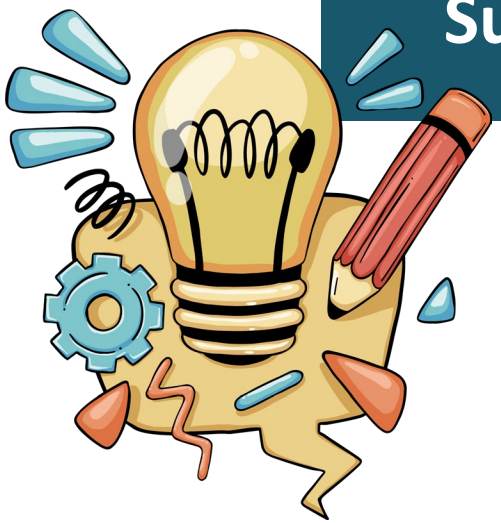
Co-funded by
the European Union



Sustainable Vocational Education and Training

A Practical Handbook for Vocational Schools

Content editor: Dr Magdalena Mazik-Gorzelańczyk (info@fundacja-faveo.pl)
Graphic design: Łukasz Strączek (l.straczek@gmail.com)

Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the Foundation for the Development of the Education System (FRSE). Neither the European Union nor FRSE can be held responsible for tchem.

This publication is free of charge and is available under a Creative Commons CC BY-NC-SA 4.0 licence.

To make the handbook easier to read and use, the masculine form is used in the text to refer to students and teachers. This should be understood as referring to both genders and non-binary people.

Dear users of this handbook!

Due to the environmental impact of printing, we ask that you use electronic versions (where possible).

Thank you ☺

“Big changes are made up of many small steps”, or a word of introduction

We are pleased to present the second handbook in a series of educational materials dedicated to the green transition in vocational education. This publication covers education in the fields of forestry, cosmetology, the textile industry, chemistry, mechatronics, and tourism.

We often think of protecting the Earth in terms of global agreements and megatrends, yet true transformation takes place in the gestures and actions we perform every day - including at work. It is the sum of small, conscious decisions: choosing reusable equipment in the laboratory, programming a machine precisely to minimise waste, or offering tourists local products instead of imported ones. Sustainable development in vocational education is about learning to recognise that every workplace is a ‘frontline’ in the fight to improve the climate.

Our approach is firmly rooted in the European Green Deal strategy. The European Union clearly states that climate neutrality by 2050 will not be achieved without the involvement of millions of workers. In accordance with the Osnabrück Declaration (2020) and the EU Council Recommendations on learning for sustainable development, vocational education must provide ‘green competences’. These are not merely an add-on to a diploma, but a necessary, integral part of every qualification.

The Erasmus+ programme provided funding for the project, enabling us to work with an international team of experts from Poland, Germany, and North Macedonia. This allowed us to approach the topic from a transnational perspective and develop universal tools that can be used across multiple education systems. Our aim was to prepare materials compatible with the core curriculum for vocational education, attractive to young people and easy for teachers to use, in order to maximise their application.

With this publication, we demonstrate that a textile industry worker mindful of a fabric’s life cycle, or a designer creating with easy disassembly in mind, is a key player in global change. We teach how to turn these small actions into a standard that builds a sustainable, ethical, and competitive economy. I invite you to read this publication and share best practices.

dr Magdalena Mazik-Gorzelańczyk
Project Manager

Methodology for using the handbook: from reflection to action

The project is based on the approach of environmental and social education, which distinguishes several levels of impact that must be activated to ensure that the results achieved are real and lasting: from actions to halt processes harmful to the environment, through practices supporting the development of new models, to changes in public awareness – an indispensable condition for success*. The structure of the handbook has been designed to ensure that the learning process is active, engaging, and focused on solving real-world problems that students will encounter in their professional careers. The methodology is based on three pillars: understanding, analysis, and application.

1. Structure of the textbook

The textbook is divided into chapters corresponding to specific sectors. Each module has been developed to combine professional knowledge with aspects of protecting natural resources and people. As a result, we do not teach 'about sustainable development', but rather how, for example, to reduce microplastics in a beauty salon, maximise water retention in forestry, or use natural dyes in the textile industry. Each industry-specific chapter identifies specific moments in the work process (e.g. preparing the workstation, selecting raw materials, waste disposal) where the student can make a 'green' decision. We show how optimising a small action translates into real annual savings in raw materials. Knowledge of sustainable development should become a natural backdrop to learning.

The publication consists of two parts. The first part was developed in response to the experiences of vocational education experts from partner organisations and the recommendations of the Council of the European Union, which highlight the need to involve vocational education staff in global education and to enhance their competence in teaching in the spirit of sustainable development. Without these resources, it is difficult for instructors to address similar gaps among students. Therefore, the first part includes fifteen lesson plans intended for use in training educators. These can be delivered by teachers with more experience in this area, such as coordinators of international projects in schools, as well as green education trainers. It is advisable that teachers who will be using the lesson plans with students during their lessons undergo prior training based on the section dedicated to them. These consist of three introductory topics and two topics relating to each selected vocational area**.**

The second part of the textbook contains lesson plans for students. These are divided into modules dedicated to specific sectors: forestry, tourism, cosmetics, textiles, chemicals and mechatronics. Each module contains nine lesson plans corresponding to the topics included in the curriculum for the relevant profession, but presents them from the perspective of the entire ecosystem in which the profession and sector of the economy operate.

2. Lesson plan outline

Each lesson plan is based on a template containing fixed elements:

- lesson title and number: the number next to the title indicates the lesson number and the number of the competence module to which the lesson plan belongs; for example, lesson plan 2.6 ‘The impact of environmental stress on trees’ refers to module 2 ‘forestry’ and lesson plan number 6 within that module;
- learning objectives, which are defined in terms of knowledge (“after the lesson, the student knows”), skills (“after the lesson, the student can”), and attitudes (“after the lesson, the student understands”);
- lessons broken down into stages to help the teacher navigate the lesson (“step by step”);
- the time required to conduct the lesson;
- a list of necessary materials and teaching aids;
- the preferred number of participants;
- notes for the facilitator on implementing the lesson plan (optional);
- a list of source materials used.

3. Guidelines for working with lesson plans

The authors’ intention is for this handbook to be as user-friendly and straightforward as possible for teachers of vocational subjects, hence:

- the lesson plans are divided into clear sections to make it easy to quickly familiarise oneself with the lesson objectives and content;
- the lesson plans contain all the materials and attachments needed to cover the topic, presented in a user-friendly format (usually for display, to minimise the use of printed materials);
- the lessons are tailored to the rhythm of 45-minute lessons, making them easy to integrate into the school timetable

The lesson plans are ready-to-use materials. They contain not only instructions for the suggested exercises but also, for example, questions and tips to help summarise the work. To achieve the educational objective, it is not necessary to cover all the lesson plans, nor to follow the order in which they appear in the handbook. The teacher can select topics and arrange them into a personalised sequence tailored to the needs of the group. It is also possible to carry out a single lesson plan if a particular topic is missing from the current lesson, or to use a specific exercise. This will also fulfil its purpose. Each module contains lesson plans that can be used to teach several professions within a given industry.

A large proportion of the lesson plans are based on the idea of teamwork. This method has been tested by the experts who developed the handbook and is valued for the results it can achieve when working with young people. It involves engaging the students themselves in the process and building on their existing experience. This allows participants to identify more closely with the subject matter and remain grounded in the realities of their world of study and work, and consequently fosters greater emotional engagement. For the instructor, this method requires moving away from 'lecture-style' teaching and actively involving the participants. In practice, this means reducing the number of lectures and talks in favour of exercises, simulations, and discussions.



4. Use of visual materials and sources

Most lesson plans include attachments in the form of photos, drawings, or diagrams to make learning new information easier and more engaging. For several lesson plans, video material has been produced to illustrate the theoretical content. The videos can be viewed on YouTube by clicking the link or by scanning the QR code. All videos are available under an open licence, in the language in which the relevant version of the publication is written. It is worth using these materials when teaching, as they align with the educational preferences of the younger generation, often referred to – not without reason – as the 'visual generation'.

The graphics in the lesson plans and the pictograms have been designed to suggest the individual stages of the lesson and indicate what each section covers. The sources listed at the end of each lesson plan provide a basis for additional information that the teacher can refer to.



5. Good practices and fostering critical thinking

The main aim of this publication is to encourage young readers to think independently and to optimise their professional activities in the spirit of sustainable development. The lesson plans contain the necessary theoretical background and numerous references to the realities of professional life. The content includes practical guidance for teachers, suggesting how to support students in analysing their own behaviour and in independently seeking effective solutions. Self-assessment questions assist in this process, for example: 'How will a single change in my daily work routine affect energy consumption across the whole company?'. Here, the teacher takes on the role of a facilitator, helping students to understand that their daily work has significant systemic importance. An integral part of the materials is also examples of good practices already in use in the market, which bring the real world and the actual challenges facing their industry closer to the students.

***** Concept described in J. Macy, Ch. Johnstone, 'Active Hope', Warsaw 2023.

Project Partner Organizations and Outline Authors

FAVEO Foundation for Vocational and Intercultural Education, Partnership Leader
Since 2007, the Foundation has been working to promote internationalization and improve the quality of vocational education in Poland and other European Union countries. Its goals include promoting a modern, environmentally and socially sustainable labor market policy; improving the professional qualifications of employees and students; and promoting high standards of vocational education that take global market processes into account. The results of the FAVEO Foundation's work include hundreds of completed international student internships and dozens of vocational school teachers who have acquired international competencies. It also includes the exchange of experiences among company employees throughout the European Union and several textbooks on modern vocational education. Sustainable development is a cross-cutting theme in all of FAVEO's initiatives. Thanks to a broad and stable network of cooperation with vocational education institutions in Poland and abroad, the Foundation benefits from the synergies and potential offered by a diversity of perspectives on education and development.
Website: www.fundacja-faveo.pl

dr Magdalena Mazik-Gorzelańczyk

professor at the Poznań School of Management and Psychology, holds a Ph.D. in social and political sciences; she is the president of the FAVEO Foundation for Vocational and Intercultural Education in Wrocław and the rector of the Poznań School of Management and Psychology. She has many years of experience in managing international projects. She is a trainer in intercultural communication and the author of publications on the European labor market and vocational education. She specializes in Polish-German relations and innovations in education. She is a fan of the "slow life" philosophy and Vinted.

Sandra Domagalska

holds a master's degree in law and is a psychology student. She serves as the coordinator of the European Works Councils at the National Secretariat of the Chemical Industry and as a delegate to the Executive Committee of IndustriAll Global. She has experience in project management and testing innovations based on new technologies. In her professional work, she combines legal, organizational, and social skills to carry out tasks in both national and international contexts. A travel enthusiast, she creates custom itineraries for small groups, taking into account the principles of sustainable development and responsible tourism.

Agnieszka Krzywda

is a forester by profession; she earned her master's degree from the Faculty of Forestry at the University of Agriculture in Kraków. She has experience working within the State Forests of Poland. She currently teaches vocational subjects at the Forestry Technical School in Milicz.

Agnieszka Zabrzewska

holds a master's degree in landscape architecture; she is a florist, teacher, and educator specializing in environmental, climate, and biodiversity issues. She has experience in intercultural and global education and emphasizes the practical application of knowledge. She is a member of the German Federal Working Group of Independently Managed Horticultural Enterprises (BaseG), which volunteers to develop nature-friendly green spaces. She has worked for the German Association for Garden, Landscape, and Sports Field Construction (Verband Garten-, Landschafts- und Sportplatzbau Baden-Württemberg e. V.). She participates in numerous interdisciplinary and international projects.

Project Partner Organizations and Outline Authors

INNOVA LAB Bitola

This is a non-profit, non-governmental organization founded in 2017 in North Macedonia, whose mission is to support young people, teachers, and local communities through non-formal education, innovation, entrepreneurship, and sustainable development. The organization has extensive experience in vocational education and training, as well as in developing innovative curricula, textbooks, and training modules tailored to the needs of the labor market and European priorities.

INNOVA LAB actively promotes sustainable development, the circular economy, and sustainable fashion, including eco-design, upcycling, and green skills. It has extensive experience in implementing Erasmus+ and national projects, working closely with VET schools, universities, local authorities, and civil society organizations. The organization supports the development of key competencies and skills that enhance employability by organizing training sessions, pilot activities, and capacity-building programs, particularly for disadvantaged youth.

Social media profiles:

https://www.facebook.com/innovalab.mk

https://www.instagram.com/innovalab.mk/

https://www.linkedin.com/in/innova-lab-bitola-macedonia-4142a617a/

Prof. Dr. Elizabeta Tosheva

is a Full Professor at the Faculty of Law, University "St. Kliment Ohridski" – Bitola, and Founder and President of the Center for Educational and Development Initiatives – INNOVA LAB, Bitola. She has more than 27 years of professional experience in higher education, teaching, research, and the development and implementation of national and international projects.

Her expertise includes entrepreneurship, social and green entrepreneurship, international economics, sustainable development and the circular economy, youth skills development and employability, as well as innovation in education. She has extensive experience in developing curricula, training programmes, handbooks and educational resources, as well as in research, mentoring, and working with young people, educators and other target groups within Erasmus+ and other European and national initiatives.

Prof. Dr. Meri Boshkoska

is a university professor at the Faculty of Economics – Prilep, UKLO. She has extensive experience in implementing national and international projects, focusing on entrepreneurship, digitalization, sustainable development, and curriculum design. Her work includes developing educational materials and supporting innovation and organizational capacity building.

Project Partner Organizations and Outline Authors

Ausbildungsverbund Olefinpartner gGmbH (AVO)
operates as a vocational training center in cooperation with 70 companies and supports firms in the fields of electrical engineering, automation, mechatronics, metalworking, and systems engineering, as well as chemistry, process engineering, and laboratory work, in imparting practical skills and professional competencies to 400 apprentices.
In addition, AVO is integrated into the career counseling system in Saxony-Anhalt as a project leader and, in cooperation with associations, chambers, and social partners, certifies schools for high-quality career counseling by awarding them the “Berufswahl-SIEGEL” certificate.
Competencies related to sustainable development, particularly skills, are strongly developed among AVO staff through the publicly funded MONAMINT project, which combines online courses and interactive workshops and contributes to the development of foundational knowledge about the concept of sustainable development and teaching strategies in this area.

Matthias Hirschman

holds a Master of Arts in adult education, a degree in management, and a teaching certification for secondary schools. He holds the title of education specialist. He coordinates projects under the Erasmus+ program and other initiatives, and has served as academic director and manager at various educational institutions. He currently works as general director and head of education at Ausbildungsverbund Olefinpartner gGmbH.

Christopher Peschel

holds a master’s degree in natural sciences, with a major in chemistry. He is a research fellow at Martin Luther University in Halle and a doctoral candidate in the field of chemistry education. He is the author of curricula and educational materials for the “InnoVET CLOU” project, as well as the project manager and creator of teaching aids for the Erasmus+ program “INFINITE.” His area of expertise is innovative and sustainable practices in the field of chemistry



Dana Sommerfeld

holds a master's degree in educational sciences and is the author of publications on education for sustainable development. She currently leads the "Monamint" project, which focuses on promoting sustainable development practices in vocational education within the chemical industry.



Dennis Zacher

holds a bachelor's degree in English Cultural Studies; he is a foreign language teacher and an English instructor in vocational training at Ausbildungsverbund Olefinpartner. He has experience as an author of training materials for national (InnoVET CLOU) and European educational projects (INFINITE).



Kay Huber

holds a master's degree in the natural sciences, with a focus on biochemistry. He is a high school biology and chemistry teacher and a vocational training specialist in chemistry for the profession of analytical technician at Ausbildungsverbund Olefinpartner gGmbH.



Christian Hoffmann

is an electronics technician specializing in building and infrastructure systems and a master craftsman in electrical engineering. At Ausbildungsverbund Olefinpartner gGmbH, he is responsible for the quality of vocational training for occupations in the electronics and mechatronics sectors.

Table of Contents

General Lesson Plans for Teachers
1.1. Credible environmental claims – Green Claims Directive
1.2 Benefits of Circular Packaging
1.3 Teaching sustainability in education

Lesson Plans for Teachers - Forestry Industry
1.4 The impact of energy sources on the environment
1.5 Forests in the era of global economic pressure

Lesson Plans for Teachers – Tourism Industry
1.6 Virtual travel agency
1.7 Modern marketing methods in a travel agency

Lesson Plans for Teachers – Cosmetics Industry
1.8 Advancing Sustainability and Eco-Friendly Packaging in the Cosmetic Care and Beauty Industry
1.9 Building a Greener Future: Implementing Sustainable Practices in Cosmetic Beauty Salons

Lesson Plans for Teachers – Textile Industry
1.10 RETHINKING SUSTAINABLE FASHION
1.11 ECO-DESIGN FOR CIRCULAR ECONOMY IN THE TEXTILE AND FASHION INDUSTRIES

Lesson plans for teachers – chemical industry
1.12 The ozone layer and CFCs
1.13 Biofuels

Lesson plans for teachers – mechatronics industry
1.14 Technical oils in the metal workshop
1.15 3D printing as a manufacturing technology

Lesson plans for students – forestry industry
2.1 Alternative methods of using wood of reduced quality.
2.2 Sustainable methods of shaping tree stand structure.
2.3 Optimal use of habitat conditions for tree growth.
2.4 The effects of disrupted water circulation in the forest during timber harvesting
2.5 Application of new technologies in forest protection
2.6 The effect of environmental stress on trees
2.7 Local communities as stakeholders in sustainable forest management
2.8 International cooperation in the conservation of natural resources
2.9 The educational potential of forests. Traditional and new trends

Lesson plans for students – tourism industry
2.10 The impact of climate change on tourism
2.11 Sustainable forms of tourism
2.12 Sustainable development in the hotel and catering industry
2.13 Sustainable tourism certificates
2.14 Local communities as stakeholders in sustainable tourism
2.15 Social responsibility and tourist education
2.16 International cooperation in the organisation of sustainable tourism
2.17 International good practices in sustainable forms of tourism
2.18 Is it really beneficial? Case study.

Lesson plans for students – cosmetics industry
2.19 Plastic-Free Beauty: Reducing Single-Use Plastics in Cosmetics
2.20 Cosmetic & beauty Trends: driving sustainability
2.21 Practical Steps for an Eco-Friendly Beauty Salon
2.22 Eco-Symbol Safari
2.23 DIY Green Beauty: Crafting Your Own Eco-Friendly Product
2.24 Challenges of Selling Natural Cosmetics Online
2.25 Green Marketing and Ethical Beauty Branding

Lesson plans for students – mechatronics industry

2.26 Palm Oil’s Hidden Footprint in Cosmetics

2.27 Water Matters in Cosmetics

Lesson plans for students – textile industry

2.28 Eco-Friendly Textiles: Shaping a Sustainable Future

2.29 Zero Waste Design in Fashion

2.30 Consumer Behaviour and Sustainable Fashion

2.31 Alternatives to Harmful Dyeing and Finishing Techniques

2.32 Greenwashing in Fashion

2.33 "THE LIFE OF A T-SHIRT"

2.34 Care and Repair: Extending the Life of Clothing

2.35 Synthetic Fibres and Sustainable Solutions

2.36 Sustainable Dyeing Techniques from Natural Materials

Lesson plans for students – chemical industry

2.37 Green Chemistry

2.38 Renewable Raw Materials

2.39 Energy efficiency

2.40 CO_2 in transition: From climate problem to resource

2.41 Sustainable laboratory practice

2.42 Circular Economy

2.43 Biodegradable plastics

2.44 Fundamentals of Organic Photovoltaics

2.45 Biotechnological processes

2.46 Designing the ideal workshop

2.47 Energy efficiency in the training workshop

2.48 Safe electrical appliances, safe systems and safe machines

2.49 Tracking materials: Understanding the supply chains of the materials used

2.50 Potential savings through modernisation, using engines as an example
2.51 Put to the test – researching opportunities for optimisation and evaluating their impact
2.52 "Under scrutiny – researching optimisation opportunities and evaluating their impact"
Module 1: Optimising energy consumption.
2.53 Under scrutiny – researching optimisation opportunities and evaluating their impact.
Module 2: Optimisation through maintenance.
2.54 Put to the test – researching optimisation options and evaluating their effects.
Module 3: Optimisation through control technology.
2.55 Put to the test – researching optimisation opportunities and evaluating their impact.
Module 4: Optimisation through production planning.

Co-funded by the European Union



1.1 TOPIC: Credible environmental claims – Green Claims Directive

PROCEDURE:

Steps	Time
Step 1: Explanation of the Green Claims Directive	15 min
Step 2: Examples of greenwashing	15 min
Step 3: Exercise – learning the definitions of unfair practices	20 min
Step 4 Summary – quiz	10 min.

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• what the EU Green Claims Directive is and why it was developed • what definitions are used to describe pseudo-environmental practices	• identify unfair market practices in the field of environmental communication • recognise EU labels confirming the environmental credibility of a product	• initiatives to counteract companies falsifying the impact of a product on the environment and people



Number of participants: any



Materials needed: projector, A4 paper, pens



Comments: -



Planned time: 60 min.

STEP 1: Explanation of the content of the Green Claims Directive

The trainer displays information about the Green Claims Directive – Annexes 1A and 1B to the participants. Everyone reads the text.

STEP 2: Examples of greenwashing

The trainer shows what constitutes unfair practices in environmental information – Appendix 2.

STEP 3: Exercise – learning the definitions of unfair practices

The trainer displays Appendix 3. Participants are asked to correctly match the concepts related to unfair practices with their definitions. The correct answers are provided in the solution to Appendix 3 – on the next slide.

STEP 4: Summary – quiz

The trainer displays the questions – Appendix 4. Participants are asked to give the correct answers. The correct answers are provided in the solution to Appendix 4 – on the next slide.

ANNEX 1 A

From 2026, the EU **Green Claims Directive** will apply in the European Union
(Green Claims Directive).

It was introduced after the European Commission examined the market and found that companies were misleading consumers about the environmental impact of their products. The market is not controlled in terms of environmental certificates, and there are no uniform standards for recognizing the carbon footprint of a given product or service. In 2024, there were over 230 eco-labels for products on the European Union market.

The European Commission's research on companies' environmental claims shows that 53% of the claims examined were unclear, misleading or unfounded, and 40% were completely unjustified. 'You can find eco-friendly slogans everywhere – ocean-friendly T-shirts, carbon-neutral bananas, bee-friendly juices, deliveries with 100% CO2 compensation, and so on. Unfortunately, too often these claims are made without any evidence or justification' (European Commission). This situation was unfair to companies that conducted honest research.

- Therefore, a directive was introduced to:
  - make environmental claims credible, comparable and verifiable across the EU;
  - protect consumers from greenwashing;
  - contribute to the creation of a circular and green EU economy by enabling consumers to make informed purchasing decisions;
  - help establish a level playing field in terms of the environmental performance of products.

- Once the directive is in place, phrases about positive environmental impact, such as 'carbon neutral' and 'environmentally friendly', will be banned unless they are justified and verified by an accredited third party.

The authenticity of eco-labels (known as sustainable labelling) will have to be proven.

New labels will have to comply with four principles of general eco-labelling:

1. credibility
2. transparency
3. verifiability by independent bodies
4. the possibility of regular review

Before a company uses a 'green' claim, it will be mandatory to have it independently verified and to provide scientific evidence to support it. The labels used will also have to include a link or QR code to verify their credibility.

The directive also provides for the introduction of stricter regulations on eco-labelling. It is necessary to introduce uniform and reliable standards, such as the existing 'EU Ecolabel'. This is an official European distinction awarded to environmentally friendly products and services that meet high quality and health standards.



- The provisions of the directive will also apply to non-EU manufacturers who target their environmental claims at consumers in EU countries.
- Member States will be responsible for enforcing the new rules and imposing penalties for non-compliance. Penalties will include fines, confiscation of the company's profits and even temporary exclusion for up to 12 months from public procurement procedures and access to public funding.

ANNEX 2

Unfair practices in providing information about the environmental impact of a product:

• providing general information such as ‘product tested for environmental impact’ without specifying who tested it, when, how, and according to what standards
• displaying a label that is not based on a certification system or established by public authorities
• making a general claim for which the manufacturer is unable to provide specifics, e.g. ‘environmentally friendly product’, ‘chemical-free product’, ‘100% natural’
• stating that the product has been tested, but the testing institution is unknown or appointed/funded by the manufacturer to carry out the tests, e.g. ‘tested and recommended by the XYZ Institute’
• using a product name that suggests it is environmentally friendly, e.g. using the prefixes ‘eco’, ‘natural’, ‘bio’
• using symbols on the packaging that suggest the product is environmentally friendly, e.g. a leaf, green packaging
• unfounded use of symbols of recognised environmental organisations
• exaggerated product benefits, consisting of overemphasising features that are standard, e.g. the powder does not contain formaldehyde, when no powder on the market contains it
• using terms that are incomprehensible to consumers, terms specially created for the purposes of a given communication
• suggesting that a given product complies with environmental protection principles, but presenting only part of its cycle and not taking into account the overall environmental impact of the production process, use, and waste disposal

APPENDIX 3

A Greenwashing	1. Avoiding communication or concealing activities by companies for fear of being accused of greenwashing
B Greenhushing	2. A term that has become widely used in the public sphere since Russia's aggression in Ukraine, used by companies that continue to operate in Russia despite providing aid to Ukraine
C Whitewashing	3. A combination of the words "green" (meaning ecological, environmentally friendly) and "whitewash" (meaning to cover up, manipulate or mislead information).
D Warwashing	4. A term used to describe activities that exaggerate a company's commitment to responsible social practices related to the protection of human rights, improvement of living conditions, etc. For example, suggesting that a company has sponsored a water supply system in an African village that provides access to water for all residents, when in fact only some of them can use the water
E Purplewashing	5. Refers to attempts to use issues related to equality and the rights of the LGBTQ+ community to improve one's image or gain marketing benefits; this may include, for example, sponsoring LGBTQ+ events, products or services with rainbow-coloured logos, but without any actual involvement in the fight for the rights of this community
F Bluewashing	6. "Whitewashing", i.e. the practice of camouflaging bad actions by highlighting other actions in order to improve one's image

APPENDIX 4 Summary – quiz

1. How many eco-labels for products were in use on the EU market before the introduction of the Directive on Environmental Claims?

a) 30

b) 230

c) 15

2. Following the introduction of the Environmental Labelling Directive, labelling products as environmentally friendly:

a) will be possible after submitting your own product research

b) will be possible after testing by an independent research institution

c) will be possible after placing a QR code or link to content containing the product's composition on the packaging

3. The use of symbols such as a green leaf or blue planet on product packaging is an example of a practice known as:

a) Greenhushing

b) Whitewashing

c) greenwashing

SOLUTION APPENDIX 3

Correct answers:

A 3 B 1 C 6 D 2 E 5 F 4

SOLUTION APPENDIX 4

Correct answers:

1 B 2 B 3 C

SOURCES

- Monika Rak, Green Claims Directive as a step towards verified ecological choices and the fight against greenwashing (accessed on 10 May 2024)
- Klementyna Sęga, An end to greenwashing? https://pl.tergo.io/blog/co-trzeba-wiedziec-o-green-claims-directive/https://wodnesprawy.pl/green-claims-directive-jako-krok-ku-sprawdzonym-eko/ (accessed on 11 May 2024)
- https://environment.ec.europa.eu/publications/proposal-directive-green-claims_en (accessed on 8 May 2024)
- https://www.stenarecycling.com/pl/aktualnoci-publikacje/informacje-inspiracje/artykuy-i-ebooki/esgwashing-czyli-jak-nie-komunikowa-dziaania-firmy-w-obszarze-zrownowaonego-rozwoju/ (accessed on 4 May 2024)
- https://nowymarketing.pl/bliski-koniec-greenwashingu/ (accessed on 4 May 2024)

Prepared by:

Magdalena Mazik-Gorzelańczyk,
FAVEO Foundation

Co-funded by the European Union



1.2. TOPIC: Benefits of Circular Packaging

PROCEDURE:

Step by step	Time
Step 1: Introduction	15 min.
Step 2: Exploring Four Key Models of Reuse	40 min.
Step 3: Case Studies of Circular Packaging	40 min.
Step 4: Summary	10 min.

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• The benefits of circular packaging. • How can circular packaging be integrated into everyday life?	• Give examples of circular packaging. • Identify and evaluate different models of circular packaging.	• The importance of minimizing waste and reusing materials in packaging. • The broader environmental impact of adopting circular packaging practices.



Number of participants: At least 12



Planned time: 105 min



Required materials:
Projector, laptop
Sticky notes
Whiteboard and markers
Sheets and pens



Remarks: -

Click to see movie

STEP 1: Introduction

- To open the session and stimulate discussion among participants, the trainer asks, “What do you know about circular packaging?”
- The trainer writes each answer on the whiteboard and then provides a brief overview of what circular packaging is and its benefits. To ensure these benefits are clear, the trainer explains the objectives of circular packaging: minimizing waste, reusing materials, and designing for recyclability and sustainability.
- Finally, to wrap up the introduction, the trainer shares the following video with the participants:



Click to see movie

STEP 2: Exploring Four Key Models of Reuse

- To explore practical ways to reuse packaging, the trainer introduces the participants to the framework (Appendix 1), which outlines key models for effective packaging reuse.
- The trainer divides participants into four groups, each assigned to focus on a specific model from the packaging reuse framework. Each group must provide at least one example of their assigned model.
- Group 1: Model - Refill at home
- Group 2: Model - Return from home
- Group 3: Model - Refill on the go
- Group 4: Model - Return on the go
- The trainer asks each group to present their work and encourages discussion among the participants.

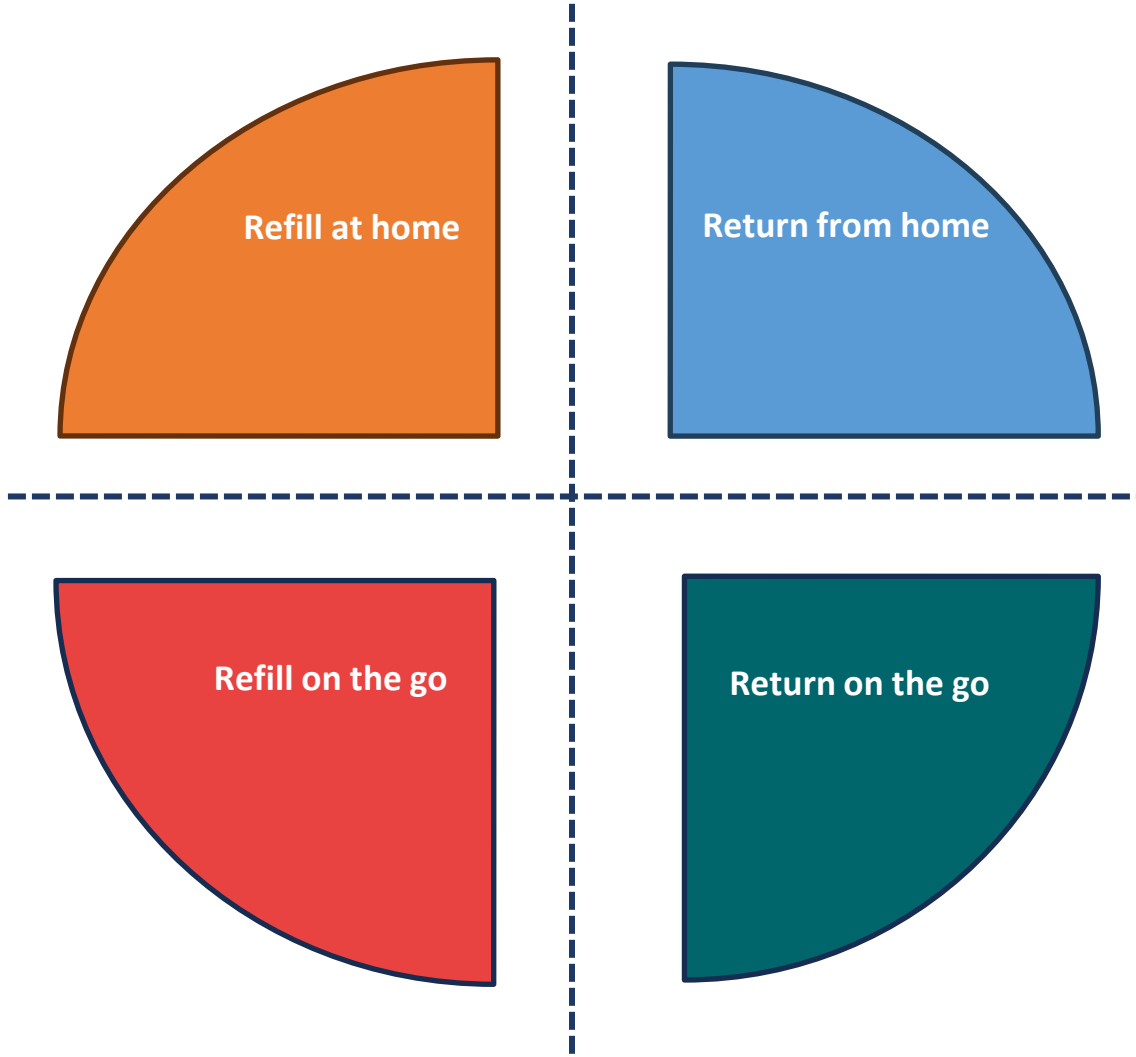
STEP 3 Case Studies of Circular Packaging

- The trainer starts with a brief introduction to case study analysis and explains the importance of learning from successful examples of circular packaging.
- The trainer divides the participants into four groups and assigns each group a different example of circular design from this link: https://www.ellenmacarthurfoundation.org/topics/circular-design/examples.
- The trainer writes on a whiteboard the following questions and asks each group to draw a conclusion for their assigned case studies.
    - What makes it circular?
    - What are the benefits of circular packaging in your assigned case study?
- The trainer invites each group to share their findings and write the key points on the whiteboard to stimulate discussion.

STEP 4 Summary

The trainer asks the participants:

- How can circular packaging be effectively integrated into everyday practices?


Refill at home
Return from home
Refill on the go
Return on the go

SOURCES

- Step 1 - https://emf.thirdlight.com/file/24/_A-BkCs_aXeX02_Am1z_J7vzLt/Reuse%20%E2%80%93%20rethinking%20packaging.pdf
- Step 1 - https://meyers.com/meyers-blog/circular-economy-packaging/
- Step 1 - https://noissue.co/blog/the-ultimate-guide-to-circular-packaging-and-the-circular-economy/?srsltid=AfmBOooKoQz3uD4VyT--PY5SO9HkZ13wXGefDXdrUUDtCZHb3ZpBOuD0
- Step 2 - https://emf.thirdlight.com/file/24/_A-BkCs_aXeX02_Am1z_J7vzLt/Reuse%20%E2%80%93%20rethinking%20packaging.pdf
- Step 3 - https://www.ellenmacarthurfoundation.org/topics/circular-design/examples.

Developed by:

Meri Boshkoska, Elizabeta Tosheva

Innova Lab - Bitola

Co-funded by
the European Union



1.3. TITLE: Teaching sustainability in education

PROCEDURE:

Steps:	Time
Step 1: Input on teaching methods for ESD	5 min
Step 2: Exercise on basic didactic principles	35 min
Step 3: Evaluation & conclusion	20 min



Number of participants: 15-20



Planned time: 60 min



Materials required:
Facilitation materials
Pinboard/blackboard
Printed appendix
Pens



Comments: -

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• That there are various strategies for teaching sustainability in training and will be familiar with 10 basic teaching principles.	• How to incorporate sustainability into their work with trainees in a low-threshold and practice-oriented manner.	• What to look out for when addressing trainees if they want to teach sustainability-related skills.

STEP 1 Input

There are various ways of implementing sustainability in training. These include methods that directly impart knowledge about sustainability and thus build sustainability-related professional skills, as well as strategies that promote these skills more incidentally. In addition, there are methods that focus on training locations (e.g. vocational schools, training companies, training centres) and aim to make them more sustainable. Here, too, there are both concrete methods and incidental strategies that can contribute to redesigning learning environments (see Appendix 1).

When implementing these methods and strategies, various basic rules should be observed are covered in this unit: (Appendix 2.0)

1. Do not overwhelm trainees with "mega problems" but encourage them to take responsibility in their own sphere of influence!
2. Sustainability is not an "extra topic", but an integral part of professional activity!
3. Regulatory measures are the basis of vocational training – it is important to reinterpret them in terms of sustainability!
4. Professional activity is never without consequences: make far-reaching and long-term effects visible!
5. Don't stick to "business as usual"; instead, support trainees in discovering alternatives and innovations!
6. Do not hide contradictions behind supposedly simple solutions but use them as opportunities for learning and development!
7. Sustainable action requires knowledge, but also willingness!
8. Enable lively learning with creative and experience-based methods!
9. Use motivating examples: talk about success stories, positive visions of the future and inspiring role models!
10. Organisations can also "learn sustainability": develop your institution step by step into a sustainable place of learning!

STEP 2 Exercise

Task:

Form groups of 2–4 people.

Read the descriptions of the basic teaching principles and answer the corresponding question. Write your answer in keywords on a card. One thought per card and a maximum of three bullet points.

Prepare to present your answers.

You have 35 minutes.

Note for trainers:

Print out Appendices 3–12 for the participants.

There probably won't be enough time for each group to work through all the rules. You can then divide the rules among the groups. The aim should be to present two examples per rule.

STEP 3 Evaluation & conclusion

Note for trainers:

In the evaluation, the results of the small groups are collected, presented and discussed.

To do this, the rules must first be visualised. The rules can be cut out from Appendix 2 and pinned to a wall, written on a board, or just the rule numbers can be visualised.

The groups present their results one after another and briefly explain them. Questions may be asked. There are no right or wrong answers here. The aim of the exercise is to apply the rules to one's own professional situation and to find a set of examples for one's own professional reality.

The cards are pinned to the rules and, if necessary, sorted by topic.

At the end of the session, participants will have an overview of how they can incorporate sustainability into their everyday training.

Methods and strategies for implementing sustainability in education

	Methods	Strategies
Developing sustainability-related professional skills	- Thematic teaching units - Project days - Simulation games - Ecological footprint	- Emphasize safe working practices - Promoting economical working practices - Highlighting the requirements and consequences of the profession in the context of sustainability
Making the training centre a sustainable place of learning	- Company visits - Ecological handprint - Brainstorming	- Reducing paper consumption through digitalization - Share knowledge about sustainability

Basic teaching principles

10 didactic rules of conduct for BBNE

1. Don't overwhelm trainees with "mega problems"; instead, encourage them to take responsibility within their own sphere of influence!

2. Sustainability is not an "extra topic", but an integral part of professional activity!

3. Regulatory instruments are the basis of vocational training – it is important to reinterpret them in terms of sustainability!

4. Professional actions are never without consequences: make far-reaching and long-term effects visible!

5. Don't stick to "business as usual"; instead, support trainees in discovering alternatives and innovations!

6. Don't hide contradictions behind supposedly simple solutions but use them as opportunities for learning and development!

7. Sustainable action requires knowledge, but also willingness!

8. Enable lively learning with creative and experience-based methods!

9. Use motivating examples: talk about success stories, positive visions of the future and inspiring role models!

10. Organisations can also "learn sustainability": develop your institution step by step into a sustainable place of learning!

1. Do not overwhelm trainees with "mega-problems" but encourage them to take responsibility within their own sphere of influence.

Sustainable action begins in one's own sphere of experience. Work and business processes are the starting point for professional sustainability-oriented learning. It can be assumed that learners will expand their repertoire of actions and worldview (attitude) with regard to sustainability if they are more directly affected by it and if it has immediate practical value for them. Otherwise, sustainability will only be seen as an abstract concept. This leads to mental overload, frustration and a feeling of powerlessness. The aim should be for everyone to be convinced that they can contribute to solving the major problems of our time, but always in relation to their own sphere of influence.

Example

In the chemistry lab: When trainees carry out chemical experiments, environmentally harmful and hazardous by-products can be produced, which must be collected and disposed of appropriately.

Question

What key work and business processes come to mind when you think of sustainability? Where could you place this topic for your trainees?

2. Sustainability is not an "extra topic", but an integral part of professional activity!

Integrating sustainability does not require any additional new learning tasks. Acting sustainably does not mean doing "more" but doing things "differently". Professional activities are generally embedded in ecological, social and economic contexts. For this reason, it is often sufficient to change the perspective of job-specific tasks and emphasise a sustainability-oriented approach. The idea of sustainable development, therefore, offers an ideal relevance filter for selecting suitable content. Set priorities! It is not always necessary to consider all ecological, economic and social impacts, as this can lead to fatigue and loss of motivation among students.

Example

Metalworking: A typical task for trainees is cutting sheet metal to size. Taking care to produce as little waste as possible reduces overall resource consumption. This not only saves money but also conserves raw materials.

Question

Decide on a work or business process. How could you change the perspective and actions there?

3. Regulatory instruments are the basis of vocational training – it is important to reinterpret them in terms of sustainability!

According to the KMK (Conference of Ministers of Education and Cultural Affairs), the educational mandate of vocational schools aims to enable trainees to "play a sustainable role in shaping the world of work and society in terms of social, economic, ecological and individual responsibility". The basis for sustainable professional conduct is thus explicitly defined as an educational requirement. Starting points in the learning fields for sustainability in professional conduct can be found to a greater or lesser extent. However, framework curricula are deliberately formulated in an open manner – use this leeway to differentiate between career-related activities in a sustainability-oriented manner. Sustainability aspects can be identified in almost every vocational learning field. Here, too, set reasonable priorities in accordance with the training or development level of the learners and try to address core sustainability-related topics for the respective training occupation.

Example

One learning area of training to become **an electrical engineer for industrial engineering** involves the maintenance of electrical systems. This is a sustainability-related practice that extends equipment's service life. The topic can be discussed from this perspective.

Question

Think of a typical learning area in your training occupation. What sustainability aspects come to mind?

4. Professional actions are never without consequences: make far-reaching and long-term effects recognisable!

The consequences of professional decisions and actions are not always immediately apparent but may only become apparent in the future and in more distant locations. Sustainability-oriented efforts can seem futile if the far-reaching and long-term effects are not perceptible. Therefore, make the spatial and temporal connections visible by using visualisations, research assignments and reflection prompts. Learning processes should be designed in such a way that they link the local, regional and global as well as long-term consequences of one's own actions and make systemic connections recognisable. Link professional knowledge and skills to these interactions so that trainees can recognise and reflect on the positive spatial and temporal effects of their sustainability-oriented professional actions.

Example

Building construction: There are various ways to insulate buildings. Trainers can compare with their trainees how these materials are disposed of, whether they can be recycled or biodegraded.

Question

Think about your professional activities and consider the spatial and temporal effects of your professional actions.

5. Don't stick to "business as usual"; instead, support trainees in discovering alternatives and innovations!

Company employees play a crucial role in the development of sustainable alternatives and new solutions. Innovation processes depend not least on creative potential – with the right support, the fresh perspective of trainees can become an important factor for success. In general, innovations in companies that are linked to efficiency gains are crucial. However, this strategy falls short, as the "rebound effect" shows. In addition to increasing efficiency, sustainable economic activity also requires alternative strategies that address necessity (sufficiency) and environmental compatibility (consistency). Sustainable corporate development can be ensured by harmonising the three strategies mentioned above. Tomorrow's skilled workers must be trained and continuously supported in this regard in order to enable further innovation and long-term success.

Example

One company has introduced a **trainee council** that works closely with the management. This allows trainees' comments and suggestions to be passed on directly to the relevant department.

Question

Does your company offer the opportunity to submit suggestions for more sustainable practices? How do you support your trainees in initiating innovations?

6. Do not hide contradictions behind supposedly simple solutions but use them as opportunities for learning and development!

Sustainable goals are not always easy to achieve and often involve compromises or dilemmas. Problematic situations often require a balance to be struck between ecological, economic and social considerations. Contradictions can also arise between everyday routines and desired ideals, which can lead to conflicts. Even if win-win situations are desirable, in reality one should not rely on achieving them without compromise. In order to initiate sustainability-oriented progress, conflicts and dilemmas must not be covered up and harmonised but should be addressed openly and with understanding. They offer the opportunity to reflect on individual views and values in dialogue with others and to develop personally. Actively use creative tension, as it can be very motivating to want to solve problems.

Example

Dilemma: The demand for rare earths is growing due to climate action. They provide the necessary efficiency in wind turbines, electric motors and LED lamps. However, their extraction involves invasive mining, the release of CO_2 and the creation of toxic sludge. Recycling old devices to recover rare earth elements may be the solution here. The advantages and disadvantages can be discussed with the trainees.

Question

Can you think of an example of a dilemma in the context of sustainability? How would you discuss this with your trainees?

7. Sustainable action requires knowledge, but also willingness!

Knowledge about sustainability issues and solutions alone is not enough to act sustainably. Although knowledge is an essential basis for informed decisions, other individual factors also influence whether actions are sustainable. Without the will to act, clear values, a positive attitude towards sustainable behaviour, reflection on one's own habits and a willingness to change them, there is a gap between knowledge and action. To enable trainees to critically examine their own actions and make informed decisions for a positive future, it is necessary to incorporate psychological influences into professional learning. This is because sustainability-oriented decisions made consciously in professional life are based on more than just knowledge of sustainability; they are based on the interplay of perception, desire and values in a given situation against the backdrop of one's own values. It is important to address personal fears and hopes, as well as what one can do and what one needs to learn in order to meet the challenges of sustainable professional work. Sustainable action is not only the result of pure knowledge acquisition but requires the conviction that one can make a difference and thus develop a sustainability-oriented professional identity.

Example

In your private life, you attach great importance to a sustainable lifestyle, but you work in the automotive industry and fear losing your job if combustion engines are phased out. In this case, you could ask your employer to invest in further training in electric mobility.

Question

What is your personal view on sustainability? Gather your reservations and convictions. Where would you be willing to compromise?

8. Enable lively learning with creative and experience-based methods!

Contemporary sustainable learning involves imagination, intellect, emotion and action. Such "living learning" does not focus solely on cognitive processes and the transfer of established knowledge, but takes the actions and experiences, desires and fears of individuals as its starting point. In the spirit of living learning, VESD (vocational education for sustainable development) should

- incorporate personal biographies and life plans,
- appeal to all the senses and
- enable interactions within a community.

Examples of this include the creative exploration of a sustainable "lighthouse company", sensory experiences and complex learning projects. At the same time, "journalistic" explorations (i.e. gathering information, researching background and contexts), playful trials (i.e. trying out alternative courses of action, becoming active in protected spaces, experimenting) and transformative-creative formats (i.e. helping to shape work processes, products and structures) have proven to be effective. It is essential that students are able to make individual decisions, take responsibility and act largely independently. Be creative yourself and try out innovative methods of lively learning.

Question

Can you think of a complex learning project that you could use to teach sustainability for your profession in training?

9. Use motivating examples: talk about success stories, positive visions of the future and inspiring role models!

Show that sustainable development is possible! Aspects of sustainable working practices or lifestyles often seem to be associated with sacrifice, which is unattractive to young people. Against this backdrop, sustainable topics must be handled sensitively in the classroom. Instead of pointing the moral finger, positive visions for the future should be developed. It is important that trainees develop positive associations with sustainability. As a teacher, you should gauge the level of confrontation and point out or help find constructive solutions. We all bear responsibility for a more sustainable lifestyle, and it is important to recognise the problematic and, above all, the positive consequences of our actions. In other words, we must not lose heart in the face of problems and threats, because ultimately every profession can contribute to sustainable development. Trainees need positive role models and hopeful guiding principles. Inspire them to help shape a more sustainable future!

Example

A well-known Swedish furniture manufacturer offers its employees various benefits, including a bicycle leasing programme. This programme enables employees to lease bicycles or e-bikes and thus use an environmentally friendly means of transport to get to work.

Question

Can you think of any examples where your profession has played a positive role in the context of sustainability?

10. Organisations can also 'learn sustainability': develop your institution step by step into a sustainable place of learning

For sustainable learning to be authentic, it needs learning environments that learners can perceive as sustainable with all their senses. Vocational schools are run with social responsibility in mind, have technically and didactically competent staff, and offer learners positive spaces for experience and opportunities for participatory shaping. This means that the "vocational school as a place of learning" as a whole should be committed to education for sustainable development in order to be fully effective. Such a holistic approach to sustainability is known as the whole school approach. Places of learning cannot be transformed overnight. Agree on priorities that will enable you to embark on the path to becoming a holistically sustainable school. Involve all stakeholders (sponsors, management, teaching staff, employees, learners) as far as possible and encourage them to take responsibility. In this way, a learning organisation can emerge as a space for experience where it is fun to engage with sustainable development perspectives.

Example

Training in the electrical sector: Work with your trainees to identify energy guzzlers in the company and replace them with more efficient alternatives.

Question

What could be one aspect that makes your company a sustainable place of learning? What potential for development do you see?

SOURCES

- Kuhlmeier, Werner; Pillmann-Wesche, Rainer; Schütt-Sayed, Sören; Vollmer, Thomas (2024): The toolbox for sustainability-oriented vocational school teaching. Hamburg 2024. URL: https://cloud.klimaschutzstiftunghamburg.de/index.php/s/p2BXKENEqoCdL3F
- https://www.nachhaltige-lernorte.de/ideenbox/
- https://www.ikea.com/de/de/this-is-ikea/work-with-us/mitarbeiter-benefits-zusatzleistungen-pub4d687fb0/

Developed by:

Dana Sommerfeld
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by the European Union



1.4 TITLE: The impact of energy sources on the environment

PROCEDURE:

Steps	Time
Step 1. Energy production and consumption worldwide	5 min
Step 2. The effects of global warming	5 min
Step 3. Global primary energy consumption and ways to reduce greenhouse gas emissions	10 min
Step 4. Energy resources – overview	10 min
Step 5. Quiz – characteristics of renewable energy resources	10 min
Step 6. The environmental impact of renewable energy sources and future trends	20 min

OBJECTIVES:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What are the effects of global warming on different regions of the Earth • What are the alternative energy sources to fossil fuels	• Identify the impact of energy use on the environment • Explain the environmental impacts of using renewable energy sources, including forest ecosystems	• The impact of human activity on climate change • The need to take action to reduce greenhouse gas emissions



Number of participants: any



Estimated time: 60 mins.



Materials required: projector, A4 paper, pens



Notes: at the start of the session, the trainer should assess the participants' knowledge of the topic and, if necessary, briefly explain what renewable energy sources are

STEP 1. Energy production and consumption worldwide

The trainer displays the slide and briefly discusses the global situation regarding the generation, use, and distribution of energy – Appendix 1.

STEP 2. Effects of global warming

The trainer displays a slide and gives participants time to familiarise themselves with the described effects of global warming – Appendix 2.

STEP 3. Global primary energy consumption and ways to reduce greenhouse gas emissions

The trainer displays a chart showing the breakdown of primary energy consumption worldwide (Appendix 3), ways to mitigate the effects (Appendix 4, and a chart showing the extent to which individual EU countries have reduced their primary energy consumption between 2005 and 2023 (Appendix 5).

STEP 4. Energy resources – overview

The trainer displays the chart in Appendix 6. They discuss it and briefly describe the various energy resources.

STEP 5. Quiz – characteristics of renewable energy resources

The trainer displays Appendix 7. Participants are asked to match the given characteristics with the energy resources. At the end, the trainer displays the correct answers (slide 13). If necessary, they lead a discussion on the most common mistakes in the answers.

STEP 6. The environmental impact of RES and future trends

The trainer displays Appendix 8 and discusses the issue of zero-emission renewable energy. They then present good examples of mitigating the environmental impact of renewable energy investments, using the company ABO Energy as an example (Appendix 9). They ask participants to provide other examples of similar initiatives they are aware of. Finally, the trainer outlines the projected global trends in energy use. Participants may comment on the points raised. As part of the summary, the trainer asks each participant to share the one most important piece of information they will take away from the session. The task is simply to share this information; the aim is not to expand on it, as everyone is entitled to their own opinion.

APPENDIX 1. Global energy production and consumption

Currently, the main source of greenhouse gas emissions on Earth is the generation and use of energy. This accounts for around two-thirds of man-made emissions. The remaining emissions are caused by:

- agriculture
- land-use change
- chemical production, cement production, etc.

Energy use (and sources of greenhouse gas emissions) can be divided into three categories:

- electricity
- transport
- heat (used mainly for space heating and industrial processes)

Originally, energy was obtained mainly through photosynthesis: people ate plants and burned wood. Later, animal labour (oxen and horses) was used. At the start of the modern era, 95% of the energy used by humanity came from the living environment. Now, 80% of energy comes from fossil fuels. The extraction of raw materials used as energy sources degrades the natural environment, but has prevented the complete deforestation of the Earth's surface.

Currently, 2.7 billion people on Earth still cook their food using traditional fuels – wood, animal dung, charcoal, and agricultural waste.

The use of 100 joules of energy in a rich country translates proportionally to much more than in a poor country. There, it means access to light, hot food, education, and transport.

The average American consumes over six times more energy than the average African.

APPENDIX 2. The effects of global warming

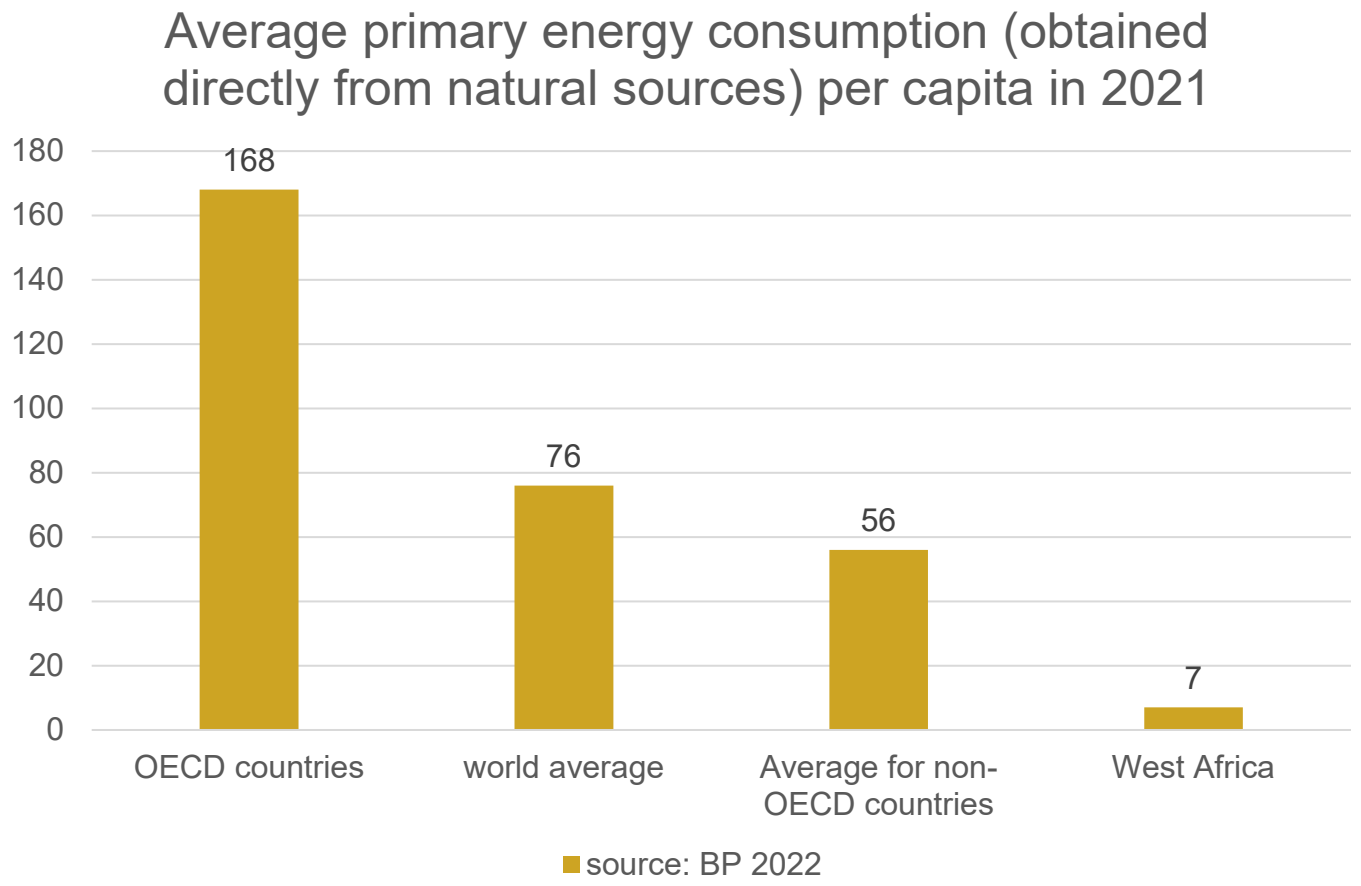
Around 80% of the energy consumed by humans comes from fossil fuels (coal, oil, natural gas). When these are burned, carbon dioxide is released; this is a greenhouse gas that traps heat in the atmosphere, thereby altering the Earth's climate.

Global temperature has risen by about 1°C compared to pre-industrial levels. This is causing the death of coral reefs, the rapid melting of polar ice caps (the temperature in the Arctic is rising twice as fast as the global average), prolonged droughts, and uncontrolled wildfires.

With a 1.5˚C rise in temperature (we are approaching this level), a 25% drop in wheat yields is already forecast for West Africa, and the melting of glaciers will cause sea levels to rise to such an extent that areas currently inhabited by 46 million people will be flooded.

The expected rise in temperature of 2˚C in the near future will mean the extinction of all coral reefs, regular and frequent heatwaves claiming the lives of people and animals, and droughts destroying farmland. Severe water shortages will threaten around 8% of humanity. In some parts of Africa, temperatures will rise to 46˚C, rendering them uninhabitable. Food supplies will shrink significantly. The decline in fish stocks in the seas and oceans, already being observed, will intensify further.

These changes will trigger mass migration of people determined to fight for survival from areas rendered uninhabitable. The desire of the inhabitants of the North to maintain their status quo in terms of territory and standard of living will lead to unrest, wars and global destabilisation.


Average primary energy consumption (obtained directly from natural sources) per capita in 2021
180
160
140
120
100
80
60
40
20
0
168
76
56
7
OECD countries
world average
Average for non-OECD countries
West Africa
source: BP 2022

APPENDIX 4. Mitigating global warming

There are several options for action to halt global warming:

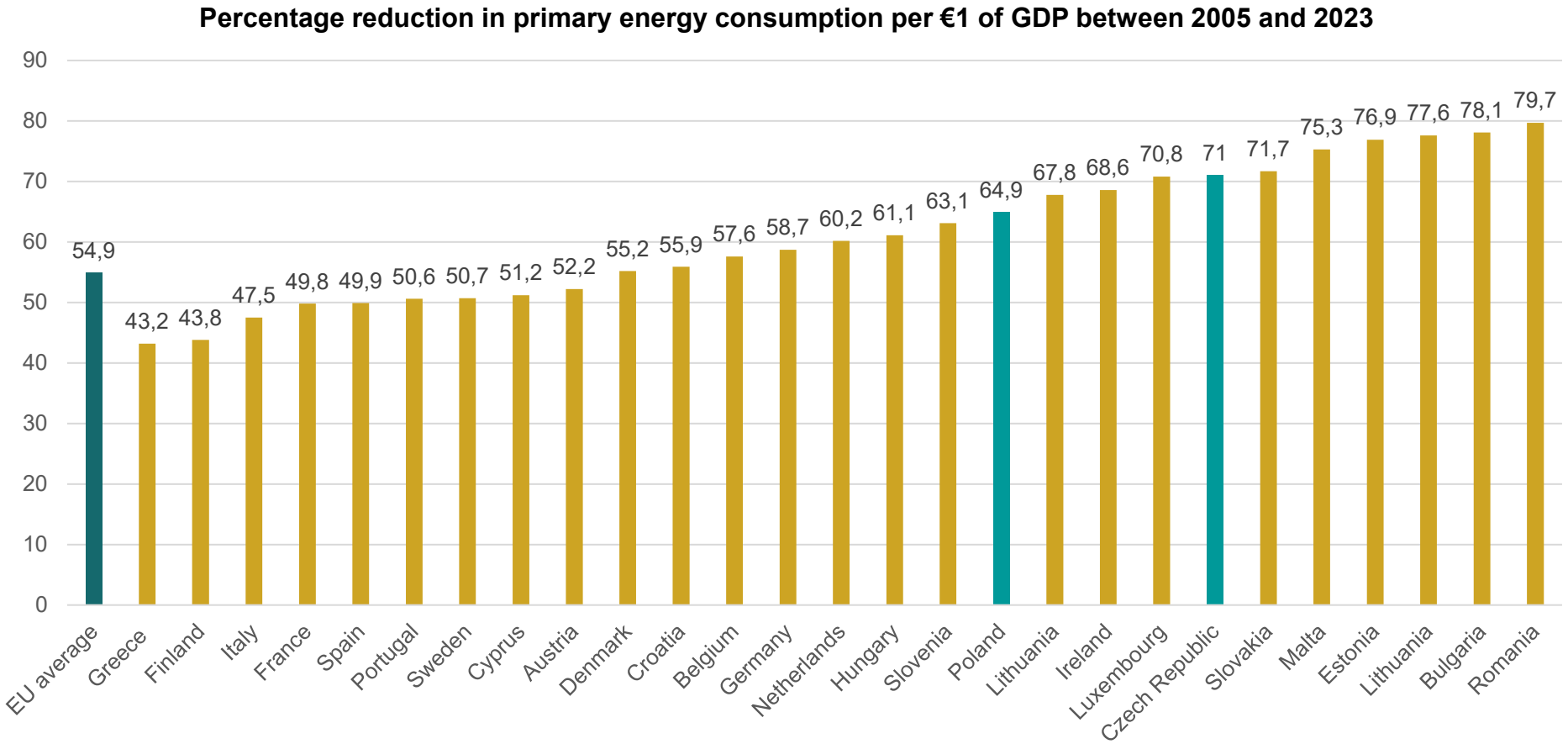
- capturing carbon dioxide from the atmosphere, which is a difficult process and requires the storage of this gas; an alternative is to increase the forest cover of the Earth, which is difficult to implement due to economic constraints;
- reducing emissions, i.e. reducing energy consumption;
- using low-carbon energy sources.

The European Union aims to achieve climate neutrality by 2050.

Annual emission limits have been set for each Member State. The regulation stipulates that Member States with a higher GDP per capita have higher emission reduction targets.

Norway, Sweden, France, and Belgium are leading the way in decarbonisation (stopping harmful emissions from fossil fuels). Norway relies heavily on hydroelectric and wind power; the other countries mainly rely on nuclear power.

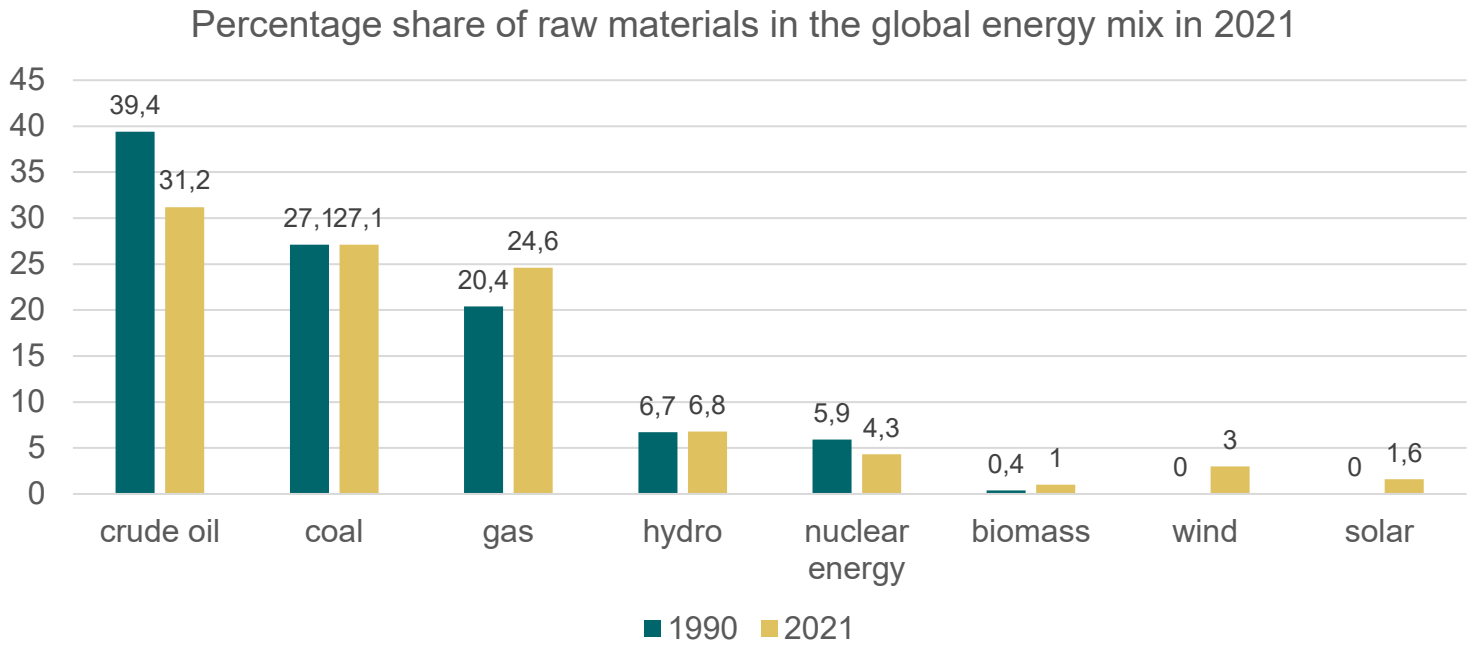
As early as 1990, France and Sweden were already generating over 80% of their energy in a carbon-free manner.


Percentage reduction in primary energy consumption per €1 of GDP between 2005 and 2023
90
80
70
60
50
40
30
20
10
0
54,9
43,2
43,8
47,5
49,8
49,9
50,6
50,7
51,2
52,2
55,2
55,9
57,6
58,7
60,2
61,1
63,1
64,9
67,8
68,6
70,8
71
71,7
75,3
76,9
77,6
78,1
79,7
EU average
Greece
Finland
Italy
France
Spain
Portugal
Sweden
Cyprus
Austria
Denmark
Croatia
Belgium
Germany
Netherlands
Hungary
Slovenia
Poland
Lithuania
Ireland
Luxembourg
Czech Republic
Slovakia
Malta
Estonia
Lithuania
Bulgaria
Romania

APPENDIX 6. Percentage share of raw materials in the global energy mix

Fossil fuels account for 80% of the world's energy. The extraction of coal, oil and gas alone consumes energy (pumps used to extract groundwater, the use of machinery, and the construction of infrastructure).

To prevent further global warming, harmful emissions would need to be reduced by 80% by 2050, and at least two-thirds of the known fossil fuel reserves would need to be left in the ground.



The percentage share of coal has not changed, but in absolute terms its consumption has risen by 72% (source: BP Statistical Review of World Energy 2022)

APPENDIX 7. Quiz – renewable resources

A
biomass

B
photovoltaic panels

C
wind turbines

D
hydroelectric power stations

E
natural gas installations

F
nuclear power stations

1. If half of the demand for electricity were to come from renewable sources by 2050, this source would consume all the silver reserves on Earth.

2. This source causes a drop in the groundwater level, leading to localised drought.

3. This source causes methane emissions into the atmosphere. Methane remains in the atmosphere for a shorter time than carbon dioxide, but is a more potent greenhouse gas.

4. Increased use of this energy source may lead to changes in land use (monoculture farming) and threaten biodiversity.

5. Equipment used for this source has a negative impact on birds and bats.

6. Energy production from this source disrupts fish migration routes, causing their populations to decline and even putting them at risk of extinction.

7. Spent components from this source's installations pose a serious environmental problem for which there is as yet no satisfactory solution.

8. Preparing the raw material requires a great deal of labour and energy consumption during the preparation and drying processes.

9. The use of this source requires the highest expenditure on the construction of facilities and safety measures among all renewable energy sources.

10. The low density of the raw material makes it harder to store and transport, which consumes more energy.

11. The use of this source may pose a threat to the safety of people living nearby due to the risk of explosion and environmental contamination.

Renewable sources are a good alternative, but there are no zero-emission sources!

- Renewable sources also require energy consumption – for extraction, infrastructure construction, storage, and transport.
- They require the use of rare minerals, as well as steel, copper, and aluminium.
- The average lifespan of renewable energy generation equipment is 20–40 years. After that, it must be disposed of.
- The production of solid biomass requires the use of plant products, such as wood, from which briquettes or pellets are made. Common reed and Jerusalem artichoke are grown specifically for biomass production – monoculture crops.
- Renewable energy investments affect the environment and people (wind farms, solar fields, hydroelectric power stations), which is why they require an environmental impact assessment and a balancing of benefits and costs.
- Digitalisation is considered to be environmentally friendly (saving paper, printer ink, etc.), but it consumes huge amounts of energy (servers, data transmission, etc.). According to the AI itself, generating one of the images below required between 0.01 and 0.1 kWh of electricity (depending on various factors, such as the efficiency of the equipment).

  By way of comparison:

  - 0.01 kWh is roughly the same as an energy-saving LED bulb (10 W) consumes in an hour
  - 0.1 kWh is roughly the amount needed to boil water in an electric kettle.





Possible pro-environmental measures by investors – the example of ABO Energy



Field margins

Monoculture farming makes it difficult for insects and insectivores to find food. In collaboration with local farmers, field margins have been created on the edges of fields in Arzfeld.



Ant relocation

As part of the site clearance work near the wind farm in Kirchhain, a relocation of a forest ant nest was organised with the support of the Ant Conservation Observatory in Hesse. Following the relocation, the ants were fed for a period of time, which helped them to adapt more easily to their new habitat.



Habitats for endangered species

The sand martin chooses its natural habitats on vertical cliffs and high river banks or on vegetation-free field slopes. Today, such places are rare in Central Europe due to widespread river regulation and extraction activities (clay, sand, gravel, etc.). This bird is strictly protected in Poland and is on the red list of birds in Germany. Therefore, as part of one of the projects, a wall was constructed to reinforce the slopes so that the sand martin could find optimal sites for nesting and breeding.



Aquatic habitats

Naturalists carried out work in a former fish pond in the Berngerode valley, involving the removal of remaining fish, dredging and transforming it into a biotope for amphibians. Among others, populations of crested newts and common toads have established themselves in the habitat. Aquatic habitats are being lost as a result of intensive agriculture.

APPENDIX 10. Future trends

Future trends in global energy use:

- Generally, energy is becoming cheaper thanks to ever-improving extraction technologies and access to previously inaccessible deposits (seabeds, permafrost regions).
- Prices and availability are subject to significant fluctuations due to political, military, and environmental events – countries are striving for energy independence (a return to nuclear energy as a source independent of climatic and environmental conditions)
- Thanks to new technologies, the energy consumption of appliances (e.g. electronic equipment) and buildings (thermal modernisation) is falling – leading to a reduction in consumption
- There is a certain saturation in energy use; it is estimated that demand will fall in developed countries. This is also driven by growing environmental awareness among the public – decarbonisation initiatives and environmental movements.
- Globally, the human population on Earth is predicted to decline, and with it the number of users.







SOLUTION APPENDIX 7

Correct answers:

1 B

2 D

3 E

4 A

5 C

6 D

7 B

8 A

9 F

10 A

11 F

SOURCES

- Naukaoklimacie.pl
- https://www.europarl.europa.eu/topics/pl/article/20180208STO97442/ograniczanie-emisji-gazow-cieplarnianych-w-ue-krajowe-cele-na-2030-r
- https://www.poradnikbiznesu.info/transformacja-energetyczna/branza-oze-w-polsce-jakie-wyzwania-stoja-przed-tym-sektorem/
- https://bank.pl/polska-trzecia-najbardziej-energochlonna-gospodarka-ue-27/

Prepared by:

Magdalena Mazik-Gorzelańczyk, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by the European Union



1.5 TOPIC: Forests in the era of global economic pressure

PROCEDURE:

Steps	Time
Step 1: Introduction to the topic of economic exploitation of forests	10 min
Step 2: Examples of deforestation and forest land degradation around the world	20 min
Step 3: Exercise: "Hidden costs"	30 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What are the causes and effects of excessive economic exploitation of forests around the world?	• Explain the concept of "hidden costs" in forestry • Conduct an economic simulation of the profits and losses of different forest cultivation models	• The need and purpose of shaping responsible environmental attitudes among future foresters



Number of participants: up to 20 people



Materials needed: projector, A4 paper, pens



Notes: -



Planned time: 60 min.

STEP 1: Introduction to the topic of economic exploitation of forests

The trainer introduces the participants to the topic. He explains that we are currently facing global economic pressure driven by growing consumption. Demand for biofuels and industrial agriculture is growing, which poses new challenges for modern forestry.

This topic is crucial for at least two reasons:

- Today's decisions about the species composition of forests or the intensity of exploitation will have consequences in 80–100 years. In an era of rapid climate change, improper management leads to degradation, the costs of restoration of which far exceed the profits gained. The effects of today's decisions are irreversible.
- Today's forester must be not only a grower but also a risk manager and guardian of ecosystem services such as water retention and biodiversity protection, which are becoming more valuable than timber itself. Foresters manage forests under conditions of extreme water shortages and market pressure. Understanding the mechanisms of degradation – from avocado plantations to spruce monocultures – is essential to teaching an economy based on sustainability rather than exploitation.

STEP 2: Examples of deforestation and forest land degradation around the world

The trainer shows participants examples of forest devastation under pressure from economic profit (Appendices 1, 2, 3). He allows participants to discuss – supplementing information and giving other examples

STEP 3: Exercise: "Hidden costs"

Participants take part in an exercise that they will also be able to use in classes with students. The exercise can be made more or less difficult, depending on the participants' level of advancement, by adding situations that may occur during forest cultivation. The aim of the exercise is to make participants aware that cultivation decisions focused on short-term profit generate hidden costs of forest restoration and protection.

Course of the exercise

Step 1: The trainer divides the participants into smaller teams.

Step 2: Each group receives a blank form for calculating the costs of planting a 500-hectare forest complex on post-agricultural land.

Option A: We plant a pine/spruce monoculture (fast-growing raw material, low planting costs).

Option B: We plant a mixed forest, in accordance with the habitat (high costs of seedlings and fencing, slower return on investment).

Example of a form with estimated costs – Appendix 4

Step 3: Simulation of a "random event". The instructor announces, for example, "In the 15th year of cultivation, there is a 3-year drought, and in the 20th year, there is an infestation of primary pests."

Step 4: The groups calculate (approximately) the costs of possible renewal of lost crops and pest control.

Step 5: The instructor gives the participants another form to fill out – this time with the forest's "ecosystem services" (form with sample calculations – Appendix 5). After completing the task, the participants discuss the results. They can be divided into two groups, which defend options A and B for the crops.

Summary of the exercise, which can be done by the instructor:

- The diverse species composition of the forest is an "insurance policy". If one species is attacked by a pathogen, the rest of the forest takes over the functions of the ecosystem, preventing soil degradation.
- A degraded forest (model A) ceases to perform non-productive functions, which in a modern state generates costs for agriculture and water management.
- The apparent profit from option A may be offset by the costs of forest protection (spraying, removal of dead wood).
- A forest is not just "boards". It is water retention (prevention of drought in agriculture) and carbon sequestration.
- Global customers (IKEA, Castorama, premium markets) require certification. Wood from degraded forests (e.g. from predatory logging in the Amazon or Siberia) loses access to high-margin markets.
- An economy focused on quick profits often uses seeds with a narrow genetic pool. Sustainable development focuses on preserving local ecotypes that are best adapted to climate change in a given region.

Monocultures and 'green deserts' – oil palm plantations in Indonesia and Malaysia

Reason: high global demand for cheap vegetable oil and biofuels

On nearly 30 million hectares of land, multi-storey, species-rich rainforests are being turned into monocultures of oil palm. The industry provides jobs and helps combat poverty, but at the same time, dust and pollution from fires have caused illness and death for tens of thousands of people.

Other effects:

- loss of vertical structure and elimination of ecological niches for epiphytes and tree canopy fauna;

- hydrological disturbances, as palm trees have a different root system than forest trees, leading to a decrease in water retention and an increased risk of flooding;
- draining peatlands for plantations causes huge carbon dioxide emissions and irreversible changes in soil structure (oxidation of organic matter);
- populations of orangutans and other animals deprived of their habitat are shrinking.



A palm plantation bordering a rainforest.

Photo: https://blog.manifestklimatyczny.pl/2024/01/30/994/

Industrial cattle farming and soybean cultivation – Brazilian state of Mato Grosso (Amazonia)

Reason: export of beef and soybeans for animal feed (mainly to China and the EU)

Undergrowth and trees are being burned to clear land for pasture and soybean cultivation. The construction of roads through forests causes their fragmentation. This causes the 'interior' of the forest to become the 'edge', which changes the microclimate (higher temperature, lower humidity) and leads to the extinction of shade-loving species. Furthermore, in tropical forests, most of the nutrients are found in biomass rather than in the soil. The removal of trees degrades the soil almost immediately.



Soybean cultivation in Brazil.

Photo: Victor Moriyama/Bloomberg, Getty Images

Exploitation of the taiga in Russia (Siberia)

Reason: quick profits from the export of raw materials (round timber) to China, with weak state supervision. In the Amur River basin, illegal and semi-legal logging of the most valuable species (e.g. Mongolian oak, Siberian cedar) is carried out without observing regeneration cycles. A large part of the felled timber is left on site and wasted. The lack of professional transport infrastructure leads to severe soil erosion on slopes. This leads to fires and the release of carbon from the permafrost in Siberia, which is warming three times faster than the rest of the world. This has global climate consequences. Leaving the forest to its own devices after cutting down the most valuable trees leads to the domination of pioneer species with low biocenotic and economic value.



Forest fire in Siberia

Photo: Greenpeace

Cost/revenue category	Model A: monoculture (intensive)	Model B: mixed forest (sustainable)	Comment
Cost of seedlings and planting	100	180	Model B is more expensive (different species, mycorrhiza).
Fencing and protection costs	50	150	Model B requires protection against wildlife (deciduous trees).
Maintenance (cleaning) costs	80	120	Model B requires knowledge and species selection.
TOTAL INITIAL COSTS	**230**	**450**	***The investor chooses model A.***
Random event: drought/pests (year 15)	-200 (losses)	-40 (losses)	Monoculture is less resistant.
Chemical protection costs	10	20	In model B, natural enemies limit pests.
Value of wood (year 20 – previous crop)	150	100	Model A produces faster mass, but of poorer quality.
BALANCE AFTER 20 YEARS	**-180**	**-410**	***In purely financial terms, model A still seems "cheaper"...***

"Invisible" category	Model A (degradation)	Model B (durability)	Explanation
Water retention value	0	+200	Mixed forest retains water for neighbouring fields.
Soil quality loss	-150	0	Coniferous monoculture acidifies the soil (cost of liming).
Risk of total collapse	High (80%)	Low (10%)	Model A may require replanting from scratch.
Certification and timber price	Standard price	Premium price (+20%)	FSC/PEFC-certified timber sells for a higher price.

SOURCES

- https://www.greenpeace.org/poland
- Forest Research Institute, https://www.ibles.pl/
- https://wyborcza.pl/7,75399,24113518,chinczycy-ogola-syberie-na-lyso-co-w-rosji-piszczy.html
- https://blog.manifestklimatyczny.pl/
- IPCC (Intergovernmental Panel on Climate Change), Report "Climate Change and Land", Report "Climate Change and Land"

Prepared by:

Magdalena Mazik-Gorzelańczyk, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by the European Union



1.6. TOPIC: Virtual travel agency

PROCEDURE:

Steps	Time
Step 1: Virtual tourism – explanation and necessary equipment	20 min
Step 2: Virtual travel agency – development of travel agents	5 min
Step 3: Virtual travel agency – customer support	10 min
Step 4: Summary	10 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• How to define virtual tourism • What conditions must be met to implement virtual tourism in a travel agency	• Create a virtual tourism offer • Identify the opportunities offered by virtual tourism	• Awareness of the necessity and purpose of introducing technological innovations in the industry



Number of participants: any



Materials needed: Laptop, multimedia projector.



Comments: -



Planned time: 45 min

Click to see movie

STEP 1: Virtual tourism – explanation and necessary equipment

Virtual reality refers to interactive images or videos that allow the viewer to explore the entire image in 360 degrees. Unlike regular video, which is recorded from a fixed point of view, VR production captures every part of the location.

In the tourism industry, virtual reality can be used to capture tourist destinations in a unique and immersive way. This is achieved using specialised cameras, devices, and software. The finished content can then be viewed on VR goggles, which enable a realistic perception of the displayed image.

Many people think of VR as computer-generated images. However, there is another form of virtual reality known as 360 VR or 360VR video. 360 VR focuses on the real world rather than computer-generated images. This makes it ideal for the tourism industry, where it is important to show users the real location rather than a mock-up or simulation.

360 VR content in tourism is recorded in a similar way to regular image and video content. A professional team involved in the production of this type of recording arrives on site with specialised equipment to film the scene. The material is then taken back to the studio, where it is processed into VR content using appropriate software.

STEP 1: Virtual tourism – explanation and necessary equipment

- VR technology includes the following equipment: VR headsets, controllers, haptic vests and VR treadmills.
- **VR headsets (Virtual Reality head-mounted devices)** allow users to immerse themselves in a virtual environment, creating the impression of complete immersion in a digital world. These devices are equipped with screens and motion sensors that track the position and movement of the user's head, enabling real-time interaction with the virtual environment.
- **Controllers** enable interaction with the virtual world. They track hand and finger movements, allowing precise manipulation of virtual objects. Some advanced VR systems feature touchless interfaces that recognise hand gestures.
- A **haptic vest** contains built-in actuators and electromyostimulators that simulate various physical sensations, such as impacts, touch, vibrations and gusts of wind, thereby enhancing the realism of the experience.
- A **VR treadmill** allows users to walk, run, jump and perform other movements in place, which are then translated into motion within the virtual environment. These treadmills typically feature a low-friction surface that enables users to slide their feet, often in combination with specialised footwear designed for compatibility with the device.

STEP 2 : Virtual travel agency – development of travel agents

The use of virtual reality in travel agencies

- **Training travel agents**: Virtual reality can be used as a training tool, enabling travel agents to virtually explore destinations and gain a deeper understanding of the products and services available. This technology allows agents to familiarise themselves with travel offers efficiently, without the need for physical travel. As a result, time and financial resources are saved, while presentations to clients become more engaging and informed.

- **Customer service scenarios**: VR simulations provide opportunities for agents to practise handling a variety of customer service situations, thereby improving overall service quality. These simulations can replicate scenarios such as problem-solving or crisis management, allowing agents to gain practical experience in a controlled, risk-free environment.

- **Personalised recommendations**: By drawing on virtual experiences, travel agents are better equipped to tailor offers to the individual needs and expectations of their clients, leading to more customised and satisfactory travel solutions.

STEP 3: Virtual travel agency – assistance for customers

The Virtual Reality Travel Agency represents an innovative approach to booking holidays and trips, offering an immersive method of exploring destinations through advanced technology. Such agencies may provide services either at a physical customer service office or by delivering VR equipment, including a headset and controllers, directly to the client's home.

Once equipped, customers can access the agency's online platform and select a destination of interest. They are then able to explore the location virtually, either as a preview before travelling or as a fully virtual experience. When combined with a VR treadmill, users can move freely within the simulated environment and interact with their surroundings using handheld controllers.

Virtual travel agencies may offer a practical alternative for individuals who wish to explore the world without leaving their homes. They can also provide valuable opportunities for those unable to travel due to health conditions or other personal limitations.

The possibilities offered to customers by a virtual travel agency include the following:

Preparation for travel: Customers can participate in virtual simulations of activities such as diving, skiing or guided city tours, enabling them to prepare more effectively for real-life travel experiences.

'Try before you buy' experiences: Simulated previews of destinations or activities may encourage informed purchasing decisions by allowing customers to experience selected options prior to booking.

Interactive travel planning: Virtual reality enables users to design personalised itineraries by selecting attractions, accommodation and travel routes according to their individual preferences.

Virtual tourism: Fully virtual world tours may be particularly beneficial for older adults, individuals with disabilities or those with limited financial resources. Additionally, such experiences can provide access to destinations for people who suffer from claustrophobia or a fear of flying.

Click to see movie

Sustainability Aspects of Virtual Tourism

1.Environmental Protection

- **Reduction of CO_2 emissions**:
  Virtual tourism significantly decreases the need for physical travel, thereby lowering carbon dioxide emissions associated with air, road and maritime transport.

- **Conservation of natural resources**:
  A decline in physical tourist arrivals results in reduced pressure on essential natural resources such as water, energy and raw materials, while simultaneously limiting environmental pollution in heavily visited destinations.

- **Biodiversity conservation**:
  Lower visitor numbers contribute to the protection of fragile ecosystems and wildlife by reducing overexploitation, habitat degradation and environmental disturbance.

2. Socio-cultural Benefits

- **Cultural accessibility**:
  Virtual tourism provides access to cultural and historical sites that may otherwise be inaccessible due to financial constraints, health conditions or physical limitations.

- **Education and awareness**:
  Virtual tours can enhance public understanding of the importance of preserving cultural heritage and protecting the natural environment, thereby fostering greater support for sustainable development initiatives.

- **Protection of cultural heritage**:
  Reduced physical visitation minimises structural deterioration and wear on historical monuments and culturally significant sites, helping to safeguard them for future generations.

3. Reduction of Tourist Pressure

- **Distribution of tourist flows**:
  Virtual experiences may help redistribute tourist interest, alleviating pressure on overcrowded destinations while simultaneously promoting lesser-known locations.

STEP 4: Summary

The trainer asks participants to respond briefly (preferably in one sentence) to the following questions:

- Do you believe that virtual travel agencies will become more popular in the future? Please justify your answer.
- Would you consider using a virtual travel agency? If so, what type of offer would interest you most (e.g. hotel previews, attractions, complete destinations)?
- What are your main concerns regarding the use of virtual travel agencies?

APPENDIX 1

VR goggles



VR treadmill



Haptic vest for VR goggles



SOLUTION TO THE EXAMPLE

What could cause virtual travel agencies to gain popularity?

Virtual travel agencies have the potential to revolutionise the way we plan and experience travel. Thanks to VR technology, they can offer more immersive, convenient and personalised experiences that better meet the needs of today's customers. As technology continues to evolve, VR may become a standard tool in the travel industry.

Would you be interested in using a virtual travel agency? If so, what type of offer would you be interested in (e.g. hotels, attractions, tourist destinations)?

Time savings, convenience, the opportunity to familiarise oneself with a destination before booking, personalisation of the offer, and curiosity about VR technology.

What are your main concerns about using virtual travel agencies?

Lack of physical contact with an agent, technical problems, lack of trust in VR technology, and the cost of renting VR equipment.

SOURCES

- https://techcrunch.com/
- https://pronetkrakow.com.pl/
- APPENDIX 1 – https://www.meta.com/
- APPENDIX 2 – https://selltapvs.life/
- APPENDIX 3 - https://www.ikarvr.pl/

Prepared by:

Sandra Domagalska, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by the European Union



1.7 TITLE: Modern marketing methods in a travel agency

PROCEDURE:

Steps	Time
Step 1. Modern marketing methods in a travel agency – introduction	10 mins
Step 2. Social media marketing	15 mins
Step 3. PPC – Pay Per Click, chatbots, and AI in customer service	15 mins
Step 4. Summary – exercise	20 mins

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What modern marketing methods can be implemented in a travel agency	• List modern digital marketing methods.. • Define the role of digital marketing in the operations of a travel agency.	• Innovative tools to support travel agency operations.



Number of participants: any



planned time: 60 mins



Materials required: Laptop, projector, sheets of paper, pens, felt-tip pens.



Notes: -

STEP 1 Modern marketing methods in a travel agency – introduction.

The implementation of modern marketing methods in a travel agency is crucial to its success and competitiveness in the rapidly changing tourism market.

Modern marketing methods, such as social media advertising, SEO, and email marketing campaigns, help travel agencies reach a wider audience. This allows the brand to become more visible, both locally and globally. Digital marketing enables travel agencies to precisely identify and reach target groups using tools such as targeted advertising (e.g. Facebook Ads, Google Ads) and customer segmentation (e.g. personalised offers tailored to travellers' interests, such as sustainability, families, luxury travel, or younger travellers).

Through social media and email marketing, a travel agency can build lasting relationships with customers, providing them with regular access to offers, travel inspiration, and promotions. Building an engaged community increases customer loyalty. Modern marketing tools, such as sales process automation and CRM systems, allow travel agencies to track customer needs more effectively and offer them tailored products at the right time. Examples include notifications about promotions, reminders about expiring discounts, and last-minute offers.

In the age of digitalisation, travel agencies that do not use modern marketing methods risk losing customers to more innovative competitors. Implementing such techniques allows agencies to stay ahead of the competition and attract younger generations of customers, who often plan their trips online.

Modern marketing tools offer the ability to monitor campaign effectiveness in real time. This allows travel agencies to identify which marketing channels generate the highest returns and optimise campaigns based on analytical data, enabling them to respond more quickly to changing market needs.

Compared to traditional forms of advertising (e.g. billboards or leaflets), digital marketing methods are often more cost-effective and flexible. They reduce the need for traditional advertising methods, such as printing leaflets, posters, or catalogues, which generate waste and require natural resources (paper, ink, energy). Online advertising takes place in the digital space, which reduces the negative impact on the environment.

STEP 2 Social media marketing

Social media marketing in travel agencies plays a key role in promoting sustainable tourism. With the right strategies, it is possible not only to raise customers' environmental awareness but also to encourage them to choose more responsible ways of travelling.

Below are some examples of modern social media marketing methods:

1. **Interactive content** – this involves engaging the user through activities requiring their active participation. This could include:

- Surveys and quizzes – which help personalise content and collect data, suggesting eco-friendly travel options tailored to the user.
- Interactive graphics or videos – allow users to explore content at their own pace and can explain the impact of tourism on the environment and promote sustainable practices.
- Interactive maps and guides – apps showing eco-friendly attractions, local products, or environmentally friendly places.

2. Gamification – this involves using game-like elements to engage users.

- Eco-friendly challenges – apps that reward tourists for choosing public transport, sorting waste, or avoiding plastic.
- Badges and rewards – earning points for visiting sustainable places, using local services, or taking part in clean-up campaigns.
- Eco-tourist rankings – comparing eco-friendly choices and competing to care for the environment.
- Interactive educational trails – outdoor activities in national parks or cities that teach visitors about nature conservation and local culture.

Examples:

- "Eco-passport" apps – platforms that reward users for staying at eco-friendly accommodation.
- GeoGuessr – a game that allows users to discover different places around the world using Google Street View. It can be used by travel agencies to promote destinations. Users must guess where in the world they are, which can spark interest in travel.

FairTrip (App 1) – an app packed with places to stay, eat and shop, selected based on their sustainability credentials. Using filters, you can choose the key attractions for your holiday to ensure they are sustainable. This travel guide features over 3,000 places from around the world. It has been created by 'FairTrippers', users of the app who contribute to the map, meaning that anyone can add their favourite spots.

3. **Videos and live streams –** these can show how specific tourist destinations implement sustainable practices, for example, how local transport operators maintain an eco-friendly fleet of vehicles, how organic farms produce food, or how hotels implement energy-saving programmes.

- Guides can host live streams where they show tourists how cultural and natural heritage is protected, and discuss important aspects of visiting these places responsibly. This could, for example, be a broadcast from a trip to a national park, during which the guide educates viewers about local flora and fauna and environmental conservation practices.

- Live broadcasts of interviews with tourism industry experts who can discuss trends in sustainable tourism, responsible travel, or the impact of tourism on local communities and ecosystems. Such broadcasts can engage viewers by allowing them to ask questions live.

- Showcasing authentic local experiences: Presenting authentic local experiences, such as craft workshops, cooking local dishes, or participating in ceremonies related to the culture of a given region, can help build a bond between tourists and local communities, demonstrating how sustainable tourism supports the local economy.

- Promoting eco-friendly transport: Live travel broadcasts showcasing eco-friendly modes of transport, such as trains, bicycles, or eco-powered boats, can inspire more responsible choices when planning a trip.

- Educational campaigns: Broadcasts can also be used to run educational campaigns on the impact of tourism on the environment and ways to minimise this impact, such as reducing plastic use, choosing responsible tour operators, or caring for local ecosystems.

4. **Influencer marketing** is an approach that combines traditional marketing techniques with modern solutions, harnessing the influence of influencers to promote responsible travel. In an era of growing environmental awareness and social responsibility, influencers can play a key role in shaping tourists' attitudes and promoting destinations that prioritise sustainability. Here are some key elements that characterise this trend:

- Brand ambassadors – Influencers can act as ambassadors for tourism brands that adhere to the principles of sustainable development. For example, they travel to places that focus on minimising their negative impact on the environment, promote ecotourism, or support local nature conservation initiatives.

- Influencers can engage their followers in eco-friendly activities, such as beach clean-ups, tree planting, or organising local events that support sustainable development. Collaboration with non-governmental organisations and participation in environmental initiatives further reinforces the message.

5. **SEO** (Search Engine Optimisation) **on social media**, i.e. optimisation for search engines, is a set of activities aimed at improving a website's visibility in search results on search engines such as Google, Bing, or Yahoo. The aim of SEO is to increase organic (i.e. unpaid) traffic to the website by improving its ranking in search results for specific queries (keywords). SEO on social media is a key element of a marketing strategy, enabling you to reach the right target audience, increase the visibility of content related to responsible travel, and attract tourists interested in eco-friendly and ethical tourism options. Optimising content for social media SEO is a process that enables you to better reach people interested in sustainable tourism, which can influence their travel decisions.

An effective campaign should begin with identifying keywords. In the case of sustainable tourism, it is worth focusing on phrases related to ecotourism, responsible travel, and environmental protection, such as:

- Ecotourism
- Sustainable tourism
- Responsible travel
- Eco-friendly hotels
- Green tourism
- Carbon-neutral tourism
- Environmental protection in tourism

Every social media platform (Instagram, Facebook, Twitter, LinkedIn, TikTok, Pinterest) has its own rules and algorithms that influence the visibility of content. The key aspects of social media SEO are:

- Hashtags: Using relevant hashtags that align with the theme of sustainable development is one of the fundamental ways to increase reach. On Instagram and Twitter, hashtags can help you reach people interested in ecotourism, e.g.: #Ecotourism, #SustainableDevelopment, #ResponsibleTravel, #GreenTravel, #EcoTourism, #SustainableTravel.

Geo-tagging: Adding locations to social media posts is a way to increase visibility in local search engines. In the case of sustainable tourism, it is worth tagging places that are particularly well-known for their pro-environmental activities, protected nature reserves, or popular ecotourism destinations.

On social media, algorithms favour posts with high engagement. Responding to comments, encouraging interaction, and organising competitions, polls, or challenges related to sustainable tourism are ways to increase visibility. The more people engage with posts, the greater the chance that they will have a wider reach.

Regularly monitoring SEO results on social media, such as the number of likes, comments, shares, and clicks on links, will help you adjust your strategy. Tools such as Google Analytics, Facebook Insights, Instagram Analytics (Appendix 2) and TikTok Analytics allow you to track the effectiveness of posts and hashtags.

PPC – Pay Per Click, chatbots and AI in customer service

Conversational marketing and community marketing – this focuses on direct, real-time interaction with customers to establish and maintain a personal connection, thereby building engagement and loyalty. In the context of sustainable tourism, this means establishing a dialogue that promotes responsible travel, educates about eco-friendly alternatives, and encourages conscious choices.

PPC is an online advertising model in which tourism organisations pay for every click on their advert. It can be an effective tool for promoting ecotourism and responsible travel.

Applications of PPC in sustainable tourism include, for example:

- Targeting ecotourists – PPC ads can be targeted at people interested in eco-friendly travel.
- Promoting certified destinations and services – PPC campaigns can encourage the choice of hotels and attractions with eco-certifications.
- Educating tourists – adverts can redirect users to pages containing information on the principles of sustainable tourism.

Chatbots, or virtual assistants, can improve customer service and educate travellers about sustainable tourism.

The advantages of chatbots include:

- Quick responses to tourists' questions – chatbots can answer questions about the principles of eco-friendly travel.
- Suggestions for eco-friendly options – recommendations for hotels, restaurants, and attractions that adhere to sustainable development principles.
- Notifications about environmental initiatives – chatbots can inform travellers about local eco-friendly campaigns, such as beach clean-ups, or tree planting.

AI in data analysis and sustainable tourism planning

Artificial intelligence can help tourism organisations optimise their offerings and manage tourist flows in a more environmentally friendly way.

Benefits of using AI:

- Optimisation of tourist traffic – predicting traffic volumes and suggesting alternative routes.
- Analysis of tourist preferences – tailoring tourism offers to ecotourism.
- Automation of recommendations – AI can suggest sustainable travel options based on historical data.

Modern technologies, such as PPC, chatbots, AI, influencer marketing, and social media, are transforming the way tourism is promoted. Effective marketing strategies enable offers to be better tailored to customer needs, increase audience engagement and build loyalty to tourism brands. Implementing modern marketing tools is the key to success in the rapidly evolving tourism industry.

STEP 4 Summary – exercise

The trainer divides the participants into teams of 3–4 people. Each group chooses one travel agency specialism (e.g. exotic holidays, city breaks, ecotourism).

Each team is tasked with creating a marketing strategy comprising:

- a PPC campaign (keywords),
- specifying the tools used in the strategy,
- influencer marketing – selection of a brand ambassador and promotional channel.

Time allowed for the task: 10 mins.

The team prepares a short presentation (max. 3 mins) in which they will present their strategy.

During the presentation, please focus on:

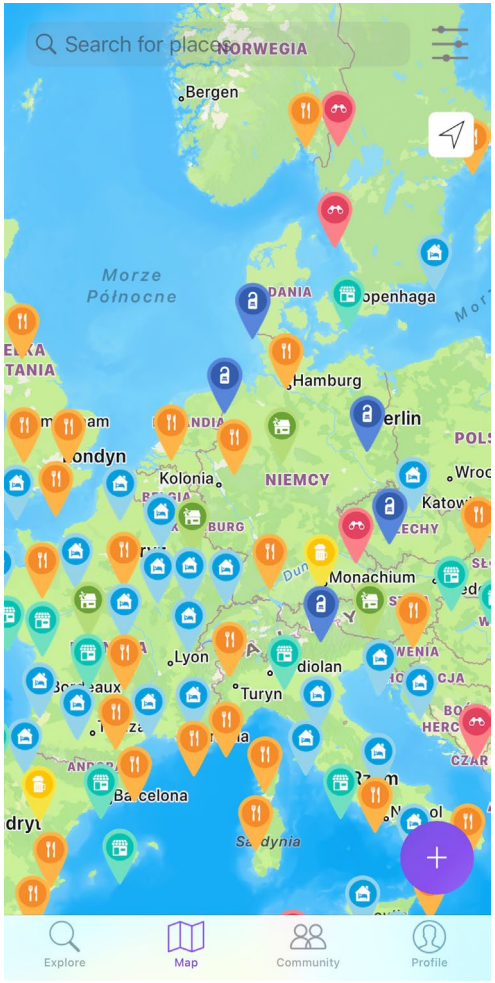
- creativity in the selection of tools

- the effectiveness of the proposed marketing activities

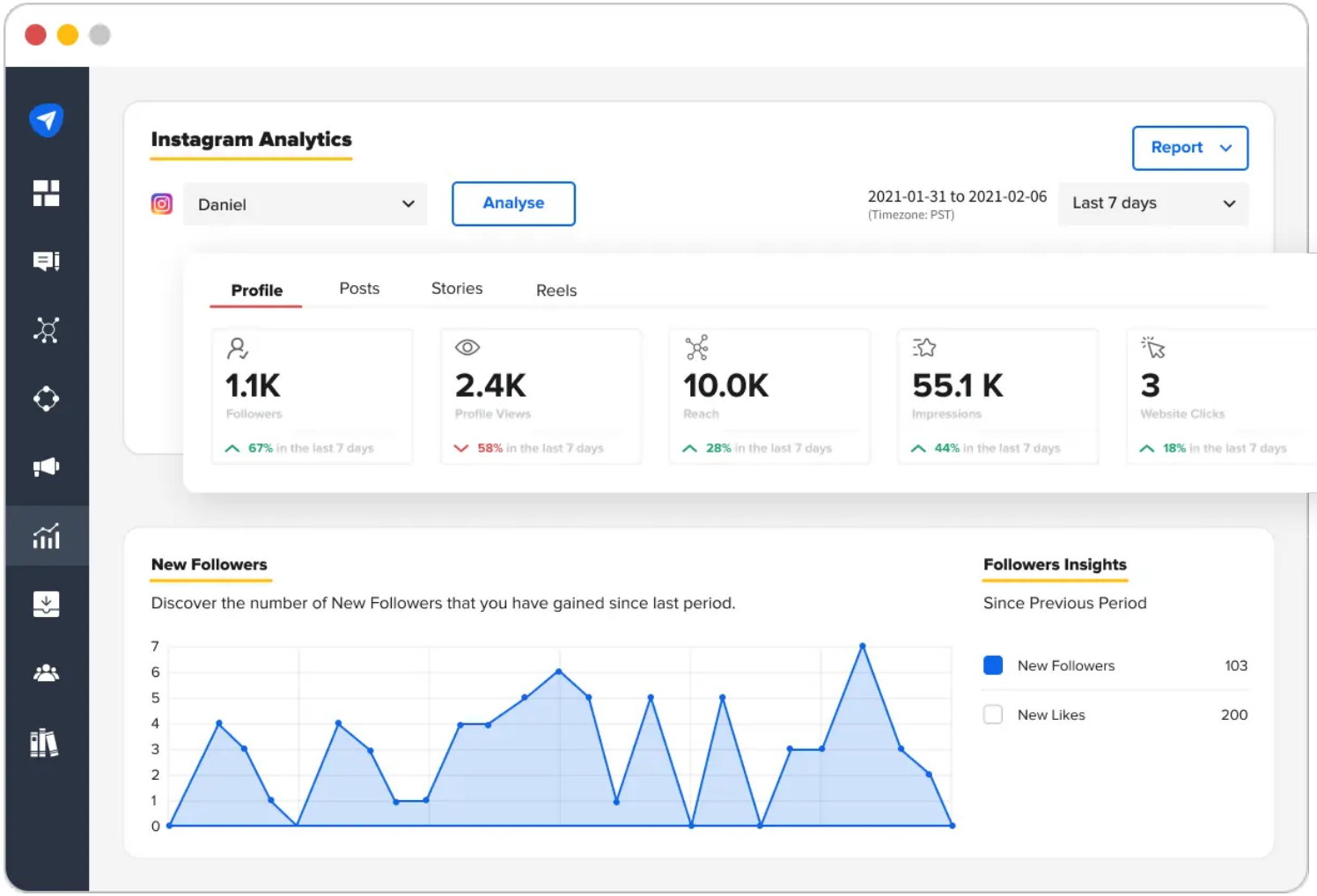
- the alignment of the strategy with customer needs.

Presentations should demonstrate that the key element of effective online marketing in tourism is the skilful combination of modern tools, such as PPC, chatbots, AI, influencer marketing, and social media. In their group work, teams should focus on personalising offers and automating processes, which allows for a better alignment of the strategy with the needs of modern travellers. An innovative approach to promotion allows online travel agencies to stand out from the competition and effectively reach potential customers.

Fair Trip


Search for places
NORWEGIA
Bergen
Morze
Północne
DANIA
Hamburg
NIEMCY
Kolonia
Monachium
Lyon
Turyn
Explore
Map
Community
Profile

Instagram Analytics



SOURCES

- “The Importance of Online Marketing Tools in Tourism” – by Dariusz Strzębicki, Warsaw University of Life Sciences
- “Artificial Intelligence in Digital Marketing” – author: A. Panasiuk
- APPENDIX 1 – screenshot from the FairTrip app
- APPENDIX 2 – https://www.socialpilot.co/instagram-marketing/instagram-analytics

Compiled by:

Sandra Domagalska, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by the European Union



1.8. TITLE: Advancing Sustainability and Eco-Friendly Packaging in the Cosmetic Care and Beauty Industry

PROCESS:

Steps	Time
Step 1. Introduction	30 min.
Step 2. Sustainability in Cosmetic Care and Beauty Industry (quiz)	20 min.
Step 3. Creating a Mind Map on Sustainable Packaging in Cosmetic Care and Beauty Industry	40 min.
Step 4. Summary	10 min.

AIMS TO ACHIEVE:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• The significance of sustainability packaging in the cosmetic care and beauty Industry.	• Describe the meaning of purchasing sustainable package in cosmetic beauty salons. • Provide examples of sustainable packages options for cosmetic beauty products.	• The importance of teaching about sustainable packaging in beauty and cosmetics industry.



Number of participants: 8 - 10



Planned time: 100 min

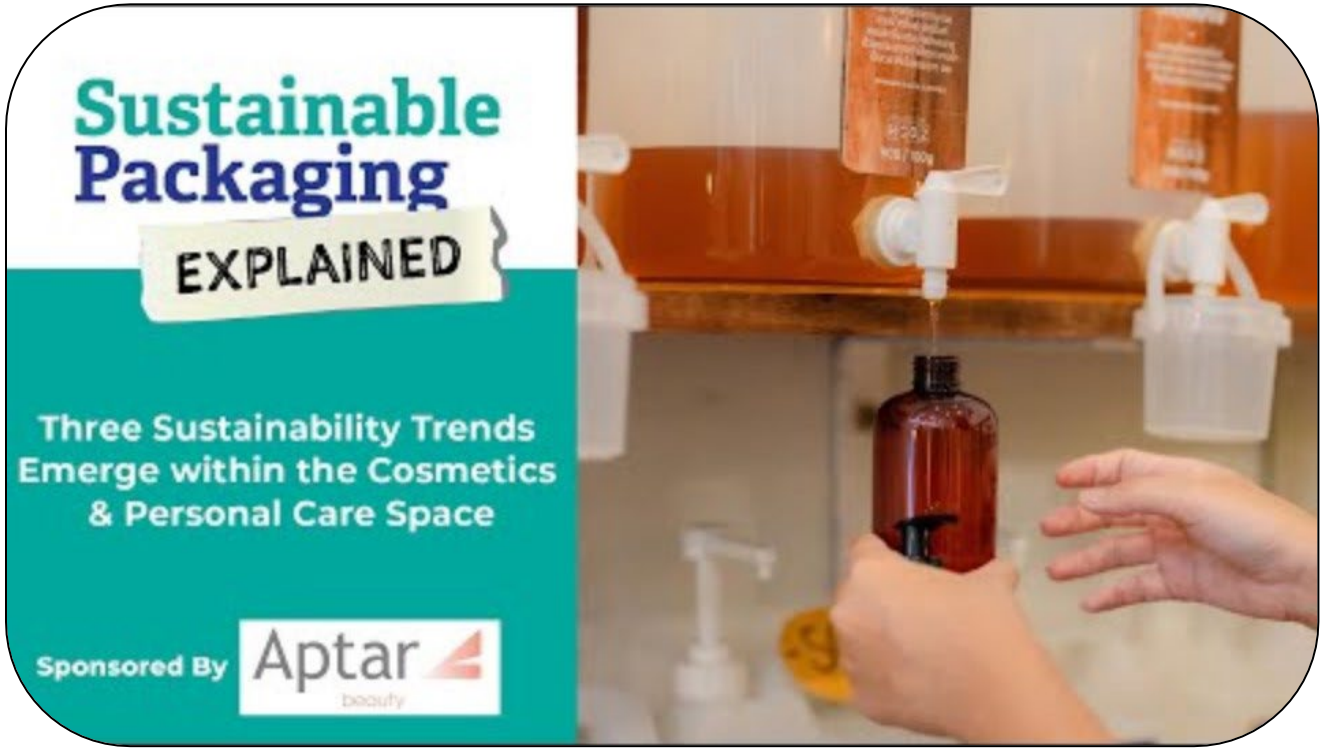


Required materials:
Projector, laptop
Whiteboard
Markers or pens in different colors
Sticky notes (optional)



Remarks: Digital tools (optional): Mind mapping software like MindMeister or online collaboration tools like Miro.

- The trainer makes a general explanation of what sustainable packaging is, and briefly presents each step.
- To finish the introduction, and to sum up all the steps covered in the subject matter, the teacher shows the following video to the participants: Sustainability in Cosmetics & Personal Care Packaging
- After watching the video, have participants write a short reflection on what they learned and how it affects their perspective on packaging, both in their personal lives and in their work.



STEP 2 . Sustainability in Cosmetic Care and Beauty Industry (quiz)

- The trainer assign each participant a multiple choice quiz (Appendix 1) and asks them to choose the correct answers. The quiz solutions are provided in Appendix 2. At the end of the activity, the trainer encourages a discussion among the participants about why sustainable packaging is important in the cosmetic industry?

STEP 3 Creating a Mind Map on Sustainable Packaging in Cosmetic Care and Beauty Industry

- The trainer begins with the explanation the importance of sustainable packaging in cosmetic care and the beauty industry. The trainer describes sustainable packaging as the use of the environmentally friendly materials and design techniques, that have lowest impact on the environment and the smallest possible footprint. He emphasizes that by adopting eco-friendly packaging, we can significantly reduce waste and reduce our carbon footprints. This change not only benefits the planet, but also encourages healthier consumer habits. The trainer then prepares to introduce the following activity:

Activity: **Creating a Mind Map on Sustainable Packaging in the Cosmetic Care and Beauty Industry**

- The trainer divides the participants into smaller groups in order to mind map, what the concept of sustainable packaging is in the cosmetic care and beauty industries.

- To set up the mind map, the trainer write the central theme *"Sustainable Packaging in Cosmetic Care and Beauty"* in the center of a whiteboard. The trainer continues by brainstorming with the participants to come up with several ideas and writes them around the main topic. The trainer assigns each group a topic that they should further work on. Each group explain the different topics assigned. At the end, participants discuss how salon owners can be encouraged to switch to purchasing products with sustainable packaging.

The information that the trainer needs to carry out this activity can be found in the following sources:

- https://www.cosmeticdesigner.co/blog/sustainable-packaging-design-in-the-beauty-industry.html

- https://energytheory.com/eco-friendly-skincare-cosmetic-packaging/

STEP 4 Summary

The trainer ask the participants:

- Which part of the today's training session do you think you learned the most from?
- Do you prefer to buy cosmetic products that are produced from sustainable packaging?
- Are you wiling to pay pay more for a cosmetic products whose packaging is made from sustainable materials?

APPENDIX 1 Quiz about sustainability in cosmetic care and beauty Industry

Instruction: Select the best answer for each question.

Question 1: What aspect of sustainability is represented on these images?





a) Sustainable packaging
b) Ethical sourcing
c) Eco-friendly production methods
d) Fair trade practices

Question 2: Why is sustainable packaging important in the cosmetic industry?

a) It reduces waste and environmental impact.
b) It increases product cost.
c) It improves product efficacy.
d) It boosts brand popularity.

Question 3: What do these ingredients represent in terms of sustainability?





a) Ethical sourcing
b) Organic ingredients
c) Cruelty-free products
d) Greenwashing products *(refer to items that are marketed as environmentally friendly or sustainable, but do not actually provide significant environmental benefits.)*

Question 4: How do organic ingredients contribute to sustainability in cosmetics?

a) They reduce chemical exposure to consumers.
b) They decrease product shelf life.
c) They increase production costs.
d) They have no impact on sustainability.

Question 5: What aspect of sustainability is depicted in this image?



a) Renewable energy
b) Waste reduction
c) Ethical sourcing
d) Eco-friendly packaging

Question 6: How does the use of renewable energy promote sustainability in the cosmetic industry?

a) It reduces greenhouse gas emissions.
b) It increases production costs.
c) It speeds up product development.
d) It has no impact on sustainability.

Question 7: Why is ethical sourcing important in the cosmetic industry?

a) It ensures fair treatment of workers.
b) It has no impact on product quality.
c) It increases production costs.
d) It boosts brand popularity.

APPENDIX 2 Quiz solutions

1. a) Sustainable packaging
2. a) It reduces waste and environmental impact.
3. b) Organic ingredients
4. a) They reduce chemical exposure to consumers.
5. a) Renewable energy
6. a) It reduces greenhouse gas emissions.
7. a) It ensures fair treatment of workers.

SOURCES

- Step 1 - https://www.youtube.com/watch?v=40X73eRBbqw
- Step 1, 2 & 3 - https://www.cosmeticseurope.eu/files/4214/6521/4452/GSP_Brochure.pdf
- Step 2/Appendix 1 - https://www.investopedia.com/terms/g/greenwashing.asp
  https://www.minimum.com/resources/what-is-greenwashing-definition-examples
- Step 3 - https://www.cosmeticdesigner.co/blog/sustainable-packaging-design-in-the-beauty-industry.html
- Step 3 - https://energytheory.com/eco-friendly-skincare-cosmetic-packaging/
- Step 3 - https://www.adelaide.edu.au/writingcentre/sites/default/files/docs/learningguide-mindmapping.pdf

Developed by:

Meri Boshkoska,
Innova Lab - Bitola

Co-funded by
the European Union



1.9. TOPIC: Building a Greener Future: Implementing Sustainable Practices in Cosmetic Beauty Salons

PROCESS:

Steps	Time
Step 1: Sustainable Practices in a Cosmetic Beauty Salon	20 min
Step 2: Successful Sustainable Beauty Salons	45 min
Step 3: Educating and Engaging Clients	60 min
Step 4: Summary	10 min

AIMS :

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• The importance of sustainability in running a cosmetic beauty salon. • Practical steps to incorporate sustainability into everyday salon operations	• Explain the sustainability practices in the cosmetic beauty salon. • Give examples of cosmetic beauty sustainable practices.	• The importance of teaching sustainability principles in beauty and cosmetics. • Various strategies and techniques for effectively communicating and engaging clients in sustainable initiatives.



Number of participants: At least 6



Planned time: 135 min



Required materials:
Projector, laptop
Sticky notes
Whiteboard and markers
Sheets and pens



Remarks: -

STEP 1: Sustainable Practices in Cosmetic Beauty Salon

- In this scenario, participants take part in a brainstorming session to explore why it is beneficial to implement sustainable practices in a beauty salon.

- The brainstorming method encourages participants to inspire one another, fostering creative ideas and guiding the discussion toward new perspectives on sustainability. This collaborative approach allows participants to explore different points of view and encourages them to consider sustainability in a broader context beyond environmental issues.

- The trainer moderates the discussion by asking participants to share their thoughts on what sustainable development means to them, particularly in the context of a beauty salon. The answers are written on a board for everyone to see, creating a visual map of collective thoughts.

- Once all the participants' answers have been collected, the trainer groups them and assesses whether they are consistent with the principles and objectives of sustainable development. It should be noted that in groups with limited experience, participants may initially focus exclusively on ‘green’ issues.

- To ensure a broader understanding, the trainer displays a slide outlining the core values of sustainable development and briefly discusses aspects that may not have been addressed during the brainstorming session. This helps participants gain a more comprehensive understanding of sustainable development and its importance for their beauty salon, beyond environmental issues (Appendix 1).

The trainer begins with a brief introduction to case study analysis and explains the importance of learning from successful industry examples. The trainer then moves on to the following task:

1. **Distribute case studies (5 minutes): (Appendix 2)**

- Distribute printed or digital case studies to participants.
- Ensure that each group or individual has access to a unique case study.

2. Individual or group reading (10 minutes):

- Give participants time to read their assigned case study.
- Encourage them to highlight key points and take notes.

3. Guided analysis (15 minutes):

Distribute materials to participants containing guiding questions, such as:

- What sustainable practices have been implemented in this salon?
- How has the salon benefited from implementing these practices?
- How might the salon's commitment to sustainability influence consumer behaviour?
- What potential challenges might the salon face in maintaining its commitment to sustainability?
- Ask participants to discuss their findings in small groups or pairs.

4. **Group discussion and sharing insights (10 minutes):**

- Bring the whole group together and ask each group or individual to share their insights.
- Write down the key points on a board or in a digital collaboration tool so that everyone can see them.

5. **Summary (5 minutes):**

- Summarise the key conclusions from the case study analysis.

STEP 3: Educating and Engaging Clients

The trainer begins with a comprehensive introduction, emphasizing the importance of developing strategies to educate and involve clients in sustainability initiatives. Following this introduction, the trainer initiates the following activity:

- *Round Robin Brainstorming:* Divide participants into small groups and give each group a set amount of time to brainstorm ideas for client engagement in sustainability initiatives. After the initial brainstorming, rotate the groups to different stations or tables, allowing each group to build upon the ideas generated by the previous group. Use session sticky notes for additional thoughts or to highlight particularly strong ideas.
- After several rounds, reconvene as a larger group to share and discuss the ideas.
- Ask participants to reflect on the process and share their thoughts on the most promising ideas.
- To provide a broader understanding, the trainer then displays a slide outlining some ideas for client engagement in sustainability initiatives. (Appendix 3)

STEP 4: Summary

The trainer asks the participants:

- What were the most valuable takeaways from today's session?
- How has today enhanced your understanding of the topic?
- Which parts of the session did you find most engaging and insightful?

APPENDIX 1

Sustainability goes beyond environmental issues and encompasses various aspects, such as social and economic benefits:

Social benefits

- Employees are more motivated and proud to work for a company that prioritises sustainability, which translates into higher morale, productivity and retention rates.
- By addressing social issues such as diversity, equality and inclusion, sustainable businesses demonstrate their commitment to ethical practices and contribute to building a more equitable society.

Economic benefits

- Implementing sustainable practices can lead to significant cost savings by reducing energy and resource consumption, improving waste management and lowering operating costs.
- Consumers increasingly prefer companies that focus on sustainability, giving sustainable businesses the opportunity to stand out in the market and attract environmentally conscious customers.
- Sustainable businesses are better equipped to adapt to changing market dynamics, regulatory requirements and environmental challenges, increasing their long-term profitability and resilience.

Case Study No. 1 – Spa Ritual (Los Angeles, California, USA)

Description: Spa Ritual is a sustainable, vegan cosmetics brand based on self-care rituals. It creates clean, non-toxic, professional and consumer products for body and nail care.

Sustainable practices:

- The brand is committed to environmental protection and sustainable development.
- It supports the sustainable development of the urban environment.
- It is committed to creating clean, non-toxic, vegan products for spa professionals and self-care activists.

Social engagement:

Spa Ritual believes that active participation in community life is an essential part of sustainable business practices. Therefore, **it is** proud to sponsor selected local charity events.

Benefits:

- Attracts customers who are committed to using natural and organic skincare products.
- Opportunity to establish partnerships.
- Strengthens the brand's reputation as a leader in sustainable body and nail care.

Case study no. 2 – Osmosis Day Spa Sanctuary **(California, USA)**

Description: Osmosis Day Spa Sanctuary combines environmentally friendly practices with luxurious beauty treatments, promoting sustainability in all aspects of its business.

- *Sustainable practices:*
- Green building: The spa was designed using sustainable materials and practices, including solar panels and water-efficient landscaping.
- Natural treatments: Beauty treatments use organic products sourced from local and biodynamic farms.
- Waste management: A robust recycling and composting programme has been implemented to minimise waste.
- Environmental initiatives: Water-saving technologies and energy-efficient systems are used throughout the facility.

Benefits:

- Attracts customers seeking high-quality, natural beauty treatments in an eco-friendly environment.
- Significantly reduces environmental impact through sustainable construction and operational practices.
- Increases customer loyalty through commitment to sustainability.

Case study no. 3 – Bliss Organic Day Spa **(California, USA)**

- **Description:** Organic Bliss Day Spa offers a full range of beauty treatments using sustainable and eco-friendly practices.

Sustainable practices:

- •Eco-friendly products: The spa uses only certified eco-friendly products.
- •Energy efficiency: The spa is equipped with energy-efficient lighting and appliances.
- •Recycling and waste reduction: Comprehensive recycling programmes and initiatives to reduce the use of single-use plastics.
- •Eco-friendly interiors**:** Interior design based on sustainable and recycled materials, creating a soothing and environmentally friendly atmosphere.

Benefits:

- •Customers can enjoy the benefits of organic and natural skincare products.
- •Lower energy costs thanks to energy-efficient lighting and appliances.
- •A strong reputation for sustainability attracts environmentally conscious customers.

APPENDIX 3 - Ideas for Client Engagement in Sustainability Initiatives

- Implementing a loyalty program that offers discounts or rewards to customers who opt for sustainable products or services.
- Hosting workshops or seminars to educate clients about sustainability practices like composting, water conservation, and eco-friendly product selection.
- Launching social media campaigns to showcase the salon's sustainability efforts and encourage clients to share their own eco-friendly actions.
- Creating interactive displays or exhibits within the salon to educate clients about sustainability practices and the salon's commitment to environmental stewardship.
- Offering demonstrations of eco-friendly products or services to highlight their benefits and encourage clients to make sustainable choices.

SOURCES

- Step 1 - https://www.ripeinsurance.co.uk/small-business/hair-and-beauty-insurance/blog/8-tips-for-salon-sustainability/
- Step 1 - https://www.gettimely.com/the-source/salon-sustainability/
- Step 1 - https://www.ecisolutions.com/blog/manufacturing/success-in-cosmetics-navigating-a-competitive-market-through-transparency-sustainability/
- Step 2 - https://sparitual.com/
- Step 2 - https://www.sonomacounty.com/profiles/osmosis-day-spa-sanctuary/
- Step 2 - https://www.blissorganicdayspa.com/
- Step 3 - https://www.linkedin.com/advice/1/how-can-you-educate-customers-sustainability-your
- Step 3 - https://www.infosysbpm.com/blogs/customer-service/how-to-attract-customers-with-sustainability.html

Developed by:

Meri Boshkoska,
Innova Lab - Bitola

Co-funded by the European Union



1.10. TITLE: RETHINKING SUSTAINABLE FASHION

PROCESS:

Steps	Time
Step 1. Introduction to Sustainable Fashion Concept and Principles	15 min.
Step 2. “Fashion Revolution - Rethinking Our Wardrobes”- Individual Activity	35 min.
Step 3. Ethical Fashion Brands - Research Activity and Presentations	40 min.
Step 4. Summary, Conclusion and Evaluation	10 min.

AIMS TO ACHIEVE:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• Key principles and concepts of sustainable fashion • The various environmental and social impacts of the fashion industry	• Discuss the environmental and social impacts of the fashion industry • Identify and evaluate sustainable fashion brands	• The importance of supporting ethical and sustainable fashion brands • The complex challenges and opportunities within the sustainable fashion industry



Number of participants: 10-15



Planned time: 90 min



Required materials:
Power point presentation, flip charts, sheets of paper, marker pens, projector and a laptops/tablets (optional)



Remarks:

The trainer starts a group discussion on following topics:

1. **What is the concept of sustainable fashion?**

- Sustainable fashion is a concept that encompasses various practices and principles aimed at reducing the negative impact of the fashion industry on the environment, society, and economy. Sustainability in the textile sector is based on reducing *environmental impact, improving working conditions, supply chain ethics and sustainable product design.*

- For better visualization, the trainers shows materials in Appendix 1.

2. What are the environmental consequences of the fashion industry?

- The production of clothing involves intensive use of natural resources, such as water, land, and energy. Additionally, the use of toxic chemicals in dyeing and finishing processes contributes to water pollution and damage to ecosystems.

- The textile industry significantly impacts the environment through its intensive use of natural resources and the release of pollutants. Here are some key statistics illustrating these effects:

- **Water Consumption:** Producing a single cotton T-shirt requires approximately 2,700—litres of water, enough for one person to drink for over two years.

- **Waste management:** The global fashion industry consumes about 93 billion cubic meters of water annually, accounting for 4% of all freshwater withdrawal worldwide.

- **Land Use:** Cotton cultivation occupies 2.5% of the world's arable land, often displacing food crops and leading to habitat destruction.

- **Energy Consumption and Greenhouse Gas Emissions:** The apparel and footwear industries contribute 8-10% of global carbon emissions, surpassing the emissions from international aviation and shipping combined.

- **Chemical Pollution:** Textile dyeing and finishing processes are responsible for approximately 20% of global industrial water pollution, releasing harmful substances like lead, mercury, and arsenic into water bodies.

- The use of synthetic fibers, such as polyester, contributes to microplastic pollution, with an estimated 500,000 tons of microfibers entering the oceans annually from washing synthetic textiles.

3. Why environmental consequences of the fashion industry matters?

- Sustainable fashion matters for a multitude of reasons, ranging from its impact on the environment to its economic and social implications.
- The production of clothing involves the use of vast amounts of water, energy, and chemicals.
- Additionally, the disposal of clothing leads to massive amounts of waste that end up in landfills, contributing to pollution and resource depletion.

4. **What are key principles of sustainable fashion?**

- *Ethical Production and Fair Trade* - Safe working conditions and respecting workers' rights.
- *Eco-friendly Materials Usage* - Organic cotton, hemp, linen, and bamboo, recycled fabrics made from pre-consumer or post-consumer waste, such as recycled polyester or upcycled denim.
- *Design for Longevity* - Creating timeless pieces that can be worn for years.
- *Recycle, Repurpose, Reuse* - Donating clothes to second-hand stores or clothing banks, repurposing old garments into new items, recycling clothing through textile recycling programs.

1. **Online Research (10-15 minutes).** Use Step by Step Instructions **(Appendix 2)**

The trainer gives a task to the participants to conduct their own personal fashion footprint assessment. They should focus on:

- Types of materials: identifying if their clothes are made from natural, synthetic, or artificial fibers, and their sustainability.
- Origin of the clothes: where and how the garments were made.
- Recycling options: availability and viability of recycling specific garments.
- Zero-waste options: strategies to minimize waste.

2. Wardrobe Audit (5-10 minutes): Use Example Wardrobe Audit Chart: **(Appendix 2)**

Participants conduct an audit of their wardrobes to assess the sustainability of their clothing collections.

- They need to identify if they have garments that are rarely worn, damaged, or no longer fit their style.
- They explore creative upcycling techniques to repurpose these items.

3. Open Discussion and Brainstorming (10 -15 minutes):

Participants share their findings and suggestions with the group.

Discussion points include:

- Areas where they can reduce the environmental impact of their clothing choices.
- Reflecting on personal values related to sustainability.
- Sharing creative upcycling ideas and tips.

STEP 3 Research Activity and Presentations of Ethical fashion Brands

1. The trainer briefly presents **Top 5 Sustainable Clothing Companies in EU (**Appendix 2). (10-15 minutes).

Then divides participants into smaller groups of 3 to 5 people each. Each group is given one of the brands in Appendix 2 to analyze. Groups investigate and analyze their chosen brand using online resources, company websites, and reputable sustainability reports by exploring the following factors:

- What materials they use, and how sustainable are they?
- What steps does the brand take to minimize environmental harm?
- Are workers treated fairly and paid equitably? What are the working conditions?
- How transparent is the brand about its supply chain?
- What certifications (e.g., Fair Trade, GOTS) does the brand hold?

2. Each group present their findings to the rest of the participants using a flip chart. (10-15 minutes).

Key points to include:

- Overview of the brand.
- Sustainable practices and materials.
- Impact on the environment and society.
- Innovative solutions and best practices.

3. The trainer facilitates an open discussion that could include: (10-15 minutes).

- Comparing different brands and their approaches.
- Identifying common best practices in sustainable fashion.
- Discussing how these insights can be applied in personal lives of the participants and teaching.

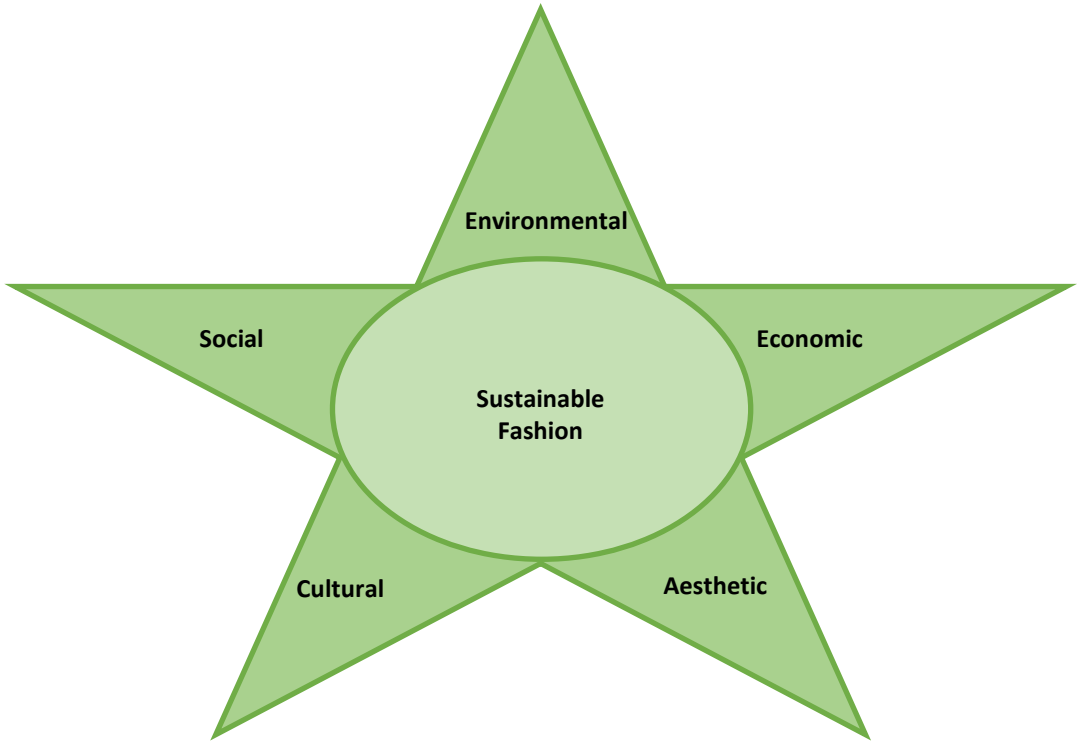
STEP 4 Summary, Conclusion and Evaluation

- The trainer concludes the session with a reflection by emphasizing the innovative solutions and best practices within the sustainable fashion industry.

Following topics can be discussed:

- Have you increased your knowledge about the latest innovations in Sustainable Fabric and Materials?
- How important is to support Ethical Fashion Brands?
- Fast Fashion vs Sustainable Fashion - What can you personally do about It?

Figure 1. Five Dimensions of Sustainable Fashion



Source: *Tools for Sustainable Fashion Design: An Analysis of Their Fitness for Purpose*. Available from: https://www.researchgate.net/publication/334098113_Tools_for_Sustainable_Fashion_Design_An_Analysis_of_Their_Fitness_for_Purpose

APPENDIX 2

- **Instructions for Wardrobe Audit:**

1. **Step 1: Identify Materials** – Use clothing labels to classify items as natural (e.g., cotton), synthetic (e.g., polyester), or blended fabrics.
2. **Step 2: Sustainability Check** – Determine if the materials are renewable, biodegradable, or recyclable.
3. **Step 3: Evaluate Usage** – Identify underused, damaged, or outdated items.
4. **Step 4: Suggest Upcycling** – Think of creative ways to repurpose these items.

- **Example Wardrobe Audit Chart:**

Item Type	Material Composition	Sustainability Status	Upcycling Idea
T-Shirt	60% Cotton, 40% Polyester	Unsustainable (Polyester)	Turn into reusable tote bag
Jeans	100% Organic Cotton	Sustainable	Patchwork project for repairs

Visual Guide: Show images of upcycled clothing (e.g., old jeans into bags, shirts into cushion covers) to inspire creativity.

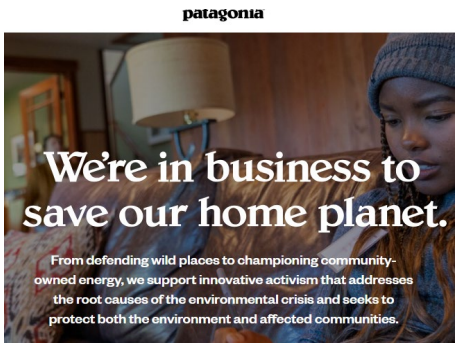






Top 5 Sustainable Clothing Companies in European Union

1. Patagonia
https://youtu.be/ihbZNkE7SBU



2. Tentree
https://youtu.be/LGcXQfgSK6s



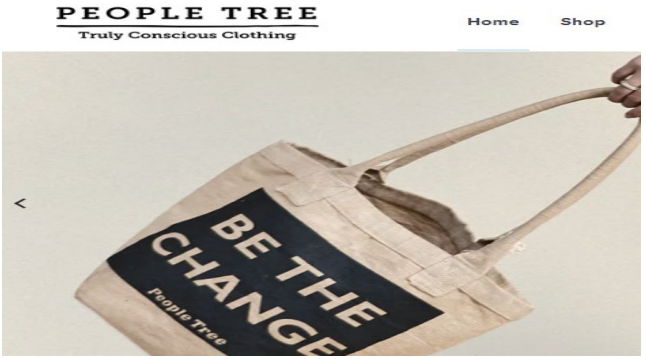
3. Adidas
https://www.youtube.com/watch?v=pJBRqespiOA&embeds_referring_euri=https%3A%2F%2Fsustainabilitymag.com%2F&feature=emb_imp_woyt



4. Amour Vert
https://amourvert.com/pages/our-story



5. People Tree
https://peopletree.eu



SOURCES

- *Tools for Sustainable Fashion Design: An Analysis of Their Fitness for Purpose*. Available from: https://www.researchgate.net/publication/334098113_Tools_for_Sustainable_Fashion_Design_An_Analysis_of_Their_Fitness_for_Purpose [accessed Jun 10 2024]. (Appendix 1)
- https://www.oxfam.org.uk/documents/607/edu-sustainable-fashion-teachers-guide-290922-en_h8TlBZq.pdf]. (Appendix 1)
- The Environmental Impact of Fast Fashion, Explained: https://earth.org/fast-fashions-detrimental-effect-on-the-environment/(Appendix 2)
- What are the environmental impacts of the textile industry? https://www.eea.europa.eu/en/about/contact-us/faqs/what-are-the-environmental-impacts-of-textiles (Appendix 2)
- Fashion's Environmental Impacts**:** https://www.sustainyourstyle.org/en/environmental-impacts (Appendix 2)
- https://sustainabilitymag.com/articles/top-10-sustainable-clothing-companies https://youtu.be/ihbZNkE7SBU (Appendix 3)
- https://youtu.be/LGcXQfgSK6s (Appendix 3)
- https://www.youtube.com/watch?v=pJBRqespiOA&embeds_referring_euri=https%3A%2F%2Fsustainabilitymag.com%2F&feature=emb_imp_woyt (Appendix 3)
- https://amourvert.com/pages/our-story (Appendix 3)
- People Tree: https://peopletree.eu (Appendix 3)

Developed by:

Elizabeta Tosheva, Centar for Educational and Development Initiatives INNOVA LAB Bitola

Co-funded by the European Union



1.11. TITLE: ECO-DESIGN FOR CIRCULAR ECONOMY IN THE TEXTILE AND FASHION INDUSTRIES

PROCEDURE:

Steps	Time
Step 1: Introduction to the Concept of Eco Innovation	20 min
Step 2: "Quiz on the topic of Circular Economy in the Textile and Fashion Industries"	15 min
Step 3: Curriculum Design Exercise on Eco-Innovations and Circular Economy in the Textile and Fashion Industries	45 min
Step 4: Summary, Conclusion and Evaluation	10 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• The fundamental concepts of eco-innovation and the circular economy in the textile and fashion industries • Practical examples of sustainable practices, materials, and technologies used in the industry	• Develop and implement curriculum modules that effectively teach eco-innovation and circular economy principles to students	• The importance of incorporating sustainability and circular economy principles into education and their influence on students' readiness to face industry challenges



Number of participants: 10-15



Planned time: 90 min



Required materials: Power point presentation, flip charts, sheets of paper, marker pens, projector and a laptops/tablets (optional)



Remarks:

STEP 1: Introduction to the concept of Eco – Innovation:

- **What is eco-innovation in the textile industry?**
  Each participant is encouraged to share their opinion on the subject.
- After the discussion, the trainer provides a clear definition, explaining that eco-innovation in the textile industry refers to innovations that result in products that are safer, more efficient, healthier and environmentally friendly. These innovations aim to reduce the use of materials, waste and energy.
- Key practices in this area include eco-design, eco-labelling, life-cycle analysis and improvements in materials and packaging.
- Next, the trainer introduces the four types of eco-innovations:
- Eco-innovative product or service (eco-product)
- Eco-innovative production process or method (eco-process)
- Eco-innovative organisational change (eco-organisational)
- Eco-innovative marketing solution (eco-marketing)



- The trainer shows examples of innovative and sustainable textile solutions (Appendix 1).
- Participants are then divided into four groups of 3–4 people. Each group is tasked with identifying one or more examples of eco-innovations in the textile industry that correspond to the four categories previously mentioned.
- The session concludes with each group presenting their findings to the whole group.

STEP 2: "Quiz on the topic of Circular Economy in the Textile and Fashion Industries"

- The trainer introduces the concept of Circular Economy and asks participants to take part in a quiz. The main goal of the quiz is to initiate a discussion about the circular economy in the textile and fashion industries.

- This exercise can be conducted either electronically using tools like Mentimeter or Kahoot, or with printed worksheets. Each question has one correct answer (see Appendix 2 for the correct answers).

1. **Question 1: What is the primary goal of a circular economy in the textile and fashion industry?**
   a) To increase production of new clothing
   b) To minimize waste and maximize resource efficiency
   c) To promote fast fashion trends



2. **Question 2: Which of the following practices supports circular economy principles in the fashion industry?**
   a) Designing clothing for single-use
   b) Using synthetic materials that cannot be recycled
   c) Implementing take-back schemes for used clothing

3. **Question 3: What is upcycling in the context of circular fashion?**
   a) Transforming old or discarded materials into new, higher-value products
   b) Burning old clothes to generate energy
   c) Recycling textiles into lower-quality materials

4. **Question 4: Which of the following is a key challenge for the circular economy in the textile industry?**
   a) High demand for sustainable fashion
   b) Difficulty in recycling blended fabrics
   c) Availability of eco-friendly dyes



5. **Question 5: How can digital tools contribute to a circular economy in fashion?**
   a) By enabling mass production of cheap garments
   b) By facilitating the tracking and management of resources throughout the product lifecycle
   c) By reducing the need for sustainable practices

6. **Question 6: Which strategy aligns with the circular economy model in fashion?**
   a) Encouraging the frequent purchase of new clothing
   b) Designing for durability and repairability
   c) Disposing of unsold inventory in landfills

The session concludes with an open discussion on the topic and how it may be included in curriculums.

STEP 3: Curriculum Design Exercise on Eco-Innovations and Circular Economy in the Textile and Fashion Industries

In this exercise, teachers will work collaboratively to create a curriculum focused on Eco-Innovations and the Circular Economy in the Textile and Fashion Industries.

The trainer divides the participants into small groups of 3–4 people. Each group, using their previous knowledge of eco-innovations, will be tasked with designing a curriculum module that can be implemented in their classrooms.

Four possible topics that teachers can focus on when creating the curriculum:

1. Sustainable Materials in Textiles – The curriculum could cover the environmental benefits of alternative fibres, such as hemp, bamboo, recycled polyester and biodegradable materials, compared to conventional textiles.

2. Circular Fashion Design and Production – The curriculum could include lessons on the principles of circular design, including designing for durability, reparability and recyclability.

3. Textile Recycling and Waste Management – The curriculum can focus on the different methods of textile recycling (e.g. mechanical and chemical).

4. Digital and Technological Innovations for Sustainability – The curriculum could explore how technologies such as 3D printing, digital fabric design and virtual fashion contribute to a more sustainable textile industry.

- The trainer guides participants in designing a lesson plan for students that addresses a specific topic. The focus should be on key curriculum elements, including Learning Objectives, Content Topics, Learning Activities and Assessment Methods. It is important to emphasise the alignment of learning objectives, assessment methods and instructional strategies with curriculum standards and educational goals.
- (A template for this activity is provided in Appendix 3, or teachers may use their own templates.)
- After the groups complete their curriculum outlines, each group will present its module to the rest of the participants. Presentations are kept concise (5 minutes per group) to allow time for interaction, discussion and feedback from the audience.
- The trainer and the group will provide constructive feedback on each other's work, highlighting strengths, areas for improvement and creative ideas, focusing on how to enhance the curriculum and make it more practical and engaging for students.

STEP 4: Summary, Conclusion and Evaluation

- The trainer reviews the main ideas covered in the session, including eco-innovations and circular economy principles in the textile and fashion industries.
- Participants are encouraged to reflect on how the knowledge and curriculum they developed can be implemented in their own teaching.
- Participants may share ideas on:
- How to keep students engaged and motivated when learning about sustainability and eco-innovations, particularly through hands-on activities and projects.
- How students can apply the principles of the circular economy in practical ways, such as through projects or collaborations with local industries.
- What challenges and obstacles teachers encounter when implementing eco-innovations in their lessons, and what resources and support are required to effectively incorporate these concepts into their teaching.

APPENDIX 1:

- Nine innovative and sustainable textile solutions, with examples for each, are:

1. **New Alternative Fibres** – fibres made from hemp, banana, nettle, pineapple and seaweed.
2. **Recyclable Materials** – textiles created from recycled materials such as plastic, polyester and discarded fishing nets.
3. **Yarn from Marine Animals** – innovations using squid genes and shrimp waste to create sustainable yarns.
4. **Natural Dyes** – dyes that significantly reduce water consumption and pollution.
5. **3D Printing** – a technology that eliminates the waste of raw materials during production.
6. **Digital Printing on Fabrics** – a process that achieves the same quality with less environmental impact and waste.
7. **Virtual Sampling** – using virtual reality to create realistic digital representations of fabrics, reducing the need for physical samples.
8. **Self-Cleaning Clothes** – incorporating tiny copper or silver structures between fibres to create fabrics that clean themselves.
9. **Rechargeable Fabrics** – smart clothing capable of collecting energy from body movements.



APPENDIX 2

Correct Answers to the Quiz:

Question 1:
Correct answer: b) Minimise waste and maximise resource efficiency

Question 2:
Correct answer: c) Implementing take-back schemes for used clothing

Question 3:
Correct answer: a) Transforming old or discarded materials into new, higher-value products

Question 4:
Correct answer: b) Difficulty in recycling blended fabrics

Question 5:
Correct answer: b) By facilitating the tracking and management of resources throughout the product lifecycle

Question 6:
Correct answer: b) Designing for durability and repairability

APPENDIX 3

Lesson plan on the topic or theme XXXXXX	
Objectives of the subject program (competencies): Define the specific learning objectives or outcomes that the methodology is designed to achieve.	
Materials and Resources (list of the materials, tools and resources needed for the activity)	
Learning Outcomes List the expected learning outcomes or skills that participants should gain from the activity.	
Methods and Techniques: Detail the Learning methods including any exercises, simulations, role-playing, discussions, or other instructional strategies.	
Description of the class activities (An outline of the class's flow, discussions, reflections)	
Assessment and Evaluation: Describe how the methodology incorporates assessment and evaluation of student's learning. This could include grades, quizzes, surveys, self-assessments, peer evaluations, or other feedback mechanisms.	

SOURCES

- Yurdakul, M.; Kazan, H. Effects of Eco-Innovation on Economic and Environmental Performance: Evidence from Turkey's Manufacturing Companies. *Sustainability* **2020**, *12*, 3167. https://doi.org/10.3390/su12083167 *(Appendix 1)*
- *https://www.mdpi.com/2071-1050/15/2/1549#:~:text=The%20product%20innovation%20practiced%20in,analysis%2C%20material%2C%20and%20packaging. (Appendix 1)*
- *Antony, Rinsey. (2018). Eco friendly Textiles. 5. 67 -73.* Eco friendly Textiles (researchgate.net) *(Appendix 3)*
- *https://voyado.com/resources/blog/the-circular-economy-in-the-fashion-industry/(Appendix 3)*
- *https://www.lead-innovation.com/en/insights/blog/kreislaufwirtschaft-in-der-textilindustrie (Appendix 2)*
- *https://www.tandfonline.com/doi/full/10.1080/1331677X.2021.1889393#d1e817 (Appendix 1)*
- *https://discover.certilogo.com/blogs/insights-blog/sustainable-textile-innovations (Appendix 1)*

Developed by:

Elizabeta Tosheva, Centar for Educational and Development Initiatives INNOVA LAB Bitola

Co-funded by
the European Union



1.12. TITLE: The ozone layer and CFCs

PROCEDURE:

Steps:	Time
Step: CFCs and the ozone layer	15 min
Step 2: Reaction between CFCs and the ozone layer	10 min
Step 3: Global cooperation to combat the ozone hole	10 min
Step 4: Summary	10 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What CFCs are • The impact of CFCs on the ozone layer • What the Montreal Protocol is	• Explain the reactions between CFCs and ozone • Name substitutes for CFCs	• The importance of global cooperation • The necessity of research into sustainable substitutes



Number of participants:
min. 5



Materials required:
Laptop, projector



Comments: -



Planned time: 45 min

STEP 1 CFCs and the ozone layer

1. Question: What is ozone?

The trainer asks those present about their knowledge of ozone.

Answers: Ozone is an oxygen molecule consisting of three oxygen atoms instead of two.

Near the ground, ozone is an air pollutant that can cause respiratory problems.

In high concentrations in the stratosphere, it forms the ozone layer.

2. Question: What is the ozone layer?

The ozone layer is essential for shielding the Earth from the sun's ultraviolet radiation.

It is located between 15 and 50 km above sea level in the stratosphere.

At this altitude, ultraviolet radiation, UV-C (240 nm wavelength), converts oxygen molecules into ozone, a process known as photolysis.

(see Appendix 1).

At the same time, UV-B radiation (300 nm wavelength) converts ozone back into oxygen molecules. A chemical equilibrium is formed.

Ultraviolet radiation is carcinogenic and can cause eye diseases.

3. Question: What are CFCs?

CFCs stand for chlorofluorocarbons, also known as Freon.

They have been manufactured technically since 1930.

In hydrocarbons (methane, ethane, etc.), hydrogen atoms form compounds with carbon.

In CFCs, fluorine or chlorine takes the place of hydrogen atoms.

They are stable, odourless, colourless, non-flammable and often non-toxic.

The methane and ethane series are easily liquefied and have low boiling points.

During evaporation, they can absorb large amounts of heat, which makes them important as refrigerants.

They can also be used as propellants, solvents, cleaning agents and in the manufacture of flat screens, solar cells and microcircuits.

In addition, CFCs are highly effective greenhouse gases.

In the 1970s, scientists discovered that CFCs depleted the ozone layer.

STEP 2 Reaction between CFCs and ozone

1. Question: But how do CFCs destroy ozone in the ozone layer?

Using chlorine as an example, the following reactions are involved:

(Show Appendix 2)

Chlorine interrupts the aforementioned cycle in the stratosphere.

On the other hand, chlorine monoxide reacts according to the reaction $ClO + O \rightarrow Cl + O_2$.

And at this point, the first reaction mentioned starts again.

This is called the catalytic chlorine cycle. Cl and ClO are always the end products of their respective reactions.

In this way, a single chlorine atom can destroy thousands of ozone molecules and bind the atomic oxygen necessary for ozone formation.

Chlorine acts as a catalyst in this degradation process.

In the polar regions, further catalytic cycles occur when there is an abundance of ClO molecules and sufficient solar radiation.

(see Appendix 3).

Here, two ClO molecules first react with each other to form (ClO)2, which decomposes into two Cl atoms and one oxygen molecule under the influence of solar radiation.

The now free Cl atoms can then react with ozone again.

STEP 3 Global cooperation to combat the ozone hole

As early as 1974, scientists proposed that CFCs in the stratosphere were depleting the ozone layer.

In 1985, a research team from the British Antarctic Survey reported a decrease in the ozone layer over Antarctica, thereby discovering the ozone hole.

In 1987, the Montreal Protocol on Substances that Deplete the Ozone Layer was adopted for the first time. Participating states committed to regulating and reducing CFC emissions by setting maximum levels.

It came into force on 1 January 1988 and became the first treaty to be signed by all member states of the United Nations.

A total of 198 Parties are participating in the agreement.

In the following years, there were repeated adjustments to the maximum emission levels, the inclusion of new substances and financial support for developing countries through a Multilateral Fund.

However, this global cooperation has led to an improvement in ozone levels. Despite fluctuations, the ozone layer has been recovering since around 1997.

(Show Appendix 4)

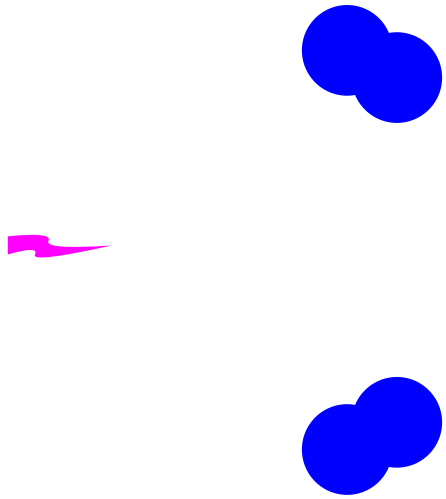
CFCs could be replaced as propellants and refrigerants by propane, butane, pentane and carbon dioxide, for example.

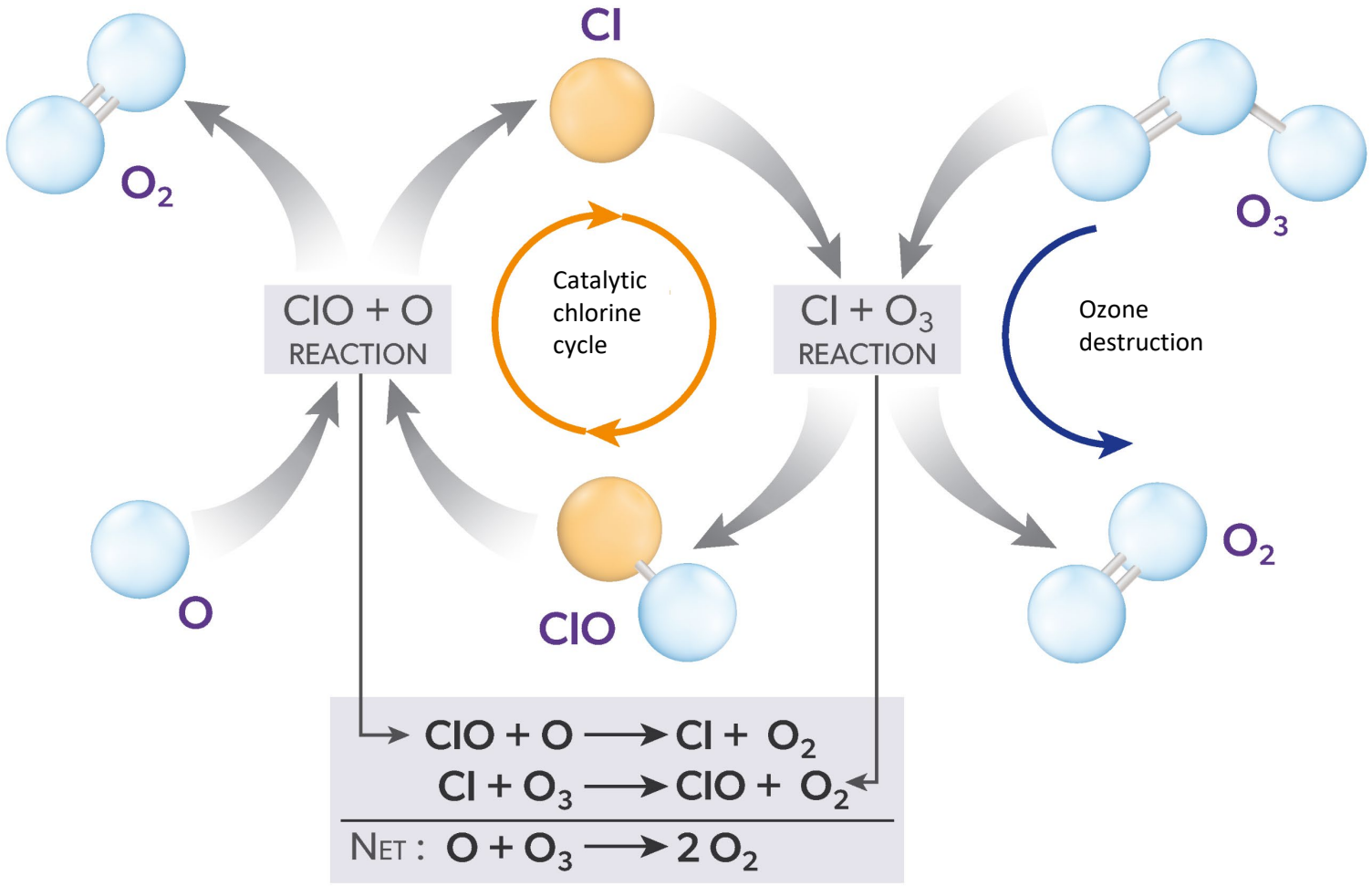
STEP 4

Finally, let's do a quiz to reinforce what we've learned.

(Show Appendix 5 – answers can be found at the end of the appendix)

$3\ O_2$ $2\ O_3$




Cl
O_2
O_3
ClO + O
REACTION
Catalytic
chlorine
cycle
Cl + O_3
REACTION
Ozone
destruction
O
ClO
O_2
ClO + O ⟶ Cl + O_2
Cl + O_3 ⟶ ClO + O_2
NET : O + O_3 ⟶ 2 O_2

$$ClO + ClO \rightarrow (ClO)_2$$

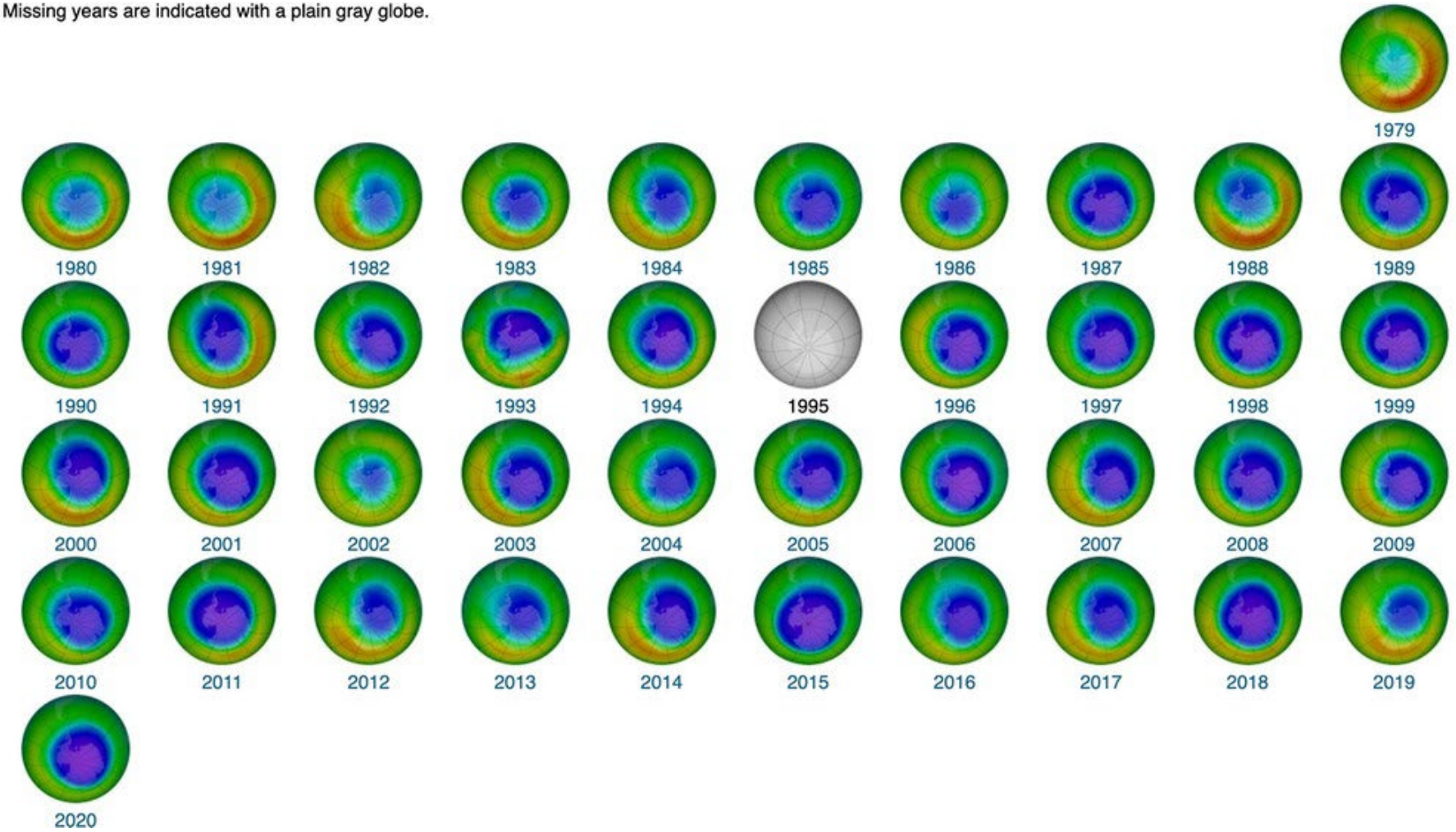
$$(ClO)_2 + \text{Sunlight} \rightarrow ClOO + Cl$$

$$ClOO \rightarrow Cl + O_2$$

$$2(Cl + O_3 \rightarrow ClO + O_2)$$

$$\text{Net: } 2O_3 \rightarrow 3O_2$$

Missing years are indicated with a plain gray globe.



APPENDIX 5

Quiz 1:

Question 1: What is the chemical formula for ozone?

Question 2: In which reaction is ozone formed and where does this take place?

Question 3: What were CFCs mainly used for?

Question 4: What are the properties of CFCs?

Question 5: What reactions are CFCs responsible for in the ozone layer?

Question 6: What role does chlorine play in this?

Question 7: When was the harmful effect of CFCs on the ozone layer first discovered?

Question 8: What is the name of the agreement to restrict CFC emissions?

Question 9: How many countries have ratified the agreement and what is special about it?

Question 10: What are CFCs being replaced with today?

SOLUTIONS TO THE TASKS

Question 1: What is the chemical formula for ozone?

Answer: O_3

Question 2: In which reaction is ozone formed and where does this take place?

Answer: In the stratosphere during photolysis

Question 3: What were CFCs mainly used for?

Answer: As refrigerants, propellants, cleaning agents and in the manufacture of flat screens, solar cells and microcircuits

Question 4: What are the properties of CFCs?

Answer: CFCs are stable, odourless, colourless, non-flammable and often non-toxic.

Question 5: What reactions are CFCs responsible for in the ozone layer?

Answer: Cl + O3 → ClO + O2 and ClO + O → Cl + O2

Question 6: What role does chlorine play in this process?

Answer: Chlorine acts as a catalyst for the depletion of ozone.

Question 7: When was the harmful effect of CFCs on the ozone layer first discovered?

Answer: In 1974

Question 8: What is the name of the agreement to restrict CFC emissions?

Answer: Montreal Protocol on Substances that Deplete the Ozone Layer

Question 9: How many countries have ratified the agreement and what is special about it?

Answer: 198 Parties have ratified the Protocol, and it is the first agreement to be ratified by all member states of the United Nations.

Question 10: What are CFCs replaced with today?

Answer: Propane, butane, pentane and carbon dioxide

SOURCES

- https://www.stmuv.bayern.de/themen/luftreinhaltung/verunreinigungen/ozon/index.htm
- https://www.lfu.bayern.de/buerger/doc/uw_48_ozonschicht_ozonloch.pdf
- https://csl.noaa.gov/assessments/ozone/2022/twentyquestions/
- Image source Appendix 1: https://de.wikipedia.org/wiki/Ozonschicht#/media/Datei:Ozone_from_photolysis_of_O2.svg
- Image source Appendix 2: https://csl.noaa.gov/assessments/ozone/2022/twentyquestions/images/Q8-1.png
- Image source Appendix 3: https://csl.noaa.gov/assessments/ozone/2022/twentyquestions/images/Q8-2.png
- Image source Appendix 4: https://www.ardalpha.de/wissen/environment/climate/ozone-hole-ozone-layer-climate-change-fckw-108~_v-img__16__9__xl_-d31c35f8186ebeb80b0cd843a7c267a0e0c81647.jpg?version=70c6d

Developed by:

Dennis Zacher,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



1.13. TITLE: Biofuels

PROCEDURE:

Steps:	Time
Step 1: What are biofuels and what can they do?	20 min
Step 2: CO_2 e balance and limitations of biofuels	7 min
Step 3: Impact of biofuels on agriculture	8 min
Step 4: Summary	10 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What biofuels are • The carbon footprint of biofuels • Disadvantages of biofuels	• Weigh up the advantages and disadvantages of biofuels • Explain the limitations of biofuels	• The importance of alternatives to fossil fuels • Impact of biofuels on meeting nutritional needs



Number of participants:
min. 5



Materials required:
Laptop, projector



Remarks: -



Planned time: 45 minutes

STEP 1: What are biofuels and what can they do?

1. Question: What are biofuels?

The trainer asks the participants about their knowledge of biofuels.

Answers:

Biofuels are produced either from **starch and sugar for ethanol** production or from **vegetable oils for biodiesel**.

(Show Appendix 1)

Biofuels are derived from **plant material** and are therefore renewable energy sources.

These **renewable fuels** have the great advantage that vehicles with conventional combustion engines can use them as an alternative to petrol or diesel.

First-generation biofuels are those produced from food and feed crops such as maize, cereals, rapeseed, palm oil or soybean oil.

There are **second-generation fuels** produced from by-products, residues, and waste; e.g., sugar from sugar cane and ethanol from the by-product bagasse, or biodiesel from used cooking oil (UCO).

Third-generation fuels, which aim to produce fuels from residues such as straw or sawdust, are still in their infancy.

2. Question: Can every vehicle run on biofuels?

Answer:

As a general rule, you should check with your vehicle manufacturer.

For modern petrol-engined vehicles, ethanol should generally not pose a problem.

However, older generation cars, such as classic cars, may be more susceptible.

Bioethanol is used in E5 and E10 petrol blends at petrol stations. The number indicates the percentage.

Biodiesel is used in B7 diesel blends and as B100 pure biodiesel. Pure biodiesel is mainly used in lorries and machinery.

3. Question: What can biofuels achieve?

Answers:

Regional supply can be achieved through local cultivation and processing.

Savings and even the avoidance of fossil raw materials.

Ideally, waste can be utilised.

4. Question: What steps are required to produce bioethanol?

Raw materials:

Starchy raw materials such as grain are ground. Enzymatic decomposition converts the starch into sugar during liquefaction/saccharification.

Sugar-containing raw materials such as molasses can be fermented directly.

Cellulose-containing raw materials, such as straw, must also be broken down using acids and enzymes.

Steps:

The product of raw material processing is a sugar-containing mash, which is mixed with yeast during fermentation.

This produces an alcoholic mash with an ethanol content of around 12%.

This is purified by distillation/rectification to 94.6% concentration, producing what is known as raw alcohol.

During dehydration, the remaining water content of approximately 5% is removed via adsorption using a molecular sieve.

The end product usually has a purity of over 99.95%.

Depending on the application, other process steps (such as membrane processes, pressure swing adsorption, etc.) may also be used.

(Show Appendix 2 and explain only briefly)

5. Question: What steps are required to produce biodiesel?

Raw materials:

Vegetable oils, often rapeseed, palm or soybean oil

Steps:

Production involves the transesterification of vegetable oil with methanol.

To do this, the vegetable oil is mixed with methanol at a 9:1 ratio.

To speed up the process, 0.5–1% of a catalyst (sodium or potassium hydroxide) is added and the mixture is stirred at temperatures of 50–80 °C for several hours.

The chemical reaction that then takes place breaks down the vegetable oil molecule, which consists of glycerol and three fatty acid chains.

The trivalent alcohol glycerol is exchanged for the monovalent alcohol methanol, so that the fatty acids combine with methanol to form biodiesel.

At the end of the reaction, crude biodiesel and crude glycerol are present in two easily separable phases.

(Show Appendix 3 and only discuss it briefly)

To achieve the desired biodiesel quality, crude biodiesel must undergo several processing steps.

The glycerol produced can be used in the pharmaceutical and food industries after appropriate processing.

STEP 2: carbon footprint and limitations of biofuels

1. Question: What is the carbon footprint and what are the limitations of biofuels?

Answers:

The average greenhouse gas savings of biofuels compared to fossil fuels are approximately 90 per cent. (Germany 2023)

Biodiesel accounts for the largest share of total biofuel use, at approximately 60 per cent. (Germany 2023)

The raw materials used to produce biofuels were 60 per cent waste and residues and 40 per cent cultivated biomass, primarily rapeseed and maize. (Germany 2023)

Since 2023, biofuels from palm oil no longer count towards the greenhouse gas reduction quota. (EU Directive)

Biofuels are also used in power generation.

Overall, this is a cycle in which the materials' carbon footprint is neutral. However, cultivation, production, transport and other associated processes are not CO_2 neutral.

(Show Appendix 4)

Many accompanying processes occur in the same or a similar way in the production of fuels from fossil raw materials, which is why greenhouse gas savings are generally used in comparisons between biofuels and fossil fuels.

As with most aspects of sustainability, reducing the use of all fuels has the greatest positive effect on the climate.

STEP 3: Impact of biofuels on agriculture

1. Question: What impact does the biofuel industry have on agriculture?

The trainer asks the participants about their knowledge of the impact on agriculture.

Answers:

Fundamentally, biofuel production requires large areas of land for crop cultivation. This is especially true compared with other sustainable energy sources (solar, wind power, etc.).

Slash-and-burn clearing of rainforests (for crop cultivation) is extremely harmful to the climate.

Soil health must be considered. Monocultures in fields deteriorate soil quality. Humus loss and desertification can progress. However, this applies generally to cultivation in fields.

Wood is already used extensively for economic purposes (e.g., energy, paper, and building materials). A significant expansion of forest use for the bioeconomy is not possible.

When used as "fuel" crops, the land or the plants themselves are not available to the food industry. With over 2 billion people without reliable access to adequate and sufficient food, this is not a negligible factor. A reduction in feed production in favour of biofuels would be necessary and would have further positive side effects on the carbon footprint.

(Appendix 5 shows that there has been no significant change in land use since 2008).

STEP 4

Finally, let's do a quiz to reinforce what we've learned.

(Show Appendix 6 – answers can be found at the end of the appendix)

These and other plants can be processed into biofuel:



Sugar cane
and others



Corn



Wheat

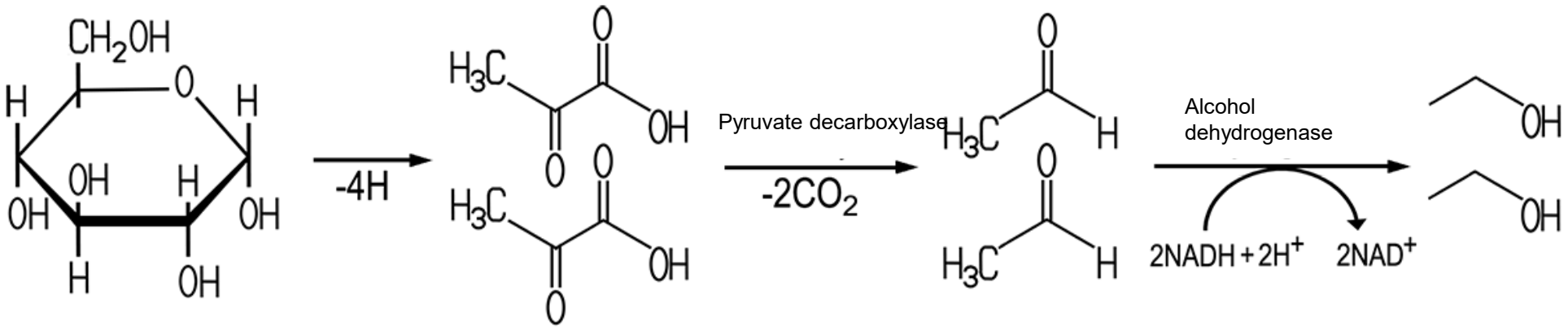


Beets



Soybeans





Glucose

Pyruvic acid

Ethanal

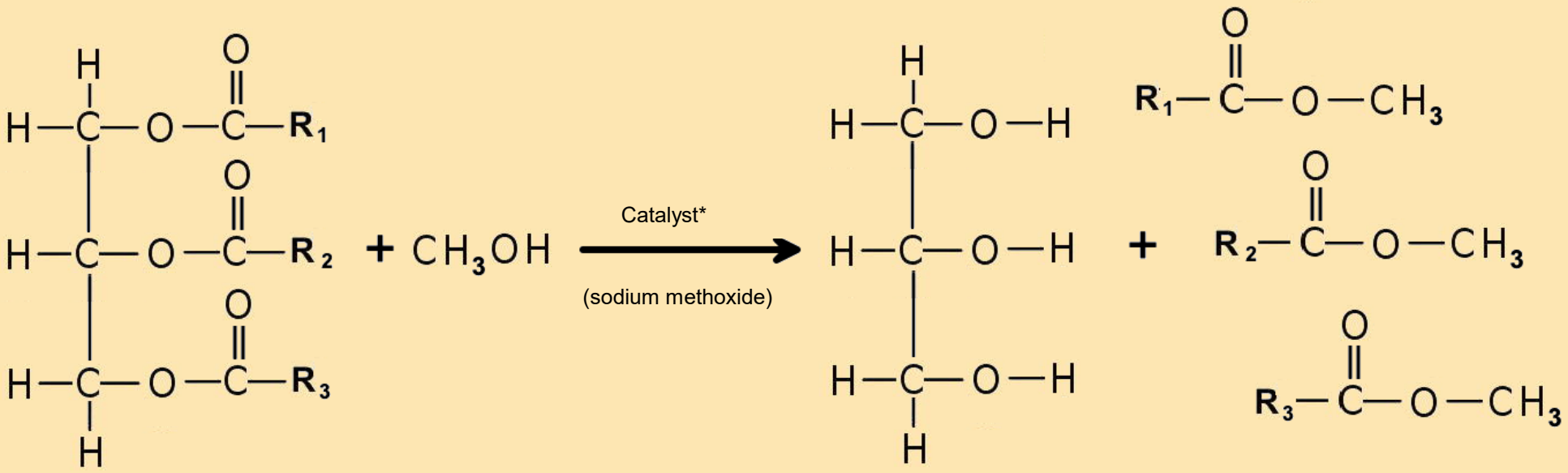
Ethanol

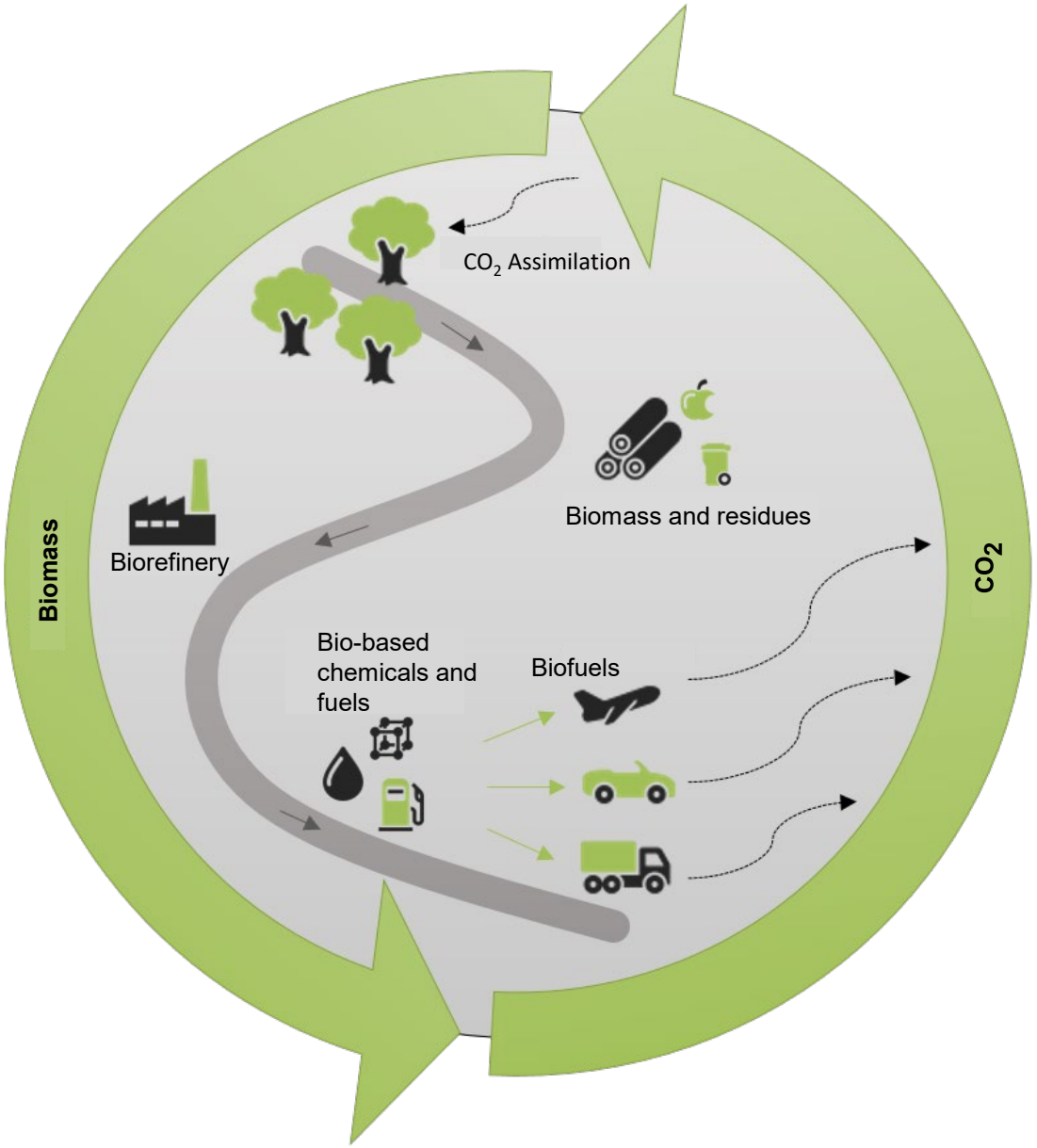
Triglyceride (fatty acid glycerol ester)

Methanol

Glycerine

Biodiesel (fatty acid methyl ester)

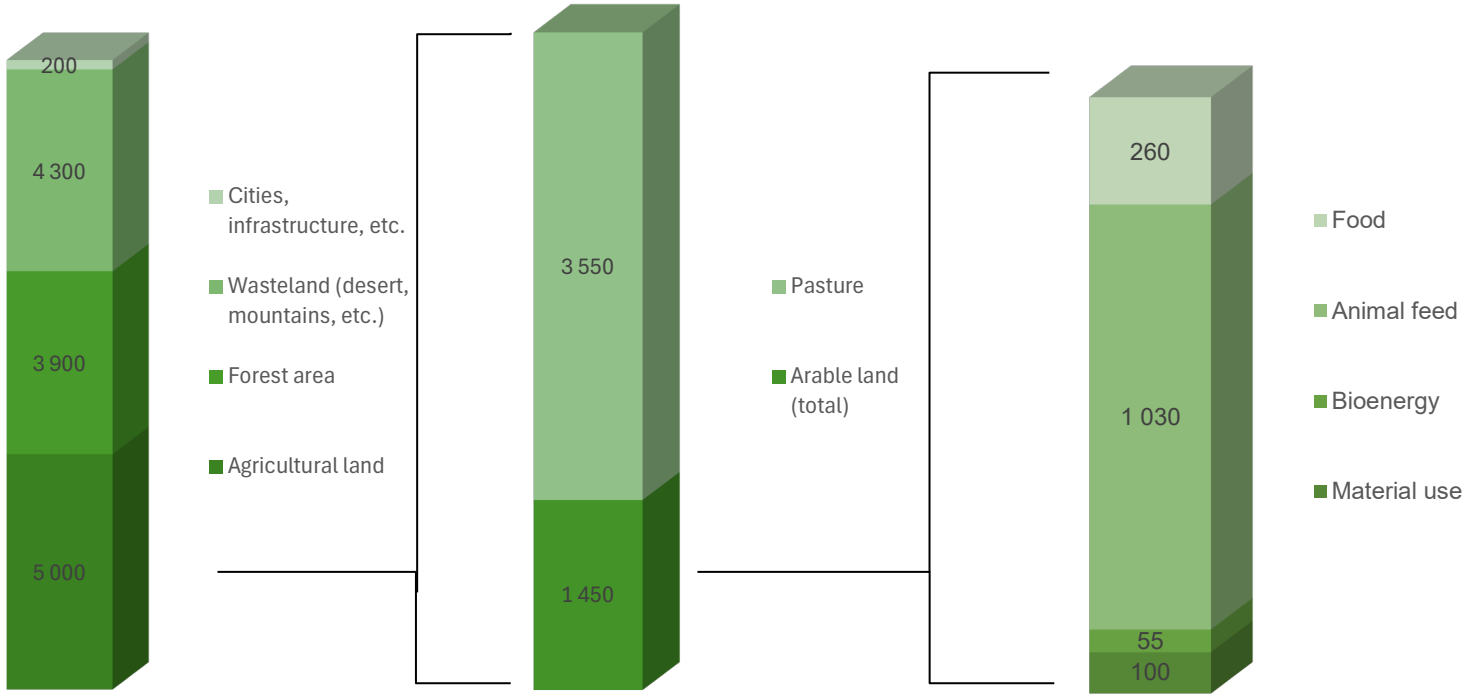



CO_2 Assimilation
Biomass and residues
Biorefinery
Biomass
CO_2
Bio-based chemicals and fuels
Biofuels

Total land area of the Earth 13.4 billion ha

Agricultural land on Earth 5.0 billion ha

Arable land on Earth 1,450 million ha



In million ha

In million ha

In million ha

APPENDIX 6

Quiz 1:

Question 1: What is the origin of the raw materials used in biofuels?

Question 2: What characterises first-generation fuels?

Question 3: What characterises second-generation fuels?

Question 4: What distinguishes third-generation fuels?

Question 5: What should be considered when using biofuels in your own motor vehicle?

Question 6: What is the process behind the production of bioethanol?

Question 7: What is the process behind the production of biodiesel?

Question 8: How much greenhouse gas can biofuels save in direct comparison with fossil fuels?

Question 9: What problem arises in relation to the use of wood as a raw material for bioethanol?

Question 10: What consequences could the expansion of agricultural use for biofuels have on the global food supply?

SOLUTIONS TO THE TASKS

Question 1: What is the origin of the raw materials used to produce biofuels?

Answer: Plant-based

Question 2: What characterises first-generation fuels?

Answer: They are produced from food and feed crops such as maize, cereals, rapeseed, palm oil and soya oil.

Question 3: What characterises second-generation fuels?

Answer: They are produced from by-products, residues and waste (e.g. bagasse – ethanol; used frying oil – biodiesel).

Question 4: What characterises third-generation fuels?

Answer: They are made from residues such as straw or sawdust.

Question 5: What should be considered when using biofuels in your own vehicle?

Answer: First, clarify whether your car is compatible with these fuels.

SOLUTIONS TO THE TASKS

Question 6: What process is involved in the production of bioethanol?

Answer: Fermentation of sugar with yeast/alcoholic fermentation

Question 7: What process is involved in the production of biodiesel?

Answer: Transesterification of vegetable oil with methanol

Question 8: How much greenhouse gas can biofuels save in direct comparison with fossil fuels?

Answer: approximately 90 per cent

Question 9: What problem arises in relation to the use of wood as a raw material for bioethanol?

Answer: Wood is already used intensively for other economic purposes (e.g. for energy, paper, building materials).

Question 10: What consequences could the expansion of agricultural use for biofuels have on the global food supply?

Answer: Reduction in the amount of arable land available for food production, contributing to food shortages

SOURCES

- https://www.ble.de/DE/Themen/Klima-Energie/Nachhaltige-Biomasseherstellung/Informationsmaterial/informationsmaterial_node.html?
- https://utopia.de/ratgeber/biokraftstoffe-sind-sie-wirklich-nachhaltig_282342/
- https://www.wwf.de/themen-projekte/landwirtschaft/bioenergie/biokraftstoffe
- https://www.bdbe.de/bioethanol/bioraffinerie
- https://biokraftstoffe.fnr.de/kraftstoffe/biodiesel
- Image source Appendix 1: https://images.ctfassets.net/uaddx06iwzdz/6qbXtgYGMePWnr7Rz0wMJ9/27068b68406e48987ab62ad3f2b14a45/pflanzen_fuer_biokraftstoff.svg
- Image source Appendix 2: https://www.seilnacht.com/Lexikon/agaerung.gif
- Image source Appendix 3: https://grafs-bio-seiten.de/wp-content/uploads/2022/08/Biodiesel-Umesterung_katalytisch.png
- Image source Appendix 4: https://www.oxfa.eu/maerkte/
- Image source Appendix 5: https://www.umweltbundesamt.de/sites/default/files/medien/479/publikationen/globale_landflaechen_biomasse_bf_klein.pdf

Developed by:

Christopher Peschel,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



1.14. TITLE: Technical oils in the metal workshop

PROCEDURE:

Steps:	Time
Step 1: Basics of technical oils	10 min
Step 2: Types of cooling lubricants and their advantages/disadvantages	15 min
Step 3: Minimum quantity lubrication	15 min
Step 4: Summary	5 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What technical oils are • What alternatives there are to mineral oils • What minimum quantity lubrication is	• Name the properties of technical oils • Compare the advantages and disadvantages of different types of technical oils	• How to reduce mineral oil consumption in the metal workshop



Number of participants:
Min. 5



Materials required:
Laptop, projector



Comments: -



planned time: 45 minutes

STEP 1: Basics of technical oils

The term "technical oils" refers to all types of oils used as aids in metalworking.

This includes cooling lubricants/metalworking fluids (MWF), such as lubricating oils, cutting oils and forming lubricants, as well as hydraulic oils, corrosion protection oils, etc.

The selection of the right oil depends on the work being done, the material being processed and the environmental conditions.

What physical properties need to be considered when making a selection?

Expected answers: viscosity, lubricity, temperature dependence, oxidation stability, corrosion protection, flash point and pour point.

Please now assign the following definitions to their respective properties [see Appendix 1].

Of course, economic aspects such as price, durability and the quantity required also have an impact on the selection of the right oil.

Historically, animal fats and vegetable oils were mainly used, but this changed rapidly with the discovery and refining of mineral oil.

Today, there are three main types of oils in use: mineral oils, vegetable oils and synthetic oils.

In many cases, these are used as base oils in combination with various additives to achieve the desired properties.

STEP 2: Types of cooling lubricants and their advantages and disadvantages

We will now take a closer look at these types of oil, starting with the most widely used:

Mineral oils as technical oils/base oils for technical oils.

Mineral oils are base oils derived from crude oil.

They therefore consist of various hydrocarbon compounds (different molecular shapes and sizes).

In addition to these hydrocarbons, they may also contain oxygen, nitrogen, sulphur or organometallic compounds.

Separation and conversion processes are used to adapt the composition to the respective application.

High-quality mineral oils are usually used as base oils, as they result in a longer oil service life and fewer disruptions in the process.

The advantages of mineral oil-based MWF are:

- Low price
- Wide range of applications under "average" environmental conditions
- Good compatibility with seals and metals

The disadvantages are:

- Lower ageing resistance than synthetic oils
- Environmental impact during production and disposal
- Limited performance under extreme conditions

STEP 2: Types of cooling lubricants and their advantages and disadvantages

The second major type of cooling lubricants uses synthetic oils as base oils.

These are often produced from the residues of atmospheric distillation during petroleum processing.

The most common synthetic oils are polyolefins, alkylbenzenes, polyglycols, carboxylic acid esters and polyol esters.

These are either mixed with mineral oils or used as fully synthetic oils.

While mineral oils are usually produced on the basis of saturated hydrocarbons, synthetic oils are often produced from unsaturated hydrocarbons.

The process of producing these unsaturated hydrocarbons is known as "cracking".

This is followed by further separation of the substances and then synthesis, during which the synthetic base oils are built up step by step.

However, this more complicated process means that additives are often not required for synthetic oils, as the oil is already produced with the desired properties during manufacture.

.

The advantages of synthetic oils as MWF are:

- Better properties in more extreme environments (lower evaporation loss, higher flash point)
- Enables longer service life of the machine tool → less frequent replacement
- Smaller quantities can often be used

The disadvantages:

- More complicated manufacturing → higher energy requirements for production
- More expensive than mineral oils

STEP 2: Types of cooling lubricants and their advantages and disadvantages

The last type of MWF to be considered is vegetable oils, which are used in the production of bio-lubricants.

The vegetable oils most commonly used in the production of biosimilars are: rapeseed oil (largest share in Germany/Europe), sunflower oil, soybean oil (largest market share in North America), palm oil and castor oil.

These can be used as bio-lubricants in their native form or as synthetic esters.

The EU standard EN 16807 specifies the following four criteria:

Renewable: they must be produced from at least 25% renewable raw materials

Rapidly biodegradable: they must be more than 60% biodegradable (according to OECD 301)

Not harmful to the environment: they must not be classified as harmful to the environment (OECD 201/202/203)

Suitable for use: they must be suitable for the specified application

STEP 2: Types of cooling lubricants and their advantages and disadvantages

The advantages of bio-lubricants are:

- Biodegradable when disposed of
- Correspondingly low environmental impact in the event of spillage (accidents)
- Good lubrication at "normal" temperatures
- Low toxicity

The disadvantages are:

- Less durable/effective than synthetic oils, especially under more extreme conditions
- Often more expensive than conventional lubricants
- Special components are sometimes required that are compatible with the oil

STEP 3: Minimum quantity lubrication

In addition to the use of alternative cooling lubricants, there is another option for sustainable action:

Although minimum quantity lubrication requires the conversion of most conventional machines or the purchase of special machine tools, it enables much more economical consumption of cooling lubricants.

Compared to conventional flood lubrication, minimum quantity lubrication consumes only approx. 5 to 50 ml of cooling lubricant per process hour.

This has not only ecological but also economic advantages, as cooling lubricants account for between 8% and 16% of production costs in conventional cooling lubricant systems.

MQL enables virtually dry workpieces/chips in production, which reduces the cost of cleaning the workpieces and makes it easier to recycle the dry chips.

Losses due to evaporation and entrainment are also greatly reduced, as is the risk to employees from MWF emissions in the air they breathe or on their skin.

MQL can basically be carried out in two different ways:

1. From the outside: as an aerosol with compressed air or droplets

2. As an internal lubricant supply: through internal channels in the tool spindle and the tool [see Appendix 2]

Both types of MQL have their own advantages and disadvantages [see Appendix 3].

STEP 3: Minimum quantity lubrication

However, not all cutting processes can be carried out using minimum quantity lubrication.

While processes such as milling, turning or drilling can be carried out without any problems, grinding and honing, for example, are not yet feasible.

The choice of material also plays an important role. Cast materials containing graphite are particularly suitable, but non-ferrous metals such as aluminium can also be machined using minimum quantity lubrication.

For steel materials, there is a limit of approximately 800 N/mm² in terms of strength. Free-cutting or heat-treated steel can therefore be machined without any problems using minimum quantity lubrication.

STEP 4: Summary

After this presentation, the trainer can point out that there are alternatives to the use of mineral oils in metal workshops.

The right choice of an alternative to mineral oil-based technical oils must always take into account the material, the environmental conditions, the machine tool and the process, but this choice can lead to a more economical, more ecological and less hazardous solution for employees.

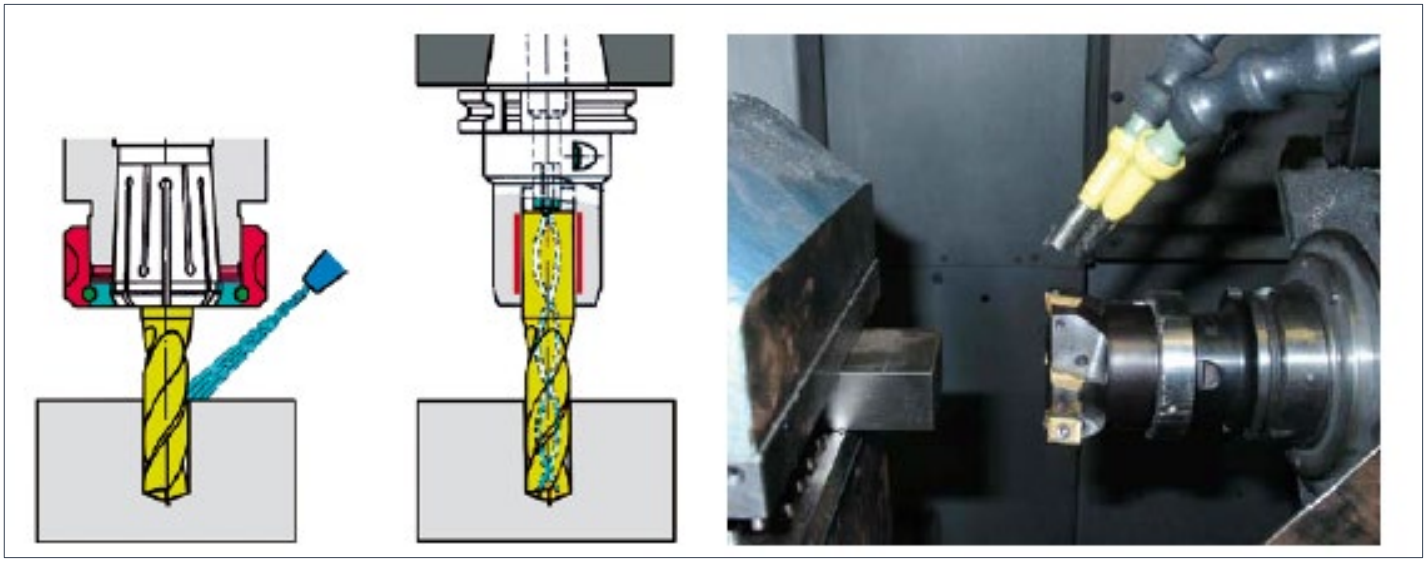
Furthermore, minimum quantity lubrication, for example, is a resource-saving alternative in many metal workshops and can be considered by companies.

Discussion: Have you already had experience with the processes or alternative oil types mentioned here? Can you imagine implementing changes in your workshop?

APPENDIX 1

Match the properties of technical oils with their definitions:

- "How the viscosity of an oil changes with temperature."
- "A measure of how thick an oil is and how much it resists flowing."
- "The lowest temperature at which a liquid produces vapours that can ignite."
- "The ability of an oil to reduce friction between two surfaces."
- "How resistant an oil is to reacting with oxygen, which can cause its properties to deteriorate."
- "The lowest temperature at which an oil can still flow."
- "The ability of an oil to protect metals from corrosion."



External supply

Internal supply

External supply system

External supply for minimum quantity lubrication

Advantages	Disadvantages
• Easy adaptation • Low investment costs • Low retrofitting costs for conventional machine tools • No special tools required	• Limited adjustment options for the nozzles due to differences in the tools • Possible shadowing effects of the spray jet during machining • Possible spray jet dispersion losses

Internal supply for minimum quantity lubrication

Advantages	Disadvantages
• Optimal lubrication of the contact point (every tool, even in hard-to-reach machining areas) • No dispersion or spray losses • Lubricant quantity can be optimised for each tool	• Special tools required • High investment costs • Suitability of the machine is a prerequisite

SOLUTIONS TO THE TASKS

Solutions to Appendix 1:

Temperature dependence

Viscosity

Flash point

Lubricity

Oxidation stability

Pour point

Corrosion protection

SOURCES

- https://kluthe.com/magazin/synthetische-schmierstoffe/
- https://www.dguv.de/ifa/praxishilfen/kuehlschmierstoffe/kuehlschmierstoff/zusammensetzung/index.jsp
- https://kluthe.com/magazin/synthetikoele-als-basis-fuer-schmierstoffe/
- https://www.schmierstoff-zentrale.de/blog/unterschied-zwischen-mineraloel-und-synthetikoel
- https://www.dguv.de/ifa/praxishilfen/kuehlschmierstoffe/lexikon/minimalmengenschmierung/index.jsp
- https://www.dguv.de/ifa/praxishilfen/kuehlschmierstoffe/lexikon/mineraloele/index.jsp
- https://www.dguv.de/ifa/praxishilfen/kuehlschmierstoffe/lexikon/pflanzenoele/index.jsp
- https://www.dguv.de/ifa/praxishilfen/kuehlschmierstoffe/lexikon/synthetische-oele/index.jsp
- https://industrie.de/technik/vdi-zre-legt-vergleichsstudie-zu-kuehlschmierstoffen-vor/
- https://bioschmierstoffe.fnr.de/

- Image source Appendix 2: DGUV Information 209-024 "Minimum quantity lubrication in machining, November 2010

Developed by:

Dennis Zacher,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



1.15. TOPIC: 3D printing as a manufacturing technology

PROCEDURE:

Steps	Time
Step 1: Introduction to sustainability and 3D printing	10 min
Step 2: Advantages of 3D printing from a sustainability perspective	15 min
Step 3: Comparison of conventional manufacturing methods and 3D printing	10 min
Step 4: Practical application in everyday training	10 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• The role of 3D printing in sustainable manufacturing • How 3D printing can be used in mechatronics training	• Name examples of 3D printing processes • Compare the advantages and disadvantages of different types of 3D printing processes	• How they can contribute to reducing material consumption and emissions through the use of 3D printing processes



Number of participants:
Min. 5



Materials required:
Laptop, projector



Comments: -



Planned time: 45 min

Introduction to Sustainability and 3D Printing
Sustainability as a Key Topic in Mechatronics Training

Sustainability is playing an increasingly important role in industrial manufacturing and is also an important part of training for mechatronics engineers. In addition to technical and economic aspects, increasing emphasis is being placed on ecological and resource-saving manufacturing methods. Sustainable action includes the efficient use of materials, energy savings, and the reduction of emissions to enable more environmentally friendly production in the long term.

Additive Manufacturing as a Resource-Saving Alternative

3D printing, also known as additive manufacturing, is a sustainable alternative to traditional manufacturing processes. Instead of removing material by milling or drilling, the workpiece is built up layer by layer. This not only reduces material consumption but also enables more targeted manufacturing, minimising waste. In addition, additive manufacturing allows the production of complex geometries that would be difficult or impossible to achieve with conventional methods.

Relevance for Industrial Applications and Education

3D printing is already used in many industries, including mechanical engineering, the automotive industry, and medical technology. In mechatronics training, it provides practical insight into sustainable production methods and promotes innovative solutions. Trainees learn how the use of additive manufacturing can reduce both costs and environmental impact.

Advantages of 3D printing for sustainability

Reduction of material waste through layer-by-layer application

Unlike traditional subtractive manufacturing methods, where material is removed by milling or drilling, 3D printing is additive. This means that material is only applied where it is actually needed. As a result, there is hardly any waste, which significantly reduces material consumption and disposal costs.

Use of recycled materials for filaments and plastics

Many 3D printers now use recycled materials, especially for plastic filaments. Old plastic waste can be processed into new printing materials, reducing the need for new raw materials. This contributes to the circular economy and reduces the ecological footprint of production.

Advantages of 3D printing for sustainability

Energy-efficient production through precise manufacturing

3D printing often requires less energy than conventional manufacturing methods, especially when it comes to small series or prototypes. Since the material is used in a targeted manner, less energy-intensive post-processing is required, which reduces overall energy consumption. In addition, components can be designed more efficiently, which further optimises material and energy use.

Reduction of transport and storage costs through decentralized manufacturing

Since 3D printers can be used close to where they are needed, there is no need for long transport routes. Companies can manufacture spare parts or tools directly on site instead of importing them from distant production facilities. This not only saves transport costs but also reduces the CO_2 emissions associated with transport. In addition, fewer components need to be kept in stock, as they can be printed as needed, saving storage space and resources.

Comparison of conventional manufacturing methods with 3D printing

Milling & drilling: Material is removed, with high amounts of waste

[See Appendices 1 and 2] In these subtractive manufacturing methods, material is removed from a solid workpiece to achieve the desired shape. This produces a large amount of waste in the form of chips and dust. In addition, this process often requires the use of cooling lubricants to reduce friction and heat, which introduces additional environmental impacts.

Casting: High energy consumption, complex shaping required

[See Appendix 3] Casting is an energy-intensive process, as the material (usually metal or plastic) is heated to high temperatures and poured into a mould. In addition to the high energy consumption, the tools and moulds are often only reusable to a limited extent. Material losses are also considerable due to the necessary casting runners and gates. In addition, the production of metal castings often generates harmful emissions.

Comparison of conventional manufacturing methods with 3D printing

3D printing: Material is only used where it is needed

In contrast to the above-mentioned processes, 3D printing applies material in a targeted manner and layer by layer. This results in minimal material loss, as no chips or excess material need to be disposed of. Energy consumption can be significantly reduced compared to casting processes, as no high temperatures are required. In addition, complex geometries can be created in a single step, eliminating assembly steps and saving further resources.

Case study: Manufacturing a housing for a control unit

A housing for a control unit can be milled, cast, or manufactured using 3D printing. While milling causes significant material loss and casting requires energy-intensive mould production, 3D printing can create the housing directly in the desired shape with minimal material consumption and low energy consumption. In addition, 3D printing allows for quick design adjustments without the need to produce new moulds or tools.

Practical application in everyday training

Designing a component in a CAD program

The first step in the 3D printing process is the digital design of the component using a CAD (computer-aided design) program. Here, trainees learn to take sustainable design principles into account, such as minimising material consumption through optimised geometries or integrating cavities to reduce weight. Digital planning also allows the design to be quickly adapted without incurring additional material costs.

Selecting sustainable materials for 3D printing

The choice of materials is crucial for the sustainability of 3D printing. Various environmentally friendly materials are available, including biodegradable plastics such as PLA (polylactide), recycled filaments, and even bio-based polymers. Trainees learn which materials are suitable for specific applications and what environmental benefits they offer.

Practical application in everyday training

Printing process and quality control

After design, the component is printed. It is important to optimize the printing process in order to minimize material waste. Trainees learn the importance of printing parameters, including layer height, printing speed, and temperature control. After printing, the component is tested to ensure that it meets the necessary mechanical and functional requirements. This can be done through visual inspections or stress tests.

Analysis of savings compared to conventional processes

An essential part of the training is evaluating savings compared to conventional manufacturing processes. Trainees analyze how much material has been saved by 3D printing compared to milling or casting. In addition, the energy consumption of additive manufacturing is compared with that of traditional methods to highlight its environmental benefits.

Practical application in everyday training

Example: Production of a connecting element for a control system using 3D printing. Trainees compare material usage, waste quantities, and production times between conventional manufacturing and additive manufacturing. It becomes clear that 3D printing not only saves material and energy but also significantly reduces development time. [See Appendices 4 and 5]

Discussion and reflection

What are the advantages of 3D printing?

Flexibility and customization: 3D printing enables the production of complex geometries and individual designs that would often be impossible or difficult to achieve using conventional manufacturing methods.

This is particularly advantageous for the production of prototypes, one-off items, or small series that require a high degree of customization.

Cost efficiency: When manufacturing small series or individual products, 3D printing can be more cost-effective than conventional manufacturing processes, as no expensive tools or molds are required.

In addition, 3D printing reduces material consumption, as only the material required for the component is used.

Decentralized production: 3D printing enables decentralized production of components, which reduces transport costs and delivery times.

This is particularly advantageous for remote areas or for the production of spare parts on site.

Innovative materials and techniques: 3D printing enables the use of a wide variety of materials. [Show Appendix 6]

New techniques are constantly emerging, enabling its use in more and more areas.

Discussion and reflection

What challenges does 3D printing pose?

Material limitations: Although the variety of 3D printing materials is constantly increasing, not all materials are yet suitable for 3D printing.

The mechanical properties of 3D-printed components can vary depending on the material and process used.

Speed and scalability: Compared to conventional manufacturing processes, 3D printing is often slower, especially when producing large quantities.

Scaling production can therefore be a challenge.

Quality and precision: The quality and precision of 3D-printed components can vary depending on the process and material.

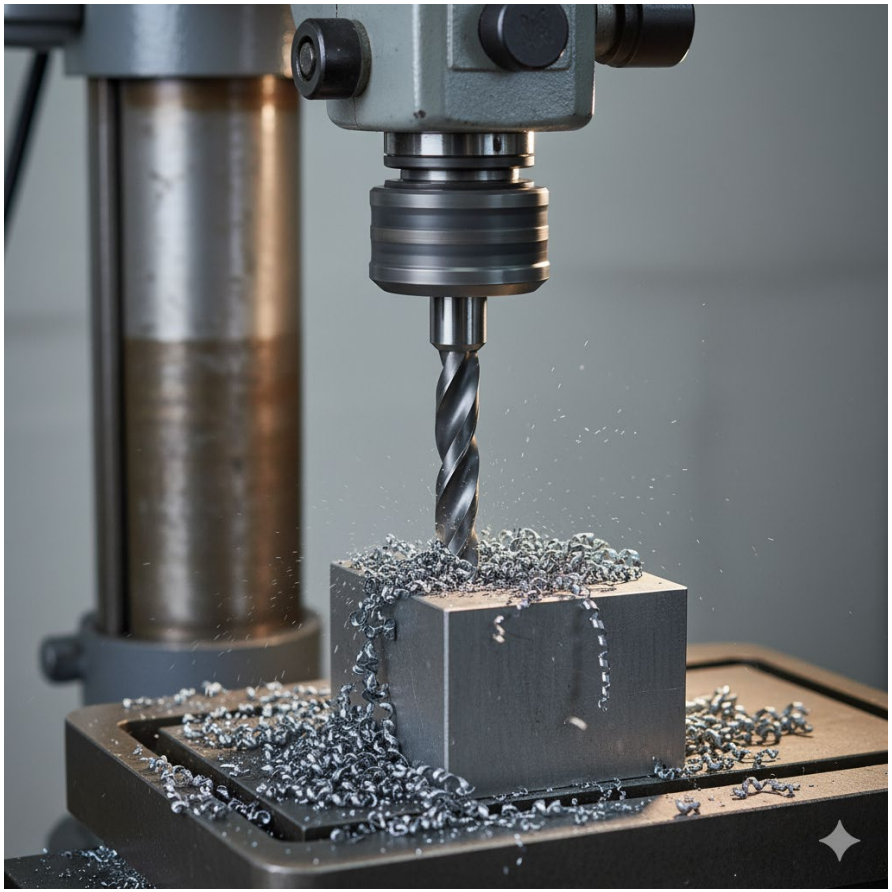
Post-processing steps may be necessary to achieve the desired surface finish and accuracy.

Cost of high-quality equipment: High-quality 3D printers for industrial applications can be expensive to purchase.

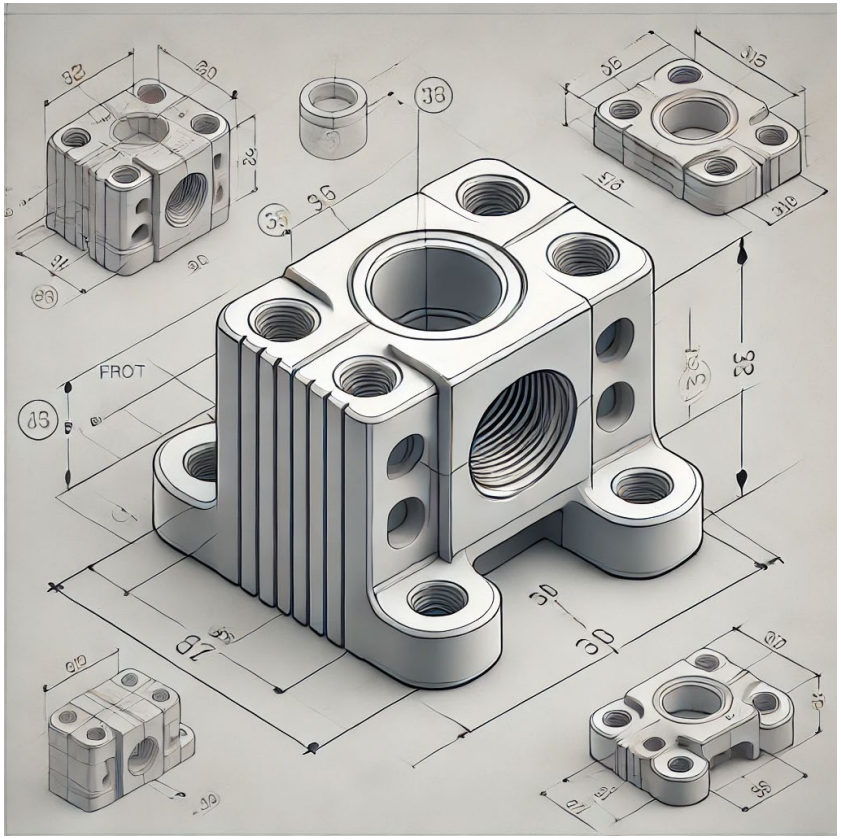
Skills shortage: Qualified specialists are needed to operate 3D printers and make optimal use of the technology.

3D printing has the potential to revolutionize the manufacturing industry, but it also presents challenges that need to be overcome.








FROT



Licensor: Marco Verch
Title: High-tech 3D printer with modern LED lighting in the laboratory
ID on ccnull.de: 1094163



Licensor: Marco Verch
Title: Close-up of a 3D printer at work with luminous plastic in a modern laboratory
ID on ccnull.de: 1100832

SOURCES

- Training framework plan for female mechatronics engineers
- Industry reports on sustainable manufacturing with 3D printing
- Manufacturer information on environmentally friendly 3D printing materials
- https://ccnull.de/foto/hightech-3d-drucker-mit-moderner-led-beleuchtung-im-labor/1094163
- https://ccnull.de/foto/nahaufnahme-eines-3d-druckers-bei-der-arbeit-mit-leuchtendem-kunststoff-in-modernem-labor/1100832
- https://cdn.canadianmetalworking.com/a/high-efficiency-milling-speed-changes-rules-1515082257.jpg?size=1000x1000
- Drilling: generated with Google Gemini
- Kritzolina - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=140413802

Developed by:

Matthias Hirschmann,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



Sustainable Vocational Education and Training.

Lesson Plans for Students

Co-funded by the European Union



2.1. TOPIC: Alternative methods of using wood of reduced quality.

LESSON OUTLINE:

Steps	Time
Step 1: Introduction to the topic, raising the issue of carbon dioxide accumulation.	10 min.
Step 2: Working in groups.	17 min.
Step 3: Discussion of ideas presented by students, presentation of the current use of wood of reduced quality in wood processing	18 min.



Number of participants: any



Materials: Projector or multimedia screen, internet access (for students to use)



Time: 45 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• Which assortments in forest production have the lowest utility value in terms of quality? • For what purposes are the lowest quality assortments used in wood processing?	• seek alternative solutions, take a broader view of the possibilities for using wood raw material despite its low quality • be critical of the methods of using the lowest quality wood that prevail in wood processing	• the possibility of using the lowest quality assortments in a way that allows for the longest possible accumulation of carbon dioxide, as well as the maximum use of wood raw material in ways other than for fuel or pulp and paper production

STEP 1: Introduction to the topic, raising the issue of carbon dioxide accumulation.

The teacher introduces the topic of the lesson to the students and discusses with them the importance of diversified development in relation to the use of wood raw materials in forest management, as well as the problem of carbon dioxide accumulation in nature (Appendix 1, p. 1). They discuss what qualitative and dimensional classification is, i.e. the standard used to collect timber in a systematic manner within a given country (Appendix 1, p. 2). They present the lowest quality assortments in the qualitative and dimensional classification applicable in Poland. The teacher tells the pupils about the modifications that have been made to the classification over the years in order to adapt the standards to the needs of the environment and the economy. The teacher then presents the factors that influence the assessment of individual assortments (Appendix 1, pp. 3, 4, 5) and presents the most popular uses of lower quality assortments (fuel, pellet processing, pulp and paper industry).

STEP 2: Working in groups.

In the next step, students are divided into teams of 3–4 (Appendix 2, p. 1), and their task is to come up with as many ways as possible to use the listed assortments in an alternative way (other than fuel) that ensures the longest possible accumulation of carbon dioxide, the best economic return, and the least amount of waste during production. The students come up with as many examples as possible of how to use both S2AP wood (short wood) and WDP wood (long wood/logs). The students work in groups, using their own creativity and external resources (using their mobile phones). The students present their solutions to the class, and together with the teacher, they consider the usefulness of the ideas presented. The number of examples devised and the best use of the raw material are assessed.

STEP 3: Discussion of ideas presented by students, presentation of the current use of wood of reduced quality in wood processing

The students remain in the teams formed in the previous step. The teacher shows the next slide of the presentation (Appendix 3, p. 1), which presents data collected from wood processing companies on other uses of low-quality wood than those mentioned at the beginning of the lesson. Together, they check how many of the solutions proposed by the pupils have already been implemented in the forestry industry. The teacher summarises the lesson by emphasising how important and, unfortunately, still not very popular it is to use the lowest quality assortments for purposes other than fuel.

SUSTAINABLE DEVELOPMENT



Appendix 1 Introduction to the topic, raising the issue of carbon dioxide accumulation.

SUSTAINABLE DEVELOPMENT ACCORDING TO THE PRINCIPLES OF FOREST USE

„ Nowadays, forests are managed with care for the richness of fauna and flora, based on a rational compromise between the demand for various forest products and the natural processes occurring in forest communities. The principles and ideas of semi-natural forest management and protection, aimed at maintaining and strengthening the natural diversity of the forest ecosystem, require extensive knowledge, but also intuition in the management of each forest stand. In changing natural conditions, the adopted cultivation and protection objectives are achieved through forest use, which allows for the maintenance of the proper sanitary condition of the forest, improves its spatial and age structure, and, as a result, ensures the sustainability of the forest and the continuity of its multifunctional role for future generations. In changing environmental conditions, the sustainability of forests can be maintained by taking into account the natural processes observed in nature when managing forest resources.

CARBON DIOXIDE ACCUMULATION

Forests in Poland absorb approximately 40 million tonnes of CO_2 annually and have stored over 1 billion tonnes of carbon to date. Wood consists of approximately 50% carbon. Trees absorb the most carbon dioxide from the atmosphere during their growth phase; the older the tree, the less CO_2 it absorbs, and old trees eventually die, decompose and begin to release CO_2 back into the atmosphere, which is why it is so important to manage timber resources rationally, ensuring that the growth phases of the forest stand are balanced. Using timber in ways that do not involve combustion or natural decomposition ensures that carbon is accumulated in the product, e.g. in boards or paper.

Appendix 2 Introduction to the topic, raising the issue of carbon dioxide accumulation.

KJW – quality and dimensional classification, i.e. technical conditions applicable to the trade in wood raw materials within a given country. A set of appendices aimed at organising the rules related to the division, terminology and symbols used in timber trading, the rules for preparing and performing measurements, determining timber defects and the rules for classifying raw materials according to the above.

On 1 July 1993, the first Polish standard based on the principles of quality and dimensional classification was introduced to replace the classification of wood raw materials by intended use. Since then, this classification has been systematically improved and modified in line with current economic and environmental needs.

The lowest quality assortments intended for sale to companies (we also distinguish the S4 assortment intended for retail sale) in the current version are large-size (long) WDP wood and medium-size (stackable) S2AP. These assortments were introduced successively on 17 April 2012 (S2AP) and 30 September 2019 (WDP). These assortments were created as a result of an analysis of the timber market's needs and the maximisation of the use of harvested raw materials

WDP – large-size hardwood of reduced quality (out-of-grade**) from all types of hardwood trees, which due to its quality characteristics cannot be classified as grade A, B, C or D or as special wood assortments, but which can be used for industrial applications.**



S2AP – Medium timber for general purposes.



S2AP – medium-sized general purpose stacked timber

Dimensional requirements	
acceptable range of nominal lengths [m]	1.00 - 3.00
standard lengths [m]	1,20; 1,80; 2,40; 2,50
log taper [cm]	10
deviation [cm]	+/-5
min. upper diameter (dg) without bark [cm]	5
max. lower diameter (dd) without bark [cm]	not limited

Quality requirements	
unilateral curvature	12 cm/1
multilateral curvature	equal to half the curvature on one side
colouring	permissible
rot	permissible, soft rot: maximum 50% of cross-sectional area.
signs of insect presence	permissible
presence of foreign bodies	unacceptable visible
charring	unacceptable

WDP – large-size hardwood of reduced quality (non-standard) from all types of hardwood trees, which due to its quality characteristics cannot be classified as grade A, B, C or D or as special wood assortments, but which can be used for industrial applications.

Dimensional requirements	
smallest top diameter without bark [cm]	14
length [m]	2,5 to 14
Quality requirements	
single-sided curvature	permissible
multilateral curvature	permissible
hard rot	permissible
soft rot	permissible; soft rot: maximum 40% of cross-sectional area.
colouring	permissible
presence of foreign bodies	permissible

Explanation of requirements:

lower diameter – diameter of the thicker end of the piece of wood

upper diameter – diameter of the thinner end of the piece of wood

curvature – the defect is specified in centimetres per metre (cm/m) or as a percentage of the deflection **in relation to the diameter**

colour changes – blue stain (a) and brown stain (b)

a)



nsec

b)



o a d

c)



rot – symptoms of wood decay caused by fungi, resulting in a change in colour and, in advanced stages, also in structure (hard rot – does not change the structure of the wood; soft rot – causes the decomposition of wood cells and affects the structure). Rot can occur in wood in various ways:

scattered rot



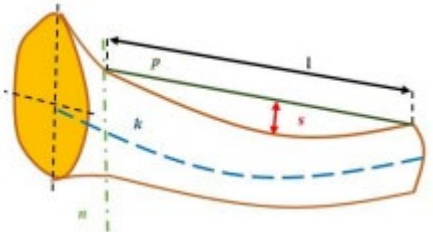
internal rot



external rot



Unilateral curvature



Multilateral curvature



presence of foreign bodies



charring



APPENDIX 2 Working in groups.

Task for group work:1. Using your own creativity and online sources, come up with as many examples as possible of how to use the lowest quality wood (S2AP, WDP) in a way that: allows carbon dioxide to be accumulated for as long as possible, generates the highest profit from sales for the manufacturing company,allows maximum use of the raw material in a way that minimises waste.

Assortment used	The proposed product	Projected length of carbon dioxide accumulation	Projected product sales value [PLN]	Forecasted use of wood raw material [%]

Assessment of correct execution

Creativity, way of thinking, relevance of proposed solutions, applicability in the real world, and other students' reactions to the proposed solutions should be assessed.

APPENDIX 3 Discussion of ideas presented by students, presentation of the current use of non-classroom wood in wood processing.

According to data obtained from companies purchasing S2AP and WDP assortments, apart from fuel, the raw material is also processed into:

- Pallets / Euro pallets
- Crates for securing transported items
- Formwork boards (securing concrete screeds)
- Squared timber
- Tables and countertops filled with epoxy resin
- Fences, wooden garden furniture, garden boxes
- Crayons



















ŹRÓDŁA

•Rules for Forest Use, Appendix No. 1 to DGLP Order No. 66 of November 7, 2019.
•Z. Malinowski, M. Wieruszewski, “Changes in the standardization of large-size pine wood in the post-war history of the State Forest Enterprise,” Sylwan 161 (4): 287−294, 2017.

- https://drewno.zilp.lasy.gov.pl/drewno/Normy/zarzadzenie_nr_33-s2ap.pdf
- https://siedlce.warszawa.lasy.gov.pl/aktualnosci/-/asset_publisher/t9xJ/content/rola-lasow-w-pochlanianiu-i-magazynowaniu-wegla-z-atmosfery
- https://drewno.zilp.lasy.gov.pl/drewno/Normy/zarzadzenie_nr_51_z_30_wrzesnia_2019_r._w_sprawie_warunkow_technicznych.pdf
- https://drewno.zilp.lasy.gov.pl/drewno/Normy/1._podzia_terminologia_i_symbole_-_ujednolicono_wg_zarz_54-2020.pdf
- https://drewno.zilp.lasy.gov.pl/drewno/Normy/3._wady_drewna_-_ujednolicono_wg_zarz_54-2020.pdf
- https://drewno.zilp.lasy.gov.pl/drewno/Normy/9._drewno_sredniowymiarowe_-_ujednolicono_wg_zarz_54-2020.pdf
- https://drewno.zilp.lasy.gov.pl/drewno/Normy/11._drewno_pozaklasowe.pdf
- https://sklep.kampol-logistyka.pl/paleta-1200x800-mm-nowa-paleta-5-deskowa-lekka
- https://www.rotomshop.pl/paleta-euro-epal-1200x800x144mm-sku11852htkd.html#gallery
- https://opakowaniaeksportowe.pl/opakowania-transportowe/skrzynie-transportowe/skrzynie-drewniane/
- https://www.leroymerlin.pl/produkty/skrzynka-ogrodowa-32x14-cm-drewniana-tajemniczy-ogrod-45894765.html
- https://bergatelier.pl/produkt/stolik-olbia-99/
- https://drewnianeklimaty.pl/produkt/stolik-z-zywica-epoksydowa/
- https://drewnobalcer.pl/kat/kantowki-i-legary/
- https://ogrodosfera.pl/plot-sztachetowy-1000-x-2000
- https://hurtowniaopalu.pl/strona-glowna/31-deski-szalunkowe.html?gQT=1
- https://www.lumagadzety.pl/akcesoria-biurowe-z-logo/13222-kredki-drewniane-4-szt-ma-1112801.html#consentok
- https://firmylesne.pl/tag/id3734/
- https://www.drewno.pl/artykuly/11447,drewno-klasy-wdp-oficjalnie-wprowadzone-do-zasad-sprzedazy-lasow-panstwowych.html

Information on the processing of reduced-quality wood was obtained with the help of the Milicz Forest District.

Opracowane przez:

Agnieszka Krzywda, Technikum Leśne w Miliczu

Co-funded by the European Union



2.2. TOPIC: Sustainable methods of shaping tree stand structure.

PROCEDURE:

Steps	Time
Step 1: Introduction to the issue of sustainable development in relation to forest management. Discuss the issue of forest management as a field concerned with shaping the forest landscape.	16 min.
Step 2: Presentation of the structure of forest stands, discussion of the sequence of felling and treatments.	17 min
Step 3: Practical exercises	12 min



Number of participants: does not matter



Planned time: 45 min



Materials needed: Projector or multimedia screen, students' personal phones for calculations or simple calculators

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• how forests are managed in Poland • what solutions have been introduced to deal with pine monocultures in a way that allows for sustainable development	• how to manage solid coniferous stands • calculate the length of a forest stand • the volume of timber harvested in a single cutting cycle in a given forest stand	• the need for careful planning of timber harvesting in order to maintain continuity of production

Click to see movie

STEP 1: Introduction to the issue of sustainable development in relation to forest management. Raising the issue of forest management as a field concerned with shaping the forest landscape.

The teacher introduces the concept of 'sustainable development' (Appendix 1, p. 1) to the students in the context of forest management, and then presents the topic of the lesson, which will be sustainable methods of shaping the tree stand structure.

The teacher talks about the need to organise timber harvesting activities (Appendix 1, p. 2), their scale and intensity, in a way that allows for the sustainability of the forest stand. They present the issue of pine monoculture management and a brief history of its origins, pointing out that pine monoculture is completely natural in Polish climatic conditions, and that the problem lies in the similar age of a significant part of the tree stands established in the post-war period.

STEP 2: Presentation of the structure of forest stands, discussion of the order of felling and treatments.

In the next step, the teacher shows a short film illustrating the structure of the forest management system (Appendix 2, p. 1) and then, using the example of a graphic (Appendix 2, p. 2), explains the reasons for this particular order of work, discusses the order of felling (Appendix 2, p. 3), and the calculation methods used to calculate individual parameters using formulas (Appendix 2, p. 4) and tables of stand density and growth (Appendix 2, p. 5).

STEP 3: Practical exercises.

The students are divided into pairs, and the teacher discusses the task to be performed (Appendix 3, p. 1). The students perform the calculations. The teacher checks the correctness of the calculations (Appendix 3, p. 2).

SUSTAINABLE DEVELOPMENT

in relation to the forest management plan

In accordance with the Forest Act of 21 January 2000,

Sustainable forest management is carried out in accordance with a forest management plan (state forests, with the exception of national parks) or a simplified forest management plan (non-state forests).

The purpose and task of forest management are:

To organise forest management in terms of space and time in all its areas (use, cultivation, protection, improvement, infrastructure and recreation) in a manner that meets the requirements of sustainable and multifunctional forest management.

APPENDIX 1

In order to reconcile timber harvesting with the preservation of the stability of pine monocultures, it is necessary to shape the structure of tree stands in such a way that the removal of trees from the area as part of clear-cutting does not adversely affect neighbouring tree stands.

A pine monoculture is defined as a stand in which Scots pine constitutes all or the vast majority of the species composition. Such plant formations may occur naturally or have an anthropogenic origin (resulting from artificial regeneration and afforestation). Pine is a species that prefers relatively poor, acidic (low pH) habitats, most often formed on sandy soils. Such conditions can be found in many places in our country, but pine monocultures are also often found in habitats that deviate from this pattern, which means that these stands have been artificially introduced by humans in these places.

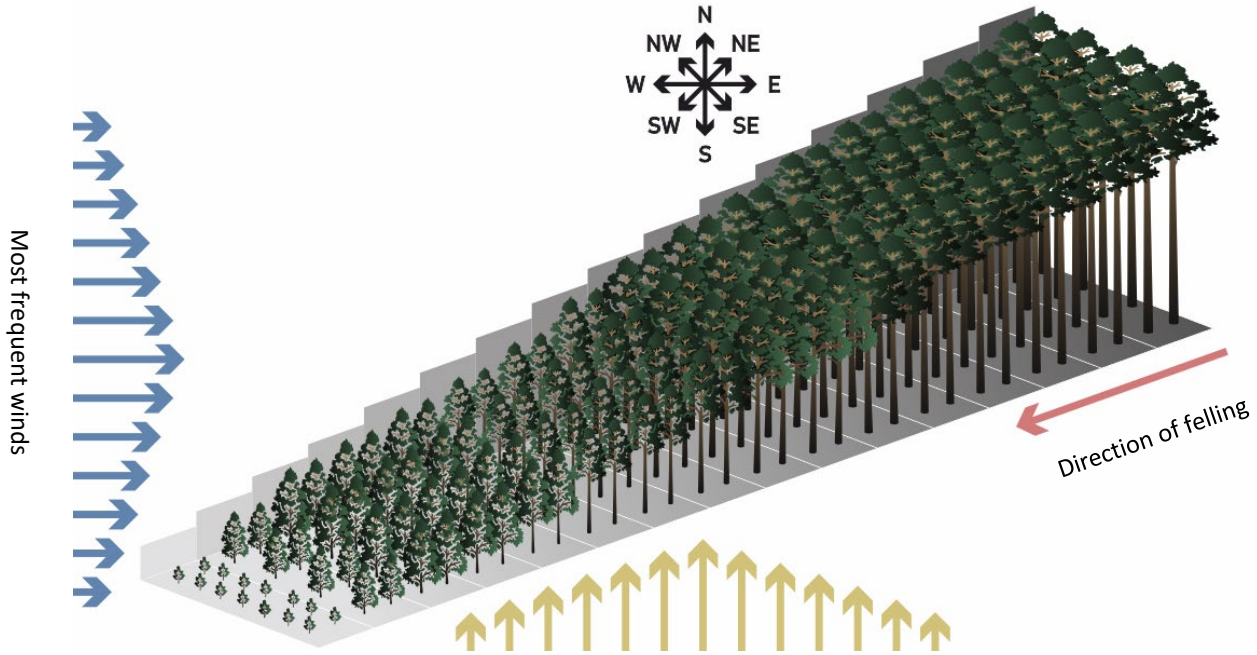
The main reason for the large number of pine monocultures in Poland was the need for rapid regeneration or afforestation of areas that had undergone large-scale deforestation as a result of war damage and often irrational, even predatory, forest management during the period of partition. At that time, the main species introduced into such areas was Scots pine, due to the high availability of planting material, the ease of seedling production, the possibility of introducing one-year-old seedlings, and the low trophic requirements and rapid growth rate of the species, ensuring high crop yields and, in the long term, rapid growth of tree stands. The stands created in this way covered large areas, resulting in large expanses of solid pine stands of similar age. Management of such stands is very difficult, as pine is a highly light-demanding species, which necessitates clear-cutting to allow the younger generation to grow properly. However, creating larger open spaces in older, single-age stands may expose them to significant damage from winds, to which pine is very sensitive.

Modern forest management deals with this problem in two ways. Where pine trees have been introduced into habitats that are too fertile and better suited to other species, forest stands are being restructured with the aim of gradually changing the species composition by reducing the proportion of pine trees or removing them completely and introducing species that fully exploit the potential of the habitat, which also meets the requirements of sustainable development. However, where pine stands grow in habitats suitable for them, it is not necessary to change the species composition, but rather the spatial and age structure of the stands, so that the forest complexes consist of stands of different ages (from the youngest to the oldest) occupying similar areas and appropriately located in relation to each other, which ensures their continuity and stability. This is precisely how we refer to the correct formation of pine monocultures as a backcountry system.



Click to see movie

Cutting system – a series of tree stands of a specific width, arranged in such a way that each subsequent stand differs from the previous one in age, and this difference is equal to the time needed to complete a complete cut and renew the stand, which is called a cutting cycle. In addition to ensuring sustainability through the constant presence of stands of all age classes in the forest, this system also ensures the stability of the stands by creating conditions in which younger generations protect older trees from the destructive effects of wind and at the same time have access to light, which promotes their proper growth while protecting the older generation from excessive sunlight on their trunks. In order for these conditions to be met, taking into account that the most frequent winds in Poland blow from the west and the strongest sunlight in our hemisphere comes from the south, the stands in the forest form a characteristic stepped structure in which the youngest stands are located on the south-west side and the strips of increasingly older stands progress towards the north-east.



Each forest stand is characterised by three parameters:

1. Cutting cycle (n) – the period between cutting and regeneration on a single strip of forest stand, expressed in years.

2. Cutting area width (s) – determines the width of the stand strip at a given age, expressed in metres.

3. Felling cycle (k) – corresponds in the forest compartment system to the felling age, i.e. the number of years that must elapse from regeneration to the moment of felling the stand.

The animation presents the changes occurring in the forest over the entire cutting cycle, showing the successive rounds of cutting in the stands and their regeneration, as well as the gradual transition of the stands to subsequent stages of development over time.



APPENDIX 2

Knowing the aforementioned parameters of the forest stand:

1. Cutting cycle (n) [years]

2. Width of the felling plot (s) [m]

3. Felling sequence (k) [years]

The following can be calculated:

1. The number of successive strips of tree stands comprising the forest stand, differing in age by the amount of the established cutting rotation:

"N = k / n [units]"

2. The total length of the forest stand:

"L = N × s [m]"

3. Additionally, knowing the length of the felling plot (l [m]), we can use tabular data on abundance (V1ha [m^3/ha]) to calculate the approximate volume of timber that can be harvested in a single felling cycle.

"s × l / 10,000 [ha] × V1ha [m^3/ha]"

APPENDIX 2 – Tables of tree stand density and growth by Szymkiewicz – excerpt

PINE — **Table A – more intensive maintenance measures** — **PINE**

Age	Main stand: Mean height	Mean diameter at breast height	number of stems	Basal area	Form factor: Coarse wood	Form factor: Whole tre	volume per hectare: Coarse wood	volume per hectare: Small wood	volume per hectare: Coarse and small	Secondary stand: volume per hectare: Coarse wood	volume per hectare: Small wood	volume per hectare: Coarse and small	thinning yield: Coarse wood	thinning yield: Coarse and small	Total production: Coarse wood	Total production: Coarse and small	including thinning yield: Coarse wood	including thinning yield: Coarse and small	Average annual increment of total volume: Coarse wood	Average annual increment of total volume: Coarse and small	Current annual increment of total volume: Coarse wood		Current annual increment of total volume: Coarse and small		Age
years	m	cm	pcs	m^3	0.			m^3		m^3			m^3		m^3		%		m^3		m^3	%	m^3	%	years
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Habitat assessment class I																									
20	7.8	-	-	-	-	-	63	107	170	-	-	-	-	-	63	170	-	-	-	-	-	-	-	-	20
25	10.0	8.7	4380	26.0	424	800	110	98	208	5	7	12	5	12	115	220	4.3	5.4	4.6	8.8	-	-	-	-	25
30	12.0	11.1	2880	27.9	460	708	154	83	237	11	8	19	16	31	170	268	9.4	11.5	5.7	8.9	11.1	10.1	10.0	4.8	30
35	13.9	13.5	2080	29.3	471	648	192	70	262	20	10	30	36	61	228	323	15.8	18.9	6.5	9.2	11.5	7.5	11.2	4.7	35
40	15.7	15.9	1570	30.5	474	603	227	62	289	23	9	32	59	93	286	382	20.6	24.3	7.2	9.5	11.5	6.0	11.8	4.5	40
45	17.4	18.2	1194	31.4	469	574	256	57	313	24	8	32	83	125	339	438	24.5	28.5	7.5	9.7	10.9	4.8	11.5	4.0	45
50	18.9	20.3	998	32.1	465	553	282	53	335	24	7	31	107	156	389	491	27.5	32.8	7.8	9.8	10.3	4.0	11.0	3.5	50
55	20.3	22.1	851	32.6	462	539	306	51	357	25	5	30	132	186	438	543	30.1	34.3	8.0	9.9	9.7	3.4	10.5	3.1	55
60	21.6	23.8	739	33.0	461	529	328	49	377	25	4	29	157	215	485	592	32.4	36.3	8.1	9.9	9.2	3.0	9.9	2.8	60
65	22.7	25.4	652	33.3	460	521	347	47	394	25	4	29	182	244	529	638	34.4	38.2	8.1	9.8	8.7	2.7	9.2	2.4	65
70	23.7	27.0	583	33.5	459	515	363	46	409	25	3	28	207	272	570	681	36.3	39.9	8.1	9.7	8.3	2.4	8.6	2.2	70
75	24.6	28.5	527	33.6	458	511	378	44	422	25	3	28	232	300	610	722	38.0	41.5	8.1	9.6	7.9	2.2	8.2	2.0	75
80	25.4	29.9	480	33.7	457	507	391	43	424	25	3	28	257	328	648	762	39.5	43.0	8.1	9.5	7.6	2.0	7.8	1.9	80
85	26.1	31.3	439	33.8	456	505	403	42	445	24	3	27	281	355	684	800	41.0	44.4	8.0	9.4	7.3	1.9	7.4	1.7	85
90	26.8	32.7	403	33.9	455	502	413	42	455	24	3	27	305	382	718	837	42.4	45.6	8.0	9.3	6.9	1.7	7.1	1.6	90
95	27.4	34.1	371	33.9	454	499	422	41	463	24	3	27	329	409	751	872	43.7	46.9	7.9	9.2	6.6	1.6	6.8	1.5	95
100	28.0	35.4	342	33.8	453	497	429	41	470	24	3	27	353	436	782	906	45.1	48.1	7.8	9.1	6.3	1.5	6.5	1.4	100
105	28.6	36.7	317	33.7	452	495	435	41	476	24	3	27	377	463	812	939	46.3	49.3	7.7	8.9	6.0	1.4	6.2	1.3	105
110	29.1	37.9	296	33.6	451	492	441	40	481	24	2	26	401	489	842	970	47.6	50.4	7.6	8.8	5.7	1.3	5.9	1.2	110
115	29.6	39.0	279	33.5	451	491	447	39	486	23	2	25	424	514	871	1000	48.6	51.4	7.6	8.7	5.4	1.2	5.6	1.2	115
120	30.1	40.0	265	33.3	451	490	452	39	491	22	2	24	426	538	898	1029	49.6	52.3	7.5	8.6	5.0	1.1	5.2	1.1	120
125	30.5	40.8	253	33.1	450	489	455	38	493	21	2	23	467	561	922	1054	50.6	53.2	7.4	8.4	4.6	1.0	4.8	1.0	125
130	30.9	41.6	242	32.9	450	488	457	37	494	20	2	22	487	583	944	1077	51.6	54.1	7.3	8.3	4.3	0.9	4.5	0.9	130
135	31.2	42.4	232	32.7	450	487	458	36	494	18	2	20	505	603	963	1097	52.4	54.9	7.1	8.1	3.8	0.9	4.3	0.8	135
140	31.5	43.1	223	32.4	449	486	458	36	494	16	2	18	521	621	979	1115	53.2	55.7	7.0	7.9	3.3	0.8	4.0	0.7	140

APPENDIX 3

Task to be completed

For the given parameters of the forest stand, calculate:

a) the number of consecutive strips of forest stands comprising the forest stand (N)

b) the length of the forest stand (L)

c) the approximate volume of timber that can be harvested in a single felling cycle

Data for calculations:

n = 5 years,

s = 60 metres,

l = 650 metres,

R = 80 years.

The table on the right contains an extract of data on stand density from the Tables of Stand Density and Growth.

Age of the forest stand	Stocking (V_{1ha})
[years]	[m^3 /ha]
50	282
55	306
60	328
65	347
70	363
75	378
80	391
85	403
90	413
95	422
100	429

APPENDIX 3

Solution:

For the given parameters of the forest stand, calculate:

a) N = 80 / 5; N = 16 pcs.

b) L = 16 * 60; L = 960 m

c) 60 * 650 / 10,000 = 3.9 ha * 391 = 1,524.9 m^3

Age of tree stand	Stocking (V_{1ha})
[years]	[m^3 /ha]
50	282
55	306
60	328
65	347
70	363
75	378
80	391
85	403
90	413
95	422
100	429

SOURCES

- Forest Act of 28 September 1991; Journal of Laws 91 No. 101 item 444 of 8 November 1991, as amended.
- Collective work edited by Prof. B. Ważyński, PhD; Forest Management Guide; Publishing House "Wydawnictwo Świat"; Warsaw 2005
- Order No. 116 of the Director General of State Forests of 14 December 2023 on the introduction of the "Forest Management Instructions" in the State Forest National Forest Holding (ZU.0210.1.2023)
- K. Fronczak, "Towards nature. Sustainable forest management", State Forests Information Centre, Warsaw 2017.
- B. Szymkiewicz, "Tables of tree stand abundance and growth," State Agricultural and Forestry Publishing House; Warsaw 2001.
- Own graphic design

Prepared by:

Agnieszka Krzywda, Forestry Technical College in Milicz

Co-funded by the European Union



2.3. TOPIC: Optimal use of habitat conditions for tree growth.

PROCEDURE:

Steps	Time
Step 1: Introduction to the issue of sustainable development in relation to forest management. Discussion of basic forest habitats and their potential, as well as forest-forming species and their requirements	18 min.
Step 2: Matching species to habitats, proposing optimal species compositions	17 min
Step 3: Practical exercises using photographs of tree cross-sections	10 min



Number of participants: does not matter



Planned time: 45 min



Materials needed: Projector or multimedia screen, box for drawing lots, printed materials, habitat cards for drawing lots

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What basic habitats occur in Poland • What habitat requirements do the basic forest-forming species in Poland have	• How to optimally match a species to habitat conditions, utilising the potential of the habitat without overburdening it	• Diversified use of habitat potential, understanding that one should not be guided by the maximum use of available components, but by their use in a way that ensures the continuity and sustainability of the forest in a given area

STEP 1: Introduction to the issue of sustainable development. Discussion of basic forest habitats and their potential, as well as forest-forming species and their requirements

The teacher introduces the concept of "sustainable development" to the students (Appendix 1, p. 1). Together, they create a definition related to forest management based on their own knowledge and associations, and then familiarise themselves with the definition of sustainable development, which serves as an introduction to the Principles of Forest Management (Appendix 1, p. 2). Referring to the definition they have created, the teacher introduces the topic of the lesson, which is the optimal use of habitat conditions for tree growth.

In the next step, the teacher uses a multimedia presentation to introduce the students to basic forest habitats and their potential, as well as basic forest-forming species and their habitat requirements (Appendix 1, pp. 3–5). The teacher presents the problem of optimally matching species to their habitats and discusses the importance of the sustainable use of habitat potential in order to maintain continuity of production.

STEP 2: Matching species to habitats, proposing optimal species compositions

In the next step, the students are divided into teams of four or five, and their task is to create optimal regeneration for the habitat indicated by the teacher, using the knowledge acquired in the first part of the lesson. The students draw two habitats from a prepared box (Appendix 2) and use the materials prepared by the teacher (printed descriptions of habitats and species (Appendix 1, pp. 3–5)) to complete the task. After completing the task, the students present their proposed solutions to the rest of the class and jointly determine whether this is the optimal solution for the example studied.

STEP 3: Practical exercises using photographs of tree cross-sections

The students remain in the teams formed in the previous step, and the teacher presents the next slide of the presentation, which discusses the conditions that favour or limit tree growth, supplementing the habitat requirements (Appendix 3, p. 1). The teacher discusses the impact of each of these conditions with the students, then displays photos of tree cross-sections (Appendix 3, p. 2), and together they consider the conditions in which the tree grew, thus consolidating the knowledge acquired during the lesson.

SUSTAINABLE DEVELOPMENT



Sustainable Development in Relation to Forest Management

1. In accordance with the provisions of the Act of 28 September 1991 on Forests, the task of forest management is to ensure the sustainability of forests and the continuity of their multifunctional role in the country's spatial development.

2. In a changing natural environment, forest sustainability can be maintained by taking into account the natural processes observed in nature when managing forest resources.

3. When shaping the future image of forests, it is necessary to consider the country's socio-economic development trends, which will affect the natural environment and the expectations of society.

4. Forest management in the 21st century should build on good methods developed in the past, while at the same time being open to innovations that take into account comprehensive knowledge of nature and forests, while respecting economic and social conditions.

Typological Grid of Lowland Habitats

Increasing humidity ↓	Improving fertility →				
	FORESTS	MIXED FORESTS	MIXED FORESTS	FORESTS	RIVERBANK FORESTS
	Bs				
	Bśw	BMśw	LMśw	Lśw	
	Bw	BMw	LMw	Lw	Ł
	Bb	BMb	LMb	Ol	OŁ

Typological Grid of Upland Habitats

Increasing moisture ↓	Improving fertility →			
	MIXED FORESTS	MIXED FORESTS	FORESTS	RIVERBANK FORESTS
	BM	LMwyżśw	Lwyżśw	
	BMhigh	LMhigh	Lhigh	Łwyż
				OŁwyż

Forests – poor habitats on acidic soils forming podzolic soils; the dominant species in the lowlands is So, and in mountainous conditions it is Św; other species, e.g. Db, can only occur as undergrowth.

Mixed Forests – moderately fertile habitats; fresh, clayey-sandy ochre and rust-coloured soils; the dominant species is So, with Db as an admixture in the upper storey; in the mountains, the dominant species is Św, with Bk as an admixture.

Mixed Forests – rich habitats; brown and grey soils; the dominant species are So and Db; Bk may occur as an admixture in the upper storey (within its range); Gb may occur as an admixture in the lower storey; Bk dominates in the mountains and Św is the co-dominant species.

Forests – the most abundant habitats (soils); brown and grey soils, black earth, and lowland peat soils; deciduous forests with Db or Bk as the dominant species (within their natural range) occur, with Gb as an admixture, among others, and Jd and Bk in mountainous areas.

Floodplain Forests – occur in moist and fertile habitats, mainly on river floodplains and deluvial soils; in habitats shaped by surface and groundwater flow with short periods of flooding; Ol, Js, Wz and Db dominate the tree stand.

Pine – dominates throughout the country, mainly in coniferous habitats; requires fresh, deep and airy soils for optimal growth; does not thrive in overly fertile soils (broadleaved habitats); is a very light-demanding species.

Spruce – grows on shallow but moist soils; requires moderately fertile soils; grows less well on dry sands and waterlogged soils; is a shade-tolerant species.

Fir – occurs on fertile, deep, fresh soils; grows poorly on dry, sandy, heavy, waterlogged and marshy soils; grows very well in shade.

Alder – grows well on moist, deep and fertile soils, often along watercourses; tolerates standing water; tolerates shade well when young and becomes a moderately light-demanding species in old age.

Ash – requires fertile, deep, moist or wet soils; is light-demanding and tolerates shade only when young.

Pedunculate Oak – occurs on fresh, deep soils rich in minerals and organic compounds; tolerates soil moisture well; is a light-demanding species (tolerates shade only in early youth).

Beech – grows on humus soils, slightly moist or fresh clayey and clayey-sandy soils; tolerates moderate moisture; does not like permanently waterlogged soils; is one of the most shade-tolerant species.

Hornbeam – requires fresh sandy loam soils rich in humus; avoids acidic, waterlogged, nutrient-poor and dry soils; tolerates periodic flooding; is a very shade-tolerant species.

Birch – a pioneer species; can grow on sandy, dry and moist soils but cannot tolerate proximity to groundwater; is the most light-demanding of all Polish deciduous species.

Elm – requires rich soils; grows well in river valleys and on periodically flooded soils; is a shade-tolerant species.

APPENDIX 2

Task for Group Work:

1. Select species that you consider appropriate for restoring areas located in the indicated habitats, and indicate the main species and admixture species (each group draws two habitat types and creates a proposed tree stand for them):
   a) Dry forest in the lowlands
   b) Fresh mixed forest in the lowlands
   c) Moist forest in the highlands
   d) Fresh mixed forest in the highlands
   e) Riparian forest in the lowlands

Flashcards for group work:

Dry forest in lowlands	Dry coniferous forest in the lowlands	Dry coniferous forest in the lowlands	Dry coniferous forest in the lowlands
Fresh mixed forest in lowlands	Fresh mixed forest in the lowlands	Fresh mixed forest in the lowlands	Fresh mixed forest in the lowlands
Moist forest in the highlands	Moist forest in the highlands	Moist forest in the highlands	Moist forest in the highlands
Fresh mixed forest in the highlands	Fresh mixed forest in the highlands	Fresh mixed forest in the highlands	Fresh mixed forest in the highlands
Riparian forest in the lowlands	Riparian forest in the lowlands	Riparian forest in the lowlands	Riparian forest in the lowlands

SOLUTION TO THE EXAMPLE

a) **Dry Forest in the Lowlands** – main species: So; admixture species: Brz

b) **Fresh Mixed Forest in the Lowlands** – main species: Db So Św / Bk Db So / Św Db / Brz **Św** Db / Brz Db / Bk So / So Db / Brz Św Db / Db So / Brz So; admixture species: So / Brz / Św / Bk / Db / Gb

c) **Moist Forest in the Highlands** – main species: Js Db / Db / Jd Db; admixture species: Wz / Św / Js / Brz / Ol / Db / Jd / Gb

d) **Fresh Mixed Forest in the Highlands** – main species: So / Jd So / Db So; admixture species: Brz / Db / Bk / Jd / Św / Brz / Bk / Jd

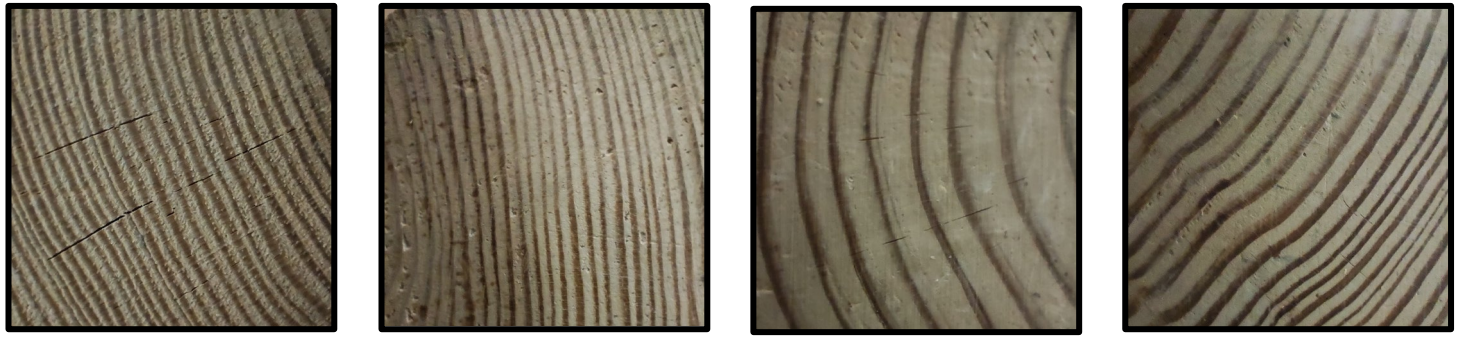
e) **Riparian Forest in the Lowlands** – main species: Js Db; admixture species: Wz / Gb / Ol / Js / Db

	Narrow-leaved	Broad-leaved
Habitat fertility	Poor habitats	Rich habitats
Humidity	Low	High
Living space	Large compact	Loose spacing
Length of growing season	Short period	Long period
Temperature	Low	High

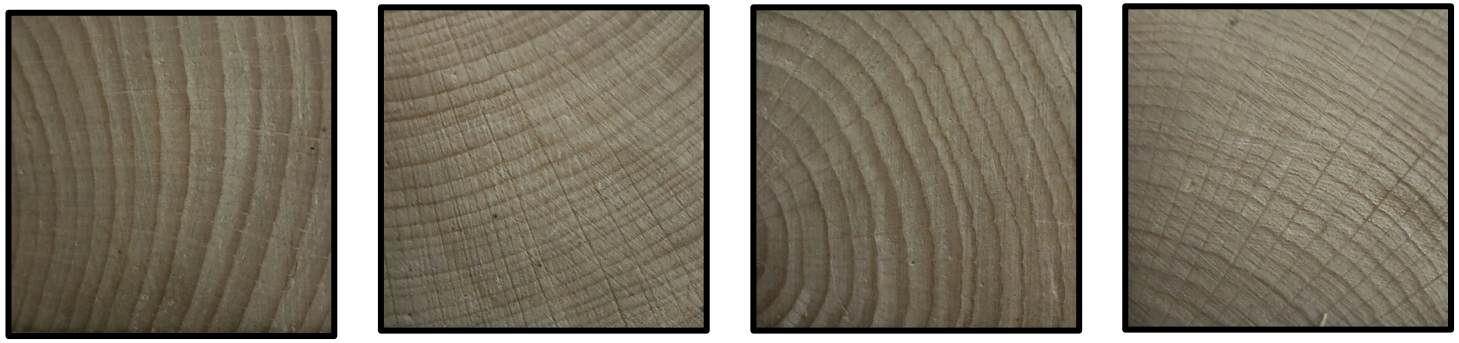
APPENDIX 3

Photographs of cross-sections of selected species for analysis:

Pine:



Hornbeam:



Alder:



SOURCES

- Forest Management Principles, Appendix No. 1 to DGLP Regulation No. 108 of 5 December 2023.
- J. Tomanek, L. Witkowska-Żuk, "Forest Botany," PWRiL, Warsaw 2008.
- T. Puchalski, Z. Prusinkiewicz, "Ecological Foundations of Forest Habitat Science," Państwowe Wydawnictwo Rolnicze i Leśne, Warsaw 1975
- Photos from private archives

Prepared by:

Agnieszka Krzywda, Forestry Technical College in Milicz

Co-funded by the European Union



2.4 TITLE: The effects of disrupted water circulation in the forest during timber harvesting

PROCEDURE:

Steps	Time
Step 1. The natural water cycle and water retention in the forest – exercise with discussion	10 min
Step 2. Damage to the forest caused by tree felling – discussion.	10 min
Step 3. Increased flood risk in mountainous areas – discussion and film.	20 min
Step 4. Summary	5 min

OBJECTIVES:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• How the natural water cycle works in the forest • What human activities can disrupt the natural water cycle in the forest	• Explain the effects of poor forest management on the ecosystem • List the mechanisms behind flooding in mountain forests	• Understands the need to manage forests in a way that respects natural processes within the forest ecosystem



Number of participants: any



Materials required: Projector with speakers, laptop



Notes: -



Estimated time: 45 mins

Click to see movie

STEP 1. Natural water cycle and retention in the forest – exercise

1. The teacher shows the students a diagram of the water cycle in the forest (Appendix 1) and asks them to write down on their sheets of paper which process each number represents. The answer to the task can be found in the table in Appendix 2.

2. The teacher displays the slide from Appendix 3 and reminds the students how natural water retention works in the forest:

- ✓ Tree canopies retain some of the rain on their leaves and branches. The water partly evaporates and partly flows slowly to the forest floor, without hitting the ground with full force.
- ✓ A thick layer of fallen leaves, moss, twigs and humus acts like a natural sponge. It absorbs huge amounts of water and slows down its further flow.
- ✓ Beneath the litter lies a porous soil rich in organic matter. It is criss-crossed by a dense network of roots from trees and smaller plants, which form natural channels. Rainwater does not run off the surface, but slowly seeps into these layers, replenishing groundwater and maintaining moisture in the ecosystem long after rainfall.

This natural system makes the forest an extremely effective retention reservoir, which mitigates sudden floods and prevents drought.

STEP 2. Damage to the forest caused by tree felling

The teacher shows the photos on slide 4 and discusses the consequences of improper felling and skidding (transport) of trees:

- Heavy machinery moving off designated transport routes causes severe **soil compaction**. Compacted soil loses its natural porosity, which drastically reduces its ability to absorb water and aerate. This results in the death of tree roots and prevents the growth of the next generation of the forest.
- During timber harvesting, **the trunks and roots of trees** that are to remain in the forest **are** often **damaged**. Such injuries provide an open invitation to fungi and other pathogens, leading to the weakening and disease of the tree stand. Heavy machinery also destroys the forest floor and undergrowth, which play a key role in water retention and maintaining biodiversity.
- On steep terrain, particularly in the mountains, ruts left by heavy machinery turn into channels through which rainwater flows at high speed. This leads to **soil erosion**, the leaching of the valuable humus layer, and the exposure of barren bedrock.
- Removing all fallen and dead trees deprives the forest of an extremely important element. Dead wood provides a habitat for thousands of species of fungi, insects and microorganisms that are crucial to the proper functioning of the ecosystem. Its removal **impoverishes biodiversity** and disrupts natural material cycles.

STEP 3. Increased flood risk in mountainous areas

1. The teacher discusses the causes of flooding in mountainous areas resulting from improper logging:

- **Reduced** soil **retention**: compacted and damaged soil is unable to absorb large amounts of water. Instead of seeping deep into the ground and replenishing groundwater, rainwater runs off the surface.
- Tree canopies, shrubs and forest litter slow down the flow, allowing water to gradually seep into the ground. **The removal of a large part of the tree stand and the destruction of the lower layers of the forest** eliminate this barrier. Instead of slowly seeping into the soil, the water flows rapidly across the surface, particularly in ruts and artificially created erosion channels.
- Rapid surface runoff from forested areas leads to **a rapid increase in the flow of streams and rivers**. As a result, even after moderately heavy rainfall, water levels in watercourses rise sharply, creating sudden flood waves and flash floods.
- Fast-flowing water in ruts has enormous erosive power. It washes away soil, stones and wood debris, which then end up in streams and rivers. This material (debris) shallows riverbeds, reducing their capacity and leading to easier flooding.

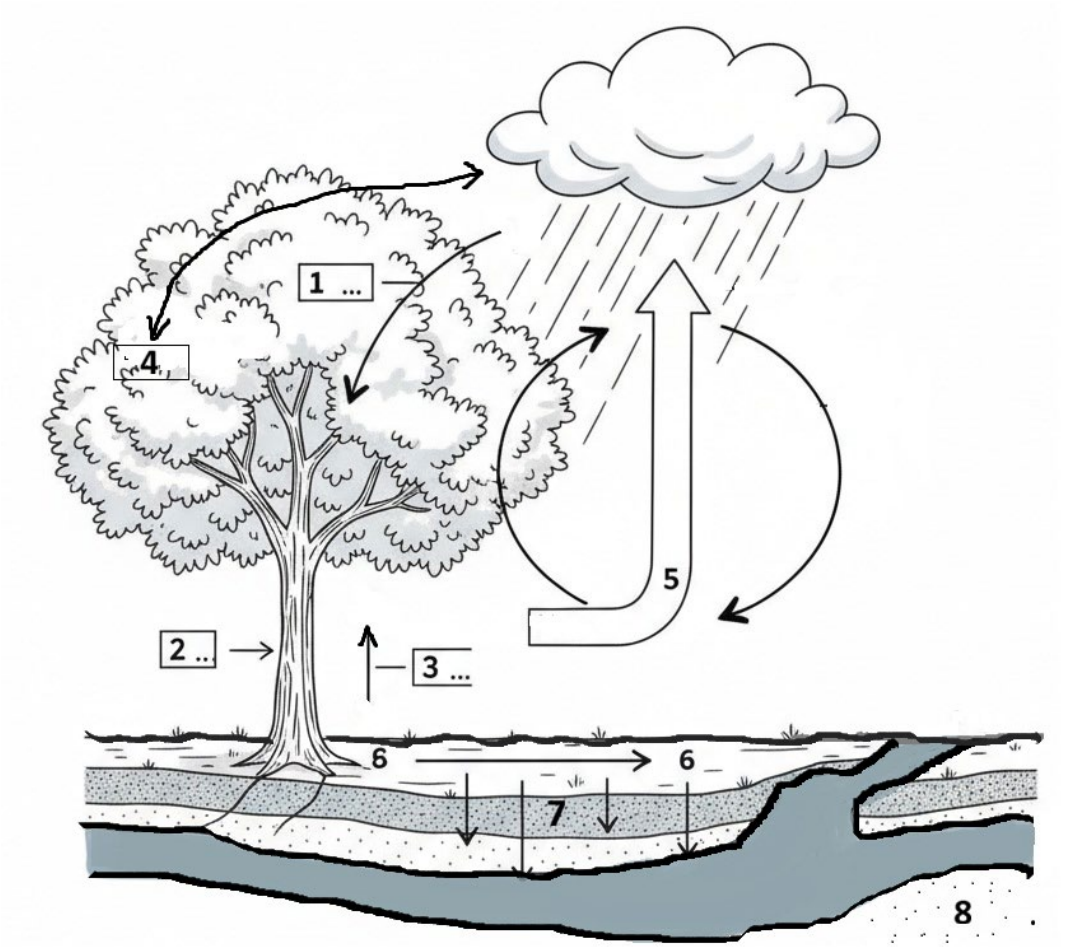
2. The teacher illustrates the topic under discussion: they display photographs of the Kłodzko Valley (Poland) flooded by a mountain flood in September 2024 (Appendix 5) and a video showing the causes and effects of the flood in Poland's Karkonosze Mountains in 2024.

STEP 4. Summary

The teacher asks the students to list at least three negative effects caused by improper timber harvesting in the forest.

Click to see movie

APPENDIX 1 Diagram of the water cycle in nature



APPENDIX 2 Answers to the exercise in Appendix 1

number and name	process
1. precipitation	a product of water vapour condensation that falls to the ground in the form of rain, snow or hail
2. run-off down a tree trunk/run-off	rainwater running down a tree trunk
3. evaporation	the process of water evaporating directly from the soil surface and other water-saturated surfaces, such as water bodies
4. interception / canopy retention transpiration	the retention of rainwater by tree canopies (interception); the water does not reach the ground but accumulates on the surface and then evaporates (transpiration)
5. evapotranspiration	evaporation + transpiration, the combined process of water vapourisation from the soil surface (evaporation) and plants (transpiration), as a result of which moisture from the Earth enters the atmosphere
6. surface runoff	some of the rainwater flows over the ground's surface into a nearby stream
7. infiltration	the penetration of water into the soil
8. groundwater flow	water seeping into the groundwater

APPENDIX 3. Natural water retention in the forest



APPENDIX 4. The consequences of improper timber harvesting in mountain forests









APPENDIX 5. The effects of the floods in the Kłodzko Valley, Poland, in September 2024







SOURCES

- Information gathered in the Karkonosze Mountains in Poland following the floods in September 2024
- The photographs in Appendices 3 and 4 were generated using Gemini AL.
- Photographs in Appendix 5: Jacek Halicki

Compiled by:

Magdalena Mazik-Gorzelańczyk,
FAVEO Foundation

Co-funded by the European Union



2.5 TOPIC: Application of new technologies in forest protection

PROCEDURE:

Steps	Time
Step 1: The greatest current threats to forests – mind map	10 min
Step 2: The use of modern technologies in forest protection – presentation with examples	25 min
Step 3: Negative effects of using new solutions – completing the mind map	10 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• How modern technologies are used in forest protection	• Explain the positive and negative effects of using new technologies in nature conservation	• Opportunities and limitations in civilisational development and nature conservation • The ethical aspects of using modern digital and technological solutions



Number of participants: up to 30 people



Materials needed: Projector, laptop, large sheet of paper, coloured pens



Comments: -

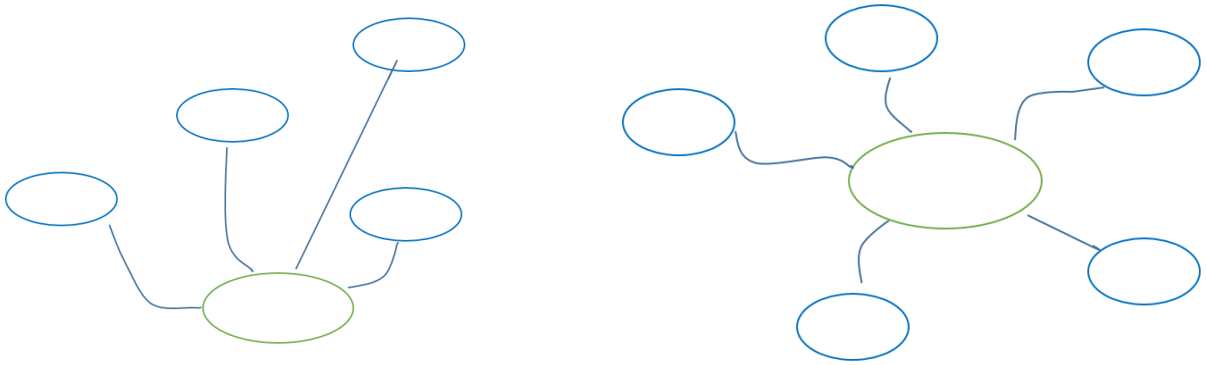


Planned time: 45 min

STEP 1. The greatest current threats to forests – mind map

1. The teacher hangs a large sheet of paper in a visible place or spreads it out on the floor to draw a mind map. They ask the students what they think are the greatest threats to forests and other natural areas at present. Each student who answers writes their answer in keywords on the paper and circles it. This serves as a starting point for further additions to the mind map. Possible answers: fires, droughts, pests, diseases, winds, poachers, illegal logging, litter.

Examples of mind map diagrams:



2. After filling in a few examples, the mind map sheet is set aside. The teacher discusses examples of the use of new technologies in forest protection and illustrates this with photographs (Appendices 1 and 2).

Remote Sensing – Satellites and Laser Scanning

This is the remote acquisition of information about the Earth's surface using sensors placed on flying platforms (satellites, aeroplanes). Satellites regularly scan vast areas.

Advantages of the equipment:

- ✓ A comprehensive and continuous overview of a large area without the need to physically inspect each section
- ✓ Rapid detection and assessment of disasters such as windbreaks, fires, and large pest infestations
- ✓ Assessment of tree health and identification of weakened stands before changes become visible from the ground
- ✓ 3D inventory: aerial laser scanning and the creation of precise digital models of the forest, including the measurement of tree height and biomass

Drones

These are unmanned aerial vehicles equipped with cameras and sensors. They provide high spatial resolution in a shorter time.
Drones allow for:

- ✓ Quick, safe and detailed inspection of hard-to-reach and dangerous places
- ✓ Monitoring of pests and diseases thanks to high-resolution cameras identifying individual trees attacked, for example, by bark beetles or mistletoe
- ✓ Firefighting support, as thermal imaging cameras detect sources of fire and indicate to foresters and firefighters the exact points for intervention, even at night or in smoke
- ✓ Monitoring of areas for illegal logging, littering or poaching (also thanks to night cameras)
- ✓ Rapid inventory, as geometrically corrected aerial photographs and 3D models are used for precise planning

Artificial intelligence (AI)

These are computer systems that can analyse and process huge amounts of data (photographs, measurements, weather data), learn from them, and generate useful information.

The Use of AI in Forest Protection

Automatic diagnostics: AI analyses satellite and drone imagery and can automatically recognise tree species, measure their parameters, and detect early signs of disease or pest infestation with much greater precision than the human eye.

- ✓ Analysis of historical data (weather patterns, pest occurrences) to predict where and when the next pest outbreak or natural disaster is likely to occur, allowing preventive measures to be implemented.
- ✓ Support in search operations: AI filters thermal images from drones, increasing the effectiveness of locating missing persons in dense forests.

Biotechnology Achievements

This involves the use of biological processes to protect forests and increase their resilience.

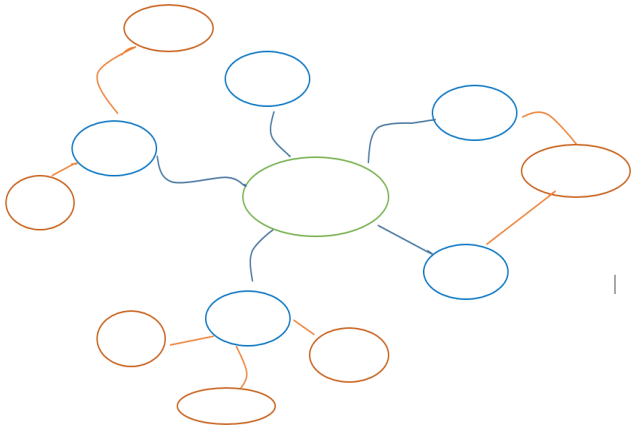
Biotechnology enables activities such as:

- ✓ Biological pest control methods: instead of chemicals, preparations containing entomopathogens (microorganisms pathogenic to insects, e.g. bacteria or fungi) are used for selective pest control.
- ✓ The use of synthetic chemical compounds that mimic insect pheromones. These can be used to set traps to determine pest population levels or to disorient pests (e.g. by introducing large amounts of pheromones into the environment so that pests cannot locate mates and reproduce). Strengthening seedlings through controlled inoculation with mycorrhizal fungi in nurseries to increase their resistance to stress and disease.

STEP 3. Negative effects of using new solutions – completing the mind map

1. The teacher returns to the mind map and asks the pupils to consider which of the technological and scientific achievements discussed could be helpful in combating the threats to the forest that were defined earlier. The pupils add their solutions to the mind map.

An example of a mind map at this stage of the task:



2. The teacher initiates a discussion with the pupils: do the modern solutions identified have side effects? If so, for whom and what are they? The pupils discuss and, if there is space on the sheet of paper, add the threats to the mind map. Example answers: drones can cause stress to animals, especially birds during the breeding season; the sound of drones can disrupt communication between animals; large birds may collide with drones; drones equipped with high-resolution cameras can record people in forest areas and violate their privacy. The completed map can be hung in the classroom for a few days to help students consolidate the new information.

APPENDIX 1 Images of new technologies used in forest protection











ANNEX 2 SAFERS Project

- Forest fires in the European Union are becoming more frequent and intense due to climate change. As part of the EU-funded SAFERS project, an integrated platform has been created that includes a decision support system for forest fires.

- The project uses multiple data sources that are provided in real time – from satellites, observation stations, but also from social media and citizen reports. Artificial intelligence algorithms use this data to detect crisis situations more effectively than humans.

- In 2023, more than 40% of the areas destroyed by fires in the EU were part of Natura 2000, the EU's network for the protection of biodiversity. SAFERS has been tested in Mediterranean countries, where fires are particularly destructive. In Greece, where advanced data analysis has become accessible and practical, it has made it easier for those responsible for rescue operations to make the most optimal decisions.

A film showing how a simple app for citizens to report hazards works in the SAFERS project:
https://www.youtube.com/watch?v=H1Z65AQyHsE

SOURCES

- SAFERS project, https://www.safers-project.eu/index.php/they-tested-safers/greece.html?iccaldate=2024-6-1
- Agronomist portal, https://agronomist.pl/artykuly/powstal-pionierski-system-wspomagania-decyzji-dotyczacych-pozarow-lasow
- Photos in Appendix 1: pixabay.com

Prepared by:

Magdalena Mazik-Gorzelańczyk, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by
the European Union



2.6 TOPIC: The effect of environmental stress on trees

PROCEDURE:

Steps	Czas
Step 1: The concept of abiotic stress	5 min.
Step 2: Causes of abiotic stress	15 min.
Step 3: The reaction of trees to stress factors	15 min.
Sters 4: Exercise	10 min.

Aims:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What is abiotic stress and what causes it?	• Identify the effects of exposing trees to prolonged stress factors • Discuss how plants cope with stress	• The need to limit human-induced environmental changes that affect plants and cause negative effects in them.



Number of participants: any



Materials
Projector, laptop, coloured sheets of paper



Comments -



Time: 45 min

Step 1: The concept of abiotic stress

The teacher shows the students the definition of abiotic stress (Appendix 1) and gives them 5 minutes to read it. Then *they* ask if the concept is clear and answer any questions the *students* may have.

Step 2: Causes of abiotic stress

The teacher displays a slide showing the causes of abiotic stress in plants (Appendix 2) and asks whether the students know of any areas in their environment where such factors may occur.

Step 3: The reaction of trees to stress factors

The teacher shows how trees react to stress factors (Appendix 3). He provides an example of an experiment conducted in Poland between 2008 and 2016: some poplars were planted in uncontaminated soil, while others were planted in soil contaminated with tannery waste. After 8 years, the poplars growing on uncontaminated soil were twice as tall as those growing on the contaminated soil.

Step 4: Exercise

At the end of the class, students complete an exercise individually: based on their existing dendrological knowledge, they are tasked with assigning the indicated tree species to three groups (Appendix 4).

Correct answers:

A. 3, 8

B. 1, 7

C. 2, 4, 5, 6

Abiotic stress is the response of plants to adverse environmental factors originating from the inanimate world.

Unlike biotic stress, which is caused by other organisms (e.g., pests, bacteria, or fungi), abiotic stress results from the physical and chemical conditions prevailing in the environment. It is particularly severe for plants because they cannot escape or change their habitat, forcing them to activate complex defence mechanisms at the cellular level.

In the case of climate change, plants are subjected to chronic stress. They must then adapt their physiology to the long-term adverse environmental conditions affecting them. They do not always succeed and die as a result of chronic stress.

APPENDIX 2 Causes of abiotic stress

Drought – a lack of water in the soil and low air humidity

Salinity – excess salt in the soil, blocking water uptake

Heat – high temperatures that destroy protein structures



Cold injury – tissue damage caused by low temperatures or ice

Flooding – lack of oxygen for the roots (plant suffocation)

Heavy metals (e.g. lead, cadmium, aluminium) – soil toxicity

UV radiation – damage to the photosynthetic apparatus and DNA

Deficiency of nutrients – lack of minerals (nitrogen, phosphorus, magnesium, etc.).

Quick response:

Stomatal closure: under the influence of stress hormones, the plant closes its leaf pores. It may also roll its leaves. This reduces water evaporation, which is crucial during drought or salinity.

Long-term reaction:

Stress proteins: the plant produces special proteins that act as ‘scaffolding’ – they stabilise other proteins and cell membranes, preventing them from being damaged by frost or heat.

Osmoregulation: plants produce so-called osmolytes (e.g. proline, sugars). These compounds *‘concentrate’* the cell sap, allowing the cell to retain water even in saline or dry environments.

A reaction requiring at least several weeks, or even months or years:

Changes in leaves: new leaves may be smaller, thicker, covered with a thicker layer of wax or denser hairs, which provide additional protection from the sun and water loss.

Investing in roots: the plant inhibits leaf and stem growth (to conserve energy) and instead directs resources to the roots, sending them deeper in search of water.

Restricting growth to save energy for adaptation measures.

A. Species growing under low stress intensity but facing biological competition. They are characterised by more efficient resource uptake, rapid growth rates and high phenotypic plasticity (variability in external traits).

B. Species growing under high stress with constant intensity. They are characterised by slow growth rates but a long lifespan, high nutrient retention rates and low phenotypic plasticity.

C. Pioneer species, which are the first to colonise transformed areas. They grow in stressful conditions with a low intensity but a highly variable nature. They grow quickly and complete their life cycle rapidly, producing a large number of seeds. They are often annual plants.

1. Juniper
2. Pine
3. Ash
4. Poplar
5. Birch
6. Aspen
7. Yew
8. Sycamore

ŹRÓDŁA

- A. Szuba, Jak drzewa odpowiadają na stres?, Las Polski, Nr 15-16, 2020.
- Photo in Appendix 2: generated using Gemini AI

Developed by :

Magdalena Mazik-Gorzelańczyk, Fundacja Kształcenia Zawodowego i Międzykulturowego FAVEO

Co-funded by the European Union



2.7 TOPIC: Local communities as stakeholders in sustainable forest management

PROCEDURE:

Steps	Time
Step 1: Mind map	20 min
Step 2: Developing an action strategy	20 min
Step 3: Summary	5 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• that there are different stakeholder groups with specific needs when it comes to forests • the role of foresters in communicating with stakeholders is crucial	• propose solutions to mitigate conflicts of interest between different social groups using the forest	• forests fulfil biological, social and economic functions that must be pursued in parallel, rather than mutually exclusive



Number of participants: any



Materials needed: Projector, laptop, flipchart paper, coloured markers



Comments: the classes are aimed at older vocational school students who have knowledge of forest management



Planned time: 45 min

STEP 1: Mind map

The teacher divides the students into smaller groups. Each team receives felt-tip pens and a large sheet of paper with the word "forest" written in the middle. The students' task is to create a mind map.

Step 1. The teacher asks the students to choose a specific forest area within their group, which will form the basis for their further work. This could be a forest in the students' place of residence or another forest (e.g. a forest near dunes, a mountain forest, a protected forest in a national park). The students write the name of the selected forest on the paper.

Step 2. The teacher asks the students to add the groups of stakeholders who use "their" forest in the form of a mind map (e.g. local farmers, tourists, mushroom pickers, local residents, joggers, school trips, hunters, environmental organisations, forest workers, loggers, local entrepreneurs).

Step 3. The teacher asks the students to continue the mind map by adding to each group what its needs are in relation to the forest (e.g. local farmers – the forest has passable roads; hunters – the forest can be hunted in; tourists – the forest is quiet; foresters – biodiversity is preserved in the forest; local government – agricultural land tax is paid).

Step 4. The teacher gives examples of how conflicts between different groups can arise, e.g.:
- noise and damage to local roads caused by heavy forestry equipment;
- access restrictions due to tree felling, fire hazard or habitat protection;
- restrictions on felling to protect biodiversity (e.g. the creation of bird protection zones) reduce the supply of wood, which can lead to higher raw material prices and job losses in local sawmills;
- some trees or parts of the forest are of historical or religious significance to local communities. Cutting down "the old oak tree where grandparents used to meet" may be seen as an attack on local heritage, even if the tree is diseased and poses a safety hazard.

Step 5. Students use the same colour to circle the conflicting interests of different groups on their posters (e.g. forest workers – logging; tourists – peace and quiet).

STEP 2: Developing an action strategy

The teacher asks the *students* to choose one of the ‘conflicts’ they have defined on the mind map and, on a second sheet of paper, to develop actions that can be taken to prevent the conflict from occurring or to mitigate it.
Example: There are plans to cut down trees in the "forest near the city", which is a favourite walking spot for residents of a nearby housing estate.

Actions to reduce residents' dissatisfaction:

The forester who looks after the area organises a meeting with the estate council and informs them about the felling so that residents are not taken by surprise. He explains why this action is necessary and what the benefits are for the sustainability of the forest. The felling will be carried out in stages to preserve the walking areas for as long as possible. One section of the forest will be left until planting in the remaining area has been renewed after felling. The start of felling is planned for late autumn so that residents can still enjoy the entire forest in summer. Information boards about the new plantings will be placed next to the felling site. Residents are invited to plant new trees so that they feel that this will be "their" forest and can watch it grow during their walks. There are plans to create educational trails and tourist shelters in the new forest.

STEP 3: Summary

The teacher points out the important role of foresters in managing the forest in a way that integrates the local community and protects its interests. The forest is not only a place of cultivation, but also fulfils many other functions: educational, recreational and economic.

SOURCES

- Forest Stewardship Council, https://pl.fsc.org
- https://lasyiobywatele.pl/
- Guidelines for the management of forests with increased social functions on land managed by the State Forests, State Forests, 2022.

Prepared by:

Magdalena Mazik-Gorzelańczyk, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by the European Union



2.8. TOPIC: International cooperation in the conservation of natural resources

PROCEDURE:

Steps	Time
Step 1. Why do forests require international cooperation?	5 min
Step 2. International cooperation initiatives – exercise	15 min
Step 3. Practical action in an emergency	15 min
Step 5. International timber trade certificates	10 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• what international timber trade certificates exist • what are examples of international cooperation projects in forest areas	• justify the need for international cooperation in forest protection • identify the basic issues determining joint international activities in forest areas	• that international cooperation in forest protection is essential and more effective



Number of participants: max. 30



Estimated time: 45 minutes



Materials required: projector, laptop, A4 paper, computers or smartphones with Internet access



Notes: the classes are aimed at older vocational school students who have knowledge of forest management

STEP 1: Why do forests require international cooperation?

The teacher gives the students two minutes to think about **what factors might influence the need for international cooperation in forest management**. Then, the teacher invites the students to share their ideas. Possible answers:

- *Animal migration: large mammals (wolves, bison, lynx) need larger areas to live in. If one country protects a species, but a neighbouring country allows uncontrolled hunting or fences off forests, the population will not survive.*
- *Pests and diseases: fungal spores and insects (e.g. bark beetles) are carried by the wind. If an outbreak occurs on one side of the border and the neighbours do not take joint action to combat it, the forests in both countries will be destroyed.*
- *Fires and floods: smoke and fire spread rapidly. Joint monitoring systems (camera towers) and cooperation between fire brigades are crucial in border areas.*
- *Rivers: forests act as a "sponge" that retains water. As rivers flow through many countries, forest management in the upper reaches of a river (e.g. in the Czech Republic) directly affects the risk of flooding or drought in the lower reaches (e.g. in Poland).*
- *Global timber market: timber harvested in one country may be processed in another and sold as a wood product in a third country. For this process to be legal and profitable, there must be common standards and certification for timber and timber products.*
- *Combating illegal logging: international agreements compel countries to cooperate in order to eliminate timber from illegal logging in tropical forests or taiga.*
- *Transboundary pollution: the phenomenon of "acid rain", which destroyed forests in the Jizera Mountains in the 1980s, showed that emissions from power plants in one country (the so-called Black Triangle: Poland, East Germany, Czechoslovakia) can kill forests in neighbouring countries.*
- *Transboundary tourism: hiking and cycling trails in border forests require common signage, maps and safety rules.*

STEP 2: International cooperation initiatives – exercise

The teacher divides the students into three subgroups. Each subgroup receives a sheet of paper, pens for note-taking and a sheet with the name of an international forest cooperation initiative. The task of each subgroup is to search the Internet for information about this initiative and prepare a short presentation that answers four questions:

Where? Which countries? What activities? For what purpose?

After 10 minutes of work, each subgroup presents its initiative.
The teacher can choose the initiatives to be discussed by the students (e.g. those close to their place of residence). They can also use these examples:

"Beekeeping – a tradition across borders". This is a Polish-Lithuanian project from 2024, co-financed by the European Union. Its main objective is to protect and promote traditional beekeeping and improve the living conditions of bees in the forests on the Polish-Lithuanian border. The project recreates methods of bee breeding in beehives (hollows in living trees) and in beehive logs (places for bees in hollow tree trunks, imitating natural hollows, hung in forests as artificial hives for wild bees).

Greater Virunga Transboundary Collaboration – cooperation between the Democratic Republic of Congo, Rwanda and Uganda in managing the Virunga Mountains area, inhabited by mountain gorillas. Foresters and rangers from these countries conduct joint cross-border patrols to combat poaching and illegal charcoal burning. They have standardised security procedures and jointly plan the development of eco-tourism. Animals migrate between the countries' national parks, so forest protection must be continuous, regardless of borders.

The Convention on the Protection of the Alps was concluded between Austria, France, Germany, Switzerland and Italy. Its aim is to prevent ecological disasters and keep the forests in the Alps in the best possible condition. The countries have committed themselves to common principles, including the use of natural forest regeneration methods, ensuring good forest resources through appropriate tree species, using native forest reproductive material and preventing soil erosion. Joint management in this difficult mountainous terrain is important because if, for example, the Swiss neglect a forest on a slope, an avalanche could hit a village on the Italian side.

STEP 3: Practising how to act in an emergency

The teacher divides the students into subgroups and describes the scenario:

"On the Czech side of the border, an outbreak of bark beetles has been detected in a 100-metre strip along the border with the Polish forestry district. The Czechs are planning to cut down the trees, but the area is difficult to access."

Task for the subgroups: the students prepare **a list of points to be agreed upon at a meeting with the neighbouring forest district before specific actions are taken**.

The exercise develops technical forest protection planning skills and cross-border thinking.

Examples of points that students may define:

- *Will logging on the Czech side take place before the next generation of bark beetles emerges? Should trap trees be designated on the Polish side as a preventive measure, or should the number of pheromone traps be increased to intercept insects flying across the border?*
- *What will be the common method of reporting new infested trees in the border zone (e.g. a shared group on a messenger app or exchange of GPX files)?*
- *Does the Polish forest district agree to the export of Czech timber via its forest roads (if this is not possible on the Czech side due to the terrain)?*
- *Who will cover the costs of any repairs to Polish roads after heavy equipment has passed through?*
- *Do we allow the establishment of a temporary timber storage facility on Polish territory?*
- *Are Czech contractors familiar with Polish fire and health and safety regulations applicable in forests if they are to be present on Polish territory?*
- *Will the noise from the machinery disturb the peace in Polish protected areas (e.g. near the nests of protected birds)?*
- *Who should be called in the event of a fire caused by a spark from a machine on the border itself? What is the procedure for notifying the fire services of both countries?*

STEP 4: International timber trade certificates

The teacher explains the purpose of international timber trade certificates and shows the two most common certificates and their labels on products (Appendices 1 A and B).

Certificates are systems that confirm that timber has been sourced sustainably.
For foresters (and customers in shops), they are a guarantee that nature has not been harmed during logging and that people working in the forest have been treated fairly. They can be compared to a "passport" for timber – without them, the raw material loses its value and cannot be sold to many large customers (e.g. furniture or paper manufacturers).
Certificates help consumers make ethical purchasing decisions.

The Forest Stewardship Council (FSC) is an international non-governmental, non-profit organisation active in over 80 countries to protect forests. It sets standards for responsible forest management, taking into account environmental, social and economic aspects. FSC certification guarantees that wood or paper products come from responsible sources.

The organisation certifies forests and monitors the entire supply chain, which means that the product meets strict environmental and social standards from the forest to the shop shelf.

The FSC label is one of the most reliable certification systems. Companies and forest managers who comply with the 10 main FSC principles are granted the right to use the label on their products (e.g. furniture, paper products, construction timber).

PEFC (Programme for the Endorsement of Forest Certification) is the world's largest certification organisation in terms of forest area covered. It was established in Europe as an initiative of forest owners and the timber industry. It is a "bottom-up" system – it accepts national forest standards as long as they comply with general international guidelines.

The certificate requires sustainable forest management, care for forest health and maintenance of its productive functions. The PEFC chain of custody certificate monitors forest products from sustainable sources (forest cultivation) to the final product.


Pure-Pak
ORANGE
JUICE
Packaging by Nature®
By choosing this FSC®-certified packaging, you are doing your part to protect forests.


PEFC


FSC
www.fsc.org
100%
From well-managed forests of small or community producers
FSC® C016343
Cooperativa COATLAHL, Honduras


GHF
AMAZÔNIA
Informação Nutricional
FSC
100%
FSC C167230

SOURCES

- https://bartnictwo.com
- https://greatervirunga.org/
- https://leap.unep.org/en/countries/at/national-legislation/protocol-mountain-forests-implementing-alpine-convention-1991
- https://fsc.org
- https://www.pefc.org

- Photos in Appendix 1 A and B
- https://www.rynekpapierniczy.pl/artykul/produkty-i-opakowania-z-certyfikatem-fscr-dobre-nie-tylko-dla-srodowiska-4074

Prepared by:

Magdalena Mazik-Gorzelańczyk, FAVEO Foundation for Vocational and Intercultural Education

Dofinansowane przez Unię Europejską



2.9 TITLE: The educational potential of forests. Traditional and new trends

PROCEDURE:

Steps	Time
Step 1. The educational role of forests. Traditional and new trends.	5 mins
Step 2. Forest kindergarten.	10 mins
Step 3. Educational initiative – group work.	20 mins
Step 4. Presentation and discussion of the results of the group work.	10 mins

LEARNING OBJECTIVES:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• that the forest can successfully serve as a venue for comprehensive education, including education for sustainable development • what a forest nursery is	• list various methods of forest-based education and give examples of selected forest-based educational initiatives • plan an educational project taking place in the forest or at a small-scale structure supporting forest-based education	• social responsibility • cross-sectoral cooperation • the educational role of forests



Number of participants: any



Planned time: 45 mins.



Materials required: the ability to display slides and a video, internet access, optionally paper and pens for group work



Notes: Ideally, the lesson should take place at the end of a series of sessions on sustainable development.

Click to see movie

STEP 1. Forest-based educational activities. Traditional and new trends.

The teacher reminds the class that the role of a forestry technician includes carrying out activities related to nature conservation, tourism and education. Today's lesson will focus on forest-based education, with reference to the goals of sustainable development. The teacher asks what forms of public education in the forest the students have already encountered.

Most commonly, we encounter education in specially equipped centres or educational rooms. Educational shelters are also used to conduct classes. The State Forests also run arboreta, dendrological parks and forest botanical gardens. Nature trails, however, are the most popular. The number of people taking advantage of the forests' educational offerings is growing. According to a report by the State Forests, 1,713,864 visitors took part in educational activities in Polish forest districts in 2022. To maintain this positive trend, it is worth ensuring a high standard of training for forest educators, as well as good infrastructure and innovative teaching aids.

In the slides, we will look at a few interesting examples from Europe (Appendix 1). We will then move on to a video – a puzzle – concerning a trend in education that is gaining popularity.

STEP 2. Forest kindergarten.

The teacher shows video 2.9 and asks the students what they think the clip is about.

The correct answer is a forest nursery – an example of an institution that comprehensively familiarises children with the forest and educates them within it. The teacher recounts the history of forest nurseries and explains the principles behind them. They pose the following question to the class for brief reflection:

“What do you think of this form of pre-school education?”

Forest kindergarten – the history of forest kindergartens dates back to 1954, when a group of parents in a small Danish town were intrigued by the educational approach of one of the mothers – Elle Flatauem – who took her children for a daily walk in the forest. The parents took a similar initiative and founded the first forest kindergarten (in Danish – skovbornehave). The idea spread to other countries. Forest kindergartens are places where children are brought up in harmony with nature and its cycles. They learn about the order of nature using all their senses. They spend most of their time outdoors. They only use covered buildings in the event of exceptionally adverse weather conditions. They acquire new skills and knowledge based on respect for the surrounding natural, cultural and historical environment. An important element of the educational programme in such settings is the children’s participation in organised festivals and the celebration of holidays observed within the local community.

Click to see movie

STEP 3. Educational initiative – group work.

Diversity and widespread accessibility are key to effective education. Cross-sectoral cooperation helps to achieve this. For example, the Polish State Forests collaborate with local authorities, schools, universities for the elderly, scouts, volunteer fire brigades and churches. Media support from radio or television is also crucial. In 2022, an average of 20 people from each of Poland's forest districts were involved in public education.

We will split into 3 teams. Each team is to develop an idea for an educational project related to forests and implementing the task drawn by the group leader, which is included in Sustainable Development Goal 4 of the 2030 Agenda (Appendix 2.1). The activity you propose should be carried out in a forest area. Remember that the entire project must be fully in line with the principles of sustainable development and the law. The table attached to the task (Appendix 2.2) may help you in presenting your idea. As the central theme of your project, you may choose one of the key issues discussed in the sustainable development lessons (e.g. water management in the forest, accessibility of the forest for people with disabilities), an interesting figure who has contributed to the development of forestry (especially a woman :), as the percentage of women in forestry is still lower than that of men), or an interesting location.

You have 20 minutes to complete the task. This will be followed by a presentation of the group work to the class. Good luck!

STEP 4. Presentation and discussion of the results of the group work.

APPENDIX 1

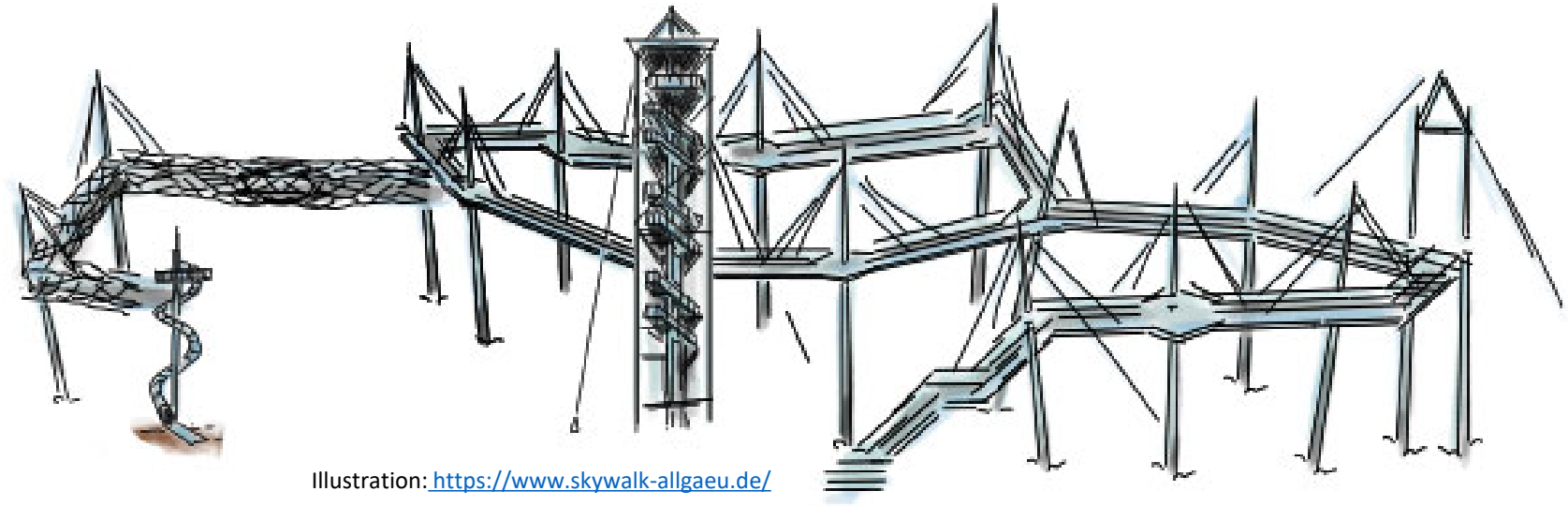


Illustration: https://www.skywalk-allgaeu.de/







Photographs: A. Zabrzewska 2024, viewing platforms, walk in the treetops at Waldwelt Skywalk Allgäu Scheidegg, Germany

APPENDIX 1



Photograph: A. Zabrzewska 2024, ant hill playground, more information about the forest park's attractions Waldwelt Skywalk Allgäu Scheidegg Germany https://neu.waldwelt-allgaeu.de/erlebnisse-ubersicht/



Photograph: A. Zabrzewska 2024, outdoor obstacle course for marbles; a marble rolling downhill plays the tune of a popular song about mushrooms, Landesgartenschau Wangen im Allgäu, Germany

APPENDIX 1



Photograph: permanent exhibition – an experimental display on climate change in relation to forests, Haus des Waldes, Stuttgart, Germany https://hausdeswaldes.forstbw.de/ausstellung/dauerausstellung-stadtwaldwelt8a/content/



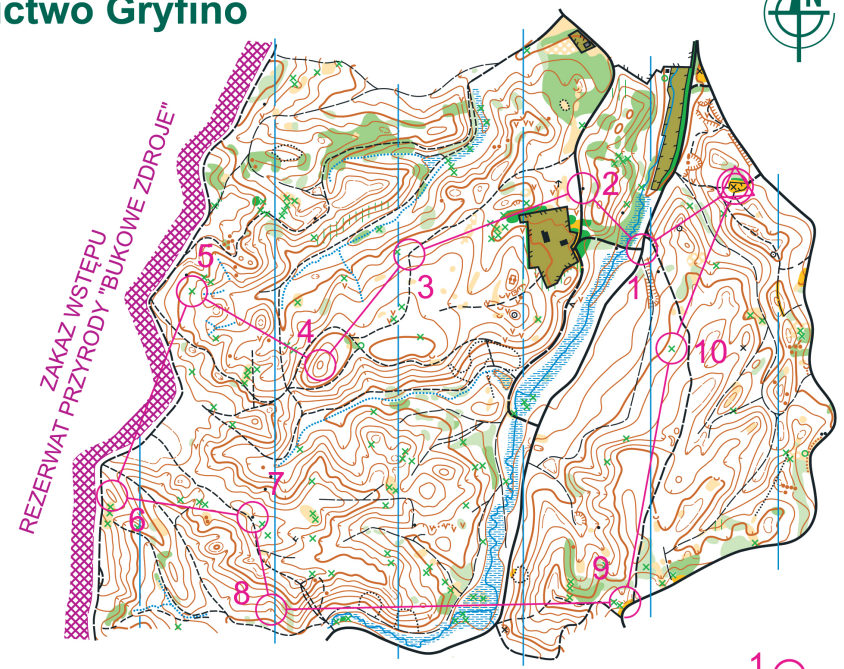
Photograph: interactive permanent exhibition on the forest, inatura museum, Dornbirn, Austriahttps://www.inatura.at/besucherinfo/museumsbesuch#wald-wiese

MAPA ŁATWA

Nadleśnictwo Gryfino

Leśniczówka Klęskowo
skala 1 : 10 000
e = 5m

ŁATWA		3.8 km			175 m	
1	116					
2	119			0,5		
3	101					
4	105					
5	102					
6	108					
7	106			0,8		
8	107					
9	112					
10	110					
340 m						



LEGENDA

- warstwica główna i pomocnicza
- skarpa
- rów
- górka, kopczyk
- niecka, zagłębienie
- dołek
- kamień, słup kamienny
- strumień
- liniowy teren podmokły
- bagno do przejścia
- teren otwarty, półotwarty
- las - utrudniona przebieżność, trudna przebieżność,
- las - b. trudna przebieżność, łatwo przebieżny
- las - b. trudna przebieżność, łatwo przebieżny
- porost niski, porost wysoki
- granica kultur
- samotne drzewo, wykrot
- droga utwardzona, droga
- ścieżka, mała ścieżka
- zanikająca ścieżka, przecinka
- płot wysoki i niski
- paśnik, inny sztuczny obiekt
- teren prywatny, budynki

1 116
2 119
3 101 | 4 105 | 5 102 | 6 108 | 7 106 | 8 107 | 9 112 | 10 110

KLUB ORIENTACJI SPORTOWEJ BnO SZCZECIN

Enea Fundacja



Zielony Punkt Kontrolny CERTYFIKAT

www.gryfino.szczecin.lasy.gov.pl

Photograph: A route marked out to be covered against the clock, using a map and compass, with the requirement to check in at control points
https://gryfino.szczecin.lasy.gov.pl/zielony-punkt-kontrolny-w-puszczy-bukowej

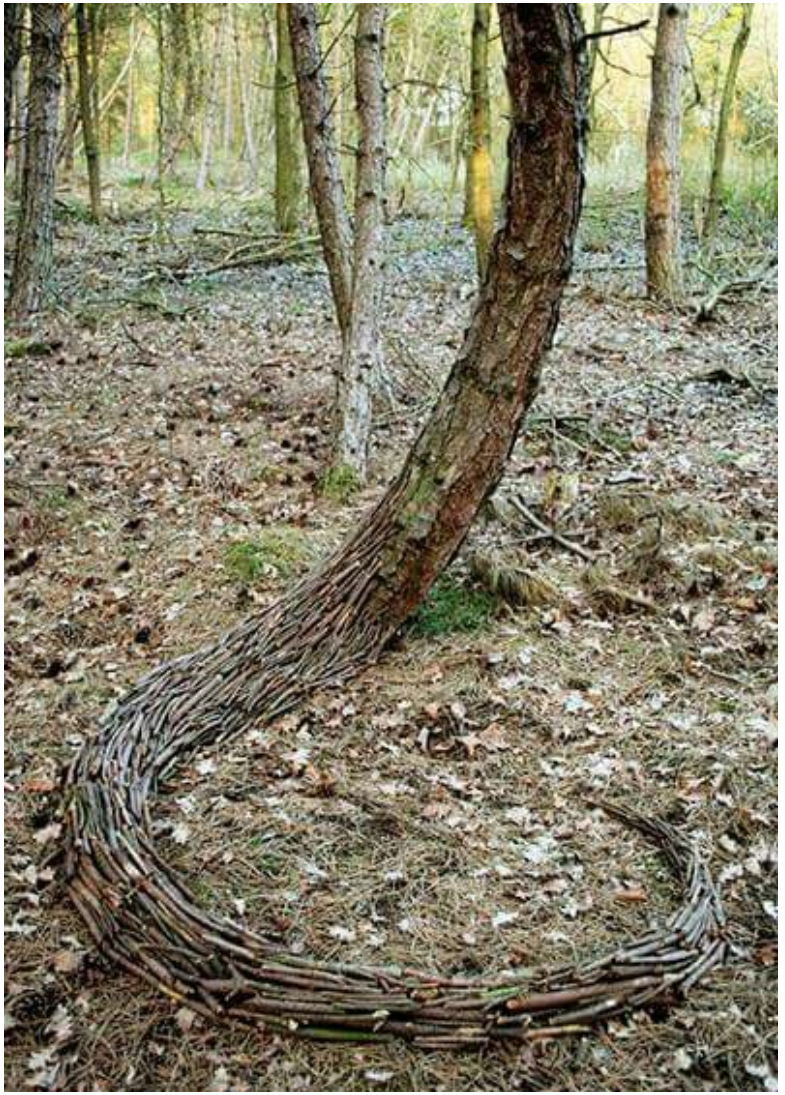
APPENDIX 1



Photograph: figures inviting visitors to the Education Centre Negrevo, North Macedonia https://ecnegrevo.mk/en/home/



Photograph: an example of Land Art
https://pl.pinterest.com/pin/747808713164387650/



Photograph: example of Land Art
https://pl.pinterest.com/pin/1618549856088597/

Group I

Establish new educational facilities and improve existing ones, which should take into account the needs of children and people with disabilities, both boys and girls, and ensure a safe, violence-free, inclusive and productive learning environment for all.

Group II

By 2030, eliminate gender disparities in education and ensure equal access to education at all levels and to vocational training for the most vulnerable groups, including people with disabilities, indigenous peoples and children in difficult circumstances.

Group III

By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, inter alia, through education for sustainable development and sustainable lifestyles, human rights, gender equality, the promotion of a culture of peace and non-violence, global citizenship, and an appreciation of cultural diversity and the contribution of culture to sustainable development.

Name of the activity	
Target group	
Type of project (street furniture/one-off event/recurring event)	
Objective of the activity	
Description of the activity	

SOURCES

- Education Report 2022.pdf
- https://www.skywalk-allgaeu.de/
- https://neu.waldwelt-allgaeu.de/erlebnisse-ubersicht/
- https://hausdeswaldes.forstbw.de/ausstellung/dauerausstellung-stadtwaldwelt8a/content/
- https://www.inatura.at/besucherinfo/museumsbesuch#wald-wiese
- https://gryfino.szczecin.lasy.gov.pl/zielony-punkt-kontrolny-w-puszczy-bukowej
- https://ecnegrevo.mk/en/home/
- https://pl.pinterest.com/pin/747808713164387650/
- https://pl.pinterest.com/pin/1618549856088597/
- https://www.encyklopedialesna.pl/haslo/lesne-przedszkole/
- https://www.un.org.pl/cel4
- https://www.un.org/sustainabledevelopment/education/

Compiled by:

Agnieszka Zabrzewska, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by the European Union



2.10. TOPIC: The impact of climate change on tourism

PROCEDURE:

Steps	Time
Step 1: What is climate change and what are its causes?	5 min
Step 2: The impact of climate change on various forms of tourism	10 min
Step 3: Tourist regions particularly vulnerable to climate change	10 min
Step 4: Pro-environmental activities in the tourism industry – summary	10 min.



Number of participants: any



Planned time: 45 min



Materials needed: Laptop, multimedia projector, printed flashcards



Comments: -

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• Which tourist regions are particularly vulnerable to climate change? • What climate change is and what causes it?	• Recognise environmentally friendly activities in the tourism industry. • Determine the impact of climate change on various forms of tourism.	• They are aware of ways in which tourism can adapt to climate change.

STEP 1: What is climate change and what are its causes?

The teacher introduces the term "climate change" to the students, and together they create a short definition based on their existing knowledge and associations. The teacher then presents the definition (Appendix 1).

Following the introduction, the teacher presents the lesson topic: an analysis of the impact of climate change on different types of tourism worldwide. Using a multimedia presentation, the teacher discusses the main human-caused causes of climate change, including tourism (Appendix 2).

The teacher presents the problem of the relationship between climatic conditions and the tourist attractiveness of regions to the pupils. They discuss how deteriorating environmental conditions affect the tourism industry and the possibilities for sustainable use of natural resources.

STEP 2: The impact of climate change on various forms of tourism

The teacher distributes printed and cut-out flashcards (Appendix 3-4) to the pupils. The pupils are asked to find a description of the positive and negative impact of climate change on each form of tourism. A sample solution can be found in Appendices 5-6. The pupils have 7 minutes to complete the task. The teacher discusses the solution with the pupils.

STEP 3: Tourist regions particularly vulnerable to climate change

The teacher discusses tourist regions particularly vulnerable to the negative effects of climate change using Appendices 7, 8, 9, and 10.

STEP 4: Eco-friendly activities in the tourism industry – summary

The teacher displays Appendix 11 with the question of how tourism can adapt to climate change. After a short reflection, the pupils share their ideas and jointly decide whether this is a solution to the problem.

APPENDIX 1

Climate change refers to long-term changes in the average weather conditions on Earth. These include rising temperatures, changes in precipitation, more frequent extreme weather events (e.g. hurricanes, droughts) and rising sea levels. They have a huge impact on tourism, as climatic conditions often determine the attractiveness of a destination.

APPENDIX 2

Climate change is having an increasing impact on various types of tourism, both in terms of weather conditions and the accessibility of tourist attractions.

Examples of the impact of climate change on different forms of tourism:

Mountain and ski tourism:

Positive impact:

- In some higher altitude regions, the ski season may be extended (e.g. in Scandinavia).

Negative impact:

- Glacier melt and decreasing snowfall are shortening the ski season in the Alps, Tatra Mountains and Dolomites.
- The risk of avalanches and landslides is increasing, posing a threat to tourists.
- Ski resorts have to invest in artificial snow, which increases costs and water consumption.

Coastal and beach tourism:

Positive impact:

- Rising temperatures may make northern countries (e.g. Norway, Sweden) more attractive to tourists seeking warmth.

Negative impact:

- Rising sea levels and beach erosion threaten coastal resorts (e.g. the Maldives, Venice, the Netherlands).
- More frequent hurricanes and storms may destroy tourist infrastructure (e.g. the Caribbean).
- Rising temperatures in the tropics may make it uncomfortable to stay on the beach in some regions.

Mountain and ski tourism	Coastal and beach tourism	Ecotourism and nature tourism
More frequent hurricanes and storms may damage tourist infrastructure (e.g. the Caribbean).	Rising temperatures may make northern countries (e.g. Norway, Sweden) more attractive to tourists seeking warmth.	Ski resorts must invest in artificial snow, which increases costs and water consumption.
Heat waves may make summer city breaks less comfortable (e.g. Rome, Barcelona).	Rising sea levels and beach erosion threaten coastal resorts (e.g. the Maldives, Venice, the Netherlands).	Rising temperatures in the tropics may make it uncomfortable to be on the beach in some regions.
Rising temperatures and droughts are reducing the number of animal species, which has a negative impact on wildlife viewing.	In some higher altitude areas, the skiing season may become longer (e.g. in Scandinavia).	Glacier melt and decreasing snowfall are shortening the skiing season in the Alps, Tatra Mountains and Dolomites.
Reduced biodiversity (e.g. coral reef extinction and threats to safaris in Africa).	Forest fires (e.g. in the Amazon, Australia) destroy natural ecosystems and limit sightseeing opportunities.	Air quality and smog problems may deter tourists.

Polar and Arctic tourism	**Urban tourism**	
Flooding and extreme weather conditions can damage monuments and tourist infrastructure.	Warming makes cruises to the Arctic and Antarctic more accessible to tourists.	Glacier melt and shrinking ice cover are limiting unique tourist experiences (e.g. expeditions to Antarctica).
The declining population of polar bears and other Arctic species may have a negative impact on nature tourism.	More and more cities are investing in green solutions and developing tourism based on sustainable transport (e.g. bicycles, public transport).	

APPENDIX 5

Main causes of climate change:

1. Air and road transport

- CO_2 emissions from aeroplanes, ships and cars contribute to the greenhouse effect.
- Aviation accounts for approximately 2-3% of global CO_2 emissions.

2. Mass tourism and excessive environmental impact

- Large numbers of tourists lead to environmental degradation (e.g. destruction of coral reefs, water and air pollution).
- The construction of hotels, roads and infrastructure increases greenhouse gas emissions.

3. Consumption of natural resources

- Tourist resorts consume huge amounts of water (e.g. golf courses, swimming pools, hotels).
- Over-exploitation of nature causes soil erosion, desertification and destruction of ecosystems.

4. Deforestation and urbanisation of tourist areas

- Cutting down forests for new resorts contributes to a reduction in CO_2 absorption capacity.

Ecotourism and nature tourism:

Negative impact:

- Reduction in biodiversity (e.g. extinction of coral reefs and threat to safaris in Africa).
- Forest fires (e.g. in the Amazon, Australia) destroy natural ecosystems and limit sightseeing opportunities.
- Rising temperatures and droughts reduce the number of animal species, which negatively affects wildlife viewing.

Urban tourism:

Negative impact:

- Heat waves can make summer city tours less comfortable (e.g. in Rome, Barcelona).
- Air quality and smog problems may deter tourists.
- Flooding and extreme weather conditions can damage monuments and tourist infrastructure.

Positive impact:

- More and more cities are investing in green solutions and developing tourism based on sustainable transport (e.g. bicycles, public transport).

Polar and Arctic tourism:

Negative impact:

- Glacier melting and shrinking ice cover are limiting unique tourist experiences (e.g. expeditions to Antarctica).
- The declining population of polar bears and other Arctic species may have a negative impact on nature tourism.

Positive impact:

- Paradoxically, warming makes cruises to the Arctic and Antarctic more accessible to tourists.

Examples of regions that are particularly at risk:

1. Pacific Islands (e.g. Marshall Islands)

- **Main threat:** Rising sea levels.
- **Impact on tourism:** These islands, which are only a few metres above sea level, are particularly vulnerable to flooding. Rising sea levels lead to the loss of beaches, destruction of tourist infrastructure and a decline in the attractiveness of tourist regions that rely on white beaches and coral reefs.



2. Alps

- **Main threat:** Temperature increase, glacier melting.
- **Impact on tourism:** This region is one of the main winter tourism centres in Europe. Rising temperatures are causing glaciers to melt and the skiing season to shorten, which directly affects winter tourism. In some places, such as Switzerland, melting glaciers are changing the landscape and causing a decline in winter tourism.

The Pizol Glacier in 2006 and 2018. The volume of the glacier decreased by 80-90% during this period.

3. Coral reefs (e.g. the Great Barrier Reef in Australia)

- **Main threat:** Change in water temperature, ocean acidification.
- **Impact on tourism:** Coral reefs are one of the main tourist attractions in many tropical destinations. Climate change leads to coral bleaching, when corals lose their colour and die due to rising water temperatures. Reef bleaching reduces biodiversity and the attractiveness of tourist destinations that attract tourists interested in diving.

4. Great Western Desert (e.g. Sahara)

- **Main threat:** Increased frequency of extreme weather events such as sandstorms and rising temperatures.
- **Impact on tourism:** Tourist regions based on desert landscapes may face extreme temperatures that make tourist travel difficult, especially in the summer. Reduced water availability and changes in the ecosystem may affect tourist attractions.

5. Sub-Saharan Africa (e.g. Kenya, Tanzania)

- **Main threat:** Changes in rainfall, droughts, reduction in biodiversity.
- **Impact on tourism:** Climate change may cause a decline in the number of wild animals in national parks, which will affect safari tourism. In addition, changes in water availability and more frequent droughts may make life difficult for residents and affect tourist infrastructure.

6. Antarctica

- **Main threat:** Rising temperatures, melting glaciers.
- **Impact on tourism:** Antarctica is one of the regions most sensitive to climate change. Rising temperatures are causing glaciers to melt, which may threaten both nature and tourist infrastructure. Although tourism in this region is strictly controlled, climate change may limit the accessibility of certain areas, affecting the development of adventure and scientific tourism.

How can tourism adapt to climate change?

APPENDIX 12

1. How can tourism adapt to climate change?

- The development of sustainable tourism
- Support for ecotourism
- Reduced dependence on seasonality
- Use of technologies that reduce CO_2 emissions
- Reducing short-haul flights – replacing them with rail travel or supporting environmentally friendly aviation fuels (e.g. biofuels, hydrogen).
- New travel destinations – development of tourism in less climate-impacted regions (e.g. Northern Europe instead of Mediterranean resorts).
- Promoting local tourism – encouraging people to discover attractions closer to home, which reduces CO_2 emissions from air transport.
- Limiting overtourism – regulating the number of tourists in popular destinations, introducing climate fees.

SOURCES

- https://pracezturystyki.dyplom.eu/wplyw-zmian-klimatu-na-rozwoj-turystyki/
- https://plusydlabiznesu.pl/aktualnosci/2838/climate-change-affects-tourism-worldwide?utmhttps://op.europa.eu/en/publication-detail/-/publication/6185be71-faab-11ed-a05c-01aa75ed71a1/language-en
- https://irme.pl/technologie-przyszlosci-innowacje-w-dziedzinie-ochrony-srodowiska
- Photo - APPENDIX 8 - https://www.egu.eu/medialibrary/image/3880/evolution-of-pizol-glacier/

Prepared by:

Sandra Domagalska, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by
the European Union



2.11. TOPIC: Sustainable forms of tourism

PROCEDURE:

Steps	Time
Step 1: What is eco-friendly tourism?	5 min
Step 2: Forms of ecotourism	5 min
Step 3: How to create an eco-friendly travel offer?	10 min
Step 4: Group work	25 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What ecological tourism is • What forms of ecotourism exist • What elements should be taken into account when preparing an offer	• Suggest sustainable forms of recreation • Identify examples of eco-friendly forms of transport	• The essence of ecology in tourism



Number of participants: any



Planned time: 45 min



Materials needed:
Laptop, multimedia projector, sheets of paper, felt-tip pens, crayons, envelope (for drawing lots), scissors, printed worksheets, flashcards



Comments: -

STEP 1: What is eco-friendly tourism?

The teacher introduces the concept of *ecotourism* to the students and asks them to spontaneously share their associations with eco-friendly travel. Then, the teacher presents the definition of ecotourism and its main principles formulated by Nicolas Hetzer: minimal impact on the environment, respect for local culture, benefits for local residents, and a high level of tourist satisfaction (Appendix 1).

STEP 2: Forms of ecotourism

In the next step, the teacher discusses the various forms of **ecotourism** presented in the presentation (Appendix 2). They explain how each type supports environmental protection and local communities and minimises tourist pressure.

STEP 3: How to create an eco-friendly travel offer?

The teacher introduces the concept of sustainable tourism services—such as eco-friendly means of transport, environmentally friendly accommodation, and responsible attractions—emphasising the importance of conscious decision-making by tourists. The teacher then displays Appendix 3 and discusses the individual elements of an eco-friendly travel offer. Next, the teacher shows a film promoting the platform (Appendix 4) and its sustainable development activities. Finally, the individual points of the offer (Appendix 5) are discussed together with an appendix presenting examples of travel gadgets (Appendix 6).

STEP 4 Group work

In the next stage, the pupils divide into groups of four to six. Each group draws one card from the ecotourism cards (a template of the cards can be found in Appendix 8). The task of each group is to prepare a poster, presentation, or description of an ecotourism trip. Full instructions for the task, along with supporting questions, can be found in Appendix 7. The teacher distributes the previously printed worksheets (Appendix 9). Before starting the task, the teacher explains what should be included in each section. The pupils work based on the teacher's presentation and the knowledge acquired during the lesson. After completing their work, the groups present their mini-offers to the other pupils, jointly analysing their compliance with the principles of ecology and sustainable tourism

APPENDIX 1

Ecotourism is, simply put, a form of travel often described as “green” because it stands in opposition to mass tourism, which frequently leads to water, air, and soil pollution. The aim of ecotourism is to ensure the sustainable use of natural resources and tourist attractions so that people can interact harmoniously with nature, admire its beauty, and avoid exploiting or destroying it.

Ecotourism combines leisure with exploration of the natural environment while emphasising its preservation. During this form of travel, tourists enjoy close contact with nature, peace and quiet, and the sense of freedom it provides. At the same time, they support initiatives focused on protecting wild and relatively untouched areas around the world.

The concept of ecotourism emerged in the 1960s and 1970s, when ecologist Nicolas Hetzer formulated four fundamental principles of ecotourism:

- minimal impact on nature
- maximum respect for local culture
- maximum benefit for local residents
- maximum satisfaction from leisure

APPENDIX 2

A tourism organisation technician should possess the skills required to create offers for ecotourists, taking into account the principles of sustainable development and environmental protection. They must be able to analyse the needs of tourists interested in nature, select environmentally friendly means of transport, plan routes that minimise environmental impact, and choose accommodation facilities that operate in an eco-friendly manner. In addition, they should be familiar with the region's natural assets, cooperate with local communities, promote local products and services, and ensure that tourism activities do not lead to environmental degradation.

Below are some examples of forms of ecotourism:

1. Agritourism
– holidays spent in rural areas
– promotion of local products, traditions, and sustainable agriculture
– reduction of pressure on large tourist resorts

2. Sustainable tourism
– focus on balancing environmental, economic, and social factors
– inclusion of environmentally friendly transport, accommodation, and tourist attractions

3. Qualified tourism
– activities requiring physical fitness or specific skills, such as hiking, canoeing, or cycling
– low environmental impact, provided activities are carried out in accordance with nature conservation principles

4. Nature tourism
– observation of animals, plants, and landscapes
– does not require specialised infrastructure and promotes “light” contact with nature

5. Low-carbon tourism
– travelling with minimal CO_2 emissions, for example by train, bicycle, or shared transport
– choosing destinations close to home in order to reduce air travel

6. Slow tourism
– travelling without fast means of transport, such as cars or aeroplanes
– promotion of zero-emission or low-emission transport and the minimisation of greenhouse gas emissions

7. Volunteer tourism
– travel combined with participation in nature conservation or social assistance activities, such as environmental protection work, cooperation with local communities, or support for sustainable development projects in a given region

APPENDIX 3

Travelling can be not only inspiring but also responsible. Increasingly, people are choosing trips that promote environmental protection and support local communities. When creating an eco-friendly tourism offer, several key aspects should be taken into account.

Sustainable transport
Travellers are encouraged to use trains, buses, or carpooling, as these options significantly reduce CO_2 emissions. Whenever possible, exploring destinations on foot or by bicycle is also recommended—not only because it is environmentally friendly, but also because it allows tourists to experience visited places more deeply.

Environmentally friendly accommodation
Cooperation with hotels and guesthouses that implement eco-friendly solutions is essential. Such facilities save water and energy, use renewable energy sources, and apply recycling practices. Travellers can be guided towards verified accommodation providers that follow sustainable development principles.

There are platforms and search engines that offer accommodation consistent with sustainable tourism principles, such as:

- **EcoBnB** – a platform focused exclusively on facilities that meet ecological criteria.
- **BookDifferent** – an accommodation comparison website featuring an “eco-friendly” rating system in cooperation with ecological certification bodies
- **Green Pearls** – a portal presenting carefully selected, certified eco-friendly hotels and resorts worldwide

Some popular booking platforms also include ecological filters in their search engines, for example:

- **Booking.com** – offers “Travel Sustainable” labels indicating establishments engaged in pro-environmental activities
- **Expedia** – provides sustainability labels for selected hotels and cooperates with environmental certification organisations

A film promoting the **EcoBnB** platform, which offers accommodation in facilities that meet sustainability criteria.

https://youtu.be/Vy2TwQw2fCo?si=TjyDP7gzzXbEWiG8



Reduce waste

Travellers should be provided with filter bottles or reusable water bottles, as well as cotton shopping bags. This helps to limit the use of disposable packaging and protects the environment, while also allowing tourism companies to promote their brand. Such initiatives additionally contribute to increased customer loyalty (Appendix 6).

Support local producers

By choosing local restaurants and regional artisans, tourists not only reduce the carbon footprint associated with food transport but also actively support the local economy.

Respect nature

Travellers are encouraged to stay on designated trails, avoid littering, and refrain from interfering with the natural environment. Protecting nature is a shared responsibility of all tourists.

Responsible attractions

Activities that do not harm the environment or exploit animals are recommended. Tourism companies should also advise travellers on selecting attractions that align with the principles of sustainable tourism.

Travel gadgets







APPENDIX 7

The teacher divides the class into groups of **four to six** students. Each group draws or selects one form of eco-friendly tourism:

- **Ecotourism**
- **Agritourism**
- **Slow travel**
- **Volunteer tourism**
- **Low-carbon tourism**

Each group is tasked with developing a complete mini-offer for an ecotourism trip in accordance with the principles of ecology and responsible tourism.

The offer should include the following elements:

- **Purpose and nature of the trip** – What type of tourism does the offer represent? Why is this form of tourism ecological?
- **Destination** – region, country, or town, and an explanation of what makes the location ecologically attractive
- **Plan for a two- to three-day trip** – eco-friendly accommodation, environmentally responsible activities, local cuisine, and regional products
- **Eco-friendly travel principles** – methods of reducing the carbon footprint and waste, as well as ways of supporting the local community
- **Promotional element** – an advertising slogan
- **Form of presentation:** written description, poster, or presentation

Time allocation:

- group work: 10 minutes
- group presentation: 3 minutes

Ecotourism	**Low-carbon tourism**	**Slow travel**
Agritourism	**Volunteer tourism**	

Purpose and nature of the trip:

……

……

……

……

Place of departure: ……

……

Plan for a 2–3-day trip:

……

……

……

……

……

……

……

……

……

Eco-friendly travel principles:

……

……

……

……

……

……

……

……

……

……

Promotional element (advertising slogan):

……

……

SOURCES

- https://ekotablica.pl/ekoinspiracje/ekoturystyka
- https://timesagriculture.com/ecotourism/?utm_source
- Maria Burmecha-Olszowy, Slow tourism – characteristics and functions of a new trend in tourism, Academy of Physical Education in Wrocław, 2014.
- Witold Toczyski, Jacek Lendzion, Jacek Zaucha, "SUSTAINABLE TOURISM IN THE BALTIC REGION Products, cooperation networks and marketing", Gdańsk University Development Foundation, 2007.
- Film - APPENDIX 4 - https://youtu.be/Vy2TwQw2fCo?si=TjyDP7gzzXbEWiG8
- Photos – APPENDIX 6 – https://lar-sklep.eu/gadzety-reklamowe-dla-biur-podrozy

Prepared by:

Sandra Domagalska, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by
the European Union



2.12. TOPIC: Sustainable development in the hotel and catering industry

PROCEDURE:

Steps	Time
Step 1: Sustainable development in the hotel and catering industry – introduction	5 min.
Step 2: Solutions implementing sustainable development in the hotel and catering industry – good practices	15 min
Step 3: Green hotel or eco-restaurant project.	25 min.

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What sustainable development means in the context of the hotel and catering industry • How the hotel and catering industry affects the environment	• Identify environmental problems in the industry and propose solutions for sustainable development	• Be aware of environmental challenges in the hotel and catering industry



Number of participants: any



Planned time: 45 min



Materials needed: Laptop, multimedia projector, sheets of paper, writing materials



Comments: -

STEP 1: Sustainable development in the hotel and catering industry – introduction

The teacher introduces students to the topic of ecology in the hotel and catering industries. Using a presentation, the teacher raises students' awareness of the impact these sectors have on the environment and the risks to the industry associated with climate change (Appendix 1).

STEP 2: Solutions implementing sustainable development in the hotel and catering industry – good practices

The teacher asks the pupils about solutions they think could be implemented in the hotel and catering industry to make it more eco-friendly. Using a presentation, the teacher elaborates on the ideas discussed and adds any solutions that the pupils did not mention. The teacher then asks the students whether they have ever encountered such environmentally friendly practices in their own lives.

Next, the teacher presents examples of good practices in hotels (Appendix 3) and restaurants (Appendix 4). Appendix 5 (a film about McDonald's Market Drayton) and Appendix 6 (a photo of the barbecue at El Diablo) are used as illustrations of innovative solutions.

STEP 3: Designing a green hotel or eco-restaurant

The teacher divides the students into four groups. Two groups prepare a project for an eco-friendly restaurant, while the other two prepare a project for an eco-friendly hotel. The project should include the name and location of the facility, a description of eco-friendly solutions, and ways of promoting its eco-friendly character.

The project may take the form of a presentation, a poster, or a written description of the offer. Each group has 10 minutes to work on the project and a maximum of 3 minutes to present their work. During the presentations, the teacher asks additional questions, e.g. *Why did you choose this location?*

APPENDIX 1

Sustainable development in the hotel and catering industry refers to measures taken to reduce the negative impact of these sectors on the natural environment. This includes both sustainable development practices and ecological innovations that help save resources, reduce waste, and minimise pollutant emissions.

Thanks to eco-friendly measures in the hotel and catering industry, it is possible to reduce the negative impact on the environment and attract environmentally conscious customers, for whom sustainability is an important criterion when choosing services.

Industry risks related to climate change:

- **Rising temperatures and extreme weather conditions** – heatwaves, hurricanes, floods, and forest fires can damage hotel infrastructure, reduce tourist numbers, and increase maintenance costs.
- **Rising sea levels** – a threat to hotels located on the coast, especially on islands and in low-lying areas.
- **Water supply issues** – in drought-stricken areas, hotels may have limited access to water, which can affect guest comfort and increase operating costs.
- **Rising energy costs** – the need for more intensive cooling of rooms and the adaptation of buildings to new climatic conditions leads to increased energy consumption.
- **Changing tourist preferences** – customers are increasingly choosing environmentally friendly destinations and eco-friendly hotels, forcing the industry to invest in sustainable solutions

APPENDIX 2

Sustainable solutions in the hotel and catering industry are becoming increasingly popular, as both customers and industry professionals are increasingly recognising the need to care for the environment. These changes aim to reduce the negative impact of business activities on nature, lower the consumption of natural resources, and optimise waste management.

Below are some key green solutions that are gaining importance in the hotel and catering industry:

1. Energy saving

- **Energy-efficient appliances** – Hotels and restaurants are increasingly investing in energy-efficient equipment, such as LED lighting, air conditioners, ovens, and refrigerators with low energy consumption.
- **Energy management systems** – The implementation of smart energy management systems (e.g. motion sensors in hotel rooms that automatically turn off the lights when rooms are not in use) allows for significant reductions in energy consumption.
- **Renewable energy sources** – Many hotels and restaurants choose to install solar panels, wind turbines, or heat pumps, enabling them to use renewable energy and reduce their dependence on fossil fuels.

2. Water conservation

- **Water-saving systems** – Hotels and restaurants install devices such as aerators in taps and showers, which reduce water consumption without compromising quality. It is also worth investing in greywater recovery systems (e.g. water from washbasins and showers used for garden irrigation).

- **Efficient sanitary and hygiene equipment** – Modern facilities, such as water-saving toilets and smart washing systems that automatically adjust the amount of water depending on the load, help reduce water consumption in hotels and restaurants.

3. Zero waste and waste management

- **Recycling** – Many hotels and restaurants are implementing waste-sorting systems that enable the separate collection of plastics, glass, paper, and organic waste. This helps reduce the amount of waste sent to landfill and allows materials to be recycled.
- **Composting** – Many restaurants are introducing the composting of organic waste (e.g. food scraps and plant waste), which can then be used to fertilise gardens or areas around the hotel.
- **Reducing the use of disposable packaging** – Hotels and restaurants are increasingly moving away from plastic straws, disposable plates, and cutlery, replacing them with biodegradable or reusable alternatives (e.g. steel straws and ceramic tableware).

4. Local, seasonal, and organic products

- **Local and seasonal ingredients** – Restaurants focus on products from local suppliers that are available during a given season. This reduces the carbon footprint associated with transportation and supports the local economy.
- **Organic products** – Many catering establishments choose organic ingredients that are free from pesticides and artificial fertilisers. The production of organic products is associated with lower levels of soil and water pollution and has a more positive impact on health.
- **Vegetarian and vegan options** – With growing environmental awareness, more and more restaurants are introducing plant-based menus, which have a lower environmental impact than meat production.

5. Sustainable architecture and materials

- **Sustainable architecture** – Modern hotels are designed with sustainability in mind, using energy-efficient materials, effective thermal insulation, rainwater harvesting systems, and green space designs that improve air quality around the property.

- **Recycling and reuse of building materials** – Recycled materials such as reclaimed wood, eco-friendly paints, and building materials made from waste are becoming increasingly popular in hotel and restaurant construction

6. Sustainable transport

- **Electric transport** – More and more hotels offer guests the option of renting electric cars or using electric scooters and bicycles. In addition, electric vehicle charging stations are often available on site.

- **Sustainable transport** to and from the hotel – Hotels organise transport for their guests while promoting eco-friendly public transport, carpooling, or other low-emission transport options.

7. **Guest education and engagement**

- **Educating guests** – Many hotels and restaurants engage guests in eco-friendly activities, for example by informing them about water- and energy-saving practices, offering recycling options, encouraging the avoidance of single-use plastics, or promoting the use of public transport.

- **Loyalty programmes** – Establishments may introduce loyalty programmes that offer discounts or other benefits to guests who make eco-friendly choices, such as opting out of daily room cleaning or arriving by public transport.

APPENDIX 3

Examples of hotels applying good practices:

- **Tristan Hotel & Spa** – Located on the Vistula Spit, the hotel is surrounded by a landscape park and situated close to a sandy beach. It has introduced environmentally friendly solutions such as a water-chiller-based air conditioning system and technologies that reduce water and energy consumption. The restaurant serves dishes made from local ingredients, and the spa uses biodegradable cosmetics.
- **The Kip** – An intimate guesthouse surrounded by jungle that promotes local culture and organic meals, creating a natural and eco-friendly atmosphere.
- **Oasia Hotel Downtown** – Designed by WOHA, this hotel is an example of how green façades and terraces can reduce building temperatures and provide natural ventilation.
- **Juvet Landscape Hotel** – A unique facility that blends seamlessly with the Norwegian landscape. Its architecture uses natural materials, and the design focuses on integration with the surrounding environment, minimising environmental impact.

.

APPENDIX 4

Examples of restaurants applying good practices:

- **Amass** – This restaurant is an icon of the zero-waste movement. It uses food scraps to create new dishes and limits the use of plastic. Amass also has its own garden, which supplies fresh ingredients for its menu.

- **McDonald's - Market Drayton** – The world's first fully eco-friendly restaurant of this chain. It was designed to achieve net-zero emissions by using renewable energy sources and recycled materials, such as kerbstones made from plastic bottles.
  (Film – Appendix 5)

APPENDIX 4

Nolla – A zero-waste restaurant awarded a Michelin Green Star. It does not use plastic packaging or cling film, and all waste is composted on site and returned to producers as fertiliser, thus closing the production cycle.

El Diablo – A restaurant that uses the natural heat of a volcano to cook food. Special grills allow dishes to be roasted using hot air rising from within the Earth. This innovative approach to cooking is an environmentally friendly solution that reduces the use of traditional energy sources. The use of natural resources, such as volcanic heat, combined with a focus on local and organic ingredients, makes this restaurant an example of a sustainable approach to gastronomy.

(Photo – Appendix 6)

McDonald's (Market Drayton, United Kingdom) - The world's first fully eco-friendly restaurant of this chain.



https://youtu.be/Ul7ua_HbmTg

APPENDIX 6

The grill at El Diablo restaurant uses only heat from the volcano.



STEP 3 Design of a green hotel or eco-restaurant.

The students are divided into four groups. Two groups prepare a project for an eco-friendly restaurant, while the other two prepare a project for an eco-friendly hotel.

The project should include:

- the name and location of the facility,
- a description of eco-friendly solutions,
- ways of promoting the eco-friendly nature of the facility.

Form of the project: presentation, poster, or written description of the offer.

Time for group work: 10 minutes.
Presentation time: a maximum of 3 minutes per group.

SOURCES

- https://doyourorder.com/pl/blog/the-climate-crisis-deepens-a-call-to-action-for-the-restaurant-industry-94/
- https://www.akademiahoreca.pl/artykul/przepisy-dotyczace-ochrony-srodowiska-w-hotelu-co-warto-wiedziec-502904#zrownowazony-rozwoj-w-hotelarstwie
- https://tristan.com.pl/jestesmy-eko/
- https://www.thekipsrilanka.com/
- https://biz.dinnerbooking.com/pl-pl/blog/podroz-przez-trzy-restauracje-z-zielona-gwiazdka-michelin
- https://www.vogue.pl/a/5-najbardziej-ekologicznych-barow-kawiarni-i-restauracji-na-swiecie

Photo – APPENDIX 5 – https://youtu.be/Ul7ua_HbmTg

Photo - APPENDIX 6 – https://www.arrivalguides.com/en/Travelguide/LANZAROTE/dining/el-diablo-11191

Prepared by:

Sandra Domagalska, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by the European Union



2.13. TOPIC: Sustainable tourism certificates

PROCEDURE:

Steps	Time
Step 1: Sustainable tourism certificates – introduction	3 min
Step 2: The role of sustainable tourism certificates	7 min
Step 3: Sustainable tourism certificates – types	10 min
Step 4: Summary – group work. Environmental audit – check whether the facility deserves certification	25 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What sustainable tourism certificates are • What is their role in promoting sustainable development in tourism	• Define the role of sustainable tourism certificates • Create a tourism offer that includes certified locations.	• Awareness of the diversity of sustainable tourism certificates



Number of participants: any



Planned time: 45 min



Materials needed: Laptop, multimedia projector, sheets of paper, pens



Comments: -

STEP 1: Sustainable tourism certificates – introduction

The teacher introduces the concept of a 'sustainable tourism certificate' (Appendix 1) to the students and asks them to spontaneously come up with associations related to the principles of such certificates (example warm-up questions: 'Have you ever come across any environmental certificates?', 'What activities can certificates promote?'). The teacher then explains that these certificates are awarded to facilities and organisations that operate in accordance with the principles of environmental protection, support for local communities and ethical management (Appendix 2).

STEP 2 : The role of sustainable tourism certificates.

In the next step, the teacher discusses the most important functions of certificates (Appendix 3). Then, they divide the students into 5 groups. They hand out several printed worksheets (Appendices 4, 5, 6, 7, 8) to each group, containing a certificate and a description of a fictional facility. The students read the text.

STEP 3: Sustainable tourism certificates – types.

The teacher introduces the students to different types of certificates (Green Key, EarthCheck, Travelife, EU Ecolabel, Rural Tourism, Green Globe, Blue Flag). Using Appendices 9, 10, 11, he/she shows what the logos of each certificate look like. He/she may ask guiding questions: "How do international certificates differ from national ones?", "Which ones apply to hotels and which ones to protected areas?"

STEP 4: Summary – group work. Environmental audit – check whether the facility deserves certification.

Students take on the role of environmental auditors who assess a selected tourist facility and decide whether it meets the requirements for sustainable tourism certification. Each group receives a summary of the requirements for their certificate and a description of the facility.
The groups analyse the description of the facility and prepare:

1. A compliance list (what the facility is doing correctly), e.g. recycling, LEDs, local food, renewable energy sources, plastic reduction.
2. A list of non-compliance (what is preventing certification), e.g. lots of single-use plastics, lack of environmental education, high transport emissions.
3. Corrective recommendations. Each non-compliance must have a solution, e.g.:

- No waste segregation → introduce a 4-bin system + instructions for guests.
- High energy consumption → motion sensors and energy-efficient lighting.

STEP 4: Summary – group work. Environmental audit – check whether the facility deserves certification.

4. Final decision:

Does the facility receive certification? YES / NO
The justification must be specific and based on criteria.

Finally, each group gives a short presentation of the audit results (3 minutes). Taking into account:

- the most important conformities and non-conformities,
- corrective recommendations.

Time for preparation and analysis: 10 min
Time for group presentations: 3 minutes/group

ANNEX 1

Sustainable tourism certificates are official documents awarded to tourism organisations that demonstrate a responsible approach to environmental, social and economic issues in their activities. Sustainable tourism certificates are an important tool in promoting responsible tourism that takes into account environmental protection, supports local communities and preserves local culture. Tourism organisations that obtain sustainable tourism certificates demonstrate their commitment to creating more sustainable tourism experiences.

APPENDIX 2

Sustainable tourism certificates aim to promote and support tourism that is consistent with the principles of sustainable development, i.e. tourism that:

- Cares for the natural environment – reduces the impact of tourism on the environment by conserving natural resources, reducing waste and CO2 emissions, protecting biodiversity and managing ecosystems.
- Supports local communities – involves and supports local residents, promoting their traditions, culture and job creation in the region.
- Complies with ethical and social principles – respects human rights, ensures fair treatment of employees and supports social justice, e.g. by combating the exploitation of children or employees.
- Promotes responsible consumption – it encourages tourists to choose appropriate services that are environmentally friendly and contribute to sustainable development.

APPENDIX 3

Sustainable tourism certifications play a key role in shaping and promoting responsible practices in the tourism industry. They play a key role in shaping tourism that responds to the challenges of environmental protection, social and economic justice, and culture. For tourism organisations, they are not only a tool to stand out in the market, but also a motivation to introduce environmentally friendly and socially responsible practices. For tourists, they provide assurance that they are choosing responsible services that contribute to sustainable development and protection of our planet. Their task is to support tourism organisations that strive to reduce their negative impact on the environment, society and the economy, as well as to promote the idea of sustainable development in tourism.

Here are some of the main roles that sustainable tourism certifications play:

1. Promoting responsible tourism

Certificates are a tool that allows tourism organisations to show that they care about protecting the environment, support local communities and adhere to ethical business principles. Thanks to these certificates, tourists can consciously choose offers that have a minimal impact on the environment and contribute to sustainable development.

2. Building trust among tourists

Certificates act as an indicator of credibility for tourists who want to support organisations working for environmental protection and social responsibility. Thanks to certificates, consumers can be sure that they are choosing services that meet high standards of sustainable development. As a result, trust in a given tourism organisation increases.

3. Increasing competitiveness in the market

Nowadays, when more and more tourists are paying attention to the ethical and ecological aspects of travel, having a sustainable tourism certificate can be an important factor in distinguishing an organisation from its competitors. Certified companies can attract tourists looking for responsible travel experiences, which can lead to increased visitor numbers and customer loyalty.

4. Motivation to improve practices and procedures

Sustainable tourism certifications often require meeting specific criteria and standards, which include resource management, CO2 emissions, waste management, biodiversity protection, and support for local communities. Obtaining certification forces tourism organisations to systematically evaluate their practices and procedures, which motivates them to continuously improve and implement innovative environmentally friendly solutions.

5. Educating tourists and employees

Certificates also play an educational role, both for tourists and for employees in the tourism industry. Certified tourism service providers educate tourists about the benefits of choosing responsible services that have a lower impact on the environment. Employees who work for certified organisations are also educated about sustainable practices and values, which has an impact on the company's overall operations.

6. Supporting local communities and heritage protection

Many sustainable tourism certifications aim to support local communities by promoting tourism that is economically beneficial to the residents of a given destination. Certifications help tourism organisations invest in the protection of local culture, traditions and heritage, as well as social development, thus creating long-term benefits for residents.

7. Strengthening brand image

Having a sustainable tourism certificate is a powerful marketing tool. Tourism companies that receive such certificates can use them to build a positive brand image that cares about the environment, ethical behaviour and supports sustainable development. It is also an important element in communicating with customers, who are increasingly looking for brands that respond to contemporary challenges such as climate change and social justice.

8. Increasing investment in sustainable development

Certificates can also be an incentive for companies to invest in modern technologies and innovations that support sustainable development. Thanks to such investments, tourism organisations can reduce operating costs, such as energy, water and waste management costs, while reducing their negative impact on the environment.

Blue Flag	**Key criteria:** • High water quality – regular, positive test results. • Safety and rescue – lifeguards, first aid equipment. • Beach cleanliness – bins, cleaning, no litter. • Protection of the natural environment – e.g. dunes, birds, protected areas. • Toilets in good condition, preferably eco-friendly. • Environmental education – information boards, campaigns. • Environmental management – no sewage discharge, waste control.
"Słoneczna Przystań" City Beach (urban recreation area) **Location:** city centre, busy river beach. **Nature of the facility:** bathing area, guarded beach, water recreation area.	
Good practices: • The water in the bathing area is regularly tested and the results are published online. • The beach has separate protected areas for birds and educational boards. • Bins for selective waste collection are available. • Lifeguards provide education on safety and environmental protection.	
Irregularities: • There are food stalls nearby that use disposable plastic tableware. • There are no eco-friendly toilets — only portable toilets that use a lot of chemicals. • On weekends, there is heavy traffic in the area and no incentives to come by bicycle. • Part of the beach suffers from coastal erosion, but no remedial action has been taken so far.	
Can the beach apply for Blue Flag certification? Which conditions are not met?	

The Green Globe Certification	**Key criteria:** • Reducing energy and water consumption. • Reducing waste and eliminating single-use plastics. • Protection of local nature and ecosystems. • Cooperation with the local community (local products, services). • Fair working conditions and ethical management. • Educating guests – information about ecology and responsible behaviour. • Reporting and continuous environmental improvement (continuous development).
"EcoGroup Travel Agency" (tour operator) **Location:** Poznań **Nature of the facility:** agency specialising in short trips in Poland and Europe.	
Good practices: • The agency cooperates with hotels that have the Travel Sustainable label. • Most trips are organised using public transport: trains, buses, bicycles. • The company supports local guides and producers — the programmes include visits to craftsmen. • The offers include eco-tours: national parks, volunteer tourism.	
Irregularities: • Contracts, cards and vouchers are printed exclusively on paper, with no electronic versions available. • There is no CO_2 offset policy for longer coach trips. • Not all transport partners meet low-carbon standards. • The office uses traditional cleaning products without eco-certificates.	
Can the office obtain The Green Globe Certification?	

EarthCheck 	**Key criteria:** • Monitoring energy, water and waste consumption. • Reducing CO_2 emissions (e.g. renewable energy sources, energy saving). • Protection of the local environment (no damage to nature). • Waste management – sorting, recycling, reducing plastic. • Sustainable purchasing – local and organic products. • Safety of guests and employees. • Environmental education for tourists and staff.
"Mountain Adventure – Ski Resort" **Location:** Tatra Mountains **Nature of the facility:** medium-sized ski resort with a restaurant and equipment rental.	
Good practices: • The rental shop has regularly serviced, durable equipment. • The resort cooperates with national parks and runs a campaign called “Do not feed wild animals”. • The ski stations use LED lighting.	
Irregularities: • The resort's buildings are located very close to a stream, violating the ecological buffer zone. • Snow cannons consume huge amounts of water, without limits or monitoring. • There is no public transport — visitors mainly arrive by car. • Large amounts of catering waste, no composting.	
Can this facility receive EarthCheck certification?	

EU Ecolabel

Key criteria:
- Energy saving – LEDs, sensors, renewable energy sources.
- Water saving – aerators, restrictors, eco-friendly showers.
- No toxic cleaning products (eco-friendly chemicals).
- Waste sorting and plastic reduction.
- Eco-friendly laundry and cleaning – towels replaced on request.
- Healthy, local food where possible

"EcoCamp Wrzosowa Polana" (campsite + holiday cottages)
Location: mountainous area near a landscape park.
Nature of the facility: small, family-run campsite with 14 wooden cabins and a tent pitch area.

Good practices:
- The cottages are heated by heat pumps.
- The campsite offers a shared zero-waste kitchen with instructions on how to avoid food waste.
- Users have access to filtered water, which reduces the purchase of plastic bottles.
- The facility organises nature workshops led by local educators.
- The campsite has a small insect hotel, a flower meadow and compost bins.

Irregularities:
- No monitoring of water consumption – guests often leave showers running for too long.
- The toilets at the campsite are old models and use a lot of water.
- The car park at the campsite is very large, and there is no incentive to arrive by public transport.
- During the season, evening bonfires are organised, which often lead to excessive wood collection from the forest by tourists.

Could the campsite obtain the EU Ecolabel or Green Globe certification? What measures require immediate improvement?

Green Key	**Key criteria:** • Energy – efficiency, renewable energy sources, air conditioning restrictions. • Water – conservation, eco-friendly taps, monitoring. • Waste – sorting, no single-use plastics. • Sustainable purchasing – local food, certified products. • Ecological cleanliness – environmentally friendly cleaning products. • Guest education – posters, instructions, eco-friendly campaigns. • Green area around the facility – nature conservation, biodiversity.

Hotel "Panorama" (lake-side hotel, 3★)
Location: on Lake Solne, surrounded by mixed forests.
Nature of the facility: holiday hotel, 120 beds.

Good practices:
- The hotel has a photovoltaic panel installation, covering 35% of its energy needs.
- LED bulbs and motion sensors are used in the corridors and rooms.
- 0% of the products in the restaurant come from local suppliers.
- The facility segregates waste (paper, glass, organic, plastic).
- Guests receive maps of walking and cycling routes, encouraging low-carbon sightseeing.

Irregularities:
- Rooms are cleaned daily without asking guests, which generates high consumption of water and chemicals.
- The rooms contain disposable mini-cosmetics and plastic cups.
- The hotel uses a large number of air conditioners, and there are no instructions on how to save energy.
- The lake area does not have any educational boards on nature conservation.

Can this facility obtain Green Key / Travelife certification? What changes are necessary?

APPENDIX 9

Green Key

This is an international certificate awarded to tourist facilities that meet high environmental standards and demonstrate care for the environment. The Green Key certificate covers a wide range of activities, such as energy saving, water management, waste minimisation and promoting eco-friendly practices among guests.

Application: Hotels, guesthouses, holiday resorts, restaurants and other tourism-related facilities.

EarthCheck

This is one of the most recognised certification systems in the tourism industry.
It is based on scientific principles of sustainable development and helps tourism businesses monitor and reduce their environmental impact.

Application: Hotels, airlines, travel agencies, ski resorts, theme parks.

Travelife)

This is a sustainable management certificate that assesses the impact of tourism companies on the environment, society and the economy.
Travelife supports organisations in developing and implementing sustainable development and socially responsible activities.
Application: Travel agencies, hotels, tourism organisations.

EU Ecolabel

EU Ecolabel is an EU certificate awarded to products and services that meet strict environmental standards.
In tourism, this applies to travel-related facilities and services that minimise their impact on the environment.
Application: Hotels, guesthouses, tourist facilities, tourist products.

Rural Tourism

A certificate awarded to agritourism operators in Poland who conduct their activities in accordance the principles of sustainable development, promote ecological methods of cultivation and breeding and engage tourists in activities related to nature and local culture.
Application: Agritourism farms, guesthouses, private accommodation in the countryside.

The Green Globe Certification

This is an international certification system that focuses on assessing the activities of tourism enterprises in the areas of sustainable development, environmental protection, resource management and social responsibility.
The Green Globe Certificate is awarded to facilities that implement responsible practices in various aspects of their operations.

Application: Hotels, resorts, travel agencies, tourism organisations.

The European Charter for Sustainable Tourism (CETS)

This is a programme that promotes sustainable tourism in national parks and nature reserves in Europe. It is one of the oldest European **programmes** for sustainable tourism, which focuses on promoting tourism in areas of exceptional natural and cultural value.

Blue Flag

The Blue Flag certificate is an international award for beaches, bathing areas and marinas, awarded by the Foundation for Environmental Education for meeting high standards in four main areas: water quality, environmental management, environmental education, and safety and services. The certificate is proof of **a** high level of cleanliness and safety, as well as compliance with the principles of sustainable development, which is important information for tourists.

Application: Bathing areas and beaches, marinas, tourist boats.

SOURCES

- "Certification programmes for sustainable tourism", author - Dawid Twardowski, Wrocław University of Economics
- https://www.ecotourism-europe.com/
- https://www.greenkey.global/
- Logo APPENDIX 9 – https://www.greenkey.global/,
- Logo APPENDIX 9 – https://earthcheck.org/
- Logo APPENDIX 10 - https://travelifesustainability.com/
- Logo APPENDIX 10 – https://ekologiczni.com.pl/?pdf=co-to-jest-ecolabel
- Logo APPENDIX 10 – https://agroturystyka.pl/
- Logo APPENDIX 11 - https://www.greenglobe.com/
- Logo APPENDIX 11 - https://www.europarc.org/
- Logo APPENDIX 11 - https://www.blekitnaflaga.org/

Prepared by:

Sandra Domagalska, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by the European Union



2.14. TOPIC: Local communities as stakeholders in sustainable tourism

PROCEDURE:

Steps	Time
Step 1: The concept of tourism stakeholders	5 min
Step 2: Responsible attitudes towards local communities and the environment	10 min
Step 3: Losses and benefits resulting from tourism development for the local community	15 min
Step 4: Ways of involving local communities in planning and implementation of tourism activities.	5 min.
Step 5: Quiz	10 min.



Number of participants: any



Planned time: 45 min



Materials needed: Laptop, multimedia projector, board, felt-tip pens/chalk, telephones (students)

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• Who the stakeholders of tourism are • What is pro-social tourism • What cooperation tools can be used to help local communities	• Describe the benefits and threats of tourism development for residents • List ways of involving local communities in the planning and implementation of tourism activities	• Attitudes of responsibility towards local communities and the environment.



Comments: -

STEP 1: The concept of tourism stakeholders.

The teacher introduces the concept *of tourism stakeholders* (Appendix 1) to students as individuals, groups, institutions or organisations that influence the development of tourism or are affected by it. The teacher discusses the most important stakeholder groups (Appendix 2).

STEP 2: Attitudes of responsibility towards local communities and the environment.

In the next step, the teacher discusses pro-social tourism and attitudes of responsibility towards local communities, cultural heritage, the natural environment and sustainable development (Appendix 3).

STEP 3: Losses and benefits of tourism development for the local community.

The teacher writes two words on the board: BENEFITS and RISKS (resulting from tourism development for the local community). The **students** spontaneously give their ideas, and the teacher writes them down in the appropriate columns. After the brainstorming session, the teacher compares the **students'** answers with the information provided in Appendix 4.

STEP 4: Ways of involving local communities in the planning and implementation of tourism activities.

The teacher discusses ways of involving local communities in the planning and implementation of tourism activities, displaying them on the board (Appendix 5).

STEP 5: Quiz.

The teacher conducts a quiz using the Kahoot online platform. First, create a free teacher account by visiting: https://create.kahoot.it/auth/login. If the teacher already has an account on the platform, they can simply use the direct link to the quiz: https://create.kahoot.it/share/spoecznosci-lokalne-jako-interesariusze-zrownowazonej-turystyki/4f7ddaa1-df1e-4ed2-9489-f1b942b6496f
Then click on the "Present Live" button (in the upper right corner). Next, display the computer screen on a projector and click on the "Start" button. Students scan the QR code with their phones or go to kahoot.it and enter the game PIN code. Questions and answers are displayed on the board. Students answer the questions by selecting the button on their phones in the colour corresponding to the selected answer. The test consists of 10 single-choice questions. After all answers have been given, the website will automatically summarise and display the results.

ANNEX 1

Tourism stakeholders are all individuals, groups, institutions or organisations that influence the development of tourism or are directly or indirectly affected by it. They are those who participate in the creation, organisation and use of tourism services or feel the effects of tourism activities.

APPENDIX 2

Several groups of **tourism stakeholders**:

1. Tourists

- People travelling for leisure, health or business purposes, for example.
- They are key participants in the tourism market – without them, tourism would not exist.

2. Tourism businesses

- Travel agencies, tour operators, carriers, hotels, restaurants, tourist attractions, guides
- Provide tourist services.

3. Residents of the tourist region

- The local community, which coexists with tourists, derives income from tourism, but also feels its negative effects (e.g. environmental pollution, noise, congestion, price increases).

4. Local and national authorities

- Local governments, marshal's offices, ministries
- Develop strategic plans for tourism, plan infrastructure, promote the country/region and regulate legal matters.

5. Industry and non-governmental organisations

- Chambers of tourism, associations, environmental organisations, local action groups.
- Represent the interests of specific groups or ensure sustainable development.

6. Scientific and educational institutions

- Universities, vocational schools, tourism research institutes.
- Train staff for the sector and conduct research on the impact of tourism.

7. Investors and the financial sector

- Banks, investment funds, private investors financing the development of tourism infrastructure.

8. Media

- Promote destinations, shape the image of regions and tourism trends.

APPENDIX 3

Pro-social tourism is a form of tourism that emphasises the positive impact of travel on local communities — economically, socially and culturally. Its main goal is to support the people living in the places visited, rather than maximising profits for travel agencies or large companies.

The development of local tourism should be sustainable and responsible, respecting both the natural environment and the communities living in the area.

Attitudes of responsibility towards local communities:

- Respect for local traditions, culture and customs.
- Supporting the local economy – buying products and services from local suppliers and artisans.
- Employing local residents in the tourism sector and providing them with decent working conditions.
- Avoiding activities that may lead to excessive commercialisation or displacement of the local population.

Responsible attitudes towards cultural heritage:

- Protecting monuments and historical sites from destruction or devastation.
- Promoting authentic forms of local culture (e.g. handicrafts, cuisine, music).
- Educating tourists about the value of the region's heritage.

APPENDIX 3

Responsible attitudes towards the natural environment:

- Care for nature conservation – avoiding pollution, not leaving waste behind, using environmentally friendly means of transport.
- Supporting environmental initiatives – participating in trail clean-up campaigns, tree planting, species protection.
- Reducing consumption of resources – water, energy, disposable materials.
- Promoting ecotourism and environmental awareness among tourists.

Responsible attitudes towards sustainable development:

- Planning tourism with long-term benefits for the region in mind, rather than short-term profits.
- Cooperation between local government, residents and businesses to create a coherent tourism strategy.
- Monitoring the impact of tourism on the environment and community and taking corrective action.

APPENDIX 4

Threats to the local community:

Social and cultural:

- Commercialisation of culture – traditions and rituals become a "show for tourists" and lose their authenticity.
- Social conflicts – between tourists and residents (noise, litter, lack of privacy).
- Loss of local identity – pressure to adapt to tourists' tastes.

Environmental:

- Environmental pollution – increased waste, exhaust fumes, sewage.
- Destruction of nature – trampling of trails, devastation of beaches, noise.
- Infrastructure overload – too many tourists cause degradation of the environment and facilities.

Economic:

- Price increases – food, property, rents, services.
- Seasonal work – employment only during the tourist season, lack of stability.
- Dependence on tourism – when tourists disappear (e.g. due to a pandemic), the local economy collapses.
- Outflow of profits – large hotel chains and foreign investors take profits out of the region.

Benefits for the local community:

Social and cultural:

- Protection and promotion of cultural heritage – revitalisation of monuments, popularisation of local traditions.
- Cultural exchange – contact with tourists promotes openness, language learning and tolerance.
- Increased local pride – residents appreciate their own culture and history more.

Environmental:

- Impetus for nature conservation – creation of national parks, reserves, ecotourism.
- Environmental education – tourism can promote pro-environmental behaviour.

Economic:

- New jobs – in the hotel industry, catering, transport, guiding, souvenir trade.
- Increased income for residents – greater demand for local products, services and handicrafts.
- Infrastructure development – better roads, transport, water and sewage systems, which also serve the residents.
- Influx of investment – construction of hotels, restaurants and recreational facilities.
- Diversification of the economy – less dependence on a single industry (e.g. agriculture).

APPENDIX 5

The development of tourism brings significant benefits, but only if it is planned and controlled. For tourism to develop in a sustainable and pro-social manner, it is important for residents to actively participate in every stage — from planning to implementation.

To this end, the following measures can be used:

1. **Public consultations:**

- organising meetings, debates and workshops with residents.
- collecting opinions, ideas and comments on tourism plans.
- enabling the local community to influence the decisions of authorities and investors.

2. Local partnerships:

- cooperation between local governments, non-governmental organisations, entrepreneurs and residents.
- creating local action groups or tourism councils.
- Involving local leaders and organisations in the development of tourism development strategies.
- jointly setting priorities and directions for development.

3. Creation of tourism products by residents:

- community participation in the creation of themed trails, events, workshops and attractions based on local culture.
- Encouraging the sharing of traditions, cuisine and crafts.

4. Supporting local entrepreneurship:

- training and grants for residents who want to start a tourism business (e.g. agritourism, handicrafts, catering).
- Promoting local products and services in the region's tourism offer.

5. Education and awareness raising:

- information campaigns on the benefits and risks of tourism.
- training in sustainable development, environmental protection and hospitality.

APPENDIX 6

Link to the website https://kahoot.it/



SOURCES

- Report: “Strategy for Sustainable Tourism Development until 2030” - https://www.gov.pl/web/sport/turystyka
- Polish Tourist Organisation https://www.pot.gov.pl
- Gołembski, G. (ed.) (2016). “Compendium of knowledge about tourism”. Wydawnictwo Naukowe PWN, Warsaw
- National Rural Network - https://ksow.pl/o-ksow/o-krajowej-sieci-obszarow-wiejskich
- Photo – APPENDIX 6 - https://kahoot.it/

Prepared by:

Sandra Domagalska, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by the European Union



2.15. TOPIC: Social responsibility and tourist education

PROCEDURE:

Steps	Time
Step1: What is social responsibility?	5 min.
Step 2: Good practices.	10 min
Step 3: Educating tourists.	10 min.
Step 4: Group work.	20 min.

OBJECTIVES:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What social responsibility is. • What behaviours companies should implement in order to operate in a sustainable manner.	• Describe ways in which tourism companies can support sustainable tourism. • Propose educational solutions for tourists. • Point out examples of responsible business practices.	• The role of social responsibility in tourism. • Shaping responsible and ethical attitudes among tourists.



Number of participants: any



Planned time: 45 min



Materials needed:
Laptop, multimedia projector, sheets of paper, felt-tip pens, crayons, envelope, scissors.



Comments: -

Click to see movie

STEP 1: What is social responsibility?

The teacher introduces the concept of "social responsibility in tourism" to students, explaining that it includes ethical, pro-environmental and community-supporting activities undertaken by tourists, businesses, authorities and other entities in the tourism industry (Appendix 1). The teacher emphasises that CSR is not only about ecology but also about educating tourists, respecting culture and minimising the negative effects of travel.

In the next step, the teacher discusses the three main areas of CSR using Appendix 2. The teacher discusses actions taken by authorities (restrictions on mass tourism, educational campaigns, promotion of slow tourism) and businesses (green technologies, waste segregation, sustainable cuisine, social partnerships).

STEP 2: Good practices.

The teacher introduces three examples from Appendix 3, discussing them as inspiration for the pupils. The teacher uses the appendices during the presentation.Boutiquehotel Stadthalle (Austria): a zero-energy hotel that reduces CO_2 emissions (e.g. by eliminating minibars), has green roofs and gardens and offers local and organic cuisine.SH Hotels & Resorts (Denmark): a hotel that derives 100% of its energy from wind, reduces water and energy consumption, has a 'Don't clean – support Green Kayak' programme (Appendix 4), uses the Too Good To Go app, trains and educates guests and staff and offers bicycle rental (Appendix 5).3 Sisters Adventure Trekking (Nepal): creates jobs for women, supports local communities through trekking and undertakes educational and social activities. The teacher displays a photo of the three sisters who founded the company (Appendix 6).

STEP 3: Educating tourists.

In the next stage, the teacher discusses the forms of education presented in Appendices 7 and 9. They then present two examples of campaigns. They use the appendix showing the poster (Appendix 8) and show a film promoting the campaign (Appendix 10).

STEP 4: Group work.

In the next stage, students are divided into four groups. The pupils are asked to create a mini social campaign that educates tourists about responsible behaviour – ecological, social and cultural – in a destination or for a social group that they draw from cards prepared by the teacher (printable template – Appendix 6). The pupils are asked to focus on examples of inappropriate tourist behaviour (littering, noise, disrespect for residents, destruction of nature and the effects of overtourism). The material created for the campaign can be a poster, a mini-spot recorded on a mobile phone or a brochure for tourists.

ANNEX 1

Social responsibility – CSR (Corporate Social Responsibility) in tourism is an approach in which all entities involved in tourism – tourists, tourism businesses, local authorities and communities – operate in an ethical and sustainable manner, respecting people, the environment and local culture. According to the European Commission's definition, **CSR** is the responsibility of companies for their impact on society.

APPENDIX 2

Social responsibility covers issues such as:

1. Environmental protection:

- minimising the negative impact on nature
- conserving resources (water and energy)
- supporting pro-environmental activities
- reducing waste

2. Tourist education:

- respect for the culture, religion and social norms of the place visited
- responsible use of tourist attractions (e.g. not damaging monuments)
- avoiding behaviour that may harm the community or the environment

3. Responsible tourism management – government/local government:

- limiting mass tourism in overcrowded areas (taxes, additional fees, visitor limits)
- supporting sustainable tourism or "slow tourism" (social actions, information campaigns, promotion)
- planning tourism development in a way that does not destroy local resources

4. Responsible tourism economy – businesses:

- reducing emissions and resource consumption
- protecting the environment
- investing in green technologies
- supporting local communities (purchasing local products)
- social engagement (e.g. sponsoring events, employee volunteering)

APPENDIX 3

Hotel Stadthalle (Austria)

Boutiquehotel Stadthalle is a hotel located in Vienna, in the 15th district, and is considered one of the pioneers of urban hotel sustainability. It has been operating in its current form since 2002, and in 2009 it was expanded with a section built to passive house standards, which significantly accelerated its eco-friendly transformation.

The hotel implements a wide range of pro-environmental measures, including:

- Energy balance (zero-energy balance): the facility generates as much energy as it needs, thanks to the use of a ground source heat pump, photovoltaic panels and a solar installation.
- Water and electricity saving: rainwater and well water are used to flush toilets and water plants, eco-friendly shower heads have been installed in bathrooms and all lighting is based on LED technology.

APPENDIX 3

- **CO_2 emission reduction**: according to the hotel, eliminating minibars from rooms reduces annual emissions by over 21 tonnes of CO_2.
- **Waste management and sustainable materials**: the hotel fully segregates waste, uses recycled and upcycled furniture (created in cooperation with a recycling company) and the detergents and cosmetics used are free of microplastics.
- **Sustainable cuisine and local sourcing**: breakfasts are prepared exclusively from organic and local products; the menu includes vegetarian and vegan dishes; coffee is delivered by sea rather than by land whenever possible, reducing the carbon footprint.
- **Greenery and biodiversity in the city**: the hotel has a green patio, an ivy-covered façade and a lavender garden on the roof, which is home to bees, thanks to which it also produces its own honey.
- **Promoting green transport**: guests arriving by train or bicycle can take advantage of the "Green Bonus", a 10% discount.

SH Hotels & Resorts (Denmark)

SH Hotels & Resorts is a hotel chain that has adopted a CSR policy which includes environmental management, social responsibility, fair business practices and care for local communities. The chain has announced that it is pursuing a sustainable development strategy: reducing its negative impact on the environment, conserving resources, implementing rational energy and water management and minimising waste — typical elements of CSR in the hotel industry.

The company's policy is dominated by the narrative that hotels should coexist harmoniously with their surroundings — the natural environment, guests, the local community and partners.

APPENDIX 3

Environmental measures offered by the hotel:

- Reducing water pressure in taps and shower heads to decrease water consumption.
- Half of the corridor lights are turned off at night.
- During Earth Hour, all lights in the hotels are turned off.
- The hotel is 100% powered by wind energy.
- The hotel serves a homemade gin called "Breakfast Gin", made from leftover fruit from the breakfast buffet.
- Coffee grounds are used as fertiliser for plants.
- Rubbish is sorted and all organic waste is used to produce biogas.
- 95% of light sources are LED or energy-efficient.
- If a guest declines room cleaning during their stay, DKK 50 is donated to Green Kayak to support efforts to keep the city's canals clean (Appendix 4).

APPENDIX 3

- It enables the use of food that has not been eaten in the restaurant via the Too Good To Go app (an app where guests can pick up a package of food at a very low price, thus preventing food waste).
  It encourages guests to book a Green Kayak adventure through the hotel.
  It provides its employees with paid training and opportunities for continuous education.

The hotel also encourages its guests to:

- unplug devices when they are charged or not in use
- reuse towels during their stay
- turn off the tap when not in use
- rent a bicycle at the reception desk to explore the city (Appendix 5)
- refuse plastic bags when shopping
- refill their bottles free of charge at the filtered water stations located in the hotel restaurant

APPENDIX 4

A simple thing for the environment: when you say "No, thank you" to room cleaning, you say "Yes, please" to cleaning the city's canals.

By limiting room cleaning at the request of hotel guests, Green Kayak supports efforts to keep Denmark's city canals clean.



APPENDIX 5



Bicycles available for hire at SH Hotels & Resorts.

APPENDIX 3

3 Sisters Adventure Trekking This is a Nepalese social enterprise that supports local women and promotes sustainable tourism. The organisation enables travellers to learn about Nepalese culture and the lives of women in remote regions. It was founded in 1994 in response to problems of harassment of tourists and a lack of education and employment opportunities for women.

Three sisters, Lucky, Dicky and Nicky Chhetri, were the first in Nepal to employ female guides and porters, and eventually founded the NGO Empowering Women of Nepal, funded by trekking activities and donations. The organisation offers educational programmes, including those preparing women for work in tourism.

To date, more than 2,000 women have been trained and the company employs more than 150 people.

3 Sisters Adventure Trekking creates routes that benefit local communities, such as the "Cultural Journey to Solu", which supports an underdeveloped region affected by earthquakes. Trekking with the company allows tourists to discover the authentic culture of Nepal and support the local economy.

Lucky, Dicky and Nicky Chhetri – founders of 3 Sisters Adventure Trekking



Click to see movie

APPENDIX 7

Educating tourists can reduce the negative effects of travel and enhance the positive social, cultural and environmental effects, making tourism more sustainable for present and future generations.

Educating tourists about sustainable development and social responsibility can be achieved by:

1. Providing information on the principles of responsible travel, e.g. how to save water and energy and choose environmentally friendly transport.
2. Organising campaigns and preparing educational materials – leaflets, films and information boards on trails, in hotels and tourist information centres.
3. Promoting local values and customs – encouraging tourists to respect the local culture, nature and community.
4. Organising workshops and meetings with local guides – direct contact allows people to understand how tourism affects the environment and the lives of residents.
5. Encouraging support for the local economy – choosing local services, products and guides strengthens communities and reduces the negative impact of mass tourism.
6. Providing education about nature conservation – rules for travelling on trails, no littering and respecting protected areas.
7. Promoting ethical choices for accommodation and attractions – choosing facilities with eco-certificates and attractions that do not harm animals or the environment.

ANNEX 7

Local campaigns — example from Poland: Tourism Connects (Kraków, Poland).

The Tourism Connects project is an initiative of the City of Kraków to promote responsible tourism. The idea is to bring together residents, tourists, entrepreneurs and various sectors — tourism, culture, science and business — to work together to ensure the quality of tourism and social responsibility. The project calls for conscious communication — promoting values such as sustainable development, respect for cultural heritage, cooperation between local communities and participation in debates and events on responsible tourism.

Appendix 9.

The "Tourism Connects" project – working together for responsible tourism in Krakow! – campaign poster.



APPENDIX 9

National campaigns – example from Germany: "Simply FEEL GOOD"

The aim of the campaign is to promote sustainable tourism in Germany — tourism that combines the pleasure of travelling with a responsible approach to the environment, climate, resources and local communities. The campaign website serves as a source of inspiration and information. It features around 140 ideas for sustainable travel, selected in a competition. The ideas are divided into four categories: "Discovering", "Pleasures", "Accommodation" and "On the road". This makes it easier to find a trip that suits one's needs while complying with the principles of sustainable development.

The campaign is promoted through various channels: advertising, social media, PR materials and newsletters. One of the key elements is to show that sustainable tourism does not mean giving up comfort or attractions — you can "have fun", enjoy your trip and at the same time minimise the negative impact on the environment and local communities.

Appendix 5.

Film promoting the "Simply FEEL GOOD" campaign



APPENDIX 11

The students are divided into four teams. The groups are tasked with creating a mini social campaign that educates tourists about responsible behaviour — ecological, social and cultural — in a destination or for a social group drawn from cards prepared by the teacher.

1. 1 Examples of social groups and destinations:
2. Morskie Oko
3. Krakow
4. Masuria
5. Families with children
6. Youth
7. Cyclists

Students are asked to focus on examples of inappropriate tourist behaviour (littering, noise, disrespect for residents, destruction of nature and the effects of overtourism). The campaign materials may include a poster, a mini-spot recorded on a mobile phone or a brochure for tourists.

Time to complete the task: 12 minutes
Time for presentation: 2 minutes per group

SEA EYE	**FAMILIES WITH CHILDREN**
KRAKOW	**YOUTH**
MAZURY	**CYCLISTS**

SOURCES

- Malara, Z., CSR in the practice of tourism enterprises, University of Economics Publishing House, 2010.
- Johannn, M., "Social Responsibility of Tourism Organisations," Warsaw School of Economics Publishing House, 2021.
- Responsible and sustainable tourism in Poland: a study of the level of knowledge, needs and personal involvement. General report from the study. Polish Tourist Organisation, 2024.
- https://sktpetri-hotel-copenhagen.h-rez.com/index.htm
- convention.krakow.pl
- https://www.3sistersadventuretrek.com/company/about-us

- Photo - APPENDIX 4 - https://sktpetri-hotel-copenhagen.h-rez.com/index.htm
- Photo - APPENDIX 5 - https://sktpetri-hotel-copenhagen.h-rez.com/index.htm
- Photo - APPENDIX 6 - https://www.3sistersadventuretrek.com/company/about-us
- Photo – APPENDIX 8 – convention.krakow.pl
- Film - APPENDIX 10 - https://www.waszaturystyka.pl/niemiecka-kampania-feel-good-wydobywa-z-podrozy-to-co-najbardziej-wartosciowe/

Prepared by:

Sandra Domagalska, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by the European Union



2.16. TOPIC: International cooperation in the organisation of sustainable tourism

PROCEDURE:

Steps	Time
Step: Introduction. Sustainable tourism	2 min
Step 2: Goals of international cooperation	15 min
Step 3: International organisations	13 min
Step 4: Summary	15 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What sustainable tourism is • What are the most important international institutions working towards sustainable tourism	• Identify the benefits of global efforts to promote responsible tourism • Give examples of international projects and programmes	• Why cooperation between countries in the field of sustainable tourism is crucial



Number of participants: any



Planned time: 45 min



Materials needed: Laptop, multimedia projector, telephones (students).



Comments: -

STEP 1: Introduction. Sustainable tourism

The teacher briefly recalls the definition of sustainable tourism – i.e., tourism that takes into account environmental protection, the well-being of local communities, and economic benefits (Appendix 1).

STEP 2: Goals of international cooperation

The teacher displays the question and asks, **"Can sustainable development in tourism be achieved in just one country?"** *(Appendix 2).* Students share their thoughts.

EXAMPLE ANSWER:

- No, sustainable development in tourism cannot be achieved in just one country because the natural environment, animal migration routes, oceans, and climate do not have borders. Problems such as pollution, climate change, and resource overexploitation affect the whole world. Tourism is also an international activity—tourists travel between countries—so standards and rules for protecting nature and heritage must be shared across countries. Only cooperation between countries and international organisations can effectively protect the environment and ensure responsible tourism.

The teacher displays the question and asks, **"Why is international cooperation important?"** *(Appendix 3).* Students share their thoughts.

EXAMPLE ANSWERS: tourism is global in nature; environmental problems know no borders; common standards facilitate the protection of resources; the exchange of experiences and good practices; and more effective promotional and educational activities.

In the next part, the teacher presents the objectives of international cooperation using **Appendix 4**.

STEP 3: International organisations

In the next stage, the teacher discusses four examples of international organisations and displays slides showing their logos *(Appendix 5).*

STEP 4: Summary

In the next stage, the teacher summarises the knowledge acquired during the lesson. To do this, they use the Mentimeter.com platform. Instructions for registering, creating a board, and completing the task are in Appendix 7. The teacher shows Appendix 6 to the students. The teacher then asks the students the following questions: "What forms of international cooperation did you learn about in the lesson?" and "What are the advantages of international cooperation?" The teacher comments on the answers. Sample answers can be found in Appendix 7.

APPENDIX 1

Sustainable tourism is a form of tourism that takes into account the needs of tourists and local communities, protects the natural and cultural environment, supports the economic development of tourist regions, and does not limit the opportunities of future generations.

Sustainable tourism is based on three pillars:

- **environmental** – protection of nature and landscape,
- **social** – respect for local culture and communities,
- **economic** – stable and equitable economic development.

Can sustainable development in tourism only be achieved in one country?

Why is international cooperation important?

ANNEX 4

The most important objectives of international cooperation are:

1. Environmental protection

- limiting the negative impact of tourism on ecosystems (emissions, waste, landscape degradation),
- protecting biodiversity, protected areas, and natural heritage,
- joint action on cross-border issues (climate change, marine pollution, mass tourism).

2. Sustainable economic development of regions

- ensuring long-term economic benefits for countries and local communities,
- reducing development disparities between regions,
- supporting local entrepreneurship and creating stable jobs.

3. Protection of cultural heritage

- preserving local traditions, monuments, and cultural identity,
- preventing the commercialisation and degradation of culture under the influence of mass tourism,
- promoting intercultural dialogue.

4. Establishing common standards and principles

- creating international standards (e.g. eco-certificates),
- harmonising tourism and environmental policies,
- exchanging good practices and experiences between countries.

5. Education and awareness raising

- educating tourists about responsible behaviour,
- training tourism staff in the spirit of sustainable development,
- promoting the idea of “responsible travel”.

6. Joint planning and management of tourism

- controlling overtourism,
- better management of destinations of international importance,
- crisis response (pandemics, natural disasters).

7. Promoting peace and international cooperation

- strengthening relations between countries through tourism,
- building mutual understanding and tolerance between nations.

APPENDIX 5

UNWTO – World Tourism Organisation (United Nations):

- the most important international organisation for tourism,
- promotes sustainable and responsible tourism,
- collects and analyses statistical data on tourist traffic,
- assists developing countries in building their tourism sector,
- creates strategies, reports, and codes of ethics, including the Global Code of Ethics for Tourism – a set of rules for responsible travel.

The organisation has approximately 160 member states, as well as associate members (regions, cities) and affiliated members (universities, companies).

UNESCO

- is responsible for the protection of cultural and natural heritage,
- maintains the World Heritage List,
- supports sustainable tourism management in protected areas,
- counteracts the degradation of monuments caused by mass tourism,
- increases the tourist recognition of regions.

The organisation has approximately 190 member states.

APPENDIX 5

European Travel Commission (ETC):

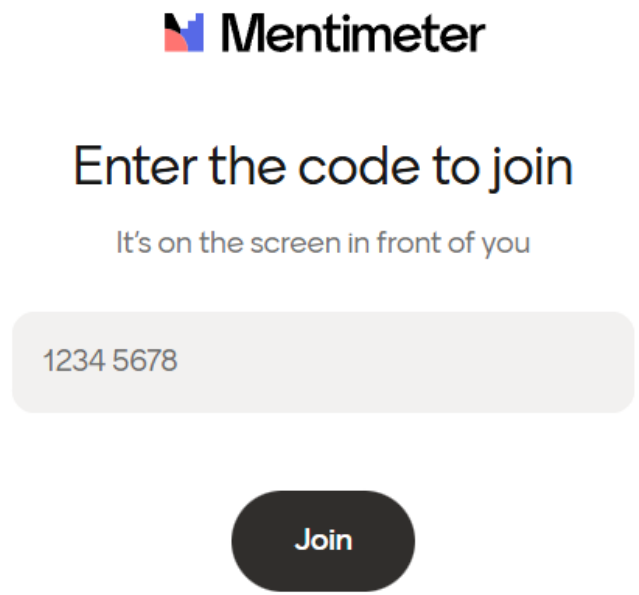
- runs promotional campaigns in the USA, Canada, China, Japan, Latin America, etc.,
- publishes industry reports (e.g. *European Tourism Trends & Prospects*),
- conducts research and analyses of the tourism market (trends, forecasts, traveller behaviour),
- organises workshops, conferences, and research projects,
- represents European tourism at international forums,
- creates joint marketing campaigns (e.g. the **visiteurope.com** platform).

The organisation has approximately **35 European member countries**.

World Federation of National Travel Agents' Associations (UFTAA):

- is an international organisation bringing together national associations of travel agencies and travel agents from around the world,
- represents the interests of travel agents internationally and supports the development of professional, ethical, and sustainable tourism,
- represents travel agents in dealings with, among others, **UN Tourism** (formerly UNWTO), airlines, hotels, a
- has members that are national chambers and associations of travel agencies (not individual agencies),
- develops professional and ethical standards,
- provides training and certification (e.g. the **UFTAA Training & Education Programme**),
- supports consumer protection and good market practices,
- promotes dialogue between agents and tourism service providers.

www.menti.com



1. Accessing the website and registering

- Open the website: https://www.mentimeter.com/
- Click **Sign up** or **Log in** if you already have an account.
- You can register using your Google account, Microsoft account, or an email address.

2. Creating a new presentation

- After logging in, click the **Create a presentation** button.
- Give your presentation a name (e.g. *Brainstorming*).
- Click **Create**.

3. Adding a Word Cloud slide

- Click **Add slide**.
- Select **Word Cloud** from the list of slide types.
- Choose the option **Participants enter multiple words**.

4. Configuring the word cloud

- In the **Your question** field, enter the question:
  What forms of international cooperation did you learn about in class?
- Click **New slide**.
- In the **Your question** field, enter the question:
  What are the advantages of international cooperation?

5. Sharing with participants

- Click **Present**.
- The following will appear on the screen: a code (e.g. *1234 5678*) and the website address **www.menti.com**.
- Participants go to **www.menti.com**, enter the code, and add their words to the first question. They can give several answers.

6. Displaying results

- The words entered automatically create a word cloud.
- The more often a word appears, the larger it will be in the cloud.
- You can discuss the results live.
- To move on to the next question, students click **Next question**.

7. Moving to the next question

- Once you have finished collecting answers to the first question, return to the slides and select the next one.
- The new question will automatically appear on the students' phones.

APPENDIX 8

EXAMPLE ANSWERS TO THE QUESTIONS

What forms of international cooperation did you learn about in class?

- creating joint tourism strategies and policies between countries,
- implementing international tourism projects,
- exchanging experiences and good practices between countries and regions,
- cooperation within international organisations (e.g. UNWTO, UNESCO, the EU),
- educational and training programmes for tourism industry employees,
- joint promotional activities for regions and countries,
- protection of cultural and natural heritage in cross-border areas,
- financing pro-environmental initiatives through international funds.

What are the advantages of international cooperation?

- better protection of the natural environment,
- preservation and promotion of cultural heritage,
- exchange of experiences and good practices between countries,
- development of sustainable tourism,
- increased tourist attractiveness of regions,
- economic development and job creation,
- access to international funds and programmes,
- standardisation of tourism service quality standards,
- development of intercultural cooperation and tolerance,
- more effective tourism promotion in foreign markets.
- Thanks to international cooperation, tourism can develop responsibly and sustainably.

SOURCES

- Halina Kiryluk, "International Cooperation in Tourism," Białystok University of Technology, Faculty of Management, Department of Tourism Economics, 2014.
- Wiesław Alejziak, Tomasz Marciniec, International Tourism Organisations, Albis, 2003
- Making Tourism More Sustainable - A Guide for Policy Makers, WTO, 2005
- https://www.untourism.int/global/publication/tourism-and-sustainable-development-goals-journey-2030
- https://etc-corporate.org/

- APPENDIX 6 – mentimeter.com

Prepared by:

Sandra Domagalska, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by the European Union



2.17. TOPIC: International good practices in sustainable forms of tourism

PROCEDURE:

Steps	Time
Step 1: Introduction – What are good practices in sustainable tourism?	3 min.
Step 2: Examples of good practices in sustainable forms of tourism	17 min.
Step 3. Summary	25 min.

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What measures should an institution implement in order to operate in a sustainable manner?	• Give examples of good practices from different countries around the world. • Propose solutions that can be implemented in tourism to make it more sustainable.	• The importance of sustainable tourism on an international scale. • Responsible attitudes of tourism industry employees.



Number of participants: any



Planned time: 45 min



Materials needed: Laptop, multimedia projector, sheets of paper.



Comments: -

STEP 1: Introduction – : What are good practices in sustainable tourism?

The teacher introduces the concept of "good practices" in sustainable tourism and why it is important for the environment, local communities and the economy (Appendix 1). The teacher divides the students into four groups. Each group receives one example of good practice:
Group 1 – Greenways (Europe)
Group 2 – Responsible Tourism Kerala (India)
Group 3 – FIVE Hotels and Resorts (Dubai)
Group 4 – Byway Travel (United Kingdom)
The teacher can print out slips of paper with the names of the examples (Appendix 2) in advance and draw lots among the group representatives.

STEP 2: Examples of good practices in sustainable forms of tourism **.**

In the next step, the teacher uses Appendices 3, 5, 7 and 9 to discuss four examples of good practices. After each example, they show a film (Appendices 4, 6, 8 and 10). Each group is tasked with noting down information about their example.

STEP 3: Group work.

In the next stage, the teacher displays the questions (Appendices 11, 12, 13). After each question, the students have 2 minutes to think. Then each group answers the question.

Question: What constitutes good practice in your example?

EXAMPLE ANSWERS:

Greenways (Europe): Creating a network of green walking, cycling and water trails that connect nature, culture and heritage of regions, promoting non-motorised and sustainable tourism.

Responsible Tourism Kerala (India): Developing responsible tourism that brings real benefits to local communities, protects the environment and preserves the cultural heritage of the region.

STEP 3 Group work

FIVE Hotels and Resorts (Dubai): Operating luxury hotels in accordance with the principles of sustainable development, combining premium offerings with environmental and social responsibility.

Byway Travel (United Kingdom): Organising slow travel without flying, based on rail, public transport, bicycles and walking routes.

Question: What activities support environmental protection?

EXAMPLE ANSWERS:

Greenways (Europe):

- Promoting walking and cycling instead of car transport,
- Protecting the landscape and natural resources,
- Limiting the pressure of mass tourism,
- Providing environmental education for tourists.

Responsible Tourism Kerala (India):

- Reducing waste,
- Saving water and energy,
- Protecting local ecosystems,
- Promoting non-mass and low-impact tourism.

STEP 3 Group work

FIVE Hotels and Resorts (Dubai):

- employing local residents **in Dubai** in hotels, restaurants, and sustainability teams,
- cooperation with **local suppliers in the UAE** and service providers,
- partnerships with **Dubai-based** environmental organisations and NGOs,
- staff training programmes focused on sustainability and resource efficiency,
- supporting **local initiatives in Dubai** related to environmental protection and education.

Byway Travel (United Kingdom):

- working closely with **local communities across the UK and Europe**, including accommodation providers, guides, and transport operators,
- supporting small, family-run businesses instead of global chains,
- encouraging tourists to spend more time (and money) **in visited regions**,
- promoting **regional** culture, food, and traditions,
- reducing pressure on overcrowded destinations and helping **lesser-known areas** benefit from tourism.

STEP 3 Group work.

Responsible Tourism Kerala (India):

- residents work as guides, artisans, and hosts,
- selling local products and services to hotels and tourists,
- organising workshops (crafts, cooking, agriculture).

FIVE Hotels and Resorts (Dubai):

- employment of local workers,
- cooperation with local suppliers,
- investment in employee skills development.

Byway Travel (United Kingdom):

- using accommodation and services from local suppliers,
- promoting lesser-known regions,
- supporting the local economy,
- educating tourists about responsible choices.

Appendix 1

Good practices are proven methods that yield optimal results in a given area and are considered models to follow.

In tourism, good practices are proven measures that improve service quality and tourist satisfaction while supporting sustainable development and local communities.

- The most important good practices in tourism in the field of sustainable tourism are:
- reducing negative environmental impact,
- saving water and energy in accommodation facilities,
- promoting public transport and environmentally friendly modes of travel.

Group 1 – Greenways (Europe)
Group 2 – Responsible Tourism Kerala (India)
Group 3 – FIVE Hotels and Resorts (Dubai)
Group 4 – Byway Travel (United Kingdom)

Greenways – Europe

Greenways are a network of green walking, cycling, and water trails located away from busy roads.
They integrate nature, local culture, and historical heritage to promote sustainable tourism.
They include trails designed for non-motorised transport and for exploring regions.

Their aim is to develop environmentally friendly tourism, in particular ecotourism and heritage tourism, while promoting a healthy, active lifestyle and supporting the local economy, with respect for natural, cultural, and landscape resources.

All Greenways routes in Central and Eastern Europe are based on common principles. These principles focus primarily on the active involvement of local communities through the promotion of entrepreneurship, the creation of “green” jobs and new sources of income, as well as the protection and restoration of traditional professions. Another important element is care for the natural environment, cultural heritage, and the preservation of landscape values.

Great emphasis is placed on the use of local resources, such as accommodation and catering facilities, tourist and guiding services, and regional products. These routes promote cooperation between countries, regions, cities, and towns, as well as between their inhabitants. At the same time, they support local communities in discovering and strengthening their own cultural and social identity and in improving their quality of life.

Greenways also have an educational function – they provide tourists with information and enable them to learn more about the region, its specific characteristics, local initiatives, activities, and organisations. They promote non-motorised and environmentally friendly forms of travel, recreation, and sport, in particular ecotourism and heritage tourism. In cities, they encourage the use of more sustainable modes of transport, such as walking, cycling, and public transport, rather than cars.

All these activities are aimed at motivating physical activity and improving health and safety during travel and leisure.

Appendix 4

Promotional film for the Greenway4tour network of green trails: https://youtu.be/ND4_KPFmUKE



Appendix 5

Responsible Tourism Kerala (India)

- Responsible Tourism Kerala (RT Kerala) is one of the world's best-known responsible tourism programmes, implemented by the authorities of the state of Kerala in southern India. Its main objective is to develop tourism in a way that brings real benefits to local communities, protects the natural environment, and strengthens local culture.

Main objectives of the programme:

- inclusion of local communities – residents are active participants in tourism (guides, hosts, artisans, artists),
- environmental protection – waste reduction, resource conservation, ecosystem protection,
- preservation of cultural heritage – traditions, cuisine, crafts, local festivals,
- support for the local economy – creating jobs and additional sources of income,
- partnership – cooperation between the administration, tourism businesses, and residents.

How does Responsible Tourism work in Kerala?

- hotels and tour operators purchase products and services locally (food, handicrafts, services),
- responsible tourism villages are created, e.g. Kumarakom, Vythiri, Thekkady,
- tourists can take part in craft workshops, cooking, fishing, and agricultural work,
- low-cost and non-mass tourism is promoted.

Appendix 6

Promotional film for the sustainable tourism programme in the Kerala region: https://www.youtube.com/watch?v=YUPPGgOkcWs



APPENDIX 7

FIVE Hotels and Resorts (Dubai)

FIVE Hotels and Resorts is a hotel brand based in Dubai, known for its dynamic lifestyle and modern design. At the same time, the company declares its commitment to **sustainable development**, striving to combine premium offerings with environmental and social responsibility.

The hotel implements a number of measures aimed at reducing its negative impact on the environment:

- reducing **energy and water** consumption through modern technologies and building management systems,
- use of **energy-efficient installations** (LED, smart air conditioning),
- reducing single-use plastics and developing **waste management and recycling**,
- initiatives related to **CO_2 emission compensation** and carbon footprint reporting,
- striving for compliance with international ESG standards.

In the social area, FIVE focuses on:

- creating **attractive jobs** and ensuring safe working conditions,
- promoting **diversity and inclusiveness** in the workplace,
- investing in employee skills development,
- cooperating with **local suppliers and partners**,
- charitable and social activities for local communities.

APPENDIX 8

Hotel promotional film: https://www.youtube.com/watch?v=sjaSOyQa8eI



ANNEX 9

Byway Travel (United Kingdom)

Byway Travel is a British travel company specialising in sustainable, low-carbon travel, recognised internationally as an innovative example of slow travel in practice.

- The agency organises holidays without flying, relying mainly on:
- railways,
- public transport,
- bicycles,
- walking sections of the routes.
- The trips take you through lesser-known regions of the United Kingdom and Europe, away from mass tourism.

Main principles and rules:

- minimising carbon footprint – no flights as standard,
- slow travel – a slower pace, getting to know places more deeply,
- discovering the periphery – small towns, the countryside, natural regions,
- supporting local communities – accommodation and services from local providers,
- climate education – conscious transport choices.

Significance for sustainable tourism:

- the company shows that attractive travel is possible without flying,
- it realistically reduces CO_2 emissions generated by tourism,
- it promotes a change in tourist behaviour, not just “green marketing”,
- it sets an example of grassroots innovation in the tourism sector.

Promotional film for **Byway Travel, an agency** specialising in **sustainable, low-carbon travel** https://www.youtube.com/watch?v=piGlq05il9s



What constitutes good practice in your example?

What actions support environmental protection?

Is the local community involved?

How?

SOURCES

- “Ecotourism and sustainable tourism. A collection of good practices FROM PLANNING TO IMPLEMENTATION”, Dominika Zaręba, Partnership Fund.
- https://www.keralatourism.org/responsible-tourism/
- https://www.five-holdings.com/sustainability-at-five/
- https://www.byway.travel/about/sustainability

- Film – APPENDIX 4 – https://youtu.be/ND4_KPFmUKE
- Film -APPENDIX 6 – https://www.youtube.com/watch?v=YUPPGgOkcWs
- Film – APPENDIX 8 – https://www.youtube.com/watch?v=sjaSOyQa8eI
- Film - APPENDIX 10 - https://www.youtube.com/watch?v=piGlq05il9s

Prepared by:

Sandra Domagalska, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by the European Union



2.18. TOPIC: Is it really beneficial? Case study.

PROCEDURE:

Steps	Time
Step: Media article on low-cost travel.	5 min.
Step 2: Division into groups and discussion.	20 min.
Step 3: Working in groups on an alternative offer.	15 min.
Step 4: Presentation of the results of group work.	5 min.

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• that air travel is a source of high CO2 emissions • that promotions and bargain prices often come with a large ecological footprint	• assess tourist offers in terms of sustainable development • prepare an attractive tourist offer based on the principles of sustainable development	• the need to change travel habits to more sustainable ones



Number of participants: minimum 6 people



Planned time: 45 min.



Materials needed:
copies of an article about travelling on a budget or an electronic version of it, caps/hats made from recycled materials in six colours, a large bag, paper and pens for note-taking and group work, an internet connection



Comments: -

STEP 1: Media article on cheap travel.

The teacher announces that the topic of the lesson will be cheap travel. They provide each student with an article from Appendix 1 (in the form of a photocopy or a QR code for a PDF file on an electronic device). They explain that the students have 5 minutes to read the text.

STEP 2: Division into groups and discussion.

Once everyone has read the article, and the teacher explains that they will discuss it using Edward de Bono's thinking hats method. Each participant draws a hat from a bag. Everyone prepares to speak from their assigned perspective:

- white – the student tries to be objective, talks about facts, and presents data and figures;
- red – the student talks about their emotions and expresses an emotional point of view (fears, joy, enthusiasm) but does not justify their emotions;
- yellow – the student points out the advantages of a given proposal;
- black – the student criticises certain aspects of a given proposal;
- green – the student suggests their own ideas and supplements the observations of others;
- blue – the participant (facilitator) organises and supervises the statements of the other hats. This hat appears individually. In younger classes, it is advisable for the teacher to take on this role.

Students have about 10 minutes to gather arguments for the discussion, and they can use the Internet to do so. Then a discussion is held.
Examples of statements for each hat are presented in solution 1.
The blue hat keeps track of the discussion time.

STEP 3: Working in groups on an alternative offer.

The teacher points out that the traveller mentioned in the article lives in a region that is very attractive to tourists. The students divide into groups of 3–4 and try to prepare an offer that would meet the presumed needs of Mr Martin Krauss from Heidenheim and at the same time comply with the principles of sustainable development of Agenda 2030. Students may use the Internet to help them. They can refer to the diagram in Appendix 2. If they do not finish the task during the lesson, they complete it as homework and present it in the next class.

STEP 4: Presentation of the results of group work.

A group is randomly selected or chosen to present their offer to the class. The teacher asks the class to reflect on the question posed in the title of the lesson: Is fast, cheap travel beneficial in all respects?

APPENDIX 2

Customer type: - ...

Alternative offer:

Programme, attraction, activity	Traveller's interests	Benefit from a sustainability perspective

SOLUTION TO THE EXAMPLE Statements by the coloured hats

White:
Mr **Krauss's** carbon footprint for six flights is **2.7 tonnes of CO_2**; a return flight without transfers would generate a carbon footprint of **2.9 tonnes of CO_2** (calculated using https://co2.myclimate.org/en/portfolios?calculation_id=7608638). Both values significantly exceed the limit that should be maintained to avoid drastic climate change.
Temperatures in the places visited ranged from **15 to 31 degrees Celsius**.
Red:
Such a journey to the destination is a failure.
I would never go on a 12-day trip with only hand luggage, especially with such temperature differences in the places I was staying.
Leaving the car on the outskirts of the airport makes me anxious; I wouldn't be able to relax because I'd be worried about whether the car would be okay when I got back from holiday.
Yellow:
It really is a half-price holiday.
So many attractive places in one trip.
The great thing is that you can also shop in the duty-free zone.
Black:
If the flights were delayed, it would ruin the holiday.
Bed linen in hotels has to be changed after one night; I would feel guilty because it's not environmentally friendly.
Gastric problems can occur on such trips.
Green:
Using a medium-sized detached house with a good ecological standard involves emissions of approx. **2–3 tonnes of CO_2 per year**.
It is worth rolling clothes in your rucksack, as they take up less space.
Dubai and the Maldives are quite a hackneyed photographic motif.
The article seems to be an advertisement for **Wizz Air** airline.

SOLUTION TO THE EXAMPLE Alternative offer for Mr Krauss from Heidenheim

Customer profile:
Mr Krauss enjoys holidays in sunny destinations.
Mr Krauss would appreciate the opportunity to swim and relax.
Mr Krauss enjoys good food.
Mr Krauss enjoys photography, especially from high places, etc.
Based on these interests, you could offer him, for example, to plan a holiday a few weeks in advance in the Lake Constance region:

Programme, attraction, activity	Traveller's interests	Benefit from a sustainability perspective
Train journey to Lindau		train connection from Heidenheim approx. 3 hours, you don't lose several days travelling, you get a break from driving, supporting the development and maintenance of infrastructure in your region of residence
Dornier Museum, Zeppelin Museum	Interest in flying, + the Dornier Museum offers a wide range of breakfast options	
Excursion on Lake Constance	Opportunity to take photographs	
Lindau Lighthouse	Opportunity to take photographs	
Pfänderbahn and Pfänder peak	a view from above of Lake Constance and the surrounding towns, photo opportunity	
…		

SOURCES

- www.schwaebische.de/panorama/flughafen-memmingen-schnaeppchenjaeger-verraet-unglaubliche-tricks-3171541
- https://pl.wikipedia.org/wiki/Kapelusze_my%C5%9Blowe
- https://co2.myclimate.org/en/portfolios?calculation_id=7608638

Prepared by:

Agnieszka Zabrzewska, FAVEO Foundation for Vocational and Intercultural Education

Co-funded by the European Union



2.19. TITLE: Plastic-Free Beauty: Reducing Single-Use Plastics in Cosmetics

PROCESS:

Steps	Time
Step 1. Introduction – Plastic in beauty	10 min.
Step 2. Plastic Lifespan Challenge	15 min.
Step 3. Eco-Swap Debate	15 min.
Step 4. Conclusion & Reflection	5 min.

AIMS TO ACHIEVE:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• That most cosmetic packaging is single-use plastic. • That recycling rates are very low and much plastic ends up in landfills or oceans.	• Identify which cosmetic plastics are recyclable, problematic, or non-recyclable. • Suggest eco-alternatives such as refills, solid products, or bamboo/glass packaging.	• The environmental impact of single-use plastic in cosmetics • The importance of reducing, reusing, and innovating with plastic-free solutions.



Number of participants: 12-16



Planned time: 45 min



Required materials:
Projector, laptop, printed product images, basket of common cosmetic packaging, sticky notes, whiteboard or flipchart, markers, Pens/pencils and paper for group work.



Remarks:

The teacher begins by saying that plastic is all over the place, even in the cosmetic industry. Things like bottles, jars, pumps, caps, those little sample packets, wrappers, and applicators are usually made from plastics such as **PET, PP, or PE**. Plastic is a hit because it doesn't cost much, it's light, and lasts a while. But it causes trouble for the Planet Earth.

Most makeup packaging is used once and tossed.

- Not much plastic gets recycled. Worldwide, it's below 10%. If it's got tricky designs, like pumps, packets with many layers, or different stuff mixed together, it's even harder to recycle.
- Plastic that's thrown away usually end up in landfills, rivers, and oceans. It breaks down into tiny pieces that hurt sea creatures and get into our food.
- Cosmetic companies are feeling the heat to look for other options, like refillable stuff, glass, metal, paper packs, or stuff that breaks down on its own.

All this plastic waste is a big deal for being eco-friendly in the makeup world - one that future cosmetic professionals must address.

Activity: Plastic Basket

- The teacher brings in a basket with common cosmetic packaging:
    - Plastic shampoo bottle
    - Lotion pump bottle
    - Lip balm tube
    - Single-use sample packet
    - Cream jar with a plastic lid

Things to talk about: (for possible answers see Appendix 1)

- *Which of these do you believe gets recycled the most?*
- *Which ones probably* don't get recycled much, and why?
- *What happens to plastic that is not recycled?*

Class engagement:

- Students raise hands and share opinions.
- Teacher writes down answers on the board in two columns: **"Recyclable"** vs. **"Hard to Recycle."**
- The teacher explains that a lot of makeup plastics *could* be recycled, but they hardly ever are because they're dirty, made of mixed stuff, or there aren't places to recycle them.

STEP 2. Plastic Lifespan Challenge

Objective: To get students thinking about how long plastic hangs around, especially when it comes to cosmetic packaging.

The teacher explains that plastic doesn't just vanish. Some stuff takes, like, 50 years to break down, some takes way longer – like hundreds of years! This **infographic (Appendix 2)** shows how long common plastic items survive in nature.

Activity Instructions

- Display the **Lifespan of Plastic** infographic on the projector. **(Appendix 2)**
- In small groups, students discuss and answer:
  - Which item surprised you the most in terms of lifespan? Why?
  - How does this compare to cosmetic packaging (like cream bottles, cream jars, or sachets)?
  - If a shampoo bottle lasts 100 years, how many bottles from a single person's lifetime could still exist in landfills or oceans?
- Each group notes down **one insight** and **one question** they still have.

Engagement

- Groups share their insights (e.g., *"We didn't know shampoo bottles last 100 years"*).
- Teacher asks a follow-up:
  - *If shampoo bottles last 100 years, what kind of packaging could replace them?*
  - *Which of these items is most urgent for the cosmetic industry to replace?*

STEP 3. Eco-Swap Debate

Objective: Get students thinking about plastic-free choices and what's good and bad about them.

Purpose of the exercise:

- Gets them to think critically and argue their ideas.
- Shows that going green isn't always easy.
- Gets everyone talking and involved, not just brainstorming.

Steps:

1. The teacher prints out pairs of product cards in color: **(Appendix 3)**
    - Shampoo bottle vs. Shampoo bar
    - Lipstick in plastic vs. Lipstick in bamboo
    - Single-use wipes vs. Reusable cotton pads
    - Cream jar vs. Lotion refill pack
2. The teacher split the class into two teams for each product pair. Each team pick a side of the room based on which option they support. Each side gets 3 minutes to get their arguments ready. Then, each team has a 2-minute debate.
    - **Team A:** They'll argue for the normal plastic version (ex. it's cheap, easy, and everywhere).
    - **Team B:** They'll argue for the eco-friendly version (es. it's good for the planet, you can refill it, and it breaks down).
3. The teacher writes down the best arguments from both sides on the board.
4. The students discuss briefly about which arguments made the most sense.

The teacher wrapped things up by saying that going green isn't just about saving the planet; it's got to be practical too. Today's debate showed that everything has its pros and cons. So, we need to find choices that are good for the Earth but still work for everyone.

STEP 4. Conclusion & Reflection

The research from Plastic Soup Foundation shows that 87% of products from the ten best-selling cosmetics brands contain microplastics. Microplastics are small plastic pieces less than five millimeters long which can be harmful to our ocean and aquatic life.

Plastic is cheap and handy, but most cosmetic packaging gets tossed after one use and barely gets recycled. Sadly, it usually ends up in landfills, gets burned, or pollutes the ocean, creating microplastic issues and harming the environment for the long haul.

With the Plastic Lifespan Challenge and Eco-Swap debate, we learned that not all plastics end up the same way, and every packaging choice has pros and cons. The best way to go is to just use less and reuse more – like refillable containers, solid products, or stuff without plastic, like bamboo, glass, or paper packaging.

The teacher points out what students can do in the future:

- As **consumers**, they can pick smarter like refills, bars, or reusable packaging..
- As **future professionals**, promoting eco-friendly products and cut down the plastic waste in cosmetic salons or businesses.

Main Point: Reducing the use of plastic in cosmetic products isn’t only important for the environment, it's also a chance to try stuff that's new and be a leader in the makeup world. Every choice, from what we buy to what we recommend, can help create a plastic-free future.

APPENDIX 1. Answers to the activity in Step 1

Question 1: Which of these do you think is recycled most often?

Possible answers:

- Plastic bottles, because we always see recycling bins for them.
- Cream jars, since they look more durable.
- Maybe lip balm tubes because they're small and easy to collect.

Teacher clarification:
Bottles are technically recyclable, but pumps and labels often make them non-recyclable.
Cream jars with mixed plastic + metal lids are rarely recycled.
Small items (lipstick, balm tubes, mascara wands) are too small for recycling machines, so they usually end up in landfill.

Question 2: Which ones are least likely to be recycled, and why?

Possible answers:

- Sachets, because they're too thin.
- Pumps, because they have springs inside.
- Wipes packaging, because it looks like foil and plastic together.

Teacher clarification:

- Sachets and pumps are **multi-layered or mixed materials** - difficult and costly to recycle.
- Single-use flexible packs are almost always landfill waste.

Question 3: What happens to plastics that is not recycled?

Possible answers:

- They go to landfills and sit there for ages.
- They get burned, which releases bad gasses.
- They end up ocean, turn into microplastics, and harm marine life, also getting into the food chain.

So yes, even though plastic is all over the place, especially used in cosmetics, most of it is not recycled. Sadly, the small, mixed, and single-use plastics usually cause the biggest problems. This is why it is important for everyone to think about plastic-free or refillable choices.

Plastic Bags:
20 years

Plastic Toothbrushes and Coffee Pods:
500 years



Disposable Coffee Cups:
30 years

Plastic Cream Jar:
400 to 500 years

Shampoo Bottle:
100 years

Plastic Straws:
200 years

6-Pack Plastic Rings:
200 years

Pack Water Bottles/Cups:
200 years

APPENDIX 3. Products photos





1. Shampoo bottle vs. Shampoo bar





2. Lipstick in plastic vs. Lipstick in bamboo





1. Single-use wipes vs. Reusable cotton pads





4 Cream jar vs. Lotion refill pack

SOURCES

- https://www.unep.org/resources/turning-off-tap-end-plastic-pollution-create-circular-economy, Date of Access: 10.09.2025.
- https://www.undp.org/belarus/stories/story-one-plastic-bottle, Date of Access: 10.09.2025.
- https://ucmpl.com/plastic-cream-jars-an-eco-friendly-way-to-store-your-creams/, Date of Access: 10.09.2025.
- https://www.makeenenergy.com/products-solutions/plastic-waste-recycling/about-plastcon, Date of Access: 11.09.2025.
- https://www.implasticfree.com/plastic-free-makeup/, Date of Access: 12.09.2025.
- https://theearthlingco.com/blogs/news/how-long-does-it-take-for-plastic-to-decompose, Date of Access: 12.09.2025.
- https://www.plasticsoupfoundation.org/en/news/almost-9-in-10-products-from-major-cosmetics-brands-contain-microplastics, 12.09.2025.
- https://oceanservice.noaa.gov/facts/microplastics.html, 12.09.2025.

Developed by:

Meri Boshkoska

Innova Lab - Bitola

Co-funded by the European Union



2.20. TOPIC: Cosmetic & beauty Trends: driving sustainability

PROCEDURE:

Steps	Time
Step 1: Beauty Industry Transformation	10 min.
Step 2: Brainstorming activity - Word Association Map	15 min.
Step 3: Sustainability in Cosmetics	15 min.
Step 4: Presentation and summary	5 min.

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• The key trends in the cosmetic and beauty industry. • The importance of sustainable ingredients in cosmetics.	• Identify sustainable and non-toxic ingredients. • Explain why inclusivity and personalization matter in beauty.	• The importance of sustainability in the cosmetics industry. • The concept of sustainability and its three key pillars.



Number of participants: up to 12



Planned time: 45 min



Required materials:
Projector, laptop
Sticky notes
Whiteboard and markers
Sheets and pens



Remarks:

- To stimulate an interactive session, the teacher asks, "Which emerging trends are shaping the cosmetics and beauty industry today?"

Answer: The cosmetics and beauty industry is focused on the following key trends:

1. Implementation of Eco-Friendly Practices

- Consumers are choosing products that contain natural and organic ingredients and feature eco-friendly properties.
- Zero-waste practices involve eliminating single-use plastics while adopting recyclable and renewable materials.

2. Clean Beauty and Transparency

- Clean beauty is synonymous with non-toxic beauty. Clean beauty products exclude harmful substances such as parabens, phthalates, sulphates, and synthetic fragrances.
- More people are choosing products labelled as “organic” or “natural” because they desire safer, non-toxic alternatives.

3. Personalisation and Inclusivity

- The production of beauty products now offers options for different skin types and tones, genders, specific skin concerns, and cultural preferences.
- Cosmetic brands use innovative marketing campaigns to showcase diversity and inclusivity as key values in their advertising strategies.

4. Tech Integration

- AI-powered personalised skincare solutions help users assess their skin type and various skin conditions, such as acne, wrinkles, and dark spots, and determine moisture levels, including whether their skin is oily or sensitive. These tools combine modern technology with smartphone apps and high-resolution cameras to capture selfies for comprehensive skin analysis.
- Augmented reality (AR) enables customers to digitally test make-up products through virtual try-ons before making purchases.

Step 2 . Brainstorming activity - Word Association Map

- The teacher writes the key topic on the board: **Emerging Key Trends in the Cosmetics and Beauty Industry**. Students call out related words or phrases, which are added to a mind map (see examples below). Once complete, the class categorises them into broader trend groups. (Appendix 1 - answer)

– natural ingredients
– non-harmful ingredients
– recyclable packaging
– organic certification
– AI-driven skincare recommendations
– virtual try-on tools
– customised products
– zero-waste initiatives
– healthy ageing products
– AI-powered chatbots
– virtual consultations
– cruelty-free ingredients
– vegan ingredients
– reusable containers
– waterless beauty products
– ingredient transparency – clear labelling



– biodegradable plastic packaging
– take-back programmes for recycling
– aloe vera
– avoidance of parabens, sulphates, phthalates, synthetic dyes, and artificial fragrances
– easy-to-understand product descriptions
– DNA-based skincare
– culturally inspired formulations
– products tailored to different life stages, such as menstruation, pregnancy, or menopause
– inclusive marketing campaigns

- The teacher asks the following questions:

    1. What is your understanding of the word “sustainability”? What is meant by the term “sustainability in cosmetics”?

    2. What are some examples of sustainable ingredients that can be used in cosmetics?

- After the Q&A session, the teacher divides the students into three or four groups and displays the quiz on s**ustainability in cosmetics (Appendix 2).**

Answer to Question 1

What is sustainability?

Sustainability refers to the practice of meeting present-day needs while maintaining the ability of future generations to meet their needs. It aims to create a healthier planet and society through equal consideration of environmental, social, and economic factors.

Three Pillars of Sustainability

1. **Environmental sustainability** involves safeguarding natural resources while reducing pollution and encouraging eco-friendly actions, such as using renewable energy sources and practising waste reduction and conservation.
2. **Social sustainability** focuses on maintaining fair labour practices, protecting human rights, and enhancing community well-being.
3. **Economic sustainability** means promoting responsible business growth that maintains economic stability for future generations while protecting both people and the environment.

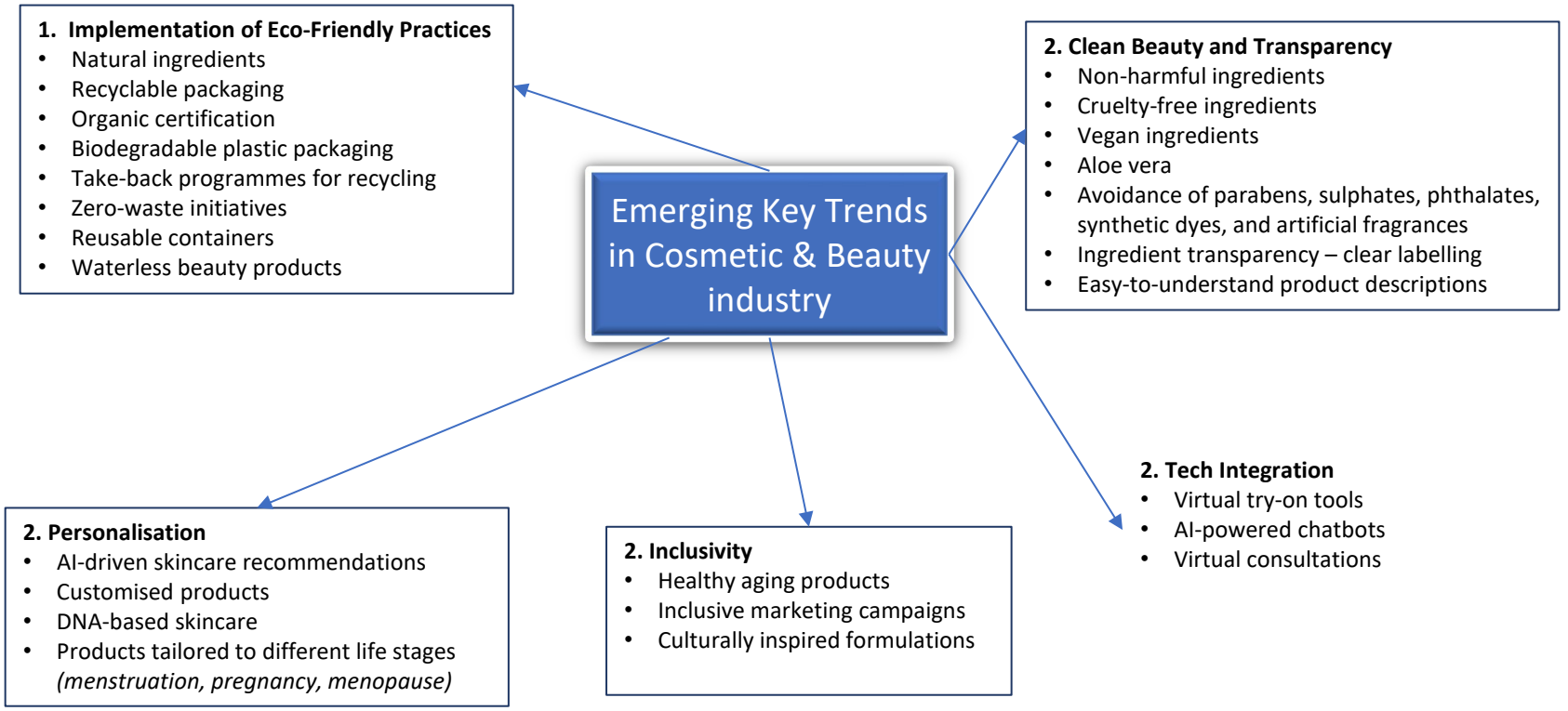
Sustainability in Cosmetics

- Using natural, non-toxic, and biodegradable ingredients.
- Implementing zero-waste packaging and recycling initiatives.
- Supporting ethical sourcing and cruelty-free practices.

Answer to Question 2

- Plant-based oils (coconut oil, jojoba oil, argan oil)
- Natural extracts (aloe vera, green tea extract, chamomile extract)
- Essential oils (lavender, peppermint, tea tree oil)
- Butters (shea butter and coconut butter)

Appendix 1. Brainstorming activity - Word Association Map - answer



Multiple-Choice Questions

1. **Which of the following is an example of a sustainable ingredient in cosmetic beauty products?**
   a) Parabens
   b) Microplastics
   c) Jojoba oil
   d) Palm oil and its derivatives

2. **Which of the following types of packaging is the most eco-friendly?**
   a) Single-use plastic bottles
   b) Biodegradable cardboard containers
   c) Plastic bags
   d) Non-recyclable glass jars

3. **Which of the following is a key characteristic of waterless cosmetic beauty products?**
   a) They contain more artificial preservatives
   b) They require plastic packaging
   c) They help conserve water and reduce waste
   d) They cannot be stored for a long time

True or False

4. Sustainability in cosmetics focuses only on using natural ingredients.
5. Refillable beauty products are a good example of a zero-waste initiative.
6. Waterless beauty products help reduce the need for synthetic preservatives.
7. Microplastics in cosmetics are biodegradable and safe for the environment.
8. Organic- and vegan-certified ingredients ensure 100% sustainability of the product.

Multiple-Choice Questions

1. **Which of the following is an example of a sustainable ingredient in cosmetic beauty products?**
   a) Parabens
   b) Microplastics
   c) Jojoba oil
   d) Palm oil and its derivatives

2. **Which of the following types of packaging is the most eco-friendly?**
   a) Single-use plastic bottles
   b) Biodegradable cardboard containers
   c) Plastic bags
   d) Non-recyclable glass jars

3. **Which of the following is a key characteristic of waterless cosmetic beauty products?**
   a) They contain more artificial preservatives
   b) They require plastic packaging
   c) They help conserve water and reduce waste
   d) They cannot be stored for a long time

True or False

- **4. Sustainability in cosmetics focuses only on using natural ingredients.**
  Answer: False. *(It also includes ethical sourcing, eco-friendly packaging and reducing environmental impact.)*

- **5. Refillable beauty products are a good example of a zero-waste initiative.**
  Answer: True.

- **6. Waterless beauty products help reduce the need for synthetic preservatives.**
  Answer: True.

- **7. Microplastics in cosmetics are biodegradable and safe for the environment.**
  Answer: False. *(Microplastics pollute the oceans, release chemicals into the water and negatively affect the health of aquatic organisms.)*

- **8. Organic- and vegan-certified ingredients ensure 100% sustainability of a product.**
  Answer: False. *(Sustainability also depends on sourcing, packaging and manufacturing practices.)*

Step 4 . Presentation and Summary

- The teacher asks each group to present their answers from the quiz.
- After each presentation, the teacher provides **a summary and clarification** of the given answers.

SOURCES

- https://www.foreo.com/mysa/what-is-clean-beauty-and-why-does-it-matter?srsltid=AfmBOoqS1dGv6qnCxVji-AGuNrFs13RP_OW1CltP55VfBL-BrRCoR4nf, Date of Access: 15.04.2025
- https://youthincmag.com/how-ai-is-revolutionizing-the-beauty-industry Date of Access: 15.04.2025
- https://www.halecosmeceuticals.com/blog/cosmetic-manufacturing-trends-adapting-to-changing-consumer-behavior Date of Access: 16.04.2025
- https://explodingtopics.com/blog/beauty-trends Date of Access: 16.04.2025
- https://www.askattest.com/blog/articles/beauty-industry-trends Date of Access: 17.04.2025
- https://www.linkedin.com/pulse/common-vegan-ingredients-used-cosmetics-saraiva-martins-costa-sua3f Date of Access: 17.04.2025
- https://www.goldenarrow.com/blog/waterless-beauty-products-and-their-impact-sustainability Date of Access: 17.04.2025

Developed by:

Meri Boshkoska

Innova Lab - Bitola

Co-funded by the European Union



2.21. TOPIC: Practical Steps for an Eco-Friendly Beauty Salon

PROCEDURE:

Steps	Time
Step 1: What Defines an Eco-friendly Beauty Salon?	10 min
Step 2: Areas for Improvement	15 min
Step 3: Presentation and Discussion	10 min
Step 4: Summary and Action Plan	10 min



Number of participants: 12



Planned time: 45 min



Required materials: Projector, laptop, sticky notes, whiteboard and markers, sheets and pens, and access to the internet for research.

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• Key sustainable practices for beauty salons. • The benefits of adopting energy-efficient equipment, water-saving techniques, and eco-friendly products.	• Identify strategies to reduce the environmental impact of salon operations. • Propose creative solutions to make salon operations more sustainable.	• The importance of eco-friendly practices in shaping consumer preferences. • The role of individual actions in contributing to a healthier planet.



Remarks:

STEP 1: What Defines an Eco-friendly Cosmetic Salon?

- The teacher asks students, "**What makes a cosmetic salon eco-friendly?",** to start the class.

Answer: An eco-friendly cosmetic salon takes care of the environment through various eco-friendly practices:

1. **Reducing Waste:** Eco-friendly salons focus on minimising waste by selecting and recycling, using refillable containers, and avoiding single-use plastics. The salons can partner with recycling companies to improve waste management.
2. **Sustainable Products**: Eco-friendly salons use, promote, and sell products with recyclable, biodegradable, or eco-certified packaging. They favour natural, organic, and cruelty-free products to reduce environmental impact and adhere to ethical standards.
3. **Energy and Water Saving**: Using energy-efficient appliances, offering waterless beauty treatments, and fixing leaks can reduce resource consumption.
4. **Eco-Friendly Decor:** Salons can use eco-friendly décor materials, such as bamboo or recycled wood, along with non-toxic, eco-friendly paints to ensure good indoor air quality. Salons can also be decorated with recycled and upcycled materials repurposed from old or discarded items, giving them new life and contributing to waste reduction.
5. **Refillable Products:** Using, promoting, and selling refillable cosmetic products helps reduce plastic waste while providing cost-effective options for both **the business and clients**.
6. **Community Involvement:** Through workshops, recycling incentives, or green consultations, salons can educate clients on making eco-friendly choices in their everyday lives.
7. **Eco Loyalty Programme: Consumers** can earn eco-points for engaging in eco-friendly actions, such as using organic or refillable products. These eco-points can be used as a discount when purchasing organic products.
8. **Waste Sorting Stations:** Clearly labelled and visually attractive waste sorting stations where clients can properly separate their waste.
9. **Specially Designed Eco-Menu** featuring eco-friendly products and cosmetic treatments such as:

- organic, cruelty-free skincare and make-up products
- seaweed- or clay-based wraps using biodegradable materials
- vegan products
- waterless cleansing methods.

- **Overview of the assignment:** Students are divided into three groups, each focusing on a different topic. Their task is to explore best practices related to their assigned topic and develop suggestions to improve the eco-friendliness of a cosmetic salon business. The teacher will either display or provide printed copies of the table shown in **Annex 1**.

Group 1 – Energy-Efficient Equipment
Focus on eco-friendly solutions to reduce energy consumption in the business, such as energy-efficient LED lighting, motion-sensor lighting, and smart thermostats.

Group 2 – Waste Reduction and Sorting
Focus on reducing waste and improving waste sorting by limiting single-use plastics and/or implementing a program for proper waste separation.

Group 3 – Eco-Friendly Alternatives

Explore alternatives that can make cosmetic salons more environmentally friendly. These may include organic or vegan cosmetics, biodegradable or recyclable packaging, or waterless cleansing methods.

STEP 3: Presentation and Discussion

- In a 10-minute presentation and discussion, each group presents its findings, including the best practices they researched, the challenges they identified, and their innovative solutions; the teacher captures key points on the whiteboard.

STEP 4. Summary and Action Plan

- To wrap up the session, the teacher summarises the key points from the groups' presentations and emphasises that even minimal changes can make a significant difference to the environment.
  The teacher presents a slide (Appendix 3) and asks students to discuss specific actions they can take personally to promote eco-friendly practices in cosmetic salons and how they can implement these concepts.

APPENDIX 1 . Areas for Improvement

- **Instructions:** Your group has been assigned one of the following areas for improving sustainability in a beauty salon: Energy Efficiency, Waste & Recycling, or Product Choices. Research best practices and potential solutions for your assigned area, and complete the table below. Use internet resources to help you find relevant information.

Category	Description
Best Practices Identified	**List at least three specific best practices for your assigned area that a salon could implement to improve its sustainability. Be specific and provide a brief explanation for each one.**
1	
2	
3	
Potential Challenges	**List at least two potential challenges or obstacles that a salon might face when trying to implement these best practices. Be realistic and consider factors such as cost, feasibility, and customer acceptance.**
1	
2	
Creative Solutions	**Suggest one innovative and practical solution to address one of the challenges you identified. This could be a new technology, a creative partnership, a revised business model, or any other idea that would help overcome the obstacle.**
1	

- Some possible answers for the activity in Step 2.

Category	Description
Best Practices Identified	**List at least three specific best practices for your assigned area that a salon could implement to improve its sustainability. Be specific and provide a brief explanation of each.**
1	Replacing traditional light bulbs with LED lights reduces energy consumption, lasts longer, and contributes to lower maintenance costs.
2	Installing motion sensors in less frequently used areas (such as bathrooms and storage rooms) helps prevent unnecessary energy waste.
3	Implementing smart thermostats that automatically adjust temperature settings based on occupancy and weather conditions helps reduce energy consumption.
Potential Challenges	**List at least two potential challenges or obstacles that a salon might face when trying to implement these best practices. Be realistic and consider factors such as cost, feasibility, and customer acceptance.**
1	High initial costs: Energy-efficient lighting and smart systems require an initial investment, which may be expensive for small businesses.
2	Staff may need time to adjust to using automated systems and new technology.
Creative Solutions	**Suggest one innovative and practical solution to address one of the challenges you identified. This could be a new technology, a creative partnership, a revised business model, or any other idea that would help overcome the obstacle.**
1	Salons can apply for grants or tax refunds for energy-efficient upgrades and gradually replace equipment to spread costs over time.

- Some possible answers for the activity in Step 2.

Category	Description
Best Practices Identified	**List at least three specific best practices for your assigned area that a salon could implement to improve its sustainability. Be specific and provide a brief explanation of each.**
1	Set up clearly labelled bins for plastic, paper, and organic waste to encourage proper waste disposal among employees and clients.
2	Replace disposable towels, cups, and applicators with reusable or compostable alternatives.
3	Work with local recycling companies to ensure proper disposal of salon-related waste.
Potential Challenges	**List at least two potential challenges or obstacles that a salon might face when trying to implement these best practices. Be realistic and consider factors such as cost, feasibility, and customer acceptance.**
1	Some customers may not be familiar with waste sorting efforts or may resist changes in salon services.
2	Small salons may struggle to find room for separate waste bins.
Creative Solutions	**Suggest one innovative and practical solution to address one of the challenges you identified. This could be a new technology, a creative partnership, a revised business model, or any other idea that would help overcome the obstacle.**
1	Offer small discounts or loyalty points to customers who bring reusable containers or participate in waste sorting efforts.

- Some possible answers for the activity in Step 2.

Category	Description
Best Practices Identified	**List at least three specific best practices for your assigned area that a salon could implement to improve its sustainability. Be specific and provide a brief explanation of each.**
1	Choose products that are free of harmful chemicals, made from natural ingredients, and not tested on animals.
2	Use brands with eco-friendly packaging or offer refilling stations for certain products.
3	Work with suppliers that use fair trade and sustainable practices.
Potential Challenges	**List at least two potential challenges or obstacles that a salon might face when trying to implement these best practices. Be realistic and consider factors like cost, feasibility, and customer acceptance.**
1	Organic and sustainably sourced products may be more expensive than conventional ones.
2	Some clients may question the effectiveness of natural products compared to conventional cosmetic beauty products.
Creative Solutions	**Suggest one innovative and practical solution to address one of the challenges you identified. This could be a new technology, a creative partnership, a revised business model, or any other idea that would help overcome the obstacle.**
1	Provide small testers of eco-friendly products and create promotional packages to encourage customer interest and gain their trust.



Source

Choose eco-friendly cosmetic packaging



Source

Reduce Your Carbon Footprint with LED Lights and Natural Sunlight!



Credit

Implement salon waste recycling practice



Source

Choose cruelty-free, organic products

1. Choose Eco-Friendly Cosmetic Packaging

- Buy products with biodegradable, recyclable, or refillable packaging to reduce plastic waste.
- Look for brands that use sustainable packaging materials, such as glass, paper or plant-based plastics.
- Instead of throwing away empty containers, consider repurposing them for DIY beauty products or storage.

2. Reduce Your Carbon Footprint with LED Lights

- Choose beauty salons that use energy-efficient lighting and sustainable practices.
- Use natural daylight at home for personal beauty routines instead of artificial lighting.
- Turn-off your styling tools when not in use to save energy.

3. Implement Waste Sorting Practices

- Dispose of beauty product containers by sorting them properly instead of throwing them into general waste.
- Use reusable beauty tools such as bamboo make-up brushes, washable cotton pads, and refillable cosmetic bottles.

4. Choose Cruelty-Free and Organic or/and Vegan Products

- Check labels for cruelty-free certifications to ensure no animal testing was involved.
- Opt for organic beauty products that use natural, non-toxic ingredients and are sustainably sourced.
- Support brands with ethical and fair-trade practices.

SOURCES

- https://www.reservio.com/blog/lifestyle/the-rise-of-sustainable-beauty-salons, Date of Access: 02.04.2025
- https://emagazine.com/4-ways-to-make-your-salon-eco-friendly/ Date of Access: 03.04.2025
- https://www.youtube.com/watch?v=ABHIf9VDwUg Date of Access: 04.04.2025
- https://professionalbeauty.co.uk/how-to-be-a-sustainable-salon Date of Access: 06.04.2025
- https://www.corpseed.com/knowledge-centre/how-to-start-an-eco-friendly-beauty-salon-business Date of Access: 07.04.2025
- https://www.twinfm.com/article/shining-light-on-the-latest-energy-efficient-lighting-and-advanced-sensor-options Date of Access: 07.04.2025
- https://dashboardbeauty.com/blogs/news/salon-waste-management Date of Access: 08.04.2025

Developed by:

Meri Boshkoska

Innova Lab - Bitola

Co-funded by the European Union



2.22. TOPIC: Eco-Symbol Safari

PROCEDURE:

Steps	Time
Step 1: How Eco-Labels Can Boost Your Cosmetic Business.	10 min
Step 2: Eco-Symbol Identification.	15 min
Step 3: Group presentation.	15 min
Step 4: Discussion and Conclusion.	5 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• Commonly used eco-symbols in the cosmetics industry. • The importance of eco-labels in promoting sustainability.	• Identify and interpret the meaning of eco-symbols on cosmetic products. • Analyse how eco-certifications impact consumer trust and decision-making.	• The importance of understanding eco-labels and avoiding greenwashing. • How eco-certifications influence product development and innovation in cosmetics.



Number of participants: 12



Required materials: Projector, laptops, sticky notes, markers/pens.



Remarks:



Planned time: 45 min

• The teacher starts the class by explaining the meaning of eco-labels and why they are important for cosmetic businesses.

Eco-labels serve as a compass for consumers navigating a complex marketplace of goods, providing an instant visual cue that a product meets certain environmental standards. These standards relate to manufacturing processes, materials used, and the product's overall environmental footprint.

The beauty and personal care industry is increasingly focusing on sustainability and environmental responsibility, reflecting growing consumer awareness of the impact of products on the planet. To qualify for an eco-label, products must minimise environmental damage at every stage of their life cycle. This starts with sustainable sourcing, where ingredients must be obtained in ways that do not deplete natural resources or harm local ecosystems.

The production process is equally scrutinised for energy efficiency, water conservation, and the reduction of greenhouse gas emissions. These processes must also exclude the use of hazardous substances that may pose risks to the environment and human health.

Packaging is another critical factor in eco-label criteria. Cosmetics and personal care products must use recyclable or biodegradable materials to reduce landfill waste and promote a circular economy. In addition, transparent labelling is encouraged to promote consumer awareness and enable informed decisions about the environmental impact of purchases.

Eco-labels can boost a cosmetics business by improving brand reputation, attracting eco-conscious consumers, and increasing customer loyalty. Using eco-friendly products with certifications that confirm sustainability and safety increases consumer confidence. In addition, companies reduce their environmental impact, which is increasingly valued in today's market. Eco-labels can also open new sales channels and opportunities for cooperation with retailers that favour sustainable, environmentally friendly products.

• The teacher continues by asking questions such as:

Why do you think cosmetic companies use specific symbols on their product labels?
Answer: Symbols on cosmetic labels not only help consumers better understand the product they are about to purchase or use, but also provide information about the producer, such as how it is made, recycling practices, or animal treatment policies.

Have you ever seen a cosmetic product label with a symbol you don't know what it means?
Possible answers: "Yes," "No," or "I never read labels."

Are you familiar with the concept of "greenwashing"?
Answer: Greenwashing is a form of advertising or marketing in which companies misrepresent the environmental benefits of a product or practice in order to attract eco-conscious consumers.

STEP 2: Eco-Symbol Identification

- To start the *Eco-Symbol Safari* game, the teacher splits the class into three groups and explains the rules of the game. The teacher **asks** the students to identify as many symbols as possible and to record their names and meanings on the provided worksheet (**Table 1**). The students can add additional rows to the table depending on the number of identified eco-symbols.
- Each group works on a laptop, where they have access to the slide with eco-labels, certifications, and sustainability symbols (**Appendix 1**) as well as **Table 1**.

Table 1. Worksheet

Product Image	Eco-Symbol	Meaning/Certification
(Image 1)	(Name of the symbol)	(Description)
(Image 2)	(Name of the symbol)	(Description)
(Image 3)	(Name of the symbol)	(Description)
(Image 4)	(Name of the symbol)	(Description)

STEP 3: Group presentation

- The groups present their findings. After their presentations, the class reviews the meanings of each of the symbols to ensure they all have a true explanation.
- The teacher gives points to the group that has identified more eco-labels correctly.

STEP 4: Discussion and Conclusion

- At the end, the teacher summarises the main points and emphasises the importance of critical thinking when evaluating cosmetic products and their claims of being good for the environment.


ECO
CERT


USDA
ORGANIC






CERTIFIED
CARBON
NEUTRAL®
product




UL
ECOLOGO


VEGAN
CERTIFIED


CLEAN
CERTIFIED




SOY
FREE

APPENDIX 2 Eco-labels, certifications, and sustainability symbols for cosmetic products - Explanation

This label will either be accompanied by the phrase "Organic Cosmetic" or "Natural Cosmetic

To display this seal, the product must contain only organically produced ingredients.

Leaping Bunny is the globally-recognisable gold standard for cosmetics, personal care and household products.

The packaging is recyclable

This badge is carried by products that have achieved carbon neutrality in line with The CarbonNeutral Protocol

The producer of the packaging has made a financial contribution toward recycling it in the country where it was made. It does not mean the package itself is made from recycled content — however, it indicates the corporation fiscally supports recycling,

Product certified for reduced environmental impact

The product is vegan and contains no animal ingredients or animal by-products, uses no animal ingredients or by-products in the manufacturing process and does not conduct testing on animals

The BIORIUS 'Clean' certification is based on a modern, benevolent and positive worldview aimed at protecting the planet and its people.

Cosmetics can only be claimed as 'Gluten-Free' if the traces of gluten do not exceed 20 ppm in the final product.

Absence of soy in the final cosmetic product.

APPENDIX 2.1. Worksheet Answers

Product Image	Eco-Label/Symbol	Meaning/Certification
	Certification label for organic and natural cosmetics	At least 95% natural ingredients At least 10% of total ingredients from organic farming (for the organic label) No GMO, parabens, synthetic fragrances, or animal testing Eco-friendly packaging
	Organic product	The product must contain only organically produced ingredients.
	Leaping Bunny	Cruelty Free Products
	Universal Recycling Symbol	The item is recyclable
	Carbon Neutral	This badge is carried by products that have achieved carbon neutrality in line with The CarbonNeutral Protocol
	Green Dot	The producer of the packaging has made a financial contribution toward recycling it in the country where it was made. It does not mean the package itself is made from recycled content — however, it indicates the corporation fiscally supports recycling
	ECOLOGO	Products and services are certified for reduced environmental and health impact
	Vegan Certified	The product is vegan and contains no animal ingredients or animal by-products
	Clean certification	Is based on a modern, benevolent and positive worldview aimed at protecting the planet and its people
	Gluten Free	Traces of gluten do not exceed 20 ppm in the final product.
	Soy Free	The absence of soy in the final cosmetic product

SOURCES

- https://www.ecolabel.com/en/eco-label-institute/importance-of-eco-label, Date of Access: 18.03.2025
- https://biorius.com/cosmetics-certifications/clean-certification/ Date of Access: 18.03.2025
- https://ecogarantie.eu/organic-cosmetic-products-ecolabels/ Date of Access: 19.03.2025
- https://www.potterclarkson.com/insights/greenwashing-in-cosmetics-the-evolution-of-the-cosmetics-industry-and-the-likely-impact-of-approaching-eu-regulations/ Date of Access: 19.03.2025
- https://artofdermatology.com/greenwashing-and-the-reality-of-skin-care-labeling/ Date of Access: 19.03.2025
- https://www.womenincleantechsustainability.org/sustainability-certificates/ Date of Access: 19.03.2025
- https://www.ecolabelindex.com/ecolabels/?st=category,cosmetics_personal_care Date of Access: 20.03.2025
- https://www.refinery29.com/ Date of Access: 20.03.2025
- https://biorius.com/cosmetics-certifications/gluten-free-and-soy-free-certifications/ Date of Access: 20.03.2025

Developed by:

Meri Boshkoska

Innova Lab - Bitola

Co-funded by the European Union



2.23. TOPIC: DIY Green Beauty: Crafting Your Own Eco-Friendly Product

PROCEDURE:

Steps	Time
Step 1: Understanding Natural Cosmetics	15 min
Step 2: Ingredient Sourcing Challenge	10 min
Step 3: DIY Body Scrubs Challenge	15 min
Step 4: Group Presentation	5 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
•The principle of using natural ingredients in skin care. •Sustainable practices in organic cosmetics.	• Design an organic cosmetic product using non-toxic materials. • Explain the benefits of sustainable packaging and ingredient selection.	• The impact of cosmetic product choices on the environment. • How to make informed decisions as a consumer in the cosmetics industry.



Number of participants: 12



Planned time: 45 min



Required materials: Projector, laptop, sticky notes, whiteboard and markers, sheets and pens, internet access for searching information..



Remarks:

Click to see movie

Preliminary discussion:

- The teacher asks the students: *What is the first thing that comes to mind when you hear the term "natural cosmetics"?*
- The students will answer, for example: plants, organic, homemade, chemical-free, beauty bloggers.
- The teacher then introduces a few key concepts:

Plant-based raw materials are any ingredients obtained from plants, in raw or slightly processed form, without the addition of synthetic chemicals. Examples: aloe vera, olive oil, coconut oil, shea butter or coconut butter, green tea extract, lavender oil, etc.

- **Natural body scrubs** are natural exfoliants made from natural ingredients such as sugar, coffee or sea salt.
- **Homemade body scrubs** – you can make a body scrub from ingredients you probably already have in your kitchen.
- **Easily recyclable –** materials such as glass, some plastics or paper that can be recycled and reused through the normal recycling process, helping to reduce waste in the environment.
- The teacher shows the students a film demonstrating how to prepare a face cream from donkey milk as an example of homemade natural cosmetics (Appendix 1).

- The teacher presents a scenario in which the students imagine they are creating a new natural body scrub. Students learn about natural cosmetic ingredients, sustainable formulas and eco-friendly packaging. The teacher divides the students into three groups. Students answer the following questions in groups based on class discussion. Each group must summarise their conclusions and prepare a short presentation.

1. **List three natural exfoliants and their benefits.**

Possible answers:

- **Sugar** – gently exfoliates dead skin cells, suitable for sensitive skin.
- **Coffee grounds** – improve circulation, tighten the skin and temporarily reduce the appearance of cellulite.
- **Sea salt** – provides deep exfoliation and removes dead skin cells.

2. What natural ingredients can be used to enrich a body scrub? Give two examples and their benefits.

Possible answers:

- **Coconut oil** is a natural emollient that soothes and softens the skin. Its active ingredients provide deep hydration and rich skin care.
- **Aloe vera** slows down the ageing process, moisturises the skin, tightens pores, prevents blackheads, helps fight wrinkles, removes acne, cleanses oily skin and renews dead skin cells, and also has a slimming effect.

3. List three packaging options that comply with the principles of sustainable development and explain their advantages.

Possible answers:

- **Glass packaging** – glass does not decompose, but can be recycled indefinitely. Glass packaging can also be reused for various purposes.
- **Biodegradable containers** for cosmetics and skincare products, which decompose naturally, reducing the amount of waste going to landfill.
- **Reusable packaging** – encourages consumers to reuse rather than throw away.

STEP 3: DIY Body Scrubs Challenge

The teacher informs the class that the next task is a continuation of the previous one and focuses on the sources of the ingredients. At this stage, students will design a specific cosmetic product – a body scrub – using natural, non-toxic ingredients.

Working in groups, students will complete the following tasks:

1. Discuss key concepts introduced at the beginning of the lesson, such as natural ingredients, natural body scrubs, DIY body scrubs, eco-friendly scrubs for sensitive skin, easily recyclable materials, etc.
2. Decide which ingredients to use to make the body scrub.
3. Describe the steps involved in making the body scrub.
4. Choose a packaging type that reduces waste and is environmentally friendly.
5. Write a short summary presenting their product design.

STEP 4: Group Presentation

Each group will give a short presentation of their product design. In their presentation, they should discuss:

- The type of product they have designed and the benefits it provides.
- The main ingredients they have used.
- The chosen packaging and its impact on waste reduction.

After each presentation, the teacher gives feedback focused on the sustainability of the students' DIY products.

APPENDIX 1. How to make face cream from a donkey milk



Click to see movie

Group 1: Body scrub with coconut oil and sugar

Idea: A soothing, moisturising body scrub for all skin types, made exclusively from natural ingredients in accordance with the zero - waste principle. The scrub helps remove dead skin cells, leaving the skin smooth and silky.

- **Ingredients:** 2 cups of brown sugar, 1 cup of coconut oil, optional ingredients such as vanilla extract or essential oils
- **Equipment needed:** measuring cups,a bowl and spoon/spatula.
- **Preparation**: First, melt the coconut oil, then mix all the ingredients with a spoon or spatula. Optional: Add natural extract or essential oils for a better scent.

Eco-friendly packaging: a reusable glass jar.

Market value and eco-friendliness:

- Attractive to environmentally conscious consumers looking for natural, non-toxic, ultra-moisturising and soothing products.
- The formula is suitable for all skin types, especially sensitive or dry skin.
- The use of natural ingredients helps to reduce environmental pollution.
- Contains no artificial preservatives or synthetic fragrances.

Group summary: A rich, creamy body scrub with coconut oil and brown sugar that gently exfoliates the skin while deeply moisturising it. Packaged in a reusable glass jar to minimise waste and promote reuse.

Group 2: Coffee and citrus body scrub

- **Idea:** A refreshing and revitalising body scrub that improves circulation and leaves the skin smooth and radiant.
- **Ingredients:** 1/4 cup of freshly ground coffee, 1 tablespoon orange peel, the juice of half an orange (about 1/8 cup), 2 tablespoons honey.
- **Equipment needed:** Food processor, mixing bowl and spoon, measuring cups and spoons.
- **Directions:** Grind the coffee into a powder, pour it into a bowl and add the juice of half an orange. Set aside for about five minutes to *allow the mixture to fully absorb the liquid*. Add honey, which is particularly suitable for gentle facial exfoliation.

Eco-friendly packaging: presented in a reusable glass jar for reuse

Market value and eco-friendliness:

- The product is aimed at consumers looking for natural, non-toxic, anti-cellulite, detoxifying and energising skincare products.
- It uses recycled coffee grounds, reducing food waste.
- Packaged in reusable containers to minimise environmental impact.

Group summary: A refreshing coffee scrub designed to stimulate the skin and enhance circulation, presented in a reusable glass jar for a zero-waste experience.

Group 3: Sea salt body scrub

Idea: A cleansing sea salt body scrub removes toxins, regulates excessive sebum secretion and stimulates collagen production, making the skin firmer.

- **Ingredients –** ½ cup of sea salt, olive oil and 10–20 drops of essential oil.
- **Equipment needed –** a bowl and spoon for mixing, a measuring cup.
- **Preparation –** Mix sea salt and olive oil in a bowl until the ingredients are thoroughly combined. Add essential oil for a better scent.
- **Eco-friendly packaging: a** recyclable plastic cup with lid.

Market value and eco-friendliness:

- Ideal for consumers with sensitive, acne-prone or combination skin.
- Salt-based formulas are popular in natural skincare products due to their detoxifying properties.
- A recyclable plastic cup promotes recycling practices.

Group summary: A cleansing salt-based body scrub that absorbs excess sebum and soothes irritation, packaged in a recyclable plastic container.

SOURCES

- https://criticalcatalyst.com/sustainable-cosmetic-products/ Date of Access: 28.03.2025
- https://dhl-consulting.com/news/exploring-the-benefits-and-trade-offs-of-sustainable-packaging/ Date of Access: 28.03.2025
- https://www.perrysplate.com/2014/06/homemade-body-scrub-brown-sugar.html Date of Access: 29.03.2025
- https://littlegreendot.com/coffee-scrub/ Date of Access: 30.03.2025
- https://www.thehealthymaven.com/how-to-make-a-salt-scrub-recipe/ Date of Access: 30.03.2025
- https://www.linkedin.com/pulse/introduction-sustainability-cosmetics-beauty-industry-mba-tssbe Date of Access: 30.03.2025
- https://www.intechopen.com/online-first/1212771, Date of Access: 09.06.2025
- https://www.healthline.com/health/skin/diy-body-scrub Date of Access: 09.06.2025

Developed by:

Meri Boshkoska

Innova Lab - Bitola

Co-funded by the European Union



2.24. TOPIC: Challenges of Selling Natural Cosmetics Online

PROCEDURE:

Steps	Time
Step 1: Introduction	10 min
Step 2: Customer Journey Map	15 min
Step 3: Discussion & Reflection	15 min
Step 4: Summary	5 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• Main challenges in selling natural cosmetics online. • Key industry trends: transparency, sustainability, innovation.	• Identify obstacles in the online shopping journey. • Suggest simple solutions to improve trust and customer experience.	• The importance of clear information and sustainable practices. • The role of individuals as both consumers and future professionals.



Number of participants: 10 - 12



Required materials: Projector, laptop, printed case study, whiteboard, sticky notes, markers or pens.



Remarks:



Planned time: 45 min

STEP 1: Introduction

The teacher starts by asking students a few quick questions to help them connect the topic to their own experiences:

- Who here has bought natural cosmetics online?
- What was easy about it? What was difficult?
- How do you know if a product is really natural?

Invite students to share their thoughts and write them on the whiteboard without giving solutions yet.

Framing the lesson:

Today, we'll look closely at the main challenges that appear when we buy or sell natural cosmetics over the internet. While many brands and entrepreneurs want to offer eco-friendly goods, the online journey can be bumpy. As shoppers, your power lies in identifying these bumpy spots.

Introducing the case study:

You'll soon read a short story about Maya, a college student who tried to purchase a natural face cream online. This narrative pinpoints the everyday pains that shoppers feel from the moment they click "add to cart" until the cream arrives. Hand out the printed case study and ask students to read it quietly. (Appendix 1)

Learning goal (explain to students):

Today's purpose is to spot and reflect on the difficulties that pop up when we buy natural cosmetics on the web. As you prepare for careers in the cosmetic industry, you'll learn to address these issues head-on by building thoughtful products, sharing clear, honest information with buyers, and committing to eco-friendly business choices.

STEP 2: Customer Journey Map

Teacher Instructions

- On the whiteboard, sketch a large map that walks the students through the online shopping journey: (Appendix 2)
  - Browsing → Selecting → Cart & Payment → Delivery → Unboxing.
- Share a stack of sticky notes and pens/markers to each pair of students.
- Ask each pair to revisit Maya's case (or their own recent purchase) and pick one major problem for every step of the journey.
  - Example: *Browsing* - Too many brands, hard to trust.
  - Example: *Delivery* - Took too long, unclear tracking.
- Students write their challenges on sticky notes. Encourage them to:
  - Keep it to a phrase (2–5 words).
  - Sprinkle in emojis or mini doodles for memorability.
- Invite them, one pair at a time, to walk to the whiteboard and add their notes to the right spot on the journey map.

Learning Purpose / Why This Matters?

- Students visualize the entire customer experience from start to finish, not just isolated problems.
- The "wall of challenges," they can clearly see which stages create the most difficulties (some steps may be overloaded with sticky notes).
- This task develops their ability to analyze customer problems, a skill that becomes essential for anyone launching and selling natural cosmetics online.

General guidelines for the implementation of the activity:

- When all sticky notes are placed, gather the class in front of the board.
- Go through each part of the shopping journey together.
- Read out a few sticky notes for each stage.
- Ask students to explain their ideas if they aren't clear.
- Group similar challenges together (e.g., "unclear ingredients" and "too many chemical names").

Guiding questions for the teacher:

Which part of the shopping process seems to have the most challenges?

- Are these problems unique to natural cosmetics, or do they also happen with other products?
- How do these problems affect customers' trust in a brand?
- If you were the producer, how could you solve at least one of these issues?

Teacher input:

From a consumer perspective, many issues related to trust, ingredients, and packaging have been identified. These are not only issues for consumers; there are key trends shaping the cosmetic industry today. Cosmetic companies need to provide transparent information about the ingredients, their sourcing, the production process and the environmental impact. Detailed labels and ingredient transparency are essential to building trust among consumers. This shift is not only about building trust but also about empowering consumers to make informed choices that align with their values and health concerns. Recently, brands have also invested in educating consumers about skincare routines and the benefits of using natural and/or organic cosmetics.

The cosmetic industry is shifting toward **customization, sustainability, eco-innovation, and transparency.** These factors are significantly shaping how companies produce, package, and market their natural cosmetic products.

What will students learn from this activity?

- The students will learn to think critically about problems and identify what matters most instead of just naming them. They will also see how these problems all link up when shoppers buy online. This encourages them to think like professionals who need to fix things to make online shopping better for customers.

Optional creative extension activity:

- Have each pair quickly think up one solution to the problem they've pointed out. For instance, if the challenge is excessive plastic packaging, a potential solution could be adopting biodegradable or recycled packaging.

STEP 4: Conclusion

The teacher wrapped up by going over the main problems the students wrote on the “wall of challenges.”

- It was pointed out which stages collected the most sticky notes.
- One or two specific problems were highlighted that really stood out, especially when it comes to natural cosmetics..

Reconnect to the lesson goal:

- Today, we learned that buying natural cosmetics online is not always easy. As future professionals and producers, it is important for you to understand these challenges. This information can help you create better products, build trust in your brand, and offer eco-friendly solutions.
- Encourage students to reflect on their own roles as both consumers and future business professionals:
  - As consumers: What will you watch out for now when buying natural or organic cosmetic products online?
  - As future business professionals: *How would you make sure your customers do not face the same challenges as Maya?*

Final Reflection

- Buying natural cosmetics online has its own set of issues that we need to understand.
- These issues tell us why transparency, sustainability, and trust are so important in business.
- The students should now be thinking both as customers and as future brand owners, who can come up with better solutions.

APPENDIX 1 Case study: Maya buys a natural face cream online

Maya, a 22-year-old student, wants to buy some natural face cream online. Her skin is sensitive, and she is into eco-friendly stuff. She starts searching and sees a bunch of brands right away. Most of them say they are “natural” or “organic” but the information feels confusing. Some websites do not look very trustworthy. After a bit, she finds two creams that seem okay. The only thing is, the ingredient lists are crazy long and full of words she does not understand. The prices are also higher than the usual creams she buys. Maya decides to add one of the creams to her shopping cart. When she sees the final cost, the shipping fee is almost as high as the cream itself. She is also worried about using her card since they do not do cash on delivery. Still, she places the order anyway, but it takes forever to arrive - like, 10 entire days. The tracking system is difficult to follow, and she starts to worry that the package might not arrive. The cream arrives by post in a plastic package. It looks okay, but the jar is smaller than she expected from the pictures. Maya is a little bummed, even though the product does work.

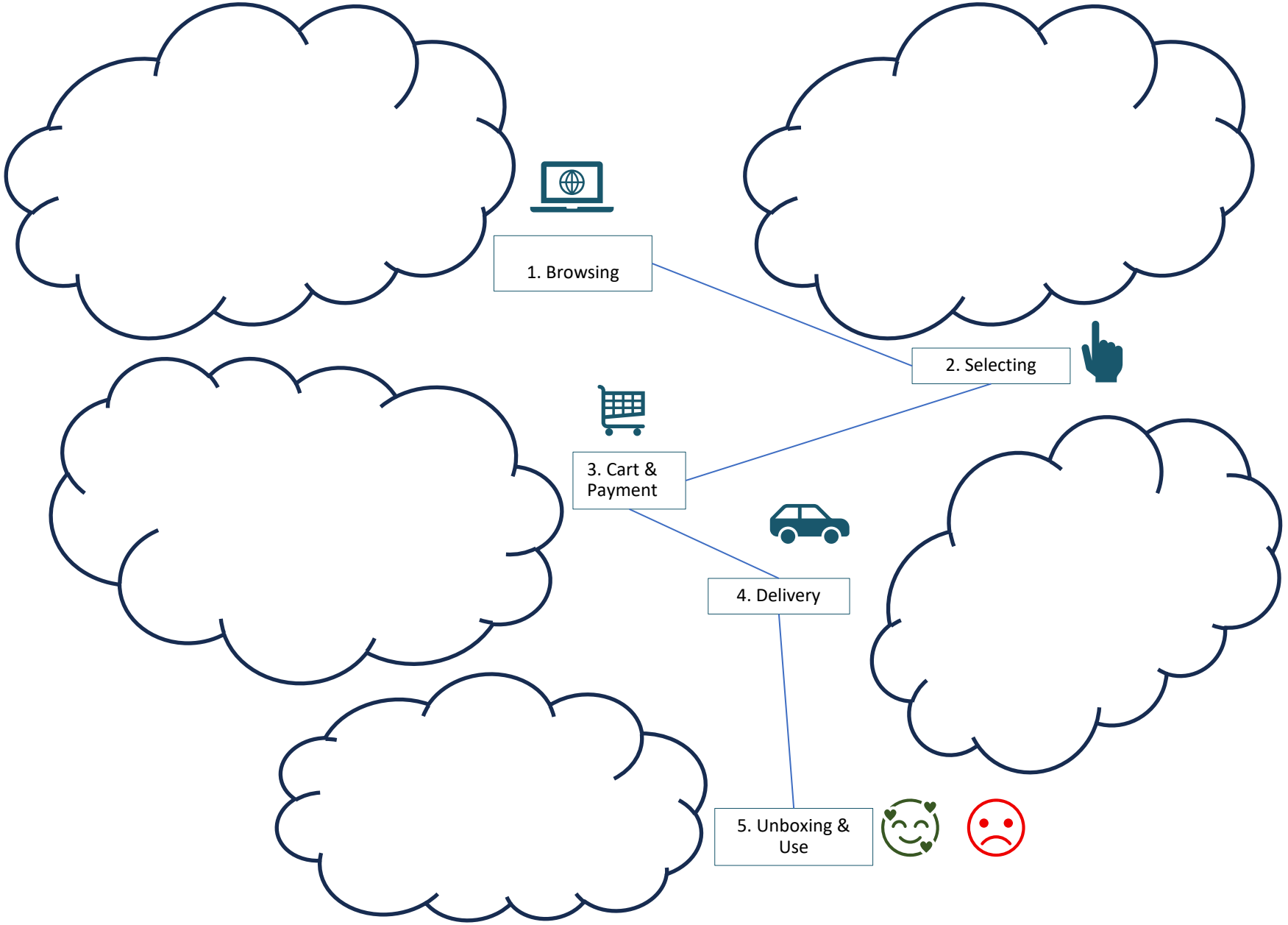
Possible answers from the students

- Confusing and untrustworthy online information
- Complicated ingredient lists and high prices
- Extra shipping costs and limited payment options
- Long delivery times and an unclear tracking process
- Excess plastic packaging and product is smaller than expected

Prompts for discussion:

- How do you decide if a brand or website is trustworthy?
- Do you usually check ingredients before buying cosmetics?
- How important is it to have different payment options?
- What is your experience with delivery delays or unclear tracking?
- How do packaging and presentation affect your satisfaction as a customer?

APPENDIX 2 Customer journey map



SOURCES

- https://anchanto.com/10-problems-holding-back-ecommerce-businesses-in-beauty-and-cosmetics-and-how-to-solve-them/ Date of Access: 22.08.2025
- https://www.monks.com/articles/beauty-and-ecommerce-beast-tackling-your-challenges Date of Access: 22.08.2025
- https://www.tcf.team/blog/challenges-in-beauty-ecommerce Date of Access: 23.08.2025
- https://www.quimivita.com/blog/the-future-of-cosmetic-formulations-innovative-ingredients-for-high-performance-products/ Date of Access: 23.08.2025
- https://www.expressvpn.com/blog/safety-tips-for-online-shopping/?srsltid=AfmBOookffO6ToyWcaH4SfcN2XFnyLr1RKOhfX8ctwx1dlK4FOVu4PTH
- https://www.ewg.org/skindeep/ Date of Access: 24.08.2025
- https://tuuskrol.com/buy-beauty-products-online/ Date of Access: 25.08.2025
- https://formulabotanica.com/how-to-sell-homemade-cosmetics/ Date of Access: 25.08.2025

Developed by:

Meri Boshkoska

Innova Lab - Bitola

Co-funded by the European Union



2.25. TITLE: Green Marketing and Ethical Beauty Branding

PROCEDURE:

Steps	Time
Step 1: Introduction and warm-up discussion	15 min
Step 2: Group Activity: Eco-Claim Detective	20 min
Step 3: Brainstorming: What makes marketing truly green?	10 min
Step 4: What Have We Learned?	10 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What green marketing is and how it applies to the cosmetic industry. • The main characteristics of greenwashing in the cosmetic industry.	• Identify greenwashing techniques in cosmetic advertisements. • Identify whether a beauty product's marketing is truly eco-friendly.	• The importance of promoting honest, ethical marketing as future beauty professionals or informed consumers. • How greenwashing can influence consumer choices.



Number of participants: 12-15



Planned time: 45 min



Materials required:
Projector, laptop, printed fake or real cosmetic product labels, worksheets, sticky notes, whiteboard, markers, pens, colored pencils.



Remarks:

STEP 1: Introduction and warm-up discussion

- **The teacher starts with questions:**
  - Are you familiar with the concepts of green marketing and greenwashing in the cosmetic industry?
  - Why is green marketing important in the cosmetics industry?
  - What makes a cosmetic beauty ad truly eco-friendly and not just “green-looking”?
- **Answers to the previous questions**:
  - **Green marketing** in the cosmetics industry is important for environmental sustainability. It addresses concerns such as reducing pollution, using less plastic, choosing sustainable ingredients, and promoting eco-friendly packaging. Meeting these criteria not only aligns with consumer preferences but also contributes to the industry's efforts toward environmental preservation.
  - **Greenwashing** happens when companies make their products seem more eco-friendly than they really are, just to attract people who care about the environment. This kind of misleading practice can confuse consumers and land businesses in court. To counter this, new regulations, especially in the EU, are stepping in to demand that brands support their green claims with solid evidence.
  - A genuinely eco-friendly ad gives clear, trustworthy details about what makes the product green, such as showing recognised certifications like ECOCERT or Vegan Society certifications, clear statements like “packaging from 100% recycled paper” that can be easily verified, and a list of ingredients along with explanations of why they are used. A “green-looking” ad, on the other hand, might only use green colours, nature imagery, or vague words like ‘natural’ or ‘clean’ without explaining what these terms actually mean. If the ad only looks eco-friendly but doesn’t provide solid evidence, it’s almost certainly greenwashing.
  - **To encourage further discussion, the teacher shows examples of photos and videos of real and misleading green cosmetic product advertisements.** (Appendices 1A, 1B, and 1C)

STEP 2: Group Activity: Eco-Claim Detective

Objective: Students work in groups to investigate eco-claims made by a fictional cosmetic brand and decide whether each one is authentic, misleading, or unclear.

Instructions:

1. The teacher distributes a worksheet with a set of six eco-claims made by fictional skincare companies (Appendix 2).
2. Each group discusses and labels each claim as:
   - Genuine
   - Greenwashing
   - Unclear / Needs more information
3. Groups must justify their decisions in 1–2 sentences for each claim.
4. Groups present their reasoning in a quick roundtable discussion (4–5 minutes total).

STEP 3: Brainstorming: What makes marketing truly green?

- The teacher leads a brainstorming session and asks the students**: What should a truly eco-friendly cosmetic brand include in its marketing?** The teacher encourages students to write their ideas on sticky notes. As students share their ideas, the teacher writes each response on the board and creates a "Green Marketing Checklist" with the class.
- Responses may include:
    - Ingredients: plant-based, cruelty-free, non-toxic, biodegradable, and free from harmful chemicals such as parabens or sulphates.
    - Packaging: recyclable, compostable, biodegradable, or refillable.
    - Certifications**:** ECOCERT, COSMOS Organic, Leaping Bunny, Vegan Society, etc.
    - Brand values: sustainable sourcing, transparency, and fair labour practices.
    - Transparency**:** clear claims, ingredient lists with explanations, and avoiding vague terms such as "natural", "eco-friendly", "pure", or "green" without explanations or certifications.

STEP 4 : What Have We Learned?

- The teacher **facilitates** a friendly group discussion in which all students have the opportunity to contribute.

Some key discussion points:

- **Q1:** How do we distinguish genuinely eco-friendly products from those that are merely green in colour on the label?
- **A1:** Authentic eco-friendly products are made with safe and natural ingredients, use packaging that can be recycled or refilled, and carry authentic eco-labels such as "Vegan" or "Cruelty-Free." Brands that only appear green may use terms such as "natural" or "pure" throughout the packaging without explaining how the product is truly sustainable. In such cases, the "green" is primarily a marketing design choice rather than a factual claim.
- **Q2:** How important are labels and certifications such as "vegan" or "organic"?
- **A2:** Certifications indicate that a product has been tested and approved by a credible organisation. They assure consumers that the product is genuinely environmentally friendly, safe, or cruelty-free. Without such labels, it can be difficult to determine whether a company is being truthful or simply using green marketing to increase sales.
- **Q3:** What can you do to make informed and responsible choices, whether you are training as a beauty professional or simply shopping for yourself?
- **A3:** We can look for genuine eco-labels, read product labels carefully, and avoid products with misleading green claims. As future professionals in the cosmetics industry, we should recommend truly sustainable brands and educate our clients on how to recognise the difference.

Ex.1 Lush Cosmetics - Real Eco-Friendly Brand

- Products are handmade using safe, natural ingredients
- No harsh chemicals or fake preservatives
- Actively supports the environment and animal rights

Video subtitle:
(0:05) Charity Pot is a self-preserving, floral-scented and vegan lotion that was created to support grassroots organisations. Made from organic, sustainable and ethically sourced ingredients from communities and co-ops around the world. Ugandan moringa oil, Kenyan aloe, Colombian cocoa butter, Ghanaian shea butter, and Arizonan jojoba oil come together to create a (0:31) rich and nourishing lotion that supports sustainable farming.
With every purchase of Charity Pot, 100% of the purchase price goes to grassroots organisations.
(0:43) We advocate for the rights of people, animals and the planet. Our Charity Pot Body Lotion
(0:48) supports groups working at the root cause of issues and creating long-term systemic change
(0:54) for human rights, animal protection and environmental justice.
Thanks to our Lushies, (1:00) we have allocated tens of millions of dollars to thousands of grassroots organisations in over 80 (1:06) countries. We think it's pretty great and Lushies agree. Charity Pot Body Lotion nourishes skin and (1:18) communities around the world. It is available in a recycled black pot or as a naked product.

Click play to watch the video ad "Lush Charity Pot - Ethical Buying & Sustainability"



Ex.2 REN Clean Skincare is a real eco-friendly brand that uses recycled packaging (even ocean plastic), aims for zero waste, and is honest about how its natural ingredients are sourced.

REN Clean Skincare has partnered with four beauty environmental brands to fight packaging waste by promoting sustainable, recyclable solutions and committing to zero-waste goals.



Click play to watch the video ad "Clean to skin. Clean to the Planet"
A sustainable beauty promise by REN Clean Skincare.



- **Ex.3** Australian beauty group **“Bondi Sands”** has been accused of greenwashing and putting profits before people and the environment Bondi Sands advertises its sunscreens as reef-friendly, dermatologist tested, fragrance-free, and gentle on the skin, claiming they offer strong protection and hydration. The brand says its products follow strict safety rules in Australia, the EU, and the US. In a class action complaint filed in the US District Court in Northern California, Bondi Sands is accused of mislabeling several sunscreen products available in the US as “reef friendly” while they contain chemical filters, such as avobenzone, homosalate, octisalate, and/or octocrylene, which, according to the plaintiff, “are not safe for reefs"



Bondi Sands’ SPF 50 Broad Spectrum UVA and UVB Protection Aerosol Mist Spray claims the product is “fragrance-free”, “non-greasy”, “reef-friendly” and “Australian-made”. However, the list of ingredients shows the presence of octocrylene but not oxybenzone or octinoxate.

Group Name/Number: _____

Instructions: Your group will analyze the eco-friendly claims made by fictional cosmetic brands.

For each of the following statements, decide whether it's:

- **Genuine** (Clear, true, and backed by certifications or facts)
- **Greenwashing** (Misleading, vague, or emotionally manipulative)
- **Unclear / Needs More Info**

Then explain **why** in one or two sentences.

Table 1. Eco-claims to Evaluate

	Eco Claim	Your decision	Why? (Your reasoning in 1–2 sentences)
1	We use clean ingredients inspired by nature.		
2	Our packaging is recyclable		
3	This product is 95% natural and 100% effective.		
4	Certified by EcoCert and Vegan Society.		
5	Reef-friendly sunscreen for ocean-safe beauty		
6	Plant-powered formula with science-backed results		

Table 2. Potential explanation for each claim

	Eco Claim	Your Decision	Why? (Your reasoning in 1–2 sentences)
1	We use clean ingredients inspired by nature.	Unclear	'Eco-friendly' and 'nature-inspired' are vague terms. There is no certification or proof of what ingredients have actually been used.
2	Our packaging is recyclable	Genuine	If the packaging bears a recycling symbol and the material it is made from is typically recyclable (e.g. cardboard or PET), then this is a true statement.
3	This product is 95% natural and 100% effective.	Greenwashing	A claim of "100% effective" is marketing hyperbole, and the phrase "95% natural" can be misleading without proper context or certification.
4	Certified by EcoCert and Vegan Society.	Genuine	These are genuine, recognised certifications issued by independent bodies that can be verified.
5	Reef-friendly sunscreen for ocean-safe beauty	Greenwashing	"Coral reef friendly" is not a regulated term. Without a list of ingredients or reference to a certificate, it is merely a marketing slogan.
6	Plant-powered formula with science-backed results	Unclear	It sounds great, but "scientifically backed" is not a defined term, and no studies or certificates are mentioned. It may well be true, but no evidence has been provided.

SOURCES

- https://www.researchgate.net/publication/387755637_Title_GREEN_MARKETING_STRATEGIES_IN_COSMETIC_INDUSTRY_Domain_Green_Marketing_Author_Details_GREEN_MARKETING_STRATEGIES_IN_COSMETIC_INDUSTRY. Date of Access: 24.07.2025
- https://www.potterclarkson.com/insights/greenwashing-in-cosmetics-the-evolution-of-the-cosmetics-industry-and-the-likely-impact-of-approaching-eu-regulations/. Date of Access: 24.07.2025
- https://www.sciencedirect.com/science/article/pii/S0272494424000549 . Date of Access: 24.07.2025
- https://www.renskincare.com/blogs/clean-thoughts/weareallies. Date of Access: 22.07.2025
- https://cosmeticsbusiness.com/bondi-sands-hit-with-class-action-against-reef-friendly-sunscreen--201064. Date of Access: 22.07.2025
- https://www.premiumbeautynews.com/en/bondi-sands-faces-us-class-action,20388. Date of Access: 22.07.2025
- https://www.provenance.org/news-insights/5-times-beauty-brands-were-accused-of-greenwashing-and-the-lessons-we-can-learn, Date of access: 25.07.2025
- https://www.youtube.com/watch?v=nCo7SuuLIYo. Date of Access: 25.07.2025

Developed by:

Meri Boshkoska

Innova Lab - Bitola

Co-funded by the European Union



2.26. TOPIC: Palm Oil's Hidden Footprint in Cosmetics

PROCEDURE:

Steps	Time
Step 1: Introduction	10 min
Step 2: From Rainforest to Lipstick: The Palm Oil Story	15 min
Step 3: Role Play Activity	15 min
Step 4: Closing Thoughts	5 min



Number of participants: 12-16



Planned time: 45 min



Required materials: Projector, laptop, printed cards, whiteboard, markers, pens.

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• The main uses of palm oil and its derivatives in cosmetics and other consumer products. • The role and significance of RSPO (Roundtable on Sustainable Palm Oil) certification	• Identify environmental and ethical issues linked to palm oil production. • Explore sustainable alternatives and certifications.	• How cosmetic product choices affect environmental sustainability and social responsibility. • The importance of transparency, labelling and credible certifications in consumer decision-making.



Remarks:

STEP 1: Introduction

The teacher shows a slide with everyday products. Students work individually or in pairs to find out what these products have in common (Appendix 1).

Teacher's explanation: These products may seem unrelated, but they often have one key ingredient in common: palm oil or one of its many derivatives. Palm oil is a type of vegetable oil produced from the fruit of the oil palm. It is extremely useful, making chocolate smooth, soap lather, shampoo foam well, and lipstick creamy. According to CRODA, one of the largest manufacturers and suppliers of ingredients for the cosmetics and personal care industry, palm oil derivatives are used in 70% of the world's personal care products (Appendix 2). Palm oil is used in products such as:

- Shampoos and conditioners
- Make-up cosmetics such as mascara, foundation, concealer, lipstick, eye shadow and eye pencils
- Skin care cosmetics
- Perfumes
- Sunscreens
- Facial tissues
- Toothpaste
- Soap and laundry detergents
- Foods such as crisps, sweets, margarine, chocolate, bread, peanut butter, baby milk, ice cream and vegan cheese

The teacher lists popular palm oil derivatives on the board, explaining that they are often hidden under unfamiliar names:

- Sodium lauryl sulphate
- Glyceryl stearate
- Stearic acid
- Cetyl alcohol
- Cetearyl alcohol
- Palmitic acid

The teacher adds: The aim of today's lesson is to learn how to recognise these ingredients on product labels, understand why they are used and consider whether their production is truly sustainable.

The teacher shows a slide with everyday products. Students work individually or in pairs to find out what these products have in common (Appendix 1).

Teacher's explanation: These products may seem unrelated, but they often have one key ingredient in common: **palm oil** or one of its many derivatives. Palm oil is a type of vegetable oil produced from the fruit of the oil palm. It is extremely useful, making chocolate smooth, soap lather, shampoo foam well, and lipstick creamy. According to CRODA, one of the largest manufacturers and suppliers of ingredients for the cosmetics and personal care industry, palm oil derivatives are used in 70% of the world's personal care products (Appendix 2). Palm oil is used in products such as:

- Shampoos and conditioners
- Make-up cosmetics such as mascara, foundation, concealer, lipstick, eye shadow and eye pencils
- Skin care cosmetics
- Perfumes
- Sunscreens
- Facial tissues
- Toothpaste
- Soap and laundry detergents
- Foods such as crisps, sweets, margarine, chocolate, bread, peanut butter, baby milk, ice cream and vegan cheese

The teacher lists popular palm oil derivatives on the board, explaining that they are often hidden under unfamiliar names:

- Sodium lauryl sulfate
- Glyceryl stearate
- Stearic acid
- Cetyl alcohol
- Cetearyl Alcohol
- Palmitic acid

The teacher adds: The aim of today's lesson is to learn how to recognise these ingredients on product labels, understand why they are used and consider whether their production is truly sustainable.

STEP 3: Role Play Activity

Objective – To simulate a real-life decision-making process in which each stakeholder must defend their values, negotiate demands and reach a sustainable solution for the launch of a new skincare product line.

- **Scenario**: A cosmetics brand intends to launch a new line of skincare products. Important decision: *Should palm oil, certified palm oil from sustainable sources, be used or avoided altogether?*
- Students are divided into four groups: the cosmetics brand, an NGO, cosmetics specialists *(make-up artists, skincare technicians, salon owners)* and interested consumers. Each group represents a key stakeholder in the cosmetics industry and must defend its position, respond to others' arguments, and help reach a compromise.
- **Exercise procedure:**

Step 1: Divide the class into four groups and distribute a printed stakeholder identity card to each group. (Appendix 3)

Step 2: Start the 'Sustainability Summit'

1. Opening statements (1 minute per group) – each group presents their stakeholders' position and key issues.

2. Open negotiations – groups challenge each other, asking questions while respecting each other's opinions. Encourage active discussion and responses among stakeholders.

3. Propose a compromise solution - What can everyone agree on?– each group suggests a realistic solution that all stakeholders can agree on.

STEP 4: Closing Thoughts

At the end of the lesson, students are encouraged to reflect on their own purchasing decisions and how the knowledge they have gained may influence their future choices. The aim of this step is not to impose a ‘right’ or ‘wrong’ answer, but to help students critically evaluate product labels, understand the consequences of palm oil production and make informed decisions in line with their values.

Sample student responses:

- Yes, I would avoid palm oil if it were not produced sustainably. I will check if it is RSPO - certified.
- No, I will not avoid it completely, but I will choose ethical brands.
- I did not know that palm oil is found in so many products. Now I will read the ingredients more carefully.

Teacher's summary:

- Thank you for sharing your thoughts. Your comments show that there is no single approach – some of you avoid palm oil completely unless it is certified as sustainable, others are willing to use it if it comes from ethical sources, and some are only now realising how common it is in everyday products.
- An important takeaway is that you now know how to recognise palm oil and its derivatives on a label, and you understand the impact of your choices. As future professionals in the cosmetics industry, your role will be not only to choose products carefully, but also to guide customers towards more conscious and responsible decisions.

APPENDIX 1. Mini Photo Quiz – What's the hidden link?



Chocolate Mars Bar



Nutella



Moisturizing Lip Balm

Ingredients:
NCI: Hydrogenated Olive Oil Unsaponifiables, Helianthus Annuus (Sunflower) Seed Oil*, Theobroma Coco Seed Butter*, Ricinus Communis (Castor) Seed Oil*, Carthamus Tinctorius (Safflower), Seed Oil*, Cetearyl Alcohol, Glyceryl Stearate, Prunus Amygdalus Dulcis (Sweet Almonds) Oil*, Copernica Cerifera (Carnauba) Wax*, Citrus Aurantium Dulcis (Orange) Peel Oil*, Zea Mays Strach*, Olea europaea (Olive) fruit oil, Lecithin*, Tocopherol, Limonene**, Linalool**.

- *Ingredientes de Agricultura Biologica/Ingredients from Organic Farming
- **constituinte natural de oleos essencials/From organic essential oils



Ultra Shimmer Lipstick

Avon Ultra Shimmer Lipstick
Ingredients: Ricinus Communies Seed Oil, Mica, Ethylhexyl, Methoxycinnamate, DI-PPG-3 Myristyl ether adipate, tridecyl trimelliate, silica, petrolatum, synthetic wax, sesamum indicum seed oil, phenyl trimethicone, cera microcristallina, simmondsia chinesis seed oil, diphenyl dimethicone, ozekerite, boron nitride, polymethylsilsesquiozane, titinum dioxide, disteardimonium hectorite, caprylyl glycol, ethylene/propylene/styrene copolymer, trithyl citrate, parfum, steracid acid, aluminium hydroxide, tocopheryl acetate, persea gratissima oil, butylene/ethylene/styrene copolymer, calcium sodium borosilicate, synthetic flourphlogopite, calcium aluminium borosilicate, tin oxide, +/- CI5858. CI77497, CI77492, CI77499, CI77891, CI45410, CI77400, CI19140, CI5985, CI42090, CI7200

APPENDIX 2. Top cosmetic and personal care brands that use palm derivatives in their products.



Source: https://www.malaysiakini.com/knowmypalmoil/488855

APPENDIX 3 Biodiversity & Palm Oil

What is the issue?

- Palm oil comes from the oil palm tree and is primarily produced in Indonesia and Malaysia, which together account for over 85% of global production.
- Palm oil is used in a range of products: food, cosmetics, cleaning products and bioenergy.
- Palm oil production has increased rapidly since the 1960s. Between 1970 and 2020, the world's production of palm oil increased by about 40 times. Global production went from only 2 million tonnes to around 80 million tonnes.
- Industrial-scale oil palm plantations occupy an area of 18.7 million hectares worldwide. (2017)
- Oil palm has a large smallholder sector, with, in some countries, up to 94% of the oil palm land allocated to smallholders.
- 85% of the global palm oil supply comes from Indonesia and Malaysia, followed by Thailand, Colombia and Nigeria. Key export markets include the EU, China, India, the US, Japan, and Pakistan.
- Oil palm produces 35% of vegetable oil on less than 10% of cropland, making it highly land-efficient.
- Expansion is a major driver of deforestation, especially in tropical Asia and parts of Central and South America.
- Oil palm expansion could affect 54% of threatened mammals and 64% of threatened birds globally.
- Around 10,000 Bornean orangutans live in areas allocated to oil palm, with 750–1,250 killed annually in human–wildlife conflicts, which are often linked to expanding agriculture.

Why is it important?

- At the household level, palm oil has been used for domestic cooking in Southeast Asia, tropical Africa, and South America for centuries.
- It provides jobs and supports economic development in producing countries (Indonesia, Malaysia).
- It contributes to the development of the infrastructure, including roads, hospitals, and schools.

Environmental costs:

- It is responsible for greenhouse gas emissions from deforestation and drainage of peatlands.
- It contributes to regional smoke haze, water pollution, and habitat loss in biodiversity-rich regions.

Social costs:

- Loss of forest access for local communities.
- Increased human-wildlife conflict.
- Labour shortages for local food production and labour in-migration from lower income countries or regions.

What can be done?

- Palm oil must be produced more sustainably; banning or replacing it is not a viable solution.
- Oil palm is more land-efficient than other crops (up to 9× more oil per hectare).
- Switching to soy, sunflower, or rapeseed would require more land and could shift biodiversity loss elsewhere.
- Sustainable production is key: strengthen certification schemes (e.g., RSPO*), improve plantation management and ensure fair treatment of communities.

* **Roundtable on Sustainable Palm Oil (RSPO)** is a voluntary, global membership organisation that partners with stakeholders from the seven sectors of the palm oil industry to develop and implement global standards for the production and procurement of sustainable palm oil. RSPO Standards provide the aims, objectives and mandatory requirements for the production and procurement of RSPO Certified Sustainable Palm Oil (CSPO).

Cosmetic Brand – Stakeholder Card
Goal: Launch a successful skincare line that is appealing, feels pleasant to use, and remains affordable.
Motivation: Use ingredients that ensure product texture, shelf life, and overall product appeal.
Concern: The brand does not want to be accused of greenwashing or damaging its reputation.
What you want: Freedom to use palm oil while highlighting positive environmental practices.
What you might compromise on: Consider using RSPO-certified sustainable palm oil and providing more transparent labelling.

Non-governmental organisation dedicated to environmental protection
Goal: To protect forests, wildlife and indigenous communities.
Motivation: To combat deforestation and habitat destruction caused by unsustainable palm oil production.
Concerns: Greenwashing, false sustainability claims.
What you expect: No palm oil unless it comes from certified, fully traceable sources that do not contribute to deforestation.
What you can agree to: Acceptance of RSPO-certified oil, subject to strict controls.

Cosmetic Professional

- **Goal**: Use safe, effective, and ethical products on clients.
- **Motivation**: Trustworthy products build client loyalty and protect skin health.
- **Concern**: Confusing labels, harsh chemicals, or products that spark client distrust
- **What You Want**: Clear ingredient lists, ethical sourcing, and skin-safe formulations
- **What You Might Compromise** On: Use palm oil if it's transparently sourced and gentle for skin.

Concerned Consumer

- **Goal**: Buy cruelty-free, eco-friendly beauty products.
- **Motivation**: Wants to make informed, ethical shopping choices.
- **Concern**: Misleading claims like 'natural' or 'green' without proof
- **What You Want**: Honest, clear labels and verified eco-certifications
- **What You Might Compromise** On: Accept palm oil if it's proven ethical and sustainable.

APPENDIX 5 Sample compromise solution.

After negotiation, all four stakeholder groups agree on the following:

- **The cosmetic brand will:**

1. Use only RSPO-certified sustainable palm oil in its new skincare line.
2. Clearly label all products with a transparent list of ingredients and include a "Certified Sustainable Palm Oil" badge.
3. Create educational materials (e.g. website information, social media posts, packaging QR codes) explaining why certified palm oil was chosen and how it is sourced.
4. Pledge to review and improve its sustainability practices each year and consider palm oil alternatives as new technologies emerge.

- **Why each stakeholder accepts this:**

Stakeholder	Reason for agreement
Cosmetic Brand	Keeps product texture and costs manageable while protecting the brand's reputation.
Environmental NGO	Accepts RSPO certification provided that there is full traceability and public transparency
Cosmetic Professional	Feels confident in recommending products with ethical and clear labeling.
Concerned Consumer	Gains trust through honest claims, visible certifications, and eco-conscious messaging.

APPENDIX 6 Possible answers to the questions from step 2**.**

1.What is palm oil and why is it used in so many products? Palm oil is a type of vegetable oil that comes from the fruit of the oil palm tree (Elaeis guineensis).

The tree is native to West Africa but is now mainly grown in Indonesia and Malaysia, which together produce over 85% of the world's supply.

2. What are the environmental issues and challenges resulting from palm oil cultivation?

Palm oil cultivation drives deforestation, destroys wildlife habitats, contributes to climate change and can involve unfair labour practices.

3. Why don't we simply substitute palm oil with other alternatives?

Oil palms produce much more oil per unit of land than other crops, so replacing palm oil would require more farmland and could cause even greater environmental damage.

4. What can consumers do to support sustainable palm oil and reduce its negative impacts?

Consumers can buy products containing certified sustainable palm oil, avoid unnecessary palm oil use, and support companies with ethical sourcing policies.

5. How does RSPO certification help address the environmental and social issues caused by palm oil production?

RSPO certification sets standards for producers to protect forests, wildlife, and workers, and promotes more responsible farming practices.

SOURCES

- https://pdr.fourpathsdigital.com/what-to-know-about-palm-oil-in-cosmetics/ Date of Access: 07.08.2025
- https://www.treehugger.com/palm-oil-cosmetics-5206444 Date of Access: 08.08.2025
- https://www.biome.com.au/blogs/beauty/palm-oil-hidden-in-the-worlds-most-glamourous-lipsticks?srsltid=AfmBOopSSsxgKyY0qhfwgagduLDkXvGnHK2-FbTqObkV8TuXsjcqPOfG Date of Access: 08.08.2025
- https://rspo.org/as-an-organisation/our-standards/ Date of Access: 08.08.2025
- https://uniiorganic.com/en/loja/face-en-2/dry-skin/moisurizing-lip-balm/ Date of Access: 09.08.2025
- https://ce.avon.com/ingredients-warning/en/1226777 Date of Access: 09.09.2025
- https://www.biome.com.au/blogs/beauty/palm-oil-hidden-in-the-worlds-most-glamourous-lipsticks?srsltid=AfmBOopSSsxgKyY0qhfwgagduLDkXvGnHK2-FbTqObkV8TuXsjcqPOfG Date of Access: 10.08.2025
- https://www.sustainablepalmoilchoice.eu/biodiversity-palm-oil/ Date of Access: 16.08.2025
- https://rspo.org/as-an-organisation/our-standards/ Date of Access: 16.08.2025
- https://ourworldindata.org/palm-oil
- https://www.mdpi.com/2304-8158/13/17/2814

Developed by:

Meri Boshkoska

Innova Lab - Bitola

Co-funded by the European Union



2.27. TOPIC: Water Matters in Cosmetics

PROCEDURE:

Steps	Time
Step 1: Introduction	5 min.
Step 2: The Water Footprint Game	15 min.
Step 3: Eco-Innovator Pitch	15 min.
Step 4: Conclusion	10 min.

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• That cosmetics often contain 60 - 95% water. • That packaging and production add to the water footprint.	• Rank products by water use by their hidden water use and justify the differences. • Suggest water-saving alternatives.	• The environmental consequences of water-intensive cosmetic products. • The importance of adopting and promoting water-saving practices in both personal choices and professional work.



Number of participants: 12-16



Required materials: Projector, laptop, printed product images, sticky notes (shaped like water drops if available). whiteboard, pens.



Remarks:



Planned time: 45 min

STEP 1: Introduction

To open the session and to stimulate discussion among the students, the teacher explains the following key points that are relevant to today's session:

1. **What is the role of water in cosmetics?**

- Water is often called the 'universal solvent' in the makeup world. When you mix it with emulsifiers, it helps blend oily things like butters into lotions and creams. Water is also essential for preparing natural ingredients for cosmetic products, sometimes with the assistance of substances such as ethanol or glycerine.

2. How much water is in your face cream?

- It is difficult to know the exact amount of water, but there is an easy way to tell if it is the main ingredient. Just look at the ingredient list. If Water or Aqua is at the very top, that means there is more water than any other ingredient.

3. **Why go water-free?**

- Water-free cosmetics require fewer preservatives and other additives, which can reduce the risk of skin irritation or allergic reactions. So, if you have sensitive skin, waterless products might be a better, gentler option.

- Waterless cosmetics help preserve the skin microbiota by avoiding harsh preservatives. This respect for the skin's natural flora promotes skin health and strengthens its protective barrier, which is essential for preventing dermatological issues.

- Waterless cosmetics reduce the ecological footprint of beauty products. Lowering the volume and weight of packaging results in less waste and lower CO2 emissions from transport, making these products more environmentally responsible.

- The compact format and leak-free nature of waterless cosmetics make them ideal for travel.

STEP 2: The Water Footprint Game

- **Objective**
  To educate students about the hidden water footprint of beauty products, including not only the water they contain but also the water used during production, packaging, and consumer use.

- **Activity**

1. The teacher displays pictures of selected beauty products (Appendix 1):
    1. Bar soap
    2. Makeup wipes
    3. Liquid face lotion
    4. Cream jar
2. The teacher divides students into small groups of 3–4.
3. Each group is asked to rank the products from the one that uses the **most** water to the one that uses the **least** water.
4. After completing the ranking, each group briefly explains the reasons for their choices.
5. The teacher then presents the correct ranking (Appendix 2) and discusses any surprising results.

STEP 3: Eco-Innovator Pitch

The teacher prepares printed product cards (Appendix 3), divides the class into small "start-up teams" of three to four students, and explains the activity.

Round 1 – Design and Innovation

- Each team receives one product card.
- The task is to design a water-saving version of the product, for example a solid, powder, refill or concentrated version.
- The teacher does not reveal any examples to the students.
- Time: 5 minutes.

Round 2 – Create an Eco-Slogan

- Each team creates a catchy eco-slogan (e.g. *"Beauty without water waste"*, *"Solid power, zero shower water"*).
- Time: 2 minutes.

Round 3 – Team Presentation

- Each team presents its idea in one minute. Presentations should include:
  - the name of the product,
  - an explanation of how it saves water,
  - the team's eco-slogan.

Round 4 – Voting:

After all teams have presented their ideas, both the students and the teacher vote in the following categories:

- Most creative idea
- Most eco-friendly idea
- Most likely to work
- Most catchy eco-slogan

- **Round 5 – Winner Announcement**
- The teacher counts the votes.
- Symbolic sticker prizes, prepared in advance (Appendix 4), are awarded.

STEP 4: Conclusion

The aim is for students to combine what they know about water in beauty products with what they can do as customers and future cosmetic industry experts.

Activity: Eco-Promise Wall

- Each student writes down one eco-action they will take to help the environment after this lesson on a sticky note (try to make it look like a raindrop if possible).
- Examples:
  - Buy refills instead of new bottles.
  - Give shampoo bars a try.
  - Tell customers about water-free products.

Engagement

- Students place their sticky notes on the board to form a large circle ♻️ or a raindrop 💧 shape.
- The teacher reads some of the ideas aloud and thanks everyone for sharing.
- Summary
- Today, we learned that makeup uses a lot of water without us even seeing it – not just the water contained in the products, but also the water used in production, packaging, and use. We saw that wipes, creams, and bottles use far more water than bars or refills. We also discovered that new ideas – such as powders and solids – can help reduce water waste. As the people who will be buying and selling these products in the future, you can choose products that protect water, which is something we all need to take care of.

APPENDIX 1. Products pictures



Bar Soap



Makeup wipes



Cream jar

Liquid face lotion



APPENDIX 2. Answers to the activity in Step 1

Here is the lowdown on the water footprint of your skincare products, ranked from worst to best:

1. **Makeup wipes** are the biggest water wasters. They are mostly water (around 90–95%) and are used only once before being thrown away. This means a lot of water is used in their production and disposal. Many also contain plastic, which further increases their environmental impact.

2. **Cream jars** are not much better. Creams and lotions contain a high proportion of water (70–90%), and the glass or plastic jars themselves require significant water to produce.

3. **Liquid face lotions** are slightly better, but still not ideal. They contain 60–80% water and come in plastic bottles. While less water-intensive than creams in jars, there is still considerable room for improvement.

4. **Bar soap** is the best option. Being solid, it contains very little added water. It also requires minimal packaging, and you only need water to rinse it off, not to use it.

- **Key insight:** The water footprint is more than just the water you see in the product. It includes:

- **Production** – Washing, mixing, and processing ingredients all consume water.

- **Packaging** – Producing glass, plastic, or paper packaging requires additional water.

- **Consumer use** – For example, rinsing off shampoo adds to the total water footprint.

To save water, choose solid or concentrated products such as soap bars, powder cleansers, or solid shampoos. These options are better for the environment at every stage, from production to use.

APPENDIX 3. Products cards for each team



Face moisturizer cream



Makeup wipes



Cream jar

Liquid face lotion




THINK
GREEN


Most Eco-Friendly
Idea


MOST
CATCHY SLOGAN


IDEA
MOST REALISTIC

SOURCES

- https://natrue.org/water-in-cosmetics-a-dive-into-water-free-beauty/, Date of Access: 24.08.2025
- https://lessismore.co/blogs/journal/role-water-cosmetics?srsltid=AfmBOop4cFlbnv4R78fvoMQVr91FRw2pagnR23JRLZUwGx9uc5n5ZZmx
- https://www.cosmeticsandtoiletries.com/formulas-products/skin-care/article/21835650/sun-chemical-formulating-on-trend-waterless-cosmetics
- https://www.evoluderm.com/en/products/lingettes-demaquillantes-eau-micellaire-1?srsltid=AfmBOoo2z9pkxoJpm_IDIudXuEyXUlNPUh3kBR10UZJSqHS7wm05InuB
- https://www.tyhcontainer.com/en/product/KN_PMMA.html
- https://www.clinique.com/product/1673/8279/skincare/cleansers-makeup-removers/all-about-cleantm-liquid-facial-soap
- https://artdeco.com/collections/facecream
- https://www.amazon.com/Eucerin-Immersive-Hydration-Moisturizer-Hyaluronic/dp/B0CHGP7GKR
- https://the-good-soap.co.uk/collections/solid-moisturiser-bars?srsltid=AfmBOooEmxFIJzdAwWtoIgLQRkHE5rOJ22MvQ6MghUPu8In1_gwuX_Og

Developed by:

Meri Boshkoska

Innova Lab - Bitola

Co-funded by the European Union



2.28. TITLE: Eco-Friendly Textiles: Shaping a Sustainable Future

PROCESS:

Steps	Minutes
Step 1. Introduction	10 min.
Step 2. Eco friendly textiles	15 min.
Step 3. QUIZ: Eco-Friendly Textiles Challenge	15 min.
Step 4. Summary	5 min.

AIMS TO ACHIEVE:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What are eco-friendly textiles and their importance for sustainability. • Examples of eco-friendly materials.	• Identify and evaluate different types of sustainable materials and their applications.	• Why eco-friendly textiles are essential for a sustainable future



Number of participants: 15-20



Planned time: 45 min



Required materials:
Power point presentation, flip charts, sheets of paper, marker pens, projector and a laptops/tablets (optional)



Remarks:

STEP 1 Introduction

- Teacher briefly introduces the concept of eco-friendly textiles and why they are essential for a sustainable future.

Definitions of Eco-Friendly Textiles:

- **Eco-friendly textiles** refer to fabrics and materials produced using sustainable practices that reduce environmental harm. This can include using organic fibers, recycling materials, minimizing water and energy consumption, and adopting ethical labor practices.
- They are created with a focus on **reducing pollution**, **conserving resources**, and **promoting fair trade**, ensuring that every stage of production—from raw materials to finished products—is environmentally and socially responsible.

Why Eco-Friendly Textiles Are Essential for a Sustainable Future:

1. **Reducing Environmental Impact:** Traditional textile production consumes large amounts of water and energy and generates significant pollution. Eco-friendly textiles lower these environmental costs by using renewable resources and sustainable manufacturing methods.
2. **Conserving Natural Resources:** By using organic fibers (like organic cotton) and recycled materials (such as polyester made from plastic bottles), eco-friendly textiles help preserve precious resources like water, arable land, and fossil fuels.
3. **Decreasing Textile Waste:** With fast fashion contributing to millions of tons of waste annually, eco-friendly practices like **upcycling** and **recycling** reduce landfill waste and promote circular economies.
4. **Improving Social Responsibility:** Eco-friendly textiles often align with fair labor practices, ensuring safer working conditions and better wages for workers in the textile industry.

STEP 2 Eco Friendly textiles

- Teacher asks students: "What eco-friendly materials or practices have you heard of in the textile industry?“
- After short discussion he/she shows examples: *Organic cotton, Hemp, Soy Silk, Banana Fiber Corn Fiber Bamboo fibers.*

1. **Bamboo Fiber -** Bamboo is a regenerated cellulosic fiber produced from bamboo pulp. It's a hardy, highly renewable grass that generally requires few chemical inputs. Bamboo fabric is soft, breathable, and has natural antibacterial properties, making it comfortable to wear.

2. **Organic Cotton -** Unlike conventional cotton, organic cotton is grown without the use of pesticides or insecticides, making it more environmentally friendly. However, it is more ~~labor-intensive~~ labour-intensive, and fields must be free of chemicals for three years before the crop can be certified organic. Some producers are also exploring ~~colored~~ coloured cotton or natural dyes to further reduce chemical usage.

3. **Hemp -** Hemp is considered one of the most eco-friendly fibers. It is rapidly renewable, requires little or no pesticides, grows without fertilizer, and doesn't deplete soil nutrients. Hemp fibers are long-lasting and have a low ecological footprint compared to other fibers.

4. **Soy Silk (Soy Cashmere)** This fabric is made from soy protein fibre left over after processing soybeans into food. The liquefied proteins are extruded into ~~fiber~~s fibres , which are then spun and used like other ~~fibers~~ fibres. The high protein content makes it receptive to natural dyes, allowing for the creation of various ~~colors~~ colours.

5. **Corn Fiber** Derived from naturally occurring plant sugars, corn ~~fiber~~ fibre balances strength and resilience with comfort, softness, and drape in textiles. It uses no chemical additives or surface treatments and is naturally flame retardant. Manufacturers claim these fibers can be used for sportswear, jackets, outer coats, and apparel.

6. **Banana Fiber** Known as musa ~~fiber~~ fibre; banana ~~fiber~~ fibre is one of the strongest natural ~~fibers~~ fibres. It is used worldwide for multiple purposes, such as making tea bags, sanitary napkins, Japanese yen notes, and car tires. Banana ~~fiber~~ fibre cloth comes in differing weights and thicknesses based on which part of the banana stem the fiber was taken from. The innermost sheaths provide the softest ~~fibers~~ fibers, while the outer sheaths yield thicker and sturdier ~~fibers~~ fibres. Its high water-absorbing property makes this fabric cool to wear.



Bamboo Textile



Organic cotton



Hemp



Soy Silk fabric



Corn fiber



Banana Fibers

STEP 3 QUIZ TIME: Eco-Friendly Textiles Challenge

- Teacher may use an interactive tool (e.g., Kahoot or Menti meter) or a printed worksheet. (For correct answers see Appendix 20.



1. What is an example of an eco-friendly textile?
   a) Polyester
   b) Organic cotton
   c) Nylon
2. Which textile production method uses the least water?
   a) Conventional cotton farming
   b) Recycled polyester production
   c) Bamboo fiber processing
3. What is "upcycling" in the textile industry?
   a) Disposing of old textiles
   b) Creating new products from waste materials
   c) Using fossil fuels for production
4. Which fiber is made from rapidly renewable resources and requires minimal pesticides?
   a) Polyester
   b) Hemp
   c) Nylon
5. Which eco-friendly fiber is derived from plant waste after food processing?
   a) Soy silk
   b) Corn fiber
   c) Milk fiber
6. Which eco-friendly fiber is derived from plant sugars and is naturally flame retardant?
   a) Corn fiber
   b) Milk fiber
   c) Bamboo fiber

STEP 4 Summary

Key points:

- Eco-friendly textiles play a crucial role in reducing the environmental and social impact of the textile industry.
- Textile industry can reduce water and energy consumption, minimize pollution, and promote fair labor practices by using sustainable materials such as **organic cotton, hemp, bamboo fibers, soy silk, banana fiber, and corn fiber.**

Reflection Questions:

1. What are the main challenges the textile industry faces when adopting eco-friendly materials?
2. How can you, as a future textile professional, contribute to making the industry more sustainable?
3. Which eco-friendly fiber do you find the most promising, and why?
4. How can consumer choices influence the adoption and growth of eco-friendly practices in the textile industry?

SOLUTIONS TO EXERCISES

1. What is an example of an eco-friendly textile?

   (Correct answer: b)

2. Which textile production method uses the least water?

   (Correct answer: b)

3. What is "upcycling" in the textile industry?

   (Correct answer: b)

4. Which fiber is made from rapidly renewable resources and requires minimal pesticides?

   (Correct answer: b)

5. Which eco-friendly fiber is derived from plant waste after food processing?

   (Correct answer: a)

6. Which eco-friendly fiber is derived from plant sugars and is naturally flame retardant?

   (Correct answer: a)

SOURCES

- Guide to Sustainable Fabrics for Beginners Accessed 30.04.2025 from: https://gbdmagazine.com/guide-to-sustainable-fabrics/
- Eco friendly Textiles: Accessed 12.05.2025 from: https://www.researchgate.net/publication/327498497
- What are sustainable textiles? Accessed 10.06.2025 from: https://www.bbc.co.uk/bitesize/articles/zrcx2v4#zc8cqyc
- What Are Sustainable Fabrics?. Accessed 10.06.2025 from: https://greenly.earth/en-us/blog/industries/what-are-sustainable-fabrics

Developed by:

Elizabeta Tosheva, Centar for Educational and Development Initiatives INNOVA LAB Bitola

Co-funded by the European Union



2.29. TITLE: Zero Waste Design in Fashion

PROCESS:

Steps	Minutes
Step 1. Introduction and Group Discussion	10 min.
Step 2. Zero Waste Design Examples	15 min.
Step 3. Zero-Waste Clothing Design Challenge - Practical Activity	45 min.
Step 4. Summary	10 min.

AIMS TO ACHIEVE:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• Key concepts of zero-waste design techniques.	• Identify zero-waste design techniques in clothing production. • Create a simple zero-waste clothing pattern using innovative design strategies.	• The importance of integrating zero-waste principles in garment design to minimize fabric waste. • How innovative approaches like upcycling and modular fashion contribute to sustainable fashion solutions.



Number of participants: 12-15



Planned time: 80 min



Required materials:
Power point presentation, sheets of paper, (or fabric scraps), scissors, glue, marker pens, projector and access to internet (telephones)



Remarks:

STEP 1 Introduction and Group Discussion

What is Zero Waste Design?

Zero Waste Design in fashion refers to creating garments with minimal or no textile waste.

Traditional fashion production generates **about 15-20% fabric waste** during cutting and manufacturing.

Zero waste techniques aim to reduce this by using **innovative design strategies**.

Why is Zero Waste Design Important?

- **Environmental Impact:** Reduces fabric waste that would otherwise end up in landfills.
- **Cost Efficiency:** Maximizes fabric usage, lowering production costs.
- **Creativity & Innovation:** Encourages designers to think differently about garment construction.

Group discussion: The teacher asks students:

“How much fabric do you think is wasted when making a T-shirt?”

"Can you think of any ways designers or brands could reduce fabric waste during the clothing production process?"

STEP 2 Zero Waste Design Examples

Teacher shows some examples for better understanding Zero Waiste Design (Appendix 1):

✅ **Pattern Efficiency:**

Some designers create **patterns that fit together like a puzzle**, using the entire fabric without leftovers.
Example: Designer **Holly McQuillan** developed **zero-waste pattern cutting**, ensuring no scraps remain. (Appendix 1)

✅ **Upcycling:**

Transforming old or discarded clothing into new fashion pieces.
Example: The brand **Eileen Fisher** has a **Renew line**, where they take back used clothes and remake them into fresh designs. (Appendix 1)

✅ **Modular Fashion:**

Clothing designed with **interchangeable or adjustable** parts to extend wearability.
Example: The brand **Petit Pli** makes **expandable children’s clothing** that grows with the child, reducing textile waste. (Appendix 1)

STEP 3 Zero-Waste Clothing Design Challenge - Practical Activity

1. Design Challenge Introduction (5 minutes)

- The teacher explains that students will work in small groups (3-4 students) to create a clothing pattern that **minimizes or eliminates waste**.
- Shows an example of a **zero-waste pattern layout** (e.g., patterns that fit together like a puzzle). See Appendix 2.

2. Sketching the Zero-Waste Pattern (15 minutes)

- Each group selects a simple clothing item (e.g., a T-shirt, tote bag, or scarf).
- Using large paper sheets, they must **design a pattern that uses the entire sheet** with **no leftover scraps**.
- Teacher encourages them to think about **geometric shapes** (e.g., rectangles, triangles) that interlock efficiently.

3. Prototype Creation - (15 minutes)

- If fabric is available, students can **cut and assemble** a rough version of their design.
- If using paper, they can **fold and tape** the pieces together to visualize the garment.

4. Presentation & Reflection (10 minutes)

- Each group presents their design to the class, explaining:

  ✅ How their pattern minimizes waste
  ✅ What challenges they faced
  ✅ How their design could be improved for real production

TOP TIPS TO ZERO-WASTE DESIGN

1. Think before you cut and be inventive and experimental
2. Construct a zero-waste pattern or drape the textile
3. Sew or heat-seal the textile together
4. Knit and you will only ever use the necessary amount of material
5. Be inspired by origami

STEP 4 Summary

Key points:

Zero-waste design plays a key role in making the textile industry more sustainable.

By reducing fabric waste, designers and manufacturers can conserve resources, lower costs, and minimize environmental pollution.

With the techniques like pattern efficiency, upcycling, and modular fashion, waste can be significantly reduced, promoting circular fashion and responsible production practices.

Reflection Questions:

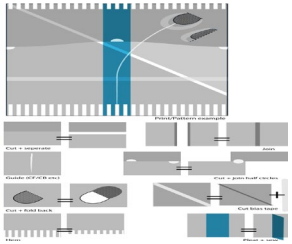
1. What are the biggest causes of fabric waste in the fashion industry?
2. Which zero-waste design technique (pattern efficiency, upcycling, modular fashion) do you find most effective, and why?
3. How can fashion designers balance creativity and sustainability when applying zero-waste design principles?

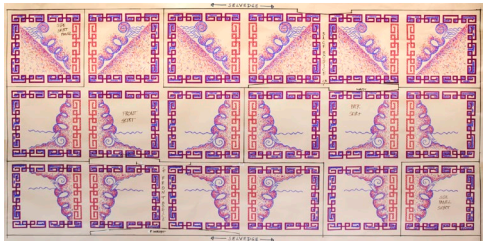
APPENDIX 1

1. Pattern Efficiency:

- **Holly McQuillan's Zero-Waste Designs:** Holly McQuillan has pioneered zero-waste pattern cutting techniques. You can explore her innovative designs and patterns on her official website: hollymcquillan.com









2. Upcycling:

- **EILEEN FISHER's Renew Line:** EILEEN FISHER's Renew program exemplifies upcycling by transforming gently used garments into new fashion pieces simple shapes made of quality fabrics. See on her official website https://www.eileenfisherrenew.com/pages/learn-more



Wear-Anywhere Essentials- Simple, suitcase-ready shapes

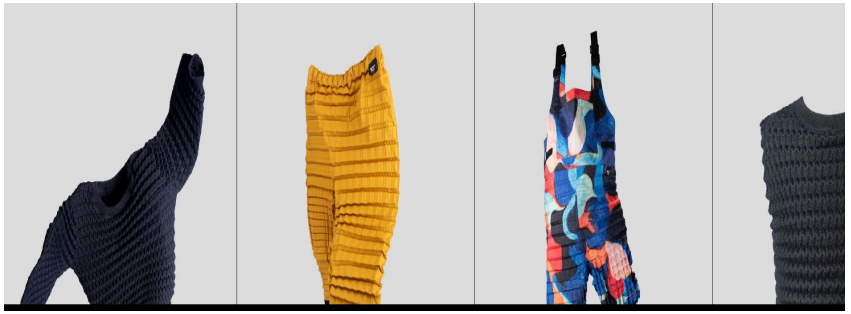


Flying Colors - One-and-done dresses, in bold shades

3. Modular Fashion:

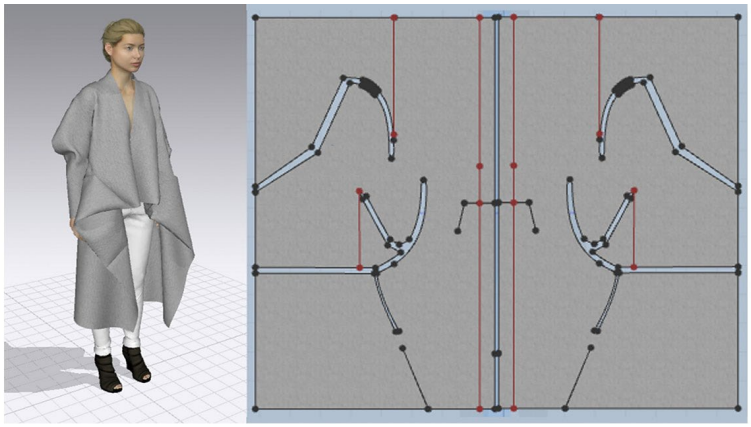
Petit Pli's Expandable Children's Clothing: Petit Pli offers innovative clothing that grows with children, showcasing modular fashion principles. Discover their designs at: shop.petitpli.com





Clothes That Grow with your child

APPENDIX 2





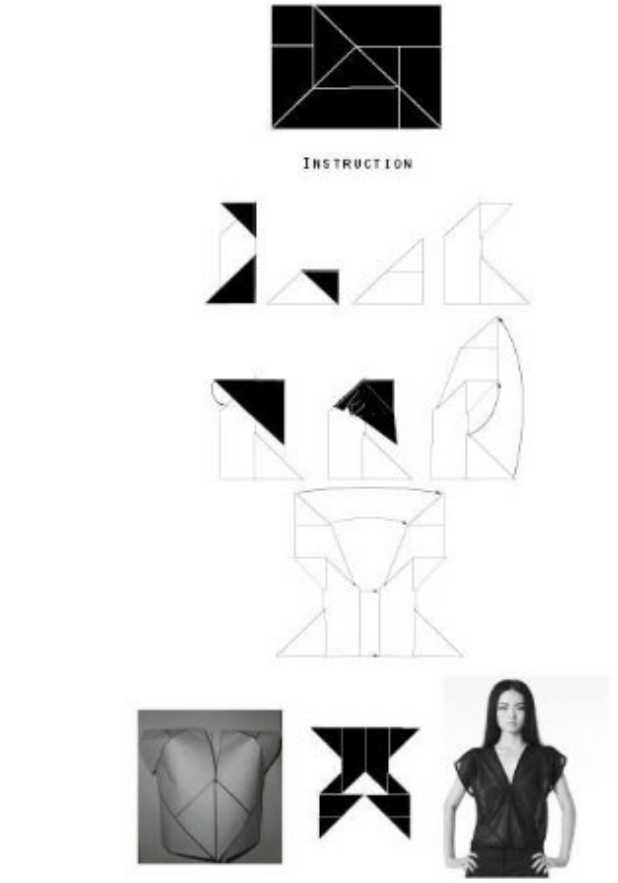
More examples of zero waste design on the following links:

- https://www.pinterest.com/fashntribalista/zero-waste-fashion-design/
- https://www.pinterest.com/elahes/zero-waste-fashion/
- https://www.pinterest.com/pin/516436282285435742/



13





SOURCES

- Review of Zero Waste Pattern Making Techniques in Building Sustainable Fashion. Accessed 31. 05.2025 from https://www.researchgate.net/publication/386445276_Review_of_Zero_Waste_Pattern_Making_Techniques_in_Building_Sustainable_Fashion (Step1)
- ZERO-WASTE DESIGN TECHNIQUE: Accessed 12.06.2025 from https://static1.squarespace.com/static/582d0d16440243165eb756db/t/5dc98b07736e6578f3c73364/1573489422952/LEARN_Zerowaste_ENG_Nov2019.pdf (Step2)
- Holly McQuillan's Zero-Waste Designs: Official website: hollymcquillan.com (Appendix 1)
- EILEEN FISHER's Renew Line: Official website https://www.eileenfisherrenew.com/pages/learn-more (Appendix 1)
- Petit Pli's Expandable Children's Clothing: Official website: shop.petitpli.com (Appendix 1)
- Zero Waste Fashion Design. Accessed 12.06.2025 from: https://www.pinterest.com/fashntribalista/zero-waste-fashion-design/ (Appendix 2)
- Zero waste fashion: Accessed 12.06.2025 from: https://www.pinterest.com/elahes/zero-waste-fashion/ (Appendix 2)
- What Is Zero Waste Pattern-making? Accessed 12.06.2025 from: https://www.pinterest.com/pin/516436282285435742/ (Appendix 2)

Developed by:

Elizabeta Tosheva, Centar for Educational and Development Initiatives INNOVA LAB Bitola

Co-funded by the European Union



2.30. TITLE: Consumer Behaviour and Sustainable Fashion

PROCEDURE:

Steps	Minutes
Step 1: Introduction and Group Discussion	15 min.
Step 2: Activity: Spot the Sustainable Choice	15 min.
Step 3: Fashion Consumption Audit Exercise	20 min.
Step 4: Summary and Reflection Questions	10 min.

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• How consumer choices impact the sustainability of the fashion industry. • Key factors that influence ethical and sustainable purchasing decisions.	• Identify sustainable alternatives when shopping clothes. • Make informed decisions that align with environmentally responsible fashion consumption.	• The role of consumers in driving positive change within the fashion industry.



Number of participants: 12-16



Required materials:
Power point presentation, sheets of paper, projector



Remarks:



Planned time: 60 min

STEP 1: Introduction and Group Discussion

What is Consumer Behavior in Fashion?

- Consumer behaviour in fashion refers to the **decisions, attitudes, and purchasing habits** of individuals when buying clothing and accessories. It includes factors such as trends, price sensitivity, ethical concerns, and environmental awareness. Sustainable fashion encourages consumers to make **responsible choices** that minimize environmental and social harm.

The Impact of Consumer Choices

- Buying a single **cotton T-shirt** requires **2,700 litres of water**—equivalent to a person's drinking water for over 2 years.
- The fashion industry is responsible for **10% of global carbon emissions**, more than all international flights and maritime shipping combined.

Why is Consumer Behaviour Important for Sustainability?

- **Fast Fashion Impact:**
- The rise of **fast fashion** has led to excessive consumption, textile waste, and unethical labour practices.
- **Influence on Industry:**
- When consumers demand sustainable products, brands are more likely to adopt ethical and eco-friendly practices.
- **Circular Fashion Economy:**
- Encouraging **reuse, repair, and recycling** reduces the environmental footprint of the fashion industry.

Group Discussion:

- "What influences your clothing purchases the most? (e.g., price, trends, sustainability, brand reputation)"
- "Have you ever considered how your shopping habits impact the environment? Why or why not?“

STEP 2: Spot the Sustainable Choice

Teacher first presents Examples of Sustainable Consumer Choices:

✅ **Secondhand & Thrift Shopping** – Reduces waste and extends clothing life.
Example: Apps like **Vinted, Depop, and ThredUp** make second-hand fashion trendy.
✅ **Slow Fashion & Quality Over Quantity** – Investing in **long-lasting** clothing reduces the need for constant repurchasing.
Example: Brands like **Patagonia** offer repair services to extend garment life.
✅ **Eco-Friendly & Ethical Brands** – Choosing brands that prioritize sustainability and fair labour conditions.
Example: Eileen Fisher uses organic materials and ethical production.

Activity: Spot the Sustainable Choice

Students work in pairs and receive **four different fashion shopping scenarios**. They must **analyse** which option is more sustainable and explain their reasoning.

Scenarios:

1. **Fast Fashion vs.-Second-hand** – Buying a trendy, low-cost fast fashion item vs. purchasing a high-quality second-hand piece from a thrift store.
2. **Synthetic vs. Organic Cotton** – Choosing a T-shirt made from conventional synthetic fibres vs. one made from organic cotton.
3. **Disposable vs. Repairable Clothing** – Buying a cheaply made jacket that will wear out in a year vs. investing in a durable jacket with repair options.
4. **Impulse Buying vs. Thoughtful Purchasing** – Making a spontaneous purchase during a sale vs. carefully researching and selecting a versatile, ethically made garment.

STEP 3: Fashion Consumption Audit

1. Teacher gives students individual task to assess their own fashion habits and identify ways to make more sustainable choices.

2. Teacher gives following **Instructions:**

- **List Your Last 5 Clothing Purchases** – Write down what you bought, why you bought it, and whether sustainability was a factor.

- **Identify Sustainable Alternatives** – Consider if the purchase could have been second-hand, or from a sustainable brand.

3. Reflection & Discussion

In small groups, students share one key change they could make to shop more sustainably in the future.

Second-hand & Thrift Shopping Apps:

- Websites:
  - Vinted
  - Depop
  - ThredUp

STEP 4: Summary and Reflection Questions

Key points:

- Consumer behaviour plays a crucial role in shaping the future of sustainable fashion.
- When individuals make mindful choices—such as buying fewer, higher-quality garments, choosing second-hand fashion or supporting ethical brands—they contribute to reducing environmental waste and promoting fair-labour practices.
- The fashion industry responds to consumer demand, meaning that collective action can drive real change toward sustainability.

Reflection Questions:

1. What are some practical steps you can take to make your fashion choices more sustainable?
2. How can brands encourage consumers to adopt more eco-friendly shopping habits?
3. In what ways do social media and marketing influence sustainable fashion choices?

SOURCES

- Business of Fashion & McKinsey & Company. (2022). *The State of Fashion: Sustainability Edition.* Retrieved from https://www.businessoffashion.com (Step 1)
- *The Impact of Cotton on Freshwater Resources.* Retrieved from https://www.worldwildlife.org (Step 1)
- United Nations Environment Programme (UNEP). (2019). *Fashion's Carbon Footprint: Addressing the Industry's Impact on Climate Change.* Retrieved from https://www.unep.org (Step 1)
- Patagonia. (n.d.). *Worn Wear: Repair & Reuse Program.* Retrieved from https://www.patagonia.com/repairs/ (Step 2)
- *Eileen Fisher Renew: A Circular Fashion Initiative.* Retrieved from https://www.eileenfisher.com/renew/ (Step 2)
- *Vinted.* Retrieved from https://www.vinted.com (Step 3)
- Depop. *Join the Circular Fashion Movement.* Retrieved from https://www.depop.com (Step 3)
- ThredUp. *Resale Market Insights and Secondhand Shopping Trends.* Retrieved from https://www.thredup.com (Step 3)

Developed by:

Elizabeta Tosheva, Centar for Educational and Development Initiatives INNOVA LAB Bitola

Co-funded by the European Union



2.31 TITLE: Alternatives to Harmful Dyeing and Finishing Techniques

PROCEDURE:

Steps	Minutes
Step 1: Introduction	20 min.
Step 2: Alternatives to harmful dyeing and finishing techniques	15 min.
Step 3: Practical activity	10 min.
Step 4: Summary	10 min.

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• Basic environmental problems linked to conventional dyeing • Four major sustainable dyeing and finishing techniques.	• Identify key features and benefits of each sustainable technique. • Explain how dyeing methods affect water pollution and chemical use.	• The social and ecological consequences of harmful dyeing practices. • The importance of choosing or promoting sustainable techniques in their future careers.



Number of participants: 15-20



Planned time: 45 min



Required materials: Power point presentation, projector, Printed or digital visuals



Remarks: The teacher may use cards for the matching activity (technique ⇄ benefit ⇄ visual)

STEP 1 Introduction

The teacher makes overview of the topic:

Textile dyeing and finishing are essential steps in creating fashion—but they are also among the most **polluting** and **resource-intensive**.

- **Conventional dyeing** uses over **70 toxic chemicals**, many of which pollute water systems.
- Textile dyeing is the **second-largest water polluter globally**.
- Conventional dyeing uses **thousands of litres of water** and **toxic chemicals**.
- Many rivers in textile-producing countries are **dyed the colour of the season** — with serious consequences for ecosystems and communities.
- **Sustainable alternatives** reduce water, chemicals, and energy use while still delivering vibrant and lasting colours.
- Moving to sustainable practices helps protect both **ecosystems and workers**.

The teacher shows printed or digital images:

Polluted rivers due to dyeing







Workers in dyeing factories







Natural Dye vs. Artificial Dyes: Pros, Cons, and Sustainability

Group Discussion:

“Have you ever thought about how your clothes get their colour?”

“Would you be willing to wear clothing dyed with natural colours even if they fade faster?”



STEP 2 Alternatives to harmful dyeing and finishing techniques

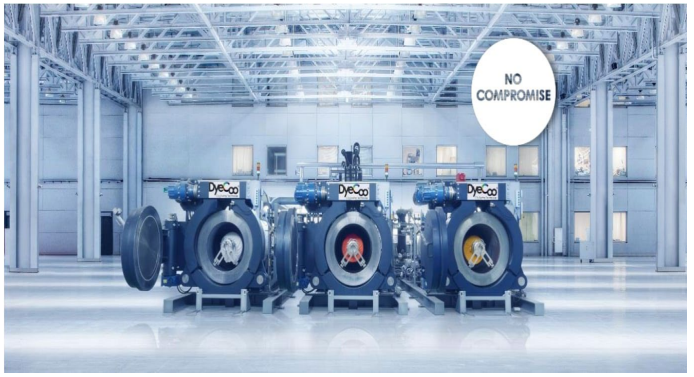
The teacher explains **Four Sustainable Dyeing Methods**

1. **Natural Dyeing**
   - Sources: turmeric, onion skins, beets, indigo
   - Used by small brands and artisans
   - Colours are softer, fade over time but are safe

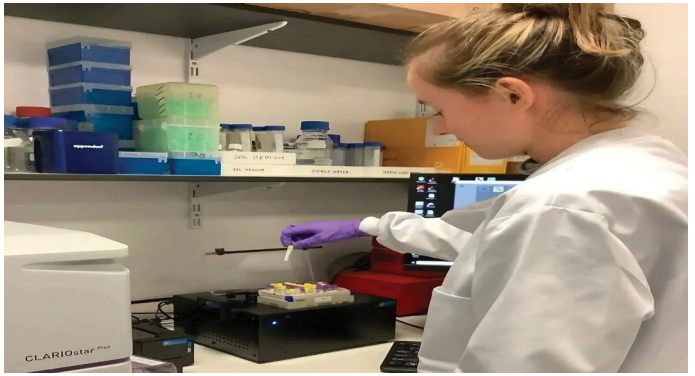
2. Low-Water & CO_2 Dyeing
   - Use air or gas instead of water (e.g., CO_2 dyeing)
   - Mostly used by big companies—reduces pollution

3. **Bio-Dyeing**
   - Made by bacteria instead of synthetic chemicals
   - Still developing, but very innovative

4. **Digital & Laser Finishing**
   - No dye baths—print-colour directly onto fabric
   - Laser finishing: removes without chemicals (used in jeans)



CO_2 Dyeing Machine



Microbial or lab-based dyeing methods

Match the Images with Technique Descriptions and Benefits:



A.



B

.

Techniques:

1. Natural Dye Bath

2. Raw Natural Dye Materials

3. Cloth Pieces Dyed Naturally

4. Natural Dye Color Samples Collage

Benefits:

a) Utilizes renewable resources

b) Minimizes wastewater

c) Produces long-lasting, vibrant colours pollution

d) Reduces water and chemical use



C.



D.

STEP 4 Summary

- Sustainable dyeing help to reduce the environmental and health hazards traditionally caused by the textile industry.
- Four alternative methods—**natural dyeing, low-water and CO_2 dyeing, bio-dyeing, and digital/laser finishing**— were explored.
- Sustainable dyeing techniques offer innovative ways to reduce water usage, limit harmful chemicals, and protect both workers and the environment.
- **Reflection Questions:**
- Why do you think conventional dyeing is one of the most polluting stages in textile production?
- Which sustainable dyeing technique would you be most interested in trying or working with?
- What are the challenges for brands or factories in switching to more eco-friendly dyeing processes?

SOLUTIONS TO ACTIVITY

Matching Activity Table

Image	Technique	Benefit
A	2. Raw Natural Dye Materials	a) Utilizes renewable resources
B	4. Natural Dye Colour Samples Collage	c) Produces long-lasting, vibrant colours
C	1. Natural Dye Bath	d) Reduces water and chemical use
D	3. Cloth Pieces Dyed Naturally	b) Minimizes wastewater

SOURCES

- Bangladesh's Polluted Waters: Rivers Dying Due to Dyeing. Accessed 07.08.2025 from: https://www.iamrenew.com/environment/bangladeshs-polluted-waters-rivers-dying-due-to-dyeing/
- To Dye For: Textile Processing's Global Impact — Carmen Busquets Accessed 07.08.2025 from: https://www.carmenbusquets.com/journal/post/fashion-dye-pollution
- Fashion hunger destroying the Asian rivers | The Business Standard Accessed 07.08.2025 from: https://www.tbsnews.net/environment/fashion-hunger-destroying-asian-rivers-139054
- Factory worker dyeing wool Accessed 07.08.2025 from https://www.sciencephoto.com/media/639099/view/factory-worker-dyeing-wool
- Colorful Garment Factory**.** Accessed 07.08.2025 from https://stockcake.com/i/colorful-garment-factory_505002_1018372
- Asian worker at a polluting chemical dye factory. Accessed 07.08.2025 from: https://www.sciencephoto.com/media/183040/view/asian-worker-at-a-polluting-chemical-dye-factory
- Natural Dye vs. Artificial Dyes: Pros, Cons, and Sustainability. Accessed 07.08.2025 from: https://www.madebygoodkarma.com/blogs/good-karma-clothing/natural-dye-vs-artificial-dye?srsltid=AfmBOorvrZtyp5v3xXPkjoA5z6oE6PBHqmRNBKLCW230aYujIWRcHPJ4

Developed by:

Elizabeta Tosheva, Centar for Educational and Development Initiatives INNOVA LAB Bitola

Co-funded by the European Union



2.32 TITLE: Greenwashing in Fashion

PROCESS:

Steps	Minutes
Step 1. Introduction	10 min.
Step 2. Key Concepts & Examples	15 min.
Step 3. Interactive Activity: "Greenwashing or Genuine?"	15 min.
Step 4. Summary	5 min.



Number of participants: 18-24



Required materials:
Power point presentation, flip charts, sheets of paper, marker pens, projector



Planned time: 45 min

AIMS TO ACHIEVE:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What greenwashing is and how it appears in fashion marketing • Key characteristics that distinguish genuine sustainability from misleading claims	• Identify and analyse examples of greenwashing in fashion • Evaluate sustainability claims based on transparency, materials, and certifications	• How greenwashing can mislead consumers and slow progress toward sustainability • The importance of honesty and accountability in sustainable fashion practices



Remarks:

STEP 1 Introduction

- Teacher briefly introduces the concept of **Greenwashing.**
- **What is Greenwashing?**
- **Greenwashing** is when a brand or company **pretends to be environmentally friendly** just to attract customers — but in reality, their actions don't match their claims. It's a marketing trick used to **make products seem „greener "** than they are.
- **Definition**: Greenwashing is **misleading marketing** that gives the **false impression that a company or its products are sustainable or eco-friendly**.
- **Why is Greenwashing a Problem in Fashion?**
- The fashion industry is one of the **biggest polluters**, and many companies now try to appear more responsible. But:

🌎 Some brands use **vague terms** like "eco," "natural," or "green" without proof.

🏷️ Others promote a single "green" product while still mass-producing fast fashion.

📉 It **confuses customers** and **slows down real sustainability efforts**.

- **Real-Life Example:**
- A fast fashion brand claims to have a "Conscious Collection" made with "sustainable materials," but offers **no information** about:

✓ What makes the materials sustainable,

✓ How the garments are produced,

✓ Or how the workers are treated.

- **Class Discussion:**

Ask students:

- **Have you ever seen clothing advertised as "eco" or "green"? What made it seem sustainable?**
- **How can we tell if a brand is truly sustainable or just pretending?**

STEP 2 Key Concepts & Examples

- Teacher shows students how to **identify greenwashing tactics** and understand how to tell the difference between **real sustainability** and **fake marketing** in the fashion industry.

Tactic	What It Means	Example
Vague Language	Using unclear terms like “eco-friendly” or “conscious” without explanation	A label says “sustainable” but gives no details about materials or processes
Lack of Proof	Claims are made without evidence or certifications	A brand says “organic cotton” but offers no certificate or transparency
Tiny Green Effort, Big Green Image	Highlighting one “green” product while the rest are unsustainable	A fast fashion brand promotes 1 eco line out of 1,000 styles
Imagery Tricks	Using green colours , leaves, or nature symbols to look eco-friendly	Green tags, nature backgrounds in ads with no real action
False Certifications	Made-up or misleading logos that look like official eco-labels	Fake “certified” logos that don’t come from real certifiers

STEP 3 Interactive Activity: "Greenwashing or Genuine?"

- **Instructions:**
- Teacher shows **6 short marketing claims or product descriptions**.
- Students work in **pairs or small groups** up to 3-4 and to guess if the claim is **Greenwashing or Genuine** and **justify** their choice.
- 🎲 **Example Scenarios: Greenwashing or Genuine?**

    1. ”Our new jeans are part of our eco collection – made with love for the planet!“

    2. "This T-shirt is made from 100% organic cotton, certified by the Global Organic Textile Standard (GOTS).“

    3. "We believe in sustainability. That’s why our stores now offer recycled paper bags.“

    4. "These sneakers are made with recycled plastic bottles and manufactured in ethical factories. Visit our site for full supply chain details.“

    5. "Conscious fashion starts here. Buy now to support the Earth!“

    6. "50% of this shirt is made with sustainable fabrics.“

- **Group Debrief:**
- What signs helped you tell if a brand was being honest or not?
- What more would you want to see on a label or website?

STEP 4 Summary

- **Key points:**

- Greenwashing refers to marketing strategies that falsely present fashion products as environmentally friendly without real sustainable practices behind them.
  It creates confusion among consumers and slows down genuine progress in the industry.

- When students learn to spot vague claims, unclear messaging, and misleading visuals, they become more thoughtful consumers and better prepared to support real sustainability in their future roles in the fashion industry.

- **Reflection Questions:**

- What are some common signs that a brand might be greenwashing?

- How can consumers check if a sustainability claim is genuine?

- As a future professional, how can you help promote real sustainability in your work or designs?

- Why is it important to be informed about greenwashing, even as a student?

SOLUTIONS TO EXERCISE: Greenwashing or Genuine?

1. *"Our new jeans are part of our eco collection – made with love for the planet!"*
   ✅ **Answer: Greenwashing**
   Why: Uses vague language ("eco collection", "love for the planet") with no specific proof or material information.

2. *"This T-shirt is made from 100% organic cotton, certified by the Global Organic Textile Standard (GOTS)."*
   ✅ **Answer: Genuine**
   Why: Clear material info + third-party certification (GOTS), a recognized standard.

3. *"We believe in sustainability. That's why our stores now offer recycled paper bags."*
   ✅ **Answer: Greenwashing**
   Why: Promotes a small environmental action while ignoring bigger product sustainability concerns.

4. *"These sneakers are made with recycled plastic bottles and manufactured in ethical factories. Visit our site for full supply chain details."*
   ✅ **Answer: Genuine**
   Why: Transparency and use of recycled materials + ethical production and traceability.

5. *"Conscious fashion starts here. Buy now to support the Earth!"*
   ✅ **Answer: Greenwashing**
   Why: Emotional marketing with no specifics and possibly promoting overconsumption ("buy now").

6. *"50% of this shirt is made with sustainable fabrics."*
   ✅ **Answer: Greenwashing**
   Why: Misleading or partial truth—what's the other 50%? "Sustainable fabrics" is also not defined or certified.

SOURCES

- **Changing Markets Foundation (2021).** *Synthetics Anonymous: Fashion brands' addiction to fossil fuels.* Accessed 08.08.2025 from: https://changingmarkets.org/portfolio/synthetics-anonymous/
- **European Commission (2022).** *Green Claims Initiative – Fighting greenwashing.* Accessed 08.08.2025 from: https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1728
- **Good On You.** *What is Greenwashing?* Accessed 08.08.2025 from: https://goodonyou.eco/what-is-greenwashing/
- **Fashion Revolution.** *Transparency Index 2023.* Accessed 08.08.2025 from: https://www.fashionrevolution.org/about/transparency/
- **Common Objective.** *How to Spot Greenwashing in Fashion.* Accessed 08.08.2025 from: https://www.commonobjective.co/article/how-to-spot-greenwashing-in-fashion

Developed by:

Elizabeta Tosheva, Centar for Educational and Development Initiatives INNOVA LAB Bitola

Co-funded by the European Union



2.33 TOPIC: "THE LIFE OF A T-SHIRT"

PROCEDURE:

Steps	Minutes
Step 1: Introduction and Group Discussion	10 min
Step 2: The Life Cycle of a T-Shirt – From Cotton Field to Wardrobe	15 min
Step 3: Practical Activity - Mapping the Life of a T-Shirt	25 min
Step 4: Summary and reflection	10 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• The 7 main stages in the life cycle of a T-shirt • The key environmental and social impacts linked to each stage	• Explain how each stage of a garment's life contributes to its overall environmental footprint • Suggest actions to reduce negative impacts at different life cycle stages	• The hidden environmental costs behind each stage of a T-shirt's life cycle. • The role of consumers, producers, and policymakers in reducing the overall impact of fashion



Number of participants: 15 - 20



Planned time: 60 min



Required materials: Power point presentation, A3 paper sheets or flipchart paper, scissors, glue, marker pens, pre-prepared cards (Stages and Facts)



Remarks: Teacher may prepare optionally Sustainability solution cards or to inspire students to create own solutions

STEP 1 Introduction and Group Discussion

The Hidden Story Behind a Simple T-Shirt

- When we pick a T-shirt from a store shelf or order one online, we often think only about its style, color, or price.
- But every T-shirt has a hidden story, a journey that starts in a field or factory and travels across the globe before it lands in your hands. Along the way, it uses precious resources like water and energy, affects the health of ecosystems, and touches the lives of many workers.
- The clothing industry is one of the most resource-intensive in the world, and the humble T-shirt is no exception.
- Producing a single shirt can require thousands of liters of water, involve chemicals that pollute rivers, and generate carbon emissions at every stage, from growing the raw material to throwing it away.
- By understanding **The life cycle of a T-shirt**, we can see how our everyday choices as consumers connect to global environmental and social issues. This knowledge empowers us to ask better questions, choose more sustainable options, and imagine solutions for the future of fashion.
- **Discussion Questions:**
- Teacher **s**how students a real T-shirt and ask them**:**
- Most of us wear T-shirts every day without thinking twice. But did you know that a single cotton T-shirt can travel over 20,000 kilometers before reaching your wardrobe?
- Did any of these facts surprise you?
- Do you know where the clothes you're wearing today were made?
- What do you think happens to your clothes after you throw them away?

STEP 1 Introduction and Group Discussion

- **Key facts:**

✅ **Raw Material Origins:**

- Most T-shirts are made of cotton. The top producers are India, China, and the U.S.
- **Conventional cotton** requires huge amounts of water. Pesticides and fertilizers used in cotton farming pollute rivers and damage soil quality.

✅ **Production & Labor:**

- Cotton is spun into yarn and woven or knitted into fabric in mills, often in **low-wage countries**.
- Many T-shirts are sewn in factories in **Bangladesh, Vietnam, or Cambodia**, where **workers may earn less than $2 per day**, often in poor working conditions.

✅ **Environmental Impact of Dyeing and Finishing:**

- Conventional dyeing uses toxic chemicals and massive amounts of water.
- In some countries, **untreated wastewater** from textile dyeing is released into rivers, turning them blue or black.

✅ **Transport & Retail:**

- After manufacturing, T-shirts are shipped (by air or sea) to Europe or North America.
- Long-distance transport contributes to **greenhouse gas emissions** and **carbon footprint** of each item.

✅ **Use & Disposal:**

- In the EU, people buy **an average of 26 kg of textiles per year**, but over **60% of clothing is thrown away within a year**.
- Globally, **92 million tons of textile waste** is generated annually.
- Less than **1% of clothing is recycled** into new garments.

STEP 2 The Life Cycle of a T-Shirt – From Cotton Field to Wardrobe

- Behind every T-shirt is a long journey that involves many stages, each with its own environmental and social impacts. This is called the **life cycle** of a product.
- **1. Raw Material Production**
- Most T-shirts are made from **cotton**.
- Cotton farming often uses **large amounts of water,** up to **2,700 liters to produce enough cotton for just one shirt** (about what one person drinks in 2.5 years).
- In conventional farming, cotton crops are treated with **pesticides and fertilizers**, which can pollute rivers and harm local wildlife.
- Many cotton farmers work in difficult conditions and may be **underpaid.**
- **2. Fabric Production**
- After cotton is harvested, it is cleaned, spun into yarn, and woven into fabric.
- This process requires **energy** (electricity for machines) and often involves chemicals to make the fabric soft or wrinkle-free.
- **3. Dyeing and Finishing**
- Fabrics are dyed in many colors.
- Conventional dyeing uses **toxic chemicals** and huge amounts of water, creating polluted wastewater that can harm the environment.
- Some dyes can cause skin irritation for workers and consumers.
- **4. Sewing and Manufacturing**
- Fabrics are cut and sewn into T-shirts, usually in large factories.
- Many garment workers are employed in **low-wage countries**, working long hours in unsafe conditions.
- Transporting fabric and finished products between countries adds **carbon emissions**.

STEP 2 The Life Cycle of a T-Shirt – From Cotton Field to Wardrobe

- **5. Distribution and Retail**
- Finished T-shirts are packaged and shipped to stores or sold online.
- Transportation by truck, ship, or plane increases the **carbon footprint** of the T-shirt.
- **6. Use and Care**
- Washing and drying a T-shirt at home also impacts the environment.
- Washing in hot water and using tumble dryers consumes a lot of **energy**.
- Each wash may release **microfibers** into the water system (especially for synthetic blends).
- **7. End of Life**
- Many T-shirts are thrown away after they are worn out or when they go out of style.
- Most end up in **landfills** or are incinerated, causing pollution.
- A smaller number are reused, recycled, or upcycled into new products.

- Additional questions for discussion:
- “How many countries do you think this T-shirt has traveled through?”
- “Which stage do you think has the biggest environmental impact?”

STEP 3 Practical Activity - Mapping the Life of a T-Shirt

- **Objective:**

Students will work together to trace the journey of a T-shirt through its life cycle, identify environmental and social impacts at each stage, and suggest more sustainable alternatives.

- **Instructions:**

1. **Teacher divides the students into small groups of 4–5 people**.

2. Provide Life Cycle Stage Cards (Appendix 1)

- Each group receives **seven cards** (one for each stage: Raw Material Production, Fabric Production, Dyeing & Finishing, Sewing & Manufacturing, Distribution & Retail, Use & Care, End of Life).

3. Students receive instructions to Match Stages with Descriptions and Impacts

- Spread the cards out on the table.
- Match each stage with a prepared **fact card** describing what happens and the main environmental/social impacts (**Appendix 2).**
    - Example: *Dyeing & Finishing → Uses large amounts of water, toxic chemicals, creates wastewater.*

4. Then teacher asks students to Add Sustainable Alternatives

- For each stage, groups brainstorm **at least one alternative** that would **make the process more sustainable.**
    - Example: *Raw Material Production → Use organic cotton or recycled fibers instead of conventional cotton.*

5. Create a Life Cycle Map

- By using a large sheet of paper, students are instructed to arrange the stages in order and connect them with arrows to create a visual map of the T-shirt's journey.
- Include cards (provided in Appendix 1 and Appendix 2) for each stage.
- Write the impacts and solutions below each picture.

6. Present to the Class

- Each group gives a short **3–4 minutes presentation** of their life cycle map, explaining the biggest impacts and their best sustainability ideas.

STEP 4 Summary

- **Key Points:**
- A T-shirt's life cycle includes seven main stages: raw material production, fabric production, dyeing & finishing, sewing & manufacturing, distribution & retail, use & care, and end of life.
- Each stage carries significant environmental and social impacts, such as high water and energy use, toxic chemical pollution, labor rights issues, and textile waste.
- Understanding these impacts helps consumers and industry professionals make informed decisions that reduce harm to people and the planet.
- Sustainable choices at each stage, such as organic materials, low-impact dyeing, ethical manufacturing, and recycling can greatly reduce the footprint of fashion products.
- **Reflection Questions:**

1. Which stage of the T-shirt's life cycle do you think has the largest environmental impact, and why?
2. What actions can you take as a consumer to make each stage of a T-shirt's life cycle more sustainable?
3. How could fashion brands redesign their processes to reduce social and environmental harm?
4. What role do governments and policies play in shaping a more sustainable textile industry?

APPENDIX 1 Life Cycle Stage Cards



1



2



3



4



5



6



7

High water use, pesticide and fertilizer pollution, land use changes, risk of poor working conditions for farm workers.

1

Significant energy use for spinning and weaving; possible dust and air pollution in factories; low wages and unsafe conditions in some regions

2

High water consumption; toxic chemicals that can harm workers and pollute rivers; large amounts of wastewater that require treatment

Labor-intensive work often done in low-wage countries; risks of unsafe working conditions; waste from offcuts and defective garments

4

Greenhouse gas emissions from transport; plastic packaging waste; energy use in retail spaces

5

Energy and water used in washing and drying; microfiber pollution from synthetic fabrics; over-washing shortens garment life

6

Landfill waste; incineration produces emissions; lack of textile recycling infrastructure means most garments are discarded

7

SOURCES

- Ellen MacArthur Foundation. (2017). *A new textiles economy: Redesigning fashion's future*. Ellen MacArthur Foundation. Accessed 12. 08.2025 from https://ellenmacarthurfoundation.org/a-new-textiles-economy
- Fashion Revolution. *Who made my clothes?* Accessed 12. 08.2025 from: https://www.fashionrevolution.org/
- Oxfam GB. (n.d.). *Life of a T-shirt learning activity*. Oxfam GB. Accessed 12. 08.2025 from: https://www.oxfam.org.uk/documents/280/Life_of_a_t-shirt_learning_activity.pdf
- Quantis. (2018). *Measuring fashion: Environmental impact of the global apparel and footwear industries study*. Quantis International. Accessed 12. 08.2025 from: https://quantis-intl.com/report/measuring-fashion-report/
- Textile Exchange. (2023). *Preferred fiber & materials market report 2023*. Textile Exchange. Accessed 12. 08.2025 from: https://textileexchange.org/preferred-fiber-and-materials-market-report/
- Water Footprint Network. *Product gallery*. Accessed 12. 08.2025 from: https://waterfootprint.org/resources/interactive-tools/product-gallery/
- World Bank. (2019, September 23). *How much do our wardrobes cost the environment?* World Bank. Accessed 12. 08.2025 from: https://www.worldbank.org/en/news/feature/2019/09/23/costo-moda-medio-ambiente
- WRAP. (n.d.). *Sustainable clothing guide*. Waste and Resources Action Programme. Accessed 12. 08.2025 from: https://wrap.org.uk/resources/guide/sustainable-clothing-guide
- WRAP. (n.d.). *Clothing knowledge hub: Process map*. Waste and Resources Action Programme. Accessed 12. 08.2025 from: https://ckh.wrap.org.uk/clothingKnowledgeHub/processStep
- U.S. Environmental Protection Agency. (2023, November 28). *Textiles: Material-specific data*. United States Environmental Protection Agency. Accessed 12. 08.2025 from: https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/textiles-material-specific-data
- World Wildlife Fund. (n.d.). *How much water does it take to make a T-shirt?* WWF. Accessed 12. 08.2025 from: https://www.worldwildlife.org/stories/how-much-water-does-it-take-to-make-a-t-shirt
- Carbonfact. (2023, March 20). *LCA for fashion and textile products: A step-by-step guide*. Accessed 12. 08.2025 from: https://carbonfact.com/blog/knowledge/lca-fashion-textile

Developed by:

Elizabeta Tosheva, Centar for Educational and Development Initiatives INNOVA LAB Bitola

Co-funded by the European Union



2.34 TOPIC: Care and Repair: Extending the Life of Clothing

PROCEDURE:

Steps	Minutes
Step 1: Introduction - Why Care and Repair Matter	10 min
Step 2: Key Facts and Techniques	20 min
Step 3: Practical Activity – “Repair & Redesign Challenge”	30 min
Step 4: Summary and reflection	10 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• Key garment care practices and repair techniques (darning, patching, replacing parts) that extend clothing life. • The concept of upcycling and its role in reducing textile waste.	• Apply basic repair methods to restore damaged garments. • Identify creative ways to redesign or upcycle old clothing.	• The environmental and social benefits of prolonging garment use instead of disposing of them. • How individual actions in care and repair contribute to a more sustainable fashion industry.



Number of participants: 15 - 20



Planned time: 70 min



Required materials:
Power point presentation, sample garments, sewing kits, replacement items, Measuring tape and fabric chalk/pens for marking



Remarks:

STEP 1 Introduction - Why Care and Repair Matter

- In today's fast-paced fashion world, clothes are **cheaper and more plentiful** than ever before.
- Many consumers wear garments only a few times before discarding them, often because they are slightly damaged, have gone out of style, or seem "old." This habit has a huge impact: globally, millions of tones of textiles end up in landfills each year, and the production of new clothing continues to demand massive amounts of water, energy, and raw materials.
- Extending the life of our garments is one of the **most effective ways** to reduce fashion's environmental footprint.
- Studies show that **wearing clothes twice as long can reduce their carbon emissions by almost 50%.**
- **Repairing, mending, and caring for our clothes** helps to keep them in use for longer, saves money, and reduces waste. It also preserves the craftsmanship and materials already invested in each garment.
- According to the **Ellen MacArthur Foundation**, extending the life of a garment by just **nine extra months** can reduce its carbon footprint, water use, and waste generation by **20–30%**.
- Unfortunately, modern fashion trends and the "fast fashion" model encourage frequent buying and quick disposal. On average, people today keep clothes for only **half as long** as they did 15 years ago, with many items worn only 7–10 times before being discarded.
- **Caring for clothing** involves more than just fixing holes or replacing buttons.
- It means learning the **best ways to wash, dry, and store garments** so they maintain their quality and appearance. It also includes **upcycling** — creatively transforming old or damaged clothes into something new and exciting, giving them a fresh life instead of sending them to the bin.
- **Repair skills** such as **darning, patching, and hemming** are not just practical, but they're part of a tradition of textile craftsmanship that has existed for centuries. In many cultures, repairing clothing was once a normal part of life.
- Today, reviving these skills is becoming essential for building a sustainable future in fashion.

STEP 2 Key Facts and Techniques

- **Why Clothes Wear Out Faster Today**
- **Lower Quality Materials** – Many garments are made from cheaper, less durable fabrics that pill, fade, or lose shape quickly.
- **Over-Washing** – Frequent laundering breaks down fibers and fades colors.
- **Poor Storage** – Hanging delicate knits or storing clothes in damp conditions causes damage.
- **Changing Trends** – Fashion cycles push consumers to replace clothes that are still wearable.
- **The Environmental Cost of Throwing Clothes Away**
- Globally, **92 million tons** of textile waste are generated each year. In many countries, most discarded clothes end up in landfills or are incinerated, releasing greenhouse gases and toxic substances.
- **Repairing and caring for clothing** is a simple yet powerful way to fight this problem. **It requires fewer resources than recycling** and helps preserve the energy, water, and labor that went into making the garment in the first place.
- **Examples from Real Life**
- **Patagonia's Worn Wear Program** – Encourages customers to return old garments for repair instead of buying new, with over 100,000 repairs completed annually.
- **Visible Mending Trend** – Influencers and crafters on Instagram and Pinterest share creative embroidery and patchwork techniques, turning repairs into fashion statements.
- **Traditional Sashiko Stitching (Japan)** – Once a necessity for extending the life of workwear, ***sashiko*** is now celebrated as an art form combining beauty and utility.
- **Why This Matters for You as a Future Textile Professional**
- Knowing how to care for and repair garments is not just a personal skill — it's a professional asset.
- Many sustainable fashion brands are now offering repair services, and customers are increasingly valuing durability.
- Whether you work in design, manufacturing, or retail, understanding garment maintenance can help create better products and stronger customer relationships.

STEP 2 Key Facts and Techniques

- **1. Why Repair Instead of Replace?**
- Repairing garments prevents waste, saves money, and reduces the need for new production. Every time you repair instead of buying new, you avoid the water use, carbon emissions, and chemical pollution that comes with manufacturing.
- 💡 *Example:* Extending the life of a cotton T-shirt by just **9 months** reduces its environmental footprint by up to **30%**.
- **2. Mending & Repair Techniques**
- **a) Darning** – A method of weaving new thread into a worn area, often used for socks or sweaters.
  Example: Visible mending, where the repair is intentionally made colorful and decorative.
- **b) Patching** – Sewing a piece of fabric over a hole or tear.
  Example: Denim jeans with creative patches made from patterned fabric scraps.
- **c) Replacing Parts** – Buttons, zippers, or elastic bands can be replaced to make a garment functional again.
- **3. Garment Care to Prevent Damage**
- **a) Washing & Drying**
- Wash less often and at lower temperatures to save energy and prevent wear.
- Air-dry instead of tumble-drying to reduce fabric shrinkage and fiber damage.
- **b) Storage**
- Use padded hangers for delicate garments to avoid stretching.
- Keep clothes away from direct sunlight to prevent fading.
- **4. Upcycling & Creative Redesign**
- Upcycling gives old garments a second life by changing their style or function.
- **Example 1:** Turning an oversized shirt into a dress or tote bag.
- **Example 2:** Adding embroidery or appliqué to cover stains or damage while making the garment unique.
- **5. Cultural and Historical Perspective**
- For centuries, repairing clothes was part of everyday life — from Japanese *sashiko* stitching to European patchwork traditions. Today, these skills are being revived by both sustainable fashion brands and DIY enthusiasts.

STEP 2 Key Facts and Techniques

- **Mending & Repair Techniques**

- Learning basic garment repair skills—such as **darning, patching, and hemming**—is one of the most effective ways to extend the life of clothing and reduce textile waste. These techniques have been practiced for centuries and are still highly relevant today, especially in the context of sustainable fashion.

- **Darning** involves weaving new thread into a worn or damaged area to restore strength and functionality. It's especially useful for repairing socks, sweaters, and knitwear. Modern *visible mending* turns darning into a decorative statement by using colorful threads and creative patterns.







- **Patching** is the process of sewing a piece of fabric over a hole or tear, commonly used on jeans, jackets, or workwear. Patches can be subtle to blend in with the garment or bold and patterned to add a unique design element.







- **Hemming** repairs frayed or damaged edges by folding and sewing the fabric to create a clean finish. This technique is ideal for extending the life of trousers, skirts, and sleeves, as well as for adjusting garment length to fit better.







STEP 2 Key Facts and Techniques

- **Upcycling & Creative Redesign**
- **Upcycling** is the process of transforming old, unwanted, or damaged garments into new products of higher quality, value, or creative appeal, rather than discarding them. Unlike recycling, which often breaks materials down into raw form, upcycling keeps much of the original garment intact and enhances it through creative redesign.
- **Creative redesign** involves altering clothing in imaginative ways like changing the cut, adding decorative elements, combining fabrics, or repurposing a garment for a new function.
- **Examples:**
- Turning a men's shirt into a women's dress.
- Adding embroidery to an old jacket for a modern look.
- Combining fabric scraps to create a patchwork skirt.









- By mastering these repair skills, people not only save money and resources but also contribute to a culture of **reuse and care**, where garments are valued for their longevity rather than treated as disposable items. Repairing clothes can also foster creativity and personal expression, turning everyday garments into one-of-a-kind pieces.

STEP 2 Key Facts and Techniques

- **Garment Care to Prevent Damage:** To prevent damage to your garments, it's essential to adopt careful washing, drying, and storage practices, and to address stains and repairs promptly.
- **Washing:**



- **Read care labels:** Always check the care label for specific washing instructions.
- **Wash less frequently:** Washing too often can wear down fabrics. Consider airing clothes out between wears.
- **Wash in cold water:** Cold water is gentler on fabrics, prevents shrinkage, and helps preserve colors.
- **Use a gentle cycle:** Delicate fabrics and items should be washed on a gentle cycle to minimize wear and tear.
- **Use a mild detergent:** Harsh detergents can strip fabrics of their natural oils and damage fibers.
- **Sort laundry properly:** Separate clothes by color and fabric type to prevent dye transfer and damage.



- **Use a laundry bag:** Protect delicate items by placing them in a laundry bag during washing.
- **Avoid overloading the washing machine:** Overloading can cause excessive friction and damage to garments.
- **Drying:**
- **Air dry whenever possible:**
- Air drying is gentler on fabrics than machine drying, preventing shrinkage and damage from high heat.
- **Use low heat or delicate settings:**
- If machine drying is necessary, use a low heat setting or a delicate cycle.
- Exposure to sunlight can cause fading, especially for dark-colored clothing.



- **Storage:**
- **Fold heavy items:** Folding helps prevent stretching and distortion of fabrics, especially for sweaters and jeans.
- **Hang delicate items:** Use padded hangers for delicate items to prevent stretching and shoulder bumps.
- **Use breathable garment bags:** Protect clothes from dust, dirt, and pests with breathable garment bags.
- **Store in a cool, dry place:** Avoid damp areas that can promote mildew and odor.

STEP 3: Practical Activity – "Repair & Redesign Challenge"

- **Objective:**
- Students will practice basic repair or creative redesign techniques on garments they bring from home (or on garments provided by the teacher) to extend their lifespan.
- **Instructions:**
- **Preparation (Before class):**
  - Teacher ask each student to bring one old or damaged garment (small tears, missing buttons, loose hems, etc.).
  - Provide basic sewing kits, spare buttons, zippers, thread, fabric scraps, needles, scissors, and measuring tape.
- **Activity Steps:**
  - **Step 1 (5 min):** Teacher demonstrates one quick example of each:
    - Simple hand darning (sock or sweater)
    - Adding a patch (on jeans or T-shirt)
    - Replacing a button or zipper
  - **Step 2 (20 min):** Students choose **one repair technique** or **one upcycling idea** to apply to their garment.
    - Examples: patching jeans with patterned fabric, shortening sleeves, turning an oversized T-shirt into a tote bag, adding embroidery to cover stains.
  - **Step 3 (10 min):** Students present their repaired or redesigned garment to the class, explaining:
    - The problem they fixed or the redesign they made.
    - Why this extends the garment's life.
    - What resources they saved by repairing instead of replacing.
- **Variation (for larger groups):** Instead of working individually, split into **pairs or small teams** where each group works on one garment.

STEP 4 Summary

- **Key Points:**
- Taking care of clothes through **regular maintenance, gentle washing, and proper storage** can significantly extend their lifespan.
- Basic repair skills such as **darning, patching, and replacing parts** help keep garments functional and reduce textile waste.
- **Upcycling and creative redesign** give old clothing a **new life**, saving resources and expressing personal style.
- **Repairing instead of replacing** not only saves money but also reduces the environmental impact of the fashion industry.

- **Reflection Questions:**
- Which repair or care technique do you think you could start using regularly at home?
- How does repairing clothing instead of buying new items help the environment?
- What creative redesign ideas could make repaired clothes more appealing?
- How can promoting repair and upcycling influence the culture of fashion consumption among young people?

SOURCES

- Ellen MacArthur Foundation. (2017). *A new textiles economy: Redesigning fashion's future*. Ellen MacArthur Foundation. Retrieved 14. 08.2025 from: https://ellenmacarthurfoundation.org/a-new-textiles-economy
- Fashion Revolution. (n.d.). *Loved clothes last: How the joy of rewearing and repairing your clothes can save the planet*. Retrieved 13. 08.2025 from: https://www.fashionrevolution.org/resources/loved-clothes-last
- Good On You. (2021, August 19). *The ultimate guide to upcycling clothes*. Retrieved 13. 08.2025 from: https://goodonyou.eco/upcycling-clothes/
- Love Your Clothes. (n.d.). *Repair your clothes*. Retrieved 14. 08.2025 from: https://www.loveyourclothes.org.uk/repair
- Patagonia. *Worn Wear: Better than new*. Retrieved 14. 08.2025 from: https://wornwear.patagonia.com/
- WRAP. *Extending the life of clothes*. Retrieved 14. 08.2025 from: https://wrap.org.uk/resources/guide/extending-life-clothes

Developed by:

Elizabeta Tosheva, Centar for Educational and Development Initiatives INNOVA LAB Bitola

Co-funded by the European Union



TITLE: 2.35 Synthetic Fibres and Sustainable Solutions

PROCESS:

Steps	Minutes
Step 1. Introduction – What are Synthetic Fibers and Microplastics	15 min.
Step 2. Common Examples and Uses	15 min.
Step 3. Practical Activity - Finding alternatives to fossil-based fibres	20 min.
Step 4. Summary and reflection	10 min.

AIMS TO ACHIEVE:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• The main types of synthetic fibers and their common uses. • How microplastics are released from synthetic textiles and their environmental and health impacts.	• Identify sustainable alternatives to fossil-fibres and practices that reduce microfiber pollution.	• The link between everyday clothing choices and global environmental challenges. • The importance of promoting circularity and sustainability in the textile industry.



Number of participants: 12 - 16



Required materials: Power point presentation



Remarks:



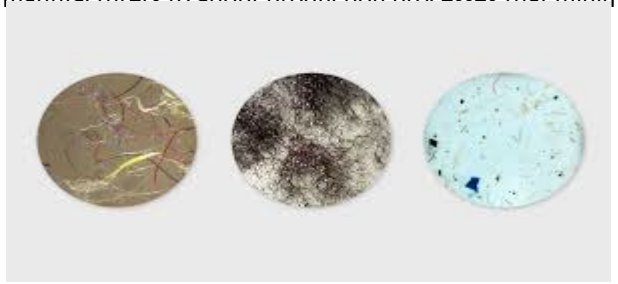
Planned time: 60 min

STEP 1 Introduction – What are Synthetic Fibres and Microplastics

- Teacher starts a discussion with a question:
- “When you wash your favourite polyester hoodie or sportswear, do you think it only gets cleaner, or does something else happen to the fabric?”
- Students are encouraged to share their opinions. Then the teacher gets insights into the subject.
- Synthetic fibres are man-made materials, created from petroleum-based chemicals through a chemical synthesis process called polymerisation.
- Examples include polyester, nylon, acrylic, and spandex, which are engineered for specific properties like durability, wrinkle resistance, and elasticity. These fibres are produced by melting or dissolving polymers and extruding them through spinnerets to form threads, which are then woven into textiles.
- Plastic-based — or ‘synthetic’ — textiles are woven into our daily lives in Europe.
- They are in the clothes we wear, the towels we use, and the bedsheets we sleep in. They are in the carpets, curtains, and cushions we decorate our homes and offices with. And they are in safety belts, car tyres, workwear, and sportswear.
- Key Characteristics
- Origin: Derived from petrochemicals, fossil fuels, or natural gas.
- Production: Involves chemical synthesis to join monomers into polymers, which are then spun into fibres.
- Properties: Engineered for desired characteristics such as strength, elasticity, wrinkle resistance, and shape retention.
- Versatility: Used in a wide range of products, including clothing, home furnishings, and industrial applications.
- Global Significance
- Synthetic fibres, particularly polyester, constitute a significant portion of the global fibre production, with estimations placing them at over 60% of the market.
- The production of synthetic fibres requires large amounts of energy and is a significant contributor to climate change and the depletion of fossil fuel resources.

STEP 1 Introduction – What are Synthetic Fibres and Microplastics

- What Are Microplastics?
- Microplastics are tiny plastic particles (smaller than 5 mm) that break off from larger plastic items or synthetic fabrics.
- When we wash clothes made from polyester or nylon, tiny fibres shed from the fabric and flow into wastewater.
- These microfibres cannot be fully filtered by water treatment plants, so they end up in rivers, oceans, and even in the food chain.
- Why Does This Matter?
- Environmental Impact: Microplastics pollute oceans and harm marine life. Fish and other animals mistake them for food.
- Health Impact: Scientists have found microplastics in human lungs, blood, and even placentas, raising concerns about long-term effects.
- Fashion Link: Every time we wash a synthetic garment, up to 700,000 microfibres can be released into the environment.
- Efforts to reduce microplastic pollution in textiles
- To combat microplastic emissions, several strategies are being explored. These include:
- Innovative Materials: Developing textiles that shed fewer fibres or are made from natural materials that biodegrade, such as cotton, hemp, or lyocell.
- Improved Filtration: Implementing more effective filtration systems in washing machines and wastewater treatment facilities to capture microplastic particles before they enter waterways.
- Responsible Production: Encouraging manufacturers to adopt production processes that minimize fibre loss and ensuring that wastewater from factories is treated properly.



Tiny Plastic Fibres in the Ocean

STEP 2 Common Examples and Uses

- **Polyester:**
- **Polyester is the most used synthetic-fibre. It's strong, durable, crease-resistant, and quick to dry.**
- **Resistant to stretching, shrinking, and abrasion, making it long-lasting.**
- **Everyday apparel: T-shirts, blouses, dresses, trousers.**



- **Nylon (Polyamide):**
- **Nylon, the commercial name for a group of polyamides, is widely used in activewear, swimwear, and other technical performance garments.**
- **Acrylic:**
- **Acrylic is a synthetic fibre designed to mimic the warmth, softness, and bulky feel of wool, making it a popular and cost-effective substitute in items like sweaters and blankets.**





- **Spandex (Lycra):**
- **Spandex, also known as Lycra or Elastane, is a petroleum-based synthetic fibre famous for its exceptional stretch and recovery.**
- **It can stretch up to five times its original length and then return to its original shape.**
- **Highly stretchy, used for sportswear and swimwear.**



STEP 2 Common Examples and Uses

- **Key messages**

- Average per capita textile consumption in the EU reached 19 kg in 2022, comprising 8 kg of clothing, 7 kg of household textiles, and 4 kg of footwear. In 2021, European consumption totalled approximately 6.5 million tonnes, with synthetic fibres (mainly polyester) accounting for 55% of fibre use.

- Synthetic textiles affect the environment and climate throughout their life cycle through resource use, and the emission of greenhouse gases and pollutants. In addition, between 200,000 and 500 000 tonnes of microplastics from textiles enter the marine environment each year.

- In contrast to cotton, the production of synthetic fibres does not use agricultural resources, toxic pesticides or fertilisers.

- EU consumers discard about 5.8 million tonnes of textiles annually – around 11 kg per person - of which about two thirds consist of synthetic fibres.

- In Europe, about one third of textile waste is collected separately, and a large part is exported.

- Promoting sustainable fibre choices and control of microplastic emissions, and improving separate collection, reuse and recycling, have the potential to improve the sustainability and circularity of synthetic textiles in a circular economy.

- EU Strategy for Sustainable and Circular Textiles - aims to create a coherent framework and a vision for increasing the sustainability of the ecosystem whereby:

- By 2030 textile products placed on the EU market are long-lived and recyclable, largely made of recycled fibres, free of hazardous substances and produced in respect of social rights and the environment.

- Consumers benefit longer from high quality affordable textiles, fast fashion is out of fashion, and economically profitable re-use and repair services are widely available. In a competitive, resilient and innovative textiles sector, producers take responsibility for their products along the value chain, including when they become waste.

- The circular textiles ecosystem is thriving, driven by sufficient capacities for innovative fibre- to -fibre recycling, while the incineration and landfilling of textiles is reduced to a minimum.

STEP 3: Practical Activity: Finding alternatives to fossil-based fibres

- **Part A: Quick-Fire Quiz (10 min)**
- The teacher asks short knowledge-check questions. Students answer individually or in teams.
- **Sample Questions & Answers:**

1. Polyester is made from which raw material?
2. Which fibre is famous for being highly stretchy?
3. Which synthetic fibre is used as a cheap substitute for wool?
4. Which fibre is widely used for swimwear and stockings?
5. How many microfibres can one wash of synthetic clothes release?

Students **stand up if they think they know the answer**.

- Whoever answers correctly earns points for their team.
- At the end, the teacher summarises key takeaways.

- **Part B: Ranking Challenge (10 min)**

Students are divided into small groups. Each group receives 4 synthetic-fibres (Polyester, Nylon, Acrylic, Spandex).

- Task: Rank the **most sustainable alternative** for each fibre (best → less sustainable but still better than virgin synthetics).
- Groups present their reasoning.

STEP 4 Summary

- Key Points:
- Synthetic fibres like polyester, nylon, acrylic, and spandex are made from fossil fuels and dominate global textile production.
- Their production is energy-intensive and contributes to greenhouse gas emissions and resource depletion.
- Washing synthetic clothes releases microfibres, which become microplastics, polluting rivers, oceans, and even entering the food chain.
- Alternatives such as recycled fibres, natural fibres (cotton, hemp, wool), and innovative bio-based materials provide more sustainable options.
- Consumer awareness and choices, along with innovation in fibre-to-fibre recycling, play a crucial role in reducing the environmental impact of fashion.

- Reflection Questions
- Which synthetic fibre do you think has the biggest environmental impact, and why?
- How could you personally reduce the release of microplastics from your clothes?
- Which sustainable alternative to synthetics seems most realistic for wider use in the future?
- How can consumer choices push brands to move away from fossil-based textiles?

SOLUTIONS TO ACTIVITY Part A.

Sample Questions & Answers:

Polyester is made from which raw material?
→ ***Petroleum / fossil fuels***

Which fibre is famous for being highly stretchy?
→ ***Spandex (Lycra)***

Which synthetic fibre is used as a cheap substitute for wool?
→ ***Acrylic***

Which fibre is widely used for swimwear and stockings?
→ ***Nylon (Polyamide)***

How many microfibres can one wash of synthetic clothes release?
→ ***Up to 700,000***

SOLUTIONS TO ACTIVITY Part B.

Solutions Slide: Sustainable Alternatives to Synthetics

Polyester →
Recycled Polyester ♻ (rPET) – made from PET bottles/textile waste
Lyocell (Tencel) – biodegradable wood-pulp fibre
Hemp – natural, strong, low water use

Nylon (Polyamide) →
Econyl – regenerated nylon from fishing nets & carpet waste
Bio-based Nylon (from renewable feedstocks)
Recycled Polyester (if stretch not crucial)

Acrylic →
Wool – natural, warm, biodegradable
Recycled Wool – from old garments
Organic Cotton – breathable, durable for sweaters

Spandex (Lycra/Elastane) →
Bio-based Spandex (new innovations from corn/sugar feedstocks)
Blends with Natural Fibres (cotton, bamboo) to reduce % of synthetic
Recycled Elastane (still emerging, but being developed)

SOURCES

- European Environment Agency. (2021). *Plastic in textiles: Towards a circular economy for synthetic textiles in Europe.* Retrieved August 24, 2025, from https://www.eea.europa.eu/en/analysis/publications/plastic-in-textiles-towards-a-circular-economy-for-synthetic-textiles-in-europe
- European Union. (2025). *EU Textile consumption hits record high, amplifying environmental concerns.* EU Textiles Ecosystem Platform. Accessed September 2, 2025, from https://transition-pathways.europa.eu/library/eu-textile-consumption-hits-record-high-amplifying-environmental-concerns
- European Commission. (2022). *Scenarios towards co-creation of a transition pathway for a more resilient, sustainable and digital textiles ecosystem* (SWD(2022) 105 final). Brussels. Accessed September 2, 2025, from https://transition-pathways.europa.eu/system/files/2025-04/SWD%282022%29105%20Scenarios%20textiles%20transition%20pathway.pdf
- Textile Exchange. (n.d.). *Nylon: Material summary.* Retrieved September 2, 2025, from https://textileexchange.org/nylon/
- Patagonia. (2017). *What do we know about tiny plastic fibers in the ocean?* Retrieved September 2, 2025, from https://www.patagonia.com/stories/what-do-we-know-about-tiny-plastic-fibers-in-the-ocean/story-30357.html
- European Parliament. (2023). *Strategy for sustainable and circular textiles.* Fact Sheets on the European Union. Retrieved September 2, 2025, from https://www.europarl.europa.eu/factsheets/en/sheet/222/textiles-strategy-for-sustainable-and-circular-textiles
- ScienceDirect. (2020). *Microfiber pollution and the apparel industry: A review of environmental and sustainability challenges.* Retrieved September 2, 2025, from https://doi.org/10.1016/j.jclepro.2020.120821
- National Geographic. (2019). *Microplastics are in our clothes. Here's what we can do.* Retrieved September 2, 2025, from https://www.nationalgeographic.com/environment/article/microplastics-in-clothes

Developed by:

Elizabeta Tosheva, Centar for Educational and Development Initiatives INNOVA LAB Bitola

Co-funded by the European Union

2.36 TITLE: Sustainable Dyeing Techniques from Natural Materials

PROCESS:

Steps	Minutes
Step 1. Introduction	10 min.
Step 2. How Natural Dyeing Works	10 min.
Step 3. Practical Activity - Dyeing Techniques from Natural Materials	40 min.
Step 4. Summary and Reflection	10 min.

AIMS TO ACHIEVE:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• The basic process of natural dyeing, from extracting pigments to fixing colors. • Common natural sources of dyes (turmeric, onion skins, rose petals, beetroot, tea, coffee).	• Apply simple natural dyeing techniques to fabric samples. • Compare and evaluate results from different dye sources and mordants.	• The value of natural and sustainable practices in reducing fashion's ecological footprint.

Number of participants: 10-12

Planned time: 80 min

Required materials: Power Point presentation, Video, Fabric samples, Natural dye materials, Equipment for Dyeing (pots, spoons, hot water, gloves)

Remarks: Students may use Handout/Worksheet for their observations

Click to see movie

STEP 1 Introduction

- **Why Talk About Dyeing?**
- When we look at colorful clothes, we rarely think about where those colors come from. Most fabrics today are dyed with **synthetic chemicals**, which often:
- Use **large amounts of water**.
- Release **toxic waste** into rivers.
- Expose workers to **harmful chemicals**.
- This creates **serious problems** for the environment and for people's health.
- Techer ask students:
- 👉 "Which natural materials from your home or garden could you imagine being used to dye fabric?"
(Encourage them to think of food leftovers, plants, or spices.)
- **Sustainable Alternative: Natural Dyeing**
- Natural dyeing uses materials from nature like **plants, flowers, fruits, vegetables, and even food waste** to color fabrics. These dyes are **biodegradable, renewable, and much safer** for workers and ecosystems.
- **Examples of Natural Dye Sources:**
- 🌱 **Turmeric (curcuma)** – creates bright yellow.
- 🌹 **Rose petals** – give shades of pink.
- 🧅 **Onion skins** – produce oranges, browns, and yellows.
- 🍵 **Green tea or spinach** – create soft greens.
- ☕ **Coffee or black tea** – result in earthy browns.
- 🍇 **Beetroot** – can give red or purple tones.

- **Why Is This Important for the Textile Industry?**
- Reduces **pollution** compared to synthetic dyes.
- Uses **renewable resources**.
- Can turn **food waste into value** (e.g., onion skins, pomegranate peels).
- Promotes **traditional craft knowledge** and cultural heritage.

STEP 2 How Natural Dyeing Works

- **1. Preparing the Fabric (Mordanting)**
- Before fabric can absorb natural dyes, it often needs to be treated with a substance called a **mordant** (from the Latin word “mordere,” meaning “to bite”).
- Mordants help the color **bind to the fiber** and stay longer.
- Common mordants include:
  - **Alum (potassium aluminum sulfate)** – safe and widely used.
  - **Iron** – darkens colors.
  - **Tannins** (from plants like oak galls or tea) – enhance shades.
- Some natural dyes (like turmeric) don’t need a mordant.
- **2. Extracting the Color**
- Plant materials (onion skins, rose petals, turmeric powder, etc.) are **boiled in water** to release their pigments.
- The longer the material is boiled, the stronger and deeper the color becomes.
- Example:
  - Onion skins → shades of yellow to orange.
  - Turmeric → strong yellow.
  - Beetroot → pink to purple (but may fade without mordants).
- **3. Dyeing the Fabric**
- The fabric is placed into the dye bath and simmered.
- Temperature, time, and fabric type affect the result:
  - Cotton absorbs dyes differently than wool or silk.
  - Longer soaking = deeper colors.

STEP 2 How Natural Dyeing Works

- **4. Fixing and Drying**
- After dyeing, fabrics are rinsed to remove excess pigment.
- Sunlight and air-drying help set the colors.
- Sometimes, a **second mordant bath** is used to fix the dye more permanently.
- **5. Why Do Colors Change?**
- Natural dyes are **sensitive to pH (acid/alkaline)**, metals, and mordants/ fixatives:
- Adding **vinegar (acid)** can shift colors toward red or pink.
- Adding **baking soda (alkaline)** can make them more green or blue.
- **Iron** can darken yellows into olive greens or browns.

- 💡 **Example Demonstration:**
- Teacher show students a piece of cotton dipped in turmeric.
- Then, dip another piece in turmeric + iron mordant — students will see how one is bright yellow, while the other is darker/olive.

STEP 3: Practical Activity - Dyeing Techniques from Natural Materials

- 👉 In the video, students will see Dyeing process **step-by-step**, connecting theory with practice.
- VIDEO LINK
- **Practical Activity – Try Natural Dyeing (30–40 minutes)**
- **Objective:**
- Students learn by doing: how to extract natural color from plants and apply it to fabric samples.
- ✨ **Expected Outcome:**
  Each student leaves with a small **naturally dyed fabric sample**. They understand how natural pigments work and see firsthand the connection between **science, sustainability, and creativity**.
- **Materials Needed:**
- Small pieces of **cotton fabric** (pre-washed, plain white, about 10x10 cm each).
- Natural dye sources:
  - Onion skins 🧅 (orange/yellow)
  - Turmeric powder 🌱 (bright yellow)
  - Beetroot slices 🍠 (pink/purple)
  - Tea or coffee 🧉 (brown shades)
- **2–3 small pots or heat-resistant bowls**.
- **Hot water** (provided by kettle or hot plate).
- **Spoons** or sticks for stirring.
- Small **containers** for rinsing.
- **Optional:** vinegar (acid) and baking soda (alkaline) to show color changes.
- **Gloves & aprons** (to avoid staining hands/clothes).

Click to see movie

STEP 3: Practical Activity - Dyeing Techniques from Natural Materials

- **Instructions**:
- **Prepare the Dye Bath (10 minutes):**
  - Place natural material (onion skins, turmeric, beetroot, or tea) in a pot.
  - Add hot water and let it simmer for 5–10 minutes.
  - Observe how the water changes color.
- **Add the Fabric (10–15 minutes):**
  - Put cotton fabric samples into the dye bath.
  - Stir gently so the fabric absorbs color evenly.
  - Leave the fabric to soak (longer = deeper shade).
- **Rinse & Fix (5 minutes):**
  - Remove the fabric, rinse lightly in water.
  - Optional: Dip one piece into vinegar water and another into baking soda water to compare color shifts.
- **Drying & Observation (5–10 minutes):**
  - Lay the samples flat to dry.
  - Students compare shades between different natural dyes.

- **For this activity students may use Student Handout (Appendix 1)**

  At the end, teacher collect all fabric samples to make a **class "color board"** showing results of different natural dyes.
- **Group Reflection (5 minutes):**
- Which natural dye gave the most vibrant result?
- How did vinegar or baking soda change the colors?
- Would you use these methods in fashion production? Why or why not?

APPENDIX 1

- 🌿 **Student Handout: Natural Dyeing with Plants**

- **Step 1: Prepare the Dye Bath**
- Collect your natural material: ☐ Onion skins ☐ Turmeric ☐ Beetroot ☐ Tea/Coffee
- Place in pot/bowl and add hot water.
- Wait 5–10 minutes.
  👉 **Observation:** What color is the water turning?
- ……
- **Step 2: Add the Fabric**
- Place your cotton sample in the dye bath.
- Stir gently.
  👉 **Observation:** What color is the fabric after 5 minutes? After 10 minutes?
- ……
- **Step 3: Rinse & Fix**
- Take out the fabric and rinse lightly in clean water.
- Optional: Dip one piece in **vinegar water** and one in **baking soda water**.
  👉 **Observation:** How did the color change?
- ……

- **Step 4: Dry & Compare**
- Lay fabric flat to dry.
- Compare your fabric with other groups' samples.
- 👉 **Which dye gave the most vibrant result?**
- ……
- 👉 **Which dye changed most with vinegar/baking soda?**
- ……

- **Reflection Questions**
- Which natural dye do you find most effective?
  ……
- Would you use natural dyeing in modern fashion? Why or why not?
  ……

STEP 4 Summary and Reflection

- **Key Points:**
- Conventional dyeing uses large amounts of water and toxic chemicals that pollute rivers and harm workers.
- Natural dyeing uses **plants, food waste, and minerals** as color sources, making it safer and more eco-friendly.
- Different natural materials create unique shades: turmeric → yellow, onion skins → orange, beetroot → pink/purple, tea/coffee → brown.
- **Mordants** (like alum, iron, vinegar) help fix the colors and can change the final shade.
- Natural dyeing connects **creativity with sustainability**, showing how tradition and innovation can reduce fashion's environmental footprint.

- **Reflection Questions**
- Which natural dye gave the strongest or most surprising color?
- What challenges might limit the use of natural dyes in large-scale fashion production?
- How can designers or consumers support more sustainable dyeing practices?
- If you had to choose one natural material to dye clothes with, which would it be and why?

SOURCES

- Ali, M., & Hussain, T. (2019). *Natural dyeing of textiles: A review*. International Journal of Materials Science and Applications, 8(3), 66–73. https://doi.org/10.11648/j.ijmsa.20190803.12
- Cardon, D. (2007). *Natural Dyes: Sources, Tradition, Technology and Science*. Routledge. https://www.routledge.com/Natural-Dyes-Sources-Tradition-Technology-and-Science/Cardon/p/book/9781904982005
- Hossain, M. M., & Chowdhury, M. A. (2020). *Eco-friendly dyeing of textiles using natural colorants: A sustainable approach*. Journal of Textile Engineering & Fashion Technology, 6(1), 31–38. https://medcraveonline.com/JTEFT/eco-friendly-dyeing-of-textiles-using-natural-colorants-a-sustainable-approach.html
- Natural Dyes in the 21st Century. (2021). *ScienceDirect Topics*. Retrieved September 3, 2025, from https://www.sciencedirect.com/topics/earth-and-planetary-sciences/natural-dye
- Textile Learner. (2023). *Dyeing with Natural Dyes: Sources, Classification, and Application*. Retrieved September 3, 2025, from https://textilelearner.net/dyeing-with-natural-dyes/
- Uddin, M. G. (2015). *Effects of different mordants on silk fabric dyed with onion outer skin extracts*. Fashion and Textiles, 2(15). https://doi.org/10.1186/s40691-015-0040-3

Developed by:

Elizabeta Tosheva, Centar for Educational and Development Initiatives INNOVA LAB Bitola

Co-funded by
the European Union



2.37. TITLE: Green Chemistry

PROCEDURE:

Steps	Time
Step 1: What is green chemistry and what are its basic principles?	15 min
Step 2: Chemistry and green chemistry in everyday life	15 min
Step 3: A future without green chemistry?!	10 min
Step 4: Summary	5 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What green chemistry is • Where chemistry surrounds us in everyday life • The impact of alternative chemistry on the environment	• Name the basic principles of green chemistry • Explain the advantages and disadvantages of chemical production	• Assess the consequences of environmentally harmful chemistry. • Making conscious decisions for a greener future.



Number of participants: min. 6



Materials required: Blackboard or whiteboard, chalk or pens, laptop, projector



Comments: -



Planned time: 45 min

STEP 1: What is green chemistry and what are its basic principles?

1. Question: What does the term green chemistry mean?

The teacher asks the students what green chemistry means to them and conducts a brainstorming session on the topic of "green chemistry" (see Appendix 1).

Answer:

Green chemistry is a concept that aims to make **chemical processes** and **products** as environmentally friendly and sustainable as possible. This involves minimising hazardous chemicals and waste, favouring renewable raw materials and energy-efficient processes, and developing alternative reaction pathways to reduce the chemical industry's ecological footprint.

2nd question: What are the basic principles of green chemistry?

- **Waste prevention**
  Chemical processes should be designed so that waste is not produced in the first place, rather than having to be disposed of in a cumbersome manner.

- **Atom economy and atom efficiency**
  Chemical reactions should be designed so that as many atoms of the starting materials as possible are retained in the end product. This results in fewer by-products.

- **Reducing the hazardousness of chemical substances**
  Processes and substances should be selected to be as non-toxic as possible to humans and the environment.

- **Development of safe chemical products**
  End products should be as non-toxic as possible to humans and the environment.

- **Use of safe solvents and auxiliary materials**
  The use of hazardous solvents and chemicals should be minimised and replaced with more environmentally friendly alternatives wherever possible.

- **Increasing energy efficiency**
  Chemical processes should be carried out with as little energy consumption as possible, preferably at ambient temperature and pressure.

- **Use of renewable raw materials**
  Where possible, renewable raw materials should be used instead of fossil raw materials.

- **Use of short synthesis routes and avoidance of derivatives**
  Unnecessary synthesis steps, protective groups and temporary modifications should be avoided, or alternative synthesis routes should be used. This ensures lower material consumption and reduced waste.

- **Use of catalysts**
  Catalysts should be preferred to stoichiometric reagents, as they are more efficient and generate less waste.

- **Design of degradable products**
  Chemicals should be designed to break down in an environmentally friendly way after use.

- **Real-time monitoring to prevent pollution**
  Processes should be continuously monitored and controlled to prevent hazardous by-products or accidents.

- **Safe chemistry to prevent accidents**
  Chemicals and processes should be designed to minimise the risk of explosions, fires and other accidents.

1. Question: Where are chemicals present in our everyday lives?

The teacher first asks the students where they encounter chemical products in everyday life and creates a mind map (see Appendix 2).

2. Question: What advantages or positive effects does green chemistry have for us in everyday life?

The teacher gives the task: “Work in pairs to identify the advantages and positive effects of green chemistry in our everyday lives.”

Answers:

Safer products

More environmentally friendly packaging: the use of refillable and recyclable packaging.

Reduction of toxic ingredients: Many everyday products (such as cleaning agents, cosmetics or food packaging) contain fewer harmful chemicals, which protects consumers’ health.

Improved product safety: Using environmentally friendly, less reactive substances reduces the risk of accidents and allergic reactions.

Environmental protection and resource conservation

- Fewer pollutant emissions: “Greener” chemical processes lead to a reduction in waste and toxic by-products, as well as cleaner exhaust air, which reduces pollution of the air, water and soil.
- More efficient use of natural resources: The use of renewable raw materials and energy-efficient processes protects the environment and ensures the availability of resources.
- Promotion of the circular economy: Green chemistry supports recycling and reuse, reducing waste volumes and keeping materials in the economic cycle.

Economic benefits and promotion of innovation

- **Cost reduction through efficiency:** Sustainable manufacturing methods are often more energy-efficient and resource-efficient, leading to long-term cost savings for consumers.
- **Creation of future-proof jobs:** The development and implementation of green technologies promote innovative industries and create new fields of work, from research and development to production. This secures jobs for the future.
- **Increased competitiveness:** Companies that rely on sustainable production processes are better positioned in a global market where environmental awareness and sustainability are becoming increasingly important.

Climate protection

- **Reduction of CO_2 emissions:** Lower energy consumption and the use of renewable energy contribute to climate protection.
- **Reduction of water consumption**: Optimised production processes can reduce water consumption, thereby protecting the environment.

Social responsibility

- **Social added value:** Sustainable production processes and products improve quality of life by contributing to cleaner air, cleaner water and a healthier environment.
- **Long-term benefits for future generations:** Greener chemistry secures livelihoods and prosperity by mitigating environmental damage and addressing resource scarcity.

STEP 3: A future without green chemistry?!

Topic: "Polluted environment, scarce resources, unsafe products – can we even afford a future without green chemistry?"

The teacher announces the topic and sets the task: "What impact could chemistry have on the environment and humans in the future if there were no regulations to promote greater environmental awareness?"

Solutions:

Environmental pollution is increasing

1. Higher emissions of toxic chemicals into the air, water and soil
2. Increase in plastic waste and substances that are difficult to break down
3. Threats to ecosystems from industrial waste

Increasing health risks for humans

1. Higher levels of pollutants in food, drinking water and the air we breathe
2. Increased risk of cancer and other diseases due to toxic substances
3. Increase in antibiotic resistance due to uncontrolled use
4. Hormonal disorders and infertility due to pollutants entering the body.

Resource scarcity and rising costs

1. Depletion of non-renewable raw materials (oil, coal, metals, rare earths)
2. Rising prices due to inefficient production methods
3. Water shortages due to chemical pollution and high consumption in the industry

Accelerating global warming

1. Higher CO_2 emissions due to unsustainable manufacturing processes
2. Increased environmental disasters (storms, droughts, floods) due to man-made climate change
3. Loss of habitats for plants and animals

Economic and social problems

1. Companies that do not produce sustainably could come under pressure from stricter laws and environmental scandals, leading to increased unemployment due to company bankruptcies.
2. Higher costs for healthcare and environmental remediation
3. Social inequality increases, as environmental pollution often affects poorer regions in particular

STEP 4

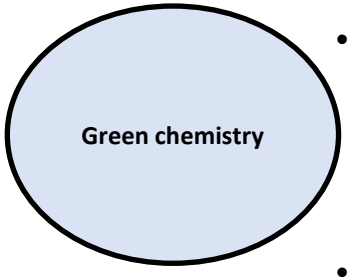
Finally, let's do a quiz to reinforce what we have learned.

(Show Appendix 3 – the answers can be found at the end of the appendix)

APPENDIX 1

Example: Brainstorming on "green chemistry"

- Environmentally friendly chemistry
- Avoidance toxic waste
- Recycling and circular economy
- Avoiding plastic and disposable products
- Reduction of hazardous chemicals
- Use of renewable raw materials
- Sustainable cosmetics and cleaning products
- Use of environmentally friendly cleaning products
- Efficient use of energy and raw materials
- Use of natural cosmetics without microplastics
- Production of biodegradable plastics
- Resource-saving processes
- Purchase of products with sustainable packaging
- Waste minimisation
- Waste prevention
- Nature-based processes
- Reduction of harmful substances
- Ecodesign



- Environmental pollution (air, water and soil)
- Health risks from toxic substances
- Waste of resources and climate change
- Burden on future generations
- Increase in allergies
- Increase in cancer cases

- Biodegradable plastics (e.g. PLA polylactides)
- CO_2-neutral production processes
- Replacement of solvents with environmentally friendly alternatives
- More efficient batteries and sustainable energy technologies
- Protection of people and the environment
- Development of non-toxic paints and varnishes
- Sustainable production of chemical substances
- Energy efficiency classes

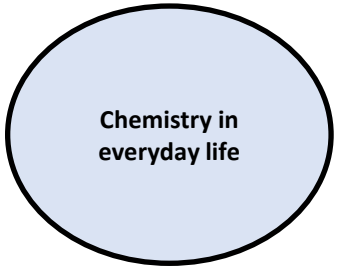
Example: Mind map on "Chemistry in everyday life"

Food & nutrition
- Food additives (colourings, preservatives)
- Flavourings & flavour enhancers
- Food packaging (e.g. plastic, bioplastic)
- Chemical reactions during cooking (e.g. browning reactions, caramelisation)

Household & cleaning
- Detergents & fabric softeners
- Washing-up liquid & soaps
- Cleaning agents & disinfectants
- Descalers & stain removers

Cosmetics & personal care
- Shampoos & shower gels
- Toothpaste & mouthwash
- Perfume & deodorants
- Sunscreen & skincare products

Health & medicine
- Medicines & active ingredients
- Vaccines
- Painkillers & antibiotics
- Diagnostic tests (e.g. COVID tests)



Transport & technology
- Fuels & alternative energies (hydrogen, e-fuels)
- Plastics in cars & aeroplanes
- Paints & coatings
- Accumulators & battery technology

Materials
- Plastics & polymers
- Metal alloys
- Glass & ceramics
- Adhesives & paints

Environment & Sustainability
- Recycling & Circular Economy
- Biodegradable plastics
- Pollution of the environment with plastics, tin cans, etc.
- Water treatment
- Air purification

Construction chemicals
- Cement, lime and asphalt
- Insulation materials such as polystyrene and PU foam
- Paints, varnishes and coatings
- Adhesives
- Sealants

APPENDIX 3

Quiz:

1. What is the main goal of green chemistry?
A) To manufacture as many chemical products as possible
B) Using hazardous chemicals to increase product quality
C) To develop environmentally friendly, safe and sustainable chemical processes
D) To abolish the chemical industry

2. Why is a sustainable chemical industry important?
A) Because it reduces costs for companies
B) Because it reduces environmental pollution and health risks
C) Because it reduces CO_2 emissions from cars
D) Because it brings new products to market more quickly

3. Which of the following products can have environmentally friendly chemical alternatives?
A) Cleaning products
B) Cosmetics
C) Packaging materials
D) All of the above

4. How can consumers support green chemistry?
A) By choosing products with sustainable ingredients
B) By using only petroleum-based products
C) By no longer using chemical products at all
D) By buying only products that have a strong smell

5. What is the danger if there are no environmental regulations for chemical companies?
A) Production becomes cheaper and more efficient
B) Environmental and health hazards increase significantly
C) Chemicals become safer
D) There are no negative effects

6. Which of these materials would be a sustainable alternative to conventional plastic?
A) Biodegradable plastics
B) Conventional plastic
C) Packaging containing lead and mercury
D) Styrofoam

7. What can happen if hazardous chemicals are released into the environment in an uncontrolled manner?
A) Plants and animals thrive
B) Water quality improves
C) Increased air and water pollution
D) The environment remains unchanged

8. How can green chemistry be implemented in everyday life?
A) By burning plastic waste
B) By using disposable plastic
C) By purchasing the cheapest chemicals possible
D) By using environmentally friendly cleaning products

9. What could be the long-term consequences of a world without green chemistry?
A) Increased environmental pollution and health problems
B) Improved water quality
C) Safer food
D) Lower energy consumption

10. Why should companies switch to sustainable chemistry?
A) To circumvent legal regulations
B) To save costs and operate in a more environmentally friendly manner
C) To release more chemicals
D) Because customers do not care about sustainability

SOLUTIONS TO THE TASKS

1st question: **C**

2nd question: **B**

3rd question: **D**

4th question: **A**

5th question: **B**

6th question: **A**

7th question: **C**

8th question: **D**

9th question: **A**

10th question: **B**

SOURCES

- https://www.umweltbundesamt.at/angebot/leistungen/gruene-chemie
- https://www.gruenechemieoesterreich.at/was-ist-gruenechemie
- https://www.acs.org/green-chemistry-sustainability/principles/12-principles-of-green-chemistry.html
- https://www.hu-berlin.de/de/pr/nachrichten/archiv/april-2017/nr_170421_01?utm
- https://www.sigmaaldrich.com/DE/de/technical-documents/technical-article/analytical-chemistry/green-chemistry-principles?srsltid=AfmBOopF0Ya1iMbcmQf2m77BGDc1IE7ORRWW-5nVevWJDRiJxrUERP0x

Developed by:

Kay Huber,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



2.38. TITLE: Renewable Raw Materials

PROCEDURE:

Steps	Time
Step 1: What are renewable raw materials?	15 min
Step 2: Current raw materials in the chemical industry!	15 min
Step 3: Renewable vs. alternative raw materials?!	10 min.
Step 4: Summary	5 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What renewable raw materials are • Which raw materials are used currently and will be used in the future	• Give examples of renewable raw materials in the chemical industry • The advantages and disadvantages of renewable and fossil raw materials Weigh up	• The special nature of renewable raw materials • The necessity of using renewable raw materials



Number of participants: min. 6



Materials required: Blackboard or whiteboard, chalk or pens, laptop, projector



Comments: -



Planned time: 45 min

STEP 1: What are renewable raw materials?

1. Question: What do you understand by renewable raw materials?

The teacher introduces the topic: "Renewable raw materials in the chemical industry".
To begin with, the teacher asks the students: What do you understand by renewable raw materials?

(Possible answers as brainstorming, see Appendix 1).

The teacher presents the explanation of renewable raw materials in the chemical industry.

Explanation:

Renewable raw materials for the chemical industry are materials that come from natural, rapidly **regenerating sources** and are used in chemical production. They are available in short periods of time.

2nd question: What renewable raw materials are available for the chemical industry?

Answers:

Fats and vegetable oils
These come from animal and vegetable fats and oils. On the one hand, they come from waste oils and fats produced in the catering industry, for example. On the other hand, they are also extracted directly from oilseeds. Examples include rapeseed oil, soybean oil, palm oil and others.

Sugar and starch:
Sugar and starch are mainly obtained by refining corn, sugar beet, wheat, potatoes or sugar cane.

Cellulose:
Cellulose is the main component of wood, plant fibres and agricultural by-products such as straw.

Lignin:
A by-product of the wood and paper industries.

Glycerine:
Glycerine is a by-product of biodiesel production from vegetable oils.
It is used in the cosmetics, food and pharmaceutical industries.

Bioalcohols:
Various bioalcohols are already in use today. These include biomethanol, produced from synthesis gas derived from renewable raw materials such as wood and straw, and bioethanol, produced by fermenting sugar with yeast cells. Similarly, biobutanol is obtained as a fermentation product of microorganisms.

Terpenes / essential oils:
These are natural substances from plants and microorganisms that are used as renewable raw materials for fragrances, medicines and plastics.

Microalgae:
These single-celled organisms perform photosynthesis and reproduce very quickly, making them a versatile source of biomass for biofuels, dyes and specialty chemicals. They grow without the need for arable land.

Organic acids:
Organic acids are used in the chemical industry as sustainable alternatives, e.g. lactic acid for bioplastics or citric acid as an environmentally friendly limescale remover.

Biomethane:
Methane is a combustible gas produced by decay processes/fermentation from organic waste, manure and energy crops in the absence of air.

STEP 2: Current raw materials in the chemical industry!

1. Question: What resources does the chemical industry currently use, and what resources will the chemical industry use in the future?

The teacher shows Appendix 2.

Answers:

In 2020:

In 2020, 94% of raw materials were of fossil origin. Only 6% of raw materials came from renewable sources (biomass).

In 2050, 28% of raw materials could come from biomass, 11% from plastic waste, 55% from carbon dioxide and 6% from fossil raw materials. Furthermore, green hydrogen will serve as an energy source of the future and as a raw material for chemical synthesis.

STEP 3: Renewable vs. alternative raw materials?!

1. Question: What advantages do renewable raw materials offer for chemical production?

The teacher asks: "What advantages do renewable raw materials offer for chemical production?" The teacher then asks the students to write down their own key points.

Answers:

Sustainability & resource conservation
Renewable raw materials are available in the long term and reduce dependence on fossil raw materials.

Climate protection & CO_2 reduction
Bio-based products can be climate-neutral.

Biodegradability & environmental friendliness
Renewable raw materials can be quickly biodegraded, thus reducing environmental impact.

Efficient use of by-products & waste
In an industry that relies primarily on renewable raw materials, by-products would be used efficiently, for example, for other products, thereby reducing waste.

Safe & less toxic chemicals
Renewable raw materials pose a reduced risk to humans and the environment.

Independence & security of supply
The use of renewable raw materials from regional production reduces geopolitical dependencies and problems with supply difficulties due to globalisation.

Innovation potential & market opportunities
The use of renewable raw materials requires the development of new, innovative products and strengthens competitiveness through sustainable products.

Greater acceptance & social benefits
Products made from sustainable, renewable raw materials are becoming increasingly popular with consumers. Furthermore, sustainable production strengthens the image of the company or brand.

2. Question: Why is it necessary to use renewable raw materials in the chemical industry?

To answer the question, the teacher gives the following assignment: "Explain why the use of renewable raw materials is necessary in the chemical industry. To do this, compare renewable raw materials with fossil (alternative) raw materials."

Answer:

The use of renewable raw materials in the chemical industry will be necessary in the future because fossil resources are finite and harmful to the environment. Renewable raw materials such as vegetable oils or biomass, on the other hand, offer a sustainable, climate-neutral alternative because they bind CO_2 during their growth. They also strengthen the regional economy and reduce geopolitical dependencies. New materials such as bioplastics and green solvents promote innovation and increase long-term competitiveness, while minimising environmental impact and health risks. These and other details about the raw materials can be found in the table below.

STEP 3: Renewable vs. alternative raw materials?!

Aspect	Renewable raw materials	Fossil raw materials
Origin	Plants, algae, microorganisms, agricultural waste	Crude oil, natural gas, coal
Sustainability	Renewable, available in the long term	Limited, non-renewable
Availability	Can be produced regionally, reduces dependence on imports	Limited reserves, availability dependent on producing countries
Carbon footprint	Low or neutral (plants bind CO_2)	High CO_2 emissions during extraction and use
Environmental impact	Low, often biodegradable	High pollution from waste & microplastics
Energy consumption	Often more energy-intensive to process	Established processes, often more efficient
Circular economy	Use of by-products & biodegradation	Mostly linear use without recycling options
Cost	Often more expensive due to complex extraction	Cheaper due to existing infrastructure
Technology & research	Innovative, but still under development	Proven, but limited innovation potential
Product selection	Bioplastics, biofuels, green chemicals	Wide range of established products
Social acceptance	Positive, as they are sustainable and environmentally friendly	Critical due to environmental impact and climate change
Security of supply	Regional production possible	Dependent on geopolitical risks

STEP 4: Summary

Finally, let's do a quiz to reinforce what we've learned.

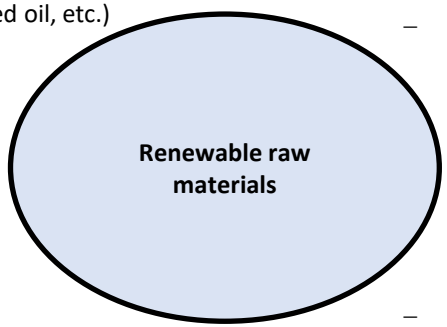
(Show Appendix 3 – answers can be found at the end of the appendix)

APPENDIX 1

Example: Brainstorming on "Renewable Raw Materials"

- Raw materials come from renewable, biological sources
- Alternative to fossil raw materials (oil, gas, coal)
- Regenerable, with unlimited availability

- Vegetable oils (rapeseed oil, soybean oil, linseed oil, etc.)
- Bioethanol
- Cellulose (straw, trees, etc.)
- Sugar (sugar beet, sugar cane, etc.)
- Starch (wheat, corn, potatoes, etc.)
- Chitin
- Microalgae
- Essential oils
- Organic acids (lactic acid, acetic acid, formic acid, etc.)
- Various solvents



- Production of bioplastics (e.g. PLA, PHA, PFA)
- Production of biofuels (biodiesel, bioethanol)
- Development of environmentally friendly solvents
- Production of environmentally friendly additives, resins, adhesives, etc.
- Use of natural ingredients in food chemistry and cosmetics

- Sustainability and resource conservation
- Reduction of the carbon footprint
- Potential for biodegradability of end products
- Support for the local economy (regional agriculture)
- Innovation potential in chemical research
- Influence on environmental and climate policy

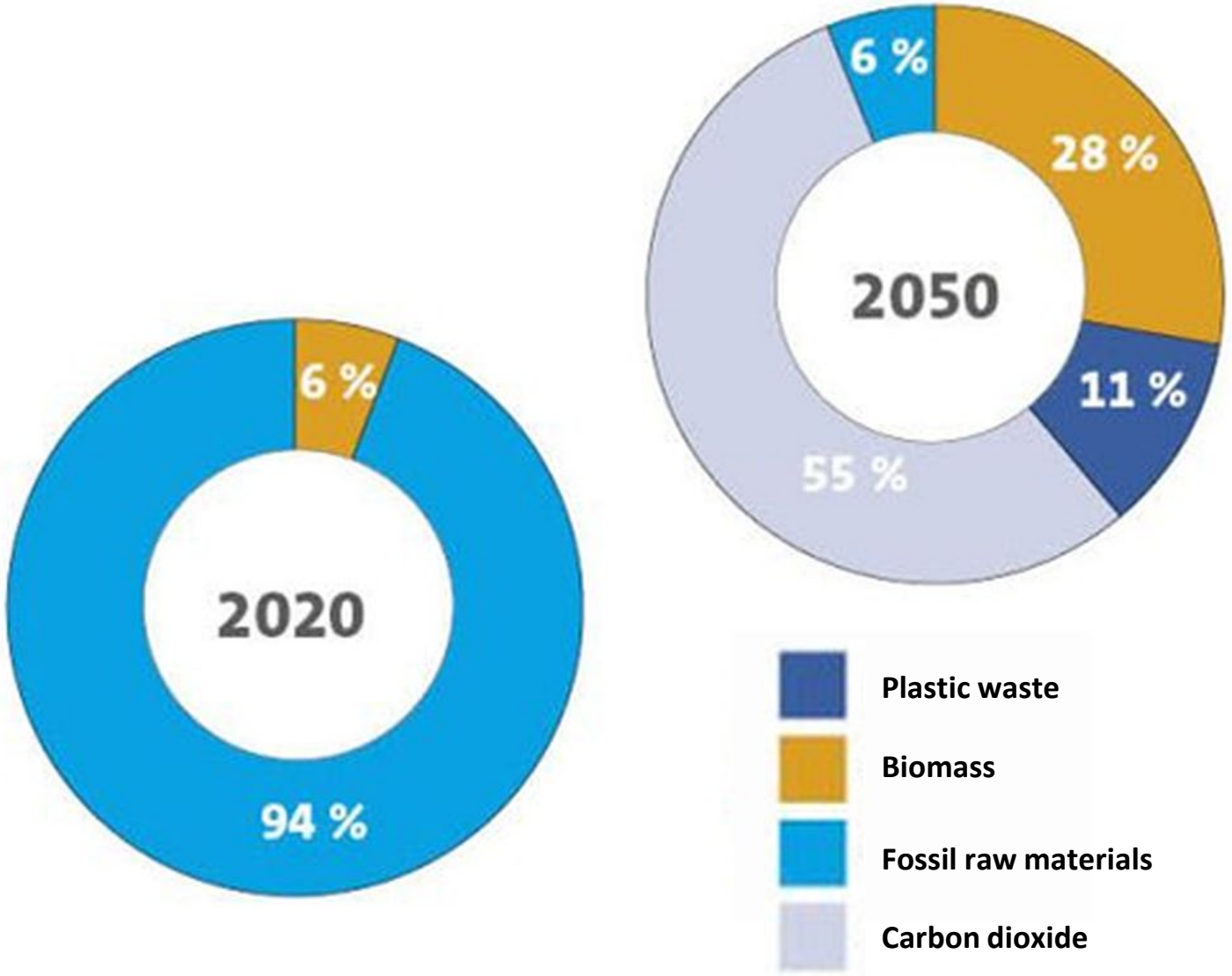


Bild: CHEMIE TECHNIK; Daten: VCI

APPENDIX 3

Quiz:

1. Why are renewable raw materials important for the chemical industry?
A) They are infinitely available.
B) They help to replace fossil raw materials and reduce CO_2 emissions.
C) They are always cheaper than fossil raw materials.
D) They do not require processing.

2. Which of these raw materials is NOT a renewable raw material?
A) Sugar cane
B) Wood
C) Corn
D) Crude oil

3. Which plant is an important source of cellulose?
A) Wheat
B) Sunflower
C) Cotton
D) Rapeseed

4. Which renewable raw material is used to produce bioplastics?
A) Lactic acid
B) Coal
C) Natural gas
D) Copper

5. Which gas is produced during the fermentation of biomass?
A) Oxygen
B) Methane
C) Nitrogen
D) Hydrogen

6. Which of the following products can be obtained from microalgae?
A) Biofuels
B) Iron
C) Coal
D) Concrete

7. Which of these renewable raw materials is used to produce bioethanol?
A) Crude oil
B) Sugar beet
C) Natural gas
D) Sand

8. Which of the following organic acids is obtained from renewable raw materials?
A) Sulphuric acid
B) Nitric acid
C) Hydrochloric acid
D) Citric acid

9. What is the advantage of using renewable raw materials in the chemical industry?
A) They reduce dependence on fossil resources.
B) They are always cheaper than fossil raw materials.
C) They do not require further processing.
D) They are available in unlimited quantities.

10. Which renewable raw material can be used to produce biofuels?
A) Natural gas
B) Coal
C) Rapeseed oil
D) Aluminium

SOLUTIONS TO THE TASKS

1st question: **B**

2nd question: **D**

3rd question: **C**

4th question: **A**

5th question: **B**

6th question: **A**

7th question: **B**

8th question: **D**

9th question: **A**

10th question: **C**

SOURCES

- https://biooekonomie.de/foerderung/foerderbeispiele/eine-flexible-biofabrik-zur-terpenherstellung
- https://www.fnr.de/nachwachsende-rohstoffe
- https://www.ineratec.de/de/glossar/erneuerbare-rohstoffe
- https://www.bmel.de/DE/themen/landwirtschaft/bioeokonomie-nachwachsende-rohstoffe/biooekonomie-nachwachsende-rohstoffe_node.html
- https://www.energie-experten.org/erneuerbare-energien/biomasse/nachwachsende-rohstoffe
- Image source Appendix 1: https://www.chemietechnik.de/markt/chemieindustrie-prognose-2020-des-chemieverbands-vci.html

Developed by:

Kay Huber,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



2.39. TITLE: Energy efficiency

PROCEDURE:

Steps	Time
Step 1: What is energy efficiency?	5 min
Step 2: Why is energy efficiency important?	15 min
Step 3:. How can energy efficiency be increased?	15 min.
Step 4: Summary	10 min.

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What energy efficiency is • Why energy efficiency is important	• Name reasons for greater energy efficiency • Measures/technologies for greater energy efficiency	• The importance of energy-efficient working in the chemical industry



Number of participants: min. 6



Materials required: Blackboard or whiteboard, chalk or pens, laptop, projector



Comments: -



Planned time: 45 min

STEP 1: What is energy efficiency?

1. Question: What do you understand by energy efficiency?

The teacher introduces the topic: "Energy efficiency in the chemical industry", because energy-efficient working is very important, and energy is expensive and even a limiting factor in the chemical industry. The teacher asks: "What do you understand by energy efficiency?"

(Possible answers as brainstorming, see Appendix 1).

The teacher presents the definition of energy efficiency in the chemical industry.

Explanation:

Energy efficiency in the chemical industry describes the relationship between the energy used for a chemical reaction or process and the product yield achieved – with the lowest possible energy consumption and minimal loss.

STEP 2: Why is energy efficiency important?

1. Question: Why is energy efficiency particularly important in the chemical industry?

The teacher shows the statistics on energy consumption in Germany (see Appendix 2) and explains the statements in the statistics.

Explanation:

The diagram shows final energy consumption by sector: transport (yellow), commerce, trade and services (green), households (dark blue) and industry (light blue) in Germany from 2003 to 2023. For 2023, transport accounts for approximately 31%, and approximately 15% of energy is consumed by the commercial, trade and service sectors. Approximately 27% of total energy is consumed by individual households and approximately 27% by industry.

Furthermore, in 2023, the industry used approximately 27% of energy for the manufacture of chemical products and approximately 24% for metal production and processing. The manufacture of coke in coking plants and mineral oil processing also accounts for a high proportion of Energy consumption, at approximately 11%.

It can be said that not only industry but also households and the transport sector consume a great deal of energy.

STEP 2: Why is energy efficiency important?

The teacher explains why energy efficiency is very important in the chemical industry.

Explanation:

(abridged: see Appendix 3)

High energy consumption

Chemical reactions occur only at very high temperatures, so this energy must be supplied as heat for a product to be manufactured. Chemical reactions often require a great deal of energy (e.g. in the form of heat or electricity).

Examples: - **Lime burning at 800 to 1000 °C:** This is the reaction of calcium carbonate (limestone) to calcium oxide (quicklime or unslaked lime) and carbon dioxide. Lime is mainly used in the construction industry, but also in agriculture and forestry, the chemical industry and wastewater treatment:

- **Extraction of iron from iron ore at temperatures of up to 2000 °C:** In this reaction, iron ore (e.g. magnetite) is reacted with coke (carbon) to form iron and carbon dioxide. This iron is then used to produce steel, which is used to manufacture vehicles, build ships or, for example, construct bridges in the construction industry.

- **Haber-Bosch process for ammonia synthesis**: The Haber-Bosch process is used to produce ammonia. For this purpose, hydrogen is extracted from methane (natural gas) and reacted with atmospheric nitrogen to produce ammonia. This process accounts for approximately 3% of global energy consumption. It is used to produce fertiliser, thereby feeding the global population.

- **Pyrolysis of plastics:** Plastics and their disposal are a growing problem in today's world. However, plastics can also be recycled and chemically broken down into smaller molecules by pyrolysis at around 800 °C. These can be monomers, which serve as the starting material for new plastics, as well as combustible gases, oils, waxes and other raw materials.

Energy-intensive processes such as drying, evaporation, distillation and rectification require a great deal of energy. However, they are necessary in order to obtain important salts and chemicals through (thermal) purification, for example.

Example of energy requirements:

- To completely evaporate 1 kg of water requires approximately the same amount of energy as 40 to 50 mobile phone charges.

STEP 2: Why is energy efficiency important?

Cost factor
Energy is a major cost factor in production. Improved efficiency reduces production costs and increases competitiveness.

Environmental protection
Lower energy consumption means lower CO_2 emissions, especially when fossil fuels are used. This helps to protect the climate.

Resource conservation
Energy efficiency not only protects the environment, but also conserves limited resources such as oil, natural gas and coal.

Regulatory requirements
Many countries have legal requirements for carbon dioxide emissions. At the same time, there are subsidy programmes that support and thus promote energy-efficient processes.

Competition for energy sources
In times of geopolitical crises or rising global energy demand, energy becomes more expensive and harder to access. Energy-efficient companies are therefore more independent and resilient.

Fluctuations in energy prices
Energy-intensive industries such as the chemical industry are particularly affected by volatile electricity and gas prices. Efficient processes reduce the risk of economic losses and production interruptions.

Positive public image and reputation enhancement
Companies that actively improve their energy efficiency benefit from a better image among customers, investors and the general public.

Waste and emission avoidance
Energy-efficient processes are often also more material-efficient, resulting in fewer by-products, lower emissions and cleaner manufacturing processes overall.

Flexibility in integrating renewable energies
Efficient processes enable better integration of renewable energy sources.

STEP 3: How can energy efficiency be increased?

The teacher gives the students the following assignment:
"Describe two technical ways of increasing energy efficiency!"

Note: Give the students approximately 10 minutes to complete the task!

(Show possible answers, see Appendix 4.)

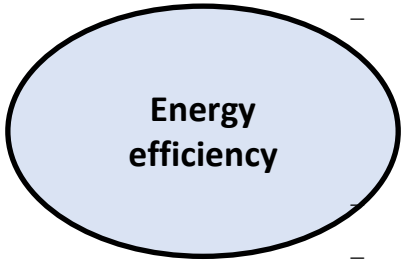
STEP 4: Summary

Finally, let's do a kind of quiz to reinforce what we've discussed.

(Show Appendix 4 – answers can be found at the end of the appendix)

APPENDIX 1

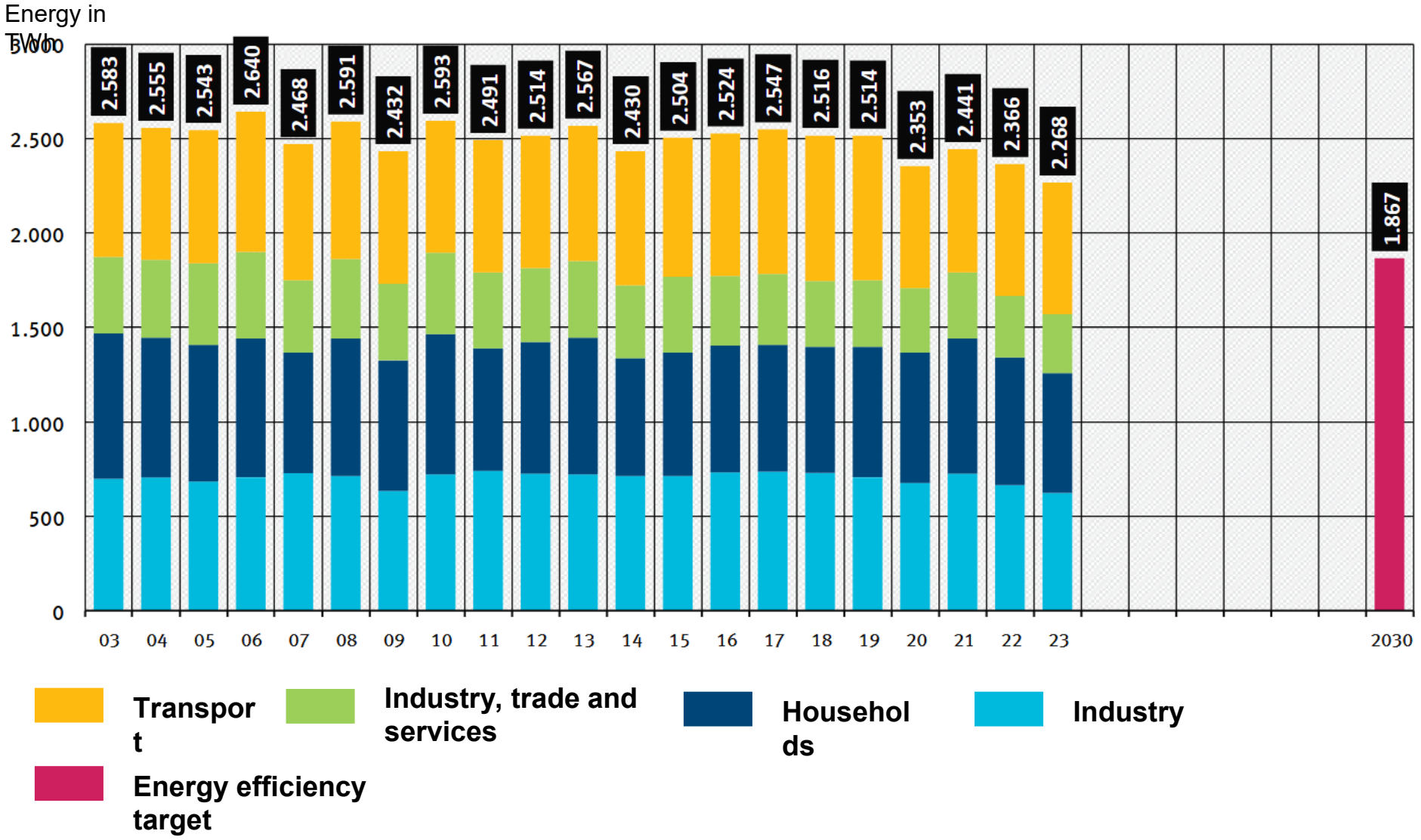
Example: Brainstorming on "energy efficiency"



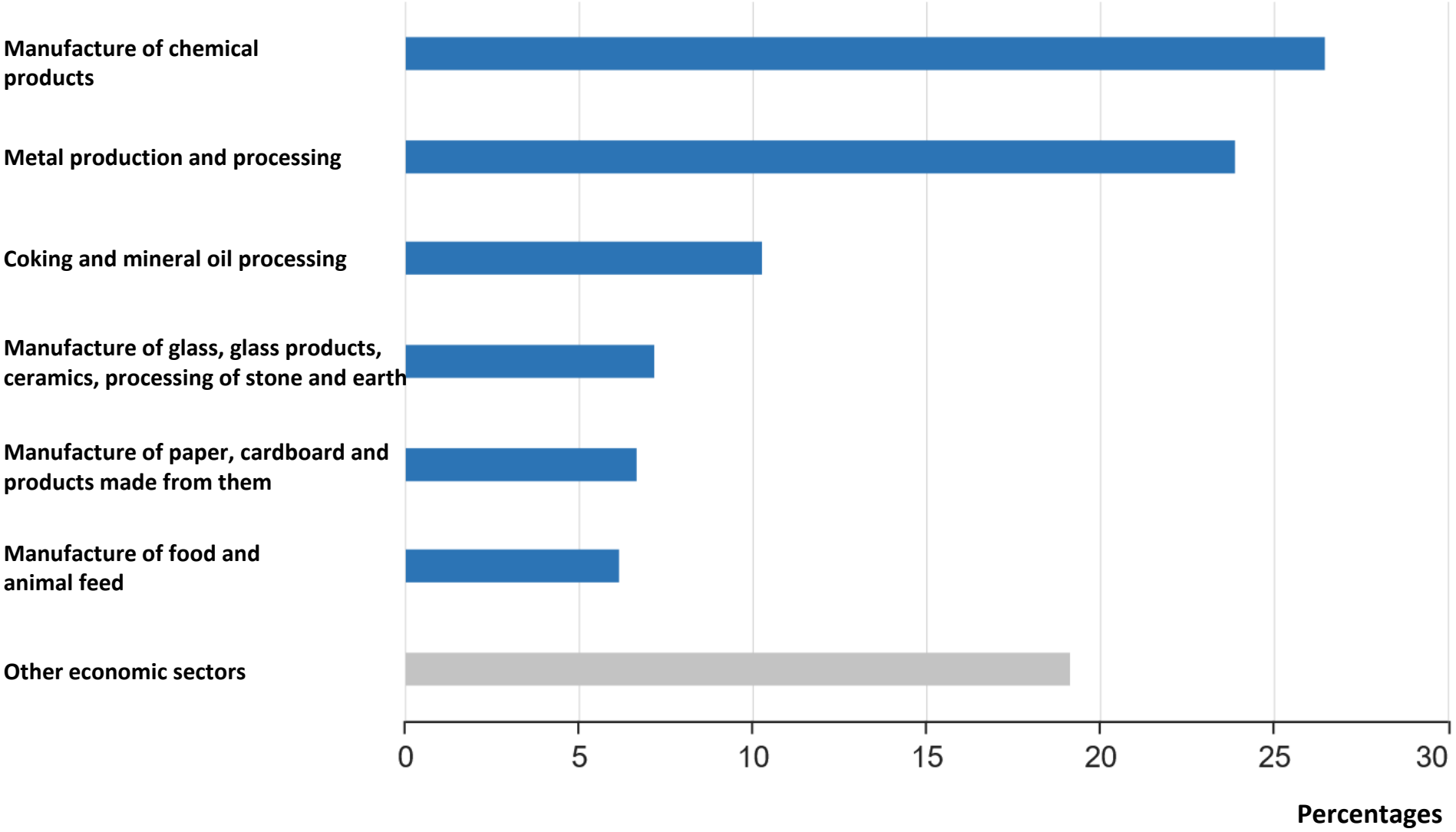
- Less energy consumption for the same performance or same benefit
- Improvement in efficiency
- Optimal use of the energy used
- Forms of energy: - Thermal energy
  - Electrical energy
  - Chemical energy
  - Radiant energy
- Minimisation of energy losses
- High energy requirements for chemical reactions
- Energy-intensive processes such as: - Distillation
  - Rectification
  - Evaporation
  - Drying
  - Pressure generation
  - ...
- Thermal separation processes are very energy-intensive
- Use of energy-efficient technologies
- Large amounts of energy are required
- Chemical processes only occur at high temperatures

- Objectives: - Low production costs
  - Low energy costs
  - Good competitiveness
  - Cost efficiency and increased profits
  - Consistent production despite fluctuating energy prices
  - Environmentally friendly company image
- Climate protection and protection of ecosystems
- Sustainability and resource conservation
- Reduction of CO_2 emissions
- Energy audits
- Investment requirements
- Political pressure
- Technologies:
  - Heat recovery
  - Process optimisation
  - Use of catalysts
  - Efficient use of waste heat
  - Modernisation of chemical plants
  - Combined heat and power

1. Final energy consumption by sector in Germany



2. Energy use in industry in Germany in 2023



APPENDIX 3 Why greater energy efficiency?

Reasons for greater energy efficiency

High energy consumption in the chemical industry

Many chemical processes require **substantial energy**, mostly in the form of **heat** or **electricity**.
Examples:

- **Lime burning (800–1000 °C):** conversion of limestone to quicklime – important for construction, industry and agriculture.
- **Iron extraction (up to 2000 °C):** blast furnace process – basis for steel, e.g. in vehicles, bridges.
- **Haber-Bosch process:** ammonia synthesis for fertiliser – consumes ~3% of global energy demand.
- **Pyrolysis of plastics (~800 °C):** plastic recycling into monomers, gases, oils – resource conservation.
- **Drying, distillation, rectification:** high energy consumption, e.g. for the recovery of salts/chemicals.

Cost factor
Energy is expensive. Greater efficiency means lower production costs and greater competitiveness.

Environmental protection
Lower energy consumption means lower CO_2 emissions, especially with fossil fuels, and thus contributes to climate protection.

Reasons for greater energy efficiency

Conservation of resources
Using petroleum, natural gas and coal sparingly means reducing the strain on natural resources.

Legislation and subsidy programmes
Many countries promote efficiency and require lower emissions through legal requirements.

Security and independence
By consuming less energy, industry is better equipped to deal with crises, price fluctuations and bottlenecks.

Reducing economic risk
Efficient processes make companies less vulnerable to fluctuating electricity and gas prices.

Image boost
Energy-efficient companies have a better public image – among customers, investors and politicians.

Less waste and emissions
Efficient processes often produce fewer by-products and are more environmentally friendly.

Integration of renewable energies
The more efficient the process, the easier it is to integrate renewable energies (e.g. solar, wind).

Technical options for increasing energy efficiency

The chemical industry relies heavily on energy-intensive processes. However, targeted process optimisation can save considerable amounts of energy, increase productivity and reduce emissions.

Heat exchangers

Heat exchangers transfer heat between two separate material flows that pass by a thermally conductive wall. Common designs include shell-and-tube, plate and spiral heat exchangers. They make it possible, for example, to use hot process fluids or exhaust air in advance to preheat feed media, thereby reducing the energy required in the main process. Condensation heat can also be utilised in this way. Heat exchangers are flexible in their application and suitable for various media, making them an important part of energy-efficient production facilities.

Optimising reaction conditions:

By precisely adjusting process parameters such as temperature, pressure or reactant concentrations, energy consumption can be reduced without compromising yield or product quality. In an equilibrium reaction, for example, a slightly increased concentration of the starting materials can increase the yield and thus save energy.

Improving insulation:

Heat is mainly "lost" through inadequately insulated pipes, reactors or containers. Using better insulation can reduce heat loss, meaning that less energy is required for the overall process.

Minimising idle times:

Plants that are not in use also consume energy, for example to carry out cleaning processes. Furthermore, energy is required to bring a plant back up to operating temperature. By optimising the times for cleaning, production and standby, it is possible to reduce energy consumption.

More efficient reactors:

Instead of using classic large-volume reactors, new reactor concepts such as microreactors enable better heat and mass transfer as well as shorter reaction times. This leads to more compact and energy-efficient plants in which chemical reactions take place under optimal conditions.

Use of modern measurement technology and process control:

Modern sensor technology, digital measurement systems and process analytics (e.g. inline spectroscopy) enable continuous monitoring and fine control of the production process. This means that energy can be provided exactly when it is really needed, avoiding unnecessary consumption.

Modern energy-saving technologies

Modern catalysts:
A modern, efficient catalyst reduces the activation energy. This allows the reaction to take place at a lower temperature, thereby saving energy.

Membrane processes:
The mechanical separation of substances using "fine filters" (membranes) instead of heating saves a lot of energy compared to thermal separation processes such as distillation.

Optimised electrochemical processes:
Electrochemical processes run on electrical current instead of heat. This is particularly interesting when renewable energies are used for this purpose.

Heat pumps:
Heat pumps use waste heat to raise residual heat (e.g. from exhaust gases or cooling water) to a higher temperature level. This heat can then be fed back into the production process.
This means that existing energy is used instead of generating new energy.

Combined heat and power:
Combined heat and power involves generating electricity and heat simultaneously from a single fuel (e.g. natural gas). In addition to electrical power, the waste heat produced is used, for example, to heat reactors or plants. This ensures a very high overall efficiency
(up to 90%) and is therefore significantly more efficient than separate electricity and heat generation.

Using solar heat or biogas:
Instead of using fossil fuels, industry can use solar thermal systems to heat water or process fluids.
Biogas from organic waste (e.g. sewage sludge, food waste) can also be used in boilers or combined heat and power plants to generate heat and electricity. These energy sources are renewable, climate-friendly and often locally available.

Using waste or by-products for energy generation:
Many chemical processes generate energy-rich residues or exhaust gases. These can be used to generate heat through combustion, gasification or pyrolysis instead of being disposed of. This means that raw materials are used efficiently and less waste is produced.

Storing heat for later use:
Heat storage systems (e.g. molten salt, hot water tanks) can be used to temporarily store excess process heat and reuse it at a later time. This can be done at night or when demand is high, for example. This allows energy to be used efficiently and compensates for fluctuations in supply.

APPENDIX 4

Quiz: **Energy efficiency in methanol production (fictitious process)**

Scenario: You operate a plant for producing methanol from synthesis gas ($CO + 2\ H_2$ or $CO_2 + 3\ H_2$) in several steps:

1. Reforming
In the first stage of the process, natural gas (mainly methane) is converted into synthesis gas (a mixture of CO and H_2) in a reformer at around 800 °C and 25 bar using steam. In addition to the main components, this also produces carbon dioxide. This reaction requires high temperatures and a large amount of energy to break the C–H bonds in methane.

2. Methanol synthesis
The purified synthesis gas enters a reactor loaded with a catalyst at a molar ratio of $H_2/CO \approx 2:1$ at 350 °C and 250 bar. There, CO and H_2 react to form methanol (CH_3OH) and a small amount of water. Although the reaction is exothermic, additional heat is supplied during the start-up phase to maintain the optimum reaction temperature.

3. Separation and purification
After the reaction, the mixture contains methanol, water, residual gases and small amounts of by-products. Methanol is separated from water and other components in several distillation columns. The products are heated and cooled several times, which accounts for the plant's largest share of energy consumption. The pure methanol is then condensed and stored..

SOLUTIONS TO THE TASKS

Option A:

Installation of a **heat exchanger** that uses the waste heat from the reformer gas to preheat the fresh gas.

Option B:

Installation of a **heat exchanger** that uses waste heat from the reactor to preheat the synthesis gas.

Option C:

Optimisation of **the reaction conditions** by using a **better catalyst** that enables the reaction to take place at 250 °C and operates at lower pressure.

Option D:

Integration of **a combined heat and power (CHP) system** to use the electricity generated and the waste heat simultaneously for heating and electricity consumers.

Option E:

Use of **heat exchangers** to heat the precursor by utilising the heat of condensation in order to make purification by distillation more efficient.

Option F:

Use of a **heat pump** to combine heating of the bottom product and condensation, thereby reducing energy requirements.

Option G:

Improvement of **insulation**.

Option H:

Improved **process monitoring** to increase efficiency.

SOURCES

- https://www.bundestag.de/resource/blob/567976/bb4895f14291074b0a342d4c714b47f8/wd-8-088-18-pdf-data.pdf
- Book: "Chemistry Technology"; Dr.-Ing. E. Ignatowitz; Europa-Lehrmittel; 13th edition; 2022
- https://www.iff.fraunhofer.de/content/dam/iff/de/dokumente/paper-energieeffizienz-fraunhoferiff.pdf
- https://energieberatung-wissen.de/energieeffizienz-und-innovation-wie-neue-technologien-den-energieverbrauch-senken
- https://edison.media/umwelt/5-wege-um-in-der-industrie-energie-zu-sparen/25254732
- https://www.weltderwunder.de/warum-die-industrie-effizienter-werden-muss-ion-power-grid/
- https://www.bmwk.de/Redaktion/DE/Publikationen/Energie/energieeffizienz-in-unternehmen.pdf?__blob=publicationFile&v=1
- Image source Appendix 2:
  https://www.umweltbundesamt.de/sites/default/files/medien/3630/bilder/dateien/2_abb_eev-sektoren_2024-12-17.pdf
  https://www.destatis.de/DE/Presse/Pressemitteilungen/2024/11/PD24_413_435.html

Developed by:

Kay Huber,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by the European Union



2.40. TITLE: CO_2 in transition: From climate problem to resource

PROCEDURE:

Steps	Time
Step 1: What is carbon dioxide?	15 min
Step 2: Carbon dioxide storage	10 min
Step 3: Utilising carbon dioxide	10 min
Step 4: Summary	10 min



Number of participants: Min. 6



Materials required: Blackboard or whiteboard, chalk or pens, laptop, projector



Planned time: 45 min

Aims:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What carbon dioxide is • Why carbon dioxide should be stored	• State the advantages and disadvantages of carbon dioxide storage • Name methods for the practical use of carbon dioxide	• The necessity of sustainable management of carbon dioxide emissions and its use as a raw material



Comments: -

1. Question: What is carbon dioxide?

The teacher introduces the topic *"Carbon dioxide as a raw material"* and begins by explaining what carbon dioxide is.

Explanation:

Carbon dioxide (CO_2) is a colourless, odourless gas consisting of one carbon atom (C) and two oxygen atoms (O). It is produced when carbon-containing substances (e.g. wood, coal, oil, and natural gas) are burned and during the cellular respiration of living organisms. The proportion of carbon dioxide in the air is around 0.04%. At the same time, plants need it for photosynthesis to produce glucose and oxygen from water and carbon dioxide:

Water + carbon dioxide ➔ glucose + oxygen ("Water and carbon dioxide react to form glucose and oxygen")

$$6\,H_2O + 6\,CO_2 \xrightarrow{Light} C_6H_{12}O_6 + 6\,O_2$$

The problem is that carbon dioxide is a greenhouse gas.

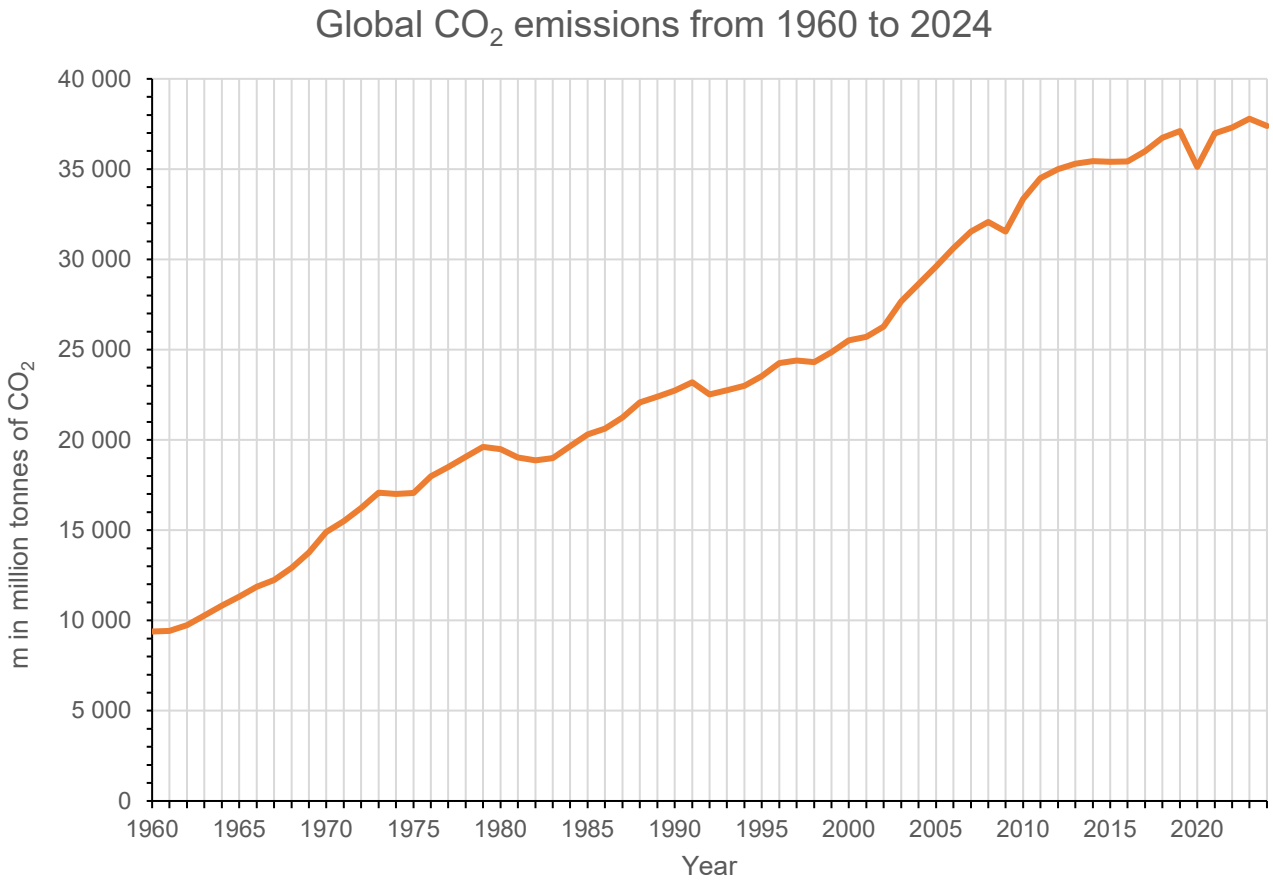
2nd question: Why are carbon dioxide emissions problematic?

The teacher explains why carbon dioxide emissions are problematic.

Explanation:

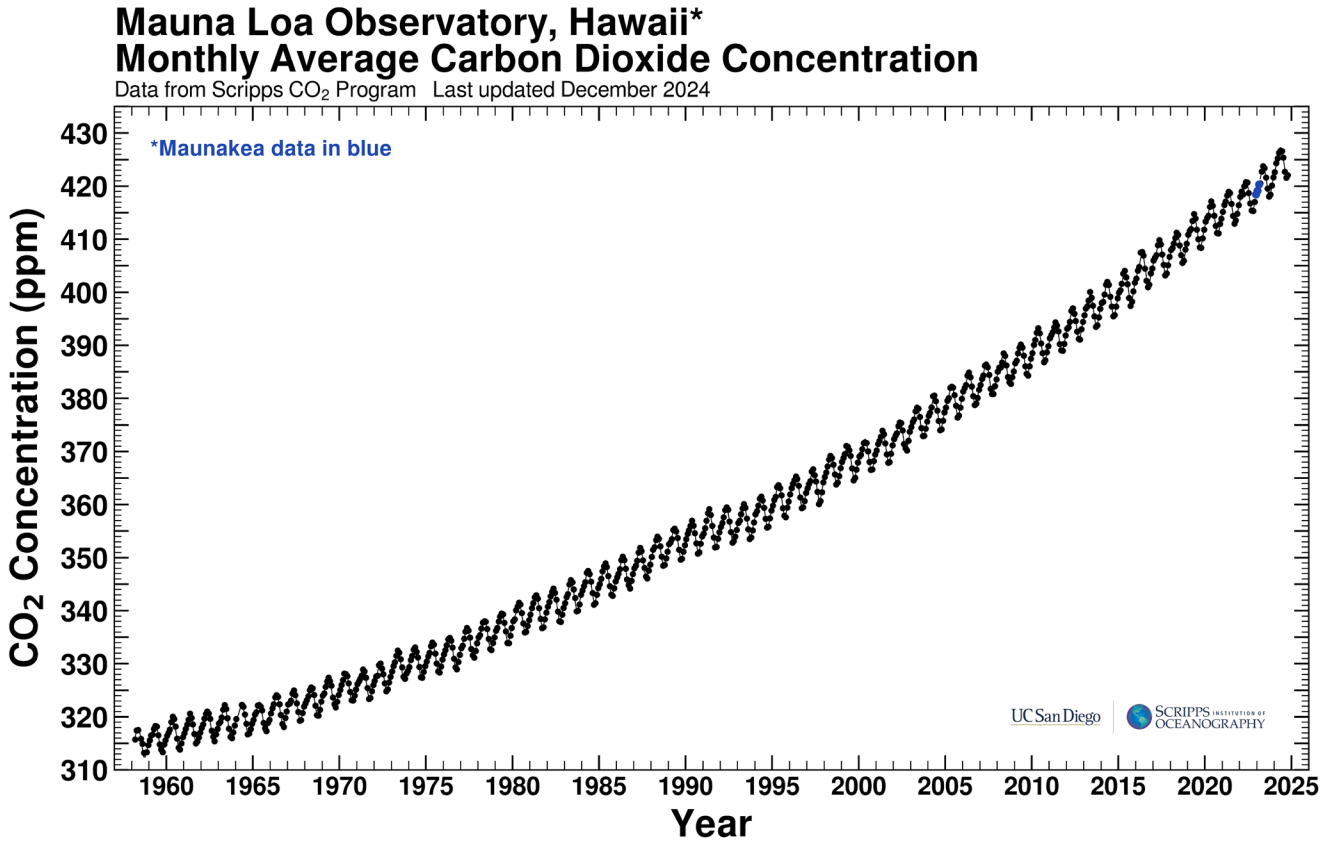
Carbon dioxide absorbs heat radiation, more precisely infrared radiation, which means that less heat is released into space. As a result, more heat is retained in the atmosphere. This causes the greenhouse effect and, consequently, global warming. However, this effect would not be harmful if plants on land and in the oceans absorbed the same amount of carbon dioxide. Human use of fossil fuels releases more carbon dioxide into the atmosphere than plants can absorb. This increases the greenhouse effect and, consequently, global warming.

(Show Appendix 1)



Between 1960 and 2024, man-made carbon dioxide emissions rose continuously. In 1960, they stood at approximately 9.5 billion tonnes, and in 2023 they were approximately 37.8 billion tonnes of carbon dioxide.

(Show Appendix 2)

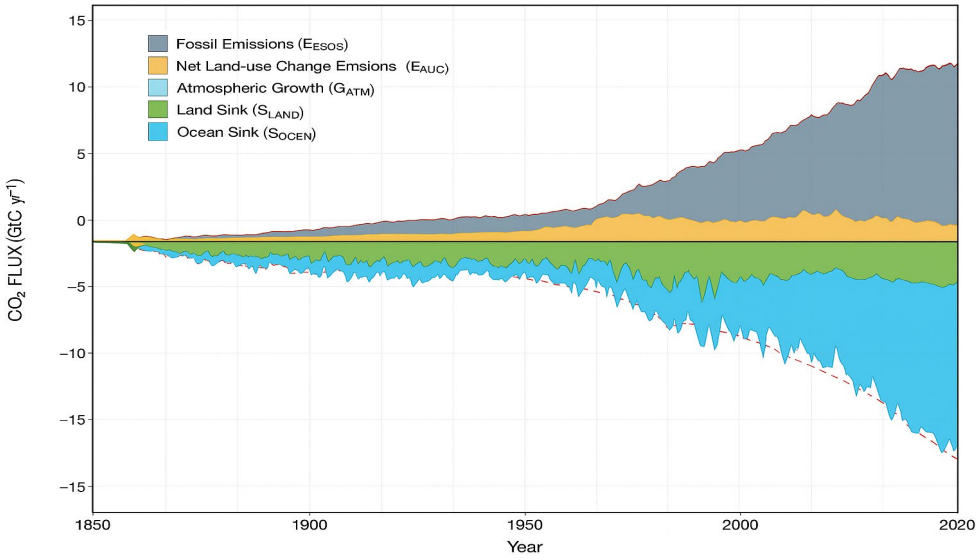


The Mauna Loa Observatory in Hawaii regularly analyses the carbon dioxide content in the atmosphere. Due to the location of the measuring station, the readings are only slightly influenced by industry and the surrounding vegetation.

The diagram shows the concentration of carbon dioxide in the air over time from 1958 to 2024. This curve, known as the Keeling Curve, is subject to seasonal fluctuations. It clearly shows that the carbon dioxide concentration increased continuously from approximately 315 ppm in 1960 to approximately 425 ppm in 2024.

This shows a direct correlation between the increasing emissions of carbon dioxide by humans and the rise in carbon dioxide concentration in the atmosphere.

To verify this increase, it is also necessary to consider how much carbon dioxide is bound by plants on land and in the oceans through photosynthesis. It should be noted that carbon dioxide acts as a fertiliser, promoting plant growth (see Appendices 3 and 4).



The diagram shows that carbon dioxide emissions from the use of fossil fuels such as oil, natural gas and coal are rising continuously. Carbon dioxide emissions from land-use changes are also increasing. Such changes in land use include deforestation, slash-and-burn farming and the drainage of moors.

On the other hand, some of the carbon dioxide is absorbed by carbon sinks, thereby being removed from the atmosphere. Carbon sinks on land include increases in biomass through plant photosynthesis, the slow decomposition of biomass in soil and the storage of carbon in peat on moors. In the oceans, carbon dioxide can be absorbed by cold seawater and sink to great depths. At the same time, it is stored in the oceans through photosynthesis by phytoplankton, algae and other aquatic plants, as well as by calcareous organisms. The remaining carbon dioxide stays in the atmosphere, increasing its concentration.

1. Question: Why is carbon dioxide stored?

The teacher explains why the chemical industry is considering storing carbon dioxide.

Explanation:

Numerous processes in the chemical industry produce large amounts of carbon dioxide, for example in the manufacture of ammonia or cement. Carbon capture and storage (CCS) makes it possible to separate carbon dioxide and store it long term in geological formations. Such storage sites include saline aquifers (underground porous rock layers beneath the seabed) or depleted natural gas fields. This prevents carbon dioxide from entering the atmosphere and contributing to the greenhouse effect. The separation process produces highly concentrated carbon dioxide, which can later be used as a raw material in carbon capture and utilisation (CCU) processes. In these processes, carbon dioxide is used to produce environmentally friendly chemicals such as methanol, synthetic fuels or plastics, thereby promoting a circular economy. Chemical companies are turning to carbon dioxide storage to comply with future regulations and legislation, improve their CO_2 footprint and replace fossil carbon sources. Technically, separation in industrial plants or power stations, such as lignite-fired power stations, is very efficient because exhaust gas streams have high carbon dioxide concentrations. Stable geological storage sites can bind carbon dioxide for hundreds to thousands of years. In the long term, this strategy contributes to reducing emissions and enhancing climate-friendly competitiveness.

2. Question: How does carbon dioxide capture and storage work?

The teacher explains how carbon capture and storage (CCS) works.
(Show Appendix 5)

Explanation:

In industrial plants, carbon dioxide is separated from the exhaust gases using special processes to prevent it from escaping into the atmosphere. The most common method involves removing carbon dioxide from the flue gas after combustion. The exhaust gas flows through a scrubbing solution (e.g. amines such as monoethanolamine), which chemically binds the carbon dioxide. It is then released again by heating. Depending on the composition of the gas mixture, the separation of carbon dioxide is either easier or more complex.

- After separation, the carbon dioxide (CO_2) is first compressed and liquefied to facilitate transport and storage. It is then pumped into suitable geological formations deep underground. The most important storage locations are:
- Depleted natural gas or oil fields
- Saline aquifers (underground porous rock layers beneath the seabed and on land)
- Deep-sea sediments (still under investigation)
- Carbon dioxide is injected at depths of approximately 800–3000 metres, where the high pressure ensures that it remains in liquid or supercritical form. Porous rock stores the carbon dioxide, while dense cap layers (e.g. clay layers) prevent it from escaping. This form of storage is essential to the carbon capture and storage (CCS) concept for achieving long-term reductions in greenhouse gas emissions.

3. Question: What are the advantages and disadvantages of *carbon capture and storage*?

The teacher explains the advantages and disadvantages of *carbon capture and storage.* (Show Appendix 6)

Explanation:

- Carbon capture and storage (CCS) is a technology that captures and stores carbon dioxide from industrial processes or power plants. It offers the advantage of significantly reducing carbon dioxide emissions and can therefore make an important contribution to climate protection. CCS is a particularly useful transitional solution in sectors where emissions are difficult to avoid. In addition, existing infrastructure, such as former oil and gas reservoirs, can be used as carbon dioxide storage facilities.
- However, storing carbon dioxide also has disadvantages. The technology is expensive and requires additional energy input, thereby reducing plant efficiency. There are also uncertainties regarding the long-term safety of carbon dioxide storage. Another criticism is that CCS may delay the transition to sustainable energy sources if it allows the continued use of fossil fuels.
- Overall, CCS is a useful measure in the fight against climate change, but it is not sufficient on its own.

1. Question: What is carbon capture and utilisation (CCU)?

The teacher asks what carbon capture and utilisation (CCU) is.

Explanation:

Carbon capture and utilisation (CCU) is a process in which carbon dioxide (CO_2) is captured from industrial processes or the air and reused. It is used, for example, in the manufacture of plastics, fuels or building materials. The aim is to prevent carbon dioxide from entering the atmosphere. Instead, carbon dioxide is integrated into economic cycles as a raw material, thereby reducing greenhouse gas emissions.

2nd question: What concepts exist for *carbon capture and utilisation*?

Explanation:

For carbon dioxide capture, carbon dioxide is separated using amine scrubbing. The captured carbon dioxide can then be used in various processes:

- In chemical CCU processes, carbon dioxide serves as a starting material for the production of valuable chemicals. In methanol synthesis, carbon dioxide is converted into methanol together with green hydrogen (H_2) using metal catalysts. Methanol is used as a versatile raw material and clean energy source.
- Furthermore, in plastics production, specifically in polycarbonate production, carbon dioxide is converted into polycarbonate with a second raw material. Carbon dioxide can also be used as a raw material to produce polyurethanes, thereby enabling the production of sustainable plastics.
- In addition, synthesis gas routes can be used to convert CO_2 together with H_2 into a mixture of carbon monoxide (CO) and hydrogen (H_2), which serves as a universal building block for the production of methane, synthetic fuels and other chemical products.
- These catalytic processes enable the direct introduction of carbon dioxide into the chemical value chain, thereby replacing fossil raw materials.

In **electrochemical CCU processes**, carbon dioxide is converted into products such as carbon monoxide, methanol, formic acid, ethylene, ethanol or monoethylene glycol using electric current. The use of renewable energy (green electricity) is particularly important here.

Biotechnological CCU processes use microalgae, cyanobacteria or genetically modified microbes to convert carbon dioxide into valuable products such as biomass, biopolymers or chemicals (e.g. acetic acid, butanol, propanol, acetone). Carbon dioxide from the air or exhaust gases is utilised via photosynthesis or other metabolic pathways. These processes promote the sustainable use of carbon dioxide and could play a central role in the circular economy in the future. Increasing the carbon dioxide concentration in greenhouses improves plant growth.

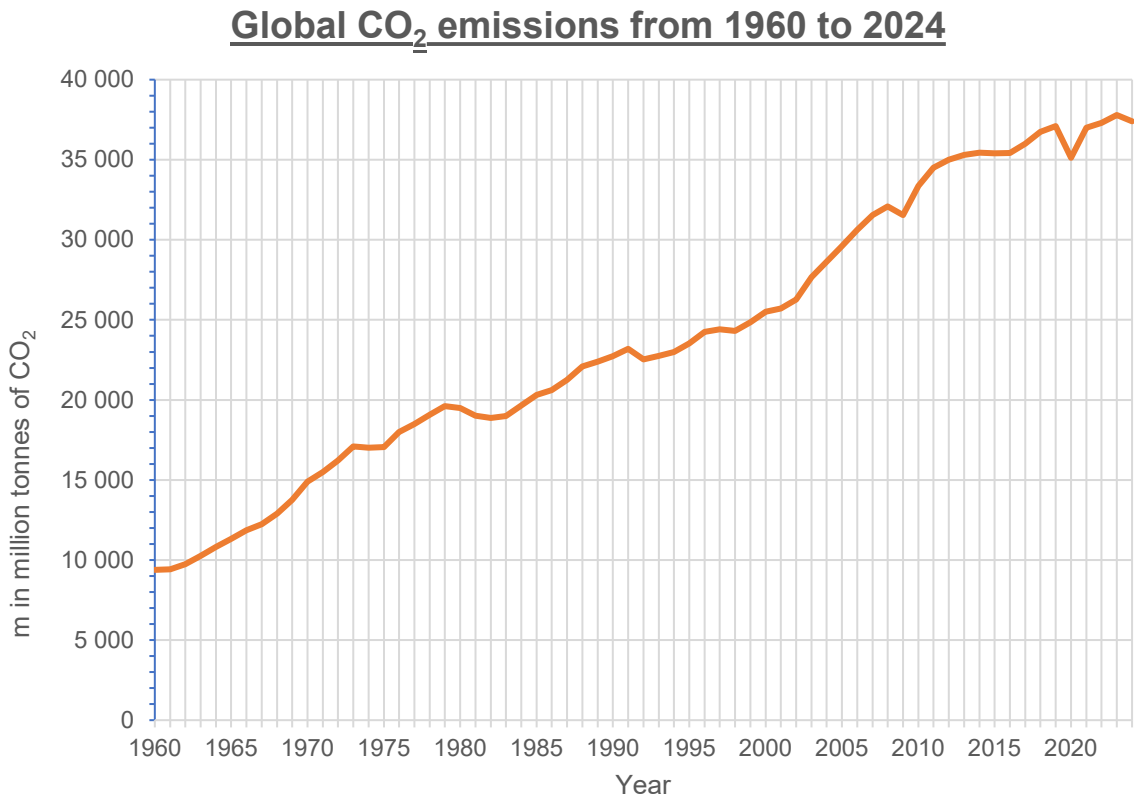
During **mineralisation as part of CCU**, CO_2 is permanently bound by reacting with mineral substances such as calcium or magnesium compounds. This produces stable carbonates (e.g. calcium carbonate) that can no longer return to the atmosphere. This process can occur naturally (e.g. in rock) or be accelerated technically. The resulting carbonates can be used, for example, as building materials in the construction industry. Carbon dioxide storage through mineralisation is considered a safe, long-term option.

Further processes for using carbon dioxide as a raw material are likely to become established in the future.

STEP 4 Summary

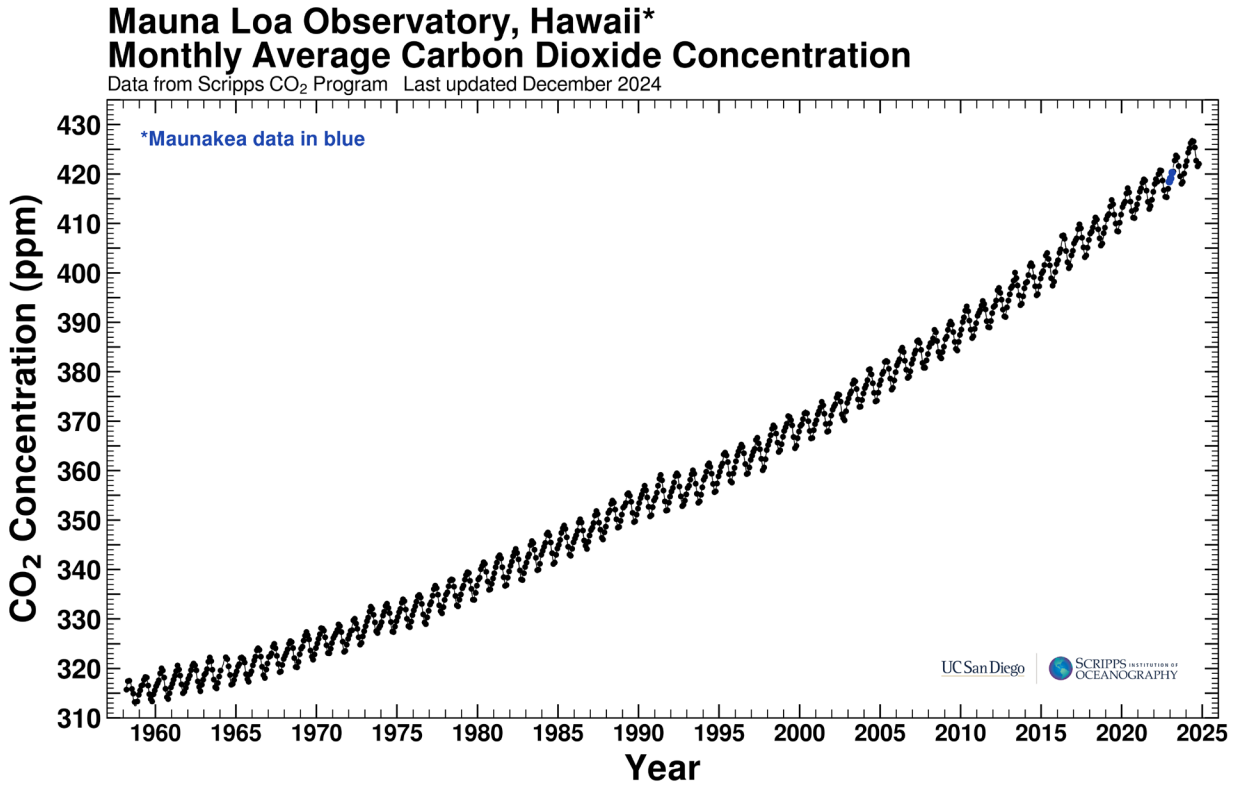
Finally, let's do a quiz to reinforce what we've learned.

(Show Appendices 8 and 9 – answers can be found at the end of the appendix)

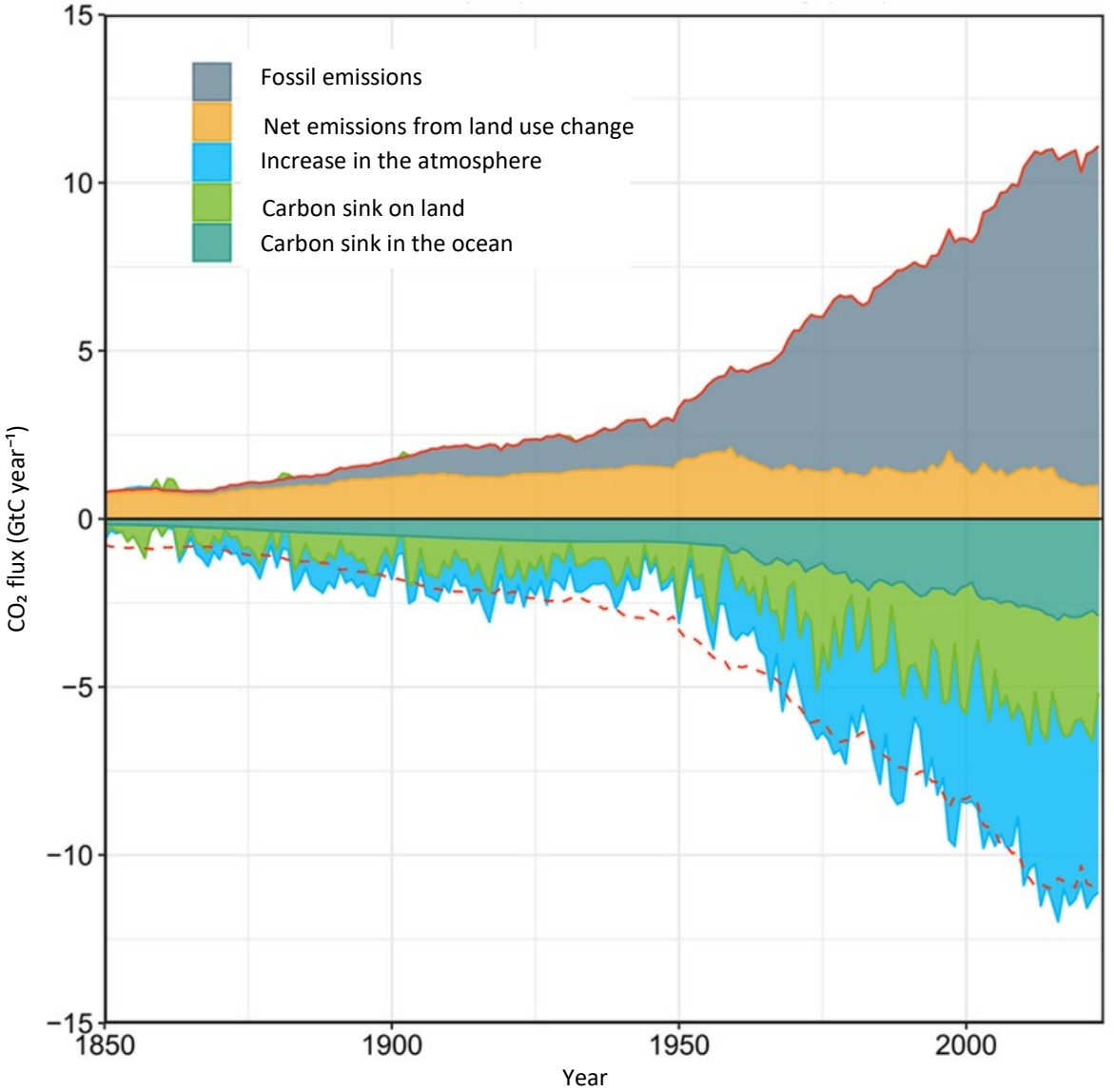


Between 1960 and 2024, man-made carbon dioxide emissions rose steadily. In 1960, they stood at approximately 9.5 billion tonnes, and in 2023 they were approximately 37.8 billion tonnes of carbon dioxide.

CO2 concentration in the atmosphere between 1958 and 2024



The Mauna Loa Observatory in Hawaii regularly analyses the carbon dioxide content in the atmosphere. Due to the location of the measuring station, the readings are only slightly influenced by industry and the surrounding vegetation.
The diagram shows the concentration of carbon dioxide in the air over time from 1958 to 2024. This curve, known as the Keeling curve, is subject to seasonal fluctuations. It clearly shows that the carbon dioxide concentration increased continuously from approximately 315 ppm in 1960 to approximately 425 ppm in 2024.
This shows a direct correlation between the increasing emissions of carbon dioxide by humans and the rise in the carbon dioxide concentration in the atmosphere.


Fossil emissions
Net emissions from land use change
Increase in the atmosphere
Carbon sink on land
Carbon sink in the ocean
15
10
5
0
−5
−10
−15
1850
1900
1950
2000
Year
CO2 flux (GtC year−1)

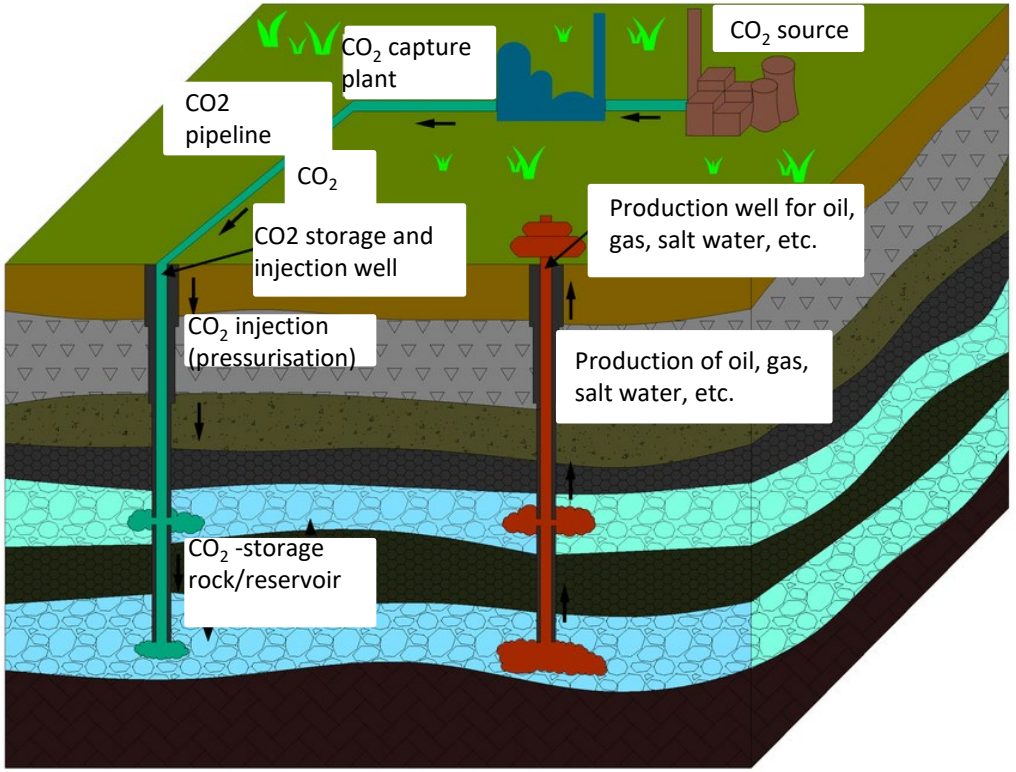
To verify this increase, the absorption of carbon dioxide by plants on land and in the oceans during photosynthesis must be taken into account. It should be noted that carbon dioxide acts as a fertiliser, promoting plant growth.

The diagram shows that between 1850 and approximately 2020, carbon dioxide emissions
from the use of fossil fuels (coal, oil, natural gas) and from land use changes (e.g. deforestation, slash-and-burn farming, peatland drainage) increased. However, some of the carbon dioxide is also reabsorbed (carbon sinks):

- **On land**, carbon dioxide is absorbed by plants (photosynthesis) and stored as biomass in the soil and as peat in moors.
- **In the ocean,** carbon dioxide is absorbed in cold water and sinks to the bottom. Furthermore, carbon dioxide is bound by plankton and algae through photosynthesis and by calcification.

Unabsorbed carbon dioxide remains in the atmosphere, causing its concentration to rise.

Carbon capture and storage (CCS)



The image shows the *carbon capture and storage* (CCS) process. First, the carbon dioxide produced in an industrial plant (*CO_2 source*) is captured and compressed in a carbon dioxide capture plant. The carbon dioxide is then transported via a pipeline to a borehole for injection and storage. There it is pumped deep underground into a CO_2 reservoir, e.g. into former oil or natural gas storage sites or into saline aquifers (rock layers containing salt water). Dense cap layers prevent the carbon dioxide from escaping. The aim of CCS is to permanently store climate-damaging carbon dioxide underground to reduce the greenhouse effect.

APPENDIX 6

Advantages and disadvantages of *carbon capture* and *storage* (*CCS*):

Advantages	Disadvantages
• Reduces CO_2 emissions from industry and power plants	• High construction and operating costs
• Supports the achievement of international climate targets	• Additional energy requirements (lower efficiency)
• Uses existing infrastructure (e.g. former oil and gas storage sites)	• Uncertainty about the long-term stability of storage facilities
• Bridge technology on the way to a climate-neutral energy supply	• Risk of delaying the phase-out of fossil fuels

Concepts for *carbon* dioxide *capture and utilisation (CCU*)

First, the carbon dioxide produced during chemical processes must be captured using suitable methods (e.g. amine scrubbing). It is then used for various processes:

Chemical CCU processes:
- Methanol synthesis from carbon dioxide (CO_2) and green hydrogen (H_2)
- Plastics production: polycarbonate is produced from carbon dioxide (CO_2) and another substance. Carbon dioxide can also be used to produce polyurethanes.
- Use of carbon dioxide for synthesis gas production of methane and higher hydrocarbons as well as other chemical products.

Electrochemical CCU processes:
- Use of electricity (preferably green electricity) and carbon dioxide to produce carbon monoxide, methanol, formic acid, ethylene, ethanol, monoethylene glycol

Biotechnological CCU processes:
- Organisms such as microalgae, cyanobacteria and genetically modified microbes produce biomass, biopolymers and chemicals (e.g. butanol, acetone) through photosynthesis and other metabolic pathways.
- Promotion of plant growth in greenhouses

Mineralisation:
Calcium and magnesium compounds form stable carbonates (e.g. calcium carbonate) with carbon dioxide. This formation of carbonates can occur naturally or be accelerated by technical means. The carbonates form a long-term storage form of carbon dioxide. The carbonates produced in this way can be used as building materials.

APPENDIX 8

Quiz

1. What does the abbreviation CCU stand for?
A) Carbon Control and Usage
B) Climate Capture Unit
C) Carbon Capture and Utilisation
D) Clean Coal Usage

2. Which process is often used to capture CO_2 from exhaust gases?
A) Distillation
B) Amine scrubbing
C) Osmosis
D) Filtration

3. Which gas is needed for methanol synthesis in addition to CO_2?
A) Oxygen
B) Nitrogen
C) Green hydrogen (H_2)
D) Methane

4. What is methanol used for in the chemical industry?

A) A versatile raw material
B) Fuel for nuclear reactors
C) A waste product
D) A greenhouse gas

5. What can be improved by using carbon dioxide in greenhouses?
A) Humidity
B) Energy consumption
C) Light incidence
D) Plant growth

6. Which organisms are used in biotechnological CCU processes?
A) Mammals
B) Algae and microbes
C) Insects
D) Mosses

7. Which plastic can be produced using carbon dioxide?
A) PVC
B) Teflon
C) Polystyrene
D) Polycarbonate

8. What role does carbon dioxide play in the circular economy?
A) It is completely avoided
B) It is stored and burned
C) It is reused as a raw material
D) It is exported

9. Why are mineralised carbon dioxide products considered particularly sustainable?
A) They permanently bind CO_2
B) They dissolve easily in water
C) They are toxic to microbes
D) They are biodegradable

10. Which of these products is NOT a target product of a CCU process?
A) Methane
B) Ethanol
C) Helium
D) Acetic acid

SOLUTIONS TO THE TASKS

1st question: **C**

2nd question: **B**

3rd question: **C**

4th question: **A**

5th question: **D**

6th question: **B**

7th question: **D**

8th question: **C**

9th question: **A**

10th question: **C**

SOURCES

- https://de.statista.com/statistik/daten/studie/37187/umfrage/der-weltweite-co2-ausstoss-seit-1751/
- https://www.mpg.de/23729143/co2-emission-bilanz-2024#:~:text=The%20Global%20Carbon%20Project%20shows%20that%20the%20ocean%20sink%20accounts%20for%20about%20half%20of%20this.
- https://scrippsco2.ucsd.edu/graphics_gallery/mauna_loa_record/index.html
- https://essd.copernicus.org/articles/17/965/2025/essd-17-965-2025.pdf
  ("*Global Carbon Budget 2024*", Friedlingstein *et al.* in Earth System Science Data, 2025)
- https://www.mdpi.com/1996-1073/12/1/23#
  ("*A Review of Carbon Capture and Storage Project Investment and Operational Decision-Making Based on Bibliometrics*", Li *et al.* in Energies, 2019)
- https://patentimages.storage.googleapis.com/f3/bd/8d/6d65ea23042320/US6288202.pdf
- https://www.covestro.com/de/sustainability/what-drives-us/circular-economy/alternative-resources/co2-as-a-raw-material
- https://www.gruenes-gas.at/was-ist-gruenes-gas/synthetisches-gas
- https://www.kunststoff-innovation.ch/forschung?tx_news_pi1%5Baction%5D=detail&tx_news_pi1%5Bcontroller%5D=News&tx_news_pi1%5Bnews%5D=3948&cHash=906122d81bba0c6297b35e0d1df52dd3
- https://www.spektrum.de/news/synthetische-biologie-gentechnik-bakterien-sparen-kohlendioxid/1990489
- https://www.heidelbergmaterials.com/de/co2-mineralisierung-von-betonabfaellen
- Image source Appendix 2: https://scrippsco2.ucsd.edu/assets/graphics/png/mlo_record.png
- Image source Appendix 3: https://essd.copernicus.org/articles/17/965/2025/essd-17-965-2025.pdf
- Image source Appendix 5: https://www.mdpi.com/1996-1073/12/1/23#

Developed by:

Kay Huber,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



2.41. TITLE: Sustainable laboratory practice

PROCEDURE:

Steps	Time
Step 1. What is sustainable laboratory practice?	5 min
Step 2. Aspects of sustainable laboratory practice	15 min
Step 3. Sustainability at your place of work?	15 min.
Step 4. Summary	10 min.

OBJECTIVES:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What sustainable laboratory practice is • Why sustainable laboratory practice is important	• Identify potential for optimisation for sustainable laboratory practice • Implementing measures for greater sustainability in the laboratory	• How important it is to work sustainably in the laboratory



Number of participants: Min. 6



Materials required: Blackboard or whiteboard, chalk or pens, laptop, projector



Notes: Have test materials ready if desired (see Appendix 5)



Planned time: 45 min

STEP 1 What is sustainable laboratory practice?

1. Question: What do you understand by sustainable laboratory practice?

The teacher introduces the topic of "sustainable laboratory practice" and asks: "What do you understand by sustainable laboratory practice?"

(Possible answers for brainstorming, see Appendix 1).

The teacher presents the definition of sustainable laboratory practice (see Appendix 2).

Explanation:

Sustainable laboratory practice refers to all measures and behaviours in the laboratory that minimise resource and energy consumption, reduce waste and lower environmental and health risks. This includes, among other things, careful experiment planning to avoid waste, use of reusable instead of disposable materials, use of non-toxic substances, energy-efficient equipment control, correct sorting and recycling of chemicals, and continuous optimisation of methods. The aim is to make laboratory processes more environmentally friendly and economical, thereby contributing to resource-efficient and safe research and production..

2. Question: Which aspects are crucial for sustainable laboratory practice?

The teacher asks, "Which aspects are crucial for sustainable laboratory practice?" and shows Appendix 3 (abridged).

Explanation:

Waste management

Waste management includes the prevention, separation, collection and proper disposal of laboratory waste.

For effective waste management, waste must be correctly separated and disposed of. Only then is it possible to avoid waste, reduce quantities or reuse waste. Otherwise, efforts are made to recycle it. For example, it is possible to melt down glass almost indefinitely and use it to manufacture new products. To do this, glass must be sorted by type (quartz glass, borosilicate glass and soda-lime glass) based on melting temperatures, and separated by colour where possible**.** If recycling is not possible, attempts are made to recover energy from the waste or, if necessary, to landfill it.

Waste should therefore be separated into the following categories:

- **Residual waste** (disposable items, gloves, paper towels, face masks, non-infectious biological waste, etc.)
- **Packaging** (empty, cleaned plastic bottles; packaging material; plastic film packaging; aluminium foil; empty gas cartridges, etc.)
- **Paper and cardboard** (writing paper, catalogues, cardboard boxes, paper packaging material, etc.)
- **Glass** (quartz glass; borosilicate glass (= laboratory glass), soda-lime glass separated by colour: white, green, brown)
- **Scrap metal** (metal containers, damaged tripod equipment, etc.)
- **Electronic waste** (printers, computers, monitors, laboratory equipment, etc.)
- **Organic, non-halogenated waste** (alcohols, acetone, toluene, xylene, etc.)
- **Organic halogenated waste** (dichloromethane, chloroform, etc.)
- **Heavy metal salts** (lead, nickel, iron, copper, cobalt, etc.)
- **Other waste** (mercury-containing waste, certain toxins, batteries, rechargeable batteries, etc.)

-

As a general rule, waste should be avoided or reduced by using reusable products instead of disposable ones wherever possible. This reduces environmental impact, as well as procurement and disposal costs.

Energy efficiency

Energy efficiency means using as little energy as possible to achieve a desired result.

In the laboratory, this can be achieved as follows:

- Use energy-efficient appliances (e.g. refrigerators, heaters). The use of modern heat pumps in cooling units significantly reduces the consumption of cooling water. Otherwise, drinking water would be used as cooling water for temperature control.

- Only switch on devices when needed and do not run them 24/7 at operating temperature (e.g. drying cabinets, muffle furnaces, etc.).

- Use of power strips with on/off switches or timers, as even an appliance in standby mode consumes electricity.

This can save energy, reduce emissions and lower energy costs in the laboratory.

Chemical management

Chemical management means the safe, economical and responsible handling of chemicals throughout their entire life cycle.

This includes purchasing only as much as is needed for a specific period of time.

After all, it is not uncommon for new experiments or analyses to be started in the laboratory. It can then happen that these experiments do not produce the desired results and the chemicals for the experiment are still there. At some point, these must then be disposed of. It is also important to record the chemicals so that risks are minimised and excess stocks are avoided. Furthermore, chemicals must be stored according to their hazard and compatibility. It is also very important to check whether hazardous chemicals can be replaced with non-hazardous ones (substitution). Finally, chemicals must be disposed of properly.

Information on the handling and disposal of chemicals can be found in the safety data sheet issued by the manufacturer/distributor. Operating instructions containing the most important information are created for the chemicals in the workplace.

Avoid unnecessary experiments

Unnecessary experiments should be avoided in the laboratory. This reduces the use of chemicals and saves working time and thus labour costs.

- **Proper handling of laboratory glassware**

  Laboratory glassware is resistant to most chemicals. However, it can shatter as a result of sudden temperature fluctuations and mechanical forces (e.g. tipping over, falling to the floor, etc.). Care must therefore be taken when cleaning and handling glassware to ensure that it lasts for a long time.

- **Working with small quantities**

  For experiments and analyses, only small quantities of chemicals should be used, i.e. as much as is needed.

Optimisation of experimental procedures

In this context, optimising experimental procedures means planning and carrying out laboratory processes in such a way that fewer resources such as chemicals, energy and materials are consumed.

Use of digital protocols instead of paper

The use of electronic laboratory journals reduces paper consumption and facilitates quick access to data.

Regular maintenance of equipment to extend its service life

Regular maintenance ensures that equipment works more efficiently and needs to be replaced less often.

Regular training and motivation of employees

Regular training and motivation sensitise employees to the proper handling of chemicals and to the issue of sustainability.

Use of renewable energies

The use of renewable energies in the laboratory, for example through solar cells on the building roof or the purchase of green electricity, contributes significantly to CO_2 reduction.

Optimisation of reaction conditions

Optimising the temperature and pressure of chemical reactions enables chemical processes to run energy-efficiently without unnecessarily affecting the reaction speed or yield. This reduces energy costs and CO_2 -emissions and conserves materials.

Use of modular laboratory systems

Mobile modules can be rearranged as needed instead of operating several fixed systems. This reduces costs. This is used, for example, in titrators, so that the appropriate measuring solution and then the appropriate sensor (electrode) can be selected by simply reconnecting. On the other hand, it is possible to recombine the individual system components in the technical centre by using hoses.
This system is already implemented in the laboratory through the use of glassware with ground joints. The "modular" design makes it possible to use a small number of glassware items to create a wide variety of apparatus for a wide range of tasks.

Sharing instead of buying

Several groups share expensive analytical equipment instead of buying it. This not only reduces the acquisition costs, but also shares the maintenance costs and reduces the overall environmental impact.

STEP 3 Sustainability at your place of work?

1. Question: How is sustainability implemented in your company and where is there room for improvement?

The teacher sets the students the task: "How is sustainability implemented in your company and where is there room for improvement?"

To answer this, the students should think about and write down where sustainability is already being practised in their company and where there is still room for improvement.
They should also consider how less sustainable work processes could be improved.

If students do not have their own company, they can report their experiences from an internship.

Alternatively, the students could also give a fictional account of how they would like to make a company sustainable.

Note: Give the students about 10 minutes for this.

Afterwards, the results can be presented.

Social form: Individual work, partner work, group work

Methodology: Presentations, plenary discussion, etc.

STEP 4 Summary

Finally, let's do a quiz to reinforce what we've discussed.

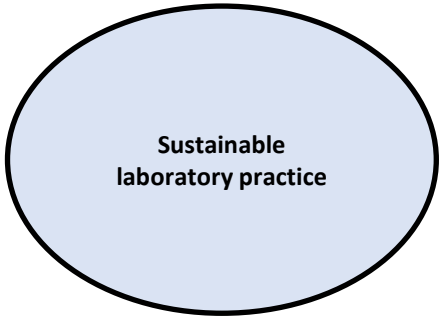
(Show Appendix 4 – solutions can be found at the end of the appendix)

Here, it would also be possible to test the theoretical values in practice by carrying out the experiment in Appendix 5.

APPENDIX 1

Example: Brainstorming on "Sustainable Laboratory Practice"

- Avoidance of unnecessary experiments
- Optimisation of sample quantity (total sample quantity)
- Fewer disposable items
- Use more reusable items
- Repairing equipment instead of throwing it away
- Optimisation of cleaning glass equipment
  ➔ Less use of chemicals
- Use minimal quantities for testing
- Use energy-efficient appliances
- Optimisation of appliance use
  ➔ Switch off when not in use
- Avoid standby mode
- Substitution of toxic chemicals
- Proper separation and disposal of chemicals
- Recycling/reuse of packaging
- Optimisation of waste prevention measures
- Use of digital protocols instead of paper forms
- Optimal container size ➔ less waste
- Maintenance and repair of equipment
  ➔ extended service life



- Training in the handling of chemicals
- Bulk orders
- Recording of water consumption
- Recording energy consumption
- Identification of "energy guzzlers"
- Optimisation of cooling water requirements
- Use of heat pumps/cooling units
- Use of renewable energies
- Improvement of atomic economy in syntheses
- Conscious use of disposable items:
  - Paper towels
  - Disposable gloves
  - Pipette tips
  - . . . . . .
- Treatment of solvent waste
- Use of software/AI for
  narrowing down screening tests
- Motivating employees to save costs
  and greater sustainability

Sustainable laboratory practice:

Sustainable laboratory practice refers to all measures and behaviours in the laboratory that minimise resource and energy consumption, reduce waste and lower environmental and health risks. This includes, among other things: careful experiment planning to avoid waste, use of reusable instead of disposable materials, use of non-toxic substances, energy-efficient equipment control, correct sorting and recycling of chemicals, and continuous optimisation of methods. The aim is to make laboratory processes environmentally friendly and economical, thereby contributing to resource-saving and safe research and production.

APPENDIX 3

Aspects of sustainable laboratory practice:

Waste management

Separate waste (residual waste, paper, glass, metals, plastics, solvents, acids/alkalis, heavy metals, hazardous waste).

Proper separation enables recycling or safe disposal and prevents unwanted chemical reactions in the collection container.

Energy efficiency

Use efficient devices (e.g. recirculating coolers = heat pumps). Only switch devices on when needed.

Use timers or on/off switches instead of standby mode.

This enables laboratories to reduce their electricity consumption and significantly lower costs.

Chemical management

Only purchase the quantities you need. Store chemicals properly. Replace hazardous substances with less hazardous ones.

Observe safety data sheets and operating instructions.

This saves chemicals and costs while protecting the environment.

Test optimisation

Digital reports should be used to optimise experiments. Furthermore, processes should be carefully planned

thus avoiding unnecessary repetitions.

This significantly reduces the amount of chemicals, time and materials required.

APPENDIX 3

Proper handling of equipment

Clean and handle glass equipment with care and maintain equipment regularly so that it lasts longer

Use only small quantities

Only use as much chemical as necessary for experiments.

Training and motivation of employees

Motivated and trained employees are aware of sustainability issues.

Renewable energies

Use your own solar power or green electricity tariffs.

Electricity from renewable sources significantly reduces the laboratory's carbon footprint.

Reaction conditions

Set temperature and pressure to the minimum necessary.

This saves heating and compression energy and reduces emissions.

Modular systems

By using modular systems, one system can be used for many tasks.

Share instead of buy

Sharing analytical equipment can significantly reduce costs.

Quiz

1. Which of the following is not considered sustainable laboratory practice?
A) Disposable plastic for every experiment
B) Using minimal quantities in experiments
C) Recycling packaging
D) Use of renewable energies

2. What contributes to reducing energy consumption in the laboratory?
A) Leaving devices switched on permanently
B) Operating drying cabinets around the clock
C) Using standby modes without checking
D) Use of energy-efficient devices

3. How can chemical waste be reduced?
A) By purchasing large quantities for storage
B) By storing them safely with other waste
C) By using very small quantities in experiments
D) By mixing all residual chemicals

4. Why is it important to separate glass waste?
A) Because glass is expensive
B) Because it is easier to recycle
C) So that it looks better
D) So that it can be disposed of more quickly

5. What is an advantage of digital laboratory protocols?
A) They require more storage space
B) They reduce paper consumption
C) They are difficult to update
D) They cost more than paper

6. What is meant by "substitution" in the laboratory?
A) Replacement of equipment
B) Hiring new employees
C) Replacing hazardous chemicals with non-hazardous ones
D) Replacing power sources

7. What increases the service life of laboratory equipment?
A) Regular maintenance
B) Continuous operation
C) Daily replacement
D) Storage at high temperatures

8. What is a typical example of hazardous waste in the laboratory?
A) Writing paper
B) Unused gloves
C) Halogenated solvents
D) Packaging

9. Why should experiments be well planned?
A) So that chemicals are used up more quickly
B) So that everyone can work at the same time
C) To use more equipment
D) To avoid unnecessary repetition and waste

10. What describes good chemical management?
A) Storage as desired
B) Purchasing as many supplies as possible
C) Responsible handling of chemicals throughout their entire life cycle
D) Disposal in residual waste

Comparison of methods: continuous versus fractional rinsing

Materials: 2 identical beakers (e.g. 250 ml), 1 measuring cylinder (100 ml), 1 spray bottle with demineralised (VE) water, 1 photometer (or spectrophotometer) with suitable cuvettes, methylene blue solution, stopwatch

Experimental setup:

1. Wet both beakers with exactly 1 ml of the methylene blue solution. Swirl the beakers until the inner walls are evenly coloured up to the 50 ml mark.

"Continuous rinsing" method:

1. Hold the beaker under a flowing stream of deionised water
2. Hold under the stream for 10 seconds
3. Measure the volume of water used (e.g. by collecting it in a large beaker) and note it down.

"Fractional rinsing" method:

1. Pour exactly 10 ml of deionised water into the contaminated glass
2. Swirl the glass thoroughly for 5 seconds so that all coloured areas on the walls are reached
3. Pour out the entire contents
4. Repeat steps 1-3 two more times with fresh 10 ml of deionised water
5. Note the total volume (30 ml)

Analysis:

1. Fill both cleaned glasses with exactly 50 ml of deionised water.
2. Stir to remove any remaining colour residue from the sides into the solution
3. Fill one cuvette at a time and measure the extinction on the photometer (wavelength of methylene blue approx. 660 nm).

Evaluation: The results obtained during rinsing can now be compared. It is also possible to evaluate the parameters "time required" and "water consumption".

SOLUTIONS TO THE TASKS

1st question: **A**

2nd question: **D**

3rd question: **C**

4th question: **B**

5th question: **B**

6th question: **C**

7th question: **A**

8th question: **C**

9th question: **D**

10th question: **C**

SOURCES

- https://www.baua.de/DE/Angebote/Regelwerk/TRGS/pdf/TRGS-600.pdf?__blob=publicationFile&v=3
- Waste Catalogue Ordinance – AVV: https://www.gesetze-im-internet.de/avv/index.html#BJNR337910001BJNE000306116
- https://www.laborpraxis.vogel.de/8-tipps-fuers-nachhaltige-labor-a-1020788/
- https://www.omnilab.de/einfuehrung-in-die-nachhaltige-laborpraxis/
- https://www.wirlebenforschung.de/nachrichten/details/auf-dem-weg-zum-nachhaltigen-labor/
- https://www.fishersci.de/de/de/scientific-products/publications/lab-reporter/2022/issue-1/strategies-for-a-more-sustainable-lab.html
- https://www.spectaris.de/fileadmin/Infothek/Analysen-Bio-und-Labortechnik/Zahlen-Fakten-und-Publikationen/Studie_Nachhaltigkeit-im-Labor2022_v7.pdf
- https://www.biomol.com/de/ressourcen/biomol-blog/lab-goes-green-machen-sie-ihr-labor-fit-fuer-die-zukunft

Developed by:

Kay Huber,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



2.42. TITLE: Circular Economy

PROCEDURE:

Steps	Time
Step 1: What is the circular economy?	5 min
Step 2: Why is the circular economy important?	15 min
Step 3: Comparison of linear and circular economies	15 min.
Step 4: Summary	10 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What circular economy • Why the circular economy is important	• Reasons for more circular economy Name • Measures/technologies for more circular economy Name	• The importance of the circular economy for the chemical industry



Number of participants: min. 6



Materials required: Blackboard or whiteboard, chalk or pens, laptop, projector



Comments: -



Planned time: 45 min

STEP 1: What is the circular economy?

1. Question: What do you understand by the circular economy?

The teacher introduces the topic: "Circular economy in the chemical industry", as the circular economy is very important because resources are becoming increasingly scarce.

The teacher asks: “What do you understand by the circular economy?”

(Possible answers as brainstorming, see Appendix 1).

The teacher introduces the definition of the circular economy in the chemical industry and the basic principles of the circular economy, see Appendix 2.

Explanation:

The *circular economy* is a sustainable economic system that aims to use resources as efficiently as possible, avoid waste and keep materials and products in the cycle of use for as long as possible – through reuse, repair, refurbishment and recycling.

There are three basic principles for implementing the circular economy:

1. *Reduce*
Avoiding or reducing resource consumption and waste generation even before a product is manufactured or used.
The aim is to use fewer raw materials, save energy and reduce the amount of packaging material.

2. *Reuse*
Products or components are used multiple times without being significantly altered or processed.
The aim is to extend product lifespans and reduce waste.

3. *Recycling*
Materials are processed after use and returned to the production cycle.
The aim is to recover valuable materials and reduce the use of primary raw materials.

STEP 2: Why is the circular economy important?

1. Question: Why is the concept of the circular economy particularly important in the chemical industry?

The teacher asks the question: “Why is the concept of the circular economy particularly important in the chemical industry?”

First, this question can be used to spark a discussion. This should not take longer than 10 minutes. The teacher then explains the reasons for the circular economy (summary; see Appendix 3).

Explanation:

Reasons for a circular economy in the chemical industry:

Raw material security and raw material efficiency:
Many basic chemicals are based on fossil raw materials (petroleum, natural gas), the availability and prices of which fluctuate greatly. Furthermore, they are not available in unlimited quantities. By recovering these raw materials as “secondary raw materials”, dependence on primary raw materials can be reduced. Furthermore, the quantities of renewable materials are often insufficient to meet actual demand. Alternative raw materials must therefore also be used efficiently.

Waste and emission reduction:
A linear economy would generate very large amounts of waste. However, this is not very efficient. That is why a circular economy is important. Furthermore, chemical processes often produce toxic waste (such as catalyst residues), solvent residues or by-products from synthesis. Circular economy concepts aim to process these unused materials as raw materials for other processes. Closed material cycles thus prevent the release of harmful substances into the environment and, at the same time, reduce greenhouse gas emissions.

Regulatory requirements and market demands:
European and national laws (e.g. the EU Chemicals Strategy for Sustainability, REACH) increasingly require proof of resource conservation and take-back obligations. End customers and consumer markets demand recycled packaging or plastics. For some applications, it is also necessary to use biodegradable materials. One such biodegradable material is PLA (polylactic acid), which is used in agriculture for biodegradable films, for disposable items and in medicine as suture material.

Economic potential and innovative edge

The development of new business models (chemical leasing, take-back services) can tap into additional sources of revenue. Investments in recycling and processing technologies (e.g. chemical recycling of plastics, solvent recycling) are also beneficial for promoting a circular economy and thereby generating competitive advantages. Such companies strengthen their position vis-à-vis less sustainable competitors.

Sustainability goals and social responsibility

The Paris Agreement and the UN Sustainable Development Goals (e.g. SDG 12: “Responsible consumption and production”) set clear framework conditions for greater sustainability. By switching to circular systems, the chemical industry actively contributes to global decarbonisation. In addition, companies that focus on sustainability improve their corporate image.

Security of supply in geopolitically uncertain times

Political crises, trade conflicts and unstable supply chains (e.g. for rare earths or critical metals) jeopardise continuous production. Companies that focus on recycling reduce their dependence on imports. In general, a well-functioning circular economy increases industrial resilience.

More efficient use of energy

Using material cycles avoids energy-intensive new production. The energy required to manufacture the monomers for plastics and then produce the plastic itself is significantly greater than the energy needed to reshape a thermoplastic into a new form. Thus, reduced energy consumption, combined with material savings, improves energy efficiency per product unit.

Recycling without compromising quality

Using single-type plastics makes it easier to recycle them after cleaning the waste. In addition, chemical or molecular recycling can be used to extract the monomers, which can then be used to produce new high-quality plastic. This has the same quality as plastic produced from primary raw materials. This enables excellent material reuse without any loss of quality (upcycling). Otherwise, the plastic waste would be processed into inferior mixed plastics for use in building panels, filling material for car seats, garden furniture or plastic pallets, for example (downcycling).

Promotion of regional material flows

Recycling goods or “waste” locally avoids long transport routes and reduces global supply dependency. This strengthens regional economic cycles and sustainable industrial parks (“industrial symbiosis”).

Better recyclability through product design

Once the circular economy has been established, design for recycling is promoted. This means that products are designed and engineered for reusability and reparability from the outset. Not only does this reduce costs for consumers, as the products are easier to repair, it also lowers subsequent disposal costs, as the products can be more easily dismantled into their individual components, allowing greater and more efficient recovery of materials and raw materials.

Knowledge and technology transfer

A company that invests early in the circular economy and sets up its processes accordingly benefits from this know-how. This know-how enables the company to take on a leading role and market this expertise in other markets, for example abroad.

Technological progress through the recycling of valuable materials

Gold and rare earths used in electronics can be recovered through closed material cycles. These materials can then be reprocessed into new products (e.g. gold for jewellery or lithium for electric car batteries). This is particularly important because mining such rare materials damages the environment.

STEP 3: Comparison of linear and circular economies

The teacher gives the students the following assignment:
“Compare the linear economy with the circular economy!”

Note: Depending on the methodology, give the students a certain amount of time to complete the task, e.g. 10 minutes.

(Show possible answers; see Appendix 4.)

STEP 4: Summary

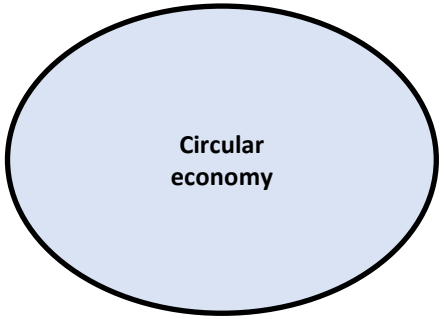
Finally, let's do a quiz to reinforce what we have discussed.

(Show Appendix 5 – the answers can be found at the end of the appendix)

APPENDIX 1

Example: Brainstorming on the circular economy

- Resource conservation
- Waste prevention
- Recycling
- Reuse
- Repair instead of throwing items away
- Extending product life
- *Design for recycling*
- *Sharing economy* (sharing instead of buying)
- Cradle-to-cradle principle (closed loop)
- Secondary raw materials
- Ecodesign
- Industrial symbiosis
- Waste as a resource
- Environmentally friendly materials
- Biological cycles
- Technological cycles
- Product responsibility+
- Take-back obligation
- Reuse concept



- *Zero waste*
- Closed-loop systems
- Energy saving
- CO_2 reduction
- Sustainable supply chains
- Recyclable packaging
- *Upcycling* vs. *downcycling*
- Legal requirements
- Responsibility of politics, business and society
- Promotion of innovation
- New economic opportunities
- Decoupling growth from resource consumption
- Reusable products / deposit systems
- Sustainable production
- Promoting reparability
- Rental models instead of purchasing
- Educational initiatives on the circular economy
- Modular construction
- Standardisation to promote the circular economy

APPENDIX 2

The *circular economy* is a sustainable economic system that aims to use resources as efficiently as possible, avoid waste and keep materials and products in use for as long as possible through reuse, repair, refurbishment and recycling.

Three basic principles:

1. *Reduce*
Avoiding or reducing resource consumption and waste generation even before a product is manufactured or used.
The aim is to use fewer raw materials, save energy and reduce the amount of packaging material.

2. Reuse
Products or components are used multiple times without being significantly altered or processed.
The aim is to extend the useful life of products and avoid waste.

3. *Recycling*
Materials are processed after use and returned to the production cycle.
The aim is to recover valuable materials and reduce the use of primary raw materials.

APPENDIX 3 Why greater energy efficiency?

Reasons for a more circular economy in the chemical industry

Raw material security & efficiency
The use of secondary raw materials reduces dependence on oil and natural gas. The efficient use of materials also reduces by-products.

Waste & emission reduction
Toxic waste streams, solvents and catalysts are recycled. Closed cycles also prevent the release of hazardous substances into the environment.

Political guidelines
EU strategies (REACH, Circular Economy Action Plan) require and promote recycled plastics and other materials, i.e. recyclates. There is also a requirement to use recycled or biodegradable plastics.

Economy & innovation
New business models (chemical leasing and take-back services) bring innovations that reduce the amount of waste that needs to be disposed of. Furthermore, recycling technologies create competitive advantages.

Resilience & costs
A circular economy ensures a crisis-proof supply and lower import risks. In addition, costs are reduced as costly primary production is minimised.

APPENDIX 3 Why greater energy efficiency?

Reasons for more circular economy in the chemical industry

Design & quality
Design for recycling promotes repairability and the reuse or recycling of individual components.
Pyrolysis and molecular recycling ensure new product quality

Regionality & symbiosis
Local recycling shortens transport routes.
Industrial symbiosis (sustainable cooperation between several companies) strengthens regional economic cycles

Knowledge and technology transfer
Early investment in the circular economy provides companies with valuable know-how.
This can be marketed internationally and strengthens the company's leading role.

Technological progress through the recycling of valuable materials
Valuable materials such as gold or rare earths (e.g. from electronics) can be recovered and reused.
This conserves resources and avoids environmentally harmful mining.

Comparison of the linear economy with the circular economy

Similarities:

Profit generation as a goal of companies

Use of industrial infrastructure for production

Use of modern technologies

Compliance with legal regulations

Management of resources and costs

Development of new products, including further development and innovation

Focus on customer needs and the market

Differences:

Aspect	Linear economy	Circular economy
Raw material use	*Take* ➔ *Make* ➔ *Waste* = Single use of new primary raw materials	Resources remain in the cycle: reuse, recycling, recovery
Resource efficiency	Low: High losses, lots of waste	High: Optimised use of materials, by-products become raw materials
Waste generation	Large amounts of waste, mostly sent to landfill or incinerated	Waste = resource ➔ Return to the cycle
Energy consumption	High primary energy requirement for new production	Energy savings through the use of secondary raw materials and waste heat
Cost structure	Rising costs due to raw material scarcity and disposal	Lower costs in the long term thanks to closed material cycles
Pressure to innovate	Little incentive for further development	Strong incentive for new recycling and processing technologies

APPENDIX 4 Comparison of linear and circular economies

Aspect	Linear economy	Circular economy
Business models	Focus on product sales	Services, take-back (e.g. *chemical leasing*, *refill*), *pay-per-use*
Environmental impact	High emissions, environmental damage from extraction and disposal	Lower emissions, protection of ecosystems through reduced mining
Dependence on raw materials	Highly dependent on imports of fossil raw materials	Less dependence thanks to secondary raw materials and regional cycles
Resilience in crises	Low: supply chain disruptions lead to bottlenecks	High: Local material flows and storage cycles keep production running
Product design	Often not designed for recycling	*Design for recycling*: separability, repairability and reusability of products

APPENDIX 4 Comparison of linear and circular economies

Aspect	Linear economy	Circular economy
Legal requirements	Responds to regulations	Proactive implementation of EU targets (e.g. *Circular Economy Action Plan*, *REACH*)
Image & market position	Risk of an "unsustainable" image	Competitive advantage through CSR (*corporate social responsibility)*, *green chemistry* and thus a positive image
Value creation potential	One-off value creation	Multiple use increases the total value of a material
Technological progress	Low pressure to innovate	High investment in molecular recycling, biocatalysis, membranes, etc.
Economic relations	Global supply chains, high transport costs	Local recycling and industrial symbiosis strengthen the regional economy and reduce the carbon footprint
Social responsibility	Focus on short-term profit	Alignment with the UN SDGs (e.g. SDG 12), Paris Agreement, holistic sustainability management

APPENDIX 5

Quiz

1. What is the main objective of the circular economy?
A) Maximising energy consumption
B) Extending product life cycles and minimising waste
C) Single use of raw materials
D) Promoting waste incineration

2. Which term describes the material recovery of recyclable materials after use?
A) Downcycling
B) Landfilling
C) Recycling
D) Incineration

3. What is meant by "*design for recycling*"?
A) Designing products so that they can be easily dismantled and recycled
B) Manufacturing products so that they are inexpensive
C) Designing products for single use only
D) Decorating products as artistically as possible

4. Which technology enables the recovery of monomers from plastics?
A) Mechanical shredding
B) Chemical (molecular) recycling
C) Thermal combustion
D) Biological composting

Quiz

5. What is the term used to describe the "refinement" of waste into products with a higher value?
A) Landfilling
B) Decomposition
C) Downcycling
D) Upcycling

6. What is a secondary raw material?
A) A newly extracted raw material
B) A recycled material that has been reintroduced into production
C) A particularly rare raw material
D) A fossil fuel

7. One advantage of recovering materials from electronic waste (e.g. rare earths) is:
A) Increased CO_2 emissions
B) Conservation of natural raw material deposits
C) Higher energy consumption than new production
D) Complete landfill disposal

Quiz

8. Which model describes the shared use of goods rather than ownership?
A) Linear economy
B) Monopoly economy
C) Fossil economy
D) Sharing economy

9. What is meant by "downcycling"?
A) Upcycling waste into higher-value products
B) Unchanged reuse
C) Recycling into products with lower material value
D) Biological decomposition

10. Which of the following measures is NOT part of the circular economy?
A) Landfilling without pre-treatment
B) Reprocessing of solvents
C) Reusable packaging
D) Development of recyclable products

SOLUTIONS TO THE TASKS

1st question: **B**

2nd question: **C**

3rd question: **A**

4th question: **B**

5th question: **D**

6th question: **B**

7th question: **B**

8th question: **D**

9th question: **C**

10th question: **A**

SOURCES

- https://www.covestro.com/de/sustainability/what-drives-us/circular-economy
- https://www.vci.de/vci-online/themen/chemikaliensicherheit/eu-chemikalienstrategie/eu-chemicals-strategy-for-sustainability-vci-position.jsp
- https://www.bmz.de/de/agenda-2030/sdg-12
- https://www.umweltbundesamt.de/themen/chemikalien/chemikalien-management/nachhaltige-chemie/chemikalienleasing-portaleinstieg#undefined
- https://www.bmuv.de/themen/kreislaufwirtschaft/kreislaufwirtschaftsstrategie
- https://www.europarl.europa.eu/RegData/etudes/BRIE/2016/573899/EPRS_BRI(2016)573899_EN.pdf

Developed by:

Kay Huber,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



2.43. TITLE: Biodegradable plastics

PROCEDURE:

Steps	Time
Step 1: Input: What are biodegradable plastics and where are they already being used today?	10 min
Step 2: Research: What are the current problems with biodegradable plastics?	10 min
Step 3: Dialogue: Evaluation of the research and discussion	20 min
Step 4: Summary	5 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What biodegradable plastics are • Where are biodegradable plastics used?	• Critically discuss the use and handling of biodegradable plastics • Explain the advantages and disadvantages of biodegradable plastics	• The potential of biodegradable plastics • Limitations of biodegradable plastics



Number of participants: Minimum 6



Planned time: 45 min



Materials required: Blackboard or whiteboard, chalk or pens, laptop, projector



Comments: From approximately halfway through the training

STEP 1 Input: What are biodegradable plastics and where are they already being used today?

1. Question: What do you understand by biodegradable plastics?

- The teacher asks the students what they understand by biodegradable plastics and collects the answers on the board or digitally using survey software.

2. Input: Biodegradable plastics

- Biodegradable plastics are plastics that decompose under certain conditions (temperature, microorganisms, UV light and moisture) and mainly leave behind carbon dioxide and water when they break down.
- These must be distinguished from bio-based plastics, which are made from biogenic raw materials (e.g. corn or sugar cane). The term *bio-based* therefore does not indicate whether the plastics are also biodegradable.
- Overall, however, bio-based plastics can also be biodegradable, and biodegradable plastics can also be bio-based.
- Typical plastics include PLA (polylactide, made from corn or sugar cane), PHA (polyhydroxyalkanoates, produced bacterially from sugar or fats), PBS (polybutylene succinate, petrochemical or bio-based), starch-based plastics (e.g. from potatoes) and cellulose derivatives (from wood or cotton).
- These are usually hydrophilic (water-loving) polymers that promote microbial degradation through water absorption. The compounds are often sensitive to hydrolysis and can be broken down by enzymes.
- .

3. Input: Use of biodegradable substances

- Packaging (PLA, PHA, starch-based plastics)
- Disposable tableware (PLA)
- 3D printing (PLA)
- Medical devices (PHA)
- Films (PBS, cellulose derivatives)
- Rubbish bags (starch-based plastics)
- Hygiene products (cellulose derivatives)

4. Input: Images of biodegradable polymers

Show Appendix 1

STEP 2 Research: What are the current problems with biodegradable plastics?

1. Research tasks:

The teacher sets the following research task (10 minutes; well suited to group work in pairs or groups of three):

What are the current problems associated with biodegradable plastics?

1. Research results

Brief presentation of the results by the students/groups; if there are many groups or large class sizes, it is advisable to use survey software to collect the results.

Comparison with Appendix 2

2. Key questions for discussion

What properties are desired in biodegradable plastics?
What needs to happen for biodegradable plastics to completely replace conventional plastics?
What advantages do biodegradable plastics already offer today?

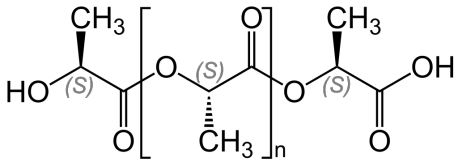
Comparison with Appendix 3.

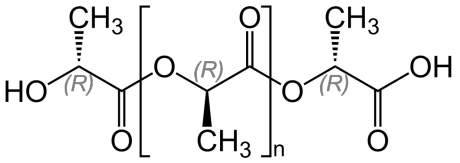
STEP 4 Summary

What have we learnt today?

- Bio-based and biodegradable refer to different properties.
- Biodegradable plastics need special conditions to decompose, which do not usually occur in nature.
- Biodegradable plastics are currently used primarily for packaging and in medicine.
- Currently, there are few advantages to this group of materials due to a lack of adaptation in waste disposal and value chains.
- It can be very difficult to combine the properties that biodegradable plastics are expected to deliver in a single material (e.g. resilience and good decomposition).
- If the many problems can be overcome, the problem of microplastics could be reduced.

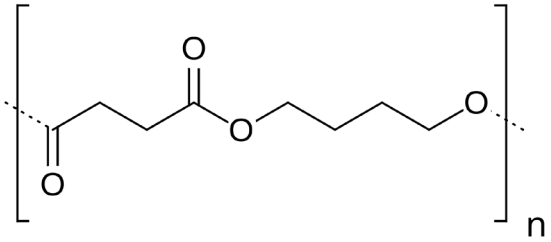
Images of biodegradable polymers and basic structures





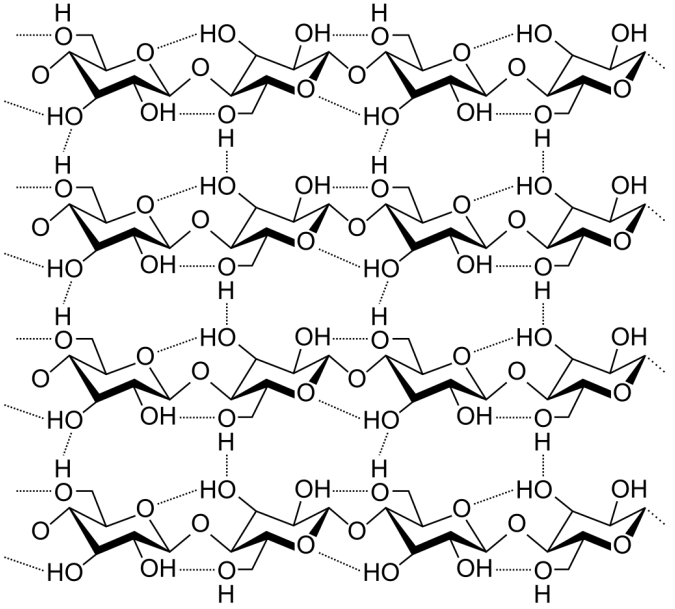
PLA

(S)-lactic acid (top)
(R)-lactic acid (bottom)

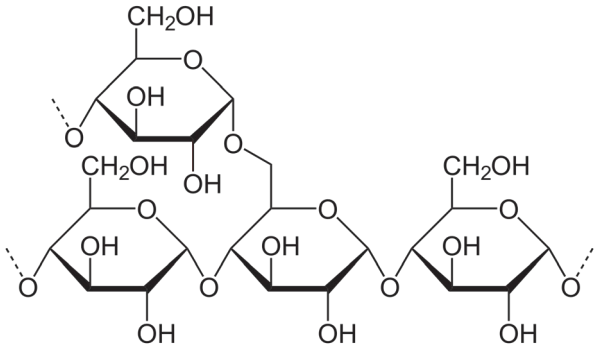


PBS

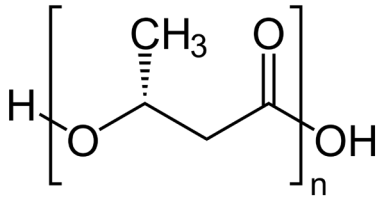
Polybutylene succinate



Cellulose



Starch



PHA

Polyhydroxyalkanoates

APPENDIX 2

Problems with biodegradable plastics

- The conditions under which plastics can biodegrade are often very specific.
- These include high temperatures, humidity, UV light and microorganisms.
- Due to the relatively mild conditions found in nature, microplastics may be formed instead of complete degradation.
- The disposal of plastics labelled as biodegradable is often confusing for consumers.
- These plastics often belong neither in the organic waste bin nor in the recycling bin.
- They are often more expensive to manufacture than conventional plastics.
- Separating conventional plastics from biodegradable plastics remains problematic (and in some cases even impossible) during the waste processing process.
- This means that other plastics are affected during the recycling process.
- Special organic waste bags may be disposed of in organic waste if they are labelled with the seedling symbol; however, composting plants are often not yet technically equipped to handle organic waste bags.
- There is an incompatibility between the rapid degradation of materials and their application in areas with high mechanical or chemical stress (weight, moisture, air).

APPENDIX 3

Key questions for discussion

What properties are desirable in biodegradable plastics?

- High mechanical strength
- Decomposition under natural conditions (e.g. seawater, soil)
- Cost-effective
- Made from renewable raw materials
- Energy efficiency

What needs to happen for biodegradable plastics to completely replace conventional plastics?

- Functional and optimised plastics must be found that have the above-mentioned properties.
- Materials must be adapted for different fields of application.
- A value chain and waste processing system adapted to this group of materials is absolutely essential.

What advantages do biodegradable plastics already offer today?

- As the value chains, waste processing and recycling are not yet adapted to this class of materials, there are currently no real advantages to biodegradable plastics in everyday life.
- Only in special fields of application such as medicine are there possible uses as slowly dissolving materials.
    - Sutures and "replacement parts" can be used in surgeries that decompose at a similar rate to that at which the body regenerates tissue and similar materials.

SOURCES

- https://www.umweltbundesamt.de/biobasierte-biologisch-abbaubare-kunststoffe
- https://www.wwf.de/themen-projekte/landwirtschaft/bioenergie/bioplastik
- https://specialty-polymer.com/de/biodegradable-compared-pha-phb-pbat-pla-pbs-pcl-and-tps/
- https://tappwater.co/de/blogs/blog/biodegradable-plastics-bioplastics
- https://www.quarks.de/umwelt/muell/darum-hat-biologisch-abbaubares-plastik-keine-vorteile/

- Image sources Appendix 1:
  - https://de.wikipedia.org/wiki/Polylactide
  - https://de.wikipedia.org/wiki/Polyhydroxyalkanoate
  - https://de.wikipedia.org/wiki/Polybutylensuccinat
  - https://de.wikipedia.org/wiki/St%C3%A4rke

Developed by:

Christopher Peschel,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



2.44. TITLE: Fundamentals of Organic Photovoltaics

PROCEDURE:

Steps	Time
Step 1. Input: How organic photovoltaics (OPV) work and comparison with silicon-based photovoltaics	15 min
Step 2. Research: Structural characteristics of molecules and molecular-level processes in OPV	15 min
Step 3. Dialogue: What are the advantages and disadvantages of OPV?	10 min
Step 4. Summary	5 min

OBJECTIVES:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• Which light-absorbing molecules are used for OPV • The advantages and disadvantages of OPV	• Explain how OPV works, how it is constructed, and what mechanisms take place at the molecular level	• What improvements need to be made to OPV in order to replace silicon-based PV



Number of participants: Minimum 6



Planned time: 45 min



Materials required: Blackboard or whiteboard, chalk or pens, laptop or tablets, projector



Remarks: From approximately halfway through the training

STEP 1 Input: How organic photovoltaics (OPV) work and comparison with silicon-based photovoltaics

1. Question: What is organic photovoltaics?

The teacher asks the students what they understand organic photovoltaics to be and collects their answers on the board or digitally using survey software.

These are revisited after the introduction. The students are made aware of this.

2. Input: Basic principle of organic photovoltaics

Show Appendix 1

- Excitation of the dye by light
- Release of 2 electrons (2 dye molecules, one electron per molecule) from the excited state of the dye molecules to titanium dioxide, leaving two positively charged dye cations
- Transfer of electrons to the anode (tin oxide, transparent)
- On the opposite side (cathode), electrons flow from the tin oxide cathode via the catalyst layer of graphite and platinum to the electrolyte
- In the electrolyte (iodine and potassium iodide), the electrons cause a transition to triiodide ions, which revert to molecular iodine by releasing two electrons

3. Input: Comparison with silicon-based photovoltaics?

See Appendix 2

- The silicon-based solar cell is composed of an n-doped layer (phosphorus) and a p-doped layer (boron).
- The phosphorus atoms provide freely moving electrons . In contrast, the boron atoms create freely moving electron vacancies (holes).
- Electrons are exchanged at the interface between the two layers, filling the holes with electrons. The resulting neutral boundary layer separates the layers.
- When sunlight reaches the boundary layer, the electrons are mobilised again and flow back into the n-doped layer.
- If both layers are electrically conductive, the mobilised electrons migrate via the contacts into the p-doped layer to restore the initial state.
- The current generated in this process can be utilised.

4. Comparison of ideas about OPV and explanation

The teacher addresses the answers given by the students in 1.

STEP 2 Research: Structural characteristics of the molecules and what happens at the molecular level in OPV?

1. Research tasks:

Show Appendix 3 and leave it open for the entire duration of the research.

Point out that these molecules usually have very complex names that are rarely used. They are almost exclusively referred to by their abbreviated names.

The teacher sets the following tasks/questions for the research (well suited for group work, 2 to 3 people together):

- What do these molecules have in common in terms of their structure?
- What happens at the molecular level when light hits these molecules?

2. Research results

Brief presentation of the results by the students/groups; if there are many groups/a large class size, survey software can be used to collect the results.

Comparison with the overview in Appendix 4

What are the advantages and disadvantages of OPV?

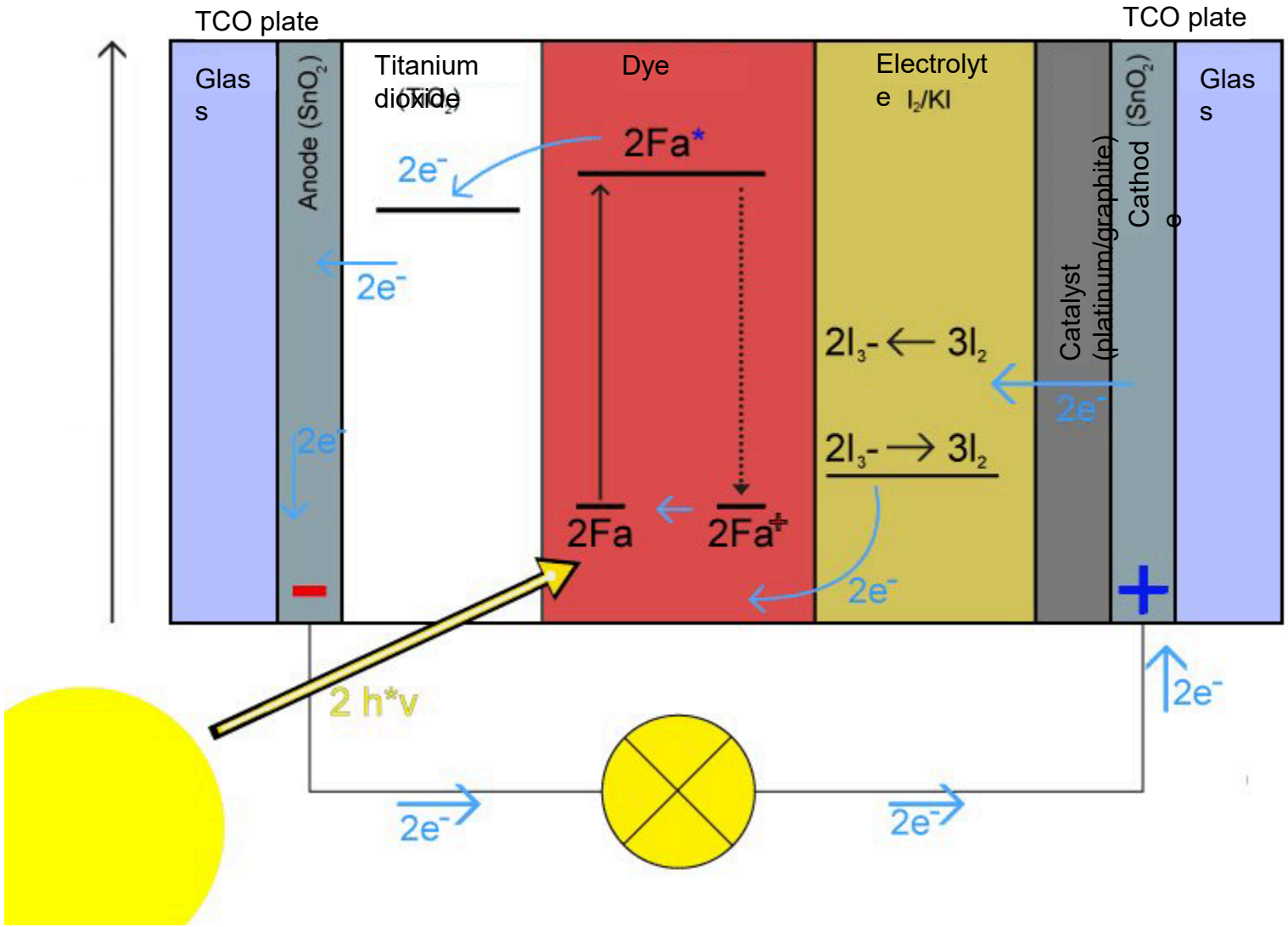
The teacher asks the students what advantages and disadvantages they see in using OPV and collects the answers on the board or digitally using survey software.

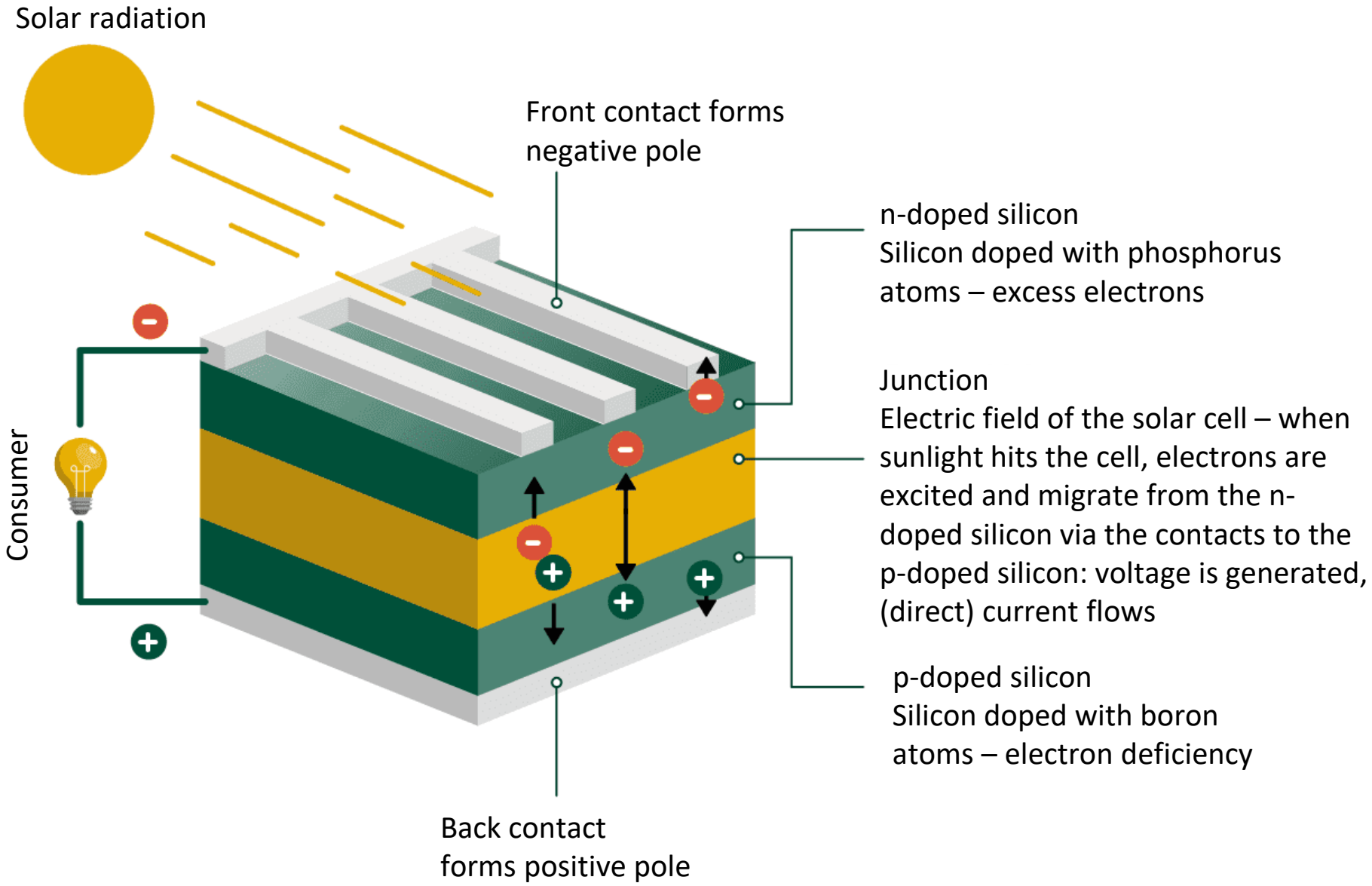
The teacher compares the collected results with Appendix 5.

STEP 4 Summary

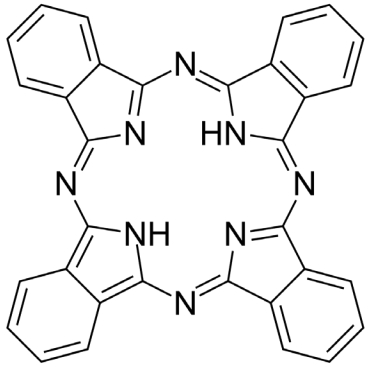
What have we learnt today?

- Photovoltaics generate electrical current from (sun)light.
- In OPV, a dye takes on the function of (doped) silicon.
- Additional layers are used to transport electrons and regenerate the dye.
- The molecules used in OPV to capture light have a large conjugated π electron system and very often contain the heteroatoms sulphur and nitrogen.
- The incident light excites a HOMO-LUMO transition. In the excited state, the dyes release their electrons particularly easily.
- In addition to the many advantages of OPV, such as low material consumption, more environmentally friendly production and flexible application possibilities, its low efficiency and shorter service life remain significant challenges that must be overcome before widespread use becomes possible.

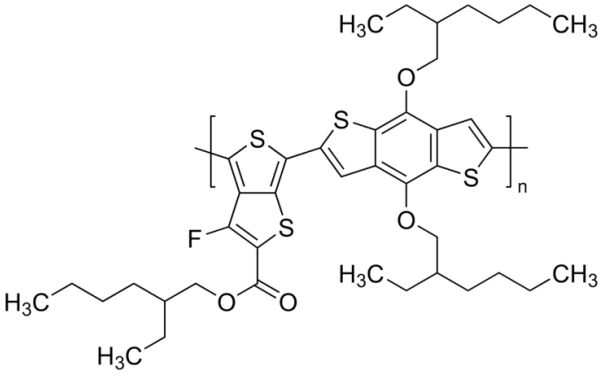

TCO plate
TCO plate
Glas s
Anode (SnO_2)
Titanium dioxide (TiO_2)
Dye
Electrolyte I_2/KI
Catalyst (platinum/graphite)
Cathod (SnO_2)
Glas s
2Fa*
2e-
2e-
2e-
2e-
2e-
2e-
2e-
$2I_3$- ← $3I_2$
$2I_3$- → $3I_2$
2Fa
$2Fa^+$
2 h*v


Solar radiation
Front contact forms negative pole
n-doped silicon
Silicon doped with phosphorus atoms – excess electrons
Junction
Electric field of the solar cell – when sunlight hits the cell, electrons are excited and migrate from the n-doped silicon via the contacts to the p-doped silicon: voltage is generated, (direct) current flows
p-doped silicon
Silicon doped with boron atoms – electron deficiency
Consumer
Back contact forms positive pole

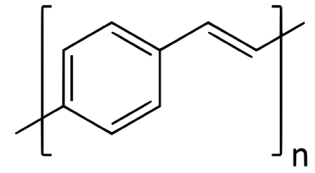
Molecules for OPV:



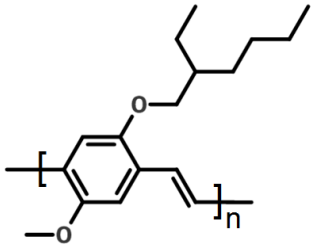
Phthalocyanines



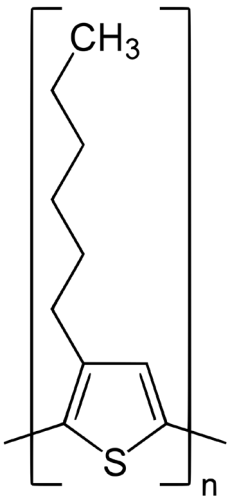
PTB7



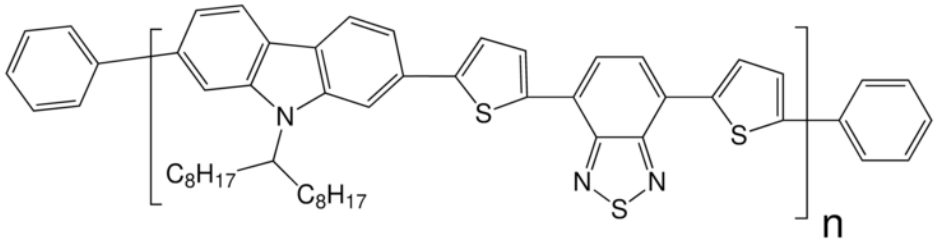
PPV



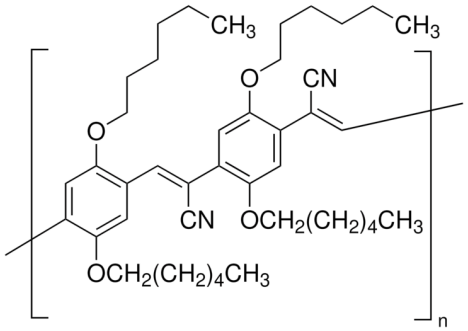
MEH-PPV



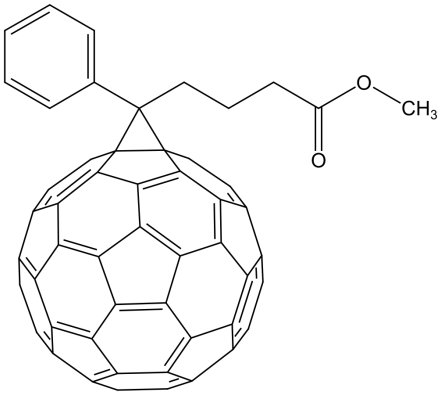
P3HT



PCDTBT



CN-PPV



PCBM

[6,6]-Phenyl-C61butyric acid methyl ester

Possible research results:

2. Similarities in molecular structure

- Large π electron system (conjugated electrons)
- Often contain heteroatoms (S and N)
- Usually complex structures

3. What happens at the molecular level when light hits the molecules?

- Absorption of light by the π electron system
- Due to the size of the π electron system, there are many possibilities for absorbing light of different wavelengths (energy gaps between energy levels match a wide range of wavelengths)
- Excitation of electrons from the HOMO (highest occupied orbital/energy level) to the LUMO (lowest unoccupied orbital/energy level)
- Transport of (excited) electrons along the π electron system
- Transfer of electrons to an adjacent layer
- "Regeneration" of the molecule, the introduction of the missing electrons (filling the holes) from outside
- A limited number of excitation processes (lifetime of the dye) leads to the decay of the dye (side reactions, decay reactions)

APPENDIX 5

The teacher asks the students what advantages and disadvantages they see in the use of OPV.

Advantages of OPV:

- Energy-efficient and therefore cost-effective production
- Very low material requirements
- Low weight and therefore suitability for lightweight halls
- Flexible structure ensures break resistance
- Easy to stick on and therefore low installation costs
- Good low-light performance thanks to a broad light spectrum
- Visually unobtrusive due to transparency
- Free choice of installation surface thanks to its flexible structure
- Environmentally friendly, as the strict requirements of the EU Directive 2002/95/EC (RoHS) prevent the use of hazardous substances
- Transparency allows use on glass surfaces

Disadvantages of OPV:

- Low efficiency means that a large surface area is required. This is the only way to make organic solar film profitable.
- Sunlight decomposes many of the organic compounds tested to date. Stability is therefore still too low.

SOURCES

- https://www.chemie-experimente.com/experimenteliste/herstellung-einer-farbstoffsolarzelle
- https://www.solaranlage.de/technik/solarzellen/
- https://www.youtube.com/watch?v=qrnacVPlhGk
- https://www.solaranlage-ratgeber.de/photovoltaik/photovoltaik-technik/organische-solarzellen
- https://www.ise.fraunhofer.de/de/geschaeftsfelder/photovoltaik-materialien-zellen-und-module/organische-photovoltaik.html
- https://chemiedidaktik.uni-wuppertal.de/fileadmin/Chemie/chemiedidaktik/files/publications/pdn_1_64_2015-opv.pdf
- https://www.energieforschung.de/de/aktuelles/projekteinblicke/2020/organische-solarzellen-schuetzen-wasserreservoire

- Image source Appendix 1: https://www.chemie-experimente.com/experimenteliste/herstellung-einer-farbstoffsolarzelle
- Image source Appendix 2: https://www.solaranlage.de/technik/solarzellen/
- Image sources Appendix 3:
  - https://de.wikipedia.org/wiki/Poly(3-hexylthiophen-2,5-diyl)
  - https://de.wikipedia.org/wiki/PCBM
  - https://www.sigmaaldrich.com/DE/de/product/aldrich/772410?srsltid=AfmBOopQTG0DUybqKicl0kNpNFa4H0Nz1QgccGlBTrzY45FykPK4OxP9
  - https://de.wikipedia.org/wiki/Phthalocyanin
  - https://en.wikipedia.org/wiki/Poly(p-phenylene_vinylene)
  - https://www.sigmaaldrich.com/DE/de/product/aldrich/646652?srsltid=AfmBOoqtezBI26FVtnV5MD9jC-3rBm-xfIL9_GQX58BAvrA-NvOKcgwz
  - https://www.sigmaaldrich.com/DE/de/product/aldrich/753998?srsltid=AfmBOoqNwvM0Pc_x4c67yEkNb1Mm1DzdWD61aBKfzyNEibJ9YBAqF2SB

Developed by:

Christopher Peschel,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



2.45. TITLE: Biotechnological processes

PROCEDURE:

Steps	Time
Step 1. What are biotechnological processes?	5 min
Step 2. Advantages of biotechnological processes	10 min
Step 3. Examples of biotechnological processes	20 min
Step 4. Summary	10 min



Number of participants: Min. 6



Planned time: 45 min



Materials required: Blackboard or whiteboard, chalk or pens, laptop, projector



Comments: Note the optional experiment setup in Appendix 5 and prepare it if necessary.

OBJECTIVES:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• What are biotechnological processes? • The advantages of biotechnological processes	• Give examples of biotechnological processes	• The need to use biotechnological processes in the production of certain substances.

Click to see movie

STEP 1: What are biotechnological processes?

1. Question: What do you understand by biotechnological processes?

The teacher introduces the topic of "biotechnological processes" and asks: "What do you understand by biotechnological processes?"

The teacher presents the definition of biotechnological processes.

Explanation:

Biotechnological processes use living organisms (e.g. bacteria, yeasts, fungi) or their components (e.g. enzymes) to manufacture products or carry out processes.
➔ Example: the production of medicines, bioplastics or bioethanol with the help of microorganisms.

2nd question: How are fermentation, enzymatics and biocatalysis defined in this context?

The teacher asks: "How are fermentation, enzymatics and biocatalysis defined?" (see Appendix 1).

Explanation:

Fermentation
Fermentation is a biotechnological process in which microorganisms break down or convert substances – usually without oxygen (*anaerobically*).
Example: Yeast converts sugar into alcohol and CO_2 (e.g. in beer or wine production).

Enzymatics
Enzymatics is the use of enzymes (biological catalysts) to specifically control or accelerate chemical reactions.
Example: Enzymes in detergents dissolve grease stains, or enzymes are used in cheese production.

Biocatalysis
Biocatalysis is the targeted use of enzymes or microorganisms to carry out chemical reactions more efficiently, in a more environmentally friendly way, and often with lower energy consumption.
Example: An enzyme serves as a chemical catalyst in industry, for example, in the manufacture of medicines.

STEP 2: Advantages of biotechnological processes

1. Question: What are the advantages of biotechnological processes?

The teacher asks: "What are the advantages of biotechnological processes?"

(Possible answers for brainstorming, see Appendix 2)

STEP 3 Examples of biotechnological processes

1. Question: What are some examples of biotechnological production?

The teacher explains which important substances are produced biotechnologically in certain processes (abridged, see Appendix 3).

Explanation: "**Biotechnological processes"**

Bioethanol:
In 2024, approximately 89 million tonnes of bioethanol were produced worldwide. In comparison, only about 2%, or 1.2 million tonnes, were produced from petroleum. In the synthesis from petroleum, ethylene is produced by cracking hydrocarbons. Water is added to this ethylene in an acid-catalysed reaction. Bioethanol, which accounts for approximately 98% of production, is produced through fermentation. In an anaerobic environment, sugar is converted into ethanol and carbon dioxide by yeast fungi, the *Saccharomyces cerevisiae*.

Glucose ➔ Ethanol + Carbon dioxide ("Glucose reacts to form ethanol and carbon dioxide.")

First-generation raw materials are used for bioethanol production. The problem with this production method is that it uses carbohydrates derived from foodstuffs. Such sugary foods include sugar beet, sugar cane, sorghum, but also molasses (a by-product of sugar production) and fruit. These sugar sources are very popular for the production of bioethanol, as the sugars they contain can be fermented directly into bioethanol. Other sources of sugar include starchy plants such as potatoes, manioc and cereals such as wheat, rye, barley, maize, rice, etc. The problem with using these starchy plants is that the starch in them must first be broken down. Starch-degrading enzymes, amylases, are used for this purpose because they are not present in yeast cells.
Second-generation raw materials are cellulose-containing raw materials. These are particularly interesting because their use does not compete with food production. Such cellulose-containing raw materials include straw, wood or wood residues, bamboo, etc. However, the problem is that the raw material lignocellulose contains not only cellulose but also hemicellulose and lignin. This lignocellulose must first be broken down into fermentable sugars using acids, bases or enzymes. On the other hand, the pre-treatment produces inhibitors that inhibit the activity of the yeast cells. This can go so far that no fermentation takes place. Therefore, these inhibitors must be separated beforehand using certain process engineering steps.
Third-generation raw materials are the latest generation. Here, algae (microalgae and macroalgae) are used, which form polysaccharides very efficiently through photosynthesis. This means that a large amount of biomass is formed in a short time. At the same time, a large amount of carbon dioxide is absorbed from the atmosphere.

Finally, bioethanol is purified by distillation for further use.

Vanillin:

Vanillin is the main flavouring agent in vanilla pods and is used worldwide in food, cosmetics and perfumes. Vanillin occurs naturally in the fermented pods of the tropical orchid *Vanilla planifolia*, which is mainly cultivated in Madagascar, Indonesia and Mexico. The production of real vanilla is complex. Hand pollination, months of ripening and fermentation are necessary to develop the aroma. Natural vanilla contains only about 1–2% vanillin and covers less than 1% of global demand.

Global demand for vanillin is around **20,000 tonnes per year**, while only about **40 tonnes** can be obtained from natural vanilla. The majority is therefore produced synthetically or biotechnologically.

In biotechnological production, microorganisms such as bacteria or yeasts use renewable raw materials (e.g. ferulic acid, eugenol) to convert them into vanillin. Genetically engineered organisms can also be used to obtain vanillin directly from sugars.

Acetic acid:

Acetic acid (CH_3COOH) is an important organic compound with a wide range of applications in the food, chemical and pharmaceutical industries. Global production amounts to around 18.7 million tonnes per year.
The majority of production is carried out using purely chemical methods. However, some is also produced biotechnologically. In this process, acetic acid is produced by the oxidation of ethanol using acetic acid bacteria of the genera *Acetobacter* and *Gluconobacter*. In this process, ethanol is oxidised to acetic acid in two steps:

1 .Ethanol + ½ O_2 → Acetaldehyde
2. Acetaldehyde + ½ O_2 → Acetic acid

Of the total acetic acid production, approximately 190,000 tonnes are produced annually by fermentation. Acetic acid is mainly produced using biotechnological processes, particularly for the food industry.

Biobutanol:

Biobutanol is an alcohol with four carbon atoms that is considered a promising biofuel. Compared to bioethanol, it offers advantages such as higher energy density, lower hygroscopicity and better compatibility. Biobutanol can be used as an additive to petrol or even as a pure fuel.
The most common method for producing biobutanol is acetone-butanol-ethanol (ABE) fermentation. In this process, anaerobic bacteria, in particular *Clostridium acetobutylicum*, convert carbohydrates from biomass into a solvent mixture that typically consists of about 60% butanol, 30% acetone and 10% ethanol. Substrates include sugar, starch and lignocellulosic materials such as straw or wood. A major problem with ABE fermentation is the toxicity of butanol to the producing microorganisms, which limits the yield. Modern approaches therefore use genetically engineered strains or alternative microorganisms such as yeasts to increase tolerance to butanol and boost the yield.
Industrial production of biobutanol is still in its infancy. Concentrations of up to 20 g/L are currently being achieved in pilot and demonstration plants. Global production volumes are currently low compared to bioethanol, but a significant increase is expected as biobutanol gains importance as a sustainable alternative to fossil fuels.

Lactic acid:

Lactic acid ($C_3H_6O_3$) is an organic acid that is widely used in the food, cosmetics and pharmaceutical industries and as a starting material for bioplastics such as polylactic acid (PLA).
Lactic acid is mainly produced industrially through fermentation. Lactic acid bacteria such as *Lactobacillus* and *Streptococcus* convert sugar or starch into lactic acid under anaerobic conditions. Depending on the bacterial strain, this produces either the L-(+)- or D-(−)-form of lactic acid, which is important for certain applications. Renewable raw materials such as corn starch, molasses or agricultural residues such as rice bran are often used as substrates.
Around 250,000 tonnes of lactic acid are produced worldwide every year, 70–90% of which is produced by fermentation. Demand is rising steadily, particularly due to the growing market for bio-based plastics.

STEP 3: Examples of biotechnological processes

1,4-butanediol:

1,4-butanediol is a versatile chemical raw material used in the manufacture of plastics (polybutylene terephthalate = PBT) , solvents (tetrahydrofuran = THF) and elastomers. Traditionally, 1,4-BDO is produced petrochemically, but
biotechnological production is becoming increasingly important, especially in the context of sustainable production methods.
The biotechnological production of 1,4-BDO is carried out by metabolically optimised microorganisms, in particular *Escherichia coli*. Through targeted genetic modifications, these microbes can convert sugars such as glucose or sucrose into 1,4-BDO.
Although there is promising research data, industrial implementation is still in the development phase. A key challenge lies in scaling up these processes and ensuring economic competitiveness with petrochemical processes.
Overall, the biotechnological production of 1,4-butanediol offers a sustainable alternative to conventional production.

Aniline:

Aniline is an important chemical compound that is mainly used in the manufacture of polyurethanes, dyes and pharmaceuticals. Aniline is traditionally produced by the catalytic hydrogenation of nitrobenzene, with around 6 million tonnes produced worldwide each year.
As part of its efforts to develop more sustainable production methods, Covestro has teamed up with partners to develop an innovative process for producing aniline entirely from plant-based biomass. This involves converting renewable raw materials such as sugar beet or straw into an aniline precursor through microbiological processes, which is then chemically processed into aniline.
In 2023, the world's first pilot plant for the production of bio-based aniline went into operation at the Leverkusen site. This process enables a reduction in the consumption of fossil raw materials and thus contributes significantly to lowering greenhouse gas emissions.
In conclusion, the biotechnological production of aniline represents a promising step towards a more sustainable chemical industry.

Conclusion:

Biotechnological processes enable the sustainable production of chemicals, food and medicines from renewable raw materials. They are more environmentally friendly than conventional processes because they require less energy, save CO_2 and can often utilise waste materials. Despite challenges in scaling up, they are considered a key technology for a resource-efficient and climate-friendly industry of the future.

Click to see movie

STEP 4: Summary

Finally, let's do a quiz to reinforce what we've discussed.

(Show Appendix 4 – solutions can be found at the end of the appendix)

If time permits, Appendix 5 can now be shown. This describes the experimental setup for the fermentation of bioethanol. The students can either prepare the mash and check the result after 3-5 days, or the teacher can show the result of the fermentation with mash prepared in advance and distillation already carried out.

To check the result, the ethanol content of the distillate can be calculated by measuring the density (hydrometer) or the teacher can demonstrate this by igniting the solution

APPENDIX 1

Definitions:

Biotechnological processes

Biotechnological processes use living organisms, cells or biological systems (e.g. enzymes) to manufacture products or carry out processes – for example in medicine, agriculture, environmental technology or industrial production (e.g. manufacture of antibiotics, biofuels or medicines such as insulin).

Fermentation

Fermentation is a biological process in which microorganisms (e.g. yeasts or bacteria) enzymatically convert organic substances under anaerobic or aerobic conditions. A typical example is the conversion of glucose to ethanol and CO_2 by yeasts.

Biocatalysis

Biocatalysis refers to the use of biological catalysts – usually enzymes or whole cells – to accelerate chemical reactions. It is mainly used in green chemistry and industrial synthesis because it is often more efficient and environmentally friendly than traditional chemical processes.

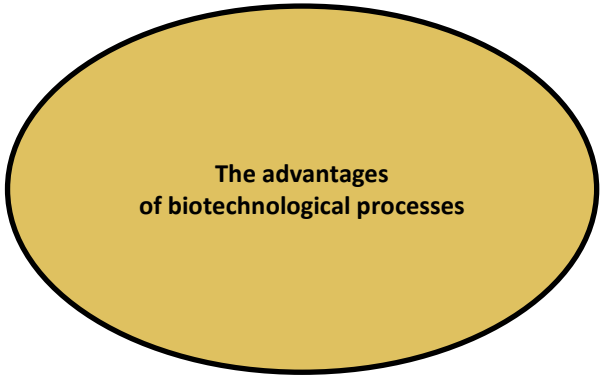
Enzymology

Enzymology is a branch of biochemistry that deals with the structure, function and mode of action of enzymes. It investigates how enzymes enable, regulate and accelerate chemical reactions.

APPENDIX 2

Brainstorming: The advantages of biotechnological processes

- More environmentally friendly, less waste and fewer toxic chemicals
- Reactions at low temperatures
- Lower energy consumption
- Use of renewable raw materials
- Biodegradable products
- Gentle reaction conditions
- Very high specificity
- Very high selectivity
- Very high yields
- Avoidance of hazardous substances
- Process control can be automated
- Sustainable and resource-efficient
- Relatively simple product purification
- Manufacture of medical products (e.g. insulin)
- A wide range of production scales is possible
- Lower CO_2 emissions compared to chemical processes
- Potentially lower wastewater treatment costs



- High acceptance in green markets
- Utilisation of residual materials
- Fewer harmful by-products
- Genetic engineering as an option for targeted product development
- Lower risks when storing raw materials
- Integration into existing facilities
- Highly suitable for sensitive products
- Enables better reusability
  ➔ Better circular economy
- An Innovation driver for other industries
- Modular system design
- Fewer regulatory requirements for green production processes
- - Promotion of regional biomass use
- Sustainable technology within the bioeconomy

Bioethanol

Global production: approx. 89 million tonnes
Breakdown: 2% synthetic vs. 98% biotechnological production
Synthetic production process: Cracking of crude oil → ethylene; ethylene + water in an acid-catalysed reaction → ethanol
Biotechnological process: Fermentation of glucose to ethanol and CO_2 by yeast (*Saccharomyces cerevisiae*) under anaerobic conditions
After fermentation, the bioethanol is purified by distillation

Raw materials:
1st generation: sugar/starch-containing plants (e.g. sugar beet, potatoes); starch is broken down by amylases
2nd generation: cellulose-containing residues such as straw or wood are broken down into fermentable sugars by acid, base or enzyme treatment
Any inhibitors produced in this process must be removed before fermentation
3rd generation: algae grow quickly, produce a lot of biomass and bind large amounts of CO_2
Currently still in the research phase

Vanillin

Main flavouring agent in vanilla pods (*Vanilla planifolia*)
Pods contain 1-2% vanillin → natural sources cover less than 1% of global demand (40 tonnes)
Global consumption: approx. 20,000 tonnes per year → most is produced synthetically or biotechnologically
Microorganisms convert renewable raw materials (e.g. ferulic acid, eugenol) or sugar directly into vanillin

Acetic acid (CH_3COOH)

Annual production: approx. 18.7 million tonnes; around 190,000 tonnes are produced by fermentation
Acetic acid bacteria (*Acetobacter*, *Gluconobacter*) convert ethanol to acetaldehyde and then to acetic acid
The food industry primarily uses biotechnologically produced acetic acid

Biobutanol

Biobutanol (CH_3 -CH_2 -CH_2 -CH_2 OH): higher energy density and lower hygroscopicity than ethanol; can be used as a biofuel
ABE fermentation: anaerobic bacteria (*Clostridium acetobutylicum*) + carbohydrates →
Mixture of approx. 60% n-butanol, 30% acetone, 10% ethanol
Toxicity of butanol limits the yield
Pilot plants achieve concentrations of up to 20 g/L.
Industrial production still in its infancy, growing due to fuel advantages.

Lactic acid

Global production of lactic acid ($C_3H_6O_3$): approx. 250,000 tonnes per year
70–90% is produced through fermentation by lactic acid bacteria (*Lactobacillus*, *Streptococcus*)
These bacteria anaerobically convert sugar or starch into the L-(+)- or D-(–)-form of lactic acid.
Common substrates: corn starch, molasses or agricultural residues (e.g. rice bran).

1,4-butanediol (1,4-BDO)

Important raw material for plastics and solvents. Traditionally produced using petrochemicals
Biotechnologically optimised *Escherichia coli* strains can convert sugar into 1,4-BDO
The process is promising but still in the development stage and needs to become competitive on a large scale.

Aniline

Production: 6 million tonnes/year through hydrogenation of nitrobenzene
New bio-based process: (pilot plant in Leverkusen, 2023)
Biomass (e.g. sugar beet, straw) → microbiologically to aniline precursor → chemically to aniline
The process reduces fossil raw material use and CO_2 emissions.

Conclusion

Biotechnological processes enable the sustainable production of chemicals and fuels from renewable raw materials. They save energy, reduce CO_2 and utilise waste materials, but face challenges such as competition for raw materials, processing and problems with scaling.

APPENDIX 4

Quiz:

1. What are biotechnological processes?
A) Chemical synthesis without the use of organisms
B) Use of living organisms or enzymes to produce useful substances
C) Physical separation processes such as distillation
D) Production of plastics from petroleum products

2. Which microorganism is mainly used for the biotechnological production of ethanol?
A) *Clostridium acetobutylicum*
B) *Lactobacillus*
C) *Saccharomyces cerevisiae*
D) *Acetobacter pasteurianus*

3. Which word equation describes the production of bioethanol?
A) Glucose → acetic acid + hydrogen
B) Glucose → ethanol + water
C) Glucose → ethanol + carbon dioxide
D) Glucose → acetic acid + Water

4. Which raw material belongs to the first generation?
A) Wood residues (e.g. straw)
B) Sugar cane
C) Straw from grain harvest
D) Microalgae

5. What is the problem with using lignocellulosic raw materials?
A) The cellulose must first be broken down, and inhibitors for yeasts are produced.
B) They contain too much sugar, which inhibits fungi
C) Microalgae grow too slowly
D) A high starch content does not require pre-treatment

6. What advantage is attributed to microalgae (third-generation raw materials)?
A) They can be fermented directly into ethanol without digestion
B) They grow slowly and consume little water
C) They naturally contain amylases for starch breakdown
D) They bind a lot of CO_2 and produce a lot of biomass quickly

7. What is a major problem in extracting vanillin from vanilla pods?
A) Vanilla pods contain over 90% vanillin
B) Monocultures grow too quickly and make harvesting difficult
C) Natural vanilla contains only 1–2% vanillin and covers < 1% of global demand
D) Fermentation of vanilla pods leads to the formation of toxic by-products

8. Which genus belongs to the acetic acid bacteria that fermentatively oxidise ethanol to acetic acid?
A) *Acetobacter*
B) *Saccharomyces*
C) *Lactobacillus*
D) *Clostridium*

9. What is the approximate composition of the product mixture from ABE fermentation (butanol fermentation)?
A) 90% butanol, 5% acetone, 5% ethanol
B) 60% butanol, 30% acetone, 10% ethanol
C) 50% ethanol, 25% butanol, 25% acetone
D) 100% pure butanol (no admixture)

10. Which microorganism is typical for lactic acid fermentation from sugar or starch?
A) *Clostridium acetobutylicum*
B) *Escherichia coli*
C) *Lactobacillus*
D) *Acetobacter*

APPENDIX 5

Experimental setup: Fermentation of sucrose to bioethanol

Equipment: 1-litre Erlenmeyer flask (wide neck), fermentation cap, magnetic stirrer with stir bar, distillation apparatus (Liebig condenser), hydrometer/pycnometer

Consumables: 150 g table sugar (sucrose), approx. 800 ml demineralised water, 10 g fresh yeast (optionally 1 packet of dry yeast), 1 g yeast nutrient salt (e.g. ammonium sulphate; optional), barium hydroxide solution (if CO_2 is to be detected)

Procedure: Part 1: Preparing the mash

1. Dissolve 150 g sucrose in approx. 600 ml warm water (30–35 °C) in an Erlenmeyer flask.
2. Add the yeast nutrient salt.
3. Suspend the yeast in a little warm water and add it to the sugar solution.
4. Fill the flask with water to approx. 800 ml.
5. Seal the flask with the fermentation lock and fill it with a little barium hydroxide solution or water.
(The barium hydroxide solution becomes cloudy due to the formation of $BaCO_3$ with CO_2)

Part 2: Fermentation

1. Place the flask in a warm place (25–30°C).
2. Observe the gas development in the fermentation cap over 3 - 5 days.
3. When no more gas bubbles rise, the process is complete.

Part 3: Distillation

1. Filter the mash to remove yeast residues.
2. Perform fractional distillation.
3. Collect the fraction in the boiling range of approx. 78–82 °C.

The ethanol content of the distillate can now be determined using a density measurement (hydrometer/pycnometer). If the content exceeds 40%, the solution is flammable.

SOLUTIONS TO THE EXERCISES IN APPENDIX 4

1**st** question:

2nd question: **C**

3rd question: **C**

4th question: **B**

5th question: **A**

6th question: **D**

7th question: **C**

8th question: **A**

9th question: **B**

10th question: **C**

SOURCES

- https://www.bdbe.de/bioethanol/bioethanol-fakten
- https://www.mordorintelligence.com/de/industry-reports/bio-ethanol-market
- https://pmc.ncbi.nlm.nih.gov/articles/PMC6233010/
  ("*Bioethanol Production from Renewable Raw Materials and Its Separation and Purification: A Review*", Bušić *et.al* in Food Technol Biotechnol., 2018)
- https://www.linkedin.com/pulse/vanillin-global-market-overview-%E6%98%8E%E6%98%8E-%E5%BC%A0-p7e5c
- https://www.mordorintelligence.com/de/industry-reports/acetic-acid-market
- https://straitsresearch.com/de/report/acetic-acid-market
- https://www.researchgate.net/publication/279908533_Biobutanol_-_Production_and_purification_methods
  ("*Biobutanol - Production and purification methods*", Kaminski *et.al. in* Ecological Chemistry and Engineering, 2011)
- https://biooekonomie.de/foerderung/foerderbeispiele/chemiebaustein-milchsaeure-aus-reiskleie-gewinnen
- https://www.mordorintelligence.com/de/industry-reports/1-4-butanediol-market
- https://www.chemie-zeitschrift.at/lexikon/14-butandiol-bdo/
- https://www.cbp.fraunhofer.de/de/referenzprojekte/bioqed.html
- https://www.cec.mpg.de/de/aktuelles/detailansicht/weltweit-erste-pilotanlage-fuer-biobasiertes-anilin-eroeffnet
- https://www.bmwk.de/Redaktion/DE/Dossier/Industrielle-Biooekonomie/Best-Practice-Beispiele/054_Covestro/00-best-practice-beispiel.html
- https://biooekonomie.de/nachrichten/neues-aus-der-biooekonomie/covestro-auf-dem-weg-zum-biobasierten-anilin

Developed by:

Kay Huber,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



2.46. TITLE: Designing the ideal workshop

PROCEDURE:

Steps	Time
Step 1: Introduction & activation of prior knowledge	15 min
Step 2: Analysis & needs assessment	10 min
Step 3: Planning an ideal workshop	10 min
Step 4: Implementation & presentation	10 min

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• ...the characteristics of a functional, safe and efficient workshop. • ...how to structure tools and work areas in a sensible way.	• ...how to effectively set up a small workshop with simple means. • ...plan and implement simple organisation systems (e.g. shadow boards, shelving systems) themselves. • ...how to design workstations ergonomically and safely.	• ...the connection between good workshop design and work quality/safety. • ...how planning and creativity can have a big impact even on a small budget.



Number of participants: min. 5



Estimated time: 45 minutes



Materials required: Laptop, projector, drawing/craft materials



Comments: -

Click to see movie

STEP 1: Introduction & activation of prior knowledge

1. Question: What is an ideal workshop?

The trainer asks those present about their knowledge of the ideal workshop. Answers: An ideal workshop is a functional space that is optimally designed for work processes, safety and efficiency. A poorly planned workshop can lead to wasted time, injury risks and employee dissatisfaction. A well-designed workshop, on the other hand, increases productivity, improves working conditions and supports ergonomic working.

2nd question: What makes a workshop ideal?

An ideal workshop is essential for enabling efficient and safe working. It takes into account both the requirements of the work processes and the needs of the employees.

Important aspects are:

- Structured layout: Clear zones for different activities (e.g. assembly, storage, maintenance)
- Ergonomics: Height-adjustable workstations, good lighting and short distances
- Safety: Clearly visible escape routes, safe storage of tools and machines
- Organisation systems: Tools and materials are systematically organised (e.g. shadow boards, shelving systems)
- Flexibility: Adaptable workstations, mobile workbenches and modular equipment

(Appendix 1 shows an example of a well-structured workshop.)

A good workshop layout ensures that employees can work in a focused, efficient and safe manner.

A poorly designed workshop can lead to mistakes, frustration and accidents.

3. Question: How can you design an ideal workshop on a limited budget?

The trainer asks those present for practical ideas for effective workshop design on a limited budget. Answers: Even with limited financial resources, a workshop can be set up to be functional and efficient.

Important measures:

- Tidy up and create structure: A tidy workplace improves clarity and efficiency. Tools should have a fixed place.
- Homemade organisation systems: Shadow boards or shelves made from scrap wood create order without high costs.
- Optimal use of space: Use walls for hanging systems, use mobile tables, and make good use of corners.
- Improve lighting: Inexpensive LED lamps provide better visibility and allow you to concentrate on your work.
- Improvising safety measures: Warning signs, simple barriers and labelled storage prevent accidents.
- Recycling: Reuse old furniture or workbench scraps to create workspaces.

(Appendix 2 shows before and after pictures of a workshop redesigned with limited resources)

Conclusion: It is not the budget that determines the quality of the workshop, but creativity, planning and a sense of order.

1. Question: What does a poorly designed workshop look like, and what does a well-designed workshop look like? Participants receive two plans for analysis.

(See Appendix 8-9)

Task: Examine the workshop shown in terms of:

- Order & structure
- Safety & ergonomics
- Lighting, pathways, storage, tool placement

Group work:

- What works well?
- What is disruptive?
- Where is room for improvement?

(Show Appendix 1: Comparison of good and bad workshops)

Aim of this step:

Participants learn to identify and name problem areas. They understand which factors influence the quality of a workshop – regardless of the equipment.

STEP 3: Planning an ideal workshop

How do I plan an ideal workshop – even with limited resources?

Participants are given the task of planning their own workshop. In doing so, they must take into account:

- Work areas (e.g. wood, metal, electrical)
- Available materials, room size and budget
- Organisation systems, workbench placement and lighting

Method:

- Make sketches
- Divide into zones (storage, work, cleaning, etc.)
- Place tools
- Simple solutions (e.g. cardboard shadow board)

Support:

The trainer provides ideas for ergonomic design, safety aspects and practical implementation on a small budget.

(See Appendix 5-7)

Objective of this step:

Participants apply their knowledge creatively and in a solution-oriented manner.
They learn to plan within realistic parameters.

- (Appendix 3: Planning with planning tools)

STEP 4: Implementation & presentation

How can I present and reflect on my workshop idea to others?

Participants present their workshop concepts to the group. Depending on the possibilities, a simple implementation or model construction takes place (e.g. with cardboard, Lego bricks, digital tools, pen and paper).

Method:

- Presentation of the planning idea
- Justification of decisions (Why this structure? Why this organisational system?)
- Feedback from the group

Reflection:

- What worked well?
- What was difficult?
- What would I do differently next time?

(Show Appendix 4: Presentation of results)

Aim of this step:

Participants practise presentation, reflection and feedback culture.

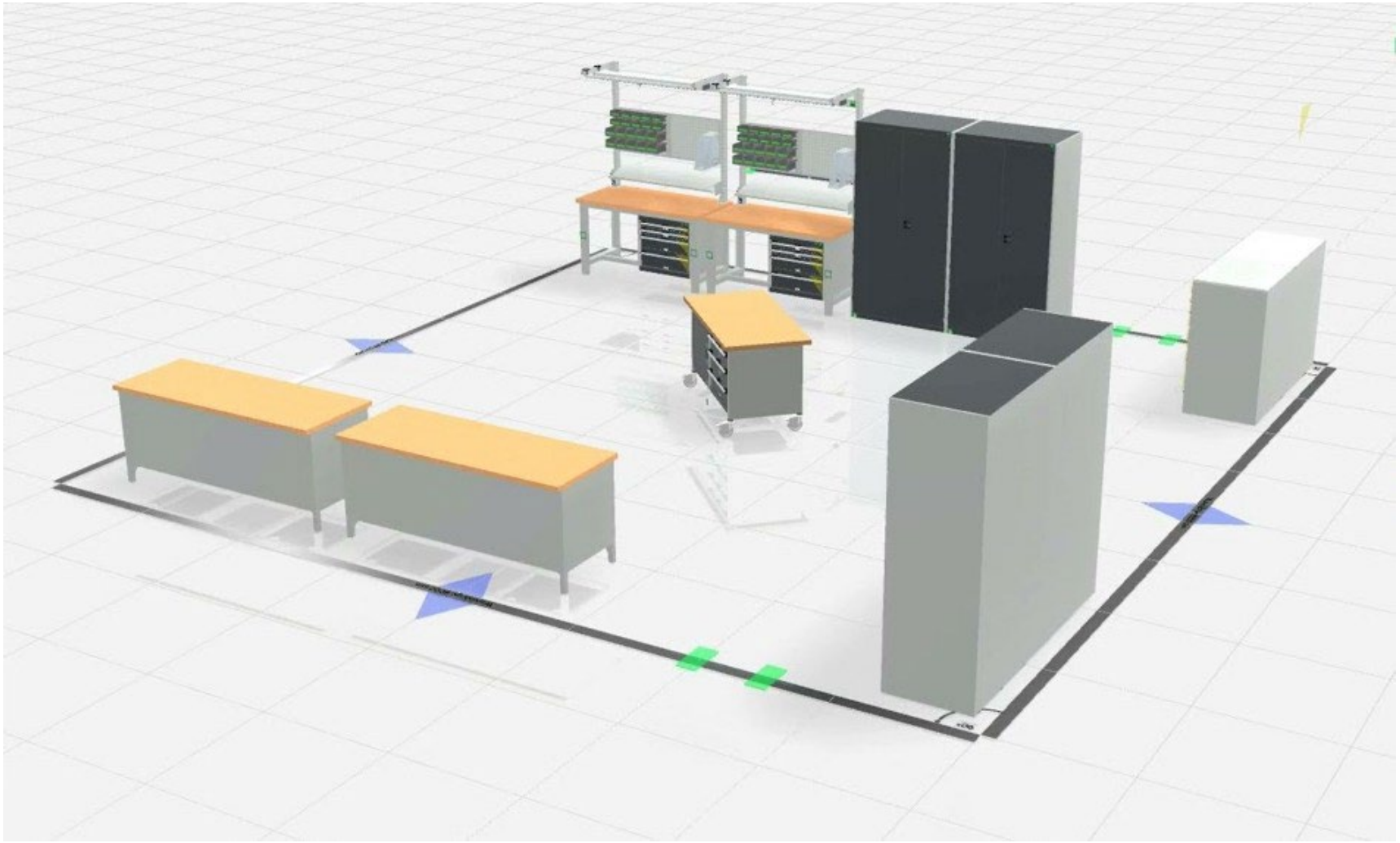
They consolidate their knowledge and apply it to real-life situations.

APPENDIX 1



APPENDIX 2






AINX

APPENDIX 5

- 1. Ergonomic design – working without straining the body

- Tips from the trainer:

- Check working heights:
- "What is the ideal height for standing and sitting activities? How does it feel?"
- → Example: Adjust workbenches to elbow height, use height-adjustable tables (including homemade ones).

- Keep movement areas clear:
- "Do you have enough space to turn, bend down and walk?"
- → Example: Minimum distance of 1 metre between work areas.

- Arrange tools sensibly:
- "How often do you reach for something? Could you reduce your movements?"
- → Example: Design shadow boards according to frequency of use.

- Compare standing/sitting workstations:
- "When is a standing stool or standing mat worthwhile?"
- → Example: Ergonomic alternatives for prolonged standing (inexpensive to retrofit).

- 2. Safety – avoiding accident hazards

- Trainer's suggestions:

- Walkways & tidiness:
- "Tripping hazards? Cables across the path? Tools on the floor?"
- → Example: Cable ducts from the DIY store, build your own tool holders.

- Check lighting conditions:
- "Where is it too dark to work?"
- → Example: Inexpensive LED lights (ceiling or work lamps).

- Use markings:
- "Which areas should be marked? How do I signal danger?"
- → Example: Floor markings with adhesive tape, self-printed warning signs.

- Make PPE visible:
- "Where do you keep safety goggles, gloves, etc. – are they within easy reach?"
- → Example: PPE wall made of wood with hooks or colour coding.

- 3. Implementation on a small budget – creative and effective

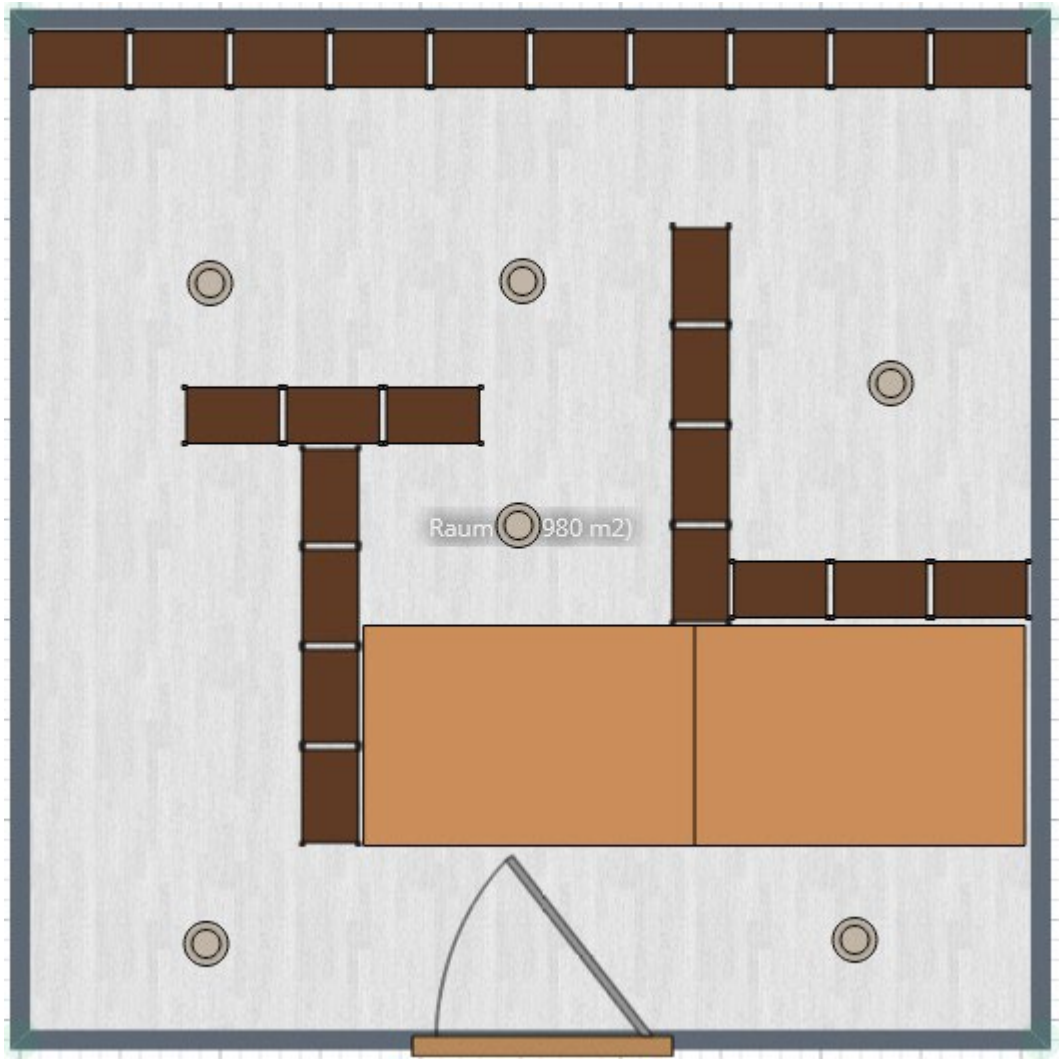
- Ideas from the trainer:

- Promote recycling and upcycling:
- "What can be built from old furniture, boxes or pallets?"
- → Example: Tool racks or material trolleys made from pallet wood.

- Show DIY solutions:
- "What ideas are there for inexpensive shadow boards, sorting systems or workbench attachments?"
- → Example: Plywood + paint on tool outlines + hooks.

- Planning & building together:
- "What can we implement ourselves as a class or team?"
- → Example: Weekly project: Build your own optimal workbench.

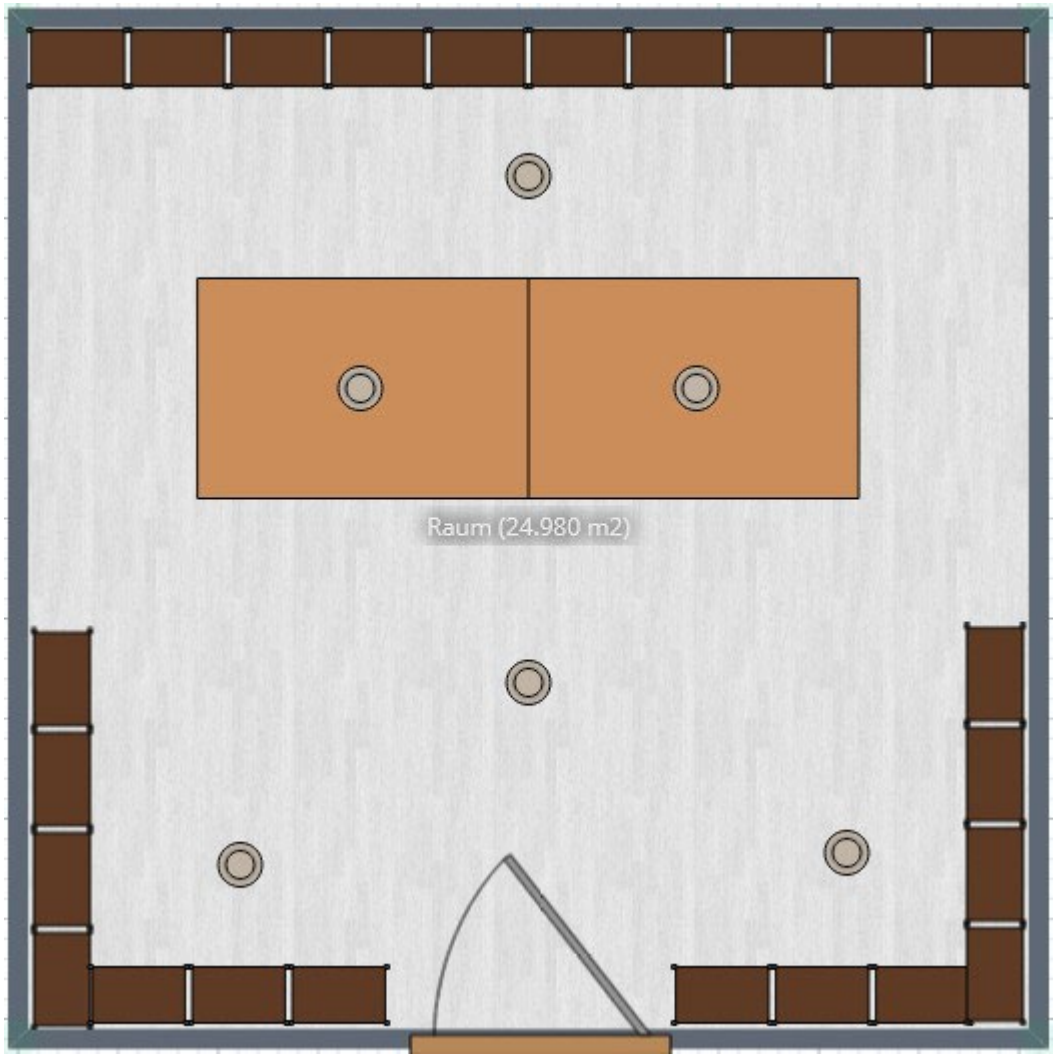
- Saving energy and space:
- "Less is more – what do you really need?"
- → Example: Mobile workshop trolleys instead of cluttered workbenches.



Light

Shelf

Workbench





Light



Shelf

Workbench



SOURCES

- Appendix 1:https://designer.microsoft.com
- Appendix 2: https://werkstatt-selber-bauen.de/
- Appendix 3:https://www.bott.de
- Appendix 4:https://www.morgenpost.de/berlin/article205422017/In-dieser-Wohn-Vision-leben-Studenten-auf-9-Quadratmetern.html

Developed by:

Christian Hoffmann,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



2.47. TITLE: Energy efficiency in the training workshop

PROCEDURE:

Steps	Time
Step: Introduction & activation of prior knowledge	10 min
Step 2: Energy analysis in the training workshop	15
Step 3: Developing solutions – working more efficiently with simple means	15 min
Step 4: Implementation & presentation	5 min



Number of participants: min. 5



Estimated time: 45 minutes



Materials required: Laptop, projector, blackboard/flipchart Energy cost meter, craft materials



Comments: -

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• what energy efficiency is and how it differs from energy saving • which areas in the workshop consume energy • where typical energy losses occur	• monitor and assess energy consumption in the workshop • identify opportunities for improvement and implement simple measures • How to make your own behaviour more energy-conscious	• Why energy efficiency is important (environment, costs, sustainability) • How technical knowledge and behaviour interact • How small measures can have a big impact

STEP 1 Introduction & activation of prior knowledge

Key question: What does energy efficiency mean – and why is it relevant to us in the training workshop?

Didactic commentary:

This step serves as an introduction to the topic. The aim is to activate existing everyday knowledge, arouse interest and make the topic tangible. Terms such as "saving electricity", "sustainability" and "carbon footprint" are familiar to many young people – now they are transferred to the workshop context.

Methodological procedure:

- Short discussion: "Where do we use electricity in the workshop?"
- Brainstorming on the whiteboard/digital board
- Clarification of terms: energy efficiency vs. energy saving (see Appendix 1)
- Show a short picture gallery: bad vs. good examples (e.g. unnecessarily open refrigerator, open windows with the heating on, LED instead of halogen) (see Appendices 2-3)
- Mini quiz: estimation questions about the electricity consumption of devices (see Appendices 4-5)

Objective:

Participants recognise that energy efficiency is not only an environmental issue, but also an economic one.

They understand that their behaviour in the workshop has a direct impact.

STEP 1: Introduction & activation of prior knowledge

Mini quiz: What consumes how much electricity?

Note to the teacher: First let the students make estimates (individually or in small groups), then reveal the answers and discuss briefly. Values can be rounded and estimated based on average devices.

Question 1: A compressed air compressor runs for 1 hour. How much electricity does it consume approximately?

A) 0.5 kWh

B) 1.0 kWh

C) 2.5 kWh

D) 4.0 kWh

✅ **Correct answer: C) 2.5 kWh**

➡️ **Compressors are real power guzzlers, especially during continuous operation or when there are leaks.**

Question 2: An LED tube light (20 watts) is on for 8 hours a day. How much electricity does it consume in a day?

A) 0.16 kWh

B) 0.8 kWh

C) 1.6 kWh

D) 2.0 kWh

✅ **Correct answer: A) 0.16 kWh**

➡️ **LEDs are significantly more economical than fluorescent tubes – this is quickly reflected in your electricity bill.**

STEP 1: Introduction & activation of prior knowledge

Question 3: A drill press (500 watts) runs for a total of 30 minutes per day. How much energy does it consume?

A) 0.1 kWh

B) 0.25 kWh

C) 0.5 kWh

D) 1.0 kWh

✅ **Correct answer: B) 0.25 kWh**

➡️ **Even if you only use it sporadically, it is worth switching it off after work.**

Question 4: A workshop PC remains switched on in standby mode around the clock. How much electricity does it consume in a week?

A) 0.3 kWh

B) 0.7 kWh

C) 1.3 kWh

D) 3.0 kWh

✅ **Correct answer: C) 1.3 kWh**

➡️ **It may not sound like much, but with 10 PCs, that's 13 kWh per week – for nothing!**

STEP 1: Introduction & activation of prior knowledge

Question 5: An electric fan heater (2000 watts) runs for 2 hours every day. How much does this cost per week (at 30 cents/kWh)?

A) €2.40

B) €3.00

C) €4.20

D) €6.00

✅ **Correct answer: D) €6.00**

➡️ **Fan heaters are extremely expensive to run, especially when used frequently.**

STEP 2: Energy analysis in the training workshop

Key question: Where exactly is energy consumed in our workshop – and where is it lost?

Didactic commentary:

This step aims to train perception and critical thinking. By analysing their own learning environment, abstract concepts become concrete and immediately relevant.

Methodological procedure:

- Tour of the workshop with task sheet (see Appendix 6):
  - Where are the light sources?
  - Which machines are permanently connected to the mains?
  - Are there any unnecessary idle times or standby loads?
  - How is the workshop heated/ventilated?
- Use of an energy cost meter (if available)
- Students document their findings with a tablet or mobile phone (photos + notes)
- Group evaluation: Everyone brings "energy guzzlers" to the meeting
- Discussion: What could be improved – immediately, in the medium term or in the long term?

Objective:

Participants learn to search specifically for energy consumers. They experience their workshop as a space that they can help to shape – not as something that is "unchangeable".

Possible materials:

- Checklist or worksheet
- Energy cost meter, thermometer, lux meter if necessary
- Visual aids: e.g. pictograms, "Power guzzler detected" stickers
- Blackboard or flipchart for collecting results

STEP 3: Develop solutions – work more efficiently with simple means

Key question: What specific steps can we take to make our training workshop more energy efficient?

Didactic commentary:

Now comes the creative phase: the previously identified potential for optimisation is translated into concrete ideas and measures. This involves technical, organisational and behavioural aspects – all three are relevant.

Methodological procedure:

- Group work: Each group works on a topic, e.g.:
  - Lighting
  - Machines & equipment
  - Ventilation & heating
  - User behaviour / organisation
- Key questions to help:
  - What is causing unnecessary energy consumption here?
  - How could this be changed immediately or inexpensively?
  - What rules of conduct would be useful?
- Collect ideas on posters / presentation slides
- Optional: Research phase (e.g. "What really saves electricity?")

STEP 3: Develop solutions – work more efficiently with simple means

Objective: Students develop practical, realistic solutions and learn how measurable improvements can be achieved even on a small budget.

They try out project-oriented, solution-oriented work.

Possible materials:

- Templates for action plans
- Examples from other workshops (e.g. "Energy Scouts", IHK projects)
- Craft materials for information posters, digital tools for sketching ideas
- Tables showing energy savings for various devices

STEP 4: Implementation & presentation

Key question: How do we implement our ideas – and how do we convince others of them?

Didactic commentary:

The final step focuses on presentation skills, reflection and reinforcement of what has been learned. The students should be able to consolidate what they have learned, put it into their own words and proudly present the results.

Methodological procedure:

- Each group presents its energy action plan:
    - What was discovered?
    - What measures do we propose?
    - What can be implemented immediately – and what cannot?
    - An exhibition or small project fair: invite other classes or teachers.Reflection round:
    - What have I learnt?
    - What will I change personally?
- (Optional) Implementation agreement: e.g. class rules for energy-conscious behaviour

Objective: Participants practise self-organisation, presentation and reflection. They consolidate what they have learned through application and exchange.

STEP 4: Implementation & presentation

Possible materials:

- Presentation cards, posters, digital tools
- Assessment sheets for peer feedback (see Appendix 7)
- Reflection cards (see Appendix 7)
- "Energy - saving contract" for the workshop (see Appendix 8)

Definition of terms: Energy efficiency vs. energy saving

Term	Energy efficiency 🛠️	Energy saving 💡
Definition	Achieving as much as possible with as little energy as possible	Consuming less energy by practising restraint or restriction
Objective	Optimise technology, avoid losses	Reduce consumption, e.g. through more conscious behaviour
Example 1	Replace old neon tubes with LED lighting	Switch off lights when leaving a room
Example 2	Retrofitting compressors with pressure sensor control	Only switch on compressors manually when needed
Mnemonic	👉 "Same result – with less electricity"	👉 "Do less – to use less electricity"

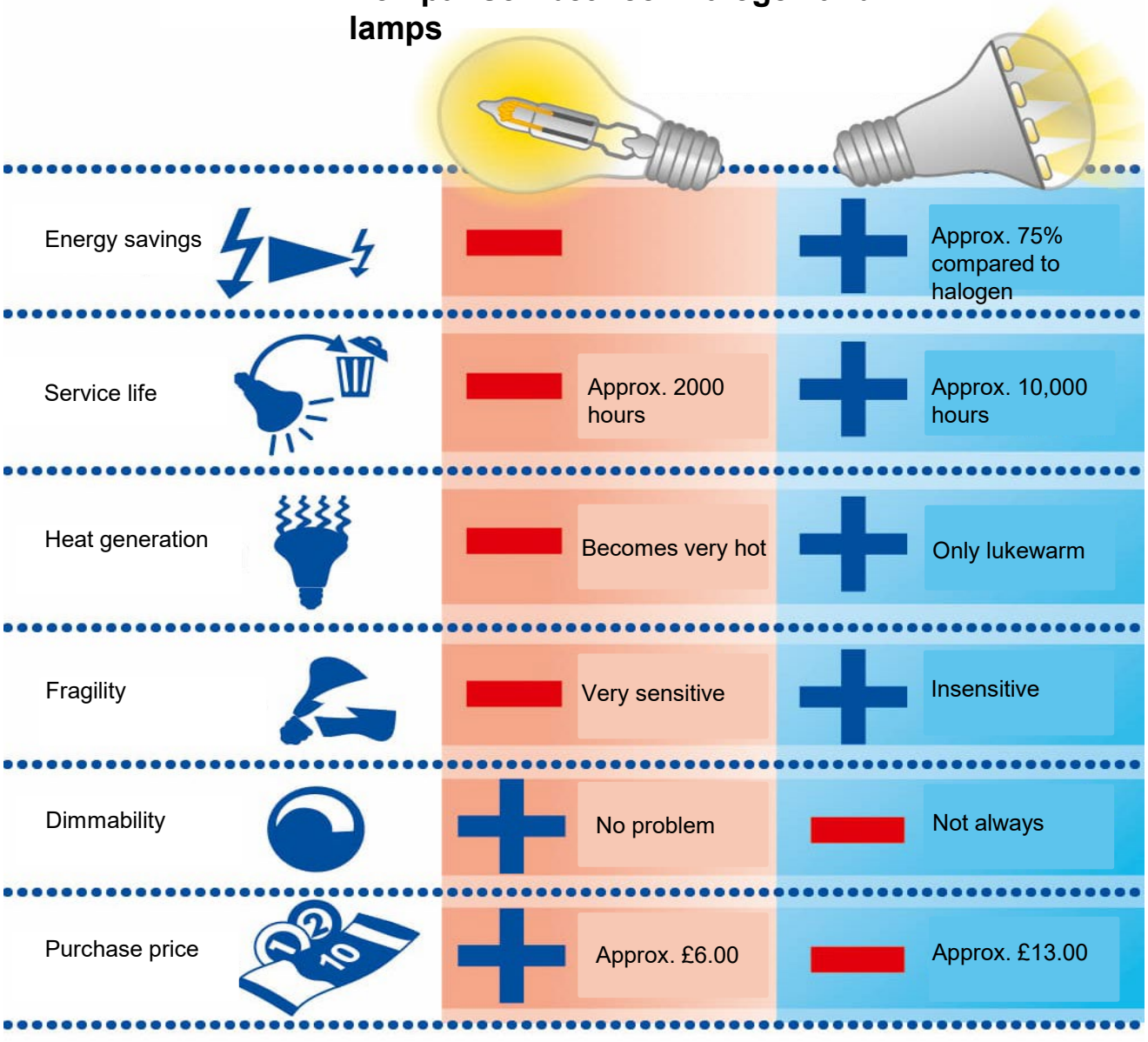
Both together = optimal ✅ Efficiency + energy-saving behaviour = maximum effect for the environment and costs

APPENDIX 2





Comparison between halogen and LED lamps



Mini quiz: How much electricity does each device consume?

Question 1: A compressed air compressor runs for 1 hour. How much electricity does it consume approximately?

A) 0.5 kWh B) 1.0 kWh

C) 2.5 kWh D) 4.0 kWh

Question 2: An LED tube light (20 watts) is on for 8 hours a day. How much electricity does it consume in a day?

A) 0.16 kWh B) 0.8 kWh

C) 1.6 kWh D) 2.0 kWh

Question 3: A drill press (500 watts) runs for a total of 30 minutes per day. How much electricity does it consume?

A) 0.1 kWh B) 0.25 kWh

C) 0.5 kWh D) 1.0 kWh

Question 4: A workshop PC remains switched on in standby mode around the clock. How much electricity does it consume in a week?

A) 0.3 kWh B) 0.7 kWh

C) 1.3 kWh D) 3.0 kWh

Question 5: An electric fan heater (2000 watts) runs for 2 hours every day. How much does this cost per week (at 30 pence/kWh)?

A) £2.40 B) £3.00

C) £4.20 D) £6.00

APPENDIX 5

🔍 Workshop tour: Energy under the microscope

🛠️ Objective: Find out where energy is being used – or wasted – in your workshop.

Write down your observations directly on the sheet.

🧠 1. Light check

🔦 Where can you find light sources?

- What type of lights (e.g. LED, neon)?
- Are lights left on permanently even when no one is there?

✍️ Notes:

.....

.....

⚙️ 2. Machine check

🔌 Which machines are permanently connected to the mains?

- Are there any devices that run on standby or are rarely used?
- Are devices switched off after work?

✍️ Notes:

.....

⏳ 3. Idle times & standby consumption

🕒 Where do unnecessary waiting times occur with devices running?

- Are there breaks during which devices are not used but remain switched on?

✍️ Observations:

.....

.....

🌡️ 4. Heating & ventilation

💨 How is the space heated or ventilated?

- Are there any open windows when the heating is on?
- Is the room regularly ventilated or permanently tilted?

✍️ Your assessment:

.....

.....

🔎 Find a specific idea for how you can save energy in one of these areas – without compromising on safety or comfort.

💡 My suggestion:

.....

APPENDIX 6

✅ Assessment form: Energy efficiency in our workshop

Name: _____ Date: _____

🔎 Assess the following areas based on your observations.

Area Current status (school grade 1–6) Comments / ideas for improvement

Lighting (type, use) _____

Machine operation & standby

_____

Order & clarity _____

Heating/ventilation system _____

User behaviour _____

Implementation of own ideas for improvement

_____

🛠️ My personal "wow" moment:

🃏 Reflection cards (group work / discussion)

Objective: Students reflect on their role and insights after the project in a playful way.

Use: As cards in a circle of chairs, on strips of paper or to draw from a box.

🎯 Reflection cards – examples

- What did I learn today about wasting energy?
- What was my best contribution to improving the workshop?
- Which idea would I implement immediately tomorrow?
- What did I notice for the first time in the project?
- Which waste of energy annoys me the most – and why?
- What was the biggest surprise during the tour?
- What can I personally do to make the workshop more energy efficient?
- Which of my classmates' ideas did I find particularly good?
- How did we work together as a group – and what went well?
- What will I take away from this project for my future work?

APPENDIX 7

📝 Energy saving contract for our workshop

Objective:

We, the learners and teachers in the workshop, voluntarily commit ourselves to saving energy, conserving resources and designing our working environment in a conscious and efficient manner.

🔹 Our joint energy saving rules

✅ 1. Switch off the lights when you don't need them!

We switch off the lights when there is enough daylight or when we leave the room.

✅ 2. Use machines consciously

We do not leave machines running unnecessarily in standby or idle mode.

✅ 3. Ventilate the workshop – but do it properly!

We ventilate intermittently and avoid leaving windows permanently tilted open when the heating is on.

✅ 4. Tidiness saves energy

We keep the workshop tidy – this way we avoid unnecessary searching and idle time.

✅ 5. Share ideas!

We actively contribute energy-saving tips and suggestions for improvement.

✅ 6. Identify and report energy guzzlers

We report suspicious devices or unnecessary consumption to the team.

✅ 7. Be a role model

Everyone pays attention to their own behaviour – together we can do better!

✍️ Our agreement

We sign this agreement as a sign of our joint commitment to an energy-efficient workshop:

Name Signature

....

....

....

....

🗓️ Date: _____

📍 Location: _____

🛠️ This agreement may be displayed in the workshop area or included in the workshop rules.

SOLUTIONS TO THE EXERCISES

Mini quiz answers:

1) ✅ Correct answer: C) 2.5 kWh

➡️ Compressors are real power guzzlers, especially when in continuous operation or when there are leaks.

2) ✅ Correct answer: A) 0.16 kWh

➡️ LEDs are significantly more economical than neon tubes – this is quickly reflected in your electricity bill.

3) ✅ Correct answer: B) 0.25 kWh

➡️ Even if you only use it sporadically, it is worth switching it off after work.

4) ✅ Correct answer: C) 1.3 kWh

➡️ It may not sound like much, but with 10 PCs, that's 13 kWh/week – for nothing!

5) ✅ Correct answer: D) £6.00

➡️ Fan heaters are extremely expensive to run – especially when used frequently.

SOURCES

Image source:

Appendix 2: https://de.cleanpng.com/png-50u0xb/

https://netzwerk-guides.de/heizung-bei-offenem-fenster-ausschalten/

Appendix 3: https://www.sanier.de/elektroinstallation/halogen-auf-led-umruesten

Developed by:

Christian Hoffmann,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by the European Union



2.48. TITLE: Safe electrical appliances, safe systems and safe machines

PROCEDURE:

Steps	Time
Step 1: Introduction & raising awareness	45 min
Step 2: Problem analysis & goal development	90 min
Step 3: Planning & implementation	180 min
Step 4: Presentation, reflection & transfer	60 min



Group size:
at least 6 people



Materials: Printouts of the appendices, blackboard, whiteboard,



Planned time: 375 min.



Comments: -

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• the potential hazards posed by electrical equipment, machines and systems. • which legal regulations (e.g. DGUV V3, BetrSichV, DIN EN 60204-1) and standards for electrical safety apply in Germany. • which test marks (CE, VDE, GS) are meaningful and how they can be distinguished. • which protective measures (e.g. insulation, earthing, RCDs) are necessary for the safe use of electrical equipment. • What role sustainability plays in the selection, use and disposal of electrical equipment.	• Check electrical devices, systems and machines for visible defects and safety risks and document them. • Apply basic electrical safety requirements to work equipment in your own training company. • Name, explain and, if necessary, implement simple safety measures under supervision. • Design information material (e.g. posters, checklists) on safety and sustainability when using electrical equipment. • Plan, implement and present safety-related projects in a team.	• Understand the importance of safety regulations for your own protection and that of your colleagues. • The responsibility that every specialist has when working with electrical technology. • The connection between safe working practices and the sustainable use of resources (e.g. energy-efficient appliances, recyclable components). • the necessity of regular inspections, documentation and maintenance in the workplace. • How small oversights can cause major hazards – and how to avoid them.

Step 1: Introduction & awareness raising

Objectives:

Trainees recognise basic hazards when working with electrical equipment, systems and machines and develop an initial awareness of safety-related aspects and protective measures.

Implementation:

At the beginning, trainees are made aware of the topic of safety with electrical devices and machines. In a short introductory question or example (e.g. a report of an electrical accident), trainees reflect on the dangers posed by electricity and defective technology. A worksheet lists typical types of accidents (electric shock, short circuit, fire, crushing) and asks: **What makes an electrical device safe?** Reflection questions encourage discussion: *What protective measures do you know (e.g. insulation, protective conductor, RCD)? Have you ever seen small fuses, such as fuse links or RCDs, installed? [Appendix 1.1]*

In a group quiz or using picture cards ("The CE mark means..."), initial myths are addressed: for example, the class discusses whether **"CE marking guarantees 100% safety"** or **"An old appliance without a test mark is just as good as a new one with one"** is true. [Appendix 2] This allows the trainees to learn the basic facts in a playful way: the CE marking merely indicates compliance with the relevant EU safety directives; independent testing can also be certified, e.g. by the GS or VDE mark. The aim of the module is to raise awareness that safety requires active design. The trainees collect their impressions on the board: What protective measures are there? What signals (pictograms, test seals) have they already seen on devices?

Materials & methods: A **worksheet on hazards associated with electrical equipment (Appendix 1)** and **discussion cards (Appendix 2)** ("My household appliance is safe because..." vs. "...it is not") help to get started. The teacher can illustrate the topic with simple demonstrations or stories (e.g. short circuit with a few LED lights and resistance). The aim is to raise awareness in a playful way without using complex technology.

Step 2: Problem analysis & goal development

Objectives:

Trainees analyse specific safety risks, learn about applicable standards and regulations, and use this knowledge to independently formulate realistic safety goals for their everyday training.

Implementation:

In the second module, trainees analyse specific problems and develop common learning objectives. In small groups, they examine typical work equipment (e.g. drills, handheld devices, power supplies) for safety aspects: Is there an intact protective conductor cable? Are switches properly earthed? Are terminal strips covered? They research the necessary inspection stickers and signs. At the same time, the teacher presents the most important regulations and standards: According to **DGUV Regulation 3** (formerly BGV A3), electrical systems and equipment may only be installed and maintained by a qualified electrician. Electrical equipment is also subject to the **Industrial Safety Regulation (BetrSichV)**. Together with the trainees, an overview is created:

- **DGUV Regulation 3 (§3)**: Employer obligations, qualified electrician
- **Industrial Safety Regulation**: inspection obligations, risk assessment (in accordance with TRBS 1201)
- **Product Safety Act (ProdSG)** and CE marking: EU requirements, declaration of conformity
- **VDE standards** (e.g. DIN VDE 0100, 0113): Technical connection rules for safe electrical installations
- **DIN EN 60204-1 (VDE 0113-1:2019)**: General requirements for the electrical equipment of machines
- The groups formulate specific learning objectives: e.g. *"Our workshop should be free of unsecured power strips"* or *"All electrical appliances should bear a GS or VDE mark."* They note down sources of danger and objectives on a flipchart. Reflection questions such as *"Who is liable in the event of an electrical accident?"* or *"Why do standards such as VDE and EN60204 exist?"* deepen understanding. Worksheets can help to roughly classify the regulations **(Appendix 3).** In this way, trainees systematically recognise that standards and laws are not a tiresome obligation, but help to avoid hazards and use equipment efficiently.

Step 3: Planning & implementation

Objectives:

The trainees plan and implement practical projects on electrical safety and sustainability, apply their knowledge in practice and learn to take on responsibility within a team.

Implementation:

In this module, trainees develop practical project ideas and implement them. They work in groups and each group chooses a topic, e.g.:

- **Safety check**: Groups check selected devices or machines in the training laboratory. They create a **checklist** (e.g. cable condition, functional test, presence of residual current circuit breaker). They document any defects found with photos or sketches. In this way, they learn to systematically identify and remedy safety gaps.
- **Information posters/presentations**: Each group designs a poster or handout on one aspect: *CE/GS/VDE marks in comparison*, *tips for maintaining and testing electrical appliances*, *protective measures (e.g. earthing, insulation, RCD)*. These posters are displayed in the classroom or workshop. The content must be presented in a clear and appealing way (e.g. with simple graphics). The groups research information sheets and standards overviews, which helps them to actively internalise the regulations.
- **Workshop analysis & sustainability**: In a "round zero" discussion, the trainees note down which devices in their environment are particularly **sustainable** (durable, repairable, energy-efficient) and which are not. They then draw up a short **list of recommendations** (e.g. replacement consumables, energy-saving alternatives). In doing so, they take into account the **Electrical and Electronic Equipment Act (ElektroG)**, which stipulates that old equipment must be taken back in an environmentally friendly manner and resources must be conserved. The guiding question could be: *"How can safety technology be designed in an ecological and resource-saving way?"* (Examples: reusable power tools, modular construction kits, recyclable materials).

Step 3: Planning & implementation

The trainees use templates such as project plans or schedules for planning. The teacher provides support and advice: they give tips on how to allocate tasks sensibly (e.g. research, design, structure) and provide materials (flipcharts, moderation cards). Reflection questions help with setting goals: *What protection goals do we want to achieve? Who do we inform about our results? How can we make our projects sustainable?*

Exemplary project ideas (sustainable and concrete):

- *Safety check in the workshop:* documentation of cable breaks, missing protective measures, action plan for rectification. **(Appendix 4)**
- *Information campaign:* posters or short presentations on **protection types (IP codes)**, **protection classes** of devices, importance of **the protective conductor**. **(Appendix 5)**
- *Energy-saving measures:* Comparison of old/new devices in terms of energy consumption, calculation of savings. (Note: Electric drives consume around 40% of electricity in industry, so there is great potential for efficiency gains here.) **(Appendix 6)**
- *Recycling campaign:* Collection of old cables and devices, presentation of the environmental effects of recycling in accordance with the ElektroG (Electrical and Electronic Equipment Act).
- *Role play/demonstration:* Simulation of a test procedure: one group carries out a test certificate in accordance with DGUV V3, others play the role of plant management. **(Appendix 7)**

These projects allow trainees to put their knowledge into practice. At the same time, they learn teamwork, project organisation and presentation skills. No special equipment is required for implementation – paper, pens and existing workshop resources are often sufficient.

Step 4: Presentation, reflection & transfer

Objective:

The trainees present their results, reflect on their learning progress and develop strategies for permanently integrating safety awareness into their everyday working lives.

Implementation:

In the final module, the groups present their results and reflect on what they have learned. Each group briefly presents its project (e.g. "Our safety check revealed three defects in the drill" or "Our poster explains the meaning of the VDE symbol"). The teacher then moderates an open discussion: *What was the most important insight? What measures will we personally take into account?* The trainees also fill out feedback forms: What did they learn, what went well, what should they implement next? Typical reflection questions include *"How safe do I feel now when using electrical equipment?"* and *"Which ideas can I pursue further in my training company?*"

The transfer to everyday working life is emphasised: the trainees consider how they can share their findings with colleagues (e.g. putting up posters in the workshop, a short information session during the daily briefing). In doing so, they recognise that they themselves bear responsibility – for example, by consulting a qualified electrician in case of uncertainty or by adhering to inspection deadlines. Finally, a reminder campaign is recommended: everyone creates a **checklist** for themselves **for everyday use (Appendix 9)**. In this way, the trainees link theoretical knowledge with practical routine tasks.

Materials & methods: The presentations can be analogue (posters, short roleplays) or digital (individual slides). A feedback form is recommended afterwards **(Appendix 8)**. At the end, there is a transfer question: *"How do I apply the safety rules in the workplace now?"* The teacher can then point out further offers (e.g. DGUV training courses, workplace instruction) and suggest a visit to a certified laboratory to observe device testing.

Appendix 1.1: Worksheet – Hazards associated with electrical equipment

Name: _____ | Date: _____

Objective: You will recognise typical hazards when working with electrical equipment and learn what to look out for in everyday life and at work.

Part 1 – Recognise the hazards!

Tick the hazards that could arise from the following situations. Multiple answers possible.

Situation	Electric shock ⚡	Fire 🔥	Mechanical hazard ⚙️	No hazard ❌
Cable with damaged insulation	☐	☐	☐	☐
Device without test mark	☐	☐	☐	☐
Multiple socket with too many consumers	☐	☐	☐	☐
Fan with open rotor	☐	☐	☐	☐
Device with damp housing	☐	☐	☐	☐
Device with VDE/GS mark, undamaged	☐	☐	☐	☐

Part 2 – What makes an appliance "safe"?

Name three features or measures that make an electrical device safe:

(1)_____ (2)_____ (3)_____

Part 3 – Reflection from everyday life

Think about your home or your training company.

- Have you ever seen unsafe electrical appliances there?

  ☐ Yes ☐ No

  If yes: _____

- How can you tell if an appliance has been tested?

Part 4 – Name protective devices

Match the terms:

A) Protective conductor

B) Residual current device (RCD)

C) Insulation

D) CE marking

Description	Letter
Disconnects the circuit in the event of fault currents	___
Prevents current flow via housing	___
Indicates compliance with European safety directives	___
Prevents direct contact with live parts	___

Final task (free response):

Which three rules for equipment safety would you teach new trainees?

(1)_____ (2)_____ (3)_____

Appendix 2: Discussion cards – Are devices safe or not?

Objective: Participants discuss typical assessments of device safety, consider different perspectives and practise identifying risks.

➤ **Application:**

- Each group receives 3–5 cards.
- Task: Take a position, collect pros and cons.
- Reflection question: What really determines safety?

Card 1 **"My household appliance is safe because it still works."**	→ **Discussion:** Is "it still works" enough? What tests are missing?
Card 2 **"The appliance is new, so it must be safe."**	→ **Discussion:** What role do CE marks, GS and VDE play? What could still be unsafe?
Card 3 **"A damaged cable is not a problem as long as nothing happens."**	→ **Discussion:** What does the law say? When is it mandatory to repair or replace it?
Card 4 **"Devices without a test mark are fine if you're careful."**	→ **Discussion:** What is your responsibility as a professional?
Card 5 **"Old appliances are often more robust and last longer."**	→ **Discussion:** What about energy efficiency, recycling, spare parts?
Card 6 **"It's normal for an appliance to get hot."**	→ **Discussion:** When does heat become dangerous? How can it be limited?
Card 7 **"Everything is checked regularly in the workshop – I don't have to do anything."**	→ **Discussion:** Who is responsible and when? What is your role as a trainee?

Appendix 3.1: Worksheet – Assigning standards and test marks

Name: _____ | Date: _____

Objective: You will learn about the most important safety standards and test marks, assign them to their functions and understand why they are relevant to your profession.

Part 1 – Assign test marks

Task: Read the descriptions and assign the appropriate test marks (CE, GS, VDE, no test mark).

Description	Test mark (CE / GS / VDE / none)
Declared by the manufacturer itself that all EU safety requirements are met	_____
Means: "Tested safety" – an independent testing agency has checked	_____
Technical and electrical testing in accordance with VDE standards, particularly relevant in the electrical sector	_____
Often not awarded to cheap products on the internet – no safety guaranteed	_____

Part 2 – Understanding regulations

Task: Read the statements and match them with the correct regulation or standard.
Choose from:

A) DGUV Regulation 3

B) BetrSichV

C) DIN EN 60204-1

D) Product Safety Act (ProdSG)

Statement	Letter
Regulates that electrical devices must be checked regularly for safety	____
Requires employers to carry out a risk assessment for work equipment	____
Lays down technical requirements for the electrical equipment of machinery	____
Requires that only safe products may be placed on the market	____

Appendix 3.2: Worksheet – Assigning standards and test marks

Part 3 – Why all this?

Tick the statements you agree with (more than one possible):

☐ Standards and test marks help to protect lives.

☐ I don't need to know the symbols and regulations – that's the job of the electrician.

☐ If I recognise the marks, I can work safely more quickly.

☐ Test marks are only important for large companies.

☐ Safety can also be sustainable – through durable and energy-efficient devices.

Part 4 – Reflection

Short answer (3–4 sentences):

What does safety mean to you when using electrical equipment?

Why are standards and regulations more than just "bureaucracy"?

_____

_____

_____

_____

_____

_____

_____

_____

_____

Appendix 4: Worksheet – Project plan template – "Team safety project"

Name: _____ | Date: _____

Objective: The project group plans its topic independently, defining tasks, deadlines and responsibilities.

| Project topic: _____ | Group: _____ |

Work step / task	Responsible	Deadline	Materials/resources	Completed? (✓)
e.g. Narrow down topic				
e.g. Research information			e.g. DGUV.de, VDE.de	
e.g. Design a checklist or poster			Paper, markers, standards sheet	
e.g. Prepare presentation			Poster, flipchart	
e.g. Presenting results				

Additional questions for the group (for reflection in advance):

- What specific protection goals are we pursuing?
- How do we ensure that our project is sustainable (e.g. long-lasting solutions, waste avoidance)?
- Who do we want to inform or raise awareness among with our project (e.g. other trainees, skilled workers, teachers)?

Appendix 5: Worksheet – Checklist "Safety inspection of electrical equipment"

Name: _____ | Date: _____

Objective: The group can use this to systematically check devices (e.g. in the workshop) for visible defects and safety deficiencies.

Test criterion	Fulfilled (✓)	Defect found? (✗)	Comment/action
Housing undamaged?			
Cable insulated, without cracks or breaks?			
Plug undamaged, securely attached?			
Test mark present (CE, VDE, GS)?			
Device protected by RCD?			
Switch function OK?			
Ventilation slots clear, no overheating?			
Last inspection documented?			

Note: This list can be supplemented with your own test criteria, depending on the type of device or project focus.

Appendix 6: Worksheet – Comparison sheet – Energy efficiency of old vs. new appliances

Name: _____ | Date: _____

Objective: The group can use this to collect and compare data on energy consumption and identify potential savings. Ideal for sustainability projects.

Appliance	Model / Year of manufacture	Power consumption (watts)	Operating time per day (hours)	Daily consumption (Wh)	Energy efficiency class (if available)	Comments
e.g. old drill	1998	900 W	2 hours	1800 Wh	Not specified	Noise, heats up significantly
e.g. new drill	2023	600 W	2 hours	1200 Wh	A	Quiet, handle protection

Reflection questions:

- How much could be saved?
- Could a more energy-efficient appliance increase safety or comfort?
- What happens to old appliances? → Are they recyclable?

Appendix 7: Role play template – "DGUV inspection at work"

Name: _____ | Date: _____

Objective: The trainees simulate the process of a safety inspection, including the allocation of roles.

Roles:

- Trainee 1 = Electrician: carries out visual and functional inspection
- Trainee 2 = Safety officer: documents defects
- Trainee 3 = Operations manager: asks critical questions about the inspection
- Trainee 4 = Observer: records errors in the process

Procedure plan (specification):

1. Select device
2. Visual inspection (cables, plugs, housing)
3. Function test (simulate under supervision)
4. Documentation with fictitious test report
5. Discuss results as a team: What stands out? What would need to be done in real operation?

Optional: A feedback form supplements the role play. Communication, diligence and understanding of test requirements, for example, are evaluated.

Appendix 8.1: Feedback form – Reflection & self-assessment

Name: _____ | Date: _____

Objective: Trainees reflect on what they have learned and evaluate their learning success.

Time required: approx. 5–10 minutes (can be completed anonymously)

Part 1 – Review of the course
Please tick how strongly you agree with the following statements:

Statement	Disagree (1)	Rather disagree (2)	Partly (3)	Somewhat agree (4)	Strongly agree (5)
I have learnt something new about device security.	☐	☐	☐	☐	☐
I now understand better why test marks are important.	☐	☐	☐	☐	☐
I am better able to identify safety deficiencies than before.	☐	☐	☐	☐	☐
I know which rules apply in the workplace (e.g. DGUV V3).	☐	☐	☐	☐	☐
I have learned how sustainability is related to safety.	☐	☐	☐	☐	☐

Part 2 – Self-assessment

- What was the most important insight you gained from the project?

- What would you do differently next time?

- Which of your ideas will you pursue further in the company?

Part 3 – Transfer to everyday life

What specific steps can you take to contribute to device safety in everyday life?

(☐ = I already do this / = ☐ I want to do this in future)

☐ Check the device for damage before use

☐ Look for test marks (CE, VDE, GS)

☐ Only use electrical appliances in a dry environment and in the correct manner

☐ Report defective devices immediately

☐ Document or check the inspection date

☐ Inform colleagues about safety

☐ Consult a qualified electrician if unsure

☐ Prefer sustainable alternatives

☐ Raise awareness of the issue among others

Appendix 9: Personal checklist for everyday life

Objective:

The trainees create their own safety checklist for everyday use. This can be laminated and hung in toolboxes, lockers or at the workplace.

My safety checklist for everyday training *(To be ticked or filled in before starting work – can be customised)*		
Checkpoint	Yes (✓)	Comment
Device is externally undamaged (cables, housing, plugs)		
Test marks are visible (CE, GS, VDE)		
Last test date has not been exceeded		
I know how to operate the device safely		
I use the device in a dry, stable location and as instructed		
I know who is responsible for safety issues at work		
I alert colleagues to any defects		

My personal safety promise:

"I take responsibility for my own safety and that of my colleagues – through attentiveness, knowledge and clear action."

Signature: _____

SOURCES

Sources:

The content is based on German standards and regulations: DGUV Regulation 3 (Electrical Systems and Equipment) publikationen.dguv.de komnet.nrw.de,BetrSichV (Industrial Safety Regulation)komnet.nrw.de, Product Safety Act/EC Machinery Directivedguv.de and DIN EN 60204-1 (VDE 0113-1:2019)de.wikipedia.org.

Information on test marks comes from the KMK guideline "Safety in the classroom" kmk.orgkmk.org and from DGUV Test dguv.de. Environmental and resource aspects are anchored in the ElektroG (Electrical and Electronic Equipment Act) umweltbundesamt.de. Energy awareness is based, among other things, on data on efficiency improvements in industrial plants dguv.de.

Sources:

- KomNet NRW's occupational safety informationkomnet.nrw.de;
- DGUV Regulation 3publikationen.dguv.de;
- DIN EN 60204-1 (VDE 0113-1)de.wikipedia.org;
- KMK guideline "Safety in the classroom" kmk.org_kmk.org;
- DGUV Test information on the Machinery Directive dguv.de dguv.de;
- Federal Environment Agency on the Electrical and Electronic Equipment Act umweltbundesamt.de;
- DGUV/IstA IFA "Energy Efficiency" dguv.de.

Developed by:

Christian Hoffmann, Training Association Olefinpartner gGmbH

Co-funded by the European Union



2.49. TITLE: Tracking materials: Understanding the supply chains of the materials used

PROCEDURE:

Steps	Time
Step 1: Introduction and division into groups	10 min
Step 2: Researching the material supply chain	20 min
Step 3: Share findings and discuss sustainability	20 min
Step 4: Reflection and outlook	10 min



Group size:
at least 8 people



Materials: printouts of the appendices, whiteboard, various visual aids if necessary



Planned time: 60 minutes



Comments: -

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• ... which materials (e.g. copper, aluminium, lithium, plastics) are commonly found in mechatronic products. • ... how typical supply chains for these materials are structured – from raw material extraction and processing to disposal or recycling. • ...what environmental and social challenges can arise along these supply chains (e.g. energy consumption, water requirements, recycling problems).	• ... describe the supply chain of a selected material and identify key sustainability aspects. • ... recognise differences between primary materials and recycled materials and classify their environmental advantages and disadvantages. • ... carry out simple material analyses in a group and present the results in a structured manner.	• ... how their own professional actions – e.g. through material selection or proper disposal – can contribute to resource conservation. • ... why sustainable thinking begins with material procurement and is becoming increasingly important for the future of technical professions. • ... that supply chains entail global responsibility and that a reflective approach to materials is part of professional ethics.

Step 1: Introduction and division into groups

Objective: To spark interest and form groups. The trainer briefly explains what raw materials and supply chains are and why they are relevant to mechatronics technicians. It should be mentioned that materials such as copper, aluminium, lithium and plastics are found in electronic devices, motors and housings. Note: Choosing energy-efficient materials at the planning stage can reduce the ecological footprint.

- The trainer explains the task: "Today, we will follow the material on its journey from extraction to recycling, always considering sustainability."
- **Group formation:** Divide the class into four groups. Each group is assigned a type of material (e.g. copper, aluminium, lithium, plastic). Also assign roles (e.g. raw material detective, manufacturing expert, sustainability auditor, documentarian). This allows each group member to work on a specific area.
- **Material distribution:** Give the groups prepared task sheets (see Appendices 1–4) with questions about their material.

Implementation: Ask each group to take on the role of their material and express their initial assumptions (e.g. "Where does aluminium come from?"). This activates prior knowledge. Duration: approx. 10 minutes.

Step 2: Research the material supply chain

Objective: The groups independently work out the supply chain for their material. They gather information about extraction/production, use and disposal.

- **Task:** The group works on the task from the respective appendix (1–4). The trainees do not need any special prior knowledge – they are allowed to use the internet, encyclopaedias or other sources. For example, they can find out in which countries copper is mined and how it is processed into cables.
- **Trainer's note:** Provide support at the beginning by asking for examples if necessary ("What products made of copper do you know?"). Make sure that the groups concentrate on their four phases: **raw material extraction, processing/production, use/application, recycling/disposal.**

Implementation: The groups work together for 10 minutes. The trainer is on hand to offer advice and ensures that all learners stay on topic.

Step 3: Share results and discuss sustainability

Objective: Each group briefly presents its findings, and everyone compares the materials from a sustainability perspective.

- **Evaluation in plenary:** Each group summarises its most important findings in 1–2 minutes (e.g. country of origin, common areas of application, recycling options). Write these points down visibly (blackboard/flipchart).
- **Special sustainability aspects:** Encourage discussion of the following points:
    - *Copper* is very durable and can be recycled repeatedly without any loss of quality. In Germany, more than half of the copper used today is obtained from recycling. Due to its high conductivity in electrical appliances, copper reduces energy consumption and thus CO_2 emissions.
    - *Aluminium* requires a great deal of electricity for primary production (Hall-Héroult process). It is important to note that secondary aluminium (recycling) requires only about 5% of the energy compared to primary production. In Germany, around 48% of aluminium comes from recycled material.
    - *Lithium* (for batteries) mostly comes from salt lakes in South America or from hard rock in Australia. Mining consumes a lot of water and creates waste ponds that can cause environmental problems if not managed properly. Demand is rising sharply (electromobility), which is why recycling is also being promoted.
    - *Plastic* is mainly based on petroleum/natural gas. In Germany, around 12.8 million tonnes of plastics are processed annually – 10.4 million tonnes of which are primary plastics based on fossil fuels. The recycling rate needs improvement: in 2023, only around 38% of plastic waste was recycled, while 61% was used for energy recovery.
- **Discussion:** Ask questions such as: Where do the trainees see differences in recycling rates? Which materials could be replaced by alternatives in the future? What role does energy consumption (electricity consumption, CO_2 emissions) play in processing?

Implementation: Duration approx. 10 minutes. Ensure a lively exchange: for example, incorporate additional facts and encourage the learners to ask questions.

Step 4: Reflection and outlook

Objective: Trainees link the results to practical applications and recognise the importance of the circular economy.

- **Knowledge consolidation:** Summarise the most important findings together. One comparison could be that metals such as copper and aluminium are highly recyclable (kupfer.de wwf.de), while the recycling of plastics and battery raw materials is still far below its potential.
- **Establish practical relevance:** Discuss how the origin of materials affects the work of mechatronics engineers. For example: Can you look for environmentally certified parts when purchasing equipment? How important is it to collect and properly separate waste materials?
- **Outlook:** Explain that companies are increasingly striving for sustainable supply chains and that every skilled worker can play a part in this. Encourage learners to look for opportunities for more recycling and resource conservation in projects or in their company.

Implementation: Duration approx. 10 minutes. Use notes from step 3 and, if necessary, the slides to reinforce key terms (e.g. *recycling rate, carbon footprint, circular economy*).

Appendix 1: Group assignment Copper

Material: Copper (metal for pipes, motor windings, contact points).

Questions (research and discuss):

- **Origin:** Which countries or mines are copper commonly sourced from? What does a copper mine or refinery look like?
- **Processing:** How is copper ore processed into the finished product (e.g. cables, wires)? What steps (smelting, refining, drawing) are typical?
- **Application:** Where is copper used in mechatronic devices? Think of motors, circuit boards, connectors, etc.
- **Disposal/recycling:** What happens to copper scrap (old cables, devices)? How is copper recycled?
- **Sustainability:** Discuss energy and water requirements for mining/production. What happens if copper is not recycled? Are there environmental risks associated with mining (e.g. landscape, water)? How can the copper cycle be improved?

Use: The group notes down key points or sketches. After 10 minutes, they prepare a short summary.

Appendix 2: Group assignment: Aluminium

Material: Aluminium (lightweight metal for housings, body parts, pipes).

Questions:

- **Origin:** Where does aluminium come from (bauxite deposits, countries)? What happens during the extraction of aluminium from bauxite (refining, smelting)?
- **Processing:** How is aluminium further processed (casting, rolling, pressing)? Which everyday products contain aluminium (e.g. profiles, engine housings)?
- **Application:** Where do we encounter aluminium in mechatronic systems (e.g. heat sinks, assemblies)?
- **Disposal/recycling:** How is aluminium collected (e.g. can recycling, scrap) and reprocessed? How high is the energy requirement for recycling compared to primary aluminium?
- **Sustainability:** Discuss the enormous energy consumption involved in primary production. How does recycling help to save energy and reduce greenhouse gases? Are there any social or environmental problems associated with bauxite mining (e.g. rainforest deforestation)?

Appendix 3: Group assignment Lithium

Material: Lithium (metal in rechargeable batteries, e.g. lithium-ion batteries).

Questions:

- **Origin:** Which regions (salt deposits, mines) does lithium come from? Who are the largest producers (e.g. Australia, Chile)?
- **Processing:** How is lithium ore processed (extraction from brine vs. hard rock)? What steps (evaporation ponds, sorting) are involved?
- **Application:** What is lithium used for in mechatronics? (Batteries for hand tools, mobility, energy storage)
- **Disposal/recycling:** How can lithium-ion batteries be recycled? Which materials (lithium, cobalt, nickel) can be recovered?
- **Sustainability:** Consider the environmental problems that arise (water consumption in dry regions, use of chemicals, working conditions in mining). How could recycling and circular economy concepts help to reduce material requirements?

Appendix 4: Group assignment on plastics

Material: Plastic (e.g. ABS, PET, polyethylene in the housing, cable sheathing).

Questions:

- **Origin:** From which raw materials (petroleum, natural gas) are plastics produced? Which global regions are leaders in production?
- **Processing:** What steps are involved in turning crude oil into finished plastic parts (refinery, polymerisation, injection moulding)?
- **Application:** Where can you find plastics in mechatronic components (encapsulations, switches, insulation)?
- **Disposal/recycling:** How is plastic waste disposed of? What is the difference between material recycling and incineration? What is the recycling rate (approx. 38% in Germany)?
- **Sustainability:** Discuss issues such as plastic waste, microplastics and CO_2 emissions during production. Which materials could perhaps be replaced or better separated and recycled? How does a functioning circular economy contribute to environmental protection?

SOURCES

1. Kupferverband e.V., *Sustainability – Copper Materials* (website; accessed 2025)kupfer.de kupfer.de.
2. Mandy Schoßig (Öko-Institut), *"Lithium & Graphite for Battery Production: The Future of the Supply Chain,"* idw online (01.09.2020)idw-online.de.
3. WWF Germany, *Germany's ecological footprint through steel and aluminium* (analysis, 2019/2020) wwf.de.
4. Federal Environment Agency, *Plastic waste – environmental data* (website, as of 30 April 2025) umweltbundesamt.de umweltbundesamt.de.

Developed by:

Christian Hoffmann,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by the European Union



2.50. TITLE: Potential savings through modernisation, using engines as an example

PROCESS:

Steps	Time
Step 1: Starting point and motivation	20 min
Step 2: Analysis of the current situation	20 min
Step 3: Modernisation measures	30 min
Step 4: Implementation and long-term benefits	20 min



Group size:
at least 8 people



Materials: Printouts of the appendices, whiteboard, various visual aids if necessary



Planned time: 90 min.



Comments: -

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• ...how large a share of the total energy consumption of industrial companies is accounted for by electric drives (approx. 50% in the EU). • ...the significance of efficiency classes IE1–IE4) and the latest EU Ecodesign Directives. • ...typical energy-saving measures (e.g. frequency converters, soft starters, motor replacement, gearbox optimisation) and their effects. • ...concepts such as life cycle costs (TCO) and amortisation for motor investments (operating costs ≈ 97%).	• ...estimate the savings potential of motors based on load profiles and performance data (e.g. calculate the effects of partial load operation or speed-controlled operation). • ...read motor labels and determining efficiency classes as well as compare drives. • ...perform sample calculations on amortisation (e.g. energy savings, costs, ROI) • ...design simple projects: e.g. plan a modernisation measure (selection of highly efficient motors or frequency converters).	• ...the relationship between motor efficiency, power consumption and CO_2 emissions (the higher the efficiency, the lower the consumption). • ...how the use of energy-saving motors pays off in the long term (amortised additional costs save significantly more money over the service life) • ...why sustainability and energy efficiency are strategic goals (ecological and economic) and how modernisation contributes to sustainable production.

Click
to see movie

Step 1: Starting point and motivation

Objective: Trainees recognise how high the energy consumption of motors in industrial plants is and why modernisation offers great potential for savings in this area.

In modern industrial plants, electric motors account for a significant proportion of energy consumption. It is estimated that motors consume around **45%** of the electricity generated worldwide. Industry is responsible for around **37% of global energy consumption**, including countless motors in pumps, fans and conveyor belts. ABB estimates that **300 million** electric drive systems are already in use worldwide (often over 10 years old) and consume over **45%** of the world's electricity. Replacing these outdated motors with highly efficient drives could save around **10%** of global electricity consumption – equivalent to the consumption of entire countries. Such figures make it clear that every newly purchased or modernised motor pays for itself through reduced operating costs (even if it is more expensive to purchase).

In Germany and Europe, EU regulations are driving this development: since 2021, three-phase motors from 0.75 kW must meet at least efficiency class **IE3**, and from July 2023 certain motor classes must even meet **IE4**. Even without legal requirements, companies can save **electricity costs** and **CO_2 emissions** through modernisation and smart control. Trainers can build on this: for example, a comparison between an old asynchronous motor and a new high-efficiency motor or the use of a frequency converter can serve as an introduction to illustrate the relevance for the environment and economic efficiency.

- **Teaching:** Show data and graphs (e.g. consumption statistics) or real motor labels with IE classes. Emphasise facts such as “Electric motors consume approx. 50% of industrial energy.”
- **Discussion:** Ask the trainees to guess which systems consume a particularly large amount of electricity (e.g. large conveyor belts, ventilation systems, compressed air compressors). Ask: *Why are old motors "energy guzzlers"?* or *What role does the price of electricity play in economic efficiency*?

Reflection: Make it clear that even small efficiency gains in motors lead to large savings over many operating hours (known as the "golden end"). Discuss how sustainability and climate protection are arguments for investment.

Step 2: Analysis of the current situation

Objective: Trainees learn about efficiency ratings and classes and how to evaluate motors during operation (e.g. utilisation, wear).

Electric motors are classified according to IEC 60034-30-1 into efficiency classes from IE1 (standard) to IE4 (super premium). [Show Appendix 1] IE3 motors already achieve efficiencies of around 94–96% and have been mandatory for many applications since 2021. They are surpassed by IE4 or IE5 motors, which have 5–10% fewer **losses** thanks to better laminations and rotor designs. In practical terms, this means that an IE3 motor converts approximately 94% of electrical energy into mechanical energy, while an IE4 motor converts around 96–97%. [Show Appendix 2] Since over 90% of the life cycle costs of a motor **are** attributable to electricity consumption (in the case of an 11 kW motor, 97% of operating costs), the use of motors with a higher efficiency class can save money over many years. The approximately £200 higher cost of a 15 kW IE3 motor compared to an IE2 motor is recouped after about 1.8 years – and after that, the savings flow back into the company (the **“golden end”**). [Show Appendix 3]

Another factor to consider is the operating condition: many motors run at idle speed or are oversized. Studies show that over 50% of motors typically operate at less than 60% of their rated load. Under partial load, efficiency decreases and unnecessarily high idle losses occur. Therefore, trainers should analyse load profiles with their trainees. First, the power and speed are measured under different load conditions (e.g. with a measuring plug or energy monitor). This can reveal whether a motor frequently runs at low capacity utilisation. For example, at 80% utilisation, there is hardly any loss of efficiency, but below 50%, efficiency drops sharply. Voltage drops and reactive power losses should also be considered. Overall, such measurements sharpen the understanding of the actual consumption values of a system.

- Teaching: Explain the IE classes using diagrams (e.g. efficiency vs. power) and examples (IE3, IE4, IE5 if applicable). Show how efficiency decreases at partial load (see figure from design data). Show a motor data sheet and determine the efficiency class together.
- Discussion: Have the trainees determine whether an existing motor is oversized or undersized. Example: A 4 kW motor often only operates in the range of 0.5–1 kW. What are the consequences of this? (Tip: possibly a smaller motor or speed-controlled drive). Also discuss service life – many old motors are in use **for** twice as long as they were designed for (usually ~10 years), which means a loss of efficiency.
- Reflection: Discuss the importance of life cycle costs: it is not only the purchase price that counts, but almost exclusively the electricity costs. Help the trainees understand why “expensive” motors are cheaper in the long run because they consume less energy.

Step 3: Modernisation measures

Objective: Trainees learn about key modernisation options and practical examples for saving energy.

When implementing a modernisation project, companies usually start by taking stock of their motors and analysing consumption (e.g. energy measurements, load profiles). [Show Appendix 7] As an ABB energy audit shows, targeted analysis can be used to identify which motors offer the greatest savings potential. Based on this data, the maintenance team and management can decide in which systems it makes the most sense to replace motors or install a frequency converter. A life cycle cost analysis is helpful here: not only the purchase price, but above all the costs over 10–20 years (electricity, maintenance) are taken into account. For example, electricity costs account for up to 97% of the total operating costs of a motor, so the benefits of an efficient motor outweigh the costs in the long term.

Another important step is to check subsidies and economic efficiency: government grants or depreciation can shorten investment periods. Many studies show payback periods of a few months to a few years for motor modernisation. Once an investment has paid for itself, every month thereafter delivers additional savings. This not only makes production more cost-effective, but also more sustainable – less CO_2 and fewer resources are consumed. Trainers should emphasise that these are issues for the future: by modernising early, companies can make their plants resilient to future energy prices and regulations (e.g. stricter efficiency guidelines).

Other measures include the conversion or retrofitting of older motors (e.g. installation of new windings or rotors) or switching to permanent magnet or synchronous reluctance motors. These have even higher efficiency (IE4/IE5) and can have up to 40% lower losses compared to IE3 drives. Optimising gear technology and couplings (direct drive instead of oversized belts or worm gears) and regular maintenance are also part of this. Practical examples: Using an IE4 motor instead of an IE3 motor slightly increases efficiency, but pays for itself just as quickly thanks to lower running costs.

- **Teaching:** Show real motors with and without frequency converters (or pictures/videos of them). Demonstrate the savings using calculation examples [Appendix 6]. Explain the terms "high-efficiency motor", "frequency converter", "soft start" and "retrofit".
- **Discussion:** Ask the trainees questions such as: *When is it worthwhile to use a frequency converter? What are the advantages and disadvantages of new motor technologies (e.g. IE4 vs. IE3)*? Analyse the amortisation example together: Is an amortisation period of less than 2 years realistic? What does this mean for investment decisions? Emphasise that after amortisation, energy and cost savings are "free" every year.
- Group task (optional): Plan a small project with the trainees, e.g. replacing a motor in a test bench system. What steps need to be taken? **Creating** a project plan promotes understanding of organisation and teamwork.
- **Reflection:** At the end, discuss how these measures contribute to sustainability: lower electricity consumption reduces CO_2 emissions, which is important from an environmental and energy transition perspective. Link this to real-world goals (e.g. EU energy targets or company policy).

Step 4: Implementation and long-term benefits

Objective: Trainees learn how to plan a modernisation measure and assess its effectiveness (e.g. ROI, TCO).

When implementing a modernisation project, companies usually start by taking stock of their motors and analysing consumption (e.g. energy measurements, load profiles). [Show Appendix 7] As an ABB energy audit shows, targeted analysis can be used to identify which motors offer the greatest savings potential. Based on this data, the maintenance team and management can decide in which systems it makes the most sense to replace motors or install a frequency converter. A life cycle cost analysis is helpful here: not only the purchase price, but above all the costs over 10–20 years (electricity, maintenance) are taken into account. For example, electricity costs account for up to 97% of the total operating costs of a motor, so the benefits of an efficient motor outweigh the costs in the long term.

Another important step is to check subsidies and economic efficiency: government grants or depreciation can shorten investment periods. Many studies show payback periods of a few months to a few years for motor modernisation. Once an investment has paid for itself, every month thereafter delivers **additional** savings. This not only makes production more cost-effective, but also more sustainable – less CO_2 and **fewer** resources are consumed. Trainers should emphasise that these are issues for the future: by modernising early, companies can make their plants resilient to future energy prices and regulations (e.g. stricter efficiency guidelines).

Teaching: Explain the concept **of return on investment (ROI)** using an example (investment costs vs. annual savings). Use graphics or formulas from a guideline or manual (e.g. **DIN EN 50598** for drive trains) for illustration. Show that even at moderate electricity prices (e.g. £0.10/kWh), the operating costs of a motor over its lifetime are orders of magnitude higher than the purchase price.

- **Discussion:** Have the trainees develop a *motor modernisation checklist*: What needs to be considered during planning, tendering and replacement? Take into account aspects such as safety standards (e.g. explosion protection), staff training, maintenance, compatibility (mechanical/electrical). Ask the trainees to calculate the total cost of ownership (TCO) and work out the benefits of regulations (e.g. **ISO 50001** energy management).
- **Group task (optional):** Plan a small project with the trainees: e.g. replacing a motor in a test bench system. What steps need to be taken? Creating a project plan promotes understanding of organisation and teamwork.

Reflection: Finally, discuss how energy efficiency fits into the corporate strategy. Make it clear that **sustainability** is not only an ecological issue, but also an economic one: lower energy consumption increases competitiveness. Topics such as electromobility or Industry 4.0 can serve as an outlook here, as they require efficient drive technology.

APPENDIX 1: Comparison described – Old IE1 motor vs. modern IE4 motor

Contents: Comparison of design, energy efficiency and operating costs between an outdated IE1 motor and a modern IE4 motor based on technical characteristics and typical application practice.

1. Design and construction	
IE1 motor (old stock):	**IE4 motor (modern):**
Classic, robust cast construction with relatively large cooling fins. Due to the lower efficiency, heat loss is higher, which is why larger fan housings are necessary. The motor often appears more cumbersome and requires more installation space.	More compact design thanks to improved winding technologies and lower-loss materials. Heat generation is lower, meaning that smaller cooling systems are sufficient. Optimised bearings and design generally make the motor quieter and lighter.
2. Energy efficiency	
Efficiency in the range of 75–85% (depending on power). A significant portion of the energy used is converted into heat – energy losses are correspondingly high.	Efficiency levels of over 90% to 96%. This means that less electricity is converted into heat and more **of it** is converted into actual mechanical work. This saves considerable energy costs over the service life.
3. Operating costs and sustainability	
Cheaper to purchase, but high operating costs due to electricity consumption. The CO_2 balance is unfavourable as more electricity is consumed. Often no subsidies **are** available for replacement or retrofitting.	Higher acquisition costs, but usually amortised within 2–4 years due to significantly lower energy consumption. Eligible for subsidies (e.g. from BAFA), climate-friendly and economical in the long term. Significantly reduces CO_2 emissions.
4. Maintenance and service life	
Higher wear due to greater heating and vibrations. Bearings and insulation age faster. More frequent maintenance and repairs are necessary.	Longer service life due to lower thermal stress and better materials. Maintenance intervals are longer, operation is more reliable.

Conclusion:

Replacing IE1 motors with IE4 motors is not only beneficial from an environmental perspective, but also from an economic **perspective** – especially in continuous operation or under high loads. Modern motors are quieter, more efficient, more durable and significantly reduce total operating costs.

APPENDIX 2: Table – Efficiency classes IE1–IE5 (according to IEC 60034-30-1)

Title: Standard overview with percentage values for efficiency per power class

Contents: Overview table of efficiency classes in accordance with IEC 60034-30-1.

Table:

Power (kW)	IE1 (%)	IE2 (%)	IE3 (%)	IE4 (%)	IE5 (%)
0.75	77.0	79.6	82.5	85.0	87.0
1.1	78.9	81.4	84.1	86.5	88.5
1.5	80.2	82.8	85.3	87.5	89.5
2.2	81.8	84.3	86.7	89.0	90.5
3.0	83.1	85.5	87.7	90.0	91.5
4.0	84.2	86.6	88.6	91.0	92.5
5.5	85.6	87.6	89.6	92.0	93.5
7.5	86.7	88.6	90.4	93.0	94.5
11.0	88.0	89.8	91.4	94.0	95.5
15.0	89.0	90.8	92.1	94.5	96.0

APPENDIX 3: Calculation example TCO – Old vs. New

Title: Sample cost calculation over 10 years with electricity price and savings

Contents:

Parameters	Old (IE1)	New (IE4)
Power (kW)	15	15
Efficiency (%)	89	94
Operating hours per year	4,000	4,000
Electricity price (€/kWh)	0.25	0.25
Annual electricity consumption (kWh)	67,416	63,830
Annual electricity costs (€)	16,854	15,958
Total costs over 10 years (€)	168,540	159,580
Savings over 10 years (€)	-	8,960

Note: The calculations are based on average values and may vary depending on the conditions of use.

APPENDIX 4: Data sheet for example motor (IE1)

Title: Technical data of an older motor for analysis

Contents:

Feature	Value
Manufacturer	Example Ltd
Model	IE1-1500-4P
Power	15 kW
Voltage	400 V
Frequency	50 Hz
Efficiency	89
Design	B3
Protection class	IP55
Weight	130 kg

APPENDIX 5: Data sheet for example motor (IE4/IE5)

Title: Comparative data for modern, high-efficiency motor

Contents:

Feature	Value
Manufacturer	Example Ltd
Model	IE4-1500-4P
Power	15 kW
Voltage	400 V
Frequency	50 Hz
Efficiency	94
Design	B3
Protection class	IP55
Weight	125 kg

APPENDIX 6: Worksheet – Calculating potential savings

Title: Calculations relating to electricity consumption, CO_2 and cost savings

Contents:

1. An IE1 motor with a power rating of 15 kW runs for 4,000 hours per year at an efficiency of 89%. Calculate the annual electricity consumption.

2. An IE4 motor with the same power and an efficiency of 94% replaces the IE1 motor. Calculate the new annual electricity consumption and the annual savings.

3. Calculate the CO_2 savings per year if 1 kWh of electricity **results in** 0.5 kg of CO_2.

4. Calculate the total cost savings over 10 years at an electricity price of £0.25/kWh.

APPENDIX 7: Checklist – Motor evaluation during operation

Contents: Practical tool for evaluating the condition and efficiency of electric motors.

Checklist:

Year of manufacture and operating hours of the motor	
Current efficiency class (IE1–IE4)	
Operating noise and vibrations	
Temperature development during operation	
Maintenance history and repairs	
Energy consumption compared to similar systems	
Potential for energy savings through replacement	

- **Is the motor more than 10 years old?** o Yes o No
- **Is the efficiency below IE3?** o Yes o No
- **Is there frequent maintenance or repair work?** o Yes o No
- **Is energy consumption above average?** o Yes o No
- **Are there modern alternatives with higher efficiency?** o Yes o No

Note: If several points are answered **“Yes”**, replacement should be considered.

APPENDIX 8: Solutions to APPENDIX 6

Title: Sample solutions for self-assessment by trainers or for discussion

Contents:

1. Electricity Consumption IE1:
0.8915 kW×4,000 h=67,416 kWh
2. Electricity Consumption IE4:
0.9415 kW×4,000 h=63,830 kWh
Savings:
67,416 kWh−63,830 kWh=3,586 kWh
3. CO2 Savings:
3,586 kWh×0.5 kg/kWh=1,793 kg CO2
4. Cost Savings over 10 Years:
3,586 kWh×0.25 €/kWh×10=8,965 €

SOURCES

1. Standards & Studies

- **IEC 60034-30-1** – Efficiency classes for electric motors (IE1–IE4) Search: "IEC 60034-30-1 efficiency classes PDF"
- **EU Regulation 2019/1781** – Efficiency requirements for motors and converters https://eur-lex.europa.eu
- **BMWK guide:** Energy-efficient drives in industry Search: "Guide to energy-efficient drives site:bmwk.de"
- **Fraunhofer ISI:** Energy consumption of industrial drives Search: "Fraunhofer ISI energy consumption drive systems PDF"

_____

2. Manufacturers & market players

- **ABB** – Energy efficiency of motors, market studies https://new.abb.com Search: "ABB energy-efficient motors white paper"
- **SEW-EURODRIVE** – IE3 to IE5 motors, TCO calculation https://www.sew-eurodrive.de
- **ERIKS Germany** – Selection of efficient drive solutions https://www.eriks.de
- **Bauer Gear Motor (Altra Motion)** – Gear motors with IE4 https://www.bauergears.com
- **WEG** – Super Premium Efficiency motors (IE5) https://www.weg.net
- **Danfoss** – Frequency converters & energy savings https://www.danfoss.com

_____

3. Data & market analyses

- **ABB / IEA** – Global potential: 300 million motors, 10% savings Search: "ABB 300 million motors 10 percent energy saving"
- **IEA – International Energy Agency** https://www.iea.org
- **Energy Agency NRW / DENA** – Life cycle costs & TCO Search: "Total Cost of Ownership Electric Motors
- site:energieagentur.nrw"

SOURCES

- Nauticexpo PDFs
- hoyermotors.com
- WEG
- topmotors.ch
- ABB Group
- hydraulic247.com
- Elektro.net
- NORD Drivesystems
- OMEC Motors | Electric Motors
- Scribd
- SEVA-tec GmbH
- YouTube
- Hoyer Motors
- backoffice.hoyermotors.com
- ekeindia.com
- orange1.eu
- Menzel Motors
- Cemp
- bonfiglioli.com
- Eaton
- inverterdrive.com
- Sew-Eurodrive Download
- Tecnica Industriale Ltd
- esko.at
- Wikipedia
- topmotors.ch
- Energy Efficient Products
- ADAJUSA International
- JS-Technik
- Austrian Energy Agency

Developed by:

Christian Hoffmann,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



2.51. TITLE: Put to the test – researching opportunities for optimisation and evaluating their impact

PROCEDURE:

Steps	Time
Module 1: Energy consumption	55 min
Module 2: Maintenance	55 min
Module 3: Control technology	55 min
Module 4: Production planning	55 min



Group size:
At least 8 people



Materials: Printouts of the appendices, whiteboard, various visual aids



Planned time per module:
55 min.



Remarks: -

AIMS:

After completing the course, participants will know:	After the class, participants will be able to:	After the class, participants will have a better understanding of:
• The trainees are familiar with basic terms and concepts (energy efficiency, preventive vs. predictive maintenance, PLC/control systems, lean production). They know that sustainable action means conserving resources and not harming future generations.	• They can measure consumption data, create maintenance plans, analyse control processes and draw up simple production plans. Trainees can identify potential for optimisation and formulate concrete measures (e.g. use of frequency converters or maintenance intervals).	• They understand the relationships between efficiency, costs and sustainability. Learners understand how a measure in one area (e.g. energy saving) can have positive effects in other areas (productivity, environment). They recognise the importance of continuous improvement (CIP) in the manufacturing process.

Module 1. Energy consumption

Objective:
Trainees will be able to measure the power and material consumption of typical plant components, identify potential savings and evaluate ecological effects.

In Module 1, trainees analyse the energy requirements of machines and systems (e.g. motors, pumps, compressed air systems, conveyor belts, lighting). They learn how to record and evaluate consumption data using electricity meters or energy monitors. Frequency converters and speed control often result in significant savings: even a small reduction in the speed of fans or pumps can lead to **considerable energy savings**. For example, trainees can use a pump to measure how power and consumption change at different speeds.

•Use of **frequency converters** and **speed controls** to run motors according to demand.
•Avoidance of idle runs: switching off conveyor systems, lighting, or compressed air compressors when idle.
•System optimisation: searching for leaks in compressed air systems (up to 70% of losses occur in the last sections of the pipes), repair and insulation.
•Use of **waste heat and renewable energies**: example of photovoltaics on hall roofs to cover part of the demand. Fraunhofer proposes synchronising **consumption and generation** – for example, adapting production processes to times when there is a lot of green electricity available.

In addition to data collection, the groups discuss measures for conscious energy use. These include simple checklists or digital monitoring systems. One example: trainees create a consumption balance for a compressor and suggest reducing overall demand with leak inspections and load management (e.g. switching off at night).

Group discussions promote awareness that even small changes can immediately reduce CO_2 emissions. By integrating these insights into their everyday work, trainees learn to make sustainable decisions.

Module 2. Maintenance

Objective: Trainees will learn to distinguish between different maintenance strategies (preventive vs. predictive) and create appropriate maintenance plans.

In Module 2, trainees develop maintenance concepts for machines and systems (e.g. conveyor technology, hydraulic units, sensor technology). First, they discuss what **preventive maintenance** (time- or usage-based intervals) means: regular oil changes, filter replacements, and lubrication work are typical tasks. Specifically, they introduce checklists, e.g. , weekly visual inspection of seals, monthly functional tests of sensors, and quarterly calibration of measuring instruments. They learn that scheduled maintenance reduces downtime, but also requires time and materials.

The groups then deal with **predictive maintenance**. This involves using plant condition data and sensors (vibration, temperature, particle detection) to identify problems at an early stage. The trainees understand that sensor monitoring and data analysis only trigger maintenance when it is really necessary. In exercises, they identify possible sensor values (e.g. vibration of a machine) whose increase indicates impending wear. They see that preventive measures, such as replacing pump bearings or refilling hydraulic oil at exactly the right moment, increase service life and reduce material waste.

Sustainability also plays a role here: the group discusses how spare parts (filters, oil, batteries) can be disposed of in an environmentally friendly manner or replaced with durable components. A well-planned maintenance cycle reduces unplanned downtime, which simultaneously saves resources and increases plant availability.

Module 3. Control technology

Objective:
Trainees learn to analyse and optimise PLC and sensor systems in order to control processes more efficiently and reliably.

Module 3 focuses on the control of systems (e.g. conveyor belts, robotics cells, measuring stations). Trainees learn how a PLC (programmable logic controller) interacts with sensors and actuators to implement processes. Modern control systems evaluate sensor data in real time – this is essential for highly efficient production machines. In practical examples, the groups recognise that optimised control processes use stoppers and bypass circuits, for example, to shorten cycle times, minimise idle time or close material cycles.

It is also important to consider energy efficiency: intelligent control systems can help to reduce the overall energy consumption of a process because optimised processes reduce the specific energy requirement per part produced. This can be seen, for example, when a control system ensures that several machines are switched cyclically in such a way that peak loads are distributed. Trainees learn that a networked PLC, for example, controls processes precisely and only provides as much energy as is currently needed.

Exercises can simulate the behaviour of a conveyor line: the group optimises a simplified sequence program (e.g. start/stop logic of a belt) and examines how shorter switching delays and better sensor positions improve throughput and cost-effectiveness. They also discuss network technology and edge computing: modern controllers analyse sensor data decentrally and dynamically adjust processes. All considerations focus on the contribution to sustainability: a stable, precisely controlled process generates less waste and conserves resources, as rework and material loss are reduced.

Module 4. Production planning

Objective:
Trainees can plan and adjust production processes to optimise throughput times, costs and energy consumption.

In Module 4, trainees combine all the knowledge they have gained about production planning. Typical tasks in industrial operations include order scheduling, capacity planning, and scheduling. They use simple planning tools (e.g. Gantt charts) and learn principles such as just-in-time and Kanban. The groups work on an example: several orders (e.g. parts production) are to be completed on time with limited machine running times and shift times.

A key aspect is the consideration of costs and energy: considerable savings can be achieved through clever timing – for example, by carrying out energy-intensive production steps during cheaper electricity tariffs. Studies show that adjusting the production time can save 10–15% of electricity costs. The trainees therefore specifically calculate breaks and shift changes in their plan when grid usage is more expensive and instead use times when energy is cheaper or renewable.

Lean principles are also introduced: avoiding overproduction and unnecessary buffer stocks reduces material and energy consumption. In this way, the groups learn, for example, that energy-efficient machines and resource-saving processes not only reduce the burden on the environment but also cut costs. In discussions, they reflect on how a sustainable supply chain (e.g. alternative transport routes) complements the production concept.
Finally, the trainees work out how they can link production planning with maintenance intervals and control logic – for example, by scheduling maintenance windows on machines where the plan already provides for breaks in order to minimise downtime. This creates a holistic understanding of how **optimisation steps in one area have a positive effect on others**.

SOURCES

- Danfoss (n.d.): 9 tips for greater energy efficiency in drive technology. Available online: danfoss.com danfoss.com.
- ALMiG Kompressoren (n.d.): Reduce compressed air leaks and save energy costs. (Guide) Online: almig.de almig.de.
- Fraunhofer Austria (n.d.): Energy efficiency and flexibility in production. Available online: fraunhofer.at fraunhofer.at.
- eMaint (n.d.): Predictive maintenance: increasing the reliability and efficiency of systems. Online: emaint.com emaint.com emaint.com.
- ADM electronic (n.d.): PLCs for controlling machines in the age of Industry 4.0. Blog post. Online: adm-electronic.de adm-electronic.de.
- DUALIS GmbH (2023): Energy cost consideration in production planning – sustainable optimisation of manufacturing processes. APS blog article, 22 June 2023, online: dualis-it.de dualis-it.de.
- umweltdialog.de (2023): Lean production for greater sustainability in companies. Online: umweltdialog.de umweltdialog.de.
- ingenieur.de (2021): Sustainably climate-neutral – and with a system. Online: ingenieur.de ingenieur.de.
- Ruhr University Bochum Academy (n.d.): Maintenance – Strategies. Website: akademie.rub.de (current overview of maintenance strategies available)akademie.rub.de.
- Swiss Federal Office of Energy (no date): Automation and electricity consumption. RAVEL Industry, Smart Energy (PDF). Available online: bfe.admin.ch bfe.admin.ch.

Developed by:

Christian Hoffmann,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



2.52. TITLE: "Under scrutiny – researching optimisation opportunities and evaluating their impact"
Module 1: Optimising energy consumption.

PROCEDURE:

Steps	Time
Step 1: Introduction: Where is energy consumed?	10 min
Step 2: Measurement & analysis of energy consumption	15 min
Step 3: Developing measures to optimise consumption	20 min
Step 4: Reflection & transfer to the business	10 min



Group size:
at least 3 people



Materials: Printouts of the appendices, whiteboard, ammeter



Planned time: 55 min.



Remarks:-

OBJECTIVES:

Students learn how and where energy is consumed in mechatronic systems, how to record consumption values and develop specific measures to reduce energy consumption – with a focus on cost-effectiveness and sustainability.

Step 1 – Introduction: Where is energy consumed?

Objective: Students recognise where energy is consumed in typical mechatronic systems and why optimisation is necessary.

In industrial systems, the greatest electricity consumption is usually found in:

- Electric motors (e.g. pumps, fans, conveyor technology)
- Compressed air systems
- Heating and cooling systems
- Lighting
- Control systems in standby mode

According to the IEA, around **70% of industrial electricity consumption** goes **towards electric drives**. At the same time, many systems are oversized or run idle.

Introductory method for teachers:

Show examples: a compressor running without a load, hall lighting that is permanently on – and ask:

"What is running here, even though no one needs it right now?"

This is how we raise awareness of the problem: electricity costs money, and every unnecessary consumption generates CO_2.

Step 2 – Measurement & analysis of energy consumption

Objective: Students learn how to record, document and evaluate energy consumption in their environment.

Possible methods:

- Electricity meter for individual machines (e.g. 3 kW motor → 24 kWh per 8-hour shift)
- Recording running times (how long does system X run per day?)
- Calculating compressed air consumption (e.g. via compressor output)
- Creating an energy consumption profile (what runs when, for how long, with how much power?)

Typical result of an analysis:

- Motor A runs 8 hours/day, requires 3 kW → 24 kWh
- Compressor B runs for 5 hours, requires 4 kW → 20 kWh
  → Total daily consumption: 44 kWh

Trainer tip: Show that devices are often left running continuously – even though they are not needed. Goal: Identify energy guzzlers!

Step 3 – Develop measures to optimise consumption

Objective: Students develop concrete, technically feasible ideas for reducing energy consumption.

Typical optimisation measures:

- **Speed control** for pumps and fans (frequency converters): 20–60% savings possible
- **Automatic shut-off**: Timers or PLC connection (e.g. compressor switched off during breaks)
- **Energy-efficient motors**: IE1 → IE3/IE4 save up to 10–15%
- **LEDs instead of fluorescent tubes**: 50–70% less electricity
- **Leak detection for compressed air**: up to 30% savings potential

Sample calculation:
A compressor (4 kW) currently runs 8 hours/day → 32 kWh → at €0.25/kWh = €8/day
With switch-off control reduced to 4 hours/day → 50% less → €4/day → €960 savings/year

Step 4 – Reflection & transfer to the workplace

Objective: Students understand how energy conservation contributes to environmental and cost targets – and consider how they can take action in their own businesses.

Reflection questions:

- Where do I see unnecessary energy consumption in my daily life?
- What could I improve immediately – even without investment?
- How can I get my colleagues involved?

Transfer method:
The pupils design an **energy tips board for the workshop**:
"5 things you can do right away" – e.g.:

1. Turn off the lights
2. Turn off compressed air
3. Avoid idling
4. Switch off machines
5. Maintain engines regularly

Appendix 1: Group task: Analysing and optimising energy consumption

Situation description:
Your company has two machines:

- Machine A (e.g. compressed air compressor): 3.0 kW, runs 6 hours/day
- Machine B (e.g. milling machine): 5.5 kW, runs 4 hours/day
- Electricity price: €0.30/kWh

Task 1:
Calculate the electricity consumption and daily costs of both machines.

Task 2:
Develop three optimisation options – e.g. shutdown times, conversion, frequency converters.

Task 3:
Estimate how many kWh and euros could be saved per year for each measure.

Task 4:
Discuss the environmental benefits:

- How much CO_2 (in kg) could be saved?
- Research the CO_2 factor for electricity (currently approx. 350–400 g/kWh in Germany).

Task 5 (optional):
Create an information board or short presentation with your results.

Initial situation (given):

Device	Power	Running time/day	Electricity price
Machine A	3.0 kW	6	0.30 €/kWh
Machine B	5.5 kW	4 h	0.30 €/kWh

Task 1: Calculate electricity consumption and costs

Daily consumption:
•Machine A: 3.0 kW × 6 h = **18.0 kWh**
•Machine B: 5.5 kW × 4 h = **22.0 kWh**

Total consumption per day:
18.0 + 22.0 = **40.0 kWh**

Daily costs:
40.0 kWh × €0.30/kWh = **£12.00**

Monthly costs (based on 22 working days):
£12.00 × 22 = **€264.00**

Task 2: Three optimisation options

1.Install a frequency converter on machine A
→ Speed control saves approx. **20% energy**
→ Savings: 18.0 kWh × 20% = 3.6 kWh/day

2.Automatic shutdown during idle times (machine B)
→ Reduction in running time by 1 hour per day
→ Savings: 5.5 kW × 1 hour = 5.5 kWh/day

3.Load management: shifting 50% of consumption to the night-time electricity tariff (0.15 €/kWh)
→ e.g. by shifting working hours or buffer operation

Task 3: Calculate annual savings

1. Frequency converter (machine A):
3.6 kWh/day × 22 days/month × 12 = **950.4 kWh/year**
→ 950.4 × €0.30 = **€285.12/year**

2. Shutdown of machine B:
5.5 kWh/day × 22 × 12 = **1,452 kWh/year**
→ 1,452 × €0.30 = **€435.60/year**

3. Night-time electricity (20 kWh/day shifted):
Daily savings: 20 × (0.30 £ – 0.15 £) = 3.00 £
→ €3.00 × 22 × 12 = **€792.00/year**

Total annual savings:
€285.12 + €435.60 + €792.00 = **€1,512.72**

Task 4: Calculate CO_2 savings

Total kWh savings:
950.4 + 1,452 = **2,402.4 kWh/year**

CO_2 factor (electricity): 350 g/kWh (GER average)

CO_2 savings:
2,402.4 kWh × 0.35 kg/kWh = **840.84 kg CO_2/year**
= **approx. 0.84 tonnes of CO_2**

Task 5 (optional): Board with 5 energy-saving tips

Design a workshop board:

"5 things you can do right now"
1.Turn off lights when not in use
2.Turn off compressed air at the end of your shift
3.Only start motors when needed
4.Equip machines with frequency converters
5.Report leaks immediately!

SOURCES

- Danfoss (n.d.): *9 tips for greater energy efficiency in drive technology*. Available online: danfoss.com danfoss.com.
- ALMiG Kompressoren (n.d.): *Reduce compressed air leaks and save energy costs*. (Guide) Online: almig.de almig.de.
- Fraunhofer Austria (n.d.): *Energy efficiency and flexibility in production*. Available online: fraunhofer.at fraunhofer.at.
- eMaint (n.d.): *Predictive maintenance: increasing the reliability and efficiency of systems*. Online: emaint.com emaint.comemaint.com.
- ADM electronic (n.d.): *PLCs for controlling machines in the age of Industry 4.0.* Blog post. Online: adm-electronic.de adm-electronic.de.
- DUALIS GmbH (2023): *Energy cost consideration in production planning – sustainable optimisation of manufacturing processes*. APS blog article, 22 June 2023, online: dualis-it.de dualis-it.de.
- umweltdialog.de (2023): *Lean production for greater sustainability in companies*. Online: umweltdialog.de umweltdialog.de.
- ingenieur.de (2021): *Sustainably climate-neutral – and with a system*. Online: ingenieur.de ingenieur.de.
- Ruhr University Bochum Academy (n.d.): *Maintenance – Strategies*. Website: akademie.rub.de (current overview of maintenance strategies available)akademie.rub.de.
- Swiss Federal Office of Energy (no date): *Automation and electricity consumption*. RAVEL Industry, Smart Energy (PDF). Available online: bfe.admin.ch bfe.admin.ch.

Developed by:

Christian Hoffmann,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



2.53. TITLE: Under scrutiny – researching optimisation opportunities and evaluating their impact.
Module 2: Optimisation through maintenance.

PROCEDURE:

Steps	Time
Step 1: Introduction: Why is maintenance more than just "repairing"?	10 min
Step 2: Assessing conditions and planning maintenance	15 min
Step 3: Developing measures for maintenance optimisation	20 min
Step 4: Reflection & transfer to your own business	10 min

OBJECTIVES:

Trainees learn how maintenance and servicing not only prevent breakdowns, but also help to save energy, materials and resources.



Group size:
at least 3 people



Materials: Printouts of the appendices, whiteboard, motor models/ sensor models/compressor or similar illustrative/exercise objects



Remarks: -



Planned time: 55 min.

Step 1: Introduction: Why is maintenance more than just "repair"?

Objective: Trainees understand the difference between reactive, preventive and predictive maintenance – and comprehend their benefits.

Many people associate maintenance with repairs. However, professional maintenance can increase plant availability, prevent waste and reduce energy consumption.
Three basic forms:

Form of maintenance	Characteristics	Example
Reactive ("firefighting")	Intervention in the event of failure	Conveyor belt stops – motor defective
Preventive	Time/usage-controlled	Oil change every 3 months
Predictive	Sensor & data-based	Vibration sensor detects bearing damage

Introductory discussion:

"What is regularly maintained in your company? And how?"
→ This makes the current situation tangible – and highlights the importance of planning.

Step 2: Record conditions and plan maintenance

Objective: Trainees learn how to define and document maintenance intervals – and how to check maintenance statuses themselves.

Typical maintenance objects in mechatronics:

- Drive units: lubrication, seal inspection, alignment
- Sensors: cleaning, calibration
- Compressed air: changing filters, checking for leaks
- Control cabinets: cleaning fans, insulation testing

Maintenance tools:

- Checklists (e.g. weekly, monthly, yearly)
- Maintenance schedules (e.g. in Excel or CMMS systems)
- Sensors (e.g. temperature, vibration, pressure) for detecting problems before failure

Example – visual inspection of a motor:

- Check bearing temperature (→ too hot = friction)
- Check for unusual vibration
- Oil leaks or noises → indications of a defect

Step 3: Develop measures for maintenance optimisation

Objective: Trainees recognise potential savings through well-planned maintenance and can suggest simple digital solutions.

Possible improvements:

- Maintenance based on usage time rather than calendar time (e.g. every 500 operating hours)
- Sensor integration for vibration monitoring → automatic alerts
- Replacement of cheap disposable components with durable alternatives
- Reduction of oil and lubricant consumption through targeted relubrication

Sample calculation:
A filter costs £50 and has previously been replaced every 3 months → 4 times per year = £200
Thanks to condition monitoring via pressure sensor, only 2 replacements are now necessary → £100 saving + reduced material consumption

Additional potential:

- Fewer downtimes → more production → better energy use per unit
- Longer machine service life
- Reduced wear → fewer spare parts

Step 4 : Reflection & transfer to your own company

Objective: Trainees recognise where they could actively contribute maintenance suggestions or carry them out themselves.

Reflection questions:

- Which machine in your company urgently needs maintenance planning?
- Are there any components that frequently fail – and how could this be prevented?
- How can I help to make maintenance more sustainable?

Transfer idea:
The trainees keep a "maintenance log" for a selected component (e.g. pneumatic valve, motor bearing, sensor) over a period of two weeks. In it, they note down: condition, abnormalities, care. At the end, they make an assessment: **"What have I improved – and what could my company learn from this?"**

Appendix 1: Group task – Planning and optimising maintenance

Situation description:
A conveyor system in your training workshop is frequently breaking down. The drive unit (1.5 kW motor with worm gear) runs in two 6-hour shifts.
Problems:

- Overheating after long periods of operation
- Leaky seal on the gearbox
- Sensor dirty, no feedback → emergency stop

Task 1:
Create a **maintenance plan** (daily/weekly/monthly):
Which checks, cleaning and lubrication tasks are advisable?

Task 2:
Consider which **sensors** you could use for monitoring (e.g. temperature sensor, vibration sensor, operating hours counter).

Task 3:
Plan a small **digital solution** (e.g. LED warning light or alarm message via PLC) for predictive maintenance.

Task 4:
Calculate the potential savings if one failure (with a 2-hour production stoppage) is prevented each month. Example:

- Machine hour = €80
- 2 hours downtime/month = €160
- → Avoidance: €1,920/year

Task 5 (optional):
Develop a **maintenance poster** for the workshop with 5 tips for sustainable maintenance.

Appendix 2.1: Solution to Module 2 – Appendix 1: Planning and optimising maintenance

Task 1: Create a maintenance plan

Interval	Action	Reason
Daily	Visual inspection for oil leaks on the gearbox	Early detection of leaks
	Cleaning of sensor surface	Ensure signal availability
Weekly	Temperature check on the motor (by hand/IR sensor)	Check for signs of overload or friction
	Check for unusual noises (check bearings)	Early detection of damage
Monthly	Check gearbox oil level, inspect seals	Avoid maintenance-related losses
	Clean all ventilation slots	Prevent overheating
Half-yearly	Vibration test on motor mount	Detect incipient bearing defects
	Calibration/replacement of the sensor	Maintaining measurement reliability

Task 2: Sensors for condition monitoring

Recommended sensors:

Sensor type	Position	Function
Temperature sensor	Motor housing	Monitoring for overheating
Vibration sensor	Motor bearing	Early detection of bearing damage
Oil level sensor	Gearbox housing (optional)	Automatic notification when level is too low
Proximity sensor with protective cap	Conveyor line	Protection against dirt → reliable part detection
Operating hours counter	Control cabinet	Plan maintenance intervals based on usage

Task 3: Digital solution for predictive maintenance

Suggestion:

•**LED warning light** on the conveyor line (yellow = maintenance due, red = malfunction)

•**Linked to operating hours counter**: e.g. every 300 hours → LED flashes yellow

•**Vibration sensor reports limit value exceeded** via PLC → display in HMI or acoustic signal

•**Additional:** Simple visualisation with traffic light logic possible via existing PLC

Task 4: Calculate savings

Assumption:
One failure = 2 hours of production stoppage → Machine hourly rate: €80

One failure prevented per month:
2 hours × €80 = €160/month
→ Annual savings: €160 × 12 = €1,920/year

Additionally:

- No emergency repairs (e.g. €200–300 per call-out)
- No production waste, no unnecessary spare parts

Task 5 (optional): Maintenance poster – 5 tips for sustainable maintenance

Maintenance = environmental protection!

1. Check for leaks and contamination every day
2. Use lubricants sparingly and selectively
3. Clean and calibrate sensors regularly
4. Protect bearings by replacing them in good time
5. Prevent failures through proactive maintenance

SOURCES

- Danfoss (n.d.): *9 tips for greater energy efficiency in drive technology*. Available online: danfoss.com danfoss.com.
- ALMiG Kompressoren (n.d.): *Reduce compressed air leaks and save energy costs*. (Guide) Online: almig.de almig.de.
- Fraunhofer Austria (n.d.): *Energy efficiency and flexibility in production*. Available online: fraunhofer.at fraunhofer.at.
- eMaint (n.d.): *Predictive maintenance: increasing the reliability and efficiency of systems*. Online: emaint.com emaint.com emaint.com.
- ADM electronic (n.d.): *PLCs for controlling machines in the age of Industry 4.0.* Blog post. Online: adm-electronic.de adm-electronic.de.
- DUALIS GmbH (2023): *Energy cost consideration in production planning – sustainable optimisation of manufacturing processes*. APS blog article, 22 June 2023, online: dualis-it.de dualis-it.de.
- umweltdialog.de (2023): *Lean production for greater sustainability in companies*. Online: umweltdialog.de umweltdialog.de.
- ingenieur.de (2021): *Sustainably climate-neutral – and with a system*. Online: ingenieur.de ingenieur.de.
- Ruhr University Bochum Academy (n.d.): *Maintenance – Strategies*. Website: akademie.rub.de (current overview of maintenance strategies available)akademie.rub.de.
- Swiss Federal Office of Energy (no date): *Automation and electricity consumption*. RAVEL Industry, Smart Energy (PDF). Available online: bfe.admin.ch bfe.admin.ch.

Developed by:

Christian Hoffmann,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



2.54. TITLE: Put to the test – researching optimisation options and evaluating their effects.
Module 3: Optimisation through control technology.

PROCESS:

Steps	Time
Step 1: Introduction: Why does a plant need "good control"?	10 min
Step 2: Analysis of existing control systems and weak points	15 min
Step 3: Improving control systems and identifying automation potential	20 min
Step 4: Reflection and application in your own business	10 min

OBJECTIVES:

Students learn how optimised control systems increase the efficiency of technical processes and reduce resource consumption.



Group size:
at least 3 people



Materials: Printouts of the appendices, whiteboard, PC/laptop; PLC; model of a control system



Remarks:



Planned time: 55 min.

Step 1: Introduction: Why does a system need "good control"?

Objective: Students understand what control means – and recognise its influence on efficiency, precision and energy consumption.

Control = targeted switching, regulation and coordination of processes.
In modern production facilities, this is typically performed by a **PLC (programmable logic controller)**. It responds to sensor values, controls motors, opens valves – and ensures that a process runs accurately and repeatably.

Simple examples:

- Conveyor belt switches on when light barrier signal is received
- Gripper arm only starts moving when a component has been detected
- Compressor switches on automatically when pressure drops

Introductory question for students:

"Which machines in your environment are controlled by sensors? What happens if a sensor fails?"
→ This makes it clear how much efficiency and availability depend on the control system.

Step 2: Analysis of existing controls and weak points

Objective: Students analyse simple control processes and learn about typical weaknesses, e.g. excessive running times, unnecessary starts or missing shutdowns.

Typical problems in real systems:

- Motor runs continuously instead of only when needed
- Switching times not synchronised → energy loss
- Sensors incorrectly positioned → incorrect responses
- Control system not flexible → no energy-saving mode possible

Method for teachers:

- Show a simplified flow chart or programme code (e.g. for a conveyor belt)
- Ask the group to evaluate:
    - "Is anything here running unnecessarily?"
    - "Could components be damaged?"
    - "How could energy be saved?"

Example:
A valve opens for 10 seconds – even though 5 seconds would suffice → 50% energy waste.

Step 3 – Improve control & identify automation potential

Objective: Students develop specific improvements and recognise how intelligent control systems make processes more ecological and economical.

Optimisation possibilities:

- **Cycle time reduction**: e.g. through parallelisation or demand-driven switching
- **Sensor optimisation**: more precise placement → better control decisions
- **Process optimisation via PLC**: e.g. only start the motor when a component is detected
- **Use of energy-saving operating modes**: e.g. shutdown after inactivity, sleep mode
- **Use of data for control**: e.g. temperature control instead of on/off control
- **Visualisation systems** for monitoring and targeted troubleshooting

Ecological impact:

- Less idling = less electricity = less CO_2
- Less wear and tear = longer component service life

Step 4: Reflection & application in your own business

Objective: Students apply their understanding of control systems to real-world systems and propose specific improvements.

Questions for reflection:

- Which machines in my environment run longer than necessary?
- Are there any repeatable processes that could be automated?
- Where could a simple control system (e.g. time relay, PLC, motion detector) help to save energy or materials?

Transfer exercise:

Develop a mini control concept for an everyday function (e.g. workshop door, ventilation system, washing area):

- What should be controlled and how?
- What sensors would be needed?
- How does the concept save energy/resources?

Appendix 1: Group task – Analysing and improving control

Situation description:
A packaging line operates as follows:

- Light barrier detects cardboard box →
- Conveyor belt runs for 10 seconds →
- Piston pushes product into chute →
- Valve opens compressed air blast →
- Process repeats every 30 seconds

Observed problems:

- Conveyor belt runs even without cardboard box
- Valve blows "empty" in 20% of cycles
- Product sometimes gets stuck, requiring manual intervention

Tasks:

1. Analysis:
Draw a diagram of the process (sequence of steps) and mark where energy or material is being wasted.

2. Suggestions for improvement:
Develop ideas for optimisation (e.g. sensor at cardboard box inlet, conveyor belt control only when needed, air blast depending on weight sensor).

3. PLC simulation (mental or software-based):
Design an improved process control system (pseudocode or simple terminal diagram logic).

4. Life cycle assessment & benefits:
Estimate:

- How many unnecessary movements/impulses are saved per hour?
- How much compressed air (in litres or euros) would be saved per day/year?
- What are the advantages in terms of service life, safety and the environment?

Appendix 2.1: Solution to Module 3 – Appendix 1: Analysing and improving control systems

Task 1: Draw the current status as a flow chart

Description as a sequence of steps:

1.Light barrier detects object
2.Conveyor belt runs for 10 seconds
3.Piston pushes
4.Air blast activated (always, regardless of actual position)
5.Wait 20 seconds → Cycle repeats

Identified weaknesses:

•Conveyor belt runs even without an object
•Air blast is always triggered
•No feedback from the piston (was the part transported correctly?)

Task 2: Suggestions for improvement

Revise sensor technology and process logic:

•Second light barrier at the end of the belt → detects whether the box has arrived correctly
•Only activate pneumatic cylinder when end position is confirmed by proximity sensor
•Air blast only in case of successful transport and positioning
•Replace conveyor belt time control with "signal on" + "signal off"

Additional measures:

•Conveyor belt only runs when needed
•Monitoring via counter → if 3 errors in a row → warning signal

Task 3: Simplified PLC design (pseudocode)

```
IF light barrier 1 = TRUE THEN
   Conveyor belt ON
ENDIF
IF light barrier 2 = TRUE THEN
   Conveyor belt OFF
   Piston EXTEND
ENDIF
IF Piston end position = TRUE THEN
   Air blast ACTIVE
   Wait 2 seconds
   Piston RETRACT
ENDIF
Wait until cycle ready = TRUE
```

Result:

•Reduced cycle time
•Actuators only run when needed
•More controllable process

Task 4:
Life cycle assessment & benefits

a) Calculate air blast savings:

Assumption:
•Current: 1 air blast/cycle (even without product)
•Optimised: 80% only when needed
•Air consumption per blast: approx. 10 litres
•Cycles/shift: 600
→ 600 × 10 L = 6,000 L = 6 m^3/shift
→ Savings: 20% × 6 = **1.2 m^3/day**

Compressed air costs: approx. €0.02/m^3

→ 1.2 × 0.02 = 0.024 €/day
→ ~5 €/month for 22 days → approx. **60 €/year**

b) Energy savings by switching off the conveyor belt:

•Savings: 10 s/30 s → 33% less running time
•Motor power: e.g. 0.37 kW
→ Savings: 0.37 kW × 4 hours/day × 33% = 0.49 kWh/day
→ 22 days × 0.49 = **10.8 kWh/month** = ~32 kWh/year
→ at 0.30 €/kWh = **9.60 €/year**

Total benefit:

•Less wear and tear
•Less energy
•Fewer malfunctions → greater efficiency
•Potential for further development

SOURCES

- Danfoss (n.d.): *9 tips for greater energy efficiency in drive technology*. Available online: danfoss.com danfoss.com.
- ALMiG Kompressoren (n.d.): *Reduce compressed air leaks and save energy costs*. (Guide) Online: almig.de almig.de.
- Fraunhofer Austria (n.d.): *Energy efficiency and flexibility in production*. Available online: fraunhofer.at fraunhofer.at.
- eMaint (n.d.): *Predictive maintenance: Increasing the reliability and efficiency of systems*. Online: emaint.com emaint.comemaint.com.
- ADM electronic (n.d.): *PLCs for controlling machines in the age of Industry 4.0.* Blog post. Online: adm-electronic.de adm-electronic.de.
- DUALIS GmbH (2023): *Energy cost consideration in production planning – sustainable optimisation of manufacturing processes*. APS blog article, 22 June 2023, online: dualis-it.de dualis-it.de.
- umweltdialog.de (2023): *Lean production for greater sustainability in companies*. Online: umweltdialog.de umweltdialog.de.
- ingenieur.de (2021): *Sustainably climate-neutral – and with a system*. Online: ingenieur.de ingenieur.de.
- Ruhr University Bochum Academy (n.d.): *Maintenance – Strategies*. Website: akademie.rub.de (current overview of maintenance strategies available)akademie.rub.de.
- Swiss Federal Office of Energy (no date): *Automation and electricity consumption*. RAVEL Industry, Smart Energy (PDF). Available online: bfe.admin.ch bfe.admin.ch.

Developed by:

Christian Hoffmann,
Ausbildungsverbund
Olefinpartner gGmbH

Co-funded by
the European Union



2.55. TITLE: Put to the test – researching optimisation opportunities and evaluating their impact.
Module 4: Optimisation through production planning.

PROCEDURE:

Steps	Time
Step 1: Introduction: Why is production planning more than just "when does what happen"?	10 min
Step 2: Recording production data & identifying bottlenecks	15 min
Step 3: Develop and evaluate optimisation measures	20 min
Step 4: Reflect and apply to your own business	10 min

OBJECTIVES:

Students learn how intelligent planning can save resources, energy and time – and how production processes can be made sustainable.



Group size:
at least 3 people



Materials: Printouts of the appendices, whiteboard, PC/laptop;



Remarks: -



Planned time: 55 min.

Step 1: Introduction: Why is production planning more than just "when does what happen"?

Objective: Students understand that production planning has a direct impact on costs, energy consumption and sustainability.

What does production planning mean in practice?

- Which machines, employees and materials are available and when?
- Which orders take priority?
- How do we avoid downtime, idle time, overtime or waste?

Practical example:

A CNC milling machine often stands idle in the afternoon because materials are not delivered on time. The result: hectic rush, rework, overtime.

→ Careful planning could have prevented this.

Typical elements of planning:

- Order sequence
- Material availability
- Machine utilisation
- Staff deployment
- Energy cost time windows (e.g. cheaper electricity at night)

Step 2: Collect production data & identify bottlenecks

Objective: Pupils learn how to observe and document processes and identify weaknesses.

What can be recorded?

- Running times (machine X: 6 hours/day)
- Set-up times (change from A to B: 30 minutes)
- Material flows (e.g. via Kanban or Excel)
- Reasons for downtime (e.g. 'waiting for material', 'maintenance', 'error message')

Analysis tools:

- Gantt chart (time planning)
- Ishikawa diagram (error causes)
- Value stream analysis (material + information)

Example analysis:

Machine A runs for 8 hours a day, but is idle for an average of 2 hours due to waiting time → 25% unused capacity!
→ Question: How can this idle time be reduced?

Step 3: Develop and evaluate optimisation measures

Objective: Students develop their own ideas for planning processes in a resource-efficient and effective manner.

Typical optimisation approaches:

- **Improve shift planning**: Distribute tasks more evenly across shifts
- **Smooth material flow**: just-in-time instead of large warehouses
- **Reduce machine changeovers**: through intelligent sequencing
- **Use break times as maintenance windows**
- **Consider energy costs**: e.g. schedule electricity-intensive processes during cheaper time slots

Ecological effect:

- Less idle time = less energy consumption
- Lower storage = less space consumption
- Less waste = less use of raw materials

Calculation example:
An order is executed in the morning instead of in the afternoon → electricity price drops from €0.30/kWh to €0.20/kWh.
Electricity requirement = 150 kWh → Savings = €15/day → ~€3,000/year

Step 4: Reflection & application to your own business

Objective: Students apply their knowledge to real-life business processes and suggest specific improvements.

Questions for reflection:

- Which processes in our company are inefficient?
- Where do delays or bottlenecks regularly occur?
- What information are we missing when planning?

Transfer idea:
The students create a mini production plan for a typical small series (e.g. switch box assembly).
They choose a sensible order sequence, plan breaks, set-up times and maintenance – and then evaluate:

"Where could we have saved energy, time or materials through better planning?"

Appendix 1: Group task – Optimising production planning

Situation description:

In your workshop, five machine operators must complete the following orders in one day:

Task	Machine	Duration	Set-up time	Materials ready?
A	M1	3	0.5	Yes
B	M2	4	0.25 hours	No (arrives at 12 noon)
C	M3	2	0.25	Yes
D	M1	5 hours	0.75 h	Yes

Tasks:

1. Create a production plan (daily overview)

→ What is the most sensible order? When do which machines need to be set up?

2. Record idle times

→ When is a machine idle? How could this be avoided?

3. Develop at least two optimisation ideas:

e.g.

- Have materials delivered in advance
- Swap orders to save set-up time
- Reschedule the order on the machine

4. Calculate energy savings (optional):

Electricity costs: €0.25/kWh in the morning, €0.15/kWh in the afternoon

→ Where does shifting to the afternoon offer an advantage?

5. Presentation (optional):

Present your plan and explain how it saves costs, time and resources. Use a flipchart or PowerPoint, for example.

Task 1: Create a daily schedule (Gantt-like)

Machine schedule (08:00–16:00)
Machine M1:
•08:00–08:30: Set-up for order A
•08:30–11:30: Order A (3 hours)
•11:30–12:15: Set up order D (0.75 hours)
•12:15–17:15: → **Job D** (5 hours) → ends **after shift ends**

Machine M2:
•08:00–12:00: **Idle** (material B missing)
•12:00–12:15: Set-up for order B
•12:15–16:15: Order B (4 hours) → ends **15 minutes after shift**

Machine M3:
•08:00–08:15: Set-up for order C
•08:15–10:15: Order C (2 hours)
•**10:15–16:00: Idle time** (unassigned)

Task 2: Analyse idle time

Machine	**Idle time**
M1	– (fully occupied, but overhang)
M2	4 hours (material not available)
M3	5 hours 45 minutes

Total idle time:
→ **9 hours 45 minutes**

Task 3: Two optimisation proposals

- **Suggestion 1: Bring forward the delivery of materials for order B**
- If materials for B were available at 8 a.m.:
    - Order B on M2 could start immediately
    - Completion on time at 12:00
    - No overtime
    - → **Savings: 4 hours of idle time**

- **Suggestion 2: Move order D to machine M3**
- After order C (end: 10:15), M3 would be free
- Order D (5 hours) can be carried out on M3
    - Set-up time: 0.75 hours → 10:15–11:00
    - Processing: 11:00–16:00
    - → **fits exactly into the shift!**

New optimised plan (abridged):

Machine	**Task(s)**	**Time**
M	A (08:00–11:30)	3 hours Production
M2	B (08:00–12:30)	4 hours of production
M3	C + D (08:00–16:00)	2 + 5 hours

→ Better utilisation of all machines

→ No overtime

→ No unnecessary downtime

Task 4: Energy savings through postponement

Assumption:

1 machine hour = 2.5 kWh

Electricity price:

Morning: 0.25 €/kWh

Afternoon: 0.15 €/kWh

Order D (5 hours): 5 × 2.5 = 12.5 kWh

Previously (morning + surplus):
12.5 × 0.25 = €3.13

After (completely in the afternoon):
12.5 × 0.15 = €1.88

→ Savings: €1.25 per day
→ For 200 operating days: **€**250/year

Task 5 (optional): Presentation

Key points for presenting results:

- Initial situation: 10 hours of idle time, overtime
- Measures: Material control + redistribution
- **Result:**
- Utilisation improved
- Idle time reduced to 0
- Energy + time saved
- CO_2 reduced through load shifting

SOURCES

- Danfoss (n.d.): *9 tips for greater energy efficiency in drive technology*. Available online: danfoss.com danfoss.com.
- ALMiG Kompressoren (n.d.): *Reduce compressed air leaks and save energy costs*. (Guide) Online: almig.de almig.de.
- Fraunhofer Austria (n.d.): *Energy efficiency and flexibility in production*. Available online: fraunhofer.at fraunhofer.at.
- eMaint (n.d.): *Predictive maintenance: Increasing the reliability and efficiency of systems*. Online: emaint.com emaint.comemaint.com.
- ADM electronic (n.d.): *PLCs for controlling machines in the age of Industry 4.0.* Blog post. Online: adm-electronic.de adm-electronic.de.
- DUALIS GmbH (2023): *Energy cost consideration in production planning – sustainable optimisation of manufacturing processes*. APS blog article, 22 June 2023, online: dualis-it.de dualis-it.de.
- umweltdialog.de (2023): *Lean production for greater sustainability in companies*. Online: umweltdialog.de umweltdialog.de.
- ingenieur.de (2021): *Sustainably climate-neutral – and with a system*. Online: ingenieur.de ingenieur.de.
- Ruhr University Bochum Academy (n.d.): *Maintenance – Strategies*. Website: akademie.rub.de (current overview of maintenance strategies available)akademie.rub.de.
- Swiss Federal Office of Energy (no date): *Automation and electricity consumption*. RAVEL Industry, Smart Energy (PDF). Available online: bfe.admin.ch bfe.admin.ch.

Developed by:

Christian Hoffmann,
Ausbildungsverbund
Olefinpartner gGmbH



Co-funded by
the European Union

Sustainable Vocational Education and Training
A Practical Handbook for Vocational Schools

Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the Foundation for the Development of the Education System (FRSE). Neither the European Union nor FRSE can be held responsible for tchem.

This publication is free of charge and is available under a Creative Commons CC BY-NC-SA 4.0 licence.





