Insights from Germany’s Energy Transition

CHRISTIAN REDL
ALPBACH, 28 AUGUST 2015
Energy transition 1.0: A fundamental transformation of the German power system.
Societal consensus on nuclear and climate change risks as starting point, energy policy as a key enabler

<table>
<thead>
<tr>
<th>Targets</th>
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<tr>
<td>Domestic greenhouse gas emissions</td>
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<td>Reduction of 40% by 2020 and 80% to 95% by 2050 below 1990 levels</td>
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<td>Nuclear phase-out</td>
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<td>Stepwise shut down of all nuclear power plants until 2022</td>
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<td>Renewables</td>
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<td>Share in gross electricity consumption of 40-45% by 2025; 55-60% by 2035; at least 80% by 2050</td>
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<td>Efficiency</td>
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<td>Reduction of electricity demand by 10% by 2020 and 25% by 2050 below 2008 levels</td>
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Gross power production in Germany in 1990, 2014 and 2050

AG Energiebilanzen (1990, 2014); illustration based on current targets for 2050
Renewables: Largest share in the 2014 power mix triggered by Renewable Energies Act

Share of energy sources in gross power production in 2014

- Hard coal: 18%
- Nuclear: 15.9%
- Lignite: 25.6%
- Gas: 9.6%
- Oil: 0.8%
- Others: 4.3%
- RES: 25.8%
- Wind: 8.6%
- Hydro: 3.4%
- Biomass: 8.0%
- Solar: 5.8%

Development of gross power production 1990-2014 in TWh

AG Energiebilanzen (2014)

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The (historic) challenge
Increased margin leads to massive investment in solar

• ~ 25 GW solar built in 4 years when feed-in tariff was still very high
• “Race” between investors and policy: market moved faster

German consumers pay for the “solar years” 2009-2012 which bought solar PV (globally) down the learning curve
The (future) challenges and opportunities
Onshore wind power and large-scale solar PV are cost competitive compared to other new conventional generation technologies – in Germany and beyond.

Range of levelised cost of electricity (LCOE) of new plants in 2015 in EUR/MWh

- Wind: 6-9ct/kWh for wind onshore and 8-9ct/kWh for large PV to 4-6ct/kWh for wind and PV during the next 10-15 years
- PV*: 6-9ct/kWh
- Lignite
- CCGT: 8-12ct/kWh
- Coal: 10-14ct/kWh
- Nuclear: 12-16ct/kWh

A mix of wind onshore, PV with gas turbines as backup costs ~70 EUR/MWh

- Also considering integration costs, RES are cost competitive with new conventional plants
- In countries with good wind and solar conditions, wind and PV will be cheaper than other generation options
- Power system transformation towards high RES shares will occur
Power system and power markets will need to cope with fluctuating wind and PV: Flexibility as cornerstone of new system, to be triggered by (regional) power market design

Electricity generation and demand in Germany in sample weeks of February, August and November 2023

Electricity Demand | Fossil Power | Wind Onshore/Offshore | Photovoltaics | Hydro | Biomass
---|---|---|---|---|---

Agora Energiewende (2013)
Key messages from the German experience
Binding policy targets required to enable the market to find efficient solutions and provide investor certainty

> Renewable targets allow market actors to make efficient investment decisions – for both non-renewable and renewable investments.
Renewable deployment policies critical. Adjusted along the way considering investment risks and investor clarity: From Feed-in Tariffs to Feed-in Premia

<table>
<thead>
<tr>
<th>Year</th>
<th>RES-Share</th>
<th>Upper end of the target range</th>
<th>Lower end of the target range</th>
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<tbody>
<tr>
<td>2000</td>
<td>7%</td>
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<tr>
<td>2005</td>
<td>8%</td>
<td></td>
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<tr>
<td>2010</td>
<td>10%</td>
<td></td>
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<tr>
<td>2015</td>
<td>14%</td>
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<tr>
<td>2020</td>
<td>16%</td>
<td></td>
<td></td>
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<tr>
<td>2025</td>
<td>20%</td>
<td></td>
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<tr>
<td>2030</td>
<td>24%</td>
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<tr>
<td>2035</td>
<td>27%</td>
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One secret to success: Renewables – especially wind and solar PV – are being installed and owned by citizens enabled by policies: Involvement and acceptance

Ownership distribution of renewable installations, 2011

- Private owners [PV, wind onshore] 42%
- Project developers [wind] 15%
- Funds / banks [bioenergy, wind onshore] 11%
- Farmers [biogas, PV] 9%
- Industrial companies and other companies 7%
- "Big 4" utilities 7%
- International utilities 3%
- Small local utilities 3%
- Regional utilities 2%

One secret to success: Renewables – especially wind and solar PV – are being installed and owned by citizens enabled by policies: Involvement and acceptance

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Thank you for your attention!

Questions or Comments? Feel free to contact us: christian.redl@agora-energiewende.de

Agora Energiewende is a joint initiative of the Mercator Foundation and the European Climate Foundation.