Pathways of the energy transition in Germany – an energy system

PD Dr.-Ing. Markus Blesl

74th SEMI-Annual ETSAP Meeting
Agenda

1. Current situation
2. Setting of frameworks
3. Modelling approach
4. Scenario analysis
5. Conclusion
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Current situation: Climate targets & structure commission

German targets

<table>
<thead>
<tr>
<th>Year</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red. comp. 1990</td>
<td>40%</td>
<td>55% (61%*)</td>
<td>70%</td>
<td>80% bis 95%</td>
</tr>
</tbody>
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*Conversion-Sector (Electricity; district heat, refineries etc.)

CO₂ Emission electricity generation [Mt]

Structure commission (since 7/2018)

- Measurements to achieve the 2030 targets of the energy sector including
- A plan to reduce the electricity generation by coal with a time schedule and additional institutional options
Coal phase-out plans in EU member states

Pledge to build no new plants from 2020 on by producers in all member states except Poland & Greece (Eurelectric)

Own illustration based on information from Politico & Eurostat

*share of coal in electricity production
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Setting the framework
What are the discussion levels?

Assumed as fixed: climate targets GER

Alternative burden sharing options

Additional institutional options

United Europe (Utd-EU)
Coalition of the Willing (CoW)

Influence of European ambition

Level of EU cooperation influences mitigation cost and achievable climate targets considerably

Scenario framework
Projections e.g. on population, industrial structure, transport activity etc.

+ further studies, e.g. German projection report according to EUR-Lex - 32013R0525
### Scenarios: Germany in EU context

<table>
<thead>
<tr>
<th>Scenario #1: Germany all alone</th>
<th>Scenario #2: Coalition of the willing</th>
<th>Scenario #3: Europe united</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Implementation of a national measure (e.g. regulated phase-out like for nuclear)</td>
<td>• Club of progressive member states takes joint measures around EU ETS</td>
<td>• EU member states give up national plans</td>
</tr>
<tr>
<td>• Other EU member states according to national plans</td>
<td>• Other EU member states according to national plans</td>
<td>• Targets on EU level backed by strong and credible policy (EU ETS fixed)</td>
</tr>
<tr>
<td>• EU level stagnating(?)</td>
<td>• EU level stagnating(?)</td>
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</tbody>
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- **Waterbed effect**: Under a joint cap, emission reduction in one state(s) leads to increase in other state(s).
- Important to consider counter measures like active managed MSR, minimum price or cancellation of EUAs.
- Scenario discussion based on work for the...
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The Times PanEU Model

Characterization TIMES PanEU

- European energy system model
  EU28, Norway, Switzerland, Baden-Württemberg
- Technology-oriented, bottom-up optimization model with perfect foresight
- Country-specific detailing of the energy generation and the demand sector, as well as detailed mapping of the boundary coupling line capacities according to ETSO
- Intertemporal optimization in the period 2010 – 2050
- 12 (up to 280) sub-annual time segments
  (four seasonal and three daily segments; five typical weeks)
- Emissions: Greenhouse gases (CO2, CH4, N2O)
- Sector-based: public and industrial energy supply, industry, households, Commercial and tertiary sector, transport, agriculture and refineries
- **Objective function**: minimization of the total costs (optimization model)
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Options for transformation paths

GHG emissions

National actions in form of a „Coalition of the Willing“ (CoW) as a possibility to bridge the gaps for fulfilling the EU climate targets.

- CoW allows to reduce emissions according to the 40% target in the short term (2030).
- In the long run (2050) a stronger engagement or an EU-wide measure is necessary, otherwise the 80% target cannot be achieved!
Options for transformation paths
Effects on the German electricity sector

• Electricity prices increase with stronger climate ambitions
• The reduced electricity generation in Germany in most scenarios is partially replaced by imports basing mainly on non-renewables
Options for transformation paths
Mitigation costs for Germany

- In the short run (2030) Germany profits from higher overall EU ambitions and joined activity (Utd-EU)
- In the long run (2050), for achieving the European 80% target, Germany (and the EU) has to expect a considerable increase in CO₂ abatement cost
Scenario comparison of the GHG emissions of Germany between sectoral and cross targets in 2030

- Abatement costs in the other sectors are higher as in the conversion sector.
- A fast phase out of coal in the power sector will be cost efficiency measure; can reduce the burden in the other sector and might be therefore reasonable.
- The sectoral targets of the conversion sector should be higher.
Analyzed (regulatory instruments) - Pathway of a coal phase out

Installed electrical plant capacity of coal plants [GW]

- Decommissioning
- Slow phase out of coal (D-CAP 2030)
- Fast phase out of coal

2017 2020 2025 2030 2035 2040 2045 2050
Scenario results – coal replacement options electricity generation capacity

Net electricity capacity [GW]

- Electricity storage (excl. pump storage)
- Others / non-renew. waste
- Other renew. energies
- Biomass / renew. waste
- Solar Photovoltaik
- Wind
- Hydro (incl. pump storage)
- Nuclear
- Gas
- Oil
- Coal
- Lignite

Timeline:
- 2010
- 2015
- 2020
- 2030
- 2040
- 2050
Scenario results – coal replacement options electricity generation

Net electricity [TWh]

-100 0 100 200 300 400 500 600 700

2010 2015 2020 2030 2040 2050


Electricity storage (excl. pump storage)
Net Imports
Others / Waste non-ren.
Other Renewables
Biomass / Waste ren.
Solar
Wind offshore
Wind onshore
Hydro incl. pump storage
Nuclear
Gas CCS
Gas w/o CCS
Oil
Lignite CCS
Lignite w/o CCS
Coal CCS
Coal w/o CCS
Rebound of coal and Gas residual amount in the case of a institutional phase out of coal in comparison with a price driven pathway
A fast phase out of coal will increase the electricity generation cost round about 3%.

The undiscounted cumulative additional cost of the fast phase out of coal for the energy system of Germany are 41 – 106 Bio. € (without possible compensation costs).

This corresponds to an extra payment of 34 – 90 € per household in Germany.
Additional institutional options: Additional Renewable electricity generation

- **Replacement options:** Beside the installation of gas power plants an increase of electricity imports can substitute coal power plants.

- **Reinforced installation of renewable electricity generation** options in Germany (open competitive bidding for generation quantities or capacities) can restrict the electricity import.

- Beside this effects the independency with the electricity generation by gas combined heat and power (CHP) and the district heating generation in Germany.
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Conclusions

1. United action on European Union level (Utd EU) is
   • preferable for Germany and the EU in the short term AND
   • necessary in the long term

2. A Coalition of the Willing (CoW) implementing a minimum price for CO$_2$
   OR
   a accelerated coal phase out in Germany
   • can achieve similar GHG mitigation targets as a united EU approach
     only in the short run BUT
   • only at higher costs AND
   • increases most probably acceptance problems in German coal regions

Different policies and ambitions can achieve the same short term targets, but cost and acceptance differ significantly!

In the long term stronger ambition is needed!

• Further analysis will be done in the
Thank you for your attention!

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