



Training Contents According to Methodology



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Circular STEM



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Boosting Circular Economy Competences for STEM

Teachers

Author (s): European Digital Learning Network ETS



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Training Contents According to Methodology

PART I: GENERAL CONTENT ON CIRCULAR ECONOMY

1.1 What is the Circular Economy?

The **circular economy** is a comprehensive and sustainable economic model that redefines traditional notions of growth by focusing on the continuous use and regeneration of resources. It is based on three core principles: **designing out waste and pollution, keeping products and materials in use, and regenerating natural systems.**

This model challenges the prevailing **linear economy**, which operates on a “take-make-consume-dispose” basis—extracting raw materials, manufacturing products, using them, and then discarding them as waste.

In a circular economy, products are intentionally designed for durability, reuse, remanufacturing, and recyclability, enabling resources to circulate within the economy for as long as possible. Instead of being thrown away, materials are given a new life through strategies such as **repairing, refurbishing, repurposing, recycling, and sharing.** For instance, used electronic devices might be repaired and sold again, or old textiles could be turned into insulation materials for buildings.

This model also integrates **innovative business strategies** like product-as-a-service (leasing instead of owning), reverse logistics, and industrial symbiosis—where the waste of one process becomes the input for another. These strategies help to **reduce dependence on finite raw materials**, lower greenhouse gas emissions, and **create new economic opportunities**, particularly in sectors such as renewable energy, eco-design, and waste management.

Moreover, the circular economy supports **resilience in global supply chains** and promotes **localized production models**, which can reduce transportation costs and environmental footprints. It aligns closely with the goals of the **European Green Deal** and the **United Nations Sustainable Development Goals (SDGs)**, particularly those related to responsible consumption and production (SDG 12), climate action (SDG 13), and decent work and economic growth (SDG 8).

Ultimately, the circular economy is not just an environmental necessity but an **economic and social opportunity**, aiming to decouple economic growth from resource consumption and environmental degradation. It envisions a future where growth is regenerative by design and where economic systems contribute positively to the planet and society.

1.2 Why Integrate Circular Economy in STEM Education?

Integrating the principles of the **circular economy** into **STEM (Science, Technology, Engineering, and Mathematics) education** equips students with the knowledge and skills needed to address some of the most pressing environmental and societal challenges of our time. It fosters a forward-thinking mindset that goes beyond technical proficiency, preparing learners to become **innovative problem-solvers, ethical engineers, and responsible global citizens.**

- **Encourages Interdisciplinary Learning**
Circular economy education naturally crosses disciplinary boundaries. It requires students to blend concepts from environmental science, engineering, chemistry, economics, and even social sciences.

By working across disciplines, students learn to see the bigger picture and appreciate how interconnected systems—ecological, economic, and social—function together. This holistic approach mirrors the complexity of real-world challenges and fosters collaborative learning environments.

- **Stimulates Critical Thinking and Systems Thinking**
Understanding and applying circular economy principles requires a shift from linear to **systems thinking**—the ability to analyze how parts of a system influence one another within a whole. Students are encouraged to explore questions like: *What are the environmental impacts of material choices? How does product design influence end-of-life options? What feedback loops exist in natural or industrial systems?* This cultivates critical thinking, strategic planning, and the ability to anticipate long-term consequences—essential competencies for 21st-century careers.
- **Connects Science and Technology to Real-World Sustainability Issues**
By embedding circular economy concepts into STEM subjects, educators can make science and technology **relevant and applicable to everyday life**. Students explore how scientific innovation and technological advancements—such as bio-based materials, renewable energy, or smart recycling systems—can solve real environmental problems. This not only enhances student engagement but also deepens their understanding of sustainability, climate change, and resource efficiency.
- **Promotes Innovation and Entrepreneurial Thinking**
The circular economy thrives on **innovation**—rethinking products, redesigning systems, and reimagining business models. STEM education that incorporates circularity can inspire students to develop new solutions, from biodegradable packaging to modular electronics designed for repair. This entrepreneurial mindset nurtures creativity and adaptability, traits that are crucial in an ever-evolving job market.
- **Aligns with Global Educational Goals and Green Transitions**
Teaching circular economy principles supports global agendas like the **UN Sustainable Development Goals (SDGs)** and the **EU Green Deal**, which advocate for sustainability, responsible consumption, and climate action. It also prepares students to participate in the **green and digital transitions**, fostering the skills needed in emerging sectors such as green engineering, eco-innovation, and clean technologies.

1.3 Frameworks Used

The integration of circular economy principles into STEM education is supported by a combination of European competence frameworks that provide structured guidance on how to develop essential transversal skills. The following frameworks offer complementary perspectives that are particularly valuable in building a holistic educational approach:

GreenComp – The European Sustainability Competence Framework

GreenComp (2022) is the European framework for sustainability competences developed by the Joint Research Centre (JRC) of the European Commission. It provides a comprehensive guide to what learners need to know, understand, and be able to do to live, work, and act in a sustainable manner.

GreenComp identifies four key competence areas:

1. Embodying sustainability values
2. Embracing complexity in sustainability
3. Envisioning sustainable futures
4. Acting for sustainability

By applying GreenComp in STEM education, educators can support learners in becoming systems thinkers, responsible citizens, and agents of change—key for engaging with circular economy concepts such as resource efficiency, product life cycles, and ecological regeneration.¹

EntreComp – The Entrepreneurship Competence Framework

EntreComp (2016) defines the key components of an entrepreneurial mindset and is designed to support the development of entrepreneurial learning across all levels of education and training.

It is built around three competence areas:

1. Ideas and opportunities
2. Resources
3. Into action

Each area includes five competences, ranging from creativity and ethical thinking to mobilizing resources and learning through experience. In the context of circular economy and STEM, EntreComp fosters innovation, problem-solving, and initiative-taking—empowering students to develop sustainable solutions and potentially launch green ventures².

DigComp – The Digital Competence Framework for Citizens

DigComp provides a structured understanding of what digital competence means across five key areas:

1. Information and data literacy
2. Communication and collaboration
3. Digital content creation

¹ Bianchi, G., Pisiotis, U., & Cabrera Giraldez, M. (2022). *GreenComp – The European sustainability competence framework*. Publications Office of the European Union.
<https://publications.jrc.ec.europa.eu/repository/handle/JRC128040>

² Bacigalupo, M., Kampylis, P., Punie, Y., & Van den Brande, G. (2016). *EntreComp: The Entrepreneurship Competence Framework*. Publications Office of the European Union.
<https://publications.jrc.ec.europa.eu/repository/handle/JRC101581>

4. Safety
5. Problem-solving

Now in its updated version (DigComp 2.2, 2022), the framework supports digital literacy and lifelong learning by helping educators and learners understand how to safely and effectively use digital tools³.

In the context of STEM and circular economy education, DigComp is crucial for teaching students how to:

- Analyze data on environmental impact
- Use digital tools for designing sustainable products
- Collaborate on green tech projects
- Leverage open-source innovation and digital platforms to share sustainable solutions

1.4 Circular Economy in Practice

The circular economy is not just a theoretical concept—it is a practical and transformative approach reshaping the way we produce, consume, and manage resources. This section highlights key areas where circularity is applied and how these practices are relevant to students, professionals, and everyday citizens. Understanding these applications provides a solid foundation for implementing sustainability in STEM education and beyond.

1. Circular Business Models

Circular business models reimagine the traditional way goods and services are delivered by **prioritizing longevity, reuse, and regeneration** over volume-based sales. These models include:

- **Product-as-a-service:** Companies retain ownership of products and offer them via leasing or subscription models (e.g., renting appliances or clothing).
- **Take-back schemes:** Producers collect used products for repair, refurbishment, or recycling (e.g., electronics manufacturers reclaiming old devices).
- **Sharing platforms:** Digital services that facilitate peer-to-peer sharing of goods, from tools to vehicles, increasing asset utilization.
- **Remanufacturing and upcycling:** Businesses that restore used components or transform waste into new, higher-value products.

These models support sustainable value creation and are increasingly aligned with EU green policies and market incentives.

2. Sustainable Design and Production

Circularity starts at the **design phase**, where products are engineered for durability, repairability, modularity, and recyclability. This includes:

- **Eco-design principles:** Minimizing environmental impact throughout the product's lifecycle.

³ Vuorikari, R., Kluzer, S., & Punie, Y. (2022). *DigComp 2.2: The Digital Competence Framework for Citizens – With new examples of knowledge, skills and attitudes*. Publications Office of the European Union. <https://publications.jrc.ec.europa.eu/repository/handle/JRC128415>

- **Material innovation:** Using biodegradable, non-toxic, or recycled materials in production.
- **Energy efficiency:** Designing processes and products that consume less energy and generate less waste.
- **Industrial symbiosis:** Where the by-product of one industry becomes the input for another, reducing waste across value chains.

In STEM education, incorporating sustainable design encourages students to think critically about the full lifecycle of what they create.

3. Waste Minimization Strategies

Minimizing waste is a core tenet of the circular economy, emphasizing prevention over treatment. Key strategies include:

- **Designing out waste:** Avoiding the generation of waste in the first place through smarter design.
- **Closed-loop recycling:** Creating systems where materials are continuously recovered and reused without quality loss.
- **Composting and biological cycles:** Returning organic waste to the soil to restore nutrients and support biodiversity.
- **Repair and maintenance ecosystems:** Encouraging repair skills, repair cafés, and maker communities to extend product life.

Embedding these strategies into classroom projects helps develop problem-solving and systems thinking skills.

4. Circularity in Everyday Choices

Circular economy principles extend into **daily consumer behavior**, demonstrating how individuals can actively contribute to sustainability through conscious decisions in areas such as:

- **Fast fashion:** Choosing quality, ethically-produced, or second-hand clothing; supporting brands with transparent, circular supply chains.
- **Food waste:** Planning meals, storing food correctly, composting organic waste, and supporting circular food businesses.
- **Technology:** Extending the life of electronics through repair, buying refurbished devices, and recycling e-waste responsibly.

Educators can engage students with real-world case studies and challenges that highlight how individual choices ripple across environmental and economic systems.

By connecting **theory to practice**, this section aims to inspire learners to adopt and promote circular behaviors in their personal, academic, and professional lives—building a generation of sustainability-minded innovators ready to reshape the future.

1.5 Teaching Strategies

Effectively integrating circular economy principles into STEM education requires dynamic, student-centered teaching approaches that foster **engagement, critical thinking, collaboration, and real-world problem-solving**.

The following teaching strategies are particularly well-suited to support this aim and to prepare students for the complexities of sustainability-focused innovation.

1. Project-Based Learning (PBL)

Project-Based Learning empowers students to engage in extended, interdisciplinary investigations centered around meaningful, real-world problems. Within the context of the circular economy, students might:

- Design sustainable products using eco-design principles
- Analyze the environmental impact of waste in their school or community
- Prototype circular business models or services

PBL promotes **active learning**, encourages teamwork, and helps students develop **21st-century skills** such as creativity, communication, and resilience. It allows learners to take ownership of their learning journey while tackling sustainability issues through concrete actions and deliverables.

2. Inquiry-Based Learning

Inquiry-Based Learning (IBL) places curiosity at the heart of the learning process. It encourages students to formulate questions, conduct research, test hypotheses, and draw evidence-based conclusions. In a circular economy context, students might explore:

- Why do some materials recycle better than others?
- What are the economic and environmental costs of planned obsolescence?
- How can we design a circular system for school cafeteria waste?

IBL cultivates **scientific literacy**, **investigative skills**, and a deeper understanding of cause-and-effect relationships, essential for engaging with the complex systems that underpin circularity.

3. Real-World Challenges and Simulations

Bringing **authentic, real-world challenges** into the classroom enables students to bridge theory with practice. This can include:

- Simulating product life cycles and material flows
- Participating in sustainability hackathons or innovation labs
- Collaborating with local businesses or municipalities on green initiatives

Simulations and scenario-based activities expose learners to **systems thinking**, allowing them to consider multiple stakeholder perspectives, balance trade-offs, and assess the long-term impacts of decisions. These experiential approaches are particularly effective in building empathy and social responsibility.

4. Use of Digital Tools and Collaborative Platforms

Technology plays a pivotal role in enriching learning environments and supporting collaboration. Digital tools help visualize complex systems, co-create content, and communicate ideas. Examples include:

- **Canva** and **Google Slides** for designing sustainability campaigns, posters, and digital presentations
- **Padlet**, **Jamboard**, and **Miro** for collaborative brainstorming, mapping, and ideation

- **Tinkercad** or **SketchUp** for prototyping circular design solutions
- **LMS platforms** (e.g., Moodle, Microsoft Teams) for managing interdisciplinary projects and tracking progress

These tools foster **digital fluency**, creativity, and cooperative learning while enabling students to present their work to real or virtual audiences—enhancing both impact and motivation.

PART II: TRAINING METHODOLOGY AND MODULE STRUCTURE

The methodology and training structure are based on an integrated framework developed by the project partners and tested through pilot activities. Each module below is paired with a corresponding PowerPoint resource containing theoretical and practical materials.

Module 1: Introduction to Circular Economy

Focuses on key CE principles, comparisons between linear and circular models, economic benefits, eco-design, and real-life applications. Includes interactive activities like infographics and domestic upcycling.



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MODULE 1: INTRODUCTION TO CIRCULAR ECONOMY

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INTRODUCTION TO CIRCULAR ECONOMY

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- **Unit 1:** Fundamentals of the circular economy
- **Unit 2:** Economic and technological benefits
- **Unit 3:** Involvement of education and awareness raising in the promotion of the circular economy



UNIT 1

FUNDAMENTALS OF THE CIRCULAR ECONOMY

The circular economy is a development model where the value of the products, materials and resources is kept in the economy for the longest possible time. Instead of being scrapped after being used, the materials are reincorporated in the production cycle as secondary raw materials.



UNIT 1 FUNDAMENTALS OF THE CIRCULAR ECONOMY

CREATION OF NEW JOBS

- Production of energy from renewable sources
- Energy efficiency
- Waste and waste management
- Air quality management
- Restoring goods and services
- Increasing recycling
- Reuse and use of new materials that they are easily recyclable or reusable



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UNIT 1: FUNDAMENTALS OF THE CIRCULAR ECONOMY EU'S ROLE

The EU aims to transition to a circular economy to make Europe cleaner and more competitive.

There is only one planet Earth, yet by 2050, the world will be consuming as if there were three. The EU's transition to a circular economy will reduce pressure on natural resources, create sustainable growth and jobs. It is essential to achieve the EU's 2050 climate neutrality target and to halt biodiversity loss.

To accelerate the EU's transition to a circular economy, the European Commission adopted the [new circular economy action plan](#) in March 2020.

90%

of biodiversity loss is caused by
resource extraction and processing

Up to 80%

of products' environmental impacts
are determined at the design phase

11.8%

the current circular material use rate
in the EU



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UNIT 1: FUNDAMENTALS OF THE CIRCULAR ECONOMY

LINEAR ECONOMY VS CIRCULAR ECONOMY

The circular economy seeks to maximise the useful life of products and minimise waste through reuse, recycling and recovery of materials.

This results in lower environmental impact, reduced natural resource extraction, and greater efficiency in resource use, which in turn promotes sustainability and economic and social innovation, in contrast to the linear model that tends to generate more waste, deplete resources and have higher long-term economic and environmental costs.

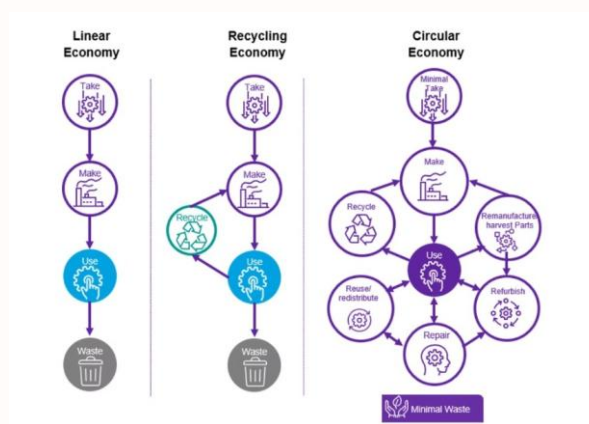


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UNIT 1

FUNDAMENTALS OF THE CIRCULAR ECONOMY



UNIT 1



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FUNDAMENTALS OF THE CIRCULAR ECONOMY

ECO DESIGN

Ecodesign represents a transformative shift in product development, deeply embedding environmental consideration into every aspect of the design process. This philosophy goes beyond mere compliance with regulations, weaving sustainability into the fabric of products from conception to disposal.

It redefines the relationship between products and the environment, ensuring that each phase of the product life cycle contributes positively to our planet's health. By adopting this approach, businesses, designers, and policymakers are empowered to minimise negative environmental impacts, fostering innovation and sustainable growth.

UNIT 1: FUNDAMENTALS OF THE CIRCULAR ECONOMY TEACHER RESOURCES

- <https://www.ellenmacarthurfoundation.org/articles/circular-economy-products>
- <https://movimentocircular.io/en/educacao>
- <https://stateofgreen.com/en/news/10-examples-of-circular-economy-solutions/>
- <https://www.europarl.europa.eu/thinktank/infographics/circulareconomy/public/index.html>



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UNIT 1

FUNDAMENTALS OF THE CIRCULAR ECONOMY

WASTE RECYCLING AND MATERIALS CYCLING

One of the main characteristics of the circular economy is that waste becomes a resource, so all biodegradable material is returned to nature and that which is not biodegradable is reused. The reuse of waste that can still work is encouraged, a second life is sought for damaged products and the materials found in waste are used, making energetic use of waste that can no longer be recycled.

Even industrial waste can contain valuable components that can be recovered and reused in the production of new products. In short, by considering waste as a potential resource and applying appropriate waste management techniques, we can reduce dependence on natural resources and promote environmental sustainability.



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UNIT 1: FUNDAMENTALS OF THE CIRCULAR ECONOMY

ACTIVITY 1: Learning about circular economy concepts

Necessary materials:

- Computer, internet connection, software for making and editing infographics.
- Paper, cardboard, paints (optional).

Description of activity:

- **Preparation of the activity:** Divide students into pairs or small groups to make the activity more dynamic.
- **Brainstorming:** Students, in small groups, have to generate an infographic in which they define the circular economy versus the concept of the linear economy using concepts such as circular economy, including reuse, repair, sustainable manufacturing, eco - design, and sharing economy.
- **Design and create:** Once the students have worked on the concepts, they can start to design and create their infographics using an online application. (Optional: the teacher can guide the group and propose different target audiences so that the students can learn how to address the message depending on who it is aimed at, for example, addressing the message to school teachers, students from other modalities, or a small group of professionals).



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UNIT 1: Fundamentals of the Circular Economy

ACTIVITY 2: Domestic upcycling

Type of activity:

Interactive Offline Activity

Necessary materials:

- A variety of recyclable and reusable waste such as paper, cardboard, plastic bottles, empty containers, lids, newspapers, etc.
- Scissors.
- Glue.
- Paints and paintbrushes (optional).
- Permanent markers.



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Description of activity:

- **Preparation of the activity:** Divide students into pairs or small groups to make the activity more dynamic.
- **Collection of materials:** Invite students to bring in different types of clean, non-hazardous waste, such as paper, cardboard, plastic bottles, cans, pieces of cloth, bottle caps, etc. You can provide a list of suggested materials or let students bring in what they have available at home.
- **Brainstorming ideas:** Students in small groups have to generate ideas on how they could transform waste into new useful or decorative products. They can look for inspiration on the internet or in magazines on DIY, decoration, art.... As an educator, you support the inspiration process.
- **Designing and creating:** After deciding on a project to do, students can start designing and creating their products using the collected materials. For example, they could turn plastic bottles into plant pots, use cardboard and paper to create greeting cards or make reusable bags, rag dolls, cushions from pieces of cloth.



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UNIT 2

ECONOMIC AND TECHNOLOGICAL BENEFITS

- Reducing raw material costs by reusing and recycling

Improves profitability in the shortterm, and fosters higher productivity in the long term.

- Companies can differentiate themselves in the marketplace and strengthen their corporate image



UNIT 2

ECONOMIC BENEFITS OF THE CIRCULARECONOMY CONCEPTS

- Slow down the use of natural resources, reduce landscape and habitat disturbance and help limit biodiversity loss.
- Reduction of total annual greenhouse gas emissions.
- Help reduce energy and resource consumption.



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UNIT 2

ECONOMIC AND TECHNOLOGICAL BENEFITS

BUSINESS OPPORTUNITIES IN THE CIRCULAR ECONOMY

Circular economy models evolve through value capture, and the following processes are identified:

- **Product as a Service (PaaS):**

This model transforms products into services, customers pay for the performance and use of a product rather than for its purchase.

Future System

Circular Economy



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UNIT 2

ECONOMIC AND TECHNOLOGICAL BENEFITS

BUSINESS OPPORTUNITIES IN THE CIRCULAR ECONOMY

- **Collaborative economy (Sharing economy):**

The collaborative economy consists of sharing goods or services in exchange for a pre-agreed compensation, financial or otherwise.

Allows companies to access new market segments where access and convenience are valued more highly than ownership. This model reduces resource consumption by maximizing the use of each product.

- **Remanufacturing:**

Remanufacturing extends the life of products and components, often making them as good as new or even better.

Businesses need to plan for the return of products, the logistics of remanufacturing and the resale of refurbished items. There is also a need to educate consumers about the value of remanufactured goods to overcome any biases towards new products.



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UNIT 2

ECONOMIC AND TECHNOLOGICAL BENEFITS

BUSINESS OPPORTUNITIES IN THE CIRCULAR ECONOMY

Type	Description
Collaborative consumption	Consumption model based on the exchange, rental, or shared use of goods or services among different users such as carsharing or the vacation rentals.
Collaborative production	It consists of the interaction between different people to implement a project usually through shared areas, either virtual or physical, such as coworking spaces.
Collaborative finance	The best known example is crowdfunding, in which different people or entities make monetary contributions so that an initiative can be launched.
Open knowledge	Refers to non-profit knowledge dissemination platforms such as open online courses, publicly accessible online encyclopaedias or free virtual archives.



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UNIT 2 ECONOMIC AND TECHNOLOGICAL BENEFITS

EXAMPLES OF INNOVATIVE TECHNOLOGIES IN RESOURCE MANAGEMENT

- **100% recycled materials** <https://ecoalf.com/en/pages/proposito>
- **PaaS model-** [Consumer electronics](#), [Consumer Goods](#), [Home & Furniture](#)
- **Products-** <https://zirkularrak.ihobe.eus/en/products>
- **10 Examples of Circular Economy Solutions** <https://stateofgreen.com/en/news/10-examples-of-circular-economy-solutions/>
- **Social Enterprise** <https://www.futurize.studio/blog/social-entrepreneurship-examples-and-how-to-set-up-a-social-enterprise>
- **Catalogue of Best Practices in Circular Economy** <https://www.miteco.gob.es/en/calidad-y-evaluacion-ambiental/temas/economia-circular/buenas-practicas-economia-circular.html>



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UNIT 2 ECONOMIC AND TECHNOLOGICAL BENEFITS MONITORING FRAMEWORK

It is essential to monitor progress towards a circular economy, and its direct and indirect benefits. This allows the EU and national authorities to assess whether policies are effective and to identify best practices.

In 2023, the Commission revised the circular economy monitoring framework, previously adopted in 2018. The revision adds new indicators on: material footprint and resource productivity - to monitor material efficiency and consumption footprint – to observe if EU consumption fits within planetary boundaries. The new framework supports the EU's circular economy and climate neutrality ambitions under the European Green Deal.



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UNIT 3

INVOLVEMENT OF EDUCATION AND AWARENESS RAISING

The possibilities of applying the circular economy in education are very diverse and encompass a wide range of perspectives. This opens the door to new job opportunities and, therefore, to a wider educational offer.

It is true that sustainability is increasingly present in higher education, but there is still room for improvement in this area. It is essential to introduce more specific content on the circular economy and the areas it covers.

By applying digital technologies and offering information adapted to each stage of education, it is possible to generate a collective change of attitude and a commitment to sustainability.

UNIT 3

Involvement of Education and Awareness Raising

ACTIVITY 3: Research and Proposal on Circular Economy for Technology and Energy Companies

Necessary materials:

- Internet access and research resources.
- Paper and pens for taking notes.
- Recorder or app to record interviews (optional).

Description of activity:

Introduction: Introduce students to the concept of circular economy and its importance in environmental sustainability. Explain the aim of the activity and the importance of researching technology and energy companies in the area.

Research:

Assign each student or group a local technology or energy company to research. Ask students to research the company's production process, including extraction of raw materials, manufacture, distribution, use and final disposal of products. Encourage students to seek information about the company's sustainability policies and environmental practices.

Interviews:

Arrange interviews with representatives of the selected companies. During the interviews, students can ask questions about the company's current practices in relation to the circular economy, challenges they face, and possible areas for improvement.

Analysis:

After collecting the information from the research and interviews, ask students to critically analyse the company's production process from a circular economy perspective. Encourage students to identify areas where the company can improve efficiency, reduce waste, recycle materials or adopt more sustainable practices.

Proposal for Improved Alternatives:

Based on their analysis, ask students to propose improved alternatives for the company's production process, with a focus on the circular economy.



UNIT 2

ECONOMIC AND TECHNOLOGICAL BENEFITS

EU'S NEW CIRCULAR ACTION PLAN

In February 2021, Parliament voted on the Circular Economy Action Plan and demanded additional measures to move towards a ~~con-~~ neutral, sustainable, toxiefree and fully circular economy by 2050. These should include stronger recycling laws and binding ~~targets~~ targets by 2030 to reduce the ecological footprint of the use and consumption of materials.

Measures that will be introduced under the new action plan aim to:

- Make sustainable products the norm in the EU,
- Empower consumers and public buyers,
- Focus on the sectors that use most resources and where the potential for circularity is high such as: electronics and ICT, ~~vehicles~~ vehicles and vehicles, packaging, plastics, textiles, construction and buildings, food, water and nutrients,
- Ensure less waste,
- Make circularity work for people, regions and cities, and
- Lead global efforts on circular economy.



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Module 2: Environmental Sustainability and Impact

Covers climate change, biodiversity, responsible consumption, renewable energy, and policy frameworks such as the EU Green Deal. Includes simulations and games for digital learning.



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Module 2: Environmental Sustainability and Impact Workshop

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Module 2: Sustainability and Impact on the Environment

This module **aims** to provide an in-depth exploration of **sustainability and its impact** on the environment. Throughout this workshop, participants will gain knowledge and insights into the importance of sustainable practices, the concept of ecological footprint, and the **role of educators in promoting sustainability**





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Objectives of the Module

- Getting to know the concept of sustainability and ecological footprint
- Understanding the importance of sustainability education
- Development of digital literacy and research skills in students



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Why Is This Topic Important?

Importance of Teacher Education

- Teacher education plays a **pivotal role** in raising awareness of sustainability among students.
- Educators are **influential figures** in instilling values of **environmental responsibility** and sustainable living.



Impact of Human Activities

- **Human activities have significantly impacted the environment**, leading to issues such as **deforestation, pollution, and climate change**
- It's crucial to **understand** the extent of this impact **to address** and mitigate these pressing challenges.

Module 2: Environmental Sustainability and Impact

Topics	Learning Outcomes
UNIT 1. Understanding Our Environmental Impact	- Understand the concept of sustainability and calculate personal ecological footprints. - Recognize the causes and effects of climate change and the importance of biodiversity.
UNIT 2. Towards a Sustainable Future	- Adopt practices of responsible consumption and understand the impact of consumer choices. - Learn about different renewable energy sources and strategies for pollution and waste management.
UNIT 3. Collective Action for the Environment	- Appreciate the importance of international cooperation and global initiatives for environmental protection. - Understand how organizations can integrate sustainable practices into business operations and promote the circular economy



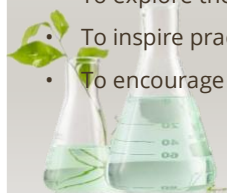
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Module 2, "Environmental Sustainability and Impact"

- To provide learners with comprehensive insights into the importance of environmental sustainability
- To raise awareness of the ecological footprint and how personal and collective actions affect the environment
- To explore the causes, consequences, and solutions for climate change and biodiversity loss.
- To inspire practical measures for sustainable living and reducing ecological footprints
- To encourage critical thinking about sustainability challenges and the implementation of effective solutions



UNIT 1.1 Sustainability and Ecological Footprint



- Sustainability means keeping our environment, communities, and economy balanced so we can use them forever.
- The ecological footprint shows how much we impact the Earth with our actions, like using resources and making waste.
- Knowing about ecological footprints helps us see how we, both individually and together, affect the world's resources. This understanding encourages us to change our ways to live more sustainably.

UNIT 1.2 Climate Change

- Climate change means big changes in the world's weather and temperatures, not only but mostly because of gases we release into the air.
- This causes the oceans to rise, ice to melt, and we see more storms and dry spells. To fix this, we need to quickly cut down on these gases, use energy more wisely, and start using energy from the sun, wind, and other clean sources.

UNIT 1.3 Protecting Biodiversity

- Biodiversity is all the different kinds of life we find on Earth, and it's really important for keeping nature strong and giving us things we need, like clean air and water.
- Sadly, when we deconstruct homes of animals, pollute, or use too much of nature's gifts, we hurt biodiversity.
- To help, people are making safe places for nature, fixing damaged areas, using land without harming it, and making rules to protect wild animals. This way, we can keep the Earth full of life.



Unit 2: Towards a Sustainable Future



Choosing What We Buy Carefully

Go for things that are good for the planet, come from fair places, and try to use less stuff that can't be recycled. Support businesses that care about the Earth.

Using Energy from Nature

Instead of using oil or coal that hurt the air, we can get power from the sun (solar), wind, moving water (hydropower), plants (biomass), and the Earth's warmth (geothermal). These clean energies help stop the Earth from getting too hot.

Making Less Trash

By following the circular economy, which means we keep using things by fixing, reusing, or recycling them, we can help cut down trash we make.

Learning and Teaching Green Habits

It's super important to learn about how to live without hurting the planet. We need to share this knowledge in schools, encourage businesses to act greener, and ask governments to make rules that help protect our future.



UNIT 2.1 Sustainable Living



Learning how our choices impact the world teaches us to live in a way that's better for the planet and ourselves.

- It's about picking products that are good for the environment, made fairly, and don't create unnecessary waste.
- We all can learn how our habits affect the planet and find ways to make better choices.
- Companies can help by making things that last longer, can be recycled, and are made in eco-friendly ways.
- Governments can help by making laws that encourage recycling, clean energy, and cutting down on single-use plastics. It's cool to think more about the quality and meaning behind what we buy and do, rather than just having more stuff.

UNIT 2.2 Renewable Energy

Switching to energy sources like the sun and wind can help us stop using fuels that pollute the air.

- These clean energy sources can lower pollution, create jobs, and might even save money in the long run. Getting these new types of energy up and running can be pricey and tricky, especially since they depend on the weather and time of day.

UNIT 2.3 Reducing Pollution and Waste

Cutting down on pollution and trash involves everyone, from big companies to each of us at home.

- Industries, cars, farming, and too much plastic are big reasons our land, air, and water get dirty.
- We can make less trash by reusing, fixing, and recycling things instead of throwing them away. It takes teamwork across the whole community to really make a difference in keeping our planet clean.



Unit 3: Collective Action for the Environment



Write a cool subtitle here to provide context



Working Together Across Borders

Solving big Earth problems, like pollution and climate change, needs countries to work together, sharing ideas, technology, and resources.

Big Plans for a Greener World

The 2030 Agenda and the Paris Agreement are like global promises to make the planet healthier and to fight climate change by working together.

Europe's Green Moves

Europe is doing its part with big projects like the European Green Deal and the EU Circular Economy Action Plan, aiming to not harm the planet and use resources wisely.

Companies Stepping Up

Businesses are also getting in on the action by making their operations more eco-friendly, aiming for green goals, and following the circular economy model, which means finding ways to reduce waste and recycle more.



European initiatives and policies

- **The European Green Deal** Launched by the European Commission, this ambitious policy initiative aims to make Europe the world's first climate-neutral continent by 2050. It encompasses a broad range of measures, from cutting greenhouse gas emissions, investing in green technologies, and preserving Europe's natural environment to promoting sustainable industry and transport.
- **The EU Circular Economy Action Plan** A central part of the European Green Deal, this action plan focuses on reducing waste and ensuring that the resources used are kept in the EU economy for as long as possible. It introduces legislative and non-legislative measures covering the entire product lifecycle.
- **The EU Emissions Trading System (EU ETS)** The EU ETS is a cornerstone of the EU's policy to combat climate change and a key tool for reducing greenhouse gas emissions cost-effectively. It is the world's first major carbon market and remains the largest one, limiting emissions from more than 11,000 heavy energy-using installations.
- **The Renewable Energy Directive (RED)** The RED sets ambitious targets for all EU countries to achieve a 32% share of renewable energy in their gross final energy consumption by 2030, promoting the use of energy from renewable sources.
- **The Energy Efficiency Directive** This directive establishes a set of binding measures to help the EU reach its 20% energy efficiency target by 2020 and aims for further improvements by 2030.
- **The LIFE Programme** The EU's funding instrument for the environment and climate action has supported thousands of projects across the EU, contributing to habitat preservation, pollution reduction, and climate mitigation efforts.
- **The Water Framework Directive** This directive aims to protect and enhance the EU's water environment, promoting sustainable water use, reducing water pollution, and protecting aquatic ecosystems.



Global initiatives

- **Global Climate Ambition Alliance (2021)** - This alliance represents a renewed partnership among countries to intensify actions and ambitions in combating climate change in line with the goals of the Paris Agreement.
- **UN Decade on Ecosystem Restoration (2021)** - This initiative aims to restore 350 million hectares of degraded land worldwide by 2030, combining efforts from governments, the private sector, and local communities.
- **Blue Economy** - A concept increasingly promoted by the UN and other international organizations, focusing on the sustainable use of ocean resources for economic growth, improving livelihoods, and ocean health protection.
- **New York Declaration on Forests (2014)** - A declaration that brings together governments, corporations, and civil society in efforts to halve the loss of forests by 2020 and end deforestation by 2030.
- **Paris Agreement (2015)** - Though adopted more than 5 years ago, the Paris Agreement remains one of the most significant recent initiatives aimed at combating climate change to keep global warming well below 2 degrees Celsius.



Digital Tools for Interactive Learning

1 Kahoot!

A game-based learning platform that allows educators to create their own quizzes on sustainability topics. [Visit Kahoot](#).

2 Quizlet

Offers study sets and interactive activities for topics on environmental science and sustainability. [Visit Quizlet](#).

3 Google Earth

Utilize to explore environmental changes, deforestation, and conservation areas around the globe. Visit Google Earth



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Footprint Calculator

The Footprint Calculator measures your ecological impact based on lifestyle choices. Answer questions to see the global effect of your habits and learn ways to live more sustainably. [Visit Footprint Calculator](#).



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Climate Change Resources

Climate Change Resources for Students and Teachers: This list curated by Common Sense Education editors includes 24 apps, games, and websites designed to educate students about climate change [Visit Climate Change Resources](#)

Climate Box

An Interactive Learning Toolkit on Climate Change: This toolkit offers interactive materials that provide important information on global climate change interestingly and entertainingly, making learning about climate change engaging for teenagers [Visit Climate Box](#)

Games for Learning

- EcoChains: Arctic Life: A card game that teaches about the impact of climate change on Arctic ecosystems and how to protect them.
- SimCity or Cities: Skylines: Use city-building simulations to understand urban planning and environmental impact. [Search for SimCity or Cities: Skylines online]
- Recycle City: An interactive game by the EPA that explores how a city can reduce waste and pollution. [Visit Recycle City](#)



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Climate games and simulations

There are many games and simulations on the theme of climate change.

Activity: Explore the game: "[Can you reach net zero by 2050](#)" created by the Financial Times. Students will need to understand the causes of climate change to keep global warming to 1.5C by cutting energy-related carbon dioxide emissions to reach net zero by 2050.

Source: <https://ig.ft.com/climate-game/>



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Module 3: STEM in Circular Economy

Highlights the interdisciplinary application of STEM for CE, showcasing innovations in recycling, energy, and resource optimization. Includes student challenges and real-world case studies.



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STEM IN CIRCULAR ECONOMY

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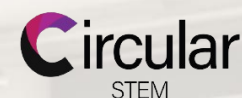


STEM disciplines are indispensable drivers of sustainable solutions, particularly in promoting the principles of the circular economy.

By emphasizing **reuse, repair, and recycling**, the circular economy aims to minimize waste and waste and maximize resource efficiency, with STEM providing the knowledge, tools, and innovation essential to achieving these goals.



Innovation and Design



1 Sustainable Product Product Design

STEM fields are leading the charge in revolutionizing product and system design, design, **fostering the creation of sustainable sustainable alternatives to traditional linear linear models.** Engineers and designers designers collaborate to develop **products products that are not only functional but but also durable, repairable, and recyclable. recyclable.**

2 Interdisciplinary Collaboration

Drawing **from materials science, chemistry, and biology, STEM experts craft solutions that align with environmental harmony** pushing creative boundaries, minimizing environmental footprints and maximizing resource utilization.

3 Data-Driven Approaches

This interdisciplinary collaboration **fosters breakthrough innovations,** optimizing designs for performance, longevity, and sustainability through data-driven approaches.



Resource Management



Mathematical Modeling

Mathematics and data science, alongside cutting-edge technologies, reshape resource management within the circular economy. Through mathematical modeling and data analytics, experts uncover nuanced efficiencies, **enhancing traditional models with machine learning and artificial intelligence.**

Predictive Analytics

Predictive analytics enables proactive proactive decision-making, aligning aligning supply with demand to minimize waste and conserve resources. STEM extends beyond traditional resource management, encompassing lifecycle assessments and eco-design strategies.

Sustainable Investments

These advancements empower businesses to **invest in sustainable sustainable technologies** and practices for efficient resource utilization.



Material Science and Recycling

Alternative Materials

1

The **dynamic collaboration** between science and engineering propels advancements in material science and and recycling technologies, **fostering innovative materials and processes that that champion circularity**. Researchers explore alternative materials, materials, biodegradable polymers, and and bio-based plastics, yielding products products easily recycled or composted. composted.

2

Recycling Technologies

Breakthroughs in **chemical recycling and and upcycling methodologies** herald resource recovery from waste streams, streams, mitigating waste burdens and and fostering a sustainable ecosystem of ecosystem of resource circulation.



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Energy Efficiency and Renewable

1

Renewable Energy Development

STEM is instrumental in developing renewable energy technologies vital for the circular circular economy. Engineers and scientists optimize solar, wind, and hydroelectric power, power, reducing reliance on finite resources and mitigating greenhouse gas emissions. emissions.

2

Technological Advancements

Innovations in solar panel materials and wind turbine design enhance efficiency and and affordability. Hydroelectric power generation is optimized with fish-friendly turbines and turbines and advanced monitoring systems.

3

Energy Storage and Smart Grids

Additionally, STEM drives advancements in energy storage technologies, like lithium-ion lithium-ion batteries, and smart grid integration, optimizing renewable energy utilization and utilization and grid efficiency.



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Fostering a Culture of Creativity



Innovative Thinking

The primary objective is to foster a culture of creativity within STEM disciplines, propelling inventive solutions for sustainable production and consumption.



Interdisciplinary Collaboration

Collaboration across STEM disciplines and industries is encouraged to create interdisciplinary solutions addressing the complexity of circular economy challenges.



STEM Education

Equipping individuals with STEM skills and knowledge is pivotal for effective participation in the circular economy landscape.



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Real-World STEM Applications: Innovations in Recycling, Renewable Energy, and Sustainability

We showcase cutting-edge STEM innovations that are driving progress in **recycling, renewable energy, and sustainable practices across Europe**. From advanced recycling technologies to large-scale renewable energy projects, these case studies demonstrate the power of STEM to create a more sustainable future.



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Recycling Innovations



Reverse Vending Machines

In countries like Norway, Sweden, and Germany, advanced **Reverse Vending Machines (RVMs)** equipped with barcode scanners and sensors incentivize recycling by providing refunds or rewards for returned beverage containers. These machines use machine learning algorithms to identify and sort different types of materials, improving recycling rates and reducing contamination.

Circular Economy Initiatives

The Circular Economy Package introduced by the European Union includes **policies and initiatives aimed at promoting resource efficiency and waste reduction**. Projects like the **Circular Economy Action Plan and the EU Plastics Strategy** encourage innovation in recycling technologies and sustainable materials development across Europe.



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Renewable Energy Innovations



Offshore Wind Farms

European countries, particularly the United Kingdom, Denmark, and the Netherlands, lead the world in offshore wind energy deployment. Technological advancements in offshore wind turbine design and installation techniques have enabled the construction of larger, more efficient wind farms in deeper waters, significantly expanding the capacity for renewable energy generation.

1

2

Solar Energy Integration

Countries like Germany and Spain have invested heavily in solar in solar energy infrastructure, leveraging advancements in in photovoltaic technology and grid integration techniques to increase solar energy penetration. Innovative Innovative projects, such as floating solar installations on on reservoirs and solar panels integrated into urban infrastructure, demonstrate Europe's commitment to expanding solar energy capacity.



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Energy Storage Innovations

1

Redox Flow Batteries

European companies like VoltStorage and ESS Europe are developing redox flow redox flow battery systems for grid-scale energy storage applications. These batteries utilize liquid electrolytes stored in separate tanks, allowing for allowing for scalable and long-duration energy storage solutions that can help can help balance supply and demand in renewable energy systems.

2

Hydrogen Storage and Fuel Cells

European countries are investing in hydrogen storage and fuel cell technologies technologies as key components of their decarbonization strategies. Projects Projects such as the HyFLEX initiative in Germany and the H2Ports project in project in Spain demonstrate the potential of hydrogen as a clean energy carrier energy carrier for transportation, industry, and grid balancing.



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Waste-to-Energy Innovations

1

Anaerobic Digestion Facilities

Biogas production facilities using anaerobic digestion technology are widespread across Europe, particularly in countries like Sweden, Denmark, and Austria. These facilities convert organic waste from agricultural, municipal, and industrial sources into biogas for electricity generation, heating, and transportation fuel.

2

Advanced Recycling Technologies

European companies like TOMRA and Bühler Bühler Group are developing advanced sorting sorting and recycling technologies to improve improve the efficiency and effectiveness of of waste processing operations. These technologies, including optical sorting systems systems and automated sorting robots, enable enable the recovery of valuable materials from from mixed waste streams while minimizing minimizing environmental impact.



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Practical STEM Projects



Renewable Energy Monitoring

Many schools and educational institutions in Europe have installed renewable energy systems such as solar panels or wind turbines on their premises. Students can engage in projects where they monitor and analyze the performance of these renewable energy systems, collecting data on energy generation, efficiency, and environmental impact.



Community Garden Initiatives

Community gardens are prevalent across Europe, providing spaces for local residents to grow their own food and engage in sustainable gardening practices. Students can participate in community garden projects where they learn about organic farming, composting, water conservation, and biodiversity conservation.



Waste Reduction and Recycling

Many European schools and municipalities have implemented waste reduction and recycling programs aimed at minimizing waste generation and promoting recycling. Students can participate in waste audits, where they assess the composition and volume of waste generated in their school or community.



Challenge



Challenge



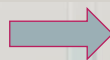
DESCRIPTION

Green Building Design



Students work in teams to develop innovative building designs that incorporate features such as passive solar design, natural ventilation, energy-efficient lighting, and renewable energy systems.

Water Quality Monitoring



Students participate in water sampling and testing activities, analyzing parameters such as pH, dissolved oxygen, turbidity, and nutrient levels in local water bodies.



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CASE STUDIES

Eco-SchoolsProgramme

The Eco-Schools Programme in Portugal encourages schools to develop eco-friendly practices, including the establishment of school gardens. Schools integrate gardening activities into their curriculum, providing students with opportunities to learn about sustainable agriculture, biodiversity conservation, and healthy eating habits.



Schuleim Grünen

Schule im Grünen (School in the Green) is a network of schools in Germany that promotes outdoor learning and environmental education through garden-based initiatives. Participating schools establish garden plots on their premises where students cultivate fruits, vegetables, herbs, and flowers.



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CASE STUDIES

Biolandhof SchulzeHamann

Biolandhof Schulze-Hamann is an organic farm and educational center located in Lower Saxony, Germany, that offers educational programs on renewable energy and sustainable agriculture. The farm utilizes various renewable energy technologies, including solar photovoltaic panels, solar thermal systems, and biomass boilers, to meet its energy needs.



Västerhöjdsgymnasiet

Västerhöjdsgymnasiet, a high school in Skövde, Sweden, has integrated renewable energy monitoring systems into its science and technology curriculum. The school's rooftop solar panels and wind turbine are connected to monitoring equipment that allows students to track energy production and consumption patterns.



Module 4: Digital Literacy and Tools in Circular Economy

Explores digital technologies like IoT, blockchain, AR/VR, and simulation software for understanding and managing circular systems. Includes collaborative platforms and virtual workshops.



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Module 4: Digital Literacy and Tools in Circular Economy

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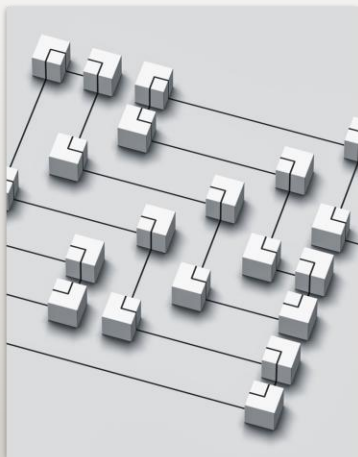
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Theoretical part on the topic

**Digital Literacy
and Tools in
Circular
Economy:
Harnessing
Technology for
Sustainable
Transformation:**

Digital Literacy:
Technological Solutions:
Supply Chain Management
Environmental Impact Assessment
Consumer Behavior
Innovation and Collaboration
Policy and Regulations
Educational Initiatives
Global Perspective



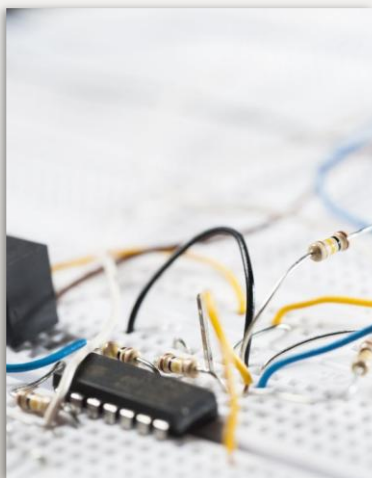


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1. Blockchain Technology:

Description: Blockchain is a decentralized and transparent ledger system where transactions are recorded and cannot be altered.

In the circular economy, blockchain helps keep things clear and easy to follow in supply chains. It does this by recording all the steps of getting materials, making stuff, and how long products last. For example, companies can use blockchain to see exactly where recycled materials go from when they're collected to when they're used again. This helps customers trust that products are real and good for the environment.



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2. Internet of Things (IoT) Sensors:

Description: IoT sensors are devices embedded in products, equipment, or infrastructure to collect and transmit data over the internet.

In the circular economy, special sensors called Internet of Things (IoT) sensors can watch how we use stuff, how much energy we use, and how well things work. Like, smart trash cans with these sensors can see when they're getting full, find the best way to pick up trash, and avoid picking up trash when it's not needed. This makes sure we don't waste stuff and helps things run better.

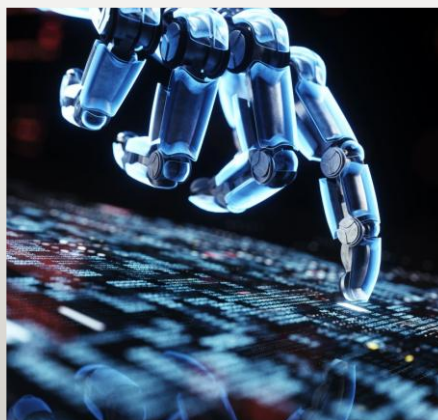


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3. Data Analytics Platforms

Description: Data analytics platforms use advanced analytics techniques to process and analyze large volumes of data for insights and decision-making.

In the circular economy, special computer programs called data analytics platforms help companies use resources better, find ways to make less waste, and see how they affect the environment. For instance, businesses can use these programs to guess how much people will want fixed-up products, manage their stock better, and make less waste by making stuff people want more.



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4. Augmented Reality (AR) and Virtual Reality (VR) Tools

Description: AR and VR technologies create immersive digital experiences by overlaying digital content onto the real world (AR) or by simulating virtual environments (VR).

In the circular economy, special AR and VR tools help with making, fixing, and looking after products. For instance, companies can use AR apps to show how to fix things step by step, see how to take stuff apart, and teach workers how to make old stuff like new again, making it all work better and faster.

Here are specific examples of using digital simulations for understanding resource management and circular processes



EcoChain:

Description: EcoChain is a digital simulation platform that models the environmental impacts of different resource management strategies and circular processes.

Companies can use EcoChain to pretend what happens to products and materials from when they're made to when they're thrown away. People can try different ideas, like recycling more, using more renewable energy, or finding better ways to move stuff around, to see how they affect the environment and find ways to do things better.



Here are specific examples of using digital simulations for understanding resource management and circular processes



AnyLogic:

Description: AnyLogic is a multi-method simulation software that enables users to model and analyze diverse systems, including supply chains, manufacturing processes, and transportation networks.

Companies can use AnyLogic to pretend how to make supply chains work better in the circular economy. For example, they can pretend to set up systems for bringing products back and making them new again, to see if it saves money and helps the environment. Also, AnyLogic can pretend how changes in how much people want stuff, delays in making things, and ways to manage stock affect how well circular supply chains work.



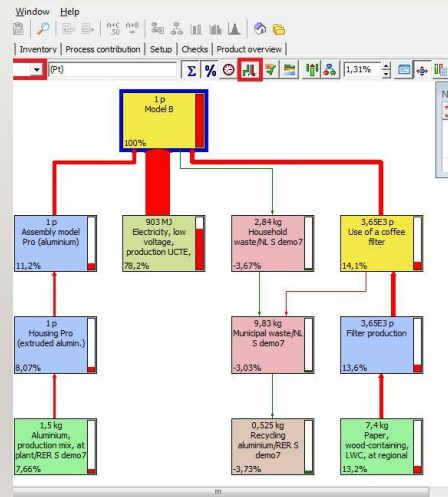
Here are specific examples of using digital simulations for understanding resource management and circular processes

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SimaPro:

Description: SimaPro is a life cycle assessment (LCA) software tool that quantifies the environmental impacts of products and processes.

Companies can use SimaPro to look closely at how much their products affect the environment, like how much carbon they make, how much water they use, and how many resources they use up. By putting in data about what they use to make stuff, how much energy they use, and what they throw away, people can see how it all affects the environment from beginning to end and find ways to do things better and come up with new ideas.



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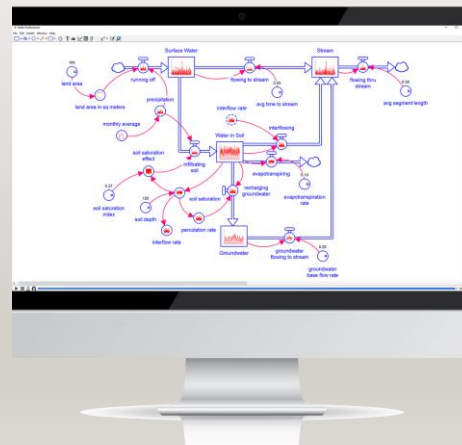
Here are specific examples of using digital simulations for understanding resource management and circular processes

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Stella Architect:

Description: Stella Architect is a simulation modeling software that allows users to create dynamic models of complex systems.

Organizations can use Stella Architect to make pretend versions of how resources move, how materials get used again, and how circular processes work in their business. For instance, manufacturing companies can pretend to set up systems where waste materials go back into making more stuff. By changing things like how much gets recycled, how much they make, and what they use to make things, people can see if it's possible and how it would affect their business to do more in line with the circular economy.



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Here are specific examples of online collaborative tools along with their descriptions:

1. Microsoft Teams:
2. Slack:
3. Asana:
4. Trello:
5. Google Workspace (formerly G Suite):



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Activities for students: Circular economy challenges to be used as inspiration for lesson topics

Virtual Reality (VR)

Field Trips





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Workshop (20 minutes)

Install the VRclassroom tool on your
computers, choose a workspace,
and execute one of the cases.

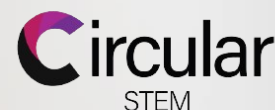


Module 5: Circular Economy Challenges and Projects

Presents real and proposed projects addressing CE challenges such as product lifespan extension and reuse of resources (e.g., coffee grounds, used oil, fashion waste). Includes group work and lab-based activities.



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Module 5: Circular Economy Challenges and Projects

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The circular economy model:
less raw material, less waste, fewer emissions



Source: European Parliament Research Service



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Circular economy advantages

- Environmental protection (reduction of waste, greenhouse gas emissions and natural resources exploitation)
- Reduce dependence on raw materials (according to Eurostat the EU imports around half of the raw materials it consumes)
- Create jobs and save consumers money (Redesigning materials and products drive to innovation in different sectors of the economy and provide consumers with longer-lasting products).

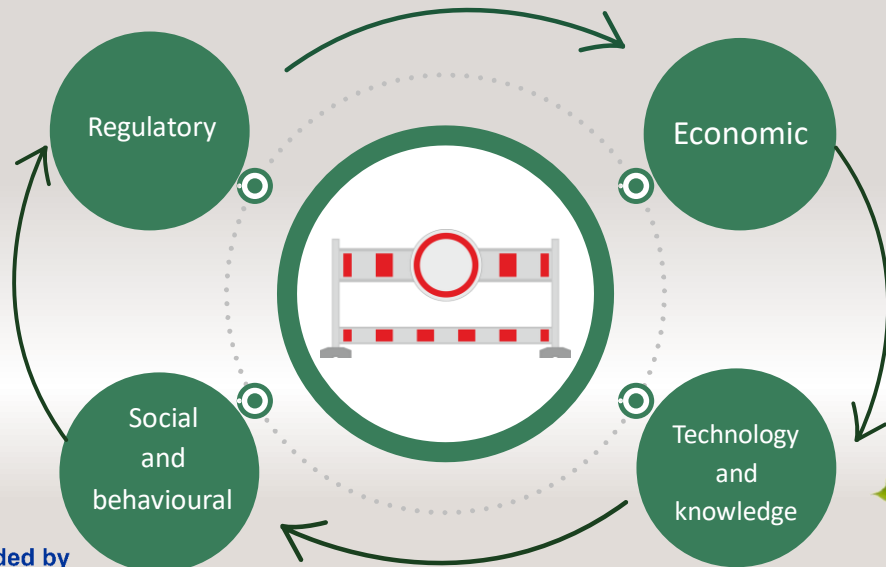


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Circular economy barriers



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Regulatory barriers



- Lack of clear policies and legislation that support the transition to a circular economy.
- Insufficient incentives for businesses to reduce waste, reuse materials, and recycle products.
- Inconsistent standards for waste management.



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Economic barriers



- Circular business models often require higher investment costs.
- Usually profits can only be achieved after several years (both for producers and consumers).
- Uncertainty existing in the field of circular economy can paralyse investments.



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Social barriers

- Consumers are accustomed to the use and discard model.
- Social habits: lifestyle that prioritizes convenience and possession.
- Unconscious prejudices that remanufactured products have less quality than new products.

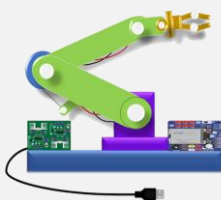
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Technological barriers

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- Lack of technology, or its high cost.
- Insufficient knowledge to convert most waste into secondary raw materials.



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Circular Economy Projects



Delta & Nâm (Portugal)

Partnership that allows controlled and certified collection of Delta coffee grounds and their subsequent use for the sustainable and conscious production of mushrooms and fertilizers.

In the last 2 years, 200 tons of coffee grounds collected gave rise to 50 tons of mushrooms and more than 150 tons of fertilizers.



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BSH Hausgeräte - project Bluemovement (Germany)



BSH is the largest manufacturer of home appliances in Europe.

With BlueMovement, BSH goes beyond selling home appliances and instead offers them as a service, delivering, installing, repairing, moving, adjusting and picking up the appliances again at the end of the contract. The lifespan of appliances is extended thanks to included repair services



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BC Materials (Belgium)

Construction is one of the most material- and carbon-intensive industries: building construction is responsible for 40 per cent of CO2 emissions globally.

BC Materials collaborates with architects, construction companies and transporters of excavated earth to recover earth-mass from construction sites. Without chemical processes, the company transforms the surplus mass into construction materials, such as clay plasters, rammed earth and compressed earth blocks, and sells it directly to building companies, architects, contractors and private customers.



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Jeplan - project Bring (Japan)

The current fashion industry supports unsustainable consumption behaviors and excessive natural resource use. BRING by JEPLAN strives to create a circular ecosystem for the fashion industry by developing recycling technology and constructing circular supply chains, with a special focus on changing consumer behavior. Specifically, they collect old clothes from consumers, recycle them and sell the material to their partners.



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Our project proposal



Let's consider this specific problem:

What to do with used cooking oil?



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Some facts

- In 2023, more than 217 million tons of vegetable oils were consumed worldwide;
- 1L of domestic oil poured down the kitchen drain, or down the toilet, can contaminate 1 million liters of water;
- There are already many responsible ways to reuse cooking oil; mainly to produce biodiesel;
- Currently Europe imports four-fifths (80%) of the used cooking oil, mostly from China, due to limited local supplies.



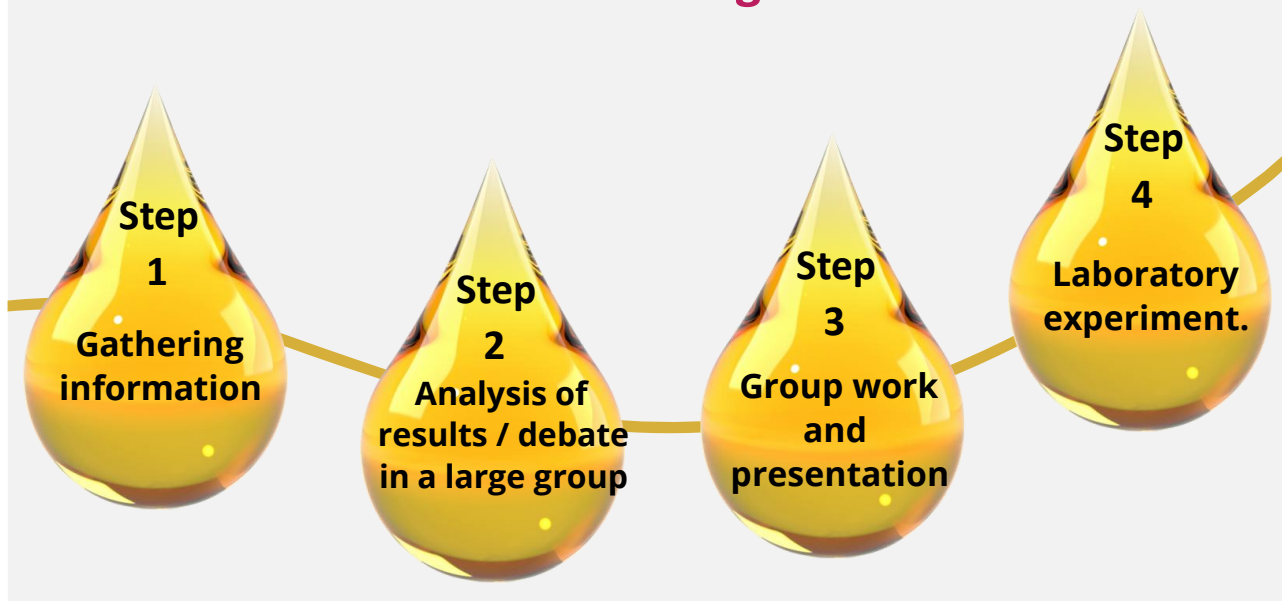
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Activities for students



What to do with used cooking oil?

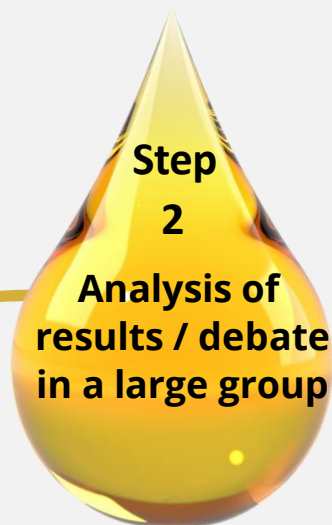


What to do with used cooking oil?



- What is the life cycle of used oils?
- How oils are discarded or treated locally or nationally?
- What is the impact on the environment when they are not properly disposed of?
- Prepare a survey that will be applied to the school community.

What to do with used cooking oil?



- Analyze the positive and negative aspects of the fate given to used oil.
- Students are invited to make suggestions on how to reduce the environmental impact of used oils:
- What can be improved? How? What difficulties might arise? How to overcome them?

What to do with used cooking oil?



- Each group has to create a project and prepare a digital presentation, explaining one of the topics analyzed:
 - the dangers of wrong disposal of used cooking oils;
 - what destination is given to used oils;
 - how to apply the concept of Circular Economy to used oils, what the challenges are and how to overcome them.
- Each group work is presented to the class and assessed using a rubric.

What to do with used cooking oil?



- Carrying out an experiment with students, in the school laboratory, where soaps are produced from used oils.
- Some students may be asked to bring a certain amount of used cooking oil from their homes in a plastic bottle.



Step 4- Laboratory experiment



- Step 1 – Prepare the sodium hydroxide solution;
- Step 2 – Mix the oils;
- Step 3 – Level the temperatures;
- Step 4 – Create the saponification process;
- Step 5 – Add the herbs and essential oils;
- Step 6 – Pouring into molds;
- Step 7 – Leave to cure.

Closing the circle



**Selling little soaps
in the community
- a beautiful gift**

**Our waste has
economic value!!**





- The school organizes a public session in which students present the work they have carried out to the community.
- Carrying out workshops guided by students, where soaps will be produced from used oils, demonstrating the possibility of creating economically viable products from waste.
- Publicity of training sessions.



Project evaluation

*Table 1 – Students' work assessment framework

General criteria	Task-specific criteria	Descriptors
<u>Knowledge</u>	Knowledge about the subject (35%)	- Mobilizes and integrates concepts and main ideas. - Provides a secure domain of content. - Uses terminology specific to the topic/discipline.
<u>Communication</u>	Linguistic correction and structure (20%)	- Respects the conventions/norms of the language, allowing a clear understanding of the exposition. - Presents a logical sequence of work, completing all its stages: - Job identification - Goal - Theoretical foundation - Data processing - Conclusions - Source identification
	Presentation and time management (10%)	- Respect the time set for the presentation. - Appropriately distributes content over the available time. - Clearly states the points to be addressed. - Presents appropriate body language.
<u>Collaboration</u>	Cooperation, commitment and autonomy (20%)	- Actively collaborates in all phases of work. - Raise problems and promote the participation of colleagues.
<u>Critical thinking</u>	Creativity and Critical analysis (15%)	- Uses different sources of information, identifying them. - Reveals creativity in the examples he presents and in the way he organizes the content. - Make a final synthesis, presenting the pros and cons with scientifically valid arguments.

- The students group work and presentation will be assessed using a rubric

Questionnaire

- A questionnaire will be held after each group presentation.



Module 6: Career Paths and Future Trends

Guides teachers and students to explore career options in sustainability and CE, covering future trends, job roles, skills, and professional development.



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Circular
STEM

Boosting Circular Economy
Competences for STEM
Teachers

Module 6: Careers Paths and Future Trends

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Circular
STEM

The Digital and Green Transitions

Steering the intertwined green and digital transitions is fundamental to delivering a future that is **sustainable, equitable, and competitive**.

A. The green transition not only targets **sustainability** but also addresses pressing issues such as **climate change** and **environmental degradation**.

B. In navigating the digital transition, Europe must leverage these technologies to foster **sustainability, enhance prosperity, and empower citizens and businesses** (Joint Research Centre, 2022).





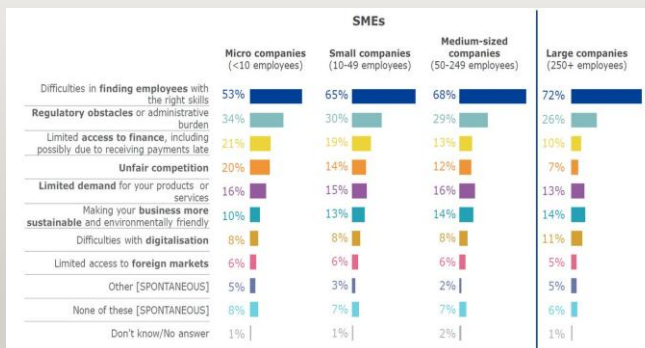
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The Talent Gap in Europe

According to the 2023 Eurobarometer Survey, the skills shortage stands out as one of the **most pressing labour market issues** across the European Union.

It is estimated that **18 million people** will need to be reskilled for Europe to reach its climate goals by 2050 (World Economic Forum, 2023b).



Source: Eurobarometer Survey 2023 – Most Serious Problems of European Companies



The Talent Gap in Europe



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- The widespread adoption of **digital technologies** is profoundly **reshaping the labour market** and redefining the skill sets required in both the economy and society.
- The Digital Economy and Society Index reveals that in Europe, **four out of ten (4/10)** adults and **every third employed individual (1/3)** lack fundamental **digital skills**.
- Moreover, there exists a notable **gender disparity** in tech-related professions and educational pursuits, with only **one in five (1/5)** information and communication technology (ICT) specialists and **one in three science (1/3)**, technology, engineering, and mathematics (STEM) graduates being women (Digital Economy and Society Index, 2022).

Key Trends on the Labour Market

The Future of Jobs Report 2023 by the World Economic Forum brought together insights from **803 companies**, collectively employing over **11.3 million workers** worldwide, representing 27 industry clusters and 45 economies.

The largest job creation and destruction effects stem from **environmental**, **technological**, and **economic** shifts.

While technological advancements and increased digital access are expected to drive job growth in many companies, some foresee job displacement as a consequence. Employers foresee a structural labour market churn of **23% of jobs** over the next five years (World Economic Forum, 2023a).



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A. Technology Adoption and Automation in Companies

In the next five years, technology adoption will continue to drive business transformation significantly.

Frontier technologies and **enhanced digital accessibility** are the primary catalysts for transformation within their organisations:

- Significant emphasis is placed on the likelihood of integrating **big data**, **cloud computing**, and **Artificial Intelligence (AI)**. More than **75%** of companies express intentions to adopt these technologies within the next five years.
- **Digital platforms** and **apps** emerge as the technologies most poised for adoption, with **86%** of companies anticipating their incorporation over the next five years (World Economic Forum, 2023a).



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B. Technological Impact on Employment

The anticipated impact of most technologies on employment is poised to be **predominantly positive** in the forthcoming five years.

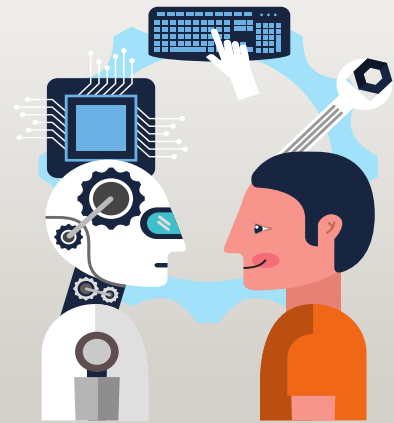
- **Big data analytics**, **climate change** and **environmental management technologies**, along with **encryption** and **cybersecurity**, are projected to serve as primary catalysts for **JOB EXPANSION**.
- Conversely, **agricultural technologies**, **digital platforms** and **apps**, **e-commerce** and **digital trade**, and **AI** are all foreseen to bring about significant **DISRUPTIONS** in the labour market, with many companies predicting job displacement within their organisations. Nevertheless, this displacement is expected to be counterbalanced by job creation elsewhere, resulting in an overall **net positive effect** (World Economic Forum, 2023a).



B. Technological Impact on Employment

The anticipated impact of most technologies on employment is poised to be **predominantly positive** in the forthcoming five years. With the exception of **robots**, all other technologies are forecasted to contribute to job creation.

Despite a **decrease** in the anticipation of **physical** and **manual labour** displacement by machines, traits such as **reasoning**, **communication**, and **coordination** – attributes with a comparative advantage for humans – are expected to become **increasingly automatable** in the future. Artificial intelligence has been identified as a pivotal driver of potential algorithmic displacement (World Economic Forum, 2023a).



C. Key Trends in Job Growth and Decline

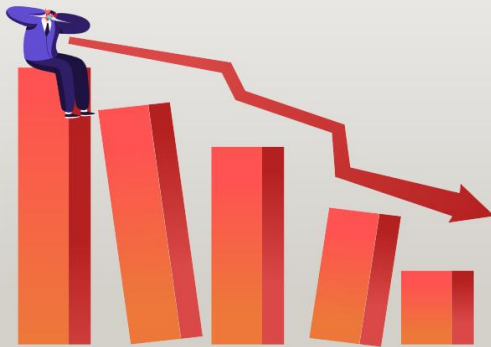
The majority of the **fastest-growing roles** are **technology-related** roles:

1. Leading this trend are **AI** and **Machine Learning Specialists**;
2. They are followed closely by **Sustainability Specialists**, **Business Intelligence Analysts**, and **Information Security Analysts**;
3. Additionally, roles such as **Renewable Energy Engineers** and **Solar Energy Installation** and **System Engineers** are experiencing rapid growth as economies transition towards renewable energy sources (World Economic Forum, 2023a).



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C. Key Trends in Job Growth and Decline



Conversely, the **fastest-declining** roles predominantly encompass:

1. **Clerical** or **secretarial** positions;
2. **Bank Tellers** and Related Clerks;
3. **Postal Service Clerks**, **Cashiers** and **Ticket Clerks**;
4. **Data Entry Clerks** expected to decline the fastest (World Economic Forum, 2023a).



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Top Skills Needed on the Labour Market



Source: WEF's Future of Jobs Report 2023 – Core Skills for Workers

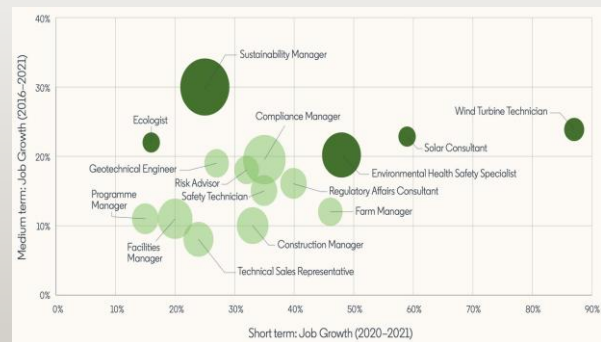


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The Future of Green Jobs

In terms of annual growth, the top five fastest-growing green jobs between 2016 and 2021 are:

1. **Sustainability Manager (30%);**
2. **Wind Turbine Technician (24%);**
3. **Solar Consultant (23%);**
4. **Ecologist (22%);**
5. **Environmental Health and Safety Specialist (20%).**



Source: LinkedIn Economic Graph: Fastest -Growing Green and Greening Jobs Globally

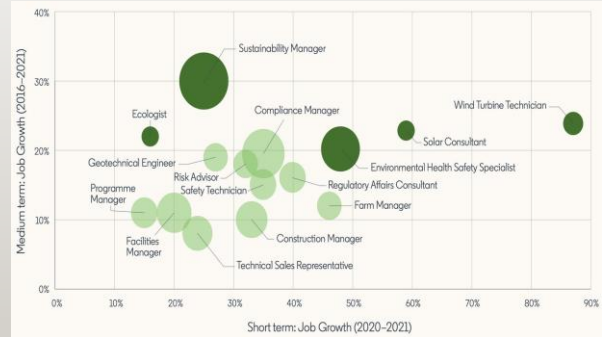


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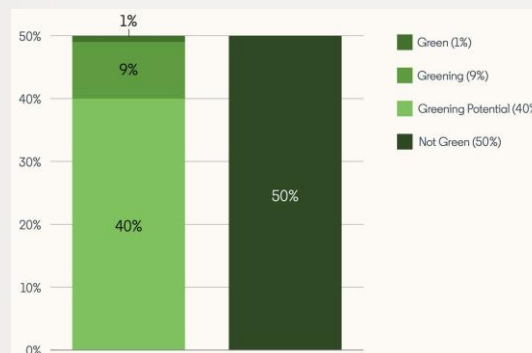


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The Future of Green Jobs

The proportion of green talent in the global workforce has risen from **9.6% in 2015** to **13.3% as of 2021** equating to an annual growth rate of **6%** and a cumulative growth rate of **38%** (LinkedIn Economic Graph, 2022).

However, despite this progress, green and greening jobs collectively only comprised **10%** of hiring in 2021, while non-green jobs dominated at **50%** of hiring.



Source: LinkedIn Economic Graph: Share of 2021 Hiring by Job Type

Sample Activity for Students: The CircularBerlin Challenge

- Berlin's local government is looking for **digital solution** to make the city more **circular**.
- The student's mission is to develop **mobile app** to engage Berlin's citizens and promote a more circular way of living.
- Their app must include **gamification** elements to induce behavioural changes in a fun way.
- Each team will present **mock-up** of their app using AI and **pitch** their idea.



Sample Activity for Students: The CircularBerlin Challenge

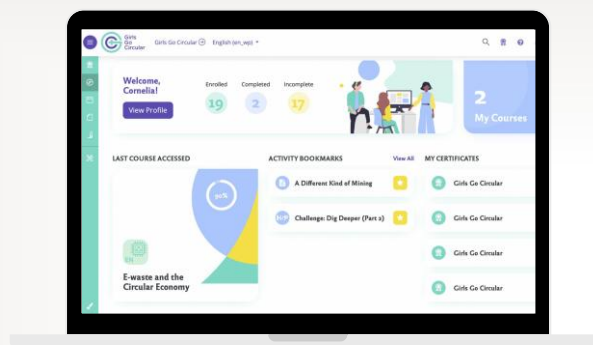
- **The Product Manager:** Responsible for managing the entire mobile app project and ensuring it is completed on time.
- **The Sustainability Expert:** The Sustainability Expert is responsible for advising the team in defining the behavioural changes needed and the data required for the app.
- **The Developer:** Also known as the backend engineer, the Developer's primary responsibility is to build the structure of the software application using AI.
- **The Rapporteur:** Responsible for pitching the app idea and main features at the end of the challenge.





Student Engagement Tools and Activities

- [Circular Learning Space](#) is an online learning platform for European secondary schools:
 - 18 courses exploring **digital tools** and the **circular economy** in different industries
 - 24 languages (all EU + guest countries)
- The teaching methodology is based on **learning-by-doing** approach, engaging students in **challenge-based exercises** such as creating app mock-ups, developing product prototypes, or planning business models.
- A **Teacher Guidebook** is available in all programme languages.



Innovative Assessment Methods

To prepare students aged **14-19** for the **digital** and **green transitions**, modern, interactive, and challengebased assessment methods based on skills can effectively evaluate their concrete competencies:

- **Project-based assessments:** Assign students complex, real-world projects related to sustainability and digital innovation. For example, they could design and implement a green technology solution for their school or community.
- **Simulation exercises:** Use digital simulations to recreate scenarios related to environmental conservation, renewable energy, or circular economy practices.
- **Hackathons and design challenges:** Organise hackathons or design challenges focused on developing solutions for sustainability issues using digital tools and technologies. Teams of students could compete to create innovative prototypes or apps aimed at promoting green practices or addressing environmental challenges.
- **Online portfolios:** Have students create digital portfolios showcasing their projects accomplishments, and reflections related to sustainability and digital skills development. Portfolios can include multimedia content such as videos, infographics, blog posts, and project documentation.



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PART III: PILOTED LESSON PLANS FROM SCHOOLS

As part of the pilot phase of the Circular STEM project, partner schools co-designed and implemented innovative lesson plans that reflect the core principles of the circular economy, digital integration, and active learning. These hands-on educational experiences engaged students in meaningful challenges, helping them understand sustainability concepts, apply STEM knowledge in real-life scenarios, and develop key competences from the GreenComp and DigComp frameworks.

Lesson Plan 1: Hydroponic Gardening System

- **Developed by:** Agrupamento de Escolas de Frazão
- **Duration:** 100 minutes
- **Target Age:** 13–16
- **Objective:** To introduce students to sustainable agriculture by designing and building a hydroponic gardening system using recycled materials and scientific methods.
- **Description:** Students explored the environmental benefits of soil-free cultivation and learned how hydroponics can reduce land and water use while enhancing food sustainability. The project combined biology, chemistry, and engineering by challenging students to control nutrient flow and monitor plant growth.
- **GreenComp Links:** Sustainable resource use, innovation, systems thinking
- **Skills Developed:** Scientific inquiry, hands-on prototyping, data collection, teamwork

Lesson Plan 2: Infographic & Video Creation: Linear vs Circular Economy

- **Developed by:** Politeknika Txorierri
- **Duration:** 4 hours
- **Target Age:** 14–18
- **Objective:** To enable students to critically compare the linear and circular economic models and creatively present their understanding using digital media. Description: Students were introduced to circular economy concepts through class discussion and group research. Working in small teams, they used digital tools to create infographics or explainer videos illustrating the differences between linear and circular models, incorporating terms like reuse, eco-design, and lifecycle thinking.
- **DigComp Links:** Digital content creation, information literacy, communication
- **Skills Developed:** Visual literacy, digital storytelling, collaboration, environmental awareness.

Lesson Plan 3: Domestic Upcycling & Awareness Campaign

- **Developed by:** Politeknika Txorierri
- **Duration:** 10 hours across 2 days
- **Target Age:** 14–18
- **Objective:** To foster creativity and environmental responsibility by transforming household waste into new products and organizing a school-wide awareness campaign.
- **Description:** Following an awareness session with the EMAUS NGO, students engaged in creative reuse workshops using old textiles and other discarded materials. They produced handmade puppets and later organized a second-hand clothes market. The campaign emphasized responsible consumption and fundraising for local causes.
- **GreenComp Links:** Circularity, responsible consumption, collective action
- **Skills Developed:** Creative design, sustainability advocacy, project planning, ethical entrepreneurship

Lesson Plan 4: Global Climate Summit Simulation

- **Developed by:** Politeknika Txorierri
- **Duration:** 2 hours
- **Target Age:** 15–18
- **Objective:** To simulate international climate negotiations and foster understanding of global climate policy through role-play and critical thinking.
- **Description:** Students were assigned roles representing countries, NGOs, and international organizations. They researched climate data and positions, participated in structured negotiations, and drafted resolutions addressing emission reductions and financial mechanisms. The session concluded with presentations and reflective discussion.
- **GreenComp Links:** Systems thinking, political agency, negotiation, collaboration
- **Skills Developed:** Argumentation, diplomacy, strategic thinking, climate literacy

