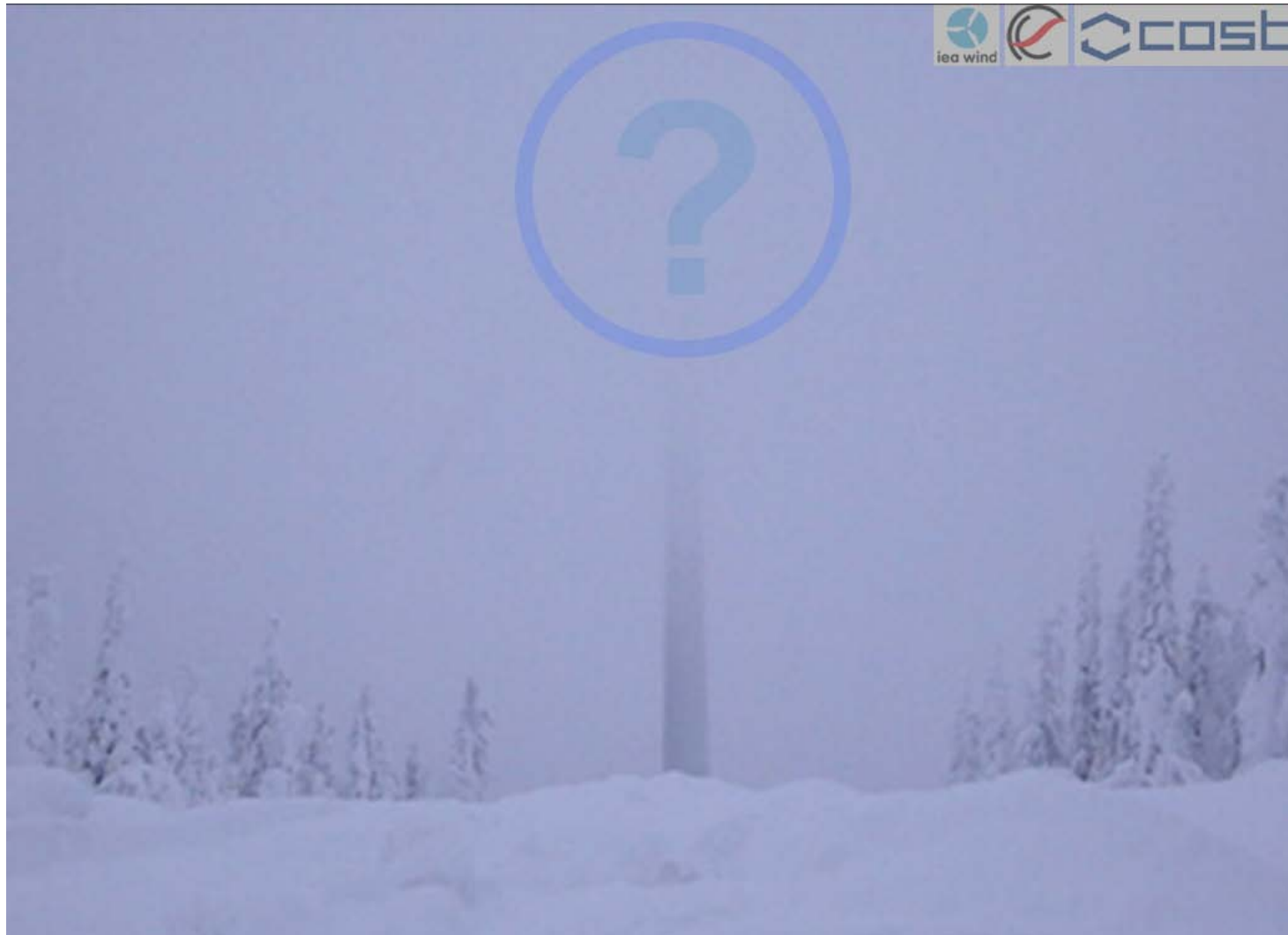


IEA RD&D Wind Task 19 - Wind Energy in Cold Climates

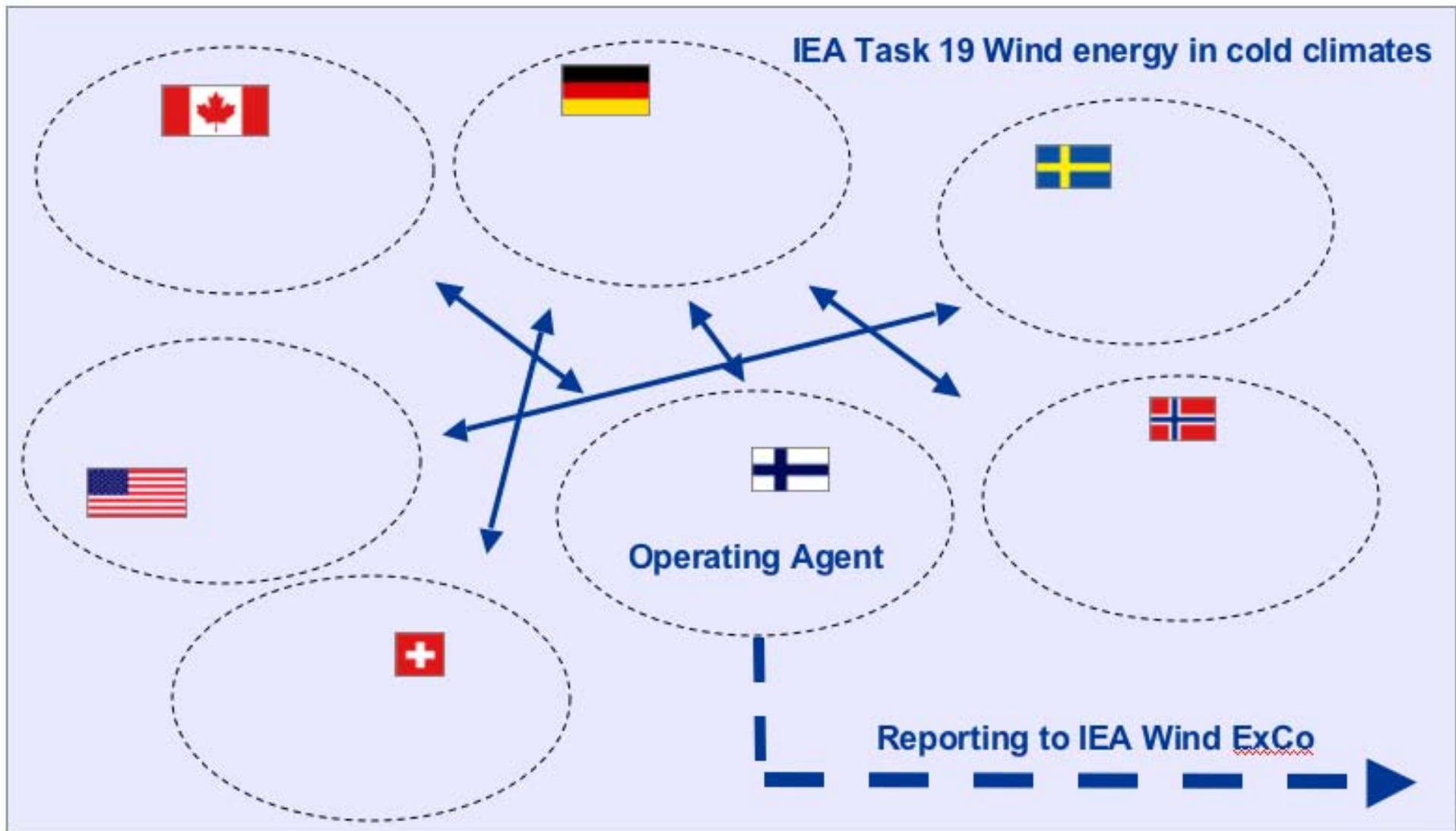
Göran Ronsten, WindREN



A major challenge - icing of rotor blades





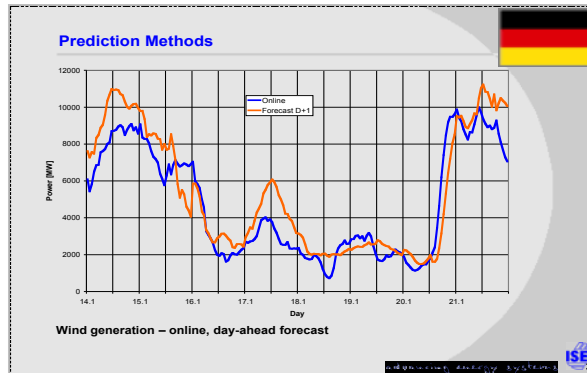



IEA Task 19 collaboration since 2002, FMI initiated the Boreas conference series in 1992



IEA RD&D Wind Task 19 – Wind Energy in Cold Climates

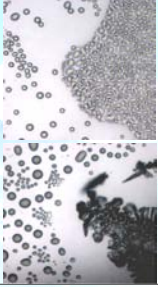
Each member country contributes with its own knowledge

Anti-freeze coating for rotorblades

The Zurich University of Applied Studies is

- studying polymers with freezing point depression properties
- binding such polymers to surfaces
- testing anti-freeze coated surfaces
- Results in laboratory conditions: Reduction of freezing point up to 30° C
- Development of final product in collaboration with wind power – and Swiss polyester company



02.04.2009 ENCO Energie-Consulting AG energie schweiz partner




Some nice pictures

Now – 4 arctic power supply units.




KJELLER



Research on new materials and coatings


- Nanomaterials
 - Nanotubes in carbon
 - Resin modification
 - Better fatigue properties - Lighter blades
 - Finnish-Chinese collaboration
- Surface coatings
 - Sol-gel based
 - In laboratory phase
 - In icing wind tunnel

21 April 2008 VIT




Wind Energy Institute of Canada


- Evolved from the Atlantic Wind Test Site established in 1980
- Headquarters and test facilities located at North Cape, Prince Edward Island
- Areas of strategic focus:
 1. Testing
 2. Research and Innovation
 3. Training and Public Education
 4. Technical Consultation and Assistance
- Signed an exclusive framework agreement with DEWI for the provision of Type Testing services in North America



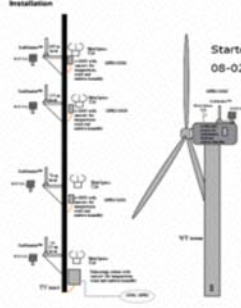
Wind Energy Institute of Canada Aerial View



Canada



The Sveg measurement set-up



Started 08-02-22 07:00

Started 2008-02-06 09:20

The present situation in Sweden IEA Task 19, Anchorage, April 28-29, 2008



IEA Task 19 har 10 mål (1-3)

1. To collect information on ice mapping and produce and verify ice maps for selected areas in order to ease and support the early phases of project development.

Yes: Uppsala Universities and SMHI's combined project and the Swedish Energy Agency's wind pilot projects.



2. To collect information and experiences related to icing forecasts with numerical weather models. This topic is expected to become more and more important as it also affects wind forecasts in cold climate regions.

Yes: Same as 1.

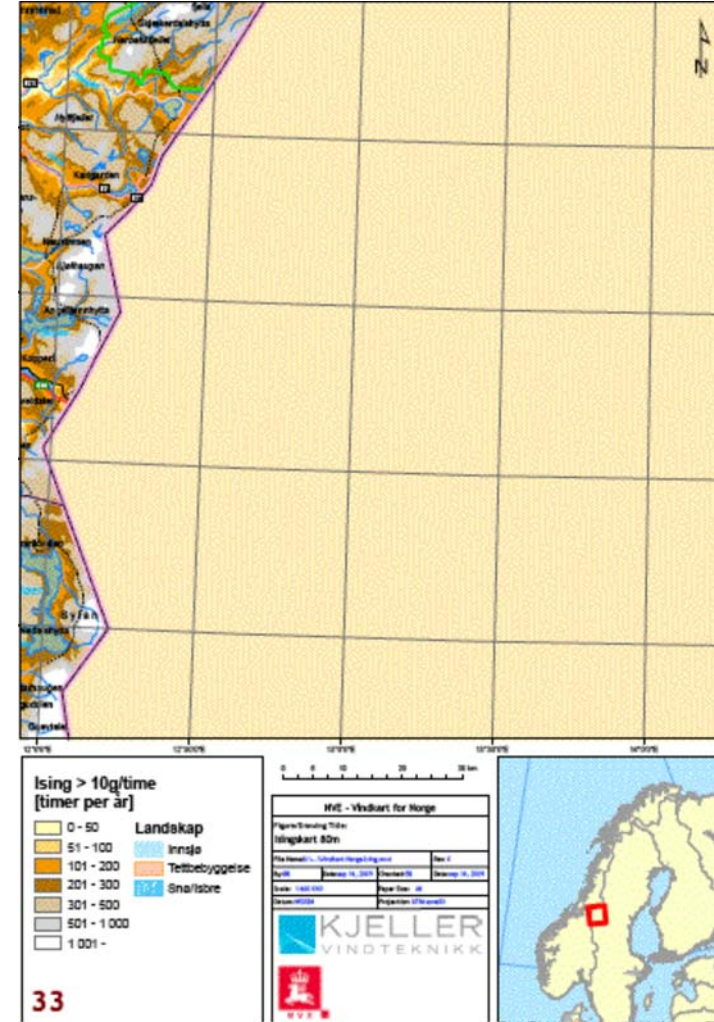


3. Find new solutions and thus improve the available methods for resource assessment and turbine operation at cold climate sites. **Power supply, sensor options and detection of ice** are focus areas.

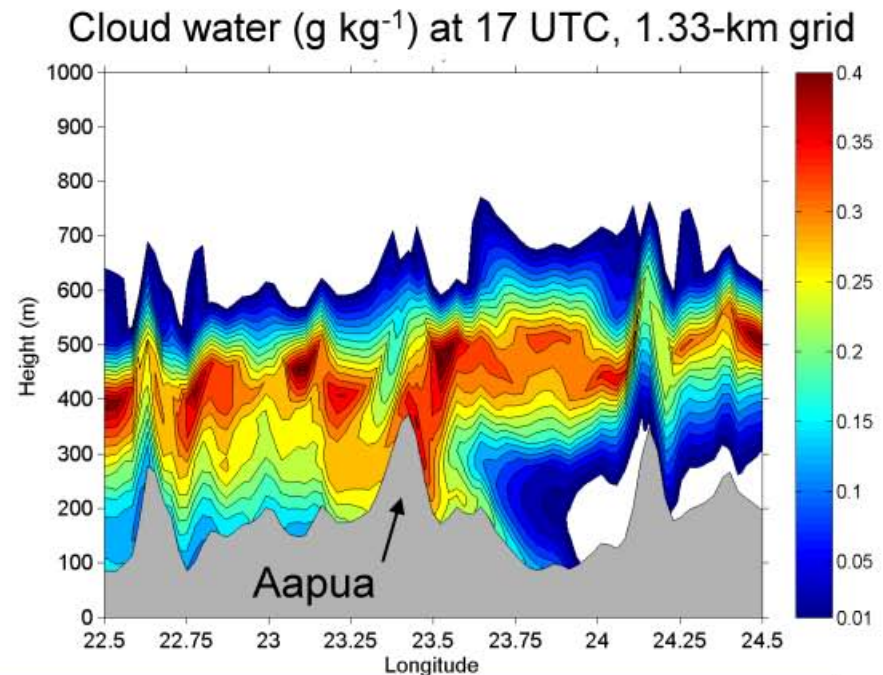
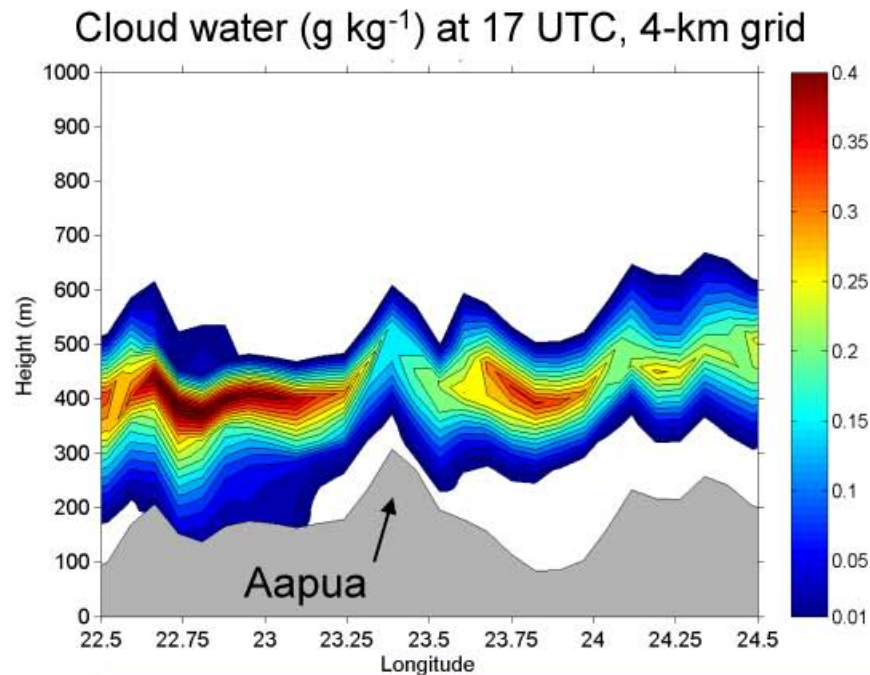
Yes: IGUS, Insensys, CMS towards RMS-system.



Icing data covering Sweden, results will not be presented for free



An increase in horizontal resolution has a profound effect on the vertical structure of the simulated boundary layer.



Interesting to see is the presence of near-surface clouds in the 1.33-km grid while the clouds in 4-km grid are found at higher altitudes. **Note in particular the high values of cloud water on the windward side of Aapua and at the top of the hill seen in the 1.33-km grid.**

IEA Task 19 har 10 mål (4-6)

4. Follow and collect up to date information from the current state of **anti- and de-icing and coating solutions** that are already available on the market or currently being developed.

Yes: many different products tested.



5. Review the current standards and recommendations from the cold climate point of view and identify the possible needs for updates.

Yes: GL has been contacted. Work is on-going.



6. Find and recommend improved methods to estimate the effects of ice on production and thus reduce the amount of incorrect estimates and the risks that are involved in cold climate wind energy projects currently. Verify the method on the basis of data from national projects according to the possibilities.

No: We're currently lacking competence to follow up on the experience gained by Staffan Meijer.

Tools needed to predict, detect and remove icing



De-/anti-icing systems



1. Black blades - Not sufficient in low solar radiation conditions
2. WindWind/Skellefteå Kraft - A developed JE-system, same as previously used on some 20 Bonus turbines (225 kW-1 MW)? Carbon fibre layer beneath the gelcoat.
3. Enercon/Svevind - Hot air based de-icing system. Official list price: 20 kEuro for 3 fans (20 kW). Will test de-icing during operation at Dragaliden and Silkomhöjden.
4. Nordex/LM/Dong Energy - Hydrophobic coatings and control system development to avoid ice build up.
5. EcoTEMP/o2VK/Vestas - Foil based anti-icing system
6. Kelly/MW-Innovation/o2VK/Vestas - Foil based anti-icing system
7. Goodrich - Foil based anti-icing system, yet to be deployed?

IEA Task 19 har 10 mål (7-10)

7. Clarify the significance of extra loading that ice and cold climate induce on wind turbine components and disseminate that result.

Yes: At least one of the wind pilot projects (o2 Vindkompaniet) contains work in this field.



8. Initiate a market survey for cold climate wind technology, including wind farms, remote grid systems and stand-alone systems.

No: The work has been ongoing without success since 2002. How to make MAKE and BTM interested in this market segment?

9. Improve the understanding of the risks and the mitigation strategies for the problem of **ice throw** from wind turbines at cold climate sites.

No: No new work currently planned or available.

10. Update state-of-the-art report and update the expert group study on applying wind energy in cold climates to guidelines.

Yes: These tasks are planned to be carried out.



WIND ENERGY IN COLD CLIMATES

Index

About the project:

- [Objectives of the project](#)
- [Participants](#)
- [Project's extranet pages](#)
Restricted access



Wind Turbine at Aapua-fjell Sweden. Photo by Kent Larsson, ABvee.

Links:

- Measuring and forecasting atmospheric icing: [COST 727](#)
- Conference: [Winterwind 2008 - Wind Energy in Cold Climate \(Norrköping, Sweden\)](#)
- International Workshop on Atmospheric Icing on Structures: [IWAIS](#) and [proceedings of IWAIS 2000](#)

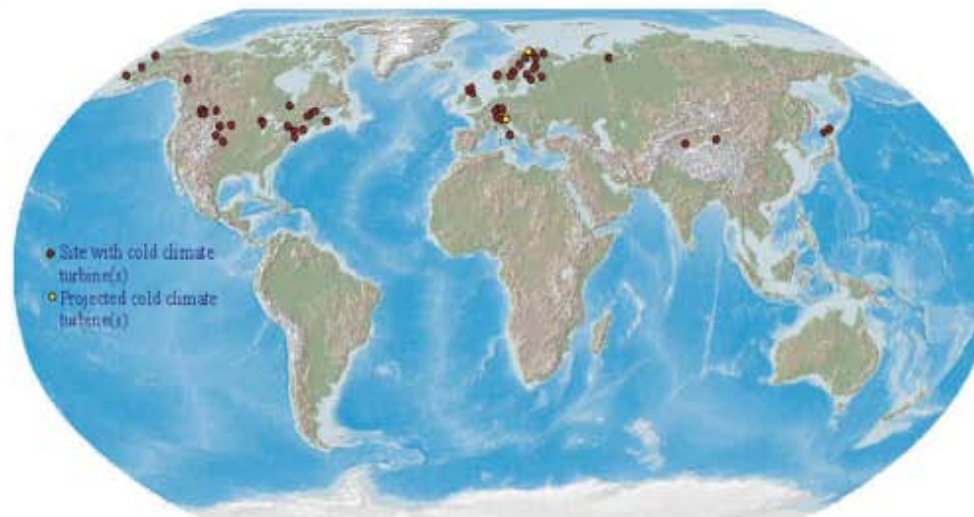
IEA Wind R,D&D Task 19

This is the home page of an International Energy Agency collaboration called Wind Energy in Cold Climates, under R,D&D Wind <http://IEAwind.org> The purpose of this project is to gather and provide information about wind turbine icing and low temperature operation.

The new 2009 version of [State-of-the-art of wind energy in cold climates \(pdf\)](#) is available. The report produced within the Task 19 summarises existing experiences in wind energy production in cold climates.

Also the new version of [Recommendations for wind energy developers in cold climates \(pdf\)](#) is available. The recommendations included in the report are intended to guide wind energy developers to a position where uncertainties related to cold climate issues are reduced to a minimum.

Wind turbines operating in cold or icing climate worldwide



Information (TO BE UPDATED...):

- [Publications](#)
- [Operational Experience](#)
- [Technical solutions in use](#)
- [Measurements & Instruments](#)
- [Knowledge on climatic conditions and resources](#)



Control anemometer and wind vane at Olostunturi-fjell Finland

- [Send us information about icing and low](#)

Rapporter på <http://arcticwind.vtt.fi/>

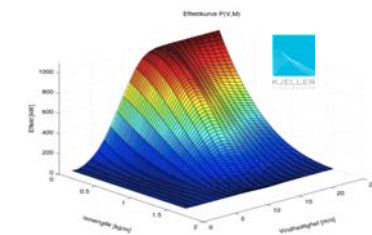
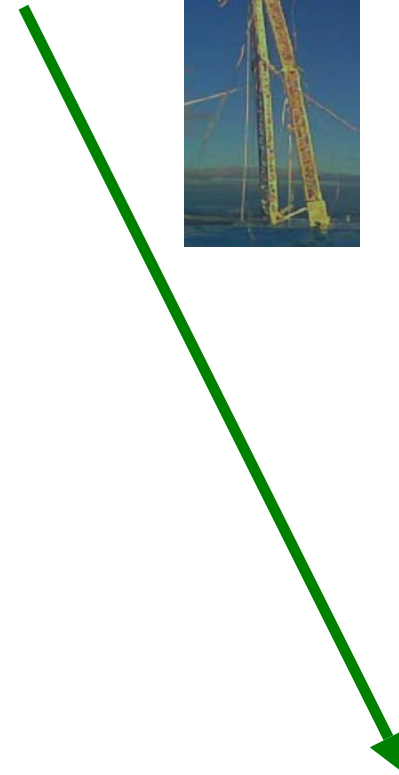
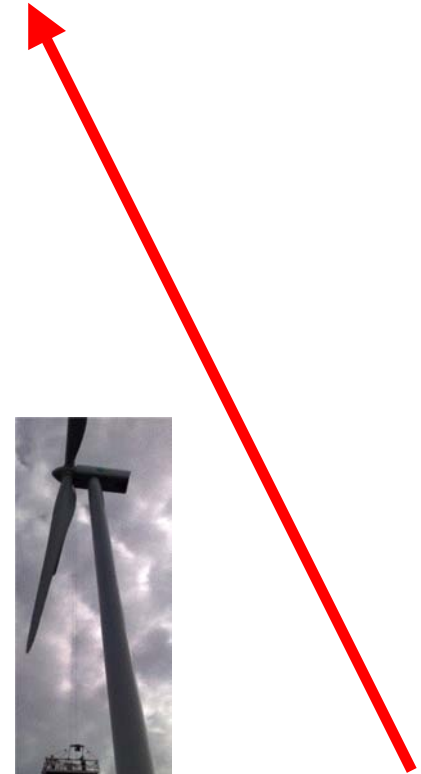
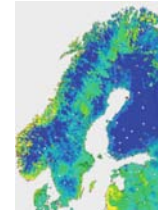


State-of-the-art of
wind energy in cold climates

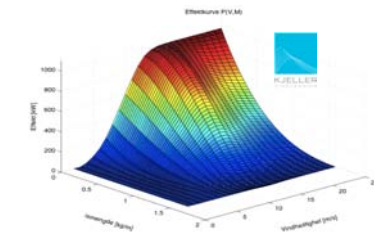
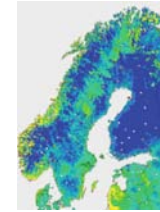
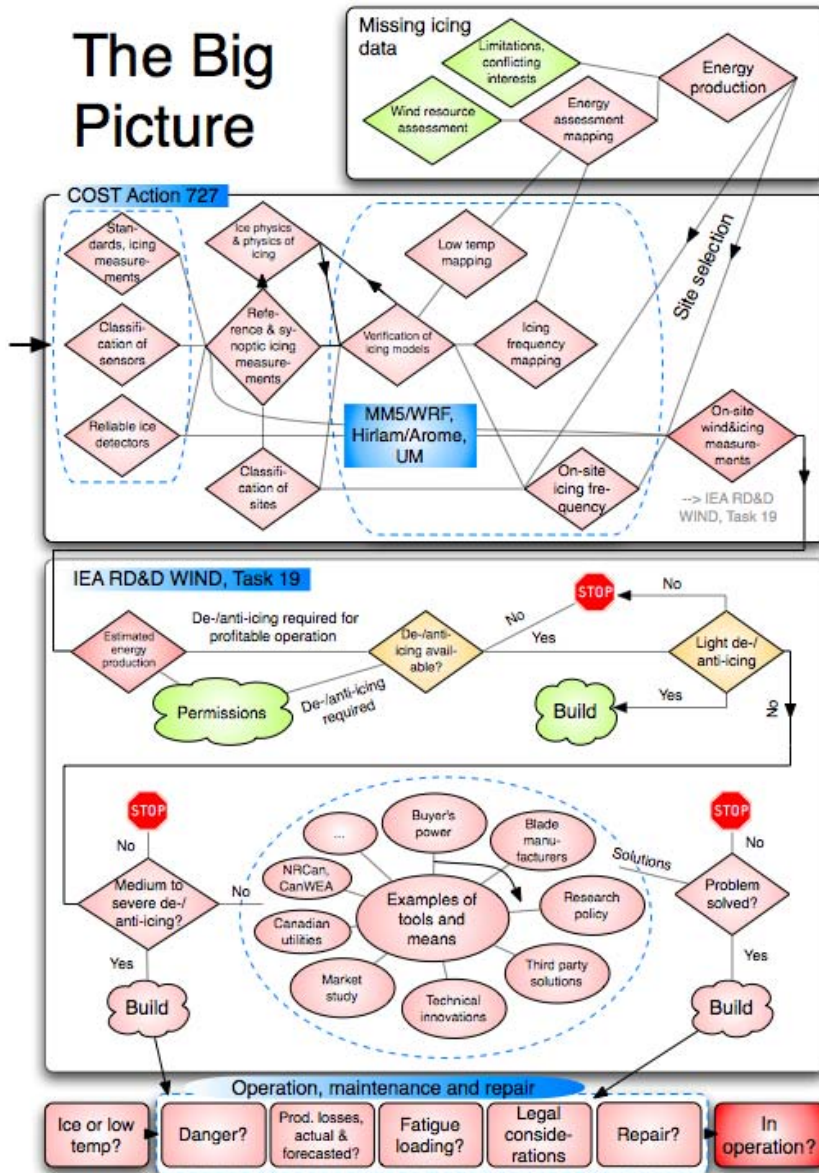
T. Laakso, I. Baring-Gould, M. Durstewitz, R. Horbaty
A. Lacroix, E. Peltola, G. Ronsten,
L. Tallhaug, T. Wallenius

August 7th, 2009

If it's this easy -
why haven't we
done it already?



The Big Picture

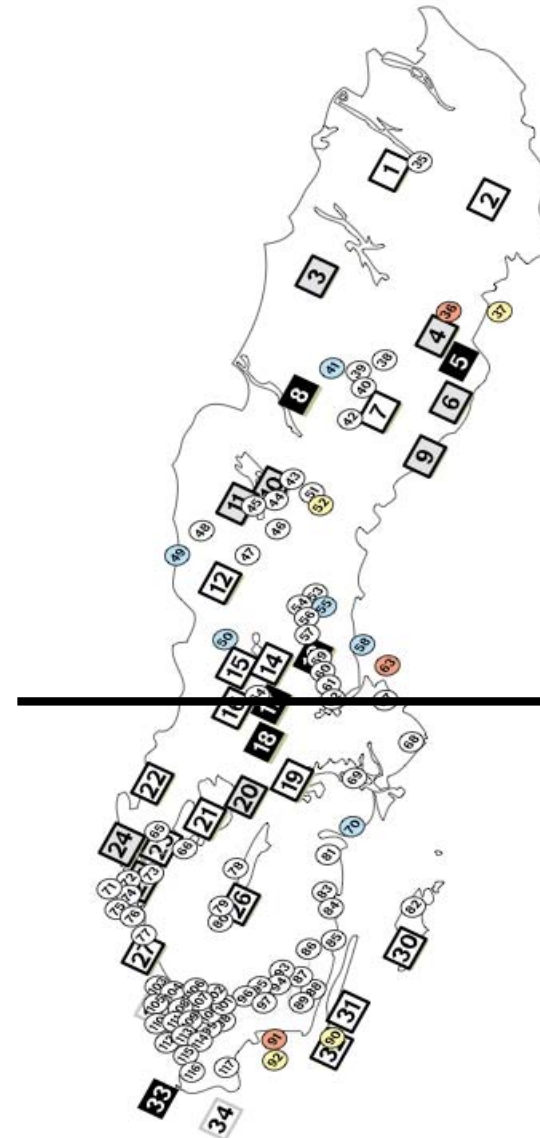


Red areas need attention

Is there a market for cold climate technologies?

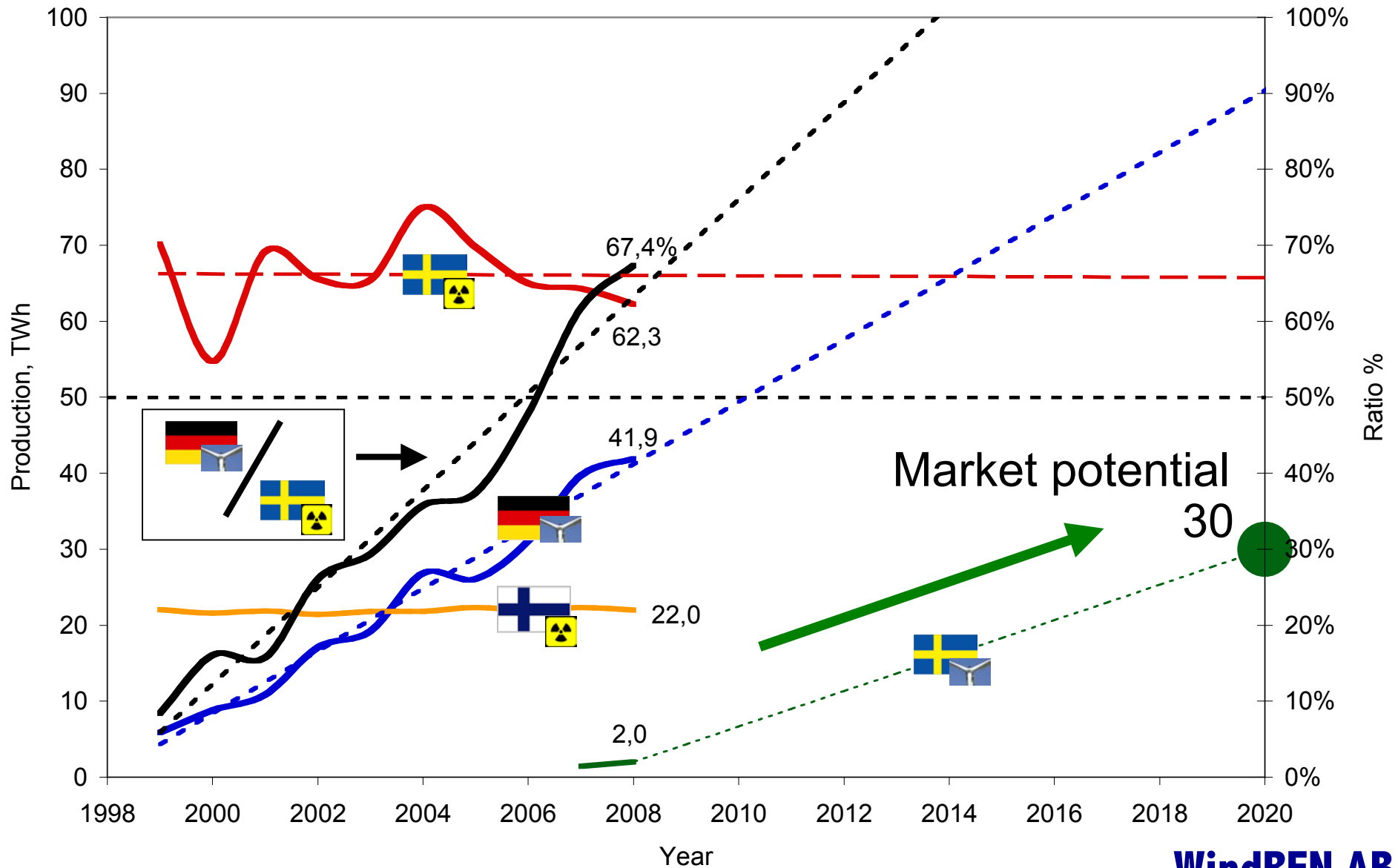
30 of 54 TWh large scale wind energy projects are planned to be deployed in Sweden's cold climate region (North)

DN - 2009-03-12



Market potential for wind energy in Sweden until 2020

Annual German & Swedish wind energy & Swedish and Finnish nuclear production



Interest org.

VINDMØLLEINDUSTRIEN
www.windpower.org

Canadian Wind Energy Association
Association Canadienne de l'Énergie Éolienne

EWEA
THE EUROPEAN WIND ENERGY ASSOCIATION

vindkraft
FORENING

Swedish Wind Energy

Wind farm dev.

Stena Adactum

Fred.Olsen Energy ASA

SVEVIND
powered by nature

Triventus

VATTENFALL

SKELLEFTEÅ Kraft

e-on

Fortum

NV nordisk vindkraft

DONG energy

SCA

Statkraft

EOLUS

Manufacturers

MAKE CONSULTING

EcoTEMP

KELLY AEROSPACE
Thermal Systems

BTM Consult Aps

MW Innovation

IN SITU

COMBITECH

SIEMENS

Vestas

Gamesa

ENERCON
ENERGY FOR THE WORLD

LM

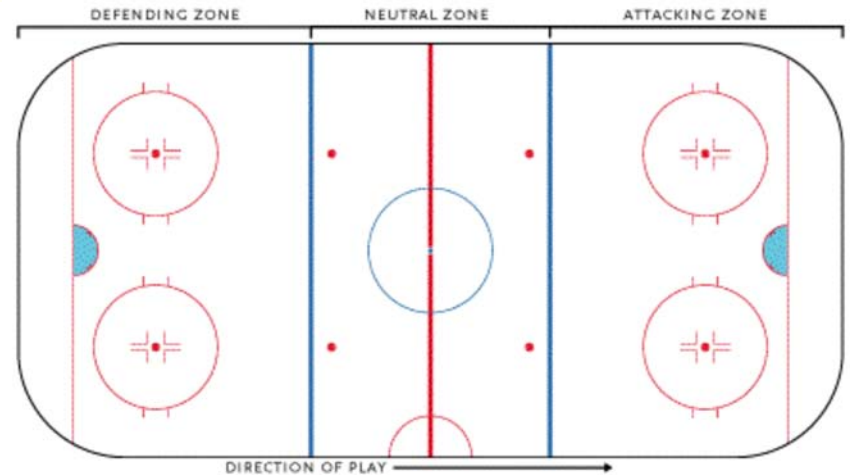
GE

NORDEX
We've got the power.

WinWind

REpower Systems

IJZLON



Research & Education

ELFORSK
SVENSKA ELFÖRETAGENS FORSKNINGS- OCH UTVECKLINGS - ELFORSK - AB

VATTENFALL

Högsolan på Gotland
Gotland University

KTH
KTHN

RISØ

LULEÅ TEKNISKA UNIVERSITET

Vindforsk

HÖGSKOLAN I HALMSTAD

Högskolen i Narvik

Nätverket för vindbruk

Government & Intl

Strömsunds Kommun

Energimyndigheten

VTT

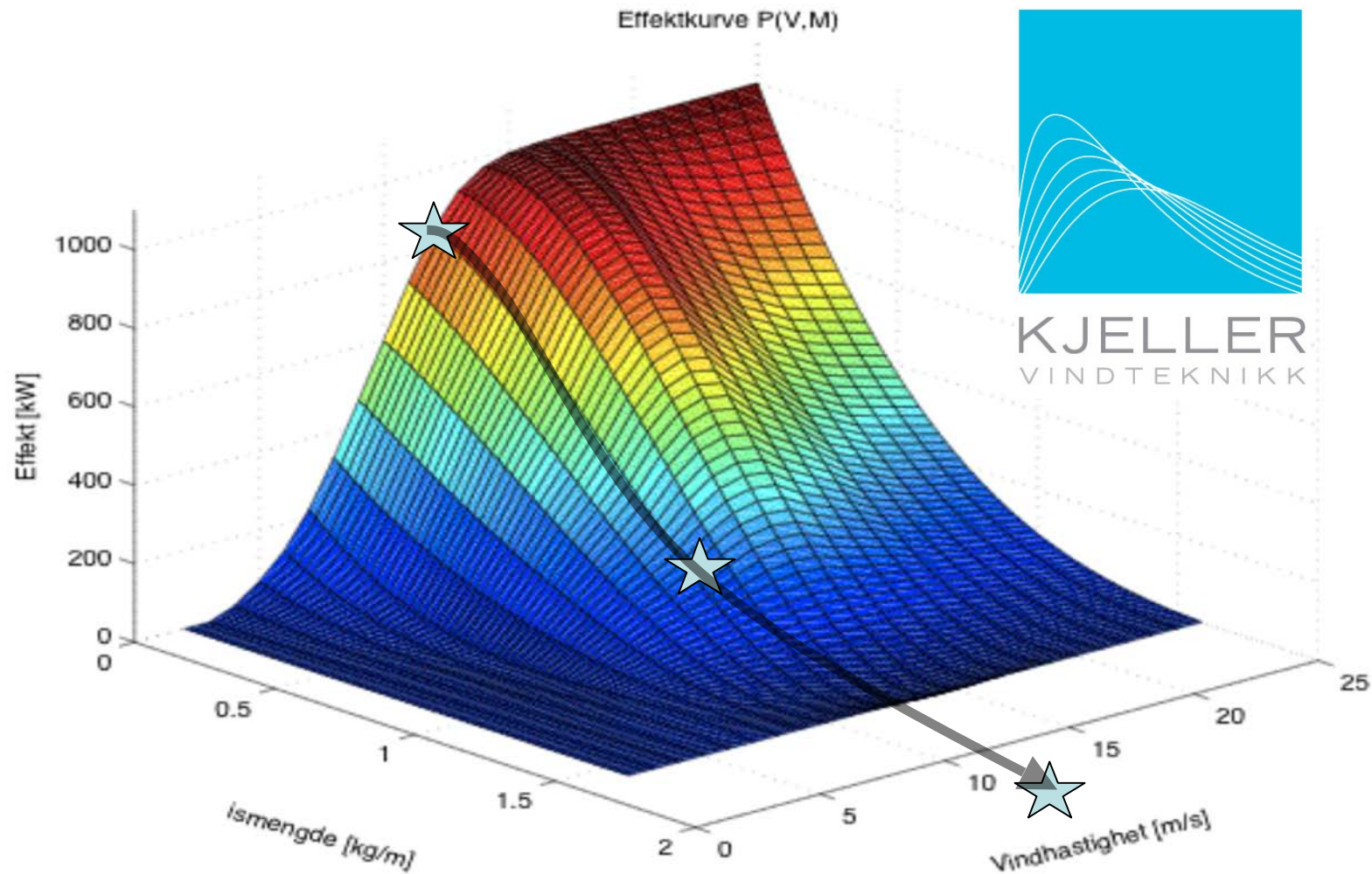
COST 727

iea wind

Natural Resources Canada

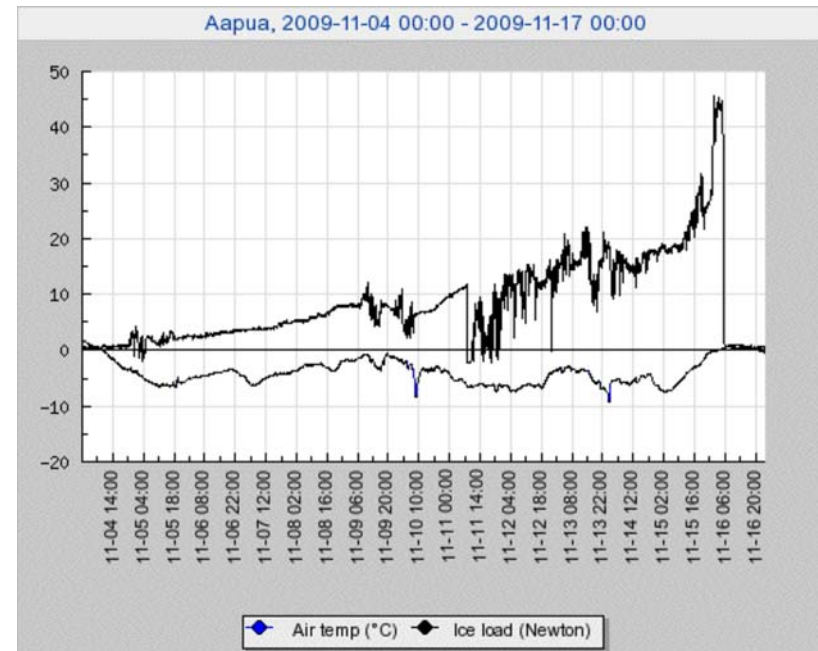
Ressources naturelles Canada

Power performance during icing conditions



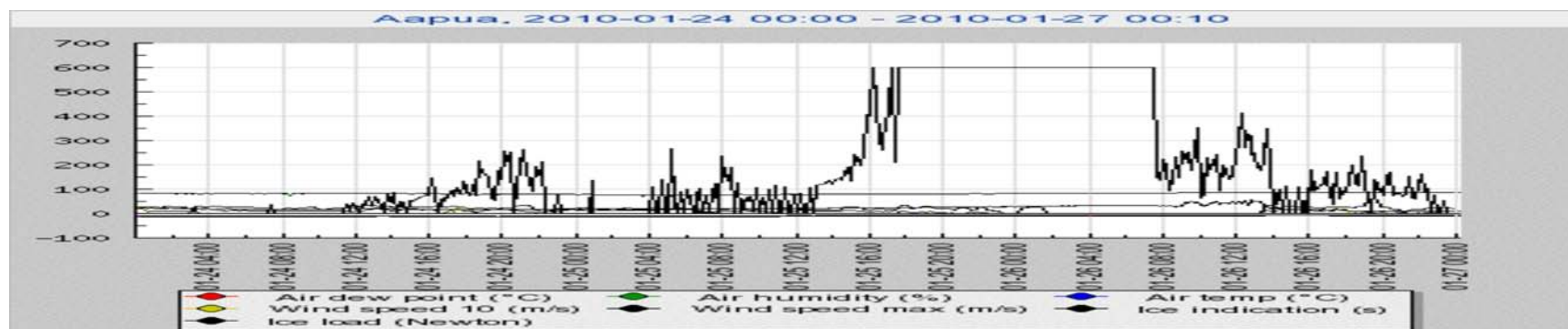
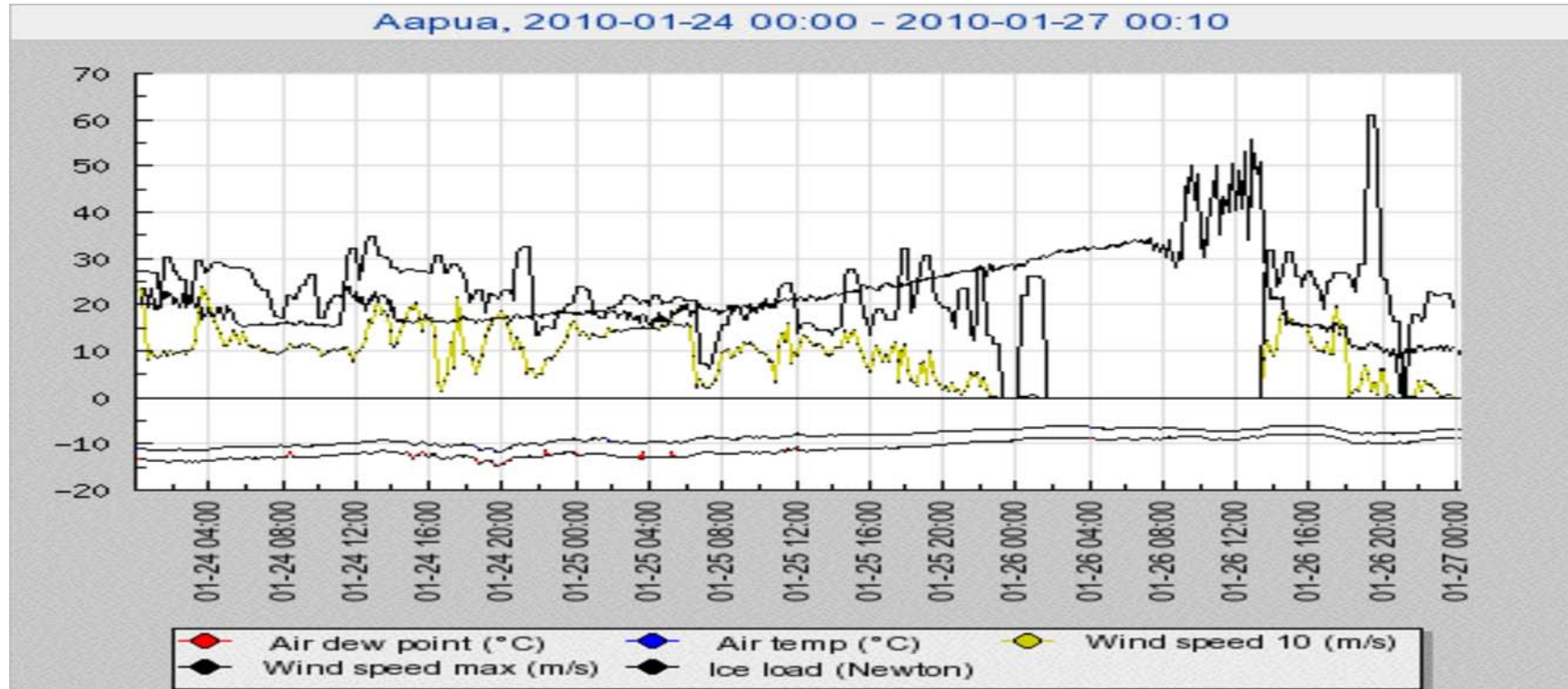
Recent ice loads:

- Aapua (Nov 4 – 16, 2009)

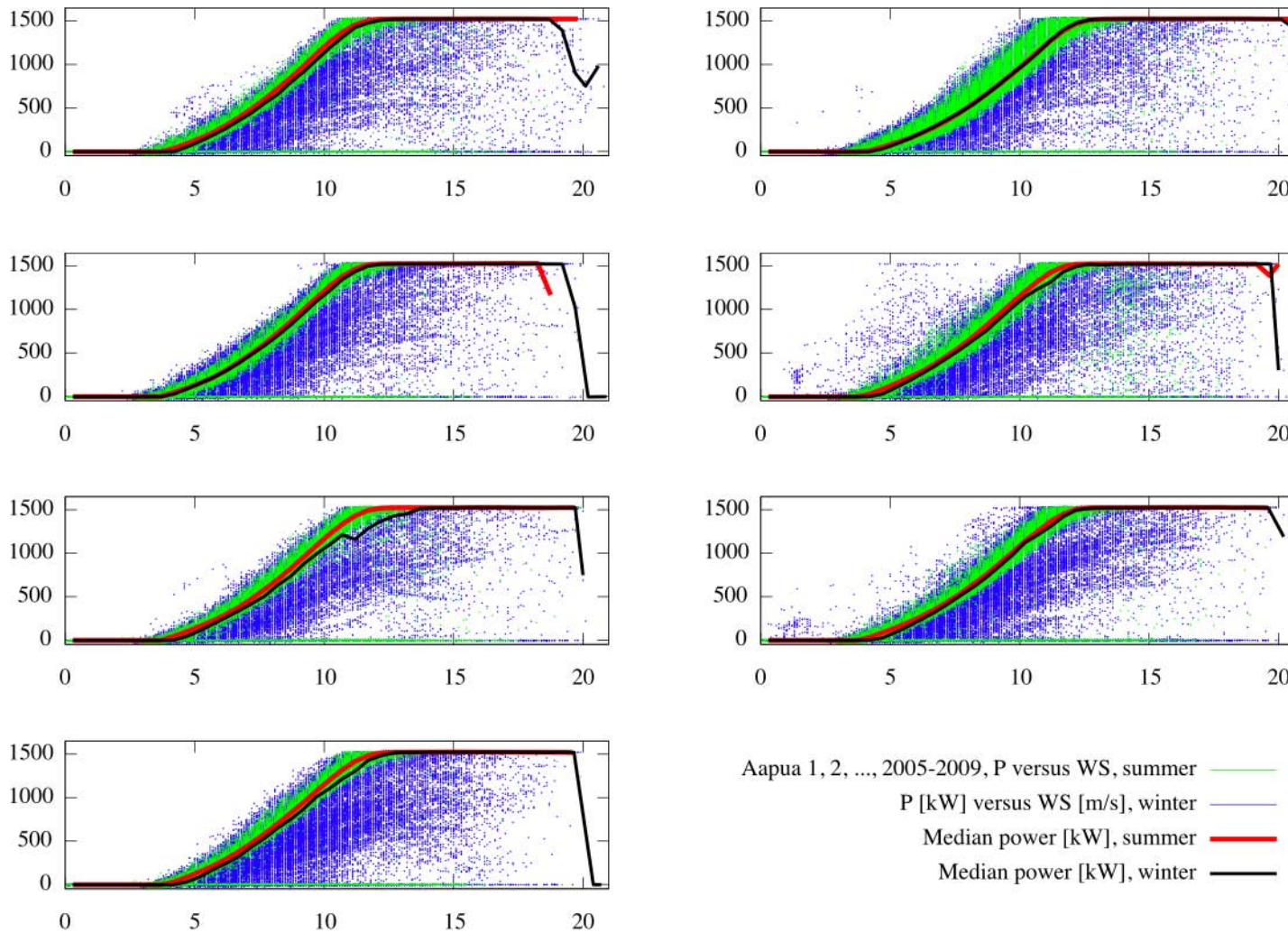


Ice load measured by IceMonitor from Combitech

Aapua wind farm iced up, ice load and intensity



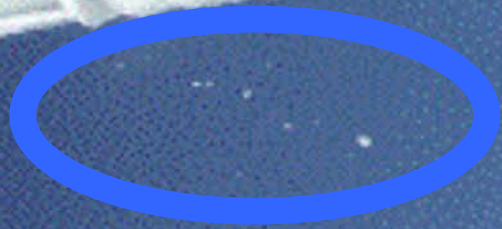
>25% wintertime energy production losses, V82-1.5



Ny Teknik, Feb 6, 2008



Aapua, 2008-03-19



Safety distances due to the risk of ice throw (ref: WECO)

Figur 51. Rekommenderat riskavstånd för iskast när vindkraftverket är igång.
Källa: WECO och DEWI.

$$d = (D + H) \cdot 1.5 \quad \text{Rotating}$$

58 (80)

Figur 52. Rekommenderat riskavstånd för iskast när vindkraftverket står stilla.
Källa: WECO och DEWI.

$$d = v \frac{D/2 + H}{15} \quad \text{Standstill}$$

Lördag 29 december 2007

LUDVIKA 5



Det fruktansvärda ljudet från vindsnurrorna förorsakar stort lidande för de boende i Örtjärn. Katrin Karlsson, här med sin man Janne Furunäs och barnen Emilia och Ellina, träder nu fram och ger nu miljöproblemet ett ansikte. FOTO: FREDRIK LARSSON

”– Jag vill påstå att det värsta ljudet kommer när det varit töväder och sedan slår om till kallt. Klara nätter verkar det vara som om ljudet går fram lättare.”

”Man blir vansinnig”

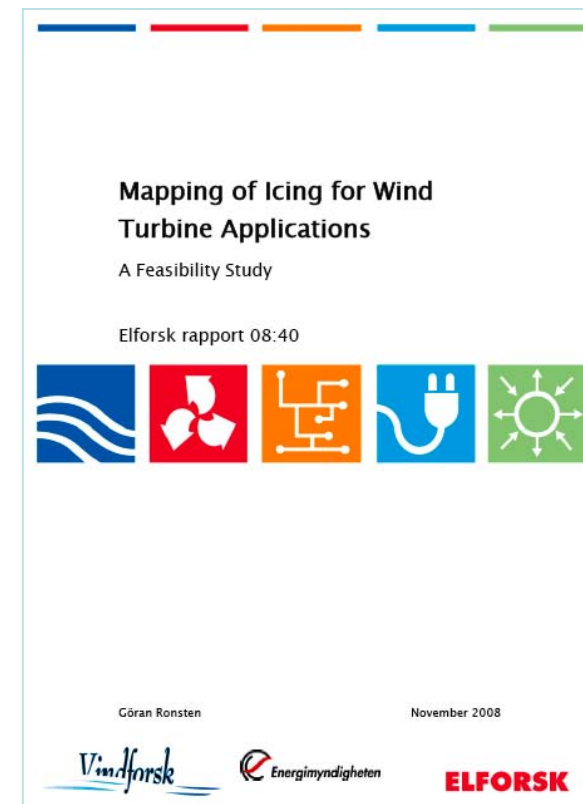
– Örtjärnsbor svårt störda av vindkraftverken

Funding of RD&D anti-icing systems

- Funding of RD&D* of anti-/de-icing systems requires
- A market study, which requires
- Mapping of icing (not a quick fix)

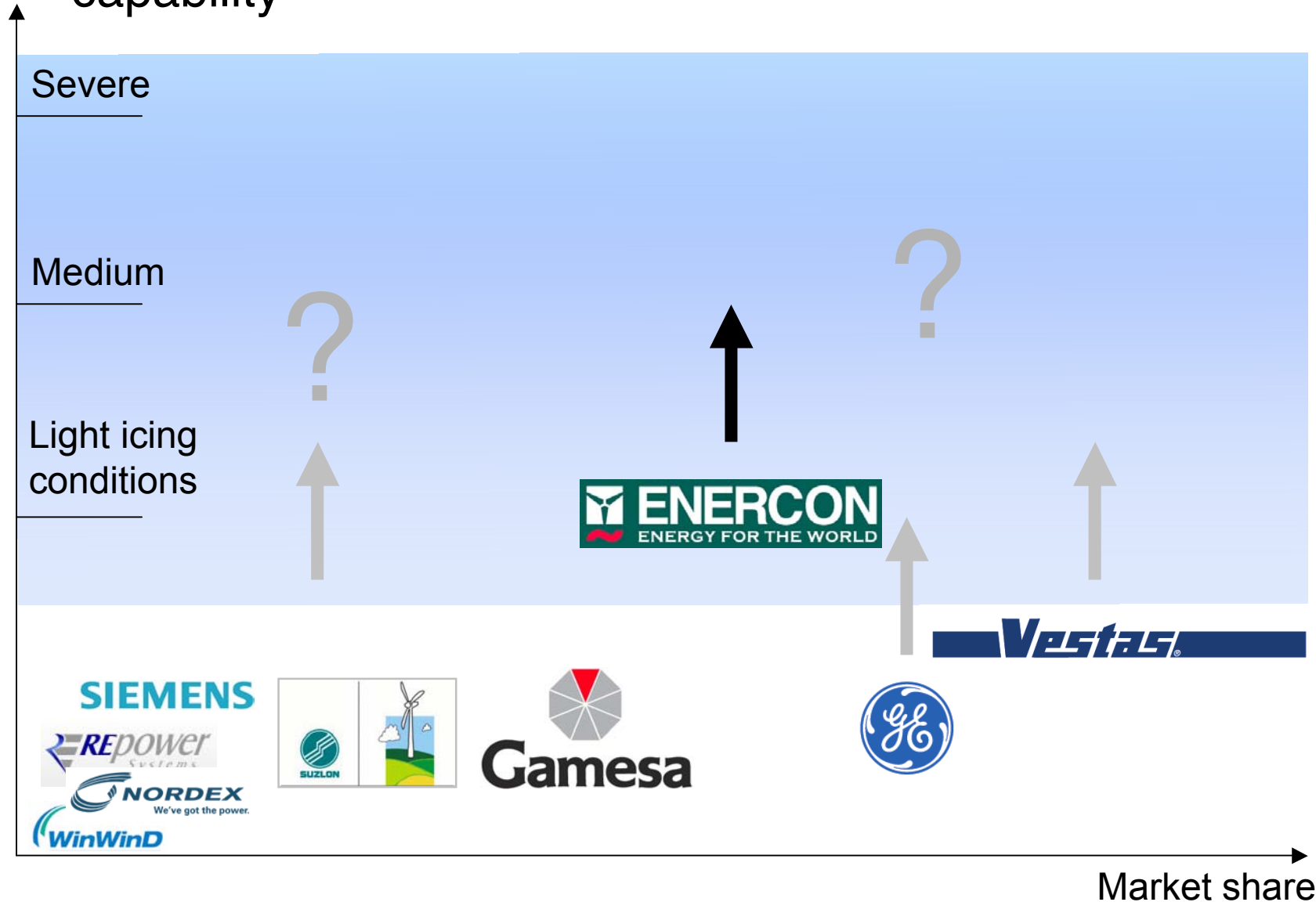
A Catch 22 situation presented
To TP WIND's WG2 in Brussels,
Oct 2008

* RD&D - Research, Development and Demonstration





Official de-icing capability



**Sweden, funding has been granted for the following
cold climate projects [kSEK]**

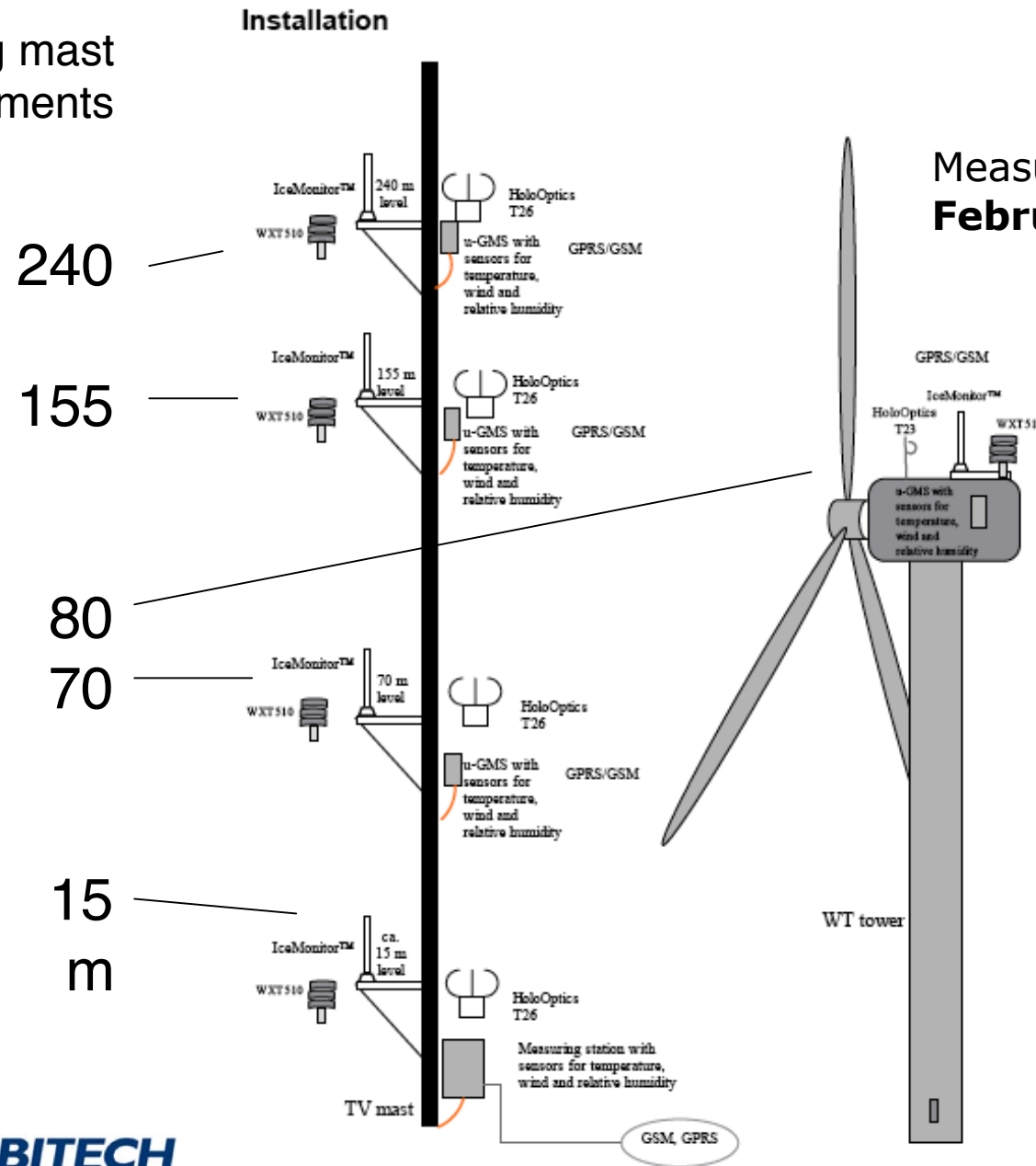
Mapping of Icing, Uppsala University, 2009-2012	8 000
Skellefteå Kraft - Anti-icing, 2007-2011	35 000
o2 Vindkompaniet - icing meas., anti-icing, 2008-2012	72 500
Svevind - 2 cold climate sites, investment subsidy, 2009-	115 000
Dong Energy - orography, coating and control, 2009-	26 000
Nordisk Vindkraft - Havsnäs, icing, foundation, 2009-	20 000
IEA Task 19 - Wind Energy in Cold Climates, 2009-2012	800
VindREN - Wind/Reindeer, 2009-2011	3 310
Swedish University of Agricultural Sciences, Reindeer	2 332
Wind in forests, Uppsala University, 2009-2012	10 000
Total: 29.3 MEuro, 27.7 MEuro excl. forest and reindeer	293 000

* not including work in kind, 1 Euro = 10 SEK



Sveg mast Measurements

WindREN AB



Measurements started
February 2008

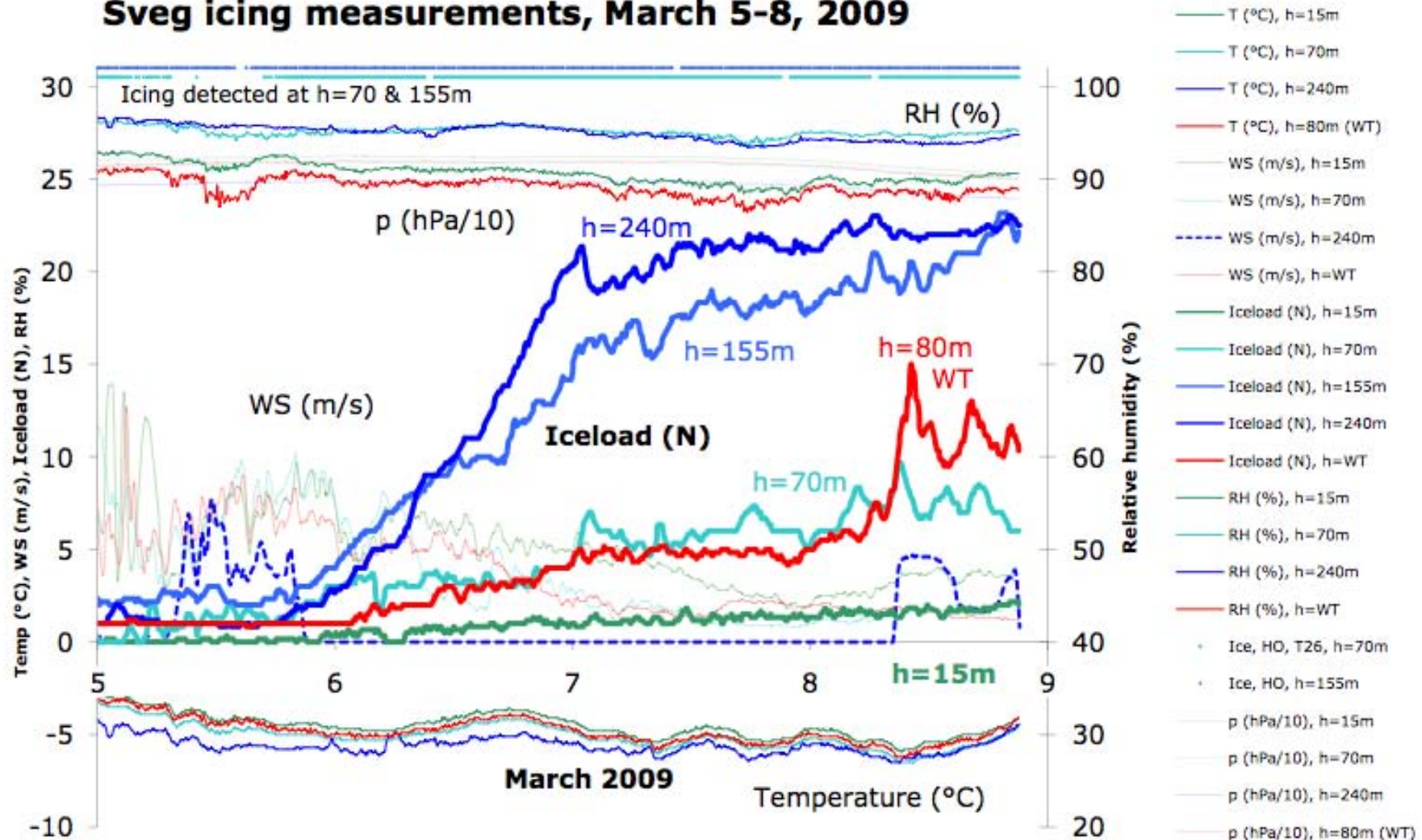


COMBITECH




Unique measurements of icing versus height

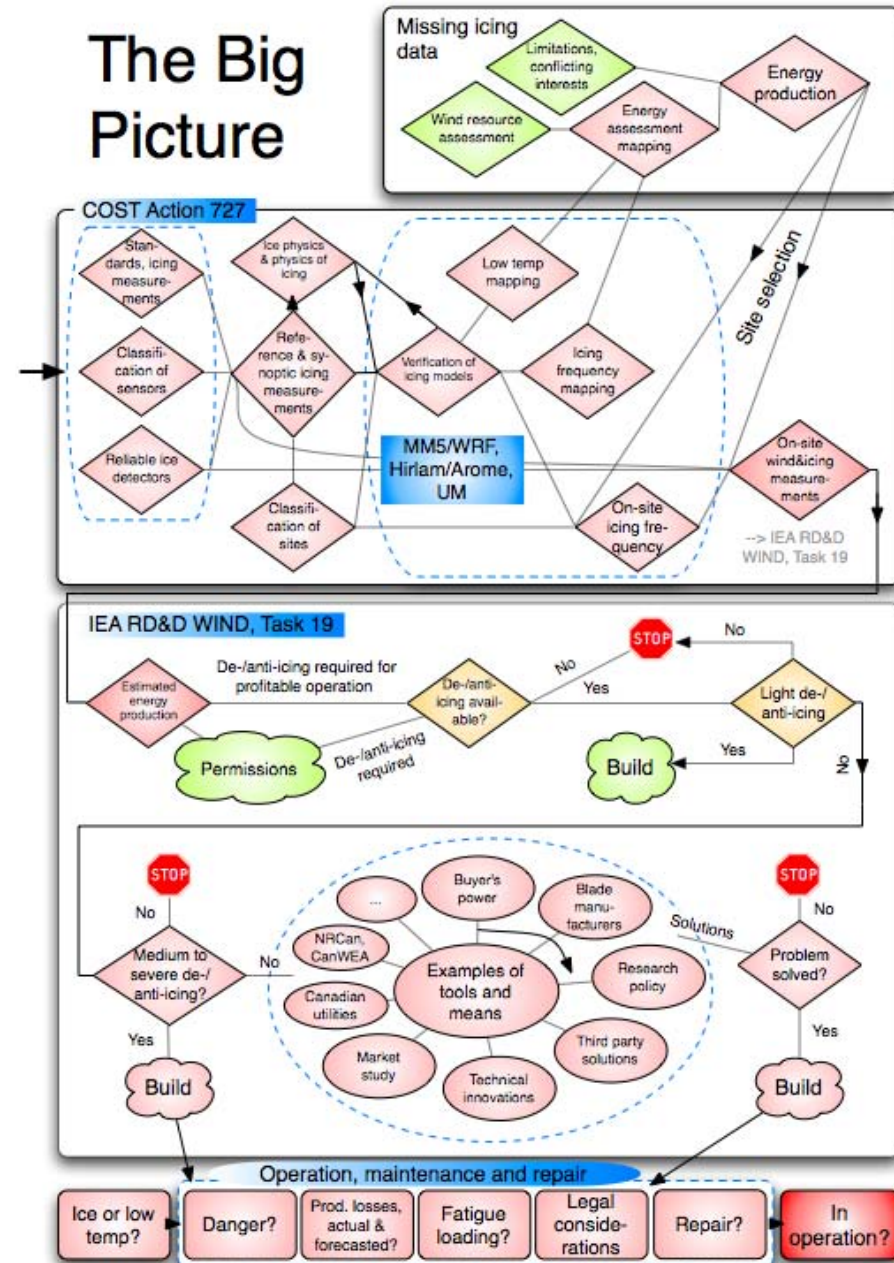
Sveg icing measurements, March 5-8, 2009



Conclusions with respect to icing

- **We've got started!** 
- Items in red need attention
- Relevant icing measurements at relevant heights for model verification of wind turbine specific icing do not yet exist
- Site specific modelling verification studies needed - to be followed by regional icing studies at 1 km resolution
- Detailed national mapping of icing is not yet a meaningful task
- Commercial de-/anti-icing systems not yet available for medium and severe icing conditions
- **O&M issues to be looked into**

The Big Picture





Thank you, sponsors of IEA RD&D Wind, Task 19!

