Integrating a carbon floor price in the policy mix for Germany’s coal phase-out

Study conducted on behalf of WWF Germany

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• **Germany has a long tradition of target-driven policies.**
  - the outcome is mixed
  - the country is going to miss its 2020 GHG emission reduction targets (40%), partly due to its high-carbon electricity exports
  - this and the need to comply with the 2030 target has triggered heated debates which will lead to action (whatever it will be)

• **Coal phase-out is eventually on the political agenda**
  - first attempts in 2014 which led to decommissioning of 2.7 GW lignite power plants (with high compensations)
  - end date for coal-based electricity generation is explicitly mentioned in the coalition treaty – without being specific on the date and the trajectory (will be topic of a coal commission)

• **Carbon pricing raised a lot of attention during the last months**
  - often mentioned in early drafts of (many) documents, never survived (explicitly) in the final versions
  - overall inconsistent (implicit/explicit) carbon pricing is realized widely
Carbon pricing in Germany
Some background

• Key legal constraints need to be considered
  – no window of opportunity for the next 5 years at the EU level
  – auction reserve prices are not possible due to EU legislation
  – recent ruling of the Constitutional Court (on the nuclear fuel tax) has far-reaching consequences for carbon pricing: CO₂ taxes as input taxes are no longer possible
  – the way out: flexible/floating energy taxation for power generation

• Key political constraints need to be considered
  – compensation of indirect CO₂ costs
  – British floor price mechanisms as a blueprint

• Consequence
  – the (original) British model will be the reference model
  – how to coordinate this cross-border (convergence or CDN model)?
Carbon floor price for electricity sector
Background on instruments (1)

• Reform of taxes, levies and surcharges is on political agenda (for many reasons)

• Also in this context: increasing interest in carbon pricing approaches (for different / all sectors) – for many good reasons

• EU ETS – the key carbon pricing approach for electricity sector will recover only very slowly from surplus crisis after measures taken on structural reform
  – Up to second half of the 2020s: price around / below 10 €/EUA
  – No / only insufficient contribution to necessary quick GHG emission reductions in power plant sector

• In electricity sector with strong cross-border integration, a number of interactions arise from carbon pricing:
  – Climate-policy and distribution effects of unilateral approaches can prove problematic (relevant for all countries with ambitious climate protection strategies, e.g. DE, FR, NL)
  – Cross-border activities of carbon pricing are (very) advantageous and on political agenda.
Carbon floor price for electricity sector
Background on instruments (2)

• Broad portfolio of instruments is available for substantial (and relatively short-term) GHG emission reductions in electricity sector
  – capacity management (e.g. security standby reserve),
  – operating restrictions (e.g. emission performance standards)
  – selective pricing instruments (e.g. special levy on coal)
  – carbon pricing (national floor prices, general floor prices in EU ETS, floor prices for regions within Europe)

• Different instruments have different ramifications:
  – GHG emission reductions (overall, in different countries)
  – costs and distribution mechanisms (electricity prices, compensations)
  – security of supply
  – balance of electricity imports and exports

• Reminder: With the current reform of EU ETS, additionality of GHG emission reductions is ensured (market stability reserve, cancellation mechanisms and their interactions).
Carbon floor price for electricity sector
Objective of analyses

- Numerical analysis of different aspects of carbon floor pricing options for electricity sector
  - for Germany alone
  - an integrated regional approach: Germany, France, Belgium, the Netherlands, Luxembourg, Austria, Denmark
  - various price levels analysed in each case
- Comparison with effects that have dominated discussion of instruments in Germany to date
  - policy-induced shutdown of coal-fired power plants
  - different variants
- Comparison with effects of combination strategies
  - different levels of carbon floor prices
  - policy-induced shutdown of power plants in different variants
Methodology and scenarios
Methodology

• Hour-by-hour *dispatch modelling* using electricity market model “PowerFlex Europe”

• *Shutdown of power plant units* endogenous to the model for the case that electricity revenues are not sufficient to cover fixed operating costs (personnel, maintenance and service, revisions) in the long term

• 2020 used as time horizon in the analysis (by way of example)
Model analyses: Scenarios considered

- Reference
  - 5.6 € / t CO₂

- Carbon floor price in Germany
  - 15 € / t CO₂ (i.e. 9.4 € / t CO₂ plus the reference amount)
  - 25 € / t CO₂ (i.e. 19.4 € / t CO₂ plus the reference amount)
  - 35 € / t CO₂ (i.e. 29.4 € / t CO₂ plus the reference amount)

- Carbon floor price in regional market
  - Germany, France, Belgium, the Netherlands, Luxembourg, Austria, Denmark

- Policy-induced shutdown of power plants
  - Shutdown of 7 GW lignite power plants (discussed in CDU-FDP-Green coalition negotiations)
  - Shutdown of all power plant units that entered operation before 1990 (8.4 GW lignite and 11 GW hard coal) based on the study “Future electricity system – Coal phase-out by 2035”

- Corresponding combinations
CO$_2$ effects beyond the fuel switch
Contribution margins as criterion for shutdown decisions

→ CO$_2$ prices have significant effects on contribution margins of lignite power plants and open-cast mines under current conditions.

→ The oft-mentioned “domino effects” can only arise if fixed operating costs of an open-cast mine can be lowered in their entirety and not modularly; this is not expected.
Results
Absolute GHG emissions and power plant shutdowns in DE
Carbon floor prices and policy-induced shutdowns

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Target area 2020s
- 250* 200*
- 180**

* 40% target
** electricity sector target according to Climate Action Plan 2050

→ Possible for electricity sector to meet 40% reduction target with carbon prices of approx. 25 €/t CO₂ in DE and 30 €/t CO₂ in European regional market or via significant shutdowns of lignite (>8 GW) and hard coal (>11 GW)

→ Electricity sector target for 2030 of German Climate Action Plan 2050 is achievable with carbon prices above 30 € (unilaterally in DE) or from 35 € (regional market) or with shutdowns >>8 GW (lignite) and >>11 GW (hard coal)
→ Carbon floor price only in DE has strongest GHG emission reduction in DE, but largest rebound effect in regional market (outside DE)

→ Carbon floor price above 15 €/t CO₂ in European regional market generates largest GHG emission reductions in regional market (incl. DE)

→ Policy-induced shutdowns of lignite >8 GW and of hard coal >11 GW bring about similar emission reductions as carbon floor prices of 25 €/t CO₂ (DE or regional market)
Electrical import-export balance
Carbon floor prices and policy-induced shutdowns

→ Carbon floor price in DE generates the strongest shift towards significant electricity imports
→ Carbon floor price of 15 to 25 €/t CO₂ in regional market balances German electricity imports
→ Policy-induced shutdowns bring about positive electricity exports or at most very low imports
→ Shutdowns decrease Germany’s surplus electricity exports more slowly than carbon floor price

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Carbon floor prices and policy-induced shutdowns

- Carbon floor price of up to approx. € 15 mainly reduces hard coal capacity compared to reference
- … up to approx. 25 €/EUA mainly reduces lignite capacity; natural gas shutdowns are avoided
- … up to approx. 35 €/EUA: carbon floor prices in DE / regional market have diff. effects on coal in DE
- Policy-induced shutdowns of lignite alone avoid hard coal but not natural gas shutdowns
- Lignite and hard coal shutdowns mean that natural gas shutdowns are avoided
Wholesale electricity prices

Carbon floor prices and policy-induced shutdowns

- Carbon floor prices in DE and in regional market have very similar effects on wholesale electricity price (35 €/t CO₂ instead of 5.6 €/EUA leads to increase of approx. 20 €/MWh)
- Effects of policy-induced shutdowns on wholesale electricity price are very low (possible compensation payments and possibly higher scarcity prices: expected amount X €/MWh)
- German EEG surcharge decreases when electricity prices increase -> decrease of approx. 50%
- Power-intensive industries (within EU): enabling compensation of indirect CO₂ costs
GHG emissions / emission reductions of DE power plants

Carbon floor prices, policy-induced shutdowns and combinations

Combinations of policy-induced power plant shutdowns and carbon floor prices generate:

… relevant additional emission reductions if volume of shutdown is low (e.g. 7 GW lignite) and carbon prices (regional market) are approx. 15/20 €

… hardly any additional emission reductions if volume of policy-induced shutdowns is high
With carbon floor prices of 15 € (regional market) additional GHG emission reductions for DE and Europe result from policy-induced shutdowns of lignite and hard coal power plants in DE.

With carbon floor prices of 25 € (regional market) additional GHG emission reductions for DE and Europe arise only through policy-induced shutdowns of hard coal power plants.
When policy-induced shutdowns of lignite power plants take place at same time:
… hard coal power plants are only shutdown when CO₂ prices (regional market) are approx. 25 €
… shutdowns of natural gas power plants are avoided when carbon floor prices (regional market) are approx. 25 €.
Electricity import-export balance

Carbon floor prices, policy-induced shutdowns and combinations

→ Higher carbon prices (also in regional market) lead to reduction of net electricity exports and to higher net electricity imports

→ Reminder: This only occurs if no new (natural gas) power plants are built in DE.
Wholesale electricity prices
Carbon floor prices, policy-induced shutdowns and combinations

Carbon prices dominate the electricity price effects on wholesale market
Conclusions
Summary
Emission reductions in Germany (1)

- Medium emission reduction targets for Germany would require carbon price levels of ~30-35 €/t CO$_2$
- The alternative would be forced the shut-down >50% of the coal fleet in the up-run to 2030 (ratio hard coal/lignite is important)
- Embarking on an ambitious emission reduction trajectory with carbon floor prices in the range of 15-20 €/t CO$_2$ would potentially require an hybrid approach
  - (hybrid model of early shut-down with compensation and an increasing carbon price floor – which is important also to increase (dis)investor certainty)
- It is completely unclear whether the coming government is willing to go for an carbon pricing approach (solely or in the framework of a hybrid approach)
- Enabling factors for the carbon floor price could be, however,
  - the cost exposure of the electricity-intensive industries
  - the opportunities from cross-border cooperation (beyond the narrow energy & climate policy perspective)
Summary
Emission reductions in Europe

• **Positive overall effect on GHG emission reductions**
  - In all scenarios considered, the emission reduction in Germany is substantially higher than the increase in emissions in its neighbouring countries

• **Rebound effects within Germany and abroad (= emission increase of the power plants that adopt electricity production of power plants with decreased production) can be effectively limited by carbon floor prices in regional market**
  - Carbon floor prices in regional market of approx. 25 €/t CO₂ substantially reduce the rebound effect in Germany as well as in European neighbouring countries

• **Higher emission reductions in combination of rather low carbon floor prices with power plant shutdowns**
  - With carbon prices of <25 €/EUA, higher GHG emission reductions are achieved through combination with policy-induced power plant shutdowns (in Germany).
Summary
Energy sector effects (1)

- **Wholesale electricity prices**
  - Lower with policy-induced shutdowns than with carbon floor price
  - But policy-induced shutdowns can entail compensation payments (incl. scarcity prices but only when \( X \, €/\text{MWh} \))
  - Effects for final energy users:
    - Approx. 50% of increase of wholesale electricity prices is absorbed via reduced EEG surcharge for final energy users that pay the (full) EEG surcharge
    - Effects for electricity-intensive industries that qualify, as before, for compensation of indirect \( \text{CO}_2 \) costs can be relieved via corresponding compensations (this essentially depends on legal design but is possible, see carbon floor price in UK)
    - Connection to other changes in tax, levy and surcharge systems (e.g. partial reduction of electricity tax) can likewise contribute to decrease of distribution effects.
Summary
Energy sector effects (2)

• Security of supply
  • Extensive power plant shutdowns necessitate complementary measures to ensure security of supply: demand response, gas power plants, electricity storage if necessary.

• Balance of electricity import and exports (for Germany)
  – Carbon floor price tends to have larger effects on electricity import-export balances than policy-induced shutdowns of power plants (considered here)
  – With approx. 20 €/EUA in regional market, Germany’s imports and exports are balanced; with higher carbon prices, there are net imports
    • The latter only occurs under the condition that no new gas-fired power plants are built in Germany, which could become necessary in any case with a view to security of supply
  – Reduced electricity exports from Germany increase production of hard coal (if carbon prices remain under approx. 20 €) and natural gas power plants in European neighbouring countries.
Thank you very much

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