Biomass burning research

1. From: Torben Sigsgaard, et al. (2015) “Health impacts of anthropogenic biomass burning in the developed world”, *European Respiratory Journal*, vol. 46, no. 6, pp. 1577-1588, **DOI:** 10.1183/13993003.01865-2014

Abstract
Climate change policies have stimulated a shift towards renewable energy sources such as biomass. The economic crisis of 2008 has also increased the practice of household biomass burning as it is often cheaper than using oil, gas or electricity for heating. As a result, household biomass combustion is becoming an important source of air pollutants in the European Union.

This position paper discusses the contribution of biomass combustion to pollution levels in Europe, and the emerging evidence on the adverse health effects of biomass combustion products.

Epidemiological studies in the developed world have documented associations between indoor and outdoor exposure to biomass combustion products and a range of adverse health effects. A conservative estimate of the current contribution of biomass smoke to premature mortality in Europe amounts to at least 40 000 deaths per year.

We conclude that emissions from current biomass combustion products negatively affect respiratory and, possibly, cardiovascular health in Europe. Biomass combustion emissions, in contrast to emissions from most other sources of air pollution, are increasing. More needs to be done to further document the health effects of biomass combustion in Europe, and to reduce emissions of harmful biomass combustion products to protect public health.

Conclusions
Biomass combustion is widespread, is increasing, and makes an important contribution to ambient PM2.5, especially in winter, in the developed world.

Epidemiological studies strongly suggest that there are adverse health effects related to short-term as well as long-term exposure to biomass smoke in the developed world.

Intervention studies performed, to date, suggest beneficial health effects of reducing exposure to biomass smoke. We recommend that emissions from biomass combustion should be kept to a minimum to protect public health.

As the evidence from studies in the developed world is still limited, further studies are necessary to more precisely quantify the adverse health effects of biomass combustion. This should include comparative studies to document similarities and differences between effects of combustion products from biomass and fossil fuels.

2. From: Birdsey, R., et al. (2018) “Climate, economic, and environmental impacts of producing wood for bioenergy”, *Environmental Research Letters*, vol. 13, no. 5, **DOI:** 10.1088/1748-9326/aab9d5

Abstract

Increasing combustion of woody biomass for electricity has raised concerns and produced conflicting statements about impacts on atmospheric greenhouse gas (GHG) concentrations, climate, and other forest values such as timber supply and biodiversity. The purposes of this concise review of current literature are to (1) examine impacts on net GHG emissions and climate from increasing bioenergy production from forests and exporting wood pellets to Europe from North America, (2) develop a set of science-based recommendations about the circumstances that would result in GHG reductions or increases in the atmosphere, and (3) identify economic and environmental impacts of increasing bioenergy use of forests.

We find that increasing bioenergy production and pellet exports often increase net emissions of GHGs for decades or longer, depending on source of feedstock and its alternate fate, time horizon of analysis, energy emissions associated with the supply chain and fuel substitution, and impacts on carbon cycling of forest ecosystems. Alternative uses of roundwood often offer larger reductions in GHGs, in particular long-lived wood products that store carbon for longer periods of time and can achieve greater substitution benefits than bioenergy.

Other effects of using wood for bioenergy may be considerable including induced land-use change, changes in supplies of wood and other materials for construction, albedo and non-radiative effects of land-cover change on climate, and long-term impacts on soil productivity. Changes in biodiversity and other ecosystem attributes may be strongly affected by increasing biofuel production, depending on source of material and the projected scale of biofuel production increases.

Conclusions and research needs

Our main conclusions are:

1. Because biomass is less energy intensive than fossil fuels, the use of biomass to substitute for fossil fuels will nearly always initially increase emissions to the atmosphere.
2. Increasing use of logging and mill residues that would otherwise decompose or burn without energy capture will typically have a net benefit in less than 20 years; however, there is a limited supply of residues that is unlikely to meet projected increases in demand.
3. Harvesting live trees for pellets or other biofuel, regardless of quality, will initially increase net GHG emissions because of emissions associated with harvesting and lost forest productivity. It will take decades to centuries to reach the point at which there will be net reductions in GHG emissions compared to burning fossil fuels.
4. There are many economic co-effects of increasing use of wood for bioenergy that may be significant for policy formulation: increased prices for other wood products; increased income for landowners and greater likelihood of 'forests remaining forests'; and reductions in cropland areas and food production.

5. Biomass supplies are finite and proposed large increases in biomass uses for energy may reduce the availability of wood for use in long-lived wood products which keep carbon out of the atmosphere for longer and can achieve greater substitution benefits than bioenergy uses.
6. Changes in biodiversity and other ecosystem attributes may be strongly affected by increasing biofuel production, depending on source of material. Harvesting additional roundwood and increasing removal of logging debris could have significant landscape-scale impacts.
7. The notion of 'carbon neutrality' is an easy-to-grasp concept that simplifies accounting and monitoring but does not accurately represent the impact of substituting biofuel for fossil fuel except in very specific circumstances and timeframes. When all of the main impacts are counted, the net reduction in emissions to the atmosphere is almost always considerably less than implied by a 'carbon neutrality' accounting assumption. Not only does carbon neutrality accounting overestimate atmospheric benefits currently, the concept would likely underestimate benefits with BECCS.

It is important to maintain a long-term perspective and develop projections of 100 years or more. Not only does this allow many regions to experience multiple harvesting rotations and accumulated emissions reductions from forest growth and effective use of wood products, it fosters the notion of retaining forests as forests rather than being diverted to other land uses that store significantly less carbon. There may be a tangible benefit to keeping fossil carbon out of the biosphere and leaving it securely stored underground where it does not have to be managed in some way to mitigate climate change.

It would benefit the science and policy communities to have user-friendly analysis tools with full capability to perform detailed lifecycle and landscape-specific analyses for both the baseline and the mitigation options. Users should be able to define wide boundaries of analysis since different sectors are influential on the assessment of net benefits on climate, environment, and economics, all of which are important to consider in policy formulation.

The scientific and policy communities should move beyond comparing lifecycle GHG emissions from woody bioenergy with emissions from fossil fuels by considering a wide range of scenarios that allow society to meet the top-line climate policy goals of limiting warming to 1.5 or 2.0° C. In this broader context, being 'better than fossil fuels' is not necessarily good enough, especially on the decadal to century time horizons considered here.

Existing analyses of this broader issue have major limitations. Scenarios presented in the Working Group 3 contribution to the Intergovernmental Panel on Climate Change Fifth Assessment Report (AR5) use models that focus primarily on the energy sector and in many cases treat the land sector cursorily. They achieve atmospheric CO_2 removal largely through massive deployment of BECCS, a technology that has not been demonstrated at the scale needed. The various models used to generate these scenarios in AR5 produce highly divergent projections of future land use, in both baseline and mitigation scenarios (reference: AR5, working group 3, chapter 6, section 6.3.5). This reflects differing

assumptions and/or model formulations and demonstrates a lack of consensus on the role of bioenergy and land generally in climate mitigation.

Finally, it is not clear how CO_2 removal and net negative emissions would be achieved and what role forest bioenergy would play if the above-mentioned limitations, and others, were addressed. A re-visitation of the role of land and the constraints on biomass availability in meeting top-line climate policy goals is urgently needed.

3. From: *EU must strip large-scale wood-burning of 'carbon-neutral' status* (2018) ClientEarth

As a vital new EU energy policy is nailed down, ClientEarth is calling for large-scale wood-burning in power stations to be stripped of its 'carbon-neutral' status.

The call comes as two reports warn policymakers that biomass power stations are jeopardising EU climate commitments. Experts from the Forestry Commission, and from conservative thinktank Bright Blue, point to the continued mislabelling of large-scale biomass as carbon-neutral.

It is a timely reminder for EU leaders as they negotiate an update to the Renewable Energy Directive (REDII): they must pay heed to the dangers of adopting a law that skimps on sustainability provisions and would allow for an unfettered biomass boom.

ClientEarth law and policy advisor Caroline Haywood said: "Huge power stations have been capitalising on one of the biggest green myths in the modern energy world – that burning wood on a massive scale is good news for the climate and somehow sustainable, on the basis that forests can be regrown.
"This shaky logic legitimises massive subsidies for large-scale combustion plants, when the money could be going to genuinely clean energy investments. It's a farce and an obstacle to climate progress."

Biomass must not become the new coal
As the pace of coal plant closures picks up across the EU, concerns that the biomass industry is poised to scale significantly are growing. If EU renewable energy policy continues to reward biomass operators with astronomical subsidies, new plants may be built and coal plant owners may see refitting their units to burn wood as an attractive alternative to demolition.

ClientEarth is calling on EU policymakers to strengthen the sustainability criteria in the REDII so that biomass power plants with high real-world carbon emissions can be prevented. Caroline added: "It's time to call foul. Biomass power plants put the EU's ability to meet climate goals in jeopardy, but they're lauded as a panacea for cutting carbon. We need energy policies that recognise and account for all carbon emissions and incentivise the growth of real renewables – not ones that keep encouraging polluting power generation."

REDII is currently in the final stages of negotiations, with EU Member States and the European Parliament due to discuss the proposals this Thursday and again in early June.

4. From: Biofuelwatch *BIOMASS BASICS - What are the problems with big biomass?*

In a nutshell – there are three problems:

1. It takes huge areas of land and huge quantities of wood to supply a tiny fraction of the energy we use.
2. Burning biomass emits CO2 to the atmosphere, just as burning fossil fuels does. Those emissions are ignored in governments' and thus energy companies' carbon accounting – yet the science increasingly shows that this is a dangerous omission and that cutting down trees for energy raises carbon in the atmosphere precisely when we need to rapidly reduce it to have any hope of keeping global warming to 1.5 degrees.
3. Burning biomass causes just as much harmful – and for some deadly – air pollution as burning coal.

1. Lots of land and wood for hardly any energy:

In 2016, Drax Power Station burned pellets made from 13.2 million tonnes of wood, which is the equivalent of 120% of the UK's total wood production that year. Burning far more than the UK's total annual wood production supplied a mere 0.74% of the energy used in the UK that year!

Even if all that wood had been burned in extremely efficient combined heat and power plants rather than in Drax power station, it would still have contributed less than 1.5% of UK energy.

The reason why biomass has a huge land footprint is that plants are very inefficient at converting energy from the sun into chemical energy. Forests and other ecosystems constantly recycle carbon, nitrogen and many other nutrients. Only a small proportion of the solar radiation that falls on a leaf is used to sequester carbon in trees and soils. Even worse, the amount of energy contained in biomass that is converted to electricity in a power station is miniscule once we compare it to all the energy that goes into building a power station, maintaining and logging tree plantations, chipping wood or turning it into pellets, transporting it, and then burning it at 35% efficiency or less.

Biomass electricity is the least efficient way of using land to produce (renewable) energy – by a long stretch! If one looks at the actual amount of electricity generated from biomass versus solar PV from one hectare of land, the figures are even worse for biomass.

No, forestry and sawmill residues are not the answer:

Energy companies and pellet producers like to tell us that they are using "residues" for their woodchips and pellets – even if photos show truck after truck of whole logs entering the pellet plant or woodchip mill.

In 2013, Timothy Searchinger from Princeton University calculated that, if the UK was to remove and burn all its forestry residues in power stations, those would supply a mere 0.9% of the UK's electricity. Because electricity accounts for just 17.5% of all the energy used in the UK, this would translate into a mere 0.16% of total energy! And removing all residues, i.e. branches and leaves will deplete forest soils and result in them losing carbon and

nutrients and in future trees growing less well. Even worse, a recent study shows that even burning US wood pellets that are made from genuine forestry residues will have a negative impact on carbon dioxide in the atmosphere for decades to come.

2. No better for the climate than burning fossil fuels:

Burning biomass emits CO2 to the atmosphere, just as burning fossil fuels does. In fact, generating a unit of energy from wood emits between 3% and 50% more CO2 upfront than generating it from coal. Governments and industry tell us that we can ignore all of those CO2 emissions because new trees will absorb them in future. But this is a dangerous and flawed assumption, for several reasons, as many studies and reports show:

- When trees are cut down for burning new ones will take decades to grow and absorb all the CO2 emitted again. At best, CO2 emitted from burning wood today still won't be sequestered for at least a generation;
- Forests sequester CO2 year on year, both in wood and other vegetation, and in soils. For a forestry company, logging the equivalent of the annual growth in trees every year appears "sustainable" because the volume of wood in a plantation or forest isn't diminished. But for the climate, this means that forests will no longer sequester any CO2 at all. At present, around 30% of all the CO2 that humans emit, mainly from burning fossil fuels, is sequestered by plants. If less CO2 is sequestered in plants, more will stay in the atmosphere, fuelling warming.
- The Paris Agreement commits Governments to trying to keep global warming to within 1.5ºC, but this will be impossible to achieve without a rapid phaseout of fossil fuel burning AND more CO2 being removed from the atmosphere. There is only one proven way of removing any CO2 from the atmosphere: Allowing natural ecosystems – including healthy soils – to flourish and regenerate and helping restore them where necessary. If we want to have any hope of stabilising the climate, we need an end to fossil fuel burning as well allowing a lot more forests and other ecosystems to grow. Cutting down forests to replace some fossil fuels is completely the wrong answer.
- If forests are replaced with tree plantations, CO2 will be lost to the atmosphere forever because tree plantations contain much less carbon than forest ecosystems;
- Storing woodchips emits significant amounts of methane, and those methane emissions are not accounted for by anybody.

In January 2018, a letter signed by 800 scientists was presented to the EU Parliament. It states: "Even if forests are allowed to regrow, using wood deliberately harvested for burning will increase carbon in the atmosphere and warming for decades to centuries –as many studies have shown –even when wood replaces coal, oil or natural gas. The reasons are fundamental and occur regardless of whether forest management is 'sustainable'."

3. As polluting as coal

Burning wood in power stations is just as polluting as burning coal. It emits less of some pollutants (especially sulphur dioxide and mercury) but more of others (especially small particulates and Volatile Organic Compounds). Toxins emitted by biomass power plants are linked to respiratory and heart disease and strokes, and some are also linked to cancer and birth defects.

5. From: Project Drawdown (2014-2019)

Project Drawdown looks at biomass as a 'bridge solution' but only on condition that "all biomass is derived from perennial bioenergy feedstock—not forests, annuals, or waste — and replaces coal and natural gas in electricity production." Land use change is needed to grow biomass supply from perennial fast-growing trees and grasses, and it is unlikely the UK can sustain this without competing with agriculture for food crops. Biomass from waste products will not be sufficient to generate significant energy supply. As researchers from Biofuelwatch have researched (see above) wood pellets are for large parts derived from primary forests in Canada and the USA and then shipped to the UK. Emissions from harvesting, processing and shipping also need to be taken into consideration and will, on balance, not make this a carbon neutral method (see the Economist below). In addition, there are other air pollutants (particulate matter (PM), nitrogen oxides (NOx), carbon monoxide (CO), sulphur dioxide (SO_2), lead, mercury, and other hazardous air pollutants (HAPs), which are not taken into consideration by Project Drawdown.

6. From: The Economist (2013) Bonfire of the subsidies

Unlike wind and solar generators, biomass burners must buy fuel. This is already putting pressure on prices for other wood users, such as builders, cabinet-makers and, we should admit, magazines that are still printed on paper. It also increases reliance on imports—one of the things that renewables are often claimed to reduce. Worse, biomass-burning is nothing like as good a climate hedge as people tend to think.

Biomass claims to be a "carbon neutral" way of generating power: although burning wood puts carbon dioxide into the atmosphere, growing replacement wood sucks that carbon dioxide back out. But the ideal of a biomass plantation that is harvested only at the rate at which it grows back is not always met. Even when it is, such plantations displace other ecosystems that would themselves have sucked down carbon. Processing and transporting the wood to the place where it is burned requires energy that may well come from non-renewable sources. According to the European Environment Agency, an EU body not involved in setting subsidies, some biomass programmes could end up emitting more carbon than the fossil fuels they are being subsidised to replace.

7. From: The Economist (2013) The fuel of the future: *Environmental lunacy in Europe*

The article explains how prices of wood have been driven up by the demand for wood pellets to burn in biomass power stations, because not enough wood can be grown fast enough anywhere in Europe. The price increase is bad for furniture and paper (magazines, etc) businesses. The high subsidies provide for this industry meant that it has moved away from "electricity from wood was a small-scale waste-recycling operation" and has become very lucrative to exploit large-scale. They question if it is an "efficient way to cut carbon emissions" and they answer no.
"Wood produces carbon twice over: once in the power station, once in the supply chain. The process of making pellets out of wood involves grinding it up, turning it into a dough and putting it under pressure. That, plus the shipping, requires energy and produces carbon: 200kg of CO2 for the amount of wood needed to provide 1MWh of electricity.

This decreases the amount of carbon saved by switching to wood, thus increasing the price of the savings. Given the subsidy of £45 per MWh, says Mr Vetter, it costs £225 to save one tonne of CO2 by switching from gas to wood. And that assumes the rest of the process (in the power station) is carbon neutral. It probably isn't." Furthermore, they indicate that for each whole tree used for biomass burning "there is no carbon reduction until 100 years have passed, when the replacement trees have grown up."