# A European Perspective of Wind Energy in Cold Climates

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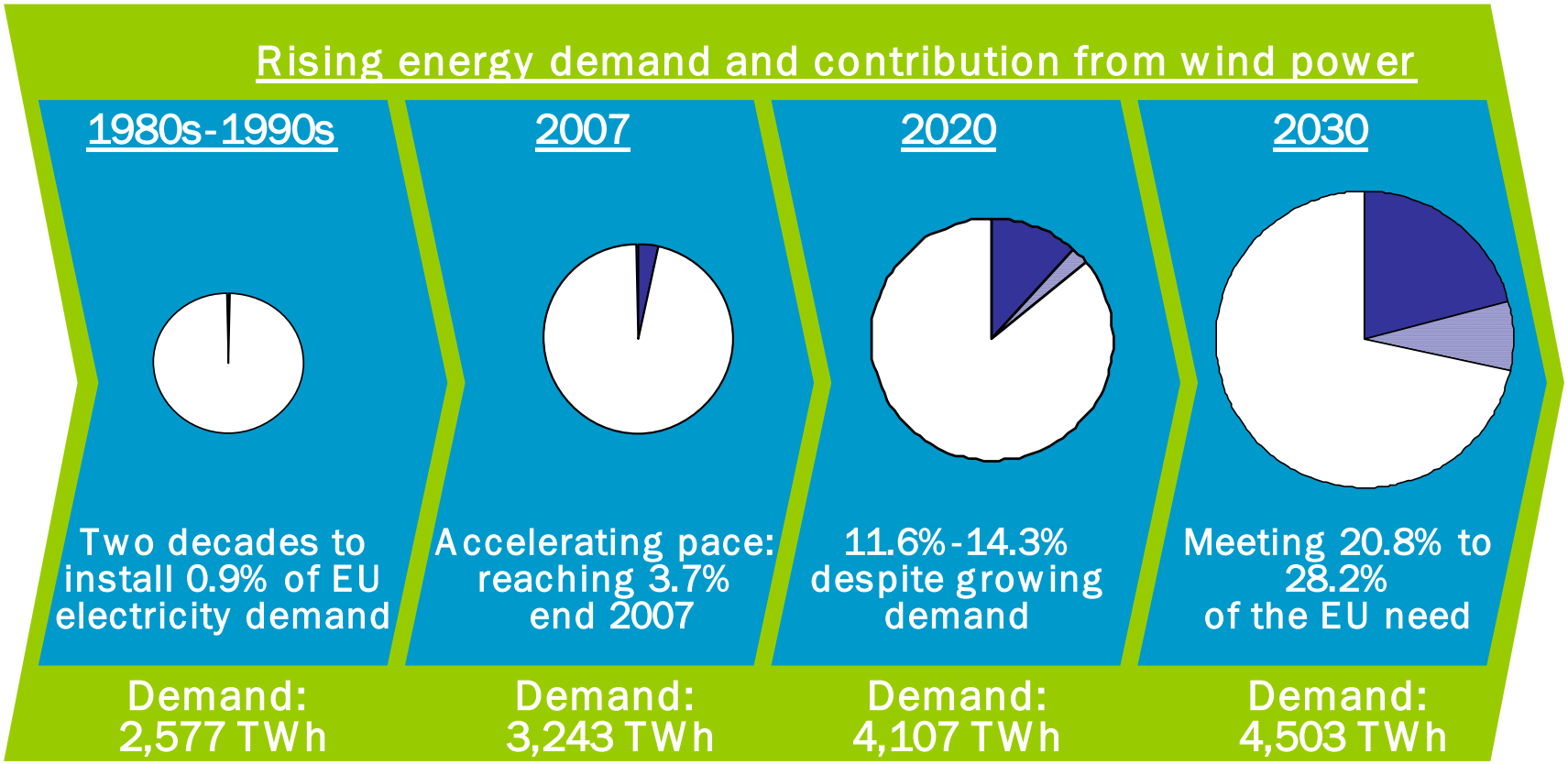
Photo Jos Beurskens (Umeå, 08-02-2011)

# This presentation

- European objectives and trends
- Cold Climate (CC), a special case?
- Comparing Offshore - CC
- Influencing European research policy
- Some specific R&D issues
- Conclusions

# European objectives and trends

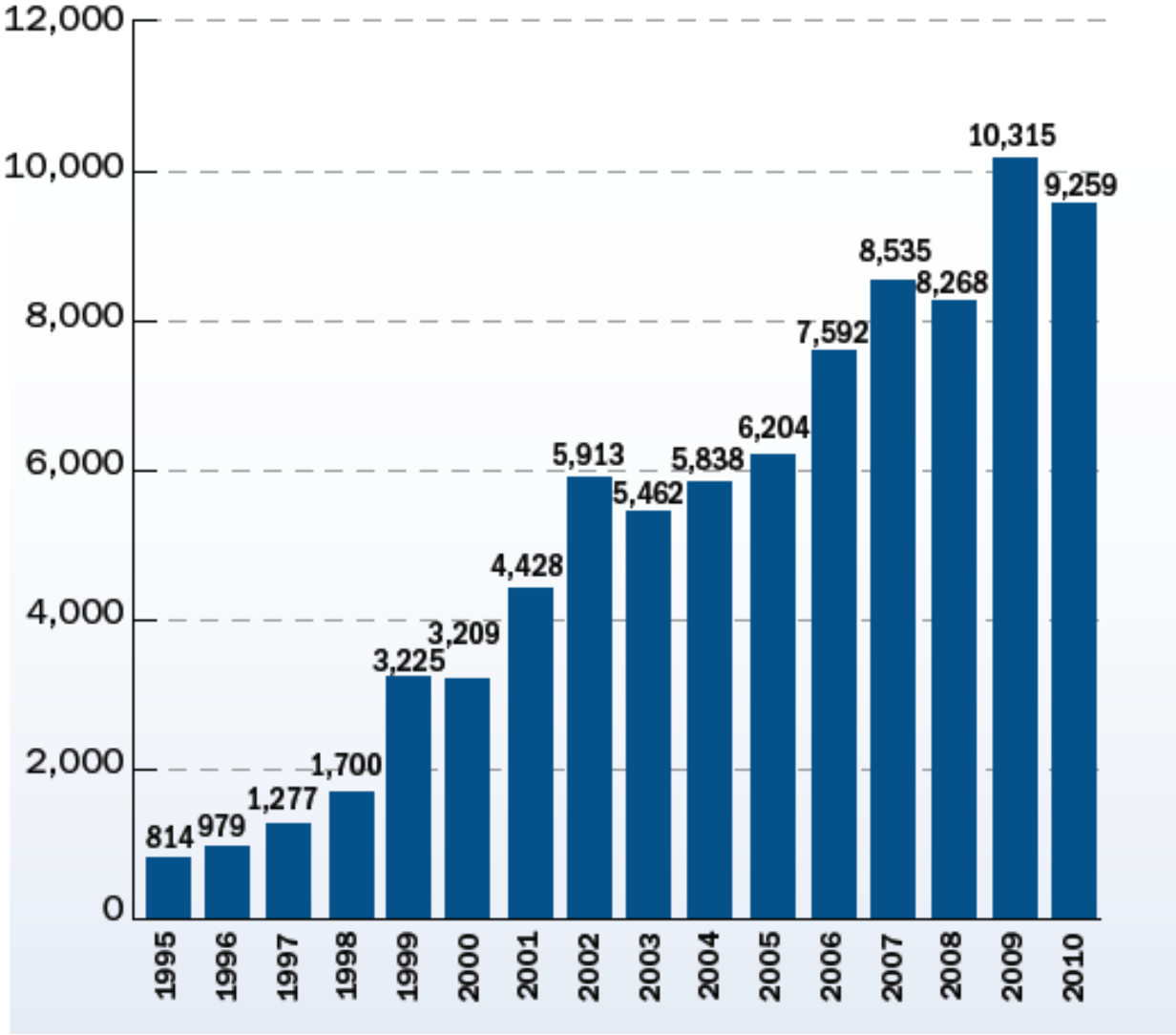



*Source: EWEA*

Reconfirmed by recent EWEA study (Comparison of 27 action plans)

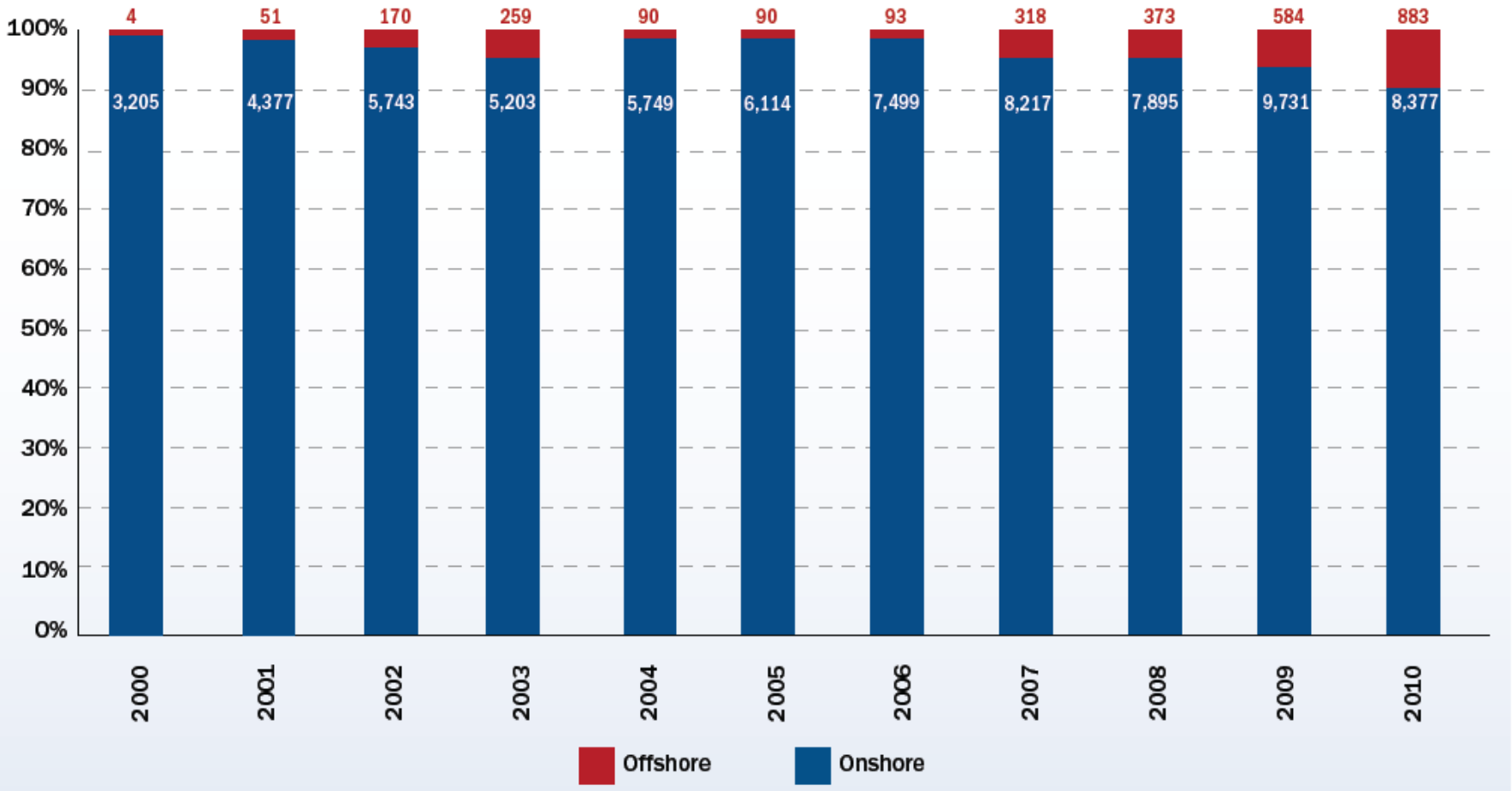
# European objectives and trends

Annual Wind Power installations in EU [MW]



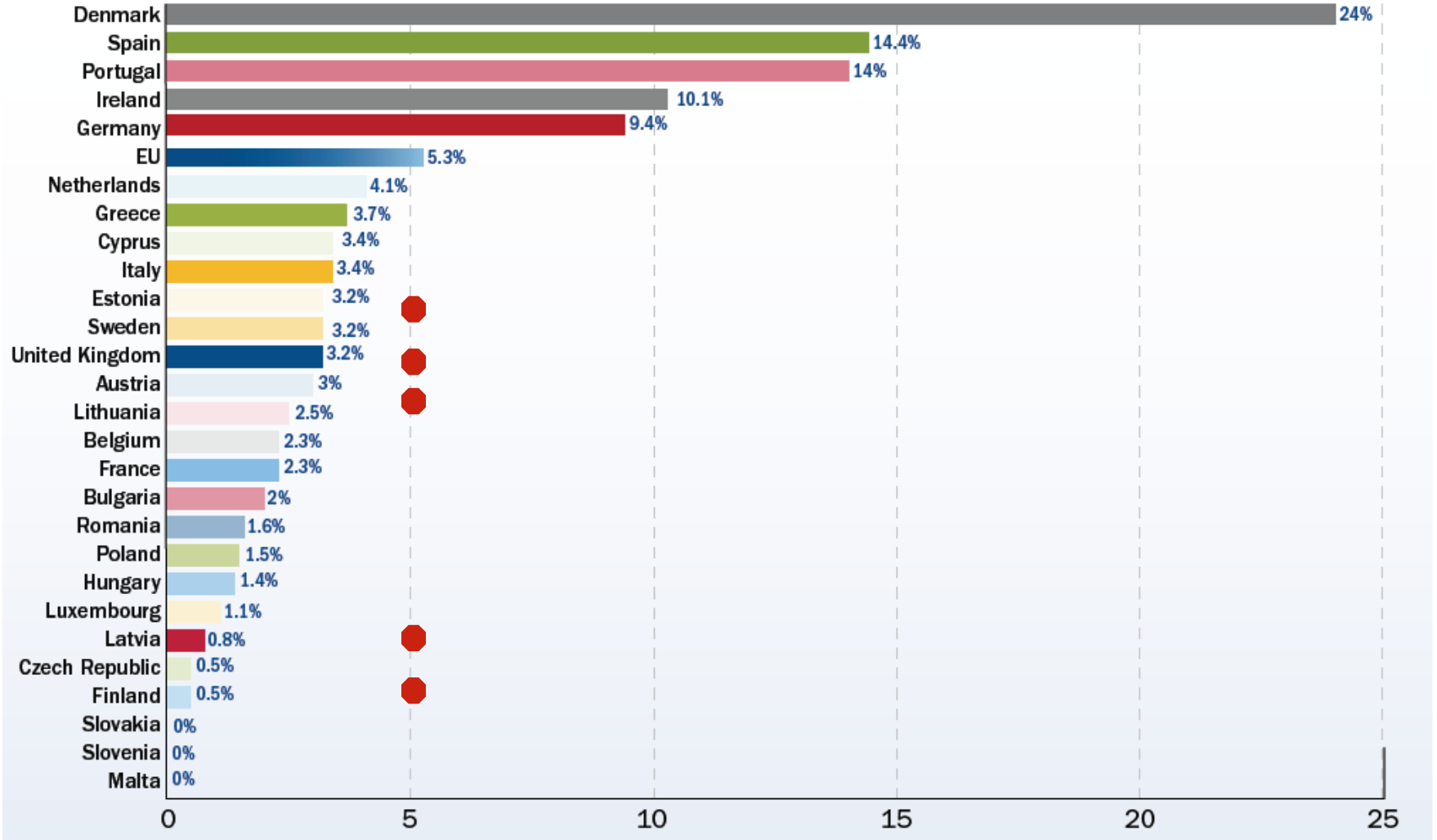
# European objectives and trends

## Offshore's share of annual EU wind power market [MW]



# European objectives and trends

## Wind share of total electricity production



# Cold Climate; a special case?

Windy sites in moderate zones are gradually being used up

Offshore sites are not compensating for the reduced installation rate.

What about other extreme zones ?

What are extreme climate zones?

# Cold Climate; a special case?

hot

extreme cold

dry

cold

humid

saline air

wind classes I, II, III

dusty

waves

extreme wind speed

lightning

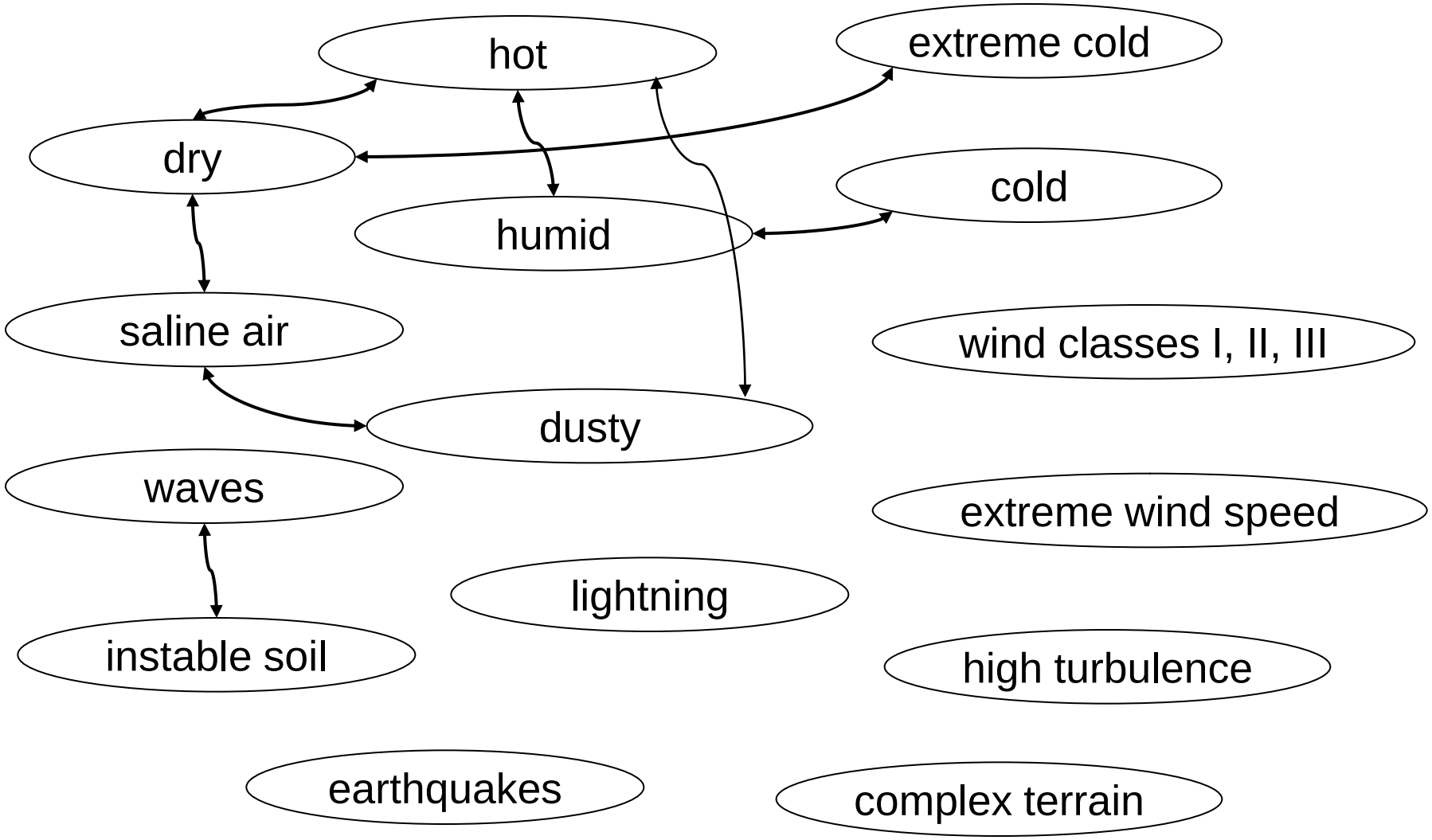
instable soil

high turbulence

earthquakes

complex terrain

# Cold Climate; a special case?



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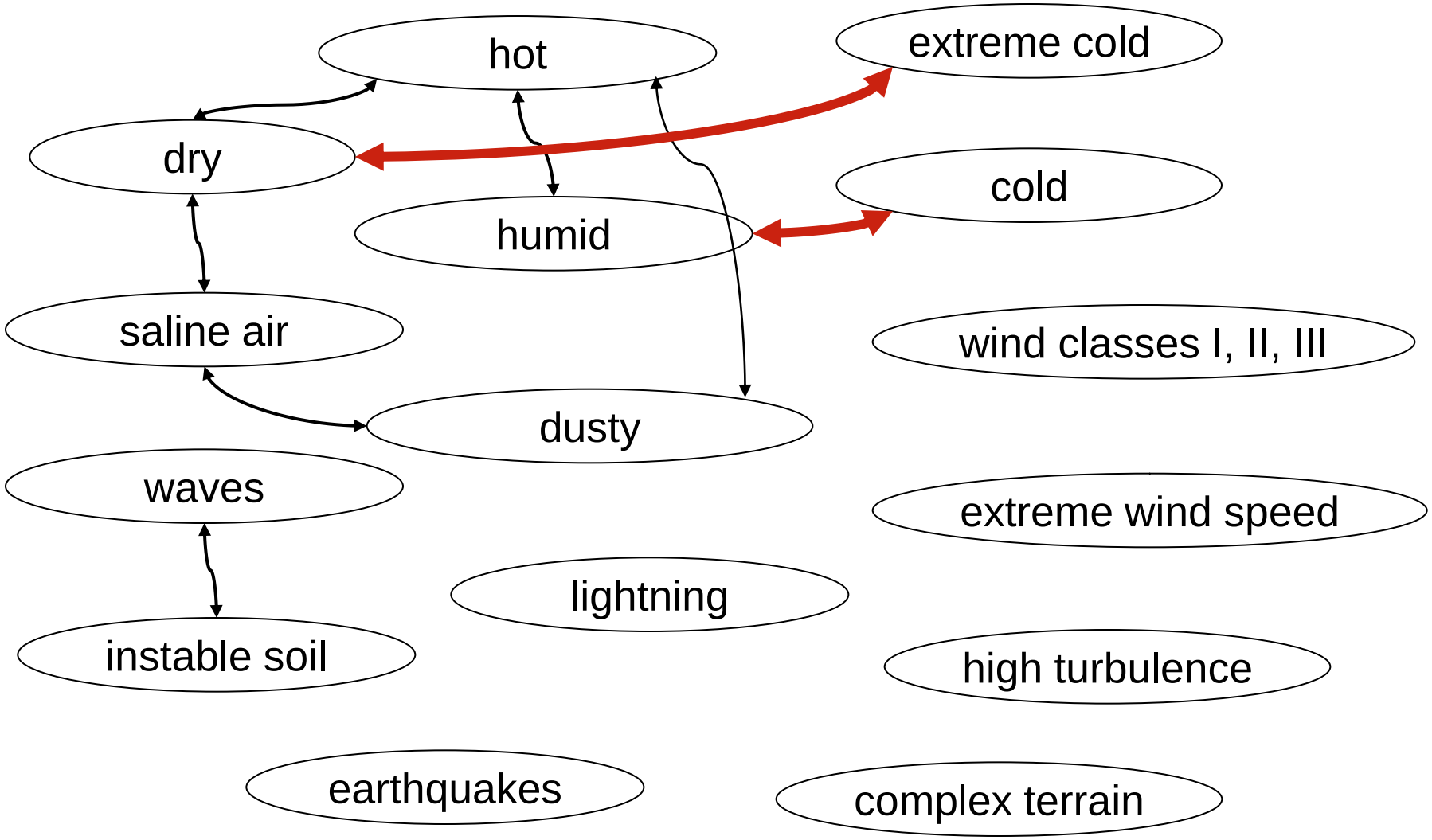

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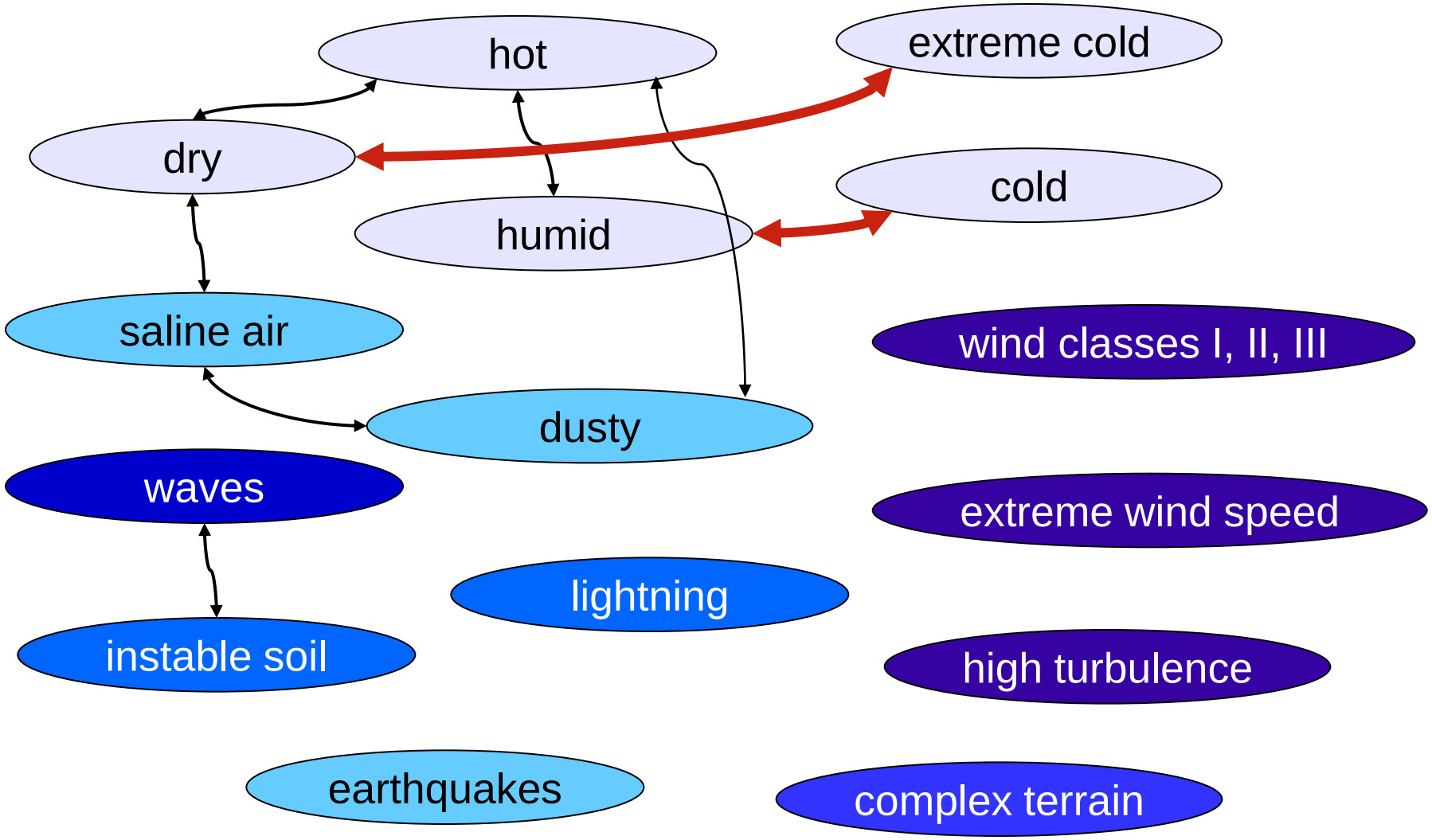
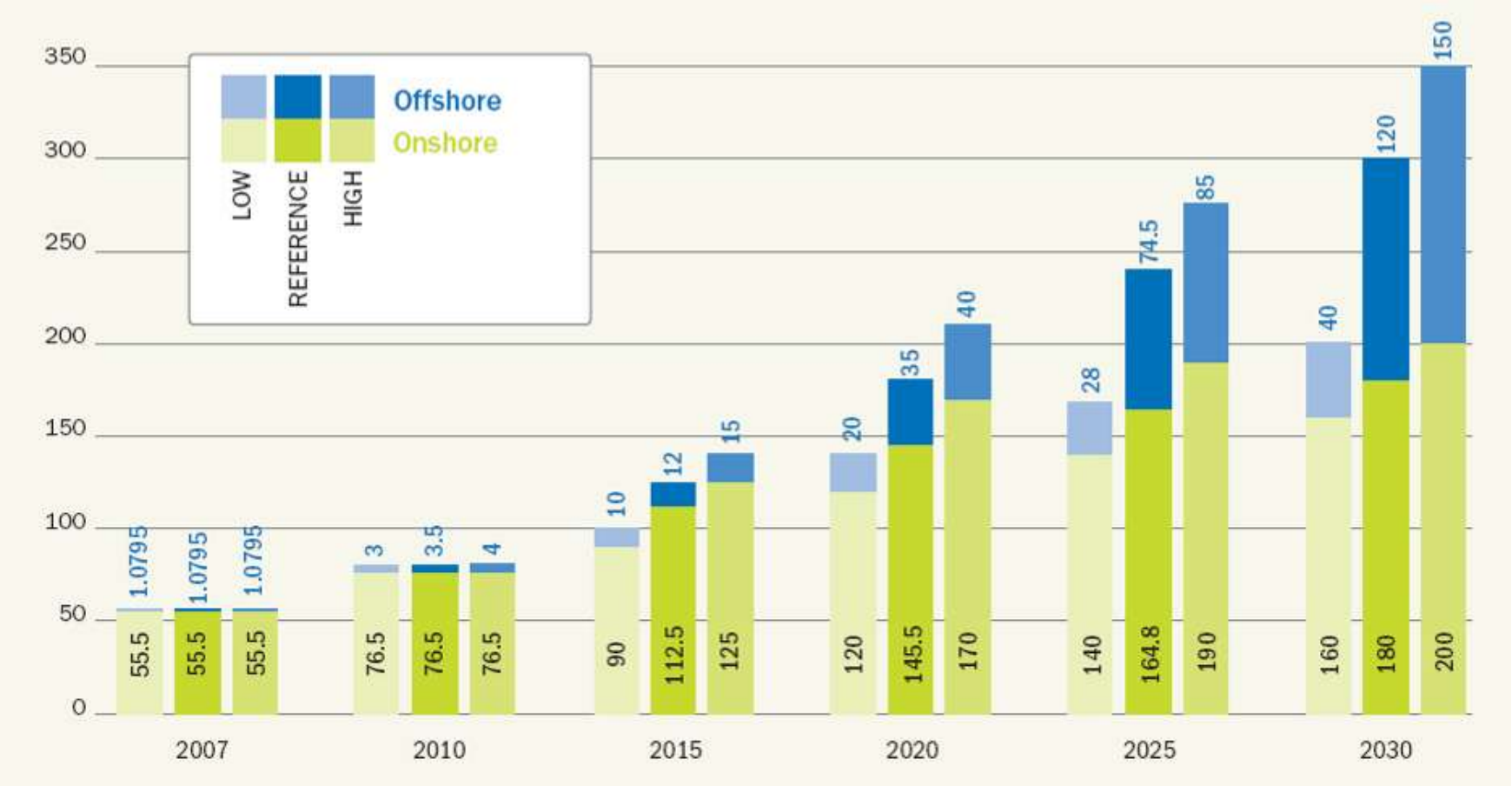


# Cold Climate; a special case?

- In order to utilise the full wind energy potential we need certified machines which operate reliably in numerous types of external conditions
- Impacts on rotor blades, generators and gearboxes (if any), towers, foundations
- Certification !

# Comparing offshore and CC




*Source: EWEA Pure Power report*

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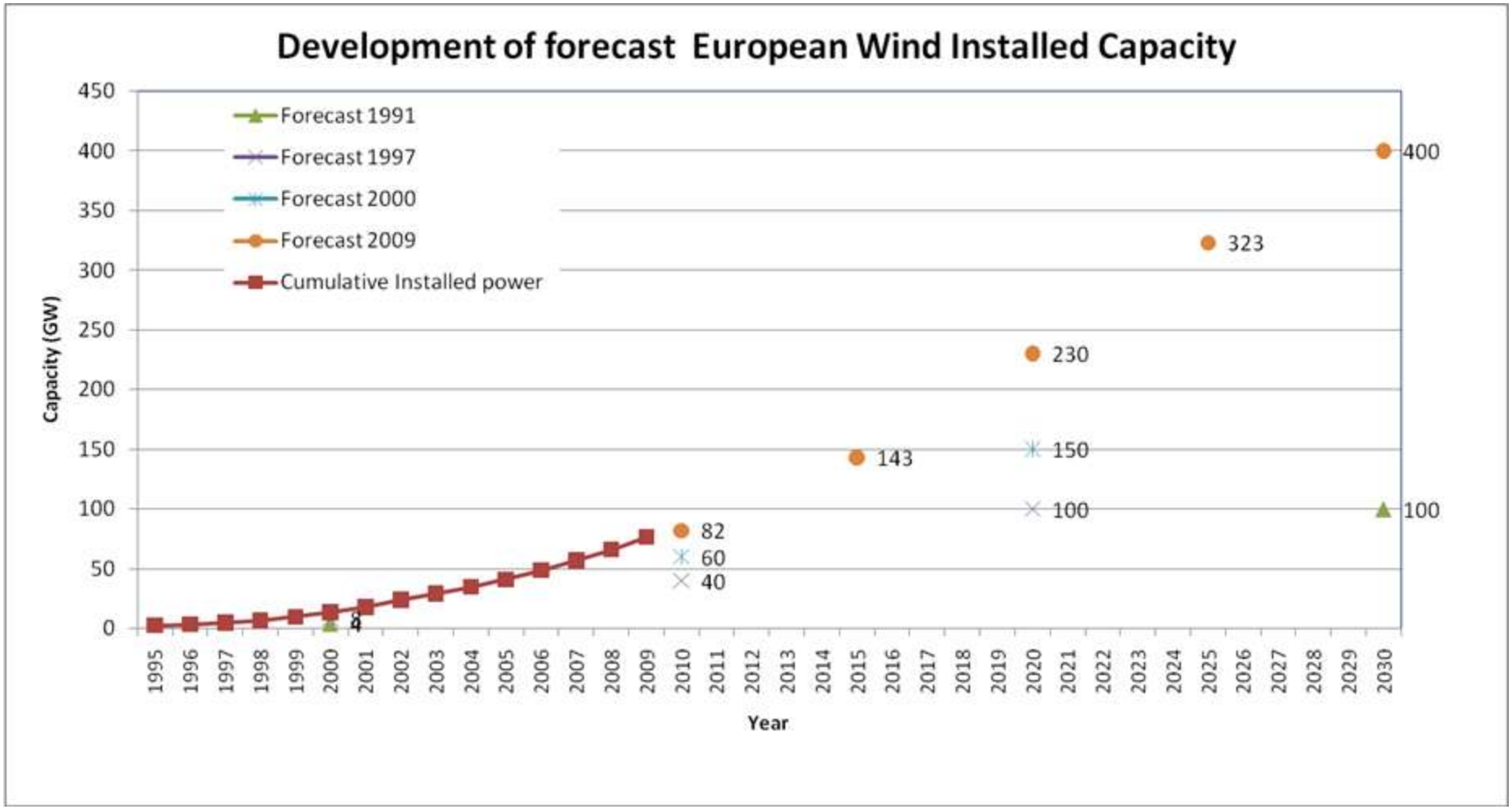

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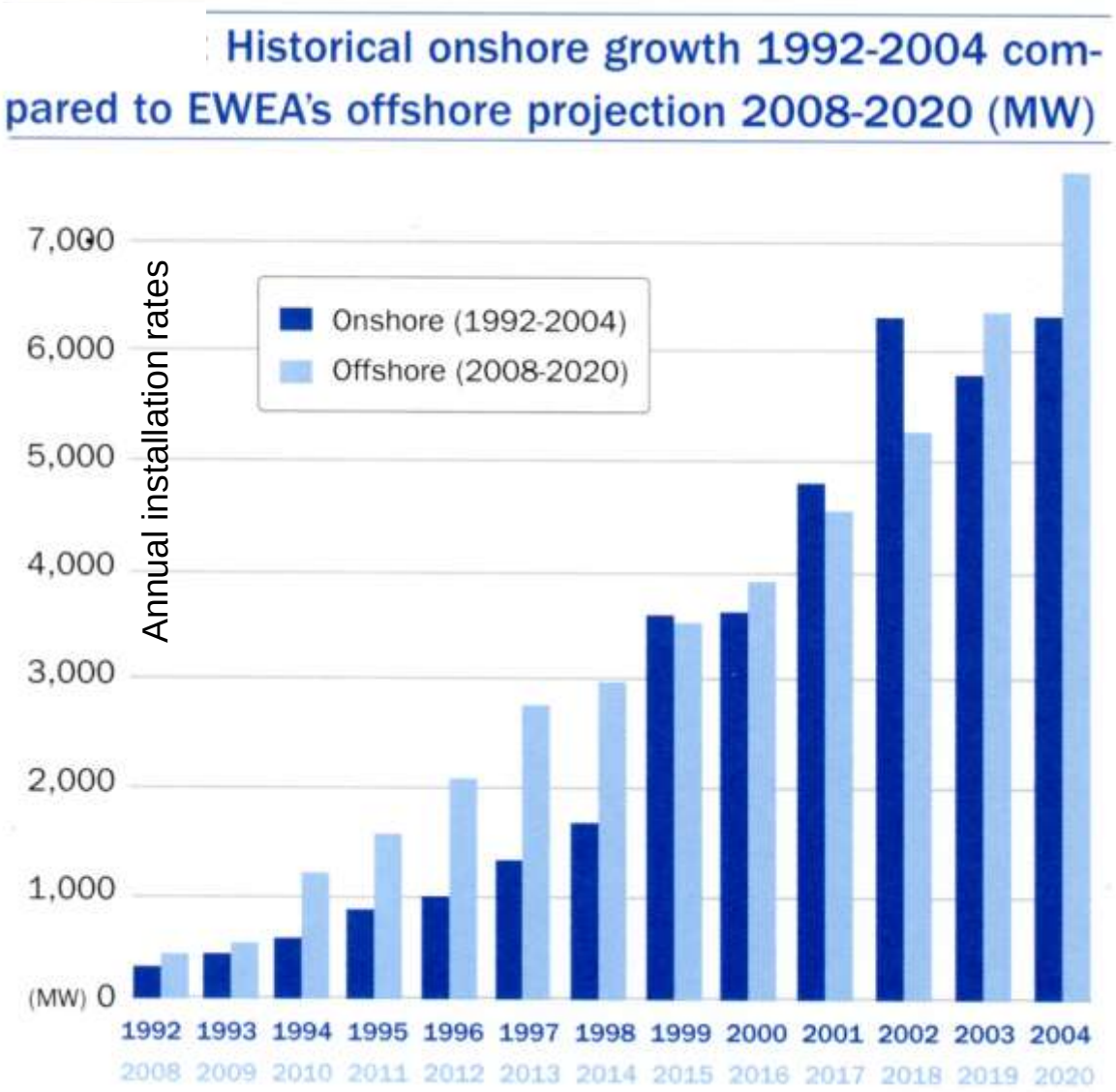



Offshore is the driver !

Time lines displaced by 16 years !

Source: EWEA
Oceans of Opportunity

# Comparing offshore and CC

Why delays in offshore development ?

- Under-estimation / ignoring of technical problems
- No adequate timely policy in place
- Grid planning behind schedule

In order to speed up offshore development R&D has been intensified. Actually Offshore has become the motor of R&D and innovation.

Could exploitation of the Cold Climate resource encounter similar problems?

Yes !!

# Comparing offshore and CC

Ignorance (basis for under-estimation of problems!)

- Potential


## Ignorance (basis for under-estimation of problems!)

- Potential

The geographical potential

Majority of cold climate wind turbine sites are located in open and forested terrain with average wind speeds of > 7m/s and altitudes > 71 m.
The total potential is 10 times more than for easily accessible offshore sites.

Ref: Vindkompaniet; Potential study

## Ignorance (basis for under-estimation of problems!)

- Potential

  113 million people in (only) 28 countries, mostly sparsely populated:
  Sweden, Finland, Norway, Iceland, Other European mountainous areas (Pyrenees, France, Austria, Switzerland, Liechtenstein, Italy, Germany. Slovenia, Romania, Slovakia, Ukraine, Hungary, Serbia & Montenegro, Scotland), North America (Canada, USA), Asia (Himalaya's in China, India, Nepal, Bhutan). Excluding South America and non Himalayan parts of China!!

- Hidden potential

  Micro climates in moderate zones: energy losses are probably large but not analysed ! (Little ice; large energy losses !!) Areas affected much larger than CC zones.

## Ignorance (basis for under-estimation of problems!)

- Effects on fatigue life time due to unbalance caused by icing
- ‘Icing is unavoidable’: too little attention for preventive solutions

What is needed for intensified policy ?

- Thorough market study (Geographic & Physical potential, CC potential, ‘hidden’ potential)
- Coherent R&D effort, comparable to offshore R&D.
  (quantifying effects of external conditions on design, specific technical concepts)

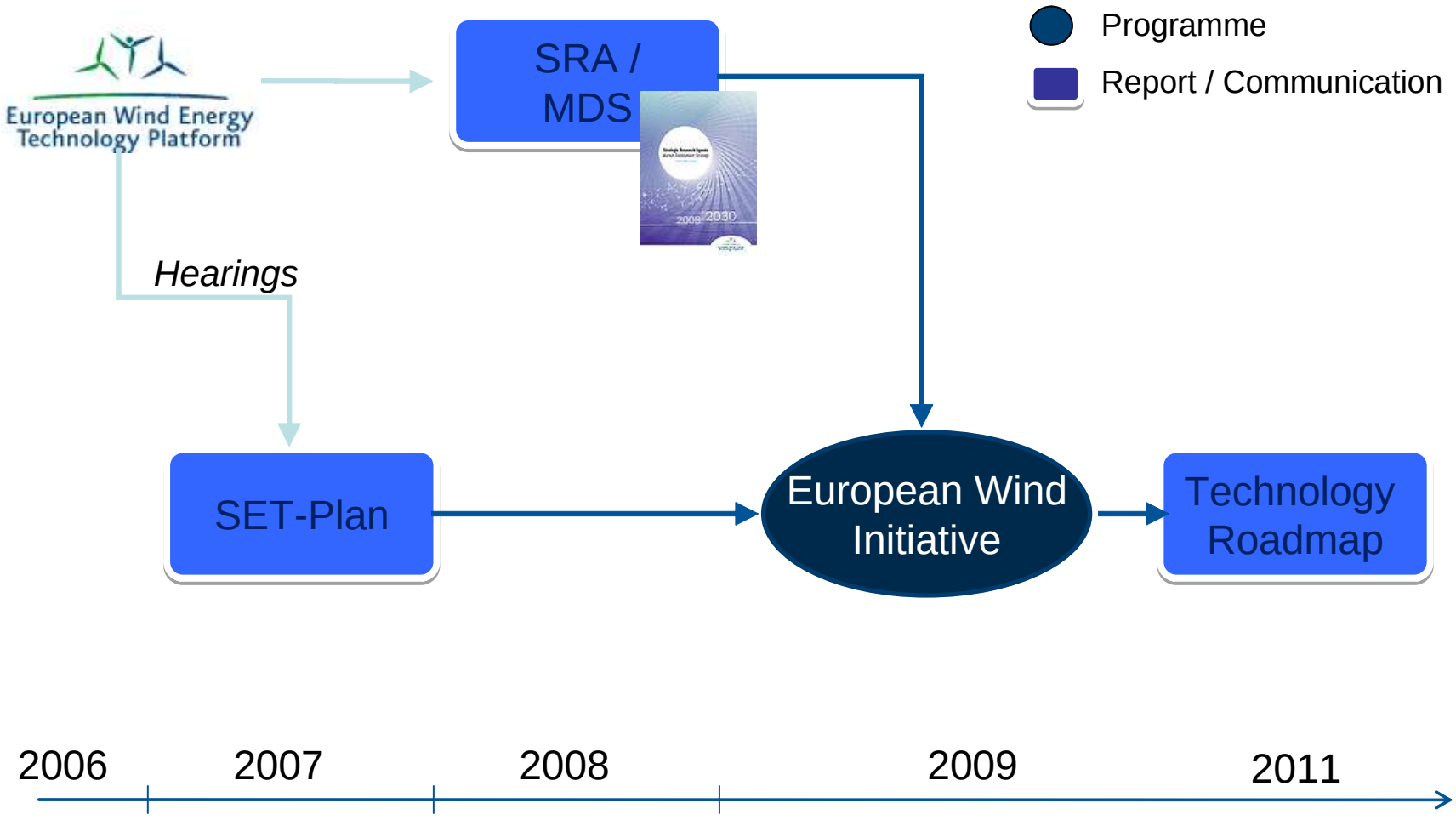
## What makes cold climate WE different from main stream applications?

- External conditions (1. probability of icing, 2. extreme low temperatures)
- Impact on mechanical loading and performance
- Transport and assembly, because of poor access
- Operation and maintenance/access
- Safety

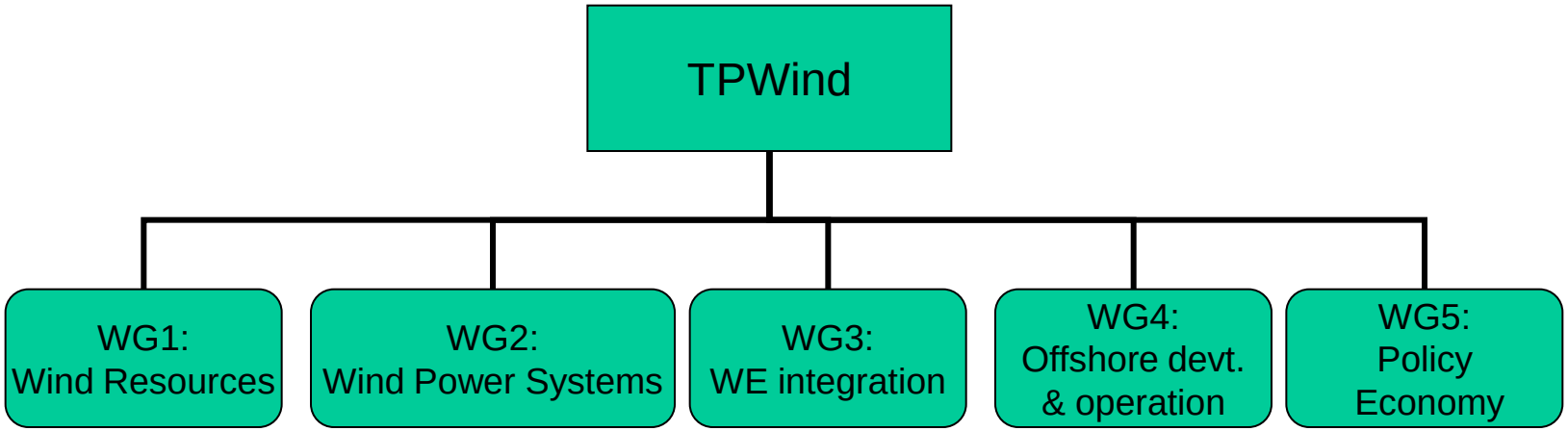
Requires dedicated or adopted concepts

# Influencing European Policy

## SET Plan



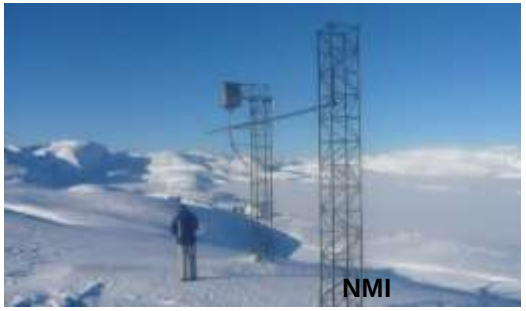
# Technology Platform

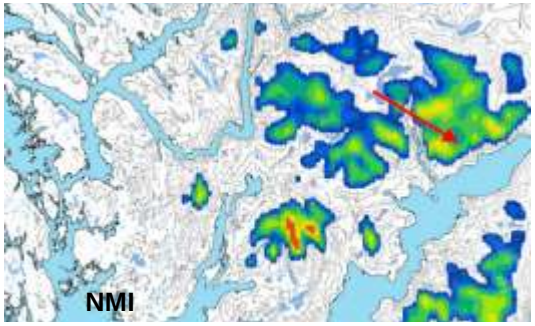


# Priorities (1)

(taken from Boreas, Swedish WE conference, IEA docs, personal communications)

- Conditions for icing (super cooling, sublimation)
- Icing probability mapping of areas with high wind potential (‘iso icing days/annum’ contours)
- Cold climate resistant measuring instruments and associated power supply units (performance, resource assessment, ice detection, loads, heating system control




# Priorities (2)

(taken from Boreas, Swedish WE conference, IEA docs, Personal communications)

- Impact on loading (aerodynamically and mechanical/aerodynamically induced loads, scale effects
- Safety (Detection methods)

Turbine 3
- Ice prevention in operation

Turbine 2
- Ice prevention system fault

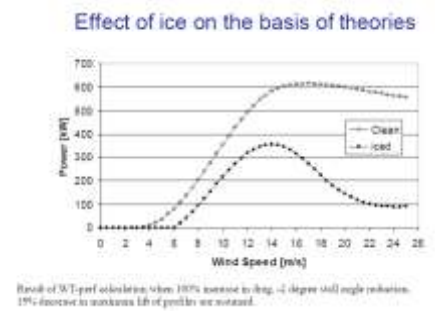
VTT

VTT

# Priorities (3)

(taken from Boreas, Swedish WE conference, IEA docs, Personal communications)

- Impact on performance
- Transport and assembly, because of poor access
- Operation and maintenance/access

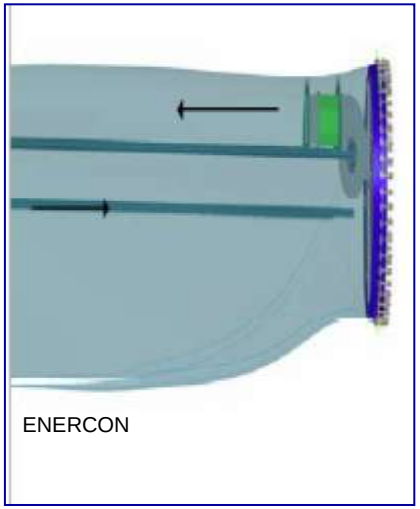



# Priorities (4)

(taken from Boreas, Swedish WE conference, IEA docs, Personal communications)

## Dedicated cold weather wind turbine concepts

- Preventing icing by heating blades (e.g. carbon fibre heating foils, warm air)
- Heating (energy) demand (Turbice)
- Breaking ice bonds by electric current
- Materials (nano structured surfaces)
- Control systems (parameter identification)

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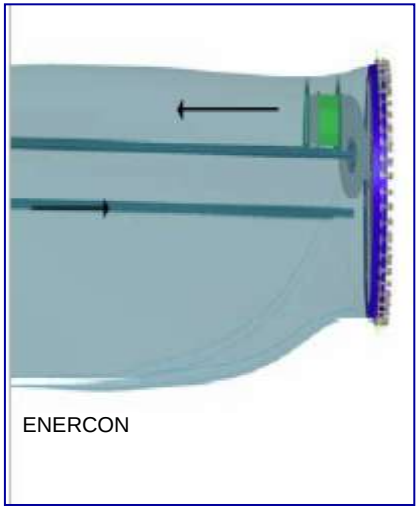
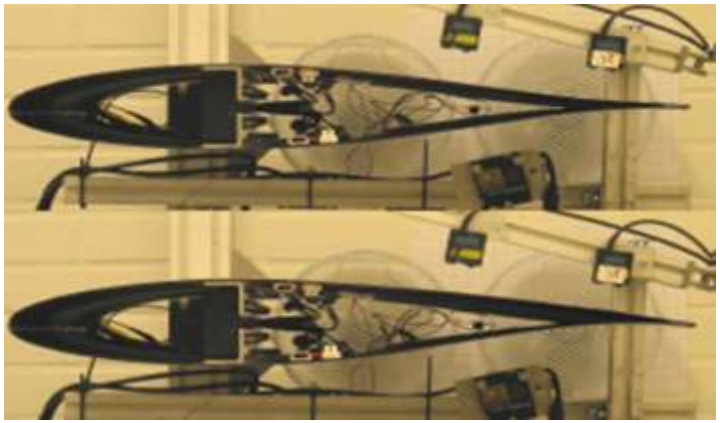
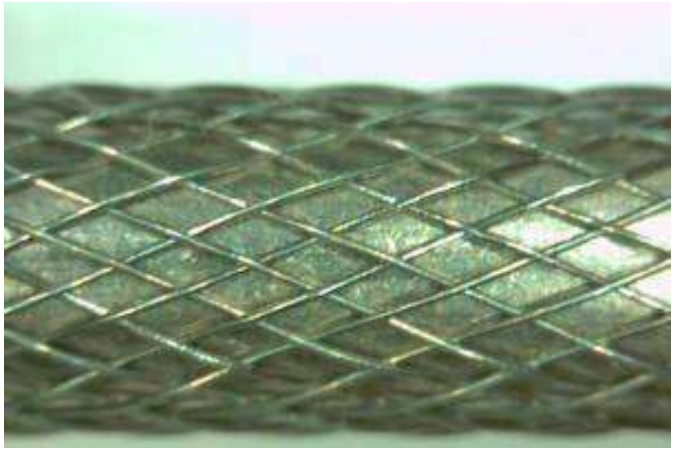


# Up scaling: distributed blade control

Modeling and production of SMA(*)-actuated, deformable aerofoil (VTT) Piezo electrically activated activator (TUD, Risø-DTU)
Synthetic jets (ECN)

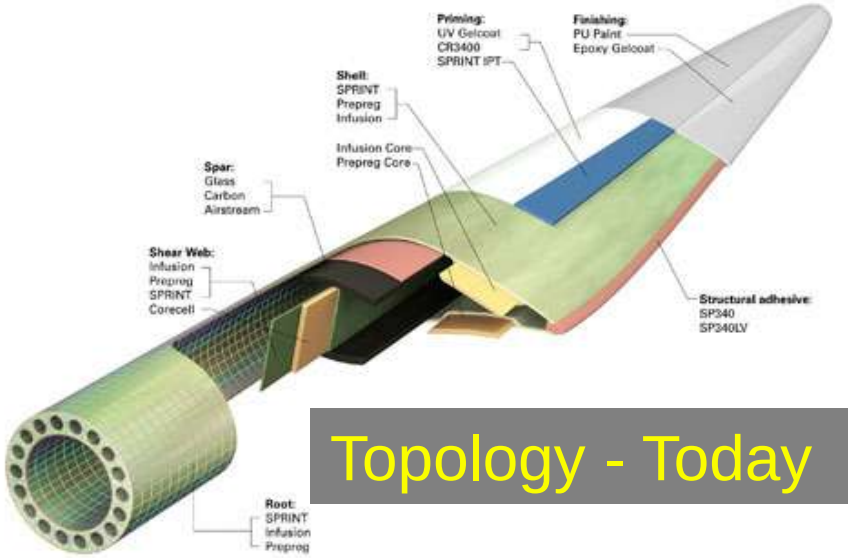
(*) Shape-Memory Alloys

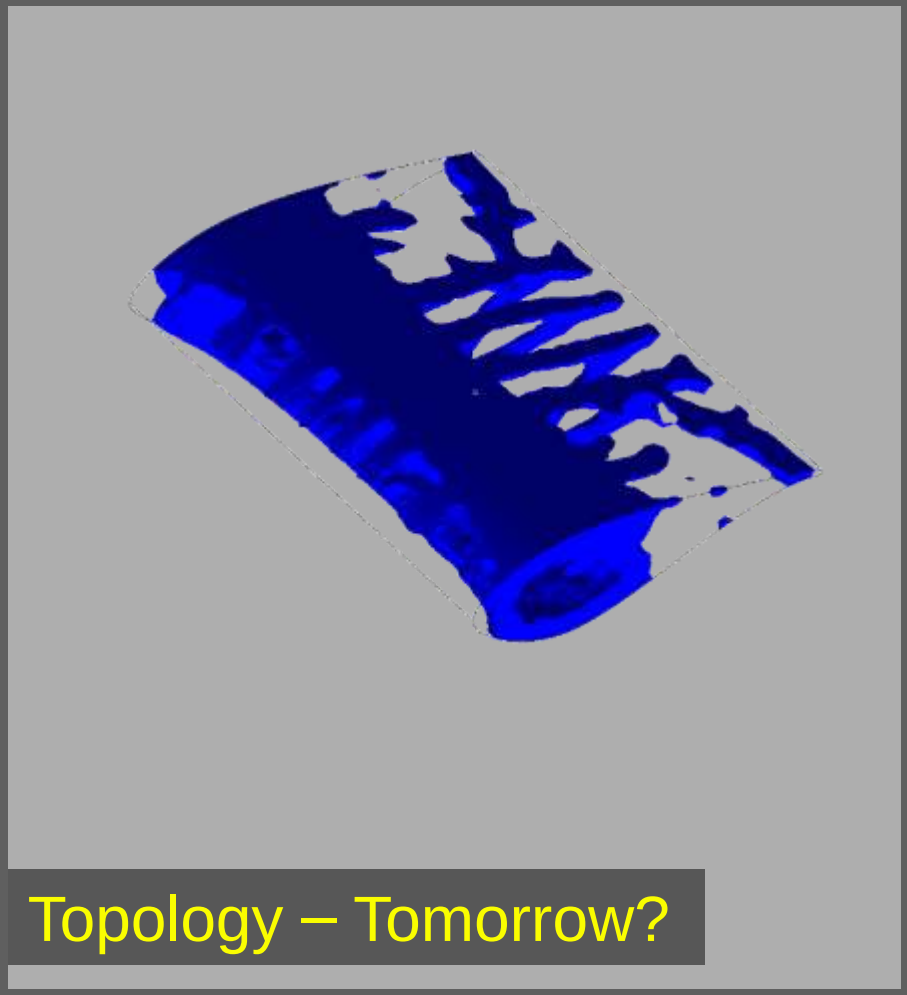




UpWind

## Thermoplastic blades



# Conclusions

- Market potential in cold climate areas is significant
- Numerous problems still unsolved
- Cold climate research issues need to be included in European research agendas
- Incorporate scientific disciples, which do not belong to the traditional core of WE research (nano materials, physics (of ice))

# Thank you for your attention !

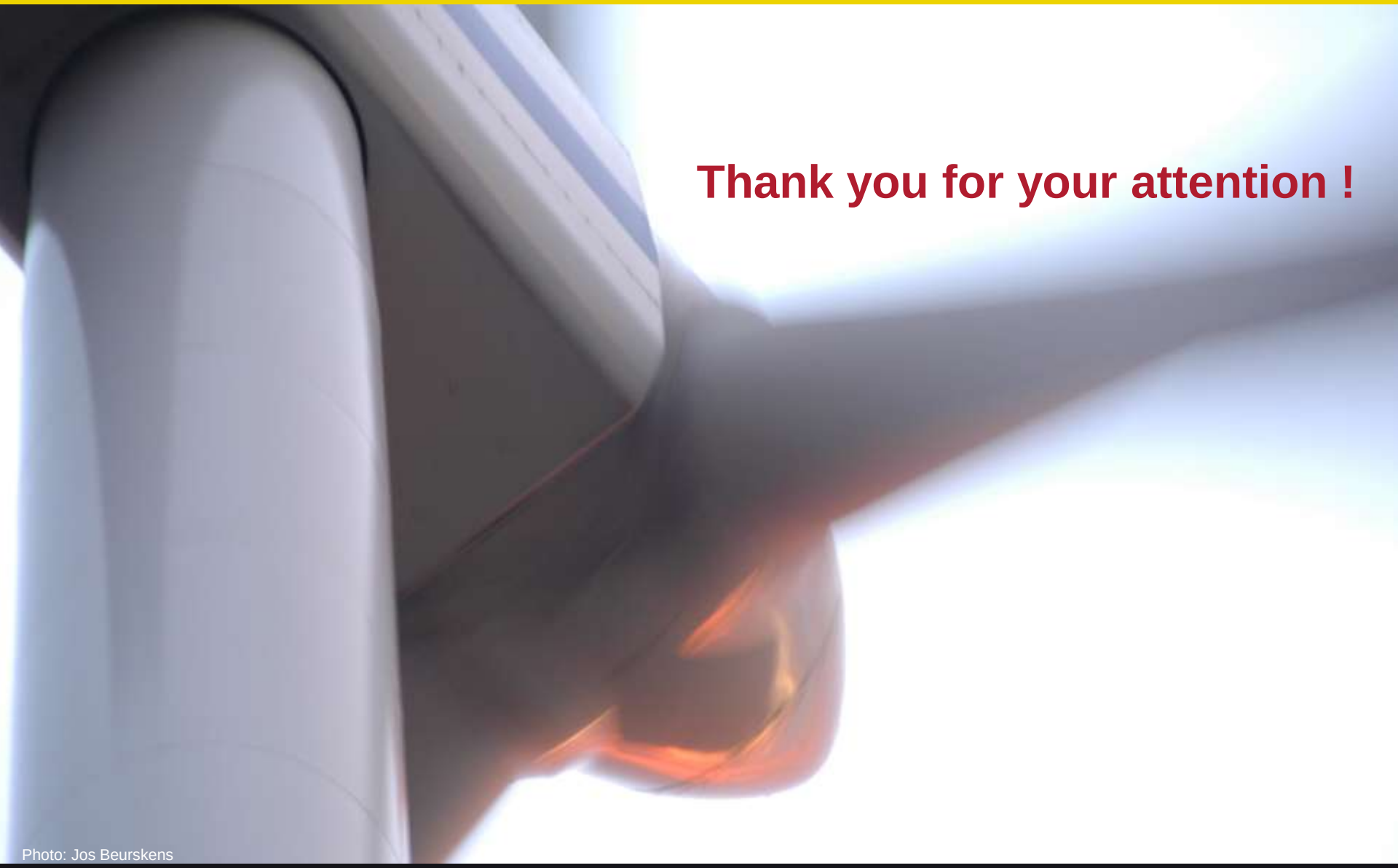


Photo: Jos Beurskens