Challenges and approaches to wind energy in cold climate

Ice & Rocks 2010
Wednesday, 5 May 2010 in Zadar, Croatia
Timo Laakso

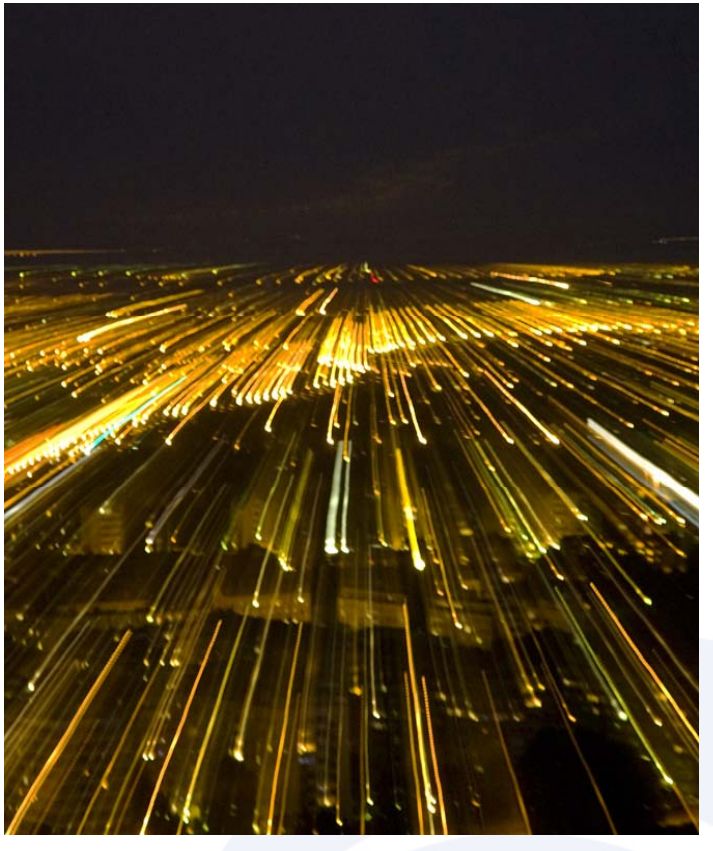
Content

Global experts in consulting and engineering

- Pöyry is a global consulting and engineering company dedicated to balanced sustainability

- 7000 experts in about 50 countries
- Project experience in more than 100 countries
- 17 000 projects annually

- Net sales in 2009 EUR 674 million
- Listed on the NASDAQ OMX Helsinki since 1997



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Does this look like a cold climate site?

Cold climate sites don’t necessary look like ones immediately

Photo credit: Timo Laakso / Pöyry

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Experience of service providers and equipment suppliers

- There's a plenty of international service and equipment providers how actually cannot distinguish a cold climate site at the moment
- But there's also those who have the needed experience and track record that can deliver the right kind of equipment and/or data

Photo credit: Timo Laakso / Pöyry

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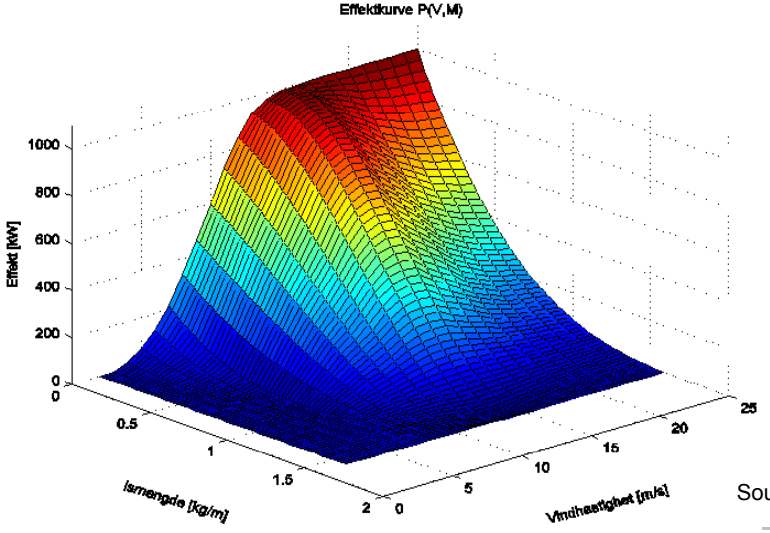
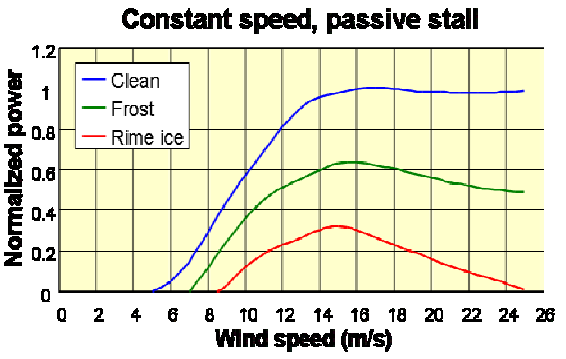
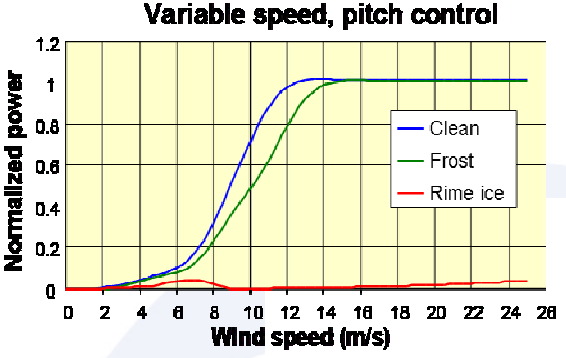
Detailed assessment of production losses due to ice

- Several methods available or under development
- Some based on detailed analysis of performance of iced airfoils some more statistical in nature
- However, not commonly known accepted and verified method available yet
- Challenge also the site dependence of atmospheric icing
- Turbine control systems actually play significant role in determining the final energy production losses

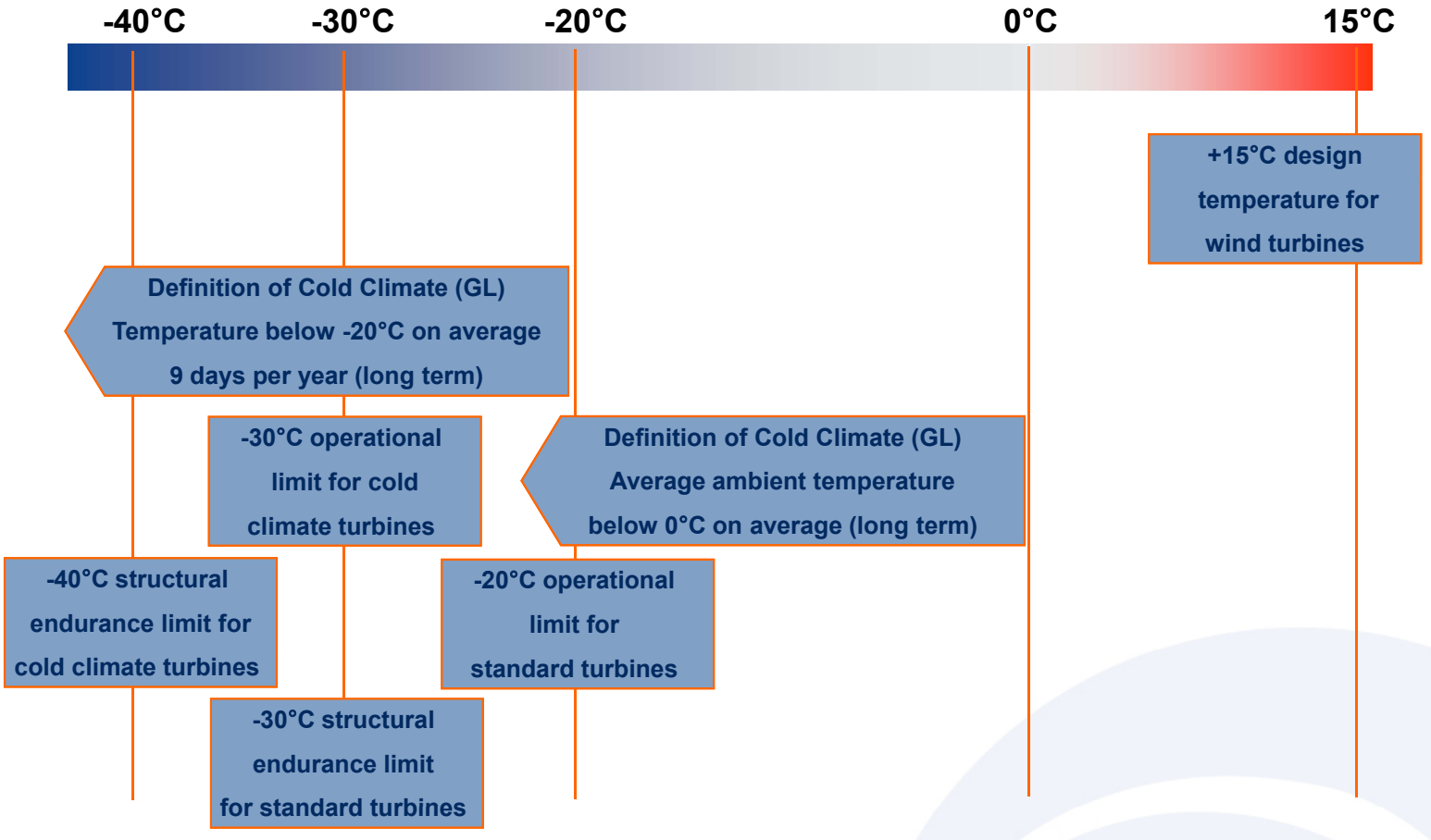






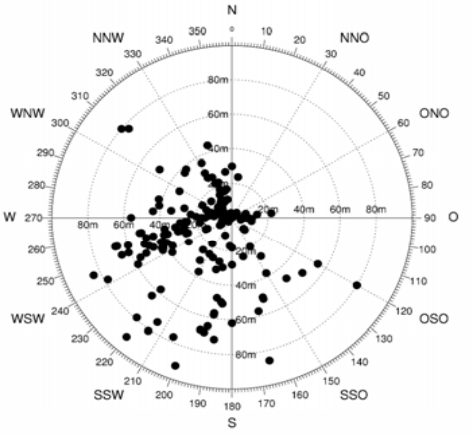
Source:Kjeller Vindteknikk and VTT

Existing definitions and standards



Safety - temperatures and ice throw

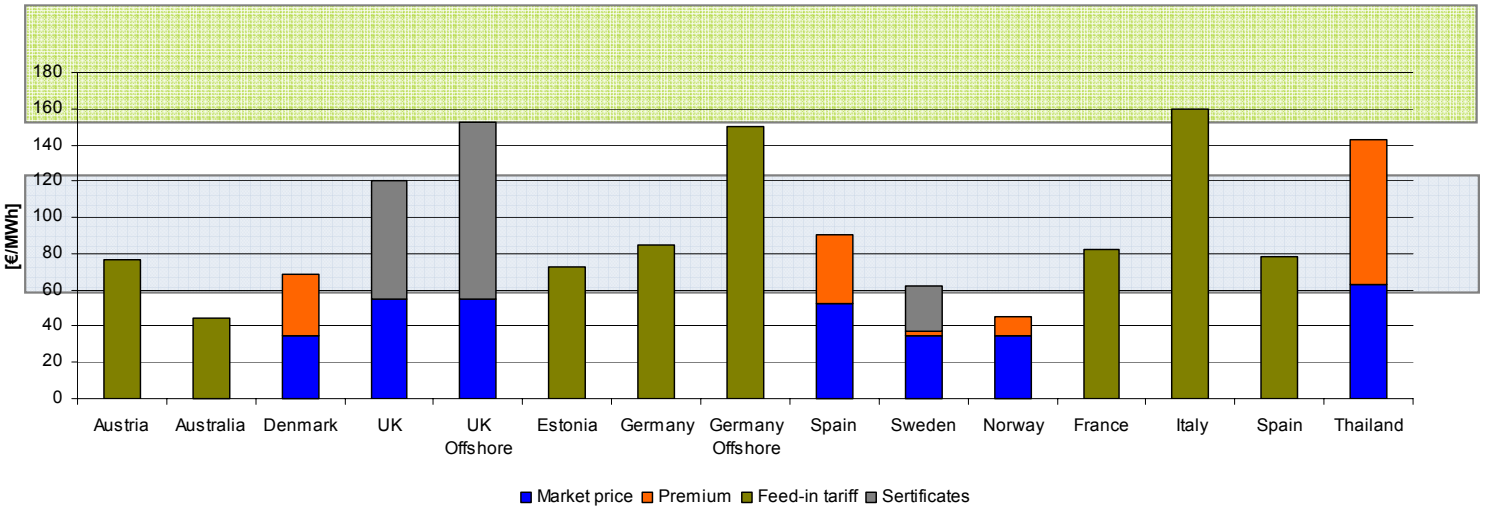
- Public safety
  - Ice throw distance
- Labour safety
  - Site access
  - Low temperature working environment
  - Emergency response
  - Evacuation procedures



Source: Gütsch Alpine Wind Test Site

Photo credit: Lars Tallhaug, Norway

Higher costs

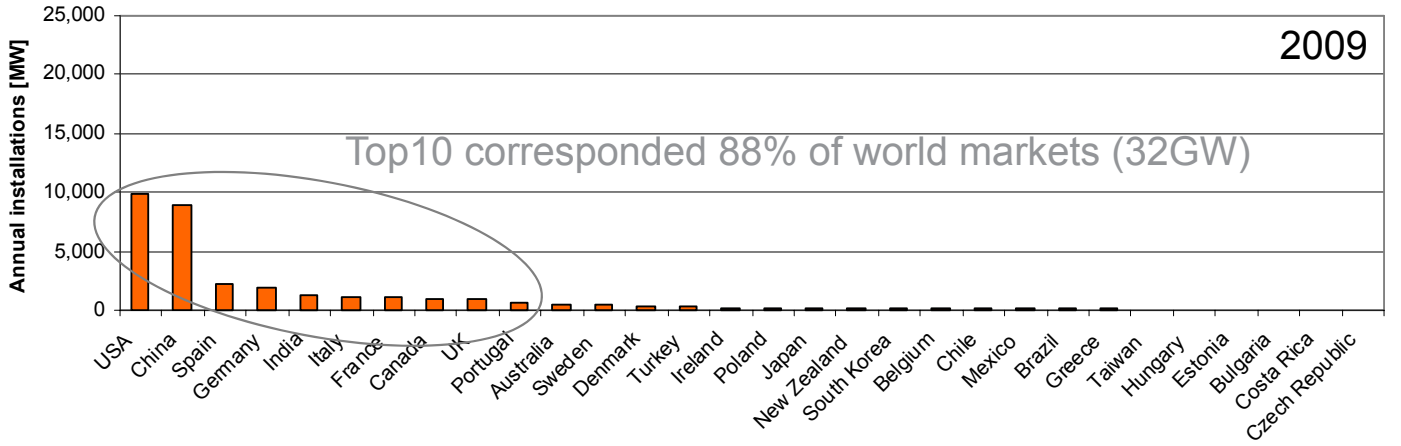


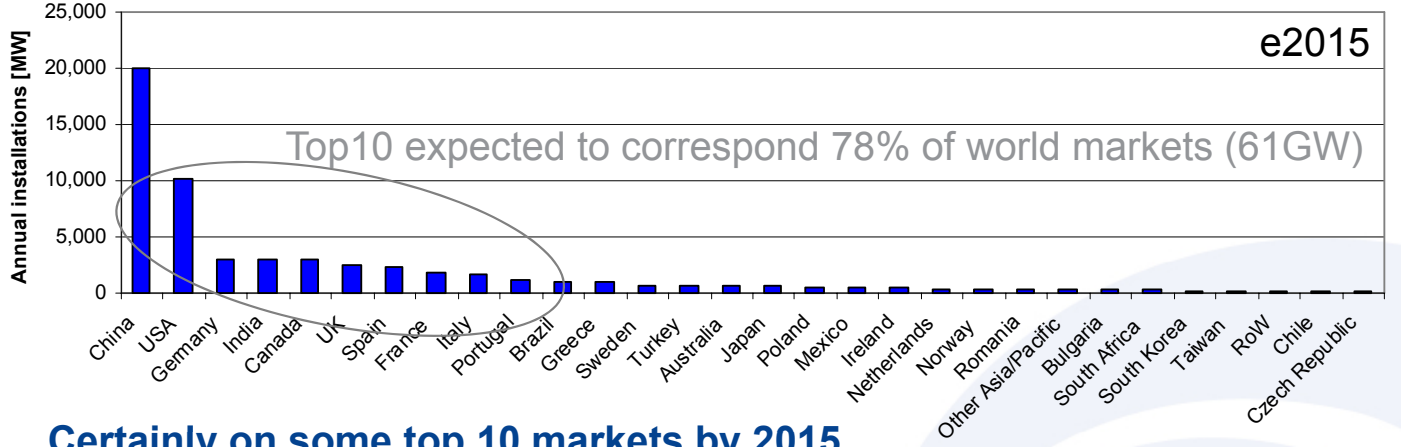
Onshore wind installations seem to start in various countries

Offshore wind installations seem to start in some countries

Somewhere in between onshore and offshore?

Cold climate market - where exactly?





Certainly on some top 10 markets by 2015

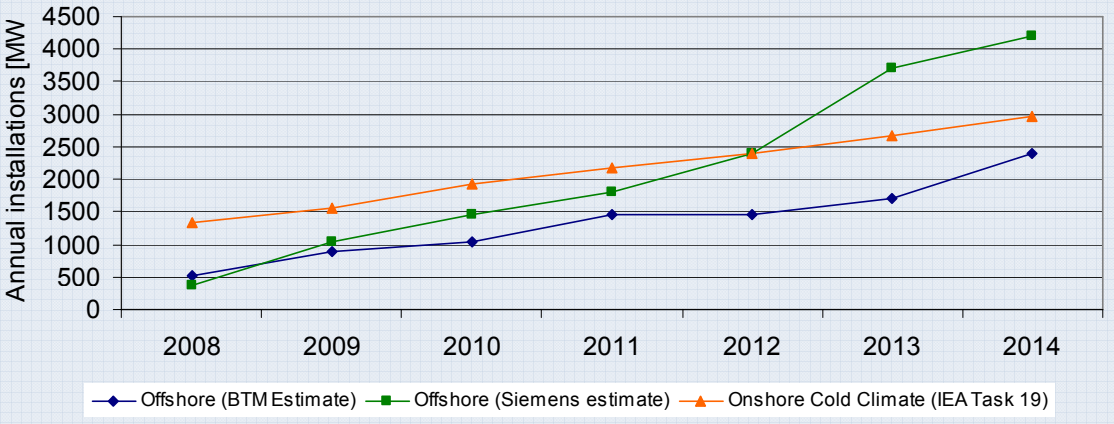
Source: BTM World Market Update, MAKE Consulting

Global trends driving the growth of cold climate wind energy

- General drivers
  - National renewable energy targets
  - Lack of other energy or renewable energy sources
  - Growing importance of security of energy supply
  - Increasing volatility of fossil fuel prices
  - Overall awareness on environmental issues

- Cold climate specific
  - Employment and local development
  - Improving cost competitiveness
  - Technology development
  - Growing cold climate experience
  - Higher cost of offshore wind
  - Possibility to large onshore projects

Share of the cold climate market



- Turbines are and will be installed to areas where icing and low temperatures are outside the operational limits of standard turbines
- Annually 4 - 6% of total installations in US, Canada, Europe and China
- Volume about the same as offshore installations
- Cold climate turbine market perhaps around 3000MW in 2014

Source: IEA Wind Task 19

Content

• Pöyry	Company in one slide
• Challenges	Cold climate specific
• Technology	Development and available
• Approaches	Things to be considered
• Summary	Conclusions

Technology development

Onshore & Offshore related benefiting Cold Climate

- Reliability of 3 to 5MW offshore wind turbines
- SCADA and remote control systems
- Access methods for maintenance of offshore turbines
- HVDC connections for large and remote offshore wind farms
- Forecasting of wind energy production
- Intelligent components and development maintenance
- New materials for large blades, e.g. composites
- Control of power quality
- Turbine technology for the low wind speed sites
- Series production and improvements in turbine quality

Cold Climate Specific

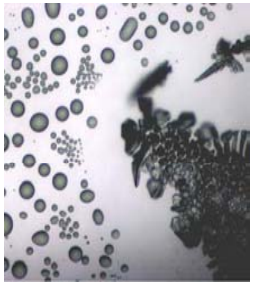
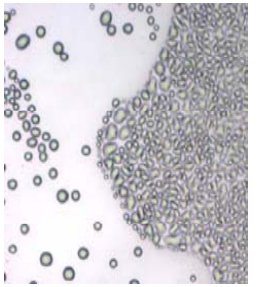
- Ice prevention and removal technologies incl. coatings
- Low temperature materials
- Ice detection technology
- Standardisation of low temperature specific wind turbine technology
- Sensors for project development
- Ice mapping and monitoring
- Evaluation of effects of ice and icing

Key technologies in terms of cold climate development

Sensors
- Anemometers
- Ice detectors

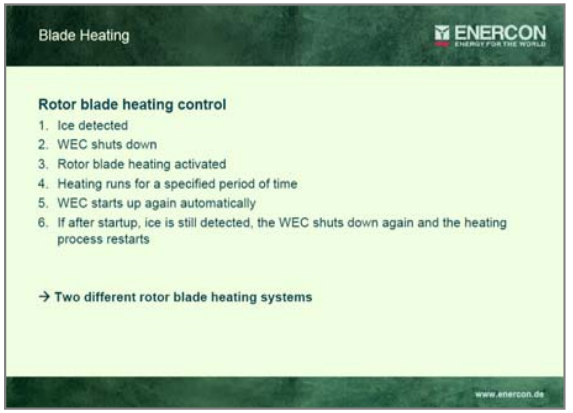
Anti and de-icing technologies
- LE heating foils
- Blade core heating
- Leading-edge heat tape
- Blade color
- Reduced stick coatings

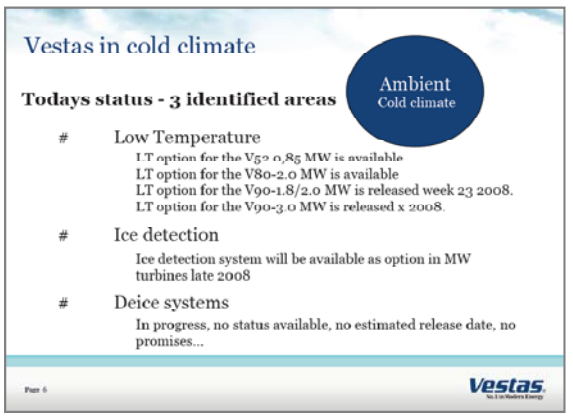
New concepts under development
- Nanotechnologies
- Piezoelectric coatings
- New engineered coatings

Photos credit: Ian Baring-Gould, Zürich university, Manitoba University

Industrial scale solutions – commercial and development





Low temperature packages are available from major manufacturers

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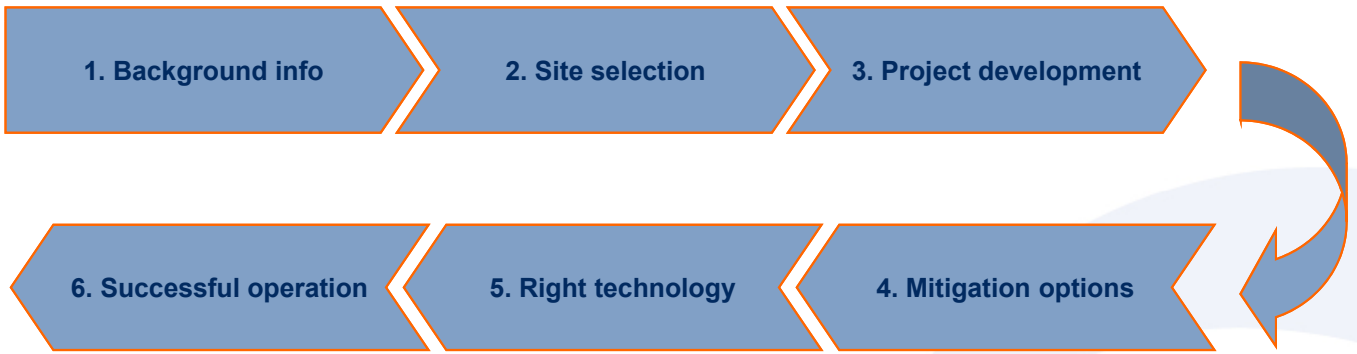
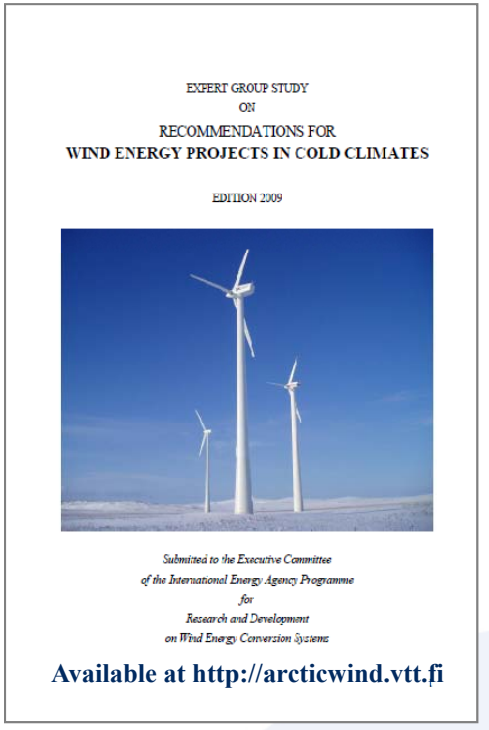
Approaches

- Higher risks involved so higher profits expected
- More prudent approach needed compared to milder climates
- Focus needs to be in quality which e.g. raises the cost of project development
- More and detailed due diligences on both service providers and equipment suppliers



Site selection and identification

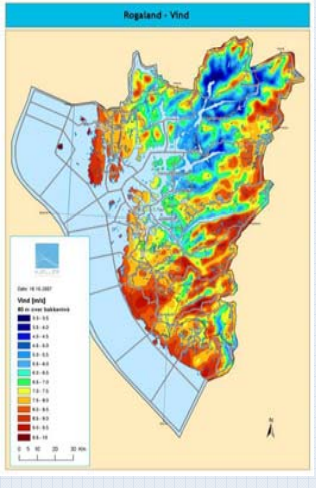
- Accept the extra risks and costs involved in CC wind energy production at early stages of the project.
- Employ available best practises to the extent possible,
- Conduct a survey to find solutions for each project understanding that CC circumstances vary greatly between different sites.
- Perform a thorough site assessment measurement.
- There is no standard method for estimating ice-induced production losses. Make the best estimate based on the results of site measurements.
- Consider CC-related safety aspects, such as low-temperature and risk of ice throw.
- Carry out a risk assessment that includes assessment of the quality of the selected turbine and experience of the installation company
- Consider the consequences of increased noise due to operation with iced-up blades
- Select CC solutions carefully as these packages differ by manufacture
- Use anti- and/or de-icing systems if site conditions require and proven technology is available.
- Insure that selected wind turbines are only operated under conditions for which they have been certified

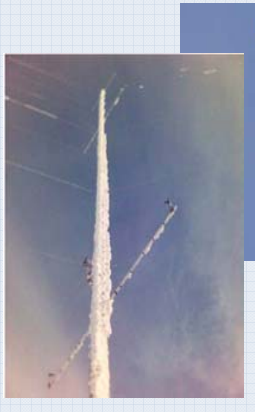


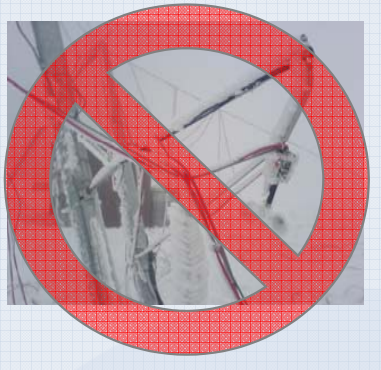
Best practices and information in fact are available

Proper pre-assessment of the site

- Climate data and ice maps for pre-assessment of sites
- Approved, standardized and calibrated methods and equipments for site evaluation
- New verified tools for cold climate project development i.e. methods for estimation of icing and low temperatures







Right designs and detailed enough site assessment

Source: Map Kjeller Vindteknikk

Wind potential survey and site feasibility

- WIND POTENTIAL SURVEYS
  - Expertise in wind measurements needed (anemometer choice, data collection security, met mast service, lidars)
  - Correct methods in production forecasts (terrain conditions, icing losses, service losses)
- FEASIBILITY STUDY PHASE
  - Low temperature and icing conditions during resource assessment
  - Estimation of the effects of ice and low temperature on turbine production
  - Effects of ice, snow and low temperature to maintenance
  - Cold climate related uncertainties in energy yield calculations
- DESIGN AND CONSTRUCTION
  - Turbine selection, tested solutions available
  - Turbines more reliable and maintenance not so much a issue
  - Due diligence on turbine suppliers true cold climate capabilities

All CC specific risks covered during the feasibility study phase

Mitigation options for ice

Several mitigation strategies are available to reduce the impact of icing events on the turbine fleet:

- **Ice prevention (anti-icing):** Modifications to turbines that prevent ice buildup on blades or other surfaces (example: heating the inside of the blades)
- **Ice removal (de-icing):** Removal of ice from blades after the icing event is over (example: leading-edge heating elements)
- **Needs to be considered:** Capital and maintenance costs and power consumption requirements

Both increases energy capture

- **Eventually needs to be decided:** Is the additional cost and energy consumption of the icing retrofit worth the increased energy capture obtained from the turbine?

This question can be answered if the development and site measurements have been done properly

With thorough project development cold climate sites are doable

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Summary & conclusions

- Challenges
  - Difficulties in accepting that some sites really do require special cold climate attention
  - Experience of the service providers and equipment suppliers
  - Cost of installations and thus produced electricity
  - Safety issues
  - Technology related more ice related than low temperatures
  - Size of the cold climate market – niche still in 2020?
- Approaches
  - More risks to be mitigated
  - As higher risks still involved – acceptable to expect higher profits
  - More attention needs to be paid to service and equipment providers
  - Large scale onshore projects in remote areas still possible
- Conclusions
  - Implementing projects in cold climates generally requires application outside of all standard wind guidelines
  - Standard equipment and assessment techniques are generally not applicable in places with icing
  - Cold climate technology development ongoing
  - Market seems to be more attractive than some years before

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