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79. DPG-Tagung- Arbeitskreis Energie

Small is beautiful but big is better: the tale of wind energy technology development

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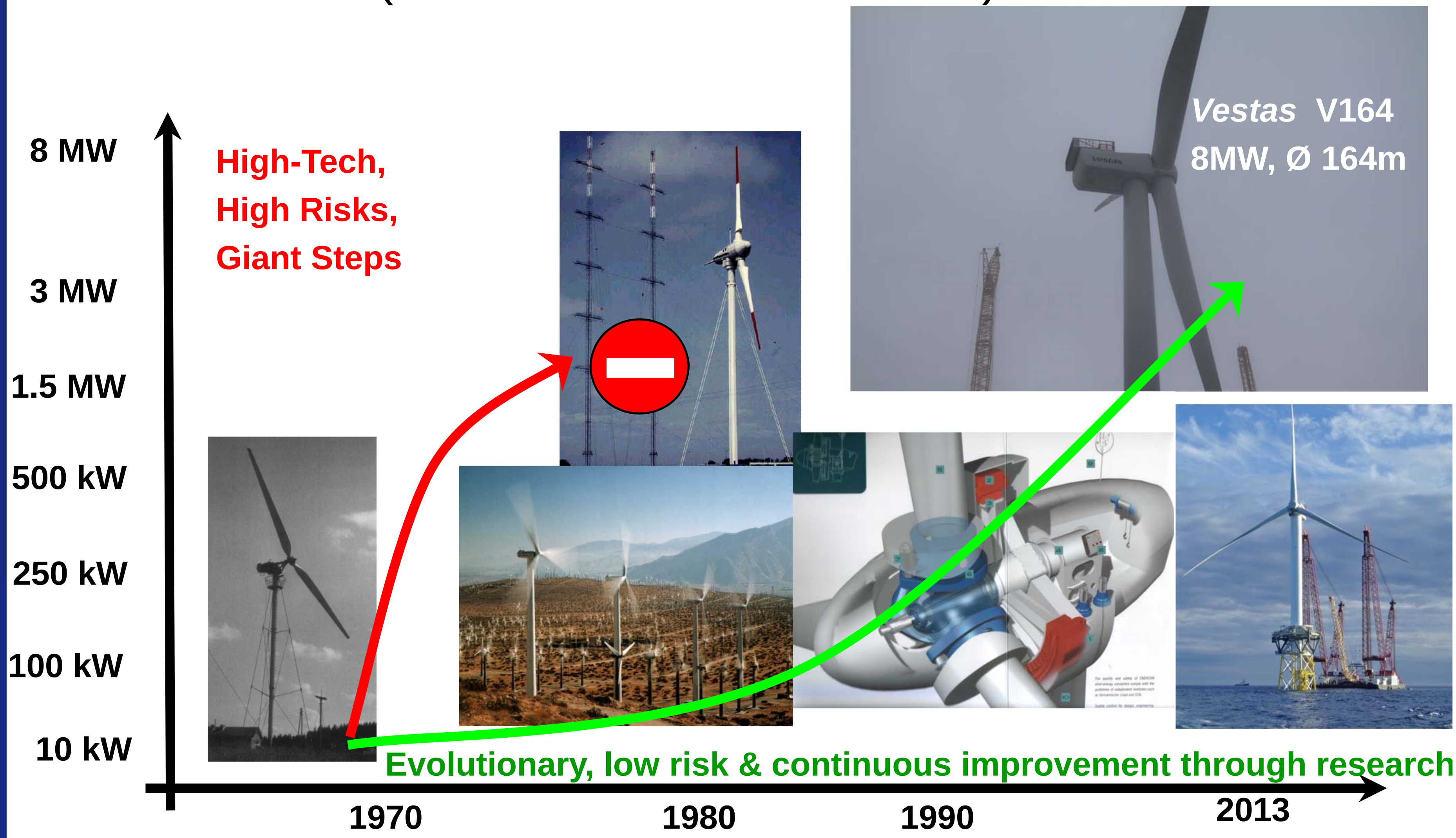
The Wind Energy Technolog Development

- **Where it started back in 1980 and key milestones**
- **Where we are today – onshore and offshore**
- **The quest for the lowest CoE , onshore and offshore**
- **Where we are heading tomorrow**
- **Conclusions and outlook**

Different Development Paths -> Different Fates
(small was indeed beautiful)



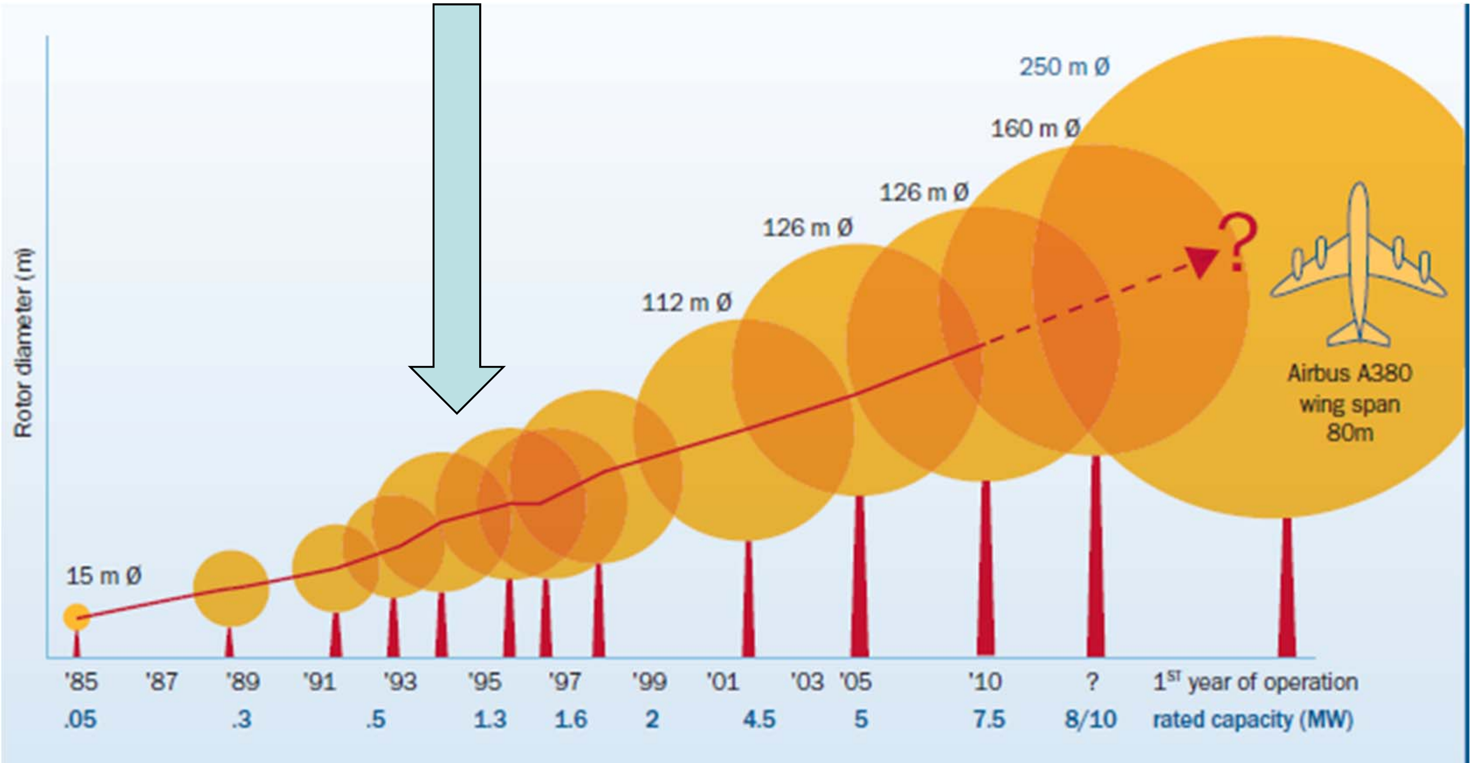
Wind Turbine Development Milestones

Starting point: 50kW, 3 blades, upwind, fixed speed stall regulated

Major milestones that propel the growth of wind turbine size

-Introduction of pitch system for multimegawatt wind turbine

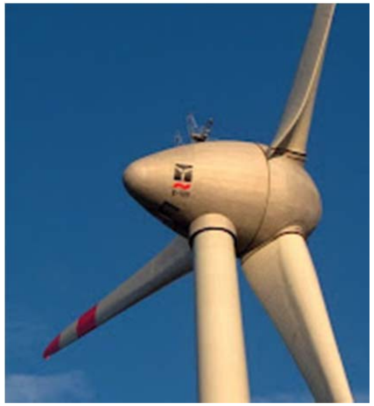
-DFIG concept and variable speed operation Cp-max tracking

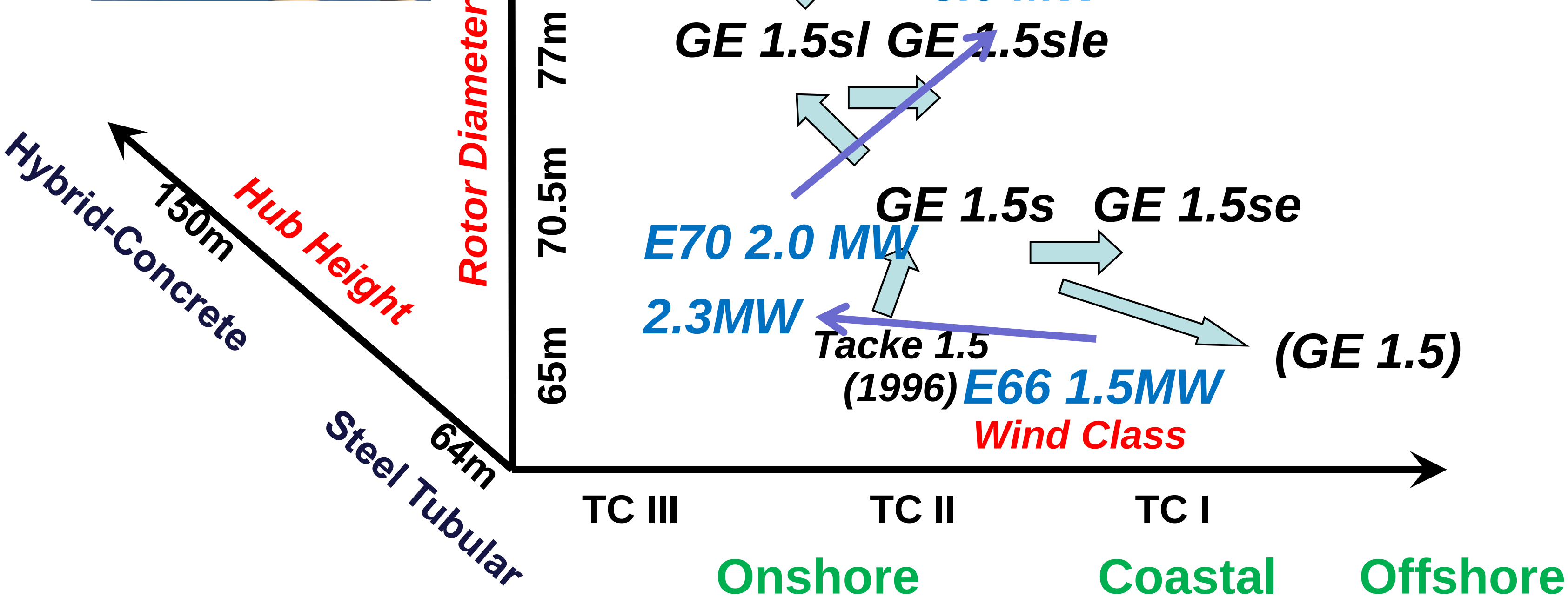


Rotor Diameters at Product Introduction

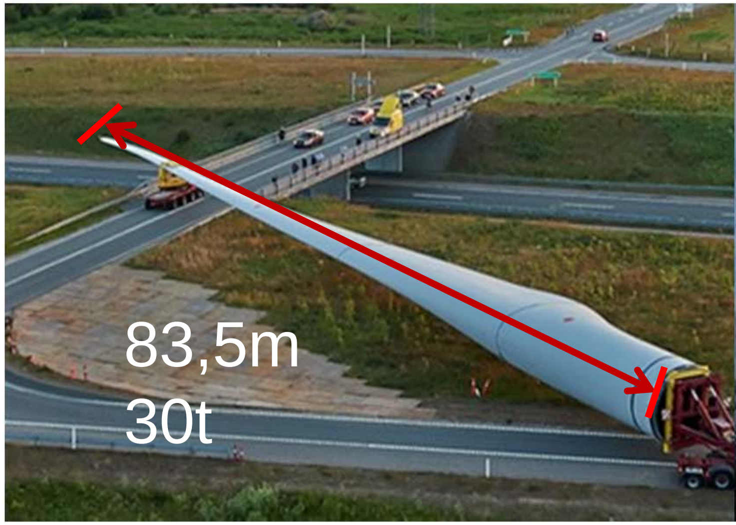
SWE

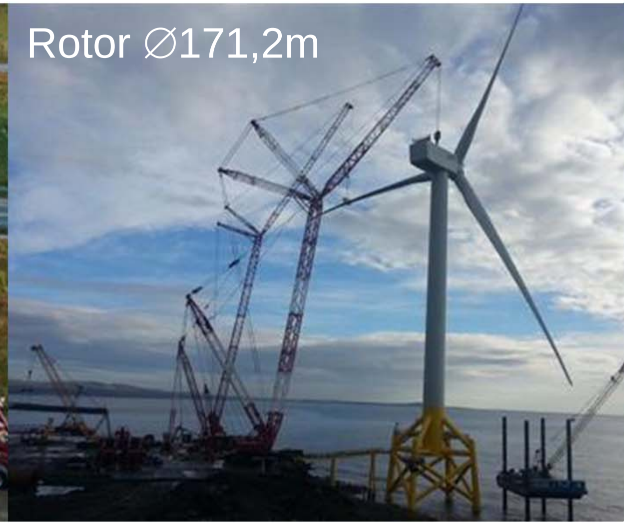
Wind Turbine Product Development





Who has the largest turbine today or mine is bigger than yours

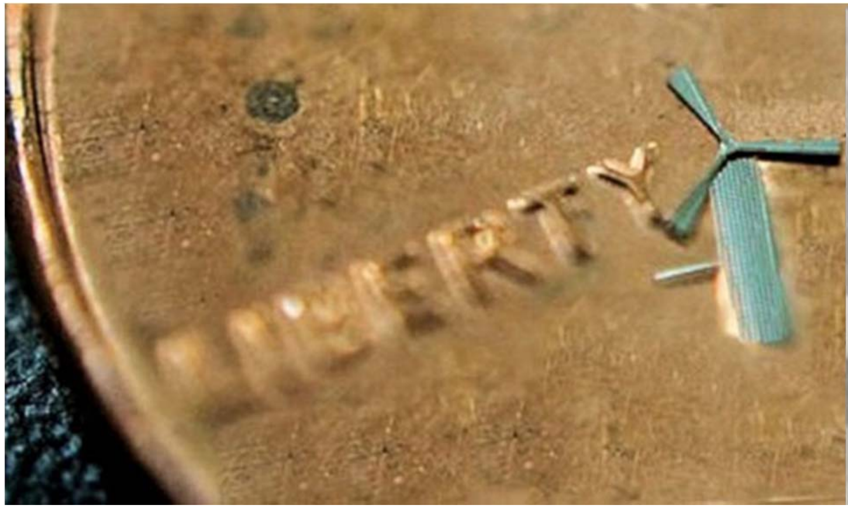




S7.0-171 (Samsung Heavy Industry)
Power : 7 MW
Tip height : 193,5 m
Rotor diameter : 171,2 m
Tower top mass: unknown

V164 (Vestas Wind Power)
Power : 8 MW
Rotor diameter : 164 m
Tower top mass: ca.500t

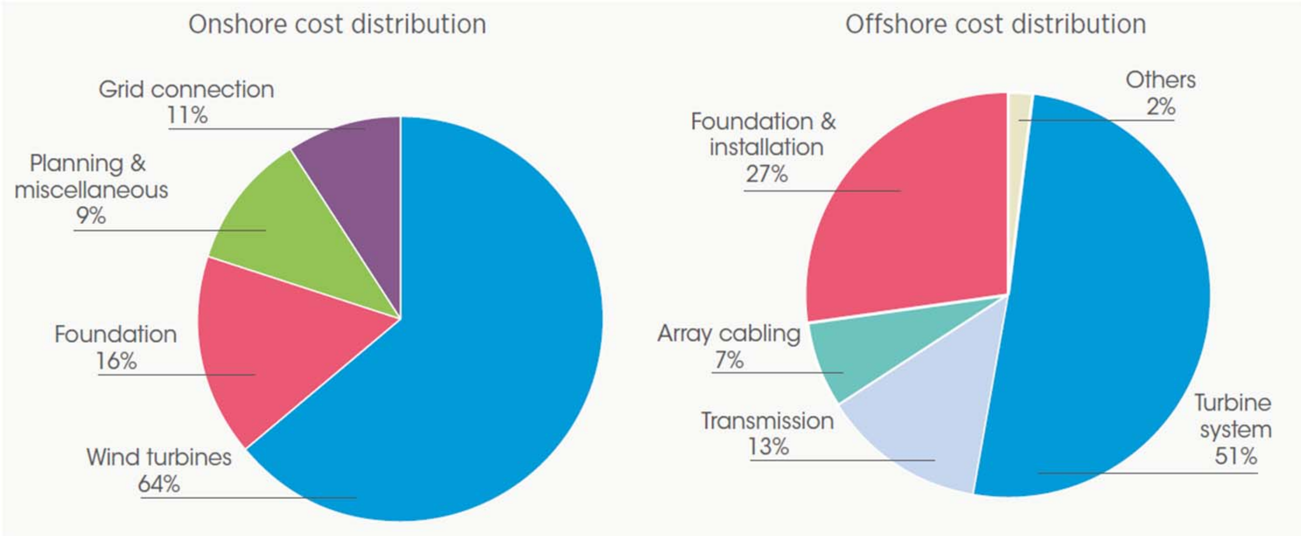
Wind smallest wind turbine



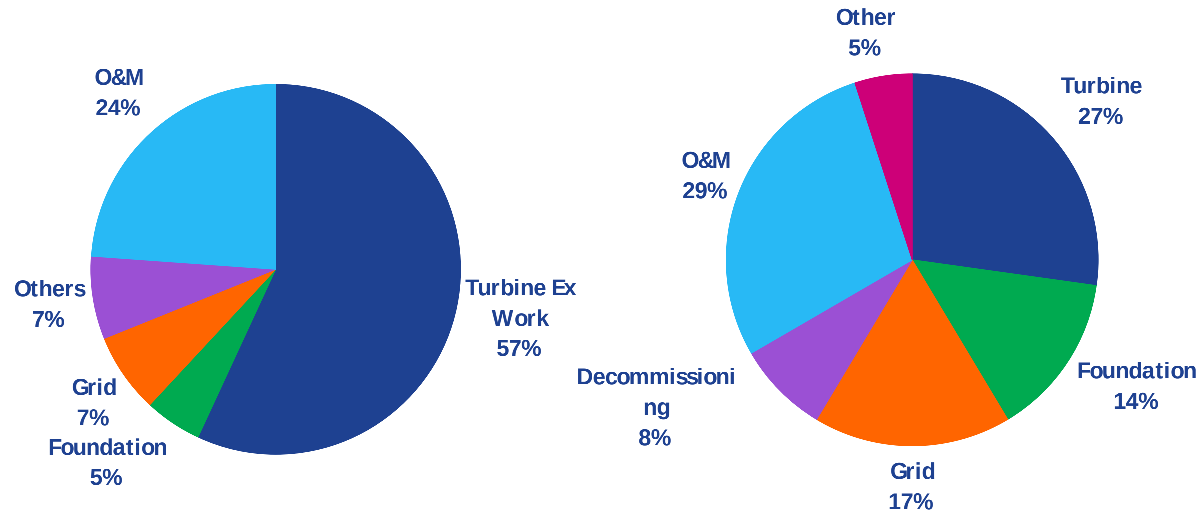
Power : unknown
Rotor diameter : 1.69 mm
On the surface of a smartphone fit ca. 2000 micro turbines
Source: UT Arlington

SWE Cost of Wind Farms and Wind Energy

Capex



LCOE



Source: IRENA, Roland Berger

SWE The Quest for a Lower Cost of Energy Onshore

Annual mean wind speed at hun height (138 Meter) : 5,5 m/s

E82: Full load hours 1874h, AEP: 3841MWh, capacity factor: 21,4%

N117: Full load hours 2631h, AEP: 6314MWh, capacity factor : 30,0%

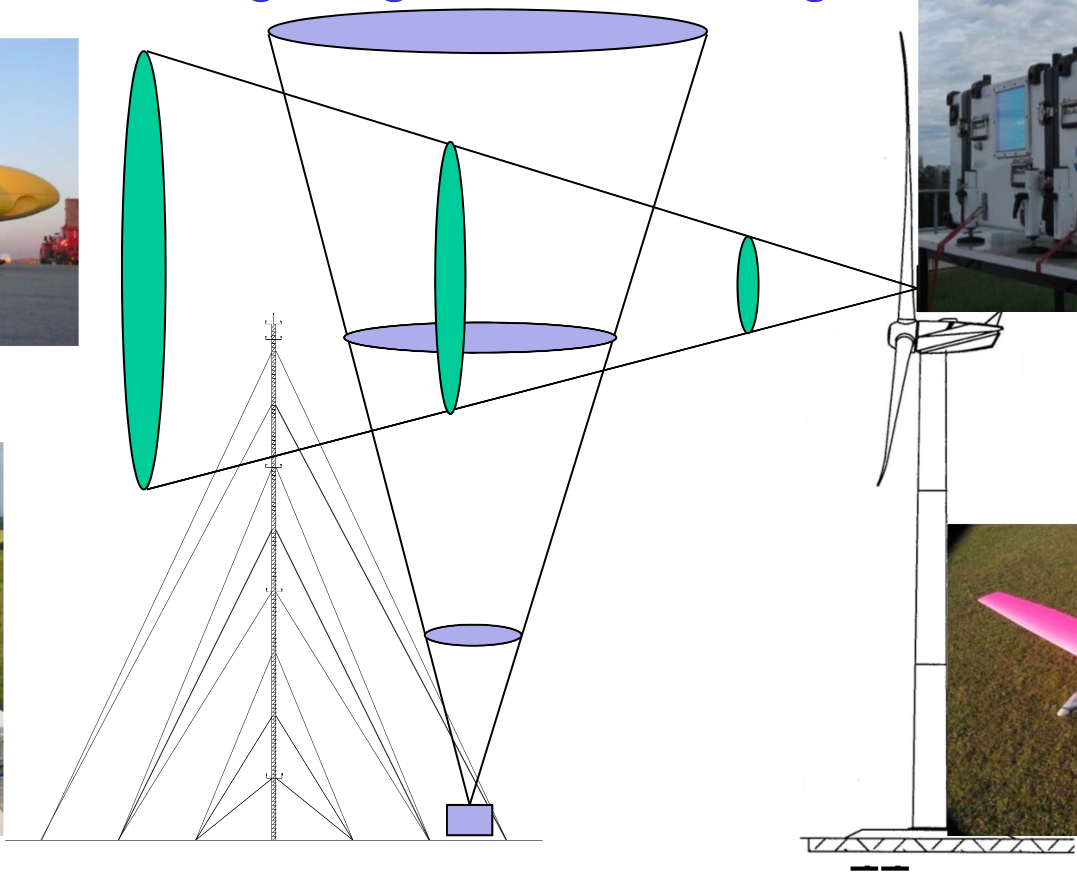
Nordex N117

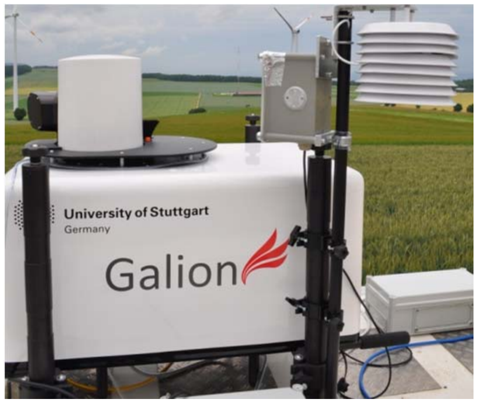
Enercon E82

- Increase hub height to increase mean wind speed
- Increase rotor diameter to increase power capture at partial load

Reduce the uncertainty of the wind resource estimate

- Mobile measurements: UAV- Helicopter and Plane
- Fixed point measurement: metmast 80 meters
- LiDAR measurements: long-range and short-range

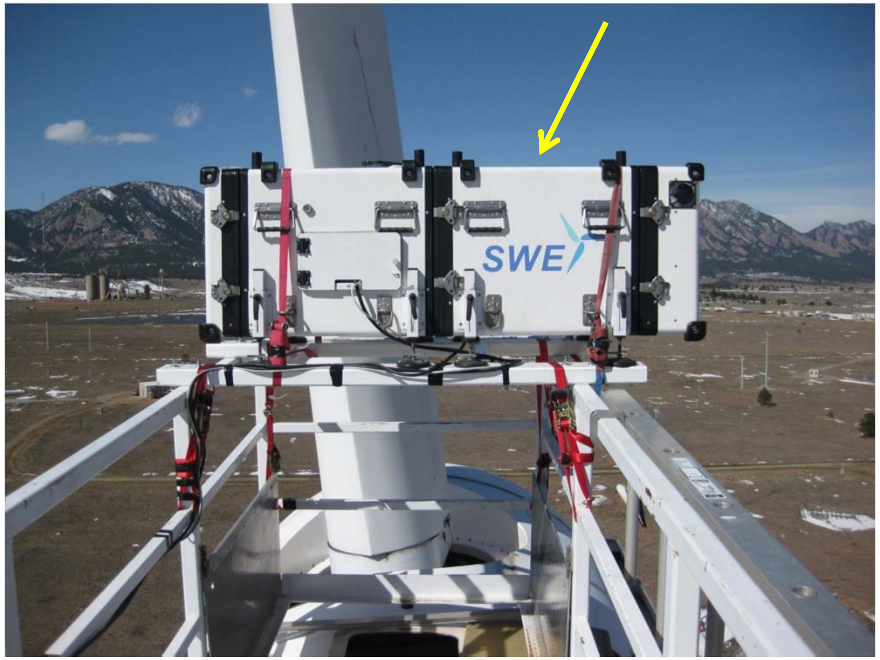




LiDAR Feed-forward Controls Field Test

First LIDAR feed-forward controller field tests successfully demonstrated (May 2012)

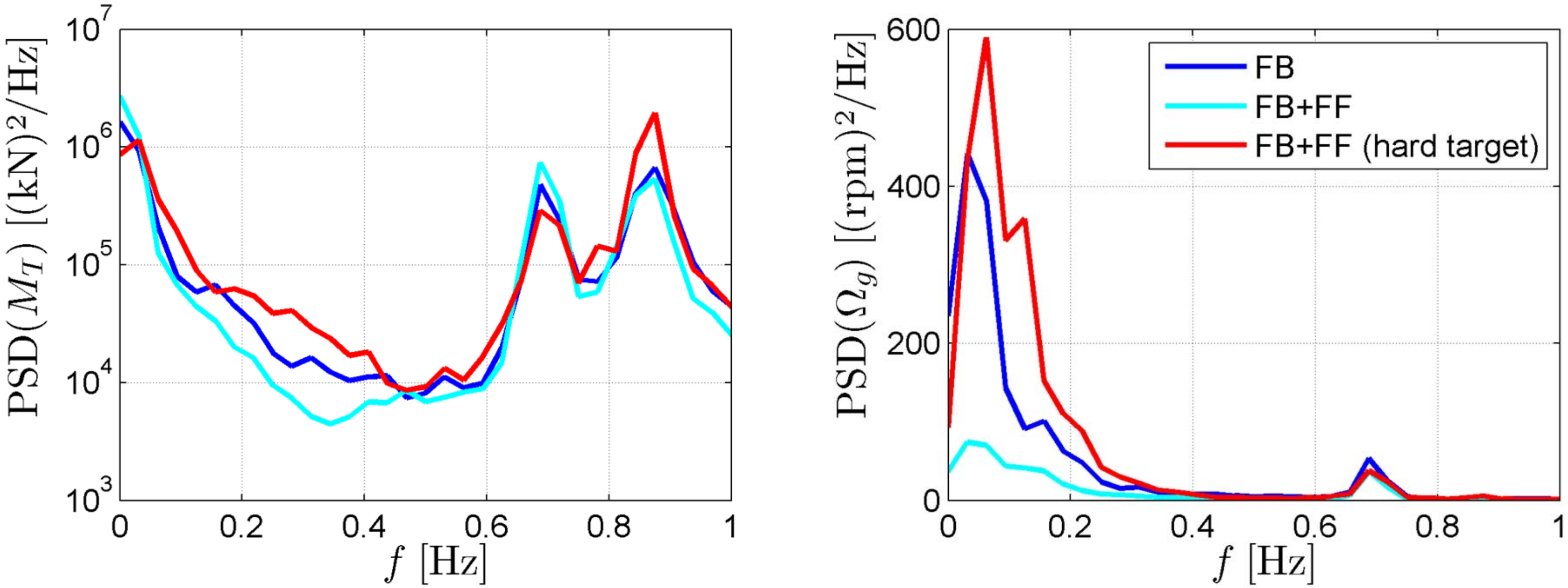
University of Stuttgart (SWE) LIDAR - CART2



Catch the Wind
LIDAR – CART3

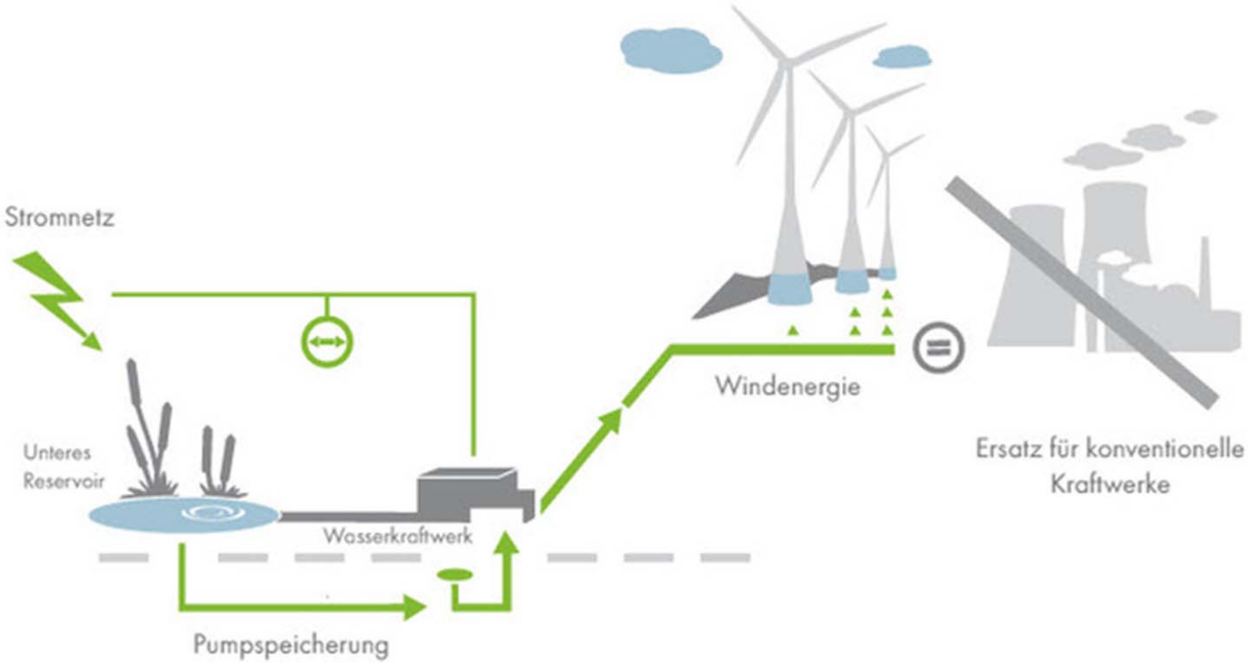
Control: Using Lidar to reduce fatigue loads

NREL Experiment - Results



- reduction in standard deviation of the generator speed of 30% at low frequencies
- but increase of 30% before solving the hard target problem
- similar behavior for the tower base bending moment and other loads

Consider the System Cost: Example of Wind Energy and Combined Storage in Gaildorf



4 x 4.5 MW Wind Turbine
1 x 12 MW Hydro Turbine
160000 m3 Water Storage in the Tower
55 Hours of Power for 12000 Inhabitants

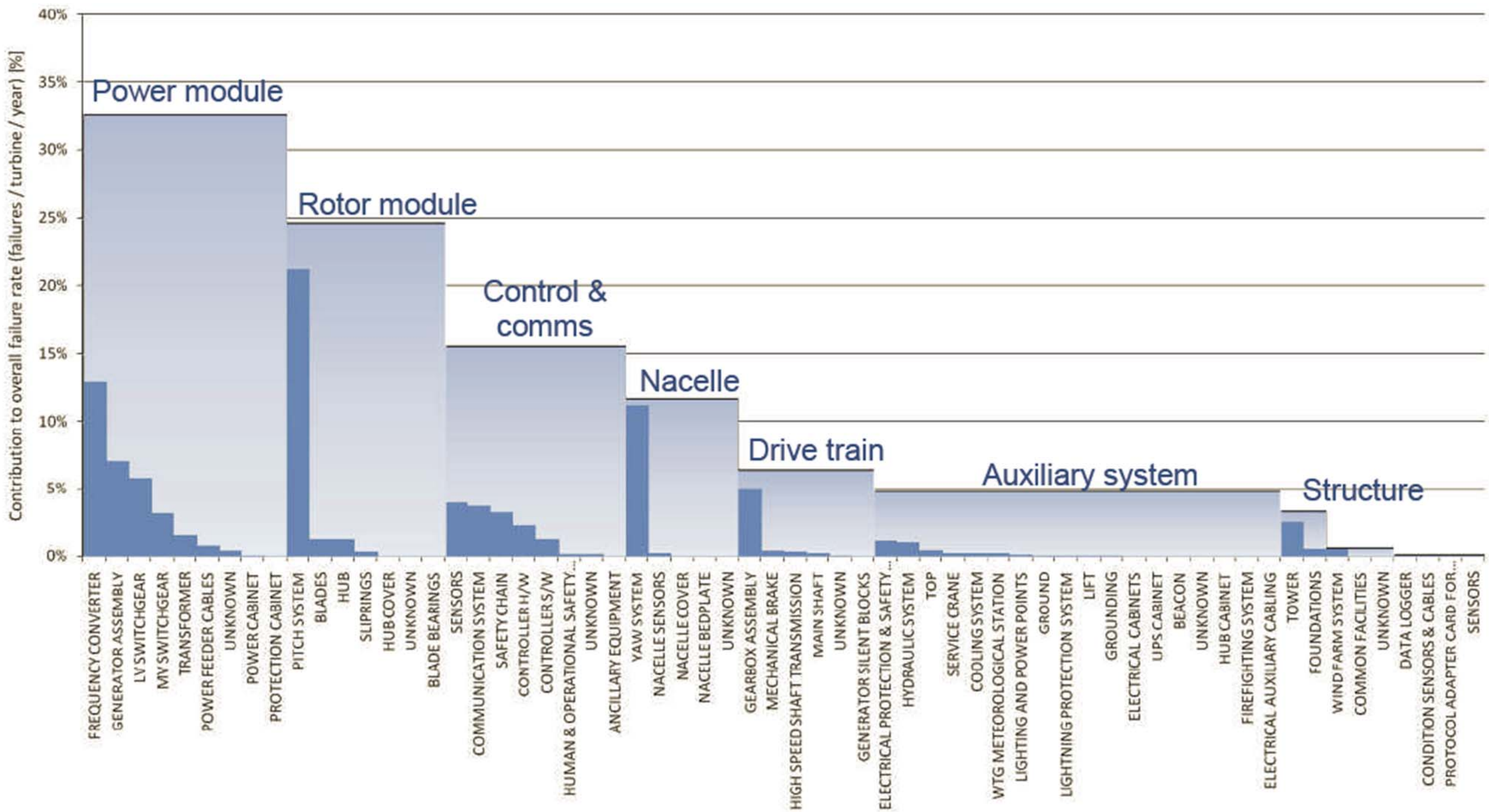
SWE

The cost reduction potential of offshore wind energy lies in installation and logistics

SWE

Reliability is another key to the reduction of CoE for offshore wind energy

Normalized failure rate of sub-systems and assemblies for turbines of mutiple manufacturers in the database



[Source: Measuring Wind Turbine Reliability – Michael Wilkinson]

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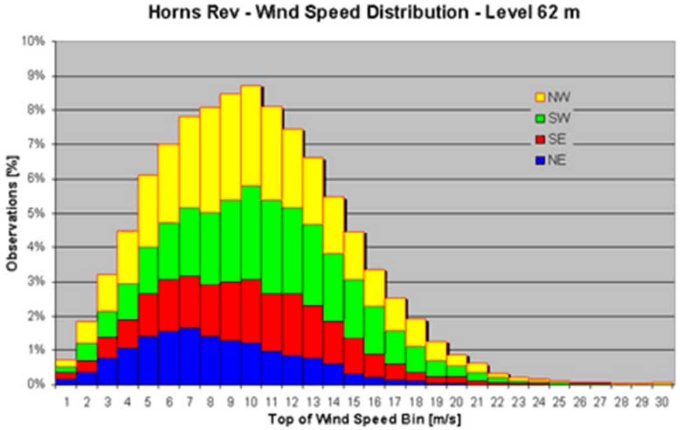
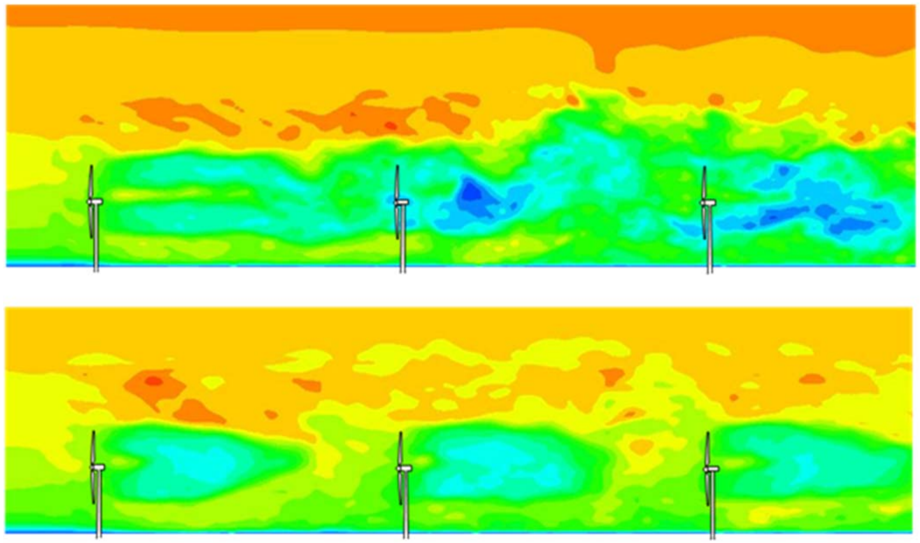
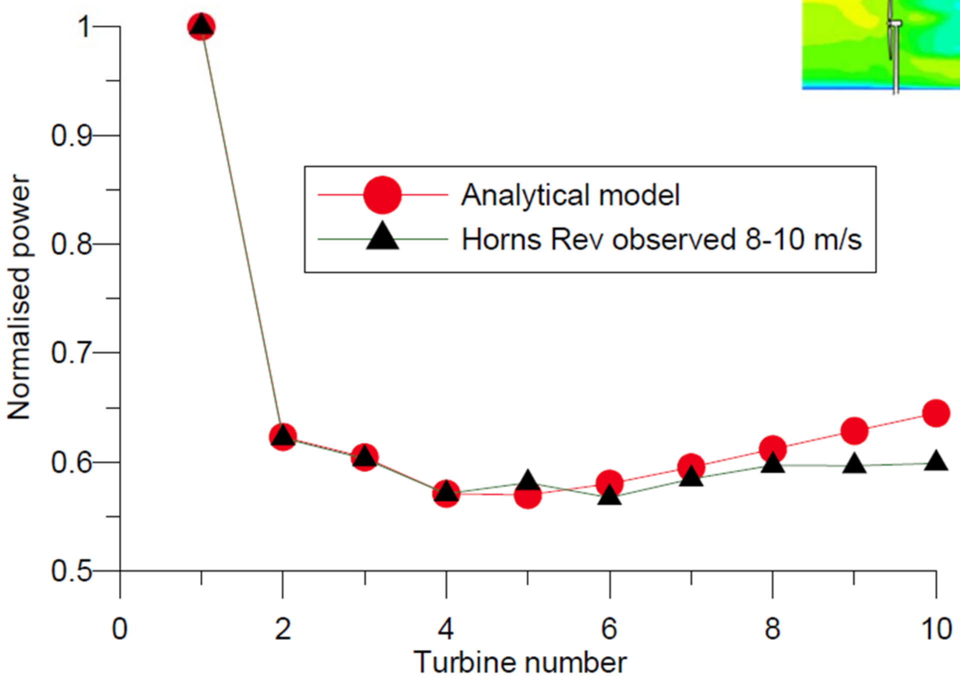
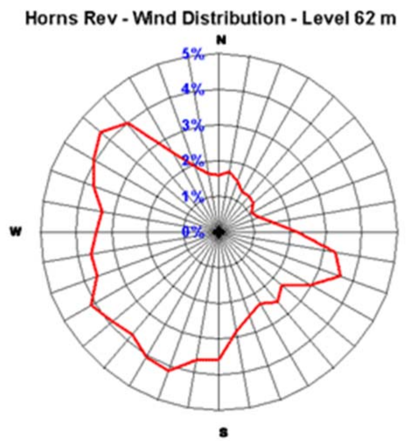
Reduction of large array loss through wind farm control







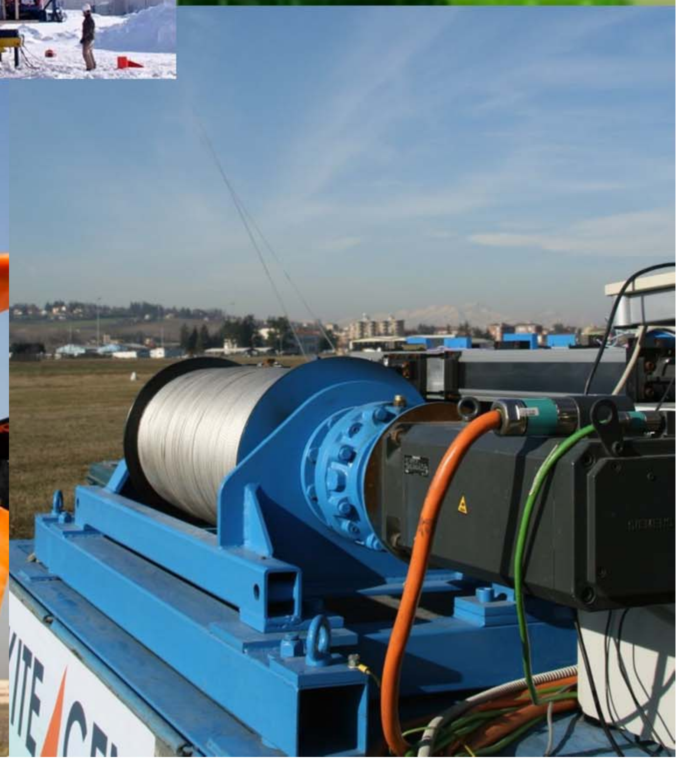


[Source: Wake effects at Horns Rev and their influence on energy production
Fug.: Dong energy]

Many New Concepts but the Market Hurdle is Very High



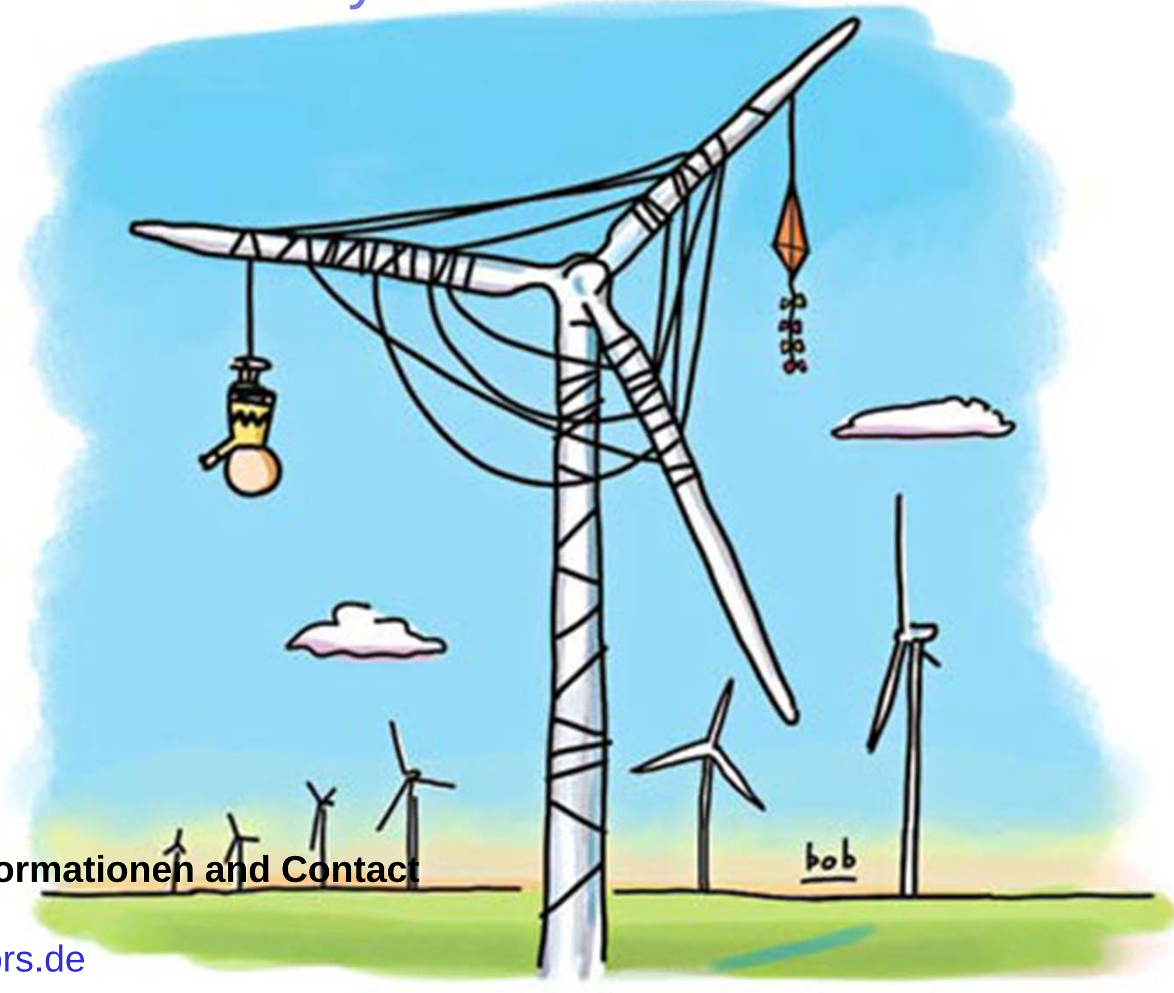




Outlook and Conclusions

- The current concept of horizontal axis wind turbine will still dominate the market in the future
- Big is indeed the only way to reduce cost of energy for large scale wind energy generation
- Cost reduction potentials are different for onshore and offshore wind energy
- For large penetration of wind energy and renewable energies in general, it is necessary to consider not only the CoE but the system integration cost
- It is unlikely that the turbine size will grow much larger beyond 10 MW (never say never)

Thanks for your attention



Further Informationen and Contact

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