Future Distribution Grids

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Dr. Stefan Küppers
Managing Director Technics, Westnetz GmbH
Westnetz is the leading Distribution System Operator in Germany

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<table>
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<tbody>
<tr>
<td>Turnover</td>
<td>5 B€</td>
</tr>
<tr>
<td>Staff</td>
<td>5,300</td>
</tr>
<tr>
<td>Distribution area</td>
<td>50,000 km²</td>
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<tr>
<td>Grid length Electricity</td>
<td>195,000 km</td>
</tr>
<tr>
<td>Grid length Gas</td>
<td>26,000 km</td>
</tr>
<tr>
<td>Connections Electricity</td>
<td>4,500,000</td>
</tr>
<tr>
<td>Connections Gas</td>
<td>600,000</td>
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1. Challenges of a Distribution Grid Operator
2. Facing the Future with New Technologies
3. Innovation Projects of Westnetz
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1 Challenges of a Distribution Grid Operator
2 Facing the Future with New Technologies
3 Innovation Projects of Westnetz
Ambitious, achievable German targets concerning renewable generation and energy efficiency

Basic points of the German energy transition

> Reduction of greenhouse-gas emissions by 40% in 2020 and by 80-95% in 2050 compared to 1990

> 80% renewable generation in 2050; 35% in 2020

> Reduction of primary energy consumption by 20% until 2020 and by 50% until 2050 compared to 2008

> Reduction of emissions caused by traffic until 2020 by 10% and until 2050 by 40%. 6 Million electrical vehicles in 2030.
Incentives for conscious energy usage and generation speed up the energy transition – supported by new technologies

Energy consumption in private households

> Almost 30% of the overall energy consumption is caused by households
> Building restoration enables an energy reduction of up to 80%  
  – Building insulation
  – Efficient heat systems, e.g. heat pumps

Conscious energy usage

> Price incentives to lower consumption
> Technological solutions like Smart Meters and Home Energy Management Systems may support

Consumers turn into producers (prosumers)

> Incentives for energy self-supply and energy feedback, e.g. photovoltaic and micro-cogeneration
Huge power plants will be increasingly completed and replaced by decentralized renewable generation units

The “Energy Turnover” takes place in the distribution grid!
The Distribution Grid in Germany

> 98% of about 1.7 Mio. km power lines...

> 99,9% of about 45 Mio. Metering points ...

> 98% of all renewable energy generation units ...

... are part/connected to the distribution grid*

* VDN-Report, Energiehorizonte 2020 – Stromversorgung der Zukunft
Customer-related power flow is overlaid by supply-related renewable generation

“A fluctuating power flow as the challenge for distribution grids!”

“Energy Transition”

26.04.2013
10% of renewable generation in Germany are connected to the Westnetz distribution grid.

12% of Germanys wind-energy and 8% of Germanys PV-energy are connected to the distribution grid of Westnetz.
Further development potential of renewable energies in the area of Westnetz

**Installed wind capacity**

- Niedersachsen: 26 GW today, 20 GW potential
- Nordrhein-Westfalen: 20 GW today, 26 GW potential
- Rheinland-Pfalz: 203 today, 23 GW potential
- Hessen: 26 GW today, 20 GW potential

**Installed PV capacity**

- Niedersachsen: 25 GW today, 20 GW potential
- Nordrhein-Westfalen: 39 GW today, 33 GW potential
- Rheinland-Pfalz: 203 today, 23 GW potential
- Hessen: 26 GW today, 20 GW potential

26.04.2013
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The energy turnover affects all sectors of the energy supply system

- **Generation**
  - Extension of renewable energies
  - Flexible controllable power plants
  - Virtual power plants

- **Consumption**
  - Demand-Side-Management
  - E-Mobility
  - Energy saving arrangements

- **Storage**
  - System stability
  - Fast, flexible control
  - Energy and power storages

- **Market**
  - Local market areas
  - Time variable tariffs
  - Cross border trading

- **Grid**
  - Grid extension
  - Observability and control
  - Operation of ICT*

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The future energy supply system integrates demand and feed in characteristics of all market participants

The future energy supply system must be **economical efficient, enduring and reliable**

*ICT = Information and Communication Technologies
Developing distribution grids towards „area generation units“

- TSO EHV-grid
- DSO HV/MV/LV-grid
- Flexibility & system security
  - Energy

In the past: centralized

In the future: area generation units
  - Also decentralized

TSO EHV-grid

DSO HV/MV/LV-grid

Ein Unternehmen der RWE
New technologies to improve the integration of renewable energies into the distribution grid

<table>
<thead>
<tr>
<th>Improving the transport of effective power</th>
<th>Improving the voltage stability</th>
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<tbody>
<tr>
<td>&gt; Demand-orientated control or shut-down of renewable energies</td>
<td>&gt; Cos((\phi))-control of renewable generation units</td>
</tr>
<tr>
<td>&gt; Integration of decentralized storages</td>
<td>&gt; Demand-orientated control or shut-down of renewable energies</td>
</tr>
<tr>
<td>&gt; Demand Side Management</td>
<td>&gt; Controllable transformers</td>
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<tr>
<td>&gt; Superconductive power lines</td>
<td>&gt; Power electronically voltage controller</td>
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Innovation projects of Westnetz

- Developing innovative grid systems
  - Smart Grids
  - Storage technologies

- Optimizing existing capacities
  - Voltage control

- Optimizing asset usage
  - Innovative assets

- Optimizing maintenance
  - Innovative procedures
Optimizing existing capacities

Smart Country – Smart Grid Solutions passed field test in rural region

Fermenter, Storage, CHPU

Voltage Controller – 20 kV

Fermenter, Storage, CHPU

Smart Country

- Smart Grid Solutions passed field test in rural region

Optimizing existing capacities

Fermenter, Storage, CHPU

Voltage Controller – 20 kV

Map showing various locations in Germany.
Voltage controllers to balance fluctuations

**Smart Country – Smart Grid Solutions passed field test in rural region**

**Schema**

- **HV/MV-Transformer**
- **MV-controller**

**Figure**

- **voltage (LV) at substation 1 – „infront the controller“**
  - Voltage fluctuations mainly coming from PV-panels

- **voltage (LV) at substation 2 – „behind the controller“**

*Smart Country – Smart Grid Solutions passed field test in rural region*
Developing innovative grid systems

Smart Operator –
decentralized intelligence in the low-voltage grid

Pilot project in
Kisselbach und Wincheringen
Converting electricity into hydrogen and feed into the natural gas grid

> Pilot project in Ibbenbüren:
  - Degree of efficiency: 70%
  - Production of hydrogen: 20 Nm³/h
  - Feed in pressure: 12 bar
  - Initial operation: Sept. 2013
  - Duration of project: 2.5 years

> Examination focus:
Effects of alternating stress; stability of the system
Conclusions

Elementary changes of the energy supply system

> Past: Huge generation facilities close to customers with high operation hours
> Future: Smaller decentralized generation fed into various grid levels

Challenges for generation, grid and consumption

> Increasing amount of decentralized and partly volatile generation
> Flexible power plants and storages will simplify the system management
> Changing supply tasks result in increasing complexity of distribution grids

Possible Solutions

> Integration of load and generation within future energy networks
> Smart Grids serving as a platform for innovative solutions within the energy sector

> Westnetz is an active player in “Energy Turnover”
Thank you very much for your attention!
Westnetz as a designer of the future distribution grid
BACKUP