Energy Structure NCs

- Germany -
  (update 2016)
Basic facts

• Area: 357 168km²

• Population: 81 272 000 (2015)

• 4 TSOs

• 883 DSOs
  (source: BNetzA)

• 45 Mio. consumers
  (source: BNetzA)

• Peak load: approx. 86 GW
  (source: German TSOs)

• Average interruption of electricity (2014): <12 min
  (unplanned interruption without exceptional contingencies (source: VDE))
Germany in the European meshed grid

- Interconnectors to:
  - Austria;
  - Czech Republic;
  - Denmark;
  - France;
  - Luxembourg;
  - Poland;
  - Switzerland;
  - The Netherlands.

Source: ENTSOE
Grid facts and characteristics

- The electricity grid in Germany is sub-divided into transmission grids (maximum voltage) and distribution grids (high, medium and low voltage)

<table>
<thead>
<tr>
<th>Voltage Level</th>
<th>Total length (approx.)</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission Grid</td>
<td>380kV</td>
<td>20 000 km</td>
</tr>
<tr>
<td>Transmission Grid</td>
<td>220 kV</td>
<td>16 000 km</td>
</tr>
<tr>
<td>High Voltage</td>
<td>60 kV to 110 kV</td>
<td>77 000 km</td>
</tr>
<tr>
<td>Medium Voltage</td>
<td>6 kV to 60 kV</td>
<td>479 000 km</td>
</tr>
<tr>
<td>Low Voltage</td>
<td>230 V or 400 V</td>
<td>1 123 000 km</td>
</tr>
</tbody>
</table>

Source: BMWI
Structure of electrical power supply

TSO

380 kV

220 kV

110 kV

20/10 kV

380 V

Source: Amprion GmbH

Industry

Utilities

Households

Dispersed Generation

Conventional Generation

Bulk-Industry

German Power System
German Power System

High Voltage Grid

Source: FNN
## The 4 German TSOs

<table>
<thead>
<tr>
<th>TSO</th>
<th>Network length [km] (380 kV)</th>
<th>Network length [km] (220 kV)</th>
<th>Served area [km²]</th>
<th>Annual transmission [TWh]</th>
<th>Share load [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amprion</td>
<td>5.300</td>
<td>6.100</td>
<td>73.100</td>
<td>27</td>
<td>35</td>
</tr>
<tr>
<td>TenneT</td>
<td>5.800</td>
<td>5.300</td>
<td>140.000</td>
<td>20</td>
<td>32</td>
</tr>
<tr>
<td>50Hertz</td>
<td>6.870</td>
<td>2.870</td>
<td>109.000</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>Transnet BW</td>
<td>1.970</td>
<td>1.721</td>
<td>34.600</td>
<td>11</td>
<td>14</td>
</tr>
</tbody>
</table>

Source: German TSOs

http://www.amprion.net/en/
http://www.50hertz.com/en/
http://www.tennet.eu/de
https://www.transnetbw.com/en
In case of (n-1)-security violations in the EHV-grid due to high dispersed generation TSO and DSO collaborate to lower the infeed of renewable generation in DSOs grid. TSO initiates and DSOs operate these measures according following cascade:

- **Transmission grid**
- **Distribution grid 1. Level**
- **Distribution grid 2. Level**
- **Distribution grid n. Level**

Source: BDEW
Responsibilities within the cascade

- TSO monitoring the overall system
- Responsibility for SoS*
- Operative contact to DSOs / generators on TSO-Level
- Requests support by the DSOs

- Monitoring own system
- Operative contact to generators on DSO-Level
- Support of TSO to operate the cascade

- Support of industrial customers to SoS through decreasing / increasing load
- End user can be disconnected

*SoS = Security of Supply

German Power System
Installed capacity with reference to primary resources

installed capacities [GW], 2014

source: BMWI

German Power System
Energy production with reference to primary resources

**electricity generation [TWh], 2015**

- lignite-fired
- hard coal-fired
- nuclear power
- gas-fired
- wind power
- biomass
- photovoltaics
- hydro power
- oil
- others

source: BMWI
Development of Generation Capacity since 2010 (share of primary energy)

Source: Amprion GmbH
Consumption

power consumption by consumer groups, 2014

- industry: 47%
- households: 25%
- business sector: 15%
- public institutions: 9%
- agriculture: 2%
- transport sector: 2%

Source: BDEW
Renewables
Location of RES

 Installed Wind turbines

 Installed PV panels

 Source: IWES
Development of PV Power

Source: BNetzA, TSOs

German Power System
German Power System

RES Installed Capacity and Production
since 2011

max. EE: 47.634 MW
Wind: 34.637 MW
PV: 12.609 MW
c. 62% (30.03.2015; 15:00)

min. EE: 118 MW
Wind: 118 MW
PV: 0 MW
c. 0,2% (19.11.2014; 23:00)

Source: Amprion GmbH
Market
Average price for electricity for industry consumers [cent/kWh] (incl. electricity tax)
Yearly consumption 160 – 20,000 MWh

*since 2010: implementation AusgleichMechV

Source: BDEW
Average price for electricity for households [cent/kWh]
Yearly consumption about 3,500 kWh
Development Price Power Exchange and RES

Source: Amprion GmbH

RES generation
Price Power Exchange
Trend RES generation
Trend Price Power Exchange

German Power System
German EEG concept

**Electricity Energy Market**

- **Power Exchange**
  - Costs / Proceeds marketing
  - Marketing through control area TSO

**Vertical balancing adjustment**

- **RES**
  - Federal and financial funding grouted under EEG
  - Energy supply

- **Connection and compensation obligated SO**
  - Federal and financial funding less network charges
  - Energy supply

- **Final consumer with own power production**
  - EEG apportionment to own consumption

- **Final consumer with own power production**
  - EEG apportionment cost reduction to energy price

**Horizontal balancing adjustment**

- **Control area TSO**
  - EEG Account
  - EEG apportionment
  - Financial Compensation
  - Vertical balancing adjustment

- **Supplier**
  - EEG apportionment nationwided to energy price

- **Final consumer**
  - EEG apportionment

**Energy supply**

- Upon application: EEG apportionment
  - Privileged final consumer

**Marketing through control area TSO**

- Proceeds from direct marketing

**Costs / Proceeds marketing**

- Energy supply
  - EEG apportionment to own consumption
GERMANY – Power balance 2015

Generation: 651.8 TWh
Consumption: 600.0 TWh
Difference: ~ 52 TWh

Source: BMWI
Energy exchange

Commercial flows

Exports:
- Germany: 72.21 TWh
- NL: 16.29 TWh
- BE: 11.73 TWh
- CH: 2.93 TWh
- FR: 7.80 TWh

Imports:
- Germany: 23.76 TWh
- NL: 0.12 TWh
- AT: 3.61 TWh
- PL: 2.25 TWh
- CZ: 0.17 TWh

Values in TWh, Jan 2015 – Dec 2015, Source: Amprion

Physical flows

Exports:
- Germany: 79.12 TWh
- NL: 0.34 TWh
- AT: 1.36 TWh
- CZ: 12.11 TWh

Imports:
- Germany: 32.16 TWh
- NL: 10.66 TWh
- AT: 6.10 TWh
- CZ: 6.27 TWh

Values in TWh, Jan 2015 – Dec 2015, Source: Amprion
Market Coupling – General principle

- 08:15: Latest time for market participants to nominate Day-Ahead
  ➔ Use acquired rights or capacity given to Market Coupling - Use-it-or-Sell-it
- 08:15: Nominations are summed up and sum is send to Common System
  ➔ Common System calculates with help of nominations the CZCs
- 10:30: Common System sends the collected CZCs to the exchange system
- 12:00: Order books of power exchange close
- 12:55: Final market results are send to all market participants
- 14:30: Deadline for nomination of schedules

CZC: cross zonal capacity
Price Coupling of Regions (PCR) in Europe

WHAT is PCR?
Price Coupling of Regions (PCR) is the initiative of seven European Power Exchanges to harmonise the European electricity markets.

HOW is this done?
By developing a single price coupling algorithm to be used to calculate electricity prices across Europe.

Source: EpexSpot