Business from technology

Cold climate wind power- Experiences in Finland

Winterwind 2011, Umeå 9th Feb, 2011
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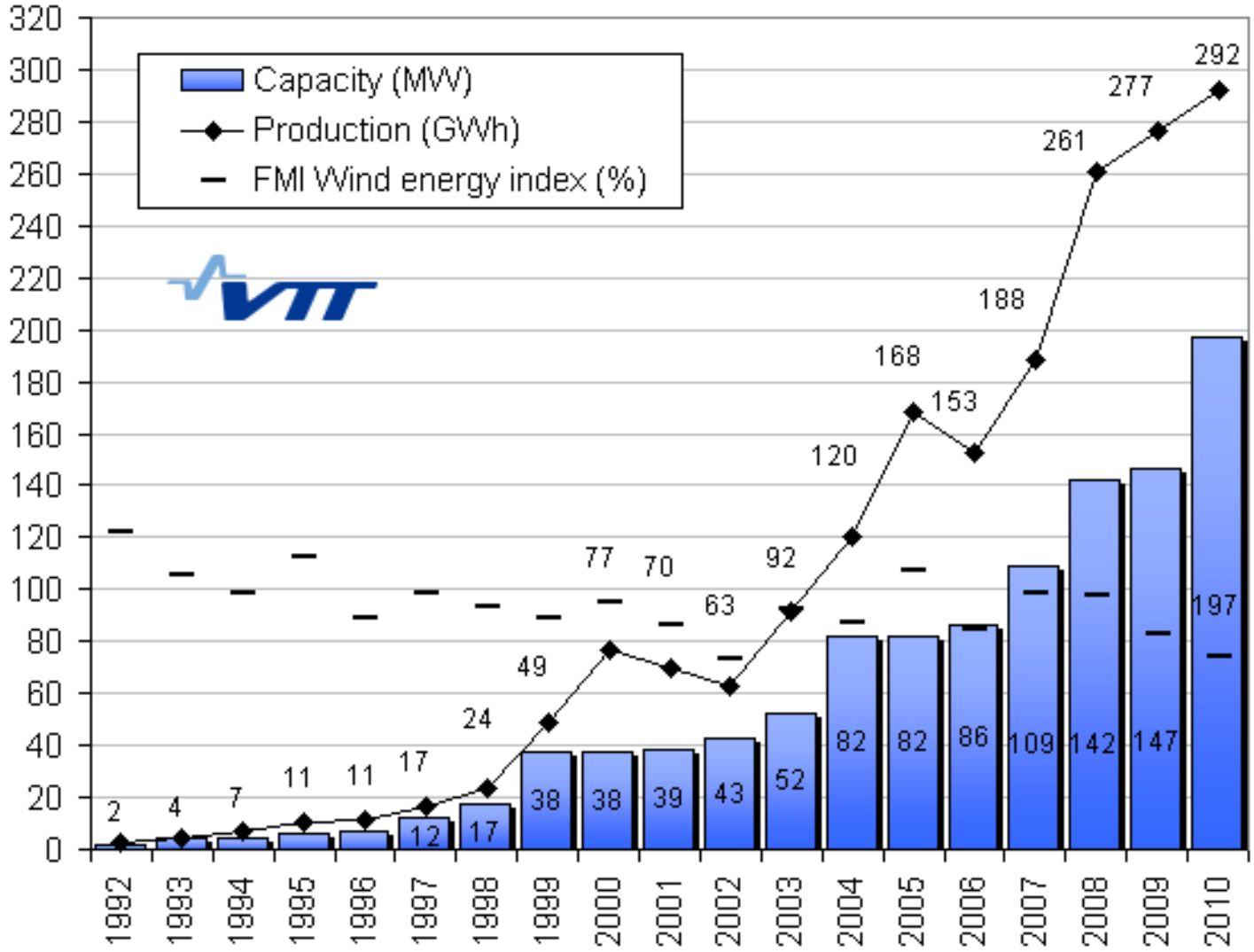
VTT Technical Research Centre of Finland

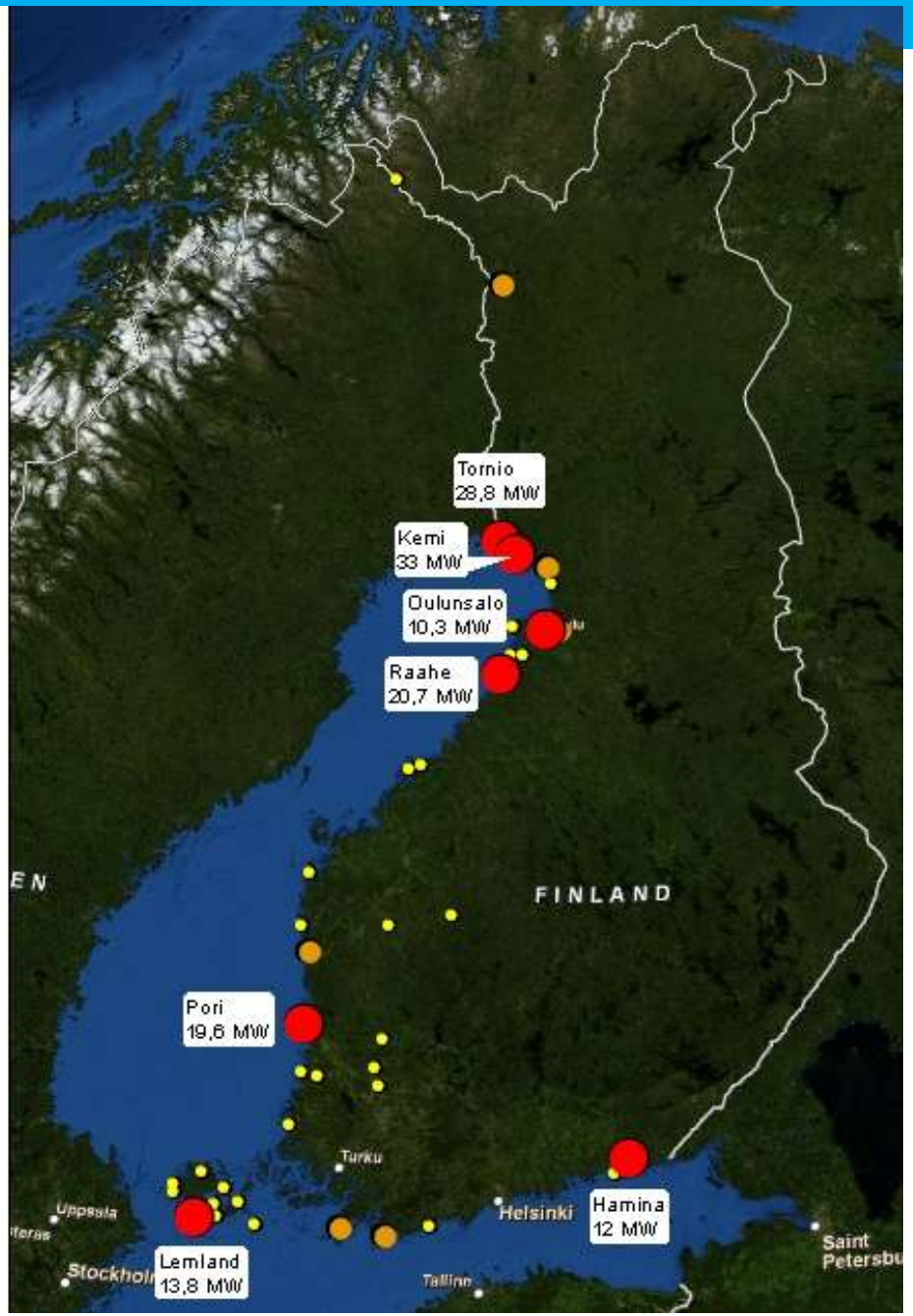
Status Finland: end of 2010: 197 MW, 0.3 % of electricity (0.3 TWh)



Finland 2010

197 MW
130 wind turbines

< 3 MW
3 - 10 MW
> 10 MW



Wind Energy Statistics in Finland
http://www.vtt.fi/windenergystatistics/

2010:

- New 50 MW, 16 turbines
- Removed 1.6 MW, 5 turbines

2020:

- Target 2500 MW (6 TWh/a), feed-in tariff starting 2011

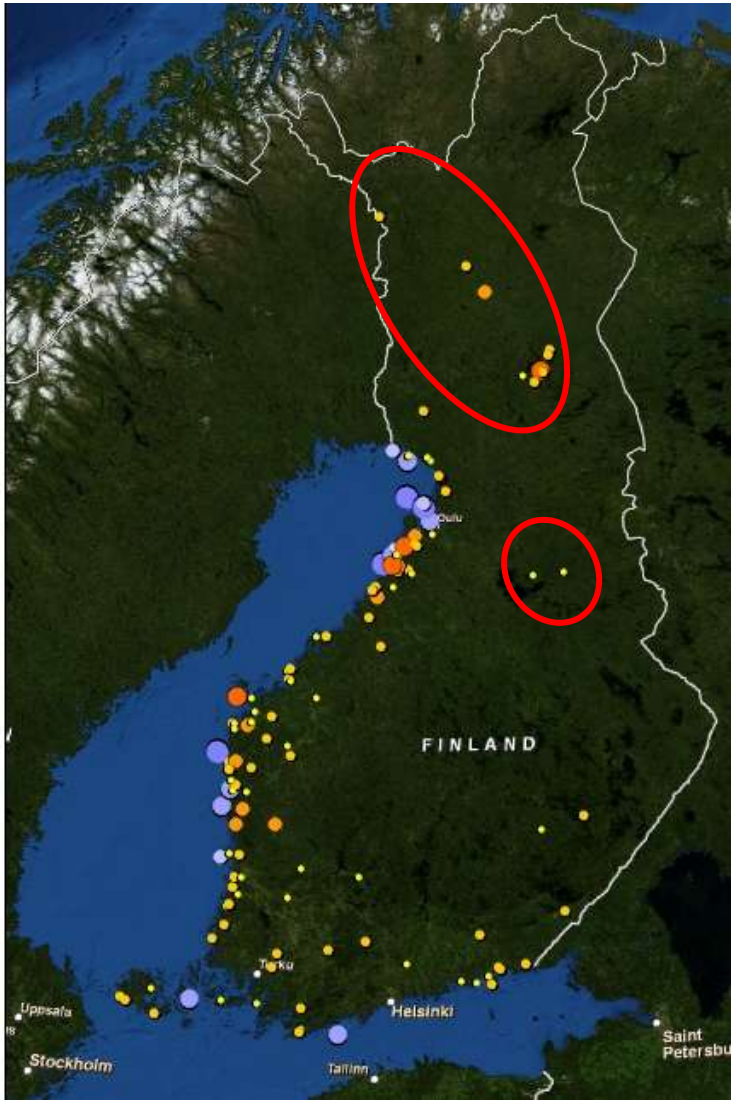
Wind power projects in Finland

Onshore: 2 900 MW
Offshore: 3 000 MW
Total: 5 900 MW

Updated in February 2011

Onshore	Offshore
< 10 MW	< 10 MW
11 - 50 MW	11 - 50 MW
51 - 100 MW	51 - 100 MW
101 - 250 MW	101 - 250 MW
> 250 MW	> 250 MW

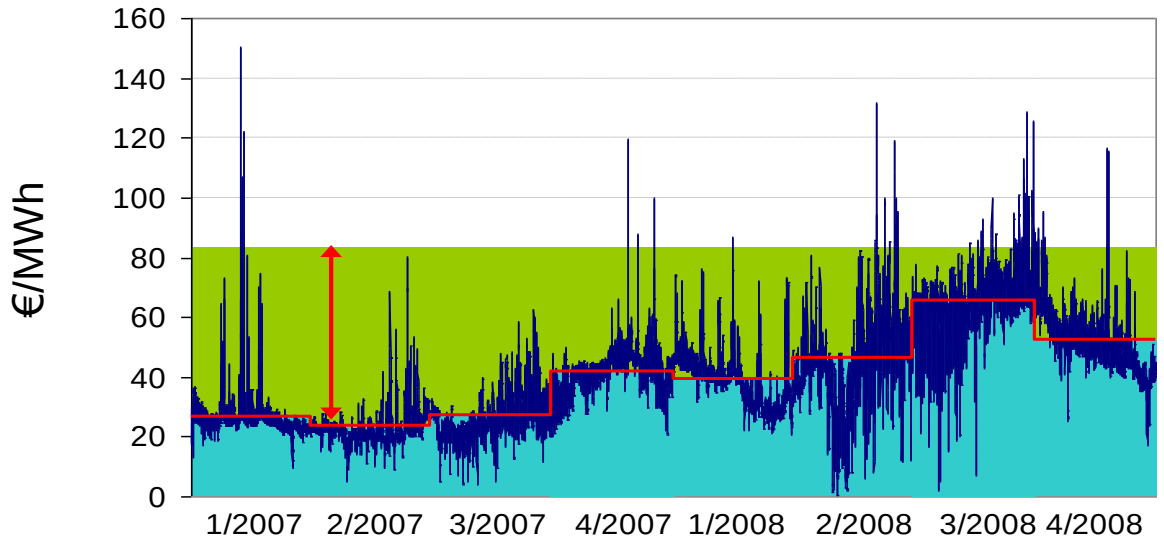
Wind Energy Statistics in Finland
http://www.vtt.fi/windenergystatistics/



- Projects with strong risk of freezing blades
  - Mielmukkavaara 30 MW, wpd Finland
  - Kuolavaara-Keulakkopää 40 MW and Joukhaisselkä-Kulvakkoselkä 60 MW Fortum
  - Kemijärvi, 5 sites, 216 MW, Oxford Intercon
  - Kemijärvi Ailakka, 30 MW, wpdFinland
  - Paltamo and Ristijärvi, E.ON Kainuu
- Projects that may have risk of freezing blades
  - Some inland sites
- Projects with risk of freezing feet
  - All offshore
  - Total >3000 MW in 15 projects

Feed-in tariff for wind power, starting in 2011
Target 6 TWh/a, 2500 MW in 2020

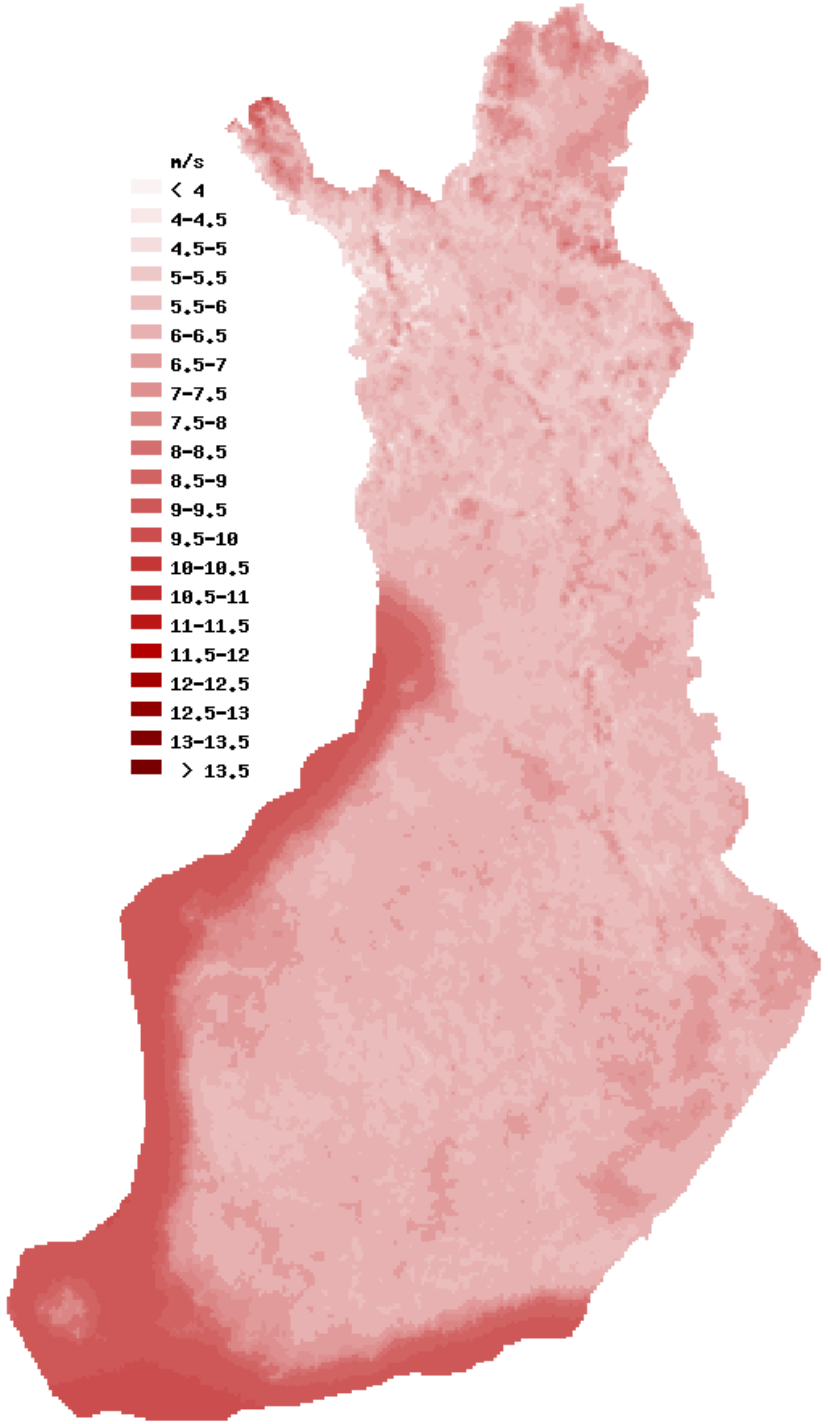
- Feed-in tariff level 83.5 €/MWh for 12 years (to >0.5 MW)
  - first 3 years 105.3 €/MWh (will be paid only until end 2015)
- Producers participate in the electricity markets
  - Income from tariff: For each quartile, difference between tariff level and average spot price will be paid
  - Income from electricity trade: from day-ahead market Nordpool. Imbalance costs have to be paid (~2 €/MWh)
- Offshore wind, still needs some other system (not decided yet)



Wind atlas for Finland

- FMI /Motiva project funded by the energy department of Ministry of Employment and Economy
- Grid of 2.5 km x 2.5 km, parts of Finland with 250 m x 250 m grid
- Meso-scale model runs for 6 selected months/month to present 20 year average wind
- Public launching of the web site 25th Nov2009, 250 m grid published spring 2011

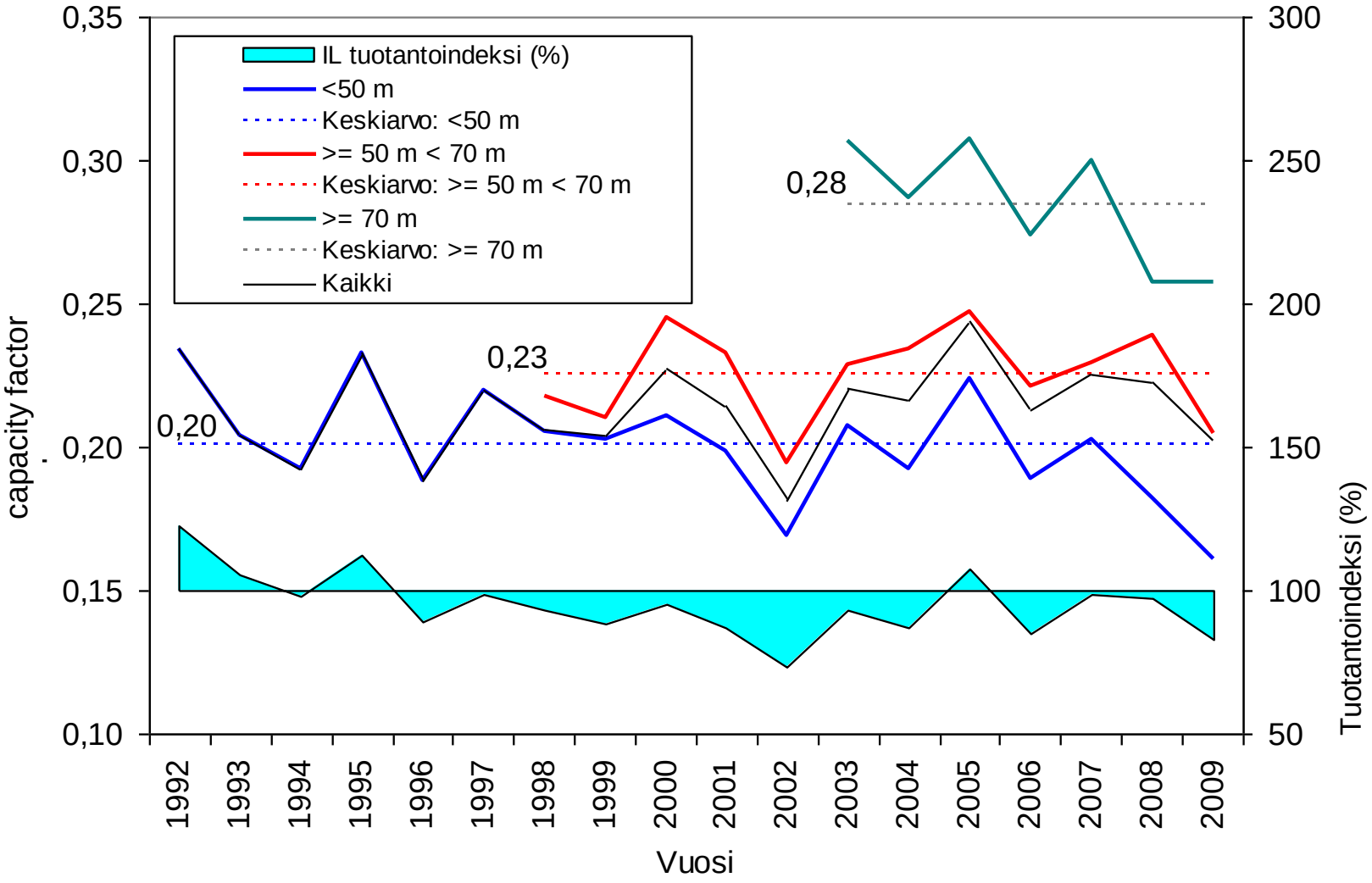
- www.tuuliatlas.fi 100 m.a.g.l:



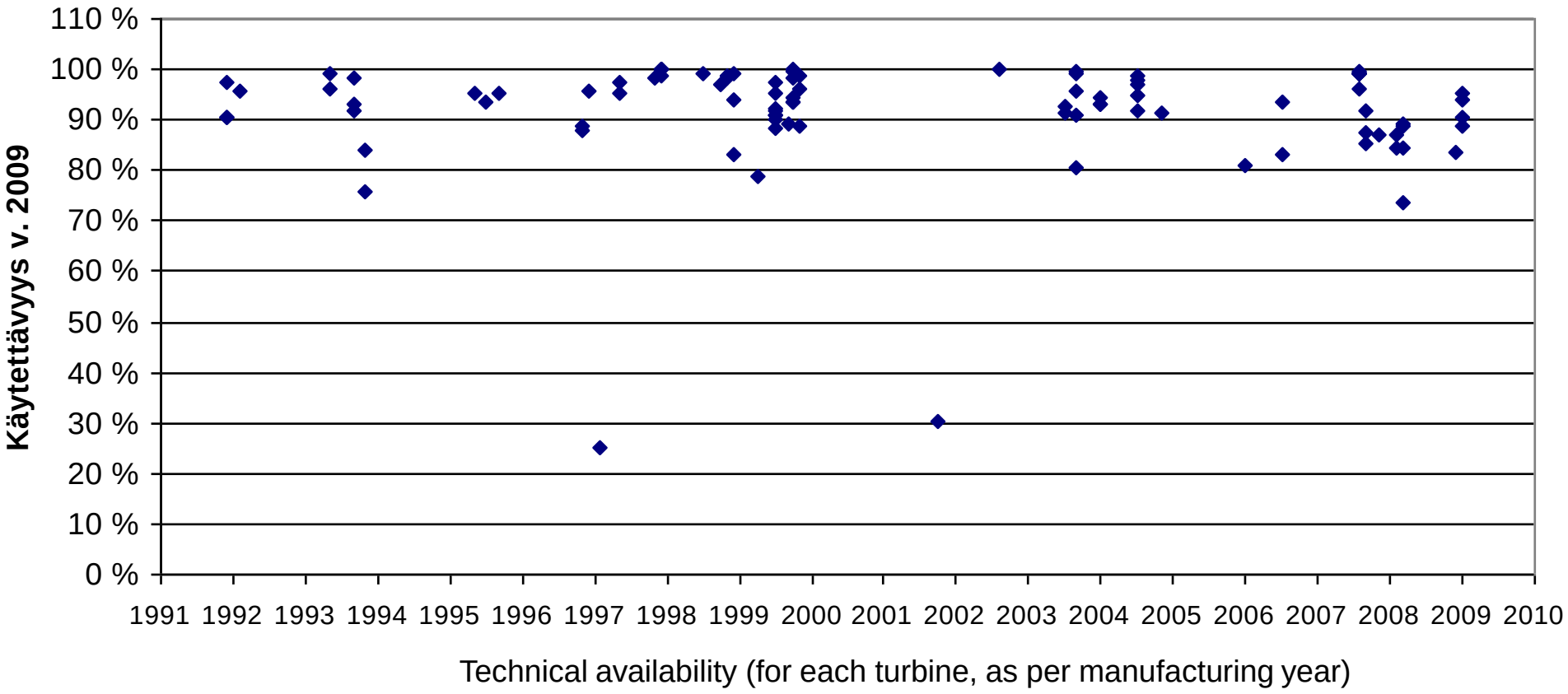
Other policy issues

- Radar interference
  - Ministry of Defence has halted development of almost all projects
  - Project started to develop a tool for ministry of Defence to assess the impacts of wind farms to radars, first results expected spring 2011 (VTT funded by ministry of Employment and Economy and developers)
- Streamlining the planning process
  - New law for building planning in preparation, expected late in 2011
- Ice throw will be an issue for some sites

Higher turbines produce more



Technical availability in 2009 as of turbine age



Technical availability in 2009 was 91 % (94-96 % in previous years)

Operational experiences from wind turbines - Icing reported to failure statistics of Finland

		Lapland	Åland	Perämeri	Selkämeri	Total Finland	Share of downtime
000	Hours	159	7	573		739	9 %
	Turbines	8	3	7		18	
001	Hours	5	44	4 143	38	4 230	26 %
	Turbines	1	3	15	1	20	
002	Hours		26	434	411	871	15 %
	Turbines		2	3	5	10	
003	Hours			408	301	709	27 %
	Turbines			1	3	4	
004	Hours	1 468		55	82	1 605	25 %
	Turbines	8		1	3	12	
005	Hours	1 527	15	35		1 577	28 %
	Turbines	8	3	1		12	
006	Hours	1 050	601	263	197	2 111	16 %
	Turbines	8	12	7	1	28	
007	Hours	817	22	511	46	1 396	10 %
	Turbines	8	1	14	1	24	
008	Hours	2 157		53	181	2 391	22 %
	Turbines	8		4	5	17	
009	Hours	2 246	15	409		2 670	15 %
	Turbines	9	3	7		19	

Cold climate R&D in Finland

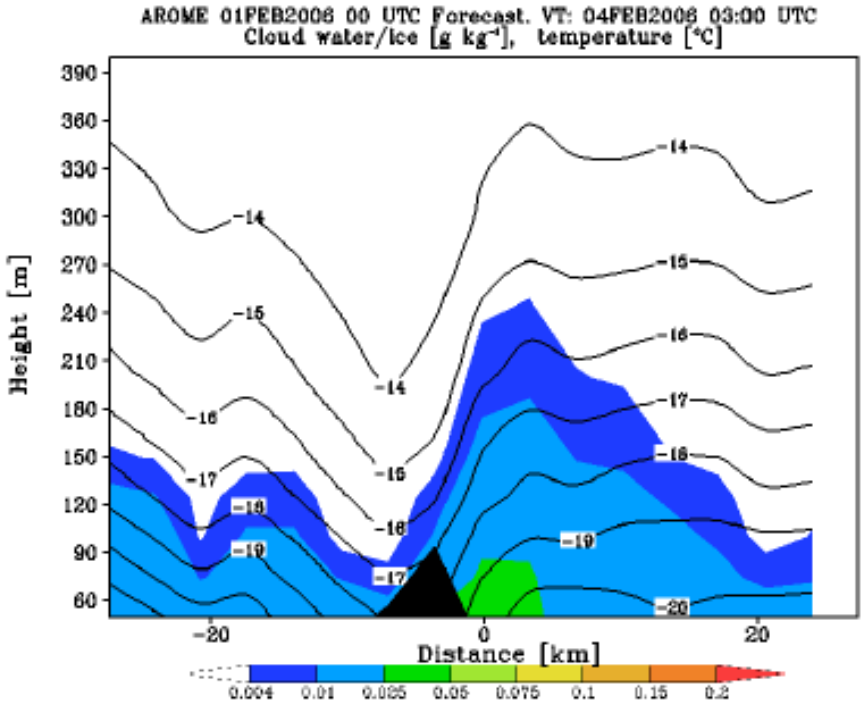
- Ice prevention equipment and instrumentation for wind turbine blades
- Instrument development and testing in icing wind tunnel – ice detectors, heated wind sensors
- Ice accretion and production loss estimation due to icing
- Ice atlas
- Measurements in icing conditions
- Operational experience from wind turbines

- Industrial involvement: Windwind 3 MW blade heated turbine, Vaisala ice free wind sensors, Labkotec ice sensors

Ice atlas for Finland (FMI)

- Under development, to be
  - based on same database as Finnish Wind Atlas
  - implemented in Finnish Wind Atlas
- Challenges in verification
  - Limited no of observation points (Luosto (Lapland), Puijo (inland), Riutunkari (coastal)
  - The observation years/months chosen based on wind atlas needs: series incomplete and stem from different years
  - Quality

AROME					Max	Min
January	1991	1993	2000	2007	1989	2004
February	1989	1992	1998	2006	1989	1994
March	1991	1994	2002	2006	1997	2006
April	2000	2003	2005	2005	2007	2004
May	1991	1996	2000	2005	2000	1994
June	1989	1991	1992	1994	2000	1997
July	1992	2000	2002	2006	1999	1997
August	1994	1997	2001	2007	2005	2006
September	1991	1996	2003	2006	2005	1993
October	1995	1997	1998	1999	2005	1992
November	1992	1997	2004	2005	1999	2002
December	1989	1990	2000	2002	1992	2000

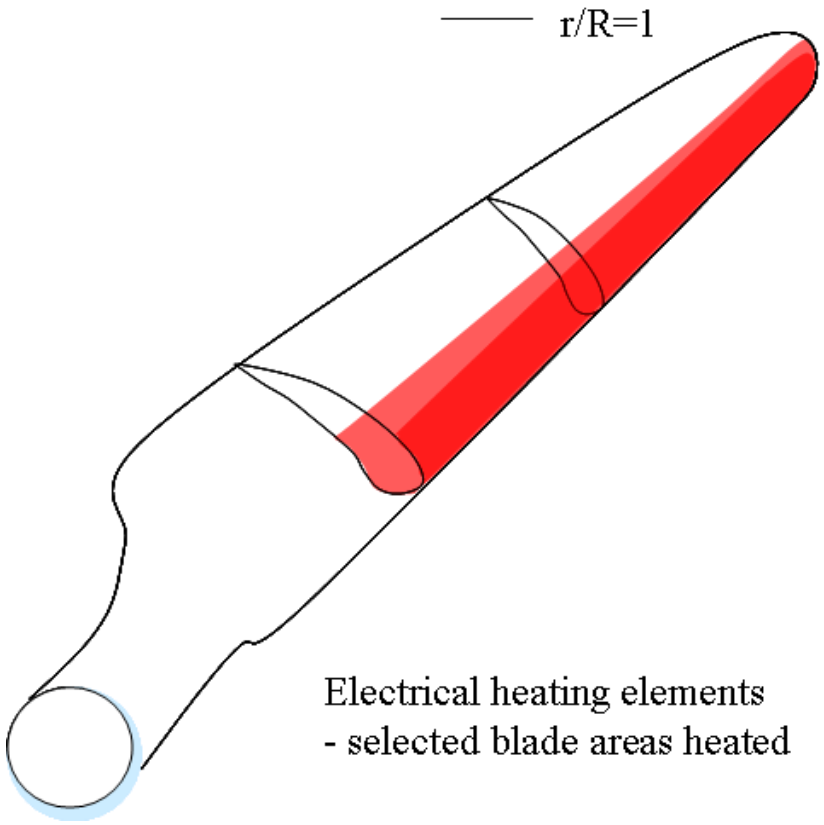


Measurements in icing conditions

- Experience from LIDAR technology in icing conditions
  - First round in winter 2009-2010
  - Second round starts in February 2011

Ice prevention system design and development

- Thermal design
  - Heating element dimensions, locations, thermal balance …
  - TURBICE simulations
  - Testing (verification) in icing wind tunnel
- Control principle design
- Mechanical design
  - Materials (conductive materials, epoxy)
  - Manufacturing process and tools
- Electrical design
  - Power supply
  - Safety features
  - Integration to turbine control, control unit
  - Blade internal wiring
  - Lightning protection
- Design documentation
- System manufacturing



Electrical heating elements
- selected blade areas heated


Thank you!