The Electric Power System

- Austria –

version 5th October 2015
Basic facts Austria

- Area: 83,850 km²
- Population: 8.5 Mio
- Number of electricity consumers
- Number of TSOs: 3
- Number of DSOs: 138
- Peak load: 10 GW
- Average interruption of electricity:
Global map of the grid and of its interconnections

Interconnectors with:
- Germany
- Czech Republic
- Hungary
- Slovenia
- Italy
- Switzerland
Challenges for Austria – central location in Europe

Increasing geographical distance between generation and consumption

Austrian Power System
The high voltage electricity grid in Austria consists of the voltage levels 380kV, 220kV, 110kV and medium voltage.

<table>
<thead>
<tr>
<th>Voltage Level</th>
<th>Total length (system length.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>380kV</td>
<td>2.838 km</td>
</tr>
<tr>
<td>220 kV</td>
<td>3.667 km</td>
</tr>
<tr>
<td>110 kV</td>
<td>11.167 km</td>
</tr>
<tr>
<td>1 kV to 110 kV</td>
<td>68.337 km</td>
</tr>
<tr>
<td>1 kV and below</td>
<td>169.175 km</td>
</tr>
</tbody>
</table>
Structure of electrical power system TSO (APG) / DSO

- **380 kV**
  - 2.838 km

- **220 kV**
  - 3.667 km

- **110 kV**
  - 11.167 km

- **< 110 kV**
  - 237.512 km
The Austrian transmission grid, located centrally within entso-e’s grid and Europe
(physical) exchange with neighbouring countries

blue: export
red: import
values for 2013

source: OE Österreichs Energie
Austria has 3 TSOs.
The main TSO is « Austrian Power Grid – APG »

- Name: Austrian Power Grid AG
- Network length 3.500 km 380kV, 220kV, 110kV
- Served area 83,850 km²
- Annual transmitted energy (TWh) see slide «power balance in 2014»
- website: http://www.apg.at
Austrian Power Grid AG, Key Facts and duties

APG is a regulated enterprise:
- Sales revenues*: € 536 million
- Total Assets*: € 1.436 million
- Yearly Investments: € ~200 million

APG is solely responsible for
- secure and reliable system operation
- grid enforcement and development
- market facilitation and integration
- forecast and balancing the Renewable Energy Production

APG is a full and active member of ENTSO-E, the European Network of Transmission System Operators for Electricity.

* Figures from 2012 Annual Report.
Austrian Power Grid AG (APG)

- Austrian Transmission System Operator
- unbundled & regulated enterprise
  - secure and reliable system operation
  - grid enforcement & development
  - market facilitation & integration
  - forecast & integration of Renewable Energy production

- 3.500km length of lines (110kV, 220kV, 380kV)
- 450 employees
- € 1.436 Mio. Assets
- € 200 Mio. investments per year
- 100% owned by Verbund, Austrian Electricity law § 28, ITO
- Member of entso-e
Cooperation of TSO and DSOs

- In Austria TSO and DSOs have a very good historical basis and close cooperation (grid restoration, grid planning...)

- New challenges for TSOs and DSOs
  - Renewable integration
  - Congestion management
  - Neutral market facilitator

- Requirement for enhancement of cooperation
  - Data exchange
  - Knowledge sharing
Pumped storage (~ 8,000 MW)
Thermal power plant (~ 8000 MW)
Wind power plants (~ 2000 MW)
Solar power plants (~ 700 MW)
Run of river power plants (~ 5500 MW)
Installed capacity in Austria with reference to primary resources

Installed capacity in Austria 2011 & 2030
APG Masterplan 2013
Renewables – current status

outlook Austria by end of 2020 app:
2 GW PV
4 GW Wind
Renewables in Austria

percentages of renewables on the energy production

source: OE Österreichs Energie
development of hydro, wind and thermal power in Austria until 2020

- Pumped storage (~ 4.000 MW)
- Thermal power plant (~ 1000 MW)
- Wind power plants (~ 3000 MW)
Comsuption per customer groups

will be adapted in english language

Quelle: Oesterreichs Energie, Statistik Austria

Source: OE Österreichs Energie
Austria as a future electricity hub

Austrian Power System
Installed capacity and production 2013

- Installed capacity: ~ 25 GW
- Maximal load: ~ 10 GW

**Installed Capacity Austria**

- Hydro: 5.6 GW
- Hydro/Storage: 7.8 GW
- Wind: 1.7 GW
- PV: 0.4 GW
- Thermal: 8.3 GW
- Hydro/Pump: 3.3 GW

**Produced Energy Austria**

- Thermal: 18.777 TWh
- PV: 295 TWh
- Wind: 3150 TWh
- Hydro Pump/Storage: 15.149 TWh
- Other: 95 TWh

Austrian Power System
Price development for industry consumers

Source: OE Österreichs Energie
Price development for households

will be adapted in english language

<table>
<thead>
<tr>
<th>Country</th>
<th>Price development (€/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deutschland</td>
<td>14.9, 14.3, 29.2</td>
</tr>
<tr>
<td>Irland</td>
<td>20.3, 3.8, 24.1</td>
</tr>
<tr>
<td>Italien</td>
<td>15.0, 8.2, 23.2</td>
</tr>
<tr>
<td>Spanien</td>
<td>16.3, 4.4, 20.8</td>
</tr>
<tr>
<td>Schweden</td>
<td>13.2, 7.3, 20.5</td>
</tr>
<tr>
<td>Österreich</td>
<td>13.6, 6.6, 20.2</td>
</tr>
<tr>
<td>Großbritannien</td>
<td>17.1, 6.0, 18.0</td>
</tr>
<tr>
<td>Frankreich</td>
<td>11.0, 4.9, 15.9</td>
</tr>
<tr>
<td>EU-28</td>
<td>13.8, 6.3, 20.1</td>
</tr>
</tbody>
</table>

Strompreisentwicklung für Haushalte im europäischen Vergleich

Basis 2005 = 100

Source: OE Österreichs Energie
Balance group model

1 Control Area Manager
2 Clearing and Settlement Agents
~ 160 registered balance groups
~ 250 Suppliers
~ 4 Million Customers
~ 65 TWh consumption (2013)

CAM...Control Area Manager
CSA...Clearing and Settlement Agent
CSR...Clearing and Settlement Representative
(= Balance Group Representative)
Power production structure

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Erzeugungsstruktur Strom 2013

Inländische Erzeugung: 68.015 GWh

Quelle: Oesterreichs Energie, E-Control 2014
*Wärmekraftwerke ohne biogene Brennstoffe

Source: OE Österreichs Energie
Power balance in 2014

- Generation (TWh) → 65,109 TWh
- Consumption (TWh) → 68,918 TWh
- Imports (TWh) → 26,712 TWh
- Exports (TWh) → 17,437 TWh
- Losses (TWh) → 3,431 TWh

source: E-Control
Energy exchanges, problem „Loop Flows“ contractual commercial path ≠ physical path
(qualitative visualisation)

Contractual path (according to schedules)

Physical path
High power imports and exports - both have to be managed.

- Maximum export: 3.200 MW
- Maximum import: 3.820 MW
- Spread between export and import of 7 GW
- Maximum variation between export and import of 4.1 GW within a day
- Intraday changes (due to market activities up to >1000 MW)
Consumption versus import/export

grey: consumption in GWh
red: import/export saldo in GWh
blue line: covering from external sources in %

Source: OE Österreichs Energie
Specific aspects of the electricity market

Dayahead / Intraday Handel

Intraday-Anteil steigt

Day-Ahead-Anteil sinkt