SET Analysis

WinterWind 2014

Sundsvall (S), February 12, 2014

Concluding Remarks

Jos Beurskens

Photo Jos Beurskens (Umeå, 08-02-2011)

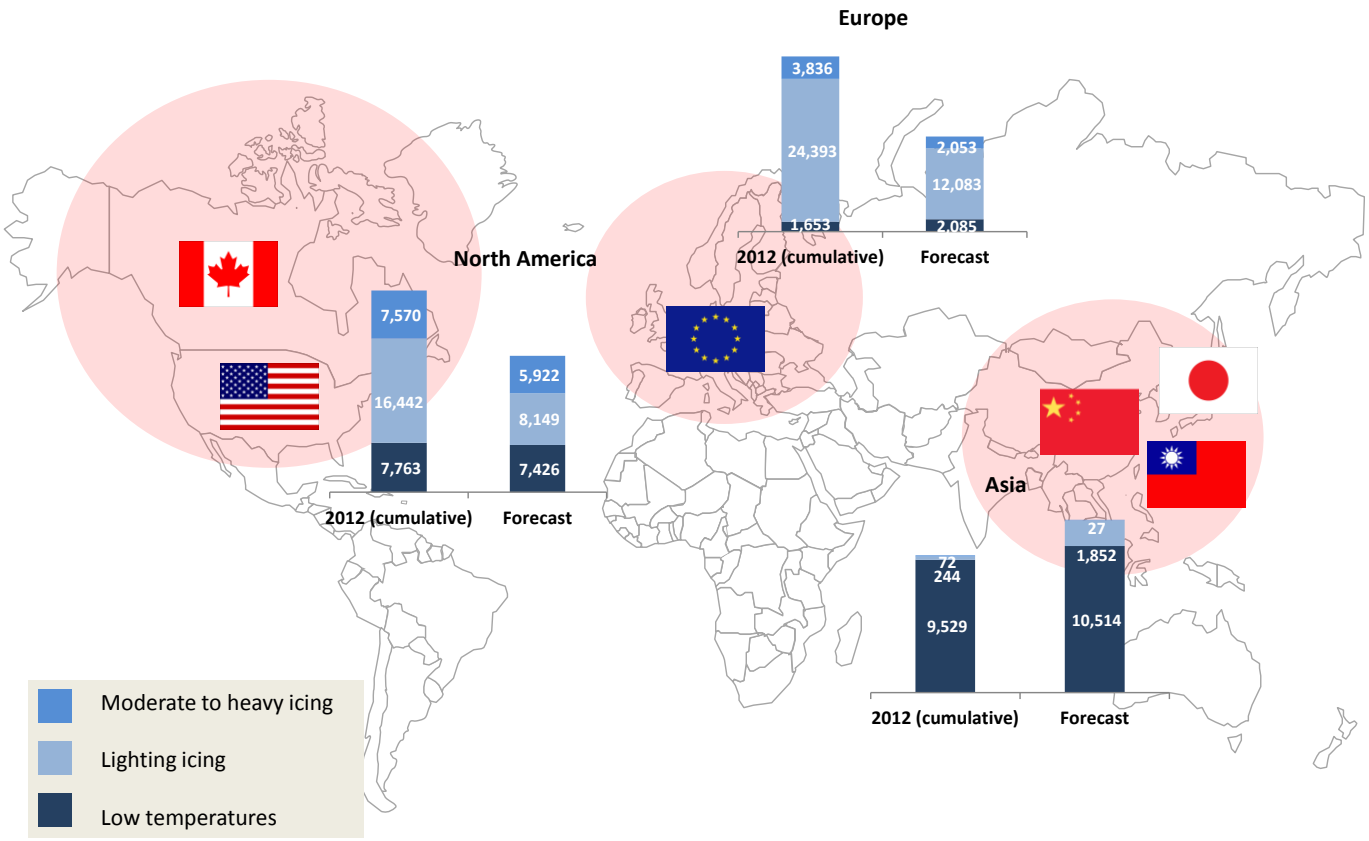
The CC agenda

- Physics of icing (accretion of ice; types of icing)
- Atlas of icing probability
- Impact on wind turbines; energy output, loads, acoustic noise emission)
- Dedicated turbine systems; anti-icing and de-icing
- Environmental issues & Safety
- Grid connection & Integration
- Market, Cost & Value

Market bigger than anticipated

Installed and forecasted capacity in the world

Capacity in CC (up to end 2012) and forecasted (2013-2017) in MW
View of World



For full country/regional breakdown see table 5.

Total installed and forecasted capacity in Cold Climates

Cumulative installed capacity by end of 2012 [MW]			Forecasted capacity 2013-17 [MW]		
Low temperature	Light icing: safety risk, some economic risk	Moderate to heavy icing: economic and safety risk	Low temperature	Light icing: safety risk, some economic risk	Moderate to heavy icing: economic and safety risk
18,945	41,079	11,478	20,025	22,083	8,003
Total 69,000 (*)			**Total 45,000 – 50,000**		

(*) The total capacity is less than the sum of individual capacities because some of the sites have both low temperatures and icing conditions.

(*)This is 20% of present world wide installed wind power !

More industries and institutions get involved in CC technology

SME"s : >40
Uni's & Institutes: 14
Large companies including wt manufacturers: 16
Authorities: 5

Dedicated CC research teams in industry

Winterwind:
5 years ago 60 particpants
Now 500.

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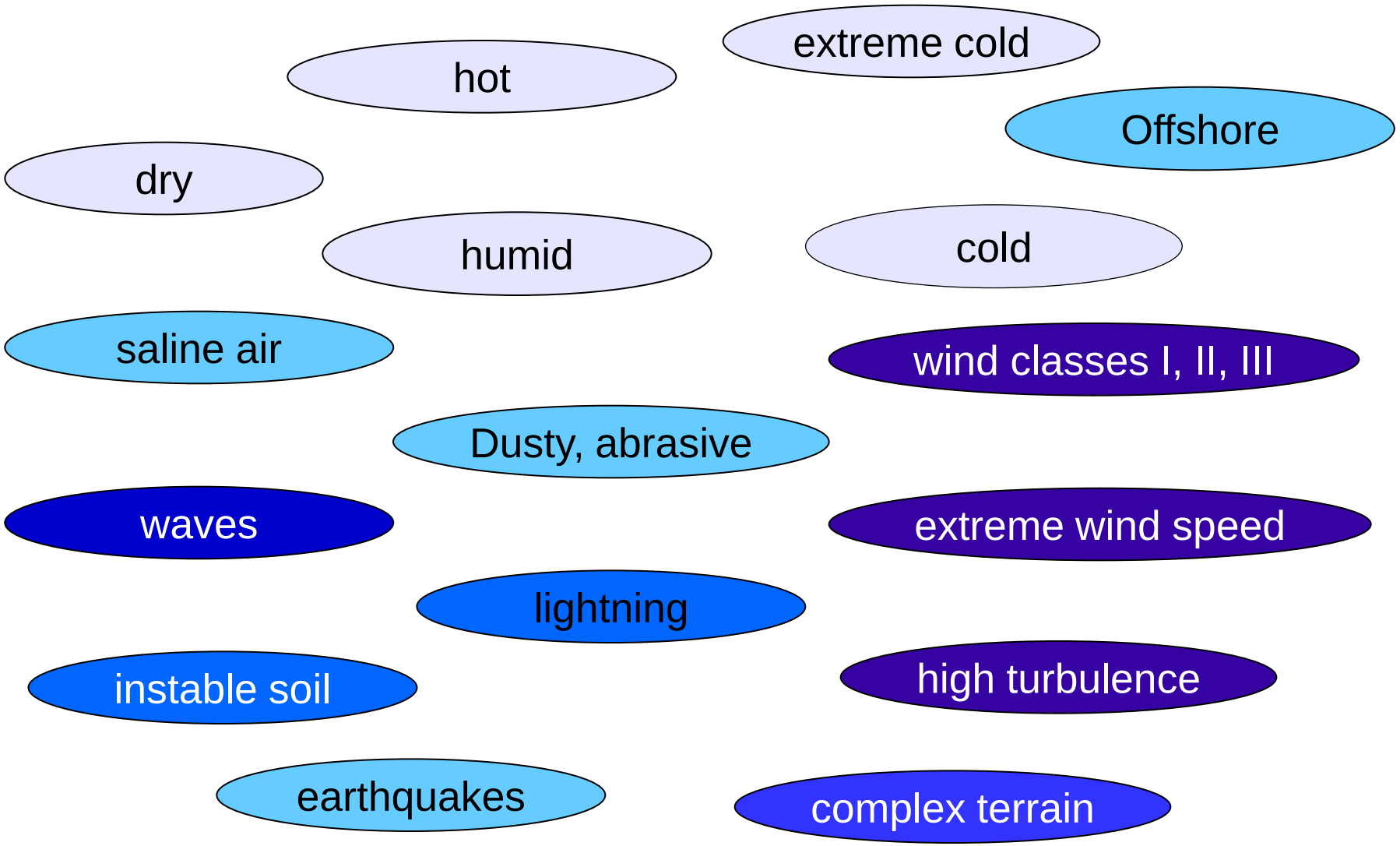
CC less and less a ‘special case’

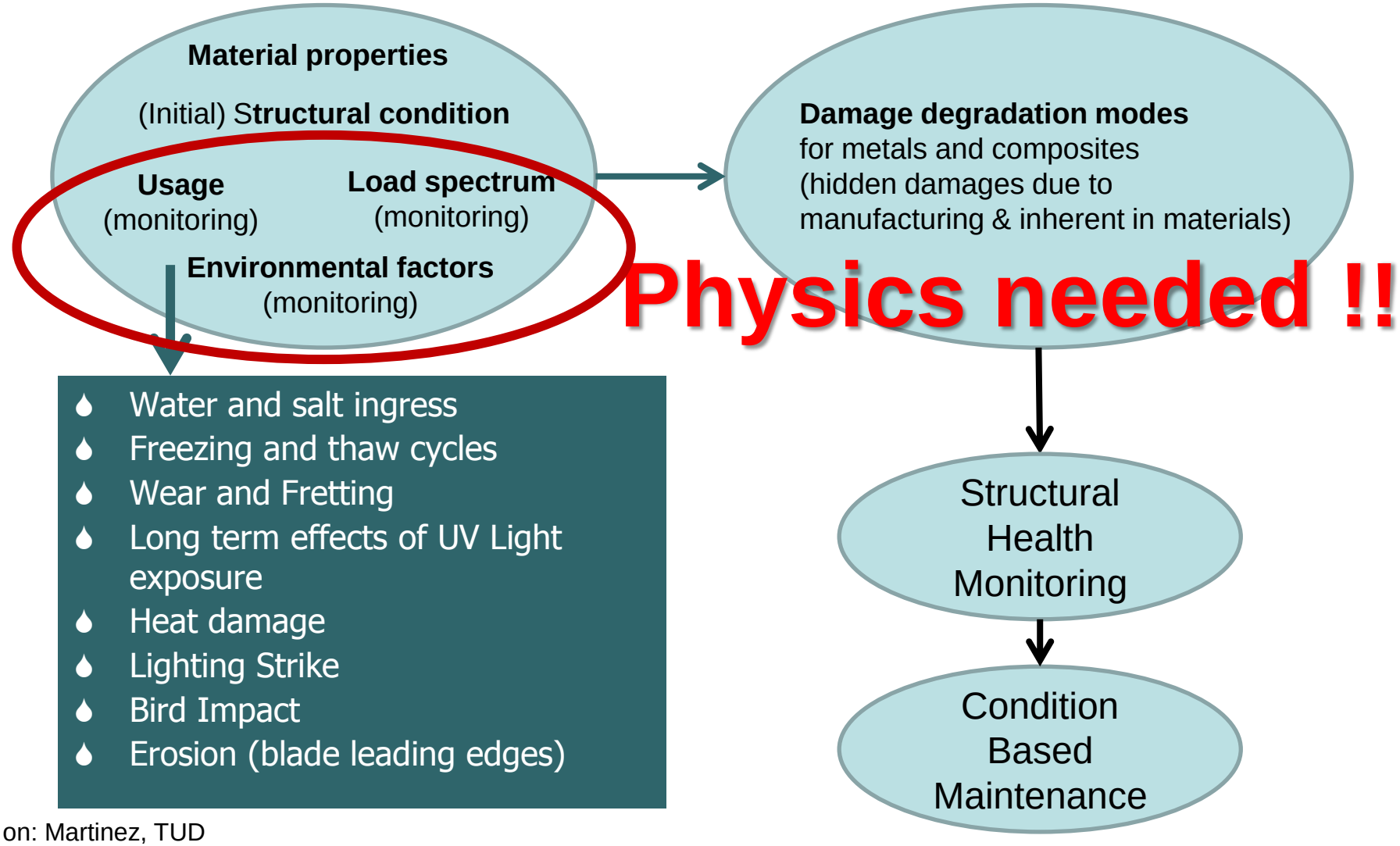


First CC standard in the making

- From field tests and analysis: input for defining design loads
- Available by 01-2016 !
- Separate ‘wind class: II A (?) (200kg !)

What we are actually doing is filling a knowledge gap on our way to a fully fledged asset management system.

There is still a long way to go from sensor to analysis !



Based on: Martinez, TUD

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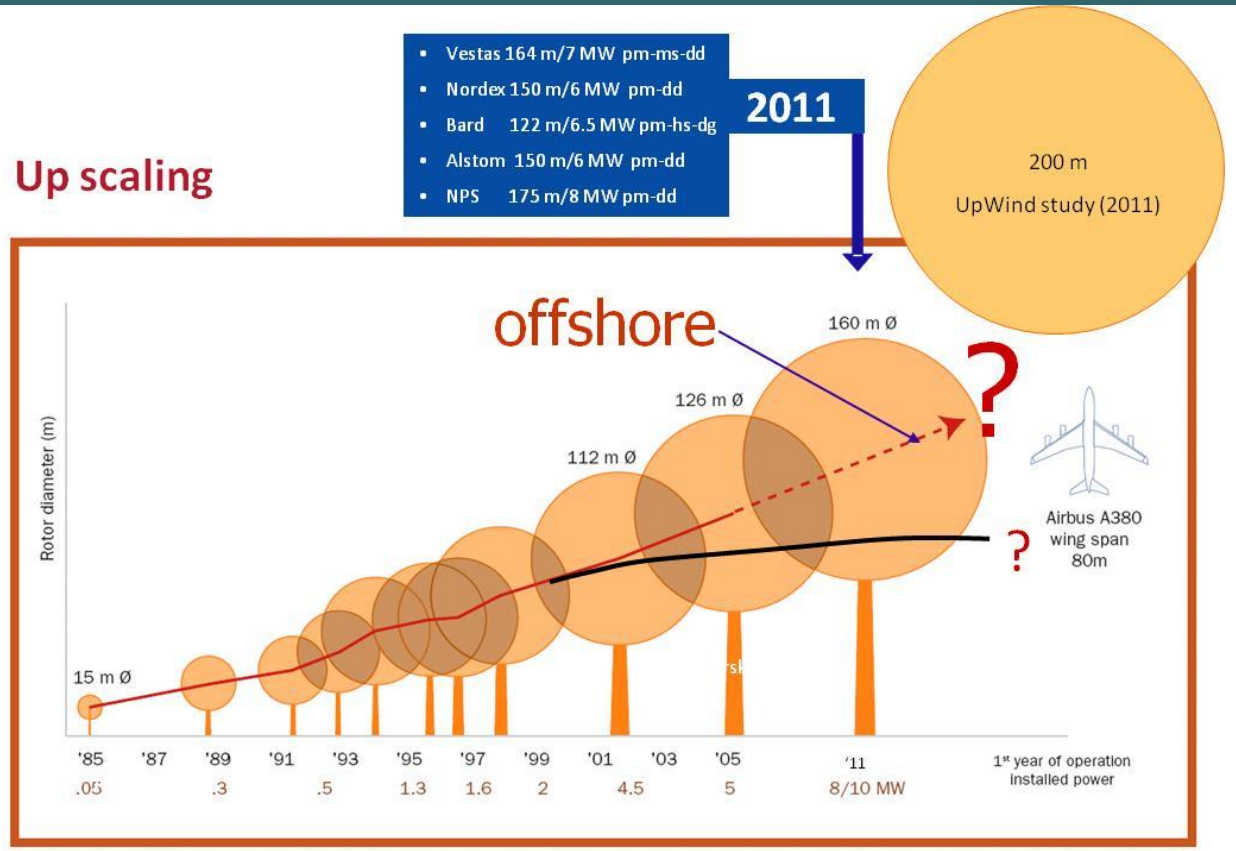
Up scaling


Up scaling
Vestas 164 m/7 MW pm-ms-dd
Nordex 150 m/6 MW pm-dd
Bard 122 m/6.5 MW pm-hs-dg
Alstom 150 m/6 MW pm-dd
NPS 175 m/8 MW pm-dd
2011
200 m
UpWind study (2011)
offshore
160 m Ø
126 m Ø
112 m Ø
15 m Ø
?
?
Airbus A380
wing span
80m
Rotor diameter (m)
'85 '87 '89 '91 '93 '95 '97 '99 '01 '03 '05 '11
.05 .3 .5 1.3 1.6 2 4.5 5 8/10 MW
1st year of operation
installed power

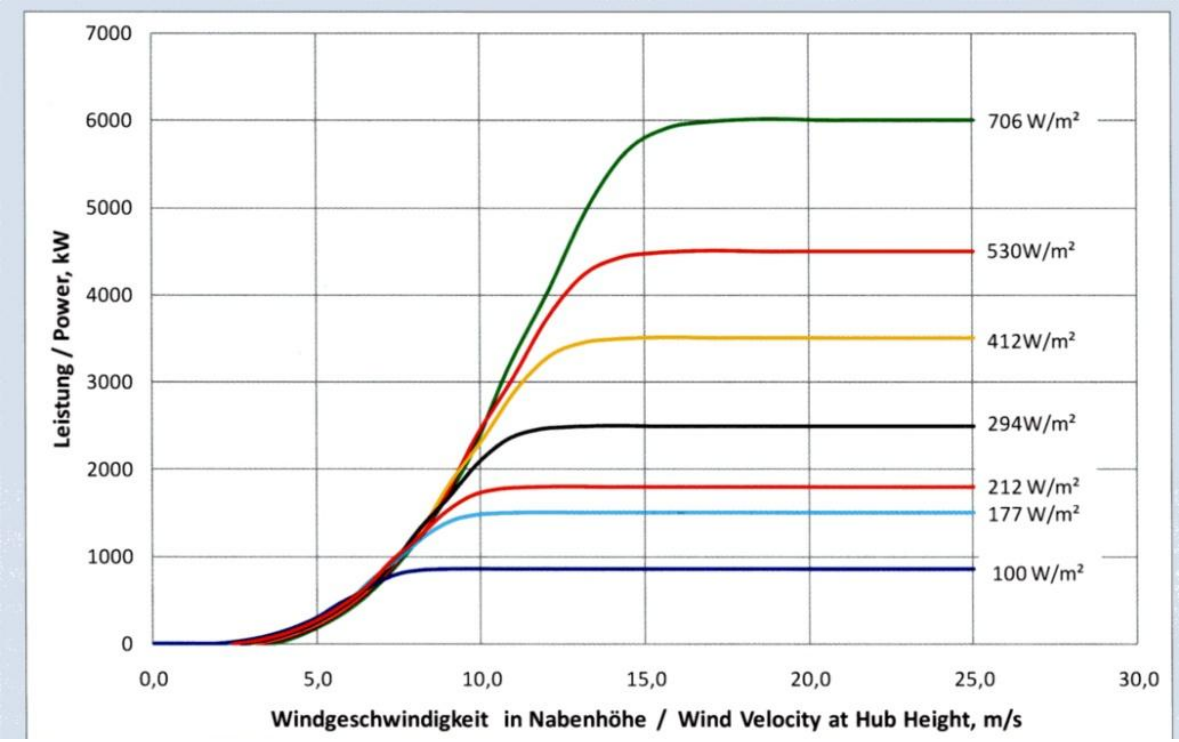

LM WIND POWER
FIRST TO 61.5 METERS
FIRST TO 73.5 METERS
©Jos Beurskens

Up scaling


Ideen.
Gemeinsam.
Umsetzen.
Von der Europäischen Union kofinanziert
Europäisches Energieprogramm zur Konjunkturbelebung
AREVA
© Jos Beurskens


TORBEN RAFN & CO. A/S
DANMARK
VOLVO
FH12
VT 92017

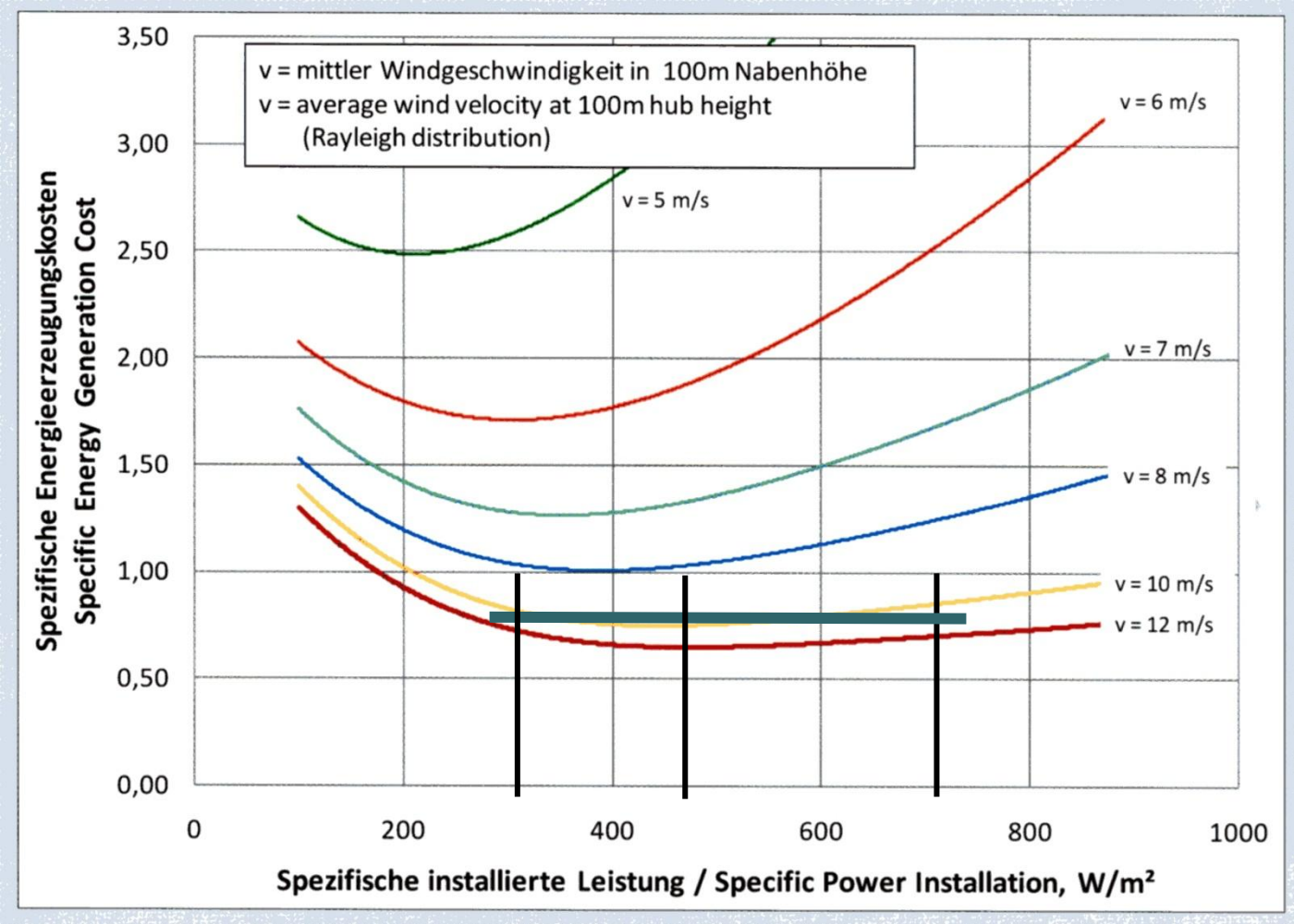
It is not size, it is not generator capacity, it is Wind turbine power rating, which counts !



Source: J.P. Molly, DEWI

$$p = \frac{P_R}{A_{rotor}} \quad [W/m^2]$$

Cost of de-rating wind turbines

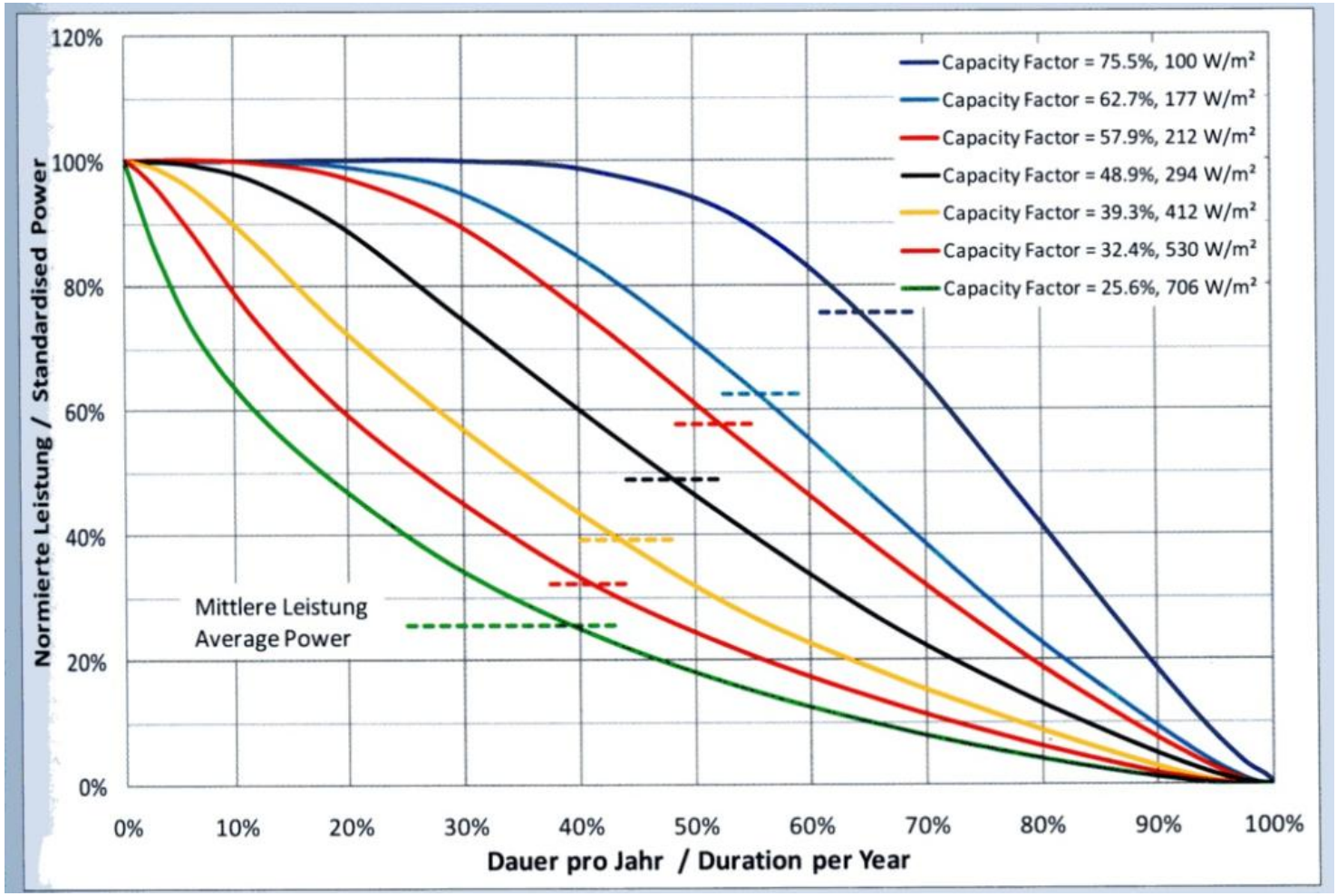


Source: J.P. Molly, DEWI

System rating: Low wind regime rating
Mechanical design: High wind speed regime

Wind turbine power rating and capacity factor

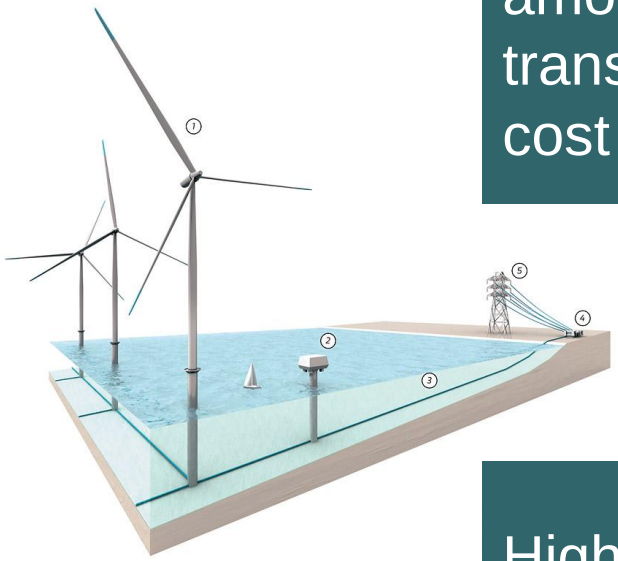
Trend turbine rating: Low specific power p in high winds



100 m hub height, Weibull k=2,92, V_{ave} = 7,3 m/s)

Source: J.P. Molly, DEWI

Low specific power in high winds:



Cable & transformer & convertor cost proportional to peak power and not to the amount of energy generated, converted and transported. This leads to lower generation cost of WE, and less government subsidies

Higher capacity factor (= equivalent full load hours) leads to higher penetration degree of wind energy systems, better predictability, lower storage capacity. This leads to higher value of WE.

Power rating is under estimated and poorly understood issue

- In the past: only maximising output [kWh] and minimising cost [€/kWh]
- Now and in the future: maximising wind contribution to electricity supply

Wind turbines need to be re-designed

- Optimised low p, high V rotor concepts
- Design control and safety strategies for lower load spectrum …. and addition of ice loading
- Modified wind farm optimisation strategies
- ……

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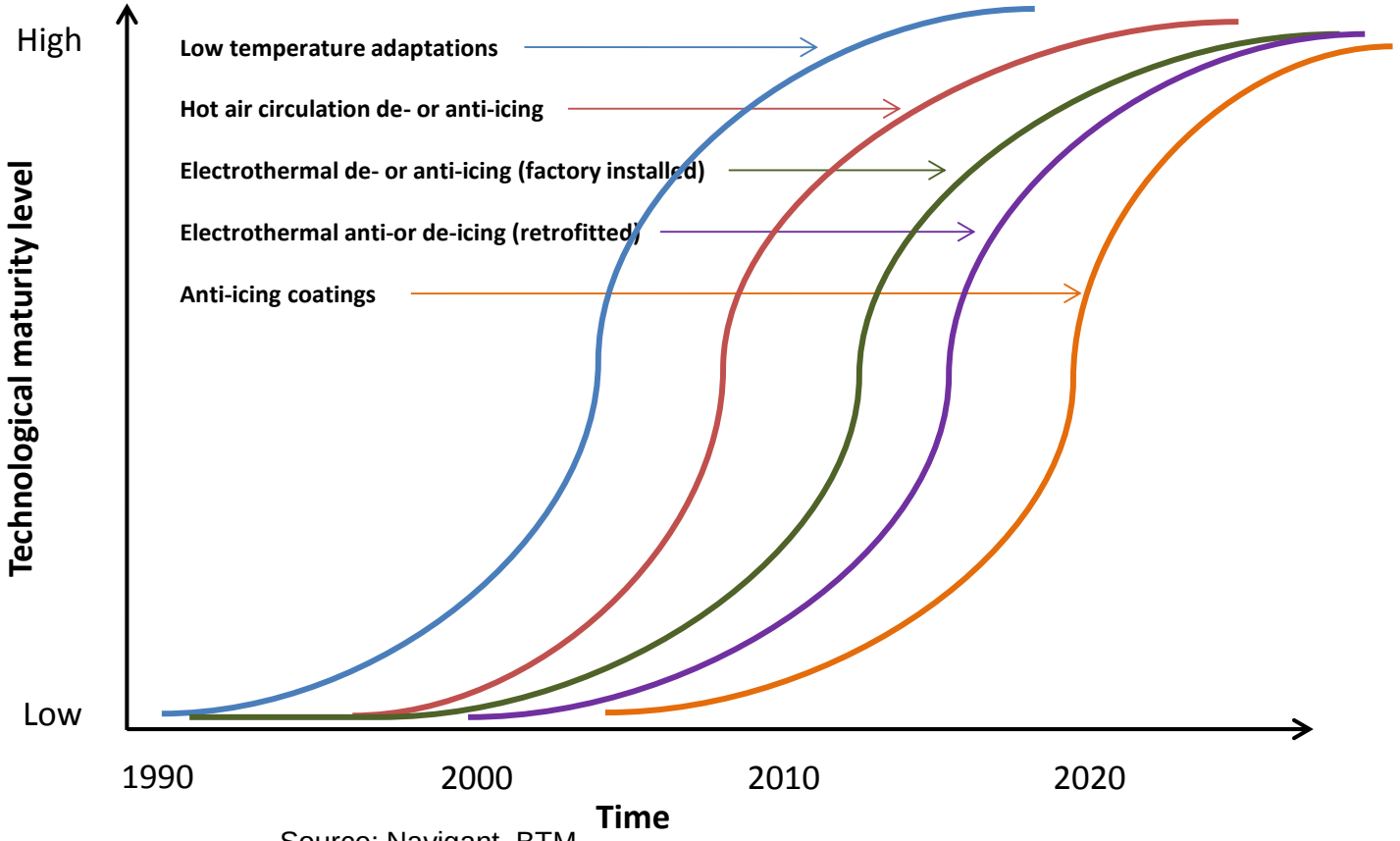
Technology maturity curves for Cold Climate adaptations



Source: Navigant, BTM

In conclusion

- Significant progress in research **and** experimental validation of icing (various types of) under various climatologiacl conditions.
- Same for **additional laoding.** Standard in the making.
- Same for **power and energy output** loss
- CC less and less a special case. Market at present 20 % of total wind power world wide.

Wind park, north of Östersund (S). Photo Jos Beurskens

Future

- Grid issues & feed back to wind turbine and farm designers
- Wind turbine CC testing and operational verification
- Communication of risks & impacts
- O&M, Asset management
- Sharing of information


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Photo: Jos Beurskens