Perspectives for Wind Energy

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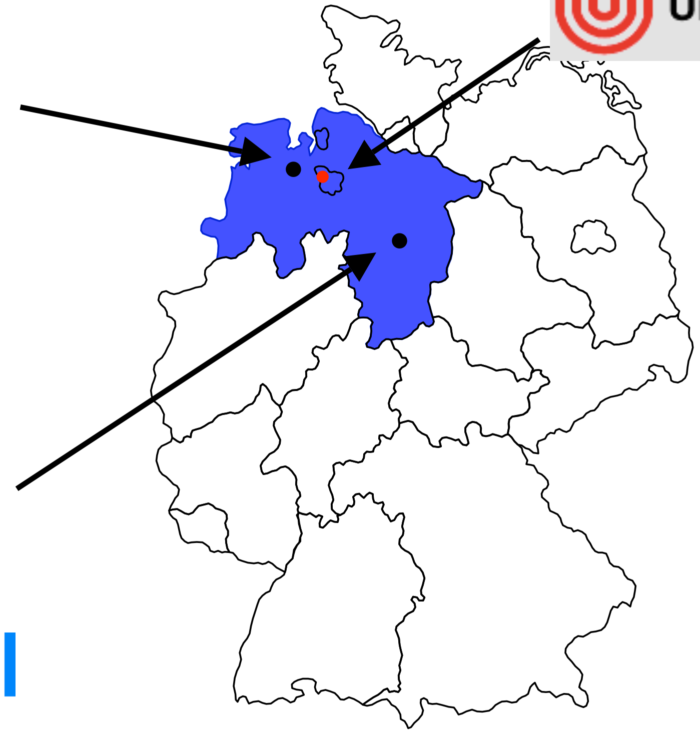
ForWind

- Center for wind energy research (ForWind) is a common center of
  - Carl von Ossietzky University Oldenburg
  - Leibniz University Hanover
  - University of Bremen in the process of joining

CARL VON OSSIETZKY universität OLDENBURG

Leibniz Universität Hannover

Universität Bremen



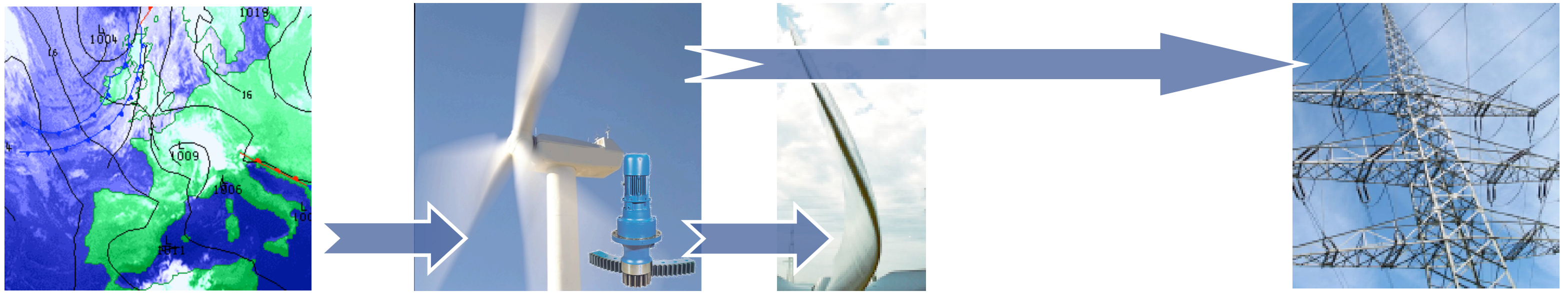
ForWind interdisciplinary research

resource
wind

system

Power production

wind **rotor** **loads** **grid**



meteorology

Civil engineering

Elect. engineering

physics

Mech. engineering

informatics

energy consumption

example electricity in households in Germany

- about 500 PJ - ???

energy consumption

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- 200 Watt/Person = 2 x 100 Watt bulbs are burning permanently

energy consumption

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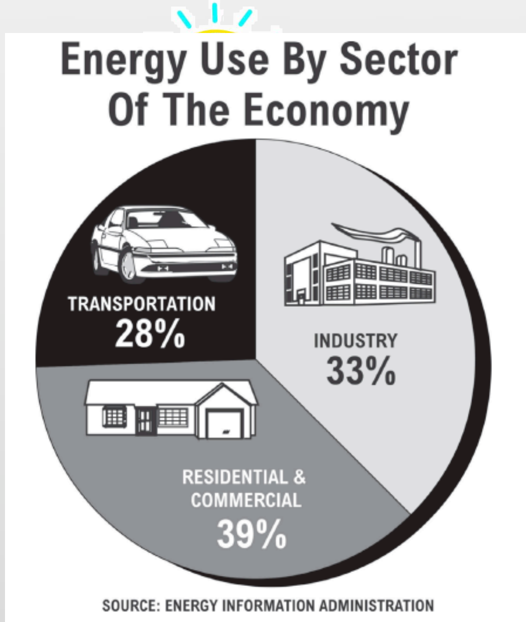


- total energy 5 - 6 kW / person

energy consumption with respect to oil

after IEA : worldwide 84,7 Million barrel / day

truck with typically 35.000 liter

energy consumption with respect to oil

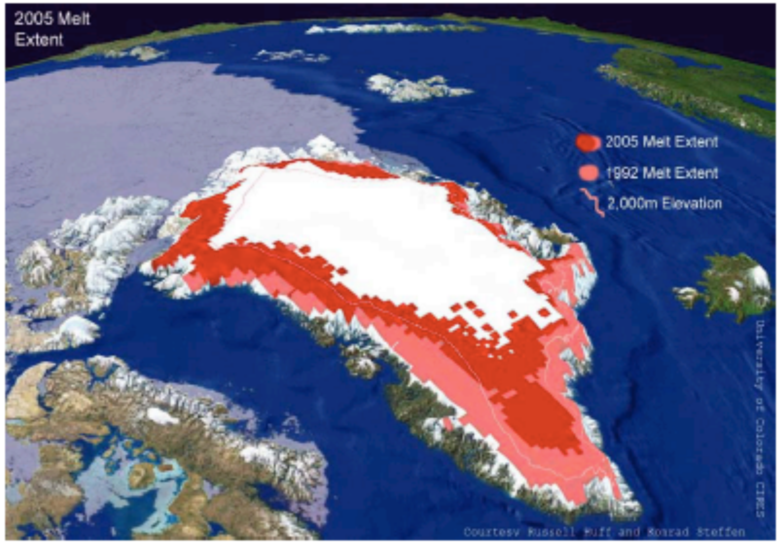
after IEA : worldwide 84,7 Million barrel / day

truck with typically 35.000 liter

=> 400.000 trucks per day or 7.200km line

Climate change ...

Accelerated Greenland Melt-Down

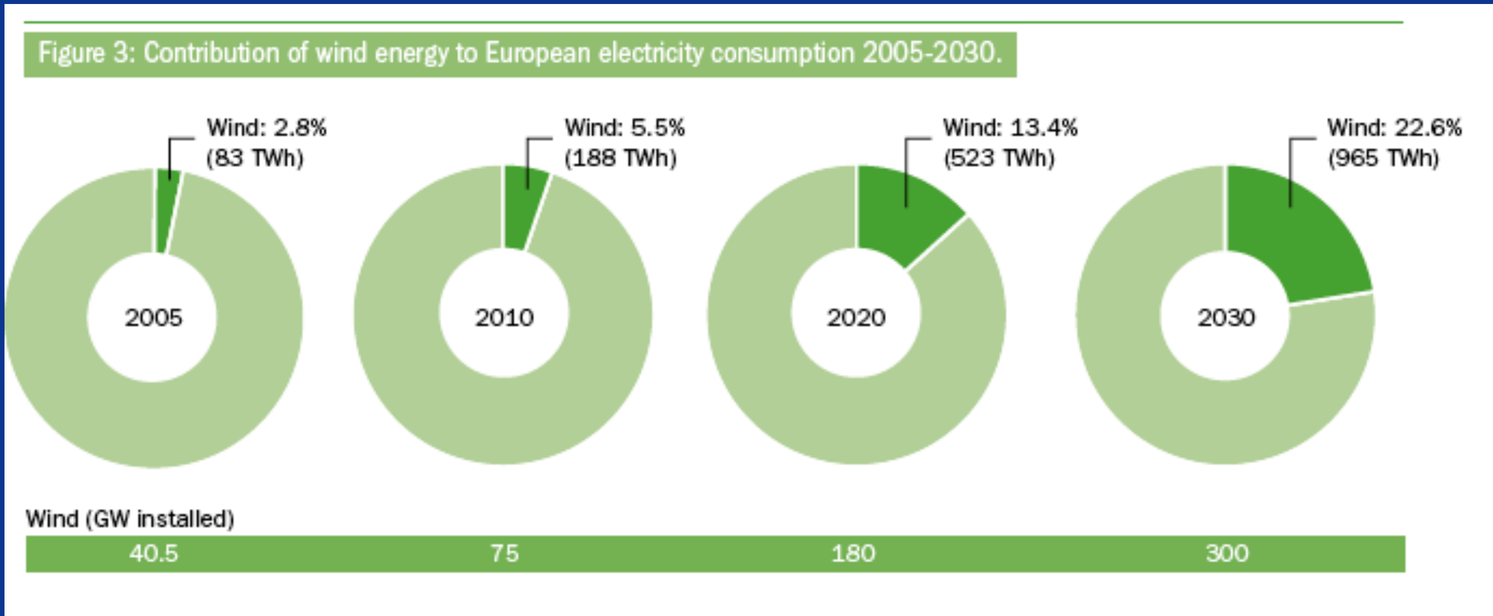


Current volume loss:
2.2×10^{11} m^3/yr ≈ 0.007 Sv
Has doubled over past decade

Volume of GIS: 2.8×10^{15} m^3
Time-scale 1000 years ⇒ 2.8×10^{12} m^3/yr ≈ 0.1 Sv

Wind energy - 20 20 20

- 2020 expected that 20% of energy provided by renewable
- 2006 additionally installed 16 GW + 32%
- Germany in total about 20 GW = 6% of electr. power



about +10 GW per year
new employees

European Wind Energy Technology Platform

resource estimation - renewable Energies

resource estimation - renewable Energies

	sun	wind
power	1 kW/m^2	1 kW/m^2
efficiency	15%	40%
running time/a	1000h	2000-3000h
mean power	17 W/m^2	100 -150 W/m^2
installation costs	4 \$/W$_{inst}$	1 \$/W$_{inst}$

private power supply (el) by 10 m^2 PV or 1.5 m^2 WEC

one wind turbine

standard size of WT 2MW

(D=80m or 5000m^2)

good for electricity of 2500 - 5000 persons (personal demand)

financial aspects

financial aspects

oil price

1 barrel (159 l) about 80 $

1 liter about 0.5 $ <=> 1 0kWh

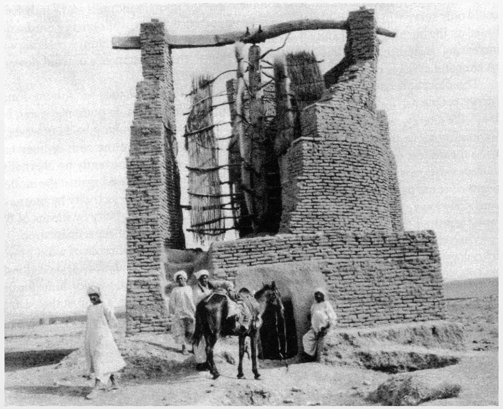
1 kWh (in oil) 5 cent

1 kWh electricity by oil (50% efficiency) 10 cent = 8 Euro cent

wind energy 1 kWh 8 cent

cheap 1 kWh 4 cent with old power plants

technological development



Persian wind mill

new dutch wind mill

modern wind mill

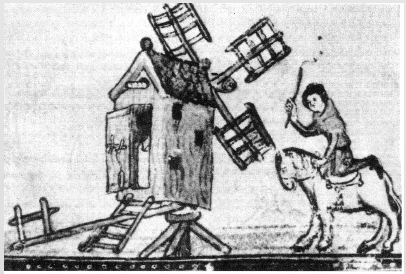


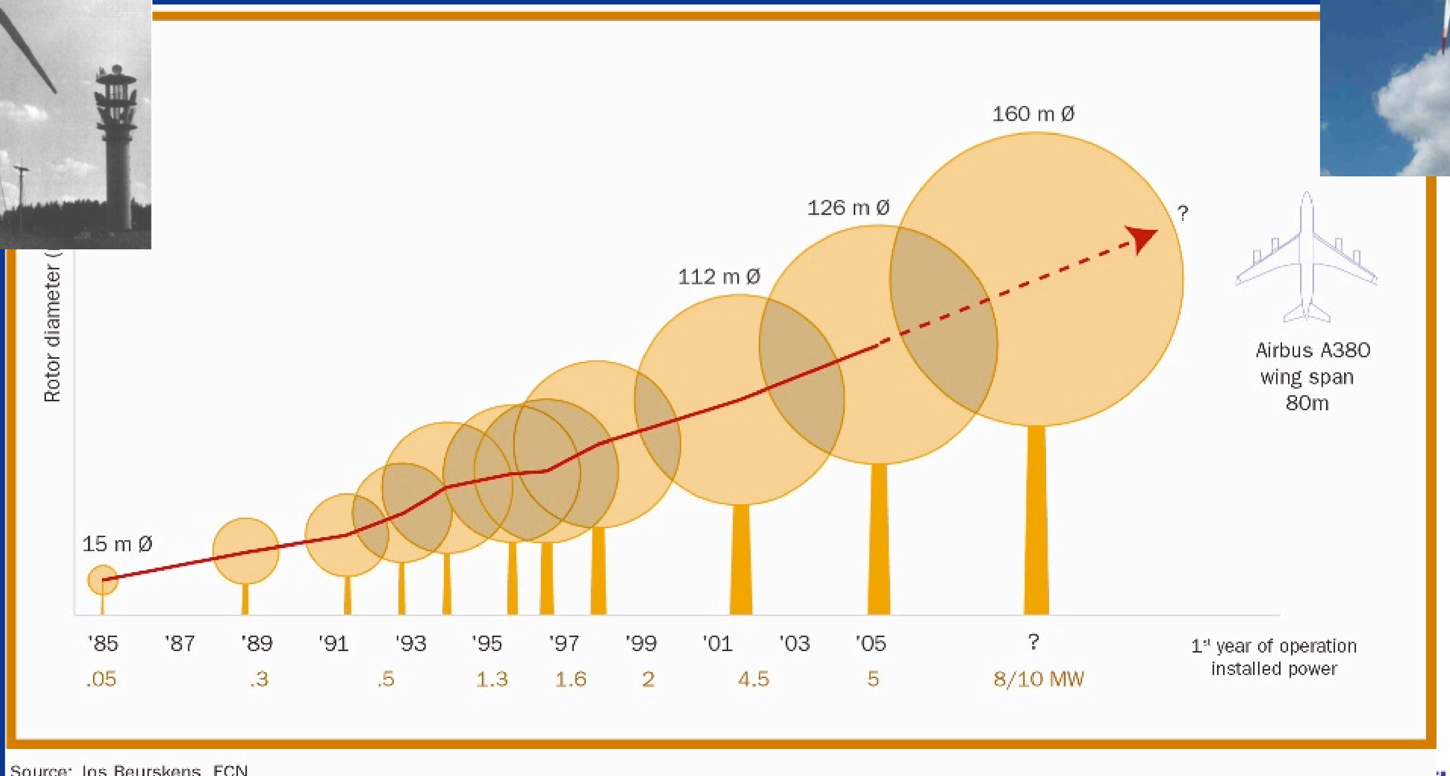
Figure 1.3. German post windmill in the 15th century (Deutsches Museum)

15th century wind mill

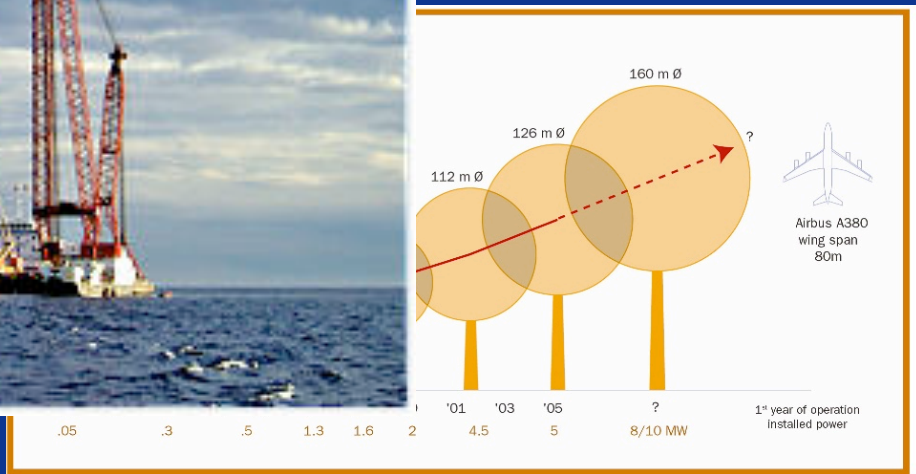
french wind mill

Wind energy - last decades

Hütter

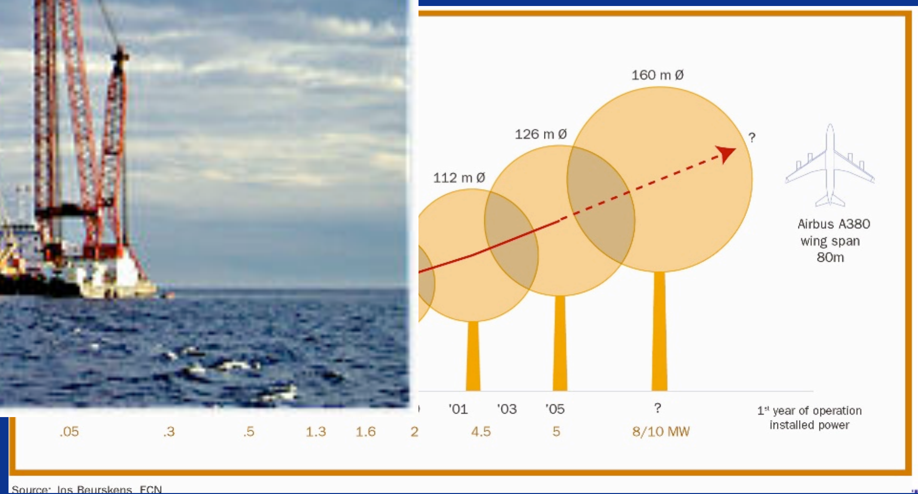


the sizes of modern offshore WEC - M5 Repower (D=126m)

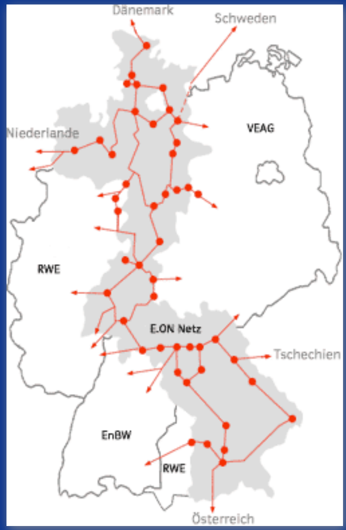


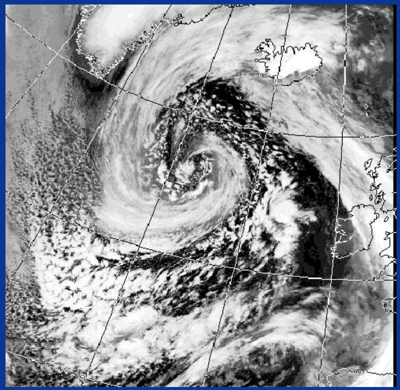
Source: Jos Beurskens, ECN

comparing the sizes of A 380 and M5 Repower (D=126m)



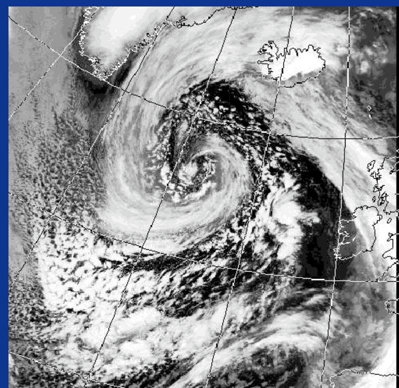
technological development
where are problems / challenges?

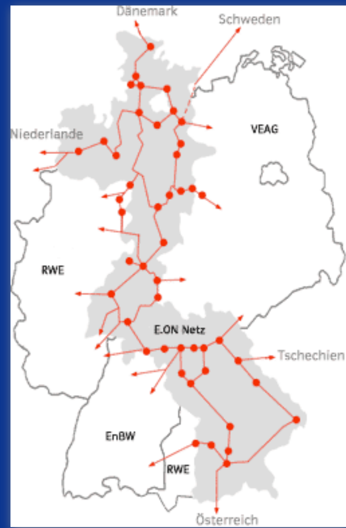




technological development
where are problems / challenges?

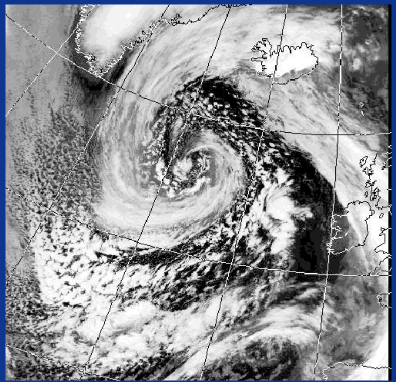
- grid integration





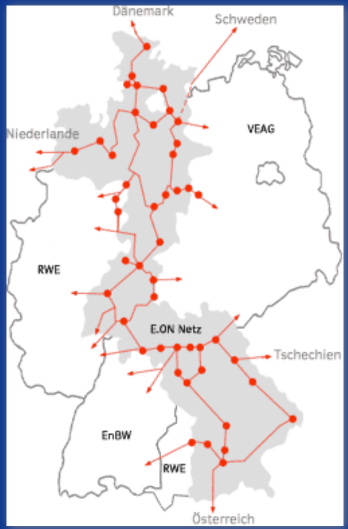
-1- grid integration
resource the wind - fluctuation power production

weather



fluctuating

to improve the wind energy conversion it is essential to improve the understanding of the source



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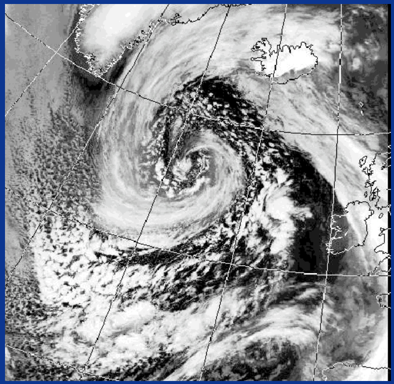
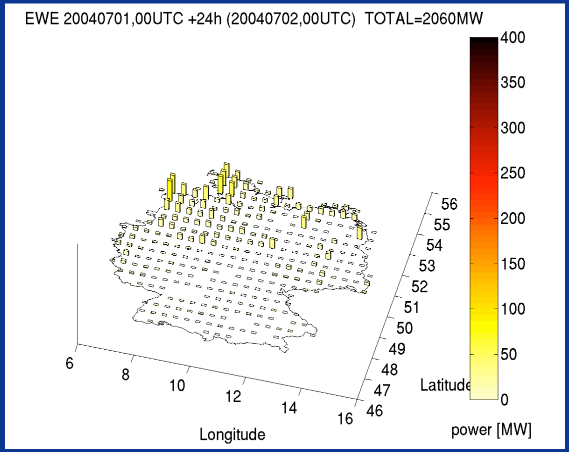
resource the wind



large scale effects

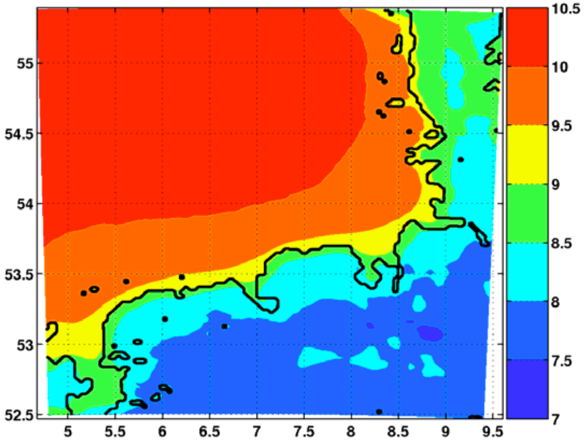
changing weather situations

forecast - energy meteorology

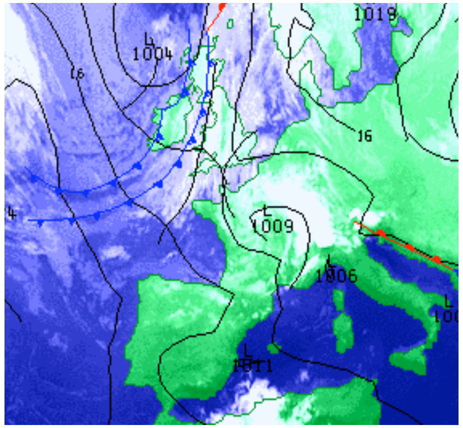


Modeling the wind field

Modeling the wind situations from annual values down to fluctautions within seconds

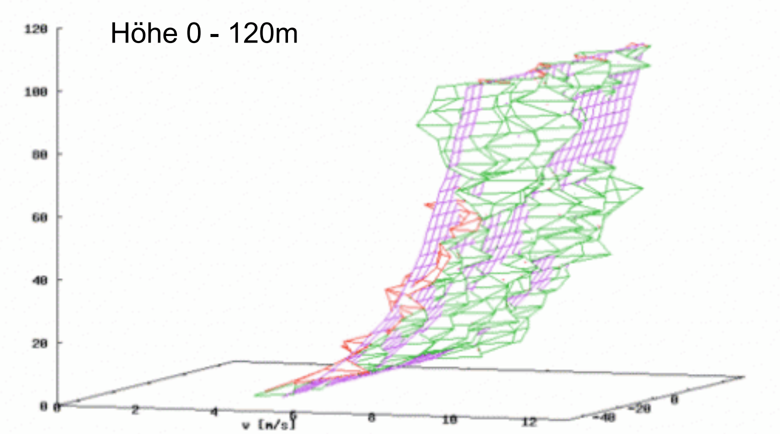


annual



daily

seconds



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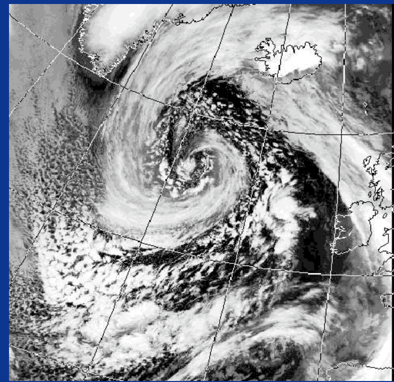
resource the wind

large scale effects

forecast - energy meteorology

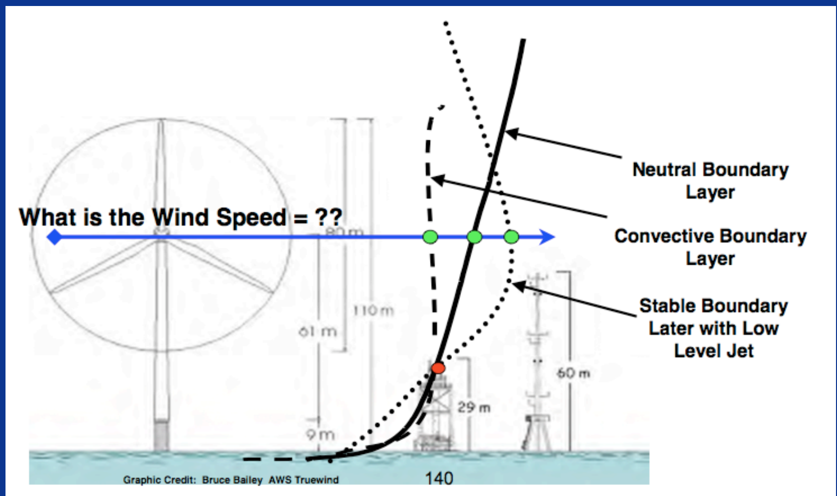
meso scale effects

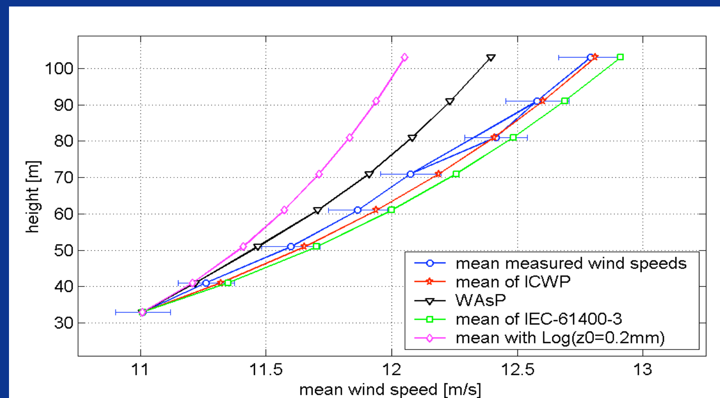
boundary layer



FINO

North sea





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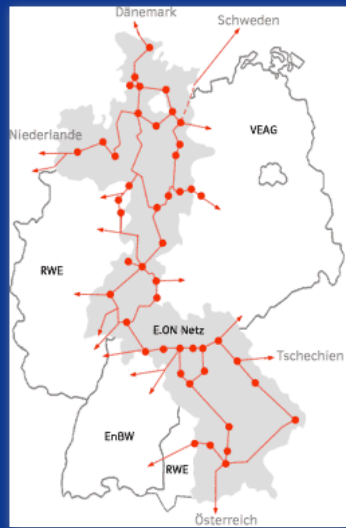
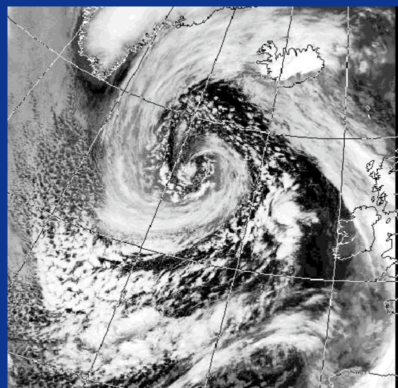
technological development
where are problems / challenges?

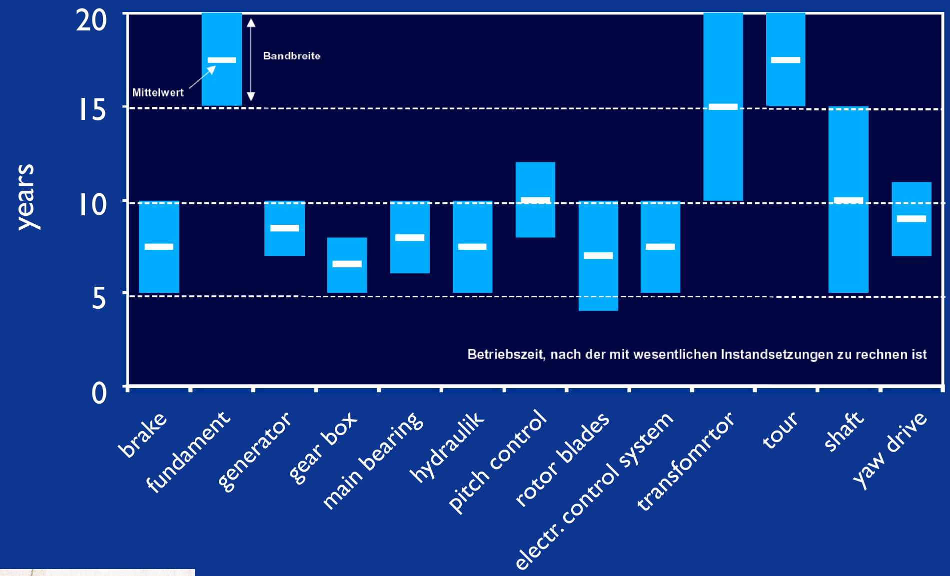
- grid integration
- failures - O&M

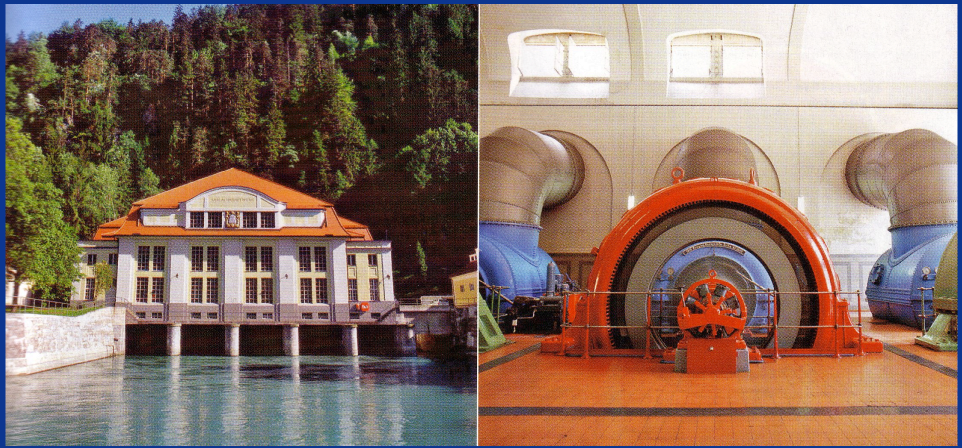




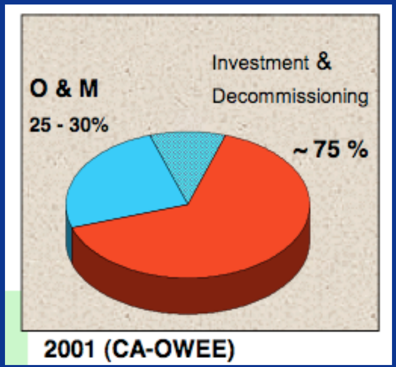
probems and challenges
-2- failures - O&M

meeting of EAWE in Ispra
good part of the costs are given
by non pre-visible failures





waterpower Saalach



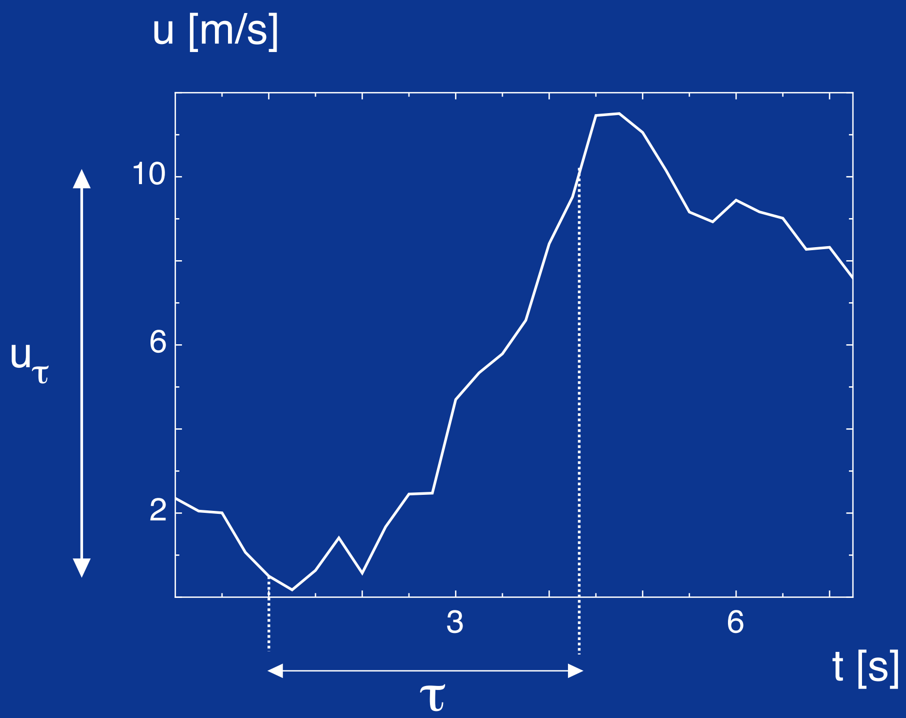
small scale turbulence
IEC - by degree of turbulence (standard deviation)
improved analysis - correlation by increments (gusts statistics)

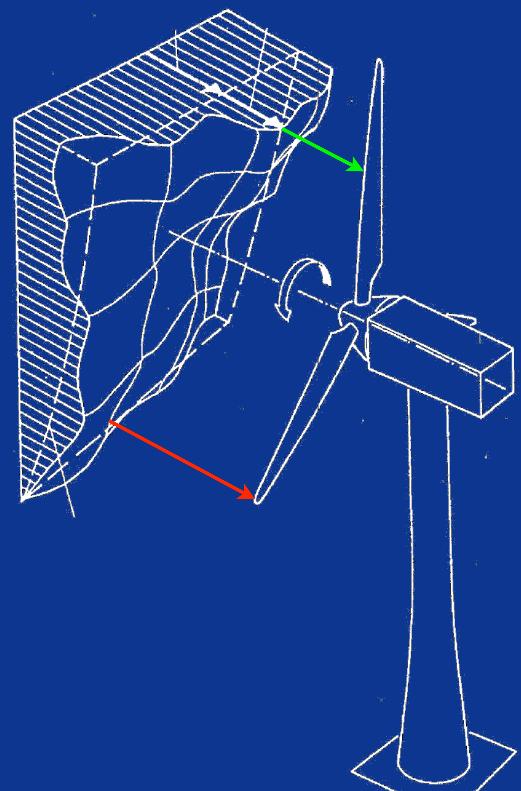
temporal increment

$$u_\tau := u(t+\tau) - u(t)$$

spatial increment

$$u_r := u(x) - u(x+r)$$

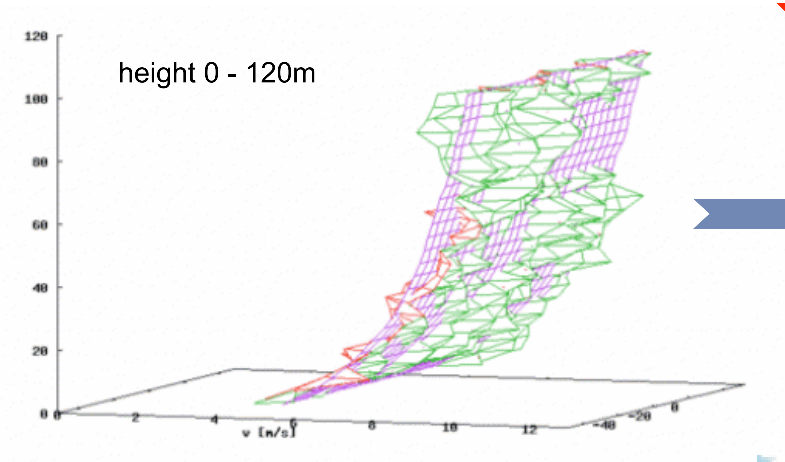




Impact of turbulence on a WEC

Dynamics of the system

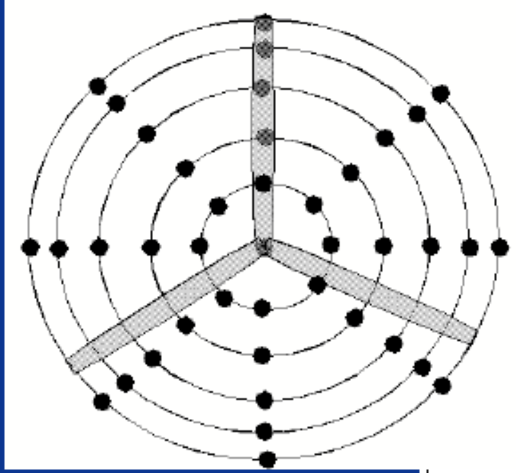
**Turbulent - gusty
Wind field**



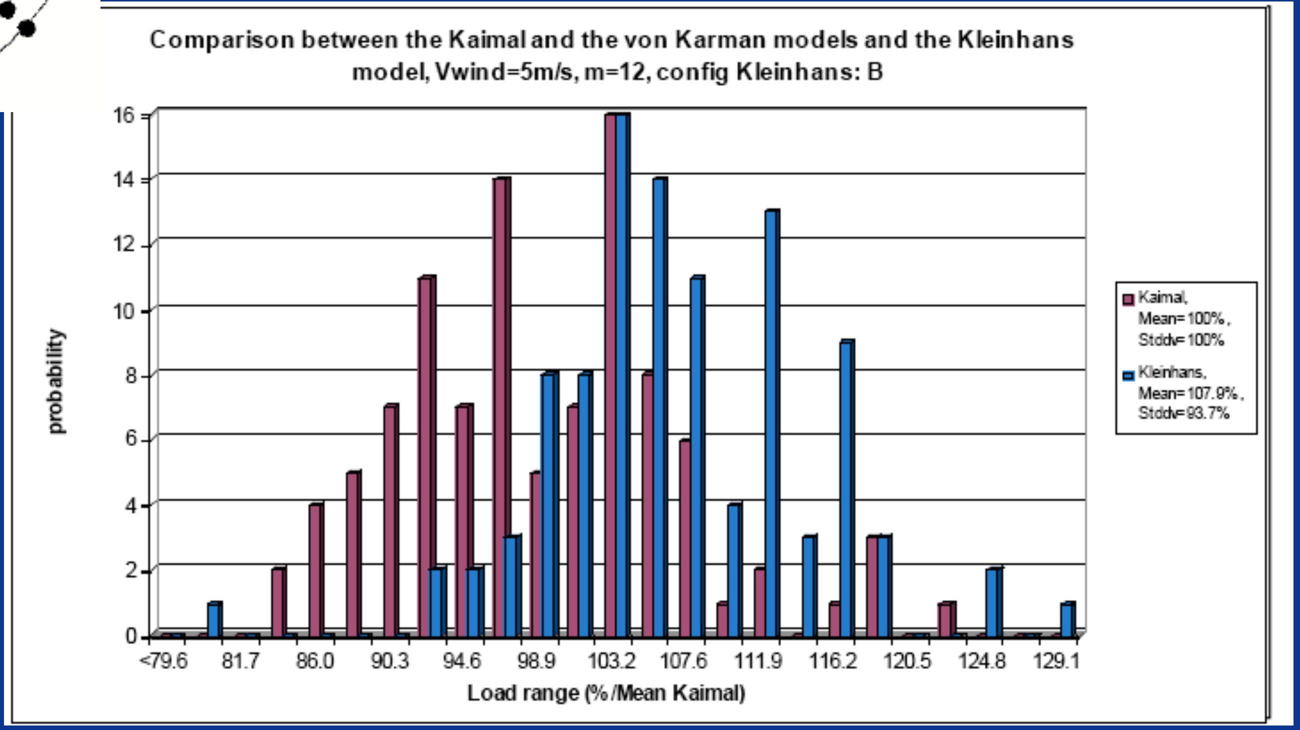
velocity. 0 - 12m/sec

Improved description of loads

mechanical loads from new wind field model



- mechanical load estimation with FLEX 5
- increased loads due to non Gaussian wind fileds



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- better understanding of high frequency dynamics
  - more reliable wind turbine
- net integration
  - save and sustainable energy supply

picture from GE - Wind

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picture from GE - Wind

- Wind energy may have an important impact on our future
- Germany in 2007: 25 bilion Euro with renewable energie and 250 000 employees (BMU - EE in Zahlen)

Thank you