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Assessment of the planned compensation payments for decommissioning German lignite power plants in the context of current developments

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Summary

The electricity industry in Germany and Europe is in a state of upheaval. Due to the developments on the international markets for natural gas and hard coal, the politically driven expansion of power generation from renewable energy sources, the price developments for emission allowances of the European Union Emission Trading System (EU ETS) and the actively accelerated phase-out of power plant capacities, coal-fired power generation in particular is hugely decreasing at the moment and in the foreseeable future.

The trends in generation costs of lignite, hard coal and natural gas power plants is already leading to a significant shift in the production patterns of fossil electricity generation. Initially, this was primarily relevant for hard coal-fired power generation, but as CO_2 prices continue to rise, older lignite-fired power plants are also increasingly affected. Much more important for lignite-fired power generation, however, is the fact that in the current and foreseeable market environment, lignite-fired power plants are increasingly only able to partially cover the fixed operating costs of power plants and the connected lignite mines (personnel, maintenance, etc.) through the revenues from the electricity market. This creates considerable incentives for decommissioning as soon as fixed operating costs can be reduced (personnel adjustments, avoidance of major maintenance investments, etc.).

In view of the current changes in the electricity and CO_2 markets and in respect of the related volatilities over the last decade, the concept of non-transparent flat-rate compensation for the majority of the lignite-fired power plant units to be finally decommissioned by 31 December 2029 (as pursued in Germany's coal phase-out legislation) does not seem appropriate. The analysis of a proposal for a rule-based (and generously designed) compensation model shows that the planned flat-rate compensation of € 2.6 billion for RWE and € 1.75 billion for LEAG under the foreseeable framework conditions is in no way (LEAG) or only under certain conditions (RWE, depending on the costs of the lignite mine adjustments) appropriate. For LEAG, the difference between the rule-based compensation and the planned flat-rate compensation amounts to approx. € 1 billion. For RWE, there is a similar difference of € 0.9 billion if the documented costs for the lignite mine adjustments amount to approx. €1 billion; if costs of € 2 billion are assumed here, compensation of approx. € 2.66 billion could be justified. The key influencing factors for the compensation calculated according to the rule-based method are thus – in addition to the conversion costs for the opencast mines in the Rhenish mining area – the revenues from the electricity market and the costs of emission allowances of the EU ETS. Corresponding sensitivity calculations show that there may be substantially larger increases in CO_2 costs in the context of the European Green Deal than in electricity market revenues in the next two years, which would tend to make it necessary to decrease the compensation payments.

In view of the above, the planned flat-rate compensation for the decommissioning of German lignite-fired power plants must be regarded as a significantly misguided model, both conceptually and in terms of the levels of compensation payments envisaged, and the transition to rule-based compensation is urgently recommended.

Zusammenfassung

Die Stromwirtschaft in Deutschland und Europa befindet sich im Umbruch. Bedingt durch die Entwicklungen auf den internationalen Märkten für Erdgas und Steinkohle, den politisch getriebenen Ausbau der regenerativen Stromerzeugung, die Preisentwicklungen für CO_2-Zertifikate des Emissionshandelssystems der Europäischen Union (EU ETS) sowie durch den aktiv beschleunigten Abbau von Kraftwerkskapazitäten, geht insbesondere die Kohleverstromung aktuell und absehbar massiv zurück.

Das Verhältnis der Erzeugungskosten von Braunkohle-, Steinkohle- und Erdgaskraftwerken führt bereits aktuell zu einer deutlichen Verschiebung der Produktionsmuster im Bereich der fossilen Stromerzeugung. Nachdem dies zunächst vor allem für die Steinkohleverstromung relevant war, sind bei weiter steigenden CO_2-Preisen in zunehmendem Maße auch ältere Braunkohlekraftwerke betroffen. Für die Braunkohleverstromung viel wichtiger ist jedoch der Sachverhalt, dass im aktuellen und absehbaren Marktumfeld Braunkohlekraftwerke zunehmend in eine Situation kommen könne, dass aus den Erträgen im Strommarkt die fixen Betriebskosten von Kraftwerken und den sie beliefernden Tagebauen (Personal, Wartung, Instandhaltung, etc.) nur noch teilweise decken können. Damit entstehen erhebliche Stilllegungsanreize, sobald fixe Betriebskosten abgebaut werden können (Personalanpassungen, Vermeidung von größeren Instandhaltungsinvestitionen etc.).

Angesichts der aktuellen Veränderungen im Strom- und CO_2-Markt, aber auch mit Blick auf die entsprechenden Volatilitäten im Verlauf der letzten Dekade, erscheint das bei der deutschen Gesetzgebung zum Kohleausstieg verfolgte Konzept intransparent zustande gekommener Pauschalentschädigungen für den größten Teil der bis zum 31.12.2029 endgültig stillzulegenden Braunkohlekraftwerksblöcke als nicht sachgerecht. Die Analysen zum Vorschlag einer regelbasierten (und großzügig angelegten) Entschädigung zeigen, dass die vorgesehenen Pauschalentschädigungen von 2,6 Mrd. € für RWE und 1,75 Mrd. € für LEAG unter den absehbaren Rahmenbedingungen in keinem Fall (LEAG) bzw. nur unter bestimmten Voraussetzungen (RWE, in Abhängigkeit von den Kosten des Tagebauumbaus) sachgerecht wären. Für LEAG beträgt die Differenz zwischen der regelbasierten Entschädigung und der vorgesehenen Pauschalentschädigung ca. 1 Mrd. €. Für RWE entsteht eine ähnliche Differenz von 0,9 Mrd. € für den Fall, dass die belegbaren Umbaukosten für die Tagebaue eher in der Größenordnung von 1 Mrd. € liegen; werden hier Kosten von 2 Mrd. € nachgewiesen, wäre eine Vergütung von ca. 2,66 Mrd. € zu rechtfertigen. Die entscheidenden Einflussgrößen für die regelbasiert ermittelten Entschädigungen sind neben den Umbaukosten für die Tagebaue im Rheinischen Revier die Ertragslage im Strommarkt sowie die Kosten für CO_2-Zertifikate des EU ETS. Entsprechende Sensitivitätsrechnungen zeigen, dass sich insbesondere für die CO_2-Kosten im Kontext des *European Green Deal* in den nächsten Jahren deutlich größere Erhöhungen ergeben können als im Bereich der Strommarkterträge, womit sich die Entschädigungszahlungen tendenziell noch verringern müssten.

Gerade vor diesem Hintergrund sind die geplanten Pauschalentschädigungen für die Stilllegung deutscher Braunkohlekraftwerke konzeptionell und mit Blick auf die geplanten Summen als eine grobe Fehlentwicklung anzusehen und der Übergang zu regelbasierten Entschädigungen dringend angeraten.

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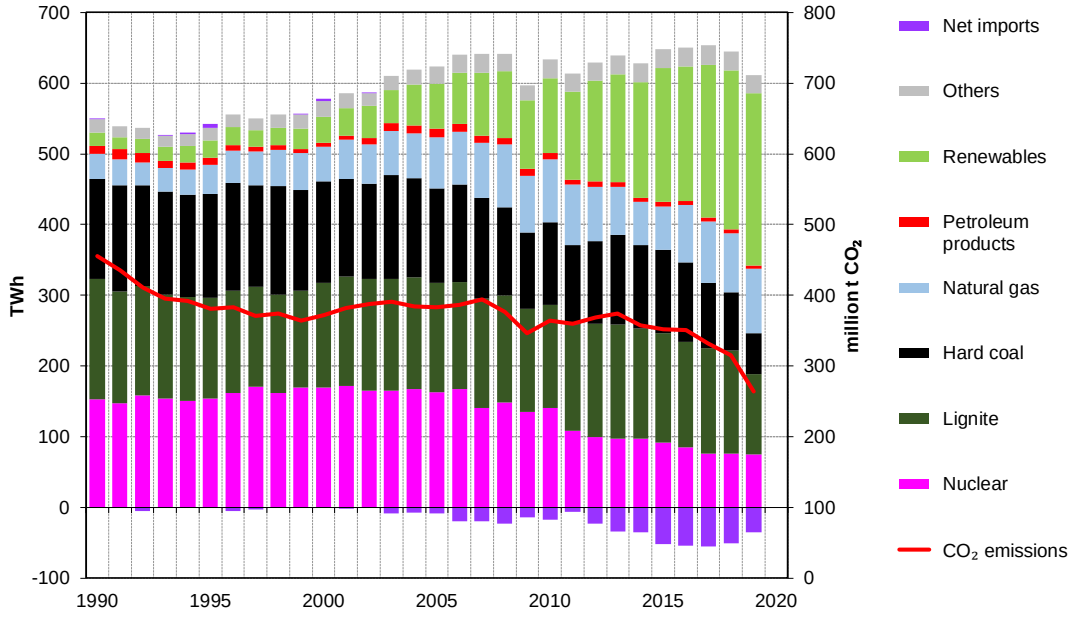
1. Introduction and Background

The German and European electricity systems are in a state of upheaval. Driven primarily but by no means solely by the energy transition and climate change policy, over the last 30 years electricity generation structures have changed very markedly and in general with increasing rapidity. To a lesser degree this is also true of power consumption, but here the advances in the more efficient use of electricity have been offset or even slightly overcompensated by new applications.

Figure 1-1: Gross power generation, net exports and CO_2 emissions from power plants in Germany, 1990-2019



Source: BMWi, BDEW, UBA, Öko-Institut calculations

Figure 1-1 shows the development in the German electricity system over the last three decades:

- Since 1990 power consumption in Germany has only changed slightly in total; gross energy consumption has risen in a long-term trend from around 550 TWh in 1990 to a value around 600 TWh;
- Electricity generation has clearly expanded further as Germany has developed into a clear net exporter of electricity, particularly since 2010, with a net balance of almost a tenth of German electricity production being exported at the highest point;
- The German structural change in electricity generation has resulted particularly with reference to renewable energies; in 2019 the renewable portion of electricity generation was around 40%; in relation to gross energy consumption the renewables accounted for 43%;

- Electricity generation from nuclear power has declined markedly since 2007 following various decisions to phase it out, this trend being reinforced since 2011;
- However, electricity generation from lignite and hard coal remained almost unchanged up to 2016, with a reduction in coal-based power generation only starting from 2017. This was partly driven by the market environment but also the first steps of an active policy of phasing out coal (transfer of lignite power plant units with a capacity of under 3 GW to what is known as the security reserve under Section 13g, EnWG (German Energy Industry Act)), which incidentally has been accompanied by a detectable decline in net electricity exports.
- Electricity generation from natural gas underwent only minor changes up to 2017 but clearer increases can be seen since 2018;
- CO_2 emissions from German power plants did not declined or only slightly over a period of around 20 years; only since 2015 has a very clear decrease in the CO_2 output come about here, mainly due to the decline in coal-fired generation.

The most recent developments are the ones of major importance for the current decisions on phasing out coal in Germany. Based on the proposals of the German Commission "Growth, Structural Change and Employment“ (KWSB 2019), Germany has decided on the concept of a hybrid model in which suppression of coal-fired generation is to be implemented and ensured partly through CO_2 pricing under the European Emissions Trading System (EU ETS) and partly through the legally controlled decommissioning of power plant capacity.

Given the fact that power plant decommissioning during the 2020s will be accompanied by considerable compensation payments, interactions with the very dynamic changes in the market environment will become increasingly important. The following analyses aim to take a closer look at the effects of these environmental conditions on coal-based power generation and the phasing out of coal in Germany. In light of the prominent role played by electricity generation in lignite power plants in the energy industry and climate policy in Germany (and also Europe), and considering the very specific cost and incentive structures in the lignite industry, which is largely characterised by vertical integration of coal mining and electricity generation, these evaluations concentrate primarily on the lignite industry.

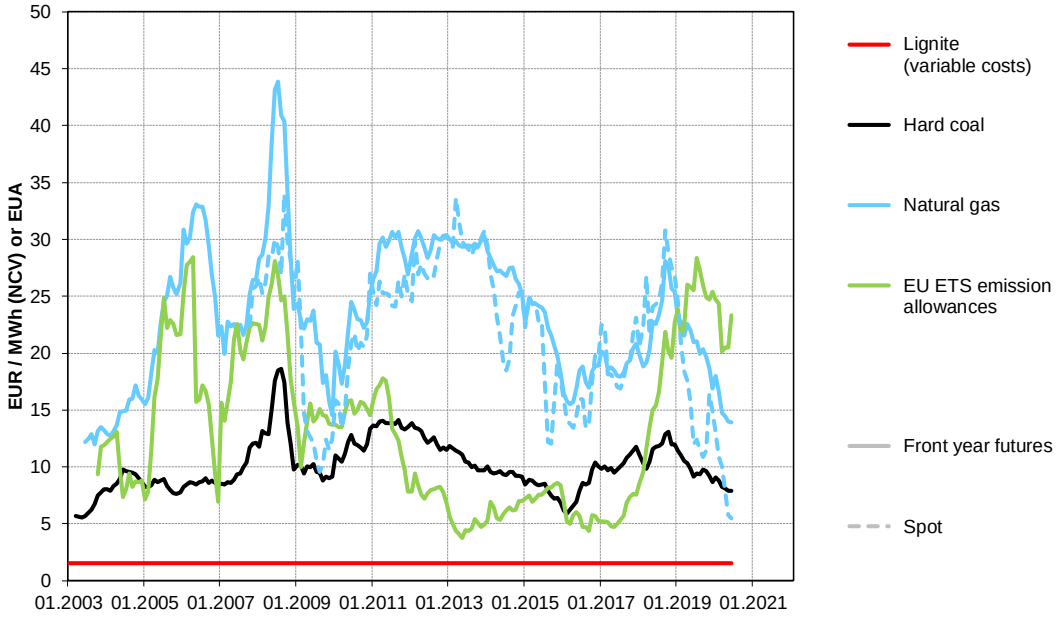
After an analysis of the historical data and trends in the market environment (Chapter 2) and the findings obtained from this on the profitability of the German lignite power plants (Chapter 3), an additional analysis will be carried out of the proposal for a rule-based compensation model and the important influencing factors for justifiable compensation payments, corresponding sensitivity analyses will be made and the results assessed in terms of the currently planned flat-rate compensation for the final power plant shutdowns by 31.12 2029 (Chapter 4). The concluding Chapter 5 summarises the important findings from the analysis.

2. The market environment

2.1. Energy and CO_2 prices

The electricity sector is a very price-sensitive segment of the economy. In contrast to other sectors (transport, building, etc.) the operating, investment and even decommissioning decisions in the electricity industry react very clearly to price signals. The main factors in this are developments in fuel costs but also the costs for the emission allowances of the EU ETS (CO_2 certificates) started in 2005.

Figure 2-1: Wholesale prices for futures and spot market supplies of fuels and CO_2 certificates, 2003–mid-June 2020



Source: EEX, ICE, Öko-Institut calculations

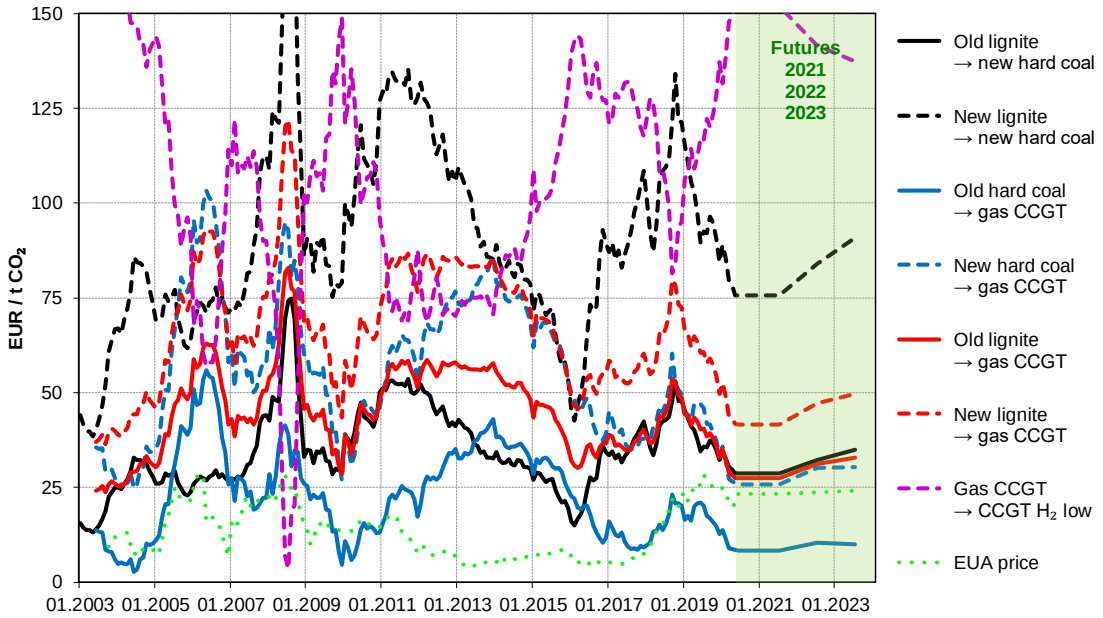
Figure 2-1 shows the development of the most important marker prices at the wholesale level since 2003:

- The prices for internationally traded fossil energy carriers show considerable fluctuations over the last 17 years; despite considerable differences in level and large variations in amplitude, the prices for natural gas and hard coal both have structurally similar dynamics;
- With the exception of the period from 2009 to 2018, the CO_2 prices also follow similar trends, but no such interrelationships are to be seen between 2009 and 2018;
- Since the start of 2019 in particular, the price developments for futures and spot market supplies for natural gas have become uncoupled, which may be mainly due to the oversupply of the natural gas market in Europe; at present the natural

gas spot prices have actually fallen below those for hard coal calculated on a comparable basis;

- The EU ETS CO_2 prices (as a monthly average value) in 2019 briefly regained the highest values of 2006 and 2008 at 30 €/t, but then declined to the values in the range of 20 to 25 €/t again;
- The short-term supply costs for crude lignite (which occur almost exclusively through internal transfer prices) were at a significantly lower level and remained largely constant over the last few decades, but need to be viewed in the context of the considerable fixed costs of the power plants and opencast lignite mines.

Figure 2-2: Fuel switching costs in the continental European electricity market, 2003–mid-June 2020



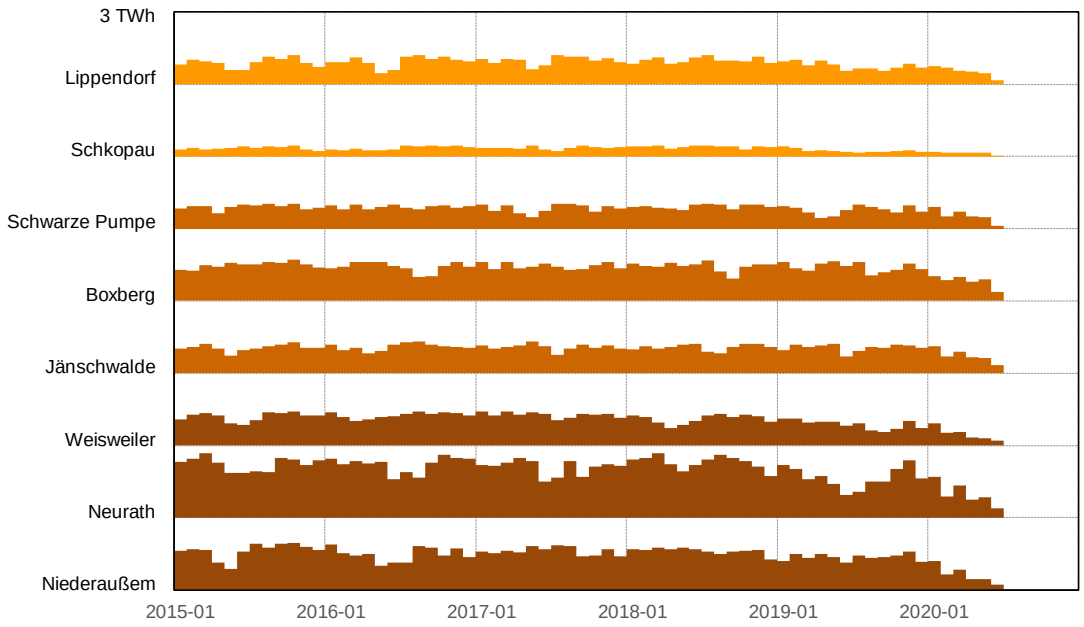
Source: EEX, ICE, Öko-Institut calculations

Using the example of fuel switching costs, Figure 2-2 illustrates that an isolated consideration of fuel or CO_2 costs is not meaningful. The CO_2 prices that were necessary to transfer electricity generation e.g. from coal to natural gas, were marked by a high volatility over the last 17 years. The overview also shows that it is only since 2019 that a market environment has arisen in which fuel and CO_2 prices produce a drop in emissions, which are a result of the replacement of electricity generation from inefficient hard coal power plants by advanced natural gas plants. It is this analysis of historical trends which shows how little point there is in basing climate protection strategies for the electricity sector on a single factor (politically driven decommissioning or CO_2 prices or the expansion of renewable energies).

2.2. Utilisation of German lignite power plants

In the lignite sector the new quality of the market environment has been demonstrated over the last two years in particular. While from 2015 to 2018 electricity generation in lignite power plants proceeded at a relatively constant level and was only subjected to fluctuations due to periodic maintenance work, etc., an entirely new development pattern has appeared since 2019.

Figure 2-3: Net monthly power generation of lignite power plant units currently operating in the market, 2015–mid-June 2020



Source: ENTSO-E, Öko-Institut calculations

Figure 2-3 illustrates the monthly production values for the eight largest German lignite power plants (each consisting of several power plant units). Only the electricity generated by the units which are currently still operating in the market was taken into account; the units taken off the market in recent years (e.g. via the security reserve for lignite power plants under Section 13g EnWG) were excluded and are not considered as a reason for production changes. Almost all lignite power plants have shown clear downward production trends since autumn 2019. In the months since March 2020, special effects from the Covid-19 pandemic have played an important role (particularly in terms of the decline in power consumption) but on closer examination, however, higher CO_2 prices, lower gas prices and the high feed-in of electricity from renewable energy plants are also important explanatory factors. With the exception of low gas prices (which can only be reliably estimated for short forecast periods), the three remaining explanatory factors (energy consumption, renewable power generation and the residual load requirement resulting from this, plus CO_2 prices) probably reflect a situation that will occur to an increasing degree and with ever greater strength going towards 2030.

3. Profitability of the German lignite power plants

3.1. Methodological approach

An established and widely used standard procedure in energy industry analysis was used to categorise the profitability of lignite power plants: the calculation of the contribution margins of a power plant in a specific market environment. This indicator, called the Green Spark Spread for natural gas power plants and Clean Dark Spread for hard coal power plants was developed further for lignite power plants and can therefore be called a Clean Brown Spread:

- The turnover of a specific power plant in the electricity market is derived from the wholesale price which is produced on the electricity exchange;
- The short-term operating costs (for fuels, CO_2 certificates, consumables for desulphurisation plants, etc.) which are directly avoided with a drop in production are deducted from this turnover;
- The fixed operating costs for the power plant (personnel, repairs and maintenance, etc.) and lignite opencast mines (personnel, repairs, modifications, etc.) have to be covered from this gross revenue as well as the restoration costs for opencast mines and the possible need to refinance investments.

For the predominant structures of vertically integrated companies in the lignite industry (the owners of opencast mines and power plants are identical), the costs for the fuel supply do not come from market prices but from internal transfer prices. This means that the short-term operating costs of opencast mining (power consumption, diesel and other fuels) are charged to the power plants which, in turn, have to cover not only the financing of their own fixed operating costs (personnel, repairs, etc.) from their revenues but also the relevant fixed operating costs of the opencast mine.

If the contribution margins on the fixed operating costs of power plants and opencast mines are not sufficient to cover these, the power plant and, ultimately, the opencast mine will be shut down (or if supplying several power plants from one opencast system, the extraction adjusted accordingly). This is carried out at a point when the opportunity arises to reduce the fixed operating costs (redundancies or transfer of personnel, avoidance of large repairs or maintenance, etc.). The opportunities this produces give rise over time to an increasing likelihood for such adjustments.

Besides the (avoidable) fixed operating costs, the contribution margins also have to bear the (sunk) investment and other fixed costs (e.g. for the opencast mine restoration). In contrast to the avoidable fixed operating costs (of the power plant and opencast mine) there are no decommissioning incentives if these costs can no longer be refinanced from the contribution margins, as this is in fact a case of sunk costs.

See Öko-Institut (2017) for a description and discussion of the details of profitability assessments, incentive and/or decommissioning mechanisms and the determination of contribution margins.

3.2. Results

Figure 3-1 and Figure 3-2 show the results of the analyses on the contribution margins of two typical classes of power plants for the period from the start of 2000 to mid-June 2020:

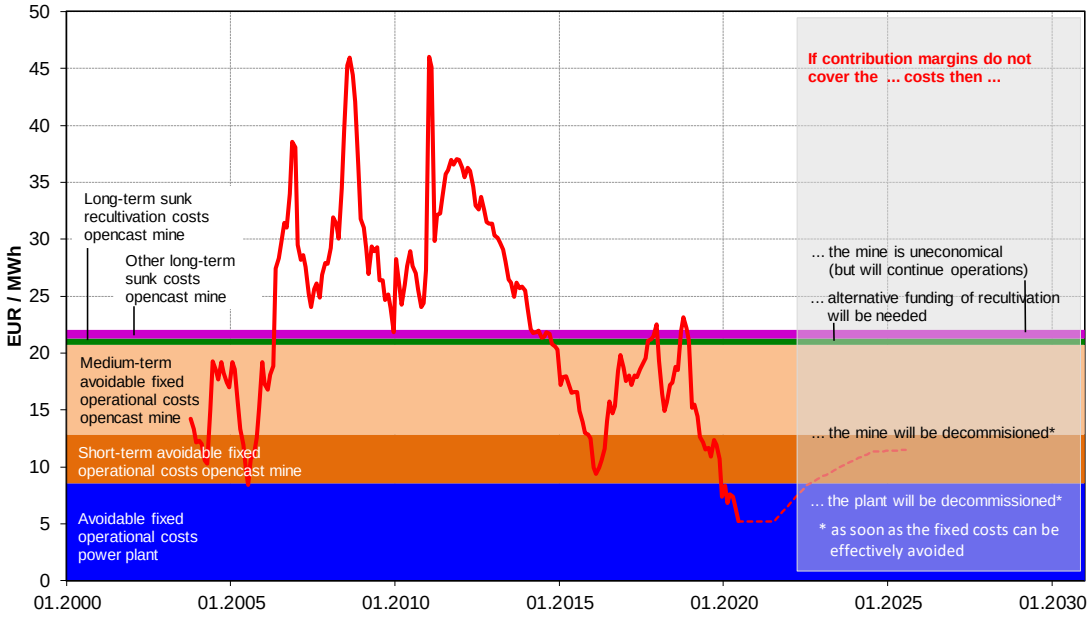
- On the one hand, for a power plant unit of the 500 or 600 MW class which was mainly constructed in the 1980s (as well as retrofitted in the 1990s in the case of the units in Lusatia) and which have utilisation levels of around 35% (the contribution margin indicator here is called LignIx35);
- On the other hand, for a power plant unit in the 900 MW class which was built new in 1995 and with a typical utilisation level of 42% (the contribution margin indicator here is called LignIx42).

The contribution margins measured in the historical market environment show considerable fluctuations when looked at in detail:

- From 2006 to 2014 there was a situation in which older lignite units were able to cover all the fixed operating costs and generate considerable surpluses. After a massive collapse of the contribution margins in 2016 (when none of the fixed operating costs of the opencast mine could be generated but the fixed operating costs of the power plant could be achieved in full), the contribution margins recovered again, but then fell rapidly from 2019 with declining electricity profits and increasing CO_2 prices, and are now at levels where the fixed operating costs of the opencast mines can no longer be covered and those of the power plant unit can only be covered in part. The current futures contracts (to 2026), however, anticipate a very slight easing of the profit situation. The foreseeable market environment will create massive decommissioning incentives for these plants, even in the short to medium term.
- Between 2006 and 2014, new lignite power plants were able not only to cover the fixed operating costs of the power plant and opencast mine, but also the prorata refinancing of investment costs. This situation also changed markedly in 2016 (for a short period): the contribution margins recovered up to 2018, then dropped significantly again and reached new depths from 2019. Currently, only about half of the fixed operating costs of opencast mining can be covered so that decommissioning incentives would tend to arise here in the medium-term.

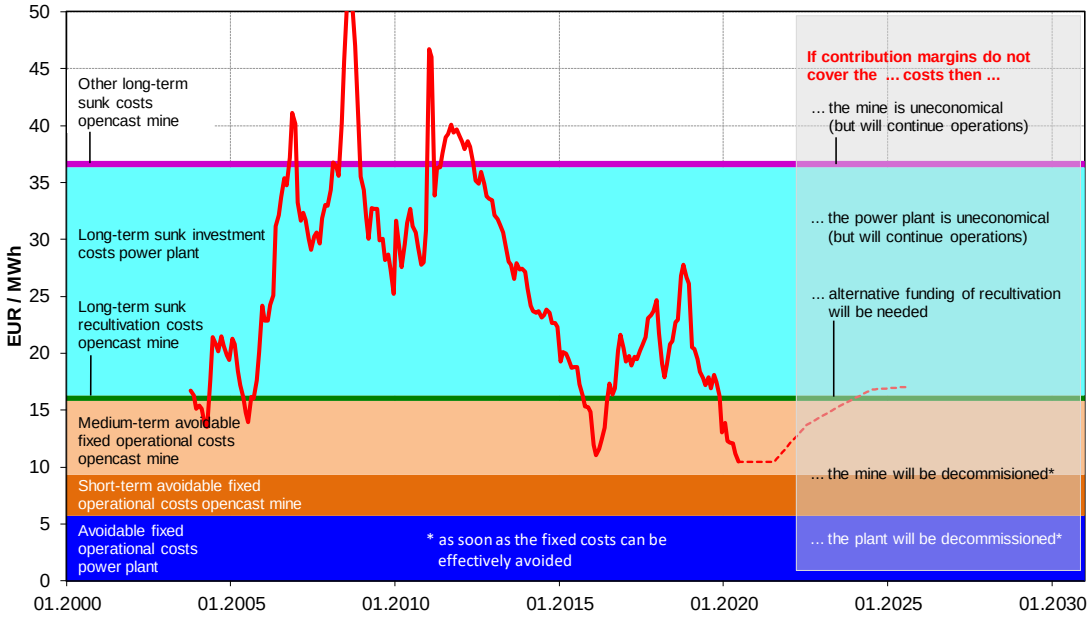
When assessing the above-mentioned contribution margins it should also be noted that, from 2005 to 2012, lignite power plants enjoyed considerable free allocations of CO_2 certificates as part of the EU ETS. Due to the market's clearly observable shifting of the opportunity costs for the free allocation of CO_2 certificates onto the electricity prices, considerable additional revenues (windfall profits) were produced for the operators of the power plants (Öko-Institut 2011), which were able to be used to cover costs and distribute profits. As the free allocation of CO_2 certificates for electricity producers under the EU ETS was completely discontinued from 2013, these types of additional revenues were accordingly lost.

Figure 3-1: Contribution margins of older lignite power plant units (LignIx35) in Germany, 2000 – mid-June 2020



Source: EEX, Öko-Institut calculations

Figure 3-2: Contribution margins of new lignite power plant units (LignIx42) in Germany, 2000 – mid-June 2020



Source: EEX, Öko-Institut calculations

3.3. Interim conclusions

Coal-based power generation in general and, over the last two years, electricity generation from lignite in particular, have come under increasing pressure in the German and continental European electricity markets, even beyond direct decommissioning policies (which in view of the various uncertainties are far from unnecessary).

- This results first from the international fuel market environment; but the medium-term price developments on the hard coal and natural gas markets remain unpredictable.
- Second, the price of CO_2 certificates is reaching levels that have a clear negative impact on the revenues of lignite power plants. This will be further intensified by the absolutely essential raising of the EU ETS emission goals in the 2020s as part of the European Green Deal.
- Third, the ongoing expansion of electricity generation from renewable energies increasingly reduces the marketing potential and therefore the profitability of electricity from lignite. From this point of view the current exceptional situation due to the Covid-19 pandemic with its major consequences, including for lignite-fired power generation, gives a preview of future increasingly frequent stressful situations.
- Fourth, due to the relevant European regulations (discontinuation of the allocation of free CO_2 certificates for electricity producers, suspension of capacity payments to coal-fired power plants under capacity instruments) there is a loss of the sources of additional profit that existed in the past or could exist in the future, which could lead to the erosion of the decommissioning incentives for coal-fired power plants (these kind of incentives are not part of the currently planned form of the decommissioning subsidies or the relevant payment modes in the context of a withdrawal from coal in Germany).

The fact that the coal-fired power plant operators very largely sell their production forward does not change the fundamental profitability problems described above. Plants in operation today profit via futures marketing (usually over up to three years) from the more adequate futures prices of 2 or 3 years ago. Futures marketing, however, merely postpones the problematic profitability situation but cannot fundamentally remove it. In this situation operators will only move or delay power plant and opencast mine shutdowns if they can argue for a reliable hope of the profit situation recovering. In the opposite situation it would be rational to reverse the agreed hedging transactions.

The completion of the withdrawal from nuclear energy in Germany in 2022 will be an important landmark for objectifying these kind of expectations. After this the decommissioning incentives will materialise, particularly in the course of periods when it is possible to avoid personnel adjustments (collective agreements, social plans, etc.) or larger maintenance, adjustment and similar costs for lignite power plants and/or mines.

4. Assessment of the planned compensation payments for lignite power plants in Germany

4.1. Background

The draft of the Kohleverstromungsbeendigungsgesetz (KVBG-E) (Coal-fired Power Generation Termination Act) envisages a clear shutdown plan for lignite power plants, setting a latest date for the shutdown of each power plant unit. Table 4-1 summarises these shutdown dates and the most important parameters of these plants.

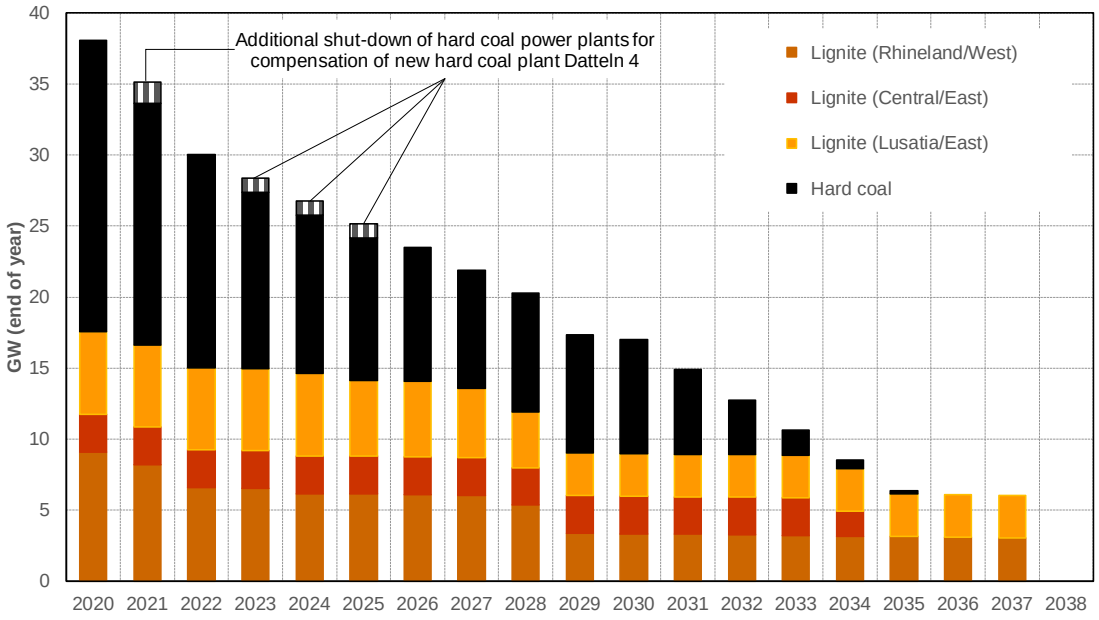
Table 4-1: The German lignite power plant units affected by the Coal Exit Law

Lignite power plant unit	Capacity (net)	Mining region	Lignite mine/ mine system	Shutdown date	Generation (net)	CO_2 emissions
					TWh	million t
Niederaußem C	295	Rhineland	Nord-Süd-Bahn	31.12.2021	1.7	2.2
Niederaußem D	297	Rhineland	Nord-Süd-Bahn	31.12.2020	1.7	2.1
Niederaußem G[a]	628	Rhineland	Nord-Süd-Bahn	31.12.2029	3.0	3.6
Niederaußem H[a]	648	Rhineland	Nord-Süd-Bahn	31.12.2033	3.3	3.8
Niederaußem K	944	Rhineland	Nord-Süd-Bahn	31.12.2038	6.5	6.6
Neurath A	294	Rhineland	Nord-Süd-Bahn	01.04.2022	1.7	2.1
Neurath B	294	Rhineland	Nord-Süd-Bahn	31.12.2021	1.3	1.7
Neurath D	607	Rhineland	Nord-Süd-Bahn	31.12.2022	1.7	2.0
Neurath E	604	Rhineland	Nord-Süd-Bahn	31.12.2022	3.2	3.7
Neurath F	1,060	Rhineland	Nord-Süd-Bahn	31.12.2038	5.6	5.5
Neurath G	1,060	Rhineland	Nord-Süd-Bahn	31.12.2038	6.6	6.5
Weisweiler E[b]	321	Rhineland	Inden	31.12.2021	1.9	2.4
Weisweiler F[b]	321	Rhineland	Inden	01.01.2025	1.1	1.4
Weisweiler G[c]	663	Rhineland	Inden	01.04.2028	3.1	3.9
Weisweiler H[c]	656	Rhineland	Inden	01.04.2029	4.3	5.3
Frechen	176[f]	Rhineland	Nord-Süd-Bahn	31.12.2022	0.5	0.8
Jänschwalde A[d]	465	Lusatia	Kohleverbindungsbahn	31.12.2028	3.5	4.2
Jänschwalde B[e]	465	Lusatia	Kohleverbindungsbahn	31.12.2028	3.4	4.1
Jänschwalde C	465	Lusatia	Kohleverbindungsbahn	31.12.2028	2.7	3.1
Jänschwalde D	465	Lusatia	Kohleverbindungsbahn	31.12.2028	3.2	3.7
Boxberg N	465	Lusatia	Kohleverbindungsbahn	31.12.2029	2.8	3.3
Boxberg P	465	Lusatia	Kohleverbindungsbahn	31.12.2029	3.7	4.3
Boxberg R	640	Lusatia	Kohleverbindungsbahn	31.12.2038	4.1	4.1
Boxberg Q	857	Lusatia	Kohleverbindungsbahn	31.12.2038	6.4	6.8
Schwarze Pumpe A	750	Lusatia	Kohleverbindungsbahn	31.12.2038	4.9	5.5
Schwarze Pumpe B	750	Lusatia	Kohleverbindungsbahn	31.12.2038	4.4	4.9
Schkopau A	450	Central Germay	Profen	31.12.2034	1.9	2.1
Schkopau B	450	Central Germay	Profen	31.12.2034	1.4	1.5
Lippendorf R	875	Central Germay	Vereinigtes Schleenhain	31.12.2035	4.8	4.6
Lippendorf S	875	Central Germay	Vereinigtes Schleenhain	31.12.2035	4.4	4.3

Notes: data for generation and CO_2 emissions as of 2019. - reciprocal option for Niederaußem G/H and security reserve from 31.12.2029 for the unit to be shutdown in 2033. - [b] reciprocal option for Weisweiler E/F. - [c] reciprocal option for Weisweiler G/H. - [d] security reserve from 31.12.2025. - [e] security reserve from 31.12.2017. - [f] shutdown of 120 MW

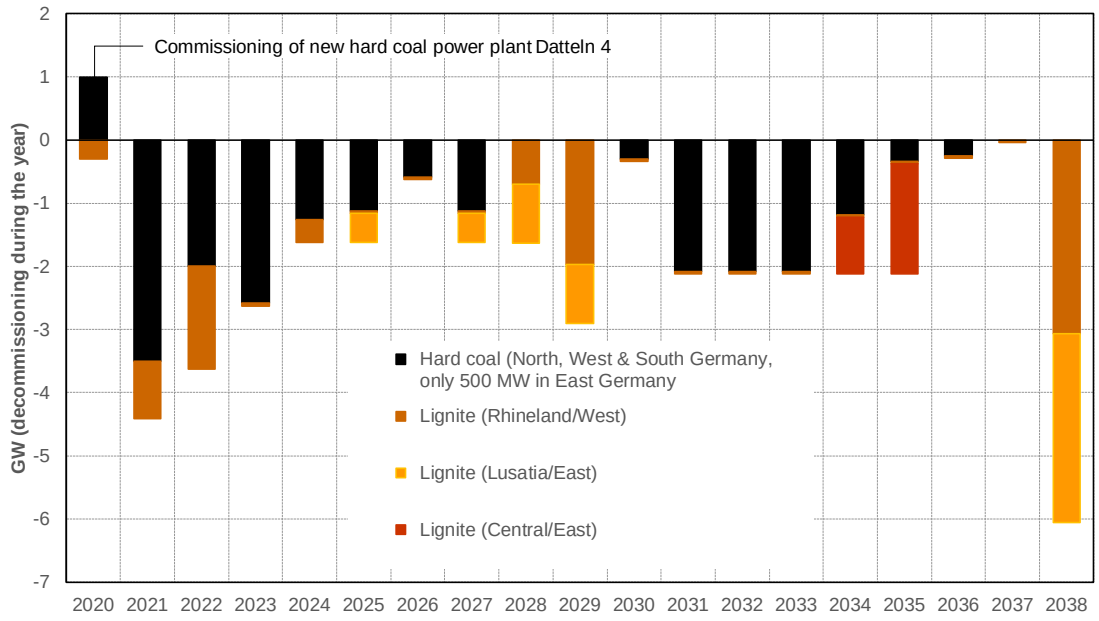
Source: German Federal Government, ENTSO-E, Öko-Institut calculations

Figure 4-1: Development of coal-fired power plant capacities (end of year), 2020-2038



Source: German Federal Government, Öko-Institut calculations

Figure 4-2: Annual change in coal-fired power plant capacities, 2020-2038



Source: German Federal Government, Öko-Institut calculations

The interaction of the various regulations of the Coal-fired Power Generation Termination Act gives rise to the picture shown in Figure 4-1 and Figure 4-2 for the German coal-fired power plants.

However, in the context of the general shutdown regulations for lignite power plant units, there are some specific details to note:

- Before final shutdown, some units are to be transferred to a security reserve in accordance with Section 13g EnWG. The plants concerned (Jänschwalde A and B plus Niederaussem G or H), while being taken out of the market and no longer producing (and emitting) in normal operation, will not be finally shutdown and will remain available until the final shutdown date and receive compensation for this to guarantee security of supply.
- The Frechen power plant will initially only be partially shut down (120 MW output of a total of 176 MW).
- Options have been created for some power plant units allowing them to swap their position in the sequence of shutdowns.
- Most power plant units are connected to larger opencast systems. In the Rhenish mining area, the Nord-Süd-Bahn connects the Hambach and Garzweiler 2 opencast mines; in Lusatia the coal rail link enables a relatively flexible supply from the Jänschwalde, Welzow-Süd, Nochten and Reichwalde opencast mines.
- However, some power plant sites are essentially only supplied by one opencast mine, meaning that a flexible supply is not possible or only within narrow limits. This applies to the Weisweiler site at the Inden opencast mine in Rhineland, the Lippendorf site and the Vereinigtes Schleenhain opencast mine and the Profen opencast mine which supplies the Schkopau power plant.

The Coal-fired Power Generation Termination Act allows for compensation for the legally prescribed shutdowns up to 31.12.2029. Shutdowns from 2030 will not be eligible for compensation:

- Compensation will therefore be due to the power plant units of Niederaussem C, D and G (or H), Neurath A, B, D and E, Weisweiler E to H, Frechen (part), Jänschwalde A to D and Boxberg N and P;
- No compensation will be available for the units Niederaussem H (or G), Niederaussem K, Neurath F and G, Boxberg R and Q, Schwarze Pumpe A and B, Lippendorf R and S and Schkopau A and B.

Under the concept of the KVBG-E, the shutdown compensation for the two companies involved, RWE and LEAG (as nominal amounts) will be determined at a flat-rate and paid out in 15 equal annual tranches.

- Compensation totalling € 2.6 billion is intended for RWE,
- The corresponding value for LEAG is € 1.75 billion.

However, against the background of the very volatile energy market and CO_2 pricing environment of the last few years and its likely continuance (cf. Chapters 2 and 3), it would appear highly questionable to determine the compensation payments as a flat rate and *ex ante*.

As an alternative to flat-rate compensation payments Matthes (2020b) proposes a rule-based method in which the changes in the energy and CO_2 markets can be reproduced with sufficient reliability.

According to this, compensation payments for the final shutdown of lignite plants should be made per unit using the following formula:

$$V_i = \sum_{t=T_i}^{T_i+VS_i} \left\{ \left[P_t + RD_i + RE_i + O_i + W_i - \left(RHB_i + \frac{C_i}{E_i} * EUA_t \right) \right] * E_i - FHIST_i + PK_i \right\} + UT$$

Where the symbols are defined as follows:

V_i *the total compensation that an operator receives for a plant i due for closure,*

i *the plant due for closure*

t *the year from that of final shutdown,*

T_i *date of the obligatory shutdown of the power plant unit i,*

VS_i *bringing forward the shutdown of the power plant unit i, usually by 3 years, for power plant units which are supplied by the Inden opencast mine, at most the period from the date of obligatory shutdown of the power plant unit until 2030,*

P_t *the calculated annual average price of all available trading days in the period from 1 July of the year T-1 to 30 June of the year T, for each year of the early shutdown t, for the Phelix-Base-Futures in the futures market of the European Energy Exchange AG stock market in Leipzig, for the relevant price zone in euros per megawatt hour,*

RD_i *the revenues demonstrated by the operator for a plant i due to be shut down, for feed-in adjustments under Section 13a EnWG as an annual average for the period July of year T-2 to June of year T 1 in euros per megawatt hour,*

RE_i *the balancing energy revenues demonstrated by the operator for a plant i due to be shut down, as an annual average for the period July of year T-2 to June of year T 1 in euros per megawatt hour,*

O_i *the optimisation additional revenues demonstrated by the operator for a plant i due to be shut down, for the period July of year T-2 to June of year T 1 compared to the annual average spot market price as an annual average for the period July of year T-2 to June of year T 1 in euros per megawatt hour,*

W_i *the heat supply revenues demonstrated by the operator for a plant i due to be shut down, as an annual average for the period of July of year T-2 to June of year T 1 in euros per megawatt hour,*

RHB_i *the short-term variable operating costs for fuels, logistics and other raw auxiliary and operating materials for generating one megawatt hour of electricity demonstrated by the operator of a plant i due to be shut down, as an annual average of the years 2018 and 2019 in euros per megawatt hour; for internal company related supplies and services any margins are excluded (elimination of intra-company results); if the power plant operation and opencast mine operation are*

are owned by different companies, the variable mining and logistics costs of the opencast mine companies for fuels and logistics are to be taken into account,

C_i *the carbon dioxide emissions for generating the energy output Ei demonstrated by the operator of a plant i due to be shut down, as an annual average of the period July of year T-2 to June of year T 1 in tonnes of carbon dioxide,*

E_i *the quantity of electricity delivered to the general supply grid and the company's own supply network from the plant to be shut down (net electricity generation) demonstrated by the operator of a plant i due to be shut down, as an annual average of the period July of year T-2 to June of year T 1 in megawatt hours,*

EUA_i *the calculated annual average price of all available trading days in the period from 1 July of the year T-1 to 30 June of the year T, for each year of the early shut down t, for the emission allowances (EUA) in the futures market of the European Energy Exchange AG stock market in Leipzig, for the relevant price zone in euros per megawatt hour,*

$FHIST_i$ *the fixed operating costs without opencast mining and logistics demonstrated by the operator for a plant i due to be shut down, as an annual average of the years 2018 and 2019 in euros,*

PK_i *the personnel costs of the plant i due to be shut down demonstrated by the operator of the plant i due to be shut down, as an annual average of the years 2018 and 2019 in euros, if it is proved that this item of the compensation amount is used entirely for the benefit of the relevant employees (personnel restructuring bonus), otherwise PKi amounts to zero euros,*

UT *proportional shutdown-related and correspondingly demonstrated restructuring and conversion costs of the opencast mines, calculated as a proportion of the delivered energy output of the plant i to the general supply grid and to the company's own supply network of the total delivered energy to the general supply grid plants and to the company's own supply network of all plants that were delivered by the opencast mine system as of 1 January 2020, as an annual average of the years 2018 and 2019.*

This compensation formula is closely aligned with the specifications for compensating the security reserve for lignite power plants under Section 13g EnWG, which in the past and in the KVBG-E should be done based strictly on the rules and taking the current environment into consideration. In comparison with the compensation regulation for the security reserve, some addition factors are taken into account:

- All specific compensation elements exclusively for the security reserve under Section 13g EnWG are no longer applicable,
- The costs arising from the restructuring and conversion of the opencast mines affected by the phase-out of lignite will also be taken into account;
- A personnel restructuring bonus will be introduced to fund personnel adjustments.

In what follows this concept will be quantitatively analysed for all the power plant units under consideration. This analysis enables the plausibility of the previously negotiated

or planned compensation payments of € 2.6 billion for RWE and € 1.75 billion for LEAG to be checked for consistency.

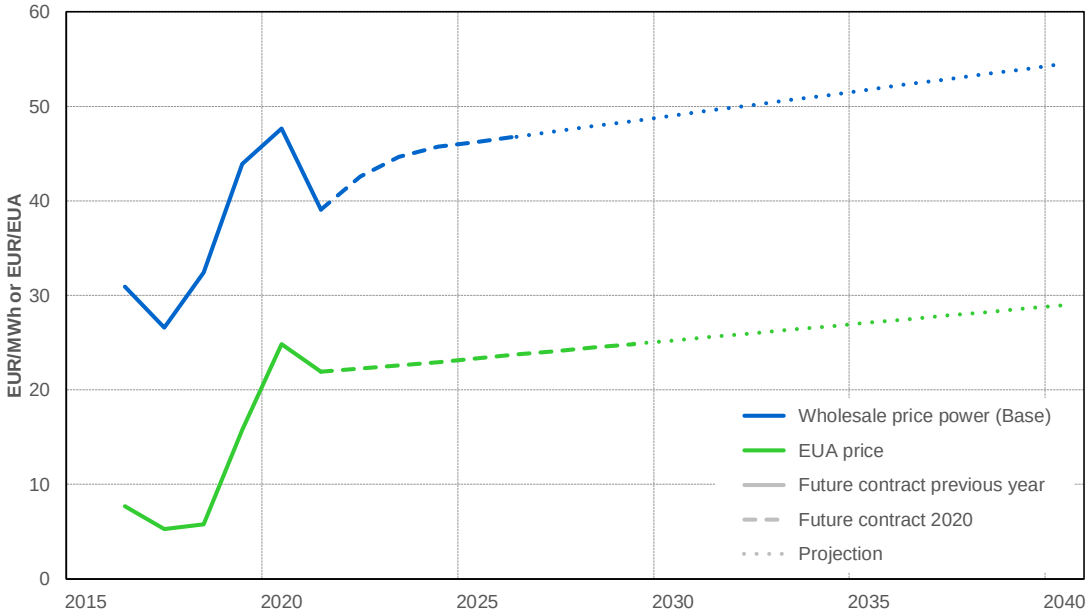
4.2. Input parameters for the calculations

A great deal of data have become available in the discussions on the future of the German lignite industry which can be used for the calculations. There are also completely up-to-date actual figures from the transparency data from the deregulated European electricity market and the EU ETS, and some very long-term contracts for futures supplies are being traded on the stock exchanges.

In view of this, the method on the detailed calculation of compensation payments described in Chapter 4.1 is being implemented with the following parameters:

- The historical production data for the individual lignite power plant units were obtained from the transparency data of the association of European Transmission System Operators (ENTSO-E);
- The historical emission data were obtained from the EU ETS transparency data;
- The continuation of the production data and CO_2 emissions was based on current modelling studies by the Öko-Institut (2019) where, after the consequences of the Covid-19 pandemic have subsided, an increase in generation can be assumed from 2021 so that by roughly 2022 utilisation will again occur at pre-crisis levels. In the wake of increasing proportions of renewable energies plus rising CO_2 prices by 2030 this will then decline for those power plants still in operation by a rather conservative estimate of an average of 10% (this utilisation is also based on the lignite demand shown in Figure 4-4);
- For the wholesale prices of base load electricity supplies (which will be employed before the final shutdown using the average of the three year period), data are available from the EEX energy exchange for futures supply contracts traded up to 2026. This makes use of the relevant average of the trading days for the period from the start of January 2020 to mid-June 2020 and there will be a continuation with a similar dynamic from 2027 (Figure 4-3);
- For the prices of EU ETS CO_2 certificates (EUA) (which are also used in the calculations for the average of the three year period before shutdown) EEX current prices for supplies up to and including 2029 are reported which were calculated and extrapolated in a similar way to the electricity prices (Figure 4-3);

Figure 4-3: Historical development for wholesale prices of electricity and EU ETS CO_2 certificates plus current futures contracts, 2015-2040



Source: EEX, , Öko-Institut calculations

- As part of grid congestion management, the operators of power plants receive what are known as redispatch payments to compensate for the curtailment of their power plants (which then results in a lower utilisation). From the relevant data this gives an average additional revenue of € 0.51 (indexed to the net electricity generation of one megawatt hour) which is being kept constant for the future (this is based on the – rather conservative – assumption that the increasing generation from wind and solar energy, particularly in North Germany, will compensate the declining trend of redispatch costs through an expansion of the grid);
- Fossil power plants contribute to the balancing energy market and can gain corresponding revenues here; however, due to the increasing openness of the balancing energy markets, these revenues have fallen sharply over the last few years and were – again at a conservative estimate – held constant at the level of an additional revenue of € 0.29 (again indexed to net electricity generation);
- In addition to the profits in the electricity market, some power plant units also obtain additional revenues from heat supplies: amongst the units with a claim to compensation, this only applies to the Jänschwalde power plant to any notable extent, for which the two units were allowed corresponding additional revenues averaging 0.7 €/MWh (in relation to total net electricity generation);
- With falling utilisation in particular, lignite power plant units can on average obtain higher revenues than would be possible solely on the basis of the prices for base load contracts over all hours of the year. These optimisation revenues in the electricity market have increased relatively constantly over the last few years

and were extrapolated accordingly so that in 2030 the specific revenues from electricity generation increase to a value of 15% above the price for base load supply contracts;

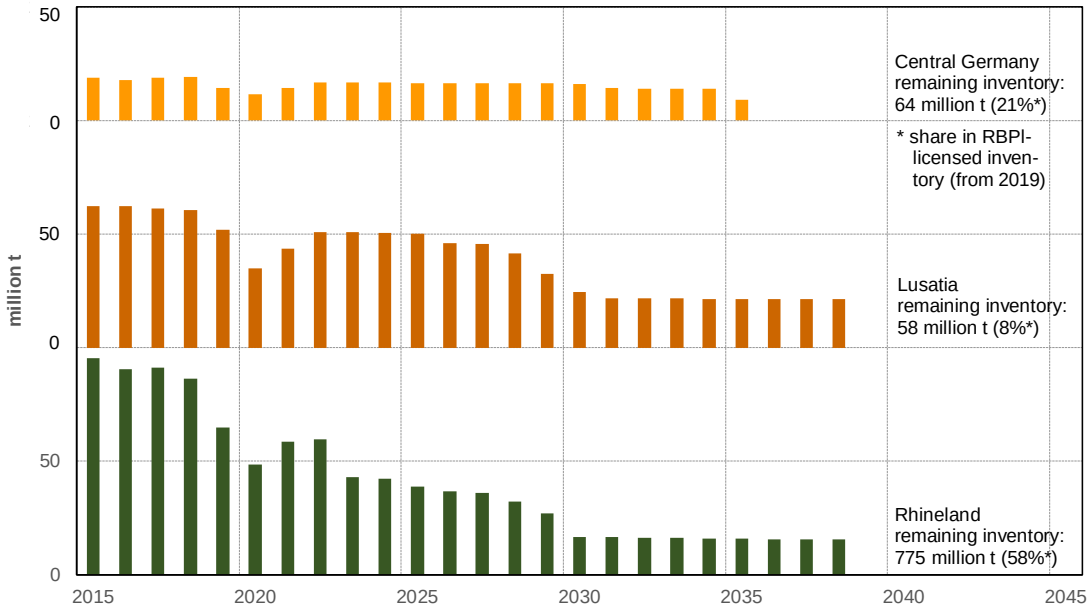
- For the fixed power plant operating costs, short-term marginal costs for the energy value of the supplied lignite of 1.5 €/MWh were used plus additional costs for the operation of flue gas desulphurisation plants etc. of around 2 €/MWh of net electricity generation;
- For the fixed operating costs (personnel, repairs and maintenance work, etc.), values of 60 €/kW were used for the older plants and 40 €/kW for the newer ones;
- For determining the personnel restructuring bonus, a value of 22 €/kW was used for the older plants and one of 12 €/kW for the newer plants (for which the personnel restructuring bonus is not applicable due to the late shutdown dates);
- Finally, the assumption about the period by which the power plant shutdown is brought forward under the KVBG-E plays an important role. Although considerable doubts remain about bringing forward the closure dates, particularly for the older power plant units in Lusatia (Matthes 2020a), a shutdown accelerated by three years was generally used. A few exceptions to this are the units of the Weisweiler power plant supplied by the Inden opencast mine for which an allowance was made because their operation was scheduled only as long as 2030 at the latest.

There is a special situation as regards the compensation costs for the opencast mine adjustment costs:

- Without doubt there are relevant costs for the adjustment of the Hambach/Garzweiler opencast system: however, there are no reliable costings available yet, so that on the basis of our own estimates, two variants were calculated with adjustment costs of € 1 billion and € 2 billion respectively which were split between the power plant units of the Nord-Süd-Bahn system entitled to compensation in line with their (historical) share of the supply;
- In view of the fact that, for the LEAG, the mining rights with general operating plans for reserves approved for mining are almost completely depleted (Figure 4-4), no restructuring and conversion costs can be used here in terms of compensation.[1]

[1] In the discussions about the largely complete depletion of the reserves approved for mining through general operating plans by LEAG, it has been argued at times that lignite power plant utilisation would fall more sharply than assumed in the calculations presented here. If this is the case, then the amounts of compensation for the lost power plant operation must likewise be adjusted (and significantly downwards) so that the results presented in this overview can definitely be considered as reliable and on the conservative side in any case (in terms of a tendency to overestimate compensation amounts).

Figure 4-4: Development of raw coal mining in the three German lignite mining areas, 2015-2038



Source: Öko-Institut calculation

In order to classify the uncertainties for the various input variables, sensitivity calculations were carried out for all parameters, in which each parameter was increased or reduced by 20%.

4.3. Results

Table 4-2 shows an overview of the results for the model calculations for the compensation amounts.

- The level of compensation for RWE largely depends on the assumption made for the conversion costs for the opencast mine: an estimate of € 1 billion gives a total compensation of around € 1.66 billion, for conversion costs of € 2 billion, this value increases to approx. € 2.66 billion;
- For LEAG there is a compensation amount of around € 0.77 billion;
- Looking at the sensitivity calculations it appears that the effect of the assumptions for redispatch, balancing energy and heat supply revenues as well as the electricity market optimisation and short-term variable operating costs only play a very minor role;
- The assumptions for the fixed operating costs and personnel costs (which are, however, very well known due to the many discussions particularly on the climate contribution in 2015 and 2016 and in view of the KWSB in 2018) influence the result in the range of the low three-figure millions;
- Assumptions about the revenues from the electricity market (especially via the development in the wholesale prices) and the costs of CO_2 certificates have the most important influence on the results;
- The part of the compensation amount which is due to the proposal for the personnel restructuring bonus shown here is approx. € 0.29 billion for RWE and around € 0.18 billion for LEAG.

Bearing in mind the categorisation of these results gives rise to the following situation compared to the proposed compensation values:

- Under the currently foreseeable framework conditions, a compensation figure of € 2.6 billion for RWE only appears robustly justifiable if costs for the opencast conversion of approx. € 2 billion occur or can be demonstrated; in the variation with conversion costs of € 1 billion, the compensation would be around € 0.9 billion too high;
- For LEAG the planned amount of compensation in the currently foreseeable environment is around € 1 billion too high.

Table 4-2: Results of compensation calculations

	Sensitivity parameters	RWE Mine conversion costs € 1b	RWE Mine conversion costs € 2b	LEAG
		€ million		
Reference case		1,661	2,661	767
Sensitivity analyses				
Wholesale market power prices	+20%	+690		+551
	-20%	-334		-535
CO_2 prices	+20%	-277		-290
	-20%	+392		+290
Redispatch revenues	+20%	+7		+5
	-20%	-7		-5
Balancing services revenues	+20%	+4		+3
	-20%	-4		-3
Power market optimization	+20%	+66		+64
	-20%	-62		-64
Heat revenues	+20%	+0		+3
	-20%	+0		-3
Fixed operational costs	+20%	-132		-84
	-20%	+156		+84
Variable operational costs (w/o CO_2)	+20%	-80		-61
	-20%	+86		+61
Without personnel restructuring bonus		-293		-184

Source: Öko-Institut calculation

In view of the uncertainties in the development of the electricity and CO_2 prices, the following aspects must be taken into account:

- Increasing revenues and therefore increasing amounts of compensation arise from higher wholesale prices for electricity only if these are not largely driven by the CO_2 price but mainly by the developments on the international hard coal and natural gas markets and potentially a significantly reduced expansion of electricity generation from renewable energies; using the sensitivity for ±20% (i.e. ±10 €/MWh in 2030) the potential developments appear to be well covered;
- With higher CO_2 prices and no great changes in fuel prices for natural gas and hard coal, the revenues decline significantly. In view of the pending changes i.e. the more ambitions EU ETS in the context of the European Green Deal, the sensitivity for ± 20% (i.e. ±5 €/EUA in 2030) describes a rather conservative approach (with an isolated rise in the EUA price to € 40 in 2030, the compensation payments for RWE would reduce by around € 0.20 billion and for the LEAG by approx. € 0.57 billion[2])

Finally it must be pointed out that, besides the calculated compensation for the Jänschwalde A and B and Niederaussem G or H power plant units, there will also be payments for the planned transfer to the security reserve under Section 13g EnWG, which are calculated for periods of one year (Jänschwalde B), three years (Jänschwalde A)

[2] These differences mainly arise from the comparatively early shutdown of significant power plant capacity for RWE and with the trend for a late final shutdown of LEAG lignite power plant units.

and 4 years (Niederaussem G or H). The allowances for the security reserve in accordance with KVBG-E are logically determined using a clear rule-based formula while, for the shutdown compensation, it is planned to pay flat-rate amounts which have been determined with no transparency and are ultimately incomprehensible and at least partially very asymmetrical and implausible.

5. Conclusions

In Germany and Europe the energy industry environment for electricity generation as well as the prices for CO_2 certificates in the EU ETS have undergone huge changes over the last few years. After this impacted the coal-fired generating sector, and initially hard coal power plants in particular, the effects have now become obvious for lignite-fired power generation as well. Lignite-fired power generation is also in decline and, in the foreseeable future, older power plant units in particular will no longer be in a position to cover the fixed operating costs of the electricity generating plants plus the corresponding attributable fixed operating costs of the associated opencast mines. A glance at the historical development shows, however, that the framework conditions, at least in part, will not necessarily hold true in the medium and longer term. The approach proposed by the German Commission on "Growth, Structural Change and Employment" (KWSB) of a legally regulated reduction in capacity in the coal-fired power plant sector in addition to the market driven phase-out of coal-fired power generation is still a sound strategy, particularly in view of the necessity for robust emission reductions.

The politically intended (and recommended by a majority of the KWSB) compensation in the context of this kind of active capacity reduction strategy must nevertheless take appropriate account of the changing energy and CO_2 market environment. Under the regulations proposed in the KVBG-E, a suitable rule-based procedure is only to be followed in certain circumstances i.e. for the power plant units due to be transferred to a security reserve. For the major part of the plants to be finally shut down by 31.12.2029, the aim is for a non-transparently negotiated flat-rate compensation for the two power plant and opencast mine operators RWE and LEAG.

The analyses of the proposal for a rule-based (and generously designed) compensation model for these power plant units shows that this type of approach is easy to implement in terms of the regulations and is closely aligned to the compensation arrangements for the security reserve under Section 13g EnWG. The numerical analyses of this proposal also show that, under the foreseeable framework conditions, the intended flat-rate compensation payments of € 2.6 billion for RWE and € 1.75 billion for LEAG are not appropriate under any circumstances (LEAG) or only under particular conditions (REW, depending on the conversion costs for the opencast mines). For LEAG the difference between the – generously determined – rule-based compensation and the proposed flat-rate compensation amounts to approx. € 1 billion. For RWE, there is a similar difference of € 0.9 billion if the documented costs for the lignite mine adjustments amount to approx. €1 billion; if costs of € 2 billion are assumed here, compensation of approx. € 2.66 billion could be justified. The key influencing factors for the compensation calculated according to the rule-based method are thus – in addition to the conversion costs for the opencast mines in the Rhenish mining area – the revenues from the electricity market and the costs of emission allowances of the EU ETS. Corresponding sensitivity calculations show that there may be substantially larger changes in CO_2 costs in the context of the European Green Deal in the next few years than in electricity market revenues.

In view of the above, the planned flat-rate compensation for the decommissioning of German lignite-fired power plants must be regarded as a significantly misguided model, both conceptually and in terms of the levels of compensation payments envisaged, and the transition to rule-based compensation is urgently recommended.

6. References

6.1. Literature

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6.2. Data

Arbeitsgemeinschaft Energiebilanzen (AGEB): Stromerzeugung nach Energieträgern 1990-2019.

Bundesministerium für Wirtschaft und Energie (BMWi): Zahlen und Fakten, Energiedaten, Nationale und internationale Entwicklung.

Bundesverband der Energie- und Wasserwirtschaft (BDEW): BDEW Schnellstatistik.

European Network of Transmission System Operators for Electricity (ENTSO-E): Transparency Platform, Actual Generation per Generation Unit.

EPEX Spot: Market data, Power, Day ahead, Settlement Price.

European Energy Exchange (EEX): Market data, Natural Gas, Day ahead and Weekend, Settlement Price, NetConnect Germany (NCG).

European Energy Exchange (EEX): Market data, Coal, Calendar Year Future, Settlement Price, API 2 CIF ARA (Argus-IHS McCloskey).

European Energy Exchange (EEX): Market data, Physical Electricity Index (Phelix), Base, Calendar Year Future, Settlement Price, Market Area Germany/Luxembourg.

European Energy Exchange (EEX): Market data, Environmental Markets, European Emission Allowances Futures, Settlement Price.

EU Transaction Log (EUTL) des EU Emission Trading System (ETS).

Intercontinental Exchange (ICE): Market Data. Energy. Coal. Settlement Price. API2 Rotterdam Coal Futures.

PEGAS/European Energy Exchange (EEX): Market data, Natural Gas, Calendar Year Future, Settlement Price, NetConnect Germany (NCG).