Important aspects of short term balancing and congestion management on electricity market with larger shares of intermittent RES

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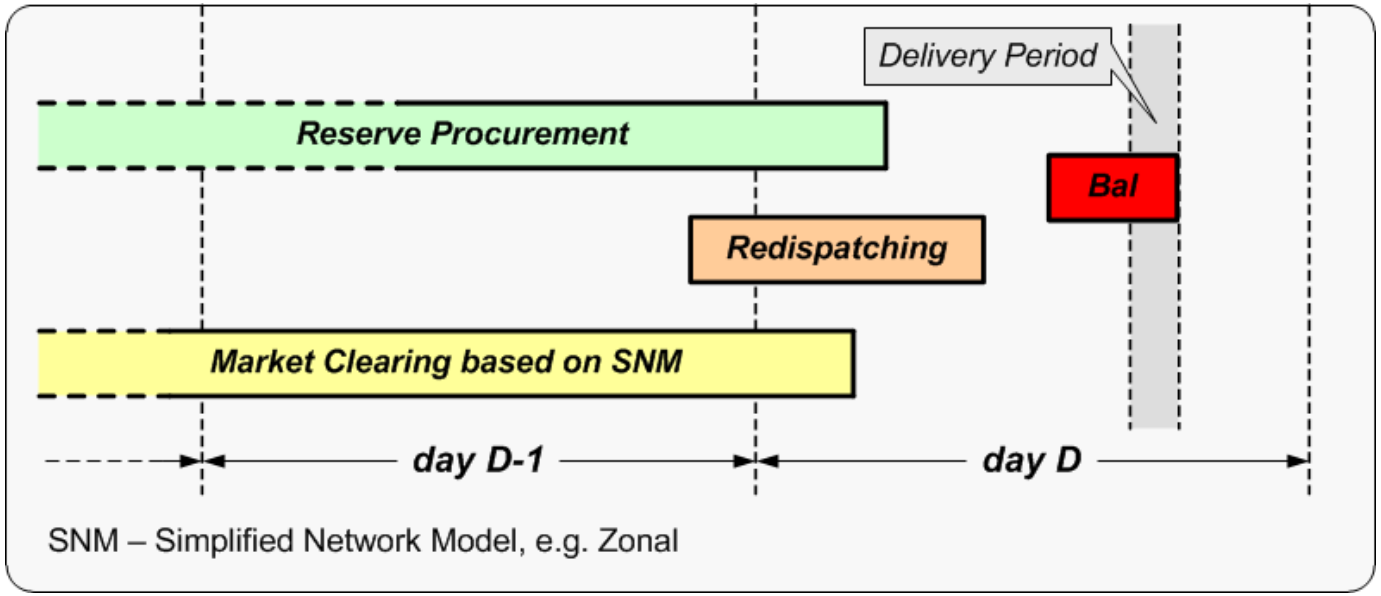
Key requirements for efficient market/system operation

- **Utilization of the transmission grid should be cost-effective while meeting all the transmission system constraints:**
  - Thermal limits
  - Voltage limits
  - Stability limits
- **When the transactions that parties wish to schedule would result in the violation of constraints, the system is congested and the TSO must take action to relieve the constraints violations - this is congestion management**
- **The options the TSO has:**

  Option 1: solve constraints outside the markets and socialize related cost

  Option 2: solve these scarce resources through market mechanisms

Option 1: Market/System operation based on two-step approach - Market Clearing & Redispatching



- **Main advantages**
  - Easy to understand and analyse
  - Simple solution algorithms
- **Main challenges**
  - Market processes run in parallel compete for the same resources (valid also for non market based redispatching)
  - A large part of the energy delivery cost is socialized (tariff charges)
  - Timing conflicts (between trading and redispatching processes)

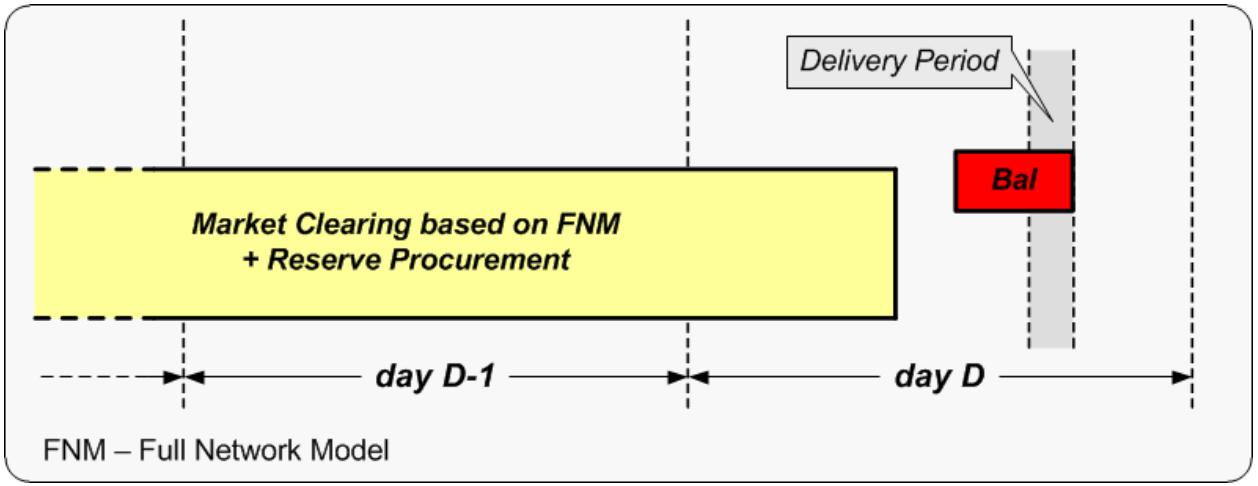
Challenges with current market design

- **Economic Efficiency** – ensure comprehensive maximization of total social welfare by including all energy supply cost components in the market clearing processes (costs of energy, reserves, congestions and losses)
- **System Security** – ensure secure operation of the power system by including detailed representation of both transmission and generation unit constraints directly in the market clearing process
- **Incentive Compatibility** – ensure coherency between market participants behaviours/ strategies and secure and costs effective use of the grid by applying correct price signals (dispatch based pricing)

Why zonal model is not the first best solution

- **Problems with Zonal Markets**
  - Intra-zonal congestion must be infrequent, inexpensive and non-predictable, to avoid:
    - Infeasible market schedules
    - Excessive need for real-time dispatch corrections
    - Gaming (i.e. DEC game)
  - Zone definition requires studies and constant monitoring
  - Challenging in highly meshed grids
  - Difficulties with Zonal PTDF calculation
  - Inefficient transmission loss allocation (losses are ignored)
  - Different treatment of intra-zonal and inter-zonal transactions
- **Market consequences**
  - Risk of infeasible schedules
  - Market prices not reflecting the real costs of electricity delivery
  - Lower social welfare

Option 2: Market/System operation based on Integrated Process



- **Main advantages**
  - Co-optimization of all resources and transmission capacity utilization (e.g. reserves and energy schedules can compete for transmission capacity)
  - System security requirements are reflected in energy prices (e.g. scarce resources and services are priced)
  - There is no timing conflict
- **Main challenges**
  - Full Network Model
  - Greater data requirements
  - More sophisticated algorithms/less intuitive market outcome

Balancing – Mechanism or Market (BM)

- **The role of the BM is strongly determined by the BRP model**

  (1) BRP is required to be balanced after intraday market, or

  (2) BRP is incentivized to be balanced but may have open position on BM

- **Balanced BRP model**
  - BM Prices act as penalties (penalised for deviations)
  - TSO procures and dispatches fast reserves to cover deviations
  - Commonly used in self-dispatch systems
- **Open position BRP model**
  - BM Prices act as value of a commodity
  - TSO performs Security Constrained Dispatch to cover imbalances (integrated balancing and congestion management)
  - Commonly used in central-dispatch systems

Crucial role of Balancing Market Prices (Real-Time Prices)

- BM Prices coordinate the behaviour of generators (consumers) in real-time regardless of the results of previous markets and therefore directly affect both the market efficiency and system security

- Given the role of BM Prices they shall properly reflect
  - the costs of energy delivery (efficiency dimension)
  - the system security conditions (security dimension)

  in order to ensure
  - coherency between market participants behaviours
  - secure and costs effective use of the grid
  - full remuneration of value provided by generation capacity to the system

Thank you for your attention