A Simulation of the European Electricity Market based on the Full Network Model

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The European electricity market today

- Capacity allocation *between* national markets (explicit/implicit auctions)
- However, network is meshed, constraints usually not aligned with political borders
- Consequence: Incoherence between institutions & technology

Source: etsovista.org
The European electricity grid

Source: Platts (2008)
Incoherence: So what?

• Constraints within national zones not resolved
  – Creation of new zones is often arbitrary

• Fragmentation of European market
  – Inefficient dispatch of power plants
  – Separation of energy market and ancillary services
  – Lack of accurate price signals

• Unexpected generation & flow patterns
  – Frequent redispatch measures required
Major challenge (1): International trade

Source: UCTE (2008)
Major challenge (2): Renewables

Source: EWEA (2009)
Comparison: Air Traffic Control

Source: Eurocontrol (2008)
Full Network Model

- ~ 10’000 nodes
- ~ 6’000 lines
- ~ 1’000 generators
Application 1: Operational Security

- Voltage angle as a measure for generation, consumption & flow pattern.
- High gradient indicates pot. critical situation.
- Examples of 16 July 2008, 10.30 am (high wind) ...
Application 1: Operational Security

- Voltage angle as a measure for generation, consumption & flow pattern.
- High gradient indicates pot. critical situation.
- Examples of 16 July 2008, 10.30 am (wind) …
- And 03.30 am (low wind)
Application 2: Market

- One price for Europe ("copper plate") is the wrong goal.
- The value of generation is dynamic: It varies by location and time.
- Locational/Nodal pricing is required.
- Provides price signals for generation investment & grid expansion.

Minnesota Hub: $131.21/MWh. First Energy Hub: $1.57/MWh.

Source: MISO/PJM (2008)
Policy Impact

- The current capacity allocation scheme is reaching its limits
  - Lack of coherence between institutions and technology
  - Short term driver: Economic crisis => different generation & consumption pattern.
  - Long term driver: Integration of large amounts of variable Renewables

- Recommendation: Nodal pricing based on the full network model as a target model for policy makers and regulators
  - Creating a truly integrated European electricity market
  - Providing accurate price signals for generation investments and network expansion: Crucial to reach sustainability goals
  - Key instrument to increase operational network security.

- Next steps:
  - Create transparent market efficiency indicators
  - Rethinking of institutional setup on European, national, and local level.
Thank You!