The *Energiewende*

Transformation of the German energy system

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Shikibu Oishi, Senior Advisor for Trade Policy and Economics
Embassy of the Federal Republic of Germany Tokyo
Three target areas of the *Energiewende*

Affordability, reliability and environmental protection are interlinked.
Energiewende targets until 2050

<table>
<thead>
<tr>
<th></th>
<th>Achieved</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Climate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% greenhouse gas</td>
<td>-22.6%</td>
<td>-40</td>
<td>-55</td>
<td>-70</td>
<td></td>
<td>-80</td>
<td>-95</td>
</tr>
<tr>
<td>reduction (vs. 1990)</td>
<td></td>
<td></td>
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<tr>
<td><strong>Renewable Energies</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>% electricity</td>
<td>25.3%</td>
<td>35</td>
<td>40 to 45</td>
<td>50</td>
<td>55 to 60</td>
<td>65</td>
<td>80</td>
</tr>
<tr>
<td>consumption</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>% final energy</td>
<td>12%</td>
<td>18</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>consumption</td>
<td></td>
<td></td>
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<tr>
<td><strong>Energy Efficiency</strong></td>
<td></td>
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<tr>
<td>% primary energy</td>
<td>-3.8%</td>
<td>-20</td>
<td></td>
<td></td>
<td></td>
<td>-50</td>
<td></td>
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<tr>
<td>consumption (vs. 2008)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>final energy</td>
<td>0.2% p.a.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+2.1% p.a.</td>
</tr>
<tr>
<td>productivity</td>
<td></td>
<td></td>
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<tr>
<td>building renovation</td>
<td>~1% p.a.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>doubling of renovation rate: 1% → 2%</td>
</tr>
</tbody>
</table>

Germany is on track to reach the ambitious targets it has set.
German gross electricity production

2003  total: 608.8 TWh  
renewables share: 45.6 TWh

- 27.1% nuclear
- 26% lignite
- 5% others
- 24.1% hard coal
- 10.3% gas
- 7.5%

2013  total: 634 TWh  
renewables share: 147.2 TWh

- 15.4% nuclear
- 25.6% lignite
- 10.5% gas
- 8.4% wind
- 6.7% biomass
- 4.7% solar
- 3.2% hydro
- 23.9%
- 5% others

Source: Statistisches Bundesamt, BDEW/AGEB 2014

Renewables have become a major electricity source in just ten years.
Feed-in Tariffs for PV: support costs decline constantly

<table>
<thead>
<tr>
<th>Feed-In Tariff Solar energy (Cent/kWh)</th>
<th>January 2006</th>
<th>August 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof-top installations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 10 kW</td>
<td>51,80</td>
<td>13,15</td>
</tr>
<tr>
<td>&lt; 30 kW**</td>
<td>51,80</td>
<td>12,8</td>
</tr>
<tr>
<td>&lt; 100 kW</td>
<td>49,28</td>
<td>11,49</td>
</tr>
<tr>
<td>&lt; 1000 kW</td>
<td>48,74</td>
<td>11,49</td>
</tr>
<tr>
<td>&lt; 10 MW</td>
<td>48,74</td>
<td>9,23</td>
</tr>
<tr>
<td>Ground-mounted</td>
<td>40,60</td>
<td>tender</td>
</tr>
</tbody>
</table>

Source: EEG 2014 (Draft, 26.06.2014), BSW 2013, 2014, BMWi 2013
Renewable Energy Sources Act Amendment 2014

More coordination
(1) Binding target corridors for RES deployment
(2) Introducing quantity control mechanisms

More efficiency
(3) Focus on cost-efficient technologies

More market integration
(4) Increase market integration through premium system
(5) Tendering scheme for ground-mounted PV

More diversified distribution of costs
(6) EEG levy on self-supply
(7) Adjusted exemptions for the industry

More Europe
(8) Open auctioning scheme for European neighbours

Affordability
Environmentally friendly energy supply
Security of supply
Renewables share in gross electricity consumption

**Overall target corridor**
- In 2025: between 40% and 45% RES-E
- In 2035: between 55% and 60% RES-E

**Capacity additions**
- **Onshore wind and PV** 2 500 MW (2.5 GW) per year each
- **Bioenergy** 100 MW per year
- **Offshore wind** 6.5 GW by 2020, 15 GW by 2030

Focus on Wind and PV as most cost-effective solutions

Source: BMWi 2014
Increase market integration through premium system

- Market price signal reaches RES-E generators, who thus react to market needs
  - RES-E generators can create additional profit by adjustment to market prices
  - Efficient market integration, incentives improved prognosis and balancing

The market premium bears new opportunities and incentivises flexibility.
Tendering scheme

- General intention: introducing tender procedures for all renewable technologies as of 2017
- First, necessary experience needs to be gained
- The first pilot phase from 2015 will cover ca. 400-600 MW ground-mounted PV per year
- Several challenges need to be solved before rolling out tendering, e.g.
  - underbidding,
  - non-realisation,
  - higher risks for investors,
  - strategic bidding

*Auctions can help to achieve further support cost reductions.*
German electricity-system volatility in 2022

Renewables can cover the total demand by 2022 but conventional back-up capacity for the winter will still be needed.
Four areas to increase flexibility

Different flexibility measures are suitable for varying shares of volatile renewables.

- Grids: Grid expansion
- Generation: Flexibility, RE curtailment
- Consumption: Demand response
- Storage: Power-to-heat, Pumped storage, Power-to-gas
The challenge: connecting supply and demand

New power lines need to transport excess supply in northern Germany to southern Germany in order to prevent shortages.
Transmission system operators in Germany and share of fluctuating renewables production

Amprion
• 11,000 km
• 29.1% volatile capacity

TransnetBW
• 3,330 km
• 42.7% volatile capacity

50Hertz
• 9,995 km
• 53.4% volatile capacity

TenneT
• 10,800 km
• 60.5% volatile capacity

Source: Transmission system operators, 2013
German transmission-grid planning

<table>
<thead>
<tr>
<th>Assessments of demand</th>
<th>Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Scenario Framework</td>
<td>Network Development Plan &amp; Environmental Assessment</td>
</tr>
</tbody>
</table>

| Responsible body | TSO/BNetzA | TSO/BNetzA | Bundestag | BNetzA | TSO |

The process ensures a continuous “one-stop shop” authority and broad stakeholder participation.
The energy transition has positive effects on various levels.