Flow-based vs ATC market coupling in the Nordic Power Market

Method and Simulation results

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Outline

- **Background**
- Method
- Simulation results

Background

- The current day-ahead market clearing coupling is based on **Available Transfer Capacities** (ATC).
- **Flow-based market coupling** (FB) has received increasing attention among responsible parties in Europe, and is currently being tested as a common coupling algorithm for all markets in the Central Western Europe (CWE) region.
- SINTEF Energy Research ran a project for Statnett in 2012 where the overall aim was to quantify the benefit of shifting from a ATC to a FB market coupling scheme.
- Comparison between the two market coupling methods is done by use of two EMPS-based simulation programs: Samlast and Samnett.

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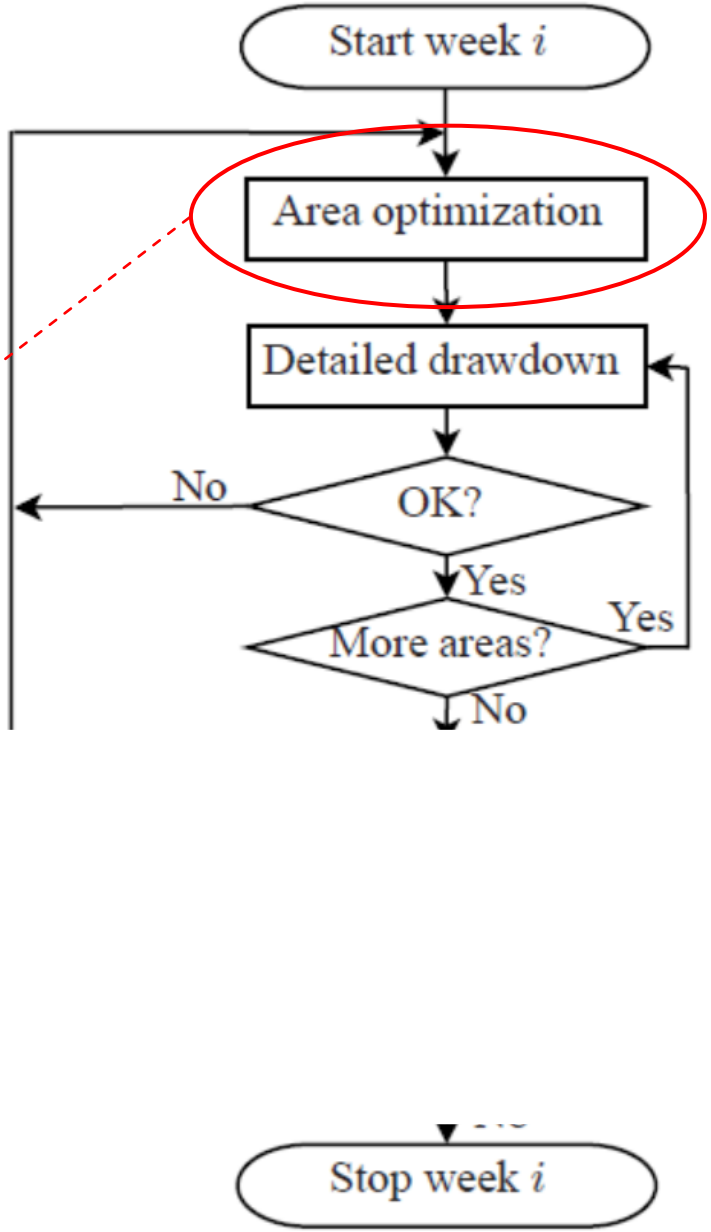
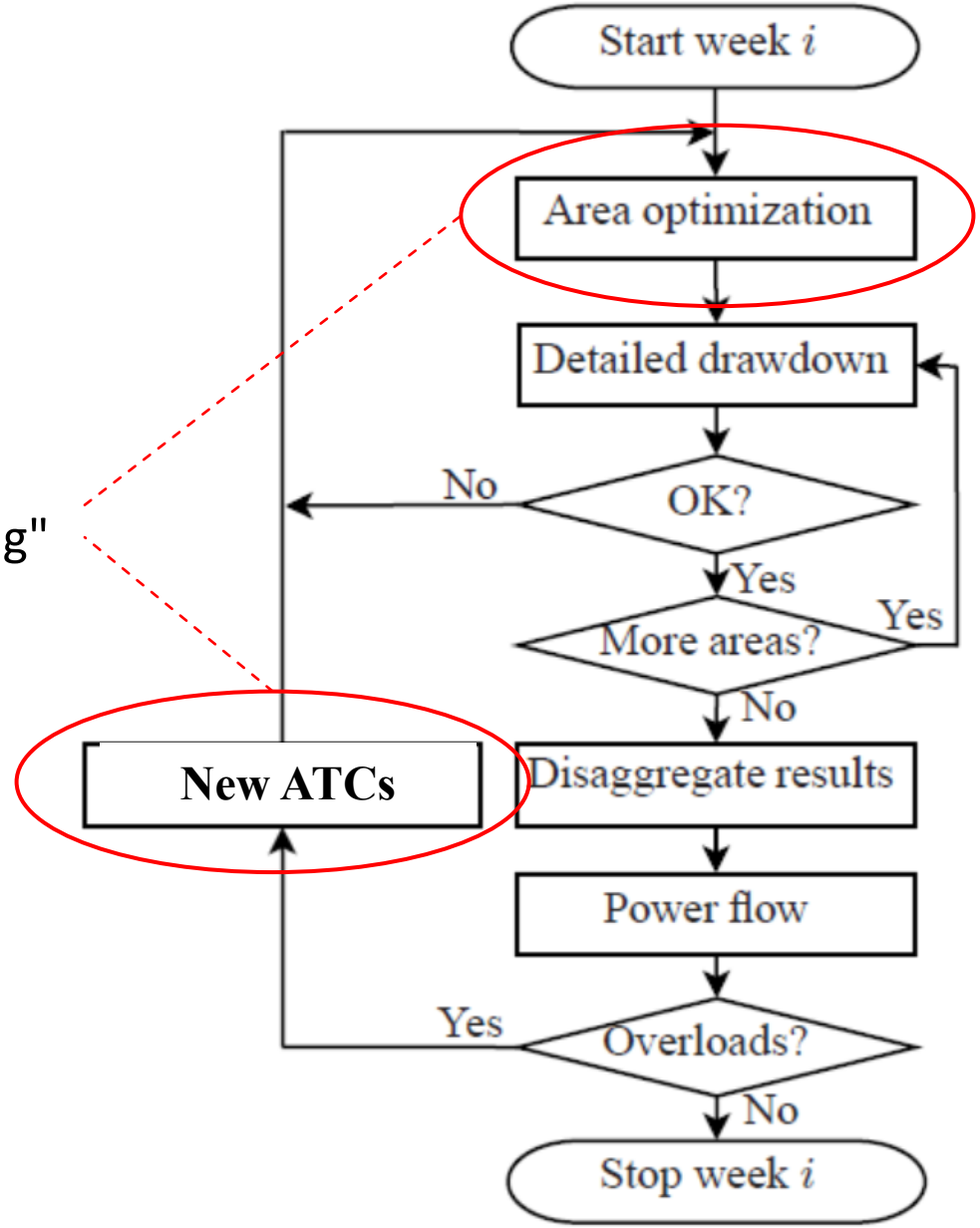
EMPS basics

"Market clearing"
LP-problem



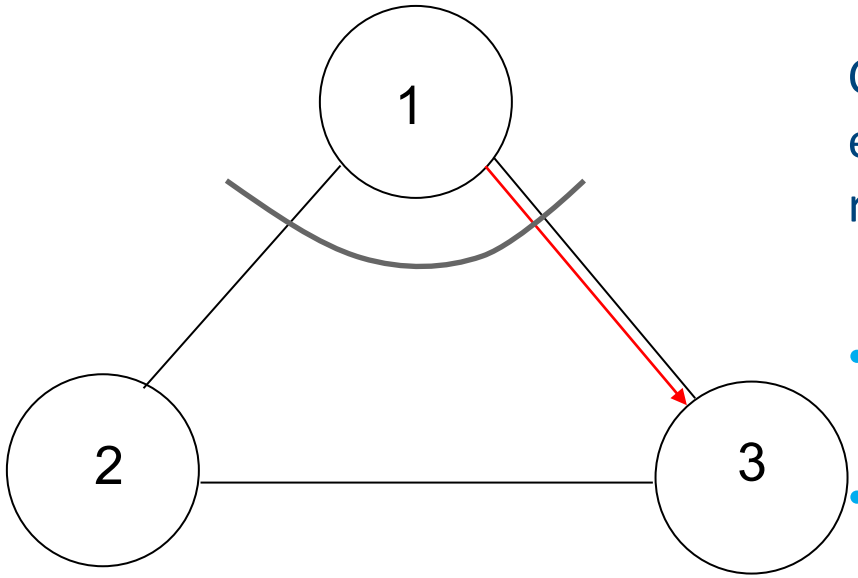
Samlast – logic

Updated
"Market clearing"
LP-problem



"Resembles ATC method"

Samlast – user interaction

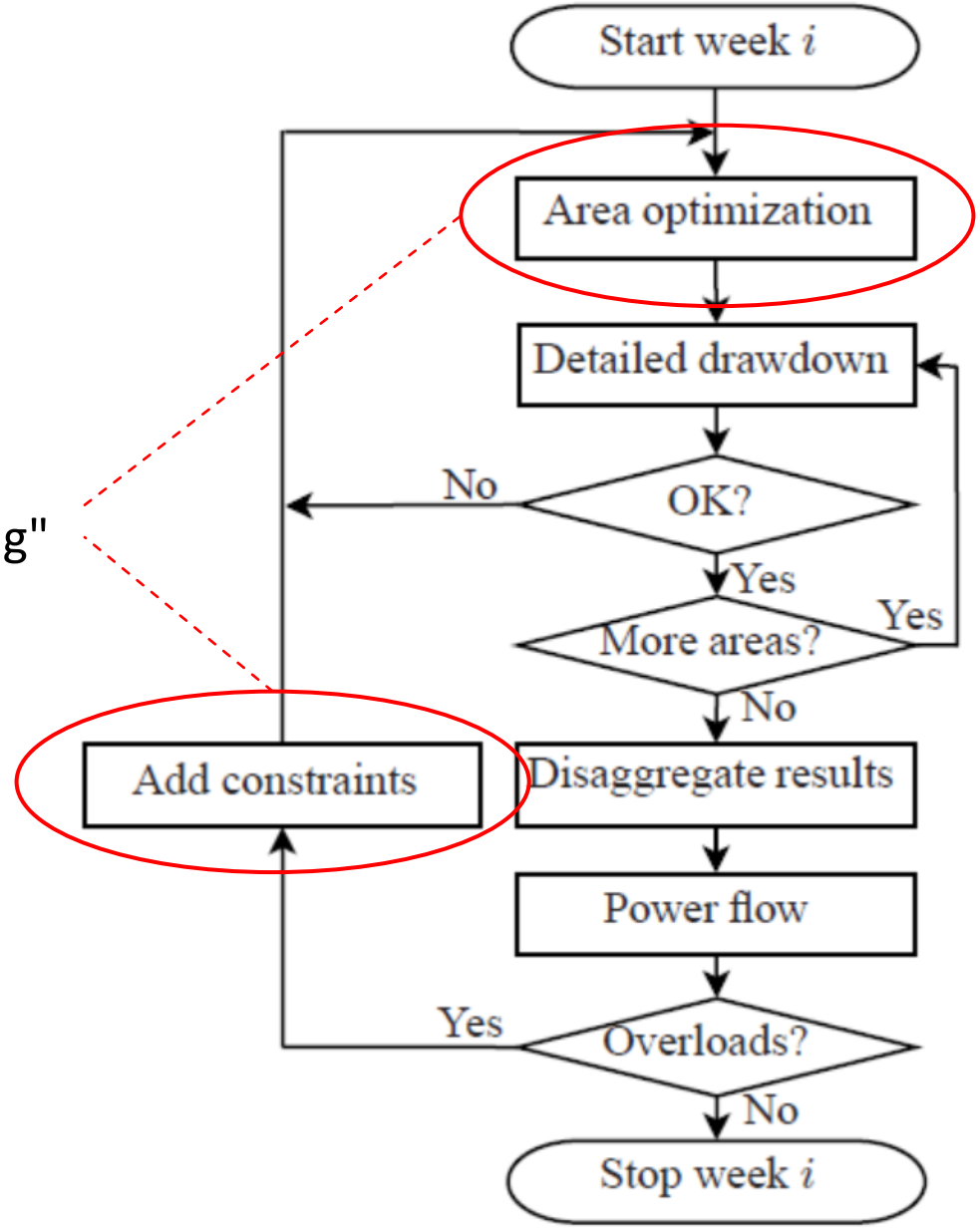


Congestion management is **implicitly** embedded in the market clearing through reduced capacities.

- Manual definition of surplus and deficit side for each potential overload.
- Capacity reduction based on magnitude of overload and user-defined coefficients.

Samnett – logic

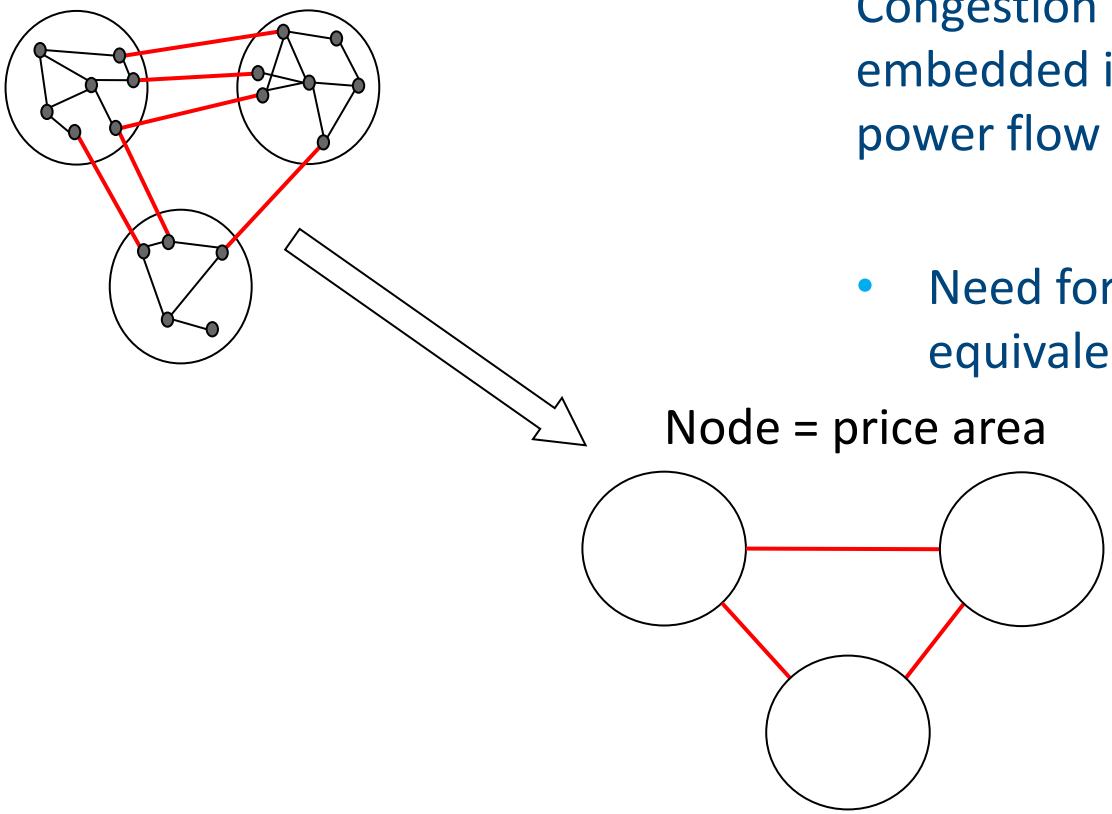
Updated
"Market clearing"
LP-problem



"Resembles FB method"

Samnett – user interaction

Node = busbar



Congestion management is **explicitly** embedded in the market clearing through power flow constraints.

- Need for accurate transmission grid equivalents.

Outline

- Background
- Method
- **Simulation results**

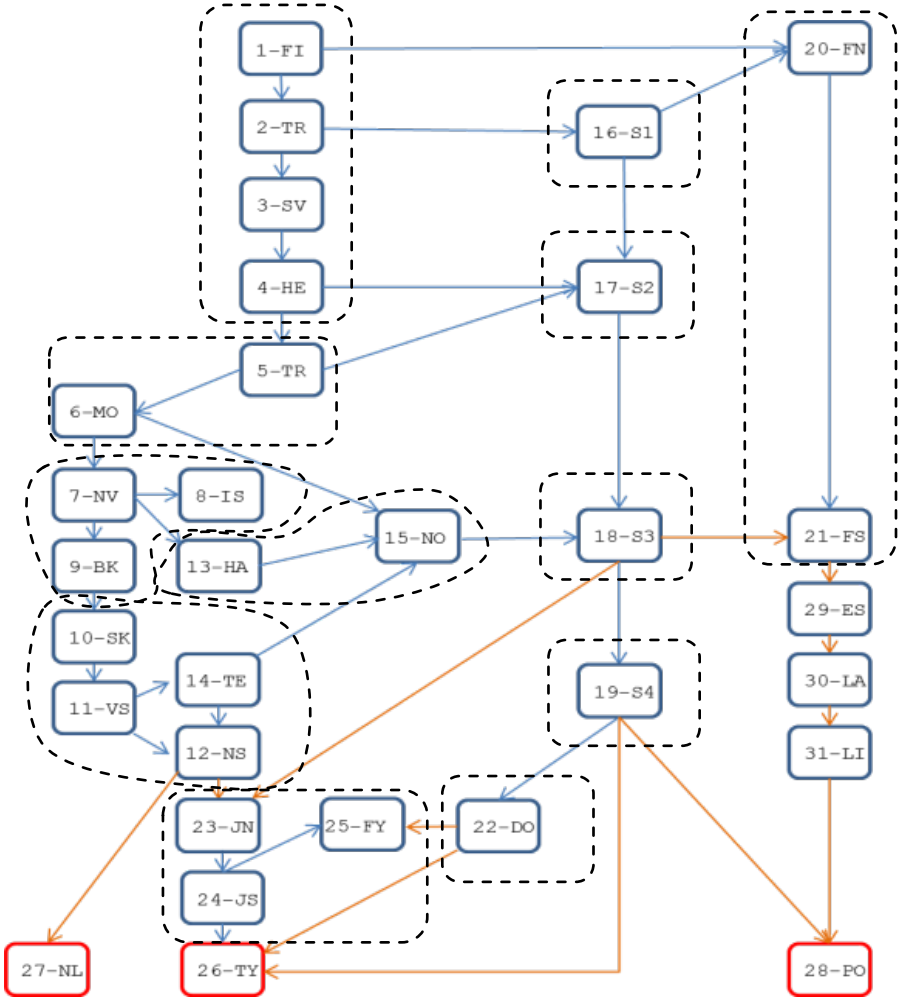
Simulations

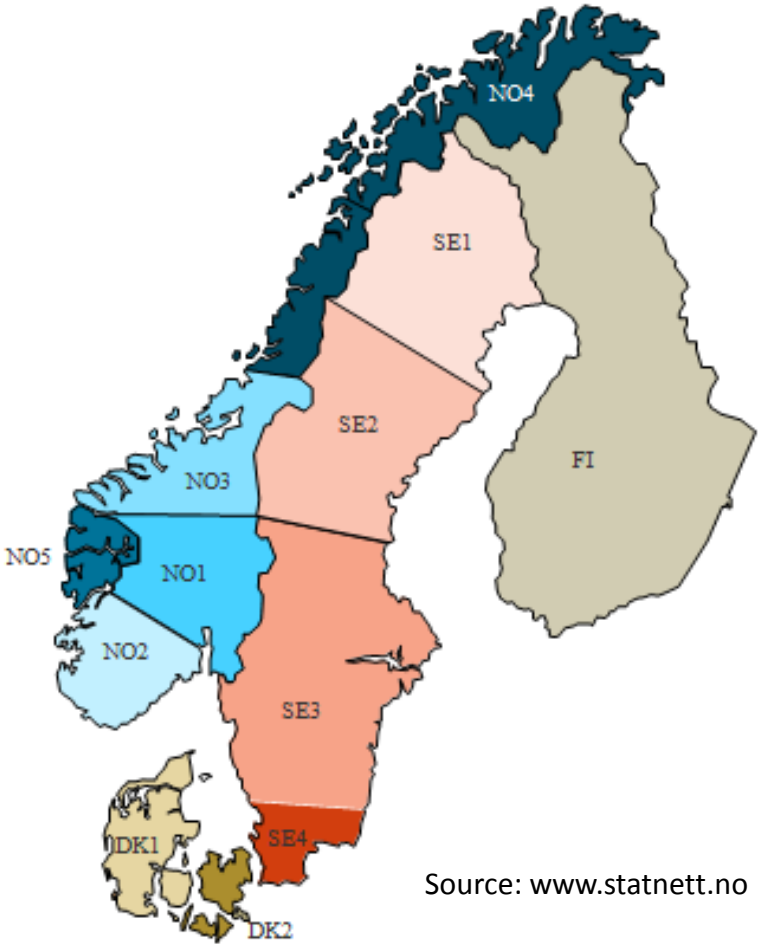
- Simulations carried out with version 8 of the models.

- Comparisons were run on 3 datasets:
  - Previous observations (2009 and 2010).
  - Future scenario (2020).

- In a related project, Samlast (ATC-based) was backtested on 2009 and 2010 datasets to verify the ATC method against observations.

System description





Source: www.statnett.no

Datasets

Data characteristics:

- 5 load periods within the week.
- Pre-computed strategy (water values).

Data preparation:

- Price series define coupling to Europe.
- Marginal costs on thermal units.
- Inflow records.
- Temperature records.
- Initial reservoir fillings.
- Availability:
  - Lines/cables.
  - Production units.

2020 scenario:

- Stronger grid (South Norway).
- 3 new HVDC connections.
- 26 TWh new hydro and wind.

Results

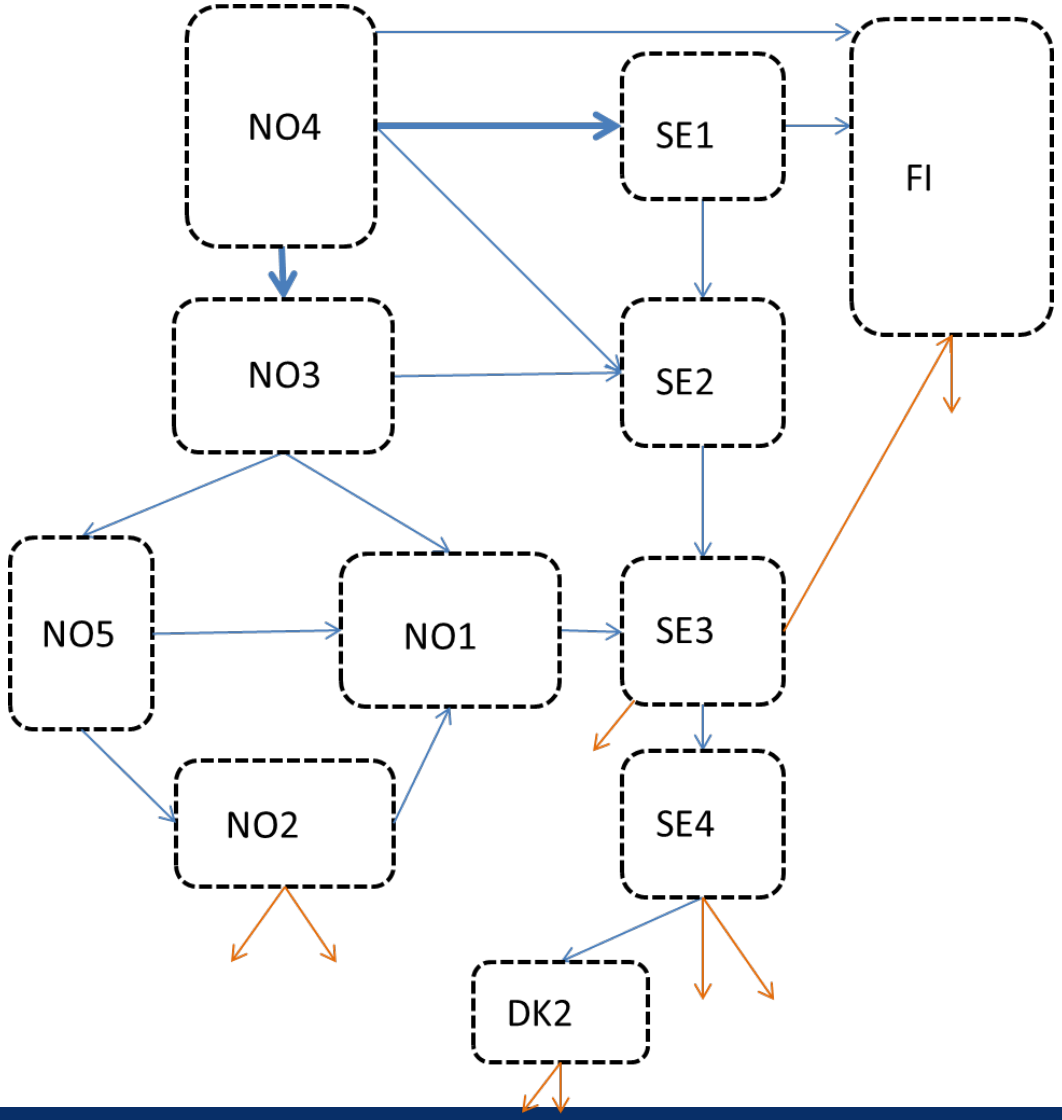
- Samnett provided a higher simulated socio-economic surplus in all simulated cases.
- Samnett utilizes the transmission grid better than Samlast; the "market clearing"/area optimization sees higher capacities.
- Differences in average power prices are small, but price convergence occur more frequent with Samnett.
  - Consumers in deficit areas are better off.
  - Producers in surplus areas are better off.

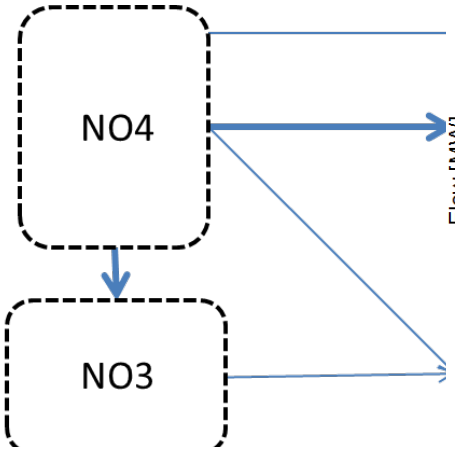
Full price convergence in the Nordic synchronous area

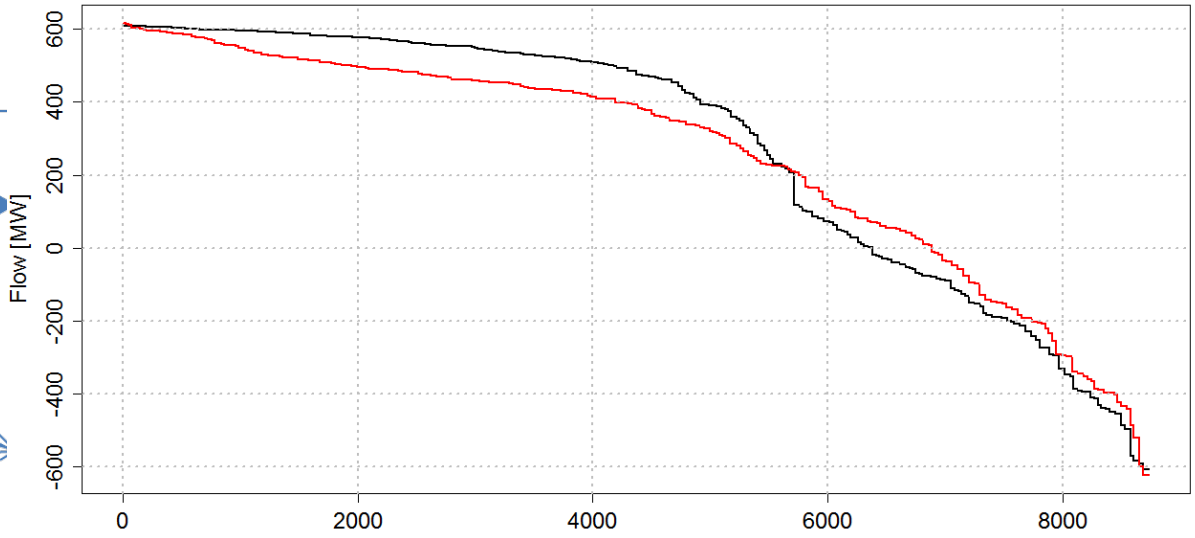
	Samlast (ATC)	Samnett (FB)
2009	10 %	14 %
2010	14 %	27 %
2020*)	30 %	46 %

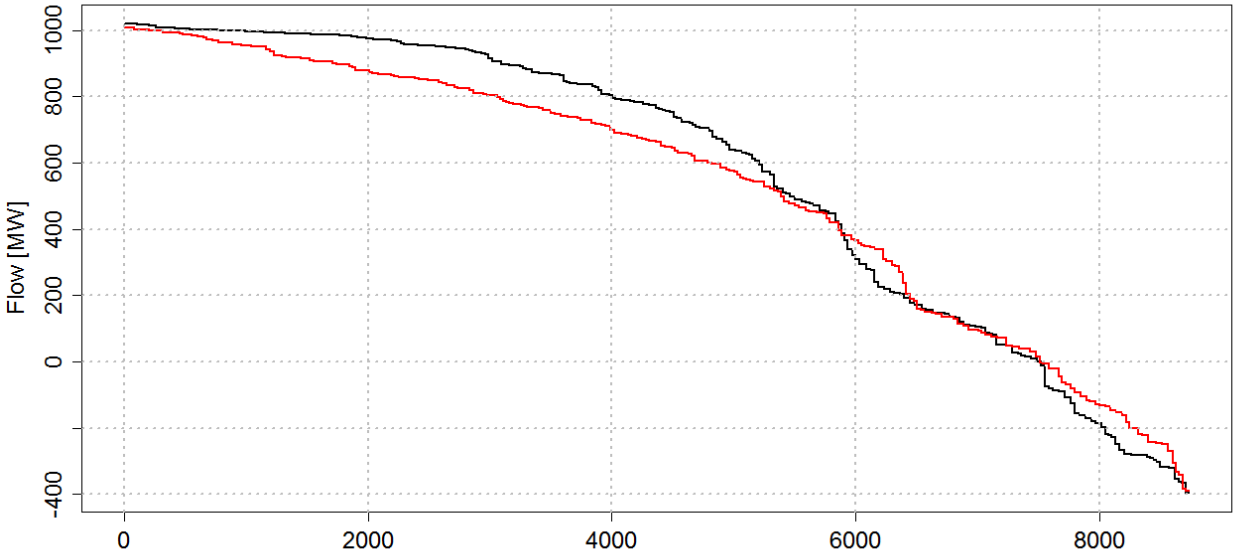
*) average numbers

Different flow patterns



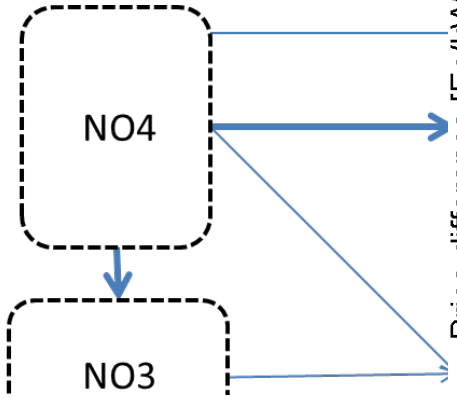


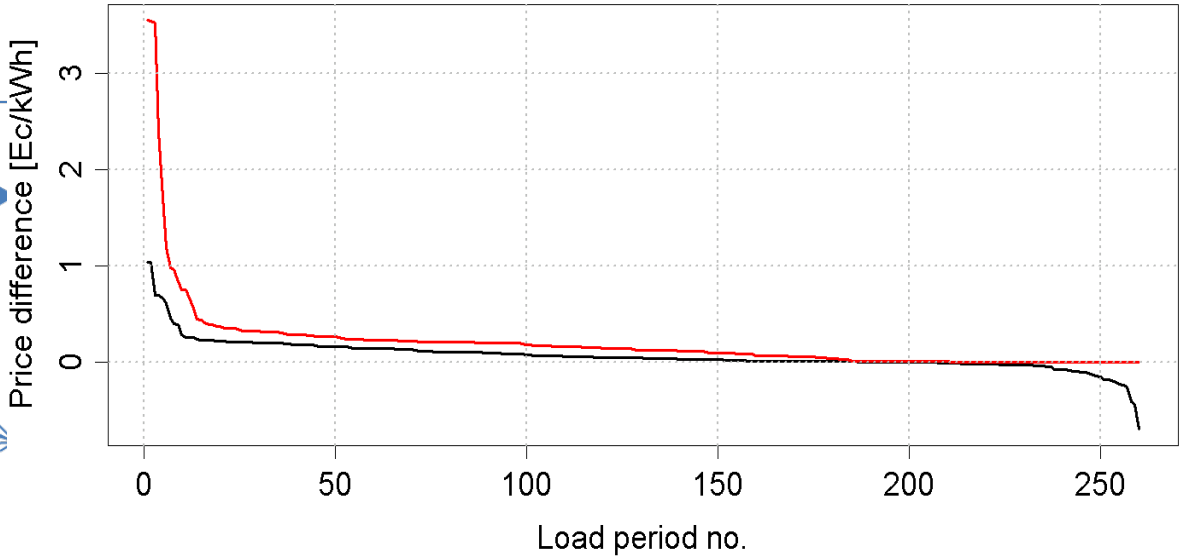


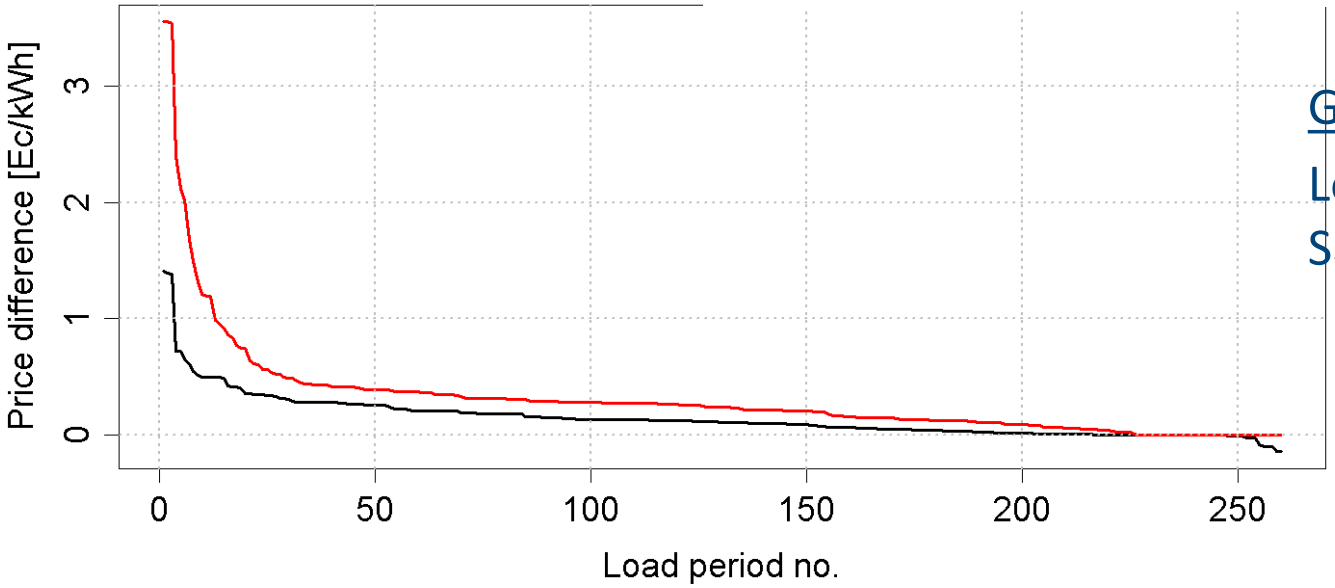


General finding:

Better utilization of the grid with Samnett (black curve).







General finding:

Lower price differences with Samnett (black curve).

Some critical remarks

- The presented models are well suited for this problem, but will not fully represent the ATC and FB methods.

- Input data and assumptions set the premises for the output;

  There are several answers!

- What is the impact of:
  - Using a finer time resolution?
  - Taking power flow constraints directly into account when computing water values?

Conclusions

- The general findings were as expected:
  - Samnett/FB market coupling provides a higher socio-economic surplus than Samlast/ATC.
  - Samnett/FB market coupling facilitates a more efficient use of the transmission grid.