EU4GREEN

DRAFT TRAINING CONCEPT: THE PATH TO A CIRCULAR ECONOMY IN THE MUNICIPALITY

The way of transitioning from a take, make, waste economy to a circular economy and the steps municipalities can take.

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INTRODUCTION

The provided draft materials were developed as part of the EU4Green Project, to support the Albanian Ministry of Tourism and Environment in providing training on relevant topics of circular economy for municipalities.

Basis for the materials were two workshops held in the municipalities Vlora and Shkodra in Albania in May of 2024 to assess the knowledge gaps concerning circular economy. Additionally, a questionnaire in Albanian was circulated to further narrow down possible interest and assess the current situation within the municipalities.

Based on this assessment, it was agreed within the Ministry that the following topics would be highlighted:

- What is circular economy?
- What is green public procurement, how can this be done and what are best-practice examples?
- How can circular economy (CE) businesses be supported by the municipality including best practice examples (short excerpt)?
- Biological waste treatment – based on pre-existing material (developed only as concept).

The training materials are developed based on available material and largely draw inspiration from the training course developed by Zwiauer (2023) and the guidelines developed by Stoifl and Broneder (2024). Session 5: Biological Waste Treatment and the chapters on anaerobic and aerobic treatment are largely based on Kranert and Cord-Landwehr (2010) and Pinasseau et al. (2018).

A tailor-cut training based on this document will be tested during the on-site training and shall be evaluated of further improve the learning materials at hand.

DESCRIPTION

This course addresses the implications of the predominant linear economic system, the approaches to a transformation towards a circular economy. The principles of the circular economy, raw material dependencies, selected key areas and the challenges associated with the transformation are dealt with in depth. Moreover, focus is given to specific strategies that can be used to make a transition to a more circular economy.

Learning Objectives

After completing this course, you shall be able to:

- explain the difference between the linear economy and the circular economy (CE)
- explain the necessity of the circular economy
- define key terms and key areas from the circular economy
- explain international and national strategies
- describe / implement possible solutions (green public procurement, supporting business, composting)
- name obstacles and necessary steps for implementation
- identify the role of biological waste treatment in a waste management system
- explain relevant processes of biological waste treatment

Key concepts

The course consists of 5 sessions, in which central aspects of circular economy are addressed.

- What is circular economy?
  - General introduction
  - International and national strategies
  - Principles of circular economy
  - Challenges in the transition
- Green public procurement (Key areas for circular economy transition in municipalities
  - General introduction
  - Modes of implementation and best-practice examples (including energy saving measures and food waste reduction measures that can be done by the municipality within their buildings)
- Supporting businesses (best practice examples) (short excerpt)
- Biological waste treatment – based on pre-existing material (developed only as concept).

Target audience

This course is aimed at people working in local government/the municipality and local decision makers. No special prior knowledge is required for the course.

Course Organisation

In the course material, a wide range of materials such as texts, images, videos, practical examples, reading tips, etc., are provided, offering the opportunity to develop a deeper understanding of the topic of the circular economy. Depending on the structure of the training plan, these can be integrated into the teaching modules and discussed with the participants.

Practical examples, in-depth texts, videos, reading tips, etc. are generally optional and not crucial for overall understanding.

It is recommended to allow room for discussion as part of the teaching method so that understanding can be further deepened, and participants can exchange ideas with each other.

The individual key concepts und their sub-chapters contain suggestions for knowledge checks to deepen the information conveyed in the blocks. A score of 80% or higher on each knowledge check is regarded as a passing grade, indicating a thorough understanding of the topics covered..

Course duration: 10 hours

Session 1: Around 2 hours including videos, discussion and the knowledge check

Session 2: Around 1.75 hours including discussion, viewing websites and the knowledge check

Session 3: Around 1.75 hours including discussion and brainstorming and the knowledge check

Session 4: Around 2 hours including videos, discussion, selection of best practice examples and the knowledge check

Session 5: Around 2.5 hours, including videos, studying main background documents and knowledge check

SESSION 1: WHAT IS CIRCULAR ECONOMY

The first session is dedicated to understanding the current economic system and its implications. It also includes the definitions of Circular economy, what exactly it means and why it is needed.

We start with a description of our currently dominant linear economic system and its implications. Specifically, the developments in global and European-wide resource consumption and the resulting consequences will be discussed.

Linear vs. Circular Economy

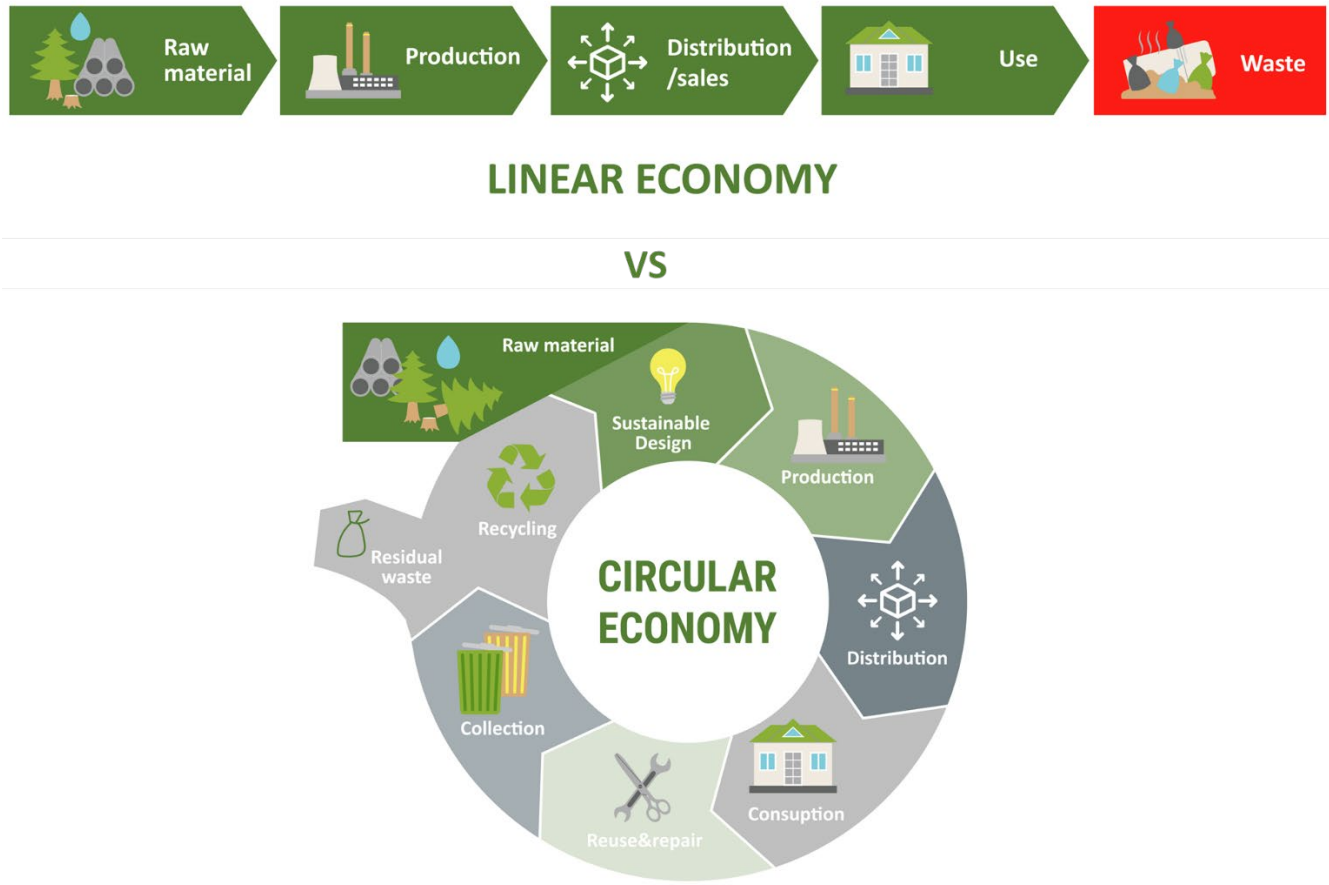

Figure 1: Linear vs circular economy

Source: EU4Green

As shown in Figure 1, the figure signifies our current linear economic system and our „careless" use of resources. This system is thus also known as "throw-away economy" or "take-make-waste" economy. The underlying principle is cheap production in large quantities utilizing (fossil) fuels and inexpensive raw materials for a short service life, without the means of repair or reuse.

The second part of the picture above shows what a circular economy can look like. The principle here is a considerate use of resources, starting from the mining process through the design of a

product or service, all the way to the usage stage – where the core principle is to keep the product in the loop for as long as possible.

VIDEO BY THE ELLEN MACARTHUR FOUNDATION EXPLAINING CIRCULAR ECONOMY AND HOW SOCIETY CAN RE-THIN PROGRESS

Source: © EllenMacArthurFoundation, 2011

Current Material Consumption

We are aware that the materials consumed can be used as an indirect measure (a proxy) for the environmental harm caused.

Our current prosperity as well as the economic and social progress, which has been achieved in the last centuries, was largely accompanied by environmental degradation which is also endangering our future development. Globally increasing amounts of natural resources consumption are used to support the economy, however, as stated by the UN, the efficiency with which these resources are used, has not changed, thus economic growth is connected to natural resource use. For example the handling and use of materials contributes around 70% of global greenhouse gas emissions and extraction and use of materials is responsible for more than 90% of biodiversity loss and water stress (Fraserm et al., 2024). From 2016 to 2021 the global economy has used 582 billion tons of materials – which is almost the same amount of materials consumed throughout the entire 20th century. This consumption rate puts unsustainable pressure on the ecosystem also considering that the planet cannot sustain infinite growth in material consumption.

Means to measure the current consumption and the status of circularity within a society are the material footprint, the domestic material consumption, municipal waste quantities and the circularity rate.

Material Footprint

Material footprint quantifies the amount of raw materials needs to meet a country`s consumption and investment demands. It includes the material footprint for biomass, fossil fuels, metal ores and non-metal ores. It also takes into account the upstream material consumption of imports and exports.

Learn more: https://www.unep.org/explore-topics/sustainable-development-goals/why-do-sustainable-development-goals-matter/goal-12-1

Domestic Material Consumption (DMC)

The DMC refers to the annual quantity of raw material extracted from the domestic territory, plus all physical imports minus all physical exports. It quantifies the amount of materials directly used within an economy.

Learn More: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Domestic_material_consumption_(DMC)

In Albania, the DMC in 2022 reached 21.4 million tons which is an increase of 5.7 % compared to 2021 (INSTAT, 2024) possibly due to an increase in the use of metal ores (OECD, 2024a). This value is below average compared to the EU27 average of 232.3 million tons (Eurostat, 2023b). Albania's DMC is dominated by biomass and non-metallic minerals (OECD, 2024a). The biomass share is higher than in the EU as Albania has a high share of agriculture and firewood is used for various heating applications (IRENA, 2021; OECD, 2024a).

Municipal waste generated

"Municipal waste consists of waste collected by or on behalf of municipal authorities and disposed of through waste management systems. Municipal waste consists mainly of waste generated by households, although it also includes similar waste from sources such as shops, offices and public institutions" (Eurostat, 2023a).

The volume of waste also highlights the scale of resource consumption.

For Albania, 295 kg per capita were reported. The EU (27) average lies at 513 kg per capita (Eurostat, 2024).

Circular Material Use Rate (CMUR)

The CMUR reflects the circularity of materials within the economy. It represents the proportion of total material consumption in the economy that comes from recycled waste. By raising the CMUR – either by increasing recycled waste or decreasing material usage – we can reduce the extraction of primary resources for production and thus mitigate negative environmental and climate impacts (European Environment Agency, 2024). The current circular material use rate in the EU is 11.8 %.

Country Overshoot Day

The Global Footprint network calculates the so-called „Overshoot Day“ for various countries. The Overshoot Day indicates the day in which natural resources available each year within a country's CO_2 budget are used up. In 2024 Albania reached this day on September 23.

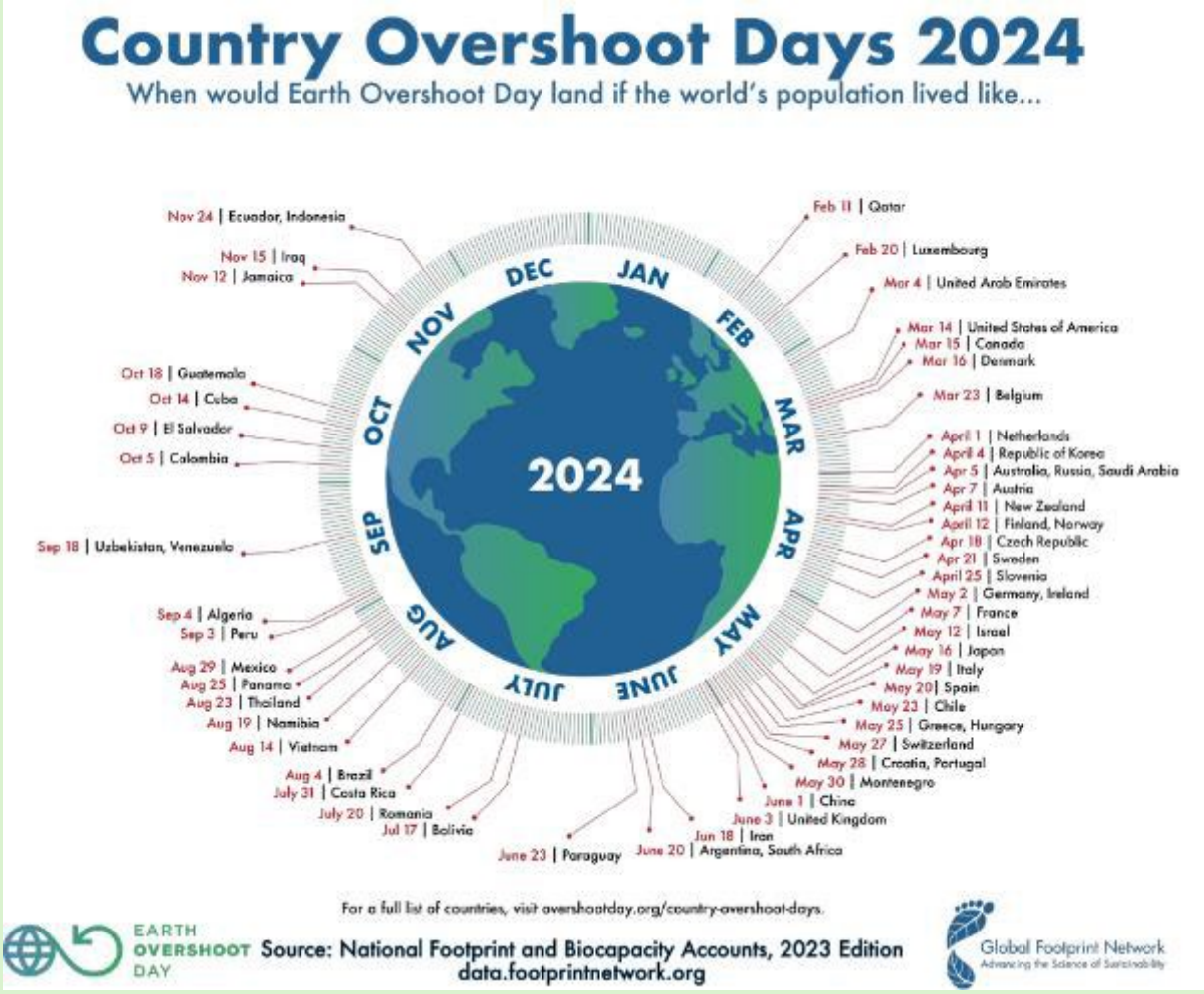

Figure 2: Country Overshoot Days in 2024

Source: Global Footprint Network, 2024

Why the shift to a circular economy?

The environment must be protected

Circular economy practices can help to slow down the consumption of natural resources, minimize landscape and habitat disruption, and contribute to limiting biodiversity loss. Furthermore, adopting circular economy practices leads to a reduction in greenhouse gas emissions (European Parliament, 2023).

Designing more sustainable products helps decrease energy and resource consumption, as it is estimated that beyond 80% of a product's environmental impact is determined during the design phase. Lastly, by reusing, repairing, upgrading, and recycling, we can significantly reduce waste (European Parliament, 2023).

Resources are finite

The vast majority of raw materials entering the economy are virgin. The share of secondary materials has shown steady decline since the Circularity Gap Report began measuring it with a decrease of 1.9 % from 2018 to 2023. At the same time the amount consumed has risen (Fraserm et al., 2024) and the increasing global population drives higher demand for raw materials, but the availability of essential resources remains limited. Consequently, some countries rely on imports from other nations for their raw materials. For example, the EU imports approximately half of the raw materials it consumes (European Parliament, 2023). In Albania, raw materials include minerals (chrome and copper), charcoal, crude oil, oil by-products, natural gas, hydropower as well as timber and fuel wood. As of 2015 waste-derived secondary materials currently only focus on scrap-metal by private businesses (European Environment Agency, 2016). 2018 the recycling industry has improved, however only using 26.8 % of its production capacity due to the lack of raw materials. Given this, Albania also relies on imports of certain raw materials/products for production and user consumption (European Environment Agency, 2019).

Recycling materials plays a crucial role in mitigating supply-related risks, such as price fluctuations, availability challenges, and import dependency. This is particularly relevant for critical raw materials essential for producing technologies that contribute to achieving climate goals, such as batteries and electric engines (European Parliament, 2023).

The following map developed by Geological Survey of Sweden shows the global production of critical and strategic raw materials (CRM/SRM) (SGU, 2023).

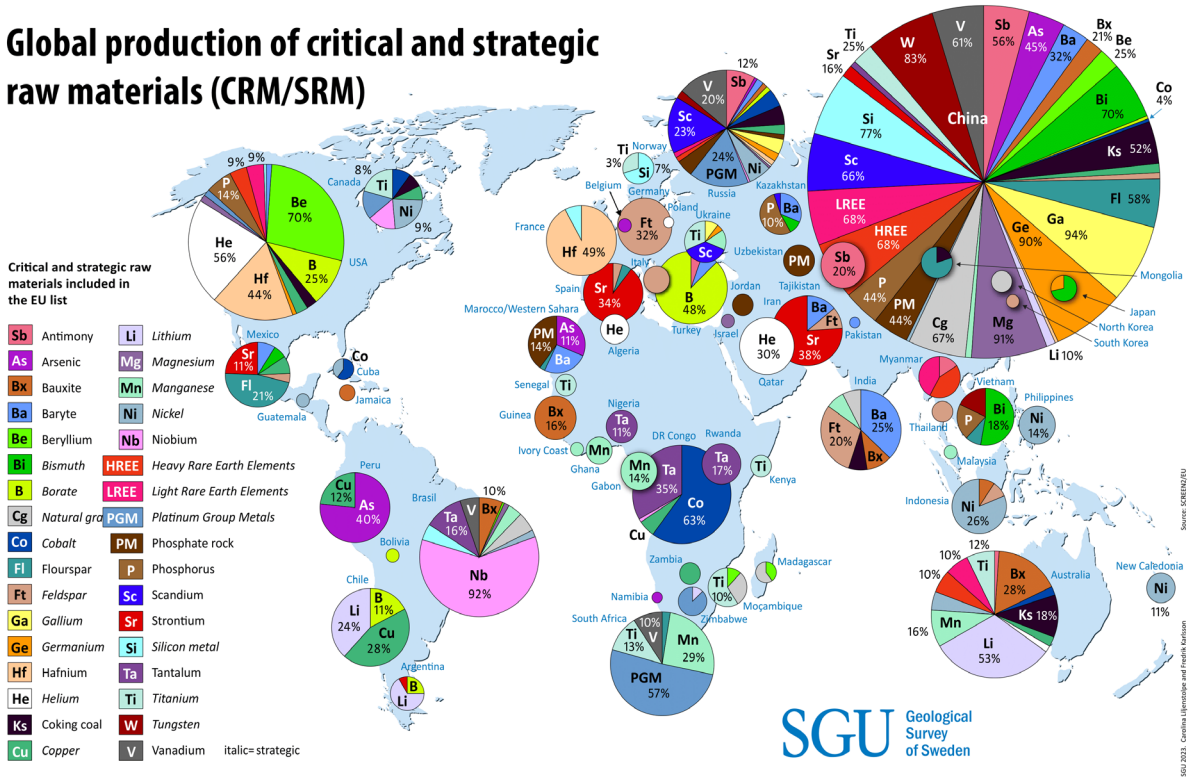

Figure 3: Map of the global production of critical and strategic raw materials

Source: SGU, 2023

The website from the International Energy Agency also provides and interactive overview of global demand projections for 37 critical minerals needed for clean energy transitions across the 3 main IEA scenarios and 11 technology-specific cases.

Within a circular economy, materials shall either be reused or recycled and waste avoided. This means that product design must be done in a way that products are durable and can be produced in a resource-efficient way, meaning that at the end of their use, minimal waste is produced and minimal resources are wasted. The raw materials contained shall be recovered.

Jobs can be created and money saved

Transitioning toward a more circular economy has the potential to enhance competitiveness, foster innovation, drive economic growth, and generate jobs. By 2030, the EU alone could create approximately 700,000 jobs through circular practices (European Parliament, 2023).

Rethinking materials and product design to align with circular principles will also spur innovation across various sectors of the economy. Consumers will benefit from longer-lasting, innovative products that enhance their quality of life while delivering long-term cost savings (European Parliament, 2023).

Knowledge check

Within the knowledge check, questions for the participants are proposed, which can be used. The correct answer is indicated in bold.

1) Today's economy is based on the following principles: Products are produced in large quantities, primarily with cheap (fossil) energy and cheap raw materials; in most cases, products have a short useful life and are designed in such a way that they cannot be repaired or reused and, in many cases, cannot be recycled.
   True/False (Points: 1)
2) The circularity rate indicates how many primary raw materials are used by the industry.
   True/**False** (Points: 1)
3) Raw material dependencies can be reduced through a circular economy.
   True/False (Points: 1)
4) What does linear economy mean? Which of the following statements applies to the term linear economy? (multiple answers possible)
   a) Linear economy means above all transparency in supply chains. (Points: 0)
   b) In a linear economic system, goods are produced and disposed of again after a short period of use. (Points: 2)
   c) A linear economy is mainly based on cheap (fossil) energy and raw materials. (Points: 2)
   d) In a linear economic system, repair and reuse are important principles. (Points: 0)
5) What does circular economy mean? Which of the following statements are true? (multiple answers possible)
   a) In a circular economy, materials are recycled. (Points: 2)
   b) In a circular economy, the recycling process is the prioritised approach. (Points: 0)
   c) In a circular economy, co-operation along the entire value chain and product design are key tools. (Points: 2)
6) When did Albania reach Country Overshoot Day in 2024?
   a) In September (Points: 4)
   b) In December (Points: 0)
   c) In August. (Points: 0)
7) Why is it necessary to switch to a circular economy? (multiple answers possible)
   a) Because the global economy is currently only 11.8 % circular and resources are not infinite. (Points: 2)
   b) Because a linear economy also means resource dependency. (Points: 2)
   c) Because in future every EU member state will be able to operate self-sufficiently with a circular economy. (Points: 0)

Additional learning material:

We recommend the following websites and videos:

https://www.europarl.europa.eu/thinktank/infographics/circulareconomy/public/index.html gives and overview including info graphics on material stock and supplies, waste generation, “R strategies” (see also session 2) and the EU actions.

SESSION 2: LEGISLATIVE FRAMEWORK AND PRINCIPLES OF CIRCULAR ECONOMY

The first part of session 2 addressed the basic principles of circular economy. Showing that circular economy means more than waste separation, management and recycling.

Within the second part you will find out which political efforts are being made at European and national level to promote a transformation towards a circular economy. You will be given an overview of legislative measures that have already come into force, what regulations are planned and which areas are to be covered. Links are provided for further reading but are not necessary for the overall understanding.

Principles of Circular Economy

The circular economy is much more than just recycling. The basic principles of the circular economy are to minimise the consumption of primary raw materials, by either making products superfluous and keeping existing products in use for as long as possible by means of repairing them or, if this is no longer possible, reusing parts or materials in other products. Only when this is no longer possible are the products recycled and the rest thermally utilised. Oftentimes in context with circular economy the R-strategies, sometimes also referred to as the R-Hierarchy or the R-Ladder, are used. These can be useful tools for visualising and understanding the different stages of resource use and waste management in a circular economy.

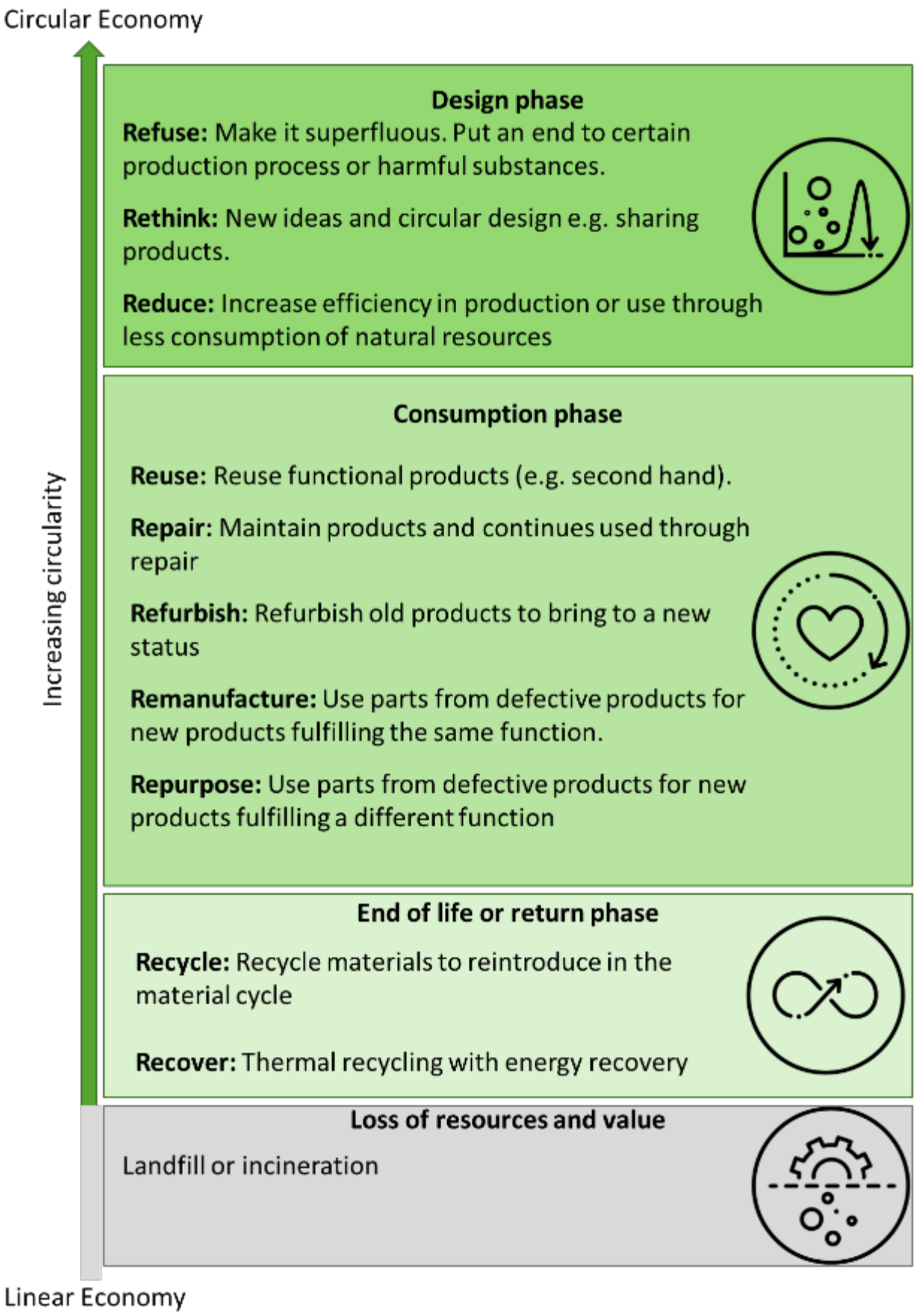

Figure 4: R Strategies

Source: Umweltbundesamt GmbH

The ten strategies are classified under three categories that demonstrate the length of the waste loop which each one represents. The shorter the loop, the more sustainable the strategy is. The higher they are on the ladder, the tighter the waste loop. This means the strategy requires fewer materials and is therefore more circular. Other means of classifying them is by phase – the design phase, the consumption phase and the end-of-life phase as shown in the figure above (see Figure 4).

In order to implement these practices outlined here, a societal change is needed. One main aspect is recognizing the key role of product design as this phase dictates whether a product is repairable and durable and whether materials can be separated and recycled. Batteries in smartphones are an example for this: if they are sealed within the device, it cannot be replaced or adequately separated and recycled.

Steps to a circular economy

Efforts to replace the linear economic system and reduce the high consumption of resources have been underway for some time. Two important concepts that emerged from the Earth Summit in 1992 associated with circular economy are Cleaner Production and Ecodesign which are outlined below:

Cleaner Production

"Cleaner production is a strategy to prevent emissions at the source and to initiate a continuous preventive improvement of environmental performance of organizations" (Fresner, 1998, p. 171). This includes analyzing where in the business waste, waste water and emissions arise to improve the status quo, reducing or substituting hazardous substances and lastly reducing the quantity and thereby the hazardousness of waste and emissions. (Zwiauer, 2023)

Ecodesgin

Ecodesign – also known as ecological design, sustainable design or circular design - is an approach to designing products and services that take into consideration their environmental impacts throughout their entire lifecycle. It aims to create products that benefit both people and the environment by integrating ecological and economic requirements during the product development process (European Environment Agency, 2001). Ecodesign follows several strategies:

- Material efficiency and dematerialisation
- Longevity and durability
- Reparability and recyclability
- Products responsibility

For more information see the summary of the Ellen McArthur Foundation on design and the circular economy: https://www.ellenmacarthurfoundation.org/design-and-the-circular-economy-deep-dive?gclid=Cj0KCQjwlemWBhDUARIsAFp1rLXh9Ckzl5bZlYxADtwSZJlhsoOXHaV_ZhD46v5arDx1MfmMrLsHlH0aAiK6EALw_wcB

International and national strategies

International

International efforts to promote a circular economy involve discussions on treaties aimed at reducing plastic pollution and fostering sustainable practices. For example, the United Nations Environment Assembly (UNEA) launched negotiations in March 2022 for an international legally binding instrument on plastic pollution. The OECD has published a paper on international trade linkage to circular economy.

Several other measures have been taken on global scale inducing the alliance "GACERE" of governments committed to promoting circular economy at the global level by UNIDO.

European Efforts

To address climate change and environmental degradation and overcome the challenges associated, the European Green Deal was published with the aim to transform the EU into a modern, resource-efficient and competitive economy. One cornerstone of the Green Deal is circular economy.

In March 2020 the European Commission presented the circular economy action plan with the aim to promote more sustainable product design, reduce waste and empower consumers (e.g. with a right to repair). Resource-intensive focus sectors such as the electronics and ICP, plastics, textiles and construction, were addressed. In 2021 the Parliament adopted a resolution on the circular economy action plan demanding additional measures to achieve carbon-neutral, environmentally sustainable, toxic-free and fully circular economy by 2025 including recycling rules and binding targets for material use and consumption by 2023 (European Parliament, 2023).

The first pack of measures was released in 2022 to speed up the transition. The proposal includes supporting sustainable products, empowering consumers, reviewing construction product regulations and creating a strategy on sustainable textiles. This was followed by a proposal for new EU-wide rules on packaging aiming at reducing packaging waste (European Parliament, 2023).

Learn more about the tools and instruments developed on EU level and the policy actions taken thus far including on plastics, repair of goods, critical raw materials, textiles, waste and recycling and beyond: https://environment.ec.europa.eu/topics/circular-economy_en

Albania

Albania has adopted legislative measures to transition from a linear economy to a circular economy, emphasizing sustainable resource use, waste reduction, and recycling. These efforts align with **EU Circular Economy Action Plan** objectives, reflecting Albania's aspirations for EU membership and compliance with international best practices.

Albania's legal framework for waste management is foundational to achieving circular economy principles. It includes laws, government decisions, and strategic plans that address waste prevention, sustainable product design, and resource recovery. The key Circular Economy related legislation is highlighted below. A full list can be found in the Annex.

- **Law No. 10463 (2011), "On Integrated Waste Management":**
  Establishes principles of waste hierarchy—preventing waste, reusing materials, recycling, and safe disposal as a last resort.
- **Decisions of the Council of Ministers (DCMs) No. 177 & 178 (2012):** Promote recycling and reuse of packaging and incineration by-products.
- **DCM No. 418 (2014):** Implements differentiated waste collection, encouraging sorting at the source.
- **DCM No. 652 (2016):** Focuses on recycling used tires and integrating them back into production cycles.
- **DCM No. 367 (2022):** Prohibits plastic bag use, aiming to reduce plastic waste.
- **National Integrated Waste Management Plan (2020–2035):**
  - Encourages extended producer responsibility (EPR) to involve manufacturers in waste management.
  - Targets increased recycling rates and improved material recovery.

Additionally, key Principles and measures of Circular Economy are embedded in the Albanian national integrated waste management plan and the strategic policy document on Integrated Waste Management. The strategic policy document outlines measures to enhance waste management and reporting and thereby circular practices.

Additionally, the Roadmap towards Circular Economy of Albania was published in 2024. The roadmap highlights three key areas where circular economy changes could benefit Albania: 1) using economic tools to promote sustainable consumption and production; 2) helping small and medium-sized businesses adopt circular business models and 3) improving the plastics value chain, especially to reduce marine litter. It includes 35 policy recommendations and systems to monitor their implementation in the key areas (OECD, 2024b).

The Albanian CE Roadmap also provides an overview of the policy landscape of Albania relevant to the Circular Economy as shown below.

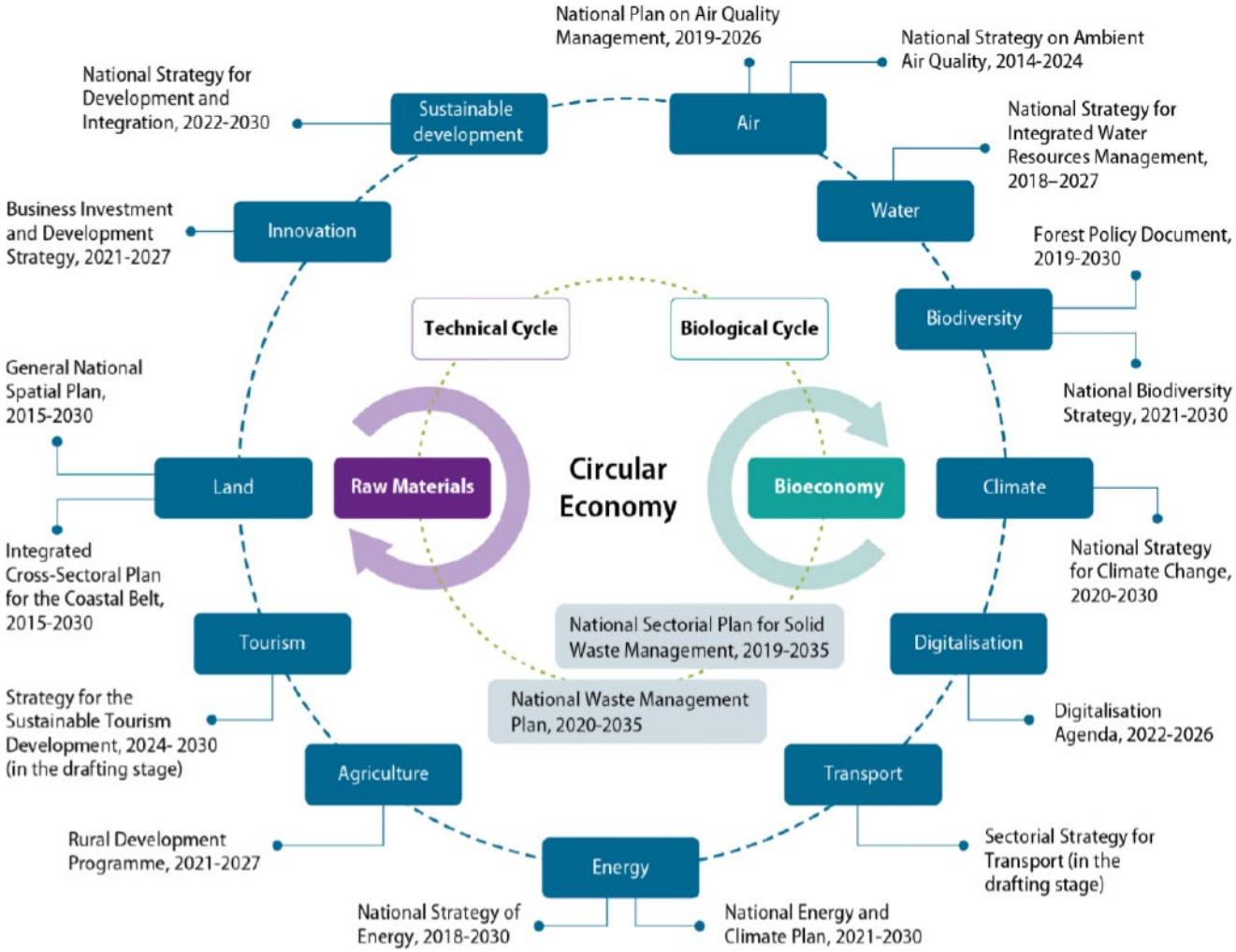

Figure 5: Overview of Albania's policy landscape relevant for Circular Economy

Source: OECD (2024b)

Discussion Points

The presented topics can be discussed with the participants focusing on their specific region/municipality. The following discussion points can be used:

1. What practices, traditional customs that are in place in Albania support circular economy?
2. How can you and other stakeholders contribute to advancing circular economy goals?
3. What are the main challenges in implementing circular economy, and how do you think they can be overcome?

Knowledge check

1) What are the basic principles of the circular economy? (Multiple answers possible)
   a) The basic principle of the circular economy is recycling. (Points: 0)
   b) A basic principle of the circular economy is to minimise the consumption of primary raw materials. (Points: 2)

c) A basic principle of the circular economy is to keep existing products in use for as long as possible, to repair or reuse them and only then to recycle them. (Points: 2)

2) 2 How long have the concepts of cleaner production and ecodesign been around?
   a) Since the Rio Conference in the 1990s. (Points: 2)
   b) They were developed with the EU Action Plan for a circular economy. (Points: 0)
3) What is the concept of Ecodesign based on?
   a) Ecodesign is based on the principle of minimising effort and impact in production while maximising product benefits. (Points: 2)
   b) Ecodesign is based on the principle of using ecological materials. (Points: 0)
4) Which of the following terms are part of the 10R principles? (multiple answers possible)
   a) Refuse (points: 1)
   b) Reject (Points: 0)
   c) Reuse (points: 1)
   d) Re-examine (Points: 0)
   e) Rethink (Points: 1)
   f) Recycle (Points: 1)
5) The central aim of the 'EU Circular Economy Action Plan' is to implement measures that cover the entire life cycle of products. The focus should be on product designs that promote circular economy processes.
   True/False (1 Point)
6) The central aim of the 'EU Circular Economy Action Plan' is to promote new waste management concepts in the individual member states.
   True/**False** (1 Point)
7) What does 'circularity material rate' mean?
   a) The circularity rate describes the proportion of products that are recirculated. (Points: 0)
   b) The circularity rate is the rate that indicates how much of the recycled materials are reused in production processes. (Points: 4)
8) What are the key elements of the 'EU Circular Economy Action Plan'? (multiple answers possible)
   a) Measures to strengthen the position of consumers. (Points: 2)
   b) Design of sustainable products. (Points: 2)
   c) Launch of a digitalisation offensive. (Points: 0)
9) Which of the following product value chains have been prioritised by the European Commission? (multiple answers possible)
   a) Electronics and ICT (points: 2)
   b) Steel products (points: 0)
   c) Packaging (points: 2)
   d) Textiles (points: 2)

SESSION 3: ADRESSING AND OVERCOMING CHALLENGES

We will look at the challenges and obstacles associated with the transformation of an economic system. Additionally, concepts that have already been implemented will be presented.

A shift toward a circular economy implies much more than moving away from the linear 'take-make-waste' model. Ideally, it involves establishing closed material cycles. This fundamental transformation of our economic system comes with significant challenges across various levels. It requires not only clarifying specific laws and eliminating misguided incentives but also breaking deeply ingrained habits. For instance, the focus should shift from product ownership (such as owning a car, lawnmower, or drill) to sharing or renting and fostering a repair culture. However, achieving this transition will not rely solely on changes in consumer behaviour or recycling.

From a global perspective, there are various starting points for the transformation, which means that it will not look the same everywhere in the world. Some countries must drastically reduce material extraction and use, while others need to stabilize or catch up (see also Fraserm et al., 2024, p. 10 where strategies for higher-, middle- and lower-income countries are outlined)

The range of topics to be addressed is also reflected in the most recent Circularity Gap Report were solutions are proposed (Fraserm et al., 2024), some outlined here:

- Create a level policy playing field;
- Get the economics right by adjusting fiscal policies and leverage public investment to promote circular solutions;
- Build circular expertise and skills;
- Develop and apply holistic indicators;
- Dismantle incentives for excessive material consumption.

In terms of legislative implementation, the challenges lie in the fact that the circular economy is a crosscutting theme. It needs to be embedded not only in tax law but also in research and industrial policies. To achieve successful implementation, a holistic perspective is essential.

Barrier and possible incentives

The barriers can be split into six categories namely "Cultural", "Market and Finance", "Technology", "Skills", "Conflicting interests" and lastly "Regulatory". In the following the barriers and possible incentives are addressed.

Cultural

Many consumers are not fully aware of the circular economy concept or its benefits. Additionally, a shift to a more circular economy might be perceived as a "downgrade" in terms of individual's

wealth[1], which can lead to resistance to change. Without sufficient understanding, they may not actively participate or demand circular products and services. Broader awareness and engagement are necessary for a widespread adoption.

Market and Finance

The majority of investors still operate within the framework of the linear economy. Their mind-set revolves around the “take, make, dispose” approach, prioritizing short-term gains. Consequently, circular economy can be perceived as a risky investment, especially as long as market prices do not fully incorporate social and environmental impacts (Bourdeau, 2022).

One associated obstacle on the path to a circular economy is the lack of true costs, i.e. external effects such as on the environment are not reflected in the price of a conventional product. This puts sustainable products at a disadvantage. This inadequate cost transparency does not provide an economic incentive for the implementation of sustainable solutions and technologies.

Businesses seeking to participate in circular practices can also face significant initial investment costs. These costs can deter businesses from adopting circular practices (Jaeger & Upadhyay, 2020).

With the targeted use of taxes and levies, economic incentives can be created to promote desirable action in the sense of the circular economy and to reduce undesirable linear practices. Another option is tax incentives, for example for circular, sustainable investments or for repair and reprocessing or for sustainable biogenic, regional products. When designing tax measures, care must be taken to ensure that they are as easy to implement as possible or that their expected steering effects justify the expense (Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, 2023).

Technology

There is a lack of proper waste infrastructure in some places hindering proper separation at source and waste treatment at a later stage. Additionally, current recycling technologies have not reached their full potential for some materials yet. For example, some plastics are shredded and reprocessed into lower-value applications. This is largely due to limitations in how plastics can be sorted by chemical composition and cleaned of additives. Once the technology is deployed at a large scale, the economic value of plastics can be captured and their recovery and recycling incentivised.

Skills

Circular systems involve intricate material flows, remanufacturing, and recycling processes. Navigating these complexities demands skilled supply chain management and coordination. Moreover, circular design principles require expertise in creating products that are durable, repairable, and recyclable. Many professionals lack adequate knowledge in this area. In addition, the implementation often involves specialized technical skills, such as disassembly,

[1] Meeting consumers' expectations for convenience.

remanufacturing, and waste reduction. A shortage of skilled professionals hinders progress (Jaeger & Upadhyay, 2020).

Addressing these skill-related barriers requires targeted training, education, and awareness building. By fostering expertise and collaboration, the transition can be achieved.

Conflicting interests

There is a conflict between the goals of circularity and zero pollution as in some cases recycling is not achievable or safe due to hazardous pollutants or prohibited materials. Current technology for separation has improved drastically, however separation of contaminated fractions still remains a challenge e.g. for some plastics.

Regulatory

There is the need for supporting legislation to forward the transition. However, legislation can also create barriers e.g. in the food sector where there are limitations which food can be donated. Additionally, packaging materials, while extending shelf life, contribute to plastic waste. However, if government regulations shift to promote eco-friendly packaging, businesses will be more inclined to adopt sustainable alternatives.

Practice Examples

Figure 6: Examples of circular practices

Source: ©Umweltbundesamt/B. Gröger

Alternative Ownership Models:

Figure 7: Examples of alternative owner ship trough bike-sharing initiatives

Source: ©Umweltbundesamt/B. Gröger

- Instead of traditional car ownership, people can explore car-sharing services or subscription-based models. This reduces the overall number of cars on the road and promotes resource efficiency. This concept is also available for bikes.
- (Urban) bike-sharing initiatives provide access to bicycles for short-term use. Users can rent bikes from docking stations and return them after their ride.
- Co-working spaces provide an alternative to traditional office leases. Multiple businesses or freelancers share a workspace, amenities, and resources, promoting collaboration and cost efficiency.
- “Tool libraries” which allow community members to borrow tools and equipment (such as power tools, gardening equipment, or kitchen appliances) instead of purchasing them individually.
- Libraries reduce the need for new consumption while allowing you to browse for new reading material.
- Instead of private gardens, community gardens or allotments offer shared green spaces where people can grow their own produce collectively.

- Subscription-Based Models for Appliances and Electronics: Rather than buying appliances outright, subscription services offer access to devices like washing machines, smartphones, or home entertainment systems or even furniture for a monthly fee.

Reusable product

Figure 8: Examples of reuse and repair through mending or second-hand shopping

Source: © Umweltbundesamt/B. Groeger

- Opting for old-fashioned safety razors with replaceable blades reduces plastic waste from disposable razors.
- Reusable cloth diapers are an eco-friendly alternative to single-use disposable diapers.
- Purchasing second-hand clothing from thrift stores or online platforms extends the lifespan of garments and reduces textile waste.
- Repairing used products e.g. by embroidery

Food Redistribution

Figure 9: Examples of food redistribution

Source: © Umweltbundesamt/B. Groeger

- Redirecting surplus food from supermarkets, restaurants, and other businesses to sharing platforms ensures that excess food does not go to waste.
- Distributing surplus food to social organizations, helps address food insecurity.

Reduction of Consumption

Figure 10: Examples of reduced consumption. Reusable cups vs. single use cups

Source: © Umweltbundesamt/B. Groeger

- Using reusable cups and bottles instead of single-use items (like disposable coffee cups or plastic water bottles) minimizes waste.
- Choosing durable, long-lasting products over disposable ones contributes to waste reduction.

Waste Separation and Management

Figure 11: Waste Separation

Source: © Andrei Marin, My City /EEA

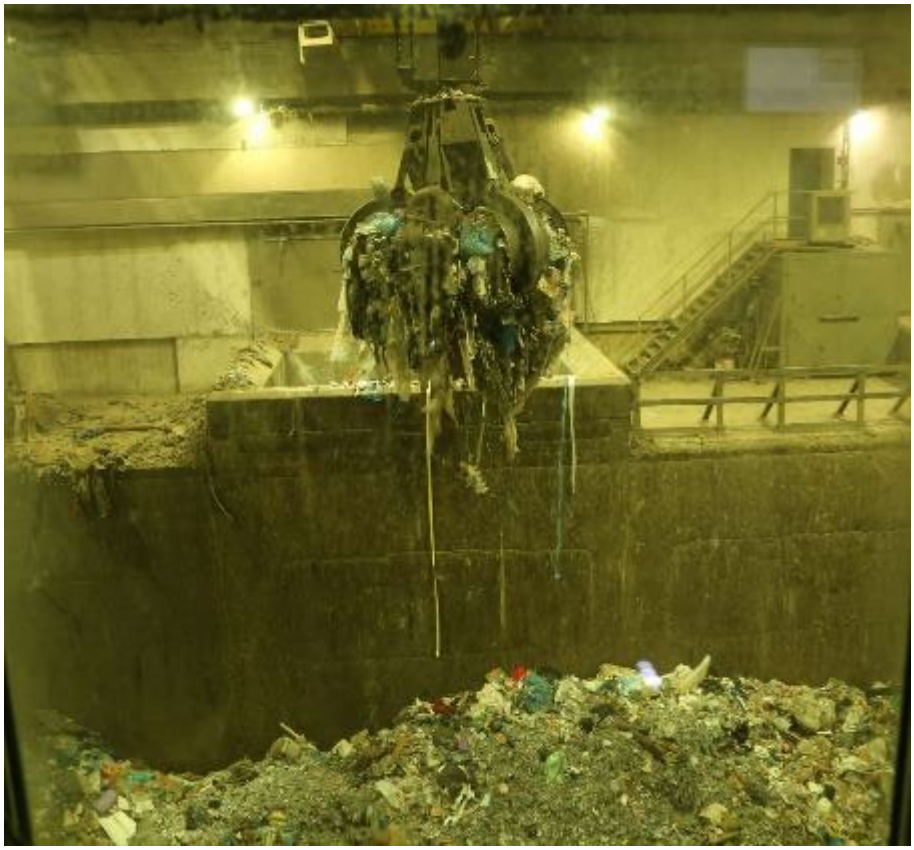

Figure 12: Waste Treatment

Source: © Umweltbundesamt/B. Groeger

- Proper waste separation (such as separating recyclables, organic waste, and non-recyclables) ensures efficient recycling and reduces landfill waste.
- Effective waste management involves responsible disposal and recycling practices.

Knowledge check

1) Why is the transition to a circular economy so complex? (multiple answers possible)
   a) Our economic system needs to be fundamentally reorganised. (Points: 2)
   b) The transition to a circular economy affects many different areas and levels. (Points: 2)
   c) Consumers must be legally obliged to change their habits. (Points: 0)
   d) Wrong incentive systems must be abolished. (Points: 2)
2) What could be possible incentives to encourage the transition to a circular economy?
   a) Everything will be greener (Points: 0)
   b) Taxation (Points: 2)
   c) Targeted training (Points: 2)
   d) Allowing only second-hand equipment to be bought (Points: 0)
3) Which of the following are possible strategies to move to a more circular economy?
   a) Buying second-hand (Points: 2)
   b) Sharing goods (Points: 2)
   c) Buying two of everything (Points: 0)

SESSION 4: IMPLEMENTATION IN PRACTICE

Session 4 introduces key areas of the circular economy for the public sector: “Green Public Procurement” and outlines options for supporting businesses.

Green public procurement

Figure 13: Green spending

Source: © Umweltbundesamt/B. Groeger

Careful and responsible use of resources and the environment through public procurement can be a driver for innovation as it can provide industry with incentives to develop and establish environmentally friendly work, products and services.

Green Public Procurement (GPP)

GPP is defined as public authorities using their purchasing power to seek to procure goods, services and work with a reduced environmental impact throughout their life cycle when compared to goods, services and work with the same primary function that would otherwise be procured (European Commission, n. d.–b; OECD, n. d.).

The European Commission has defined it within their Communication (COM-2008-400) “Public Procurement for a better environment”.

High impact sectors are buildings and building maintenance (including cleaning), food and catering, vehicles, energy-using products and cleaning supplies.

The benefits of GPP are manifold. For once GPP can foster innovation among bidders, GPP may also encourage financial savings for public bodies, if considering the full life-cycle costs and not just the purchasing price.

Public bodies implementing GPP are said to be better equipped to meet evolving environmental challenges, e.g. the reduction of greenhouse gas emissions or move towards a more circular economy (OECD, n. d.).

Green Public Procurement: a lever to accelerate the green transition

For further information and explanations, the Stockholm Environment Institute provides an in-depth training on Green Public Procurement.

Link: https://www.youtube.com/watch?app=desktop&v=fVMotAIojPY&feature=youtu.be

Steps towards green public procurement

There are several options depending on which governing level the steps towards green public procurement are taken. However, regardless of level, every governing body can take relevant steps in order to move to a greener procurement process.

As a first order of business the targeted goods, services and work must be defined and target criteria must be set. It is especially important that within this step on municipal level the personnel responsible for procurement are involved. Recommendations for targeted goods, services and work to consider are:

- Computers, monitors, tables and smartphones;
- Electrical appliances and lamps;
- Electricity;
- Food catering services and vending machines;
- Furniture;
- Imaging equipment, consumables and print services;
- Indoor cleaning products and services;
- Office supplies and paper;
- Road transport;
- Textile products and services;
- Structural (construction and deconstruction of buildings) and civil engineering (road);
- Public space maintenance (green surroundings);
- Events.

Once target groups of services and products have been chosen, the next step is to set criteria for these goods and services. The European Commission has published their voluntary criteria for different products and services. You can also find the criteria set in Austria to use as an initial starting point. If within the economy sustainability eco-labelling or certification for products and services exist, these should be considered when setting criteria e.g. for ecological textiles or green events. The following criteria are seen as a suitable starting point for all products and services:

- Durability of the products;
- Interchangeability of individual parts or disassembly (IT);
- Reparability;
- Energy efficiency;
- Substances contained – non-hazardous components and constituents.

Lastly, it is important that the set criteria are discussed with relevant departments (e.g. procurement) and training must be provided to make sure that the need and relevance are understood and the decided criteria are incorporated in the tendering process and reviewed for all offers received.

It is recommended to let the participants discuss products and services how criteria could be applied and how these criteria can look like after the initial introduction. This can be combined with the search for best practice examples.

Best practice examples

The European Commission has published a good practice library for green public procurement. Within the learning process, it is recommended for the participants of the training to browse the library and select their favourite measure and elaborate why they have chosen it and if it could be implemented within their governing body. Also, make sure to address which steps they think would be needed for implementation.

Another source for best practices is the report on best practices for sustainable procurement published by the OECD, highlighting efforts by several selected countries (OECD, 2015).

Energy saving

Figure 14: Energy saving by use of LED lights

Source: © Maria Deweis

By prioritizing energy efficiency, resources can be saved. Below, measures for public procurement but also beyond are outlined that can be set by the municipality:

- When acquiring new equipment, such as electronic devices for municipal administration, carefully evaluate their energy efficiency. By choosing energy-efficient options, one can contribute to sustainability and cost savings.
- LED Lighting for Streets and Public Facilities:
- A transition to LED bulbs in street lighting and public facilities not only reduces energy consumption but also enhances visibility and safety.
- Through extensive thermal renovations and other construction measures, the energy performance can be improved. For new constructions, buildings should adhere to low-energy house standards.
- Implement systematic measures to save energy. These include user training to promote energy-conscious behaviour and the installation of devices like timers and switches to control energy usage effectively.

Reduction of food waste

Figure 15: Donation of food surplus

Source: © Umweltbundesamt/B. Groeger

Below there are individual measures outlined that can be taken to reduce food waste within the direct influence of municipal administration. Some of these are associated with public green procurement but some go even beyond:

- Create guidelines or policies specifically aimed at minimizing food waste during community festivals and events.
- Optimize food orders for meetings, seminars, and events. Ordering based on actual demand helps prevent excess food. Avoid single use packaging e.g., for sugar and instead opt for sugar bowls.
- Ensure that surplus food from seminars or meetings is shared with employees or participants rather than being discarded.
- Provide a way for participants to take home excess food from community events. Inform them in advance and encourage the use of reusable containers.
- Collaborate with social or charitable organizations to donate excess food from events.
- Use municipal newspapers, websites, and other communication channels to inform residents about food redistribution options within the community.
- Set up accessible locations (e.g., community offices, clubrooms) with open fridges or shelves where those in need can freely take surplus food. Volunteers manage hygiene and sorting.
- Assist social institutions by enhancing storage, refrigeration, and logistics capabilities.

Additionally, for schools and kindergartens under municipal administration there are measures to minimize food waste during lunchtime:

- Adjust meal orders to match the number of required portions. For example, communicate the exact meal count to food suppliers by 9 a.m. on the same day.
- Adapt Menu Selections Based on Feedback and Plate Leftovers: Involve children and teenagers in menu decisions. Use plate leftovers as practical feedback for menu adjustments.
- Customize portion sizes based on the age group, in coordination with school or kindergarten management and food suppliers.
- Allow students to choose specific meal components rather than fixed menus.
- Utilize remaining food as afternoon snacks for students.
- Freeze surplus meals and distribute them during buffet days if suitable infrastructure is available.
- Offer leftover portions to students in their own reusable containers.
- Provide surplus meals to school personnel.

Supporting businesses

Supporting businesses and providing incentives for them to engage in practices that are more circular can have a positive impact on fostering a circular mind-set and facilitate collaboration within the community. Depending on funds available, the actions, which can be set by municipality, vary greatly. However, even a municipality with limited funds can take meaningful steps to support circular economy practices among local businesses.

Education and Awareness

- Organize workshops, webinars, or community events to raise awareness about circular economy principles. These can also be used to educate local businesses on the benefits (see also Session 1) and practical steps they can take.
- Collaborate with schools and universities to integrate circular economy concepts into the curriculum.

Collaboration and Networking

- Foster collaboration among local businesses, NGOs, and community groups to encourage knowledge sharing and to establish joint initiatives. This can also be used to facilitate ongoing circular activities by connecting businesses, sharing best practices, and boosting social capital within the circular business community.
- Create a platform (online or offline) where businesses can exchange ideas, resources, and best practices related to circular economy.

Resource Mapping

- Identify existing resources within the municipality that can be repurposed or shared. For example, unused spaces, equipment, or materials. On the municipal website or a bulletin board these can be advertised. For unused space the examples given under ideas for practice might be considered.
- Promote resource-sharing networks among businesses. This reduces costs and waste.

Local Procurement Policies (see also Session 4 on green public procurement)

- Develop procurement policies that prioritize local, circular economy-friendly products and services. This supports local businesses and reduces transportation-related emissions.
- Encourage businesses to source materials locally whenever possible.

Economic Interventions:

- Provide loans and subsidies for circular economy activities. This helps overcome financial barriers for businesses establishing circular practices e.g. by offering small grants or micro funding for circular economy projects. These can include waste reduction, upcycling, or sustainable product design.

Best practice ideas and examples

Education Centre with Showroom

RecycAl has started to construct a circular economy Park in Tirana. One aspect of this park is a showroom to display eco-products. In order to achieve this, collaborations with sustainable product manufacturers were established.

The goal is that at least 50 businesses offering circular economy solutions from or for the Western Balkans will get the chance to promote their products in the showrooms, which will be presented to at least 100 delegations from private and public institutions per year.

Figure 16: Visualization of 1st Project Phase 2024-26. Recycling Center and "World of Values"-Thrift Store (Hall) and Showroom and Training Center with Repair Café

Source: Circular Economy Park – Recycling Albania

Learn more: https://recyclingalbania.com/about/

Awareness raising

Awareness raising, platforms to be visible or networks can create an ecosystem where businesses learn, collaborate, gain visibility, and respond to market dynamics, ultimately accelerating their transition to a circular economy. As a municipality the following actions can be initiated or supported:

- Establishing education centres or online platforms where businesses can access free training on circular economy principles. Topics could include resource efficiency, waste reduction, and sustainable design.
- Create a comprehensive guide specifically for businesses committed to implementing or transitioning to a circular economy. This guide should offer practical tips, case studies, and best practices.
- Regularly awarded environmental prizes related to circular economy initiatives. Recognize businesses that demonstrate innovation, sustainable practices, and successful transitions to circular models.
- Set up a dedicated website or sub-site of the municipal website to showcase circular economy businesses within the municipality. This platform can feature profiles of local businesses, their circular practices, success stories, and resources for interested

entrepreneurs. This can provide not only an advertising platform but also informs consumers and possibly motivate other businesses. Alternatively or in addition, a dedicated section in the local newspaper/magazines can be implemented outlining the same topics.

Food waste reduction and reusable containers

Food waste has a significant environmental impact due to its energy-intensive production and methane emissions when decomposing in landfills. To avoid food waste, leftovers can be taken to go. However, single-use items contribute to pollution and resource depletion. Thus, the use of reusable containersare recommended. As a municipality the following can be done to support businesses in the reduction of food waste and the usage of reusable packaging:

- **Cooking Events and consultation for gastronomy businesses** can be organised by the municipality to showcase eco-friendly recipes and providing guidance to gastronomy businesses on waste reduction, efficient resource use, and environmentally conscious practices.
- **Designing, providing and circulating stickers** for businesses that indicate that the business if offering reusable containers for take away or accepts consumer-brought containers. Displaying such a sticker can moreover signal to customers that the establishment supports sustainability and environmental responsibility.

Reuse und Repair

Still usable electronic devices, furniture, dishes, clothing, etc. often end up in the waste. Reuse and repair can help reduce waste and extend the lifespan. To support reuse and repair efforts, the following can be done by municipalities to support businesses and NGOs:

- Promote the establishment of repair centres of cafés by means of:
  - Recruiting volunteer repair experts.
  - Offering municipal repair services.
  - Creating and promoting a digital repair guide.
  - Expanding educational programs for self-repairs.
- Supporting ReUse shops, which can accommodate larger furnishings and other items. These are typically operated by charitable organizations, which sort, refurbish and sell them at affordable prices. While running a standalone ReUse shop isn't typically within a municipality's purview, there are various ways how they can provide support:
  - Facilitating Real Estate: Offering or assisting in finding suitable properties for these shops.

    - Building Connections: Connecting with relevant parties, including charitable organizations, environmental groups, waste management associations, volunteers, and engaged citizens.
    - Financial Support: Exploring sponsorship opportunities or providing ongoing financial assistance for waste reduction or employment programs.
    - Communication and Marketing: Managing communication through events, sponsorship calls, community newsletters, websites, and advertising spaces.
    - Goods Procurement: Creating separate collection points for usable items (e.g., a ReUse corner in a recycling centre).
    - Reducing Disposal Costs: Offering free disposal of bulky waste for ReUse shops, recognizing that not all donations are suitable for reuse.
    - Providing Information: Sharing details about local activities (e.g., a list of ReUse shops) on the municipality's website.
- Promoting the concept of sharing instead of buying to encourage collaborative use and renting goods e.g. by:
    - Setting up a platform to share leftover construction and building materials and components.
    - Establishing a digital marketplace for the communication, accessible through the municipality's webpage.
- Promoting Trash Design and Upcycling Initiatives.
- Promoting Carsharing as an alternative to private car ownership. Carsharing services allow multiple users to share the same vehicle, reducing the need for individual car ownership.
- Selling of decommissioned municipally owned vehicles and other items (e.g. computers).

In less densely populated areas, it is worth considering distributing repair hubs and ReUse shops across different communities.

RecycAl has started to construct a circular economy Park, which includes a repair centre and a ReUse shop in Tirana.

Knowledge check

1) Green Public Procurement can reduce municipal waste
   a) **True**/False (Point: 1)
2) Green Public Procurement is the process of
   a) Buying only green products (Points: 0)
   b) Comparing the life cycle of products, services and work, and choosing the option with a reduced environmental impact (Points: 2)
   c) Buying the cheapest option (Points: 0)
   d) Setting criteria for specific goods which have to be considered when purchasing these goods and during tendering processes (Points: 2)
3) Possible starting points for criteria to be considered for public green procurement include:
   a) Durability (Points: 2)
   b) Purchasing price (Points: 0)
   c) Reparability (Points: 2)
   d) Looks (Points: 0)
   e) Possible hazardousness (Points: 2)
   f) Energy efficiency (Points: 2)
   g) Supplier's Sustainability Slogan (Points: 0)
4) Supporting businesses in taking up circular economy, needs a great deal of available funding
   a) True/**False** ((Point: 1)
5) Businesses can be supported by municipalities to implement circular economy practices by means of
   a) Education and awareness in circular economy practices (Points: 2)
   b) Writing their business plan (Points: 0)
   c) Sanctions (Points: 0)
   d) Local Procurement Policies (Points: 2)

SESSION 5: BIOLOGICAL WASTE TREATMENT

Session 5 introduces the term biological or green waste as well-established option of managing the organic fractions of municipal waste. It includes a description of the most suitable input material (bio-waste), the principal processes of biodegradation (aerobic, anaerobic) and relevant technical implementations, i.e. composting and aerobic digestion.

What is bio-waste?

Figure 17: Example of bio-waste
Source: © Umweltbundesamt/B. Groeger

Bio-waste is organic waste of animal or plant origin that is generated in the household or in businesses and can be degraded by microorganisms or soil-dwelling organisms. “Bio-waste includes biodegradable garden and park waste, food and kitchen waste from households, offices, restaurants, wholesale, canteens, caterers and retail premises and comparable waste from food processing plants” (Waste Framework Directive, 2018/2008/98/EC). It does not include forestry or agricultural residues, manure, sewage sludge, or other biodegradable waste such as natural textiles, paper or processed wood (European Commission, n.d.–a).

Food and kitchen waste may consist of expired food items, non-consumable residues of fruits and vegetables (e.g. potato skins) or residues such as consumed coffee grounds.

Garden and park waste, often referred to as green waste, consists of a mixture of organic materials such as grass clippings, hedge prunings, leaves and bark, flowers, branches, twigs and

other woody material, and inorganic fractions such as soil and stones. Green waste from public parks may also contain impurities, such as paper, cigarette butts or cans.

Learn more: https://environment.ec.europa.eu/topics/waste-and-recycling/biodegradable-waste_en

The initial main objective of bio-waste treatment was to keep biodegradable waste fractions away from landfills and thus prevent the formation of landfill gas and leachate. Waste treatment accounts for about 3% of total greenhouse gas emissions in the EU, but have fallen by 42% between 1995 and 2017 according to estimates of the European Environment Agency (Eurostat, 2020). Additional objectives of biological treatment are the generation of material that can be used as fertilizer or to improve soil quality or the production of energy from biogas.

The role of biological treatment in a developed waste management system

In developed waste management systems, biological treatment plays an important role in two areas (see Figure 18), either aerobic or anaerobic biological treatment of separately collected bio-waste (left side of the figure) or mechanical-biological treatment (MBT) of mixed municipal waste (right side of the figure).

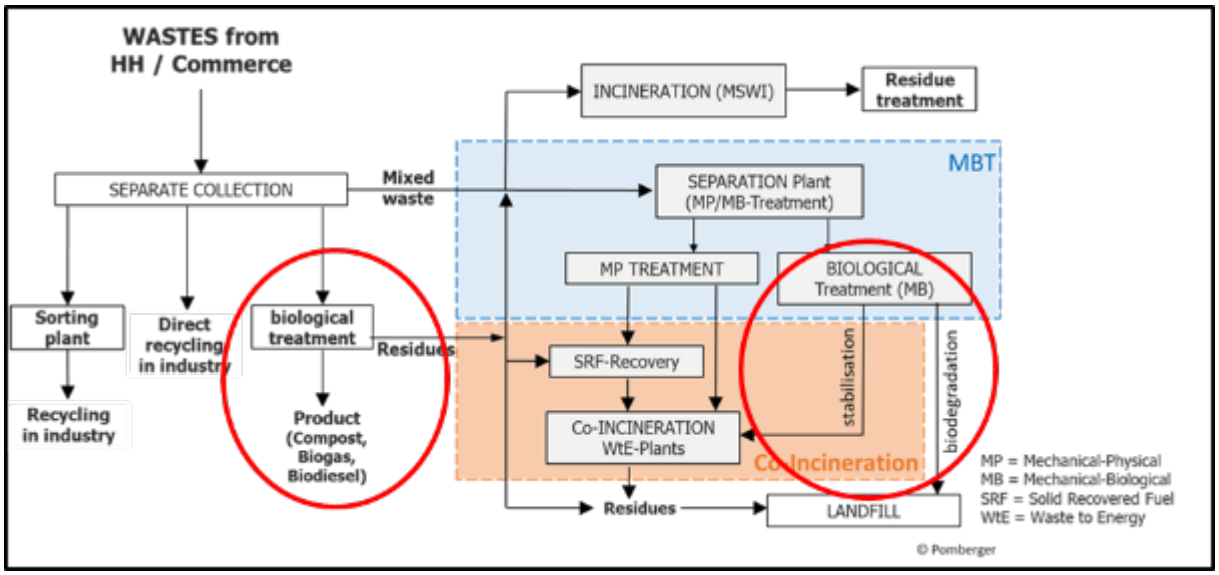

Figure 18: Role of biological treatment in a developed waste management system

Source: Weißenbach, 2021

The separate collection of bio-waste guarantees good quality of the generated compost and digestate. Mixed waste, however, contains many contaminants and other impurities so that it is not recommended to use the residues in agriculture or even landscaping, and has to be treated in Mechanical-biological treatment plants (MBT). Here, the organic share is either stabilised by removing the moisture content so that it can be energetically recovered in co-incineration plants,

or the organic content of the waste is biodegraded for subsequent landfilling, if the legal requirements and thresholds are met.

Many EU Member States use biological treatment a successful method to increase their recycling rate for municipal waste. This has led to a recycling rate for biological treatment in the EU 27 of almost 20% (see Figure 19).

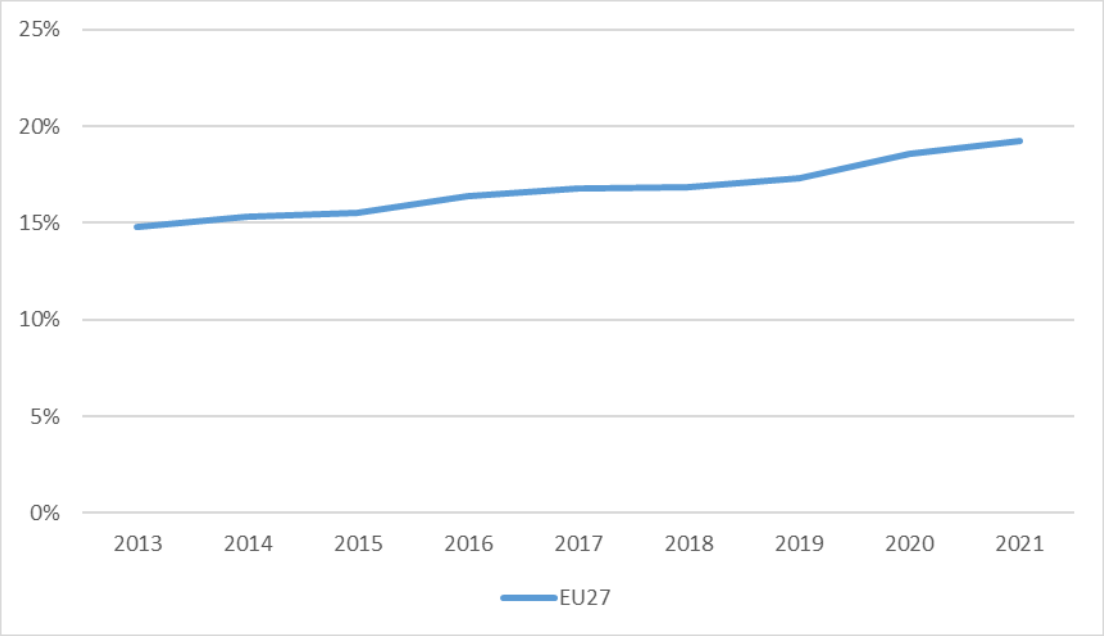

Figure 19: Rate of biological treatment of municipal waste in EU 27

Source: Eurostat, 2024

The process of biological waste treatment

In contrast to pure technical waste processing, biological treatment uses living microorganisms to decompose organic waste into either water, carbon dioxide (CO_2) and simple inorganics or into even simpler organics. Generally, biological treatment is successful only when the waste is not harmful to the microbiological community (Pinasseau et al., 2018).

A successful bio-decomposition depends on a broad variety of parameters, such as:

- Quality of the feedstock, e.g. content of nutrients (carbon, nitrogen and phosphor) and the ratio between them or content of contaminants
- Oxygen content
- Water content
- Temperature profile
- pH.

Some of these parameters may differ strongly between different types of treatment (aerobic or anaerobic) or different types of processes and technologies applied.

Although the biological waste treatment enjoys a good reputation due to its comparability to natural processes, it should be noted that environmental protection aspects have to be considered. Main hazards for the human health and the environment consist of emissions of gases and bio-aerosols (including odours) into air and liquids (e.g. condensate) into water. Therefore, the Best Available Techniques Reference Document (BREF) on Waste Treatment contains a number of requirements and rules for methods and technologies to prevent these emissions.

Home composting

Home composting belongs to the waste prevention methods, because the biological material produced in households does not enter the waste management system. Additional advantages of home composting are the following:

- Due to the simple technology, no permission regime is necessary.
- Reclamation of organic materials and nutrients for the garden.
- There is no waste collection and transport necessary, which reduces costs as well as emissions.

However, some experience is necessary to maintain a proper composting process. Process parameters are the selection of suitable organic materials and their preparation, the adjustment of the correct water content and the care for sufficient air supply. Wrong home composting may lead to release of climate gases or the attraction of vermin. Therefore, municipalities and waste associations provide manuals to help improve home composting. An example for a comprehensive manual comes from Vlaco, an organization that coordinates the organic waste policy in Flanders (Northern Belgium).

Learn more: https://vlaco.be/sites/default/files/generated/files/products/32.pdf or https://feeding.al/en/save-food-albania-network/farm-to-fork/why-how-and-what-to-compost/ (Available in Albanian).

Aerobic treatment - composting

The main method for the aerobic treatment of bio-waste is composting. In this process, organic waste is decomposed by microorganisms with the help of oxygen.

Waste input should be a mixture of **easily degradable, wet organic substances** (e.g. wet kitchen waste) and **structure-improving organic matter** (e.g. tree branches). Structure-improving materials are needed to ensure oxygen availability which is crucial to maintain aerobic degradation and to prevent the formation of anaerobic zones releasing methane. In addition, an **optimum moisture content in the range of 40–65 %** is important to maintain microorganism activity; low moisture content can lead to microorganisms becoming inactive.

The composting process usually consists of two stages, the **sanitation phase** and the **maturation phase**. During the sanitation phase intensive decomposition of the easy degradable material takes place. As a result the temperature of the rotting material climbs up to 70°C, which eliminates pathogens and weed seeds. On the other hand, most of the emissions are linked to this phase. In

the maturation phase, breakdown continues in which different types of organisms produce humic substances at gradually reduced temperatures.

Main technical solution for composting are windrows. These are long rows, in which biodegradable waste has been piled up. For aeration, composting plants can have active or passive ventilation systems or the rotting material is turned by machines. Technological advanced composting systems work with composting drums, boxes, containers and tunnels for the sanitation phase. The subsequent maturation phase then mainly takes place in windrows again.

Even smaller facilities for the biological treatment of separately collected bio-waste require a comprehensive technical infrastructure (see Figure 20). Before the actual biological treatment, valuables (mainly metals) and impurities must be removed and the organic material must be prepared for treatment by sieving, shredding and mixing. In order to guarantee a high quality product, the composted material requires a finalisation treatment to remove any remaining impurities, such as plastics, glass and stones. Low quality product containing visible contaminations will not find enough customers.

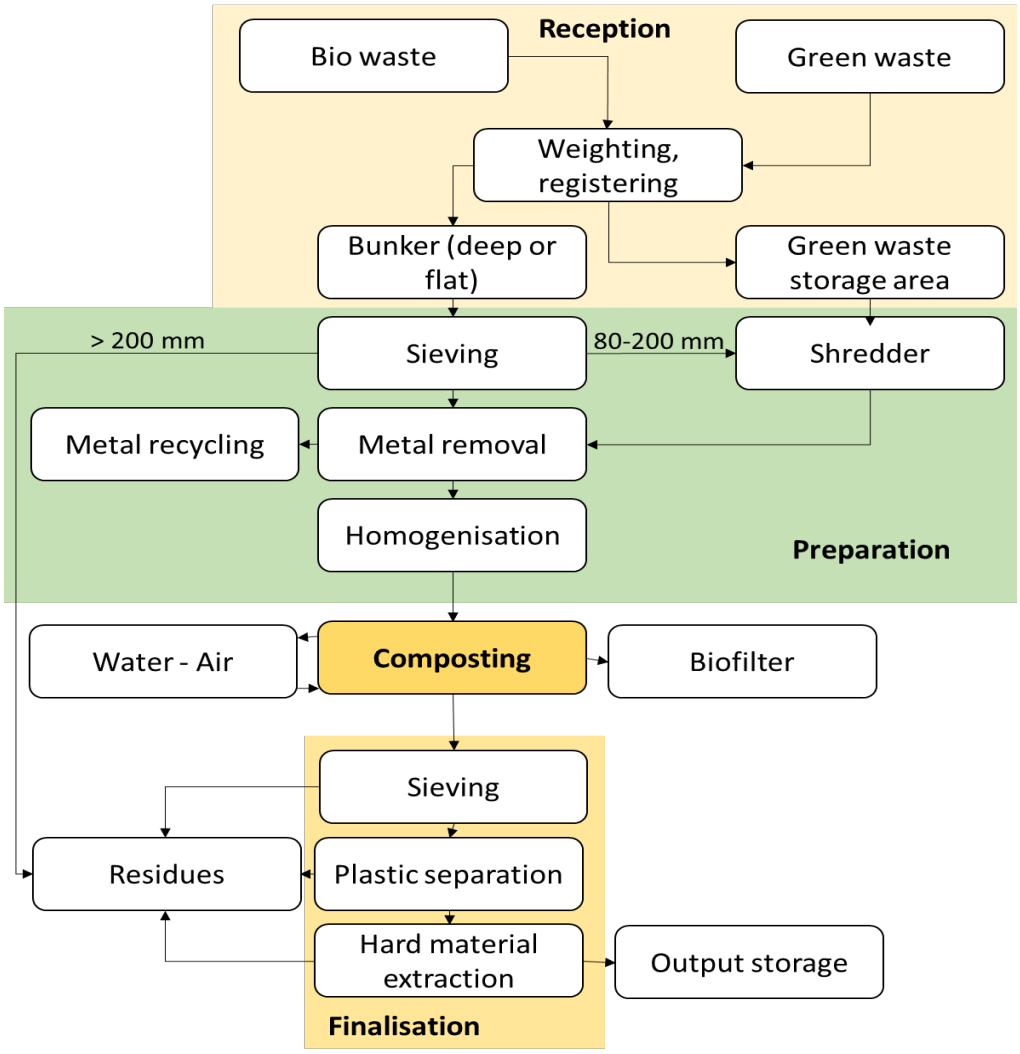

Figure 20: Flow chart of a composting facility

Source: Based on Umweltbundesamt, 2013 as published in Pinasseau et al., 2018

Anaerobic treatment - anaerobic digestion

Anaerobic digestion involves the bacterial decomposition of organic material in the absence of free oxygen. The conversion of **biomass to biogas and digestate** is a complex biochemical process with four phases. During the process, carbon from incoming organics is mostly converted to methane and carbon dioxide, and then released as biogas, which holds the energy content of the organic material.

A great variety of liquid and solid organic materials are suitable as feedstock. In contrast to aerobic treatment, however, the main limit of digestion is its inability to degrade lignin, a major component of wood. Due to the complex biochemical reactions, the control of the digestion process is technically challenging. Main parameter is not only the temperature, but also the pH, because of the mutual dependence of the bacterial groups in the process.

Comparable to composting, the technical implementation of anaerobic treatment requires pre-treatment and finalization processes. Great attention must be paid to the particle size (< 50 mm) to create a more homogeneous material, which aids anaerobic digestion and facilitates processing. For the digestion itself, different types of reactors with various mixing systems have been developed. A main difference in the area of waste treatment is the process of wet digestion vs. dry digestion.

Main output streams of the digestion are biogas and digestate. Biogas is a mixture of about 50 – 70% methane, about 30 – 50% carbon dioxide and small percentages of volatile elements (e.g. hydrogen sulphide). Due to the energy content of the methane, the biogas can be combusted in boilers to produce heat or in combined heat and power (CHP) units. It can also be upgraded to bio methane by removal of the carbon dioxide content and be injected into the natural gas grid or used as a fuel for vehicles. In order to improve the quality of the biogas, many anaerobic digestion plants are cleaning the biogas by using technologies such as sulphide precipitation or water scrubbing.

Digestate still contains a variety of usable nutrients and can be used as an organic fertiliser or soil improver in agriculture. Depending on the temperature profile during the digestion process, stabilisation of the residues may not be sufficient. In this case, a separate sanitation stage for digestate is required which also reduces the odour nuisance.

Knowledge check

Multiple answers possible

1) Which waste fractions belong to bio-waste (according to the understanding of the European Commission)?
   a) Sewage sludge (Points: 0)
   b) Grass clippings (Points: 1)
   c) Potato skins (Points: 1)
   d) Processed wood (Points: 0)
   e) Tea bags (Points: 1)
2) What are the advantages of using biological treatment of bio-waste?
   a) The use of compost improves soil quality. (Points: 1)
   b) Biological treatment of organic waste fractions reduces the production of landfill gas. (Points: 1)
   c) It has no negative environmental impacts. (Points: 0)
   d) Biological treatment of hazardous waste leads to a high-quality compost. (Points: 0)
   e) Biogas produced by anaerobic digestion can be used as energy source. (Points: 1)
3) What are main parameters to control the process of anaerobic digestion?
   a) Sufficient aeration of the reactor (Points: 0)
   b) Temperature (Points: 1)
   c) High lignin content in the feedstock (Points: 0)
   d) pH (Points: 1)
   e) Particle size of the input material. (Points: 1)
4) What are the advantages of home composting?
   a) Emissions for waste transport are prevented. (Points: 1)
   b) Municipalities do not need municipal composting facilities. (Points: 0)
   c) Home owners can reclaim nutrients for their gardening. (Points: 1)
   d) A strict permission system for home composting prevents environmental impacts. (Points: 0)
5) What kind of infrastructure is necessary around a biological treatment plant for bio-waste?
   a) Disinfection system for waste input to avoid adverse microorganisms (Points: 0)
   b) Magnetic separator for metal removal (Points: 1)
   c) Shredder to optimize particle size (Points: 1)
   d) Filter press for removal of water from sewage sludge (Points: 0)
   e) Chemical precipitation reactor to remove heavy metals from the feedstock. (Points: 0)

Additional learning material:

We recommend the following websites and videos:

Overview of biowaste treatment technologies – Further information

You can find additional training material on treatment of organic waste. The following three videos can be watched without registration.

https://www.coursera.org/lecture/solid-waste-management/3-1-overview-of-biowaste-treatment-technologies-9mHK3

https://www.coursera.org/lecture/solid-waste-management/3-4-operating-the-composting-process-HPXA6

https://www.coursera.org/lecture/solid-waste-management/3-7-the-basics-of-anaerobic-digestion-of-biowaste-tp0Qa?utm_medium=sem&utm_source=gg&utm_campaign=B2C_EMEA__coursera_FTCOF_career-academy_pmax-multiple-audiences-country-multi&campaignid=20858198824&adgroupid=&device=c&keyword=&matchtype=&network=x&devicemodel=&adposition=&creativeid=&hide_mobile_promo&gad_source=2&gclid=EAIaIQobChMI8LjzlNDqiAMVG0eRBR2GswzJEAAYASAAEgJISfD_BwE

1. REFERENCES

Bourdeau, J. D. (2022). *THE ECONOMIC BARRIERS TO A CIRCULAR ECONOMY*. https://www.themomentum.com/roundups/the-economic-barriers-to-a-circular-economy

EllenMacArthurFoundation (Ed.). (2011, August 28). *Explaining the Circular Economy and How Society Can Re-think Progress | Animated Video Essay*. https://www.youtube.com/watch?app=desktop&v=zCRKvDyyHmI

European Commission. (n.d.–a). *Biodegradable waste*. Retrieved October 7, 2024, from https://environment.ec.europa.eu/topics/waste-and-recycling/biodegradable-waste_en

European Commission. (n. d.–b). *Green Public Procurement: Procuring goods, services and works with a reduced environmental impact throughout their life cycle.* Retrieved June 11, 2024, from https://green-business.ec.europa.eu/green-public-procurement_en

European Environment Agency (Ed.). (2001). *eco-design*. https://www.eea.europa.eu/help/glossary/eea-glossary/eco-design

European Environment Agency (Ed.). (2016). *Country profile - Albania: More from less — material resource efficiency in Europe*. 2015 overview of policies, instruments and targets in 32 countries. https://www.eea.europa.eu/publications/more-from-less/albania-material-resource-efficiency

European Environment Agency (Ed.). (2019). *Resource efficiency and circular economy in Europe - even more from less: An overview of policies, approaches and targets of Albania in 2018*. https://www.eionet.europa.eu/etcs/etc-ce/products/country-factsheets/b-country-profile-albania_finalised-1.pdf

European Environment Agency (Ed.). (2024). *Circular material use rate in Europe*. https://www.eea.europa.eu/en/analysis/indicators/circular-material-use-rate-in-europe#:~:text=The%20CMUR%20measures%20an%20economy's,divided%20by%20the%20material%20use.

European Parliament (Ed.). (2023). *Circular economy: definition, importance and benefits*. https://www.europarl.europa.eu/topics/en/article/20151201STO05603/circular-economy-definition-importance-and-benefits

Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste, May 30, 2018. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32018L0851#:~:text=DIRECTIVE%20(EU)%202018/851%20OF%20THE%20EUROPEAN

Eurostat (Ed.). (2020, January 23). *Greenhouse gas emissions from waste*. https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20200123-1#:~:text=Between%201995%20and%202017,%20greenhouse%20gas

Eurostat (Ed.). (2023a). *Glossary:Municipal waste*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Municipal_waste

Eurostat (Ed.). (2023b). *Material flow accounts*. https://ec.europa.eu/eurostat/databrowser/view/env_ac_mfa/default/table?lang=en

Eurostat (Ed.). (2024, February 8). *Municipal waste by waste management operations*. https://ec.europa.eu/eurostat/databrowser/view/env_wasmun/default/table?lang=en

Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (Ed.). (2023). *Austrian Circular Economy Strategy*. https://www.bmk.gv.at/en/topics/climate-environment/waste-resource-management/ces.html

Fraserm, M., Conde, Á., & Haigh, L. (2024). *The Circularity Gap Report 2024.*

Fresner, J. (1998). Cleaner production as a means for effective environmental management. *Journal of Cleaner Production*, *6*(3-4), 171–179. https://doi.org/10.1016/S0959-6526(98)00002-X

Global Footprint Network (Ed.). (2024). www.overshootday.org

INSTAT (Ed.). (2024). *Material Flow Accounts, 2022*. https://www.instat.gov.al/media/11487/material-flow-accounts-2021.pdf

IRENA (Ed.). (2021). *Renewables Readiness Assessment: The Republic of Albania.* International Renewable Energy Agency. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/March/IRENA_RRA_Albania_2021.pdf

Jaeger, B., & Upadhyay, A. (2020). Understanding barriers to circular economy: cases from the manufacturing industry. *Journal of Enterprise Information Management*, *33*(4), 729–745. https://doi.org/10.1108/JEIM-02-2019-0047

Kranert, M., & Cord-Landwehr, K. (Eds.). (2010). *Einführung in die Abfallwirtschaft [Introduction to waste management]* (4th ed.). Vieweg+Teubner. https://doi.org/10.1007/978-3-8348-9681-0

OECD. (n. d.). *Green Public Procurement*. Retrieved June 11, 2024, from https://www.oecd.org/gov/public-procurement/green/

OECD (Ed.). (2015). *Going Green: Best Practices for Sustainable Procurement*. https://www.oecd.org/gov/public-procurement/Going_Green_Best_Practices_for_Sustainable_Procurement.pdf

OECD (Ed.). (2024a). *A Roadmap towards Circular Economy of Albania.* OECD Publishing. https://doi.org/10.1787/8c970fdc-en

OECD. (2024b). *A Roadmap towards Circular Economy of Albania.* https://doi.org/10.1787/8c970fdc-en

Pinasseau, A., Zerger, B., Roth, J., Canova, M., & Roudier, S. (2018). *Best Available Techniques (BAT) Reference Document for Waste Treatment: Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control)*. EUR 29362 EN (JRC113018). https://eippcb.jrc.ec.europa.eu/reference/waste-treatment-0 https://doi.org/10.2760/407967

SGU (Ed.). (2023). *Global production of critical and strategic raw materials (CRM/SRM)*. https://www.sgu.se/globalassets/mineralnaring/kritiska-material/critical-raw-material-world-production-2022---eng.pdf

Stoifl, B., & Broneder, C. (2024). *Leitfaden zur Erstellung regionaler Abfallvermeidungskonzepte [Guidelines for the creation of regional waste prevention concepts]: Version 2.0*. https://www.umweltbundesamt.at/umweltthemen/abfall/abfallvermeidung/regionales-abfallvermeidungskonzept

Umweltbundesamt (Ed.). (2013). *Technical Document: Treatment of Separately Collected Organic Waste (Composting and Digestion).*

Weißenbach, T. (2021). *Development of an online/ontime method for the characterization of waste streams in waste pre-treatment plants: Doctoral Thesis.*

Zwiauer, K. (2023). *Wege in die Kreislaufwirtschaft [Paths to the circular economy]*. https://www.e-genius.at/mooc/wege-in-die-kreislaufwirtschaft/wocheneinheit-0-hinweise-zum-kurs/04-nutzungsbedingungen

ANNEX

List of Albanian waste legislation is as follows:

1. Law no. 10463, dated 22.09.2011 "On integrated waste management", amended

2. DCM no. 798 date, 29.9.2010 "On the approval of the regulation "On the administration of hospital waste".

3. DCM no. 177, dated 06.03.2012 "On packaging and their waste", amended.

4. DCM no. 178, dated 06.03.2012 "On incineration waste ".

5. DCM no. 452, dated 11.07.2012 "On landfill waste", amended.

6. DCM no. 705, dated 10.10.2012 "On the management of end-of-life vehicle waste".

7. DCM no. 765, dated 07.11.2012 "On the adoption of rules for the separate collection and treatment of used oils".

8. DCM no. 866, dated 4.12.2012 "On batteries, accumulators and their waste".

9. DCM no. 957, dated 19.12.2012 "On waste from electrical and electronic equipment".

10. DCM no. 117, dated 13.02.2013 "On the criteria on the basis of which it is determined when certain types of scrap metal cease to be waste", amended

11. DCM no. 967, dated 25.10.2013 "On the establishment of the working group for the Integrated Waste Management Committee", amended.

12. DCM no. 229, dated 23.04.2014 "On the approval of the rules for the transfer of non-hazardous waste and the information that must be included in the transfer document", as amended.

13. DCM no. 371, dated 11.06.2014 "On the approval of the rules for the delivery of hazardous waste and their delivery document", as amended.

14. DCM no. 418, dated 25.06.2014 "For the differentiated collection of waste at source".

15. DCM no. 641, dated 01.10.2014 "For the approval of the rules for the export of waste and the transit of non-hazardous waste and inert waste", amended.

16. DCM no. 127, dated 11.02.2015 "Requirements for the use of polluted water sludge in agriculture".

17. DCM no. 387, dated 06.05.2015 "On the rules for controlling the disposal of PCBs/PCTs, the decontamination or disposal of equipment containing PCBs/PCTs and/or the disposal of waste of used PCBs/PCTs".

18. DCM no. 575, dated 24.06.2015 "On the approval of requirements for inert waste management".

19. DCM no. 687, dated 29.7.2015 "For the approval of the rules for keeping, updating and publishing waste statistics", amended.

20. DCM no. 1104, dated 28.12.2015 "On the approval of requirements for the prevention of the discharge of waste, created by ships and excess cargo, at sea".

21. DCM 652, dated 14.09.2016 "On the rules and criteria for the management of waste from used tires".

22. DCM no. 660, dated 31.10.2018 "On the approval of requirements for the management of metal waste".

23. DCM no. 540, dated 25.07.2019 "For the approval of the necessary measures, for carrying out extended producer responsibilities from any natural or legal person who produces, processes, treats and sells leather".

24. DCM no. 418, dated 27.05.2020 "On the approval of the strategic policy document and the national plan for integrated waste management, 2020-2035".

25. DCM no. 402, dated 30.06.2021 "On the approval of the Catalog of Waste".

26. DCM no. 367, dated 30.5.2022 "On the determination of detailed measures and institutions responsible for the prohibition of the use, placing on the market, production, importation or introduction into the territory of the Republic of Albania of carrying plastic bags, as well as oxo-degradable carrying plastic bags or oxo-biodegradable", amended.

27. Order No. 113, dated 13.4.2020 "For the approval of the authorization model for the export of non-hazardous waste, the authorization model for the transit of non-hazardous waste or inert waste and the authorization model for the eksport of hazardous waste.

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