Interreg
Baltic Sea Region

Co-funded by
the European Union

CIRCULAR ECONOMY
Circular spaces

Circular makerspaces:
training program

FOREWORD

Welcome to the training program on circular economy designed specifically for makerspaces! In a world where sustainability and resource efficiency are paramount, this program is tailored to empower makerspace enthusiasts with the knowledge and skills to thrive in the dynamic intersection of creativity and circular principles. Explore the essential concepts and working methods driving sustainable innovation and join us in reshaping the future of making through this immersive learning experience.

In the changing field of innovation, makerspaces play a crucial role in shaping the future of creative projects. As we navigate a world increasingly focused on sustainability and responsible resource management, the need for a circular mindset within makerspaces becomes ever more apparent. This circular training program is designed to empower makers with the knowledge, skills, and inspiration to infuse circular principles into their projects, fostering a community of innovators committed to both creativity and environmental responsibility. Welcome to a transformative journey, where making meets sustainability, and together, we shape a more circular and thoughtful future.

Circular Spaces Project Team

Empowering makerspace communities with a comprehensive view on circular economy principles, fostering sustainable innovation, resource efficiency, and a circular mindset

This education program was developed under the Circular Spaces project, funded by Interreg Baltic Sea Region programme 2021-2027

How to make use of this program?

Circular makerspaces training program consists of 9 Topics closely complementing each other. Topics 1-4 and 9 focus on building trainees' theoretical knowledge regarding different aspects of circular economy, while Topics 5-8 target practical application of gained insights.

1. Circular Economy and Sustainability
2. Waste as a Resource in Circular Economy
3. Circular Value Chains, Ecosystems, and People
4. Circular Business Models
5. Life Cycle Thinking and Environmental Footprint
6. Design Thinking for Circular Products
7. Reusability, Repairability, Recyclability
8. Integration of Circular Approaches into Everyday Work Life
9. Circular Economy Policies across Baltic Sea Region Countries

While the most benefits for trainees come from the exploration of all Topics, each trainer can decide individually how to structure their organization of trainings by utilizing different selected topics. Examples below suggest a few formations of such option.

Circular design-oriented training structure

- Waste as a Resource in Circular Economy
- Life Cycle Thinking and Environmental Footprint
- Design Thinking for Circular Products
- Reusability, Repairability, Recyclability

Circular behaviour-oriented training structure

- Circular Value Chains, Ecosystems, and People
- Circular Business Models Integration of Circular
- Approaches into Everyday Work Life
- Circular Economy Policies across Baltic Sea Region Countries

Introduction to circular economy training structure

- Circular Economy and Sustainability
- Integration of Circular Approaches into Everyday Work Life
- Circular Economy Policies across Baltic Sea Region Countries

Each Topic begins with methodological notes which serve as a guiding material for trainers during the preparation and the organization of training activities. These notes include a summary of each Topic, expected training outcomes, defined training benefits for different target groups, training plan and other necessary information for carrying out the training.

Action required tasks, such as discussions, workshops or case analyses, are marked with blue text and activity icon. It is up to the trainer to decide how these tasks will be carried out. For example, trainees can go through the theorical materials individually and implement action required tasks in groups.

Activity icon

In addition to this document, **each Topic is accompanied with slides** which can be utilized as a supporting material for trainers when presenting training content. The slides can be freely accessed **here**.

This document can be used both as an **instruction manual for the trainer** and as **informational material for the trainees**. Training organisers are invited to add their own insights, local best practices or creative practical exercises to the material presented.

Product Life Cycle and Ecological Footprint

Developed by
Valmiera Development Agency

Topic 5

Training Topic on "Product Life Cycle and Ecological Footprint" aims to deepen participants' understanding of sustainable business practices by exploring the concepts of Life Cycle Assessment (LCA) and Ecological Footprint. The material seeks to empower diverse target groups, including businesses, interest groups, and government institutions, with the knowledge and tools to integrate environmental considerations, circular economy principles, and eco-design strategies into their daily operations and policies, fostering a more sustainable and responsible approach to production and consumption.

Expected training outcomes

After completing this Topic, trainees will...

... deepen understanding of Life Cycle Assessment (LCA);

... be able to identify what the ecological footprint entails;

... be able to provide insights into the circular economy and its significance in sustainable production, development of product eco-design;

... deepen understanding in sustainable materials, resources, and technologies;

... be able to discuss the possibilities to enhance the selection process of materials and technologies in the context of sustainability.

Notes for target groups

Different target groups can achieve the following benefits of this training Topic.

Small and medium-sized enterprises (SMEs)

Specific examples and tips on incorporating LCA and circular economy principles into daily operations.

Business support organizations

Practical tools and resources to assist companies in adopting life cycle thinking.

Interest groups

Engagement in discussions on sustainable production and possibilities of life cycle thinking.

Regional government institutions

Discussions on regional initiatives and their impact on business.

Local government institutions

Suggestions on how to utilize life cycle thinking in local policies and project development.

Training plan

Introduction (20-30 min / 1-4 slides)	**Main part** (2-3 h / 5-27 slides)	**Conclusion** (1-2 h / 28-30 slides)
Provision of training program's goals, structure, and the significance of understanding product life cycles and ecological footprints.	Presentation of key concepts, analysis of real-life case studies that demonstrate the practical application of life cycle assessment and ecological footprint. Group workshops where participants collaborate on hands-on activities, such as conducting a simplified life cycle assessment for a specific product or brainstorming eco-design ideas. Panel discussons of guest experts.	Application of circular economy canva, participants' reflections on the training, experience sharing.
Icebreaker activities, presentation.	*Presentation, case-studies, group workshop, panel discussions.*	*Workshop, discussion.*

Total duration for the Topic 5: 4-6 h

Training modes

In person	**Online**
In-person training involves face-to-face sessions conducted in a physical location. This traditional approach allows direct interaction between trainers and participants, fostering real-time engagement, hands-on activities, and immediate clarification of doubts. It provides a social learning environment and is ideal for building interpersonal skills.	Online training is conducted through digital platforms, enabling participants to access content remotely. It offers flexibility in scheduling, self-paced learning, and the convenience of accessing materials from any location with an internet connection. Interactive modules, multimedia elements, and virtual simulations enhance the online learning experience.

Notes for the trainer

Required previous experience and theoretical knowledge	**Ethical aspects of carrying trainings**	**Training tools and resources**
Proven experience in teaching or lecturing, preferably with a focus on Product Life Cycle and Ecological Footprint. Strong theoretical foundation in Product Life Cycle Assessment and Ecological Footprint methodologies. Advanced knowledge in analysing and evaluating the environmental impact of products. A relevant academic degree, preferably in environmental science, sustainability, or a related field.	Inclusivity and diversity; transparency and honesty; voluntary participation; informed concept; confidentiality; trainer's competence; avoidance of discrimination and bias; feedback and continuous improvement. By adhering to these ethical principles, trainers can create a positive and inclusive learning environment that respects the rights and dignity of all participants.	*Presentation slides:* Develop visually appealing and informative slides to guide your presentations on each topic. Include graphics, charts, and key points to enhance understanding. *Interactive Workshops and Group Activities:* Design hands-on activities and group exercises to apply concepts learned during the program. This could include case studies, product life cycle assessments, and circular economy canvas.

Introduction

Let's begin with an exercise designed to foster alternative thinking skills and ignite the creativity of trainees. Such an exercise serves as a creative method to cultivate alternative thinking skills and inspire participants' creativity. It also provides an opportunity to rethink the use of existing items or resources and to come up with new, innovative approaches. This type of task is not only exciting and creative, but also promotes the development of new and innovative ideas, as well as facilitate group dynamics and cooperation.

Instructions for trainees

1. Find your teammate and split into pairs of two.
2. Choose an object and write on the piece of paper all the possible alternatives that could be done with this object.
3. When exchanging the ideas use these phrases - **Yes, and... Yes, or...**

Instructions for trainers

Here are some ways participants can interpret this exercise:

1. Writing: Training participants write all the possible alternatives that can be done with the chosen object. This can include both practical and creative ideas.
2. Thought cloud or sketches: Encourage participants to create mind maps or sketches to visualize their ideas and connections between them.
3. Group discussions: Individual work is followed by group discussions, where participants share their ideas and proposals.
4. Innovative approaches: Challenge participants to come up with innovative and unusual ideas, challenging preconceptions about the use of the subject.

Nature and principles of life cycle assessment

Product life cycle assessment (in English - life cycle assessment or LCA) is a scientific method that allows a comprehensive assessment of the product's impact on the environment, natural resources and human health. A full life cycle assessment examines these impacts in their full cycle, that is, from the extraction of all the necessary raw materials to what and how happens to the product when it has reached the end of its useful life and has become waste.

The essential components of a life cycle assessment include:

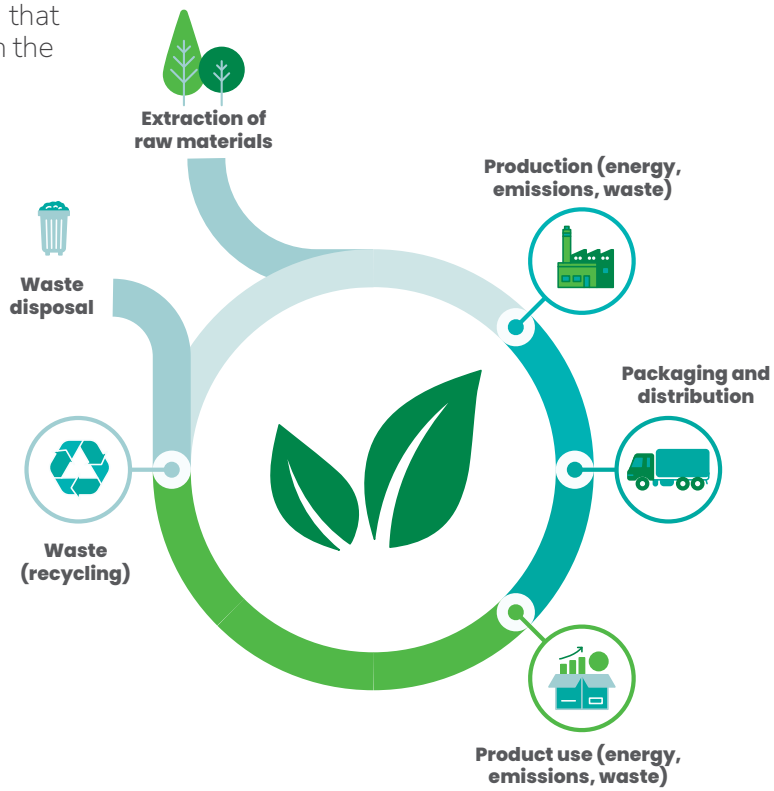
Extraction and processing of raw materials: At this stage, the raw materials needed to create products or services are analyzed. This includes extracting raw materials from nature and transporting them to the manufacturing site.

Production: At this stage, energy consumption, emissions and use of resources in the production process are evaluated. This includes both the evaluation of production technologies and the pollution caused during operation.

Usage: In this phase, the use of the product and the related impacts, such as energy consumption and emissions related to the use of the products or services, are analyzed..

Waste management: This stage evaluates how products or services are managed after their end of life. This includes waste processing, recycling methods and reuse of raw materials.

The purpose of life cycle assessment is to identify environmental aspects related to the life cycle of products or services and to provide information to producers, consumers and other stakeholders about environmental impacts. This information makes it possible to develop and choose more sustainable solutions that would reduce the negative impact on the environment.



LCA Software Tools

Life Cycle Assessment (LCA) software tools are designed to assess the environmental impacts of products and processes throughout their entire life cycle. These tools help organizations make informed decisions to reduce their ecological footprint.

When selecting an LCA software tool, organizations should consider factors such as the complexity of their analysis, the availability of databases, and the specific environmental impact categories they want to assess. Additionally, user training and support are crucial for effective utilization of these tools.

- **Ecochain** provides LCA software that helps companies measure, monitor, and reduce their environmental footprint. It offers features for product sustainability assessment and supply chain analysis.
- **OpenLCA** is an open-source LCA software that allows users to model and assess the environmental impacts of products and processes. It offers a wide range of features and databases.
- **SimaPro** is a widely used LCA software that enables users to conduct life cycle assessments, including impact assessment methods, scenario analysis, and reporting.
- **PRé Sustainability** offers LCA software solutions such as SimaPro and supports organizations in implementing sustainable practices through life cycle thinking.

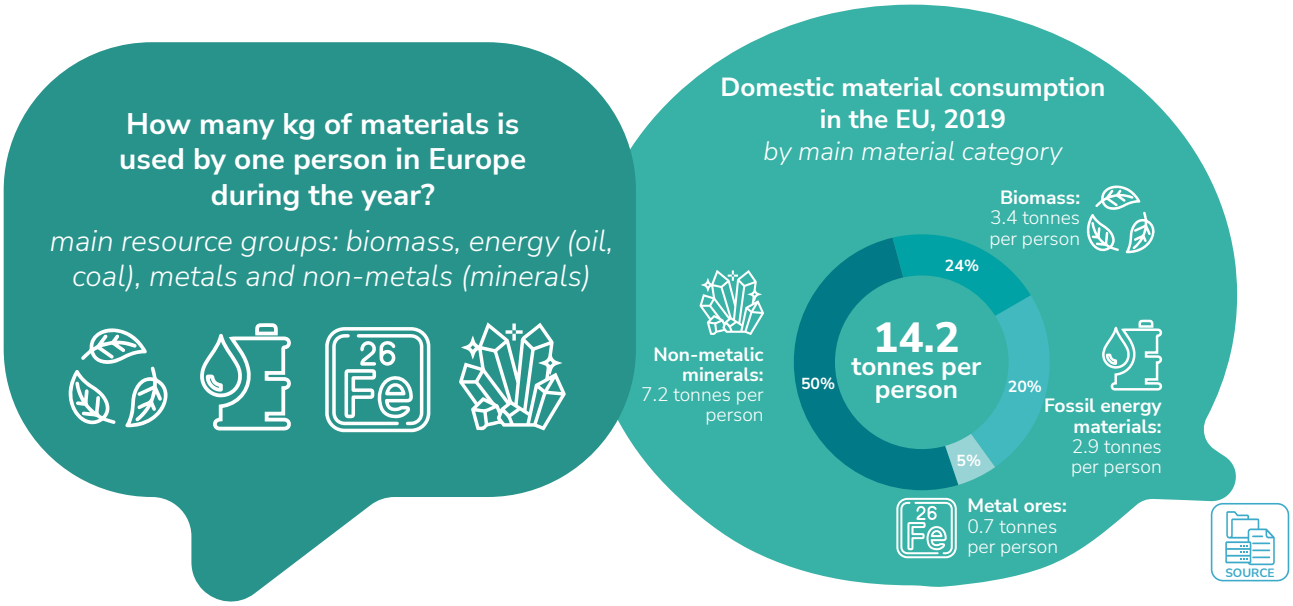
Ecological footprint

Ecological footprint is a measure of an individual's or organisation's impact on the environment, taking into account all aspects of its activities and consumption. This includes resource consumption, energy use, and the amount of emissions generated by the production of goods or services and captured during both production and usage.

The main elements of the ecological footprint are:

- **Life cycle stages:** Similar to life cycle assessment, the ecological footprint takes into account all stages from the extraction of raw materials to waste management in order to determine the full impact on the environment.
- **Resource consumption:** In this context, it is evaluated how many natural resources are needed for the production and use of the specific activity or product. This includes the amount of raw materials, water use, land use, etc.
- **Energy consumption:** Assesses energy use, including electricity and other forms of energy used in the production.
- **Emissions:** Covers greenhouse gas emissions and other forms of pollution associated with the specific activity or product.
- **Waste management:** Includes information on how waste is managed at the end of the product's life and how much waste is generated.

The purpose of the ecological footprint is to provide an overview of the environmental impact of a specific activity or product. It helps both individuals and organizations to understand and reduce their environmental impact through sustainable choices and actions. Thus, this measurement is an important tool to move towards a more sustainable and environmentally friendly lifestyle.



In 2022, the domestic material consumption of the EU economy remained relatively stable at around 14.5 tonnes per person, indicating a very slight increase of 0.4% compared with 2021 (14.4 tonnes per person). Since 2000, the EU reduced its domestic consumption of material by 0.9 tonnes per person.

By calculating how many kilograms of biomass, energy, metals and non-metals one person in Europe uses per year, could give an estimate of their ecological footprint. The Ecological Footprint is an indicator that measures the impact of human consumption and lifestyle on natural resources and ecosystems. It gives a rough idea of how much land and resources people use to meet their housing, food, clothing, energy and other needs.

Sustainable design

Why do we need sustainable design and circular economy principles?

1. To reduce greenhouse gas emissions (product production/industry is responsible for 45% of emissions).

2. To reduce plastic production (dependency on petroleum raw materials) and thus plastic consumption and pollution.

3. To make more valuable use of depleting resources.

Sustainable design and circular economy principles include environmental, economic, and social aspects. They:

- Promote resource efficiency, recycling, and reuse, which helps reduce waste and resource depletion.
- Reduce the negative impact on nature, water resources, and biodiversity.
- Improve energy efficiency, which helps reduce energy consumption and emissions that contribute to climate change.
- Promote changes in businesses and consumers behavior towards sustainable production and consumption.
- Contribute to economic stability by introducing innovative solutions in business that reflect social, environmental and economic goals.

These principles are not only part of the business strategy, but also reflect the broader sustainability goals of society and our planet. Their implementation is important to reduce the negative impact on the environment and social well-being, promoting sustainable development in business and communities.

Sustainable materials and technologies

Life Cycle Assessment (LCA) and the use of sustainable materials and technologies are closely connected, as both play pivotal roles in evaluating and promoting environmentally responsible practices. With LCA, you can evaluate the environmental impacts of your product or service from the very first to the very last stage of its life cycle, or at any stage in between.

- Identification of Environmental Hotspots: LCA helps identify the stages of a product's life cycle with the highest environmental impact. By understanding these hotspots, businesses, and industries can focus on optimizing and adopting sustainable materials and technologies in those critical areas.
- Decision-Making Tool: LCA serves as a valuable tool for decision-making, allowing companies to compare the environmental performance of different materials and technologies. It helps in selecting options that align with sustainability goals.
- Continuous Improvement: The data obtained from LCA can guide continuous improvement efforts. Companies can use this information to innovate and find more sustainable alternatives for materials and technologies at each stage of the life cycle.
- Promotion of Circular Economy: LCA emphasizes the importance of considering the entire life cycle of a product. This aligns with the principles of a circular economy, encouraging the reuse, recycling, and reduction of waste, which often involves the use of sustainable materials and technologies.
- Resource Efficiency: Sustainable materials and technologies are often associated with increased resource efficiency. LCA helps quantify resource use at different stages, highlighting areas where resource efficiency can be improved through the adoption of sustainable practices.

In summary, the integration of LCA and the use of sustainable materials and technologies is crucial for making informed decisions, reducing environmental impact, and moving towards a more sustainable and circular approach in product development and production processes.

Discussion

Sustainable materials and technologies aim to reduce the negative impact on the environment, reduce resource consumption, and promote sustainable development.

What in your opinion are sustainable materials and technologies?

The following examples show that sustainable technologies and materials can cover a wide range of industries and provide solutions to environmental problems, reducing negative impacts on nature and promoting sustainable development.

Sustainable materials

Biodegradable plastic substitutes: PLA and PHA which are biodegradable and made from natural raw materials such as corn or sugar beet.

Use of organic fabrics and textiles: Hemp, bamboo and other organic fabrics grown using sustainable methods, such as without pesticides or artificial fertilizers.

Recyclable raw materials: Materials that can be recycled and reused, such as recyclable plastics, glass, metals or paper.

Natural wood and fiber materials: Wood, fiberboard or boards that come from sustainable forestry practices.

Bioplastics and biodegradable raw materials: Biodegradable plastics or biopolymers that are made from biological sources and can break down naturally without accumulating long-term environmental waste.

Recyclable and reusable metal raw materials: Recyclable steel or aluminum that can be reused, reducing the need for new resources.

Technologies of renewable energy sources:

Use of solar and wind energy and other renewable energy technologies to reduce dependence on fossil fuels and reduce greenhouse gas emissions.

Energy efficiency technologies:

Innovative technologies that help reduce energy consumption, such as energy-efficient equipment and lighting solutions.

Virtual and augmented reality for sustainable education:

Technologies that offer virtual and augmented reality experiences to promote education about environmental protection and sustainable lifestyles.

Blockchain technologies for sustainable origin labelling:

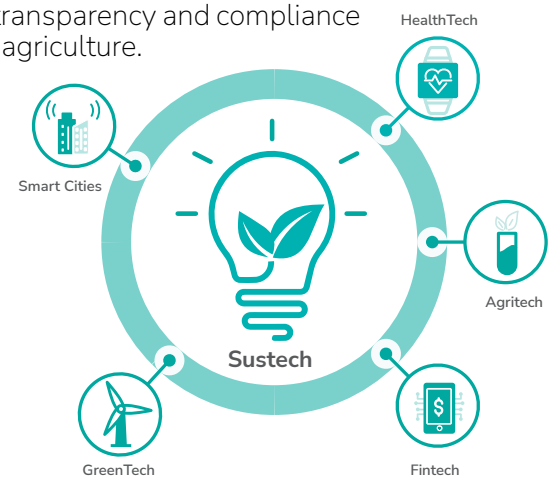
The use of blockchain to mark the origin of products to ensure transparency and compliance with sustainability standards such as fair trade or sustainable agriculture.

Using the Internet of Things (IoT) for resource efficiency:

Using IoT to optimize the use of resources, such as energy efficiency at home, water consumption monitoring or logistics optimization.

Sustainable use of 3D printing:

Using 3D printing technology to create customized and efficient products, reducing material residues and waste.



Examples

Consumer goods from secondary resources

The purchase of second-hand goods reduces the need for new resources as it utilizes existing items, thereby promoting sustainable resource use. It eliminates the necessity for new products and helps prevent the formation of waste. Companies (both Latvian and global) for which the ecological footprint and product life cycle are important:

Andele Mandele (Latvia): is an example where users can sell and buy clothes, goods, etc. from others, promoting long-lasting use of goods.

Patagonia: This company specializes in outdoor clothing and offers a "Worn Wear" program where people can sell or buy used Patagonia clothing.

The RealReal: This online store specializes in upcycled luxury clothing and accessories.

Refurbishment and repair of electronics

Refurbishment and repair of electronics align with LCA principles by focusing on extending product life, reducing environmental impact, conserving resources, minimizing waste, improving energy efficiency, and considering the entire life cycle of electronic devices. These practices contribute to more sustainable and responsible consumption patterns in the electronics industry. Companies specializing in the repair and restoration of appliances, mobile devices.

iFixit: offers tools and guides to help users repair their mobile device themselves, promoting long-term use.

Modular furniture

Modular furniture is designed with interchangeable and customizable components, allowing users to reconfigure or add elements without replacing the entire piece. This promotes resource efficiency by reducing the need for new materials and minimizing waste associated with furniture production. LCA emphasizes the importance of prolonging the use phase of products. Modular furniture is designed for adaptability, allowing it to evolve with changing needs and styles. This extends the product's life cycle, reducing the frequency of disposal and the associated environmental impact.

IKEA: the company has incorporated modular elements into its designs, allowing customers to customize their furniture as needed and change its appearance.

Transportation ecosystem

Car-sharing solutions contribute positively to LCA when they promote shared rides, reducing the number of individual vehicle trips and optimizing the use of available vehicles. Encouraging users to choose shared rides, opt for electric vehicles, or adopt eco-friendly travel practices contributes positively to sustainability. Transitioning to electric or low-emission vehicles powered by renewable energy sources can significantly reduce the carbon footprint associated with the transportation service.

Bolt, Uber or Lyft - are safe and convenient car sharing solutions.

Sustainable sports shoes

The use of completely recyclable and reusable materials in the **Adidas Futurecraft. Loop** collection is a key LCA consideration. Designing products with recyclability in mind reduces the environmental impact associated with the extraction and processing of raw materials. Glues and adhesives can contribute to environmental harm, and by avoiding them, Adidas reduces the environmental impact during production and facilitates easier disassembly and recycling. The Futurecraft.Loop collection addresses the end-of-life phase by implementing a return and recycling program. This closed-loop system helps minimize the environmental impact associated with the disposal of used shoes and encourages the reuse of materials.

Biological packaging

LCA assesses the energy and resource consumption throughout the life cycle. Recyclable packaging has a lower environmental impact compared to non-recyclable alternatives if it requires less energy and fewer resources in production, transportation, and disposal. LCA promotes the reduction of environmental impacts associated with waste. Recyclable packaging solutions aim to reduce the amount of packaging waste sent to landfills. This aligns with the principles of a circular economy by keeping materials in use for as long as possible.

V.L.T (Latvia) company specializes in the production of egg boxes and transport pallets using 100% recyclable material - waste paper.

Rēzekne meat plant (Latvia) uses 100% recyclable packaging material.

The company **EcoEnclose** (USA) offers biodegradable and recyclable packaging solutions that can be used by entrepreneurs to package their products, thus reducing the impact on the environment.

Workshop I

Taking into account the product life cycle, ecological footprint and circular economy principles, develop a product concept, for example:

- work table;
- raincoat;
- mobile phone holder;
- storage box.

Instructions:

1. Find your teammate and split into pairs of two.
2. Taking into account the principles of the product life cycle, ecological footprint and circular economy, develop a product concept.
3. Discuss the results in the group.

Workshop II

By using circular economy canvas (available for download here) map your own product or those created from during workshop I. It is important to be aware of the impact on the environment, to understand each step, to evaluate the benefits. Objective: to develop a sustainable solution for the product. Find a balance between economic viability, ecosystem and sustainability.

Instructions:

1. Choose a product.
2. Determine what is your MISSION in developing this product?
3. Put the big picture together - what is the VALUE PROPOSITION for your product? What makes it better? What else?
4. What materials will be needed for your product?
5. What could be the future life of the product?
6. What "PLAYERS" should be involved to make such a product possible?
7. Who is your client?
8. What positive, negative effects may arise from your actions?

A story of experience

Invite a representative from a company that has succeeded in implementing innovative and sustainable practices, e.g., an inspirational story that reflects the experience of implementing sustainable innovations and operating on circular economy principles. The aim of this activity is to engage and encourage others to implement sustainable practices in their company and to think about the life cycle of the product, the ecological footprint.

Additional resources

Books:

- "Cradle to Cradle: Remaking the Way We Make Things" by William McDonough and Michael Braungart
- "The Upcycle: Beyond Sustainability—Designing for Abundance" by William McDonough and Michael Braungart
- "The Circular Economy: A Wealth of Flows" by Ken Webster

Reports and Guides:

- Ellen MacArthur Foundation. (2015). "Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition."
- United Nations Environment Programme (UNEP). (2011). "Towards Sustainable Production and Use of Resources: Assessing Biofuels."

Academic journals and reports:

- Rebitzer, G., Ekvall, T., Frischknecht, R., Hunkeler, D., Norris, G., Rydberg, T., & Schmidt, W. P. (2004). "Life cycle assessment: Part 1: Framework, goal and scope definition, inventory analysis, and applications." Environment International, 30(5), 701-720.
- Wackernagel, M., & Rees, W. (1996). "Our Ecological Footprint: Reducing Human Impact on the Earth." New Society Publishers.

Online Resources:

- Life Cycle Initiative: A platform providing guidance and tools for life cycle assessment.
- Global Footprint Network: Resources and data on ecological footprint measurement.

Industry Guidelines and Standards:

- ISO 14040:2006 - Environmental management - Life cycle assessment - Principles and framework.
- ISO 14044:2006 - Environmental management - Life cycle assessment - Requirements and guidelines.

Government Publications:

- Environmental Protection Agency (EPA). (2014). "Life Cycle Assessment: Principles and Practice."
- European Commission. (2013). "Guide to the Integration of Life Cycle Thinking into Business Management."

Educational Platforms:

- MIT OpenCourseWare: Life Cycle Assessment: Open-access course materials on life cycle assessment.

Conference Proceedings:

- Proceedings of the International Conference on Life Cycle Assessment in the Agri-food Sector (LCA Food) or other relevant conferences.

Online Courses:

- Coursera: Introduction to Sustainability and Development: A course covering sustainability principles and their application.

Trade Journals:

- Explore journals related to sustainable business practices, such as the "Journal of Industrial Ecology" or "Sustainability Science."