Renewables integration in Germany

Status Quo and Main Takeaways

Dimitri Pescia, Agora Energiewende

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The key insight for the Energiewende: 重要なのは風力と太陽光！(It’s all about wind and solar!)

- Share of RES in gross power consumption to grow to 65% in 2030.
- In 2018, 120 GW variable renewables installed (peak demand ~ 82 GW):
  - 54 GW onshore wind (+3 GW since 2017)
  - 6 GW offshore wind (+1 GW since 2017)
  - 46 GW PV (+3 GW since 2017)
- Good news: cost peak in 2021;
- Bad news: slower development of wind power than expected

AGEB, own calculations based on Öko-Institut
Takeaway #1: Making renewables fit for the market

Illustration of various support scheme for RES

- Fixed Feed-in tariffs with administrative price setting
- Feed-in premium with electricity price index (floating premium)
- Auction-based floating premium
- Auction-based fixed premium*
- Banded quota models offering long term contracts
- Technology neutral quota models/green certificate

Increasing investor risk

- Step by step integration of RES in system and market. Today, support scheme is FIP (through auctions) for large projects, FIT (for small projects)
- Renewables are balancing responsible parties → strong incentive to be balanced, RES generators active on the market
- Level of support needed to cover the revenue gap decreased, but support still relevant to reduce financing costs
- Growing interest in direct PPA, as well as prosumer models to finance RES

* Not general scheme. Pilot only
**Takeway #2 : making markets fit for renewables**

(1) Short-term markets help coping with the flexibility challenge

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**Power generation from nuclear, hard coal and lignite power plants and demand in a week with high renewables in Germany (29.04-06.04.2018)**

Prices on day-ahead, intraday and balancing markets are the key indicator for dispatch and investment decisions:

- inflexibility abated in market rules/products.
- Non-discriminatory market access to all technologies (also to RES, storage, DSR,..)
- Market design gradually aligned across borders

Prices reflecting real value of power incentivize flexibility provisions:

- Number and extend of negative prices decreased*
- Dispatched-based curtailment limited (but it remains as a consequence of grid congestions)

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*A134 hours of negative prices in 2018, for a minimum price of -14€/MWh*
Installed coal capacities in the German coal consensus path and BAU path

- Adoption of a coal phase-out plan (end date 2038 at the latest), including comprehensive compensation measures and support from the federal budget (69-93 €bn until 2038)
- National managed retirement of old, high-carbon, inflexible coal capacity is the prerequisite for successful market integration of RES. It supports the shift to a more flexible production mix.
- Increasing share of flexible resources and decreasing share of inflexible resources should go hand in hand with a growing RES.

Agora Energiwende (2016)
Takeaway #4: Optimizing cross-border system integration, grid operation and grid planning

EU power system integration “success story”:  
→ gradual cross-border alignment of market rules  
→ guarantees security of supply at lower costs  
→ minimize flexibility challenges due to “smoothening-up” of RES generation

But national grid expansion remains slow:  
→ In Germany, ~6TWh of RES curtailment and increasing redispatch due to congestions.

Innovations to better align VRES and grids:  
→ RES peak shaving in grid planning (up to 3% of energy output)  
→ “Grid-friendly” placement of new VRES (zoning in RES auctions, potential price zones split?...)
Thank you for your attention!

Questions or Comments? Feel free to contact me:
Dimitri.Pescia@agora-energiewende.de

Agora Energiewende is a joint initiative of the Mercator Foundation and the European Climate Foundation.
The good news: costs for supporting renewables is likely to peak in 2021

Cost peak expected in 2021.

Reasons:
- New RES became cheaper
- Old plants exiting the support scheme after 20 years
- Emissions trading system makes power generation from fossil fuels more expensive.

In 2030, Germany will have twice as much renewables as today (65%) for a cost lower than today.

Compensation for plant operators 2010 – 2035 (with 65 per cent RES target)

Own projections based on Öko-Institut
The bad news: current RES deployment clearly not on track to reach the 2030 target

- Annual RES deployment of 10 to 12 GW needed to reach 65% in 2030.

- Current reform:
  - higher offshore target (20 GW in 2030)
  - lifting the cap on solar PV
  - easing permitting for onshore wind

- But progress are slower than expected for onshore wind: stricter minimum distance rules, too slow permitting procedures and acceptance issues

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**Yearly capacity addition of wind and solar power in Germany (GW) - historic trends, expected growth in 2019 and capacity needed to meet the 65% target**

<table>
<thead>
<tr>
<th>Capacity Addition (GW)</th>
<th>Onshore Wind</th>
<th>Offshore Wind</th>
<th>PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly capacity addition average 2014-2018</td>
<td>1.9</td>
<td>1.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Capacity addition 2019*</td>
<td>4.0</td>
<td>1.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Yearly capacity addition to meet the 65% target in 2030</td>
<td>5.0</td>
<td>1.2</td>
<td>5.0</td>
</tr>
</tbody>
</table>

*Extrapolation based on BMWi (2019), BSW (2018), IWR (2019), FA Windenergie Land (2019), Own calculations*
Takeway #2: making markets fit for renewables

(2) balancing markets can outweigh the impact of increasing renewables

Balancing reserve and cost development in Germany since 2008

<table>
<thead>
<tr>
<th>Year</th>
<th>Ex-post sizing FRR 8000MW</th>
<th>Balancing energy 750GWh</th>
<th>Wind + Solar Generation 69TWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>ex-post sizing FRR 8000MW</td>
<td>balancing energy 750GWh</td>
<td>Wind + Solar Generation 69TWh</td>
</tr>
<tr>
<td>2012</td>
<td>ex-post sizing FRR 8000MW</td>
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RES producers are balancing responsible parties → strong incentive to respect their schedule.

Balancing costs have decreased by 50% between 2008-2017, while vRES capacity has been multiplied by three.

Reasons:
- TSO cooperation (larger geographies)
- Competitive balancing power markets
- Improvement of forecasts
- More liquid spot markets

Adapted from Hirth et al. (2018)