Impact of a German/Austrian market splitting on the electricity markets and the transmission grid in CEE

- Introduction
- Assumptions and Scenario
- Market Results
- Grid Results
- Summary

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Background and Motivation

- Current definition of bidding areas in Europe mainly focusing on country borders (internal physical transmission bottlenecks mainly handled by redispatch)
- Increasing appearance of congestion and loop flows in Central Europe
- Discussion on alternative definition of bidding areas (cf. Sweden, Italy)
- Evaluation of a splitting of the German/Austrian market area in a former study (2010)
- Results not directly transferable in future systems with a higher share of Renewables and significant grid enforcement in the region

Goal of this study

- Analyzing the impact of a market splitting DE/AT on the markets and the transmission grid in Central-Eastern-Europe (CEE)
  - Focus years: 2016 and 2022 (with an hourly granularity)
  - Focus area ¹: Germany, Austria, Poland and Czech Republic

¹ Regarding simulation of necessary redispatch costs and volumes
² Splitting of bidding area at country border DE/AT (not control zones)
**Methodology**

**Objective of the study**
- Quantify impacts of a market splitting (DE/AT) on electricity markets and the transmission grid

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- Hourly Determination of
  - nodal RES feed-in
  - load

- Assumptions on NTC between DE/AT 4,5 GW (2016) and 5,5 GW (2022)

- Hourly calculation
  - unit dispatch
  - market prices
  - exchange

- Simulation of
  - (n-1) congestions
  - redispatch
Input, assumptions and focus area

- **Input data (2016 and 2022)**
  - SOAF Scenario B of ENTSO for installed capacity and load in Europe
  - Scenario of German Regulating Agency (BNetzA) for the NEP (2012) for Germany
  - Grid enforcement according to TYNDP (2012) and NEP (2012)
  - Simplified future NTC calculation

- **Market design**
  - Zonal market areas without inner transmission constraints
  - Transmission capacity constraints (NTC approach) between market areas
  - Nodal cost-minimal cross-border redispatch

- **Focus area**: AT, DE, PL and CZ

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1. No consideration of coordinated NTC (e.g. C-Function, Export Balance Poland)
2. Regarding simulation of necessary redispatch costs and volumes
3. Virtual (unconstraint) inner German border is just for monitoring the flows from North to South Germany in this study (unlimited NTC!)
Assumptions on grid enforcement in focus area

Projects ¹ from 2013 to 2016

Projects ¹ from 2017 to 2022

- Assumptions based on TYNDP (2012), German grid enforcement plan (2012), information from APG and publications from other TSOs
- Large scale upgrades of former 220 kV lines to 380 kV lines
- Partial grid enforcement until 2016 followed by massive grid enforcement until 2022

¹ Projects include new transmission lines as well topology changes due to new substations (e.g. new substation in a line)
Assumptions on congestion management (redispatch) simulation

- Identification of (n-1) grid congestions with regular AC load flow calculation

- Measures to release congestion
  1. Tapping of phase shifters (e.g. Poland, Austria) - No costs
     → Phase shifters are always first tapped according to grid situation
  2. Adjustment of hourly HVDC operation in focus area (e.g. new HVDCs in Germany)
     → HVDC is assumed to transfer simulated schedules flows with priority followed by an hourly adjustment of setpoints – No costs
  3. (Joint cross-border) redispatch of power plants – High costs

- Power plants available for redispersching
  - Decrease of generation
    - All thermal conventional power plants (up to minimum power, marginal fuel costs)
    - Wind power (up to zero feed in, highest costs)
  - Increase of generation
    - All thermal units in part-load operation (up to maximum power, marginal fuel costs)
    - Offline natural gas power plants (up to maximum power, marginal fuel costs)

- No consideration of hydro power plants in redispatch simulation
MARKET RESULTS
Generation – Comparison with 2010

- Comparison of simulation values with real generation for 2010 of ENTSO-E
- Substitution of conventional generation by renewables in Germany and overall small decrease of net power generation
- Decrease of generation in Belgium due to nuclear phase out

Shifting of exchanges estimated due to changes in generation
High exchange between northern and southern part of Germany
High exchange between southern Germany (DS) and Austria (AT)
Exports from Poland (PL) and Czech Republic (CZ) to Germany (DE)
Power flows from Poland across Czech Republic to Austria
Power flows from Czech Republic across Slovakia to Hungary

* Simulated scheduled flows in the power markets (not physical flows!)
Aggregate commercial exchange – Comparison with 2010

Differences in hourly commercial exchange (2016 – 2010) [TWh]

- High increase of exchange between northern and southern part of Germany
- Increase of exchange from southern Germany to Austria
- Increase of power flows from Poland across Czech Republic to Slovakia and Hungary
Commercial exchanges and assumptions on NTC (DE-AT)

Sorted commercial exchange in base definition

- Scheduled power flows mainly from DN to DS (North to South Germany)
  → Commercial exchange from DN to DS up to 32.9 GW in 2016 and 45.2 GW in 2022
- Exchange between DS and AT in both directions (nearly balanced)
  → Commercial exchange from DS to AT ranges from -7.6 GW to 12.2 GW in 2016 and from -14.6 GW to 15.5 GW in 2022
  → NTC assumptions from APG: 4.5 GW in 2016 and 5.5 GW in 2022
  → Exchange higher than 4.5 GW in 2,100 hours (24 %) in 2016 and higher than 5.5 GW in 2,670 hours in 2022 (30 %)
MARKET SPLITTING DE/AT
Decrease of lignite and increase of pumping and gas in Germany
Decrease of pumping and turbining as well as an increase of hard coal in Austria
Overall negligible effects on generation in other countries
Aggregated commercial exchange – DE/AT vs. Base

- Reduction of exchange from south Germany to Austria
- Negligible influences on power flows on other borders
- Overall small changes on the borders
2016 and 2022

GRID RESULTS
Significant congestion in Germany and the Central Eastern European (CEE)

Heavy negative redispatch in eastern/northern part of Germany and Poland and increase of generation in southern Germany

Frequency of (n-1) line overloading (h/a) before PST tapping and redispatch

Summed redispatch
- Power reduction
- Power increase
- Volume 2 TWh/a

Remarks
1. Line is overloaded if loading is higher than 100% of max. current without consideration of switching actions
2. Optimized adjustment of PST (e.g. in PL or AT) before redispersching measures
No significant change of locations and level of congestion in focus area

Only minor changes in grid situation due to splitting of DE/AT with assumed NTC (4,5 GW)

### Frequency of (n-1) line overloading (h/a)

- **Before PST tapping and redispach**

  - 1%
  - 15%
  - > 30%

### Summed redispach

- **Power reduction**
- **Power increase**
- **Volume 2 TWh/a**
Massive decrease of congestion (cp. 2016) due to grid enforcement

Significant reduction of overall redispatch volumes in focus area

Remaining (local) bottlenecks in CEE region

Frequency of (n-1) line overloading $^1$ (>150 kV) before PST tapping and redispatch

**Remarks**

1 Line is overloaded if loading is higher than 100% of max. current without consideration of switching actions

2 Internal HVDC dispatch according to scheduled flows

2 Optimized adjustment of PST and HVDC before redispatching measures
Light reduction of overloading in Austria and Czech Republic due to Splitting DE/AT

Overall only minor impact of DE/AT on congestions in CEE region and redispatch volumes or locations

Frequency of \((n-1)\) line overloading (h/a) before PST tapping, HVDC adjustment and redispatch

Summed redispatch

- Power reduction
- Power increase
- Volume 2 TWh/a
Marginal impact of market splitting on line *St. Peter – Pleinting*

Line not congested in 2022 due to parallel grid enforcement of *St. Peter – Isar* (380 kV)

\(^1\) (n-1) line loading before adjustment of PST or redispatch measures
No noticeable impact of splitting DE/AT on line Redwitz – Remptendorf

Line not congested in 2022 due to grid enforcement by parallel lines and new HVDC

\(^1\) (n-1) line loading before adjustment of PST or redispacth measures
Very little impact of splitting DE/AT on line Hradec – Chrast in both years (mostly in times of high line loadings)

1 (n-1) line loading before adjustment of PST or redispatch measures
Noticeable impact of splitting DE/AT on line Mikulowa – Czarna in both years (especially in situations with high line loadings)

(n-1) line loading before adjustment of PST or redispatch measures
No significant impact of splitting (DE/AT) on line Albrechtice – Dobrzen (as well as parallel line Nosovice – Wielopole)

1 (n-1) line loading before adjustment of PST or redispatch measures
Grid Results – Focus lines (6/7)

(n-1) line loading Nosovice – Varin (CZ to SK – 380 kV) ¹

Very little impact of splitting DE/AT on Nosovice – Varin in 2016 and even no impact in 2022

¹ (n-1) line loading before adjustment of PST or redispatch measures
Splitting of DE/AT leads to slight reduction of overloadings on Röhrsdorf – Hradec in both simulation years.

1 (n-1) line loading before adjustment of PST or redispatch measures
Strong increase of total redispatch volumes and costs in 2016 compared to 2010

Heavy decrease of costs and volumes in 2022 due to massive grid enforcement

Only slight impact of splitting DE/AT on redispatch costs and volumes in all future simulations

1 Summed yearly value (based on investigation of all 8760 h/a) for all countries in focus region (Germany, Austria, Poland, Czech Republic)
EXECUTIVE SUMMARY
Main findings – Future scenario

- Evaluated future scenarios are facing significant congestion in all considered countries

**Mid-Term (2016)**

- High commercial exchanges in focus area (e.g. Northern Germany to Austria)
- Large congestion and high necessary redispatch costs and volumes
- Heavy congestion in Germany and significant curtailment of wind power due to slower grid enforcement (e.g. North-South and East-South lines)
- Although exchange with Germany increases, only little congestion occurs in Austria
- Significant reduction of congestion in Poland due to Phase-Shifting-Transformers (PST)

→ Grid congestion can be successfully handled by (cross-border) redispatch

**Long-Term (2022)**

- Significant reduction of redispatch volumes due to massive grid enforcement and flexibility from HVDC components in Germany
- Remaining simulated local congestion in Germany and Poland
- High transport from North to South can be handled without large congestion

1 Without consideration of unplanned power plant non-availability and line non-availability due to maintenance
Main findings – Effects from market splitting (DE/AT)

- Increase of scheduled flows in the Eastern transmission corridor (PL->CZ->SK->HU)
- Overall only little effects from market splitting Germany/Austria

Key Conclusions

- Long-term grid enforcement (2022) reduces congestions and redispatch significantly
- Splitting of Austrian/German market area at Austrian border (splitting DS/AT) is no efficient solution for solving congestion in other countries
QUESTIONS AND DISCUSSION

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