



Vattenfall's Risky Business

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Risks of Vattenfall's German Lignite Mining and Power Operations - Technical, Economic, and Legal Considerations

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Executive Summary

The Swedish state-owned energy utility Vattenfall and its owner are currently examining strategy options to address its own ambitious sustainability targets as well as the low-carbon objectives of the Swedish government. With more than 60 million tons of CO₂ the company's German lignite mining and power operations impose an increasing risk on its business. While Vattenfall's Scandinavian generation structure corresponds to a high degree to its CO₂ target, the German lignite business puts a heavy burden on the company's aspirations. In this respect there is need for action.

The objective of this policy report is to identify the major trends that shape Vattenfall's future lignite strategy and to highlight the major risks of the German lignite mining and power operations. This will be done from a technical, an economic, and a legal perspective. The continuation of Vattenfall's German lignite operations is contradictory with both, the energy and climate strategy of the Swedish government, and the German energiewende; neither does it suit well with the 100% renewables strategy proposed by the Land of Brandenburg. The report evaluates the options that Vattenfall has in the current situation. It is based on a variety of reports published by DIW Berlin concerning the future of lignite in the context of the German energiewende (e.g. see Oei, et al., 2014a).

The main Western countries pursuing climate policies are turning away from coal and from lignite, due to the high environmental costs and the uncertain economic prospect. Thus, the USA, Canada, and the UK have de facto banned or are about to ban the construction of new coal power plants, by implementing emission performance standards (EPS). The previous hope of "clean coal" raised by the CO₂-capture, transport, and storage technology (CCTS) has failed and is no longer an option in the foreseeable future. Vattenfall itself was engaged in the failed idea of "clean coal" through CCTS, both in Germany and worldwide. Thus, the social costs of lignite, which are estimated to value approximately 80-100 €/MWh are two to three times higher than the electricity price of currently less than 35-40 €/MWh in Germany. As a consequence, phasing out lignite is not only necessary from an environmental point of view, but is also economically efficient and thus advisable.

The unconstrained operation of Vattenfall's German lignite activities is not compatible with its internal CO₂ target. With over 70 of a total 88 million tons of CO₂ the German emissions surpass the company's CO₂ budget for the year 2020, which is 65 million tons. Hence, there is urgent need for adjusting these emissions. One option to reduce these emissions is the closure of several lignite units in Lusatia.

Major risks to Vattenfall are furthermore its inconsistency of its lignite operations with the objectives of the German energiewende, which consists of, among other things, a nuclear power phase-out by 2022, greenhouse gas emissions reduced by 80-95% by 2050 (baseline: 1990), at least 80% renewable-based electricity by 2050, as well as efficiency tar-

gets. The phase-out of coal and lignite is part of this process, since there is no space for inflexible and CO₂-intensive lignite plants in a sustainable electricity system. Currently, ministries on national level are discussing greater contributions of the energy industry. In addition, there is a variety of propositions for the structured phase-out of lignite power in Germany. These propositions will also play a role in the discussion about the introduction of potential capacity payments for dispatchable power.

From a legal point of view the opening of new mining sites (current discussions focus on Welzow Süd TF II and Nochten II; Vattenfall, however, does have plans for additional sites also in Jänschwalde Nord, Bagenz-Ost and Spremberg-Ost) represents a further risk: A verdict of the German constitutional court from December 2013 not only strengthened the rights of affected citizens. It also put stricter requirements to the right to expropriate land owners. At the same time, our analysis shows that Vattenfall's currently operating lignite plants (Jänschwalde, Schwarze Pumpe, Boxberg, Lippendorf, and Berlin-Klingenberg) can be supplied by existing mines until the end of their expected economic lifetime in the 2030s, so that there is no need to open any of the new lignite mines under consideration. Since lignite will no longer be needed in the mid-term future there is no legal foundation for the expropriation of citizens in favour of unnecessary resources.

Clearly Vattenfall is facing technical, economic, and legal risks in its German lignite operations that make it not only politically but also economically difficult to sell these operations in the short term. Until now, no investor has shown any interest in either the Lippendorf power plants, or any other particular unit in Lusatia. On the other hand, both from a Swedish and a Lusatian perspective, restructuring the existing operations and developing them coherently with Vattenfall's sustainability strategy is the better option. This entails the definition of a structured phasing-out of lignite mining and electrification, and to seize the multiple options offered by the German energiewende, e.g. in renewables, storage, power-to-gas, and other technologies compatible with the energiewende.

Sammanfattning

Energibolaget Vattenfall och dess ägare svenska staten undersöker hur man ska kunna uppfylla Vattenfalls ambitiösa hållbarhetsmål samt den svenska regeringens utsläppsmål. Vattenfalls brunkolsverksamhet i Tyskland släpper ut över 60 miljoner ton koldioxid varje år, och innebär en allt större risk för företagets affärsverksamhet. Trots att Vattenfalls skandinaviska delar i stort ligger i linje med bolagets utsläppsmål, är den tyska brunkolsverksamheten en stor börda för företagets strävanden. I detta avseende behövs handling.

Syftet med denna rapport är dels att kartlägga de viktigaste trenderna som kan komma att forma Vattenfalls framtida strategi för brunkol, dels att belysa de största riskerna med den tyska brunkolsverksamheten. Dessa aspekter kommer att behandlas utifrån ett tekniskt, ett ekonomiskt och ett rättsligt perspektiv. I rapporten utvärderas de olika alternativ som Vattenfall har för närvarande. Den baseras på flera olika rapporter som publicerats av DIW Berlin, det tyska institutet för ekonomisk forskning, och som behandlar brunkolens framtid i Tysklands övergång till förnybara energikällor ("Energiewende"). För mer information se Oei, et al. (2014a).

Flera västländer med klimatpolitiska mål tar avstånd från stenkol och brunkol eftersom miljökostnaderna är höga och de ekonomiska utsikterna osäkra. USA, Kanada och Storbritannien är därför på väg att förbjuda, eller har redan förbjudit, byggandet av nya kolkraftverk genom att fastställa utsläppsnormer. Förväntningar på att kolkraften skulle kunna klimatanpassas tack vare koldioxidavskiljning och -lagring (CCTS), har hittills inte kunnat infrias. Tekniken, som lanserats som "clean coal", kommer därmed inte vara ett aktuellt alternativ inom en överskådlig framtid. Vattenfall har varit mycket engagerad i att utveckla tekniken kring CCTS, i Tyskland och andra delar av världen, utan att den har kunnat få ett genombrott. Samhällskostnaderna för brunkol, vilka uppskattas till 80 - 100 euro MWh, är två till tre gånger högre än det nuvarande elpriset i Tyskland, vilket för närvarande är mindre än 40 euro MWh. Dessa siffror visar att det inte bara är nödvändigt att utveckla brunkolsverksamheten ur ett miljömässigt perspektiv, utan även ur ett ekonomiskt.

Brunkolsverksamheten i Tyskland är inte förenlig med Vattenfalls egna utsläppsmål. Utsläppen i Tyskland uppgår till över 70 miljoner ton av företagets totalt 88 miljoner ton koldioxidutsläpp, och de tyska utsläppen överstiger Vattenfalls utsläppsmål för år 2020, vilket ligger på 65 miljoner ton. Följaktligen är det brådskande att minska utsläppen. Ett alternativ är att utveckla delar av kolverksamheten i Lausitzområdet.

En annan risk för Vattenfall är att brunkolsverksamheten är oförenlig med målen för Tysklands Energiewende som bland annat fastställer: att kärnkraftverken ska ha avvecklats år 2022, att utsläppen av växthusgaser ska ha minskat med 80 - 95 procent år 2050 (jämfört med nivån 1990), att minst 80 procent av energin ska vara förnybar år 2050 samt att uppsatta energieffektiviseringsmål ska uppnås. Utvecklingen av stenkol och brunkol är en del av denna process eftersom det inte finns plats för dåligt anpassade, koldioxidintensiva kolkraftverk i ett hållbart energisystem. För närvarande diskuterar departement på nationell nivå

Sammanfattning

huruvida energiindustrin borde bidra med större insatser. Dessutom finns flera förslag om hur en strukturerad avveckling av brunkolsverksamheten i Tyskland ska gå till. Dessa förslag kommer också att spela en roll i diskussionen om möjligheten att introducera ett betalningssystem för reglerbara energianläggningar baserat på kapacitetsförmåga.

Ur ett rättsligt perspektiv skulle öppnandet av två nya brunkolsdagbrott (här diskuteras Welzow Süd TF II och Nochten II, men Vattenfall har även planer för fler dagbrott, Jänschwalde Nord, Bagenz-Ost och Spremberg-Ost) innebära ytterligare en risk. En dom från Tysklands författningsdomstol i december 2013 stärkte inte bara de berörda medborgarnas rättigheter – den skärpte också kraven för expropriation av mark. Eftersom brunkolen i de planerade dagbrotten inte kommer att behövas framöver finns det ingen rättslig grund för att expropriera mark till fördel för resurser som inte fyller någon funktion. De existerande brunkolsdagbrotten tillhandahåller tillräckligt med energi för att driva kraftverken Jänschwalde, Schwarze Pumpe och Boxberg. Nya dagbrott är därför inte nödvändiga.

Det är tydligt att Vattenfalls tyska brunkolverksamhet står inför tekniska, ekonomiska och rättsliga problem som gör det politiskt och ekonomiskt svårt att sälja de tyska anläggningarna inom den närmaste framtiden. Ingen investerare har hittills visat intresse för Lippe-dorfkraftverken eller något av de andra verken och gruvorna i Lausitz. Från både ett svenskt och ett lokalt perspektiv, vore det bättre att omstrukturera de befintliga anläggningarna och utveckla dem i enlighet med Vattenfalls hållbarhetsstrategi. Det kräver en strukturerad avveckling av brunkolsverksamheten och att man tar fasta på de många alternativen som Tysklands Energiewende erbjuder, till exempel gällande förnybar energi, energilagring, el-tillgas och andra teknologier som är i samklang med Energiewende.

Zusammenfassung

Der staatliche Energiekonzern Vattenfall sowie sein Eigentümer, der schwedische Staat, bereiten derzeit die Anpassung der Unternehmensstruktur an die Nachhaltigkeitsziele des Konzerns sowie die anspruchsvollen energie- und klimapolitischen Ziele Schwedens vor, u.a. in Bezug auf den Einsatz erneuerbarer Energieträger und die weitgehende Dekarbonisierung des Energiesystems. In diesem Zusammenhang stellt das kontinentale und insbesondere das deutsche Geschäft ein Problem dar: Während der skandinavische Teil der Nachhaltigkeitsstrategie weitgehend entspricht, ist das deutsche Braunkohlegeschäft weder in Bezug auf den CO₂-Ausstoß noch in Bezug auf Erneuerbarenziele nachhaltig. Hier besteht dringender Handlungsbedarf für die Konzernleitung.

Die vorliegende Studie untersucht die technischen, wirtschaftlichen und rechtlichen Risiken des deutschen Braunkohlegeschäfts von Vattenfall im Kontext der energie- und klimapolitischen Rahmenbedingungen in Schweden und Deutschland sowie insbesondere in der Lausitz. Die Darstellung erlaubt eine Einschätzung der Handlungsoptionen, die Vattenfall in der gegenwärtigen Situation besitzt. Die Arbeit baut auf einer Vielzahl früherer Gutachten und Forschungsberichten des DIW Berlin zur Zukunft der Braunkohle im Rahmen der Energiewende auf, s. Oei, et al. (2014a).

Weltweit orientieren sich Länder mit einem vormals hohen Anteil an Energie aus Kohlekraftwerken an einem Kohleausstieg, so z.B. die USA, Kanada sowie das UK, welche strenge CO₂-Emissionsgrenzwerte bereits beschlossen haben oder dies in absehbarer Zeit vorhaben. Die vormals gehegte Erwartung an eine CO₂-arme Kohleverstromung durch CO₂-Abscheidung, -Transport sowie -Speicherung (carbon capture, transport, and storage, CCTS) hat sich nicht erfüllt und wird nicht ernsthaft weiterverfolgt; sie stellt auch für Vattenfall bzw. die Lausitzer Braunkohle keine Option dar. Der Ausstieg aus der (Braun-)Kohle ist bei anspruchsvollen Klimaschutzzielen unvermeidlich und er ist auch aus ökonomischer Perspektive effizient: Die sozialen Kosten der Braunkohle sind wesentlich höher als der gehandelte Wert des produzierten Stroms an der Strombörse. Diese Kosten beinhalten Treibhausgasemissionen, Stickoxid-, Schwefeloxid-, Staub- sowie Quecksilberemissionen, Grundwasserabsenkungen, Fließgewässerverschmutzungen, Lärmbelästigungen durch den Tagebaubetrieb und teilweise erzwungene Umsiedlungen, die mit dem Abbau von Braunkohle einhergehen. Die resultierenden externen Kosten werden auf ca. 80-100 €/MWh geschätzt, also ein Mehrfaches des Großhandelsstrompreises von ca. 35-40 €/MWh.

Die deutschen Braunkohleaktivitäten von Vattenfall sind weder mit den Energie- und Klimaschutzzielen der schwedischen Regierung noch den internen Nachhaltigkeitszielen von Vattenfall kompatibel. Mit über 70 Mio. Tonnen CO₂-Ausstoß (von insgesamt ca. 88 Mio. t) übersteigt allein der deutsche Betriebsteil das gesamte CO₂-Budget des Konzerns in Höhe von 65 Mio. t im Jahr 2020. Es besteht daher ein dringender Anpassungsbedarf zur Verringerung dieser Emissionen, insbesondere bei den deutschen Braunkohlekraftwerken, was durch die Schließung von Kraftwerksblöcken in der Lausitz erzielt werden kann.

Die Braunkohlestrategie ist auch nicht mit den mittel- und längerfristigen Zielen der Energiewende in Deutschland kompatibel, welche neben dem Atomausstieg bis 2022 auch eine Reduktion der Treibhausgasemissionen um 80-95% (Basis: 1990), einen Anteil von über 80% Erneuerbarer am Stromverbrauch sowie die Erreichung von Effizienzzielen vorsieht. Aufgrund der hohen CO₂-Intensität sowie der Inflexibilität von Kohlekraftwerken bedeutet die Energiewende mittelfristig den Kohleausstieg. Diskussionen zur Erreichung der Klimaschutzziele nehmen derzeit Fahrt auf, insbesondere das Aktionsprogramm Klimaschutz 2020 sowie der Klimaschutzplan 2050. Darüber hinaus liegt eine Vielzahl von Vorschlägen zur Strukturierung des (Braun-)Kohleausstiegs in Deutschland vor, welche insbesondere in der bevorstehenden Diskussion um Kapazitätsinstrumente eine Rolle spielen werden.

Die ökonomischen, technischen und rechtlichen Risiken des Braunkohletagebaus und der –verstromung in der Lausitz sind erheblich. Trotz relativ niedriger variabler Kosten ist das gesamte „Geschäftsmodell Braunkohle“ im Rahmen der Energiewende gefährdet; im Rheinland werden bereits Tagebaue und Kraftwerke vorzeitig geschlossen. Der Neubau von Kraftwerken bzw. der umfangreiche Retrofit sind unrentabel. Technische Risiken wie Erdbeben sowie Wasserverschmutzung auch durch neue Tagebaue haben sich in den vergangenen Jahren verstärkt; es ist unklar, ob die staatliche Bergbaufolgegesellschaft (LMBV) nach wie vor für all diese Schäden, deren Höhe noch dazu unbekannt ist, aufkommen wird.

Aus rechtlicher Perspektive stellt der geplante Aufschluss neuer Tagebaue (die Diskussionen konzentrieren sich derzeit auf Welzow Süd TF II und Nochten II; Vattenfall beabsichtigt jedoch mit Jänschwalde Nord, Bagenz-Ost und Spremberg-Ost noch drei weitere Neuaufschlüsse) ein weiteres Risiko dar: Das Urteil des Bundesverfassungsgerichts vom 17. Dezember 2013 stärkt nicht nur die Rechte der Betroffenen, sondern verschärft auch die Anforderungen an die „Gemeinwohlbegründung“ für Enteignungen und Umsiedlungen; da Braunkohle im zukünftigen deutschen Energiesystem nicht mehr systemkritisch ist, besteht auch kein übergeordneter Grund mehr zu ihrer Erschließung. In den vorhandenen Tagebauen lagern zudem ausreichend Vorräte zur Versorgung der drei Kraftwerke Jänschwalde, Schwarze Pumpe sowie Boxberg, sodass der Aufschluss neuer Tagebaue energiewirtschaftlich nicht notwendig ist.

Die wirtschaftlichen, technischen und rechtlichen Risiken für das Lausitzer Braunkohlegeschäft von Vattenfall sind somit erheblich. Auch widersprüche der Verkauf der Sparte der energie- und klimapolitischen Ausrichtung der schwedischen Regierung und träge auf geringes Kaufinteresse. Im Sinne der schwedischen Eigentümer sowie der deutschen und Lausitzer Energiepolitik bietet sich deshalb eine Umstrukturierung an, welche den schrittweisen Braunkohleausstieg mit der Stärkung nachhaltiger erneuerbarer Energieaktivitäten in der Region verbindet.

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1 Introduction

The Swedish state-owned energy utility Vattenfall and its owner are currently considering strategies to deal with the highly CO₂-intensive German lignite mining and power operation, that do not correspond to neither the sustainability goals of the company, nor to the energy policy of Sweden. Once a stable source of income for Vattenfall, these activities are now facing serious technical, legal, and economic risks that increase the pressure on the company and its owners to act. The objective of this policy report is to highlight the risks of Vattenfall's German lignite mining and power operations, and to discuss the implications thereof. The study is based on earlier studies of DIW Berlin on the future of coal and lignite in Germany, in the framework of the energiewende, the most recent ones being Oei et al. (2014a, 2014b).¹

The report is structured in the following way: the next section briefly describes the structure of Vattenfall, which is divided in an almost carbon-free activity in Scandinavia and a CO₂-intensive, lignite-based activity in Germany. Sections 3 to 6 then spell out risks for Vattenfall, organized by geographical level from more general levels down to the operational level: Section 3 explains why coal, in particular lignite, is not a sustainable energy source in any part of the Western world any more, given the high negative environmental effects. "Clean coal", e.g. through carbon capture, transport, and storage (CCTS), is no longer an option. Thus, coal will disappear from the energy mix of countries pursuing stringent climate policies, such as the USA, Canada, and the UK. Section 4 describes the contradiction between Vattenfall's sustainability targets for greenhouse gas emissions, and the growing political and societal pressure on the company to reduce its CO₂-footprint. Section 5 explains why lignite will be phased out rapidly in Germany, in the context of the energiewende that seeks to reduce greenhouse gas emissions by 80-95% and increase the share of renewables in electricity consumption beyond 80% (by 2050). The discussion on concrete instruments to gradually phase out coal has begun, and both the national government and the Länder agree

¹Previous publications, mainly in German language, are available from DIW Berlin's website at: http://www.diw.de/de/diw_01.c.359590.de/publikationen_veranstaltungen/publikationen/aktuelle_schwerpunkte/aktuelle_schwerpunkte.html

on a future without lignite. The concrete risks from Vattenfall's lignite mining and power plants in Lusatia (Eastern Germany) are described in section 6: They range from technical risks such as water pollution and landslides, to economic risks like uneconomic power plants, to legal risks like losing the court cases on the opening up of two new lignite mines (Welzow-Süd TF II and Nochten II).

Section 7 discusses some implications of Vattenfall's "risky business": Selling the German lignite business is neither an economic nor a political option. Instead, the potential of the energy region Lusatia should be used to phase out lignite, to convert the activities towards technologies consistent with the *energiewende* and the sustainability objectives of the company and its shareholders. Examples include lucrative renewables and new technical solutions such as storage and power-to-gas technologies. Section 8 concludes.

2 Vattenfall's Current Challenges

2.1 A hybrid energy group with a lignite legacy in Germany ...

Vattenfall is a state-owned company. It is one of the largest utilities in Europe, and the largest in Scandinavia. Over the last two decades, the company has engaged into the continental European markets, e.g. in Poland, Germany, the Netherlands, and the UK, some of which has already been divested (e.g. all Polish operations). Vattenfall's activities are concentrated in two organizational units: Nordic (operating in its home market of Sweden as well as Finland and Denmark), and Continental/UK. Vattenfall's most important markets are Sweden, Germany, and the Netherlands with the remaining markets being considerably smaller (Figure 1).

Over the last years, Vattenfall and its owner, the Swedish government, have engaged into an ambitious sustainability strategy, in line with the Swedish decarbonization targets. In this context, the focus is on renewable energies; thus, Vattenfall's sustainability performance report for 2012 states that, "a cornerstone of Vattenfall's long-term strategy is to reduce negative exposure to rising CO₂ prices by reducing emissions from the Group's portfolio and increasing the Group's investments in low-emitting electricity generation" (Vattenfall, 2013, p. 28).

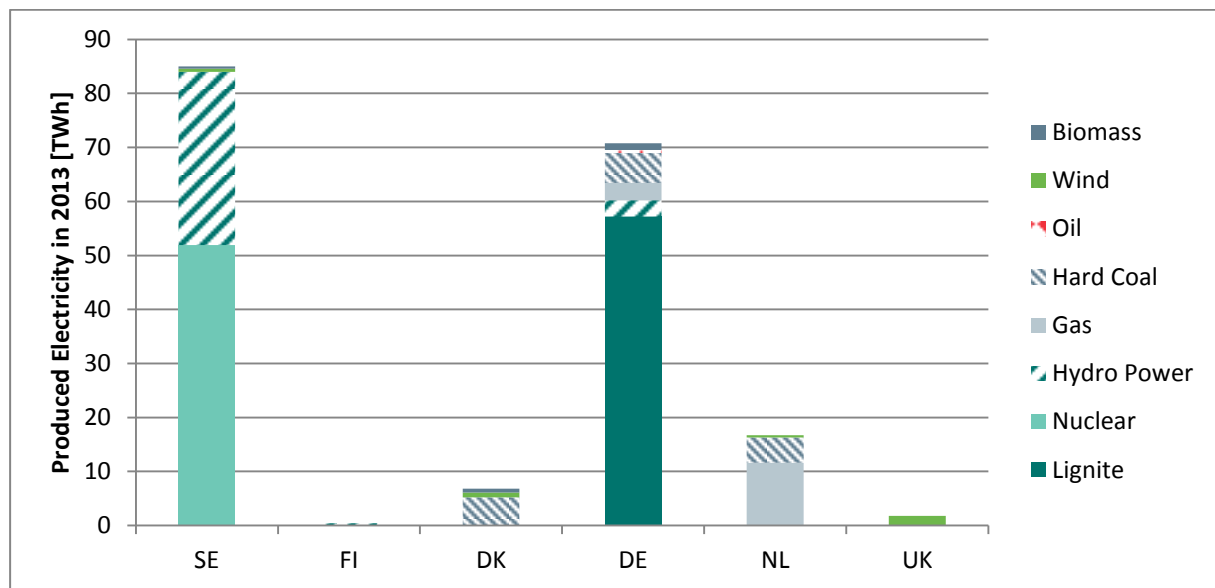


Figure 1: Portfolio of Vattenfall in the different countries

Source: (Vattenfall, 2014)

However, Vattenfall is currently trapped in a hybrid corporate structure. While its Nordic operations are virtually carbon free, and the Dutch activities are focusing on gas, Vattenfall's German operations are based on the most CO₂-intensive energy carriers of all: Lignite. Figure 1 shows the dilemma: The Nordic unit's electricity generation mix is dominated by nuclear power – 52% in 2013 – followed by hydro power with 41%. Finland, Denmark, the UK and the Netherlands are small operations with a variety of fuels. But the “big elephant” in the group's portfolio is Germany, 85% being based on lignite.²

2.2 ... facing a difficult energy economic context

Like all conventional electricity generators in Europe, Vattenfall is facing difficult market conditions. The low-carbon transformation engaged by many governments, stricter envi-

² Vattenfall's activities in Germany started with the acquisition of Hamburgische Electricitäts-Werke AG (HEW), Vereinigte Energiewerke (VEAG), Lausitzer Braunkohle (Laubag) and Berliner Bewag in the years 2000 till 2002. Several claims from the German government to VEAG and Laubag, originating from their privatization after the reunification of Germany, were dropped in this process as the German government was interested in gaining another strong player for the market. Vattenfall, on the other hand, guaranteed a continuation of the lignite electrification in Eastern Germany of at least 50 TWh per year until 31.12.2011 as well as 500 new apprenticeships until 2005. Additional payments for the extraction rights of the lignite mines in Lusatia were estimated to sum up to 412 million €. (See: Stromtarifrechner 19.02.2002: Vattenfall Europe: Weichenstellung erfolgt <http://stromtarifrechner.de/news.php?id=2617>)

ronmental regulation, and decreasing profits have led to a downgrading of many utilities. Consequently, the cost of capital for utilities is rising, leading to divestment of assets (Greenpeace, 2014). Table 1 lists the ratings of the four largest power companies in Germany, all of them ranging between the lowest A to the highest B category.³ The May 2014 outlook of S&P certifies Vattenfall a business risk of “strong” due to the risk of negative political intervention and a financial risk of “significant”, which is negatively affected by a high debt ratio and pressure on operating cash flows. S&P as well as Moody's already incorporated an uplift by one notch in their rating for Vattenfall due to its ownership by the Swedish government.⁴

Rating Agency	Vattenfall	RWE	E.ON	EnBW
S&P Jan 2008	A-	A+	A	A-
S&P July 2014	A-	BBB+	A-	A-
Moody's Jan 2008	A2	-	-	A2
Moody's July 2014	A3	Baa1	A3	A3

Table 1: Change in credit ratings of Germany's four largest energy utility companies, 2008-2014

Source: Websites of Vattenfall, RWE, E.ON, and EnBW as well as Greenpeace (2014).

In 2013 Vattenfall accounted for impairment losses of about 30 billion SEK (approx. 3.24 billion €) before taxes, which was mostly based on the poor economic prospects of thermal power plants, in particular gas. Vattenfall's Dutch business accounted for impairment losses of 14.1 billion SEK (approx. 1.52 billion €), and Germany for 4.1 billion SEK (approx. 0.44 billion €). This corresponds to the return on capital employed (ROCE) of -2.1%, which still amounted to +8.3% in 2012 (Vattenfall, 2014). In the second quarter of 2014, Vattenfall reported significantly lower impairment losses than in 2013 (0.7 billion SEK), but asset revaluation is not yet finished. Vattenfall's situation remains challenging as net sales are diminishing both in the Nordic (3.3% less in q2/2014 compared to q2/2013) and in the Continental/UK (-5.3%) segments. Compared to q2/2013, the second quarter of 2014 elec-

³An A indicates a “strong capacity to meet financial commitments, but somewhat susceptible to adverse economic conditions and changes in circumstances”, while a B stands for “adequate capacity to meet financial commitments, but more subject to adverse economic conditions”.

⁴Standard & Poor's Rating Services. Ratings Direct. Vattenfall AB. Alf Stenqvist, Stockholm. May 6, 2014 and Moody's Investors Service: Credit Opinion: Vattenfall AB. Global Credit Research. Stockholm. July 15, 2014.

tricity generation decreased by 4.8%; mostly attributable to reduced output (-8.6%) in the Continental/UK segment.⁵

In addition to the difficult economic context, Vattenfall’s continental business leads to additional risks that are described in the following sections: the phase-out of coal in the Western world, mounting pressure on sustainability targets in Sweden, the incompatibility of the German operations with the objectives of the *energie-wende*, and risks resulting from the lignite operations in Lusatia.

3 Risks from Decarbonization in the Western World and the End of “Clean Coal”

3.1 The phase-out of coal in Western countries

A major risk for any coal company in the Western world is the trend to phasing out coal from the energy mix. This process is currently ongoing in some of the major producers such as the USA, Canada, and the UK, and it is likely to spread rapidly to continental Europe as well. The reference is the internationally agreed objective for climate mitigation, i.e. to keep the average atmospheric temperature increase below 2°C, compared to the pre-industrial era. According to the Intergovernmental Panel on Climate Change (IPCC), this implies that the majority of existing fossil reserves have to remain in the ground unspent.⁶ According to Leaton (2011), complying with a total emissions limit of 886,000 Mt CO₂ proposed by the IPCC would reduce the probability of exceeding the 2°C target to 20%. However, the IPCC (2011) shows that the global fossil fuel reserves amount to approximately 2,800,000 Mt CO₂, which is more than three times this budget. Additionally, between 2000 and 2010, CO₂ emissions of approximately 320,000 Mt were already realized, more than a third of the 50-year budget (Leaton, 2011, p. 6). This means that it is not the availability of fossil fuel sources that will

⁵The report does not specify the specific generation technologies involved, but it is likely that much of the reduction is due to reduced lignite generation: electricity generation from lignite in Germany (including non-Vattenfall generation) fell by 4% in the first half of 2014 (compared to the first half of 2013). Fraunhofer Institute for Solar Energy Systems (Fraunhofer ISE) attributes this decline to favorable weather conditions for renewable power and correspondingly higher renewable generation, see Fraunhofer Institute for Solar Energy Systems(2014): Electricity production from solar and wind in Germany in 2014, retrieved July 29, 2014, from <http://www.ise.fraunhofer.de/en/downloads-englisch/pdf-files-englisch/data-nivc-/electricity-production-from-solar-and-wind-in-germany-2014.pdf>.

⁶IPCC (2011): Renewable Energy Sources and Climate Change Mitigation, Geneva/Switzerland, fig. 1.7.

limit its use, but rather a “climate constraint” imposed by public policy striving to stay within the 2-degree limit. This implies that carbon-intensive assets will lose much of their intrinsic value in the future. This is especially relevant for lignite as it has the highest CO₂-intensity among all fossil fuels used in thermal power plants.⁷

Several Western countries are undertaking steps to phase out coal. Thus, California, the largest U.S.-State, has implemented CO₂ emission performance standards (EPS), which de facto prohibits coal-based electricity in the future. In June 2014, US President Barack Obama announced the U.S.-wide Clean Power Plan, an initiative aiming to reduce CO₂ emissions from power plants, especially from coal, by 30% till 2030 compared to 2005 levels;⁸ EPS being part of this package. Two more traditional coal countries have also already banned the future use of coal, by introducing CO₂-EPS: Canada, and the UK (Ziehm, et al., 2014).

3.2 ... is economically efficient ...

From a public policy perspective, the phase-out of coal, and in particular lignite, is efficient, since the costs to society of this fuel are significantly higher than its benefits. In addition to production costs, lignite mining and burning generates a high level of additional environmental and other costs: In addition to greenhouse gases, burning lignite also produces large amounts of nitrogen oxides, sulphur oxides, mercury, and particulate matter; it also contributes to irregularities in groundwater and water pollution (e.g. through iron oxides), causes the displacement of towns and villages, and the loss of home for people. This means that burning lignite creates costs rather than adding value to society.⁹

Figure 2 shows the discrepancy between the high social costs of lignite, estimated between € 80-110/MWh, and the wholesale price, which is below € 35-40/MWh. This implies that lignite electricity costs about 2-3 times more than it is worth; a clear indication that phasing out lignite is economically efficient.

⁷ Average CO₂ intensity of German power plants: gas: 411, coal: 902, lignite: 1161 g/kWh (UBA, 2013: Entwicklung der spezifischen Kohlendioxid- Emissionen des deutschen Strommix in den Jahren 1990 bis 2012 (Dessau: Umweltbundesamt).

⁸By 2030, carbon emissions from the US power sector are to be reduced by 30% compared to 2005, the baseline year (EPA, 2014: <http://www2.epa.gov/carbon-pollution-standards/fact-sheet-clean-power-plan-overview>).

⁹ Off course, there are also non-monetary costs associated with the displacement of towns and villages. Historically, displacements have caused the loss of homes for over 120,000 people in Germany alone. For more information see www.archiv-verschwundene-orte.de.

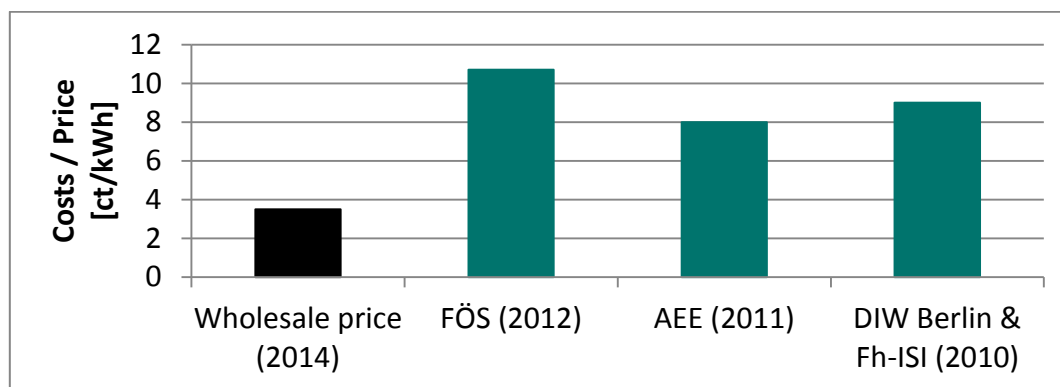


Figure 2: External costs of lignite and the current electricity price in Germany

Source: Own depiction based on Küchler and Meyer, (2012), Mühlhoff, (2011) and Breitschopf and Diekmann (2010).

3.3 ... and “clean coal” is no longer an option

One of the reasons that many governments are now phasing out coal is that they do not believe in “clean coal” technologies in the foreseeable future any more. In particular, there are no prospects for carbon capture, transport, and storage (CCTS) any longer, which has for a long time been used to justify long-term plans for lignite. Indeed, when the CCTS (carbon capture, transport, and storage) euphoria unfolded in the early 2000s, some researchers promoted this technology as a major breakthrough in the combat against climate change. Advocates of the technology assumed that the instrument would assure the survival of the coal and lignite industry. (von Hirschhausen et al., 2012)

Contrary to these expectations, however, CCTS did not take off in Europe, and there is little probability that it ever will. As of 2014, no CCTS demonstration projects have been completed, neither in the energy nor in the industry sectors. Calls for CCTS development have subsided and plans for a pan-European pipeline network have been shelved. One observes that the USA, Canada, and Norway have shifted attention to using captured CO₂ for enhanced oil recovery (EOR), which has little to do with a low-carbon technology. European countries with ambitious CCTS R&D and demonstration projects, such as the UK, the Netherlands, Germany, and Poland, have delayed or shelved all major pilot projects (see Figure 3). (Oei et al., 2014a)

Vattenfall represents the ambitions and the failure of the CCTS technology more than any other company. The oxyfuel pilot project at the Lusatian lignite power plant

SchwarzePumpe was one of the first world-wide, going into operation in 2008. Ambitious projects were undertaken for two demonstration units. The first one was supposed to be operating with an oxyfuel process, the other one with post-combustion, both at Jämschalde power plant. However, Vattenfall has shelved all CCTS projects and abandoned the technology. Further, Vattenfall’s original plans to retrofit the coal-fired power plant Moorburg in Hamburg with a capturing unit were also cancelled as it would have resulted in a 40-60% cost markup compared to constructing the plant without the capturing unit.¹⁰ In the first half of 2014, Vattenfall sold parts of their engineering facilities¹¹ and stopped its research activities in the field of CCTS, putting a definite end to this vision of “clean coal”.¹²

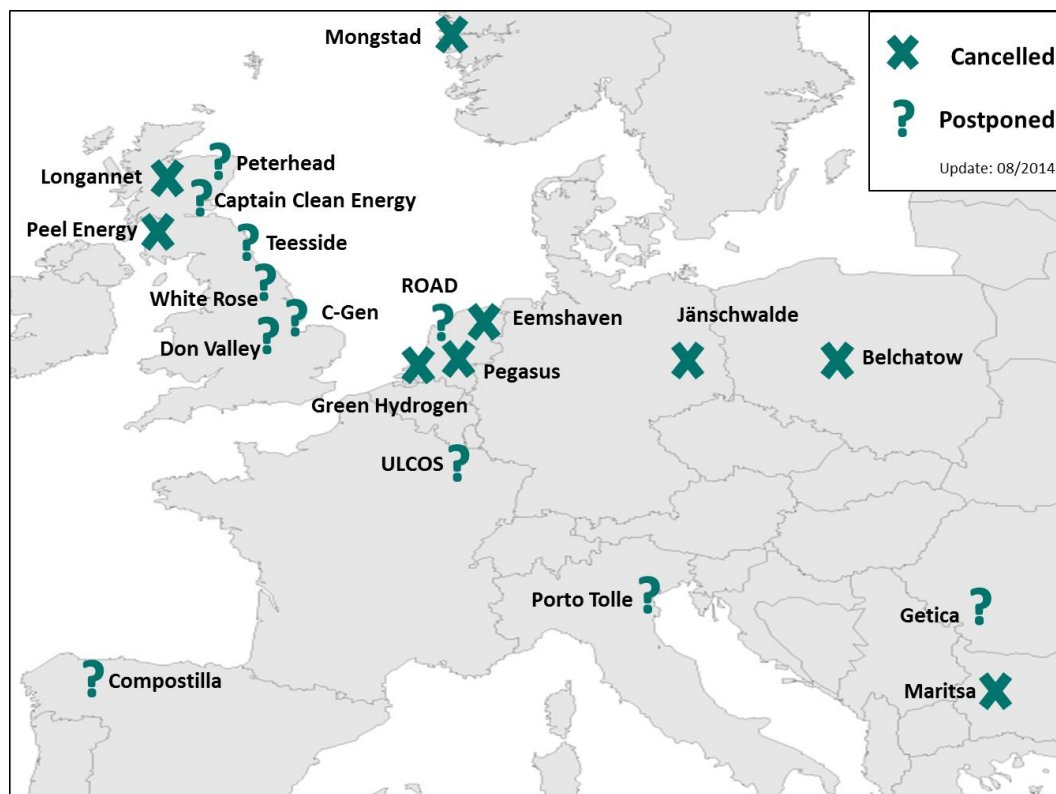


Figure 3: Cancelled and postponed CCTS-projects in Europe since 2011

Source: Oei et al., (2014a).¹³

¹⁰These cost figures were made public by Vattenfall after a request from Greenpeace according to the German Transparenzgesetz (transparency law) in June 2014.

¹¹ Vattenfall (2014): Vattenfall verkauft seine Ingenieurgesellschaft Vattenfall Europe PowerConsult GmbH (VPC) an den Private Equity Investor palero. Press release 27.02.2014.

¹² Vattenfall (2014): Vattenfall entscheidet sich für effiziente Forschungsprojekte zur Unterstützung des operativen Geschäfts. Press release 06.05.2014.

¹³ Data based on GCI (2011, 2013): The Global Status of CCS (Canberra, Australia: Global CCS Institute) and MIT (2013): Carbon Capture and Sequestration Technologies Program.

4 Risks of Incompatibility with the Climate Policy of the Swedish Government

4.1 Stringent CO₂-reduction goals ...

With CO₂ emissions of 70.7 million tons in 2012 Vattenfall is one of the biggest single GHG emitters in Germany. In its sustainability performance report for 2012 Vattenfall states that, “a cornerstone of Vattenfall’s long-term strategy is to reduce negative exposure to rising CO₂ prices by reducing emissions from the Group’s portfolio and increasing the Group’s investments in low-emitting electricity generation” (Vattenfall, 2013, p. 28). In addition, the report states that Vattenfall’s overall CO₂-emissions will be reduced from currently over 80 million tons (in total) per year to 65 million tons by 2020, a goal confirmed in Vattenfall’s 2013 annual report. This means that the 2013 emissions level of 88.4 million tons of CO₂ must be reduced by 26.5% until 2020 (s. Figure 4).¹⁴

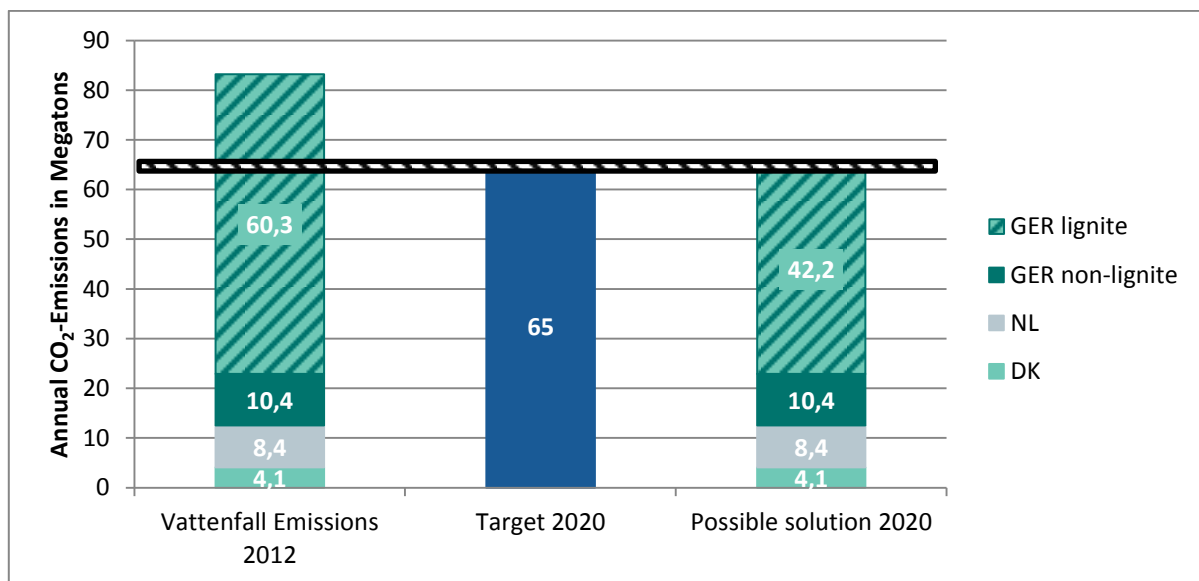


Figure 4: CO₂-emissions of Vattenfall in 2012 and its set target for 2020¹⁵

Source: Own illustration based on (Vattenfall, 2014, 2013)

A major risk consists of surpassing the self-set targets of 65 million tons of CO₂ in 2020 (e.g. in the Annual and the Sustainability Report). The main contributors to the compa-

¹⁴Vattenfall’s commitment to reduce CO₂ emissions dates back to the year 2010 and was linked to the vision of CCTS (carbon capture, transport, and storage), which will not come into practice.

¹⁵ The CO₂-emissions of Sweden, UK and Finland are < 1 million t and are not depicted in the graph.

ny's emissions are its lignite power plants. Most capacities are located in the Lusatian district in the eastern part of Germany (s. Table 4). Consequently, both German and European GHG rules significantly affect Vattenfall. This reduction can be achieved by reducing the output of carbon-intensive assets or by selling (shares of) operational units. In this respect, German lignite, which is responsible for approximately a third of Vattenfall's electricity generation and two-thirds of its CO₂ emissions, offers the highest potential for emission reduction.

4.2 ... now put pressure on Vattenfall

Vattenfall's stake- and shareholders are highly sensitive regarding sustainable and responsible business. The company is fully owned by the Swedish state. Clearly the high CO₂-intensity of Vattenfall is contradictory with the strategy of its shareholder, the Swedish Government. Overall, Sweden is pursuing an ambitious decarbonization policy, with a 40% GHG reduction target until 2020, and full decarbonization until 2050.¹⁶ It is clear that a high-carbon strategy of its major energy company Vattenfall is no option for the Swedish government. In its latest annual and sustainability report, Vattenfall reports how its stakeholders rank the company's various sustainability efforts in importance. Stakeholders ranked "shifting the energy mix in order to lower CO₂-emissions and increase renewables" as their primary goal (Vattenfall, 2014, p.18).¹⁷

The political pressure for Vattenfall to reduce its CO₂-intensity is mounting as the Swedish Parliament and the Government have already prescribed strict objectives. Thus, in 2010, the Swedish Parliament passed an "ownership directive, stating that "Vattenfall is to generate market returns by commercial energy business so that it belongs to one of the leaders in developing environmentally sustainable energy production".¹⁸ Despite references in its sustainability report, Vattenfall has not yet followed suit on this request; in particular, its German lignite strategy has remained unchanged. However, during a talkshow before the

¹⁶ See International Energy Agency (2014): Sweden: 2013 Policy Review. Paris, OECD.

¹⁷In a survey conducted by TNS SIFO for Greenpeace, 77% of the Swedish people voted to stop Vattenfall's plans for new lignite mines. Also, two out of three people would prefer if the Swedish government would encourage a shift away from fossil fuels towards renewable energy sources in Vattenfall's portfolio. <http://www.greenpeace.org/sweden/se/press/pressmeddelanden/Svenska-folket-sager-nej-till-Vattenfalls-planer/>

¹⁸ Sveriges riksdag (2010: Förtydligande av uppdraget för Vattenfall AB (No. 2009/10:NU23). Stockholm.

election in September 2014 members of all Swedish parties declared that they agreed on curtailing Vattenfall's lignite activities in Germany in the future.¹⁹

5 Risks Related to the Energiewende in Germany

5.1 The renewables-based decarbonization (energiewende) ...

The decision of the German government and society to pursue a renewables-based energiewende is an existential risk to Vattenfall's German operations, focusing on lignite. Traditionally a coal-intensive country,²⁰ Germany has made a clear decision to phase out nuclear, decarbonize the energy sector by 80-95%, and to base almost the entire electricity consumption on renewable energies (> 80%, see Table 2). The government's "Energiekonzept" of September 2010, in combination with the nuclear phase-out decision (June 2011) is commonly called "energiewende" (Von Hirschhausen, 2014). It has been confirmed by the new government in place since early 2014 (grand coalition), and is supported by all parties in parliament, thus providing a firm framework for the long-term development.²¹

With respect to the renewables targets, the energiewende is on track. Several updates of the EEG (2005, 2009, 2012, 2014) have not changed the philosophy of the renewables policy within the energiewende, i.e. a fine differentiation by technology, site, size, and other criteria. Feed-in tariffs were gradually reduced, more or less corresponding to cost reductions in renewable electricity. In 2013, Germany broke the threshold of 25% renewable electricity generation, and in the first half of 2014, a record share of 28.5% was obtained (see Figure 5).

¹⁹ RBB Online: Schwedische Spitzenpolitiker für Kohle-Ausstieg - Keine konkreten Verkaufspläne bei Vattenfall <http://www.rbb-online.de/wirtschaft/thema/kohle/welzow/beitraege/schwedische-parteien-gegen-braunkohletagebau-von-vattenfall.html> 09.09.2014.

²⁰ Germany's industrial development since the 19th century is closely linked to the exploitation of coal. The most important German lignite sources are found in North Rhine Westphalia (NRW) and in two Eastern German regions: the "Central German" district around Leipzig and the district of Lusatia around Cottbus where Vattenfall is active. Together with nuclear power, lignite and hard coal shaped the backbone of Germany's electricity infrastructure in post-World War II Germany. In the first half of 2014, 45% – 183 TWh – of Germany's electricity originated from coal and lignite.

²¹ Stricter regulation of fossil fuel sourced power is also welcomed by the German society. A survey by TNS Emnid (2014) shows that 87% of the Germans would like to see lignite electrification disappear by 2030. Only 11% of the people surveyed found it justified to relocate entire villages for the opening of new open-cast lignite mines.

	Nuclear Production ²²	Minimum Share of Renewable Energy		Reduction of GHG emissions
		Gross final energy consumption	Electricity Generation	
Base line	2010	-	-	1990
2015	53%			
2017	44%			
2019	40%			
2020		18%	35%	40%
2021	20%			
2022	0%			
2025			40-45%	
2030		30%	50%	55%
2035			55-60%	
2040		45%	65%	70%
2050		60%	80%	80-95%

Table 2: Targets of Germany’s energiewende

Source: Own depiction based on the 2013 government coalition agreements.²³

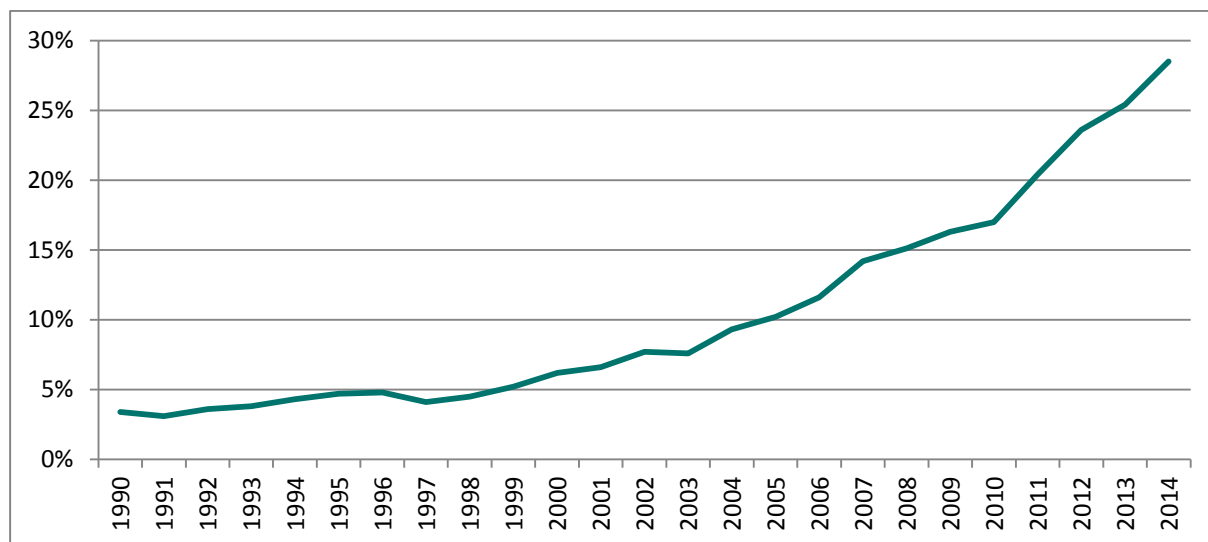


Figure 5: Share of renewables in German electricity generation (1990-2014)

Source: German Ministry of Economy and Energy (BMWi).²⁴

²²All nuclear power plants must shut down no later than December 31, 2022.

²³ Source: CDU, CSU, and SPD (2013). Deutschlands Zukunft gestalten, Koalitionsvertrag. Berlin.

²⁴Figure for 2014: Approximation for the first six months according to BDEW (2014): <http://www.bdew.de/internet.nsf/id/20140729-pi-erneuerbare-energien-erreichen-neuen-rekordwert-de>

The greenhouse gas emission targets are particularly important in the context of the energiewende. Figure 6 shows that Germany is currently not on track with respect to its target of reducing GHG by 40% before 2020. Germany’s Federal Ministry for the Environment (BMUB) estimates that current policies will lead to reductions of only about 33%, implying that further measures will be needed in the near future. Consequently, the BMUB announced that a draft program of measures to close this gap will be released in autumn 2014.²⁵ As the electricity sector is a very large source of GHG and offers an over-proportional potential for emissions reductions, it is clear that structural changes in the electricity sector offer a path to achieving the 2020 emissions goals. According to the Ministry of Environment, the power sector should play a significant role in reaching the climate targets contributing more than 50% of the overall reduction until 2020. This implies a reduction by 111 to 136 million t in the upcoming years (s. Figure 7). A separate Climate Action Plan for 2050, expected to be adopted in 2017, will add further measures to reach the national climate targets beyond 2020.

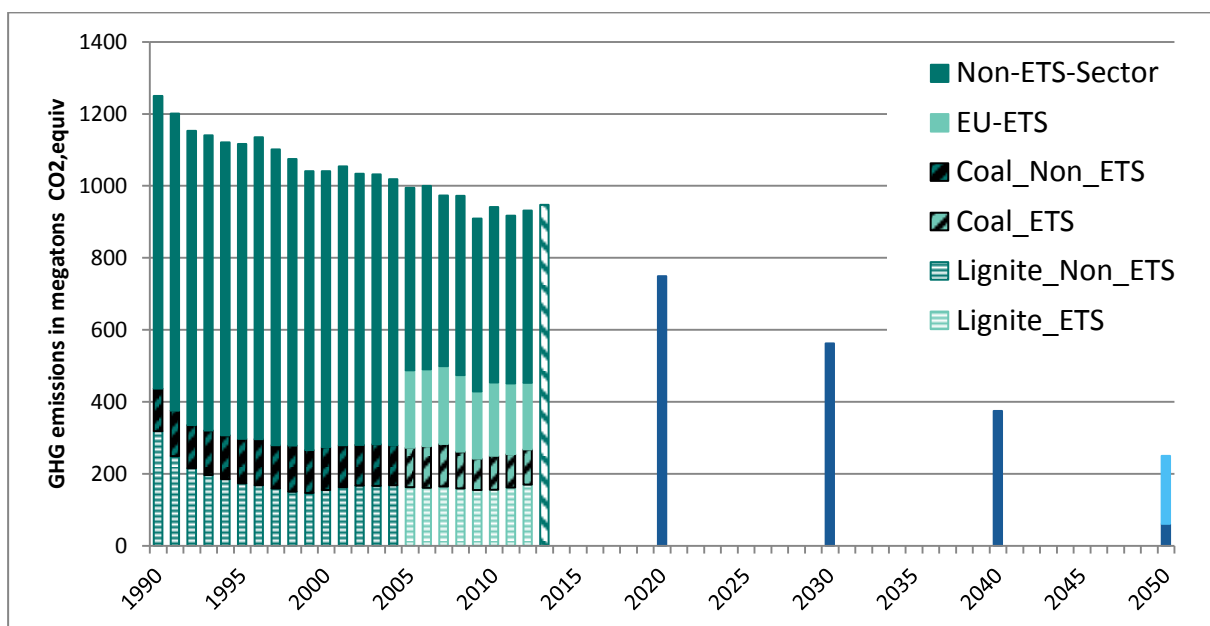


Figure 6: GHG Emissions in the Germany in the last years and climate targets until 2050

Source: Own depiction.²⁶

²⁵ A Study by Ecofys in 2014, on behalf of Greenpeace, showed that the gap might even be bigger than projected by the BMUB. Source: <https://www.greenpeace.de/themen/luecke-vor-dem-ziel>

²⁶ Calculations based on AGEB (2014): Bruttostromerzeugung in Deutschland von 1990 bis 2013 nach Energieträgern. and UBA (2013): op cit.

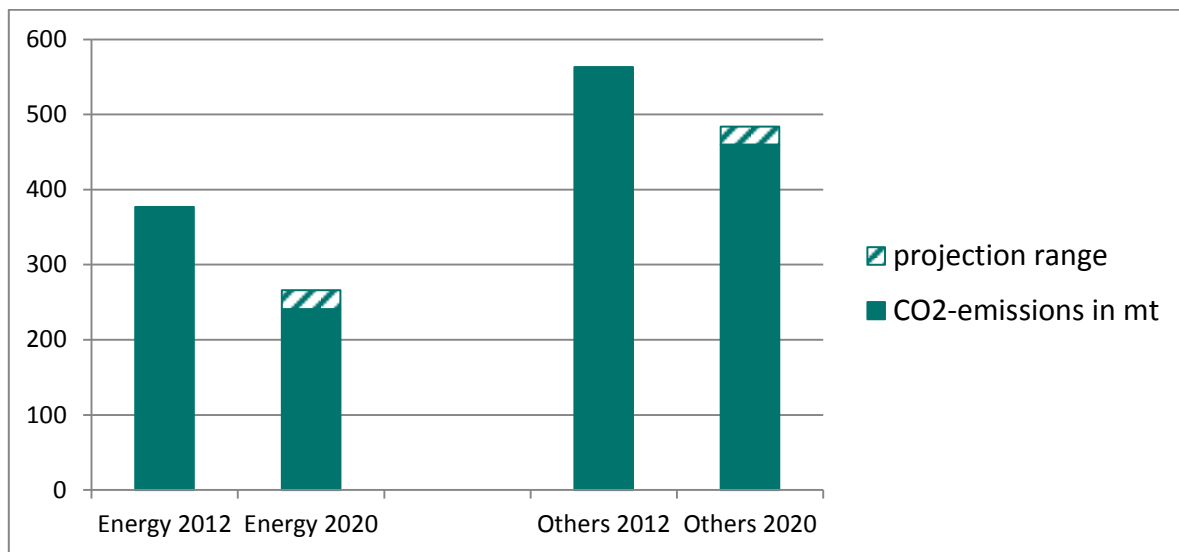


Figure 7: Current CO₂-emissions of 2012 and targets of the BMUB for 2020 for the energy sector in comparison to the other sectors.

Source: Own depiction based on BMUB (2014).²⁷

5.2 ... implies the end of coal and lignite in Germany ...

The broad consensus on the objectives of the energiewende implies that coal and lignite are phased out in Germany, and several initiatives are under preparation to accompany this phasing-out. Contrary to the past, lignite power plants will no longer provide baseload to the system. They are too inflexible to follow load or renewables, so they will be curtailed for many hours of the year, and gradually become uneconomic. Studies by DIW Berlin (Oei et al., 2014a) and other institutions (Hilmes and Herrmann, 2014; Nitsch, 2013) indicate that lignite will not contribute significantly to the electricity system after the 2030s. Figure 8 shows an example for a possible configuration of the German energy system until 2050, published in the Leitstudie for the Ministry of Environment (Nitsch, 2013).

²⁷ BMUB (2014) Aktionsprogramm Klimaschutz 2020, BMUB Vorschlag für Minderungsbeiträge, June 2014.

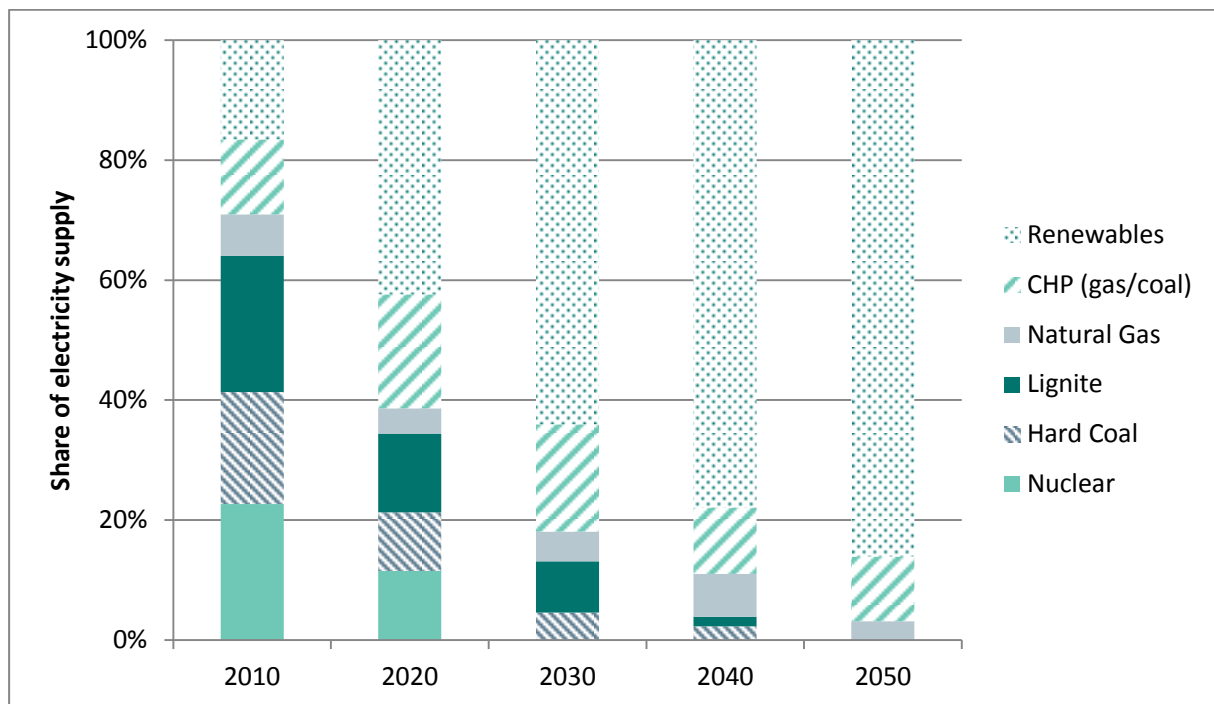


Figure 8: Exemplary share of German electricity supply till 2050

Source: Own depiction based on Nitsch (2013).

Even with the phase-out of nuclear power by 2022, the security of electricity supply in Germany is assured, including the most critical zone in southern Germany, provided that the current plans of strengthening the grid, construction of flexible gas power plants, increased demand side management and energy storage are being pursued (Kunz et al., 2013). The coal and lignite plants in North Rhine-Westphalia (NRW), Saxony, Saxony-Anhalt, and Brandenburg still generate some electricity, but they are no longer critical for system security. Both the construction of new lignite power plants and the substantial retrofit of existing plants are uneconomic, given investment costs and expected low electricity prices (Gerbaulet et al., 2012).

The risk of a lignite-based strategy can also be shown by the analyses that Vattenfall Mining and Generation (VMG) relies on. Thus, a study used by VMG to argue in favor of new lignite mines suggests the development of new lignite plants in the 2020s (Prognoseforum, 2013). However, if one calculates the CO₂-emissions of this study, scaled-up to the German level it yields annual CO₂-emissions from lignite of almost 90 million tons in 2050. This corresponds to 9% in relation to the overall emissions of 1990. This, however, is incompatible

with the GHG reduction target of 80-95%, given that other sectors have much higher abatement costs, such as industry, agriculture, and housing, and will require most of the remaining GHG budget.

5.3 ... by different instruments currently under consideration

The German Länder have also committed themselves to reducing lignite in their energy and climate policy statements, considering lignite to be a “bridge” fuel. In March 2014, the government of NRW revoked permission to expand an existing mine (Garzweiler II), saving 1,400 people from expropriation. This proves that the future of lignite in Germany not only depends on the availability of the resource, but also on (regional) climate policy decisions. Additional measures to further reduce lignite mining are expected, as the NRW government passed a law (*Klimaschutzgesetz*), which sets a 25% target of CO₂ reduction by 2020 and 80% by 2050, with 1990 serving as the base year. The Brandenburg²⁸ government is following a strategy until 2030 (*Energiestrategie 2030*), which aims at transforming Brandenburg’s energy system toward renewable energies. The strategy sets a total CO₂ limit for the entire state of 25 million tons in 2030. This is equal to the amount emitted by Vattenfall’s Jänschwalde power plant in 2013. This target is therefore incompatible with the continued usage of all existing lignite plants of Vattenfall (Hirschhausen et al., 2012). The government of Saxony agreed on an Energy and Climate Program (*Energie- und Klimaprogramm*), which seeks to reduce CO₂-emissions by 25% before 2020 (base year 2009), a program affecting Vattenfall’s Boxberg and Lippendorf power plants.

Thus, there is a broad political consensus on the incompatibility of the targets of the energiewende with the future use of coal and lignite in Germany. Therefore, a discussion about the instruments to accompany this phase-out has emerged, and it is rapidly expanding. Table 3 summarizes the current state of the discussion and concrete proposals put forward by different stakeholders. Given the low prices of greenhouse gas emission certificates in the ETS, a market driven switch from lignite to less carbon intensive fuels, e.g. natural gas, is not expected in the decade to come; this switch would require CO₂-prices of 40-60 €/t and

²⁸The majority of Vattenfall’s lignite business lies in Brandenburg and Saxony.

above.²⁹ In addition to a structural reform of the ETS, therefore, a lignite phase-out in Germany requires an appropriate mix of instruments on national level. Most of the political discussions, therefore, focus on the reduction of CO₂-emissions to reach the agreed national climate targets. The opposition (BÜNDNIS 90/Die Grünen and DIE LINKE), the Merkel-led government (CDU/SPD), as well as various non-governmental institutions (BUND, Greenpeace) and think tanks (DIW Berlin, IASS Potsdam, Öko-Institut) have therefore published several proposals to strengthen CO₂ emissions regulations. Such regulations would reduce lignite power plant emissions significantly.

Some of the proposed regulations would limit the load factor, while others would lead to an abrupt closure of Vattenfall's lignite units in Germany. The proposals currently discussed include the strengthening of the ETS, the introduction of a minimum CO₂ price floor, a minimum degree of efficiency for power plants, or a set of minimum requirements concerning the operational flexibility of thermal power plants. In addition, the introduction of any capacity mechanism could be used to negotiate an earlier closure – or shifting into cold reserve – of coal plants with the operators. Also, critics demand that the German scenario framework 2015 and the network development plan should be more aligned with the objectives of the energiewende, focussing on a better integration of renewable energy sources.³⁰

²⁹This section is based on Oei, et al. (2014).

³⁰ The focus of this criticism lies on the construction of high-voltage direct current (HVDC) transmission lines to connect lignite basins to Southern Germany, such as the planned corridors A South (Osterrath-Philippsburg) and D (Lauchstädt-Meitingen). However, the planning of the corridor D which would be of importance for Vattenfall's lignite plants in Lusatia is currently paused due to public and political opposition. Current discussions range from extending its starting point directly to the wind farms in the northern part of Germany or not constructing it at all. (see Süddeutsche Zeitung 30.07.2014: Gabriel rückt von Südost-Trasse ab <http://www.sueddeutsche.de/politik/stromleitung-von-sachsen-anhalt-nach-bayern-gabriel-rueckt-von-suedost-trasse-ab-1.2069337>)

Risks Related to the Energiewende in Germany

Instrument	Effect	Possible advantages	Possible shortcomings	Proposed by
ETS reform	Price signal through the introduction of a market stability reserve (MSR), 900 million backloading allowances directly in MSR, start of MSR in 2017 instead of 2021	EU-wide instrument; thus, no cross-border effects	Structural reforms uncertain from today's perspective; the extent of the impact is unpredictable	German government (2014)
Min. CO ₂ price ("floor")	CO ₂ certificates would become more expensive	Investment security for investors	Feasible prices probably too low to result in a switch from coal towards natural gas	Bündnis 90/the Green Party (2014)
Minimum efficiency level	Closure of inefficient power plants	More efficient utilization of raw materials	Open cycle gas turbines (OCGT) would also be affected; complex test and measurement processes	Bündnis 90/the Green Party (2009)
Flexibility requirements	Closure or singling out of inflexible power plants	Better integration of fluctuating renewable energy sources	Combined cycle gas turbines (CCGT) might also be affected	Öko-Institut/LBD/Raue (2012)
Coal phase-out law	Maximum production or emissions allowances	Fixed coal phase-out plan & schedule	Auctioning difficult to predict	Greenpeace (2012), DIE LINKE (2014)
Emissions performance standard (specifically for new plants and retrofits)	Restrictions for new plants and retrofits (without CO ₂ capture)	Prevention of CO ₂ -intensive investments	Minor short-term reduction in emissions	IASS (2014)
Emissions performance standard (emissions cap for existing plants)	Reduce load factor for older coal-fired power plants that have been written off	Maintenance of generation capacities, e.g., by shifting into a strategic reserve	Negative impact on economic efficiency of power plants; effect on energy efficiency unclear	IASS (2014)
Capacityinstruments	Incentives to develop lower-carbon conventional capacities	Support to natural gas plants, move coal plants into strategic reserve	Danger of micro-management, difficulties to identify concrete technical parameters to ensure lower-carbon output	Öko-Institut/LBD/Raue (2012)
Transmission networkpolicy	Reducing the export options for coal and lignite power plants	Less investment in new power plants, existing plants less dispatched, lower-carbon electricity mix	Potential curtailment of other generation, e.g. CHP; lines might be eventually needed to integrate renewables in the long run	Oei et al. (2012); Schröder et al. (2012)

Table 3: Possible Instruments for Reducing Coal-Based Power Generation

Source: Own depiction based on Oei et al. (2014)

One instrument that might be particularly suited to accompany the phase-out of lignite is a CO₂ emission performance standard (EPS). EPS have already been implemented in the UK, Canada and California.³¹ The implementation of a proposal by Oei et al.(2014b) and Ziehm et al. (2014) shown in Figure 9 could realize a reduction of coal-induced GHG emissions in Germany by 24% before 2020 and 66% before 2040; compared to 2012. Especially Vattenfall's older plants Jänschwalde and Boxberg (units N & P) would be affected if such measures were implemented by the German state.³²

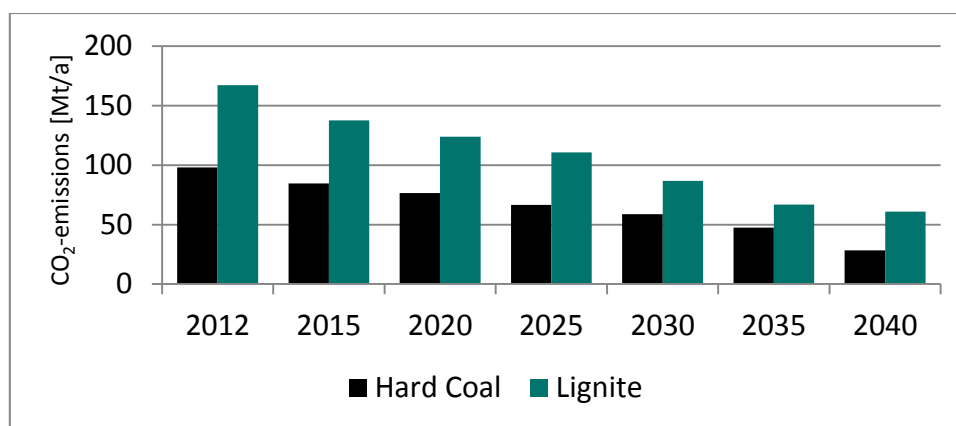


Figure 9: The effect of emissions performance standards on the German coal sector.

Source: Own calculations.

6 Risks from Lignite Mining and Electricity Generation in Lusatia

6.1 Vattenfall Mining and Generation (VMG) operations

The German operations of Vattenfall Europe, called Vattenfall Mining and Generation (VGM), comprise mainly lignite operations in Lusatia. Table 4 lists all lignite power plants run by VGM in Germany. Two of the power plants are not linked to lignite mining, which are also the only lignite operations not located in Lusatia:

- The combined heat and power plant (CHP) in Berlin-Klingenberg, which is also operated by Vattenfall, is responsible for around 20 percent of Berlin's overall emissions.

Vattenfall has announced that it should be replaced with a gas fired power plant to

³¹ There are plans by the US Environmental Protection Agency (EPA) to extend the regulation to the entire US.

³² The calculations assume a specific EPS of 450 g CO₂/kWh_{el} for new power plants. Existing plants, which surpass the age of e.g. 30 years, should be required to respect an annual emission limit of approx. 3,000 t/MW_{el}. This level corresponds to approx. 3,000 full load hours for lignite and 4,000 full load hours for steam coal plants.

meet Berlin's reduction targets by 2020. The draft of Berlin's energiewende law (*Energiewendegesetz*) seeks CO₂ reductions of 40% by 2020, 60% by 2030, and 85% by 2050, using 1990 as base year;

- VGM also owns 50% of another lignite power plant outside of Lusatia: Lippendorf. It is not connected with Vattenfall's mining sites and is therefore supplied by the Vereinigtes Schleenhain mining site, which is operated by MIBRAG, an independent firm. Attempts by Vattenfall to divest its Lippendorf holdings have failed as of 2014.

Power Plant	Unit	Starting year	Capacity [MW]	Efficiency [%]	Emissions 2012 [Mio. t CO ₂]
Berlin-Klingenberg CHP		1981	164	35.0	1.5
Boxberg (old)	N	1979	465	35.0	8,9
	P	1980	465	35.0	
Boxberg (new)	Q	2000	857	42.3	7,0
	R	2012	640	43.9	
Jänschwalde	A	1981	465	35.5	24.8
	B	1982	465	35.5	
	C	1984	465	35.5	
	D	1985	465	35.5	
	E	1987	465	35.5	
	F	1989	465	35.5	
SchwarzePumpe	A	1997	750	41.2	12.8
	B	1998	750	41.2	
Lippendorf	R	2000	875	42.8	5.3 ³³
Tot. capacity		approx. 7,800			60.3

Table 4: Lignite power plants owned by Vattenfall in Germany

Source: Own depiction based on BNetzA, thru.de, and DEBRIV.

While the power plants of Klingenberg and Lippendorf entail specific risks, the main risks of VMG are related to lignite operations in Lusatia. Currently, the Lusatian lignite district consists of the five active mining sites Cottbus-Nord, Jänschwalde, Welzow-Süd

³³The remaining 50% of the Lippendorf power plant (unit S) is owned by EnBW. The overall emissions of the plant amount to 10.5 million t annually.

TF I, Nochten I and Reichwalde, which supply three Vattenfall power plants: Jänschwalde (approx. 2,800 MW), Schwarze Pumpe (approx. 1,500 MW) and Boxberg (approx. 2,500 MW) as well as several smaller utilities (Figure 10). The Jänschwalde power plant is supplied with lignite from the adjacent mining sites of Cottbus Nord and Jänschwalde, as well as via train connection from Welzow-Süd TF I. Welzow Süd TF I is also the main supplier for SchwarzePumpe, with minor additions from Nochten I and Reichwalde. While the Schwarze Pumpe and two blocks of the Boxberg plants are relatively new, the Jänschwalde plant still dates back to Soviet Union times and is having efficiency values of around 36%.

Figure 10 also shows five new lignite mining projects pursued by VMG in order to supply the existing power plants as well as newly planned CCTS-plant in Jänschwalde: These mines are Welzow Süd TF II, Nochten II, Jänschwalde Nord, Bagenz-Ost, and Spremberg-Ost. **Fehler! Verweisquelle konnte nicht gefunden werden.** shows the available lignite resources as well as the displacements of people required to access the lignite. While Bagenz-Ost and Spremberg-Ost are projects for a far future, current plans focus on the three sites where major displacements would have to take place, i.e. approx. 800 persons for Welzow-Süd TF II, 1,700 persons for Nochten II, and 900 persons for Jänschwalde Nord. Vattenfall does not aim at Bagenz-Ost and Spremberg-Ost first, because the other projects are easier to realize. The enormous infrastructure of the old mines can still be used, which reduces investment costs. In addition, the mines are closer to the power plants.

Mining site	Expropriation of up to	Lignite resources
Welzow-Süd TF II	800 inhabitants of Proschim and Welzow	200 million t
Nochten II	1,700 inhabitants of Rohne, Mulkwitz, Schleife, Mühlrose, and Trebendorf ³⁴	300 million t
Jänschwalde Nord	900 inhabitants of Grabko, Kerkwitz, and Atterwasch	270 million t
Bagenz-Ost	–	230 million t
Spremberg-Ost	–	180 million t
Lusatia (total)	Around 3,200 inhabitants	1,180 million t

Table 5: Planned new mining sites by VMG in Lusatia

Source: Oei et al., (2014a).

³⁴ First estimates of 1582 inhabitants were corrected in 2014 to a final estimate of 1700. See Grüne Liga (2014): Der geplante Tagebau Nochten. April 2014. http://www.lausitzer-braunkohle.de/feld_nochten.php



Figure 10: Power plants, mining sites of Vattenfall Mining and Generation (VMG)

Source: Own depiction.

6.2 Reduced economic profitability of electricity

A major economic risk is that producing electricity is becoming much less profitable than before, thus stripping VMG from its role as a “cash cow” in the Vattenfall group. In particular, the older blocks with lower efficiency and higher maintenance costs, risk becoming unprofitable. At present, marginal costs for lignite power are in a range of approximately 15-20 €/MWh, depending on power plant efficiency.³⁵ Additional maintenance costs, plus poten-

³⁵This value takes into account costs for carbon emission allowances of 6 €/t of CO₂ and variable mining costs of 4€/MWh_{th}; the coal itself is untaxed and otherwise free to the mining company.

tially rising CO₂-prices have to be added. Thus, even O&M costs of lignite power plants may exceed the wholesale electricity prices, which are currently traded forward at approx. 35 €/MWh, with a falling tendency. In August 2014 Germany's second biggest energy utility RWE, for instance, announced that it is about to shut down 1000 MW of coal capacities in Germany until 2017 due to reduced profitability.³⁶ Studies by Kungl, (2014) as well as Bontrup and Marquardt (2014) also show shrinking returns of conventional utilities, due to the focus on mainly fossil electricity generation.

Gerbaulet, et al. (2012) provide concrete business plan calculations showing that investments into new lignite plants are highly uneconomic. This reasoning applies particularly to the Jänschwalde site, where – according to the energy strategy 2030 of the Land of Brandenburg – only capacities with “clean coal” are allowed. However, as shown above, carbon capture is no option in Germany anymore, and thus investments in additional lignite generation technology at Jänschwalde are no economic option. Vattenfall even states in its annual report of 2013 that “Moorburg is the last of Vattenfall's coal-based investment projects to be completed” (Vattenfall, 2014, p.15) contradicting any plans for the construction of a new power plant in Jänschwalde.

6.3 Technical risks of landslides and water pollution

Lignite mining has affected Lusatia for a long time, but the current new mining projects add to the significant technical risks in the region. Thus, in recent years the number of landslides was significant, and there are new risks from existing recent installations. For example, unexpected landslides at former mining sites and relic lakes have restricted the usage of a large territory of Lauchhammer, where 35,000 hectares of land had to be closed for open access, affected citizens even have to be relocated.³⁷ The newly built road between Hoyerswerda and Neustadt had to install a speed limit of 30 km/h due to ground instability.

Deteriorating water quality is another risk. Legal measures against extended lignite mining might arise from the interference of lignite mining with the targets of both the “Eu-

³⁶ This would affect a lignite power plant in Hürth (110 MW) and a hard coal fired plant in Wesfalen Hamm (285 MW) in 2015 as well as a hard coal unit in Wernene near Dortmund (610 MW) in 2016. (Source: Wirtschaftswoche 14.08.2014: Rettungsschirm für Energieversorger. <http://www.wiwo.de/unternehmen/energie/rettungsschirm-fuer-energieversorger-rwe-setzt-auf-hilfe-von-politikern/10332440.html>)

³⁷ Dassler, Sandra (2014): Ganze Siedlung muss geräumt werden – für immer. Tagesspiegel. 01.07.2014.

ropean Water Framework Directive” (2000/60/EG) and the European “directive on the protection of groundwater against pollution and deterioration” (2006/118/EG).³⁸ Recital 19 of the Water Framework Directive explicitly sets a target of, “maintaining and improving the aquatic environment in the Community.” Article 4 directs that, “Member States shall implement the necessary measures to prevent deterioration of the status of all bodies of surface water.”

However, it is clear that not only the old mines have deteriorated water quality, but that this is also caused by new lignite mines. A recent example has highlighted the negative environmental effects of the new mine of VMG, Welzow-Süd TF I where 11 out of 15 water samples exceeded the allowed limits for iron;³⁹ some of them even by more than a tenfold in the Petershainer Fließ stream.⁴⁰ Thus, the increasing iron sulphate concentration (“iron ochre”) in the rivers, mainly in the river Spree, are shown to also come from existing mines, threatening both the water quality (drinking water in Berlin and its surroundings) and ecosystems, such as the touristic area of Spreewald⁴¹), biological diversity and the transformation into recreational areas.

Another study points out that the opening of Welzow-Süd TF II might cause additional hazards as the remaining 600 m strip in-between the mine and the adjacent lake called Sedlitzer See consists of heaped up soil from old mining sites. The expected hydrologic pressure might therefore cause a disruption or even a land breakthrough, which could endanger the citizens of Lieske, a nearby village, as well as the workers at the mining site itself.⁴²

It is unclear how the damages caused by new lignite mining will be paid for. Previously, the mitigation costs of the old GDR mining damages were taken care of by the German federal government through its company Lausitzer und Mitteldeutsche Bergbau-

³⁸ Laskowski (2013): Zur Rechtmäßigkeit des Braunkohlenplan-Entwurfs „Welzow Süd“ nach der EU Wasserrahmenrichtlinie. Prof. Laskowski, Institut für Wirtschaftsrecht, Universität Kassel. On behalf of Greenpeace.

³⁹ Greenpeace / BUND (2014): Neue Proben: Vattenfalls aktiver Tagebau verockert Spree. Wasser aus Welzow-Süd I überschreitet Grenzwerte deutlich. Joint press release. 09.09.2014.

⁴⁰Bündnis 90/ Die Grünen (2014): Verockerung von Fließgewässern aus dem aktiven Braunkohle-Tagebau Welzow Süd? Bündnisgrüne Fraktion will Antworten haben. Pressemitteilung 14.04.2014.

⁴¹Friedrich, H., 2013. Welzow-Süd II – absehbare Schäden für Grundwasser, Flüsse und Seen in der Lausitz, Untersuchung der wasserwirtschaftlichen Auswirkungen des geplanten Tagebaus. On behalf of Greenpeace.

⁴² Krupp, R. (2013). Zur Sicherheit des Erdammes zwischen Sedlitzer See und geplantem Braunkohletagebau Welzow Süd II, Burgdorf (study on behalf of Greenpeace e.V.).

Verwaltungsgesellschaft mbH (LMBV); however, this practice might be discontinued under the new circumstances, leading to additional costs for VMG.⁴³

6.4 Risks of losing court cases against the opening of new lignite mines

A major legal risk of VMG is to lose the court cases against the opening of new lignite mines; these cases are currently unfolding with respect to the new lignite mines Nochten II and Welzow II. They are taking place in a drastically new legal framework, after the Federal Constitutional Court of Germany (*Bundesverfassungsgericht*) strengthened the legal position of citizens threatened by expropriation in 2013.⁴⁴ Historically, it was only possible to go to court once expropriation proceedings were initiated, but the court's ruling now grants land owners the power to initiate legal proceedings earlier in the process.

As outlined above, the decisions on the energiewende have fundamentally modified the future energy mix in Germany. Thus, the justification of using lignite, and thus to expropriate home owners, as a "benefit to society" (*Gemeinwohl*), has vanished. Under the new conditions of the energiewende, lignite is no longer critical to system security, as shown among others, by Kunz, et al. (2013). Thus, contrary to the last century, the expropriation of owners can no longer be justified with the general public interest. In a legal expertise, Ziehm (2014) showed the link between the December 2013 ruling of the Constitutional Court, and the upcoming cases in Lusatia. The new jurisdiction will also be highly relevant in the case of an existing mine run by Vattenfall, Welzow Süd TF I, where citizens of Proschim initiated legal proceedings in April 2014;⁴⁵ it will also impact the upcoming cases against the opening of the new mining sites Welzow Süd TFII and Nochten II.⁴⁶

⁴³The association "Netzwerk Bergbaugeschädigter e.V. der Lausitzer Braunkohleregion" was founded in May 2014 to help its members to ensure their claims due to mining damages. see Netzwerk Bergbaugeschädigter e.V. der Lausitzer Braunkohleregion: <http://www.netzbege-lausitz.de/>

⁴⁴Bundesverfassungsgericht (2013): Pressemitteilung Nr. 76/2013, „Urteil in Sachen ‚Braunkohlentagebau Garzweiler‘: Rechtsschutz Enteignungs- und Umsiedlungsbetroffener gestärkt“, 1 BvR 3139/08, 1 BvR 3386/08.

⁴⁵ Firmenverbund Proschim (2014): Firmenverbund Proschim reicht Klage gegen lfd. Tagebau Welzow I ein. Presseerklärung <http://www.wir-sind-die-lausitz.com/de/pressemitteilungen.html>

⁴⁶ A coalition of several environmental organizations as well as affected people have already started a court case against Vattenfall's opening of Nochten II in August 2014. Source: <http://www.greenpeace.de/themen/klage-gegen-kohle> Similar court cases against the new mining site in Welzow Süd TF II are expected. The opening of Welzow Süd TF II would secure 550 jobs at the mining site and 174 at the adjacent SchwarzePumpe power plant; however, about 800 citizens of Welzow and Proschim, communities in the area, would have to be relocated, leaving their homes behind.

From an energy economics perspective, the opening of new lignite mines in Germany is not necessary to supply the existing power plants with lignite into the 2030s, when they reach the end of their economic lifetime (see Figure 10 and Figure 11).⁴⁷ Von Hirschhausen and Oei (2013a, 2013b) show that no additional mining sites are needed to supply all of Vattenfall's German power plants with lignite until their closure, with respect to climate targets set by public policy.⁴⁸ Especially the remaining capacities of Nochten I and Reichwalde are more than sufficient (see Figure 11).

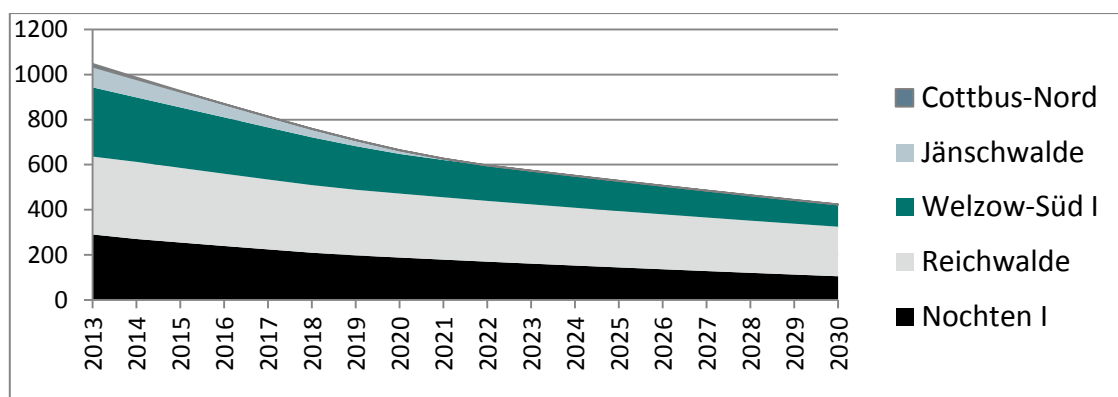


Figure 11: Remaining lignite capacities in Lusatia in million t

Source: Own calculations in Oei et al. (2014a).

7 Implications for Vattenfall: Internal Restructuring Rather than Short-term Sale

7.1 While a short-term sale of operations is no solution ...

Clearly continuing the status quo is no option for Vattenfall. Given the risks inherent in the German lignite mining and power generation business, and the obligation to pursue a coherent sustainability strategy, Vattenfall will be obliged to act. However, selling-off the lignite business as such seems to be no ideal option: First, it would leave the CO₂-footprint of the previous Vattenfall property unchanged. But second, given the high risks, it might be not only unprofitable but outright infeasible to find a buyer.

⁴⁷This argument has been developed in detail in a study for the Government of Brandenburg, Ministry of Environment, by Hirschhausen and Oei (2013)

⁴⁸We assume a lifetime for lignite power plants of 40 years for plants built before 1990, and 50 years for plants built after 1990. The average load factor of the lignite power plants in Lusatia in 2013 was around 85-90%, but is expected to shrink. Lignite plants are therefore assumed to be shut down latest in the beginning of the 40s for economic reasons (high fixed costs and a too low load factor).

As a matter of fact, first attempts to test the market were already observed in 2013, however unsuccessfully. Vattenfall had announced the willingness to sell its 50% share of the Lippendorf power plant, but no reaction ensued.⁴⁹ Following this episode, discussions that Vattenfall might be planning to sell some of its lignite assets to the local government of Brandenburg or to other buyers reoccurred in spring 2014. According to internal papers of the Brandenburg government, quoted by the German newspaper *Der Tagesspiegel*, Vattenfall's lignite assets (mines and power plants) are valued between two and four billion euro.⁵⁰ Brandenburg's government, however, announced they were not interested in buying the assets.⁵¹ PGE, a Polish firm with lignite experience, was indicated as another potential buyer for the Jänschwalde power plant. However, the director of PGE Gubin, Hanna Mrówczyńska, said the company was also uninterested in buying the inefficient plant, as its expected lifetime will end in 2025 at the latest.⁵²

7.2 ... internal restructuring is a viable option

From a Swedish and also from more local Lusatian perspective, restructuring the VMG operations and making them coherent with the sustainability strategy is the only feasible option. This entails the definition of a structured phasing-out of lignite mining and electrification, and to seize the multiple options offered by the German energiewende, e.g. in renewables, storage, power-to-gas, and other technologies compatible with the energiewende.

Lusatia is and will remain an energy region, and it has a high potential to convert from heavy industry towards a sustainable one. In fact, the biggest transformation of the lignite mining sector in Germany at large has already happened due to the reunification of Germany, reducing the number of jobs from more than 150,000 in Germany to around

⁴⁹Vattenfall (2013): Möglicher Verkauf von Block R im Braunkohlekraftwerk Lippendorf. Press Release 1.3.2013. Divesting Lippendorf would relieve Vattenfall's CO₂-emissions portfolio by around 5 million tons; this would, however, not be sufficient to reach the aimed at reduction of more than 20 million tons by 2020. The Jänschwalde power plant therefore, being relatively old and inefficient, seems to be the most likely candidate for reducing emissions from the company's portfolio. Closing the majority of Jänschwalde's units with its 24 million tons of CO₂ emissions would secure Vattenfall's CO₂-targets.

⁵⁰Tiede, Peter (2014): Christoffers erwägt Kauf von Lausitzer Vattenfall Sparte. *Tagesspiegel*. 26.01.2014

⁵¹Landtag Brandenburg, 2014: Landesdrucksache 5/8444: Wirtschaftsminister Christoffers soll Kauf der brandenburgischen Standorte des Energiekonzerns Vattenfall in Erwägung ziehen. Antwort der Landesregierung auf die Kleine Anfrage 3335 des Abgeordneten Gregor Beyer der FDP Fraktion.

⁵²Stawiarz, K. (2014). Rozmowa o kopalni: Trabanta nie chcemy, elektrowni nie kupimy. <http://zielonagora.gazeta.pl/zielonagora/2029020,35182,15488607.html>

20,000 today (see Table 6). This becomes especially visible in Eastern Germany: the mining sites in Lusatia used to deliver up to 200 million tons of lignite in the 1980s, compared to 63 million tons in 2013. An organized phase-out of the remaining lignite industry in the upcoming decades, with a concentration on new investment areas, is needed to enable a successful transformation of the region. In addition, as of 2013, 75% of the workers in the lignite industry are older than 40; with about 50% older than 50.⁵³ Hence, an organized phase-out of lignite does not necessarily lead to any layoffs, as some units will keep producing until the 2030s. On the contrary, additional work force is needed for the reclamation of the mining sites.

Year	Lusatia	Central Germany	Germany	Average Age
1980	75,100	56,000	152,300	
1990	65,500	46,800	129,700	38.6
2002	10,300	2,700	26,800	41.6
2010	7,653	2,508	22,704	45.1
2013	7,973	2,512	22,082	46.0

Table 6: Lignite sector employment in Germany (only direct jobs)

Source: Statistik der Kohlenwirtschaft e.V. (2013)⁵⁴

The biggest potential for new investments and jobs in Germany is in the renewable energies sector, with around 370,000 jobs in total and more than 200,000 new jobs between 2004 and 2013. Thus in each federal region more jobs in the renewable sector have already been created than are currently still remaining in the lignite industry.⁵⁵ Figure 12 shows that many more jobs have been created in the renewables sector than exist in lignite in the three Bundesländer in which VMG is active (Brandenburg, Saxony, Saxony-Anhalt).

Such a conversion is also feasible from a technical and an economic perspective. Several studies, including Bost et al., (2012) and Twele et al., (2012), show that the transition

⁵³ Statistik der Kohlenwirtschaft e.V., 2013. Datenübersichten zu Steinkohle und Braunkohle in Deutschland. http://www.kohlenstatistik.de/index.php?article_id=3, retrieved on September 1st, 2014.

⁵⁴ The figures for Lusatia were reduced by around 400 workers as the DEBRIV originally did include the employees from Lippendorfas well as from hydro power plants in Saxony and Thuringia. (Source: Grüne Liga (2012): Neue Tagebaue und Arbeitsplätze http://www.lausitzer-braunkohle.de/thema_arbeit.php).

⁵⁵ Ulrich, Philip; Lehr, Ulrike (2013): Erneuerbar beschäftigt in den Bundesländern: Bericht zur aktualisierten Abschätzung der Bruttobeschäftigung 2012 in den Bundesländern. Osnabrück: GWS mbH.

from lignite toward an economy based on renewable energies is possible for the region.⁵⁶ Many private and corporate investors, having focused on the new emerging sectors of renewable energies, profited from their strategy in the last ten years due to the German Renewable Energy Sources Act (EEG). This suggests that Vattenfall has a vested interest in concentrating their future investments also in the renewable sector,⁵⁷ disposing its oldest and least efficient power plants and reaching its CO₂-targets. Local and national governments in Germany would profit from Vattenfall’s closure of lignite plants to achieve their own climate targets. As the growing number of wind and solar parks indicate, this can also be a very profitable business. In addition, Vattenfall benefits from technical knowledge to advance other technologies, such as innovative storage, power-to-gas, and still others, that are compatible with the energiewende.

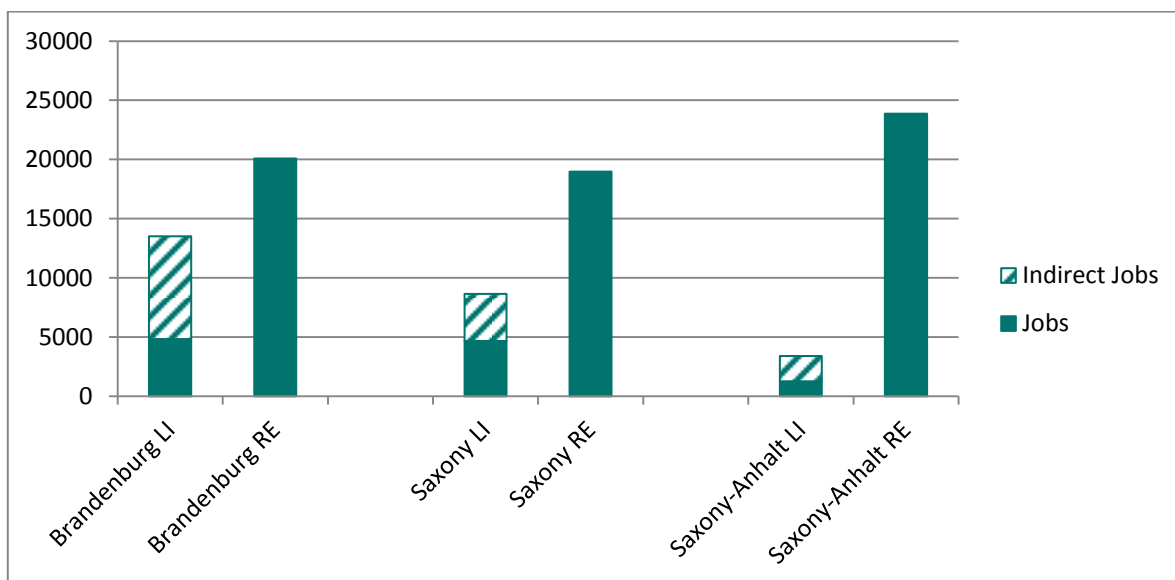


Figure 12: Jobs in renewables (RE) and in the lignite (LI) sector including indirect jobs, by Bundesland
 Source: Own depiction based on Ulrich und Lehr (2013) and Statistik der Kohlewirtschaft (2013)⁵⁸

⁵⁶Brandenburg excelled in three consecutive rounds as the best federal region of Germany with respect to the development of renewable energies and was therefore granted with the decoration of the “Leitstern” in 2008, 2010 and 2012 (von Hirschhausen et al., 2012).

⁵⁷Vattenfall is planning on investing around 10 billion SEK (~ 1 billion €) in renewable technologies in the period of 2014-2018. These figures equal around one tenth of their overall investments.

⁵⁸ s. footnote 53.

8 Conclusions

The Swedish state-owned energy utility Vattenfall and its owner are currently examining strategy options to address its own ambitious sustainability targets as well as the low-carbon objectives of the Swedish government. While Vattenfall's Scandinavian generation structure corresponds to a high degree to its CO₂ target, the German lignite business puts a heavy burden on the company's aspirations. In this respect there is need for action. The objective of this policy report is to identify the major trends that shape Vattenfall's future lignite strategy and to highlight the major risks of the German lignite mining and power operations. This is done from a technical, an economic, and a legal perspective. The report evaluates the options that Vattenfall has in the current situation. It is based on a variety of reports published by DIW Berlin concerning the future of lignite in the context of the German energiewende. For more information see Oei, et al. (2014a).

The main Western countries pursuing climate policies are turning away from coal and from lignite, due to the high environmental costs and the uncertain economic prospect. Thus, the USA, Canada, and the UK have de facto or are about to ban the construction of new coal power plants, by implementing emission performance standards (EPS). The previous hope of "clean coal" raised by the CO₂-capture, transport, and storage technology (CCTS) has failed and is no longer an option in the foreseeable future. Vattenfall itself was engaged in the failure of the idea of "clean coal" through CCTS, both in Germany and worldwide. Thus, the social costs of lignite, which are estimated to value approximately 80-100 €/MWh are two to three times higher than the electricity price of currently less than 35-40 €/MWh in Germany. As a consequence, phasing out lignite is not only necessary from an environmental point of view, but also economically efficient.

The unconstrained operation of its German lignite activities is not compatible with Vattenfall's internal CO₂ target. With over 70 of a total 88 million tons of CO₂ the German emissions surpass the company's CO₂ budget for the year 2020, which is 65 million tons. Hence, there is urgent need for adjusting these emissions. One option to reduce these emissions is the closure of several lignite units in the Lusatian region.

Major risks to Vattenfall are furthermore its inconsistency of its lignite operations with the objectives of the German energiewende, which consists of, among other things, a

Conclusions

nuclear power phase-out by 2022, greenhouse gas emissions reduced by 80-95% by 2050 (baseline: 1990), at least 80% renewable-based electricity by 2050, as well as efficiency targets. The phase-out of coal and lignite is part of this process, since there is no space for inflexible and CO₂-intensive lignite plants in a sustainable electricity system. Currently, ministries on national level are discussing greater contributions of the energy industry. In addition, there is a variety of propositions for the structured phase-out of lignite power in Germany. These propositions will also play a role in the discussion about the introduction of potential capacity payments for dispatchable power.

From a legal point of view the opening of two new mining sites (Welzow Süd TF II, Nochten II) represents a further risk: A verdict of the German constitutional court from December 2013 not only strengthened the rights of affected citizens. It also put stricter requirements to the right to expropriate land owners. Since lignite will no longer be needed there is no legal foundation for the expropriation of citizens in favour of unnecessary resources. The existing lignite mines provide enough energy to fuel the power plants Jänschwalde, Schwarze Pumpe and Boxberg; new mines are not necessary.

Clearly Vattenfall is facing technical, economic, and legal risks in its German lignite operations that make it not only politically but also economically difficult to sell these operations in the short term. Until now, no investor has shown any interest in either the Lippendorf power plants, or any other particular unit in Lusatia. On the other hand, both from a Swedish and a local perspective, restructuring the existing operations and developing them coherently with Vattenfall's sustainability strategy is the better option. This entails the definition of a structured phasing-out of lignite mining and electrification, and to seize the multiple options offered by the German energiewende, e.g. in renewables, storage, power-to-gas, and other technologies compatible with the energiewende.

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