Relevance of long-term power system planning towards high shares of RES

Insights into the German Energiewende

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SEE Grid Integration Workshop – 7 Nov 18, Vienna
German Energiewende a long-term project; built on top a „mature system“; > 50% of generation under planned conditions
Two main questions

- How did we get to where we are today?
- Where could we go from here?

Planning measures used in the past; remain significant in the future
How did we get to where we are today?

- Planning measures already in use
  - why they help,
  - how they are designed.
RES target setting

- RES targets as cornerstone for development (IRENA, 2015)
  - spectrum,
  - sector(s),
  - design methodology.

- German RES targets
  - legally binding for electricity as target share,
  - non technology-specific,
  - anchor for „further measures“.

**German RES targets effective in combination w govt. investment guidance**
Development of German RES electricity target

RES targets growing w confidence; works w updates; „easy“ so far

RES in power:
- 12.5% by 2010
- 20% by 2020
- 35% by 2020
- 50% by 2030
- 65% by 2040
- 80% by 2050
- 65% by 2030
- 40-45% by 2025
- 55-60% by 2035

Source: Bund (2000ff)
Further measures – German energy plans

- „Energiekonzept“ @ 20%RES (BMWi, 2010)
  - Long-term energy/climate policy guidelines,
  - Scenarios to identify pathways for power, heat, transport,
  - RES as main energy source,
  - Energy efficiency, grids.
- Aiming towards market-based RES and larger shares
  - Reduced financial support,
  - Produce when required,
  - Provision of ancillary services.
- Incremental development since then; comprehensive revision possible

Whole-of-system plans as checkpoints for policy adjustments
The role of German government in electricity sector investment (beyond generation)

- Competitive markets
  - Ex-post supervision by the Federal Competition Authority

- Generation
- Wholesale trading
- Transmission/distribution networks
- Retail

Natural monopolies = Economic regulation

Govt. Investment planning in Germany roughly along the lines of competitive market design structures
Transmission investment planning – results

Current grid:
35k km of electric circuits

Future grid:
42k km of electric circuits, incl. 5 HVDC lines

20% more grid makes a plan valuable
Grid planning process established in 2011 (@ 24% RES share) as response to growing needs
Transmission planning follows a comprehensive approach (IRENA, 2018)

Process delivers transparent, least-cost, policy-adjusted transmission plan to achieve timely and efficient infrastructure
Transmission investment planning – key factors

- RES capacity growing significantly in all scenarios
- Large RES bandwidth induces uncertainty
- Conventionals decline slowly
- Low uncertainty largely driven by retirement decisions

Data source: BNetzA (2011ff)
And without the grid?

- Security constraints more often binding
- Redispatch (11 TWh and 220mEUR)
- Renewables curtailment (82mEUR; 314; 643)

Source: BNetzA (2017)
Power sector planning: Planning scopes for techno-economic analysis

- Generation expansion
  - Ministry of Energy
  - Planning agency
  - Utility

- Geo-spatial planning
  - Ministry of Energy
  - Planning agency
  - Utility
  - TSO

- Dispatch simulation
  - Utility
  - Regulator
  - TSO

- In-house; based upon scenarios

- Load flow assessments; portfolio selection criteria

Regulatory simulation of; scenario-based

Regulators role along the IRENA planning scope
Where could we go from here?

- Enhanced transmission planning
  - stability assessments,
  - automated network operation,
  - storage for grid services,
  - other complements to the grid
- Distribution level planning
- Generation planning
  - nation-wide adequacy and flexibility
- Energy sector planning

All items are speculation; some could also be solved by „the market“.
Thank you for your attention!

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References

References

The big north-south divide of generation and load results in challenges for the transmission grid.
The TSOs set the extent of the network expansion by applying the NOVA-principle.

**Grid…**

<table>
<thead>
<tr>
<th>NOVA</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>optimization</strong></td>
<td>• Topology measure&lt;br&gt;• Transmission line monitoring</td>
</tr>
<tr>
<td><strong>strengthening</strong></td>
<td>• Voltage increase&lt;br&gt;• New lines in existing corridors</td>
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<tr>
<td><strong>extension</strong></td>
<td>• New 380 kV-lines&lt;br&gt;• New substations</td>
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</tbody>
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Source: BNetzA
Based on different check criteria the BNetzA analyses the projects.

**Effectiveness (n-1)**

Does the project resolve or reduce an overload?

**Necessity**

Does the use of capacity of the new project is at least 20%?

**Other considerations**

Are there special reasons to justify the confirmation or disaffirmation of a project?
Current status of grid expansion

Projects of Federal Requirements Plan (BBPG) & Projects of Power Grid Expansion Act (EnLAG)

- realized
- allowed / under construction
- Planning approval
- Federal sectoral planning
- Not yet in approval procedure
- Transmission system

Source: BNetzA
The NEP contains a method for the allocation of producers of renewable energy and the loads.

Allocation of:
- Renewable Energies
- conventional power plants
- loads
to one of approximately 450 nodes of the transmission network.
Market modeling

The electricity market is simulated for every hour of the target year.

Approach:

- Internal network is “copper plate”
- Economical priority of Renewable Energies
- Must-run plants
- Load, that cannot be served by Renewables, is covered by conventional power plants

Result:

- Hourly forecast of the power plant utilization
- Hourly load and feed-in for every node
The (n-1)-security is considered by outage calculations using a calculation software.

Source: BNetzA
Verification of maximum capacity utilization

Annual calculation

Maximum capacity utilization > 20%

Necessity confirmed
(n-1)-secure means, that with ONE line failure the grid can still work safely and reliably.

Further reasons for the efficiency of a project are, that the project...

- avoids disproportional effort for establishing (n-1)-security in subordinate grids
- leads to an intended increase of transport capacity across borders
- reduces undesired loop-flows over foreign countries significantly
Federal Requirements Plan ("BBP")

- Projects in the Federal Requirements Plan are necessary for the energy system and have “priority need” for implementation.
- The Federal Requirements Plan defines start and end point of each project.
- Legal Basis for the next steps: the planning of corridors and final routes.
- The law was passed in 2009.
- The first Federal Requirements Plan was issued in 2013 on the basis of the NEP 2012.

Source: BNetzA
Federal Sectoral Planning:

- Definition of corridors which have the least impact on people and environment
- Strategic Environmental assessment
- Cross-border projects: BNetzA (NABEG) is responsible

Planning approval:

- Final decision on the route (location of masts etc.)
- Environmental assessment
- Cross-border projects: BNetzA (NABEG) is responsible
Investments and expenditures in grid infrastructure by the TSOs

In million Euro

Source: BNetzA
Carina Heinrich | International stakeholder workshop | © Bundesnetzagentur
Aufteilung der Einzelpreisbestandteile für Haushaltskunden für das Abnahmeband zwischen 2.500 kWh und 5.000 kWh (DC) im Jahr für Ökostrom, Preisstand 1. April 2017

in Prozent

Source: BNetzA