BIO energy

What is bioenergy?

Biomass is any organic matter of plant and animal origin such as timber, agricultural residues, or organic waste. Energy produced from biomass is called bioenergy. Biomass can either be burned to create heat, converted into electricity, or processed into biofuel.

Figure 1. Most common biomass sources.

Biomass feedstock used for bioenergy production can be broadly classified into agricultural crops (e.g., sugar beet, corn, rapeseed), agricultural crop residues (e.g. wheat straw, corn cobs), forestry residues (e.g. tops, branches, bark, sawdust) and sorted municipal waste (organic fraction of municipal waste), see Figure 1. Many different processes can be used to convert these feedstocks into bioenergy in different forms.

Biomass as a renewable energy source (RES)

Bioenergy is currently the main source of renewable energy in the European Union (EU), with a share of almost 60%.[1] Biomass comes in a variety of forms and can be stored in large amounts for relatively low cost. Bioenergy produced from biomass can help replace fossil fuels in all energy sectors.

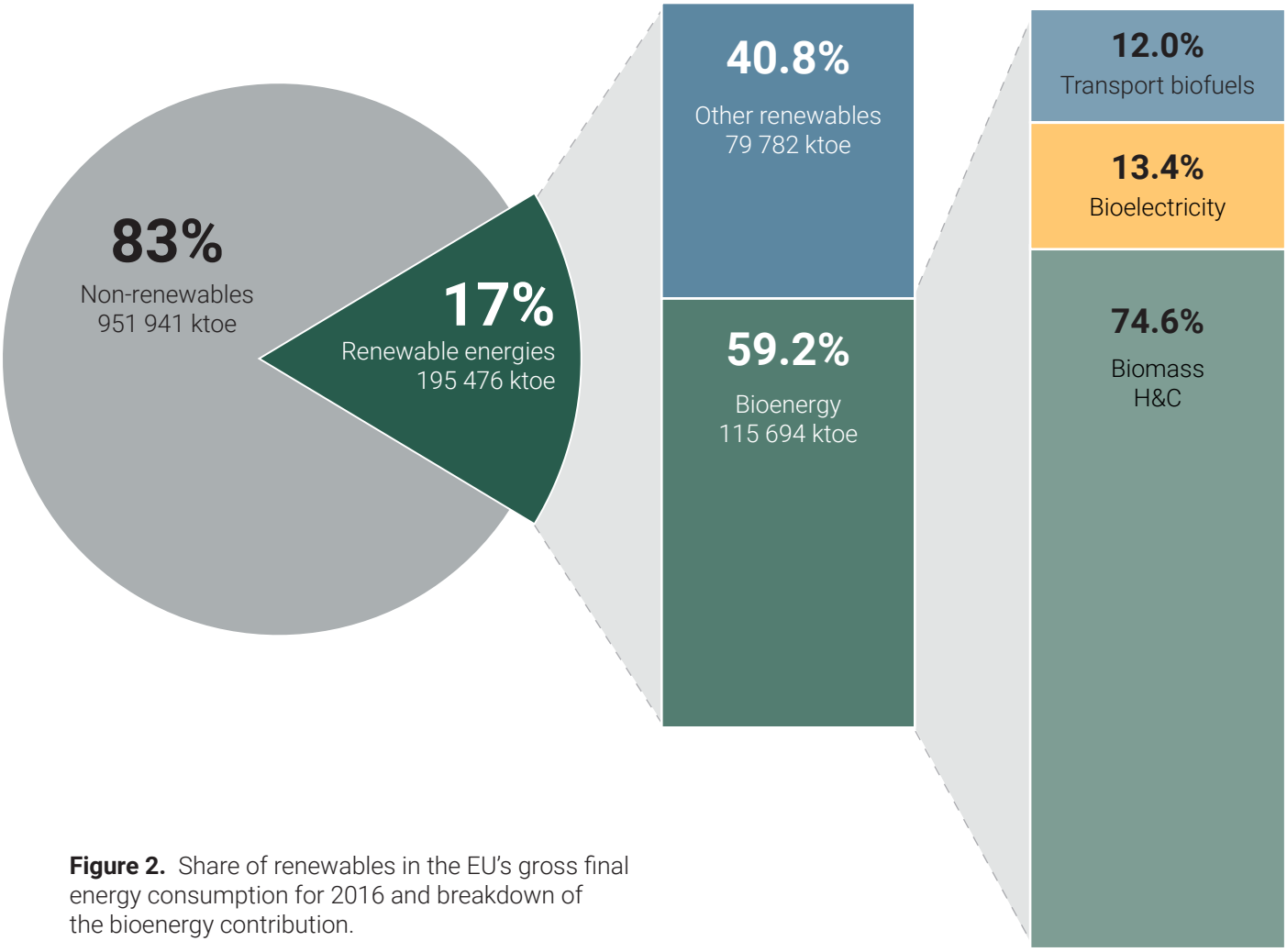


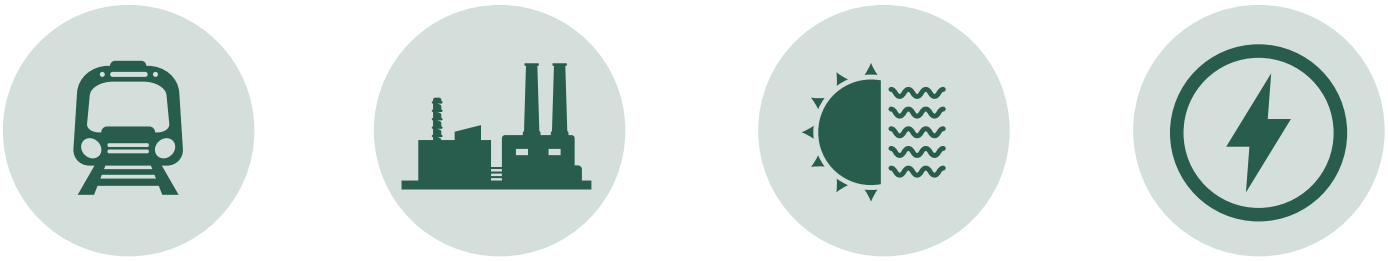
Figure 2. Share of renewables in the EU's gross final energy consumption for 2016 and breakdown of the bioenergy contribution.

Source: Eurostat 2018b and NREAP Progress Reports.

Bioenergy can be produced from a wide range of feedstocks and types of biomasses. For example, the majority of biofuel production for transportation currently uses so-called conventional feedstock like sugar beet, corn and rapeseed oil. In contrast, advanced biofuels are produced from biomass that cannot be directly used for human or livestock nutrition; examples of such biomass are wheat straw, corn cobs, bark, sawdust, organic fraction of municipal waste. However, technologies for the conversion of such biomass are not yet fully developed.

[1] European Commission, Joint Research Centre, Brief on biomass for energy in the European Union, Publications Office, 2019, https://data.europa.eu/doi/10.2760/546943

Bioenergy can be used to cover energy demand for:



transport **industry** **heating and cooling** **electricity**

The European bioenergy sector The European bioenergy sector involves several key actors: biomass producers, bioenergy conversion companies, energy utilities, research institutions, policy and regulatory bodies, and environmental organizations. Biomass producers grow, harvest, and collect organic materials like crops and agricultural waste. Farmers and foresters play a vital role in growing and supplying organic materials for bioenergy production. The food industry and forest-based industry contribute to the availability of agricultural and forestry residues as biomass feedstock. Farming cooperatives promote collective action in biomass production. Bioenergy conversion companies specialize in turning biomass into usable energy forms through technologies like combustion and anaerobic digestion. Energy utilities distribute and sell bioenergy to consumers, integrating it into existing energy infrastructure. Research institutions advance bioenergy technologies and explore sustainable feedstocks. Policy and regulatory bodies create guidelines and incentives to promote sustainable bioenergy production and use. Environmental organizations monitor and advocate for environmentally responsible practices in the sector. These actors collaborate to drive the growth of the European bioenergy sector, supporting the transition to cleaner and more sustainable energy sources.

The nexus between bioenergy and sustainability

Bioenergy production and the agricultural and forestry sector are closely linked. The agriculture sector contributes by providing biomass resources, including dedicated energy crops like corn and switchgrass and crop residues, while the forestry sector supplies wood-based biomass and forest residues like sawdust and bark. This relationship has both direct and indirect impacts on the environment, as well as on food security and sustainability.

Sustainability

Ensuring the sustainability of bioenergy production within the agricultural and forestry sector is crucial. It requires a comprehensive assessment of the social, economic, and environmental impacts and a recognition of the potential trade-offs with other land uses. The interaction between bioenergy and agriculture significantly affects land and water use, making sustainability a key consideration. While bioenergy offers benefits like enhanced energy security and climate change mitigation, it is essential to carefully

evaluate its potential effects on the agricultural sector. Promoting sustainable bioenergy production that addresses these concerns is of utmost importance. The European Union has implemented policies and regulations aimed at tackling these issues and fostering sustainable bioenergy practices.

Direct land use is a critical aspect of bioenergy production. The cultivation of bioenergy crops requires land, water, and other resources, which can lead to competition with food crops and other land uses. While bioenergy crops can present opportunities for farmers to diversify their income and improve economic viability, the potential displacement of food crops and other land uses must be considered, particularly in regions such as Europe where land scarcity is already a concern. Balancing the utilization of land for both bioenergy and food production is crucial to ensure sustainable resource management and minimize potential conflicts.

The residues generated by the forest-based industry, such as by-products from sawmills and pulp and paper manufacturing, contribute to the availability of biomass feedstocks for bioenergy. This utilization of forestry and forest industry residues not only helps reduce waste but also promotes resource efficiency and supports sustainable forest management practices. Additionally, when sourced responsibly, biomass from well-managed forests can support biodiversity conservation, soil health, and forest ecosystem resilience. However, it is crucial to ensure sustainable forestry practices, including proper harvesting techniques, reforestation efforts, and monitoring to prevent overexploitation and maintain long-term forest health.

Indirect Land and Water Use

Indirect Land Use Change (ILUC) is another important factor to consider. ILUC refers to the displacement of food crops and other land uses due to the production of bioenergy feedstocks. This can lead to increased demand for land, which can have negative consequences for biodiversity, carbon sequestration, and soil health. For example, the production of biofuels from corn in the United States has been linked to indirect land use changes in other parts of the world, where forests and natural habitats have been converted to agricultural land to meet the growing demand for corn. Similar cases can occur outside the bioenergy sphere, such as when rainforests are cleared to make way for grassland for cattle grazing, affecting both food production and biodiversity.

The European Union (EU) has implemented several policies and regulations to address these challenges. The Renewable Energy Directive (RED), for instance, includes sustainability criteria for biofuels to prevent ILUC. It also requires Member States to report on the carbon intensity of biofuels, taking into account the indirect land use emissions associated with their production. These measures aim to ensure that bioenergy production is environmentally sustainable, socially responsible, and does not compromise food security or land resources. Additionally, water resource competition between bioenergy production and agricultural use is a consideration in certain regions of Europe where water scarcity is prevalent.[2] The increased demand for water from bioenergy production could exacerbate existing water scarcity issues, creating unique challenges as food and biofuel production compete for the same limited water resource.

[2] European Environment Agency (2021). Water resources across Europe – confronting water stress: and updated assessment. EEA Report No 12/2021..

The role of bioenergy in the “just transition”

Within the EU, the European Green Deal is a comprehensive policy framework aimed at making the EU’s economy sustainable and reducing its greenhouse gas emissions. One of its elements is the just transition. This is an overarching term that considers the fairness and equitability of transitioning into a low-carbon economy, to ensure that workers or communities that are currently reliant on high-carbon industries are not left behind.

The just transition requires a societal transformation towards a more circular and sustainable economy in line with the principles of the EU’s strategy. A circular economy seeks to increase the proportion of renewable or recyclable resources and reduce the consumption of raw materials and energy in the economy, while simultaneously protecting the environment. Systemic approaches, including sharing, reusing, repairing, refurbishing, and recycling of existing products and materials, can help maintain the utility of products, components, and materials and retain their value.

Bioenergy can support the circular economy by using waste and by-products as feedstocks and creating new supply chain developments. It would thus contribute to the just transition by providing a renewable source of energy that can replace fossil fuels and reduce greenhouse gas emissions. A combination of bioenergy and a circular economy (**circular bioeconomy**) offers a conceptual framework for using renewable natural capital to transform and manage our land, food, health and industrial systems. Additionally, bioenergy can create new employment opportunities in rural areas through jobs in feedstock production and processing.

While bioenergy certainly does have the potential to reduce the EU’s dependence on imported fossil fuels, it is important to ensure that bioenergy production is sustainable and does not compete with food production or have negative social or environmental impacts. This requires careful feedstock procurement as well as monitoring and regulating the bioenergy sector to ensure that it is contributing to the just transition.

Bioenergy through the prism of “social innovation”

Certain bioenergy technologies such as biogas production, biomass combustion, and biofuels have the potential to provide clean, reliable, and affordable energy to small-scale communities. These technologies can utilize locally available biomass resources, such as agricultural waste, forestry residues, and organic waste, to produce energy, thereby creating economic opportunities and reducing waste disposal costs. Additionally, bioenergy technologies can promote energy independence in rural areas where energy access is limited.

Social innovation is referred to new ideas (products, services and models) that simultaneously meet social needs more effectively than other alternatives, thereby creating new social relationships and collaborations. Such innovation initiatives are crucial for facing environmental and societal challenges and can play a critical role in the deployment of bioenergy technologies in small-scale community projects. It can enable the deployment of bioenergy technologies in small-scale community projects by fostering partnerships

between communities, local governments, and private entities. For instance, community-based organizations can work with local governments to secure funding and support for bioenergy projects. Private entities can provide technical expertise and financing for project development, while communities can provide local knowledge and resources. By collaborating in this way, bioenergy projects can be designed and implemented in a manner that is responsive to local needs and preferences, leading to greater acceptance and adoption of these technologies.

In addition, social innovation can facilitate the engagement of energy communities in the development and operation of bioenergy projects. Energy communities are groups of people who work together to produce, distribute, and use renewable energy. If energy communities are involved in the development of bioenergy projects, they can take ownership of the technology and become active participants in the transition to a more sustainable energy system. Energy communities can participate in the planning and decision-making processes of bioenergy projects, provide labour and resources for construction and operation, and benefit from the economic and environmental advantages of the technology.

Overall, bioenergy has significant potential for deployment in small-scale community projects, and social innovation can play a critical role in enabling this deployment. By fostering partnerships and engaging energy communities, bioenergy projects can be designed and implemented in a manner that is socially, economically, and environmentally sustainable..

Why are citizens an important part of the debate?

Bioenergy in all of its forms is one of the key solutions to combat climate change and to meet the EU's renewable targets. However, without an active and informed civil society, it won't be as effective as it can potentially be when deployed in large scale. Public acceptance of bioenergy is an important factor for accelerating social innovation by deploying renewable energy sources locally, using local resources and characteristics. For instance, using residues coming from wood-based industries for the production of renewable energy.

Recent studies showed relatively positive citizen attitudes toward bioenergy overall. However, certain countries are perceived as having significant levels of greenwashing - when marketing methods are deceptively used to persuade the public that an organization's products, aims and policies are environmentally-friendly regarding industry implementation of bioenergy technologies.[3]

Greater public awareness about bioenergy can contribute to accelerating a transition to a bioeconomy, incentivizing the industry involved to implement strategies, and stimulating other organizations to engage in such initiatives and increase the production of renewable energy. Taking an active role by demanding necessary improvements to combat key challenges of bioenergy production and deployment is vital for the acceleration of renewable energy sources, decarbonization of industries and the realization of energy citizenship in Europe.

[3] Rutz et al. (2022). Technical options for retrofitting industries with bioenergy. BIOFIT. https://www.biofit-h2020.eu/publications-reports/

Key messages

- Bioenergy is energy derived from organic materials. It can provide direct heat and electricity and be stored and transported in the form of fuels.
- Biomass continues to be the main source of renewable energy in the EU, with a share of almost 60%. The heating and cooling sector uses about 75% of all bioenergy.
- Bioenergy can play a key role in achieving the EU's renewable energy targets for 2030 and beyond. However, biomass must be produced, processed and used in a sustainable and efficient way in order to optimise greenhouse gas savings and maintain ecosystem services, all without causing deforestation or degradation of habitats or loss of biodiversity.
- Well informed and engaged citizens are the backbone of a socially responsible implementation of bioenergy. They will serve to push more ambitious targets forward and avoid greenwashing.
- Public engagement is vital for involving as many stakeholders as possible and scaling the production of biomass to the necessary level for making a difference.

This project has received funding from European Union's Horizon Europe research and innovation programme under grant agreement no.101075503

ETIP Bioenergy
European Technology and Innovation Platform