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The Biomass Blind Spot

This paper highlights the biomass power sector's impact on climate change and its associated financial and reputational risks. We provide recommendations to support investors and banks engaging with the sector.

ShareAction»

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About the author

Report written and produced by Jo Alexander, a Chartered Geologist who spent 11 years working as an Exploration Geoscientist for BP. Jo's experience in the energy sector and her master's degree in Earth Sciences from Oxford University, gives her an in depth understanding of climate science and earth systems which she used to engage investors about the low-carbon transition. Input and guidance was received from the ShareAction research team.

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About ShareAction

ShareAction is a UK registered charity working globally to lay the tracks for responsible investment across the investment system. Its vision is a world where ordinary savers and institutional investors work together to ensure our communities and environment are safe and sustainable for all.

In particular, ShareAction encourages institutional investors to be active owners and responsible providers of financial capital to investee companies, while engaging meaningfully with the individual savers whose money they manage. Since 2005, ShareAction has ranked the largest UK asset owners and asset managers on their responsible investment performance.

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EXECUTIVE SUMMARY

This paper is designed to increase understanding of the complex issue of biomass that is derived from wood and used in the energy sector, amongst institutional investors and banks. We outline the risks to investors and why the expansion of biomass power infrastructure, and the corresponding increased demand for biomass feedstock, is damaging our prospects of achieving the goals of the Paris Agreement.[1,2] Based on our research we recommend:

- Investors and banks should not provide financial support for new biomass power infrastructure;
- Greater engagement is needed with existing biomass power operators and supply chains to adopt and enforce very strict criteria; and
- Biomass should not reduce or deflect funding away from solar or wind energy projects.

This topic has received relatively little attention from investors compared to the climate issues surrounding the generation of power from coal power stations. However, biomass urgently deserves greater attention because the climate impacts can be more significant than for coal and financing of new biomass infrastructure would lock in future carbon emissions, which must be avoided.

This paper focuses entirely on the climate impacts of biomass power, the combustion of solid biomass derived from wood to generate electricity. However, there are additional impacts on forest biodiversity, public health and community rights, which also need to be considered by investors. Preserving natural forests, and re-establishing biodiverse forest ecosystems, has a wide range of important benefits in addition to building climate resilience.

The key messages of this paper are summarised in the following pages.

“Biomass urgently deserves greater attention because the climate impacts can be more significant than for coal and financing of new biomass infrastructure would lock in future carbon emissions, which must be avoided.”

ON PAGE 10:

Flawed assumption

There is a flawed assumption that biomass is a carbon neutral fuel and a solution to climate change. Therefore carbon emissions from burning wood have been ignored by utility companies and policy makers for two reasons. Firstly, because it is incorrectly seen as a "renewable" resource. The carbon emissions from combustion are assumed to be recaptured as trees regrow. However, at the point of combustion, wood emits more CO_2 than coal.[3,4,5] It takes decades for this carbon to be reabsorbed by forest growth. Given that we urgently need to reduce greenhouse gas (GHG) emissions over the short-term to reach a net zero energy system by 2050, biomass is not compatible with achieving this. The second reason is related to international carbon accounting rules. UNFCCC's reporting guidelines require GHG emissions related to bioenergy to be counted in the land-use sector, where the tree is felled rather than at the point of combustion.[6] This is intended to avoid double counting of emissions, however, this gives permission for the importing country to ignore emissions of combustion by assuming they have already been accounted for, making carbon emissions of biomass power appear artificially low.

ON PAGE 11:

Damaging forest carbon stocks

This paper challenges the assumption that carbon is recaptured by forest regrowth, at the rates required to offset emissions from combustion. Converting natural forests into a managed or plantation forest reduces their stored carbon. In addition, the methods used to grow and harvest biomass feedstocks also have an enormous impact on how quickly forest carbon can recover. The good, the bad and the ugly impacts of forest management on carbon emissions are illustrated in Figure 2. For biomass to be a renewable, low-carbon fuel, forest regrowth must sequester carbon at the same (or greater) rate as carbon emitted from combustion.[7] Companies that supply this wood should adopt forest management practices that limit their impact on the carbon stocks of forests, and they should be challenged when they deplete these carbon stocks.

ON PAGE 8:

Industry growth

The situation in the UK is of particular concern as biomass power generation has grown rapidly, becoming an increasingly critical segment of the energy mix. Plant biomass now generates 20% of the UK's "renewable" energy.[8] The UK is now the largest global importer of wood pellets.[9] Demand is projected to rise by 50% over the next decade in the UK with an astonishing increase of 250% expected globally.[10] To meet growing demand for feedstocks, the manufacture of wood pellets has become a truly industrial process , with large volumes of international trade. Although some utility companies have introduced sustainability standards, these are difficult to monitor. This growth has been supported by subsidies and a blind acceptance that biomass is a "renewable" source of energy that contributes to CO_2 emission reductions relative to conventional fossil fuel sources.

ON PAGE 16:

Biomass hinders Paris goals

Increasing numbers of asset managers and asset owners have committed to carbon reduction targets or to aligning their investment policies and practices with the Paris Climate Agreement. This is particularly the case for CA100+ signatories. This large group of institutional investors "support the Paris Agreement and the need for the world to transition to a lower carbon economy consistent with a goal of keeping the increase in global average temperature to well below 2°C above pre-industrial levels". ShareAction's recent Asset Owners Disclosure Project (AODP) surveys of insurers and of pension funds highlighted that many large asset owners have identified increasing renewable investments as a key route to meeting the climate challenge.[11] However, it is essential that this does not include new biomass energy projects and that the carbon intensity of existing projects is substantially reduced. In addition, biomass should not divert investment from lower carbon forms of energy which are scalable solutions to climate change such as solar, wind, or energy storage.

ON PAGE 15:

Risks to investors

This paper seeks to support investors in understanding and addressing the risks of biomass power generation. There is a financial risk from the increasing probability that subsidy regimes will be altered, as the carbon reduction credentials of biomass are increasingly questioned by policy-makers and their advisors.[12] Removal of subsidies will impact profitability and asset valuations, as was seen when Spain changed their renewable subsidies, heavily impacting solar power projects.[13] There are also reputational risks from two sources. At the local level, biomass power plants often face opposition from local communities.[14] On a broader level, investors who have committed publicly to support the goals of the Paris Agreement could find that exposure to biomass investments and projects reduces their credibility on portfolio decarbonisation and in addressing climate-related financial risks.

ON PAGE 17:

Utilities & banks lagging behind

Most equity investors are exposed to biomass through their investments in utilities, who own and operate biomass power stations, and banks, who finance biomass projects in the quoted and private sector. We have compiled publicly available Energy and Forestry policies from the top 15 European banks[15] and 12 leading European utilities firms. Our research findings reveal that many utilities and banks have a long way to catch up to leaders:

- Most banks do not have a statement about the impact of biomass on the climate. One bank considers biofuels a climate solution,[16] which we suggest is an overly simple and misleading assumption. Several banks have a more sophisticated approach, acknowledging that biomass can only be considered low-carbon when extremely strict criteria are met.
- Utilities' and banks' policies often rely on compliance with international sustainability standards, such as the Forestry Stewardship Council,[17] to protect and monitor forest carbon stocks in supply chains. As our research shows, these standards do not give sufficient comfort. Either these international standards need to be strengthened or utilities' and banks' policies should better differentiate between practices within biomass supply chains.
- European utilities have a mix of approaches to biomass; some are withdrawing or reducing exposure, whereas others have large and growing portfolios of biomass power stations. Fortum Oyj is an example of a utility with many biomass power stations.[18] One of which uses peat as a fuel, destroying a valuable natural carbon stock that regenerates at the incredibly slow rate of 1 to 2 mm per year.[19] They also claim that co-firing biomass with coal reduces CO_2 emissions by up to 40%.[20] Not only is this claim misleading, because it relies on the incorrect assumption of carbon neutrality, but it is also a cause for serious concern if it is used to justify extending the life span of existing coal powered infrastructure, reversing the progress of investors and banks that have introduced robust coal policies.

Recommendations for engagement

The recommendations outlined in Tables 1 and 2 are designed to strengthen the biomass policies contained in investors' and banks' forestry and energy sector policies. If these criteria are implemented and enforced, they would rightly limit the supply of biomass and the scale of the industry.

Against each of these recommendations, we have set out a series of questions that asset managers, asset owners and banks should be asking forestry and utility companies (see page 22, "Recommendations for Engagement"). We hope that these will serve as a helpful guide for engagement and provide a framework for disclosure and improved industry practices. If disclosure is unsatisfactory and plans are not put in place to meet these criteria, within a reasonable timeframe, then we would recommend divestment or removal of financial backing.

The recommendations in Table 1 are designed to help the utilities sector reduce the climate impacts of biomass supply chains and carbon emissions from biomass operations. Most significantly, we recommend including emissions of combustion in full life cycle assessments, which goes beyond current UK and EU reporting requirements. We also recommend managing the composition of feedstocks to maximise residues and wastes, in line with a letter from almost 800 scientists to the European Parliament[21] and the opinion of the European Environment Agency Scientific Committee.[22]

Table 1: Recommendations to the utilities sector

Recommendation	Biomass power generation sustainability criteria
1. Quantify and minimise full life cycle GHG emissions	Measure and disclose the GHG intensity (gCO_2/MJ or $kgCO_2$/MWh) of your operations, including long-term loss of carbon from forests, cultivation, processing, transportation and, most significantly, combusion emissions.
	Maximise energy efficiency.
2. Manage composition of biomass feedstocks	Maximise the proportion of forest, processing or agricultural residues, see Recommendation 1 in Table 2 for more detail.
	Restrict wood harvested for the purpose of bioenergy to forests that are maintaining or increasing carbon stocks over short timescales, see Recommendation 2 in Table 2 for more detail.
3. Audit supply chains	Use Recommendations 3, 4, 5 & 6 in Table 2 and the questions in Table 6 to select and audit biomass suppliers. Even if only forest residues are being used, they should be sourced from forestry companies that are limiting their impact on the carbon stocks of forests.

The recommendations in Table 2 are designed to help the forestry sector eliminate the most carbon intensive forms of biomass feedstocks (Recommendations 1 and 2) and ensure suppliers of biomass are maximising the carbon stocks of the forests they manage (Recommendations 3, 4, 5, and 6).

It is important to acknowledge the sceptisism amongst campaigners about the effectiveness of sustainability criteria and a mistrust in the biomass industry's implementation of them. This has developed because of industry claims that feedstocks meet sustainability criteria whilst there is evidence of continued unsustainable practices, such as clear-cutting.[23]

Rather than continuing to give a 'green-light' to the industry, recommendations in Table 2 are intended to demonstrate that only very limited forms of biomass can be considered low-carbon or sustainable. If these recommendations were properly implemented and audited, forestry practices for biomass would have to change dramatically, reducing the supply of biomass and therefore the scale of the industry.

Table 2: Recommendations to the forestry sector

Recommendation	Forestry sustainability criteria
1. Biomass feedstocks, in the form of residues and waste, should be carefully sourced	Restrict the sourcing of forest residues (composed of tree tops and limbs) to those forests where the above- and below-ground carbon is being maintained or increased and meet the exclusion criteria in Recomendations 3, 4, 5 & 6 below.
	Ensure that the demand for residues and waste does not artificially increase its production; it should first be reduced, reused or recycled, rather than combusted, where possible.
2. Harvested biomass feed-stocks should be carefully sourced	Restrict wood harvested for the purpose of bioenergy to forests that can demonstrate increasing above- and below-ground carbon stocks, as shown in 'The Good' model in Figure 2.
	• afforested land that is not suitable for other purposes (which therefore does not compete with food production or use by local communities).
	• existing managed or plantation forests that are maintaining or increasing above- and below-ground carbon stocks and harvests never exceed the forest's the sustainable yield capacity.
	Exclude harvesting of slow growing tree species (≤2 m3/ha/yr), particularly hard woods such as oak.
3. Suppliers should maximise carbon stocks of managed forests	Exclude harvesting from natural forests. This includes wetlands and peatlands; the carbon stocks of these vulnerable ecosystems are high and should be protected.
	Exclude conversion of natural ecosystems (forests, grasslands or wetlands) into managed or plantation forests.
4. Suppliers should exclude clear-cutting	Exclude clear-cutting in any type of forest (natural, managed or plantation).
5. Suppliers should take a cautious approach to thin-ning	Exclude large whole tree stems sourced from thinning, except for trees that are diseased and their removal will benefit the rest of the forest.
	Restrict thinnings to small or early thinnings that are removed for he purpose of improving the quality of growing stock, whilst minimising disturbance of litter and soil carbon.
6. Suppliers should maximise the proportion of harvests used in long-lived products	Maximise wood used in long lived material wood products, such as those used in construction and minimise the volume of forest residues used for bioenergy.
	Exclude dedicated harvests used for bioenergy.
	Exclude additional harvesting of wood to meet demand for bioenergy that would not have otherwise been harvested.

BACKGROUND

This section describes the rapid recent growth of biomass power generation and its prospects for further growth, highlighting the leading positions of the EU and the UK, and the role that public policy has played in promoting this growth.

The scope, assumptions, and debate

The term "biomass" in the context of the energy industry covers a number of potential fuel sources. The scope of this document is to review a specific type of bioenergy: the combustion or gasification of solid biomass derived from wood, often referred to as "woody biomass," to generate electricity and heat. The wood feedstock to these processes may either be virgin wood, residues from forestry activities or processing residues.

Burning biomass derived from forests or forest products to generate electricity and heat is seen by its supporters as a credible alternative to fossil fuels in the effort to avert climate change and the UK and EU have supported it with renewable subsidies.[24, 25, 26] Drax, the single largest user of biomass for power in the world, describes itself as "playing a vital role in helping change the way energy is generated, supplied and used as the UK moves to a low-carbon future."[27] However, the environmental benefits of biomass have been widely questioned by think tanks such as Chatham House,[3] as well as civil society groups and activists.[28,29,30] With such divided opinion, it can be difficult for investors to know if woody biomass is part of the solution to decarbonise the power sector and the broader energy system or is exacerbating the problem.

In reality, the climate impact of burning biomass is most often negative, and the degree of impact depends on the quantity and type of biomass feedstock combusted and the rate that this carbon can be sequestered through forest regrowth. Burning large volumes of biomass for power generation combined with unsustainable forest management is associated with very high net CO_2 emissions (see p11 and Figure 2). This assessment is supported by a recent report by the UK's Climate Change Committee, which warns that without improved governance, 'there are risks that biomass production and use could in some circumstances be worse for the climate than using fossil fuels.'[12]

120 organisations, including foundations, civil society and non-governmental organisations, have supported a position statement saying that they do not see a place for biomass in large-scale energy production at all: 'We believe that we must move beyond burning forest biomass to effectively address climate change. We call on governments, financiers, companies and civil society to avoid expansion of the forest biomass based energy industry and move away from its use. Subsidies for forest biomass energy must be eliminated. Protecting and restoring the world's forests is a climate change solution, burning them is not.'[30]

Rapid growth

Global biomass power generation has more than doubled, from around 220 TWh in 2005 to 555 TWh in 2017.[31] Europe in particular has seen rapid growth, making up one third of the world's biomass-fired electricity generation. In 2017, 29.4% of the UK's electricity generation was from renewable[i,ii] sources with 20% of this generated from the combustion of plant biomass (see below for definitions).[8]

Public policies have been the driving force behind the growth of the industry by incentivizing biomass power. The main phase of growth in biomass power in the EU and the UK's was between 2012 and 2015 linked to member state and EU policies such as the EU's Renewable Energy Directive (2009),[24] the UK Government's Climate Change Act (2008)[32] and Bioenergy Strategy (2012).[33] This resulted in new subsidy support for dedicated biomass power stations and coal to biomass conversions. In the UK this was initially provided through the Renewable Obligation Order,[24] which has now been replaced by Contracts for Difference.[25]

As the UK's biomass power generation has grown and demand for biomass has risen, feedstocks have become more carbon intensive. In 2007 over half of the UK's "renewable" energy was generated from waste[iii] but by 2016 the sector became dominated by virgin biomass,[iv] largely in the form of imported wood pellets.[33, 34, 35, 36] The UK is now the largest importer of wood pellets in the world, accounting for 40% of the global total (almost 7 million tonnes in 2017).[9] In fact, only 4 countries make up 70% of global imports. In addition to the UK, 12% of wood pellets are imported to Denmark, 11% to Italy and 6% to Belgium; highlighting that this is an issue for the EU as well as the UK.

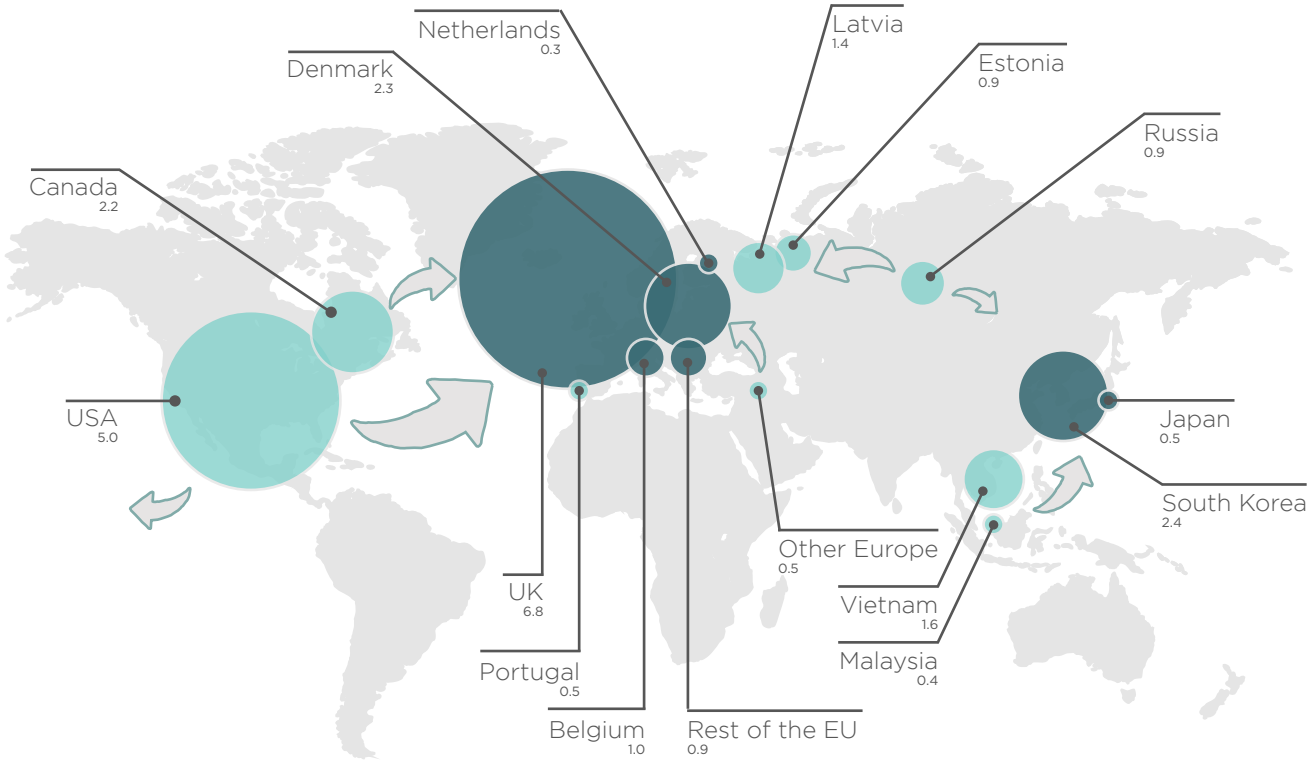
Analysis by the Environmental Paper Network predicts a 250% increase in the international trade of industrial wood pellets over the coming decade.[10] The UK is expected to maintain its leading position; substantial growth in biomass power capacity is expected if both Lynmouth Power Station and Tees Renewable Energy Plant become operational.[38] In 2027, the volume of pellets imported to the UK will be closely followed by South Korea and Japan. These rapidly expanding markets will pose a new threat to forests in Russia and South East Asia.

Figure 1: A Global Threat Map of Biomass Energy Development (on page 9)

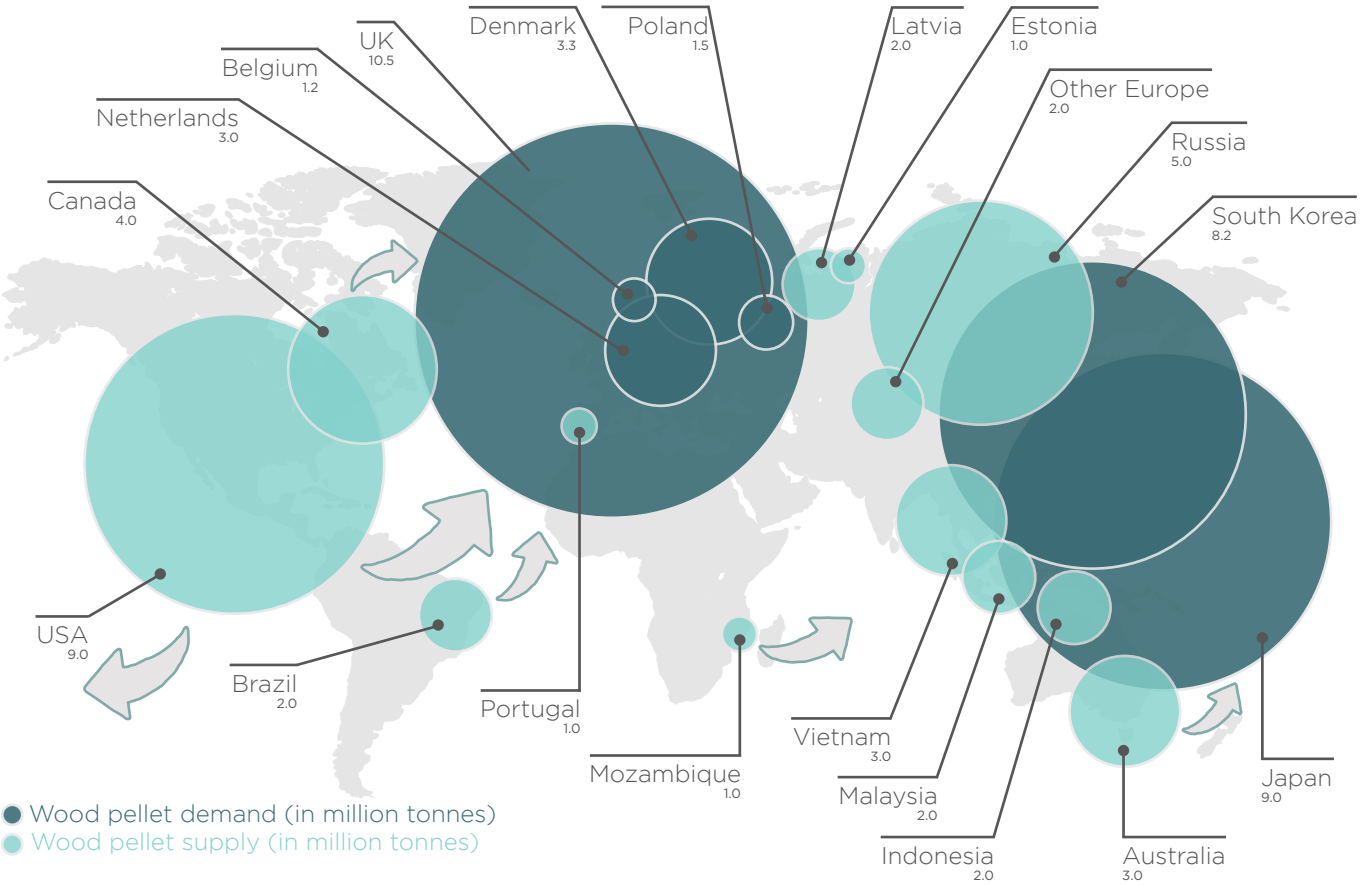
Research by the Environmental Paper Network shows that demand for industrial wood pellets exceeded 14 million tonnes in 2017. In the next decade, it is expected to more than double to over 36 million tonnes.[10]

i | Renewable sources of energy include onshore and offshore wind, shoreline wave and tidal, solar photovoltaics, hydro, landfill gas, sewage sludge digestion, energy from waste, co-firing with fossil fuels, animal biomass, anaerobic digestion and plant biomass, according to "Energy Trends" published by the UK government Department for Business, Energy and Industrial Strategy and National Statistics.[8]
ii | IPCC definition of renewable energy: any form of energy from solar, geophysical or biological sources that is replenished by natural processes at a rate that equals or exceeds its rate of use.[81]
iii | Waste includes waste wood, animal biomass and anaerobic digestion, sewage gas, landfill gas, and waste.[36]
iv | Virgin biomass includes wood used for heating and plant biomass (includes wood pellets and energy crops).[36]

Demand and Supply of Industrial Wood Pellets in 2017



Demand and Supply of Industrial Wood Pellets in 2027



CHALLENGING ASSUMPTIONS

This section explains the flawed carbon accounting behind the assumption that biomass is a carbon neutral energy source. It also demonstrates the importance of properly quantifying life cycle assessments of carbon emissions from biomass feedstocks.

Flawed carbon accounting

Drax states that the company 'saved around 86% of CO_2 emissions compared to the coal benchmark'[39] in 2016-17. We understand this calculation ignores emissions from biomass combustion and long-term loss of forest carbon stocks. Such claims about the carbon neutrality of biomass as a fuel and the resulting reduction in emissions compared to fossil fuels are therefore very misleading. This has emerged for the following two reasons.

The first is based on the fact that biomass can be regenerated leading to an assumption that the CO_2 released during combustion can be recaptured as trees and forests regrow. However, this oversimplifies a complex issue and does not take into account the time dimension. At the point of combustion wood emits more CO_2 than coal, although the quantity varies substantially. Data from Drax's 2017 annual report shows that emissions rates for wood pellets are 3% higher than coal.[5] According to IPCC data, wood emits 17% more CO_2 than bituminous coal, the most common type of coal used in electricity generation in the US, and twice the emission of natural gas.[4] The net carbon emissions then decrease over time as the carbon stock of the forest regrows, however this takes decades and not all carbon can be permanently recaptured if the forest is repeatedly harvested (as shown in Figure 2).

The second reason given for carbon neutrality relates to flaws in international carbon accounting, explained by Searchinger, T. D. et al, (October 2009).[40] UNFCCC's reporting guidelines require GHG emissions related to bioenergy to be counted in the land-use sector, in the location where the tree is felled rather than at the point of combustion.[6] This is intended to avoid double counting of emissions. In practice it gives permission for the importing country to ignore emissions of combustion by assuming they have already been accounted for, whether they have or not. As a result, carbon emissions of biomass power appear artificially low. This allows imported biomass to contribute to that country's GHG emission reduction and renewable energy targets, such as those set out by the EU's Renewable Energy Directive.[24]

This flawed assumption has led to underestimates of the full life cycle emissions related to biomass power generation, not only by Drax but also by the EU Renewable Energy Directive's methodology,[41] which omits the emissions from biomass combustion. Stephenson, A. L. and MacKay, D. J. C., (July 2014) developed an improved and comprehensive 'Biomass Emissions and Counterfactual' model of GHG emissions from biomass that fully accounts for the changes in the carbon stock of forests, emissions related to cultivation, processing, transportation and emissions from biomass combustion for electricity generation.[7] By accounting for all carbon emissions, Stephenson and MacKay demonstrate that, at the worst extreme, the GHG intensity of biomass sourced from natural timberland can be as much as 4 times that of coal over a 40-year period (4000 $kgCO_2$/MWh).

Quantifying forest carbon

Carbon emissions resulting from the reduction of carbon stored in forests are substantial and are therefore particularly important to quantify. Evaluating the impact of commercial forestry on forest carbon stocks requires assessments of both the above- and below-ground carbon over time, as illustrated in Figure 2 (The Carbon Impact of Forestry: The Good, The Bad & The Ugly). For biomass to be considered a low-carbon, renewable resource, carbon must be sequestered by forest regrowth at the same (or greater) rate as carbon is emitted from biomass combustion. Therefore, in order to offset emissions, the average carbon stocks of forests from which biomass is sourced need to be maintained or increase over short timescales, as shown in 'The Good' model. This can be achieved by restricting harvests to small volumes of wood and allowing the forest to recover before the next harvest. Carbon emissions can also be reduced by minimising the proportion of the harvest used for bioenergy and maximising the proportion used in long lived wood products.

In contrast 'The Bad' and 'The Ugly' models show the damage to average carbon stocks when natural forests are converted to managed forests and harvested for biomass. These models challenge the idea that carbon can be permanently recaptured if forests are repeatedly harvested by clear-cutting. Biomass should not be sourced from forests managed in this way.

'The Bad' model shows the minimum impact of clear-cutting; the forest carbon is given time to fully recover and there is no impact on soil carbon. In this scenario, the long-term average carbon stored in the managed forest is 100 tonnes of carbon per hectare (tC/ha) less than the natural forest that it replaced. The exact quantity of carbon loss will vary depending on the volume of wood harvested, the rate of regrowth and frequency of clear-cutting.

'The Ugly' model shows how damaging clear cutting can be; harvesting at a higher frequency doesn't allow forest carbon to recover and soil carbon is depleted through removal of all forest residues. In this scenario, the long-term average carbon stored in the managed forest is 250 tC/ha less than the natural forest it replaced. However the loss of forest carbon increases to 370 tC/ha if we assume that the natural forest would have continued to sequester carbon at a modest rate of 1 tC/ha each year.

These models form the basis of our recommendations to the forestry sector in Table 2.

Academic and industry research was drawn on to quantify the forest carbon shown in Figure 2; these can be broadly grouped into baseline estimates of forests' carbon stocks and how these are impacted by commercial forestry:

Baseline estimates of natural forests' and soils' carbon stocks

- **Above-ground carbon stocks** of most natural forests may range between 100 and 500 tC/ha,[41] with tropical, sub-tropical and boreal forests being particularly rich in carbon. Conventional wisdom has been that mature forests reach equilibrium, balancing carbon absorbed and emitted (as illustrated by the net carbon emissions coloured in yellow in 'The Bad' model). However, Luysseart et al. (2008) demonstrate that ancient forests can continue to absorb carbon at a rate of about 2 to 5 tC/ha each year (as illustrated by the net carbon emissions coloured in yellow in 'The Ugly' model).[43]
- **Below-ground carbon:** Although estimates of soil carbon stocks are much more limited, it is clear that some soils are much richer in carbon than others. For example, the soils in the woodlands of Scotland are particularly carbon rich (580 tC/ha), more the double those in England, because they grow on carbon rich moorland.[44]

Impact of commercial forest management practices on carbon stocks

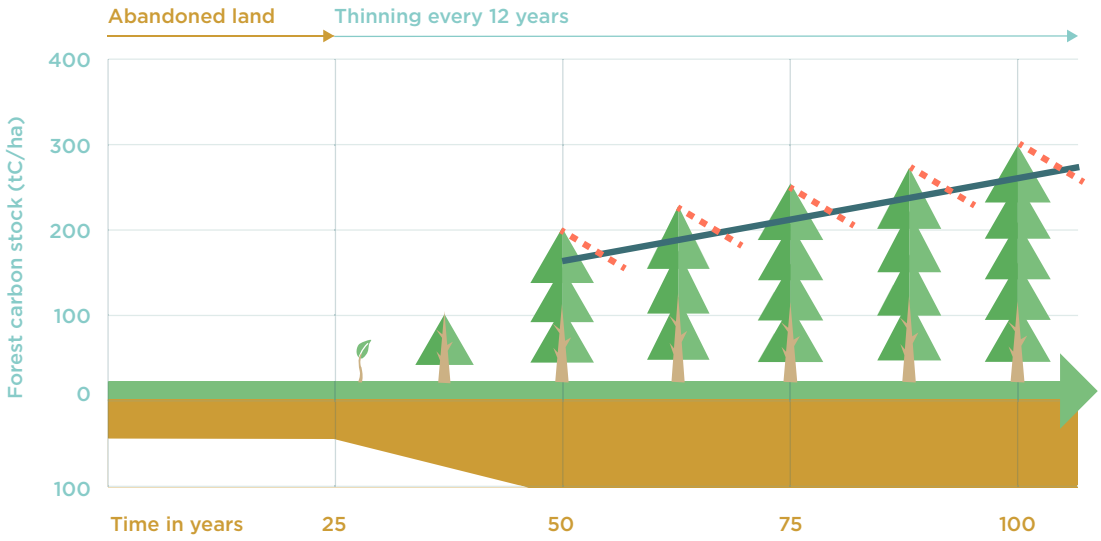
- **Above-ground carbon:** As the intensity of forest management increases, the above-ground carbon stocks decrease.[45, 46] This may be the result of replacing low impact thinning with clear cutting, increased frequency of harvests or modifying the mix of tree species to favour faster growing soft wood.
- **Below-ground carbon:** Land-use conversion, for example from woodland to arable land or pasture, has a detrimental impact on below-soil carbon. There is widespread research to show that removing forest residues will also reduce soil carbon.[3, 12]

Figure 2: The Carbon Impact of Forestry: The Good, The Bad and The Ugly (page 13)

Three models that show the impact of forestry on above- and below-ground carbon stocks.

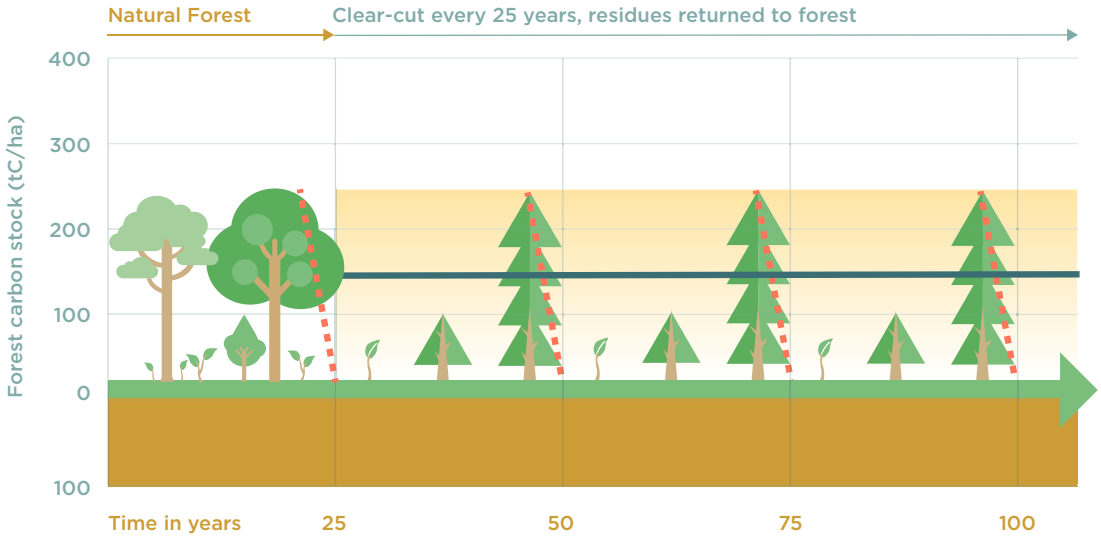
Average Carbon Stocks
+240
tC/ha

THE GOOD
Afforestation scenario



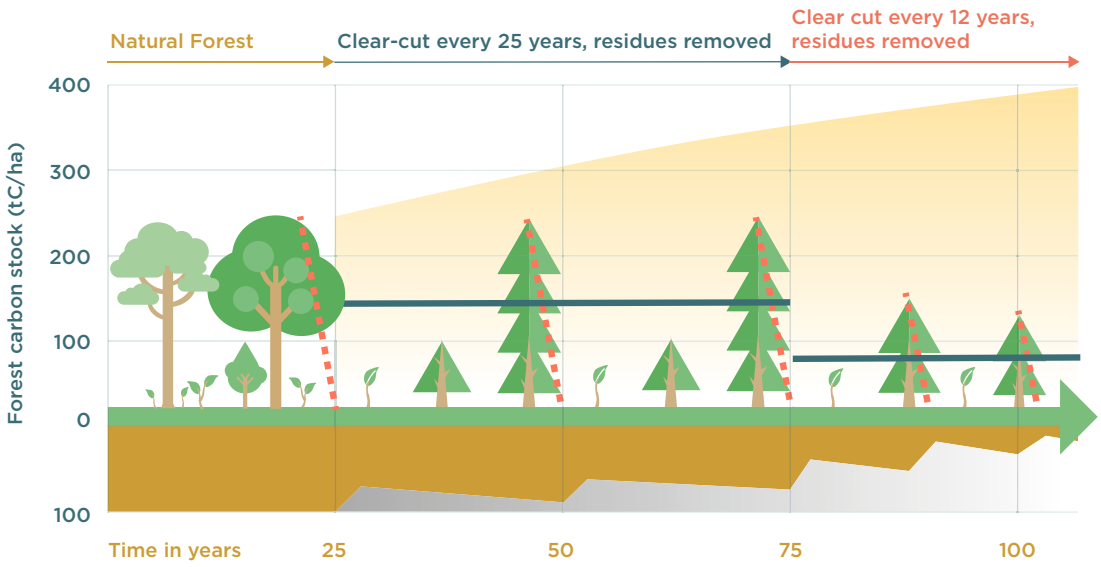
Average Carbon Stocks
-100
tC/ha

THE BAD
Clear cutting scenario



Average Carbon Stocks
-370
tC/ha

THE UGLY
Frequent clear cutting scenario



net carbon emission
below ground carbon
average carbon stock of managed forest
harvest
above ground carbon

> Currently, we do not have the level of disclosure that is necessary to assess the carbon intensity of biomass feedstocks.

Carbon intensity of feedstock is uncertain

Currently, we do not have the level of disclosure that is necessary to assess the carbon intensity of biomass feedstocks. To do this properly we require comprehensive life cycle assessments which include emissions from combustion[7] and to understand the proportion of commercial forestry that falls into each of the three models illustrated in Figure 2 by quantifying of the above- and below-ground carbon stocks. However undertaking these assessments is currently a challenge in practice because utilities and forestry companies do not have the necessary technical expertise. We strongly suggest investors demand this type of quantitative information and require due diligence to be undertaken, stronger governance processes and verification from independent auditors.

In the absence of such quantitative assessments we recommend that feedstocks be composed of the following:

- Processing residues from sawmills and paper mills, as well as agricultural residues, especially those that would have otherwise been incinerated or decomposed in landfill.
- Forest residues sourced only from companies that minimise their impact on the long-term carbon stocks of forests under their management (see Table 2, Recommendations 1, 3, 4, 5 & 6).
- Harvested wood used for biomass power generation should be minimised and sourced only from forests whose carbon stocks are increasing (see Table 2, Recommendation 2).

The increasing scale and globalisation of the biomass supply chain has inevitably made it difficult for operators to adhere to sustainability criteria outlined at the planning and approval stage. This is particularly true where operators lack control or visibility through their supply chain or where they acquire feedstock through traders whose sources are difficult to verify. Operators in the UK are required to provide an audited sustainability report to the regulator, Ofgem, aligned with the Renewables Obligation sustainability criteria,[24] however there is little guidance about the metrics that they should be reporting on. We suggest that the recommendations, in Tables 1 and 2 at the beginning of this report, provide a framework for a comparable set of metrics and targets.

THE IMPLICATION FOR INVESTORS

This section discusses the risks of investing in biomass. It also highlights the problem that biomass poses in aligning investment portfolios with the goals of the Paris Agreement.

Most well diversified asset owners or asset managers have exposure to biomass power plant operators through their holdings in utility companies and banks. An increasing number of dedicated "renewable" funds may also have exposure to biomass in the private or public markets. Here we explore the risks associated with the sector.

Financial risk

In the UK, legislation and public policies have created a business model for biomass power generation. The 2017 Drax Annual report and accounts[5] outlined the material level of subsidy received: £481 million from Renewable Obligation Certificates (ROCs)[25] and £248 million from Contracts for Difference (CfD).[26] This was a substantial increase in total subsidies compared to the previous calendar year, when Drax received £536 million from ROCs and £10 million from CfD.

As the green credentials of biomass power are increasingly being questioned, UK government policy is changing to make qualification for subsidies more challenging. Biomass power plants commissioned between April 2021 and March 2026 will need to limit 'lifecycle' CO_2 emissions to 29 kg CO_2 /MWh, an 85.5% reduction compared to the previous requirement.[47] There is growing likelihood that subsidies will be removed entirely. In November 2018, the UK's Committee on Climate Change recommended that the UK Government 'do not provide further policy support (beyond current commitments) to large-scale biomass power plants that are not deployed with CCS technology.'[12] These are strong signals that subsidy support is likely to be removed, thereby increasing financing costs and lowering returns. This will impact the competitiveness of biomass power generation projects, particularly now that solar and wind power have reached grid parity in many countries.[48]

> "The UK's Committee on Climate Change recommended that the UK Government 'do not provide further policy support [...] to large-scale biomass power plants that are not deployed with CCS technology."

Reputational risk

Reputational risks come from two sources. At the local level, parties providing finance to or investing in biomass power projects are likely to become embroiled in local disputes. For example, Grangemouth biomass power station was opposed by local councils due to a variety of concerns over air quality, sustainability, visual amenity, fisheries and water pollution.[14]

On a broader level, investors who have committed publicly to support the goals of the Paris Agreement can expect to find that exposure to biomass projects reduces their credibility on portfolio decarbonisation and in addressing climate-related risks. Increasing numbers of institutional investors have committed to support the objectives of the Paris Climate Agreement. ShareAction's recent AODP surveys[11] on the global insurance and pension fund sectors highlighted that a growing number of these investors are increasing asset allocation to renewable energy projects as a means to address climate-related financial risks. However, this research finds that large-scale biomass power generation should not be included in these investments, nor should it divert investment from lower carbon forms of energy such as solar and wind, or energy storage.

Some utility companies such as Fortum Oyj have added biomass to the fuel mix of their power plants; they claim that co-firing biomass with coal reduces CO_2 emissions by up to 40%.[20] This claim is misleading because it relies on an incorrect assumption and a cause for serious concern if it is used to justify extending the life span of existing coal powered infrastructure, reversing the progress of investors' and banks' that have introduced robust coal policies.

Even green bonds require careful due diligence to ensure they genuinely meet their own stated objectives regarding meeting the Paris goals and GHG emission reduction objectives (see page 20).[49, 50]

Our assessment of investor policies on biomass indicate that many investors are not yet fully aware of nor managing the financial and reputational risks posed by biomass projects.

CURRENT POLICIES: BANKS, INVESTORS, UTILITIES, & INTERNATIONAL STANDARDS

This section summarises and compares references to biomass contained in the publicly available energy and forestry policies, of the top 15 European banks and the largest investors. We review the approach of organisations setting relevant international sustainability standards and the importance of biomass in the portfolios of the 12 largest European utility companies.

Our analysis of biomass relevant policies show that most do not go far enough in limiting combustion emissions and protecting the carbon stocks of forests. We make recommendations to strengthen these policies in Tables 1 and 2, at the beginning of this report.

European banks' biomass and energy policies

Nine out of the fifteen European banks[15] we reviewed make no explicit mention of biomass in their publicly available energy policies. Of the six banks that do refer to bioenergy, only one views biofuels as a climate change solution[16] whilst the other five take a more nuanced approach by classifying biomass as restricted activity.

Table 3: European Banks' Biomass and Energy Policies[17, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62]

European Bank	Biomass and Energy Policies		ShareAction comment
Lloyds Banking Group, RBS, Santander, Societe Generale, Barclays	Biomass is considered a restricted activity; sustainability is assessed against the bank's criteria		We believe this to be a sensible position to take, as long as the criteria used to assess sustainability of feedstocks are comprehensive, as outlined in our recommendations detailed in Tables 1 and 2.
UBS, Deutsche Bank, Credit Suisse Group, Credit Agricole, Standard Chartered, ING, HSBC Holdings, BNP Paribas, UniCredit	Biomass is not mentioned in the banks' energy or power sector policy		We suggest that biomass be added to the banks' energy or power sector policy as a restricted activity, with sustainability assessed against comprehensive criteria, as outlined in our recommendations detailed in Tables 1 and 2.
BBVA	Biofuels are considered a solution to climate change'		We believe that this position is problematic because it over simplifies a complex issue; instead biomass, as a type of biofuel, can only be low-carbon if strict sustainability criteria are met.

All of the 15 European banks that we reviewed had public information available on their forestry policies. All information on banks in this section was sourced in November and December 2018. Table 4 provides an overview of these policy approaches:

Table 4: European Banks' Forestry Policies

	Approach / exclusions	Number of banks	UBS	RBS	Deutsche Bank	Credit Suisse Group	BBVA	Credit Agricole	Santander	Standard Chartered	Societe Generale	ING	Barclays	Lloyds Banking Group	HSBC Holdings	BNP Paribas	UniCredit
ALL BIOMASS RELEVANT POLICIES (across Energy and Forestry)	Describe the link between forest carbon stocks and climate change impact	5	●	●	○	●	○	●	○	○	○	○	●	○	○	○	○
	Biomass is a restricted activity, only supported if sustainability criteria are met	5	○	●	○	○	○	○	●	○	●	○	●	●	○	○	○
	Policies that cover 'high-risk' sectors, including Energy and Forestry, are applied to all investments rather than just 'green' investments/products	8	●	●	●	●	○	●	●	○	○	●	○	○	●	○	○
FORESTRY POLICIES	Expect compliance with international sustainability criteria (FSC and PEFC)	7	●	○	●	●	●	●	○	○	●	○	○	●	○	○	○
	Endorse the BEI Soft Commodities Compact, which requires zero deforestation by 2020	6	●	●	○	○	○	○	●	○	●	○	○	●	○	●	○
	Exclude illegal logging	7	●	●	●	○	●	●	○	○	○	●	○	○	●	○	○
	Exclude biomass sourced from environments that should be protected as rich above ground carbon stocks: primary forest and HCV forest	8	●	○	●	●	●	●	●	●	○	●	○	○	○	○	○
	Exclude biomass sourced from environments that should be protected as rich above below ground carbon stocks: peatland	2	○	●	○	○	○	○	●	○	○	○	○	○	○	○	○
	Exclude forestry that depletes soil carbon	2	○	○	●	○	○	○	○	○	●	○	○	○	○	○	○

We recommend that commercial banks adopt all policies shown in Table 4 as a minimum and that their biomass policies refer to, and are consistent with, their forestry policy. UBS and RBS have the most comprehensive list of exclusions and highlighted areas of concern.[63, 64] We find that:

- Most banks (11 out of 15) expect compliance with international forestry standards, most commonly through the Forest Stewardship Council (FSC)[17] or the Programme for the Endorsement of Forest Certification (PEFC).[65] Neither FSC nor PEFC is robust enough to protect the carbon stocks of forests (see page 20) and therefore should not be used in isolation.
- Policies often include a geographic restriction that limits their application. These restrictions should be removed.
- Only four banks have policies which protect below-ground carbon, such as soils and peatlands. This is a particular weakness in a range of banks' policies.

Investors' biomass policies

We also reviewed 10 of the largest European and 10 of the largest US asset managers' public documents in November 2018. We found it extremely difficult to identify any policies regarding biomass. Although many stated a position on climate change, only two - AXA Investment Management and Insight Investment - specifically mention biomass:

- AXA Investment Managers has eligibility criteria for a range of green investments. Biomass and biogas power are only eligible for investment if net emission reductions can be demonstrated with no deforestation.[66]
- Insight Investment raises concerns about biomass. 'While offshore wind projects have a beneficial impact on carbon reduction... conversion of central power stations to biomass is more questionable. Burning wood pellets releases a material amount of CO_2 and could accelerate deforestation if the technology is adopted on a large scale.'[67]

We commend these two asset managers for their policies on biomass.

International Sustainability Standards

Ideally, international sustainability standards would require the quantification of the both emissions from biomass combustion, for inclusion in life cycle assessment, and its impact on the carbon stocks of forests. However, this is not currently industry practice and therefore it is seen as difficult to introduce. Without requiring the industry to substantially improve carbon accounting practices, international sustainability standards do not currently go far enough in limiting the climate impacts of biomass power generation. The Climate Bonds Initiative bioenergy criteria[48] are currently being reviewed following public consultation which asked for them to be strengthened with regards to limiting the climate impact of biomass.

Banks policies and the Climate Bonds Initiative forestry criteria[50] refer to, and rely heavily on the FSC[17] or the PEFC[65] standards. These forestry criteria alone are not enough to protect the carbon stocks of forests harvested for biomass and require additional bioenergy criteria to strengthen them. We reviewed the FSC's 10 Principles and Criteria for Forest Stewardship and identified only five statements that protect forest carbon stocks. Again, we found that they are not quantitative, which is a major concern:

- Principle 5.2: The Organisation shall harvest at or below a level which can be permanently sustained.
- Principle 6: The Organisation shall maintain, conserve and/or restore ecosystem services (which includes the sequestration and storage of carbon).
- Principle 6.9: The Organisation shall not convert natural forest into plantations.
- Principle 9.1: The Organisation shall assess and record the presence of High Conservation Value (HCV) forest, including those that control erosion of vulnerable soils and slopes.
- Principle 10.1: The Organisation shall regenerate vegetation cover in a timely fashion.

As well as these criteria being weak, compliance with these standards is frequently limited. In 2015, only 12% of the wood that Enviva, the world's largest wood pellet producer, received was certified at the forest management level through standards such as the FSC, Sustainable Forestry Initiative (SFI) or the American Tree Farm System (ATFS).[68]

Utilities' biomass portfolios

We reviewed the public information available of the 10 largest European utility companies with the objective of understanding the importance of biomass in their portfolios. All information on utilities in this section was sourced in November 2018. This revealed a range of strategic approaches.

Utility companies that have significant exposure to biomass include Fortum Oyj, Engie, EDF and Drax.

- **Fortum Oyj** operates 23 Combined Heat and Power (CHP) plants, 12 of which co-fire biomass and coal. Fortum Oyj states that this reduces the CO_2 emissions of its power plans by 40% based on the assumption that biomass is a carbon neutral fuel.[20] The company is increasing its biomass power generation by redeveloping a further two plants to use biomass. One of their power stations burns peat as a fuel. Peat is a valuable natural carbon stock that takes around 100 years to reform.[19]
- **Engie** operates over 50 biomass facilities across Europe, the USA and Brazil, using more than 2 million metric tons of organic material every year to generate energy.[69]
- **EDF** operates 500MW of biomass worldwide and their subsidiary Dalkia is France's leading operator of wood fired power plants.[70]
- **Drax** operates the largest biomass fired power station in the UK with a capacity of 1935MW from its biomass generating units.[71] Drax consumed 6.8 million tonnes of wood pellets in 2017 mainly sourced from the US and Canada. According to Drax, its feedstock in 2017 was composed of 40% sawmill residues, 24% low-grade roundwood, 18% thinnings, and 17% forest residues.[5] Drax has announced that it will pilot the first European bioenergy carbon capture and storage (BECCS) project. The company claims this development would make its power station carbon negative, however this is a misleading claim as Drax continue to treat biomass as a carbon neutral fuel.

The degree of negative climate impact of biomass power generation is difficult to assess without a detailed understanding of sources of biomass used in these power plants and full life cycle GHG emissions calculations. However, co-firing biomass with coal is certain to have amongst the worst climate impact as it extends the life of coal-fired power stations.

Utility companies that have reduced exposure to biomass include RWE, Enel and Iberdrola.

- **RWE** no longer sees biomass as a core technology, and it is not listed as part of future innovations citing that the 'main challenges are access to feedstock which accounts for 25-40% of production costs' and that 'feedstock sustainability criteria become increasingly important.'[72]
- **Enel** took a strategic decision to sell its entire portfolio of Italian biomass plants during 2018 (108MW installed capacity across 5 assets).[73]
- **Iberdrola** has sold all biomass assets from its UK operations (2018). Iberdrola's remaining UK assets generate electricity entirely from wind.[74]

RECOMMENDATIONS FOR ENGAGEMENT

This section proposes questions for investors and banks to ask the utilities and forestry sectors against the criteria in Tables 1 and 2. Disclosure against these criteria should inform engagement strategies and divestment decisions.

The emerging biomass energy sector should have a far greater level of focus and engagement among investors, due to its impact on and contribution to climate change. The Ceres database of shareholder resolutions reveals that there were 33 resolutions related to deforestation and rainforest impacts (from 2009 to 2018),[75] however, none of these resolutions mention biomass harvested for energy.

We hope that our recommendations and associated questions, listed in Tables 5 and 6 below, will support investors and banks in their engagement with the forestry and utilities sectors, regarding eliminating carbon intensive and environmentally damaging biomass from their portfolios and reducing associated risks. Many require a quantitative answer and are designed to establish comparable metrics. We suggest investors and banks ask theses questions, to forestry and utility companies. Investors, as shareholders in banks, should also make sure that banks ask their clients these questions. If disclosure is unsatisfactory and plans are not put in place to meet these criteria within a reasonable timeframe, then we would recommend escalation strategies including divestment.

Table 5: Engagement questions for the utilities sector

These questions are related to the recommendation in Table 1.

Recommendation	Questions for the utilities sector
1. Quantify and minimise full life cycle GHG emissions	What are the GHG emissions (gCO_2/MJ or $kgCO_2$/MWh) related to each part of your operation: • long-term loss of carbon from forests? • cultivation and harvesting? • processing (drying, pelleting or chipping)? • transportation (by ship, rail and truck)? • stack emissions at the point of combusion?
	What is the energy efficiency of each of your biomass power stations? How do you plan to improve this?
2. Manage composition of biomass feedstocks	What proportion of your feedstocks are: • sourced from forest, processing or agricultural residues? • harvested for the purpose of bioenergy? Can you trace the supplied wood to the forest? Are the carbon stocks of that forest increasing over time?
3. Audit supply chains	See questions in Table 6.

Table 6: Engagement questions for the forestry sector

These questions are related to the recommendation in Table 2. These should be straightforward for the forestry sector to answer, and should be supported by evidence and independently verified.. Utility companies should also be expected to provide this information through their supply chain audits.

Recommendation	Forestry sustainability criteria
1. Biomass feedstocks, in the form of residues and waste, should be carefully sourced	What proportion of the wood you harvest becomes forest residues?
	How do you minimise the proportion forest residues that are made up of whole trees?
	What proportion of forest residues are returned to the forest floor, to maintain soil health and carbon?
	How do you ensure that the demand for residues and waste does not artificially increase its production?
2. Harvested biomass feedstocks should be carefully sourced	How do you quantify the above- and below- ground carbon stocks of managed forests and can you demonstrate that they are maintained or increased over time?
	Are your assessments of carbon stocks verified through independent, third party assessments?
	What proportion of your managed forest is afforested 'abandoned' land and how do you maximise this?
3. Suppliers should maximise carbon stocks of managed forests	Have you elimiated harvesting from natural, primary forests and elimated their converstion into plantation forests?
	Do you allow the forest carbon to recover following a harvest?
	* What proportion of the forest carbon is removed during each harvest?
	* How long does it take for forest carbon to regrow and cover?
	* How frequently do you harvest?
4. Suppliers should exclude clear-cutting	Is any of the wood you harvest from clear-cutting?
5. Suppliers should take a cautious approach to thinning	What proportion of the wood you harvest are thinnings?
	What are your criteria for the type and number of trees that are removed by thinning, such as a maximum tree diameter or limit to the proportion of a forest stand removed by thinning?
6. Suppliers should maximise the proportion of harvests used in long-lived products	What proportion of the wood you harvest is used for long-lived products and bioenergy?
	How do you plan to minimise the proportion of a harvest used for bioenergy, whilst maximising the proportion used in long-lived material wood products?

CONCLUSIONS

The carbon storage capacity of forests is of enormous importance to the mitigation of and adaption to climate change. The UNFCCC has estimated that globally, an additional $14billion (US) in financial flows will be required to address climate impacts in agriculture, forestry and fisheries in 2030.[76] Through deforestation and large-scale energy production that relies on biomass, we are trading our long-term climate resilience for a short-term financial gain. Currently, forests have more economic value when they are harvested, rather than left standing, because our economic system does not value forests' important role in carbon sequestration and climate mitigation.[77]

Demand for wood as a feedstock to biomass power generation has increased in the UK. This has resulted in increasing reliance on imports of wood pellets[10] and feedstocks becoming more carbon intensive.[36] The most carbon intensive feedstocks are whole trees clear-cut from natural forests, a practice that should be eliminated entirely. Feedstocks from harvested wood should be restricted to thinnings, from recently afforested areas or existing managed forests whose overall carbon stocks are maintained or increasing over short timescales. The least carbon intensive feedstocks are forest residues, processing or agricultural waste that would have otherwise been incinerated or decomposed in landfill. The proportion of waste used as feedstocks to biomass power generation should be maximised but should not be scaled up to meet growing demand. Instead the scale of the biomass industry should be limited by the supply of suitable and sustainable waste and residues.

We recommend that investors and banks no longer provide finance to new biomass infrastructure. We also agree with the recent recommendation by the Committee on Climate Change that the UK Government should no longer provide policy support to large-scale biomass, as this support was based on the flawed assumption that biomass is carbon neutral.

We recommend greater engagement with existing biomass operators and supply chains to adopt and enforce very strict sustainability criteria. However, we currently do not have the level of disclosure and regulation that is necessary to assess the climate impacts of the forestry and biomass power sectors. Biomass that meets the strictest sustainability criteria, could have a small part to play in the transition to a lower-carbon economy. However, it is not a long-term solution, nor should it divert investment from more sustainable, lower carbon forms of energy such as solar and wind, or energy storage which will enable us to increase our reliance on these.

Rigorous scrutiny of the risks and impacts of biomass power generation are urgently needed. We urge investors and banks to reduce exposure to the risks associated with large-scale biomass power generation. We believe this is in line with and reflects investors support of the Paris Agreement

GLOSSARY

Bioenergy: conversion of solid, liquid and gaseous biomass feedstocks, using several different processes, into energy in the form of heat, electricity, liquid biofuels or biogas.

Biofuel: liquid fuel produced from plant- or animal-derived material.[78]

Biomass: is any organic matter, i.e. biological material derived from animals or plants, such as wood and agricultural crops, and organic waste from municipal and industrial sources. (The use of biomass in this report refers to a specific type of bioenergy: the combustion or gasification of solid biomass derived from wood, often referred to as 'woody biomass', to generate electricity and heat. The wood feedstock to these processes may either be 'purpose-grown', virgin wood or waste wood (residues) from forestry activities or manufacturing processes).

Renewable energy (IPCC definition): is any form of energy from solar, geophysical or biological sources that is replenished by natural processes at a rate that equals or exceeds its rate of use.[78]

Forest Carbon Stocks

Above-ground carbon (AGC): biomass standing above ground level, comprising of woody stems, branches and leaves of living trees, creepers, climber and epiphytes as well as herbaceous undergrowth; some definitions also include dead fallen trees, course woody debris and the leaf litter layer.[79]

Below-ground carbon (BGC): biomass below ground level, comprising of living and dead roots, soil mesofauna and microbial community, soil humus, charcoal and inorganic calcium carbonat.[79]

High Conservation Value (HCV) forest: is a Forestry Stewardship Council designation used to describe those forests that possess one of more of the following characteristics: significant biodiversity values, contain rare, threatened or endangered ecosystems, provide basic services of nature (e.g. erosion control, carbon storage) or meet the basic needs of local communities (e.g. health, subsistence).[17]

Managed forest: an area of trees that are managed and harvested for commercial purposes.

Natural forest: an area of trees that are undisturbed by human activity, composed of biodiverse, native species of flora and fauna.

Plantation forest: a type of managed forest in which trees are planted (as opposed to naturally regenerated), low biodiversity, often composed of monocultures of fast-growing species.

Forestry management

Abandoned land: degraded, low quality agricultural land or pasture, in a state of disuse because its low productivity and is not suitable for other purposes such as agriculture and use by local communities.

Afforestation: planting new forest on lands which, historically, have not contained forests.[65]

Clear-cutting: a forestry or logging practice in which most or all trees in an area are uniformly cut down.

Deforestation: the long-term or permanent removal of forest cover and conversion to a non-forested land use.[79]

Reforestation: establishment of trees on land that has been cleared of forest within the relatively recent past.[79]

Sustainable yield capacity: managing harvests volumes to ensure long-term economic yields and ecological integrity.

Thinning: a forestry or logging practice in which trees are removed, reducing the density of a forest stand and enhancing the diameter growth and volume of the residual trees.[79]

Biomass feedstocks

Forest residues: the parts of harvested trees that are left over from traditional timber harvesting, they typically consist of branches, stem tops, bark and 'defective' tree stem pieces which are either hollow or diseased.[7]

Processing residues: by-products from sawmills (or paper mills) in the form of fine residues (sawdust, wood flour, shaving and bark) or coarser wood chips.[7]

Roundwood: logs of between 2.5'' and 16'' in diameter, although the exact diameter definitions vary between different saw-mills. Larger diameter 'saw logs' are often used in construction and the 'small roundwood' often used to make wood pellets.[7]

Power Generation

Co-firing: combustion of two (or more) different types of materials at the same time (e.g. coal & biomass).

Co-generation / Combined Heat and Power (CHP): is the use of a heat engine or power station to generate electricity and useful heat at the same time.

Units

- tC/ha/yr = tonnes of carbon per hectare per year
- TWh = terawatt-hours
- Mt = million tonnes
- gCO_2/MJ = GHG intensity measured in grams of CO_2 emitted for 1 MJ of energy generated
- $KgCO_2$/MWh = GHG intensity measured in kilograms of CO_2 emitted for 1 MWh of electricity generated

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