



Open Datasets from Cold Climate Wind Farms in Finland

Winterwind 2018, Åre Sweden

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Content

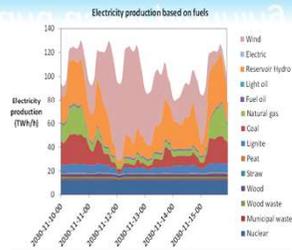
- Project
- WIceAtlas description
- Olos description & data
- Pori description & data
- WIceAtlas vs. site comparison
- How to access data

VTT Services for wind power value chain

30 % consultancy
70 % jointly funded

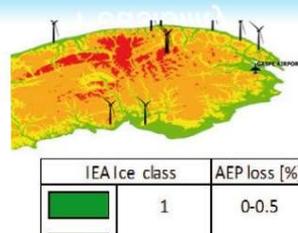
~40 person years/year

Power system design and asset planning



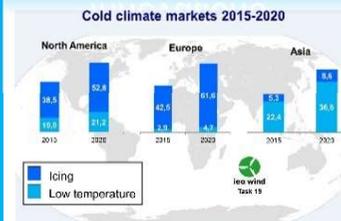
- Value of wind power generation
- Electricity market impacts
- Capacity adequacy
- Grid electricity planning
- IEA and EERA activities

Investment Feasibility



- Wind Power Icing Atlas (WIceAtlas)
- Grid Code Compliance
- Noise Assessment Methodology
- Radar, TV and communications interference

Technology and Innovations



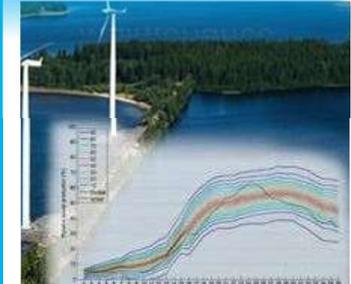
- Technologies for Cold Climates
- Ice detection systems
- IEC standards, IEA & EERA activities
- Drivetrain solutions
- Technology and Markets Foresight

Construction and Installation



- Sea ice loads
- Off- and onshore foundation measurements and design

Operation and Maintenance



- Production forecasting methods
- Smart decision-making for wind turbine O&M

International customers throughout the value chain

Related networks

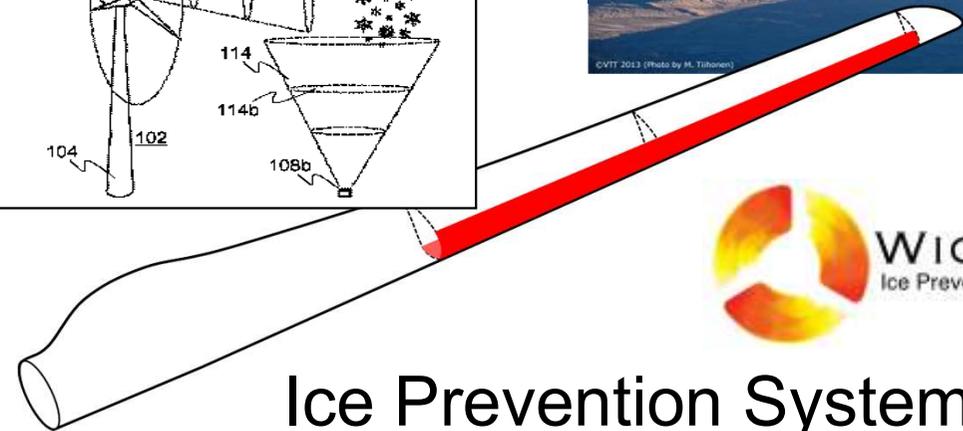
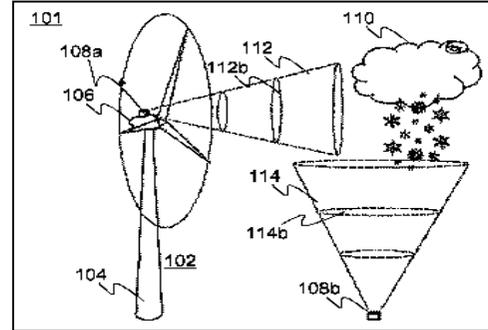


VTT Cold Climate Wind Power



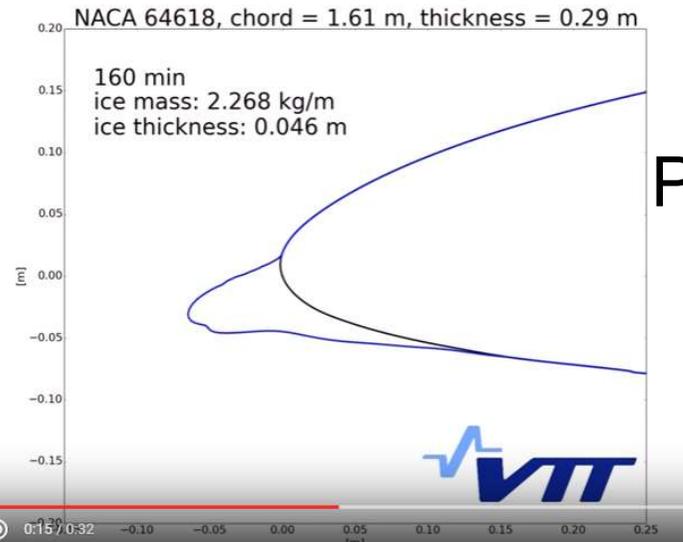
Test site Olos

Patents



Ice Prevention System Commercial spin-off

Ice accretion theory 1990s ->



Wind Power in Cold Climates

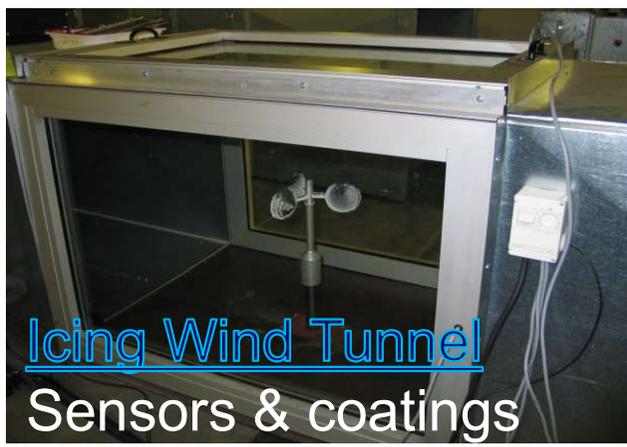
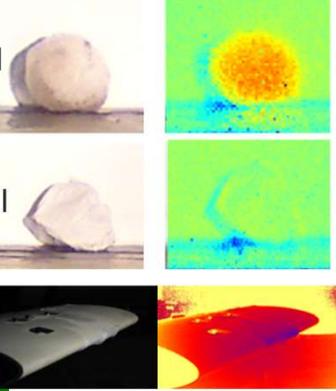
Task 19



Sea ice

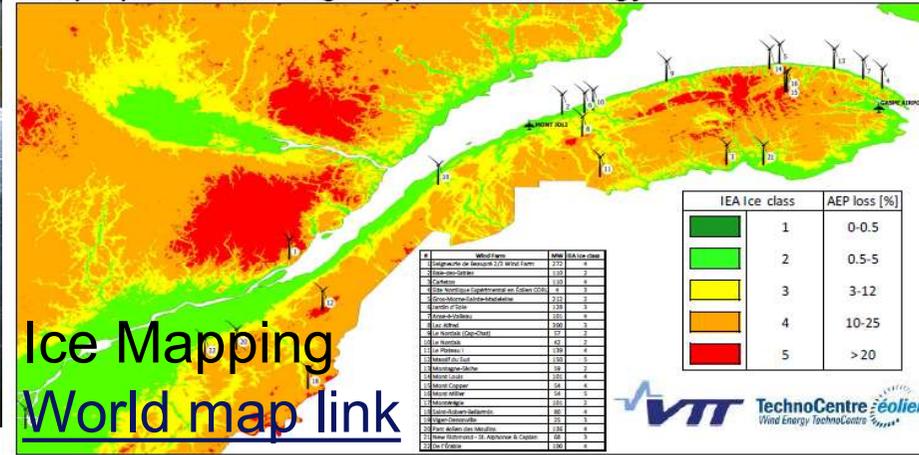


Ice imaging

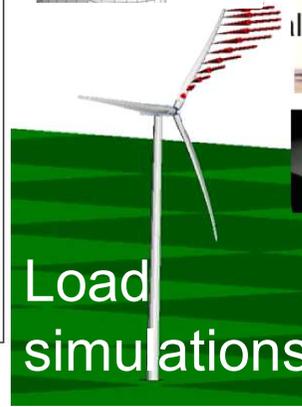


Icing Wind Tunnel
Sensors & coatings

Gaspé peninsula icing map for wind energy



Ice Mapping
World map link



Load simulations

05/02/2018

vttresearch.com/windpower

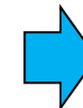
Project

H2020 IRPWIND project – 2nd Call for Joint Experiments

- Experiments results as Open Data
- Data published from 2 sites:
 - Olos in Northern Finland, a site with severe icing and complex terrain, **open for everyone**
 - Pori on the western coast, a site with less icing and terrain complexity, **only for EERA JP Wind members!**
- Longer-term time series on icing conditions on the same sites from the global WIceAtlas data

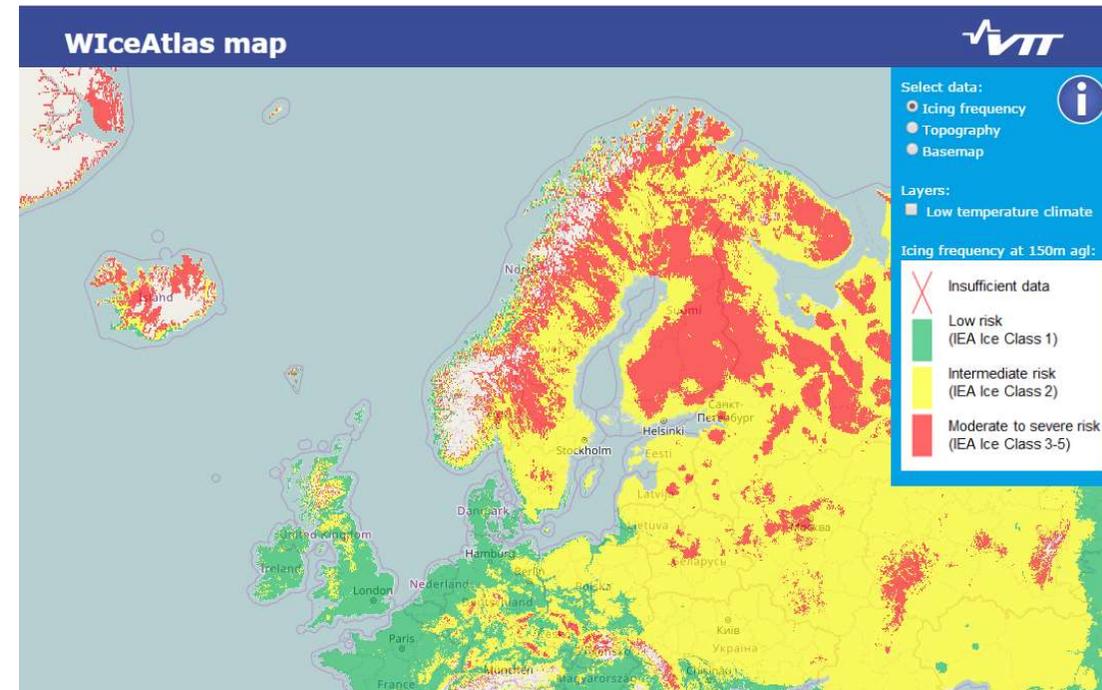
EERA JP Wind members:

Barcelona Super Computing center (ES)
BERA (BE)
CENER (ES)
Chalmers University (SE)
CIEMAT (ES)
CNR (IT)
Cranfield University (UK)
CRES(GR)
CTC (ES)
DHI (DK)
DLR (DE)
DTU Wind Energy (DK)
ECN (NL)
FhG IWES (DE)
Forwind/Univ. of OldenburG (DE) Forwind/Univ. of Bremen (DE)
Forwind/Univ. of Hannover (DE)
IEn (PL)
IFE (NO)
IREC (ES)
KTH (SE)
LNEG/INETI (PT)
NAREC UK
NTNU (NO)
MARINTEK (NO)
SINTEF (NO)
SINTEF MC (NO)
Technical University of Delft (NL)
Tubitak (TR)
University College of Dublin (IR)
University of Aalborg (DK)
University of Porto (PT)
University of Strathclyde (UK)
VTT (FIN)
WMC (NL)
CIRCE (ES)
CMR (NO)
IK4 (ES)
RISE (SE)
RSE (IT)
RWTH University Aachen
TECNALIA (ES)
TUM München
University of Athens (GR)
University of Bergen (NO)
University of Stavanger (NO)
University of Stuttgart (DE)
University of Uppsala (SE)
Politecnico di Milano (IT)
Middle East Technical University – Center for Wind Energy (TR)



WIceAtlas, description

- WIceAtlas is based on cloud base height measurements
- Data from 4500 meteorological stations, >20 yr/station
- Temperature from MERRA
- Criteria for icing: $CBH \leq 150$ m and $T < 0$ (**In-cloud icing only!**)

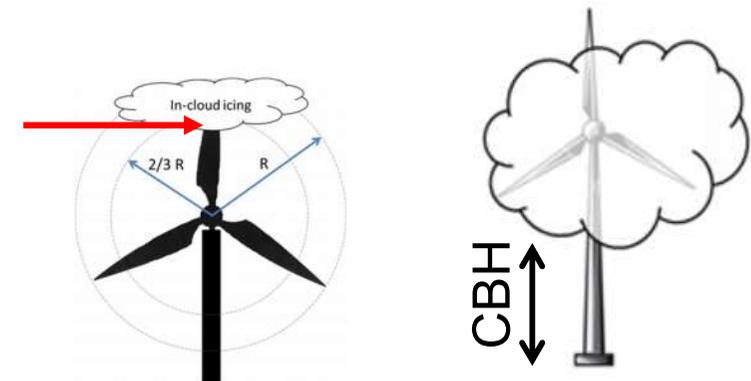


Data from closest met station

- monthly time series, $HH + 2/3 R$ elevation
- meteorological icing and data availability.

Olos: 1995-2005

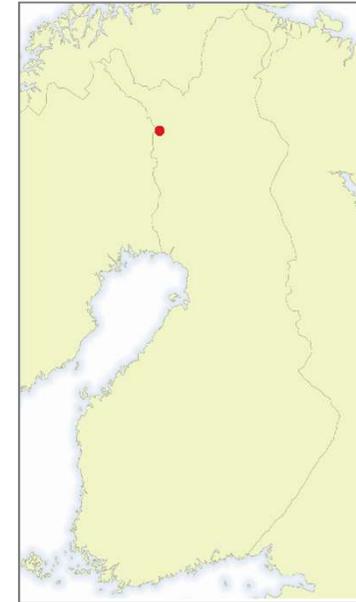
Pori: 1979-2014



Source: IEA Wind Recommended Practices 13. Wind energy projects in cold climates

Olos

- Measurements since 1999, data published 2000-2005
- 500 m a.s.l.
- Five 600 kW Bonus MK IV turbines with ice protection system
- 40 m met mast
- **IEA ice class 4**



IEA Ice class	Meteorological icing	Instrumental icing	Icing loss
	% of year	% of year	% of gross 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

Source: IEA Wind Recommended Practices 13. Wind energy projects in cold climates



Olos, available signals

- 10 min ave, max, min, std or turbulence intensity

Description	Location	Manufacturer and model
Wind speed, heated	Mast 38.8m	Vaisala WAA 252
Wind direction, heated	Mast 38.8m	Vaisala WAV 252
Temperature	Mast 38.8m	PT-100
Air pressure	Measurement hut	Vaisala PTB110
Power	Turbine 1	Mitrix Electrix EDPQL 755, one phase only
Power	Turbine 2	Indirect measurement. Calculated from wind farm power
Power	Turbine 3	Mitrix Electrix EDPQL 755, all 3 phases
Power	Turbine 4	Mitrix Electrix EDPQL 755, one phase only
Power	Turbine 5	Mitrix Electrix EDPQL 755, one phase only
Blade heating power	Turbine 3	Mitrix Electrix EDPQL 755
Icing, status signal	Nacelle of T1	Labkotec LID 3200/3500
Icing, amplitude	Nacelle of T1	Labkotec LID 3200/3500
Icing, on/off	Nacelle of T1	calculated from LID status

Data availability (%)

Year	wind_spd_39m	pwr_T1-5	wind_dir_39m	bl_heat	air_pres	bl_heat_pwr	ice_T1
2000	87	53	94	94	90	69	24
2001	86	86	87	87	86	87	87
2002	89	79	89	89	88	89	89
2003	90	90	90	90	90	91	91
2004	48	81	48	48	80	81	81
2005	41	86	41	41	86	86	88
Total	74	79	75	75	87	84	77

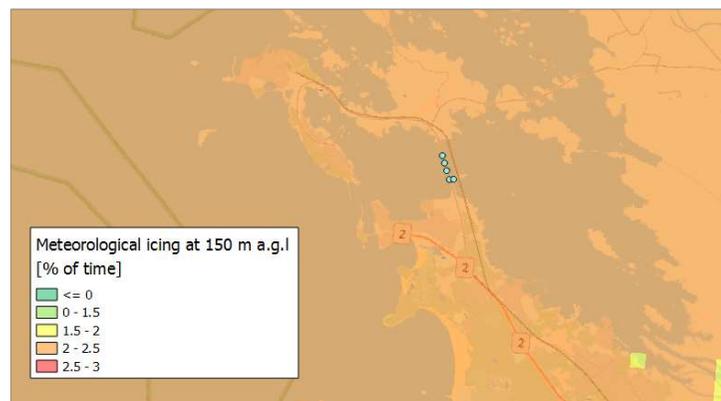
Pori description

- Measurements since 1999, data published 2000-2005
- On the coast, 2-3 m a.s.l.
- 8 Bonus 1 MW turbines, 4 with ice protection system
- 85 m met mast
- **IEA ice class 2**

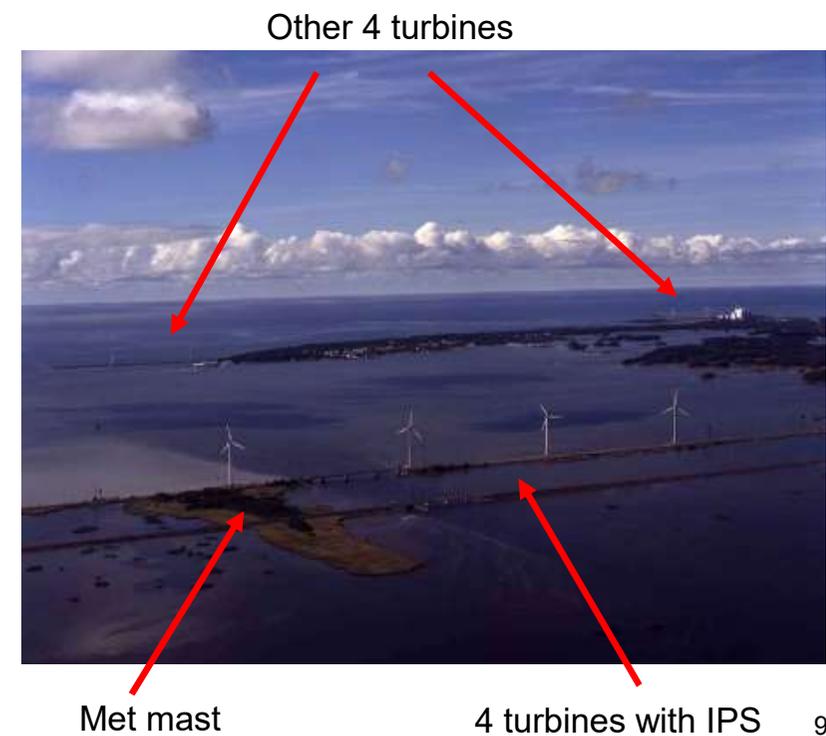
IEA Ice class	Meteorological icing	Instrumental icing	Icing loss
	% of year	% of year	% of gross annual production
5	>10	>20	> 20
4	5-10	10-30	10-25
3	3-5	6-15	3-12
2	0.5-3	1-9	0.5-5
1	0-0.5	<1.5	0 - 0.5



05/02/2018



Winterwind 2018



Pori, available signals

- 10 min ave, max, min, std or turbulence intensity

Description	Location	Manufacturer and model
Wind speed m/s	mast 87 m	Vaisala WAA 251/252
Wind speed m/s	mast 62 m	Vaisala WAA 251/252
Wind direction deg	mast 87 m	Vaisala WAV
Wind direction deg	mast 62 m	Vaisala WAV
Temperature C	mast 62 m	Vaisala HMP234
Temperature C	mast 84 m	Vaisala HMP234
Air pressure	2 m	Vaisala PTB220
Icing on/off	nacelle (Pori 1)	Labkotec LID3200
Icing on/off	nacelle (Pori 2)	Labkotec LID3200
Icing on/off	mast 73 m	Labkotec LID3500
Icing on/off	mast 84 m	Labkotec LID3500
Ice detector status	mast 73 m	Labkotec LID3500
Ice detector status	mast 84 m	Labkotec LID3500
Ice detector amplitude	mast 73 m	Labkotec LID3500
Ice detector amplitude	mast 84 m	Labkotec LID3500
Power	turbine (Pori 2)	Mittrix Electrix EDPQL 755
Blade heating power	turbine (Pori 2)	Mittrix Electrix EDPQL 755

Data availability (%)

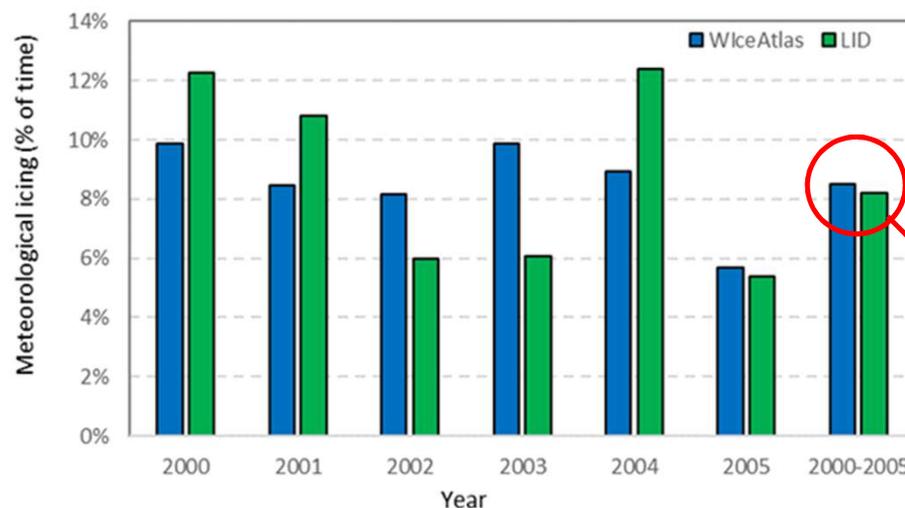
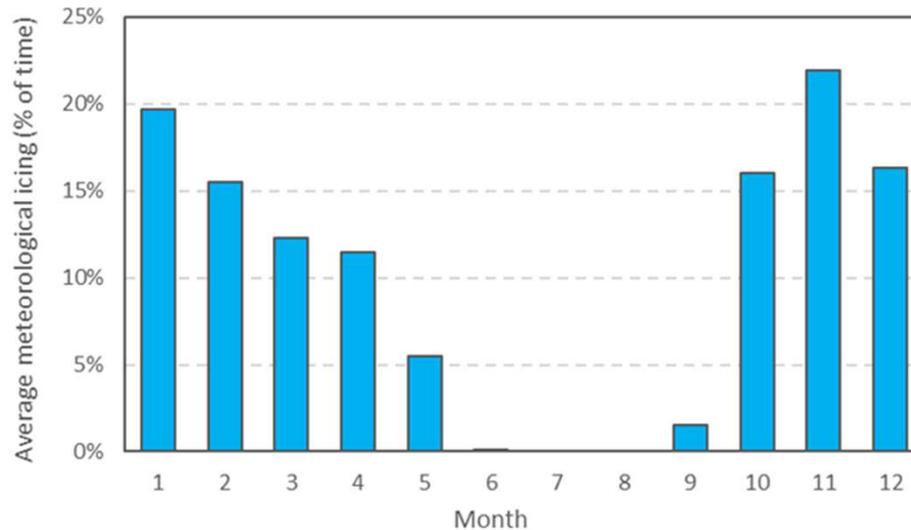
Year	Wind_spd_62m	Wind_dir_62m	Wind_spd_87m	Wind_dir_87m	T_62m	T_84m	Ice_Pori1	Ice_Pori2	Pori1_pwr	Bl_heat_pwr	air_pres_2m	BIA_Status 73 m	BIA_Status 84 m	icing 73 m	icing 84 m
2000	92	92	79	79	94	94	82	82	99	59	95	99	99	95	94
2001	91	91	91	91	92	93	93	93	93	93	91	93	93	93	93
2002	68	68	62	62	75	69	75	81	75	67	68	71	81	70	81
2003	72	72	72	72	75	89	7	7	89	89	53	89	89	89	89
2004	96	96	96	96	99	98	0	0	99	99	73	99	99	99	99
2005	86	86	81	81	96	95	0	0	97	97	86	97	97	97	97
Total	84	84	80	80	88	90	43	44	92	84	78	91	93	90	92

Data quality check

- Automatic filtering and visual check

Signal	Filter	Additional information
wind speed	≥ 0 and < 30	
Wind direction	≥ 0 and ≤ 360	
Temperature	≥ -50 and < 35	
Air pressure Olos 500 a.s.l	> 880 and < 1000	removed also if max > 1006
Air pressure Pori	> 900	removed also if min < 200
Power Olos 1,3,4 and 5	> -70 and < 650 kW	Values also compared to other turbines and wind speed
Power Olos 2	> -70 and < 700 kW	Power for Olos 2 seems to be overestimated
Power Pori 1	> -70 and < 1050 kW	
Icing, ice detector status	≥ 0 and < 16	
Icing, ice detector amplitude	≥ 0 and < 100 or 255	LID 3500 max 255, LID 3200 max 100
Pori blade heating power	≥ 0 and < 100	

WiceAtlas results, Olos



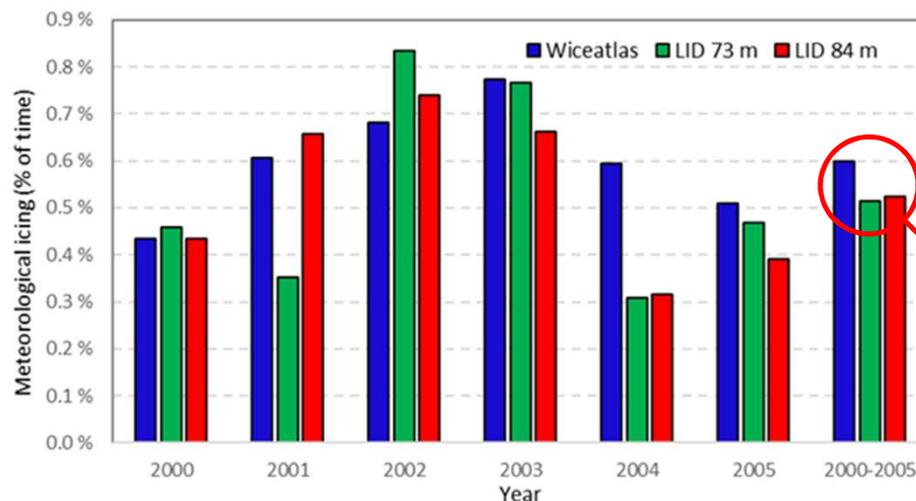
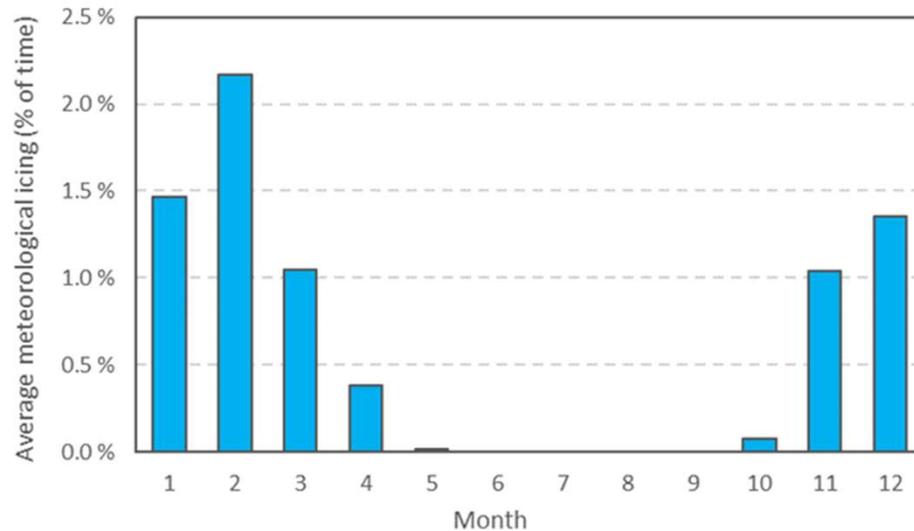
- Monthly distribution from WiceAtlas only

Comparison

- WiceAtlas elevation HH + 2/3 R = 55 m
- 6 year average close to site measurements
- Deviation in yearly values
 - Not known which one is more accurate!

Not that bad! 😊

WiceAtlas results, Pori



- Monthly distribution from WiceAtlas only

Comparison

- WiceAtlas elevation HH + 2/3 R = 78 m
- 6 year average close to site measurements
- Deviation in yearly values
 - Not known which one is more accurate!

Not that bad! 😊

How to access data and license

Data will be published soon in IRPWIND Project website

Preliminary Licences:

Pori

- Available only for EERA JP Wind members
- You can use the data, but must give appropriate credit
- Sharing is not allowed

Olos

- Creative commons Attribution 4.0 International (CC BY 4.0)
- Share the material in any medium or format
- Remix, transform, and build upon the material for any purpose, even commercially
- You must give appropriate credit, provide a link to the license, and indicate if changes were made.

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Summary

- First time ever turbine data will be published from cold climate wind farms
- WlceAtlas long term average match well with site data

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TECHNOLOGY «» FOR BUSINESS

