



Don't Look Back in Anger

A retrospective look on wind energy in Cold Climate

07.02.2018

René Cattin

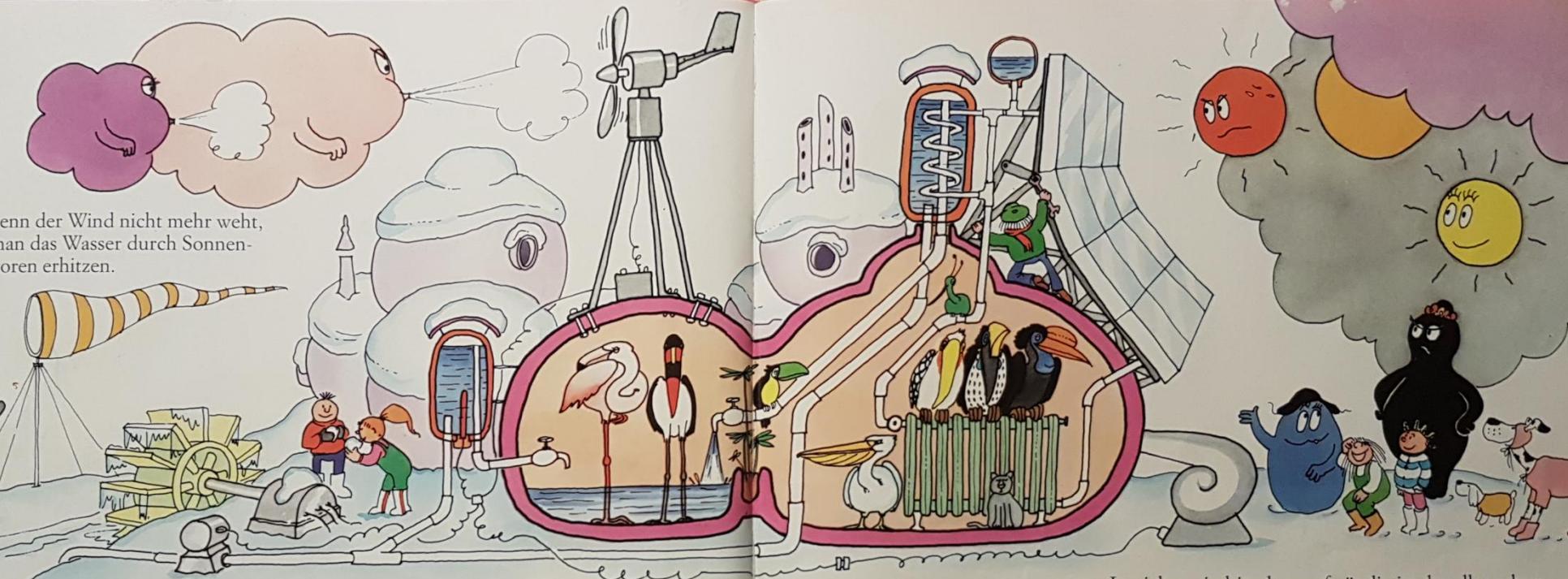
Winterwind 2018, Åre, Sweden

BARBAPAPA IM WINTER



atlantis

Wenn der Wind nicht mehr weht,
man das Wasser durch Sonnen-
oren erhitzen.



Ja, sicher, ein bisschen aufwändig ist das alles schon ...

Leider ist der Fluss am nächsten Morgen zugefroren;
aber der Wind weht und kann ein Windrad antreiben.



The Story of Wind Energy in Cold Climate

The early years (1990 to 2002)

Successful collaborations (2002 to 2011)

Commercial breakthrough (2011 to 2013)

Stadium rock (2013 to 2018)

The early years (1990 to 2002)

All ingredients were already there



The Cold Climate Soup

First Cold Climate photo?



Brain storming in Madrid; from left:
Markku Autti (Kemijoki Oy, FIN), *Esa Peltola* (VTT, FIN), *Paul Kenyon* (NRG Systems Inc., USA), *Henry Seifert* (DEWI, GER), *Georg Böhmeke* (Aerodyn GmbH, GER), *Bengt Tammelin* (FMI, FIN) and the taker of the photo *Shigeo Kimura* (KAIT, JPN).

EU projects



«**Icing of Wind Turbines**» 1993 – 1995

FMI, DEWI

«**Wind Energy in Cold Climate (WECO)**» 1996 – 1998

FMI, DEWI, Risoe, Garrad Hassan, VTT

«**New Icetools**» 2002 – 2004

FMI, DEWI, ISET, Einairgy, IMG, FOI, Teknikgruppen, VTT

«**Severe Weather Sensors I**» 1997 – 1998

FMI + MeteoSwiss

«**Severe Weather Sensors II**» 2000 – 2002

FMI+MeteoSwiss+MeteoFrance

Test sites (incl. de-icing!)



Pyhätunturi Finland



Grenchenberg, Switzerland

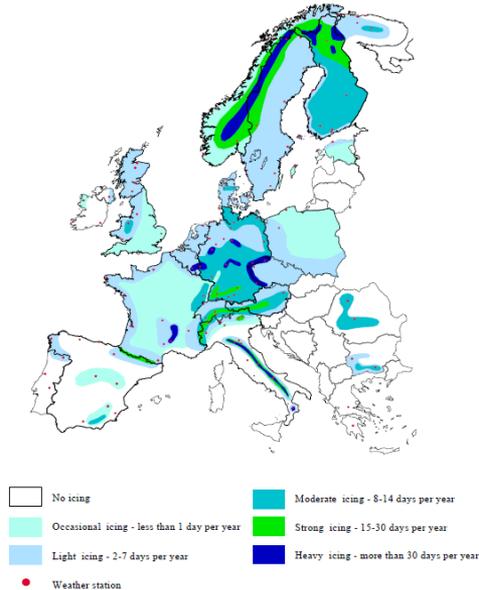
Sensor testing (with cameras)



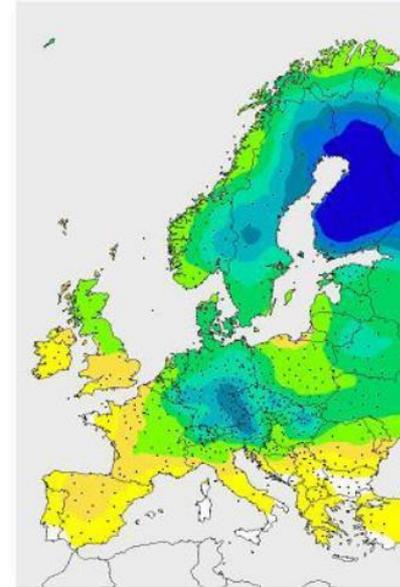
Luosto, Finland



Icing maps



First icing map of Europe
(WECO)



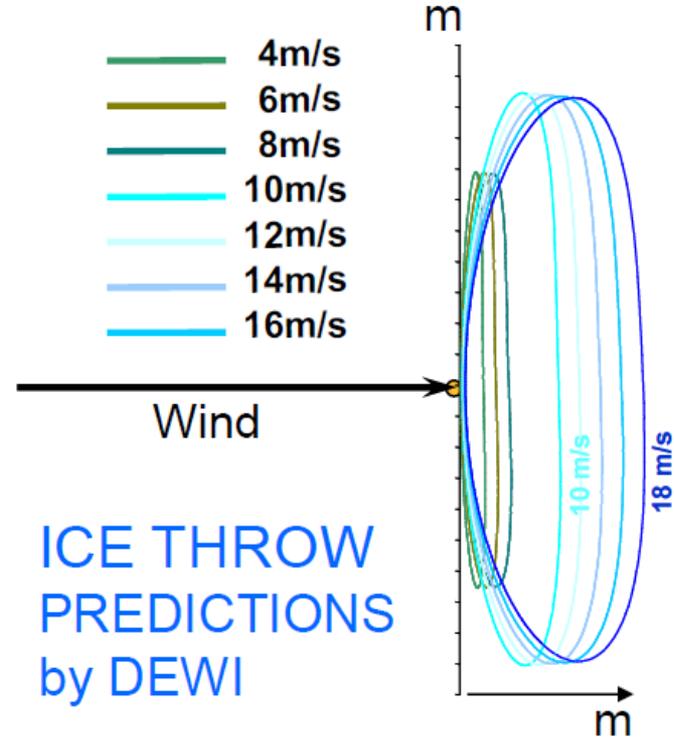
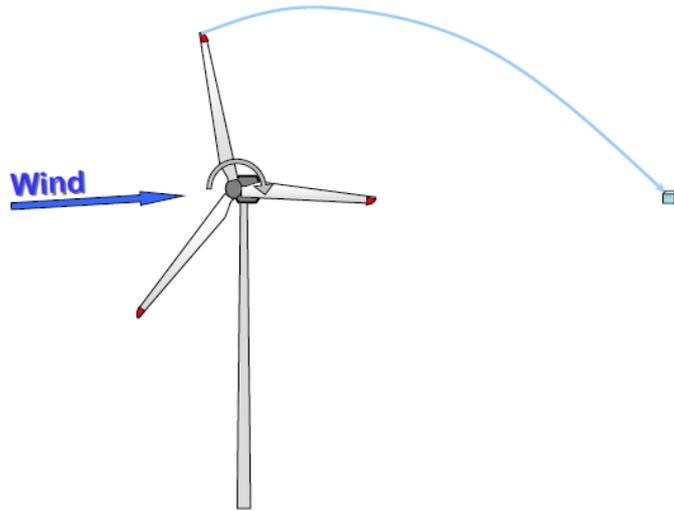
Mean Number of Icing Days

Temp.(200 m) < 0°C
Cloud height < 200 m
or Visibility < 300 m

Winter months 199901-200203,
all available stations

Second icing map of Europe
(New Ictools)

Ice throw simulations



Visions

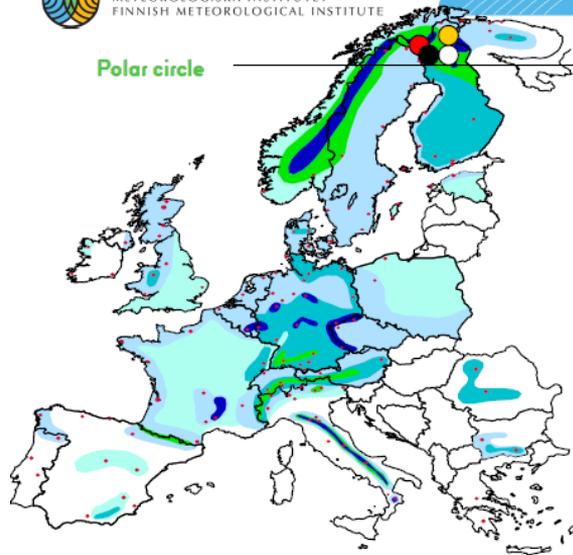
Die Zukunft ?



Die optimale WEA für kaltes Klima

Source: Henry Seifert

International Conferences



- BOREAS I at Hetta, 1992 ●
- BOREAS II at Pyhätunturi, 1994 ○
- BOREAS III at Saariselkä, 1994 ●
- BOREAS IV at Hetta, 1998 ●
- BOREAS V at Levi, 2000 ●
- BOREAS VI at Pyhätunturi, 2003 ○
- BOREAS VII at Saariselkä, 2005 ●

1992 about 36 participants
1998-2003 about 60-66 p.
2005: 61 participants

PROCEEDINGS:

- I-V as books
- VI-VII CD-ROM

with tens of good papers
and unique photos.



Boreas II



Boreas III



All ingredients were already there



The Cold Climate Soup

The outcome



No market, only few installations
Strong scientific and technical focus
An excellent foundation for the future

The «Cold Climate Way» was born

Let's solve this together!

Let's have some fun!

Proud to be different!

Successful collaborations (2002 to 2011)

The birth of IEA Wind Task 19



1st meeting
Risoe
17.-18.12.2001



Göran Ronsten, Lars Tallhaug, Per Lundsager
Markus Geissmann, Hannele Holtinen

The «Prison Meeting» Umeå 2011



René Cattin, Timo Laakso

Göran Ronsten, Lars Tallhaug

Andi Krenn, Michael Durstewitz, Tomas Wallenius

Miro Hulkkonen, Ian Baring Gould

Tang Jian Hui, Adriána Hudecz, Antoine Lacroix

Oslo 2016



Rolv Bredesen
Tse Kim
Matt Gagnon
PJ Jordaens
Jenny Longworth
Carla Ribeiro



Øyvind Byrkjedal
Göran Ronsten
Andreas Krenn
René Cattin
Dag Haaheim
Ville Lehtomäki

The secret meaning of «IEA»?

International Eating Association



Another networking platform



COST Action 727

«Measuring and Forecasting Atmospheric Icing on Structures»

2005 to 2009, 13 countries

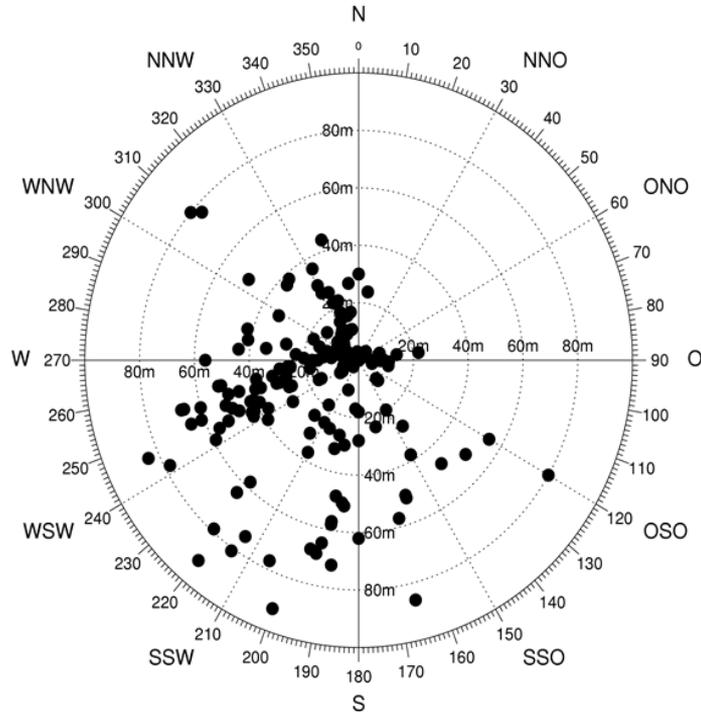
Only networking is funded, no R&D money!

A «label» to get national funding

Alpine Test Site Gütsch

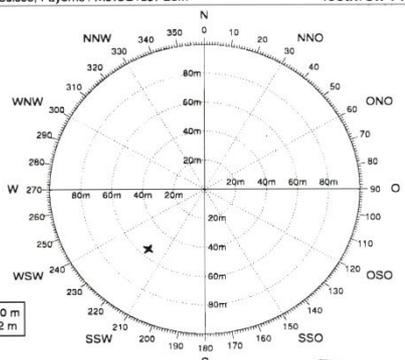


Ice throw study



Alpine Test Site Gutsch:
Meteorological measurements and wind turbine performance analysis

CBST 727 Measuring and forecasting atmospheric icing on structure
 Météo Suisse, Payerne / METEOTEST Bern **Icethrow Protocol**



1 cm = 20 m
 1 mm = 2 m

WKA: ENERCON E-40 800 kW Gutsch Anlage in Betrieb? Ja Nein
 Datum, Zeit des Fundes: 30.04.13 13:44 Name Beobachter: g R
 Filenamen des Fotos (Foto inkl. Referenz, z.B. Taschenmesser): 0402

Distanz zur WKA [m]: 58 Winkel zur WKA [Grad]: 43 Gewicht [g]: 10
 Grösse (LxBxH) [cm]: 8x4x0,5 Art des Eises: Reuhreif klares Eis

Wettercharakter: Bewölkung 2 / Achtel innerhalb der Wolken
 Schneefall Regen Windrichtung: SO

Sonstige Bemerkungen (andere Vereisungseffekte):

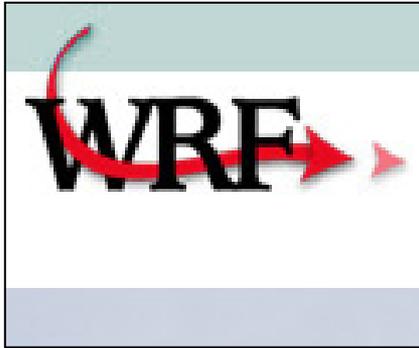
April 2007

René
Cattin

Bjorn Egil
Nygaard



Icing simulations with WRF



Weather Research
and Forecast Model
(Thompson Microphysics)

10.1098/rsta.2000.0690

 THE ROYAL SOCIETY

Models for the growth of rime, glaze,
icicles and wet snow on structures

BY LASSE MAKKONEN

*VTT Building Technology, Technical Research Centre of Finland (VTT),
Box 18071, 02044 VTT, Finland*

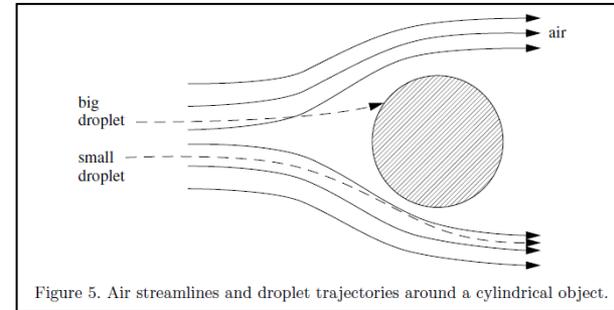
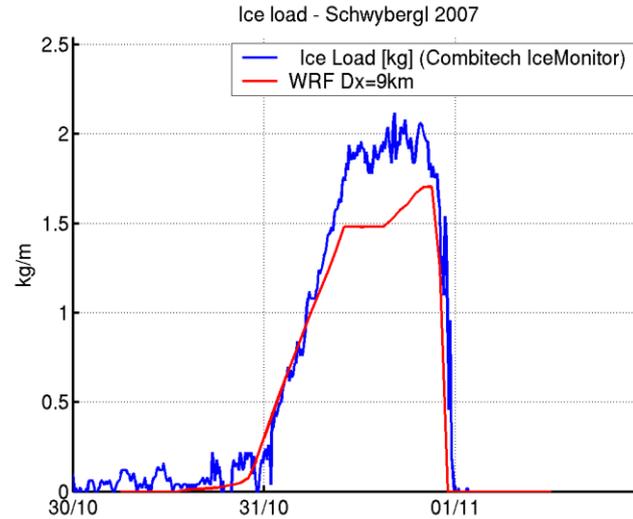
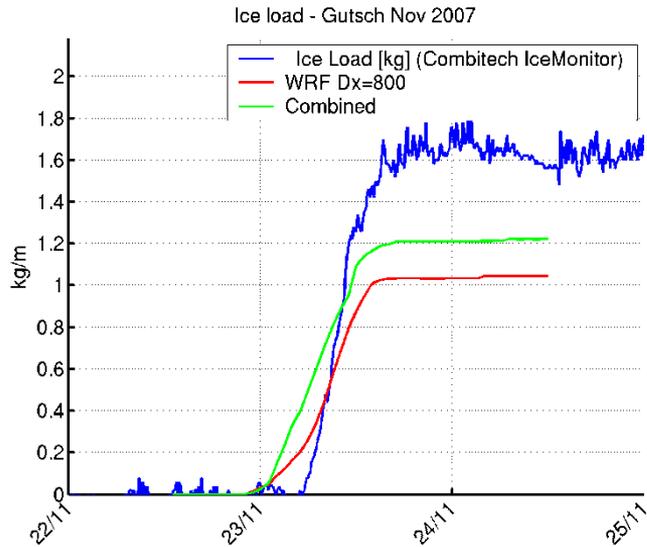


Figure 5. Air streamlines and droplet trajectories around a cylindrical object.

Makkonen
Icing model

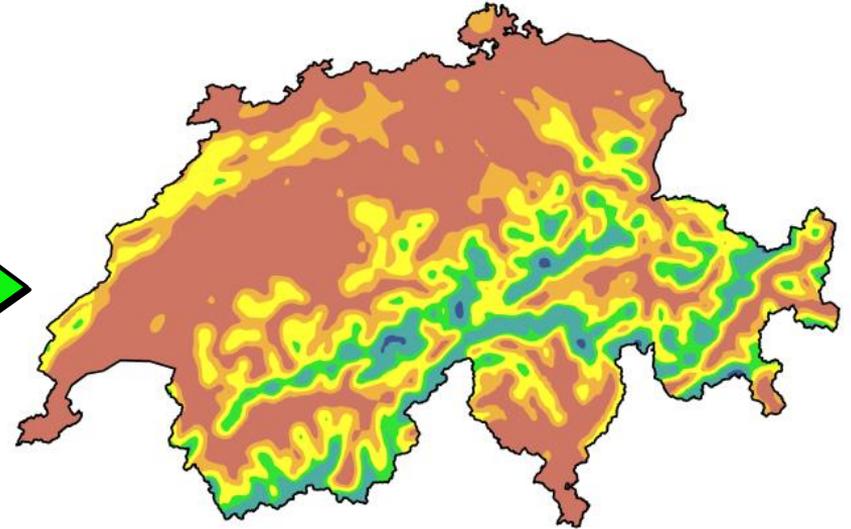
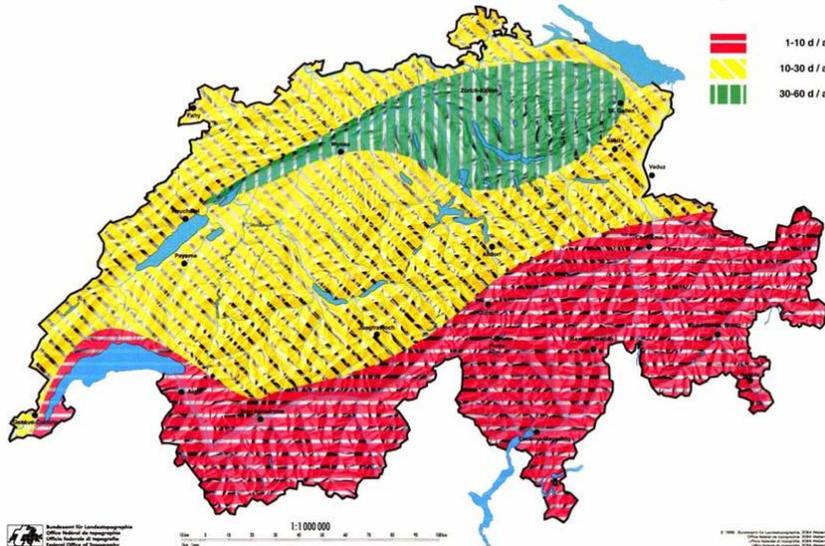
Proof of concept



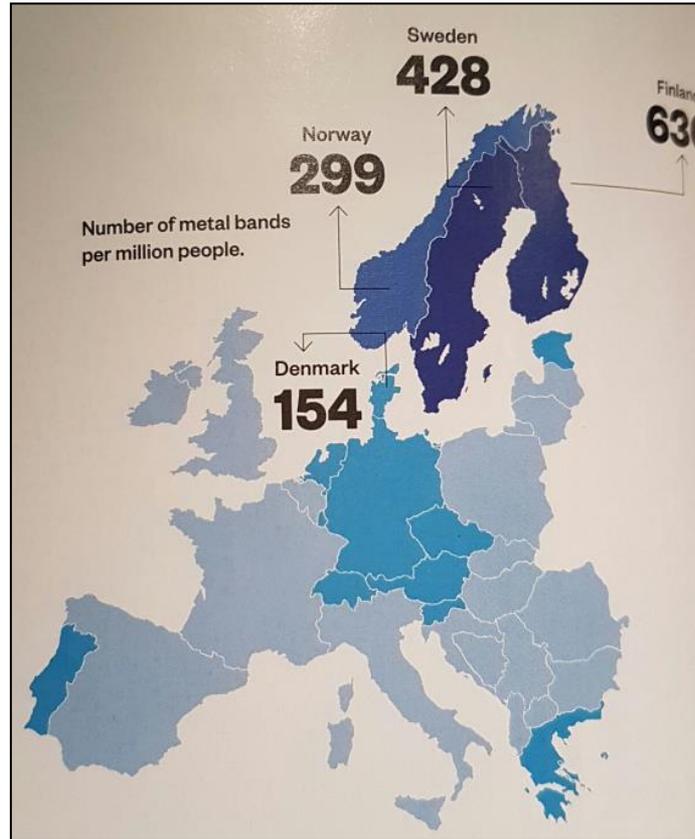
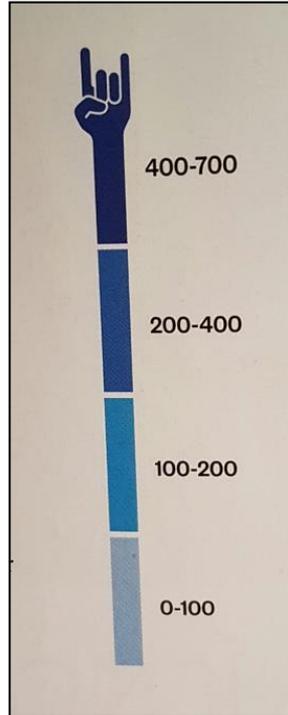
Similar results for other countries in COST 727!

Boost for icing simulations

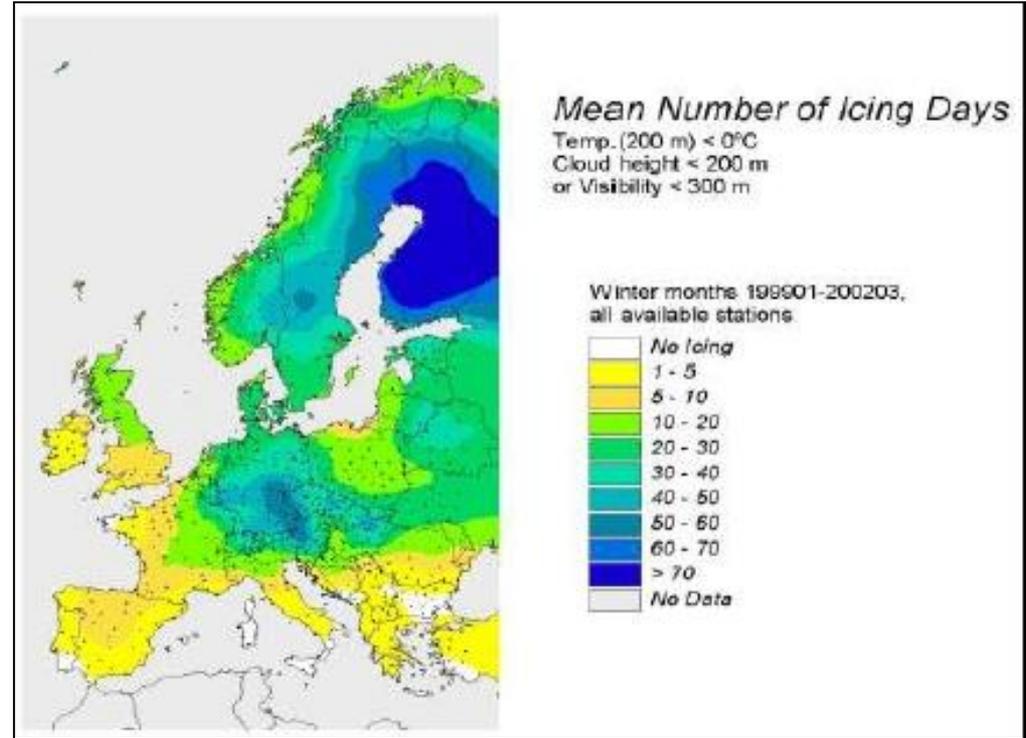
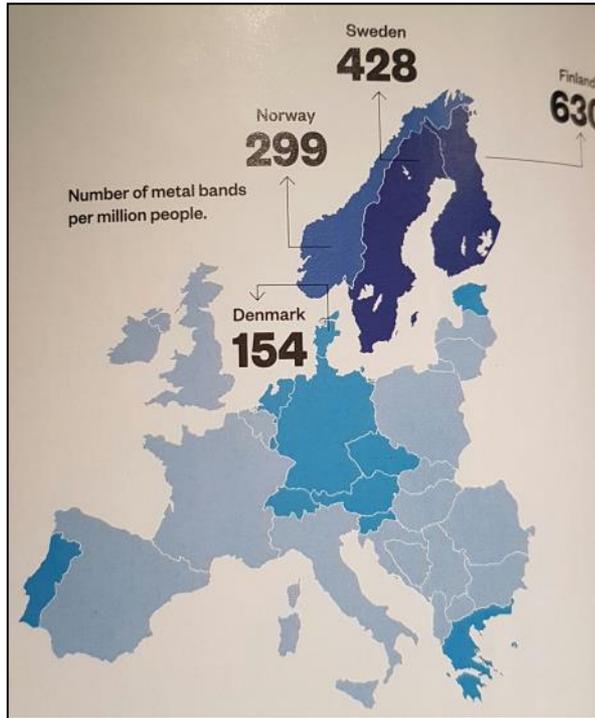
Icing Map Switzerland: 1'000 m.a.S.



A propos icing maps...



A propos icing maps...



A strong correlation between icing and metal bands!

Winterwind 2008 in Norrköping



Winterwind 2008

Wind energy in low temperature and icing conditions
December 9-10 in Norrköping, Sweden

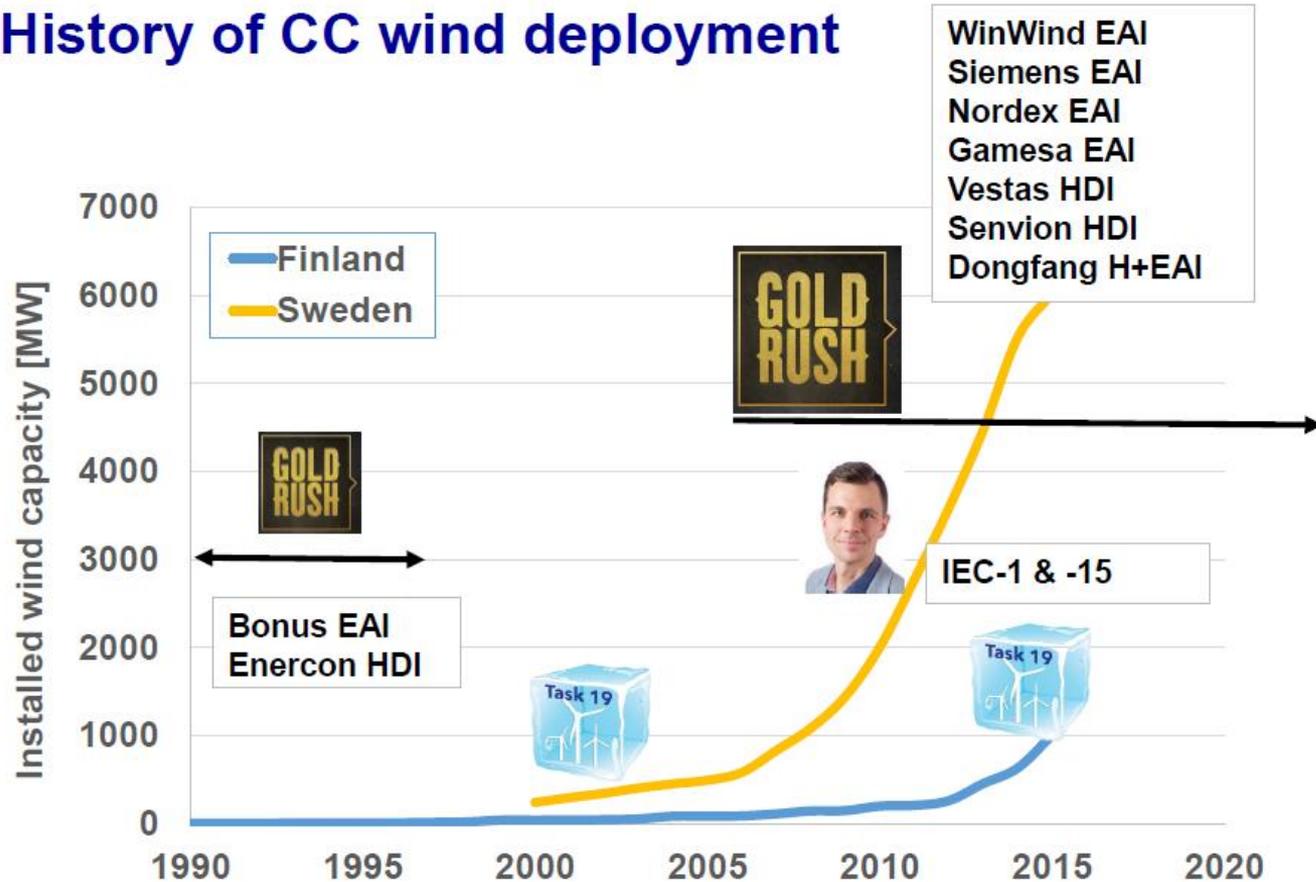
Partly also thanks to COST Action 727!

Collaboration a as key for success



Commercial breakthrough (2011 to 2013)

History of CC wind deployment



Recommended practices 2011



iea wind

EXPERT GROUP STUDY ON
RECOMMENDED PRACTICES

13. WIND ENERGY PROJECTS IN COLD CLIMATES

1. EDITION 2011

*Submitted to the Executive Committee
of the International Energy Agency Programme
for
Research, Development and Deployment on
Wind Energy Conversion Systems*

May 22, 2012

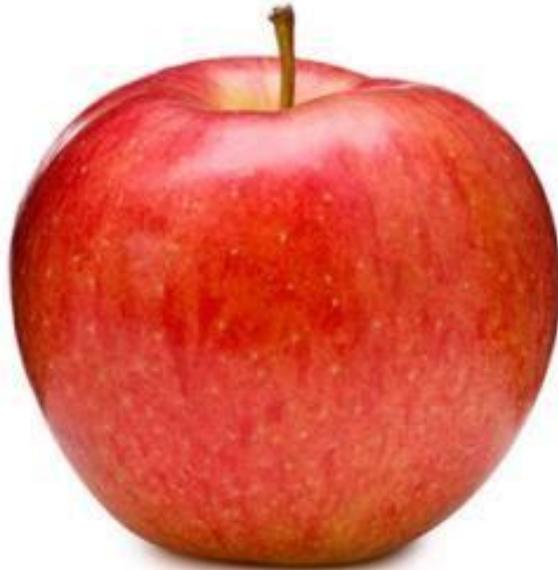
EXPERT GROUP STUDY ON
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13. WIND ENERGY PROJECTS IN COLD CLIMATES
1. EDITION 2011



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Esa Peltola, Technical Research Centre of Finland, Finland
Göran Ronsten, WindREN AB, Sweden
Lars Tallhaug, Kjeller Vindteknikk, Norway
Tomas Wallenius, Technical Research Centre of Finland, Finland

Photo: Three Vestas V27 wind turbines installed on St Paul Island, Alaska, as part of a wind-diesel power system. Photo Credit: TDX Power, USA
2 IEA Wind Recommended Practice 13: Wind Energy in Cold Climates

The «apple and pear problem»



Cold Climate «Phrasebook»



Cold Climate [kəʊld 'klaɪmɪt]. Regions where icing events or periods with temperatures below the operational limits of standard wind turbines occur.

Icing Climate ['aɪsɪŋ 'klaɪmɪt]. Areas with icing events.

Incubation Time [ˌɪnkjuː'beɪʃən taɪm]. Delay between the start of meteorological and the start of instrumental icing (dependant on the surface and the temperature of the structure).

Instrumental Icing [ˌɪnstɹu'mentl 'aɪsɪŋ]. Period during which the ice remains at a structure and/or an instrument or a wind turbine is disturbed by ice.

Low Temperature Climate [ləʊ 'tɛmpɹɪtʃə 'klaɪmɪt]. Areas where temperatures below the operational limits of standard wind turbines occur.

Meteorological Icing [ˌmɪ:tjərə'lɒdʒɪkəl 'aɪsɪŋ]. Period during which the meteorological conditions for ice accretion are favourable (active ice formation).

Recovery Time [rɪ'kʌvəri taɪm]. Delay between the end of meteorological and the end of instrumental icing (period during which the ice remains but is not actively formed).

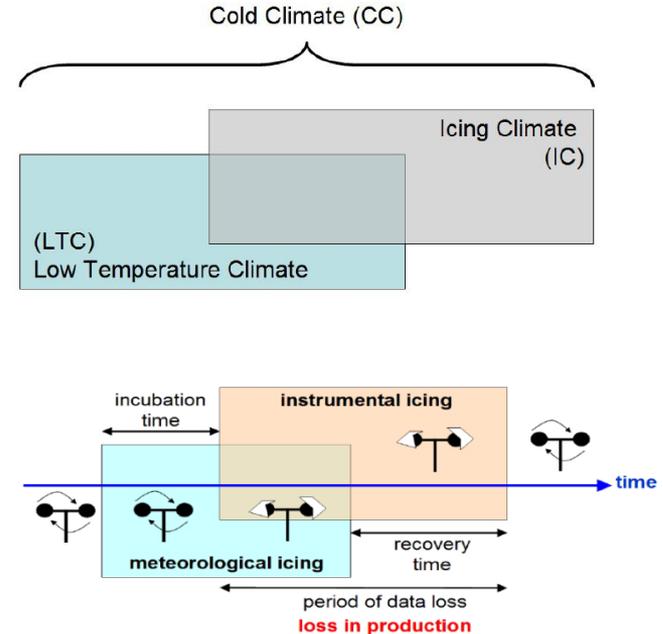


Figure 2-2: Definition of Meteorological Icing and Instrumental Icing.

Site Classification



IEA Ice class	Meteorological icing	Instrumental icing	Production loss
	% of year	% of year	% of annual production
5	>10	>20	> 20
4	5-10	10-30	10-25
3	3-5	6-15	3-12
2	0.5-3	1-9	0.5-5
1	0-0.5	<1.5	0 - 0.5

Market Study 2013



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Market Study 2013

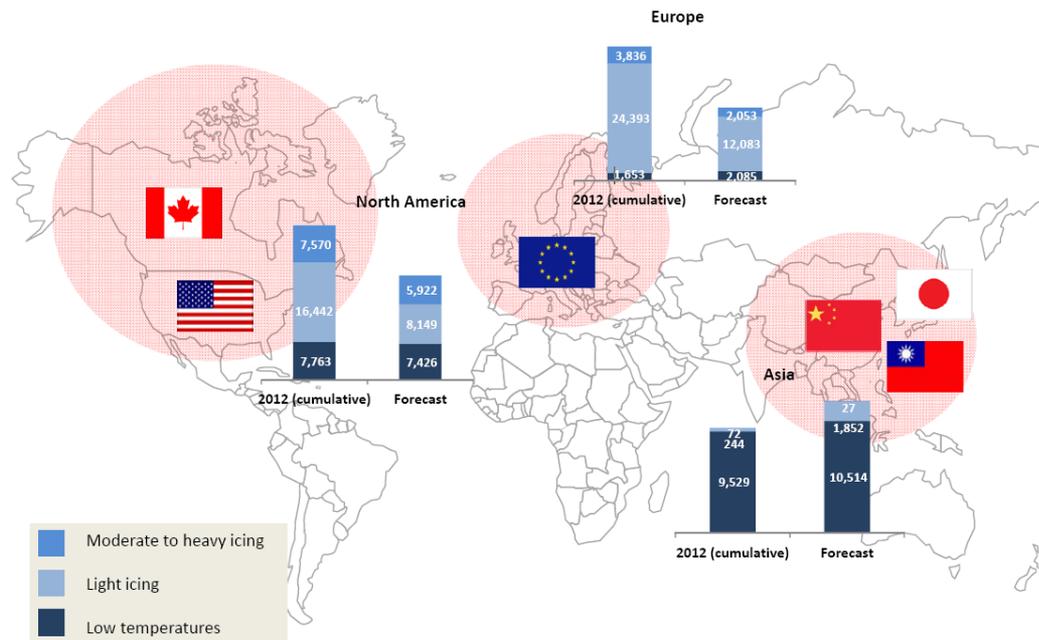


Cumulative installed capacity by end of 2012 [MW]			Forecasted capacity 2013-17 [MW]		
Low temperature	Light icing: safety risk, some economic risk	Moderate to heavy icing: economic and safety risk	Low temperature	Light icing: safety risk, some economic risk	Moderate to heavy icing: economic and safety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

Market Study 2013



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



For full country/regional breakdown see table 5.

There is a market!



Stadium Rock (2013 to 2018)

WindEurope 2016



WEDNESDAY, 28 SEPTEMBER 2016

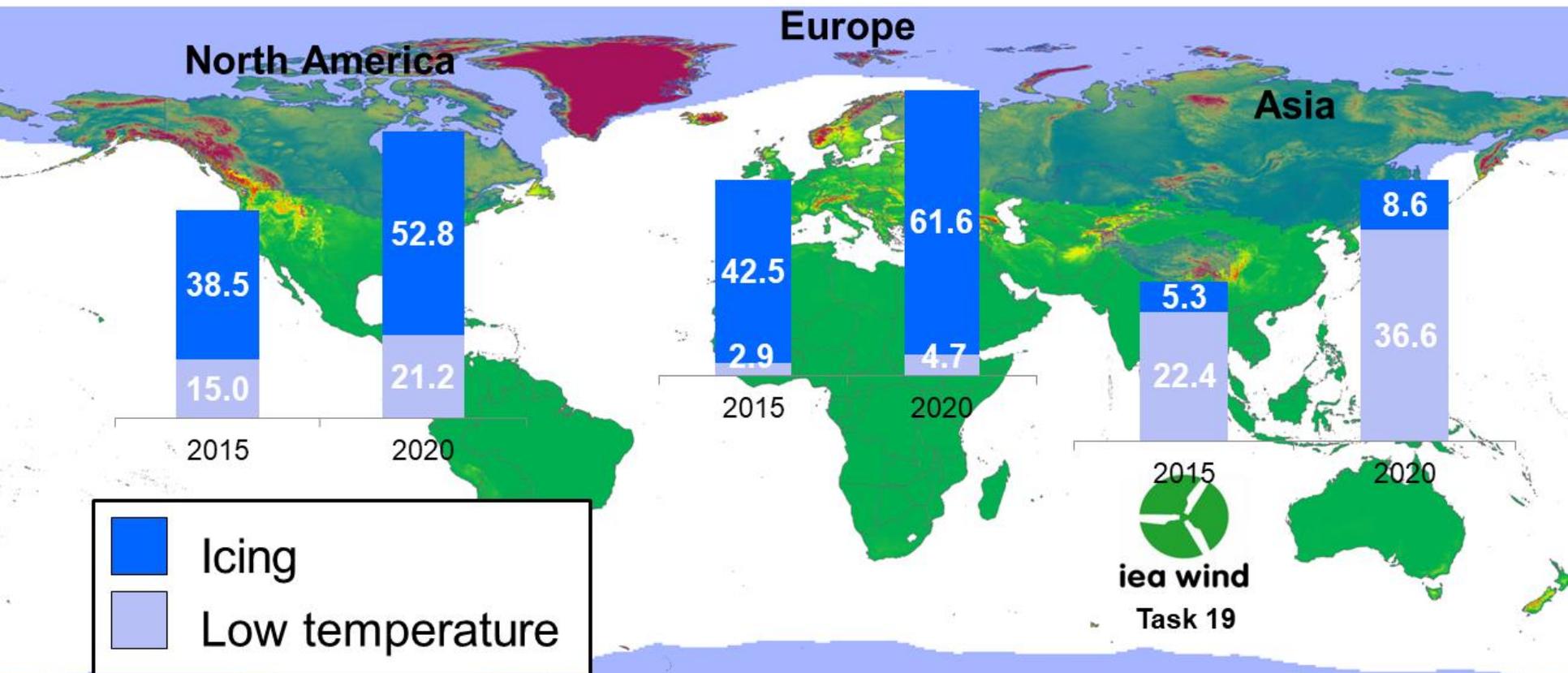
Congress Centre Hamburg CCH

09:00 10:30	<p>Wind and the electrification of transport and heating</p> <p>Room: Hall G1</p>	<p>Cold climate issues in resource assessment</p> <p>Room: Hall G2</p>	<p>Corporate PPAs: the new business model?</p> <p>Room: Hall F</p>	<p>Wind industry safety culture - from back office to front end operations</p> <p>Power Systems</p> <p>Room: Hall E</p>	<p>Making T&D networks fit for wind integration</p> <p>Room: Hall D</p>	<p>From academic research to industrial applications - linking people, projects and ideas</p> <p>Room: C 2.2</p>
10:30 11:30	Coffee break (sponsored by ABB) & poster viewing					
11:30 13:00	<p>Doing business in ... North Africa</p> <p>Room: Hall G1</p>	<p>Turbines operating in low temperatures</p> <p>Room: Hall G2</p>	<p>All in this together: how wind needs regional cooperation</p> <p>Room: Hall F</p>	<p>Innovation in safety</p> <p>Room: Hall E</p>	<p>Offshore wind power: a mature asset class</p> <p>Room: Hall D</p>	<p>Offshore wind farm lifecycle and supply chain: assessing local impacts</p> <p>Room: C 2.2</p>

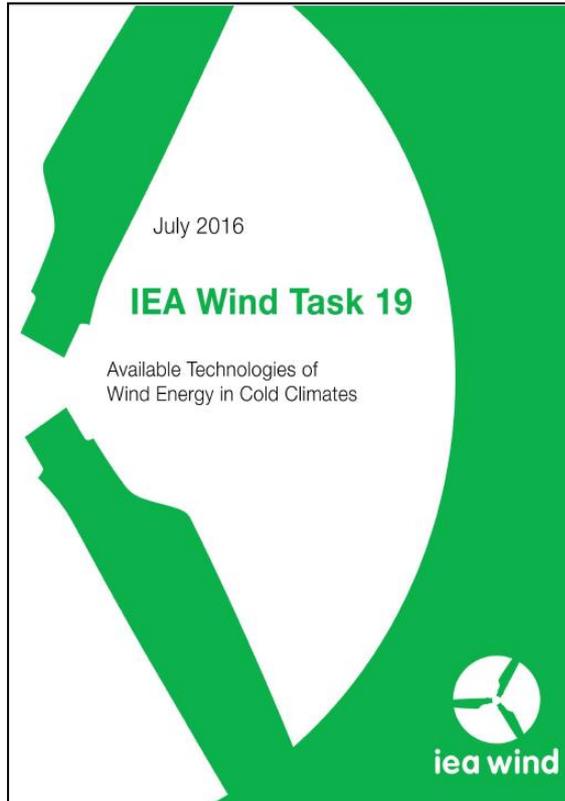
A dedicated test site for CC



Updated market study 2016



Available technology report 2016



120 pages of
available technologies !!

10 years Winterwind





Five wishes for the future

Keep the spirit

Spread the word

Collaborate and share

Go digital -> Cold Climate 4.0

Launch large EU-scale R&D projects

Don't Look Back in Anger

but

Keep on Rocking in Cold Climate!



Meteotest
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