TBMCE 2019

2nd International Conference on

TECHNOLOGIES & BUSINESS MODELS FOR CIRCULAR ECONOMY

CONFERENCE PROCEEDINGS

EDITORS
MILOŠ BOGATAJ
ZDRAVKO KRAVANJA
ZORKA NOVAK PINTARIČ

University of Maribor Press

University of Maribor

Faculty of Chemistry and Chemical Engineering

2nd International Conference on Technologies & Business Models for Circular Economy

Conference Proceedings

Editors

Miloš Bogataj

Zdravko Kravanja

Zorka Novak Pintarič

May 2020

Title
Naslov
2nd International Conference on Technologies & Business Models for Circular Economy

Subtitle
Podnaslov
Conference Proceedings

Editors
Uredniki
Miloš Bogataj
(University of Maribor, Faculty of Chemistry and Chemical Engineering)

Zdravko Kravanja
(University of Maribor, Faculty of Chemistry and Chemical Engineering)

Zorka Novak Pintarič
(University of Maribor, Faculty of Chemistry and Chemical Engineering)

Technical editor
Tehnični urednik
Jan Perša
(University of Maribor, University Press)

Cover designer
Oblikovanje ovitka
Jan Perša
(University of Maribor, University Press)

Graphic material
Grafične priloge
Authors

Conference
Konferenca
TBMCE, International Conference on Technologies & Business Models for Circular Economy

Date and location
Datum in kraj
October 24th to October 25th, 2019, Portorož, Slovenia

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Published by / *Založnik*
University of Maribor
University Press
Slomškov trg 15, 2000 Maribor, Slovenija
https://press.um.si, zalozba@um.si

Co-published by / *Izdajatelj*
University of Maribor
Faculty of Chemistry and Chemical Engineering
Smetanova ulica 17, 2000 Maribor, Slovenija
https://www.fkkt.um.si/, fkkt@um.si

Edition *Izdaja* 1st

Publication type *Vrsta publikacije* E-book

Available at *Dostopno na* http://press.um.si/index.php/ump/catalog/book/472

Published at *Izdano* Maribor, may 2020

This investment is co-financed by the Republic of Slovenia and the European Union Fund for Regional Development"

Kataložni zapis o publikaciji (CIP) pripravili v
Univerzitetni knjižnici Maribor
COBISS.SI-ID 15270915
ISBN 978-961-286-353-1 (PDF)

ISBN 978-961-286-353-1 (pdf)

DOI https://doi.org/10.18690/978-961-286-353-1

Price *Cena* Free copie

For publisher *Odgovorna oseba založnika* prof. dr. Zdravko Kačič,
Rector of University of Maribor

Education for Zero Waste and the Circular Economy Sector in Europe

Peter Glavič[1], Aida Szilagyi[2], Isavella Karouti[3], Achilleas Kostoulas[3], Oihana Hernaez[4], Martin Dolinsky[5], Thomas Schönfelder[6], Pavel Ruzicka[7], Gosia Stawecka[8], Dimitrios Karadimas[9], Cristina S. Rocha[10], David Camocho[10], Bojana Žiberna[1], Eugenia Atín[4], Barbara Hammerl[8] & Hans Schnitzer[8]

[1] University of Maribor, Faculty of Chemistry and Chemical Engineering, Maribor, Slovenia, e-mail: peter.glavic@um.si, bojana.ziberna21@gmail.com
[2] CNPCD, Timisoara, Romania, e-mail: aidaszilagyi@cnpcd.ro
[3] AKETH_DCT, Trikala, Greece, e-mail: is.karouti@aketh.gr, a.kostoulas@aketh.gr
[4] PROSPEKTIKER SA, PE Zuatzu, Donostia-San Sebastián, Spain, e-mail: o.hernaez@prospektiker.es, e.atin@prospektiker.es
[5] EKOrast, Bratislava, Slovakia, e-mail: martin.dolinsky@ekorast.org
[6] Atmoterm SA, Opole, Poland, e-mail: schoenfelder@atmoterm.pl
[7] ENVIROS, s.r.o., Praha, Czech Republic, e-mail: pavel.ruzicka@enviros.cz
[8] StadtLABOR, Graz, Austria, e-mail: gosia.stawecka@stadtlaborgraz.at, barbara.hammerl@stadtlaborgraz.at, hans.schnitzer@stadtlaborgraz.at
[9] Global Reach, Athens, Greece, e-mail: d.karadimas@vbc.gr
[10] LNEG, Lisboa, Portugal, e-mail: cristina.rocha@lneg.pt, david.camocho@lneg.pt

Abstract The Erasmus+ project Education for Zero Waste and Circular Economy started in 2018 to fill a gap in Vocational Education and Training, create a new training course and develop interdisciplinary skills needed for new jobs. The consortium of ten partners from nine European countries intends to produce an interactive platform, comprising a Knowledge Hub, an Online Course and a Diagnosis Tool. One of the first activities of the consortium was to analyse the state-of-the-art in zero waste and circular economy in partner countries. The employment situation was considered, along with experience, qualifications and skills needed for trainees. An overview of the existing training was carried out, including educational methods, types of training organizations, duration of activities, and teachers' and trainers' qualifications. Basic information on the existing curricula and certification processes was reviewed. A special section was devoted to good practices. Links and references have been collected for each partner state.

Keywords: education, zero waste, circular economy, online course, Erasmus+.

University of Maribor Press

DOI https://doi.org/10.18690/978-961-286-353-1.15
ISBN 978-961-286-353-1

1 Introduction

Skills and competences in the field of Zero Waste and Circular Economy (ZW&CE) are becoming extremely important. In 2016, sectors relevant to the CE employed more than four million workers, a 6 % increase compared to 2012. According to the statistics, the European Union (EU) economy still loses a significant fraction of potential "secondary raw materials" in waste streams. In order to avoid that, the EU adopted in 2015 an ambitious programme called "Towards a CE – an economy package to help European businesses and consumers to make the transition to CE", where resources are used in a more sustainable way, boosting global competitiveness, fostering sustainable economic growth and generating new jobs. As part of its continuous effort to transform the European economy into a more sustainable one and to implement the ambitious CE Action Plan, the European Commission (EC) adopted a new set of measures known as the 2018 CE Package. Above all, the CE transition reinforces social and territorial cohesion and favours a balanced distribution of jobs and meeting health and safety standards, while enabling generation of fair and sustainable growth.

The paper provides general information regarding EduZWaCE, an Erasmus+ project that aims to fill the gap in Vocational Education and Training (VET) through the creation of new training courses focusing on ZW&CE. The international consortium consists of ten partners from nine EU countries, with various backgrounds, ranging from Universities to VET centres, and from public organizations to private companies related to ZW&CE. The project is expected to create four distinct Intellectual Outputs by September 2020: a *Knowledge Hub*, an *Online Course*, and a *Diagnosis Tool*, connected through the *Online Platform* of the project.

The paper provides an overview of the current state of the field in the partner countries and the EU28. Major definitions are given, along with a state-of-the-art report related to the organization of training in ZW&CE and good practices in the sector for all partner countries.

1.1 Zero Waste

Waste is unwanted or unusable material. EU waste policy is to turn waste into resources. The waste strategy is based on prevention and recycling. The 7th Environment Action Programme aims to achieve the following: a) reduce waste generation, b) maximise recycling and re-use, c) limit incineration to non-recyclable materials, d) phase out landfilling to non-recyclable and non-recoverable waste, and e) accept waste policy targets in all member states. A Resource Efficiency Roadmap, Raw Materials Initiative, and EU waste legislation have been elaborated by the EC. Additionally, the EC (2010) edited a brochure on the EU approach to waste management (using a life-cycle and waste hierarchy approach).

Zero waste (ZWIA, 2019) is the conservation of all resources by means of responsible production, consumption, reuse, and recovery of all products, packaging, and materials, without burning them, and without discharge to land, water, or air that threatens the environment or human health. ZW refers to waste management and planning approaches that emphasise waste prevention as opposed to end-of-pipe waste management.

ZW is a goal, a process, and a way of thinking that profoundly changes our approach to resources and production. It is not about recycling and diversion from landfills but about restructuring production and distribution systems to prevent waste from being manufactured in the first place. ZW Europe (2019) has laid down rules for the three most important areas of ZW: cities (municipalities), businesses, and life-style.

1.2 Circular Economy

Circular Economy (CE) is inspired by nature, where the output of one being/process becomes an input to another one, and waste does not exist. Many definitions of CE exist (Rizos *et al.* 2017). "CE is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life" (WRAP, 2019). The overall objective is to "enable effective flows of materials, energy, labour and information so that natural and social capital can be rebuilt" (Ellen MacArthur, 2015). The system diagram in

Figure 1 illustrates the continuous flow of technical and biological materials through the 'value circle'.

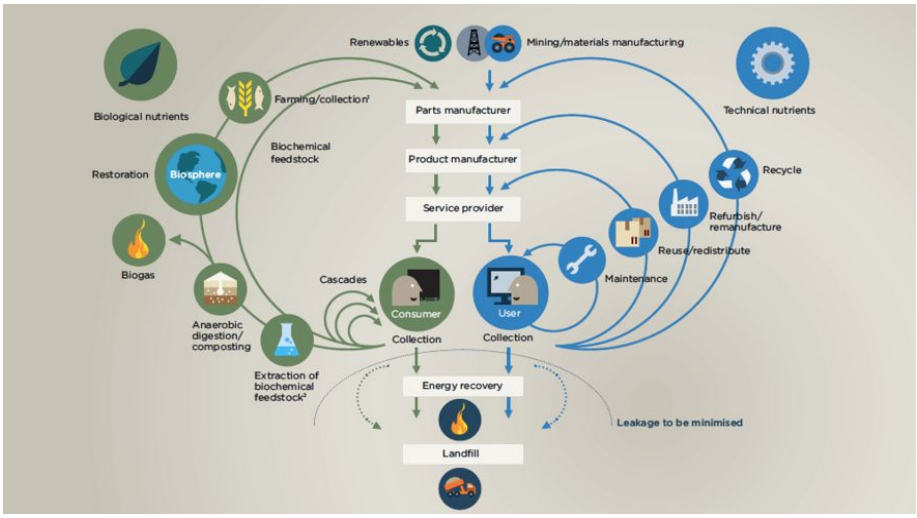

Figure 1: The circular economy – an industrial system that is restorative by design (Ellen MacArthur, 2013).

CE is central to the achievement of the Sustainable Development Goals (SDGs) and in particular, goal 12 on Ensuring sustainable production and consumption patterns. Products are designed for disassembly and re-use. Closed-loop systems advocate a 'functional service economy' in which manufacturers and retailers shift from selling products to services. Companies maintain ownership of products and act as service providers. Such a model promotes a) more durable products – longer life-span with a lower demand for energy and materials; b) disassembly and refurnishing rather than disposal; and c) new economic opportunities – through product and service shifts.

The EC has adopted a package of measures and legislative proposals to boost sustainable growth and help the EU make the transition towards a more CE. The EU CE package embraces 1) resource efficiency, 2) eco-innovation, 3) secondary raw materials, 4) production (energy and resource efficient CE), 5) smart consumption, and 6) waste prevention and management.

The EU CE Action Plan consists of 54 actions in five priority sectors: plastics, food waste, biomass and bio-based products, critical raw materials, and construction and demolition waste (CDW). The waste recycling targets for 2030 are as follows: 65 % of municipal waste, 70 % of overall packaging, 85 % of E-waste, and 89 % of CDW.

The monitoring framework on CE as set by the EC consists of 10 indicators, some of which are broken down into sub-indicators, divided into the following four thematic areas (Eurostat, 2019a): a) production and consumption, b) waste management, c) secondary raw materials, and d) competitiveness and innovation. France is using a somewhat different set of 10 indicators (SOeS, 2017). *Politico's* (2018) CE index includes 7 out of 10 EU indicators: Germany, UK and France were the leading countries. Czech Republic was 4th, Poland 6th, Slovenia 7th, Austria 9th, Spain 10th, Portugal 16th, Romania 18th, Slovakia 21st, and Greece 26th.

The *Circularity Gap Report* (CGR, 2019) showed that the Gap is not closing. Our world is only 9 % circular. Austria was the first country to elaborate a national CGR (CGR Austria, 2019). The Austrian report used four resource groups: 1) ores, 2) minerals, 3) biomass, and 4) fossil fuels. Material flow analysis included domestic extraction, net imports and recycled material as input, waste after recycling, carbon, vapour and recycled material as output. Mass flows were estimated by applying a combined production- and consumption-based approach. To increase the circularity rate from 9.1 % to 37.4 %, they proposed 1) shifting from fossil fuels to renewable resources, 2) recycling all recyclable waste, 3) sourcing all CDW of old building stocks, and 4) prioritising imports with a higher proportion of secondary content.

1.3 Online courses on ZW&CE

Massive Open Online Courses (MOOCs) about ZW&CE are available on the Internet – see, for example, the MOOC List on ZW (2019), or Ellen MacArthur (2019) courses on CE. The WRAP (2019) course has two levels: a) the Foundation level modules (waste and process mapping, measuring and monitoring, developing an action plan. gaining support, and developing your waste prevention plan), and b) Practitioner level training (resource efficiency and process improvement, behaviour

change, supply chain management and sustainable procurement, Environmental Management System, EMS).

The Solid Waste Association of North America (SWANA) and the California Resource Recovery Association (CRRA) formed a partnership to develop and offer a ZW certification course. It offers an overview of principles and practices in 10 modules including managing organics; financing and funding; contracting and partnerships; collection options and processing technology options (SWANA, 2019).

The KATCH-e (2019) Project (Knowledge Alliance on Product-Service Development towards CE and Sustainability in Higher Education), with a particular focus on the construction and furniture sectors, developed eight learning modules that are linked to each other but can also be used as stand-alone learning and teaching elements in four areas: Basics, Business, Design, and Assessment. Seven tools support the practical implementation of the knowledge and build up skills in companies.

The Finnish Innovation Fund Sintra (2019) helped five Finnish universities to develop nine multidisciplinary courses in different areas of application.

The Action Plan for Scotland, design for CE (Whicher *et al*, 2018) aimed to develop educational materials for cross-university use to increase the importance of circularity in designing undergraduate degrees.

2 Methods

The general methodology of the project was outlined in the project proposal where the expected outcomes were described. The first step in their development was the state-of-the-art review related to current research on ZW&CE in the partner countries. It aimed at outlining the following:

- Current situation of the ZW&CE sector
- Current situation of the organization of ZW&CE education and training

– The best practices emerging.

The consortium gained a better understanding of the sector and managed to point out the areas that allow further expansion for the VET in the ZW&CE sector. In order to refer to a common system, the ideas of NQFs, EQF and ECVET were respected.

A national qualifications framework (NQF) is a formalized structure in which learning level descriptors and qualifications are used to understand learning outcomes. The European Qualifications Framework (EQF) is a common European reference framework whose purpose is to make qualifications more readable and understandable across different countries and systems. According to the review publication (Cedefop, 2017), 34 countries had formally linked their national qualifications frameworks to the EQF.

The EQF is divided into eight levels that cover the entire span of qualifications from those achieved at the end of compulsory education, to those awarded at the highest level of academic and professional or VET and are described by descriptors for the expected knowledge, skills and competences at each level of qualification. In the partner countries, except Slovenia (which has ten levels), NQFs and EQF are totally aligned. Regarding what a learner knows, understands and is able to do, descriptors of learning outcomes are defined in terms of knowledge, skills and competences, relevant to qualifications at that level in any system of qualifications (Table 1).

Table 1: Knowledge, skills and competences in the European Qualifications Framework (EQF).

Knowledge	Skills	Competences
Knowledge is theoretical and/or factual related to Depth– Understanding and critical thinking	Skills are cognitive (involving the use of logical, intuitive and creative thinking), and practical (involving manual dexterity and the use of methods, materials, tools and instruments) related to breadth and depth – Purpose	Competence is described in terms of responsibility (in relation to others & self-work) and autonomy.

According to the state-of-the-art review, the consortium decided to focus on EQF levels 2 and 5, corresponding to ZW&CE Technician/Worker and Manager job-profiles, respectively. The EduZWaCE project aims to "create a certification framework for two job profiles – EduZWaCE Skill Card Sets designed to enable further European Credit System for VET **(**ECVET) certification of the course, to illustrate the skills and competences required for ZW&CE Manager and Worker profiles".

To support the transfer, recognition and accumulation of assessed learning outcomes, the EduZWaCE Curriculum also encompasses technical components of the ECVET, such as the definition of learning outcomes (knowledge, skills and competences) structured into a specific Learning Unit. They can be subject to evaluation and autonomous validation, incorporated into existing systems or qualifications yet to be designed, within the various NQFs. Assigning points to the Learning Units enhances compatibility between different VET Systems and makes it easier for ZW&CE Manager and Worker to obtain validation and recognition of work-related skills and acquired knowledge.

The ECVET (Cedefop, 2016) is one of the important common European tools to support and increase European mobility. ECVET is also meant to support learners on their career and learning paths to a recognized vocational qualification, through transfer and accumulation of their assessed learning outcomes acquired in different national, cultural, and education and training contexts. In a broader sense, ECVET should contribute to promoting lifelong learning and increase the employability of Europeans. The ECVET system is based upon the four concepts:

- Units of learning outcomes
- Transfer and accumulation of learning outcomes
- Learning agreement and personal transcript
- ECVET points.

Learning outcomes are used as a basis for credit transfer and accumulation. They do not dependent on the learning process, the content of teaching or the learning context. Therefore, it is possible to compare learners' achievements in different settings or contexts. The learning outcomes and the approach chosen for identifying them will depend on the specific qualifications system or context, enabling the provider of the training to design and describe the units overall. However, irrespective of the selected approach, learning outcomes should be designed so that they can be clearly understood by the actors involved: achieved during mobility, assessed abroad and recognized when the learner returns to the home institution.

ECVET points are a numerical representation of the overall weight of learning outcomes in a qualification and of the relative weight of units in relation to the qualification. Together with units, descriptions of learning outcomes and information about the level of qualifications, ECVET points can support the understanding of a qualification. The number of points allocated to a unit provides the learner with information concerning the relative weight of what he has accumulated. It also provides the learner with information concerning what remains to be achieved.

Each Learning unit is expected to correspond to 1 ECVET point – in total each course will be certified with 5 ECVET points.

3 Results and discussion

3.1 State-of-the-art in zero waste

Global annual waste generation is expected to jump from 2.01 Gt (billion tonnes) to 3.4 Gt over the next 30 years (The World Bank, 2019). At least 33 % of that is not managed in an environmentally safe manner. Worldwide, waste generated per person averages 0.74 kg/d (kilogram per day) but ranges widely, 0.11–4.54 kg/d. Global waste composition is: food and green 44 %, paper and cardboard 17 %, plastic 12 %, glass 5 %, metal 4 %, rubber & leather 2 %, wood 2 %, other 14 %. Global treatment and disposal of waste distribution: open dump 33 %, landfill (unspecified) 25.2 %, *recycling* 13.5 %, incineration 11.1 %, sanitary landfill (with

landfill gas collection) 7.7 %, composting 5.5 %, and controlled landfill 3.7 %. It is estimated that 1.6 Gt of CO_2 equivalent greenhouse gas emissions were generated from solid waste treatment and disposal in 2016, or 5 % of global emissions.

EU-28 waste generation per inhabitant was 4950 kg/a in 2016, and included the following waste fractions: CDW 38 %, mining and quarrying 25 %, manufacturing 10 %, energy 3 %, other economic activities 18 %, and households 8 %. In partner countries, the mass of waste generated per capita was the highest in Romania (9,0 t/a) followed by Austria (7,0 t/a), Greece (6,7 t/a), Poland 4,8 t/a, Spain (2,8 t/a), Slovenia (2,7 t/a), Czech Republic (2,4 t/a), Slovakia (2,0 t/a), and Portugal (1,4 t/a).

Recycling is the process of converting waste materials into new materials and objects. It can prevent the waste of potentially useful materials and reduce the consumption of fresh raw materials, thereby reducing energy usage, air pollution (from incineration), and water pollution (from landfilling). Fractions of recycling (Eurostat, 2019b) are high in CDW (89 %), medium in overall packaging waste (67 %), and low in recycling municipal waste (46 %), plastic packaging (42 %), and e-waste (41 %). Regarding the total waste recycling fractions, Austria is in the 1st group, Slovenia in the 2nd one, Poland in the 3rd, Portugal, Czech Republic and Spain in the 4th, and Slovakia, Greece and Romania in the last one (Fig. 2). High recycling rates are a precondition for the CE. In urban solid waste recycling, the situation is very much the same.

In *Austria,* the annual mass rate of waste continues to increase. According to the Austrian Federal Waste Management Plan 2017, around 4.2 Mt of municipal waste was generated from households and similar establishments – an increase of 6.8 % compared to 2009. Approximately 10 Mt of CDW accrued in 2015 in Austria. The average was 1160 kg per person. The mass of excavated materials and soils was approximately 32.8 Mt. In 2015, 420 plants were available for treating CDW. Approximately 9.7 Mt of CDW and excavated materials were treated in these plants. A new waste prevention program has been published by the BMNT ministry in 2017, supporting environmental goals by defining targets for avoiding waste, reducing pollutants and establishing CE.

In the *Czech Republic*, 34.5 Mt/a waste was generated in 2017. 80.4 % of it was recovered as waste to material, and 3.6 % as waste to energy. Recycling of packaging waste achieved 73.7 %; 98 % of CDW was materially recovered. While 49.6 % of municipal waste was recovered, 45.4 ended in landfills. Municipalities have to ensure separate collection of paper, plastic, glass, metals and biodegradable municipal waste. Separation and recycling centres, operated by municipalities, accept bulky waste (e.g. old furniture), metals, bio-waste, fats and oils, hazardous waste, household appliances, tyres, small CDW, and other waste that cannot be separated in small containers.

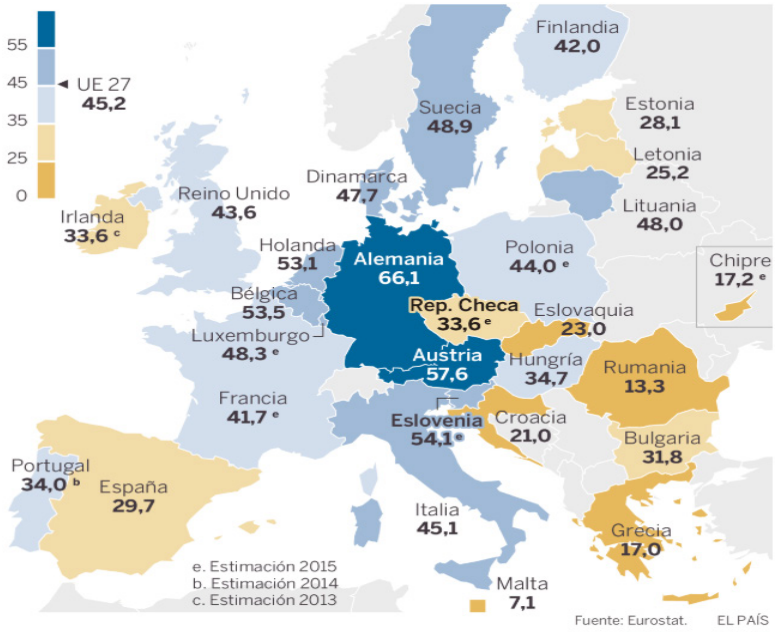

Figure 2: Total waste recycling fractions in Europe 2016
(Eurostat).

In *Poland*, environmental education is crucial for the success of transformation towards ZW&CE. Research on sustainable consumption indicates that the level of consumer awareness is still low. Pricing is still almost the only criterion when making consumer decisions. In this context, it is important to focus education on changing consumer behaviour by raising their awareness of environmental protection and

developing their knowledge about rights in access to information about the product and the producer to minimize the impact of products during their lifecycle.

Portuguese material productivity in 2016 was 1.08 €/t, which is half the European average (2.07 €/t). The Portuguese economy tends to accumulate materials in its territory, since more materials are extracted and imported than exported, thus accumulating stocks of materials, mainly in real estate. In 2014, extraction plus imports represented 202 Mt of materials, of which 93 Mt were accumulated in stock and 109 Mt left the economic circuit as emissions and exports. Regarding the production of waste in 2016, urban waste production per inhabitant was 454 kg/a, with a recycling rate of 40.4 %, below the European average (43.7 %). However, waste production in Portugal is lower than the European average: the total dredged waste and contaminated soil reached 1184 kg/a, 69 % of the EU average.

Romania is far behind in terms of implementation of the CE principles. Landfilling continues to be the prevalent management practice, with only 13.3 % of waste recycled. Consequently, the collection targets for waste packaging, waste electric and electronic equipment, and waste batteries and accumulators are not met, and the circular material use rate is the lowest in Europe. The key challenge is the inability to sort all waste. There are many reasons for that, starting with the continuous changing of legislation and its poor implementation, the failure of various key actors in taking responsibility, ineffective extended producer responsibility schemes, and low levels of awareness and education. Inadequate practice in reporting, collecting, integrating and evaluating data, and the slow implementation of policy and economic instruments are serious barriers to enhancing waste prevention and reduction, and transition to CE.

In *Slovakia*, interest in ZW has increased among the broader public and younger generation. There are various growing ZW communities even outside the big cities, and an increasing number of shops. E.g. a Facebook group *ZW Slovakia* has close to 12 000 followers. There are various start-ups and social enterprises focusing on upcycling fashion, and producing bags and bottle holders using recycled textiles. Fashion brands that focus on clothing rental and swapping are coming. In 2019, a conference *Slovakia Goes ZW* was organized in Stara Trznica, again with various Slovak companies and e-shops present.

In 2017, *Slovenia* produced 483 kg of municipal waste per capita including 60 kg of food waste; 70 % of waste is separated. The system is similar to the Czech one. ZW Europe reported that Slovenia was the best performing EU country, with the lowest mass of residual waste, just 102 kg per capita in 2014.

Spanish companies are proving to be up to the challenge of CE and have launched programs of all kinds: ensuring the durability of products, recovering resources within the value chain, extending the life of the product, marketing products as services, etc. In this new panorama, companies have begun to rethink their production processes in order to minimize waste generation.

3.2 State-of-the-art in circular economy

Eurostat is following the CE results by using 16 indicators and calculating their normalized values for each member state. The best results have been achieved by Netherlands, Belgium and Slovenia. Austria is 5th, Poland 9th, Spain 14th, Portugal 15th, Slovakia 17th, Romania 22nd, and Greece 24th. There are no data available for the Czech Republic. CE ranking in Europe is presented in Figure 3.

The circular material use fraction (rate) of total material use in EU-28 reached 11.7 % in 2016 (Eurostat, 2018). Netherlands managed 29 %, Austria 10.6 %, Poland 10.2 %, Slovenia 8.5 %, Spain 8.2 %, Czech Republic 7.6 %, Slovakia 4.9 %, Portugal 2.1 %, Romania 1.5 % and Greece 1.3 %.

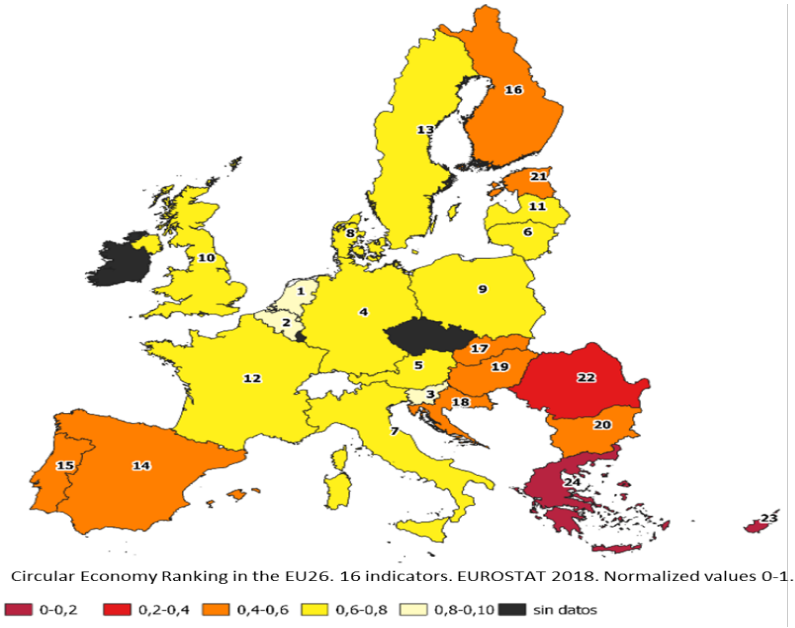

Figure 3: Circular Economy Ranking in the EU26.

3.2.1 Organization of training sessions

In partner countries, ad hoc seminars, scientific and professional conferences are organized; web platforms, books, and e-manuals are available; no regular and systematic education is taking place from the elementary level to tertiary education. In some of them, new MSc courses are starting in 2018 and 2019 at university level.

In *Austria* an International Masters Programme on CE has recently been introduced at Graz University.

In *Czech* Republic, the VET course on CE was organized by the University of Chemistry and Technology in Prague in 2017/18. The aim of the course is to offer specific knowledge in the field of CE, which will influence activities from product development and production, recycling technology, waste management, marketing, and environmental protection, to social issues, and business responsibility. The course is suitable for waste management, CSR experts, environmental ecologists and

managers determining the strategies chosen to ensure business resilience and new strategies. The course is officially accredited as Lifelong learning instruction.

In *Portugal*, the following courses were identified at the university level:

- A new curricular unit on "Product Design in CE" at the University of Aveiro (KATCH-e, 2019)
- A post-graduate course "CE – Environment as a Competitiveness Factor" at Lusófina University
- A training unit at the University of Porto (Faculty of Engineering).
- Courses (e.g. "Training on CE" provided by SGS) and workshops (e.g. workshops on circular design, circular business models, life cycle perspective on CE and managing CE provided by LNEG and IAPMEI) have also been organized.

In *Slovakia*, the levels of EQF are unified with the National levels published by the Ministry of Education.

1) In primary and secondary school education (Levels 1–4), training for the CE is not approached in a systemic way. Elementary schools may join as associated parties in various EU funded projects or can join initiatives organized by local/municipal authorities in the region.
2) Post-secondary education (Level 5) – this level of education was omitted in the strategy document of the Ministry of Environment. Similarly, no initiatives are being performed in relation to this target group.
3) University studies – the only existing accredited study program in "CE" is offered by the Slovak University of Agriculture in Nitra.
4) Informal education – training in CE is being offered in the form of internationally recognized project initiatives (e.g. Interreg Danube Transnational Programme MOVECO) or as initiatives of national agencies or local NGOs (e.g. Open Source CE days organized by EKOrast). The target groups are university students, teachers and entrepreneurs.

3.2.2 Characteristics of training for the circular economy

Training sessions are *organized* by research/project groups, regional/national chambers of industry and commerce, universities, R&D institutes, competence/technology centres, local communities, ministries (regional and national ones), NGOs, media, or service providers. They are also given as a part of another course or degree; e.g., formal CE education is organized by the Slovak University of Agriculture in Nitra; however, the systemic approach towards sustainable development is best embraced by the Slovak University of Technology.

The *duration* of training is 1–2 days for seminars, up to 2 years for a university degree. For example, in Portugal, the module "Product Design in a CE" curricular unit at the University of Aveiro takes 1 semester, while the "CE – Environment as a Competitiveness Factor" post-graduate course at Lusófona University lasts 1 year.

Trainers are professionals, environmental consultants, R&D team members, ministries, universities, institutes, competence centres, technology centres, or companies. They are not employed as VET teachers of ZW & CE.

3.2.2 Curriculum content

A Master's course on CE exists in *Spain*, and a course on environmental management and sustainability in *Greece*.

In 2017 the *Portuguese* Ministry of Environment presented the National Strategy of Environmental Education 2020 with three thematic pillars, one of them being CE (APA, 2017).

In *Austria*, several courses are offered:

- Vocational training for Waste Disposal and Recycling Experts by the Federal Economic Chamber (WKÖ)

- Courses are offered by the Austrian Water and Waste Management Association (ÖWAV) in CDW, waste management, municipal waste management, construction law, and waste management law
- International Master's Programme on CE at the University of Graz.

In *Czech Republic* several course blocks on CE are offered.

In most partner countries, there are no certification processes.

3.3 Good practices in circular economy

Austria

1) *RepaNet Initiative* (Re-Use- und Reparaturnetzwerk Österreich), launched in 2004 to increase the supply of repaired products and the demand of repair and rental services.

2) *BauKarussell*, the first Austrian cooperation that addresses reuse in buildings on a large scale. Together with property developers, the consortium removes selected materials and products to make them available for new buildings. The operational work is performed by employees from social enterprises. These unemployed people gain jobs, training and support to find their way back to the labour market.

3) *Re-Use Box*, the first collection system for reusable small goods to be distributed to the population at several points in Graz. The collected goods are sorted by the participating social economy enterprises and prepared for reuse in the reuse shops.

4) A *Reuse shop* at the resource park in Leibnitz, Styria, offers the possibility to sell used, but still well-functioning household and garden equipment, books, toys, decorative items, and much more.

Greece

1) *ReWeee* Project (Reducing Waste Electrical and Electronic Equipment, WEEE) aims to prevent the creation of WEEE and to demonstrate that WEEE can be efficiently sorted and reused.

2) *Close the loop in ceramic industry*: Valorisation of various types of inorganic and organic wastes as substitutes for clayey raw material. The quality of extruded and pressed ceramic products was evaluated for their properties and the environmental impact.

3) *HYDROUSA*, Demonstration of water loops with innovative regenerative business models for the Mediterranean region will provide innovative, regenerative and circular solutions for (1) nature-based water management of Mediterranean coastal areas, closing water loops; (2) nutrient management, boosting the agricultural and energy profile; and (3) local economies, based on circular value chains. The services lead to a win-win-win situation for the economy, environment and community within the water-energy-food-employment nexus.

Poland

1) *5 Fraction Coalition* – a transparent pictogram system for packaging in Poland.

2) *BREAM certification of Skanska buildings* – a developer with a recycling rate of 97 % in 2018.

3) *Think*, eliminate everything that you don't need – Studio 102, based on the 5R approach (Refuse/Reduce/ Reuse/Repurpose/Recycle).

Czech Republic

1) *Strategy Circular Czechia 2040* – under preparation

2) *Several bottom-up initiatives*

3) CE course.

Portugal

1) The *National Action Plan for the Circular Economy,* with strategies and mechanisms to implement CE;

2) The *ECO.nomia Portal,* a knowledge sharing platform promoting CE, tools, funding opportunities, examples of best practices, etc.

3) The *Research and Innovation Agenda on CE*

4) Five regional agendas

5) Funding opportunities for CE, such as an Environmental fund to support CE projects, an EC Voucher to fund companies in small EC projects, etc.

6) The *EcoLab,* a collaborative laboratory on CE to promote cooperation between academia and companies in transition to CE, with a particular focus on industrial biotechnology, green chemistry and eco-design

7) Several national R&D projects.

Romania

1) The use of sludge for agricultural purposes

2) A law on food donation.

Slovenia

1) SMEs' Green action plan for transition to CE

2) Indicators, methods and tools for measuring CE

3) Use of eco-design for SMEs in civil engineering.

Spain

1) Circular business training (furn360.eu)

2) Resources offered by Ihobe, the Environmental Basque Agency.

3.4 Intellectual Output 1

The **Knowledge Hub** supports the development of interdisciplinary skills needed for new jobs in this area. It is an interactive online resource centre, gathering selected information to enable circular projects and ideas to be used and applied as inspiration coming from existing best cases and success stories.

VET teachers, professionals from companies and other users will have access to this open education resource, with tailored information in a structure that will allow further enclosure by all partners of newly released information, which is continuously being developed in the area of ZW&CE.

The taxonomy of the Knowledge Hub includes relevant content about CE, waste and ZW concept, critical raw materials, circular design, etc., available in literature, standards and legislation, books, good practices, case studies, presentations, videos, software, methods, tools and other relevant resources. It has a user-friendly structure and functionalities, and because of its concept and architecture, it is easily transferable to other educational systems and topics.

3.5 Intellectual Output 2

The **EduZWaCE platform** is developed on the open source of Moodle, an e-learning platform designed to provide trainers, administrators and learners with a reliable, secure and integrated system of personalized learning environments. Moodle is provided freely as Open Source software that anyone can adapt, extend or modify for commercial or non-commercial projects without any licensing fees, and benefit from the cost-efficiencies and flexibility.

Moodle's multilingual backbone ensures that there are no linguistic limitations to learning online. The community has started translating Moodle into more than 120 languages, and users can easily localize their Moodle approach, along with plenty of resources, support and community discussions available in various languages, including those of the project partners.

Moodle (2019) is used as technical base in almost 20 million online courses. It is one of the best open source learning management systems, offering a plethora of features in comparison to other providers (Capterra, 2019). The system allows a wide range of different possibilities from which the project will use the following:

- The Quiz option to test trainees
- The features of Forum, Chat and Teleconference to ensure communication between trainers and trainees
- The possibility to assess trainers by surveying them in order to improve the quality of course organization.

The possibilities of the open source learning management system will be used in the EduZWaCE platform by a modular approach to use exactly those features that fulfil the multifunctional and collaborative needs in the area of administration, the platform itself and the course content.

3.6 Intellectual Output 3

The **ZW&CE on-line course** targets two jobs: the Manager, and the Technician/Worker.

3.6.1 Focus group 01

ZW&CE Manager is a professional able to asses resource use, waste generation, and product lifecycles, and to develop, implement and monitor CE projects in a company. He/she should be able to perform systems evaluation by identifying its indicators and the actions needed to improve or correct performance, relative to the goals of the system, monitor organization performance in material resource/waste

management, and propose improvements or take corrective action. A Manager's tasks would be to assess resource consumption and waste generation, develop material and waste balances in the company, assess root causes of material inefficiencies and waste, generate, evaluate and implement waste reduction options, evaluate companies' products and propose ways of greening them, perform circularity assessment in a company, propose circular solutions for products, operations and services, and propose/evaluate new circular business models. Considering that companies are acting within a value chain, networking and cooperation with actors from the value chain are requirements.

Entry requirements correspond to the EQF level 5 completed by the interest in acquiring specialized knowledge in ZW&CE. It requires at least one year's work experience in resource and waste management, production operations, specialised factual and theoretical knowledge within the field of waste and resource management and specific production operations. A comprehensive range of cognitive and practical skills required to solve abstract problems and develop creative solutions are also desired.

As for learning outcomes, the individual shall demonstrate mastery of acquired learning outcomes in accordance with certain performance criteria and context conditions. Five learning units are being developed: 1) Introduction to CE, 2) Material and resource efficiency, 3) Circular design, 4) Value creation in CE, Circular business models, and 5) Self-assessment and co-creation of circular solutions. Their content is elaborated in sub-sections, e.g. for learning unit (4): a) Self-assessment tools – benefits and limitations, b) Assessment of product environmental performance, c) Assessment of material flows and waste streams in production processes, and d) Cooperation within value chains.

The knowledge skills and competencies are presented in Table 2. Performance criteria and workloads in hours can be added. The learning outcomes for the content in sub-sections are organized the same way.

Table 2. Learning Outcomes.

Knowledge	Skills	Competences
Depth: The learner has knowledge in design of CE procedures and their applicability in practice in the development of circular products and services. **Understanding and critical thinking:** The learner understands the concepts of design for CE and the strategies for implementation.	**Breadth and depth:** The learner is able to apply the design methodology with a circularity approach, applying strategies and tools aiming to develop new and innovative circular solutions **Purpose:** The learner is able to apply practical strategies and tools to solve specific problems and challenges faced by an actual design problem.	**Responsibility (relation to others & self-work):** The learner is able to carry out projects individually if he/she has adequate knowledge of specific methods in line with product and service development. He is able to manage and establish the link between other team members and review their work from a methodological and practical point of view. The learner will be able to transfer the knowledge and skills to their own project and to implement it. **Autonomy:** High level of autonomy.

Main action / achievement	**Workload**
The learner will have an understanding of the role of design and designers in the CE model and become acquainted with circular design concepts and strategies, be able to select and apply them, design and develop processes, products and services in a holistic manner.	**25 hours**

3.6.2 Focus group 02

Training material for focus group 2, to be developed within the EduZWaCE Project, is designed for technicians and workers from reuse, repair and recycling centres who are interested in acquiring knowledge and new skills in the field of reuse and CE.

Since CDW is the largest waste stream in the EU in volume (EPRS, 2015), the main focus of this EduZWaCE training programme will be on CD sector. In this context a comprehensive training manual ("Qualified workers for the reuse of CD materials") will be developed.

This qualified worker carries out an assessment of reusable CDW streams prior to demolition and renovation of buildings. The aim is to facilitate and maximize recovery of materials and components from demolition or renovation of buildings and infrastructures for beneficial reuse, without compromising safety measures and practices. In the EU context, this task could be performed by trained workers within the reuse parks and recycling and waste collection centres, as well as construction or demolition companies.

By the end of the course, participants should be familiar with different types of reusable CD materials as well as techniques of dismantling and material recovery. The course will combine theory with practical examples and assignments. It will be divided into five learning units: 1) Introduction, 2) Furniture, 3) Construction elements, 4) Electric equipment in buildings, and 5) Conduct of an assessment of reusable CD materials

The introductory learning unit will give an overview of aspects such as the following: What is an assessment of reusable construction and demolition materials (purpose, target groups, added value, etc.)? What are the major steps in conducting such an assessment? A summary of best practices in cities will then be presented. The subsequent learning units (2–4) will focus on selected reusable materials and elements, i.e. furniture, construction elements and electric equipment in buildings, providing information on different dismantling and material recovery techniques (including instructions, videos, graphics, etc.).

At the end of the course (learning unit 5), a fictitious assessment of a building will be performed by the course participants. They will be given an opportunity to perform the assessment within the framework of a focus group and under guidance of an expert in the field of circular economy.

The requirement for entering the course is completion of Level 2 of the EQF.

3.7 Intellectual Output 4

The ZW&CE Diagnosis Tool, developed within the EduZWaCE project, is considered to be a useful self-assessment tool for companies (in particular SMEs) that will help them investigate opportunities for circular economy solutions in their specific context. The company will be able to identify the most effective opportunities for improvements in terms of circularity, as well as the overall sustainability performance, and to choose the most effective leverage points and feasible measures leading to both an improvement in circularity and efficient allocation of its limited resources.

In order to optimise improvement measures and actions, it is important to review the whole system of a business in a consistent way; therefore, all levels of a company need to be assessed in a systematic way, including the physical level (products, production processes), the information level (management systems) as well as the governance level (business strategy, stakeholders relations).

Understanding of the main materials (and energy) flows and waste streams is the key to assessing the company's situation in relation to circularity; in this regard, the internal circular economy opportunities are addressed in a first step based on the following elements:

- Level of integration of circular economy objectives into the core business strategy and business models;
- Key materials used, risks and opportunities related to these and relevant waste flows;

- Real costs of materials and waste flows, including non-product output related costs;
- Actions already implemented towards circularity.

At the same time, the external opportunities of circular economy will be assessed. These will address, in particular, the life cycle perspective of products, and opportunities within value chains and with other stakeholders (e.g. industrial symbiosis).

The main feature of the Diagnosis Tool is the holistic approach, which is manageable at the SME level. In contrast to other methodologies that provide a diagnosis in this field, our tool is strictly based on a need-driven approach. Instead of assuming that any existing tool can produce the desired positive changes, the Diagnosis Tool focuses first on improvement potential within the given company, and only after that, does it assign suitable measures that address this potential to be further developed by the company.

The tool will be made available in the Collaborative Section of the Platform to be used for free by companies and circular economy experts. We expect about 10 companies per partner to be logged in on the Platform and use the Diagnosis Tool during the project lifetime.

Apart from the Platform, the Diagnosis Tool will also be closely linked with the other intellectual outputs. The tool users will have a possibility to explore received recommendations through the resources of the Knowledge Hub, as well as to learn more about actual topics in the On-line Course.

4 Dissemination

The results of the project need to achieve maximum impact: they should radiate as widely as possible so that the valuable lessons and experience gained by one group can benefit others. Moreover, what is learned from a project should inform future policy. All this can happen only if connections are made between the project partners and the wider community. The key means of connecting with the target audience is

the process of communication and dissemination. Three types of audience have been defined at individual, local and national, EU and global levels: 1) Dissemination inside and outside an organization will tackle project partners and users. 2) Dissemination at local and national levels will target potential users: key players in VET, teachers' associations, VET learners/students and employees, universities and research institutions, NGOs, innovators and sustainability experts, company representatives, industrial associations, clusters on one side, and local and regional policy makers, on the other side; 3) Dissemination at the European and global levels will address European and international organisations and institutions, policy makers, academia, NGOs and international networks with varied interests, from education and awareness creation, to policy development and support.

Dissemination is carried out according to the Plan for Communication and Dissemination, having as its main objective to communicate the project objectives, collect feedback and contributions from the target audience, and disseminate results, technical achievements and innovations. The project portal plays a central role in communication and dissemination of the project ambitions and results, while communication by social media is of great importance. The outcomes of the project, any tangible resources, products, deliverables and outputs resulting from the funded projects, will also be available for dissemination purposes at the Erasmus+ Project Results Platform and the EduZWaCE platform (https://www.eduzwace.eu/).

New CE phenomena bring to the forefront new managerial challenges as they evoke cooperative attitudes in situations that used to be fully competitive. If the business success of circularity is based on successful collaboration of previously unlinked industries, then there is a need to forecast how this cooperation could turn out.

In CE, there is a disproportionally larger number of collaborative incentives and needs than ever before. This is well documented by recycling, reuse, recovery, restoration or revitalisation projects. The issue of cooperation is significantly present as a key-enabling driver for sharing ideas, testing approaches or constant improvements.

5 Conclusions

Earth Overshoot Day (2019) moved from August 1 last year to July 29 this year, the earliest ever. This is the day when humanity has used nature's budget for the entire year. This means that humanity is now using nature 1.75 times as fast as the planet's ecosystems can regenerate. Carbon dioxide emissions currently make up 60 % of humanity's demand on nature. The partner countries' overshoot days occur even earlier: Austria, April 9; Czech Republic, April 17; Slovenia, April 27; Poland, May 15; Greece, May 20; Slovakia, May 22; Portugal, May 26; Spain, May 28, and Romania, July 12.

The warming up of land and oceans is causing faster and more abundant water evaporation and many extreme events: record-breaking heat waves with fires, droughts, melting of polar ice and glaciers, and sea level rise, tornadoes, typhoons, powerful storms, hail, floods, and land-slippage. Biodiversity is reduced by species extinction. Food production is lowered and woods are endangered. Hydro energy production is reduced; river transport is stopped. Many people are killed in extreme events, and the number of climate refugees is rising. Education for ZW&CE can help slow climate change and reduce the scarcity of materials.

"Decoupling environmental degradation from economic growth by doing more and better with less" is needed. Slower growth, or even *degrowth*, particularly in the developed countries, is required to stay within planetary limits. Degrowth requires changes in consumption patterns (habits, behaviours, and life styles), better prediction mechanisms, reduction in consumption levels, and changes in infrastructure. It is also called *strong sustainable consumption*. Education for degrowth is badly needed, and education for ZW&CE can be very helpful as a first step.

Our research has shown that universities have started to introduce courses on CE, but curricular units on ZW are very scarce. VET education is even less developed – there are no curricula, no courses, no teachers and no students to do the jobs of the future; the only exception seems to be Austria. The younger generation is requiring changes towards degrowth that can be connected with education to yield synergies. In contrast with schools, there are many bottom-up initiatives and good practices that can be integrated into education for ZW&CE.

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