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Collection of information sheets

BIOECONOMY IN CE EUROPE

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CONTENT

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BIOECONOMY IN GENERAL

The bioeconomy aims to address environmental, economic, and social challenges by promoting the sustainable use of biological resources, reducing greenhouse gas emissions, and creating new economic opportunities. It emphasizes the integration of biological knowledge, technological innovation, and responsible resource management to build a more resilient and eco-friendly economy.

WHAT ARE THE GENERAL CHALLENGES THE BIOECONOMY CONCEPT IS GOING TO ADDRESS

1. SUSTAINABLE RESOURCES USAGE
2. ENVIRONMENT - water use, soil degradation, biodiversity loss
3. LAND USE - deforestation, palm oil etc.
4. ECONOMY - competing with non-bio based alternatives
5. MARKET DEVELOPMENT AND CONSUMERS - bio-based alternatives may be less familiar or more expensive than traditional alternatives.
6. GLOBALIZATION AND TRADE - intellectual property rights, and access to genetic resources can pose challenges
7. CLIMATE CHANGE - affecting the availability and quality of biomass resources
8. TECHNOLOGICAL INNOVATION AND INFRASTRUCTURE - infrastructure for the bioeconomy can be a costly and time-consuming process.
9. SOCIAL ACCEPTANCE - social acceptance and addressing ethical concerns are vital for the success of the bioeconomy.
10. POLICY AND REGULATORY FRAMEWORKS - Coordination among different sectors and stakeholders is essential.

DEFINITION

According to the United Nations Food and Agriculture Organisation, the bioeconomy is „the production, use and conservation of biological resources, including related knowledge, science, technology, and innovation to provide information, products, processes and services to all economic sectors with the aim of moving towards a sustainable economy".

SPECIFIC PROBLEMS FOR THAT WE ARE GOING USE BIOECONOMY CONCEPT

- USE OF SUSTAINABLE ENERGY
- CLIMATE CHANGE
- TECHNOLOGICAL INNOVATION
- ECONOMIC DEVELOPMENT
- ENVIRONMENTAL IMPACT

WHAT ARE THE MAIN TOOLS OFFERED BY BIOECONOMY

BIOTECHNOLOGY:

Biotechnology is the basis for numerous processes for the production of bio-based products such as food and feed, pharmaceuticals, chemical products and energy sources. It plays a central role also by providing tools for manipulating biological systems at the molecular and cellular levels. This includes genetic engineering, synthetic biology, and metabolic engineering, which allow for the modification of organisms to enhance their productivity and create new bio-based products.

ADVANCED AGRICULTURE PRACTICES:

Precision agriculture, agroecology, and other advanced farming practices contribute to sustainable and efficient crop production. These approaches optimize resource use, reduce environmental impact, and enhance the resilience of agricultural systems.

BIOMASS CONVERSION TECHNOLOGIES:

Various technologies are employed to convert biomass into valuable products. Examples include:
Biochemical Conversion: Enzymes and microorganisms are used to convert biomass into biofuels, chemicals, and other products.
Thermochemical Conversion: Heat and chemicals are used to convert biomass into bioenergy, biofuels, and bio-based chemicals.

BIO-BASED MATERIALS AND PRODUCTS:

The bioeconomy produces a range of bio-based materials, including bio-plastics, bio-textiles, and bio-composites, as alternatives to traditional, fossil-based materials. These materials contribute to the development of a more sustainable and circular economy.

RENEWABLE ENERGY TECHNOLOGIES:

Technologies for the production of bioenergy resources, such as biofuels and biogas, are critical components of the bioeconomy. This includes processes like anaerobic digestion, fermentation, and thermochemical conversion to produce energy from organic materials.

BIOREFINERIES:

Biorefineries are facilities that integrate various biomass conversion processes to produce a range of bio-based products and bioenergy. They play a key role in maximizing the value obtained from biomass resources.

SUSTAINABLE FORESTRY PRACTICES:

Sustainable forestry practices contribute to the responsible management of forest resources, ensuring that biomass is harvested in an environmentally and socially sustainable manner. This includes practices like selective logging and reforestation.

CIRCULAR ECONOMY PRINCIPLES:

The bioeconomy aligns with circular economy principles, emphasizing the reduction, reuse, and recycling of materials. This helps minimize waste and ensures a more sustainable and resource-efficient economic model.

DIGITAL TECHNOLOGIES:

Digital technologies, including precision farming tools, sensors, and data analytics, enhance the efficiency and productivity of bioeconomy activities. These technologies contribute to smart and data-driven approaches in agriculture and bio-based production.

POLICY AND REGULATORY INSTRUMENTS:

Effective policies and regulatory frameworks are essential tools for guiding the development of the bioeconomy. These instruments can provide incentives for sustainable practices, address ethical concerns, and create a supportive environment for bioeconomy activities.

BACKGROUND OF BIOECONOMY (WHY THIS CONCEPT HAS BEEN DEVELOPED - E.G FAILURE OF MAINSTREAM ECONOMIC THINKING)

The concept of the bioeconomy has emerged in response to various challenges and drawbacks associated with conventional economic models. While not explicitly framed as a rejection of mainstream economic thinking, the development of the bioeconomy reflects a growing recognition of the limitations and environmental consequences of traditional economic systems

WHICH FACTORS CONTRIBUTE TO THE BACKGROUND OF THE BIOECONOMY?

FINITE FOSSIL RESOURCES:

Traditional economic models heavily rely on finite fossil resources like coal, oil, and natural gas. Concerns about depletion and environmental impact, particularly climate change, drive the need for alternative, renewable resources.

ENVIRONMENTAL DEGRADATION AND CLIMATE CHANGE:

Mainstream economic activities are often linked to environmental degradation, deforestation, and greenhouse gas emissions. The bioeconomy concept responds to the demand for more sustainable and environmentally friendly economic practices to address climate change and protect ecosystems.

DEPENDENCY ON NON-RENEWABLE RESOURCES:

The bioeconomy aims to reduce reliance on non-renewable resources and shift towards a model based on renewable biological resources. This shift addresses concerns about the long-term sustainability of using finite resources for economic development.

CIRCULAR ECONOMY PRINCIPLES:

The bioeconomy aligns with the principles of a circular economy, emphasizing the importance of reducing waste, reusing materials, and recycling resources. This stands in contrast to linear economic models following a „take, make, dispose“ pattern.

DIVERSIFICATION OF ENERGY SOURCES:

The bioeconomy addresses concerns about energy security by promoting the development of bioenergy as a renewable and diversified energy source. This diversification is seen as a way to enhance resilience in the face of energy supply challenges.

DESIRE FOR SUSTAINABLE AGRICULTURE:

Conventional agricultural practices are often criticized for environmental impacts like deforestation, soil degradation, and excessive use of agrochemicals. The bioeconomy encourages the adoption of sustainable agricultural practices prioritizing ecological health and resource efficiency.

ADVANCEMENTS IN BIOTECHNOLOGY:

Advances in biotechnology provide new tools for modifying and utilizing biological systems for various applications. These technologies enable the development of bio-based products, biofuels, and sustainable agricultural practices aligned with the goals of the bioeconomy.

ECONOMIC OPPORTUNITIES AND INNOVATION:

The bioeconomy presents an opportunity for economic growth and innovation by tapping into the potential of biological resources. It opens new markets for bio-based products, bioenergy, and biotechnological applications, contributing to job creation and economic development.

GLOBAL SUSTAINABILITY GOALS:

International agreements and sustainability goals, such as the United Nations Sustainable Development Goals (SDGs), emphasize the importance of sustainable and inclusive economic development. The bioeconomy aligns with these goals by promoting practices that balance economic, social, and environmental considerations.

THE STRATEGICAL ROLE OF BIOECONOMY

The bioeconomy strategically addresses global challenges by utilizing renewable biological resources to diversify and secure our resource base. It plays a pivotal role in mitigating climate change through bioenergy, aligns with circular economy principles, and fosters economic growth and innovation across sectors like agriculture and biotechnology.

Strategically, the bioeconomy promotes sustainable agriculture practices, contributes to biodiversity conservation, and drives biotechnological advancements for improved global health outcomes. It serves as a catalyst for transitioning to a bio-based economy, reducing environmental impact.

Governments and international organizations recognize its strategic importance, guiding its responsible development through policy frameworks and international cooperation. In summary, the bioeconomy‘s strategic role extends beyond economic considerations, addressing complex global challenges through sustainable practices and resource efficiency.

EAGER TO DISCOVER MORE ?

As you may noticed, bioeconomy is rather a broad topic. Are you interested to discover more? The European strategy and scenarios for the future are hinted below.

CURIOUS ABOUT THE FUTURE OF BIOECONOMY?

CHECK OUT WHAT IS IN THE EU BIOECONOMY STRATEGY FOR YOU!

DID YOU KNOW THAT THE CENTRAL AND EASTERN COUTRIES ARE WORKING TOGETHER TO BOOST BIOECONOMY?

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GREENING HOUSEHOLD IN EVERYDAY LIFE

Greening a household involves adopting environmentally friendly practices and making sustainable choices in everyday life such as Energy efficiency, water conservation, waste reduction etc.

HOW CONSUMPTION AFFECTS THE STATE OF THE ENVIRONMENT

Consumption profoundly influences the state of the environment, playing a central role in various environmental challenges. As demands for goods and services increase, so do the environmental impacts associated with production, transportation, and disposal. The consequences of consumption include resource depletion, deforestation, and pollution. The extraction and use of natural resources, often exceeding the Earth‘s regenerative capacity, contribute to habitat loss and biodiversity decline. Additionally, manufacturing processes and the disposal of goods result in pollution of air, water, and soil. Greenhouse gas emissions, driven by energy-intensive consumption habits, contribute to climate change, altering weather patterns and raising sea levels. The generation of vast amounts of waste, including single-use plastics and electronic waste, poses threats to ecosystems and wildlife. Overconsumption also contributes to water scarcity, land degradation, and the overfishing of marine resources. The cumulative impact of unsustainable consumption patterns is a significant driver of environmental degradation, affecting the health and resilience of ecosystems on a global scale. Addressing these issues requires a shift towards sustainable and responsible consumption, emphasizing resource efficiency, waste reduction, and environmentally conscious choices.

ECOLOGICAL FOOTPRINT

The ecological footprint is a metric used to quantify the environmental impact of human activities. It measures the total area of land and water required to sustain a particular lifestyle, organization, community, or country. This footprint encompasses the resources consumed and the waste generated. Expressed in global hectares or acres, it assesses whether human activities align with the Earth's capacity to regenerate resources and absorb waste.

WHERE AND HOW WE CAN GREEN THE HOUSEHOLD

1. **ENERGY EFFICIENCY**:
Use energy-efficient appliances and light bulbs.
Turn off lights and electronics when not in use.
Consider investing in renewable energy sources, such as solar panels.

2. **WATER CONSERVATION**:
Fix leaks promptly.
Install water-saving devices, such as low-flow faucets and showerheads.
Collect rainwater for outdoor plants.

3. **WASTE REDUCTION**:
Practice recycling and composting.
Use reusable shopping bags, water bottles, and containers.
Avoid single-use plastics, such as straws and disposable utensils.

4. **SUSTAINABLE TRANSPORTATION**:
Use public transportation, carpool, bike, or walk whenever possible.
Consider hybrid or electric vehicles.
Maintain vehicles for optimal fuel efficiency.

5. **ECO-FRIENDLY PURCHASES**:
Choose products with minimal packaging.
Opt for eco-friendly and sustainable products.
Buy second-hand or repurpose items to reduce waste.

6. **ENERGY-EFFICIENT HOME DESIGN**:
Ensure proper insulation for energy efficiency.
Use curtains or blinds to regulate temperature and reduce heating or cooling needs.
Plant trees strategically to provide shade and reduce cooling costs.

7. **SUSTAINABLE FOOD CHOICES**:
Support local and organic food producers.
Reduce meat consumption or consider a plant-based diet.
Grow your own herbs or vegetables, even if it's just a small garden or indoor pots.

8. **GREEN CLEANING PRACTICES**:
Use environmentally friendly cleaning products.
Make your own cleaning solutions using natural ingredients like vinegar and baking soda.
Limit the use of disposable cleaning wipes.

9. **CONSCIOUS WATER USAGE**:
Shorten shower times and turn off the faucet when not in use.
Use a dishwasher or washing machine only for full loads.
Consider installing a low-flow toilet.

10. **EDUCATION AND AWARENESS**:
Stay informed about environmental issues.
Share eco-friendly practices with family and friends.
Participate in community initiatives or events promoting sustainability.

11. **REDUCING ELECTRONIC WASTE**:
Recycle electronic devices responsibly.
Consider repairing electronics instead of replacing them.
Dispose of e-waste through designated collection points.

12. **COMMUNITY ENGAGEMENT**:
Participate in local environmental initiatives or clean-up events.
Join or support community gardens and local farmers' markets.
Advocate for environmentally friendly practices in your community.

WHAT TO PAY ATTENTION TO WHEN SHOPPING

1. **PRODUCT LIFECYCLE**:
Consider the entire lifecycle of a product, from raw material extraction and manufacturing to transportation, use, and disposal. Choose products with a minimal environmental impact throughout their life cycle.

2. **CERTIFICATIONS AND LABELS**:
Look for recognized certifications and eco-labels that indicate a product meets specific environmental standards. Examples include the Forest Stewardship Council (FSC) certification for sustainably sourced wood and ENERGY STAR for energy-efficient appliances.

3. **PACKAGING**:
Avoid excessive packaging and opt for products with minimal or eco-friendly packaging. Choose items with packaging that can be recycled or is made from recycled materials.

4. **MATERIALS USED**:
Check the materials used in the product. Choose items made from renewable, recycled, or biodegradable materials. Avoid products with harmful chemicals or materials that have a significant environmental impact.

5. **ENERGY EFFICIENCY**:
Consider the energy efficiency of electronic devices and appliances. Look for products with the ENERGY STAR label or those that have been rated for energy efficiency.

6. **LOCAL AND SUSTAINABLE OPTIONS**:
Choose locally produced items to reduce the environmental impact of transportation. Additionally, opt for products that are certified as sustainable, whether it's food, clothing, or other goods.

7. **FAIR TRADE AND ETHICAL PRACTICES**:
Support brands and products that adhere to fair trade practices and ethical labor standards. This ensures that workers are treated fairly and that social and environmental considerations are taken into account.

8. **DURABILITY AND QUALITY**:
Choose products that are durable and of high quality. Items that last longer reduce the need for frequent replacements, thus decreasing overall resource consumption.

9. **SECOND-HAND AND VINTAGE SHOPPING**:
Consider buying second-hand or vintage items. This reduces the demand for new production and helps extend the life of products.

10. **TRANSPORTATION IMPACT**:
Assess the transportation impact of a product. If possible, choose locally produced items to minimize the carbon footprint associated with long-distance transportation.

11. **WATER USAGE**:
Be mindful of the water footprint of products, especially in industries like fashion and agriculture. Choosing water-efficient products contributes to water conservation efforts.

12. **BRAND VALUES AND PRACTICES**:
Research the sustainability initiatives and values of the brands you support. Choose brands that prioritize environmental responsibility and are transparent about their practices.

13. **WASTE REDUCTION**:
Consider the end-of-life disposal of a product. Choose items that are easily recyclable or biodegradable to minimize the environmental impact when they are no longer in use.

ECOLABES

„Ecolabels“ are labels or certifications placed on products to indicate that they meet specific environmental and sustainability standards. These labels serve as a quick reference for consumers who want to make environmentally friendly choices. Ecolabels are typically granted by independent third-party organizations or governmental agencies, and they signify that a product or service has undergone a thorough assessment based on predefined environmental criteria.

HOW MUCH DOES IT COST TO BE GREEN

The cost of adopting green practices at home can vary depending on the specific initiatives and upgrades you choose to implement. Some eco-friendly measures may have upfront costs, but many can result in long-term savings and environmental benefits. It‘s important to note that the cost-effectiveness of green practices varies, and the return on investment often extends beyond financial savings to include environmental and health benefits. Additionally, government incentives, rebates, and tax credits may be available to offset some of the initial costs. When considering green initiatives, it‘s advisable to conduct a cost-benefit analysis and explore available incentives to make informed decisions based on your budget and sustainability goals.

COMPARISION OF PRICE OF NORMAL AND GREEN PRODUCTS

1. LED VS. INCANDESCENT BULBS:
Regular Product: Incandescent bulbs are generally cheaper upfront.
Green Product: LED bulbs may have a higher upfront cost but consume less energy and last longer, resulting in long-term savings.

2. ENERGY-EFFICIENT APPLIANCES:
Regular Product: Conventional appliances may have a lower initial cost.
Green Product: Energy-efficient appliances, such as those with ENERGY STAR ratings, might be more expensive upfront but can lead to reduced energy bills.

3. SOLAR PANELS:
Regular Product: Relying solely on grid power has lower initial costs.
Green Product: Solar panels require a significant upfront investment but offer long-term energy savings and potential government incentives.

4. LOW-FLOW FIXTURES:
Regular Product: Standard faucets and showerheads are often cheaper upfront.
Green Product: Low-flow fixtures may have a slightly higher initial cost but can lead to water savings and lower bills over time.

5. REUSABLE VS. DISPOSABLE PRODUCTS:
Regular Product: Single-use products like plastic water bottles are inexpensive.
Green Product: Reusable products like stainless steel water bottles may have a higher upfront cost but eliminate the need for constant repurchase.

6. SMART THERMOSTATS:
Regular Product: Traditional thermostats are generally less expensive upfront.
Green Product: Smart thermostats may have a higher initial cost but can optimize energy usage and lead to long-term savings.

FOODWASTE - PACKAGING

REDUCING PACKAGING:
Implementing strategies to reduce unnecessary packaging and opting for minimalist, eco-friendly designs can help mitigate the environmental impact of packaging.

RECYCLABLE MATERIALS:
Choosing packaging that is easily recyclable promotes a circular economy. This involves using materials that can be recycled and reintroduced into the manufacturing process.

BIODEGRADABLE AND COMPOSTABLE MATERIALS:
Using packaging materials that are biodegradable or compostable can reduce the long-term environmental impact. These materials break down more efficiently, reducing the burden on landfills.

REUSABLE PACKAGING:
Encouraging the use of reusable packaging, such as containers that customers can return, refill, or exchange, can significantly reduce the generation of single-use packaging waste.

COSMETICS

The trend of „going green“ in the cosmetics industry involves adopting practices that prioritize environmental sustainability, ethical sourcing, and the use of ingredients that have minimal impact on the environment.
The „green“ movement in cosmetics reflects a growing awareness of the environmental and ethical considerations associated with personal care products. Consumers are increasingly seeking products that align with their values, leading to a shift in the industry toward more sustainable and eco-friendly practices.

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SUSTAINABLE BUSINESSES OF THE FUTURE

Sustainable businesses of the future are expected to prioritize environmental, social, and economic responsibility, reflecting a commitment to long-term sustainability. Three types of sustainable businesses are presented below that may play a crucial role in the future:

1 RENEWABLE ENERGY COMPANIES:

As the world transitions to a low-carbon economy, the demand for renewable energy sources is expected to rise. Sustainable businesses in the renewable energy sector may include companies involved in solar, wind, hydro, and geothermal energy. These companies focus on providing clean and sustainable energy solutions, contributing to reduced greenhouse gas emissions and mitigating climate change.

Examples of renewable resources RURES project

2 CIRCULAR ECONOMY ENTERPRISES

Businesses adopting a circular economy model aim to minimize waste by designing products with longevity, recyclability, and reusability in mind. These companies may engage in product refurbishment, recycling initiatives, and waste reduction strategies. Circular economy businesses are likely to play a significant role in addressing the global challenge of resource depletion and waste management.

Examples and additional information & training about how to implement circularity are provided by the CASCADE

3 ETHICAL TECHNOLOGY COMPANIES:

The technology sector has a crucial role in shaping the sustainable future. Ethical technology companies prioritize the responsible and ethical use of technology, including considerations for privacy, data security, and social impact. Sustainable technology businesses may focus on developing innovations such as green tech solutions, eco-friendly electronics, and sustainable software development practices.

HOW TO SUBSTITUTE THE FOSSIL BASED MATERIALS WITH BIO-BASED MATERIALS

To substitute fossil-based materials with bio-based alternatives, businesses can begin by assessing the specific requirements of the materials they aim to replace. Researching available bio-based materials, such as bioplastics, biocomposites, and advanced bio-based options, is crucial. Utilizing renewable resources, including plant-based sources and waste by-products, can support sustainability in material sourcing.

Exploring collaborations with suppliers specializing in bio-based materials can provide valuable insights, while investments in research and development help optimize the performance of bio-based materials for specific applications. Considering end-of-life aspects, such as biodegradability or compostability, contributes to a circular economy.

Adhering to certifications and standards, such as the USDA Certified Biobased Product label, helps verify the bio-based content. Businesses should also stay informed about regulatory compliance and communicate their sustainability efforts transparently. Overall, a comprehensive approach that considers sourcing, performance, end-of-life considerations, and regulatory compliance is essential for a successful transition to bio-based materials.

BIOECONOMY INNOVATION FOR BOOSTING THE BUSINESS

Bioeconomy innovation can play a pivotal role in boosting businesses by leveraging sustainable practices, renewable resources, and cutting-edge technologies. Here's an overview without bullet points:

1 Embracing bioeconomy innovation presents a strategic opportunity for businesses to enhance their sustainability efforts while unlocking new avenues for growth. By integrating renewable resources and advanced technologies, businesses can achieve a competitive edge in the evolving market landscape.

2 SUSTAINABLE SOURCING:
Businesses can explore innovative approaches to source raw materials sustainably. This may involve using bio-based feedstocks, waste-to-product conversion, or adopting circular economy principles. Sustainable sourcing not only aligns with environmental goals but also resonates with conscientious consumers.

3 BIOTECHNOLOGY AND GENETIC ENGINEERING:
The application of biotechnology and genetic engineering allows businesses to optimize processes, enhance product quality, and develop bio-based alternatives. This innovation can lead to the creation of bio-based materials, chemicals, and pharmaceuticals with improved properties and reduced environmental impact.

4 ADVANCED MANUFACTURING PROCESSES:
Innovations in manufacturing processes, such as biofabrication and synthetic biology, enable the production of bio-based products with increased efficiency and precision. These processes can be tailored to specific industrial needs, fostering flexibility and customization.

5 WASTE VALORIZATION:
Businesses can innovate by incorporating waste valorization strategies, converting organic waste into valuable products. This not only reduces the environmental footprint but also contributes to resource efficiency and the circular use of materials.

6 DIGITALIZATION AND DATA ANALYTICS:
Leveraging digital technologies and data analytics enhances efficiency in bioeconomy operations. Real-time monitoring, predictive analytics, and automation contribute to streamlined processes, reduced waste, and improved decision-making.

7 COLLABORATIVE ECOSYSTEMS:
Establishing collaborative ecosystems with research institutions, startups and industry partners fosters a culture of innovation. By participating in cross-sector collaborations, businesses can access diverse expertise, share resources, and accelerate the development of bioeconomy solutions.

In summary, bioeconomy innovation offers a pathway for businesses to integrate sustainability into their core strategies, respond to market demands, and create value through responsible and forward-thinking practices.

Case example for inspiration

Project: **CircularPP**

SOPKÖKET
Use of waste as resource (raw material)
challenge: Regulations on the management of raw materials or semi-finished products
URZA
Simplification of procedures of consumption brought about by streamlining
challenge: Consumers' distorted perceptions of lower hygiene requirements
ACCUS
Changing sales to Rent
challenge: need for flexibility design for product reuse
RE-MATCH
Transforming waste into raw material
challenge: Insufficient information on the possibility replacing natural grass with turf synthetic

Company: **TrafinOil**

Source of business: Recycling of used cooking oils from catering businesses and citizens. Company collects used cooking oils not only from restaurants and other catering businesses, but also from municipalities and citizens. All the collected waste oils and fats are then processed at the factory for secondary use. Through gradual mechanical purification, it produces clean raw material used in the production of modern fuels.

Links:
www.trafinoil.com
www.cirkularpp.eu

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THE MANY USES OF HEMP

Hemp is a versatile plant that has been used for thousands of years for various purposes, including textiles, paper, and food. In recent years, there has been a growing interest in using hemp as a source of bio-based materials. Bio-based materials from hemp offer a sustainable, environmentally-friendly, and versatile alternative to fossil-based materials, with benefits ranging from carbon sequestration to economic opportunities.

SUSTAINABILITY: Hemp is a renewable resource, it can be replanted and harvested multiple times. In contrast, fossil-based materials are non-renewable and deplete natural resources.

CARBON SEQUESTRATION: Hemp plants absorb carbon dioxide (CO_2) from the atmosphere during their growth, helping to reduce greenhouse gas emissions. This makes hemp-based materials carbon-neutral or even carbon-negative, whereas fossil-based materials release stored carbon into the atmosphere when used or burned.

BIODEGRADABILITY: Bio-based materials from hemp are often biodegradable, meaning they can decompose naturally without leaving harmful residues. Fossil-based materials, especially plastics, can persist in the environment for hundreds of years, leading to pollution.

REDUCED ENERGY CONSUMPTION: The cultivation and processing of hemp typically require less energy compared to the extraction and refining of fossil-based materials. This can lead to a reduction in energy consumption and associated emissions.

ZVT Agricultural Research, Ltd. Troubsko
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SOIL HEALTH: Hemp cultivation can improve soil health by preventing soil erosion, replenishing vital nutrients, and breaking disease cycles. This contrasts with some of the negative environmental impacts of extracting fossil fuels, such as oil spills and habitat destruction.

REDUCED TOXICITY: Hemp-based materials often have fewer toxins and harmful chemicals compared to some fossil-based materials, leading to safer products and reduced environmental contamination.

DIVERSE APPLICATIONS: Hemp fibers can be used to produce a wide range of products, including textiles, bioplastics, building materials, and more. This versatility offers a broader range of substitution possibilities for fossil-based materials.

ECONOMIC BENEFITS: The cultivation and processing of hemp can provide economic opportunities for farmers and industries, especially in regions looking to diversify their agricultural or manufacturing sectors.

DID YOU KNOW HEMP IS A NATURAL FIBER?

GOOD PRACTICE from the BIOEAST HUB CZ

Agritech Plant Research, Ltd. private research institutions with a long tradition of hemp breeding and cultivation (the institute was established during the 2nd World War when hemp was envisaged as a key military material)

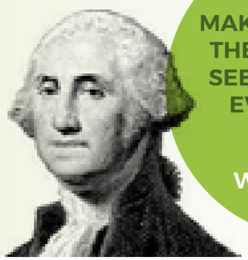
www.agritec.cz

▸ VIDEO ABOUT HEMP

Bohemia Plant is a czech company engaged in both B2B and B2C activities, the hemp shoes stand for a great innovation! And their hemps socks actually eliminate nuisance odours.

www.bohempia.com

Did you know that the first jeans were actually made from hemp? Well the hemp harvest is depicted on the dollar note...



> MAKE THE MOST OF THE INDIAN HEMP SEED, AND SOW IT EVERYWHERE.
>
> GEORGE WASHINGTON

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BIOGAS

Biogas is a renewable energy source with enormous potential to address environmental, energy, and sustainability challenges. It is a versatile and sustainable form of energy that is produced through the anaerobic digestion of organic materials, such as agricultural residues, food waste and wastewater. Biogas not only provides a renewable source of electricity and heat but also plays a crucial role in waste management and reducing greenhouse gas emissions. This fact sheet provides an overview of biogas as a renewable energy source, explaining how it is produced, its components, and its environmental and economic benefits.

BIOGAS: Biogas is a renewable energy source produced through the anaerobic digestion of organic matter, such as agricultural waste, animal manure, and sewage, by microorganisms.

MAIN COMPONENT OF BIOGAS: Methane (CH_4) is the primary component of biogas, typically constituting 50-75% of its composition.

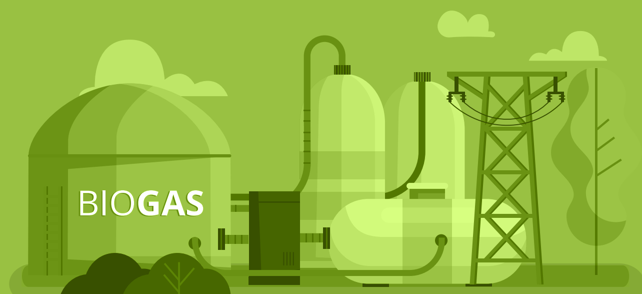
BIOGAS PRODUCTION AND PROCESSES: Biogas is produced through a natural biological process called anaerobic digestion, where microorganisms break down organic matter in the absence of oxygen.

MAIN STEPS IN BIOGAS PRODUCTION: The main steps include feedstock preparation, anaerobic digestion, gas collection, and gas utilization.

FEEDSTOCK FOR BIOGAS PRODUCTION: Organic materials such as agricultural residues, animal manure, food waste, and sewage are common feedstocks. But almost every organic waste can be utilised for biogas production.

MULTIPLE TYPES OF FEEDSTOCK IN A BIOGAS SYSTEM: Using a mix of feedstocks can enhance nutrient balance and improve gas production efficiency.

BIOGAS APPLICATIONS: After several cleaning and purification steps, biogas can be used for cooking, heating, electricity generation, and as a fuel for vehicles.



BIOGAS IN INDUSTRIAL PROCESSES: Biogas can be used in various industrial applications, such as heat generation and powering equipment.

ENVIRONMENTAL BENEFITS: Biogas helps reduce greenhouse gas emissions by capturing methane from organic waste and converting it into a usable energy source.

IMPACT OF BIOGAS ON WASTE MANAGEMENT: Biogas technology facilitates the effective management and recycling of organic waste, reducing the need for landfill disposal.

ECONOMIC VIABILITY: Biogas projects can be economically viable, especially when considering factors like reduced energy costs, waste management savings, and potential revenue streams.

Good practice

Village Kněžice (energy self sustainable village) (https://obec-knezice.cz/obec-knezice/energeticky-sobestacna-obec)

Linking fishery with biogas plants (https://naschov.cz/vyuziti-odpadniho-tepla-k-chovu-ryb/#:~:text=Bioplynov%C3%A9%20stanice%20se%20staly%2b%C4%9B%C5%BEnou,nebo%20k%20su%C5%A1en%C3%AD%20rostlinn%C3%A9%20produkce)

DID YOU KNOW THAT BIOGAS ?

...IS MUCH OLDER THAN FOSSIL FUELS?

Microorganisms that produce biogas are among the oldest forms of life on Earth, more than three billion years older that the plants and animals that have become today´s fossil fuels.

...IS A RENEWABLE ENERGY SOURCE?

Biogas is produced through the anaerobic digestion of organic matter, such as agricultural waste, manure, and sewage. Unlike finite fossil fuels, the sources of biogas are abundant and continuously generated, making it a sustainable and renewable energy option.

...REDUCES GREENHOUSE GAS EMISSIONS?

The process of producing biogas helps in the decomposition of organic waste, preventing the release of methane, a potent greenhouse gas, into the atmosphere. By utilizing biogas as an energy source, we not only generate clean energy but also contribute to mitigating climate change.

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SUSTAINABLE WOODY BIOMASS

INTRODUCTION

Sustainable woody biomass encompasses organic materials obtained from trees and woody plants through sustainable forest/agriculture management practices. These renewable resources play a pivotal role in combating climate change, simultaneously supporting local economies and enhancing societal well-being.

- Woody biomass serves as a versatile source of renewable energy, reducing dependence on non-renewable resources and contributing to a diversified and resilient energy portfolio.
- Woody biomass is converted to energy through various processes, especially direct combustion (burning) to produce heat and thermochemical conversion to produce solid, gaseous, and liquid fuels.
- Woody biomass can also be turned into transportation fuels using three main methods.
    - The first method involves heating wood with limited oxygen to create syngas, which can be turned into liquid fuels, e.g. ethanol or diesel[1].
    - The second method breaks down parts of wood into sugars, ferments them into ethanol using microbes, which convert them into ethanol[2].
    - The third method heats wood without oxygen, so called pyrolysis (thermochemical) to produce bio-oil, which can be refined into diesel, gasoline, or other related products[3].

[1] Tunå P, Hulteberg C. Woody biomass-based transportation fuels-A comparative techno-economic study. Fuel. 2014 Jan 30;117:1020-6.

[2] Wackett LP. Biomass to fuels via microbial transformations. Current opinion in chemical biology. 2008 Apr 1;12(2):187-93.

[3] Isahak WN, Hisham MW, Yarmo MA, Hin TY. A review on bio-oil production from biomass by using pyrolysis method. Renewable and sustainable energy reviews. 2012 Oct 1;16(8):5910-23.

- Wood pellets are a type of solid biomass fuel made from compacted sawdust, wood shavings, and other wood waste materials. These small, cylindrical pellets are produced through a process called pelletization.

Figure 1. Wood pellets

- Another valuable product derived from woody biomass is biochar, a carbon-rich material produced through the process of pyrolysis, which involves heating biomass in the absence of oxygen. This results in a stable, charcoal-like substance that can be used for various purposes, particularly in agriculture. Sources of biochar from woody biomass include twigs and leaf litter forestry.

Figure 2. Biochar

DO YOU KNOW THAT WOODY BIOMASS ?

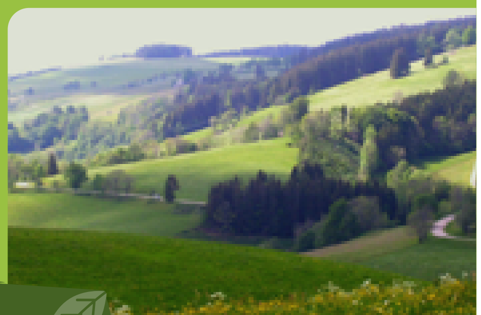
...IS CONSIDERED „CARBON NEUTRAL“[4]?

It means the carbon footprint associated with combustion or utilization of woody biomass is considered to be neutral or close to zero, as the carbon emitted during its utilization is offset by the carbon sequestration that occurred during the trees and plants‘s growth phase

...SOURCES OF WOODY BIOMASS ARE NOT ONLY FROM PRIMARY PRODUCTS OF NATURAL FORESTS AND PLANTATIONS?

They also encompass residues and wastes, such as those from plantation and agriculture operations, wastes from construction and wood processing industries, as well as household wood waste.

Figure 3: Forest trees and agriculture crops →



GOOD PRACTICE

“Let’s clean up the Czechia” (www.kamsnim.cz)

A project from a non-profit organization to collect recycled materials including woody biomass for reutilization with more than 50,000 collection points.

[4] FAO. Implications of Woodfuel Use for Greenhouse Gas Emissions. In Asia-Pacific Forestry Sector Outlook Study: Regional Study on Wood Energy Today and Tomorrow in Asia; Working Papers Series. Field Document No. 50; Regional Wood Energy Development Programme in Asia: Bangkok, Thailand, 1997.

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FOOD PRESERVING

Preserving practices for a more sustainable food consumption

The bio-based economy can play a fundamental role in the production of healthy food and in shifting to healthier and more sustainable consumption patterns. It can strengthen local value chains, promoting the reuse and recycling of food resources. There are increasing changes toward sustainable consumer lifestyles, where consumers are better informed, willing to buy environmentally friendly products as well as to prepare them themselves. These changes create opportunities for the utilisation of household food residues and reduction of food waste.

Eco-friendly living starts locally, in our immediate environment, at home. Food consumption is one of the most essential elements of everyday life, so practices that can make it more sustainable and reduce food waste are of significant importance.

Preserving practices support the minimization of both food surplus and avoidable food waste, which is positioned as the most attractive option in the food waste hierarchy. **Preserving allows individuals to take advantage of the following sustainability-friendly opportunities:**

1. local food being in season, produced by themselves or bought at local markets;
2. raw food ingredients purchased in larger quantities when they are cheaper at retailers or on "pick it yourself" promotion days directly from farmers;
3. pre-packed boxes of vegetables and other food items, ordered online and delivered weekly throughout the whole year from local producers or "vegetable box communities", meaning a group of producers offering different products that can be selected by consumers to be put in the vegetable box they order (in Hungary they are known as "basket communities");
4. food rescue actions organised by supermarkets, where vegetables and fruits that are still edible but have minor defects are offered in a 3-4 kg unit package, at an extremely favourable price;
5. valorising certain types of food wastes, such as fruit peels.

Foods quickly deteriorate because of the natural spoiling process caused by microorganisms (bacteria and fungi such as mould, yeast). Preservation technologies can extend the life of foods by stopping this process. **Freezing** is the simplest way to store food for a longer time, however, it requires energy continuously. There are different ways such as **canning, pickling, drying/dehydrating, fermenting** to preserve food safely without refrigeration, to save energy and space for leftovers and other foods that can be preserved only by freezing.

CANNING PRESERVES

food in tightly sealed glass jars by a heat treatment. The boiling water bath method is the simplest way for canning: jars packed with food are placed in a hot water bath for a certain time where microorganisms are killed by the heat treatment. The later cooling forms a vacuum seal under the lid which prevents microbial recontamination. Foods with lower acidity may necessitate the use of the pressure canning method which operates at higher temperature up to 130 °C. It involves specialised and thus more expensive equipment, but it will also allow to can meat, fish, poultry, ready-to-eat soups and other meals with high water content. It is always useful to check a canning reference listing the correct canning time for each food.

PICKLING

is a special type of canning mostly suitable for high-acidity foods such as tomatoes, cucumbers or fruits. Pickling solutions are typically highly acidic from vinegar added, with a pH under 5, and often high in salt, preventing microorganisms from growing and enzymes from altering the food texture.

DRYING/DEHYDRATING

removes moisture from food to an insufficient extent for the growth of microorganisms. It is suitable for fruits, mushrooms, herbs and vegetables. At home food can be dried both indoors and outdoors. Air and solar dehydrating outside require an airy place with low humidity. Inside, a conventional oven or a food dehydrator machine can be used, or simple hanging in a warm, dry place can dry out foods and preserve them.

FERMENTATION

preserves food by involving anaerobic bacteria to convert the natural sugars in the food to lactic acid, thereby creating an acidic environment in which food-spoiling microorganisms are not able to grow. The raw ingredients are sliced or shredded, salted with non-iodised salt and packed into containers, then allowed to sit at room temperature until the fermentation process is complete which takes 2-3 weeks in general. Most traditional vegetable fermentation techniques rely on naturally occurring bacteria on the vegetables and in the environment. Fermentation can even boost the nutritional value of the preserved food because during the process food ingredients are broken down in a way that makes the nutrients more available for the human metabolism.

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THE TABLE BELOW PRESENTS A COMPARISON BETWEEN THE THREE MOST COMMONLY USED PRESERVATION METHODS:

Comparison point	CANNING	DRYING	FREEZING
MAINTAINING QUALITY	maintains the original quality and flavour of food natural ingredients are well retained, however, higher temperature in pressure canning is more likely to damage nutrients	can lead to a loss of some nutrients and natural ingredients causes changes in flavour and texture	preserves well the natural ingredients maintains also heat-sensitive vitamins and other nutrients might cause an undesirable change in texture and flavour when defrosted
EXPIRY	canned foods can maintain their quality and validity for a period of up to many years	dried foods can be stored for several months to even a couple of years	frozen foods can maintain their quality and validity for several months to a year
CONVENIENCE	the process is easy and accessible to everyone simple tools are needed	may require specific equipment such as an oven or a special drying device, usually takes more time in preparation and execution than the other two methods product requires little storage space because dried foods are compact	easy process requires a refrigerated storage space, which requires certain planning and organisation of storage and arrangement
SAFETY	serious food safety implications can occur if made inappropriately safe way if the health guidelines and standards required are followed	may allow some settling of pathogenic microbes if not dried properly a package of dried food can be opened again and again without damaging the contents	microorganisms are not killed but their growth is prevented by the low temperature, thus products have to be cooked in a short time after thawing
SUSTAINABILITY	saving energy and reducing food waste	saving energy and reducing food waste	less sustainable as it depends upon a source of non-renewable energy

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PRESERVING CAN PROVIDE MANY BENEFITS TO INDIVIDUALS, FAMILIES, LOCAL COMMUNITIES AS WELL AS GLOBALLY:

PRESERVING QUALITY AND FRESHNESS

Products are secured from spoilage, given a longer shelf life while their flavour and nutritional value are preserved.

HEALTHY EATING

Canned food can increase fibre intake which is essential to reduce the risk of developing various conditions, including heart disease, diabetes and colon cancer, and to lower blood cholesterol level. Fermented foods contain probiotics that are highly important as they help in keeping the digestive and immune systems healthy.

SAVING MONEY

Homemade preserved food products are more economical compared to buying ready-made packaged products. It can be produced seasonally and preserved when cheap and fresh.

REDUCING WASTE AND PRESERVING NATURAL RESOURCES

People can fine-tune quantities and avoid food waste as well as reuse food parts that would become waste otherwise.

CONTROL OF INGREDIENTS

Home preservation provides individuals with the opportunity to have complete control over the ingredients used in the process. They can choose fresh and organic ingredients and adjust proportions and seasonings to personal taste. Adding preservatives or potentially harmful substances (artificial colourings, flavour enhancers etc.) can be avoided and healthy ingredients can be used.

CONVENIENCE

Pre-packaged healthy, custom-prepared meals can be easily made using preserved food with favourite ingredients, saving time and effort in preparation.

VERSATILITY

Dried fruits are an excellent snack or addition to a muesli, porridge or desserts. Dried herbs and vegetables can be rehydrated with water, and give an extra flavour boost to soups, stews, risottos and more. Dried berries and herbs make fantastic herbal tea.

Practical examples and useful tips for home scale preservation:

- homemade vegetable stock using tops, bottoms, skins of onion, garlic, celery, carrot, potato; mushroom and parsley stems, etc.
- dried and grounded tomato peel: "tomato powder" for seasoning, vegetable spice rubs, colourant ingredient
- homemade chips from vegetable peels such as carrot and potato peel
- special tips for preserving mushrooms
- downloading and using a seasonal food calendar that gives a useful guide on what raw foods are in season or likely to be available from storage locally
- "sauerkraut" (fermented cabbage) as a rich source of probiotics and vitamins
- air drying by hanging herbs like chamomile, mint, lemon balm etc.
- sun drying in the summertime

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COMPOSTING

POLICY BACKGROUND

As defined in Directive (EU) 2018/851 of the European Parliament and of the Council, bio-waste includes „biodegradable garden and park waste, food and kitchen waste from households, offices, restaurants, wholesale, canteens, caterers and retail premises and comparable waste from food processing plants". According to this definition, bio-waste does not include forestry and agricultural residues, manure, sewage sludge, or other biodegradable waste such as paper or processed wood.

The theoretical potential generation of bio-waste has been calculated as 114 million tonnes per year for the EU 27+ countries (EU 27, Norway and Switzerland) by the European network of communities 'Zero Waste Europe' in 2020. The data report released by the European Compost Network (ECN) in 2022 verifies that less than 40 million tonnes of municipal bio-waste are separately collected and processed annually into high-quality compost and digestate in Europe. This means that only 17% of municipal solid waste is organically recycled through composting and anaerobic digestion.

The Waste Framework Directive (2008/98/EC) mandates bio-waste collection from January 2024 onwards, furthermore, it includes another mandatory target: the goal of having at least 65% of municipal waste collected and prepared for reuse and recycling by 2035. As pointed out also in the ECN data report mentioned above, in order to reach this overall recycling target there is a **need to set further incentives to improve the separate collection and the biological management of bio-waste at the European level.**

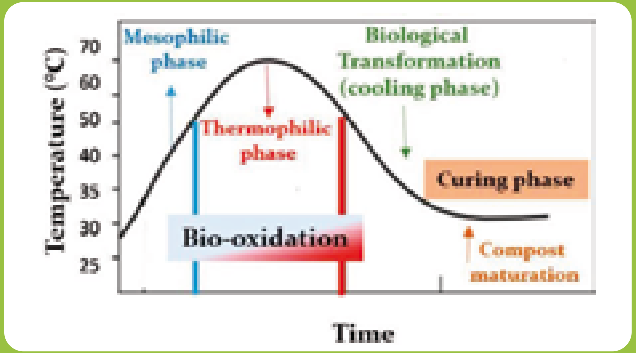
HOW DOES COMPOSTING WORK AND WHY IS IT IMPORTANT?

If prevention at source is not possible, bio-waste can be managed in various ways, among others by separate collection and composting. Composting is a natural, self-heating, solid-phase biological recycling process, during which organic waste materials are degraded by aerobic microorganisms. The bioconversion of organic household waste and residues through the composting process results in a **stabilised, nutrient-rich, humus-like end-product** known as compost. This material is hygienically safe and can be used as a **soil improver or fertiliser**. Composting creates a **natural source of nutrients for plants** and promotes the circular use of renewable resources and thus can significantly reduce the amount of household waste disposed to landfills.

Compost plays a crucial role in improvement of the structure of the soil:

- It allows more air into the soil, improves drainage and reduces erosion.
- It helps to stop the soil from drying out in times of drought by holding more water.

During composting the materials go through several physical, biological and chemical transformations. The composting process is characterised by four phases, which are depicted in the following figure (Papale, M. et al., 2021):



(1) MESOPHILIC PHASE:

The composting process starts at ambient temperature and in a short time (few days or even hours), the temperature rises to 40-45˚C, initiating organic matter decomposition by mesophilic microorganisms, which function best between 30 and 50 ˚C. Metabolic activity of various heterogeneous group of these microorganisms results in increased temperature as they utilise the N and C of the organic matter for their body assimilation. Decomposition of soluble compounds, such as sugars, produces organic acids and hence, pH can drop to 4.0-4.5.

(2) THERMOPHILIC PHASE:

When the temperature in the pile rises higher than 45 ˚C, within 24 to 72 hours of the pile formation, the mesophilic microorganisms are replaced by the thermophilic ones (mostly bacteria) which has capacity to grow at higher temperature. They facilitate the degradation of complex organic plant materials, i.e., cellulose and lignin. Conversion of nitrogen into ammonia by the thermophilic microbes results in pH rise of the compost pile during this stage. The most active “hot phase” (65-70 ˚C), where decomposition is the most rapid, lasts for two to eight days.

(3) COOLING PHASE:

After the exhaust of carbon and nitrogen sources from the raw material, the microbial activity decreases and thus the temperature of the pile declines again. As temperature goes below 45 °C, mesophilic microorganisms recolonise and pH of the compost pile slightly decreases, whereas in general pH of the compost pile remains slightly alkaline. This cooling phase requires several weeks.

(4) CURING/MATURATION PHASE:

The temperature of the compost pile drops from 40-45 ˚C to the ambient temperature level. The oxygen consumption declines, and organic materials continue to decompose and biologically stable humic substances that are characteristic to the mature compost are formed. A long curing phase is needed if the compost is immature, which usually happens if the pile contained too little oxygen or either too little or too much moisture.

HOME COMPOSTING

Composting (including the selective collection of bio-wastes for composting) is a traditional and probably the most convenient way to recycle bio-waste produced at smaller scale. Home composting is a great way of being greener, improving soil in farms and gardens, and making use of organic waste which would ordinarily be sent to landfill. Obviously not all household waste materials are suitable for composting, even if they are bio-based or biodegradable. The table below presents a list of waste materials that should and should not be composted.

Compostable materials **FROM THE YARD** (garden waste)	• shredded branches, twigs and bark of garden plants • withered flowers, cut plant stems • grass clippings • leaves • untreated wood • potting soil
Compostable materials **FROM THE KITCHEN** (household organic waste)	• unprocessed fruit and vegetables leftovers (peels, leaves, stems) • eggshells (crushed) • coffee ground and tea leftovers (without filter), spices, herbs • overblown flowers, potted plants and their soil (without pot) • pets’ litter (only herbivorous)
Materials **WITH LIMITED SUITABILITY** for composting	• conifers, weeds, walnut leaf, peels of non-treated tropical fruits • wood ash • shredded uncoloured or untreated, non-glossy paper packaging, newspapers, • undyed or untreated textiles with 100% natural ingredients (e.g. cotton, wool)
NON-COMPOSTABLE materials	• packaging materials, • hazardous waste, chemicals, paints, • leftovers of cooked and processed food, baked goods, • bones, dairy products, fat, used household oils, • content of vacuum cleaner dust bag, cigarette butts, • litter of carnivorous and omnivorous pets

Compost feedstocks are the organic material you put in your compost pile. There are two broad categories of feedstock to put in the compost bin or pile: **greens and browns**.

Greens the nitrogen source, are colourful and wet (e. g.: grass clipping, fresh manure, garden clean out, food scraps). They provide nutrients and moisture for the compost decomposers, so they grow and reproduce quickly.

Browns the carbon source, provide energy, and are also used for absorbing excess moisture and giving structural strength to the compost pile. They help keep the pile porous, facilitate airflow and prevent compaction (e. g.: brown leaves, branches, straw, paper, sawdust, woodchips).

Layering and choosing the right organic materials creates an optimal environment for the composting process. Building of a compost pile is started with a layer of coarse "browns" in contact with the soil. Then a well or depression is made in this layer and the "greens" are put into the well. The food scraps should be kept away from the outside edges of the pile, only brown material should be visible. The layer of "greens" has to be covered with a generous layer of "browns" so that no food is showing. The pile can be finished with a layer of soil or finished compost. These covering methods will keep insect and animal pests out of the pile and filter any odour.

A minimum volume of 1 m3 (1x1x1 m) is required for a pile to become sufficiently self-insulating to retain heat. Heat will help reduce pathogens and allow the process to occur more quickly. This size is usually enough for the kitchen and garden waste of an average family. More containers can also be used: when a bin is full, while it is processing and curing, a second one can be started to be filled.

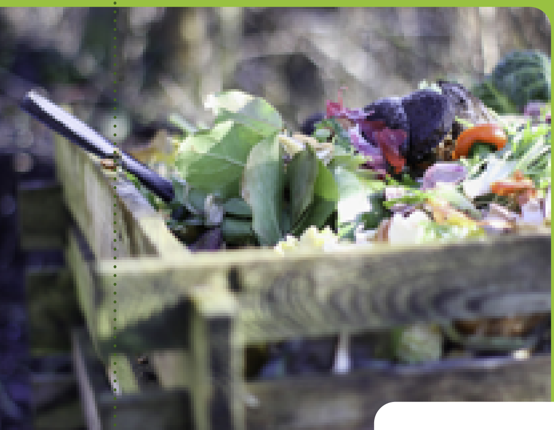
Composting bins can be either three or four sided, with a removable front to facilitate turning. Containers can even be built of scrap wood, pallets, fencing or cement. Ready-to-use metal, wood and moulded plastic composting containers can be purchased as well.

Location of the pile can have a significant effect on the composting process. It should be located in a level, well-drained area. In cool climates, putting it in a sunny spot can help trap solar heat, while shade in warmer climates may keep it from drying out.

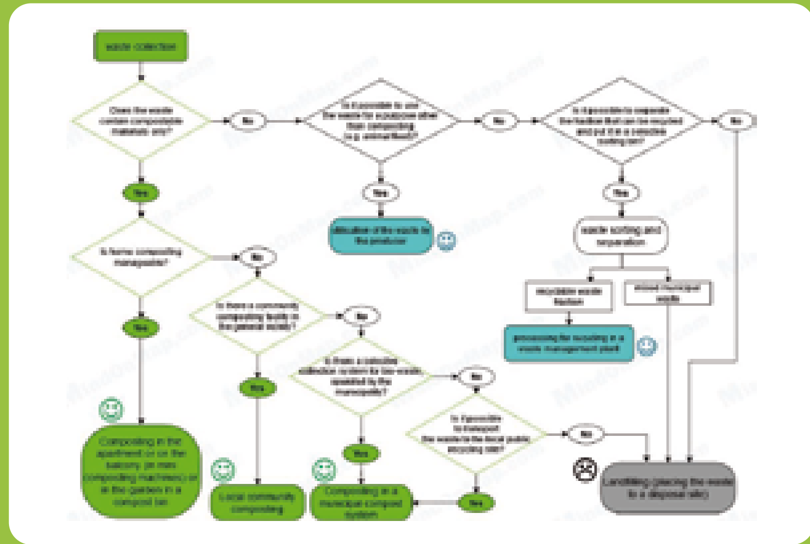
Different management choices can be made when building the pile. Passive composting requires less labour but more time. If there is time and space to wait for a usable product (9 to 15 months after building the pile), the process can be let work passively. If processing space and time is limited, turning will help to speed the process. The pile can be turned with a pitch fork or shovel, which helps to break up material and better homogenise the mass.

Composting process largely depends on raw materials and environmental conditions, and several parameters affecting compost preparation (e.g. moisture content, aeration, carbon-nitrogen ratio, particle size etc.) have to be appropriately set and kept in an optimal range.

Finished compost is applied to the soil at rates from 10 to 100 tonnes per hectare or 1 to 10 kg/m2. The bulk density of compost ranges between 420 to 655 kg/m3. A pile size of 1 m3 is roughly enough for a 50-500 m2 garden plot, depending on the dose of application.



The aim of the flowchart below is to present the possibilities regarding waste management at the level of individual waste producers. The green elements on the left side of the chart show the different options for composting.



BENEFITS OF COMPOSTING

1 reducing the waste stream

2 reducing personal food waste

3 recycling nutrients in a controlled and accelerated way

4 positively impacting the environment (improving soil structure and health, and lessens erosion)

5 minimising environmental impact (reducing CO2 emissions; cutting methane emissions from landfills)

6 source of renewable energy

7 producing a valuable product that can be utilised as a high-quality fertiliser or soil additive

8 saving money on buying expensive fertilisers

9 making a shift toward a greener future

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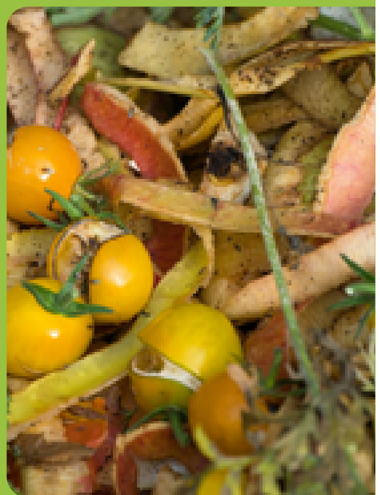

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AGRO-BIOMASS

Residues and waste from agriculture - biomass potential refers to the maximum amount of biomass that can be expected to be available for various uses, including energy production, organic fertilizers, composting and other industrial applications. This potential varies depending on the type of crop, growing conditions and technologies used in harvesting and processing. This can be straw, corn pulp, husks, seeds, etc. They can be used as fuel in our own boiler rooms or as raw material for the production of products such as briquettes and pellets (so-called agro-pellets made of straw).[1]

The bioeconomy strategy is one of the policies of the European Union, which aims to strengthen economies through greater efficiency in the use of biomass through numerous innovations and to facilitate the transition to green policies through the supply of renewable carbon to society. Agriculture as the primary production sector plays an important role in the development of a circular and sustainable bioeconomy.[2]

AGRICULTURAL BIOMASS IS DIVIDED INTO[3]:

1. Biomass of crop production (hay, straw, stalks, corn stalks, husks, husks of agricultural crops),
2. Biomass of fruit and viticulture production (pruned remains of permanent plantations),
3. Biomass from the processing of agricultural raw materials in the food industry (grape pomace, olive pomace, oilseed pomace, fruit pits, lupine fruit shells),
4. Biomass from vegetable growing and ornamental horticulture (remainder from gardens and parks),
5. Livestock production biomass (manure, slurry, slaughterhouse waste, fishery waste, meat and bone meal),
6. Agricultural biomass of crops for energy production on separately established plantations (Miscanthus sp., Sudanese grass).

[1] Circular economy and economic potential of agricultural residues https://zir.nsk.hr/en/islandora/object/pfos%3A3145/datastream/PDF/view

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[3] The Bioeconomy in Europe: An Overview, https://www.mdpi.com/2071-1050/5/6/2589?frbrVersion=6

THE ADVANTAGES OF USING BIOMASS AS AN ENERGY SOURCE ARE:

1. Huge energy potential,
2. Renewable and sustainable form of energy,
3. Reducing dependence on the import of fossil fuels (energy independence),
4. Possibility of storage,
5. Reduction of emissions of harmful gases into the atmosphere (CO_2, SO_2, NOx),
6. CO_2 emissions are equal to zero,
7. Increase of arable land under the cultivation of energy crops,
8. Socio-economic aspects (creation of new jobs, development of rural communities and increase of local and regional economic activity).

BIOMASS OF AGRICULTURAL PRODUCTION

In agricultural production, the most important material that bioenergy resources can be made of is the biomass of wheat, corn, barley,followed by oilseeds and grain legumes, with special emphasis on the dedicated production of oilseeds for biofuel. The energy value of biomass is different and depends on the amount of water in the mass and its chemical composition. The fuel value of wheat straw, biomass of oilseeds and legumes with approximately 15% water is about 14.5 MJ/kg. A part of the biomass is returned to the soil as organic matter, and a part is lost during collection and manipulation, and the utilization is calculated at 30%.

Collection of pruning residues is done in two ways, manually and mechanically. As for manual harvesting, it is most often done using human labor or rakes on smaller areas and narrow rows, and the biomass is brought to the end of the rows. In the second case, mechanical collection, it is carried out with the help of connected and carried machines and is also brought to the end of the rows. Machines mean shredders that shred the cut mass and leave it in the inter-row spaces.

In addition to shredders, there are also machines for baling the pruned mass, where the end product of the so-called „bale“ is put into a furnace and thermal energy is obtained. The worst scenario is to burn the pruning residues, thus losing a valuable source of energy and polluting the atmosphere and destroying the microflora and fauna in the arable soil layer and consequently reducing the proportion of soil organic matter. [4]

BIOMASS PELLET

Straw after the harvest of wheat, barley, oats, corn husks after harvesting corn or any other residues after field crops can be used for pellets. These are desirable raw materials that farmers normally burn or plow.

[4] AGRICULTURAL BIOMASS FROM HARVEST RESIDUES, https://projekt-klima.eu/wp-content/uploads/2021/05/Brosura_Poljoprivredna-biomasa-iz-zetvenih-ostataka.pdf

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In the production of agricultural crops, the amount of wheat, corn or other cereals you have harvested is estimated to be approximately the same amount of remaining biomass. So, if you removed five tons of wheat, you also have about five tons of straw. In some varieties, it is 10 to 15% more, in others a little less.

However, even when the costs of collection of harvest residues, transport and processing are deducted, it should be a profitable production and a solid additional income in agriculture. [5]

BIOMASS FROM FRUITS AND VEGETABLES

Pruning products are pruned branches or pruning residues that need to be disposed of. A significant amount of agricultural biomass comes precisely after the pruning of orchards and olive groves. The energy potential from fruit and viticulture production includes the amount and energy value of pruned wood material in apple, pear, peach, olive, plum, cherry and vine plantations.

The processing of fruits and vegetables into a semi-finished or finished product leaves a large amount of „waste“, where a significant part consists of pits (plums, sour cherries, cherries and olives) and ljuska (walnuts, hazelnuts and almonds). [6]

BIOMASS FROM THE PROCESSING OF AGRICULTURAL RAW MATERIALS

OLIVE PITS

It is a cheap energy source, not a waste produced by processing the fruit. In addition to its high energy value, it is also significantly cheaper than, for example, heating oil or pellets. Instead of throwing it away as biological waste, some oil mills in Istria sell it and use it for heating.

They are separated from pomace with a special machine during fruit processing and olive oil production. Ten to 12 percent of the total mass at the entrance means that if we have a ton of olives, we have 100, 120 kilos of pits, which are currently thrown away in most oil mills and not pitted, and most houses on the Adriatic, buildings, schools, can be heated with that pit. Because 2 kilos of seeds have the same energy value as one liter of heating oil. [7]

They need about 7 tons of olive pits to heat the 300-square-meter house and the large oil mill.

The price of the olive pit is 0.13 cents per kilo, that is still in the experimental phase of distribution. They are taken by people who have pellet stoves that they have adapted to be able to burn stone.

[5] Energy potential of biomass agriculture in Croatia, https://hrcak.srce.hr/file/223346
[6] Energy potential of biomass agriculture in Croatia, https://hrcak.srce.hr/file/223346
[7] 5 portal, https://5portal.hr/vijesti_detalj.php?id=16107

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Some have already acquired specialized boilers for biomass, which burn stone without problems.

Separating the stone from the pomace reduces the biomass that oil producers have to dispose of, and composting the pomace is faster and simpler..

GRAPE POMACE

Picture 1. Grape pomace, family winery Pervino ↑

Pomace as a by-product of winemaking has a valuable raw material potential, and almost one hundred percent of the pomace can be used, and grape seed oil, grape seed flour, and skin flour can be produced from it. It is a valuable raw material for the production of biomass in the process of obtaining „clean“ energy. It is used as an organic fertilizer in gardens, olive groves and vineyards. Compost can be an excellent fertilizer because it contains nitrogen, phosphoric acid, potassium. It is suitable for improving soil structure. Grape pomace is also used to obtain biofuel because wine pomace is a good source of thermal energy. This mainly involves the production of pomace pellets. By burning wine pomace, there is no sulfur that affects environmental pollution and the formation of slag after burning, so a wider application of pomace is expected in the production industry of pellets, which are considered to be the energy source of the future. As an energy source, pellets are environmentally friendly and not expensive, so their production is safe and profitable in the long term. [8]

LIVESTOCK PRODUCTION BIOMASS

The energy utilization of biomass from animal husbandry is significant for the production of biogas. Biogas can be used in the household for heating, cooking and lighting. The production of biogas from manure ensures the preservation of the environment and good technological solutions for the disposal of waste that is converted into usable energy. This way of processing waste reduces the cost of importing energy and petroleum products. There are several important roles of biogas, but the most important is that it represents a renewable source of energy. By producing biogas from cow and pig manure, farms can become producers of electricity and thermal energy, thus reducing the emission of greenhouse gases and preventing the release of methane into the atmosphere. Biogas can be considered an alternative fuel, because its production requires animal waste, which is in excess in agriculture.

Through the process of anaerobic fermentation in biogas plants, both solid and liquid residues are formed in the form of decomposed organic matter, i.e. digestate. Digestate, which contains useful ingredients, is a quality fertilizer obtained after aeration, squeezing and drying for several weeks. Its values are manifested in ecological, economic and agronomic terms. Applying digestate improves the level of humus in the soil and reduces the risk of soil erosion. Its advantage is also manifested in the maximum utilization of nutrients, high speed and lower costs of application, as well as improvement of soil pH and high microbiological activity. The energy utilization of biomass from animal husbandry is significant for the production of biogas. Biogas can be used in the household for heating, cooking and lighting. The production of biogas from manure ensures the preservation of the environment and good technological solutions for the disposal of waste that is converted into usable energy. This way of processing waste reduces the cost of importing energy and petroleum products. There are several important roles of biogas, but the most important is that it represents a renewable source of energy. By producing biogas from cow and pig manure, farms can become producers of electricity and thermal energy, thus reducing the emission of greenhouse gases and preventing the release of methane into the atmosphere. Biogas can be considered an alternative fuel, because its production requires animal waste, which is in excess in agriculture. [9]

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Picture 2. An example of a biogas plant in Pisarovina ↑

AGRICULTURAL BIOMASS CROPS FOR ENERGY PRODUCTION ON SEPARATELY FORMED PLANTATIONS - MISCANTHUS

The energy possibility of using Miscanthus x giganteus is that it is mostly used as firewood, i.e. for co-combustion with coal and/or independent direct combustion for the production of heat and/or electricity. By using different compaction technologies, the produced biomass is refined into solid biofuels (briquettes and pellets) and after the briquetting/pelleting process, it can be used more efficiently for the production of „green energy“.

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[8] Gospodarski list, Compost from pomace of olives and grapes, https://gospodarski.hr/rubrike/vinogradarstvo-rubrike/kompost-od-komine-grozda-i-maslina/

[9] PRODUCTION OF BIOGAS FROM STAGE MANURE, https://ips-konzalting.hr/blog/ips-novosti-8/post/proizvodnja-bioplina-iz-stajskog-gnoja-605

GOOD EXAMPLE

Agrobioheat project (www.zez.coop/agrobioheat)

The AgroBioHeat project aims to initiate the mass implementation of improved and market-ready solutions for the use of agricultural (agrarian) biomass for heating in Europe. Agricultural biomass is a significant, insufficiently researched and locally available energy source, which can contribute to the achievement of European energy and climate goals, and at the same time promote rural development and circular economy.

OBJECTIVES:

- To increase agrobiomass for heating deployment accompanying 8 flagship projects and triggering more than 80 initiatives.
- To raise trust among stakeholders in agrobiomass heating solutions.
- To provide guidance and recommendations to policy makers at local, regional and national level to understand and set the instruments that will overcome the barriers for the advancement of **the** agrobiomass heating sector.
- To influence the review of the Ecodesign Regulation for solid biofuels boilers and the implementation of emissions limits for heating facilities of 500 kW to 1 MW.
- To understand the social acceptance factors and local specificities behind the success or hindering the development of agrobiomass heating solutions.
- To promote changes in the mind-set of the value chain actors and clusters as well as to empower them for the deployment of agrobiomass heating solutions.
- To enhance the competitiveness position of the European biomass heating solutions manufacturers and installers.
- To promote the visibility of agrobiomass heating to a large audience, including target and key actors as well as the general public.

WOOD CHIPS IN THE PRODUCTION OF ELECTRIC AND HEAT ENERGY

Wood chips can be used as fuel in boilers for the production of electricity and heat in houses and residential buildings, and therefore represents a more environmentally friendly alternative to fossil fuels. Wood chip heating equipment has been modernized, so the process of adding fuel to the boilers is easier, can be automated and adapted to the individual needs of the user. [10]

Picture 3. Wood chips as fuel in boilers →

[10] Many faces of wood chips, https://www.jutarnji.hr/domidizajn/d-d-vrt/mnoga-lica-drvne-sjecke-jeftina-i-pristupacna-sirovina-koju-mozete-koristiti-na-bezbroj-nacina-15046694

WOOD CHIPS IN THE GARDEN AND AGRICULTURAL PRODUCTION

In addition to hobby garden decoration, wood chips also have their place in intensive agricultural production and are often present on areas that are managed according to the principles of ecological or regenerative agriculture.

In the case of a large previous weediness of the surface and consequently a large wealth of weed seeds in the soil, it would be good to put a barrier like cardboard under the wood chips that would prevent the penetration of light to the soil. Nevertheless, it can be expected that in the conditions of the garden where it is grown organically, due to the high microbiological activity, in two, and certainly three years, the wood chips will decompose so much that it will be difficult to recognize individual pieces of wood, it would be good in the garden reapply as needed to achieve adequate weed control. [11]

WOOD CHOPS AS FERTILIZER AND SOIL IMPROVEMENT

Some gardeners worry that wood chips could negatively affect the availability of nitrogen in the soil precisely because of the work of microorganisms that could use the nitrogen that should be available to plants for the development of their own organism. However, until the so-called nitrogen depression occurs when plant residues are plowed into the soil, and by imitating natural processes such as those in the forest, where leaf biomass is deposited in layers on the surface and animals and microorganisms in the soil bring it into deeper layers, it does not pose a threat to the successful cultivation of crops. That is why wood chips added to the surface of the soil are used as organic fertilizer, which microorganisms then break down and make nutrients available to plants. [12]

Picture 4. Blue sheep brand from Krk whose products are made exclusively from wool [13] ↑

Wool waste - use of wool for washing and drying

- Using wool to create wool balls - the balls are used in the dryer to reduce drying time and save energy.
- Balls are dripped with essential oil to obtain scented laundry without fabric softener. Raising awareness and educating people to reduce waste and use ecological products.
- In addition to wool dryer balls, a wool car diffuser and an anti-stress ball with a lavender scent are also produced.

[11] Many faces of wood chips, https://www.jutarnji.hr/domidizajn/d-d-vrt/mnoga-lica-drvne-sjecke-jeftina-i-pristupacna-sirovina-koju-mozete-koristiti-na-bezbroj-nacina-15046694

[12] Many faces of wood chips, https://www.jutarnji.hr/domidizajn/d-d-vrt/mnoga-lica-drvne-sjecke-jeftina-i-pristupacna-sirovina-koju-mozete-koristiti-na-bezbroj-nacina-15046694

[13] OPG Tohoraj, https://opgtohoraj.com/pocetna/

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CULTIVATING MUSHROOMS

ON WOOD

An eco-friendly approach to Fungi Farming

Cultivating mushrooms on wood is an innovative, sustainable method of producing edible and medicinal fungi. This technique, often referred to as log or woodchip cultivation, harnesses the natural relationship between mushrooms and wood, their native substrate, to create a low-impact, high-yield form of agriculture.

To care for mushroom growing kits, ensure a high air humidity of at least 75%, proper ventilation, and temperatures between 15-20°C. Place the kit in a naturally humid area or inside a large, moistened plastic container with a water-retaining material at the bottom. Avoid direct sunlight and do not fully close the container. Spray the container walls with water twice daily without spraying the mushrooms directly. After harvesting, soak the kit in water for 12-24 hours to encourage new growth.

READ MORE

WHY CULTIVATE MUSHROOMS ON WOOD?

Mushrooms, particularly varieties like Shiitake, Oyster, and Lion's Mane, thrive on dead organic material, making wood an ideal growth medium. This method offers several benefits:

SUSTAINABILITY:

Wood-based cultivation mimics natural processes, allowing for organic and eco-friendly farming practices. It utilizes byproducts of forestry and tree maintenance, thus reducing waste.

LOW RESOURCE USE:

Unlike other agricultural practices, growing mushrooms on wood doesn't require fertile land, making it suitable for areas with poor soil quality. It also minimises the need for synthetic fertilizers and pesticides.

BIODIVERSITY:

Cultivating a variety of mushrooms can support local biodiversity, offering habitats and nourishment to various organisms within the ecosystem.

HOW TO CULTIVATE MUSHROOMS ON WOOD?

1. **SUBSTRATE PREPARATION:** Select hardwood logs or woodchips from species like oak, maple, or beech. The wood should be fresh to ensure it's free from competing fungi.
2. **INOCULATION:** Drill holes in the logs and insert spawn plugs, or mix spawn with woodchips. The spawn serves as the seed material, which will colonize the wood.
3. **INCUBATION:** Place the inoculated logs or woodchips in a shaded, moist area. The environment should be kept at optimal humidity to encourage mycelial growth.
4. **HARVESTING:** Depending on the mushroom species and environmental conditions, mushrooms will begin to fruit within several months to a year after inoculation. Harvesting can continue periodically for several years with proper care.

CHALLENGES AND CONSIDERATIONS

While cultivating mushrooms on wood is an eco-friendly option, it does come with challenges. It requires patience, as the colonization and fruiting processes take time. Environmental conditions such as temperature, humidity, and light levels must be carefully managed to ensure successful cultivation. Additionally, sourcing quality spawn and maintaining disease-free conditions are critical for a healthy yield.

CONCLUSION

Cultivating mushrooms on wood offers a sustainable alternative to traditional agriculture, aligning with ecological values and contributing to a more resilient food system. By understanding and applying this method, growers can produce nutritious, delicious mushrooms while positively impacting their local environment and promoting circular bioeconomy.

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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.

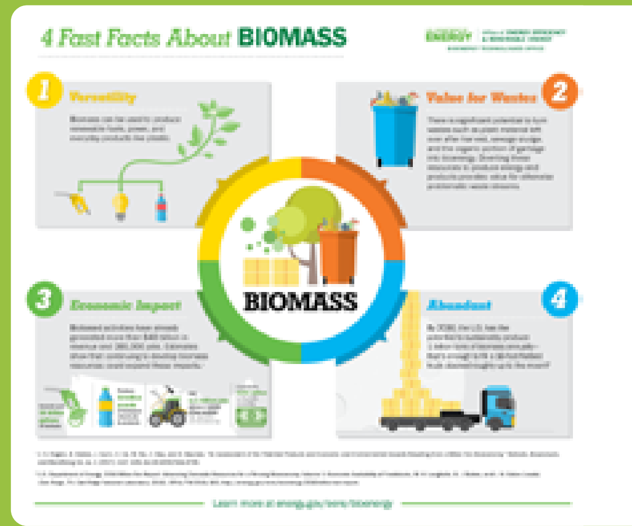


__Figure 1.__ Four fast facts about biomass.
Source: https://www.energy.gov/eere/bioenergy/

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.

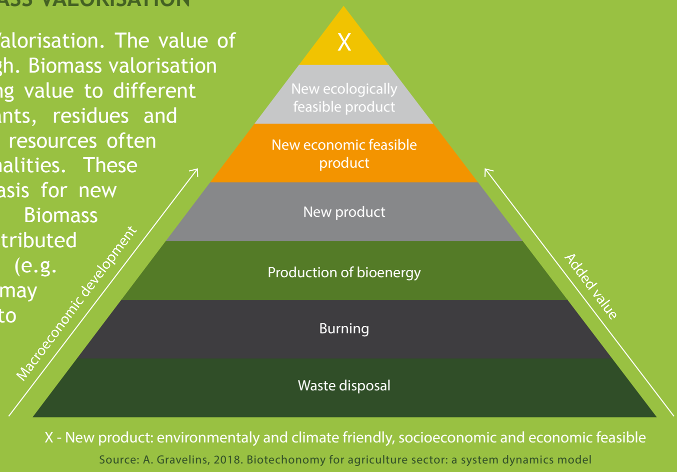


Figure 2. Pyramid for use of biomass with increase of added value (Gravelins et al. 2018)

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.

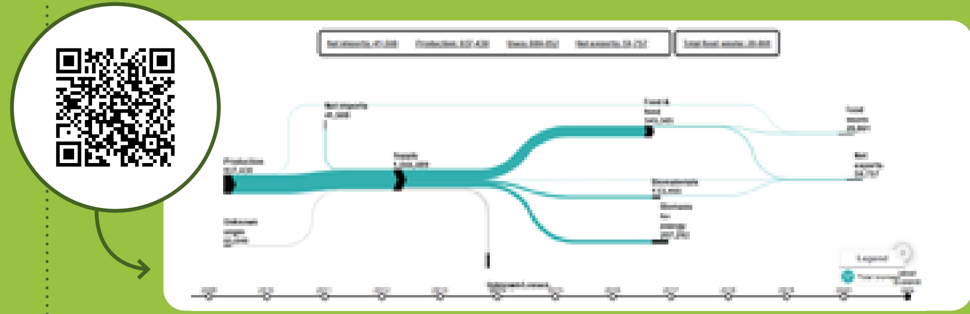


Figure 3. Biomass flows in 1000T of dry matter for EU-27 based on latest available data (agriculture - 2020 year, fisheries and aquaculture - 2016 year and forestry - 2017 year) Source: https://datam.jrc.ec.europa.eu/datam/mashup/BIOMASS_FLOWS/index.html

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.

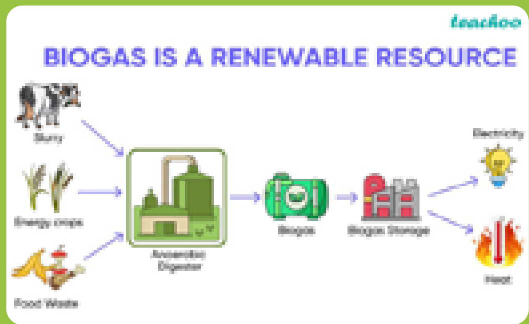
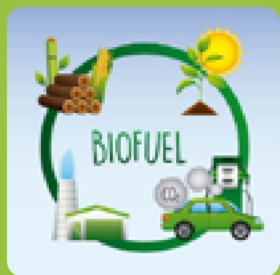


__Figure 6.__ Biogas production stages. Source: https://medium.com/@codedesignstech/biodigesters-vs-biogas-understanding-the-key-differences-c3c1fed01254

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

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



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

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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.

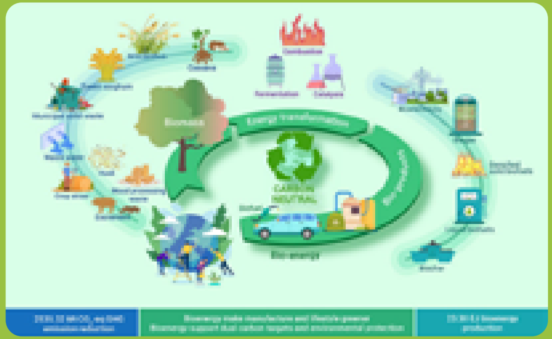

Figure 9. Schematic of biomass energy conservation and carbon reduction using multiple sources and multiple approaches. Source: Wang et al. 2023

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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THE AMAZING PROPERTIES OF BIOCHAR

Biochar is the product of the thermal conversion of biomass in an oxygen-limited environment. This allows approximately 50% of the elemental carbon from the original biomass to be retained, bound in a highly stable form. The resulting product can be used in agriculture, industry and the energy sector. The greatest potential of biochar is represented by its potential for significant soil improvement and long-term carbon sequestration.

PRODUCTION: Biochar is obtained by various thermal processes: pyrolysis, gasification and controlled combustion, often referred to as carbonization processes. Material produced in the temperature range of 350-1000 ¤C, fully thermally processed, can be qualified as biochar. Product can be obtained by various methods and at different scales, from micro solutions to industrial facilities.

SUBSTRATES: Biochar can be produced from any type of biomass. The greatest potential is found in wood industry, agricultural residues and communal biodegradable waste. Through pyrolysis, these materials can be converted to a more valuable material than if they were composted, fermented, burnt or simply left to decompose.

RENEWABLE ENERGY: Pyrolysis is a high-energy process from which heat can be recovered, electricity generated and renewable fuels such as syngas, oils and char obtained. Biochar is actually a by-product of the energy process and should only be used for environmental purposes.

CARBON SEQUESTRATION: Carbonization of biomass is a process that preserves half of the elemental carbon from the starting material. In any other process, almost all of the organic carbon from the biomass would eventually decompose and return to the atmosphere in the form of carbon dioxide. Biochar is a very stable and decomposition-resistant material, thus taking carbon dioxide out of the cycle for thousands of years.

SANITARY SAFETY: Biochar is a sterile product, free of all organic compounds. Weed seeds, pest eggs, plant and animal pathogens and any toxic organic substances are completely neutralized. Biochar applied to soils reduces the harmfulness of fungal pathogens and enhances plant health.

SMELL REDUCTION: Biochar has strong sportive properties and is therefore excellent at suppressing offensive odors from agriculture. It can be used as an additive for manure, liquid organic fertilizers, waste composting and for bedding in livestock production. Good quality biochar is used as a feed supplement in order to regulate the digestive processes of animals.

IMPROVING SOIL PROPERTIES: Biochar enhances soil properties in a comprehensive way. Depending on the dose applied, the water holding capacity of soils, pH value, electrical conductivity, sorption capacity, and microbial activity are increased. Nutrient losses and greenhouse gas emissions from the soil are reduced. An increase in soil organic matter is recorded in the short term.

YIELD INCREASE: Biochar is not itself a fertilizer, however it significantly improves the use of fertilizers by reducing nutrient losses, thereby increasing crop yields. Depending on the application rate and crop species, yield increases of 20-50% have been reported. Unlike natural and synthetic fertilizers, once applied, biochar can increase yields for many years.

SUSTAINABILITY: once incorporated into the soil, biochar remains there for thousands of years, undergoing only minor transformations. Residues of charcoal produced several thousand years ago are still found in the world's best soils, such as some tropical black soils and chernozems. Carbon produced by primitive methods such as controlled biomass burning was a key component of these soils. Today, there are opportunities to produce biochar much more efficiently on an unprecedented scale.

NEW OPPORTUNITIES: Producing biochar can be a profitable occupation, as the value of the product is tens of times greater than the substrate from which it is made. With large--scale production, producers can register the product as a soil improver and undertake a certification process. Producers' income can also be based on renewable energy provision and organic waste collection. Farmers making biochar and using it on their farms can apply for carbon credits and achieveing higher crop yields at the same time.

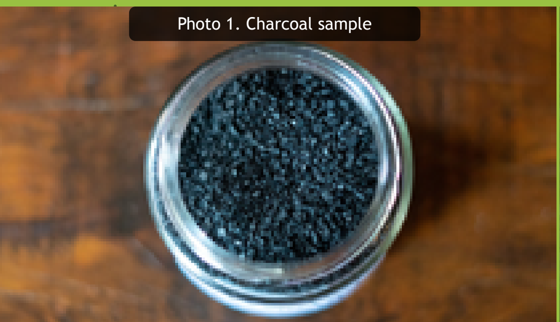
Photo 1. Charcoal sample


Photo 2. Charcoal structure


Photo 3. Wood turning to charcoal


Photo 4. Compost soil

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DID YOU KNOW THAT ?

- Some of the best soils in the world terra preta do Indio were created by the Paleo-Indians some two thousand years ago using, among other things, charcoal?
- Black soils in North America and Eurasia were most likely created by the deposition of carbon left over from natural and man-made fires?
- Carbon from biomass burning is already present in all soil types worldwide. It accounts for up to 30% of total soil organic carbon.
- A great enthusiast for the use of charcoal in agriculture was Justus von Liebig, known mainly for the law of the minimum attributed to him, which states that, plant growth is limited by that nutrient which is currently most lacking in the environment, i.e. below the necessary minimum in relation to needs.

Useful links

Biochar Europe - CO2 Removal Technology
→ https://biochareu.com/en/

Biochar: How burning stubble could FIGHT air pollution
→ https://www.youtube.com/watch?v=zFX1mOsg36w&t=22s

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REDESIGNING THE FUTURE

The role of (eco)design in making bioeconomy circular and sustainable

We live in a consumer society in which the well-being of citizens is ensured by the exchange of large quantities of goods and the economic growth is driven by the philosophy of taking, making, consuming and disposing. Due to this kind of thinking the production requires huge amounts of resources such as oil, soil, water, chemicals, ores and energy. The globalised world has allowed us relatively easy access to resources that are otherwise unavailable in our region. This social organisation approach has become incompatible with safe, sustainable and peaceful future for all humanity. We need an immediate solution that breaks the link between economic growth and resource depletion and recognize the scarcity of environmental goods like biodiversity, clean air, biosphere, fresh water and soil. The bio-based sectors are also hit by overuse of resources and waste accumulation and these have an increasingly depressing effect on our everyday life and damage to ecosystems.

Sustainable and circular bioeconomy helps not only to make our economy and lifestyle sustainable but also to regenerate the ecosystems which we destroyed from the beginning of the industrial revolution. Through design, we can replace the linear thinking with the circular one in order to close the loop, eliminate waste and pollution, and circulate products and materials. Design has played an essential role not only in modern economy but also throughout human history. It is not only about creativity, functionality and building new knowledge but it has been a form of social communication as well.

Design decisions influence the quantity of waste and pollution generated. For example the destruction of rainforests or soil depletion are the result of harmful design which does not take the interest of wildlife or natural resources into consideration. Eco-design may create a positive impact and has a transformative role by developing new business models and supporting the out of the box and system thinking. Briefly, design has the power to put the development on a new path and may support the spread of circular bioeconomy through the creation of innovative products, using bio-based materials instead of fossil-based ones, creating new business models and affecting the value chains.

SOME POSITIVE EFFECTS OF ECO-DESIGN:

It supports a holistic approach that considers environmental, social and economic impacts. It contributes to the decrease of carbon-footprint by optimising resource use and adopting eco-friendly production processes.

It contributes to resilience and climate adaptation.

It accelerates social changes by influencing consumer behaviour, inspires conscious decision-making and contributes to a sustainable lifestyle.

Design is a powerful tool for education and raising awareness about global problems. Through visually compelling graphics, animations and interactive experiences, we can communicate complex environmental issues in accessible and engaging ways.

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Good practices

There are a number of organisations, sole designers and companies supporting the spread of eco-design or using it as a powerful tool to make businesses more sustainable. While the European Union promotes the wide spreading of eco-design with policy instruments, charity founder Ellen MacArthur is using her reputation to create evidence-based original research on the benefits of a circular economy and explore the opportunities across stakeholders and sectors, and highlight examples of how circular economy principles are being put into practice today. Furthermore several companies have already realised the opportunities in eco-design to decrease material use. For example **(1)** packaging industry may replace traditional plastics with biodegradable one, **(2)** furniture industry may use AI and 3D printing technology in generative design, **(3)** textile industry may use yarn made of cellulose fibrils from plant--based materials just to mention a few.

Industry 4.0 era may offer new solutions to the biorefinery process design and provide alternatives for biomass valorisation. By applying digital technologies we can increase production efficiency, productivity and quality, enhance operational flexibility; and integrate the production system with customers and the supply chain. We may extend the life of products by applying zero waste solutions or the principles of reuse or refurbishment.

Artificial Intelligence tools empower designers to develop interior spaces based on the concept of circular bioeconomy by using innovative materials.

Also we may decrease the harmful effects of Fast Fashion by the extension of fashion products' lifecycle and changing consumer behaviour. New, innovative bio-based materials and textiles offer sustainable alternatives to oil-based fibres (e.g. polyester) and help to lay the foundation of a more sustainable textile industry.

It can be seen from the above examples that by connecting the principles of the circular bioeconomy throughout the design process, we can make the bio-based sectors profitable.

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BIO-PRODUCTS FROM WASTE

EVEN WASTE CAN HAVE A VALUE:

Did you know that everyday consumer products can be obtained using waste from agricultural production and the food industry?

THIS MEANS CIRCULAR ECONOMY...

In fact, this approach represents an application of the principle of circularity, whereby a by-product of an agricultural or industrial process can become raw material for another process, even in a commercial sector different from that of origin.

...AND SUSTAINABILITY!

This virtuous approach improves the Sustainability of our Society, with a more responsible approach, which minimizes the amount of waste that is sent to incineration or landfill and attributes a value to what for us is waste.

DO YOU KNOW YOUR ROLE?

You too can contribute to this! if each of us carries out accurate separation and timely disposal of waste, it facilitates downstream transformation, for example of the organic fraction into compost.

Some examples

From the waste it is possible to extract cellulose, which can be used for paper and packaging, or chitin, from the exoskeletons of crustaceans, to make bioplastics or health products, or useful components (saccharides) for diets or animal feed

From the waste of the tomato industry it is possible to obtain a bio-coating, to coat packaging materials used in the food industry

From the waste of the citrus industry it is possible to extract cellulose from which to obtain fibers for use in textiles

From waste from the apple juice production industry, such as peels and seeds, it is possible to obtain a paste for use in the cosmetics sector

From agricultural and food waste it is possible to obtain biofuels, soil improvers for agricultural use, bioplastics and raw materials for industry.

clusteragrifood.it/en

b-plas.it/en

b-plas.it/en/cross-life-project

prolific-project.eu

ingreenproject.eu

agrimax-project.eu

it.tomapaint.com

Fossil fuels are a resource whose exploitation has favoured industrial development in the last century, but which have caused damage to the environment and geopolitical and social problems. Moreover, the use of fossil resources has led to global warming, nowadays one of the major challenges we have to face.

As the world's population and resource consumption grows, waste generation has also increased. This excessive accumulation in waste materials harms the ecosystem and human beings by depleting water quality, air quality, and biodiversity.

Therefore, the idea of a "circular (bio)economy" has emerged, where products are made, used and re-used, rather than being discarded. Scientific research is studying methods to develop economically viable and sustainable solutions to make this paradigm possible. The aim is to manage resources in a responsible way, while preserving human health and environment.

The transformation of organic by-products into fuels or high-value chemicals is becoming a strategic field of the so-called "green chemistry". This allows to convert the by-products from agro-industry, food industry and in principle even household waste, into valuable products. The economic advantage of this approach, compared to processes from conventional sources, is given by the availability of raw material, sometimes even at almost-zero cost. Compost is also a precious asset for farmers to combat soil desertification by reducing the need for water.

The challenge is to reduce costs for by-products transformation and increase sustainability, guaranteeing high yields of the desired product. Examples include not only the production of energy, but also the synthesis of biofertilizers, materials for the textile industry, for the furniture industry, for cosmetics and home-caring, and others. In order to do this, new technologies and processes have been or are going to be developed and industrially implemented, such as new procedures for the extraction of chemical compounds (eg, microwave-based extraction), new enzymes and new type of bio-reactors.

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BIODEGRADABLE PLASTICS

YES BUT LET'S MAKE IT RIGHT

This is ok for the compost bin

This is ok for the backyard composter too

WHAT IS A BIOPLASTIC?

BIOPLASTIC can be either a biodegradable plastic or a biobased plastic obtained from renewable resources alternative to fossil feedstock. Don't confuse them, they are very different one from the other!

HOW CAN I DISPOSE OF A BIOPLASTIC?

Not all biodegradable bioplastics are the same. Indeed, only "COMPOSTABLE" plastics can, and should, be composted at the end of their life cycle.

WHAT DOES "COMPOSTABLE" MEAN?

Composting is a process accounting for material's decomposition carried out thanks to microorganisms which work within controlled temperature and humidity conditions. The final product, i.e. "compost", is often used as fertilizer. Such a process can be homemade, in a garden, thanks to specific container called COMPOSTER. In the case bioplastics are processable in home composters, this is clearly indicated in the label.

WHAT CAN I DO ABOUT IT?

Remember that, even if plastic is marked as biodegradable, it should ALWAYS be correctly disposed of in the convenient bin, and it should not be freely released in the environment. Indeed, if not dealt with convenient disposing conditions, such materials might still take years or decades to fully biodegrade.

ATTENTION PLEASE!

Biodegradable bioplastics should never be mixed up with traditional plastics to avoid "contamination" of the latter which would hamper and compromise the overall recycling and re-use process.

DON'T MIX UP THE DUMPSTER!

Learn how to read packaging labels before disposing of them, to provide all the plastic wastes with the end-of-life treatment they actually deserve! And while in doubt, put in the compostability bin and not in the home composter!

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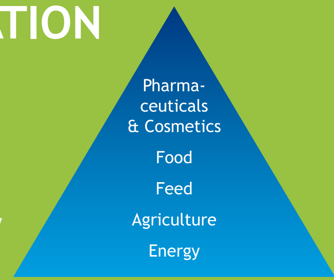
AQUATIC BIOMASS

VALORIZATION



THE BLUE BIOREFINERY FOR THE ENVIRONMENT and ECONOMY

HAVE YOU EVER HEARD ABOUT BLUE ECONOMY?

The blue economy is a sustainable economic model that proposes new solutions for ocean-related activities and in which aquatic spaces are considered engines of innovation and growth. The concept is based on the imitation of nature, following the principle of the circular economy, to convert waste back into efficient materials.

FISH WASTE OR ALGAE CAN ALSO HAVE A VALUE:

every year, 6-8 million tons of fish waste are produced globally. Do you know that fish waste can be a raw material to produce new biomaterials?

CLOSING THE CIRCLE: THE CIRCULAR ECONOMY

The valorization of waste or residues from the processing of aquatic biomass can reduce waste disposal costs and generate added value with the recovery of several valuable molecules such as oils, proteins, pigments, bioactive peptides, amino acids, collagen, chitin, and gelatin. They can have applications in several industrial sectors!

Some examples

Calcium carbonate, a biomaterial useful in the building industry or for water treatment, chitin for cosmetic or health products, and proteins for animal feed or use as fertilizer can be recovered from shell waste.
https://site.unibo.it/caseawa/en

Green algae waste extracts incorporated into a chitosan-based edible coating and applied to red tomatoes, can minimize post-harvest losses and extend shelf life, improving product quality.

Fish gelatine and chitosan have excellent characteristics for the production of films to be used in food packaging as an alternative to plastics.

Fish scales have a structure similar to that of human tissues: they are rich in collagen, peptides, gelatin, chitin, and hydroxyapatite, and therefore can be used in the food, cosmetic, medical, bone or cartilage repair industries, and for wastewater treatment.

MICOPERI BLUE GROWTH

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AGROFOOD BIOCOSMETICS

PLANT CHEMISTRY A SERVICE OF BEAUTY

DO YOU KNOW THE "FACTORIES OF NATURAL CHEMISTRY"?

Plants, stationary yetpowerful, harness solar energy to manufacture unique substances that protect them from atmospheric agents, forming a biodiversity of natural chemistry adapted to the environment.

AGRO-FOOD WASTE AS A SOURCE OF NATURAL CHEMISTRY

Agro-food waste, originating from the plants that make up our diet, is a treasure trove of beneficial substances. Thoughtful selection of these residues allows for the recovery of valuable ingredients for sustainable biocosmetics.

FUNCTIONAL BIOCOSMETICS

Biocosmetics, derived from agro-food waste such as grape peel, create a protective veil inspired by nature, replicating the natural defensive effect on the skin.

WHAT IS YOUR ROLE?

Every citizen can contribute to sustainability by embracing biocosmetics from agro-food waste because conscious choices promote circular economy, fostering beauty in harmony with nature.

Some examples

phenbiox SMART NATURAL INGREDIENTS

The mechanisms of plants are our inspiration, and our technological platforms are the tools through which we transform the intelligence of plants into effective active cosmetic ingredients. Our productive technological platforms enable us to obtain natural, high-performing, and cutting-edge products.

phenbiox.it

fresCosmesi degustazioni per la pelle

We create effective cosmetic products using fresh fruits and vegetables, offering a fully customized service for technological research and development.

frescosmesi.it

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ALGAE BIOREMEDIATION

TRANSFORMING WASTEWATER INTO VALUABLE PRODUCTS

Algae cultivation in the wastewater as the parallel bioremediation and biomass production presents an innovative ecology model. Nutrients, organic carbon, and minerals that would otherwise be lost by the discharge into environment, are recovered by algae for production of biomass that can be used further. Biomass can be valorised for a variety of products, from the low-added-value biofuels, organic fertilisers, or biomaterials (including biodegradable bioplastics) to the high-added-value compounds for phyto-pharmacy, cosmetics, and agriculture, bringing new financial streams to the companies.

ADVANTAGES OF ALGAE BIOREMEDIATION FOR WASTEWATER TREATMENT

1. **VERSATILITY IN GROWTH CONDITIONS:** Algae have the remarkable ability to grow in various wastewaters, making them suitable for different industrial applications. This adaptability ensures that algae bioremediation can be implemented across multiple sectors, contributing to widespread environmental benefits.

2. **SOURCE OF ECONOMIC GROWTH:** The cultivation of algae in wastewater treatment facilities can create additional jobs and income opportunities. This aspect of algae bioremediation is particularly appealing as it not only addresses environmental issues but also supports economic development.

3. **CONTRIBUTION TO THE CIRCULAR BIOECONOMY:** Algae and wastewater together form essential components of the circular bioeconomy. By transforming wastewater into a resource, this approach promotes sustainability and resource efficiency.

4. **MITIGATION OF EUTROPHICATION:** The use of algae helps in absorbing excess nutrients from wastewater, which, if untreated, could lead to the eutrophication of water bodies. This significantly reduces the negative impacts on aquatic ecosystems and environmental health.

5. **RECOVERY OF VALUABLE RESOURCES:** Algae bioremediation facilitates the recovery of nutrients and energy from wastewater, turning waste into valuable secondary raw materials. This maximizes resource utilization and supports sustainable waste management practices.

6 **WATER RECYCLING AND REUSE:** Treated water can be safely returned to technological processes, used for agricultural irrigation, or released into the natural environment. This promotes water conservation and ensures that water resources are efficiently utilized.

7 **CARBON SEQUESTRATION:** Industrial CO2 emissions can be utilized for algal growth, which captures and fixes carbon into biomass. This process contributes to the reduction of greenhouse gases and can aid in the establishment of carbon credits, aligning with global efforts to combat climate change.

8 **ENERGY SAVINGS IN WASTEWATER TREATMENT:** The symbiotic relationship between algae and bacteria in wastewater treatment systems reduces the need for energy-intensive oxygenation processes. Since oxygenation accounts for a significant portion of a wastewater treatment plant's energy consumption, using algae can lead to substantial energy savings.

9 **ENHANCED BIOMASS PRODUCTION:** Algae utilize the nutrients and organic carbon in wastewater for biomass production. This biomass can be further processed into biofuels, fertilizers, and other value-added products, offering a sustainable alternative to conventional resources.

10 **IMPROVEMENT OF ENVIRONMENTAL SUSTAINABILITY:** By integrating algae bioremediation into wastewater treatment, industries and communities can significantly lower their environmental footprint and reduce unpleasant odor.

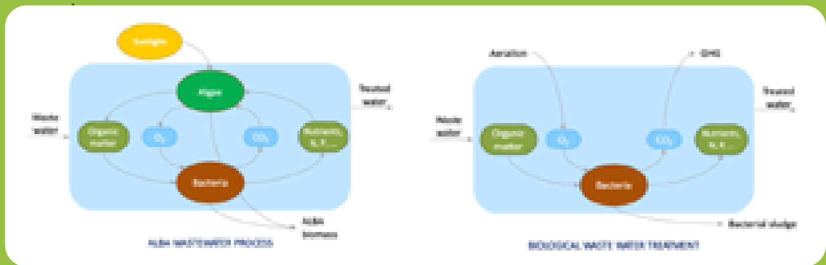

Figure 1. Wastewater treatment with (left) and without algae (right). Source: AlgEn, algal technology center, llc.

ADVANTAGES OF ALGAL TREATMENT FOR BIOGAS PLANT DIGESTATE

1 **NUTRIENT RECOVERY:** The algal treatment process effectively recovers nutrients from the liquid phase of anaerobic digestate, which is rich in agricultural value. This not only addresses waste management challenges but also repurposes valuable resources for sustainable use.

2 **REDUCTION OF POLLUTANTS:** In the case study of the Koto biogas plant in Slovenia, algae demonstrated an impressive ability to reduce COD (Chemical Oxygen Demand) by 90%, nitrogen by 91%, and phosphorus by 64%. Such high reduction rates indicate the potential for significantly mitigating environmental pollution.

3 **BIOMASS PRODUCTION:** The process leads to the production of substantial amounts of biomass, reaching up to 30g/m2 per day in optimal conditions. This biomass can serve various purposes, including as a substrate for fertilizer or biogas production, showcasing the versatility of algal treatment.

4 **COST AND EMISSION REDUCTIONS:** By stabilizing the liquid digestate into biomass, logistical costs and greenhouse gas emissions associated with storage and transportation are significantly reduced. This makes the algal treatment a cost-effective and environmentally friendly solution.

5 **ENHANCED BIOGAS PLANT EFFICIENCY:** Implementing algal technology in biogas plants offers a pathway to improve the quality of the liquid digestate fraction. It supports the creation of better-quality energetic substrates, enabling a more efficient and sustainable biogas production process.

6 **CO2 AND HEAT UTILIZATION:** The process facilitates the recycling of CO2 emissions and the effective use of excess heat, aligning with circular economy principles and contributing to the overall efficiency of biogas plants.

7 **ODOR REDUCTION:** Algal treatment can help reduce odors associated with biogas digestate, improving the environmental and social acceptability of biogas plants.

8 **ON-SITE RECYCLING:** Nutrients recovered from the digestate can be cycled back on-site, promoting a closed-loop system that minimizes waste and enhances sustainability.

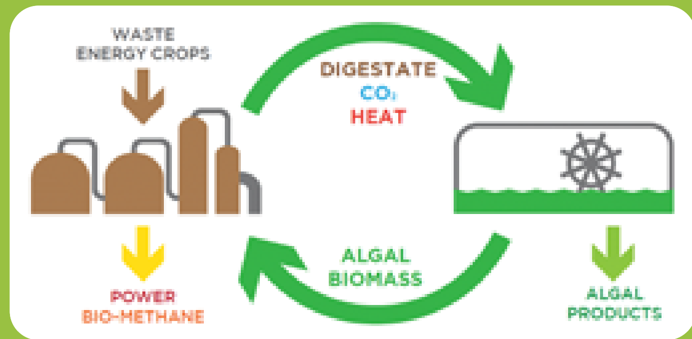

Figure 2. Circularity in biogas plants with algal systems (source: Algen, algal technology center, llc (www.algaebiogas.eu)).[5]

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WIDE VARIETY OF NEW PRODUCTS

1 **VERSATILE PRODUCT RANGE:** Algae biomass can be valorized into a wide array of products, spanning from biofuels, organic fertilizers, and biomaterials such as biodegradable bioplastics, to high-value compounds used in phyto-pharmacy, cosmetics, and agriculture. This versatility allows for the development of sunscreens, moisturisers, biopesticides, biostimulants, and animal feed supplements from algal extracts, highlighting the potential of algae as a key resource in sustainable product development.

2 **SUSTAINABLE AGRICULTURE AND SOIL IMPROVEMENT:** Through processes like composting and pyrolysis, macroalgal biomass can be stabilized for agricultural use, enhancing soil fertility, nutrient retention, and plant growth. Biochar produced from macroalgae improves the retention of essential nutrients in soils and acts as a bioenergy source, carbon sequestration agent, and a component for water treatment and soil remediation.

3 **BIOREFINERY AND RESOURCE RECOVERY:** A biorefinery approach to microalgae production maximizes the utility of the biomass by producing both high- and low-value products while recovering nutrients from waste streams. This strategy, exemplified by projects like SABANA, Water2Return, and Saltgae, demonstrates the efficiency of algae in nutrient recycling, offering a sustainable solution for waste management and product diversification.

4 **BIOSORBENTS FOR ENVIRONMENTAL REMEDIATION:** Algal biomass can serve as an effective biosorbent for the removal of pollutants, including heavy metals from contaminated effluents. After their use as biosorbents, algae can be repurposed as fertilizers, contributing to soil enrichment and sustainability. This dual use of algae not only addresses pollution but also supports agricultural practices by improving soil health and nutrient content.

ALGAE SYSTEMS INTEGRATION INTO EXISTING INSTALLATIONS

1 **DIVERSE PRODUCTION SYSTEMS:** Algae biomass production is versatile, utilizing both closed systems like (photo)bioreactors for sterile and rapid biomass production of specific ingredients such as pigments, and open systems like raceway ponds for cost-effective production with lower initial investments. Photobioreactors can be installed both indoors and outdoors, including vertical setups to maximize yield per land area, while raceway ponds offer flexibility by operating either completely open or within greenhouses for continuous production in various climatic conditions.

2 **INNOVATIVE AND PROMISING APPROACHES:** Research and development efforts are ongoing to explore various algae cultivation systems, including thin-layer systems, biofilms, and algal turf scrubbers. These innovative approaches aim to achieve higher production efficiencies and offer promising solutions for algae biomass production on a global scale.

3 **INTEGRATION WITH EXISTING TECHNOLOGIES:** Algae cultivation systems can be easily integrated as side streams into existing technological setups without necessitating significant changes. This feature is particularly beneficial for wastewater treatment systems and industrial technologies, where algae can contribute to the treatment process by utilizing waste streams for biomass production, thereby enhancing sustainability and efficiency.

4 **BENEFITS FOR BIOGAS PLANTS AND WASTEWATER TREATMENT:** Algal systems can significantly augment biogas plant operations by treating digestate to recycle nutrients, thus reducing storage, transport costs, and the environmental footprint. Moreover, the addition of algal raceway ponds to wastewater treatment processes can potentially replace secondary and tertiary treatment stages, leading to a substantial reduction in the production of unwanted sludge, aligning with agricultural regulations in many countries.

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BUSINESS MODELS WITH ALGAE GROWN IN WASTEWATER OR DIGESTATE

To fully realize the potential of algae grown in wastewater or anaerobic digestate, innovative business models are needed that can capture the value of these products. Here are some possible business models:

1. Algae production and processing for specific industries: Companies can focus on producing algae for specific industries, such as aquaculture or biofuels. By optimizing their production and processing methods for these specific markets, they can create high-value products that meet the needs of those industries.

2. Integrated systems for wastewater treatment and resource recovery: Companies can develop integrated systems that use algae to treat wastewater and recover valuable resources, such as nutrients and biofuels. By offering a complete solution for wastewater treatment and resource recovery, these companies can provide value to municipalities, industrial facilities, and agricultural operations.

3. Carbon credits and offsets: Companies that use algae for carbon sequestration or biofuel production can generate carbon credits or offsets that can be sold on carbon markets. This can provide a new revenue stream for companies and incentivize the development of sustainable practices.

4. Direct-to-consumer products: Companies can develop direct-to-consumer products, such as fertilisers or biostimulants, that use algae grown in wastewater or anaerobic digestate. This can provide a way to capture value from these products without relying on traditional supply chain.

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Experts involved in the **INTERREG BIOECO-UP** project carefully selected topics to highlight the importance of bioeconomy and the impact it has on the environment. If you care for the planet and want to discover more about bio materials, biogas stations or sustainable businesses, our seminars and webinars are for you!

MORE INFORMATION

Webinars will be organised in national languages (HUN, PL, IT, SI, CZ, HR)

BIOeco Up project supports development and recognition of circular bioeconomy and value changes, empower citizens to become bioeconomy consumers; it also enhance implementation of transnational policy analysis of bioeconomy measure.

Hereby BIOeco Up supports several Agriculture Ministries - members of the BIOEAST Iniative (Associated partners). **BIOEAST.EU**

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