GRID CONGESTIONS IN CENTRAL EUROPE: ISSUES AND CONSEQUENCES IN AND AROUND GERMANY

Hydrobalance User meeting

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SUMMARY

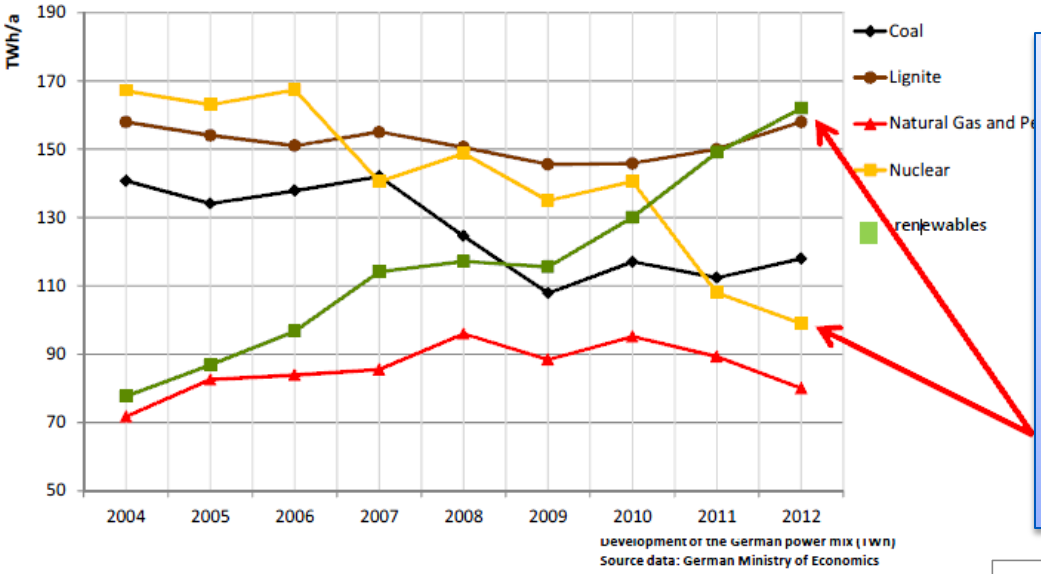
1. CONTEXT OF GERMAN POWER SYSTEM

2. PROBLEMS AND CONSEQUENCES OF GRID CONGESTIONS AROUND GERMANY

3. WHICH SOLUTIONS ?

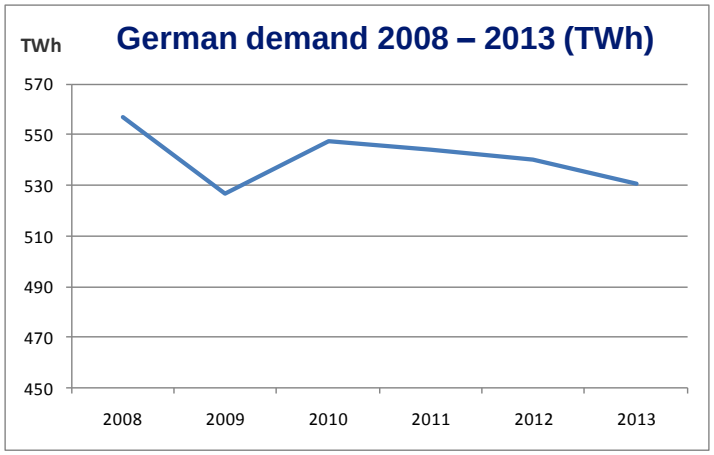
CONTEXT OF GERMAN POWER SYSTEM

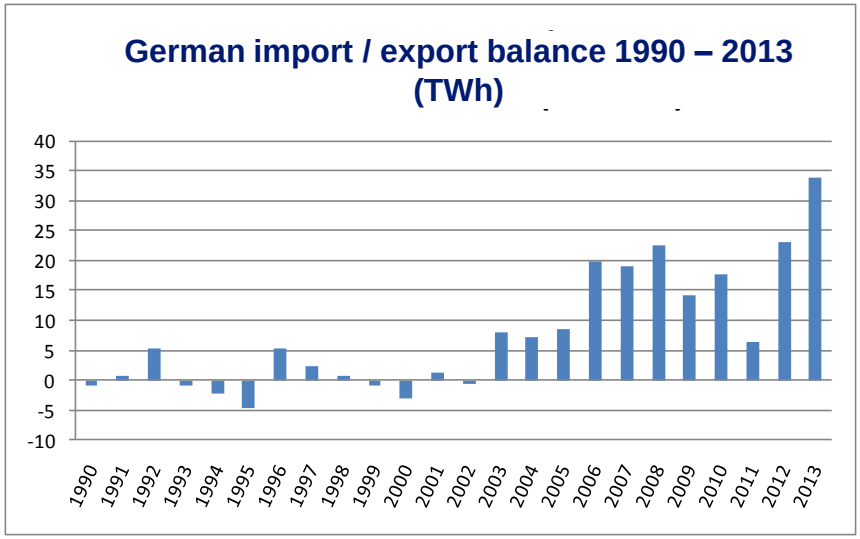
GERMANY HAS A HIGH COMPETITIVE ELECTRICITY MIX



A huge evolution in production mix since 2004 :

- Increase of intermittent RES production (2012-2013 : + 12%).
- Nuclear phase-out since 2011 (Fukushima).
- Increase of coal and lignite production because of low C02 and coal prices.

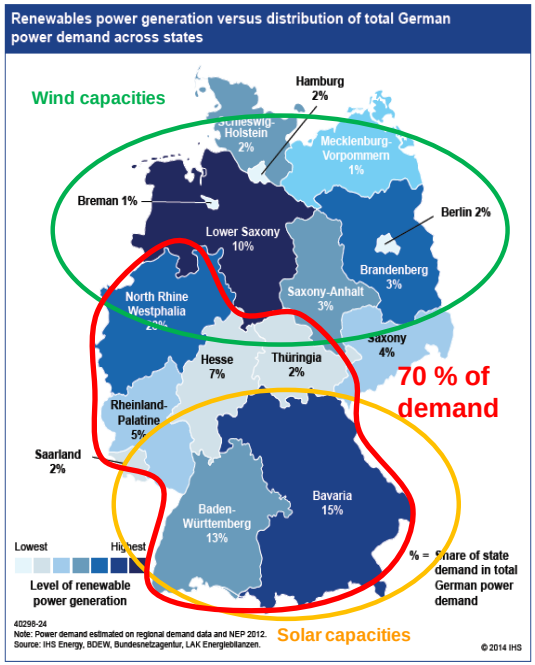




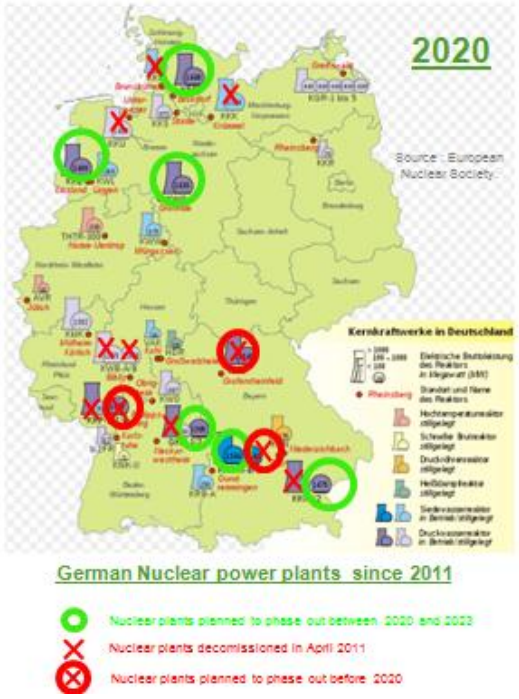
- Decrease of electricity consumption since 2008 (economic crisis, energy efficiency ?) .
- **Increase of German export since 2003** (2013 : 34 TWh).

Source : AGEB

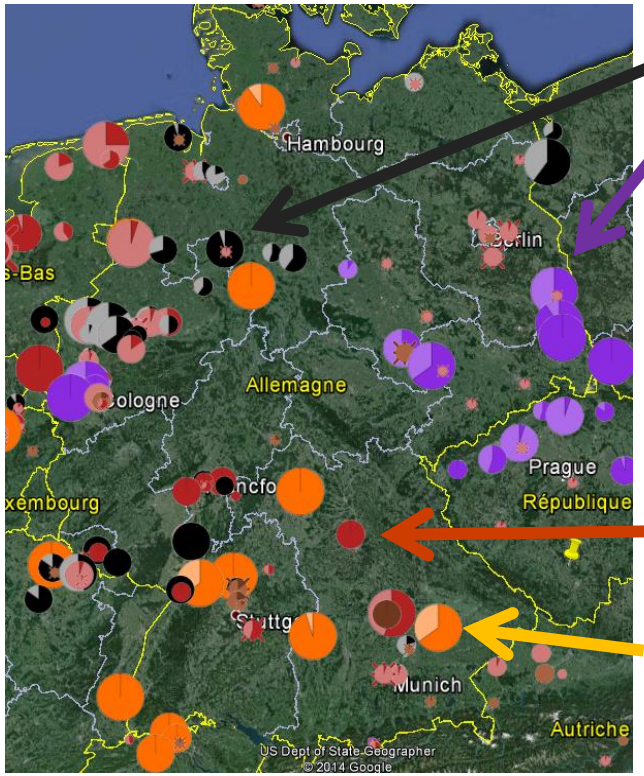
INADAQUACY BETWEEN LOCALIZATION OF PRODUCTION AND DEMAND



Intermittent RES and demand in 2013



Planned Nuclear phase out in Germany



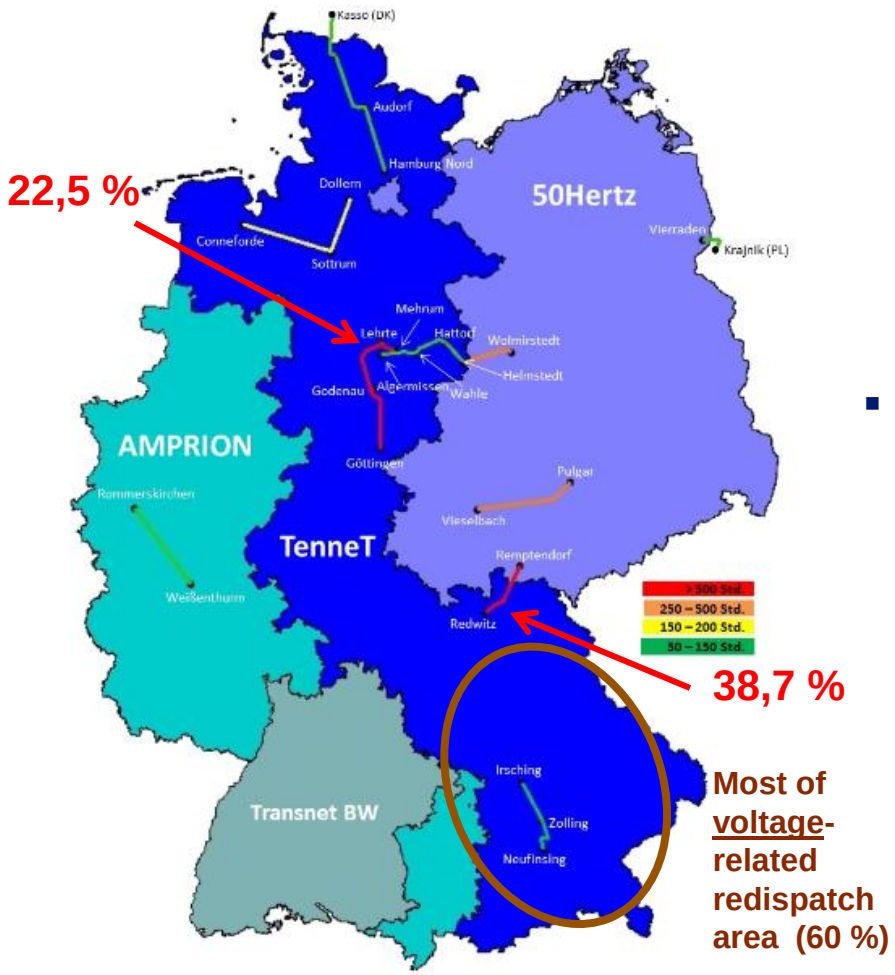
German thermal power plant capacities in 2013

- Most of **low cost production** (wind power, lignite, coal) is located **in the North**, whereas **most expensive production** (gas) and high rate of **demand** are located **in the South**.
- **The imbalance should increase by 2020 with the planned nuclear phase out**.

PROBLEMS AND CONSEQUENCES OF GRID CONGESTIONS AROUND GERMANY

GERMAN INTERNAL GRID IS ALREADY UNDER STRESS

Figure 22: Electricity-related redispatch measures on the most strongly affected network elements in 2012 as notified by TSOs. Source: Own graph based on BNetzA GIS



Most of voltage-related redispatch area (60 %)

Main elements affected by electricity-related redispatch in Germany - 2012

- TSOs are required to take **more and more redispatch measures** in order to prevent congestions of power lines, infringements of (n-1) criterion or voltage collapse.

  2011 – 2012 : increase of 42 % (7160 h vs. 5030 h, i.e. 2,6 TWh in 2012). Most affected areas = 50 Hz and TenneT control areas.

- In addition, **network operators operate RES curtailments**: 385 GWh in 2012 (milder conditions reported to 2011). 93 % wind power plants, 4 % PV installations, only 2 % on transmission network.

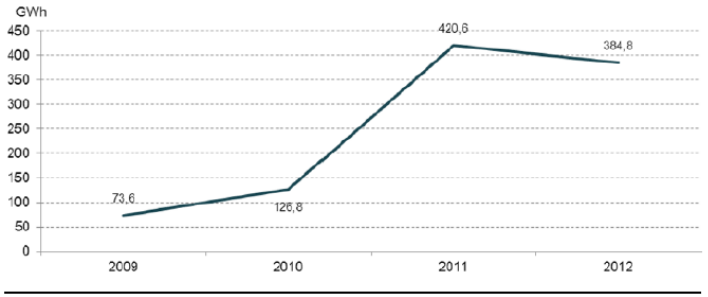
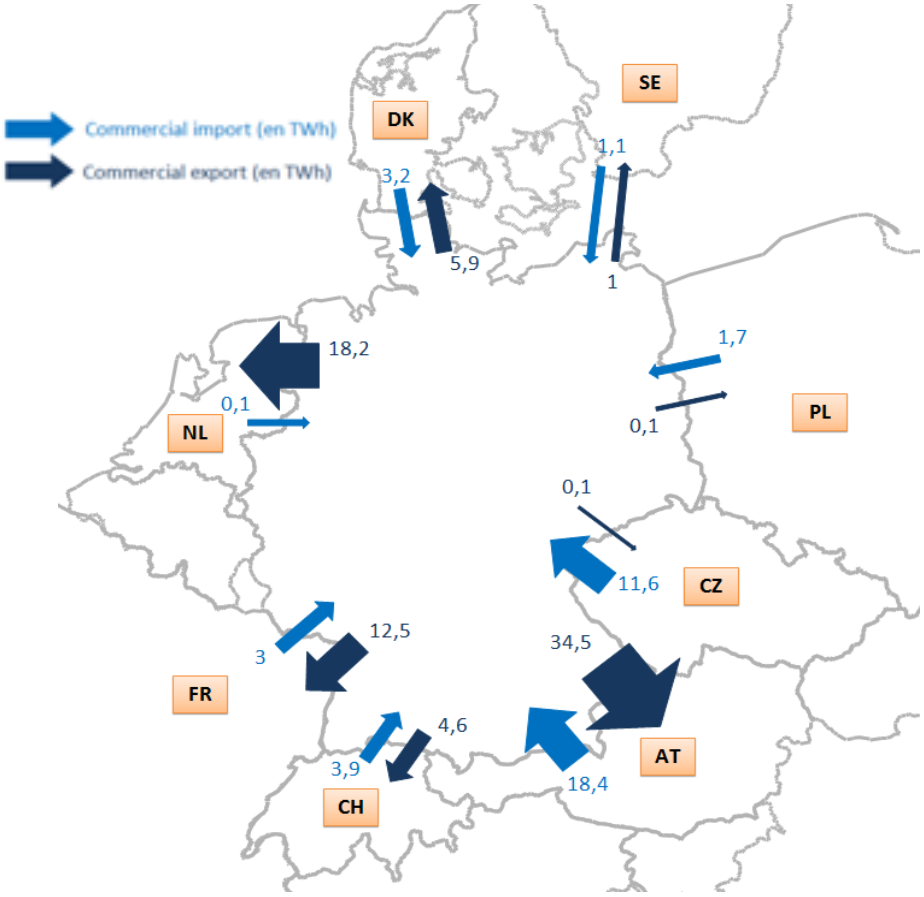


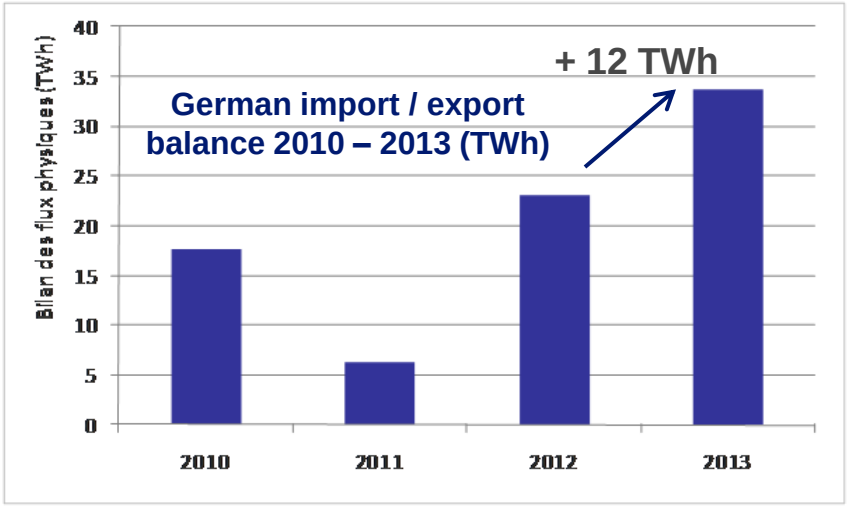
Figure 8: RES-E curtailments (GWh) in the period 2009 - 2012 | Bundesnetzagentur and Bundeskartellamt (2013)

RES curtailments (in GWh) in Germany – 2009/2012

GERMAN POWER TRADE EXPORT POSSIBILITIES ARE MORE AND MORE LIMITED BY THE GRID



Power trades between Germany and its neighbours in 2013 (TWh) – ENTSO-E

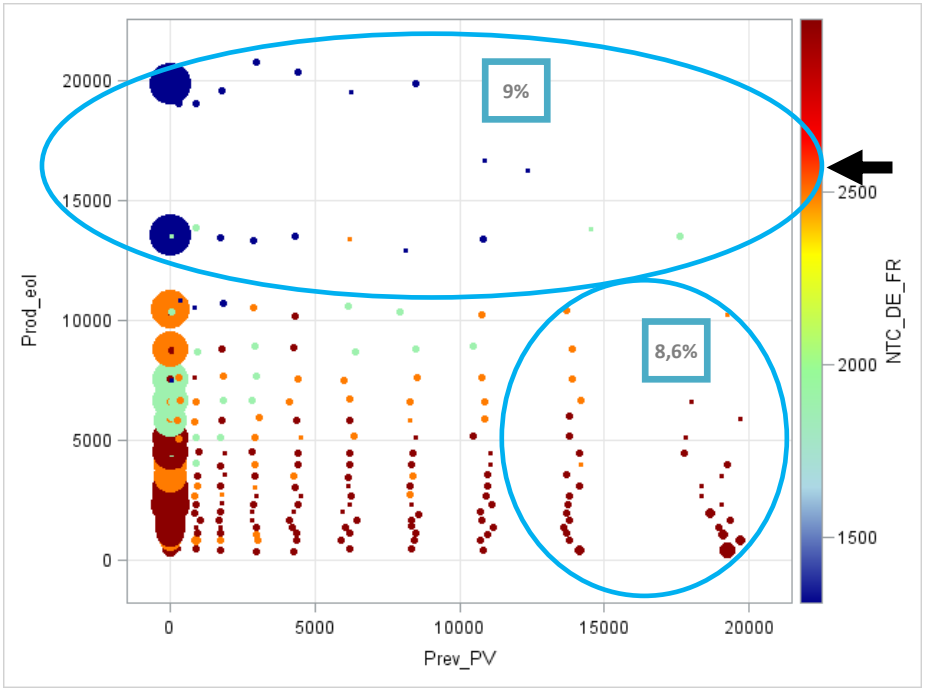


Source : https://www.entsoe.eu/data/data-portal/exchange/

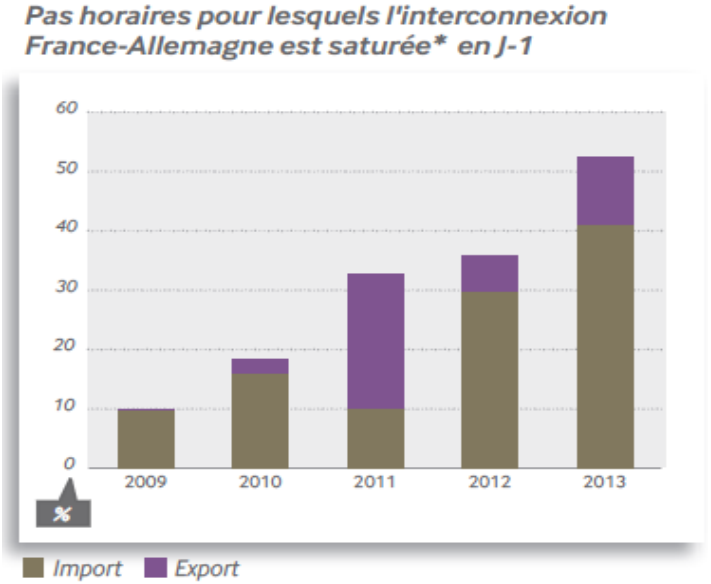
- **German power trade exports have hugely increased since 2011, because of a more competitive production mix.**
- Germany mostly exports to Austria, the Netherlands and France.
- But …

GERMAN POWER TRADE EXPORT POSSIBILITIES ARE MORE AND MORE LIMITED BY THE GRID

Impact of German RES production on NTC DE→FR (transmission capacity in MW) - 2013



Source : Internal study – EDF R&D 2014



Frequency of saturation of FR→DE interconnexion (in %) – 2013 – source : RTE

- **Export transmission capacities with FR and NL** :
  - ***Decrease when German wind power production is important***,
  - *Increase when German solar production is important.*

- Consequence **: cross border capacities with FR and NL are more and more frequently saturated** (high correlation with german wind power production). Then **German export possibilities can be reduced** (saturation DE→ FR : 30 % (2012), 41 % (2013)).

UNSCHEDULED POWER FLOWS: DEFINITION

Commercial power trade

Physical flow

Difference between scheduled flows (cross zonal commercial shedules or intra-zonal exchange) and physical flows caused by 1st Kirchhoff law

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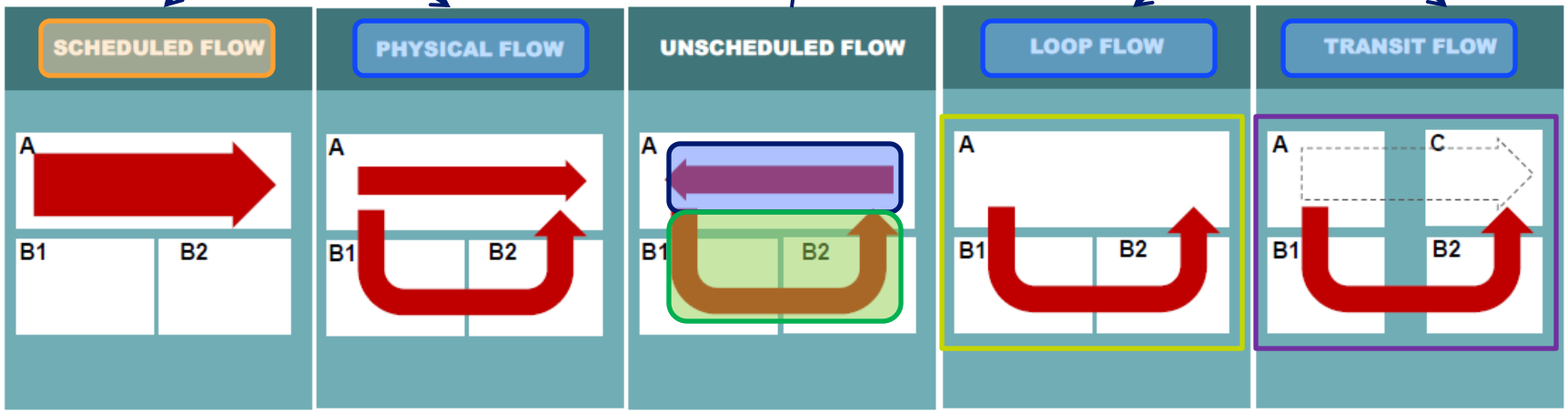
Unscheduled flows:
- internal *or*
- external

… divided in 2 types:



Source : THEMA report 2013-36, October 2013, p 8

- **Loop flows :**

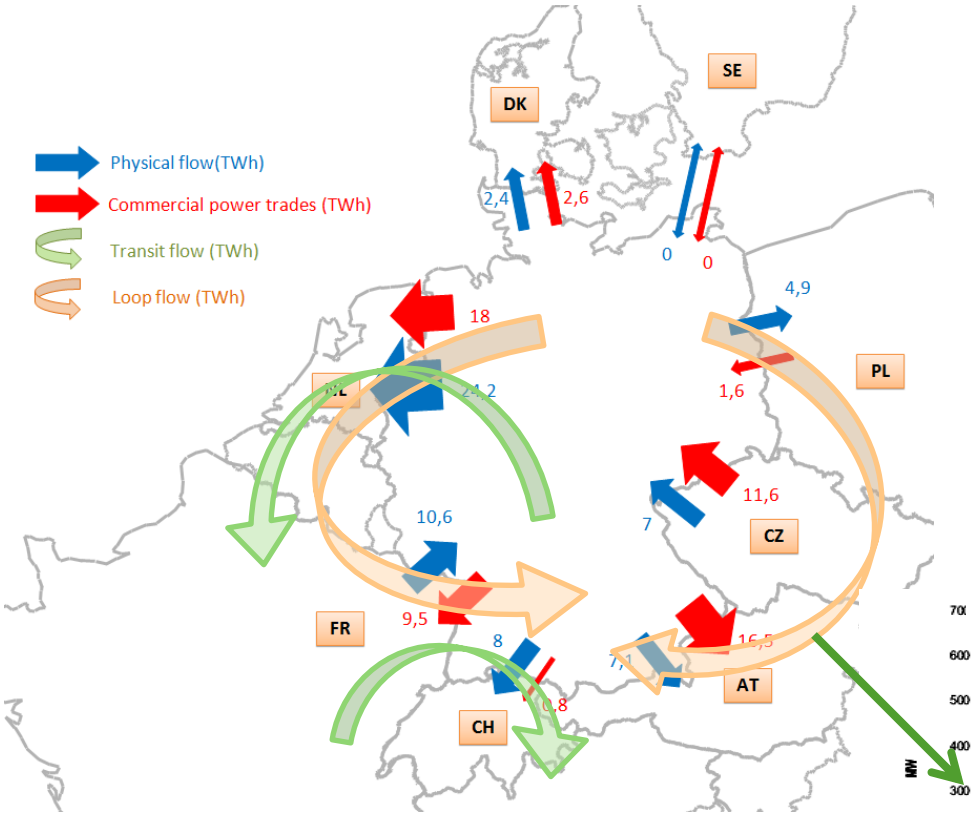
  Physical flows occuring in external control areas caused by origin and destination of a scheduled flow within one control area (intra-zonal exchange). This is not related with cross zonal commercial schedules.

- **Transit flows :**

  Physical flows stemming from a scheduled flow between 2 adjacent control areas or bidding zones, but occuring in other external control areas.

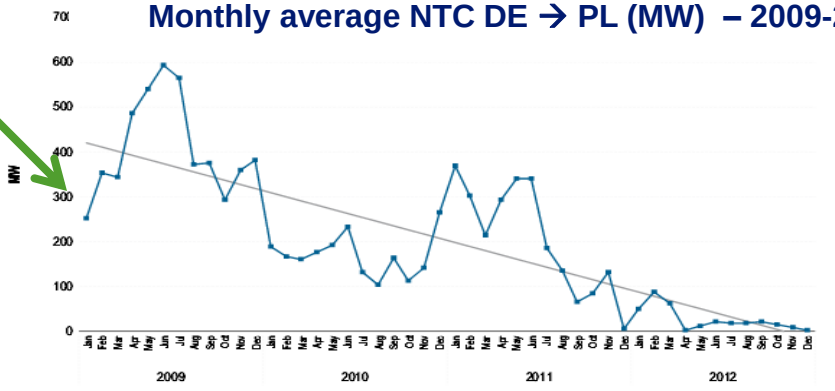
PHYSICAL FLOWS ALSO HAVE AN IMPACT ON GERMANY NEIGHBOURS

Power trades / physical flows between Germany and its neighbours in 2013 (TWh) – ENTSO-E



- The inadaquacy between the localizations of German production and consumption, and the current grid structure / topology in Central Europe **bring about important loop flows (mainly in Poland and Czech Republic)**.
- Import / export commercial schedules and physical flows are in the opposite side on french and polish borders.
- Consequence: **German and Polish TSOs have to reduce transmission capacities (NTC) on DE-PL border** (NTC = 0 MW very often).

Monthly average NTC DE → PL (MW) – 2009-2012



Source : ACER Market Monitoring Report 2013

WHICH SOLUTIONS ?

SHORT-TERM SOLUTIONS FOR DE-PL BORDER

- **Inter-TSOs cooperation** allows (by using curative actions) to limit the danger on SoS but is insufficient :

First alerts to reach secure limits (N-1) between DE and PL because of unplanned power flows.

« HVDC reschudeling » : simultaneous change of schedules on 2 HVDC links to deload DE-PL border (depending on availability of capacity of HVDC cables).

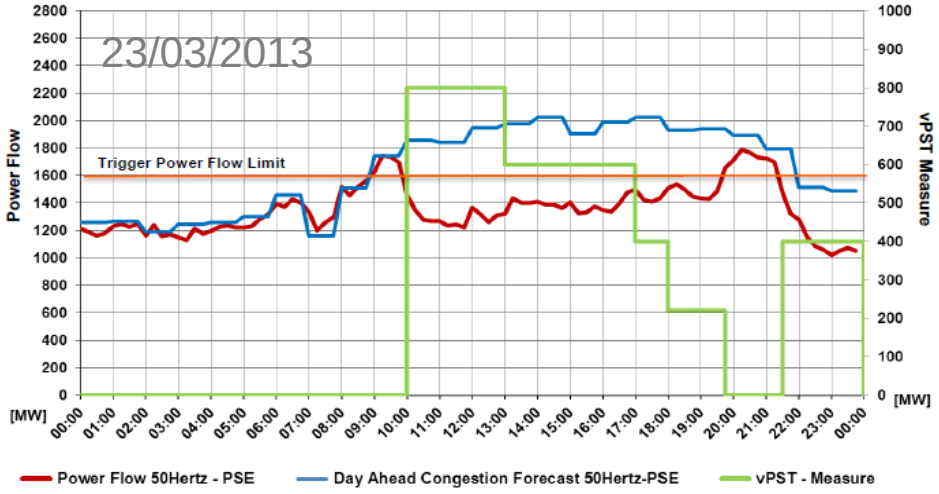
Inefficiency of operational measures in certain situations → **PSE plan to install Phase Shift Transformers (PST) in DE-PL border by 2016 / 2017.**

2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014

Bilateral (DE – PL) cross-border redispatch with a 50/50 cost sharing.

Multilateral redispatch with TSC TSOs(PL, CZ, AT etc.)

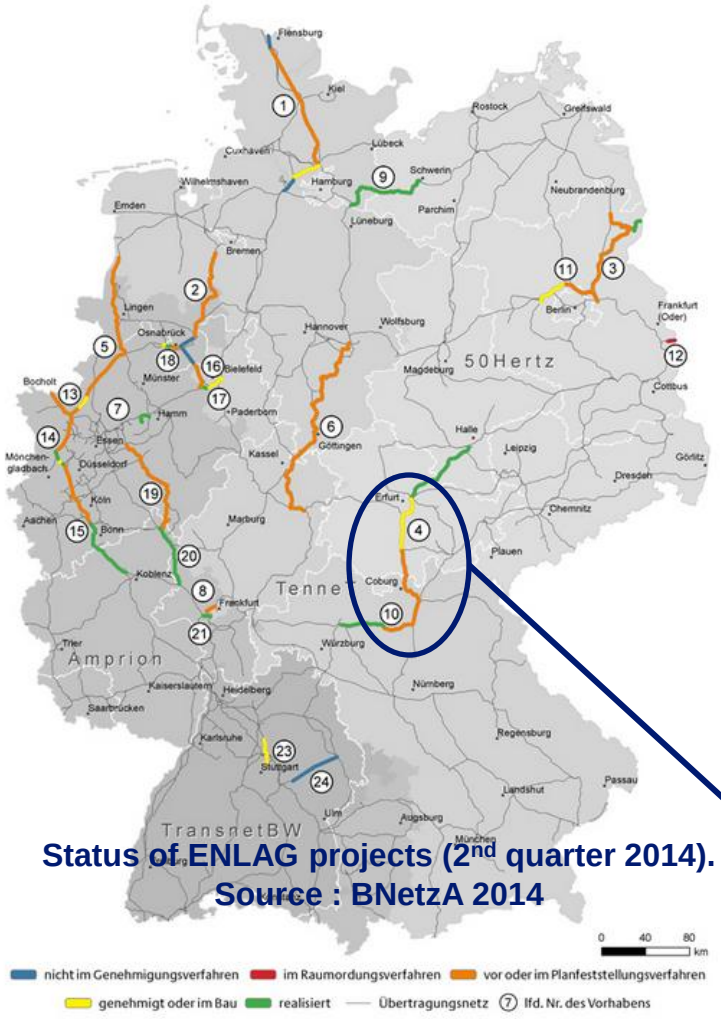
Source : Report on vPST pilot phase experience (Avril 2014)



- As physical PSTs are not expected before 2016/2017, 50 Hz and PSE aggreed to implement a **special croos-border redipatch regime** aiming at limiting unplanned cross border power flows between DE and PL: **virtual PST (vPST).**

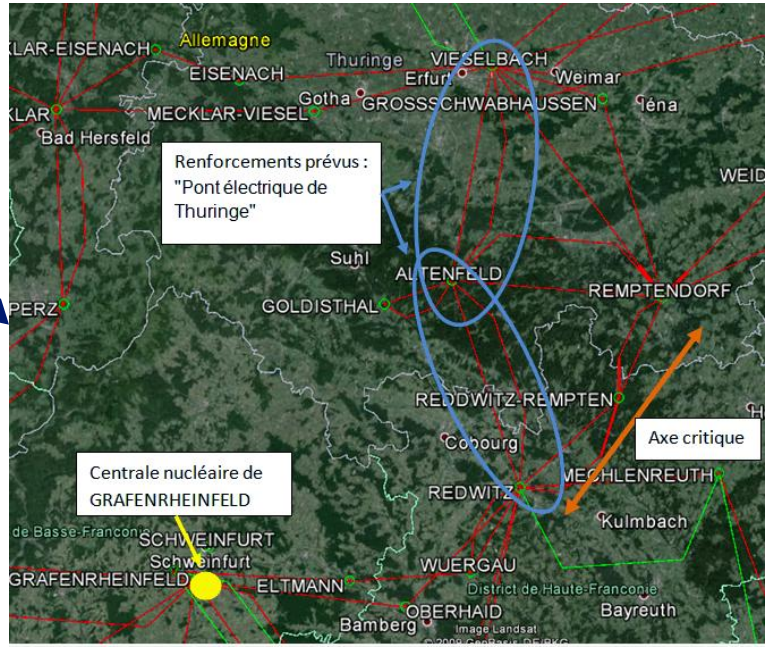
- Objective of vPST: by using coordinate redispatch measures, **limit physical flows** (DE→PL) and **increase NTC DE → PL** (+ 52 % during pilot phase) and thus commercial power trades, without reaching over secure limits.

GRID DEVELOPMENT SUFFERS FROM DELAYS



Status of ENLAG projects (2nd quarter 2014). Source : BNetzA 2014

- **EnLAG law 2009** : Power grid expansion act to speed-up the installation of extra high-voltage power lines in order to secure future supplies in Germany (growing share of RES).
- 23 projects, 1855 km of new routes, initially aims at being completed in 2015.
- Today (2nd quarter 2014) : 416 km completed (22 %), 50 % planned in 2016. Delays are due to public opposition and administrative approval procedures.

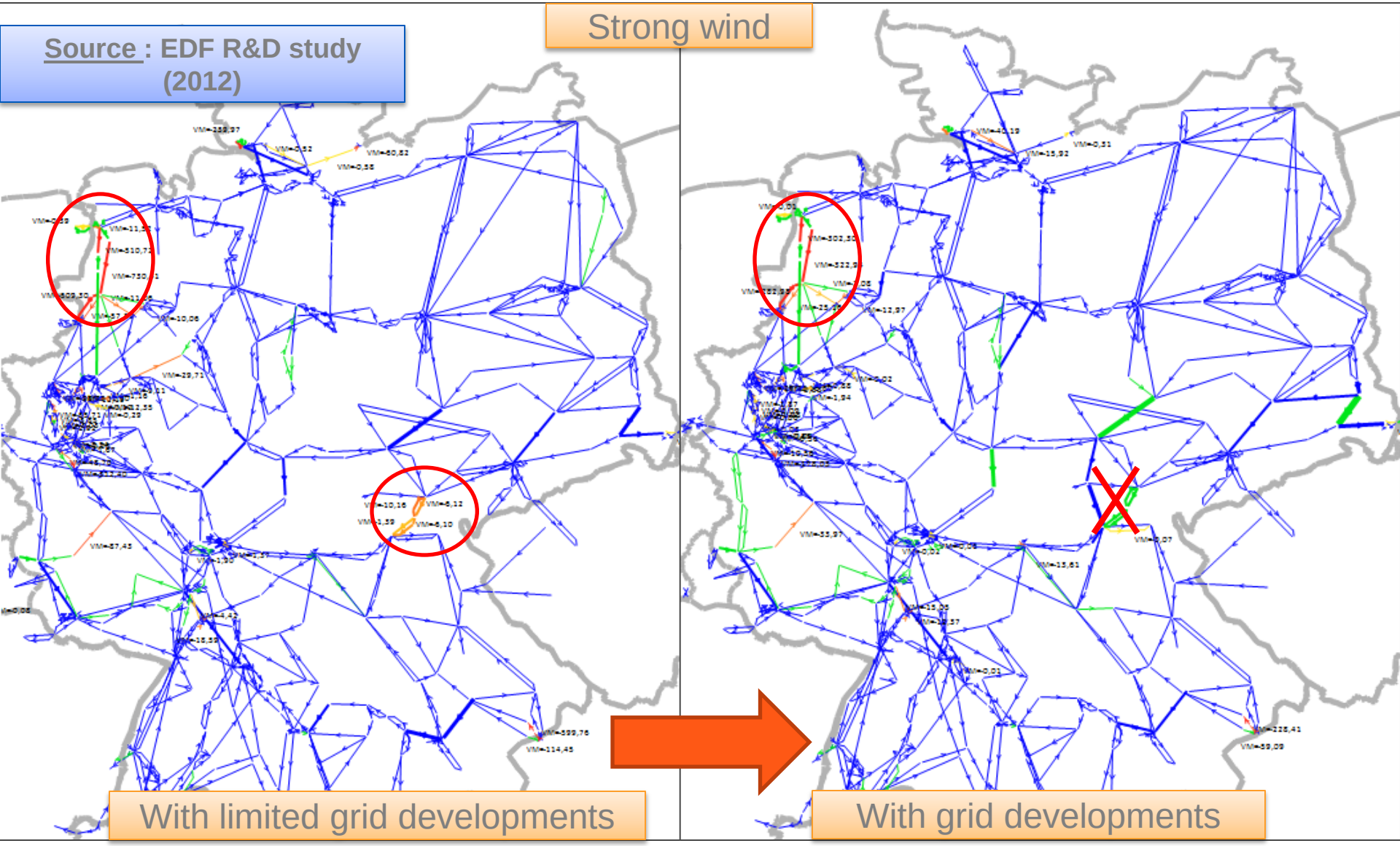


- **Delays can endanger security of supply**: example of Thuringian power bridge (project n°4), probably commissioned in 2017, whereas Grafenrheinfeld nuclear power plant should phase out before in May 2015 → higher risk for SoS in Bavaria.

LOCALIZATION OF GERMAN CONGESTIONS AREAS IN 2020

Source : EDF R&D study (2012)

Strong wind

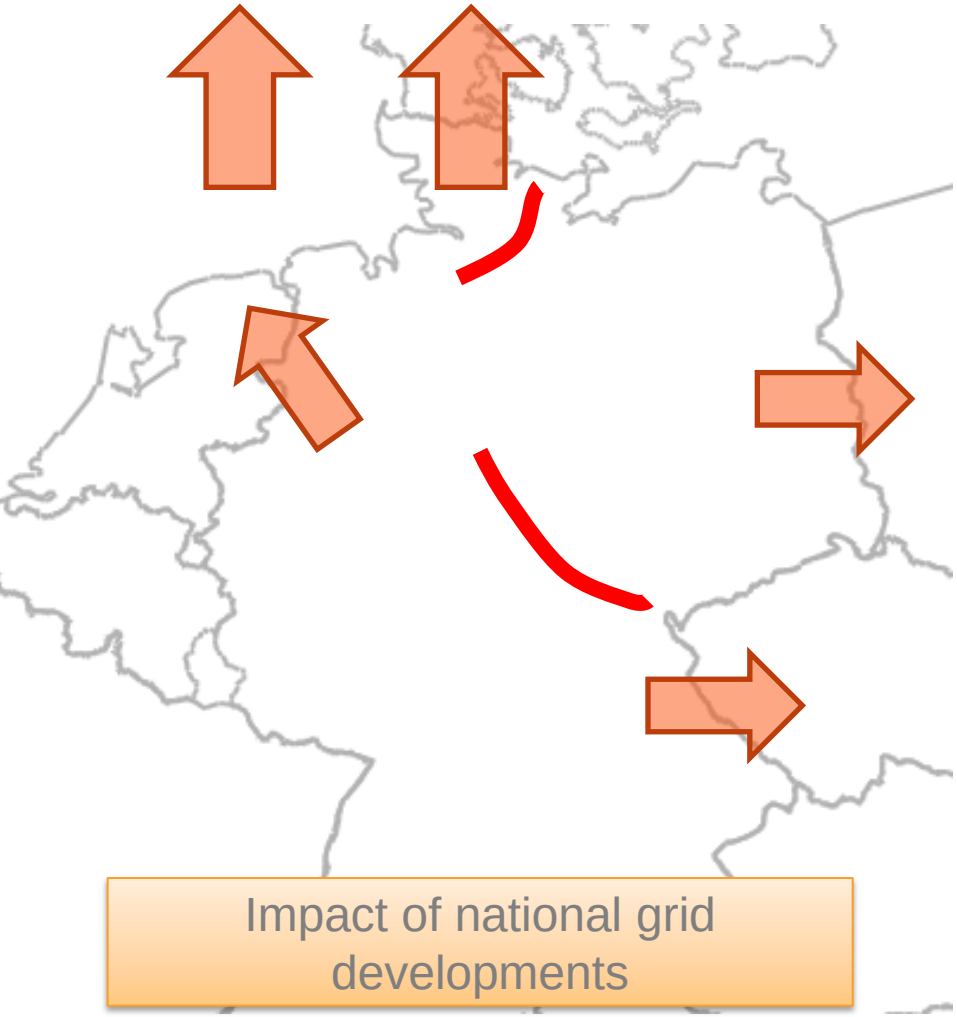


With limited grid developments

With grid developments

- The grid developments allow to reduce congestions on North/South lines, mainly between TenneT and 50 Hz TSOs areas. Some congestions remain in the surroundings of the border with NL (interest for DC corridors development ?)

GERMAN GLOBAL TRANSMISSION EXPORT CAPACITY



Impact of national grid developments

Disappearance of congestions

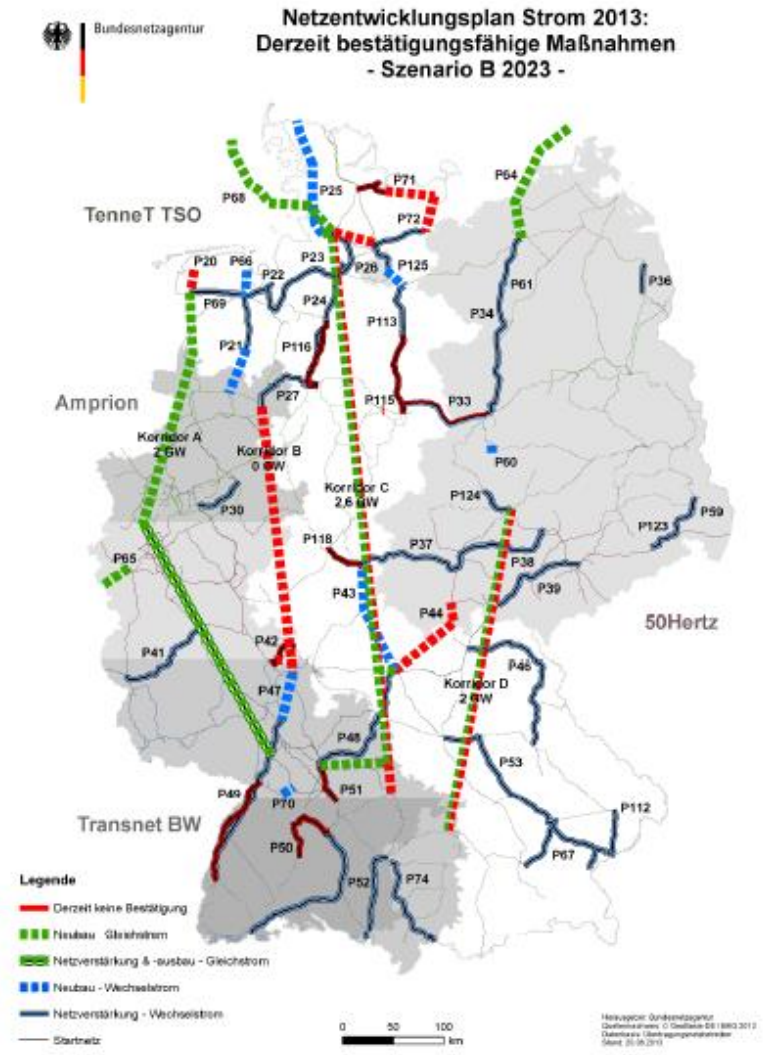
Additional possible export transit.

Source : EDF R&D study (2012)

- The national grid developments in Germany **allow to decrease structural congestions** (mainly because of security criterion N-1), which imply **an increase of possible export mainly to the North and the East of the country** (strong wind generation)

- If the grid developments are not realized, the transmission capacities of Germany towards Eastern and Northern countries are strongly reduced.

A COMMON NETWORK DEVELOMENT PLAN SINCE 2012



Projects in NEP 2013, validated by BNetzA (12/2013). Source : BNetzA 2013.

- **Unique ten-year onshore network development plans** are produced every year since 2013. Federal Requirements Plan Act are then voted every 3 years (first one in 2013 from NEP 2012) to speed-up priority projects.
- **Scenarios** (2023 / 2033) are developped by TSOs, with considering more or less RES development. Sc. B is considered as the main one by TSOs and BNetzA.
- Main projects: **development of 3 HVDC corridors by 2023** in order to reduce the imbalance North-South → best solution to reduce loop flows. But : public opposition, in particular with corridor D (Green-Washing → increase the use of lignite production instead of RES ?).

Thank you