A Foundation-Based Framework for Phasing Out German Lignite in Lausitz

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Contents

Executive Summary

Germany's ambitious targets for responding to climate change imply a phase-out of lignite—the highest carbon-emitting source of energy—by as soon as 2030.

The aim of this study is to explore whether the private sector can meet the cost of mine rehabilitation, to return sites to alternative, productive uses. IEEFA focuses here on a cluster of lignite mines in the Lausitz region of eastern Germany and their associated power plants. At the time of writing, these assets were in the process of transfer from the Swedish state-owned utility Vattenfall to a privately owned Czech consortium comprising Energetický a Průmyslový Holding (EPH) and PPF Investments Limited. The sale has triggered a discussion about a long-term strategy for the mines and power plants, making these assets a topical subject.

According to German law, mine operators are obliged to meet the cost of rehabilitation. However, we identify two key uncertainties. First, operators may fail to calculate these liabilities accurately and thus make inadequate provisions. Second, they may fail to accumulate sufficient funds to finance their obligations, as they fall due. A related question is whether parent companies can be held to account for their subsidiaries. IEEFA tests the first two questions by comparing the estimated rehabilitation liability of the Lausitz lignite mines with the cash flows of the associated power plants. In addition, we explore institutional frameworks for managing a phase-out, from 2018 to 2030.

Regarding institutional framework, we borrow from German approaches for the restructuring of nuclear power, hard coal and lignite, and propose that the Lausitz mine liabilities are managed by a foundation, perhaps the public company LMBV, which already has vast experience of cleaning up lignite mines and power plants in former East Germany. The owners of the mine and power plants would retain ownership and full responsibility for the mining liability, and provide the necessary financial resources.

Regarding cost, we reviewed the size of the mine rehabilitation liability, and compared this with the cash flow generation of the associated lignite power plants, to determine whether these could meet the clean-up costs. We found that Vattenfall may have under-estimated the scale of the rehabilitation costs, by nearly one half, at €1.4 billion versus up to €2.6 billion. We note that this higher figure is an upper estimate and approximation, based on historical data for clean-up costs and the area of the Lausitz mines. Such uncertainty regarding the scale of rehabilitation liability underlines an urgency for the German government to commission its own estimate, for the lignite mining sector, as it has for nuclear power clean–up costs.

The upper estimate for the rehabilitation liability may consume most of the calculated, cumulative discounted cash flows, or net present value (NPV), of the associated Lausitz lignite power plants, of €3.1 billion, threatening their viability.

Fortunately, the owners can ensure that they meet their rehabilitation obligations sustainably. Under the asset transfer from Vattenfall, the acquirers received €1 billion in cash attributed to the company. In addition, some €0.6 billion in capacity payments will accrue to two power

plant units, under a standby capacity reserve. IEEFA proposes that EPH and PPF Investments pay a half-share of these windfalls, at around €0.75 billion, upfront into the foundation, as a guarantee for mine rehabilitation. In addition, IEEFA proposes that the power plants pay a levy of €3/ MWh through the phase-out period, raising a further €1.5 billion. That is barely a quarter of an estimated average undiscounted cash flow of €11.79/ MWh through 2030.

Provided these funds were invested cautiously, they would comfortably meet the upper end of the estimated €1.4-€2.6 billion mine liability. This proposal would thus help avoid any prospect of a taxpayer-funded lignite bailout; lay a sustainable path for Germany to meet its climate goals; and allow the asset owners to operate their power plants profitably through the phase-out period.

Introduction

The lignite industry will most likely be an early casualty of efforts to build lower carbon, more flexible and smarter digital electric grids. There are both environmental and economic reasons for this. First, as one of the most polluting and highest carbon-emitting sources of power, lignite is coming under increasing pressure from climate policies intended to curb carbon emissions. Second, lignite-fired power plants are typically older, less efficient and less flexible than fossil fuel peers such as natural gas, making them less suitable for responding to the demands of a modern grid that is supplied more and more with intermittent renewable power.

This study suggests a reasonable approach to managing the transition, using the example of a privately-funded foundation ("Stiftung"). A similar approach is currently being applied to a phase-out of hard coal production in Germany and decommissioning of lignite assets in former East Germany. It has also been considered as an approach to nuclear phase-out.

The aim of the study is to demonstrate an economically viable timeline for phasing out lignite mining and lignite power generation in Germany, and in particular, to show how the private sector can bear the burden of costs of mine rehabilitation, in line with the "polluter pays principle". It is intended in part to expose the risk of default on rehabilitation responsibilities if operators do not put aside sufficient rehabilitation funds today and/or while the plants remain operational.

A transition from lignite will incur social costs: mining and energy companies will probably face higher costs or new regulatory limits, and employees and their families may face professional or physical dislocation. Managing the transition well will involve both protecting the vulnerable through compensation and by offering retraining for growth industries. Consideration of such social impacts is beyond the scope of this study.

Our analysis focuses on lignite mining and power generation in Lausitz, Eastern Germany. These assets were formerly owned by the Swedish state-owned utility, Vattenfall, and at the time of this writing were in the process of being transferred to a privately owned, Czech-based consortium, Energetický a Průmyslový Holding (EPH) and PPF Investments Limited. Vattenfall announced the sale in April 2016, and the Swedish state approved the deal on July 2. At this time of writing, the sale awaits European Commission approval, which is expected in the autumn of 2016.

IEEFA focuses here on the former Vattenfall assets because the topicality and controversy surrounding the sale has triggered much discussion regarding the costs of and the mechanism for a lignite phase-out.

Background: Sale of Vattenfall's Lignite Business

The Swedish state-owned energy company Vattenfall announced in April 2016 the sale of lignite and associated assets in Lausitz to a privately held, Czech-based consortium made up of EPH and PPF Investments Limited. Following is a brief overview of the transaction.

Assets

The sale of lignite mining and power operations in the Lausitz region of Eastern Germany from Vattenfall, a big Swedish power company, to a Czech-based consortium, EPH, and PPF Investments Limited, was announced in April 2016. Controversy surrounding the sale has triggered a discussion regarding the costs of and mechanism for a lignite phaseout.

The combined lignite mines and power plants are in Eastern Germany near the Polish border in the states of Sachsen and Brandenburg. The businesses employ approximately 7,500 people, and many more jobs are indirectly dependent on lignite in the local economy. They comprise the following assets:[1]

[1] Various financial reports were examined for this section of the report:
Vattenfall, 2016. Overview of Vattenfall's lignite operations (Slide 36). In: *Vattenfall Full year 2015 results*. Available at: https://corporate.vattenfall.com/globalassets/corporate/investors/presentations/2015/q4_presentation_2015.pdf

- **Five open-cast lignite mines in Lausitz**, with annual production of 60-65 million tonnes. The mines have a combined area of about 23,000 hectares, to be cleaned up, or rehabilitated, over time. We consider the mining area because the rehabilitation liability per unit area provides a useful benchmark for comparing average costs at different sites. The five Lausitz mines occupy the following land areas:[2]
    - Jänschwalde (6,015 hectares),
    - Nochten (4,825 hectares),
    - Welzow-Süd (9,000 hectares)
    - Reichwalde (1,131 hectares), and
    - the recently closed mine, Cottbus Nord (2,038 hectares).
- **Four lignite-fired power plants** (see Table 1). Three of the power plants, Jänschwalde, Boxberg and Schwarze Pumpe are in the Lausitz region and previously wholly owned by Vattenfall. The Lippendorf plant near Leipzig was 50% owned by Vattenfall. The combined generating capacity of the three wholly owned power plants, plus the 50% stake in the fourth, totals 7,595 megawatts (MW), net of power consumed on-site.

Vattenfall, 2016. *Press release: Vattenfall to sell German lignite operations*. April 18, 2016. Available at: https://corporate.vattenfall.com/globalassets/cision/documents/2016/20160418-vattenfall-to-sell-german-lignite-operations-en-0-2176615.pdf

Vattenfall, 2016. *Vattenfall Q2 and H1 Results 2016*. Available at: https://corporate.vattenfall.com/globalassets/corporate/investors/presentations/2016/q2_presentation_2016.pdf

Vattenfall, 2016. *Interim report January-June 2016*. Available at: https://corporate.vattenfall.com/globalassets/corporate/investors/interim_reports/2016/q2_report_2016.pdf

[2] Various sources were used for these estimated areas:

Parlament Brandenburg Ordinance, 2004a. *Verordnung über den Braunkohlenplan Tagebau Cottbus-Nord*. Available at: http://bravors.brandenburg.de/de/verordnungen-212413

Parlament Brandenburg Ordinance, 2004b. *Verordnung über den Braunkohlenplan Tagebau Jänschwalde*. Available at: http://bravors.brandenburg.de/de/verordnungen-212412

Parlament Brandenburg Ordinance. 2004c. *Verordnung über den Braunkohlenplan Tagebau Welzow*.

RPV Oberlausitz-Niedersachsen (1994a): *Braunkohlenplan Tagebau Nochten*. Bautzen.

RPV Oberlausitz-Niedersachsen (1994b): *Braunkohlenplan Tagebau Reichwalde*. Bautzen.

Table 1. Lignite-fired power plants transferred to EPH and PPF Investments

Power plant	Unit	Federal state	Start date, year [3]	Net capacity MW[4]	Heat used[5]	Efficiency[6]	gCO2/ kWh [7]	Mothball date [8]
Boxberg	N	Sachsen	1979	465	Y	35.0%	0.964	N/A
Boxberg	P	Sachsen	1980	465	Y	35.0%	0.964	N/A
Jänschwalde	A	Brandenburg	1981	465	Y	35.5%	1.163	N/A
Jänschwalde	B	Brandenburg	1982	465	Y	35.5%	1.163	N/A
Jänschwalde	C	Brandenburg	1984	465	Y	35.5%	1.163	N/A
Jänschwalde	D	Brandenburg	1985	465	Y	35.5%	1.163	N/A
Jänschwalde	E	Brandenburg	1987	465	Y	35.5%	1.163	2019
Jänschwalde	F	Brandenburg	1989	465	Y	35.5%	1.163	2018
Schwarze Pumpe	A	Brandenburg	1997	750	Y	41.2%	0.983	N/A
Schwarze Pumpe	B	Brandenburg	1998	750	Y	41.2%	0.983	N/A
Boxberg	Q	Sachsen	2000	857	Y	42.3%	1.159	N/A
Lippendorf	R	Sachsen	2000	875	Y	42.8%	0.949	N/A
Boxberg	R	Sachsen	2012	640	N	43.9%	1.159	N/A

- **9.4 billion Swedish Krona (€1 billion) in cash.** In its Q2 2016 report,[9] Vattenfall stated that alongside its lignite business, it would transfer some Swedish Krona (SEK) 9.4 billion in cash (€1.01 billion [10]), to the consortium of EPH and PPF Investments. Under the contracted terms, the buyers would not be able to extract cash from the business for three years, and extract cash only as a result of profits from normal operations for a further two years.[11] Vattenfall stated that the cash was "attributable to the (lignite) Company." The company made no statement on how the sum of cash was agreed

[3] Energy Brainpool, 2015. *Appendix 1*
[4] Energy Brainpool, 2015. *Appendix 1*
[5] Federal German Ministry of Energy. *German Power Plant List.* 2016. Available at: http://www.bundesnetzagentur.de/cln_1911/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Versorgungssicherheit/Erzeugungskapazitaeten/Kraftwerksliste/kraftwerksliste-node.html
[6] Energy Brainpool, 2015. *Appendix 1*
[7] E3G, 2015. *Vattenfall's Lignite Business: A risky bet for investors*. Available at: https://www.e3g.org/docs/Vattenfall_Report_E3G.pdf
[8] European Commission, 2016. *State Aid: Germany Closure of German lignite-fired power plants*.
[9] Vattenfall, 2016. *Interim report January-June 2016*.
[10] A euro/SEK exchange rate of 0.107 is applied throughout this study, and corresponds with the average exchange rate both in 2015 and Q1 2016
[11] Vattenfall, 2016. *Press release: Vattenfall to sell German lignite operations*.

upon, nor any conditions on how it could be spent, beyond the time constraints. We note that no clean power spread hedges were transferred, exposing the business to wholesale power and carbon prices. In answer to a question on the purposes of the cash and of the five-year lock, Vattenfall's head of investor relations told the authors: "It stabilises the prospects of the business. It (the five-year lock) is a comfort for the employees." [12]

- **Cash to accrue to the lignite business, under a "standby capacity reserve"** In 2015, Vattenfall agreed with the German government to place 2 of its 13 lignite power plant units in a "standby capacity reserve."[13] In all, some 2.7 gigawatts of German lignite power plants will be paid some €1.61 billion from 2016-2023 for participating in the reserve. Vattenfall's pro rata share, by capacity, would be €0.56 billion.

Liabilities

At the time of the announcement of the sale, Vattenfall stated that the transfer of its lignite business to EPH and PPF Investments would include "all its liabilities and provisions." In its Q2 2016 report, the company stated that the vast bulk of these were "provisions for mining operations, other environment-related provisions, and provisions for pensions," totalling SEK 16.5 billion (€1.77 billion).

In its Q2 report, Vattenfall did not disaggregate this total figure. In email correspondence with IEEFA, the Vattenfall investor relations department elaborated the breakdown, including a mining rehabilitation provision of SEK 13.2 billion (€1.41 billion), see Table 2 below.[14]

Table 2. Breakdown of Lausitz lignite liabilities

	SEK, bln	€, bln
Mining rehabilitation	13.2	1.412
Environment	0.9	0.096
Pension provisions	0.8	0.086
Other	1.6	0.171
TOTAL	16.5	1.766

[12] Telephone conversation with Vattenfall's head of investor relations, Johan Sahlqvist, on August 9 2016.
[13] European Commission, 2016. *State Aid: Germany Closure of German lignite-fired power plants*. Available at: http://ec.europa.eu/competition/state_aid/cases/261321/261321_1762503_157_2.pdf
[14] Vattenfall investor relations disaggregated the figure for this study, in email correspondence with the authors on August 10 2016

The Seller: Vattenfall

Vattenfall is wholly owned by the Swedish state and is one of Europe's largest generators of electricity.[15] The company's main markets are Sweden, Germany, Finland, the Netherlands and Denmark, and its main products are electricity, heat and gas. In electricity and heat, Vattenfall works in all parts of the value chain, from generation to distribution and sales. In gas, it is active in sales. The company also has an energy trading operation. The company has 6.2 million electricity customers and 2.1 million gas customers, and about 28,600 employees.

In 2015, Vattenfall generated some 173 terawatt hours (TWh) of electricity. Lignite was its single biggest source of power generation, at 55 TWh, and is entirely sourced from the assets that are in the process of transfer to EPH and PPF Investments. Half the company's entire generation was thermal fossil fuel-based power. The other half was divided almost equally between nuclear and hydropower, with a small fraction of renewables, at 4%. Vattenfall's lignite also produced some 5.5 TWh of heat, equivalent to more than a fifth of the company's total heat output.

The Buyers: EPH and PPF Investments

Energetický a Průmyslový Holding (EPH) is a privately-owned, Czech-based company, formed in 2010 by the financial firm J&T Finance Group SE. According to the company's website, two individuals, Daniel Křetínský and Patrik Tkáč, hold two thirds of EPH voting rights, with the balance of shares owned by J&T.[16] EPH operates in the Czech Republic, Slovakia, Germany, Italy, Britain, Poland and Hungary. The group comprises more than 50 companies operating in coal extraction; electricity and heat production from conventional and renewable sources; gas, electricity and heat distribution; energy trading; and sales. In aggregate, EPH employs about 12,000 people.[17]

Prior to completion of the purchase of Vattenfall's German lignite assets, EPH's portfolio of power-generating assets comprised: 4,026 megawatts (MW) of gas; 2,598 MW of hard coal; 790 MW of lignite; 420 MW of dedicated biomass (in the process of conversion from hard coal); and 25 MW of variable renewable power.[18] According to the company's 2014 annual report, EPH had additionally acquired a 95% stake in three gas-fired combined heat and power units in Hungary, with a combined thermal capacity of 1,182 MW.

PPF Investments is a Czech-based private equity firm with a single controlling shareholder, Tomas Brzobohaty.[19] The company's website provides no further information.

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[15] Vattenfall, n.d.. *Vattenfall at a Glance*. Available at: https://corporate.vattenfall.com/globalassets/corporate/investors/vattenfall-in-brief_2015.pdf
[16] EPH, n.d.. *Shareholding Structure*. Available at: http://www.epholding.cz/en/investors/shareholding-structure/
[17] EPH, n.d.. *Facts and Figures*. Available at: http://www.epholding.cz/en/about-us/facts-and-figures/
[18] EPH, n.d.. *Power Generation*. Available at: http://www.epholding.cz/en/segments/electricity-generation/
[19] PPF Investments, n.d.. *Who We Are*. [Accessed on August 15]. Available at: http://www.ppfinvestments.com/

Controversy Over the Transfer

Environmental groups including Greenpeace, E3G, BankTrack, urgewald and Friends of the Earth, have criticised the opacity of EPH and PPF Investments. These critics argue that poor transparency—compared for example with Vattenfall—may lead to weaker commitments to social and environmental mitigation, including the long-term rehabilitation of lignite mines and a shift towards less carbon-emitting sources of electricity.

In the wake of the transaction announcement, Greenpeace noted a lack of annual reporting by PPF Investments, which publishes no detailed financial information.[20] The most recent detailed financial reporting by EPH was for the calendar year 2014, published in December 2015, nearly 12 months after the end of the reporting period. Greenpeace suggested that the registration of both PPF Investments and various EPH holding companies in tax havens including Jersey and Cyprus further reduces transparency and accountability. Regarding the company's commitment (or lack thereof) to social governance, Greenpeace highlighted the European Commission's past conviction of EPH for obstruction of an antitrust investigation.

A group of environmental organisations in July wrote an open letter to banks that have participated in loans to EPH. They highlighted how the acquisition would make EPH the third-most polluting electric utility in Europe. They argued that the acquisition suggested a strategy to expand fossil fuel use[21] and they argued that banks committed to divesting from high-carbon assets should stop supporting EPH.

Arguments for a German Lignite Phase-out

There are both economic and environmental arguments for reducing the proportion of lignite in the power generation mix in Germany.

Economics

Lignite-fired power plants have higher operating margins than fossil fuel peers in Germany, as measured by clean dark spreads, which account for variable mining and power plant costs, and that exclude fixed costs such as investment and maintenance. Table 3 shows how lower fuel costs and low carbon prices (European Union allowances, EUAs) benefit lignite compared with natural gas and hard coal. As a result, lignite comes higher in the so-called merit order of power plants that dispatch electricity to the grid, and higher capacity factors

[20] Greenpeace, 2016. *Nice and Clean? Does EPH meet Sweden and Vattenfall's ethical standards?* Available at: https://blog.campact.de/wp-content/uploads/2016/06/Nice-and-Clean-Final-report-Eng.pdf

[21] E3G, 2016. *Environmental organisations call on major European and American banks to stop bankrolling EPH*. Available at: https://www.e3g.org/news/media-room/environmental-organisations-call-on-major-european-and-american-banks-to-st

(the number of hours power plants operate annually), even though they are less efficient and more polluting.

Table 3. Illustrative German clean power spreads: lignite, coal and natural gas, €/MWh*

Units: €/MWh electricity	Hard coal	Natural gas	Lignite
Wholesale power price [22]	27.0	27.0	27.0
Fuel cost	18.6[23]	33.0 [24]	4.3 [25]
EUA cost [26,27]	5.6	2.4	6.0
Clean spread	**2.8**	**-8.4**	**16.7**

*Assumes 2017 futures prices for carbon permits (EUAs), of €6 per tonne of CO2 emissions, and wholesale power prices, of €27/MWh; industry and market estimates for fuel costs; operating efficiency of 35% for coal and lignite, and 50% for gas.

However, once additional, long-term fuel costs and fixed power plant O&M (operating and maintenance) costs are taken into account, the same lignite power plants may be loss-making, depending on their energy efficiency and capacity factor and on wholesale power prices.

At the time that it announced the prospective sale to EPH and PPF Investments, Vattenfall underlined the deteriorating economics of its lignite business. In April 2016, Vattenfall Chairman Lars Norstrom said that the sale was motivated by both financial and regulatory headwinds: "The financial reasons are obvious, given our views on current and expected price development and market conditions. Divestment is better than any hold scenario. We see some additional regulatory and financial risks, such as additional costs for re-cultivation; additional cost for restructuring; additional, maybe costly, negotiations with different stakeholders in Germany; and an increasing scepticism among financial institutions regarding CO2-heavy industries."[28]

[22] EEX, n.d.. *Phelix Power Futures, EEX Power Derivatives*. Available at: https://www.eex.com/en/market-data/power/futures/phelix-futures#!/2016/08/03
[23] EEX, n.d.. *API-2-CIF-ARA-(Argus-HIS McCloskey)-Coal Futures, European Energy Exchange*. Available at: https://www.eex.com/en/market-data/coal/derivatives-market/api-2-cif-ara-argus-ihs-mccloskey-coal-futures#!/2016/08/03
[24] ICE Endex, n.d.. *German NCG Gas Futures*. Available at: https://www.theice.com/products/27996810/German-NCG-Gas-Futures/data
[25] VGB PowerTech, 2015. *Levelised cost of electricity, Issue 2015*. Available at: https://www.vgb.org/en/lcoe2015.html?dfid=74042
[26] Thomson Reuters Point Carbon, 2016. Email communication with Point Carbon analysts, July 2016
[27] International Energy Agency (IEA), n.d.. *Unit Converter*. IEA, Paris. Available at: https://www.iea.org/statistics/resources/unitconverter/
[28] Vattenfall, 2016. *Investor and analyst conference call*. April 18 2016. Available at: https://corporate.vattenfall.com/press-and-media/press-releases/2016/vattenfall-to-sell-german-lignite-operations/

Unusually, Vattenfall provided separate financial figures for the lignite unit, in its first half 2016 results, ahead of the sale to EPH and PPF Investments.[29] In the first six months of 2016, electricity revenues at the lignite business were down more than 20%, year on year, while sales rose across Vattenfall as a whole. Funds from operations (sales minus variable costs and excluding impairment losses) fell by nearly 30% to SEK 0.9 billion, compared with a 10% rise across Vattenfall. Chief Financial Officer Ingrid Bonde concluded: "The lignite operations are having a tough financial time. That was the rationale for us divesting it."[30]

Climate Policy

The "additional regulatory risks" Norstrom referred to include climate policy. Coal is the highest carbon-emitting source of energy in Germany, across all sectors, and lignite the highest carbon-emitting form of coal (See Table 4). Lignite is therefore under the most pressure from Germany's ambitious targets, to cut greenhouse gas emissions by 40% and 55% in 2020 and 2030 respectively, compared with 1990 levels.

Table 4. Carbon intensity of energy sources in Germany, tonnes of carbon per terajoule

Fuel	Carbon emissions per unit of energy (t C/TJ)
Lignite	30.26
Peat	27.76
Hard coal	26.36
Solid biomass	25.39
Waste	21.82
Gasoline	19.93
Natural gas	15.28

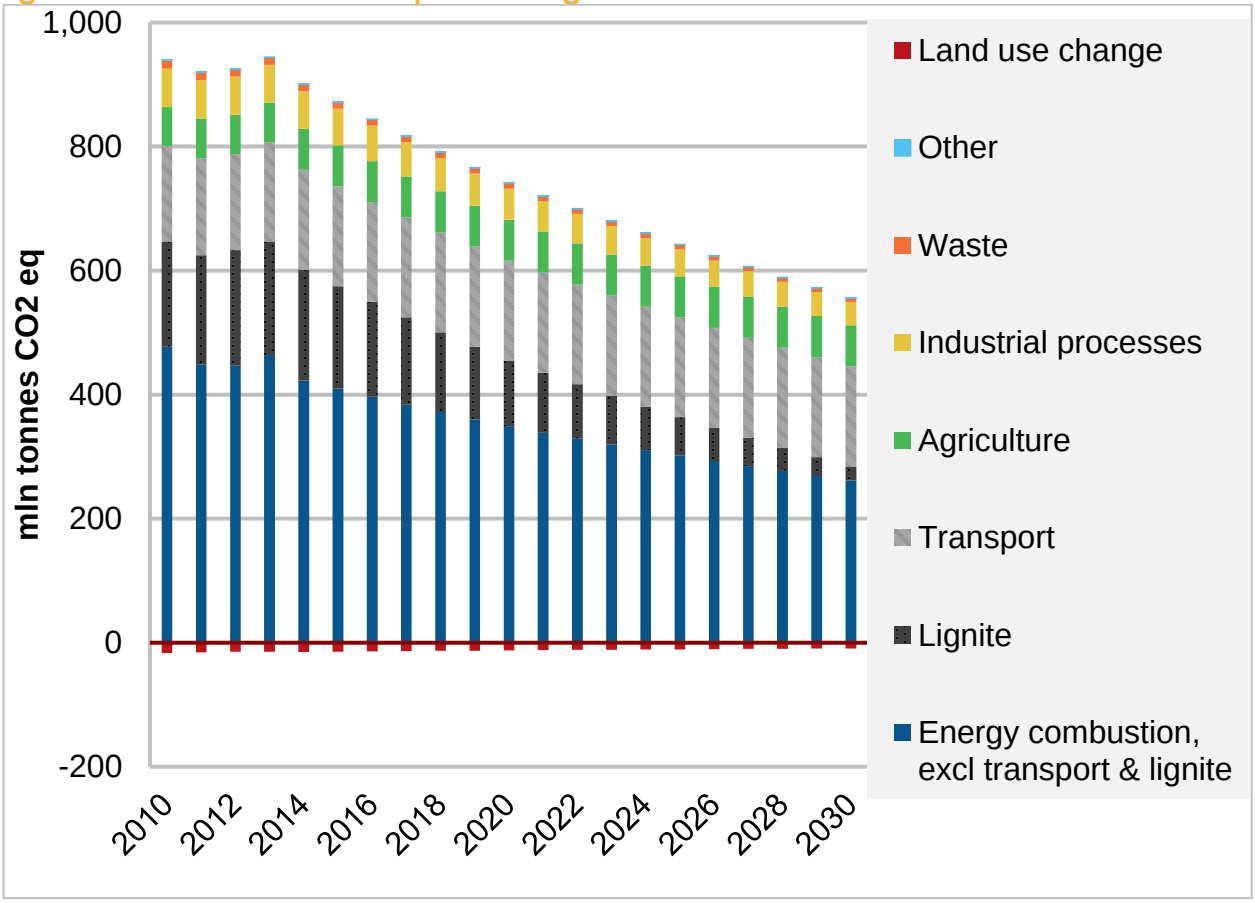
Source: UNFCCC [31]

In 2014, lignite accounted for 19% of Germany's national greenhouse gas (GHG) emissions, in carbon dioxide equivalent. As the most carbon-intensive fuel, lignite may therefore shoulder a relatively bigger burden of carbon emissions cuts. This is especially so given that lower-carbon alternatives already exist in power generation, such as natural gas and renewables, in contrast with the relative dearth of alternatives in transport and agriculture.

[29] Vattenfall, 2016. *Vattenfall Q2 and H1 Results 2016*. Available at: https://corporate.vattenfall.com/globalassets/corporate/investors/presentations/2016/q2_presentation_2016.pdf
[30] Vattenfall, 2016. *Webcast: Vattenfall Q2 and H1 Results 2016. July 21*. Available at: http://vattenfallwebcasts.creo.tv/160721/vattenfall_interim_report_january-june_2016
[31] United Nations Framework Convention on Climate Change (UNFCCC), 2016. *2016 Annex I Party GHG Inventory Submissions: Germany CRF (common reporting format).* Available at: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/9492.php

Figure 1 shows the sectoral impact of meeting Germany's 2020 and 2030 carbon targets, distributing mitigation pro rata across all sectors with the exception of transport and agriculture, whose emissions are held constant, and lignite, which makes up the resulting ambition gap. Sectoral mitigation in reality will depend on the costs of cutting emissions, and political and societal factors. However, the truth is that Germany's climate targets imply pressure on lignite.

Figure 1. Sectoral emissions to meet German climate action targets in 2020 and 2030, where lignite balances excess transport and agriculture emissions



Source: UNFCCC[32], IEEFA analysis

[32] United Nations Framework Convention on Climate Change (UNFCCC), 2016. *2016 Annex I Party GHG Inventory Submissions: Germany CRF*

Social and Environmental Implications of a Lignite Phase-out Lignite Mine Rehabilitation

Mining of lignite from opencast mines involves substantial land-use intervention, including farmland and forest destruction; accumulation of rock and soil slag heaps; and lower groundwater levels.

Germany's 1980 Mining Law (Bundesberggesetz) requires that mining sites and facilities be returned to ecological balance and productive use, once their mining use is finished, a process called rehabilitation.[33] German mining and commercial laws require mine operators to make provisions for these future rehabilitation costs.[34,35] However, these laws do not require companies to ring-fence financial resources to cover their obligations, leaving concerns regarding the impact of insolvency. Similarly, while Germany's mining law states that a parent company is entirely responsible for damage caused by its subsidiaries, it is unclear how insolvency may impact this consolidated liability. [36,37]

Lignite rehabilitation tasks include the following:[38]

- Decommissioning of above-ground facilities, buildings and equipment, including the demolition of power plants and mining machinery, and removal of associated waste.
- Re-cultivation of the land to productive use, such as agriculture and forestry.
- Remediation of contaminated sites.
- Development of a self-regulating, water balance, including restoration of ground water to original levels; flooding of surface-mining depressions; and remediation of water quality.
- Assurance of geotechnical and public safety, e.g. securing open pits and making above-ground land formations stable from landslides.
- Creation of a master plan for future regional use of former mining activities.

The duration and cost of the rehabilitation period for lignite opencast mines depends on the balance of tasks. However, rehabilitation will take a finite period, unlike the rehabilitation of underground, hard coal mines, which can continue indefinitely given the long-run impact of mine shafts on groundwater and water courses.

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[33] Federal Ministry of Justice and Consumer Protection, n.d.. *Bundesberggesetz*. Available at: http://www.gesetze-im-internet.de/bbergg/

[34] Federal Ministry of Justice and Consumer Protection, n.d.. *Bundesberggesetz*.

[35] Federal Ministry of Justice and Consumer Protection, n.d.. *Handelsgesetzbuch.* Available at: https://www.gesetze-im-internet.de/hgb/

[36] Federal Ministry of Justice and Consumer Protection, n.d.. *Bundesberggesetz*.

[37] Federal Ministry of Justice and Consumer Protection, n.d.. *Handelsgesetzbuch.*Available at: https://www.gesetze-im-internet.de/hgb/ Green Budget Germany and IASS Potsdam, 2016. *Financial Foresight in the Lignite Sector: Options for securing lignite reserves and for implementing the polluter pays principle*. Available at (in German): http://www.die-klima-allianz.de/wp-content/uploads/2016-06_FOES_IASS-Finanzielle-Vorsorge-im-Braunkohlebereich.pdf

[38] Drebenstedt, C. and Kuyumcu, M. 2014. *Braunkohlesanierung: Grundlagen, Geotechnik, Wasserwirt-schaft, Brachflächen, Rekultivierung, Vermarktung.* Springer, Berlin.

A Just Transition: Protecting Vulnerable Communities

In this study, IEEFA focuses here on the rehabilitation of the lignite mines. However, a socially-just transition will also take into account the impact on vulnerable communities. Proper efforts to mitigate these impacts will reduce the social and economic costs of transition and involve affected communities and the mining companies themselves. [39,40]

A lignite phase-out raises particular economic challenges because the plants and mines are concentrated geographically in a central band across Germany and affect the area disproportionately. These regions comprise the Lausitz region near the Polish border in the East; Rhineland in the West; and Middle Germany. Employment support is crucial.

Such social challenges may have eroded political determination to drive a lignite phase-out in Germany compared with the speed of agreement on a nuclear phase-out timetable in the wake of the Fukushima disaster in 2011. A lack of policy coherence over the medium- and long-term future of coal and lignite has increased in the run-up to national elections in 2017.[41]

Institutional Approaches for Decommissioning Energy Assets

Germany has accumulated much recent experience in minimising the environmental, social and economic impacts of decommissioning or phasing out large-scale energy infrastructure. That precedent includes the decommissioning of lignite mines following German reunification in 1990 and, more recently, an ongoing phasing out of hard coal mining and nuclear power and plans to decommission older lignite power plants. These are described briefly.

Lignite Decommissioning, German Reunification in 1990

In the aftermath of reunification, Germany cut excess lignite mining capacity in the former East Germany, eliminating more than 86,000 jobs in Lausitz and surrounding areas from 1990 to 1995.[42] That example offers an order of magnitude greater than the scale of job losses that would accompany a complete phase-out of lignite today. In 1990, the East German lignite

[39] Global Commission on the Economy and Climate, 2014. Chapter 5 Economics of Change. In: *Better Growth Better Climate*. Available at: http://newclimateeconomy.report/2014/wp-content/uploads/2014/08/NCE_Chapter5_EconomicsOfChange.pdf

[40] Schultz, S. and Schwartzkopff, J., 2016. *Instruments for a Managed Coal Phase-out: German and International Experiences with Structural Change*. E3G, Berlin. Available at: https://www.e3g.org/library/after-the-vattenfall-deal-making-a-just-transition-happen-remains-as-necess

[41] Schultz, S. and Schwartzkopff, J., 2016. *Instruments for a Managed Coal Phase-out*

[42] Agora Energiewende, 2016. *Eleven Principles for a Consensus on Coal*. Available at: https://www.agora-energiewende.de/en/topics/-agothem-/Produkt/produkt/270/Eleven+Principles+for+a+Consensus+on+Coal/

industry employed some 113,000 miners, 10 times its current number (11,300) of miners and power plant workers now.

The sheer size of the restructuring precluded the private sector from bearing the full cost of mine rehabilitation. The German government formed a new public company, Lausitzer und Mitteldeutsche Bergbau und Verwaltungsgesellschaft" (LMBV), to handle these costs, and funded the company publicly from federal and local state budgets.[43] The original mining assets were nationalised and transferred to LMBV, which became legally responsible for the implementation of rehabilitation work, including restoring groundwater levels and providing future uses for the mining areas. Such an approach would not be applicable under the smaller-scale transition that is likely facing Lausitz, where mining companies will be legally responsible for rehabilitation. We mention the LMBV model here as an example of Germany's proven experience with such transitions.

As of end-2015, LMBV had completed the rehabilitation of some 81,603 hectares of post-reunification, opencast lignite mines and power plants, or 76% of the planned rehabilitation of a total area of 106,795 hectares, in the four regions of Sachsen, Sachsen-Anhalt, Thüringen and Brandenburg.[44]

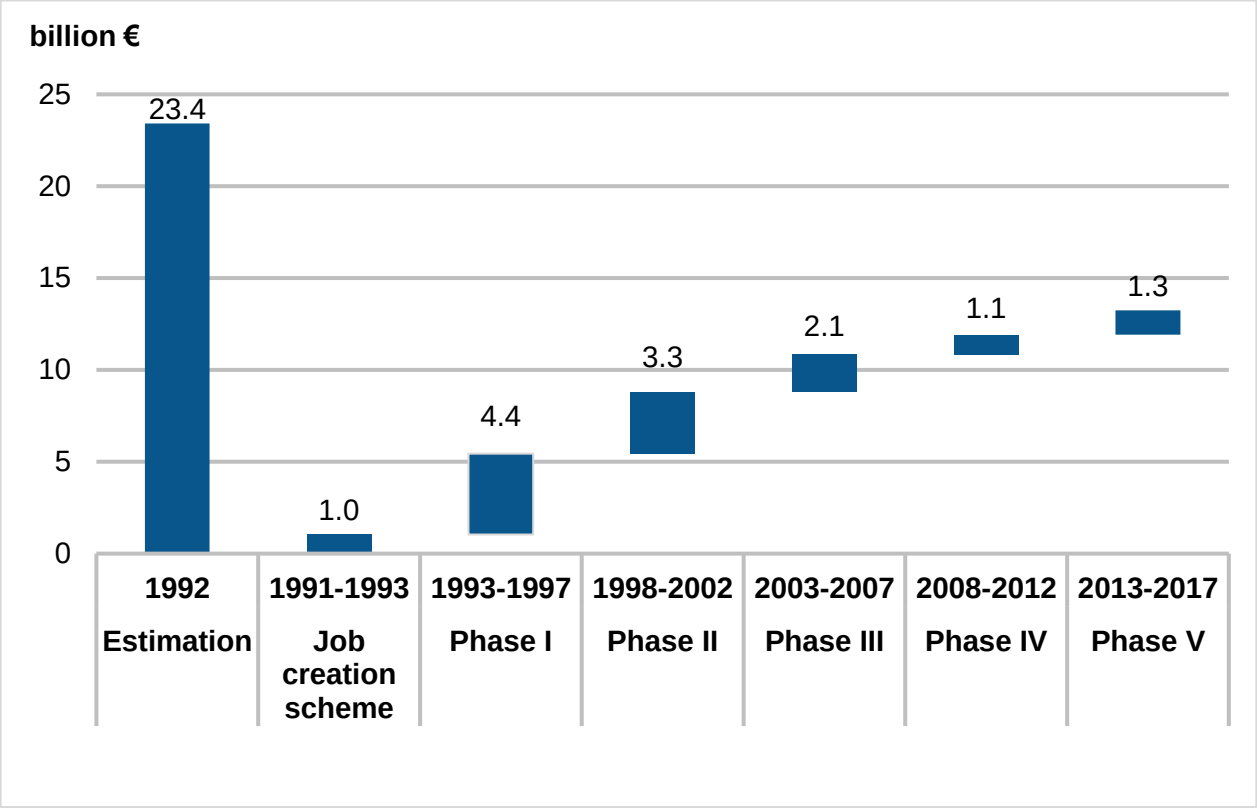
LMBV has disbursed funds to date totalling €10.9 billion, or €13.2 billion in real 2015 euros (Figure 2). These compare with original estimates in 1992 for the total cost of the assigned rehabilitation of 32 billion Deutsch Marks (€16.3 billion, or €23.4 billion in real euros).[45]

[43] German Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. 2012. *Sanierung der Altlasten des Braunkohlebergbaus.* Available at: http://www.bmub.bund.de/themen/wasser-abfall-boden/bodenschutz-und-altlasten/braunkohlesanierung/

[44] Lausitzer und Mitteldeutsche Bergbau-Verwaltungsgesellschaft (LMBV), n.d.. *Financing*. Available at: https://www.lmbv.de/index.php/Finanzierung.html

[45] Federal and State Government Office for Lignite Rehabilitation (Bund-Lander-Geschaftsstelle fur die Braunkohlesanierung). 2012. *Twenty Years of Administrative Agreement for Lignite Rehabilitation: Faces and Stories*. Available at: http://www.braunkohlesanierung.de/docs/112_broschuere_20_Jahre_stuba.pdf

Figure 2. LMBV disbursement of rehabilitation funds, 1991-2017, compared with initial cost estimate



Source: Federal and State Government Office for Lignite Rehabilitation [46]

Various factors affected the duration of LMBV rehabilitation, including location, site and required tasks.[47] At the lower end, reclamation of a lignite-processing site took as little as five years, and at the upper end, the remediation of groundwater contamination is seen as taking as long as 100 years. On average, opencast mine rehabilitation took about 25 years, depending on the pit area and depth, and, in the case of artificial lakes, the water source used to fill the mine. The creation of artificial lakes required embankment restoration, followed by flooding, which took from as little as 3 years in some cases, and is seen as lasting as long as 40 years in others. LMBV's project planning currently runs through 2030, but follow-up activities may continue for several decades beyond that date.

[46] Federal and State Government Office for Lignite Rehabilitation. 2012. *Twenty Years of Administrative Agreement for Lignite Rehabilitation: Faces and Stories*.
[47] LMBV provided these further cost details for this study, through email correspondence with the authors, August 11, 2016

Hard Coal Mining Phase-Out, 2007-2018

In 2007, the coal-mining, chemicals and real estate conglomerate RAG AG agreed—in a deal struck with Germany's federal government, local authorities and the Mining, Chemical and Energy Industrial Union (IG BCE)—to close Germany's last remaining hard-coal mines.

The mines, located in the in the states of North Rhine-Westphalia and Saarland, are due to be closed by 2018.

RAG AG's shareholders, including German energy companies RWE and E.ON agreed to transfer their shares for a nominal sum to a private foundation, RAG-Stiftung ("RAG Foundation"), which will use corporate profits from legacy businesses to finance the costs that arise from previous mining activities.[48] This transfer was part of a long-run understanding that private industry would finance long-run liabilities after the end of active mining.

RAG AG conglomerate had comprised a plethora of companies in mining, chemicals and real estate, and had implemented several restructurings as it sought to shift from state-subsidised mining to more profitable enterprises, and in particular to chemicals.

The three main legacy businesses transferred to the Foundation in 2007 are as follows: [49]

- **RAG:** the Foundation still owns 100% of RAG, the original coal mining business. RAG generated €1.9 billion in revenues in 2014/15, from the production of 7.6 million tons of largely thermal, hard coal, at two hard-coal mines: the Prosper-Haniel mine in Bottrop, and a mine in Ibbenbüren. Both mines will continue to operate through 2018 on a for-profit basis. RAG receives subsidies from the German government capped at €1.1 billion in 2016, which will fall to €794 million in 2019. As of the end of 2015, the company had some 10,000 employees, including 5,300 mineworkers and 700 trainees. The company also develops mining technologies and associated intellectual capacity, programs that will continue after closure of the mines.
- **Evonik Industries:** the Foundation has a 68% holding in this specialty chemicals firm. Evonik Industries is one of the world's leading healthcare, nutrition and resource-efficiency companies, with 33,000 employees, sales of €12.9 billion, and adjusted EBITDA of €1.9 billion in 2014/15. Evonik is responsible for the vast majority of the Foundation's income. RAG Foundation is gradually divesting its Evonik stake, with a long-term target of 25.1%. In 2008, it reduced its share to 75%, from 100%, and in 2013 divested to 68%.
- **VIVAWEST:** RAG Foundation has a 30% stake in VIVAWEST, the leading housing company in North Rhine-Westphalia, with more than 120,000 apartments in 76 towns and cities in the Rhine and Ruhr regions, achieving sales of 808 million euros and an EBITDA of 339 million in 2014/15. VIVAWEST traditionally provided homes for mining families, and still houses many current and former mining employees.

[48] RAG-Stiftung, n.d.. *Welcome to the RAG-Stiftung*. Available at: http://www.rag-stiftung.de/en/ [Accessed on: July 18 2016]
[49] RAG Stiftung, 2016. *The Past Shapes the Future: Our origins show is the way.*

The Foundation generates income from these three companies via profit distribution, dividend income and share divestment. In 2014/15, Evonik Industries provided dividend income of €317 million, and VIVAWEST a profit distribution of €36.4 million. The Foundation has used the income from these legacy businesses to diversify, acquiring assets worth €4.1 billion as of the end of 2015. These investments were divided between: fixed income (49%); equity (17%); cash (13%); and real estate (11%).[50]

The RAG Foundation reports that its income presently far exceeds its expected, long-term rehabilitation commitments of €220 million annually from 2019.[51] In 2015, the Foundation generated a profit of €334 million. So far, the Foundation has made provisions of some €4.4 billion against its "perpetual obligations." Responsibility for managing and funding the mining phase-out is divided between the RAG Foundation and the German government: the Foundation is responsible for mine rehabilitation, including permanent obligations to protect groundwater and water courses, as well as worker pensions, while the government is responsible for social assistance.

The Foundation must meet rehabilitation costs, including protection of drinking water through pumping of former mine shafts; remediation of water quality at contaminated sites; and pumping of surface depressions caused by shaft subsidence. In addition, the Foundation supports adaptation of coal-mining sites for alternative uses, such as commercial property and generation of energy from renewable sources, and supports local scholarship and training programs to boost alternative employment. In the event that the RAG Foundation's income is insufficient to cover these tasks, the federal government and the governments of the two former coal-mining states would step in.

The German federal budget supports social programs for affected workers over a certain age, at 50 years for underground miners.[52] Past programs to help younger workers to transition to alternative careers are not available under the present hard-coal phase-out program. Assistance for older workers includes early retirement payments and "adjustment money" (*Anpassungsgeld*).[53] The Anpassungsgeld was first given to coal miners during closures in the 1960s, when imports became cheaper than domestic coal. The Anpassungsgeld is paid for up to five years and amounts to €13,500 annually, on average, representing approximately 34% of the current yearly average miner salary, assuming an hourly rate of €19/ hour.[54] In 2016, a total of €113 million will be disbursed for such assistance,

[50] RAG Stiftung, 2016. *The Past Shapes the Future: Our origins show is the way.*
[51] RAG Stiftung, 2016. *The Past Shapes the Future: Our origins show is the way*. Available at: http://www.rag-stiftung.de/fileadmin/user_upload/rag-stiftung.de/Dokumente/geschaeftsberichte/RAG-Stiftung_Annual_Report_2015.pdf
[52] German Federal Ministry of Justice and Consumer Protection, 2007. *Coal Financing Act*. Available at: https://www.gesetze-im-internet.de/bundesrecht/steinkohlefing/gesamt.pdf
[53] Schultz, S. and Schwartzkopff, J., 2016. *Instruments for a Managed Coal Phase-out*
[54] Hans Boeckler Foundation. 2016. *Mining Industry Salary Report.* Available at: http://www.boeckler.de/pdf/p_ta_tarife_steine_erden_industrie_2016.pdf

greatly reduced from around €1 billion annually in the late 1960s.[55, 56] The Anpassungsgeld is only available for workers in the hard-coal sector, not the lignite sector.

This early retirement assistance is in addition to other social supports, including health insurance and pensions. Health insurance is mandatory for all German citizens. Salaried employees, pensioners and the unemployed have public health insurance, either paid for by the state or deducted from salaries, while the self-employed often use private insurance. Miners are entitled to a state pension, amounting to on average €1,090 per month, depending on contributions made during the working life of each recipient. For example, a mine engineer who has worked all his life in a mine would receive about €2,000 per month. In addition to the state pension, retired hard-coal miners are entitled to a Kohledeputate of 2.5 tonnes of coal annually for home heating, or an equivalent sum in cash (Energiebeihilfe) of €300 /per year. The Kohleduptate costs the state €61 million annually, and benefits 145,000 people, including current workers, retired miners and widows. The Kohledeputate will end at the end of 2018, with the closing of the last hard-coal mine. At that time, all retired employees will receive a one-time compensation of €1.275€ on average.

Nuclear Power Phase-out, 2002-2022

The Fukushima nuclear disaster in Japan in 2011 gave new momentum to Germany's phase-out of nuclear power, originally underpinned by the 2002 Nuclear Power Phase-out Act. The phase-out of nuclear power generation is due to be completed in 2022. Under German law, operators have responsibility for funding the cost of decommissioning and dismantling of nuclear power plants and of nuclear waste disposal. Governments have responsibility for oversight, including site selection and operation of the final waste repositories.

In 2015, the federal government appointed a commission to "review financing for the phase-out of nuclear energy" (called the KFK Commission), and in particular to investigate whether operators could meet their nuclear waste clean-up obligations.[57] The commission found that the operators of nuclear power plants were not in the best financial health as a result of factors including high indebtedness; falling capacity factors; low wholesale power prices; and the prospect of a costly exit from lignite. Such factors could threaten private-sector financing of nuclear waste disposal, the commission concluded, in addition to creating uncertainty regarding the true extent of waste-disposal liabilities. The commission assumed a German audit estimate for a nuclear phase-out liability of €48.8 billion, compared with actual German operator provisions of €38.3 billion (in 2014 prices, recorded as debt on balance sheet).

[55] German Federal Ministry of Finance, 2015. *Subsidy report 2013-16*. Available at: http://www.bundesfinanzministerium.de/Content/DE/Standardartikel/Themen/Oeffentliche_Finanzen/Subventionspolitik/2015-08-26-subventionsbericht-25-vollstaendig.pdf?__blob=publicationFile&v=2

[56] Green Budget Germany. 2010. *Coal Subsidies 1950-2008* Available at: http://www.foes.de/pdf/Kohlesubventionen_1950_2008.pdf

[57] Commission to Review the Financing of the Phase-out of Nuclear Energy, 2016. *Responsibility, Safety and Certainty: A new consensus on nuclear waste disposal.* Available at: http://www.bmwi.de/English/Redaktion/Pdf/bericht-der-expertenkommission-kernenergie,property=pdf,bereich=bmwi2012,sprache=en,rwb=true.pdf

The commission made recommendations for ensuring that these companies met their obligations sustainably. The commission differentiated between "fund" and "foundation" approaches. Under a fund approach, operators would extend their liabilities indefinitely, placing these companies at risk of never-ending financial uncertainty. Under a foundation approach, operators would pass their liabilities to a publicly-owned foundation alongside a cash injection that could still cripple them. The commission combined both approaches, proposing a "new assignment of tasks" by which the government would release operators from future waste disposal liabilities in return for cash, including a risk surcharge of 35%, to be place €23.3 billion, to be placed in a public fund or foundation. Meanwhile, operators would continue to have unlimited responsibility for decommissioning and dismantling of power plants, and for packaging and transport of waste. The commission suggested that the operators make provisions against these liabilities more transparently than previously, for €22.2 billion.

The four affected utilities rejected the recommendations, saying these would "overburden … their economic capabilities."[58] They have sued the government for compensation for the early closure of some nuclear power plants (before 2022) under the phase-out program.

Analysts, meanwhile, have suggested that the commission proposals may be too lenient.[59]

Decommissioning of German Lignite, 2016-2023

In 2015, Germany introduced a new "standby capacity reserve" program to mothball and then decommission eight lignite-fired power plants with a combined capacity of 2.7 gigawatts (GW), accounting for 13% of Germany's total of 21 GW of lignite power.[60] The affected owner-operators were Vattenfall, RWE and Mibrag. The measure was intended to help Germany meet its target to cut greenhouse gas emissions by 40% by 2020 compared with 1990 levels. The decommissioning was expected to lead to the abatement of 12.5 million tonnes of CO2 annually in 2020.

The power plants will be mothballed over the course of four years and then permanently decommissioned. The measure will be implemented over an eight-year period, with the first power plant mothballed in 2016 and the last decommissioned in 2023. The eight power plants are some of the oldest and most polluting in Germany. They have been selected from three separate lignite mining regions to minimise socioeconomic impacts and from three different grid balancing areas to minimise grid impacts.

The operators will be remunerated on the basis of foregone profits from selling electricity and heat, as well as ancillary services for re-dispatch and balancing, using 2012-14 power prices

[58] RWE, 2016. *Energy companies are ready for a joint solution to finance the phase out of nuclear power generation in Germany*. April 27 2016. Available at: http://www.rwe.com/web/cms/de/37110/rwe/presse-news/pressemitteilungen/pressemitteilungen/?pmid=4014862

[59] Cleanenergywire, 2016. *"An incalculable risk"*. July 16 2016. Available at: https://www.cleanenergywire.org/news/nuclear-clean-more-expensive-2-billion-euros-year-steel-industry-study/incalculable-risk

[60] European Commission, 2016. *State Aid: Germany Closure of German lignite-fired power plants*.

and capacity factors.[61] Remuneration will include the costs of mothballing, minus avoided fixed costs while mothballed. Transmission system operators (TSOs) will pass the costs on to electricity consumers, through higher grid distribution charges. German regulators estimate the total cost at 230 million euros annually, or 1.61 billion euros in total over the seven years of the scheme, or the equivalent of €149 / kW/ year each plant over the course of the four years of being mothballed.

Power prices have fallen sharply since 2012-14. Nevertheless, regulators justify using historical prices to calculate foregone profits on the basis that this approach makes the financial impact of the scheme clearer for operators. In addition, regulators argue that compensation be paid over a shorter period than the theoretical lifespans of these power plants, which were forecast otherwise to continue to make operating profits beyond 2030 in some cases. The capacity reserve program received EU state aid approval in May 2016.

The scheme includes two Lausitz lignite power plant units previously owned by Vattenfall, Jänschwalde unit's E and F, each with a net generating capacity of 465 MW. Jänschwalde F will be mothballed in 2018 and decommissioned in 2022, and unit E will be mothballed in 2019 and decommissioned in 2023. Assuming these plants were to receive a pro rata share of the €1.61 billion, based on capacity, the plant would receive some €555 million in total. This income will now accrue to EPH and PPF Investments on completion of the transfer of the assets from Vattenfall. There is no constraint on how the operators allocate the money.

A Phase-out Plan for Lausitz Lignite

IEEFA draws upon lessons both from recent precedent and the literature in making a Lausitz lignite phase-out proposal.

Historical Precedent

Germany's past experience of wide-scale energy infrastructure decommissioning and phase-out (see above) allows for some general observations.

First, there are critical differences between coal, lignite and nuclear power. In particular, both hard coal and nuclear have long-term or permanent obligations, in contrast with shorter-term open-pit rehabilitation required of lignite.

Second, there is a broad division of responsibility between the public and private sector. The private sector provides worker pensions. And the private sector operators are responsible for clean-up of waste and environmental damage, in line with the "polluter pays" principle in Germany's Mining Act. The fundamental challenge is to ensure reliable funding of future environmental obligations from private sector companies which cannot be guaranteed to remain solvent. The nuclear phase-out is a good example of this predicament, given the

[61] European Commission, 2016. *State Aid: Germany Closure of German lignite-fired power plants*.

large and long-term waste disposal liability and the present financial difficulties of some German electric utilities. The public sector, meanwhile, picks up the social cost of large-scale industrial restructuring, such as early retirement for older workers. There are exceptions to these public-private roles. In the decommissioning of lignite power plants and mines in former East Germany, in the wake of the 1990 German reunification, the assets were transferred to the LMBV, a public company, rather than managed by the private sector. And in the case of mitigation of carbon emissions, the decommissioning of some 2.7 GW of lignite power plants from 2016 (the "standby capacity reserve") will be compensated for by energy consumers, as a "climate protection" measure, rather than absorbed by the companies.

Third, a foundation approach is already used extensively in Germany. Foundations are used to manage both the phase-out of hard coal mining, and the decommissioning of lignite mines and power plants in former East Germany. In both cases, the assets and liabilities, including responsibility for mine rehabilitation, were transferred to foundations, to the privately owned RAG Stiftung, in the case of hard coal, and to the LMBV, in the case of the former East German lignite.

In summary:

- German law and precedent support a "polluter pays" principle, where lignite mine and power plant rehabilitation are paid by the operator. The exception in the former East Germany reflected the scale of the task to reduce an over-sized industry, and the financial status of the former communist state-owned operators.
- Past precedent supports some limited compensation for the premature closure of profitable power plants, which in the case of the recently agreed "standby capacity reserve" program for lignite amounted to the equivalent of four years' forgone profits.
- Recent proposals under the nuclear power phase-out suggest an appetite for more accurate provisioning of rehabilitation liabilities under a more precautionary approach. The KFK Commission argued for a 35% risk surcharge, on top of estimated liability, in the case of up-front funds for long-term nuclear waste disposal.

Recent Proposals

Proposals for reducing emissions from German coal and lignite have included emissions-trading reforms for higher carbon prices; emissions performance standards to ban unabated lignite; capacity reserve markets; and a planned phase-out.[62]

We review two recent, relevant contributions.

First, in January 2016, the think tank Agora Energiewende argued for a German "Consensus on Coal," to provide certainty for investors and the energy sector and to reflect the country's ambitious carbon emissions reduction targets.[63]

[62] E3G, 2015. *Vattenfall's Lignite Business: A risky bet for investors*.
[63] Agora Energiewende, 2016. *Eleven Principles for a Consensus on Coal*.

- The study proposed a coal and lignite phase-out plan from 2018-2040, including an immediate end to lignite mine expansion and community resettlement. It included two concrete alternatives for implementation. First, the creation of a private foundation to finance mine rehabilitation, funded from a new levy per tonne of mined lignite equivalent to 2.5 euros/ MWh, from 2018. The levy was calculated as that required to meet the provisions reported by operators, given the cumulative electricity generated by the power plants over the phase-out period. Alternatively, lignite companies could simply transfer the cash value of their provisions into a public fund, similar to the recent KFK Commission's proposals for funding the long-term waste disposal aspect of a nuclear phase-out.
- There would be minimal income transfers to the lignite industry. Instead, the industry would benefit from a clear, long-term trajectory for decommissioning, where no power plants would be closed before a minimum 27 years of operation. A small rump of remaining power plants at the end of the phase-out period would be placed in a capacity reserve, similar to the present, planned "standby capacity reserve."
- The state would pay €250 million euros annually through the 22-year phase-out period into a "Structural Change Fund" to ensure a robust post-coal future for communities in affected regions, to fund early retirement, new energy and other infrastructure investment, and economic diversification.

Second, the NGO Greenpeace Nordic sought to participate as a bidder in the sale of Vattenfall's lignite assets in 2015. Greenpeace proposed to act as an intermediary between Vattenfall and a foundation ("RAG Stiftung") under German law.

The Greenpeace proposal used analysis by Energy Brainpool and the Institute for Ecological Economy Research. The proposal included a gradual phase-out of lignite mining and power generation for closure no later than 2030. Lignite assets would be transferred to a newly created RAG Stiftung ("Beyond Lignite Foundation"), in which Vattenfall could participate. Funding for the Foundation would be drawn from the operation of the lignite assets, with potential tax and other benefits for Vattenfall, and in the medium term from other sources including the generation of renewable power.

Recommendation: A Foundation-Based Approach

IEEFA proposes the following scenario:

Adoption of a phase-out plan for gradual closure of all Vattenfall's former power plants from 2018 to 2030. A 2030 closure date is in line with meeting Germany's 2020 and 2030 emissions targets. The power plant units would be closed at a rate of one per year. The first two power plants would be mothballed in 2018 and 2019, as planned under Germany's existing, standby capacity reserve. The remaining units would be closed starting with KW Jänschwalde, one of the oldest and least efficient power plants, followed by units at Boxberg, Schwarze Pumpe and Lippendorf, in reverse order of efficiency. Selection of power plants for step-wise closure

in this way would be broadly in line with the example of the standby capacity reserve program, and the recent Energy Brainpool and Agora studies.

No compensation for closure of lignite power plants. Vattenfall would not divulge the book value of its lignite business, but it has written down this asset on numerous occasions. EPH and PPF Investments acquired the business for a nominal sum, alongside some SEK 9.4 billion (€1.01 billion) in cash.[64] The phase-out period assumed by IEEFA in this study (2018-2030) implies that the average age of the 13 lignite power plant units at closure will be 34 years, ranging from 18 to 45 years. In its 2015 annual report, Vattenfall reports an estimated useful life of 5 to 50 years for non-hydro, non-nuclear power plants.[65] Chief executive Magnus Hall stated in 2015 that he expected the Jänschwalde units E and F built in 1987 and 1989 to remain in operation until the middle or second half of the 2020s, implying a lifetime of no more than 40 years.[66] In its 2014 annual report, EPH records an estimated useful life of 20-50 years, for "electric generators, gas producers, turbines and boilers".[67]

Rehabilitation liabilities are placed in a Foundation, which the asset owners EPH and PPF Investments support with regular financial contributions, in a contract with the federal and state governments and unions. Such a participatory approach would be similar to the 2007 agreement on the phase-out of hard coal mining, which established the RAG Stiftung. It is proposed here that the asset would remain with EPH and PPF Investments, while the foundation would be responsible for managing the rehabilitation, in a similar assignment of duties as the recent proposal for long-term nuclear waste disposal. The public company LMBV would be one candidate to run the foundation, given its experience of lignite mine rehabilitation in former East Germany. The foundation would invest contributions from the mine and power plant owners, to ensure a diversified asset base and source of funding as the rehabilitation liabilities fall due, as in the case of the RAG Stiftung.

The government would meet the bulk of the costs of a social transition, including local re-skilling and funding of early retirement.

[64] Vattenfall, 2016. *Vattenfall Q2 and H1 Results 2016*.
[65] Vattenfall, 2016. *Energy you want: Vattenfall Annual and Sustainability Report 2015*. Available at: https://corporate.vattenfall.com/globalassets/corporate/investors/annual_reports/2016/vattenfall_annual_and_sustainability_report_2015_eng.pdf
[66] Vattenfall, 2015. *Lignite capacity to be phased out in power reserve. Oct 27 2015*. Available at: http://news.vattenfall.com/en/article/lignite-capacity-be-phased-out-power-reserve
[67] Energetický a PrůmyslovýHholding (EPH), 2014. *Annual Report*. Available at: http://www.epholding.cz/en/investors/annual-reports/

Cost of a Lignite Phase-out

In this section, we derive estimates for the rehabilitation liability of the Lausitz lignite mines and the cash flows from the associated power plants over the proposed phase-out period, 2018-2030. The aim is to determine whether the power plants can fund their rehabilitation obligations.

Methodology

Discounting approach

Vattenfall discounted its German mining provisions at a discount rate of 1.5%-4%.[68] For this report, we therefore discount our own estimate for Vattenfall's mining liabilities at the mid-point of this range, 2.75%, and assume that these liabilities fall due from 2025-2035. Regarding our estimated cumulative cash flows from the Lausitz power plants, we apply a weighted cost of capital (WACC) rate as used by Energy Brainpool in its analysis of lignite cash flows, of 7.2%, over our proposed phase-out period of 2018-2030.[69]

Closure Scenario

Vattenfall has already agreed to place two units at the KW Jänschwalde power plant into Germany's lignite "standby capacity reserve" to be mothballed in 2018 and 2019. IEEFA assumes that these are the first two units to close, in the same years. The remaining 11 lignite power plant units are closed in step-wise fashion over an 11-year period from 2020 to 2030, at a rate of one unit per year (see Table 5). This stepwise approach to a lignite phase-out is similar to that taken by the Energy Brainpool think-tank in its 2015 study for Greenpeace.[70]

[68] Vattenfall, 2016. *Energy you want: Vattenfall Annual and Sustainability Report 2015*.
[69] Energy Brainpool, 2015. *Appendix 1*
[70] Energy Brainpool, 2015. *Appendix 1*

Table 5. Proposed order of power plant closures, 2018-2030

Power Plant	Unit	Efficiency (%)	CO2 Emissions (gCO2/ kWh)	Start date	Closure date	Age at closure
KW Jänschwalde	F	0.36	1.16	1989	2018	29
KW Jänschwalde	E	0.36	1.16	1987	2019	32
KW Jänschwalde	A	0.36	1.16	1981	2020	39
KW Jänschwalde	B	0.36	1.16	1982	2021	39
KW Jänschwalde	C	0.36	1.16	1984	2022	38
KW Jänschwalde	D	0.36	1.16	1985	2023	38
Boxberg	N	0.35	0.96	1979	2024	45
Boxberg	P	0.35	0.96	1980	2025	45
Schwarze Pumpe	A	0.41	0.98	1997	2026	29
Schwarze Pumpe	B	0.41	0.98	1998	2027	29
Boxberg	Q	0.42	1.16	2000	2028	28
Lippendorf	R	0.43	0.95	2000	2029	29
Boxberg	R	0.44	1.16	2012	2030	18

In addition to closing units, one by one, IEEFA assumes that the running time, or capacity factor, of the remaining power plants falls over time. The rationale is that the remaining lignite fleet would be less called upon as Germany transitions to a renewable power system backed by more flexible gas, interconnectors and hard coal. Thus, the lignite capacity factors are reduced from 80% (7,000 hours of annual operation) from 2015-2019; to 68% in 2020-2024 (6,000 hours); to 46% in 2025-2030 (4,000 hours).

Combining this step-wise closure of lignite assets and declining capacity factors, we can calculate a cumulative generation of electricity over time, for each unit and collectively. The total power generation through 2030 is 498 terawatt hours (TWh) (See Table 6). We note that if the power plants ran at 80% capacity factor throughout the phase-out period, the cumulative power generation would rise to 574 TWh.

Table 6. Cumulative generation of electricity, 2018-2030, Lignite power units

Power plant	Unit name	Cumulative power generation, MWh
KW Jänschwalde	F	13,020,000
KW Jänschwalde	E	16,275,000
KW Jänschwalde	A	19,065,000
KW Jänschwalde	B	21,855,000
KW Jänschwalde	C	24,645,000
KW Jänschwalde	D	27,435,000
Boxberg	N	30,225,000
Boxberg	P	32,085,000
Schwarze Pumpe	B	54,750,000
Boxberg	Q	57,750,000
Schwarze Pumpe	A	69,417,000
Lippendorf	R	74,375,000
Boxberg	R	56,960,000
TOTAL		497,857,000

Rehabilitation Liability

We use two estimates for rehabilitation liability of the lignite mines: Vattenfall's reported provision against future liabilities, and LMBV's actual mine rehabilitation experienced costs to date.

Regarding provisions, Vattenfall most recently has ceased to report its specific mine rehabilitation provisions, conflating these with other liabilities, including pensions. As a result, we approached the company directly for their latest rehabilitation provision in calendar year 2015 (See Findings, below).

Regarding LMBV costs, we used published LMBV data for the total cost of rehabilitation to date to calculate historical rehabilitation costs per hectare. We then apply those unit area costs to the area of Lausitz mines, of 23,000 hectares, as noted above. We stress the uncertainties in this calculation. First, we use an upper estimate for the area of Lausitz mines, given that Vattenfall declined to provide these data. Second, use of historical costs will take no account of learning by doing over the past several decades. Third, it is a big approximation to apply average historical clean-up costs to today's mining areas, given different starting points for rehabilitation, and different clean-up tasks.

Lignite Power Plant Cash Flows

Lausitz power plants have three main marginal costs: fuel; carbon emissions permits; and fixed operating and maintenance (O&M) costs.

In this study, IEEFA focuses solely on the cash flows of the power plants, and treats the Lausitz lignite mines as a cost. Lignite does not have a market price in Germany because of the relatively high cost of transport. As a result, we derive lignite fuel costs from 2015 estimates for the marginal cost of lignite mining, of €5/ MWh thermal, as published by VGB PowerTech (VGB), the European technical association for power and heat generation.[71] This estimate comprises short-term lignite extraction costs of €1.5/ MWh, plus mine development costs of €3.5/ MWh. A thermal lignite cost of €5/ MWh is equivalent to around €12-14/ MWh of electricity, depending on the efficiency of the power plant.

Regarding carbon prices, we use Thomson Reuters Point Carbon real 2015 price projections over the proposed phase-out period through 2030.[72] We adapt VGB 2015 price estimates for fixed O&M costs, which comprise expenses including auxiliary and operating materials, personnel, administration and insurance.

The costs are summarized in Table 7, using carbon prices and capacity factors as assumed at the start of the phase-out period in 2018. These costs will rise through the phase-out period, as carbon prices rise, and capacity factors fall. Table 7 shows how costs vary according to the efficiency of the power plant. Note that the energy efficiency of the Lausitz lignite power plants range from 35% to 44%, as shown in Table 1 above. We note that we have made no account of the cost of expected tougher European Union pollution controls under the Industrial Emissions Directive for large combustion plants, from 2021.

[71] VGB PowerTech, 2015. *Levelised cost of electricity, Issue 2015*. Available at: https://www.vgb.org/en/lcoe2015.html?dfid=74042

[72] Email correspondence with a senior analyst at Thomson Reuters Point Carbon in July 2016, who provided carbon price projections from 2016-2030

Table 7. Cost calculation for lignite-fired generation, assuming carbon prices and capacity factor at start of phase-out period

Assumptions	Unit	Cost Calculation	
		Energy Efficiency	
		35%	44%
Coal plant efficiency			
Capacity factor	Running hours/ year	7,000	7,000
Emissions factor	tCO2 /MWh electricity	1,155	963
EUA price	€/ tCO2	7.0	7.0
Short-term mining variable cost	€/ MWh thermal	1.5	1.5
Long-term mining cost	€/ MWh thermal	3.5	3.5
O&M costs power plant	€/kW	43.0	35.0
Costs			
EUA cost	€/ MWh electricity	8.1	6.7
Marginal fuel cost	€/ MWh electricity	14.3	11.4
O&M costs power plant	€/ MWh electricity	6.1	5.0
Total cost	**€/ MWh electricity**	**28.5**	**23.1**

Turning to revenues and cash flows, lignite power plants have three principle products: electricity, heating and ancillary services such as grid re-dispatch.

Power generation revenues were calculated using real, wholesale power price projections through 2030, as published by Agora Energiewende.[73] We take no account of the impacts of hedging on realised power prices, since EPH and PPF Investments acquired the Lausitz lignite business without clean dark spread hedges. We generated cash flows per MWh by subtracting marginal fuel costs, carbon costs and O&M costs, as described above.

Regarding heating revenues, the company reported group-wide sales in 2015 of SEK 27.4 billion. We apply the lignite pro rata contribution of 22% of total heat output to estimate lignite heating revenues of SEK 6.1 billion. We convert this figure into heating revenues per unit of 5.5 TWh heat production (€118/ MWh thermal) and per unit of 55.3 TWh power generation (€11.8/ MWh electric). We derive cash flows from heating using a similar approach based on group-wide heating EBITDA (earnings before interest, tax, depreciation and amortisation) in 2015 of SEK 5.6 billion. We estimate pro rata lignite heating EBITDA of SEK 1.23 billion, or €24/ MWh thermal, and €2.4/ MWh electricity. All units except Boxberg R supply

[73] Agora Energiewende, 2016. *Eleven Principles for a Consensus on Coal*.

district heating. For the sake of simplicity, we assume that all other units achieve the same heating revenues per MWh of power generation.[74]

Finally, regarding ancillary services, we make a very approximate assumption that both revenues and cash flows are equivalent to 5% of power generation revenues and cash flows from 2018-2030.

Findings

Rehabilitation Liability

As noted above, LMBV is rehabilitating opencast lignite mines and associated power plants in the former East Germany. LMBV estimates that it has invested €13.2 billion to date, in real 2015 euros, to rehabilitate an area of 81,603 hectares. One should exercise caution calculating costs per hectare, given that these vary hugely according to activities ranging from tree planting to creation of artificial lakes. However, average costs per hectare are a useful measure for comparing average costs of rehabilitation, and are more robust when applied to a scale of tens of thousands of hectares. The LMBV cost data indicate an average unit area cost to date of €162,000 per hectare.

The authors derived directly from the company Vattenfall's latest provision against its mining rehabilitation liabilities of €1.4 million. Compared with a currently mined area of up to 23,000 hectares, this liability value implies an expected rehabilitation cost of €61,300 per hectare, or less than half the actual unit area costs experienced by LMBV to date.

When we apply the LMBV cost of rehabilitation per hectare to the area of Vattenfall's lignite mines, the undiscounted rehabilitation liability rises to €3.7 billion. Applying a discount rate of 2.75%, the estimated liability is €2.6 billion, or nearly double Vattenfall's latest provision. Combining estimates for rehabilitation liability and cumulative power generation, we drive an estimate for the rehabilitation cost per unit of power generation, ranging from €2.84 to €5.20 per MWh (see Table 8).

Table 8. Mine rehabilitation liability per MWh of power generation, 2018-2030

		Lausitz lignite rehabilitation costs	
	Unit	Vattenfall provision	LMBV cost
Total rehabilitation liability	€ mln	1,412	2,587
Cumulative power	TWh	498	498
Unit rehabilitation cost	€/MWh	2.84	5.20

[74] Energy Brainpool, 2015. *Appendix 1*

Lignite Power Plant Cash Flows

Figure 3 below shows how we project costs to vary over time, averaged across the 13 power plant units. Carbon prices are the biggest source of cost inflation, rising as European carbon market reform leads to an expected gradual tightening in the present surplus of emissions permits. Power plant O&M fixed costs rise, per MWh, as the capacity factor falls. Fuel costs are assumed to be unchanged.

Figure 3. Average costs per MWh electrical output, 2018-2030

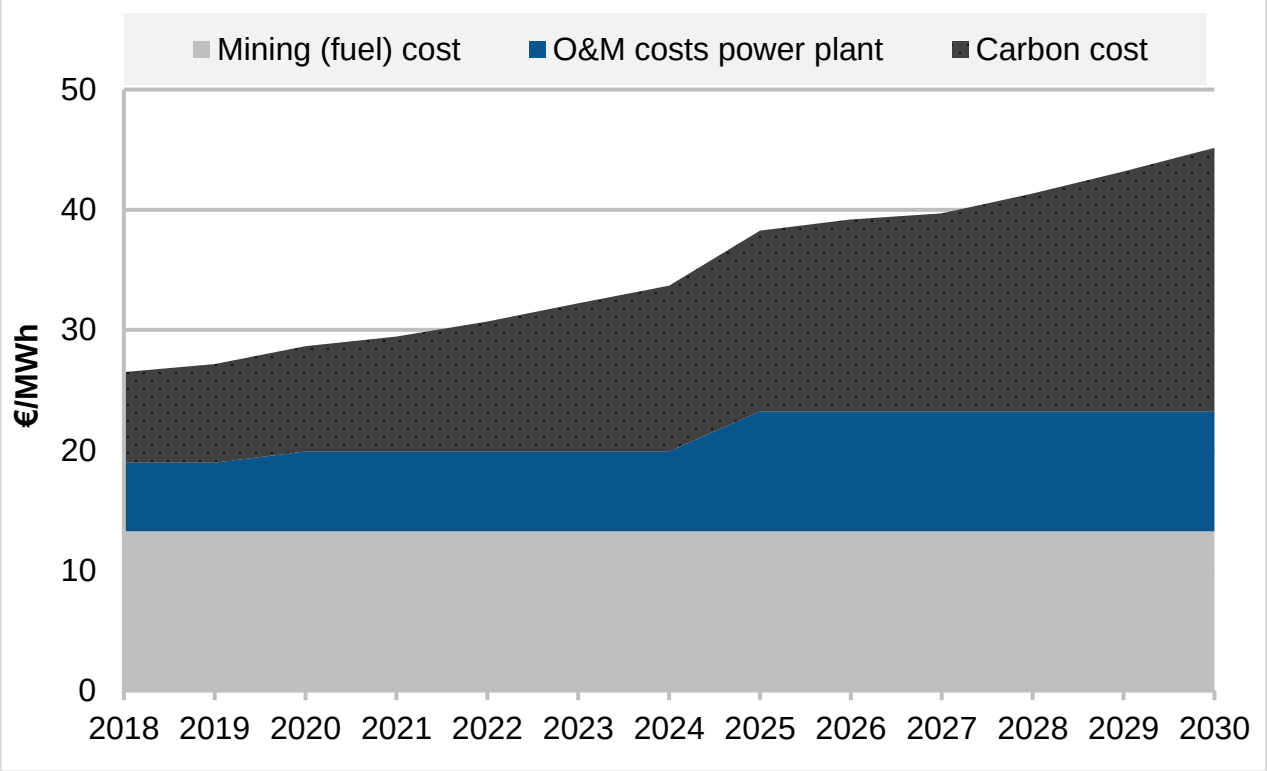


Figure 4 shows the relative contribution of power generation, heating and ancillary services to overall revenues per MWh electricity generated. We assume that heating revenues are unchanged on today's levels through the phase-out period. We note that revenues fall from 2028, as wholesale power prices plateau and fall.

Figure 4. Average revenues per MWh electrical output, 2018-2030

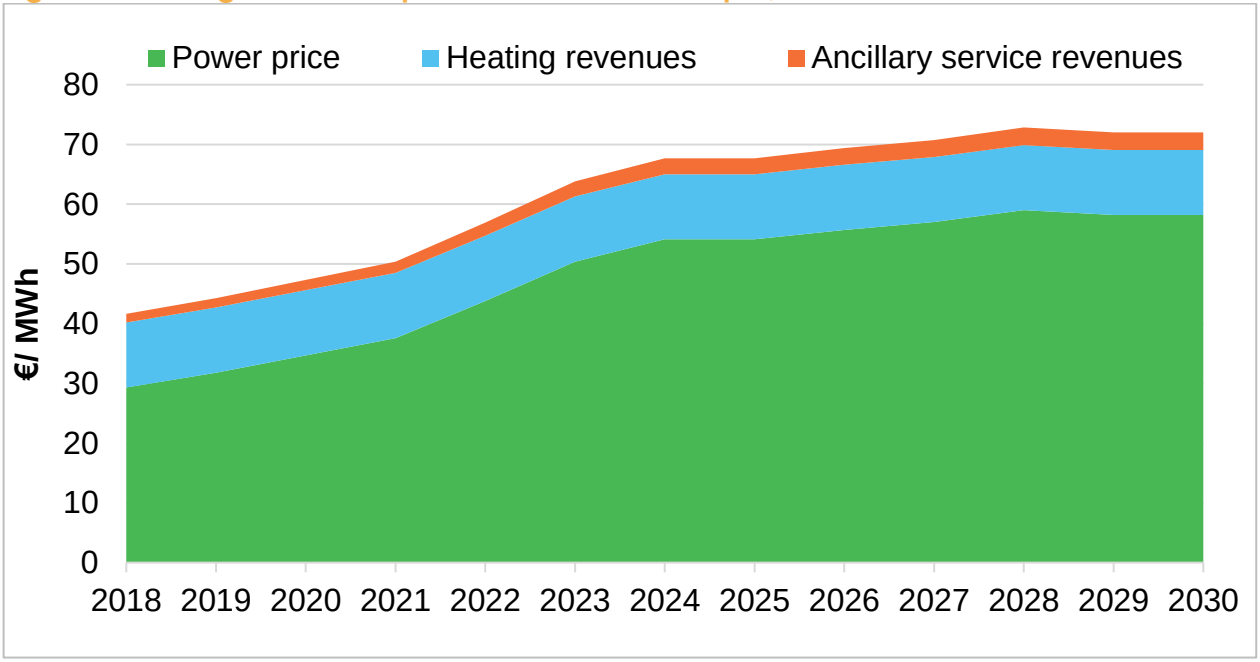
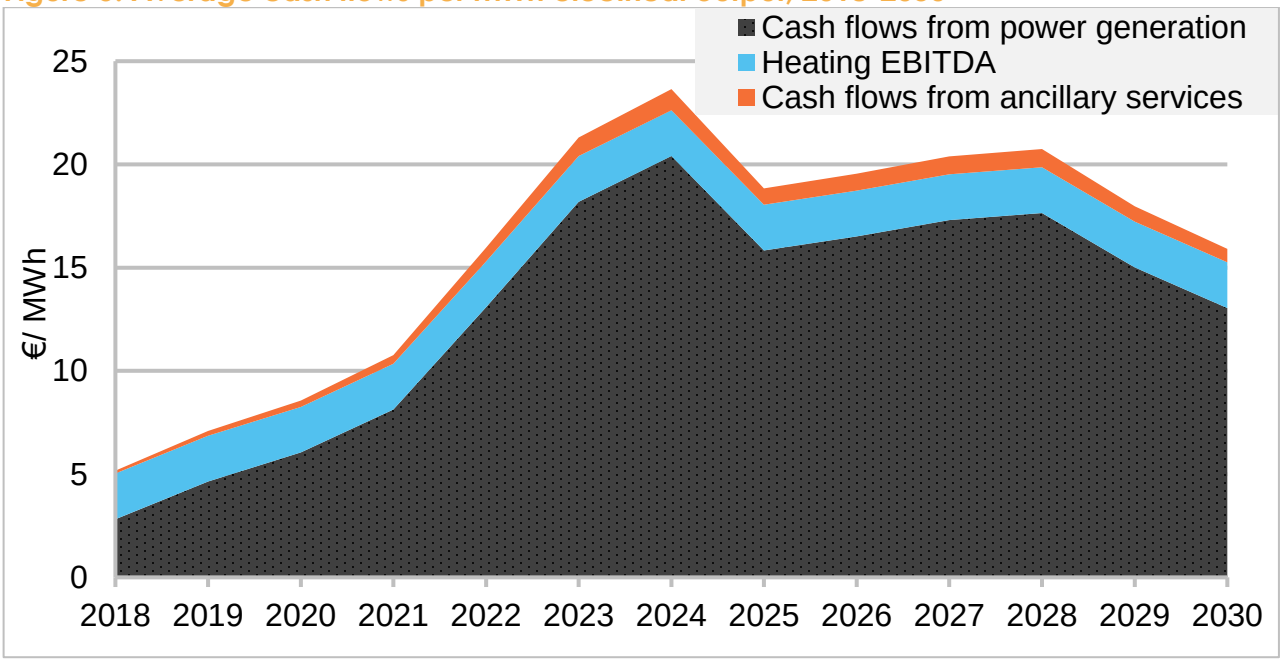


Figure 5 shows the distribution of cash flows between power generation, heating and ancillary services. We note how total cash flows vary according to the balance between growth in power and carbon prices. Cash flows rise when power prices rise more quickly than carbon prices, as they do in the first half of the 2020s, and the reverse is true in the second half of the 2020s. We assume constant heating cash flows throughout at today's levels.

Figure 5. Average cash flows per MWh electrical output, 2018-2030



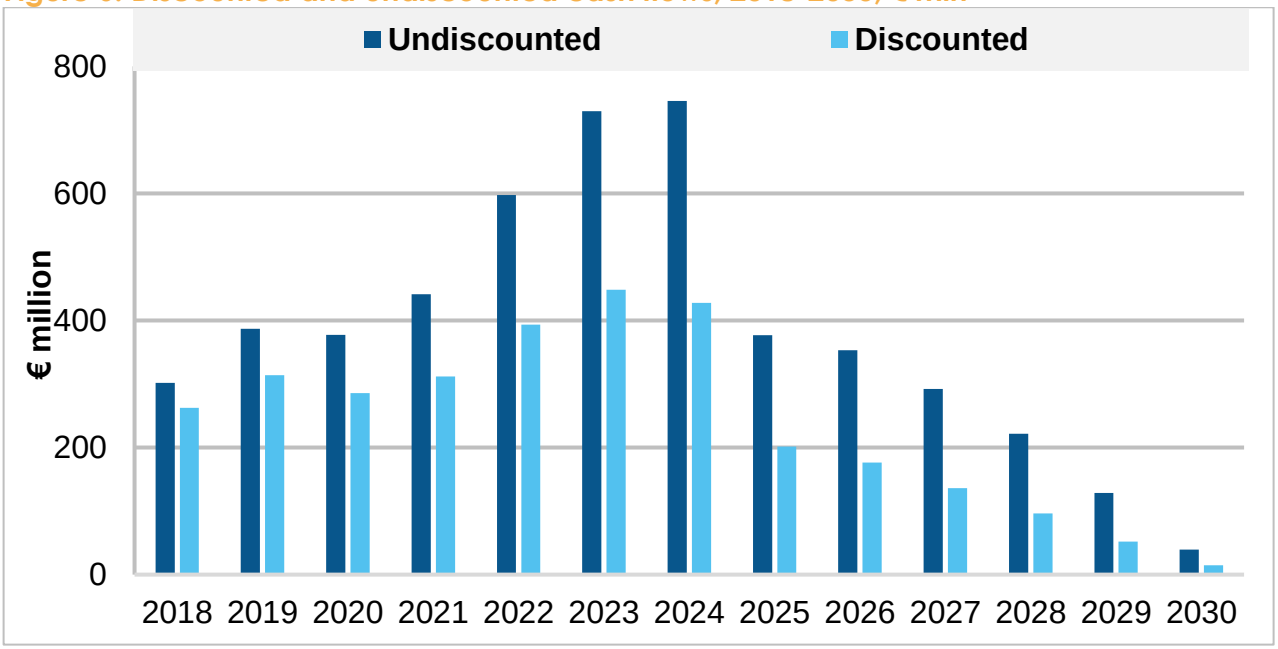
Cash flows varied across individual power plants according to efficiency and carbon factor. Fixed power plant costs, fuel costs and carbon costs varied according to efficiency, and carbon costs also according to carbon factor. The power plant with the highest cash flows through the phase-out period is Lippendorf, which is the second-most energy efficient and least carbon-intensive. The average, undiscounted cash flow generation across all power plant units through the phase-out period is €11.79/ MWh.

A Comparison of Cumulative Cash Flows and Rehabilitation Liability

Finally, we combine these estimates of per MWh cash flows with actual power generation through the proposed phase-out period, to generate total cash flows across all power plants (See Figure 6). Annual cash flows rise initially, in line with an assumed rise in power prices, as discussed previously, in the first half of the 2020s. Cash flows then fall, as more power plants close and costs rise. Cumulative, undiscounted cash flows reach €5.0 billion, from 2018-2030. Applying a WACC of 7.2%, we derive a net present value (NPV) of cumulative discounted cash flows of €3.1 billion.

Comparing this NPV of €3.1 billion with the range of estimated rehabilitation liability, from €1.4 billion (Vattenfall's provision) to an upper estimate of €2.6 billion, we see that power plant profitability may be seriously impacted by the cost of rehabilitating the lignite mines.

Figure 6. Discounted and undiscounted cash flows, 2018-2030, € mln



Summary of Findings and Conclusion

IEEFA's findings are as follows:

There is ample precedent in Germany for taking a foundation approach to managing the Lausitz lignite liabilities. The owner-operator of the mines and power plants would retain ownership of the liabilities, but these could be placed in a Foundation, perhaps managed by LMBV, into which the owners would make upfront and regular contributions. The funds would be invested cautiously, to secure robust financial resources for funding mine rehabilitation as these costs fall due.

Vattenfall may have made inadequate provisions against the cost of rehabilitating its former lignite mines. We find that applying LMBV's actual rehabilitation cost per hectare would imply a liability almost double Vattenfall's provision, at €2.6 billion versus €1.4 billion. Uncertainty regarding the full rehabilitation liability underlines an urgency for the German government to commission its own estimate for clean-up costs in the lignite mining sector, as it has for nuclear power.

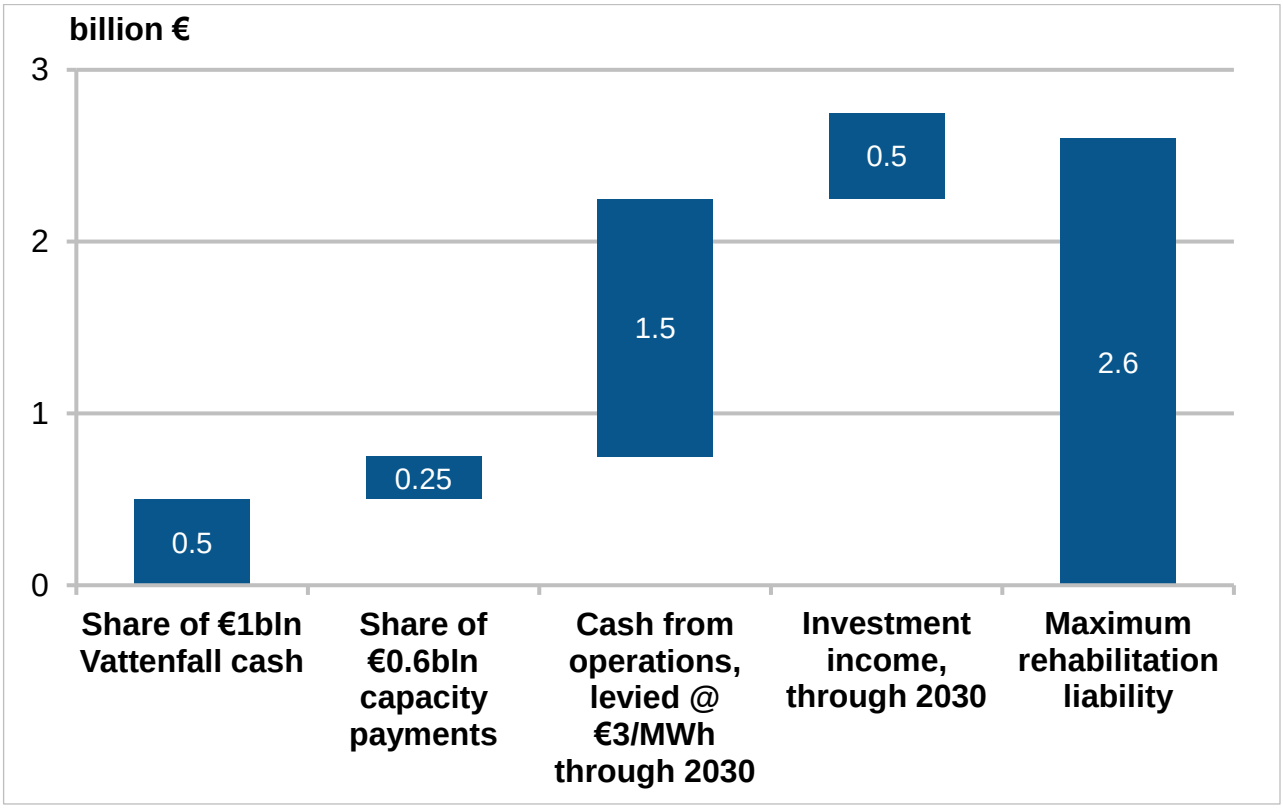
The estimated rehabilitation costs may seriously undermine the profitability of the associated lignite power plants. At the upper end of the range of estimated rehabilitation costs, these would consume more than half cumulative cash flows from the power plants over the phase-out period, of €3.1 billion, threatening the viability of the lignite business. As a result, German taxpayers may be left to fund a bailout, either to subsidise the power plants, or to plug a rehabilitation funding gap, or both.

We conclude that the lignite power plants in Lausitz may face difficulty in meeting the rehabilitation costs of their associated mines. Given that the asset owners are obliged to meet these costs, under Germany's Mining Act and according to the polluter pays principle, additional resources may be required.

Fortunately, under the terms of the transfer from Vattenfall, the buyers, EPH and PPF Investments, will receive €1 billion in cash. In addition, the power plant business will receive some €0.6 billion from the participation of two power plant units in a standby capacity reserve. IEEFA proposes that this cash be directly invested as seed finance in a foundation, which would be responsible for mine rehabilitation. This foundation would invest in capital markets as a means of diversify its asset base.

In addition, we propose a continuous levy of €3 per MWh of power generation from the power plants, to be paid annually into the foundation, depending on the actual, emerging costs of rehabilitation. These funds should be affordable, given an estimated average cash flow generation by the power plants through the phase-out period of €11.79/ MWh. Combined, these funds should allow for the sustainable operation of the power plants until phase-out in 2030, and full funding of the rehabilitation liability, without a taxpayer-funded bailout (see Figure 7).

Figure 7. Lausitz lignite owners can meet their mining rehabilitation liability using a share of cash windfalls



Important Information

IEEFA acknowledges certain assumptions in this study, including that:

- We have not analysed the cost of compliance with new, stricter pollution controls under the European Union's Industrial Emissions Directive, expected from 2021, which may substantially increase the costs of lignite power generation.
- We assume capacity factor falls over time, which will reduce profitability.
- We do not consider whether Vattenfall adequately provisioned pension and other liabilities associated with its former lignite business.

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