Assessment of geographic scope of electricity markets: the case of flow-based market coupling

Dmitri Perekhodtsev
LECG

The Economics of Energy Markets

Toulouse, June 20-21, 2008

Introduction

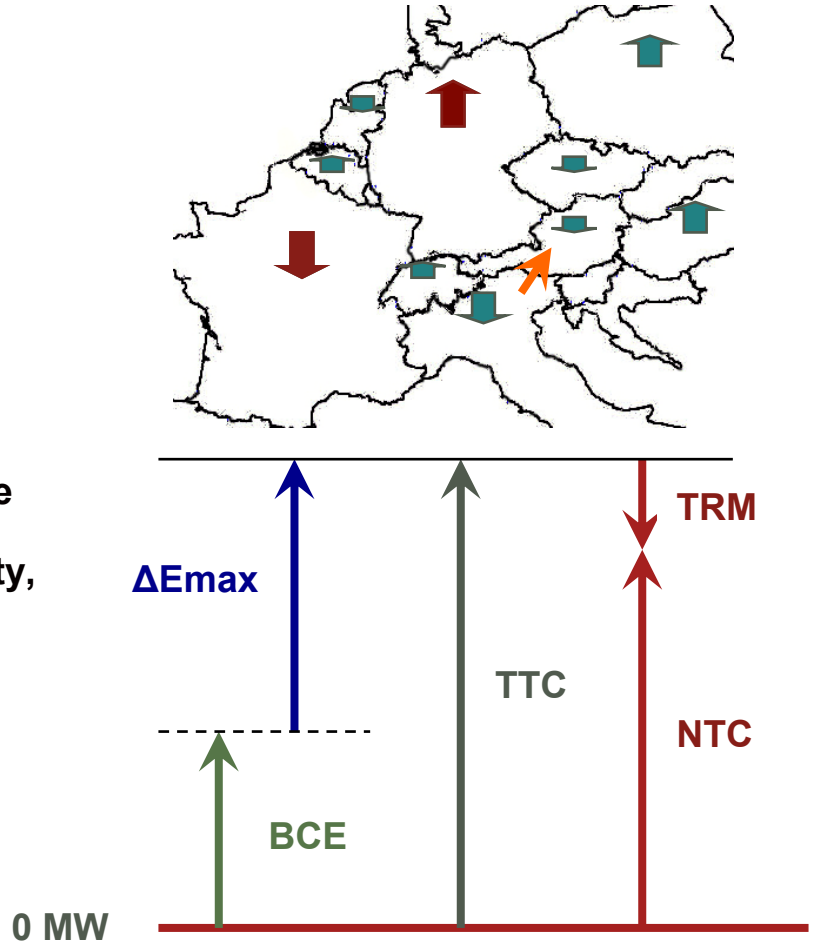
- **Method currently used by ETSO to determine cross-border Net Transfer Capacity (NTC) available for commercial use is inefficient.**
- **NTC may result in allocating less cross-border capacity than is physically feasible.**
- **That aggravates to geographic fragmentation of electricity markets along national borders and potential competition problems in each national market**
- **Flow-based market coupling initiatives of ETSO and EuroPEX have a potential to significantly improve the efficiency of cross-border capacity determination and allocation. That alone may extend the geographic scope of national markets.**
- **This paper attempts to quantify the possible effect of market coupling on the geographic scope of European electricity markets**

Outline

- **Current methodology of NTC identification flow-based market coupling**
- **Assessment of geographic scope of electricity markets**
- **Model of measuring unilateral market power in a meshed network**
- **Data**
- **Results**

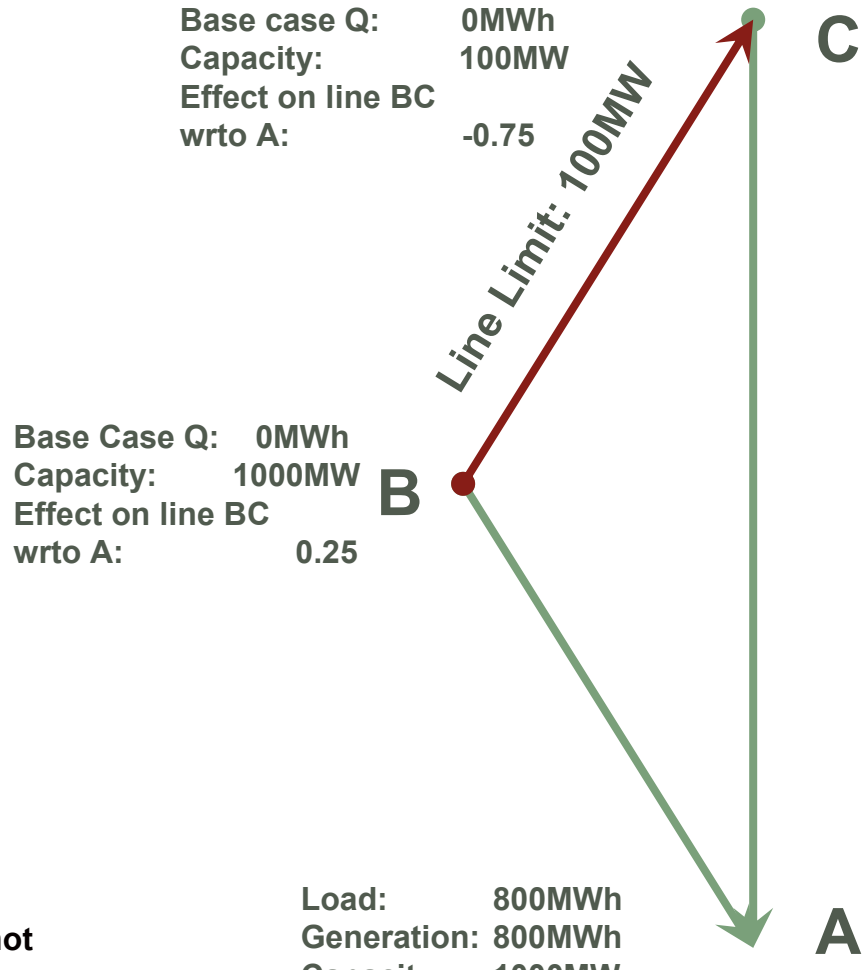
ETSO methodology for cross-border NTC determination

- **Current definition of cross-border capacity**
  - Base case: load and gen
  - Base case exchange
  - Maximum interchange (ΔEmax)
  - Total Transfer Capacity (TTC)
  - Transmission reliability margin (TRM)
- **Capacity is conditional on the base case**
- **Uncertainty in base case reduce capacity, although in reality it can be otherwise**



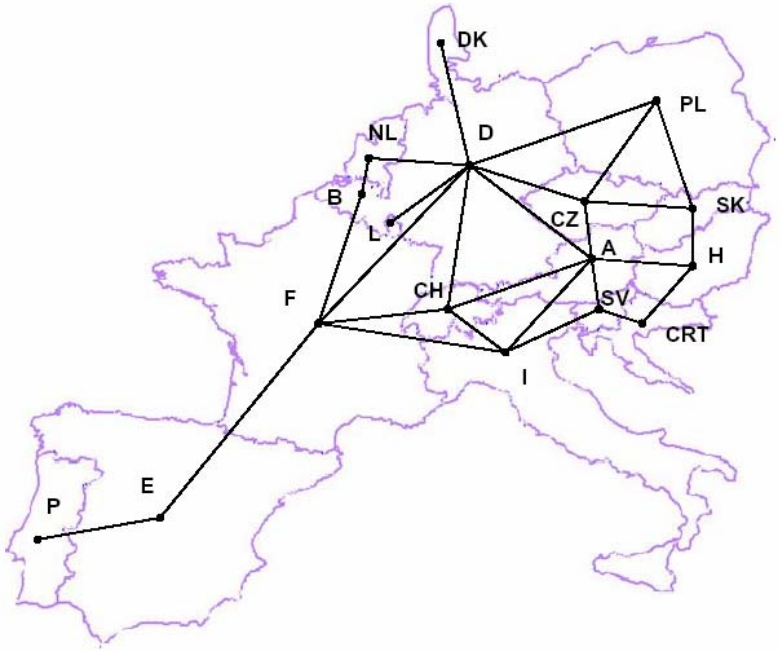
Example: Transfer capacity B-A and C-A

- **Base case:**
  - 800 MWh load in A is served by local generation;
  - 0 generation at B and C.
  - 0 BCE: BA and CA
- **Emax BA**
  - Determined by BC limit
  - 400 MW
- **Emax CA**
  - Determined by BC limit
  - 133.3 MW
- **Energy deliverable to A under cross-border**
  - 400 MWh from B
  - 100 MWh from C
  - 500 MWh total
- **Maximum actual energy deliverable to A**
  - 700 MWh from B
  - 100 MWh from C
  - 800 MWh total
- **Current transfer capacity calculation does not take into account possible counterflow that can be provided by C**



Flow-based market coupling

- **Simplified transmission model using:**
  - Physical capacities of cross-border links and
  - Power Transfer Distribution Factors (PTDF)
- **Coordinated cross-border congestion management based on:**
  - Implicit auctions
  - Export-import bids from national power exchanges
- **Does not rely on the base case**
- **Provides more flexibility to allocate available capacity**



Identification of geographic relevant markets

- **SSNIP test**
  - Starts from a smallest candidate geographic market (a country)
  - Tests whether if this market was controlled by a hypothetical monopolist, it would be profitable for the monopolist to raise prices.
  - NO means that the competitive pressure from the neighboring countries is strong, need to expand the geographic market definition and repeat the exercise
  - YES means that external competitive pressure is week, the boundary of the geographic market is reached
- **Profitability of a price increase by a hypothetical monopolist**
  - Pivotality – whether the demand can be met without relying on the capacity of a particular generator
  - Residual Supplier Index – share of demand that can be met without relying on capacity of a particular generator.
  - RSI < 1 means a generator is pivotal, the smaller RSI the smaller is the external competitive pressure on the generator

Model

- **Minimize the output of the considered firm, while:**
  - Meeting load in all locations;
  - Respecting generation capacity constraints;
  - Respecting transmission constraints

Flow-based market coupling

$$\min_{q_i, q_i^f, \forall i} \sum_{i=1}^{N} q_i$$

s.t.

1. $0 \le q_i \le c_i$
2. $0 \le q_i^f \le c_i^f$
3. $\sum_{i=1}^{N} q_i + q_i^f = \sum_{i=1}^{N} d_i$
4. $\mathbf{PTDF}^{(r)} \cdot \left(\mathbf{q} + \mathbf{q}^f - \mathbf{d}\right) \le \mathbf{L}_{mc}$

Bilateral cross-border NTC

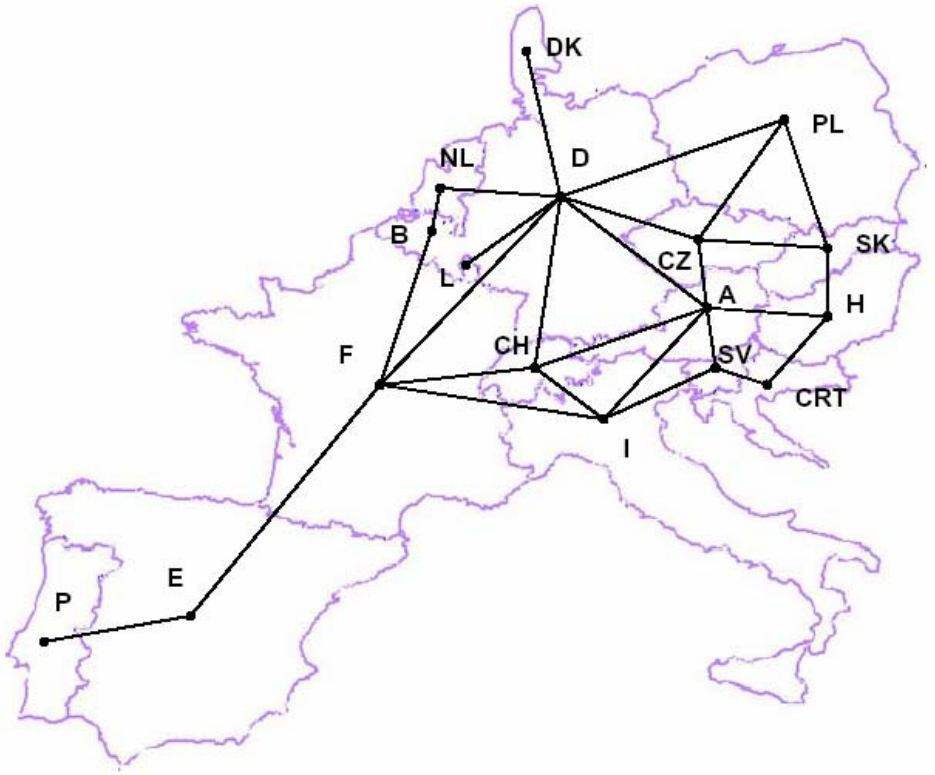
$$\min_{q_i, q_i^f, f_j, \forall ij} \sum_{i=1}^{N} q_i$$

s.t.

1. $0 \le q_i \le c_i$
2. $0 \le q_i^f \le c_i^f$
3. $\mathbf{f} \le \mathbf{L}_{cb}$
4. $\mathbf{A} \cdot \mathbf{f} = (\mathbf{q} + \mathbf{q}^f - \mathbf{d})$

Data

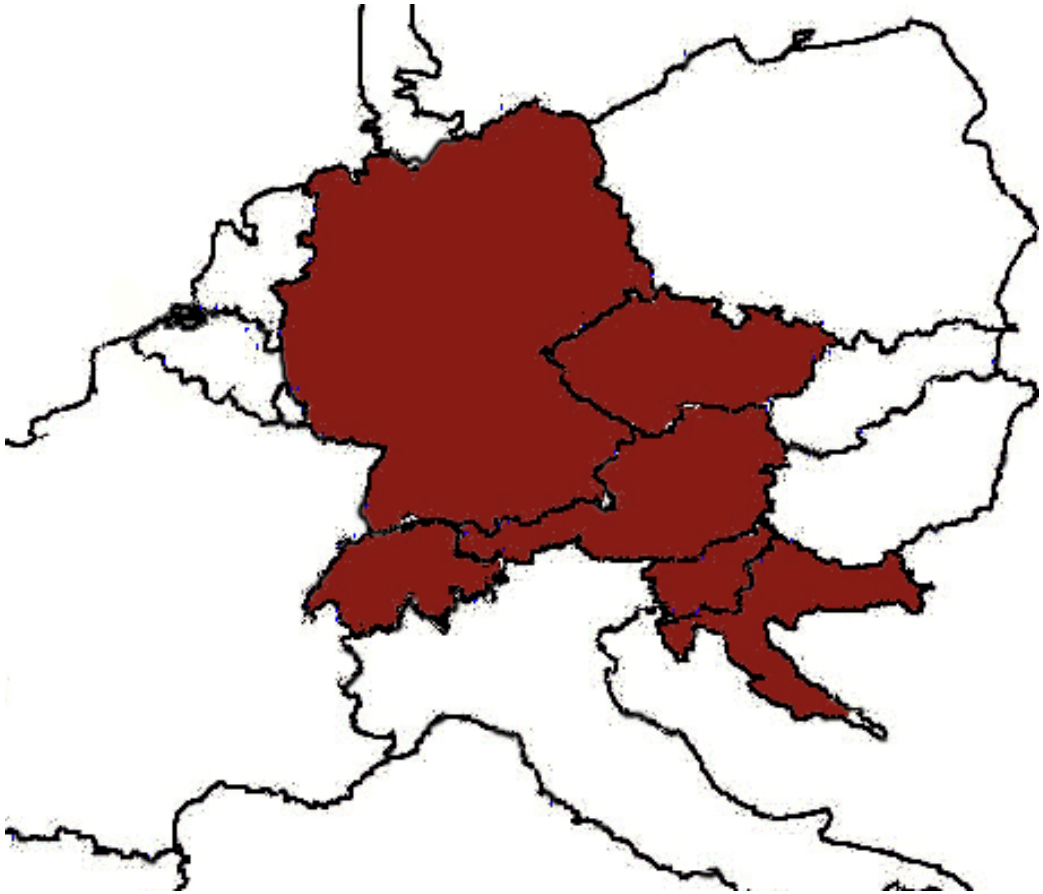
- **Transmission model**
  - Market coupling scenario
    - Zhou and Bialek, 2005
    - PTDF matrix, transmission limits
  - Current scenario:
    - NTC from ETSO
- **National load scenarios**
  - Winter Off-Peak/Peak,
  - Summer Peak
- **National generating capacity**
  - DG-TREN 2004



Results: Germany

Candidate Market	Cross-border allocation			Market coupling		
	Competitive import	Demand at candidate market	RSI	Competitive Import	Demand at candidate market	RSI
D	20,253	49,899	41%	34,938	49,899	70%
D-A	21,423	56,180	38%	36,886	56,180	66%
D-CH	25,853	59,069	44%	41,209	59,069	70%
D-CZ	21,178	58,054	36%	36,509	58,054	63%
D-NL	17,603	57,136	31%	27,001	57,136	47%
D-F	18,903	106,527	18%	42,213	106,527	40%
D-PL	20,253	67,423	30%	32,293	67,423	48%
D-A-CH	24,023	65,349	37%	42,233	65,349	65%
D-A-CZ	20,778	64,335	32%	35,440	64,335	55%
D-A-H	21,973	60,582	36%	34,768	60,582	57%
D-CH-I	29,053	87,837	33%	43,314	87,837	49%
D-A-CH-CZ	23,378	73,505	32%	40,139	73,505	55%
D-A-CH-CZ-SV-CRT	23,178	76,221	30%	38,251	76,221	50%

Result: Germany



Results: France

Candidate Market	Cross-border allocation			Market coupling		
	Competitive import	Demand at candidate market	RSI	Competitive Import	Demand at candidate market	RSI
F	7,150	56,628	13%	19,757	56,628	35%
F-E	6,800	79,587	9%	19,078	79,587	24%
F-D	18,903	106,527	18%	42,213	106,527	40%
F-B	7,000	66,388	11%	22,358	66,388	34%
F-B-NL	7,500	73,624	10%	25,799	73,624	35%
F-B-NL-D	10,653	123,523	9%	32,118	123,523	26%
F-I	11,000	85,397	13%	19,780	85,397	23%
F-CH	12,900	65,798	20%	19,811	65,798	30%
F-CH-I	13,500	94,567	14%	16,445	94,567	17%

Conclusion

- **This work attempts to quantify the effect of a change of transmission model on geographic scope of electricity markets in Europe.**
- **The approach based on assessment of pivotality of hypothetical national monopolists.**
- **Little chances of expansion of relevant markets for France**
- **German market can be expanded to include Czech Republic, Switzerland, Austria, Slovakia, and Croatia**
- **Further analysis: perform for other countries**