

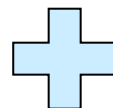
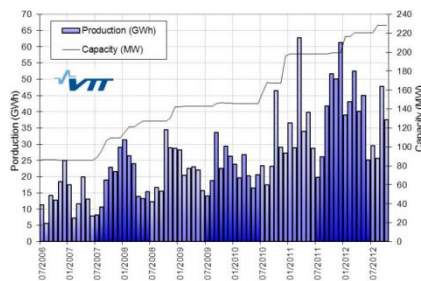
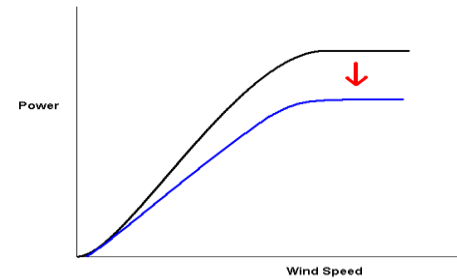
Lessons learned from public cold climate wind power statistics

Winterwind 2013

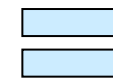
Turkia Ville, Wallenius Tomas, Peltola Esa

VTT Technical Research Centre of Finland

Introduction



FINNISH
wind ATLAS
Finnish Icing Atlas



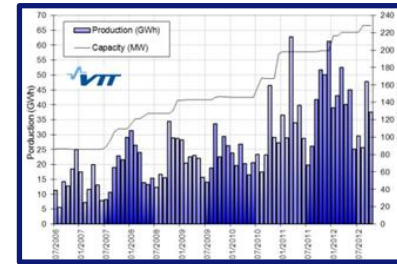
Lost production
due to icing

Introduction



MONTHLY PRODUCTION ESTIMATE

REAL MONTHLY PRODUCTION

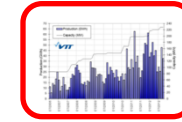


MONTHLY PRODUCTION LOSS ESTIMATE DUE TO BLADE ICING


BLADE ICING LOSSES VS. TOTAL WINTER TIME PRODUCTION LOSSES



Methods/Approach



FINNISH
wind ATLAS
Finnish Icing Atlas

Legend:  Lost production due to icing

Wind energy statistics of Finland

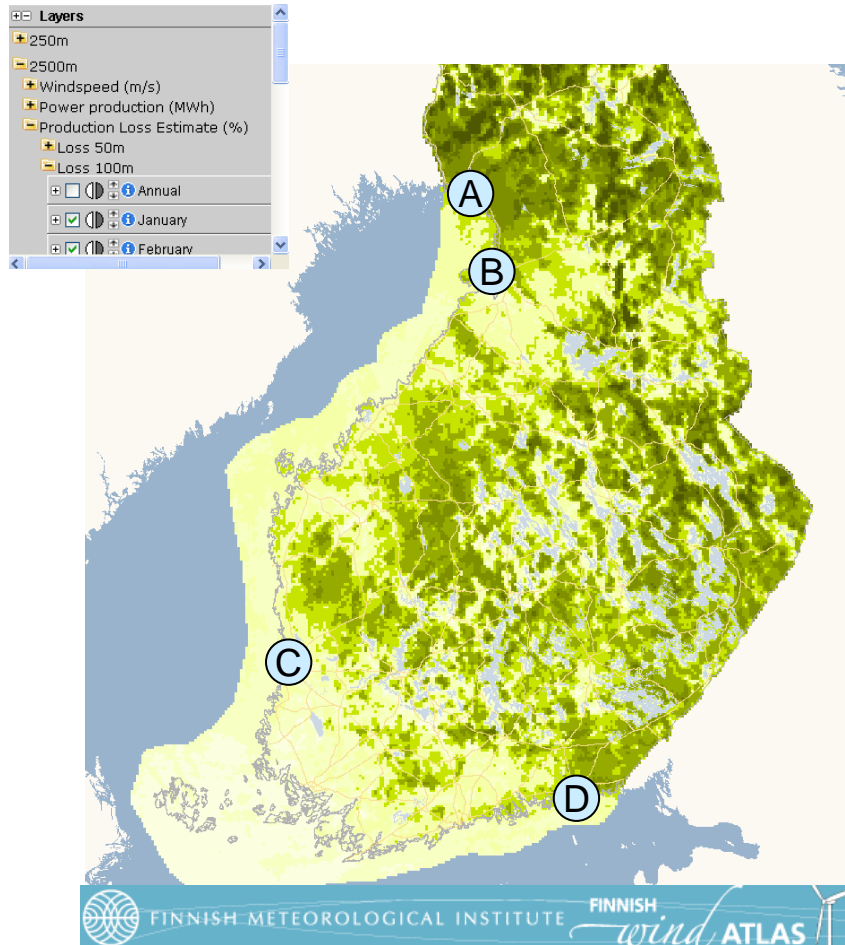
- Monthly production data
- Monthly data for technical availability
- Monthly wind index produced by FMI

Sample and data for this study

- X 3 MW turbines in 4 locations
- Data from years 2007-2012
 - not for all locations
- Data filtration and correction to enable comparison with Wind Atlas
 - Technical availability



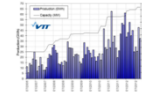
Methods/Approach



<http://www.tuuliatlas.fi/en/index.html>

For the same locations

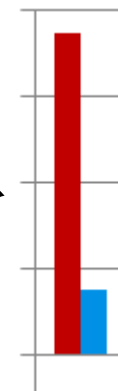
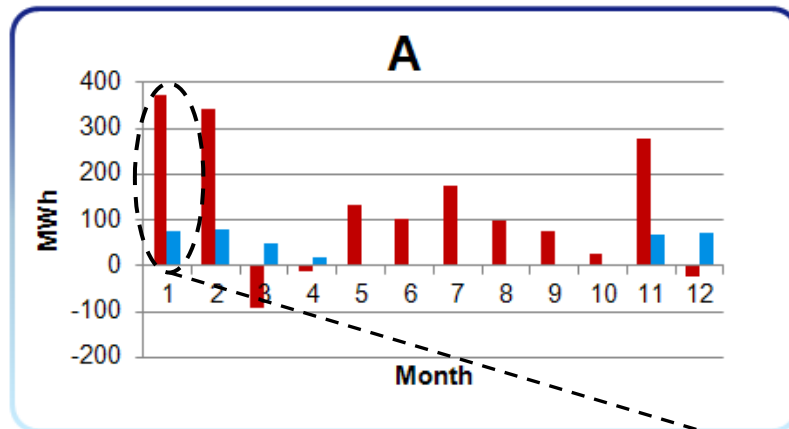
- Monthly production (for 3MW turbine) from Finnish Wind Atlas
- Monthly production loss estimate from Finnish Icing Atlas



+ FINNISH *wind* ATLAS
Finnish Icing Atlas

Lost production due to icing

Contents of result summary



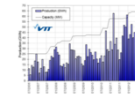
Average production difference to Wind Atlas

- Lower efficiency and higher unavailability due to blade icing
- Other unavailability
- Wind atlas unaccuracy on the location

Icing Atlas Production loss

- Estimate due to blade icing

Results



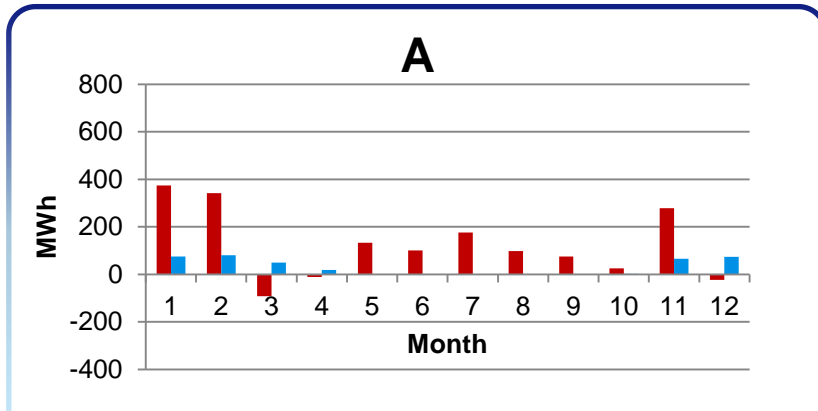
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FINNISH *wind* ATLAS
Finnish Icing Atlas

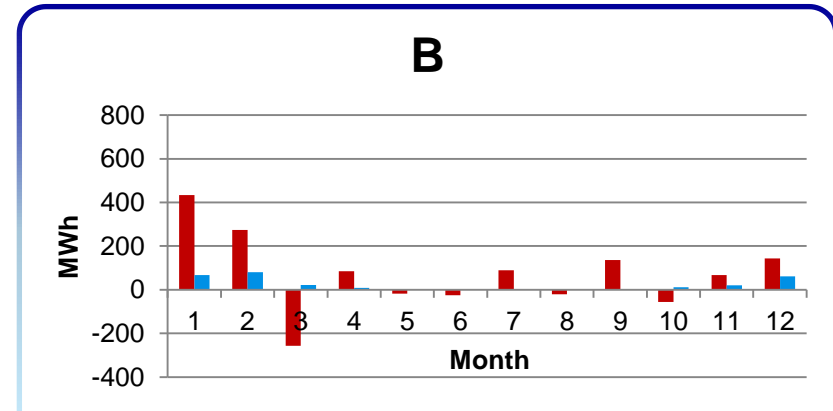
Lost production due to icing

■ Production difference (Wind Atlas estimate - Statistics)

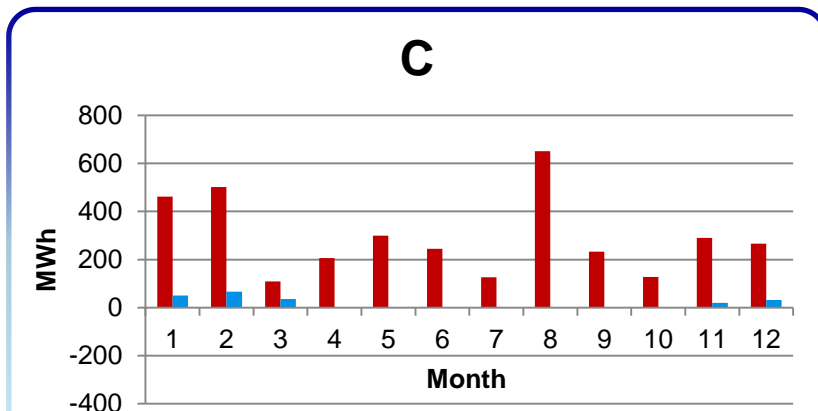
■ Production loss, Icing Atlas



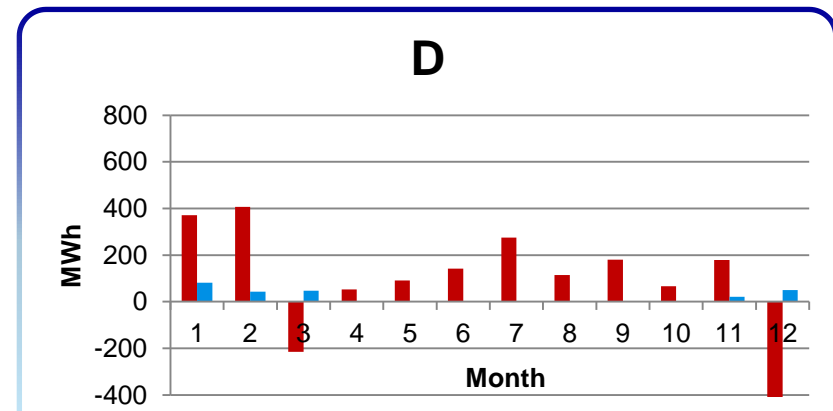
Sample size: 29 34 33 35 37 30 27 33 25 25 25 24



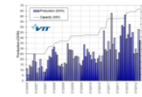
Sample size: 6 7 6 7 5 7 6 6 6 4 6 7



Sample size: 3 5 4 5 4 4 3 0 2 3 3 2



Sample size: 2 3 4 4 3 4 4 4 4 4 4 4



FINNISH
wind ATLAS
Finnish Icing Atlas



Lost production
due to icing

Conclusions

Average production difference to Wind Atlas estimate

- Varies between locations
- Bigger during winter months
 - Blade icing and other cold climate effects offer a natural explanation
- Low sample size in some cases

Average production difference to Icing Atlas loss estimate

- Icing Atlas loss estimate smaller
- Explained by other technical reasons – both cold climate related and other

Further work

- Finnish Wind Atlas estimates may as such be optimistic for project development
- Continuation of production and failure statistics work
- Icing Atlas may underestimate production losses

References

- VTT Wind Energy Statistics of Finland
 - <http://www.vtt.fi/windenergystatistics>

- Wind and Icing Atlas of Finland /FMI/
 - <http://www.tuuliatlas.fi/> in Finnish
 - <http://www.tuuliatlas.fi/se/index.html> på Svenska
 - <http://www.tuuliatlas.fi/en/index.html> in English



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