



Summary

# GERMANY'S ELECTRIC FUTURE

# Coal phase-out 2035

The German electricity sector is of paramount importance for both energy and climate policy. The electricity sector's share of emissions within total greenhouse gas emissions (taking into account non-CO<sub>2</sub> greenhouse gases and the emissions from fuel quantities tanked in Germany for international transport) currently amounts to approx. 37%. The electricity sector makes by far the largest single contribution to the release of greenhouse gases into the atmosphere. In terms of the total greenhouse gas reduction brought about to date, the electricity sector has made a disproportionately low contribution since 1990. With the largely stagnating contributions of the electricity sector to these emission reductions, the pressure is increasing for the sector to take greater action.

Given that German lignite and hard coal-fired power plants currently account for approx. 80% of the total CO<sub>2</sub> emissions of the electricity sector (48% from lignite and 32% from hard coal-fired electricity generation), progress can only be made in reducing the sector's CO<sub>2</sub> emissions if the phasing-out of coal-based electricity generation is made a high priority. The fact that the German coal-fired power plant fleet has very high shares of comparatively old (and refinanced) power plants that entered operation by 1990 and have particularly high emissions (48% of the production capacity installed in lignite and 51% of the production capacity installed in hard coal-fired power plants) is highly relevant in this context. The crucial question is, on the one hand, which paths are helpful and necessary for decreasing and phasing-out coal-based electricity generation and, on the other hand, which political strategies and implementing instruments can trigger the developments needed. Coal-based electricity generation is highly relevant today, not only in terms of its significance for CO<sub>2</sub> emissions but also in terms of its important role in electricity supply (approx. 40% of net electricity generation and approx. 45% of dispatchable generation capacity in Germany). Lignite also has a high regional economic significance in part. This makes holistic strategies and implementation measures necessary.

In view of phase-out paths for coal-based electricity generation, the 2015 Paris Agreement that entered into force in 2016 has created a new framework of reference. The Paris Agreement's central aim is to limit the increase in global mean temperature to well below 2°C compared to pre-industrial levels. The Agreement also pursues efforts to limit the temperature increase even further to 1.5°C. The targeted limit is the central indicator for assessing the climate policy ambitions of individual states within the architecture of the Paris Agreement. It leads to a less rigid focus on emission reduction targets for specific time horizons or target years and a stronger consideration of the emission budget concept which seems more suitable with a view to the effects needed from the measures.

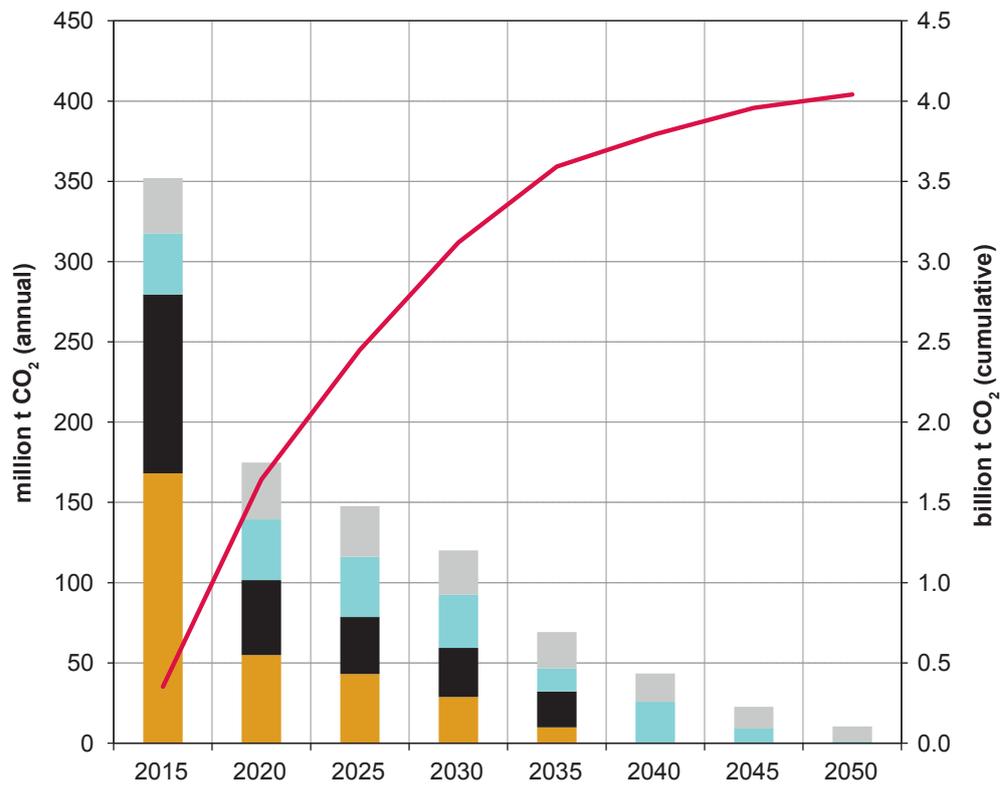
From analyses conducted on the requirements for adhering to the 2°C limit in global temperature increase, clear CO<sub>2</sub> emission budgets can be derived for both Germany and the German electricity sector based on transparent distribution concepts. The concept of emission budgets geared to a specific country (derived using a global per capita approach and without taking into account historical emissions) and a specific sector (derived using approximately proportional emission reductions in the different sectors) has proven to be a productive approach for identifying, on the level of smaller scopes of action, fair contributions to be made in order to meet the global targets. With an emissions budget for Germany of approx. 10 billion t CO<sub>2</sub> for the period of 2015 to 2050, the emissions budget for the German electricity sector amounts to 4.0 to 4.2 billion t CO<sub>2</sub>.

Analyses on the phasing-out of German coal-based electricity generation that consider the field of tension between technically feasible adaptation processes and regulatory boundaries for the necessary measures clearly show that adhering to an emission budget of 4.0 to 4.2 billion t CO<sub>2</sub> for the period of 2015 to 2050 is possible in principle. For this to be achieved, significant emission reductions need to be implemented relatively quickly (Figure S-1).

Figure S-1:

**Annual and cumulative CO<sub>2</sub> emissions in the Transformation Scenario for an accelerated phase-out of coal-based electricity generation in Germany, 2015–2050**

Source: Calculations by Öko-Institut and Prognos

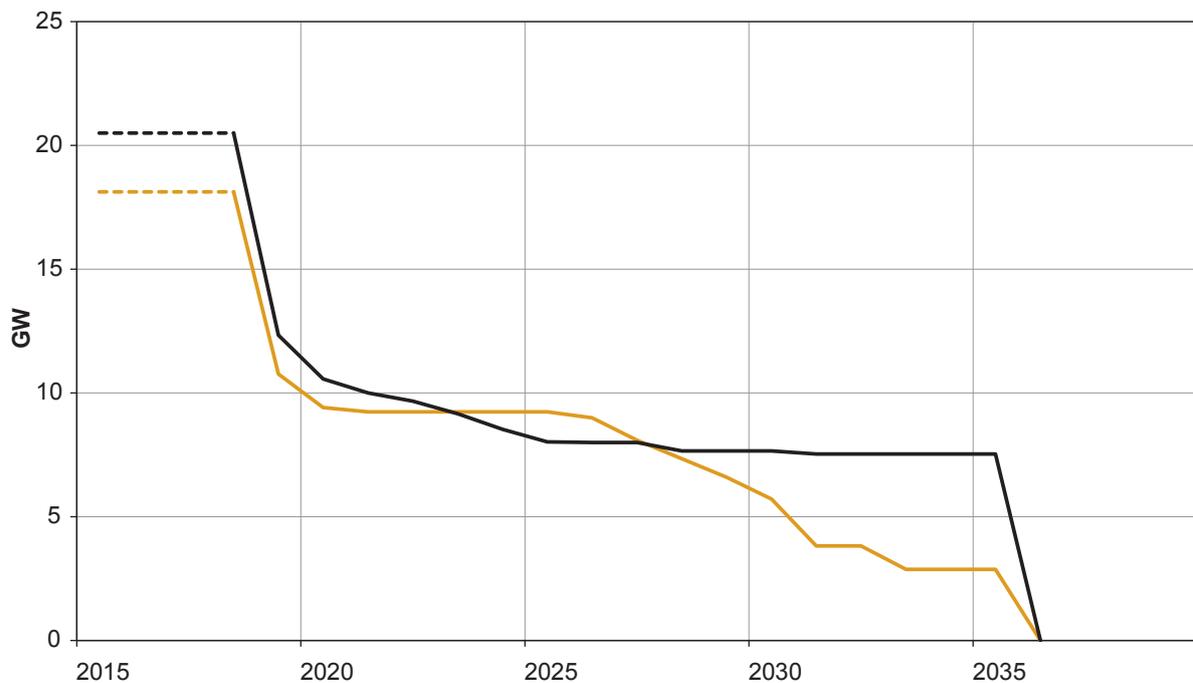


- Other fossil
- Natural gas
- Hard coal
- Lignite
- Cumulative CO<sub>2</sub> emissions

Furthermore, an accelerated phase-out of the electricity generation of newer coal-fired power plants is also needed in the short and medium term (by 2035). Moreover, if medium- and long-term renewable generation capacities cannot be created that go well beyond the level envisaged by the current German Renewable Energy Sources Act (EEG 2017), a long-term emission base arises from the gas-fired electricity generation that is then needed to balance the reduction in coal-fired electricity generation; this emission base also contributes to the CO<sub>2</sub> emission budget being exceeded.

**Figure S-2: Reduction of lignite and hard coal-based generation capacities in the Transformation Scenario for an accelerated phase-out of coal-based electricity generation in Germany, 2015–2035**

Source: Calculations by Öko-Institut and Prognos



- Lignite power plants
- Hard coal power plants
- - - Without lignite security standby & decommissioning expected anyway

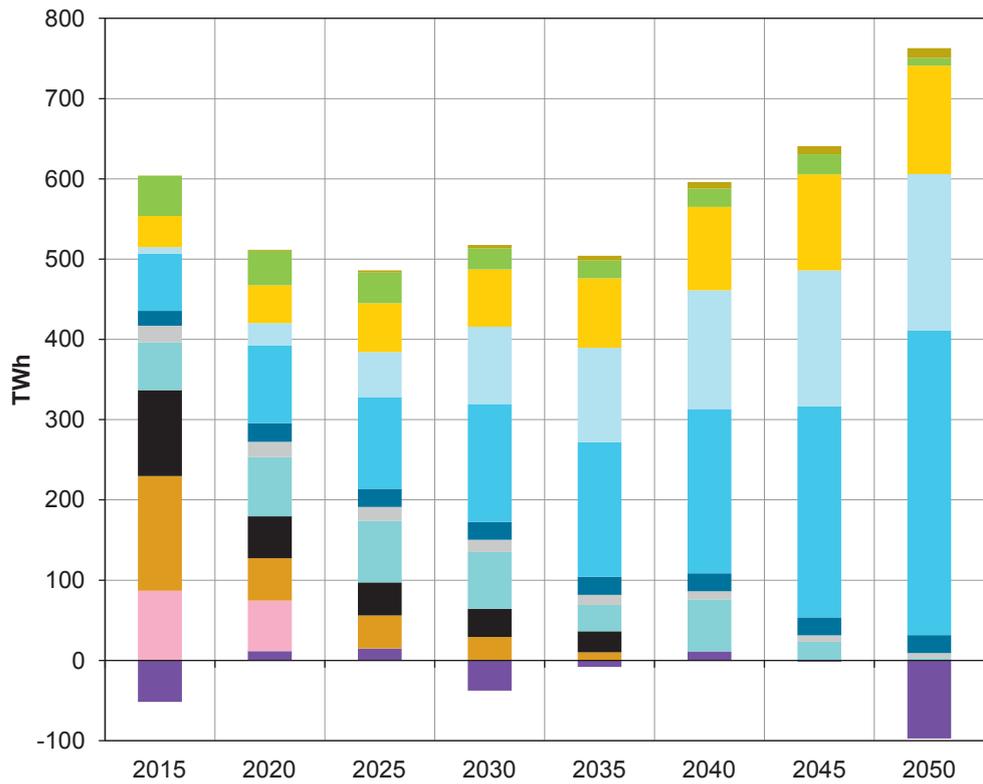
Based on comprehensive electricity market analyses, eight elements of a development or model can be identified for keeping within the German electricity sector’s emissions budget of 4.0 to 4.2 billion t CO<sub>2</sub> by means of an accelerated phase-out of coal-based electricity generation and system-compatible implementation (Figure S-2 and Figure S-3). These are as follows:

- » The first key element is to accelerate the expansion of electricity generation based on renewable energies to the level originally envisaged by EEG 2014 and the 2030 Network Development Plan.
- » The second element is to decommission in the short term coal-fired power plants that have been in operation for more than 30 years. The reduction of these capacities should start in 2019, given the high emission base of the coal-fired power plant fleet and the tight CO<sub>2</sub> emissions budget.
- » The third element is to set the end of 2035 as the deadline for completing the phase-out of lignite and hard coal-fired electricity generation.

**Figure S-3:**

**Electricity generation in the Transformation Scenario for an accelerated phase-out of coal-based electricity generation in Germany, 2015–2050**

Source: Calculations by Öko-Institut and Prognos



- Other renewable
- Biomass
- Photovoltaics
- Offshore wind
- Onshore wind
- Hydro
- Other fossil
- Natural gas
- Hard coal
- Lignite
- Nuclear energy
- Net electricity imports

- » The fourth element is to implement a mix of capacity and emission management to establish continuity in emission reductions, capacity reduction and electricity market effects and to facilitate the adaptation processes for companies and regions for the period of 2019 to 2035.
- » The fifth element is the need to develop instruments which, on the one hand, reduce the high export surpluses of Germany from CO<sub>2</sub>-intensive electricity generation and, on the other hand, strive to achieve a balanced decade average of electricity imports and exports (fossil-generated power) from 2020 onwards.
- » The sixth element is the need to review, in the context of the accelerated phase-out of coal-based power generation, the already implemented and planned instruments for ensuring system stability and security of supply.

- » The seventh element concerns the regulatory framework for open-cast lignite mining. In view of the German electricity sector's CO<sub>2</sub> emission budget, which is compatible with the 2°C temperature limit, all lignite mining areas that have already received approval for lignite quantities to be mined should expect to be decommissioned sooner than envisaged. Approval procedures for expansions of existing open-cast mines should be stopped until the phase-out path for coal-based power generation in Germany has been reliably clarified and reasonable reductions have been shown with legal certainty. The associated consequences (financing of follow-up costs etc.) have to be taken into consideration at an early stage.
- » An eighth element is the need to conduct comprehensive analyses on the regional economic and social impacts of an accelerated phase-out of coal-fired electricity generation and the creation of necessary compensation mechanisms (from the expansion of renewable energies, through location policy to infrastructure expansion).

Against this background, the main elements of instruments needed for phasing-out coal-fired electricity generation in Germany are as follows:

1. The date set for completing the phase-out of coal-fired electricity generation in Germany by 2035 needs to be laid down in regulation. With a view to the age structures of the affected power plants, this means, with some exceptions, a minimum plant operating life of 20 years.
2. Limiting the operating life of coal-fired power plants to a maximum of 30 years can be implemented via legal regulation or by contractual arrangements. In both cases, this can, at least in principle, be combined with compensation payments; however, it should be pointed out that this approach deviates from the polluter pays principle and should therefore be considered a less suitable option from this perspective.
3. Optimizing power plant operation from the 21st to the 30th operating year (after commercial operation commenced)—which results in the yearly emissions of the power plant being limited to a maximum of 3.35 t CO<sub>2</sub> per kilowatt of net output—can be implemented both via legal regulation (e.g. following the model of the British emissions performance standard on which the modelling is based) and via pricing mechanisms (minimum price in the EU Emissions Trading System, selective pricing according to the climate levy model) or via compensation payments. Due to its deviation from the polluter pays principle, the latter approach should also be regarded as less suitable.

4. Finally, the dismantling and renaturation of open-cast mining areas should be financially secured with the strict participation of the polluters. Expansions of existing open-cast mines should not be pursued further; legally secure approaches to reasonable and necessary reductions in the scope of existing open-cast mining must be developed relatively quickly.

From an overall perspective, therefore, a broad spectrum of options is available for developing instruments to phase out German coal-fired electricity generation by 2035. The options can be implemented within the context of very different preferences and (European) policy framework conditions.

In addition to the implementation of an accelerated phase-out of coal-fired electricity generation in Germany in narrow climate and energy policy terms, further measures have to be taken to broaden integration of the coal phase-out (social and regional economic adaptation strategies for lignite mining areas, incorporation in the electricity market design of the future, infrastructural aspects). These were not included in the present study; they cannot, however, be meaningfully conceived and implemented without specification of the phase-out path for coal-fired electricity generation.

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