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Northern European power system scenarios for EMPS – 2010 to 2030

Brukermøte Produksjonsplanlegging

22. Mai 2013

Outline

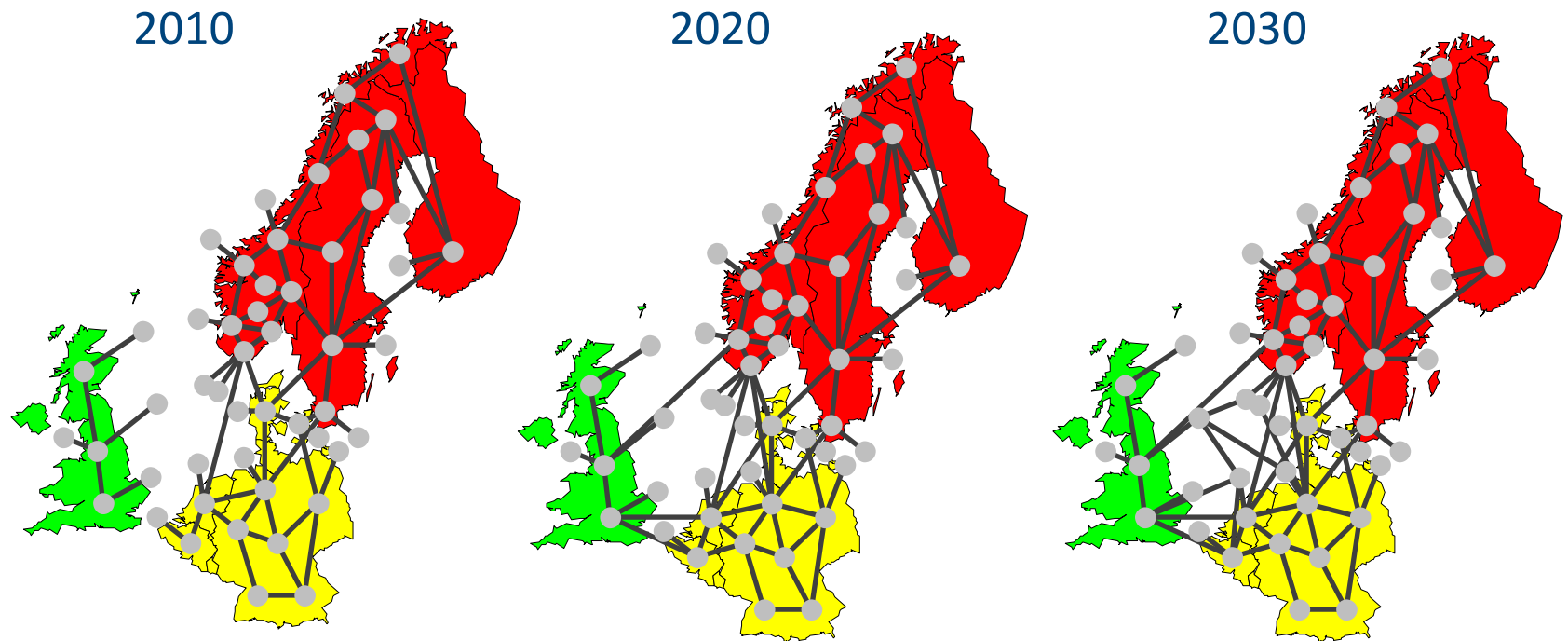
1. Basic modelling assumption – Northern Europe
2. 2030 scenario development
3. Simulation results
4. Transmission investment analysis

Modell development

- Objective:
 - Develop a data model set for EMPS, which takes into account the hydro system characteristics in the Nordic as well as the thermal characteristics in continental Europe. The data model shall be suited to assess the (economic) outcome of the prospective integration of variable renewable energy sources in the Northern European power system.
- under development in:
 - PhD in the project "Balance management in multination power markets"
 - EU FP7 Twenties – Transmitting wind
 - Implementation of the investment analysis in EMPS

Geographic overview

- Denmark, Finland, Norway, Sweden, Belgium, Germany, the Netherlands, Great Britain



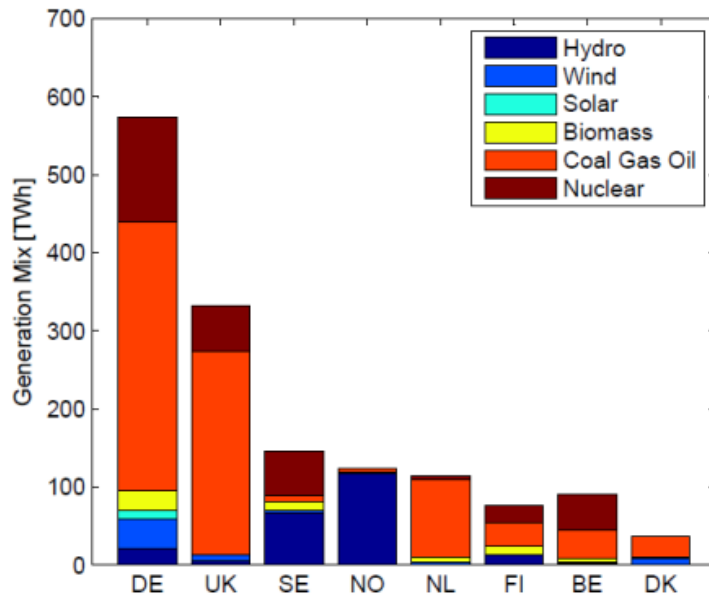
Basic assumptions

- 56 areas (including neighbouring countries)
- 80 corridors (including HVDCs)
(3900 busses for Norway / 30 busses for Sweden => Samnett /NVE – dataset)
- 75 climatic years (temperature, hydro, wind, solar)
- Series simulation (34 sequences per week / 52 weeks per year)
- 320 - 350 thermal power plants with start up costs
(marginal production costs / start up costs based on fuel prices)
- Operational (spinning) reserve requirements
- District Heating

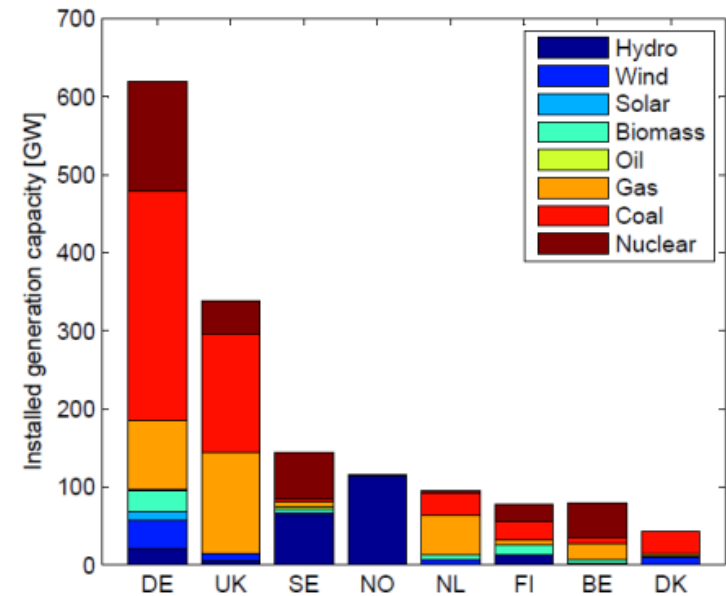
- **Max. calculation time => 1.5 days in Version 9.3 (using CPLEX)
(2.5 weeks in Version 8.4)**

Fitted generation mixes (per country)

ENTSO-E 2010:



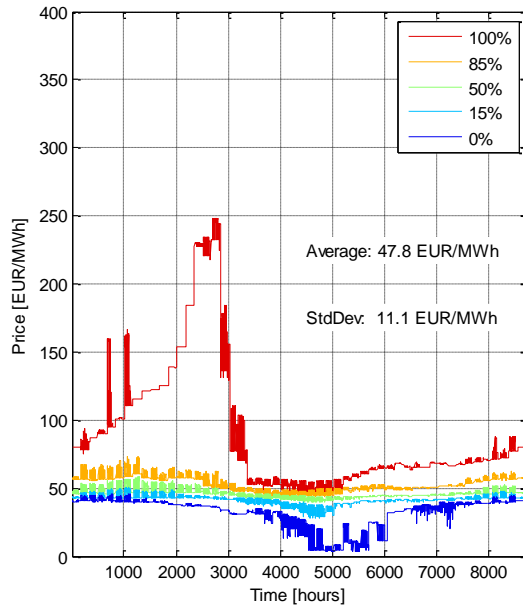
EMPS 2010:



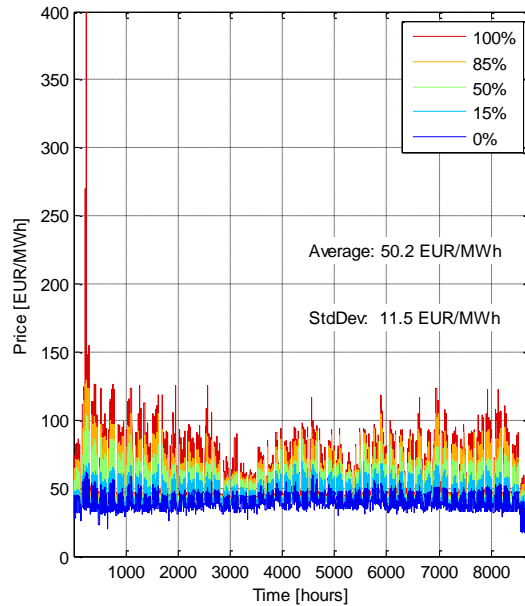
Differences due to load definition (transmission system load vs. total system load)

2010 Scenario

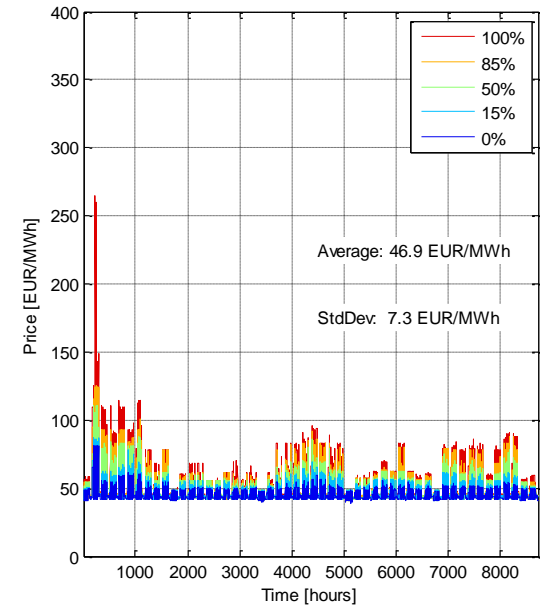
- Electricity prices per country:
 - Norway



Germany



Great Britain



(shown are 0%, 15%, 50%, 85% ,100% percentiles of the 75 climatic years)

Future scenarios – sources

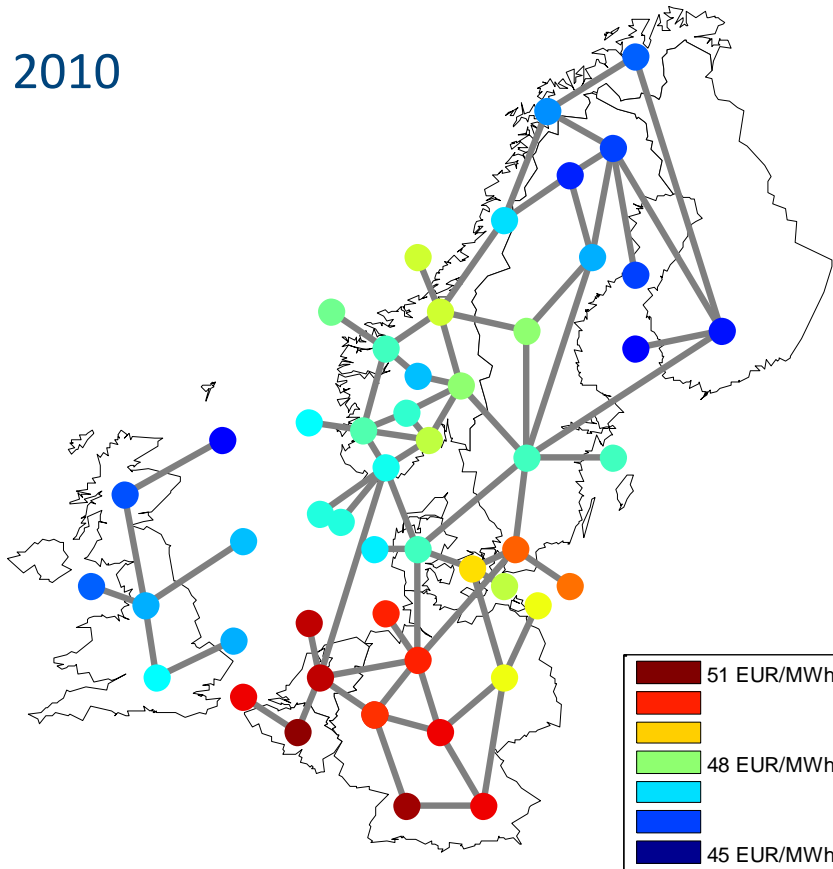
- Main sources:
 - European Commission - EU energy trends up to 2030 (PRIMES model)
 - ENTSO-E - Ten-Year Network Development Plan
 - Statnett / Svenska Kraftnät - Swedish-Norwegian Grid Development
 - DENA - Grid study II
 - Dep. of Energy & Climate Change - DUKES report
 - National Grid - Seven-Year Statement
 - CEDREN / HydroPeak - Expansion of hydro capacity in Southern Norway
- Additional sources:
 - EWEA - wind energy scenarios
 - BDEW - power plant list
 - ECN - reference projections

Future scenarios – updates

- Generation portfolio:
 - 11 GW increase in hydro generation capacity in Southern Norway (including pumping), small scale hydro in Norway and Sweden
 - Adapted thermal capacity - commissioning and decommissioning of (individual) thermal power plants
 - Constant fuel cost / CO₂ emission cost increased
 - Increased WPP (up to 191 GW throughout the modelled area)
- Transmission capability:
 - Internal (Norway west coast, Sweden north-south, Germany north-south)
 - Cross-border (HVDCs subsea cables, AC interconnectors)
 - North-Sea offshore grid in 2030 (according to OffshoreGrid project)
- Consumption increase by 5-15%

Average electricity prices (per area)

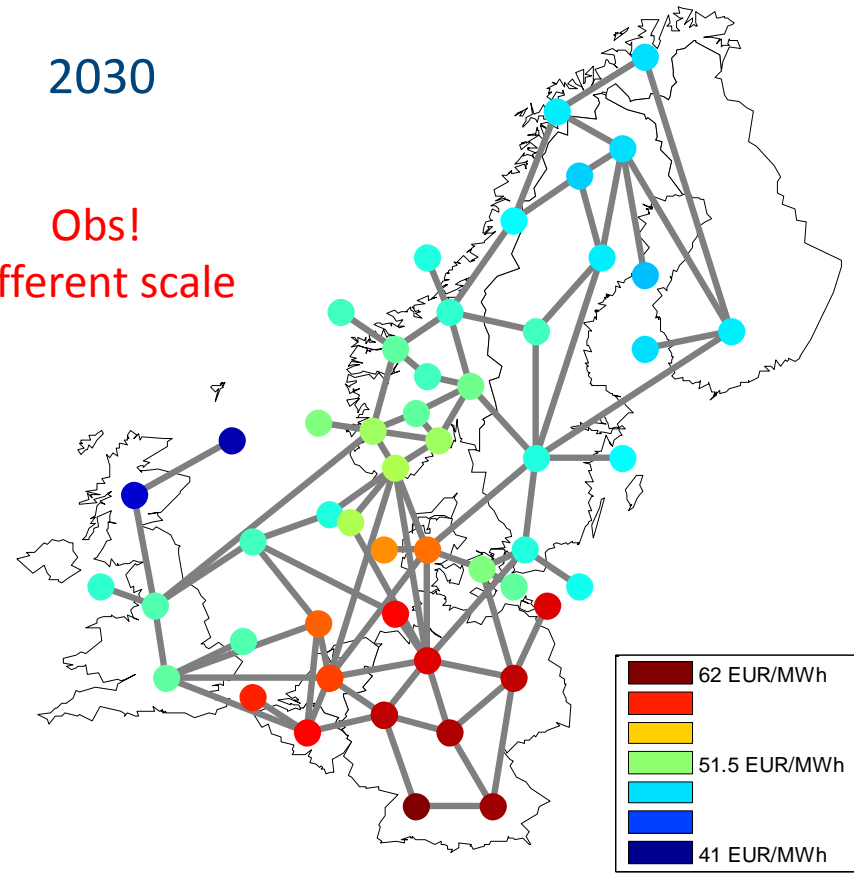
2010



45 – 51 €/MWh

2030

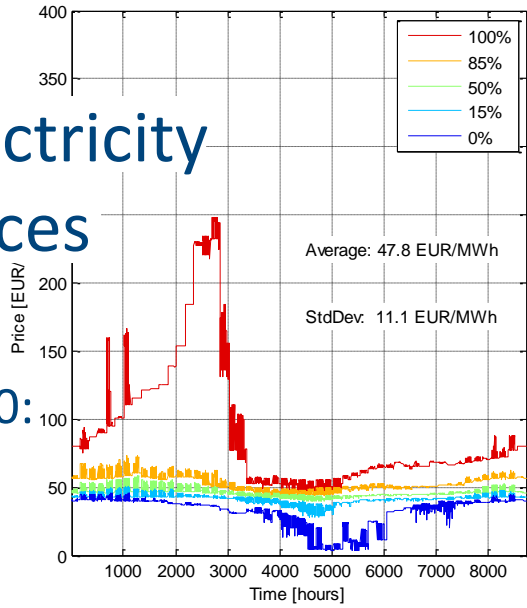
Obs!
Different scale



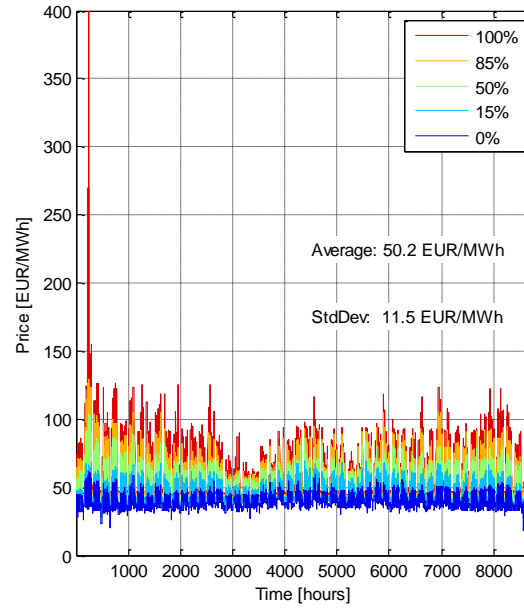
41 – 62 €/MWh

Electricity prices

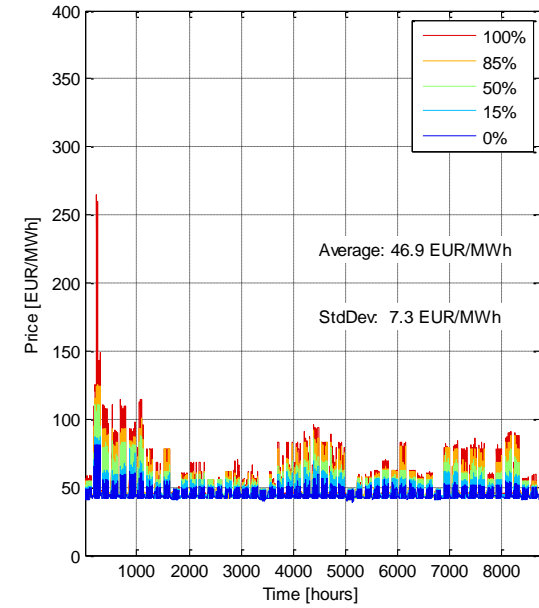
2010:



Norway

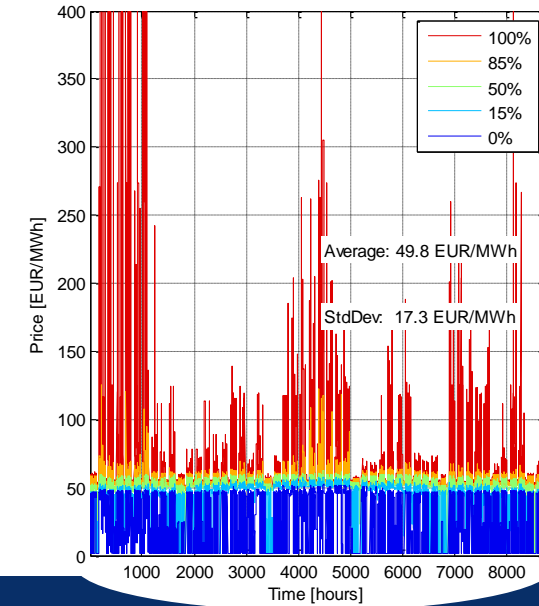
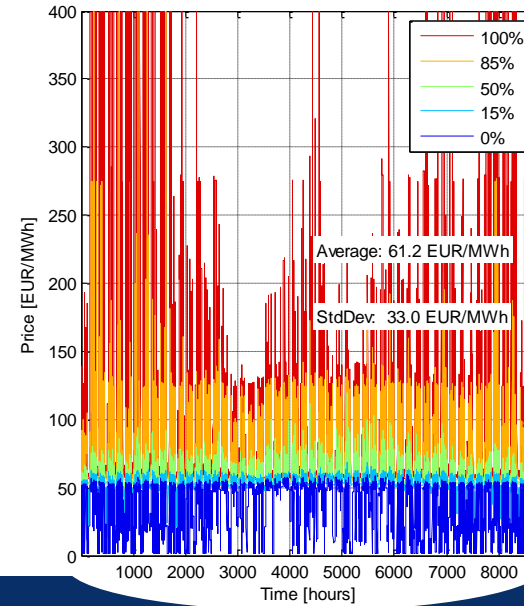
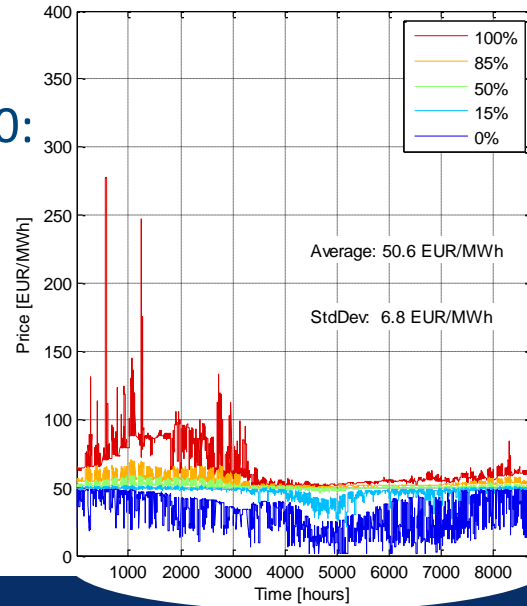


Germany



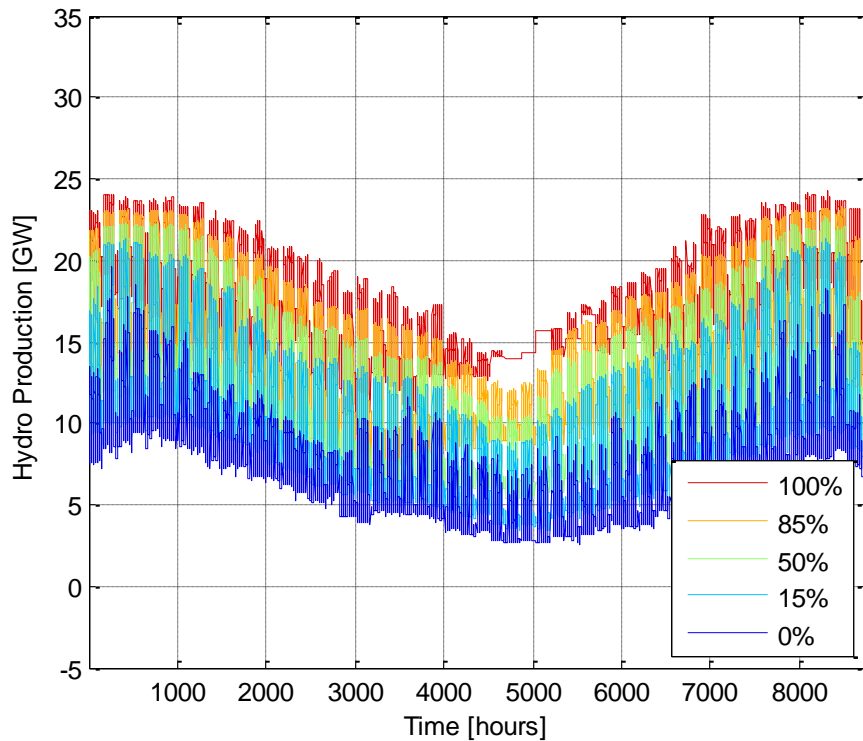
Great Britain

2030:



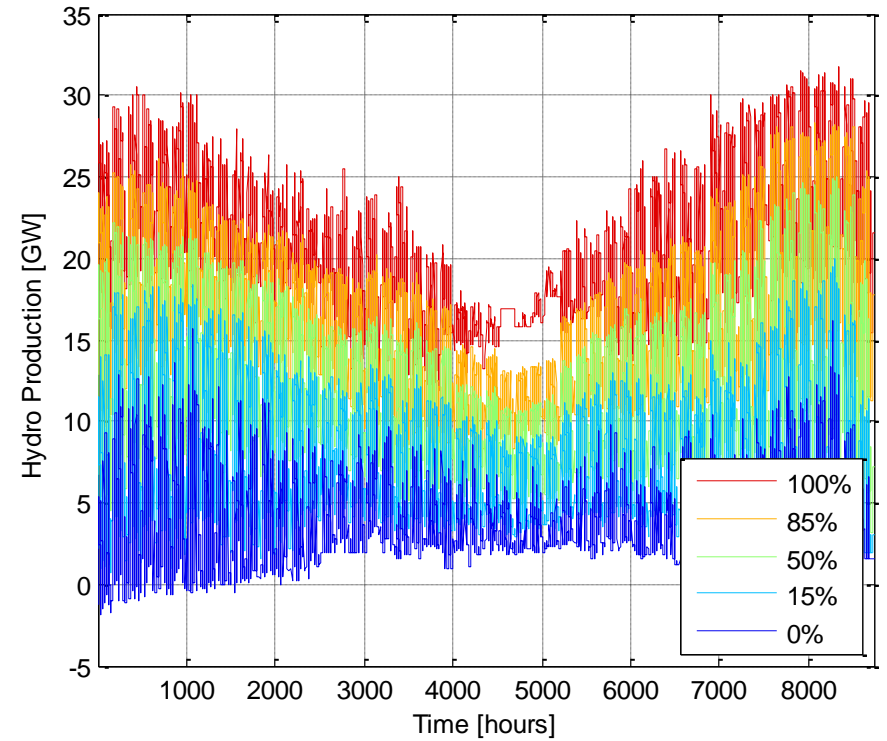
Hydro power production in Norway

2010



Total annual production: 113 TWh

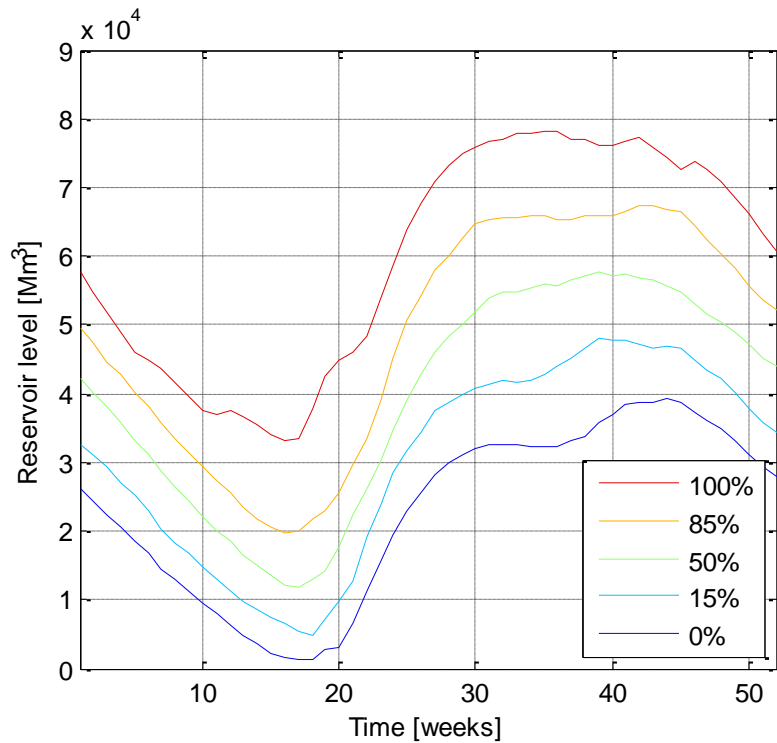
2030



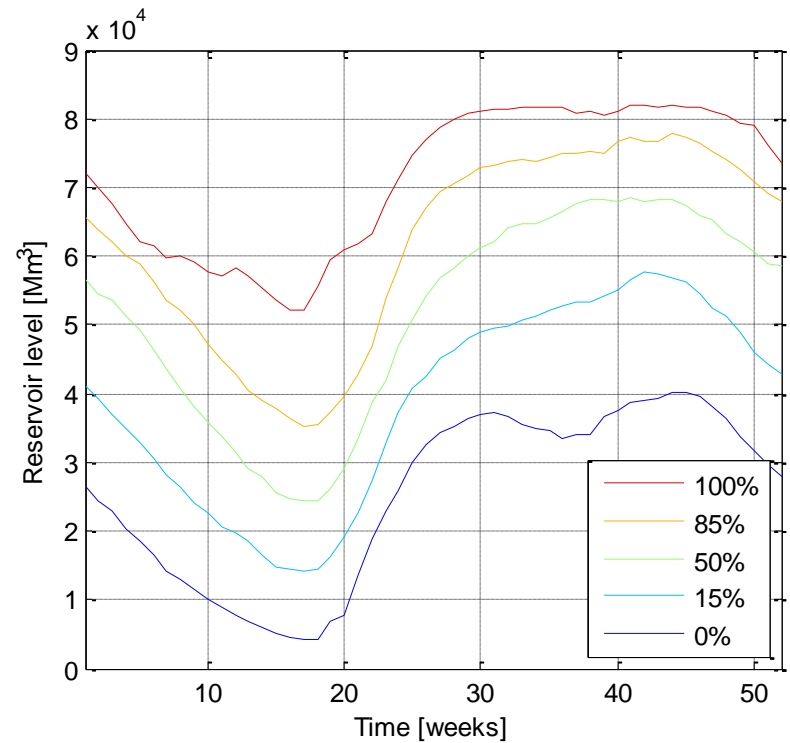
109 TWh

Reservoir handling in Norway

2010



2030



(Generally higher levels due to increased energy inflow to the system (from WPP))

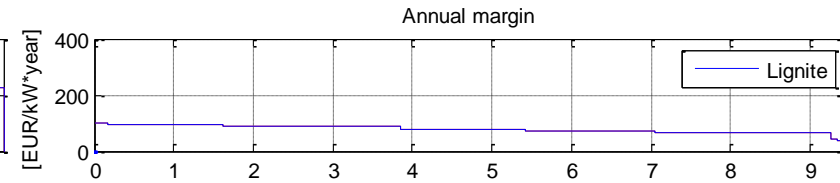
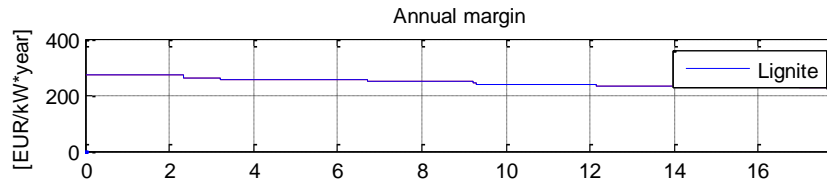
Power production – Profitability of assets

Thermal

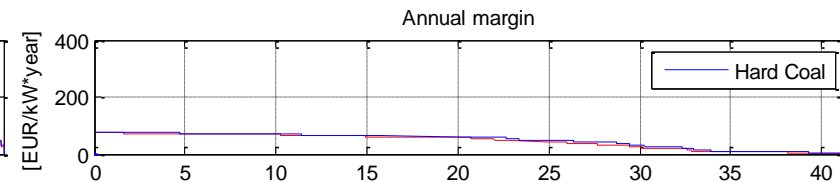
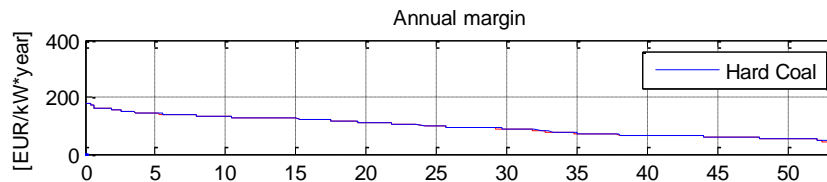
2010

2030

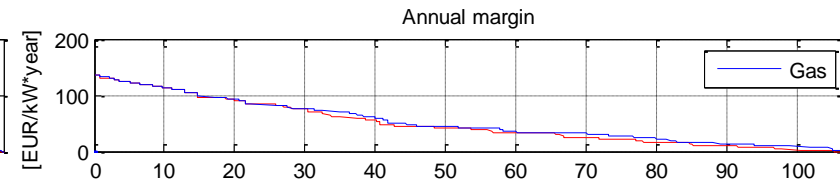
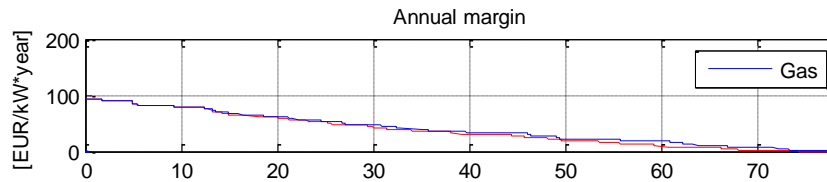
Lignite:



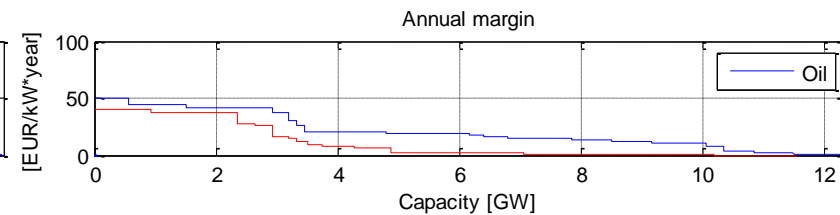
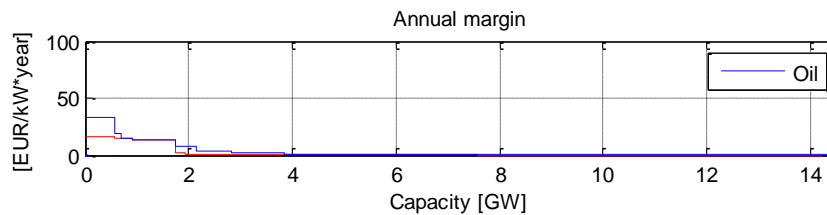
Hard
Coal:



Gas:



Oil:

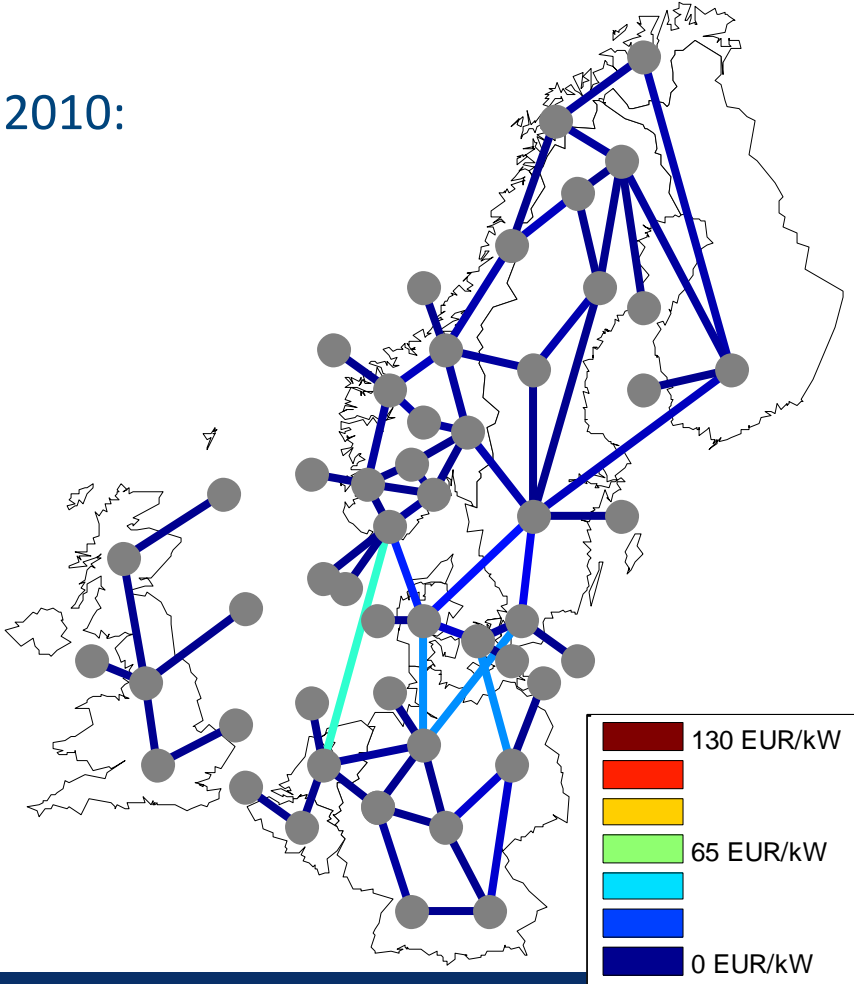


Power production – Profitability of generation assets

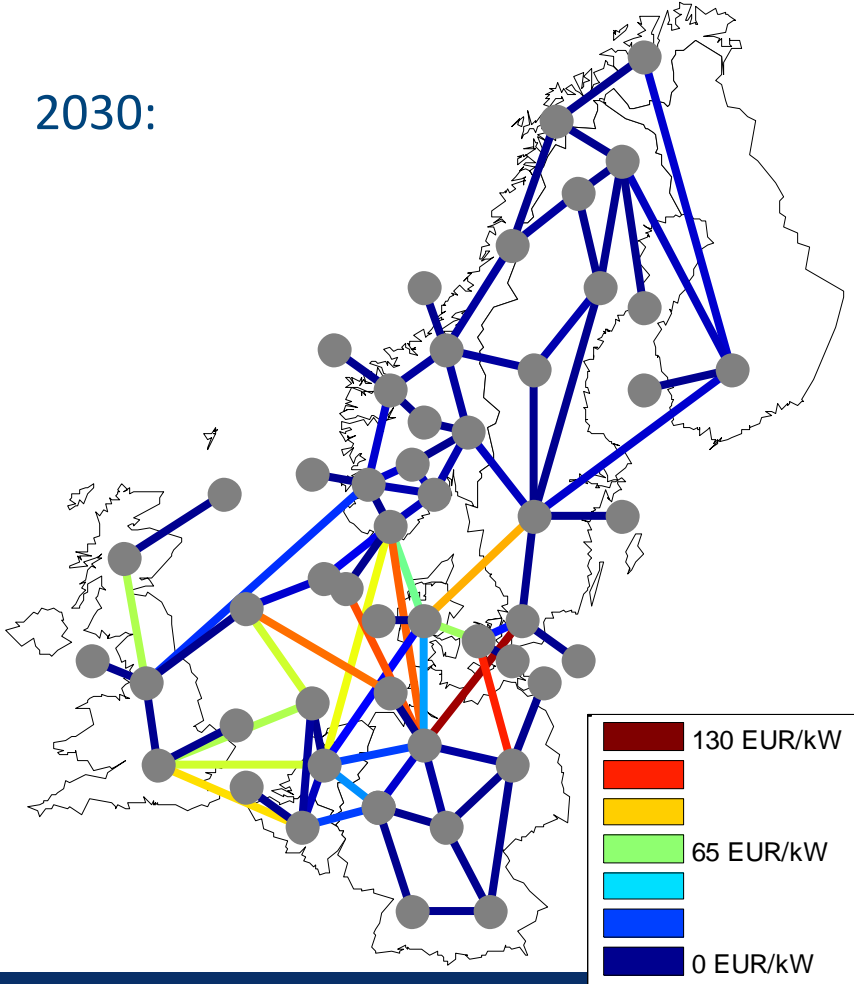
- Thermal
 - Significantly reduced operating hours => reduced income and profitability of thermal power plants
=> will thermal capacity be decommissioned ?
- Hydro
 - Reduced annual profitability from 180 €/kW to about 135 €/kW due to increased hydro generation capacity
=> is building new generation capacity profitable ?

Transmission profitability (congestion rent)

2010:



2030:

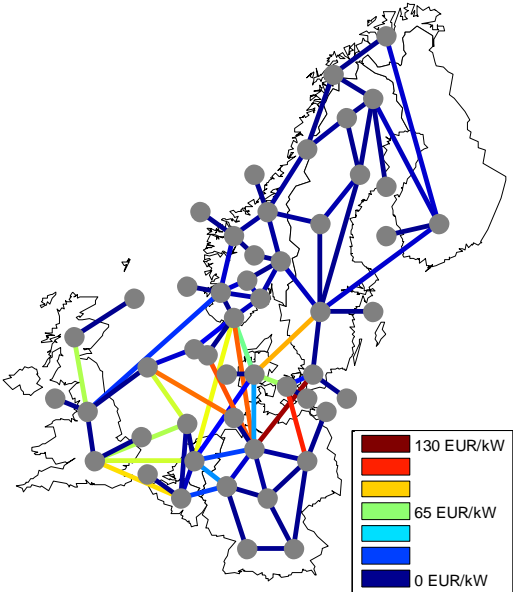
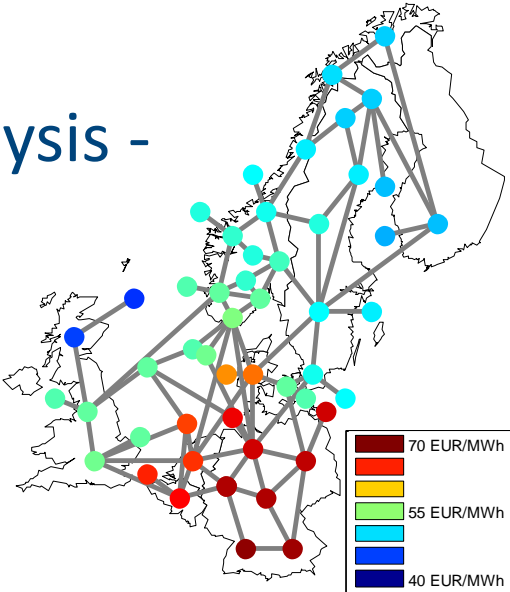


Investment analysis – transmission expansion in 2030

- Expanded lines:
 - Middle Sweden => Southern Sweden: 2080 MW
 - Southern Sweden => Northern Germany: 4010 MW
 - Western Germany => The Netherlands: 3750 MW
 - The Netherlands => England: 2330 MW
 - England => Scotland: 4030 MW
- => main corridor around the North Sea
- => transport of surplus energy (mainly WPP) to load centres

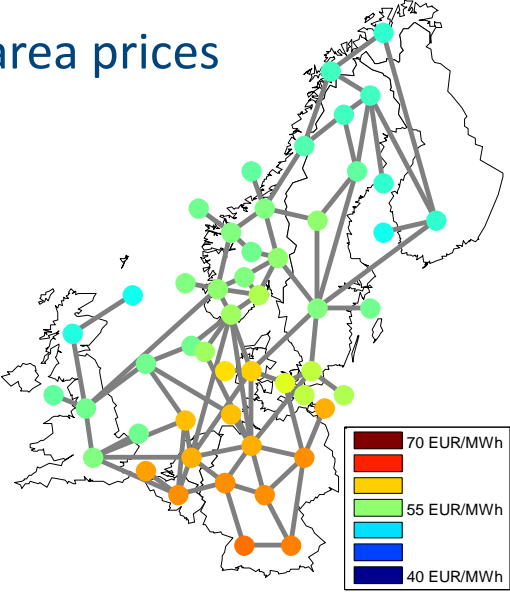
Investment analysis - Transmission expansion

Before:

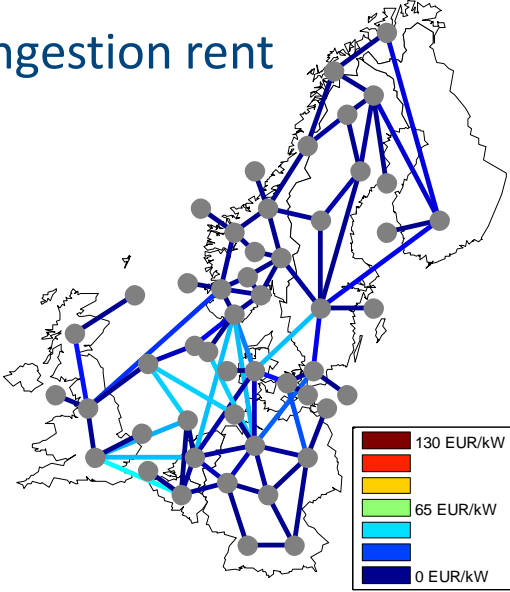


area prices

After:



congestion rent

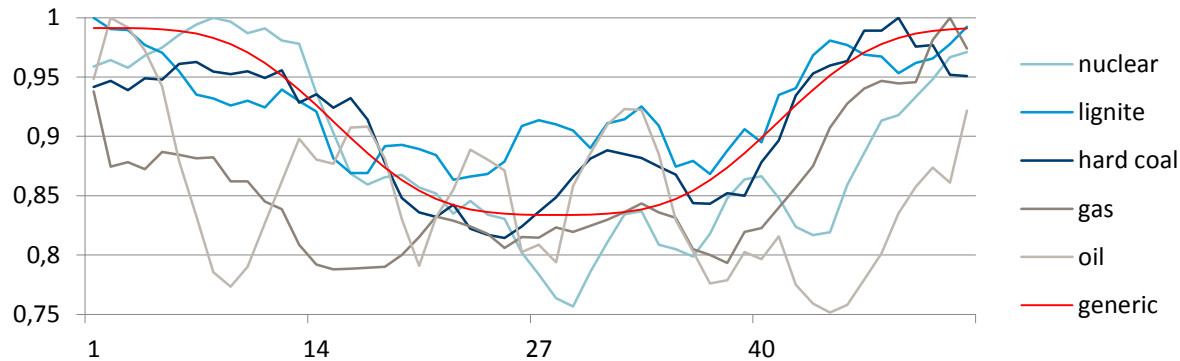




Technology for a better society

2010 Scenario – Fitting of generation mix

- ENTSO-E generation capacities / installed assets (ADAPT sheet & updates from various countries)
- Implementation seasonal availability of thermal power plants (EEX data):

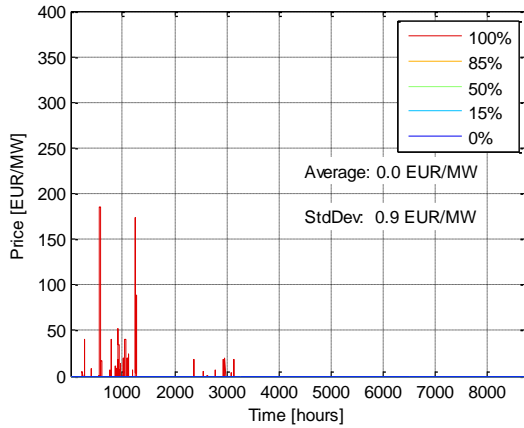


- Fitting through tuning of general availability of thermal power plants (values)

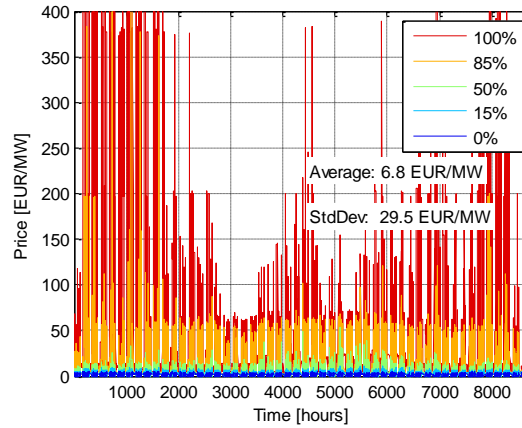
	Lignite	Hard coal	Gas	Oil	Bio
Availability	85	75	90	95	70

(Spinning) reserve prices in 2030

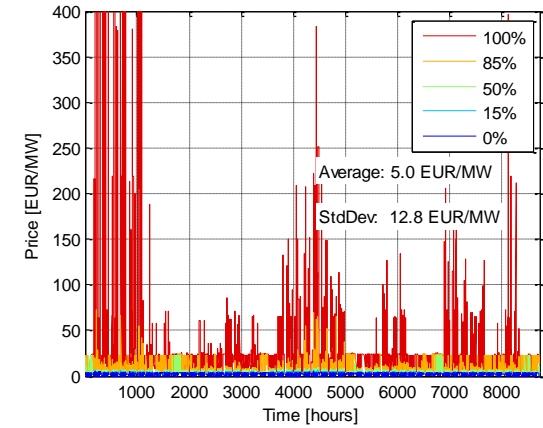
upward



Norway



Germany



Great Britain

downward

