New market model based on price decoupling

SINTEF Energy Research
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Brukermøte Produksjonsplanlegging

Outline

- **Background**
- Method
- Results
- Future work

What is ProdMarket?

- Internally financed project
  - 2014 to 2017
- Goal: Use optimization to calculate individual water values
- New market model
- Test a new iterative concept:
  - Each producer optimizes their profit assuming they are price taker
  - Each producer sends a supply curve
  - Market clearing
  - Many similarities to how the power market works

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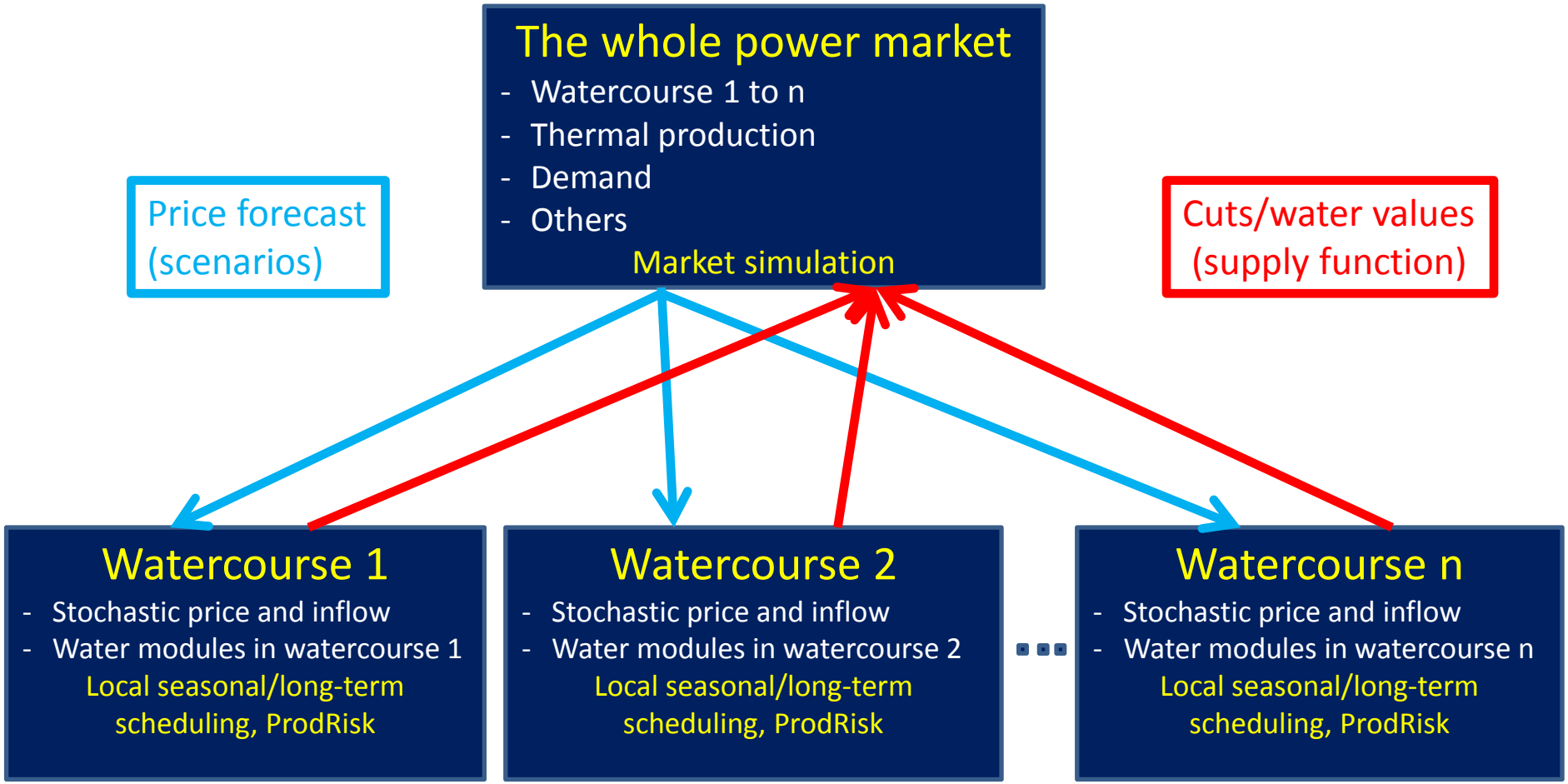
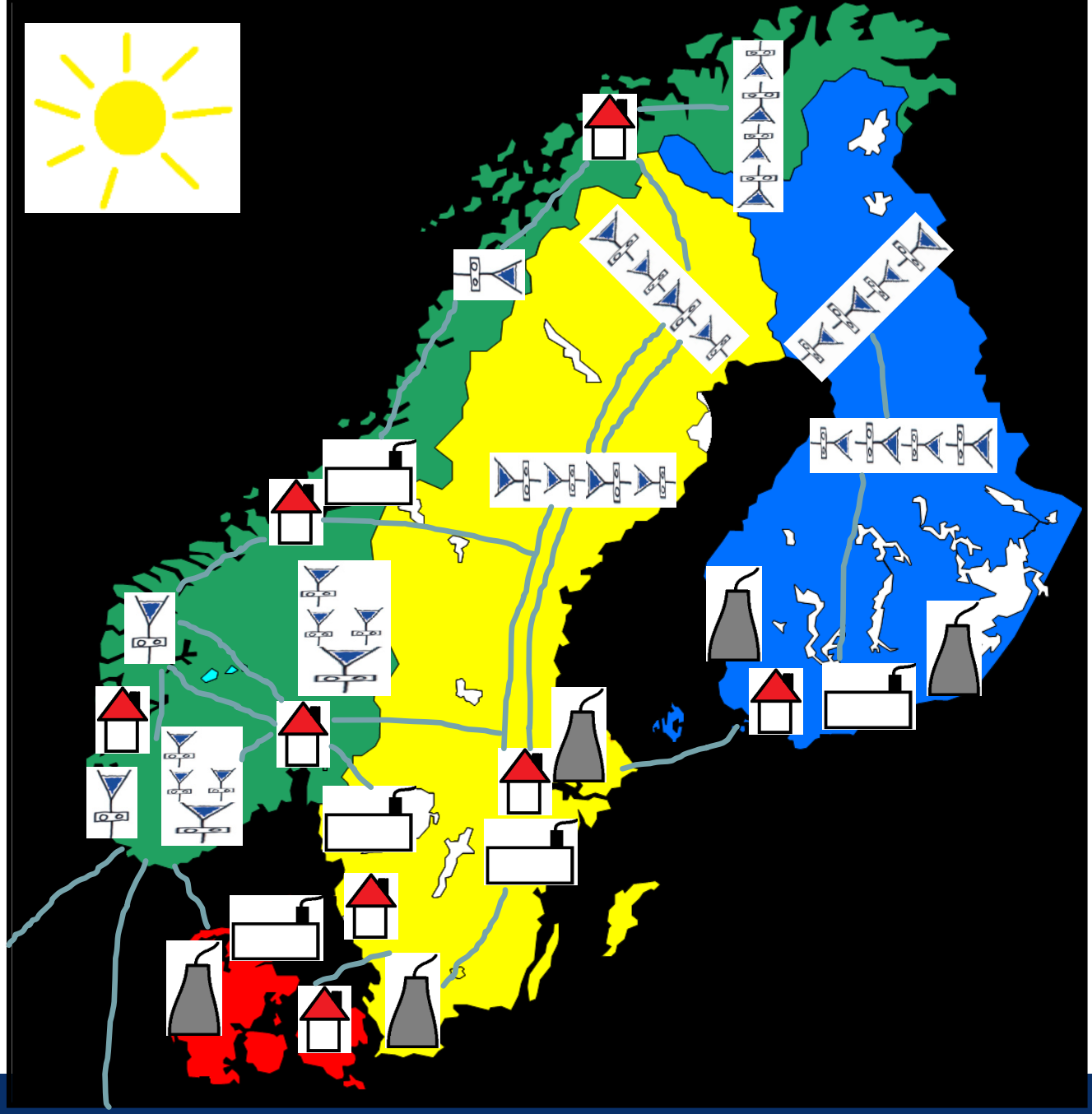
Principle in the market model



Nordic

- Power system
- Current model does not include the transmission system
  - System price



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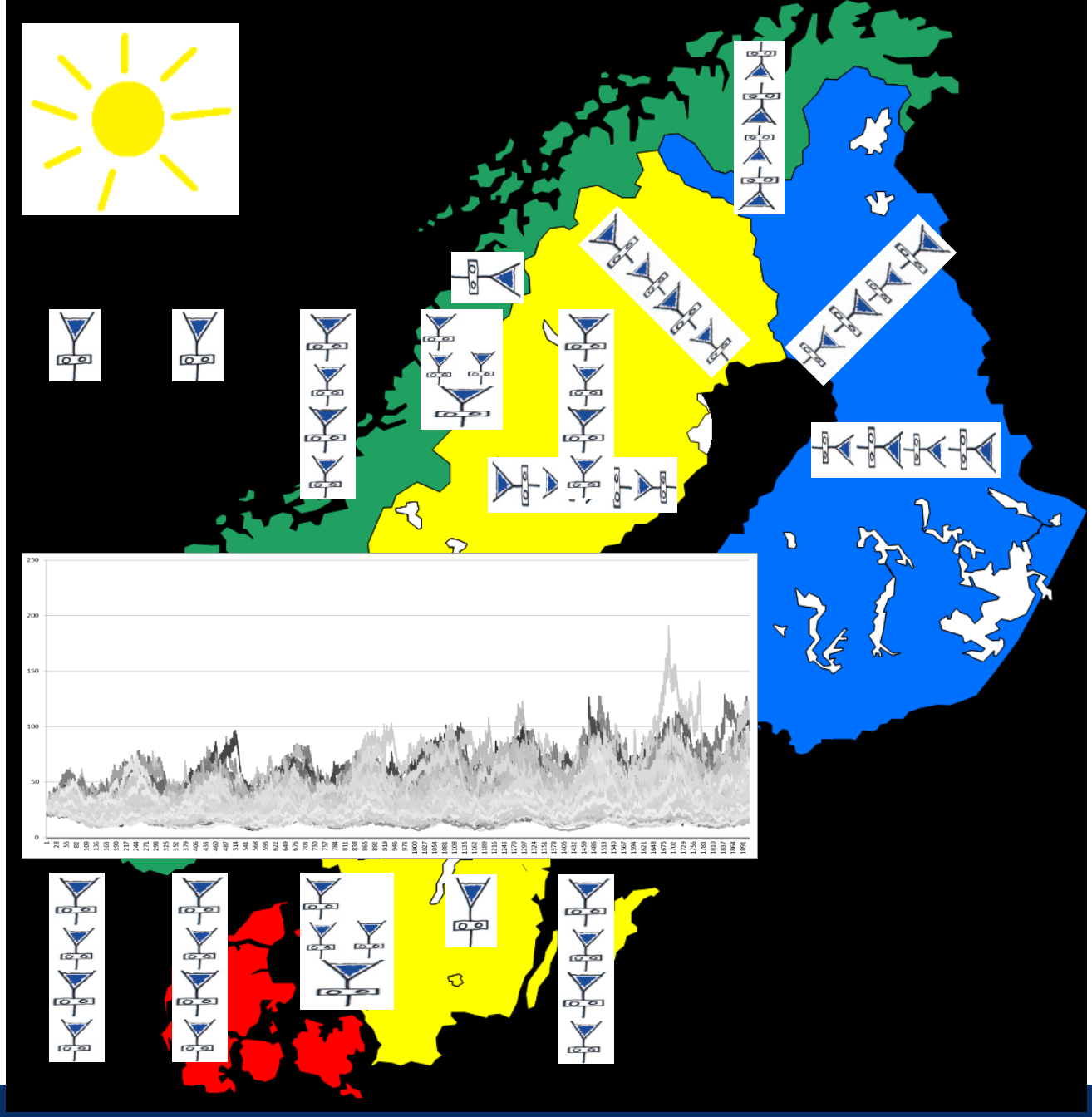
Decoupling

- Optimize each watercourse with ProdRisk
- Stochastic inflow
- Stochastic price



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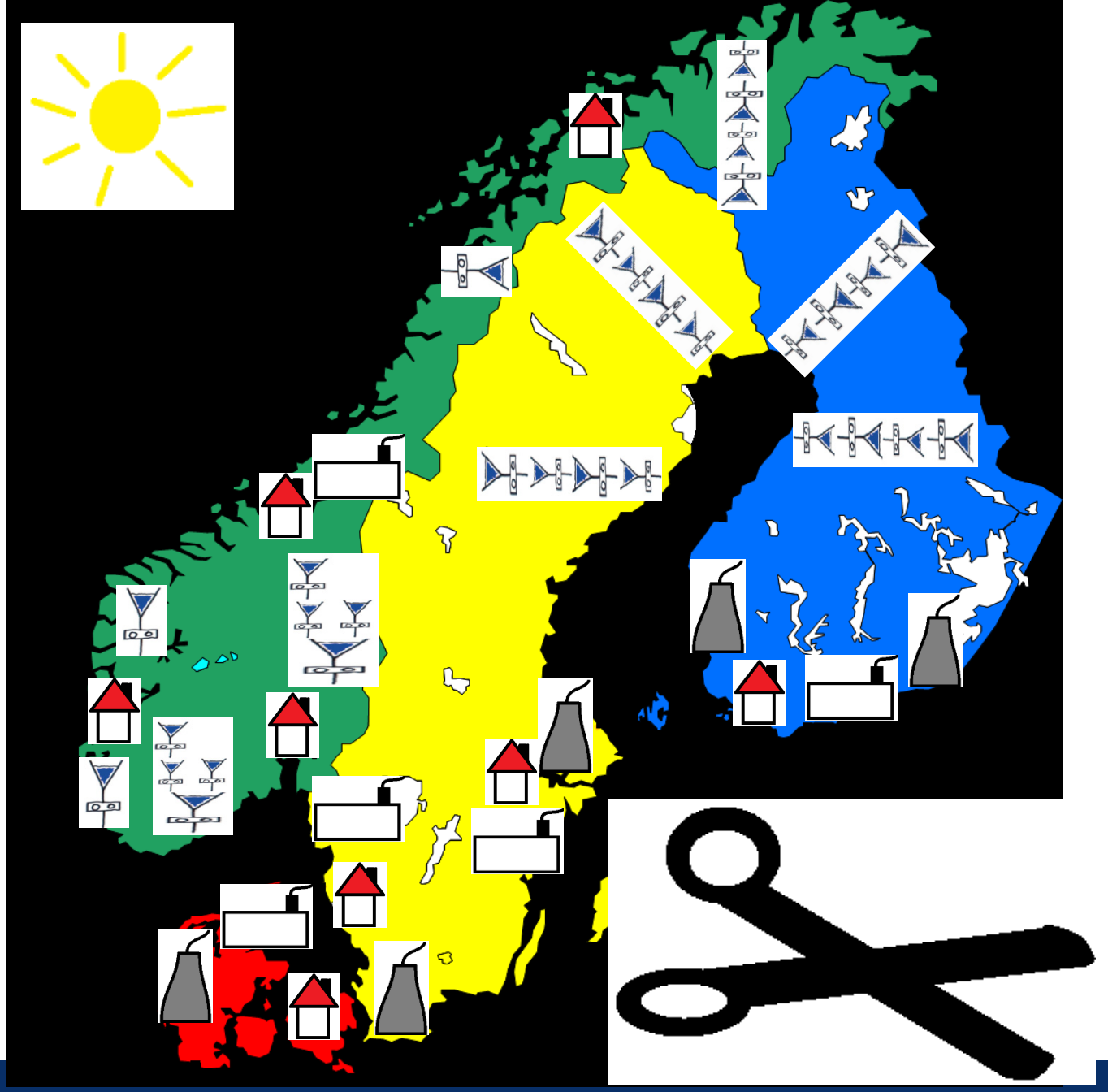
Merging

- Cut from each watercourse, supply curve
- Simulation



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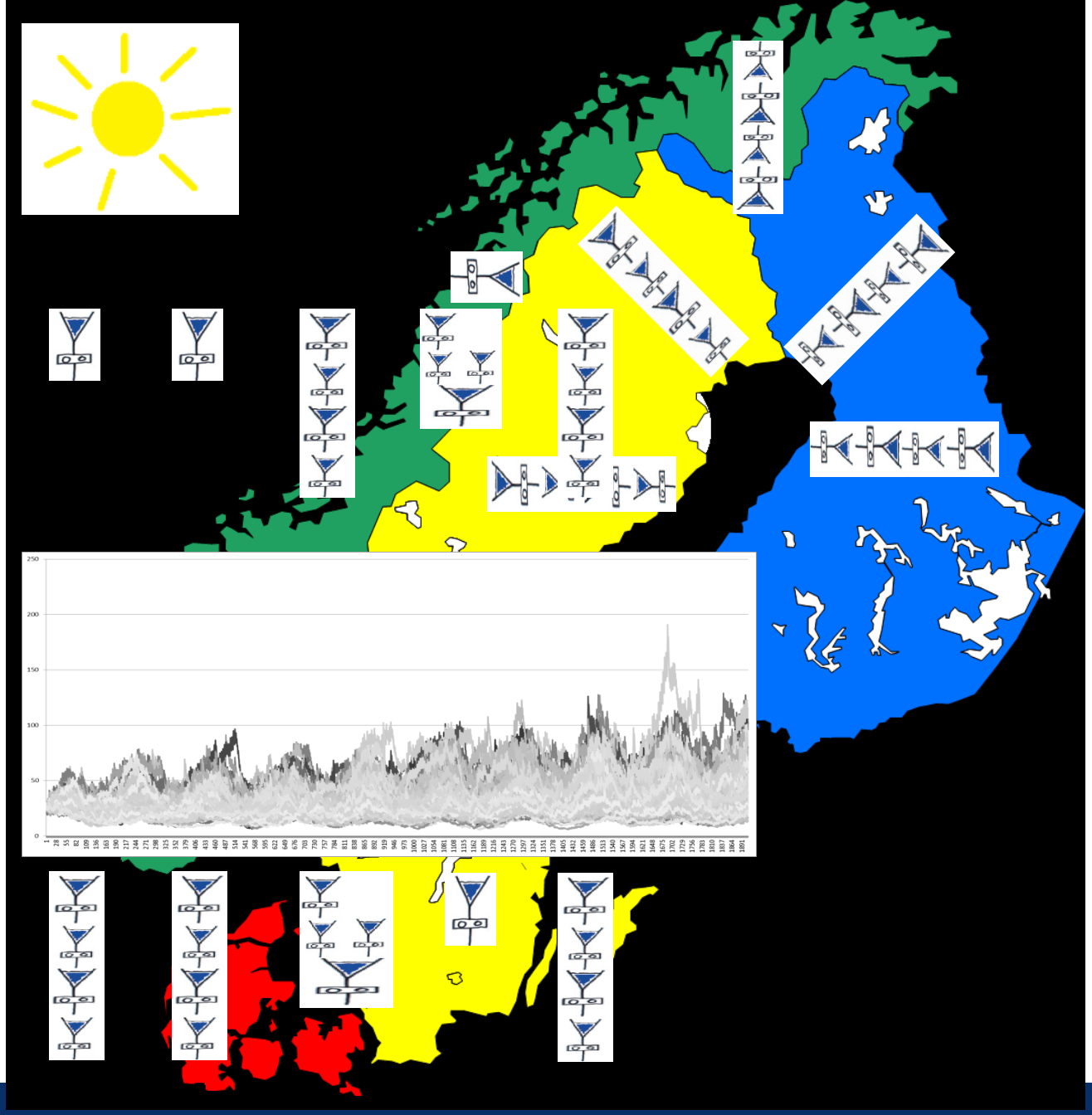
New lap



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Case study – case description

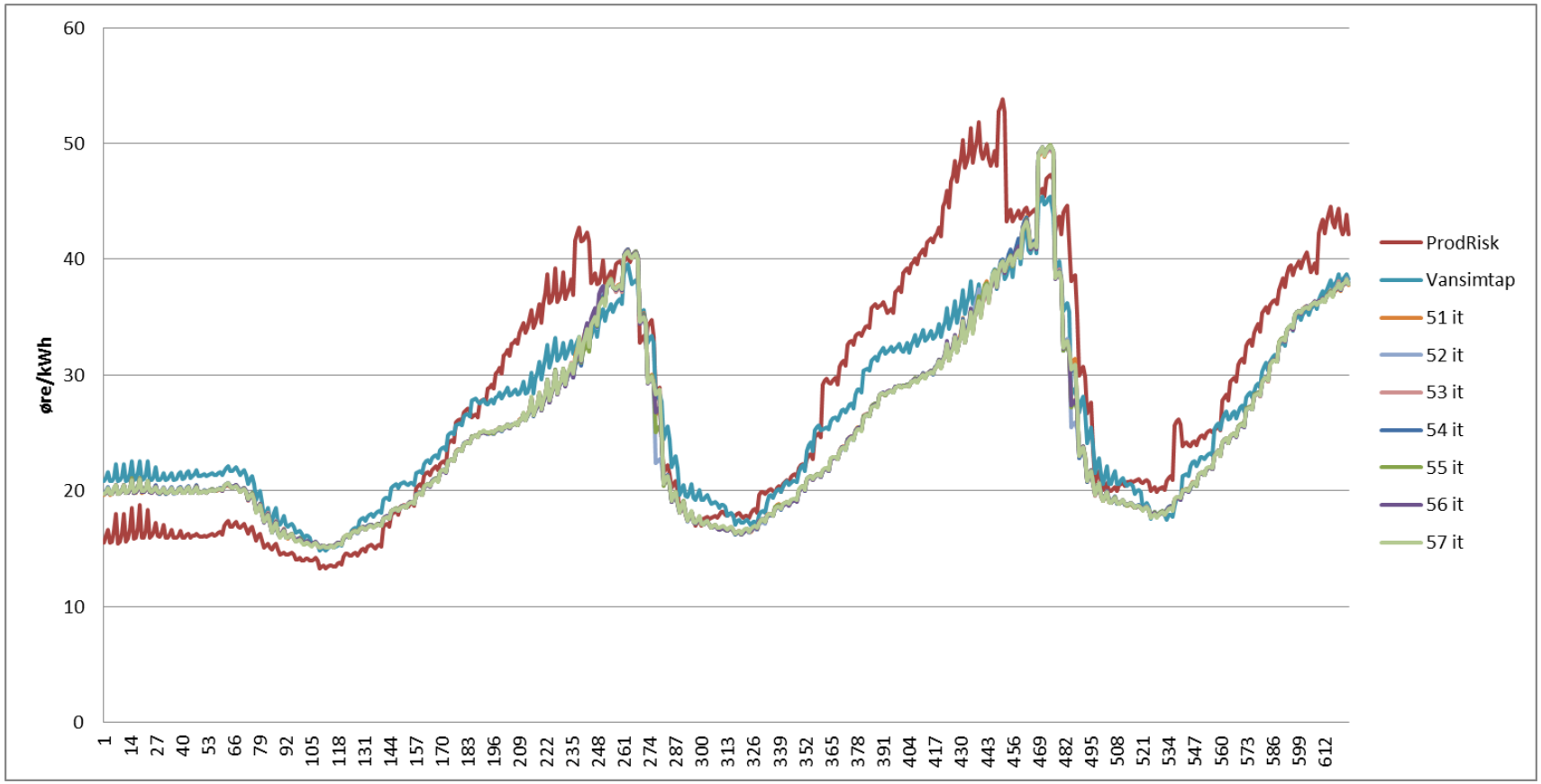
- A small Nordic system
- 50 water modules, reservoirs
  - Three watercourses
  - 2 064 MW production capacity
  - 6 000 GWh or 4 260 Mm3 reservoir capacity
- 31 733 GWh on 11 Contractual obligations
- 107 Price depending market
- No restriction on transmission capacity

- 4 number of load periods in a week
- 156 weeks in simulation period
- 50 years in the inflow statistics

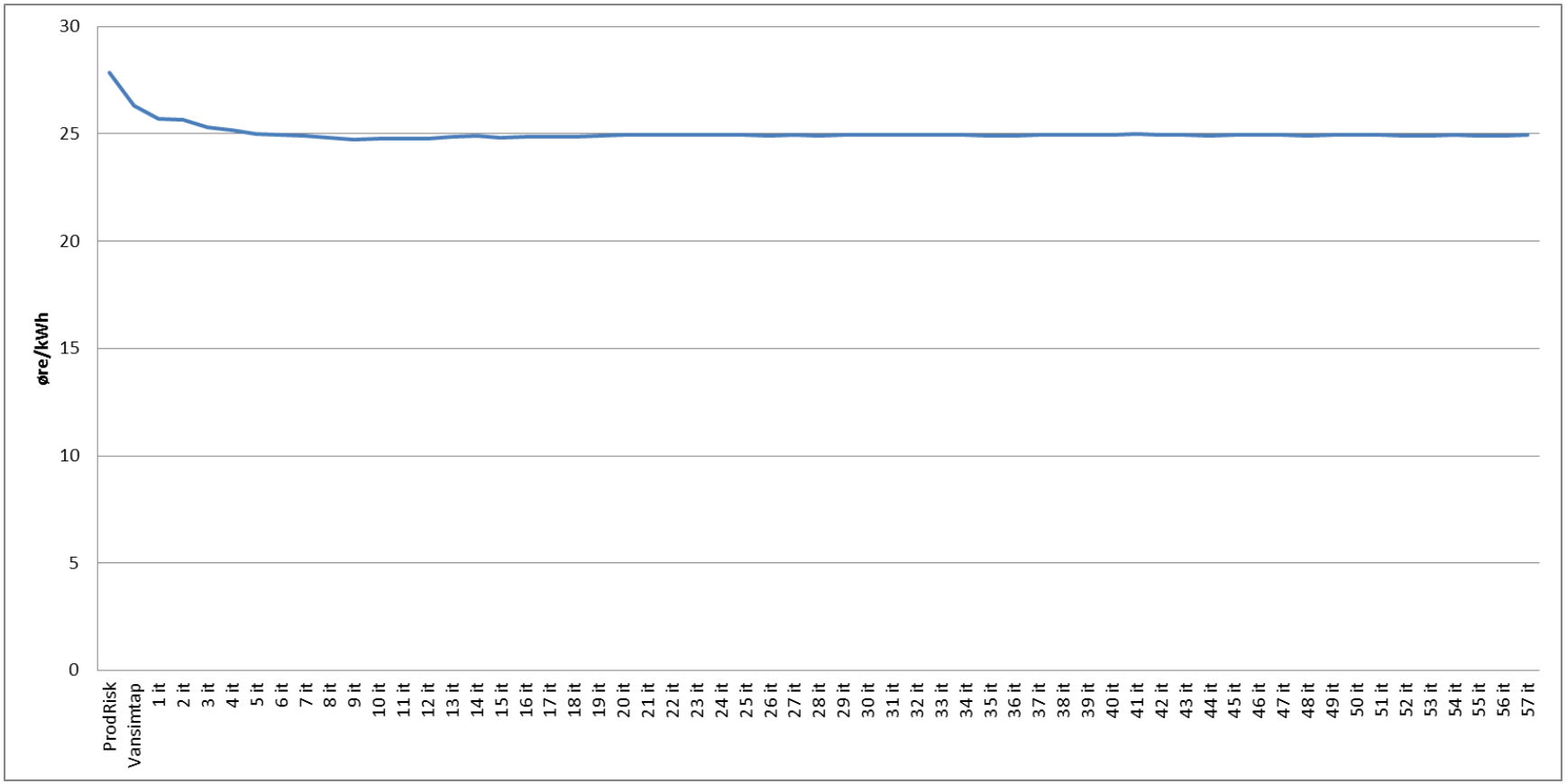
- High risk for rationing

Average power values

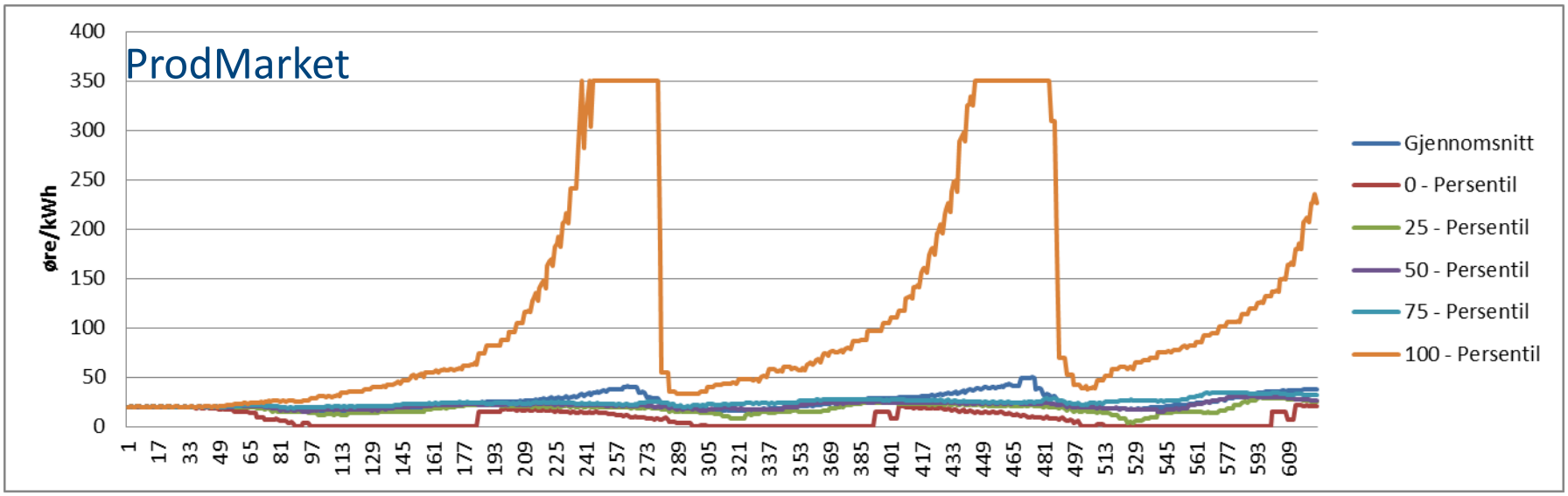
- ProdRisk and EOPS as Market Models
- 51 to 57 is iteration with ProdMarket

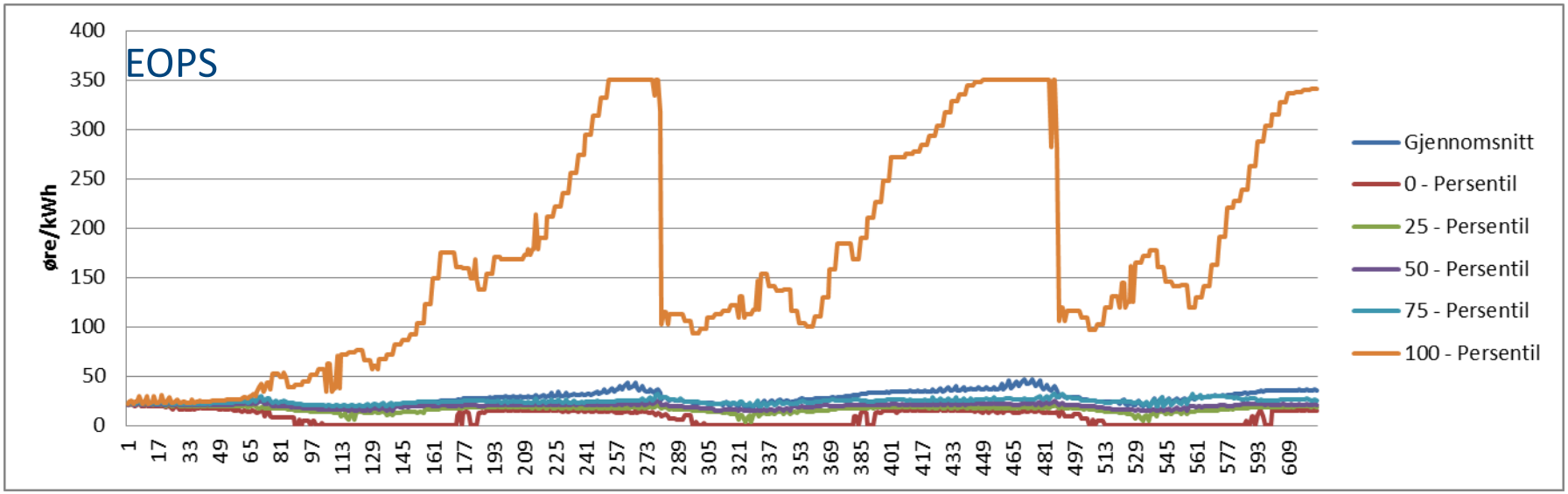


Average power values



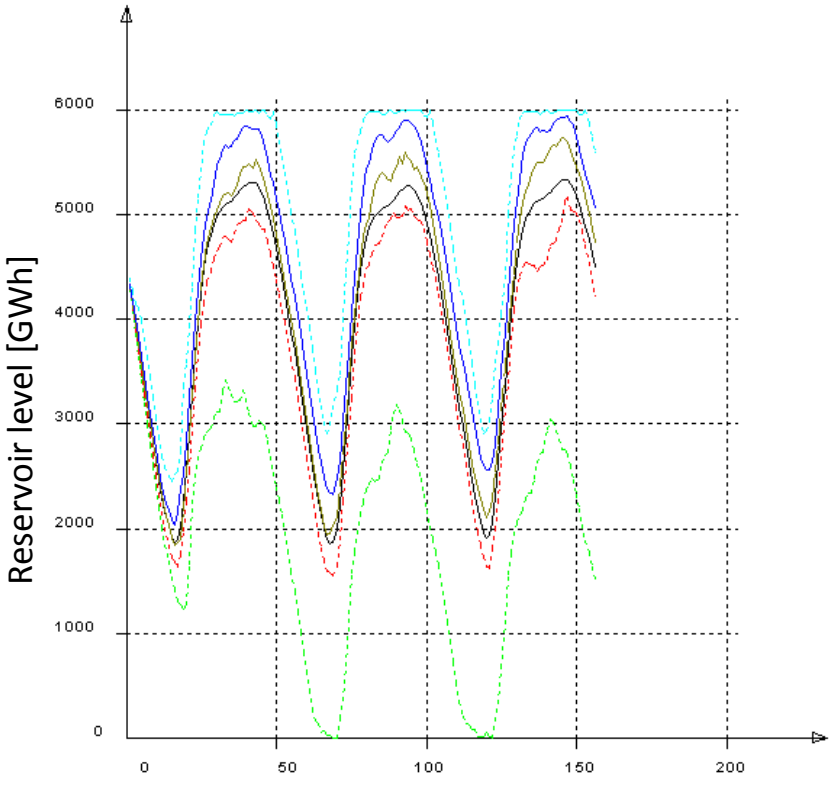
Power values



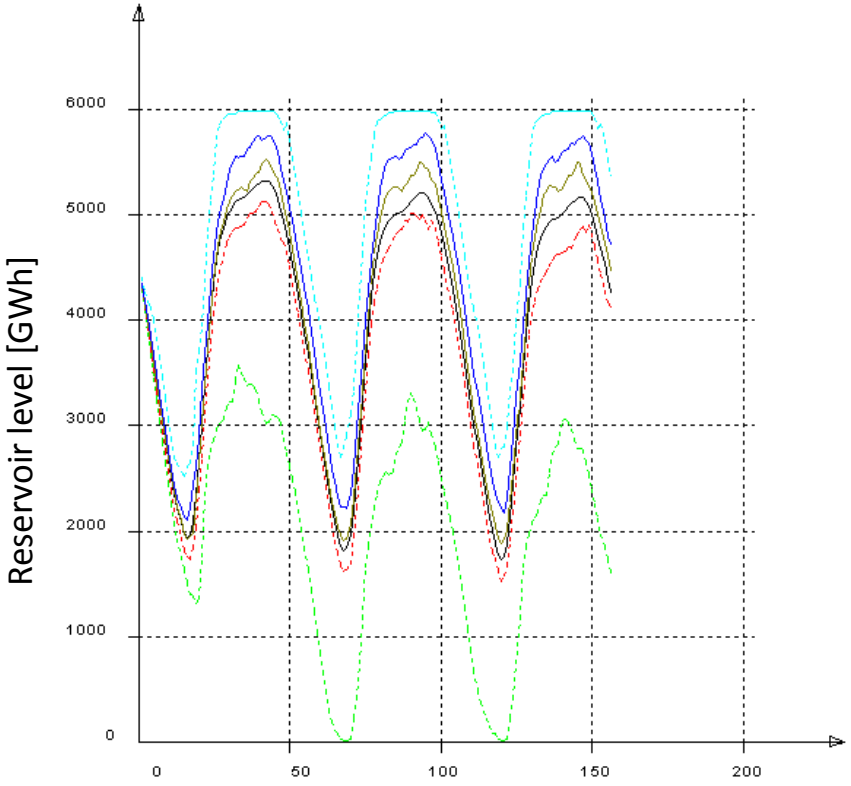


Reservoir level –
Percentiles for all reservoirs aggregated

ProdMarket

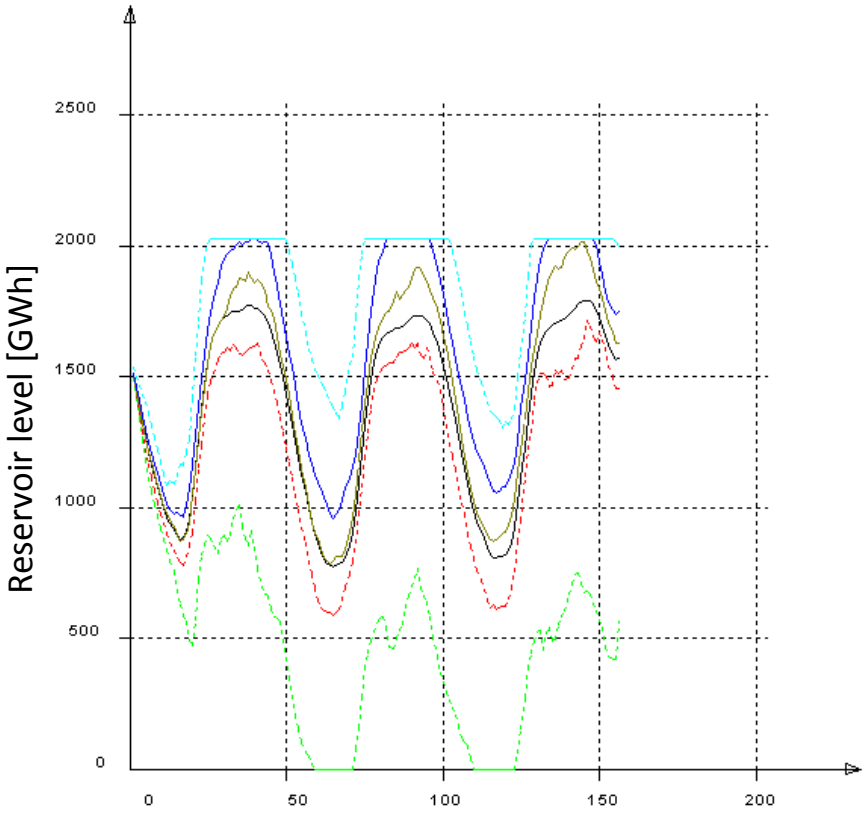


EOPS

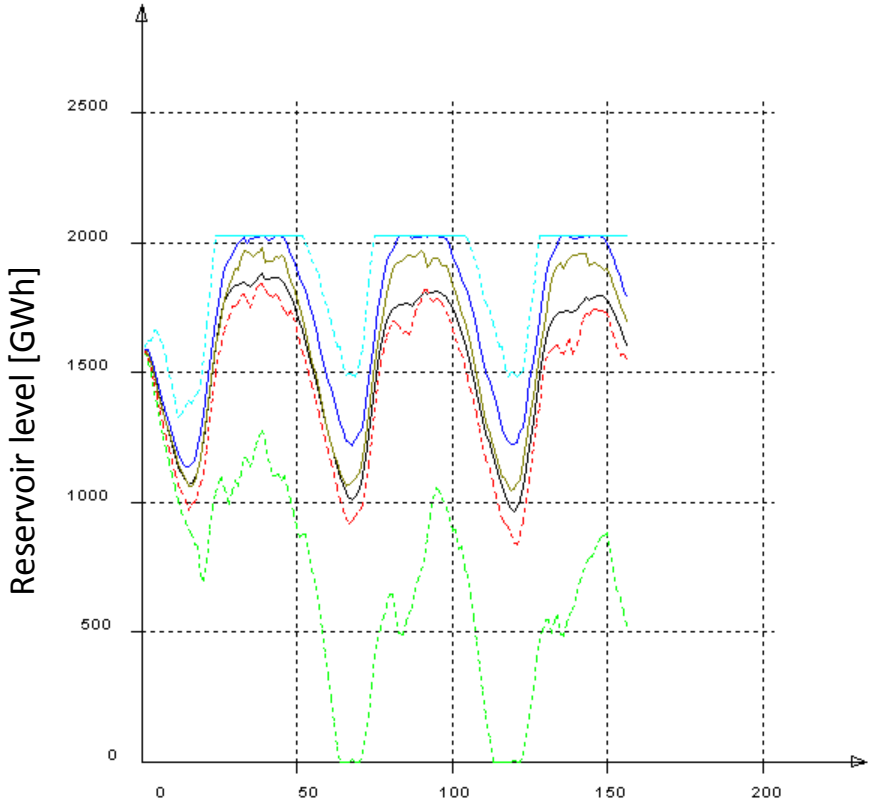


Reservoir level –
Percentiles for Vatnedal reservoir

ProdMarket



EOPS



Overview results – EOPS vs ProdMarket

Model	Hydro production [GWh]	Spillage [GWh]	Reservoir changes [GWh]	Total Costs [MNOK]
EOPS	26913,5	1 666,6	- 235,6	1 248,4
New Market model	26686,7	1 683,3	7,1	1 172,1
Differences	- 226,8	- 16,7	242,7	76,3

No revenue from hydropower

Challenges

- Iteration loop
- Convergence
- Stochastic price model
- Limited numbers of scenarios

- Time usage
  - CPLEX and COIN
  - Parallelization at several levels
- Memory usage

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Future work

- Issues
  - Convergence
  - Limited numbers of scenarios
  - Stochastic price model

- Possibility to handle large data set
  - 1 500 hydro plants, 200 water course, hourly time resolution, 1000 cuts or more for each water course
  - Reduce time
  - Memory usage

- Include transmission capacity

- Tests
  - Hydro pump storage
  - Compared to similar models (EMPS, SOVN)

Reference picture

- Left picture on the front slide:
  - http://ezhestnesk.ezpub01.byte.no/Energi-Miljoe/Paradigmeskifte-for-stroemproduksjonen
  - 04.02.2015
  - InnoDesign: Truls Berg
- Right picture on the front slide:
  - http://www.lyse.no/omlyse/
  - 04.02.2015
  - Lyse
- Picture at the second slide:
  - http://kpx.no/index.php?route=product/product&product_id=106
  - 13.05.2015
  - Kipox AS
- Picture at the third slide:
  - http://www.oldtidskundskab.dk/METODE/metode.html
  - 11.05.2015
  - Peter Sand

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