Co-funded by the Erasmus+ Programme of the European Union

Management and Technologies of Water, Waste Water, Waste and Circular Economy
WWW&CE

WP4. E-FUNDAMENTALS OF THE CIRCULAR ECONOMY

CURRICULUM

VSRC

2020

1. INTRODUCTION

1.1. Aim and objective of the Curriculum:

To train a qualified worker/environmental consultant who can apply the principles of the circular economy in the daily operation of an SME and to deliver the message to customers, workers, and other involved agents. After completion of the course, the learners will be equipped with all needed skills, knowledge, and competence to meet current and emerging workplace demands with regards to the circular economy and related processes.

In WP4 six additional qualifications are developed:

A Technologies water supply

B Technologies water saving

C Greywater and rainwater utilisation technologies

D Technologies decentralised wastewater treatment

E Fundamentals of the circular economy

F Systemic solution-oriented consulting

This program can be completed as a separate module or as an integral part of the training course "Environmental consultant".

1.2. Target group:

The training program intended for stronger VET learners or skilled workers.

1.3. Competencies acquired:

1. ENVIRONMENTAL MOTIVATION, (acting and behaving according to a set of reasons and facts to preserve materials, resources and products for the circular economy);
2. LEGAL (knowing of the content of EU documents regulating the implementation of the principles of the circular economy, United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, Paris Climate Change Agreement, National regulatory requirements applicable to the waste management);
3. RESPONSIBILITY (knowing, evaluating and comparing one's own and others behaviors, thoughts, values and emotions in the preservation of materials and resources to contribute to the circular economy);
4. CREATIVITY (responding in a circular economy approach to a complicated situation to optimize resources and products in a new and original way);
5. TAKING ENVIRONMENTAL INITIATIVE (showing initiative and encouraging others in dealing with environmental behaviors to promote the principles of the circular economy);

6. VALUING ENVIRONMENTAL IDEAS (identifying, analysis, measuring and considering ideas to face the challenge of resource preservation in the field of circular economy);
7. WORKING WITH OTHERS (combining different contributions and find ideas (also from outside of environment) to create environmental value to reuse and optimate recourse and products);
8. WORK SUSTAINABLE (applying the most appropriate environmental management in a given scenario);
9. SPOTTING OPPORTUNITIES (making connections between ideas and concepts from different fields, linking different disciplines and ideas with a circular economy approach);
10. COPING WITH RISKS (assuming the challenges, accept the risk and to succeed in a situation of danger and doubt);
11. ENVIRONMENTAL VISION (communicating clearly to others a compelling and inspired vision or sense of a core environmental purpose to optimize resources to contribute to the transition to the circular economy).

1.4. Duration: 88 contact hours, 54 hours for self-learning and 2 hours for assessment

Based on ECVET principles, the length of a course counted by accumulating the following:

- contact hours (Theory): the amount of expected timetabled hours of teacher-student contact, including lectures, tutorials, seminars, and workshops for delivering the theoretical part.
- self-study hours (Individual work): the study of something by oneself without direct supervision or attendance in a class.
- hands-on hours (Practice): practical sessions that can also be supervised.
- assessment hours: the time needed to prepare an assignment, including the time allocated to the exam.

1.5. Prerequisites to enter (minimum education required):

Based on the content of Curriculum the basic requirement for a learner to meet before undertaking this program is set as at least one of the following:

a) young people who are still undergoing school-based or dual initial vocational training, have particularly good learning outcomes and acquire qualifications in addition to their normal vocational training.

b) persons who, after undergoing initial vocational training, acquire these additional qualifications in the context of further vocational training.

1.6. Content and scope of the Curriculum:

No of Unit	Course contents	Learning objectives	Time guideline	
			Contact hours	Self-study
I.	**Definition of the circular economy**		**10**	**6**
	What is the circular economy?	Basic facts and knowledge about the circular economy; EU documents regulating the implementation of the principles of the circular economy (*Report of the implementation of the Circular Economy Action Plan, Documents on the circular economy package*); New business opportunities; Case studies		
	Why shift to the circular economy is important?			
	Principles of the circular economy			
	Aims, objectives, and rules			
	Opportunities for business			
II.	**Stages of the circular economy**		**36**	**20**
1.	**Resources**		4	2
	Primary raw materials	Minerals commonly used in the industry (oil, metal ores, peat, dolomite, limestone, gravel, chalk, clay, groundwater)		
	Secondary raw materials	Residues of used materials (paper, glass, plastic, metal, etc.)		
	Secondary raw materials by composition	Used plastic, paper, glass, metals, wood, biological materials		
2.	**Design**		4	2
	Eco-design strategies for products	Choosing the right environmentally friendly or less hazardous materials, reducing the amount of materials used, optimizing the management system of production processes, shipments, end-of-life products, extending product life		

	Results of eco-design	Discussion of best practices in eco-design strategies for products		
3.	**Production**		4	2
	Effective technologies applied in industry (production)	Innovative and environmentally friendly technologies		
	Eco-labels	Eco-labels and their meanings Eco-labeled goods and products		
4.	**Distribution**		4	2
	Types of packaging	Classification of packaging according to purpose, type, use, material from which made		
	Marking of packaging	Labeling of plastic, metal, paper, glass, textile, composite packaging		
5.	**Re-use**		8	4
	“Zero waste” concept	“Zero waste” philosophy and movement		
	Sharing economy	Practical best practice examples		
	Possibility of waste re-use	Examples of re-using possibilities for plastic, glass, paper, metal, wood, ceramic, concrete, brick, car tires		
6.	**Collection**		8	6
	Waste sorting	Advantages and disadvantages of waste sorting		
	Sorting of glass, paper, and plastic	National regulatory requirements applicable to the sorting of different waste		
	Biodegradable (organic), green and food waste			
	Sorting of construction and demolition waste			
7.	**Recycling**		4	2
	Advantages and disadvantages of waste recycling	Common understanding of waste recycling technologies Good practice for EU companies in recycling plastic waste		
	Waste recycling technologies			
III.	**Climate change**		**8**	**4**

	Consequences of air pollution	Global warming, acid rain formation, ozone depletion. Impact of climate change on Europe and the world Discussing the actions that every person can take		
	International agreements and obligations of the parties	United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, Paris Climate Change Agreement		
IV.	**Waste management**		**12**	**8**
	State regulation of waste management	National regulatory requirements applicable to the waste management		
	Economic and financial measures for waste management	Support for environmental projects, financial measures for waste management		
	Hierarchy of waste management	Principles of waste management		
	Responsible consumption, waste reduction			
	Organization of waste management and accounting	Waste catalog, codes, quantification Waste storage and accounting requirements for businesses		
V.	**Management of specific waste types**		**14**	**8**
	Household waste management	Requirements for the management of specific types of waste		
	Biodegradable waste management			
	Packaging waste management			
	Construction and demolition waste			

	management			
	Bulky waste management	Requirements for bulky waste management		
	Waste disposal in landfills	Requirements for setting up a landfill		
	Using waste for energy production	Waste incineration Positive and negative aspects of waste incineration		
VI.	**Management of hazardous waste**		**8**	**8**
	Properties that make waste hazardous	Identification of hazardous waste Impact of hazardous chemicals in waste on the environment and human health		
	Labeling of hazardous materials	Warning icons Requirements for labeling of hazardous materials		
	Management of electronic waste	Requirements for hazardous waste management Dangers of improper handling		
	Management of oil waste			
	EVALUATION		**2**	
		TOTAL	**90**	**54**

Table 1. Content of the Curriculum

2. PROGRAMS‘ SPECIFICATIONS

2.1. Content and scope of the Programme:

Learning outcomes	Recommended content to achieve the learning outcomes	No of Hours	
		Contact hours	Self-study
1. Knows the principles of the circular economy, EU legal documents in this field	**1. Topic: Definition of the circular economy** **Tasks:** 1.1. Define what the circular economy is; 1.2. Describe principles of the circular economy; 1.3. Get acquainted with EU documents regulating the implementation of the principles of the circular economy (Report of the implementation of the Circular Economy Action Plan, Documents on the circular economy package); 1.4. Give a practical exemple of new business opportunities.	10	6
2. Knows, can describe, if possible, to adapt to all stages of the circular economy	**2. Topic: Stages of the circular economy** **Tasks:** 2.1. Know primary and secondary raw materials; 2.2. Familiarize with eco-design strategies for products; 2.3. Get acquainted with innovative and environmentally friendly technologies, eco-labels and their meanings; 2.4. Identify packaging types; 2.5. Provide examples of re-using possibilities for plastic, glass, paper, metal, wood, ceramic, concrete, brick, car tires; 2.6. Get acquainted with national regulatory requirements applicable to the sorting of different waste; 2.7. Have a common understanding of waste recycling technologies, provide	36	20

	good practice for EU companies in recycling plastic waste.		
3. Perceives the consequences of air pollution, are familiar with international agreements and obligations of the Parties.	**3. Topic: Climate change** 3.1. List, describe the consequences of human activities on he environment; 3.2. Know United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, Paris Climate Change Agreement provisions.	8	4
4. Knows State regulation of waste management, able to apply them.	**4. Topic: Waste management** 4.1. Know and follow National regulatory requirements applicable to the waste management; 4.2. Know and can apply principles of waste management; 4.3. Explain waste storage and accounting requirements for businesses.	12	8
5. Knows how to handle different types of waste	**5. Topic: Management of specific waste types** 5.1. Know and can apply requirements for the management of specific types of waste; 5.2. Know requirements for setting up a landfill.	14	8
6. Evaluates properties that make waste hazardous can handle various types of hazardous waste.	**6. Topic: Management of hazardous waste** 6.1. Evaluate hazardous waste Impact of hazardous chemicals in waste on the environment and human health; 6.2. Know and can explain to others the requirementsfor hazardous waste management.	8	8
	Total:	**142 + 2 for assessment**	

Table 2. Content and scope of the Programme

2.2. Teaching/learning tools and literature:

- Tools:

Theory: classroom equipped with school furniture, demonstration tools, and IT devices.

- Literature/sources:

Textbooks, methodical handout materials, EU documents regulating the implementation of the principles of the circular economy (*Report of the implementation of the Circular Economy Action Plan, Documents on the circular economy package*), Convention on Climate Change (UNFCCC), Kyoto Protocol, Paris Climate Change Agreement, National regulatory requirements applicable to the different types of waste management, good practices examples (https://circulareconomy.europa.eu/platform/en/good-practices).

2.3. Learning methods:

Lecture, presentations, discussions, group work, projects, hands-on activities, company visits.

2.4. Requirements for the trainer's qualification:

The trainer must meet the requirements for a VET trainer by the procedure established by the national legal acts.

2.5. Assessment of competence:

The program assessment (exam) consists of two parts:

1. Assessment of theoretical knowledge (multiple-choice test of 20 questions)
2. Analysis of case study

After passing the exam, the participants will receive a qualified certificate of participation. If all six additional qualifications are completed, the degree "Environmental Consultant" is obtained.

Assessment: passed/failed

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WWW&CE Water, Waste Water, Waste & Circular Economy

TECHNOLOGIES OF THE CIRCULAR ECONOMY MODEL

LEARNING OUTCOMES

- Why does we need to apply the circular economy aspects in construction sector?
- What are technologies of circular economy in non-construction sector?
- What are the best practices for use alternative technologies for the site management?

IMPACT OF THE CIRCULAR ECONOMY TECHNOLOGIES IN WASTE MANAGEMENT

Improved Recycling Rates	• Recycling and waste management companies are investing in improving their tools and techniques.
Automated Waste Collection	• Technology has transformed the way waste management works with automated sensors that trigger instant alerts every time a container is full and needs service.
Route Optimization	• Technology has made point-to-point pickups eco-friendly and financially viable while improving energy -efficiency.
Landfill Modernization	• Solar panel systems integrated with geomembrane are facilitating the production of sustainable energy while preventing carbon from re-entering the environment.
Enhanced Safety	• Recycling and waste management companies are making consistent efforts to improve safety which is of prime importance to an industry running several 30-ton trucks through residential areas.
Quick Turnaround Time	• Technology has greatly reduced the complexity and cost of modern day waste management systems making them all the more efficient, safer and productive while reducing their environmental impact.

CIRCULAR ECONOMY ASPECTS ACROSS A BUILDING'S LIFE CYCLE STAGE

LIFE CYCLE STAGE	CIRCULAR ECONOMY ASPECT
Design	DfD, design for adaptability and flexibility, design for standardisation, design out waste, design in modularity, specify reclaimed materials, specify recycled materials.
Manufacture and supply	Eco-design principles, use less materials/optimise material use, use less hazardous materials, increase the lifespan, design for product disassembly, design for product standardisation, use secondary materials, take-back schemes, reverse logistics.
Construction	Minimise waste, procure reused materials, procure recycled materials, off-site construction.
In use and refurbishment	Minimise waste, minimal maintenance, easy repair and upgrade, adaptability, flexibility
End of life	Deconstruction, selective demolition, reuse of products and components, closed-loop recycling, open-loop recycling

EXISTING TECHNOLOGIES FOR SIMILAR WASTE STREAMS

Segregation and sorting	• Manual sorting, multi-compartment bins, automatic bottle sorting system, mechanical biological treatment (MBT), optical sorting, Eddy current sorting, multi compartment bins, optical sensor based sorting technologies.
Collection and transporting	• Underground collection system, Web based GIS technology, Waste bin monitoring system using GSM, Waste compactors.
Recycling	• De-Inking technology for paper recycling, biodegradable and degradable plastic, cullet remanufacturing (for glass).

Click on each technology for more information

EXISTING TECHNOLOGIES FOR SIMILAR WASTE STREAMS

Processing	• Autoclaving, Fluffing, Melting technology, Incineration, Vermicomposting
Energy recovery	• Thermal Conversion, advance thermal treatment technologies (pyrolysis, gasification), plasma gasification and plasma pyrolysis, refuse derived fuel (RDF), fluidized bed technology, bio-conversion, dry anaerobic composting.
Disposal	• Bioreactor technology, landfill gas recovery technologies (microturbine technology, fuel cell technology).

Click on each technology for more information

EXAMPLE FOR USE TECHNOLOGY FROM NON-CONSTRUTION SECTOR

- **ZenRobotics Heavy Picker**

ZenRobotics Heavy Picker is the strongest waste sorting robot on the market. It can easily lift objects weighing up to 30 kg. It minimizes the need for pre-shredding of waste and also reduces the need for pre-sorting with an excavator.

https://zenrobotics.com/solutions/applications/

Watch this material for more information

USING ZENROBOTICS FOR C&D MANAGEMENT

SORTED FRACTIONS:	KEY BENEFITS:
1. Metals; 2. Wood mixed and by type (A-wood, B-wood, C-wood); 3. Inert mixed and by type (asphalt, bricks, concrete etc.); 4. Rigid plastics mixed and by polymer (PE, PET, PVC, OCC).	1. Simple, automated sorting process, the possibility for 24/7 continuous sorting; 2. High purity of recycled materials, higher aftermarket revenues; 3. Sort weighty and large objects; 4. Sort multiple fractions with one robot; 5. Reduce excavator sorting; 6. Reduce shredding.

EXAMPLES OF GOOD PRACTICES

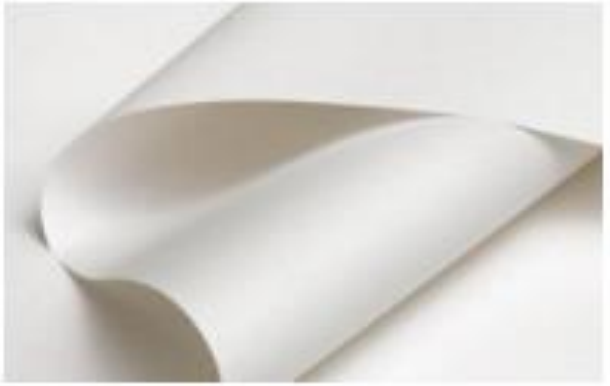
EcoAllene® is a product of recycling, yet it boasts the most important properties of a raw product: consistency and uniformity of supply.
virgin plastic is made from crude oil, whereas the source of EcoAllene® is waste from food packaging, which is consistent over time in terms of composition and characteristics.

https://circulareconomy.europa.eu/platform/en/good-practices/ecoplasteam-recycles-multi-layer-packaging-integrally-produce-ecoallene

Watch this material for more information

EXAMPLES OF GOOD PRACTICES

Description:
Shiro Alga Carta paper, patented by Favini in the ’90s, is the pioneer in their upcycling ecological paper range. It uses algae from the Venice lagoon, whose proliferation would put at risk the lagoon’s fragile ecosystem.



Watch this material for more information

https://circulareconomy.europa.eu/platform/en/good-practices/favinis-upcycled-ecological-papers-shiro-alga-carta-tackles-harmful-algae

EXAMPLES OF GOOD PRACTICES

UK startup uses recycled plastic to build stronger roads

British engineer Toby McCartney has devised an innovative process to replace much of the crude oil-based asphalt in pavement with tiny pellets of plastic created from recyclable bottles. The result is a street that's 60 percent stronger than traditional roadways, 10 times longer-lasting, and a heck of a lot better for the environment.

Watch this material for more information

https://www.curbed.com/2017/4/26/15428382/road-potholes-repair-plastic-recycled-macrebur

ALTERNATIVE TECHNOLOGIES FROM NON CONSTRUCTION SECTOR FOR CONSTRUCTION SECTOR

- Vacuum Tube Window;
- Self-Cleaning Coatings;
- Phase Change Materials;
- Aerogel and Vacuum Insulated Panels;
- Passive zenithal light guides;
- PV Systems and Facade Integrated PV Systems;
- Solar Thermal Heating Systems;
- Gas absorption Heat Pumps.

Click on each technology for more information

TECHNOLOGIES OF THE CIRCULAR ECONOMY MODEL

Well done! You have reached the end of this Learning Unit.
Now complete the following questions to check your understanding

Good Luck!

MULTIPLE CHOICE QUESTIONS

1. What is the correct sequence of waste management processes?
A. Energy recovery→ Reuse → Landfill
B. Prevention→Landfill→Reuse →Recycle →Energy recovery
C. Prevention→Reuse →Recycle →Energy recovery→ Landfill
D. Reuse →Energy recovery→ Recycle

2. What are processing technologies for waste treatment?
A. Autoclaving and incineration;
B. Thermal conversion and pyrolysis;
C. Bioreactor technology and microturbine technology;
D. Biodegradable and degradable plastic and Cullet remanufacturing.

3. What type of technology is used to segregate and sort the waste?
A. De-Inking technology for paper recycling;
B. Underground collection system;
C. Cullet remanufacturing (for glass);
D. Optical sorting.

4. What is the alternative technology for waste treatment?
A. Landfill gas recovery technologies;
B. Pyrolysis;
C. Self-Cleaning Coatings;
D. Shredding.

5. What new material Ecoplasteam produces from „tetrapack“?
A. EcoAllene;
B. EcoTetrapack;
C. EcoPaper;
D. EcoPlastic.

MULTIPLE CHOICE QUESTIONS: ANSWERS

1. What is the correct sequence of waste management processes?
A. Energy recovery→ Reuse → Landfill
B. Prevention→Landfill→Reuse →Recycle →Energy recovery
C. Prevention→Reuse →Recycle →Energy recovery→ Landfill
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Exersice 1. Fill the table

LIFE CYCLE STAGE	CIRCULAR ECONOMY ASPECT
Design	
Manufacture and supply	
Construction	
In use and refurbishment	
End of life	

Answer of Exersice 1.

LIFE CYCLE STAGE	CIRCULAR ECONOMY ASPECT
Design	DfD, design for adaptability and flexibility, design for standardisation, design out waste, design in modularity, specify reclaimed materials, specify recycled materials.
Manufacture and supply	Eco-design principles, use less materials/optimise material use, use less hazardous materials, increase the lifespan, design for product disassembly, design for product standardisation, use secondary materials, take-back schemes, reverse logistics.
Construction	Minimise waste, procure reused materials, procure recycled materials, off-site construction.
In use and refurbishment	Minimise waste, minimal maintenance, easy repair and upgrade, adaptability, flexibility
End of life	Deconstruction, selective demolition, reuse of products and components, closed-loop recycling, open-loop recycling

Exersice 2.

Link each technology to the correct discription

Automatic Bottle Sorting System	According to this technology waste bins or containers are being replaced by underground collection points. This includes the placement of the plastic container in the excavation of 2-3m with the only inlet in the environment.
Underground collection system	Using this technology paper ink is removed from the recycled paper slurry. In Europe, the annual production of de-inked pulp has to be increased up to 15%. Frequent recycling of newspaper and printed white paper can challenge the quality of paper . According to studies newspaper can be recycled up to 5 times.
Compact garbage collection trucks	Small garbage collection trucks are used. these trucks have achieved high compression rate as they can carry 1.5 times more waste as compare to flat pile trucks. The technology does not only increase collection capacity, but also increases the fuel efficiency which is more environmentally and economically feasible.
De-Inking Technology	Technology comprised on sizing, aligning and clearing machine, along with color identification sensors. The role of sizing machine is to divide the bottles according to the size, after which bottles will send to color sensing machine and then conveyer belt. The bottles of each color are shredded and cullet is prepared.
Melting technology	This technology is used to supply electricity to the small scale nearby projects. This technology is helpful in resolving the issue of air pollution and global warming due to the emission of landfill gas air.
Autoclaving	The technology involve treating the waste with steam at 140-160 OC for 30-40 minutes. This sterilize the waste and the residue is subjected to screening. Where waste is separated on the basis of weight, organic fiber is segregated from glass and girt. Metals and plastics will send for recycling.
Incineration	This technology reduces the waste volume up to certain degree and the stable stag is obtained as a byproduct. The solidified residue has many application in construction industry and in land reclamation. The technology has many advantages over incineration.
Microturbine Technology	A thermal waste treatment process in which the unprocessed waste is burn at high temperature is commonly known as Incineration. Sufficient quantity of air is needed in order to oxidize the feedstock or the fuel. For combustion, waste has exposed to 850 ºC, and then it is converted to H2O, CO2, and the non-combustible material which is known as incinerator bottom ash (IBA).

Answer of exersice 2