iea wind

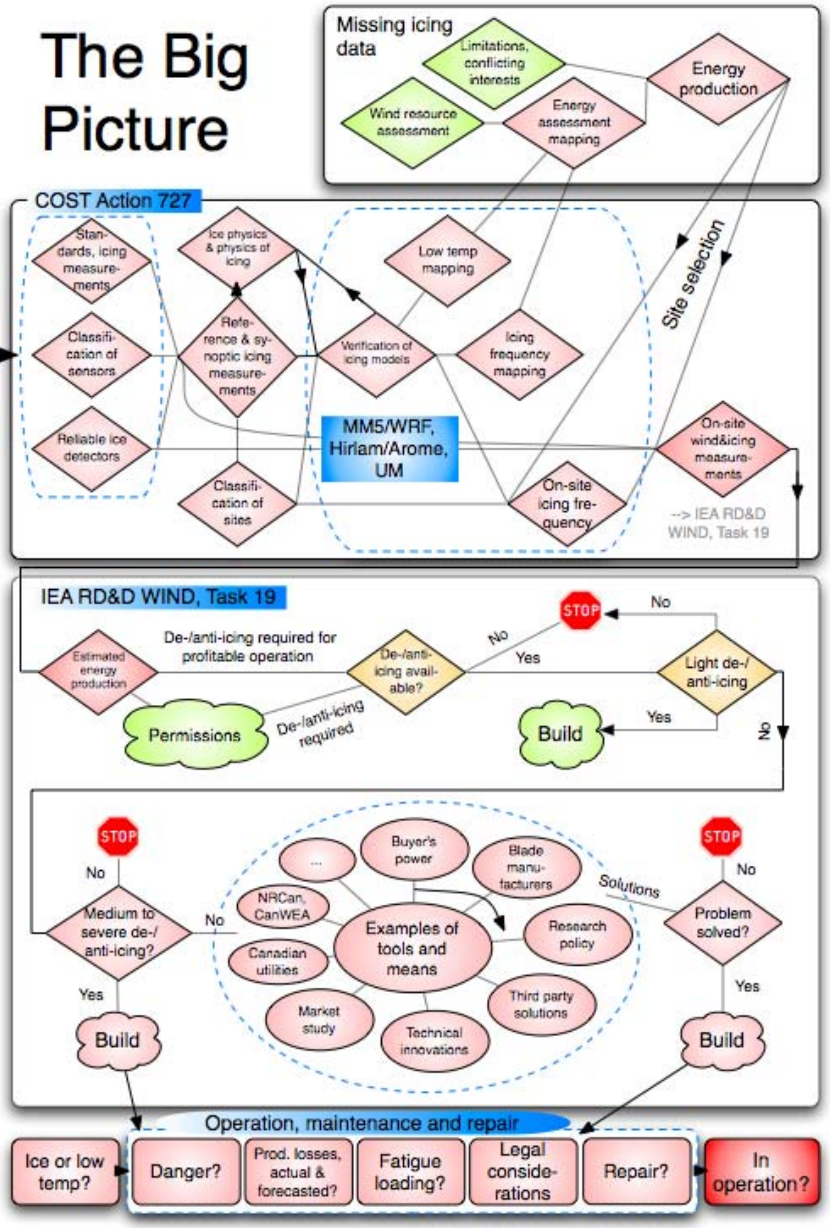
WindREN AB

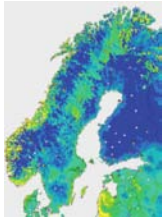
Swedish cold climate wind energy projects

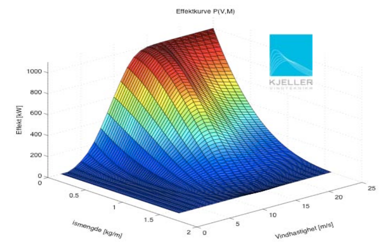
Göran Ronsten, WindREN

A major challenge - icing of rotor blades

The Big Picture



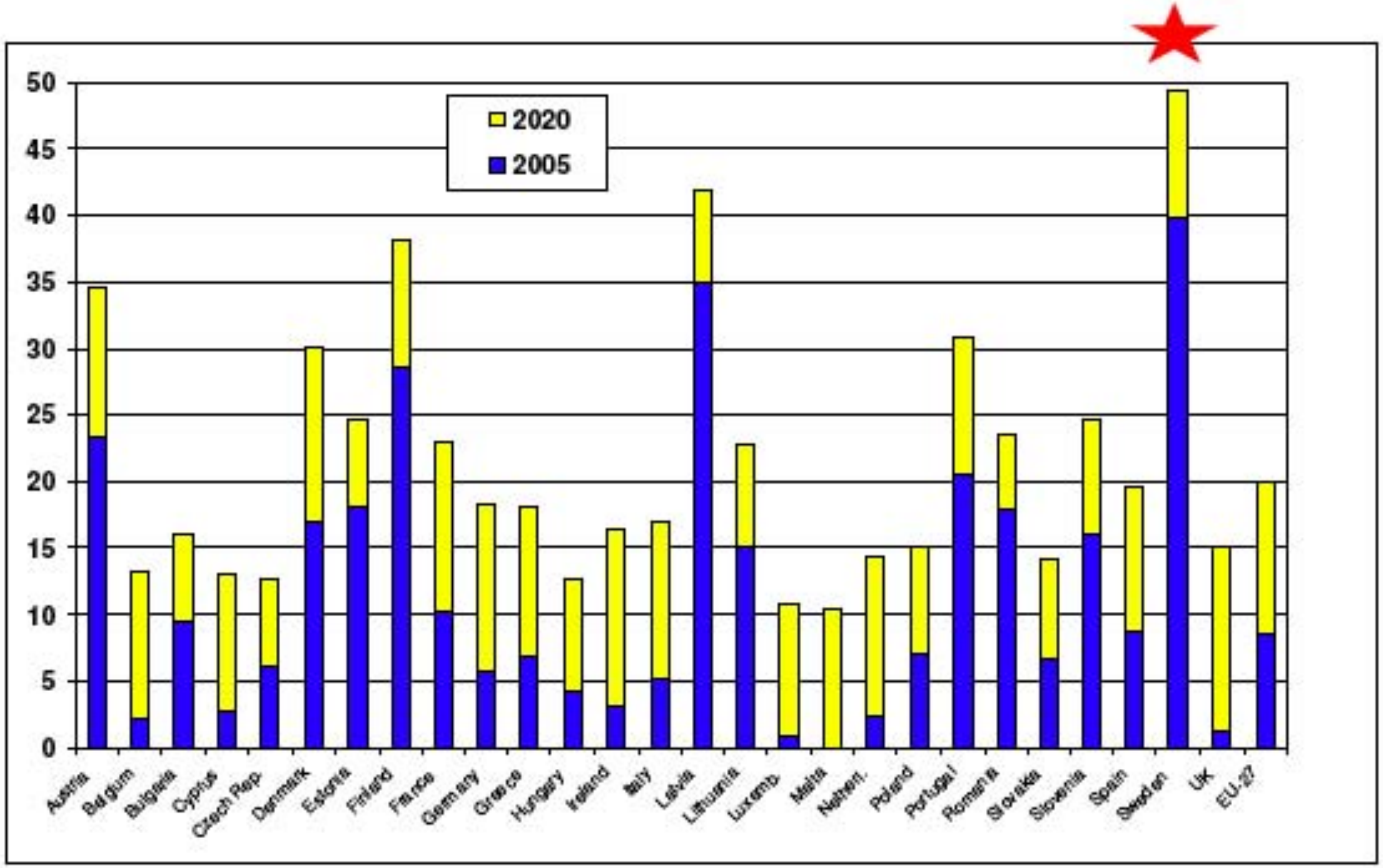




Red areas need attention

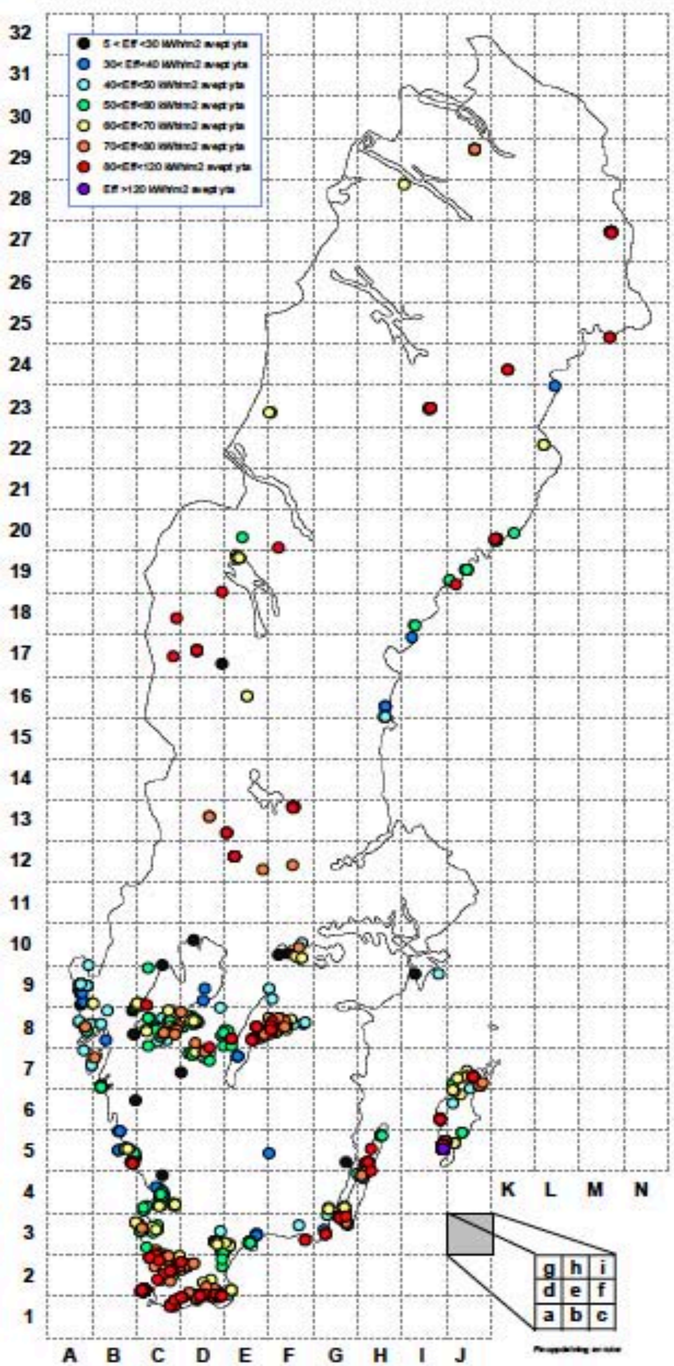
WindREN AB

Shares of RE, 2005 and 2020



Ministry of Enterprise, Energy and Communications

REGERINGSKANSLIET
Government Offices of Sweden



Statistics, March 2010

Installerad effekt	(MW)	1063
Antal verk	(st)	1070
Rapporterade denna månad	(st)	924
Elproduktion		
2008	(MWh)	1 680 427
2009	(MWh)	1 779 997
2010	(MWh)	471 436
Rapporterat denna månad	(MWh)	168 021
Medeleffekt denna månad	(MW)	226

Vindens energiinnehåll

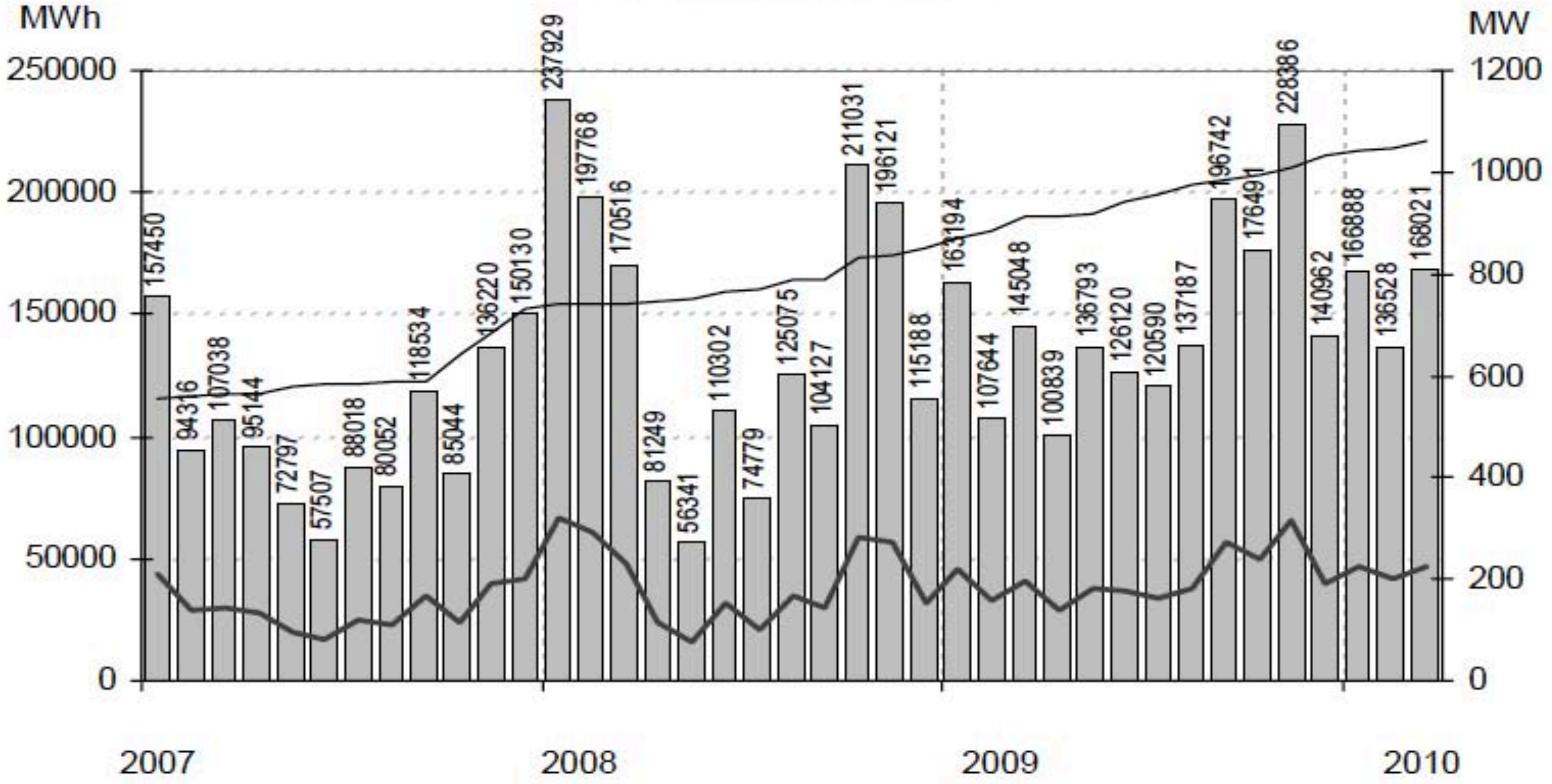
Månaden jämfört med samma månad tidigare år	102 %
Året hittills jämfört med samma period under tidigare år	82 %
Senaste 12 månaderna jämfört med samma period under tidiga	94 %

Vindkraftverk

mars 2010

Internetadress: http://www.vindstat.nu

Vindproducerad el



Vindkraftprojekt > 10 MW i Sverige, januari 2010

Med alla tillstånd/under byggnad

Under byggnad

Under byggnad/I drift

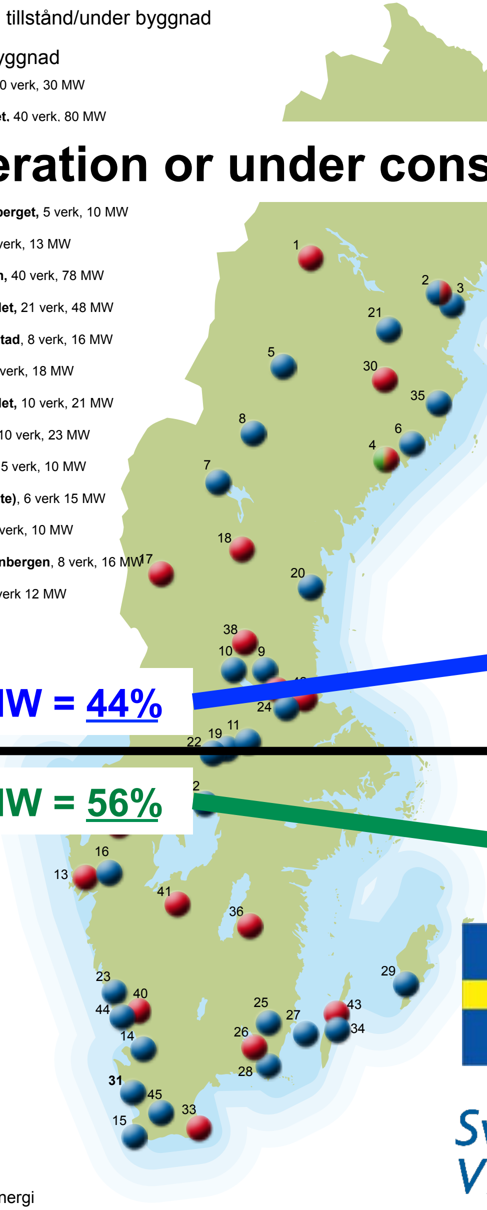
I drift

1. **Uljabuouda,** 10 verk, 30 MW
4. **Gabrielsberget,** 40 verk, 80 MW

In operation or under construction

18. **Rätan-Digerberget,** 5 verk, 10 MW
26. **Brunsmo**, 5 verk, 13 MW
30. **Stor-Rotliden,** 40 verk, 78 MW
32. **Töftedalsfjället,** 21 verk, 48 MW
33. **Östra Herrestad**, 8 verk, 16 MW
36. **Brahehus,** 9 verk, 18 MW
37. **Töftedalsfjället,** 10 verk, 21 MW
38. **Kyrkberget,** 10 verk, 23 MW
39. **Tavelberget,** 5 verk, 10 MW
40. **Fröslida (Hylte)**, 6 verk 15 MW
41. **Källeberg,** 5 verk, 10 MW
42. **Vettåsen/Finnbergen**, 8 verk, 16 MW
43. **Gärdlösa**, 6 verk 12 MW

2. **Dragaliden,** 12 verk, 24 MW
8. **Havsnäs,** 48 verk, 95,4 MW
9. **Hedbodberget 1**, 9 verk, 18 MW
10. **Säliträdberget,** 8 verk, 16 MW
11. **Fjällberget/Saxberget**,17 verk, 34 MW
12. **Gässlingegrund,** 10 verk, 30 MW
14. **Oxhult,** 12 verk, 24 MW
15. **Lillgrund,** 48 verk, 110 MW
16. **Hud,** 6 verk, 15 MW
19. **Rödbergsfjället,** 8 verk, 16 MW
20. **Håcksta,** 5 verk, 10 MW
21. **Hornberget,** 5 verk, 10 MW
22. **Silkomhöjden,** 6 verk, 12 MW
23. **Sotared,** 5 verk, 10 MW
24. **Högberget,**, 5 verk, 10 MW
25. **Råbelöf**, 5 verk, 10MW
27. **Utgrunden 1,** 7 verk, 10 MW
28. **Yttre Stengrund,** 5 verk
park, 5 verk, 10 MW
31. **Lundabukten,** 16 verk, 16 MW
34. **Stora Istad,** 5 verk, 10 MW
35. **Granberget,** 6 verk, 12 MW
44. **Lövstaviken,** 5 verk, 11,5 MW
45. **Skarhult**, 8 verk, 10,4 MW



565 MW = 44%

720 MW = 56%

Svensk Vindenergi

Vindkraftprojekt > 10 MW i Sverige, januari 2010

Med alla tillstånd/godkänd anmälan

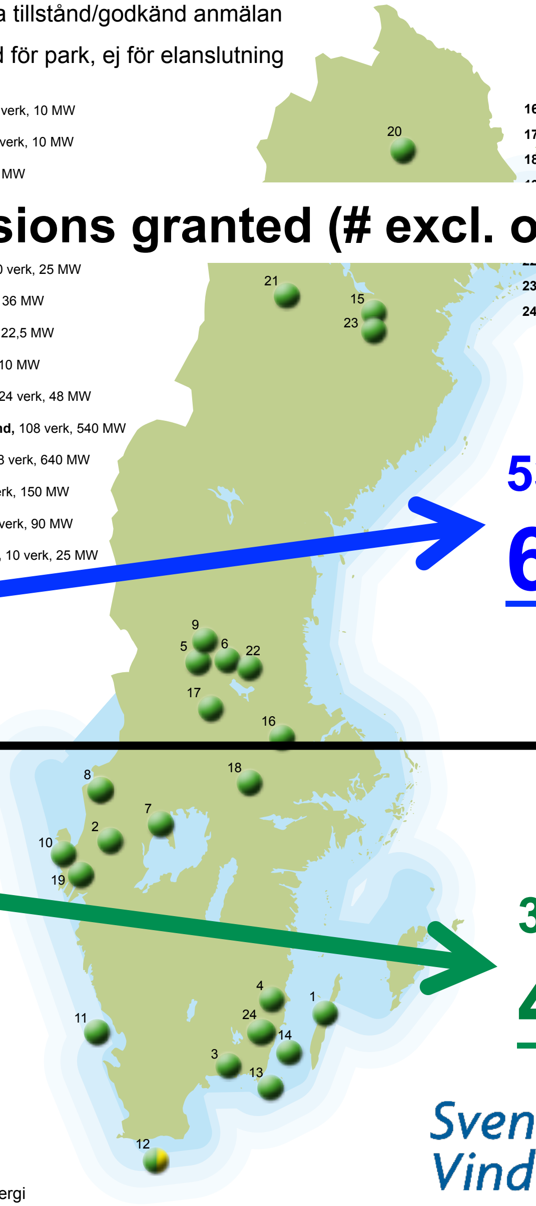
Tillstånd för park, ej för elanslutning

1. **Ryd/Rönnerum,** 5 verk, 10 MW
2. **Töftedalsfjället,** 4 verk, 10 MW
3. **Hakarp,** 8 verk, 16 MW

Permissions granted (# excl. offshore)

6. **Mässingberget,** 10 verk, 25 MW
7. **Torserud,** 12 verk, 36 MW
8. **Årjäng NV,** 9 verk, 22,5 MW
9. **Granberg,** 5 verk, 10 MW
10. **Tolvmanstegen,** 24 verk, 48 MW
11. **Stora Middelgrund,** 108 verk, 540 MW
12. **Kriegers flak,** 128 verk, 640 MW
13. **Trolleboda,** 30 verk, 150 MW
14. **Utgrunden II,** 21 verk, 90 MW
15. **Jokkmokksliden,** 10 verk, 25 MW

16. **Högtjärnsklack,** 7 verk, 14 MW
17. **Korpfjället,** 12 verk, 36 MW
18. **Sundbyholm,** 10 verk, 20 MW
23. **Storliden,** 8 verk, 25 MW
24. **Stengårdsholma,** 11 verk, 22 MW



530 MW

60%

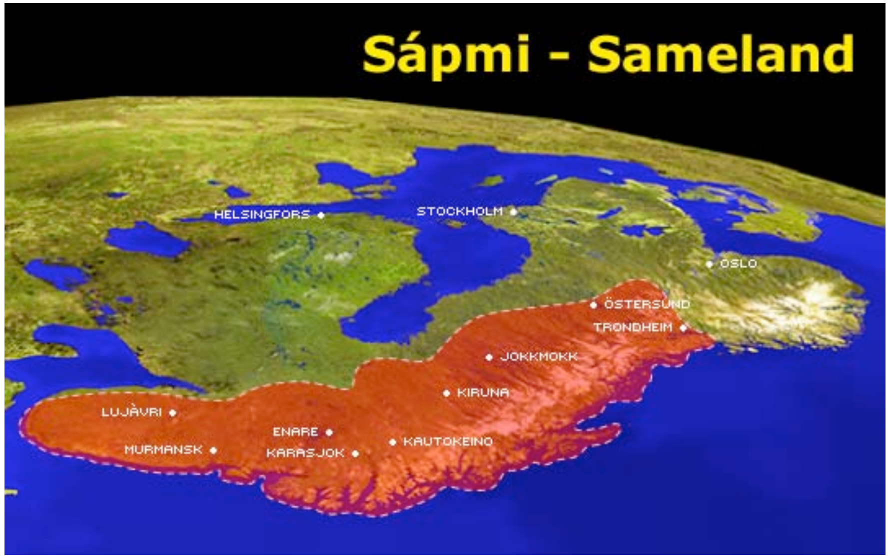
360 MW

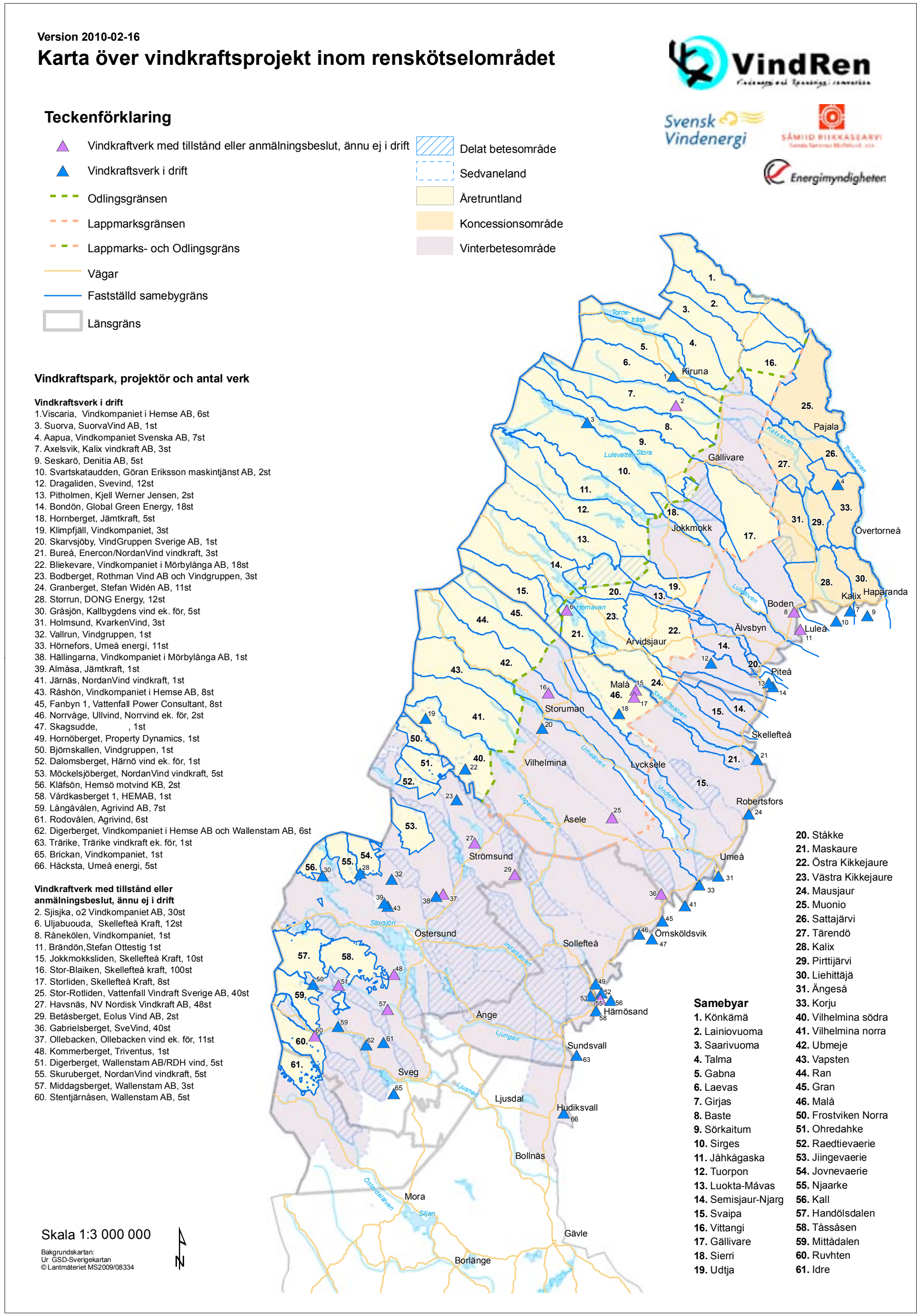
40%

Svensk Vindenergi

iea wind

- 500 WT in operation or under construction in Swedish **reindeer country**, many more planned



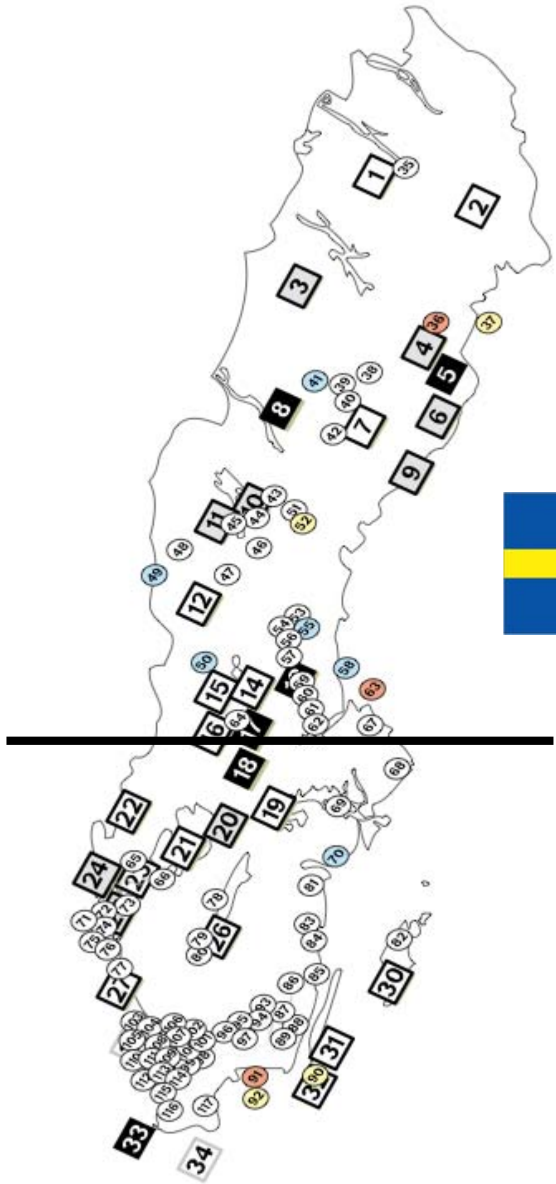


Planned large projects

March 2009

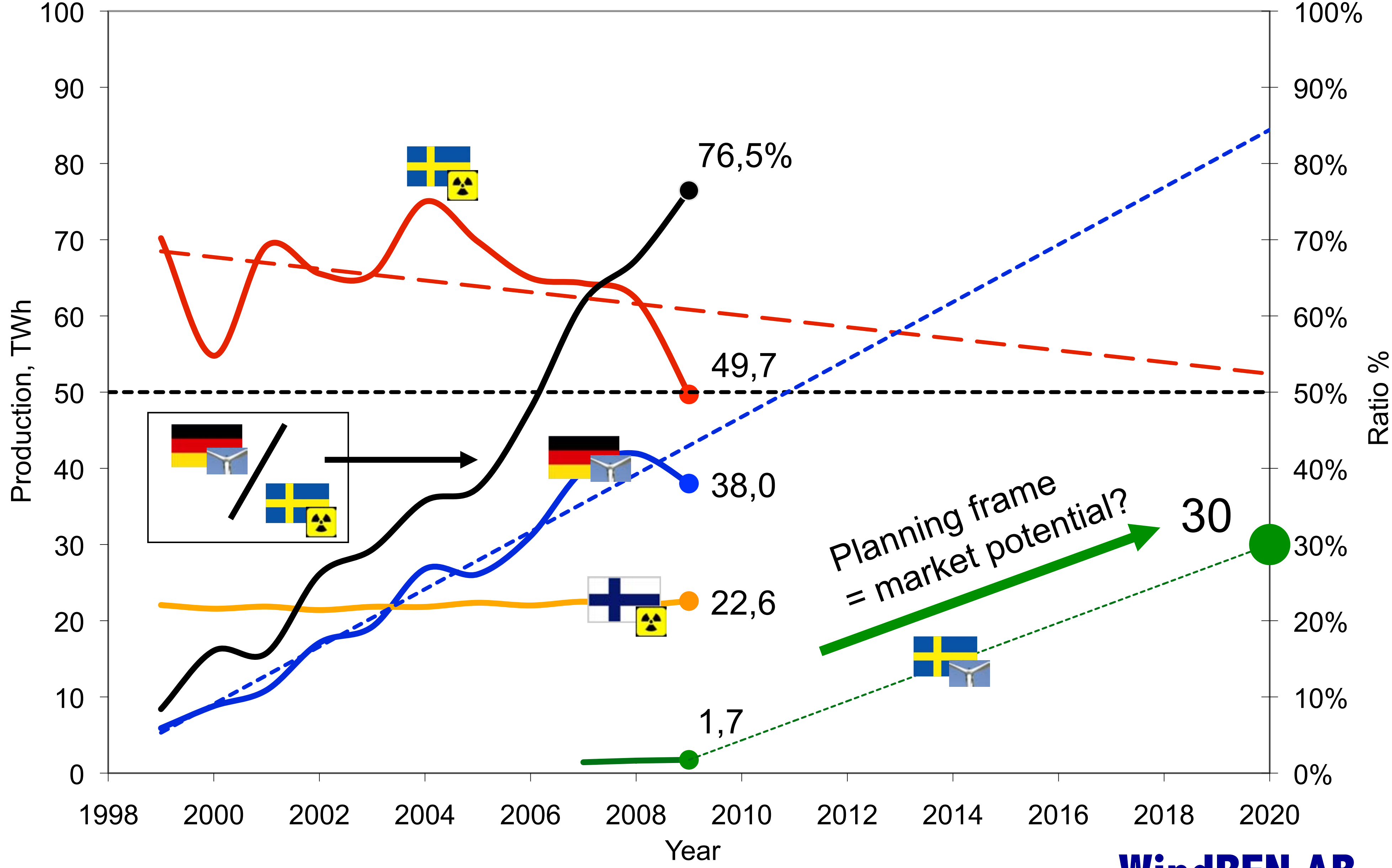
30 of 54 TWh large scale wind energy projects are planned to be deployed in Sweden’s cold climate region (North)

DN - 2009-03-12



Planning frame for wind energy in Sweden until 2020

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



WindREN AB

Interest org.

VINDMØLLEINDUSTRIEN
www.windpower.org

Canadian Wind Energy Association
Association Canadienne de l'Énergie Éolienne

中国可再生能源学会风能专业委员会
（中国风能协会）
CHINESE WIND ENERGY ASSOCIATION

EWEA
THE EUROPEAN WIND ENERGY ASSOCIATION

Svensk vindkraft förening

Swedish Wind Energy

MAKE CONSULTING

EcoTEMP

KELLY AEROSPACE
Thermal Systems

MW Innovation

IN SITU

BTM Consult ApS

COMBITECH

Wind farm dev.

O2 VINDKOMPANIET

VATTENFALL

Triventus

Stena Adactum

SKELLEFTEÅ kraft

e.on

Fortum

Fred.Olsen Energy ASA

SCA

EOLUS

nordisk vindkraft

SVEVIND
powered by nature

Statkraft

DONG energy

Manufacturers

SIEMENS

Vestas

Gamesa

ENERCON
ENERGY FOR THE WORLD

LM

GE

NORDEX
We've got the power.

WinWinD

SUZLON

REpower Systems

Research & Education

ELFORSK
SVENSKA ELFÖRETAGENS FORSKNINGS- OCH UTVECKLINGS - ELFORSK - AB

UPPSALA UNIVERSITET

VATTENFALL

Högskolan på Gotland
Gotland University

KJELLER

KTH VETENSKAP OCH KONST

RISØ

LULEÅ TEKNISKA UNIVERSITET

HÖGSKOLAN HALMSTAD

Nätverket för vindbruk

Vindforsk

Hogskolen i Narvik

Government & Intl

iea wind

COST 727

Strömsunds Kommun

Energimyndigheten

VTT

Natural Resources Canada

Ressources naturelles Canada


Clipper®
MEGA FLUX

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

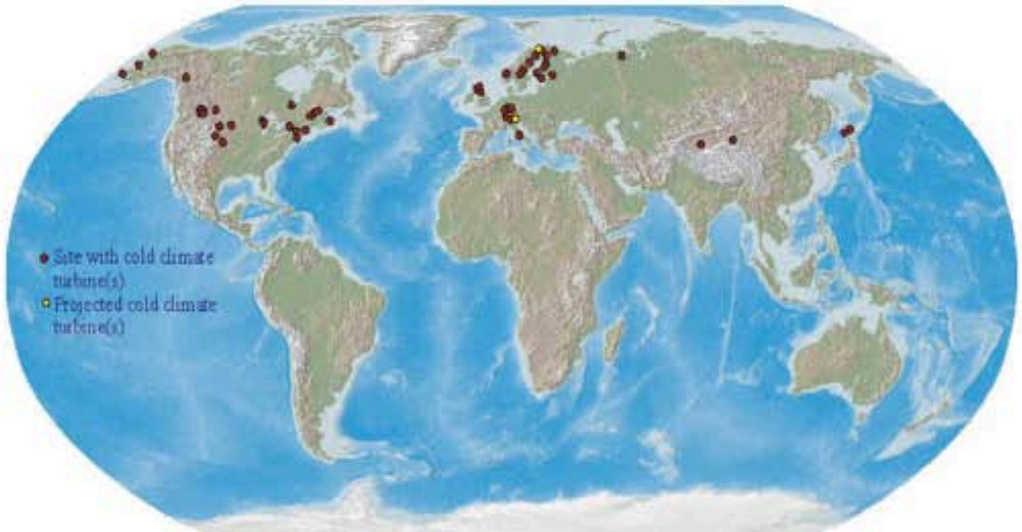
IEA Wind R,D&D Task 19

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...):

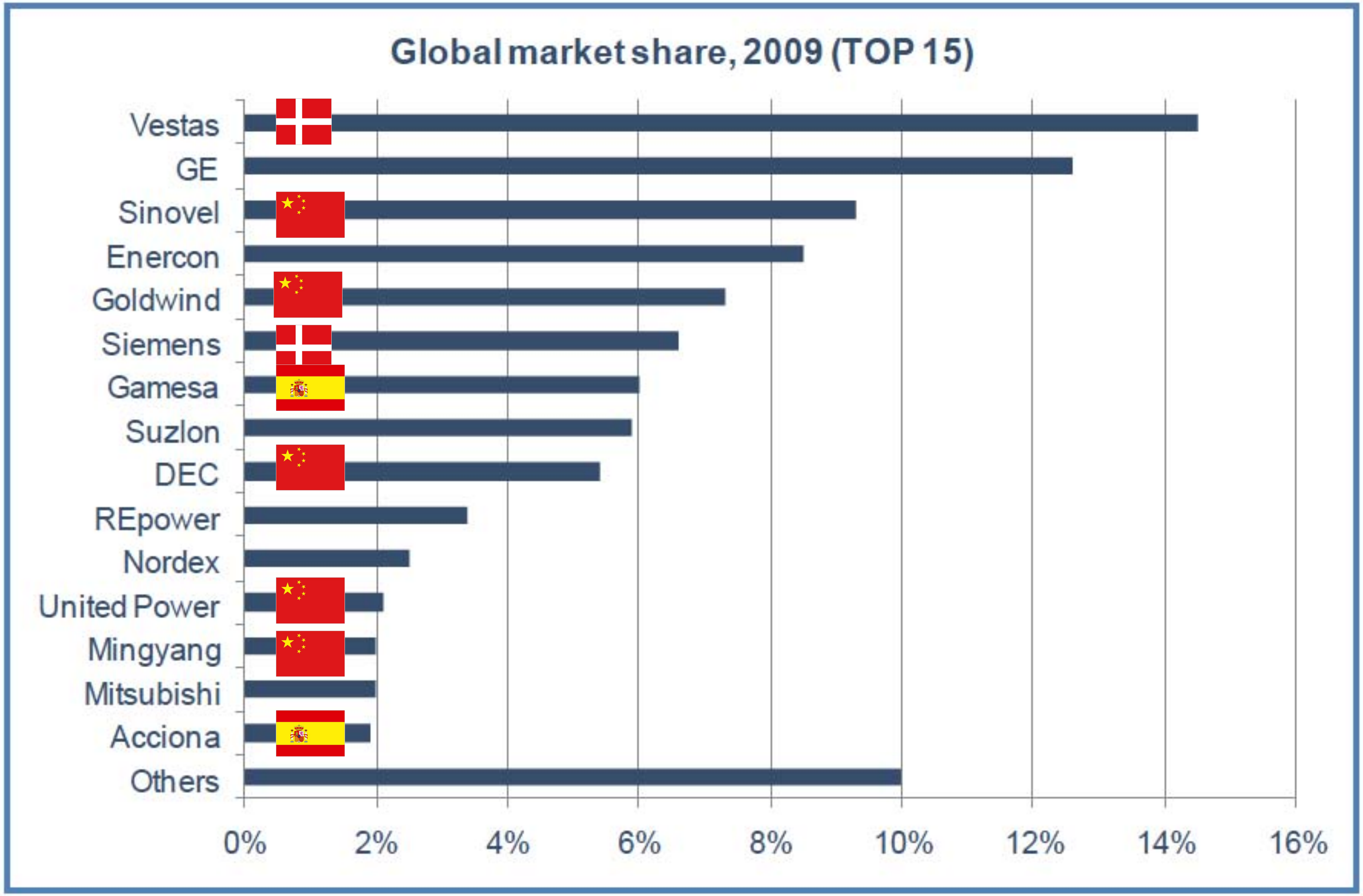
- Publications
- Operational Experience
- Technical solutions in use
- Measurements & Instruments
- Knowledge on climatic conditions and resources

Control anemometer and wind vane at Olostunturi-fjell Finland

- Send us information about icing and low

WindREN AB

Denmark, China & Spain are not involved in IEA Task 19

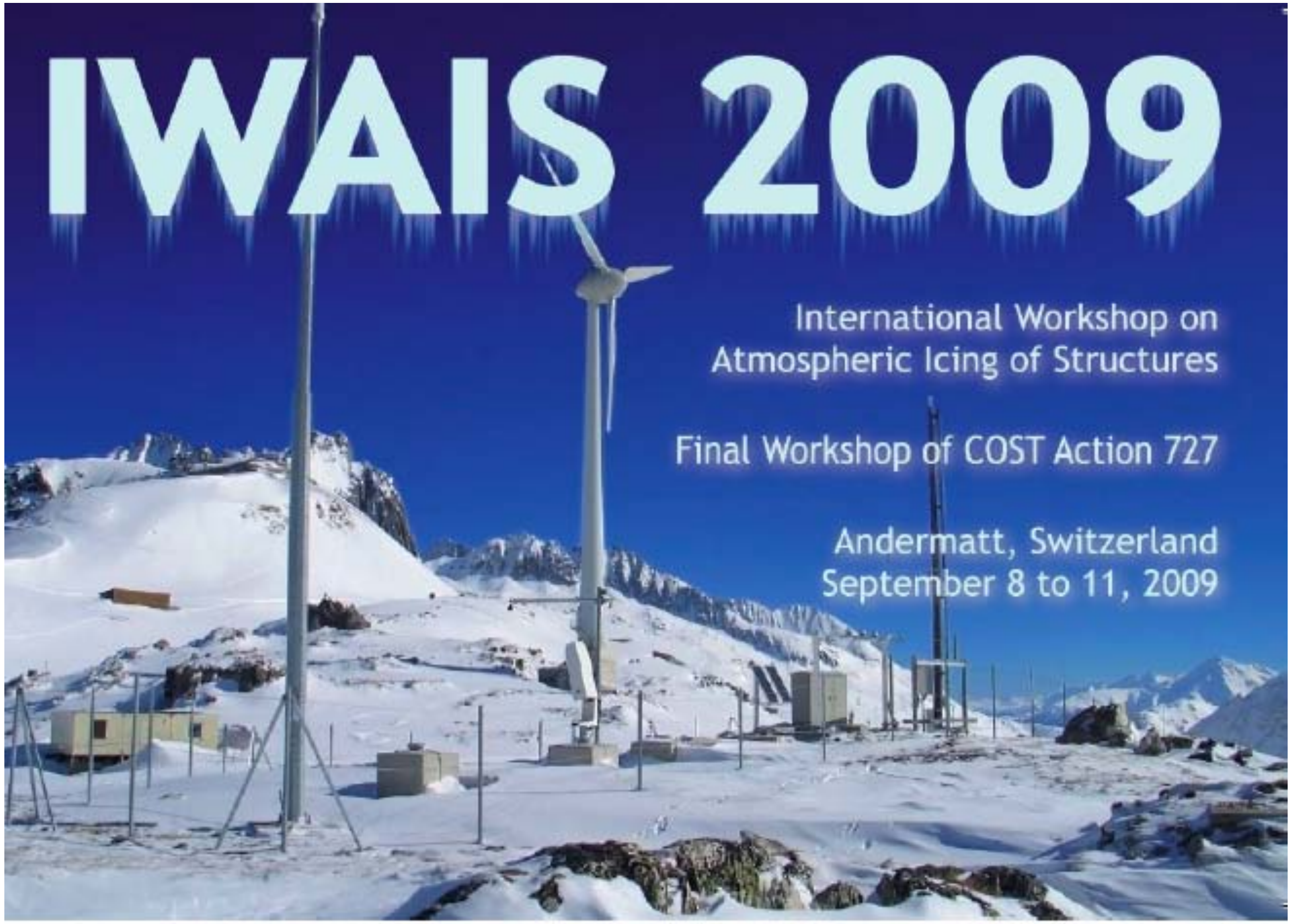


Source: MAKE Consulting

The Russian WE market; 15 GW by 2020, = Sweden = Canada

IWAIS 2009 - Summary of Cold Climate Wind Energy Presentations

Göran Ronsten, WindREN



VATTENFALL

Swedish Energy Agency

Thanks to the presenters, members of COST 727, the COST office, Vattenfall Power Consultant & The Swedish Energy Agency!

The work of COST Action 727 is carried out in two Working Groups

WG2: Measurements and data collection on icing

The work carried out in Phase 1 (2004-2006) is presented in a report containing a survey of icing detectors and other measuring principles applicable both for the initial stages of icing as well as for accumulated ice loads. A survey is also provided on historical ice measurement programs in Europe, and more briefly in Canada and Russia. References are made to tests of anemometers and other meteorological instruments whose sensitivity is influenced by ice accretion. The report can be downloaded from www.cost727.org.

In Phase 2 (2007-2009) WG2 is involved in measurement programs on selected sites in Europe. On the Gütsch test site (CH) a comprehensive program is performed for inter-comparison of ice detectors and meteorological instruments. The Luosto site (FI) and Deadwater Fell (UK) are important for providing data for modelling icing events by using atmospheric weather forecasting models. Mast measurements of icing versus elevation are particularly important for the development of wind energy will be carried out at Sveg (SE). Tests will also take place in Studnice (CZ) and Zinnwald (DE). Actions are taken to promote atmospheric icing as a meteorological parameter in appropriate WMO guidelines and to recommend a long term program for monitoring of atmospheric icing in Europe.

The participants of COST Action 727 come from 13 different countries

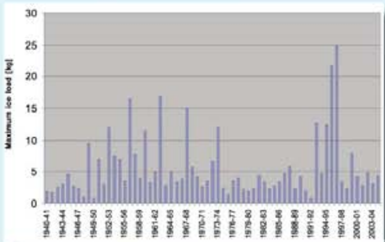
Signatories: Austria, Bulgaria,Czech Republic, Finland, Germany, Hungary, Norway, Slovakia, Spain, Sweden, Switzerland and UK. **Non-European member:** Japan

Executive members of COST 727

Chairman	Alain Heimo	CH
Vice-chairman	Dimitar Nikolov	BG
Vice-chairman	Bengt Tammelin	FI
WG1 Chairman	Lasse Makkonen	FI
WG1 Vice-chairman	Jiri Hosek	CZ
WG2 Chairman	Svein Fikke	NO
WG2 Vice-chairman	Göran Ronsten	SE
Action Secretary	Jiri Hosek	CZ
Home page	**www.cost727.org**	

Science Officer: Carine Petit, ESSEM (Earth System Science & Environmental Management), COST Office
149 Avenue Louise, Brussels 1050, Belgium
tel: 32 (0)2 533 38 31, fax: 32 (0)2 533 38 90
email: cpetit@cost.esf.org
web: http://www.cost.esf.org/

Figure below: Annual maximum ice loadings at Studnice (CZ) from 1940 to 2005.



cost

Measuring and Forecasting Atmospheric Icing on Structures

- COST Action 727 -

COST is supported by the EU RTD Framework programme

European Science Foundation

ESF provides the COST Office through an EC contract

Participating countries

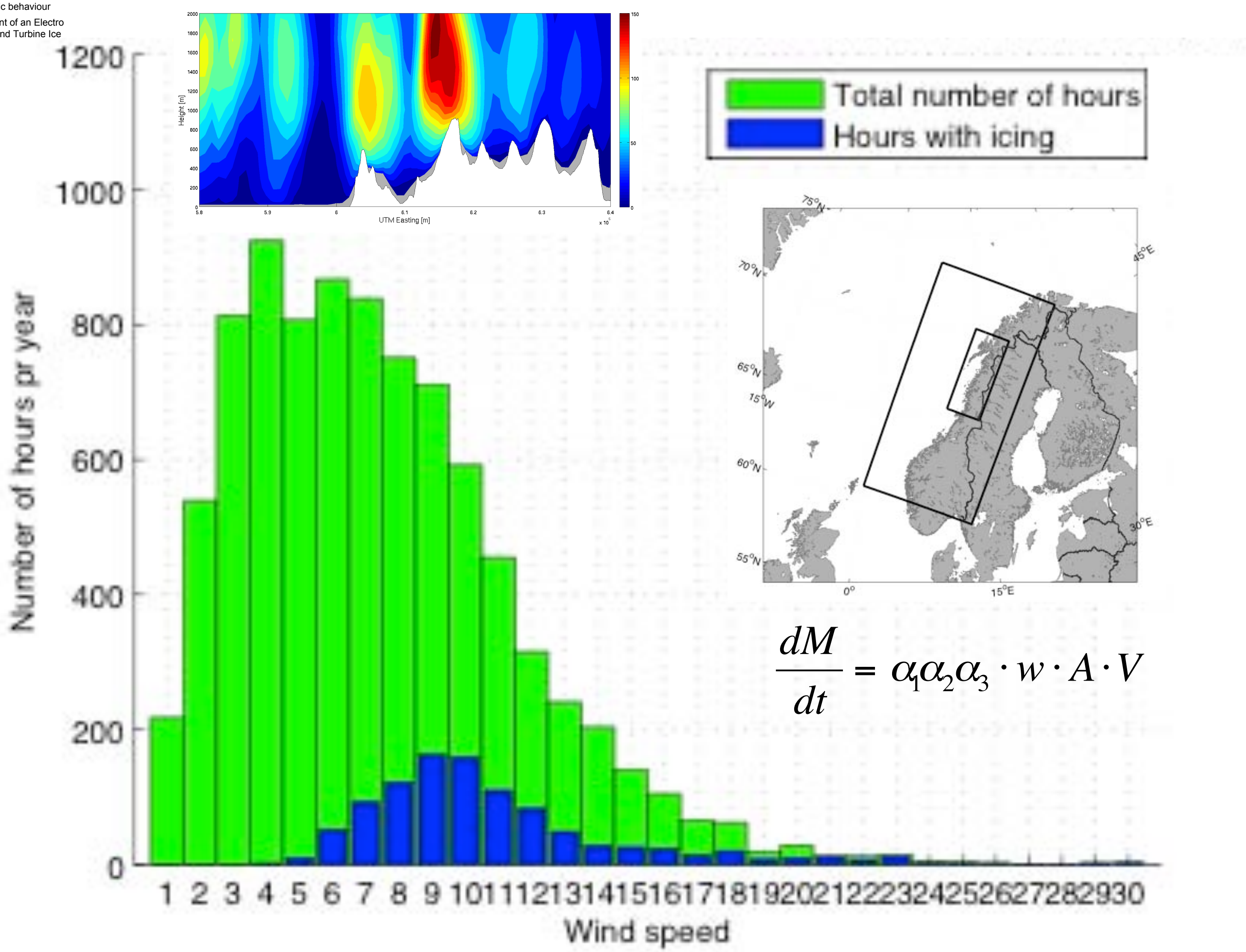
- Austria
- Bulgaria
- Czech Republic
- Finland
- Germany
- Hungary
- Iceland
- Norway
- Slovakia
- Spain
- Sweden
- Switzerland
- UK
- Japan

VATTENFALL

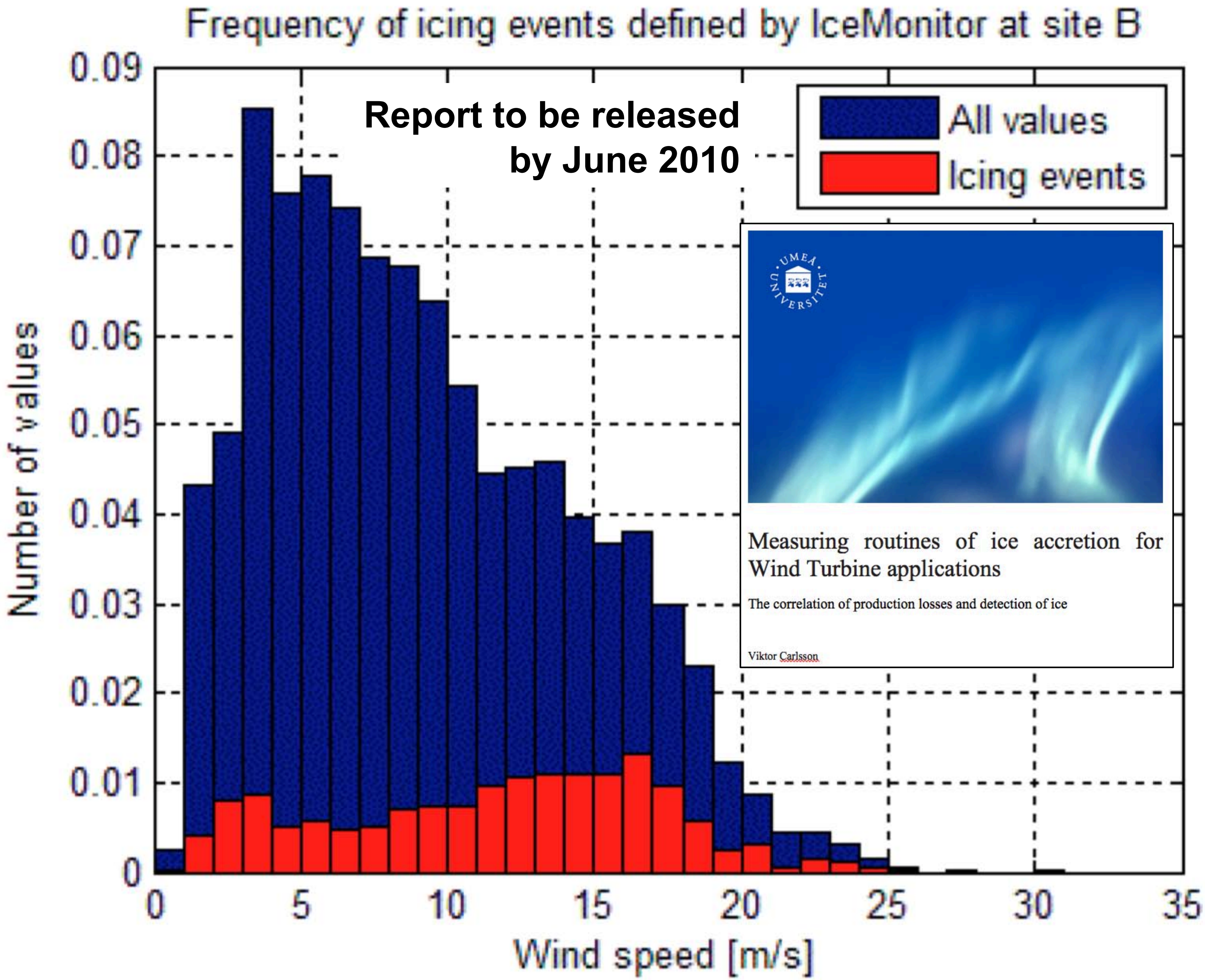
Swedish Energy Agency

1. T. Laakso — Wind Energy in Cold Climates IEA Task 19 - Outlook 2010
2. D. O'Hern — Development of an Electrothermal Ice Protection System for Wind Turbine Applications
3. A. Westerhellweg — Evaluation of Operational Data in respect to Production Losses due to Icing
4. Ø. Byrkjedal — Estimating wind power production loss due to icing
5. C. Hochart — Methodology and validation of wind farm production loss estimates due to icing events
6. L. Fuchs — Ice accretion on wind-turbines
7. S. Barber — The effect of ice shapes on wind turbine performance and aerodynamic behaviour
8. H. Gedda — Development of an Electro Thermal Wind Turbine Ice Protection

Frequency distribution with wind speed



$$\frac{dM}{dt} = \alpha_1\alpha_2\alpha_3 \cdot w \cdot A \cdot V$$



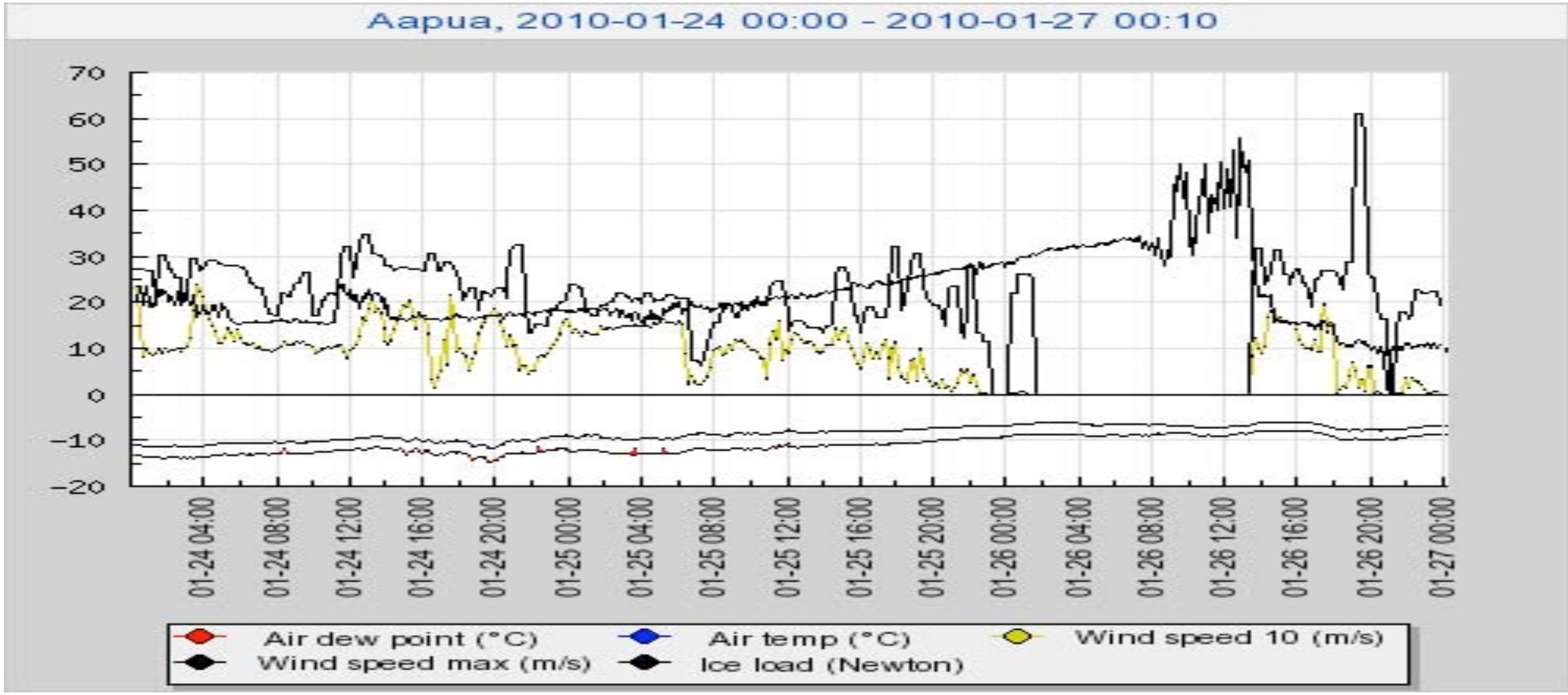
Report to be released by June 2010

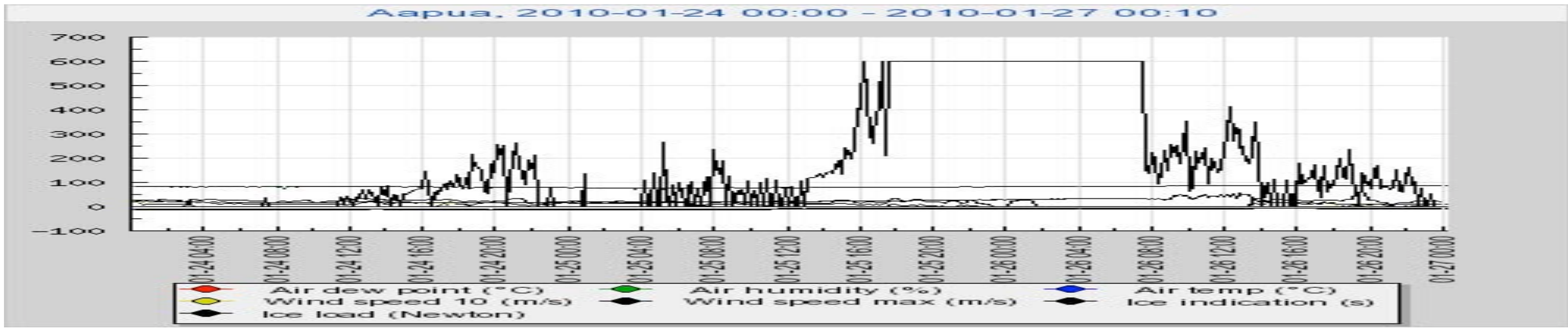
WindREN AB

Icing measurements in Aapua on a Vestas V82

WindREN AB

Aapua wind farm iced up, ice load and intensity





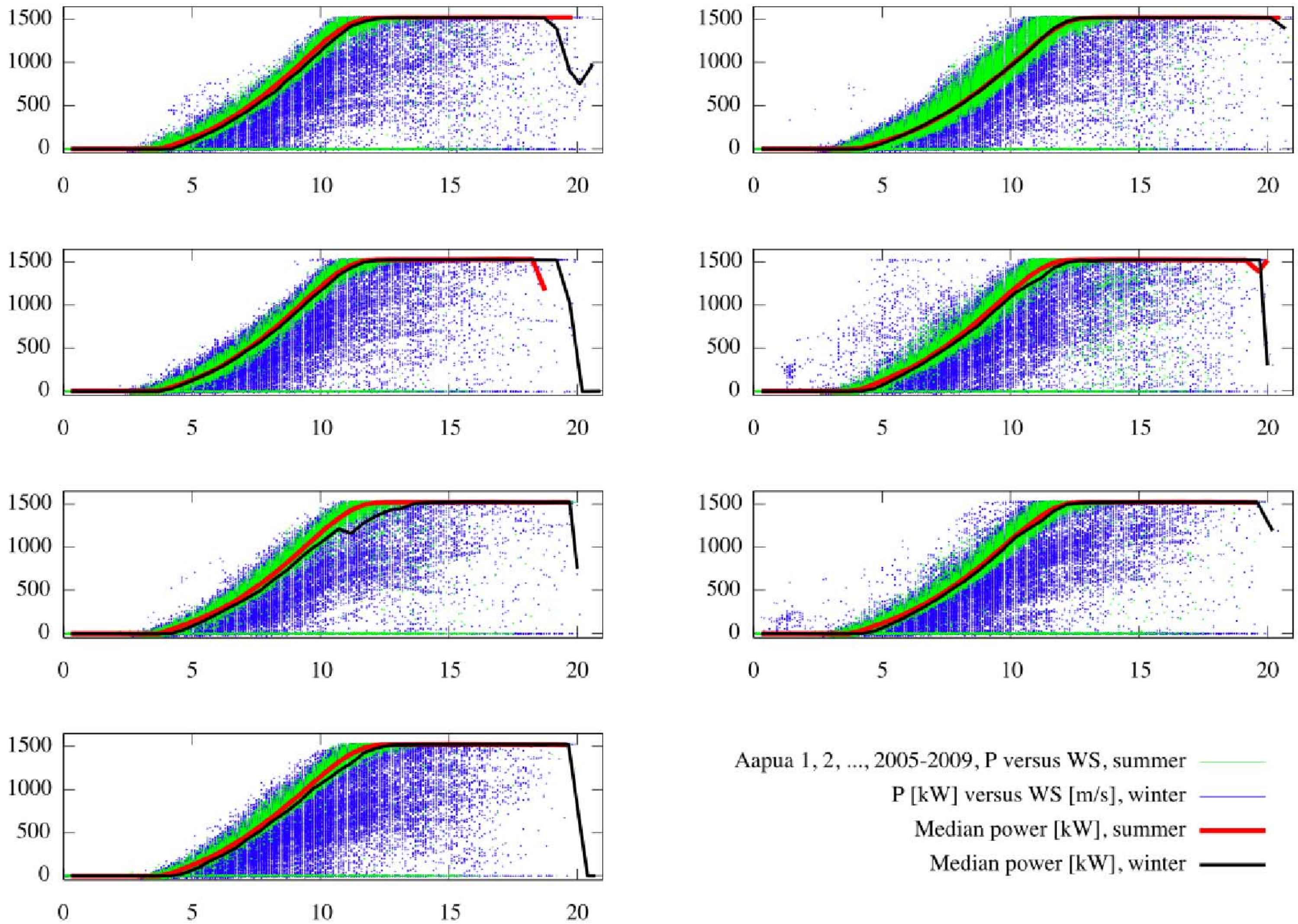
WindREN AB

Aapua wind farm iced up, 2009-01-27 00:08

iea wind

WindREN AB

>25% wintertime energy production losses, V82-1.5



Ny Teknik, Feb 6, 2008

ldat alla ... m jordar skon är lösningen. Tofflorna förbjöds på många ställen sedan de visat sig fungera som isolatorer och byggt upp spänningar på 25 000 volt. Medicinteknisk utrustning klarar inte mer än 8 000 volt. NyT

NR 6 • 6 FEBRUARI 2008 • NY TEKNIK 5

NYHETER

VARNING: FALLANDE FÖREMÅL

Att ett rotorblad lossnar från ett vindkraftverk och gör en farligt okontrollerad luftfärd tillhör inte vanligheterna. Det hände på Näs på Gotland för tio dagar sedan.

Däremot är isbildningar på vindkraftsvingarna ett hot som ökar i takt med att vindkraften drar till fjälls. Isflak som lossnar utgör en livsfara för omgivningen och vindkraftsbranschen och den statliga energimyndigheten lägger nu ned stora utredningsresurser på hur man ska lösa problemet.

För att hindra isbildning har tillverkarna provat en rad olika metoder: tunna elslingor i bladen, små varmluftsfläktar i aggregaten. Det finns ännu ingen metod som helt motverkar isbildning.

1 Det blåste kraftigt och vindkraftverket hade precis satts igång, när ena vingen plötsligt lossnade från sina fästen.


Aapua, 2008-03-19

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

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

$$d = (D + H) \cdot 1.5$$

Rotating

58 (80)

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

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

Standstill

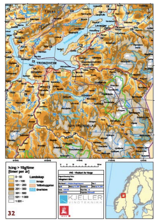
Det fruktansvärda ljudet från vindsnurrorna förorsakar stort lidande för de boende i Örtjärn. Katrin Karlsson, här med sin man Janne Furunäs och barnen Emilia och Elina, träder nu fram och ger nu miljöproblemet ett ansikte. FOTO: FREDRIK LARSSON

”Man blir vansinnig”

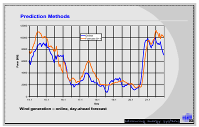
– Örtjärnsbor svårt störda av vindkraftverken

”– 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.”

IEA Task 19 targets 1-3



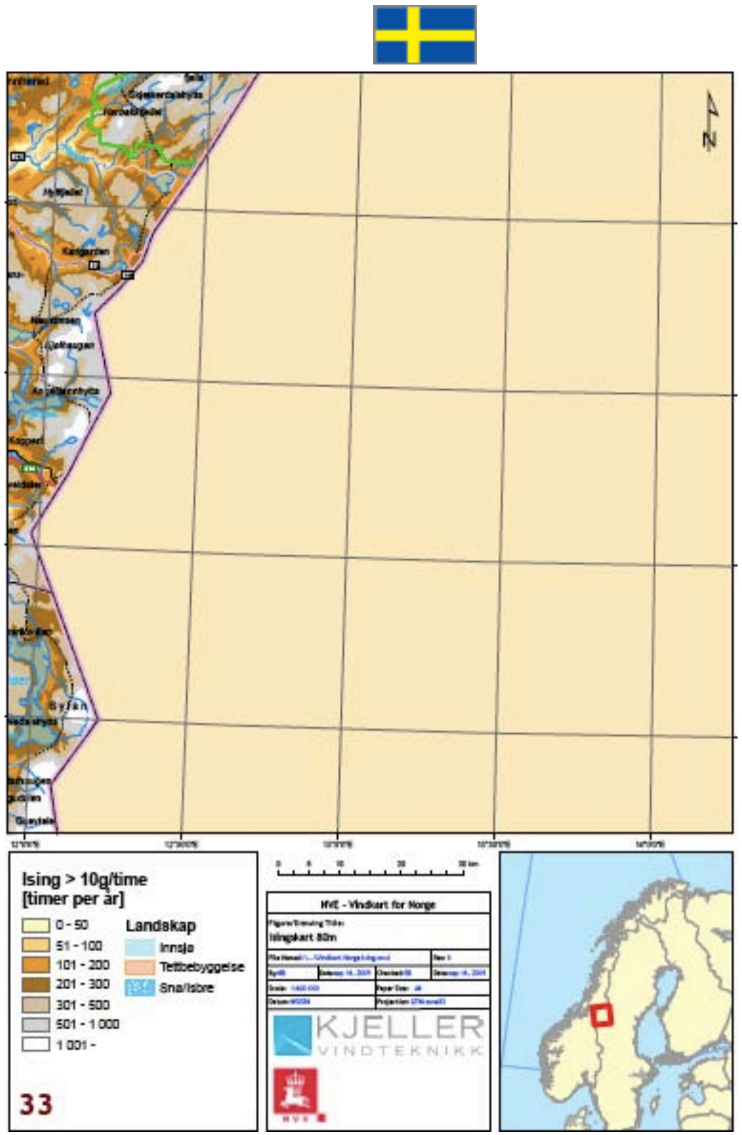
1. To collect information on ice mapping and produce and verify ice maps for selected areas in order to ease and support the early phases of project development.
Yes: Uppsala Universities and SMHI's combined project and the Swedish Energy Agency's wind pilot projects.



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



UPPSALA UNIVERSITET

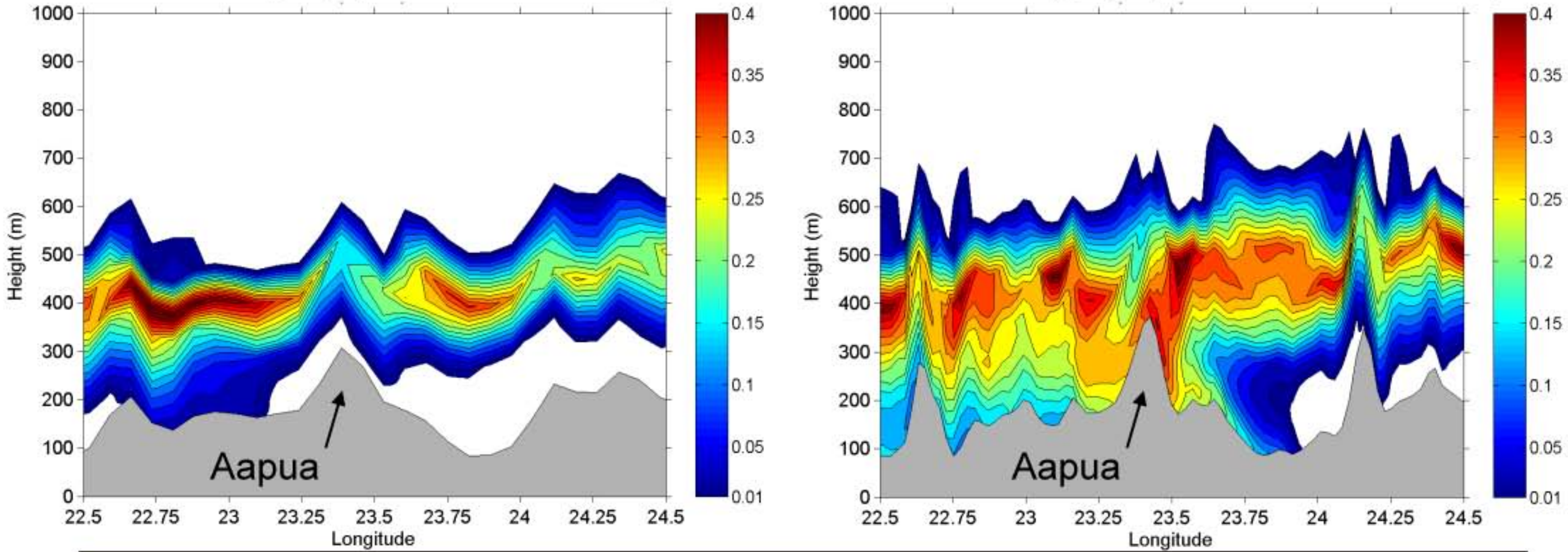
Vindforsk

Mapping of icing using COAMPS, 2008-2012, **R&D: 0.8 MEuro**

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

Cloud water (g kg^{-1}) at 17 UTC, 4-km grid

Cloud water (g kg^{-1}) at 17 UTC, 1.33-km grid



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.**

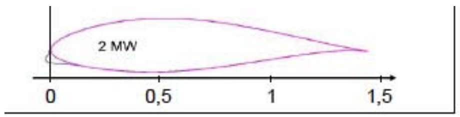
IEA Task 19 targets 4-6

CGC

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 under test.

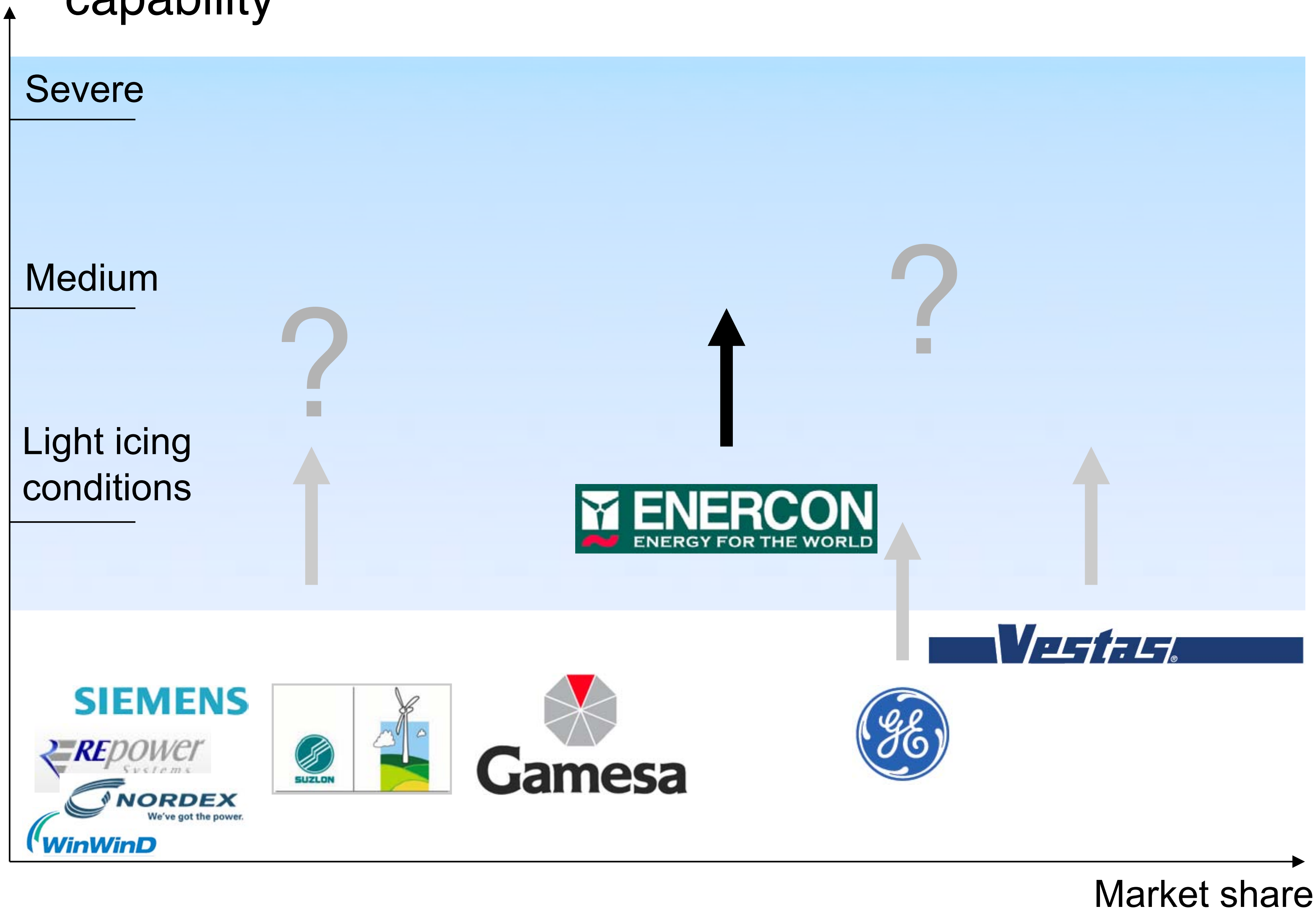
5. Review the current standards and recommendations from the cold climate point of view and identify the possible needs for updates.
Yes: GL has been contacted. Work is on-going.

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

Official de-icing capability



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 targets 7-10

Forces & Dynamics

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?

Ice throw

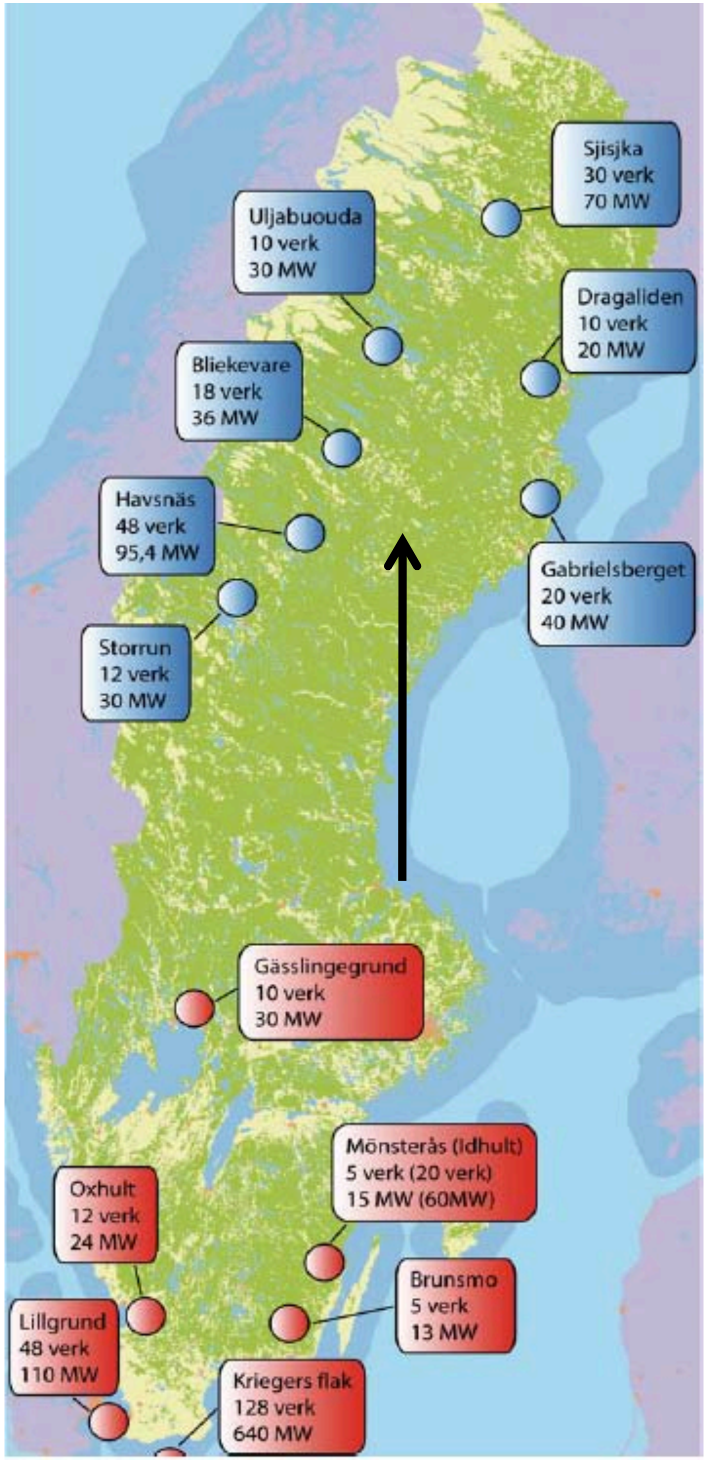
9. Improve the understanding of the risks and the mitigation strategies for the problem of **ice throw** from wind turbines at cold climate sites.
No: No new work currently planned or available.

Reports, dissemi-nation

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 pilot projects: 70 Meuro/10years

From offshore to cold climate and forests



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

Anti-icing (40 WT) and icing measurements (8 sites),

Bliekevare & Sjisjka, 2008-2012, **R&D: 7.2 MEuro**

VINDKOMPANIET MW Innovation KELLY AEROSPACE Thermal Systems COMBITECH EcoTEMP° IN SITU ...

International support for o2 Vindkompaniet's wind pilot project


HEATER MATS
HEATER MATS
O2
KELLY
AEROSPACE
Thermal Systems
MW
Innovation
WWW.MW-INNOVATION.SE

Sveg mast Measurements

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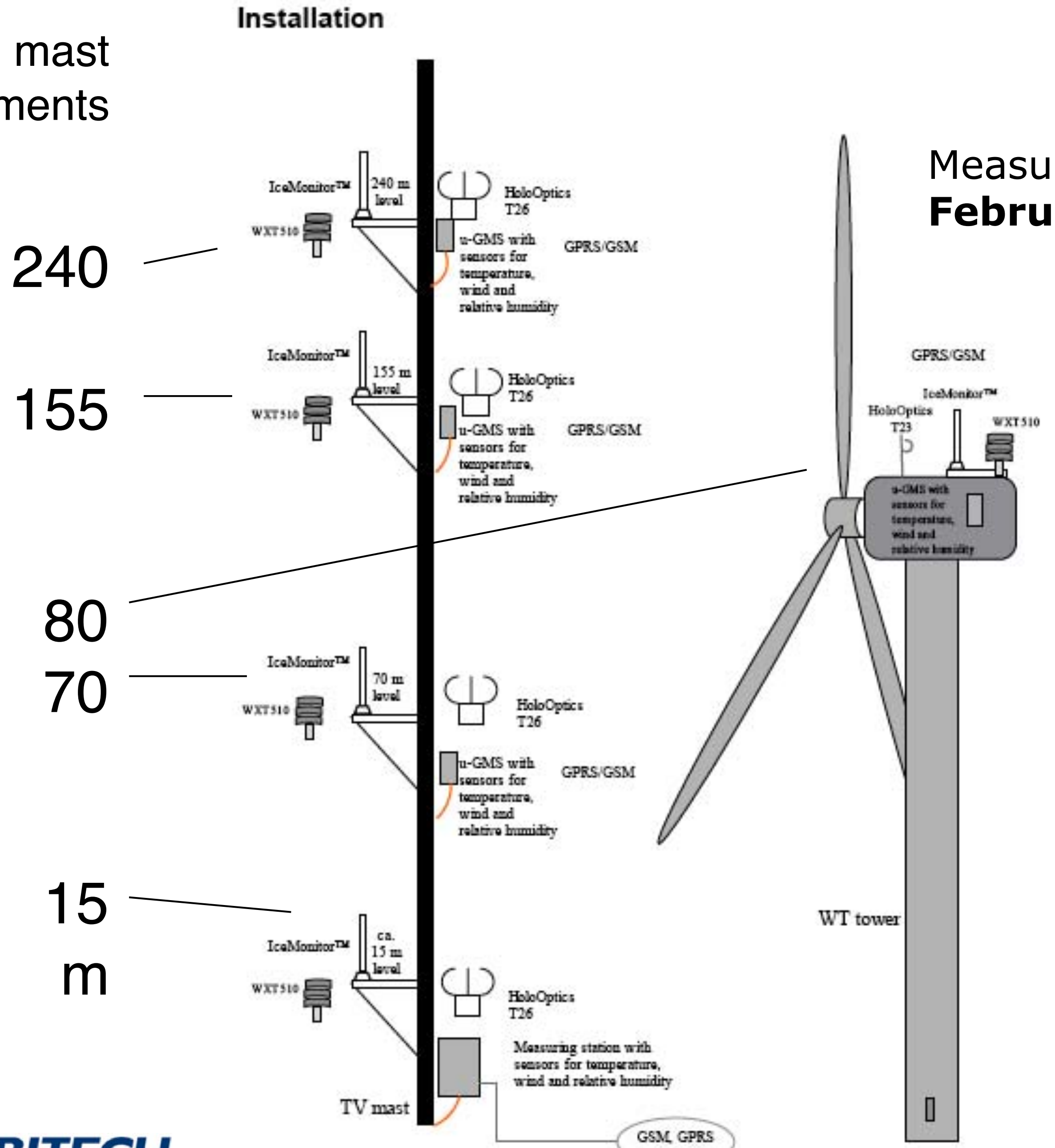
Measurements started
February 2008



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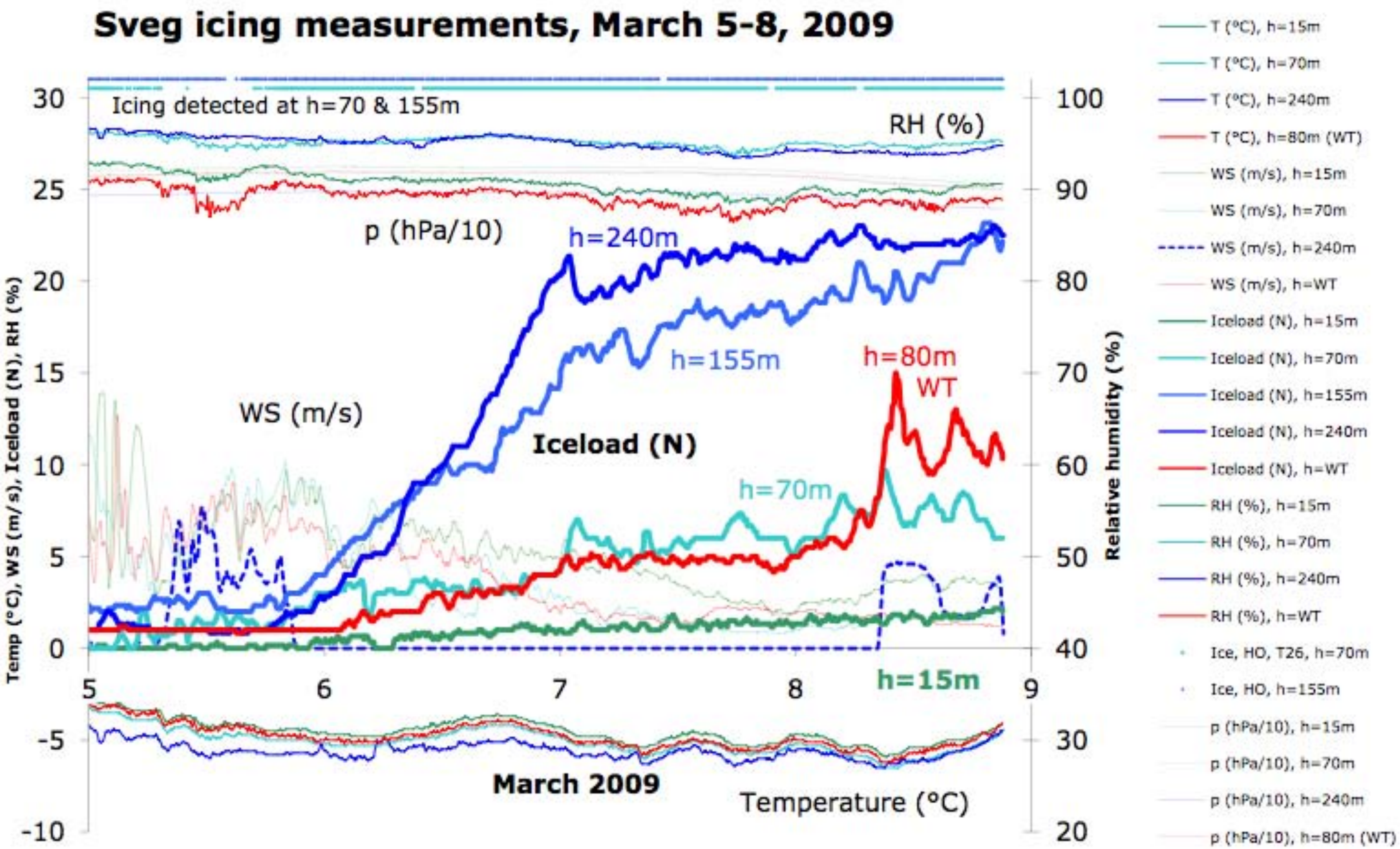
Unique measurements of icing versus height



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Equipment used on WT

Ice detector, ice load, met sensor

Long boom for WS

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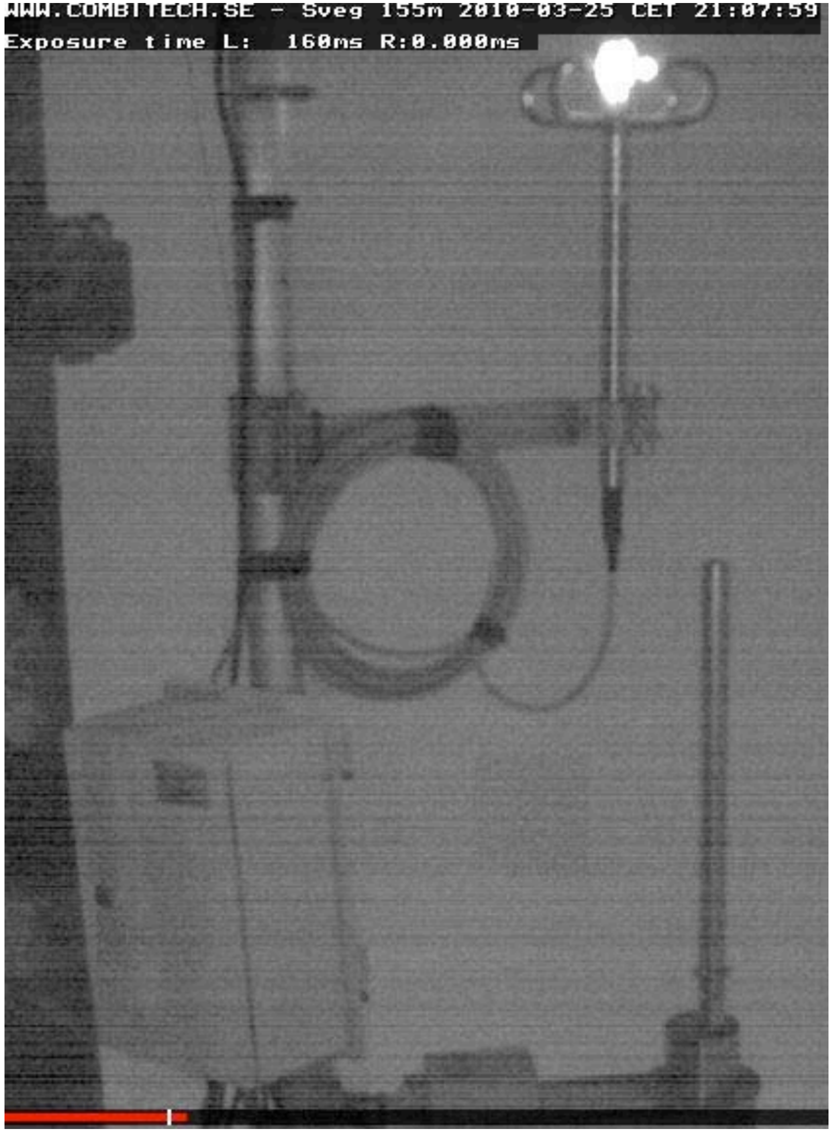
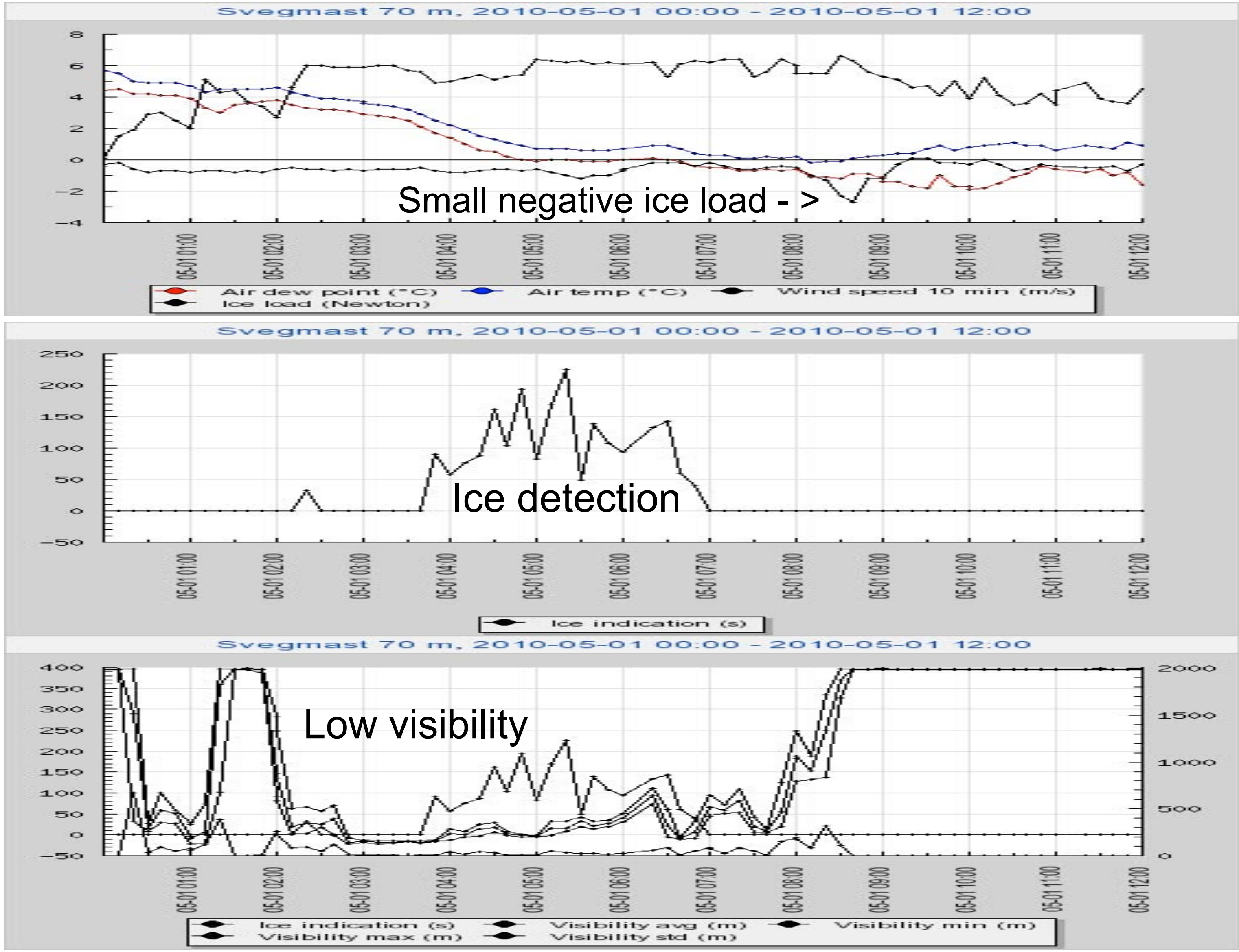
& in the masts (14 stations)

O2 VINDKOMPANIET COMBITECH

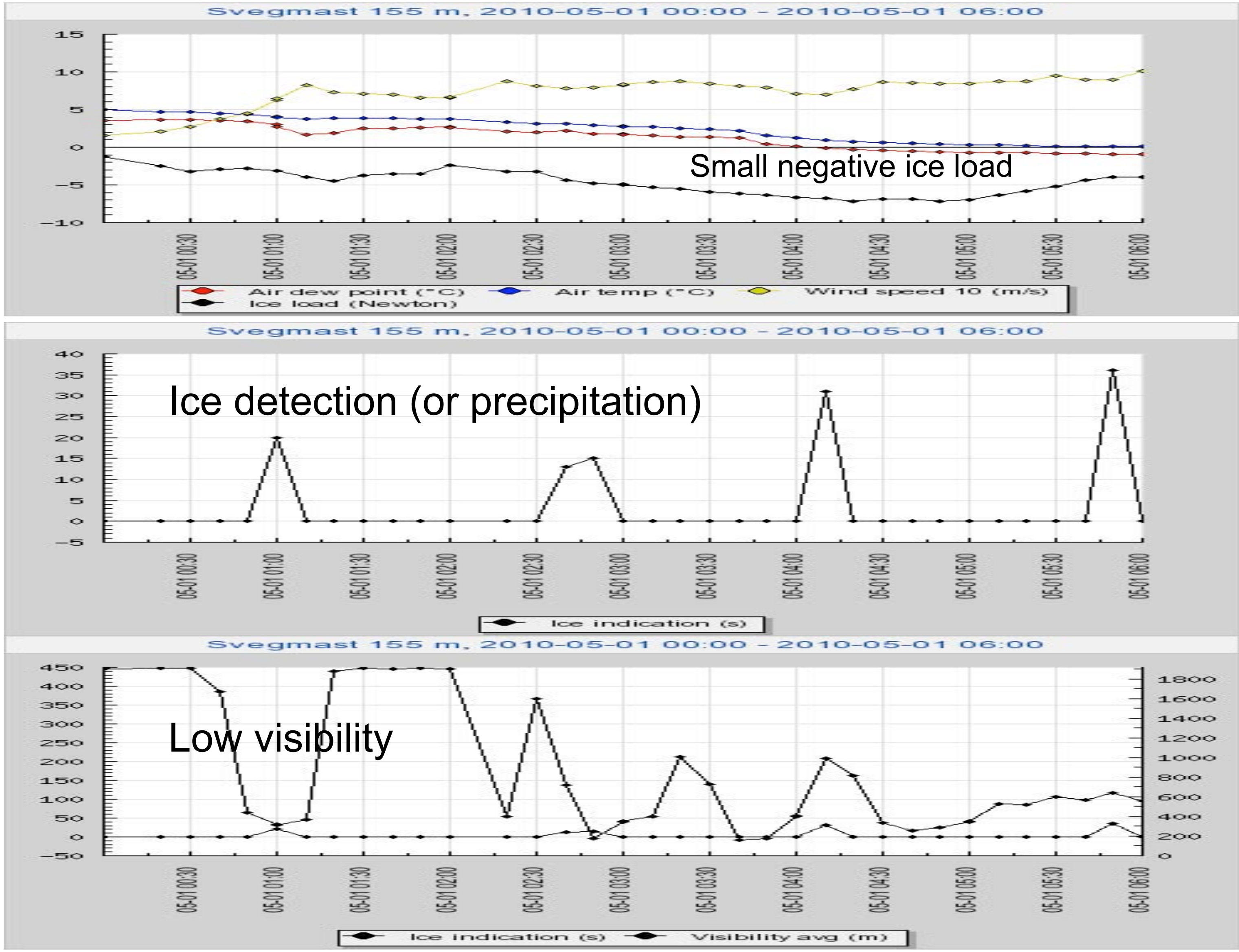
Examples of photos taken on March 25 after 21:00 in SVEG at h=70m & 155m



An icing period on May 1st 2010, 00:00-12:00, in SVEG at h=70 m



An icing period on May 1st 2010, 00:00-06:00, in SVEG at h=155 m



VINDKOMPANIET COMBITECH

Uljabuouda, anti-icing (10 WT), 2009 & 2010, **R&D: 3.5 MEuro**

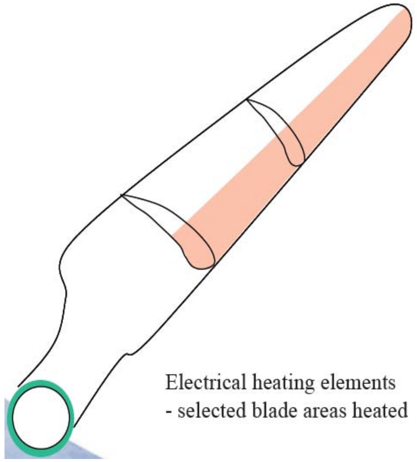
Anti-icing experiences from Uljabuouda

Description:

• Situated in the Lapland Sweden at a low mountain about 780 meters above sea level.

• Consists of 4, installed 2009 (6 to be installed 2010), 3 MW wind turbines with anti-icing system installed.

• Severe icing conditions at the site, several met mast failures due to high ice loads.



The anti-icing equipment consists of coal-fibre heating elements at the leading edge of the blade.

SKELLEFTEÅ kraft

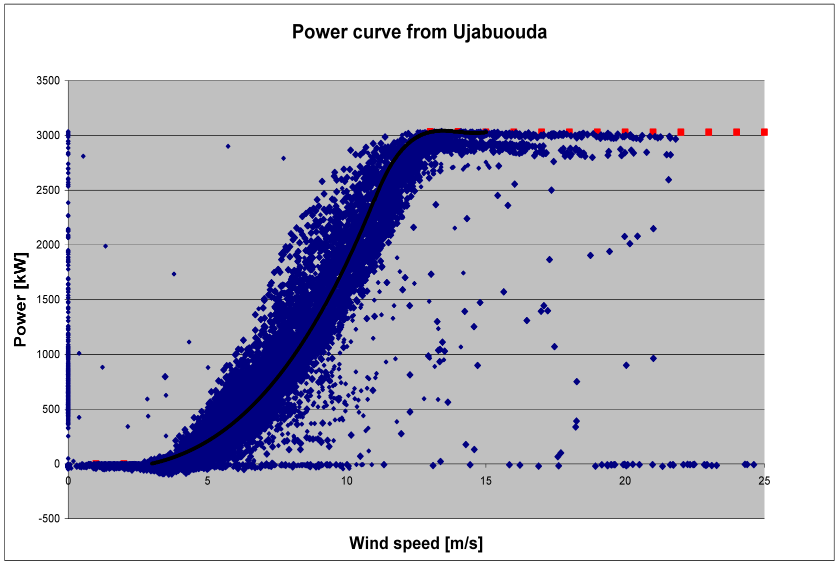
Anti-icing experiences from Uljabuouda

Preliminary production results with respect of ice accretion:

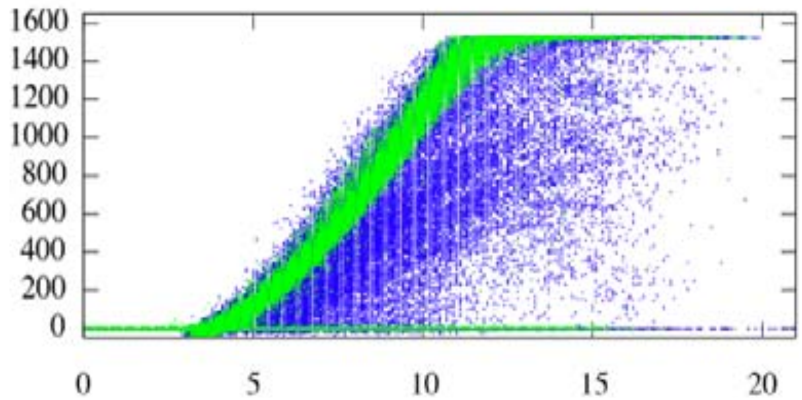
• The anti-icing system seems to **work well**, a preliminary estimation of the losses due to icing is **~5%** of the production during the winter months.

• Compare this to a wind park **without anti-icing** equipment, e.g. Aapua in Sweden (Göran Ronsten Elforsk report 09:59), where losses up to **~30%** has been reported.

Power curve from Uljabuouda.



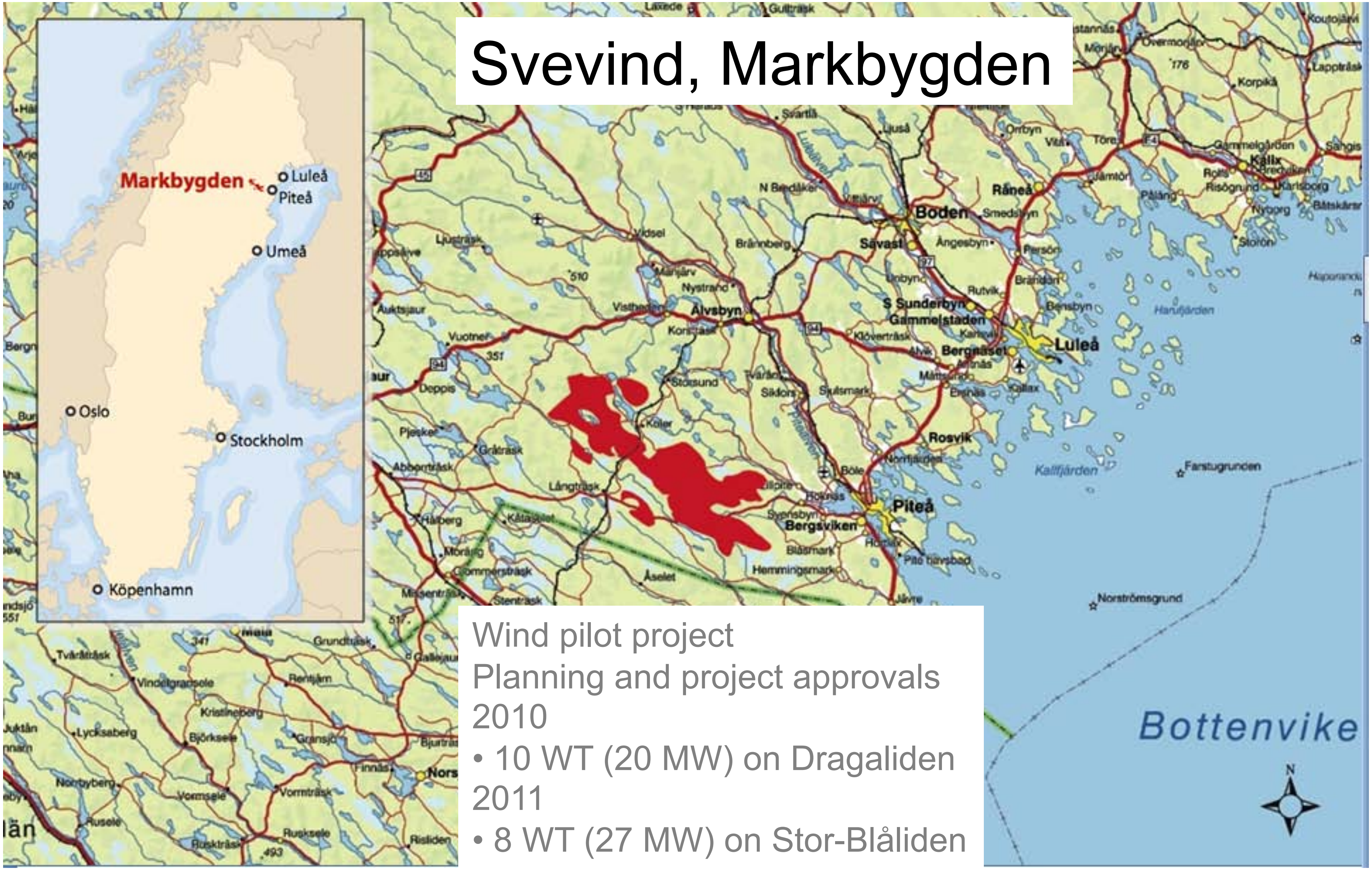
Power curve from Aapua.



Göran Ronsten, Elforsk report 09:59.

Svevind, Markbygden,
Aim: 1101 Enercon turbines, 8-12 TWh
Investment subsidy and R&D: 11.5 MEuro

Svevind, Markbygden



Wind pilot project

Planning and project approvals

2010

- 10 WT (20 MW) on Dragaliden

2011

- 8 WT (27 MW) on Stor-Blåliden

SVEVIND powered by nature

ENERCON ENERGY FOR THE WORLD

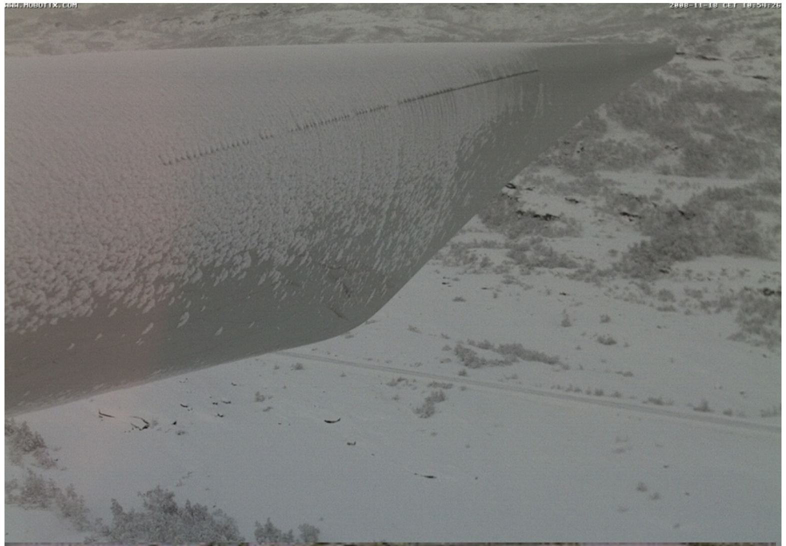
Storrun-Icing of WT 2009-, **R&D: 2.6 MEuro**

- Background
  - Significant icing conditions expected at Storrun
  - Causes reduction of production, increased loads and raises safety issues
  - DONG Energy is involved in R&D project in Norway
- Project description
  - Establish base line – Determine extent of icing problems
  - Calculate and validate estimates of production loss
  - Optimisation of start-stop algorithms
  - Testing of anti-icing coating
  - Model loads on structures
- Results
  - Improved adjustment for icing losses in production estimates
  - Reduced production loss due to start-stop hysteresis
  - Practical use of results from basic research
- Partners:
  - LM Glasfiber
  - Nordex
  - Possible coordination to other projects e.g. Uljabuouda and Narvik

DONG energy

NORDEX We've got the power.

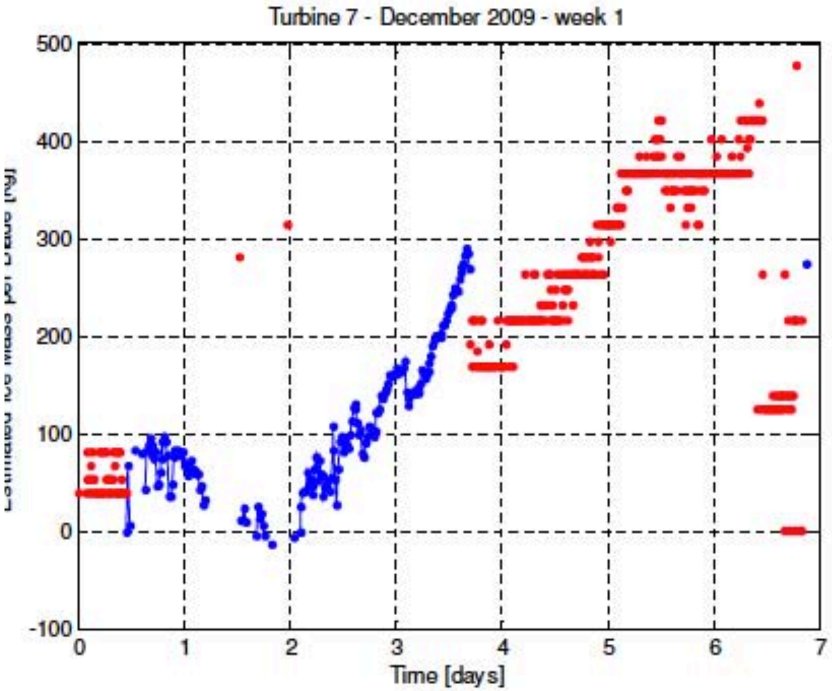
LM

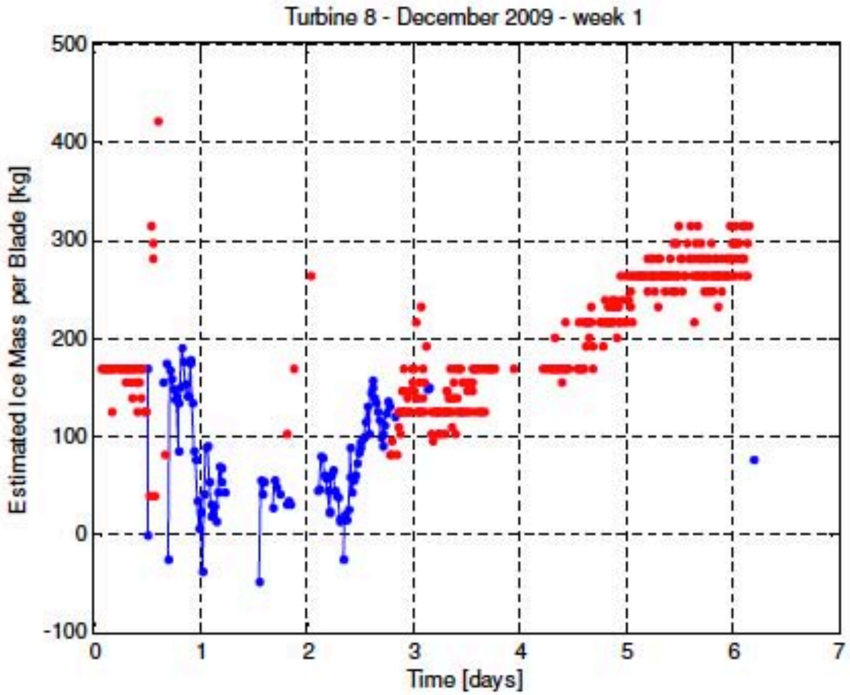


Preliminary results

Ice loads on blades measured by means of frequency analysis

- Significant periods of icing since end October
- Min. 5-10% total production loss – this year!





DONG energy

Havsnäs, 45 * 2 + 3 * 1.8 = 95.4 MW, **R&D: 2 MEuro**

nordisk vindkraft res borevind Vestas

HAVSNÄS – FÖRST AV DE STORA

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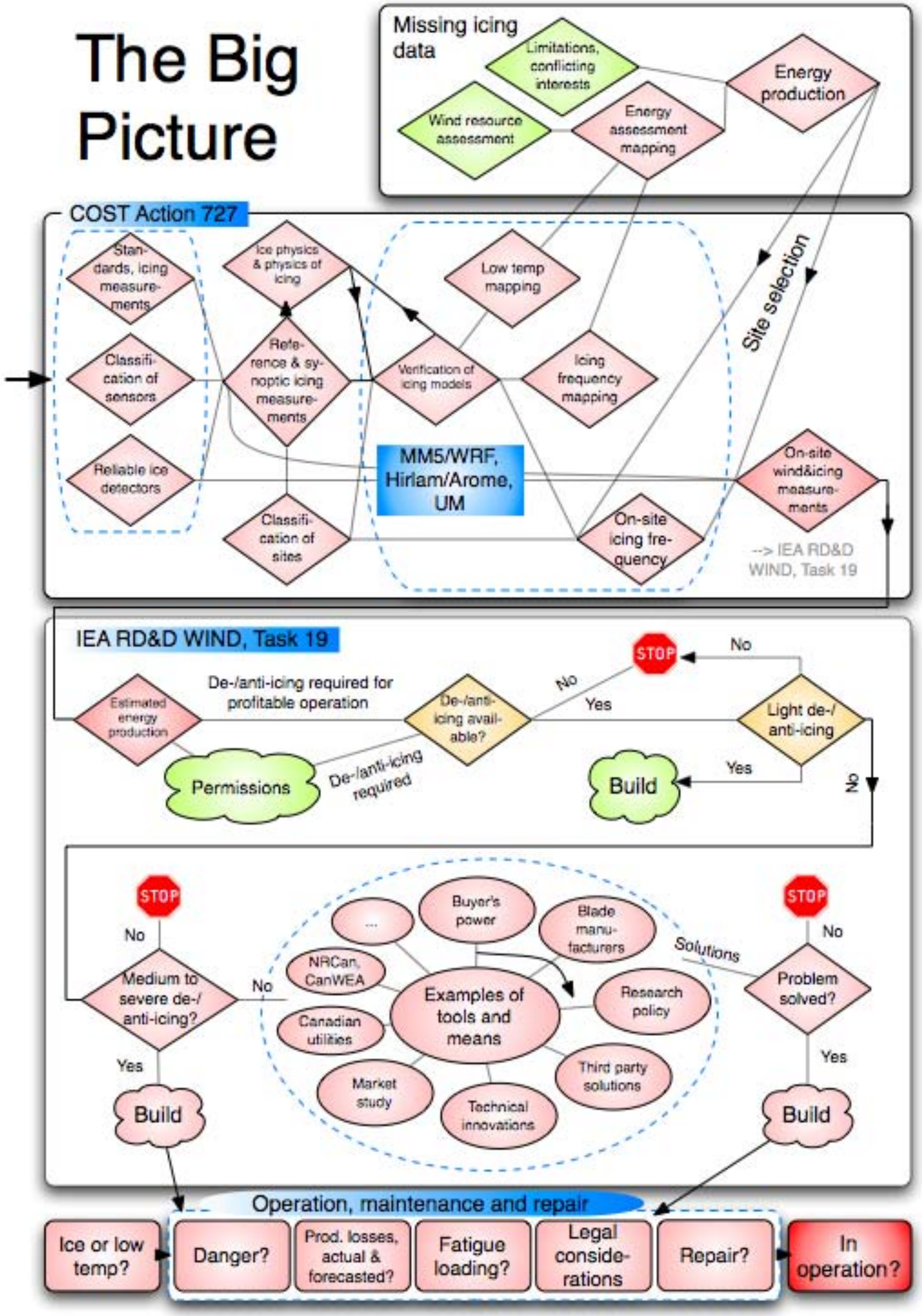
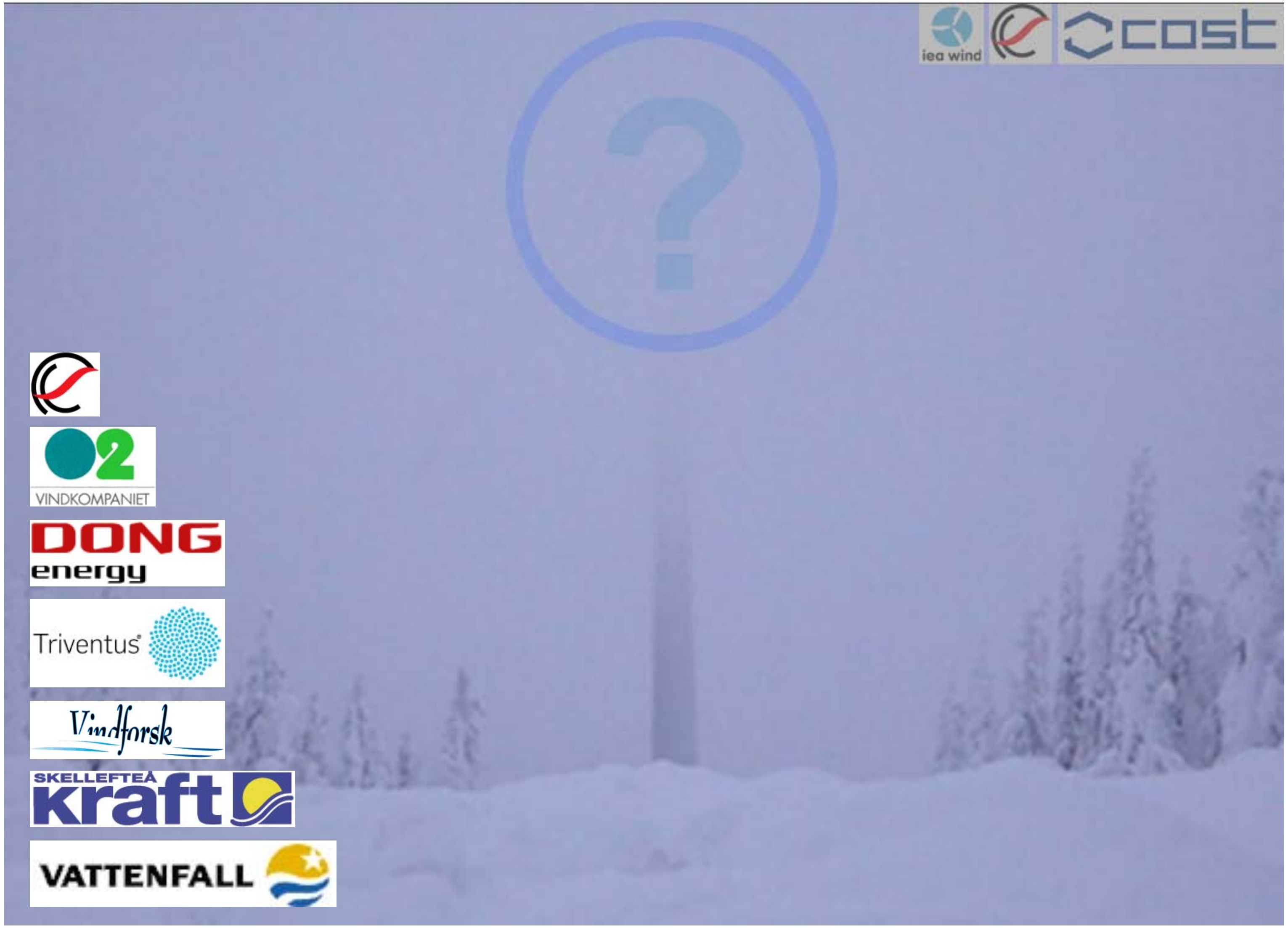
Conclusions with respect to icing

- **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



Thanks to the sponsors of IEA RD&D Wind, Task 19!



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Welcome to Winterwind 2011 Umeå, Sweden, Feb 9-10

http://winterwind2011.se

Winterwind2011

Wind energy in low temperature and icing conditions

- Programme
- Visitor registration
- Travel
- Accommodation
- Sponsorship opportunities
- Exhibition
- Proceedings
- Links
- Printable information
- Contact

Welcome to Winterwind 2011!

Winterwind 2011 is an international special-topic conference about wind power in low temperature and icing conditions. The conference will take place in Umeå, Sweden February 9-10.

This website is under construction. Please visit us later for updated information.

Subscribe to our newsletter to receive the latest updates

goranronsten@windren.se submit

Proceeding from Vintervind 2008, Winterwind 2008 and Vintervind 2010 are available at *http://vintervind.se* and *http://winterwind.se*

Svensk Vindkraft Förening