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CRCLEcon Project

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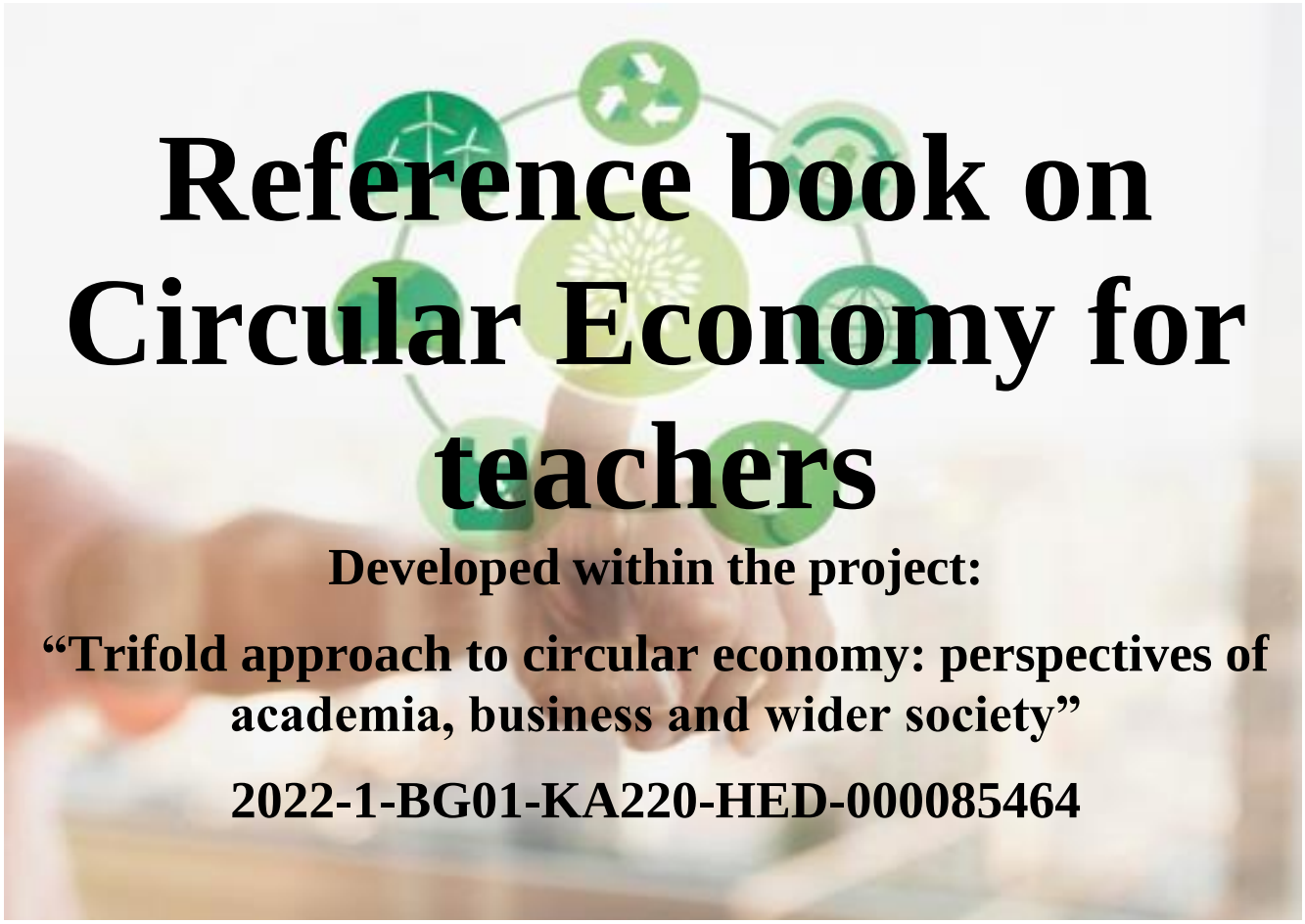

Reference book on Circular Economy for teachers

Developed within the project:

"Trifold approach to circular economy: perspectives of academia, business and wider society"

2022-1-BG01-KA220-HED-000085464

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This edition is developed under the work package two of the project number 2022-1-BG01-KA220-HED-000085464 “Trifold approach to circular economy: perspectives of academia, business and wider society” and addresses concretely the first project specific objective on exploring the components of circular economy from teachers’ perspective.

Reference book on Circular Economy for teachers

Textbook, first edition

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Content

INTRODUCTION

Circular Economy is a viable and promising alternative to the currently prevailing linear economic system. The fact of having a world with finite resources involves the need to adopt a sustainable economic system where sustainable processes must be prioritized. Therefore, in this context of finite resources, Circular Economy seeks economic growth only if achieved in a sustainable way by keeping resources within closed cycles as long as possible.

In this regard the project is aimed to explore the aspects of circular economy in details and in various aspects – students, academic staff, business people and society activists. The project will suggest visualized summary brochures on the main identified challenges.

The general project objective is to present implications and introduce solutions of circular economy challenges in an adapted way bringing together students from various social categories with focus on those who are discouraged and lagging behind their peers. This will be done through provision of training materials and organization of a series of matching activities and joint workshops.

Specific objectives of the project are: exploring the components of circular economy from teachers' perspective; exploring the components of circular economy from students' perspective; exploring circular economy challenges to business and wider society.

Planned results include:

- Development of Reference book on Circular Economy for teachers
- Development of Repertory on Circular Economy for students
- Development of Handbook on Circular Economy Challenges to business and society
- Organization of 6 joint workshops

- Organization of meetings with business experts
- Organization of 12 local dissemination events
- Organization of joint final events

The main target groups are direct and indirect beneficiaries.

Direct beneficiaries:

- Students from economically challenged families who are discouraged about their career perspectives and who tend to miss their chances to find right positions within the changed working environment posed by circular economy because of losing the common sense with their peers.
- Students willing to master their capabilities to address challenges of circular economy as well as to try approaches to intervene in practice.

Indirect beneficiaries:

- University professors in the involved HEIs who teach subjects not directly related to economy and ecological challenges by receiving a common insight for further research work.
- Business people aware of the complications and benefits of circular economy.
- The objective of work package two (WP2) of the project is to provide content for educators and to check its applicability with students. In this way, WP2 contributes to the general project objective on presenting challenges and introducing solutions of circular economy in an adapted way bringing together students from various social categories with focus on those who are discouraged and lagging behind their peers. WP2 addresses concretely the first project specific objective on exploring the components of circular economy from teachers' perspective. Development of Reference book on Circular Economy for teachers including:
- Workshop 1 on applicable methodology in teaching circular economy, organized by D. A. Tsenov Academy of Economics.
- Workshop 2 on branch specifics in circular economy, organized by Artifex University of Bucharest.


AGENDA

of the First workshop on applicable methodology in teaching circular economy of Erasmus+ KA220-HED project

"Trifold approach to circular economy: perspectives of academia, business and wider society"

Project number: 2022-1-BG01-KA220-HED-000085464

30.04. – 02.05.2023
Chiflik, Troyan municipality, Bulgaria

AGENDA

Second workshop on Branch specifics in circular economy of Erasmus+ KA220-HED project

"Trifold approach to circular economy: perspectives of academia, business and wider society"

Project number: 2022-1-BG01-KA220-HED-000085464

18.05. – 20.05.2023, Bucharest, Romania

The project workflow is planned as monthly based distribution of tasks and activities:

Work Packages	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X
WP 1 Project Management																								
Transnational meetings for project administration	■								■							■							■	
WP2 Circular Economy and Teachers' perspective																								
Preparation of Workshop 1	■	■	■																					
Workshop 1 - BG				■																				
Preparation of Workshop 2					■	■	■																	
Workshop 2 - RO								■																
WP3 Circular Economy and Students` perspective																								
Preparation of Workshop 3									■	■	■													
Workshop 3 - RS												■												
Preparation of Workshop 4													■	■	■									
Workshop 4 - TR																■								
WP4 Circular Economy, Business and Society																								
Preparation of Workshop 5																	■	■	■					
Workshop 5 - RO																				■				
Preparation of Workshop 6																					■	■	■	
Workshop 6 - RS																								■
WP5 Sharing and Promotion																								
Creation of promotional materials - banners, articles, posts, newsletters	■	■	■												■	■	■							
Publications									■								■							■
Web hosting and support	■	■									■	■										■	■	
Organising national dissemination events				■				■	■				■			■	■				■			
Production of promotional materials																								
Organising joint final conferences - BG and TR																							■	■

CHAPTER ONE. INSIGHTS FROM EXISTING CURRICULA ABOUT THE CIRCULAR ECONOMY

1. The concept of circular economy

The circular economy (CE) is a relatively new paradigm designed to overcome the existing linear model. CE is part of the wider concept of sustainable development and is mainly seen as the operationalization of sustainable development.

The circular economy aims to keep products, components and materials at their highest utility and value for as long as possible. In addition, the aim is to minimize waste and reduce the use of resources, and when the life of a product is over, to use it to create further value. It is based on three principles: eliminate waste and pollution; circulate products and materials (at their highest value) and regenerate nature.

Figure 1.1. The circular economy model

Source: European Parliament, 2015

In the EU action plan (2015), the circular economy is described as “where the

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value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised." The transition to a circular economy represents a systemic change that requires changes in all areas: economic, political and socio-cultural.

According to Ellen MacArthur Foundation (2013, p.7), circular economy is "an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models". The objective is to "enable effective flows of materials, energy, labour and information so that natural and social capital can be rebuilt".

The transition to a circular society requires the strengthening of circular literacy, that is, the ability to understand and respect natural cycles and material flows. In order to reorient to the circular model, both society and business, as well as individuals, must adopt new models of behavior. Since the future implementers of the circular model are now in the process of education, in schools and universities, the importance of education in the adoption of the circular economy is of the utmost importance.

1.1. The role of Higher education institutions in the implementation of the CE concept

The transition to CE is a complex, long-term process that requires the engagement and contribution of various stakeholder groups (state and local authorities, private sector, educational institutions, non-governmental sector, etc.). Although the role of the private sector in this process is mostly emphasized (Bocken et al., 2017; Heshmati, 2015; Jiang & Zheng, 2014; Kirchherr et al., 2014), in recent years more and more attention has been given to the significant role of education,

especially higher education, in the process of transition to CE (Kirchherr&Piscicelli, 2019). As education is considered a starting point in achieving social, political and economic growth, as well as a prerequisite for linking theory and practice (Bakken et al., 2017; Suárez-Eiroa et al., 2019), there is increasing interest in including CE through conceptual changes in education and placing circularity and sustainability in priority positions in the economy and society (Pandey &Vedak, 2010; Keramitsoglou et al., 2023).

Higher education institutions (HEIs) are the main actors in economic development and innovative potential, but now, in addition to influencing social, economic and cultural development, their involvement in the promotion and application of the concept of sustainability is expected (Salas et al., 2021; Leal et al., 2019). This is supported by the fact that international organizations (OECD, UNESCO, EC) broadly define higher education as one of the key drivers of growth, prosperity and competitiveness (EC, 2020), as well as a key factor in promoting the culture of sustainable development (SD) (Paletta, et al., 2019; Serrano-Bedia& Perez-Perez, 2022).

In addition, since the first presentation of the concept of sustainable development in 1987, there has been an aspiration of the international community to make education a factor supporting sustainable development through a series of activities and documents, such as Agenda 21 (SDGKP, 1992), the Decade of Education for Sustainable Development of the United Nations (2005-2014) (UNESCO, 2003), the EU's Circular Economy Action Plan (CEAP), the Global Action Program for Education for Sustainable Development (2015-2019 (UNESCO, 2014) and the Education 2030 Framework for Action (UNESCO, 2015) (Dongxu et al. al., 2021), as well as within three major United Nations conferences: the UN Conference on Environment and Development (Rio de Janeiro, 1992); the World Summit on Sustainable Development (Johannesburg, 2002); the UN Conference on Sustainable Development (Rio de Janeiro, 2012) (Leicht et al., 2018).

Higher education institutions are seen as generators of system-level transformation that is required for the adoption of CE (Paletta et al., 2019), so in the mentioned documents, a higher level of engagement of higher education institutions in certain areas of sustainability is emphasized (Salas et al., 2021).

From the above, it can be noted that the role of higher education institutions in promoting the circular economy is multiple and is reflected in their contribution primarily through the provision of new skills and abilities required by CE, which is achieved by revising curricula (Salas et al., 2021). However, these institutions contribute not only by spreading the necessary knowledge and tools that support the transition to CE, but also by spreading the values needed to increase awareness of sustainable development (Merli et al., 2018) by encouraging policymakers, stakeholders and private sector representatives to learn, think and act differently (Serrano-Bedia& Perez-Perez, 2022).

One of the reasons for the interest of the government and the private sector in the circular economy (CE) is the expected financial, social and environmental benefits (Lewandowski, 2016; Uribe-Toril, 2022). In addition, following the trend and moving towards environmental sustainability, leads to a lack of workers with the relevant skills needed for the transition to a circular economy (OECD, 2023; Guerreschi et al., 2023). In this sense, the emergence of the circular economy paradigm also puts pressure on the education system to revise its content and develop new learning modules in order to provide the skills and abilities required by the circular economy model.

The higher education system helps to develop the appropriate skills and competencies of future business leaders and policymakers as well as to create awareness of behavior that is in line with CE principles (Giannoccaro et al., 2021). Professionals, experts and decision-makers will have a key role in creating the future, which is why their education and orientation toward the circular economy are essential (Minguez, 2021). Accordingly, an increased effort by higher education

institutions is needed to support the development of CE, introducing new programs and courses related to sustainable development education and expanding the scope of their research (Paletta et al., 2019; UNESCO, 2017). As the role of HEIs in sustainable economic and social development is increasing year by year, it means that higher education institutions must take this task seriously and adapt their activities to social needs, in order to justify their role as initiators of change toward solving global challenges (GUNI, 2021).

An innovative approach to education, curricula and educational strategies oriented towards CE could help create new generations with a more environmentally responsible way of thinking and more sustainable habits (Ludwig, 2020). Therefore, efforts should be made to integrate the circular economy into the curricula of higher education institutions in order to help raise awareness of sustainability and develop systemic thinking (Minguez, 2021).

2. Integrating the circular economy into the curricula of higher education institutions

In accordance with the recognized need to improve the curriculum in the direction of CE in higher education institutions from various fields, work on innovating curricula and creating new forms of education has begun (Keramitsoglou et al., 2023).

Initially, environmental education was developed, emphasizing the ecological pillar of sustainable development. Environmental education has been part of university curricula since the late 1970s (Kirchherr&Piscicelli, 2019). After that, from the early 1990s, forms such as "education for sustainability" and "education for a sustainable future" (Kopnina, 2014), i.e., "education for sustainable development" (Kirchherr&Piscicelli, 2019; Vukić, 2020), which aim to create a more sustainable society through changes in knowledge, skills, values and attitudes (Leicht, et al., 2018). This form of education was primarily focused on environmental problems,

such as climate change and the loss of biodiversity, and later included content related to problems such as poverty reduction and gender equality in the curricula (Joyce, 2018; Vukić, 2020). The integration of sustainable development into the curriculum requires educational institutions to recognize knowledge, skills, problems, and perspectives key to each of the dimensions of sustainable development (environmental protection, society, and economy) and integrate them into the curriculum, taking into account the specifics of the local environment. However, the national goals of sustainable development and the local context were often neglected, and curricula were "copied" from universities in other countries and regions (UNESCO, 2012).

The field of circular economy was first introduced in design schools, where circular practices were adopted and new products and services were designed according to the new approach (Andrews, 2015; Vicente, 2020; Troiani et al., 2022).

However, in recent years there has been a noticeable change, so the circular economy is becoming a multidisciplinary subject and finding application in new disciplines, including management, architecture, engineering, fashion design, consumer behavior and psychology. The circular economy is by nature both a multidisciplinary and interdisciplinary concept and therefore should be present in all areas of education (EMF, 2020).

To facilitate the introduction of the circular economy into education, higher education institutions from around the world have joined the Ellen MacArthur Foundation (EMF) to create new academic curricula, research and collaborative projects based on the philosophy of CE (EMF 2015a; EMF 2015b). As a result, new courses have been created to help better understand the principles, applications and benefits of CE (EMF 2015c, Mendoza et al., 2019).

Most of the partners of the EMF Foundation are from the USA, Europe and to a lesser extent, other regions. However, not all universities involved in circular economy research are included. Research interest in the circular economy has grown

a lot in recent years, and it is noticeable that this topic has been researched the most by Chinese, European and North American scientists (Wuyts, 2017). The growth of interest at universities in Europe can be linked to the promotion of the circular economy through the European circular economy package (European Commission, 2015 in Geissdoerfer et al., 2017), while in China there is a law on the promotion of the circular economy (Lieder & Rashid, 2016 in Geissdoerfer et al., 2017).

In 2018, EMF published a study (A global snapshot of circular economy learning offerings in higher education) that identified circular economy course offerings at universities around the world. The results showed that there are 138 higher education institutions that have circular economy courses (in English, Finnish, Dutch and Chinese). Of these, 51 higher education institutions contained the words "circular economy" in the course title, while other universities found related thematic areas (EMF, 2020). The following topics were highlighted: environmental aspects (39 mentions), social aspects (32 mentions), policy levers (28), digital technology (14), design (35), servitization (22), circular business models (28), systems thinking (22) (EMF, 2020).

It is important to keep in mind that when adapting or creating curricula in order to include the circular economy or related thematic areas, there is no universal approach because each institution can adapt the scope and content of teaching modules in accordance with the local environment and needs. Any effective curriculum reform towards CE requires a comprehensive reform of the methodological approaches used, in order to overcome all the challenges (Cother, 2020). Also, existing knowledge about learning methodologies in CE courses, which is mainly contained in European universities, should be supplemented and expanded to other disciplines and geographical contexts (Serrano-Bedia& Perez-Perez, 2022).

A good example is Finland, where learning about the circular economy is included in all levels of education, from primary to higher education, which creates experts in the circular economy, in which the country is becoming a leader (EMF,

2020).

Below is an overview of universities in countries that are leaders in the introduction of CE in higher education (Finland, Netherlands, United Kingdom, USA, China). Universities that have programs directly related to the circular economy and that have circular economy courses in their curricula are included. There are a greater number of universities that contain programs and courses that study environmental protection, and sustainable development, and only indirectly, within these courses, they deal with topics from the circular economy.

A large part of courses in the field of circular economy have been introduced as optional subjects or in the form of open online courses. Also, these topics are mostly studied in master's-level studies.

Table 1.1. Circular economy in university curricula in Finland, the Netherlands, the United Kingdom, the USA and China

Country	University	Course	Department/Program
Finland	Aalto University	Circular Economy & Markets of Tomorrow Circular Economy Design Forum D Circular Economy for Energy Storage D Circular Economy for Materials Processing Circular Economy in Environmental Engineering D Innovative Approach to Circular Economy Strategies and management for circular economy	Department of Marketing Department of Chemical and Metallurgical Engineering Zero Defect Manufacture for a Circular Economy
	Haaga-Helia University	Circular Economy and Supply Chain Management Innovate Circular Economy and Sustainable Future	Supply Chain Management
	Häme University of Applied Sciences	Circular Economy Responsible Circular Bioeconomy Design Business Ideas to Circular Business	Information and Communication Technology, Bioeconomy Smart Organic Farming Information and Communication

			Technology, Bio and Circular Economy Degree Programme
	Karelia University of Applied Sciences	Climate Change and Circular Economy Circular.now	Online courses
	LUT University	Introduction to Circular Economy	Master's programme in circular economy
	Savonia University of Applied Sciences	Renewable Energy and Circular Economy Circular Economy Alternating circular economy studies	Degree Programme in Energy Engineering
	South-Eastern Finland University of Applied Sciences – Xamk	Introduction to circular economy	Environmental engineering
	Tampere University of Applied Sciences	Kick of for Circular Economy and Risk Management Circular economy value chains and consumer engagement Development of circular economy business Innovation pipeline of circular economy products and services	Risk Management and Circular Economy, Master
	University of Helsinki	Green, circular, bioeconomy: limits and synergies of three sustainability avenues	
	ÅboAkademi University	Sustainable and Circular Economy	Sustainability Studies
	Arcada University	Circular Economy	Development studies Mechanical and Sustainable Engineering
Netherlands	HAN University of Applied Sciences		Circular Economy program

	Rotterdam School of Management, Erasmus University	Circular Economy: Strategies & Business Models Circular and Digital Business Design	
	Wageningen University and Research	Circular Economy Biobased and circular economy	MSc Biobased Sciences
	University Leiden	Materials and Circular Economy Circular Economy Circular Economy: from Challenge to Opportunity Climate policy and circular economy Governance of Materials and Circular Economy	Governance of Sustainability (MSc)
	University of Twente (UT)	Sustainability and Circularity in Civil Engineering	Construction Management & Engineering
	Aeres University of Applied Sciences	Circular economy in food	European Food Business Bachelor degree
	Delft University of Technology	Circular Product Design Geo-design for a Circular Economy in Urban Region Environmental and Circularity Assessment Methods Design for the Circular Economy Circular Economy for a Sustainable Built Environment Circular Building Products for a Sustainable Built Environment Circular Strategies for Sustainable Healthcare Spatial Circularity Strategies for Sustainable Regional Development	
	Maastricht University	Engineering in a Circular Economy Circular Business Development	Circular Engineering Bachelor

		Circular Process Design and Control	
	University of Amsterdam	The Circular City: Towards a Sustainable Urban Ecosystem	Summer School
	University of Groningen	MC Leadership in Circular Economy Circular Economy for Process Industry	
United Kingdom	The University of Edinburgh	Fundamentals of a Circular Economy Designing for a Circular Economy Circular Economy in Business Circular Economy in the Built Environment Waste Law in Circular Economy	Circular Economy
	University of Bradford	Circular Economy Core Principles and Concepts Business Models for a Circular Economy	Innovation, Enterprise and Circular Economy
	The University of Exeter	Circular Economy Management Consultancy Services Biomimicry and Circular Economy Design Principles	Sustainable Business Management MSc
	University College London (UCL)	Decarbonisation, dematerialization (the circular economy), detoxification LCA application in circular economy	Navigating the Business Sustainability Agenda Conducting a Life Cycle Assessment (LCA): from Theory to Practical Application Engineering for Circular Economy Sustainable Resources: Economics, Policy and Transitions MSc
	University of Huddersfield	The Circular Economy and Responsible Resource Management	Strategic Communication, Leadership and Sustainability MSc Sustainable Supply Chain Management (Professional Practice) MSc
	Swansea University	Circular Economy and Sustainable Engineering	Circular Economy Innovation Communities (CEIC)

			Sustainable Engineering Management for International Development, MSc
	Cranfield University	Waste Management in a Circular Economy: Reuse, Recycle, Recover and Dispose Sustainable and Circular Supply Chains Circular Innovation	Environmental Engineering MSc Sustainability MSc Global Environmental Change MSc
	University of Cambridge, Cambridge Judge Business School	Circular Economy & Sustainability Strategies Circular Economy & Sustainability: Impact on Business Models, Finance & Investments	Circular Economy Centre (CEC)
	University of Leeds	Circular Approaches to Sustainable Agri-food Systems Circular Economy and Resource Recovery from Waste	Sustainable Agriculture and Food Production MSc Civil and Environmental Engineering MEng, BEng
	University of Sussex Business School	Enterprise in the Circular Economy The Role of Design in the Circular Economy	Business and Management Studies BSc
	University of Strathclyde	Circular Economy & Transformations Towards Sustainability	Environmental Entrepreneurship
USA	The College for Creative Studies	Circular Economies	Design for climate action
	Stanford University	Design and Innovation for the Circular Economy Desalination for a Circular Water Economy	
	Bard College	Circular Value Chain Management	
	Harvard Division of Continuing Education	Circular Economy	
	The University of Chicago	Circular Economy and Sustainable Business	

	University of Pittsburgh	Design for Circular Economy Capstone Course on Design for Circular Economy	The Covestro Circular Economy Program
	Arizona State University	Fundamentals of Circular Economy	
	Northwestern University	Circular Economy	Master of science in energy and sustainability
	Virginia Polytechnic Institute and State University	Circular Economy Analytics for Sustainable Systems A Sustainable Future through Circular Economy Circular Economy Analysis	Packaging Systems and Design degree
China	Beijing Normal University	Circular Economy and Sustainable Development Enterprises (MOOC)	
	Beijing University of Technology	Resource Environment and Circular Economy Theory and Practice of Circular Economy (MOOC)	
	Dongguan University of Technology	Circular Economy and Sustainable Development	
	Renmin University of China	Urban and Regional Circular Economy and Sustainable Development Strategy	

Thanks to the recognized need for joint action and mutual cooperation in the transition to the circular economy, Finland has become a leader in the field of introducing the circular economy in education, primarily in higher education institutions. The Finnish Innovation Fund - Sitra, the Ministry of Education and Culture, as well as a large number of regional and local actors played their role in this process (EMF, 2018).

Based on EMF published a study and data concerning distribution of hours per type of student work, some rules can be generalized. The domination of Directed Learning and Independent Learning Hours is obvious (Table 1.2).

Table 1.2. Distribution of hours per type of student work

Types of student work	Percentage of hours per type of student work
Lecture Hours	5-10%
Seminar/Tutorial Hours	1-5%
Supervised Practical/Workshop/Studio Hours	5-15%
Fieldwork Hours	2-5%
Interactive Learning and Teaching Hours	5-20%
Directed Learning and Independent Learning Hours	60-80%

The Netherlands pays a lot of attention to the promotion of the circular economy, which is reflected in the significant number of courses offered at Dutch universities. TU Delft stands out, as an educational institution that has the most courses directly related to the circular economy in its curriculum and program. In both countries, the circular economy is mainly studied at universities of applied sciences

3. Curricula for certain areas of study in project partners countries

The importance of Circular Economy (CE) has been well recognized in theory and in practice in a very short time period. The rising trend of CE recognition has led to numerous study programs being introduced within universities worldwide to tackle this important topic. Therefore, our intention first is to investigate the practice of CE curricula development and introduction at public and private universities in the partner countries – Bulgaria, Romania, Turkey, and Serbia. Having insights into the existing curricula about CE in these countries will be a starting point for the in-depth analysis of the most prominent courses and programs, with the aim of designing and recommending the training material for teachers regarding CE in an adapted way to involve students from various social categories especially focusing on those who are

discouraged and lagging behind their peers. Therefore, the state-of-the-art in higher education (HE) in partner countries will be brought up on the scene.

3.1. The state-of-the-art in HE in Bulgaria

According to the data available on the website of the National Evaluation and Accreditation Agency in Bulgaria (NEAA)[i], there are 52 higher education institutions (HEIs) (Table 1.3).

Table 1.3. Accredited HEIs in Bulgaria

1.	ACADEMY OF ECONOMICS "D. A. TSENOV" – SVISHTOV
2.	ACADEMY OF MINISTRY OF INTERIOR – SOFIA
3.	ACADEMY OF MUSIC, DANCE AND FINE ARTS – PLOVDIV
4.	AGRICULTURAL UNIVERSITY – PLOVDIV
5.	AMERICAN UNIVERSITY IN BULGARIA – BLAGOEVGRAD
6.	BURGAS FREE UNIVERSITY
7.	COLLEGE OF MANAGEMENT, TRADE AND MARKETING – SOFIA
8.	COLLEGE OF TOURISM – BLAGOEVGRAD
9.	EUROPEAN HIGHER SCHOOL OF ECONOMICS AND MANAGEMENT - PLOVDIV
10.	EUROPEAN POLYTECHNICAL UNIVERSITY – PERNIK
11.	HIGHER AIR FORCE SCHOOL "GEORGI BENKOVSKI" - DOLNA MITROPOLIA
12.	HIGHER SCHOOL OF MANAGEMENT – VARNA
13.	HIGHER SCHOOL OF SECURITY AND ECONOMICS – PLOVDIV
14.	HIGHER SCHOOL OF TELECOMMUNICATIONS AND POST – SOFIA
15.	INTERNATIONAL BUSINESS SCHOOL – BOTEVGRAD
16.	MEDICAL UNIVERSITY "PROF. PARASKEV STOYANOV" - VARNA
17.	MEDICAL UNIVERSITY – PLEVEN

18.	MEDICAL UNIVERSITY – PLOVDIV
19.	MEDICAL UNIVERSITY – SOFIA
20.	NATIONAL ACADEMY FOR THEATRE AND FILM ARTS “KRUSTYO SARAFOV”
21.	NATIONAL ACADEMY OF ART – SOFIA
22.	NATIONAL ACADEMY OF MUSIC “PROF. PANCHO VLADIGEROV” - SOFIA
23.	NATIONAL DEFENCE COLLEGE „G. S. RAKOVSKI"– SOFIA
24.	NATIONAL SPORTS ACADEMY “VASSIL LEVSKI” – SOFIA
25.	NEW BULGARIAN UNIVERSITY – SOFIA
26.	NICOLA VAPTSAROV NAVAL ACADEMY – VARNA
27.	PLOVDIV UNIVERSITY “PAISII HILENDARSKI”
28.	RUSE UNIVERSITY “ANGEL KANCHEV”
29.	SOFIA UNIVERSITY “ST. KLIMENT OHRIDSKI”
30.	SOUTH-WEST UNIVERSITY “NEOFIT RILSKI” – BLAGOEVGRAD
31.	ST. CYRIL AND ST. METHODIUS UNIVERSITY OF VELIKO TURNOVO
32.	TECHNICAL UNIVERSITY – GABROVO
33.	TECHNICAL UNIVERSITY – SOFIA
34.	TECHNICAL UNIVERSITY – VARNA
35.	THEATRE COLLEGE “LUBEN GROYS” – SOFIA
36.	TODOR KABLESHKOV UNIVERSITY OF TRANSPORT - SOFIA
37.	TRAKIA UNIVERSITY – STARA ZAGORA
38.	UNIVERSITY OF AGRIBUSINESS AND RURAL DEVELOPMENT - PLOVDIV
39.	UNIVERSITY OF ARCHITECTURE, CIVIL ENGINEERING AND GEODESY – SOFIA

40.	UNIVERSITY OF CHEMICAL TECHNOLOGY AND METALLURGY – SOFIA
41.	UNIVERSITY OF ECONOMICS – VARNA
42.	UNIVERSITY OF FOOD TECHNOLOGIES – PLOVDIV
43.	UNIVERSITY OF FORESTRY – SOFIA
44.	UNIVERSITY OF INSURANCE AND FINANCE – SOFIA
45.	UNIVERSITY OF LIBRARY STUDIES AND INFORMATION TECHNOLOGIES – SOFIA
46.	UNIVERSITY OF MINING AND GEOLOGY "ST. IVAN RILSKI"- SOFIA
47.	UNIVERSITY OF NATIONAL AND WORLD ECONOMY – SOFIA
48.	UNIVERSITY OF SHUMEN “KONSTANTIN PRESLAVSKY”
49.	UNIVERSITY OF STRUCTURAL ENGINEERING AND ARCHITECTURE “LYUBEN KARAVELOV” – SOFIA
50.	UNIVERSITY “PROF. D-R ASSEN ZLATAROV” – BURGAS
51.	VARNA FREE UNIVERSITY "CHERNORIZETS HRABAR"
52.	VASIL LEVSKI NATIONAL MILITARY UNIVERSITY – VELIKO TARNOVO

Varna Free University is organizing the master’s degree programme in the Circular Economy. This University has recognized the need for a transition from a linear economy, through a reuse economy toward a circular economy (Figure 1.2)and has offered this course accordingly.

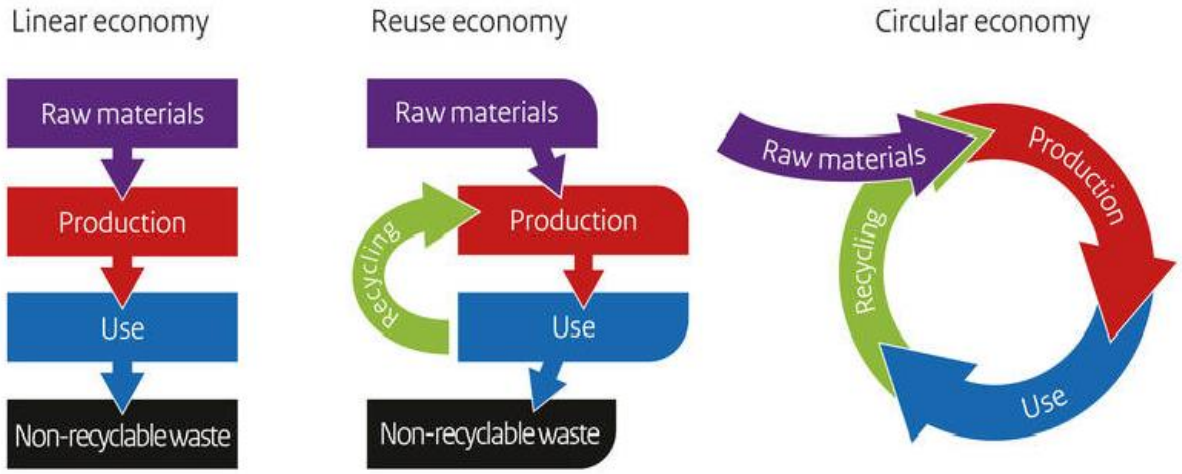


Figure 1.2. Transition from linear to circular economy

Source: Pereira, A., Fonseca, M., & Fernandes, P. O. (2019). Come in, who is it?: the predisposition of the social economy to the circular economy. *4th Regional Helix*, 287-295.

It is envisaged for the programme to last 1 year (2 semesters) for those who have completed the educational and qualification bachelor`s degree in Economics. For the students who want to attend this programme, but have graduated in some other areas outside Economics, there is an additional semester with the following mandatory courses: General Economic Theory, Fundamentals of Accounting, Finance, International Business, and European Economic Integration.[ii]The study programme offers 10 compulsory courses:

- Global Problems of Modernity,
- EU Environmental Policy,
- Circular Economy,
- Life Cycle of Raw Materials,
- Materials and Products,
- Waste Management
- Intercompany Collaboration
- Partnership and Coordination of Regional Projects

- Tax Practices and Solutions
- Financial Models in the Circular Economy
- Technology Entrepreneurship and Innovation;

9 elective courses:

- Eco-Entrepreneurship
- Sustainable Business Systems
- Circular Economy and Resource Efficiency
- Technological Infrastructure
- Investment Evaluation
- EU Institutional System
- EU Structural Instruments
- EU Law
- Business Intelligence Analyses

and 6 optional courses:

- Circular and Green Economy
- Social Interaction
- Change Management
- Design Management
- Sustainable Architectural Solutions
- Master Class/Graduate Seminar.

The Department of Economics of the Faculty of Economics and Business Administration of Sofia University "St. Kliment Ohridski" provides the teaching of a master's course in Circular Economy and Sustainable Development.[iii]

The University of Chemical Technology and Metallurgy in Sofia offers the course Circular economy and zero-waste technologies as part of its bachelor's study programme Green Technologies. Also, this University is organising a joint master

degree programme Circular economy with the International Business School in Botevgrad, and Burgas Free University. This joint master program has been developed as the result of the Project BG05M2OP001-2.016-0030-C01 "Modernization of educational solutions for circular economy, strategic infrastructures and productions (MIKS-IP)", financed by the Operational Program "Science and Education for Smart Growth", co-financed by the European Union through the European Structural and Investment funds. This study programme consists of following courses:

- Circular economy and models of sustainable development
- Recycling and processing for a circular economy
- Entrepreneurship in the circular economy
- Environmental and Technology Assessment
- Financing and accountability in the circular economy
- Legal aspects of EU circular economy policy
- Areas of strategic infrastructures and productions
- Integrated Marketing Communications
- Project Management (elective)
- Financial Strategies of the European Union (elective)
- Technologies for Obtaining Metal Materials (elective)
- Recycling of secondary materials containing precious metals (elective)
- Risk management (elective)
- Electronic control and communication systems (elective).

Having investigated all accredited universities in Bulgaria and their bachelor's and master's study programmes it is evident that the awareness of the necessity for the circular economy still has not reached the adequate level. There are a few humble attempts to introduce some courses for bachelor's degrees or even whole master's degree study programmes, but in the majority of cases, these

attempts are linked to projects financed by the EU. It seems that this project comes at the right time and it is unique in its attempt to raise the awareness of the circular economy and make it available to students from vulnerable groups.

3.2. The state-of-the-art in HE in Romania

According to the data available on the website of the Romanian Agency for Quality Assurance in Higher Education (ARACIS)[iv], there are 96 HEIs (Table 1.4).

Table 14. Accredited HEIs in Romania

1.	"1 DECEMBER 1918" UNIVERSITY FROM ALBA IULIA
2.	"AGORA" UNIVERSITY FROM ORADEA
3.	"ALEXANDRU IOAN CUZA" POLICE ACADEMY FROM BUCHAREST
4.	"ALEXANDRU IOAN CUZA" UNIVERSITY FROM IAŞI
5.	"ANDREI ŞAGUNA" UNIVERSITY FROM CONSTANTA
6.	"APOLLONIA" UNIVERSITY FROM IAŞI
7.	"ARTIFEX" UNIVERSITY FROM BUCHAREST
8.	"ATHENAEUM" UNIVERSITY FROM BUCHAREST
9.	"AUREL VLAICU" UNIVERSITY FROM ARAD
10	"BABEŞ-BOLYAI" UNIVERSITY FROM CLUJ-NAPOCA
11	"BIOTERRA" UNIVERSITY FROM BUCHAREST
12	"BOGDAN VODĂ" UNIVERSITY FROM CLUJ-NAPOCA
13	"CAROL DAVILA" UNIVERSITY OF MEDICINE AND PHARMACY FROM BUCHAREST
14	"CONSTANTIN BRANCUŞI" UNIVERSITY FROM TĀRGU JIU
15	"CONSTANTIN BRĆCOVEANU" UNIVERSITY FROM PITEŞTI
16	"DANUBIUS" UNIVERSITY FROM GALAțI

17.	"DIMITRIE CANTEMIR" CHRISTIAN UNIVERSITY FROM BUCHAREST
18.	"DIMITRIE CANTEMIR" UNIVERSITY FROM TARGU MUREŞ
19.	"DRĂGAN" EUROPEAN UNIVERSITY FROM LUGOJ
20.	"EFTIMIE MURGU" UNIVERSITY FROM RESIŢA
21.	"EMANUEL" UNIVERSITY FROM ORADEA
22.	"GEORGE BACOVIA" UNIVERSITY FROM BACăU
23.	"GEORGE EMIL PALADE" UNIVERSITY OF MEDICINE, PHARMACY, SCIENCES AND TECHNOLOGY FROM TARGU MUREŞ
24.	"GEORGE ENESCU" NATIONAL UNIVERSITY OF ARTS FROM IAŞI
25.	"GEORGE ENESCU" UNIVERSITY OF ARTS FROM IAŞI
26.	"GHEORGHE DIMA" ACADEMY OF MUSIC IN CLUJ-NAPOCA
27.	"GRIGORE T. POPA" UNIVERSITY OF MEDICINE AND PHARMACY FROM IAŞI
28.	"HENRI COANDĂ" AIR FORCE ACADEMY IN BRAŞOV
29.	"HYPERION" UNIVERSITY FROM BUCHAREST
30.	"ION MINCU" UNIVERSITY OF ARCHITECTURE AND URBANISM IN BUCHAREST
31.	"IULIU HATIEGANU" UNIVERSITY OF MEDICINE AND PHARMACY FROM CLUJ-NAPOCA
32.	"King Mihai I" University of Life Sciences from Timişoara
33.	"LOWER DANUBE" UNIVERSITY FROM GALAțI
34.	"LUCIAN BLAGA" UNIVERSITY FROM SIBIU
35.	"MIHAIL KOGĂLNICEANU" UNIVERSITY FROM IAŞI
36.	"MIRCEA THE ELDER" NAVAL ACADEMY FROM CONSTANTA
37.	"NICOLAE BĆLCESCU" LAND FORCES ACADEMY FROM SIBIU
38.	"NICOLAE TITULESCU" UNIVERSITY FROM BUCHAREST

39	"OVIDIUS" UNIVERSITY FROM CONSTANTA
40	"PARTIUM" CHRISTIAN UNIVERSITY FROM ORADEA
41	"PETRE ANDREI" UNIVERSITY FROM IAŞI
42	"PETU MAIOR" UNIVERSITY FROM TĀRGU MUREŞ
43	"POLITEHNICA" UNIVERSITY FROM TIMIŞOARA
44	"ROMANIAN-GERMAN" UNIVERSITY IN SIBIU
45	"SAPIENTIA" UNIVERSITY FROM CLUJ-NAPOCA
46	"SPIRU HARET" UNIVERSITY FROM BUCHAREST
47	"Ștefancel Mare" Academy of the Ministry of Internal Affairs in Chisinau, Republic of Moldova
48	"ŠTEFAN CEL MARE" UNIVERSITY FROM SUCEAVA
49	"TIBISCUS" UNIVERSITY FROM TIMISOARA
50	"TITU MAIORESCU" UNIVERSITY FROM BUCHAREST
51	"TRANSYLVANIA" UNIVERSITY FROM BRASOV
52	"VALAHIA" UNIVERSITY FROM TĀRGOVIŞTE
53	"VASILE ALECSANDRI" UNIVERSITY FROM BACAU
54	"VICTOR BABEŞ" UNIVERSITY OF MEDICINE AND PHARMACY FROM TIMIŞOARA
55	“CAROL I” NATIONAL DEFENSE UNIVERSITY IN BUCHAREST
56	ADVENTUS UNIVERSITY OF CERNICA
57	AGORA UNIVERSITY FROM ORADEA MUNICIPALITY
58	ECOLOGICAL UNIVERSITY OF BUCHAREST
59	INSTITUTE OF BUSINESS ADMINISTRATION IN BUCHAREST
60	MARITIME UNIVERSITY OF CONSTANTA
61	MILITARY TECHNICAL ACADEMY "FERDINAND I" IN BUCHAREST
62	NATIONAL ACADEMY OF INFORMATION "MIHAI VITEAZUL" FROM BUCHAREST

63	NATIONAL ACADEMY OF MUSIC "GHEORGHE DIMA" FROM CLUJ-NAPOCA
64	NATIONAL SCHOOL OF POLITICAL AND ADMINISTRATIVE STUDIES FROM BUCHAREST
65	NATIONAL UNIVERSITY OF ARTS FROM BUCHAREST
66	NATIONAL UNIVERSITY OF MUSIC FROM BUCHAREST
67	NATIONAL UNIVERSITY OF PHYSICAL EDUCATION AND SPORT IN BUCHAREST
68	NATIONAL UNIVERSITY OF THEATRICAL AND CINEMA ARTS "IL CARAGIALE" IN BUCHAREST
69	PENTICOSTAL THEOLOGICAL INSTITUTE IN BUCHAREST
70	POLYTECHNIC UNIVERSITY OF BUCHAREST
71	PROTESTANT THEOLOGICAL INSTITUTE OF CLUJ-NAPOCA
72	ROMANIAN UNIVERSITY OF SCIENCES AND ARTS "GHEORGHE CRISTEA" IN BUCHAREST
73	ROMANIAN-AMERICAN UNIVERSITY IN BUCHAREST
74	TECHNICAL UNIVERSITY "GHEORGHE ASACHI" IASI
75	TECHNICAL UNIVERSITY OF CLUJ NAPOCA
76	TECHNICAL UNIVERSITY OF CONSTRUCTION OF BUCHAREST
77	THE ACADEMY OF ECONOMIC STUDIES IN BUCHAREST
78	THE UNIVERSITY OF BUCHAREST
79	TIMISORA POLYTECHNIC UNIVERSITY
80	UNIVERSITY FOR LIFE SCIENCES "ION IONESCU DE LA BRAD" FROM IAŞI
81	UNIVERSITY OF AGRICULTURAL SCIENCES AND VETERINARY MEDICINE IN CLUJ-NAPOCA

82.	UNIVERSITY OF AGRICULTURAL SCIENCES AND VETERINARY MEDICINE OF BANAT "KING MIHAI I OF ROMANIA" FROM TIMISOARA
83.	UNIVERSITY OF AGRONOMIC SCIENCES AND VETERINARY MEDICINE IN BUCHAREST
84.	UNIVERSITY OF ART AND DESIGN IN CLUJ-NAPOCA
85.	UNIVERSITY OF ARTS FROM TĀRGU MUREŞ
86.	UNIVERSITY OF CRAIOVA
87.	UNIVERSITY OF MEDICINE AND PHARMACY "GR. T. POPA" FROM IAŞI
88.	UNIVERSITY OF MEDICINE AND PHARMACY FROM TĀRGU MUREȘ
89.	UNIVERSITY OF MEDICINE AND PHARMACY OF CRAIOVA
90.	UNIVERSITY OF MEDICINE, PHARMACY, SCIENCES AND TECHNOLOGY OF TĀRGU MUREț
91.	UNIVERSITY OF ORADEA
92.	UNIVERSITY OF PETROLEUM AND GAS FROM PLIOESTI
93.	UNIVERSITY OF PETROSANI
94.	UNIVERSITY OF PITEŞTI
95.	WEST UNIVERSITY OF TIMIŞOARA
96.	WESTERN UNIVERSITY "VASILE GOLDIŞ" FROM ARAD

"BABEŞ-BOLYAI" University from Cluj-Napoca is offering master specialization programme Sustainable Development and Environmental Management whose part is the course Circular Economy.

Table 1.5.

BULGARIA	ROMANIA
1. Varna Free University is organizing the master's degree programme in the Circular	1. "BABEŞ-BOLYAI" University from Cluj-Napoca is offering master specialization

Economy (compulsory course: Circular Economy, elective course: Circular Economy and Resource Efficiency; optional course: Circular and Green Economy.	programme Sustainable Development and Environmental Management whose part is the course Circular Economy.
2. University "St. Kliment Ohridski" provides a master's course in Circular Economy and Sustainable Development	2. Technical University of Cluj Napoca within the Faculty of Building Services Engineering is offering a Circular Economy course in the master study programme Building Services for Regenerative Cities.
3. The University of Chemical Technology and Metallurgy in Sofia within the bachelor's study programme Green Technologies has the course Circular economy and zero-waste technologies.	3. Technical University of Cluj Napoca within the Faculty of Materials and Environmental Engineering offers the master study programme Integrated Management of Natural Resources and Waste and course Circular Economy Engineering.
4. The University of Chemical Technology and Metallurgy in Sofia is organising a joint master study programme Circular economy with the International Business School in Botevgrad, and Burgas Free University (course: Circular economy and models of sustainable development	4. The Academy of Economic Studies in Bucharest within the Faculty of Agrifood and Environmental Economics is offering the master's degree programme Sustainable Development of Business and Economic Organizations, and subjects: Basics of the circular economy and Circular management of resources.
	5. University of Agricultural Sciences and Veterinary Medicine in Cluj-Napoca within the Faculty of Agriculture is offering the master study programme Protection of Natural and Human Systems and Circular Economy obligatory course.

3.3. The state-of-the-art in HE in Turkey

According to the data available on the website of the Turkish Higher Education Quality Council (THEQC)[v], there are 53 HEIs accredited in the period 2020-2022 (Table 1.6.)

Table 1.6. Accredited HEIs in Turkey

1.	ABDULLAH GÜL ÜNİVERSİTESİ
2.	AKDENİZ ÜNİVERSİTESİ

3.	ALTINBAŞ ÜNİVERSİTESİ
4.	ANKARA ÜNİVERSİTESİ
5.	ATATÜRK ÜNİVERSİTESİ
6.	ATILIM ÜNİVERSİTESİ
7.	BAHÇEŞEHİR ÜNİVERSİTESİ
8.	BAŞKENT ÜNİVERSİTESİ
9.	BOLU ABANT İZZET BAYSAL ÜNİVERSİTESİ
10.	BURSA TEKNİK ÜNİVERSİTESİ
11.	BURSA ULUDAĞ ÜNİVERSİTESİ
12.	ÇAĞ ÜNİVERSİTESİ
13.	ÇANAKKALE ONSEKİZ MART ÜNİVERSİTESİ
14.	ÇUKUROVA ÜNİVERSİTESİ
15.	DOĞUŞ ÜNİVERSİTESİ
16.	DOKUZ EYLÜL ÜNİVERSİTESİ
17.	EGE ÜNİVERSİTESİ
18.	ERCİYES ÜNİVERSİTESİ
19.	FIRAT ÜNİVERSİTESİ
20.	GAZİ ÜNİVERSİTESİ
21.	GAZİANTEP ÜNİVERSİTESİ
22.	HACETTEPE ÜNİVERSİTESİ
23.	HARRAN ÜNİVERSİTESİ
24.	İHSAN DOĞRAMACI BİLKENT ÜNİVERSİTESİ
25.	İNÖNÜ ÜNİVERSİTESİ
26.	İSTANBUL AREL ÜNİVERSİTESİ
27.	İSTANBUL AYDIN ÜNİVERSİTESİ
28.	İSTANBUL BEYKENT ÜNİVERSİTESİ
29.	İSTANBUL OKAN ÜNİVERSİTESİ

30.	İSTANBUL SABAHATTİN ZAİM ÜNİVERSİTESİ
31.	İSTANBUL TEKNİK ÜNİVERSİTESİ
32.	İZMİR EKONOMİ ÜNİVERSİTESİ
33.	İZMİR YÜKSEK TEKNOLOJİ ENSTİTÜSÜ
34.	KADİR HAS ÜNİVERSİTESİ
35.	KARADENİZ TEKNİK ÜNİVERSİTESİ
36.	KIRŞEHİR AHİ EVRAN ÜNİVERSİTESİ
37.	KOÇ ÜNİVERSİTESİ
38.	MANİSA CELÂL BAYAR ÜNİVERSİTESİ
39.	ONDOKUZ MAYIS ÜNİVERSİTESİ
40.	ORTA DOĞU TEKNİK ÜNİVERSİTESİ
41.	ÖZYEĞİN ÜNİVERSİTESİ
42.	RECEP TAYYİP ERDOĞAN ÜNİVERSİTESİ
43.	SABANCI ÜNİVERSİTESİ
44.	SAKARYA ÜNİVERSİTESİ
45.	SELÇUK ÜNİVERSİTESİ
46.	SÜLEYMAN DEMİREL ÜNİVERSİTESİ
47.	TED ÜNİVERSİTESİ
48.	TEKİRDAĞ NAMIK KEMAL ÜNİVERSİTESİ
49.	TRAKYA ÜNİVERSİTESİ
50.	UŞAK ÜNİVERSİTESİ
51.	VAN YÜZÜNCÜ YIL ÜNİVERSİTESİ
52.	YILDIZ TEKNİK ÜNİVERSİTESİ
53.	ZONGULDAK BÜLENT ECEVİT ÜNİVERSİTESİ

The Department of Economics of the Faculty of Economics and Business Administration of Sofia University "St. Kliment Ohridski" provides the teaching of master's course in Circular Economy and Sustainable Development.[vi]

The Faculty of Engineering of the Ankara University[1] offers the course Sustainable development innovation and entrepreneurship as part of the bachelor's study programme Chemical Engineering, , and the course Entrepreneurship, project management, and sustainable innovation within the bachelor's study programme Energy Engineering. Also, this Faculty is organising a Master of Energy Engineering Program, which is designed for students who are motivated to take on the challenges facing society in the areas of sustainable energy generation, storage, and conversion. In this program, students will learn about alternative and conventional energy technologies, the societal and environmental impact of technology developments, and the economic benefits of those developments.

The Middle East Technical University Northern Cyprus Campus (METU NCC)[2] was established in 2000 as a result of an invitation from the governments of the Republic of Turkey and the Turkish Republic of Northern Cyprus. METU NCC receives full academic and administrative support from METU in Ankara. The Center for Sustainability of METU NCC focuses on six main research areas:

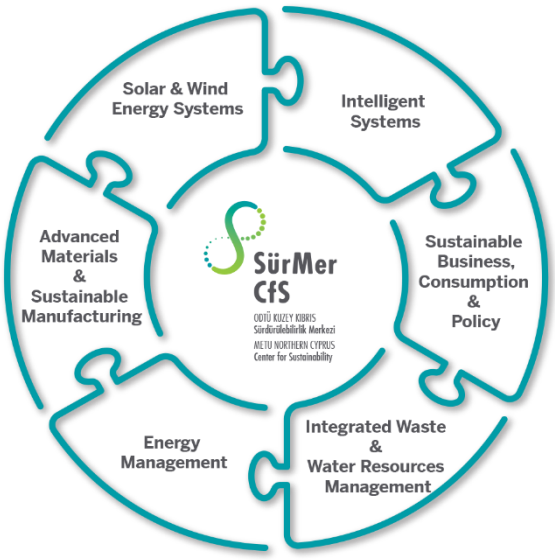


Figure 1.3. Six main research areas

Source: https://ncc.metu.edu.tr/research-areas

[1] https://www.ankara.edu.tr/en/programlar/2/
[2] https://ncc.metu.edu.tr/cfs/research-areas-em

Topics in the Energy Management programme include Energy efficiency, Green buildings, Sustainable transportation, Sustainable Manufacturing Systems, Circular Economy, Sustainability Integration.

The Department of Economics of the Boğaziçi University[3] provides the teaching of several undergraduate courses. The course in **Environmental and Ecological Economics provides** development of environmental thinking in economics; alternative definitions and measurements of sustainability; a survey of contemporary economic approaches that conceptualize the economics-environment relationship; environmental valuation; decision-making techniques, cost-benefit analysis and multi-criteria evaluation; environmental policy instruments. The course in **Diverse Economies provides** alternative ways of conceptualizing economies and organizing economic processes. Alternative ways of conceptualizing economies taught are diverse economies framework with special emphasis on household economies, gift economies, sustainable economies, communal economies, cooperative economies and participative economies. Alternative ways of organizing economic processes taught are controlling markets, extending credit, taming capital and building community and solidarity economies. Also, this Faculty provides the teaching of a graduate course in **Environmental Economics. The course** considers the reasons for, and possible ways of solving, the problems of the degradation of the environment and the depletion of non- renewable resources.

The Faculty of Technology of Gazi University[4] is organizing the bachelor's degree programme in the Energy Systems Engineering, which includes acourse in **Environmental effects of Energy Systems.** The graduates of the department of Energy Systems Engineering, will find opportunity in the areas of production, transmission, distribution and using of energy as a designer and an operator.

The Faculty of Economics, Administrative, and Social Sciences of the Bilkent

[3] https://www.boun.edu.tr/en-US/Index
[4] https://gazi.edu.tr/

University[5] has within the Department of Economics the course in Environmental Economics. Also, the Faculty of Business Administration has within the Department of Management the course in Sustainable Management of Urban Mobility.

3.4. Curricula for certain areas of study in Serbia

According to the data available on the website of the National Body for Accreditation and Quality Assurance in Higher Education (NAT), there are 97 state HEIs and 75 private HEIs in the Republic of Serbia.

The Faculty of Engineering Management is organizing the doctoral studies in the Waste management (https://fim.edu.rs/studirajte-na-fim/doktorske-studije/studijski-program-doktorske-studije/).

The program of doctoral studies includes 3 compulsory subjects, 4 elective subjects (out of the 8 subjects offered, the student chooses 4 subjects). In addition, the curriculum includes 2 study-research papers, 1 study-research and 1 scientific-research project. On the basis of such a consistent curriculum, the student is qualified to approach the study-research work, the part of the curriculum that aims to elaborate the subject and goal of the doctoral dissertation. After the defended and publicly accepted study and research work, the student approaches the preparation and defense of the doctoral dissertation - the most important part of the curriculum.

This study programme consists of the following courses:

- Research methods of engineering management
- Waste management
- Waste recycling
- Geographic information systems and waste management
- Selected chapters from waste management and clustering
- Modeling of waste storage systems

[5] https://w3.bilkent.edu.tr/bilkent/

- Sustainable Development
- Nanotechnology and recycling
- Medical and biological waste
- Selected chapters on waste reduction in production processes
- Nanotechnology and waste

The Faculty of Applied Ecology - FUTURA Faculty at the Metropolitan University is organizinig a bachelor's study programme in Environmental Protection (https://futura.edu.rs/zastita-zivotne-sredine). The teaching process is organized in semesters, two semesters making up an academic year. The total duration of academic studies is 4 years (8 semesters). In that period, the student should collect a minimum of 240 ESPB points.

The structure of this programme is as follows:

- Environmental and resource economics
- Information systems in environmental protection
- Waste resource management
- Environmental policy
- Ecology
- Environmental chemistry
- Social ecology
- Land resource management
- English
- Physical pollution of the environment
- Basics of environmental physics
- Protection of biodiversity
- Protection of geodiversity
- Philosophy of natural sciences
- Rural ecology
- Technological processes in environmental protection

- Renewable energy
- Recycling industry
- Biological high value production systems
- Air pollution and protection
- Ecology of microorganisms
- Geographic information systems
- Environmental management
- Environmental law and natural resources
- Protection and improvement of forest and hunting resources
- Preservation and improvement of urban ecosystems
- Ecotoxicology
- Environmental impact assessment
- Ecohydrology and conservation of water resources
- Management of protected natural resources
- Sustainable tourism in the service of rural development
- Ecological ethics
- Ecoremediation
- Climate change and the global economy
- Environmental protection project management
- Natural hazard
- Ecology and energy
- Basics of methodology
- Ecosystem monitoring
- Global ecology
- Valuation of natural resources

The Faculty of Applied Ecology - FUTURA Faculty at the Metropolitan University also provides the teaching of a master's course in Economics of the

Environment and Climate Change (https://futura.edu.rs/ekonomija-zivotne-sredine-i-klimatske-promene/). This study programme consists of the following courses:

- The science of climate change
- Socio-economic aspects of climate change
- Environmental safety system
- Statistics and processing of climatological data
- Climate change and preservation of biodiversity
- The role of the media in the development of environmental awareness
- Risk management in accordance with climate change
- Methodology of scientific research work
- Climate change and energy technologies
- Application of ecological modeling

The Faculty of Economics University of Niš within the master's study programme in Economy on the General Economics module and Management in Tourism module has the course Economics of Sustainable Development (http://www.eknfak.ni.ac.rs/src/Nastavni-plan-MASTER-studija.php).

The master academic studies are designed in accordance with the Law on Higher Education of the Republic of Serbia and the Bologna Declaration. The studies in this program last 2 semesters and carry a total of 60 ECTS, which makes a total of 300 ECTS from the previously achieved 240 ECTS in basic academic studies. After completing these studies, the student can enroll in doctoral studies. Graduate academic studies (master's) last 1 year (2 semesters) and will take place on one study program - Economics with 7 modules, namely:

1. General Economy
2. Accounting, Audit and Financial Management
3. Finance, Banking and Insurance
4. Company Management
5. Marketing

6. International Management
7. Management In Tourism

In the first semester of master academic studies, the student attends lectures and takes 6 exams, three of which are mandatory and three are optional. Each subject is taught 4 hours a week, i.e. 20 classes for the semester.

The second semester is designed so that students carry out professional practice that gives 3 ESPB. In this semester it is mandatory to prepare a final (master's) thesis that gives 27 ESPB.

The study programme on the General Economics module offers the following courses:

1. Compulsory courses:

- Methodology of economic sciences
- Micro and macro-economic analysis
- Contemporary economic theories

2. Choice block – 3 out of 7 are chosen

- Regional economy
- Agrarian policy
- Macroeconomic policy and economic development
- Competition protection policy
- Macroeconomics of an open economy
- Labor economy
- Economics of sustainable development

The study programme on the Management in tourism module offers the following courses:

1. Compulsory courses:

- Valorization of tourist potential
- Quality management
- Tourism and Hotel

2. Choice block – 3 out of 7 are chosen

- Electronic business management
- Management of small and medium enterprises1
- Marketing services
- Economics of sustainable development
- Regional economy
- Statistical analysis in marketing
- Labor economy

The *Faculty of Occupational Safety of the University of Niš*, offers a master's degree programme in Management of Environmental Protection (https://www.znrfak.ni.ac.rs/PP_2022/index-MAS-2021.html#MZZS).

- Management of environmental protection
- Management and development of human resources
- The right to environmental protection
- Social ecology
- Air pollution and air quality monitoring
- Ecotoxicology
- Water quality monitoring
- Ecological psychology
- Circular economy
- Environmental protection policy
- Municipal waste management
- Ecological andragogy
- Business ethics in environmental protection
- Information and public relations
- Project Management
- Local sustainable development

- Adaptation to the effects of climate change
- Economics of environmental protection

The Master's study program in Economics and Business Management, at the *Faculty of Economics of the University of Kragujevoc* (https://www.ekfak.kg.ac.rs/sr/mas-studijski-programi) offers a wide range of compulsory subjects: Economic policy and sustainable development, Theoretical controversies about economic policy, Institutional economics; and elective subjects: International economic integration, Tourism and agribusiness, Globalization and transition, Globalization and transition, Financial system and economic growth, Macroeconomics, Financing of economic development, Contemporary markets.

The *Faculty of Technology and Metallurgy of the University of Belgrade*[6] has the Study program of basic academic studies, named Environmental Engineering. Also, the Faculty has a a study program in master's degree academic studies, named Environmental Engineering.

The *Technical Faculty in Bor of the University of Belgrade*[7] has the course Engineering for environmental protection within its basic academic study programme Technological engineering .

The *Faculty of Mining and Geology of the University of Belgrade*[8] has a study program of basic academic studies, named Environmental Engineering. Also, the Faculty has a study program of master academic studies, named Environmental Engineering.

The *Faculty of Agriculture of the University of Belgrade*[9] has the Study program of basic academic studies, named Environmental protection in food

[6] http://www.tmf.bg.ac.rs/en/studies/basic-studies/study-program-of-basic-academis-studies-2022#gsc.tab=0
[7] https://www.tfbor.bg.ac.rs/tehnolosko-inzenjerstvo University of Belgrade
[8] https://rgf.bg.ac.rs/eng/page.php?page=program_studija&id=98&tip=O
[9] https://agrif.bg.ac.rs/en/studies/master-of-academic-studies/environmental-protection-in-agriculture

production. Also, the Faculty has a study program of master academic studies, named Environmental protection in agriculture.

The *Faculty of Technical Sciences of the University of Novi Sad*[10] has the Study program of Undergraduate academic studies, named Environmental Engineering. Also, the Faculty has a study program of master academic studies, named Environmental Engineering.

References for chapter one

Andrews, D. (2015). The circular economy, design thinking and education for sustainability. *Local Econ.* 30, 305–315. doi: 10.1177/0269094215578226

Bakken, L., Brown, N., and Downing, B. (2017). Early childhood education: the long-term benefits. *J. Res. Childh. Educ.* 31, 255–269. doi: 10.1080/02568543.2016.1273285

Bocken, N.M.P., Ritala, P., Huotari, P., (2017). The circular economy: exploring the introduction of the concept among S&P 500 firms. J. Ind. Ecol. 21, 487–490. https://doi.org/10.1111/jiec.12605

Cother, G. (2020). Developing the circular economy in Tasmania. Act. Learn., 17 (1) (2020), pp. 108-124.

Dongxu, Q., Shevchenko, T., Saidani, M., Xia, Y., Ladyka, Y. (2021). Detritus. Volume 17 – 2021, pp 3-14 https://doi.org/10.31025/2611-4135/2021.15141

Heshmati, A., (2015). A Review of the Circular Economy and Its Implementation.International Journal of Green EconomicsVol. 11, No. 3-4. pp 251-288https://doi.org/10.1504/IJGE.2017.089856

European Commission(2015)Closing the Loop - an EU Action Plan for the Circular Economy, Com(2015) 614 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions

[10] http://www.ftn.uns.ac.rs/2003627913/environmental-engineering

EC, European Comission, (2020). Transition to Circular Economy: the role of education from youth to higher education. https://epale.ec.europa.eu/en/blog/transition-circular-economy-role-education-youth-higher-education.

European Parliament(2015). Circular economy: definition, importance and benefits. https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits

EMF (2013). Towards the circular economy:Economic and business rationale for an accelerated transition. https://emf.thirdlight.com/file/24/xTyQj3oxiYNMO1xTFs9xT5LF3C/Towards%20the%20circular%20economy%20Vol%201%3A%20an%20economic%20and%20business%20rationale%20for%20an%20accelerated%20transition.pdf

EMF (2015a). Circular economy and curriculum development in higher education: Briefing notes, case studies and illustrative resources. Isle of Wight: Ellen MacArthur Foundation (EMF).

EMF (2015b). Higher education programmes. Isle of Wight: Ellen MacArthur Foundation (EMF).

EMF, (2015c). Higher education academic profiles. Isle of Wight: Ellen MacArthur Foundation (EMF).

EMF (2018) A global snapshot of circular economy learning offerings in higher educationhttps://indd.adobe.com/view/a76263e6-f75f-4f12-bbdc-920c01f42c6f

EMF, Ellen MacArthur Foundation (2020). Higher education resources. https://emf.thirdlight.com/link/mk4v9gsntsgm-63ocgv/@/preview/1?o

Geissdoerfer, M., Savaget, P., Bocken, M.P. N., Jan Hultink, E., (2017), The Circular Economy – A new sustainability paradigm?, Journal of Cleaner Production, Volume 143, Pages 757-768, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2016.12.048.

Giannoccaro, I.; Ceccarelli, G.; Fraccascia, L. (2021). Features of the Higher

Education for the Circular Economy: The Case of Italy. Sustainability 2021, 13, 11338. https://doi.org/10.3390/su132011338

Guerreschi, A.; Piras, L.; Heck, F. (2023). Barriers to Efficient Knowledge Transfer for a Holistic Circular Economy: Insights towards Green Job Developments and Training for Young Professionals. Youth 2023, 3, 553–578. https://doi.org/10.3390/youth3020038

Global University Network for Innovation (GUNI). (2021). GUNI world report special issue. New visions for Higher Education towards 2030. Available at: https://www.guninetwork.org/files/concept_note_guni_2021_new_visions_for_he_2030_def.pdf.

Jiang, Y., Zheng, X., (2014). Private sector participation and performance of urban water utilities in China. Econ. Dev. Cult. Change 63, 155–189. https://doi.org/10.1086/677739

Joyce, A. (2018). How Can Information and Communication Technologies Support Education for Sustainable Development. Preuzetosa https://www.researchgate.net/publication/326507525_How_Can_Information_and_C

ommunication_Technologies_Support_Education_for_Sustainable_Development_A _Critique (pristupljeno 12. 1. 2020). doi:10.21125/edulearn.2018.2170.

Keramitsoglou, K., Litseselidis, T. and Kardimaki, A. (2023) Raising effective awareness for circular economy and sustainability concepts through students' involvement in a virtual enterprise. *Front. Sustain.* 4:1060860. doi:10.3389/frsus.2023.1060860

Kirchherr, J., Scherf, G., Suder, S., (2014). Creating Growth Clusters: What Role for Local Government? McKinsey Center for Government (Global). McKinsey & Co. Ecological Economics. Volume 150, Pages 264-272https://doi.org/10.1016/j.ecolecon.2018.04.028

Kirchherr, J. Piscicelli, L. (2019). Towards an Education for the Circular Economy

(ECE): Five Teaching Principles and a Case Study. *Resources, Conservation and Recycling*, Volume 150, ISSN 0921-3449, https://doi.org/10.1016/j.resconrec.2019.104406.

Kopnina, H. (2014). Revisiting Education for Sustainable Development (ESD): Examining Anthropocentric Bias Through the Transition of Environmental Education to ESD. Sustainable Development, 22, 73–83. doi:10.1002/sd.529.

Leal Filho, W.; Vargas, V.R.; Salvia, A.L.; Brandli, L.L.; Pallant, E.; Klavins, M.; Ray, S.; Moggi, S.; Maruna, M.; Conticelli, E.; et al. (2019). The Role of Higher Education Institutions in Sustainability Initiatives at the Local Level. J. Clean. Prod. 2019, 233, 1004–1015.

Leicht, A., Heiss, J., & Byun W. J. (Eds.) (2018). Issues and Trends in Education for Sustainable Development. Paris, France: UNESCO.

Lewandowski, M. (2016) Designing the Business Models for Circular Economy—Towards the Conceptual Framework. Sustainability 2016, 8, 43.

Lieder, M. and Rashid, A. (2016). Towards circular economy implementation: a comprehensive review in context of manufacturing industry, Journal of Cleaner Production, Volume 115, Pages 36-51, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2015.12.042.

Ludvig, V. (2020). Transition to Circular Economy: the role of education from youth to higher education. Available at:https://epale.ec.europa.eu/en/blog/transition-circular-economy-role-education-youth-higher-education

Mendoza, J. M. F., Gallego-schmid, A., &Azapagic, A. (2019). A methodological framework for the implementation of circular economy thinking in higher education institutions: Towards sustainable campus management. Journal of Cleaner Production, 226, 831-844. https://doi.org/10.1016/j.jclepro.2019.04.060

Merli, R., Preziosi, M., Acampora, A. (2018). How do scholars approach the circular economy? A systematic literature review.*Journal of Cleaner Production*, 178 (2018), pp. 703-722.

Minguez, R., Lizundia, E., Iturrondobeitia, M., Akizu-Gardoki, O., &Saez-de-Camara, E. (2021). Fostering Education for Circular Economy through Life Cycle Thinking. IntechOpen. doi: 10.5772/intechopen.98606

OECD. (2023). Job Creation and Local Economic Development 2023: Bridging the Great Green Divide. 2023. Available online: https://www.oecd-ilibrary.org/sites/21db61c1-en/1/3/1/index.html?itemId=/content/publication/21db61c1-en&_csp_=f2842cfcbf9633a0ce68042bae4d00dd&itemIGO=oecd&itemContentType=book#section-d1e1144-df7ea1d597 (accessed on 08 May 2022).

Paletta, A., Fava, F., Ubertini, F., Bastioli, C., Gregori, G., La Camera, F.,Douvan, A.R. (2019). Universities, industries and sustainable development: outcomes of the 2017 G7 Environment Ministerial Meeting. Sustain. Prod. Consumpt., 19, pp. 1-10.

Pandey, N., and Vedak, V. (2010). Structural transformation of education for sustainable development. *Int. J. Environ. Sustain. Dev.* 9, 3–15. doi: 10.1504/IJESD.2010.030063

Salas, D.A.; Criollo, P.; Ramirez, A.D. The Role of Higher Education Institutions in the Implementation of Circular Economy in Latin America. Sustainability 2021, 13, 9805. https://doi.org/10.3390/ su13179805

SDGKP. Sustainable Development Goals Knowledge Platform, (1992). Agenda 21. Available online: https://sustainabledevelopment.un-.org/outcomedocuments/agenda21

Serrano-Bedia, A. M., Perez-Perez, M. (2022). Transition towards a circular economy: A review of the role of higher education as a key supporting stakeholder in Web of Science,*Sustainable Production and Consumption*, Volume 31, pp 82-96, ISSN 2352-5509, https://doi.org/10.1016/j.spc.2022.02.001.

Suárez-Eiroa, B., Fernández, E., Méndez-Martínez, G., and Soto-Oñate, D. (2019). Operational principles of circular economy for sustainable development: linking theory and practice. *J. Clean. Prod.* 214, 952–961.

doi:10.1016/j.jclepro.2018.12.271

Troiani, L., Sehnem, S., and Carvalho, L. (2022). *Sustainable Fashion: An Analysis From the Perspective of Teaching Good Sustainability Practices and Circular Economy*. CAD. EBAPE.BR, 20.

UNESCO. United Nations Educational Scientific and Cultural Organization, (2014). Global Action Programme on Education for Sustainable Development (2015-2019). Available online: https://en.unesco. org/globalactionprogrammeoneducation

UNESCO, (2015). Education 2030 Framework for Action. Available online: http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/ED/ ED_new/pdf/FFA-ENG-27Oct15.pdf

UNESCO, (2003). The United Nations Decade of Education for Sustainable Development (2005-2014). Available online: https://en.unesco. org/themes/education-sustainable-development/what-is-esd/undecade-of-esd

UNESCO (2012). Education for Sustainable Development Sourcebook. Paris, France: UNESCO.

Uribe-Toril, J.; Ruiz-Real, J.L.; Durán, A.C.G.; Arriaza, J.A.T.; Valenciano, J.D.P. (2022). The Circular Economy and retail: Using Deep Learning to predict business survival. Environ. Sci. Eur. 2022, 34, 2

Vicente, J. (2020). "Product design education for circular economy," in *International Conference on Applied Human Factors and Ergonomics* (Springer), 519–525. doi: 10.1007/978-3-030-51194-4_68

Vukić, T. (2020). Obrazovanje za održivirazvojkaoizborni program. Research in Pedagogy, Vol.10, No.1, pp. 93-107

Wuyts, W. (2017). Facilitating the Implementation of new Circular Economy Practices in Higher Education Institutes Learning through Action Research at the Asian Institute of Technology. Master's Thesis

CHAPTER TWO. METHODOLOGICAL REMARKS ON TEACHING ON CIRCULAR ECONOMY

The educational process typically comprises several key components that work together to facilitate effective teaching and learning. These components can vary based on the educational context and the specific goals and approaches employed. Thus, when planning the process of teaching circular economy, *it is essential to formulate what we want to achieve (learning goals) in the specific context of the subject matter*.

1. Learning goals, learning objectives, approaches and teaching methods

1.1. Learning goals

The context of learning circular economy involves understanding the principles and practices of circular economy within the broader *environmental, economic, and social contexts*. On the environmental side, the context of learning circular economy is shaped by the pressing global challenges such as climate change, resource depletion and pollution. The increase of global wealth (Woetzel, et al., 2021) and world population in the last two decades has led to a growth in consumption, which has respectively put to the front the question what is to be done to use our planet's resources in the most reasonable and responsible way. In this context, circular economy seems to be a viable and promising alternative to the currently prevailing take-make-use-dispose linear model. Then, it is essential students to grasp the economic and business aspects of circular economy and most importantly, to critically assess them and actively seek opportunities associated with transitioning to circular business models, such as resource efficiency, cost savings,

job creation, and innovation. Last, but in no case least, as the concept of circular economy is inherently linked with the concept of sustainable development, it is essential learners not only to grasp the various aspects, but also the interconnectedness between economic growth, social-well-being and environmental sustainability. As the transition to circular economy is a systemic change (Marouli, 2016), it presupposes fundamental changes that affect the whole system – in the economic, the political and in the socio-cultural aspect. It is probably in this last aspect that the transition will be the most difficult to implement, as it is related to cultivation of new values and behaviours through effective education.

At the same time, most professionals have either little or quite superficial knowledge on circular economy, because the matter was not part of their curricula at the time, they completed their studies. In this sense, education is of paramount importance to fill this knowledge gap. As for the younger people, who will enter the business world in the next years, the integration of circular economy into the curricula will help raising sustainability awareness, transforming the attitude towards economy, society and nature and will empower them with the knowledge on what is to be done.

It is in this broad context and accounting for the specificity of the educational level, institution, program, etc., the learning goals in teaching circular economy are to be set. They can be sought in two directions*: (1) understanding the basis of the circular model* and *(2) grasping the idea of a new business model*. In the first direction, it is essential to develop students' understanding of the principles and practices of circular economy as paradigm that suggests a redesign of the current linear economic system and their ability to apply them in real-world contexts. Then, the students need to grasp the idea that the economic activity in circular economy is to be based on creation, capturing and delivering value with the value creation logic designed to improve resource efficiency through contributing to extending useful life of products and parts (e.g., through long-life design, repair and remanufacturing)

and closing material loops (Nussholz, 2017) and strive to develop innovative solutions, business models, and technologies that promote circularity and resource efficiency.

1.2. Learning objectives

While learning goals formulate the general aims to be achieved in a course, they are to be mapped in learning objectives. Learning objectives specify the learning outcomes to be achieved upon completion of an educational or learning activity. In the context of teaching circular economy - *the totality of information, knowledge, understanding, attitudes, values, skills, competencies or behaviours the learners expected to master* (UNESCO, 2012) in the course of the educational process. In concert with the above set learning goals, we can formulate the following learning objectives:

- **Understanding the Concept.** The primary learning objective is to ensure that students grasp the fundamental concept of the circular economy. This involves explaining the principles, benefits and the importance of the transition from a linear, wasteful economy to a regenerative, sustainable one (Makio & Virta, 2019).
- **Analysing Systems Thinking.** Circular economy education should encourage students to develop systems thinking mindset. They should learn to identify and analyse on the one hand the complex relationships between the different actors, resources and processes in the context of the circular economy as well as to analyse and evaluate the interactions and interdependencies between various components of the economy itself including production, consumption, waste management, and supply chains (Iacovidou, Hahladakis, & Purnell, 2021)
- **Applying Lifecycle Thinking.** Students should learn to apply lifecycle thinking and conduct lifecycle assessments. They should be able to evaluate

the environmental and social impacts of products and processes throughout their entire lifecycle, from raw material extraction and production to consumption and end-of-life disposal, and identify opportunities for improving resource efficiency, reducing waste, and increasing recycling and reuse (Minguez, Lizundia, Iturrondobeitia, Akizu-Gardoki, & Saez de Camara, 2021)

- **Encouraging Innovation and Entrepreneurship.** Teaching circular economy involves fostering creativity, innovation, and entrepreneurship. Students should be encouraged to develop innovative solutions, business models, and technologies that promote circularity and resource efficiency (Ruiz-Pastor, Chulvi, Royo, & Sampaio, 2023). This involves developing skills in biomimicry, eco-design, and product-service systems (Andrews, 2015). They should develop an entrepreneurial mindset and explore how circular economy principles can drive new business models and opportunities.
- **Assessing Environmental Impacts.** Students should develop the ability to evaluate the environmental impacts of different economic activities and identify strategies for reducing resource consumption, waste generation and pollution through circular practices (Tian, et al., 2020). This includes understanding methods such as recycling, reusing, remanufacturing, repairing, and redesigning products to extend their lifespan and reduce waste.
- **Critical Thinking and Problem-Solving.** Students should enhance their critical thinking skills to identify and analyze circular economy challenges and develop innovative solutions. They should be able to assess trade-offs, evaluate the feasibility and scalability of circular initiatives, and consider the broader impacts and implications of proposed strategies (Marouli, 2016).
- **Promoting collaboration, communication, and stakeholder engagement.** Circular economy education emphasizes the importance of collaboration and stakeholder engagement. Students should develop effective collaborative and

communicative skills to work together in multidisciplinary teams, understanding the importance of (Salvioni & Almici, 2020) and engaging with various stakeholders, including businesses, policymakers, and community organizations, to drive systematic change towards circular economy.

- **Understanding Policy and Governance.** Circular economy education should introduce students to relevant policies, regulations and governance mechanisms that can facilitate the transition to a circular economy. This includes exploring the role of government, international organizations, and industry in implementing circular economy strategies. Students should be able to analyse existing policies, identify barriers and opportunities and explore potential policies and incentives that can support circular practices.
- **Cultivating Ethical Considerations.** Students should consider the ethical dimensions of the circular economy, including social equity, fair distribution of resources and the well-being of marginalized communities. They should explore how circular economy practices can contribute to a more just and inclusive society.

1.3. Approaches and teaching principles

When teaching circular economy, various methods and approaches can be employed to enhance learning experience. Literature on teaching CE is grounded on a variety of theories of learning and teaching. Most authors adopt outcome-based teaching and learning approaches such as *constructive alignment* or *problem-based learning* (Kirchherr, 2019). Constructive alignment (CA) is a design for teaching in which what it is intended students should learn, and how they should express their learning, is clearly stated before teaching takes place. Teaching is then designed to. engage students in learning activities that optimise their chances of achieving. Problem-based learning (PBL) is a student-centered approach in which students

learn about a subject by working in groups to solve an open-ended problem. This problem is what drives the motivation and the learning.

The teaching in circular economy is also to follow the principles of *interactivity, non-dogmatism* and *reciprocity* (Kirchherr, 2019). The principle of interactivity suggests that students are encouraged to show active involvement in the learning process. Interactive teaching methods involve two-way communication (teacher-to-student, student-to-student, student-to-teacher). The most effective ways to engage students through interactive teaching methods are brainstorming, buzz sessions, question and answer sessions and other. The principle of non-dogmatism postulates that the courses should be designed with the purpose of developing critical thinking, avoiding overcommitment to optimistic win-win scenarios or skepticism. The principle of reciprocity refers to continuously incorporating students' feedback into a course. It reflects the idea that the students taking a course know best how to improve it.

1.4. Teaching methods

In terms of the teaching methods and the learning context, an education that supports the transition to a circular economy should: provide a forum for the required knowledge and skills via a classroom that fosters critical thinking, problem-solving and entrepreneurship, be relevant to the learners' own lives, promotes communication and collaboration and cultivates ethical considerations. In the context of teaching circular economy, lecturers can use the typical teaching methods as follows:

- **Lectures:** Traditional lectures can be used to provide foundational knowledge about the circular economy, its principles, and relevant concepts. This method is particularly useful for introducing key theoretical frameworks, case studies, and historical context.

- **Case Studies:** Analyzing real-world case studies allows students to understand the practical implementation of circular economy principles in different industries and contexts. Case studies can illustrate successful circular initiatives, challenges faced, and lessons learned, fostering critical thinking and problem-solving skills.
- **Group Discussions:** Facilitating group discussions encourages students to actively engage with the subject matter. Through dialogue and exchange of ideas, students can deepen their understanding of circular economy concepts, explore different perspectives, and collectively generate innovative solutions to circular challenges.
- **Workshops and Interactive Activities:** Hands-on workshops and interactive activities can provide practical experiences related to circular economy practices. These activities may include designing circular product prototypes, conducting material flow analyses, exploring business model canvases, or participating in waste upcycling projects.
- **Field Trips and Industry Visits:** Visiting businesses, waste management facilities, recycling centers, or other relevant sites can offer students firsthand exposure to circular economy practices. They can observe circular initiatives in action, interact with professionals in the field, and gain insights into the challenges and opportunities associated with circularity.
- **Guest Lectures and Expert Panels:** Inviting guest speakers, industry experts, or practitioners to share their experiences and insights can provide diverse perspectives and practical knowledge. These sessions can inspire students, provide real-world context, and facilitate networking opportunities.
- **Simulations and Gamification:** Simulations or gamified activities can immerse students in a virtual environment where they make decisions related to resource management, circular design, or policy development. Such

simulations can enhance problem-solving skills and allow students to explore the consequences of different strategies.

- **Project-Based Learning:** Assigning projects or group assignments that require students to address specific circular economy challenges fosters practical application of knowledge. Students can engage in research, problem analysis, and develop innovative solutions, encouraging creativity and teamwork.
- **Online Resources and Multimedia:** Utilizing online platforms, digital resources, videos, and interactive materials can supplement classroom learning. These resources can provide additional information, case studies, interactive simulations, or video documentaries that enhance understanding and engagement.
- **Assessment and Feedback:** Assessments such as quizzes, exams, presentations, or research papers can evaluate students' understanding of circular economy concepts. Providing constructive feedback helps students improve their understanding and encourages critical thinking.

It is important to employ a combination of these methods to cater to different learning styles, encourage active participation, and facilitate practical application of circular economy principles.

2. Learning content

As noted above, when teaching circular economy, most authors adopt outcome-based teaching approaches, and in particular the principle of constructive alignment, which approach we also highly recommend. It provides for clear and explicit articulation of expected learning outcomes (what students are expected to know and to be able to do upon completion of the course) and ensures that the teaching/learning activities and resources as well as assessment are systematically linked with the learning objectives.

The lecture goals when teaching circular economy can be classified as: *conceptual* and *generic*. Conceptual lecture goals are more related with giving knowledge on circular economy, while generic goals are more related with developing skills.

Some *lecture goals* when teaching circular economy are:

- to introduce the concept of circular economy (providing a definition and explanation of the CE concept, its key principles and key characteristics)
- to explore the environmental impacts of CE (negative consequences of the linear model, pollution, waste generation, etc.)
- to present the benefits of CE (resource conservation, waste reduction, energy efficiency, creation of new business opportunities, etc.)
- to explain various CE strategies (product design for recyclability, resource recovery and regeneration, sharing and collaborative consumption, optimization of supply chains)
- to discuss case studies and real-life examples of successful companies from various industries and regions, the approaches they used, the challenges they faced and the outcomes they have achieved
- to analyse the economic implications and potential advantages of CE such as job creation, saving costs through resource efficiency, the shift to service-based models, etc.
- to address policy and regulatory frameworks
- to encourage systems thinking through emphasizing the interconnectedness of economic, social and environmental systems in the context of CE; to consider the lifecycle impacts of products and processes
- to foster innovation and entrepreneurship through inspiring students to think creatively and develop innovative solutions to promote circularity; to discuss the role of entrepreneurship in driving CE innovation, giving examples of successful startups;

- to engage in discussions on challenges, trade-offs and barriers to CE and encourage students to critically evaluate the feasibility and scalability of CE solutions
- to encourage student projects and research on specific aspects of CE
- to promote awareness and action, highlighting the role of individuals, communities and businesses in the transition to CE.

When teaching about circular economy, it's important to provide a comprehensive learning experience that covers key concepts, principles, and practical applications. Table 2.1 gives an outline of potential *learning content* to include when teaching about circular economy:

Table 2.1. Potential learning content when teaching circular economy

Topic	**Sub-topics**
1. Introduction to CE.	• Definition and basic principles of CE • Contrasting linear economy and circular economy models • Environmental, economic and social benefits of CE
1. Circular Economy strategies and approaches.	• Design for CE: cradle-to-cradle, eco-design, biomimicry • Product life extension: repair, refurbishment and remanufacturing • Resource recovery and recycling: waste reduction and close-loop systems • Sharing economy and collaborative consumption • Digitalisation and circular economy
2. Circular business models	• Overview of the different business models (product-as-service, leasing, sharing platforms)

	• Case studies and examples of successful circular businesses • Benefits, challenges and risks associated with the different business models • Strategies for transitions from linear to circular business models
3. Circular supply chains and logistics	• Sustainable sourcing and procurement practices • Reverse logistics and product recovery • Waste management and recycling infrastructure • Collaborative networks and partnerships in circular supply chains
4. Policy and regulatory Frameworks	• Overview of national and international policies promoting circular economy • Extended producer responsibility (EPR) and product stewardship • Legal and regulatory considerations for circular business models • Incentives and subsidies for circular practices
5. Circular economy in different sectors	• Circular economy applications in industries such as manufacturing, energy, fashion, food, and construction • Industry-specific challenges and opportunities for circularity • Case studies and best practices from various sectors
6. Circular economy and innovation	• Role of innovation in driving circular economy solutions

	• Technological advancements supporting circularity (e.g., IoT, blockchain) • Start-ups and entrepreneurship in the circular economy • Circular economy as a source of competitive advantage and market differentiation
7. Assessing the environmental and social effect	• Life cycle assessment (LCA) and environmental impact assessment (EIA) • Social and ethical considerations in circular economy practices • Metrics and indicators for measuring circularity and sustainability
8. Circular economy and consumer behaviour	• Educating consumers about circularity and sustainable consumption • Influencing consumer behavior towards circular choices • Role of marketing and communication in promoting circular products and services
9. Future trends and emerging topics	• Circular economy in the context of the Fourth Industrial Revolution • Circular economy and the transition to a low-carbon economy • Circular economy and the role of cities and urban planning • Circular economy and global initiatives (e.g., Sustainable Development Goals)

3. Evaluation aspects

When evaluating the effectiveness of teaching circular economy, various aspects can be considered to assess student learning and the overall impact of the educational program. It is essential to align the evaluation aspects with the specific learning objectives and desired outcomes of the circular economy education program. This alignment ensures that the assessment provides evidence of the intended learning outcomes and guides the assessment process (Table 2.2).

Table 2.2. Alignment between learning objectives and evaluation aspects

Learning objective	Evaluation aspects
Understanding the content	• evaluation of students' comprehension of circular economy concepts, principles, and key elements. • assessment of their understanding of the interconnections between economic, environmental, and social factors within a circular economy framework.
Analysing systems thinking	• evaluation of students' ability to identify and map system components, analyze interconnections and feedback loops, and propose interventions or solutions. • assessment of the ability to do in-depth analysis, clarity of system diagrams, and ability to identify leverage points within the system.
Applying life-cycle thinking	• Evaluation of students' ability to identify relevant life-cycle stages, analyse impacts, propose sustainable alternatives, and critically reflect on the implications of their findings

Encouraging innovation and entrepreneurship	• Evaluation of students' ability to apply circular economy principles creatively, think critically, develop viable business plans, and demonstrate an entrepreneurial mindset. • Evaluation of students' ability to make strategic decisions, identify circular opportunities, and manage the complexities of running a circular economy business within a simulated environment
Assessing environmental impacts	• Evaluation of students' ability to identify and assess potential environmental impacts, propose mitigation measures, and analyze the overall environmental sustainability of the project. • Assessment of students' understanding of environmental impact assessment methodologies, data analysis, and their ability to communicate the findings effectively
Critical thinking and problem-solving	• assessment of the students' ability to apply critical thinking skills to analyze circular economy challenges, identify opportunities, and propose innovative solutions. • evaluation of students' capacity to consider multiple perspectives, evaluate trade-offs, and think systemically.
Promoting collaboration, communication, and stakeholder engagement	• assessment of students' capacity to effectively communicate their ideas, engage in collaborative activities, and work in multidisciplinary teams.

	• evaluation of students' ability to articulate and present their thoughts on circular economy topics to both expert and non-expert audiences.
Understanding policy and governance	• evaluation of students' understanding of policy concepts, their ability to critically assess policy effectiveness, and their capacity to identify strengths, weaknesses, and potential areas for improvement in policy and governance approaches. • Evaluation of students' understanding of different viewpoints, their ability to present coherent arguments, and their capacity to engage in critical discussions on policy implications and governance considerations
Cultivating ethical considerations	• evaluation of the students' understanding and awareness of ethical dimensions within the circular economy. • assessment of students' ability to consider social equity, inclusivity, and environmental justice in the context of circular practices.

The evaluation of students' knowledge and understanding of circular economy, their ability to apply the acquired theoretic knowledge in practice and their mindset and values towards sustainability and circularity, can be done using various *assessment methods.* Evaluation can be done using a combination of assessment methods, including exams, quizzes, presentations, project evaluations, case studies, portfolios, reflective journals, etc. (Table 3). It is essential to note that the link between assessment methods and corresponding assessment criteria is crucial for evaluating learning outcomes effectively. Assessment methods refer to the specific

tools or approaches used to gather evidence of student learning, while assessment criteria are the specific standards or expectations against which student performance is evaluated. The connection between these two elements ensures that assessment aligns with the intended learning outcomes and provides meaningful information about student achievement.

Table 2.3. Assessment methods and corresponding assessment criteria for evaluation of learning outcomes

Assessment tool	Assessment criteria
Written assignments (essays, reports, research papers)	• students' ability to articulate key ideas, analyse case studies, and propose innovative solutions within a circular economy framework
Presentations on topics related to CE	• students' ability to communicate effectively, synthesize information, and present their findings and ideas in a clear and engaging manner. • Students' understanding of circular economy principles and their ability to apply them to real-world contexts.
Project or case studies (individual or group assignments)	• Students' ability to apply circular economy principles, analyze potential impacts, and propose feasible and sustainable strategies. • students' critical thinking, creativity, and problem-solving skills.
Exams or quizzes	• students' knowledge and comprehension of circular economy concepts, theories, and frameworks.

	• Students' understanding of key principles, their ability to apply them to different scenarios, and their grasp of the economic, environmental, and social dimensions of circularity.
Practical implementation (workshops, hands-on activities, etc.)	• students' ability to apply circular economy principles in practical settings • students' technical skills
Peer-review and feedback	• the quality of feedback provided by students to their peers • students' ability to effectively collaborate and communicate with their peers during the peer review process • ability to recognize and analyze circularity in their peers' work, and their capacity to provide suggestions for improving circularity
Reflection and self-assessment	• the depth and quality of students' reflections on their learning journey in the course • ability to articulate insights, identify areas of strength and improvement, and demonstrate a thoughtful understanding of the course material ability to self-assess their knowledge, skills, and abilities related to circular economy concepts, strategies, and implementation
Portfolios	• depth and breadth of the portfolio, • students' ability to reflect on their learning and growth

Surveys, questionaries to assess students' attitudes and values	• students' attitudes and values towards sustainability, circularity, and responsible consumption and production

It is also important to note, that assessment methods should allow for differentiation and provide opportunities for students to demonstrate different levels of achievement. The assessment criteria should include different levels or benchmarks of performance that align with the learning outcomes and provide a clear progression of skills or knowledge. This link ensures that the assessment methods provide sufficient depth and breadth to capture different levels of student achievement. It is also important the methods and criteria to be designed and implemented in a way that ensures reliability and consistency in the evaluation of student performance. They should provide consistent and comparable results when applied to different students or in different contexts.

4. Quality standards and interactivity notes

4.1. ISO framework for Universities' quality assurance

The management of the higher education institution introduces, maintains and continuously improves the System for ensuring the quality of education and academic staff, according to the requirements of the Higher Education Act, the National Evaluation and Accreditation Agency and the International Quality Management Standards of the ISO 9000:2000 series. This commitment also requires the provision of the necessary resources for its functioning. Through the introduction of the Quality Assurance System, the goal is to achieve the maximum possible level of quality through the most efficient use of external and internal resources. The quality management system is introduced step by step, and its character remains conservative with a guaranteed ability to expand as well as its functions. Its scope is academic units, activities, processes, training specialties.

The main and determining factor for the quality of education is the creation and maintenance of motivation to achieve quality in students, teachers and management.

The Commission for the Quality of Education is a specialized collective body of the higher school in matters of the quality of education. The commission studies the foreign and national experience in the quality of training, academic, educational and professional standards, regulates the compliance between external bodies (of NEEA and other quality bodies - BDS EN ISO 9001:2000) and the criteria for quality in the Higher School, prepares and permanently updates the normative base on quality, monitors and discusses all aspects of the University's quality assurance activities; prepares analyses and proposals for decisions of the rector and the Academic Council. It also carries out internal program accreditations of the University, when this right is given to it by the Higher Education Act and by the NEEA.

The Chairman of the Commission for Quality of Education at the Academy of Economics is responsible for planning and organizing all the Commission's activities, assigning tasks within the Center for Quality of Education, allocating tasks within of the commission and the coordination of their implementation, as well as assignment of tasks to the Faculty Quality Committees and other units of the higher education institution.

He has the powers and responsibilities to ensure the processes of creation, implementation and maintenance of the system and is responsible to the Rector and the Academic Council for the effective functioning of the system, for transfer Providing information to the higher authorities and accurately assessing the requirements of the University's customers. The Chairman presents the Commission on the quality of education to the Academic Council, the Rector and the National Assessment and Accreditation Agency.

The main functions of the management bodies of the education quality system are:

- Study of foreign and national experience to ensure the quality of education.
- Preparation and training of teachers on the quality system.
- Internal program accreditations of (when this right is given to them by the national legislation and by NEAA).
- Carrying out periodic internal reviews of the specialties, regarding the quality of training.
- Organization of periodic reviews of academic disciplines.
- Organization of teacher evaluation.
- Development and permanent updating of academic standards.
- Development of procedures and tools for collecting objective quality data.
- Studying the opinion of students and users, by conducting surveys and processing the results.
- Preparation and permanent updating of the normative base on quality.
- Thematic inspections (reviews), by decision of the Academic and Faculty Councils, related to problematic units and activities.
- Organizing and conducting periodic meetings of the students with the academic management at the relevant levels to raise quality issues.
- Organizing and conducting periodic meetings with the workers.
- Entering up-to-date data and using the quality information system in accordance with the established access hierarchy in it.
- Supporting the analysis, the conclusions, the formation of management actions and the monitoring of the effect of management impacts on quality improvement.
- Periodic broadcasting and announcement of the best specialties, study courses and teachers.
- Suggestions to the academic guides to encourage teachers and students.
- Publication of examination results.

The functions of the Center for Quality of Education are:

- Organization of the work, according to the academic standards of the University and their permanent updating and maintenance.
- Organization of the work and preparation of the report for the institutional accreditation.
- Organization of internal periodic reviews of specialties.
- Development of procedures and tools for collecting objective quality data.
- Organization of thematic inspections (reviews) by decision of the Academic Council.
- Organization and holding of periodic meetings of the students with the academic management.
- Analysis of results and formation of management actions and corrections, which are proposed to the Academic Council or the rector.
- Monitoring the effect of management impacts on quality improvement.
- Entering current data and using the quality information system (after its construction)
- Ensuring the internal exchange of information and documentation on the quality of training.
- Proposals to the academic management for the promotion of teachers and students.
- Periodic announcement of the best majors and teachers at the University.
- Publication of the results of the reviews, expertise and evaluations and dissemination of good practice in the University.
- Training of the management bodies of the quality system, students and other staff from faculties and departments.

The development of educational documentation for teaching the circular economy following the framework of the integration of educational policy with the needs of

the labour market. It is the basis of the construction of the European Credit Transfer System (ECTS). Through this system for the accumulation and transfer of academic credits, mutual recognition of studies in European universities is ensured. This creates conditions for student mobility, increases the attractiveness and competitive positions of the higher education system in Europe, and globalizes the European educational space.

4.2. Flowchart of CRCLEcon teaching quality assurance

In the area of circular economy education, the quality standards follow the latest advances in technology to achieve global environmental goals with an appropriate performance evaluation model - financial analysis (Zahariev, 2022) or benefit-cost analysis (Laktionova, Dobrovolskyi, Karpova, & Zahariev, 2019).

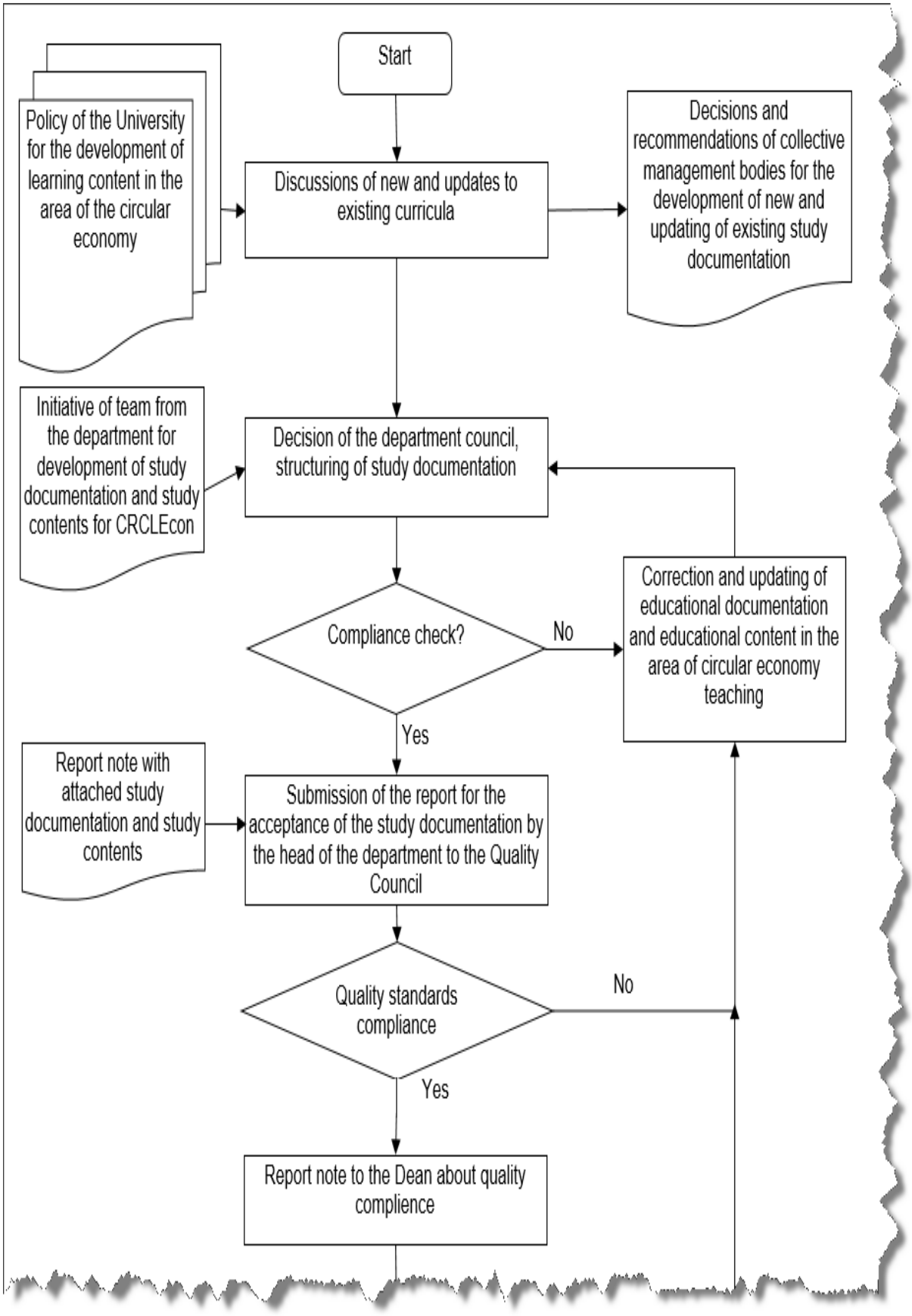
The application of quality standards in the process of development and adoption of learning documentation in the field of circular economy education follows a classic ISO procedure for agreeing and validating a decision in an academic environment. This procedure regulates and determines the activities related to the organization of the development and acceptance of the study documentation of the higher school. The procedure is applied in all units of the higher education institution in all cases related to the development and acceptance of educational documentation for the acquisition of a bachelor's or master's degree. The responsibilities related to the activities in this procedure are presented in the matrix of responsibilities and in the description of the procedure itself.

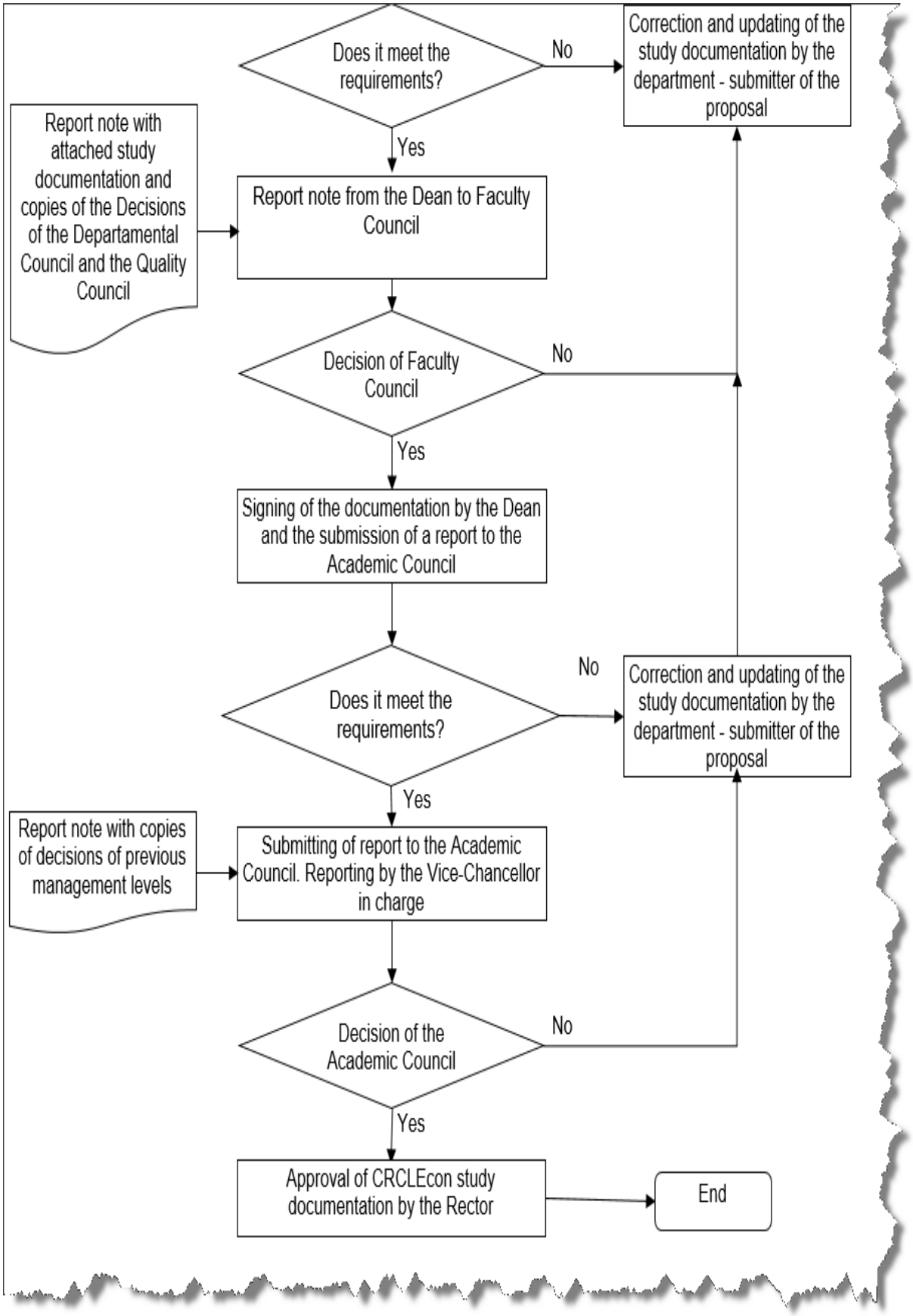
The Quality Manual is the main and most comprehensive document in the Quality Management System, through which the quality policy and objectives in the University, the organizational structure and control necessary to achieve the set objectives are announced. Through the remaining documents (procedures, work instructions and operational documents) the quality management system is detailed. The quality management procedures contain a detailed description of the processes

that are included in the Quality Management System at the University, as well as the responsibilities, competencies and organizational relationships between the structural units, in accordance with the fulfilment of the requirements. In quality management procedures reference is made to work instructions, control instructions, regulations, rules and operational documents of the System.

Activity \ Authority	Rector	Vice rector n charge	Dean	Head of Quality Council	Head of Department	Team leader	Quality administration	Academic Council	Faculty Council	Quality Council	Departmental Council	Author
Decision of the faculty council on the preparation of study documentation for training in the circular economy	**Is**	**C**		**C**		**CO**	**Is**				**D**	**У**
Report note from the Head of Department to the Quality Council	**Is**	**C**		**Is**	**D**	**CO**	**Is**			**Is**	**Is**	
Decision of the Quality Council	**Is**	**C**		**CO**	**Is**	**Is**	**Is**			**Is**		
Report note from the Quality Council to the Dean for coordination of study documentation	**Is**	**C**	**Is**	**CO**			**Is**		**Is**			
Decision of the faculty council	**Is**	**C**	**CO**	**C**	**P**	**P**	**Is**		**D**			
Report note from Dean to the Rector	**Is**	**C**	**C**	**C**		**Is**	**Is**		**CO**			
Decision of the Academic Council to accept the circular economy study documentation	**Is**	**C**	**C**	**C**		**Is**	**Is**	**D**	**CO**		**Is**	
Approval of the study documentation on circular economy by the Rector	**D**	**C**	**C**	**C**		**У**	**Is**		**CO**		**Is**	

Note: D – decides; CO - carries out; P - participated; A - agrees; Is - inform (self); C – controls.


Start
Policy of the University for the development of learning content in the area of the circular economy
Discussions of new and updates to existing curricula
Decisions and recommendations of collective management bodies for the development of new and updating of existing study documentation
Initiative of team from the department for development of study documentation and study contents for CRCLEcon
Decision of the department council, structuring of study documentation
Compliance check?
No
Correction and updating of educational documentation and educational content in the area of circular economy teaching
Yes
Report note with attached study documentation and study contents
Submission of the report for the acceptance of the study documentation by the head of the department to the Quality Council
Quality standards compliance
No
Yes
Report note to the Dean about quality complience


Does it meet the requirements?
No
Correction and updating of the study documentation by the department - submitter of the proposal
Yes
Report note with attached study documentation and copies of the Decisions of the Departamental Council and the Quality Council
Report note from the Dean to Faculty Council
Decision of Faculty Council
No
Yes
Signing of the documentation by the Dean and the submission of a report to the Academic Council
Does it meet the requirements?
No
Correction and updating of the study documentation by the department - submitter of the proposal
Yes
Report note with copies of decisions of previous management levels
Submitting of report to the Academic Council. Reporting by the Vice-Chancellor in charge
Decision of the Academic Council
No
Yes
Approval of CRCLEcon study documentation by the Rector
End

Work instructions describe individual activities, parts of processes or fulfil in detail the requirements of the quality manual and quality management procedures. Operational documents in the Quality Management System, after their completion, are used as quality records. The documents from the Quality Management System cannot contradict the state normative and administrative regulations, as well as the accepted and approved regulations of the University.

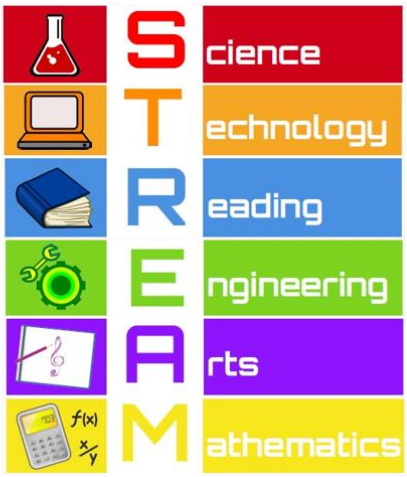
4.3. Interactivity notes on teaching CRCLEcon

At the international seminar held in Ghent in 2004 on the topic "Bologna and the challenges of E-learning and distance education", a report by a representative of the European Commission launched prospective visions for building a European virtual campus: e-Bologna. Actions in this direction were to ensure "better integration of the virtual dimension in higher education". The aim of the European Commission was defined as promoting the development of new organizational models for the provision of higher education, incl. through virtual universities and virtual mobility supported by existing European programs and cooperation schemes (Erasmus program, Bologna process, etc.). Twelve years later, the technological boom has transformed the original goals of the European Commission to introduce information and communication technologies in higher education into a stage in the global development of the educational society. Despite the specificity in each of the fields of scientific knowledge (Zahariev, Ivanova, Angelov, & Zaharieva, 2021), the last announcement of specialties for priority development in the system of higher education in Bulgaria sent the economics and management specialties traditionally sought by candidate students out of the rankings.

This raises even more strongly the issue of achieving quality in the face of resource scarcity. If we look for an answer through the prism of employers, then the expectation is for graduates-entrepreneurs who have made the transition from the conservative "I know" to the U-learning-based "I can": I can research, argue, model,

communicate, present, publish in the web environment, do business in our country and around the world. However, a key feature of the higher education system should be its accessibility, as well as its openness to reform and innovation.

That is why interactive elements in circular economy education should complement the learning content (Zahariev, Mihaylova, Monev, & Dikov, 2021). They are an innovative tool to increase its accessibility through greater visualization and focus on the most important elements of the course (Gilch & Sieweke, 2021).



In the conditions of Covid-19, academic centres for distance learning have provided an environment for conducting a learning process for all forms of learning in higher education. Full-time and part-time students embraced this environment. It has proven its effectiveness and has already imposed a new model of providing the training courses, which is very close to the concept of blended learning. Once familiar with the qualities of distance learning systems, full-time and part-time students have already imposed on rectors' management, deanship and leading specialty departments a regime of permanent access to distance learning resources, test modules and communication with teachers through video conferencing systems. Thus, the digitization and interactivity typical of distance learning became identically available to all forms of learning.

BEST: **Business, Entrepreneurship, Science and Technology**

or

BEST': **Business Excellence in Science and Technology**

Ensuring an audience standard for interactivity in the higher education system requires serious technological resources and large-scale investments in teacher training. Interactivity itself should have a connection with business and from there with the development of entrepreneurial skills in all spheres of science and technology. This can be achieved by upgrading the STEM standard to the BEST standard (Zahariev, Simeonov, & Todorova, 2023), which is a recommended trajectory for the development of universities in the orbit of the European Higher Education Area. The positive accumulations in the school sphere through STEM classrooms are a prerequisite for and with the support of business, they can find their academic equivalent. This, in turn, will not only modernize the learning spaces, but through branding and technology, investments from leading companies will provide an ecosystem for symbiosis between universities and corporations in the digital 21st century.

References for chapter two

Andrews, D. (2015). The circular economy design thinking and innovation for sustainability. *Local Economy*.

Gilch, P. M., & Sieweke, J. (2021). Recruiting digital talent: The strategic role of recruitment in organisations' digital transformation. *German Journal of*

Human Resources Management, 35(1), 53-82. doi:10.1177/2397002220952734

Iacovidou, E., Hahladakis, J. N., & Purnell, P. (2021). A systems thinking approach to understanding the challenges. *Environmental Science and Pollution Research*, 24785–24806.

Kirchherr, J. P. (2019). Towards an education for the circular economy (ECE). Five teaching principles and a case study. *Resources, concervation and recycling*.

Laktionova, O., Dobrovolskyi, O., Karpova, T. S., & Zahariev, A. (2019). Cost Efficiency of Applying Trade Finance for Agricultural Supply Chains. *Management Theory and Studies for Rural Business and Infrastructure Development, 41*(1), 62-73. doi:https://doi.org/10.15544/mts.2019.06

Makio, I., & Virta, M. (2019). *Methods for Circular Economy Teaching.* Turku University of Applied Sciences.

Marouli, C. (2016). Moving Towards a Circular Economy: Educate - Why and How? *International Conference of Solid Waste Management.* Limasol.

Minguez, R., Lizundia, E., Iturrondobeitia, M., Akizu-Gardoki, O., & Saez de Camara, E. (2021). Fostering Education for Circular Economy through Life Cycle Thinking. DOI: http://dx.doi.org/10.5772/intechopen.98606.

Ruiz-Pastor, L., Chulvi, V., Royo, M., & Sampaio, J. (2023). Bio-inspired design as a solution to generate creative and circular. Free University of Bozen-Bolzano, Faculty of Science and Technology.

Salvioni, D., & Almici, A. (2020). Transitioning towards circular economy: the impact of stakehoder engangement on sustainability culture. *Sustainability*.

Tian, D., Wang, T., Su, W., Yang, S., Zheng, Y., Zhao, M., . . . Liu, X. (2020). *IOP Conf. Ser.: Earth Environ. Sci. 585 012066.*

UNESCO. (2012). *International Standard Classification of Education.* Montrel: UNESCO Institute for Statistics.

Woetzel, J., Mishke, J., Madgavkar, A., Windhagen, E., Smit, S., Brshan, E., . . . Andersson, R. (2021). *The rise and the rise of the global balance sheet: How productively are we using our wealth?* McKinsey :& Co.

Zahariev, A. (2022). *Financial Analysis.* Svishtov: AI "Tsenov". Retrieved from https://www.researchgate.net/publication/365793801

Zahariev, A., Ivanova, P., Angelov, A., & Zaharieva, G. (2021). Evolution in the regulatory framework for distance learning in a pandemic environment-the experience of Bulgaria. *8th International Conference on Education and Education of Social Sciences, 14-15 June 2021.* doi:10.46529/socioint.202102

Zahariev, A., Mihaylova, M., Monev, V., & Dikov, V. G. (2021). Upgrading competencies of master's degree students through E-learning in business communications in a foreign language. *IJASOS- International E-journal of Advances in Social Sciences*. doi:10.18769/ijasos.972228

Zahariev, A., Simeonov, S., & Todorova, T. (2023). From STEM to BEST: two standards, one goal. *Strategies for Policy in Science and Education, 31*(4s), 89-100. doi:https://doi.org/10.53656/str2023-4s-7-fro

CHAPTER THREE. DISTINCTIONS AND PATTERNS RELATED TO TEACHING CIRCULAR ECONOMY CONCEPTS TO DISADVANTAGED OR DISCOURAGED STUDENTS

1. The circular economy as an alternative growth model for a sustainable future

In the last century, humanity has experienced an unprecedented evolution, marked by profound transformations at all levels of economic and social life. It is easy for us to notice the amazing leaps that most countries of the world have had in the economic field throughout this period, which has also led to significant increases in the standard of living of the population in these countries. Modernization and economic development are, without a doubt, a phenomenon that has positively marked the evolution of modern states, but also of each person. In specialized works of the XX and early XXI centuries this phenomenon is extensively treated, being well known by economic specialists, but also by the large mass of the population.

What has been less analyzed, however, at least in the first part of the considered range, is the subject of the costs that such development entails. Thus, in recent years, the voice of those signaling that the beneficial evolution of the world economic system has entailed important costs in terms of environmental protection and management of material resources (especially primary ones) has been increasingly heard. It is now widely accepted that economic development from 1900 to the present has been achieved at very high environmental costs, the long-term effect of which is still difficult to estimate.

That is why, in these first two decades of the XXI century, the concept of economic development has been increasingly replaced by that of sustainable economic development. Economic specialists agreed that economic growth can only

be considered as fully beneficial for society when it is associated with compliance with strict rules regarding environmental protection and ensuring real sustainability of life on this planet in the long and very long term.

In this context, at global level, the first real steps have been defined and are being taken to introduce a new model of economic development, namely that of the circular economy. Its role has been increasingly important in recent years and is expected to increase significantly in the near future, people being increasingly aware that the resources available to this planet are limited and it is imperative to protect and use them rationally, so that our descendants have the opportunity to enjoy an environment conducive to human development.

The main objective of the circular economy is to genuinely and effectively protect the environment and use resources sustainably, all of which can be achieved by extending the life cycle of products. Practically, the circular economy is a new production and consumption model, which comes to replace the current linear model of "procurement – production – disposal" type and which is based on the idea of recycling existing products for a longer time horizon.

In order to better understand why the future undoubtedly belongs to the circular economy, it is necessary to mention what are the main elements that differentiate it from the classical linear economic model. It is easy to see that the linear economic model, specific to the eighteenth and twentieth centuries, was noted by a very high economic growth rate, but with enormous long-term costs. This type of economy is based on an intensive and, one might even say, uncontrolled use of material resources, mainly primary ones, and an almost total absence of awareness of the effects that human activities have on the natural environment. In other words, for almost three centuries, mankind has not given due importance to the way natural resources are used in the long term and to the amount of waste produced by individual or industrial activities and how they are managed, so as to minimize the impact on the natural environment. The effects of such an economic model have not

been expected, so we are talking more and more often about a potential depletion of some categories of raw materials in a much too short forecasted period of time, but also about a perhaps irreparable damage to the environment, which is manifested by increasingly visible climate changes or the decrease in the population's comfort index as a result of intensive pollution.

Faced with an unattractive perspective, humanity has been forced since the end of the last century to identify and implement new models of economic development, models that must take into account, first of all, the long-term effects on the environment.

In practice, the circular economy involves a series of specific elements that ensure a significant decrease in environmental effects, but also a profitability of long-term economic activities. We are talking here, first of all, about a much better management of raw materials as a result of the reuse and recycling of materials and products already existing in the economic circuit. By increasing the life cycle of products, unnecessary exploitation of primary resources is reduced, which will also allow future generations to enjoy their existence.

Secondly, the circular economy requires rigorous management of the residual outputs of human activities. The introduction of such a system of sustainable economic development ensures a minimization of waste quantities. A product that has reached the end of its life cycle can be reused, at least partially, by reintroducing into the production circuit a large part of the materials that were used in its manufacture. In addition to the obvious positive effect that such a policy has on the environment, we must note that it also leads to an increase in the added value of each product and, implicitly, to a profitability of economic activities in the long term.

The circular economy is a system where materials stop turning into waste (or at least the amount of waste is much lower) and nature has a real chance to regenerate. In this type of economy, products and materials are kept in circulation for much longer through specific mechanisms and processes such as maintenance,

reuse, refurbishment, remanufacturing, recycling or composting (Ellen MacArthur Foundation, Circular economy introduction, 2017). All this will have a major positive impact on the economic and, above all, on the natural environment.

Figure 3.1. Circular economy processes

(Kumar-Sharma & Madsen, 2021)

If we are to briefly present the principles underlying the circular economy, they could be formulated synthetically as follows (Ellen MacArthur Foundation, Circular economy introduction, 2017) (Government of Romania, 2022).

- Phasing out non-recoverable waste and reducing pollution.
- Keeping products and materials at the highest value of use for as long as possible.
- Regeneration of natural systems (biodiversity and ecosystem).

The three principles mentioned above are extremely important for creating a modern economic framework, adapted to the requirements of the contemporary

world. Moreover, the three principles seen in a systemic vision can be considered as the premise for a better future for all humanity, based on them there is a real possibility to find a common denominator between carrying out economic activities based on profitability principles and actively protecting the environment, as a component of sustainability and sustainability of all human activities.

The same institution (Ellen MacArthur Foundation) proposed the most complex diagram showing the cycle specific to the circular economy, this being known in the literature as the "Butterfly Diagram". According to this diagram, there are two main product-specific cycles, namely the technical cycle and the biological cycle:

- in the case of the first cycle (technical cycle) products are returned to the economy through reuse, repair or recycling;
- In the case of the biological cycle, nutrients from waste products are returned to nature to ensure its regeneration.

Over time, many international or regional bodies have tried to define an appropriate conceptual framework, meant to ensure a good knowledge of the mechanisms specific to the circular economy.

The United Nations Environment Organization (UN Environment) is one of the international institutions that constantly strives to promote circular economy mechanisms. In doing so, a series of measures to ensure the success of the new economic model, known as the '9 Re's, were identified (United Nations Environment Organization, 2023) (Potting, Hekkert, Worrell, & Hanemaaijer, 2017). These measures can be grouped, depending on the actors involved in their implementation, as follows:

First. Measures that can be implemented at user level (user to user)

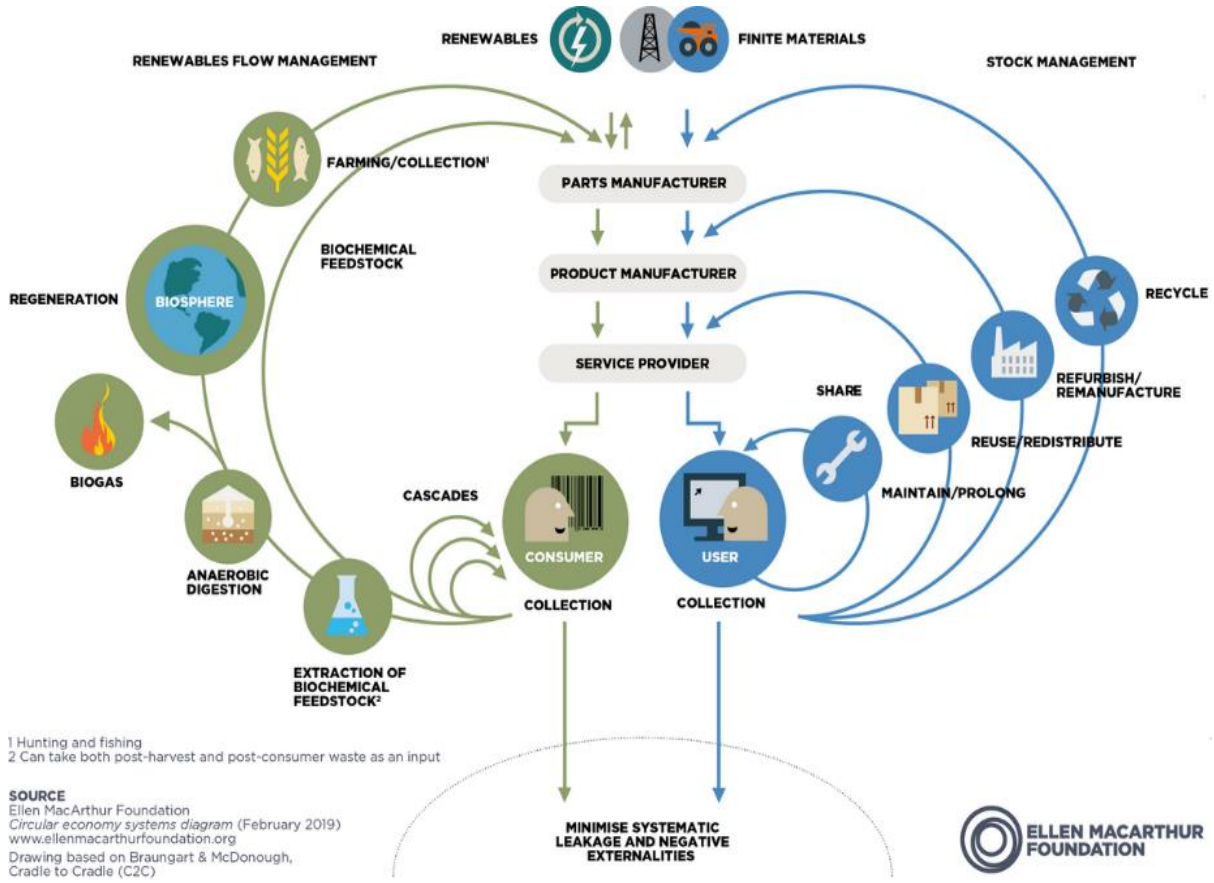


Figure 3.2. Circular economy diagram – Ellen MacArthur Foundation

(Ellen MacArthur Foundation, The butterfly diagram: visualising the circular economy, 2017)

- *Refusal of consumption*

  This measure concerns each of us individually, consumers being the main actors in implementing the new economic model. Thus, it is necessary for us, as buyers of goods and services, to change our consumption habits, in the sense that we give up purchasing those products or services that are not necessarily necessary or that do not contribute significantly to improving the standard of living or to use economically this category of goods and services (example: limiting the use of cars in situations where distance or other objective criteria do not require us to use this means of transport).

- *Reducing*

For those categories of products or services that cannot be totally excluded from our shopping cart, circular economy mechanisms recommend a limitation of this consumption. Thus, in a first stage, it is desirable for people to make efforts to decrease the consumption of energy and drinking water, finite natural resources that should be used as rigorously as possible or to use as little as possible those categories of products with negative impact on the environment (example: plastic products).

- *Reuse*

  One of the problems specific to the linear economic system is that it promotes the marketing of single-use products. Through the transition to the circular economy, buyers will be required to make extensive use of products that can be used repeatedly. For example, to support sustainable economic development, shoppers will have to phase out disposable bags in favor of cloth shopping bags.

Second. Measures that can be implemented in the relationship between the user and economic entities (user to business)

- *Repair*

  Circular economy products have a substantially longer life cycle than products used in the linear economy. In this respect, in order to extend the life of the product, it is necessary to ensure adequate maintenance and, where necessary, repair mechanisms. This measure limits the unnecessary use of material and energy resources, which contributes to protecting the environment. From an economic point of view, such a measure comes to increase the efficiency of the investment made by the buyer by using that product for a longer period, but also offers new perspectives to economic agents that have the possibility to make repair shops new profit centers.

- *Refurbishment*

  If products can no longer be repaired, within the framework of the circular

economy, buyers have the possibility to have them refurbished by the manufacturer or specialised companies. Similarly, to repairs, product reconditioning is a means of increasing efficiency both for the buyer (he has the possibility to have a perfectly functional product with a significantly lower cost than when purchasing a new one) and for the business environment (manufacturers or specialized companies can collect not insignificant amounts for product reconditioning services), contributing at the same time to reducing the costs related to recycling or landfilling/disposal of waste.

- *Restoration or remanufacturing*

  This measure is one that can be applied to those products that can neither be repaired nor reconditioned. Under these circumstances, in order to avoid costs related to the purchase of a new product, the consumer has the possibility to call on the services of the manufacturer, who will rebuild the product by using its component parts that are still functional and can be reused, and the unusable ones will be recycled. In this way, it will be possible to obtain a perfectly functional product with a lower cost as a result of reusing certain materials. Such an approach is also favorable to economic operators, who have the possibility to supply a product at a lower cost due to the reuse of certain components, thus eliminating the problem of managing large quantities of waste.

Third. Measures that can be implemented in the relationship between economic entities (business to business)

- *Reuse (finding a new purpose)*

  If a product can no longer be used or cannot be subject to repairs, reconditioning or restorations, in order to reduce the negative effects, economic agents have the possibility to use it as raw material to make a completely new product, with completely different functionality and utility.

- *Recycling*

This is, in fact, the final version that we can use to maintain the materials in a product in the economic circuit. Recycling involves a number of specific costs such as collection, sorting, processing and redistribution. However, its use is less expensive compared to waste management, through landfilling or incineration.

- *Reduction by design*

  Reducing the consumption of raw materials and materials can also be achieved by fundamentally rethinking the design of products, so as to encourage their longevity and maintain them in use for as long as possible.

Starting from the analysis of the advantages and disadvantages implied by the linear and circular economic system, international bodies have made major efforts in recent years to implement the new economic model, based on recycling and protection of the natural environment, which is seen as the best option for the future.

In this regard, it is worth noting that already in 2015, the European Commission adopted the first European Union Action Plan for the Circular Economy (Commission, European, 2015). This document defined the priorities of the European Union in terms of sustainable economic development, identifying employment and employment development as main directions of action, developing and implementing a coherent common agenda in the field of investment, combating climate change, transforming the energy field in order to protect the environment, promoting innovation in the industrial field and, last but not least, setting common goals in the social field.

Building on the provisions of the aforementioned document and the experiences gained in the first five years of implementation, the European Commission adopted in March 2020 an Action Plan for the Circular Economy (European Commission , 2020), as part of the European Green Deal (European Commission , 2019), an instrument aimed at ensuring sustainable economic development of all Member States by identifying the main climate and

environmental issues and turning them into development opportunities for EU countries. In February 2021, the European Parliament adopted a new resolution on this action plan, which expressly states that the European Union's economy must become fully circular by 2050 (Parliament, 2021).

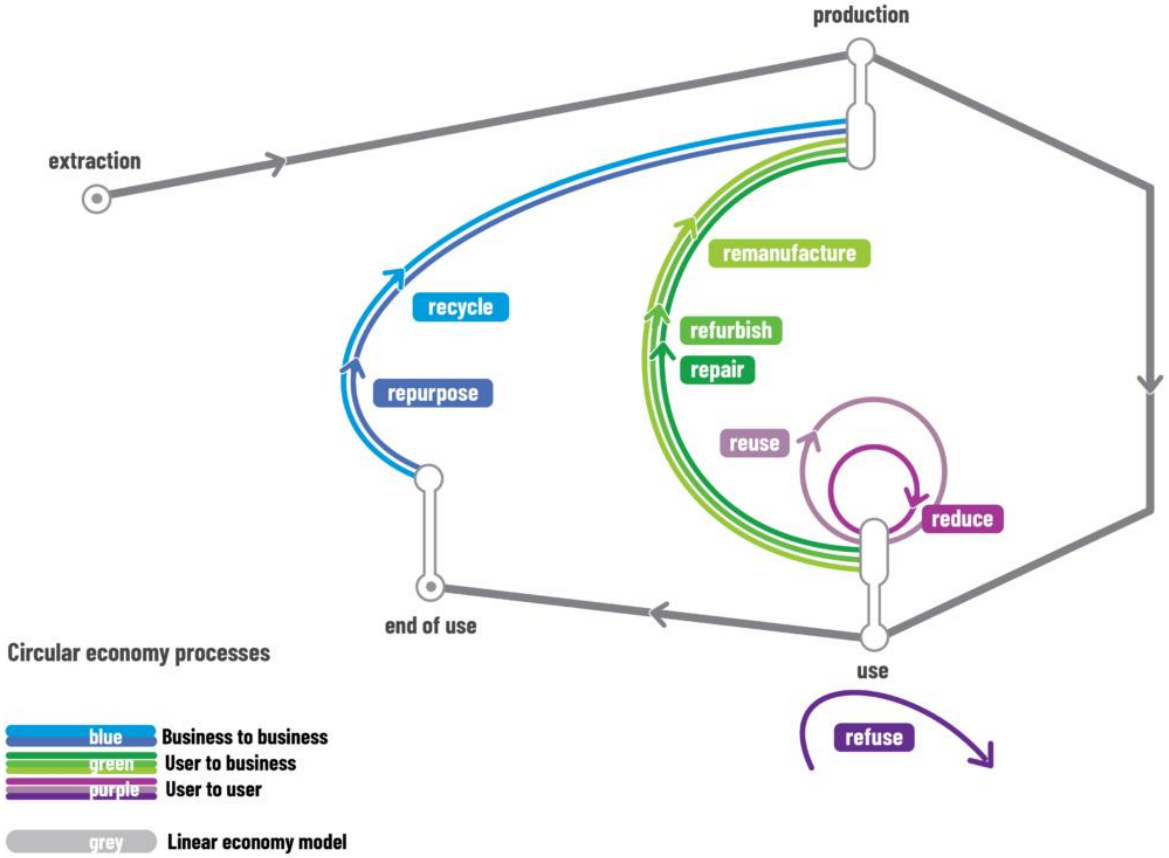


Figure 3.3. Circular economy diagram – United Nations Environment Organization

(United Nations Environment Organization, 2023)

Based on the above-mentioned strategic documents, the European Commission presented in March 2022 the first package of proposals on the implementation of the circular economy in the European Union states (European Commission, 2022). This document establishes specific actions aimed at providing the framework for large-scale implementation of the circular economy model and stimulating all businesses promoting this type of economy. The European Commission's measures provide the framework for the vast majority of products

made in European Union countries to be more environmentally friendly, circular and energy efficient throughout their entire life cycle. Final consumers are also encouraged to join the circular economy mechanism by purchasing "green" products. Last but not least, this document calls for the implementation of much stricter rules on recycling of all product categories and the establishment of clear and binding targets regarding the consumption of raw materials in the 2030-time horizon.

Based on the above-mentioned documents and the realities specific to the national economic system, a large part of the Member States of the European Union adopted, between 2020 and 2022, national strategies for implementing the circular economy. If we analyze the case of Romania, we can see that the National Strategy on Circular Economy was approved in the second half of last year (Government of Romania, 2022).

The European Parliament has produced an eloquent summary of the main beneficial effects that the circular economy has for contemporary society (European Parliament , 2023). In this sense, we can mention the following direct benefits of the circular economy:

First. Environmental effects

- The reuse and recycling of products is the most effective way of slowing down the rate of depletion of natural resources. From this point of view, humanity is at a turning point. On the one hand, there is a significant increase in the world's population and, implicitly, an increase in the demand for raw materials. On the other hand, we all know the finite nature of the material resources available on Earth and the endless discussions about their depletion. Given the situation, it was necessary to identify ways to streamline the use of material resources, and the circular economy came up with a solution that is unanimously accepted as sustainable in the long run. The reuse and recycling

of products will lead to a better use of primary material resources and an increase in their availability.

- The implementation of the circular economy model will also ensure the reduction of the impact on landscapes and natural habitats, implicitly to a limitation of partial or definitive loss of plant or animal species. Sustainable management of material resources ensures the reduction of the number of active exploitations, which has an extremely beneficial effect on the conservation of the natural potential of our planet.
- Reducing greenhouse gas emissions is another advantage specific to the circular economy. Thus, by creating more efficient and sustainable products with a significantly extended life cycle, we will achieve a decrease in the amount of raw materials and energy used both in the production phase itself and in the product design and testing stage.
- Reuse and recycling also ensure a significant reduction in the amount of waste resulting from human activities. Managing enormous quantities of waste products is a significant challenge for today's human society. Large amounts of waste, represented by products that have completed their life cycle, but also packaging and other accessories, tend to "suffocate" human communities and, especially, those in urban areas. By introducing the circular economy, waste will be significantly reduced by using extended life cycles and avoiding excessive packaging.

Second. Effects on the world economy

- The implementation of mechanisms specific to the circular economy will lead to the creation of a long-term sustainable system, which will provide a favorable framework for the development of all economic activities, with radically diminished negative effects.
- The reuse and recycling of products and materials will lead to an improvement in the trade balance of a large part of the world's countries, which are no longer

dependent on the import of significant quantities of raw materials. Thus, we can mention that, if at this moment the trade balance of the European Union is a negative result (EU states import more than export), by implementing the mechanisms specific to the commercial economy, a decrease in the trade deficit in the short term and even obtaining a surplus in the medium and long term is forecast.

- The recycling of raw materials will lead to a reduction in the risks of interruptions in the supply activity of economic agents, who will be much less affected by the volatility of raw material prices and their lack of availability at any time.
- Although many have been quick to say that the circular economy will lead to an increase in unemployment as a result of the closure of exploitation of primary material resources, in reality this new economic system is one that creates jobs. Thus, only at the level of European Union states it is expected that, by applying mechanisms specific to the circular economy, no less than 700,000 jobs will be created in the next seven years.
- Another major advantage of implementing this new economic system is the encouragement of research and innovation activities in all economic sectors. By introducing the circular economy, all economic agents are stimulated to identify and implement new products with a longer lifetime, to determine new ways of using and, above all, reusing raw materials and so on. All this will lead to an increase in the importance given to innovation and, implicitly, to ensuring sustainable economic development.
- From the point of view of the final consumer, the main advantage of the circular economy is that he will have the opportunity to enjoy better quality products, with a high degree of innovation implemented and extended service life. All this will increase the quality of life of each person and create the

framework for a better management of the financial resources available to each household.

If this theoretical presentation is not enough, the European Parliament has also produced a series of sectoral practical analyses aimed at ensuring a better understanding of the concept of circular economy. Thus, in order to show how important it is to implement as soon as possible the mechanisms specific to the circular economy, it is enough to analyze the waste management situation in the European Union. Thus, from the available statistical data, we can see that each year around 2.2 billion tonnes of waste are generated in Member States, of which more than a quarter is municipal waste, generated mainly by individual households. Of this amount, more than half goes to landfill, which generates serious logistical problems (in many regions, the availability of waste storage spaces is very low), but also environmental problems.

In these circumstances, it is easy to understand why the European Commission considers the issue of waste management and especially municipal waste management to be a priority and has imposed that by 2030 all Member States ensure a degree of reuse of waste of over 60% and a reduction of the landfill filling rate of less than 10% by the end of 2035 (European Parliament, 2023).

From this perspective, if we analyze the specific situation in Romania and Bulgaria, we can see that the second country is among the EU leaders in terms of recycling and compaction, with a rate of over 65.5% at the end of 2021, while in Romania the value of this indicator is the lowest in the entire European Union (11.3%). However, both countries have serious problems with the filling rate of landfills, in Romania it exceeds the threshold of 51%, while in Bulgaria it reaches an even higher value of 73%. Starting from this simple comparative analysis, it is easy to see how important it is to implement correctly and as quickly as possible the mechanisms specific to the circular economy, so as to ensure an optimization of waste recycling activity. This action will have an immediate positive impact on the

environment and on the economic profitability associated with the marketing of each product.

Taking into account the above-mentioned elements, we can conclude that, at this moment in the evolution of contemporary society, the implementation of mechanisms specific to the circular economy is no longer just an option, but an obligation for all states of the world, this being the premise for a sustainable and sustainable development, allowing us to enjoy a less polluted world in the future. It is obvious that the transition from one economic system to another will not be easy, but it is the best option for the long-term evolution of the economy and society.

2. Transition to the circular economy – roles and impact

The implementation of circular economy mechanisms is undoubtedly a complex and far-reaching activity for all actors involved in this process. The transition from the current linear economic system to the circular economy challenges national authorities, economic operators and final consumers alike. They are forced to fundamentally rethink production and consumption models, but also to reinterpret the term "economic growth" in the sense of introducing social and environmental benefits within it, beyond the classical indicators on profitability and profitability of economic activities. Unequivocally, the circular economy aims to decouple economic activities from the use of natural resources by recirculating materials using the Technosphere (that part of the environment that is created or modified by humans) and the biosphere, while eliminating negative externalities (waste and pollution) within the new economic system.

The transition to the new economic system based on circularity has profound political and economic implications worldwide. In order to understand the extent of this process, it is enough to recall that, to date, more than 500 policies and regulations on the circular economy have been adopted at national, regional or international level, of which more than half concern waste product management and recycling

activities. More and more countries are adopting specific regulations aimed at ensuring the fastest and most efficient implementation of the new economic system (World Trade Organization, 2023).

The main barriers faced by the circular economy in these early stages of its implementation can be summarized as follows: (European Commission, 2014):

- Today's systems, infrastructure, business models and technology limit or make it difficult to identify and deploy circular economy solutions on a large scale;
- companies do not know or are not really able to choose the mechanisms specific to this new economic model;
- Even if there is a positive evolution in many countries or regions of the world, investments in measures and programmes aimed at implementing the circular economy or developing circular business models are still insufficient due to their complexity and the higher degree of risk they currently have;
- consumers are not yet willing to change their consumer behavior on a large scale towards purchasing predominantly products and services marketed by economic entities that have already adopted the new business model;
- prices do not always reflect the actual costs that society incurs in consuming primary material resources and energy or other environmental costs associated with the production process;
- The political signals aimed at implementing the circular economy are still insufficiently strong and consistent, and there are still decision-makers "scared" by the effects of implementing a new economic system.

Although, by its magnitude, it is an unprecedented challenge, the transition to the circular economy benefits from the support of the vast majority of the world's states, as well as from the direct involvement of international bodies (especially those dealing with environmental protection), being seen as the only real possibility for managing climate change and keeping it within acceptable limits for sustaining

life on Earth.

As I said above, the transition from linear to circular economic system is not easy at all. In order to preserve all the positive elements of the current system, coupled with the benefits of the circular economy, it is necessary to use very well-defined strategies specific to each stage of the value chain. They can be systematized as follows: (Government of Romania, 2022):

- Closing material loops involves substituting raw materials and new products with secondary materials and repaired or reconditioned products;
- Closing material flows involves extending the life cycle of products through proper design, better maintenance and better repair. Also, even after the end of the life cycle, products become the source of secondary materials for new products, reducing the cost of raw materials and materials used.
- The reduction of material flows is based on using fewer resources to make a product or using fewer products to provide a particular type of service.

If we approach the issue of actors involved in implementing the circular economy system from top to bottom, we will be able to notice that international bodies with relevant activity in the field are those who initiated and effectively support this transition. Thus, it is worth mentioning the efforts made mainly by the European Commission, but also those of other representative bodies at global level, such as the World Trade Organization to establish the necessary framework for carrying out at a sustained pace the transition to the new socio-economic system. Moreover, it is noted that the European Union actively stimulates organizations adopting the circular economic model by granting special funds that will help these organizations meet the challenges that arise in this process of radical change of economic activities.

Although it is extremely important, the role of international bodies is relatively limited, and these efforts need to be implemented effectively and effectively in the legislation and economic practice of each state. In this respect, a

fundamental role in the implementation of circular economy mechanisms belongs to the political factors at the level of each country. They must provide the framework for changing the economic system by:

- approving an appropriate legislative package allowing the implementation of mechanisms specific to the circular economic system and encouraging economic operators and final consumers to use them on a large scale;
- creating a predictable and confidence-inspiring macroeconomic environment;
- redefining the role of consumers, becoming an active part of the new socio-economic system;
- raising awareness of the benefits of the circular economy, so that citizens are prepared to truly accept the changes that will occur.

As it is easy to understand, the most important role in implementing the circular economy belongs to companies, which will be the ones that will directly face the fundamental change in the way of carrying out productive and marketing activities.

As a first challenge faced by economic agents is that of redefining supply chains, so that they meet the requirements related to the more efficient use of resources and, especially, to the recycling and reintroduction into the production circuit of certain categories of resources. Such a complex transition could not have been possible just a few decades ago; Currently, the evolution of information and communication technology, but also social changes have created a favorable framework for adapting economic and non-economic entities to the requirements of the circular economy. With this in mind, it is clear that the circular economy has the capacity to create new markets and contribute to the emergence of new and often better jobs than currently exist.

An extremely important element of the transition that must take place at the level of companies is the one that refers to the type of products they will sell. Currently, the vast majority of economic agents promote the marketing of products

with a very short lifetime, frequently using technological developments as an excuse for such a process (the most eloquent example is that of smartphone companies that annually launch new models of devices, transforming this type of product, which in theory has a long lifespan, in one that is changed with a very high frequency and, most of the time, without a real justification related to its functionality). In the circular economy, short-lived products will no longer exist, they will be replaced by products that have a long-life cycle, products that withstand over time both physical and moral wear. The development of circularity products will lead to the development of new supply chains, the implementation of new production models and technologies and, last but not least, a significant decrease in waste quantities, which will have a significant beneficial impact on the environment.

In the newly created economic environment, companies will have the opportunity to move to new markets, to complete their offer with new products or services that can be marketed, to develop innovative business models based on leasing, sharing, repair, modernization or recycling. These opportunities are all the more important as they will also be able to be successfully enjoyed by small and medium-sized enterprises or those located in economically disadvantaged areas, representing a real possibility of improving the quality of life in these regions.

All these changes that will affect the activity of companies will also require the rethinking of the financial and accounting system of companies, being necessary for it to align with the general desideratum regarding the efficient use of all resources and ensuring circularity at all levels of the economic circuit.

Final consumers are also important actors in the mechanism for implementing the new economic system based on circularity. Thus, they must become aware that, in order to benefit from a natural environment as little polluted as possible, they must always choose products or services specific to organizations that have adopted the circular economy. By encouraging the activity of these economic entities, final consumers have the opportunity to enjoy products with a high level of innovation,

with a longer lifespan and lower costs for long-term use, while contributing to reducing the waste of raw materials, materials or energy and, implicitly, to minimizing the impact on the natural environment.

Currently, 60% of Europeans say they have information about the mechanisms of the circular economy, but only 25% of them really understand what it means and how it works (L'Observatoire Cetelem, 2023). In this context, it becomes obvious that for a well-functioning circular economy it is absolutely necessary for all final consumers to be as well informed as possible on this topic of real interest.

Another particularly important role in the transition to the circular economy is played by non-governmental organizations, associations, trade unions or other such entities without economic activity. They have a particularly important role to facilitate the implementation of mechanisms specific to the new economic system and to promote the benefits that this organizational model brings.

Even if they remained at the end of this section, it is not at all negligible the role that education and research institutions have in implementing the circular economy, as a real long-term sustainable development solution. Through these institutions it is possible to disseminate relevant information to a significant number of people, especially young people, who can get in touch with the notions specific to the circular economy and have the chance to learn the mechanisms of this system that will ensure a better future for everyone, in a cleaner world. The importance that education and innovation have to provide the necessary framework for the proper functioning of the mechanisms specific to the social economy is one that cannot be denied or diminished and which has determined us to pay special attention to it in continuing this work.

3. Bottom-up change through education

As can be seen from the previous subchapter, the transition to the circular

economy is a complex and difficult process, involving the synergistic action of a very large number of factors. Thus, in order to truly implement the new economic mechanism, we need business innovation, changing consumer behavior, creating an appropriate legislative framework or actively involving local communities. These are all possible goals, but not at all easy to achieve if we do not first adapt the base of this pyramid. People need to learn what the circular economy is, how it works and what they need to do to implement such a system (Circular Berlin, 2023). And, above all, they must be helped to change their ideas and mentality regarding sustainable economic development and environmental protection, in the sense that this should be perceived as a real investment for the benefit of future generations. People are the basis for any change, and the circular economy cannot make a discordant note from this principle.

As said earlier, education is one of the pillars on which the new circular economic system is based. If we are to ask ourselves what is the role of the education system in the development of the circular economy, it certainly refers to the transmission of information on recycling, reduction or reuse, as vectors for sustainable economic development. For this, educational institutions must act to develop specific skills among young people (and not only), being necessary for them to develop a systemic thinking, initiate circular ideas and collaborate for their practical implementation (Circular Berlin, 2023).

Given that we are facing an unprecedented challenge, with a fundamental rethinking of the global economic system, it is obvious that each of us must find the time and resources to cope with the transition from linear to circular economy. And such a shift can only truly happen when people truly learn what the circular economy is, how it works and, above all, what its long-term benefits are. That is why specialists in the field have unanimously accepted the idea that school, with all its forms and levels, is at the heart of the process of transformation of the world economic system.

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We have indicated in the first part of this chapter which are the factors involved, at national or international level, in the transition process from linear to circular economy. We could see that, for such a complex and difficult process, the joint intervention of international organizations with relevant activity in the field, national political factors, the business environment, non-governmental organizations and, last but not least, of each of us, as final consumers, is necessary. However, all this cannot exist without specialized education in the field. It makes absolutely no sense to expect the circular economy to be imposed by international institutions or national policymakers. For the new socio-economic system to truly exist, it is necessary for each of us to take important steps to implement this system. And the first steps that should be taken are to learn what such a system is and how it works.

All the more, it should be mentioned that the transition process to a green economy is one with profound implications in the lives of young people, the main beneficiaries of the education process. The circular economy has at the heart of all its activities the protection of the natural environment, and young people are the ones who will really enjoy the beneficial effects of this approach. Through your complexity, the transition to the circular economy is a process that will bring a change for the better for the living standards of future generations. This new economic model was not designed to reach its beneficial potential in the short term, it is one that will ensure a better future, a sustainable long-term economic development, being rather intended for future generations. But for these changes to be profound and lasting, it is necessary that, today, each of us prepare both theoretically and practically to face the challenges of the new economic system.

Given the above-mentioned elements, it is necessary to establish which methods and models of good practice can be successfully used in order to succeed in transmitting information on the circular economic model to as many people as possible and, in particular, to you. However, this teaching approach must be

adequate to the students' requirements and their real learning possibilities. In this sense, it is necessary to always bear in mind that "many students learn best when they do things actively and not just study ideas in the abstract: when their curiosity is aroused, when they ask questions, discover new ideas and feel for themselves the enthusiasm of these disciplines" (Robinson & Aronica, 2015).

In order to establish what are the steps to be followed in educating the young generation in the spirit of circular economy, it is necessary to analyze, in a first stage, what is the current perception of this category of people on the transition to this new economic model (Kranic, Kovacevic, Zunec, Brglez, & Lukman, 2022). Through this study we have the opportunity to discover how young people view environmental protection issues and mechanisms specific to the circular economy.

Thus, it can be noted that most young Europeans have a high degree of understanding of issues related to the protection of the natural environment and the negative impact that the linear economic model has on it. Starting from this premise, young people understand the need for sustainable economic development, having a positive perception both on it and in terms of mechanisms specific to the circular economy.

However, there is a perception problem regarding the adoption of sustainable consumption behavior, young people being rather reluctant to radically change the way they act as consumers (for example, a large proportion of young people are still dependent on behavior towards unsustainable consumption with regard to those product categories that are considered to give them a better image among themselves. Community. Thus, many young people are still tempted to change a smartphone just because it is no longer fashionable, even if from a functional point of view the terminal does not present serious problems of physical or moral wear).

A real problem faced by young people in relation to schools is that of the lack of subjects related to environmental protection in the curricula. The implementation of this type of educational programs is difficult, most schools and higher education

institutions still having real problems in developing an education system that is centered on the idea of sustainable development and environmental protection.

It is also noted that there are currently very few study programmes to acquire knowledge about the circular economy and develop the entrepreneurial spirit of the younger generation based on the principles of this new economic system, in line with the provisions of the European Green Plan.

Given the rapid pace at which the implementation of the circular economy is desired worldwide, it is obvious the importance of good training of young people in this field. Thus, it is absolutely necessary for them to benefit from a proper framework for acquiring all theoretical and practical knowledge on this subject of real interest to the young generation.

To summarize all the aforementioned elements, it is necessary to say that education for a circular economy:

- It allows the beneficiaries of the educational process to acquire the basic notions regarding this economic-social system, to gather knowledge, skills and competences, attitudes and values specific to this economic system, so that they are able to adopt measures to reduce waste and negative impact on the environment.
- It focuses on not accepting a situation with a negative impact on sustainable development and militates for increasing the circularity of products and services, as factors for sustainable and environmentally friendly economic development.
- It is accessible at all levels of young people's development, involving actions carried out at family, school, workplace or community level.
- develops the concept of active citizenship, militating for the affirmation of the rights and responsibilities of each individual in their approach to identifying options for sustainable economic development.

- It is based on the principle of lifelong learning, the beneficiaries of the educational process understanding better and better the problems specific to the circular economy over time, with the accumulation of relevant experiences in the field.
- uses varied and creative educational methods.
- promotes grassroots action on global issues.

By attending circular economy courses, young people can acquire a range of specific knowledge and skills such as:

- multidisciplinary knowledge.
- the ability to analyze, understand and optimize the lifecycle of products and services.
- eco-design thinking.
- notions of business ethics.
- information on the principles of social entrepreneurship.
- negotiation skills.
- systems thinking.

As we all know, the ultimate goal of education is to help young people acquire the knowledge, skills and motivation necessary for them to become active citizens at regional or global level, involved in developing a sustainable and equitable development of their communities. Such education, oriented towards sustainable development and sustainability, will provide young people with the necessary skills to find the balance between social and economic well-being and real needs to protect the environment, while instilling in them values such as solidarity, equality, mutual respect and concern for social harmony (Kumar-Sharma & Madsen, 2021).

Even though the European Green Deal obliges the European Commission and Member State governments to develop a common competence framework for the entire education system (schools, training and higher education institutions) through which real skills, skills and knowledge on climate change, sustainable economic

development and, above all, how to implement the new model of economic evolution can be developed, It is hard to believe that a systemic approach will be achieved in a very short time. That is why it is very important to stop waiting for this framework to be standardized at international level and to try to transfer responsibility for transmitting information on the circular economy directly to schools or even to each class or teacher. Such a bottom-up approach will allow better dissemination of information on the benefits of implementing this new economic system, radically shortening the time required to implement its specific mechanisms. Young people are eager to get involved in such a radical change, but it is our duty as teachers to guide their steps on this path.

The Ellen MacArthur Foundation conducted in 2018 a practical study on the implementation of circular economy courses in the educational offer of existing higher education institutions worldwide, identifying a number of 138 universities that offer such opportunities for the development of the young generation. Since now, the number of institutions that have included the issue of the new economic system in the curricula for students is increasing, but it is worth noting that this evolution is insufficient if we refer to the total number of young people who should acquire knowledge and skills in this field of activity (Ellen MacArthur Foundation, The circular economy in higher education, 2023).

The role of these educational institutions can be classified into five analytical categories, as follows:

- effective teaching of circular economy concepts.
- leading innovation by students.
- stimulating research into the circular economy.
- influencing changes at local level, both conceptually and in terms of the actual implementation of circular businesses.
- campus management.

The main approach that educational institutions have in terms of training

students in the field of circular economy is to increase the level of awareness and understanding of technological challenges in a world with exhaustible resources (Angelov, 2023).

Three different types of skills are identified in the literature that require development in order to prepare the beneficiaries of the educational process in order to implement the circular economy (Weenk, 2021):

- technical skills: knowledge and understanding of basic fundamental concepts and frameworks relevant to the Circular Economy;
- valorization skills: being able to apply these fundamental concepts and make judgments about potential courses of action;
- Transversal skills: Sometimes also referred to as 21st century skills, covering "gentler" aspects such as complex problem solving, critical thinking, creativity, people management, coordination with others, and so on.

This report also identified a number of concrete measures aimed at ensuring a better transmission of information on the specifics of the new economic system among young people:

- Widely teach circular economy so that all students, regardless of the university center where they study, have access to information about this new economic system.
- Promoting applied research in the field of circular economy as a supporting factor for sustainable businesses in the respective regions.
- Stimulating innovative teaching-learning methods, based on practical elements, is an opportunity to be exploited in the educational process aimed at circular economy. Thus, given that we are talking about elements related to the environment and its protection, it is desirable that the learning of circular economy elements be done less in the rigid framework of university halls and more in places where this economic model is implemented, on campus or off campus.

- Development of circular campuses and their proper management, so that students are effectively part of a circular economy environment from university benches. In fact, it is easy to understand that universities must be a component part of practical efforts to implement sustainable development, as they can become an example of good practices in the field of circular economy and environmental protection.
- Stimulating student initiatives to promote circular economy activities both on and off campus. Certainly, the change towards a circular economy can have at its core students, who thus have the opportunity to learn responsibly what entrepreneurship entails in the field of circular economy.
- Influencing governmental or regional strategies based on practical experiences gained in the field of circular economy by higher education institutions implementing this new economic model, university campuses being an excellent testing ground for its functioning mechanisms.

Starting from the above-mentioned elements, a series of recommendations can be synthesized that can be used to better educate the young generation in the spirit of circular economy, as follows:

- Raising young people's awareness of the importance of sustainable development and environmental protection and, especially, of the fact that their individual or collective actions can be a vector for the growth of a new economic model, with an obvious positive impact on their future quality of life;
- Motivating and stimulating young people to acquire theoretical knowledge and practical skills related to the implementation of the circular economic model and sustainable business. In this respect, it is desirable that the activity of institutions providing training for young people, from kindergartens to higher education institutions, should not be limited to transmitting dry information about the new economic system, but actively participate in the

practical implementation of its mechanisms, so that the beneficiaries of the educational process acquire, from this stage of training, practical skills specific to the new economy.

- Transforming the consumption behavior of the younger generation by educating them about the benefits that sustainable products with a much longer life cycle and reduced impact on the environment have.
- Preparing young people as future actors on the labor market so that they have the opportunity to integrate effectively and effectively into companies that have adhered to the circular economic model, thus shortening their adaptation periods to the specific realities of this system.
- Development of interdisciplinary environmental education and sustainable development programs, adapted to developments in the world economic system.
- Encouraging young people to get involved in civic activities related to environmental protection.
- Involve young people in research activities in the field of circular economy, giving them the opportunity to share their ideas on how the circular economic system should be implemented at national or regional level.
- Creating a favorable framework for collaboration between young people from different regions of the world, thus having the opportunity to exchange ideas and practical solutions regarding the implementation of the circular economy.

As can be seen, there is now an obvious opportunity to offer students a complex learning experience, theoretical and practical, in terms of the specific notions of the social economy and the benefits it can bring to the university campus, local communities or even nationally, regionally or globally. This approach enjoys a real support from teachers, 2 out of 3 teachers considering it appropriate to introduce circular economy notions in the university curriculum, and 7 out of 8 teachers promoting the idea of incorporating these mechanisms into the

infrastructure of university campuses and even transforming them into what are called circular campuses. Starting from these elements, we can say that the educational system, through educational institutions, can be a basis for implementing and promoting the circular economic system, the conclusions reached from the practical experience of these institutions can then be used to the top of the pyramid and included in the general mechanism of functioning of the circular economy.

Undoubtedly, the education system around the world needs to make the leap from a classical course-based approach to a modern, participatory one, in which analyses about sustainable consumption and sustainable environmental protection must become more than mere topics of discussion. Each participant in the educational process must manage to understand and adopt the mechanisms specific to the circular economy. For example, it is insufficient to discuss the negative impact that plastic has on the environment. Through the education system, we need to convey to the younger generation that there are real and sustainable alternatives to plastic products and to convince them to introduce ecological alternatives into their consumption behavior (Circulare Collective, 2022).

Currently, teachers who carry out teaching activities in the field of circular economy have at their disposal electronic support resources, available free of charge and which make the learning teaching experience much more attractive. In this category of auxiliary teaching products, we can include:

- The Circular Classroom Toolbox allows teachers to easily and attractively introduce circular economy concepts into the lessons they teach. The tool is interactive and allows the development of circular thinking among the beneficiaries of the education process. This tool is available at: https://circularclassroom.com/.
- Bloom School Box is a tool that allows the presentation of notions in the field of biochemistry to all categories of students. Thus, based on complex

scientific experiments, the program shows the beneficiaries of the educational process what can be the results of working with nature, insisting on the special importance of raw materials and recycling. This resource is available through the dedicated web page: https://bloom-bioeconomy.eu/schoolnetwork/schoolbox/.

- Circular Economy by European Parliament is basically an interactive and informational graph explaining the main differences between linear and circular economy. In this context, relevant information on waste management, efficient use of raw materials, materials and energy and drinking water resources is presented. There is also a section dedicated to presenting extensively the measures that the European Union is implementing to move towards the circular economy. The application is available at the web address: https://www.europarl.europa.eu/thinktank/infographics/circulareconomy/public/index.html.
- Ecological Footprint (Earth Overshoot Day) is a calculator that allows determining the ecological footprint and allows students to analyze, from year to year, the availability of primary material resources. The application is available on the website: https://www.footprintcalculator.org/home/en.
- The Rediscovery Centre's Sustainable Classroom Guidelines are a tool to identify ways in which classrooms can be made sustainable. This IT resource can be accessed at: http://www.rediscoverycentre.ie/wp-content/uploads/2021/02/Sustainable-Classroom-Information.pdf

Another aspect that we must take into account when redesigning curricula to the specifics of the circular economy refers to the place and role of teachers in the process of training the young generation in the spirit of the new economic model. Education professionals have a key role to play in the transition from linear to circular economic model. But in order to be able to transmit the knowledge and skills

specific to this new economic system to the beneficiaries of the educational act, teachers also need to be trained in the specific functioning mechanisms of the circular economy, they need to learn and use new and innovative pedagogical skills to build a sustainable circular society. Thus, the education system must promote peer-to-peer educational programs, collaborative projects, encourage students to rethink existing systems, adopt interdisciplinary learning techniques. In this context, it is necessary to make education policy less rigid and centralized, encouraging its adaptation to both general developments in the economic system and the specificities of each region (Circulare Collective, 2022).

Education in the field of circular economy must start from kindergarten, where children have the opportunity to discover in a dynamic and attractive way the realities of society and the environment. Subsequently, the education of young people is carried out through primary and secondary education institutions and is completed at the level of higher education institutions. This process does not have to be rigid; it develops in parallel with the inclusion of circular economy mechanisms in the daily behavior of the beneficiaries of the educational process. In this evolutionary process, young people learn about the importance of raw materials and materials and about protecting the environment from the negative effects of waste products, acquiring knowledge and skills designed to allow them to integrate into organizations that have implemented the circular economy system or to initiate, alone or in collaboration with their peers, we such business. Only in this way, the educational system will achieve its ultimate goal, namely to prepare its beneficiaries to face the challenges of the contemporary world (Circulare Collective, 2022) (Ellen MacArthur Foundation, The circular economy in higher education, 2023).

An example of good practice in education is Finland, which has for years adopted the principles of sustainability and circular economy as part of the education system at all levels (Circulare Collective, 2022). Sitra (The Finnish Innovation Fund Sitra, 2023) recognized the great importance that education has in creating a new

society based on circular economy. They insist on the importance of learning the mechanisms specific to this economic system for creating new expertise, adapted to the requirements of the future. Sitra has actively promoted Finnish education in the field of circular economy by developing specialized study packages and communication materials specific to this field of activity.

Educational institutions, and in particular higher education institutions, have the possibility to facilitate the transition from linear to circularity-based economic models by (Deda, Murillo Vetroni - Barros, & Teixe, 2022):

- teaching and researching notions aimed at sustainability and circularity in the development of the economic environment and incorporating them into the curricula of each discipline.
- educating and training the next generation of economic professionals, familiar with the specific notions of the new economic model.
- promoting an institutional culture of sustainability, designed to significantly increase the awareness of university staff, as well as community members.
- implementing sustainable policies on university campuses through efficient use of energy and water resources, reducing ecological footprint, optimal waste management, promoting biodiversity.
- development of joint projects with local economic partners aimed at ensuring the implementation of the circular economy.

A special mention is given to the role of circular economy education in the lives of young people with special needs or those coming from disadvantaged areas. For them, implementing the principles of the new economic model is a real chance for a normal life, an opportunity through which they can overcome the problems they are currently facing.

As we showed in the first part of this chapter, the circular economy is a vector of regional development, which can be successfully used even in the most disadvantaged regions. Thus, the circular economy creates the premises for creating

new businesses built on recycling and superior capitalization of all existing resources in these areas. By creating such companies, disadvantaged areas will benefit from the favorable boost they have on the number of jobs available in these regions and will become attractive, especially to young people. The adoption of the new economic model also creates the necessary framework for these disadvantaged areas to obtain additional income from newly established businesses, but also to enjoy the benefits that closer management of waste products brings. Thus, by implementing circular economy mechanisms, disadvantaged areas will become less polluted and cleaner, but also more economically profitable.

In this context, it is important to mention that modern education, based on circular economy principles, is a real opportunity for disadvantaged people and, in particular, for young people in this category. They have the opportunity to acquire the knowledge and skills necessary for this economic system, which will make them adapt much easier to the requirements of circular economic agents. In most cases, disadvantaged people show a greater interest in learning new notions, considering that this is a real possibility to overcome the barriers they face and to integrate more easily into economic activities and society in general. Also, people in disadvantaged areas have a greater inclination to reuse and recycle products, an attitude that can be attributed to a good knowledge of the difficulties they currently face when they want to purchase a new product.

In fact, today's difficult situation makes disadvantaged young people better prepared for the implementation of the circular economy. They are already used to looking for products with a long-life cycle at the expense of "fashionable" ones or to repair products that do not have major malfunctions. Also, disadvantaged young people have already learned much better the lesson of recycling and reusing products.

Starting from these elements, it can be easily noted that the education of disadvantaged young people in the spirit of the new economy is both a challenge and

a real chance that they can enjoy in shaping a better future.

Education for the circular economy and sustainable development trains the beneficiaries of the educational process the ability to think critically and truly understand how important it is to protect the environment to ensure the well-being and prosperity of individuals and communities. The use of modern, interdisciplinary learning methods will create the framework for a safer, healthier and more prosperous world, improving the quality of life of each individual and, in particular, of those from disadvantaged areas or backgrounds.

Analyzing the mode in which education helps us implement the circular economy allows us to affirm that a bottom-up, bottom-up approach is the optimal option for this process. From both a theoretical and a practical point of view, it is necessary that in the first stage we teach as many people as possible what this change of economic system entails and only then wait until, based on the results of their work, we can enjoy the results at the zonal, regional or even global level. Only when people really know the mechanisms of the circular economy will we be able to hope that this system will be adopted by companies.

References for chapter three

Strategii și politici de management în economia contemporană, (pg. 160 - 166). Chişinău.

Hotărârea de Guvern nr. 1172.din 27 septembrie 2022 pentru aprobarea Strategiei naţionale privind economia circulară. Preluat de pe

L'Observatoire Cetelem. (2023). *L'Observatoire Cetelem de la Consommation*

CHAPTER FOUR. BRANCH SPECIFIC CONSIDERATIONS ON CIRCULAR ECONOMY

1. Glass Industry

The glass industry encompasses five primary sectors, each with distinct glass products, applications, and markets. These sectors exhibit significant differences in terms of manufacturing processes, products, market dynamics, and economic factors. However, they all share the common process of transforming raw materials into glass through melting (Winter 2015).

The subsequent descriptions are adapted from Glass Alliance Europe (Anon 2022).

Flat glass serves a dual purpose in the construction realm, forming windows and facades, and in the automotive industry, where it contributes to the production of windshields, side windows, rear-side glazing, backlights, and sunroofs. This versatile material is also harnessed for solar-based applications. The predominant manufacturing method for almost all flat glass is the float process.

The Container Glass sector stands as a prominent supplier of an expansive array of glass packaging solutions, catering to the needs of the food and beverage industries. Furthermore, it provides essential vessels for perfumery, cosmetics, and pharmaceutical products, with a customer base that spans across Europe and the global market.

Continuous filament glass fiber holds a strategic role primarily within the realm of composite material production. This fiber variety is pivotal in enhancing the structural strength of materials while maintaining a lightweight profile. Its applications extend across various sectors, including automotive and transportation, encompassing areas such as airplane manufacturing. This multifaceted material is also indispensable in sectors like wind energy, agriculture, construction, and communication, as well as the realm of electrical and electronic goods.

The sector of Domestic Glass encompasses the craft of producing an assortment of glassware for daily use. This includes a portfolio of kitchen equipment and decorative products, all of which enrich the visual and functional aspects of domestic life.

Special glass distinguishes itself through its heightened technological complexity, which adds substantial value to the sector. This realm encapsulates an extensive assortment of products, ranging from intricate lighting glass and glass tubes to laboratory glassware, glass ceramics, heat-resistant glass, optical and ophthalmic glass, as well as ultra-thin glass catering to the electronics industry, including applications like liquid crystal display (LCD) panels, photovoltaic technology, and radiation protection glass. The process of glass melting for these specialized products entails a fusion of distinct raw materials, encompassing various types of sand and recycled glass. This mixture undergoes a rigorous heat treatment, with temperatures reaching around 1500°C, resulting in molten glass. Subsequently, the molten glass is carefully extracted from the furnace, shaped according to specifications, and then cooled systematically. The prevalent composition in this sector is soda-lime glass, primarily made from a blend of silica sand, soda ash, limestone, dolomite, and glass cullets sourced from recycled glass materials. In 2022, world glass production was estimated at a total value of USD 265 billion and estimated at a total value of USD 465 billion in 2032 (Pulidindi and Patel 2022).

Estimations regarding global employment figures in the glass industry vary, with the industry not being notably labor-intensive. The flat glass and container glass sectors are highly automated, whereas certain segments within the domestic glass industry retain labor-intensive characteristics. Although the industry operates on a global scale encompassing production, transformation, and distribution, prevailing market conditions impose cost and transport limitations, rendering long-distance transportation of flat and container glass uneconomical. Nevertheless, such constraints apply to a lesser extent in the case of tableware and reinforced fiberglass, driven partly by higher profit margins. More than 90% of glass industry products are supplied to other industries. Consequently, the glass manufacturing sector's vitality is closely intertwined with the building construction sector, automobile manufacturing, and the food and beverage industry. Additionally, niche sectors

producing high-value technical or consumer products contribute to the industry's dynamism.

Why the glass industry is important?

The glass industry supplies many sectors and houses such as construction, automotive, white goods, food, drink, soft drinks, medicine, cosmetics, tourism (such as restaurants), furniture, pipes, electricity, and electronics. Particularly in flat glass, the effects of developments experienced in the construction and automotive sectors are observed individually. High-performance glass in the construction sector, solar energy, or new projects in the automotive sector are factors affecting flat glass preparation (glassspecialtywlc 2016).

Glass is a highly brittle material and one has to be very careful while handling this material. Glass is a solid substance that has a see-through character that is transparent. The sector employs thousands of people. It is linked to other sectors such as construction, automotive, domestic, and leisure. It is directly related to the growth of the economy of the countries (glassspecialtywlc 2016).

By 2025, the worldwide glass recycling market is projected to reach US$ 3.7 billion. However, the contamination of unwanted materials present in the post-consumer glass waste stream stands in the way of true recycling potential(Linnenkoper 2019).

European Achievements and Goals in Glass Recycling.

European Union (EU) nations achieved a record average glass collection rate of 78% in 2019, a two-percentage-point increase from the previous year, as reported by Close the Glass Loop. With a post-consumer glass container collection target of 90% by 2030, the multi-stakeholder stewardship partnership strives for continuous improvement. The majority of the 13.7 million tonnes of glass collected for recycling is remelted to create new bottles and jars. This achievement demonstrates that ambitious targets can be met through collaborative efforts involving various stakeholders and innovative collection models, effective sorting and recycling, and consumer communication campaigns (Reintjes 2023).

‘The high glass collection for recycling rate shows that targets can be achieved with close cooperation between all players in the value chain, sharing best practices on innovative and tailored collection models, high-quality sorting and recycling and communication campaigns for consumers (Reintjes 2023).

Glass Recyclers' Collaborative Efforts in Europe:

EuRIC, the umbrella organization for recycling industries in Europe, has established a subgroup dedicated to advancing the interests of glass recyclers across the continent. Founding members include Anarevi from Spain, BVSE Glas from Germany, and FEDEREC Verre from France. This newly formed group focuses on glass recycling within the context of the EU Circular Economy package and addresses pertinent policy issues on a European scale. This initiative demonstrates EuRIC's commitment to embracing various resource streams under its umbrella and promoting sustainable recycling practices (RecyclingInternational 2016).

The waste management system in Serbia is based on its 2009 environmental legislation, which includes the polluter pays principle. The City of Belgrade in 2015 announced a public-private partnership tender for the huge Vinca landfill to also include an energy-from-waste facility. (Anon n.d.-b)

The new recycling hub will be constructed near the country’s capital of Bucharest and is scheduled to be completed in 2023. Besides handling glass packaging such as bottles and jars, the new plant will also recycle flat glass from the automotive industry and from construction and demolition. Most material is collected via Romania’s deposit return scheme. (Linnenkoper 2022).

Bulgaria's Environment Minister Nona Karadzhova has broken the ground for the construction of a glass recycling plant near the capital Sofia. The currently existing system for the separation and recycling of household waste in Bulgaria features 22 000 containers in 101 municipalities with more than 3 million people (Anon 2010a).

Glass Recycling Initiatives by Şişecam:

In 2016, Şişecam took significant steps to foster a transition towards a recycling

society. Through the establishment of Şişecam Çevre Sistemleri A.Ş., in collaboration with the European Bank for Reconstruction and Development (EBRD), the company aspired to become a key authority in environmental and energy matters, particularly waste management, in Turkey. Şişecam Çevre Sistemleri's endeavors encompass glass recycling, waste collection, and consultancy services, focusing on quality, environment, and occupational safety. This strategic initiative aligns with Şişecam's commitment to sustainable growth, modernization of waste management, and effective know-how transfer (Anon 2023).

Şişecam Çevre Sistemleri commissioned two glass recycling facilities. It is planned to further boost its efforts toward recycling with capital investments and sustainable supplier management. The target is to reach a glass recycling capacity of 250,000 tons/year by end-2020 (Anon 2023).

Innovative Recycling Technologies and Sustainability:

Glass recycling involves multiple stages, including the sorting and processing of cullets and intact glass waste. Various technologies, such as optical and magnetic separators, contribute to efficient glass recycling. The resulting benefits include reduced carbon emissions and resource conservation. Through Şişecam's dedicated efforts, over 1.3 million tons of waste glass have been recycled since 2011, significantly curbing CO2 emissions and promoting sustainable practices. By prioritizing circular design and sustainable consumption, the glass industry contributes to waste reduction and efficient resource utilization.

Challenges and Opportunities in Glass Recycling:

The glass industry offers vast recycling potential due to its ability to be endlessly recycled without quality loss. However, global recycling rates vary significantly among glass applications and regions. While container glass achieves recycling rates above 90% in some countries, the overall recycling rate remains below 35%. The challenge lies in decoupling production volumes from resource consumption. With worldwide glass production exceeding 130 million tonnes annually, efforts to

enhance recycling rates and sustainable practices are imperative. Circular economy principles, characterized by circular design, innovative business models, and sustainable consumption, are integral to achieving a resource-efficient and environmentally conscious glass industry. (Anon 2023).

Worldwide CRT production was 83,300,000 units in 2002 and can approximately release 83,000 metric tons of lead (Ahluwalia and Nema 2006).

Only in the case of container glass are recycling rates of above 90 % achieved in some countries today. However, on a global scale, this only amounts to a recycling rate of less than 35 % (Anon 2020).

Global recycling volumes are currently estimated to be around 27 Mt, which represents only 21 % of the amount of glass produced. The highest recycling rates are achieved for container glass, with an estimated 32 %, while the recycling rate of flat glass is only 11 % (Anon 2020).

2. Plastic Industry

Plastic is one of the leading materials we use almost every moment of our lives. Regardless of the product, plastic has been integrated into our lives and appears everywhere in terms of usage. The increase in the variety of use of this material is one of the leading sectors examined by the circular economy with the creation of its own economy. Especially within the scope of the circular economy, the plastics industry is very important within the scope of reusability and production of products compatible with nature in terms of green economy (Pacheco-López et al., 2023). Circular economy examines the product life process from the raw material to the final point in the user's consumption, as well as all the processes of returning the product back to the production line from its form at the end of use (Thi-Kieu Ho et al., 2023). Although the linear economy includes the stages of plastic disposal and disposal at the end of use, the circular economy argues that plastics that do not need to be disposed of in this process should be raw materials for production again. In this

cycle, it contributes to the longer life cycle of plastic, recycling, and reduce (Ramos et al., 2023).

In this section, many topics such as the components of the plastics industry, plastic use, plastic waste and packaging values on a country basis, recycling and factors contributing to production are covered. The section emphasizes the use of plastics and the importance of plastics within the framework of the circular economy (Echchakoui & Barka, 2020).

In terms of the plastics industry, the European Union has made great progress until recent years. Especially in 2021, the fact that there are 52,000 companies including small and medium-sized enterprises on plastics, 1.5 million employees in terms of labor force in this industry and 400 billion Euros in terms of economic recycling is enough for the plastic industry to attract attention (Plastics Europe, 2022).

In terms of the world economy, the importance of mass production in the reshaping of economic structures, especially after the Great Depression, is quite high. The increase in the need for raw materials in order for the mass production line to meet the needs and the formation of alternative raw material usage areas helps plastic to attract attention at this point (Lisiecki et al., 2023). Especially since the 1950s, the expansion of the usage of plastic has been an advantage for manufacturers. While the use of plastic was 1.5 million metric tons in the 1950s, this figure reaches 390.7 million metric tons in 2020. Here, it also gives us information about how much the production industry has developed, how much customer demands have increased and product diversity. The usage rates of plastic are shown in the figure below according to years (Viles et al., 2022a).

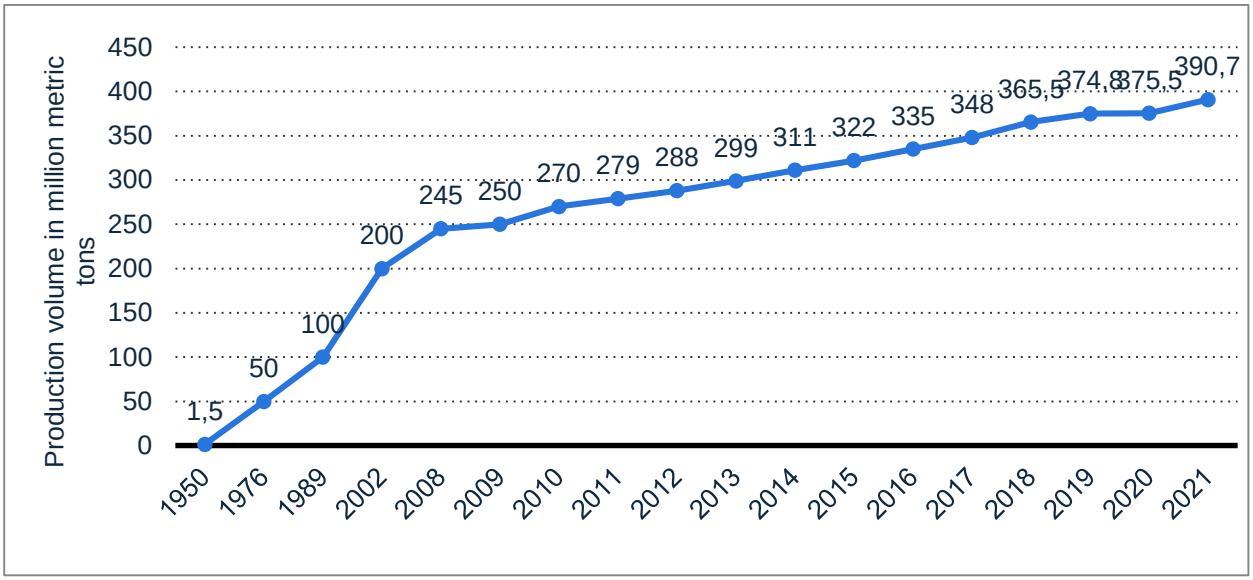

Figure 4.1. Global Plastic Production 1950-2021

Resource: Statista

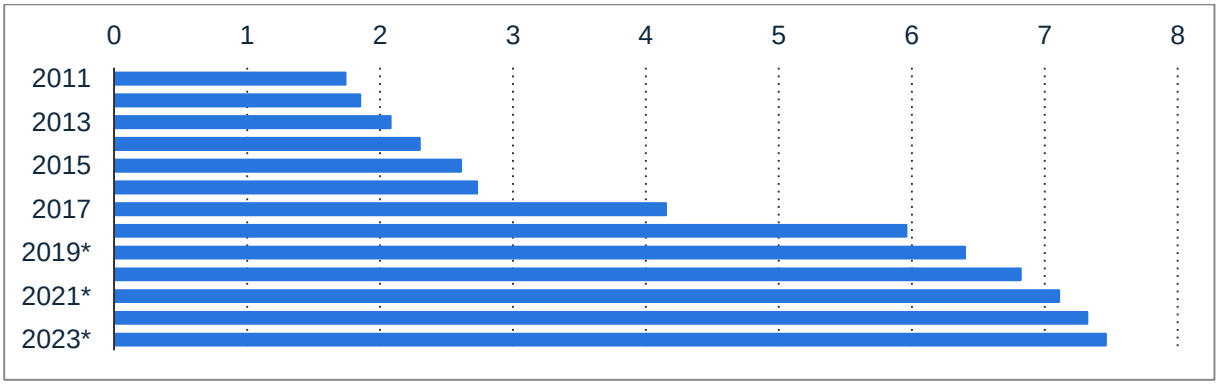

Figure 4.2. Industry Revenue Of "Manufacture Of Plastics İn Primary Forms" In Turkey 2011-2023

Resource: Statista

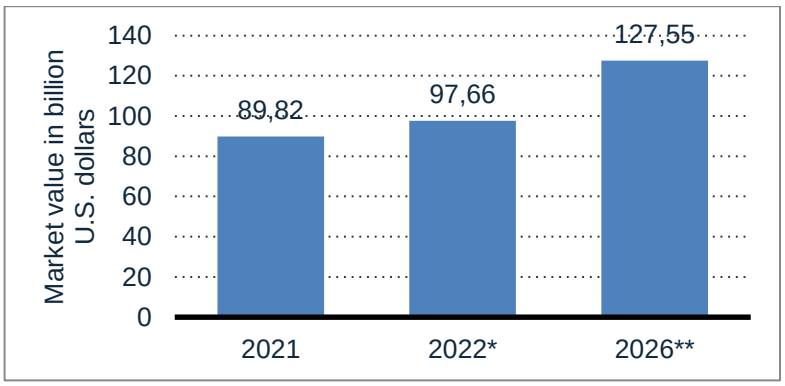

Figure 4.3. Global Market Value of Sustainable Plastic Packaging 2021-2026

Resource: Statista

The fact that plastics are used in many areas and have a long service life gives them a wide range of usesfrom the sports sector to the food sector, from decoration to security systems (Gutberlet et al., 2023). It is also widely used in the health sector. Plastic products have been integrated into our lives by being used in many areas such as packaging, the automotive industry, electrical electronics, agriculture sector (Viles et al., 2022b).

The plastic products and varieties produced today differ in lifetime. They can be used for years (electrical cables, signboards, parts used in cars), but they are not recycled as waste as of the year they are produced (Fatimah et al., 2023). In terms of household appliances, furniture and kitchen utensils can be resold and second-hand markets are also very popular. For this reason, it is very difficult to track the rate of plastic returning in the second-hand market, and it is not possible to analyze how much it contributes to the year-on-year increase in the plastics industry (Rodrigues Dias et al., 2022).

Plastics are basically divided into two categories. These are pre-consumer plastic waste and post-consumer plastic waste.

Pre-consumer Plastic Waste

Pre-consumer plastic waste arises from plastic production and conversion processes (e.g. faulty production and runners, edges of plastic sheets, production residues). Pre-consumer plastic waste does not include reprocessing materials, such as millings or scrap, which are produced and recovered in the same production process (Haq & Alam, 2023).

Post-Consumer Plastic Waste

Post-consumer plastic waste includes plastic products (plastic packaging, old window frames, used electronic devices, etc.) that are discarded by final consumers after they have served their purpose and can no longer be used. This category of waste also includes assembly waste (e.g. cut pieces of insulation boards, flooring or wall cladding when they are installed in a building) (Ren et al., 2023) (Agliardi &

Kasioumi, 2023).

Exports of plastic waste outside the European Union and the United Kingdom halved from 2016 to 2020. Factors such as plastic waste bans imposed by countries as targets and new regulations on the shipment of plastic waste from 2021 onwards have led to a decline in plastic waste exports (Ahmed, 2023). In order to increase plastic circularity and recycling capacities, countries need to make new areas and studies in this sense. In this regard, Plastics Europe member companies create physical recycling campaigns to increase recycling capacity in Europe (Illankoon & Vithanage, 2023). While these campaigns vary from country to country, the most common is the recycling of plastic beverage bottles and the distribution of discount coupons. While many countries in Europe have generalized this system, there is an increasing effort to separate garbage waste and recycle plastics separately (Banjerdpaiboon & Limleamthong, 2023). One of the different incentives is the campaign in Turkey to collect water bottle caps to buy wheelchairs for disabled people (Plastics Europe, 2022).

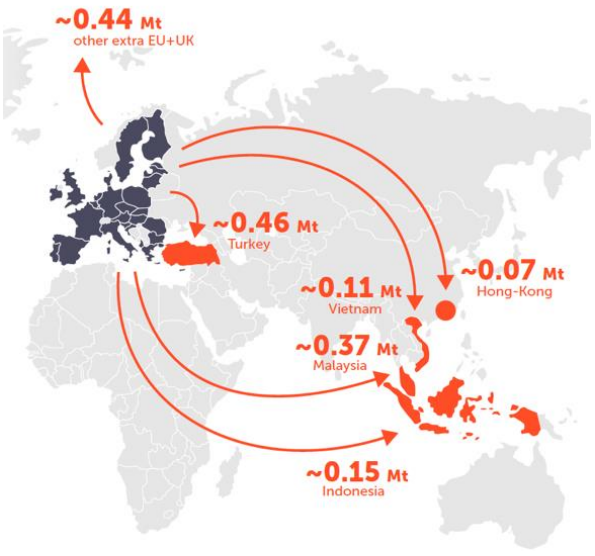

Figure 4.4. Distribution Methods of Plastic Waste

Resource: Plastic Europe

In 2020, more than 10 million tons of post-consumer plastic waste was sent for recycling. Almost 90% (9.1 million tons) was processed in the EU27+3, producing 5.5 million tons of post-consumer recycled plastics (Plastics Europe, 2022). When collected plastic waste enters sorting and recycling facilities, it must first be separated from other types of waste, potential residues and foreign materials that are collected together (Rai et al., 2023). These foreign substances and residues can be organic matter (e.g. water, milk, yogurt and other food residues), moisture, paper, adhesives, textiles, composites, metals, etc. Residues also include small pieces of plastic waste and collected plastic waste discarded from the recycling process (Simon, 2019). Plastic waste enters the recycling process after being separated from all kinds of dirt, impurities, and residues. As with any other industrial activity, losses occur at different stages of the process. This explains the difference between input and output quantities in plastic waste recycling. As an impact of the COVID-19 pandemic, consumption of household plastic packaging has increased. These often come with higher levels of residues (e.g. mixed with organic residues) (Khatami et al., 2023). This, combined with increased market requirements for the quality of recycled plastics in 2020, has led to higher process losses. The plastics value chain is working to improve these processes and achieve maximum yields of recycled plastics of the required quality (Yamamoto & Eva, 2022).

To accelerate the circularity of plastics, the quantity and overall quality of recycled plastics need to be increased. Different technologies are available that maximize the value of plastics at the end of their useful life. Today, mechanical recycling is the recycling process that yields the highest quantities of recycled plastics (Kubiczek et al., 2023). Complementary to this, different chemical recycling technologies have also been developed. These technologies are currently operating on a smaller scale, but they will be indispensable not only to achieve higher quantities of recycled plastics, but also to contribute to the transition to a climate-neutral circular economy (Liu et al., 2018).

Between 2018 and 2020, there was a positive increase in the plastics industry from a transformational perspective. Polymerization, i.e. plastic production, decreased by 10.3% in 2020. The decrease in this rate is a signal that the plastic used contributes to recycling. The rate of waste returned from recycling and consumer use increased by 8.5%. For the first time since 2006, there was no increase in energy use from plastics. The use of plastic recovered from recycling in newly manufactured products increased from 7.2% in 2018 to 8.5% in 2020 (Plastics Europe, 2022).

3. Metal Industry

Almost every metal is recyclable and plays an essential role in the circular economy. The scrap metal industry, which is highly resistant to economic fluctuations, contributes significantly to the global economy in terms of energy saving, reducing production costs, reducing the need for landfills, and using natural resources such as water and soil. Many substances obtained by mining have an important place in our lives. These mines must be used repeatedly to protect nature and save energy.

Mineral compounds from which metals can be extracted, are called mineral ores. Mineral ores minerals are not always in suitable chemical and physical form to be converted directly into metals. Sulfur and fine ores, for example, cannot be used directly in blast furnaces, they need to undergo some processes such as roasting and sintering.

The processing of metal ores at relatively high temperatures and in the presence of excess air without melting in order to perform chemical changes in their structures for various purposes is called *roasting*. Roasting can be considered mainly as an oxidation process since it is applied to convert the sulfur of sulfurous (sulfurous) minerals to their oxide state by burning them. Roasting is the process of converting the metal compound in the ore or concentrates into a suitable compound for subsequent processes, removing impurities, separating the metal in the ore from the gangue minerals by evaporation, changing the physical shape of the material (for

example, porous and coarse fragmentation) purposes.

Sintering is a heat treatment process that is used to combine powder piles with the help of thermal energy, in which pressed parts gain strength. The aim is to agglomerate the product. Although sintering varies depending on the type of material, the shape, and the size of the sample, it is generally divided into three groups solid, liquid, and pressure-assisted sintering. In the sintering facility, firstly, the blending and mixing of the raw materials, combustion at a temperature of approximately 1,350°C, and cooling are carried out. The system is heated to a temperature of 0.5-0.75 times the melting temperature of the material. The powders do not melt, the particles come together and the porosity is reduced. This type of sintering is generally referred to as solid-phase sintering. In solid-phase sintering, it is difficult to obtain materials with high densities, especially in covalently bonded ceramics (e.g., Si3N4 and SiC). In order to overcome this difficulty in liquid phase sintering, liquid phase formation is provided at grain boundaries and sintering temperature by using additives. It is applied by pressure-assisted sintering, hot pressing, and hot isostatic pressing (Yang, Tang, and Xue 2021). *Pelleting* is also applied to increase the efficiency of the blast furnace. It is the process of adding a binder to materials not suitable for sintering and that cannot be used directly in the blast furnace and bringing them to certain dimensions with the effect of moisture and heat (Cöcen 2013).

Iron makes up 95% by weight of all metals produced in the world. Its low price and high strength properties make it indispensable in automotive, ship hull construction, and as a structural component of buildings. Iron and steel production technology includes stages ranging from raw material to semi-finished steel production. Iron-based materials (iron ore, scrap), fuels and reducers (coke, coal, gas), slag makers, and alloys are the basic raw materials used in iron and steel production.

Aluminum is one of the metals with the lowest recycling cost. Using recycled aluminum by mining provides 95% energy savings. It is used in construction,

electronic devices, and transportation vehicles. Recycling a single aluminum can save energy the equivalent of burning a 100-watt light bulb for four hours. Aluminum can be recycled 8 times a year.

Using recycled *copper* saves 85% of energy compared to mining and reduces CO2 emissions by up to 65%. Like many metals, it can be recycled endlessly. As the demand in the world is constantly increasing, recycled copper is used in a range of products including roofing material, trains and cars, coins, kitchenware, and musical instruments. Because it is a good conductor, it is mostly used in electrical devices.

Zinc is the most used metal after iron, aluminum, and copper. It is easily recyclable and is most commonly used in alloys such as brass and bronze. When the car is recycled, the zinc-coated panels can be recycled completely and with the same quality. Zinc is used in the manufacture of many products such as batteries, paint, sunscreen, ink, soap, and medicine. Using recycled zinc saves up to 76% of energy. 30-40% of the zinc supply comes from old scrap and residues.

Steel is among the most recycled metals. The tin cans we use are made of 99% steel. On average, 70% of the mass of a car is *steel*. In automobile recycling, with the help of magnets, steel is separated from plastic and non-ferrous alloys and contributes to the return of tons of steel to the economy. Using recycled steel from scratch reduces carbon emissions by up to 80%, water use by 40%, and water pollution by up to 76%. Steel products can be recycled many times without losing their quality.

A great metal for the circular economy, *lead* can be recycled endlessly with the same quality. More is recycled than metals such as aluminum, copper, zinc, or even common products such as glass and newspaper. The use of recycled lead provides 99% energy savings compared to production with traditional methods.

Lithium is used in electric car batteries and is only found in small amounts in the earth's crust. Lithium is difficult to recycle.

Tungsten is one of the hardest metals and can withstand extreme temperatures. So, it can be used in engine injectors.

Titanium is 45% lighter than steel and is resistant to corrosive factors such as seawater. It can therefore be used in the healthcare industry, for example in joint replacement procedures.

Aluminum is not affected by the magnet, but steel is. Beverage cans are usually made of aluminum, and food cans are made of steel. Recycling metal scraps (such as iron and aluminum) contributes to local construction projects (road and bridge construction). Scrap metals are recycled and used in the construction of bicycles, automobiles, airplanes, and other means of transportation. Scrap metals are also used in the construction of containers used in international transportation and storage. Metal recycling is effective in reducing CO2 emissions from smelting, mining, and transport. A computer is 1.5 kg, an average house is 100 kg, and a wind turbine is 5 tons containing copper (aged_admin 2022).

About 40 percent of steel production worldwide uses recycled steel. About 42 percent of crude steel in the United States is made from recycled materials. About 100 million steel and tin cans are used every day in the US alone. Steel and iron are the world's most recycled materials due to their ease of reprocessing and the opportunity to recycle large structures. The use of magnets in the sorting process allows recyclers to easily separate them from the mixed waste stream. About 400 million tons of metal are recycled worldwide each year. Currently, the most recycled consumer product in the US is aluminum cans. Wasting a single aluminum can mean wasting that can full of gasoline.

Metals can be classified as *ferrous* or *non-ferrous*. Ferrous metals consist of a combination of iron and carbon. Some common ferrous metals include carbon steel, alloy steel, wrought iron, and cast iron. On the other hand, non-ferrous metals include aluminum, copper, lead, zinc, and tin. Precious metals are non-ferrous, the most common precious metals are gold, platinum, silver, iridium, and palladium.

The first step in metal recycling is the collection of discarded metal items from various sources, including households, industries, and construction sites. These

items may include old appliances, vehicles, machinery, electronic devices, and more. To ensure effective recycling, collected materials are sorted into different categories based on the type of metal and its composition (Hagelüken and Goldmann 2022). This sorting process can be manual or automated, using technologies like magnets, eddy current separators, and optical sensors (Liu et al. 2021). In manufacturing half of the material is transformed to quick scrap.

Processing and Preparation:

Once sorted, the collected metal items undergo further processing to prepare them for recycling. This stage typically involves cleaning, removing contaminants (such as plastics and rubber), and reducing the size of the materials through shredding or cutting. The processed metal pieces are then ready to be transformed into reusable raw materials.

Melting and Purification:

The next stage involves melting the processed metal pieces to remove impurities and create uniform alloys. The metal is subjected to high temperatures in furnaces, which causes it to melt. During this process, any remaining contaminants are burned off or separated from the molten metal. This purification step is crucial to ensure the quality and integrity of the recycled metal.

Casting and Forming:

After purification, the molten metal is cast into molds to create new products or semi-finished forms. This can involve casting ingots, billets, or slabs, which serve as the building blocks for further manufacturing. Alternatively, the molten metal can be directly formed into various shapes using techniques like extrusion, rolling, or forging (Mahto 2015).

Refinement is done to ensure that the end product is of high quality and free of contaminants. The traditional approach is using electrolyze.

Applications of Recycled Metals:

Recycled metals find applications across a wide range of industries:

Manufacturing: Recycled metals are used to produce new products such as automobiles, appliances, construction materials, and packaging materials. The automotive industry, for example, extensively utilizes recycled steel and aluminum in the production of cars and trucks.

Construction: Recycled metals contribute to sustainable building practices by being used in the construction of bridges, buildings, and infrastructure. Steel and aluminum are commonly employed in these applications due to their durability and versatility.

Electronics: Many electronic devices contain valuable metals like gold, silver, and copper. Recycling these metals from old electronic devices reduces the need for mining and conserves these precious resources.

Packaging: Aluminum recycling, in particular, is instrumental in the production of beverage cans and other packaging materials. This practice conserves energy compared to producing aluminum from bauxite ore (Cengiz 2019).

Advantages of Metal Recycling:

Metal recycling offers numerous benefits for both the environment and the economy:

Resource Conservation: Recycling metals reduces the need for extracting raw materials from the earth, preserving valuable resources and reducing environmental damage associated with mining.

Energy Savings: Recycling requires significantly less energy than primary metal production. For example, recycling aluminum saves up to 95% of the energy needed to produce the same amount of aluminum from bauxite ore.

Emission Reduction: Metal recycling reduces greenhouse gas emissions associated with mining, refining, and transportation of raw materials.

Job Creation: The recycling industry generates employment opportunities in collection, processing, and manufacturing.

Waste Reduction: Recycling metal items prevents them from ending up in landfills or incinerators, minimizing waste disposal issues.

Economic Benefits: Metal recycling contributes to local economies by providing raw materials for manufacturing industries and reducing reliance on expensive imported metals.

As an important indicator of the metal industry, world steel trade numbers in million tonnes are given in Table 4.1 (Anon n.d.).

Table 4.1. World Steel Trade Excluding intra-regional trades

Destination	European Union (27)	Other Europe	Russia & Other CIS + Ukr	North America	South America	Africa and Middle East	China	Japan	Other Asia	Oceania	Total imports	of which: extra-regional imports
European Union (27)	100.0	10.3	8.8	0.1	1.2	1.9	4.3	1.7	13.3	0.2	141.9	41.9
Other Europe	10.2	2.7	6.3	0.0	0.3	0.8	2.8	0.5	5.1	0.1	28.7	26.0
Russia & Other CIS + Ukraine	0.5	0.5	1.9	0.0	0.0	0.0	1.3	0.0	0.2	0.0	4.5	2.6
North America	6.0	2.6	0.9	17.1	7.9	1.5	4.4	2.9	10.9	0.4	54.6	37.6
South America	1.0	0.8	0.3	0.1	3.0	0.1	5.4	0.9	1.9	0.0	13.4	10.4
Africa	1.8	3.1	0.6	0.0	0.1	1.5	8.1	0.9	1.9	0.0	18.0	16.5
Middle East	0.9	4.3	0.4	0.1	0.1	2.9	7.1	0.8	2.4	0.1	19.1	16.2
China	0.8	0.0	2.6	0.0	0.1	1.6	-	3.8	8.0	0.0	17.1	17.1
Japan	0.0	0.0	0.0	0.0	0.0	0.0	1.0	-	4.3	0.0	5.3	5.3
Other Asia	1.3	0.6	3.4	4.1	0.2	5.0	32.8	20.1	28.9	0.3	96.6	67.8
Oceania	0.2	0.2	0.0	0.0	0.0	0.1	0.9	0.1	1.3	0.2	2.9	2.7
Total Exports	122.9	25.0	25.1	21.6	12.9	15.3	68.1	31.7	78.1	1.3	402.1	244.0
of which: extra-regional exports*	22.9	22.4	23.2	4.5	9.9	10.9	68.1	31.7	49.2	1.2	244.0	
Net exports (exports-imports)	- 19.0	- 3.6	20.6	-33.0	-0.5	-21.8	51.1	26.4	- 18.5	- 1.6		

The average recycling rate stands at 28%, with Slovenia leading the pack with an impressive 49%. In stark contrast, Montenegro, Macedonia, Serbia, Turkey, and Bosnia and Herzegovina have minimal waste reuse rates, hovering around a mere

1%. Astonishingly, the remaining countries dispose of nearly all their waste in landfills, far exceeding the continent's average landfill rate of 28% (Jovičić 2016).

In conclusion, the metal recycling process plays a crucial role in promoting sustainability, conserving resources, and reducing environmental impacts. Through a series of stages, from collection and sorting to melting and forming, recycled metals find their way into various industries, contributing to the creation of new products while minimizing the strain on natural resources and energy consumption. Metal recycling stands as a shining example of how innovative practices can drive positive change on both a local and global scale.

4. Paper Industry

The material we call paper today was first produced in China 2000 years ago, by using vegetable fibers called cellulose. With the emergence of the printing press in the 15th century and the industrial revolution afterward, the use of paper spread all over the world and diversified. Parallel to the developments in printing and drawing techniques, paper has started to be used in many areas such as valuable papers, personal use, communication, packaging, cleaning, and construction. Paper is usually obtained by pressing cellulose pulp. Pulp is a fibrous material prepared by chemically or mechanically separating cellulose fibers from wood. Globally 40% of trees cut for industrial purposes are used solely for paper production. Cut trees account for 12 to 17% of global greenhouse gas emissions each year (KYOCERA, 2023). Due to the rise in global environmental issues such as air and water pollution, deforestation, and reduction in biodiversity, there are complaints about harvesting wood for pulp mills since. This trend towards sustainability in the pulp and paper industry has increased the importance and interest to paper recycling sector, which is another source of pulp and paper production.

According to industry experience, paper can be recycled 3 to 8 times. Every time it is recycled, the fibers get shorter and weaker. In order to increase the strength and

quality of the fiber, it is necessary to add unprocessed pulp to the recycled paper. The recycling of paper follows a series of steps which may vary depending on the type of paper and its degree of deterioration. These are sorting, baling, shredding, washing, bleaching, pressing, and rolling. Recycling one ton of paper saves 4100 kWh of energy, 1720 liters of oil, approximately 32,000 liters of water, and an average of 17 trees, while preventing the emission of 27 kg of air pollutants. Burning that same ton of paper would generate about 750 kg of carbon dioxide. Recycling cardboard requires only 75% of the energy required to make new cardboard (BIR, 2023).

There is a continuous increase in world paper and cardboard production between 1961-2021. Production, which was 77,1 million tons in 1961, reached 417,3 million tons in 2021. In 2021, 76% (317.3 million tons) of world production was made by 11 countries, including China, the USA, Japan, Germany, India, Indonesia, South Korea, Brazil, Russia, Sweden, and Finland. However, in 1961 the global production was 77,1 million tons, and 63% (47,7 million tons) of it was made by only 6 countries, the United States of America, Japan, Germany, China, Sweden, and Finland. In 1961 the share of the USA was 63%, Japan's and Germany's were around 10%, and China's, Sweden's, and Finland's were around 5%. In 2021 China's share jumped to 40%, USA's decreased to 20%, Japan's and Germany's were around 7,5%, India's was 5%, other 6 countries were around 3%. Germany has increased its production 6 times, Japan 5 times, USA 2 times, and China has increased its production 50 times. Despite their small shares, in the last 50 years India with its production of 17 million tons, Indonesia, South Korea, Brazil, and Russia with approximately 10 million tons, have become important players in the paper and cardboard sector (GREYCON, 2023). The paper and cardboard industry is a labor-intensive sector. The number of people employed by the top 10 companies is close to 300.000.

Leading Pulp and Paper Manufacturers in the world in 2022 based on revenue

Table 4.2. Leading paper companies

Company	Headquarters Country	Revenue (in billion USD)	Employee
International Paper Co	USA	21.160	39.000
Westrock Co	USA	21.300	50.000
Smurfit Kappa Group Plc	Ireland	13.700	48.000
UPM-Kymmene Corp	Finland	12.500	17.000
Stora Enso Oyj	Finland	12.500	21.000
Oji Holdings Corp	Japan	12.200	35.600
Mondi	United Kingdom	9.540	22.000
Nine Dragons Paper Holding	Hong Kong	9.100	20.000
Nippon Paper Industries	Japan	7.500	16.000
Sappi Limited	South Africa	7.300	12.400

Resource: GREYKON,2023

The consumption of paper and cardboard are very close to the production. World paper consumption, which was 77,2 million tons in 1961, increased to 418,3 million tons in 2021. What we observe from these quantities is that the world paper and cardboard industry balances the supply and demand in the world market . In 2021, China ranks in 1st place for consumption with 132,6 million tons, USA 2nd with 65,6 million tons, Japan 3rd with 22,6 million tons. Germany ranks 4th with 18,8 million tons and India 5th with 16 million tons. Italy, Mexico, South Korea, Brazil and France consume approximately 10 million tons of paper and cardboard annually (GREYCON, 2023).

In 2021, the paper and cardboard production was distributed to regions as follows: 49,5% Asia, 25,1% Europe, 18,4% North America. Europe produced approximately

105 million tons. 75 million tons of this production is made by eight European Union countries (Germany, Italy, Sweden, Finland, France, Spain, Poland and Austria), (Statista, 2023). The value of paper and cardboard production in these eight EU countries in 2019 was 141,4 billion Euros. When the paper and cardboard production in the project countries is compared with eight European Union member countries, it can be seen that the production amounts and values were very low. The value of paper and cardboard production in the top three EU countries was 40,8 billion Euros in Germany, 24,1 billion Euros in Italy, 17,9 billion Euros in France. In contrast the value of paper and cardboard production was: in Romania 1,3 billion Euros, in Serbia 0,8 billion Euros and in Bulgaria 0,7 billion Euros. Turkey ranks 16th globally in paper and cardboard production with a capacity of 3,8 million tons and 8,3 billion Euros (Nationmaster, 2023).

The most important factor for the emergence of the recycling industry were the 1st and the 2nd World Wars. The recycling industry provided the European industry with an important alternative for survival, as the wars severely disrupted the import of raw materials from overseas lands. The raw material required for more than half of the world's paper production, which is approximately 420 million tons, was obtained from recycled paper. 60% of the recycled paper is obtained from the Industry and Trade sector. The rest of the recovered paper comes from households (BİR, 2023).

The production of recycled paper fiber globally was 250 million tons in 2018 and 243,6 million tons in 2019. 105,8 million tons (43,5%) of this production is made in Asia, 65,5 million tons (26,9%) in Europe, 48,8 million tons (20%) in the USA and Canada, and the rest in other countries of the world. Despite this global decline, Asia increased its share of 42,6% in 2018 and maintained its leadership in recycled paper fiber production. Parallel to the decrease in world production, it is observed that the production of five leading European recycled paper fiber producing countries' decreased in 2019. The use of recovered paper in these countries was as follows:

Germany (17,2 million tons), the UK (3,1 million tons), France (5,2 million tons) and Italy (5,1 million tons). In contrast, Spain recorded an increase of more than 5% to 5,2 million tons (BİR, 2023).

Due to the increase in the demand for paper consumption, production also increases, but the amount of recycled paper fiber is not sufficient in some of paper and cardboard producing countries. In this case, international recovered paper trade becomes mandatory. There is recovered paper surplus in developing countries that recycle paper due to imports of used paper from the countries with high paper consumption.

The international recovered paper exports, which was 56 million tons in 2018, decreased to 49,3 million tons in 2019, mainly due to the strict controls imposed by Chinese government on imports. As a result of this, Asia's recycled paper fiber imports decreased from 37,4 million tons in 2017 to 28,4 million tons in 2019 (28,5%). In 2019, 17 million tons of recovered paper fiber were imported and 22,8 million tons (46.3%) exported by Europe. , and 18,2 million tons (37%) by the United States and Canada. So, Europe is the first among exporters and second among importers. This is because of the trade of recovered paper within the continent. For example, in 2018, 12,3 million tons of recovered paper was traded between different member states of the European Union.

China reduced its recovered paper imports to 11 million in 2019, however it remained to be the largest importer in the world. Half of these 11 million tons was supplied by the United States. For the first time in 2019, the amount of recycled paper imported from Europe to India exceeded imports to China. Vietnam showed its determination to become the leading used paper fiber importer in 2019. Europe's strong paper recovery rate of around 70% creates a significant surplus. In 2019, 65,5 million tons of used paper was collected in Europe and 58,5 million tons of this was used in paper production. This resulted in a surplus of 7 million tons. In 2019, Europe's largest exporters of recycled paper were England with 3 million tons,

Netherlands with 2,6 million tons, Germany with 2,5 million tons, France with 2,4 million tons, Italy with 1,8 million tons, and Poland with 1 million tons. These figures include exports to both continental and non-European destinations. Although China remains the main destination for recovered paper export of the European Union, there is a serious decline in China's imports. China imported 7,5 million tons of recovered paper from Europe in 2017, 4,8 million tons in 2018 and 2,2 million tons in 2019, which is a decrease of more than 54% year-on-year (BİR, 2023).

Considering that the world's population lives in cities, it turns out that most of the waste in the world is produced in municipalities. Urban waste generation in the European Union has been increasing continuously since 2014. The amount of urban waste, which was 225,3 million tons in 2019, increased to 233,2 million tons in 2020 and 236,8 million tons in 2021 (Statıstа, 2023). In 1995, the amount of municipal waste in Europe was 198 million tons, of which 23 million tons (11,6%) recycled. In 2021, the amount of urban waste increased to 236 tons. 71,5 million tons (30,2%) of this was recycled (Alves, 2023).

Overall recycling rate of municipal packaging waste in the European Union (EU-27) in 2020 is 64%. Recycling rate in 2020 by material is highest for paper and cardboard 81,5%, glass 75,9%, metallic 75,7%, plastic 37,6% and wood 31,9% (STATISTA, 2023). Overall recycling rate of packaging waste in the European Union (EU-27) 2020 is 64,3%. In recycling rate of packaging waste by country Belgium ranks 1st with 79,2%, Netherlands 2nd with 78,8%, Luxembourg 3rd with 71,9%, Bulgaria is 19th with 61,2% and Romania 27th with 44% (Alves, 2020).

The amount of municipal waste materials recycled in the European Union was 23 million tons in 1995. This amount increased to 55 million tons in 2010 and to 70 million tons in 2021. The amount of packaging waste generated per capita in the EU in 2010 was 154 Kg. 120 Kg (76%) of this amount was recovered and 98,5 Kg (63%) was recycled. In 2020 packaging waste generated per capita increased to 178 Kg. 142 Kg (80%) of this amount was recovered and 114 Kg (64%) was recycled (Alves,

2021). 60 Kg (52,6%) of the 114 Kg recycled packaging waste was paper and cardboard waste (Alves, 2022).

According to the municipal solid waste recycling rate globally, Slovenia is in the 1st place with 58,5%, South Korea is the 2nd with 56,5%, Germany is the 3rd with 46,3%, Austria is the 4th with 40,6% and Latvia is the 5th with 34%. Turkey is the 30th with 12,8% (Alves, 2023).

Recycling of municipal waste in EU was 48% in 2020. When the European Union countries are ranked according to their total waste treatment methods in 2020, Italy ranks 1st with 83,1% in recycling, Belgium 2nd with 74,1%, Slovakia 3rd with 64,4%, Latvia 4th with 64,2% and Spain 5th with 60,4%. Bulgaria ranks 26th with 7.7 percent and Romania 27th with 5,2% (Statista, 2023).

As the statistics in 5.6 show and considering the low population growth rate in Europe, it can be put forward that there has been no significant improvement in recovery and recycling rates in the last decade. The European Union has set new targets to increase recycling rates that have been stagnant for a long time. The targets for Municipal waste recycling are 55% for 2025, 60% for 2030 and 65% for 2035. The targets for recycling all packaging waste in 2025 is 65%, in 2030 70% (Alves, 2023).17 The target for recycling paper and cardboard waste in 2025 is 75%, in 2030 85%. If a good recycling system is established and the citizens are persuaded to recycle, urban waste, which is the primary raw material source of the industry, will become a golden opportunity for the residents of this region. A poorly functioning waste system and non-recyclable waste will present difficult environmental and health problems to cities.

In Turkey, the recovery rate of bulky paper/cardboard, which is also called corrugated cardboard, has already reached its natural upper limit in 2018. This rate is 93% according to the data of the Ministry of Environment and Urbanization (Tiseo, 2023). Although there is a high level of paper/cardboard collection from industrial and commercial sources in Turkey, there is not enough collection from

households. One of the most efficient ways of collecting waste paper from households can be possible with the establishment of a mechanism where the citizens can give their recyclable waste directly to the collection system for a fee.

References for chapter four

Agliardi, E., & Kasioumi, M. (2023). Closing the loop in a duopolistic circular economy model. International Journal of Production Economics, 262, 108927. https://doi.org/10.1016/J.IJPE.2023.108927

Ahluwalia, Poonam Khanijo, and Arvind K. Nema. 2006. "Multi-Objective Reverse Logistics Model for Integrated Computer Waste Management." Waste Management & Research 24(6):514–27. doi: 10.1177/0734242X06067252.

Ahmed, N. (2023). Utilizing plastic waste in the building and construction industry: A pathway towards the circular economy. Construction and Building Materials, 383, 131311. https://doi.org/10.1016/J.CONBUILDMAT.2023.131311

Alves, B. (2020). Recycling rate of packaging waste in the European Union (EU-27) 2020, by country. Statista: https://www.statista.com/statistics/1317909/packaging-waste-recycling-eu-27-countries/

Alves, B. (2021). Amount of packaging waste generated, recovered, and recycled per capita in the European Union (EU-27) from 2009 to 2020. https://www.statista.com/statistics/1316625/packaging-waste-generated-recycled-in-european-union-per-capita/

Alves, B. (2022, June 28). Amount of packaging waste recycled per capita in the European Union (EU-27) in 2020, by type. https://www.statista.com/statistics/1316641/packaging-waste-recycled-in-

european-union-per-capita-by-type/

Alves, B. (2023, June 15). Municipal solid waste recycling rates in selected countries worldwide in 2021. Statista: https://www.statista.com/statistics/1052439/rate-of-msw-recycling-worldwide-by-key-country/

Alves, B. (2023, June 27). Municipal waste recycling targets in the European Union (EU-27) from 2020 to 2035.

Alves, B. (2023). Municipal waste treated in the European Union (EU-27) from 1995 to 2021, by method. Statista: https://www.statista.com/statistics/1315763/waste-treatment-by-method-european-union/

Alves, B. (2020). The recycling rate of packaging waste in the European Union (EU-27) 2020, by country. Statista: https://www.statista.com/statistics/1317909/packaging-waste-recycling-eu-27-countries/

Alves, B. (2021). Amount of packaging waste generated, recovered, and recycled per capita in the European Union (EU-27) from 2009 to 2020. https://www.statista.com/statistics/1316625/packaging-waste-generated-recycled-in-european-union-per-capita/

Alves, B. (2022, June 28). Amount of packaging waste recycled per capita in the European Union (EU-27) in 2020, by type. https://www.statista.com/statistics/1316641/packaging-waste-recycled-in-european-union-per-capita-by-type/

Alves, B. (2023, June 15). Municipal solid waste recycling rates in selected countries worldwide in 2021. Statista: https://www.statista.com/statistics/1052439/rate-of-msw-recycling-worldwide-by-key-country/

Alves, B. (2023, June 27). Municipal waste recycling targets in the European Union (EU-27) from 2020 to 2035. Statista: https://www.statista.com/statistics/1315931/recycling-rate-targets-in-

european-union/

Alves, B. (2023). Municipal waste treated in the European Union (EU-27) from 1995 to 2021, by method. Statista: https://www.statista.com/statistics/1315763/waste-treatment-by-method-european-union/

Banjerdpaiboon, A., & Limleamthong, P. (2023). Assessment of national circular economy performance using super-efficiency dual data envelopment analysis and Malmquist productivity index: Case study of 27 European countries. https://doi.org/10.1016/j.heliyon.2023.e16584

BİR. (2023). THE NEED FOR FREE TRADE. https://www.bir.org/the-industry/paper#ImportantFacts

BIR. (2023). Victims of irrational legislation. BIR: https://www.bir.org/the-industry/paper

Burger, P. C. (2007). Fenerty and his Paper Invention. Toronto: PB Publishing. http://www.charlesfenerty.ca/book_folder/BURGER%20-%20Charles%20Fenerty%209780978331818.pdf

Echchakoui, S., & Barka, N. (2020). Industry 4.0 and its impact in plastics industry: A literature review. Journal of Industrial Information Integration, 20. https://doi.org/10.1016/j.jii.2020.100172

Fatimah, Y. A., Kannan, D., Govindan, K., & Hasibuan, Z. A. (2023). Circular economy e-business model portfolio development for e-business applications: Impacts on ESG and sustainability performance. Journal of Cleaner Production, 415, 137528. https://doi.org/10.1016/j.jclepro.2023.137528

glassspecialtywlc. 2016. “Importance of Glass in Our Daily Life.” Medium. Retrieved August 10, 2023 (https://medium.com/@glassspecialtywlc/importance-of-glass-in-our-daily-life-88d558ad4322).

GREYCON. (2023). GREYCON. https://www.greycon.com/industry/paper/top-10-

pulp-paper-manufacturers/

Gutberlet, M., Preuss, L., & Thorpe, A. S. (2023). Macro level matters: Advancing circular economy in different business systems within Europe. Ecological Economics, 211, 107858. https://doi.org/10.1016/J.ECOLECON.2023.107858

Hagelüken, Christian, and Daniel Goldmann. 2022. "Recycling and Circular Economy—towards a Closed Loop for Metals in Emerging Clean Technologies." Mineral Economics 35(3–4):539–62. doi: 10.1007/s13563-022-00319-1.

Haq, U. N., & Alam, S. M. R. (2023). Implementing circular economy principles in the apparel production process: Reusing pre-consumer waste for sustainability of environment and economy. https://doi.org/10.1016/j.clwas.2023.100108

Illankoon, C., & Vithanage, S. C. (2023). Closing the loop in the construction industry: A systematic literature review on the development of circular economy. Journal of Building Engineering, 76, 107362. https://doi.org/10.1016/J.JOBE.2023.107362

Khatami, F., Vilamová, Š., Cagno, E., De Bernardi, P., Neri, A., & Cantino, V. (2023). Efficiency of consumer behaviour and digital ecosystem in the generation of the plastic waste toward the circular economy. Journal of Environmental Management, 325, 116555. https://doi.org/10.1016/J.JENVMAN.2022.116555

Kubiczek, J., Derej, W., Hadasik, B., & Matuszewska, A. (2023). Chemical recycling of plastic waste as a mean to implement the circular economy model in the European Union. Journal of Cleaner Production, 406, 136951. https://doi.org/10.1016/J.JCLEPRO.2023.136951

KYOCERA. (2023). Reducing Paper Consumption. KYOCERA: https://www.kyoceradocumentsolutions.com.tr/tr/smarter-workspaces/insights-hub/articles/kagit-tuketimi-gercekleri.html

Linnenkoper, Kirstin. 2019. “Global Glass Recycling Market to Exceed US$ 2.5 Billion • Recycling International.” Recycling International. Retrieved August 10, 2023 (https://recyclinginternational.com/business/global-glass-recycling-market-to-exceed-us-2-5-billion/19529/).

Linnenkoper, Kirstin. 2022. “‘Most Modern’ Glass Recycling on the Way in Romania • Recycling International.” Recycling International. Retrieved August 11, 2023 (https://recyclinginternational.com/business/most-modern-glass-recycling-on-the-way-in-romania/48113/).

Lisiecki, M., Damgaard, A., Ragaert, K., & Astrup, T. F. (2023). Circular economy initiatives are no guarantee for increased plastic circularity: A framework for the systematic comparison of initiatives. https://doi.org/10.1016/j.resconrec.2023.107072

Liu, Z., Adams, M., Cote, R. P., Chen, Q., Wu, R., Wen, Z., Liu, W., & Dong, L. (2018). How does circular economy respond to greenhouse gas emissions reduction: An analysis of Chinese plastic recycling industries. Renewable and Sustainable Energy Reviews, 91, 1162–1169. https://doi.org/10.1016/J.RSER.2018.04.038

Mahto, D. G. 2015. “Casting and Casting Processes.” SSRN Electronic Journal. doi: 10.2139/ssrn.2776565.

Nationmaster. (2023). https://www.nationmaster.com/nmx/ranking/paper-and-paper-products-production-value

Pacheco-López, A., Gómez-Reyes, E., Graells, M., Espuña, A., & Somoza-Tornos, A. (2023). Integrated synthesis, modeling, and assessment (iSMA) of waste-to-resource alternatives towards a circular economy: The case of the chemical recycling of plastic waste management. Computers & Chemical Engineering, 175, 108255. https://doi.org/10.1016/J.COMPCHEMENG.2023.108255

Plastics Europe. (2022). THE CIRCULAR ECONOMY FOR PLASTICS: A European Overview.

Pulidindi, Kiran, and Hiralkumar Patel. 2022. “Glass Manufacturing Market Size | Industry Report 2023-2032.” Global Market Insights Inc. Retrieved August 8, 2023 (https://www.gminsights.com/industry-analysis/glass-manufacturing-market).

Rai, P. K., Sonne, C., Song, H., & Kim, K. H. (2023). Plastic wastes in the time of COVID-19: Their environmental hazards and implications for sustainable energy resilience and circular bio-economies. Science of The Total Environment, 858, 159880. https://doi.org/10.1016/J.SCITOTENV.2022.159880

Ramos, T., Christensen, T. B., Oturai, N., & Syberg, K. (2023). Reducing plastic in the operating theatre: Towards a more circular economy for medical products and packaging. Journal of Cleaner Production, 383, 135379. https://doi.org/10.1016/J.JCLEPRO.2022.135379

RecyclingInternational. 2016. “EuRIC Launches Glass Recycling Group • Recycling International.” Recycling International. Retrieved August 11, 2023 (https://recyclinginternational.com/business/euric-launches-glass-recycling-group/4028/).

Reintjes, Martijn. 2023. “Majority of EU States Set to Miss Recycling Targets • Recycling International.” Recycling International. Retrieved August 10, 2023 (https://recyclinginternational.com/plastics/majority-of-eu-states-set-to-miss-recycling-targets/53898/).

Ren, Y., Li, R., Wu, K.-J., & Tseng, M.-L. (2023). Discovering the systematic interlinkages among the circular economy, supply chain, industry 4.0, and technology transfer: A bibliometric analysis. https://doi.org/10.1016/j.clrc.2023.100123

Rodrigues Dias, V. M., Jugend, D., de Camargo Fiorini, P., Razzino, C. do A., & Paula Pinheiro, M. A. (2022). Possibilities for applying the circular economy in the aerospace industry: Practices, opportunities and challenges. Journal of

Air Transport Management, 102, 102227. https://doi.org/10.1016/J.JAIRTRAMAN.2022.102227

Simon, B. (2019). What are the most significant aspects of supporting the circular economy in the plastic industry? Resources, Conservation and Recycling, 141, 299–300. https://doi.org/10.1016/J.RESCONREC.2018.10.044

Statista, 2023, statista.com

Statista:https://www.statista.com/statistics/1315931/recycling-rate-targets-in-european-union

Statista. (2023). Distribution of paper and paperboard production worldwide in 2021, by region. Statista: https://www.statista.com/statistics/595787/paper-production-worldwide-distribution-by-region/

Statista. (2023, April 17). Distribution of total waste treatment in European Union (EU-27) countries in 2020, by type of recovery and disposal. https://www.statista.com/statistics/1341031/european-union-total-waste-treatment-shares-by-method-and-country/

Statısta. (2023). Generation of municipal waste in the European Union (EU-27) from 2004 to 2021. https://www.statista.com/statistics/983592/municipal-waste-generation-european-union-eu-28/

STATISTA. (2023). Recycling rate of municipal packaging waste in the European Union (EU-27) in 2020, by material. Statista Research Department: https://www.statista.com/statistics/1072637/recycling-of-municipal-waste-in-the-eu-by-material/

Statista.(2023) https://www.statista.com/statistics/1316423/recycling-rate-targets-for-packaging-types-in-european-union/

Statista.(2023) https://www.statista.com/forecasts/932483/manufacture-of-articles-of-paper-and-paperboard-revenue-in-turkey

Statista. (2023). Distribution of paper and paperboard production worldwide in 2021, by region. Statista: https://www.statista.com/statistics/595787/paper-

production-worldwide-distribution-by-region/

Statista. (2023, April 17). Distribution of total waste treatment in European Union (EU-27) countries in 2020, by type of recovery and disposal. https://www.statista.com/statistics/1341031/european-union-total-waste-treatment-shares-by-method-and-country/

Statısta. (2023). Generation of municipal waste in the European Union (EU-27) from 2004 to 2021. https://www.statista.com/statistics/983592/municipal-waste-generation-european-union-eu-28/

STATISTA. (2023). Recycling rate of municipal packaging waste in the European Union (EU-27) in 2020, by material. Statista Research Department: https://www.statista.com/statistics/1072637/recycling-of-municipal-waste-in-the-eu-by-material/

Tiseo, I. (2023,) Packaging recycling targets in the European Union (EU-27) for 2025 and 2035, by type. https://www.statista.com/statistics/1316423/recycling-rate-targets-for-packaging-types-in-european-union/

Thi-Kieu Ho, O., Gajanayake, A., & Iyer-Raniga, U. (2023). Transitioning to a state-wide circular economy: Major stakeholder interviews. 19, 200163. https://doi.org/10.1016/j.rcradv.2023.200163

Viles, E., Kalemkerian, F., Garza-Reyes, J. A., Antony, J., & Santos, J. (2022a). Theorizing the Principles of Sustainable Production in the context of Circular Economy and Industry 4.0. https://doi.org/10.1016/j.spc.2022.08.024

Viles, E., Kalemkerian, F., Garza-Reyes, J. A., Antony, J., & Santos, J. (2022b). Theorizing the Principles of Sustainable Production in the context of Circular Economy and Industry 4.0. Sustainable Production and Consumption, 33, 1043–1058. https://doi.org/10.1016/J.SPC.2022.08.024

Winter, Nour. 2015. “The Glass Industry: Recent Trends and Changes in Working Conditions and Employment Relations.”

Yamamoto, M., & Eva, S. N. (2022). What activities reduce plastic waste the most? – The path to a circular economy for Japan's manufacturing industry. Waste Management, 151, 205–213. https://doi.org/10.1016/J.WASMAN.2022.07.041

[i] https://www.neaa.government.bg/en/
[ii] https://circulareconomy.vfu.bg/en/master.html
[iii] https://www.uni-sofia.bg/index.php/eng/the_university/faculties/faculty_of_economics_and_business_administration/faculty_members_departments/departments/economics
[iv] https://www.aracis.ro/en/
[v] http://yokak.gov.tr/
[vi] https://www.uni-sofia.bg/index.php/eng/the_university/faculties/faculty_of_economics_and_business_administration/faculty_members_departments/departments/economics