Lignite Retreat:

RWE's Short-Term Pain, Long-Term Gain

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Table of Contents

Executive Summary

Coal phaseout discussions are hot topics in Germany. Chancellor Angela Merkel's government has created a panel, dubbed the Coal Exit Commission, to propose a phaseout pathway before the end of the year, including an end-date for coal generation. RWE will be one of the company's most affected by this coming transition—60% of its installed generating capacity in Germany uses lignite or hard coal. Its Hambach opencast lignite mine in Nordrhein-Westfalen (North-Rhine Westphalia), lying within the world's largest lignite deposit, has become a lightning rod for the debate. RWE had planned to expand the mine, beginning in mid-October. However, the Münster Higher Administrative Court put those plans on hold over concerns about the neighbouring Hambach Forest. The mine's future is now in limbo, pending this legal process, and the proposals of the Coal Exit Commission.

RWE's CEO has stated that immediate closure of the Hambach mine would cost €4-5 billion, calculated as a combination of foregone profits from the related power plants, plus impacts on mine recultivation. Capital markets appear to agree that near-term closure would be bad for RWE; the company's share price fell sharply in the aftermath of the court ruling.

In this report, we explore the impact of halving RWE's lignite output at Hambach and the neighbouring Garzweiler mine. This stylised scenario is assumed to be in line with ambitious action both to protect the Hambach Forest and avoid further village relocations around Garzweiler. We note RWE's view that the Hambach Forest cannot be saved, regardless, because soil and rubble ("overburden") beneath the forest is required for mine recultivation. Under our scenario, we agree that RWE would post a loss on foregone lignite generation in the short term, but we find RWE benefits in the longer term.

- Our scenario would remove lignite equivalent to about 3.3 gigawatts (GW) of local generation, in addition to already planned and paid for power plant closures. By selecting older generation, these closures could be limited to units with an average age of 46 years, leaving remaining generation with an average age of 18 years. We assume that alternative uses of lignite, such as briquette manufacture, would be unaffected.

- Closing these ageing units would avoid capital expenditure (capex) to meet pollution limits that come into force in 2021. All but one of RWE's 11 local generation units presently exceed those limits. We estimate total upgrade capex at €200-600 million. We note risks associated with this capex, given forward power and carbon prices indicate that these 11 units, at the Niederaussem and Neurath power plants, will be barely profitable or loss-making in the 2020s.

- Halving lignite output could supercharge benefits from the strategic repositioning that RWE is already embarking on through acquisition of E.ON's renewable infrastructure assets. Our scenario could cement a stable revenue outlook, favoured by rating agencies, and increase the prospect for a higher ESG (environmental social governance) score, for example from avoided emissions of 26 million tonnes of CO_2 annually.

- On the down side for RWE, we note that halving lignite output could threaten its wider lignite operation. Fixed costs would be spread over less generation, making it even less competitive. Other additional costs may arise, from redundancies and accelerated recultivation. If the alternative is to keep mining at the present rate to achieve declining profitability, the question becomes: when does RWE want to stop running to stand still?

Introduction

A coal phaseout is a climate action priority for three main reasons. First, coal-fired power plants are the biggest single source of carbon emissions, accounting for more than a quarter of all global energy-related carbon dioxide emissions.[1] Second, alternative technologies are immediately available, such as renewable power. And third, it is one of the least-cost climate actions, given the alternatives are competitive and many coal power plants are old and fully depreciated.

Agreeing on a coal phaseout pathway is the subject of a German government-appointed panel called the Commission on Growth, Structural Change and Employment, or the Coal Exit Commission.[2] By the end of the year, the panel is expected to propose a date for closing the country's coal-fired power plants and develop transition plans for its coal and lignite mining regions.

Various studies have looked at a coal phaseout in Germany. One approach would be to set an end date, say 2030, and close power plants in reverse order of age or carbon intensity.[3] Other possible approaches include the introduction of stricter carbon dioxide or air pollutant emissions limits, or mandatory efficiency standards.[4] Regardless of the method chosen, any phaseout plan will have to address the related social and energy security impacts. In the case of domestically sourced coal, there will be mining job impacts, often in economically struggling regions. In addition, coal still plays an important part in the German national energy mix, with implications for security of supply. In 2018, through the end of September, hard coal and lignite accounted for 39% of the country's generation (14% and 25% respectively).[5]

The focus of this report is lignite mining in Nordrhein-Westfalen (North-Rhine Westphalia or NRW), the world's biggest deposit of lignite, a soft, brown coal, distinct from hard coal. We investigate the implications for RWE value of halving lignite production, a scenario we assume is compatible with preserving the Hambach Forest and avoiding further village relocations.

Mining in the region is owned by RWE and has attracted significant public attention because the next phase of production at the largest mine, Hambach, involves encroaching on the Hambach Forest. In September 2018, RWE started evicting long-standing protesters with the intent of completing that work by mid-October, preparatory to expanding the mine. However, in early October, the Münster Higher Administrative Court ruled that RWE must cease forest clearances, pending consideration of an appeal by Bund, the German environmental group. RWE protested the decision, warning of negative domino effects on production from the mine.[6] However, at present, the order stands, placing both the future of the forest and RWE's lignite mining in NRW in limbo.

[1] https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html and https://www.iea.org/weo2017/
[2] https://www.cleanenergywire.org/factsheets/germanys-coal-exit-commission
[3] https://www.oeko.de/fileadmin/oekodoc/Coal-phase-out-2035.pdf
[4] https://eeb.org/publications/60/mercury/52524/report-mercury-emissions-from-coal-power-plants-in-germany.pdf
[5] https://www.energy-charts.de/energy_pie.htm
[6] https://news.rwe.com/munster-higher-administrative-court-temporary-stop-of-hambach-forest-clearance-by-rwe-power/

How Important is the Hambach Mine to RWE?

Lignite Mining in the North-Rhine Westphalia Region

The Hambach mine is located in the Lower Rhine Basin, west of Cologne, alongside the Inden and Garzweiler mines (see Figure 1). Together, they represent the world's biggest single lignite deposit.[7]

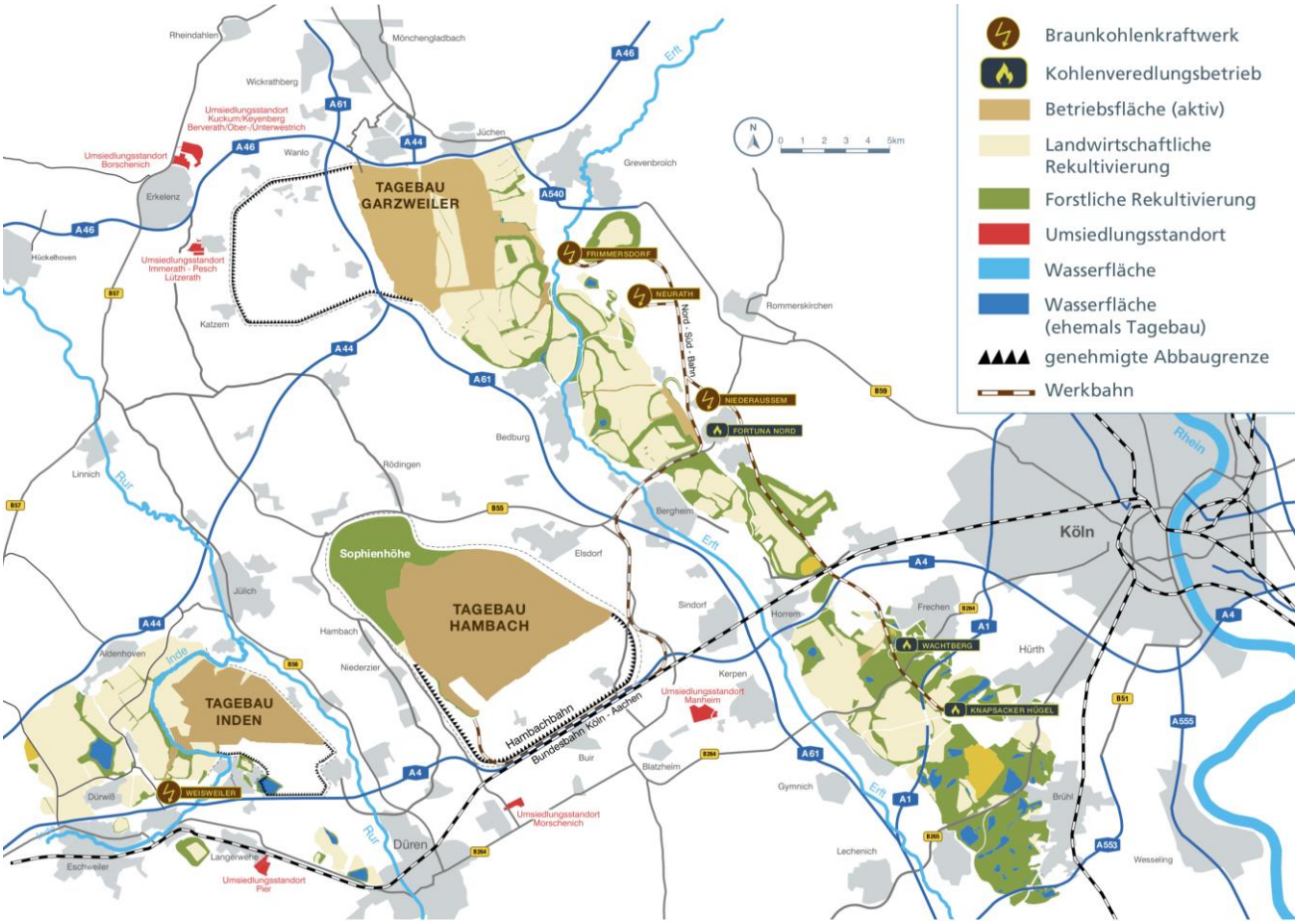
- Hambach has an operating area of 4,380 hectares (ha), within a wider, approved excavation area of 8,500 ha.[8] The mine produced 38.7 million tonnes in 2017, up 0.5% on the year before.[9] It has a total remaining coal capacity of 1.35 billion tonnes, implying an operating life of three decades.

- The Garzweiler mine has an operating area of 3,200 ha, within an approved mining area of 11,400 ha.[10] The mine produced 32.8 million tonnes in 2017, up 0.9% on the year before. It has a total capacity of 1.1 billion tonnes, also implying an operating life of more than three decades.

- The Inden opencast mine has an operating area of 1,700 ha within an approved mining area of 4,500 ha. It produced 19.8 million tonnes in 2017, up 1.5% on the year before. It has a total coal capacity of 260 million tonnes, implying an operating life of about a decade.[11] RWE states that the Inden mine and associated Weisweiler power plant will close by 2030. The Inden mine is a standalone facility with no logistical connection to the other regional lignite operations, and so is not further reviewed in this report.[12]

[7] https://www.hambacherforst.com/tagebauhambach/hambacherforst-tagebau/
[8] https://www.group.rwe/en/our-portfolio/our-sites/hambach-mine-site
[9] https://braunkohle.de/105-1-DEBRIV.html
[10] https://www.group.rwe/en/our-portfolio/our-sites/garzweiler-mine-site
[11] https://www.group.rwe/en/our-portfolio/our-sites/inden-mine-site
[12] https://www.gdmb.de/fileadmin/Verlag/Zeitschriften/WoMin/Teaser/WoMin_Teaser_2006_6_web.pdf

Figure 1. Hambach Mining Area



Source: DEBRIV.[13]

Lignite has a high water content, at around 55%, and so is not suited to long-range transport. Consequently, it is most commonly used as fuel for on-site power plants. It is also used to manufacture products such as lignite briquettes, as well as for local fuel operations. Table 1 shows the uses of lignite produced from RWE's NRW mines.

[13] "Braunkohle in Deutschland" - https://braunkohle.de

Table 1. Output and Uses of Lignite from North-Rhine Westphalia Mines

		Mln tonnes, 2016	Mln tonnes, 2017	% share in 2017	% Change 2017 vs 2016
Mine	Garzweiler	32.5	32.8	35.9%	0.9%
	Hambach	38.5	38.7	42.4%	0.5%
	Inden	19.5	19.8	21.7%	1.5%
	TOTAL	**90.5**	**91.3**	**100.0%**	**0.9%**
Lignite use	Utility & mine-mouth power plants	80.4	80.7	88.5%	0.4%
	Own consumption	5.4	5.6	6.1%	3.2%
	Lignite upgrading	4.4	4.6	5.0%	4.8%
	Sales to other buyers	0.2	0.2	0.2%	6.0%
	Sales to MIBRAG	0.1	0.1	0.1%	7.1%
	Change in stocks	0.0	0.0	0.0%	N/A
	TOTAL	**90.5**	**91.2**	**100.0%**	**0.8%**

Source: The German Lignite Industry in 2017.[14]

Lignite Power Plants in North-Rhine Westphalia

The three NRW lignite mines fuel four, large local power plants: Niederaussem, Neurath, Frimmersdorf and Weisweiler.

- The Niederaussem and Neurath plants are supplied by the Hambach and Garzweiler mines. RWE states that the two power plants ideally require a "special mix" of lignite from both mines.[15] Niederaussem units E and F were mothballed in 2018, prior to closure in 2022, under Germany's standby capacity reserve programme (see Table 2). Neurath unit C will be mothballed in 2019 prior to closure in 2023.

- The Frimmersdorf power plant was supplied by the Garzweiler mine. The remaining Frimmersdorf generation units were placed in standby last year, under the lignite reserve, and will close in 2021.

- The Weisweiler power plant is exclusively supplied by the Inden mine, and so is not reviewed in this report, given its independent status.

[14] https://braunkohle.de/105-1-DEBRIV.html
[15] RWE Investor Relations in correspondence with the authors of this report

Table 2. Overview of RWE Lignite Power Plants in North-Rhine Westphalia

Plant name	Gross capacity	Mothball date	Close date	Age now	Lignite burned (2016)	Generation (2016)	CO2 (2017)
	MWe	Date	Date	Years	mln tonnes	TWh	mln tonnes
Frimmersdorf P	315	Oct 1 2017	Sept 30 2021	52	1.95	1.91	
Frimmersdorf Q	308	Oct 1 2017	Sept 30 2021	48	2.23	2.19	
TOTAL	**623**				**4.17**	**4.10**	**3.58**
Niederaussem C	335			53	2.53	2.81	
Niederaussem D	320			50	2.64	2.60	
Niederaussem E	315	Oct 1 2018	Sept 30 2022	48	2.46	2.38	
Niederaussem F	320	Oct 1 2018	Sept 30 2022	47	1.80	1.77	
Niederaussem G	687			44	5.23	5.16	
Niederaussem H	687			44	4.49	4.47	
Niederaussem K	1012			16	4.54	6.00	
TOTAL	**3676**				**23.70**	**25.20**	**27.17**
Neurath A	312			46	2.33	2.16	
Neurath B	312			46	2.72	2.53	
Neurath C	312	Oct 1 2019	Sept 30 2023	45	2.47	2.28	
Neurath D	644			43	4.04	3.90	
Neurath E	644			42	5.21	5.03	
Neurath F	1100			6	6.61	7.54	
Neurath G	1100			6	7.32	8.33	
TOTAL	**4424**				**30.68**	**31.75**	**29.90**
GRAND TOTAL	**8723**				**58.55**	**61.05**	**60.66**

Sources: RWE; Europe Beyond Coal, EU CO_2 Union Registry, EEA LCPD Database.

Impact of Halving Lignite Output on RWE Power Generation

We estimate that the Niederaussem, Neurath and Frimmersdorf power plants consumed around 60 million tonnes from the Hambach and Garzweiler mines in 2016.[16] However, by 2019, this should fall to about 50 million tonnes, all else being equal, as the Frimmersdorf power plant is placed in the reserve, alongside two Niederaussem units and one Neurath unit (see Table 2 above).

Historically, utility-scale power plants have consumed nearly 90% of the output of NRW mines (Table 1). Applying this rate to our scenario of halved output from the Garzweiler and Hambach mines corresponds to around 30 million tonnes of lignite. We can conclude that the Niederaussem and Neurath power plants would have access to about 60% of their required annual consumption of 50 million tonnes. This 20 million tonne shortfall corresponds to closing 2.6 gigawatts of generating capacity, in addition to the 1.6GW already closing under the standby reserve.

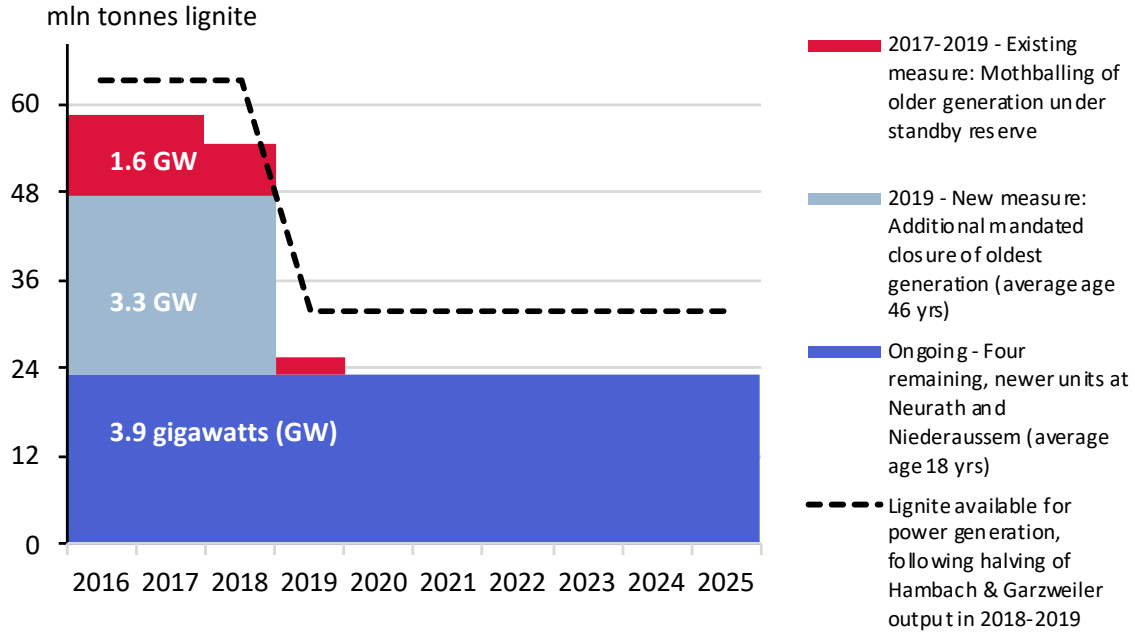
However, RWE reports that upgrading of lignite to products such as briquettes used by local cement, sugar and paper industries, depends entirely on the Hambach mine (corresponding to 4.6 million tonnes of lignite in 2017, see Table 1 above). As a result, we remove a further 687

[16] RWE declined to provide information on the exact origin of lignite used by each of these power plants.

megawatt (MW) generation unit, in our stylised scenario, so that briquette manufacture is less impacted by a halving of production at Hambach. In total, therefore, we remove 3.3GW of generation.

Figure 2 below summarises the discussion above. We find that by selecting older generation, RWE could limit the 3.3GW of closures to generation with an average age of 46 years, already beyond their expected operating life. These older units with a combined capacity of 3.3GW are: Niederaussem units C (53 years old), D (50) and G (44), and Neurath units A (46), B (46), D (43) and E (42). From 2019, under our scenario, RWE would continue operating 3.9GW of lignite plants, with plenty of lignite still available even after halving the output at Hambach and Garzweiler, with the aim of supplying alternative uses as discussed above.

Figure 2. Impact of Halving Output at Hambach and Garzweiler Mines (mln tonnes lignite/year)



Sources: IEEFA calculations; RWE.

Positive Impacts on RWE Value

Avoided Cost of Power Plant Upgrades

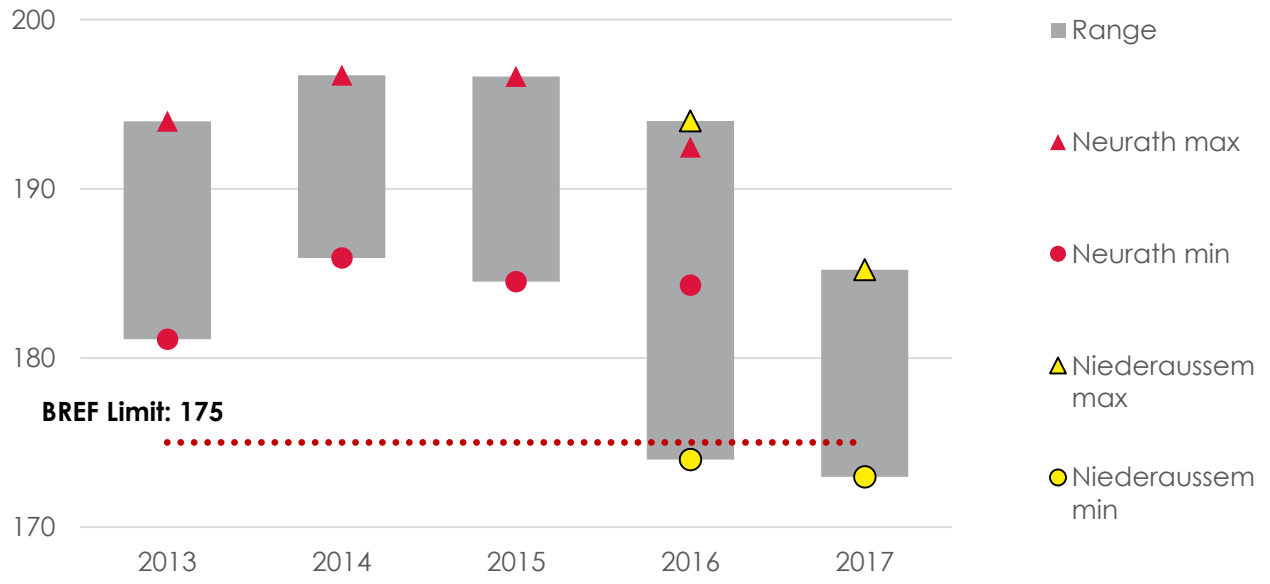
The EU's Industrial Emissions Directive (IED), requires large combustion plants (LCP) to use best available techniques (BAT) to control emissions of the main toxic air pollutants including oxides of nitrogen (NOx) and sulphur (SOx), as well as mercury and dust. Acceptable control techniques are updated approximately every eight years via a BAT reference document known as BREF. European Union member states agreed to new BREF emissions ranges in April 2017, with a compliance deadline no later than mid-August 2021.[17]

[17] The 2017 revised LCP BREF available here: http://eippcb.jrc.ec.europa.eu/reference/BREF/LCP/JRC_107769_LCPBref_2017.pdf

The new standards give owners of non-compliant units three choices: close or sell the units; invest in anti-pollution upgrades to make them compliant; or run them for fewer than 1,500 hours annually from 2021. The looming deadline means utilities must decide now which path to choose, since upgrading involves a multi-year process of tendering for and carrying out work.

Official emissions data indicate that Niederaussem and Neurath power plants are non-compliant, in particular with respect to NOx emissions.[18] From 2021, the maximum NOx emissions limit is 175 mg per standard cubic metre of flue gas (mg/Nm3). Environmental groups are pushing Germany to apply a stricter limit, ranging from 120-150 mg/Nm³, according to how long the plant wishes to continue to operate.[19] Figure 3 below shows that of the 11 units not already scheduled for retirement, just one (Niederaussem Block K) presently meets the 175 mg limit.

Figure 3. NOx Emissions by Niederaussem and Neurath Power Plants, 2013-2017 (mg/Nm3)



Source: IEEFA, Klima Allianz, EEB.[20]

The required capital expenditure (capex) to meet the new BREF limits will depend on the technology used. We note there would be additional downtime costs of several months' lost production to complete any retrofits.

For an upper estimate of BREF compliance costs, we assume all of RWE's older power plant units would have to retrofit selective non-catalytic reduction (SNCR) technology to achieve NOx emissions below 175mg. We assume that the new power plant units, Niederaussem K and Neurath F and G, would have to retrofit more expensive selective catalytic reduction (SCR) technology, to achieve lower emissions compatible with future, progressively stricter rounds of BREF controls.

[18] These data are not generally publicly available and were obtained by advocacy groups via freedom of information requests. Data were available for 2013-2016 for Neurath, and 2016-2017 for Niederaussem.
[19] The EEB expects the government to require stricter BAT ranges for NOx and mercury for plants wishing to operate beyond 2025. The EEB states that it intends to launch court cases at the level of individual emissions permits.
[20] http://eeb.org/publications/60/mercury/52524/report-mercury-emissions-from-coal-power-plants-in-germany.pdf

Table 3 summarises the resulting capex, using cost data published by the risk management company DNV, totalling nearly €600 million.[21]

For a lower estimate of BREF compliance costs, we use RWE's own calculation of "low three digit million euros", which we assume to mean around €200 million.[22] We note that large engineering projects of this calibre are rarely on budget or on time.

Table 3. Cost of Achieving BREF NOx Compliance

Power plant name	Installed capacity, MW	NOx emissions, mg/Nm3	BREF limit, mg/Nm3	Suggested upgrade	Capex, € mln
Neurath A	312	191.9	175	SNCR	15.6
Neurath B	312	191.0	175	SNCR	15.6
Neurath D	644	187.9	175	SNCR	32.2
Neurath E	644	192.5	175	SNCR	32.2
Neurath F	1,100	187.0	85	SCR	132.0
Neurath G	1,100	184.3	85	SCR	132.0
Niederaussem C	335	183.0	175	SNCR	16.8
Niederaussem D	320	185.2	175	SNCR	16.0
Niederaussem G	687	182.6	175	SNCR	34.4
Niederaussem H	687	179.9	175	SNCR	34.4
Niederaussem K	1,012	173.0	85	SCR	121.4
TOTAL					**582.5**

Sources: RWE; Advocacy groups; DNV.

Avoided Losses at Unprofitable Power Plants

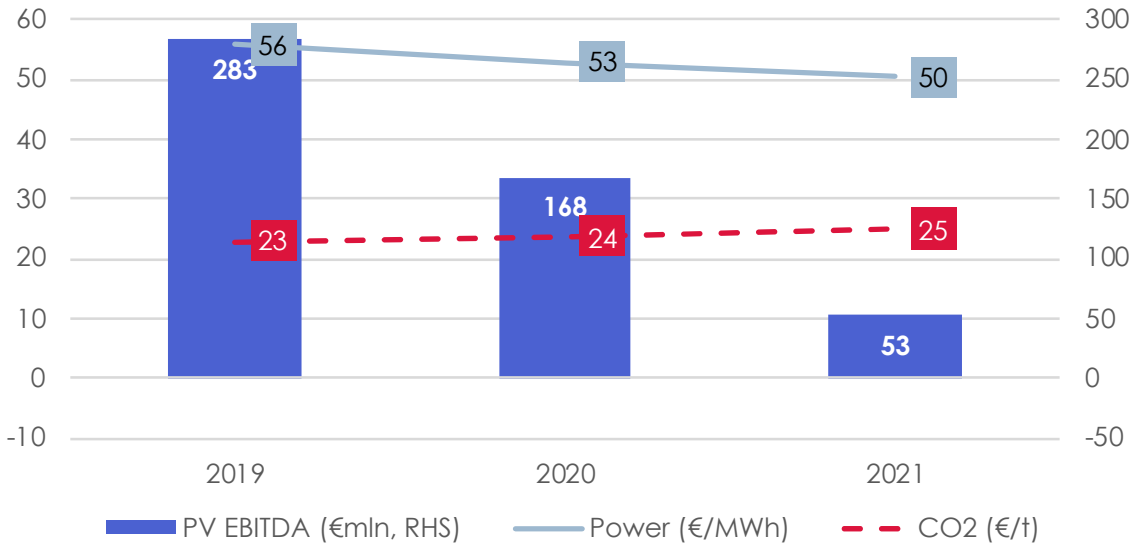
When the Münster court forced RWE to cease work in the Hambach Forest until an appeal by Bund, a German environmental group, was decided, the company warned that this would have an immediate impact on its lignite mining operations. The court ruling, RWE said, would cause an annual economic loss of "low three-digit million euro amount". The implication of RWE's statement is that these operations are at present profitable. We ran a simple discounted cash-flow (DCF) model to test whether these power plants are indeed profitable, and under what assumptions for power and carbon prices and running regimes. We base our model on current forward prices, to 2023 for power, and 2021 for carbon. We benchmarked our lignite cost assumptions to research from the OKO Institut/Agora and from Greenpeace/Brainpool (see the appendix for a description of the method used in our DCF and other details). In addition, we ran the same DCF using RWE's own estimate for its full lignite generation costs, at €22/MWh plus carbon costs. Our cost estimates were marginally higher than RWE's, resulting in a lower EBITDA.

Figure 4 below shows the present forward curves for carbon and power prices, before accounting for RWE power and carbon hedges. Figure 4 presents EBITDA estimates based on RWE's own generation cost data. The results reflect the fact that wholesale electricity prices in Germany are currently at historically high levels. The forward curve for German power closed on Friday 5 October at nearly €56/MWh for baseload power in calendar year 2019. Given this, even

[21] We use DNV estimates; for SNCR capex @ €50/kW and SCR capex @ €120/kW. Page 19 here: https://europeanclimate.org/wp-content/uploads/2017/06/16-1213-rev2-DNV-GL-report-ECF-BREF-LCP2.pdf
[22] As stated in correspondence with the authors of this report.

at very high carbon prices these affected lignite units are profitable. It should be noted that the current forward power market curve is in "backwardation", meaning power prices are higher in the near term, until 2021, when they start to increase marginally, while remaining well below current prices for year-ahead delivery (e.g., €56/MWh for 2019 vs €52/MWh for 2023). By contrast, the forward curve for EU allowances (carbon emission certificates) shows price rises over the period. As a consequence, power plant profits fall sharply moving from 2019 to 2023.

Figure 4. Impact of Current Forward Curve (2019-21) for Power and Emissions on Neurath's EBITDA on a Present Value Basis



Sources: IEEFA, EEX.

However, the combination of prices displayed by the current forward curve that generates a positive EBITDA in our model (e.g. baseload power >€50/MWh, EUAs >€20/t) is actually out of RWE's reach when we take its hedges into account. RWE has already sold forward (or has an implicit hedge on) more than 90% of its production values for 2018-2020.[23] With its hedging practices, RWE has secured a very low financial cost for its carbon certificates (EUAs), buying the vast majority at a price of €5-6/t, equivalent to €6-7/MWh. By contrast, EUAs for the 2019 contract trade today at more than €21/t. However, RWE also has sold more than 90% of its power production for 2018-2020 over the past years, when prevailing power prices were exceedingly low. RWE states that it achieved a realised power price of €31/MWh in 2017, which it expects to fall to €28 in 2018.[24] When we use this combination of power prices (revenues) and EUA prices (costs) in our model for the Neurath plant in 2019, EBITDA falls to below €50 million, compared with €283 million as indicated by our DCF model when using current forward prices.

All in all, our modelling shows generating margins to be compressed going forward, with all Niederaussem and Neurath generating units becoming only marginally profitable under central scenarios from around 2022. To make matters worse, RWE has already sold most of its production forward to 2020, at least, and cannot take full advantage of current high power prices.[25] Factoring in the age (46 years) of the 3.3GW of power plant closures under our scenario, and the

[23] https://www.group.rwe/-/media/RWE/documents/05-investor-relations/2018-Q2/RWE-Presentation-H1-2018.pdf
[24] See slide 41 in RWE's 2018 "Company Presentation", here - https://www.group.rwe/en/investor-relations/financial-reports-presentations-videos/presentations
[25] We note that RWE also operates a commercial asset optimisation unit (CAO) capable of adding (according to RWE) a further €2-3/MWh on top of hedging activities.

extra capex cost of the required BREF upgrades as discussed above, we are unconvinced of a significant net cashflow benefit from continuing to operate them beyond 2021. In conclusion, we agree with RWE that there would be a short-term annual loss through 2021. Beyond that date, we believe closing the older units would be financially prudent.

Benefit from Accelerated Repositioning into Renewables

In March 2018, Germany's two biggest utilities E.ON and RWE announced an exchange of assets and businesses that will result in RWE focusing on power generation and E.ON on networks and retail.[26] As a result of the transaction, RWE will own and operate some 8GW of renewables generation, including hydropower, wind and solar. The transaction will make RWE the third biggest renewables business by capacity in Europe, after Iberdrola and Enel. RWE stresses that it will have a diversified portfolio, However, its enlarged renewables business will dominate EBITDA.[27] We note expected 171% growth in renewables EBITDA in 2020 versus 2017, compared with a 3% decline in lignite and nuclear (see Table 4 below).

Credit rating agencies favour the E.ON-RWE transaction, because of the lower market risk and regulatory character of renewables assets.[28] This positive view of renewables assets was previously seen in agencies' reaction to RWE's spin-out of its retail, grid and renewables businesses into a new subsidiary, Innogy, in 2016. Fitch and Moody's now rate RWE at BBB and Baa3 respectively, and Innogy at A- and Baa2.[29] RWE itself recognises that its improving strategic outlook is founded on transforming itself into a major renewables player, and that coal and lignite represent the high-risk segment of its portfolio.[30]

Table 4. Analyst 2020 Estimates for RWE Adjusted EBITDA, Versus 2016-17 Actual (€ mln)

Year	TOTAL	Renewables	Lignite & Nuclear	European Power	E.ON dividend	Supply & Trading	Grid	Retail	Other
2016	5,403	671	1,079	377	N/A	-139	2,622	1,057	-264
2017	5,756	694	671	463	N/A	271	2,874	1,005	-222
2020e	3,445	1,879	653	474	221	212	0	0	87
2020/2017, %	**-40%**	**171%**	**-3%**	**2%**		**-22%**			**-139%**

Source: RWE.[31]

[26] https://news.rwe.com/en/eon-and-rwe-two-european-energy-companies-focus-their-activities/
[27] This is an RWE summary of analyst forecasts, as of July 30 2018. The analysts comprise: BAML, Berenberg, Bernstein, Commerzbank, Credit Suisse, Goldman Sachs, Jefferies, Macquarie, Morgan Stanley, Oddo Seydler, Raymond James, RBC, Santander, Société Générale. RWE publishes a summary here - https://www.group.rwe/en/investor-relations/the-rwe-share/analyst-recommendations-and-consensus
[28] Moody's restored RWE's rating to stable
[29] RWE and Innogy ratings here: https://www.group.rwe/en/investor-relations/bonds-and-rating; https://iam.innogy.com/en/about-innogy/investor-relations/bonds/credit-rating
[30] See slides 7-8 in RWE SRI presentation in 2018: https://www.group.rwe/en/investor-relations/financial-reports-presentations-videos/presentations
[31] Sources: 2017 annual reports for RWE and Innogy; and RWE's summary of analyst 2020 estimates.

A Faster Rise Through ESG Rankings

ESG refers to the measurement of how a company performs against environmental, social and governance metrics. Investors are increasingly interested in ESG products, partly because strong ESG metrics are linked with good investment performance, and partly because investors are increasingly keen to align with ESG issues such as sustainable development. Strong ESG performance is also seen as an indicator of preparedness for a low-carbon transition. One development in this regard has been the recommendations of the global Financial Stability Board's taskforce on climate-related financial disclosure (TCFD). The TCFD's September 2018 status report recommended that companies and investors specify concrete strategies for identifying and mitigating climate risk, a recommendation likely to be adopted by national financial regulators.[32] Fossil fuel companies that appear poorly prepared for tougher carbon policies are likely to be more exposed, and thus subject to growing divestment pressures.

RWE has historically scored poorly against environmental ESG criteria, including both bottom-up metrics such as carbon intensity, and more top-down measures such as preparedness for tougher climate policies. The completion of the RWE-E.ON transaction will improve RWE's bottom-up ESG score, as it ramps up its share of renewables generation. A willingness to accelerate its transition away from coal would support its top-down ranking. Regarding selected, specific measures of social and environmental performance, we calculate that early retirement of 3.3GW of older lignite generation, associated with halving lignite output (see Figure 2 above), would avoid emissions of about 26 million tonnes of CO_2 annually, more than 40% of RWE's total CO_2 emissions from NRW power plants in 2017.

Strategic Engagement with Germany's Coal Exit Commission

RWE is certain to be affected by Germany's Coal Exit Commission, and especially its lignite operation in NRW. At present, RWE states that it intends to exit lignite generation by 2050.[33] This will certainly be beyond any likely coal exit date set by the commission. It makes financial sense for RWE to stand by its lignite assets, not least to maximise potential compensation for mandated early retirement. But it also makes sense to engage with the phaseout process since changes are coming, probably more quickly than imagined even 2-3 years ago. The October 2018 report of the UN's Intergovernmental Panel on Climate Change (IPCC) underscored the importance of an accelerated transition and decarbonisation efforts by all. Retrofitting end-of-life, out-dated coal power plants does not fit with this strategy.

Negative Impacts on RWE Value

Foregone Compensation

As noted above, there is direct, recent precedent in Germany for operators of aging, highly polluting, lignite power plants to be paid to shut them early. In the case of the standby capacity reserve, three utilities agreed in 2015 to mothball and close eight lignite generation units with a combined capacity of 2.7GW in return for compensation totalling €1.6 billion. The owners, Mibrag, RWE and Leag, will mothball their units for four years each, from 2016-2023, before closing them.

[32] https://www.fsb-tcfd.org/publications/tcfd-2018-status-report/
[33] Page 20, RWE 2017 annual report - https://www.group.rwe/en/investor-relations/financial-reports-presentations-videos/financial-reports

RWE was the chief beneficiary, owning five of the eight units: Frimmersdorf units P and Q, Niederaussem units E and F and Neurath unit C.[34]

It would clearly be financially prudent for RWE to delay any closure until the outcome of the Coal Exit Commission and determine then whether it can negotiate compensation for premature asset closures. But we note that the standby capacity reserve was negotiated when RWE was under severe financial stress, having been forced at the time to scrap its dividend and watch its shares fall to an all-time low.[35] It may not be so favoured by a taxpayer bailout a second time.

Accelerated Recultivation Costs

In late September, RWE chief executive Rolf Martin Schmitz told public broadcaster ZDF that immediate abandonment of the Hambach mine would cost €4-5 billion.[36] Schmitz attributed this in part to a technically challenging mobilisation of rubble to stabilize existing mining edges. However, after considering readily available evidence we find that this cost estimate appears high, as discussed briefly below.

RWE was unable to provide a detailed breakdown of the €4-5 billion figure, but stated that it would include items such as:[37]

- Lost revenue from power generation and refining products. As discussed, our analysis suggests that these units will only be comfortably profitable until the early 2020s at best.
- Costs for safety and service operations during the 15-year approval process for the new permits. This item is unclear and beyond the scope of this report.
- Mine recultivation costs, which RWE is already liable for and has budgeted for, but whose funding might now be brought forward. RWE's lignite mining provision is presently €2.3 billion.

Recultivation refers to the process of returning mining sites and facilities to productive use once mining is finished. Such recultivation is required under Germany's 1980 Mining Law (Bundesberggesetz). Coal mining utilities discount expected recultivation costs according to standard discount rates. In the case of RWE, the applicable real discount rate for lignite mine recultivation presently is 1.3%, resulting in a budgeted cost today of €2.3 billion. Given that RWE anticipates lignite mine recultivation work to continue through 2100, immediate Hambach mine closure could bring forward some planned work resulting in higher costs in present value terms. In addition, RWE may incur extra costs, given such mine closure would be unplanned. We acknowledge such higher costs are possible, but detailed analysis is beyond the scope of this report, absent more transparent reporting by RWE. We also note that there is no escaping responsibility for mine recultivation, regardless of its precise timing.

[34] http://ec.europa.eu/competition/state_aid/cases/261321/261321_1762503_157_2.pdf
[35] https://www.rwe.com/web/cms/en/113648/rwe/press-news/press-release/?pmid=4014653
[36] https://uk.reuters.com/article/us-rwe-coal/mining-halt-at-germanys-hambach-forest-would-cost-rwe-up-to-5-9-billion-zdf-idUKKCN1M10VK
[37] Correspondence between RWE Investor Relations and the authors of this report on Sept 27, 2018.

Appendix: DCF Methodology – Estimation of Prices for Lignite, Wholesale Power and EUAs

In our simplified discounted cash flow (DCF) model, we use forward curve values for prices for German power (2019-2023), and EUAs (2019-21), as of October 5, 2018. As a caveat, it should be noted that our DCF calculations represent a static, single-date value. In addition, forward curve values beyond 2021 should be approached with caution due to low liquidity. In the DCF model, values for power prices, fuel and emission costs beyond 2023 for power, and beyond 2021 for CO_2 are assumed to escalate at 1%/yr. Similarly, we assume the relationship between lignite, power and CO_2 prices is "locked" as of 2021, when in reality it might change. In other words, values beyond 2021 for these variables are close to being simply illustrative, as well as the resulting cash flows. Only 2019 and 2020 DCF numbers based on October 5, 2018 forward curves should be relied upon.

Calculation Method

We used a DCF approach to value RWE's lignite power plants in Germany, focusing on Neurath (blocks A, B and E-G) and Niederaussem (blocks C, D, G, H and K). According to a standard DCF methodology, the value of an asset is determined by its capacity to generate future cash flows for the company. The net cash flow generated by the firm's assets is often referred to as free cash flow (FCF). FCF represents the cash generated from the firm's asset-based activities – namely, the operating and investing (but not financing) activities for any given asset. For our valuation of RWE's lignite power plants, we focused on EBITDA (earnings before interest, tax, depreciation and amortisation) as an estimate of free cash flow, noting that this is an overstatement given the absence of stay-in-business maintenance capex. We discounted yearly EBITDA at a nominal rate of 2% to assess the power plant in present value terms. EBITDA is a function of sales minus variable and fixed costs, briefly summarised:

- Sales – Key relevant variables include power and heat sales and grid support services. In this study we focused on power sales as the main determinant of revenues. We base our projections on actual 2016 fuel intake and operating hours.

- Variable operating costs – Key relevant variables include: fuel cost; cost of carbon emissions permits; and the cost of equipment operation and maintenance (O&M). In this study, we benchmarked our lignite cost assumptions to research from the OKO Institut/Agora and from Greenpeace/Brainpool, and used a proxy for O&M costs derived from EIA and Greenpeace/Brainpool estimates.[38]

- Fixed operating costs – Relevant variables include IT, head office and personnel costs. We used a proxy for fixed costs, also derived from Greenpeace/Brainpool values.

[38] https://www.agora-energiewende.de/fileadmin2/Projekte/2017/Deutsche_Braunkohlenwirtschaft/Agora_Die-deutsche-Braunkohlenwirtschaft_WEB.pdf
https://www.energybrainpool.com/fileadmin/download/Studien/Studie_2015-10-20_Greenpeace_Study_on_Lignite_Power_Plants_EnergyBrainpool.pdf
https://www.eia.gov/analysis/studies/powerplants/capitalcost/pdf/capcost_assumption.pdf

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