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BIOECO-UP

BIOMASS AND ITS VALORIZATION

WHAT IS BIOMASS?

Material whose origin is living, or recently living biological organisms. Biomass can be a source of renewable fuels, energy and everyday products such as plastics and other materials. The energy in biomass comes from the sun: plants absorb the sun's energy through photosynthesis. The energy from these organisms can be converted into usable energy by burning to produce heat, converting into electricity, processing into biofuel or creating new bioproducts.

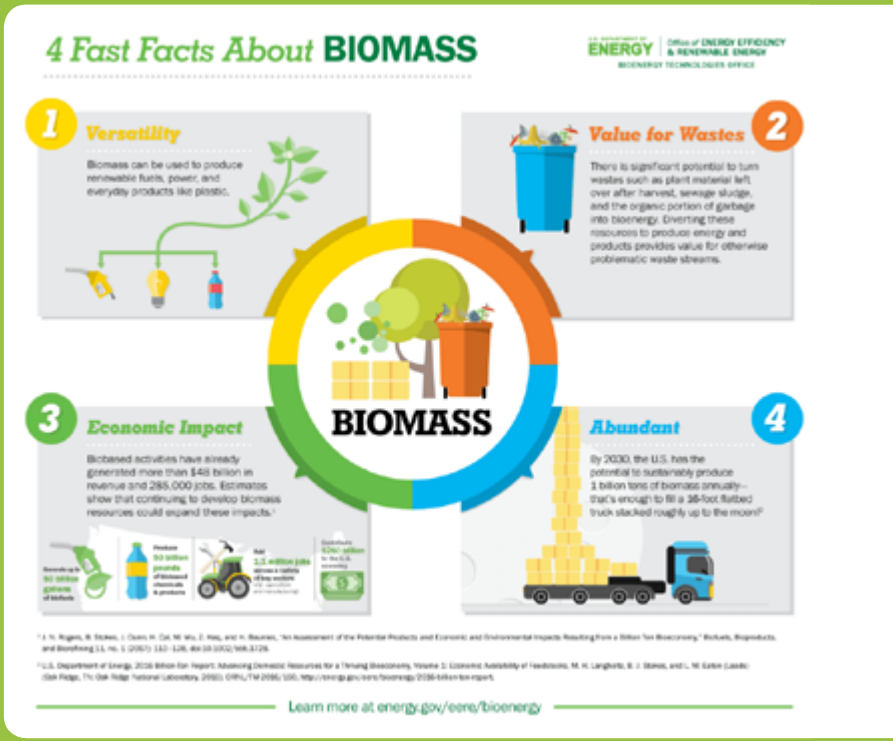
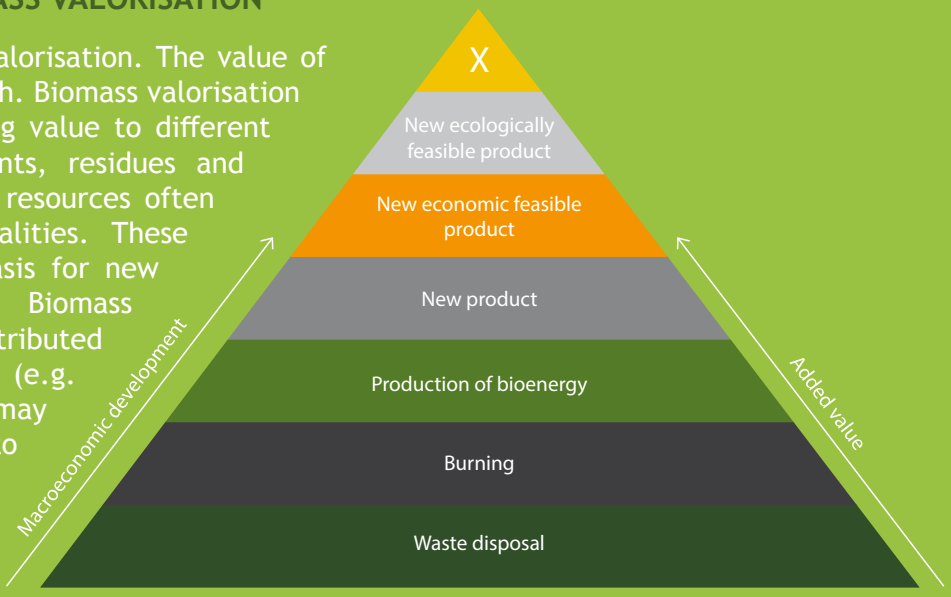


Figure 1. Four fast facts about biomass. Source: https://www.energy.gov/eere/bioenergy/

DEFINITION OF BIOMASS VALORISATION

Definition of Biomass Valorisation. The value of biomass can be very high. Biomass valorisation is the process of adding value to different types of biomass (plants, residues and wastes). These natural resources often have specific functionalities. These can be used as the basis for new product applications. Biomass can be traded and distributed as it is produced (e.g. exporting apples). It may also be processed into intermediate products to achieve the highest possible added value. Depending on the biomass, it can be burned to produce either heat or electricity.



X - New product: environmentaly and climate friendly, socioeconomic and economic feasible

Source: A. Gravelins, 2018. Biotechonomy for agriculture sector: a system dynamics model

Figure 2. *Pyramid for use of biomass with increase of added value (Gravelins et al. 2018)*

BIOMASS VALORISATION EXAMPLES

Plant biomass (food crops that are starch-rich, aquatic plants and lignocellulosic plants) can be converted into several types of products (e.g. chemicals, biofuels and advanced materials). Waste materials, including agricultural residues, municipal waste, animal waste can be converted into valuable products, such as chemicals, materials, or fuels. Biomass valorisation is increasing worldwide interests because it is an accessible and low-cost (often) feedstock for chemical and material production. It is also resource neutral and burns cleaner than fossil fuels for renewable energy production. It is important to remember that these sustainable resources play an important role in replacing fossil resources (for chemicals, materials and everyday products), but are also used in food and feed products.

BIOMASS SOURCES

Agriculture, forestry, fisheries, aquaculture, and algae production are the main suppliers of biomass. Agricultural industry is one of the most important biomass producing sectors. Another important biomass producing sector is forestry.

EU BIOMASS FLOWS

Agriculture, followed by forestry, is the largest producer of domestic biomass with 69% of the total and 31% of the dry matter content, respectively. Crop production is the main source of biomass in the agricultural sector, with biomass from grazing and residues from harvested crops. Biomass flows in 1000T of dry matter for EU-27 based on the latest available data (agriculture - year 2020, fisheries and aquaculture - year 2016 and forestry - year 2017) are shown in Figure. Most biomass is used for food and feed purposes, with the remainder used to produce energy and materials for non-food and non-energy purposes.

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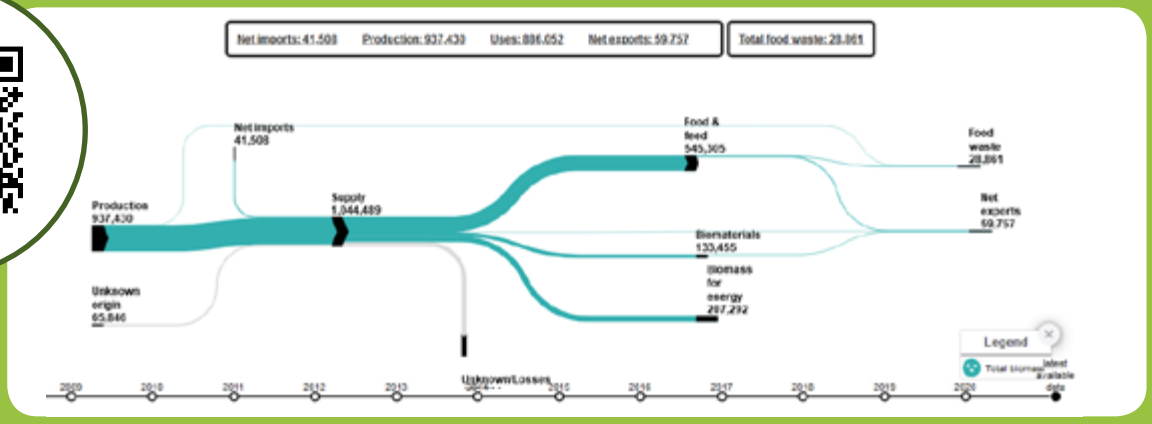

Figure 3. Biomass flows in 1000T of dry matter for EU-27 based on latest available data (agriculture - 2020 year, fisheries and aquaculture - 2016 year and forestry - 2017 year) Source: https://datam.jrc.ec.europa.eu/datam/mashup/BIOMASS_FLOWS/index.html

VALORISATION OF BIOMASS FROM PRIMARY SECTORS

Biomass comes mainly from primary sources such as agricultural crops and their collected residues, grazed biomass, forestry, fisheries and aquaculture. The rest of the biomass comes from secondary sources (such as recycled paper, by-products of wood processing and recovery, and other bio-waste) and is also recovered from waste. This biomass can be used for animal feed and bedding, followed by various material uses (e.g. wood products and furniture, textiles, and different types of innovative bio-based chemicals) and bioenergy (heat, power and biofuels), which is important part or valorisation as it exploits biowaste. The rest is used for plant-based food and seafood.

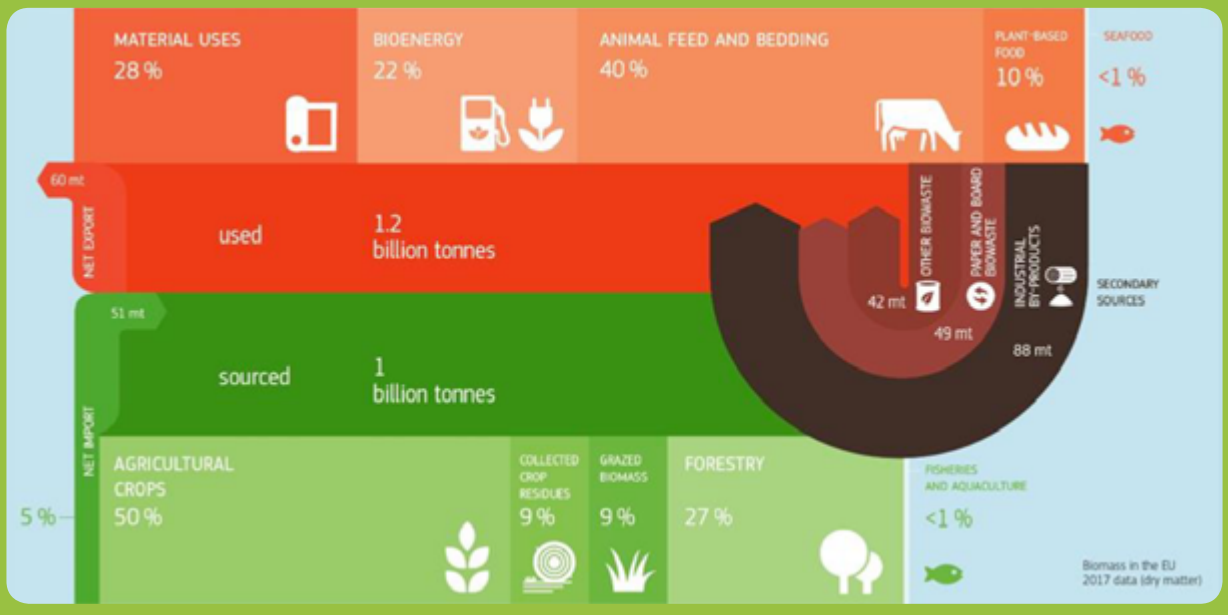

Figure 4. BSources and uses of biomass in the EU in 2017. Source: Avitabile et al. 2023

WHAT IS BIOENERGY?

Bioenergy is a type of renewable energy produced from biomass resources through biological (e.g. anaerobic digestion) or thermal conversion (e.g. combustion). Biomass, derived from organic material such as trees, plants and agricultural and urban waste, is an important renewable energy source in the EU. It is mainly uses for heating and cooling sector. Forestry is the most important source of biomass used for energy, but agricultural crops represent the largest source used to produce biofuels. There are three main categories of bioenergy provided by agriculture: biogas, biodiesel and bioethanol. Bioethanol is produced by yeast fermentation of sugar and starchy crops (mainly EU cereals and sugarbeet). Vegetable oils and animal fats are the raw materials used to make biodiesel. In EU, almost half of biogas is made from agricultural crops, crop residues, and animal manure.

BIOMASS SOURCES FOR ENERGY

Biomass for energy can include a wide range of materials, with five basic categories:

- **Virgin wood**, from forestry, arboricultural activities or from wood processing
- **Energy crops**: high yield crops grown specifically for energy applications
- **Agricultural residues**: residues from agriculture harvesting or processing
- **Food waste**, from food and drink manufacture, preparation and processing, and post-consumer waste
- **Industrial waste and co-products** from manufacturing and industrial processes.

Figure 5. Sources of biomass. Source: http://www.bioenergyconsult.com/biomass-energy-introduction

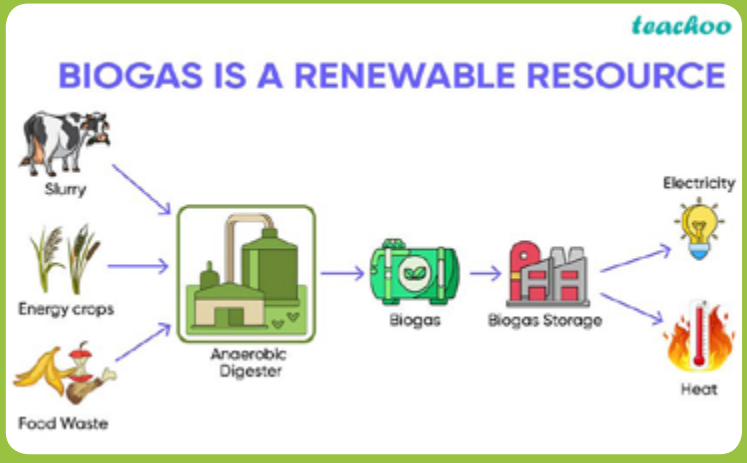

Figure 6. Biogas production stages. Source: https://medium.com/@codedesignstech/biodigesters-vs-biogas-understanding-the-key-differences-c3c1fed01254

Figure 7. Biofuel Life Cycle. Source: https://ipsunsolar.com/blog/biofuels-a-valuable-resource-to-fight-climate-change/

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VALORISATION OF WASTE PLAYS IMPORTANT ROLE

Biomass waste includes e.g. wood, food, or agricultural waste. Waste valorisation is a process that converts waste materials into valuable products, such as chemicals, materials, fuels, and bioenergy. Diverting waste to produce energy and products adds value to what would otherwise be problematic waste streams. Failure to use waste biomass can lead to significant environmental hazards, as biomass is converted into large-scale waste and causes serious problems for society.

EVERYDAY BIO-PRODUCTS

Products made from biomass can be found in everyday products, such as personal care products, drink containers, nutritional supplements, and detergents and cleaning products. Bio-based feedstocks can be used to make a range of personal care products (e.g. skin cream, shampoo, mascara and more). Omega-3 fatty acids, which are typically found in fish oils, are extracted directly from algae by some brands of food supplements. Plant-based materials can be used in bio-based plastic production.

Figure 8. *Everyday products made from biomass. Source: https://www.energy.gov/eere/articles/5-everyday-products-made-biomass-few-may-surprise-you*

USE OF BIOMASS AND ITS ADDED VALUE

Biomass can be traded and distributed as it is produced (e.g. exporting apples). It may also be processed into intermediate products to achieve the highest possible added value. Depending from the biomass, it can be burned to produce either heat or electricity.

Figure 9. *Schematic of biomass energy conservation and carbon reduction using multiple sources and multiple approaches. Source: Wang et al. 2023*

BIOREFINERIES

The valorisation of biomass supports the production of energy (biofuel) as well as various types of bio-based products thanks to the biorefinery concept. The use of biorefineries to produce bioenergy from agro-industrial biomass residues can be a solution for sustainable energy supply combined with greenhouse gas (GHG) emission reduction. Due to their versatility rather than focusing on the production of a single product, biorefineries can generate multiple products (i.e. fuels, animal feed, electricity, heat or nutrients). Thanks to their broad spectrum, biorefineries appear to be a very good alternative to conventional methods due to which the output product is only one.

SIGNIFICANCE

Adequate management of biomass has become a very important social challenge in recent years, and the bioeconomy itself is an important part of the countries' economy today. Proper assessment of the availability of biomass in different countries and the possibility of using it in their economy is becoming a key challenge for them. An important element of a proper bioeconomy is the skillful use of biomass resources and flows without sacrificing environmental or economic sustainability which may often not fully coincide.

SUSTAINABLE BIOMASS

Increased use of biomass in the EU can contribute to the diversification of Europe's energy supply, the creation of growth and jobs and the reduction of greenhouse gas emissions. In order to achieve the goal of reducing greenhouse gas emissions, biomass has to be produced and processed in a sustainable way. At each stage of biomass production, from growing feedstock to final energy conversion, different suitability challenges need to be addressed. All biofuels and bioliquids consumed in the EU must meet sustainability criteria. The sustainability criteria include large-scale biomass for heat and electricity, agricultural waste and residues, forest biomass, new biofuel plants and bioelectricity.

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