TREE
Micro- and project-based learning programme for Teaching ciRcular Economy and Ecological awareness in VET

Funded by the European Union

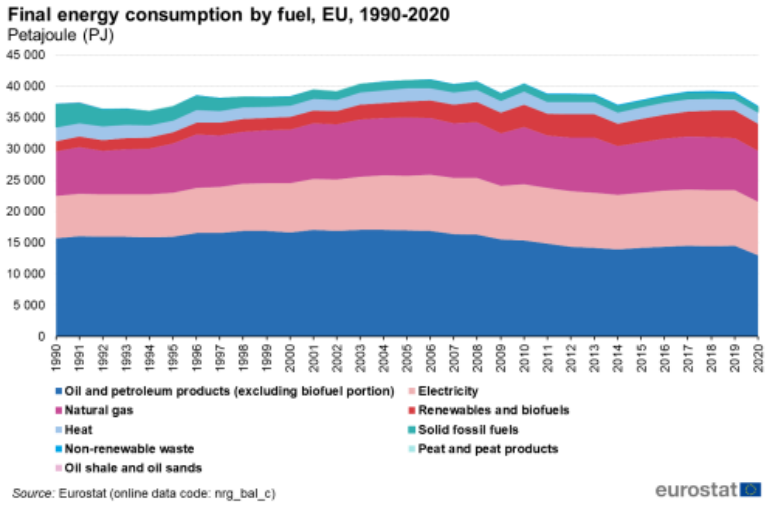
TRAINING LESSON 3 - Part 2 (Wood sector)

Title	**Energy production and consumption (Wood energy efficiency)**
Part of the training course referred to in this lesson	○ □ Part 1 General information about sustainability and CE Part 2 Specific Information about: X Wood sector □ Plastic sector □ Agrifood sector
EQF level	Level 4
Where the lesson was tested	//
General Learning objective(s) according to the Bloom Taxonomy https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/	□ **Create** Produce new or original work (design, assemble, construct, investigate, formulate) □ **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)	• *Learn about energy production and consumption in the EU* • *Learn about the importance of wood energy* • *Learn about different sources and types of wood energy* • *Understand the link between production and consumption and related patterns* • *Evaluate the possibilities for the future of wood energy*
Cognitive, socioemotional and behavioural outcomes	**SDG 7 | Affordable and Clean Energy**

based on https://www.unesco.de/sites/default/files/2018-08/unesco_education_for_sustainable_development_goals.pdf	**Cognitive learning objectives:** 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. **Socio-emotional learning objectives:** The learner is able to assess and understand the need for affordable, reliable, sustainable and clean energy of other people/other countries or regions. **Behavioural learning objectives:** The learner is able to analyse the impact and long-term effects of big energy projects (e.g. constructing an off-shore wind park) and energy related policies on different stakeholder groups (including nature) **SDG 11 | Sustainable Cities and Communities** **Cognitive learning objectives:** The learner knows the basic principles of sustainable planning and building, and can identify opportunities for making their own area more sustainable and inclusive. **Socio-emotional learning objectives:** The learner is able to contextualize their needs within the needs of the greater surrounding ecosystems, both locally and globally, for more sustainable human settlements. **Behavioural learning objectives:** The learner is able to speak against/for and to organize their voice against/for decisions made for their community. **SDG 12 | Responsible Consumption and Production** **Cognitive learning objectives:** The learner understands production and consumption patterns and value chains and the interrelatedness of production and consumption (supply and demand, toxics, CO2 emissions, waste generation, health, working conditions, poverty, etc.). **Socio-emotional learning objectives:** The learner is able to communicate the need for sustainable practices in production and consumption. **Behavioural learning objectives:** The learner is able to challenge cultural and societal orientations in consumption and production. **SDG 15 | Life on Land** **Cognitive learning objectives:** The learner understands the manifold threats posed to biodiversity, including habitat loss, deforestation, fragmentation, overexploitation and invasive species, and can relate these threats to their local biodiversity.

	Socio-emotional learning objectives: The learner is able to argue against destructive environmental practices that cause biodiversity loss
Green skill(s) addressed	□ Creative problem-solving X Forward-thinking X Monitoring skills X Analytical skills □ Lean production □ Maintenance and repair skills X Pollution prevention □ Eco-design □ Management skills X Impact quantification X Life-cycle management □ Science skills □ Waste management X Environmental auditing X Ecosystem management □ Other_____
Duration	20 min
Structure and content of the lesson	**Intro** Energy's production and consumption have been economic drivers, and the importance of this sector continues to grow. Our dependency on energy and the increase in consumption, leads to the need for an increase in production and diversification. **Topic 1 Background: The EU and energy production and consumption- overall statistics** EU member states use and rely on a variety of energy resources. The energy mix and the quantity distribution, as well as the reliance on imports changes from one country to another. Eurostat provides updated statistical information on both energy production and consumption within the Union, which includes a breakdown of the different resources and categories. The take-aways from the most recent statistics is that EU energy import dependency rate stood at 57.5% in 2020, and the gross available energy in the EU in 2020 decreased by 8.1% compared to 2019. The primary production of energy within the EU in 2020 amounted to 24 027 petajoules (PJ), which according to the publication is 7.1 % lower than in 2019. According to the information released, there has been a downward trend in the production related to fossil fuels, oils and natural gas. The statistics further show an increase in the use of renewable energies, which accounted for the highest share in primary energy production in the EU in 2020 (40.8 %). In terms of energy consumption, 2020 showed a decrease of 5.6% compared to the

previous year. The changes in consumption, including the main types of resources can be observed in the graph below, published by Eurostat.



As it is seen on this graph, the main energy sources are as follows: oil and petroleum products, natural gas, heat, non-renewable waste, oil shale and oil sands, electricity, renewables and biofuels, solid fossil fuels and peat.

Topic 2 Main types of wood energy and related production/consumption

According to the WHO, more than two billion people depend on wood energy for cooking and/or heating, particularly in households in developing countries. It is increasingly getting attention due to renewable energy targets, combined with the modernization of extraction, combustion and use. In fact, " wood and wood products accounted for 6 % of the total energy consumed within the EU in 2016." The use of wood and wood products varies between member states. For instance, according to statistics, in " 2016 it ranged from over 20 % in Latvia and Finland down to less than 1 % in Cyprus and Malta. Wood was the source for more than three quarters of the renewable energy consumed in Estonia, Lithuania, Hungary, Latvia, Finland, and Poland. By contrast, the share of wood in the mix of renewables was relatively low in Cyprus and Malta (where the lowest share was reported, 4.5 %); this was also the case in Norway (6.4 %)."

" Wood energy refers to any energy source that comes from woody biomass, including, among others, fuelwood (sometimes used synonymously with firewood), charcoal, industrial wood residues, wood pellets, cellulosic ethanol, and other advanced forms of bioenergy." (Sepp, 2014)

Fuelwood is harvested and used directly, without further conversion, the main source being fresh wood from small trees. It is predominantly used by households for cooking and/or space heating.

Woodfuel comes from a variety of both forest and agricultural land use systems. These can include, but are not limited to tree or agrifood plantations,

and forests. According to experts, when considering sustainable woodfuel production, it takes two forms. It can either be the direct target for production, or it can be sourced as a by-product. Due to pressure from the need for an increase of renewable sources, as well as illegal harvesting, natural forests have suffered. This has led to the emergence of more and more forest plantations, which have the specific role of meeting the demand for this energy resource.

"Charcoal is a woodfuel made from burning wood in a low-oxygen environment (pyrolysis). The black solid that results in a carbon-rich energy carrier, which contains about 1.8 times more energy per kilogram than fuelwood. Charcoal is generally sold as a commodity primarily in urban and peri-urban areas and its production requires a certain investment. This implies that the charcoal sector constitutes a different set of stakeholders from those of fuelwood (Mwampamba et al. 2013)". Because in comparison to other key energy sources charcoal is cheap to transport, reportedly it is often illegally harvested and then sold far from the sourcing country. This in itself leads to inaccurate reporting, difficulties in tracking, monitoring and control.

Wood pellets or wood chips are used for the production of pellet fuels. "Pellet fuels are made from compressed biomass and their high density permits compact storage and rational transport over long distances. Densification increases the energy density of biomass by approximately 10 to 15 percent compared to raw wood. They are less expensive than wood pellets and more energy efficient, because less energy is required for manufacturing and processing. "

Waste wood or industrial wood residues is also an important category, especially in the EU. Waste wood combustion, partly in co-combustion with wood chips and industrial pellets has become common practice in many EU Member States (Lamers, et al. 2012), with timber residues having the most potential for further development and investment (de Gouvello et al. 2008).

Topic 3 Organisations and further information related to the sector

Due to its role as the leading source of renewable energy in the EU, and the Union's ambitious target of 20% of energy consumption from renewable sources by 2020, the consumption and hence the production of wood energy is expected to continue to increase. Due to its importance for the UNECE region, monitoring its use is a crucial part of the work of the UNECE/FAO Forestry and Timber Section. The monitoring is done through a number of activities, with the Joint Wood Energy Enquiry (JWEE) having perhaps the most crucial role.

Furthermore, the Section's work is assisted by the ECE/FAO Team of Specialists on Wood Energy and guided by the Joint ECE/FAO Working Party on Forest Statistics, Economics and Management.

Additional information on wood energy availability in the UNECE region can also be found in other ECE/FAO publications:

- State of Europe's Forests
- European Forest Sector Outlook Study
- Forest Products Market Review

The role of the UNECE Committee on Forests and the Forest Industries, which is a principal subsidiary body of the UNECE (United Nations Economic Commission for Europe) based in Geneva, cannot be undermined. All countries of Europe, the Commonwealth of Independent States, the United States of America, Canada and Israel are members of the UNECE and participate in its work. The UNECE Committee on Forests and the Forest Industries has to provide member States with the "information and services needed for policymaking and decision-making with regard to their forest and forest industry sectors, including the trade and use of forest products and, where appropriate, will formulate recommendations addressed to member governments and interested organizations."

Topic 4 Energy efficiency: production and consumption in wood sector

Wood energy is considered to be one of the most important sources of renewable energy, accounting for 46% of all renewable sources in the 27 UNECE countries who replied to the Joint Wood Energy Enquiry (JWEE) in 2013. In countries with significant forest industries, such as Finland and Sweden, a high share of forest energy comes from industrial and forestry residues.

Although in many EU Member states there are substantial supplies, there are a number that still rely on imports to meet their renewable energy targets. According to the COMEXT database, the "EU's overall imports from non-EU countries - including logs, chips and particles, sawdust, wood waste and scrap, wood pellets, wood briquettes and similar forms - grew sharply between 2005 and 2017. The quantities increased by approximately 13 % to 41 million tonnes, while their value increased by 50 % to 12600 million EUR. The increase is clearly visible in the article on Wood products - production and trade." According to the published data, the overall price of these imports went from 234 Euro per tonne to 310 Euro per tonne in the same period.

The EU-28 was the largest global producer of "wood pellets and other similar products, its output exceeding an estimated 16.0 million tonnes in 2016; production in the EU-28 rose by 106.3 % overall between 2010 and 2016." As previously mentioned, the data may not be fully accurate due to limited reporting and the large quantities of unofficial and/or illegal harvesting.

Some key takeaways from the research:

Wood is the most widespread renewable source of energy

Renewable energy (RE) accounts for 18% of the global energy supply; nearly 13% of this can be attributed to traditional biomass.

Wood energy accounts for more than 80% of household energy consumption in many developing countries

By 2030, roughly 2.7 billion people in developing countries will depend on wood as a fuel

Nature produces about 170 billion tonnes of biomass annually, equivalent to 25 times the annual production of crude oil.

Topic 5 Wood energy and the future

The use of wood energy, similarly to other renewable sources, is expected to continue growing in the future. This is due to the benefits related to that, which have social, environmental and economic aspects. What will prove to be of great importance is the way in which these resources are managed, used and consumed. Private sector decisions should be aligned with public policy, responsible and sustainable forest management, protection of soils, water and biodiversity as well as taking into account the maximum levels of extraction at different sites.

In terms of social benefits, reportedly the production and consumption of bioenergy may lead to the increase in “green jobs” and sustainable local practices.

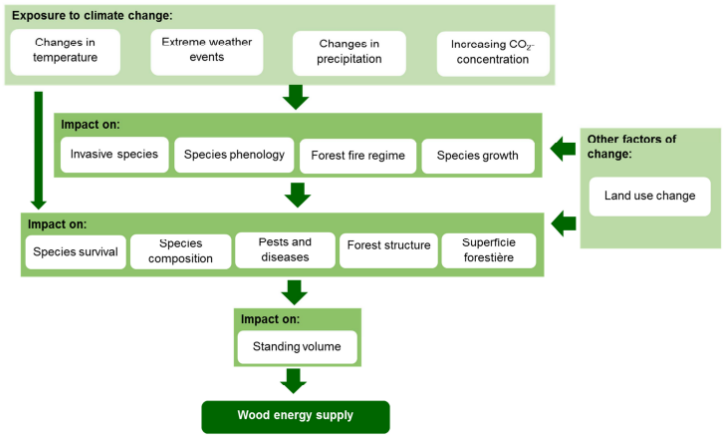
According to the research and relevant data, in terms of the environment, having regular assessments on harvesting needs vs. sustainable sourcing will lead to better forest management and will ensure the protection of biodiversity. Of course, the use of renewable energy resources will have an undisputed positive impact on the environment. As far as the issue of climate change is concerned, reduced greenhouse gas emissions are one of the main policy rationales for promoting woodfuels through reforestation. “Wood fuels can reduce carbon emissions in two ways (Kartha 2006). First, over their life cycle, woodfuels absorb and release carbon from the atmospheric pool without adding to the overall quantity of circulating carbon (in contrast to fossil fuels). Second, they displace the use of fossil fuels.”

In terms of economics, in addition to the new job opportunities, costs of wood-based fuels and sources still remain lower in comparison to others and require lower investment.

Conclusion

The wood energy sector is complex and it is marked with challenges. However, wood energy, due to the variety it has in terms of products, the relatively low cost and its renewable nature, will continue to be one of the main energy sources. What is important is to use it in a sustainable manner, with controlled sourcing and production, continuous monitoring and consumption that takes both needs and responsibility into account.

References	(2022) Electricity production, consumption and market overview, Eurostat Statistics Explained, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Electricity_production,_consumption_and_market_overview FAO (2022), Wood Energy, as seen at: https://www.fao.org/forestry/energy/en/ FAO (2022) FAO Forestry statistics, Global compilations of comparable statistics, https://www.fao.org/forestry/statistics/84922/en/ and https://www.fao.org/faostat/en/#data/FO (as pop -up Eurostat, (2018), Archive: Wood as a source of Energy, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Archive:Wood_as_a_source_of_energy&oldid=427588 Sepp, Steve, (2014) ECO Consulting Group, ed. Heike Volkmer, Wood Energy Renewable, profitable and modern ,Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, pp. 1-25. Dr. Sepp ,Steve; Sepp, Cornelia; Mundhenk, Marion; (2014), Towards sustainable modern wood energy development, Stocktacking paper on successful initiatives in developing countries in the field of wood energy development, GIZ Sector Project to Combat Desertification and the Sector Project on Sustainable Agriculture for the Global Bioenergy Partnership (GBEP), pp.1-67. UNECE, (2020), About Wood Energy, as seen at: https://unece.org/about-wood-energy UNECE (2018), Wood Energy in the ECE Region Data, trends and outlook in Europe, the Commonwealth of Independent States and North America, New York and Geneva, 2017, ISBN: 978-92-1-117154-9,
Interactive questions for R3	1. Which of these sets of countries are NOT part of UNECE a) Canada and the United States b) Kyrgyzstan and Tajikistan c) Australia and Brazil 2. The use of wood energy is expected to: a) Increase b) Decrease 3. What are the main types of wood energy: …… fuelwood, charcoal, industrial wood residues or waste wood, wood pellets, cellulosic ethanol, and other advanced forms of bioenergy
Keywords	Wooden energy efficiency, production, consumption

Questions for reflection	1. Reflect on how you see the future of wooden energy production. 2. Reflect on how you see the future of wooden energy consumption. 3. Discuss and groups and conduct ideation processes on solutions for existing problems.
Additional resources	https://yearbook.enerdata.net/total-energy/world-consumption-statistics.html Total Energy consumption Statistics (9pop up|) https://yearbook.enerdata.net/total-energy/world-energy-production.html Total Energy production Statistics (9pop up|) IEA (2021), World Energy Balances: Overview, IEA, Paris https://www.iea.org/reports/world-energy-balances-overview/oecd#abstract IEA (2021), *World Energy Balances: Overview*, IEA, Paris https://www.iea.org/reports/world-energy-balances-overview Energy Return on Investment (EROI) of Different Wood Products Zdravko Pandur, Marijan Šušnjar, Marko Zorić, Hrvoje Nevečerel and Dubravko Horvat Submitted: December 3rd, 2014 Reviewed: July 1st, 2015 Published: September 30th, 2015; DOI: 10.5772/61144 https://www.intechopen.com/chapters/48973 Source:(Bailis 2011) Figure 16: Potential impacts of climate change on the sustainable supply of wood energy  Source: adapted from CIFOR, World Agroforestry Centre & USAID 2009 Eurostat, the Timber Committee of the United Nations Economic Commission for Europe (UNECE), Forestry Section of the United Nations Food and Agriculture Organisation (FAO) and the International Tropical Timber Organisation (ITTO) collect and collate statistics on the production and trade of wood through their Joint Forest Sector Questionnaire. Each partner collects data from a different part of the world; Eurostat is responsible for

	the data collection exercise pertaining to the EU Member States and EFTA countries.
Vocabulary	**biofuel** (in solid, liquid or gaseous state) is produced directly or indirectly from biomass and used for generation of bioenergy. Total mass of a solid biofuel includes oven dry matter (organic and inorganic) and moisture (ISO 16559:2014; adapted from EN 14588:2010). bioenergy energy derived from biomass **Biomass** may either be directly converted into energy or processed into solids, liquids or gases. (ISO 16559:2014; adapted from EN 14588:2010) biomass material of biological origin excluding material embedded in geological formations and/or fossilized (adapted from EN 14588:2010) **woody biomass** biomass originating from trees, bushes and shrubs This definition includes forest, plantation and other virgin wood, wood processing industry by-products and residues, and used wood. (ISO 16559:2014; adapted from EN 14588:2010) **total mass** mass of all components of the solid fuel, including dry matter and moisture (ISO 16559:2014; adapted from EN 14588:2010) **inorganic** matter non-combustible fraction of a fuel (ISO 16559:2014; adapted from EN 14588:2010) **ash** (ash content) mass of inorganic residue remaining after combustion of a fuel under specified conditions, typically expressed as a percentage of the mass of dry matter in fuel (ISO 16559:2014; adapted from ISO 1213-2:1992) **wood fuels** (wood based fuels, wood-derived biofuels) all types of biofuels originating from woody biomass (ISO 16559:2014; adapted from UBET, 2004) **forest fuels** forest fuel is produced directly from forest wood or plantation wood by a mechanical process, the raw material has not previously had another use (ISO 16559:2014; adapted from EN 14588:2010) **fuelwood** wood fuel where the original composition of the wood is preserved, unaltered from original form (ISO 16559:2014; adapted from EN 14588:2010) **firewood** cut, and split fuelwood usually with a length of 20 to 100 cm used in household appliances like stoves, fireplaces and central heating devices (ISO 16559:2014; adapted from EN 14588:2010)

	hog fuel shred fuelwood that has pieces of varying size and shape, produced by crushing with blunt tools such as rollers, hammers, or flails (ISO 16559:2014; adapted from EN 14588:2010) **black liquor** liquor obtained from wood during the process of pulp production, in which the energy content is mainly originating from the content of lignin removed from the wood in the pulping process (ISO 16559:2014; adapted from EN 14588:2010) **wood chips** chipped woody biomass in the form of pieces with a defined particle size produced by mechanical treatment with sharp tools such as knives (ISO 16559:2014; adapted from EN 14588:2010) **cutter chips** wood chips made as a by-product of the wood processing industry, with or without bark (ISO 16559:2014; adapted from EN 14588:2010) **forest chips** forest wood in the form of wood chips (ISO 16559:2014; adapted from EN 14588:2010) densified biofuel, compressed biofuel solid biofuel made by mechanically compressing biomass or thermally treated biomass to mould the solid biofuel into a specific size and shape such as cubes, pressed logs, biofuel pellets or biofuel briquettes (ISO 16559:2014; adapted from EN 14588:2010) **wood briquette biofuel** made with or without additives in the form of cubiform or cylindrical units and a diameter of over 25 mm produced by compressing pulverised woody biomass (ISO 16559:2014; adapted from EN 14588:2010) **wood pellet biofuel** made from woody biomass with or without additives in the form of cubiform, polyhedral, polyhydric or cylindrical units of random length (typically from 3.15 mm to 40 mm) with broken ends, and a diameter up to 25 mm (ISO 16559:2014; adapted from EN 14588:2010) thermally-treated **biomass** whose chemical composition has been changed by heat (usually by temperatures of 200 to 300°C and above) (ISO 16559:2014) **charcoal solid biofuel** derived from carbonization distillation and pyrolysis of biomass (ISO 16559:2014, adapted from ANSI/ASABE S593)

Icons & related info for the hints of the PowerPoint presentation	 This hint is used to show sources on further information according to the topic.  This hint indicates that something important is written.  This hint indicates a question/task for reflection.
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