FanSi in Statnett

Using the market model FanSi in Statnett; our experience and strategy

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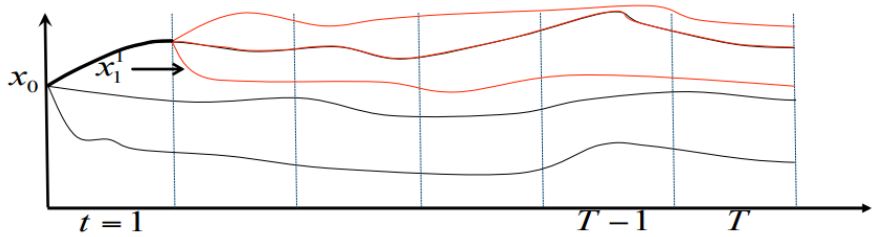
Our experience in summary

- It's slow
  – but much faster with some investments
- Results are promising
  – worth investing in
- We need (want) much more/better data
  – optimizing reveals our weaknesses

FanSi, The scenario fan simulator

SOVN model

- Simulation along observed *weather scenarios* by solving a sequence of stochastic optimization problems
  - Two-stage stochastic problems
  - Uncertainties known in the first-stage (week)
  - All uncertainty is resolved in the second stage
  - First-stage decision is implemented and state variables are updated
  - Rolling horizon, fixed problem size



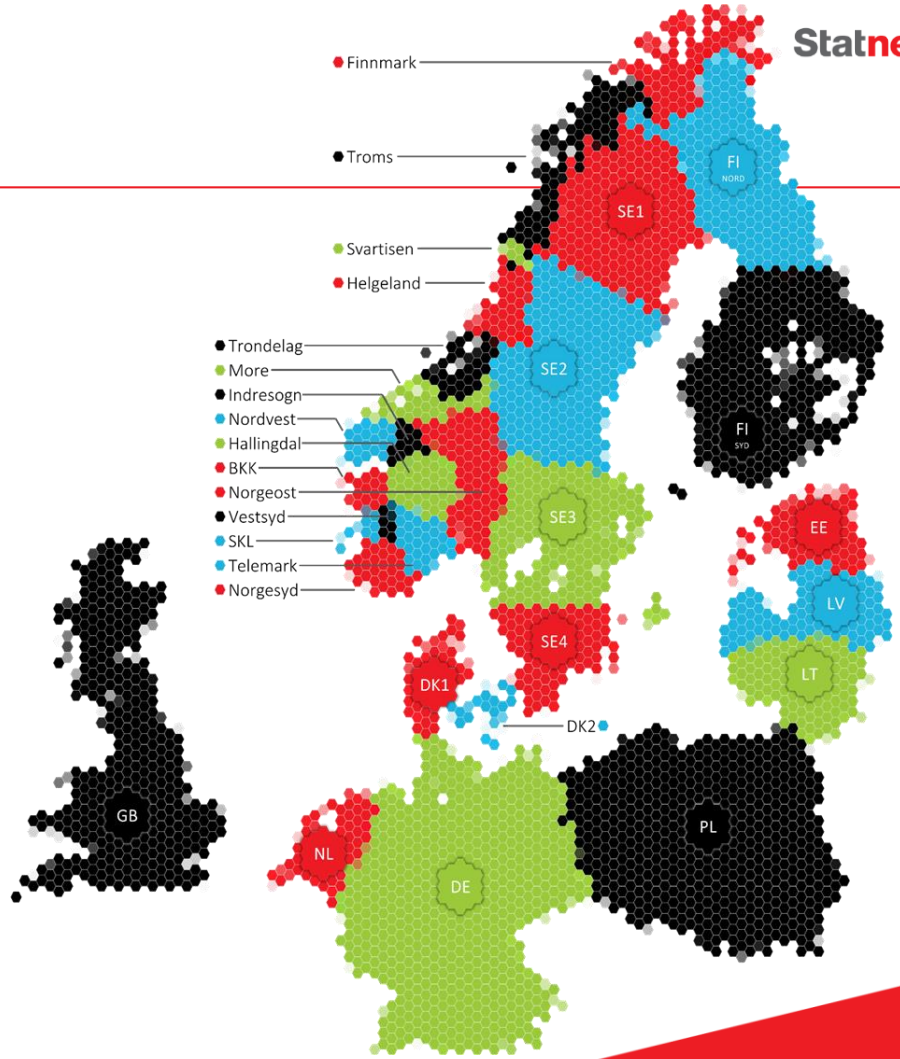
Source:
Birger Mo, 5th International Workshop on Hydro Scheduling in Competitive Electricity Markets (2015)

Developing a model to solve everything

- Developed to solve problems with current models
  - More intermittent production and little price volatility
  - Need for individual hydro power and short term storage optimization
  - To much user adjustment of current model
- A project was started to make a optimizing model
- We expected perfect results from perfect calculations
- We did learn that optimal isn't the same as better, and it takes a long time to compute
- At the end, we had a model that we didn't expect to use a lot, perhaps for research

Our Nordic dataset

- Approx. 800 reservoirs
- Approx. 800 HPP
- Detailed modelling of Nordic and Baltic countries
- 25-55 weather years
- Ideally with load flow
- Price array from BID for GB, NL, DE and PL



Making FanSi work for us

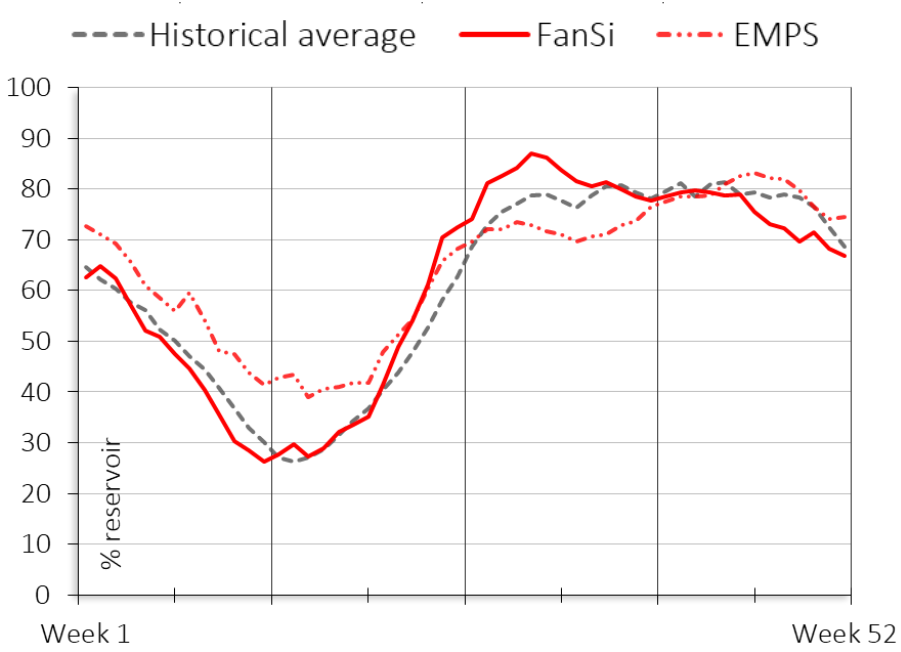
- We really want FanSi to work for us
- Realistically, a normal 5-minute EMPS simulation would take several months on our original setup
- Upgrade from 16 to 144 core servers with better CPU
- Invested in commercial LP-solver - Xpress
- Combining better servers and solvers, we hope to reduce initial simulation time by 90-99%

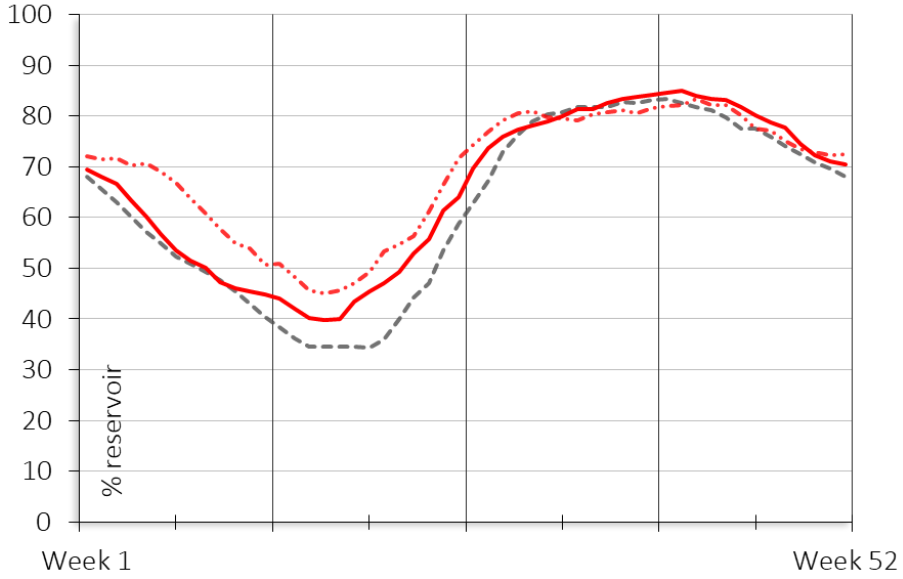
- So, is it worth it?

Results are interesting and promising so far

- When evaluating a run we consider amongst other things
  - Socio economic surplus
  - Price patterns and rational behaviour
  - Historic reservoir path
- FanSi is near target on all of these factors without user interference
- The model is still to optimal, reflecting in very flat prices

Reservoir curves close to historic values with no adjustment





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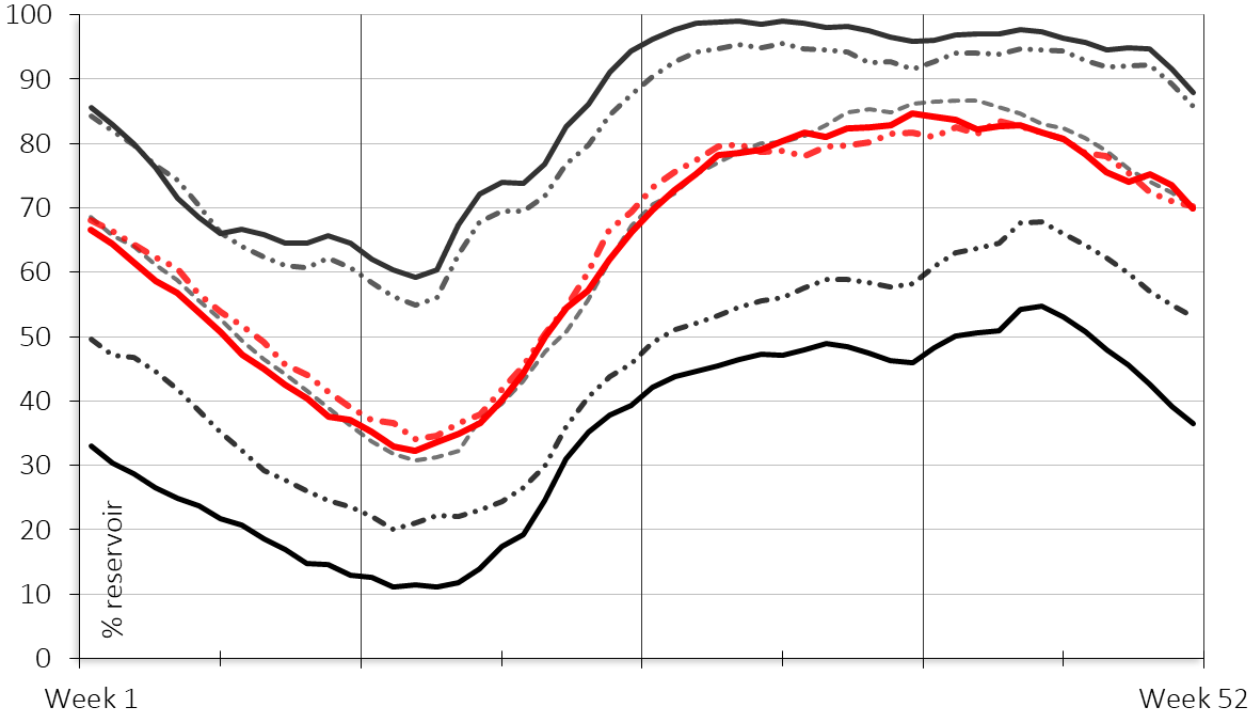
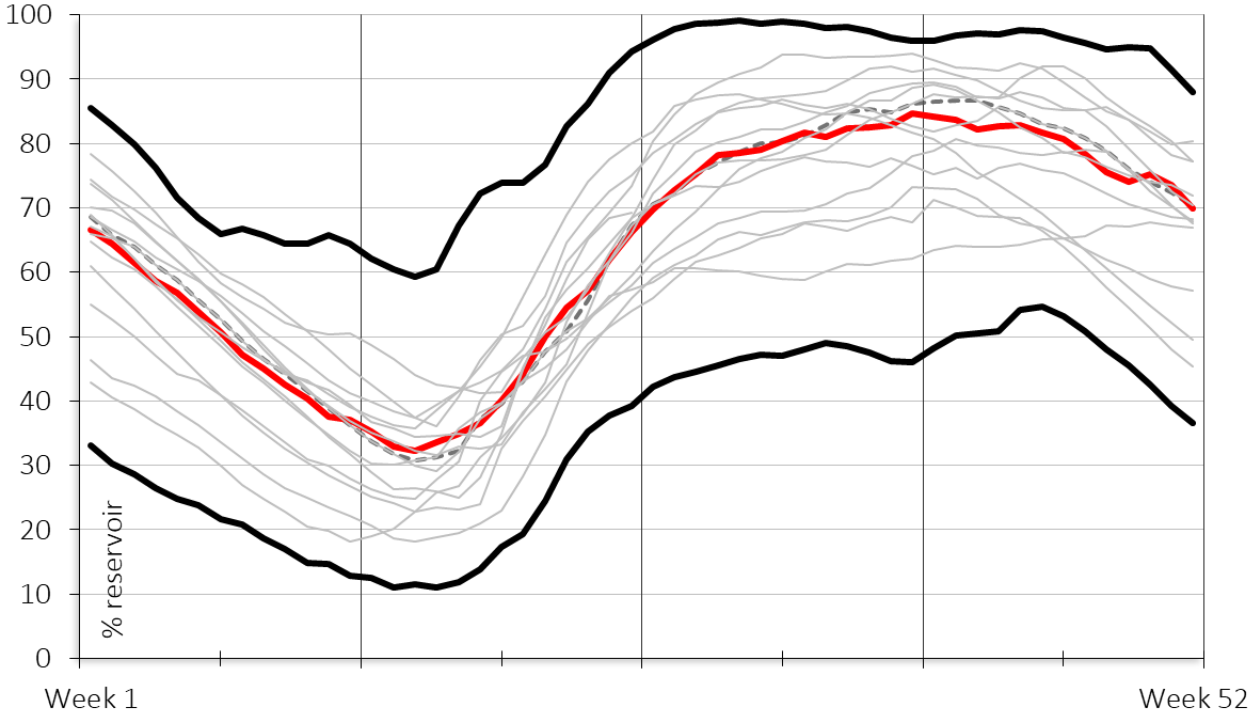
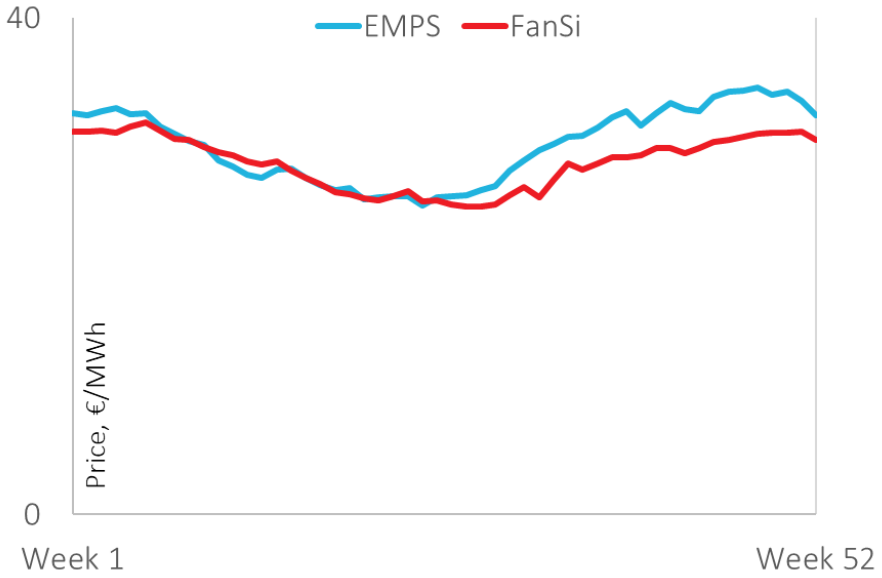
More of reservoir is in use – good or bad?

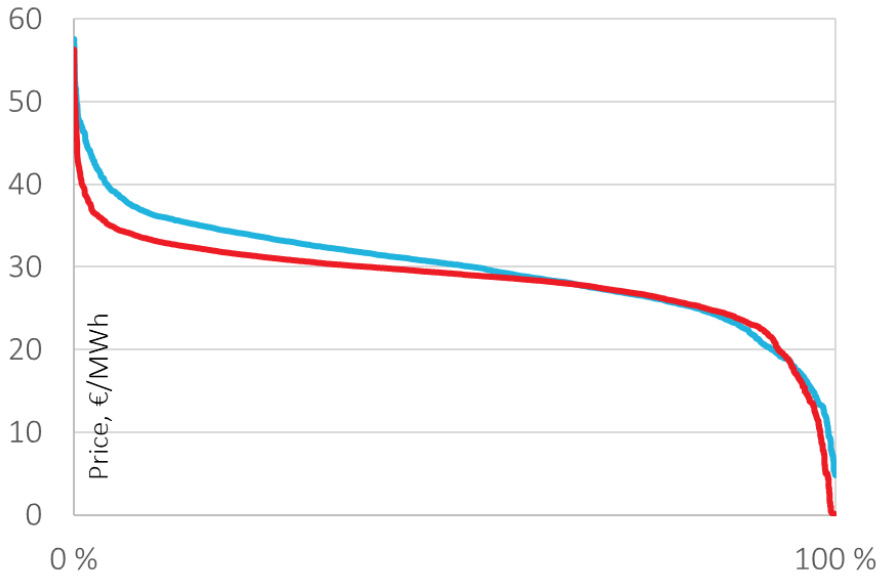


Not quite as good match with history



Price is flatter, but peak is intact





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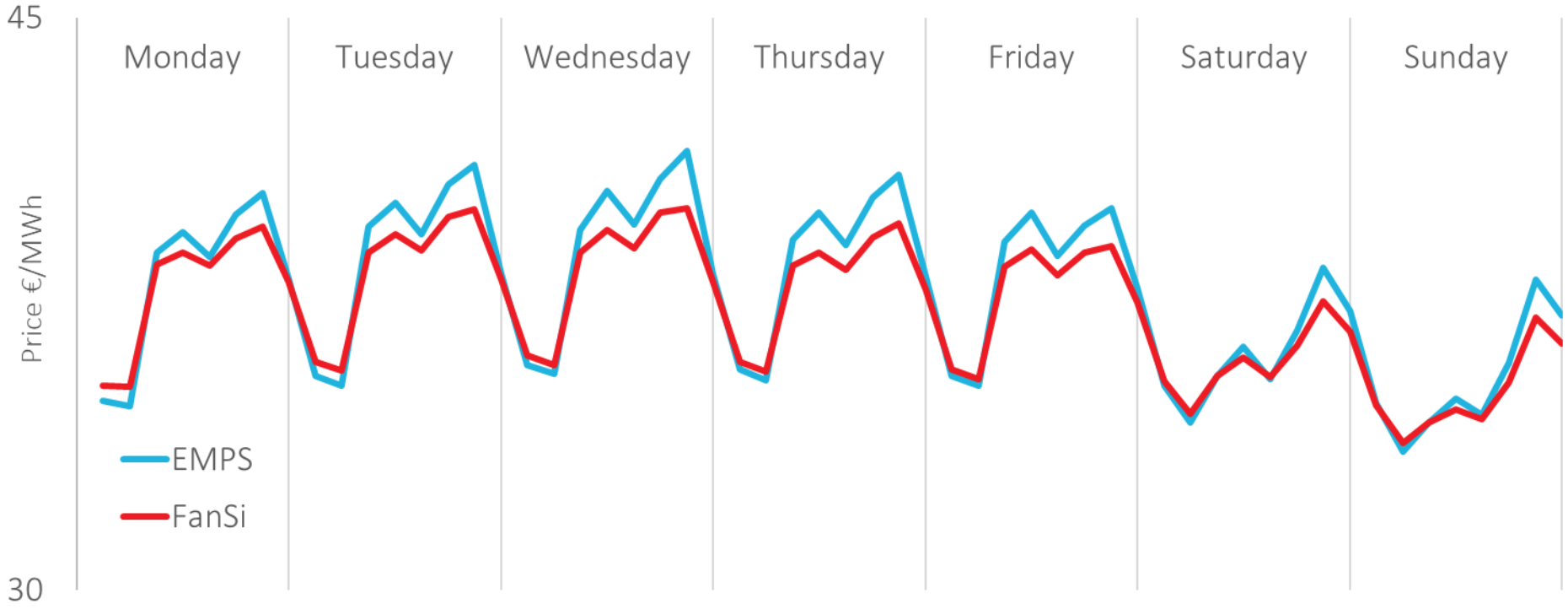
Average prices, 56 load blocks



What will we use FanSi for

- Not for everyday simulations
  - It's not necessary or convenient
- Important role for verifying other models
- Analysing problems where individual hydro power optimization is important
  - Effect of updated restrictions on multiple water courses
- Analysing problems where user tweaking is significant
  - Reservoir curves after new interconnectors to Europe
  - All changes that significantly impact hydro power strategy

Conclusion

- When development started:
  - FanSi will be the solution to all our problems
- When FanSi was complete:
  - Maybe we can use it for research?
- Now:
  - Possibly useful tool that can help us with the "big" questions
  - Servers and solvers cost roughly 1/3 FTE
    – and there are secondary benefits of having both anyway
- Future:
  - Data must be improved to utilize potential of FanSi
  - Many development possibilities, both in model and how we run it