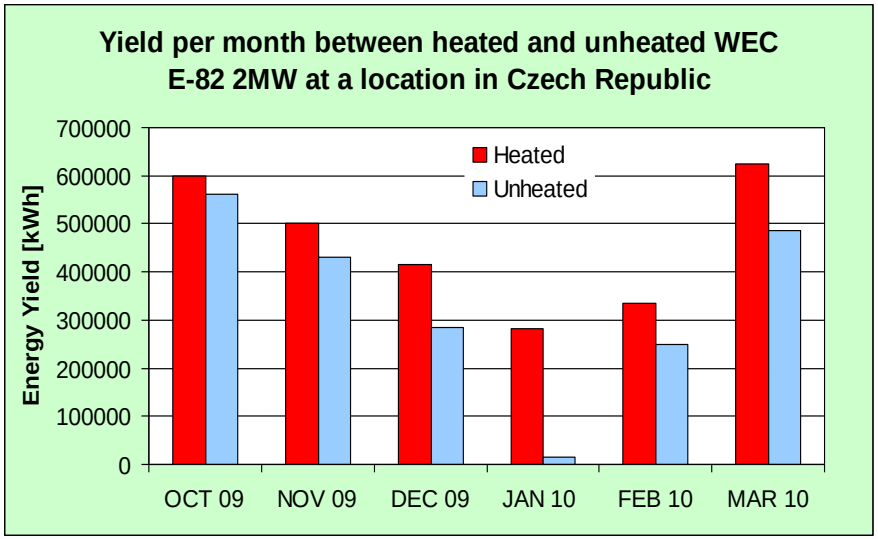






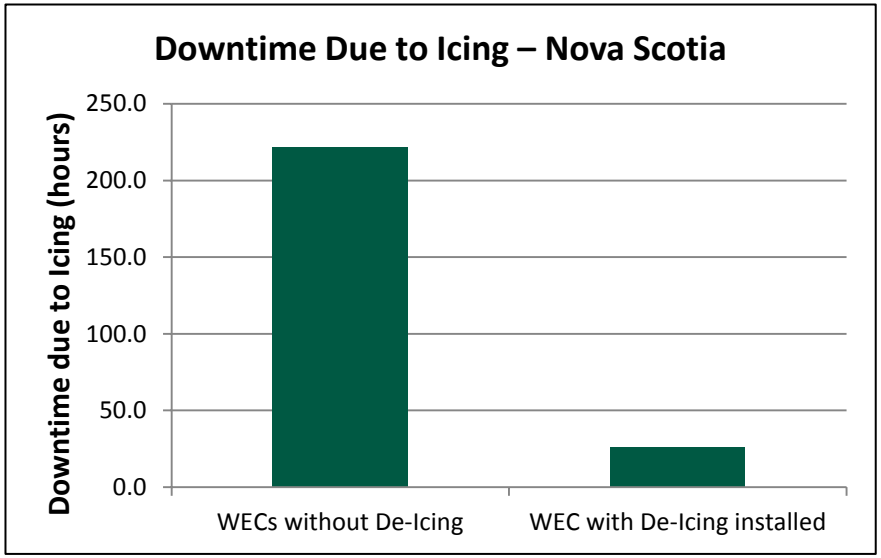
- Innovative and accurate ice detection system
- Recirculating hot air for uniform heating
- Preemptive de-icing; no stoppage in energy production

De-Icing Performance



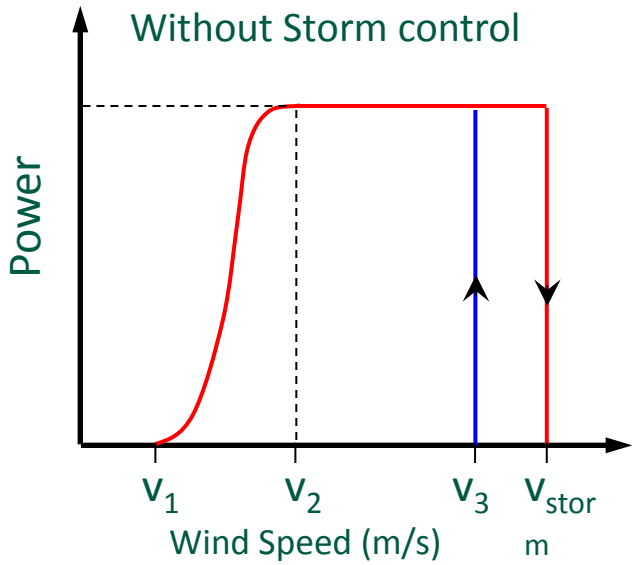
Europe

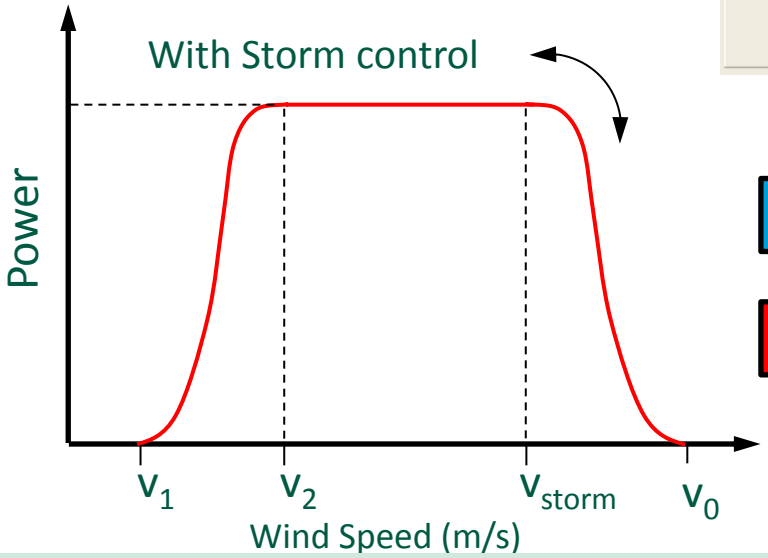
- 2 case studies: Dragaliden, Sweden; Krystofovy-Hamry, Czech Republic
  - Reductions in downtime due to icing: **93.5%** and **87.6%** respectively
- 30% extra yield during six month winter period in Czech Republic

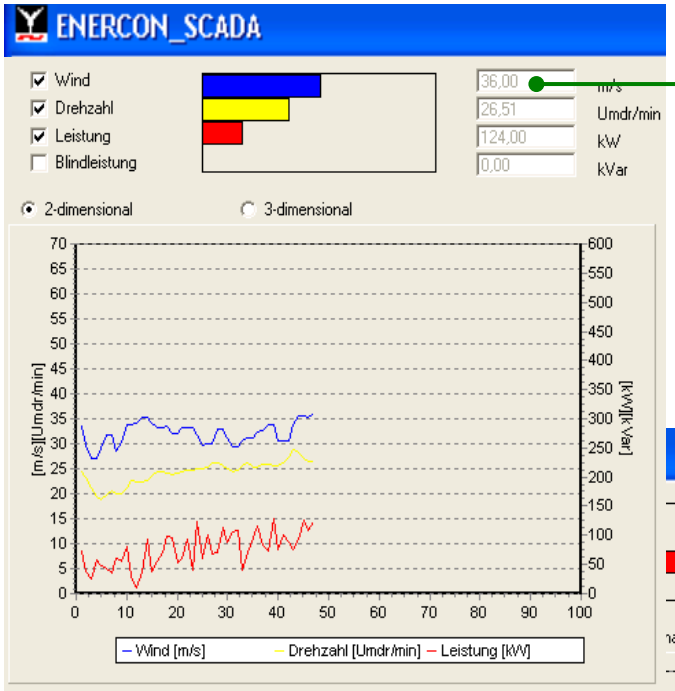


Canada

- De-icing systems installed in a number of locations:
  - 1 x E-53, 800kW (2011)
  - 28 x E-82, 2.3MW (2011)
  - 60 x E-70, 2.3MW (2012)
- Data from 2012 shows drastic decrease in downtime due to icing:
  - **88.3%** reduction compared to WECs without de-icing installed

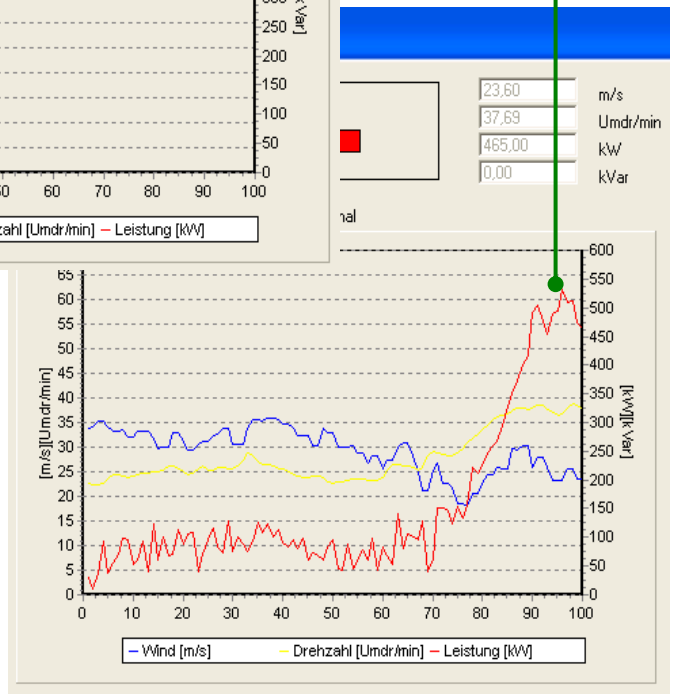






WEC in operation until 36 m/s

Full operation

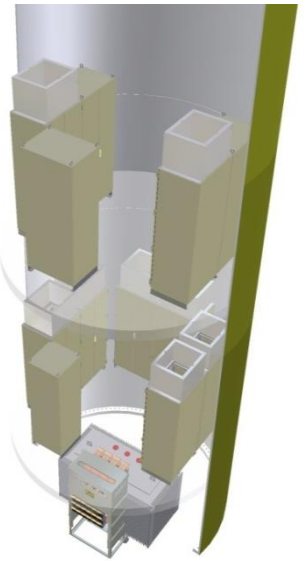


Wind Speed

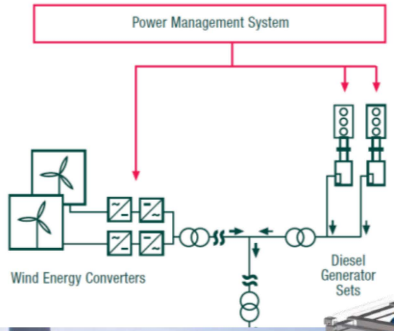
Power

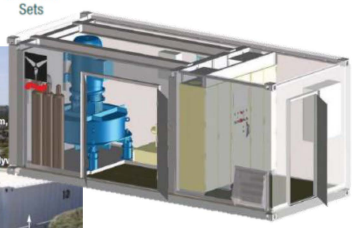
ENERCON Converter

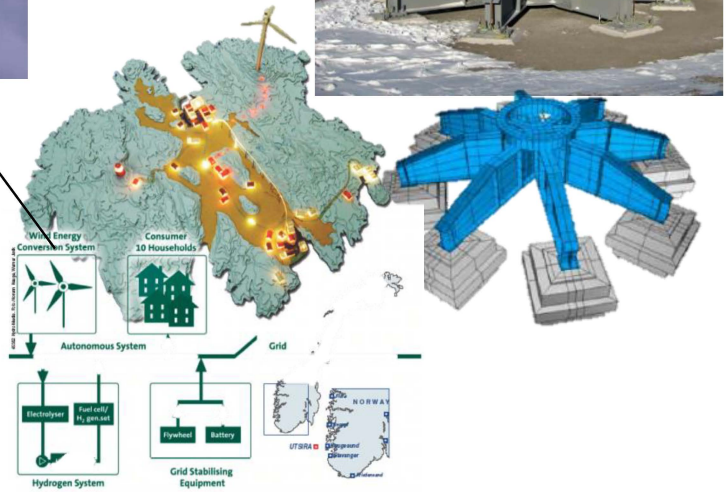
- High compatibility with actual advanced grid codes due to the flexible ENERCON grid management system and its full-scale power electronics
- Superior power quality characteristics with low flicker and harmonics
- Flexible and dynamic control of active and reactive power at WEC and wind power plant level.
- Strong support for power system stability during short circuits and other power system disturbances
- No stress or additional loads for the mechanical components because of faults in the power system.
- From small scale distributed generation to large scale wind power plants.



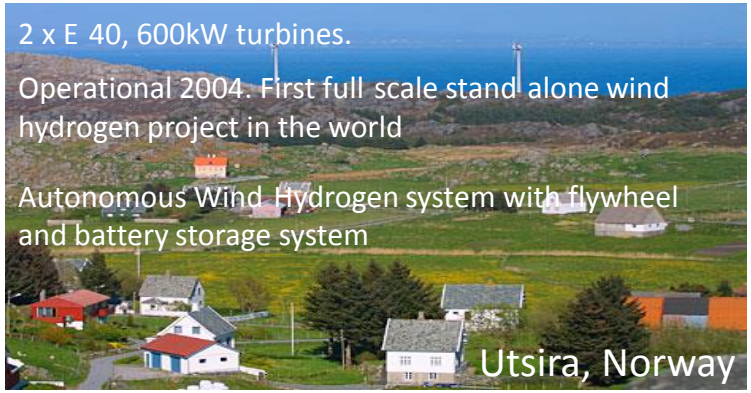
Project Design & Management: Beyond Turbine Supply

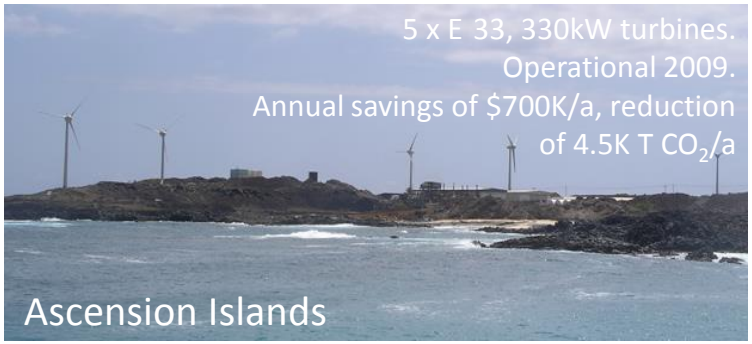


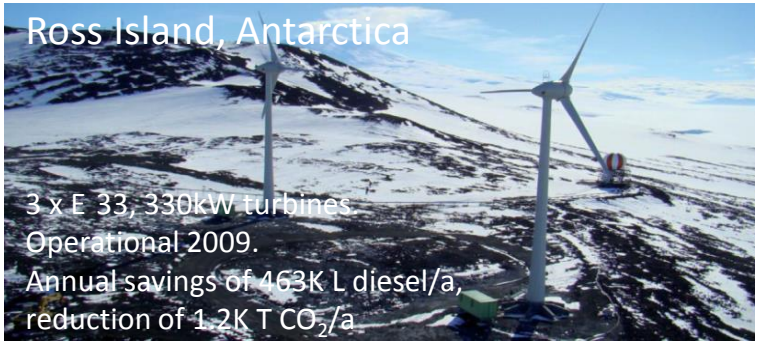




ENERCON Remote Projects Around the World





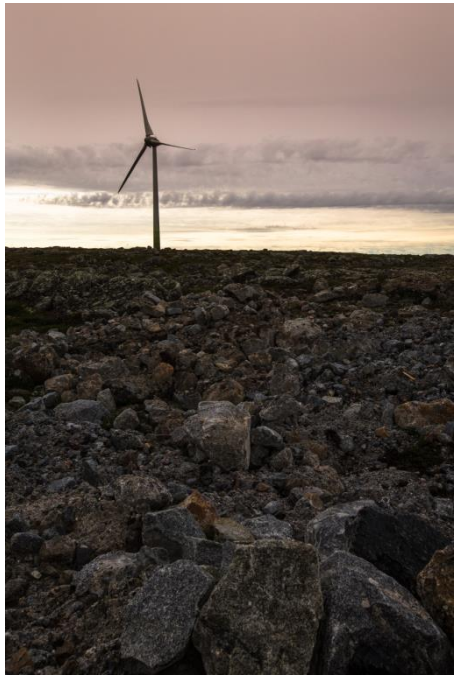


Celebrating Important “Firsts”: Remote Mining Supply in Canada

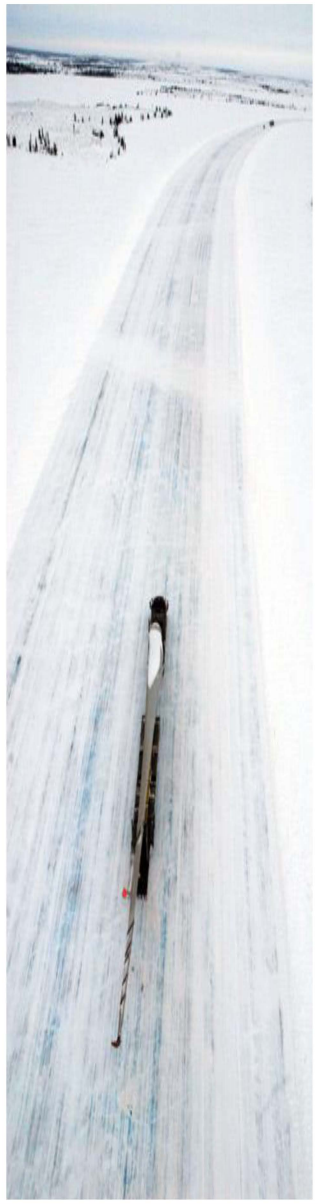
Diavik, North West Territories

Diavik Diamond Mine, North West Territories

- Rio Tinto
- 4 x E-70 2.3MW = 9.2MW
- Offset 4.3 millions liters of diesel per year (10% Displacement of existing diesel grid)
- Turbine operational down to -40°C
- First large wind park on mining site in Canada



Diavik Diamond Mine, North West Territories



The Future of Canada's North

Diesel bills spur wind hopes in far north

Canada's northern territories are pursuing smaller-scale wind development as they seek to reduce dependence on expensive imported diesel generation.

Yukon and Nunavut territories are exploring a number of publicly funded projects. Diavik Diamond Mines is meanwhile in the home stretch on the first industrial-size Arctic wind project in the Northwest Territories.

"We are in the final stages of commissioning and have targeted October as the month for completion," said Diavik spokesperson Corey McLachlan.

Enercon erected four 2.3MW turbines at the isolated mining operation. The site, located on an island in Lac de Gras, 300 kilometers northeast of Yellowknife, is only accessible by road for eight or nine weeks a year.

All turbine components were trucked in last winter over a 600-kilometer temporary ice road built across the tundra and lakes.

The cold-climate turbines, which are guaranteed to operate down to minus 40 degrees Celsius, will be integrated into an existing diesel-powered system. "The turbines have produced over 250,000kWh to date," said McLachlan.

Diavik, a joint venture between mining giant Rio Tinto and Harry Winston Diamond Corporation, expects the 9.2MW wind project to reduce diesel generation by 10%, saving C$5m to C$6m a year in fuel costs.

Tundra turbines : the hardware at Diavik's 9.2MW wind farm is guaranteed t 40 degrees Celsius

The government of the Northwest Territories is working on a number of small early-stage wind-diesel schemes in remote settlements.

The Ross River Dena Council received federal funding to develop potential wind and run-of-river hydro projects in conjunction with the proposed Selwyn Chihong zinc-lead mining project, which straddles the Yukon and Northwest Territories border

The First Nation group plans to create a clean energy inventory and assess commercial opportunities to develop generating facilities throughout its traditional territory.

Yukon Energy is developing a 21MW wind project at Tehcho (formerly Ferry Hill) near Stewart Crossing. The utility installed wind resource monitoring equipment in 2011. Initial data shows a 10-turbine array could produce about 56GWh/year.

Yukon Energy said high costs make it unfeasible to build a wind farm now. However, it plans to complete development "to have this project shelf-ready for a time when it

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Thank you for your attention.

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