NERA
ECONOMIC CONSULTING

Confidential

Economic Assessment of Biomass Conversion

ICSID Case No. ARB/21/4

18 December 2021

CONFIDENTIALITY

Our clients' industries are extremely competitive, and the maintenance of confidentiality with respect to our clients' plans and data is critical. NERA Economic Consulting rigorously applies internal confidentiality practices to protect the confidentiality of all client information.

Similarly, our industry is very competitive. We view our approaches and insights as proprietary and therefore look to our clients to protect our interests in our proposals, presentations, methodologies, and analytical techniques. Under no circumstances should this material be shared with any third party without the prior written consent of NERA Economic Consulting.

Contents

Introduction and Executive Summary

1. NERA Economic Consulting GmbH ("NERA") have been asked by RWE AG and RWE Eemshaven Holding II BV (collectively "Claimant")[1] to provide an independent expert opinion in connection with arbitration proceedings between Claimant and the Kingdom of the Netherlands ("the Netherlands") in ICSID Case No. ARB/21/4 ("the Arbitration").

2. We, Tomas Nikolaus Haug, Managing Director, and Bastian Gottschling, Associate Director, are professional economists at NERA. We have specialised in energy and financial economics, serving as experts in disputes, transactions and advisory. Our CVs are enclosed as Appendices A and B to this report.

3. This report has been prepared by us, but we have been assisted by other NERA professionals. We have supervised and reviewed the team's research and analysis. The opinions expressed correspond exclusively to our expert judgement.

4. We understand that Claimant's dispute arises out of the Netherlands' decision to ban the use of coal for electricity generation, and that the Coal Ban law, the Electricity Production Prohibition Act, was adopted by the Dutch parliament on 10 December 2019.[2] Existing coal-fired power plants with an efficiency of at least 44%, like Claimant's coal-fired power plant Eemshaven ("the Eemshaven plant" or "Eemshaven"), were granted a transitional period until 31 December 2029 during which they are still permitted to burn coal.[3] The Eemshaven plant was expected to continue operation until the end of 2054 prior to the Coal Ban.[4]

5. The Coal Ban law does not provide for financial compensation. In the explanatory memorandum to the Coal Ban law, this is explained among other by referring to the possibility that coal-fired power plants can use the transitional period to convert to alternative fuels.[5]

6. Against this background, we have been instructed by Stibbe N.V. and Luther Rechtsanwaltsgesellschaft mbH ("Counsel for Claimant") to independently assess whether a reasonable and prudent investor would invest in converting a coal-fired plant like Eemshaven to using biomass by 2030 in the absence of biomass support schemes. This would only be the case if

---

1 We refer to the RWE group of companies as "RWE". NERA have been formally retained by RWE Generation NL B.V., RWE's holding company for its Dutch business.

2 We refer to the Electricity Production Prohibition Act, dated 20 December 2019, as "the Coal Ban".

3 See Tweede Kamer (March 2019), Explanatory Memorandum, pp. 4. Exhibit NERA-0001.

4 The Eemshaven plant opened in 2015. In line with industry expectations for coal-fired power plants, its expected operation life was at least 40 years, i.e. until 2054. See International Energy Agency and Nuclear Energy Agency (September 2015), Projected Costs of Generating Electricity, p. 30. Exhibit NERA-0002.

5 See Tweede Kamer (March 2019), Explanatory Memorandum, pp. 13. Exhibit NERA-0001.

the investor were to consider such a conversion to be economically viable, and to be technically and legally feasible.

7. In our assessment, we focus on the economic aspect mentioned above. We do not assess whether a conversion would be technically and legally feasible. In particular, we do not assess whether the investor would be able to obtain any necessary permits required for the conversion. We do however take into account general expectations about the regulatory development with regard to biomass.

8. We have been instructed to conduct this assessment based on information available or readily foreseeable on 9 October 2017.[6] We have also been asked to review whether our assessment would be different if made from today's perspective.

Converting a coal-fired plant like Eemshaven to biomass would run a high risk of losses, which is why a reasonable and prudent investor would not make the necessary conversion investment

9. An investor would only make a conversion investment if he considered it to be profitable. A conversion would be profitable if it allowed the investor to at least recoup his investment costs for the conversion as well as the related cost of capital.[7]

10. Irrespective of the technical and legal feasibility of the conversion, we conclude that an investor would expect a conversion to unsubsidised biomass-fired generation to cause losses and therefore not make such an investment.

11. In the following, we provide a brief summary of the main findings of our assessment.

Biomass-fired plants are not competitive without subsidies, and the outlook for large-scale electricity generation from biomass is negative

[6] We understand that this reflects an instruction Counsel for Claimant has provided to Claimant's quantum experts in the Arbitration, for the assessment of damages caused to Eemshaven by the Coal Ban.

[7] The cost of capital includes the cost of equity, i.e. the return on equity shareholders require in expectation when investing in the project, given the investment's risk and other investment opportunities available in the capital market. An investment project whose payoff exactly covers investment costs including cost of capital makes an investor indifferent between investing and not investing. A project whose payoff is greater than investment costs including cost of capital could be considered profitable for the investor. A project whose payoff falls short of investment costs including cost of capital would not be realised, because there are superior investment opportunities in the capital market. If such a project was realised (hypothetically), it would be considered loss-making from the perspective of the investor.

12. Biomass generation costs are not competitive without subsidies and, already in 2017, large-scale electricity generation using woody biomass was expected to face additional viability risks in the future.

13. In a competitive electricity market, like the Dutch one, the ability of a power plant to sell electricity at a given point in time depends on its variable costs of generating electricity (“marginal costs”) and, thereby, mainly on its fuel costs and the price of emission allowances. If electricity demand at a given point in time can be met by plants with lower marginal costs, plants with higher marginal costs cannot sell electricity profitably.

14. An investor invests in electricity generation capacity or a conversion from burning coal to using biomass if he expects the plant to earn sufficiently high margins through electricity sales over the course of the plant’s lifetime to at least recoup the initial capital expenditure (“CAPEX”) and cost of capital. All else equal, higher marginal costs lead to a lower earnings potential.

15. Based on contemporaneous generation cost assessments biomass plants have the highest marginal costs among the major generation technologies in the Dutch electricity system. Biomass plants have even higher marginal costs than gas-fired plants which supply peak demand in the Dutch market. Therefore, unless subsidies offset part of their high fuel costs, biomass plants can hardly compete in the Dutch electricity market.

16. Precedents suggest that biomass plants are not viable without subsidies: We are not aware of any biomass conversion project in Europe which was realised without subsidies. Planned biomass conversion projects were cancelled or constructed plants even shut down when the expected subsidies were not received. We expand on the above issues in Section 1.

17. Already in 2017, the future outlook for biomass plants was rather grim. Firstly, the public and political opinion on biomass was changing. In particular, it was increasingly challenged whether biomass should continue to be treated as a (CO2 neutral) renewable energy source. This had already led the Dutch government to announce that no new subsidies would be granted for biomass conversion projects. If stricter sustainability standards for biomass were introduced in the Netherlands or if biomass plants were required to obtain EU Emission Allowance certificates (“EUAs”) from the EU Emission Trading System (“ETS”), such measures would further increase the marginal costs of biomass plants and make them even less competitive on the electricity market.

18. Secondly, even hypothetical upside scenarios where biomass conversion would in principle become profitable, e.g. in a scenario of very high gas prices or CO2 prices, would not change this assessment of a reasonable and prudent investor. If prices allowed biomass plants to be profitable

in principle, an investor would take into account that this profitability may lead to large-scale conversions by other coal plants in the Netherlands and Europe, leading to the associated risk of rising biomass demand and costs of biomass generation. Section 2 explains this in more detail.

19. Biomass plants are unable to compete on the Dutch electricity market without subsidies. Considering that regulatory conditions might even worsen and that any hypothetical upside scenarios are exposed to the threat of further entry, a reasonable and prudent investor would not make such an investment. Our results are in line with the view of market participants at the time based on equity analyst reports covering the Drax power plant, with large biomass-fired electricity generation units in the UK.

The prospects for conversion to biomass have deteriorated

20. Lastly, Section 3 reviews whether an analysis as of today would lead to different results than our assessment from the 2017 perspective. We find the prospect of converting a Dutch coal-fired power plant to biomass has deteriorated, meaning the risk of a conversion leading to losses has increased.

21. It seems highly unlikely that a plant like Eemshaven could be operated as a biomass-fired plant from 2030 – 2054 based on recent government proposals to phase out energy generation from biomass. Even if the government were to abandon its ambitions for a phase out of power generation from woody biomass,[8] the downside risks of stricter sustainability criteria have only increased since 2017. While electricity and gas prices are currently high and positive for biomass, this price increase is expected to be temporary.

Conclusion

22. In summary, we conclude that given the information available in October 2017 an investor would expect a conversion from burning coal to biomass to cause losses. An investor would arrive at the same conclusion given the information available today. Therefore, the investor would not pursue the conversion at either one of the two dates.

8 See the coalition agreement for the new Dutch government published in December 2021: VVD, D66, CDA en ChristenUnie (December 2021), Omzien naar elkaar, vooruitkijken naar de toekomst Coalitieakkoord 2021 – 2025, p. 8. Exhibit NERA-0021.

1. Biomass plants are unable to compete in the electricity market without subsidies

23. We analyse the question whether a reasonable and prudent investor would consider biomass conversion to be economically viable. For a coal-fired plant of the size of Eemshaven, fully converting from c.15% co-firing to 100% biomass would likely require CAPEX in the range of c. [redacted] to c. €457 million based on recent observations in the context of the SDE+ support scheme.[9] A precondition for biomass conversion to be economically viable, however, is that the converted biomass plant would at all be able to sell electricity in the competitive Dutch electricity market to a relevant degree.

24. Therefore, we start by setting out how the Dutch electricity market works (Section 1.1) and then assess whether biomass plants would be able to compete in this market without subsidies. We explain that due to their high marginal costs of generation, a reasonable and prudent investor would be sceptical whether unsubsidised biomass plants could sell electricity given the competition from other technologies and their cost structures (Section 1.2). We then review biomass conversion projects in Europe, finding that none of these projects has been realised without subsidies. This suggests that without subsidies biomass plants are not economically viable investments (Section 1.3). This view is shared by equity analysts covering the power plant operator Drax Group plc. (Section 1.4).

1.1. Power plant's earnings potential in the electricity market

25. This section provides a brief introduction to key concepts of the wholesale electricity market. It provides the relevant background information underlying the analysis of earnings potential in Section 1.2 and the market evidence on biomass plants in Section 1.3.

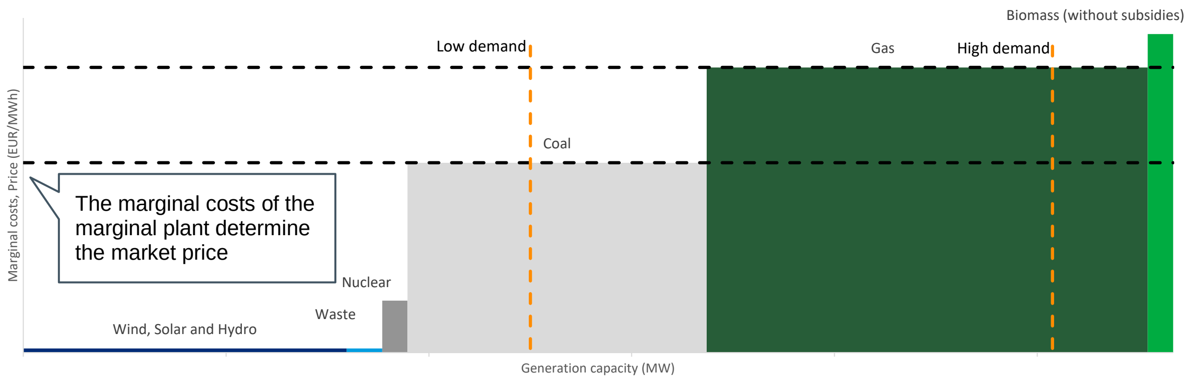
26. A competitive wholesale market consists of multiple electricity producers or generators that each may operate multiple power stations. Generators can employ a wide range of technologies and fuels with very different production costs – including gas, coal, fuel oil, nuclear, hydroelectric power, onshore wind, offshore wind, biomass, solar photovoltaics, or geothermal.

---

9 The lower estimate of [redacted] is based on RWE Eemshaven's SDE+ application, see Exhibit NERA-0005. There, the CAPEX expectation to convert 255.56 MW to biomass is [redacted]. Eemshaven has a remaining coal-fired capacity of 1,304.4 MW that could theoretically be converted to biomass. This gives the estimate of [redacted] $\times \frac{1{,}304.4\ MW}{255.56\ MW} \approx$ [redacted]. We discuss the SDE+ scheme in more detail in Section 1.3.2. The higher estimate of c. €457 is based on the "Final advice on base rates SDE+ 2017", a report prepared by ECN and DNV GL from April 2017, which is the basis for calculating the subsidies under the SDE+ scheme. The report includes an estimate for "biomass direct co-firing" of €350/kW of capacity. This gives the estimate of $€350 \times 1{,}304.4\ MW \frac{1{,}000\ MW}{1\ kW} \approx$ €457m. See ECN, DNV GL (April 2017), Final advice on base rates SDE+ 2017, p. 53-54. Exhibit NERA-0003.

27. To understand how the wholesale market price for electricity delivery in a given time period is set, it is helpful to imagine ordering the different available generators who use different generation technologies by their short-run variable (or "marginal") production costs. The electricity supply curve constructed in this way is often referred to as a "merit order". The merit order is time dependent, because plants' position in the merit order depends on the prices of fuels and emission allowances. Plants' positions may switch when prices for fuel or emissions allowances change. In addition, electricity network connections to neighbouring markets can add to supply or to demand, depending on the market price in the neighbouring market being lower or higher, respectively. Figure 1.1 below illustrates a simplified merit order for the Dutch wholesale electricity market.

Figure 1.1: Merit Order Illustration



Source: Own illustration.[10]

28. The figure shows the total capacity of each type of generating technology on the horizontal axis (measured in megawatts ("MW"), or gigawatts ("GW")). The vertical axis shows the marginal costs of producing each unit of electricity (measured in Euro per megawatt-hours ("MWh") at the wholesale level). Demand (or "load") at any particular time can be represented by a vertical line – indicating the amount of power that end-users require to meet their needs at that time.

29. A given plant is willing to offer electricity to the market if the market price is at or above the plant's marginal costs. The intersection of the load curve and the merit order curve identifies the market price, i.e. the price at which demand and supply match. The market price is equal to the marginal cost of the most expensive generator which is required to meet demand ("marginal

10 For simplicity, the figure shows identical marginal costs of generation for plants of a given technology. In reality, plants using the same fuel may still have different marginal costs, depending on plant efficiency and other factors. The figure also leaves out interconnection capacity which could add to supply when the electricity price in the neighbouring market is lower or to demand when the price in the neighbouring market is higher. Plants' position in the merit order could switch if the prices of fuel or emission allowances changed sufficiently.

plant”). Plants with lower marginal costs than the prevailing market price earn a “margin” – the difference between their marginal costs and the market price – on the electricity they sell at this price.

30. Taking into account the marginal costs of the given plant and the expected developments of electricity demand, an investor needs to assess among others whether its plant would have sufficient periods during which it could supply electricity to the wholesale market.[11]

31. Broadly speaking, in most electricity markets two different demand periods can be distinguished: There is high (“peak load”) demand during daytime on weekdays and low (“baseload”) demand during the night and on weekends and holidays. Figure 1.1 illustrates this by showing two demand curves, one labelled “high demand” and the other “low demand”.

32. Plants with relatively low marginal costs can almost always run. They are on the left-hand side of the merit order and their marginal costs are almost always lower than those of the marginal plant, even in periods of low demand. These plants are called “baseload plants” and achieve a high number of “full load hours”.[12] Nuclear plants in Figure 1.1 serve as baseload plants.

33. Power plants with higher marginal costs, i.e. those on the righthand side of the merit order, only run during periods of high demand, but remain idle in periods of low demand. These plants are called “peaking plants” and achieve a low number of full load hours per year. As demand increases and decreases over time, peaking plants switch back and forth between being idle, producing electricity at full capacity, or at less than full capacity. Gas-fired plants in Figure 1.1 serve as peaking plants.

34. The paragraphs above introduce key concepts of the electricity market. The next section considers biomass plants and investigates if and how they might fit in the Dutch electricity market, given the other generation technologies that are already present in the Netherlands.

1.2. Biomass generation costs are not competitive

35. This section explores how a converted biomass plant would fit into the Dutch electricity market. The section compares the marginal costs of a biomass plant with those of competing generation

---

[11] Investors only invest in generation capacity, if they believe that margins earned by electricity production are sufficient to cover all long-term costs of a generator, including fixed costs such as investment and capital costs.

[12] Full load hours (FLH) measure the utilisation of a power plant. A calendar year with 365 days has $365 \times 24 = 8{,}760$ hours. Consider a power plant with 100 MW generation capacity. If the plant runs at full capacity for the entire year, it generates $8{,}760 \times 100 = 876{,}000$ MWh of electrical energy, which is the maximum the plant can possibly generate in one year. In that case the plant has 8,760 FLH. If the plant instead generates only 80 MW of power for 2,000 hours, it generates $2{,}000 \times 80 = 160{,}000$ MWh of electrical energy. This corresponds to $8{,}760 \times \frac{160{,}000}{876{,}000} = 1{,}600$ FLH. This means if the plant had run at its nameplate capacity of 100 MW instead of only 80 MW, it had taken the plant only 1,600 hours instead of 2,000 hours to generate 160,000 MWh of electrical energy.

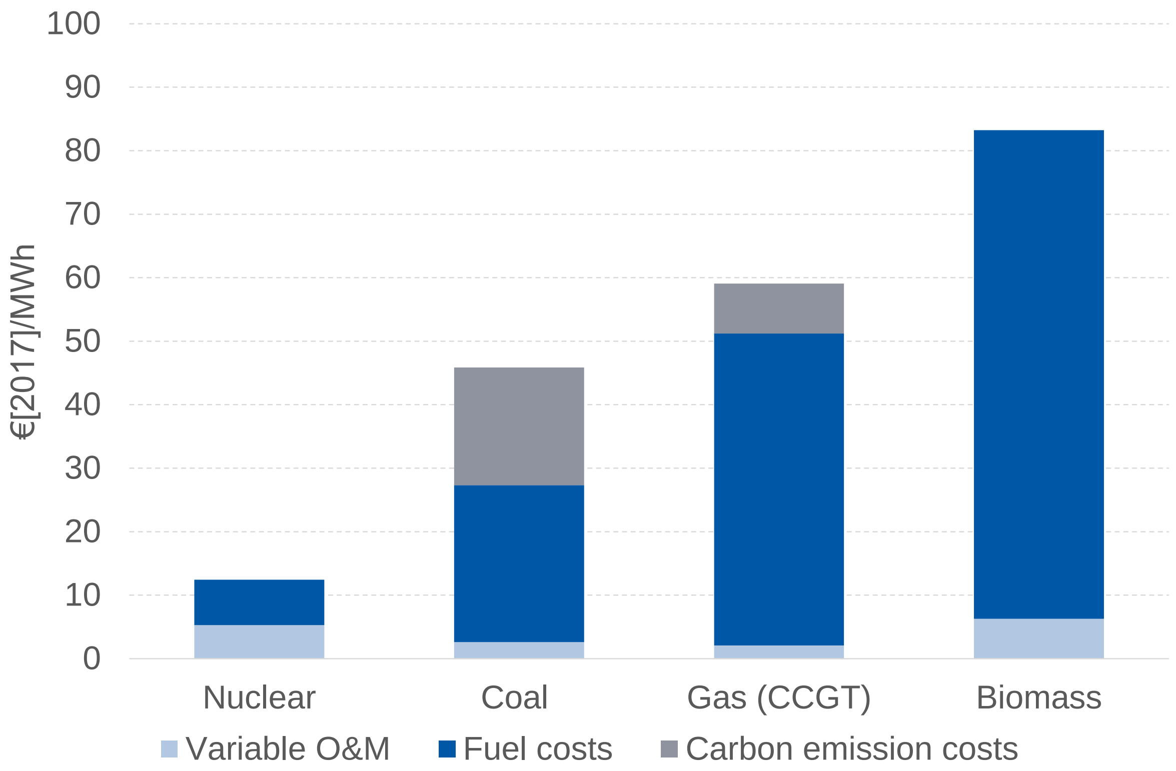
technologies in the Dutch electricity market. We derive a 2017 benchmark for marginal costs of generation based on the IEA's study on "Projected Costs of Generating Electricity 2015 Edition", given that 2017 spot prices for natural gas were low.[13] A converted biomass plant would have the highest marginal costs and would therefore generally not be expected to be able to make successful bids on the Dutch electricity market.

36. We compare the marginal costs of generating electricity from industrial wood pellets against the marginal costs of the most relevant other generation technologies in the Netherlands, i.e. nuclear, coal, and natural gas. Technical characteristics and market conditions make wood pellets the most suitable biomass fuel for large scale power generation.[14] Figure 1.2 shows the 2017 marginal costs for nuclear, coal, and natural gas, broken down by fuel costs, variable operation and maintenance costs (O&M), and costs for emission allowances.

[13] International Energy Agency and Nuclear Energy Agency (September 2015), Projected Costs of Generating Electricity, p. 30. Exhibit NERA-0002.

[14] Unlike other biomass fuels, firing wood pellets causes fewer issues with slagging and fouling in coal plant burners. Higher energy density and international trade make wood pellets the most economic fuel alternative. For details see Appendix C. Both [redacted] as well as the Dutch government's guidelines for co-firing in the SDE+ scheme confirm that industrial wood pellet prices should be considered when assessing the economic viability of electricity generation from biomass in (partially) converted former coal plants. See [redacted], and ECN, DNV (April 2017), Final advice on base rates SDE+ 2017, p. 45-46, Exhibit NERA-0003.

Figure 1.2: 2017 marginal costs of electricity generation



Source: NERA analysis, IEA, ECN.[15]

37. The 2017 marginal costs of biomass-fuelled generation absent subsidies are higher than those for natural gas.[16] This means an unsubsidised biomass plant would generally not be expected to be able to sell electricity on the Dutch electricity market. Existing biomass plants in 2017 rely on subsidies, which is the topic of the next section.

---

15 Fuel costs and variable cost analysis for conventional technologies are based on IEA (September 2015), Projected Costs of Generating Electricity 2015 Edition, biomass cost analysis is based on ECN, DNV (April 2017), Final advice on base rates SDE+ 2017. See NERA Electricity generation cost – Fuel Cost, Conventional O&M and Biomass O&M, Exhibit NERA-0004.

16 The Eemshaven plant has been granted subsidies for up to 1,788,889 MWh of biomass-based electricity generation per year. With these subsidies in place, marginal costs of generation for the Eemshaven plant are lower than shown in Figure 1.2. However, if the Eemshaven plant and other Dutch coal plants were to be converted to biomass, the subsidies would have expired at that time. Therefore, the unsubsidised marginal costs of generation from biomass are the relevant figure in the context of converting to biomass. For details, see Rijksdienst voor Ondernemend Nederland (Dezember 2016), Beschikking tot subsidieverlening. Exhibit NERA-0013. The marginal costs of gas in Figure 1.2 reflect an electrical efficiency of 59 per cent, as provided in IEA (September 2015), Projected Costs of Generating Electricity 2015 Edition. A lower efficiency would lead to higher marginal costs of gas. However, a converted biomass plant would have higher marginal costs of generation than even older gas-fired plants in the Netherlands with lower efficiency scores, e.g. Engie's gas-fired plant in Eemshaven ("Eemscentrale"), which we understand had an efficiency of 51 per cent.

1.3. Existing biomass conversion projects in the Netherlands and the EU rely on subsidies

38. Although marginal costs of generation for biomass are relatively high, there are biomass plants in operation and there is biomass co-firing at the Eemshaven plant. This section shows that existing biomass plants in Europe rely on subsidies.

1.3.1. We are not aware of any European precedent for unsubsidised electricity generation from biomass

39. Several EU Member States have introduced financial support schemes for energy generated from biomass. Co-firing and conversion are uneconomical, because the marginal costs of generation from biomass are higher than the marginal costs of generation from coal. Therefore, financial support schemes can incentivise investment in biomass generation capacity, which would not be economical otherwise.

40. We understand Directive 2009/28/EC, the Renewable Energy Directive (RED), adopted on 23 April 2009, is the legal framework for financial support to renewable plants in the EU. Article 3(1) identifies a target of at least a 20 per cent share of energy from renewable sources in the EU's gross final energy consumption[17] by 2020 and, in Article 3(3) permits Member States to introduce support schemes for energy from renewable sources to reach these targets. Article 2(a) includes biomass as such a renewable energy source. Moreover, Directive 2003/87/EC, establishing the EU's emission trading scheme (ETS), provides that biomass is considered not to produce any emissions for the purposes of ETS.[18]

41. Yet, already at the introduction of RED, there had been a debate around the sustainability of energy from biomass. This debate is ongoing. Section 2.1 illustrates that NGOs and environmental activists consider existing sustainability standards insufficient and lobby for stricter environmental regulation of biomass. At the introduction of RED, the Commission prepared a report on requirements for a sustainability scheme for energy uses of biomass following RED Article 17 (9). The Commission published the report in February 2010. The report evaluates the main sustainability issues identified in the public consultation in July-September 2008: 1) sustainability in production, 2) land use, land use change and forestry accounting, 3) life

---

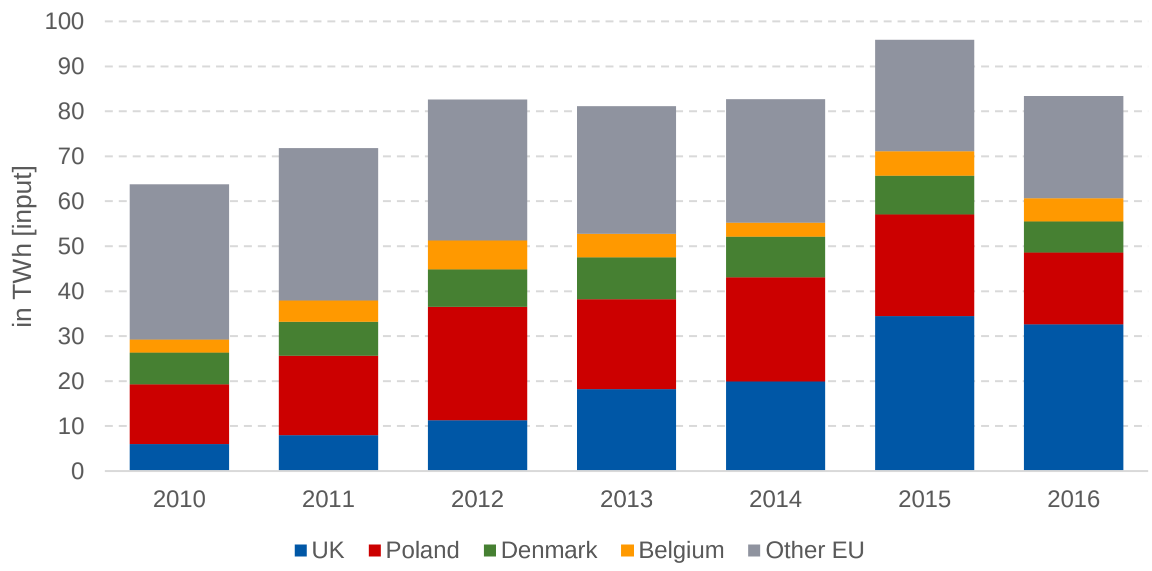
17 Directive 2009/28/EC defines gross final consumption of energy as energy commodities delivered to final customers (industry, transport, households, services, agriculture, forestry and fisheries), including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution and transmission.

18 The emission factor for biomass burned in power plants is set to zero, see Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003, Annex I and Annex IV.

cycle greenhouse gas performance, and 4) energy conversion efficiency.[19] To promote the sustainable production and use of biomass, the Commission recommends sustainability schemes similar to the sustainability criteria introduced by RED for biofuels and bioliquids. The sustainability criteria include among others minimum greenhouse gas reductions compared to conventional fuels and restrictions on sourcing biomass from high biodiversity value areas.[20] Section 2.1 illustrates that NGOs and environmental activists consider existing sustainability standards insufficient and lobby for stricter environmental regulation of biomass.

42. Following the adoption of RED, several European countries introduced subsidy schemes as part of their emission reduction and renewable energy strategies to incentivise investments in biomass for electricity generation. The UK, Poland, Denmark, and Belgium account for the majority of biomass used in co-firing or converted coal plants in the EU. Figure 1.3 below illustrates this. Therefore, we consider these four countries in greater detail in Appendix D.

Figure 1.3: EU-28 Biomass Burnt in Current and Former Coal Power Plants [in TWh]



Source: NERA illustration, Sandbag 2019.[21]

19 European Commission (February 2010), Report from the Commission to the Council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass in electricity, heating and cooling, p. 3-7. Exhibit NERA-0006.

20 European Commission (February 2010), Report from the Commission to the Council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass in electricity, heating and cooling, p. 8. Exhibit NERA-0006.

21 Illustration based on Sandbag (2019) Playing with Fire: An assessment of company plans to burn biomass in EU coal power stations, Chart data Fig. 7 – Conversion. See NERA Exhibit-0007.

43. Table 1.1 summarises the precedent for failed and successful biomass conversion projects in the UK, Belgium, Denmark, and Poland. Plants who did not secure subsidies either abandoned their conversion plans and shut down instead or they shut down shortly after conversion. Only plants who secured subsidies converted and maintained operations.

44. This is clear evidence that without subsidies a conversion to biomass is not economically viable given the market conditions as of the valuation date.

Table 1.1: Failed and Successful Coal to Biomass Power Plant Conversions in the UK, Belgium, Denmark, and Poland

Country	Plant	Capacity (MW_e)	CAPEX (million)	CHP	Subsidies	Note
UK	Drax	2580*	£673*		Yes	Conversion ongoing*
	Lynemouth	420			Yes	Conversion ongoing
	Tilbury B	742			Yes / No	Conversion 2011 / Shut 2013*
	Ironbridge	740			Yes	Conversion 2013 / Shut 2015*
	Eggborough	2,000			No	Shutdown after Valuation Date
Belgium	Les Awirs	75			Yes	Conversion 2005
	Rodenhuize	205	€ 125		Yes	Conversion 2011
	Langerlo	400		Yes	No	Shut in 2017
Denmark	Herning	77		Yes	Yes	Conversion 2009
	Avedøre 2	394		Yes	Yes	Conversion 2014
	Avedøre 1	254	€ 100	Yes	Yes	Conversion 2016
	Studstrup 3	362	€ 175	Yes	Yes	Conversion 2016
	Skærbæk 3	95	€ 242	Yes	Yes	Conversion 2017
Poland	Bialystok	166	$28	Yes	Yes	Conversion 2012

Source: NERA analysis, various sources.[22]
Note: Tilbury B shut down in 2013 when it failed to qualify for a CfD from the British government. Ironbridge shut down in 2015 after the loss of one of two units due to a fire and as subsidies were insufficient to allow for the installation of emission abatement systems, which would have been required due to stricter EU criteria on plant emissions. CAPEX estimate for Bialystok is for the replacement of the boiler only. Drax converted three units of 645 MW capacity by 2017, a fourth identical unit was converted in 2018. Conversion CAPEX as of 31. December 2016.

22 Analysis based on sources quoted in Appendix D. See Exhibit NERA-0008 to Exhibit NERA-0036. See NERA Conversion Case Studies, Exhibit NERA-0037 for additional info on plant capacities and investments.

1.3.2. Generation from biomass and co-firing in the Netherlands

45. Coal-fired power plants in the Netherlands have co-fired biomass since the 1990s. By 2000, several coal-fired power stations had added up to 5 per cent of different fuels.[23] A 2005 report by the IEA suggests that the 2002 coal covenant envisaged an increased use of biomass co-firing in coal-fired power plants to reduce CO_2.[24]

46. To incentivise co-firing and achieve the target set by the Dutch government in accordance with EU Directive 2001/77/EC[25] of 9 per cent renewable electricity in gross electricity consumption by 2010, the Ministerial Regulation on the Environmental Quality of Electricity (MEP) replaced an earlier tax-exemption in 2003. The MEP paid a guaranteed ten-year feed-in-tariff (FIT) for renewable energy to compensate electricity producers.[26] Figure 1.4 illustrates that following the introduction of MEP, biomass co-firing in existing power plants increased significantly from 795 GWh in 2003 to 3,449 GWh in 2005.[27] This amounts to 3.4 per cent of gross electricity generation in 2005.[28] In total, 24 co-firing projects received support through the MEP.[29]

47. In 2006, the MEP subsidy decreased for biomass fuels except for wood pellets and no further commitments for MEP were entered after 2006.[30] This led to a significant drop in electricity generation from liquid biomass, e.g. palm oil. Since then, solid biomass such as wood pellets are the main fuel for biomass co-firing and generators replaced liquid biomass inputs with wood pellets as of 2007.[31] In 2008, MEP was replaced by the Stimuleringsregeling Duurzame Energieproductie (Incentive Scheme for Sustainable Energy Production, SDE). SDE excluded

---

23 Netherlands Energy Research Foundation ECN (November 2000), Biomass Cofiring Potential and Experiences in The Netherlands, p. 4-5. Exhibit NERA-0038.

24 IEA Bioenergy (July 2005), IEA Bioenergy task 40 – Country report for the Netherlands, Report NWS-E-2005-48, ISBN 90-73958-96-2, p. 2. Exhibit NERA-0039.

25 Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001.

26 IEA Bioenergy (July 2005). "IEA Bioenergy task 40 – Country report for the Netherlands", Report NWS-E-2005-48, p. 4. Exhibit NERA-0039.

27 The 795 GWh of electrical output from biomass co-firing in 2003 may have been produced from plants for which the tax exemptions existing until 2003 were sufficient to compensate for the higher marginal costs of generation. We are not aware of a source with plant- or unit-level information on tax exemptions, which would allow to confirm this.

28 Centraal Bureau voor de Statistiek, Staline (2021) Database: Renewable electricity; production and capacity. See Exhibit NERA-0040.

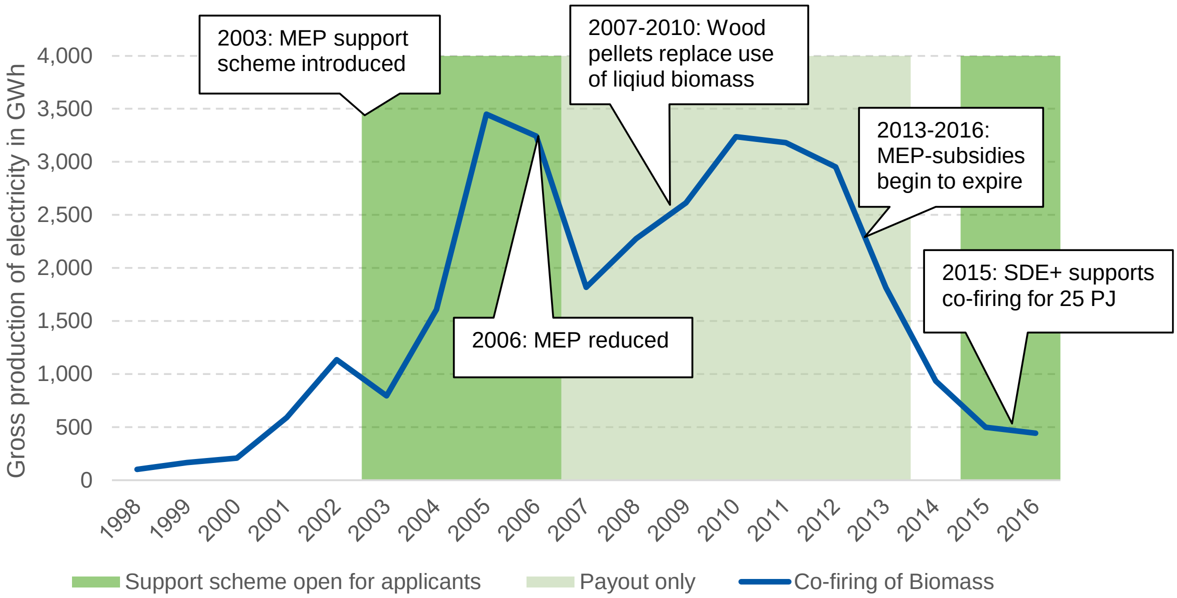
29 Netherlands Enterprise Agency (September 2014), Renewable energy report: Part 1 Implementation 2003-2013, p. 48. Exhibit NERA-0041.

30 Netherlands Enterprise Agency (December 2019), Energy from renewable sources in the Netherlands 2017 – 2018. Progress report, p.20. Exhibit NERA-0042.

31 IEA Bioenergy (October 2010), IEA Bioenergy Task 40 / EUBIONETIII Country report for the Netherlands – Update for 2009, p.26-27. Exhibit NERA-0043.

biomass co-firing in coal plants.[32] As the legacy MEP subsidies expired starting in 2013, co-firing in coal power plants subsequently decreased. By 2015 co-firing in coal plants had decreased to 498 GWh, or 0.43 per cent of gross electricity generation in the Netherlands.[33]

Figure 1.4: Electricity Generation from Biomass Co-firing in Large Power Plants in the Netherlands [in GWh]



Source: NERA illustration, CBS.[34]

48. In 2013, the government committed to supporting biomass co-firing in coal power plants of up to 25 PJ in the Dutch Energy Accord.[35] The government reintroduced subsidies for co-firing biomass in the revised SDE+ scheme for existing and new coal plants in 2015.[36] The plants at Amer and Eemshaven, which both belong to RWE, and the plants at Maasvlakte, which belong to Onyx and

32 Netherlands Enterprise Agency (September 2014), Renewable energy report: Part 1 Implementation 2003-2013, p. 48. Exhibit NERA-0041.

33 The 498 GWh of electrical output from biomass may have been generated using remaining MEP subsidies. We are not aware of a source with plant- or unit-level information on MEP subsidies, which would allow to confirm this.

34 Illustration based on: Centraal Bureau voor de Statistiek, Statline (2021), Database: Electricity and heat; production and input by energy commodity, years 1998-2020. Exhibit NERA-0040.

35 Netherlands Enterprise Agency (September 2014), Renewable energy report: Part 1 Implementation 2003-2013, p. 48. Exhibit NERA-0041

36 Netherlands Enterprise Agency (2015), SDE+ 2015: Instructions on how to apply for a subsidy for the production of renewable energy, p. 4. Exhibit NERA-0044.

Uniper, secured subsidies under SDE+.[37] As of autumn 2017, the SDE+ subsidy scheme for biomass co-firing was discontinued, i.e. the scheme is closed for new biomass applications.[38]

49. In 2016, the Eemshaven plant applied for SDE+ funding and later also received it. The subsidy, which extends over eight years, i.e. until April 2027, covers electricity generation from biomass of up to 1,789 GWh per year, which is about equivalent to the electricity generated from the 800,000 tonnes of biomass Eemshaven is allowed to burn each year.[39] Allowing for co-firing required the installation of additional biomass logistics and storage facilities as well as modifications to one coal mill.

50. The oscillating history of (re-)introduction and discontinuation of biomass subsidies in the Netherlands confirms the evidence found in other European markets. While the MEP subsidy scheme was in place, electricity generation from biomass increased, but once the MEP subsidies expired, biomass-fuelled electricity generation in power plants declined. Biomass-fuelled electricity generation increased again when the SDE+ subsidy scheme was introduced, but it has been closed to new applicants in autumn 2017.

51. This means that in the Netherlands, just like in the other European states, electricity generation from biomass takes places only when it is supported by subsidies, but not in the absence of subsidies. This is also reflected in the IEA's assessment that *"[d]emand markets are still influenced* ***exclusively*** *by policy framework providing incentives in different forms to biomass combustion"*.[40] The reason is that marginal costs of generating electricity from biomass are too high relative to other fuels.

52. In the UK, Drax Group plc. ("Drax") is an exchange-listed operator of a former coal-fired power plant, which in October 2017 had converted several of its generation units from coal to biomass. The next section analyses equity analyst reports on Drax and finds that Drax's business case, too, is primarily influenced by the prevailing subsidy regime for biomass.

---

37 Rijksdienst voor Ondernemend Nederland (January 2017), Beschikte projecten SDE+ najaar 2016 (18 januari 2017), and Rijksdienst voor Ondernemend Nederland (2017), Positief beschikte projecten SDE+ voorjaar 2017. Exhibit NERA-0045.

38 Netherlands Enterprise Agency (2017), SDE+ Autumn 2017: Instructions on how to apply for a subsidy for the production of renewable energy, p. 4. Exhibit NERA-0046.

39 See RWE (December 2007), VERGUNNING WET MILIEUBEHEER verleend aan RWE Power AG te Essen, pp. 90-92 (Exhibit NERA-0017) for the granted request for biomass firing at Eemshaven and KEMA (December 2006), Aanvraag om (oprichtings)vergunning: 1600 MWe kolencentrale van RWE aan de Eemshaven, pp. 48-49 Table 3.1.2. (Exhibit NERA-0018). for the request details. For the SDE+ grant see Rijksdienst voor Ondernemend Nederland (Dezember 2016), Beschikking tot subsidieverlening (Exhibit NERA-0013). The 800,000 tonnes of biomass translate to 1,789 GWh of electrical output if one assumes an energy density of biomass of 17.5 GJ/t and a plant efficiency of 46 per cent. However, if the energy density of biomass or the plant efficiency is lower, the amount of electrical output that can be produced from 800,000 tonnes of biomass is lower, too.

40 IEA (2017), Global wood pellet industry and trade study 2017, p. 231. Emphasis added. Exhibit NERA-0047.

1.4. Drax's business case also relies on subsidies

53. Market commentary on the future of Drax power station may offer some insights on market participants' valuation of subsidised and unsubsidised electricity generation from biomass as of the valuation date.

54. Drax operates a former coal-fired power plant that is now producing power from biomass in four of its six units. Drax's conversion from coal to biomass firing has been supported through renewables obligations ("ROCs") and Contracts for Difference ("CfDs"). The subsidies are planned to end in 2027 and the UK government has already implied that no further subsidies can be expected.[41] Besides the converted coal plant, Drax's other businesses include retail, pellet production, and power generation from gas.

55. Drax's market capitalisation as of 2017 primarily reflects the value of its subsidised biomass business until 2027 and does not allow us to make a direct conclusion on how the market values a potential unsubsidised generation from biomass after 2027. However, as a listed company, Drax's business is covered by several equity analysts, who regularly publish reports and opinions assessing the results, strategy, and valuation of the company. The analyst reports reflect how market participants view Drax's current and future business. Any value assigned to Drax's converted power plant after 2027 would be indicative of the value of unsubsidised generation from biomass.

56. We have analysed a broad sample of analyst reports between 2015 and 2017 (the full list is provided in Appendix E). The main findings are:

- Analysts do not assign any value to Drax's biomass generation business after 2027. In other words, as of 2017 the value of Drax's unsubsidised biomass generation business is zero.
- Any future business case for Drax rests on its efforts to diversify from coal and biomass generation into the development of alternative generation in its gas plants, retail electricity supply or biomass production as a fuel.

1.5. Conclusion

57. In summary, Section 1.1 introduces key concepts of the electricity market and the merit order model. The earnings potential of any generation technology depends on its marginal costs of generation relative to competing technologies. Section 1.2 shows that a reasonable and prudent investor would be sceptical whether unsubsidised biomass plants could sell electricity given the

[41] Department of Energy & Climate Change (December 2013), Electricity Market Reform Delivery Plan, p. 49-50. Exhibit NERA-0075.

competition from other technologies and their cost structures. Section 1.3 suggests that without subsidies biomass plants are not economically viable investments. We are not aware of any large-scale plants with co-firing of biomass or electricity generation purely based on biomass which can profitably operate without any subsidies. This applies to Europe and the Netherlands alike. Equity analysts share this view for Drax in the UK. Section 1.4 shows that in 2017, analysts did not attribute any value to Drax's electricity generation business after subsidies will expire in 2027.

2. Outlook for biomass generation in large-scale power plants reveals substantial risks

58. Section 1 suggests that given the market environment in October 2017, investments in biomass-fired power plants are not economically viable without subsidies, but rather lead to losses. Therefore, a reasonable and prudent investor would not anticipate investing in the biomass conversion of a Dutch coal-fired power plant such as Eemshaven.

59. This section looks into the future from the perspective of 2017. The outlook as of that date for electricity generation from unsubsidised biomass was negative, in particular due to two key risks:

- Section 2.1 addresses the risk of tightened environmental regulations which may lead to heightened sustainability requirements for biomass and increased prices of sustainable biomass or biomass plants being subjected to the ETS. As a result, marginal costs for biomass plants may increase substantially.

- Section 2.2 discusses the potential scarcity of biomass in upside scenarios where biomass conversion would in principle become profitable, e.g. in a scenario of very high gas prices or CO2 prices. A reasonable and prudent investor who considered that such upside scenarios might materialise in the future, would nevertheless not change the above assessment of biomass. In such upside scenarios for biomass, the investor would expect large coal-fired plants in the Netherlands and potentially other European countries to also convert to wood pellets. Then, pellet prices – due to the increasing demand – would likely rise substantially and cap the earnings potential of a converted plant.

2.1. Risks of tightening environmental regulations

60. In 2017, there was an increasing risk that environmental regulation for biomass plants would be tightening in the future. There was growing political opposition to large-scale biomass plants, which e.g. aimed at classifying energy generation from woody biomass no longer as carbon neutral.

61. The political opposition was grounded in the criticism by some scientists and NGOs of the use of biomass as a fuel. Using biomass as a fuel for electricity generation emits greenhouse gases in the short run. These greenhouse gases may be recovered from the atmosphere over a longer horizon by growing plants and trees, i.e. biomass. Due to this circle, biomass has been classified as a sustainable fuel. Nevertheless, the long delay between greenhouse gas emissions when generating energy and its recovery from the atmosphere through growing plants ("carbon debt") has led some scientists and NGOs in the Netherlands and internationally to criticise the treatment of biomass as carbon neutral. They point to the potential additional greenhouse gas emissions when processing

biomass, e.g. during transport, and due to concern over land use (meaning that areas used for growing the fuel stock are neither available for growing food plants, nor as natural reserves).

62. This criticism already led the Dutch government to announce in 2017 that no further subsidies would be granted for biomass conversion projects under its renewable energy support scheme SDE+.[42] Also, already in the years prior to 2017, sustainability criteria for biomass have been tightened. In particular, the Netherlands enforces more stringent sustainability criteria for energy generation from biomass than required by the European Union.[43]

63. Nevertheless, there continued to be risks of a further tightening of future environmental regulation. This risk was mainly twofold: sustainability criteria for biomass could be even further tightened and CO2 emissions from biomass-fuelled power plants could be subjected to the ETS. Both would increase the marginal costs of the converted plant and thereby make it even less viable.

64. Despite the already heightened sustainability criteria, NGOs and environmental activists continue to lobby for even stricter standards. For instance, the think tank Chatham House published a research paper on 23 February 2017, in which it reviewed the sustainability criteria of several jurisdictions including the Netherlands. The paper finds that the Dutch system has the most detailed of all the national sustainability criteria[44] but that even the Dutch sustainability criteria are not fit for purpose in mitigating climate change.

"The requirements in the Dutch criteria that the forest is managed 'with the aim of retaining or increasing carbon stocks in the medium or long term', and in the SBP's standard that 'regional carbon stocks are maintained or increased over the medium to long term' are too

---

42 The Dutch government had already once before excluded biomass from its renewables support schemes. After initially providing substantial subsidies for co-firing under the MEP subsidy regime, subsidies for large-scale biomass co-firing had been excluded in the new SDE subsidy regime in 2008 due to the *"risks regarding the sustainability of the biomass to be used with regard to the greenhouse gas balance, biodiversity, land use and competition with food"*. (See Staatscourant van het Koninkrijk der Nederlanden (March 2008), Regeling aanwijzing categorieën duurzame energieproductie 2008, Staatscourant 2008, 44 pagina 8. Exhibit NERA-0048. Original quote: "*Verder is bij de categorie-indeling voor 2008 ook rekening gehouden met de risico's ten aanzien van de duurzaamheid van de in te zetten biomassa met betrekking tot onder andere de broeikasgasbalans, biodiversiteit, landgebruik en concurrentie met voedsel*." Exhibit NERA-0048.) Later, the Netherlands reintroduced subsidies for biomass under the SDE+ scheme but subjected them to newly developed mandatory sustainability criteria.

43 The Dutch standard applies to electricity production from biomass, including co-firing, and large-scale heat production seeking to qualify for an SDE+ subsidy. The standard identifies five potential feedstock sources for biomass, each of which is subject to different sustainability requirements (see Netherlands Enterprise Agency (March 2021), Guidance for the use of pellet certification within SDE+, Table 2.1, p.5. Exhibit NERA-0049.). A 2016 report commissioned by the NGO Fern found that the Dutch standard *"is the most comprehensive standard yet developed, dealing with most of the sustainability issues that are relevant for bioenergy production. The only issues not covered are resource efficiency and competition over raw materials in the forest-based sector."* Fern (July 2016), A comparison of national sustainability schemes for solid biomass in the EU, p.19. Exhibit NERA-0050.

44 Chatham House, The Royal Institute of International Affairs (February 2017), Woody Biomass for Power and Heat: Impacts on the Global Climate, p. 63. Exhibit NERA-0051.

vague. […] [F]rom the point of view of mitigating climate change, there is a major difference between the medium term and the long term; arguably, anything longer than the short term is too long.”[45]

65. Moreover, as of 2017, the European Commission was working towards introducing the first set of sustainability criteria for biomass at the European level (RED II). Until then, there had not been a harmonised set of criteria with EU-wide scope. Tightening the sustainability criteria across the EU would reduce the pool of eligible biomass sources for European plants. A set number of European producers would compete for a reduced supply, which would lead to an increase in prices for sustainable biomass, which also Dutch biomass plants are required to use. Likewise, an even further tightening of the sustainability by the Netherlands would further reduce the available biomass supply and increase costs.

66. The threat of stricter sustainability criteria would mean for investors an even higher risk that due to increased costs, a conversion to biomass would not be viable and cause losses.

2.2. Increasing demand for renewable power from biomass may adversely affect biomass prices

67. Section 2.1 addressed the threat of more stringent regulations regarding the sustainability of biomass as a fuel for power generation. This section explains how the global market for biomass, in particular wood pellets, would change if unsubsidised electricity generation from biomass became competitive. Section 2.2.1 gives an introduction to the global market for wood pellets as of October 2017. Section 2.2.2 shows that a conversion of existing Dutch coal-fired power plants would imply a significant increase in global pellet demand, and it considers the potential additional demand from coal-fired power plants in Europe in a hypothetical scenario where biomass became commercially attractive.

2.2.1. The global market for wood pellets as of 2017

68. Wood pellets are the most suitable biomass fuel for large scale power generation, because of favourable technical characteristics and an existing international market. Appendix C includes a detailed discussion of the reasons for burning wood pellets in a large-scale biomass plant.

69. Global pellet consumption was c. 28 Mt in 2016.[46] Consumption in Europe was c. 22 Mt, pellet consumption in Asia and North America totalled 3 Mt in each region. Figure 2.1 shows the ten

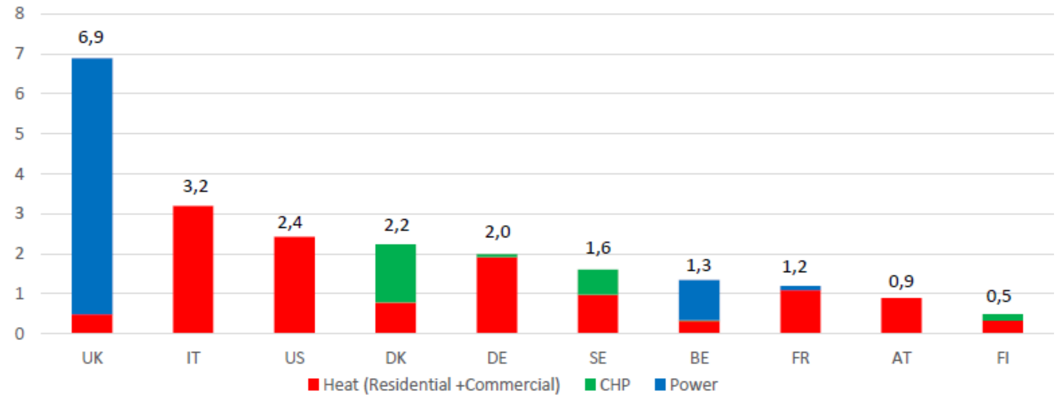
---

[45] Chatham House, The Royal Institute of International Affairs (23 February 2017), Woody Biomass for Power and Heat: Impacts on the Global Climate, p. 66. Exhibit NERA-0051.

[46] AEBIOM (2017), European Bioenergy Outlook Statistical Report, p. 158. Exhibit NERA-0052.

countries with the highest pellet consumption by end-use. Except for the United States all of the countries are located in Europe.

Figure 2.1: Top 10 Wood Pellet Consuming Countries by End-use in 2016 [in Mt]



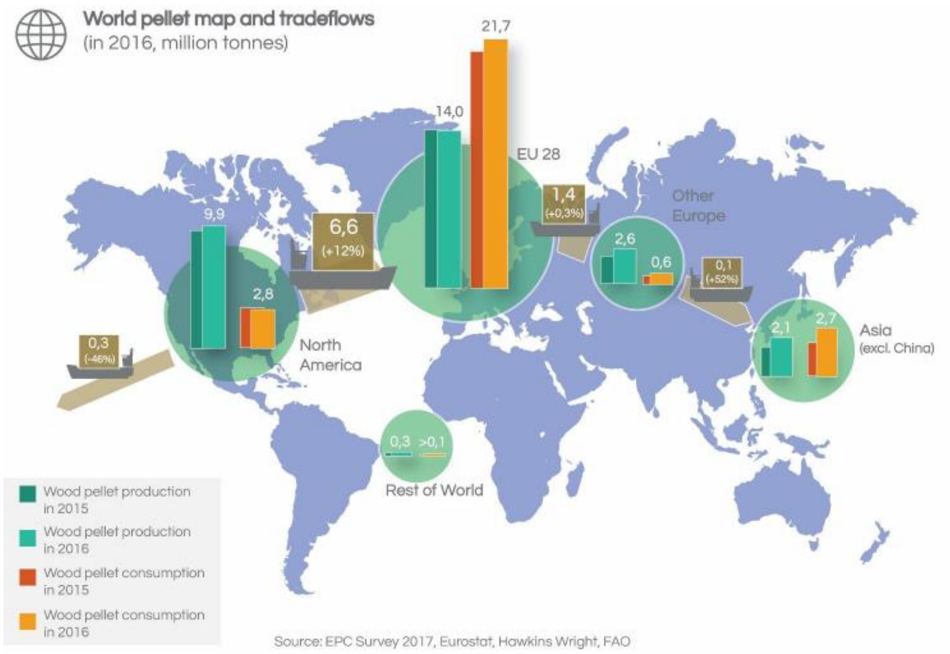
Source: AEBIOM.[47]

70. Within the European Union, total pellet consumption exceeded domestic production by 7.7 Mt in 2016. Figure 2.2 demonstrates that imports to Europe mostly originate from North America, with 6.6 Mt of wood pellets imported to the EU in 2016. North American wood pellets are primarily consumed in dedicated large-scale power generation plants in the UK and Belgium.[48]

[47] AEBIOM (2017), European Bioenergy Outlook Statistical Report, p. 157. Exhibit NERA-0052.

[48] AEBIOM (2017), European Bioenergy Outlook Statistical Report, p. 203. Exhibit NERA-0052.

Figure 2.2: Pellet Market and Trade Flows in 2016 [in Mt]



Source: AEBIOM.[49]

71. Pellet consumption can be divided in two segments: residential heat and industrial applications.[50] Customers in the residential market require "premium" pellets with higher quality. Industrial applications include commercial heat, CHP, and dedicated electricity generation.[51] Out of the c. 28 Mt of pellets consumed in 2016, demand for dedicated electricity generation accounted for c. 10 Mt or 35 per cent.[52]

72. From the perspective of 2017, global pellet consumption was expected to increase. In its 2017 Wood Pellets Outlook, Hawkins Wright, an independent market intelligence provider, reports that industrial-grade pellet consumption amounted to 13.4 Mt in 2016 but expected it to almost double to 29 Mt by 2021,[53] with much of the additional demand coming from Asia.

---

49 AEBIOM (2017), European Bioenergy Outlook Statistical Report, p. 155. Exhibit NERA-0052.

50 IEA (2017), Global wood pellet industry and trade study 2017, p. 16. Exhibit NERA-0047.

51 IEA (2017), Global wood pellet industry and trade study 2017, p. 16. Exhibit NERA-0047.

52 AEBIOM (2017), European Bioenergy Outlook Statistical Report, p. 158. Exhibit NERA-0052. To calculate the share of industrial pellets, we have added pellets consumption classified as "commercial", "CHP" and "dedicated power".

53 Hawkins Wright (September 2017), The global outlook for wood pellet markets, WPAC Annual Conference, Ottawa, September 2017, p. 6, 22. Exhibit NERA -0053. He reports a total pellet demand of 28.6 Mt in 2016, which is consistent with the figures reported by AEBIOM.

2.2.2. Large scale conversion of coal plants would add a significant share to present global pellet consumption

73. Section 1 shows that biomass-fired plants' marginal costs of generation are too high to operate in the Dutch electricity market. This section addresses the hypothetical scenario where biomass plants could compete, in principle, in the Dutch wholesale electricity market, e.g. in a scenario of very high gas prices or CO2 prices. In such a scenario, a full conversion of the Dutch coal-fired power plants, as contemplated by the Dutch government, would add significant demand to the worldwide pellet market. The exact volume of pellets consumed would depend on the converted plants' full-load hours ("FLHs"), i.e. their electrical output.

74. Subsidised biomass plants exhibit a high number of FLHs, i.e. they run in many of the year's 8,760 hours at full capacity. In the hypothetical scenario contemplated by the Dutch government, where converted Dutch coal plants produced electricity, their consumption of pellets would amount to a significant share of the global pellet market even if they ran for less hours than subsidised biomass plants do momentarily.

75. Coal-fired power plants in the Netherlands have a total generation capacity of 3,961 MW.[54] SDE+ subsidies have incentivised plant operators to convert c. 791 MW of that generation capacity to biomass.[55] The remaining generation capacity which could theoretically be converted to biomass amounts to c. 3,170 MW. If this generation capacity ran for 8,000 hours out of the 8,760 hours per year, its approximate pellet consumption would add c. 12,21 Mt to global demand.[56] In other words, the 2016 global pellet consumption dedicated to electricity generation of c. 10 Mt would more than double because of the incremental demand from converted Dutch power plants. Total global pellet consumption (i.e. regardless of end-use) would increase by c. 44 per cent. Even if the Dutch plants ran for only 2,000 hours per year, they would add c. 3.05 Mt to global demand.[57] This would increase global pellet consumption dedicated to electricity generation by c. 32 per cent. Figure 2.3 illustrates by how many per cent global pellet consumption and global pellet

---

54 The coal-fired plants are RWE Eemshaven (1,560 MW), Uniper Maasvlakte (1,070 MW), Onyx Rotterdam (731 MW) and RWE Amer (600 MW).

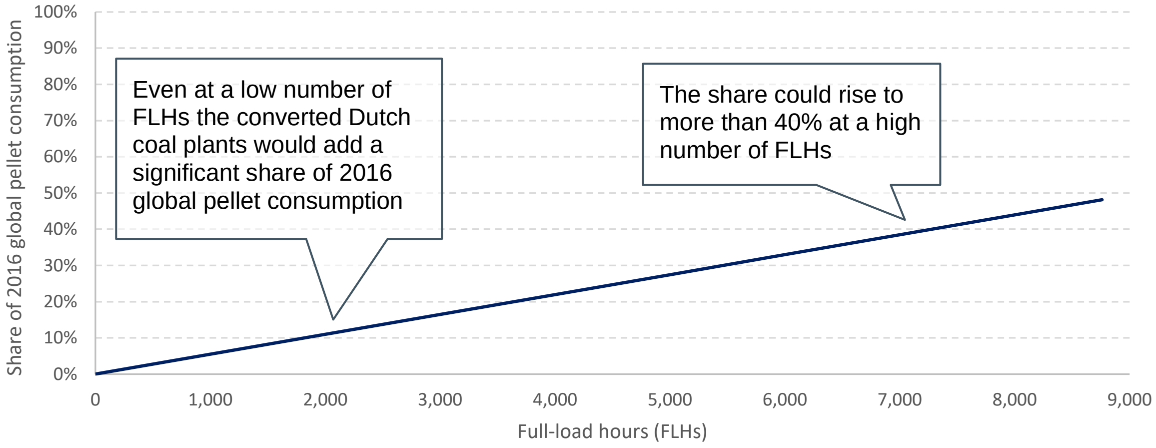
55 The SDE+ project list reports biomass generation capacity of 255.56 MW for RWE Eemshaven, 272 MW for Uniper Maasvlakte, c. 6.2 MW for Onyx Rotterdam, and 257.2 MW for RWE Amer. See Rijksdienst voor Ondernemend Nederland (January 2017), Beschikte projecten SDE+ najaar 2016 (18 januari 2017), and Rijksdienst voor Ondernemend Nederland (2017), Positief beschikte projecten SDE+ voorjaar 2017. Exhibit NERA-0045.

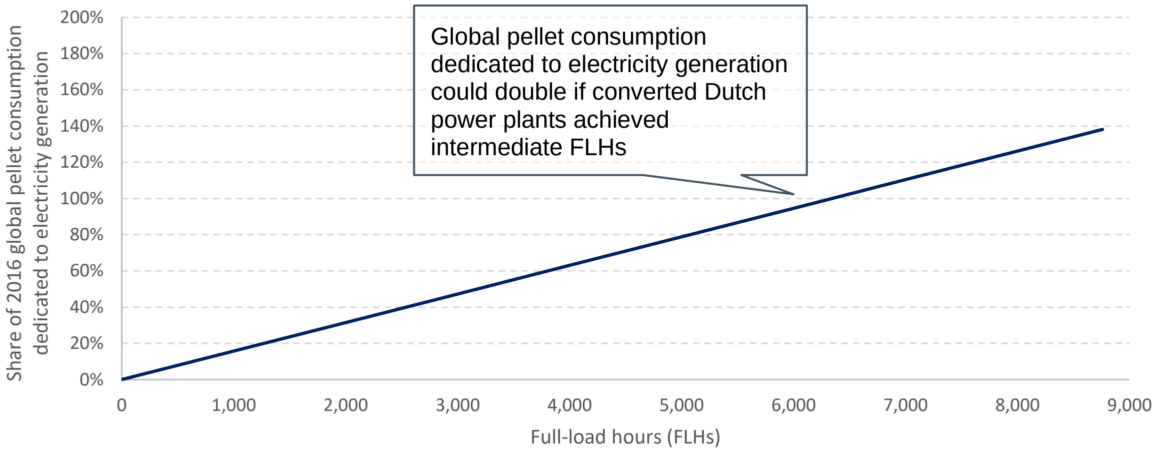
56 The figure of 12.21 Mt for 8,000 FLH is based on the following calculation. We consider 3,170 MW of generation capacity and 8,000 hours of runtime. The electrical output is $3{,}170 \times 8{,}000 = 25{,}360{,}256$ MWh. Assuming an average efficiency of 44% for the converted coal plants, the required thermal energy is $\frac{25{,}360{,}256}{44\%} = 57{,}636{,}945$ MWh. One MWh equals 3.6 GJ, so the thermal energy required equals $57{,}636{,}945 \times 3.6 = 207{,}493{,}004$ GJ. Assuming an energy density for pellets of 17 GJ/t, the required pellets are $207{,}493{,}004 \times 17 = 12{,}205{,}471$ t, or c. 12.21 Mt.

57 The figure of 3.05 Mt for 2,000 FLH is based on an analogous calculation as for 8,000.

consumption dedicated to electricity generation would increase depending on converted Dutch plants' FLHs.

Figure 2.3: Incremental Pellet Demand from Converted Dutch Power Plants as Share of Existing Global Pellet Consumption in 2016





Source: NERA analysis, AEBIOM, Rijksdienst voor Ondernemend Nederland.[58]

76. The above analysis shows that in the hypothetical scenario where Dutch coal plants were fully converted to biomass as per the governmental proposal, their incremental demand would significantly add to the global demand for industrial pellets, even if the converted plants had only modest FLHs.

---

58 Analysis based on AEBIOM (2017), European Bioenergy Outlook Statistical Report, Table 1.4 p. 14., and Rijksdienst voor Ondernemend Nederland (January 2017), Beschikte projecten SDE+ najaar 2016 (18 januari 2017), and Rijksdienst voor Ondernemend Nederland (2017), Positief beschikte projecten SDE+ voorjaar 2017. See NERA Incremental market share Dutch pellet conversion demand – Pellet Consumption. Exhibit NERA-0076.

77. So far, the analysis has considered the impact of incremental demand from converted Dutch plants in isolation. This section considers the wider European landscape. In the absence of subsidies, Dutch plants would only be converted in a hypothetical situation where their marginal costs of generation were competitive relative to other technologies, such that a reasonable and prudent investor could expect to earn back the conversion CAPEX through margins earned by the plant. If this was possible in the Netherlands, it may also be possible in other European markets. Then, not only Eemshaven and the other Dutch coal power plants, but also many other former coal-fired power plants all over Europe might have an incentive to take up biomass-based power generation – either equivalently threatened by coal exit decisions or purely because of commercial reasons.

78. New power plants with several years of remaining technical lifetime would be particularly interested in converting to biomass. For example, between 2000 and 2017 more than 26,000 MW of hard coal capacity were added in Europe.[59] This is about eight times as much as the capacity in the Netherlands, which could theoretically be converted to biomass. Assuming a typical lifetime of 40 years for coal-fired power plants, these power plants would be expected to run for at least another ten years as of 2030.

79. Accommodating substantial additional demand will lead to higher pellet prices if pellets have to be diverted from the residential market segment or if additional pellet production capacities lead to higher transport and production costs.

80. The academic literature does not expect economies of scale for the pellet industry.[60] This means a substantial increase in pellet demand and pellet production capacity would not lead to lower average production costs, as it is the case in industries which exhibit economies of scale.

81. In 2020, Lotte Visser, Ric Hoefnagels, and Martin Junginger, researchers from the university of Utrecht, published a literature survey article in a peer-reviewed journal (Visser et al.). The researchers review academic papers on the costs and prices of the biomass supply chain published between 2007 and 2017. With respect to feedstock prices, Visser et al. explain that *"increased pellet production is expected to result in more competition for feedstock and increased feedstock prices."*[61] In addition, transport distances are expected to increase after "prime spots" close to the

[59] Europe Beyond Coal (July 2021), European Coal Plant Database, Status 21. July 2021. Exhibit NERA-0054.

[60] Economies of scale exist if the average cost of producing one unit of pellets decreases when expanding production. See Joaquim Silvestre (1987), Economies and Diseconomies of Scale, Palgrave Macmillan (ed.), The New Palgrave Dictionary of Economics. Exhibit NERA-0055.

[61] Visser et al. (2020); Wood pellet supply chain costs – A review and cost optimization analysis, p. 13. Renewable and Sustainable Energy Reviews 118. Exhibit NERA-0056.

coast are taken and the production moves further inland. Visser et al. confirm that e.g. in the US, *"pellet plants producing for the export market are currently located close to export ports"*.[62]

82. According to Visser et al. *"the cost reduction potential of optimisation strategies was found to be limited"*, mainly due to trade-offs between cost components.[63] Increasing the size of a pellet plant may enable efficiencies in pelletising and shipping but at the same time require to source feedstock from a larger area with increased transport costs.

83. A reasonable and prudent investor would anticipate that if unsubsidised electricity generation became competitive in the Netherlands, it may likewise become competitive for other currently coal-fired plants in Europe. A substantial increase in global pellet demand would likely increase pellet prices, in a magnitude that cannot be foreseen ex-ante.

---

[62] Visser et al. (2020); Wood pellet supply chain costs – A review and cost optimization analysis, p. 13. Renewable and Sustainable Energy Reviews 118. Exhibit NERA-0056.

[63] Visser et al. (2020); Wood pellet supply chain costs – A review and cost optimization analysis, p. 1. Renewable and Sustainable Energy Reviews 118. Exhibit NERA-0056.

2.3. Conclusion

84. In summary, Section 2 reveals substantial risks for converting Dutch coal plants to biomass. As Section 2.1 explains, politics was increasingly reacting to the criticism that biomass should no longer be treated as carbon neutral because it creates a "carbon debt". A tightening of environmental regulations for biomass in the future, such as even more stringent sustainability requirements or subjecting biomass plants to the ETS, would further increase marginal costs of generation from biomass. Section 2.2 illustrates that, should biomass-fuelled electricity generation become viable in principle in the future, there is the risk of large-scale conversion by other coal-fired plants; wood pellet demand and prices would likely rise substantially. Consequently, the additional cost risks of any hypothetical upside scenario further reduce the chances of a positive investment decision by a reasonable and prudent investor.

3. The outlook for electricity generation from biomass has deteriorated since 2017

85. In Sections 1 to 2.3, we have discussed the conversion of Dutch coal plants to biomass generation as of the valuation date in October 2017. In this section, we comment on changes with respect to the outlook for unsubsidised electricity generation from biomass between 2017 and 2021. We explain why the outlook for a conversion of Dutch coal plants to biomass has deteriorated relative to our assessment as of the valuation date. In the view of market observers, the recent increase in gas and electricity prices in the autumn of 2021 is transitory (Section 3.1). Political support for large-scale electricity generation from biomass has eroded in the Netherlands since 2017 (Section 3.2).

3.1. Recent increase in gas and electricity prices is considered transitory

86. Closures of biomass-fuelled power plants once subsidies ended indicate that also after 2017 operators did not expect biomass plants to be viable without subsidies. For example, in Belgium the Les Awirs biomass plant closed in 2020 once Belgian Green Certificates, which have supported the plant for 15 years, ran out.[64]

87. In light of the recent gas and electricity price increases, some equity analysts include a value for unsubsidised biomass generation in their valuation of Drax, while others continue to mention the possibility without assigning any value as of today:

- [redacted]

64 Bioenergy Insight (4 September 2020), ENGIE's Les Awirs biomass plant closes. Exhibit NERA-0057. Also the Belgian Rodenhuize 4 is expected to close down once its Green Certificates ran out since it already had to close down from 2014 to 2016 when it was not able to obtain Green Certificates (see Power Technology (2021), Rodenhuize Power Station. Exhibit NERA-0058.)

65 [redacted].

66 [redacted].

[redacted]

[redacted]

[redacted]

[redacted]

88. While gas prices and, consequently, electricity prices, in the EU increased sharply starting in August 2021,[73] leading to speculation as to whether unsubsidised generation from biomass could become economically viable going forward,[74] this rise was only considered to be temporary. The

67 Based on the efficient market hypothesis, which was developed in the 1960s by Eugene Fama and Paul Samuelson, market prices fully reflect all available information. See Lo A.W. (2008) Efficient Markets Hypothesis. In: Palgrave Macmillan (eds) The New Palgrave Dictionary of Economics. Palgrave Macmillan, London. Exhibit NERA-0060.

68 [redacted]

69 [redacted]

70 [redacted]

71 [redacted]

72 [redacted]

73 Financial Times (September 2021), Energy price surge to drive inflation, say experts. Exhibit NERA-0061. Rising gas prices led to rising electricity prices since gas-fired generation is usually the marginal source of electricity.

74 See for example [redacted].

World Energy Outlook 2021 comments that the high gas prices *"in the third-quarter of 2021 […] fed through into higher wholesale electricity prices in many markets"*.[75] At the same time, it emphasises that *the "immediate period of higher prices [for natural gas] is expected to be temporary"*.[76]

89. Natural gas and electricity prices spiked upwards in autumn 2021. This led equity analysts to speculate that electricity generation from biomass might become economically viable if the high gas and electricity prices could be maintained. However, the IEA considers the elevated prices to be merely temporary. In addition, political support for biomass has further eroded, which we discuss in Section 3.2.

3.2. Political and scientific support has eroded, and regulatory tightening threatens the future feasibility of biomass for large-scale electricity production

90. The Dutch government's stand on the future of large-scale power generation from biomass has deteriorated since 2017. Since the autumn of 2017, co-firing of biomass is no longer included in the SDE+ subsidy scheme. In 2020, "The Social and Economic Council of the Netherlands" ("SER"), which advises the Dutch government and parliament on social and economic policy, published a report (the "SER Report") outlining a sustainability framework for biomass. The report introduces three categories for biomass applications: "low-grade", "bridging" and "high-grade".[77] Among others, "low-grade" applications include (baseload) power generation and low temperature heat.[78] SER strongly recommends to phase-out the use of "low-grade" applications.[79] In a debate in the Dutch Upper House ("*Eerste Kamer"*) on 29 June 2021, state secretary Ms. Yesilgöz-Zegerius confirmed that the Cabinet adopted the classification of the SER Report and intends to phase-out the use of biomass for "low-grade" applications.[80]

91. It seems highly certain that electricity generation from biomass will not be allowed for the complete remaining lifetime of Eemshaven, i.e. from 2030 to 2054. On 15 December, the newly

---

75 IEA (2021), World Energy Outlook 2021, p. 90. Exhibit NERA-0062.

76 IEA (2021), World Energy Outlook 2021, p. 101. Exhibit NERA-0062.

77 SER (2020), Biomassa in balans, p. 24. Exhibit NERA-0063.

78 SER (2020), Biomassa in balans, p. 25. Exhibit NERA-0063.

79 SER (2020), Biomassa in balans, p. 14-15. Exhibit NERA-0063.

80 Eerste Kamer (2021), Wijziging van de Wet verbod op kolen bij elektriciteitsproductie in verband met beperking van de CO2-emissie, p. 32 and p. 35, Exhibit NERA-0064. This has been confirmed by Minister Van 't Wout on several occasions, for example in his responses to parliamentary questions on 20 May 2021 (Tweede Kamer (2021), Vragen gesteld door de leden der Kamer, met de daarop door de regering gegeven antwoorden, Exhibit NERA-0065), and in his responses to questions of the parliamentary committee on economic affairs and climate policy on 21 April 2021 (Tweede Kamer (2021), 32 813, nr. 682, Vragen en opmerkingen vanuit de fractie en reactie van de bewindspersonen. Exhibit NERA-0066).

formed Dutch coalition government published its Coalition Agreement for the period of 2021 to 2025. The coalition stated that it was *"phasing out the use of woody biomass for energy purposes as quickly as possible, taking into account cost effectiveness. Biomass is used in the highest possible quality according to the cascading ladder. We [the Dutch coalition government] only allow the use of woody biomass produced in the EU, so that we can monitor compliance with sustainability criteria. We ensure that the development of sustainable alternatives to heat is accelerated."*[81]

92. This confirms that in December 2021 the newly formed Dutch coalition government continues planning to phase out low-grade biomass applications such as electricity or heat generation, as had also been stated by the previous government in June 2021. In addition, the government plans to tighten the sustainability criteria for biomass. It plans to disallow biomass imports from outside the EU. Biomass production in the EU is insufficient to cover its demand. The EU is dependent on biomass imports, e.g. from North America (see Figure 2.2). The Dutch government's plan will significantly restrict the biomass supply available to Dutch electricity generators and will very likely lead to higher costs of biomass in the Netherlands. It means the risk of tighter environmental regulation, which an investor would have anticipated in 2017 (see Section 2.1), will materialise.

93. Growing scientific and political scepticism has also caused the German government to rethink its plans to provide up to € 1bn in subsidies for the conversion of coal-fired power plants to biomass.[82] The decision came after the "Deutsche Biomasseforschungszentrum" published a critical position paper on coal to biomass conversions, highlighting that an efficient use of biomass should in particular require an efficient use of residual heat and a flexible operation.[83]

94. The political developments are in line with growing scepticism about the sustainability of electricity produced from biomass, as already discussed in Section 2.1. One prominent example is an open letter from 11 February 2021, in which more than 500 scientists and economists, including more than 20 from the Netherlands, have addressed leading policymakers from the United States, the European Union, Japan, and South Korea, including President Joe Biden and EU Commission President Ursula von der Leyen. The letter has been widely cited in the press.

---

81 VVD, D66, CDA en ChristenUnie (December 2021), Omzien naar elkaar, vooruitkijken naar de toekomst Coalitieakkoord 2021 – 2025, p. 8. Exhibit NERA-0021.

82 Energate Messenger (July 2021), Kohleausstieg: Förderung für Kraftwerksumrüstungen unwahrscheinlich. Exhibit NERA-0067.

83 Deutsches Biomasseforschungszentrum (2021), Positionspapier: DBFZ-Expert*innen sehen keine Vorteile für die Umrüstung von Kohlekraftwerken auf Biomasse, Pressemitteilung. Exhibit NERA-0068.

The scientists warned against using wood for bioenergy, citing carbon debt as one of the main reasons: [84]

"We urge you not to undermine both climate goals and the world's biodiversity by shifting from burning fossil fuels to burning trees to generate energy. […] In recent years, however, there has been a misguided move to cut down whole trees or to divert large portions of stem wood for bioenergy, releasing carbon that would otherwise stay locked up in forests. The result of this additional wood harvest is a large initial increase in carbon emissions, creating a 'carbon debt,' which increases over time as more trees are harvested for continuing bioenergy use. […] As numerous studies have shown, this burning of wood will increase warming for decades to centuries. That is true even when the wood replaces coal, oil or natural gas."

95. The undersigned scientists and economists state clear policy recommendations including:[85]

"To avoid these harms, governments must end subsidies and other incentives that today exist for the burning of wood whether from their forests or others. The European Union needs to stop treating the burning of biomass as carbon neutral in its renewable energy standards and in its emissions trading system."

96. Growing public opposition to biomass is clear due to numerous appeals against biomass-related permits. For example, campaigners from the "Mobilisation for the Environment (MOB)" have appealed the environmental permits granted for increasing the co-firing share at the Eemshaven plant. In a recent ruling, the administrative court required the Groningen Province to re-open the consultation process.

97. Vattenfall postponed its plans for construction of the Diemen plant, which, if built, will be the largest biomass-fuelled district heating station in the Netherlands. The decision to postpone the construction came after local politicians and many residents in Diemen protested.[86] Vattenfall plans not to take the final decision until the spring of 2022**.**[87]

98. In summary, the political environment and the outlook for electricity generation from biomass in the Netherlands has deteriorated since 2017. In line with these developments, scientific and public opposition of the recognition of biomass-based power generation as carbon free and sustainable continues to grow globally.

---

[84] Raven et. al (2021), Letter Regarding Use of Forests for Bioenergy, p.1. Exhibit NERA-0069.

[85] Raven et. al (2021), Letter Regarding Use of Forests for Bioenergy, p. 2. Exhibit NERA-0069.

[86] Netherland News Live (2021), Permits for biomass power plant in Diemen legally granted. Exhibit NERA-0070.

[87] Netherland News Live (2021), Permits for biomass power plant in Diemen legally granted. Exhibit NERA-0070.

3.3. Conclusion

99. In summary, market observers expect the price spikes in European electricity markets of autumn 2021 to be only temporary. It seems highly unlikely that Eemshaven could be operated as a biomass-fired plant from 2030 – 2054 based on recent government proposals on the future of biomass. Even if the government were to abandon its ambitions for a phase out of power generation from woody biomass, the downside risks of stricter sustainability criteria have only increased since 2017.

Declaration

100. We have been retained by RWE Generation NL B.V. to provide an independent expert opinion in connection with arbitration proceedings between RWE AG and RWE Eemshaven Holding II BV and the Kingdom of the Netherlands.

101. We declare that:

- We are independent of the parties to the Arbitration, their legal advisors, and the Arbitral Tribunal, within the meaning of Section 5 of the IBA Rules on the Taking of Evidence in International Arbitration. NERA's remuneration for this Expert Opinion is in no way contingent on the outcome of the case.
- We understand that our duty in giving evidence in the Arbitration is to assist the arbitral tribunal to decide the issues in respect of which expert evidence is adduced. We have complied with, and will continue to comply with, that duty.
- We confirm that this is our own, impartial, objective, unbiased opinion which has not been influenced by the pressures of the dispute resolution process or by any party to the Arbitration.
- We confirm that all matters upon which we have expressed an opinion are within our area of expertise.
- We confirm that we have referred to all matters which we regard as relevant to the opinions we have expressed and have drawn to the attention of the arbitral tribunal all matters, of which we are aware, which might adversely affect our opinion.
- We confirm that, at the time of providing this written opinion, we consider it to be complete, accurate and constitute our true, professional opinion.
- We declare the foregoing opinions to be correct to the best of our knowledge and belief.

[redacted]

Tomas Haug

18 December 2021

Place of signature: Berlin

[redacted]

Bastian Gottschling

18 December 2021

Place of signature: Frankfurt

Appendix A. CV Tomas Haug

Tomas Haug, CFA
Managing Director

NERA Economic Consulting
Unter den Linden 14
10117 Berlin, Germany
Tel: +49 30 700 1506 10
tomas.haug@nera.com
www.nera.com

Overview

Tomas Haug is a Managing Director in NERA's Energy practice and co-head of NERA's Berlin office. He has more than 17 years of economic consulting experience mainly in Energy across Europe, in a range of economic and regulatory issues including tariff design, efficiency studies, risk modelling, cost of capital and wider regulatory and competition issues. He has strong experience with European regulation of both power and gas networks.

Mr. Haug acted as expert witness in several arbitrations in the energy sector (gas, nuclear, coal, solar, renewables) and has testified on issues involving change in circumstances, hardship, and competition claim issues.

Qualifications

2007 **CHARTERED FINANCIAL ANALYST (CFA)**

2006 **AMSTERDAM INSTITUTE OF FINANCE**
Executive Programme in Project Finance

2004 **UNIVERSITY OF QUEBEC IN MONTREAL**
MSc Economics (with distinction)

2002 **UNIVERSITÄT MAGDEBURG**
Master in Management and Finance, (Faculty Prize "Best Graduate")

Career Details

08/2012 – today **NERA Economic Consulting,** Berlin (Managing Director)

06/2004 – 07/2012 **NERA Economic Consulting,** London

Selected Project Experience

2020

- [redacted]
- For an **electricity interconnector**, support in the consultation process in setting an appropriate cap and floor on the allowed rate of return.

- For an **international construction company**: Quantum expert and testimony in an ICC arbitration in the context of alleged faults in equipment supplied to a European operator of underground gas storages.

- For a **European construction company**: Expert witness support in the context of a EUR 2bn arbitration relating to alleged faults in the construction of various nuclear power plants covering cost analysis, power market modelling, and damage estimation.

- For a **gas supplier**: Arbitration support in relation to a price adjustment under a long-term gas storage contract. Calculation of expected damages in the event of no adjustment.

- For a **German gas TSO**: Support regarding regulatory efficiency benchmarking. This project includes a full empirical replication of the German benchmarking for gas TSOs.
- For **Swiss gas network operator**: Analysis of different scenarios of economic regulation. This analysis includes a detailed review of the European gas guidelines.

2019

- For a **gas transport operator**, expert witness in an ICC arbitration over long-term gas transportation contracts; claims were based on alleged violations of Article 101 (restriction of competition) and Article 102 (abuse of dominance) TFEU, as well claims of hardship and an unforeseen change of circumstances.

- For a **European State**, quantum expert work and testimony in an ICSID arbitration over an allegedly unlawful termination of a feed-in tariff for a renewables plant.

- For a **European gas supplier**: Support on a price review arbitration in a long-term gas supply agreement. Work included quantifying the value of volume flexibility and assessing security of supply.

- For a **European gas import pipeline operator**: Support in the application for derogation from regulation following the May 2019 amendment of the EU gas Directive.

- For a group of **E.ON's power distribution network operators**: Economic support during their appeal against the regulatory determination of the "general sectoral productivity factor" (X-factor).

- For **Ardian**: Regulatory due diligence of EWE, a German power and gas utility.

- For a **German gas transmission network operator**: Evaluation of options for regulatory optimisation to increase the regulatory efficiency score. The work includes replication and amendment of the regulator's statistical efficiency analysis.

- For a **European gas TSO**: Assessment of the benefits the transit system has for domestic gas consumers, review and comparison of the regulatory regime with the electricity sector, and competition assessment.

- For a group of **German power distribution companies**: Economic support during their appeal against the regulatory determination of the "service quality element" assessing the statistical robustness and economic plausibility of the regulator's approach.

- For [redacted]: Review of European precedent for setting the initial regulatory asset base (iRAB). Our review covered the introduction of network regulation in major European markets and described the relevant economic principles.

- For an **Austrian gas network operator**: Study on the future role of gas infrastructure in light of decarbonisation and intended electrification of heat and transport sectors. The study includes drawing implications for the regulation of gas networks.

2018

- For a **pump storage operator in [redacted]**, quantum expert work in relation to lost profits due to a construction delay [redacted].

- For a **gas storage operator (Germany/Netherlands)** expert witness work in relation to a DIS arbitration involving competition claims and change in circumstances.

- Assessment of an abuse of a dominant position as part of expert witness work in the context of an DIS arbitration involving **a virtual power plant**.

- For a gas **infrastructure operator in Central and Eastern Europe**, expert witness work in relation to competition claim issues relating to foreclosure and excessive pricing.

- For the **Croatian Government**, expert witness work in relation to claims arising out of a series of State measures that allegedly delayed and frustrated the claimant's biomass power plant project in an ICSID arbitration.

- **For a subsidiary of [redacted]:** advising on the implementation of and alignment with European network codes, including TAR NC and other relevant regulations.

2017

- For a **European power generator**: Economic advice on lost profits from the delayed completion of a coal power plant including an analysis of lost profits at the plant in question, the impact of the delay on power prices and the "portfolio effect" of the price change on other plants' run times and realized spreads.

- For a **storage customer** (Germany): Expert report on (1) the change in circumstances in the German gas and gas storage market, as well as (2) an assessment of the competitive position of the storage seller and an abuse of a dominant position, for a DIS arbitration.
- For several **German TSOs and DSOs**: Economic advice in the course of an appeal against the regulator's decision to cut the allowed rate of return on equity investments in new electricity networks.

- For the **French DSO [redacted]:** Review of the regulator CRE's determination of the beta parameter in its latest cost of capital decision.

- For a **confidential client** (Europe): Advice on state aid and merger control issues in relation to a major merger in the energy sector.

- **For a French-German consortium**: Advising in litigation against a French utility company in relation to additional requirements in connection with the construction of a nuclear power plant

2015/2016

- Regulatory due diligence advise to **China Three Gorges** in its successful acquisition of the offshore wind park Meerwind from U.S. buyout firm Blackstone.

- Expert witness in an electricity market damages case brought against the **State of Hessen and the Federal Government** in relation to Germany's nuclear phase-out.
- For an **electricity interconnector**, valuation support under different merchant and regulatory scenarios.
- For a **German distributor**, expert witness work in relation to arbitration proceedings concerning a long-term oil-indexed gas contract, including the calculation of compensation payments.
- For an **international gas shipper**, economic expert support in an arbitration on gas storage in relation to antitrust considerations (Article 101 and 102 TFEU).
- **Asian manufacturer**: Advising in ICC arbitration against a German seller of silicon wafers under a long-term supply contract subject to the UN Convention on Contracts for the International Sale of Goods.
- For a **European nuclear provision operator**, calculating the appropriate actualisation rate for provisions for future nuclear dismantling and storage liabilities.
- For a large **financial institution**, expert witness work in relation to litigation proceedings in the context of fraudulent EU ETS certificate trading, including the calculation of damages.
- For **a Japanese Power Venture**, provided recurring valuation support in the context of impairment test of a portfolio of generators.
- For **Électricité Réseau Distribution France,** development of alternative tariff regimes after the Conseil d'Etat's anullment of electricity distribution tariffs in France.
- For **Engie**, support in the consultation process with the French national regulator on the allowed cost of capital for Engie's infrastructure assets (distribution, transport, LNG).
- For J**.P. Morgan Infra**, regulatory due diligence for its attempt to acquire Swedegas.
- For a **German electricity network**, expert witness work in support of the company's appeal against the regulator's benchmarking determination.
- For the **Austrian Energy Association** (ÖE), review of innovative regulatory mechanisms in Sweden, Norway, Germany, UK and assessment of their transferability into Austria.
- Regulatory due diligence on an **Austrian TSO** in connection with a Joint Venture between two European network operators.
- For **TenneT NL**, expert witness work in relation to TenneT's appeal against the Dutch regulator's allowed revenue determination.
- For **GdF Suez Infrastructure**, regulatory advisory work on efficiency benchmarking and cost of capital, including a relative risk assessment of gas networks and LNG terminals.
- For a consortium of **infrastructure funds** and strategic investor, regulatory due diligence support in relation to a European gas network.

2014

- For a **German electricity network**, expert witness work in support of the company's appeal against the regulator's benchmarking determination.

- For **Njordgas** in Norway, litigation work concerning the assessment of the reasonableness of the Norwegian Government's proposal to cut Gassled's tariffs by 90%.
- For a **electricity interconnector**, valuation support under different commercial scenarios following the EC's attempt to impose economic regulation upon the interconnector.
- For an **energy company,** in the context of an international arbitration case, company valuation in the determination of settlement charges between the previous and current owners of the company.
- For a group of **13 European TSOs including TenneT and 50 Hertz**, performed efficiency benchmarking of operating and capital costs.
- For **VNG-Ontras, Thyssengas, and Gasunie Deutschland,** acted as expert witness at the higher district court in Düsseldorf in the appeal against the allowed return on equity decision by the Bundesnetzagentur.

Recent Publications

- *German efficiency gone wrong: Unintended incentives arising from the gas TSOs benchmarking* – published in Energy Policy [Forthcoming]
- Regulatorische Kapitalkosten **-** Neue Daten zur Beantwortung alter Fragen (2021) – published in Zeitschrift für Energiewirtschaft
- *Implications of Decarbonisation for Gas Network Regulation August 2020* – published in the German trade journal E|M|W on the transformation of the energy supply system to achieve the required decarbonisation targets, August 2020
- *Eigenkapitalzinssätze für zukünftige Regulierungsperioden – Bedeutung des BGH-Urteils (2019)* – published in the industry journal "Energiewirtschaftliche Tagesfragen" on a Supreme Court Ruling on the regulatory cost of equity
- *Regulatorischer Effizienzvergleich: Schlangenöl statt Herzstück der Anreizregulierung? (2019)* – published in the industry journal "Energiewirtschaftliche Tagesfragen" on the merits and limitations of efficiency benchmarking when determining allowed revenues for regulated gas and electricity network operators, May 2019
- Contribution to "Legal Commentary on Germany's Renewable Energy Act (EEG)" edited by Prof. F-J. Säcker (Berlin), April 2018
- *Cost of Equity for regulated networks: Recent developments in continental Europe (2019)* – published in The Electricity Journal on ongoing legal proceedings at the German Supreme Court concerning the allowed cost of equity for German energy network operators.

Appendix B. CV Bastian Gottschling

Bastian Gottschling

Associate Director

NERA Economic Consulting
MesseTurm
Friedrich-Ebert-Anlage 49
60308 Frankfurt, Germany
Tel: +49 69 710 447 504
bastian.gottschling@nera.com
www.nera.com

Overview

Bastian Gottschling serves as an economic expert in dispute resolution. He has been with NERA Economic Consulting for more than 13 years. Since 2008, Mr Gottschling has provided economic consulting in relation to complex valuation issues and acted as expert witness in commercial disputes, investment arbitration and international tax disputes.

More recently, he has specialised in economic and finance issues arising from commercial and investment disputes, competition and regulation. His expert witness experience includes the preparation of expert and rebuttal reports, oral testimony under cross-examination, and expert witness conferencing in high-stakes energy arbitrations, such as long-term contract disputes.

Currently, Mr Gottschling is performing assignments in three investor-state disputes. His work encompasses economic analysis of competitive and regulated markets as well as valuation analysis of investor's position in the counterfactual scenarios relevant for assessment of damages, i.e., assessing hypothetical situations under the assumption that the state's measures had not taken place.

Before joining NERA in 2008, Mr Gottschling worked in Mergers & Acquisitions. He acted as M&A advisor in the energy and infrastructure team of the investment bank Rothschild, with a focus on energy utilities. Bastian Gottschling also has prior professional experience as an economic analyst with Ernst & Young London, where he started his career in 2004.

Qualifications

2006	**QUEENS' COLLEGE, UNIVERSITY OF CAMBRIDGE** MPhil Economics
2004	**LONDON SCHOOL OF ECONOMICS** BSc Economics

Career Details

Since 2008	**NERA ECONOMIC CONSULTING (Frankfurt)**
2006 – 2007	**ROTHSCHILD (Frankfurt)**
2004 – 2006	**ERNST & YOUNG (London)**

Selected Project Experience

- Calculation of future lost profits and expert report for Respondent in international commercial arbitration proceedings (2020 to current)

- Damages assessment for Claimant in an investor-state dispute, valuing renewable energy assets under the state's support scheme (2020 to current)

- Damages assessment and expert report for Respondent in an international post-M&A dispute in relation to electricity distribution and retail companies (2019-2021)

- Counterfactual analysis of electricity tariffs in a liberalized market, for Claimant in an investor-state dispute (2019 to current)

- Expert report on excessive pricing in the context of a long-term electricity supply contract dispute (2019-2021)

- Preparation of economic evidence for submission to the European Commission, in the context of antitrust investigations by the European Commission (2018-2021)

- Damages assessment for Claimant and two expert reports on quantum, in the context of a construction dispute in relation to a power plant (2018-2020)

- Two expert reports on quantum for Respondent, including DCF valuation of renewable energy projects and cost-based evaluation of investments made by Claimant based on documentation submitted by Claimant, in the context of an investment arbitration (2017 to current)

- Various expert reports and oral testimonies on gas and gas storage markets, including analysis of market developments, price adjustments and valuation of flexibility, in the context of several long-term contracts disputes (2014 to current)

- Expert reports including analysis of solar markets and price adjustments for solar wafers, for Respondent in a long-term contract dispute (2015-2017)

- Calculation of lost profits and three expert reports on quantum for Claimant, in the context of a construction dispute in relation to a refinery (2014-2017)

- Two expert reports and oral testimony on competition analysis of German gas markets, including market definition and margin control, for Claimant in a long-term contract dispute (2015-2016)

- Valuation of an electricity interconnector under different scenarios for the asset owner, in the context of current regulatory frameworks and regulatory developments at the EU level and the national level of the member states involved (2014-2016)

- Expert reports on regulatory efficiency benchmarking for [redacted], in the context of regulatory proceedings and court proceedings in [redacted] (2013-2016)

- Valuation of a long-term gas supply contract, two expert reports and oral testimony, for Claimant in a long-term contract dispute (2014-2015)

- Assessment of hurdle rates for renewable energies, for the UK Department of Energy and Climate Change (2013)

- Economic consulting services to European transmission system operators and expert report for submission to national regulators, in the context of the regulatory European efficiency benchmarking e3GRID2012 (2013)

- Analysis of coal-to-biomass conversion, assessing the impact of the discount rate and differences in risk for a large power plant (2013)

- Evaluation of the sustainability of the German renewable energies regulation, in the context of a buyer's due diligence for German offshore transmission assets (2013)

- Expert report on German electricity and gas supply contracts for submission to the German tax authorities, for an international energy group in the context of the group's evaluation of its contracts portfolio and business activities (2012)

- Cost-benefit analysis of business restructurings and expert report for an international enterprise, in the context of a tax dispute on accumulated losses in France (2011-2012)

- Valuation of trademarks and expert report for an energy group, in the context of a tax dispute on license fees in Australia (2010)

- Post-M&A advice to an energy company in relation to acquired power generation capacities in Russia (2009)

- Probabilistic analysis of investment decisions under uncertainty and design of a valuation model for a strategic investor, in the context of the company's business development efforts (2008-2009)

Selected Presentations and Publications

- Gottschling, Huebler and Wieshammer (2018): Cost of Capital Allowance (WACC): A View from an Economist, KNect365 Competition Law and Regulation in the Energy Sector Conference, Brussels, 13 November 2018.

- Geffert und Gottschling (2017): An Economic Assessment of Contracts and Requests for Contract Reform and Damages in International Arbitration, in Carpenter, Jansen, Pauwelyn (2017): The Use of Economics in International Trade and Investment Disputes, Cambridge University Press.

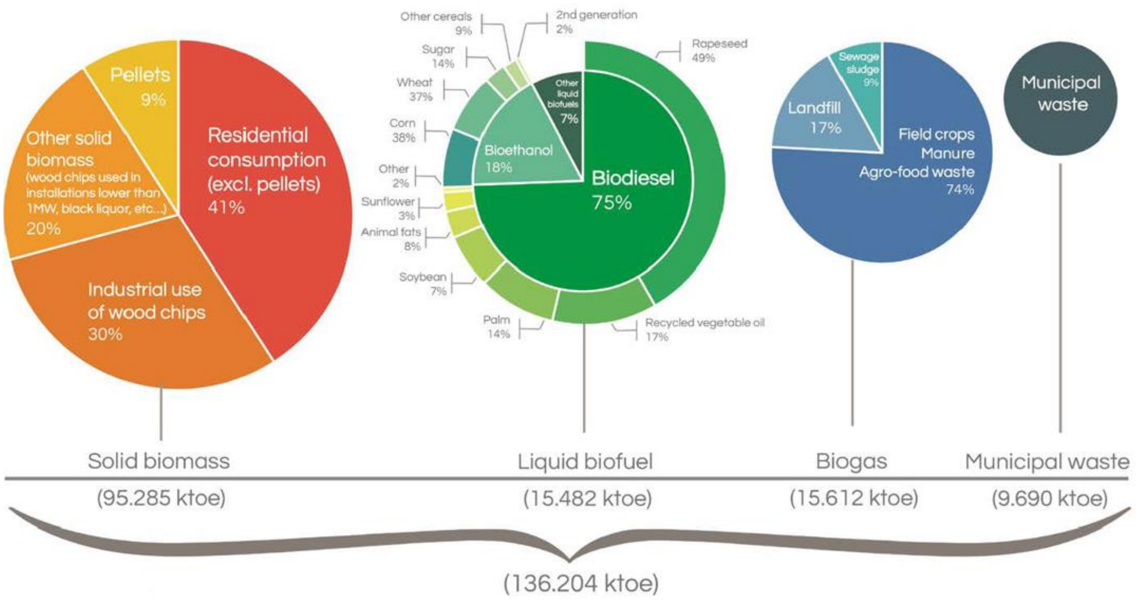
- Gottschling und Haug (2017): How Sustainable is the Current Momentum Towards More Competitive Gas Markets?, C5 Asia Congress on Successfully Negotiating & Renegotiating Long Term Gas Supply Contracts, Singapore, 27 February 2017.

- Gottschling und Haug (2014): e3GRID: Was machen wir mit den Ergebnissen des Effizienz-Benchmarkings? (What are we going to do with the results of the efficiency benchmarking?), Energiewirtschaftliche Tagesfragen, 1st issue of 2014, pp. 104.

Appendix C. Using pellets as an input fuel for large-scale electricity generation from biomass

102. A wide range of modern uses of bioenergy has been developed. Figure C.1: shows an overview of the different types of biomass consumed in the EU in 2016. At the same time, not all types of biomass are appropriate for electricity generation in converted large-scale power plants. In particular, our review shows that for a fully converted, large-scale power plant in the Netherlands such as Eemshaven, wood pellets were the only suitable biomass-based fuel as of 2017. This is confirmed by an analysis of the fuels used in existing converted large-scale power plants, which exclusively rely on industrial wood pellets.

Figure C.1: Consumption of Different Types of Biomass in the EU28



Source: AEBIOM.[88]

103. The IEA describes that several types of biomass have been used as a co-fuel in in former coal-fired power plants, such as for example non-woody biomass (solid waste materials from agricultural products, dried sawdust or straw pellets, dried sewage sludges and baled agricultural residue materials) and woody biomass (wood chips or pellets).[89] However, to be considered as a suitable fuel for a large power plant such as Eemshaven, which is converted to 100 per cent biomass firing, the respective fuels need to fulfil both commercial (available in a sufficient

88 AEBIOM (2017), European Bioenergy Outlook Statistical Report, p. 53. Exhibit NERA-0052.

89 IEA (2016), The status of large scale biomass firing, p. 3. Exhibit NERA-0071.

quantity) and technical (suitable for envisaged firing ratio, adhere to standard definition) requirements.

104. According to the IEA, non-woody biomass fuels are not suitable for fully converted plants due to their technical characteristics. The IEA differentiates between processed biomass, such as residues from vegetable oil, nut, fruit, flour or grain production, and unprocessed biomass, such as grasses, reeds and straws. Processed biomass has *"higher moisture and ash contents"*.[90] Similarly, non-processed biomass tends to be in the *"high slagging"* and the *"severe fouling category"*, also with high ash contents.[91] IEA notes that the risk of increased ash deposition and excessive slag formation is a principal concern when considering the conversion of a coal boiler to 100 per cent biomass.[92] Accordingly, IEA concludes that these types of biomass are "*non suitable for firing on their own in large boilers designed for firing coal"* meaning that they *"are best employed as fuels for co-firing with coal at relatively low co-firing ratios".*[93]

105. In contrast, woody biomass typically has a lower ash content and modest levels of alkali metals so that the IEA assesses that *"high quality wood fuels are significantly more forgiving"* than non-woody biomass.[94] In fact, IEA concludes that *"for 100% biomass firing, only the higher grade wood materials are suitable"*.[95]

106. Among the woody biomass, wood pellets have the most favourable properties among biomass types (Table C.1). Their energy density of 2.6 to 3.3 MWh per loose m^3 is the highest of all biomass fuels, which means lower volumes are necessary to generate the same amount of energy as other biomass types. Moreover, their bulk density is twice as high as that of wood chips, meaning pellets require smaller storage space making them easier and cheaper to transport.[96] Thus, moving pellets over long distances is more economical than transportation of other biomass

90 IEA (2016), The status of large-scale biomass firing, p. 17. Exhibit NERA-0071.

91 IEA (2016), The status of large-scale biomass firing, p. 18. Exhibit NERA-0071.

92 IEA (2016), The status of large-scale biomass firing, p. 16. Exhibit NERA-0071.

93 IEA (2016), The status of large-scale biomass firing, p. 18. Exhibit NERA-0071.

94 IEA (2016), The status of large-scale biomass firing, p. 16. Exhibit NERA-0071.

95 IEA (2016), The status of large-scale biomass firing, p. 3 Exhibit NERA-0071.

96 For instance, the IEA states: „Without densification of the woodchips (a patented process developed in the US) woodchips require specialty vessels (woodchip carriers) in order to make the transportation on a long haul basis economically feasible. Pellets in comparison have better transport qualities: high homogeneity, high heating value and bulk density (thus high energy density per ship load), ability to be transported in standard sized vessels for greater ocean transportation economy, plus flexible end use regarding combustion technology and scale (e.g. co-firing in pulverized coal combustion plants)." See IEA (June 2012), Global Wood Chip Trade for Energy, p. 16. Exhibit NERA-0072. Similarly, Chatham House states: "*Compared to wood chips, pellets are more dense and have a lower moisture content, and are therefore better suited to transport and storage. They are now the favoured form of wood for biomass power generation, particularly where transport distances are great.*" See Chatham House, The Royal Institute of International Affairs (February 2017), Woody Biomass for Power and Heat: Impacts on the Global Climate, p. 12. Exhibit NERA-0051.

types. Also, wood pellets have an ash content of 0.2 to 0.5 per cent, one of the lowest among biomass types.

Table C.1: Properties of Selected Biomass Types

Fuel	Net calorific value, dry content kWh/kg (moisture content 0%) ($q_{p,net,d}$)	Moisture content w-% (Mar)	Net calorific value, as received=actual value kWh/kg ($q_{p,net,ar}$)	Bulk density kg/loose m³	Energy density (MWh/loose m³)	Ash content, dry, %
Sawdust	5,28-5,33	45-60	0,60-2,77	250-350	0,45-0,70	0,4-0,5
Bark, birch	5,83-6,39	45-55	2,22-3,06	300-400	0,60-0,90	1-3
Bark, coniferous	5,14-5,56	50-65	1,38-2,50	250-350	0,50-0,70	1-3
Plywood chips	5,28-5,33	5-15	4,44-5,00	200-300	0,9-1,1	0,4-0,8
Wood pellets	5,26-5,42	7-8	4,60-4,90	550-650	2,6-3,3	0,2-0,5
Steam wood chips	5,14-5,56	40-55	1,94-3,06	250-350	0,7-0,9	0,5-2,0
Log wood (oven-ready)	5,14-5,28	20-25	3,72-4,03	240-320	1,35-1,95	
Logging residue chips	5,14-5,56	50-60	1,67-2,50	250-400	0,7-0,9	1,0-3,0
Whole tree chips	5,14-5,56	45-55	1,94-2,78	250-350	0,7-0,9	1,0-2,0
Reed canary grass (spring harvested)	4,78-5,17	8-20	3,70-4,70	70	0,3-0,4	1,0-10,0
Reed canary grass (autumn harvested)	4,64-4,92	20-30	3,06-3,81	80	0,2-0,3	5,1-7,1
Grain	4,8	11	4,30	600	2,6	2
Straw, chopped	4,83	12-20	3,80-4,20	80	0,3-0,4	5
Miscanthus, chopped	5,0	8-20	3,86-4,06	110-140	1,72-2,19	2,0-3,5
Straw pellets	4,83	8-10	4,30-4,40	550-650	2,4-2,8	5
Olive cake (olive pomace)	4,9-5,3	55-70	1,00-3,10	800-900	1,46-1,64	2-7
Olive cake (olive marc)	4,9-5,3	<10	4,30-4,70	600-650	2,6-2,9	2-7

1kWh/kg = 1 MWh/ton = 3.6 GJ/ton

Source: Bioenergy Europe. [97]

[97] Bioenergy Europe (2020), Statistical Report 2020 – Pellet Report (Sample), p. 116. NERA Exhibit-0073.

107. Combined, these characteristics make wood pellets the most attractive fuel for large scale biomass firing, according to the IEA: [98]

"For 100% biomass firing, only the higher grade wood materials are suitable. For handling, transportation and firing in very large quantities, dry materials in pelletised and other densities forms have been preferred."

108. While smaller power and heat plants in Europe also use other fuel types (see Section 1.3.1, examples in Denmark and Poland),[99] wood pellets are used in all large-scale and dedicated power plants.[100] For instance, Drax, the largest biomass-fired power plant in the world, started to switch from burning coal to wood pellets in 2013.[101]

109. In addition to their advantageous properties relative to other types of biomass, pellets are the dominant biomass resource on the international market. Consumption in the EU in 2016 amounted to 21.7 Mt, with more than 7.7 Mt imported from other continents.[102]

110. In conclusion, the industrial wood pellet market remains the relevant biomass market segment for a fully converted Dutch coal plant such as Eemshaven.

---

98 IEA (2016), The status of large scale biomass firing, p.14. Exhibit NERA-0071.

99 For instance, a number of energy plants in EU28 use wood chips for the (combined) generation of electricity and heat. However, most of these plants are CHP plants and substantially smaller than Eemshaven. (See AEBIOM (2017), European Bioenergy Outlook Statistical Report, p. 78. Exhibit NERA-0052.)

100 All plants with a capacity of 400 MW or more that have been discussed in Section 2.1.1, i.e. Drax, Lynemouth, Tilbury B, Ironbridge and Langerlo run exclusively on wood pellets. See IEA (2016), The status of large scale biomass firing, p. 61 for Drax, p. 74 for Tilbury, p. 63 for Ironbridge. Exhibit NERA-0071. For Lynemouth, see European Commission (February 2015), Subject: State aid SA.38762 (2015/C) (2014/N) – United Kingdom Investment Contract for Lynemouth Power Station Biomass Conversion, p. 3. Exhibit NERA-0074. For Langerlo, see EU Bioenergy (April 2017), The end of Big Biomass in Flanders. Exhibit NERA-0025.

101 Drax (06 October 2016), This is how you make a biomass wood pellet, Website: [Accessed 29 October 2021] Exhibit NERA-0026.

102 AEBIOM (2017), European Bioenergy Outlook Statistical Report, p. 155. Exhibit NERA-0052.

Appendix D. Details on biomass projects in Europe

D.1. The UK

111. In the UK, biomass (co-)firing plants were initially eligible to issue Renewables Obligation Certificates (**ROCs**), which provided plant operators with an additional source of revenue and thereby subsidised electricity generation from biomass. Electricity suppliers needed to present these ROCs to the regulator in order to avoid a penalty.[103] In July 2011, the government announced it intended to close the Renewables Obligations scheme to all new generating capacity on 31 March 2017.[104] To continue to support low-carbon electricity generation, the government has introduced the Contracts for Difference (CfDs) scheme as part of its 2013 Electricity Market Reform (EMR), which ensure that generators receive an agreed price for renewable energy.[105] A tax exemption further incentivised biomass co-firing and conversions until it was repealed in 2015.[106]

112. In 2015, the UK government committed itself to a complete coal phase-out by 2025.[107] Four power plants, Drax, Lynemouth, Tilbury B, and Ironbridge, converted from coal firing to biomass firing between 2011 and 2017.[108]

113. Receiving support through the ROC scheme, Tilbury B and Ironbridge initially converted some of their generation capacity to biomass. Under the EU's Large Combustion Plant Directive both plants were allocated of quota of 20,000 hours of operation. The operator of Ironbridge, E.ON, decided to close the plant once the limit was reached.[109] The operator of Tilbury B, npower, explored to extend the plant's lifetime for another 10-12 years through a bid for the new CfD support scheme.[110] npower estimated the CAPEX to fully convert Tilbury B to biomass at c. £450m, which it hoped to recoup through CfDs.[111] Once the UK Department of Energy and

---

103 Ofgem, Website: Renewables Obligation (RO), [Accessed 18 August 2021]. Exhibit NERA-0008.

104 UK Department of Energy & Climate Change (2011) – Planning our electric future: a White Paper for secure, affordable and low-carbon electricity, Ref: ISBN 9780101809924, 11D/823, Cm. 8099, p. 13. Exhibit NERA-0009.

105 Department of Energy & Climate Change (March 2014), Government Response to the consultations on the Renewables Obligation Transition and on Grace Periods, para. 1.1. Exhibit NERA-0010.

106 House of Commons Library (April 2016), Climate Change Levy: renewable energy & the carbon reduction commitment, p. 7-9. Exhibit NERA-0011.

107 Department of Energy & Climate Change (November 2015), Pre-market announcement on unabated coal-fired power stations. Exhibit NERA-0012.

108 See Exhibit NERA-0037 for additional information on plant capacities and investments.

109 ENP Newswire (November 2015), E.ON's Ironbridge Power Station to generate electricity for the last time. Exhibit NERA-0014.

110 Financial Times (August 2013), Tilbury power plant closes after biomass grant refused. Exhibit NERA-0015.

111 The Guardian (16 August 2013), Tilbury power station mothballed after investment burns out. Exhibit NERA-0016.

Climate Change had decided that Tilbury B was not eligible for support through CfDs, npower decided the conversion plan *"no longer economically viable"*.[112]

114. Other coal plants explored conversion, e.g. Rugeley and Eggborough. However, these plants were not converted. Rugeley ceased its plans in 2013.[113] Eggborough was unable to secure CfDs and also abandoned its conversion plans and shut down instead.[114] A unit of the Drax power plant and Lynemouth power station secured CfDs in 2014 and subsequently converted to biomass.[115] Support through these subsidies was a pre-condition for Drax's conversion.[116]

D.2. Poland

115. In Poland, biomass co-firing and converted plants were eligible for "green" certificates, which provided plant operators with an additional source of revenue in a similar manner as ROCs did in the UK. Beneficiaries received "green" certificates for the electricity generated from renewable resources, e.g. from co-firing biomass, and a number of entities are required to purchase a set number of certificates or face a penalty.[117] In 2016, the system was replaced by auctions for CfDs which provide support for 15 years.[118]

116. Supported by the Polish green certificates, several coal plant operators invested in biomass firing capabilities. This included the conversion of existing power stations, the addition of dedicated biomass units in existing coal plants, as well as the replacement of coal fired power plants with new biomass fired units. At the Bialystok plant, a coal-fired boiler was converted to biomass firing.[119]

[112] Financial Times (August 2013), Tilbury power plant closes after biomass grant refused. Exhibit NERA-0015.

[113] See Exhibit NERA-0037.

[114] Biomass Magazine (September 2015), Eggborough Power Station to close, biomass not an option. Exhibit NERA-0018.

[115] Department of Energy & Climate Change (April 2014), FID Enabling for Renewables: Successful Projects offered an investment contract (listed in alphabetical order). Exhibit NERA-0020.

[116] European Daily Electricity Markets (19 December 2016), Drax boosted in plans for pre-2025 biomass conversion. Exhibit NERA-0019.

[117] European Commission (August 2016), State Aid SA. 37345 (2015/NN) – Poland: Polish certificates of origin system to support renewables and reduction of burdens arising from the renewables certificate obligation for energy intensive users, p. 4-5. Exhibit NERA-0022.

[118] AURES II (August 2019), Auctions for the Support of Renewable Energy in Poland: Main results and lessons learnt, p. 10. Exhibit NERA-0023.

[119] Biomass Magazine (September 2011), Metso to convert Polish coal-fired CHP plant to biomass. Exhibit NERA-0024.

D.3. Denmark

117. Converting power plants to biomass is an important aspect of Danish climate policy. Converted plants receive a feed-in premium on top of electricity market prices of DKK150/MWh (approximately €20/MWh).[120]

118. District heating networks supply almost two-thirds of Danish households with heat mostly from CHP plants.[121] Tariffs for district heat are regulated and based on the cost of heat production, which include financing costs and depreciation.[122] CHP plants, which were converted to biomass, can recoup part of the conversion CAPEX and ongoing operating costs through regulated heating tariffs.[123] To avoid cross-subsidisation between heat and electricity production, small scale CHP plants are not allowed to make a profit on electricity sales.[124] Large scale CHP plants are allowed to make profits from generating electricity sales, but the generation costs have to be distributed between the electricity and heating side.[125]

119. Partially state-owned utility Ørsted (formerly Dong Energy) converted four CHP plants at Herning (in 2009), Avedøre (two blocks, in 2014 and 2016), Studstrup (in 2016), Skærbæk (in 2017) to biomass, using wood pellets or wood chips as primary fuels.[126] Ørsted announced to phase out coal in Denmark by 2023 and in 2017 was planning to convert the remaining two coal CHP-plants Asnæs (in 2019) and Esbjerg (after 2020) to biomass firing.[127]

120. Since valuation date, the support scheme for electricity generation from biomass expired in April 2019, but the Danish Energy Agreement from 2018 continued the feed-in premium for converted plants that were not fully depreciated and included a new support scheme to cover the extra operating expenses of using biomass in fully depreciated plants. For converted plants, the depreciation period is 15 years.[128] Hence, conversion CAPEX should be recovered during the first 15 years of operation following conversion.

---

120 Danish Energy Agency (March 2017), Memo on the Danish support scheme for electricity generation based on renewables and other environmentally benign electricity production, p. 5. Exhibit NERA-0027.

121 Danish Energy Agency (June 2017), Regulation and planning of district heating in Denmark, p. 4. Exhibit NERA-0028.

122 Danish Energy Agency (June 2017), Regulation and planning of district heating in Denmark, p. 9. Exhibit NERA-0028.

123 Danish Energy Agency (June 2017), Regulation and planning of district heating in Denmark, p. 9. Exhibit NERA-0028.

124 Danish Energy Agency (June 2017), Regulation and planning of district heating in Denmark, p. 18. Exhibit NERA-0028.

125 Danish Energy Agency (June 2017), Regulation and planning of district heating in Denmark, p. 18. Exhibit NERA-0028.

126 Dong Energy (February 2017), Bioenergy & Thermal Power, Meet the Management, p. 61. Exhibit NERA-0029.

127 Dong Energy (February 2017), Bioenergy & Thermal Power, Meet the Management, p. 61-62. Exhibit NERA-0029.

128 Danish Ministry of Climate, Energy and Utilities (June 2018), Energy Agreement of 29 June 2018, p. 7. Exhibit NERA-0030.

121. For depreciated plants, the new support scheme provides a lower feed-in premium determined annually to cover the difference between the operating costs of a typical CHP coal plant and a typical CHP plant using wood pellets, wood chips or other eligible materials. The feed-in premium is differentiated between wood pellets and other eligible biofuels.[129] Thereby, depreciated plants are incentivised to continue firing biomass instead of coal to generate electricity through the feed-in premium covering the fuel cost differences.

122. In 2019, no state aid was found to be necessary for wood pellets, but in 2020 the premium is DKK80/MWh, and the maximum premium is capped at DKK110/MWh.[130] The duration of the notified support scheme is until 31 December 2029, or if Denmark decides to impose a ban on the use of coal in electricity production before that date.[131]

123. The Danish Energy Agreement from 2018 also foresees the modernisation of the heating sector and district heating and the support of renewable energy sources.[132] The tax exemption for biomass from energy taxes remains unchanged.

124. Ørsted converted Asnæs CHP plant to biomass firing in 2019.[133] Ørsted's last coal fired power plant, Esbjerg CHP station, is scheduled to close in 2023.[134]

D.4. Belgium

125. In Belgium, converted plants receive Green Certificates, which provide plant operators with an additional source of revenue.[135] The plants at Les Awirs and Rodenhuize converted to biomass in 2005 and 2011, respectively.[136] A third potential conversion project at the plant in Langerlo failed

---

129 European Commission (May 2020), P. State Aid SA.55891 (2019/N) – Denmark – Operating aid scheme for electricity generated by incinerating biomass in existing and fully depreciated biomass plants in Denmark, p. 4. Exhibit NERA-0031.

130 European Commission (May 2020), P. State Aid SA.55891 (2019/N) – Denmark – Operating aid scheme for electricity generated by incinerating biomass in existing and fully depreciated biomass plants in Denmark, p. 5. Exhibit NERA-0031.

131 European Commission (May 2020), P. State Aid SA.55891 (2019/N) – Denmark – Operating aid scheme for electricity generated by incinerating biomass in existing and fully depreciated biomass plants in Denmark, p. 6. Exhibit NERA-0031.

132 Danish Ministry of Climate, Energy and Utilities (June 2018), Energy Agreement of 29 June 2018, p. 10-12. Exhibit NERA-0030.

133 Biomass Magazine (November 2019), Orsted: Biomass unit at Asnæs Power Station generates power. Exhibit NERA-0032.

134 Ørsted, Website: Our heat and power plants – Esbjerg. Exhibit NERA-0033.

135 Vito (December 2011), IEA BIOENERGY –TASK40: Sustainable International Bioenergy Trade Securing Supply and Demand Country report Belgium, p. 18-22. Exhibit NERA-0034.

136 Abiom Statistical Report (2016), 2016 European Bioenergy Outlook: Pellet Market Overview, p. 35. Exhibit NERA-0035.

following technical delays and the withdrawal of subsidies in 2017.[137] After the valuation date, the Les Awirs biomass plant closed in 2020 once Belgian Green Certificates, which have supported the plant for 15 years, ran out.[138]

137 Estonian Public Broadcasting (June 2017): Website: Graanul Invest's €250 million Belgian power plant project fails. Exhibit NERA-0036.

138 Bioenergy Insight (4 September 2020), ENGIE's Les Awirs biomass plant closes. Exhibit NERA-0057. Also the Belgian Rodenhuize 4 is expected to close down once its Green Certificates ran out since it already had to close down from 2014 to 2016 when it was not able to obtain Green Certificates (see Power Technology (2021), Rodenhuize Power Station. Exhibit NERA-0058.)

Appendix E. Analyst reports on Drax Group plc.

126. We review 25 analyst reports for Drax Group plc. published between 2015 and 2021 to understand the market perception of the biomass conversion of the UK's largest coal power plant and the prospects of unsubsidized biomass-based electricity generation. Seven of the analyst reports were published prior to the valuation date in October 2017. We select analyst reports from ten financial institutions[139] with a focus on the biomass conversion of Drax power station and the valuation of the generation business.

127. The analyst reports highlight the high sensitivity of the group's valuation to subsidy decisions by the UK government and the uncertain future for the biomass generation business following the end of the subsidies in 2027, especially as of the valuation date in October 2017.

Table E.1: Review of Analyst Reports Covering Drax Group plc.

Date	Institution	Title	Analysis of biomass generation
16. Jan 2015	[redacted]	[redacted]	[redacted]
8. Jul 2016	[redacted]	[redacted]	[redacted]
26. Jul 2016	[redacted]	[redacted]	[redacted]
6. Dec 2016	[redacted]	[redacted]	[redacted]
13. Dec 2016	[redacted]	[redacted]	[redacted]
2. May 2017	[redacted]	[redacted]	[redacted]
29. Jun 2017	[redacted]	[redacted]	[redacted]
11. Apr 2018	[redacted]	[redacted]	[redacted]
21. Aug 2018	[redacted]	[redacted]	[redacted]
25. Mar 2019	[redacted]	[redacted]	[redacted]

139 [redacted]

Date	Institution	Title	Analysis of biomass generation
19. Nov 2019	[redacted]	[redacted]	[redacted]
20. Nov 2019	[redacted]	[redacted]	[redacted]
31. Mar 2020	[redacted]	[redacted]	[redacted]
29. Jul 2020	[redacted]	[redacted]	[redacted]
15. Dec 2020	[redacted]	[redacted]	[redacted]
26. Jan 2021	[redacted]	[redacted]	[redacted])
20. Apr 2021	[redacted]	[redacted]	[redacted]
2. Aug 2021	[redacted]	[redacted]	[redacted]
11. Aug 2021	[redacted]	[redacted]	[redacted]
26. Aug 2021	[redacted]	[redacted]	[redacted]
16. Sep 2021	[redacted]	[redacted]	[redacted]
17. Sep 2021	[redacted]	[redacted]	[redacted]
17. Sep 2021	[redacted]	[redacted]	[redacted]

Date	Institution	Title	Analysis of biomass generation
23. Sep 2021	[redacted]	[redacted]	[redacted]
4. Oct 2021	[redacted]	[redacted]	[redacted]

Source: NERA analysis, analyst reports.[140]

140 For the complete set of analyst reports, see NERA Exhibit-0059.

Appendix F. List of Exhibits

Exhibit number NERA-	Title
0001	Tweede Kamer (March 2019), Explanatory Memorandum.
0002	International Energy Agency, Nuclear Energy Agency (September 2015), Projected Costs of Generating Electricity 2015 Edition.
0003	ECN, DNV (April 2017), Final advice on base rates SDE+ 2017.
0004	NERA (2021), Electricity generation cost.
0005	RWE Eemshaven (2016), Model exploitatieberekening SDE+ subsidielooptijd 8 jaar: Voor categorieën bij- en meestook van biomassa in kolencentrales en ketel industriële stoom uit houtpellets - versie februari.
0006	European Commission (February 2010), Report from the Commission to the Council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass in electricity, heating and cooling.
0007	NERA / Sandback (December 2021), Playing with Fire: An assessment of company plans to burn biomass in EU coal power stations.
0008	Ofgem Website: Renewables Obligation (RO) [Accessed 18.08.2021].
0009	Department of Energy & Climate Change (2011), Plannning our electric future: a White Paper for secure, affordable and low-carbon electricty.
0010	Department of Energy & Climate Change (March 2014), Government Response to the consultations on the Renewables Obligation Transition and on Grace Periods.
0011	House of Commons Library (April 2016), BRIEFING PAPER Number 07283, 20 April 2016: Climate Change Levy: renewable energy & the carbon reduction commitment.
0012	Department of Energy & Climate Change (November 2015), Pre Market Announcement on Unabated Coal-fired Power Stations.
0013	Rijksdienst voor Ondernemend Nederland (December 2016), Beschikking tot subsidieverlening.
0014	ENP Newswire (November 2015), E.ON's Ironbridge Power Station to generate electricity for the last time.
0015	Financial Times (August 2013), Tilbury power plant shut after grant refused.
0016	The Guardian (August 2013), Tilbury power station mothballed after investment burns out.
0017	RWE (December 2007), VERGUNNING WET MILIEUBEHEER verleend aan RWE Power AG te Essen.
0018	KEMA (December 2006), Aanvraag om (oprichtings)vergunning: 1600 MWe kolencentrale van RWE aan de Eemshaven.
0019	European Daily Electricity Markets (December 2016), Drax boosted in plans for pre-2025 biomass conversion.
0020	Department of Energy & Climate Change (April 2014), FID Enabling for Renewables: Successful Projects offered an investment contract (listed in alphabetical order).
0021	VVD, D66, CDA en ChristenUnie (December 2021), Omzien naar elkaar, vooruitkijken naar de toekomst Coalitieakkoord 2021 - 2025.
0022	European Commission (August 2016), State Aid SA. 37345 (2015/NN) - Poland: Polish certificates of origin system to support renewables and reduction of burdens arising from the renewables certificate obligation for energy intensive users.
0023	Aures II (August 2019), Auctions for the Support of Renewable Energy in Poland: Main results and lessons learnt.

0024 Biomass Magazine (September 2011), Metso to convert Polish coal-fired CHP plant to biomass.

0025 EU Bioenergy (April 2017), The end of Big Biomass in Flanders.

0026 Drax Website: This is how you make a biomass wood pellet [Accessed on 29. October 2021].

0027 Danish Energy Agency (March 2017), Memo on the Danish support scheme for electricity generation based on renewables and other environmentally benign electricity production.

0028 Danish Energy Agency (June 2017), Regulation and planning of district heating in Denmark.

0029 Dong Energy (February 2017), Bioenergy & Thermal Power, Meet the Management.

0030 Danish Ministry of Climate, Energy and Utilities (June 2018), Energy Agreement of 29 June 2018.

0031 European Commission (May 2020), P. State Aid SA.55891 (2019/N) – Denmark – Operating aid scheme for electricity generated by incinerating biomass in existing and fully depreciated biomass plants in Denmark.

0032 Biomass Magazine (November 2019), Orsted: Biomass unit at Asnæs Power Station generates power.

0033 Orsted Website: Our heat and power plants – Esbjerg [Accessed 3. December 2021].

0034 IEA Bioenergy (December 2011), Task 40: Sustainable International Bioenergy Trade Securing Supply and Demand - Country report Belgium.

0035 Abiom Statistical Report (2016), 2016 European Bioenergy Outlook: Pellet Market Overview.

0036 Estonian Public Broadcasting (June 2017), Website: Graanul Invest's €250 million Belgian power plant project fails.

0037 NERA Conversion Case Studies Various authors and sources.

0038 Netherlands Energy Research Foundation ECN (November 2000), Biomass Cofiring Potential and Experiences in The Netherlands.

0039 IEA Bioenergy (July 2005), IEA Bioenergy task 40 – Country report for the Netherlands.

0040 CBS, Statline (2021), Database: Electricity and heat; production and input by energy commodity, years 1998-2020.

0041 Netherlands Enterprise Agency (September 2014), Renewable energy report: Part 1 Implementation 2003-2013.

0042 Netherlands Enterprise Agency (December 2019), Progress Report: Energy from renewable sources in the Netherlands 2017-2018.

0043 IEA Bioenergy (October 2010), IEA Bioenergy Task 40 / EUBIONETIII Country report for the Netherlands – Update for 2009.

0044 Netherlands Enterprise Agency (June 2015), SDE+ 2015: Instructions on how to apply for a subsidy for the production of renewable energy.

0045 Rijksdienst voor Ondernemend Nederland (2017), Beschikte projecten SDE+ najaar 2016 & Positief beschikte projecten SDE+ voorjaar 2017.

0046 Netherlands Enterprise Agency (September 2017), SDE+ Autumn 2017: Instructions on how to apply for a subsidy for the production of renewable energy.

0047 IEA Bioenergy (June 2017), Global wood pellet industry and trade study 2017.

0048 Staatscourant van het Koninkrijk der Nederlanden (March 2008), Regeling aanwijzing categorieën duurzame energieproductie 2008.

0049 Netherlands Enterprise Agency (March 2021), Guidance for the use of pellet certification within SDE+.

0050	Fern (July 2016), A comparison of national sustainability schemes for solid biomass in the EU.
0051	Chatham House, The Royal Institute of International Affairs (February 2017), Woody Biomass for Power and Heat.
0052	AEBIOM (2017), European Bioenergy Outlook Statistical Report.
0053	Hawkins Wright (September 2017), The global outlook for wood pellet markets.
0054	Europe Beyond Coal (July 2021), European Coal Plant Database, 21. July 2021.
0055	J. Silvestre (1987), Economies and Diseconomies of Scale.
0056	L. Visser, R. Hoefnagels and M. Junginger (February 2020), Wood pellet supply chain costs – A review and cost optimization analysis.
0057	Biomass Magazine (September 2020), ENGIE's Les Awirs biomass plant closes.
0058	Power Technology (2021), Rodenhuize Power Station.
0059	Various authors and sources Analyst reports by financial markets analysts.
0060	Lo (2008), Efficient Markets Hypothesis.
0061	Financial Times (September 2021), Energy price surge to drive inflation, say experts.
0062	International Energy Agency (October 2021), World Energy Outlook 2021.
0063	SER (2020), Biomasa in balans.
0064	Eerste Kamer (2021), Wijziging van de Wet verbod op kolen bij elektriciteitsproductie in verband met beperking van de CO2-emissie.
0065	Tweede Kamer (May 2021), Vragen gesteld door de leden der Kamer, met de daarop door de regering gegeven antwoorden.
0066	Tweede Kamer (2021), 32 813, nr. 682, Vragen en opmerkingen vanuit de fractie en reactie van de bewindspersonen.
0067	Energate Messenger (July 2021), Kohleausstieg: Förderung für Kraftwerksumrüstungen unwahrscheinlich.
0068	Deutsches Biomasseforschungszentrum (July 2021), Press release: Positionspapier: DBFZ-Expert*innen sehen keine Vorteile für die Umrüstung von Kohlekraftwerken auf Biomasse.
0069	Raven et al. (February 2021), Letter Regarding Use of Forests for Bioenergy.
0070	Netherland News Live (2021), Permits for biomass power plant in Diemen legally granted.
0071	International Energy Agency (2016), The status of large scale biomass firing.
0072	International Energy Agency (June 2012), Global Wood Chip Trade for Energy.
0073	Bioenergy Europe (2020), Statistical Report 2020 – Pellet Report (Sample).
0074	European Commission (February 2015), Subject: State aid SA.38762 (2015/C) (2014/N) – United Kingdom Investment Contract for Lynemouth Power Station Biomass Conversion.
0075	Department for Energy & Climate Change (December 2013), Electricity Market Reform Delivery Plan.
0076	NERA (2021), Incremental market share Dutch pellet conversion demand.

Qualifications, assumptions, and limiting conditions

This report is for the exclusive use of the NERA Economic Consulting client named herein. This report is not intended for general circulation or publication, nor is it to be reproduced, quoted, or distributed for any purpose without the prior written permission of NERA Economic Consulting. There are no third-party beneficiaries with respect to this report, and NERA Economic Consulting does not accept any liability to any third party.

Information furnished by others, upon which all or portions of this report are based, is believed to be reliable but has not been independently verified, unless otherwise expressly indicated. Public information and industry and statistical data are from sources we deem to be reliable; however, we make no representation as to the accuracy or completeness of such information. The findings contained in this report may contain predictions based on current data and historical trends. Any such predictions are subject to inherent risks and uncertainties. NERA Economic Consulting accepts no responsibility for actual results or future events.

The opinions expressed in this report are valid only for the purpose stated herein and as of the date of this report. No obligation is assumed to revise this report to reflect changes, events, or conditions, which occur subsequent to the date hereof.

All decisions in connection with the implementation or use of advice or recommendations contained in this report are the sole responsibility of the client. This report does not represent investment advice nor does it provide an opinion regarding the fairness of any transaction to any and all parties. In addition, this report does not represent legal, medical, accounting, safety, or other specialized advice. For any such advice, NERA Economic Consulting recommends seeking and obtaining advice from a qualified professional.