

# THE BURNING QUESTION

Should the UK end tax breaks on burning wood for power?

**EMBER**  
COAL TO CLEAN ENERGY POLICY



## Executive summary

The UK has now left the EU, and there's an opportunity to reassess some EU legislation which has been brought into UK law. In this research, we demonstrate why the UK should abandon the carbon tax exemption afforded to large power stations burning biomass (mostly wood in the form of pellets or chips).

Unlike other large thermal generators, biomass power plants do not pay for their carbon emissions. This is because biomass is assumed to be inherently carbon neutral under the EU Emissions Trading System and the UK Carbon Price Support. That assumption, however, is not supported by the weight of recent science, or by data provided by power plant operators themselves.

## Tax breaks

The carbon tax exemption means biomass generators are receiving an unfair tax-break, diverting much needed funds away from other renewable sources which are guaranteed to be low-carbon. **Using a mid-range estimate for biomass carbon intensity,<sup>1</sup> we estimate the carbon tax break to large<sup>2</sup> UK biomass power stations will be £333 million next year (£246m at Drax alone).** Current sourcing rules for biomass allow for a large range of possible carbon outcomes, which leads to uncertainty as to how high the tax break is. At higher-end estimates of biomass emissions,<sup>3</sup> the tax break could be up to £754 million a year (£557m at Drax alone).

- Since Drax began burning biomass for power generation in 2012, our mid-range estimate shows the government has already forgone around **£1 billion** in carbon taxes.<sup>4</sup>
- Over the entire period over which subsidies are available to burn biomass (2012-2027), **the government will forgo £2.8 billion in carbon taxes** (on a mid-range estimate which assumes the UK's post-Brexit total carbon price remains at the 2019 average). On a high-end estimate, the UK could forgo up to £6.4 billion.

## Direct subsidy

This tax break is in addition to direct subsidies: **this report finds subsidies to large biomass power plants will cost the energy billpayer more than £1 billion this year** - or almost £3 million a day. Up until most subsidies are due to end in 2027,

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1. 468kgCO<sub>2e</sub>/MWh from the SIG scenario, discussed in section 2

2. >100MW

3. 1059kgCO<sub>2e</sub>/MWh from the BEIS BEAC scenario 14, discussed in section 2. At this emissions level, it's highly likely that the carbon price would affect dispatch decisions and so significantly reduce biomass generation

4. At our High-end scenario of 1059kgCO<sub>2e</sub>/MWh

we calculate UK energy billpayers will spend £13 billion in direct support to large biomass power plants (including £10bn at Drax alone).<sup>5</sup> This figure is all the more extraordinary considering wind and solar generation is now effectively subsidy free, and guarantees real emissions reductions.

The government is now considering further multi-billion subsidy for biomass with carbon capture and storage (BECCS) in pursuit of the UK's net zero emissions goal. This research argues that biomass cannot be assumed to be carbon neutral, and so by extension BECCS projects are not guaranteed to deliver negative emissions. The government must only support BECCS projects when a full life cycle assessment demonstrates they are net carbon negative within the decade - and that the cost of negative emissions is equivalent to other options.

## The science: Why is biomass not inherently carbon neutral?

Gas and coal power plants in the UK pay for the CO<sub>2</sub> they emit; both via the EU Emissions Trading System (EU-ETS), and the UK's additional Carbon Price Support (CPS). Power plants that burn wood do not pay for their CO<sub>2</sub> emissions under either scheme, as it has been assumed that burning wood is carbon-neutral.

In fact, burning wood releases more CO<sub>2</sub> per unit of electricity generated than coal (due to the higher moisture content). The carbon-neutral status of wood rests on the assumption that the CO<sub>2</sub> emitted by the power station is absorbed by forest growth at some point in the future.

**However, a vast body of scientific research indicates that burning wood cannot be assumed to be inherently carbon-neutral.**<sup>6</sup> We discuss this further later in the report.

*"Most current uses of biomass do not sequester carbon and are in sectors where there are increasingly other viable low-carbon alternatives. Current uses of biomass will therefore need to change.*

*Over time, Government policies should assist a transition towards increased use of biomass in construction and BECCS, and away from using biofuels in surface transport, biomass for heating buildings, or biomass for generating power without CCS."*

**The Committee on Climate Change,**  
*Biomass in a low carbon economy* (2018)<sup>7</sup>

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5. At 2019 prices.

6. For more information, please refer to the literature reviews conducted by the European Academies' Science Advisory Council (EASAC) - which includes the Royal Society [1], the Chatham House Environment, Energy & Resources Department [2] and the UK's Committee on Climate Change [3].

7. Page 12, Biomass in a low carbon economy - The CCC (2018) <https://www.theccc.org.uk/publication/biomass-in-a-low-carbon-economy/>

## Solutions

### Biomass

- The government must abandon the assumption that burning wood for power is inherently carbon neutral.
- The government should work urgently to remove the biomass carbon tax break.
  - » To do so, UK carbon pricing will need to account for the net carbon emissions from biomass power stations measured on a full life cycle basis vs. a counterfactual with no bioenergy. Emissions should be calculated on Paris-relevant timescales (e.g. 10 years).
  - » To start to restore confidence in biomass, the onus is on biomass power plants to provide independently verified full lifecycle assessments of their feedstock carbon intensity over Paris-relevant timescales (for instance, 10 years) - vs a counterfactual in the absence of their activities. This can then be subject to a carbon price.
- The government should further tighten the sustainability criteria to drastically reduce the risk of high carbon biomass sourcing. The CCC has already set out a number of immediate steps that need to be taken to improve the current sustainability framework. Sustainability criteria should be applied to all biomass sourcing - not only subsidised projects.

### BECCS

- Biomass is not inherently carbon neutral, therefore, BECCS projects cannot be assumed to be inherently carbon negative.
- The government must only support BECCS projects when a full life cycle assessment demonstrates they are net carbon negative within Paris-relevant timescales (e.g. a decade) - and that the cost of negative emissions is equivalent to other options.
- Nature based solutions (such as afforestation and restoration) which do not burn wood can deliver negative emissions now at low cost and risk - the UK must begin to deploy at scale immediately.

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## Methodology

The report focuses on forest biomass i.e. wood, but for simplicity we use the term 'biomass' at some points.

This report is indebted to the comprehensive annual reports of Drax, which give estimates of supply chain emissions and stack emissions from their biomass plant. For EPH Lynemouth and MGT Teesside, where annual reports weren't available, we've used actual generation data from the BMRS API, as well as information in Lynemouth's European Commission state aid decision, and CfD agreement data from BEIS's Low Carbon Contracts Company.

All subsidy and tax amounts in this report are calculated at 2019 values - inflation will mean the nominal amounts the government and energy billpayer give out to biomass companies will be larger.

The report derives estimates for carbon pricing appropriate for biomass generation, stemming from the differing estimates for life cycle emissions in the scientific literature. These range from emissions of 1059kg CO<sub>2</sub>-eq/MWh over a 40 year time horizon (a BEIS commissioned scenario) down to 124 (Drax's own estimate just for supply chain emissions). More information is available in Section 2.

TABLE 1:

### Carbon intensity of electricity generated under different biomass sourcing scenarios

Carbon intensity of biomass generation		Source
High-end scenario (BEIS)	1059kg CO <sub>2</sub> -eq/MWh over a 40 year time horizon	BEIS BEAC model Scenario 14. <sup>a</sup> <i>'Electricity from pellets produced from additional wood (compared to counterfactual) from intensively managed pine plantation in South USA. Counterfactual = increasing rotation time from 25 to 35 years.'</i> as referenced in the Climate Change Committee's 2018 report. <sup>b</sup>
Mid-range scenario (SIG)	468kg CO <sub>2</sub> -eq/MWh over a 40 year time horizon	Spatial Informatics Group. <sup>c</sup> A life cycle assessment of wood pellets from Drax's pellet mills in the South-Eastern United States (468kgCO <sub>2</sub> -eq/MWh was the lowest emissions intensity SIG found).
Mid-range scenario (BEIS)	389kg CO <sub>2</sub> -eq/MWh over a 40 year time horizon	BEIS BEAC model Scenario 4. <i>'Electricity from pellets produced from coarse forest residues in South USA, continuously removed over the time frame. Counterfactual = decay in forest.'</i> as referenced in the Climate Change Committee's 2018 report.
Low-end scenario	124kg CO <sub>2</sub> -eq/MWh over a 100 year time horizon	Drax Supply-Chain Emissions. <sup>d</sup> Assumes biomass generation is carbon neutral, and makes an estimate for the emissions involved in felling, drying, pelletisation and shipping of wood pellets from the US to the UK.

<sup>a</sup> Life cycle impacts of biomass electricity in 2020, BEIS. BEAC Model Scenario 14. <https://www.gov.uk/government/publications/life-cycle-impacts-of-biomass-electricity-in-2020>

<sup>b</sup> Biomass in a low-carbon economy. CCC, 2018.

<sup>c</sup> Wood Pellets from Drax's U.S. Mills Increase Carbon Emissions During the Timeframe Necessary to Address Climate Change. Spatial Informatics Group, LLC (SIG), 2019. [https://www.southernenvironment.org/uploads/publications/2019-08-08\\_FINAL\\_Biomass\\_Factsheet\\_Drax\\_SIG\\_Report\\_Updated1.PDF](https://www.southernenvironment.org/uploads/publications/2019-08-08_FINAL_Biomass_Factsheet_Drax_SIG_Report_Updated1.PDF)

<sup>d</sup> Drax Annual Report 2019. <https://www.drax.com/wp-content/uploads/2019/03/Drax-Annual-report-accounts-2018.pdf>

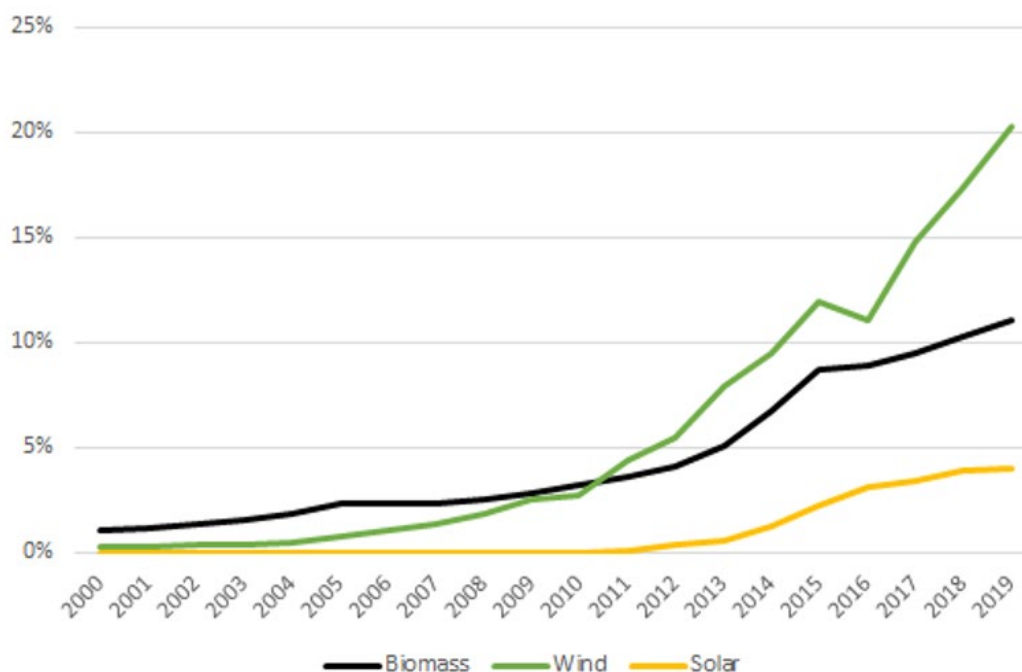
# 1. The biomass subsidy burden

Biomass is plant material (and rarely, animal) used for energy generation. For the large UK power stations focused on in this report, it is principally forest biomass in the form of wood-pellets from the southern United States. Large-scale electricity generation using biomass is reliant on subsidy. The UK has two existing large-scale biomass power plants, both are coal power plant conversions: Drax, owned by Drax Group, and Lynemouth, owned by the Czech company (EPH). One new biomass plant plans to go into operation this year: MGT Teesside.

Drax and Lynemouth have government contracts to subsidise their operation until March 2027, after which BEIS has indicated it will cease support for biomass conversions without CCS, although dedicated biomass with CHP can still operate and apply for a CfD. This briefing will focus on Drax, which is by far the largest of the three, with a total electricity generation from biomass capacity of 2,580MW, compared to Lynemouth's 420MW and MGT Teesside's 299MW. However, the recommendations apply to all large-scale biomass, whether subsidised or not.

FIGURE 1:

Wind, solar and biomass as a percentage of UK electricity generation



Source: Ember European Power Sector Review 2019.

In 2019, biomass made up 29% of UK non-fossil, non-nuclear generation, and produced 11% of UK electricity.<sup>8</sup> With the government unlikely to grant any new large-scale biomass subsidy contracts, and the advent of extremely low-cost offshore wind, biomass generation in the UK will make up a smaller proportion of the renewable category in future years.

#### INFOBOX

### Lynmouth

Lynmouth power plant began generating with biomass in Q2 2018, after a conversion of the RWE coal plant which closed in 2015.

Lynmouth has a slightly higher initial CfD strike price than Drax, of £105/MWh (2012 prices) – currently worth £120/MWh.<sup>9,10</sup> We calculate total direct subsidy (2018– March 2027) will be £1.5 billion. Biomass is supplied by Enviva,<sup>11</sup> who also supply Drax.

The plant is owned by the UK subsidiary of Czech utility company Energetický a Průmyslový Holding (EPH). EPH has a number of other European coal-to-biomass conversion plans.<sup>12</sup>

#### INFOBOX

### MGT Teesside

MGT Teesside is a combined heat and power (CHP) biomass plant, due to open in July 2020 with a capacity of 299MW.

The plant has agreed an initial CfD strike price of £125/MWh (2012 prices), which is currently worth more than £145/MWh.<sup>13</sup>

We estimate that MGT Teesside will collect a total subsidy of £1.4 billion, from 2020– March 2027.

We have assumed the plant will open on time in July this year, but construction has been halted during the coronavirus pandemic,<sup>14</sup> and there were existing

8. The European Power Sector in 2019, Sandbag <https://ember-climate.org/project/power-2019/>

9. <https://www.lowcarboncontracts.uk/cfds/lynemoumouth-power-station>

10. [https://europa.eu/rapid/press-release\\_IP-15-6214\\_en.htm](https://europa.eu/rapid/press-release_IP-15-6214_en.htm)

11. <https://www.power-technology.com/projects/lynemoumouth-biomass-power-station-northumberland/>

12. <https://ember-climate.org/project/playing-with-fire/>

13. <https://www.lowcarboncontracts.uk/cfds/teesside>

14. <https://www.argusmedia.com/en/news/2090790-construction-suspended-at-mgt-teesside-plant?backToResults=true>



signs of construction difficulties, including mass redundancies in the second half of 2019.<sup>15</sup>

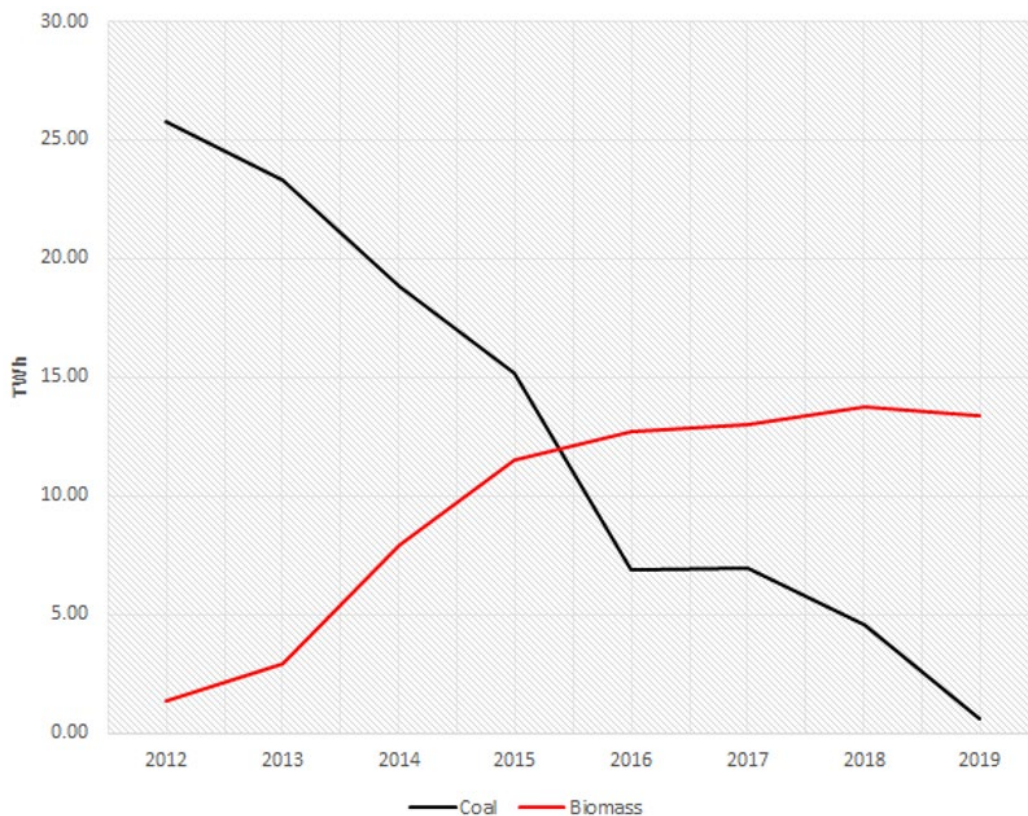
MGT Teesside is a new-build biomass CHP, so is not covered by the March 2027 closure of the CfD.

## Biomass at Drax

With a total capacity of 3,960MW, Drax is the UK's largest power plant. Since 2012, it has gradually switched from coal-based to biomass-based electricity generation (see Figure 2).

FIGURE 2:

Drax's coal use for electricity has declined as four out of six units have converted to biomass



15. <https://www.argusmedia.com/en/news/1955262-hundreds-of-redundancies-at-mgt-power-unite>

**Drax Unit #1** has generated with biomass on a government-backed Contract for Difference since December 2016, at a guaranteed price of £100/MWh (2012 prices).<sup>16</sup> This is approximately double the current wholesale power price.<sup>17,18</sup> The 645MW unit produces ~3.6TWh of electricity per year.<sup>19</sup>

**Drax Units #2, #3 and #4** have Renewable Obligation Certificate (ROC) contracts. Units #2 and #3 have 'grandfathered' contracts which were agreed before the government capped ROC costs in 2018. Unit #4, the most recent to convert to biomass, has a much tighter ROC cap, but Drax can optimise generation across units, up to the level of their total cap. In total, Drax is expected to generate 10,193,875 ROCs in the 2018/19 obligation year, across three units each of 654MW.<sup>20</sup>

## Drax biomass subsidies

Drax has already received almost £4 billion in combined ROC and CfD subsidy. With the contracts existing until 2027, we estimate Drax will receive a total of £10 billion in subsidy (at 2019 prices).

TABLE 2:

### Drax subsidies to date and total committed subsidies (2019 prices)

	Subsidies to date 2012-2019	Estimated subsidies 2020-2027	Total subsidies 2012- 2027
ROCs	£3,297m	£3,690m	£6,986m
CfD	£866m	£2,144m	£3,010m
<b>Total</b>	<b>£4,163m</b>	<b>£5,834m</b>	<b>£9,996m</b>

We've held the subsidies at 2019 prices for ease of understanding, but the nominal size of the subsidy will increase by more than we show here, as ROC prices increase each year by RPI, which currently stands at 3.3%,<sup>21</sup> and CfDs are increased each year by the Consumer Price Index, which currently stands at 2%.<sup>22</sup>

16. <https://www.drax.com/investors/european-commission-approves-cfd-contract/>

17. <https://www.lowcarboncontracts.uk/cfds/drax-3rd-conversion-unit-unit-1>

18. Page 6 [https://ec.europa.eu/competition/state\\_aid/cases/257954/257954\\_1720554\\_105\\_2.pdf](https://ec.europa.eu/competition/state_aid/cases/257954/257954_1720554_105_2.pdf) "The wholesale price of electricity is assumed to be approximately £ 55 £/MWh in real terms increasing to 65 £/MWh in 2020."

19. [https://europa.eu/rapid/press-release\\_IP-16-4462\\_en.htm](https://europa.eu/rapid/press-release_IP-16-4462_en.htm)

20. [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/732905/Explanatory\\_note\\_on\\_2018\\_19\\_exempt\\_combustion\\_unit\\_estimate.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/732905/Explanatory_note_on_2018_19_exempt_combustion_unit_estimate.pdf)

21. <https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/czbh/mm23>

22. <https://www.ons.gov.uk/economy/inflationandpriceindices/bulletins/consumerpriceinflation/july2019>

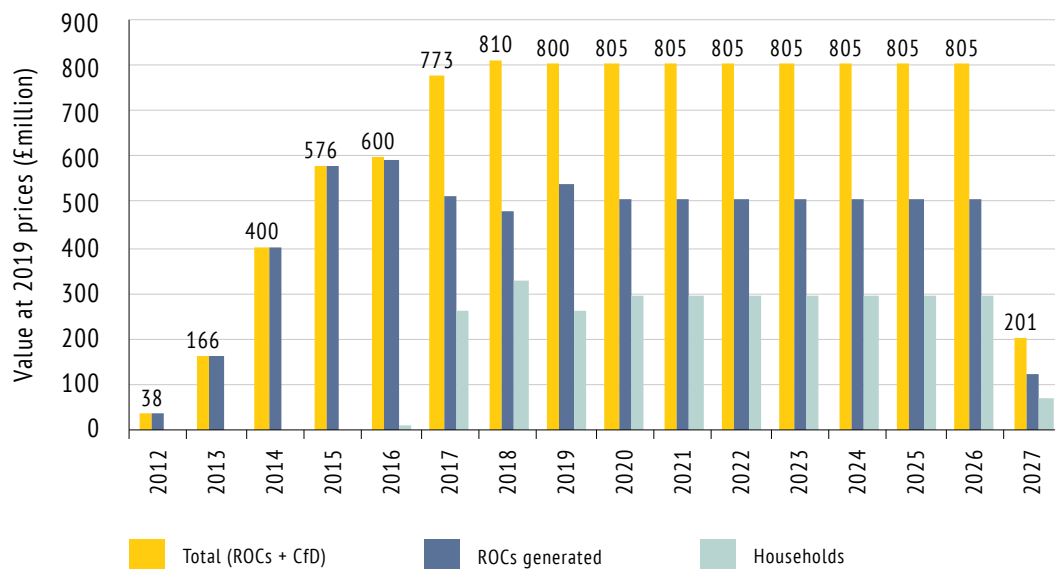
The calculation above takes an average of 2018 and 2019 ROC income across three units, and averaged CfD income across one unit, and assumed that generation will continue at that level to 2027.

The estimated future subsidies are likely to be an underestimate for three reasons:

- The 2018-2019 average generation we used to calculate future earnings was lower than expected, in 2018 following a fire at Drax's biomass rail unloading facilities in December 2017, and an outage at Unit 1 across summer 2019.
- With the advent of extremely cheap wind and solar, power prices are widely expected to fall in the coming years. This will increase the size of Drax's CfD subsidy, as the government tops up the difference between the wholesale power price and the strike price.

FIGURE 3:

### Drax ROC and CfD subsidy (2019 prices)



Actuals 2012-2019 (at 2019 prices). Estimate for 2020-2027.  
Source: Drax Annual Reports



## 2. UK carbon pricing and the wood burning loophole

Gas and coal power plants in the UK pay for the CO<sub>2</sub> they emit; both via the EU Emissions Trading System (EU-ETS), and the UK's additional Carbon Price Support (CPS). Power plants that burn wood do not pay for their CO<sub>2</sub> emissions under either scheme, as it has been assumed that burning wood is carbon-neutral. UK and EU law – legislated when the science around biomass was in its infancy – does not recognise biomass emissions' contribution to global atmospheric carbon dioxide levels, assuming instead that forest growth fully sequesters this carbon.

In fact, burning wood releases more CO<sub>2</sub> per unit of electricity generated than coal (due to the higher moisture content). The carbon-neutral status of wood rests on the assumption that the CO<sub>2</sub> emitted by the power station is absorbed by forest growth at some point in the future.

**However, a vast body of scientific research indicates that burning wood cannot be assumed to be inherently carbon-neutral.<sup>23</sup>**

Drax, Europe's largest generator of electricity from biomass,<sup>24</sup> reports stack emissions (emissions from the chimney) at 955gCO<sub>2e</sub> per kWh, with another 124g/kWh emitted in the processing and supply chain<sup>25</sup> (for comparison, Drax's coal stack emissions are 898gCO<sub>2e</sub> per kWh, whilst the coal supply-chain emissions are not reported).

Recent evidence from the European Academies' Science Advisory Council suggests that burning forest biomass leads to an initial increase in atmospheric carbon, which can then take decades to be reabsorbed. The Paris agreement requires reductions over much shorter timescales, meaning biomass generation should pay a carbon tax proportional to its carbon impact over these timescales.

*“Current policies are failing to recognize that removing forest carbon stocks for bioenergy leads to an initial increase in emissions. Moreover, the periods during which atmospheric CO<sub>2</sub> levels are raised before forest regrowth can reabsorb the*

23. For more information, please refer to the literature reviews conducted by the European Academies' Science Advisory Council (EASAC) – which includes the Royal Society [1], the Chatham House Environment, Energy & Resources Department [2] and the UK's Committee on Climate Change [3].

24. EU Large Combustion Plant Database 2019

25. Page 9, Annual Report – Drax (2018) <https://www.drax.com/wp-content/uploads/2019/03/Drax-Annual-report-accounts-2018.pdf> (BEIS mandates a supply-chain emissions standard 285kgCO<sub>2</sub>-eq/MWh, reducing to 200 kgCO<sub>2</sub>-eq/MWh of electricity in 2020).

*excess emissions are incompatible with the urgency of reducing emissions to comply with the objectives enshrined in the Paris Agreement.”*

**European Academies’ Science Advisory Council, August 2019**

When biomass legislation was being developed back in the early 2000’s, the carbon intensity of the UK electricity grid was above 500gCO<sub>2e</sub>/kWh. It is now around ~250gCO<sub>2e</sub>/kWh, and the Committee on Climate Change’s 2030 target for the electricity system is a total carbon intensity of 50-100gCO<sub>2e</sub>/kWh.<sup>26</sup> This scenario was in-line with the UK’s older, less ambitious Climate Change Act target, and the CCC now says that “*achieving net-zero emissions by 2050 could require earlier electrification and/or earlier power sector decarbonisation*”.

On the CCC pathway, the UK electricity system needs to be operating at a carbon intensity significantly below that of large-scale biomass – even when only accounting for the emissions released during processing and the supply chain. Without implementing a carbon price, there is a risk that biomass generation continues after the government ends direct subsidies in 2027, increasing the UK grid’s emissions.

## Different emissions scenarios from burning wood

Burning wood sourced from the harvest of additional trees entirely for the purpose of energy production is likely to lead to very high CO<sub>2</sub> emissions – even vs. fossil fuels – over timescales appropriate to meeting climate targets.

Conversely, burning wood sourced from industrial residues (such as sawmill residues) which would have otherwise been burnt as waste or landfilled is likely to lead to low overall CO<sub>2</sub> emissions.

Calculating the net CO<sub>2</sub> emissions caused by wood burning in UK power stations is complex and depends on a number of factors including: the likely source of wood, the forest management practices, the supply chain emissions, the timescales considered and what would have happened to the wood if it had not been burnt for bioenergy (*the counterfactual*).<sup>27</sup>

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26. Page 72, Progress Report – The CCC (2019) [Reducing UK emissions – 2019 Progress Report to Parliament](#)

27. For a more detailed discussion of how these factors impact the net carbon emission of burning wood for electricity, please see chapter 2 of the Committee on Climate Change’s (CCC) 2018 paper: [Biomass in a low-carbon economy](#).

However, research<sup>28</sup> commissioned by the UK Government has identified a number high carbon<sup>29</sup> scenarios for wood sourced from the South-East USA that are likely to be happening now. The South-East USA is the largest supplier of wood burnt in UK power stations.

While there was a great deal of uncertainty over the scale at which these high carbon sourcing strategies were occurring, one scenario at least (the use of coarse forest residues, see figure 4 from the CCC below) was considered “moderately likely now [in 2016] and more likely in the future. This scenario could be common in the

FIGURE 4:

GHG emissions associated with a subset of South-East USA biomass for electricity pathways from the BEAC study

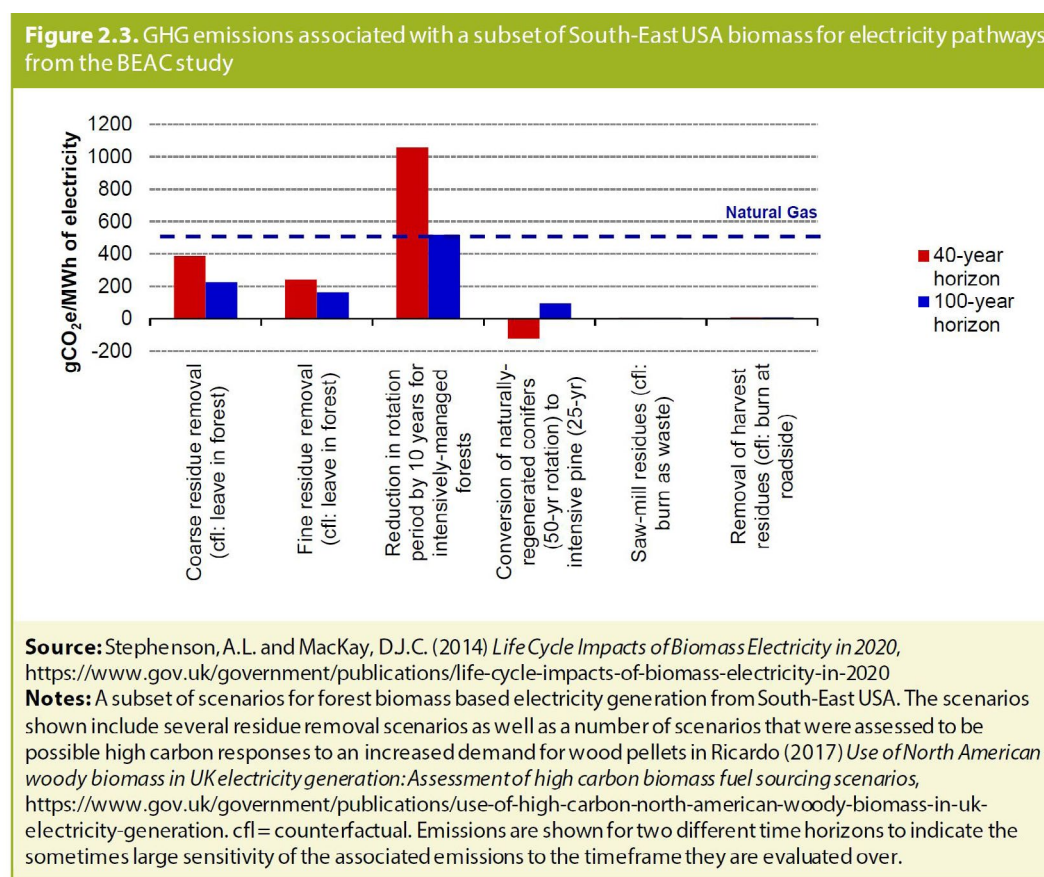


Chart from [Biomass in a low-carbon economy](#), CCC, Page 49

28. Ricardo - Use of North American woody biomass in UK electricity generation: Assessment of high carbon biomass fuel sourcing scenarios, <https://www.gov.uk/government/publications/use-of-high-carbon-north-american-woody-biomass-in-ukelectricity-generation>.

29. The definition of high carbon for the research was >200gCO<sub>2</sub>/kWh.



vicinity of pellet mills.”<sup>30</sup> This is our *Mid-range scenario* (BEIS) in the table below. It’s important to note these scenarios assess emissions across 100 year (blue bar) and 40 year (red bar) timescales – both far too long to meet the targets in the Paris Agreement. Emissions calculated across shorter, Paris-relevant timescales (e.g. 10-20 years) may be significantly higher.

Recent research by Spatial Informatics Group (SIG), further challenges the assumption that wood burnt in UK power stations is carbon-neutral. The research estimated that wood burnt at Drax power station supplied from the company’s own pellet mills in the USA had an emissions intensity of 468kgCO<sub>2</sub>/MWh over the 40 year period from 2019-2059. We’ve included this in our calculations as the *Mid-range scenario* (SIG).

‘Thinnings’ is the sourcing strategy examined in the SIG analysis. It’s a process which Drax explains as “periodically felling a proportion of the forest to aid its overall health and vigour”, and considers as best-practice forestry.<sup>31</sup> Thinnings are also confirmed by the UK government commissioned research discussed earlier in this chapter as a likely source of wood for power stations.<sup>32</sup>

When the BEAC report was completed in 2016, the High-end scenario we include below was deemed to be unlikely by the surveyed stakeholders in the North American pellet supply chain – but respondents couldn’t agree on what would happen if pellet demand increased. Since then, pellet demand has risen, and our *Playing With Fire* report has shown how just the planned coal-to-biomass plants in Europe could increase biomass consumption by the equivalent of five new Drax power stations.<sup>33</sup> Therefore whilst we think this scenario shouldn’t be considered the default, there’s a significant risk that such sourcing, or similar scenarios, are beginning to occur.

*“The amount of biomass used by the UK should be constrained by the supply of low-carbon sustainable feedstocks. Potential demand in the future is likely to exceed sustainable supply”*

**UK’s Committee on Climate Change – 2018**

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30. Ricardo report for DECC. 2016 pg. 113. Use of North American woody biomass in UK electricity generation: Assessment of high carbon biomass fuel sourcing scenarios

31. Drax What is a working forest?

32. *Use of North American woody biomass in UK electricity generation* – Summary report, conclusions, pg. 45.

33. *Playing With Fire*, Sandbag, 2019 [Playing With Fire](#)

The following table shows the main emissions scenarios we've considered for biomass generation:

TABLE 3:

### Carbon intensity of electricity generated under different biomass sourcing scenarios

Carbon intensity of biomass generation		Source
High-end scenario	1059kg CO <sub>2</sub> -eq/MWh over a 40 year time horizon	BEIS BEAC model Scenario 14. <sup>a</sup> <i>'Electricity from pellets produced from additional wood (compared to counterfactual) from intensively managed pine plantation in South USA. Counterfactual = increasing rotation time from 25 to 35 years.'</i> as referenced in the Climate Change Committee's 2018 report. <sup>b</sup>
Mid-range scenario (SIG)	468kg CO <sub>2</sub> -eq/MWh over a 40 year time horizon	Spatial Informatics Group. <sup>c</sup> A life cycle assessment of wood pellets from Drax's pellet mills in the South-Eastern United States (468kgCO <sub>2</sub> -eq/MWh was the lowest emissions intensity SIG found).
Mid-range scenario (BEIS)	389kg CO <sub>2</sub> -eq/MWh over a 40 year time horizon	BEIS BEAC model Scenario 4. <i>"Electricity from pellets produced from coarse forest residues in South USA, continuously removed over the time frame. Counterfactual = decay in forest."</i> as referenced in the Climate Change Committee's 2018 report.
Low-end scenario	124kg CO <sub>2</sub> -eq/MWh over a 100 year time horizon	Drax Supply-Chain Emissions. <sup>d</sup> Assumes biomass generation is carbon neutral, and makes an estimate for the emissions involved in felling, drying, pelletisation and shipping of wood pellets from the US to the UK.

<sup>a</sup> Life cycle impacts of biomass electricity in 2020, BEIS. BEAC Model Scenario 14. <https://www.gov.uk/government/publications/life-cycle-impacts-of-biomass-electricity-in-2020>

<sup>b</sup> Biomass in a low-carbon economy. CCC, 2018.

<sup>c</sup> Wood Pellets from Drax's U.S. Mills Increase Carbon Emissions During the Timeframe Necessary to Address Climate Change. Spatial Informatics Group, LLC (SIG), 2019. [https://www.southernenvironment.org/uploads/publications/2019-08-08\\_FINAL\\_Biomass\\_Factsheet\\_Drax\\_SIG\\_Report\\_Updated1.PDF](https://www.southernenvironment.org/uploads/publications/2019-08-08_FINAL_Biomass_Factsheet_Drax_SIG_Report_Updated1.PDF)

<sup>d</sup> Drax Annual Report 2019. [Enabling a zero carbon, lower cost energy future](#)

For comparison, table 4 below shows example emissions (not including supply-chain) for other generation technologies in the UK.

TABLE 4:

### Direct emissions (Scope 1) from different fuel sources

Fuel	gCO <sub>2e</sub> /kWh
Coal	937
Gas (Open Cycle)	651
Gas (Closed Cycle)	394

Source: <https://www.sciencedirect.com/science/article/pii/S0301421516307017?via%3Dihub>

In other words, supply-chain emissions alone are significantly higher than the life cycle estimates for other low-carbon generation technology: rooftop solar PV (41kgCO<sub>2</sub>e/MWh); onshore wind (11kg); offshore wind (12kg); and nuclear (12kg).<sup>34</sup> Additionally, each of these technologies have life cycle emissions significantly below the Committee on Climate Change target for 2030 (50-100g).

## Sustainability criteria

Wood used for burning at UK power stations must adhere to sustainability criteria, if the power plant is in receipt of ROCs<sup>35</sup> or a CfD.<sup>36</sup>

However, it is imperative to note that under the current framework, this does not guarantee that wood used for electricity generation is low-carbon. The high carbon scenarios identified in the previous section would all be classified as *sustainable* under the current framework.

**To support the UK's climate objectives, wood burnt for electricity generation must be both sustainable and low-carbon.**

*Compliance with sustainable forest management criteria reduces the risk of harm to forest soils, water, biodiversity and long-term productivity but does not guarantee bioenergy supply chains reduce carbon emissions when used in place of fossil fuels.*

UK's Committee on Climate Change – 2018<sup>37</sup>

We've then calculated the Carbon Price Support and EU Emissions Trading System implications for each of the biomass scenarios in Table 3.

If only Drax's supply-chain emissions were subject to the equivalent of the UK Carbon Price Support and the average EU ETS price, Drax would have paid £65.2m in tax in 2019. This can be compared to the entire £65m CfD budget for offshore wind in 2019, which procured more than 5GW of capacity without being fully spent.<sup>38</sup>

However, the research outlined in Table 3 shows the full life cycle emissions at Drax could be much higher. Our Mid-range estimate from the BEIS BEAC research would have seen Drax pay £204m in carbon tax in 2019.

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34. IPCC WG111 Page 1335 Technology-specific Cost and Performance Parameters

35. IPCC WG111 Page 1335 [Technology-specific Cost and Performance Parameters](#)

36. Ofgem [Renewables Obligation: Sustainability Criteria Reporting](#)

37. *Biomass in a low-carbon economy* (November 2018) - Committee on Climate Change. Pg. 61

38. <https://www.gov.uk/government/publications/contracts-for-difference-cfd-allocation-round-3-statutory-notices>



FIGURE 5:

Potential carbon taxation at Drax in 2019 under different biomass sourcing scenarios

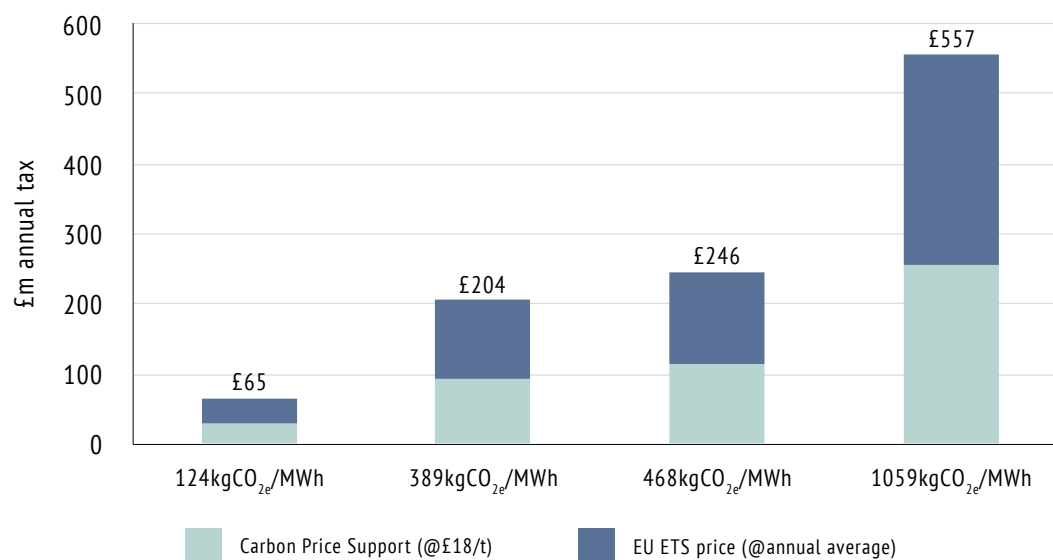


TABLE 5:

Annual carbon taxation for Drax biomass under four different scenarios

	Low-end estimate (Drax)	Mid-range estimate (BEIS)	Mid-range estimate (SIG)	High-end estimate (BEIS)
Scenario carbon intensity (CO <sub>2</sub> -eq/MWh)	124kg	389kg	468kg	1059kg
Carbon Price Support (currently £18.08/t)	£30.0m	£93.8m	£113.4m	£256.6m
EU ETS (2019 average £21.15/t)	£35.2m	£110.3m	£132.7	£300.2m
Total	£65.2m	£204.1m	£246.0m	£556.8m

TABLE 6:

Theoretical carbon taxation for Lynemouth & MGT biomass under four different scenarios

	Low-end estimate (Drax)	Mid-range estimate (BEIS)	Mid-range estimate (SIG)	High-end estimate (BEIS)
<b>Lynemouth biomass plant</b>	£11.9m	£37.2m	£44.8m	£101.4m
<b>MGT Teesside biomass plant</b>	£11.2m	£35.1m	£42.2m	£95.6m
<b>Total (Drax, Lynemouth, MGT)</b>	£88.3m	£276.8m	£333.1m	£753.7m

## Should we implement a carbon tax on supply-chain emissions?

The UK has the power to immediately adjust the Carbon Price Support to cover some emissions from biomass. The planned post-Brexit Carbon Emissions Tax (or UK ETS) could also include biomass carbon.

However, carbon prices are currently calculated on the carbon content of the fuel,<sup>39</sup> not on the supply chain emissions. There are significant hidden emissions in coal and gas supply chains, especially from methane leakage.<sup>40</sup> This raises the possibility of changing carbon pricing wholesale to include life cycle emissions. Such a move would have some positive effects, for instance increasing the carbon price applied to less well regulated, leaky gas sources (LNG from US hydraulic fracturing or the Middle East).

Combined cycle gas turbines have supply-chain emissions of ~120gCO<sub>2</sub>eq/kWh, according to IPCC AR5,<sup>41</sup> but more recent research has suggested methane leakage may be much higher,<sup>42</sup> dependent on gas sourcing and transportation method (LNG introduces substantial supply-chain emissions).

BEIS and DEFRA provide GHG conversion factor tables for company reporting. Biomass is a special case, and the CO<sub>2</sub> emissions value is set as net zero, but

39. [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/768292/20181108\\_Copy\\_of\\_2018-EUETS-CEFsGCVs-v01-05\\_-\\_version\\_for\\_GOV.UK.xlsx](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/768292/20181108_Copy_of_2018-EUETS-CEFsGCVs-v01-05_-_version_for_GOV.UK.xlsx) [EXCEL]

40. Sandbag, 2019 - [Coal mine methane leakage](#)

41. IPCC WG111 Page 1335 [https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc\\_wg3\\_ar5\\_annex-iii.pdf](https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_annex-iii.pdf)

42. <https://science.sciencemag.org/content/361/6398/186>

companies already have to calculate and report the true amount of CO<sub>2</sub> they emit from the stack. Companies must be obliged to carry out an independently audited full life cycle carbon assessment for their biomass supplies over climate relevant timescales vs. an appropriate counterfactual. In the absence of that BEIS should set default values for types of feedstock, which fully account for the risks of high-carbon scenarios.

## Conclusions

Substantial questions remain over the true lifetime emissions of biomass. The risk that high-carbon wood is being burnt in UK power stations is unacceptable given the availability of genuinely low carbon alternatives. The assumption of carbon-neutrality for wood under the UK's new carbon pricing regime prolongs a tax incentive that is no longer justified on a balance of risk and climate benefits.

Policymakers and investors considering biomass generation must become familiar with the concept of 'carbon debt' - that biomass emissions released into the atmosphere today create an immediate spike that may not be sequestered by growing forest for many decades.<sup>43</sup> Given these concerns, further support for biomass generation is not guaranteed to reduce emissions, and we echo the CCC conclusion that the UK should transition away from the use of biomass for power generation without CCS.

When biomass contracts were initially agreed, biomass looked like a much better deal than it does now. In their 2005 Select Committee evidence, Drax stated that offshore wind was five times more expensive than biomass in terms of CO<sub>2</sub> abated.<sup>44</sup> The economics have now decisively shifted. The 2019 CfD auction results procured offshore wind at megawatt of power for £44 (£39.65 initial strike price),<sup>45</sup> whilst Drax's CfD currently provides a megawatt for £116.50 (£100 initial strike price).<sup>46</sup>

Applying a carbon price for burning wood closes one loophole around the emissions produced by biomass generation. Moreover, as other countries consider biomass in an effort to follow the UK's climate lead, we can send a vital signal internationally that biomass cannot be assumed to be carbon neutral.

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43. <https://onlinelibrary.wiley.com/doi/full/10.1111/gcbb.12643>

44. [House of Commons - Environmental Audit - Written Evidence](#)

45. Carbon Brief Analysis: [Record-low price for UK offshore wind cheaper than existing gas plants by 2023](#)

46. Low Carbon Contracts Company [Drax 3rd Conversion Unit \(Unit 1\)](#)



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### **Data**

A full version of the data behind the charts in this document are available to download on our website at <https://ember-climate.org/project/the-burning-question/>

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