TRAINING LESSON 5 - Part 2 (Agrifood sector)

Title	○ **Biomass production and management**
Part of the training course referred to in this lesson	○ □ Part 1 General information about sustainability and CE Part 2 Specific Information about: □ Wood sector □ Plastic sector X Agrifood sector
EQF level	Level 3
Where the lesson was tested	//
General Learning objective(s) according to the Bloom Taxonomy	□ **Create** Produce new or original work (design, assemble, construct, investigate, formulate) X **Evaluate** Justify a stand or decision (appraise, argue, defend, critique, select, support) X **Analyze** Draw connections among ideas (differentiate, organize, relate, compare, distinguish, test, experiment) X **Apply** Use information in new situations (execute, implement, solve, use, demonstrate, operate) X **Understand** Explain ideas or concepts (classify, discuss, describe, identify, locate, translate) X **Remember** Recall facts and basic concepts (define, duplicate, list, memorize, repeat)
Specific learning objective(s)	● *To understand what biomass is and its main characteristics.* ● *To understand and analyze the problems related to the disposal of biodegradable waste.* ● *To understand how biomass is managed.*
Cognitive, socioemotional and behavioural outcomes	**SDG 2 Zero Hunger End hunger** Socio-emotional learning objectives:

	1. The learner is able to communicate on the issues and connections between combating hunger and promoting sustainable agriculture and improved nutrition. **SDG 4 Quality Education** Cognitive learning objectives: - The learner understands the important role of culture in achieving sustainability. - The learner understands that education can help create a more sustainable, equitable and peaceful world Socio-emotional learning objectives: – The learner is able through participatory methods to motivate and empower others to demand and use educational opportunities. – The learner is able to recognize the intrinsic value of education and to analyse and identify their own learning needs in their personal development. – The learner is able to recognize the importance of their own skills for improving their life, in particular for employment and entrepreneurship Behavioural learning objectives: – The learner is able to contribute to facilitating and implementing quality education for all, ESD and related approaches at different levels. 2 – The learner is able to use all opportunities for their own education throughout their life, and to apply the acquired knowledge in everyday situations to promote sustainable development **SDG 7 Affordable and Clean Energy** Cognitive learning objectives: - The learner knows about different energy resources – renewable and non-renewable – and their respective advantages and disadvantages including environmental impacts, health issues, usage, safety and energy security, and their share in the energy mix at the local, national and global level.. - The learner knows about harmful impacts of unsustainable energy production, understands how renewable energy technologies can help to drive sustainable development and understands the need for new and innovative technologies and especially technology transfer in collaborations between countries. S**DG 12 Responsible Consumption and Production** Cognitive learning objectives: -The learner understands how individual lifestyle choices influence social, economic and environmental development. Socio-emotional learning objectives: – The learner is able to envision sustainable lifestyles. – The learner is able to feel responsible for the environmental and social impacts of their own individual behaviour as a producer or consumer.

	Behavioural learning objectives: – *The* learner is able to plan, implement and evaluate consumption-related activities using existing sustainability criteria. – the learner is able take on critically on their role as an active stakeholder in the market.
Green skill(s) addressed	X Creative problem-solving X Forward-thinking ☐ Monitoring skills X Analytical skills ☐ Lean production ☐ Maintenance and repair skills X Pollution prevention ☐ Eco-design X Management skills ☐ Impact quantification X Life-cycle management X Science skills X Waste management X Environmental auditing ☐ Ecosystem management ☐ Other_____
Duration	15 min.
Structure and content of the lesson	**Introduction** Biomass is organic, meaning it is made of material that comes from living organisms, such as plants and animals /National geographic/. Biomass is one of the most valuable and versatile resources on Earth. It is solar energy stored in chemical form in plant and animal tissues. Plants make up 82% of the total biomass of Earth. Of all the mammals on Earth, 96% are livestock and humans, only 4% are wild mammals. Of all the birds on Earth, 70% are chicken and poultry, 30% are wild birds. The total biomass of the human race accounts for just 0.01% of all life on Earth. /Agriculture & Forestry/ Biomass as a natural product is subject to continuous natural regeneration and therefore it is classified as a so-called renewable energy source /RES/. The use of biomass for energy purposes, although not always in practice, does not pollute the environment and is therefore considered a source of ecologically clean or "green energy". **TOPIC 1. Types of biomass** There is a wide variety of different types of biomass worldwide, but the ones we are interested in are: plants, wood, waste products from agriculture, food industry, as well as the organic components of domestic and industrial waste. The agri-food sector generates a significant waste stream, mainly due to inefficiencies arising from product damage and loss throughout the supply chain.

TOPIC 2. Problems

The world's population is rapidly increasing, environmental degradation and depletion of biological resources are becoming challenges of paramount importance. Agricultural production and the food supply chain are major sources of waste biomass, posing an unprecedented risk to land and water pollution and ultimately public health. However, agricultural food processing residues are also recognized as materials with high biorefining efficiency, offering a range of opportunities for sustainable food, fodder, chemical and energy production. (Dimitris P. Makris 2019).

Biomass is an integral part of the Earth's carbon cycle. Carbon cycle is the process by which carbon is exchanged between all layers of the Earth: atmosphere, hydrosphere, biosphere and lithosphere. Carbon helps regulate the amount of sunlight that enters the Earth's atmosphere. It is exchanged through photosynthesis, decomposition, respiration and human activity. Carbon that is absorbed by the soil when the organism decomposes can be absorbed by the plants that synthesize biomass - nutrients in the biosphere in the process of photosynthesis. Under the right conditions, the decaying organism can be converted to peat, coal or oil before being extracted by natural or human activity. The carbon locked in fossil fuels is released into the atmosphere when they are burned for energy. Unlike fossil fuels, biomass comes from recently dead plant and animal organisms. In order to maintain the balance of the Earth, we must monitor the carbon cycle. Plants and forests must be sustainably grown. It takes decades to absorb and re-lock the carbon. Sustainable cultivation of trees, crops and other plants is vital to maintaining a healthy environment.

TOPIC 3. Biomass waste management

3.1. Energy from biomass

The use of biomass for energy purposes covers the following main directions:

- Use of plant waste by direct burning or other processing;

-Use of energy farms (special farms where fast-growing plant species are grown for energy purposes);

- Use of plant species in fresh or ocean waters;

- Use of waste from animal husbandry, food industry, etc. for biogas production.

In the latter direction, there are two options for gas production.

- The process of gasification of biomass such as rice husks, wood, cotton sticks, etc. are gasified (incomplete combustion with air) to produce the so-called "producer gas" containing carbon monoxide, hydrogen, methane and some other inert gases.

- Biomethanation. A biological conversion process that converts biomass in the absence of oxygen into methane and carbon dioxide, better known as biogas, and leaves a residue - an excellent organic fertilizer. The downside is that the time it takes to start the process is too long. If suitable biomass is not available in sufficient quantities, it may take up to several months to start the system. Biogas is stored in a gas chamber and burned in an internal combustion engine connected to a generator to produce electricity.

3.2. Composting

Composting turns raw organic residues into a humus-like material through the activity of soil microorganisms. Mature compost stores well and is biologically stable, odorless, easier to handle and less bulky than raw organic waste. Compost can be used as a soil amendment, seed starter, mulch, container mix ingredient, or natural fertilizer, depending on its characteristics. Composting can also reduce or eliminate weed seeds and plant pathogens in organic residues.

Compost provides many benefits as a soil additive and source of organic matter by improving the biological, chemical and physical characteristics of the soil:

- Increases microbial activity
- Improves plant disease suppression
- Increases soil fertility
- Increases cation exchange capacity
- Improves soil structure in clay soils
- Improves water retention in sandy soils
- Reduces the bioavailability of heavy metals

Microorganisms drive the composting process, so creating an optimal environment for microbial activity is critical to successful and efficient composting. Collecting an appropriate mixture of organic residues or raw materials and maintaining appropriate moisture and oxygen levels are necessary.

As soon as the raw materials are mixed, the composting process begins. As the microorganisms begin to break down the organic materials, the compost pile is heated and the active phase of composting begins. During this phase of rapid decomposition, temperature in the pile rises.

Maintaining adequate aeration during this phase of intense microbial activity is particularly important, as aerobic decomposition is most efficient and produces finished compost in the shortest time. As readily available organic matter is used up and decomposition slows, temperature in the compost pile drops and the solidification phase begins. The compost can be stored at this stage.

	3.3. Production of biologically active substances. The design of new bio-based formulas - Exploitation of the side streams of the food industry through the implementation of environmentally friendly and cost-effective technologies is considered a major path to zero-waste production. For example, production of polyphenols - substances with versatile properties, such as long-term protection from cardiovascular diseases, antioxidant and anti-inflammatory power. Dimitris P. Makris, 2019 **Conclusion** Population growth brings with it the need to increase food resources, and this also leads to an increase in waste from the agricultural sector and the food industry. Biological waste is biodegradable, but the problems associated with it come precisely from the process of biodegradation - rotting. As a result of this process, methane - a greenhouse gas - is released into the atmosphere. This is also the reason why the attention of the public has been directed towards the development of biomass waste management strategies. The holistic recovery of food waste through a biorefinery approach can play a crucial role in sustainable zero-waste global development.
References	Andrew Turgeon, Elizabeth Morse, May 2022, Article: Biomass energy biomass energy | National Geographic Society Agriculture & Forestry, November 5, 2020, By Fantastic Facts https://fantasticfacts.net/2467/ Dimitris P. Makris and Selin, Sahin, 2019, Polyphenolic Antioxidants from Agri-Food Waste Biomass https://pubmed.ncbi.nlm.nih.gov/31817614/ DEVELOPMENT ENVIRONERGY SERVICES LTD, December 2016, Biomass management & pricing for power generation https://www.aedb.org/images/BiomassManagementPricingforPowergenerationV3.pdf Emily Marriott, Ed Zaborski, University of Illinois at Urbana-Champaign, January 2009, Making and Using Compost for Organic Farming https://eorganic.org/node/2880
Interactive questions for R3	1. Biomass is only waste of plant origin, waste products from agriculture True **False** 2. Energy can be produced from biological waste **True** False

	3.What is obtained as a residual product in the production of biogas? -fertilizer - methane - unusable waste
Keywords	Biomass, Biofuel, Biogas, Composting
Questions for reflection	Watch the videos ACCIONA, 2015, How does biomass work? https://www.youtube.com/watch?v=slQRWbRE8VI DW Planet, 2022, Biomass: How clean is energy from waste and plants really? https://www.youtube.com/watch?v=XXu15NlOuGo Discuss the topics presented in the videos. Homework Students investigate what organic waste is thrown away at home and the possibilities of composting at home. Students present the results of the research.
Additional resources	**Documents:** European commission, Agriculture and rural development. Agriculture and rural development Agricultural biomass (europa.eu) A.MuscatE.M.de OldeI.J.M.de BoerR.Ripoll-Bosch, June 2020, The battle for biomass: A systematic review of food-feed-fuel competition The battle for biomass: A systematic review of food-feed-fuel competition - ScienceDirect **Video** SPECTRAFORCE TV, April 2022, 8 Sustainable Practices In The Workplace https://www.youtube.com/watch?v=CfM0MxBfi2g
Icons & related info for the hints of the PowerPoint presentation	This hint is used to indicate that there's a link to other websites with additional information.

	 This is used within the PPT to indicate that something important is written/ to invite the reader to pay attention to essential information.  This hint indicates a question/task for reflection.
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