Robust and efficient reservoir operation

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Robust and efficient reservoir operation

Responsible organisation: Å Energi, Project leader: Birger Mo SINTEF Energi

Partners: SINTEF Energi, Skagerak Energi, Statkraft, Hafslund Eco, Lyse Produksjon, Hydro Energi, NVE

Project period: 2025-2028

Project type: Innovation Project for the Industrial Sector

Total Budget: 16.6 mill MOK (incl. in-kind)

Public financing: 5.399 mill. NOK

Motivation

- Experiences indicate that simulated operation from formal optimization models based on maximizing expected profit give too risky operation (Prodrisk)
  - Too early and too often empty reservoirs

- Increased focus from Government on individual producer's reservoir operation
  - From the parliamentary proposition. Pro 33L: "Required to develop reservoir operation strategies that contribute to security of supply"

Causes for too risky operation

- Risk aversion is not represented
- Extreme events is underrepresented
- Lack of physical modelling details give to high flexibility
- Outages is not represented

Project activities

- Formal handling of risk aversion in Prodrisk
  - Build risk modelling competence for stochastic optimization problems.
  - Conditional value at risk (CVaR)
- Representation of extremes and outages
  - Develop a simulator (EMPS-Prodrisk) to be used for:
    - Verifying reservoir management from seasonal planning .
    - Improving the price model in seasonal planning
- Other methods that methods that can be used to give robust and efficient reservoir operation in Prodrisk

Status

- Consortium agreement
- Start project work i June

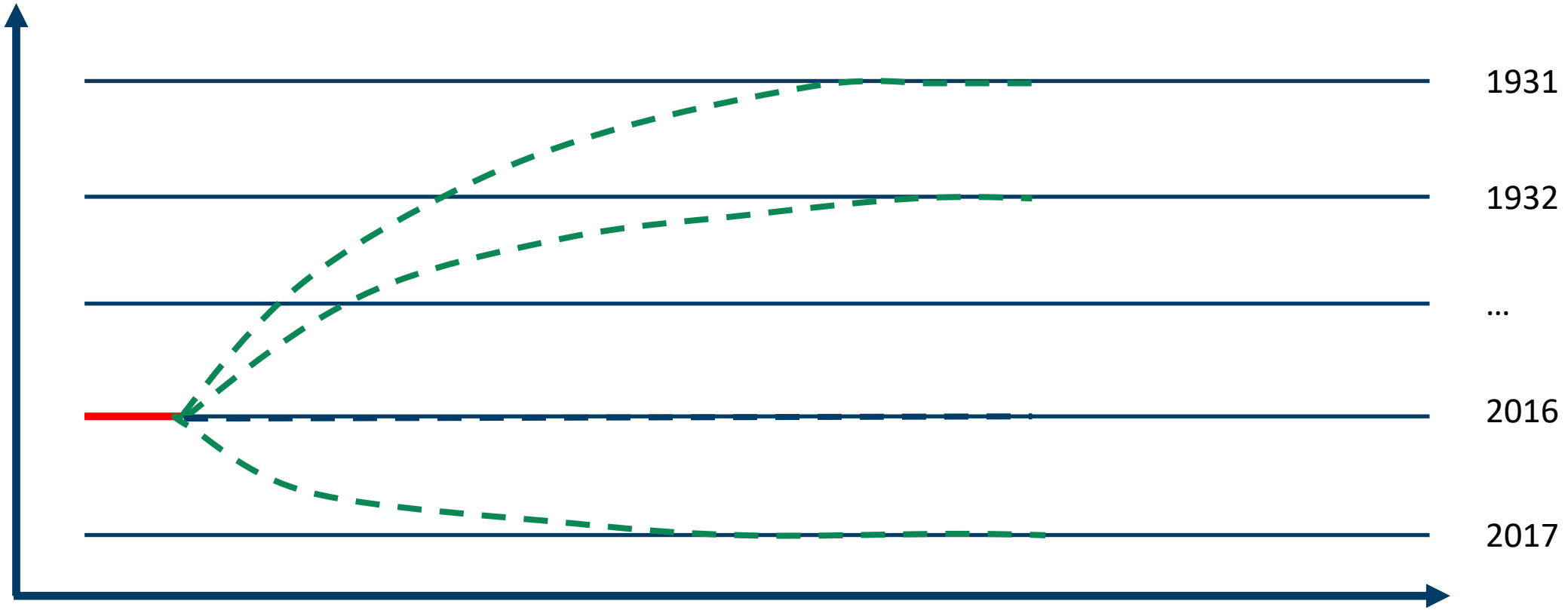
FanSi with CVaR

Historical Records

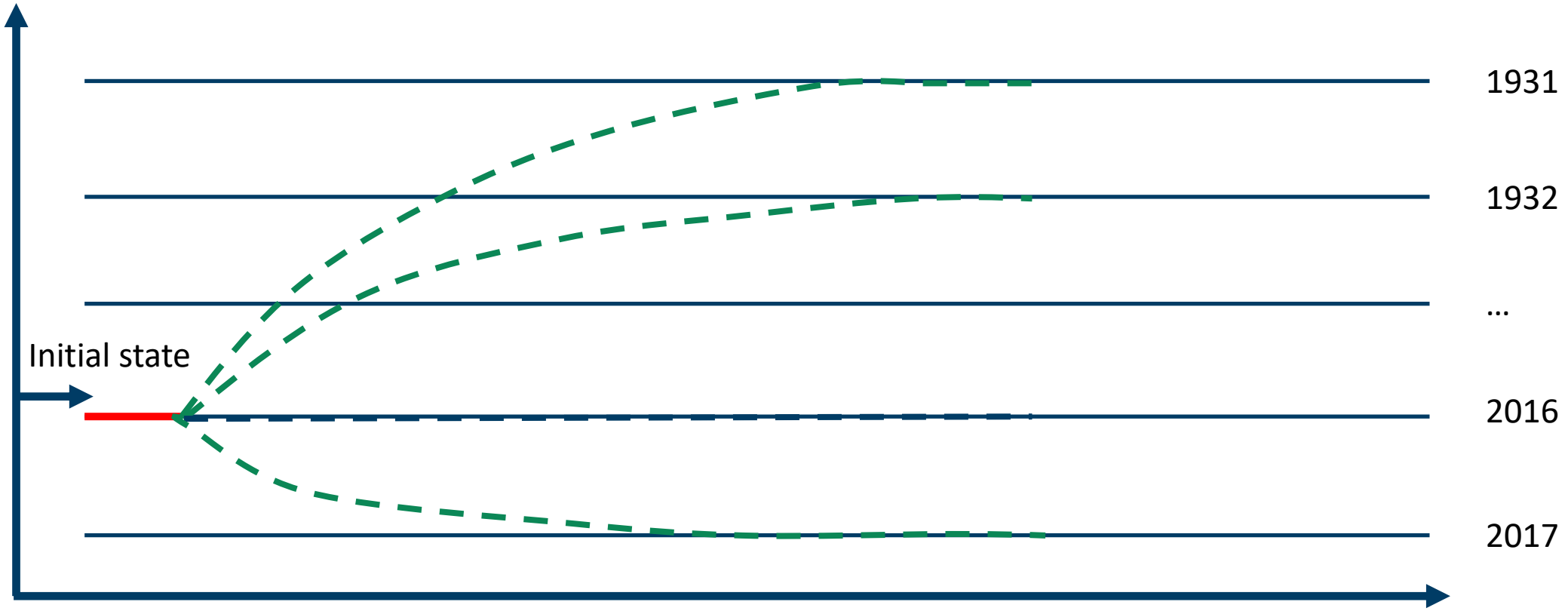
- Inflow and snow pack
- Wind and solar power
- Temperature-dependent demand
- Exogenous market prices
- Etc.

We form a two-stage scenario fan problem

- **First-stage:** current week
- **Second-stage:** week 2 –> end of horizon



Example: Simulate operation for year 2016



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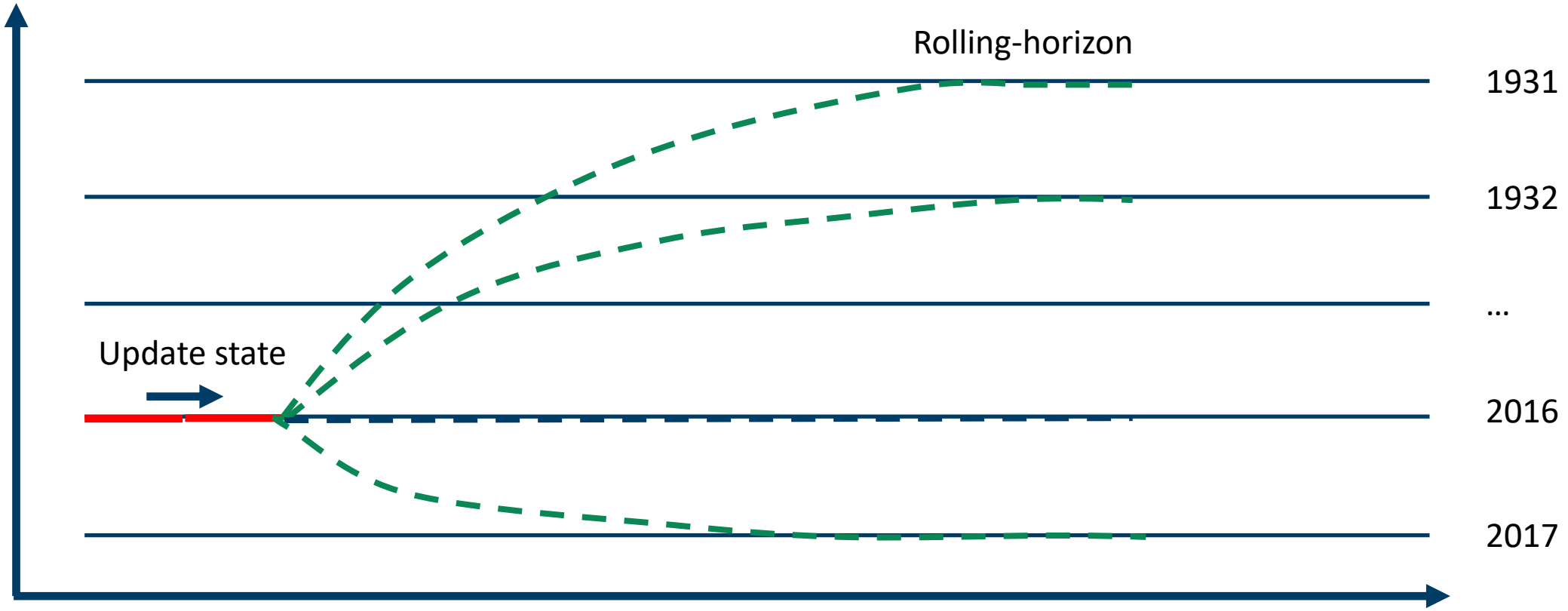

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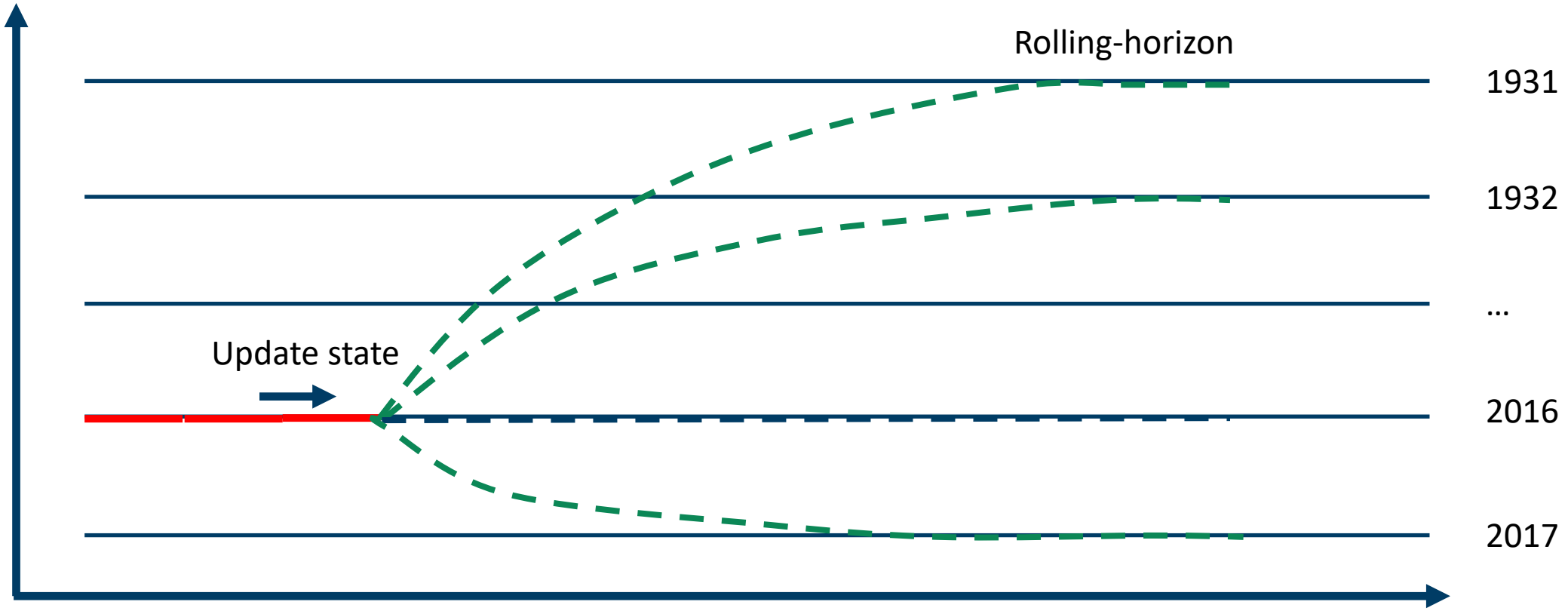


FanSI with CVaR

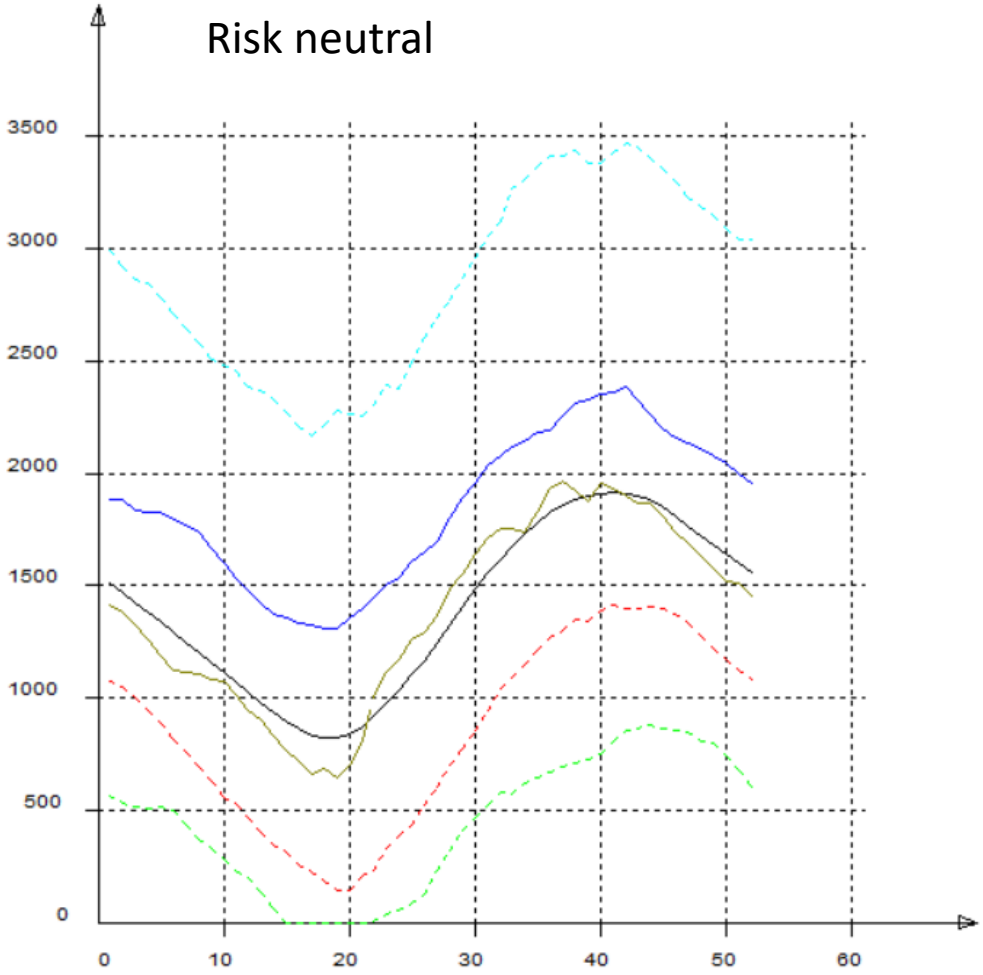
- FanSi - market model based on formal optimization
  - Method also implemented in ngLTM
- Observed similar reservoir operation from FanSi as observed in ProdRisk
- Implemented CVaR functionality in FanSi last autumn
- Show result from preliminary testing

Test dataset

- Dataset representing a detailed model of North-Europe referred to 2030
- Two cases
  - Risk neutral
  - Risk averse (50 % weight on 10 % worst scenarios)
  - 35 scenarios (the same number as used in the simulation)

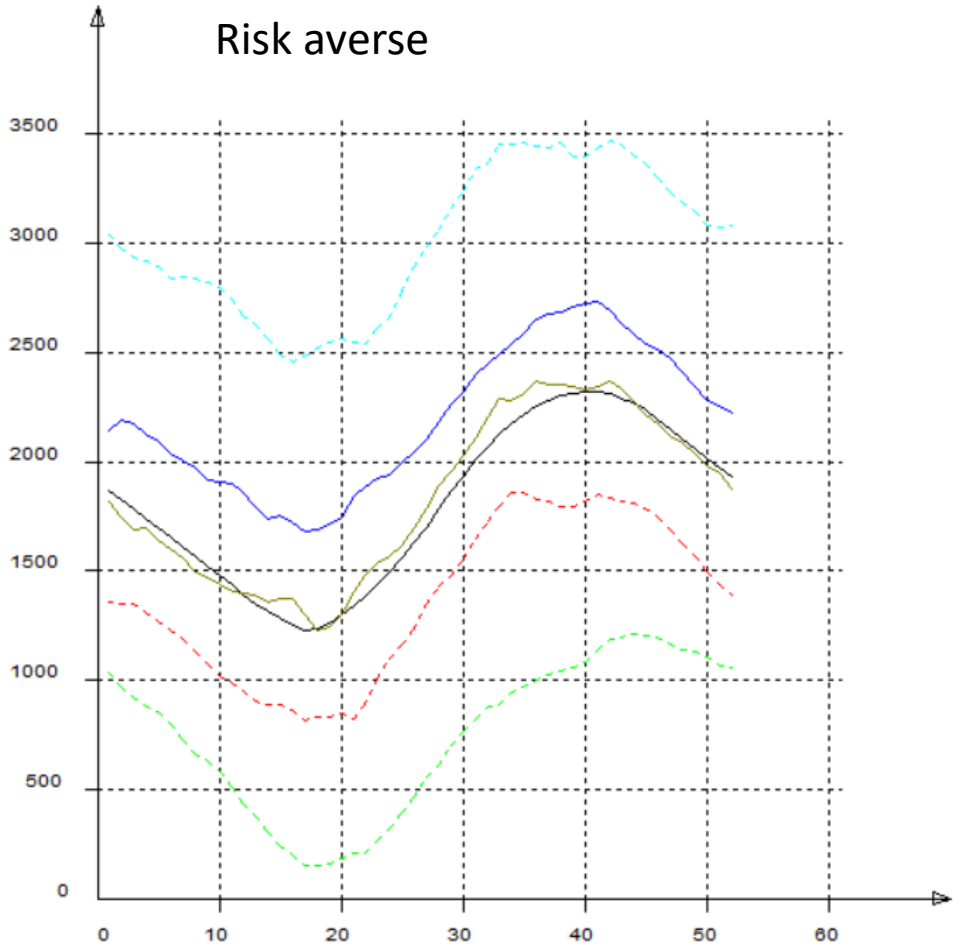
Reservoir filling - Svartisen

Risk neutral



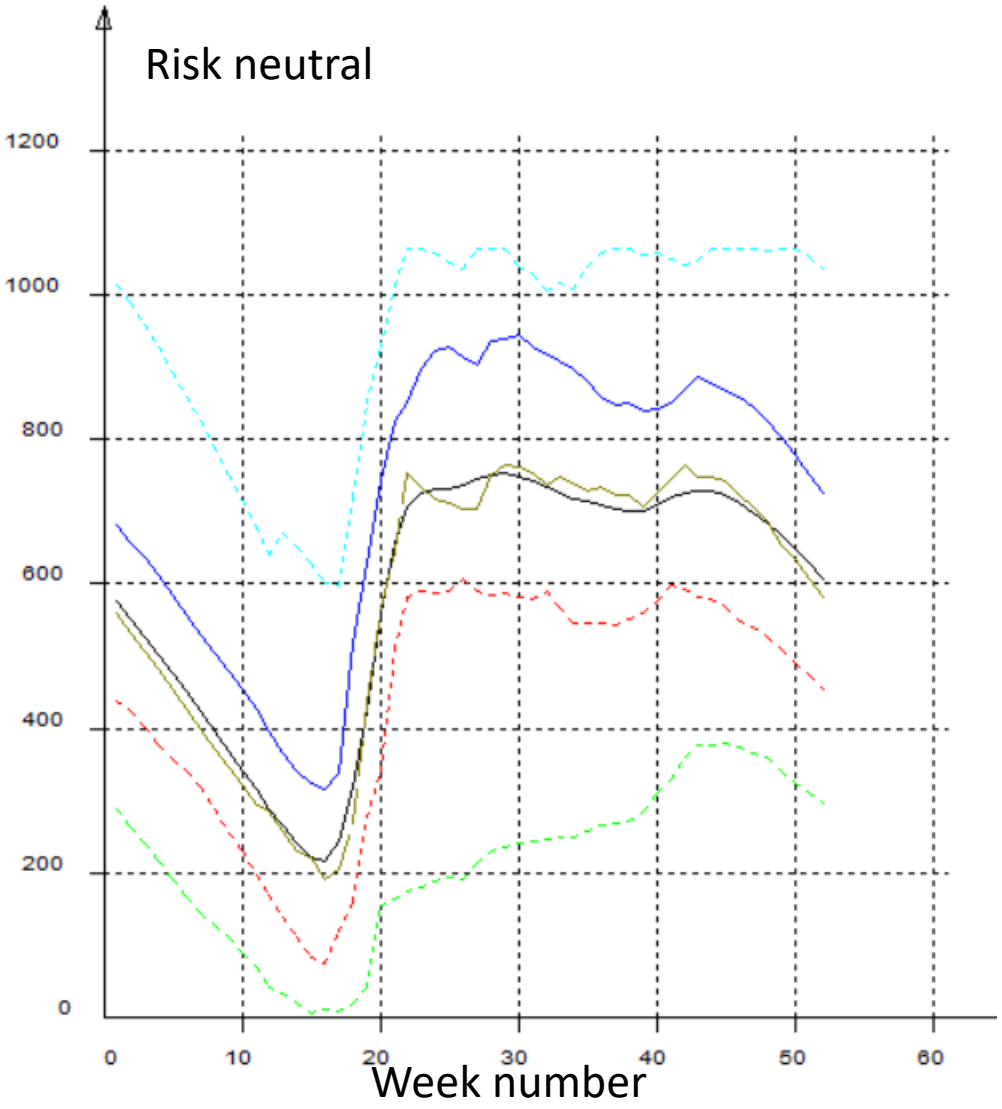
Week number

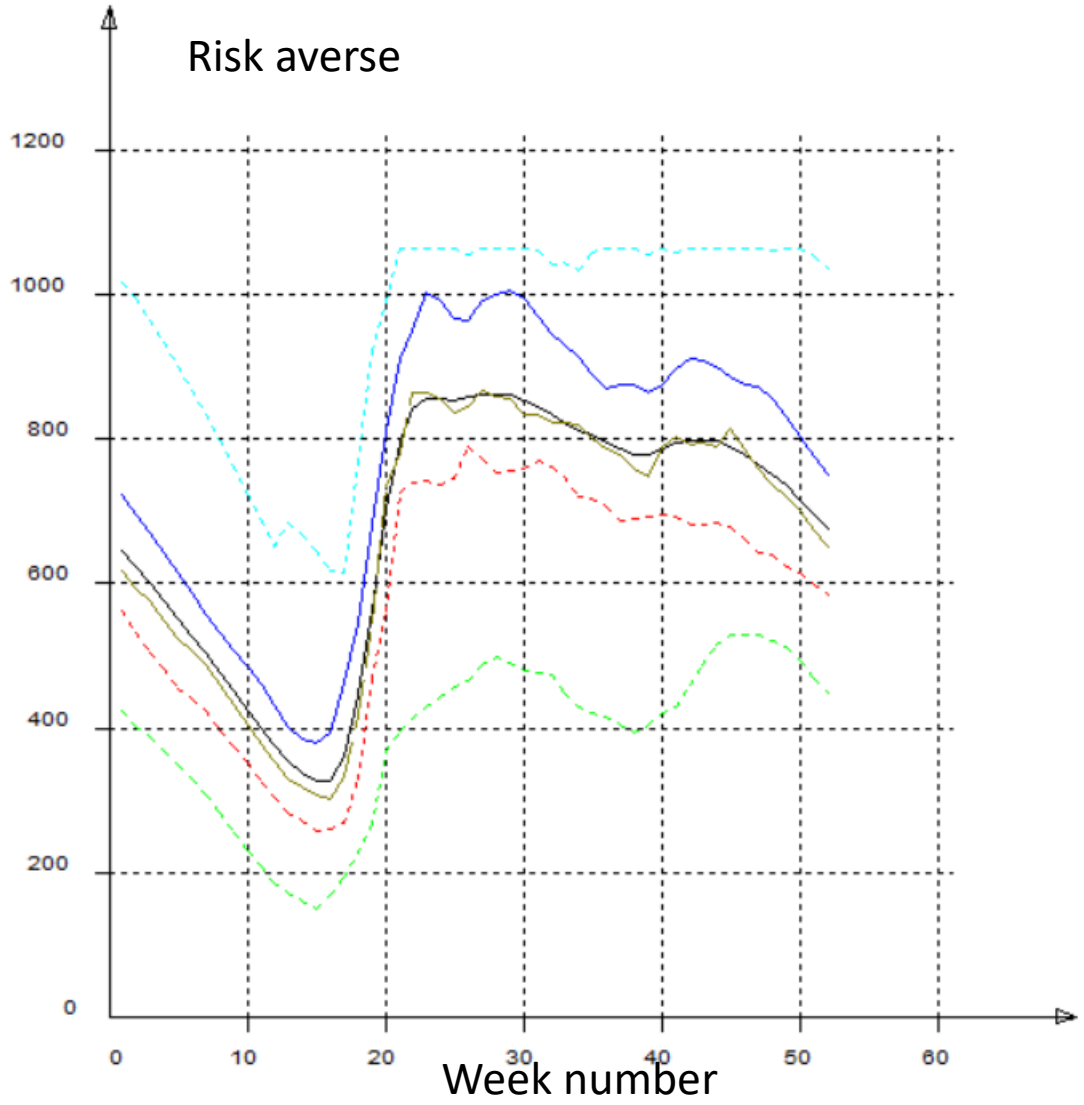
Risk averse



Week number

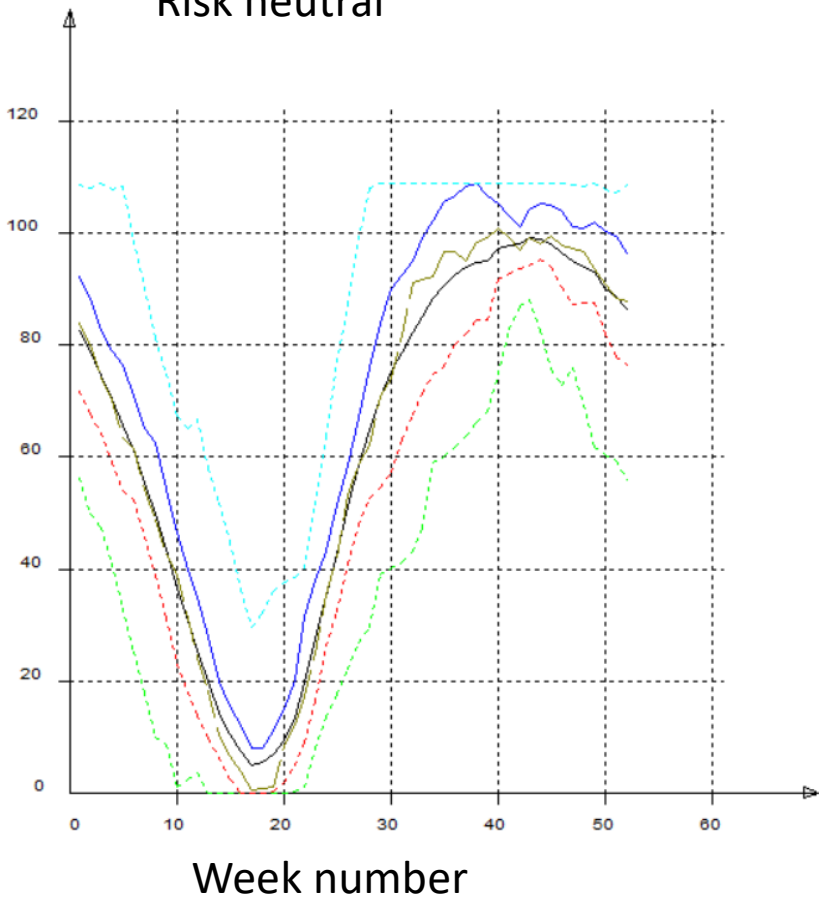
Reservoir filling - Møsvann





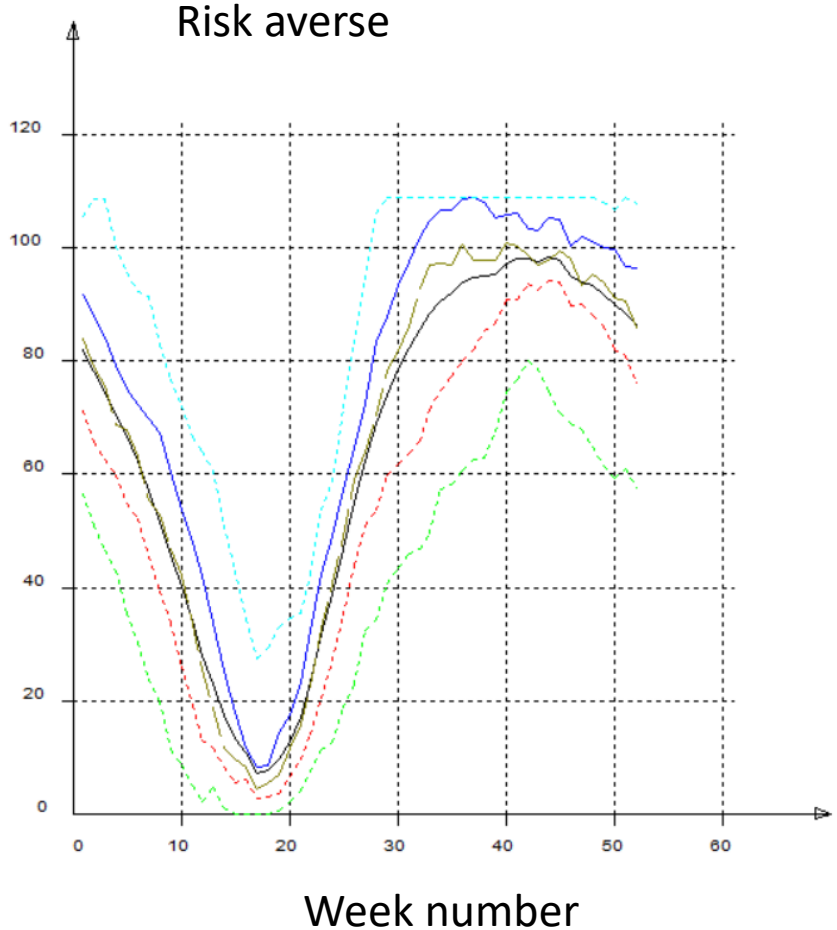
Reservoir filling - Herva

Risk neutral



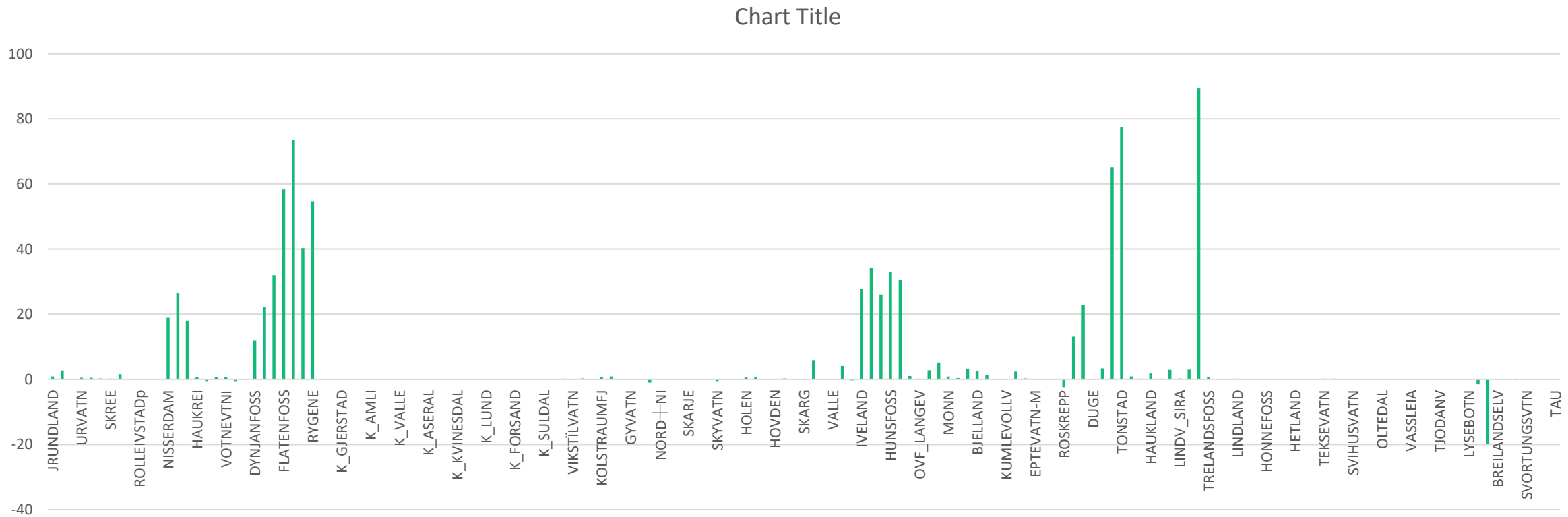
Week number

Risk averse

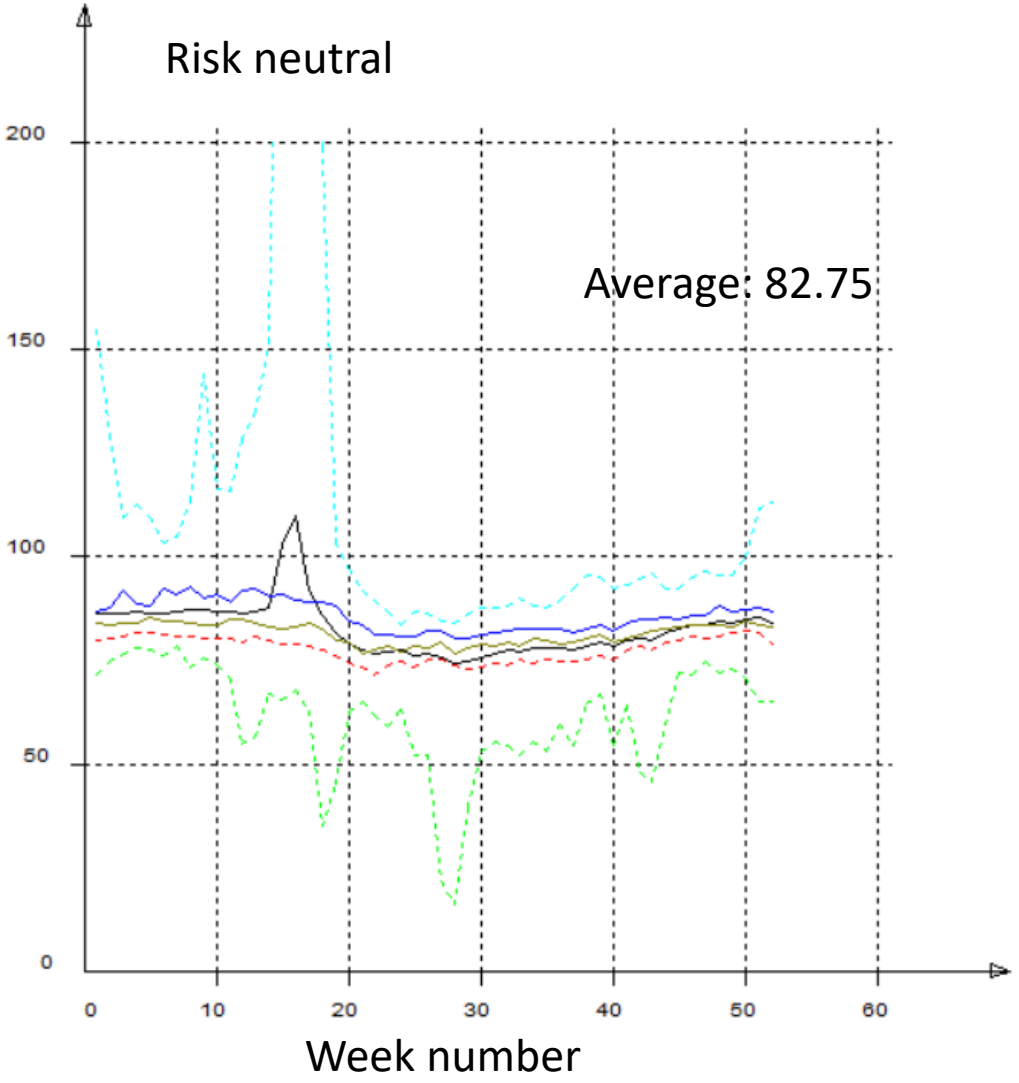


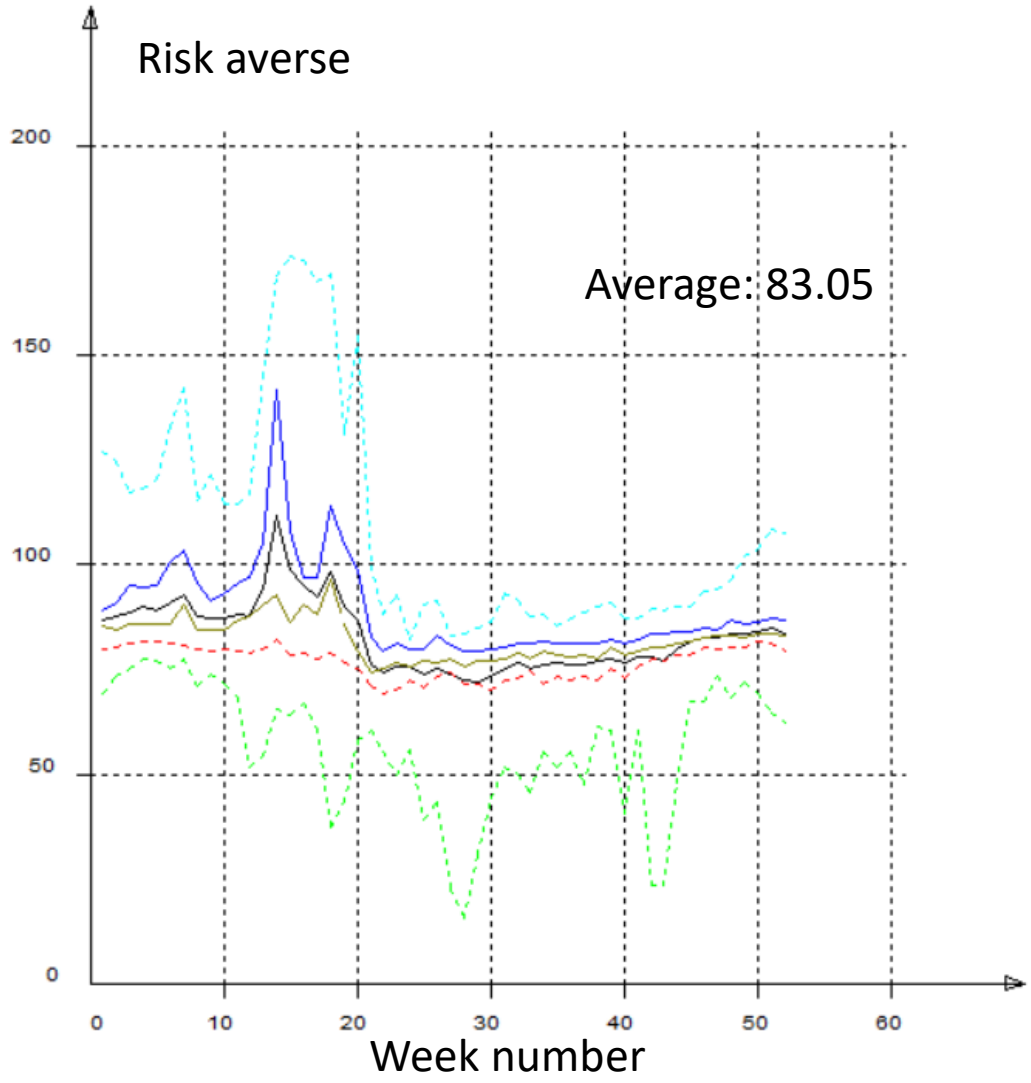
Week number

Changes (overflow+ bypass) (MM3) (SORLAND)



Prices Ostland





Changes in socioeconomic surplus (Mill NOK)

	Risk averse	Risk neutral	Diff (averse-neutral)
Norge	466822.1	466995.2	-173.1
Sverige	480679.9	480683.8	-3.87
Finland	189078.4	189086	-7.63
Danmark	121058.6	121054.9	3.74
Tyskland	1711788	1711774	13.54
GB	1088401	1088387	14.72
Polen	543635.1	543619.4	15.71
…			
SUM	6893396	6893524	-127.3

Concluding remarks

- CVaR seem to work fine for the FanSi model
  - Cost minimization for the whole system
  - “calibration” with few parameters
- The local problem addressed in the IPN project “Robust. . “ is very different:
  - Producer is a price taker.
  - Maximizing profit and no demand obligations
  - Solution methodology is different
- CVaR for SDDP but including some automatic allocated local load obligation.
  - Want to avoid dependence on actual financial obligations

SINTEF

75 år

75 år med teknologi for et bedre samfunn

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