

Industry meets science

14 Feb 2013



KONGSBERG

Presentation overview

- Global macro trends – Why invest in wind
- The Norwegian possibilities
- Future developments of Wind energy
- The wind business culture

Global macro trends – Why invest in wind



Electricity demand ➡ 2X by 2030



Population ➡ 8 billion by 2030



Security ➡ increased energy security concerns



Environment ➡ 50 countries have renewable targets



Energy prices ➡ Wind cheapest by 2020

Changing energy needs drive new opportunities

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The Norwegian possibilities



«Det er typisk norsk å være god»

"It is typically Norwegian to be good»

Gro Harlem Brundtland-1992

Let's be a bit more specific.....

The Norwegian possibilities

Referanse:

Torger Reve og Amir Sasson (2012): Et Kunnskapsbasert Norge.
Universitetsforlaget.

For Norway, it's all about water and the sea

Identified 3 knowledge hubs

- 1.Oil and gas
- 2.Maritime
- 3.~~Seafood~~ – obviously not important for wind

Oil and gas will together with the maritime knowledge hub melt into one main knowledge hub called Offshore.

Norwegian offshore technology can compete and contribute significantly to the renewable energy segment.

Norwegian Hydro power knowledge could, combined with the Offshore knowledge, be a potential game changer for offshore wind. This knowledge can also be utilized for Onshore wind.

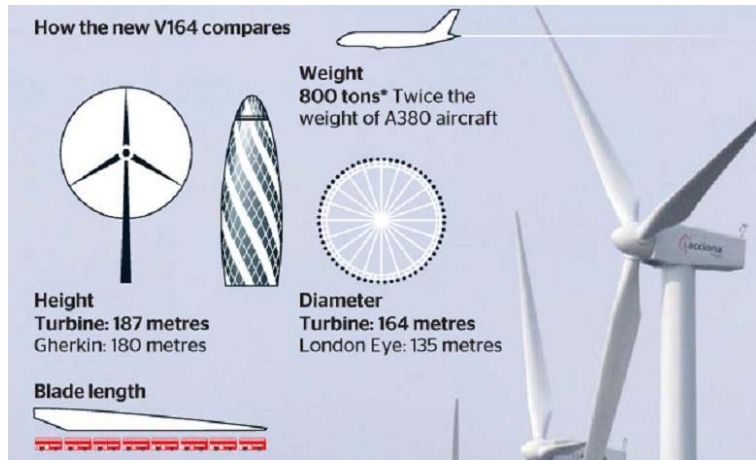


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Wind Turbine Development Trends

Historically cost-out has been achieved by R&D (40%) and economies of scale (60%) (source: TPWind)



Going bigger and taller

1980 – 50 kW,	Ø15m
1990 – 500 kW,	Ø40m
2000 – 2 MW,	Ø80m
2010 – 5 MW,	Ø130m
2020 – 10-15MW,	Ø150-180m

$$P = \frac{1}{2} \rho \pi r^2 V^3$$

Going from the reactive to the proactive turbine

- Predicting turbine output through forecasting
- Long term production planning
- Improved wind measurements
- Wake and turbulence prediction
- Wind speed measurements
- Condition monitoring
- Remaining lifetime calculations
- Climate change scenarios



Future developments of Wind energy

R&D focus on:

- Aerodynamic improvements (focus on the long blades)
- New control systems for enhanced wind utilization and load mitigation
- Weight reduction
- New, automated manufacturing techniques
- Improved load calculations: rationalization of safety factors
- Reliability-based design (focus on pitch, electrical and drive-train)
- Better condition monitoring
- Increased focus on the output from the wind farm (less focus on the single turbine)
- Improved O&M based on Condition Based Monitoring
- Offshore foundations including mass-manufacturing.

Increased focus on standardization is important in order to drive costs in the right direction.

Let's challenge current opinions

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Wind business culture

- The wind business is still immature. In a much higher degree in Offshore Wind.
- “Do we have the right technology or could a wind turbine be something completely different”?
- Conservative business that have grown to be even more conservative driven by the current economic climate.
- Technology are driven by countries like Denmark and Germany (countries that Norway has a close relationship to).
- Largest markets are China, USA and Europe (with Europe in the forefront of the technology).

The conservatism in the business is it's biggest challenge but also our biggest opportunity!



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