20 February 2023

SENT TO LSU AGCENTER/LOUISIANA FOREST PRODUCTS DEVELOPMENT CENTER - FOREST SECTOR / FORESTY PRODUCTS INTEREST GROUP

ACADEMIA INSIGHT Forestry DOI: 10.24425/academiaPAS.138414

Woody Biomass for Energy Production

Is the burning of woody biomass climate friendly?

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Based on how the topic of combusting woody biomass for bioenergy production is presented in the media, most of us are probably quick to
imagine a massive, beautiful tree, almost large enough to be declared a natural monument, being cut down, chopped into pieces and thrown into the furnace of
a combined heat and power plant.

Such a vision sparks outrage for obvious reasons and prompts a number of questions. How many years will it take for a tree planted today to grow to the size of the
one that has just been cut down? What about carbon neutrality? After all, emitting carbon dioxide (CO2) takes just minutes, but its reabsorption takes years, if
not decades. How much CO2 do we emit during the transportation of woody biomass to the place where it is burned? Hidden behind all these dilemmas the most
fundamental question: can woody biomass actually be classified as a renewable energy feedstock?

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Scientific Board Member (https://www.forest-journal.com/)

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Is the burning of woody biomass climate friendly?

The role of forests in climate change mitigation is twofold: sequestering carbon and acting as a source of renewable energy

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In recent months, the media have spread numerous half-truths or outright misrepresentations about bioenergy produced from woody biomass, often playing on the emotions of the audience by linking images of massive trees being fallen to the ground to satisfy the growing use of biomass in the energy sector. Unfortunately, the real situation is often obscured by catastrophic language ("biomassacre"), misleading oversimplifications ("electric cars to be powered by burned forests"), or – as it was the case with a certain highly-publicized article in Britain's *The Guardian*[1] – combinations of unrelated but very emotional stories about environmental activists fighting to protect specific forests and sweeping generalizations about the blame allegedly attributable to the EU legislation and about an imminent environmental disaster.

[1] https://www.theguardian.com/world/2021/jan/14/carbon-neutrality-is-a-fairy-tale-how-the-race-for-renewables-is-burning-europes-forests

The situation has been worsened by letters of support and scientific articles written by individuals who do not typically deal with such issues as biomass, bioenergy, or assessing the life cycle and carbon footprint of wood products. This may mislead the public not merely about the scale but also about the very nature of the issues related to the use of woody biomass for energy production. In response to such reports, numerous articles have been published to explain the misunderstandings on this topic.

In the remainder of this article, we will try to identify and clarify these misunderstandings.

Objective: decarbonization

Reducing greenhouse gas emissions currently poses a key global environmental problem. The role of forests in these efforts is twofold: sequestering carbon (capturing it from the atmosphere) and acting as a source of renewable energy.

Overall, the use of woody biomass in the EU has grown by 20% over the past two decades. This means that we are faced with the challenge of reconciling increased demand for woody biomass (while being aware of its advantages in replacing non-renewable materials and fossil fuels) with sustainable forest management, including the protection and restoration of the forest ecosystems. The European Green Deal is a fairly ambitious plan, and its success will largely depend on how we use natural resources to produce energy.

What is biomass, and how is it used?

Woody biomass is not the same thing as forest biomass. In short, woody biomass includes both forest biomass (unmerchantable trees, branches, logs, and logging residues) and wood processing residues from the wood industry (for example in the sawmilling industry), as well as post-consumer wood (such as old furniture). Also, biomass is sometimes categorized into primary biomass (forest biomass) and secondary biomass (wood processing residues plus post-consumer wood).

Only the biomass from the forests managed in sustainable manner can be classified as renewable, and this is one of the issues regulated by the revised EU Renewable Energy Directive (RED II) of 2018.

Biomass (e.g., forest biomass, agricultural biomass) currently accounts for approximately 60% of total renewable energy in the EU. This applies to primary energy and, by the same token, comprises the energy used both in the heating sector and in the electricity sector. The total share of biomass is dominated by the biomass originating from the forest sector (forestry and the wood industry). Its share equals 60%, while the remaining 40% consists of agricultural biomass and waste, among other types.

According to the latest estimates, nearly half of the woody biomass in the EU used for bioenergy production comes from the wood processing residues or post-consumer wood, with primary woody biomass accounting for the other half. Around 20% of all forest biomass used for energy production comes from small-diameter logs (half of which are logs that come from coppice forests in the Mediterranean Basin), while 17% comes from other woody components (branches, tree tops).

Contrary to the suggestions made in the media, a vast majority of bioenergy in the EU is used in the heating sector, and not for power generation (in the electricity sector). From a global point of view, firewood is the most frequently used wood type in the world (approximately 1.9 billion m^3). The same amount is used by practically the whole of the world's wood industry.

Bioenergy, emissions, and "carbon neutrality"

It is argued that bioenergy is carbon neutral, and those who raise this argument in discussions point out that the CO_2 emitted during wood combustion

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Forests can support the achievement of numerous different objectives, including the production of timber and ecosystem services

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had to be earlier absorbed from the atmosphere during tree growth. This is a major oversimplification, and the term "carbon neutrality" used here is misleading because we should consider emissions in the whole of the supply chain and their impact on the level of CO_2 sequestration in the forest. For this reason, when we quantify the benefits from the use of woody biomass for bioenergy production, we should consider the question of whether the use of forest biomass leads to a reduction in forest carbon stocks or to the weakening of the forest ecosystem's CO_2 sequestration capacity. Also, we should take into account all the emissions that arise in the supply chain (such as these associated with production, processing, and transportation). After that, the scenario of the use of woody biomass for bioenergy production should be compared with another scenario, namely one that uses alternative energy sources, to determine which energy source emits less greenhouse gases. For this reason, bioenergy should be considered not in terms of carbon neutrality, but in terms of the climate benefits that it brings compared with other energy sources (such as coal).

Alarmist publications use confusing and very emotional language, for example by mentioning "burning forests" in the context of woody biomass. Considering only the tree stand level, much of the carbon that was absorbed in a tree stand during the growth of trees is suddenly removed from ecosystem when wood is harvested and transported to the bioenergy facility. In order to reach the same level of CO_2 absorption, this tree stand must again reach the felling age. In Poland's forest-growing conditions, this may take even more than 100 years. The scenario presented in this way will always lead to the conclusion that the use of forest biomass for bioenergy leads to net CO_2 emissions (more CO_2 is released to the atmosphere than absorbed). However, on the scale of the landscape (which includes many diverse tree stands), CO_2 losses in mature stands are offset by CO_2 absorption in younger stands. This is why it is very important that we analyze the levels of CO_2 release and sequestration on the scale of the landscape, as opposed to individual trees or tree stands. The factors that influence the level of carbon (C) stock on the landscape scale include, for example, growing conditions, current and past forest management practices, the ownership structure of forests, and changes in demand for and supply of wood products. Although this may seem counterintuitive, an increase in demand for woody biomass may lead to an increase in the forest area in a given region. This is because growing demand drives up the price of wood products, which encourages private forest owners to reforest new areas, which consequently increases the CO_2 sequestration at the landscape level.

In addition, we must remember that forests can support the attainment of numerous objectives, which include not only the production of timber, but also provision of ecosystem services (such as improving air quality, stabilizing soil, maintaining biodiversity). Timber is typically used to produce high-value products (such as lumber and engineered wood), for which the seller can charge much higher prices per cubic meter than for the biomass intended for bioenergy purposes. For this reason, during the production of lumber (which in many countries replaces more emission-intensive construction materials such as steel, concrete, and aluminum), woody biomass is produced as a by-product that is used for bioenergy purposes. In turn, if such biomass (for example in the form of wood pellets and wood chips) replaces more

Photo 1
An example of the use of pulpwood in the production of woody biomass for energy purposes (wood pellets), the United States

Photo 2
Almost half of the woody biomass used for bioenergy production is a by-product of the production of high-value wood products

RAFAŁ CHUDY (2)

ROBERT GRALA

In the EU, less than 20% of the primary biomass used for bioenergy comes from logging debris

emission-intensive and non-renewable fossil fuels, then we can talk about further increasing the climate benefits of woody biomass.

Finally, we should stress that the burning of woody biomass produces emissions that are part of the biogenic carbon cycle, unlike the burning of fossil fuels, which releases the CO_2 that has been trapped in the ground for millions of years. Other greenhouse gases, such as sulfur dioxide (SO_2), are also emitted, which additionally contributes to air pollution. In other words, the burning of fossil fuels increases the level of carbon in the atmosphere-biosphere system when the burning of woody biomass takes place within that system. If the carbon stocks stored in forests remain at the same level, the levels of CO_2 in the atmosphere due to forestry practices do not increase. Therefore, claiming that burning wood emits more CO_2 into the atmosphere than coal, because we have to burn more wood to achieve the same level of energy, is a serious misunderstanding.

Long-distance transportation of woody biomass and CO_2 emissions

It might appear that the importing of wood pellets across the Atlantic, from North America into Europe, negates the climate benefits gained from the burning of woody biomass for reasons related to its transportation. However, research shows that the energy produced from fossil fuels in the biomass supply chain is generally low compared with the content of energy in wood products even during international transport. Transporting wood pellets between North America and Europe increases supply chain emissions by 5 g CO_2/MJ. To put this into perspective, contribution to CO_2 emissions in the chain of coal supply and combustion are about 115 g CO_2/MJ. Transporting wood pellets from the United States to Europe, therefore, does not nullify the climate benefits achieved by the replacement of fossil fuels with biomass from managed forests.

Summary

So, is the burning of woody biomass climate friendly? The answer is: it depends. Mainly on whether the biomass is produced in a sustainable way and used efficiently, which is extremely important for keeping forest ecosystems in healthy condition. The literature clearly shows that efficient use of woody biomass for energy production can help mitigate the climate change which is considered the most serious environmental challenge facing the world in the 21st century.

The main added value that bioenergy offers in mitigating climate change will involve a gradual shift away from fossil fuels and other emission-intensive products to alternative feedstocks. Wood, which is a renewable material sourced from plantations and managed forests, will help us achieve this goal.

Woody biomass may be an important solution that will help Poland increase energy security while implementing the EU climate policy targets. Since forests make up one-third of the country's land area and the wood industry is booming, sustainable forest management and the production of woody biomass may be part of a suit of scalable solutions allowing the achievement of climate neutrality in the future. Bioenergy has the potential to fill gaps in both the heating sector and the electricity sector, where multiple woody biomass biopower systems distributed across the country could supplement in an important and sustainable way the energy mix, which by necessity will be largely reliant on intermittent renewable sources.

We must also remember that burning good quality wood, which may be a side effect of poorly constructed mechanisms for supporting renewable energy sources, is not an optimal solution either for the forest sector, or for forest ecosystems, or for the national economy. ■

Further reading:

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