Coal Phase-Out in Germany: The Role of Coal Exit Auctions

ANALYSIS

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Dear reader,

The coal phase-out announcements by multiple countries in 2019–2021 have created a crucial momentum. The question now is how best to implement these phase-outs. There are several instruments available for their facilitation. Reverse auctions are one option, although not a universal solution applicable in all circumstances.

The German governing parties of the 20th legislative period (2021–2025) agreed to phase out coal "ideally by 2030". A gradual phase-out of German lignite and hard coal is therefore planned and enshrined in law.

This analysis aims to answer the many questions we receive about the German coal exit auction process. It summarises the phase-out process for hard coal and small lignite power plants in Germany, beginning with a short historical overview. It then identifies the primary factors that make reverse auctions suitable in the German context. It also describes how the auction design interacts with adjacent regulations. Finally, the paper presents the auction results and lessons learned with the goal of being useful for an international audience.

We hope you enjoy reading this paper.

Jesse Scott

Director International Programme,
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Key findings

1

Coal exit reverse auctions are not a universal solution applicable in all markets.
This analysis identifies the primary drivers that make reverse auctions suitable to facilitate coal phase-out in Germany and reviews what other jurisdictions should consider when preparing a coal phase-out implementation policy.

2

Successful implementation of a coal-exit reverse auction depends on three key factors.

1. State readiness
   Security of electricity supply is well-planned, and the state has sufficient financial resources to fund compensation for early decommissioning.
2. Local context
   The existence of laws for the protection of businesses against expropriation and the fact of political support for coal together make a reverse auction a pragmatic legal solution supported by government, civil society, and industry.
3. Auction design
   Creating complementarity between pull and push measures – auction ("carrots") and forced closure ("sticks") – incentivises most power plant operators to seek decommissioning.

3

The right policy mix can increase the likelihood of successful auctions.
Germany has implemented several additional policies, adjacent to the reverse auctions, including renewable buildout and carbon pricing, that have helped to accelerate the phase-out of coal.

Content

Executive Summary

Since 2018, Germany has implemented a consensual, regulated coal phase-out policy that differs from more confrontational approaches such as exclusive reliance on carbon pricing. It is worth analysing what other countries may learn from this approach to phasing out coal, especially the reverse auction scheme that was set up to close hard coal power plants in Germany. This report evaluates the four auctions that have taken place to date and offers preliminary conclusions.

To accelerate the phase-out of coal, the German government set up a commission with membership spanning civil society, NGOs, the energy industry, and the wider business community. The Coal Commission, as it would become known, was tasked with preparing a plan to help Germany reduce coal-fired electricity generation and CO_2 emissions.

Wary of the lessons of Germany's nuclear exit plan earlier in the decade, the Coal Commission proposed a set of measures based on discussions with and approval by civil society, NGOs, trade unions, and the energy industry. The result is a plan that reduces Germany's use of coal in electricity generation and avoids the costly lawsuits that accompanied the nuclear exit. A key pillar of the proposal was the reverse coal auction: pay-as-bid auctions that are designed to compensate hard coal and small-scale lignite power plants for decommissioning early.

Overall, auctions have been an effective – albeit not necessarily cost-effective – tool in accelerating the German coal phase-out. However, they are not a one-size-fits-all solution everywhere in the world. A successful implementation of coal exit auctions depends on the right policy mix, as well as on the national and local political context and the auction design itself.

The right policy mix is key for the successful implementation of coal auctions. In the German example, decommissioning power plants through the auction system is accompanied by numerous other policies that help reduce emissions and reduce the profitability of coal firing for electricity generation. These policies include carbon pricing, support policies for building out renewables, strong air quality standards that mandate pollution-reduction investments in coal power plants, and government support for combined heat and power (CHP) conversion that incentivises coal-fired power plants to change to gas or biomass instead.

Security of supply needs to be ensured when seeking to decommission significant capacity from the energy system. Germany has a modern gas power plant fleet. Consequently, Germany has not faced security of supply issues through its initial coal closures. However, countries with tighter capacity margins or concerns about gas supply (now also an issue in Germany) should assess the potential impact of large coal capacity decommissioning on the system's security and make clear plans to build up renewables and low- or zero-carbon dispatchable capacity to replace the phased-out coal.

The national political, legal, and financial context is an important factor for determining the suitability of auctions. In 1996, Germany became one of the first countries to transform its energy system from a monopoly to a liberalised electricity market. Most energy companies in Germany are privately owned. Strong laws for the protection of businesses in Germany against the expropriation and devaluation of their assets have led to compensation being paid to operators in order to avoid lengthy lawsuits. At the same time, the German government has been able to commit funding to facilitate early closures with relative political ease. Countries with weaker balance sheets may opt to give a larger role to revenue-positive measures such as carbon pricing.

An auction design needs to be thoroughly evaluated to avoid perverse incentives. One of the shortcomings of auctions identified in this paper is that, depending on their design, they may prolong the lifetime of loss-making power plants because the expectation of compensation may have motivated some loss-making power plants to stay online longer.

Another risk is that auctions encourage the early closure of modern rather than older, less efficient coal power plants. The early auction rounds in Germany saw power plants with less than ten years of operation compensated for early closure. This was caused by the mechanism employed to evaluate the bids.

1 Background

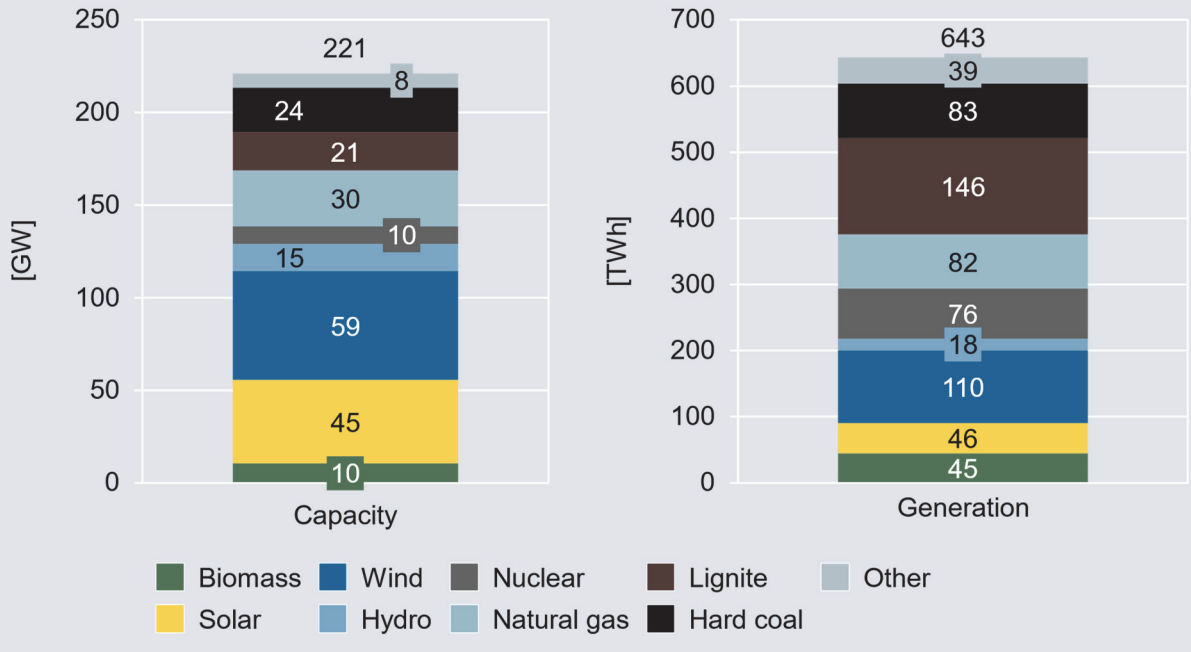
1.1 History of the Coal Commission: The 2018 German coalition agreement

Coal has played a major role in German electricity generation since the industrial revolution when both hard coal and lignite were mined domestically in Germany. After German hard coal mining started to decline in the 1960s due to its decreasing competitiveness as well as the diversification of the energy mix toward nuclear, natural gas, and oil, an ever-increasing share of hard coal had to be imported. Lignite continues to be mined in Germany in three major mining regions.

In the early 2010s, Germany started to focus on lowering its high reliance on coal and lignite electricity in order to reduce the country's emissions from power generation. Civil society and the scientific community started calling for more robust policies for reducing emissions in general, especially those from coal-fired power generation.

In response, in 2014, the 2013–2018 German federal coalition government adopted the Climate Action Programme 2020[1] which set out measures to reduce the use of coal-fired power plants. Despite this programme, CO_2 emissions decreased slowly and, according to the government's own biennial reports, Germany was on track to miss its emissions reduction target for 2020. The 2020 target was for a

Figure 1: Coal capacity made up only 20% of total installed capacity, but generated more than 35% of the country's electricity in 2018



BMWi (2019)

1 BMUV (2015).

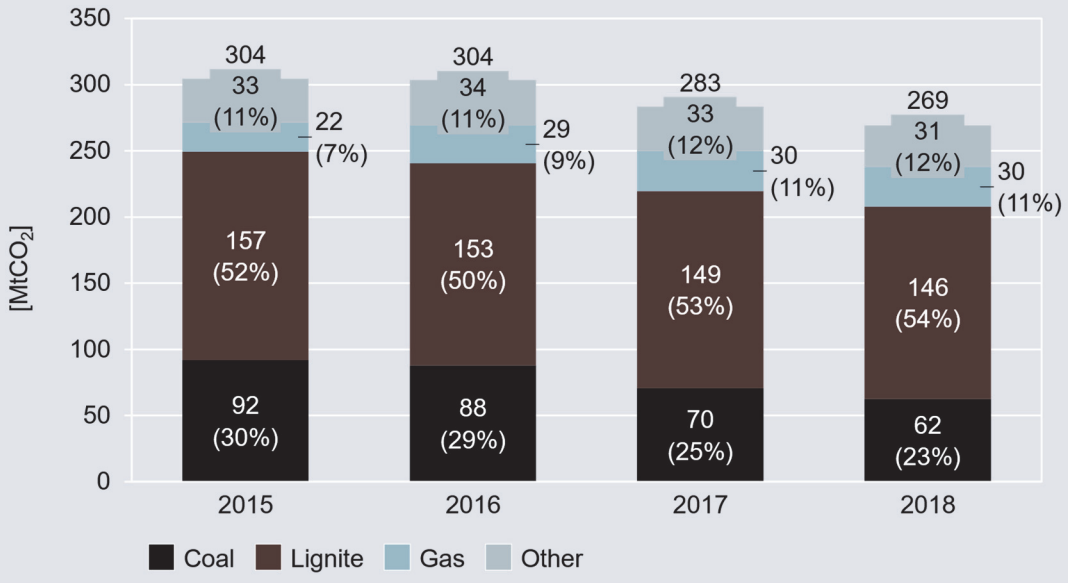
40% reduction of CO_2 emissions relative to 1990 and was adopted in 2007 to address the rising threat of climate change.

The Climate Action Programme 2020 was followed by the adoption of the UN Paris Climate Agreement in 2015. The Paris accords pushed Germany to strengthen its ambition and accelerate the reduction of coal firing. In 2016, Germany adopted the Climate Action Plan 2050[2] which pledged to establish a commission to draft a consensus proposal to phase out coal in electricity generation. In 2018, the new government established the commission. It was officially named the Commission for Growth, Structural Change and Regional Development, though it has since become better known under its informal name: the Coal Commission.[3]

1.2 Why phase out coal: the German coal fleet in 2018

In order to understand the context, it is worth considering the German energy mix prior to the Coal Commission's formation. German hard coal power plant capacity already began decreasing between 2015 and 2018. By 2018, coal-fired electricity generation (including both hard coal and lignite) comprised only 20% of total capacity and one-third of total electricity generation in Germany (Figure 1). However, coal-fired electricity generation accounted for nearly 80% of total emissions from the power sector during the same year (Figure 2). This meant that Germany had one of the most carbon-intensive energy mixes in the European Union.[4]

Figure 2: Coal-fired generation accounted for almost 80% of electricity generation emissions in 2018; but CO_2 emissions from coal-fired generation decreased by ~20% between 2015-2018



BMWi (2020)

2 BMUV (2016).

3 Bundesregierung (2021).

4 European Environment Agency (2021).

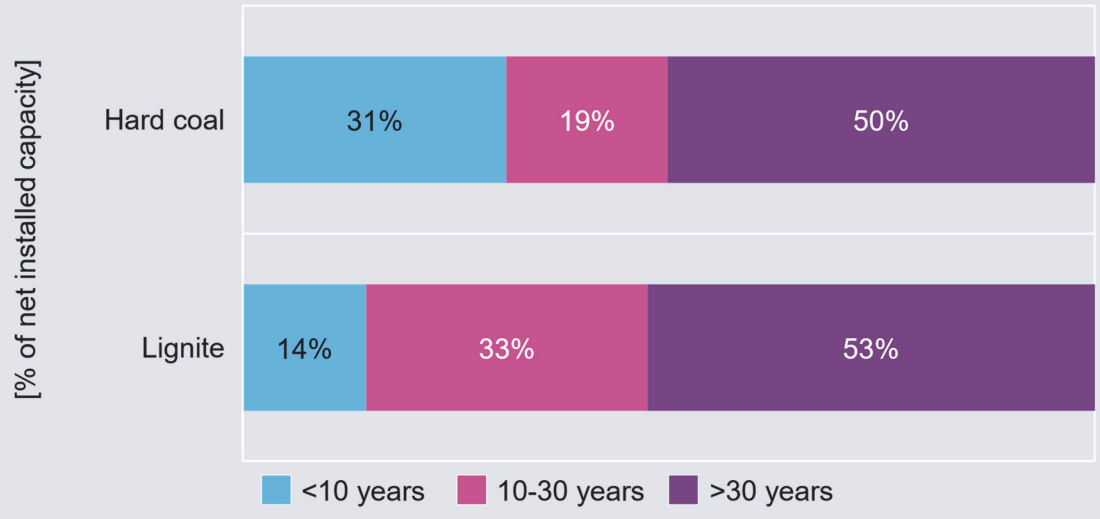
1.2.1 Overview of the German power sector capacity mix in 2018

In 2018, Germany had a relatively old coal fleet, with a capacity-weighted average age of ~30 years. However, 7 gigawatts of hard coal and just under 3 gigawatts of lignite capacity had been built since 2010. With the expected lifetime of a coal plant spanning many decades, an additional argument for the phase-out of coal power plants was that these newly built power plants could emit well into the 2040s. Hard coal power plant capacity in Germany exists throughout the country, but it has been concentrated in the industrialised west, while lignite mining and capacity are in the west and the east.

1.2.2 Emissions from German coal-fired generation in 2018

Figure 2 shows that total electricity system emissions decreased by over 10% between 2015 and 2018. Emissions from coal-fired generation decreased by ~20% in the same period, indicating some decarbonisation. Nevertheless, the pace of decarbonisation was clearly insufficient to reach Germany's emissions reduction goal of 40% for 2020, and currently it is not on track to meet its 2030 target of 65%.[5]

Figure 3: The hard coal fleet was renewed in the 2010s, with a significant amount of new capacity entering the system



Bundesnetzagentur (2021)

5 Agora Energiewende (2016): Eleven Principles for Reaching a Consensus on Coal.

1.3 Achieving a consensus plan: The Coal Commission process

1.3.1 The mission and organisation of the Coal Commission

The Coal Commission was established by the German Federal Cabinet in June 2018 to accelerate a coal phase-out. It was entrusted with the following tasks:

- Propose measures so that the energy industry can meet the 2030 emissions reduction target of 55%.
- Develop a plan for the gradual reduction and phase-out of coal-fired electricity generation, including a completion date and the necessary legal, economic, social, and structural measures.

The Coal Commission aimed to propose measures that would meet coal-firing reduction targets while helping coal-reliant regions to create a just transition for the workforce in the coal industry.

In order to achieve broad societal buy-in, the Coal Commission was established as an independent body comprising 31 representatives from trade unions (3 representatives), environmental associations (3), the energy industry (4), research (5), business organisations (5), the public administration (1), and the affected regions (7). The meetings of the Coal Commission were also attended by three members of the German Federal Parliament (Bundestag), however, they had no voting rights on committee resolutions.

The Coal Commission was led by four co-chairs: Ronald Pofalla (former head of the German Chancellery and current board member at Deutsche Bahn), Barbara Praetorius[6] (energy and environmental economist), and the former regional state-level prime ministers Matthias Platzeck (Brandenburg) and Stanislav Tillich (Saxony). The co-chairs were supported by an administrative department in the Federal Ministry of Economic Affairs and Energy. Coal Commission decisions had to be made by a two-thirds majority, which meant that each of the major stakeholder groups had a veto and needed to agree to the result.

The members of the Coal Commission reflect the German approach to political decision-making, which relies on consensus-building rather than majoritarian rule. The reason behind this approach is the large number of veto players in German political and economic governance, especially among the Federal states. Moreover, the German constitution offers strong protection against expropriation. Hence, a solution not supported by the private sector could have resulted in lawsuits. Consider what happened when the German government decided to accelerate the phase-out of nuclear energy in 2011. This ultimately resulted in settlements with the nuclear power industry exceeding 2.4bn EUR. The Coal Commission wanted to avoid such an outcome.

1.3.2 The Coal Commission's proposal and legal implementation

After eight months of meetings and a two-month delay of the final report, the Coal Commission's proposal was published on 26 January 2019. It recommended decommissioned 44 gigawatts of coal-fired capacity at an estimated cost of 69–93bn EUR[7]. By comparison, the German nuclear exit encompassed 12 gigawatts of nuclear capacity and came at a cost

6 Note: Dr. Barbara Praetorius has previously served as the director of Agora Energiewende.

7 Agora Energiewende und Aurora Energy Research (2019): The German Coal Commission.

of ~38bn EUR[8] for decommissioning and waste storage, before the additional 2.4bn EUR paid to operators[9].

The Coal Commission's consensus proposal to the government focused on five points of action:

1. Phase out coal: It was agreed that no new coal power plants and mines were to be opened in Germany and that all existing coal-fired power plants were to be shut down stepwise by 2035 or by 2038 at the latest. Operating coal capacities were to decrease to 15 gigawatts each of lignite and hard coal by 2022, and to 9 gigawatts of lignite and 8 gigawatts of hard coal by 2030. In order to reasonably compensate the owners, hard coal power plants were to be decommissioned through reverse auctions, and lignite power plants were to be decommissioned through a negotiated phase-out. (Note: The new federal coalition government has changed the date for completing the coal-fired exit from 2038 to 2030.)

2. Support the transition: Use structural financial aid to boost investment in advanced energy systems to expand transport and digital infrastructure, promote innovation, and create alternative employment and economic opportunities in today's coal-mining regions.

3. Modernise the power system: in order to replace phased-out coal-fired generation, the plan included building up renewables and cogeneration power plants. The point is to maintain security of supply while increasing system flexibility. The Coal Commission also proposed a cancellation of CO_2 certificates under the European Union's Emissions Trading System (EU ETS) in line with the coal phase-out (see section 2 below).

4. Alleviate hardship: Commission recommended extensive labour market measures to benefit those currently employed in the coal industry, including protections against dismissal, provisions for retraining, and measures for reallocation to new jobs. The aim is to ensure that those still affected by possible resettlement have a reliable basis for planning. Consumers should be protected against a rapid increase in electricity prices, with subsidised prices if necessary. Power plant operators will be compensated for the early shutdown of capacities.

5. Monitor and adjust measures: monitoring reports were agreed to be published starting in 2023 and released every three years. Positive reports could lead to an acceleration of the coal exit timeline.

As the above recommendations show, the five points of actions sought to address the concerns of all the key stakeholders.

The reason the Commission proposed different mechanisms for lignite and hard coal was that the German lignite sector is dominated by only two major players, RWE and EPH (owners of LEAG and MIBRAG), making competitive auctions impossible. Furthermore, in the case of lignite plants, open-pit mines and power plants are usually co-located, leading to complex interactions that are difficult to account for in auctions.

8 Clean Energy Wire (2015).

9 BMWK (2021).

1.3.3 Points of contention

Several points of contention arose during the drafting of the Coal Commission's recommendations.

Trade unions were critical about whether sufficient protection was provided for the affected workforce. And they have continued to be concerned that the Commission did not specify how affected coal regions will be transitioned.

It was also criticised by many that the coal phase-out would place too much cost on the federal budget. Another important financial criticism is that there is no published formula or mechanism to calculate compensation, especially that awarded to lignite operators. In 2020–21, it was argued that the high carbon prices in the EU ETS show that it might not have been necessary to create an additional regulatory mechanism in order to achieve a coal phase-out.

The participating environmental associations and climate scientists, for their part, argued that the timeline of the coal phase-out would not reach the objectives of the Paris Agreement.

Finally, civil society groups such as representatives from the 'Fridays for Future' movement and human rights organisations argued that the interests of young people, future generations, and those directly affected by climate change were not sufficiently represented as stakeholders in the Commission.

1.3.4 The Coal Exit Act

To implement the Coal Commission plan, the German Coal Exit Act was passed in July 2020 as part of a package of two laws that also included the broader Regional Development Act.

The Coal Exit Act committed financial support for the most affected coal regions of ~40bn EUR until 2038, and a budget to fund the coal auctions, CHP conversion, and lignite plant decommissioning. The funding equalled ~11% of the federal budget in 2020. It will be taken and spent from the federal budget over several years to support the affected regions (Saxony, Saxony-Anhalt, Brandenburg and North Rhine-Westphalia) on adjustment allowances for early retirement; on the expansion of infrastructure such as local public transportation, broadband and mobility; and on environmental protection and landscape conservation. In addition, the creation of new federal and research institutions and other innovative companies will create new jobs (see Structural Development Act[10]). The Coal Exit Act was passed in the Bundestag, Germany's federal parliament, with 314 votes in favour and 237 against.

The Coal Exit Act broadly reflects the Coal Commission's recommendations but deviates from them in some ways. Like the Commission's proposal, it requires a hard coal exit by 2035 and lignite exit by 2038. The most important change is that the law does not follow the linear reduction path proposed by the Commission. Instead, there is a late exit of over 6 gigawatts of installed lignite capacity in 2038. This means that some large power plants will stay in the system significantly longer than under the Commission's proposal.

The law also specifies a target for the total coal capacity operating in the German electricity market each year. Target capacities for both lignite and hard coal power plants are set for 2022, 2030, and 2038. In 2022, there is to be no more than 30 gigawatts of coal capacity, consisting of 15 gigawatts of hard coal capacity and 15 gigawatts of lignite capacity. For 2030, the target is 17 gigawatts, of which 8 gigawatts are hard coal and 9 gigawatts are lignite.

10 Bundesregierung (2020).

For hard coal, the Coal Exit Act implements a reverse auction mechanism and specifies the timeline for auctions, while delegating their administration to the German Federal Network Agency (Bundesnetzagentur – BNetzA). The BNetzA is responsible for publishing all information about the upcoming auction round, evaluating the bids, determining the clearing orders, and announcing the results.

For lignite, the Coal Exit Act defined a timeline and compensation level for the largest lignite power plants, which are mainly operated by RWE and EPH (LEAG). Under this part of the plan, which is detailed in Annex 2 of the Act, lignite closures are to begin in the western part of Germany to avoid an immediate economic shock to lignite-reliant regions in the east, which are economically weaker.

Smaller lignite power plants that are not specified in Annex 2 are eligible for participation in the main coal exit auctions from the third round onwards (see section 3 on auction results).

The law also includes provisions about ensuring the faster deployment and financing of cogeneration power plants. Finally, the Coal Exit Act eliminates excess CO_2 allowances under the EU ETS.

1.3.5 Compatibility of the German coal phase-out mechanism with European Union competition law and state aid

It is important to note, however, that the special arrangement that the Coal Exit Act established for large lignite power plants is now being challenged under European Union state aid law by the European Commission's competition authorities.

In March 2021, the European Commission opened an in-depth investigation into the specific compensation mechanism for lignite power plants, assessing whether it constitutes illegal state aid. This inquiry is still ongoing as of the time of writing (January 2022).

The reason for the investigation is that the European Commission doubts the proportionality of the compensation awarded to the companies RWE (2.6 bn EUR) and LEAG (1.75 bn EUR) for lost revenues and mine-site rehabilitation.

The European Commission also carried out a similar inquiry into the coal reverse auction mechanism. It was concluded that the auction design was in line with the European Commission's state aid rules and that it serves to promote EU climate policy objectives.

2 Auction design and adjacent regulations

INFOBOX 1. Reverse auction mechanism

A reverse auction is a type of auction in which sellers bid for the prices at which they are willing to sell their goods and services. The buyer puts up a request for a required good or service. Sellers then place bids for the amount they are willing to be paid for this good or service, and at the end of the auction the seller with the lowest amount wins. This mechanism encourages competition and pushes down the costs of production.

2.1 The starting point: How Germany's auction process works

2.1.1 Coal auctions timeline and volume

As described above, the Coal Exit Act specifies the German coal power plant capacity that is allowed and that will need to be decommissioned for each year through 2038.

Hard coal power plants cleared in round 1 of the auction had to be decommissioned in 2021. The auctions take place each half-year, with the last auction preliminarily scheduled for mid-2023 and the decommissioning for 2026 (Table 1).

The capacity volumes for the first two auctions were set by the Coal Exit Act at 4 gigawatts and 1.5 gigawatts, respectively.

The subsequent auction volumes will be defined to reflect the difference between the coal capacity actually operating in the market in a given year and the maximum capacity that is allowed by the law in the closure year linked to each auction round. This takes into account that coal capacity might close for reasons other than the auctions, so that the difference between the actual and the target capacities might be smaller than current information in 2021 would have forecasted.

The formula for calculating the capacity that will be auctioned in this way reflects the combined facts of the target for total coal capacity and the "starting level" of currently operating power plants. The formula does not include capacities that are either ineligible to participate in auctions or that have already announced closure (because they were successful in previous auctions or for other market and regulatory reasons). Subtracting the target level and the ineligible power plants from the starting level yields the capacity volume to be auctioned. If the volume calculated is zero or negative, an auction will not take place.

An additional 1 gigawatt is then added to the results of this calculation in order to reflect the issue posed by the 2020 commercial operation date of Uniper's Datteln 4 power plant unit[11]. If the difference between the starting and target volumes is negative, and the additional 1 gigawatt turns the value positive, a small auction will occur. Auction round 4 took place because of the additional gigawatt in the calculation.

11 Datteln 4 was the only coal power plant to commence operations after the conclusion of the Coal Commission's work. As a result, it aroused controversy.

The Coal Exit Act says that the last auction will take place in 2023, with the last year for decommissioning power plants cleared in the auction to be 2026. (The 2026 date was set in an amendment to the law made on 27 July 2021, moving the year of the final decommissioning forward from 2027).

2.1.2 Coal auction bids

Table 1: Maximum permitted bids by auction round

Auction round (year)	Maximum bid (EUR/MW)	Auctioned capacity (MW)	Decommissioning year
Round 1 (2020)	165 000	4 000	2021
Round 2 (2021)	155 000	1 500	2021
Round 3 (2021)	155 000	2 480	2022
Round 4 (2021)	116 000	433	2023
Round 5 (2022)	107 000	1 222	2024
Round 6 (2022)	98 000	TBA	2025
Round 7 (2023)	89 000	TBA	2026

Bundesnetzagentur (2021)

Each round has a limit on the maximum amount of euros per MW bid with which a plant can enter an auction (Table 1).

The purpose of the decreasing maximum bids is to reflect that the foregone revenues from power plant operations also decrease with every year and auction round as the final phase-out date approaches. Importantly, the decreasing maximum encourages companies to participate earlier in coal exit auctions (section 2.2).

2.2 Carrots: The auction bidding mechanism and bid evaluation

It is useful to explain the process for submitting and evaluating bids to the coal exit auctions, and what happens once an accepted auction bid for a power plant is cleared.

In this section, we also describe how the auction system treats power plants that are deemed crucial to maintaining system stability but that nevertheless decide to participate in an auction.

2.2.1 Submission of bids

First, power plant operators submit sealed bids to the BNetzA so that no operator can see the bids submitted by competing power plant operators.

The exit auctions operate on a pay-as-bid basis, meaning that every successful bidder receives only the amount that they bid. Bidders are asked to submit the bid amount in EUR per MW of net installed capacity, together with their verified CO_2 emissions from the past three years. Full sets of exact bids are never published by the BNetzA, which releases only the capacity-weighted average successful bid and the total capacity cleared. No information on unsuccessful bids is made available.

Regarding the question of system stability, it is interesting to note that no southern German power plants were permitted to participate in the first round of the auction due to the importance of these power plants for the maintenance of system balance in the German electricity grid.

2.2.2 Bid rescaling and ranking based on emissions

After bids are submitted, the EUR amounts are rescaled and ranked by the emissions intensity of each unit of installed capacity over the past three years, as shown in Figure 4. This rescaling identifies the power plants with the highest emissions intensity.

The process consists of three steps:

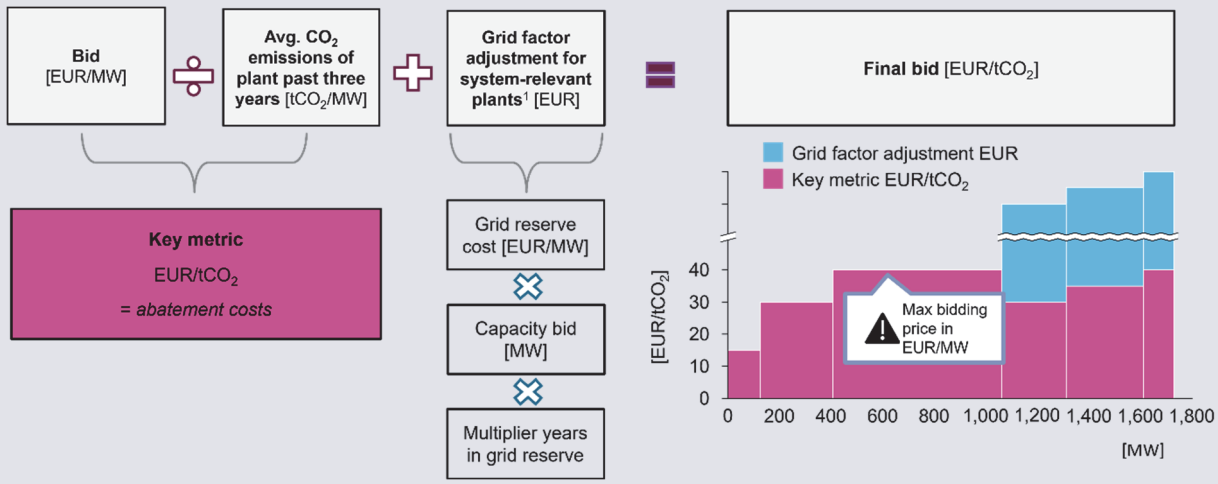
1. Bids are submitted in EUR per MW
2. Each bid is divided by the average annual CO_2 emissions per MW of net installed capacity
3. This results in a ranking metric of EUR per tCO_2, which is then used as a basis to evaluate auction bids

Accordingly, it is not the cheapest EUR per MW bid that wins the auction but the bid that offers the lowest CO_2 abatement costs.

The auction design favours power plants that have emitted relatively large amounts of CO_2 per unit of installed capacity. With the power market merit order, this mainly means favouring modern power plants that operate more hours than older, less efficient power plants. It also favours cogeneration power plants that run more hours than would make economic sense on the power market due to their heat off-take requirements.

Likewise, the design disadvantages older power power plants with higher CO_2 per MWh emissions if they have not generated as many hours as modern power plants because of lower efficiency and EU ETS CO_2 prices.

Figure 4: Sealed bids submitted by power plant operators are assessed based on the bid's EUR amount and the power plant's emissions intensity



Bundesnetzagentur (2020), Aurora Energy Research (2021)

2.2.3 Evaluation of bids and possible outcomes

As seen in the previous section, the power plants offering the lowest CO_2 abatement costs are cleared first in the auction. These power plants are then paid their EUR per MW bid in return for agreeing to decommission in line with the bid commitment.

The combination of the pay-as-bid mechanism with the lowest CO_2 abatement costs creates an incentive for tactical bidding. By analysing what the clearing price of the auction might likely be, operators can place bids that are above their reservation prices, with the reservation price defined as foregone revenues and other costs from closing a power plant earlier than originally planned. In short, operators can earn additional profits on top of their expected foregone profits and exit costs if they bid just under the level of the marginal power plant.

An auction round can also be over-cleared if the capacity of a particular cleared power plant exceeds the set auction volume. This is because it is not possible to clear only a part of a bid. Over-clearing occurred in the first, second, and fourth rounds.

2.2.4 Power plants that are important for system stability

A key feature of the coal exit auction is the possibility that there will be a so-called "grid factor" (Netzfaktor) in a power plant bid. The grid factor is an additional malus added to a power plant's bid in case that power plant is deemed to be important for the maintenance of system stability.

The electricity grid linking Germany's northern and southern regions is significantly constrained. Most generation capacity is located in the north and a large share of industry is located in the south. This means that electricity must flow primarily from the north to the south, leading to grid bottlenecks. Hence, decommissioning coal power plants in the south of Germany would aggravate existing congestion.

For this reason, southern and system-relevant power plants were prohibited from participating in the first auction round. The second round and later coal exit auctions include a grid factor malus to disadvantage southern coal power plants relative to other auction bidders.

Which power plants receive the grid factor is determined by the BNetzA based on an assessment from the German Transmission System Operators' (TSOs) about the importance of the particular power plant for maintaining the electricity system's balance and security. Notably, the grid factor malus is added to power plants only after the auction bids have been all submitted. Alternatively, TSOs can veto the clearing of certain power plants, although, at the time of writing (January 2021), no such veto had yet occurred.

The treatment of southern power plants adds to the complexity of the auction system because it is often not clear, ex-ante, which power plants would receive a grid factor, and hence whether and how these power plants can be expected to participate.

2.2.5 After the auction

Once a power plant has been cleared in the auction, the operator is required to sign a declaration committing them to the phase-out. The declaration states that the particular power station will not use coal for power generation from a certain date onwards. But the operator is still entitled to convert the power plant to another fuel such as biomass or natural gas. Consequently, success in the auction does not mean that the installation must be decommissioned, only that it will stop using coal.

Power plants that cleared in the first round of the auction were prohibited from selling additional coal-fired electricity beginning one month after the

auction. They were also forbidden from supplying any electricity starting from the seventh month after clearing in the auction. This was to ensure that power plants could meet existing contractual obligations without making new commitments to supply coalfired electricity.

Once a plant is cleared in the auction, it can no longer sell additional electricity. However, if the plant had pre-existing obligations (i.e. a bilateral power supply agreement with an industrial plant), it can continue delivering on that agreement. Hence the power plant can continue producing the power it sold prior to being cleared for auction, but it cannot sell new power after the auction clearing date. Therefore, power plants that were cleared in the second round were prohibited from selling coal-fired power from the date the contract was awarded, which was set as the auction clearing day. However, in the cases where the power plant had pre-existing obligations (i.e. a bilateral power-supply agreement with an industrial power plant), it could continue delivering on that agreement. Auction round three has a prohibition date of October 2022. Round four's prohibition date is May 2023 (Table 1).

2.3 Sticks: Auction undersubscription and the option of forced closure

While German reverse auctions initially offer operators generous financial compensation for decommissioning coal-fired power plants, the Coal Exit Act also includes provisions to dissuade operators from excessive tactical bidding and to encourage early auction participation rather than waiting until later rounds. The aim of these provisions is to avoid the undersubscription of auctions and to balance the "carrot" and "stick" elements of the phase-out plan.

To create the "stick", the Coal Exit Act includes provisions on forcing compulsory power plant closures without financial compensation. This provision comes into effect at auction rounds five and higher in case of undersubscription and it allows the government to order a forced closure of the net installed capacity equivalent to the undersubscription volume.

To ensure a fair choice of the power plants to be closed, the law tells the BNetzA to choose the oldest power plants to be decommissioned first. To this end, the BNetzA maintains and publishes an age ranking list of all German hard coal and small-scale lignite power plants ordered by the date they began commercial operation (Altersreihung)[12]. In the case of undersubscription of the auction, the oldest power plants that are still operating at the time of the auction are selected for uncompensated closure. The forced closures continue until the capacity target for the auction is achieved.

This provision on compulsory power plant closures without financial compensation increases the likelihood that older power plants will be closed without compensation if they are not successful in the first few auction rounds.

Notably, coal-fired power plants can move up in the age ranking if operators invested a certain amount in the power plant's modernisation between 1 January 2010 and 31 December 2019. Depending on the volume of the investment, the plant can have up to 36 months reduced from its age, making it 3 years "younger". The volume of the investment is calculated based on a capex benchmark set by the government of 1 500 000 EUR per MW. If an investment in a given power plant exceeds a certain percentage of the benchmark sum, then the power plant will receive additional months. The required investment volumes are summarised in Table 2.

12 Bundesnetzagentur (2021a).

Table 2: Capex investment needed to move up the age list

Investment capex per MW as % of the benchmark	Number of months added to the date of commissioning
≥ 5%	12 months
≥ 7.5%	18 months
≥ 10%	24 months
≥ 15%	36 months

§31 KVBG (Kohleverstromungsbeendigungsgesetz)

2.4 Additional regulatory drivers

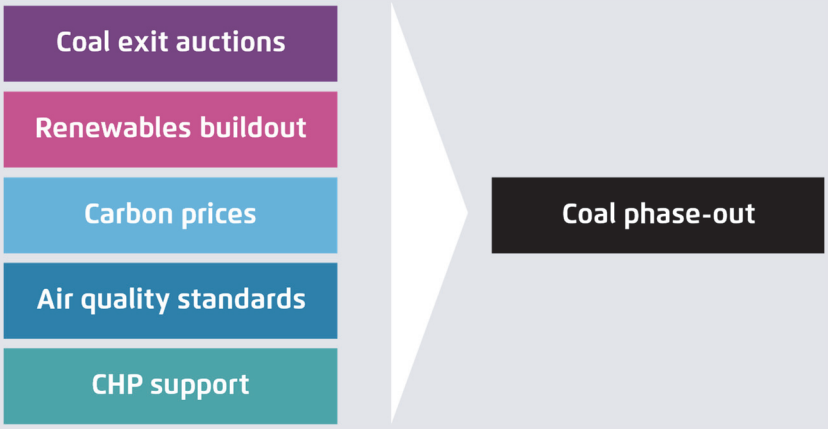
The German reverse auctions for the coal phase-out do not take place in isolation, but in the context of power sector regulations that affect the economics of coal power plants. This section focuses on the following regulations: subsidised buildout of renewables, air quality standards, carbon prices, and CHP support (Figure 5).

2.4.1 Buildout of renewables

At the time of the first coal phase-out auction, Germany had an ambitious target: 65% of electricity generation from renewables (RES) by 2030. In 2018 the actual level of electricity generated from RES was 38%. The new coalition government that formed after the 2021 general elections has raised the 2030 target to 80%.

Some of RES generation will come from dispatchable sources, but most of it will be wind and solar. The high levels of low-cost intermittent RES is likely to bring a significant drop in the utilisation of all types of fossil-fuel power plants. In fact, this already started happening in the mid-2010s. Because of its low marginal costs of generation, RES is usually at the beginning of the power-market merit order, pushing higher-marginal cost fossil-fuel power plants out of the system. This reduces the utilisation and profitability of coal power plants, and hence has an important impact on their auction bids.

Figure 5: Additional drivers supporting the hard coal phase-out in Germany



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2.4.2 Carbon pricing

Coal power plants in Germany and Europe are covered by the EU ETS cap-and-trade system. In the EU ETS, a certain number of CO_2 emission allowances are made available to the installations covered by the market. Operators are then obliged to surrender an emission allowance certificate for every tonne of CO_2 that their power plants emit. The market cap sets the maximum number of allowances that can be in circulation at any given moment. Parties covered by the EU ETS can trade these allowances.

The limited (and ever declining) supply of ETS allowances has the aim of creating scarcity, increasing the prices of the allowances over time, and making the operation of the most polluting installations, such as coal power plants, increasingly unprofitable.

When the Coal Commission first met in July 2018, the EU ETS allowance price was at ~15 EUR per tCO_2. The price level had approximately doubled to ~30 EUR per tCO_2 by the time of the first auction, and it increased again to ~50 EUR per tCO_2 by the time of the third auction. At the time of writing, the EU ETS price is above 80 EUR per tCO_2.

The ETS price increases reflect many factors in the carbon market and are closely monitored by operators and government policymakers. Some operators bidding in the German coal auctions are likely to have anticipated further price increases and factored these into their bids. The main reason for expecting ETS prices to increase is that the EU is now planning the implementation of the "Fit for 55" legislative policy package, which strengthens climate targets for 2030 throughout the European economy. The EU package is likely to include a tightening of emissions budgets in the ETS, reducing the total supply of allowances and putting additional pressure on coal power plants.

Carbon pricing directly reduces the profitability of coal power plants in two ways. First, it raises coal-fired electricity generation costs and hence reduces the so-called inframarginal rents those generators can earn: i.e., the price differential between their own variable costs and the variable costs of the most expensive generator required at any point in time. Second, a higher carbon price pushes coal power plants further back in the power market merit order – behind gas power plants – which reduces the running hours of coal power plants.

2.4.3 Air quality standards

All coal power plants in the EU need to meet the standards of the Industrial Emissions Directive (IED), which determines the amount of sulphuric SO_2, nitrogenous NO_X and dust that a power plant can emit.

Because coal power plants are high emitters of these pollutants, compliance usually requires additional investment in specialised stack filters.

In 2017, the European Commission adopted the latest version of the best available techniques reference documents (BREFs) that set the minimum standards for large combustion power plant emissions under the IED. The updated standards need to be achieved by installations starting in August 2021.

The IED sets a range of standards that EU countries can choose to apply. The lower standards can be achieved by most power plants with minimal capex, while the higher standards require substantial capex. German legislators chose the higher end of the range. Applying more stringent standards makes existing coal power plants less viable and to some degree reduces the cost of the auction bids.

2.4.4 Support for cogeneration (CHP)

Cogeneration, or combined heat and power (CHP), plays a substantial role in the German power system: around 57% of coal power plants produce heat

besides electricity[13]. For these cogenerating power plants, there is an alternative to participating in the coal reverse auctions.

Under a separate German CHP law, if a coal CHP plant is replaced with another CHP solution, e.g., a gas-fired CHP plant, the operator can claim a "coal replacement bonus". The financial bonus depends on the size of the replacement capacity as well as the age of the power plant being replaced. However, receiving the CHP bonus precludes power plants from participating in the auction.

For many CHP power plants, the replacement bonus is more attractive and less risky than the auction, because the bonus amount is guaranteed. The amount that would be awarded in an auction is less predictable, of course. This means that there are likely to be a substantial number of coal cogeneration power plant closures outside the auctions. This reduces the overall coal capacity and also reduces the level of competition in the auctions. Moreover, it may decrease the need for forced closures.

Some auctions might not need to take place in the event that many CHP power plants opt for the replacement bonus instead of auction participation. As a result, non-CHP coal-fired power plants may face some tactical considerations about the timing and cost of their bids.

2.5 Pressure from shareholders and financial markets

German coal-fired electricity generation capacity has also come under pressure as company shareholders and financial markets have become increasingly unwilling to own coal assets.

The creation of the German reverse auctions for the coal exit and the holding of the first auctions coincided with the start of significant pressure to phase out coal. Institutional investors exerted pressure on publicly listed utilities, and government twisted the arms of state-owned utilities. Each day, more and more financial institutions are seeking to "green" their portfolios.

In the case of German coal auctions, the financial and investor pressure is likely to have brought forward the participation of some relatively modern power plants with bids significantly below the maximum permissible bid. Most notably among them are the auction participation decisions of RWE and Uniper. RWE cleared its Westfalen plant in the very first auction. The coal power plant closed just 6 years after going online. Vattenfall, a utility owned by the Swedish state, may have been motivated to bid for its Moorburg plant on account of government pressure to decarbonise its portfolio.

2.6 Summary

The German coal exit auction system was set up to incentivise the decommissioning of coal power plants (the "carrot") and to impose declining compensation levels or forced closures (the "stick") for plants that wait.

The total capacity targets for the auctions are unlikely to match the capacity of the German hard coal fleet. This incentivises participation in auction bids to avoid uncompensated regulatory closure. Alternatively, a compensation mechanism is in place for cogeneration power plants.

Alongside the auction process, additional drivers such as carbon prices, air quality standards and RES buildout play a key role in reducing the profitability of coal power plants and lowering the cost of auction bids (Figure 5).

13 Bundesnetzagentur (2021b).

Finally, external pressure from shareholders, financial institutions, and government actors has increased the willingness of some coal operators to either decommission or convert existing coal assets.

3 Auction results

3.1 German auction results to date

3.1.1 Auction 1 – September 2020

The first German coal exit reverse auction took place in September 2020 (Auction 1). This section analyses that auction.

In Auction 1, the maximum bid was set at 165 000 EUR per MW. However, the actual bids ranged from 6 047 EUR to 150 000 EUR per MW, with no power plant bidding the maximum price. The capacity-weighted average bid was 66 259 EUR per MW, significantly below the permitted maximum bid. The total sum of the payouts was reported to be ~317m EUR.

Auction 1 had a target of 4 gigawatts of installed capacity and cleared 4.8 gigawatts across 11 power plants. The largest power plant cleared in the first auction round was 875 megawatts, while the smallest was only 3.6 megawatts. Table 3 provides an overview of the cleared power plants. More detailed information on bids or the GHG emissions of power plants were not provided by the BNetzA.

The over-clearing of nearly 800 megawatts occurred because RWE's Ibbenbüren power plant was very narrowly cleared (by 6 megawatts) so that the total capacity cleared by the auction was over 4 gigawatts. This made RWE by far the largest beneficiary of Auction 1, with the company receiving in total 216m EUR (more than two-thirds of the total pay-out for the auction).

Another successful participation was Vattenfall's Moorburg power plant. It was also considered remarkable and surprising because this power plant had only entered operation in 2015, making it one of the youngest coal-fired power plants in Germany. The reason for its success was that Moorburg was relatively competitive in the auction bid ranking for the lowest CO_2 abatement cost per MW of capacity (Table 3). However, analysis shows that Vattenfall did not take full advantage of this ranking benefit and could have had the power plant cleared with a significantly higher bid. This suggests a strong will by the company to close the power plant. Moorburg bid for the decommissioning of 1.6 gigawatts of capacity, which accounted for 32% of the total cleared capacity in the largest coal exit auction.

Another relatively young power plant, RWE's Westfalen, was successful in the auction. This power plant entered operation in 2014 and was responsible for another 763.7 megawatts of cleared capacity. Overall, new coal power plants comprised just under 60% of the total cleared capacity in Auction 1.

Nevertheless, the outcome left limited space for the decommissioning of power plants with higher CO_2 emissions per MWh relative to the newer power plants.

Table 3: Power plants cleared in the first round of the coal exit reverse auction

Plant name (operator)	Installed capacity (MW)	Start of operation
Heyden (Uniper)	**875**	**1987**
Moorburg – Block A **(Vattenfall)**	**800**	**2015**
Moorburg – Block B **(Vattenfall)**	**800**	**2015**
Ibbenbüren (RWE)	**794**	**1985**
Westfalen (RWE)	**764**	**2014**
Walsum 9 (Steag)	370	1988
Hafen – Block 6	303	1979
Infraserv GMBH CHP	51	NA
CHP plant Jülich	23	NA
Sugar factory Brottewitz power plant	4	NA
Sugar factory Brottewitz power plant	5	NA

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3.1.2 Auction 2 – January 2021

The second coal exit reverse auction took place in January 2021 (Auction 2).

Auction 2 cleared just over 1.5 gigawatts. The capacity was from much older power plants than those cleared in Auction 1. Auction 2 was over-cleared by 14 megawatts.

No power plants in the south of Germany were cleared in Auction 2. With the grid factor set at 118 898.47 EUR per MW, it is possible that southern power plants chose not to participate because they believed that their bids would not be competitive.

Auction 2 also had the smallest range of bids: ranging from 0 EUR per MW to 59 000 EUR per MW. These bids were significantly below the maximum bid of 155 000 EUR per MW, indicating that the cleared power plants did not expect a third auction to take place. Some operators most probably chose to under-bid their power plants in round 2 in order to ensure that they would get cleared.

Table 4: Power plants cleared in the second round of the coal exit reverse auction

Plant name (operator)	Installed capacity (MW)	Start of operation
Wilhelmshaven (Uniper)	757	1976
Mehrum (EPH)	690	1979
Deuben (EPH)	67	1936

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3.1.3 Auction 3 – April 2021

The third auction took place in April 2021. The volume announced was unexpectedly large: almost 2.5 gigawatts. It was undersubscribed by 347 megawatts, leading to a clearing volume of 2 132 megawatts.

Auction 3 was the first undersubscribed auction, and the auction in which power plants got cleared with a full maximum bid of 155 000 EUR per MW.

The undersubscription allowed the clearing of four southern power plants with a total capacity of 425 megawatts, despite the grid factor malus applied to their bids.

Table 5: Power plants cleared in the third round of the coal exit reverse auction

Plant name (operator) *Southern plant	Installed capacity (MW)	Start of operation
Bergkamen (Steag)	717	1981
Farge (Onyx Power)	350	1969
Scholven C (Uniper)	345	1969
Power plant I, Block 4 (EVONIK)	258	1971
HKW Fenne (Steag)*	211	1982
MKW Fenne (Steag)*	179	1982
Anlage 80 (Henkel)	36	1983
Kassel 9 (Sappi)*	27	1970
HK Venator Block 1 (Venator)	19	1971
K06 (Smurfit Kappa Zülpich Papier)	14	1964
HK Magirusstraße (Fernwärme Ulm)*	8	1992

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3.1.4 Auction 4 – October 2021

Auction 4 took place in October 2021. The fourth auction was the smallest round so far, with an announced capacity of only 433 megawatts and a maximum bid of 116 000 EUR per MW.

Auction 4 cleared 532.5 megawatts of capacity, leading to an over-clearing of 99.5 megawatts. Nevertheless, the auction saw power plants cleared that bid maximum amount. Bids ranged from 75 000 EUR per MW to 116 000 EUR per MW.

This auction saw the clearing of two small-scale lignite power plants and a large hard coal power plant, Uniper's Staudinger. This Uniper power plant was the marginal power plant cleared and received a high grid factor malus.

Table 6: Power plants cleared in the fourth round of the coal exit reverse auction

Plant name (operator) *Southern plant	Installed capacity (MW)	Start of operation
HKW Euskirchen	14.2	NA
HKW Könnern - Block 1	8.3	NA
Kraftwerk Staudinger Block 5*	510	1992

Bundesnetzagentur (2021)

3.2 Summary

In summary, the first four rounds of the German coal exit reverse auctions cleared nearly 9 gigawatts of coal capacity, representing 82% of Germany's 11 gigawatt reduction target for coal-fired power plant capacity between 2018 and 2022.

While Auctions 1, 2, and 4 were oversubscribed and saw significant levels of competition, Auction 3 was undersubscribed by 347 megawatts.

The maximum bids allowed for Auctions 1 and 2 were 165 000 EUR per MW and 155 000 EUR per MW, respectively, but the cleared power plants' bids were significantly lower. By contrast, in Auctions 3 and 4, power plants putting in the maximum bid were cleared.

Auction 1 resulted in the clearing of relatively new coal-fired power plants while leaving older power plants in the system. This was primarily driven by the auction bid ranking for the lowest CO_2 abatement cost per MW via the rescaling process described above. Here, the older power plants' generation hours resulted in a higher merit-order ranking.

In the first two auctions, no southern power plants cleared (in the first auction they were prohibited from participating). This is because southern power plants automatically receive a grid factor surcharge on top of their bid, reducing their competitiveness in the bid.

Figure 6: Three of the four auctions were oversubscribed, with only the third auction undersubscribed

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4 Evaluation and lessons learned

4.1 Security of supply needs careful planning

The primary concern when decommissioning large amounts of electricity generation capacity is security of supply.

A key enabling factor for the German coal exit is that in 2018 the country installed dispatchable power plant capacities of ~100 gigawatts, compared with a peak demand of ~80–85 gigawatts, indicating an overcapacity of at least 20 gigawatts. Germany also has grid interconnections and electricity market trading with its EU neighbours.

Moreover, Germany has a large, modern gas-fired power plant fleet, which was severely underutilised in 2018. According to German Federal Economics Ministry (BMWi; renamed as BMWK) data,[14] the average utilisation rate for gas-fired power plants in 2018 was only 31%. Consequently, significant coal capacities could be closed in the near term without endangering Germany's security of supply.

Conversely, countries with tighter capacity margins than Germany may find it more difficult to phase out coal without simultaneously introducing a policy framework that ensures the construction of new RES wind and solar capacity together with new dispatchable capacity to replace coal. It is also important to consider the alternative flexibility measures in storage and demand-side market design that can help ensure the balancing of supply and demand.

Figure 7: Auctions 3 and 4 saw power plants bidding the maximum possible amount cleared

Aurora Energy Research (2021)

14 BMWK (2021).

In fact, the Coal Commission called for the assessment of such a scheme in Germany, which may reconsider introducing more security of supply measures as firm capacity decreases in the coming years.

The other key factor is grid topology: removing coal power plants located near large off-take locations can constrain the grid, making the phase-out of coal more difficult.

In sum, both sufficient capacity planning and adequate grid planning must be provided as part of Germany's coal exit.

4.2 Policy mix as a key driver for achieving good outcomes

The first two coal exit auctions cleared significantly less than the maximum amount of permitted bidding. Even the most modern power plants participating in these auctions bid very low costs. This indicates a strong interest among power plant operators to participate in the auctions in order to achieve reimbursement for decommissioning. The pressure to participate came primarily from RES buildout targets, EU ETS prices and other related policies.

Coal exit auctions should not, therefore, be viewed in a vacuum. They need to be considered as part of a broader suite of policies to improve auction effectiveness and accelerate the coal phase-out. These include "carrots" – decreasing bid caps – as well as "sticks" – forced closures.

4.3 Trade-offs between "carrots" and "sticks"

The German constitution and international investor protection clauses such as those in the Energy Charter make it difficult to force coal closures without compensating power plant operators, due to the risk of lengthy lawsuits. Hence, it is important to offer compensation through an exit process, so that power plants that do not participate in the offered solution can be subject to forced closure. (See section 2 above for details.)

A combination of "carrot" and "stick", decreasing bid caps and forced closures are a strong incentive for power plants to participate in the auctions. Moreover, because older coal power plants have relatively low levels of production and hence low rankings for CO_2 abatement, the threat of forced closures further incentivises lower bids in an effort to beat competing power plants and avoid undersubscription, which could result in closures without compensation.

The German examples show that coal exit design has trade-offs. More operator-friendly designs will tend to result in greater compensation (and costs to the taxpayer). More stringent designs may still lead to lawsuits. German reverse auctions are an attempt to find a pragmatic solution.

4.4 Fleet effects on other power plants

The coal phase-out makes the electricity system tighter than it would be otherwise. Paradoxically, this can increase the value of power plants that stay in the system longer. The reason is that a system with lower capacity margins usually results in higher power prices and a higher utilisation rate for the capacity that remains in the market. This can translate into higher revenues for coal-fired power plants at the end of the merit order, possibly reducing their incentive to participate in the coal exit auction.

In other words, coal-exit auctions decrease the capacity margin, which means that the very measure designed to decommission coal power plants can increase the value of the remaining assets, including those it seeks to decommission.

However, operators that bet on this outcome take certain risks regarding policy and new capacity. The paradoxical effect can also be countered through policies such as carbon pricing, which reduce the profitability of the remaining power plants, and policies that incentivise non-coal newbuild capacities, which reduce scarcity in the system through, say, the introduction of a capacity market.

4.5 Factors that define the suitability of auctions for electricity system decarbonisation

Coal exit auctions are not a universal solution for all markets. Germany has had a liberalised energy market since 1996 and its energy companies are privately owned.[15] The primary factors that support the suitability of auctions in Germany are the historically strong political support for coal generation, the fiscal capacity of the state to finance compensation payments, and the constitutional protection against expropriation.

Reverse auctions were employed to offer power plant operators compensation for the coal exit. The government has also offered financial aid to the regions most affected by the coal exit.

In circumstances where there is less political support for the coal industry, a coal phase-out could be accelerated by higher carbon prices (either through taxes or carbon markets). For example, in 2013 the United Kingdom introduced carbon price support above the EU ETS. This gave investors certainty about the minimum price they would have to pay for CO_2 emissions and pushed coal power plants to the end of the merit order. The result was to accelerate the British coal exit by making coal uncompetitive without paying compensation to operators. The UK was able to introduce the measure because the power of its trade unions, utilities, and energy-intensive industries was substantially weaker in the UK than in Germany.

In Germany, the combined costs of regional financial aid, auctions, and the CHP replacement bonus will place a large burden on the government budget and/or consumers. Hence, a government-financed coal exit requires a large budget to cover the expenses.

A heavily indebted country might struggle to raise the capital for sponsoring a coal exit and might therefore prefer revenue positive measures, such as carbon taxes. Another option is to look for financial support from other financial institutions such as development banks and private investors.[16]

However, it is also true that most governments spend much more on other policies and technologies than they do on energy or climate. This means that financing a coal exit is ultimately a question of a country's political priorities.

Finally, although other countries may not have the same constitutionally grounded protection rules regarding expropriation as in Germany, awareness of investor rights and interest groups and the desire to avoid legal challenges mean that most countries will need to consider some compensation for phase-outs.

15 Agora Energiewende (2019): The Liberalisation of Electricity Markets in Germany.

16 Asian Development Bank (2021): Energy Transition Mechanism Explainer.

4.6 Auction incentives and impact on bidding

In terms of bidding behaviour, Germany's coal exit reverse auctions have resulted in several surprising outcomes.

4.6.1 Ranking and strategic bidding

The ranking of bids based on emissions (section 2.2.2) placed modern, coal-fired power plants at an advantage relative to older, less-efficient units. This is because the emissions intensity of a power plant, a key indicator in the merit order of the bids, was defined as tCO_2 per MW of installed capacity, rather than per MWh of electricity generated. While older power plants may be more emissions-intensive per MWh, it is the newer power plants that have higher emissions per MW of installed capacity due to the simple fact that they run more hours and therefore produce more electricity prior to the auction.

As a result, three of the most modern power plants in the German system closed in Auction 1, while older and more polluting power plants continue to operate. Moreover, the older power plants now operate more hours than they would have been able to if the modern power plants had not closed, because they moved up in the merit order. This effect actually slows the pace of emissions reduction achieved by the exit process. Countries seeking to adopt a similar auctioning mechanism would be well-advised to conduct a thorough impact assessment of the auction design before its implementation.

4.6.2 Prolongation of plant operation

Another effect of the coal auctions observed in Germany has been a somewhat prolonged operation of unprofitable coal power plants.

Typically, a coal plant would be expected to close if it cannot cover its annual fixed operation and maintenance costs, and the operator does not expect it to be able to recover those costs in the future. These fixed operation and maintenance costs for coal-fired power plants are estimated to be in the range of 30–50k EUR per MW.

In the period between 2018 and 2020, it is presumed that some old coal power plants in Germany were in a loss-making position and may therefore have been likely to close even without compensation.

However, the auction mechanism created the possibility of a pay-out exceeding the annual operation and maintenance costs of some power plants. This may have incentivised a few plant operators to continue running their loss-making power plants with the goal of being cleared in the auction. The idea is that the auction proceeds cover operation costs, while any revenue generated during the additional period they stayed online amounts to pure profit.

The problem is that the older power plants might have been decommissioned earlier without the auctions. But in all likelihood, this is not the standard mode of operation for power plant operators. Rather, it is a high-risk strategy that may have been enabled by the auction design.

4.7 Summary

Overall, the suitability and successful implementation of a coal exit auction depend on three key factors: state readiness, local context, and good auction design.

In terms of state readiness, German coal auctions worked partly because i) security of supply is ensured and ii) the state has sufficient fiscal power to cover compensation for early decommissioning.

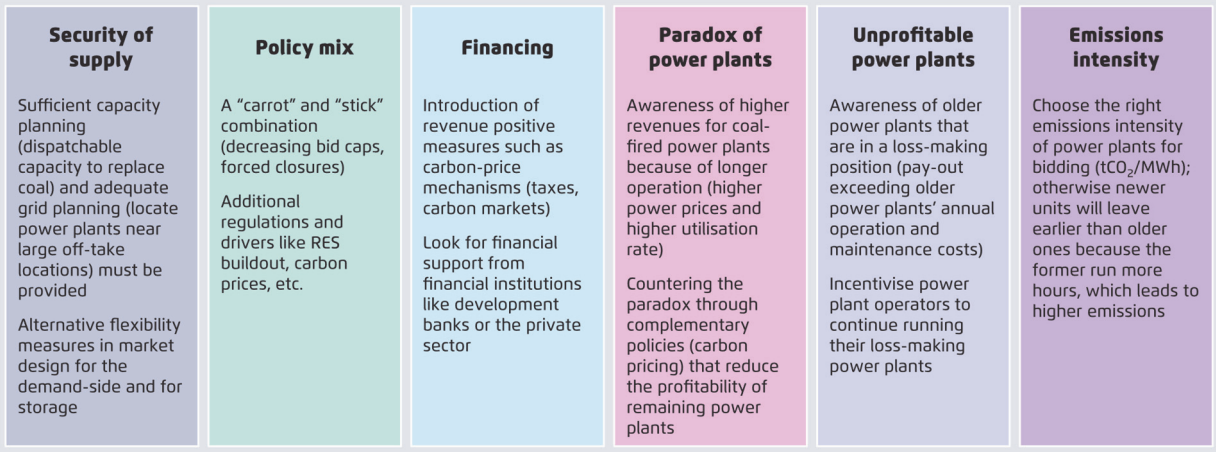
Germany's large and modern gas-fired power plant fleet ensures that the coal exit will not endanger the security of supply before sufficient RES and low- or zero-carbon dispatchable capacity are built up.

What is more, Germany has been able to fund the coal exit without taking on heavy government debt or compromising its other budget priorities. Combined with the protection of businesses and local political support for coal, these factors have made reverse auctions a pragmatic compromise that the German government, civil society, and industry can support.

The complementarity between the auctions ("carrot") and forced closures ("stick") provided ample incentive for most power plant operators to seek decommissioning.

Finally, and most important, auctions are not a stand-alone solution. Germany also implemented additional policies, including the buildout of renewables and carbon pricing, that have significantly helped to accelerate the phase-out of coal. In sum, then, having the right policy mix in place can increase the likelihood that auctions will succeed.

Figure 8: Aspects to consider when designing an auction mechanism



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