From icing loss to production loss -

a comprehensive comparison of today´s tools

(in Sweden)

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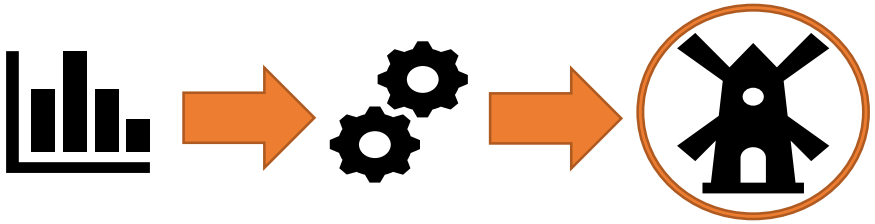
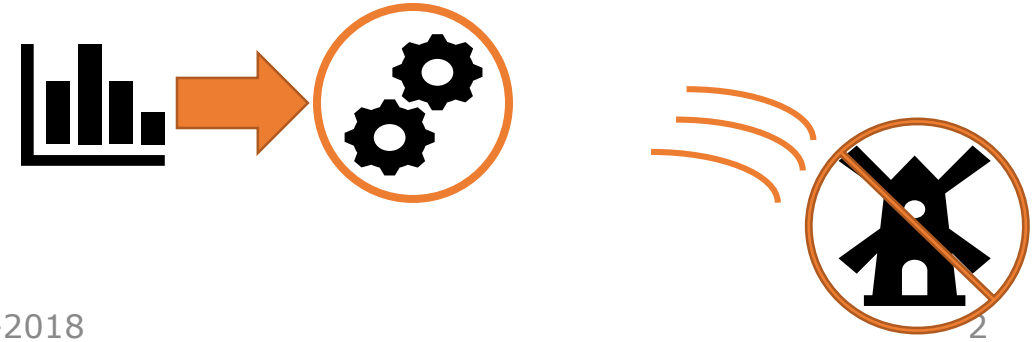
Background

Purpose of presentation

- Most presentations focus on this:



Today, Im going to talk about this:



Limitations

Goal of the Presentation

- Compare the different methods on the same location
- Create a basis for expected differences and uncertainties in pre construction situations

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Available methods

In this presentation the following methods were observed:

- IEA icing classification
- “Fiddle factor” estimate
- Kjeller Vindteknikks icing map
- DNV/GL Ice map.
- WIceAtlas map

Model description

IEA icing classification

- Presents icing in five different classes

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

Challenges

- Overlapping Classes and "unusable" range of expected losses

Model description

"Fiddle factor"

- Uses a factor on the observed icing to present icing loss
- Examples have been seen varying from 0,25-0,5

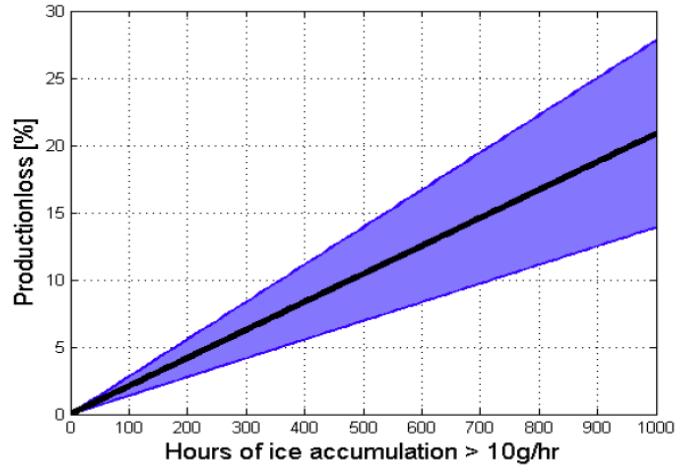
Challenges

- Result highly dependent on the factor chosen
- "Based on experience" is a rather vague argument

Model description

Kjeller Vindteknikks icing map

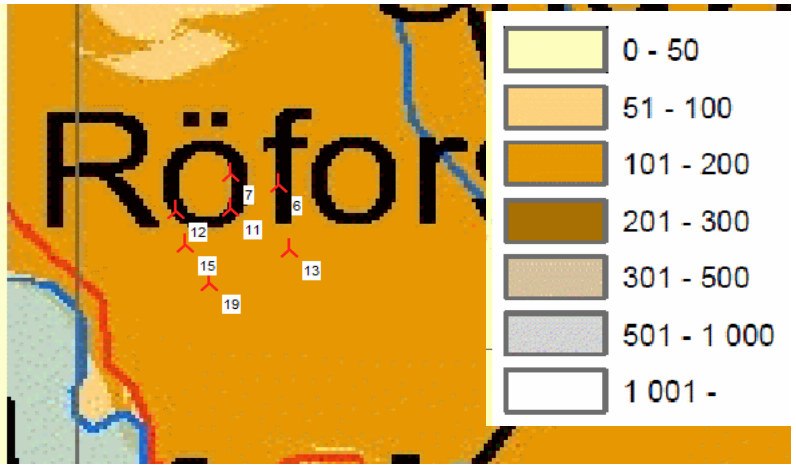
- Presents icing as number of icing hours per year which is converted to production loss.



g. 6. Estimated range for production loss. Lower boundary is given by (2). pper boundary is given as twice the lower boundary.

Challenges

- Low Resolution and inability to capture local "coldspots"
- Estimates presented in a range



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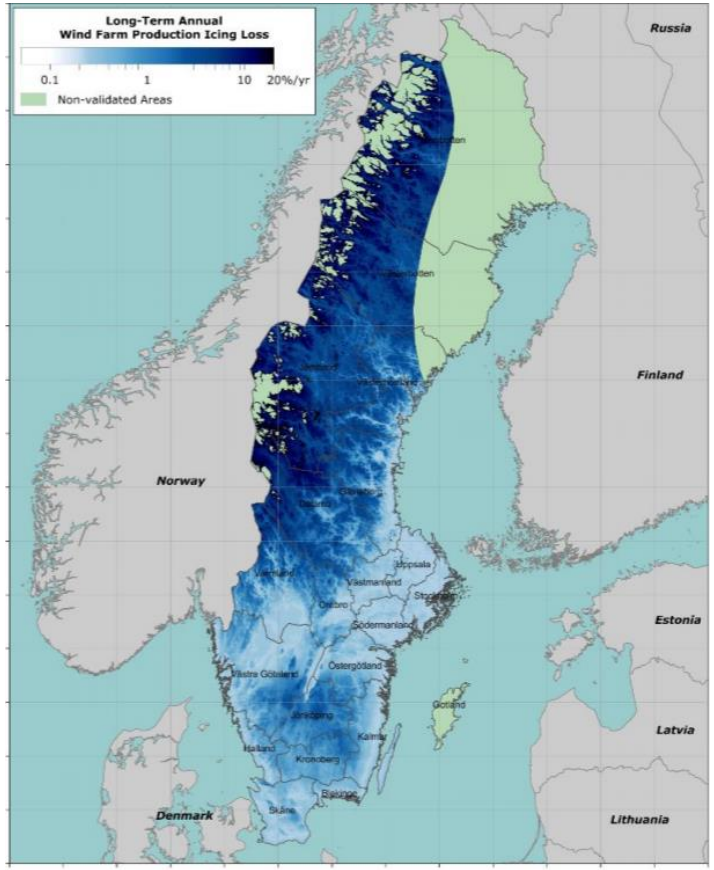
Model description

DNV/GL map

- Presents icing as a fixed number, based on production data and the relationship between hub height elevation and ice loss

Challenges

- Questions related to the second trend (not implemented in the current ice map)



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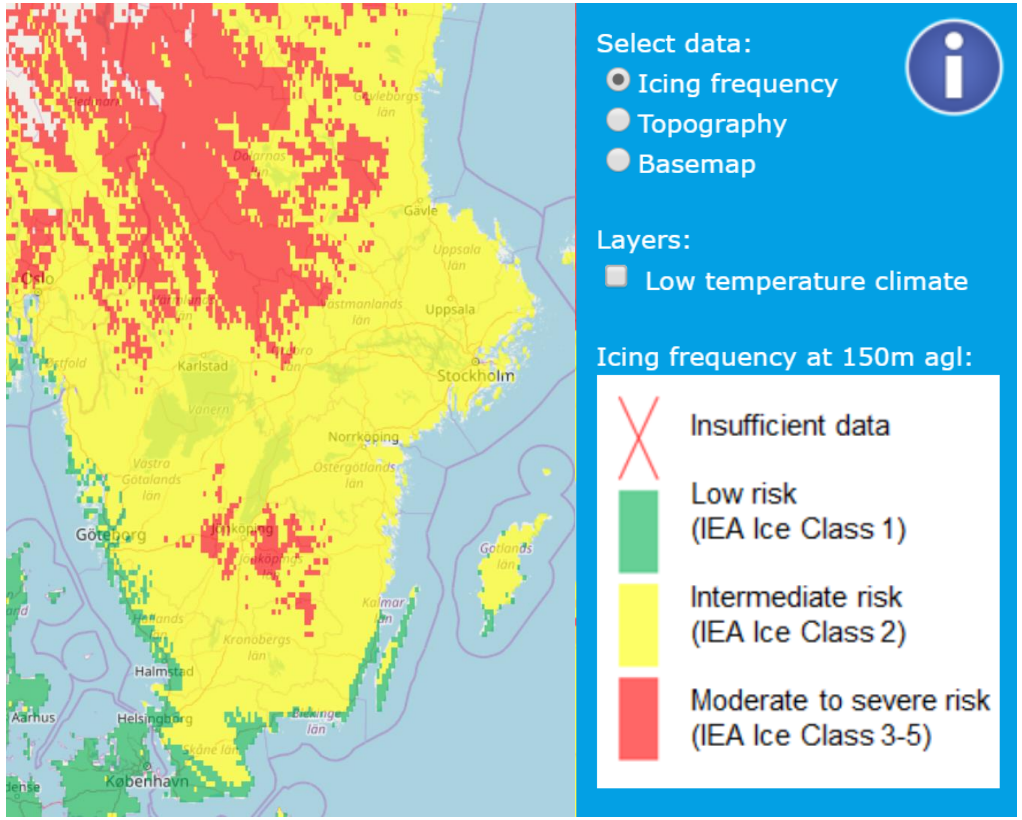
Model description

WIceAtlas map (honorable mention)

- Presents results as different IEA ice classes



Challenges

- Hard (as in not really possible) to convert to a single value

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Methodology

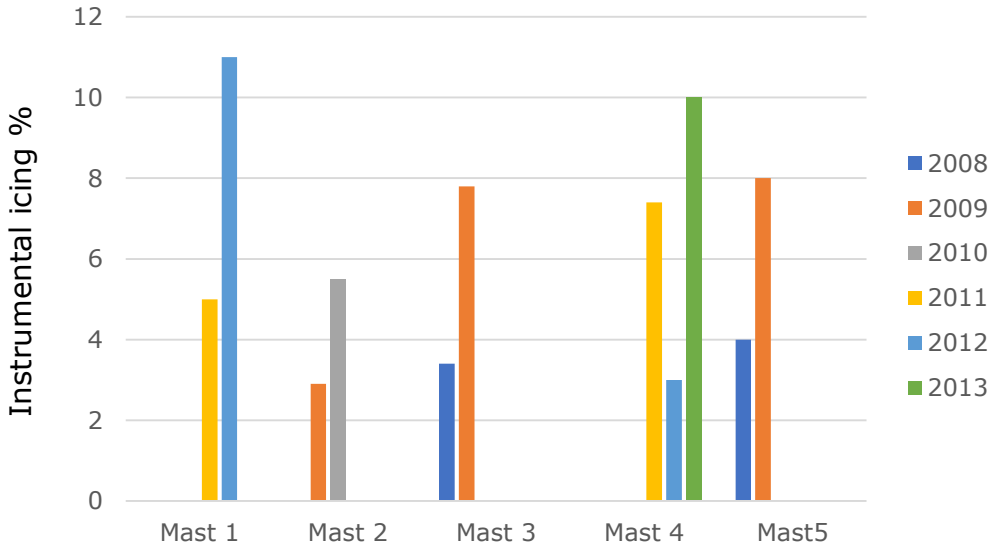
Assumptions and methodology

- Flagging system based on difference in ΔV between fully heated and shaft heated anemometer as well as instrumental stand-still during icing season
- Period assumed to start 30 minutes before and after each flagged period
- Only one winter season is taken into account
- Multiple winters are split and treated separately
- Mean value from Kjeller Vindteknikk map ranges used
- No consideration taken in regards to proximity to nearby areas (KVT)
- Single value obtained from the IEA relationship between instrumental icing and production loss
- "Fiddle factor" of 0,4 used for presentation
- All instrumental icing Long term corrected with seasonal Icing index
- Only masts between 85-100m used for evaluation
- Only Thies first class shaft heated anemometers used for evaluation

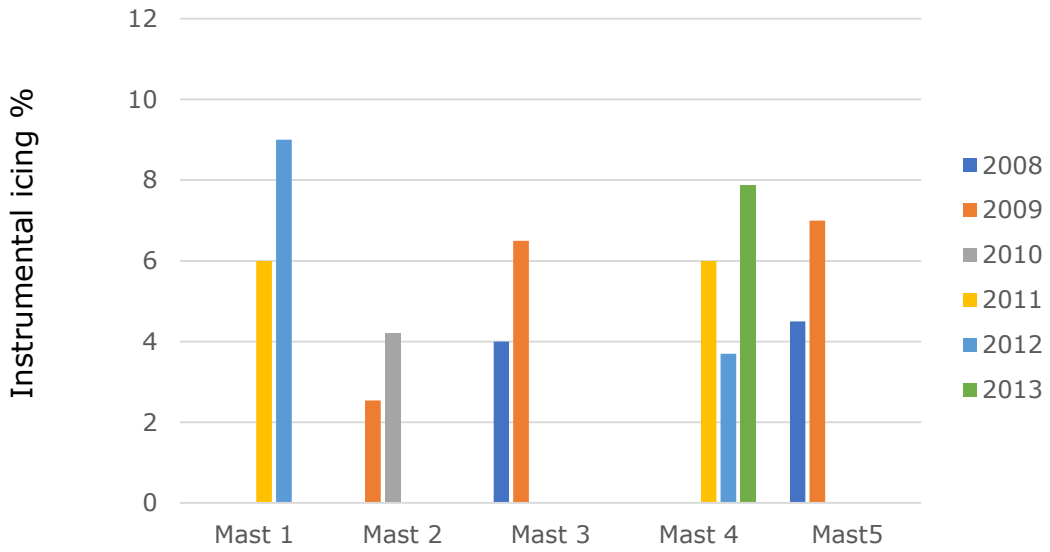
Results

Examples of Inter annual difference in instrumental icing

Before seasonal index correction

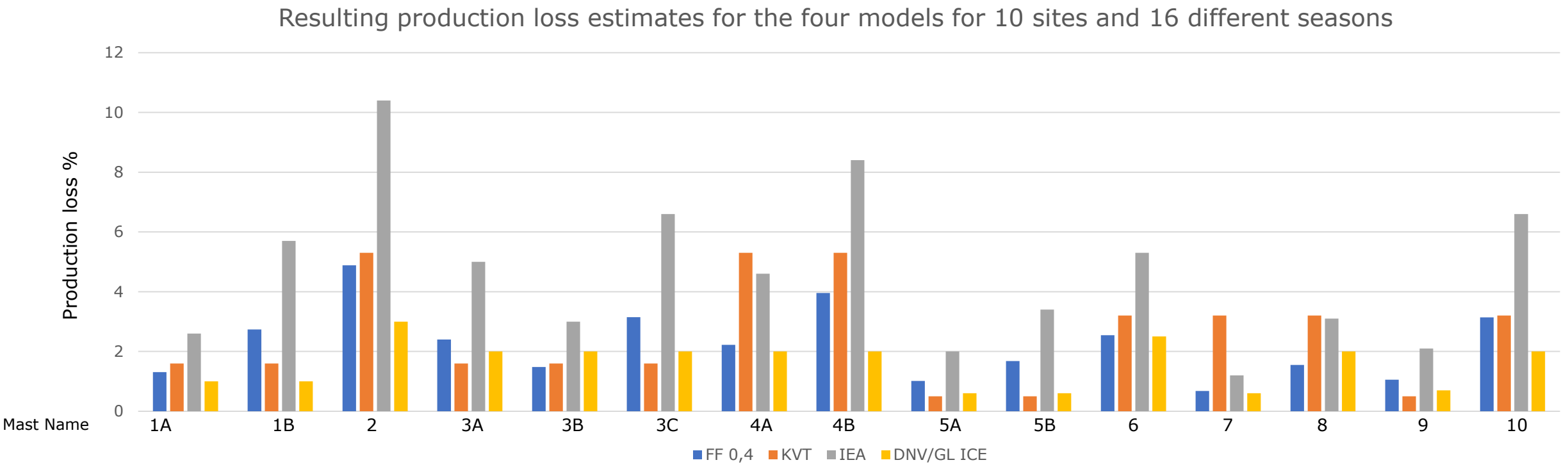


After seasonal index correction



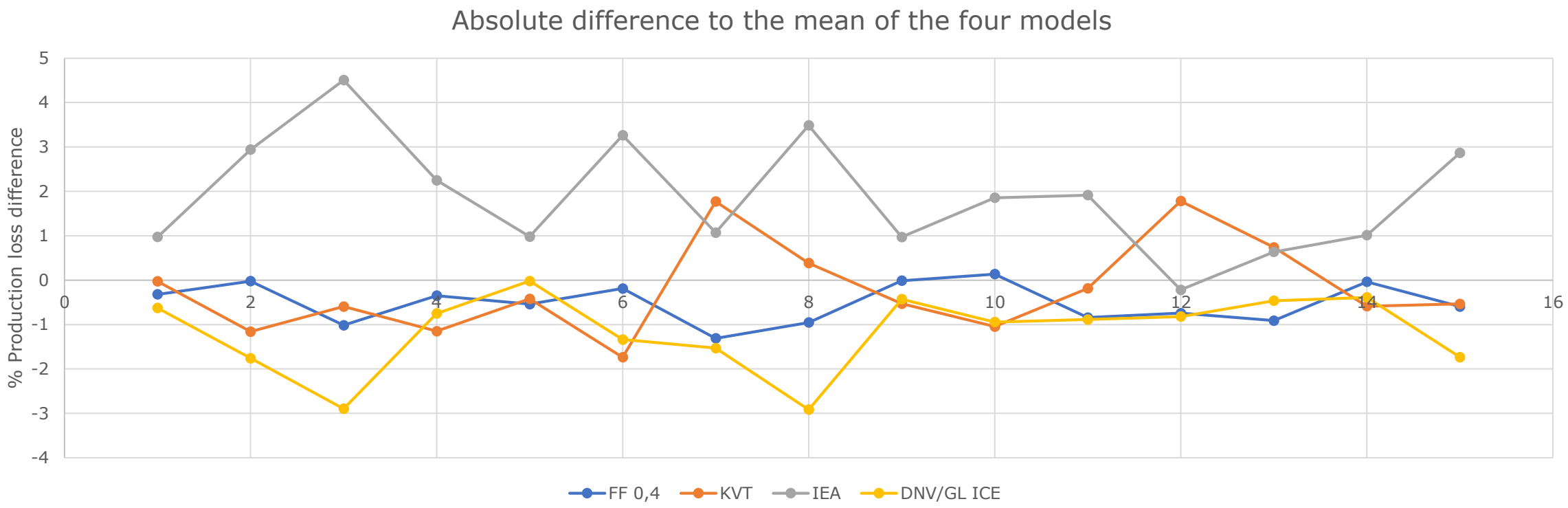
Results

Difference of expected long term production loss



Results

Difference of expected long term production loss



Wrap-up

What can be learned

- Some spread can be observed (and was expected), but given the strict input procedure, the results are looking promising
- Using a mean value of all methods is a possible approach
- Having one year of measurement as a basis for a icing loss evaluation increases uncertainty due to inter annual variability

Thank you for listening!

Och håll ut!