

”Balance Management in multinational power markets”

Teknologisk Møteclass 4. oktober 11

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The Balance Management Project

- Competence building project in the framework of The Norwegian Research Council - Renergi Program.
- Project period 2007-2011
- Project partners: TSOs (Statnett, TenneT), regulator (NVE), 4 Norwegian producers, GDF Suez, Delft University of Technology, The Norwegian University of Science and Technology (NTNU)
- 2 Norwegian and 2 Dutch PhDs
- PhD funding from The Norwegian Research Council, Next Generation Infrastructure (NGI) NL and GDF Suez, Belgium
- <http://www.sintef.no/balance-management>

The Balance Management Project

Motivation

- Optimal use of reserves over national borders
- Reduce reserve costs
- Exploit the favorable properties of hydro power plants as balancing resources
- Increased need for reserves due to a growing share of RES with less predictable output.
- Market coupling of European day ahead markets and the ongoing integration process in Europe

Norway as "battery" and/or "balancing resource" for Europe.

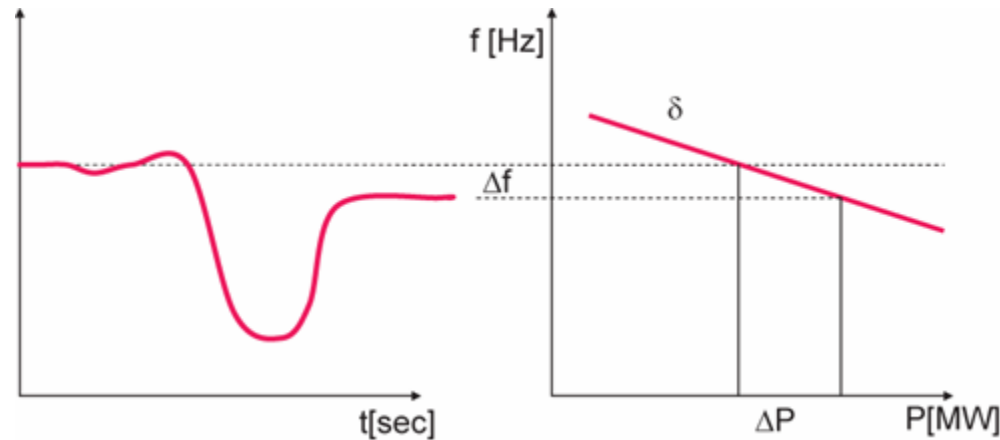
Different purposes, different characteristics (?)

- **Battery – pump/ storage:** Export daytime, import night/low load by optimal utilization of hydro reservoir capacity and power (MW) surplus.
(Day Ahead or bilateral trade)
- **Balancing resource:**
Exploit the flexible controllability of hydro power for balancing purposes within the hour of operation
(Balancing markets - TSO responsibility)

Definitions

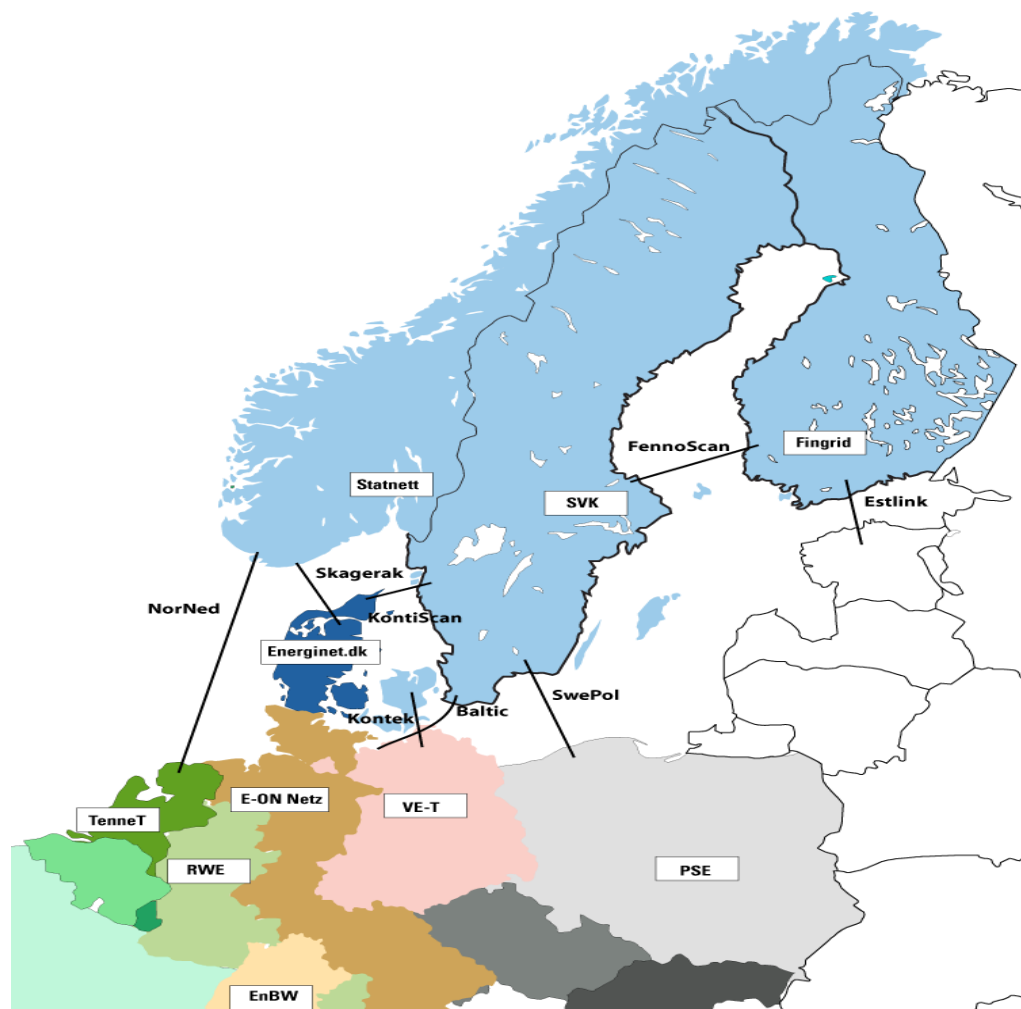
Imbalance

- **Power Deviation:** *Difference between production output and consumption that will cause a rise or fall in frequency leading to activation of the primary control and subsequently secondary (automatic) and tertiary (manual) control in order to replace the primary activated reserves.*
- **Regional/Area imbalance:** *Deviations from exchange plan for the defined balancing region/area.*
- **Settlement imbalance:** *Deviations from exchange plans for the balance responsible parties (BRP), in average over the settlement period (MWh/period) where the settlement period can be 60, 30 or 15 min.*



Area Control Error:
 $ACE = \Delta P_{exc} + R\Delta f$

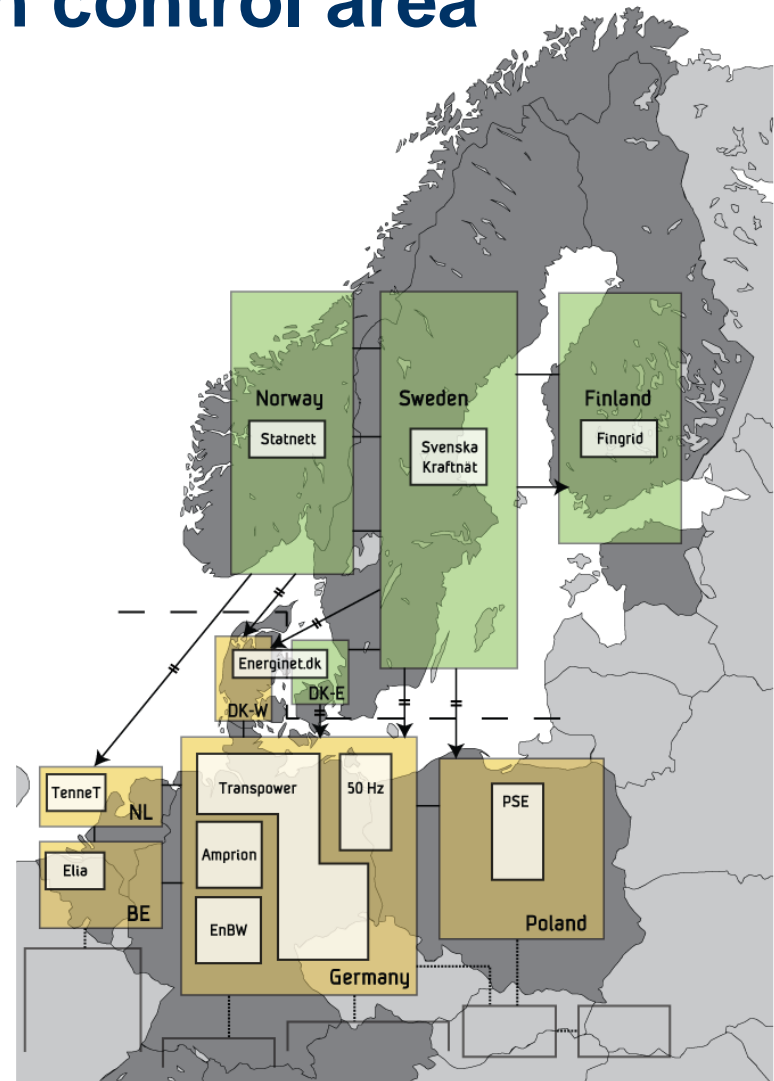
Balancing Areas in Northern Europe



- Nordic system:
91 GW (47 GW hydro)
- Central European system: 667 GW
- Development towards integration:
 - Market coupling DA (TLC, CWE)
 - Implicit auction on all HVDC links
 - Integration of balancing markets

Near future(?): Exchange between the Nordic synchronous region and the merged Northern Central European control area

- Nordic system one control area with common merit order list from 2001/2
- 4 steps towards ACE netting in Germany completed in 2010
- Annual cost reduction of ~280 M €



Balance management project

Results

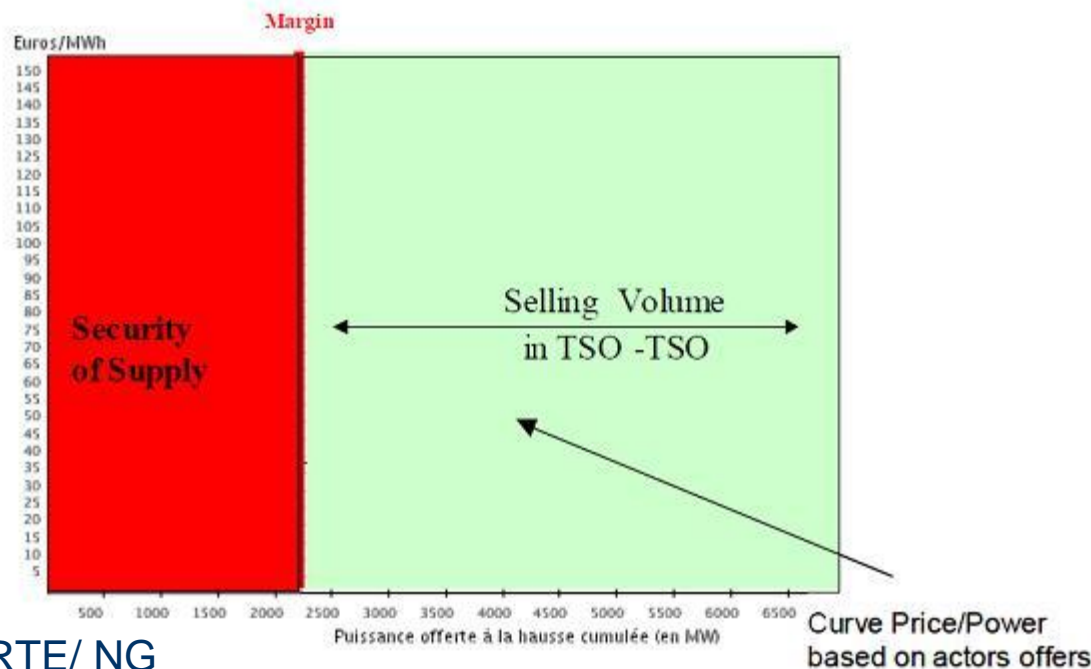
- Overview Balancing Mechanisms Northern Europe
- Analyses of present costs (incl. database marginal costs thermal prod)
- General market design aspects
- Exchange of balancing resources between the Nordic and the Central European synchronous systems (6 alternative schemes described)

- PhD work:
 - Market design and regulatory aspects (TU Delft)
 - Market models and simulations (NTNU)

- Open documents downloadable at <http://www.sintef.no/balance-management>

Security of supply restriction

- *The TSOs are responsible to ensure system security within their control area. Cross-border balancing shall not jeopardise system security.*
(Key principles Balance Market integration (ERGEG))



Source RTE/ NG

Balancing resources available for trading

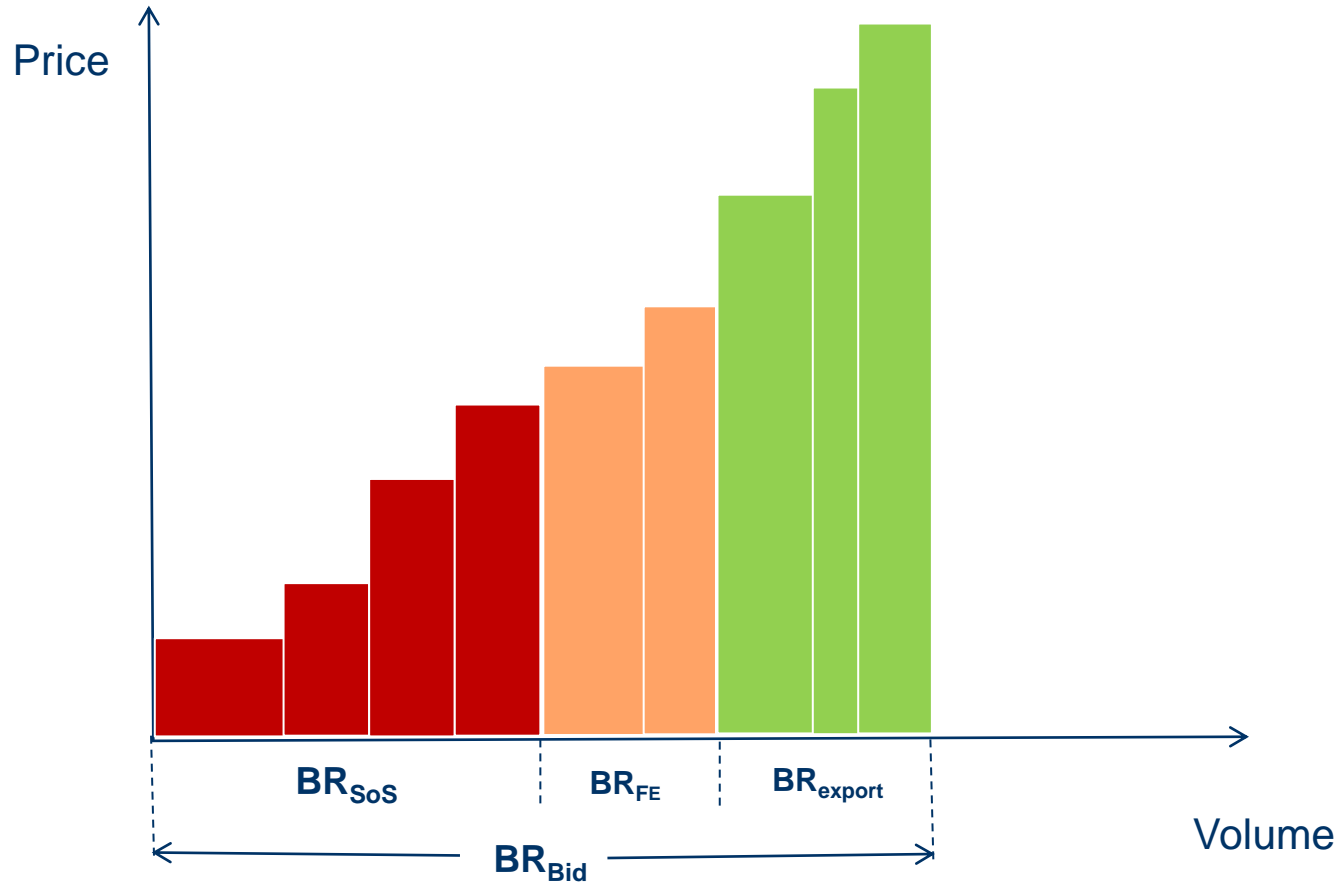
$$BR_{\text{export}} = BR_{\text{Bid}} - BR_{\text{SoS}} - BR_{\text{FE}}$$

BR_{Bid} = Resources bid into the Regulation Power Market

BR_{SoS} = Resources kept for Security of Supply (SoS) referring to dimensioning fault

BR_{FE} = Resources kept for potential forecast error

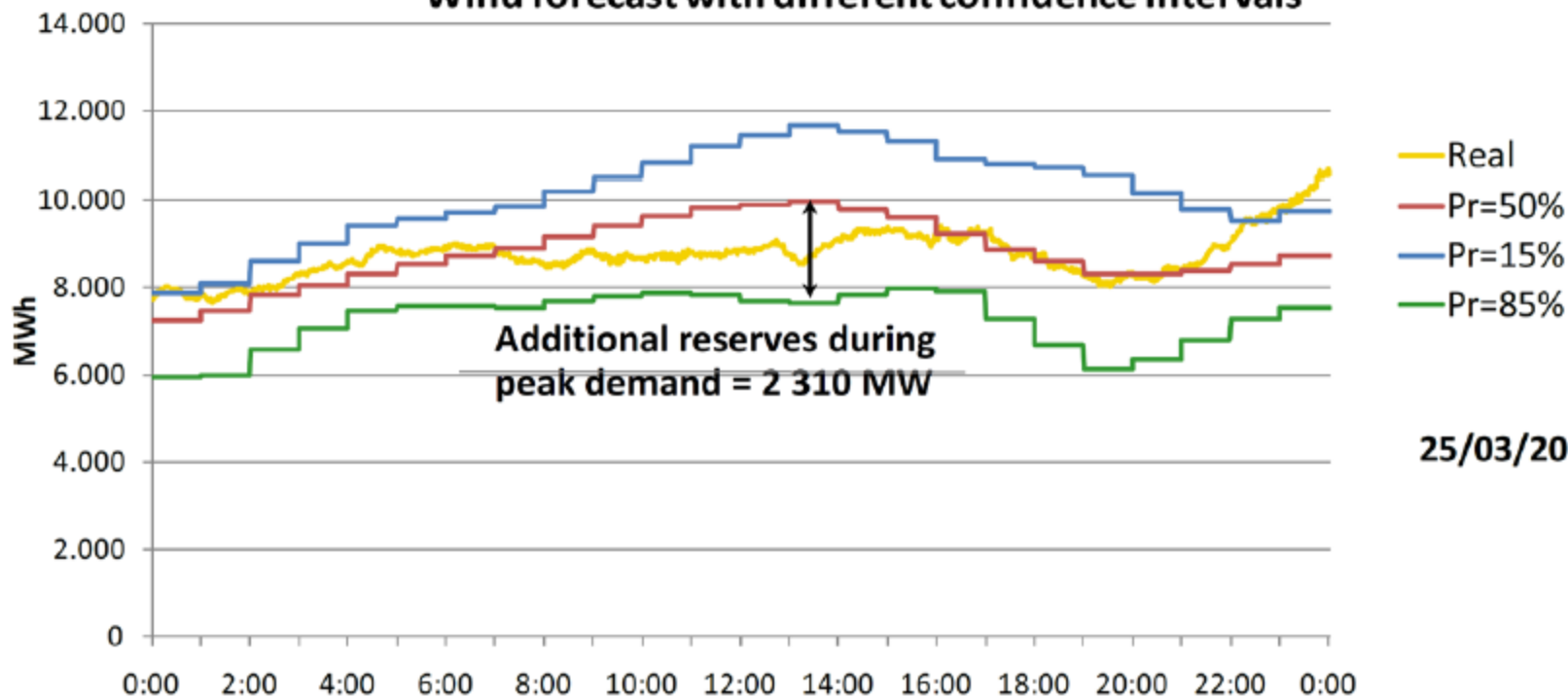
Balancing resources available for trading





Influence of forecast uncertainty

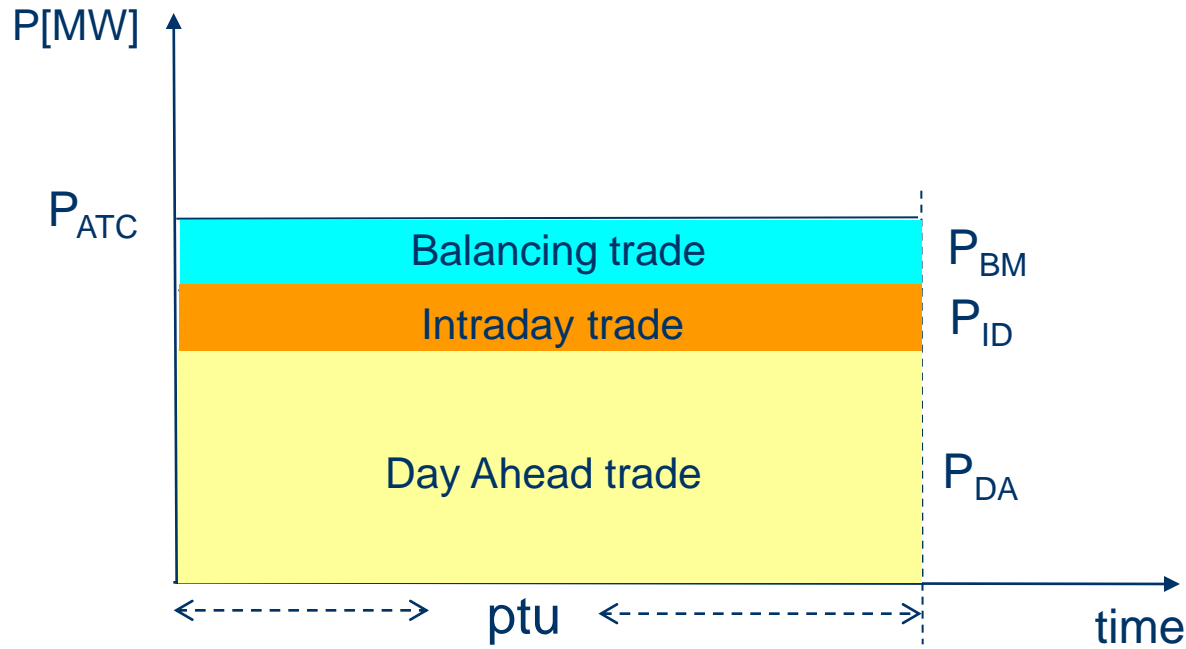
Wind forecast with different confidence intervals



- **P-85%** : 85% probability that the wind forecast is *below* the actual wind production for each hour. This constitutes the *lower-bound* of the wind forecast with a 15 % confidence margin.
- **P-15%**: 15% probability that the wind forecast is below the actual wind production at the given hour, *i.e.* 85% probability that the wind forecast is *above* the actual wind production at the given hour. This constitutes the *higher-bound* of the wind forecast with a 15 % confidence margin
- **P-50%**: 50% probability that the wind forecast is below the actual wind production at the given hour. This is the forecast with the lowest mean square error. “**Point prediction**” forecast



Allocation of HVDC transmission capacity

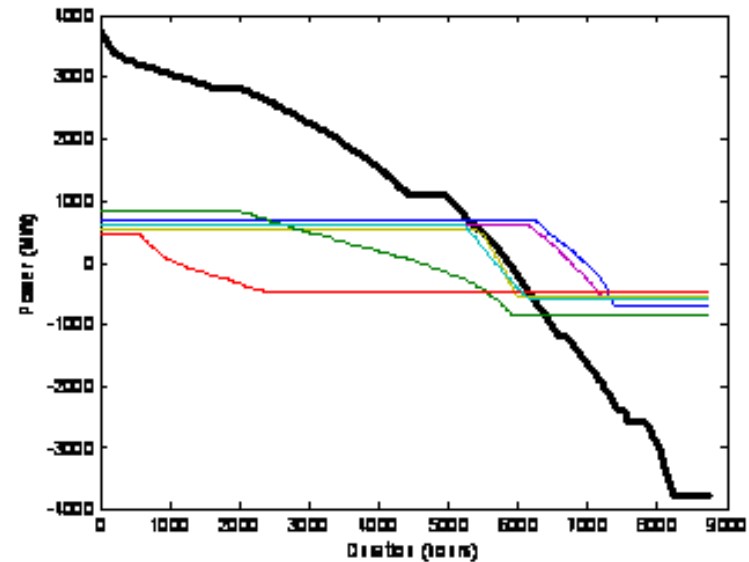
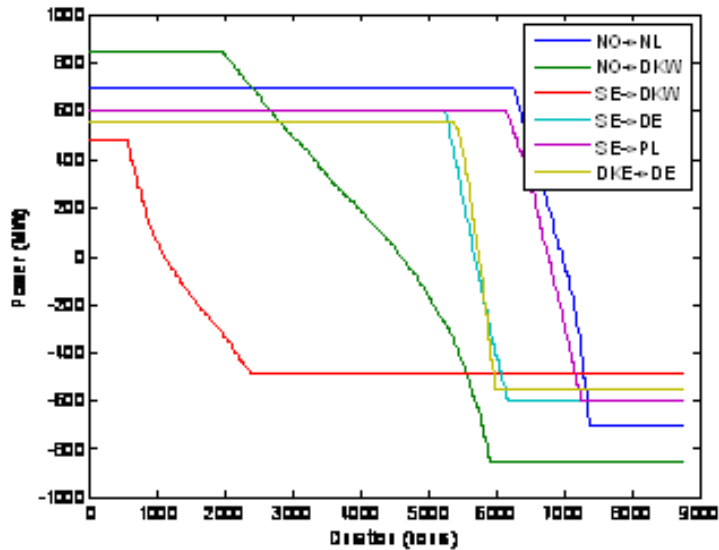


ERREG:

Cross-border balancing shall not lead to withdrawal of interconnection capacity from the market players and neither shall it limit opportunities for cross-border trade.

Comment: In special case where HVDC capacity is reserved for cross-border balancing, procurement of reserve capacity shall be subject of evaluation of the TSOs, in accordance with criteria defined by ENTSO-E and approved by regulators in a transparent way.

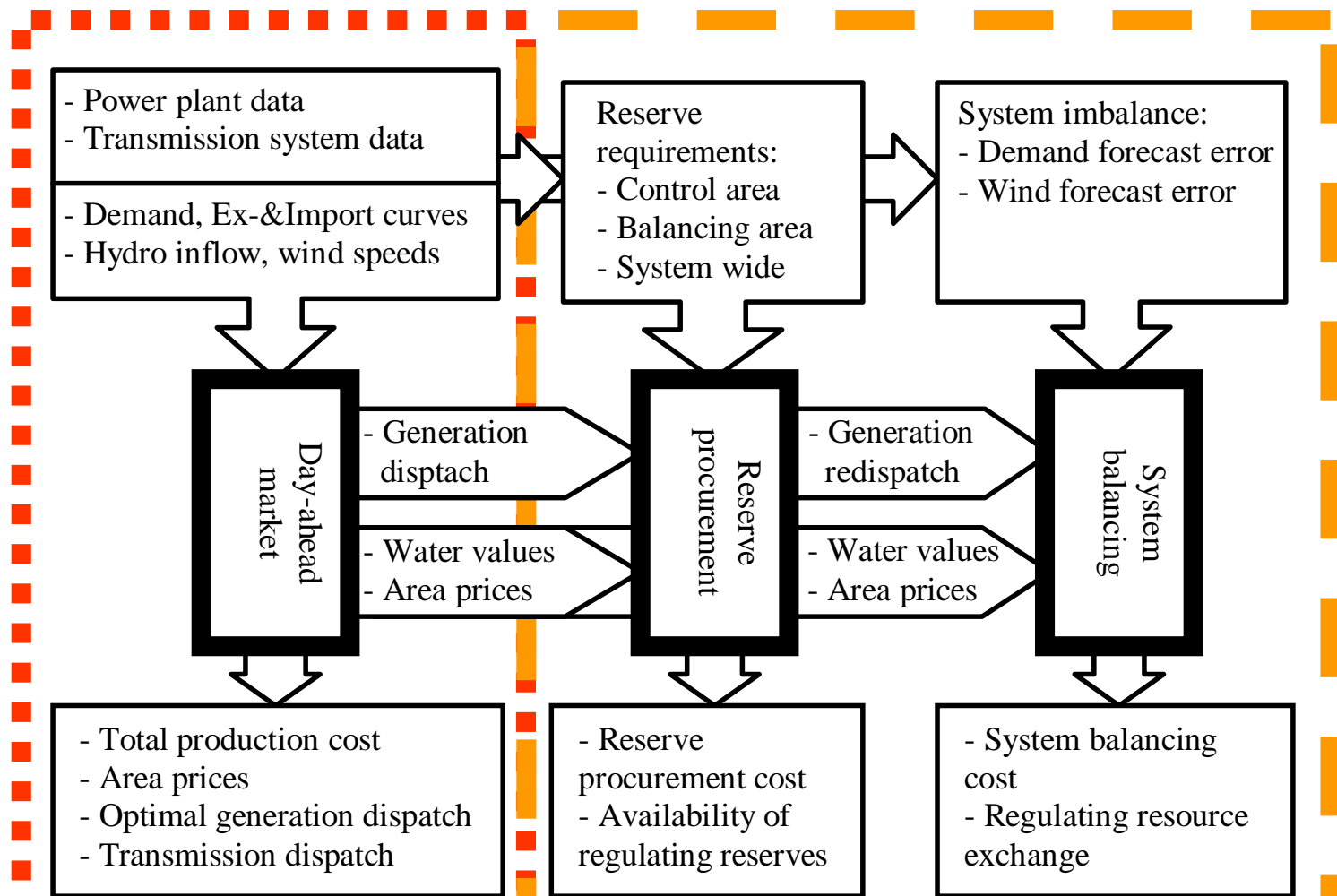
Individual vs. parallel utilizations of Nordic HVDC links for BM purposes



Paper IAEE-2010 “RESERVATION OF TRANSMISSION CAPACITY FOR THE EXCHANGE OF REGULATING RESOURCES IN NORTHERN EUROPE: IS THERE A BENEFIT?”

Simulation Model

Global Optimization



Samkjøringsmodellen Regulerkraftmodul IRIE

Competence building project (KPN) applications 2011

- CEDREN HydroBalance – Balancing services from Norwegian hydropower; Environmental, political, technical, and economical aspects
 - The project will address key questions for balancing power by developing new hydropower plants and pumped storage regimes between reservoirs, popular known as the 'green battery' for Europe.
 - Supported by: Fraunhofer (Ger), EnergiNorge, Agder Energi, Sira Kvina, Statkraft, Statnett
- Tools for Integrated Modelling of pan-European Transmission and Balancing Power
 - The project's main objective is to build new competence, methods and tools for analysis of the future pan-European electricity system.
 - Supported by: Statnett, Statkraft, ECO, Agder Energi, Energinet.dk(?)