Result 5.2
Green Economy Study Modules

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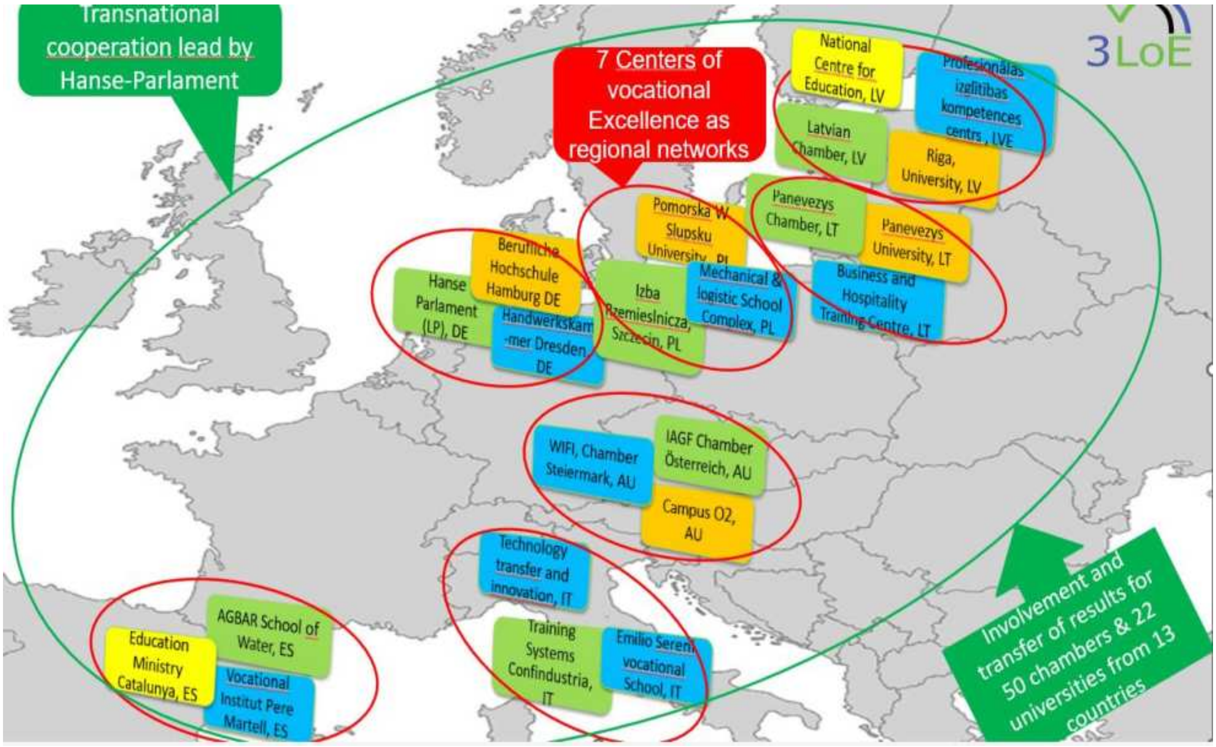

Language

English

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Summary of the Project and Introduction

1. About the 3LOE project

Around 99% of all EU businesses are SMEs, creating up to 70% of all jobs. In general, SMEs have good growth prospects for the future and are particularly well equipped to solve environmental problems and to enhance the green economy. However, in most of the project countries, SMEs are confronted with a shortage of skilled workers and young entrepreneurs. This shortage of skilled workers is even more alarming taking into account that due to aging of current entrepreneurs, a large and growing number of companies will have to be handed over to the next generation. Furthermore, young specialists and entrepreneurs often lack the qualifications and skills needed in order to respond to contemporary developments in the fields of energy, climate and environmental protection. The following problems have been identified in SMEs working in the fields of green economy, energy and environmental protection:

- Blatant and growing shortage of skilled workers.
- Large qualification deficits, especially in the Green Economy.
- Loss of attractiveness and low qualification of school-based VET.
- Low rates of further training and insufficient orientation of offers to SME needs.
- Ageing of entrepreneurs and increasing shortage of young people (demographic change).
- Failure of business transfers and low rates of business start-ups.
- Low innovation rates and insufficient productivity.
- Not enough cooperation between universities and SMEs and a lack of teaching geared to SME needs.
- Comparably low internationalization of SMEs and vocational training providers.
- Lack of national level support for SMEs".

To meet these challenges, work-based learning and new paths in vocational training must be provided through cooperation between educational institutions, economic chambers and SMEs. University graduates are often well-qualified in theory, but lack practical knowledge, skills and abilities that are crucial for SMEs. For this reason, VET reforms must also involve higher education, and should implement dual bachelor's degree programs that combine a bachelor's degree with vocational training and on-sight work in companies.

In the 3LOE project, an innovative and complex project structure with 22 project partners from 7 countries as well as 60 associated partners from 13 countries was designed. In each country, centers of vocational excellence (COVEs) in Green Economy will be established, managed and their permanent continuation ensured. A transnational cooperation of the centers will be developed, extended to 60 education stakeholders from 13 countries and operated permanently in an institutionalized form. The centers will offer a wide range of dual education measures in vocational training, further education and higher education, that are being developed, tested and evaluated in the project. These educational measures on EQF levels 3-7 focus on Green Economy, Digitalization and Entrepreneurship. Furthermore, vocational and educational consulting and innovation support for SMEs will be developed and implemented. In total, seven Train-the-Trainer programs will be developed and implemented permanently by the project partners. All results will be transferred to the 60 associated partners together with implementation advice.

The objectives and aimed outcomes of the 3LOE project can be summarized as following:

1. Foundation of a three-level Center in each project country

1.1 Building the "Green Economy" skills alliance for qualifications in SMEs with educational and economic actors from the 7 project countries; development of information and cooperation tools.

1.2 Expansion of the skills alliance to the 60 associated partners from 13 countries, comprising chambers of commerce, SME associations, as well as universities of applied sciences/colleges.

1.3 Development, testing and evaluation of a curriculum and teaching materials for Train the Trainer courses for personnel and center management (vocational schoolteachers, trainers in SMEs and lecturers in further and higher education institutions).

1.4 Evaluation of the construction and operation of the seven centers of Excellence and of the transnational cooperation.

1.5 Development of business and financing plans and ensuring the long-term continuation of the seven centres and transnational cooperation.

1.6 Development, consulting and introduction of political strategy program.

2. Implementation and realization vocational training

2.1 Development and implementation of a tool for vocational and qualification counselling as well as a training for consultants and teachers to use the tool.

2.2 Implementation of the dual system, so that work-based learning is put into practice in the project countries.

Preparation and transfer of curricula and examination regulations for dual vocational training for different professions and implementations in Poland, Lithuania, Latvia and Spain.

Development, test and implementation Trainings for teachers to conduct dual vocational training as well as Training of trainers in SMEs.

2.3 Development political concept for the training and integration of young people with learning difficulties for young people with learning difficulties (EQF level 3).

Development, test and implementation of a dual vocational training "Specialist for Building Insulation”.

2.4 Development, testing and evaluation of education programme, teaching materials and examination regulations for the provision of sector-specific qualifications already during the initial vocational training for stronger learners. Implementation in the dual system, so that work-based learning is put into practice in the project countries.

2.5 Development and implementation five-year technician training „Ecologic Solutions in Logistics”.

3. Implementation and realization of further vocational training

3.1 Development and implementation of concepts and instruments for the management of continuing vocational training.

3.2 Development, test and implementation of a Train-the-Trainer program for teachers to conduct further training.

3.3 Development and implementation of a concept "SME-fair digitalization" as well as development, test and implementation of two train the trainer programs "Basic and advanced digital skills".

3.4 Transfer and implementation of four further trainings Energy Saving and Renewable Energies.

3.5 Preparation, transfer and implementation of six further trainings in the Green Economy.

3.6 Development, testing and evaluation of different training programs and teaching material for owners, managers and qualified workers of SMEs (EQF level 5 and 6). The trainings are specifically tailored to SME needs and different qualification levels and combine the transfer of technical, professional and management know-how.

- Training Enterprise and Entrepreneurship in Green Economy
- Training Energy Service Manager
- Trainings vocational Master Carpenter and Electric
- Training Construction Technician
- Training Service Technician
- Training Sustainability in foodservice industry

3.7 Development of regulations for new continuing education occupational profiles with a focus on the green economy.

3.8 Development of an integration programme for the unemployed (EQF level 4) in order to be able to place the unemployed in permanent jobs through further training seminars and a further training qualification.

4. Implementation and realization of higher education

4.1 Preparation and transfer of curricula, evaluation and examination regulations for two existing dual Bachelor degree programmes "Management of Renewable Building Energy Technology" and "Business Administration for SMEs".

4.2 Development and beginning of implementation of new dual Bachelor degree programs

- Business Administration & Sustainable Management of SMEs
- Entrepreneurship and Innovation in Green Economy
- Logistics - Green Supply Chains
- Service technician

- Tutorial "Sustainable management Climate neutrality for companies"

4.3 Development, test and implementation of four study modules (EQF level 6) on SME management in the Green Economy sector, which will be carried out in the dual study system and integrated into existing Bachelor degree programmes.

4.4 Development and implementation of concept for innovation promotion Solutions for manageable R&D tasks of SMEs and conducting manageable R&D projects for SMEs-

4.5 Development, testing and implementation of Training program for university lecturers and SME advisors.

5. Dissemination, transfer and use of the project results

5.1 Development of a concept and summary evaluation of the dissemination results of all partners

5.2Transfer of all educational measures to 60 educational institutions in 13 countries and needs-oriented implementation consultations as well as realization of a bundle of measures for further dissemination of the project results.

5.3 Further dissemination activities such as presentations online, at third-party events, press releases and conferences.

5.4 Book with all results of the project and distribution via book trade.

For each of the three levels of educational measures there will be:

- Target-group-specific educational programs.
- Curricula, teaching materials, etc. developed in a leading role by the educational institutions of the respective level, whereby the educational institutions of the other levels (in particular universities) participate in an advisory and supportive manner.
- Representatives of the participant target groups involved in the development work.

All educational measures will be tested with the respective target groups under different national conditions in the countries, evaluated and completed on the basis of the evaluation results with application notes.

2. About the Green Economy Study Modules

SMEs need specialists, leaders and entrepreneurs with sound theoretical and in-depth practical job-related knowledge and skills. Graduates of traditional study programs are unsuitable as they lack professional practice and experience, and they need two to three years of on-the-job training upon completing their study. Thanks to dual bachelor`s programs, a combination of a Bologna-compliant study with complete vocational training or professional on-hands-practice, SMEs, being the competent partner of choice for about 50 percent of the training time, may thus win much-needed junior staff as potential future managers and entrepreneurs.
Students of technical and business study programs are expected to be trained in SME-related green technologies and skills in technologies and management in the fields of

water/sewage/waste treatment and in Circular Economy. Transfer will take place under a dual system; the university study modules are interdisciplinary, while the on-the-job training in the companies will be specifically focused on SME-related occupations and branches. Learning results are rated at EQF Level 6.
The project will develop, test and evaluate four main modules, each covering 150 to a maximum of 175 teaching lessons:
A Management & water, wastewater technologies
B Waste management & technologies
C Management & technologies of Circular Economy
D Management concepts for sustainable economic activity
Testing is to be carried out by graduates or students, structured as advanced training or embedded in an existing study program. In countries where dual study programs have not yet been established, testing of the four main modules can also be performed in a conventional way, entirely at the university.
Under dual study programs, close collaboration between academia and small medium-sized enterprises is achieved. In that regard, further welcome features are active exchanges of knowledge and experience as well as implementation of manageable research and development tasks for and by SMEs. Students will implement their semester or bachelor`s theses at companies where they complete their practical training. They will select topics that are particularly business-relevant, thus ensuring notable benefits to SMEs.
Upon completion of the project, the four modules developed in the project will be offered and implemented as part of existing bachelor`s programs either as extra selective modules, as obligatory modules or as integral part of postgraduate education at colleges/universities.

COVE Poland was confronted by vocational schools, public administrations and companies to develop and implement specific study modules for the agricultural sector. To meet these needs, Akademia Pomorska W Slupsku has developed a Training for Farmers and Students from the Secondary Agricultural School in Słupsk and implemented it at the university.

Accordingly, the following Result 5.2 Green Economy Study Modules comprises the following parts:

1. Evaluation Concept

2. Study module A Management & Technologies of the Water and Wastewater industry
    - Curricula and Teaching Materials
    - Implementation Reports
    - Evaluation Report

3. Study module B Waste Management & Technologies
    - Curricula and Teaching Materials
    - Implementation Reports
    - Evaluation Report

4. Study module C Management & Technologies of the Circular Economy
    - Curricula and Teaching Materials

- Implementation Reports
- Evaluation Report

5. Study module D Management of sustainable economic activity

- Curricula and Teaching Materials
- Implementation Reports
- Evaluation Report

6. Training for Farmers and Students from the Secondary Agricultural School

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Result 5.2
Green Economy Study Modules

Evaluation Concept

Prepared by:

Panevezio kolegija, Lithuania

PANEVĖŽIO KOLEGIJA

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

CONCEPT
EVALUATION OF THE COURSES

1. Objectives and Methods of Evaluation

The study evaluates the courses:

- Technologies water supply
- Technologies water saving
- Greywater and rainwater utilization technologies
- Technologies decentralized Wastewater treatment
- Fundamentals of the circular economy
- Systemic solution-oriented consulting
- Work-related English with Focus on Green Economy for companies
- Waste Management & Technologies
- Management of sustainable economic activity
- Management & Technologies of the Water and Wastewater industry
- Management & technologies of the circular economy

The Aim of the Evaluation:

The general aim of the study is to evaluate the effectiveness of courses realized within the Project project „Three-level Centers of Professional Excellence: Qualification, Entrepreneurship and Innovation in the Green Economy". The following purposes of evaluating courses are defined:

- To determine whether the objectives of the courses were achieved.
- To see how the knowledge and skills learned in the courses are put into practice.
- To assess the results of the courses.
- To assess the effectiveness of the courses.
- To assess whether the courses were properly implemented.
- To identify the strengths and weaknesses of the courses.
- To assess whether the courses were suitable in terms of the training contents, timing, participants and other aspects.
- To find problems of the courses and solutions for improvement.

The conclusions of the evaluation research will contribute to improve the quality and especially the effectiveness of courses, show the limitations of the courses models and indicate the direction for further activities.

The Methods of the Evaluation:

Summative and **Formative Evaluation** are used for courses evaluation. A **formative evaluation** (sometimes referred to as internal) is a method for judging the worth of a course while the course activities are forming (in progress). This part of the evaluation focuses on the process. Thus, formative evaluations are basically done on the fly. A **summative evaluation**

(sometimes referred to as external) is a method of judging the worth of a course at the end of the course activities (summation). The focus is on the outcome.

Evaluation Tools:

Evaluation tools are selected depending on the purposes and methods of evaluation (Table 1). Survey is one of the ways to provide feedback. For the **Formative Evaluation** surveys are used:

- Online survey of students using an identical questionnaire (Section 2).
- Online survey of the teachers using an identical questionnaire (Section 3).

For the **Summative Evaluation** Results implementation report of partner is used. This report provides course's statistics, for example number of participants, dropouts of students, student's exam results, etc.

Table 1. **Evaluation Tools According Methods of Evaluation**

A formative evaluation	Online survey of students using an identical questionnaire (Section 2). Online survey of the teachers using an identical questionnaire (Section 3).
A summative evaluation	Implementation report of partner

Data collection:

Online surveys for participants and teachers will be carried in the last week of the training.

2. Survey of Students

The objective of the survey is to evaluate the course. The questionnaire is part of the project „Three-level Centers of Professional Excellence: Qualification, Entrepreneurship and Innovation in the Green Economy“. We would appreciate you taking a few minutes of your time to complete this evaluation form. Your comments and suggestions will help us to improve the course for development and implementations of additional qualifications.

1. Choose the course you will evaluate:

❍ Technologies water supply
❍ Technologies water saving
❍ Greywater and rainwater utilization technologies
❍ Technologies decentralized wasterwater treatment
❍ Fundamentals of the circular economy
❍ Systemic solution-oriented consulting
❍ Work-related English with Focus on Green Economy for companies
❍ Waste Management & Technologies
❍ Management & Technologies of the Water and Wastewater industry
❍ Management & technologies of the circular economy
❍ Management of sustainable economic activity

2. Provide the name of the school/institution:

....
....
....

	Background information

3. Please indicate your gender:

❍ Woman ❍ Man ❍ Prefer not to answer

4. Please indicate your age:

❍ Under 20 ❍ 20–29 ❍ 30–39 ❍ 40–49 ❍ 50–59 ❍ 60+

	Evaluation of course content and teaching quality

5. I have attended at least 2/3 lectures of the course

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

6. Lecturer encouraged my participation, initiative and interaction during the lectures

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

7. The objectives of the course and study results, evaluation criteria were clearly defined from the very begining of the course

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

8. Assessment of the study results was appropriate

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

9. The content was interesting, relevant, useful and alowed to achieve study results

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

10. The course content responds to the latest scientific achievements

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

11. Theory was taught in conjunction with the practical examples

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

12. Theory was taught in context of the sustainable development issues

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

13. The course topics were not repetitive

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

14. The teaching materials were presented in an organized manner

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

15. The teaching materials distributed were helpful to achieve study results

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

16. The study methods chosen by the lecturer helped to understand the course

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

17. The teaching process included interactive methods

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

18. The lecturer was a good communicator

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

	Comments on strengths and ways of improvement

19. How do you evaluate the course quality

❍ Very satisfied	❍ Satisfied	❍ Neither satisfied nor disstisfied	❍ Dissatisfied	❍ Very dissatisfied

20. How do you evaluate the course lecturer

❍ Very satisfied	❍ Satisfied	❍ Neither satisfied nor disstisfied	❍ Dissatisfied	❍ Very dissatisfied

21. Could you name the main advantages of this course?

....

....

....

22. Which specific difficulties you encountered while studying the course?

....

....

....

23. Could you name the main disadvantages of this course?

....

....

....

24. What changes would you recommend to improve this course?

....

....

....

Thank you for your answers!

Electronic version of the survey available at https://forms.gle/LRbGeYi12dySA3kV8

3. Survey of Teachers

The objective of the survey is to evaluate the course. The questionnaire is part of the project „Three-level Centers of Professional Excellence: Qualification, Entrepreneurship and Innovation in the Green Economy". We would appreciate you taking a few minutes of your time to complete this evaluation form. Your comments and suggestions will help us to improve the course for development and implementations of additional qualifications.

1. Choose the course you will evaluate:

❍ Technologies water supply
❍ Technologies water saving
❍ Greywater and rainwater utilization technologies
❍ Technologies decentralized wasterwater treatment
❍ Fundamentals of the circular economy
❍ Systemic solution-oriented consulting
❍ Work-related English with Focus on Green Economy for companies
❍ Waste Management & Technologies
❍ Management & Technologies of the Water and Wastewater industry
❍ Management & technologies of the circular economy
❍ Management of sustainable economic activity

2. Provide the name of the school/institution:

....
....
....

	Background information

3. Please indicate your gender:

❍ Woman ❍ Man ❍ Prefer not to answer

4. Please indicate your age:

❍ Under 25 ❍ 25-29 ❍ 30-39 ❍ 40-49 ❍ 50-59 ❍ 60+

5. Please indicate how long have you worked as a teacher:

❍ This is my first year ❍ 1–2 years ❍ 3–5 years ❍ 6–10 years ❍ 11–15 years ❍ 16–20 years ❍ More than 20 years

6. What is your employment status as a teacher:

❍ Permanent employment ❍ Fixed term contract for a period of more than 1 academic-year ❍ Fixed term contract for a period of 1 academic-year or less

7. What is the highest level of education you have completed:

❍ Barchelor´s degree or equivalent qualification ❍ Master´s degree or equivalent qualification ❍ Doctor´s degree or equivalent qualification ❍ Other

	Evaluation of course structure and description

8. Do you agree that the course aims are clear and well defined?

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

9. Do you agree that the competencies clearly describe knowledge and skills of student graduating from this course?

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

10. Do you agree that the learning outcomes correspond to the competencies?

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

11. Do you agree that the division of course hours into contact and self-learning hours is appropriate?

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

12. Do you agree that prerequisites to enter (minimum education required) is clear and well defined?

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

	Evaluation of course content

13. Do you agree that the course content corresponds to the learning outcomes?

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

14. Do you agree that the course content is consistent?

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

15. Do you agree that the course topics are not repetitive?

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

16. Do you agree that the course content is modern?

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

17. Do you agree that the learning methods are appropriateto to achieve the intended competences?

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

18. Do you agree that the assessment of competence is appropriate?

❍ Strongly agree ❍ Agree ❍ Neither agree nor disagree ❍ Disagree ❍ Strongly disagree

	Comments on strengths and ways of improvement

19. Could you name the main advantages of this course?

....

....

....

20. Could you name the main disadvantages of this course?

....

....

....

21. What changes would you recommend to improve this course?

....

....

....

Thank you for your answers!

Electronic version of the survey available at https://forms.gle/srHZJ1ji7GyJShMm8

Result 5.2
Green Economy Study Modules

Study module A
Management & Technologies of the Water and Wastewater industry

Curricula and Teaching Materials

Work Package 5: Third center level "Higher education" (EQF Level 6)

Activity 8: Study modules "Green Economy"

Module A – Management and Technologies of Water and Wastewater Industry

Developed by:

VILNIAUS GEDIMINO TECHNICAL UNIVERSITY (VGTU) and SATAKUNTA UNIVERSITY OF APPLIED SCIENCES (SAMK) in the Project "Management and Technologies of Water, Wastewater, Waste and Circular Economy (WWW&CE)"

Prepared by:

Wirtschaftsförderungsinstitut (WIFI) Steiermark

May, 2022

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

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Chapter 1: Executive summary

The course "Management & Technologies of the Water and Wastewater Industry" was developed in the project "Management and Technologies of Water, Wastewater, Waste and Circular Economy – WWW&CE", which was funded by the Erasmus+ Programme of the European Union. Eleven partners from seven EU Member States developed tools according to work-based learning principles that are piloted and evaluated. For more information see: https://www.sa-ce.eu

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The module is part of a higher education course with four modules, dealing with key areas of sustainable economy, energy and water, wastewater and waste management as well as circular economy. The modules are designed to provide higher education qualifications on the European Framework Qualification Level 6. Furthermore, the four modules are primarily designed for people striving for a higher education, who have the necessary requirements to start an education at a university or university of applied sciences. Completing all four modules enables the participants to understand the relationships of sustainability and the circular economy, the requirements for waste and wastewater applications as well as energy generation and to steer towards a more environmentally conscious approach to their personal and business objectives in order to generate a more sustainable world.

The four modules in the higher education programme are:

- A – "Management & Technologies of the Water and Wastewater Industry"
- B – "Waste Management & Technologies"
- C – "Management & technologies of the circular economy"
- D – "Management of sustainable economic activity"

Each module may be completed individually or as part of the higher education programme. For each participated and completed course, a participation degree according to the respective provider is provided.

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The course is designed according to the qualifications on the European Framework Qualification Level 6. All courses of the "WWW&CE" project shall direct participants and in further sequence small and medium sized companies towards a more environmentally conscious approach to their personal and business objectives in order to generate a more sustainable world.

One aim of the course "Management and Technologies of Water and Wastewater Management" is, on the one hand, to present the importance of laws and guidelines that regulate water and wastewater supply. On the other hand, the study module aims to teach technological aspects such as water and wastewater networks, water and wastewater treatment, sludge treatment as well as developments in the fields of automation, digitalisation, and circular economy.

The Module "Management and Technologies of the Water and Wastewater Industry" comprises of two parts, "Water Supply" and "Wastewater sewerage" and comprises of the following modules:

- 1 – Introduction to water and wastewater services
- 2 – Regulatory frameworks and water and wastewater works management
- 3 - Water and wastewater networks and engineering design principles
- 4 - Water and wastewater treatment methods and engineering design principles
- 5 - Sludge treatment and disposal
- 6 - Energy efficiency and circular economy in water and wastewater facilities
- 7 - Automation and digitalization in water and wastewater systems
- 8- Greening water and wastewater systems

With rising energy costs, tightening regulations, a growing population, rapid urbanization and climate challenge water and wastewater utilities to operate and perform more efficiently. These challenges are reflected in the design and operation of water and wastewater utilities. Planning engineers, constructing companies, stakeholders, managers, operators and customers must do everything in their power to ensure a sustainable water supply and sewerage treatment. Water and wastewater utilities must become more flexible, efficient, and cost-effective, and planning engineers and operators can benefit from technologies and concepts that drive digitalization and circular economy. The unanswered challenges result in degraded water quality and inadequate water supply and sanitation infrastructure, particularly in expanding peri-urban and informal settlements. This may result in significant implications for public health, environmental sustainability, and social equity. The investment needs in the water supply and sanitation industry are significant. Future urban development requires approaches that minimize resource consumption and focus on resource recovery, following principles of the circular economy. Wastewater is a valuable resource from which energy and nutrients can be extracted, as well as an additional source of water.

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Because of the very different national circumstances, climate, topography, and local conditions in EU countries, the management & technologies curriculum of the Water and Wastewater Industry give a general framework for managing water and wastewater issues in municipalities, rural areas, and companies.

In this curriculum Management & Technologies of the Water and Wastewater Industry refers to both municipal and industrial water and wastewater utilities. It also covers urban and rural settlements

Chapter 1.1: Name of the Course

"Management & Technologies of the Water and Wastewater Industry"

Chapter 1.2: Contact Details

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To be adapted by each partner

Chapter 1.3: Type of the Module

Higher education course.

Chapter 1.4: Target Group

The target group of the curriculum consists of Bachelor's programme students at universities and universities of applied sciences. The individual modules are also well suited to be applied as open-university courses.

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Chapter 1.5: Assessment

Examinations will be coordinated, and competencies will be controlled according to local regulation and locally required qualifications. It is each local actor's responsibility to take care that the admission requirements are fulfilled before the qualification application.

Assessment's criteria of student's achievement:

Full-time studies:GĮ =

GA* 0,60 + ND* 0,40
GĮ, Final Assessment
GA, Full Credit
ND, Homework

Chapter 1.6: Competences Obtained

ENVIRONMENTAL MOTIVATION	Seeing the necessity of effective water and wastewater management, knowing water and wastewater management technologies, the participant can act in spreading a sustainable water and wastewater consumption life style. As a responsible person regarding water and wastewater, the participant has knowledge and the intention to act in informing others of water-saving behaviour in business.
LEGAL KNOWLEDGE	Knowledge of EU Directives, international recommendations and conventions and domestic legislation on water and wastewater management and technologies as well as in the necessity of water and wastewater in sustainable development.
RESPONSIBILITY	Knowing her own and others' thoughts, personal and/or business behaviour and motivations, the participant can assess and compare these activities from the perspective of a responsible participation in sustainable water and wastewater management.
CREATIVITY	Using technological knowledge, the participant can offer solution driven opportunities to new problems regarding

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	water and wastewater from a conscious and responsible perspective.
SENSITIVITY TO TECHNICAL PROBLEMS	With an approach towards responsible water and wastewater management, the participant can interpret technical conditions, assess the enforcement of the aspects of purpose-oriented utilisation of water and wastewater and support it with recommended technical solutions.
COOPERATION WITH OTHERS	Effective in exploring various problems, the participant can provide supportive cooperation with stakeholders and professionals in the water and wastewater sector.
ATTITUDE TO SUSTAINABILITY	Sensitivity and information about a sustainable world, sustainable economy, deficiencies resulting from climate change, increase of population and the change of people's living habits and critical situations. Ability to consciously participate in actions for preserving life and resources for future generations.
PERCEPTION OF OPPORTUNITIES	Identification of connections for various existing or future technical conditions and economical water and wastewater utilisation solutions suitable for the purpose.
RISK MANAGEMENT	Reasonably taking challenges and risks, the participant can perceive emergencies in specific problem solving processes as well as manage those preventively and constructively.
APPROACH OF ENVIRONMENT CONSCIOUSNESS	The participant can perceive responsible water and wastewater management and opportunities of human and technological processes related to the water and wastewater management.

Chapter 1.7: Course Duration

In the curriculum, the average work required by each module is measured in ECTS credit units (abbreviated in this presentation as CU). One credit unit equals 27 hours workload.

The curriculum of this module consists of a total of six (6) ECTS credit units, corresponding to 160 hours containing lectures, professional field visits, individual studies and assignments.

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Cooperation with the local experienced industry practitioners is highly recommended.

All modules can be studied individually, so the modules can be offered also via open studies to all companies and organizations, that intend to implement or develop sustainable management.

Chapter 1.8: Required Prerequisites

The content of the course is designed as a training according to level four (6) of the European Qualifications Framework (EQF).

The participants entering the training programme shall meet the following requirements based on the content of the curriculum and the classification according to the EQR:

a) They possess an entrance qualification to participate in bachelors' studies.

Note: The required prerequisites may vary according to the respective country where the course is being held.

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Chapter 2: Curriculum

Chapter 2.1.: Contents of the curriculum

The variation in regulations and circumstances and qualification requirements are quite different in the BSR-countries, thus the curriculum can be written only as a form of framework inside which the local actors should be able to modify the contents of modules according to their regulations and local requirements. Using innovative, problem-based, and experiential educational approaches, students build on their professional experience to become experts who can create and implement effective water and wastewater solutions.

The overall objectives of the curriculum are to

- give an understanding of the importance of laws and guidelines that govern water and wastewater utilities
- give the students deep knowledge on water and sewerage networks and water and wastewater treatment methods, processes and design parameters
- introduce various sludge treatment methods
- introduce the latest developments in automation, digitalization and circular economy
- highlight the water and wastewater systems' role in urban, peri-urban and rural contexts

The curriculum is divided into eight (8) modules:

- Module 1: Introduction to water and wastewater services
- Module 2: Regulatory frameworks and water and wastewater works management
- Module 3: Water and wastewater networks and engineering design principles
- Module 4: Water and wastewater treatment methods and engineering design principles
- Module 5: Sludge treatment and disposal
- Module 6: Energy efficiency and circular economy in water and wastewater
- Module 7: Automation and digitalization in water and wastewater systems
- Module 8: Greening water and wastewater systems

The training times provided below in the table are suggestions and should be adapted according to respective focus points of the organization that carries out the modules.

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Module Number	Module Name	Content	Training Time	
			Contact Hours	Self-Study Time
I	**Introduction to water and wastewater services**	Module I provide an overview of water and wastewater services. The student knows the sources and uses of water and various wastewater streams and the classification of treatment methods. The student gains a basic understanding of how circular economy and digitalization link in the water industry.	**8**	**8**
I.1	Introduction to water and wastewater services	Essential elements and main functions of water supply and wastewater treatment	1,5	1,5
		Surface water and groundwater sources, quantity and abstraction.	1,5	1,5
		Domestic and industrial wastewater sources; grey and black wastewater.	1,5	1,5
		Water for firefighting.	1,5	1,5
		Principles of circular economy and digitalization in the water industry	2	2
II	**Regulatory frameworks and water and wastewater works management**	Note: Module 2 must be designed country wise to meet the legislative frameworks and strategies. Module II deals with the Water and Wastewater Directives of the European union, and their application in different countries and how cities and municipalities manage water utilities and distribution networks. The student gets a basic understanding of different water supply and wastewater treatment organizational models.	**8**	**8**
II.1	Regulatory frameworks and water and wastewater works management	European Union water policy, European Union water directive and wastewater directive, national legislation and local regulations.	2	2
		European Union and national requirements for design and engineering.	2	2

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		Legal regulations and responsibilities of municipal waterworks, house owners, and industrial premises. Sustainable urban and rural waterworks management: municipal, public-private-partnerships and private systems (individual or cooperative).	2 2	2 2
III	**Water and wastewater networks and engineering design principles**	Module III introduces the students to the area of water, wastewater, and storm water networks. They know pipe and fitting materials and network renovation methods. After the module, the students will have a working knowledge of the water and wastewater networks and have the skills to perform a preliminary design of a network.	**16**	**16**
III.1	Water and wastewater networks and engineering design principles	Water supply pipelines materials: elements, installation, and main equipment; pipeline connections and main wells. Wastewater sewerage pipelines materials: elements, installation, and main equipment; pipeline connections and main wells. Wastewater networks in urban areas. Integrated storm water management Backlogs and network renovation methods, incl. leakage reduction	4 4 4 2 2	4 4 4 2 2
IV	**Water and wastewater treatment methods and engineering design principles**	Module IV presents various methods and means used for the treatment of water and wastewater in urban and rural areas and industrial and commercial activities. After the module student should be able to recognize the process units, describe their functions, and make basic calculations for a preliminary design of a water and wastewater treatment plant.	**16**	**16**
IV.1	Water and wastewater treatment methods and	Water quality and treatment requirements regarding different parameters (for municipal, industrial, commercial).	4	4

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	engineering design principles	Water and wastewater treatment methods for municipalities.	4	4
		Water and wastewater treatment in rural areas (outside municipal systems).	4	4
		Main waterworks for storing and cleaning water: pollutants removal, filters, residuals removal, and modern equipment.	2	2
		Water supply and wastewater treatment methods for industrial purposes and commercial consumption.	2	2
V	**Sludge treatment and disposal**	Module V examines the characteristics of municipal and industrial sewage sludge and the options available for subsequent treatment and reuse. The student understands how sludge is produced and measured, including key terminology. He/she can identify the principal elements of sludge treatment including advanced treatment and utilization of treated sludge.	**8**	**8**
V.1	Sludge treatment and disposal	Sludge quality requirement and assurance	3	3
		Sludge treatment processes: sludge removal and consolidation, conditioning, anaerobic (and aerobic) digestion, mechanical dewatering, thermal drying, incineration, pyrolysis and gasification.	3	3
		Utilization of treated sludge: agriculture, energy production, and disposal at the landfill site	2	2
VI	**Energy efficiency and circular economy in water and wastewater facilities**	Module VI describes how water and wastewater facilities can achieve multiple benefits by improving energy efficiency. After the module student understands the steps and considerations involved in developing and implementing energy efficiency improvements and circular economy solutions in water and wastewater facilities. He/she also gains awareness of expected investments.	**8**	**8**

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VI.1	Energy efficiency and circular economy in water and wastewater facilities	Energy use assessment	1,5	1,5
		Energy efficiency in water and wastewater works	1,5	1,5
		Energy management for water supply and sanitation facilities	2	2
		Circular economy examples	2	2
		Greenhouse gas reduction programmes	1	1
VII	**Waste, circular economy and digitalization**	Module VII approaches the latest trends of automation and digitalization in water and wastewater systems. The module gives the student understanding of the principles and applications of smart solutions for integrating and analyzing data, both on-premises and across systems and treatment plants.	**8**	**8**
VII.1	Waste, circular economy and digitalization	Concepts of automation	3	3
		Concepts of digitalization	3	3
		Applications to water and wastewater systems	2	2
VIII	**Green water and wastewater systems**	Module VII approaches water and wastewater systems from the green infrastructure point of view. The module gain students' ability to contextualize and plan nature-based solutions taking into account ecological, social and financial aspects of sustainable development. He/she understands the working principles of water-saving equipment and know the applications in different structures.	**8**	**8**
VIII.1	Green water and wastewater systems	Water supply in the sustainable living environment	1,5	1,5
		Water and wastewater systems in public areas	1,5	1,5
		Water and wastewater reuse or closed-loop possibilities	2	2
		Water and sewer lines inside buildings	2	2
		Water-saving devices, equipment, calculation	1	1
		Total	**80**	80

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Chapter 2.2: Knowledge acquired

Learning achievements
The student has an understanding of the importance of laws and guidelines that govern water and wastewater utilities.
The student deepens his/her knowledge on water and sewerage networks and water and wastewater treatment methods, processes and design parameters.
The student is introduced to various sludge treatment methods.
The student is introduced to the latest developments in automation, digitalization and circular economy
The student knows the water and wastewater systems' role in urban, peri-urban and rural contexts.

Chapter 2.3: Possible Teaching/Learning Materials

This chapter provides possible materials for each module.

Module 1: Introduction to water and wastewater services

- Selected materials from European Commission / Environment. Water. Available https://ec.europa.eu/environment/water/
- EurEau. (2021). Europe's Water in Figures: An overview of the European drinking water and wastewater sector. Available https://www.eureau.org/resources/publications/eureau-publications/5824-europe-s-water-in-figures-2021/file
- Selected chapters from the book Xiaochang C. Wang, and Guangtao Fu (eds.). 2021. Water-Wise Cities and Sustainable Water Systems: Concepts, Technologies, and Applications. IWA Publishing. DOI: https://doi.org/10.2166/9781789060768. Available https://iwaponline.com/ebooks/book/809/Water-Wise-Cities-and-Sustainable-Water-Systems
- Hong Li. (2016). Global Trends & Challenges in Water Science, Research and Management. International Water Association (IWA). Available https://iwa-network.org/publications/global-trends-challenges-in-water-science-research-and-management/

Module 2: Regulatory frameworks and water and wastewater works management

- Drinking Water Directive. Available https://ec.europa.eu/environment/water/water-drink/legislation_en.html
- Urban Waste Water Directive Overview. Available https://ec.europa.eu/environment/water/water-urbanwaste/index_en.html
- AWWA.(2019). A Water Utility Manager's Guide to Community Stewardship. Available https://www.awwa.org/Portals/0/AWWA/ETS/Resources/AWaterUtilityManagersGuidetoCommunityStewardship.pdf?ver=2019-12-10-141648-837
- Legislation on water resources and marine protection in Finland https://ym.fi/en/legislation-on-the-protection-of-water-and-the-sea

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- Inha, L., Katko, T.S. and Rajala, R. 2019. Improved Water Services Cooperation through Clarification of Rules and Roles. Water 2019, 11(10), 2172; https://doi.org/10.3390/w11102172.
- Laukka,V., Kallio, J., Herrmann, I., Malila, R., Nilivaara, R. and Heiderscheid, E. 2022. Governance of on-site sanitation in Finland, Sweden and Norway. Reports of the Finnish Environment Institute 8 / 2022. Available
- https://helda.helsinki.fi/bitstream/handle/10138/340576/SYKEra_8-2022_Governance-of-on-site-sanitation.pdf?sequence=1&isAllowed=y

Module 3: Water and wastewater networks and engineering design principles

- Selected standards from European Standards: Construction and testing of drains and sewers https://www.en-standard.eu/search/?q=Construction+and+testing+of+drains+and+sewers, 93.040 Pipeline components and pipelines https://www.en-standard.eu/bs-standards/23-fluid-systems-and-components-for-general-use/23-040-pipeline-components-and-pipelines/ and 93 Civil engineering https://www.en-standard.eu/ics-codes/93-civil-engineering/
- Dube, R. 2013. Refresher course for plumbers on household connectivity. Plumber's manual. Available http://www.urbansanitation.org/live/hrdpmp/hrdpmaster/hrdp-asem/content/e30293/e31169/e49811/e60457/PlumbersManual.pdf
- Mäkinen, R. (ed.). 2008. Drinking water quality and network materials in Finland. Summary report. Publications of Finnish Institute of Drinking Water 5. Available https://www.samk.fi/wp-content/uploads/2016/06/Summary-report-ed1.pdf
- Hamilton, S., Charalambous, B., and Wyeth, G. 2021. Improving Water Supply Networks
- Fit for Purpose Strategies and Technologies. IWA. DOI: 10.2166/9781780409207. Available https://iwaponline.com/ebooks/book/819/Improving-Water-Supply-Networks-Fit-for-Purpose.
- Helcom. 2021. Reduction of discharges from urban areas by proper management of stormwater systems. Baltic Marine Environment Protection Commission. Available http://helcom.fi/wp-content/uploads/2021/06/Rec-23-5-Rev.1.pdf
- Stormwaters: From waste to resource. Integrated Stormwater Management (iWater). Available http://www.integratedstormwater.eu/
- Selected chapters from the book Xiaochang C. Wang, and Guangtao Fu (eds.). 2021. Water-Wise Cities and Sustainable Water Systems: Concepts, Technologies, and Applications. IWA Publishing. DOI: https://doi.org/10.2166/9781789060768. Available https://iwaponline.com/ebooks/book/809/Water-Wise-Cities-and-Sustainable-Water-Systems
- Gupta, A.D., Pandey, P., Feijóo, A., Yaseen, Z.M. and Bokde, N.D. 2020. Smart Water Technology for Efficient Water Resource Management: A Review. MDPI. Available https://www.mdpi.com/1996-1073/13/23/6268/pdf

Module 4: Water and wastewater treatment methods and engineering design principles

- Selected chapters from the book Xiaochang C. Wang, and Guangtao Fu (eds.). 2021. Water-Wise Cities and Sustainable Water Systems: Concepts, Technologies, and Applications. IWA Publishing. DOI: https://doi.org/10.2166/9781789060768. Available https://iwaponline.com/ebooks/book/809/Water-Wise-Cities-and-Sustainable-Water-Systems
- Hong Li. (2016). Global Trends & Challenges in Water Science, Research and Management. International Water Association (IWA). Available https://iwa-network.org/publications/global-trends-challenges-in-water-science-research-and-management/

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- Davis, S. and Rosenblum, E. (eds.). 2021. Sustainable Industrial Water Use: Perspectives, Incentives, and Tools. IWA Publishing. DOI: https://doi.org/10.2166/9781789060676, Available https://iwaponline.com/ebooks/book/814/Sustainable-Industrial-Water-Use-Perspectives
- Finnish Industrial Wastewater Guide. (2018). Publication series no. 69 of the Finnish Water Utilities Association. Available https://www.vvy.fi/site/assets/files/4829/finnish_industrial_wastewater_guide.pdf
- Selected standards from European standards https://www.en-standard.eu/
- Selected materials from BEST – Better Efficiency for Industrial Sewage Treatment https://bestbalticproject.eu/

Module 5: Sludge treatment and disposal

- Hong Li. (2016). Global Trends & Challenges in Water Science, Research and Management. International Water Association (IWA). Available https://iwa-network.org/publications/global-trends-challenges-in-water-science-research-and-management/
- Barber, W. 2020. Sludge Thermal Hydrolysis: Application and Potential. IWA Publishing. DOI: 10.2166/9781789060287. Available https://iwaponline.com/ebooks/book-pdf/895720/wio9781789060287.pdf
- Reuna, S. 2022. Development of a method for phosphorus recovery from wastewaters. JYU Dissertations 486. Available https://jyx.jyu.fi/handle/123456789/79359
- BSRWater. 2021. Guidelines on integrated model for Water-Sludge-Energy cooperation. Available https://www.bsrwater.eu/news/publication-guidelines-water-sludge-energy

Module 6: Energy efficiency and circular economy in water and wastewater facilities

- Ganora, D. et al. 2019. Opportunities to improve energy use in urban wastewater treatment: a European-scale analysis. Environ. Res. Lett. 14 044028. Available https://iopscience.iop.org/article/10.1088/1748-9326/ab0b54/pdf
- Yu Liu and Jun Gu, Meng Zhang. 2020. A-B Processes: Towards Energy Self-sufficient Municipal Wastewater Treatment. IWA Publishing. DOI: 10.2166/9781789060089. Available https://iwaponline.com/ebooks/book-pdf/645726/wio9781789060089.pdf
- EPA. Energy Efficiency for Water Utilities. Available https://www.epa.gov/sustainable-water-infrastructure/energy-efficiency-water-utilities
- EurEau. 2019. Reducing the Energy Footprint of the Water Sector. Possibilities, Success Stories and Bottlenecks. Available https://www.eureau.org/resources/briefing-notes/3890-briefing-note-on-reducing-the-energy-footprint-of-water-sector/file
- Smol, M. and Koneczna, R. 2021. Economic Indicators in Water and Wastewater Sector Contributing to a Circular Economy (CE). Resources 2021, 10, 129. https://doi.org/10.3390/resources10120129. Available https://www.mdpi.com/2079-9276/10/12/129/pdf
- Neczaj, E. and Grosser, A. 2018. Circular Economy in Wastewater Treatment Plant– Challenges and Barriers. MDPI proceedings. Available https://www.mdpi.com/2504-3900/2/11/614/pdf
- https://www.balticwaterhub.net/tool/audit-energy

Module 7: Automation and digitalization in water and wastewater systems

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- Olsson, G. 2021. Urban water supply automation – today and tomorrow. Journal of Water Supply: Research and Technology-Aqua (2021) 70 (4): 420–43. Available https://doi.org/10.2166/AQUA.2020.115
- Müller-Czygan, G., Tarasyuk, V., Wagner, C. and Wimmer, M. 2021. How Does Digitization Succeed in the Municipal Water Sector? The WaterExe4.0 Meta-Study Identifies Barriers as well as Success Factors and Reveals Expectations for the Future. Energies 2021, 14(22), 7709. Available https://doi.org/10.3390/en14227709
- Kapelan, Z., Weisbord, E. and Babovic, V. 2020. Artificial Intelligence Solutions for the Water Sector. IWA Publishing. Available https://iwa-network.org/wp-content/uploads/2020/08/IWA_2020_Artificial_Intelligence_SCREEN.pdf
- Hong Li. (2016). Global Trends & Challenges in Water Science, Research and Management. International Water Association (IWA). DOI: 10.2166/9781789062267. Available https://iwa-network.org/publications/global-trends-challenges-in-water-science-research-and-management/

Module 8: Green water and wastewater systems

- Cross, K. & Tondera, K., Rizzo, A., Andrews, L., Pucher, B., Istenič, D., Karres, N. and McDoald, R. (eds.). 2021. Nature-Based Solutions for Wastewater Treatment: A series of factsheets and case studies. Water Association (IWA). Available https://iwaponline.com/ebooks/book/834/Nature-Based-Solutions-for-Wastewater-Treatment-A
- Selected chapters from the book Xiaochang C. Wang, and Guangtao Fu (eds.). 2021. Water-Wise Cities and Sustainable Water Systems: Concepts, Technologies, and Applications. IWA Publishing. DOI: https://doi.org/10.2166/9781789060768. Available https://iwaponline.com/ebooks/book/809/Water-Wise-Cities-and-Sustainable-Water-Systems
- Hong Li. (2016). Global Trends & Challenges in Water Science, Research and Management. International Water Association (IWA). Available https://iwa-network.org/publications/global-trends-challenges-in-water-science-research-and-management/
- Valentukevičienė M. and Rynkun G. 2016. Water reuse possibilities at students dormitories. Annual Set the Environment Protection. T. 18 (2016), p. 927-936. Available https://www.researchgate.net/publication/306285865_Water_reuse_possibilities_at_students_dormitories
- European Standard EN8558:2015 Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Available https://www.en-standard.eu/bs-8558-2015-guide-to-the-design-installation-testing-and-maintenance-of-services-supplying-water-for-domestic-use-within-buildings-and-their-curtilages-complementary-guidance-to-bs-en-806/
- Selected materials from Water reuse https://ec.europa.eu/environment/water/reuse.htm
- Selected materials from Ecologic Institute https://www.ecologic.eu/topic-clusters

Chapter 2.4.: Further literature

Further material can be applied according to needs. Following links, e.g., are worth looking into:

- European environmental Agency https://www.eea.europa.eu/themes/water
- Kemira's Water Handbook: Water https://www.kemira.com/water/

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- Smart Water solutions : Opportunities and challenges for the water sector https://www.vvy.fi/site/assets/files/3047/smart_water_solutions_web_003.pdf
- AWWA https://www.awwa.org/Resources-Tools/Technical-Reports
- Sustainable Sanitation and Water Management Toolbox https://sswm.info/about-toolbox
- Stormwater report https://stormwater.wef.org/
- Platform on integrated water cooperation BSRWater https://www.bsrwater.eu/
- Protecting the Baltic Sea from untreated wastewater spillages during flood events in urban areas, NOAH project https://sub.samk.fi/projects/noah/
- Smart Water Magazine https://smartwatermagazine.com/themes/
- Guidelines for drinking-water quality: Fourth edition incorporating the first and second addenda https://www.who.int/publications/i/item/9789240045064
- Zhiyong Jason Ren and Krishna Pagilla. 2022. Pathways to Water Sector Decarbonization, Carbon Capture and Utilization. Available https://iwaponline.com/ebooks/book/843/Pathways-to-Water-Sector-Decarbonization-Carbon

Chapter 2.5: Further Information

Modifications are allowed: The proportional division and content of separate modules suggested above can be changed if local conditions or needs of participants could be responded to better by other solutions.

Examinations and qualifications: Examinations will be coordinated and competences will be controlled according to local regulation and locally required qualifications. It is each local actor's responsibility to take care that the admission requirements are fulfilled before the qualification application.

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Chapter 3: Notes for Teachers

Satakunta University of Applied Sciences (SAMK)

Compiled by Dr Sirpa Sandelin and Dr Kari Lilja

The material enclosed is an example showing how the topics of this course could be presented. Each teacher should adjust this to the circumstances of his own country, considering the local regulation and the study programme of the students; are they studying engineering, environmental topics, finance or marketing, some examples to be given. Each programme may require different weightings and highlights, and it is on the responsibility of each teacher to consider these special needs.

Chapter 3.1: Target Group

The target group of the curriculum consists of Bachelor's programme students at universities and universities of applied sciences. The individual modules are well suited also to be applied as the open university courses.

Chapter 3.2: Work required

In the curriculum, the average work required by each module is measured in ECTS credit units (abbreviated in this presentation as CU). One credit unit equals 27 hours workload. The curriculum consists of modules totalling six (6) ECTS credit units corresponding to 160 hours containing lectures, professional field visits, individual studies, and assignments.

Chapter 3.3: Teaching Methods

Teachers are encouraged to use varying methods containing e.g.:

- Lectures,
- Visiting lecturers,
- Professional field visits,
- Visits in enterprises,
- Videos approaching the topics (Reliability of the source must be evaluated),
- Individual studies and
- Assignments.

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Cooperation with the local experienced industry practitioners is highly recommended. All modules can be studied individually, so the modules can be offered also via open studies to all companies and organizations, that intend to implement or develop water and wastewater systems.

Chapter 3.4: Contents of the Curriculum

The variation in regulations and circumstances and qualification requirements are quite different in the BSR-countries, thus the curriculum can be written only as a form of framework inside which the local actors should be able to modify the contents of modules according to their regulations and local requirements. Using innovative, problem-based, and experiential educational approaches, students build on their professional experience to become experts who can create and implement effective water and wastewater solutions.

The overall objectives of the curriculum are to

- give an understanding of the importance of laws and guidelines that govern water and wastewater utilities
- give the students deep knowledge on water and sewerage networks and water and wastewater treatment methods, processes and design parameters
- introduce various sludge treatment methods
- introduce the latest developments in automation, digitalization and circular economy
- highlight the water and wastewater systems' role in urban, peri-urban and rural contexts

The curriculum is divided into modules as follows:

- Module 1: Introduction to water and wastewater services (8 + 8 hours)
- Module 2: Regulatory frameworks and water and wastewater works management (8 + 8 hours
- Module 3: Water and wastewater networks and engineering design principles (16 + 16 hours)
- Module 4: Water and wastewater treatment methods and engineering design principles (16+16 hours)
- Module 5: Sludge treatment and disposal (8 + 8 hours)
- Module 6: Energy efficiency and circular economy in water and wastewater facilities (8 +8 hours)
- Module 7: Automation and digitalization in water and wastewater systems (8 + 8 hours)
- Module 8: Greening water and wastewater systems (8 + 8 hours)

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Chapter 4: Teaching Plan

This chapter summarizes the teaching plan for the part I "Wastewater sewerage" and the part II "Water supply".

Chapter 4.1.: Wastewater Sewerage

Annotation of course: Wastewater sources; wastewater sewerage systems, pumping stations; wastewater treatment; general requirements for design and calculations. Systems of wastewater reuse, elements, sanitary appliances, materials for pipes; additional elements of grey and black wastewater sewerage systems. Building constructions and wastewater sewerage systems. Connection to the centralised networks.

Aim of the course: General knowledge transfer related to wastewater sewerage systems, main equipment, devices and installation, main requirements for the design and engineering; adaptation to wastewater reuse; wastewater systems for sustainable living environment.

Chapter 4.1.1.: Distribution of Course Hours by Study Form and Ways

Study form	Code	Study way	Hours			Thereof		Course volume in Credits
			Lectures	Independent Work	Total	Contact	Classroom	
Full-time studies	NL	S	40	40	80	-	40	3

Chapter 4.1.2.: References

Main references (not more than five references)

Number	Authors and title (site address in case of e-publication)
1	Rev May. Plumbing design. 2018.
2	Regina Dube. Manual for plumbers, urban sanitation. 2013.

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3	EN 752 - Drain and sewer systems outside buildings.
4	EN 1295-1 - Structural design of buried pipelines under various conditions of loading.

Additional references (not more than ten references)

Number	Authors and title (site address in case of e-publication)
1	Valentukevičienė M; Rynkun G. Water reuse possibilities at student's dormitories. Annual set the environment protection. T. 18 (2016), p. 927-936.
2	EN 161 Construction and testing of drains and sewers.

Chapter 4.1.3.: Independent work

Content of Independent Work:

Assignment title	Recommended hours	Separated hours	Number of tasks	Total hours
		NL(S)	NL(S)	NL(S)
Homework	8-27	20	1	20
Examination	16-24	20	1	20
			Total hours:	40

Individual Work Schedule:

Task type	Week of assignment setting(*) and assessment (+)																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Full-time studies																					
Homework Other	(*) +	*									+										

Chapter 4.1.4.: Course lecture topics

Topic title	Number of hours
	NL
1. Main wastewater sewerage systems. Domestic and industrial wastewater sources; grey and black wastewater.	2
2. Essential elements and main functions of wastewater sewerage. EN requirements for design and engineering	2
3. Wastewater flows and estimation methods. Wastewater pumping stations, installation and calculation.	2
4. Wastewater sewerage for the buildings and small settlements.	2
5. Design of wastewater sewerage networks and equipment. Wastewater sewerage systems (domestic and industrial) calculations: flows estimation, hydraulic calculation of wastewater pipelines.	4
6. Wastewater treatment plants, classifications; general scheme and essential elements. Requirements for the wastewater quality. Local wastewater treatment plants.	4
7. Alternative devices of wastewater reuse; heat pump installations for energy recovering.	2
8. Wastewaters reuse systems in the buildings. Reuse systems and schemes; design and engineering. Essential elements of wastewater reuse systems.	4
9. Wastewater sewerage pipelines materials: elements, installation, and main equipment. Pipelines connections and main wells.	2
10. Main wastewater works for storing and cleaning wastewater: pollutants removal, green filters, sludge management, and required equipment.	4
11. Special wastewater systems of the green buildings; required devices, equipment, calculation.	2
12. SPA centrams, baseinams; automobilių stovėjimo aikštelėms. Industrial wastewater sewerage. Wastewater sewerage systems in public areas; SPA facilities, swimming pools; parking.	4

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13. Underground constructions of wastewater sewerage pipes and wells. Inspection and operating considerations.	4
14. Wastewater sewerage in sustainable living environment. Energy Management for Wastewater sewerage Facilities.	2
Total hours:	40

Course compiled by (full name, signature) Marina Valentukevičienė

Chapter 4.2.: Water supply

Annotation of course

Water sources; Water supply systems, pumping stations; drinking water treatment; An EN (European Standard) general requirements for design and calculations. European Union water policy, national legislation and local regulations. Systems of water reuse industrial and domestic, elements, sanitary appliances, materials for pipes; additional elements of water supply system. Building constructions and water supply systems. Connection to the centralised networks.

Aim of course

General knowledge transfer related to water supply systems, main equipment, devices and installation, European Standard main requirements for the design and engineering; adaptation to water reuse; water systems for green buildings.

Chapter 4.2.1.: Distribution of course hours by study forms and ways

Study form	Code	Study way	Hours			Thereof		Course volume in Credits
			Lectures	Independent Work	Total	Contact	Classroom	
Full-time studies	NL	S	40	40	80	-	40	3

Chapter 4.2.2.: References

Main references (not more than five references)

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Number	Authors and title (site address in case of e-publication)
1	EN 805:2000 Water supply. Requirements for systems and components outside buildings
2	William Kinninmond Burton. The Water Supply Of Towns And The Construction Of Waterworks: A Practical Treatise For The Use Of Engineers And Students Of Engineering. 2019.
3	EN 12201-1:2011 Plastics piping systems for water supply, and for drainage and sewerage under pressure.
4	EN8558:2015 Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages.

Additional references (not more than ten references)

Number	Authors and title (site address in case of e-publication)
1	Valentukevičienė M; Rynkun G. Water reuse possibilities at students dormitories. Annual set the environment protection. T. 18 (2016), p. 927-936.
2	Mäkinen, Riika. DRINKING WATER QUALITY AND NETWORK MATERIALS IN FINLAND. 2008
3	https://iwa-network.org/resources/

Chapter 4.2.3.: Independent Work

Content of Independent Work:

Assignment title	Recommended hours	Separated hours	Number of tasks	Total hours
		NL(S)	NL(S)	NL(S)
Homework	8-27	20	1	20
Examination	16-24	20	1	20
			Total hours:	40

Individual Work Schedule:

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Task type	Week of assignment setting(*) and assessment (+)																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Full-time studies																					
Homework Other	(*) +	*									+										

Chapter 4.2.4.: Course lecture topics

Topic title	Number of hours
	NL
1. Main water supply systems. Open water sources; groundwater.	2
2. Essential elements and main functions of water supply. European Union EN requirements for design and engineering. Legal regulations and responsibilities of municipal water works, house ownwers and industrial premises.	2
3. Water quality and treatment requirements regarding different parameters (for municipal, industrial, commercial).	2
4. Water treament methods for municipalities	2
5. Water and wastewater treatment in rural areas (outside municipal systems)	4
6. Water supply and wastewater treatment methods for industrial purposes and for commercial consumption.	4
7. Water reuse or closed loops possibilities	2
8. Energy efficiency at water works	4
9. Water supply pipelines materials: elements, installation, and main equipment. Pipelines connections and main wells.	2
10. Main waterworks for storing and cleaning water: pollutants removal, filters, residuals removal, and modern equipment.	4
11. Special water system of the green buildings. Water saving devices, equipment, calculation.	2
12. Water supply systems for the public purpose. - Water for fire fighting	4

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13. Sustainable urban and rural water works management: municipal, public-private-partnerships and private systems (individual or cooperatives).	4
14. Water supply in sustainable living environment. Energy Management for Water Supply Facilities.	2
Total hours:	40

Chapter 5: Teaching Material

The teaching material can be found in the documents entitled:

- 3LoE_WP5A8_A_Attachment1_TeachingmaterialModulAWaterWastewaterSAMK_FV
- 3LoE_WP5A8_A_Attachment2_TeachingmaterialModulAWaterWastewaterVGTU_FV

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Management & Technologies of the Water and Wastewater Industry

Satakunta University of Applied Sciences (SAMK),

Compiled by Dr Sirpa Sandelin and Dr Kari Lilja

HANSE-PARLAMENT E.V.

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

Content

- Module 1: Introduction to water and wastewater services
- Module 2: Regulatory frameworks and water and wastewater works management
- Module 3: Water and wastewater networks and engineering design principles
- Module 4: Water and wastewater treatment methods and engineering design principles
- Module 5: Sludge treatment and disposal
- Module 6: Energy efficiency and circular economy in water and wastewater facilities
- Module 7: Automation and digitalization in water and wastewater systems
- Module 8: Greening water and wastewater systems

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The overall objectives of the curriculum are to

- give an understanding of the importance of laws and guidelines that govern water and wastewater utilities
- give the students deep knowledge on water and sewerage networks and water and wastewater treatment methods, processes and design parameters
- introduce various sludge treatment methods
- introduce the latest developments in automation, digitalization and circular economy
- highlight the water and wastewater systems’ role in urban, peri-urban and rural contexts

Module 1: Introduction to water and wastewater services

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Topics to be discussed

- Essential elements and main functions of water supply and wastewater treatment
- Surface water and groundwater sources, quantity and abstraction
- Domestic and industrial wastewater sources; grey and black wastewater
- Water for firefighting
- Principles of circular economy and digitalization in the water industry

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Water…

- covers 70% of our planet, but only 3% of the world’s water is potable freshwater. Only one percent of that amount is in an easily exploitable form in rivers and lakes and the rest is hidden in glaciers or inaccessible.
- is at the heart of sustainable development and is necessary for socio-economic development, healthy ecosystems and for human survival itself. (Unwater, 2021)
- is critical part of adaptation to climate change, serving as the crucial link between the climate system, human society and the environment.

Water facts (UN)

Water is linked to almost everything in the world:

- Climate change
- Disasters
- Ecosystems
- Financing Water and Sanitation
- Gender
- Human Rights to Water and Sanitation and hand hygiene
- Quality and wastewater
- Water scarcity
- Transboundary waters
- Urbanization
- Water, food and energy

The challenge can also be seen as an opportunity:

- Globally, it is evaluated that over 80% of wastewater is released to the environment without adequate treatment (UN WWDR, 2017).
- The potential for wastewater recovery is huge - Safely managed wastewater is an affordable and sustainable source of water, energy, nutrients and other recoverable materials. (UN WWDR, 2017).
- Globally almost three out of four jobs that make up the entire global workforce are water-dependent so investments in water infrastructure and 'water jobs' make positive returns and have a multiple effect on job creation across all economic sectors (WWAP Presentation: Launch of the UN World Water Development Report 2016)

Water cycle and climate change

- ***The water cycle*** shows the continuous movement of water between the Ground, the Earth and Atmosphere by Evaporation, Condensation, Sublimation, Precipitation, Transpiration, Runoff, and Infiltration. Except the precipitation, these occur continuously.

- "Climate change impacts are most felt through changing hydrological conditions including changes in snow and ice dynamics. " (United Nations, 2020)

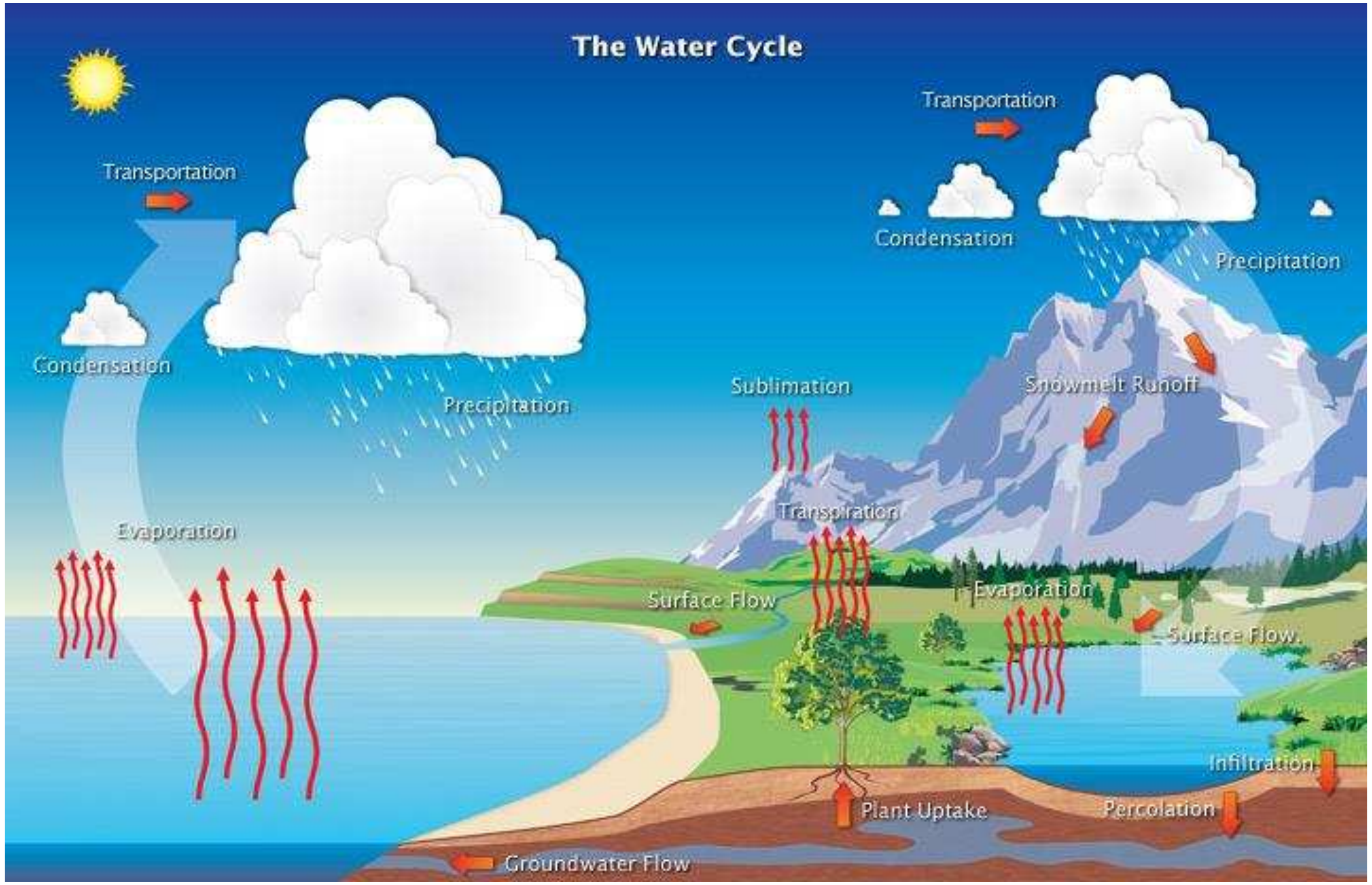


Image credit: The water cycle by NOAA National Weather Service Jetstream, CC BY 2.0

Essential elements and main functions of water supply

The Drinking Water Directive applies to:

- all distribution systems serving more than 50 people or supplying more than 10 cubic meter per day, but also distribution systems serving less than 50 people/supplying less than 10 cubic meter per day if the water is supplied as part of an economic activity;
- drinking water from tankers;
- drinking water in bottles or containers;
- water used in the food-processing industry, unless the competent national authorities are satisfied that the quality of the water cannot affect the wholesomeness of the foodstuff in its finished form.

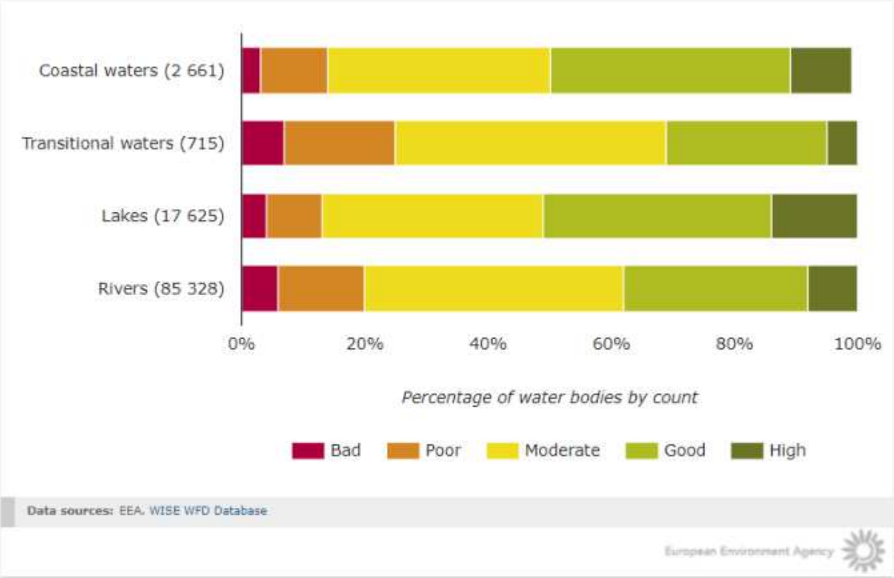
Source: https://ec.europa.eu/environment/water/water-drink/index_en.html

Picture: https://pixabay.com/fi/photos/napauta-musta-hana-keitti%c3%b6-791172/

Video: Te European Environment Agency: Tap water: one of our most valuable resources https://www.youtube.com/embed/AVLRBVAOlUU

Surface water and groundwater sources, quantity and abstraction

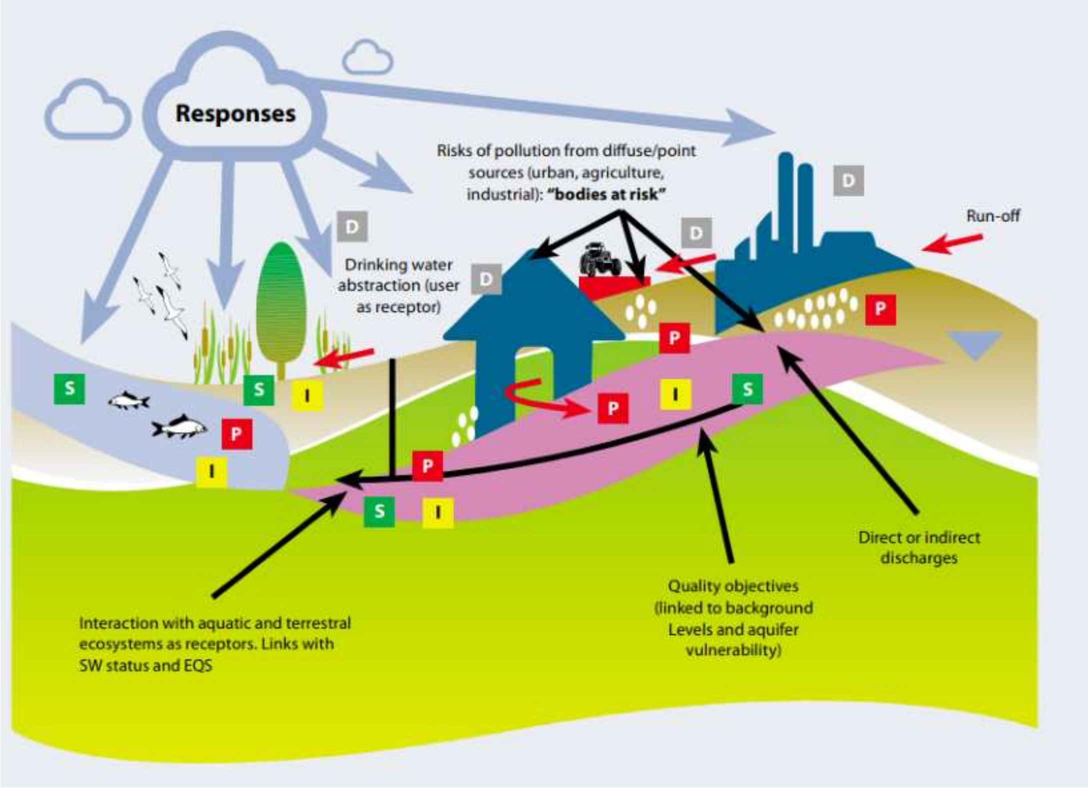
- Ecological status of surface water bodies in EU



Indicator	EU indicator past trend	Selected objective to be met by 2020	Indicative outlook for the EU meeting the selected objective by 2020
Status of surface waters	▲ (1)	Achieve good status of transitional, coastal and fresh waters — Water Framework Directive	●

Source: https://www.eea.europa.eu/airs/2018/natural-capital/surface-waters

Surface water and groundwater sources, quantity and abstraction

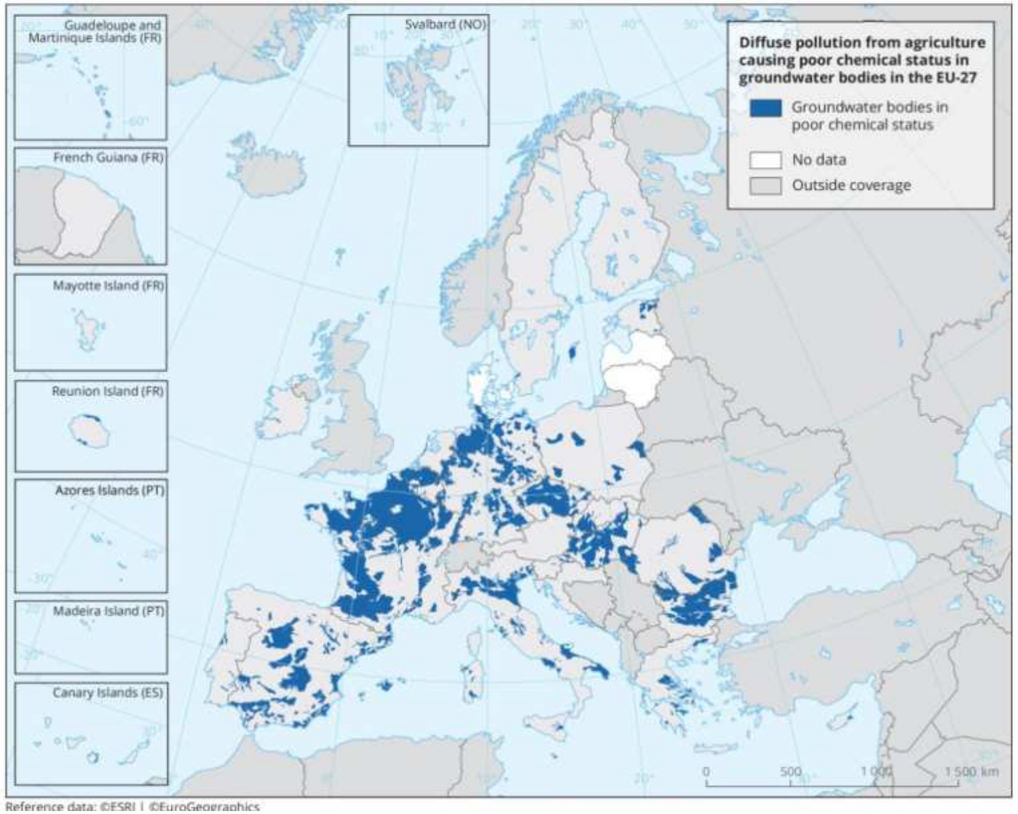


Source: https://ec.europa.eu/environment/water/water-framework/groundwater/pdf/brochure/en.pdf

- Main driving forces (D) and related pressures (P) affecting groundwater.
- The status (S) and impacts (I) concerns both the groundwater resource and the associated and dependent
- aquatic and terrestrial ecosystems.
- The responses (R) are the action programmes of relevant
- EU legislations (primarily the programme of measures of the Water Framework Directive)

State of groundwater in Europe

- Groundwater supplies 65% of drinking water and 25% of water for agricultural irrigation in the 27 EU Member States (EU-27).
- According to Member States' second river basin management plans (2016), 24% of the total groundwater body area was reported to be of poor chemical status and 9% to be of poor quantitative status in the EU-27.
- A combined assessment of chemical status and quantitative status shows that 29% of the total groundwater body area lacks sufficient capacity to meet the needs of ecosystems and people, owing to deterioration of groundwater quality or quantity.
- Groundwater is under widespread pressure from pollution and abstraction. Pressures are likely to increase as result of population growth and increasing water demand in a changing climate.



Source: BRIEFING Europe's groundwater — a key resource under pressure
https://www.eea.europa.eu/publications/europes-groundwater/europes-groundwater

Surface water and groundwater sources, quantity and abstraction

- Water statistics can be found from Eurostat page https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Category:Water
- See the latest figures of Water and SDG related statistics from SDG 6 - Clean water and sanitation (statistical annex)
- Example from Finland: Protection of groundwater https://ym.fi/en/protection-of-groundwater

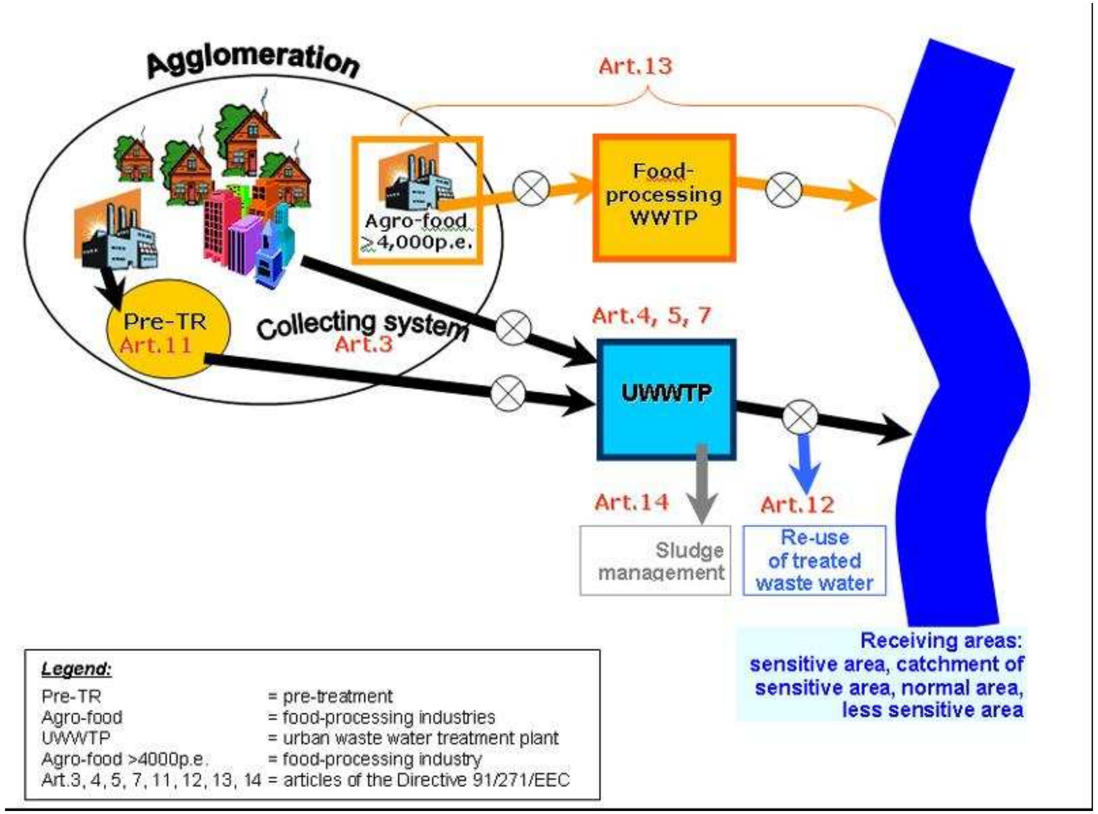
Essential elements and main functions of wastewater treatment

Requirements according to the Council Directive 91/271/EEC concerning urban waste-water treatment

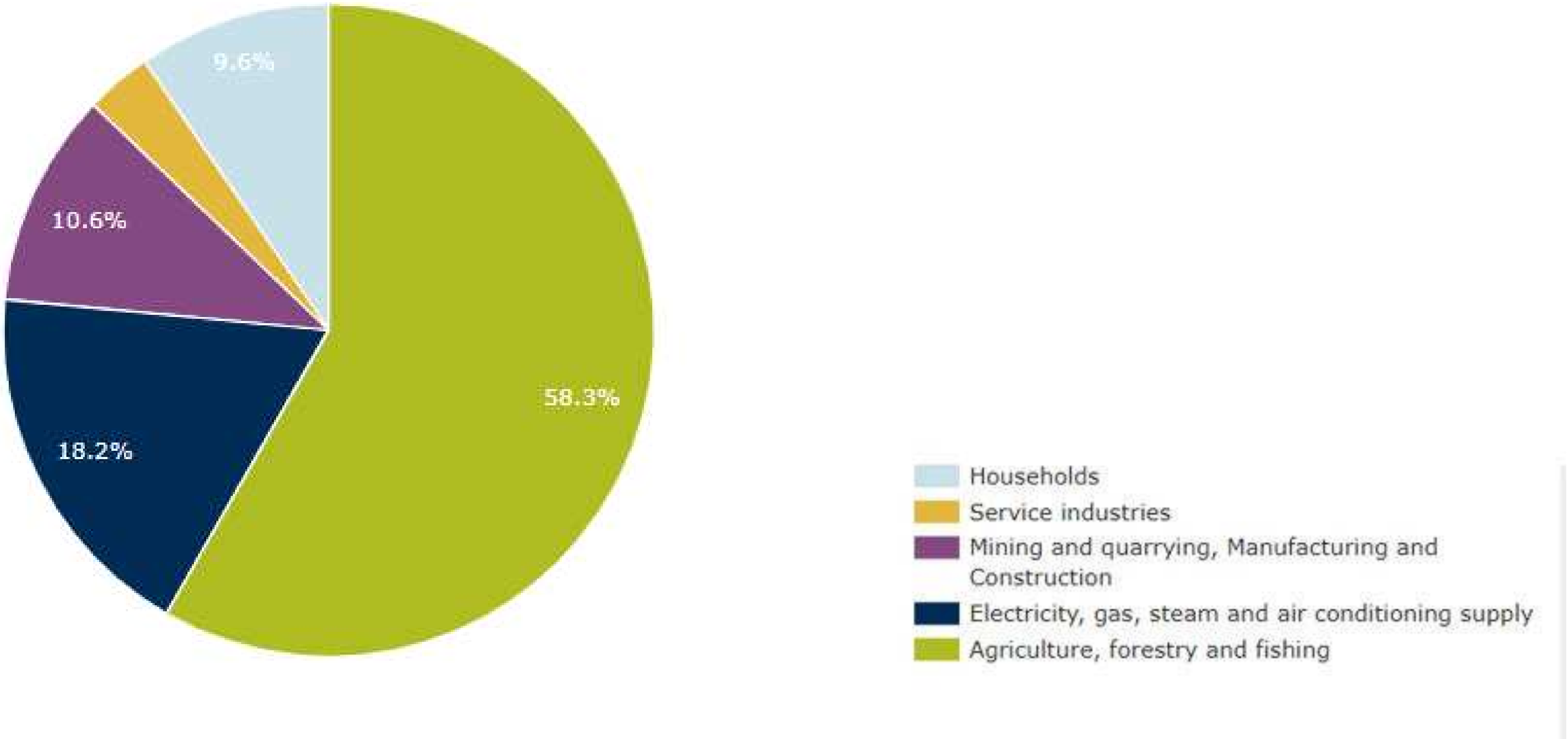
- The collection and treatment of waste water in all agglomerations of >2000 population equivalents (p.e.);
- Secondary treatment of all discharges from agglomerations of > 2000 p.e., and more advanced treatment for agglomerations >10 000 population equivalents in designated sensitive areas and their catchments;
- A requirement for pre-authorisation of all discharges of urban wastewater, of discharges from the food-processing industry and of industrial discharges into urban wastewater collection systems;
- Monitoring of the performance of treatment plants and receiving waters; and
- Controls of sewage sludge disposal and re-use, and treated waste water re-use whenever it is appropriate.

Source: https://ec.europa.eu/environment/water/water-drink/index_en.html

- See also **Country profiles on urban waste water treatment** https://water.europa.eu/freshwater/countries/uwwt



Water use by sectors



Source: https://www.eea.europa.eu/data-and-maps/daviz/annual-and-seasonal-water-abstraction-7#tab-dashboard-02

17 Sustainable Development Goals, SDG

In 2015, the United Nations member states adopted the Agenda to achieve the 17 Sustainable Development Goals (SDGs) with the purpose of building a better and more sustainable future for all by the 2030.

17 goals containing 169 targets.

Ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth

- All tackling climate change and working to preserve oceans and forests.

The circular economy is relevant to all sectors of the economy.

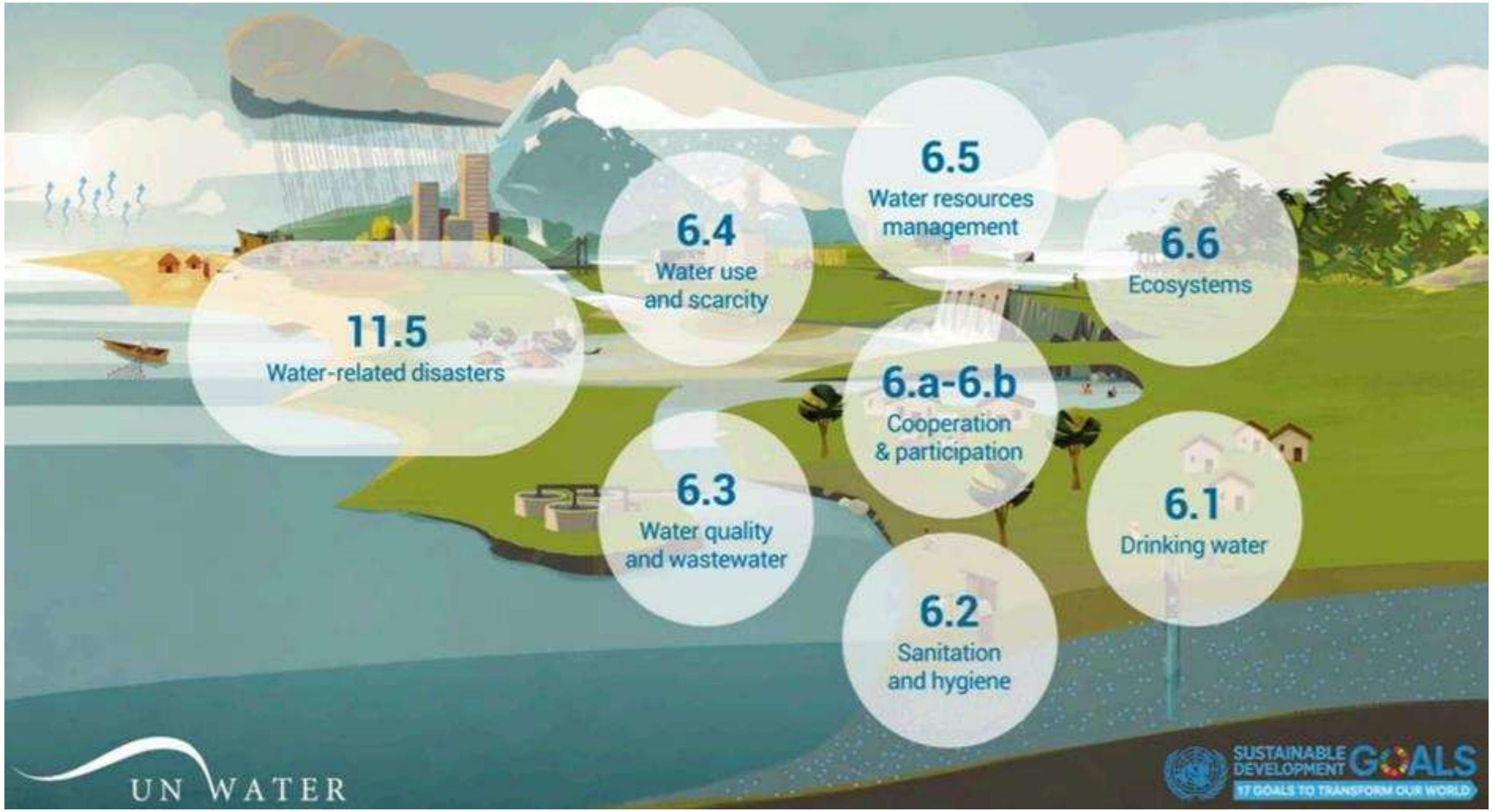
- It has gained increasing prominence as a tool which presents solutions to some of the world’s most pressing sustainable development challenges.

Source: https://sdgs.un.org/goals

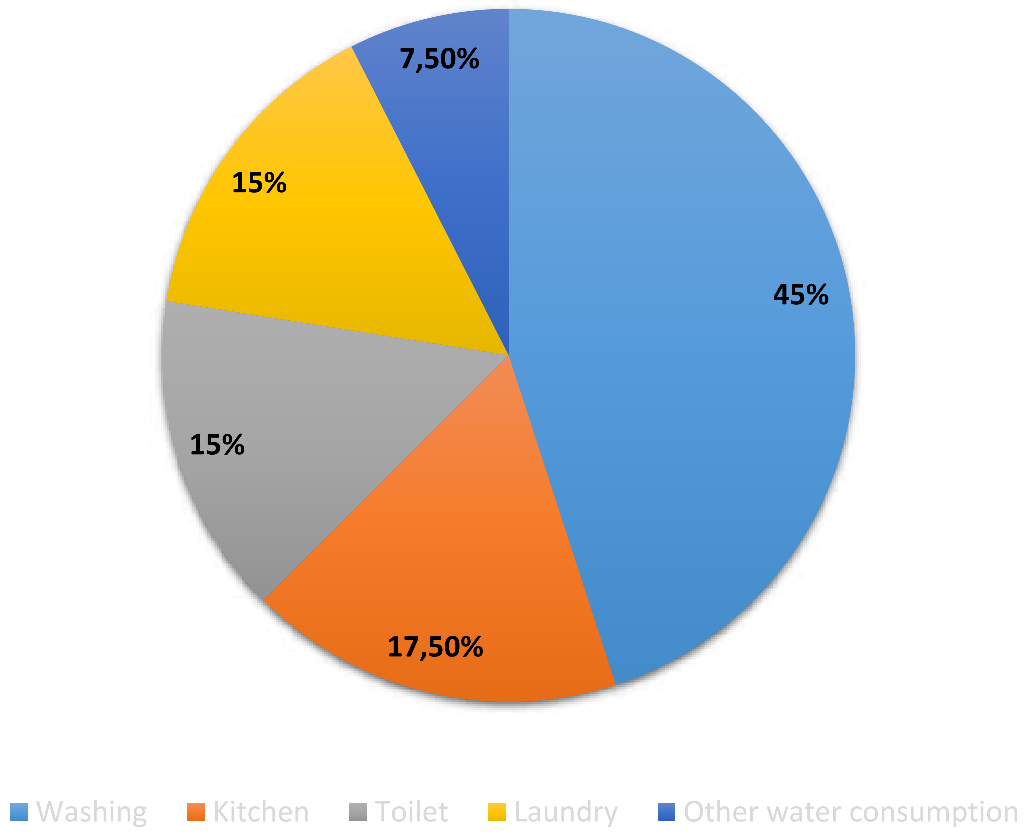
Water and Sustainable Development Goals

- Aims to work on issues related to clean water, sanitation, but also the sustainability of the hygiene of water resources worldwide. Some of the relevant targets expected by 2030 are:
  - Implement integrated water resources management
  - Protect and restore water-related ecosystems
  - Support activities to developing countries for water and sanitation as wastewater treatment , recycling and reuse technologies

Issues concerning the Water Cycle in Sustainable Development Goals



Household water consumption



Distribution of water use according to the 2020 water use survey (in Finland).
Source: Kestävä veden käyttö -Vedenkäyttöselvitys

The average water consumption of the participants in the survey was 110 l / person / day

- There are big differences in water consumption between households: Some households can consume just under 50 liters a day, whereas the others may consume closer to three hundred liters or more of water per day.

Domestic and industrial wastewater sources

Domestic wastewater sources

- Wastewater from homes and offices.
- Wastewater from the kitchen, shower, wash basin, toilet and laundry.

Industrial wastewater cources

- Agriculture
- Breweries
- Dairy
- Pulp and paper
- Iron and steel
- Food industry
- Mine and quarry
- Chemical industry
- Nuclear power plant

Water for firefighting

- Local provisions and requirements must be followed.
- See fire protection guidelines from https://cfpa-e.eu/cfpa-e-guidelines/guidelines-fire-protection-form/
- Options for firefighting water:
  - public or company water lines (with hydrants),
  - firefighting water wells,
  - firefighting water ponds, pools, tanks or cisterns,
  - open bodies of water (rivers, harbour basins),
  - recycled or reclaimed water;
  - others (sedimentation basins, cooling water reservoirs etc.).

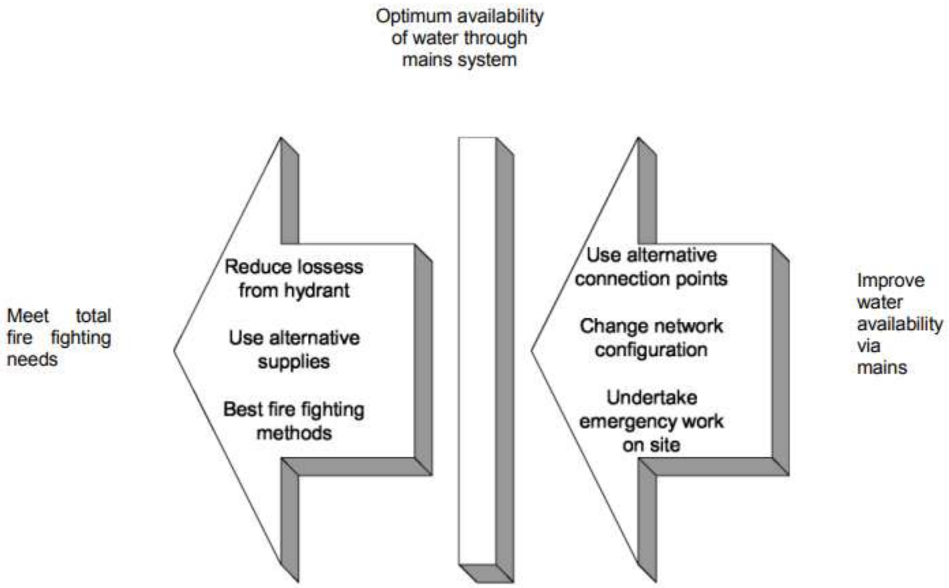


Figure source: https://www.water.org.uk/wp-content/uploads/2018/11/national-guidance-document-on-water-for-ffg-final.pdf

Principles of circular economy and digitalization in the water industry

- The SDG 6.2 aims to increase the level of wastewater treatment from today's level of 20% of all wastewater generated globally, to 60% in 2030.
- Decarbonize treatment plants
- Save energy
- Increase energy production

Source: https://iwa-network.org/how-can-more-water-treatment-cut-co2-emissions/

Module 2: Regulatory frameworks and water and wastewater works management

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Topics to be discussed

- European Union water policy, European Union water directive and wastewater directive, national legislation and local regulation
- European Union and national requirements for design and engineering
- Legal regulations and responsibilities of municipal waterworks, house owners, and industrial premises
- Sustainable urban and rural waterworks management: municipal, public-private-partnerships and private systems (individual or cooperative)

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European legal framework related to water

"The main overall objective of EU water policy is to ensure access to good quality water in sufficient quantity for all Europeans, and to ensure the good status of all water bodies across Europe." (European Commission)

Laws governing water protection and wastewater treatment (e.g.):

(These policies regulate the discharges from dwellings not connected to the wastewater collection only partially or indirectly.)

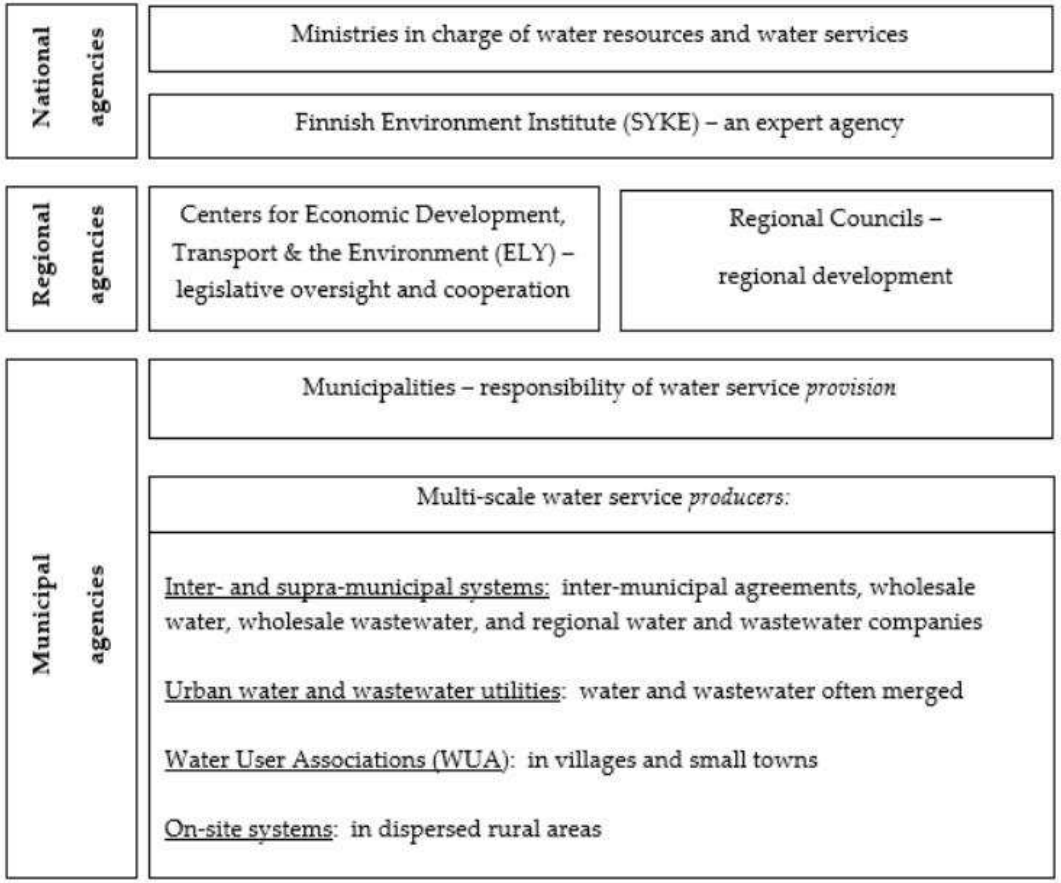
EU Water Framework Directive 2000/60/EC (WFD)

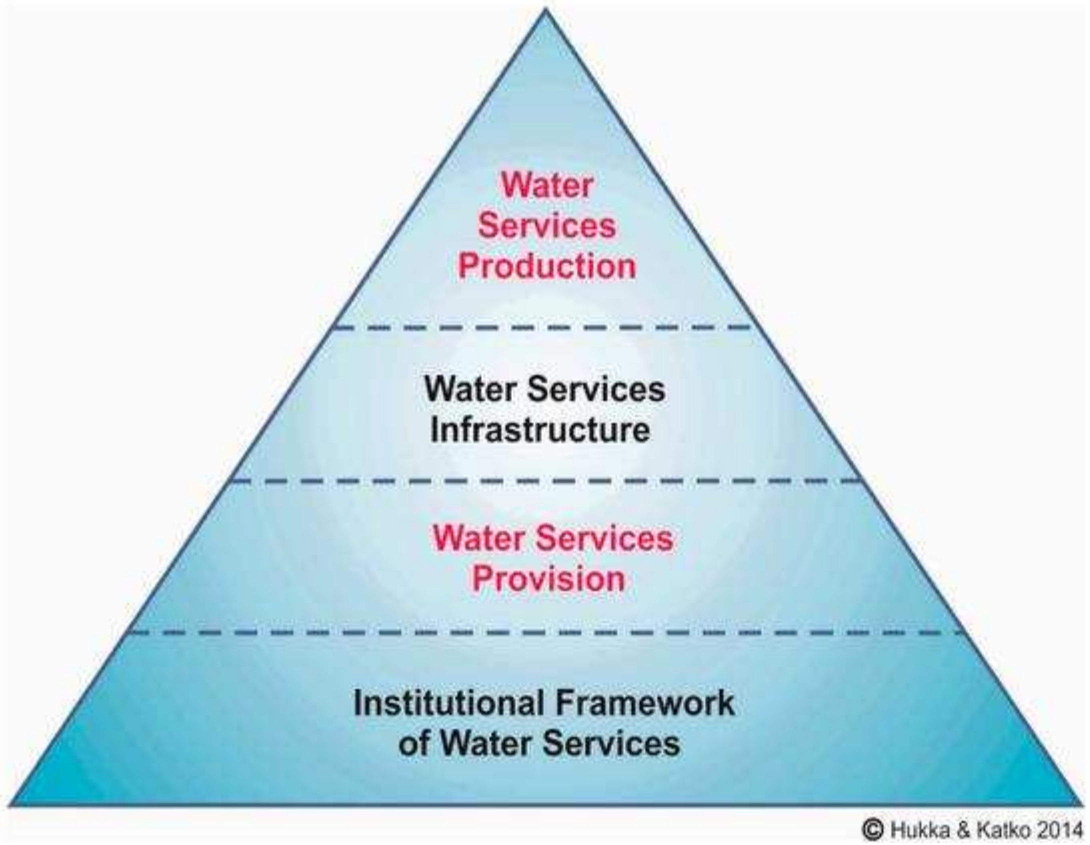
EU Urban Wastewater Directive 91/271/EEC (UWD)

The Bathing Water Directive

In addition, there are various strategies, plans and recommendations that support international and transboundary water cooperation (e.g., European Green Deal, EU Water Strategy (Blueprint), The HELCOM Baltic Sea Action Plan, River Basin Management Plan (RBMP), SDGs)

Case: Water services governance in Finland





Source: Improved Water Services Cooperation through Clarification of Rules and Roles, https://www.mdpi.com/2073-4441/11/10/2172

Case: Finnish water services legislation and regulation

- The whole legislation https://ym.fi/en/legislation-on-the-protection-of-water-and-the-sea
- Water Services Act (119/2001, amendments up to 979/2015 included) https://www.finlex.fi/en/laki/kaannokset/2001/en20010119_20150979.pdf
- Water Act (587/2011) https://www.finlex.fi/en/laki/kaannokset/2011/en20110587.pdf
- Government Decree on Urban Waste Water Treatment (888/2006) https://www.finlex.fi/en/laki/kaannokset/2006/en20060888.pdf
- Drinking water https://thl.fi/en/web/environmental-health/water/drinking-water

Module 3: Water and wastewater networks and engineering design principles

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

Topics to be discussed

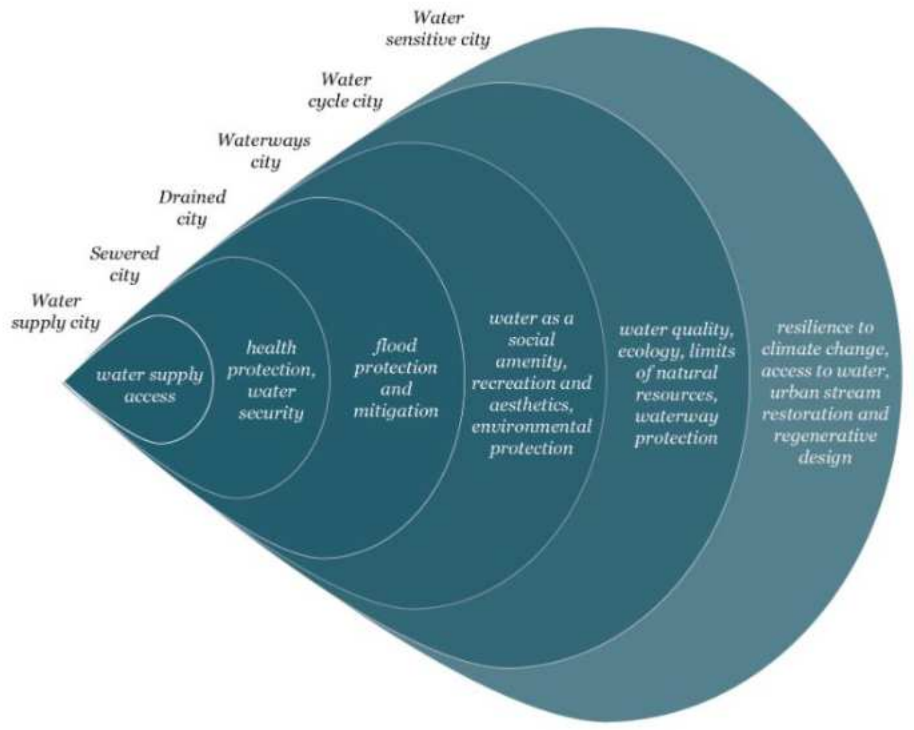
- Water supply pipelines materials: elements, installation, and main equipment; pipeline connections and main wells
- Wastewater sewerage pipelines materials: elements, installation, and main equipment; pipeline connections and main wells
- Wastewater networks in urban areas
- Integrated stormwater management
- Backlogs and network renovation methods, incl. leakage reduction

Water and wastewater networks' design principles

- Network types are: municipal, industrial, stormwater and combined.
- Network planning and design should be based on each country's own planning guidelines and designing guidelines.
- Optimisation in drinking water systems: methods, tools and applications https://iwa-network.org/learn/optimisation-in-drinking-water-systems-methods-tools-and-applications-2/, incl. video (1 hour)
- Examples from Helsinki metropolitan area: How the water supply workshttps://www.hsy.fi/en/water-and-sewers/how-the-water-supply-works/, Stormwater management at Helsinki https://www.hsy.fi/en/water-and-sewers/stormwater/ and Network renovation project https://www.hsy.fi/en/pitajanmaki-marttila-water-network-renovation/

Integrated stormwater management

- See IWATER https://www.integratedstormwater.eu/
- See IWATER pilot sites https://www.integratedstormwater.eu/pilot-sites



Source: IWATER https://www.integratedstormwater.eu/

Module 4: Water and wastewater treatment methods and engineering design principles

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Topics to be discussed

- Water quality and treatment requirements regarding different parameters (for municipal, industrial, commercial)
- Water and wastewater treatment methods for municipalities
- Water and wastewater treatment in rural areas (outside municipal systems)
- Main waterworks for storing and cleaning water: pollutants removal, filters, residuals removal, and modern equipment
- Water supply and wastewater treatment methods for industrial purposes and commercial consumption

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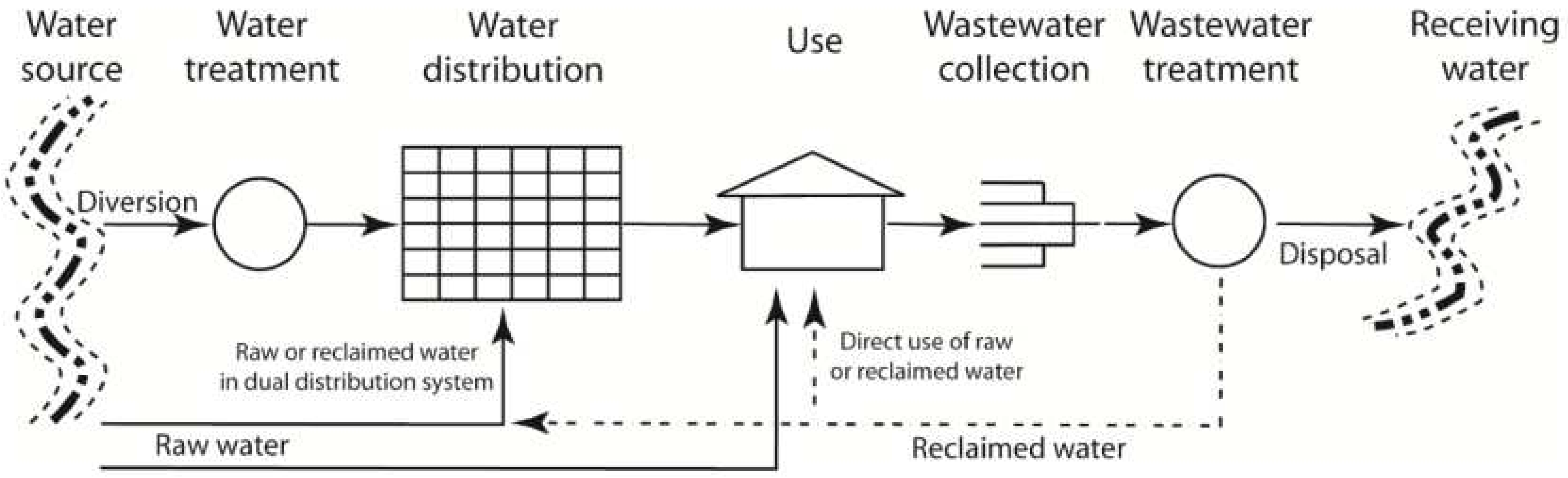
WWW&CE Water, Waste Water, Waste & Circular Economy

Water and wastewater treatment design

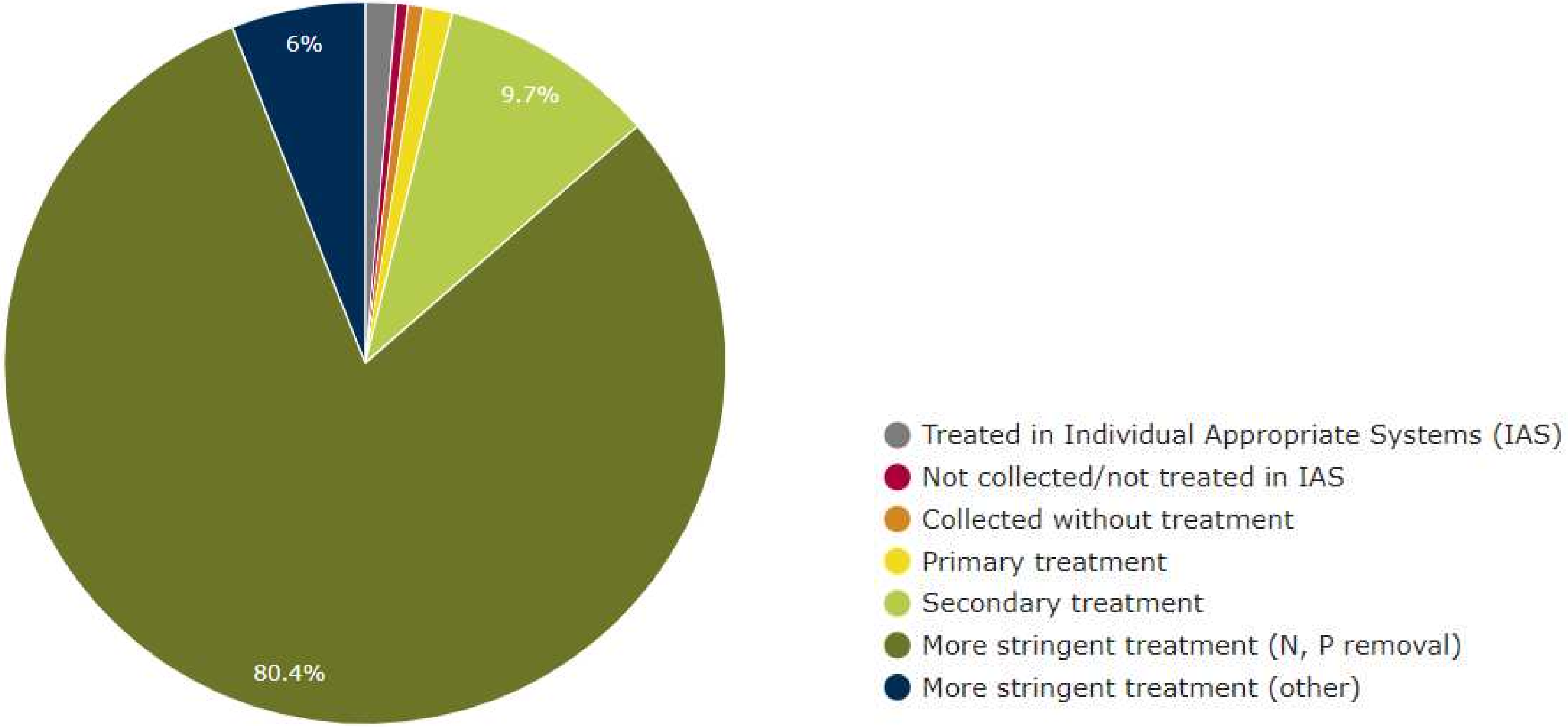
- Water and wastewater treatment planning and design should be based on each country's own planning and designing guidelines.
- Example from Helsinki metropolitan area: New wastewater treatment plant to Blominmäki https://www.hsy.fi/en/blominmaki/
- Videos Wastewater treatment https://youtu.be/b4D6OaIo2eg (ab. 2,5 hours), https://youtu.be/JcoNDThNwYk (ab. 2 hours) and https://youtu.be/TcvjQ5Pv-8A (1,5 hours), Activated sludge https://youtu.be/sb_heMM5vzs (32 min.)

Urban water and wastewater system



Source: Economic Framework of Smart and Integrated Urban Water Systems https://www.mdpi.com/2624-6511/5/1/15/pdf

Urban wastewater treatment in big cities in EU



Source: https://www.eea.europa.eu/data-and-maps/daviz/type-of-waste-water-treatment-1#tab-googlechartid_googlechartid_googlechartid_chart_3111

Urban wastewater treatment in Europe

- The treatment of urban wastewater is essential to ***ensuring health*** and ***the environmental protection***.
- Urban wastewater treatment has improved across Europe over the last 30-40 years.
- In 2017, most European countries collected and treated wastewater to tertiary stage. In EU-27 countries (EEA 2020), 69% of the population were connected in tertiary treatment and 13% in secondary treatment.
- Less than 80 % of the population were connected to public urban wastewater treatment systems in Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Ireland, Italy, Lithuania, Poland, Romania, Serbia, Slovakia and Slovenia.
- Small rural villages or non-connected dwellings place significant pressures on 11% of the EU's water surface bodies (Urban Waste Water Treatment Directive, does not cover this issue).
- Video: [Introduction to Integrated Decentralised Wastewater Treatment for Rural Areas - RUVIVAL Toolbox]

Figure 1-1 Surface water bodies affected by pressures in Europe: Number affected by diffuse pollution; Number with diffuse pollution from non-connected dwellings[14]

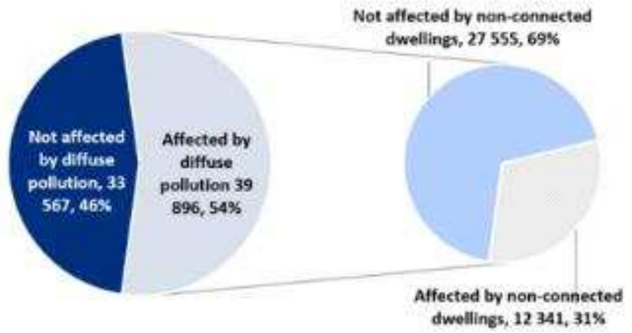
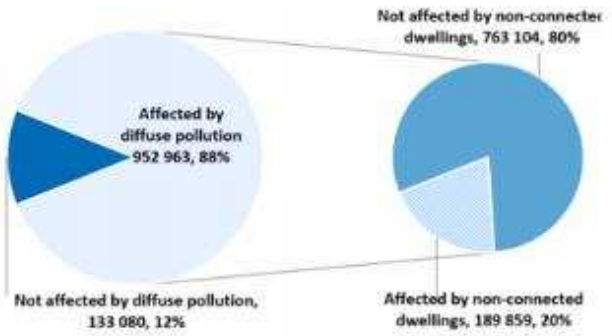


Figure 1-2 Ground water body area (km²) affected by pressures in Europe: Area affected by diffuse pollution; Area with diffuse pollution from non-connected dwellings[15]

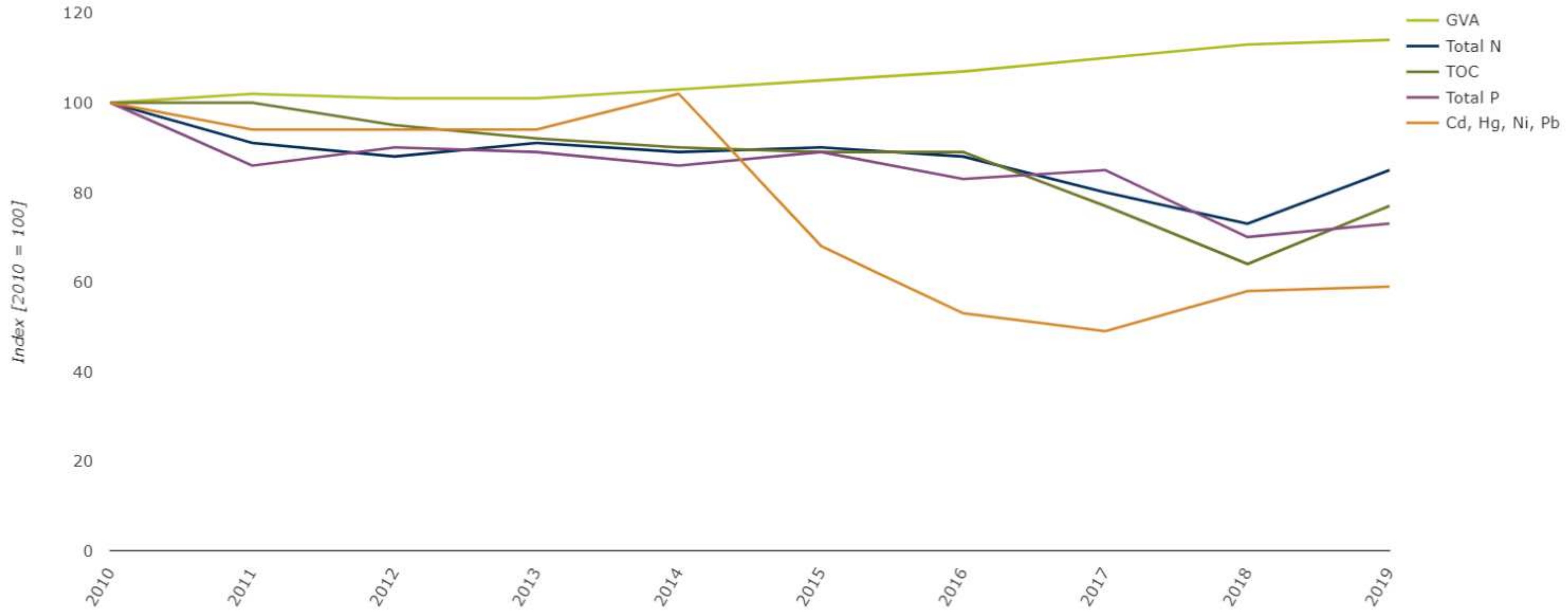


14; 15 EU-28 and Norway. Water bodies may be affected by more than one pressure.
Source: Figure 1-1, 1-2: EEA, Urban Wastewater – Non-Connected Dwellings: Final report

Industrial wastewater treatment

- See BEST – Better Efficiency for Industrial Sewage Treatment https://bestbalticproject.eu/
- Video (18:11) Guidelines for management of industrial wastewaters https://www.youtube.com/watch?v=VyjpiEKX__U
- Video (21:17) Assessment of the current situation in the industrial wastewater management in the Baltic Sea Region https://www.youtube.com/watch?v=KEmknRpkk8c
- Video (26:48) HELCOM for wastewater management https://www.youtube.com/watch?v=INtoFoecNQU

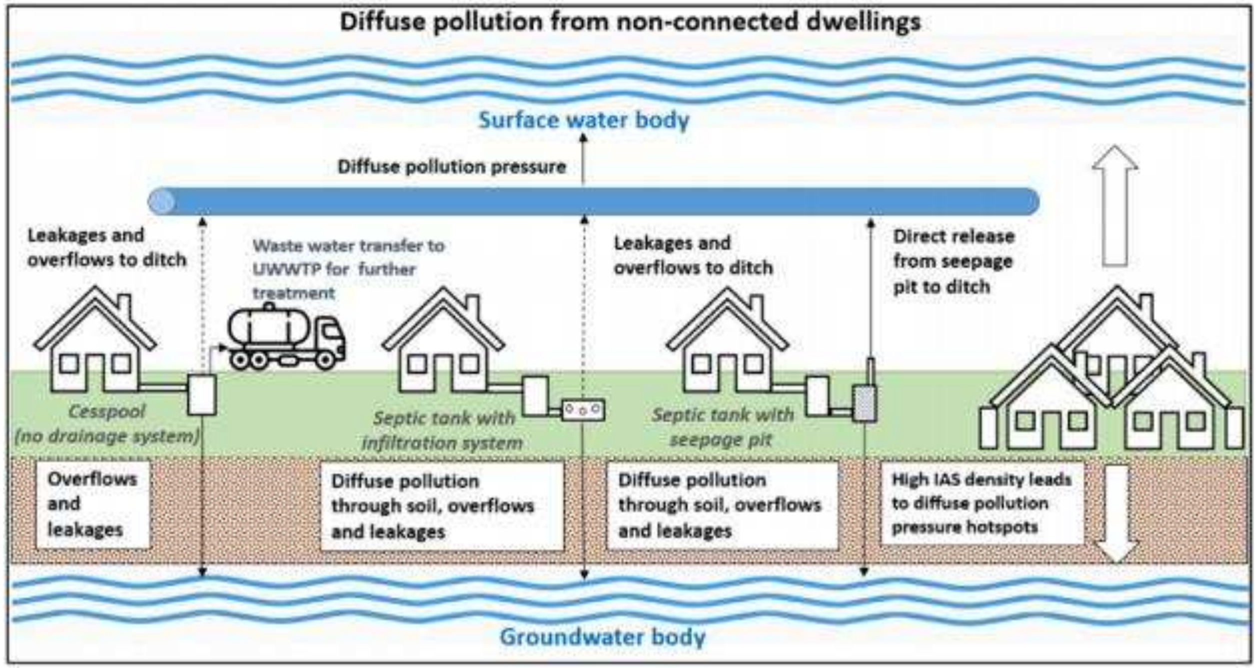
Industrial releases of pollutants to water from industry in the EU-27



Source: https://www.eea.europa.eu/ims/industrial-pollutant-releases-to-water

Wastewater from outside of sewerage networks

- Wastewater from areas outside of sewage networks is mostly domestic wastewater.
- The aim of wastewater treatment in areas outside of sewage networks is to improve the quality of the environment: in particular, to ensure clean drinking water, to slow down the eutrophication of water bodies and to prevent groundwater pollution.
- The most challenging settlements are located close to water bodies, groundwater areas and densely populated areas.



Source: Picture: Diffuse pollution from non-connected dwellings, EEA, Urban Wastewater – Non-Connected Dwellings: Final report

Different stages of wastewater treatment

Physical, chemical, and biological processes to remove contaminants from wastewater

Primary treatment

"consists of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface (such as from septic tanks). "

Secondary treatment

"Removes dissolved and suspended biological matter and is typically performed by indigenous, water-borne micro-organisms in a managed habitat. Secondary treatment may require a separation process to remove the micro-organisms from the treated water prior to discharge or tertiary treatment (such as aerated wastewater treatment systems). - Advanced secondary treatment systems, includes textile filters and sand filters."

Tertiary treatment

"is sometimes defined as anything more than primary and secondary treatment in order to allow ejection into a highly sensitive or fragile ecosystem. Treated water is sometimes disinfected chemically or physically."

Sewage sludge is by-product of sewage treatment, and it must undergo further treatment before being suitable for disposal or land application.

Source: Vorne & Silvenius, 2019: A survey of available wastewater treatment technologies for sparsely populated areas, https://www.villagewaters.eu/s2/994_608_70_A_survey_of_available_WWTT_-_User8217s_Manual.pdf?v=18230656

Module 5: Sludge treatment and disposal

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Co-funded by the Erasmus+ Programme of the European Union
WWW&CE Water, Waste Water, Waste & Circular Economy

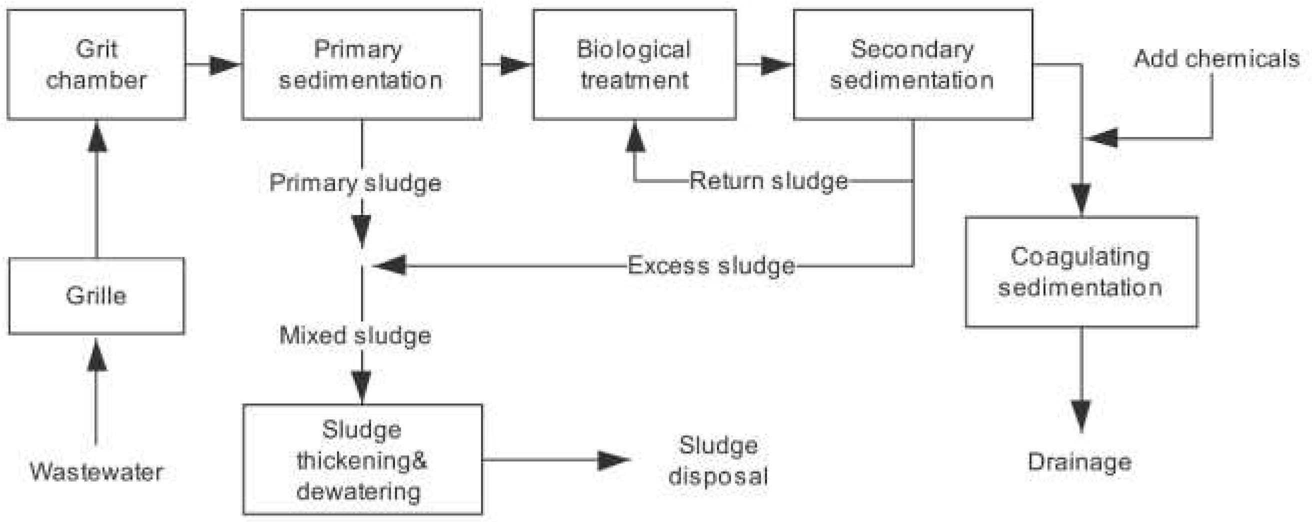
Topics to be discussed

- Sludge quality requirement and assurance
- Sludge treatment processes: sludge removal and consolidation, conditioning, anaerobic (and aerobic) digestion, mechanical dewatering, thermal drying, incineration, pyrolysis and gasification.
- Utilization of treated sludge: agriculture, energy production, and disposal at the landfill site

Sludge treatment design

- Sludge treatment design should be based on each country's own planning and designing guidelines.
- Video https://www.youtube.com/watch?v=huXYwH5Wsbk (ab. 9 min.)

Wastewater and sludge treatment



Source Application and Evaluation of Energy Conservation Technologies in Wastewater Treatment Plants https://www.mdpi.com/2076-3417/9/21/4501/pdf

Sludge dewatering

- Sewage sludge is a mud-like residue resulting from wastewater treatment.
- Sewage sludge contains heavy metals and pathogens such as viruses and bacteria.
- It also contains valuable organic matter and nutrients such as nitrogen and phosphorus, and can therefore be very useful as a fertilizer or soil improver.
- See the Sludge directive https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31986L0278
- See the latest statistics Sewage sludge production and disposal on http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_ww_spd&lang=en

Source: https://ec.europa.eu/environment/topics/waste-and-recycling/sewage-sludge_en

- The aims of sludge dewatering is to minimize sludge volumes and reach high dry-solids content.
- Organic and inorganic coagulants used in dewatering process.
- Various dewatering methods
- See the concept https://www.huber.de/fileadmin/huber/images/imagemap/schlamm_entwaesserung_721.jpg
- Video (5:08) Efficient sludge dewatering with ANDRITZ screw press C-Press technology https://youtu.be/6rEnmdwgtq8
- Video (1:44) Screw press-Sludge dewatering machine https://youtu.be/PRv8ZrdcP7I

- Design of sludge dewatering units according to manufacturers' guidelines. See also CHAPTER 6: DESIGN AND CONSTRUCTION OF SLUDGE TREATMENT FACILITIEShttp://cpheeo.gov.in/upload/uploadfiles/files/engineering_chapter6.pdf.

Module 6: Energy efficiency and circular economy in water and wastewater facilities

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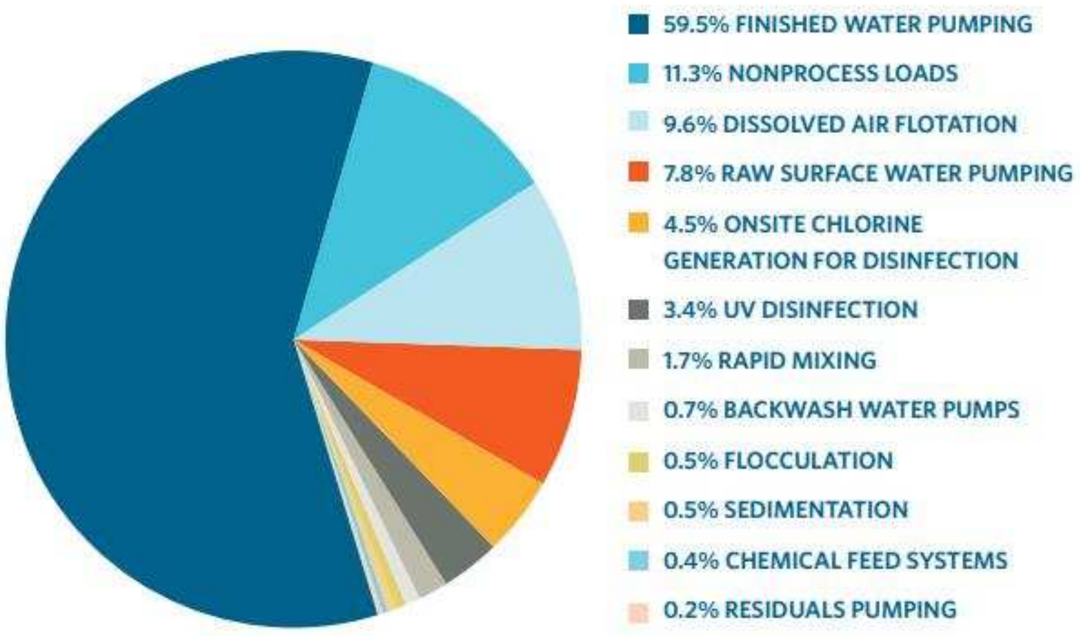
WWW&CE Water, Waste Water, Waste & Circular Economy

Topics to be discussed

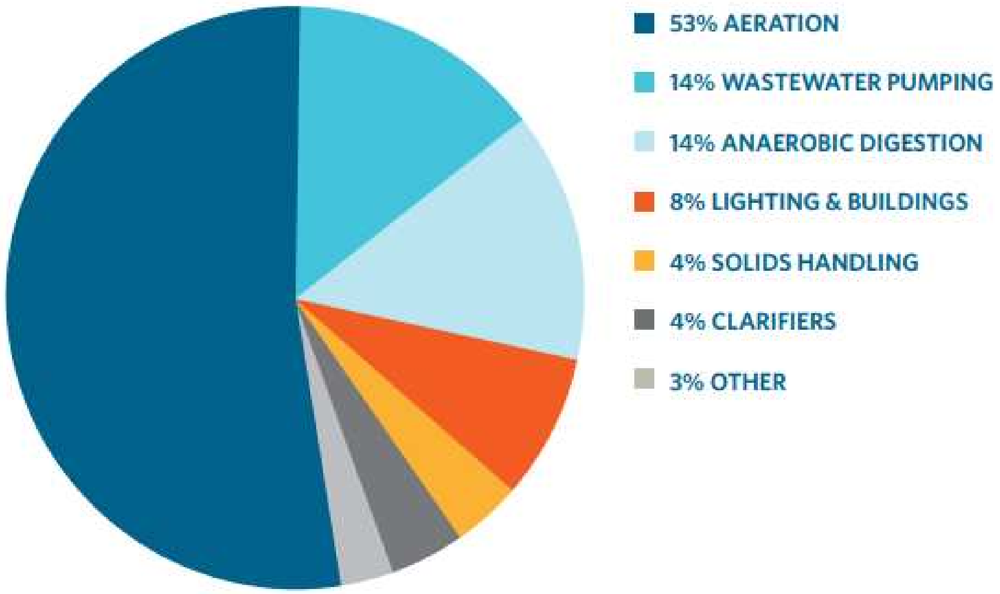
- Energy use assessment
- Energy efficiency in water and wastewater works
- Energy management for water supply and sanitation facilities
- Circular economy examples
- Greenhouse gas reduction programmes

Energy use in water and wastewater utility

Energy use distribution in water treatment



Energy use distribution in wastewater treatment

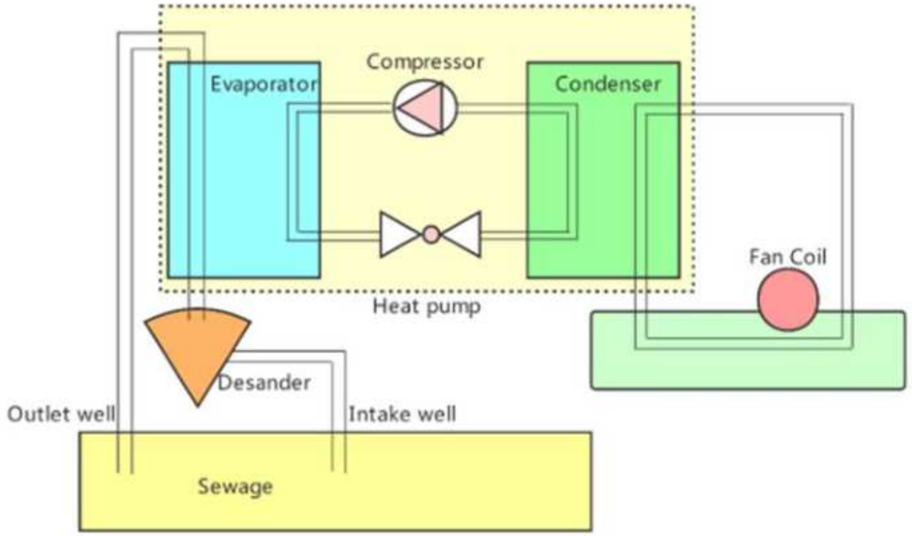


Source: Water and Wastewater Treatment Energy Savings Guide https://forms.energytrust.org/wp-content/uploads/2016/10/PE_fs_guide_wastewater.pdf

Energy efficiency

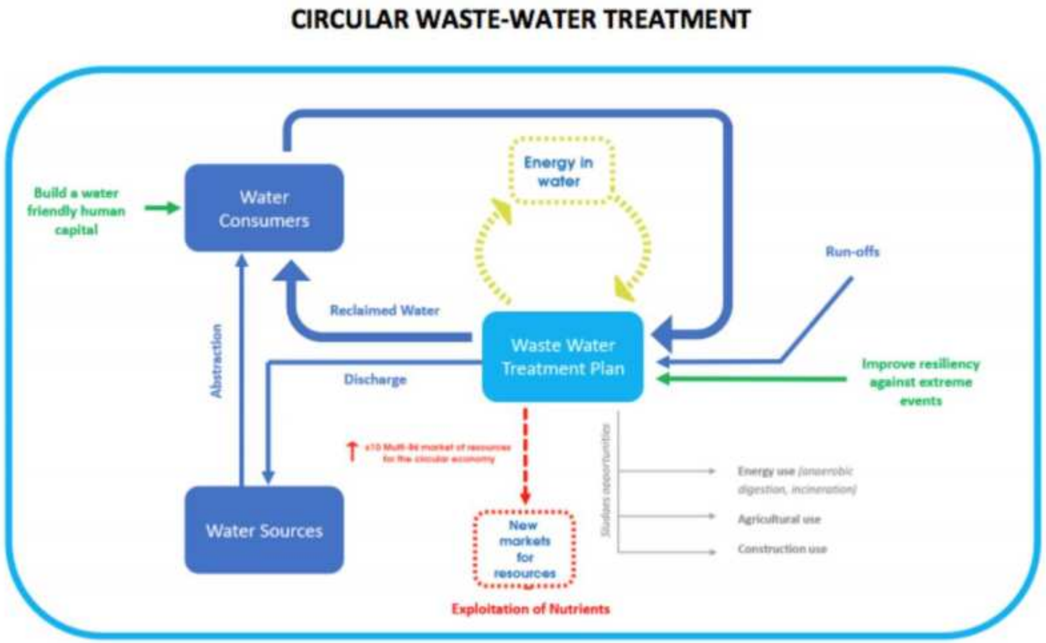
- IWAMA project. Energy efficiency http://www.iwama.eu/theme/energy-efficiency
- IWAMA project. Smart Energy Management Self Audit tool http://www.iwama.eu/output/audit-concept-smart-energy-and-sludge-management
- EurEau. 2019. Reducing the Energy Footprint of the Water Sector: Possibilities, Success Stories and Bottlenecks, see https://www.eureau.org/resources/briefing-notes/3890-briefing-note-on-reducing-the-energy-footprint-of-water-sector/file
- Yongteng Sun, Ming Lu, Yongjun Sun and Zuguo Chen, Hao Duan and Duan Liu. 2019. Review: Application and Evaluation of Energy Conservation Technologies in Wastewater Treatment Plants, see https://www.mdpi.com/2076-3417/9/21/4501/pdf
- Video (7:05) http://www.energywater-project.eu/wp-content/uploads/2019/02/EnergyWater_en.mp4

- Heat pump in wastewater treatment



Source: Application and Evaluation of Energy Conservation Technologies in Wastewater Treatment Plants, see https://www.mdpi.com/2076-3417/9/21/4501/pdf

Circular economy examples



Source: https://thewaternetwork.com/article-FfV/for-a-green-circular-smart-urban-wastewater-treatment-directive-EsWm5OpTX_klG979aKg63A

- See article: Water Utility Pathways in a Circular Economy https://www.iwa-network.org/wp-content/uploads/2016/07/IWA_Circular_Economy_screen.pdf
- See article: Towards the Implementation of Circular Economy in the Wastewater Sector: Challenges and Opportunities https://www.mdpi.com/2073-4441/12/5/1431

Module 7: Automation and digitalization in water and wastewater systems

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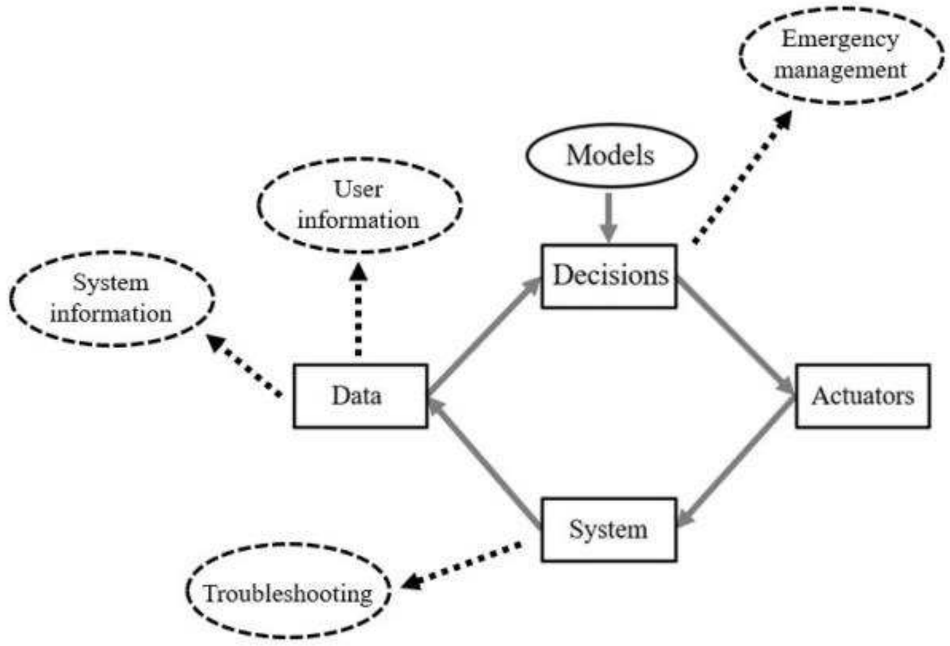
WWW&CE

Topics to be discussed

- Concepts of automation
- Concepts of digitalization
- Applications to water and wastewater systems

Smart water system



- A smart integrated urban water system would contain
  - featured infrastructure controls,
  - collection of system and user information,
  - application of the information to control water operations and
  - application to inform citizens.
- It would be available for emergency management

Source: Economic Framework of Smart and Integrated Urban Water Systems https://www.mdpi.com/2624-6511/5/1/15/pdf

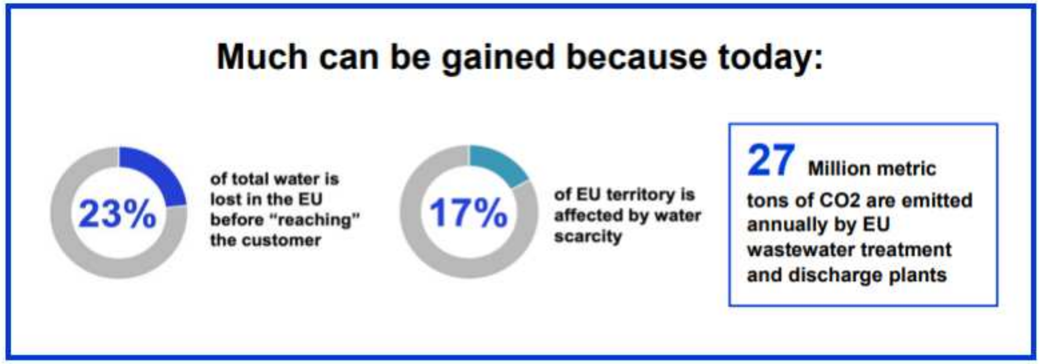
Digitalisation in water and wastewater systems

- Under EU water legislation, municipalities and water utilities are required to reduce their CO_2 footprint and improve water conservation.
- Digital technologies offer hardware, software and equipment infrastructure to enable more connected, intelligent, efficient and responsive water systems and services.
- Leakage is a critical issue in water conservation. A 5% decrease in water distribution system leakage would save 1 million m^3 per day of water and 313 million kilowatt-hours of electricity annually.

Key figures: expenses and return on investment

1 – 1.5 years is the estimated time for the return on investment (ROI)

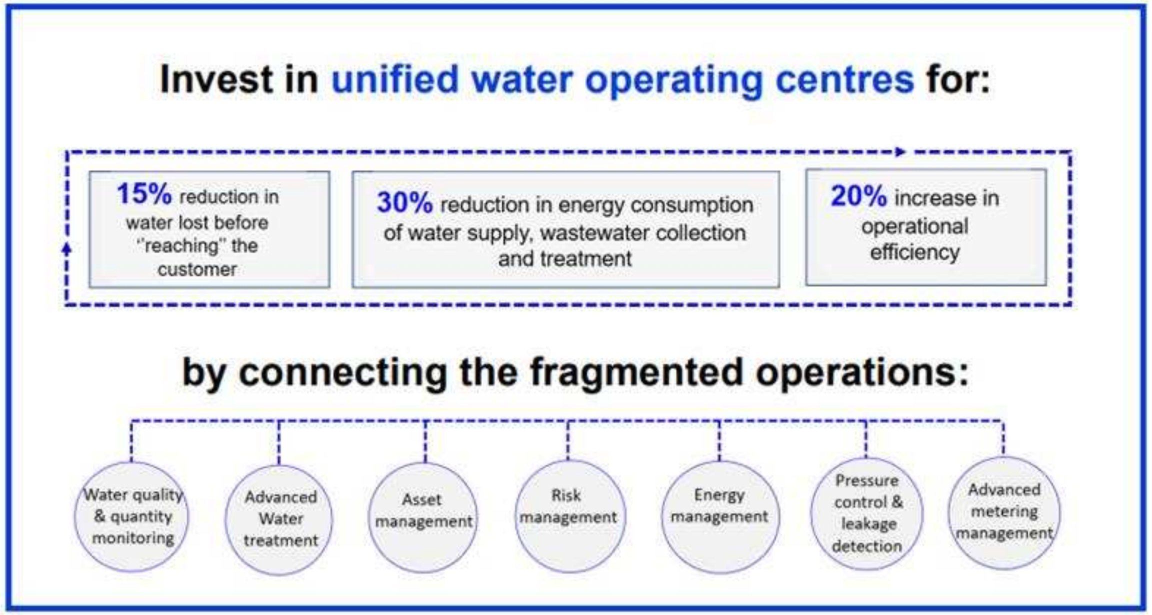
400 – 700k is needed to set up a unified water operating centre for a mid-sized water utility



Source: Upgrading water management: how to turn digital investment into real sustainability gains https://www.digitaleurope.org/wp/wp-content/uploads/2021/01/FINAL_DIGITALEUROPE-use-case-on-digital-investments-for-EU-national-recovery-plans_Smart-Asset-Management__14012021-clean-Copy.pdf

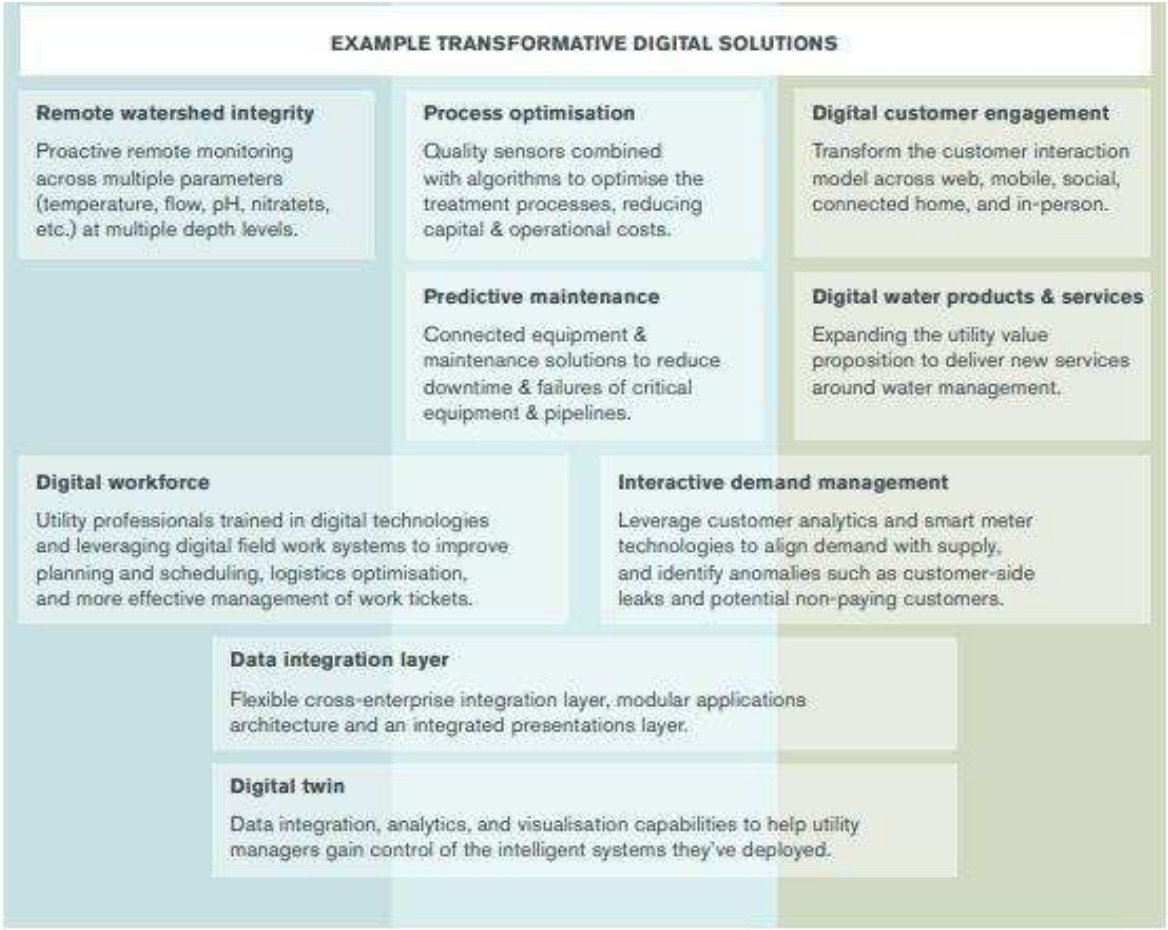
Digitalisation in water and wastewater systems

- Water utilities will face growing operational continuity challenges due to ageing systems and workforce changes.
- This urges for profound infrastructure renovations pivoting to digital.



Source: Upgrading water management: how to turn digital investment into real sustainability gains https://www.digitaleurope.org/wp/wp-content/uploads/2021/01/FINAL_DIGITALEUROPE-use-case-on-digital-investments-for-EU-national-recovery-plans_Smart-Asset-Management__14012021-clean-Copy.pdf

Digital Water and Wastewater Utility: Inputs and Solutions



Source: Digital Water - Industry leaders chart the transformation journey https://iwa-network.org/wp-content/uploads/2019/06/IWA_2019_Digital_Water_Report.pdf
,

Module 8: Greening water and wastewater systems

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

Topics to be discussed

- Water supply in the sustainable living environment
- Water and wastewater systems in public areas
- Water and wastewater reuse or closed-loop possibilities
- Water and sewer lines inside buildings
- Water-saving devices, equipment, calculation

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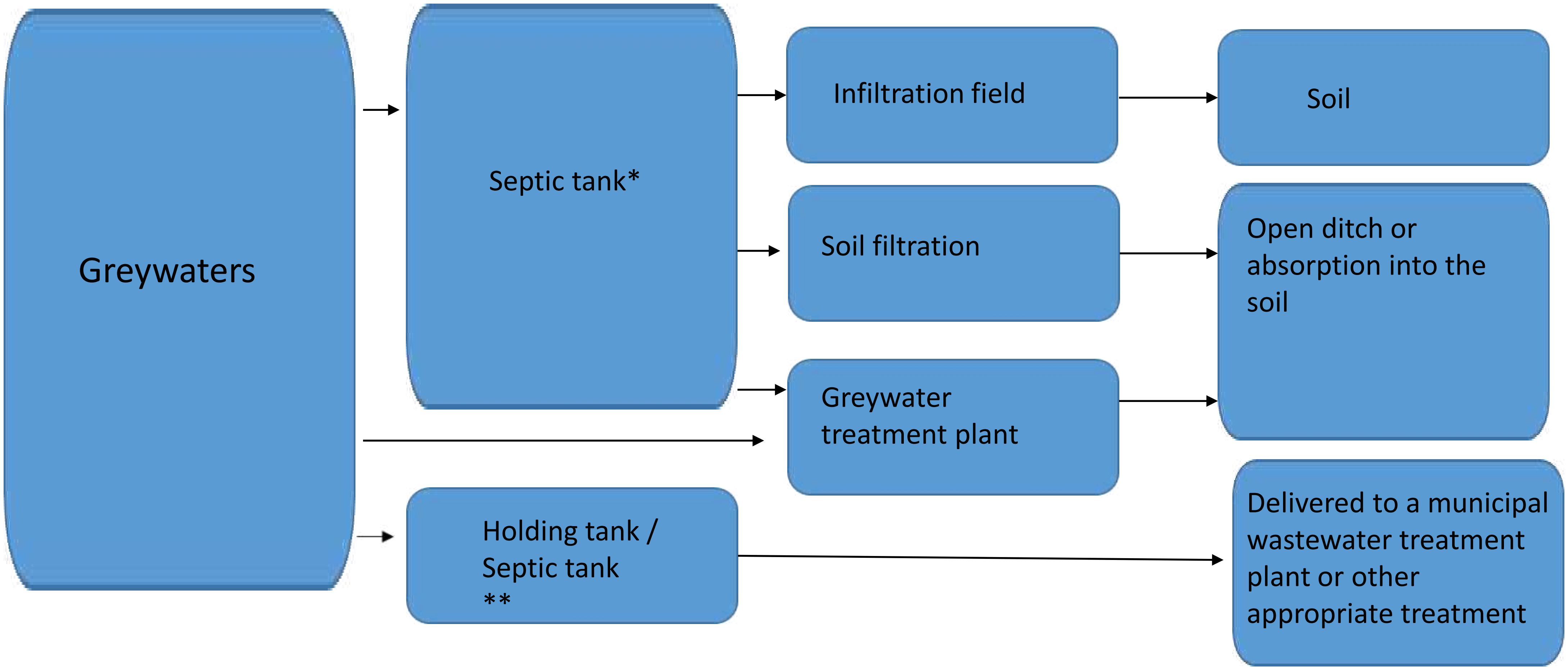
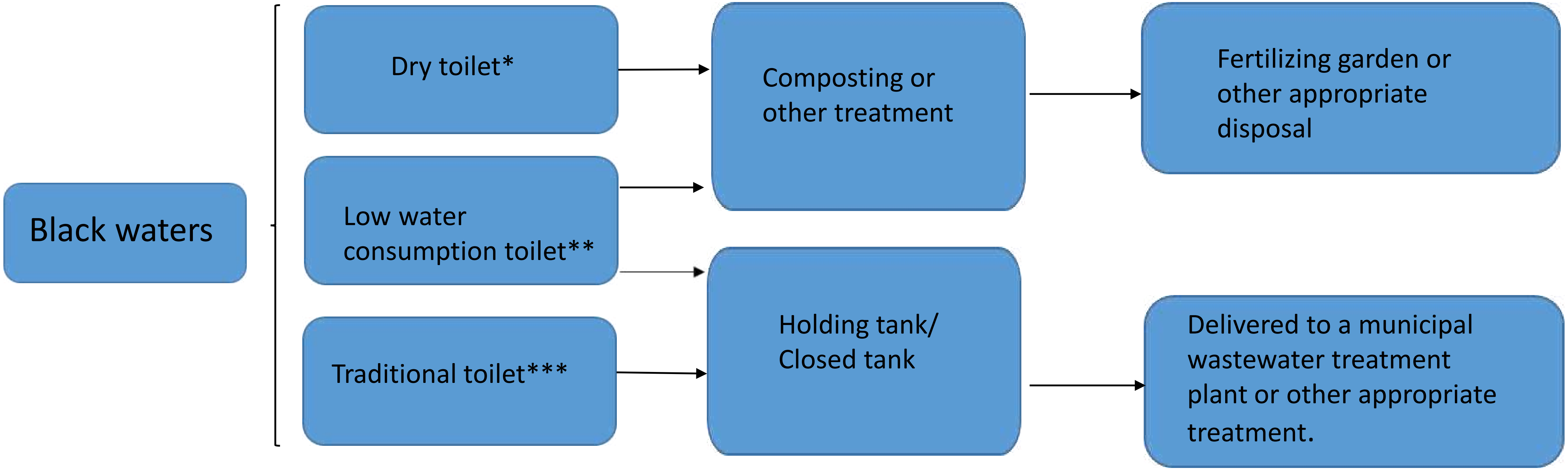
Example from Finland
Wastewater treatment systems which separate black and greywater: Greywaters



*Sevage sludge to a wastewater treatment plant or other appropriate treatment.
**Only for special properties that other systems are not suitable for

Source: Haja-asutuksen jätevedet -lainsäädäntö ja käytännöt (Wastewater from sparsely populated areas - legislation and practices)

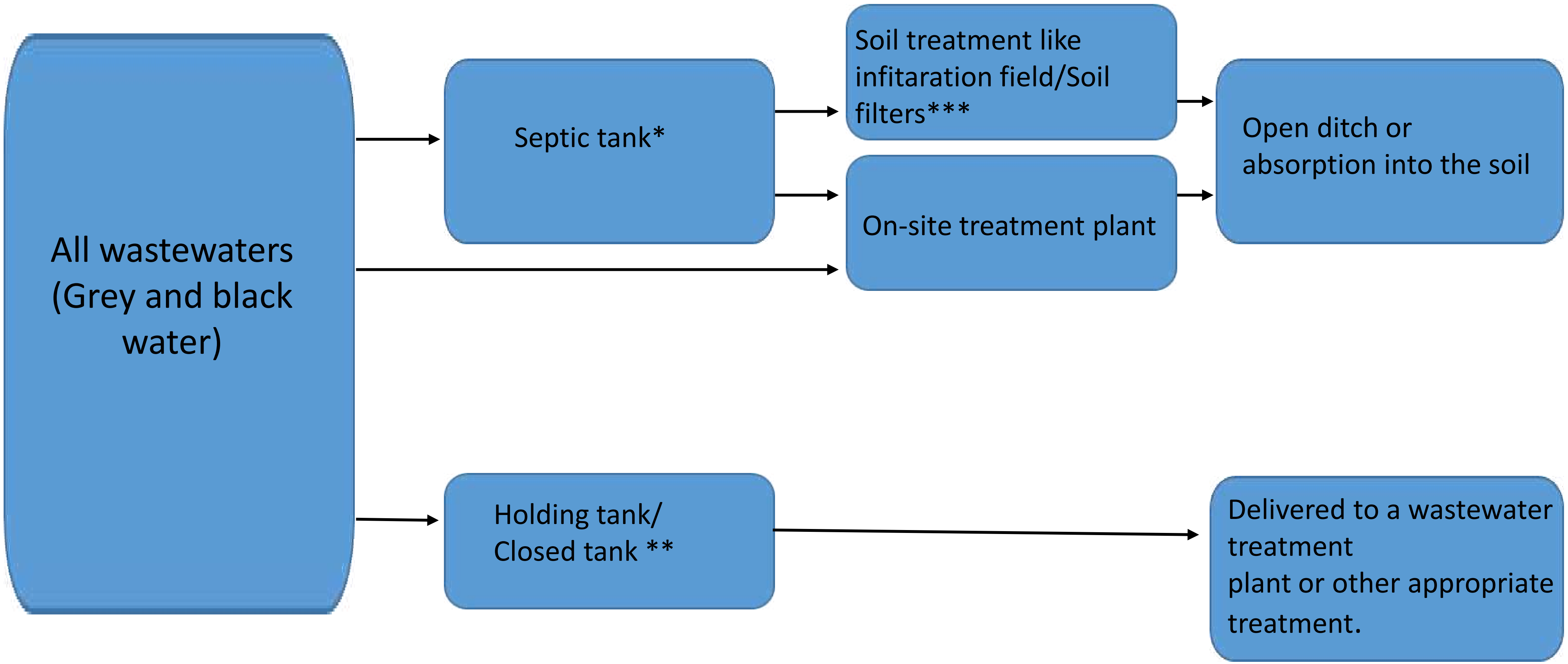
Example from Finland
Wastewater treatment systems which separate black and greywater: Black waters



*If excrement is composted to soil, appropriate post-composting has to be arranged. Filtered liquids or separated urine is collected to a closed tank or is directed to approptiate post-treatment system. After aging, the nutrient-rich liquids can be usedon the property for fertilizing or for refreshing a leaf compost.
** excrements and urine are directed to a large compost tank or are stored in a holding tank
***Waters are directed to a holding tank, which has to be emptied regularly

Source: Haja-asutuksen jätevedet -lainsäädäntö ja käytännöt (Wastewater from sparsely populated areas - legislation and practices)

Example from Finland
Black and greywater treatment in a single system



*Sevage sludge to a wastewater treatment plant or other appropriate treatment.
**Only for special properties that other systems are not suitable for
***Whether materials or additives are needed that improve the phosphorus retention

[Source: Haja-asutuksen jätevedet -lainsäädäntö ja käytännöt (Wastewater from sparsely populated areas - legislation and practices)]

Water and energy efficient home

Opportunities for more efficient use of water :

- Regular care, cleaning and maintenance of the indoor plumbing fixtures and appliances
- Measurement and control of water system pressure and water usage (water meters in houses and apartments)
- Water leaks:
  - Fix water leaks right away: A seemingly harmless leaking tap alone can consume 1,200 liters per month and a leaking toilet seat up to 33,000 liters per month
  - Unintentional water consumption can be curbed simply by monitoring the movements of the water meter in the home, and in addition, technical innovations such as smart water meters with alarm functions have been developed to detect water leaks
- The user plays a significant role in water consumption
  - For example, shortening the time spent in the shower and stopping unnecessary running of water, using a dishwasher instead of a doing dishes by hand saves water

Source: Motiva & TTS, 2020. Kestävä veden käyttö –Vedenkäyttöselvitys https://www.motiva.fi/files/17613/Kestava_veden_kaytto_-_vedenkayttoselvitys.pdf

Water and energy efficient home

Water saving technology

- **Shower type and condition**: Old showers consume up to 18-20 liters of water per minute, a standard shower has a flow rate of about 12 liters per minute and water-saving models have a flow rate of only 8-9 liters per minute.
- **Toilet seat**: The toilet seat from the 1970s uses about 9 liters of water per flush. A standard toilet seat with one knob uses about 6 liters of water for one flush, and the latest, double-knob savings models use 4 liters of water for larger flushes and 2 liters of water for small flushes.
- **Washing machine**: Old washing machine models use twice as much water and more than half as much electricity than new models
- **Dishwasher:** The latest Class A dishwashers consume about 10-12 liters of water in one wash. With Eco programs, consumption is even less than ten liters per wash. Doing the same number of dishes by hand it consumes 50 to 150 liters of water, depending on the washing method. The worst possible way is to both wash and rinse the dishes under running water.
- Technical solutions for plumbing fixtures: such as non-contact taps, flow restrictors and water-saving shower heads are workable solutions that achieve significant savings in water consumption.
- Energy-efficient appliances, home automation and technology that reports water leaks reduce water consumption.

Source: Motiva & TTS, 2020. Kestävä veden käyttö –Vedenkäyttöselvitys https://www.motiva.fi/files/17613/Kestava_veden_kaytto_-_vedenkayttoselvitys.pdf

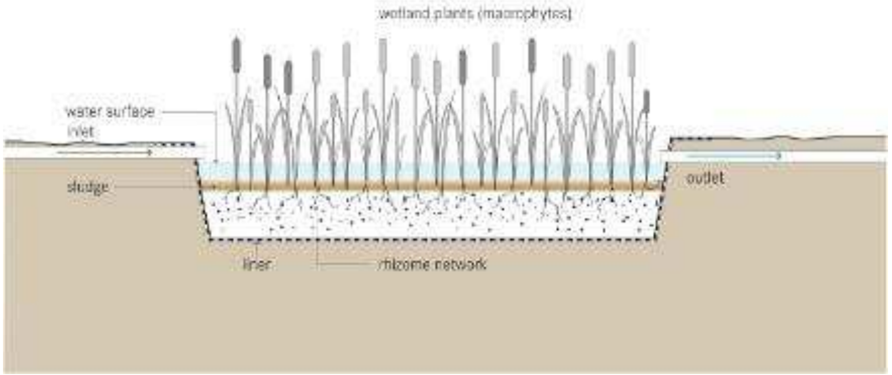
Natural wastewater treatment systems

Natural wastewater treatment systems:

- Constructed wetland is based on slow filtration of pre-treated wastewater and provides biological treatment stage – secondary and/or tertiary

Three types of constructed wetlands:

1. sub-surface flow constructed wetland
2. surface flow constructed wetland
3. hybrid system - a combination of subsurface flow and surface flow systems



Picture: Schematic of the Free Water Surface Constructed

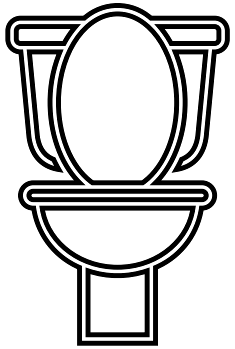
https://commons.wikimedia.org/wiki/File:Schematic_of_the_Free_Water_Surface_Constructed_Wetland.jpg

Good practice: Wetlands treat water in Soderhamn, Sweden
Video (26:10): Constructed Wetland Design
Video (12:37): Building a Constructed Wetland for Better Water Quality

Towards low-flush toilets

Dry toilet does not use water to transport urine and feces:

- **Composting dry toilet:** Urine and faeces go to the same tank, from which urine is collected in a separate tank
  - Biolan composting toilet Eco (Instruction for use in several language)
  - Kekkilä Composting Toilet
- **Separating dry toilet:** Urine and faeces go into their own tank and the separated urine is pure and can be used as a fertilizer
  - Biolan Separating Dry Toilet
  - Biolan simplett
- **Evaporative dry toilet:** Almost like a composting dry toilet, but urine is evaporated from a collection container
- **Freezing toilet:** Freezes toilet waste and the residue is often emptied into the composter. Needs electricity.
  - Biolan icelett (Inside)
- **Incineration toilet:** Evaporates urine and ash in faeces and requires a replacement air valve and electricity



Switching to low-flush toilet is a step forward – it uses only about 0,2-0.5 liters water depending on model:

- Low-flush toilets:
  - Double sewer system and for example in old buildings the existing piping can be utilized
  - The tank of a low-flush toilet is an emptyable closed tank or a large composting tank
  - FANN Green Jets vacuum toilet with extremely small flush water
  - FANN Roslagen vacuum toilet

Source: Global Dry toilet Association of Finland

Water-based solutions

Integrated urban water management (IUWM)

- The SWITCH approach to integrated urban water management (IUWM) : From the present time to the ‘City of the Future’:
  - All segments of the water cycle – water, wastewater, stormwater and natural systems; · A wide range of climatic, socio-economic and institutional situations; · Social, economic and environmental perspectives; · Scales ranging from household to city levels; · Water as part of urban planning and the built environment;

Sustainable Water Management (SUWM)

- Sustainable Water Management (SUWM): European policies on water, Management plans, Water management in Europe: price and non-price approaches to water conservation

Integrated Water Resources Management (IWMR)

- The Global Water Partnership's definition for IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

Water Sensitive Urban Design (WSUD) and Low Impact Development

- Video explaining Water sensitive Urban Design (4:15):
- iWater Toolsheets /Approaches and concepts:
- https://www.thesourcemagazine.org/integrating-nature-based-solutions-into-wastewater-treatment/

Integrated solutions: What will future cities be like?

What if we combine water management with other areas like housing and sustainable mobility?

Smart cities use technical solutions to improve the management and efficiency of the urban environment to create smarter urban transport networks, improved water supply and waste treatment facilities, and more efficient ways to illuminate and heat buildings. (EU COMMISSION)

The Liveable Cities Lab is Ramboll's innovation and research laboratory, which is intended to support cities in envisioning their future development. Their work addresses global challenges such as demographic changes, urbanization and climate change through a multi- and transdisciplinary approach.

- Blue-Green Infrastructure (BGI): Use visions of liveability and prosperity to show the advantages of BGI
- For example, for Climate Resilience, Green City Vision, Biophilia, Sustainable Urban Design, Water Sensitive and Water Wise City).

- Other integrated solutions: Compact City, Resilient City, Disaster Reduction, Mitigation and Adaptation

EUROPEAN GREEN CAPITAL

An initiative of the European Commission

EUROPEAN GREEN CAPITAL

City of Lahti European Green Capital 2021

- *Green Lahti*
- Natural treatment of stormwater on large scale in Lahti
- Lahtiaqua - The Worlds' best groundwater

Additional sources

- Hybrid Models in Wastewater: Merging Mechanistic with Data-Driven https://iwa-network.org/learn/hybrid-models-in-wastewater-merging-mechanistic-with-data-driven , incl. video (ab. 1 hour)
- Integrating Nature-Based Solutions for Water in Urban Water Infrastructure. Part 2, https://iwa-network.org/learn_resources/integrating-nature-based-solutions-for-water-in-urban-water-infrastructure-part-1-2/, incl. video (ab. 41 min.)
- Climate Smart Utilities – Tools for adaptation under uncertainty https://iwa-network.org/learn/climate-smart-utilities-tools-for-adaptation-under-uncertainty/, incl. video (ab. 1,5 hours)
- Green Infrastructure for Water Wise Cities https://iwa-network.org/learn/green-infrastructure-for-water-wise-cities/, incl. video (ab. 1 hour)
- Aeration control in activated sludge systems: from concept to practice https://iwa-network.org/learn/aeration-control-in-activated-sludge-systems-from-concept-to-practice-2/, incl. video (ab. 1,5 hours)
- Sustainable SCADA for Your Water Utility https://inductiveautomation.com/resources/video/sustainable-scada-for-your-water-utility, incl. video (ab. 46 min.)
- More examples and videos https://iwa-network.org/resources/

Additional sources

- Smart water solutions: Opportunities and challenges for the water sector https://www.vvy.fi/site/assets/files/1110/smart_water_solutions_web_003.pdf
- Finnish industrial wastewater guide: Conveying non-domestic wastewater to sewers https://www.vvy.fi/site/assets/files/1110/finnish_industrial_wastewater_guide.pdf
- Sweden water research https://www.swedenwaterresearch.se/en/

Hanse-Parlament

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

VILNIUS TECH
Vilniaus Gedimino technikos universitetas

MANAGEMENT & TECHNOLOGIES OF THE WATER AND WASTEWATER INDUSTRY

Vilnius Gediminas Technical University (VilniusTech), project partner number3

Introduction

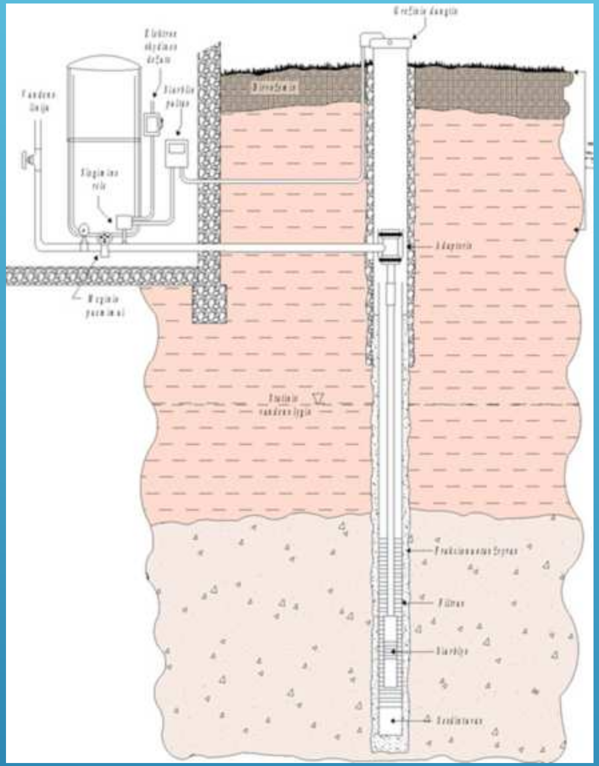
- Consist of two parts:
- ■Water supply, 3 ECTS
- ■ Wastewater sewerage 3 ECTS
- ■Lectures –40+40 hours
- ■Independent work –40+40 hours

ANNOTATION OF COURSE

- Water sources; Water supply systems, pumping stations; drinking water treatment; An EN (European Standard) general requirements for design and calculations. European Union water policy, national legislation and local regulations. Systems of water reuse industrial and domestic, elements, sanitary appliances, materials for pipes; additional elements of water supply system. Building constructions and water supply systems. Connection to the centralised networks .
- Wastewater sources; wastewater sewerage systems, pumping stations; wastewater treatment; general requirements for design and calculations. European Union water policy, national legislation and local regulations. Systems of wastewater reuse, elements, sanitary appliances, materials for pipes; additional elements of drainage water, grey and black wastewater sewerage systems ; the industrial waste water with possible poisons, oils, corrosive substances. Wastewater treatment methods, including sludge treatment. Municipal water and sewer networks. Water and sewer systems in buildings.

- General knowledge transfer related to water supply systems, main equipment, devices and installation, European Standard main requirements for the design and engineering; adaptation to water reuse; water systems for green buildings .
- General knowledge transfer related to wastewater sewerage systems, main equipment, devices and installation, main requirements according European Standard for the design and engineering; adaptation to wastewater reuse; wastewater systems for making path towards smart water cities.

AIM OF COURSE



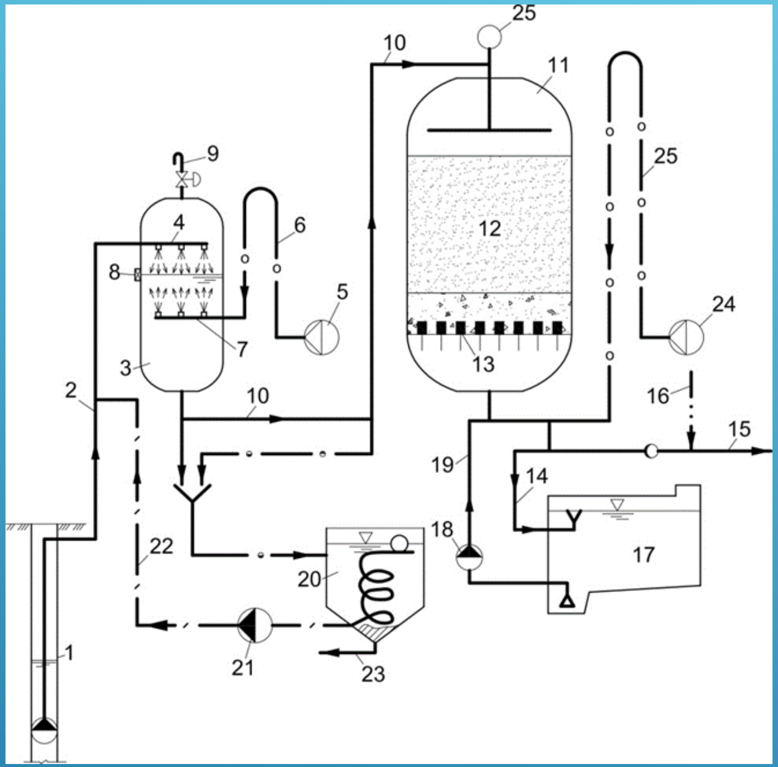
MAIN WATER SUPPLY SYSTEMS. OPEN WATER SOURCES; GROUNDWATER .

- European Union EN requirements for design and engineering. Legal regulations and responsibilities of municipal water works, house ownwers and industrial premises.

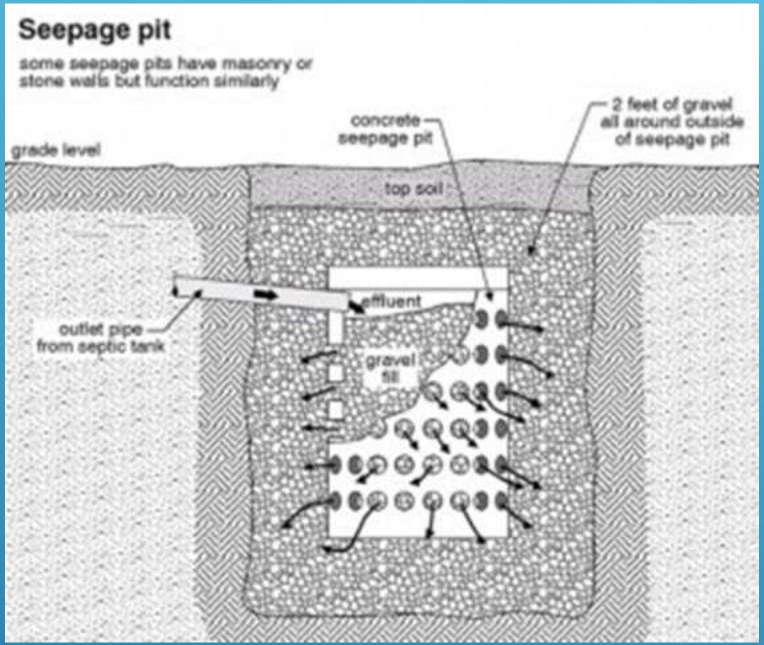
EUROPEAN STANDARD EN8558:2015 GUIDE TO THE DESIGN, INSTALLATION, TESTING AND MAINTENANCE OF SERVICES SUPPLYING WATER FOR DOMESTIC USE WITHIN BUILDINGS AND THEIR CURTILAGES.

- Water quality and treatment requirements regarding different parameters (for municipal, industrial, commercial).

COUNCIL DIRECTIVE 98/83/EC
of 3 November 1998
on the quality of water intended for human consumption
(OJ L 330, 5.12.1998, p. 32)
Corrected by:
►**C1** Corrigendum, OJ L 111, 20.4.2001, p. 31 (98/83/EC)



WATER TREAMENT METHODS FOR MUNICIPALITIES



WATER AND WASTEWATER TREATMENT IN RURAL AREAS (OUTSIDE MUNICIPAL SYSTEMS)

WATER SUPPLY AND WASTEWATER TREATMENT METHODS FOR INDUSTRIAL PURPOSES AND FOR COMMERCIAL CONSUMPTION.

WATER REUSE OR CLOSED LOOPS POSSIBILITIES

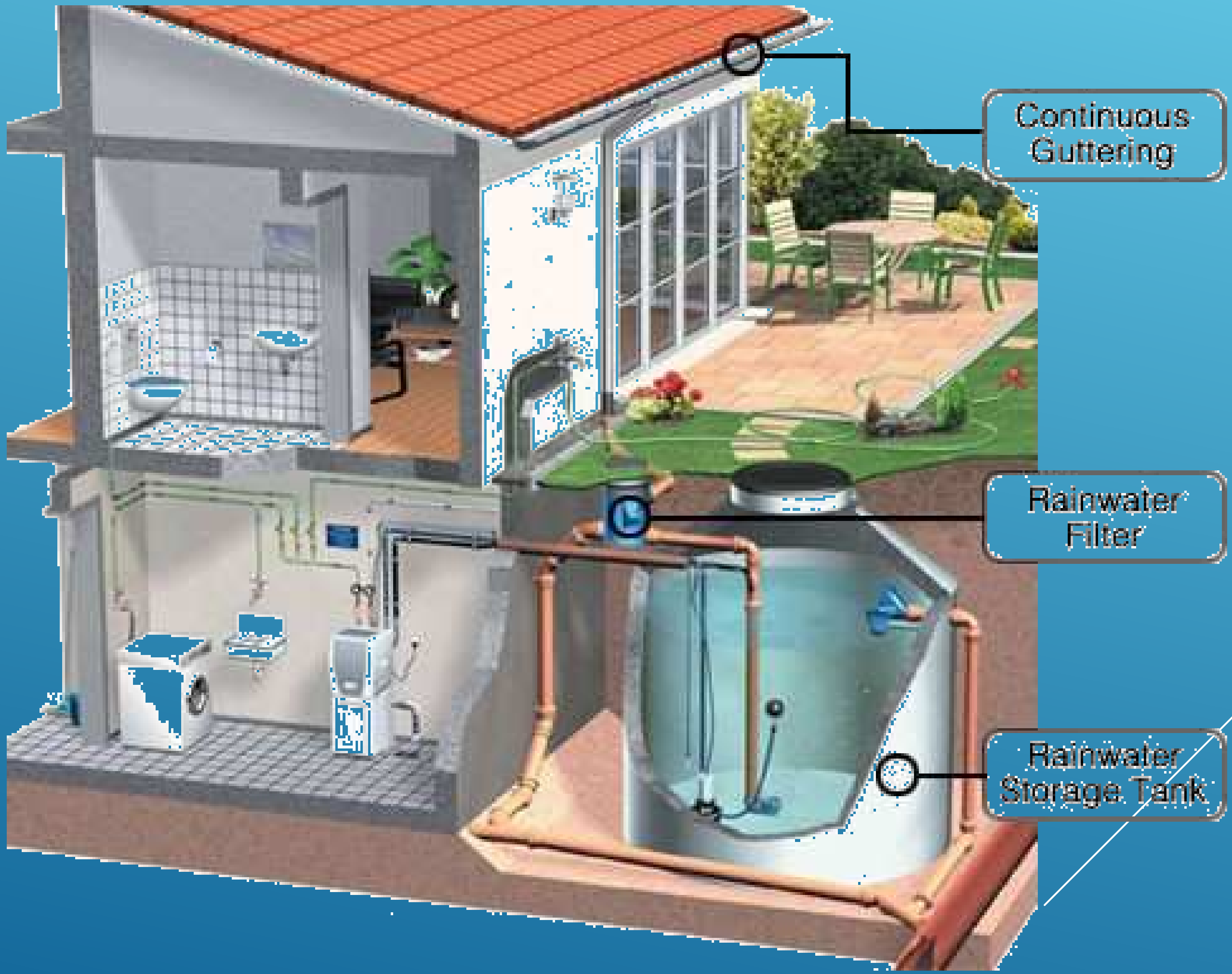
1. MAIN IDEA.

2. ELIMINATION MEASURES.

3. GREEN FILTERS.

1. MAIN IDEA

- To reuse the water supplies for the washing machine, kitchen, shower, taps and rain water using green filters in combination with other type of filters.



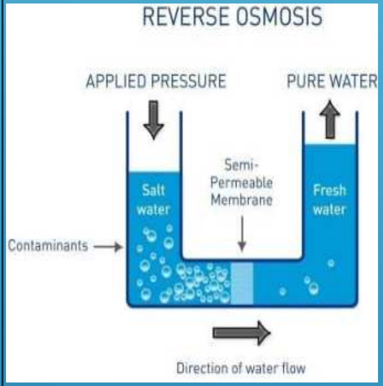
- **GREEN ROOFS: With other concept.**

	Extensive (Modular)	Extensive (Built Up)	Biodiverse	Intensive
				
Suitable for	Smaller projects requiring 'Instant greening'	Larger projects (more cost effective)	Projects with specific biodiverse objectives	Roof Gardens, Recreational Applications
Specification Drivers:	An ecological protection layer for: • Air & Water quality • Lower carbon emissions • Storm water attenuation • Wildlife habitat • Extended membrane life	An ecological protection layer for: • Air & Water quality • Lower carbon emissions • Storm water attenuation • Wildlife habitat • Extended membrane life	Diverse plant strategies can: • Replicate or enhance the building's pre-development habitat • Attract specific wildlife	A roof affording benefits of a small urban park or domestic garden, offering recreational and amenity benefits
Planting:	Colourful carpet of planting: • Hardy Succulents • Hardy Succulents & Herbs • Hardy Succulents & Grasses & Herbs Pre-grown mat as part of self-contained complete modules.	Colourful carpet of planting: • Hardy Succulents • Hardy Succulents & Herbs • Hardy Succulents & Grasses & Herbs Pre-grown mat, plug planted or seed system available	Options for non-vegetated brown roofs or planted with native species such as: • Hardy Succulents • Grasses • Herbs • Wildflowers	Planting includes: • Lawn & bushes • Shrubs & small trees • Can combine with hard landscapes & water features
Build-up Height:	80-90mm	70 – 120 mm	70 – 200 mm	150 – 1500 mm
Weight:	**64.5 kg/m²**	**80 – 125 kg/m²**	**90 – 225 kg/m²**	**200 kg/m² +**
Maintenance:	Minimal	Minimal	Minimal	Regular
Irrigation:	No, unless specified	No, unless specified	No	Regular

2. ELIMINATION MEASURES

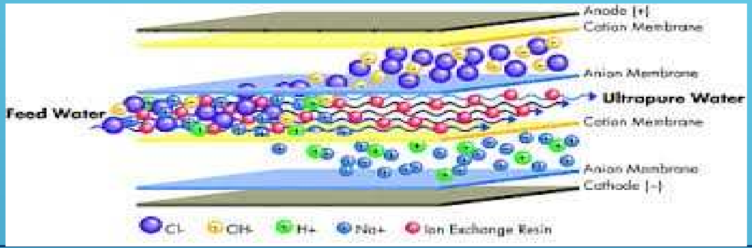
- **THE MAIN METHODS FOR PROCESS THE POLLUTED WATER AND REMOVE THE EXCESS OF NUTRIENTS ARE:**

1- Reverse osmosis

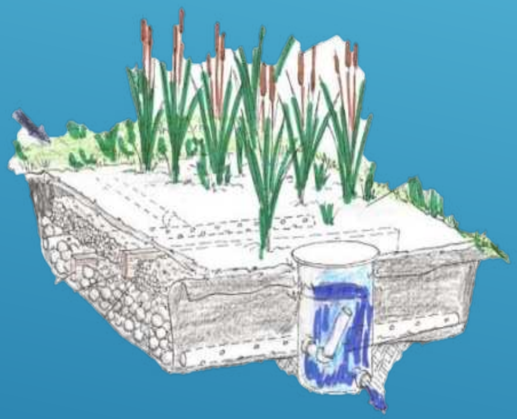


2- Chemical process by the use of iron hydroxide in the presence of a copper catalyst.

3- Electrodialysis

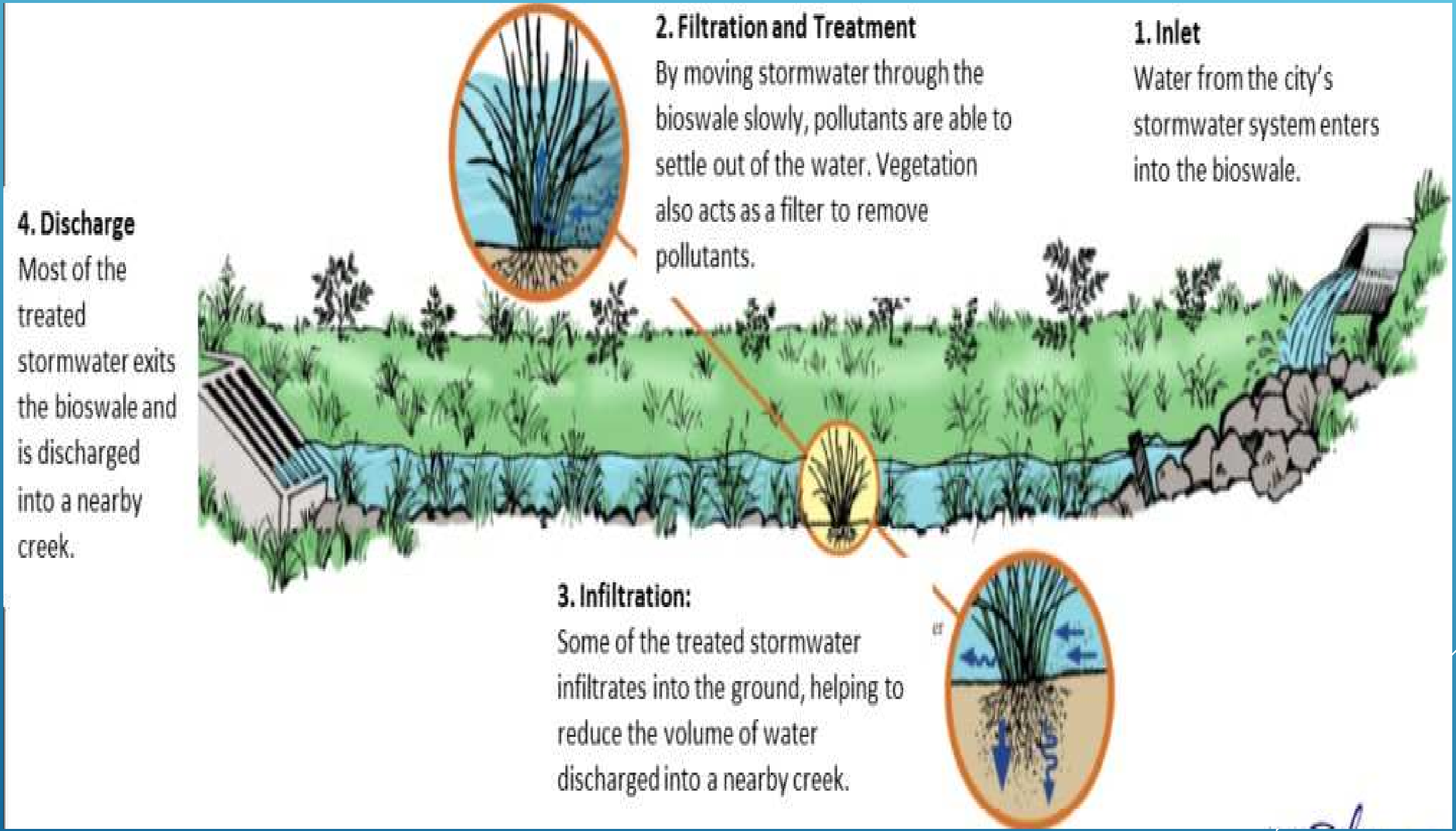


4- Green filters.



	Efficiency %					Mud Pro-duction	Mud colection
	BOD	COD	SS	P	N		
Filter	90-95	90-95	95-99	85-90	90-95	No	No

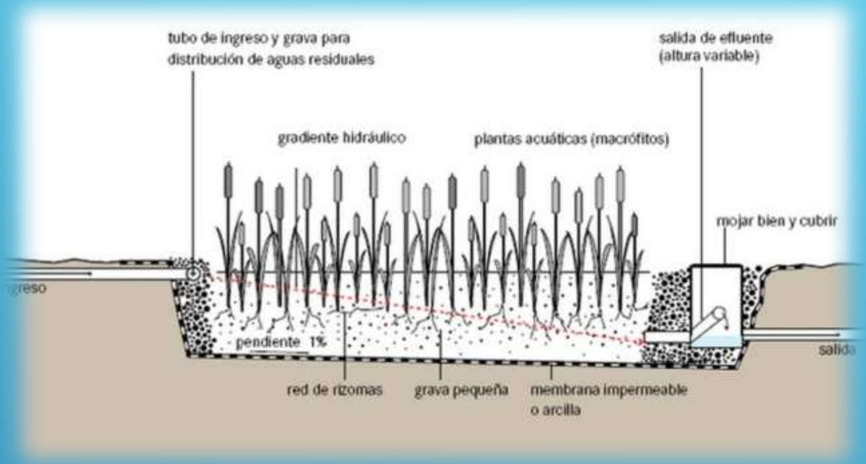
- **HOW GREEN FILTERS WORK?:**



3. GREEN FILTERS

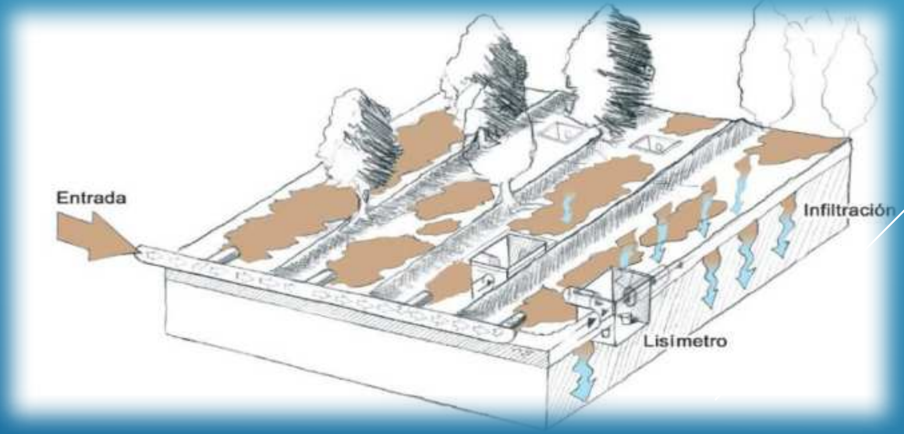
- PRINCIPAL TYPES OF GREEN FILTERS

1-Emerging subsurface flow plant system.



2-Floating plant system.

3-Surface flow emergent plant systems.



ADVANTAGES:

- remove efficiently the pathogens.
- have an easy construction and work.
- have a good integration on the environment.
- favor the protection of the forest and atmosphere quality improvement.

DISANVANTAGES:

- need enormous land areas.
- It isn't possible to introduce in all types of soils. (The main reasons: infiltration capacity and phreatic level).
- limitations if it's so rainy areas.
- a possibility that it alter subterranean waters.

ENERGY EFFICIENCY AT WATER WORKS

RE-USE FOR INDUSTRIAL PURPOSE

- Reuse for general services (cooling circuits and boilers);
- Specific reuse in various technological processes (textile, tannery, paper mills, steel mills)

Guidelines exist in technical literature which set the characteristics of the water for reuse both general and specific

RE-USE FOR INDUSTRIAL PURPOSE

- For reuse in cooling circuits using the treatment: flocculation - filtration - and possible disinfection
- For reuse in the boilers, the flocculation - filtration is added a demineralization

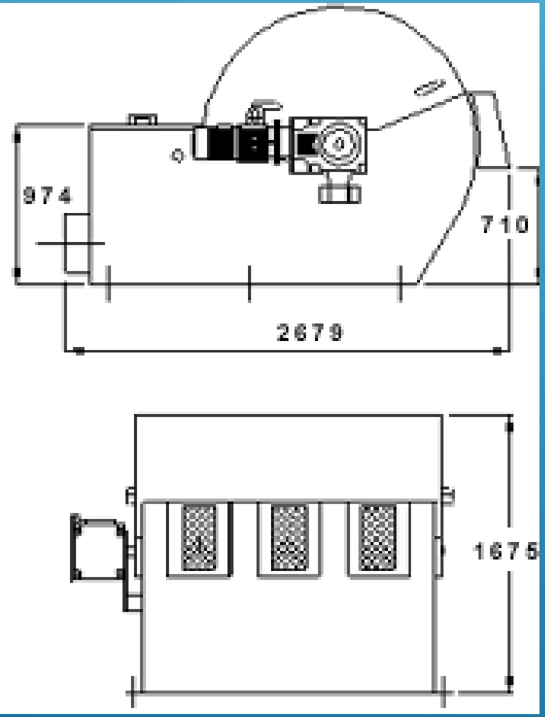
APPLICATIONS

- textile company
- Steel plant in Piombino
- In power plants, refineries, chemical industries

TECHNIQUES OF PURIFIED WASTEWATER

- The aging techniques are mainly directed:
  - The removal of SS (Suspended Solids)
  - Slaughter of BOD (Biochemical Oxygen Demand)

MICROFILTERS



- CIS (Groundwater Bodies) is between 3 and 10 m3/m2 *h
- 50-60% removal of SS
- Reduction of BOD by 20-30%

SYSTEMS OF NATURAL AGING

- Are processes that use crops that use solar energy to produce oxygen through photosynthesis
- Advantages
  - reduced energy consumption
  - management costs limited
  - Good results in terms of reduction
- disadvantages
  - Need for large surfaces

PHYTOREMEDIATION *VERTICAL FLOW FILTRATION*

- Grain size varies:
- Gravel 2-8 mm
- Gravel from 10-20mm
- Drainage of 20-40mm

- The tributary undergoes a physical treatment (filtration) and biologic tratment thanks to the biomass present on the support
- The supply of water must be higher than the infiltration and intermittent speed.

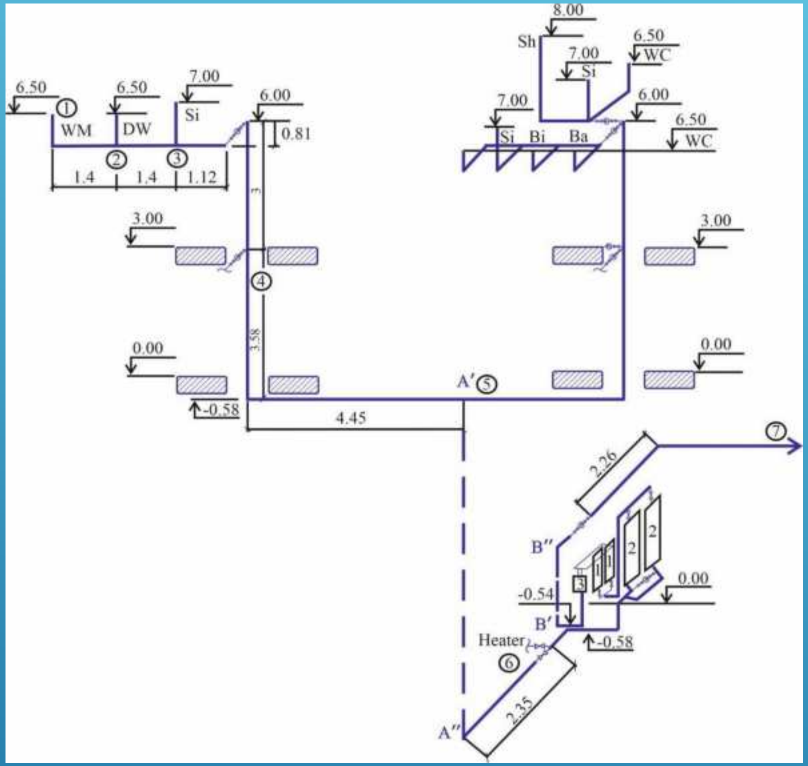
PHYTOREMEDIATION *HORIXONTAL FLOW FILTRATION*

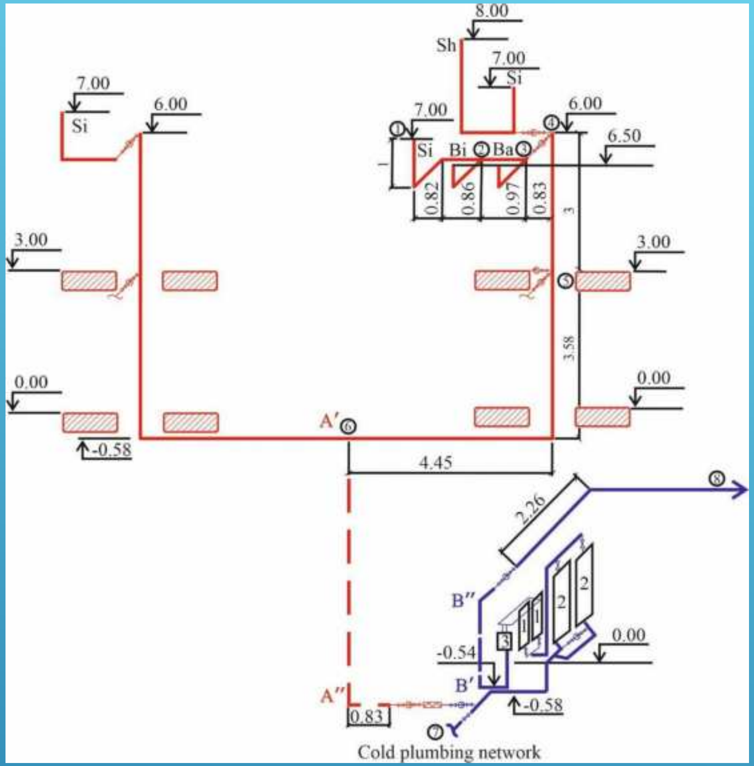
- Drainages at the
- extremities
- S = 60 cm (=L roots)

- The removal of BOD is due to microorganisms placed in the root system

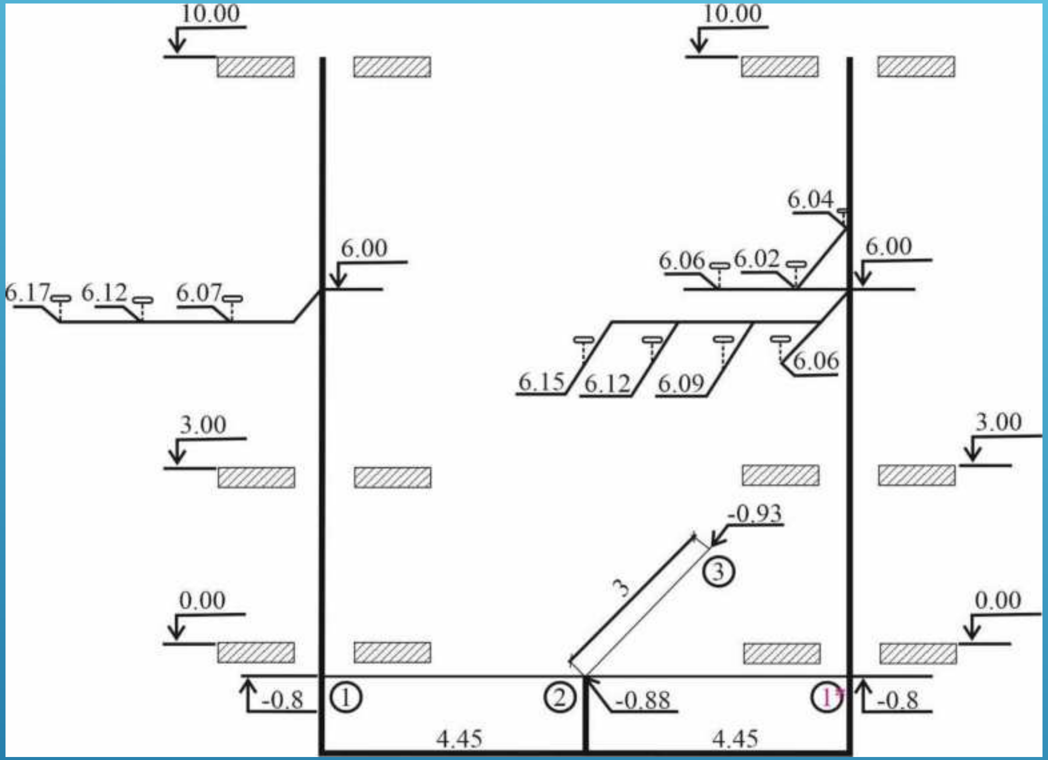
NATURAL IMPOUDMENT

- The mechanism is
  - based on use of
  - photosynthesis
- The algae which are
  - formed produce
  - Oxygen needed from
  - aerobic bacteria.





WATER SUPPLY PIPELINES MATERIALS: ELEMENTS, INSTALLATION, AND MAIN EQUIPMENT. PIPELINES CONNECTIONS AND MAIN WELLS.



10.00
10.00
6.04
6.00
6.06
6.02
6.00
6.17
6.12
6.07
6.15
6.12
6.09
6.06
3.00
3.00
-0.93
3
3
0.00
0.00
1
-0.8
2
-0.88
1
-0.8
4.45
4.45

SPECIAL WATER SYSTEM OF THE GREEN BUILDINGS. WATER SAVING DEVICES, EQUIPMENT, CALCULATION.

CONTENT

- Definition „green roof“
- Classification
- Construction
- Advantages/disadvantages
- Technologies rainwater harvesting systems
- Case studies
- Prospect/conclusion

- Extensive
- Semi-intensive
- Intensive

CLASSIFICATION

extensive green roof

semi-intensive green roof

intensive green roof

	Extensive Green Roof	Semi-Intensive Green Roof	Intensive Green Roof
Maintenance	Low	Periodically	High
Irrigation	No	Periodically	Regularly
Plant communities	Moss-Sedum-Herbs and Grasses	Grass-Herbs and Shrubs	Lawn or Perennials, Shrubs and Trees
System build-up height	60 - 200 mm	120 - 250 mm	150 - 400 mm on underground garages > 1000 mm
Weight	60 - 150 kg/m^2 13 -30 lb/sqft	120 - 200 kg/m^2 25 - 40 lb/sqft	180 - 500 kg/m^2 35 - 100 lb/sqft
Costs	Low	Middle	High
Use	Ecological protection layer	Designed Green Roof	Park like garden

DEFINITION

A green roof as a sustainable landscape design, is a layered system comprising of a waterproofing membrane, growing medium and the vegetation layer itself.

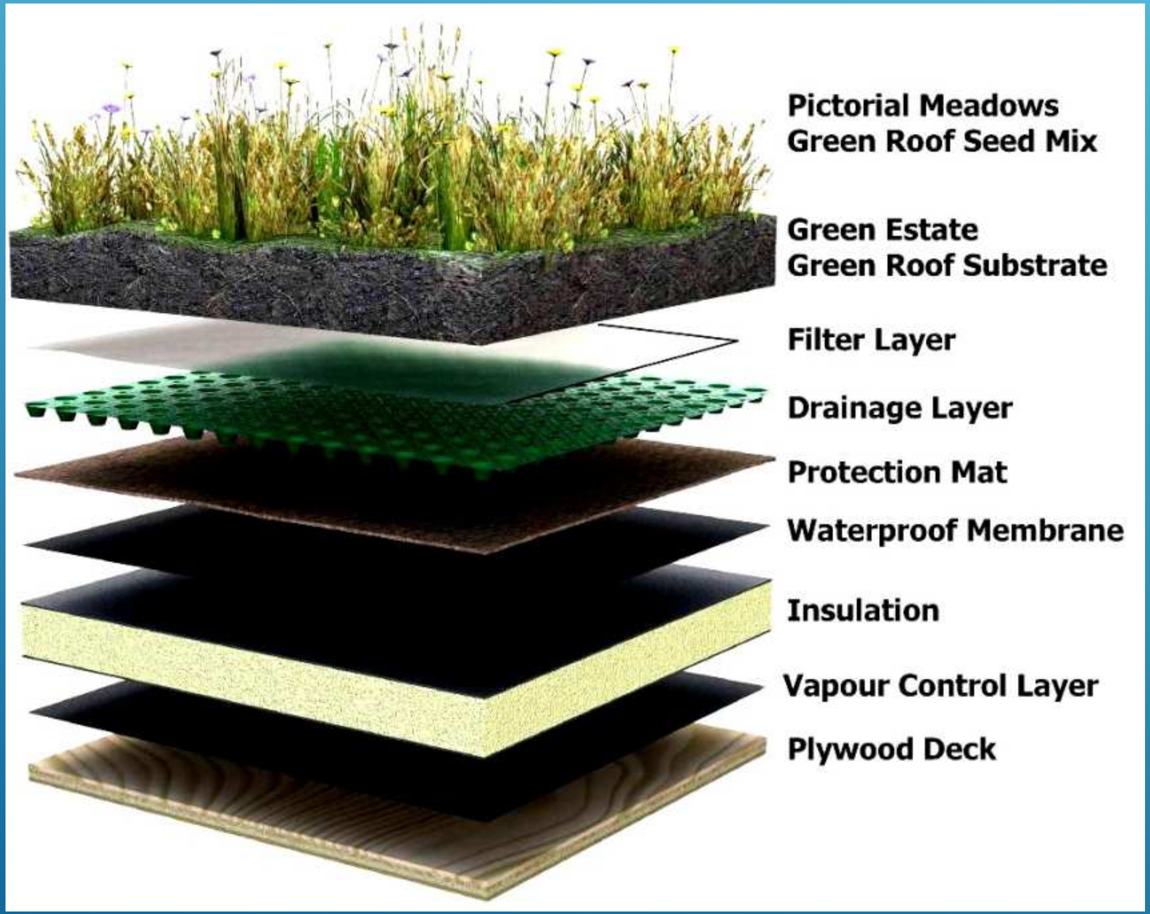
Combination with „green“ technologies

„Cooling Roofs“, Solar thermal collectors, PV panel

ADVANTAGES OF EACH CATEGORY

Extensive Green Roof	**Semi-Intensive Green Roof**	**Intensive Green Roof**
-Lightweight -Suitable for large areas -Low maintentance -Best cost/Benefits ratio -Low front cost -Easier to replace -Can leave vegetation to grow spontaneously	-Combines -Benefics from intensive and extensive	-Aesthetic -Plant diversity -Range of design -Often accessible, with diverse utilization of the roof -More energy efficiency and storm water retention capacity

CONSTRUCTI



Pictorial Meadows
Green Roof Seed Mix
Green Estate
Green Roof Substrate
Filter Layer
Drainage Layer
Protection Mat
Waterproof Membrane
Insulation
Vapour Control Layer
Plywood Deck

ADVANTAGES

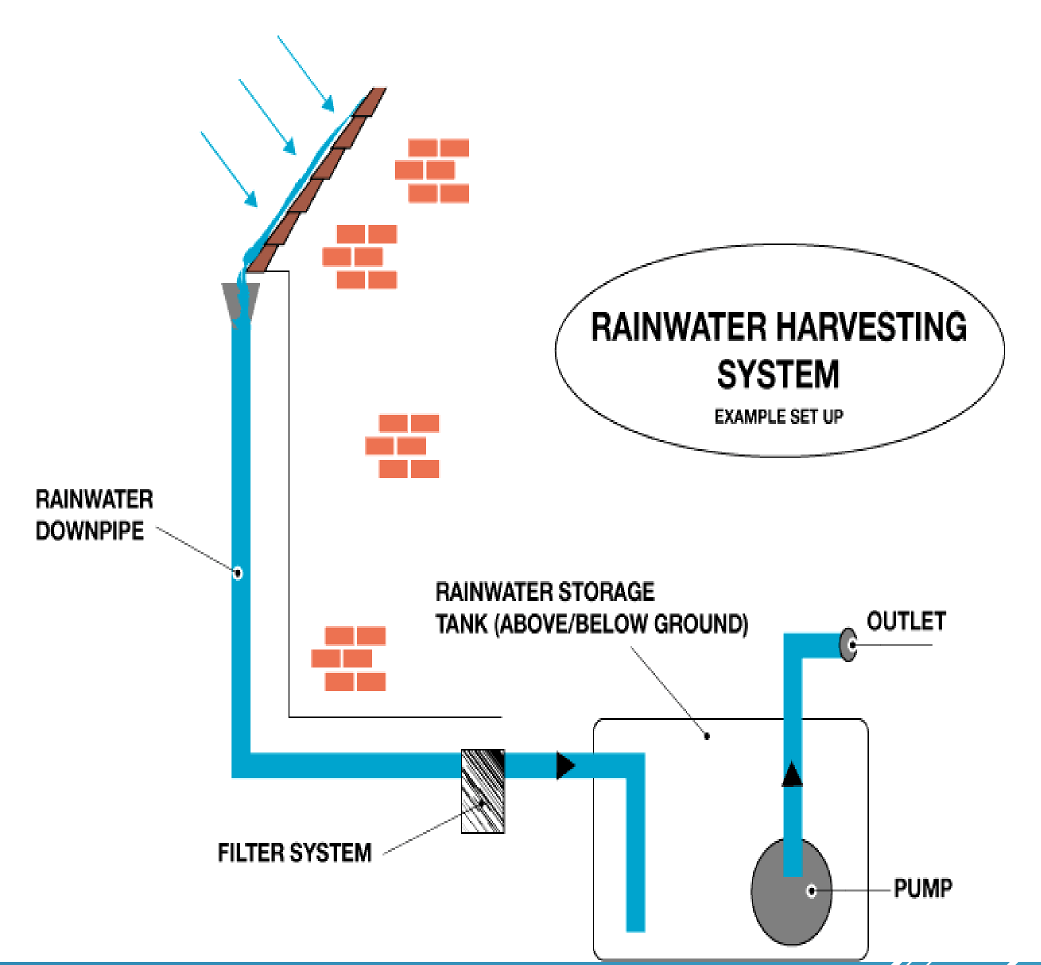
Category	Advantages
environmental	–reduction of stormwater run-off –better air quality –reduction of Urban Heat Island Effect (UHI) –perservation of biodiversity –better sound insulation, fire retardation –reduction of electromagnetic radiation penetration
economic	–double lifespan of roof –higher real estate value of the building –thermal insulation –financial incentives –new job opportunities, new market –reuse of rainwater
aesthetic	–beautifying urban areas –new design possibilites –integration into nature
psychological	–improvement of life quality –stress-reduction –support of human interaction

Disadvantages
–irrigation costs –potential risk of pesticide leakage –higher insurance costs (building) –unwelcome wildlife –maintenance + acquisition costs –special construction (heavy weight)

DISADVANTAGES

TECHNOLOGIES RAINWATER HARVESTING SYSTEMS

- Technical requirement
- Water management function
- Technical devices
  - Cistern
  - Filter system
  - Built-in filter
  - Downpipe-filter
  - Vortex fine filter



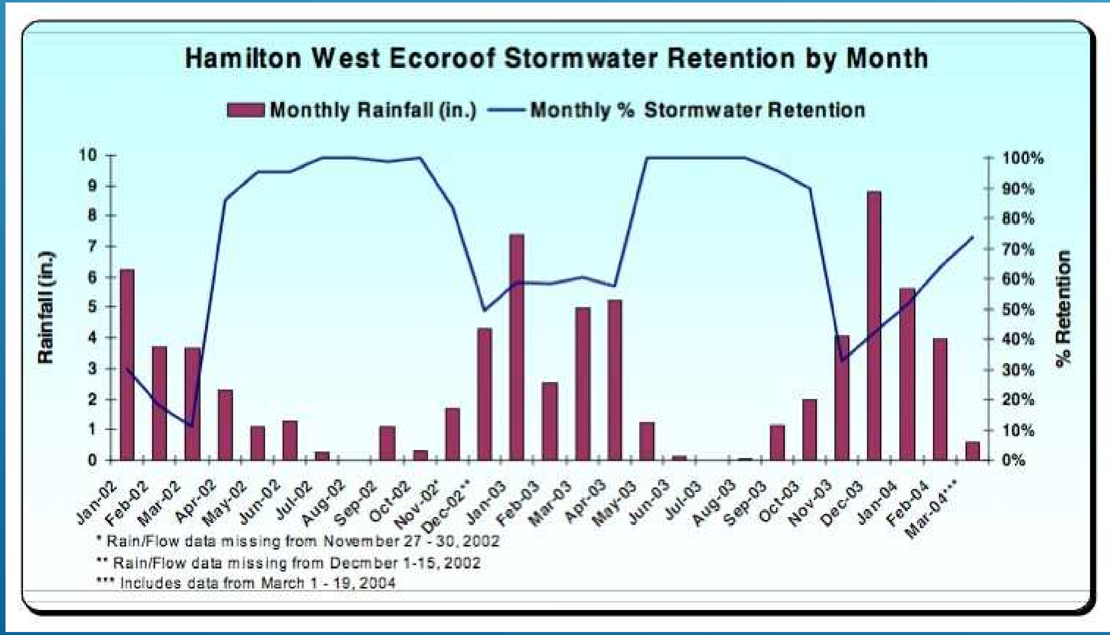
EXAMPLEM1: VANCOUVER PUBLIC LIBRARY

- 1850 m² extensive green roof
- 3 different materials for growing material
- present: reduction of run-off volume by 16%
- future: reduction of run-off volume by 48%

EXAMPLE 2: HAMILTON APARTMENT

- 808 m² green roof
- located in Portland USA
- divided in two parts: east and west
- storm water and water quality monitoring

- east part: extensive
- west part: semi-intensive



- summer: roof gathers total rainfall
- winter: average 40% of rainfall can be absorbed

- Tremendous potential
- Grants, incentive taxes, bylaws
- EFB (=European Federation of Green Roof Association)
- LEED certification
- Example: Toronto

PROSPECT/CONCLUSION

WASTEWATER DISCHARGE

LAW LEVEL

2000/60/CE → **LEGISLATION DECREE: 152/2006**

LAWS AGAINST WASTE OF NATURAL RESOURCES

- DISCHARGE INTO UNDERGROUND WATER IS FORBIDDEN
- DISCHARGE ON THE GROUND IS ALLOWED
- REGULATION OF EXECUTIVE PARAMETERS OF WASTEWATER TREATMENT PLANTS

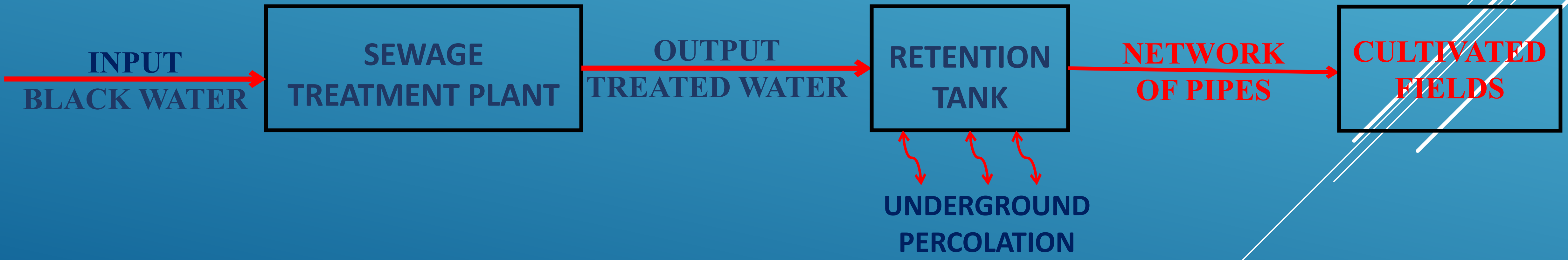
POLLUTANT	LIMIT OF QUANTITY OF POLLUTANT [mg/L]
BOD	20
COD	100
SST	25
N	15
P	5

COMPARISON OF POLLUTANT LAW LIMITS IN DISCHARED WATER

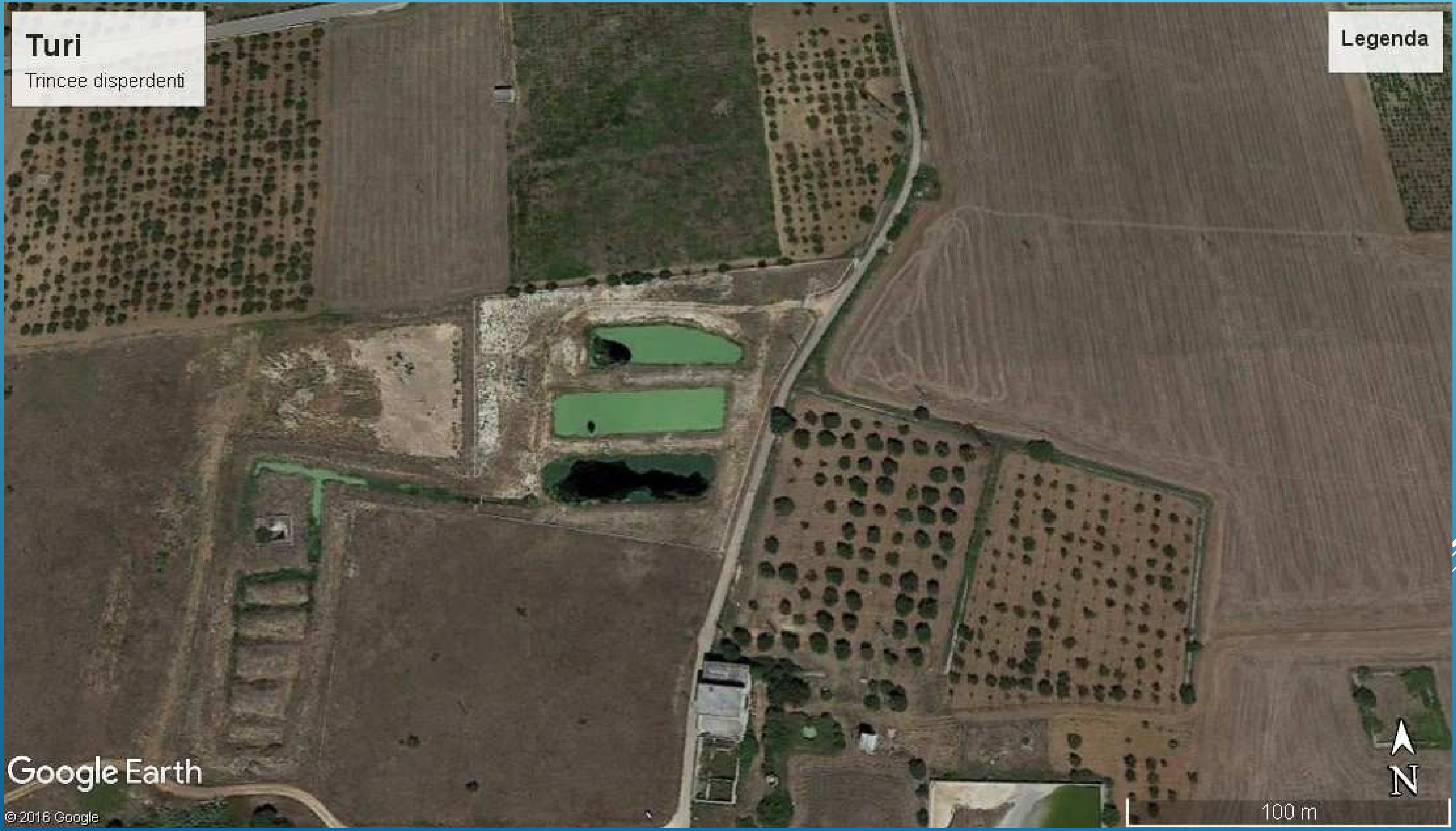
POLLUTANT	LIMIT OF POLLUTANT DISCHARGED TO THE RIVER [mg/L]	LIMIT OF POLLUTANT DISCHARGED IN THE SEA [mg/L]
BOD	20	25
COD	100	125
SST	25	35
N	15	-
P	5	-

ISSUE: dischargemant of water on the ground is a waste of water resouceS

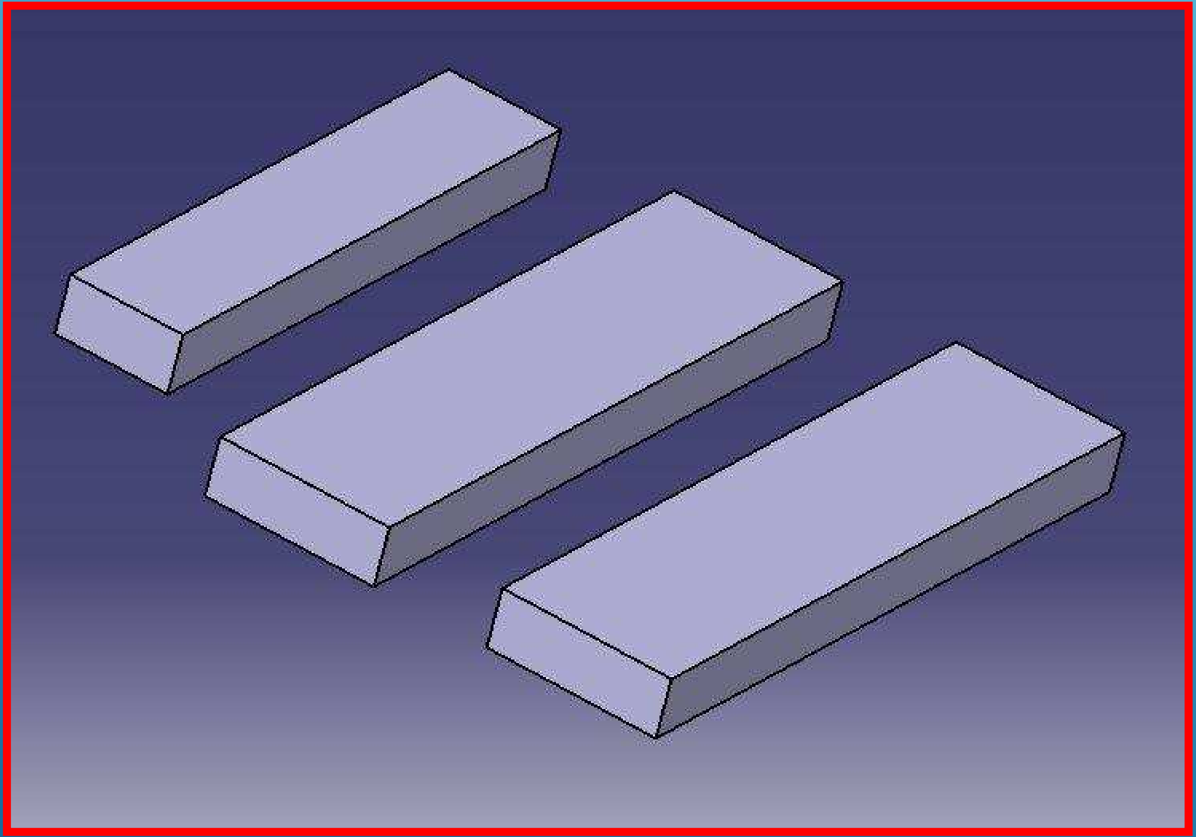
SOLUTION: WE CAN START FROM SEWAGE TREATMENT PLANT IN ORDER TO OBTAIN CLEAN WATER FOR IRRIGATION

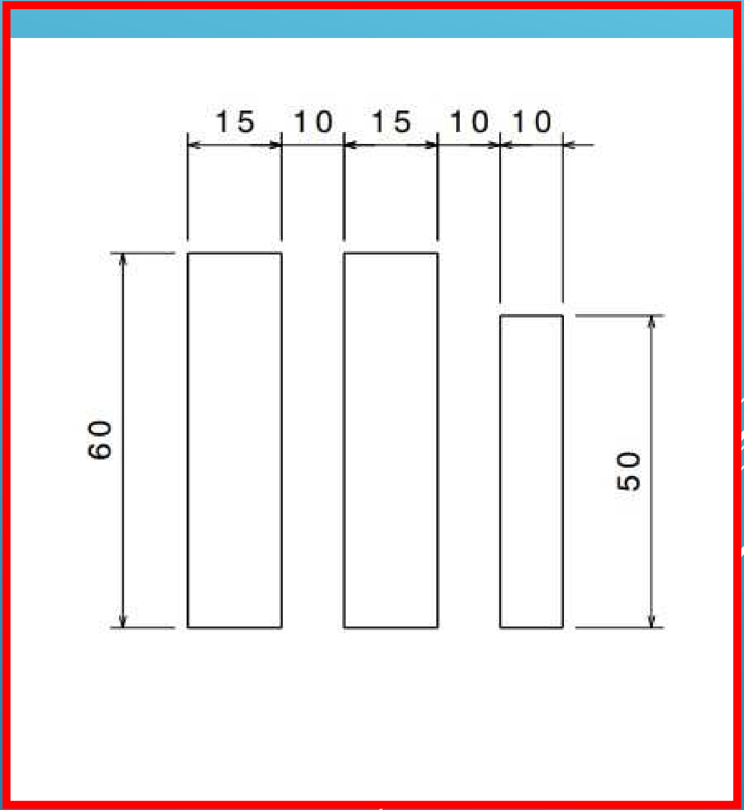


RETENTION TANKS
OF THE SEWAGE TREATMENT PLANT



RETENTION TANKS
OF THE SEWAGE TREATMENT PLANT





1. (CAD)

PIPES DIMENSION

Stevino's law [1]

$+$

Bernoulli [2] → [3]

Mariotte's law

[4]

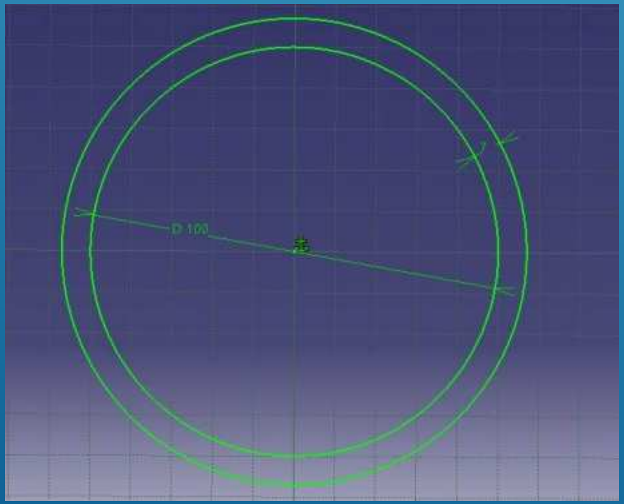
Commercial thickness $= 7\ mm$

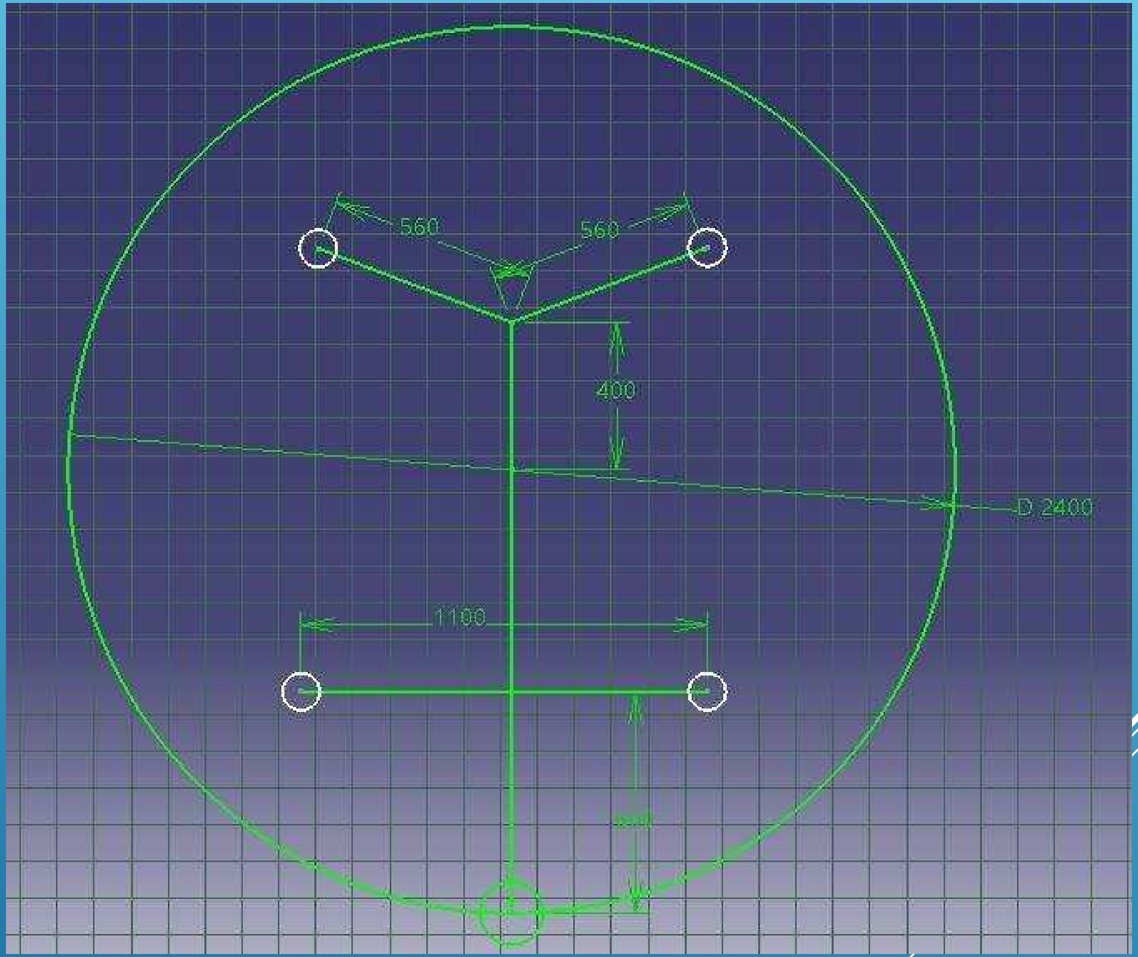
1.
2.
3.
4.

PIPES NETWORK DESIGN

PIPE DIAMETER

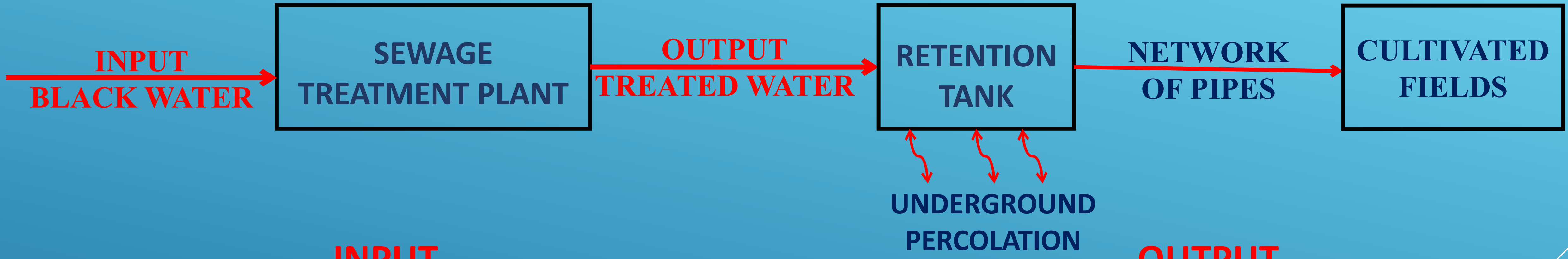
114 *mm*





1. (CAD)

CHEMICAL COMPOSITION



INPUT

POLLUTANT	CONCENTRATION OF POLLUTANT [mg/L]
BOD	384
COD	871
SST	325
N	102
P	13

OUTPUT

POLLUTANT	CONCENTRATION OF POLLUTANT [mg/L]
BOD	9
COD	19
SST	6
N	6
P	1

1. (arpa.it)

1. Background of house scheme and pipeline design.
2. Stormwater system: construction design + pipeline calculation
3. Cold water supply: axonometric design + pipeline calculation.
4. Hot water supply: axonometric design + pipeline calculation.
5. Wastewater system: axonometric design + pipeline calculation.

TABLE OF CONTENT

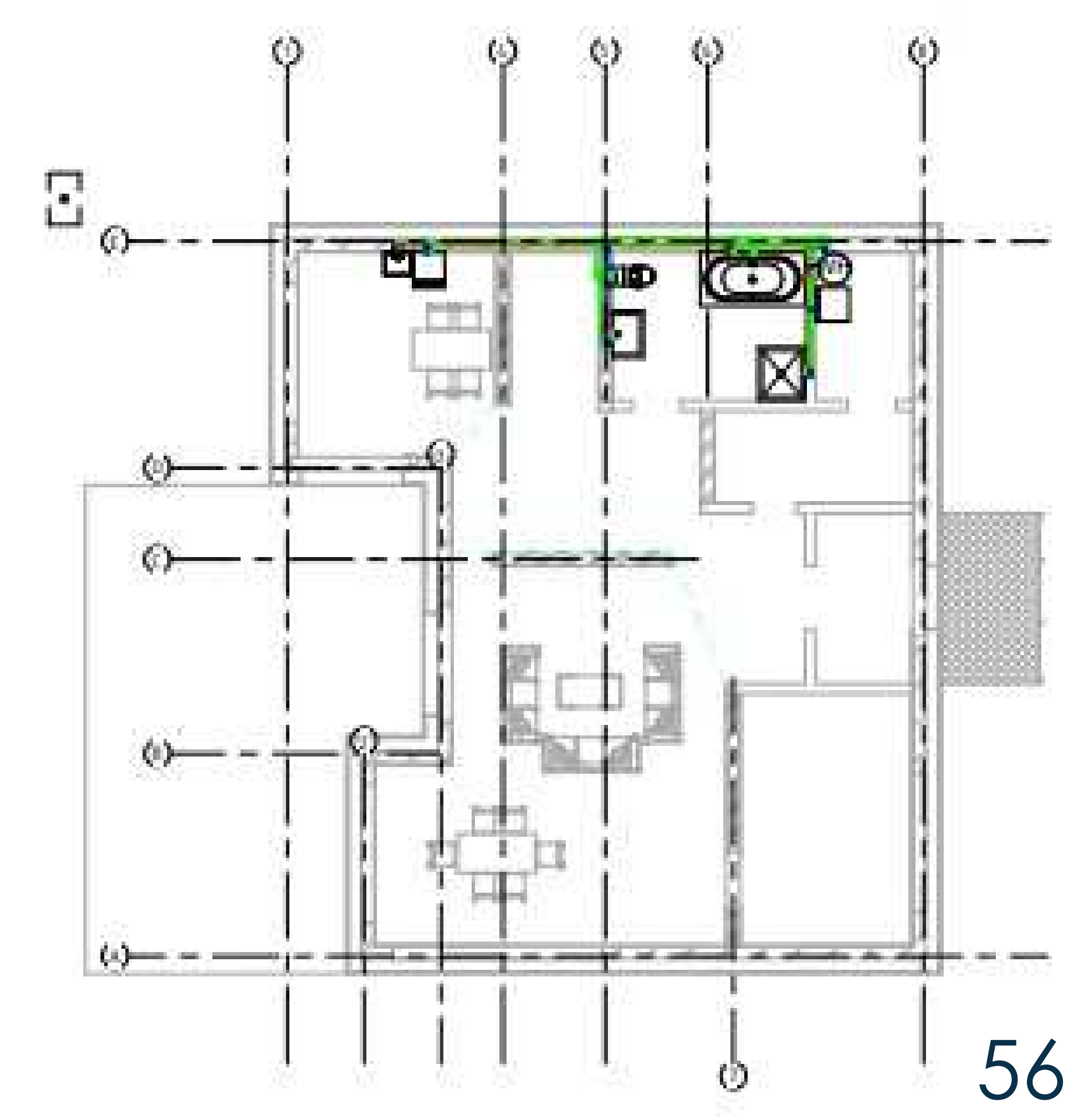
BACKGROUND OF HOUSE SCHEME AND PIPELINE DESIGN

- Water tank for colecting storm water from roof (200L volume). Everything else goes to central city pipeline.

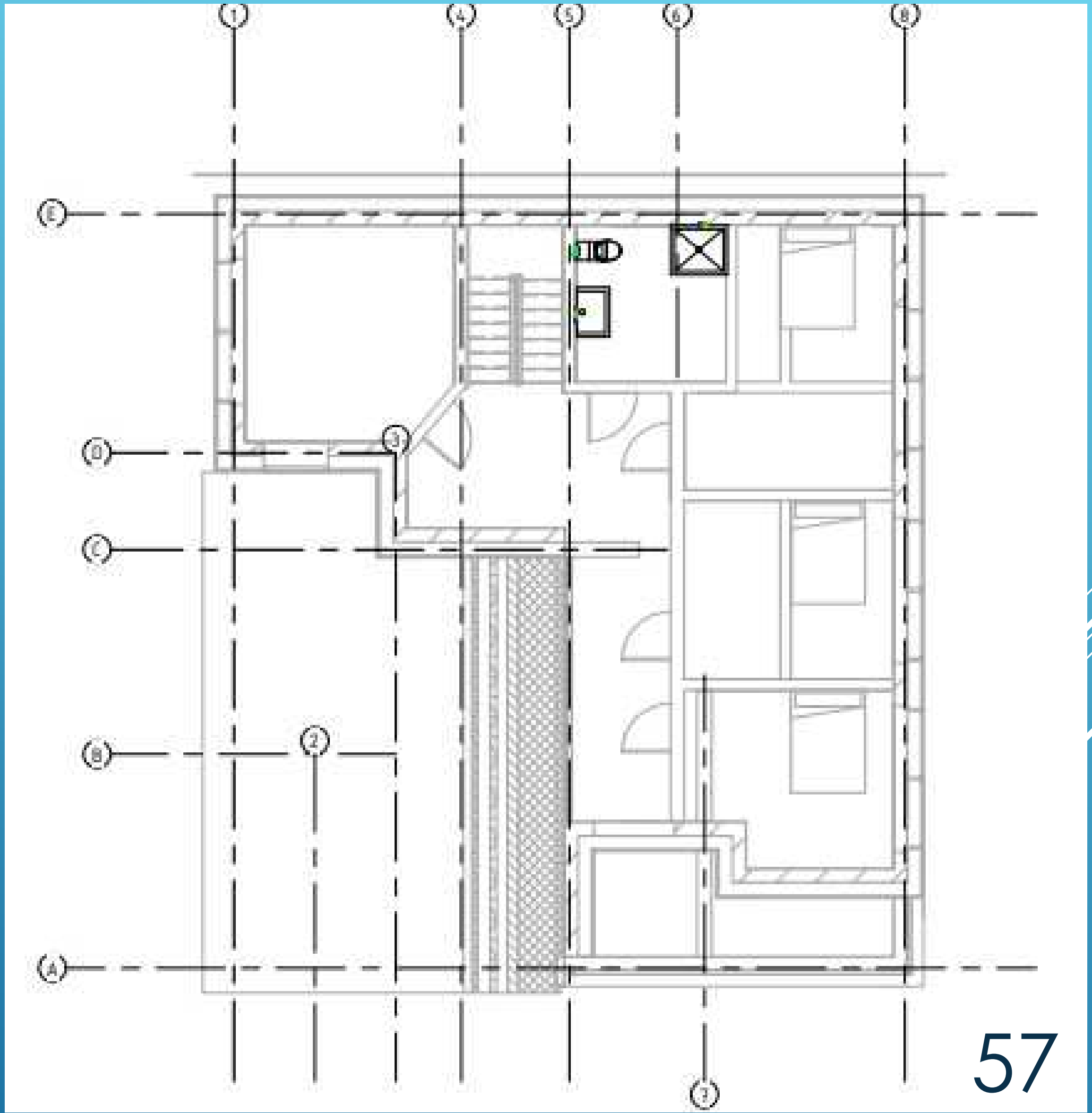
- Private pipe of water supply and wastewater has been joint with street’s main pipe system.
- All water pipes are under the ground 0.8 meters deep.
  - Cold water main pipe will pump water to water tank on second floor and distribute to each floor by branch pipes.
  - Hot water will be produced from boiler located in first floor.
  - Water from raining being colected and reused for watering garden.
  - Black water wont be used.

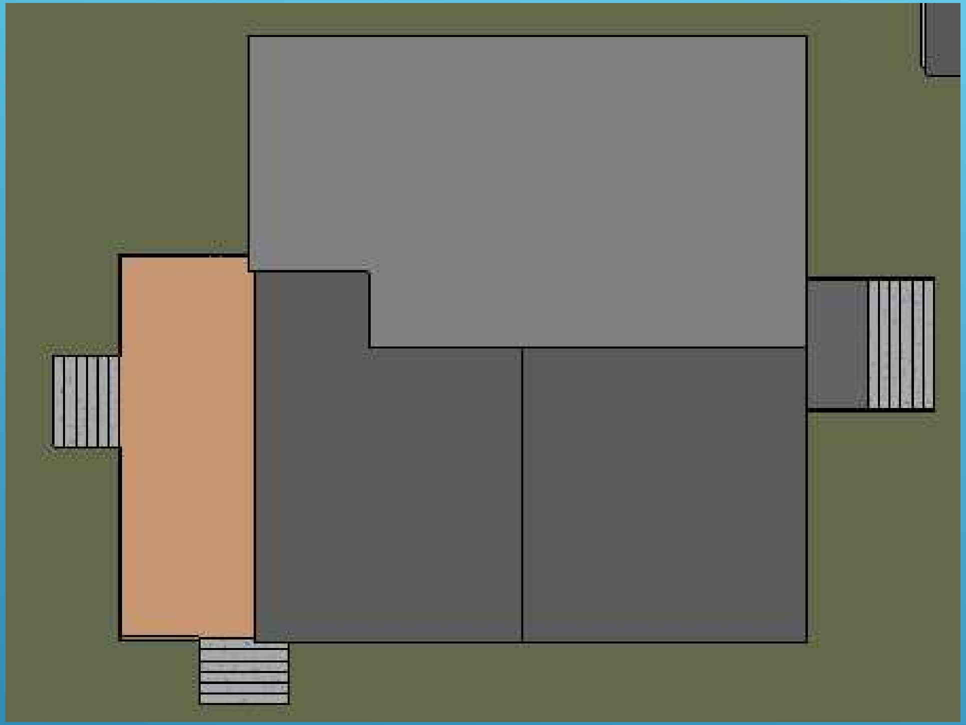
PIPELINE SYSTEM INFORMATION

1ST FLOOR



2ND FLOOR





ROOF DESIGN

2. STORMWATER

Storm water

A1 = 106m2 = 0.0106 15°

A2 = 54m2 = 0.0054 15°

A3 = 61m2 = 0.0061 15°

Section Nr.	Length (m)	d, mm	i	v, m/s	h/d	$\Delta h = i \cdot L$, l
1-2	1.4	100	0,04	0.76	0,2	0.056
2-3	9.7	100	0,04	0.76	0,2	0.388
3-4	7	100	0,04	0.76	0,2	0.28

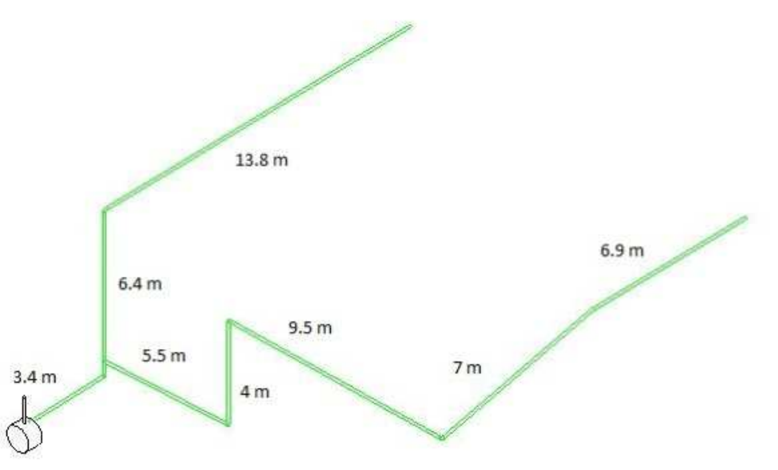
P=63% (Druskininkai)

A1 debit = 83*0.0106 = 0.8798

A2 debit = 83*0.0054 = 0.445

A3 debit = 83*0.0061 = 0.506

D=100 mm2



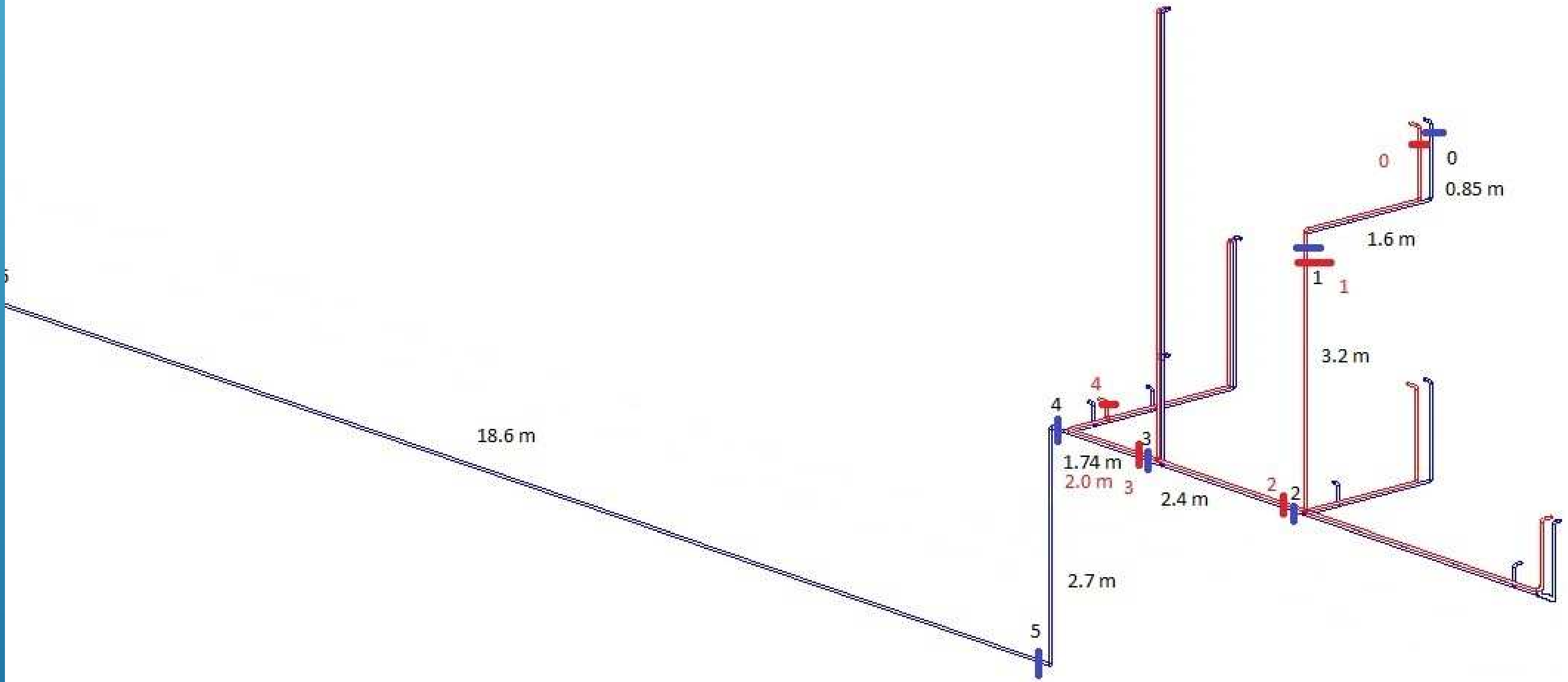
Section	Accum N TAPS	Flow (1/s)	N*P cold	α	q sum flow (L/s) = 5 *flow *α	D (mm)	Lenght (m)	V (m/s)	Presureless – friction (Pa/m)	Hitot
0-1	1	0.12	0,00666	0.2	0.12	12	2.45	0.66	377,00	923.65
1_2	6	0.12	0.04	0.256	0.15	12	3.2	0.87	643,00	2057.6
2_3	7	0.18	0.04666	0.268	0.24	20	2.4	0.61	233,00	559.2
3_4	10	0.18	0.06666	0.301	0.27	20	1.74	0.91	494,00	859.56
4_5	10	0.25	0.06666	0.301	0.37	25	2.7	0.75	256,00	691.2
5_6	10	0.25	0.06666	0.301	0.37	25	18.6	0.75	256,00	4761.6

$Total = 9852.81$

3. COLD WATER SUPPLY

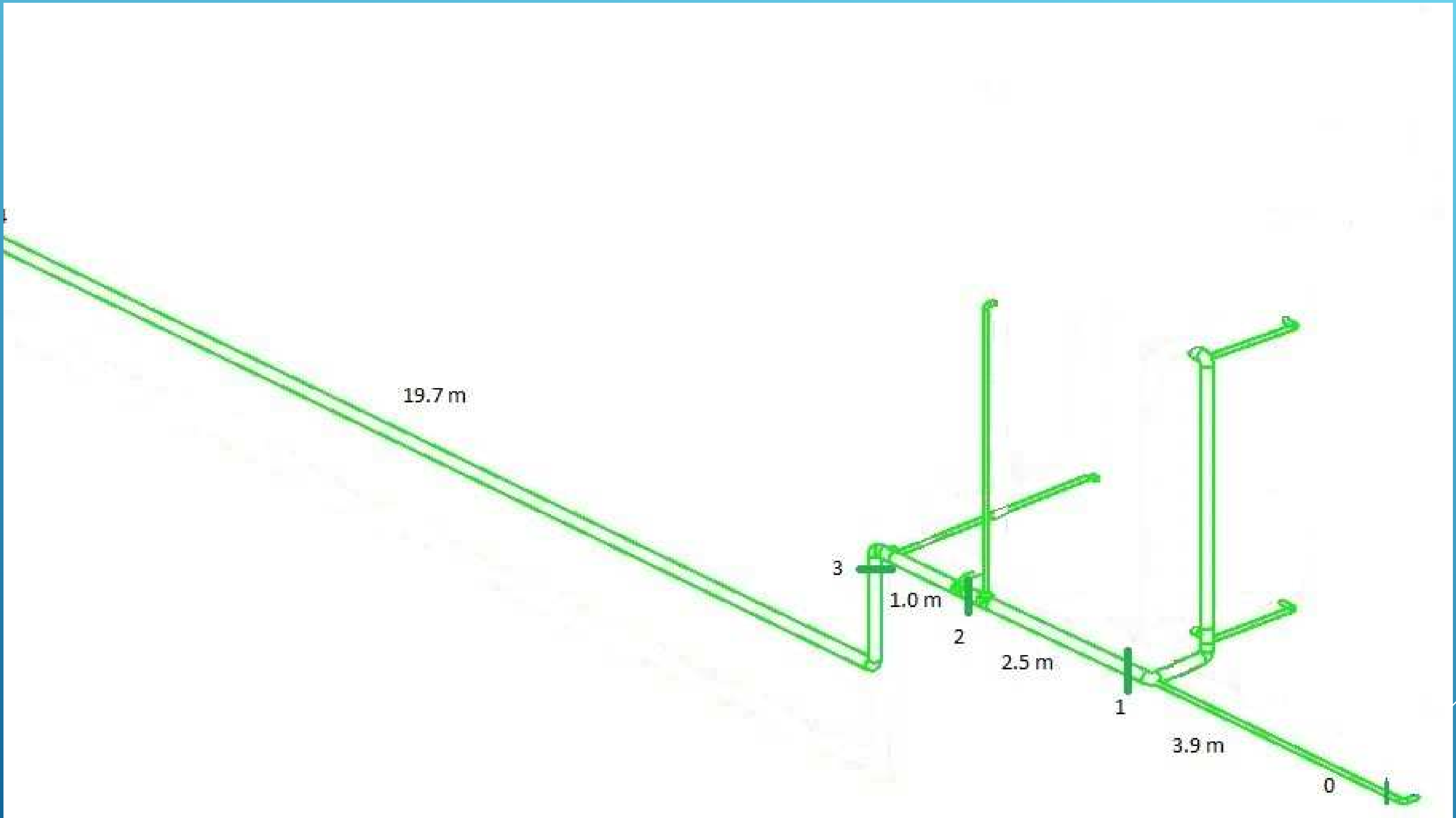
Section	Accum N TAPS	Flow (1/s)	N*P cold	A	q sum flow (L/s) = 5 *flow *α	D (mm)	Lenght (m)	V (m/s)	Presureless – friction (Pa/m)	H_{itot}
0-1	1	0.12	0,00666	0.2	0.12	12	2.45	0.66	377,00	923.65
1_2	6	0.12	0.04	0.256	0.15	12	3.2	0.87	643,00	2057.6
2_3	7	0.18	0.04666	0.268	0.24	20	2.4	0.61	233,00	559.2
3_4	10	0.18	0.06666	0.301	0.27	20	1.74	0.91	494,00	859.56
4_5	10	0.25	0.06666	0.301	0.37	25	2.7	0.75	256,00	691.2
5_6	10	0.25	0.06666	0.301	0.37	25	18.6	0.75	256,00	4761.6

4. HOT WATER SUPPLY


0
0
0.85 m
1.6 m
1
1
3.2 m
4
4
3
1.74 m
2.0 m
3
2.4 m
2
2
18.6 m
2.7 m
5

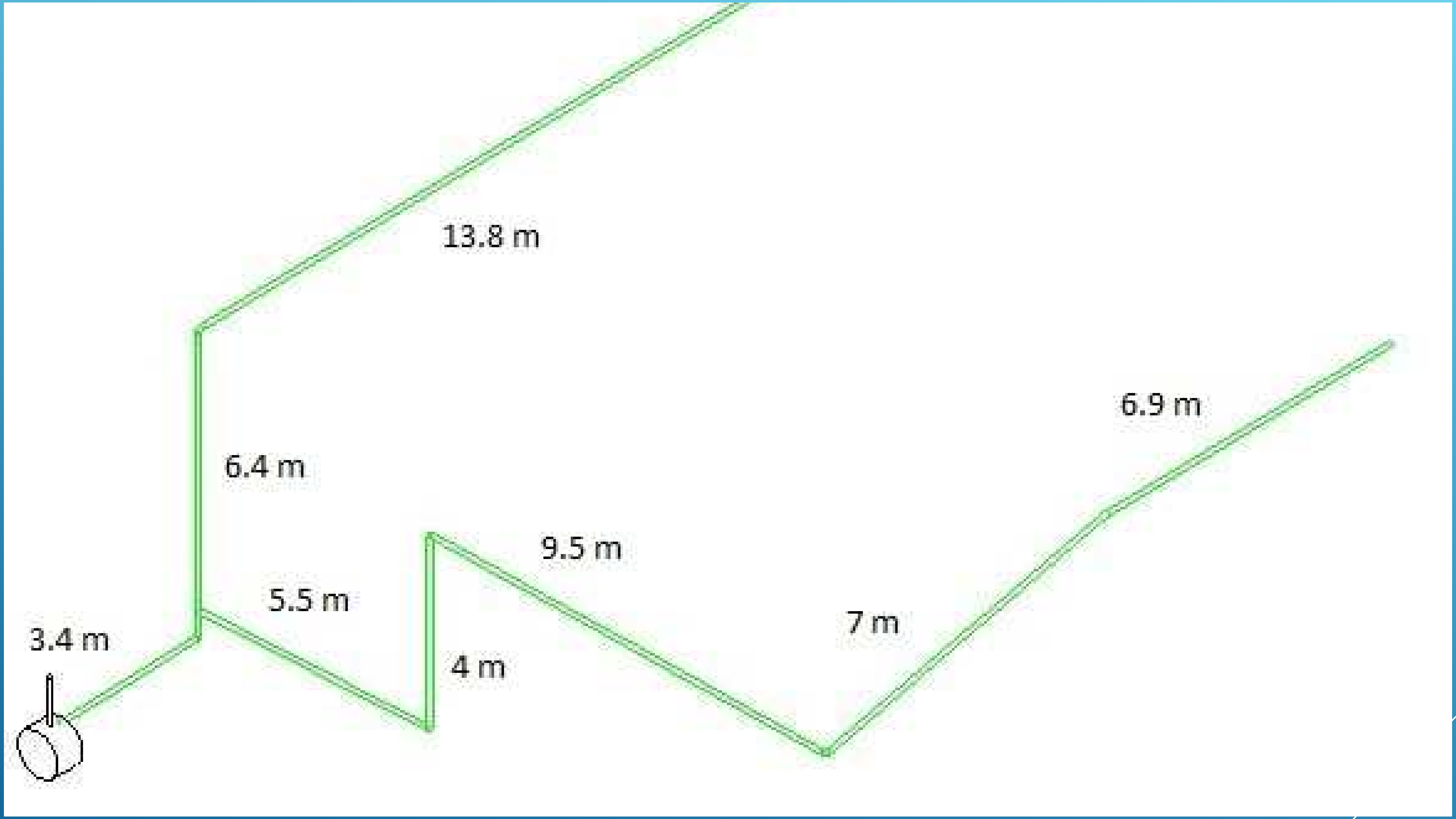
Section	Accum N TAPS	Flow (1/s)	N *P cold	α	q sum flow (L/s) = 5 *flow *α	Q	Qsum	D (mm)	Lenght (m)	Inclination	V (m/s)	h/d	ΔH*lenght
0-1	5	0.12	0.044	0.367	0,216	0.15	0.366	50	3.9	0.03	0.5	0.4	1.6
1_2	6	0.12	0.045	0.367	0,216	1.6	1.816	100	2.5	0.04	0.96	0.3	0.75
2_3	8	0.18	0.006	0.43	0,387	1.6	1.987	100	1.0	0.05	1.07	0.3	0.3
3_4	8	0.25	0.006	0.493	0,616	1.6	2.216	100	19.7	0,02	0.79	0.4	7.88

5. WASTEWATER


19.7 m
3
1.0 m
2
2.5 m
1
3.9 m
0

Section Nr.	Length (m)	d, mm	i	v, m/s	h/d	$\Delta h = i \cdot L$, l
1-2	1.4	100	0,04	0.76	0,2	0.056
2-3	9.7	100	0,04	0.76	0,2	0.388
3-4	7	100	0,04	0.76	0,2	0.28

6. STORM WATER


13.8 m
6.9 m
6.4 m
9.5 m
5.5 m
7 m
3.4 m
4 m

SamSamWater Rainwater Harvesting Tool

Step 4 of 4 (results)

print

Summary of results

During an average year there is no need to construct a large storage reservoir, but during a dry year a storage reservoir of **200 litres** (0.2 m³) is required to have enough water during the dry season.

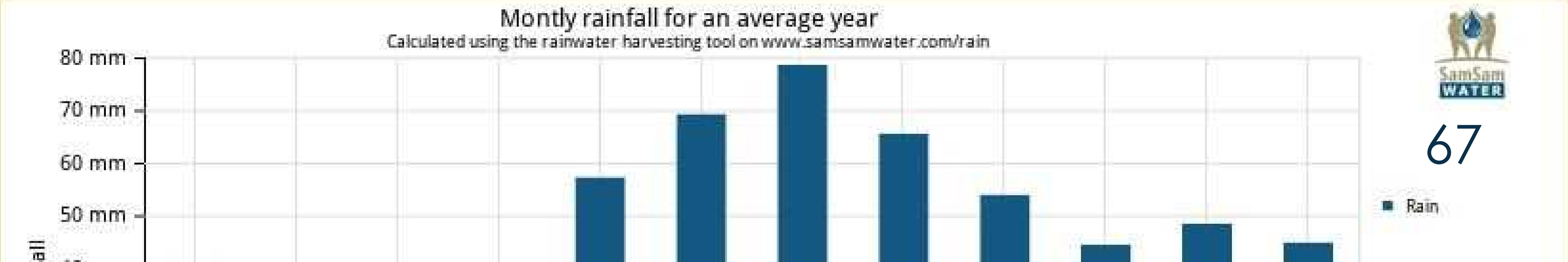
Details on the results and calculations can be found below.

Location

Location:	Gardino g. 6, Druskininkai 66204, Lietuva
Latitude:	54.00694 degrees
Longitude:	23.98145 degrees
Roof size:	221 square metres
Roof type:	tiles
Runoff coefficient:	0.9
Water demand:	100 litres per day

Rainfall

The average rainfall at this location varies between 26.8 mm in the driest month (February) and 78.4 mm in the wettest month (July). The total annual rainfall in an average year is 596 mm.



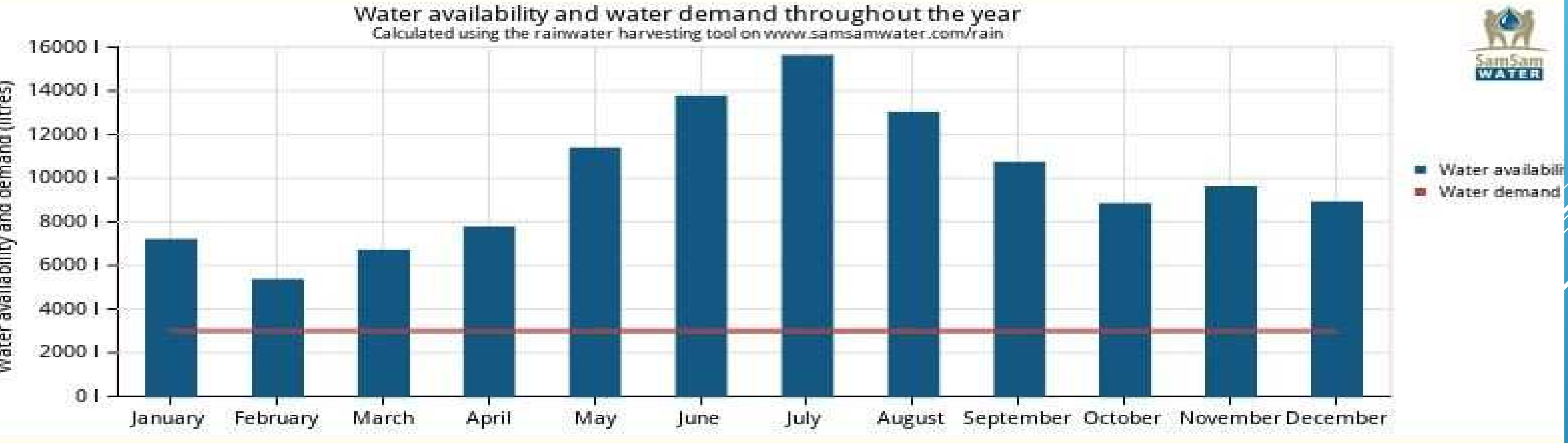
ater availability

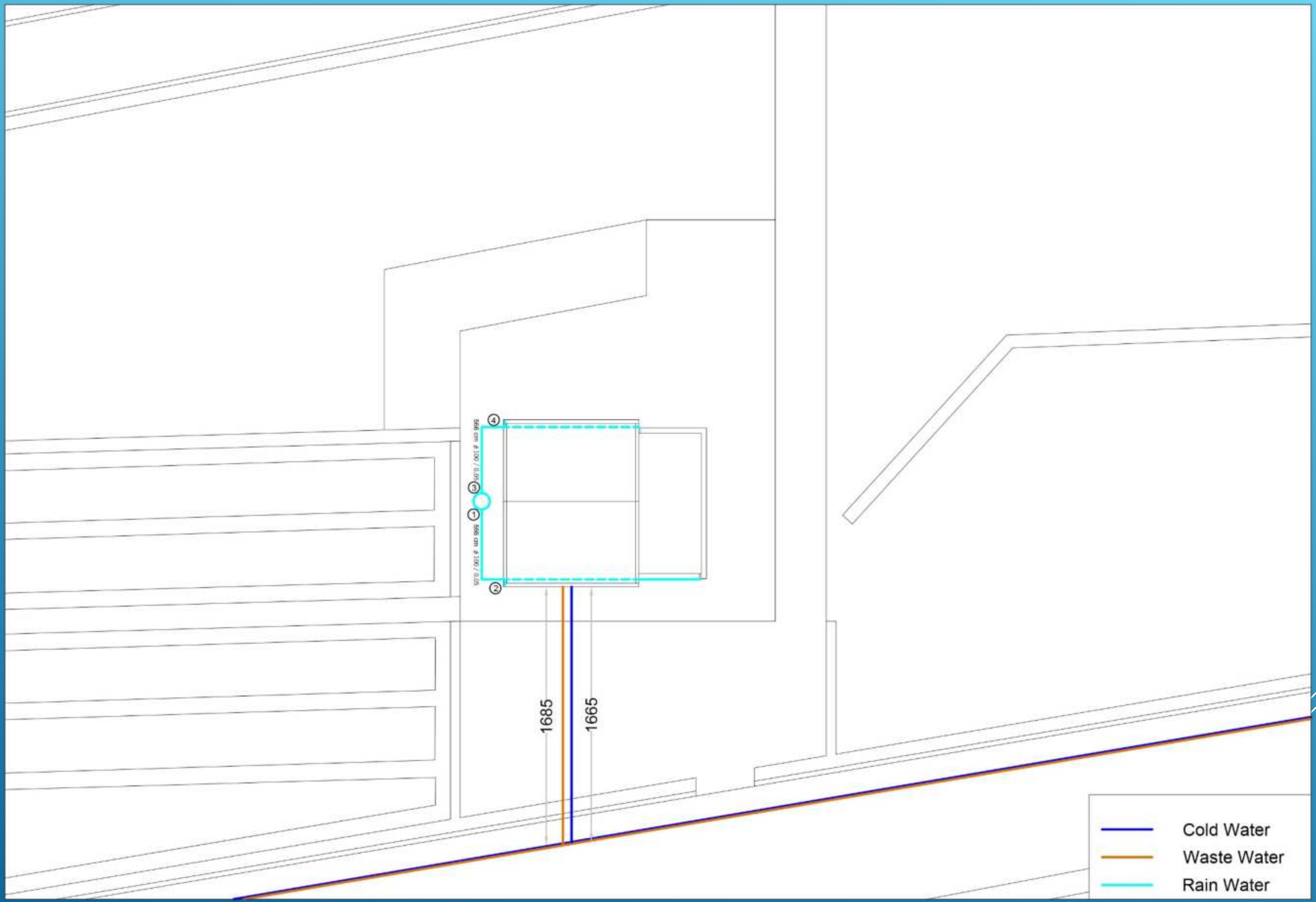
les roof has a runoff coefficient of 0.9, which means that 90% of the rain can be harvested. Based on this runoff coefficient and a roof area of 221 uare metres a volume of 5331 litres (26.8 mm x 221 m² x 0.9) of water can be collected in the driest month (February) and 15594 litres (78.4 mm x x 0.9) in the wettest month (July).

e total yearly amount of water that can be collected from the roof is 118600 litres (119m³) in an average year.

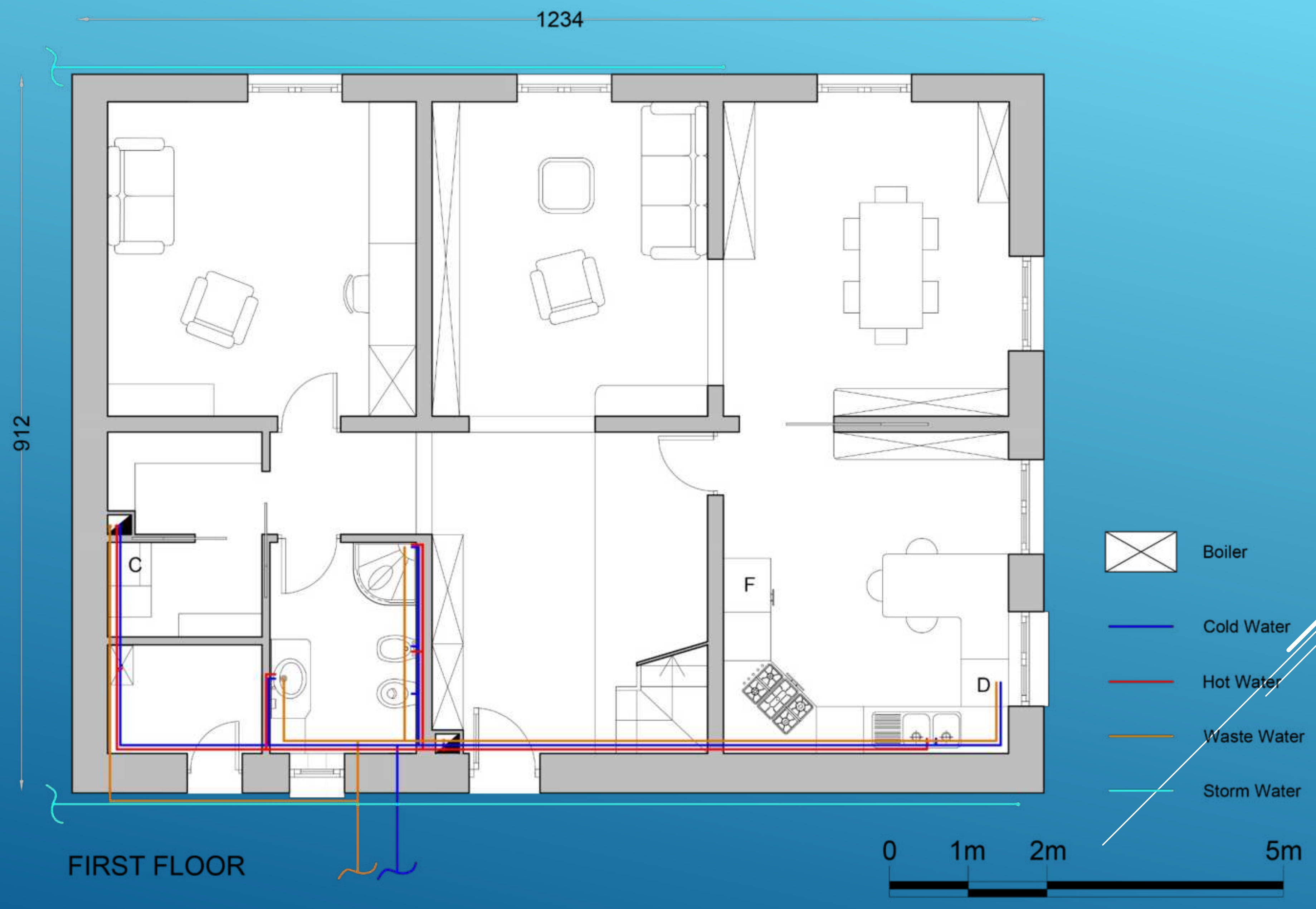
ater demand

e water demand is 100 litres per day, which equals to about 3000 litres per month. The total water demand is 36500 litres (36.5 m³) per year. ring every month the amount of water that can be collected from the roof is larger than the water demand.

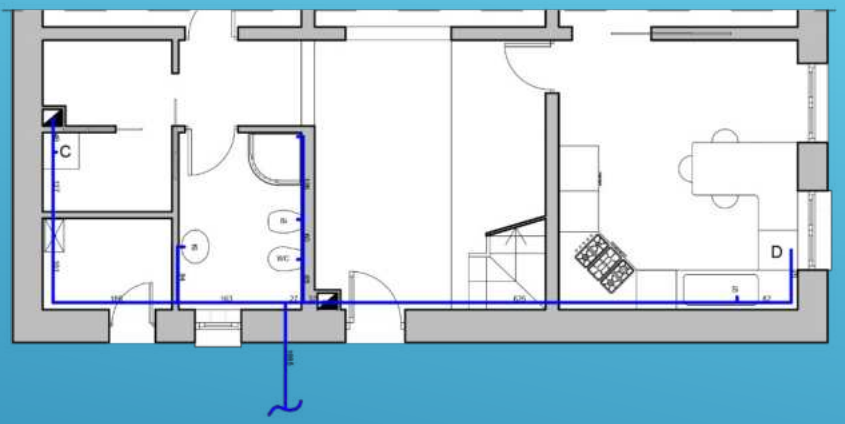


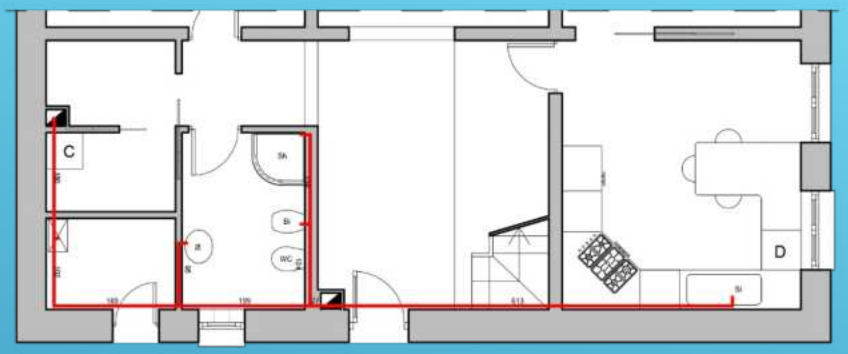


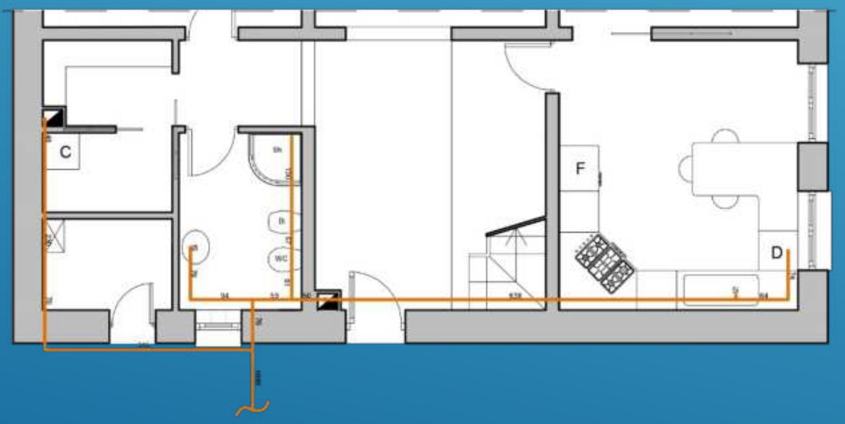
GENERAL PLAN


1234
912
C
F
D
Boiler
Cold Water
Hot Water
Waste Water
Storm Water
0
1m
2m
5m

FIRST FLOOR







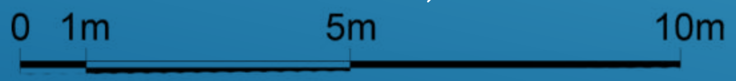
Boiler

Cold Water

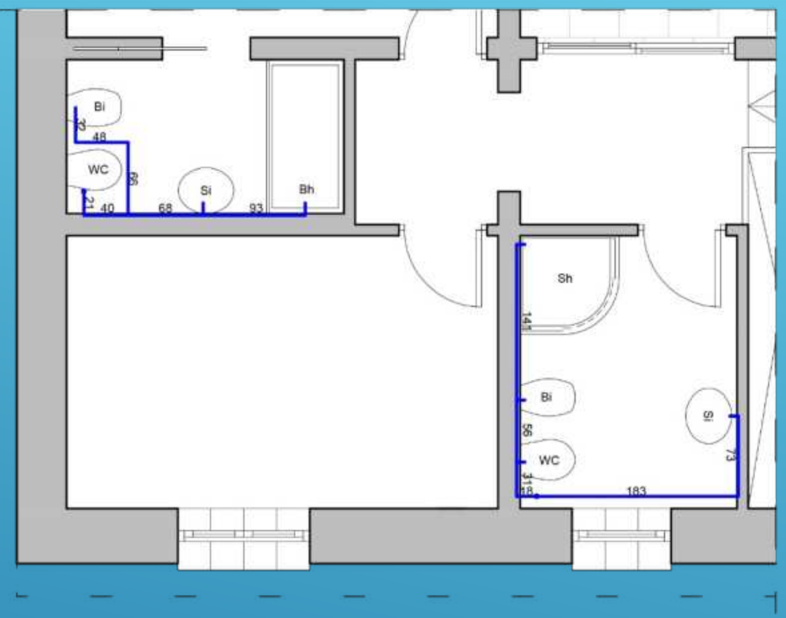
Hot Water

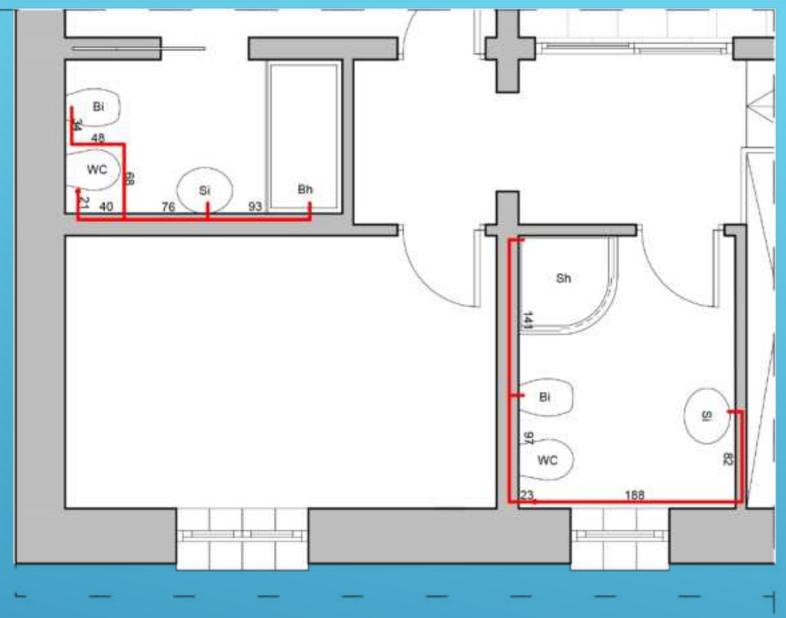
Waste Water

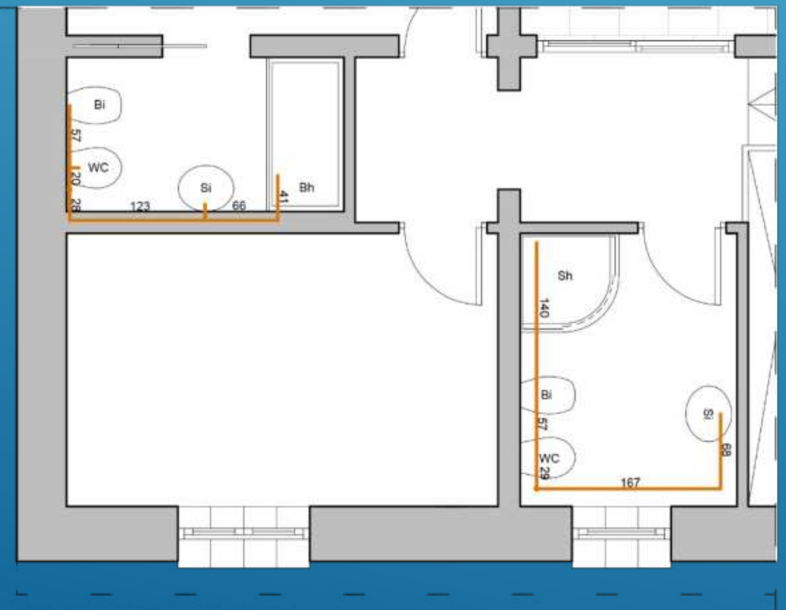
FIRST FLOOR



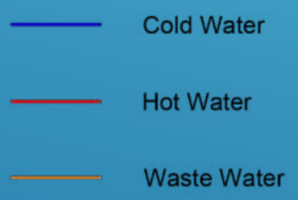
SECOND FLOOR

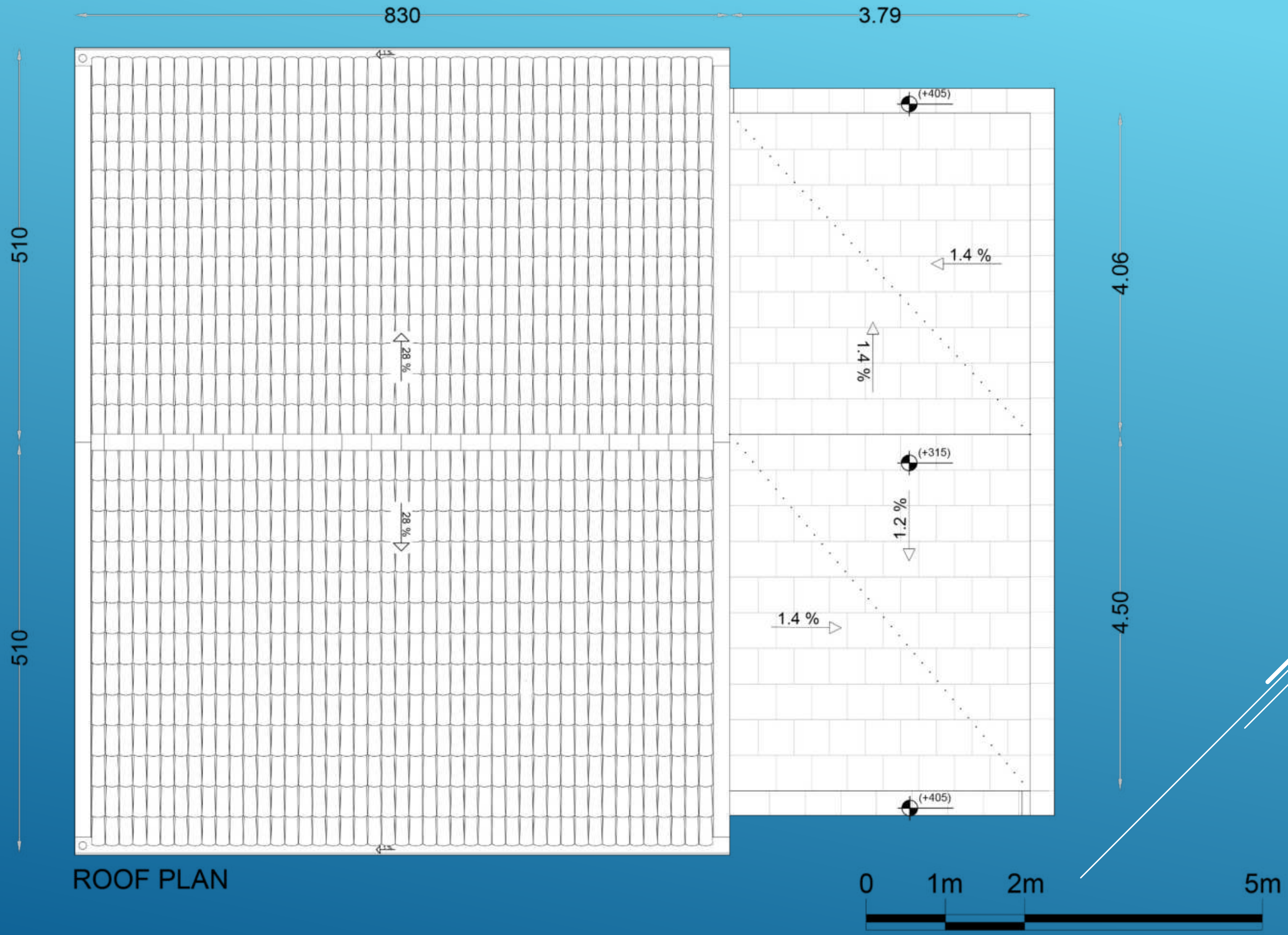




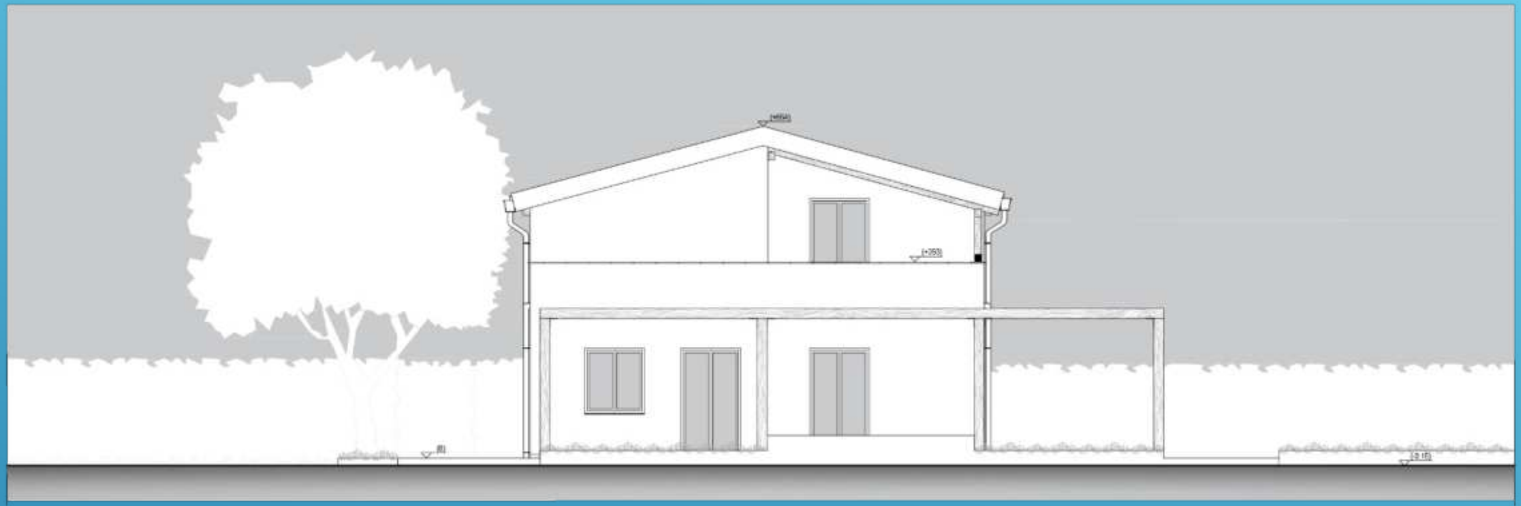


SECOND FLOOR

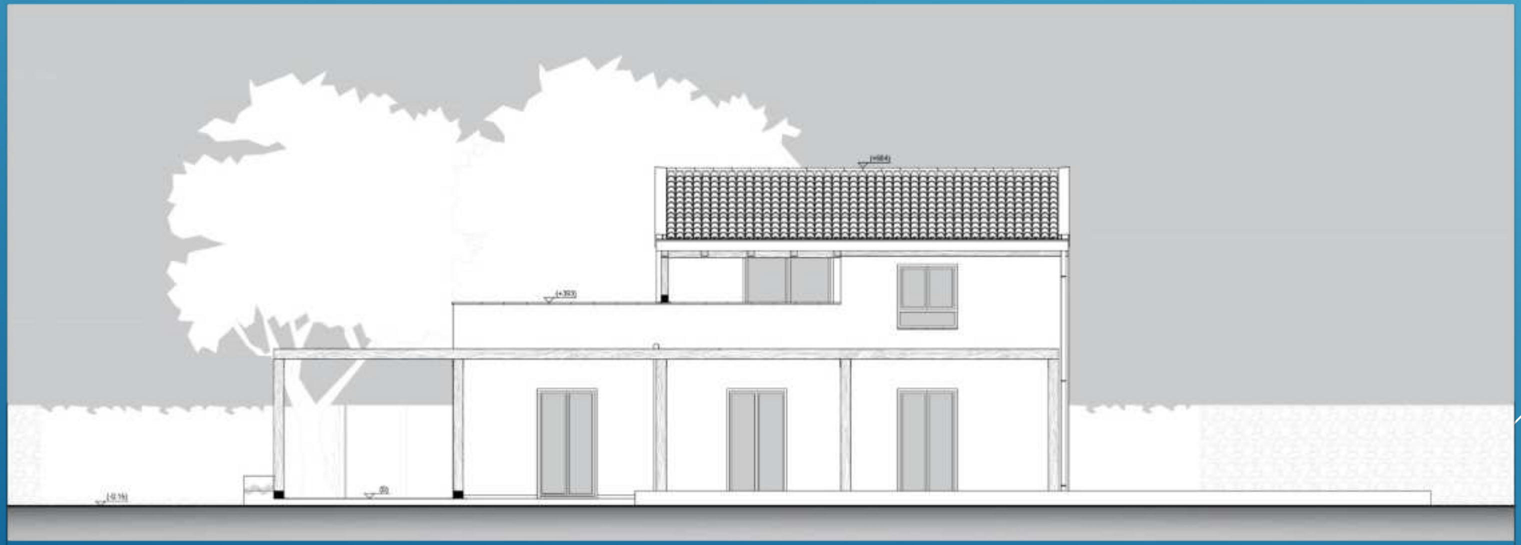




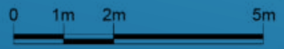
ROOF PLAN

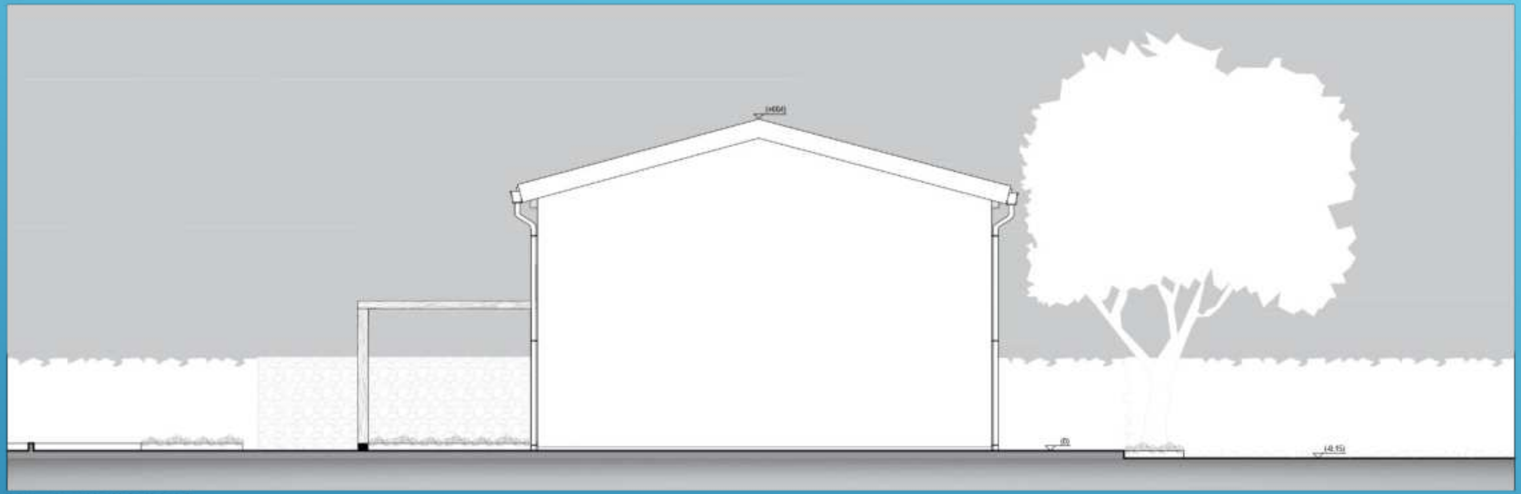


EAST FACADE

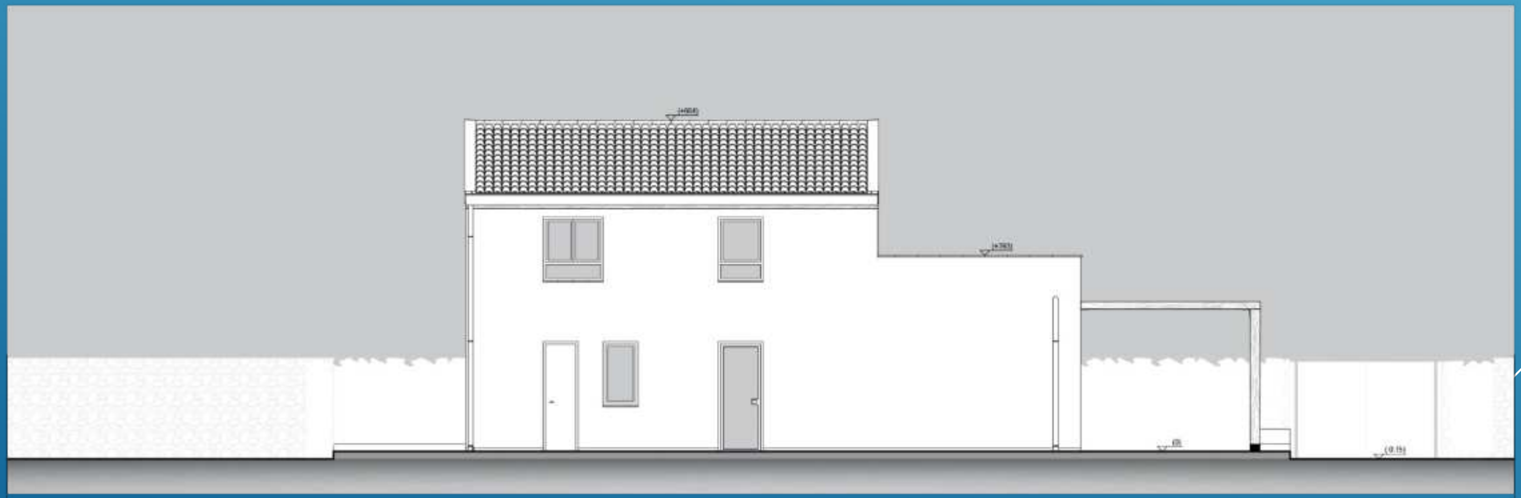


NORTH FACADE

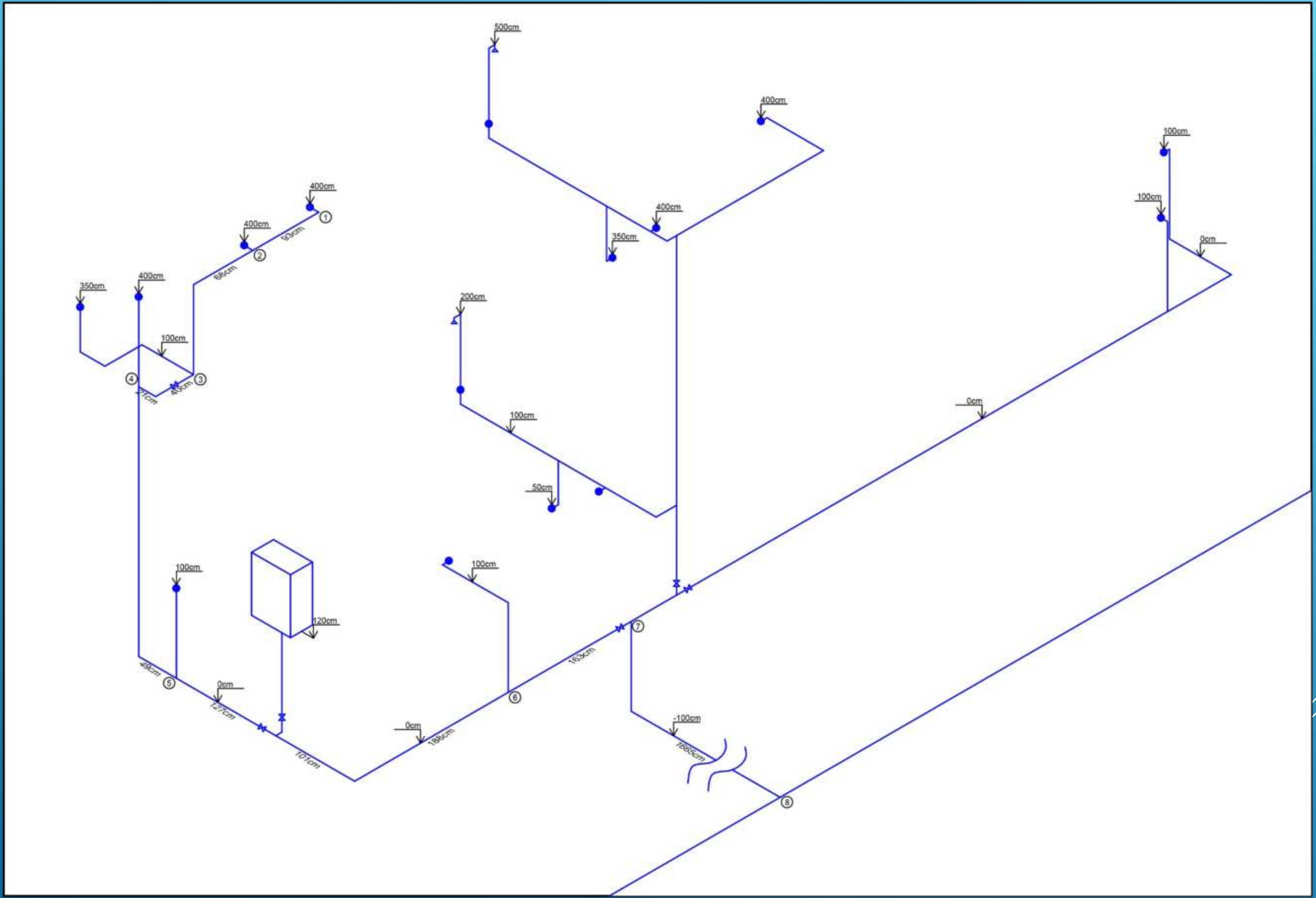




WEST FACADE



SOUTH FACADE



COLD WATER AXONOMETRY

Cold water supply

Probability of cold water is:

here:

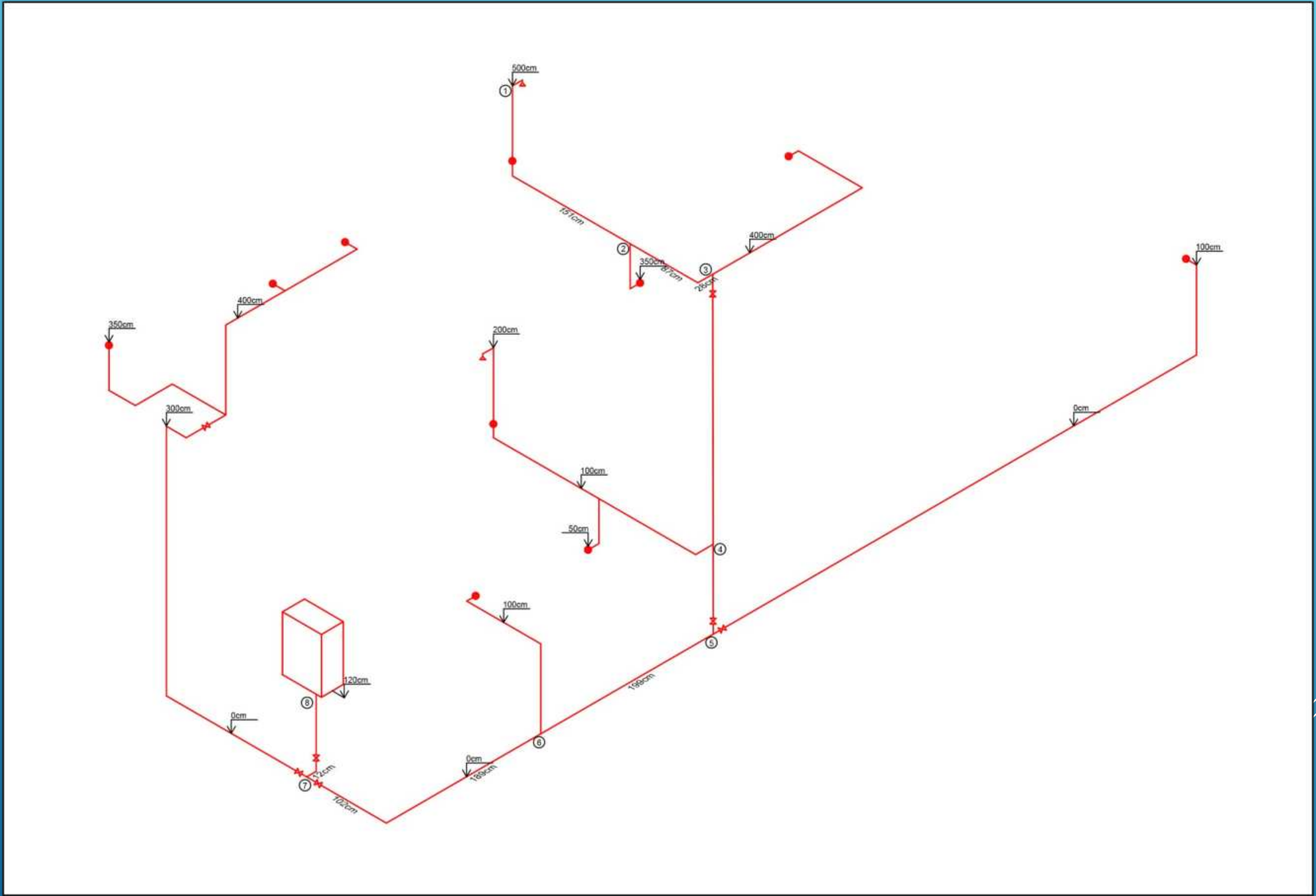
- ***N*** is number of total taps;
- is number of inhabitans;
- is the water instantaneous flow rate (L/s);
- is the cold water intake for maximum use per hour.

Sanitary appliances	Flow (L/s)
Handwash, shower, sink, WC, dishwasher, washing machine	0,12
Bath	0,18
Boiler	0,25

This is the cold intake for maximum use per hour in every section, here is a coefficient function found from a table.

COLD WATER CALCULATION

Section	NB Taps	(L/s)	P cold*N	a	q section (L/s)	d (mm)	v (m/s)	h (Pa/m)	L (m)	h*L (Pa)
1-2	1	0,18	0,0062	0,2	0,18	20	1,12	12	0,93	11,16
2-3	2	0,18	0,0124	0,2	0,18	20	1,12	12	1,68	20,16
3-4	3	0,18	0,0186	0,212	0,19	20	1,13	12,5	0,70	8,75
4-5	4	0,18	0.0248	0,226	0,20	20	1,15	13	3,49	45,37
5-6	5	0,25	0,0310	0,239	0,30	25	1,35	10,03	4,25	42,63
6-7	6	0,25	0,0370	0,250	0,31	25	1,36	10,04	1,56	15,66
7-8	15	0,25	0,0930	0,338	0,42	32	1,1	4,3	17,65	75,89
Total								73,87		219,62



HOT WATER AXONOMETRY

Hot water supply

Probability of hot water is:

here:

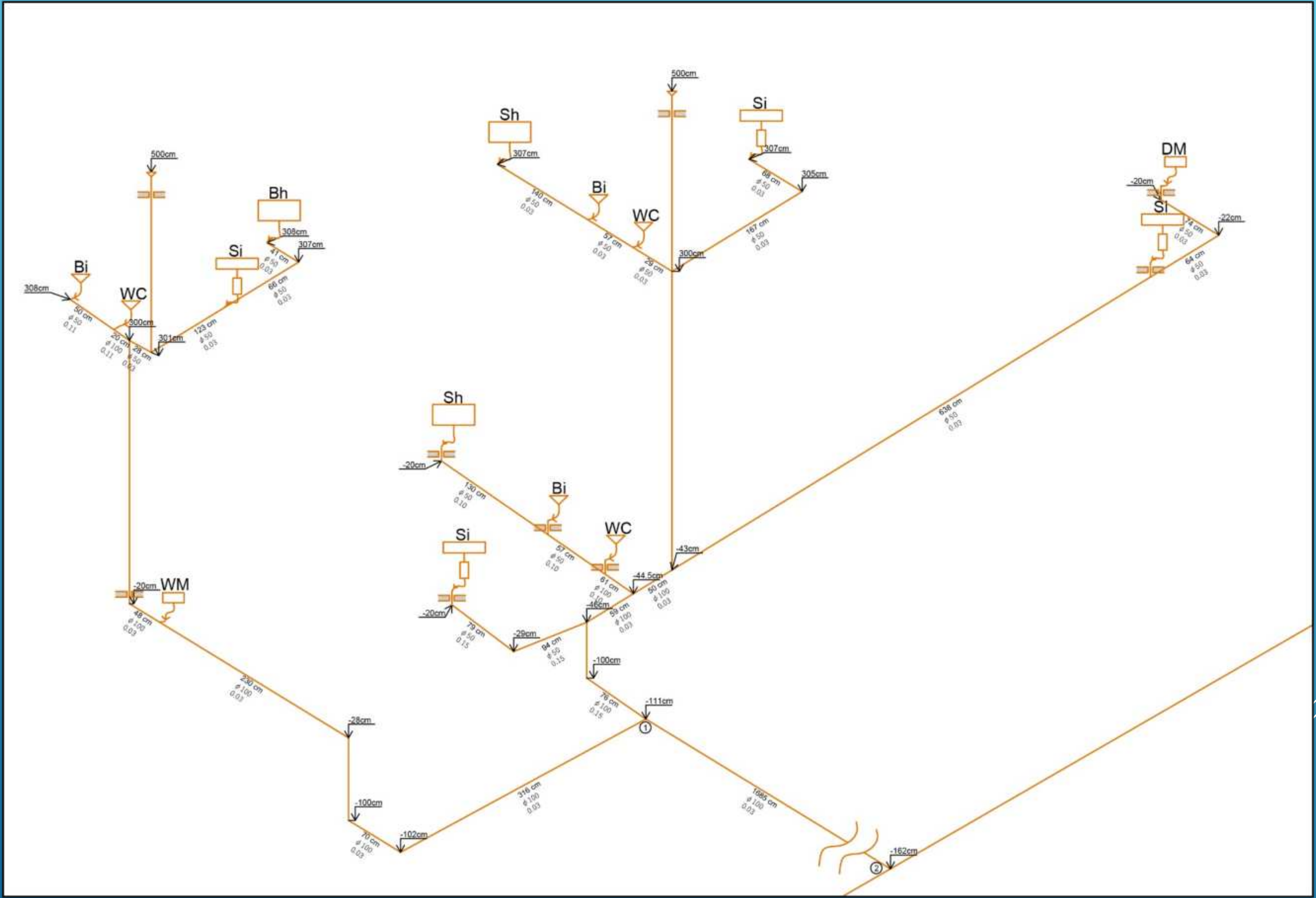
- ***N*** is number of total taps;
- is number of inhabitans;
- is the water instantaneous flow rate (L/s);
- is the hot water intake for maximum use per hour.

Sanitary appliances	Flow (L/s)
Handwash, shower, sink, WC, dishwasher, washing machine	0,12
Bath	0,18
Boiler	0,25

This is the hot intake for maximum use per hour in every section, here is a coefficient function found from a table.

HOT WATER CALCULATION

Section	NB Taps	(L/s)	P hot*N	a	q section (L/s)	d (mm)	v (m/s)	h (Pa/m)	L (m)	h*L (Pa)
1-2	1	0,18	0,0093	0,200	0,18	20	1,12	12	2,51	30,12
2-3	2	0,18	0,0186	0,212	0,19	20	1,13	12,5	1,15	14,38
3-4	3	0,18	0,0279	0,233	0,21	20	1,25	14,5	3,00	43,50
4-5	5	0,18	0,0465	0,268	0,24	25	1,20	9,0	1,00	9,00
5-6	6	0,18	0,0558	0,283	0,25	25	1,25	9,1	2,23	20,29
6-7	7	0,18	0,0651	0,301	0,27	25	1,30	9,5	3,00	28,50
7-8	10	0,18	0,0930	0,338	0,42	32	1,1	4,3	1,32	5,68
Total								69,9		151,47



WASTE WATER AXONOMETRY

Wastewater system

Probability of wastewater is:

here:

- ***N*** is number of total taps;
- is number of inhabitans;
- is the water instantaneous flow rate (L/s);
- is the hot water intake for maximum use per hour .

Sanitary appliances	Flow (L/s)
Handwash, shower, sink, WC, dishwasher, washing machine	0,12
Bath	0,25

q section (s)
is: sink = 0,6 (L/s), bath = 0,8 (L/s), WC = 1,6 (L/s).

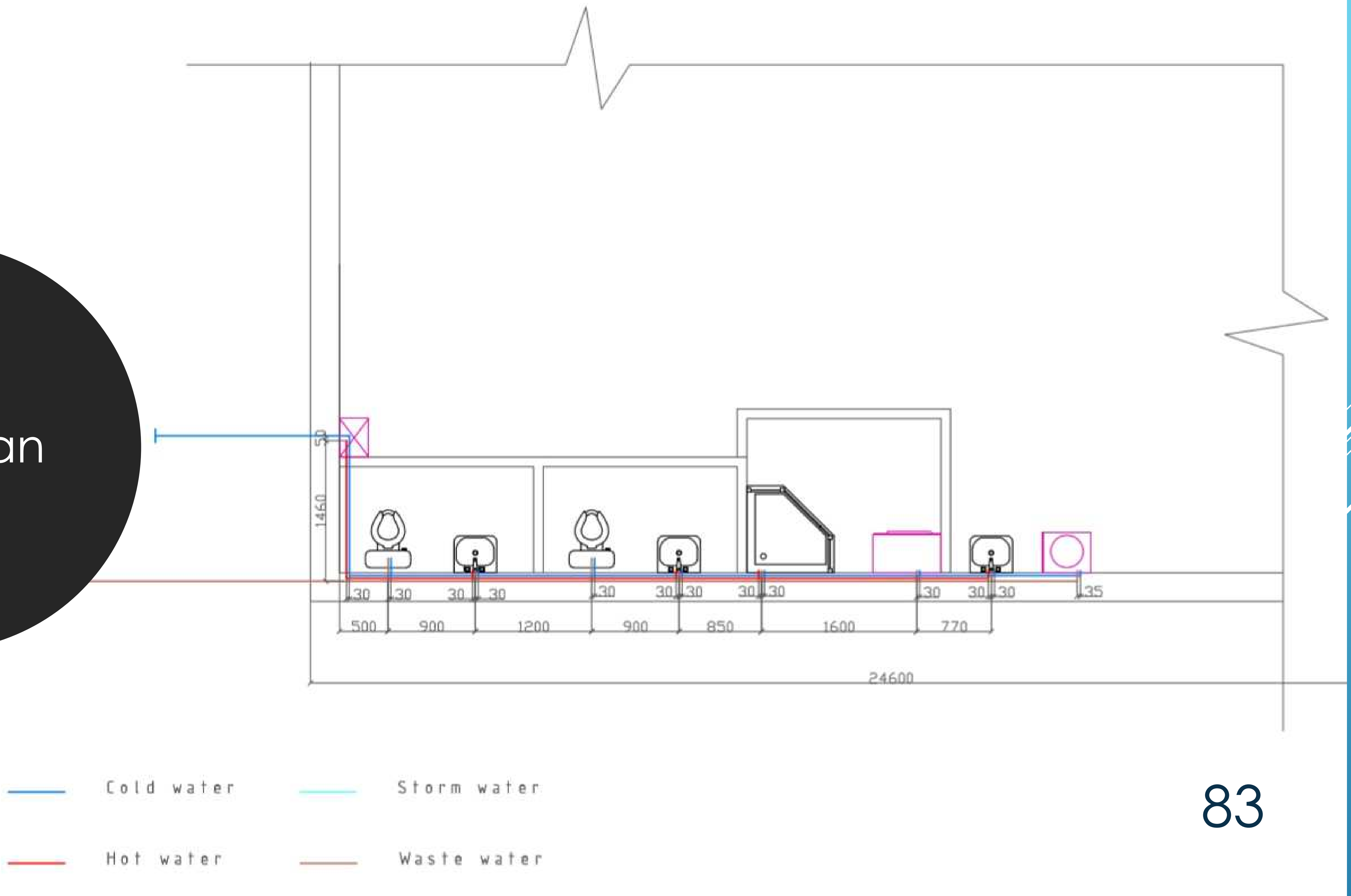
is the hot intake for maximum use per hour in every section, here is a coefficient function found from a table.

q tot = q section + q section (s)
is daily flow rate.

WASTEWATER CALCULATION

Section	NB Taps	(L/s)	P waste*N	a	q section (L/s)	q section (s) (L/s)	q tot (L/s)	d (mm)	v (m/s)	Pendence i	h/d	L (m)	h=i*L (m)
1-2	15	0,25	0,0926	0,336	0,420	1,6	2,020	100	0,870	0,030	0,33	16,850	0,506

Main Plan



50
1460
30
30
30
30
30
30
30
30
30
30
30
30
35
500
900
1200
900
850
1600
770
24600
Cold water
Storm water
Hot water
Waste water

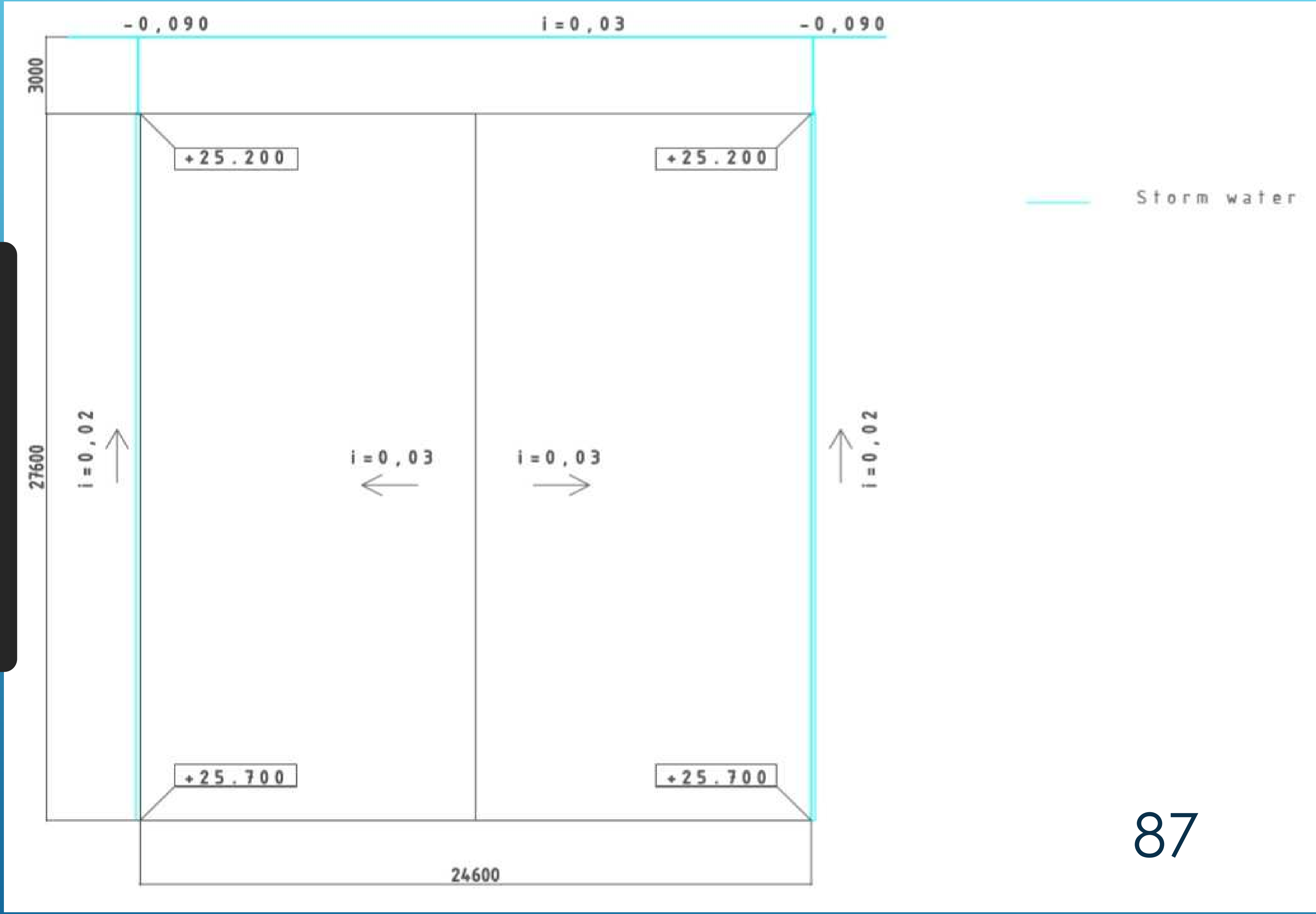
COLD WATER CALCULATIONS

Sections	N	q (L/s)	P	N*P	a	q(max)	d (mm)	V (max)	Pressure losses	L (m)	i (pressure losses in pipeline
1-2	1	0,1		0,0514	0,276	0,138		0,42	120,4	1,47	177,0
2-3	2	0,1		0,103	0,349	0,175		0,55	192	0,77	147,8
3-4	3	0,1		0,154	0,405	0,203		0,61	233	1,6	372,8
4-5	4	0,1		0,206	0,458	0,229		0,685	298,25	0,85	253,5
5-6	5	0,1	0,05144	0,257	0,502	0,251	20	0,765	363,5	0,9	327,2
6-7	6	0,1		0,309	0,542	0,271		0,835	428,75	1,2	514,5
7-8	7	0,1		0,360	0,58	0,29		0,91	494	0,9	444,6
8-9	8	0,1		0,412	0,617	0,309		0,91	494	1,45	716,3
9-10	9	0,12		0,463	0,645	0,387		1,22	842	8,2	6904,4
											9858,1

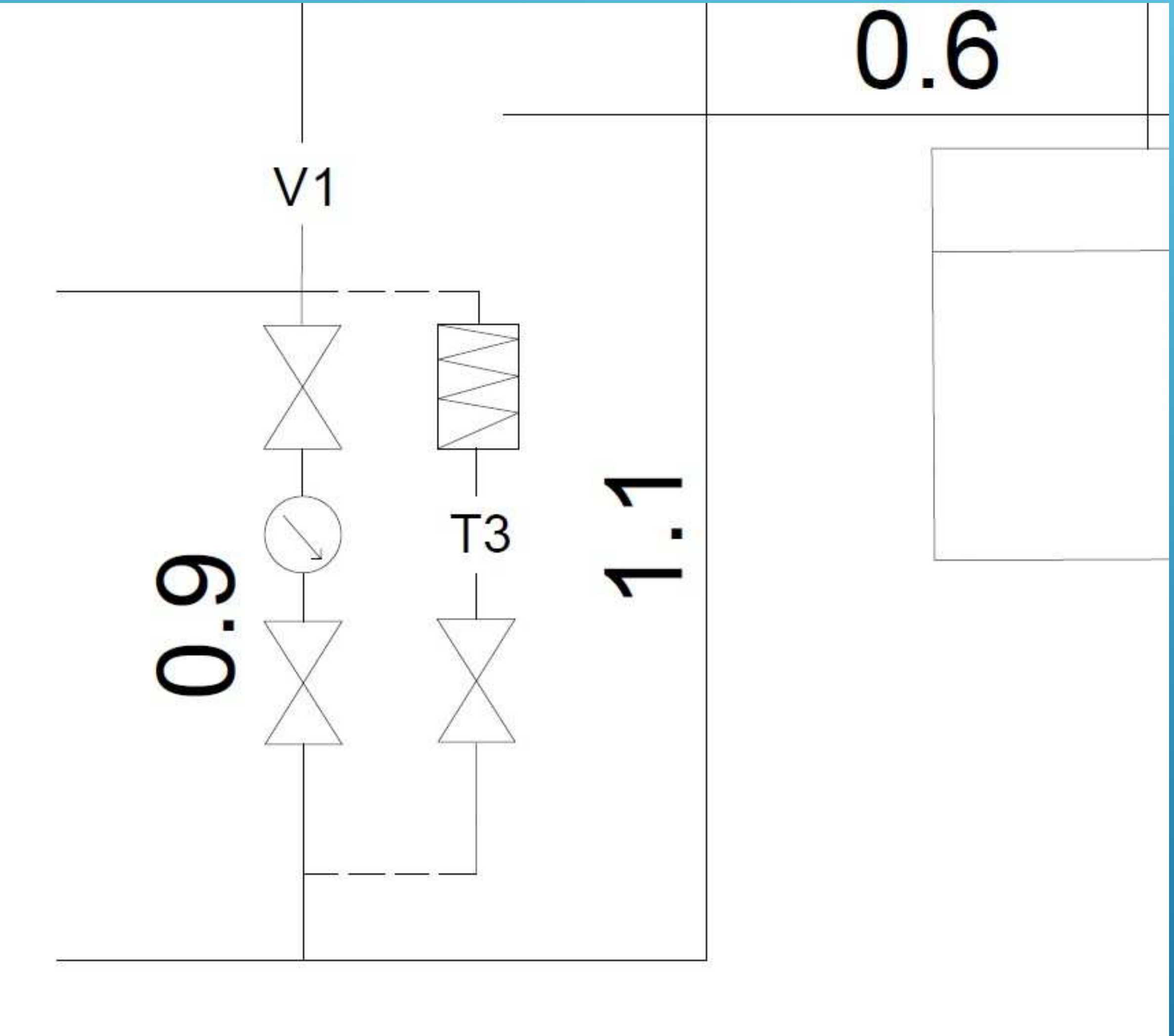
Sections	N	q (L/s)	P	N*P	a	q(max)	d (mm)	V (max)	Pressure losses	L (m)	i (pressure losses in pipeline
1-2	1	0,09	0,115741	0,116	0,361	0,162	20	0,48	154,4	2,45	378,28
2-3	2	0,09		0,231	0,476	0,214		0,61	233	0,85	198,05
3-4	3	0,09		0,347	0,573	0,258		0,765	363,5	2,1	763,35
4-5	4	0,09		0,463	0,645	0,29025		0,91	494	3,93	1941,42
											3281,1

Sections	taps N	q	P	p*N	a	q(max)	Q	Q+qmax	d	i	h\d	v	L	L*i
1-2	1	0,12	0,05144	0,05144	0,276	0,1656	0,15	0,3156	0,05	0,05	0,3	0,65	0,885	0,044
2-3	2	0,12	0,05144	0,102881	0,343	0,2058	0,15	0,3558	0,05	0,05	0,3	0,68	0,77	0,039
3-4	3	0,12	0,05144	0,154321	0,405	0,243	0,15	0,393	0,05	0,05	0,4	0,7	1,6	0,080
4-5	4	0,12	0,05144	0,205761	0,449	0,2694	0,15	0,4194	0,05	0,05	0,4	0,72	0,85	0,043
5-6	5	0,12	0,05144	0,257202	0,493	0,2958	0,15	0,4458	0,05	0,05	0,4	0,74	0,9	0,045
6-7	6	0,12	0,05144	0,308642	0,542	0,3252	1,6	1,9252	0,1	0,045	0,2	1,52	1,2	0,054
7-8	7	0,12	0,05144	0,360082	0,58	0,348	1,6	1,948	0,1	0,05	0,2	1,62	0,9	0,045
8-9	8	0,12	0,05144	0,411523	0,617	0,3702	1,6	1,9702	0,1	0,05	0,2	1,63	0,46	0,023
9-10	8	0,12	0,05144	0,411523	0,617	0,3702	1,6	1,9702	0,1	0,05	0,2	1,63	1	0,05
10-11	8	0,12	0,05144	0,411523	0,617	0,3702	1,6	1,9702	0,1	0,05	0,2	1,63	3	0,15

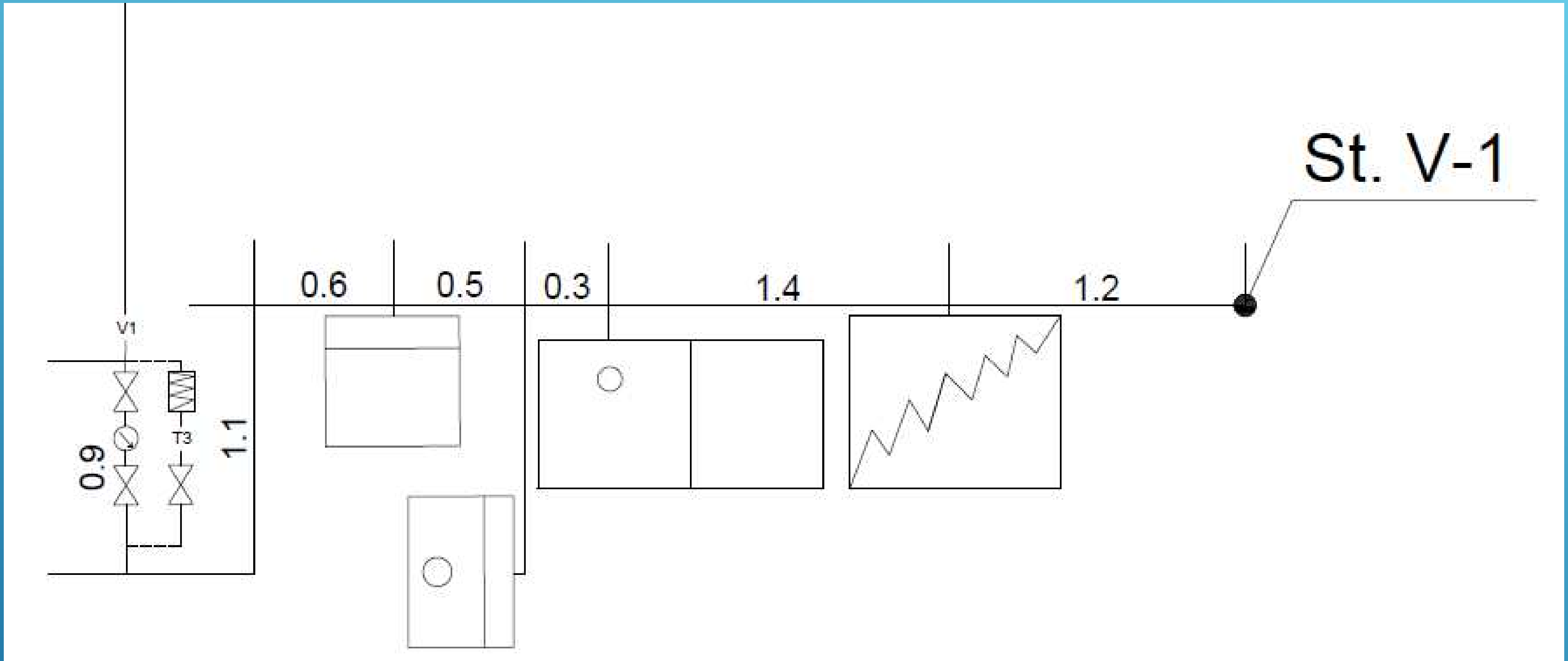
STORM WATER



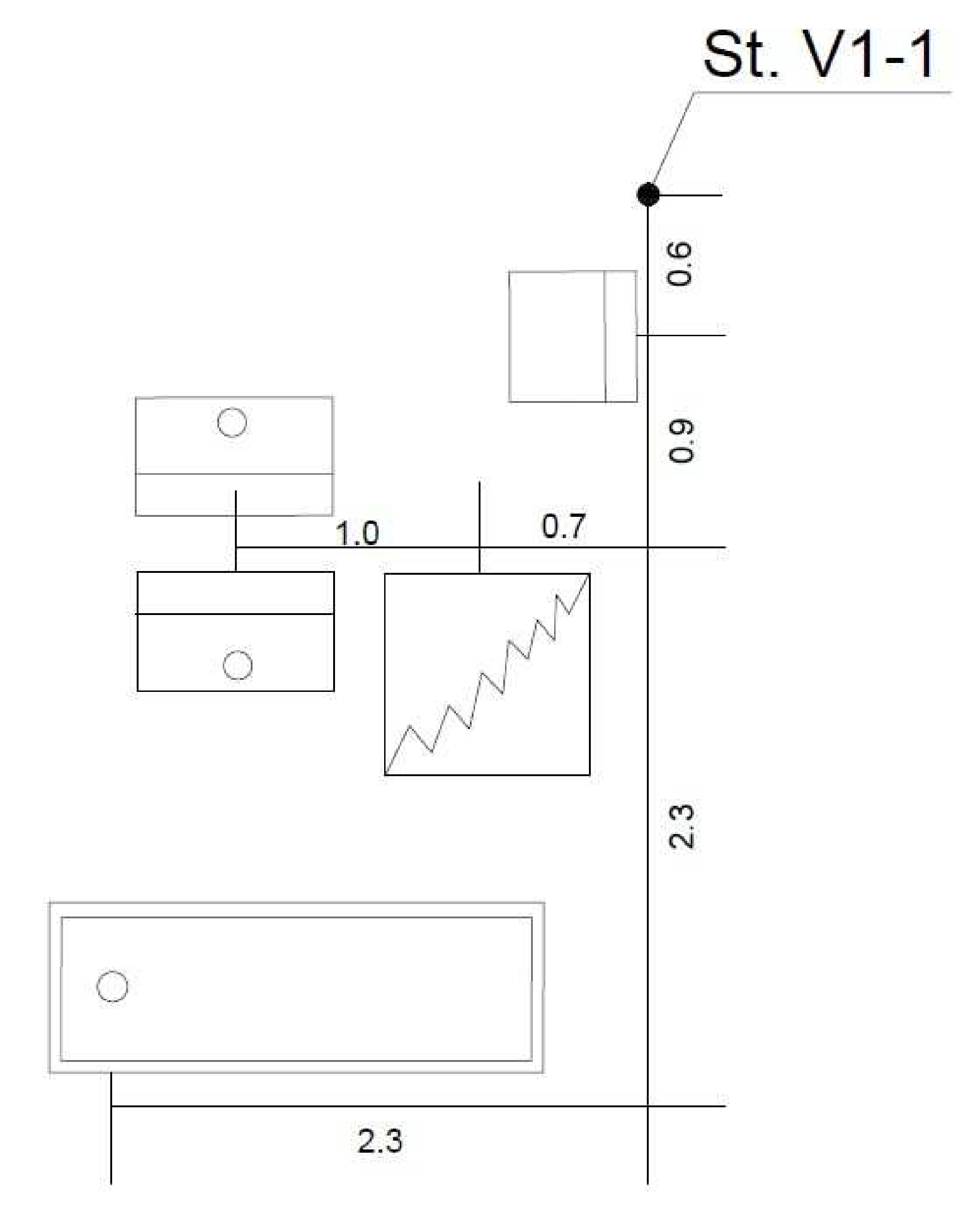
-0,090
i=0,03
-0,090
3000
+25.200
+25.200
Storm water
27600
i=0,02
i=0,03
i=0,03
i=0,02
+25.700
+25.700
24600



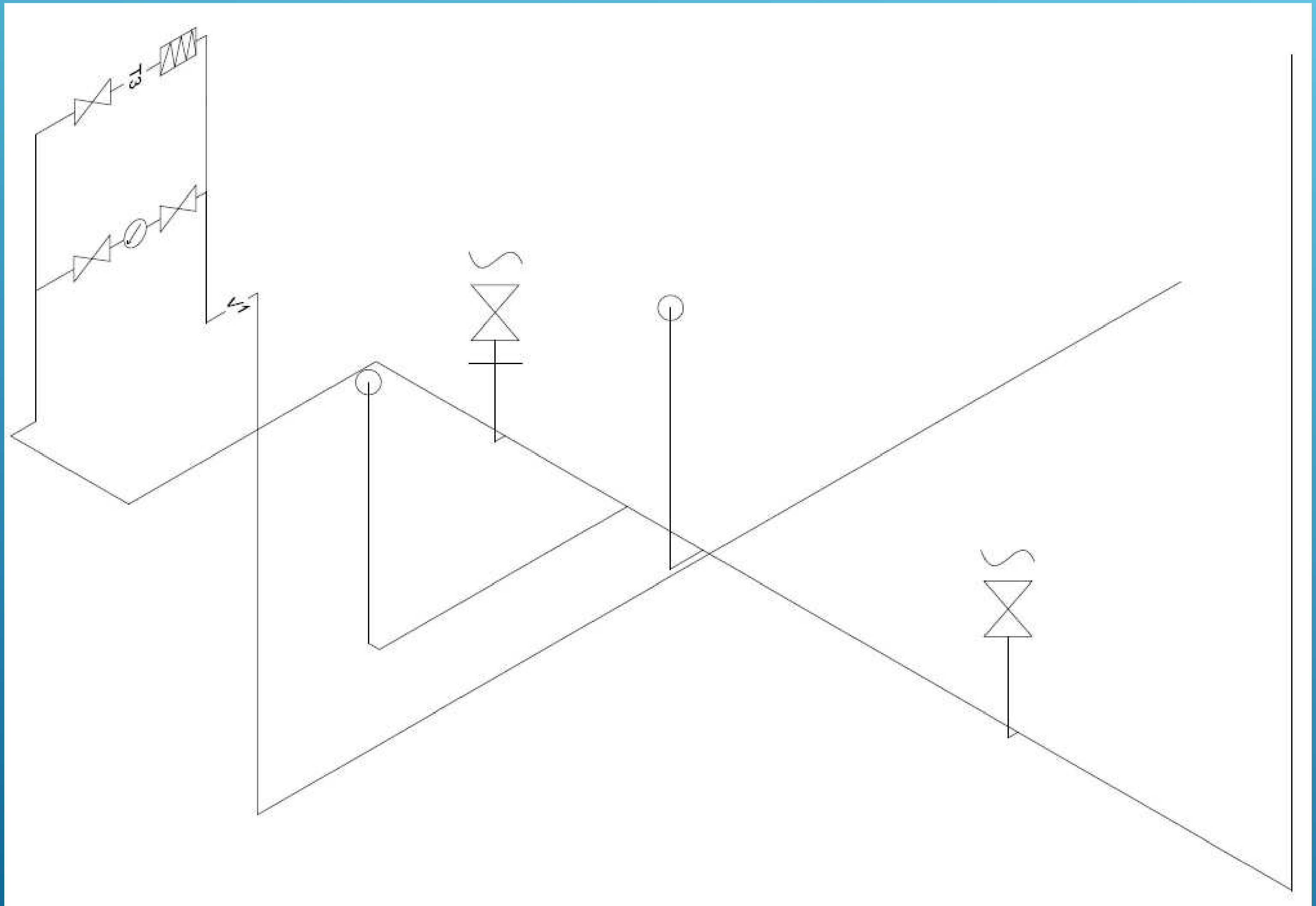
MAIN WATER SUPPLY HEATING SYSTEM



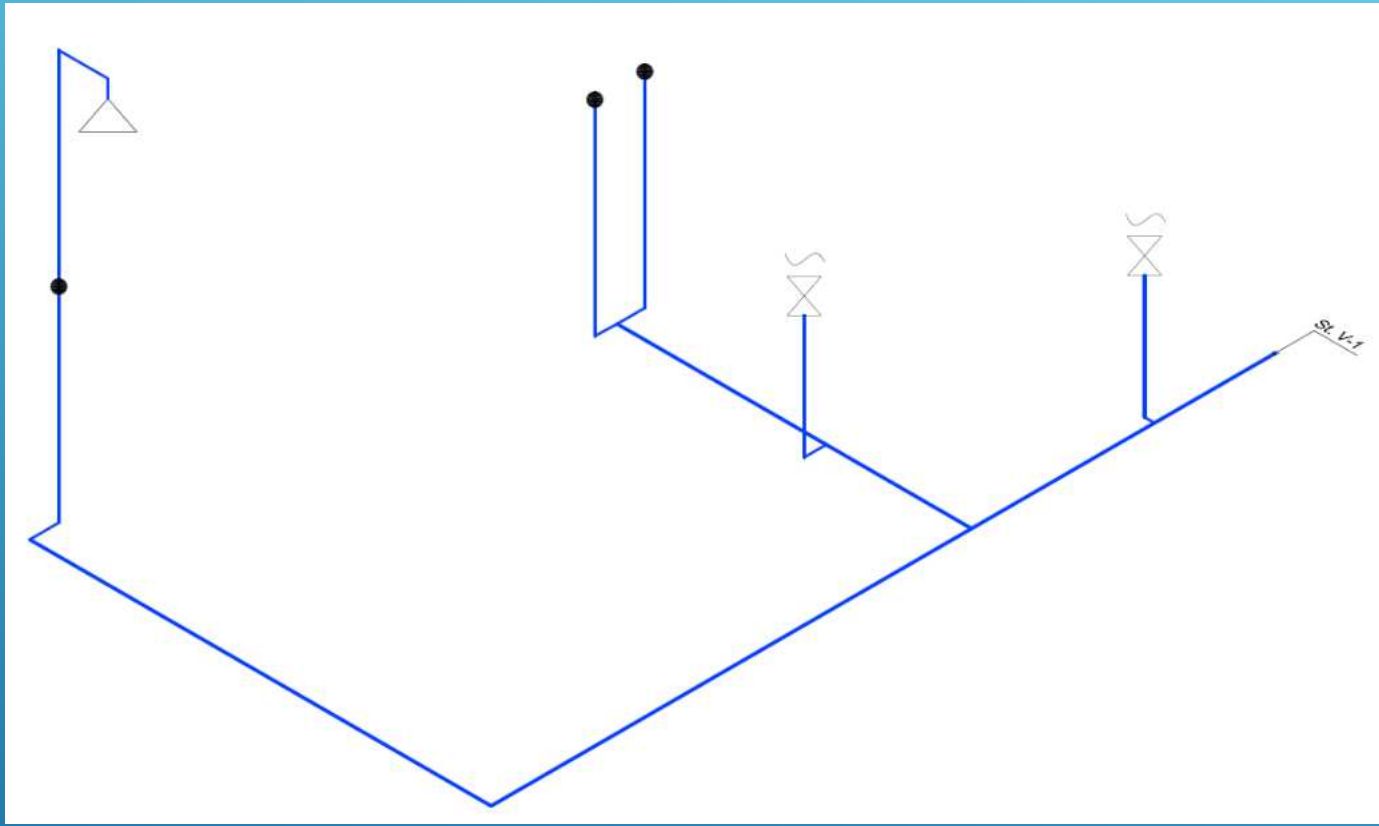
GROUND FLOOR



FIRST FLOOR



3D VIEW GROUND FLOOR



3D VIEW SECOND FLOOR

- Domestic and industrial wastewater sources;
- grey and black wastewater.
- Different network for run-off water and nature based solutions.

MAIN WASTEWATER SEWERAGE SYSTEMS

Wastewater and Sludge Management

Wastewater pollution, flow calculation

the end

flow

type

source

introduction

Wastewater (or waste water) is any water that has been contaminated by human use. Wastewater is "used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff or stormwater, and any sewer inflow or sewer infiltration".

Source of waste water pollution

01

INDUSTRIAL

02

HOUSEHOLD

03

OTHER

the end

flow

type

source

introduction

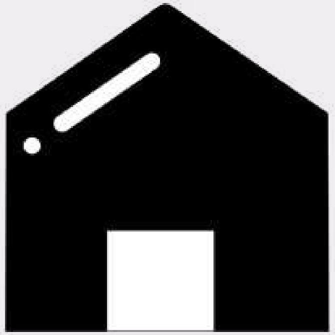
INDUSTRIAL

In the industrial production process to consume a large amount of fresh water, discharge a large number of waste water, which entrained many raw materials, intermediate products or finished products, such as heavy metals, toxic chemicals, acid and alkali, organic matter, oil, suspended matter, etc.

Different industries, different products, different processes and different raw materials, such as the discharge of wastewater quality, the amount of water is very different.

Therefore, industrial wastewater has the characteristics of wide area, large quantity, complex composition, high toxicity, and is not easy to purify and treat.

HOUSEHOLD



Wastewater contains a large amount of organic matter (70%), pathogenic bacteria and parasite eggs, discharged into water body or seep into the underground will cause serious pollution, sewage water quality of the material is relatively regular changes, water changes into the regular season, as the growth of the urban population and the change of the diet, the water will continue to increase, water quality ingredients will also change.

the end
flow
type

OTHER

Rain and snow water wash toxic pollutants in the atmosphere and wash pollutants on the ground before entering water bodies;

The water bodies are seriously polluted by the runoff of rural sewage, such as pesticides and fertilizers applied in farmland and livestock dung.

This kind of sewage has the characteristics of wide area, scattered, difficult to collect and difficult to treat.

source
introduction

At present, there are several types of wastewater pollution worthy of attention

Pathogen contamination

Aerobic pollution

Pollution of plant nutrients

Oil pollution

Thermal pollution

Radioactive contamination

Pollution by toxic compounds

Acid, alkali and salt pollution

Waste waterflowrate (Q_{ww})

Q_{ww} *is the expected flowrate ofwaste waterin a part or in the whole drainage system where only domestic sanitary appliances (see Table 2) are connected to the system.*

$$Q_{ww} = k\sqrt{\sum DU}$$

where:

Q_{ww} = *Waste waterflowrate* (l/s)

K = *Frequency factor*

$\sum DU$ = *Sum of discharge units*

EN 12056-2

Total flowrate (Q_{tot})

Q_{tot} is the design flowrate in a part or in the whole drainage system where sanitary appliances, appliances with continuous flow and/or waste water pumps are connected to the system. Continuous flows and pump discharge rates shall be added to the waste water flowrate without any reduction.

$$Q_{tot} = Q_{ww} + Q_c + Q_p$$

where:

Q_{tot} = Total flowrate (l/s)

Q_{ww} = Waste water flowrate (l/s)

Q_c = Continuous flowrate (l/s)

Q_p = Pumped water flowrate (l/s)

EN 12056-2:2000

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Wastewater mechanical and chemical treatment

According to the concentration, nature and flocculation performance of suspended particles in wastewater, precipitation phenomena can be divided into the following types:

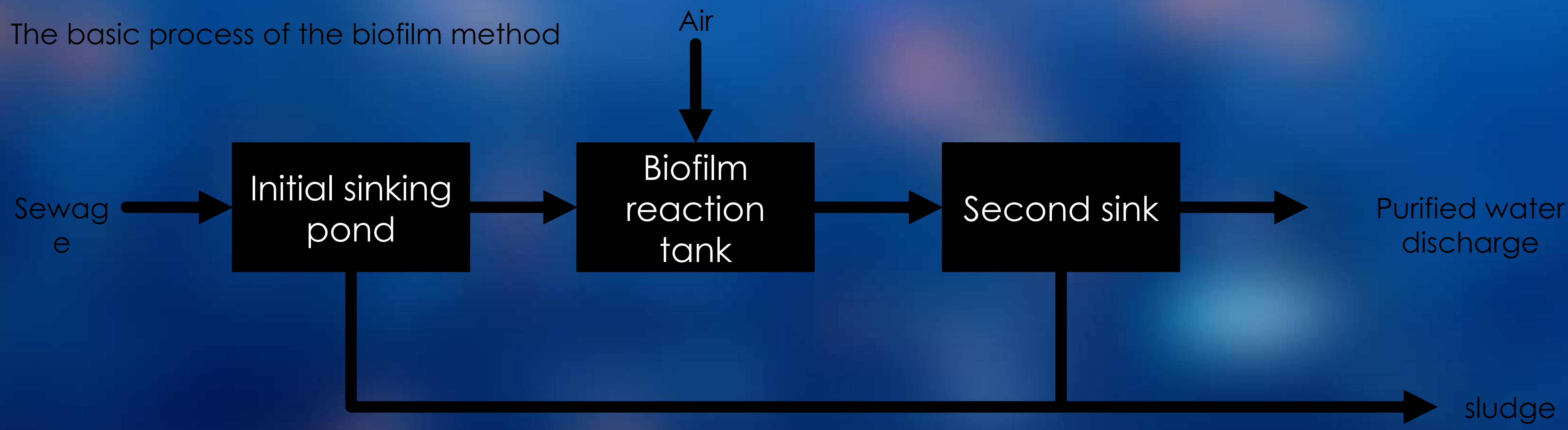
1. Free sedimentation
2. Flocculation sedimentation
3. Crowded sedimentation
4. Compression sedimentation

Biological wastewater treatment

The biofilm method and activated sludge method are mostly aerobic biological methods. The biofilm method utilizes the metabolism of fixed-growing microorganisms-biofilm to remove organic matter. There are two types: anaerobic and aerobic.

The biofilm method is mainly suitable for the treatment of dissolved organic matter. After the sewage is in contact with the biofilm, the dissolved organic matter and a small amount of suspended matter are adsorbed and degraded by the biofilm into stable inorganic substances (CO_2, H_2O, etc.). This is the basic principle of the biofilm method to remove organic matter.

The basic process of the biofilm method



The basic process of the biofilm method is shown in the figure. The sewage enters the biofilm reaction tank after removing suspended matter through the sedimentation tank to remove organic matter. The effluent from the biofilm reaction tank enters the secondary sedimentation tank to remove the fallen organisms, and the clarified liquid is discharged. After the sludge is concentrated, it is transported away or further disposed of.

Wastewater treatment

1 **Biological filter**

2 **Biological turntable**

3 **Biological contact oxidation**

4 **Biological fluidized bed**

01 Biological tretament

According to the organic loading rate, the biological filter can be divided into three types: ordinary biological filter (low-load biological filter), high-load biological filter (reflux biological filter) and tower biological filter. The load rate of the municipal sewage biological filter is shown in the table

Biological filter type	BOD5 load rate/[kg/(m3·d)]	Hydraulic load rate/[m3/(m2·d)]	Processing efficiency/%
Low load	0.15~0.30	1~3	85~95
Reflow	< 1.2	< 10~30	75~90
Tower	1.0~3.0	80~200	65~85

Biological filter

Influencing factors of biological filter performance

The height of the filter bed, load rate, reflux ratio and oxygen supply have a significant impact on the working performance of the filter.

(1) Filter

When treating urban sewage, the economic height of the ordinary biological filter is 2.0-3.0m, and the economic height of the tower filter is 7-10m.

01 Biological filter

Influencing factors of biological filter performance

(2) Load rate

There are two ways to express the loading rate of the biological filter, namely, the organic loading rate and the hydraulic loading rate.

①Organic load rate

Choose according to the table

Biological filter type	BOD5 load rate/[kg/(m3·d)]	Hydraulic load rate/[m3/(m2·d)]	Processing efficiency/%
Low load	0.15~0.30	1~3	85~95
Reflow	＜1.2	＜10~30	75~90
Tower	1.0~3.0	80~200	65~85

②Hydraulic load rate

When treating urban sewage, the suitable area hydraulic load of the ordinary biological filter is 1 ～ 4m3/(m2·d), and the high-load biological filter is 10 ～ 30m3/(m2·d).

01 Biological filter

Influencing factors of biological filter performance

Reflow

The reflux ratio is related to the concentration of raw sewage, the reflux ratio under different concentrations is shown in the table.

Influent BOD5/(mg/L)	< 150	150~300	300~450	450~600	600~750	750~900
First level	0.75	1.50	2.25	3.00	3.75	4.50
Level 2 (all levels)	0.5	1.0	1.5	2.0	2.5	3.0

01 **Biological filter**

Influencing factors of biological filter performance

Oxygen supply

Whether natural ventilation can meet the needs of biochemical reactions is also related to the concentration of influent organic matter. When the organic matter concentration is low, the oxygen demand is small, and natural ventilation can meet the requirements; when the organic matter concentration is high, the oxygen demand is large, and the oxygen supply is prone to insufficient. For this reason, often control BOD≤200mg/L. If BOD>200mg/L, use reflux water to dilute and flush the biofilm, add dissolved oxygen or use forced ventilation.

Biological filter

Design of biological filter

$$V = \frac{c_{s0}Q}{N_V}$$

V——filter bed volume,
——Concentration of influent organic matter,
Q——filter inlet water flow rate, ;
——Volume organic load rate, or

01 Biological filter

Design of biological filter

b. Filter bed height The filter bed height is generally determined by experiment or experience. Ordinary biological filter is about 2.0m; the first stage of the two-stage return biological filter is about 1.5~2.0m, and the second stage is about 1.0m; the diameter of the tower biological filter is 1~3.5m, the height is more than 8m, and the diameter is 6 ~ 8 times, adopting multi-layer structure, each layer is 2.0m, and the gap height between upper and lower layers is 200-400mm.

01 Biological filter

Design of biological filter

c. Filter bed area The following formula can be used to calculate the filter bed area.

[redacted]

A——filter bed area,;
V——filter bed volume, ;
H——The height of the filter bed,m.
The diameter of the biological filter is generally below 35m, and the maximum diameter is 60m.

d. Check the filtration rate After calculating the area of the filter bed, check whether the area organic load rate and area hydraulic load rate are reasonable.

01 Biological filter

Design of biological filter

②Area organic loading rate method

a. Filter bed area

[redacted]

——Area organic load rate, or))

A——filter bed area,;

——Concentration of influent organic matter,

Q——filter inlet water flow rate, ;

01 Biological filter

Design of biological filter

b. Filter bed height The determination of the filter bed height is the same as before (volume organic loading rate method).

c. Filter bed volume

[redacted]

d. Check whether the volumetric organic load rate and area hydraulic load rate are within the appropriate range.

01 Biological filter

1.4 Design of biological filter

③Area hydraulic load rate method

a. Filter bed area

[redacted]

area hydraulic load rate,

b. Filter bed height and volume: the determination method and calculation method are the same as before (area organic loading rate).

c. Check: Check whether the volumetric organic load rate and area organic load rate are within the appropriate range.

01 Biological filter

1.4 Design of biological filter

①Number and diameter of horizontal pipes: The number of horizontal pipes for water distribution depends on the diameter of the pool surface and the amount of water. Use 4 sticks when the amount of water is large, generally use 2 sticks. The diameter (D) of the water distribution pipe can be calculated by the following formula:

[redacted]

D——diameter of water distribution horizontal pipe, m;

Q'——Flow rate at the water inlet end of each horizontal pipe, m/s;

u——The flow velocity at the water inlet end of the horizontal pipe, m/s; generally u≤1.0m/s.

01 Biological filter

1.4 Design of biological filter

②The number of outlets is the same as the service area of each outlet at the position on the horizontal pipe, then the number of outlets (n) is:

[redacted]

n——the number of orifices on each horizontal pipe, one;

l'——The distance between the center of the n-th hole from the center of the pool and the free end of the horizontal tube, generally l'≥40mm;

D'——The span of the water distributor, mm, 200mm smaller than the diameter of the filter bed.

Evaluation of biodegradability

The bioaturation of sewage is often evaluated by the ratio of BOD5 to COD. 5 day biochemical oxygen demand BOD5 roughly represents the content of biodegradable reduced substances (mainly organic matter), chemical oxygen demand COD roughly represents the total amount of reduced substances (mainly organic matter). By

$$(BOD5/COD)=(1/m)*(CODB/COD)$$

(CODB) is the biodegradable reduced substance content) known, BOD5/COD as a proportion of the biodegradable part (CODB/COD) and biodegradable velocity (1/m) of the product, can roughly represent the degree and speed of biodegradable substances, that is, the biochemicality of sewage. In general, the larger the BOD5/COD value, the stronger the bioaturation of sewage, the specific evaluation standard reference table.

BOD5/COD	**< 0.3**	**0.3~0.45**	**> 4.5**
Biodegradability	Difficult biochemical	Biochemical	Easily biochemical

Natural, semi-natural (extensive) technologies for biological wastewater treatment

1. Natural
2. Semi-natural

Natural

Natural biological treatment of sewage

The process of removing pollutants by self-purification of the environment is called natural biological treatment of sewage.A natural biological treatment system that uses the self-purification of water to remove pollutants is called a stabilization pond, and a natural biological treatment system that uses the self-purification of soil to remove pollutants is called a land treatment system.

1 **Stabilization pond**

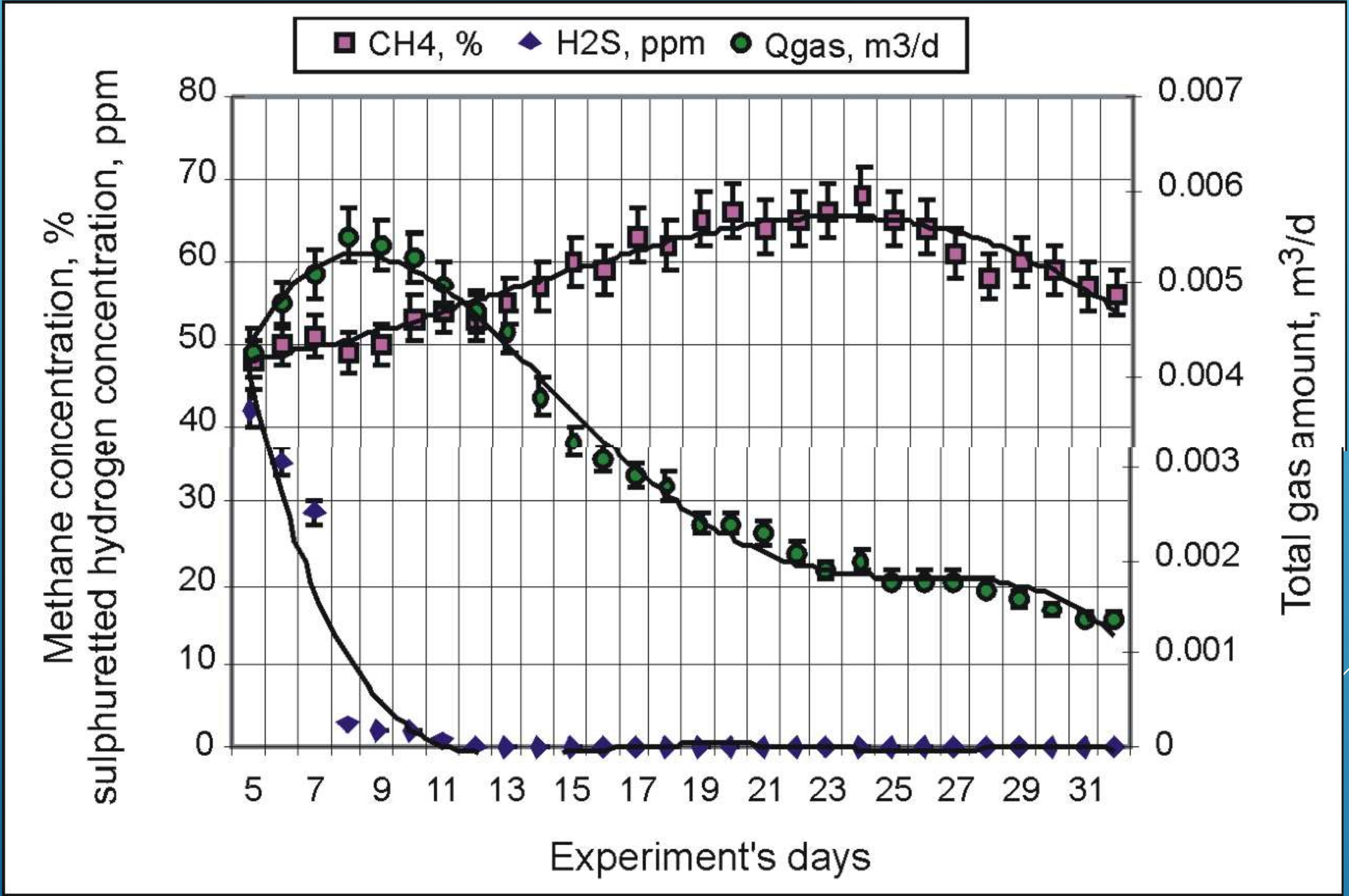
2 **Land treatment system**

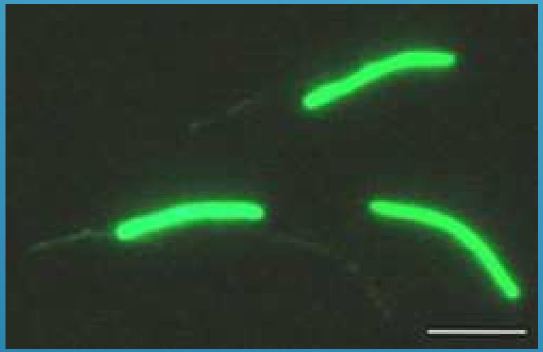
Natural

Stabilization pond

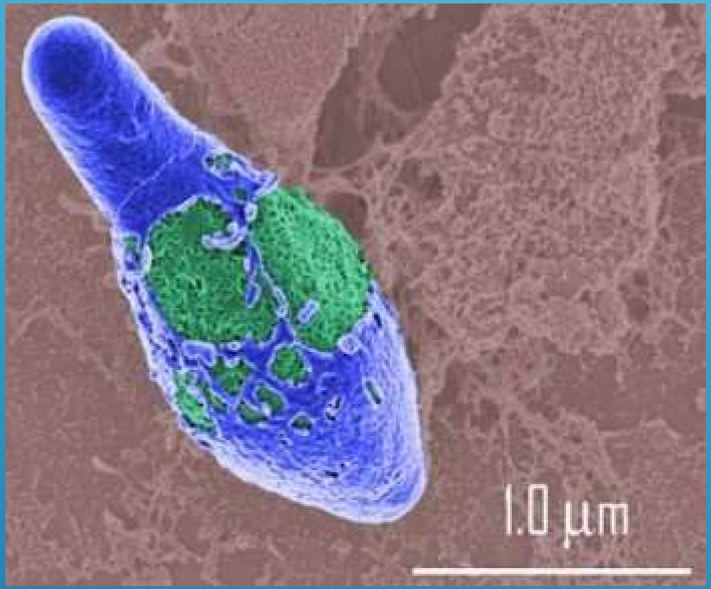
1. Aerobic Pond
2. Facultative pond
3. Anaerobic pond
4. Aeration pond

SLUDGE TREATMENT , BIOGAS PRODUCTION





Methanothermobacter thermoautotrophicus



Clostridium (anaerobic)

BIOMASS PROCESSES (KG/KG OF TREATED SLUDGE)

- Hydrogen 1,04;
- hydrocarbons 0,23;
- proteins 0,13;
- lipids 0,42.

European Standard EN 805:2000 Water supply. Requirements for systems and components outside buildings

William Kinninmond Burton. The Water Supply Of Towns And The Construction Of Waterworks: A Practical Treatise For The Use Of Engineers And Students Of Engineering. 2019.

European Standard EN 12201-1:2011 Plastics piping systems for water supply, and for drainage and sewerage under pressure.

European Standard EN8558:2015 Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages.

MAIN REFERENCES

Rev May. Plumbing design. 2018 .

Regina Dube. Manual for plumbers, urban sanitation. 2013.

European Standard EN 752 - Drain and sewer systems outside buildings.

European Standard EN 1295-1 - Structural design of buried pipelines under various conditions of loading.

Hong Li. Global Trends & Challenges in Water Science, Research and Management. 2016.

Result 5.2
Green Economy Study Modules

Study module A
Management & Technologies of the Water and Wastewater industry

Implementation Reports

Green Economy Study Modules

Implementation Report Training A

Operation and Maintenance of Wastewater Treatment Plants (WWTPs) and Industrial Wastewater Treatment Plants (IWTPs)

Prepared by:

AGBAR - Escuela del Agua

September, 2024

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Introduction

- Contextualisation within the overall project:

The training on "Operation and Maintenance of Wastewater Treatment Plants (WWTPs) and Industrial Wastewater Treatment Plants (IWTPs)" is a crucial component within a broader initiative aimed at enhancing technical expertise and operational efficiency in the field of water treatment. This initiative is part of a larger project designed to address contemporary challenges in environmental management and industrial operations.

It focuses on improving the sustainability and effectiveness of wastewater treatment processes. As urban areas expand and environmental regulations become more stringent, there is a growing need for specialized knowledge and skills to manage these advanced facilities. This training program is strategically positioned to bridge the gap between existing knowledge and the demands of modern wastewater management.

The course is aligned with the project's goals of fostering a more skilled workforce capable of handling complex and technologically advanced wastewater treatment plants. By providing participants with a comprehensive understanding of both WWTPs and IWTPs, the training supports the project's objective of promoting best practices and innovative solutions in wastewater management.

Modality, where and when:

The training program "Generation of Energy from Wastewater and Waste" is structured as a The training program titled "Operation and Maintenance of Wastewater Treatment Plants (WWTPs) and Industrial Wastewater Treatment Plants (IWTPs)" is designed to be both accessible and flexible, catering to the diverse needs of professionals in the water treatment sector.

Modality

The training is delivered through a blended learning approach, combining online and interactive elements to enhance learning outcomes. This modality allows participants to engage with the content in a dynamic and flexible manner. The course utilizes a transmedia format and an expert's manual, ensuring a comprehensive and multi-faceted learning experience. Participants will access instructional materials and resources through an online platform that supports both asynchronous and synchronous learning activities.

Where

The course is hosted on a virtual learning platform, providing participants with access to all course materials, interactive modules, and assessment tools. The virtual campus is designed to facilitate seamless communication between participants and instructors, as well as to offer a range of digital resources. This online environment is accessible from any location, allowing participants to engage with the course content at their convenience while benefiting from a collaborative learning atmosphere.

When

The online training program "Operation and Maintenance of Wastewater Treatment Plants (WWTPs) and Industrial Wastewater Treatment Plants (IWTPs)" is conducted over a period of six weeks. Each participant is given a two-week period to complete each module within the course. The training starts on May 20, 2024, and concludes on June 30, 2024.

The course is structured into three distinct modules with the following schedule:

- **Module 1: How to Operate a Treatment Plant Under Normal Conditions**
  From May 20, 2024, to June 2, 2024
- **Module 2: How to Manage Treatment Assets**
  From June 3, 2024, to June 16, 2024
- **Module 3: How an Industrial Wastewater Treatment Plant Operates**
  From June 17, 2024, to June 30, 2024

Skills Acquired:

Participants will acquire a range of essential skills crucial for managing and optimizing wastewater treatment facilities. These skills include:

1. **Operational Proficiency**: Participants will gain a deep understanding of the operational aspects of both municipal and industrial wastewater treatment plants. They will be adept at managing daily operations, ensuring efficient and effective treatment processes under normal conditions.
2. **Asset Management Expertise**: The seminar will equip participants with the skills to manage and maintain treatment assets effectively. They will learn to implement strategies for asset optimization, ensuring long-term reliability and performance of treatment facilities.
3. **Technical Knowledge of Industrial Plants**: Participants will develop specialized knowledge in the functioning of industrial wastewater treatment plants. They will understand the specific processes, technologies, and requirements unique to these facilities, enabling them to address complex operational challenges.

4. **Problem-Solving Abilities**: The training will enhance participants' ability to identify and resolve common issues that arise in wastewater treatment operations. They will be trained to apply theoretical concepts to practical problems, improving their troubleshooting skills.
5. **Integration of Technical and Economic Aspects**: Participants will learn to integrate technical and economic considerations in their decision-making processes. This will help them optimize operational efficiency while managing costs effectively.
6. **Application of Best Practices**: The seminar will provide insights into best practices and innovative solutions in wastewater treatment. Participants will be able to apply these practices to improve the performance and sustainability of their facilities.

By the end of the seminar, participants will be well-prepared to take on advanced roles in wastewater treatment management, equipped with the knowledge and skills to contribute to the effective operation and maintenance of both WWTPs and IWTPs.

Attendants:

The seminar on "Operation and Maintenance of Wastewater Treatment Plants (WWTPs) and Industrial Wastewater Treatment Plants (IWTPs)" is designed for professionals involved in the water treatment industry. The target audience includes:

Water Treatment Technicians and Engineers: Individuals who are directly involved in the operation and maintenance of wastewater treatment facilities. This includes those who manage the day-to-day functions of these plants and need to stay updated with the latest practices and technologies.

Environmental Engineers: Professionals who work on projects related to water treatment and environmental protection. They will benefit from a deeper understanding of plant operations and maintenance to better design and oversee water treatment solutions.

Facility Managers: Those responsible for overseeing the overall functioning of wastewater treatment plants. The seminar will provide them with insights into improving plant efficiency and managing technical and operational challenges.

Competence acquisition methodology:

The seminar on "Operation and Maintenance of Wastewater Treatment Plants (WWTPs) and Industrial Wastewater Treatment Plants (IWTPs)" employs a comprehensive and effective methodology designed to ensure the acquisition of competencies essential for managing wastewater treatment facilities. The methodology encompasses several key components:

Challenge-Based Learning: Participants engage with real-world professional challenges that require practical solutions. This approach allows them to apply theoretical knowledge to realistic scenarios, thereby enhancing problem-solving skills and practical application. Each module begins with a challenge that participants must address using the concepts learned throughout the course.

Transmedia Learning Resources: The seminar incorporates a transmedia approach, which involves diverse formats such as interactive content, videos, and simulations. This multifaceted approach ensures that participants can engage with the material in various ways, catering to different learning preferences and reinforcing understanding through multiple channels.

Expert Manual: Participants have access to a detailed manual authored by subject matter experts. This manual provides in-depth explanations of key concepts, processes, and techniques relevant to wastewater treatment. It serves as a crucial resource for detailed study and reference throughout the training.

Self-Assessment Exams: To consolidate learning and gauge comprehension, participants complete self-assessment exams. These exams consist of multiple-choice questions and are linked to the content of each module. Immediate feedback is provided, allowing participants to assess their understanding and identify areas needing further review.

Interactive Online Platform: The seminar is delivered through a virtual learning environment that facilitates interaction between participants and instructors. The platform supports discussion forums, where participants can exchange ideas, ask questions, and engage in collaborative problem-solving. This interactive component enriches the learning experience and fosters a sense of community.

Admission and organization of the trainings

- Organization of the training

    - **School of Water.** created by Agbar in 2012, is the benchmark in training, awareness, talent development and knowledge in the field of water and the environment.Our activity is aimed at training for companies, administrations and professionals in the water sector, as well as for the general public. Thus, we develop training programs, promote dual vocational training in the water sector, develop environmental education programs and design exhibition, museum and hydraulic heritage projects.The training programs, whether those in our catalog or those custom-designed for companies, cover all areas of the complete water cycle; they use methodologies that facilitate a unique learning experience and immediate applicability in all key positions of an organization. Our approach combines the academic and technical rigor provided by 165 years of experience in integrated water cycle management and collaboration with the best universities, technical schools and business schools.

- Selection of participants, possible admission requirements

    Participants in the seminar were informed by HR for the internal participants and via web for the external participants.

- Brief notes on counselors and teachers:

Throughout the seminar on "Operation and Maintenance of Wastewater Treatment Plants (WWTPs) and Industrial Wastewater Treatment Plants (IWTPs)," participants benefit from the support and guidance of two key figures who play crucial roles in enhancing their learning experience:

1. **The Expert**: The expert is a pivotal figure in the training, providing technical support and addressing any queries related to the course content. As the primary authority on the material covered, the expert is responsible for evaluating each module. Participants can turn to the expert for in-depth explanations and clarifications, ensuring they fully understand the complex concepts and processes involved in wastewater treatment.

2. **The Academic Tutor**: The academic tutor offers personalized guidance and support throughout the participants' educational journey. This role involves providing individual assistance and addressing any questions or concerns related to the overall program. The academic tutor helps participants navigate the course structure, manage their progress, and maximize their learning outcomes.

Execution of the training

- Organization and plan

Period	Credit	Content
May 20, 2024 - June 2, 2024	How to Operate a Treatment Plant Under Normal Conditions	- Personnel Management - Process Control - Emission Limits - Equipment Regulation Criteria - Ratio Control - Cost Control
June 3, 2024 - June 16, 2024	How to Manage Treatment Assets	- Asset Management Goals for Treatment Plants - Inventory Creation - Legal Maintenance Requirements in Asset Management - Maintenance - Decision Making Based on Internal and External Constraints
June 17, 2024 - June 30, 2024	How an Industrial Wastewater Treatment Plant (WWTP) Operates	- Introduction to Industrial Water Treatment and Legal Framework - Industrial Wastewater Discharge - Industrial Wastewater Treatment Plant (IWWTP)

Evaluation Ratings

The following metrics summarize the results and satisfaction levels for the "Operation and Maintenance of Wastewater Treatment Plants (WWTPs) and Industrial Wastewater Treatment Plants (IWTPs)" training:

- **Total registrations:** 46

- **Internal participants:** 21
- **External participants:** 25
- **Participants who completed the course:** 16
- **Participants who did not complete the course:** 30

Based on participant feedback, the training received the following ratings:

- **Overall satisfaction with the training received:** 4.3/5
  Participants expressed a high level of satisfaction with the course content and structure.
- **Overall rating of the online expert:** 3.5/5
  While the expert's knowledge was acknowledged, some participants indicated room for improvement in responsiveness.
- **Overall rating of the academic tutor:** 3.8/5
  The tutor was generally well-regarded, providing support throughout the training.
- **Functionality of the virtual campus:** 4.3/5
  The virtual platform performed well, offering an easy-to-navigate and reliable experience.
- **Overall rating of course content and resources:** 4.04/5
  Participants found the materials helpful, though a few mentioned the need for more interactive and practical content.

Main Findings and Conclusions

Strengths:

The training program on "Operation and Maintenance of Wastewater Treatment Plants (WWTPs) and Industrial Wastewater Treatment Plants (IWTPs)" was widely appreciated for its dynamic and engaging format. Participants highlighted several positive aspects:

- **Practical Application:** The course's real-world challenges allowed participants to apply theoretical knowledge to actual scenarios, reinforcing learning. Many participants emphasized that they gained a deep understanding of the operations of WWTPs and IWTPs, thanks to the practical approach of the training.
- **Engaging Learning Experience:** The course was described as both enjoyable and highly useful. The practical cases required participants to think critically and review the theoretical content thoroughly to solve real-world problems.
- **Effective Platform and Resources:** The platform functioned well, providing easy access to all documentation and links. Despite some resources being in English, participants found the materials, particularly the videos, to be instructive. The detailed descriptions of processes in IWTPs, coupled with graphic materials, were especially praised.
- **Valuable Manuals:** The extensive information provided in the manuals was seen as particularly relevant and helpful for understanding key concepts and processes.

Areas for Improvement:

Despite the positive feedback, several areas for improvement were identified by participants:

- **Additional Video Summaries:** Some participants suggested that each section of the manuals could benefit from video summaries to enhance understanding, complementing the videos already included in each unit.
- **Increased Personal Interaction:** Participants expressed a desire for more personalized interaction, such as live online classes or presentations, to foster engagement and clarify doubts in real-time.

- **More Quiz Attempts:** Some participants felt that the quizzes could allow for more attempts before revealing the correct answers. This would enable participants to assess their initial understanding more accurately before receiving feedback.
- **Content Complexity:** A few participants found the content to be broad and complex for an online format, noting the absence of live explanations. While the documentation was useful, some had to supplement their learning with additional materials from external sources.
- **Course Title Misalignment:** Several participants believed the course title did not fully align with the content. While the title suggests a focus on "operation and maintenance," participants felt that the course leaned more toward asset management.
- **Evaluation Delays:** Some participants reported uncertainty regarding the time required for the evaluation of their challenges after submission.
- **Test Validation:** There were also concerns about the tests, with participants suggesting that certain questions could have more than one correct answer.

Attachments

- **ATTACHMENT 1: LIST OF PARTICIPANTS**
- **ATTACHMENT 2: PUBLICATION ABOUT THE COURSE (web)**

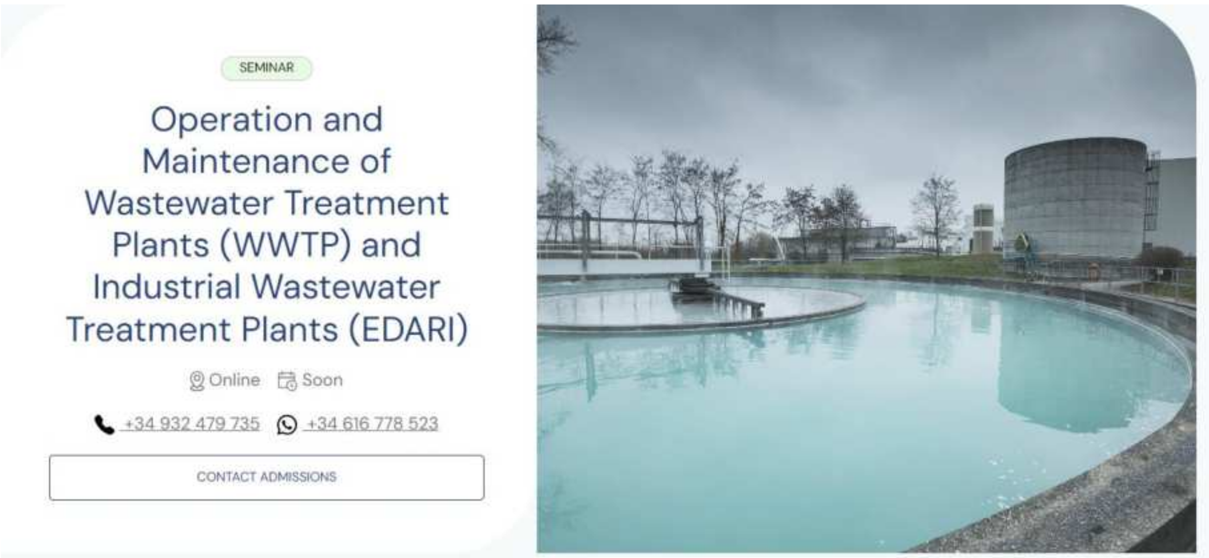
ATTACHMENT 1: LIST OF PARTICIPANTS

Name	Last name	Company
Alberto	Dominguez Corral	AQUANEX, SERVICIO DOMICILIARIO DEL AGUA DE EXTREMADURA, S.A.
Ana	Rodriguez Roda	HIDROGEA, GESTION INTEGRAL DE AGUAS DE MURCIA, S.A.
Ana Maria	Torrico Diaz	AGUAS DE PUERTOLLANO, S.L.
Asier	Cumbreño Pulido	AQUANEX, SERVICIO DOMICILIARIO DEL AGUA DE EXTREMADURA, S.A.
Carmen	Aguilar García	HIDRAQUA, GESTION INTEGRAL DE AGUAS DE LEVANTE S.A.U
Carmen	De La Torre Mendez	AGUAS DE ALBACETE. S.A.
Marcos	Pérez Díaz	HIDROGEA, GESTION INTEGRAL DE AGUAS DE MURCIA, S.A.
Gabriel	Lopez Montoya	AQUATEC PROYECTOS PARA SECTOR DEL AGUA, S.A.U.
Noelia	Fernandez Bregon	Aigües de Barcelona
Laura	Torregrosa Canales	AQUAMBIENTE SERVICIOS PARA SECTOR DEL AGUA, S.A.U.
Sandra	Rubio Santos	AQUANEX, SERVICIO DOMICILIARIO DEL AGUA DE EXTREMADURA, S.A.
Manuel	Ballesta Caravaca	AGUAS DE ALBACETE. S.A.
Maria Teresa	Perez Capel	AGUAS DE LORCA, S.A.
Marta	Bronsoms Planas	Aigües de Barcelona
Michelle Estefania	Crespo Pico	UTE SERVICIO AGUAS DE PLASENCIA
Borja	Segovia Duran	HIDRALIA
Pablo	Alcaraz Navarro	AQUATEC PROYECTOS PARA SECTOR DEL AGUA, S.A.U.
Justo	Vivar Lopez	AQUONA GESTION DE AGUAS DE CASTILLA, S.A.U.

Sandra	Delgado Santos	AQUAMBIENTE SERVICIOS PARA SECTOR DEL AGUA, S.A.U.
SANDRA	LOPEZ DE LA TORRE BARGUEÑO	AQUONA GESTION DE AGUAS DE CASTILLA, S.A.U.
Laura	Villarrubia Gonzalez	AQUONA GESTION DE AGUAS DE CASTILLA, S.A.U.

ATTACHMENT 2: PUBLICATION ABOUT THE COURSE

https://www.laescueladelagua.com/ca/programa/executive-education/seminario/operacion-y-mantenimento-edar-yedari/



Work Package 5: Third center level "Higher Education) (EQF 6)

Activity A8.11 Test study module A

Management & Technologies of the Water and Wastewater industry

Implemented by:

SFC Sistemi Formatici Confindustria and

Scuola Sant'Anna di Pisa University

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

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Chapter 1: Executive Summary

This report relates to the implementation activities in Italy of the 4 modules:

A – "Management & Technologies of the Water and Wastewater Industry"

B – "Waste Management & Technologies"

C – "Management & technologies of the circular economy"

D – "Management of sustainable economic activity"

developed by VILNIAUS GEDIMINO TECHNICAL UNIVERSITY (VGTU) and SATAKUNTA UNIVERSITY OF APPLIED SCIENCES (SAMK) in the Project 'Management and Technologies of Water, Wastewater, Waste and Circular Economy (WWW&CE)'

Methodology for adaptation of VGTU – SAMK curricula to Italian training needs

Following the analysis of the Module A-B-C-D curricula developed by the 3LoE partners, SFC found it beneficial to propose to the Scuola Superiore Sant'Anna (SSSA) the validation of potentially integrating the 4 modules, their structure, learning outcomes and main topics into existing university pathways.

This analysis, conducted in March 2023, resulted in Sant'Anna expressing interest in incorporating the four modules into the MASTER GECA specialization pathway.

The GECA Master is a 2nd level university Master's degree program offered by the Institute of Management at the Scuola Superiore Sant'Anna in Pisa. For nearly three decades, it has provided a high-level, continuously updated, multidisciplinary course in the environmental sector and green management.

The professional profile emerging from the GECA Master is that of an "Expert in Corporate Sustainability and Circular Economy."

The GECA Master was identified as the most suitable existing program into which all four modules proposed by the 3LoE project could be integrated.

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Meetings to finalize and adapt the contents and learning outcomes of all the 4 modules within the framework of the GECA Master's Course were held from April 2023 to September 2023. This timeline ensured that the necessary authorizations from the college of university lecturers could be obtained in time for implementation during the GECA Master's Course, which ran from October 2023 to July 2024.

The competencies of the four modules are attributable, according to the Italian Atlas of Competences and Professions, to:

SECTOR 24: Common Area

PROCESS: Ecological transition, reduction of energy consumption, circularity, and containment of environmental impacts

PROCESS SEQUENCE: Activation of circular production processes and increase of recycling activities

The Expected Result of the learning pathway is:

RA2: Adopt circular closed-loop production processes, implementing lean production logics and techniques, and improving the energy efficiency of production processes to reduce environmental impact.

The main activities envisaged are:

- Optimization of production processes
- Implementation of closed-loop production and waste minimization
- Energy efficiency and use of renewable energy in production processes

It was determined that the four modules could contribute significantly to the formation of the GECA Master's graduate profile. Specifically, they could contribute to developing the learning outcomes related to the process sequence as detailed in Annex A.

Introduction to Module A implementation

In response to the multifaceted challenges facing water and wastewater utilities, this module provides a comprehensive examination of key aspects in water resource management. Beginning with an analysis of national and international regulatory frameworks, participants

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will gain an understanding of the objectives of regulation in the water sector and the governance models employed.

The module then delves into the operational aspects of the integrated water cycle, including water withdrawal mechanisms, adduction systems, and drinking water distribution networks. Participants will also explore sewage systems and wastewater treatment methods within the context of holistic water management strategies. A critical focus is placed on sustainable management and protection of water resources, encompassing the utilization of ecosystem services and nature-based solutions. Additionally, the module addresses the impacts of climate change on water resources management, emphasizing adaptation strategies and resilience-building measures. Technological innovation is integral to meeting these challenges. Participants will examine innovative technologies for sustainable water management, including circular water management in companies, industrial water management techniques, and solutions for reducing water consumption and recovering wastewater. Overall, this module equips participants with the technical knowledge and practical tools necessary to navigate the complexities of water management effectively and ensure the sustainability of water resources for future generations.

In this curriculum **Management & Technologies of the Water and Wastewater Industry** refers to both municipal and industrial water and wastewater utilities, also covering urban settlements.

Target group

The Master GECA in Environmental Management and Control: Circular Economy and Resource Efficient Management envisages a minimum of 15 and a maximum of 24 participants.

Those who have obtained a master’s degree, a specialized degree or an old university degree, or an equivalent qualification obtained at an Italian or foreign university or institute of equal standing may apply for admission.

Undergraduates who have completed their final examinations before the start of the master's course and who plan to acquire the qualification in the extraordinary session of the academic year preceding the start of the Master's course may also apply for admission.

Work required

In the MASTER GECA curriculum, the average work required by each module is measured in units of ECTS credit (abbreviated in this presentation as CU). The curriculum consists of four modules of total 6 ECTS credit units, corresponding to 91 hours of lectures, professional field visits, individual study and assignments. The Management & Technologies of the Water and Wastewater Industry module can be administered individually, thus can be offered to those wishing to implement or develop knowledge and practical skills necessary to navigate the complexities of water management.

Contents of the curriculum

The module aims to train managers who are able to make decisions and to define and implement waste management strategies strategies in the context of the challenges posed by the circular economy. The main objective is to transmit competences and skills (knowing, knowing how to do, feeling) related to the main managerial tools - methodologies and operational tools - supporting management oriented towards circular and efficient resource management.

The module aims to provide interdisciplinary content to various corporate functions involved in the management of water and wastewater services, emphasizing the development of effective management strategies through advanced technologies and sustainable practices. Specifically, it seeks to develop:

a) Interdisciplinary skills in Green Management and Circular Economy, particularly in water and wastewater management, enhancing the knowledge base and experience of students in their academic and professional careers;

b) Problem-solving abilities, project development skills, and proficiency in using tools for managing environmental issues in water and wastewater companies, from eco-design to efficient management of resources;

c) Team-working behavior, fostering active participation in organizational life and continuous improvement of sustainability performance;

d) Competencies in the analysis, measurement, evaluation, organization, management, and communication of environmental issues within the water and wastewater industry.

The curriculum of Module A has been divided into four units as follows:

- Unit 1: Sector regulation and governance in the water service
- Unit 2: Integrated water cycle and circularity management
- Unit 3: Water resource sustainable management and protection
- Unit 4: Technologies for sustainable water management

The curriculum on Management & Technologies of the Water and Wastewater industry module structure is shown in the following Tables.

Table 1 Contents of Unit 1

<table>
<tr><td>Unit 1:
Sector regulation and governance in the water service</td><td>Learning outcomes: The learning outcomes of this module are to understand and apply the principles of sector regulation and governance in the water service industry. This includes exploring regulatory frameworks, governance structures, and policy-making processes essential for effective water service management and compliance.</td></tr>
<tr><td colspan="2">Contents:
• Overview of the national and international regulatory framework
• Objectives of regulation in the water sector
• Governance models</td></tr>
</table>

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• Roles and responsibilities of the different entities involved • Analysis of the main laws and regulations in the water sector
Student's workload: 11 lecture hours + 5 individual study hours (1 CFU)
Possible materials: Selected materials from European Commission / Environment. Water. Available https://ec.europa.eu/environment/water/ EurEau. (2021). Europe's Water in Figures: An overview of the European drinking water and wastewater sector. Available https://www.eureau.org/resources/publications/eureau-publications/5824-europe-s-water-in-figures-2021/file Drinking Water Directive. Available https://ec.europa.eu/environment/water/water-drink/legislation_en.html Urban Wastewater Directive Overview. Available https://ec.europa.eu/environment/water/water-urbanwaste/index_en.html

Table 2 Contents of Unit 2

Unit 2: **Integrated water cycle and circularity management**	**Learning outcomes**: By the end of this module, students will be able to understand and explain the operation of water withdrawal mechanisms and the adduction system within the integrated water cycle. Participants will gain comprehensive knowledge of the principles of operation of drinking water systems, water distribution networks, sewage systems, and wastewater purification treatments in the context of the integrated water cycle.
Contents: • Operation of water withdrawal mechanisms for the integrated water cycle • The adduction system for the integrated water cycle	

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• Principles of operation of the integrated water cycle drinking water system • The water distribution system in the water cycle, • Sewage system • Wastewater purification treatments
Student's workload: 15 lecture hours + 9 individual study hours (1 CFU)
Possible materials: Nika, C. E., Vasilaki, V., Expósito, A., & Katsou, E. (2020). Water cycle and circular economy: developing a circularity assessment framework for complex water systems. Water Research, 187, 116423. Ferraro, C. (2018). Circular Water Management: co-design process towards the development of Action Plans. Coombes, P. J. (2005). Integrated water cycle management: Analysis of resource security. Water, 32, 21-26. I Quaderni della Formazione Ambientale – Acqua, (2006). APAT - Agenzia per la protezione dell'ambiente e per i servizi tecnici. ISBN: 88-448-0197-3

Table 3 Contents of Unit 3

Unit 3: **Water resource sustainable management and protection**	**Learning outcomes:** Understand and implement sustainable management and protection of water resources through the lens of integrated water services, emphasizing ecosystem services and nature-based solutions. Additionally, the module aims to address climate change impacts and promote comprehensive and sustainable water resource management practices.
Contents: • Sustainable management and protection of water resources. • The functioning of ecosystem services • Nature based solutions for the preservation and restoration of ecosystem services related to water resources.	

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• The effects of Climate Change on water resources management
Student's workload: 18 lecture hours + 9 individual study hours (2 CFU)
Possible materials: EPA. Energy Efficiency for Water Utilities. Available https://www.epa.gov/sustainable-water-infrastructure/energy-efficiency-water-utilities EurEau. 2019. Reducing the Energy Footprint of the Water Sector. Possibilities, Success Stories and Bottlenecks. Available https://www.eureau.org/resources/briefing-notes/3890-briefing-note-on-reducing-the-energy-footprint-of-water-sector/file Ruiz-Ocampo, H., Katusic, V., & Demetriou, G. (2023). Closing the loop in water management. In Water Management and Circular Economy (pp. 3-24). Elsevier. UN Environment-DHI, UN Environment and IUCN 2018. Nature-Based Solutions for Water Management: A Primer. https://www.unepdhi.org/wp-content/uploads/sites/2/2020/05/WEB_UNEP-DHI_NBS-PRIMER-2018-2.pdf Bąk, J. (2023). Circular Water Management in Smart Cities. In Water in Circular Economy (pp. 31-40). Cham: Springer International Publishing.

Table 4 Contents of Unit 4

Unit 4: **Technologies for sustainable water management.**	**Learning outcomes:** The learning objectives of this module are to explore innovative technologies for circular water management in companies, focusing on industrial water management and technologies that reduce water consumption. Additionally, the module aims to cover advanced technologies for wastewater recovery, promoting sustainable water management practices in industrial settings.
Contents:	

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• Innovative technologies for circular water management in companies. • Industrial water management. • Technologies for reducing water consumption. • Technologies for wastewater recovery.
Student's workload: 16 lecture hours + 8 individual study hours (2 CFU)
Possible materials: Selected chapters from the book Xiaochang C. Wang, and Guangtao Fu (eds.). 2021. Water-Wise Cities and Sustainable Water Systems: Concepts, Technologies, and Applications. IWA Publishing. DOI: https://doi.org/10.2166/9781789060768. Available https://iwaponline.com/ebooks/book/809/Water-Wise-Cities-and-Sustainable-Water-Systems Liu, Q., Yang, L., & Yang, M. (2021). Digitalisation for water sustainability: Barriers to implementing circular economy in smart water management. Sustainability, 13(21), 11868. Yadav, G., Mishra, A., Ghosh, P., Sindhu, R., Vinayak, V., & Pugazhendhi, A. (2021). Technical, economic and environmental feasibility of resource recovery technologies from wastewater. Science of The Total Environment, 796, 149022. Evans, R. G., & Sadler, E. J. (2008). Methods and technologies to improve efficiency of water use. Water resources research, 44(7). Alias, A. H., Boyle, C. A., & Hassim, S. (2017). Water demand management: A review on the mechanisms to reduce water demand and consumption. International Journal of Civil Engineering and Technology, 8(3), 554-564.

Teaching methods

The courses will be taught by lecturers from the Scuola Superiore Sant'Anna and experts in the topics covered by the courses. The aim of the course will not only be to transfer knowledge on the key concepts related to the management of integrated water distribution system, but also to enable course participants to be autonomous in the search for sectorial best practices, technological-organisational solutions to be implemented. The instructors will ensure:

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- the development and maintenance of a positive classroom environment;

- effective interpersonal communication processes, stable relationships of trust and collaboration;

- an adequate evaluation process, with respect to the overall course objectives.

Prior to the start of each module, the participants will be provided with bibliographic reference material for each course, which will be useful in preparing the students for active and expert participation. This bibliographic material will cover not only basic skills, but also further levels of in-depth study.

Teachers are encouraged to use varying methods containing e.g.:

- Lectures,
- Visiting lecturers,
- Professional field visits,
- Visits in enterprises,
- Videos approaching the topics (Reliability of the source must be evaluated),
- Individual studies

Teaching module delivery schedule

Module	**Days (8 hours per day)**
A - Management & Technologies of the Water and Wastewater Industry	• From 6 to 8 March 2024 • From 11 to 15 March 2024 • From 18 to 21 March 2024

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INAPP
ISTITUTO NAZIONALE PER L'ANALISI DELLE POLITICHE PUBBLICHE

Dettaglio Area di attività

SETTORE - 24 Area comune
PROCESSO - Transizione ecologica, riduzione dei consumi energetici, circolarità e contenimento degli impatti ambientali
SEQUENZA DI PROCESSO - Attivazione di processi di produzione di tipo circolare e incremento delle attività di riciclo

ADA.24.08.06 (ex) - Sviluppo di programmi di riciclaggio e valutazione del ciclo di vita delle risorse

RA1: Progettare prodotti tenendo conto del loro fine vita, facilitando il processo di riciclaggio, privilegiando l'uso di materie prime rinnovabili, o a basso impatto ambientale, e massimizzando l'utilizzo di quelle riciclate, riciclabili e biodegradabili

ATTIVITA' RA.24.08.06.1

Progettazione di prodotti circolari

Eco-design e progettazione modulare

Scelta di materiali sostenibili

Progettazione per il riciclaggio

RA2: Adottare processi produttivi di tipo circolare a ciclo chiuso, implementando logiche e tecniche di produzione lean e migliorando l'efficienza energetica dei processi produttivi anche al fine di ridurre l'impatto ambientale

ATTIVITA' RA.24.08.06.2

Ottimizzazione dei processi produttivi

Implementazione della produzione a ciclo chiuso e minimizzazione degli scarti

Efficienza energetica e uso di energie rinnovabili nei processi produttivi

RA3: Implementare processi per il riciclo interno ed esterno dei materiali di scarto, o di prodotti rigenerati, creando infrastrutture per la raccolta degli scarti e dei prodotti a fine vita, sia all'interno dell'azienda che attraverso reti di raccolta esterne o attraverso piattaforme di sharing economy

ATTIVITA' RA.24.08.06.3

Sviluppo di un sistema di raccolta e riciclaggio

Creazione di circuiti di riutilizzo e rigenerazione dei materiali

RA4: Sviluppare sistemi di logistica inversa, implementando piani di monitoraggio e tracciabilità dei prodotti lungo tutta la catena di approvvigionamento anche al fine di garantire il recupero e il trattamento dei materiali

ATTIVITA' RA.24.08.06.4

Sviluppo della supply chain circolare

Sviluppo della logistica inversa

Implementazione dei sistemi di tracciabilità lungo tutta la catena di approvvigionamento

Codici ISTAT CP2021 associati all'ADA

Codice CP	Titolo CP
2.2.1.7.0	Ingegneri industriali e gestionali
2.5.1.3.2	Specialisti dell'organizzazione del lavoro
3.3.1.5.0	Tecnici dell'organizzazione e della gestione dei fattori produttivi
3.1.4.1.5	Tecnici della conduzione e del controllo di catene di montaggio automatiche
3.1.5.3.0	Tecnici della produzione manifatturiera

Codici ISTAT ATECO associati alla sequenza di processo

Codice Ateco	Titolo Ateco
70.22.01	Attività di consulenza per la gestione della logistica aziendale
70.22.09	Altre attività di consulenza imprenditoriale e altra consulenza amministrativo-gestionale e pianificazione aziendale
71.12.10	Attività degli studi di ingegneria
70.10.00	Attività delle holding impegnate nelle attività gestionali (holding operative)

INAPP
ISTITUTO NAZIONALE PER L'ANALISI DELLE POLITICHE PUBBLICHE

Dettaglio Area di attività

SETTORE - 24 Area comune
PROCESSO - Transizione ecologica, riduzione dei consumi energetici, circolarità e contenimento degli impatti ambientali
SEQUENZA DI PROCESSO - Contenimento degli impatti ambientali delle attività produttive, dei materiali e degli imballaggi

ADA.24.08.09 (ex) - Valutazione e monitoraggio degli impatti ambientali delle attività produttive e individuazione di misure di contenimento

RA1: Creare un piano d'azione di dettagliato con tempistiche, risorse necessarie e responsabilità assegnate per ciascuna misura di contenimento, stabilendo target specifici per la riduzione degli impatti ambientali e sviluppando strategie utili a minimizzare gli impatti negativi identificati

ATTIVITA' RA.24.08.09.1

Definizione degli obiettivi ambientali

Individuazione delle misure di mitigazione

Elaborazione del piano di gestione degli impatti ambientali

RA2: Identificare i rischi di impatto ambientale associati alle attività aziendali, eseguendo un'analisi dei processi produttivi e valutando il ciclo di vita delle materie prime e dei prodotti

ATTIVITA' RA.24.08.09.2

Valutazione del ciclo di vita delle materie prime e dei prodotti

Analisi del rischio di impatto ambientale

Verifica del rispetto delle normative in tema di impatto ambientale

RA3: Implementare tecnologie e processi produttivi a minor impatto ambientale e a maggiore sostenibilità, ottimizzando l'uso delle risorse e promuovendo una gestione sostenibile degli scarti e dei rifiuti

ATTIVITA' RA.24.08.09.3

Implementazione delle misure di contenimento

Codici ISTAT CP2021 associati all'ADA

Codice CP	Titolo CP
3.1.8.2.0	Tecnici della sicurezza sul lavoro
3.3.1.5.0	Tecnici dell'organizzazione e della gestione dei fattori produttivi
3.1.4.1.5	Tecnici della conduzione e del controllo di catene di montaggio automatiche
3.1.5.3.0	Tecnici della produzione manifatturiera

Codici ISTAT ATECO associati alla sequenza di processo

Codice Ateco	Titolo Ateco
70.22.01	Attività di consulenza per la gestione della logistica aziendale
70.22.09	Altre attività di consulenza imprenditoriale e altra consulenza amministrativo-gestionale e pianificazione aziendale
71.12.10	Attività degli studi di ingegneria
70.10.00	Attività delle holding impegnate nelle attività gestionali (holding operative)

Istituto Nazionale per l’Analisi delle Politiche Pubbliche - Corso d’Italia, 33 - 00198 Roma - C.F. 80111170587

Result 5.2
Green Economy Study Modules

Study module A
Management & Technologies of the Water and Wastewater industry

Evaluation Report

PANEVĖŽIO KOLEGIJA

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

REPORT ON THE Evaluation OF COURSE

Management & Technologies of the Water and Wastewater industry

Prepared by Panevėžio kolegija/University of Applied Sciences

2024

PANEVĖŽIO KOLEGIJA

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

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3. THE COURSE EVALUATION BY TEACHER 6

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PANEVĖŽIO KOLEGIJA

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

1. STATISTICS OF RESPONDENTS (Students)

1. Number of respondents (students):

10 students took part in the survey (PANKO – 10)

2. Number of respondents according to gender:

4 *Man, 6 Woman*

3. Number of respondents according to age:

Age group	*Percentage*
Under 20	0
20-29	20
30-39	80
40-49	0
50-59	0
60+	0

2. THE COURSE EVALUATION BY STUDENTS

Course evaluation by students was performed using online survey. Electronic version of the survey available at https://forms.gle/LRbGeYi12dySA3kV8. 10 students took part in the survey (PANKO – 10).

7. Evaluation of course content and teaching quality

7.1. The objectives of the course and study results, evaluation criteria were clearly defined from the very beginning of the course:

	Number	Percentage
Strongly agree	6	60
Agree	4	40
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0

7.2. Assessment of the study results was appropriate:

	Number	Percentage
Strongly agree	2	20
Agree	8	80
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0

7.3. The content was interesting, relevant, useful and allowed to achieve study results:

	Number	Percentage
Strongly agree	6	60
Agree	4	40
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0

7.4. The course content responds to the latest scientific achievements:

	Number	Percentage
Strongly agree	6	60
Agree	4	40
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0

7.5. Theory was taught in conjunction with the practical examples:

	Number	Percentage
Strongly agree	6	60
Agree	4	40
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0

7.6. Theory was taught in context of the sustainable development issues:

	Number	Percentage
Strongly agree	6	60
Agree	4	40
Neither agree nor disagree	0	0
Disagree	0	0

Strongly disagree	0	0

7.7. The course topics were not repetitive:

	Number	Percentage
Strongly agree	4	40
Agree	4	40
Neither agree nor disagree	2	20
Disagree	0	0
Strongly disagree	0	0

7.8. The teaching materials were presented in an organized manner:

	Number	Percentage
Strongly agree	6	60
Agree	4	40
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0

7.9. The teaching materials distributed were helpful to achieve study results:

	Number	Percentage
Strongly agree	6	60
Agree	4	40
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0

7.10. Lecturer encouraged my participation, initiative and interaction during the lectures:

	Number	Percentage
Strongly agree	6	60
Agree	4	40
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0

7.11. The study methods chosen by the lecturer helped to understand the course:

	Number	Percentage
Strongly agree	2	20
Agree	6	60
Neither agree nor disagree	2	20
Disagree	0	0
Strongly disagree	0	0

7.12. The teaching process included interactive methods:

	Number	Percentage
Strongly agree	2	20
Agree	8	80
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0

7.13. The lecturer was a good communicator

	Number	Percentage

Strongly agree	2	20
Agree	8	80
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0

8. Comments on strengths and ways of improvement

8.1. How do you evaluate the course quality

	Number	Percentage
Very satisfied	2	20
Satisfied	8	80
Neither satisfied nor disstisfied	0	0
Dissatisfied	0	0
Very dissatisfied	0	0

8.2. How do you evaluate the course lecturer

	Number	Percentage
Very satisfied	2	20
Satisfied	8	80
Neither satisfied nor disstisfied	0	0
Dissatisfied	0	0
Very dissatisfied	0	0

8.3. Could you name the main advantages of this course?

Know how the water service works, Understand that wastewater can be a resource to be reused, study of the water cycle and solutions to avoid waste, good teaching.

8.4. Which specific difficulties you encountered while studying the course?

Difficulty understanding the service pricing system, pricing, northing.

Could you name the main disadvantages of this course?

Few examples of circularity in the use of water from production companies.

8.5. What changes would you recommend to improve this course?

I would have liked to see more examples linked to private companies that use water.

3. THE COURSE EVALUATION BY TEACHER

Course evaluation by teacher was performed using online survey. Electronic version of the survey available at https://forms.gle/srHZJ1ji7GyJShMm8. Online survey was carried in the last week of the training.

9. Evaluation of course structure and description:

Course teacher agree that:

9.1. The course aims are clear and well defined.

9.2. The competencies clearly describe knowledge and skills of student graduating from this course.

9.3. The learning outcomes correspond to the competencies.
9.4. The division of course hours into contact and self-learning hours is appropriate.
10. Evaluation of course content:
Course teacher agree that:
10.1. The course content corresponds to the learning outcomes.
10.2. The course content is consistent.
10.3. The course topics are not repetitive.
10.4. The course content is modern.
10.5. The learning methods are appropriateto to achieve the intended competences.
10.6. The assessment of competence is appropriate.
11. Comments on strengths and ways of improvement:
11.1. According to the teacher the main advantages of this course:
Novelty, relativeness; timeliness and relevance in the context of the Green Deal.
11.2. According to the teacher the main disadvantages of this course:
Maybe too many topics, I would like to see more freedom for discussion and self-orientation.

CONCLUSIONS

After implementation of the course “Management & Technologies of the Water and Wastewater industry“ was conducted within the Project project „Three-level Centers of Professional Excellence: Qualification, Entrepreneurship and Innovation in the Green Economy “the following conclusions are defined:

- The objectives of the course were achieved.
- The teacher and students highly rated the quality of course content.
- Students were satisfied with the quality of teaching.
- The knowledge and skills learned in the courses were put into practice.
- The course was properly implemented.

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Result 5.2
Green Economy Study Modules

Study module B
Waste Management & Technologies

Curricula and Teaching Materials

Workpackage 5 Third center level "Higher education"

Activity 8 Preparation and transfer of study modules "Green Economy"

8.2 Module B "Waste Management & Technologies"

Introduction

As part of the project "Management and Technologies of Water, Waste-Water, Waste and Circular Economy" (WWW&CE), Vilnius Gediminas Technical University and Satakunta University of Applied Sciences have developed curriculum and teaching materials for the study module B "Waste Management & Technologies". Part I below lists this curriculum.

Module B has been practically tested by Gediminas Technical University and integrated into existing Bachelor's programmes. Part II contains the curriculum developed for this and Attachment I contains the teaching materials and presentations developed and used by Vilnius Gediminas Technical University.

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Part I

Curriculum B
Waste Management & Technologies

Vilnius Gediminas Technical University (VGTU), PP 3

Satakunta University of Applied Sciences (SAMK), PP 11

Compiled by Dr Sirpa Sandelin and Dr Kari Lilja

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Introduction

Waste is one of the most critical issues of our time. In the past, waste was only seen as a discarded substance, but now waste fractions are a valuable raw material. Legislation has been tightened and numerous laws guide waste sorting and organisation of waste management operations and business models. On the other hand, natural resources need to be conserved, as the growing population of the planet is consuming raw materials at an accelerating rate.

Waste management has become particularly challenging with urbanization. In developed countries, waste management technologies are developed and utilized effectively. However, in the least developed countries, in which the population growth is accelerating, waste collection and disposal are left behind, and are beyond access.

The waste management sector has to respond to several contemporary local and global challenges. The waste hierarchy governs waste treatment and measures to reduce the waste amount and seek possibilities to recycle the valuable materials. Carbon neutrality and digitalisation also apply to the waste sector.

Because of the very different national circumstances, climate, topography and local conditions in EU countries, the curriculum on Waste Management & Technologies gives a general framework for managing waste issues in municipalities and companies.

In this curriculum Waste Management & Technologies refers to the collecting, treating, and disposing of waste materials that are discarded from municipalities and industrial plants.

Target group

The target group of the curriculum consists of Bachelor's programme students at universities and universities of applied sciences. The individual modules are well suited also to be applied as the open university courses.

Work required

In the curriculum, the average work required by each module is measured in ECTS credit units (abbreviated in this presentation as CU). One credit unit equals 27 hours workload. The curriculum consists of modules totalling 6 ECTS credit units corresponding to 160 hours containing lectures, professional field visits, individual studies and assignments. Cooperation with the local experienced industry practitioners is highly recommended. All modules can be studied individually, so the modules can be offered also via open studies to all companies and organizations, that intend to implement or develop waste management solutions.

Contents of the curriculum

The variation in regulations and circumstances and qualification requirements are quite different in the BSR-countries, thus the curriculum can be written only as a form of framework inside which the local actors should be able to modify the contents of modules according to their regulations and local requirements. Using innovative, problem-based and experiential educational approaches, students build on their professional experience to become experts who are can explain and implement effective waste management solutions.

The overall objectives of the curriculum are:

- The student deepens his/her knowledge about underlying basic information about waste management in the context of sustainable development.
- The student can explain general responsibilities that relate to waste management and the essential contents of legislation on waste management. The student can describe the producer's responsibilities according to the regulations.

- The student understands waste hierarchy principles, different waste fractions and their properties from a sorting, collection and treatment perspective.
- The student deepens his/her knowledge about waste management methods and their performance assessment in the context of sustainable development.

The curriculum is divided into modules as follows:

- Module 1: Sources, composition and properties of waste
- Module 2: Regulatory frameworks, strategies and organization of waste management
- Module 3: Waste management hierarchy
- Module 4: Waste treatment methods
- Module 5: Waste, circular economy and digitalization

Table 1 Contents of Module 1: Classification, characteristics and sources of waste

<table>
<tr><td>Module 1:
Sources, composition and properties of waste</td><td>Learning outcomes: Module 1 provide an understanding to waste types, sources, and properties. It also highlights the future trends of waste management. The student can explain the waste fractions and their properties as well as the effects on the environment. He/she understands the future trends and can develop waste management.</td></tr>
<tr><td colspan="2">Contents:

Environmental impacts and risks of waste

Waste definitions, sources and streams

Physical, chemical and biological properties of waste

Future trends and challenges of waste management</td></tr>
<tr><td colspan="2">Student’s workload:
12 lecture hours + 20 individual study hours</td></tr>
<tr><td colspan="2">Possible materials:

Selected materials from European Commission, Waste and recycling https://ec.europa.eu/environment/topics/waste-and-recycling_en

Chandra, R. 2020. Environmental Waste Management. CRC Press.

Selected chapters from Letcher, T. and Vallero, D. (eds.). 2019. Waste - A Handbook for Management. Elsevier Inc.

ISWA. 2021. The Future of The Waste Management Sector: Trends, Opportunities and Challenges for the Decade. ISWA. Available https://www.iswa.org/wp-content/uploads/2021/10/ISWA-2021f-Rev2-FK-1.pdf?v=f0aa03aaca95</td></tr>
</table>

Table 2 Contents of Module 2: Regulatory frameworks and strategies

Module 2: **Regulatory frameworks, strategies and organization of waste management** Note: Module 2 must be designed country wise to meet the legislative frameworks and strategies.	Learning outcomes: Module 2 deals with the European waste and recycling-related directives and their application in different countries' regional and local levels. The student gains a solid understanding of legislative and normative regulations. He/she understands companies' obligation to handle the waste produced from materials of products they have imported or manufactured when the products are discarded.
Contents: European and national waste legislation and regulations National waste management plans and road maps Regional and local regulation on waste and road maps Extended producer responsibility Organization and responsibilities of waste management	
Student's workload: 8 lecture hours + 8 individual study hours	
Possible materials: Waste framework directive https://ec.europa.eu/environment/topics/waste-and-recycling/waste-framework-directive_en Selected legislation and specific policies of European Commission related to waste and recycling https://ec.europa.eu/environment/topics/waste-and-recycling_en Selected materials from Extended producer responsibility alliance https://www.expra.eu/en/epr-partnerships Selected materials from Finland https://www.ymparisto.fi/en-us/consumption_and_production/Waste_and_waste_management Selected materials from the Ministry of the Environment, Finland. Waste. https://ym.fi/en/waste	

Table 3 Contents of Module 3: Waste management hierarchy

Module 3: **Waste management hierarchy**	Learning outcomes: Module 3 introduces the waste hierarchy ranking system is used for the different waste management options according to which is the best for the environment. The module deepens students' knowledge on the prevention, reuse, recycling, recovery and disposal of waste. He/she understands prevention of waste through chain optimization. He/she also understand how product design can support efficient recycling and remanufacturing. The student recognizes current challenges and opportunities in resource resilience. He/she can explain what waste hierarchy means

	for businesses and organizations that produce waste.

Contents: Principles of the waste hierarchy Waste reuse Waste recycling Waste recovery, incl. critical raw materials Waste disposal
Student's workload: 12 lecture hours + 20 individual study hours
Possible materials: European Commission, Waste and recycling, https://ec.europa.eu/environment/topics/waste-and-recycling_en European Commission, Implementation of the Waste Framework Directive, https://ec.europa.eu/environment/topics/waste-and-recycling/implementation-waste-framework-directive_en Bobba, S., Carrara, S., Huisman, J., Mathieux, F., Pavel, C. 2020. Critical Raw Materials for Strategic Technologies and Sectors in the EU - A Foresight Study. European Commission. Available https://ec.europa.eu/docsroom/documents/42881/attachments/1/translations/en/renditions/native Selected materials from European Environment Agency, Resource efficiency and waste, https://www.eea.europa.eu/themes/waste ZeroWasteEurope. 2021. Rethinking the landfill target. Available https://zerowasteeurope.eu/wp-content/uploads/2021/10/Rethinking-the-Landfill-Target_OCT2021.pdf

Table 4 Contents of Module 4: Waste treatment methods

Module 4: **Waste treatment methods**	Learning outcomes: Module 4 introduces core concepts of waste treatment and provides an understanding of waste processing and transformation options. The module also explains waste collection methods and efficient collection of waste in households and at companies. After the module, the student can examine appropriate methods of waste collections and can choose and design waste treatment systems and components.
Contents: Sorting and collection of waste The main types of waste management technologies Mechanical, biological treatment and thermal treatment	

Waste composting Anaerobic digestion Waste incineration Waste gasification and pyrolysis Waste landfilling Hazardous waste
Student's workload: 20 lecture hours + 44 individual study hours
Possible materials: Selected chapters from Letcher, T. and Vallero, D.(eds.). 2019. Waste - A Handbook for Management. Elsevier Inc. Selected chapters from Rao, M.N., Sultana, R. and Kota, S.H. 2016. Solid and Hazardous Waste Management. Butterworth-Heinemann Inc. Selected chapters from Pichtel, J. 2014. Waste management practices: municipal, hazardous, and industrial. CRC Press. Selected chapters from Rynk, R., Black, G., Gilbert, J., Biala, J., Bonhotal, J., Schwarz, M. and Cooperband, L. (eds.). 2021. The Composting Handbook - A how-to and why manual for farm, municipal, institutional and commercial composters. Elsevier. Selected materials from Resource efficiency and waste, https://www.eea.europa.eu/themes/waste Selected materials from CEWEP, https://www.cewep.eu/

Table 5 Contents of Module 5:

Module 5: **Waste, circular economy and digitalization**	Learning outcomes: Module 5 gives an overview of a shift in thinking of waste as a resource from the perspective of the circular economy and the green transition. Basic information on digitization in different waste management processes is also provided. The student can explain green transitions and digitalization and can search for the latest information on emerging topics.
Contents: Waste and circular economy Sustainable development goals and waste Zero Waste EU Green Deal Digitalization in the circular economy	

Student's workload: 8 lecture hours + 8 individual study hours
Possible materials: Selected chapters from Rathouse, A.R. 2020. Zero Waste Management Practices for Environmental Sustainability. CRC Press. Selected materials from European Commission. Green growth and circular economy. https://ec.europa.eu/environment/green-growth/index_en.htm Selected materials from Ellen MacArthur Foundation https://ellenmacarthurfoundation.org/ Selected materials from Zero Waste Europe https://zerowasteeurope.eu/ Selected materials from CEWEP, https://www.cewep.eu/ Selected materials from SDGs, https://sdgs.un.org/goals Prognos and CE Delft. 2022. Study: CO2 reduction potential in European waste management. Available https://fead.be/co2-study-higher-climate-benefits-thanks-to-the-european-waste-management-sector/ BRIEFING: Digital technologies will deliver more efficient waste management in Europe https://www.eea.europa.eu/themes/waste/waste-management/digital-technologies-will-deliver-more ETC/WMGE Report 4/2020: Digital waste management. Available https://www.eionet.europa.eu/etcs/etc-wmge/products/etc-wmge-reports/digital-waste-management

Further material

Further material can be applied according to needs. Following links and books, e.g., are worth looking into:

- EU Science Hub. Waste and circular economy, https://ec.europa.eu/jrc/en/research-topic/waste-and-recycling
- ISWA, https://www.iswa.org/
- OECD. 2022. Global Plastic Outlook, Economic Drivers, Environmental Impacts and Policy Options, https://www.oecd-ilibrary.org/environment/global-plastics-outlook_de747aef-en
- Williams PT (2013) Waste treatment and disposal. 2nd edition. John Wiley & Sons.
- Best Environmental Management Practice for the Waste Management Sector (2018). JRC Science for Policy report.
- Reynolds JJ, Jeris J, Theodore L (2007) Handbook of Chemical and Environmental Engineering Calculations. John Wiley & Sons.
- Azapagic A, Perdan S, Clift R (2011) Sustainable Development in Practice. Case studies for Engineers and Scientists. 2nd edition. John Wiley & Sons.
- Ram Chandra (2015) Environmental Waste Management. Routledge. 586 p.
- BILITEWSKI Bernd, HÄRDTLE Georg, MAREK Klaus. 1997. Waste management, Berlin : Springer

Modifications allowed

The proportional division and content of separate modules suggested above can be changed if local conditions or needs of participants could be responded to better by other solutions.

Examinations and qualifications

Examinations will be coordinated and competences will be controlled according to local regulation and locally required qualifications. It is each local actor's responsibility to take care that the admission requirements are fulfilled before the qualification application.

Notes for the Teacher

Satakunta University of Applied Sciences (SAMK)

Compiled by Dr Sirpa Sandelin and Dr Kari Lilja

The material enclosed is an example showing how the topics of this course could be presented. Each teacher should adjust this to the circumstances of his own country, considering the local regulation and the study programme of the students; are they studying engineering, environmental topics, finance or marketing, some examples to be given. Each programme may require different weightings and highlights, and it is on the responsibility of each teacher to consider these special needs.

Target group

The target group of the curriculum consists of Bachelor's programme students at universities and universities of applied sciences. The individual modules are well suited also to be applied as the open university courses.

Work required

In the curriculum, the average work required by each module is measured in ECTS credit units (abbreviated in this presentation as CU). One credit unit equals 27 hours workload. The curriculum consists of modules totalling 6 ECTS credit units corresponding to 160 hours containing lectures, professional field visits, individual studies, and assignments.

Teaching methods

Teachers are encouraged to use varying methods containing e.g.:

- Lectures,
- Visiting lecturers,
- Professional field visits,
- Visits in enterprises,
- Videos approaching the topics (Reliability of the source must be evaluated),
- Individual studies and
- Assignments.

Cooperation with the local experienced industry practitioners is highly recommended. All modules can be studied individually, so the modules can be offered also via open studies to all companies and organizations, that intend to implement or develop water and wastewater systems.

Contents of the curriculum

The variation in regulations and circumstances and qualification requirements are quite different in the BSR-countries, thus the material was written only as a form of framework inside which the local actors should modify the contents of modules according to their own regulations and local requirements, without forgetting the needs of different study programmes. By using innovative, problem-based and experiential educational approaches, teacher will be able to help students to become experts who are able to create and implement sustainable wastewater treatment solutions to regions outside of the sewage network.

The overall objectives of the curriculum are:

- The student deepens his/her knowledge about underlying basic information about waste management in the context of sustainable development.
- The student can explain general responsibilities that relate to waste management and the essential contents of legislation on waste management. The student can describe the producer's responsibilities according to the regulations.
- The student understands waste hierarchy principles, different waste fractions and their properties from a sorting, collection and treatment perspective.
- The student deepens his/her knowledge about waste management methods and their performance assessment in the context of sustainable development.

The curriculum is divided into modules as follows:

- Module 1: Sources, composition and properties of waste (12 + 20 hours)
- Module 2: Regulatory frameworks, strategies and organization of waste management (8 + 8 hours)
- Module 3: Waste management hierarchy (12 + 20 Hours)
- Module 4: Waste treatment methods (20 + 44 hours)
- Module 5: Waste, circular economy and digitalization (8 + 8 hours)

The slides

It is recommended, that the usability (According to immaterial rights legislation and Copyright clauses) of pictures and other material used in the slides will be checked and sources will be inserted to the slides before publishing them.

Part II Teaching Plan “Waste Management & Technologies“

Prof. Dr. Romualdas Ginevicius

Prof. Dr. Saulius Vasarevicius

Vilnius Gediminas Technical University

Introduction to Waste Management

PATVIRTINTA
Vilniaus Gedimino technikos universiteto rektoriaus 2015 m. rugpjūčio 6 d. įsakymu Nr. 766

(Pavyzdinė studijų dalyko (modulio) kortelės forma)

VILNIAUS GEDIMINO TECHNIKOS UNIVERSITETAS

STUDIJŲ DALYKO (MODULIO) (SD(M)) KORTELĖ PIRMOSIOS IR ANTROSIOS PAKOPŲ BEI VIENTISOSIOMS STUDIJOMS

Aplinkos apsaugos ir vandens inžinerijos **katedra**

COURSE CARD FOR THE FIRST AND SECOND CYCLE AND INTEGRATED STUDIES

.... ***Department***

SD(M) dėstomas:	☐ lietuvių kalba	☐ anglų kalba	☒ lietuvių ir anglų kalba
Language of studies:	*Lithuanian*	*English*	*Lithuanian and English*

SD(M) pavadinimas	***Course title***
Įvadas į atliekų tvarkymą	**Introduction to Waste Management**

SD(M) priklausomybė studijų pakopai

Course subjection to study level

Studijos: *Studies:*	B	– pirmosios pakopos – *First cycle*	☒	A	– vientisosios – *Integrated*	☐	M	– antrosios pakopos – *Second cycle*	☐

SD(M) priklausomybė programai

Course subjection to programme

SD(M) priklausomybė dalykų grupei* *Course subjection to group*	1
SD(M) priklausomybė programos daliai** *Course subjection to part of the programme*	B
Struktūrinė SD(M) priklausomybė*** *Course structural subjection*	K

SD(M) priklausomybė studijų kryptis ir krypčių grupė

Course subjection to science area and field

Studijų krypties ir krypčių grupės kodas *Study area and field code*	
04	T

*) **Grupė:** *) 1 – studijų dalyko (*Course*); 2 – praktikos (*Practice*); 3 – baigiamojo darbo ar projekto (*Final Work or Project*); 4 – tiriamojo darbo (*Research Work*); 5 – profesinio testavimo (*Professional Testing*); 8 – kitas (*Other*).
**) A – Bendrųjų universitetinių studijų (*General*); B – Studijų krypties (*Field*); C – Specializacijos (*Specialization*).
***) U – universiteto (*University*); F – fakulteto (*Faculty*); K – katedros (*Department*).

SD(M) kodas **SD(M) kreditai** **SD(M) atsiskaitymo forma**

Course code **Course volume in credits** **Course assessment**

Fakultetas *Faculty*		Katedra *Department*		Pakopa*) Study cycle	*SD(M) Nr. 15**) 001***) Number*
A	P	A	V	B	

Iš viso: *Total:*	Iš jų: KD, KS, KP, PR *There out:*
3	

Į, E1, E2, E, BE, BD, TD, A	KD, KS, KP, PR
E	

*) B – pirmoji pakopa (*first cycle studies*); A – vientisosios studijos (*integrated studies*); M – antroji pakopa (*second cycle studies*).

**) Naujoms ir atnaujintoms programoms skirtus studijų dalykus siūloma koduoti pirmais dviem skaitmenimis priskiriant 15 (pagal 2015 metus)

***) Dalyko registracijos numeris katedroje.

SD(M) valandų paskirstymas pagal studijų formas ir būdus

Distribution of course hours by study forms and ways

Studijų forma *Study form*	Kodas *Code*	Studijų būdas*) *Study way*	Valandos *(Hours)*						Iš jų: *There out:*	
			Paskai-toms *Lectures*	Laborato-riniams darbams *Laborotory works*	Praty-boms *Practical works*	Konsul-tacijoms *Consultation*	Savaran-kiškam darbui *Independent work*	Iš viso *Total*	Kontak-tinių *Contact*	Auditorinio darbo *Classroom*
Nuolatinės studijos *Full-time studies*	NL	S	30				50	80		30

*) Studijų būdas: S – semestrais (*semesters*); M – moduliais (*modules*); C – ciklais (*periods*); T – nuotolinis (*distance*).

**) Pildoma tik tada, kai taikomas SD(M) kortelėje nenurodytas studijų būdas (*must be used in case study way does not fall into standard category*).

ANNOTATION OF COURSE

Studijų dalyko modulis (SDM) padės studentams gilinti žinias apie prioritetinius atliekų tvarkymo metodus, jų veiksmingumo vertinimą darnios plėtros kontekste. Studentai įgys specialiųjų gebėjimų sprendžiant su atliekų tvarkymu susijusius klausimus; jų sprendimui taikant naujausias informacines technologijas. Studentai įgys bendrųjų gebėjimų gilinant ir sisteminant žinias; savarankiškai atliekant paskirtą užduotį (-is) semestro metu ir ruošiantis atsiskaitymams; kritiškai mąstant ir vertinant situaciją; dirbant kolektyve, tvarkingai ir aiškiai rengiant užduotis; sistemingai, aiškiai ir panaudojant vaizdines priemones pristatant darbo rezultatus.

Study discipline module will help students to deepen knowledge about underlying waste management methods and their performance assessment in the context of sustainable development. Students will gain special abilities to find solution for the waste management problem using modern informative technologies. Students will gain general abilities to deepen and structure the knowledge; to ful fill assigned task(s) and prepare for assessments independently during the semester; to think and assess situations critically; to work in a team; to prepare work tasks carefully and clearly; to submit work results tematically and clearly using visual aids.

AIM OF COURSE

Šio kurso tikslas yra gilinti studentų žinias apie prioritetinius atliekų tvarkymo metodus, jų veiksmingumo vertinimą darnios plėtros kontekste. Tai pasiekiama įgyjant supratimą apie susijusią riziką ir grėsmes, vystant savarankiško darbo ir darbo kolektyve gebėjimus, taikant kritinį mąstymą problemoms identifikuoti.

The aim of this course is intended for deepening student knowledge about underlying basic information about waste management in the context of sustainable development. This is achieved by gaining understanding about related risk and threats, developing abilities to work independently and in a team, using critical thinking for identification of problems.

Pagrindinė literatūra (ne daugiau kaip 5 šaltiniai):
Main references (not more than 5 references)

Eil. Nr. No.	Leidinio autoriai ir pavadinimas (elektroninių leidinių ir žiniatinklio adreso) *Authors and title (site address in case of e-publication)*	Egzempliorių skaičius *) *Number of copies*		
		VGTU bibliotekoje ir skaityklose *VGTU library*	Fakulteto ir katedros metodiniuose kabinetuose *Faculty library*	Kitose Lietuvos bibliotekose *Rest of the country*
1.	Trevor M. Letcher; Daniel A. Vallero. (2011) Waste. A Handbook for Management. Elsevier. 543 p.			
2.	Williams PT (2013) Waste treatment and disposal. 2nd edition. John Wiley & Sons. 424 p.			
3.	Ram Chandra (2015) Environmental Waste Management. Routledge. 586 p.			
4.	https://ec.europa.eu/environment/waste/index.htm			
5.	Best Environmental Management Practice for the Waste Management Sector (2018). JRC Science for Policy report. 658 p.			

*) Kortelės pildymo metu (*at the form filling moment*).

Papildoma literatūra (ne daugiau kaip 10 šaltinių):
Additional references (not more than 10 references)

Eil. Nr. No.	Leidinio autoriai ir pavadinimas (elektroninių leidinių ir žiniatinklio adreso) *Authors and title (site address in case of e-publication)*	Egzempliorių skaičius *) *Number of copies*		
		VGTU bibliotekoje ir skaityklose *VGTU library*	Fakulteto ir katedros metodiniuose kabinetuose *Faculty library*	Kitose Lietuvos bibliotekose *Rest of the country*
1.	Reynolds JJ, Jeris J, Theodore L (2007) Handbook of Chemical and Environmental Engineering Calculations. John Wiley & Sons. 948 p.			
2.	Azapagic A, Perdan S, Clift R (2011) Sustainable Development in Practice. Case studies for Engineers and Scientists. 2nd edition. John Wiley & Sons. 536 p.			

Savarankiško darbo turinys

Content of independent work

Užduoties pavadinimas *Assignment title*	Savarankiško darbo apimtis vienai užduočiai valandomis *Amount of hours of independent work for a single task*					Užduočių skaičius *Number of tasks*				Iš viso valandų *Total hours*			
	Rekomend-uojamos val. Recommended hours	Skirta val. Separated hours											
		NL(S)	I(S)	I(T)	*)	NL(S)	I(S)	I(T)	*)	NL(S)	I(S)	I(T)	*)
Kolokviumas *Intermediate examination*	8–27	27				1				27			
Egzaminas *examination*	16-24	23				1				23			
									Iš viso: *Total:*	50			

Savarankiško darbo grafikas
Individual work schedule

Užduoties tipas *Task type*	Užduoties pateikimo (*) ir atsiskaitymo (+) savaitė *Week of Assignment setting (*) and assessment (+)*																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Nuolatinės studijos (S) ***Full-time studies (S)***																					
Namų darbas *Home work* Kontrolinis darbas *test* Kolokviumas *Intermediate examination* Kita... *Other*	*) +																				

*) – Žymėjimo pavyzdys.

Paskaitų temų sąrašas
List of the Course lecture topics

Temos pavadinimas *Topic title*	Valandų skaičius *Number of hours*			
	NL	I	I(T)	*)
1. Categories of waste according their physical form.	2			
2. Categories of waste according their impact on humans and environment.	2			
3. Categories of waste according their chemical composition and their origin source.	4			
4. Waste classification according their generation streams.	2			
5. The main stages of waste management.	2			
6. Possible impacts of waste on environment.	2			
7. Waste reduction hierarchy.	2			
8. 4 main waste management principles.	2			
9. The aim of waste recycling. The aim of waste re-use.	4			
10. The physical and chemical properties of waste.	4			
11. Hazardous waste.	2			
12. EU Green Deal	2			
Iš viso: ***Total:***	30			

PATVIRTINTA
Vilniaus Gedimino technikos universiteto rektoriaus 2015 m. rugpjūčio 6 d. įsakymu Nr. 766

(Pavyzdinė studijų dalyko (modulio) kortelės forma)

VILNIAUS GEDIMINO TECHNIKOS UNIVERSITETAS

STUDIJŲ DALYKO (MODULIO) (SD(M)) KORTELĖ PIRMOSIOS IR ANTROSIOS PAKOPŲ BEI VIENTISOSIOMS STUDIJOMS

Aplinkos apsaugos ir vandens inžinerijos **katedra**

COURSE CARD FOR THE FIRST AND SECOND CYCLE AND INTEGRATED STUDIES

.... Department

SD(M) dėstomas: ☐ lietuvių kalba ☐ anglų kalba ☒ lietuvių ir anglų kalba

Language of studies: Lithuanian English Lithuanian and English

SD(M) pavadinimas	***Course title***
Atliekų tvarkymo technologijos	**Waste Management Technologies**

SD(M) priklausomybė studijų pakopai

Course subjection to study level

Studijos: *Studies:*	B	– pirmosios pakopos – *First cycle*	☒	A	– vientisosios – *Integrated*	☐	M	– antrosios pakopos – *Second cycle*	☐

SD(M) priklausomybė programai

Course subjection to programme

SD(M) priklausomybė dalykų grupei* *Course subjection to group*	1
SD(M) priklausomybė programos daliai** *Course subjection to part of the programme*	B
Struktūrinė SD(M) priklausomybė*** *Course structural subjection*	K

SD(M) priklausomybė studijų kryptis ir krypčių grupė

Course subjection to science area and field

Studijų krypties ir krypčių grupės kodas *Study area and field code*	
04	T

*) **Grupė:** *) 1 – studijų dalyko (*Course*); 2 – praktikos (*Practice*); 3 – baigiamojo darbo ar projekto (*Final Work or Project*); 4 – tiriamojo darbo (*Research Work*); 5 – profesinio testavimo (*Professional Testing*); 8 – kitas (*Other*).
**) A – Bendrųjų universitetinių studijų (*General*); B – Studijų krypties (*Field*); C – Specializacijos (*Specialization*).
***) U – universiteto (*University*); F – fakulteto (*Faculty*); K – katedros (*Department*).

SD(M) kodas

Course code

Fakultetas *Faculty*		Katedra *Department*		Pakopa*) Study cycle	*SD(M) Nr. 15**)001***)Number*
A	P	A	V	B	

SD(M) kreditai

Course volume in credits

Iš viso: *Total:*	Iš jų: KD, KS, KP, PR *There out:*
3	

SD(M) atsiskaitymo forma

Course assessment

J, E1, E2, E, BE, BD, TD, A	KD, KS, KP, PR
E	

*) B – pirmoji pakopa (*first cycle studies*); A – vientisosios studijos (*integrated studies*); M – antroji pakopa (*second cycle studies*).
**) Naujoms ir atnaujintoms programoms skirtus studijų dalykus siūloma koduoti pirmais dviem skaitmenimis priskiriant 15 (pagal 2015 metus)
***) Dalyko registracijos numeris katedroje.

SD(M) valandų paskirstymas pagal studijų formas ir būdus

Distribution of course hours by study forms and ways

Studijų forma *Study form*	Kodas *Code*	Studijų būdas*) *Study way*	Valandos *(Hours)*						Iš jų: *There out:*	
			Paskai-toms *Lectures*	Laborato-riniams darbams *Laborotory works*	Praty-boms *Practical works*	Konsul-tacijoms *Consultation*	Savaran-kiškam darbui *Independent work*	Iš viso *Total*	Kontak-tinių *Contact*	Auditorinio darbo *Classroom*
Nuolatinės studijos *Full-time studies*	NL	S	30				50	80		30

*) Studijų būdas: S – semestrais (*semesters*); M – moduliais (*modules*); C – ciklais (*periods*); T – nuotolinis (*distance*).
**) Pildoma tik tada, kai taikomas SD(M) kortelėje nenurodytas studijų būdas (*must be used in case study way does not fall into standard category*).

ANNOTATION OF COURSE

Studijų dalyke įgyjamos žinios apie atliekų susidarymą, šaltinius, atliekų rūšis ir sudėtį, atliekų fizines, chemines ir biologines savybes, atliekų tvarkymo principus, teisinį reglamentavimą ir tvarkymo prioritetus, atliekų surinkimą, mechaninį, biologinį ir terminį apdorojimą, atliekų šalinimą sąvartynuose, pavojingas atliekas ir jų susidarymo šaltinius, pakartotinį atliekų naudojimą, atliekų tvarkymą darnaus vystymosi kontekste.

Knowledge acquired during study subject on the generation, sources, waste type and composition, physical, chemical and biological characteristics, waste management principles, the legal regulation and waste management priorities, collection, mechanical, biological and thermal treatment, waste disposal in landfills, hazardous waste and their generation sources, re-use of waste and waste management in the context of sustainable development.

AIM OF COURSE

Šio kurso tikslas yra sužinoti apie atliekų susidarymo šaltinius, atliekų kiekius ir juos įtakojančius faktorius, atliekų savybes ir pagrindinius jų tvarkymo metodus ir įrengimus. Suprasti darnios aplinkos principų taikymą atliekų vadyboje. Žinoti atliekų perdirbimo principus, rūšiavimo mechanizmus, technologijas. Įgusti savarankiškai organizuoti savo darbą, sprendžiant uždavinius atliekų tvarkymo sistemos organizavime.

The aim of this course is to analyse the sources of waste generation, waste amounts, and factors which may affect them, and the main characteristics of the waste, methods and equipment used for waste management. To understand principles of sustainable environmental application in waste management. To know the principles of waste recycling, sorting mechanisms, and technologies. To become proficient in self- work organizing, solving problems of waste management systems organization.

Assessments criteria of students achievements

Pagrindinė literatūra (ne daugiau kaip 5 šaltiniai):
Main references (not more than 5 references)

Eil. Nr.	Leidinio autoriai ir pavadinimas (elektroninių leidinių ir žiniatinklio adreso)	Egzempliorių skaičius *) *Number of copies*

No.	Authors and title (site address in case of e-publication)	VGTU bibliotekoje ir skaityklose *VGTU library*	Fakulteto ir katedros metodiniuose kabinetuose *Faculty library*	Kitose Lietuvos bibliotekose *Rest of the country*
6.	PICHTEL John. Waste management practices :municipal, hazardous, and industrial. Boca Raton (Fla.): Taylor & Francis, 2005. 659 p.			
7.	Williams PT (2013) Waste treatment and disposal. 2nd edition. John Wiley & Sons. 424 p.			
8.	Ram Chandra (2015) Environmental Waste Management. Routledge. 586 p.			

*) Kortelės pildymo metu (*at the form filling moment*).

Papildoma literatūra (ne daugiau kaip 10 šaltinių):
Additional references (not more than 10 references)

Eil. Nr. No.	Leidinio autoriai ir pavadinimas (elektroninių leidinių ir žiniatinklio adreso) *Authors and title (site address in case of e-publication)*	Egzempliorių skaičius *) *Number of copies*		
		VGTU bibliotekoje ir skaityklose *VGTU library*	Fakulteto ir katedros metodiniuose kabinetuose *Faculty library*	Kitose Lietuvos bibliotekose *Rest of the country*
1.	Reynolds JJ, Jeris J, Theodore L (2007) Handbook of Chemical and Environmental Engineering Calculations. John Wiley & Sons. 948 p.			
2.	BILITEWSKI Bernd, HÄRDTLE Georg, MAREK Klaus. Waste management, Berlin : Springer, 1997. 699 p..			
3.	Azapagic A, Perdan S, Clift R (2011) Sustainable Development in Practice. Case studies for Engineers and Scientists. 2nd edition. John Wiley & Sons. 536 p.			

Savarankiško darbo turinys

Content of independent work

Užduoties pavadinimas *Assignment title*	Savarankiško darbo apimtis vienai užduočiai valandomis *Amount of hours of independent work for a single task*					Užduočių skaičius *Number of tasks*				Iš viso valandų *Total hours*			
	Rekomenduojamos val. Recommended hours	Skirta val. Separated hours											
		NL(S)	I(S)	I(T)	*)	NL(S)	I(S)	I(T)	*)	NL(S)	I(S)	I(T)	*)
Kolokviumas *Intermediate examination*	8–27	27				1				27			
Egzaminas *examination*	16-24	23				1				23			
Iš viso: *Total:*										50			

Savarankiško darbo grafikas
Individual work schedule

Užduoties tipas *Task type*	Užduoties pateikimo (*) ir atsiskaitymo (+) savaitė *Week of Assignment setting (*) and assessment (+)*																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Nuolatinės studijos (S)																					

Full-time studies (S)																					
Namų darbas *Home work* Kontrolinis darbas *test* Kolokviumas *Intermediate examination* Kita... *Other*	*) +																				

*) – Žymėjimo pavyzdys.

Paskaitų temų sąrašas
List of the Course lecture topics

Temos pavadinimas *Topic title*	Valandų skaičius *Number of hours*			
	NL	I	I(T)	*)
13. Solid waste collection	2			
14. The main types of waste management technologies	2			
15. Waste composting	2			
16. Waste incineration	2			
17. Waste reuse/recycling	2			
18. Waste gasification and pyrolysis	4			
19. Mechanical biological treatment	2			
20. Landfilling	2			
21. Anaerobic digestion	4			
22. Medical waste management. Hazardous waste management	4			
23. Construction and demolition waste management	2			
24. Sewage sludge management	2			
Iš viso: ***Total:***	30			

Attachmwnt I Teaching Material Modul B Waste mangement

Waste management

Vilnius Gediminas Technical University (VilniusTech), project partner number 3

- Compiled by Dr Saulius Vasarevicius

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

Introduction

<u>Consist of two parts:</u>

- Introduction to Waste Management, 3 ECTS
- Waste Management Technologies, 3 ECTS

- Lectures – 30+30 hours
- Independent work – 50+50 hours

Introduction

- Study discipline module will help students to deepen knowledge about underlying waste management methods and their performance assessment in the context of sustainable development. Students will gain special abilities to find solution for the waste management problem using modern informative technologies. Students will gain general abilities to deepen and structure the knowledge; to fulfill assigned tasks and prepare for assessments independently during the semester; to think and assess situations critically; to work in a team; to prepare work tasks carefully and clearly; to submit work results tematically and clearly using visual aids.
- Knowledge acquired during study subject on the generation, sources, waste type and composition, physical, chemical and biological characteristics, waste management principles, the legal regulation and waste management priorities, collection, mechanical, biological and thermal treatment, waste disposal in landfills, hazardous waste and their generation sources, re-use of waste and waste management in the context of sustainable development

Introduction

The main aims:

- The deepening student knowledge about underlying basic information about waste management in the context of sustainable development. This is achieved by gaining understanding about related risk and threats, developing abilities to work independently and in a team, using critical thinking for identification of problems.
- The analysis of thesources of waste generation sources, waste amounts, and factors which may affect them, and the main characteristics of the waste, methods and equipment used for waste management. To understand principles of sustainable environmental application in waste management. To know the principles of waste recycling, sorting mechanisms, and technologies. To become proficient in self- work organizing, solving problems of waste management systems organization.

Introduction

Main definitions:

- Waste – any substance or object which the holder discards or intends or is required to discard.
- Waste recycling – waste management practices when waste materials are reprocessed into the same or another destination products or materials. This includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuel or filler.
- Waste management – waste collection, transport, use and disposal, organization and monitoring of these actions, after-care of disposal sites, including, when carried out by a waste dealer or broker.
- Biodegradable waste – any waste that can degrade or be fragmented aerobically or anaerobically.
- Municipal waste – household (home generated) waste and other waste which, by its nature or composition, is similar to waste from households.

Different types of waste

- Hazardous waste
  - E.g. Chemicals etc.
- Nuclear waste
  - E.g. Containing radioactive material etc.
- Electrical waste
  - E.g. Mobiles, computers, television sets etc.

Waste properties

- According to the physical form, can be distinguished following categories of waste: solid, liquid, pasty and gaseous.
- According to the impact on humans, animals, plants, other components of the environment, waste can be classified into hazardous and non-hazardous.
- Hazardous waste: toxic; highly flammable; cancerogenic; corrosive; explosives; self flammable; radioactive; hazardous to the environment and others.

Waste properties

According to the chemical composition, waste can be classified into inorganic and organic wastes.

- Organic waste can be classified in many different ways: animal origin, anthropogenic origin, easy or hard biodegradable.

- According to the calorific value, waste can be classified into self flammable, incinerated (with additional fuel) and a nonflammable.

Waste properties

- Inert waste (e.g. construction debris) over time practically does not change its properties, it is very difficult to break down and in the environment does not emit hazardous gases or liquids.

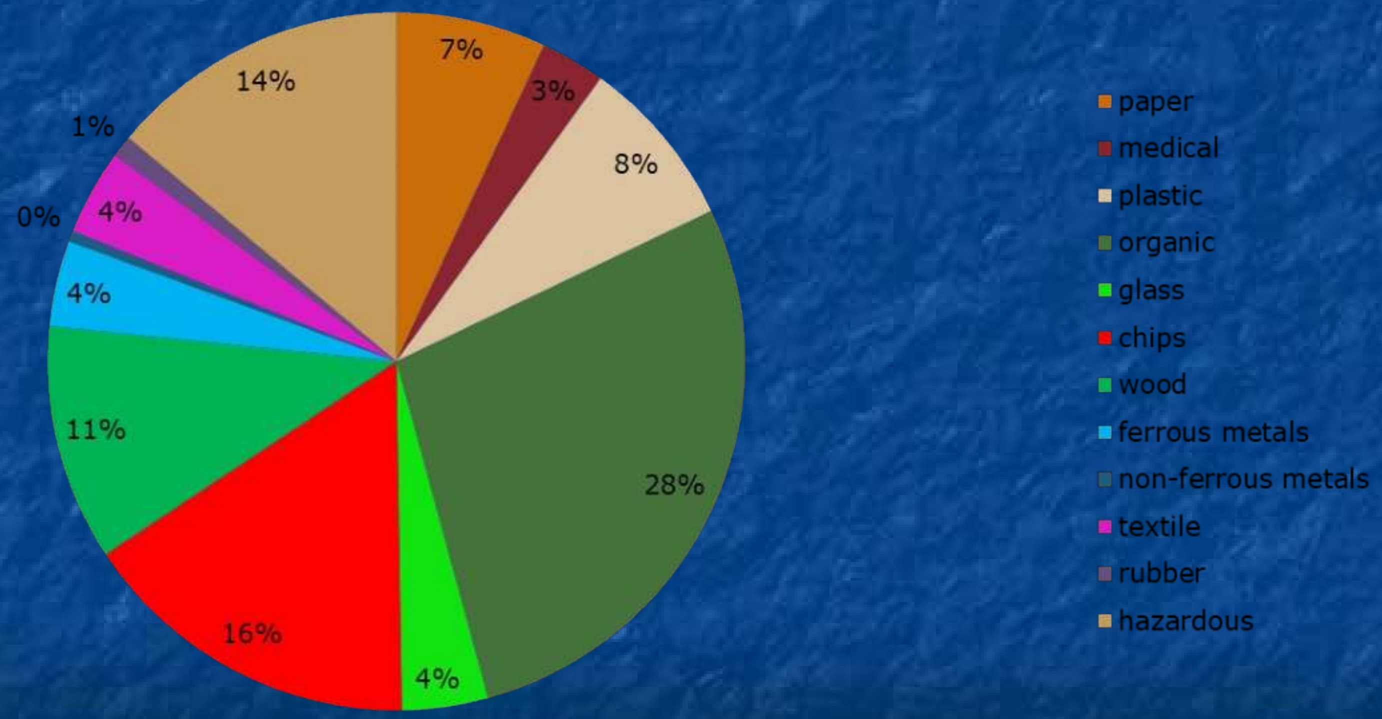
- According to their use, waste can be classified into secondary raw materials and waste not suitable for recycling.

Classification

According to the generation streams, waste can be classified into:

- municipal waste;
- industrial waste;
- hazardous waste;
- packaging waste;
- biodegradable waste;
- bulky (massive, large) waste;
- inert construction waste.

Composition (example)

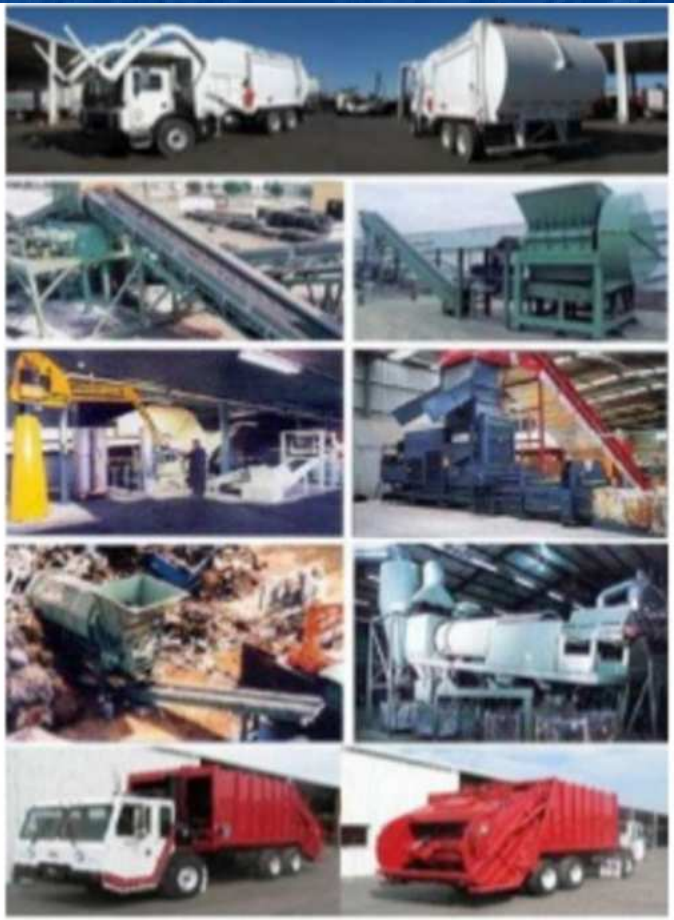


Classification

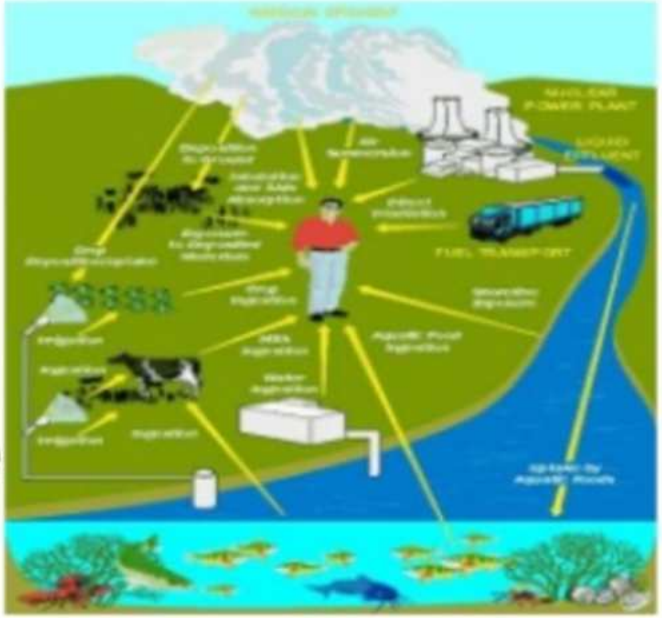
- According to the **origin source**, waste can be classified into:
  - household;
  - commercial;
  - institutions;
  - construction;
  - municipal services;
  - waste management companies;
  - production;
  - agriculture.

Waste management includes

- Collection
- Transportation
- Disposal
- Treatment
- Storage
- Processing
- Source separation
- Transfer

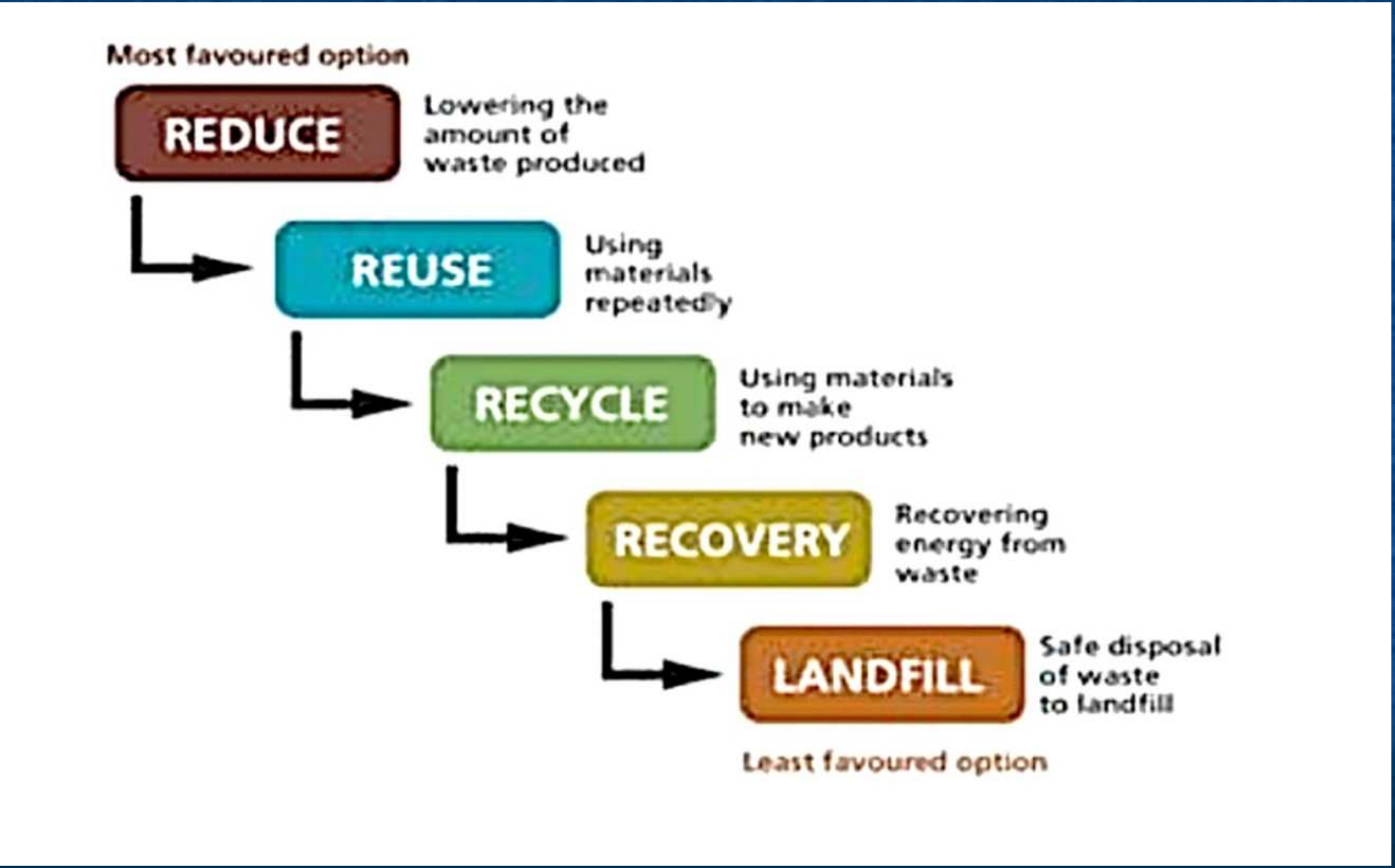


Effects of waste if not managed



- Affects on human health
- Affects on animals health
- Affects our climate
- Rise in global temperature
- Rise in sea levels
- Affects our coastal and marine environment

Waste reduction hierarchy



Reduce and Reuse of Waste

- Process of reducing the amount of waste produced by a person or a society.
- To reuse a item that again after it has been used.

<u>Ways to reduce and reuse waste:</u>

- Say no to plastic bags
- Use cloth diapers for your baby
- Buy reusable water bottles
- Use rechargeable batteries
- Give away or sell things you do not use
- Save and reuse gift bags that you receive

Reuse

reuse

Recycling of Waste

- Process that takes waste items and turns them into raw materials that can be made into new products.

<u>Tips to recycle waste:</u>

- Sort waste in recycling bins that is provided in your area.
- Recycle your newspapers.
- Find out what recycling programmes or centers exist in your area.
- Set up your own recycling system.
- Spread the word.

Recycling of Waste

Recovering of Waste

- Using waste to replace other non-waste materials to achieve a beneficial outcome in an environmental sound manner.

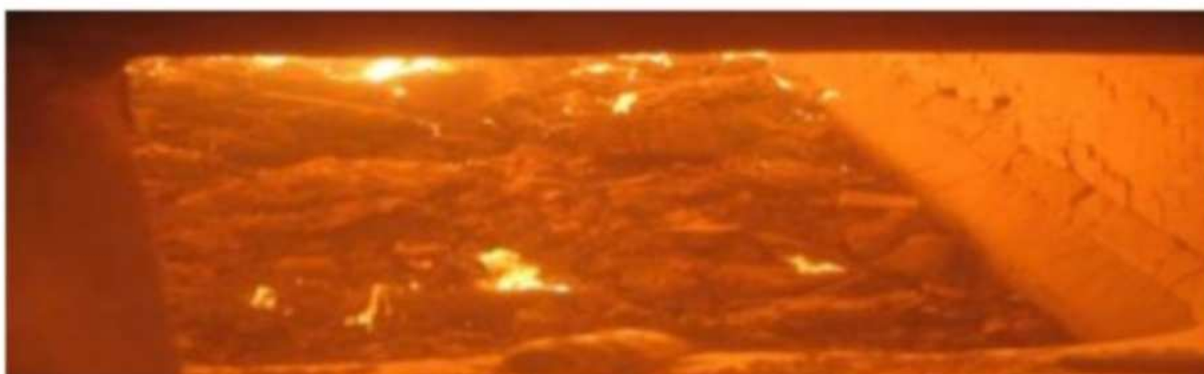
Ways of recovering of waste:

- Grass clippings.
- Vegetable waste.
- Heat recovery from your home.

Disposal of Waste

<u>Methods to dispose of waste:</u>

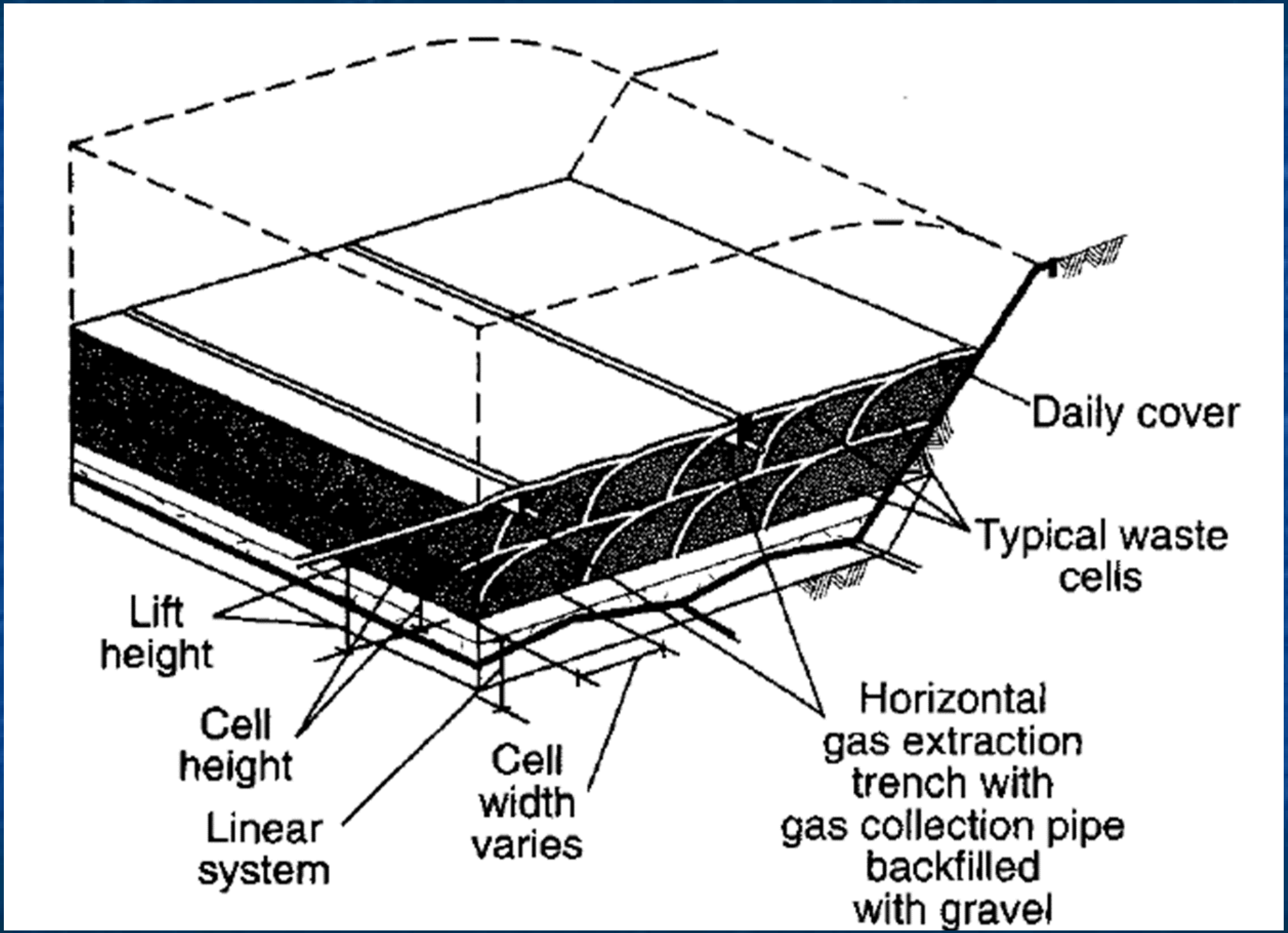
- Landfills
  - Burying waste
- Incineration
  - Controlled burning at high temperatures
- Recycling



Landfills

- Carefully engineered area in the ground
- Man-made construction or erosion of the Earth
- Different shapes and sizes
- Objective is to fill with wastes
- Main goal is to keep hydraulic connection between wastes and surrounding environment

Landfills


Daily cover
Typical waste cells
Lift height
Cell height
Linear system
Cell width varies
Horizontal gas extraction trench with gas collection pipe backfilled with gravel

Landfills

- **Bottom liner-** separates trash and subsequent leachate from groundwater
- **Leachate collection system-** collects water that has percolated through the landfill itself and contains contaminating substances (leachate)

Landfills

- **Cover-** seals off the top of the landfill
- **Natural hydrogeologic setting-** the area in which a landfill is located must be simple and waterproof to prevent wastes from escaping

Properties of the waste

Physical properties of waste

Waste	Average density, kg/m^3	Average humidity, %
Food	290	70
Paper	70	5
Plastic	60	2
Glass	200	2
Metal	200	2
Textile	60	10
Ash and dust	500	8

Properties of the waste

Physical properties of waste (Waste density)

- Waste density is changing at various management stages:
  - density before transportation – 200–300 kg/m^3;
  - density after transportation – 300–400 kg/m^3;
  - compacted waste density – 400–600 kg/m^3;
  - burned waste density – 800–1500 kg/m^3;
  - solid waste density – 800–2000 kg/m^3;
  - typical non-compacted waste density – 300 kg/m^3 (using for calculations).

Waste density is 200–400 kg/m^3 at landfill.

Hazardous wastes and their hazardous properties determining

Mechanical Biological Treatment of Municipal Solid Waste

Goals of MBT

Volume reduction of waste to be landfilled to minimize the necessary landfill capacity and to prolong the operating life of a landfill.

Reduction of the microbiological activity of the biodegradable waste fraction so that the uncontrolled generation of climate-damaging landfill gas is minimized as far as possible.

Mass reduction of dangerous substances which otherwise will elute to the leachate on the landfill and can led to a groundwater contamination if the leachate is not collected and treated.

Material and energy recovery by material separation and where applicable generation of refused derived fule (RDF) or biogas (MBT-plants with anaerobic digestion)

Principle of the process

Material flow oriented approach

Separation of the mixed waste in:

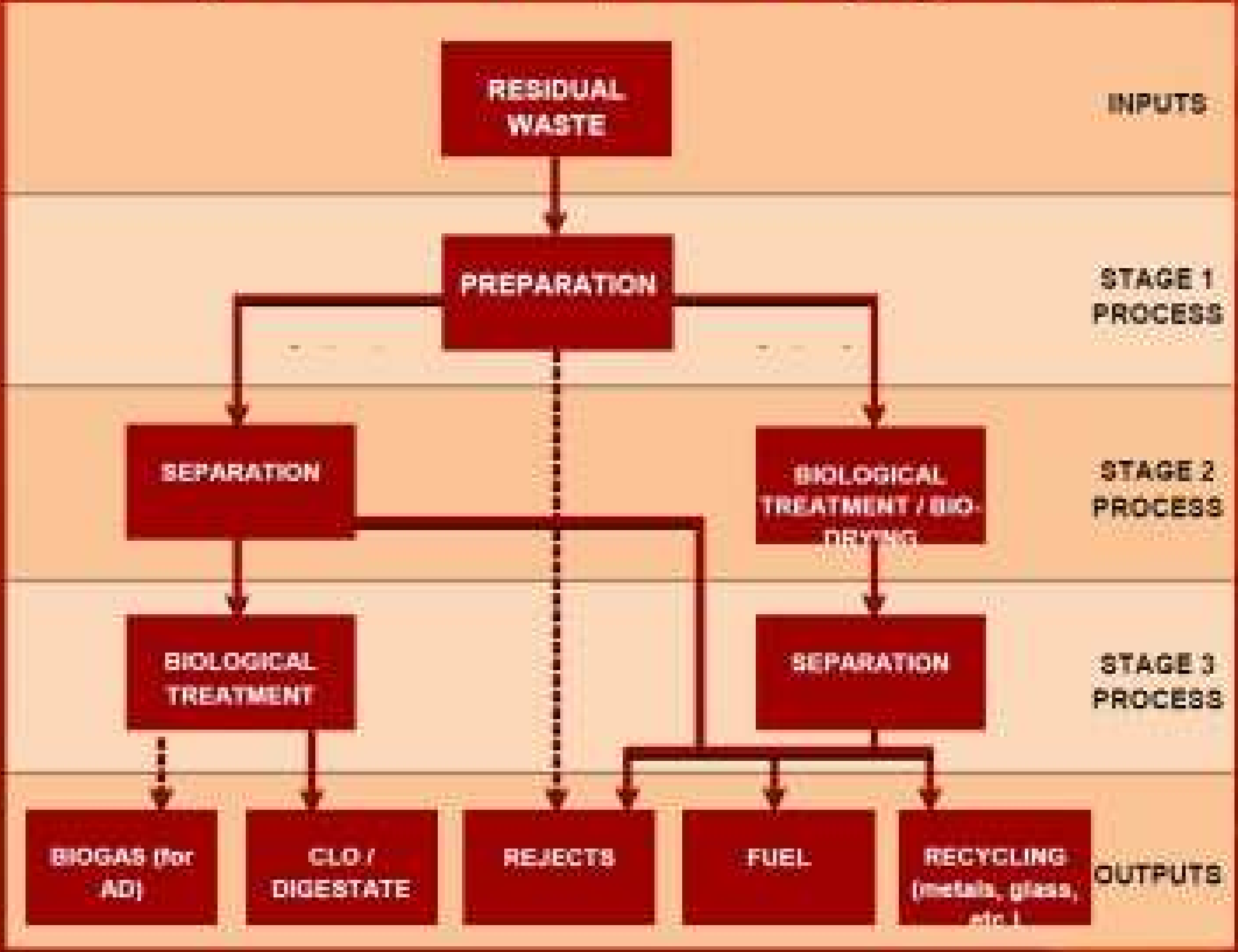
- *waste for material recovery*
- *waste for energy recovery*
- *waste for biological treatment*

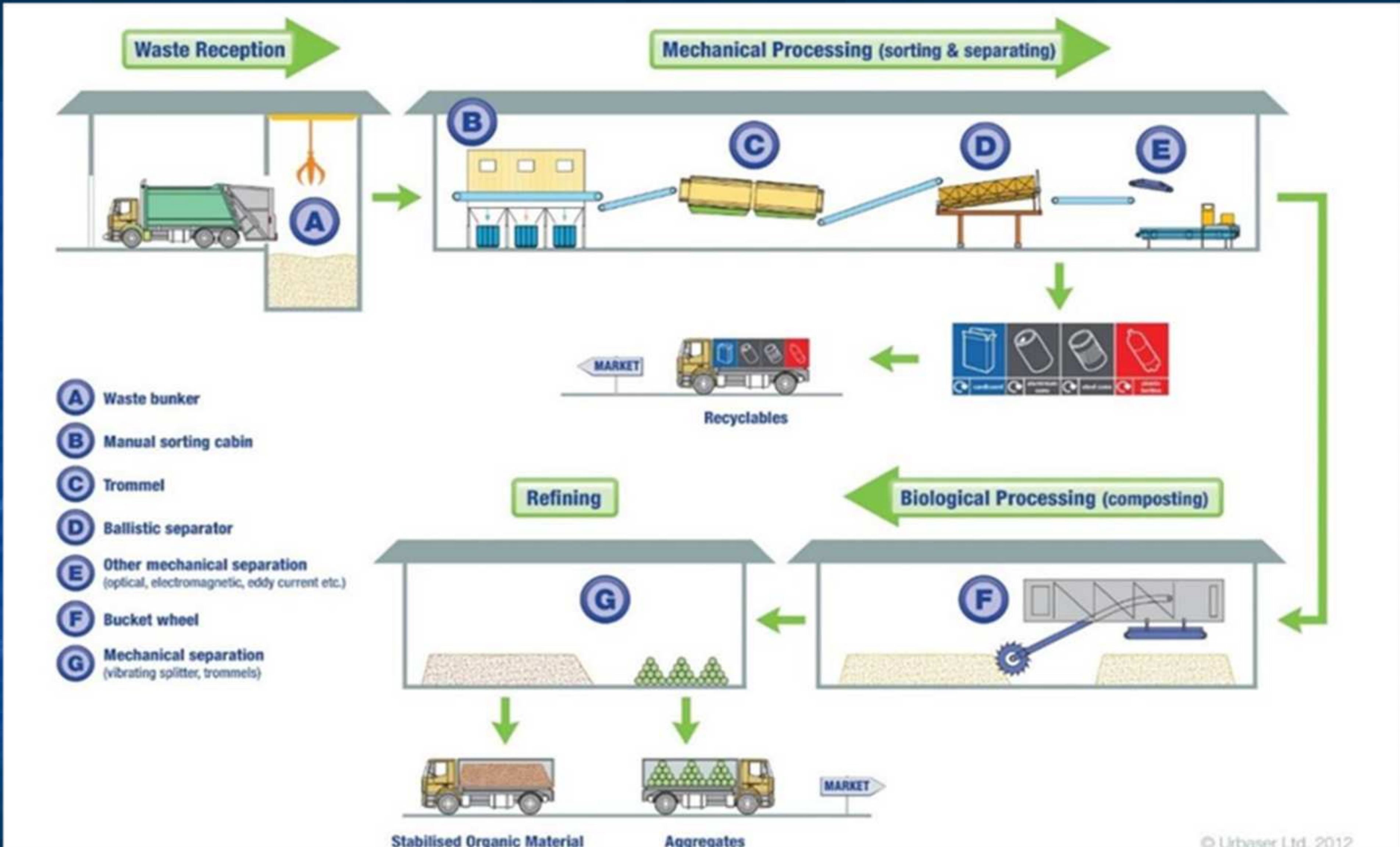
2 basic processes

Stabilization and drying of waste for energy recovery

Treatment of waste for a low-emission landfilling

MBT plants may be configured in a variety of ways to achieve the required recycling, recovery and biodegradable municipal waste (BMW) diversion performance. Configurations for MBT plant and highlights the process steps.




Waste Reception
Mechanical Processing (sorting & separating)
A
B
C
D
E
MARKET
Recyclables
A Waste bunker
B Manual sorting cabin
C Trommel
D Ballistic separator
E Other mechanical separation
(optical, electromagnetic, eddy current etc.)
F Bucket wheel
G Mechanical separation
(vibrating splitter, trommels)
Refining
Biological Processing (composting)
G
F
MARKET
Stabilised Organic Material
Aggregates
© Urbaser Ltd. 2012

Waste Preparation Techniques

Technique	Principle	Key Concerns
Hammer Mill	Material significantly reduced in size by swinging steel hammers.	Wear on Hammers. Pulverising and 'loss' of glass / aggregates. Exclusion of pressurised containers.
Shredder	Rotating knives or hooks rotate at a slow speed with high torque. The shearing action tears or cuts most materials.	Large, strong objects can physically damage the shredder. Exclusion of pressurised containers.
Rotating Drum	Material is lifted up the sides of a rotating drum and then dropped back into the centre. Uses gravity to tumble, mix, and homogenize the wastes. Dense, abrasive items such as glass or metal will help break down the softer materials, resulting in considerable size reduction of paper and other biodegradable materials.	Gentle action – high moisture of feedstock can be a problem.
Ball Mill	Rotating drum using heavy balls to break up or pulverise the waste.	Wear on balls. Pulverising and 'loss' of glass / aggregates.
Wet Rotating Drum with Knives	Waste is wetted, forming heavy lumps which break against the knives when tumbled in the drum.	Relatively low size reduction. Potential for damage from large contraries.
Bag Splitter	A relatively gentle shredder used to split plastic bags whilst leaving the majority of the waste intact.	Not size reduction. May be damaged by large strong objects.

Separation technologies exploit varying properties of the different materials in the waste. These properties include the size and shape of different objects, their density, weight, magnetism, and electrical conductivity. A summary of the different options for waste separation is shown in table

Separation Technique	Separation Property	Materials targeted	Key Concerns
Trommels and Screens	Size	Oversize – paper, plastic Small – organics, glass, fines	Air containment and cleaning
Manual Separation	Visual examination	Plastics, contaminants, oversize	Ethics of role, Health & Safety issues
Magnetic Separation	Magnetic Properties	Ferrous metals	Proven technique
Eddy Current Separation	Electrical Conductivity	Non-ferrous metals	Proven technique
Wet Separation Technology	Differential Densities	Plastics, organics will float Stones, glass will sink	Produces wet waste streams
Air Classification	Weight	Light – plastics, paper Heavy – stones, glass	Air cleaning
Ballistic Separation	Density and Elasticity	Light – plastics, paper Heavy – stones, glass	Rates of throughput
Optical Separation	Diffraction	Specific plastic polymers	Rates of throughput

Optical plastics separation. Image courtesy of New Earth Solutions Ltd.

Biological Treatment Options

Options	Biological Treatment
I	Aerobic – Bio-drying / Bio-stabilisation: partial composting of the (usually) whole waste.
II	Aerobic – In-Vessel Composting: may be used to either bio-stabilise the waste or process a segregated organic rich fraction.
III	Anaerobic Digestion: used to process a segregated organic rich fraction.

MBT – Lessons

1. Capital costs and tipping fees can be high
2. Material recovery rates are low
3. Compost quality is poor
4. Diversion rates are 20%




Possible Opportunities

Separate Collection and utilization of waste

Separation of recyclable waste fractions recirculation into the material circular flow

Mechanical-biological Treatment

(among others a high share of biodegradable waste, i.e. biowaste => composting)

Incineration of waste

Mineralization/ Inertization of organic waste fractions by oxidation under high temperatures

Waste to Energy

Promoting a clean future

- **Turning non-recyclable waste to a useable form of energy**
- **E.g. Electricity, heat or fuels**
- **Through combustion, gasification, anaerobic digestion, landfill gas recovery, and pyrolysis**

Presentation Outline

- What is Waste-to-Energy?
- Incineration
- Gasification
- Waste to Fuel
- Plastic to Fuel

Incineration

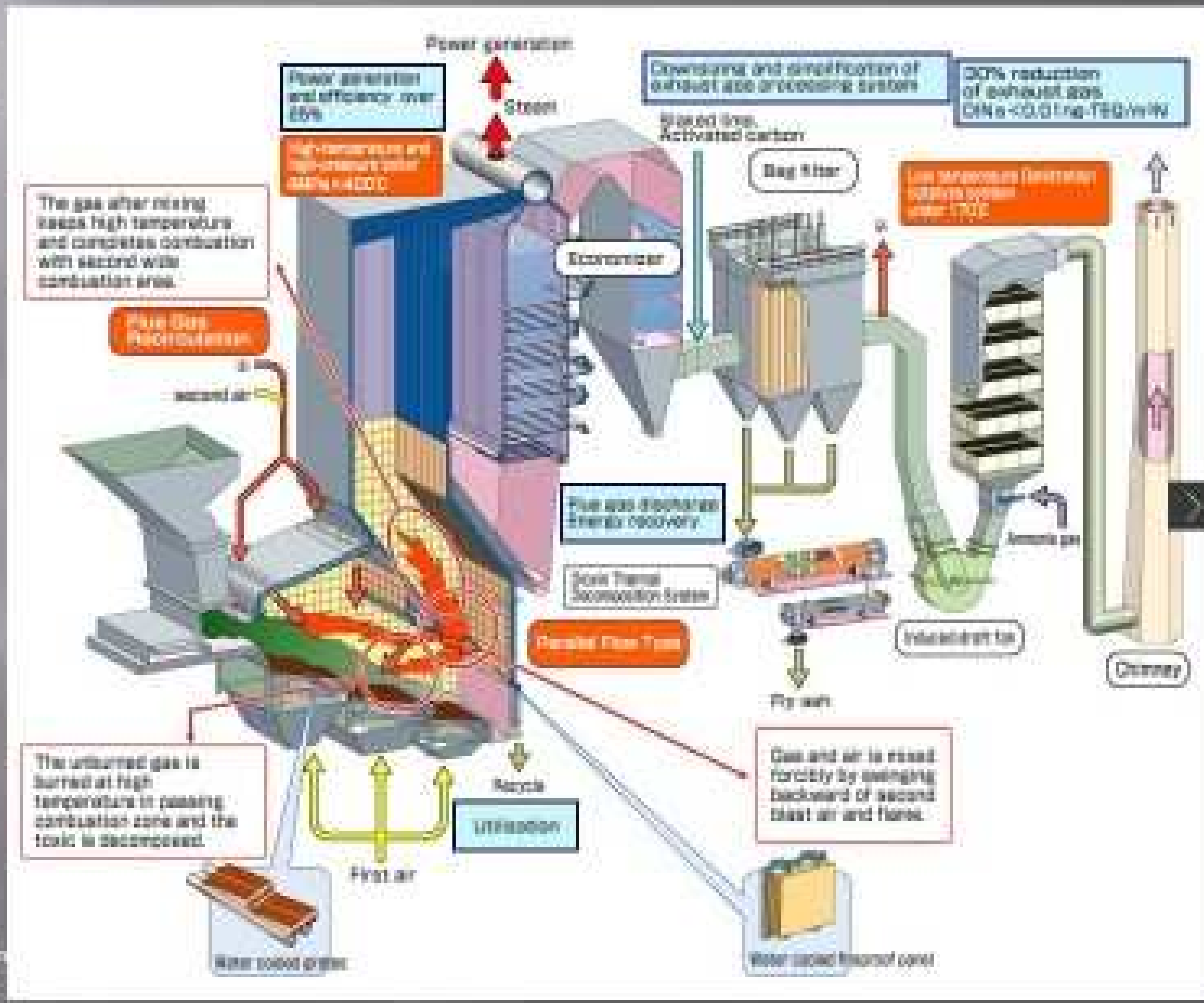
- **Works primarily on the combustion of municipal waste to generate heat for use in electricity generation.**
- **Key features:**
  - Waste storage and handling
  - Waste feeding
  - Combustion
  - Steam and electricity generation
  - Air pollution control
  - Ash residue handling
- **Combustion Stages:**

1. **Drying** — Moisture is evaporated
2. **Devolatilization** — Combustible volaties are released
3. **Ignition** — Volaties are ignited in the presence of oxygen
4. **Combustion** — Volatile matter is completely combusted and fixed (Carbon is oxidized to CO_2)

http://www.rpi.edu/dept/chem-eng/[illegible]

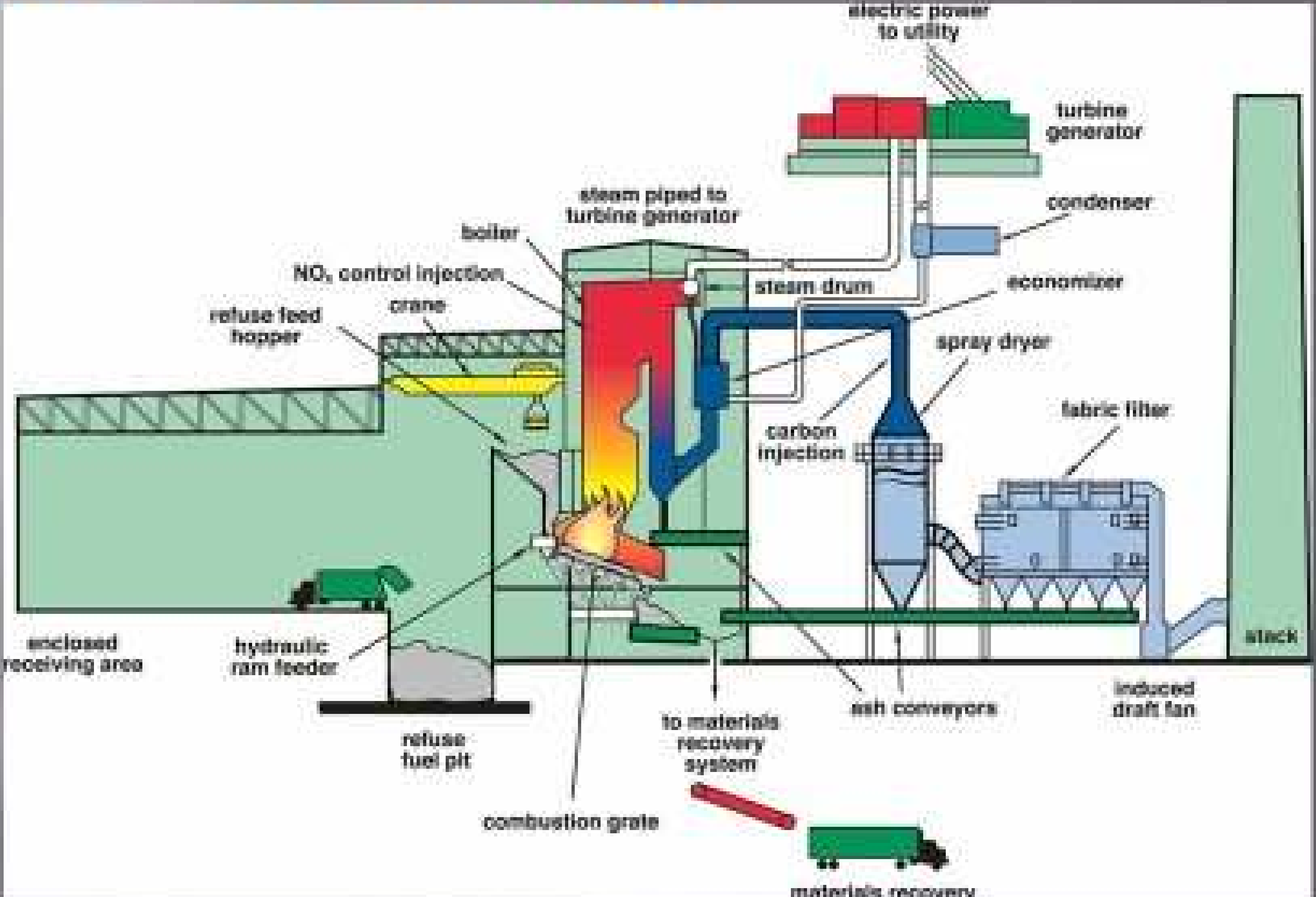
Incineration

Advanced Stoker System



http://www.khi.co.jp/english/kplan /environment/e_waste/heat.html

WtE Technology



Waste is energy!
– heat values of different fuels

85 % of MSW in Sweden is of biological origin

Incineration

Pros and Cons

Advantages

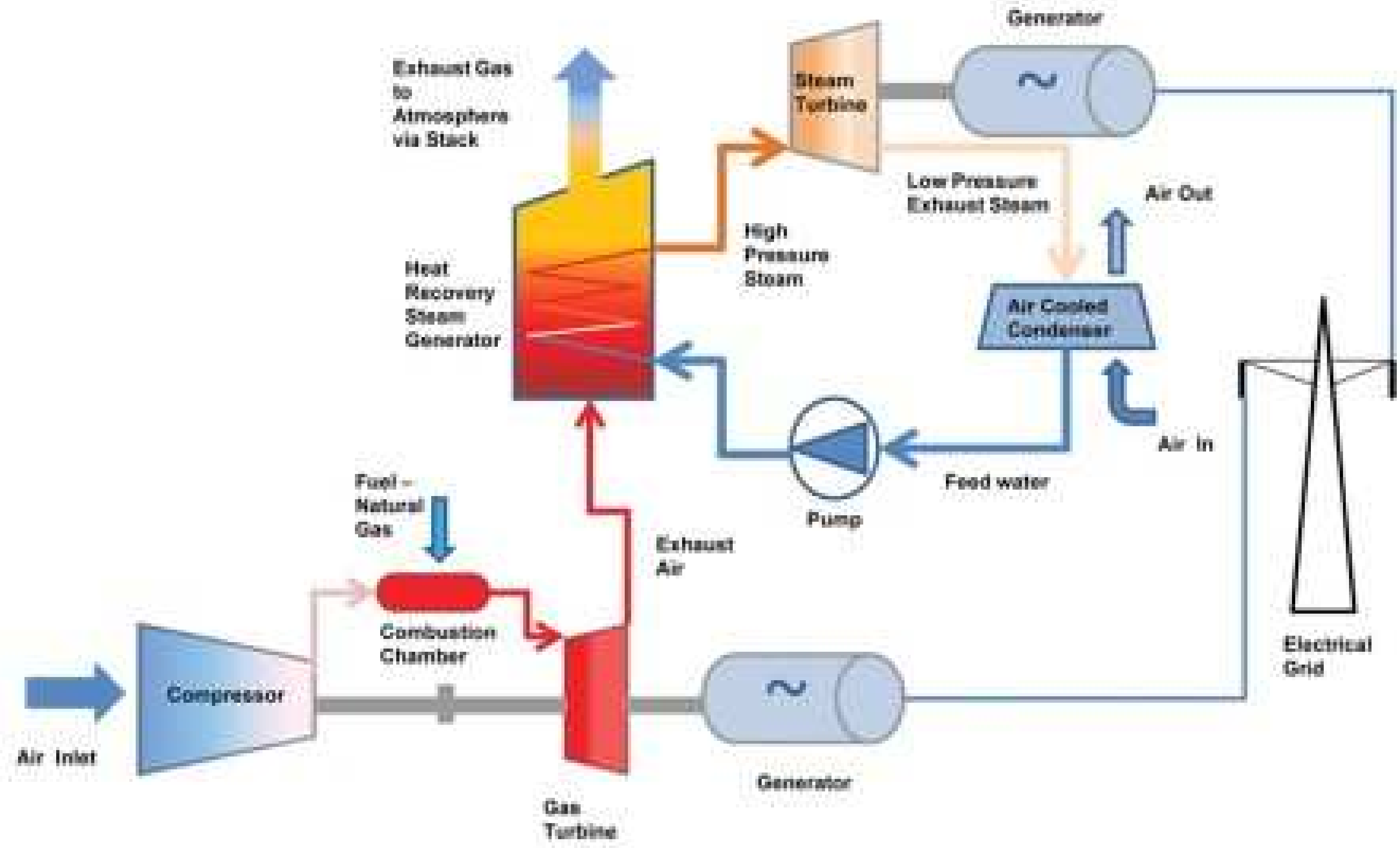
- Waste volume reduction (95%-96%)
- Destruction of combustible toxins
- Destruction of pathogenically contaminated material
- Energy recovery

Disadvantages

- Air pollution
- Ash must be landfilled and may be hazardous
- High capital and operation cost
- Wastewater problems

http://www.rpi.edu/dept/chem-eng/Biotech-Environ/incinerator.html

Gasification



Waste to Fuel: Biogas

Biogas Production

- Anaerobic digestion of organic matter in airtight digesters
- Anaerobic digestion in landfills

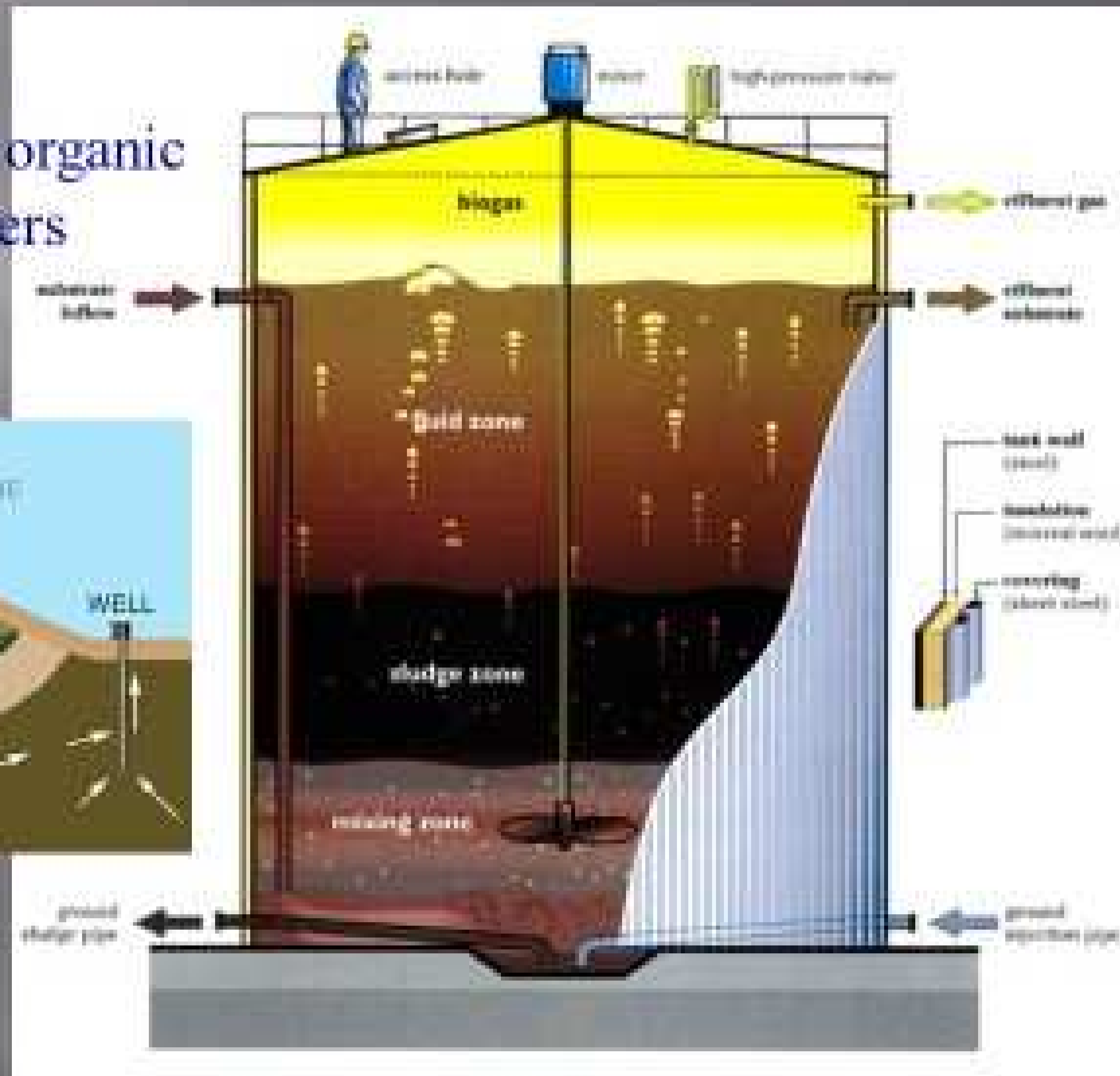
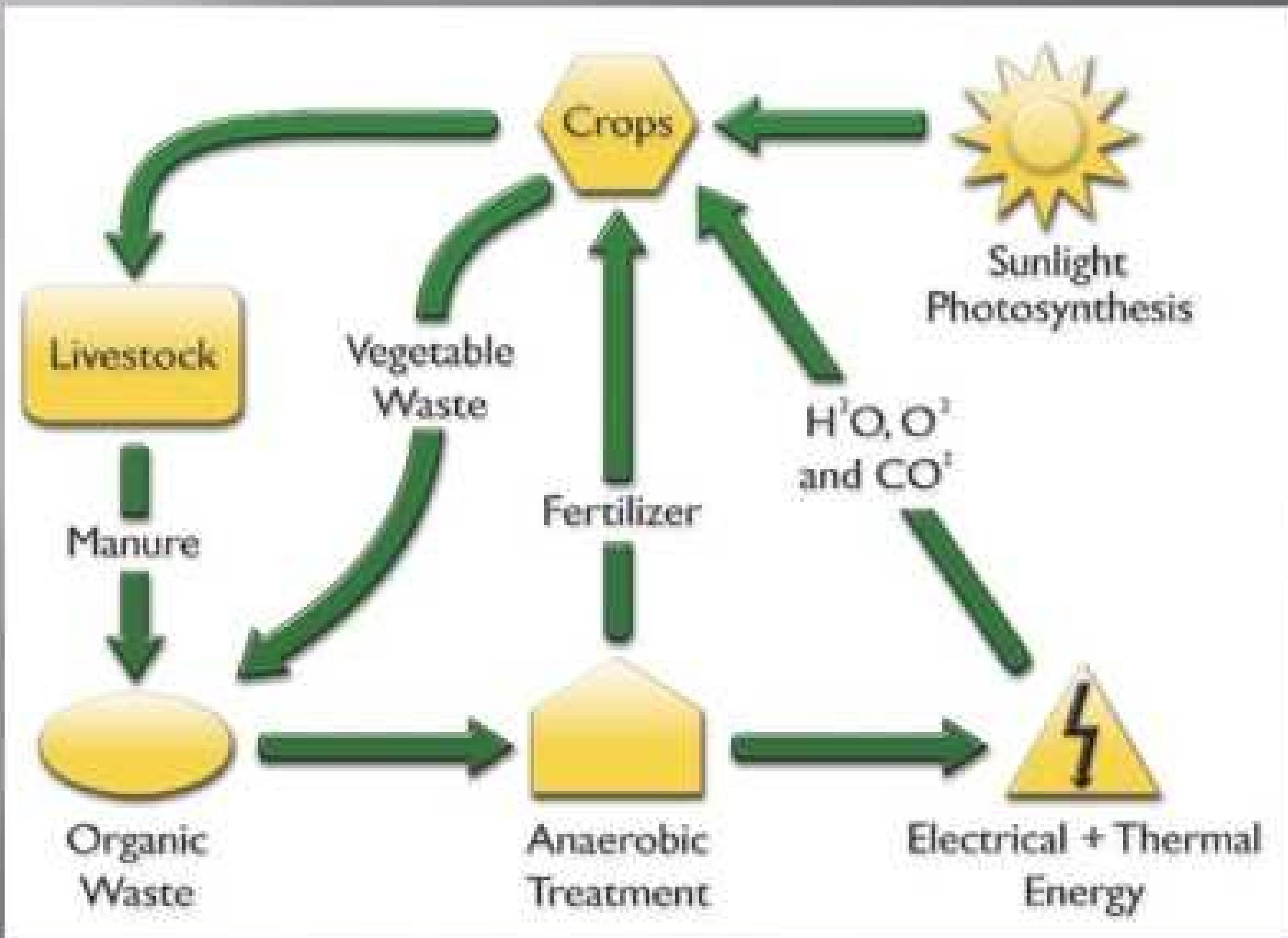


Image: http://www.msn.com/green-tech/research-innovations/blogs/landfill-methane-could-power-3-million-homes#
Image: http://www.daviddarling.info/encyclopedia/A/AE_anaerobic_digestion.html

Waste to Fuel: Biogas



Waste to Fuel: Biogas

Advantages

- Efficient way of energy conversion
- Household and bio-wastes can now be disposed of in a useful manner
- Provides a non-polluting and renewable source of energy*
- Significantly lowers the greenhouse effect on the earth's atmosphere
  - E.g. removing N_2O from manure**
- Excellent solution for agricultural & livestock waste

Disadvantages

- Less efficient than natural gas as direct fuel (low % purity)
- Process is not suitable for commercial use – largely domestic/rural cooking, etc.

Waste to Fuel: Biomethane

Biogas Upgrading

- Biogas is 65% methane, compared to 98.5-99% fuel grade
- Also contains other contaminants
  - Inert diluents reduce energy content: CO_2, N_2
  - Contaminants: Biologicals, Microbes, Trace Metals
  - Corrosives: Sulfur & H_2S, Siloxanes, Ammonia

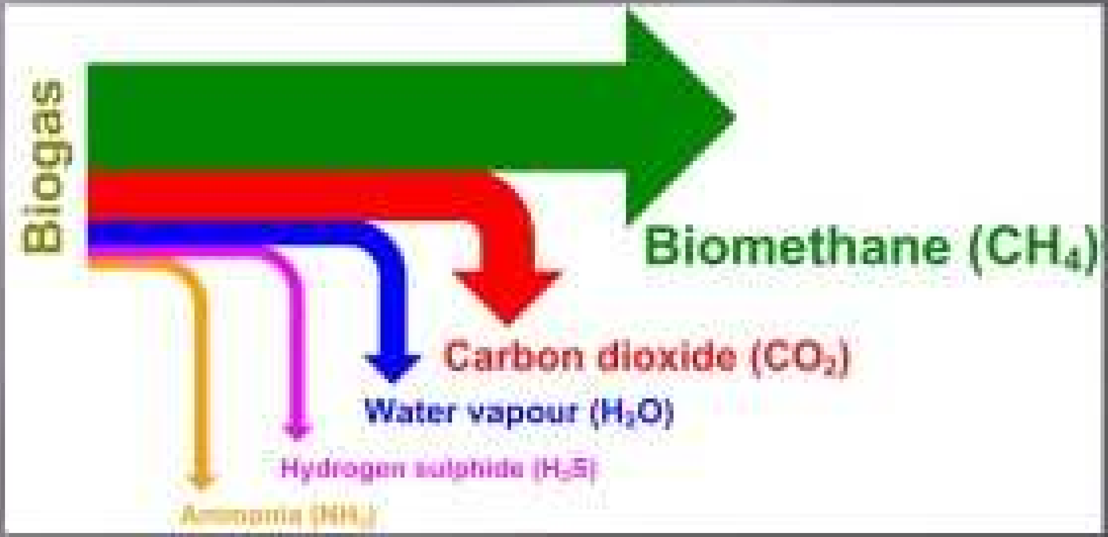


Image: http://www.bio-methaneregions.eu/?q=node/41

Waste to Fuel

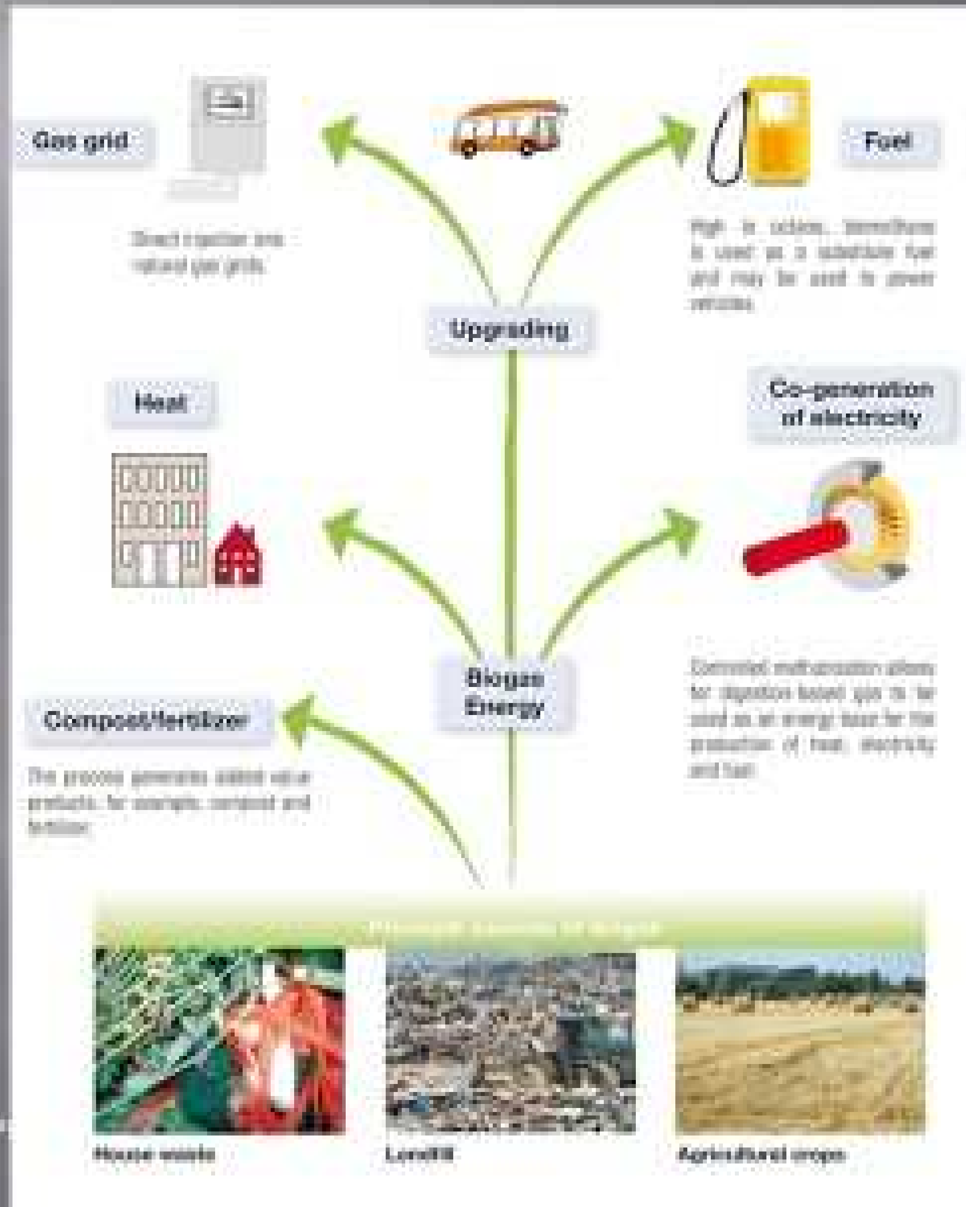


Image:
http://www.biogasman.co.uk/biogas-strate
biofuel-opportunities-from-biogas-to-
biomethane-and-biofuel.html

Syngas

- **A promising process for green-fuel and electricity production involves the formation of SYNGAS which can be converted to useful fuel and other organic materials.**

What is syngas?

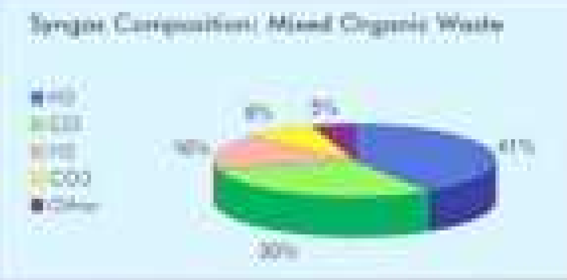
Abbreviation of "synthetic gas".
It can be the end product of thermally processed biomass

<u>the main compounds in syngas are:</u>

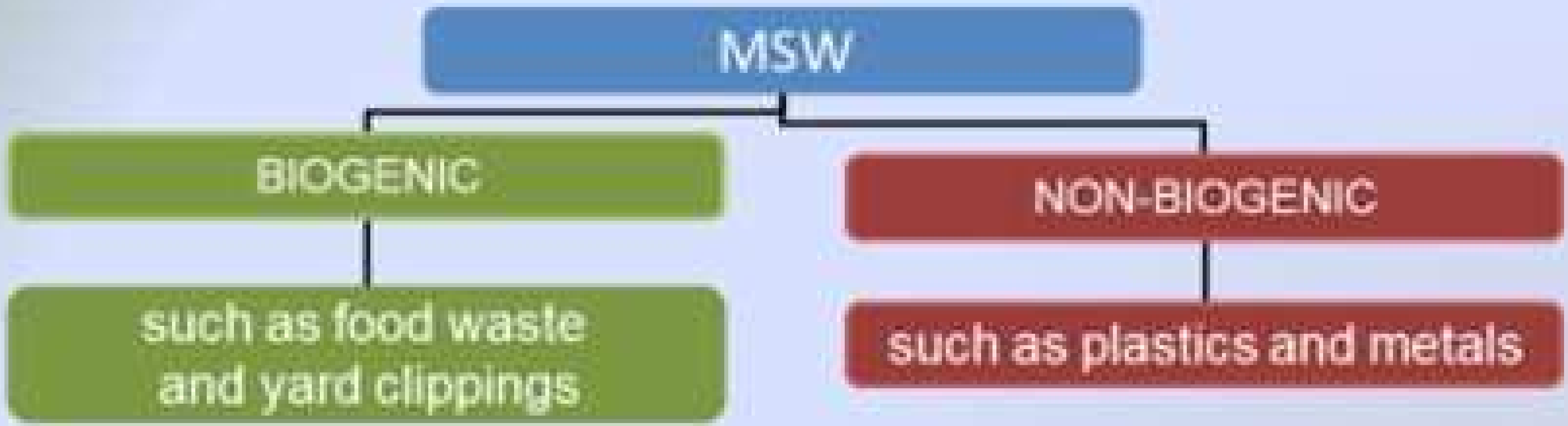
* Carbon monoxide : CO
* Hydrogen: H_2

<u>Other by-products:</u>

* Carbon dioxide: CO_2
* Methane: CH_4



Municipal Solid Waste



Heat contents for select components of municipal solid waste

Biogenic	Heat content MWh/ton	Non-biogenic	Heat content MWh/ton
Newsprint	4.7	Rubber	7.9
Paper	2.0	PET (polyethylene terephthalate)	6.0
Containers and packaging	4.8	HDPE (high-density polyethylene)	5.7
Textiles	4.0	PVC	4.8
Wood	2.9	LDPE/LLDPE (low-density polyethylene)	7.1
Food waste	1.5	PP (polypropylene)	11.1
Yard trimmings	1.8	PS (polystyrene)	6.0
Leather	4.2	Other (plastic)	5.3
Average	**3.3**	**Average**	**6.7**

http://www.eia.gov/todayinenergy/detail.cfm?id=8010

Thermal waste treatment

Thermal waste treatment

- **Combustion**

  rapid oxidation of a feedstock as it is exposed air . heat in a boiler where steam, under high pressure, is passed through a turbine which powers a generator

- **pyrolysis**

  Thermal degradation of waste in the absence of air to produce char, oil, and syngas. e.g. wood to charcoal

  $300^0C - 600^0C$

- **gasification**

  Breakdown of hydrocarbons into syngas by controlling the amount of oxygen during burning.

  $\sim 1400^0C$

  $7000KPa$

Packaging waste

Different kinds of packaging waste

- Glass
- Polymers
- Paper and cardboard
- Aluminum
- Liquid packaging
- Wood
- Other materials






Packaging waste

Waste prevention

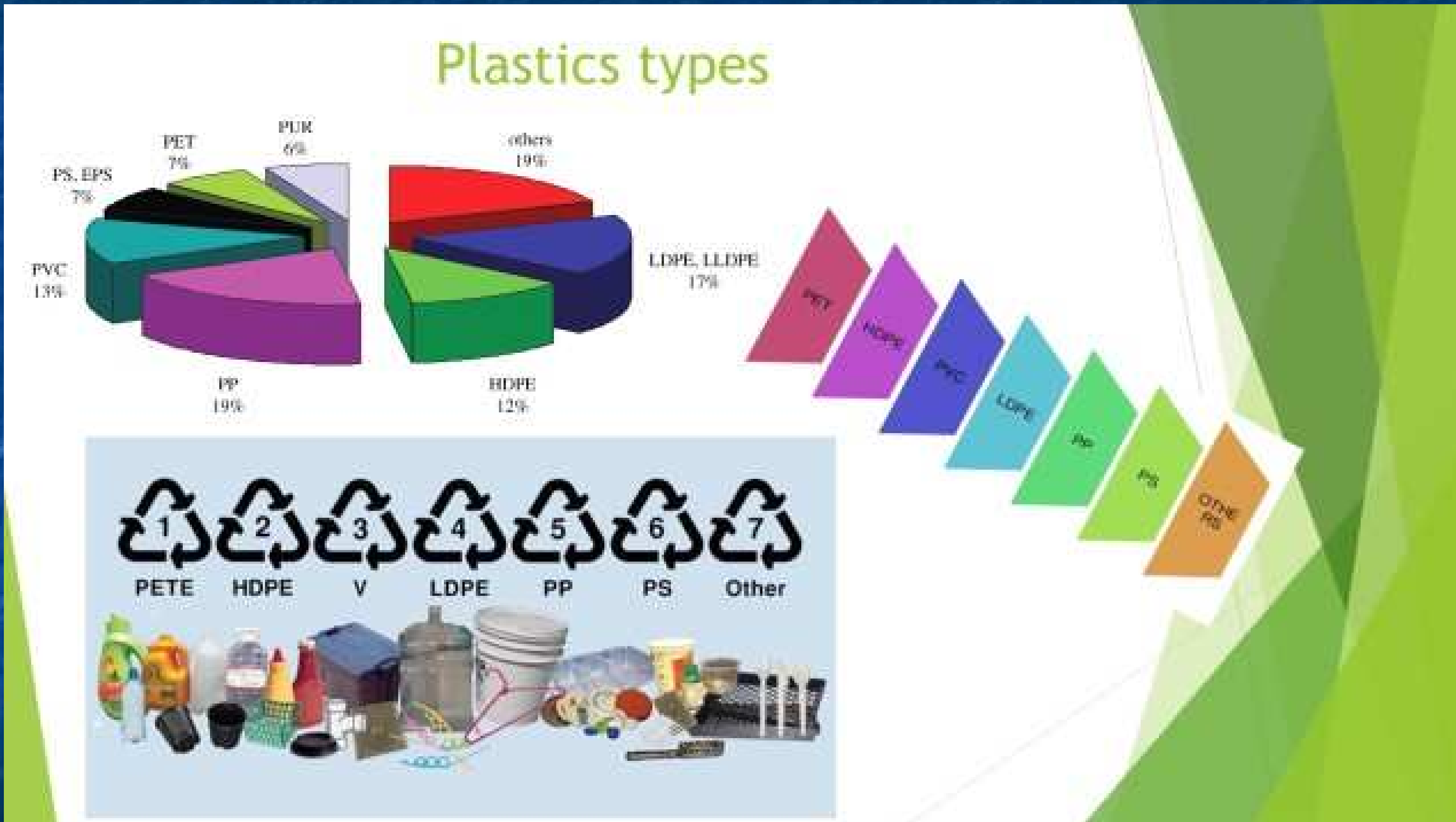
- Education
  - Elementary school
  - Campaigns
- Deposit system
  - Reusable
    - Glass bottles
    - Hard plastic
  - One-way
    - PET
  - Commercial
    - Cardboard
    - Wood packaging

Reusable	One-way
Für die Umwelt MEHRWEG	
Label can be on product	Label has to be on product
8 or 15 cent deposit	Always 25 cent deposit

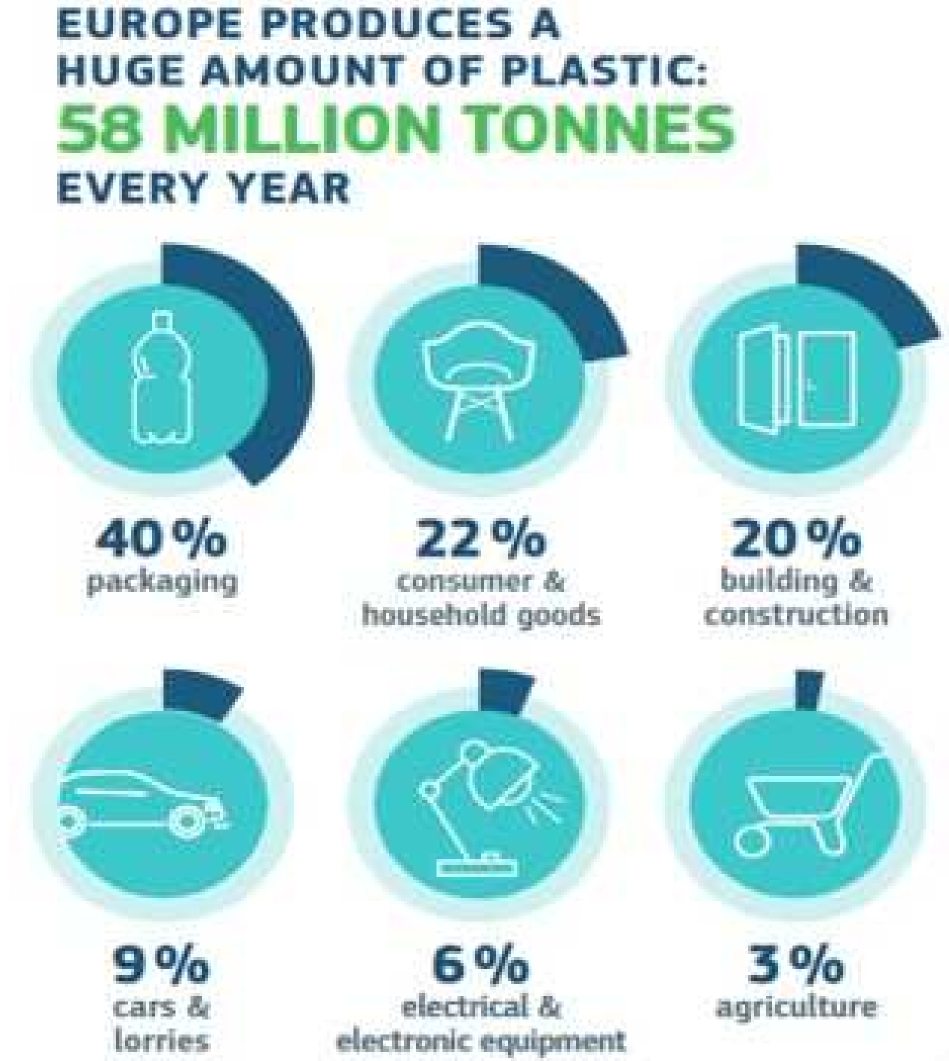
Packaging waste

Packaging waste

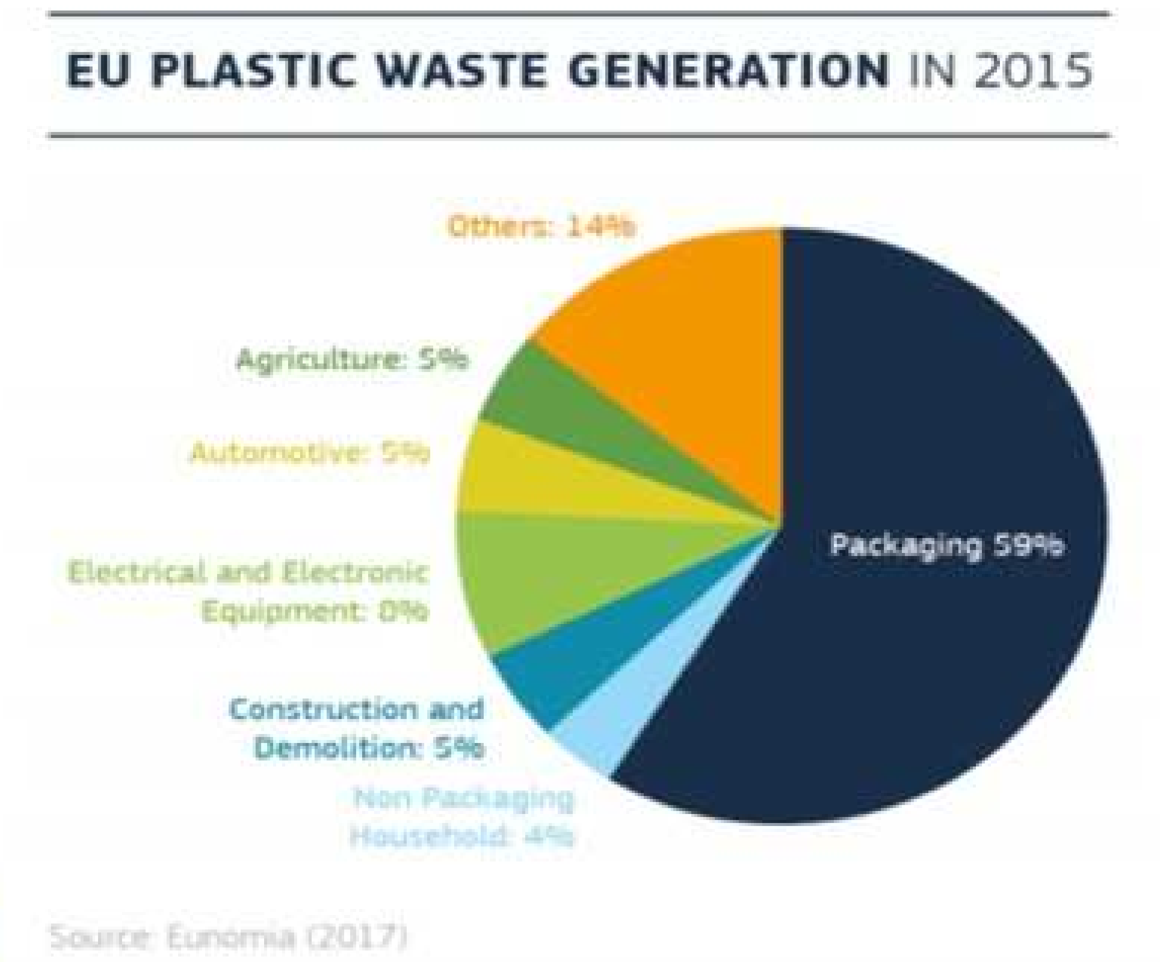
Plastic waste



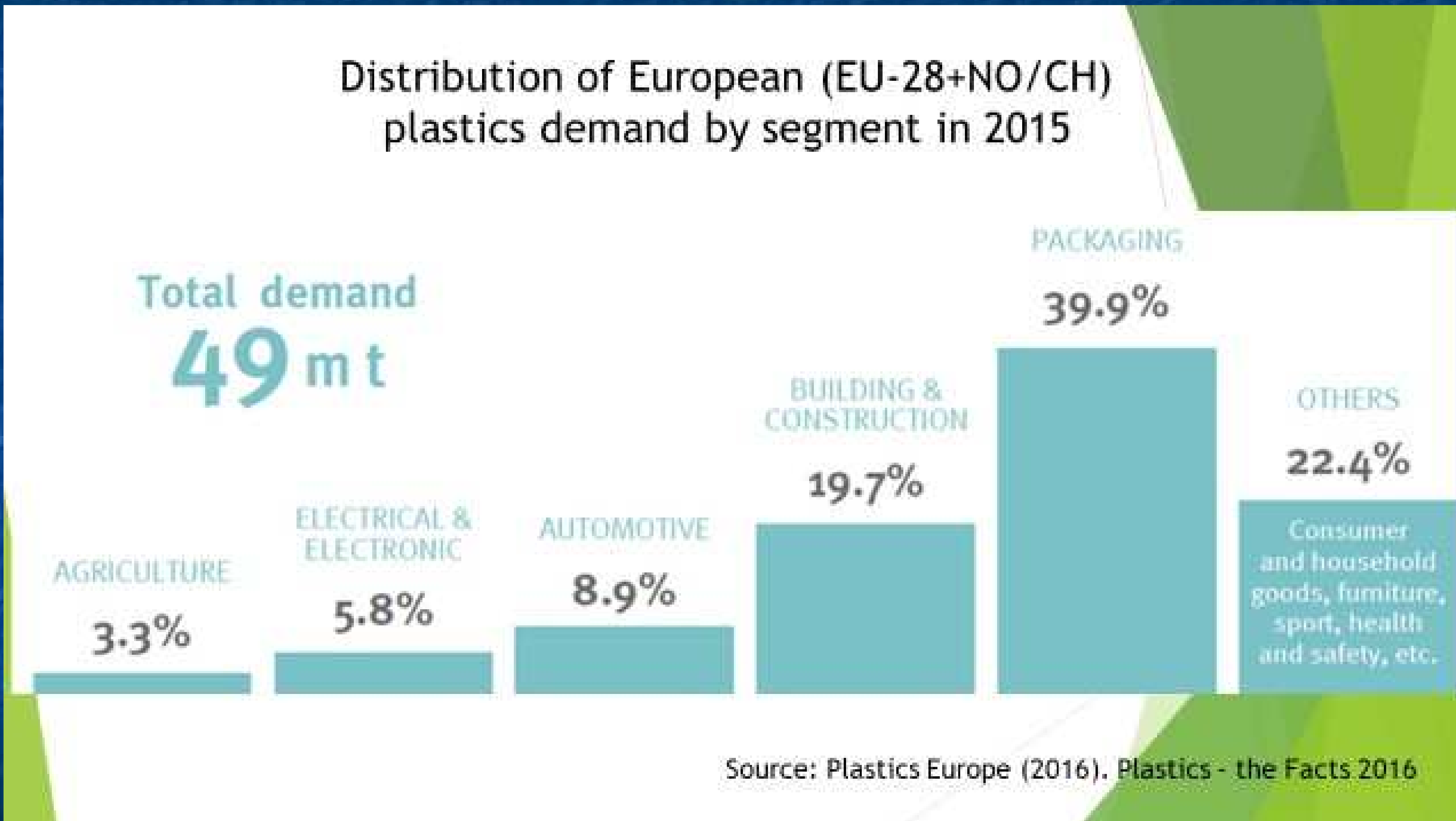
Plastic waste



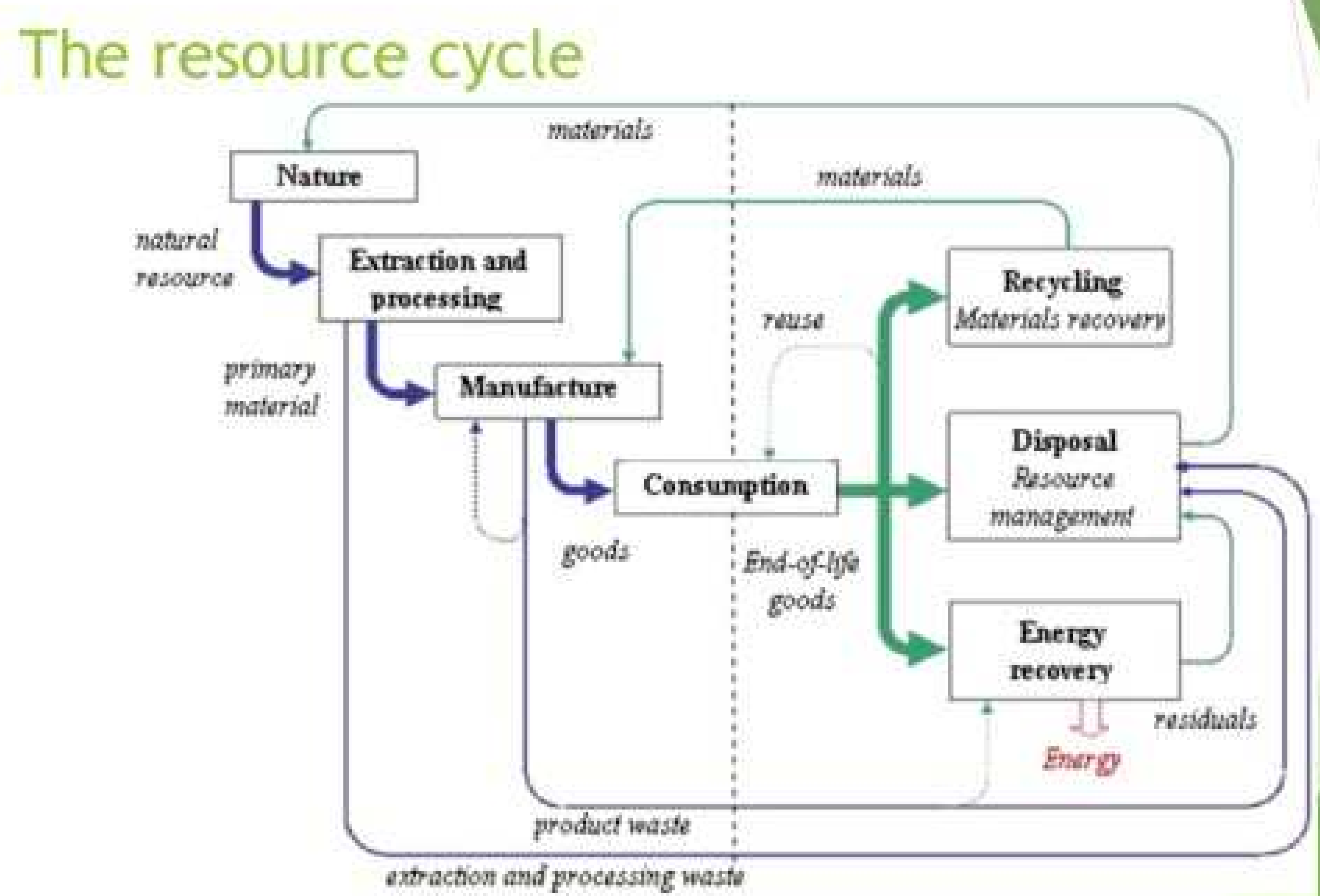
Plastic waste



Plastic waste

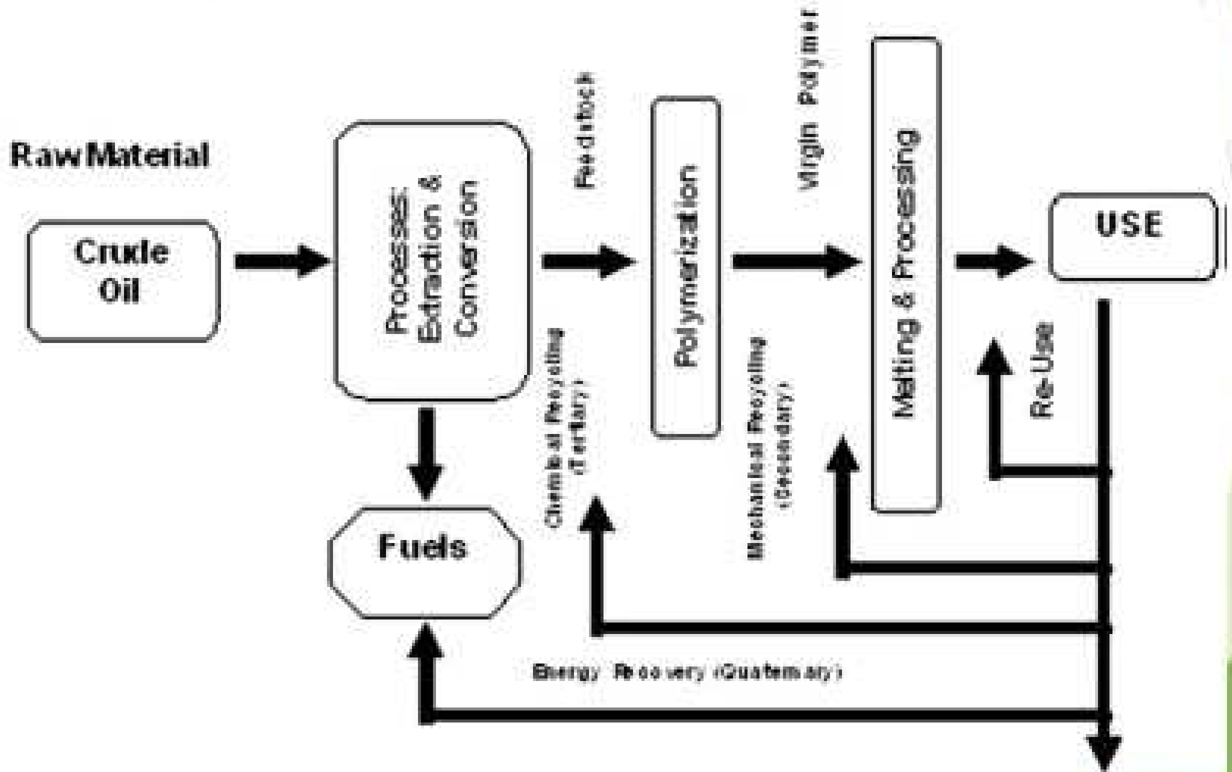


Plastic waste



Plastic waste

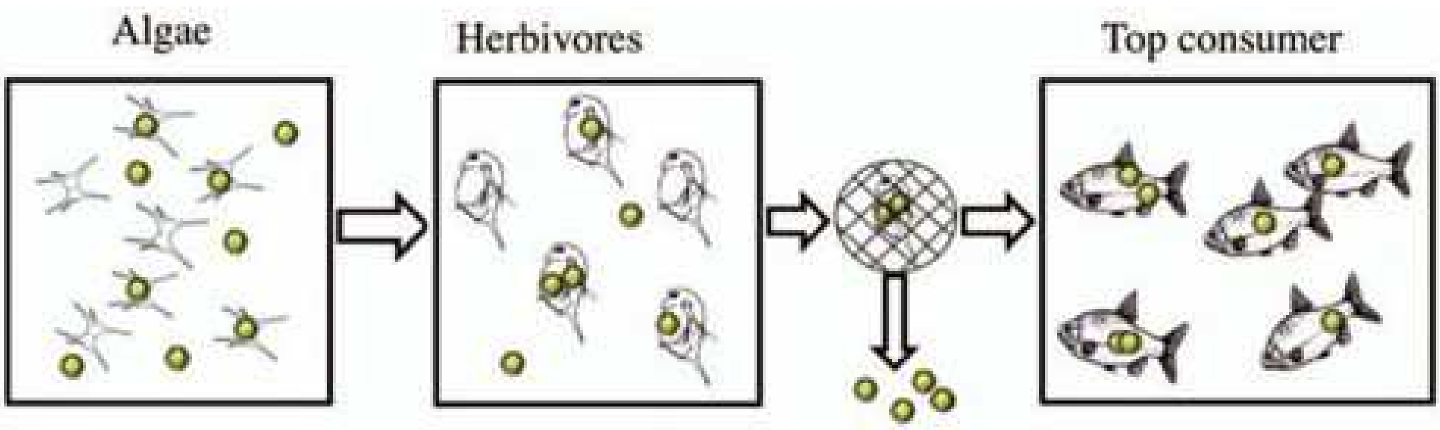
Treatment methods related to the production cycle of polymers



Plastic waste

Effects of Plastic Pollution

- It upsets the food chain



Food waste

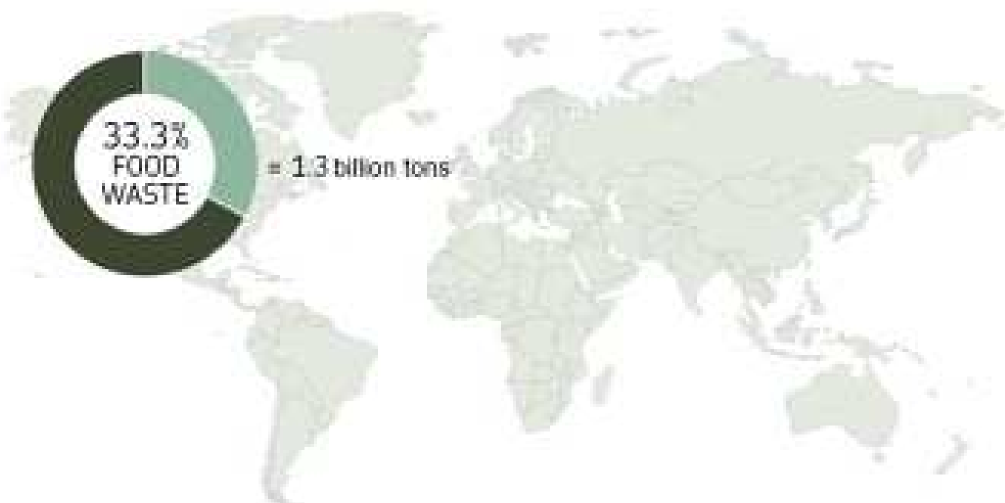
- ***Food losses***, meaning the losses that occur upstream of the food supply chain, mainly during sowing, cultivation, harvesting, processing, preserving, and first agricultural transformation stages;

- ***Food Waste***, meaning the waste that takes place during industrial processing, distribution,and final consumption.

Food waste

Amount of food waste and losses

FAO which estimates an annual world waste of about 1.3 billion tonnes, equivalent to about a third of the total production of food for human consumption.



Food waste

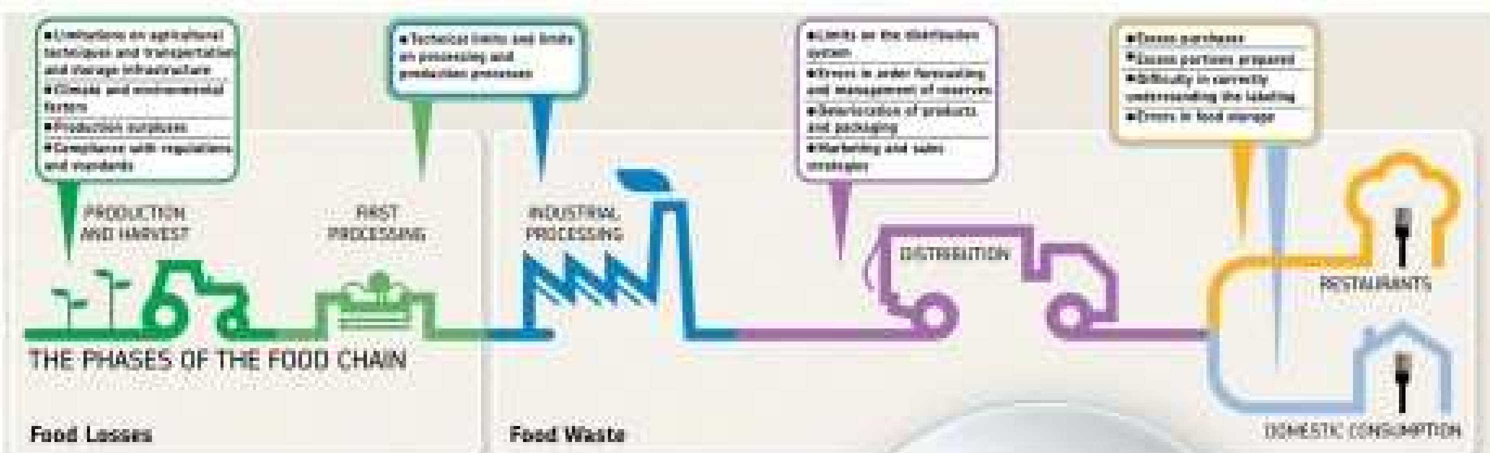
Amount of food waste and losses

FOOD CATEGORIES	QUANTITY AVAILABLE g/PERSON/DAY (A)	ESTIMATED CONSUMPTION g/PERSON/DAY (B)	SURPLUS (A) - (B)
 Grains, grain products and substitutes	433	258	40%
 egetables, fresh and processed	463	211	54%
 Fruit, fresh and processed	418	208	50%
 Drinks, beverages and substitutes	206	91	55%
 Meat, meat products and substitutes	242	110	54%
 Fish and fish	67	44	33%

Food waste

Origin of food waste -*food supply chain*-

- production and harvest;
- first processing;
- industrial processing;
- distribution;
- restaurants
- domestic consumption.



Food waste

Food waste management – *priority actions*

- 1) *Education and training*
- 2) *Communication, awareness and sharing*
- 3) *Documentation and data*
- 4) *Research and regulatory interventions*
- 5) *Donations*
- 6) *Green Public procurement*
- 7) *Voluntary agreements*
- 8) *Legislative transformation*
- 9) *Corporate social responsibility*
- 10) *Social innovation*

Waste prevention

Waste prevention - methods

- In the EU community 2 000 million tonnes of waste, and of this 40 million tonnes are classed as hazardous, is generated every year.
- Waste prevention includes strict avoidance of waste generation and reducing the hazardous content of waste. It also includes reuse of waste.
- Reduce of waste production is one of the best indicators of how we succeed in achieving sustainable development.
- Our current production and consumption must be adjusted so that the pressure on the earth's non-renewable resources are diminished.

Waste prevention

Prevention

Prevention is closely linked to improving manufacturing methods.

One of the tools is eco-design, which focuses on environmental aspects during the design phase of a product.

Prevention is also linked to consumers so that they demand greener products and less packaging.

Waste prevention

A holistic view on waste prevention

Business marketing and efficiency

Waste management

Greater consumer awareness and green consumption

Green procurement

Green manufacture of products

Legislation

Eco design

Greater resource efficiency

Lower ecological impact with methods like LCA

Eco labels
Carbon footprints

CO2 reduction

Waste prevention

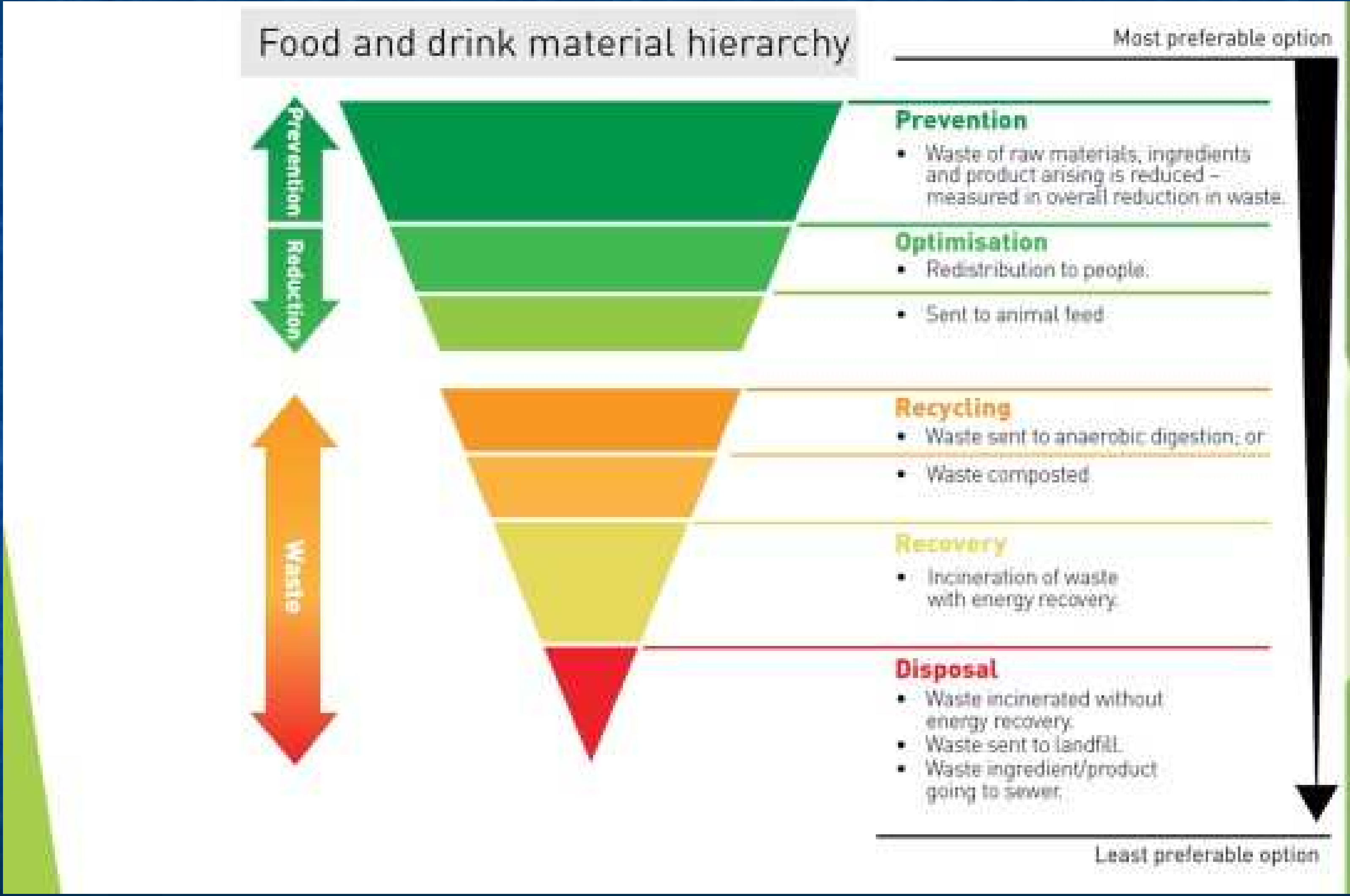
Policies with relevance to waste prevention

- European Commission's Communication on Integrated Product Policy IPP
- Integrated Pollution Prevention and Control Directive IPPC
- Eco Management and Audit Scheme EMAS
- EU Ecolabel
- Ecodesign Directive
- Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals REACH
- Environmental Technologies Action Plan EATP
- Sustainable Consumption and Production and Sustainable Industrial Policy SCP/SIP
- European Commission's Communication on Green Public Procurement GPP

GPP is a process where public authorities seek to source goods, services or works with a reduced environmental impact.

Waste prevention

Waste prevention



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Williams PT (2013) Waste treatment and disposal. 2nd edition. John Wiley & Sons. 424 p.

Ram Chandra (2015) Environmental Waste Management. Routledge. 586 p.

Reynolds JJ, Jeris J, Theodore L (2007) Handbook of Chemical and Environmental Engineering Calculations. John Wiley & Sons. 948 p.

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Azapagic A, Perdan S, Clift R (2011) Sustainable Development in Practice. Case studies for Engineers and Scientists. 2nd edition. John Wiley & Sons. 536 p.

Thank you for your attention

Result 5.2
Green Economy Study Modules

Study module B
Waste Management & Technologies

Implementation Reports

PANEVĖŽIO KOLEGIJA

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

REPORT ON THE IMPLEMENTATION OF COURSE

Waste Management & Technologies

Prepared by Panevėžio kolegija/University of Applied Sciences

2022

PANEVĖŽIO KOLEGIJA

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

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2. THE COURSE EVALUATION BY STUDENTS 4

3. THE COURSE EVALUATION BY TEACHER 7

CONCLUSIONS 8

1. THE COURSE IMPLEMENTATION STATISTICS

1. Number of students register in the course:
Autumn semester (*14 students*) Spring semester (*15 students*)

2. Number of students according to gender:
Autumn semester (*7 Man, 7 Woman*)
Spring semester (*2 Man, 13 Woman*)

3. Number of students according to age:

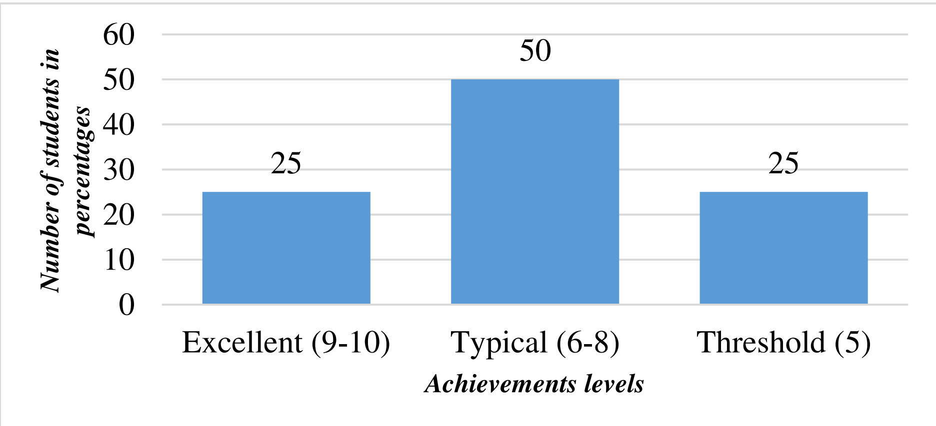
Age group	Autumn semester:		Spring semester:	
	Number	*Percentage*	*Number*	*Percentage*
Under 20	4	28,6	2	13,3
20-29	6	42,9	3	20,0
30-39	2	14,3	3	20,0
40-49	1	7,1	3	20,0
50-59	1	7,1	3	20,0
60+	0	0,0	1	6,7

4. Number of students remaining at the completion of the course:
Autumn semester (*11 students*) Spring semester (*13 students*)

5. Number of students withdrawn:
Autumn semester (*3 students*) Spring semester (*2 students*)

6. Grade Distribution:

Achievements levels	Number	Percentage
Excellent (9-10)	6	25,0
Typical (6-8)	12	50,0
Threshold (5)	6	25,0



2. THE COURSE EVALUATION BY STUDENTS

Course evaluation by students was performed using online survey. Electronic version of the survey available at https://forms.gle/LRbGeYi12dySA3kV8. Online survey was carried in the last week of the training. 20 students took part in the survey, i. e. 83,3 percent of students who successfully completed the course.

7. Evaluation of course content and teaching quality

7.1. The objectives of the course and study results, evaluation criteria were clearly defined from the very beginning of the course:

	Number	Percentage
Strongly agree	15	75,0
Agree	3	15,0
Neither agree nor disagree	2	10,0
Disagree	0	0,0
Strongly disagree	0	0,0

7.2. Assessment of the study results was appropriate:

	Number	Percentage
Strongly agree	10	50,0
Agree	6	30,0
Neither agree nor disagree	2	10,0
Disagree	1	5,0
Strongly disagree	1	5,0

7.3. The content was interesting, relevant, useful and allowed to achieve study results:

	Number	Percentage
Strongly agree	14	70,0
Agree	3	15,0
Neither agree nor disagree	1	5,0
Disagree	1	5,0
Strongly disagree	1	5,0

7.4. The course content responds to the latest scientific achievements:

	Number	Percentage
Strongly agree	12	60,0
Agree	3	15,0
Neither agree nor disagree	5	25,0
Disagree	0	0,0
Strongly disagree	0	0,0

7.5. Theory was taught in conjunction with the practical examples:

	Number	Percentage
Strongly agree	15	75,0
Agree	2	10,0
Neither agree nor disagree	2	10,0
Disagree	1	5,0
Strongly disagree	0	0,0

7.6. Theory was taught in context of the sustainable development issues:

	Number	Percentage
Strongly agree	15	75,0
Agree	5	25,0

Neither agree nor disagree	0	0,0
Disagree	0	0,0
Strongly disagree	0	0,0

7.7. The course topics were not repetitive:

	Number	Percentage
Strongly agree	12	60,0
Agree	3	15,0
Neither agree nor disagree	5	25,0
Disagree	0	0,0
Strongly disagree	0	0,0

7.8. The teaching materials were presented in an organized manner:

	Number	Percentage
Strongly agree	8	40,0
Agree	6	30,0
Neither agree nor disagree	6	30,0
Disagree	0	0,0
Strongly disagree	0	0,0

7.9. The teaching materials distributed were helpful to achieve study results:

	Number	Percentage
Strongly agree	14	70,0
Agree	4	20,0
Neither agree nor disagree	2	10,0
Disagree	0	0,0
Strongly disagree	0	0,0

7.10. Lecturer encouraged my participation, initiative and interaction during the lectures:

	Number	Percentage
Strongly agree	15	75,0
Agree	3	15,0
Neither agree nor disagree	2	10,0
Disagree	0	0,0
Strongly disagree	0	0,0

7.11. The study methods chosen by the lecturer helped to understand the course:

	Number	Percentage
Strongly agree	13	65,0
Agree	2	10,0
Neither agree nor disagree	5	25,0
Disagree	0	0,0
Strongly disagree	0	0,0

7.12. The teaching process included interactive methods:

	Number	Percentage
Strongly agree	6	30,0
Agree	7	35,0
Neither agree nor disagree	7	35,0
Disagree	0	0,0
Strongly disagree	0	0,0

7.13. The lecturer was a good communicator

	Number	Percentage
Strongly agree	15	75,0
Agree	3	15,0
Neither agree nor disagree	2	10,0
Disagree	0	0,0
Strongly disagree	0	0,0

8. Comments on strengths and ways of improvement

8.1. How do you evaluate the course quality

	Number	Percentage
Very satisfied	10	50,0
Satisfied	6	30,0
Neither satisfied nor disstisfied	4	20,0
Dissatisfied	0	0,0
Very dissatisfied	0	0,0

8.2. How do you evaluate the course lecturer

	Number	Percentage
Very satisfied	15	75,0
Satisfied	3	15,0
Neither satisfied nor disstisfied	2	10,0
Dissatisfied	0	0,0
Very dissatisfied	0	0,0

8.3. Could you name the main advantages of this course?

Very good teacher; Good training; Interesting topics; I got much new knowledge, Modernity; Practicality; Content, connection to the global village, awareness; Good training; I liked the training, it was very useful for my work; Made me think more about the waste we produce and pushed me a bit to start recycling and try to lower the waste we make.

8.4. Which specific difficulties you encountered while studying the course?

I didn't encounter nothing difficult; There was no difficulties; No problem; I didn't have any difficulties; None; Get information, not much can find.

8.5. Could you name the main disadvantages of this course?

None; I don't know; Too short; No; Intensity; Too many topics.

8.6. What changes would you recommend to improve this course?

Less topics; I don't know; I would like to have more similar trainings; All this is a novelty, a good start, everything will improve in the future; Could be longer; Make it longer.

3. THE COURSE EVALUATION BY TEACHER

Course evaluation by teacher was performed using online survey. Electronic version of the survey available at https://forms.gle/srHZJ1ji7GyJShMm8. Online survey was carried in the last week of the training.

9. Evaluation of course structure and description:

Course teacher agree that:

9.1. The course aims are clear and well defined.

9.2. The competencies clearly describe knowledge and skills of student graduating from this course.

9.3. The learning outcomes correspond to the competencies.

9.4. The division of course hours into contact and self-learning hours is appropriate.

10. Evaluation of course content:

Course teacher agree that:

10.1. The course content corresponds to the learning outcomes.

10.2. The course content is consistent.

10.3. The course topics are not repetitive.

10.4. The course content is modern.

10.5. The learning methods are appropriateto to achieve the intended competences.

10.6. The assessment of competence is appropriate.

11. Comments on strengths and ways of improvement:

11.1. According to the teacher the main advantages of this course:

Novelty, relativeness; Expands students' knowledge of waste recycling; Clarity, consistency.

11.2. According to the teacher the main disadvantages of this course:

Intensity

11.3. The teacher recommends the main changes to improve this course:

There could be more excursions to manufacturing companies.

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CONCLUSIONS

After implementation of the course Waste Management & Technologies realized within the Project project „Three-level Centers of Professional Excellence: Qualification, Entrepreneurship and Innovation in the Green Economy " the following conclusions are defined:

- The objectives of the course were achieved.
- The teacher and students highly rated the quality of course content.
- Students were satisfied with the quality of teaching.
- The knowledge and skills learned in the courses were put into practice.
- The course was properly implemented.

Green Economy Study Modules

Implementation Report Training B

Efficiency in the Operation of Reverse Osmosis Desalination Plants: Advanced Practices and Innovative Solutions

Prepared by:

AGBAR - Escuela del Agua

September, 2024

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Introduction

- Contextualisation within the overall project:

The training course titled "Efficiency in the Operation of Reverse Osmosis Desalination Plants: Advanced Practices and Innovative Solutions" is an integral component of a broader initiative aimed at enhancing water management practices amidst growing challenges such as water scarcity and climate change. This initiative focuses on advancing the technical skills and operational knowledge required to manage and optimize water treatment facilities effectively.

This course serves as a critical educational tool designed to address specific needs identified in the realm of water treatment and desalination. The goal is to develop sustainable and innovative solutions for water management, aligning with contemporary demands for efficient resource use and environmental protection. By providing targeted training on reverse osmosis desalination, the course contributes directly to improving operational efficiency and incorporating advanced practices in water treatment technologies.

The course is strategically positioned to equip professionals with the expertise necessary to tackle complex challenges associated with water treatment and desalination. The acquired knowledge ensures that participants are well-prepared to implement effective solutions in their respective roles. This alignment not only supports the project's aim of enhancing technical competencies but also fosters a deeper understanding of best practices and innovative approaches in the field.

Modality, where and when:

The course on "Efficiency in the Operation of Reverse Osmosis Desalination Plants: Advanced Practices and Innovative Solutions" is delivered through an online modality, making it accessible to a wide audience regardless of their geographic location. This flexible approach allows participants to engage with the content at their own pace, while still benefiting from structured learning and expert guidance.

The online format is designed to accommodate a six-week study period, starting from May 20, 2024, and concluding on June 30, 2024. Participants are provided with a two-week timeframe to complete each ECTS credit, ensuring that they have adequate time to grasp the material and apply their knowledge effectively.

The course is divided into three key modules, each focusing on different aspects of water treatment and desalination:

1. **Designing Membrane Treatments** (May 20, 2024 - June 2, 2024)
2. **Managing a Water Treatment Plant** (June 3, 2024 - June 16, 2024)
3. **Operating a Reverse Osmosis Desalination Plant** (June 17, 2024 - June 30, 2024)

Participants will access course materials and engage with the content through a dedicated online platform. This platform supports various learning formats, including transmedia content and an expert’s manual, to provide a comprehensive educational experience. Additionally, the platform facilitates interaction through forums, where participants can discuss topics with peers and seek advice from instructors.

This online modality not only offers convenience but also ensures that the training remains relevant and adaptable to the needs of professionals in diverse settings. The structured timeline and access to expert resources are designed to maximize learning outcomes and ensure effective knowledge transfer.

Skills Acquired

By completing the seminar "Efficiency in the Operation of Reverse Osmosis Desalination Plants: Advanced Practices and Innovative Solutions," participants will gain a range of valuable skills crucial for advancing their expertise in water treatment and desalination.

Participants will develop a comprehensive understanding of the fundamental principles and design considerations for membrane treatment systems. This includes knowledge of various types of membranes, their applications, and how to design effective water treatment systems tailored to specific needs and operational conditions.

They will also acquire practical skills in managing and optimizing the operation of water treatment plants. This encompasses planning, organizing, and overseeing plant operations, as well as implementing strategies to enhance efficiency, reduce operational costs, and ensure compliance with safety and environmental regulations.

Moreover, participants will gain expertise in the specific processes involved in reverse osmosis desalination. They will learn how to operate these systems effectively, address common operational challenges, and leverage innovative practices to improve plant performance.

Overall, the seminar equips professionals with the technical knowledge to address current challenges in water treatment, contribute to sustainable water management practices, and enhance their capabilities in managing complex desalination systems.

Attendants:

The seminar on "Efficiency in the Operation of Reverse Osmosis Desalination Plants: Advanced Practices and Innovative Solutions," is designed for professionals involved in the water treatment industry. The target audience includes:

Water Treatment Technicians and Engineers: Individuals who are directly involved in the operation and maintenance of wastewater treatment facilities. This includes those who manage the day-to-day functions of these plants and need to stay updated with the latest practices and technologies.

Environmental Engineers: Professionals who work on projects related to water treatment and environmental protection. They will benefit from a deeper understanding of plant operations and maintenance to better design and oversee water treatment solutions.

Facility Managers: Those responsible for overseeing the overall functioning of wastewater treatment plants. The seminar will provide them with insights into improving plant efficiency and managing technical and operational challenges.

Competence acquisition methodology:

The seminar "Efficiency in the Operation of Reverse Osmosis Desalination Plants: Advanced Practices and Innovative Solutions" employs a comprehensive and effective methodology designed to ensure the acquisition of competencies essential for managing wastewater treatment facilities. The methodology encompasses several key components:

- **Challenge-Based Learning**: Participants engage with real-world professional challenges that require practical solutions. This approach allows them to apply theoretical knowledge to realistic scenarios, thereby enhancing problem-solving skills and practical application. Each module begins with a challenge that participants must address using the concepts learned throughout the course.
- **Transmedia Learning Resources**: The seminar incorporates a transmedia approach, which involves diverse formats such as interactive content, videos, and simulations. This multifaceted approach ensures that participants can engage with the material in various ways, catering to different learning preferences and reinforcing understanding through multiple channels.
- **Expert Manual**: Participants have access to a detailed manual authored by subject matter experts. This manual provides in-depth explanations of key concepts, processes, and techniques relevant to wastewater treatment. It serves as a crucial resource for detailed study and reference throughout the training.
- **Self-Assessment Exams**: To consolidate learning and gauge comprehension, participants complete self-assessment exams. These exams consist of multiple-choice questions and are linked to the content of each module. Immediate feedback is provided, allowing participants to assess their understanding and identify areas needing further review.
- **Interactive Online Platform**: The seminar is delivered through a virtual learning environment that facilitates interaction between participants and instructors. The platform supports discussion forums, where participants can exchange ideas, ask questions, and engage in collaborative problem-solving. This interactive component enriches the learning experience and fosters a sense of community.

Admission and organization of the trainings

- Organization of the training
    - School of Water. created by Agbar in 2012, is the benchmark in training, awareness, talent development and knowledge in the field of water and the environment.Our activity is aimed at training for companies, administrations and professionals in the water sector, as well as for the general public. Thus, we develop training programs, promote dual vocational training in the water sector, develop environmental education programs and design exhibition, museum and hydraulic heritage projects.The training programs, whether those in our catalog or those custom-designed for companies, cover all areas of the complete water cycle; they use methodologies that facilitate a unique learning experience and immediate applicability in all key positions of an organization. Our approach combines the academic and technical rigor provided by 165 years of experience in integrated water cycle management and collaboration with the best universities, technical schools and business schools.

- Selection of participants, possible admission requirements

  Participants in the seminar were informed by HR for the internal participants and via web for the external participants.

- Brief notes on counselors and teachers:

Throughout the seminar on "Efficiency in the Operation of Reverse Osmosis Desalination Plants: Advanced Practices and Innovative Solutions," participants benefit from the support and guidance of two key figures who play crucial roles in enhancing their learning experience:

1. **The Expert**: The expert is a pivotal figure in the training, providing technical support and addressing any queries related to the course content. As the primary authority on the material covered, the expert is responsible for evaluating each module. Participants can turn to the expert for in-depth explanations and clarifications,

ensuring they fully understand the complex concepts and processes involved in wastewater treatment.

2. **The Academic Tutor**: The academic tutor offers personalized guidance and support throughout the participants' educational journey. This role involves providing individual assistance and addressing any questions or concerns related to the overall program. The academic tutor helps participants navigate the course structure, manage their progress, and maximize their learning outcomes.

Execution of the training

- Organization and plan

Period	Credit	Content
20/05/2024 al 02/06/2024	How to design membrane treatments	1. Introduction to membrane processes 2. Classification of membrane processes 3. Classification of raw water used for purification using membranes 4. Membrane fouling 5. Conceptual model of transport through a membrane 6. Basic design and operation parameters of UF membranes 7. Basic design and operation parameters of RO membranes 8. Conservation of membranes during plant shutdowns
03/06/2024 al 16/06/2024	How do I manage my water treatment plant	1. Personnel management 2. People management 3. Control panel 4. Management systems 5. Cost estimation. Budget monitoring 6. Asset management

Period	Credit	Content
20/05/2024 al 02/06/2024	How to design membrane treatments	1. Introduction to membrane processes 2. Classification of membrane processes 3. Classification of raw water used for purification using membranes 4. Membrane fouling 5. Conceptual model of transport through a membrane 6. Basic design and operation parameters of UF membranes 7. Basic design and operation parameters of RO membranes 8. Conservation of membranes during plant shutdowns
17/05/2024 al 30/06/2024	How do I operate a reverse osmosis desalination plant?	1. Introduction 2. Desalination techniques 3. Desalination using reverse osmosis (RO) 4. Operation and maintenance of a desalination plant using RO 5. Possible incidents in desalination plants using RO 6. Environmental impact of an RO process 7. Conclusions

Evaluation Ratings

Total registrations: 45

Internal participants: 26

External participants:19

Participants who completed the course: 16

Participants who did not complete the course: 29

Based on participant feedback, the training received the following ratings:
Overall satisfaction with the training received: 3.8/5
Participants expressed a high level of satisfaction with the course content and structure, although some felt there could be improvements in the depth of certain areas.

Overall rating of the online expert: 3.5/5
While the expert’s knowledge was acknowledged, some participants indicated room for improvement in responsiveness and engagement with inquiries.

Overall rating of the academic tutor: 3.7/5
The tutor was generally well-regarded, providing consistent support throughout the training, though some participants noted gaps in response times to specific questions.

Functionality of the virtual campus: 4.0/5
The virtual platform performed well, offering an easy-to-navigate and reliable experience, with very few technical issues reported.

Overall rating of course content and resources: 3.8/5
Participants found the materials useful, though several mentioned a need for more interactive content and practical examples to better apply the theoretical knowledge presented.

Main Findings and Conclusions

Strengths:

Participants appreciated the detailed content, which included essential examples and calculation formulas specific to wastewater treatment processes. Many found the practical approach to the course engaging, as it helped solidify their knowledge through real-world applications. The thematic focus of the course was also well-received, especially the specific, targeted information related to water treatment. Some participants noted that, despite the challenges being long, they were useful in reinforcing the material covered in the modules.

Areas for Improvement:

Several participants struggled with the clarity of the first exercises and felt that more real-world examples could have helped them understand the material better. There were also suggestions to enhance interaction with the tutor, particularly in a collective setting within the forum, which was often disabled, hindering communication. Participants working in desalination plants expressed the need for more content specific to their field, as the second module focused too much on potable water treatment. Some found the challenges overly complex, especially in the section on membrane technologies, and suggested simplifying these to suit participants with less experience. Finally, the request for shorter challenges and extended time to complete the course was common, as many participants were balancing the training with their professional responsibilities.

Attachments

- **ATTACHMENT 1: LIST OF PARTICIPANTS**
- **ATTACHMENT 2: PUBLICATION ABOUT THE COURSE (web)**

ATTACHMENT 1: LIST OF PARTICIPANTS

Nombre	Apellidos	Empresa
Francisco Manuel	Alcaraz Jodar	Veolia
Itmar	Alsinet Gili	Agbar
Francisca	Álvarez Vergara	External
Oscar	Arrestegui Pulido	External
Borja	Carballosa Fernández	External
Diego	Casanova	External
Brayan José	Castro Gutiérrez	Uabc
Christian	Chiroque Ruiz	External
Jorge	Correa Mendioroz	Aquambiente
Sandra	Diaz Arroniz	Aquambiente
Alfredo	Domingo Valera	Aquona
María	Frutos Sansano	Aquatec
Mario	Galiana Dorado	Aguasdealicante
Luis Alberto	Gonzalez Huaynacari	External
Danna	Guevara Fernández	External

Emanuel Alejandro	Idiarte	External
Carlos	Iglesias Madueño	External
Juan	Lopez Martin	Talman Group
Natalia	Martinez Carretero	Aquona
Laura	Mena Casanova	Agbar
Estefanía	Menárguez Manzano	Aquambiente
Jose Antonio	Merino Trujillo	Hidralia
Irma	Montesinos Ramon	External
Janeth Elizabeth	Morales Escalante	External
Manuel	Moreno Cebolla	Boru Supply
Luis Miguel	Navasquillo Gallego	Aquambiente
Gianella	Neyra Shuña	External
Nataly	Orozco Galeano	External
Raquel	Pallach Pascual	Agbar
Jonatan Antonio	Posito Pinto	Aquambiente
Alba	User Ramirez	Learnwus
Luis Miguel	Rea Marcos	External
Germán	Reyes Aguilar	Hidralia

Antonio	Rico Campos	Agbar
Belgimar	Rodríguez Vespa	Ecoriles
Javier	Rosado Franco	Aguas De Benahavís
Wilder Vicente	Rosales Yanac	External
Noemi	Rubio Fernandez	Aquona
Nazaret	Tebar Perez	Aquona
Sabina	Torralba Hauck	Hidralia
Mar	Torres Fontes	Hidraqua
Francisco	Vargas	External
Manuel Edison	Villalba Román	External
Charles Eduard	Zapata Rui	External
Edwin Romeo	Zepeda Guardado	External

ATTACHMENT 2: PUBLICATION ABOUT THE COURSE (web)

https://www.laescueladelagua.com/en/programa/executive-education/seminario/eficiencia-en-la-operacion-de-plantas-desalacion/

SEMINAR

Efficiency in the Operation of Reverse Osmosis Desalination Plants: Advanced Practices and Innovative Solutions

Online Soon

+34 932 479 735 +34 616 778 523

CONTACT ADMISSIONS

Presentation | Program | Admission and basic data

The Water School as a participant in the project 3LoE, has organized the course "Efficiency in the Operation of Reverse Osmosis Desalination Plants: Advanced Practices and Innovative Solutions"75 hours of **online self-study.**

The main objective of this program is to acquire knowledge on the general aspects to understand the fundamental principles and key aspects of the design of membrane treatments, know howDesign water treatment systems using membrane technologies, taking into account factors such as feedwater quality, treatment requirements and operational efficiency.

Learn strategies and techniques to optimize the efficiency and profitability of a water treatment plant, including implementing resource management practices, reducing operating costs, and continuously improving performance.

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

Work Package 5: Third center level "Higher Education) (EQF 6)

Activity A8.21 Test study module B

Waste Management & Technologies

Implemented by:

SFC Sistemi Formatici Confindustria and

Scuola Sant'Anna di Pisa University

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

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Chapter 1: Executive Summary

This report relates to the implementation activities in Italy of the 4 modules:

B – “Waste Management & Technologies”

developed by VILNIAUS GEDIMINO TECHNICAL UNIVERSITY (VGTU) and SATAKUNTA UNIVERSITY OF APPLIED SCIENCES (SAMK) in the Project ‘Management and Technologies of Water, Wastewater, Waste and Circular Economy (WWW&CE)’

Methodology for adaptation of VGTU – SAMK curricula to Italian training needs

Following the analysis of the Module A-B-C-D curricula developed by the 3LoE partners, SFC found it beneficial to propose to the Scuola Superiore Sant'Anna (SSSA) the validation of potentially integrating the 4 modules, their structure, learning outcomes and main topics into existing university pathways.

This analysis, conducted in March 2023, resulted in Sant'Anna expressing interest in incorporating the four modules into the MASTER GECA specialization pathway.

The GECA Master is a 2nd level university Master's degree program offered by the Institute of Management at the Scuola Superiore Sant'Anna in Pisa. For nearly three decades, it has provided a high-level, continuously updated, multidisciplinary course in the environmental sector and green management.

The professional profile emerging from the GECA Master is that of an "Expert in Corporate Sustainability and Circular Economy."

The GECA Master was identified as the most suitable existing program into which all four modules proposed by the 3LoE project could be integrated.

Meetings to finalize and adapt the contents and learning outcomes of all the 4 modules within the framework of the GECA Master's Course were held from April 2023 to September 2023. This timeline ensured that the necessary authorizations from the college of university

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lecturers could be obtained in time for implementation during the GECA Master's Course, which ran from October 2023 to July 2024.

The competencies of the four modules are attributable, according to the Italian Atlas of Competences and Professions, to:

SECTOR 24: Common Area

PROCESS: Ecological transition, reduction of energy consumption, circularity, and containment of environmental impacts

PROCESS SEQUENCE: Activation of circular production processes and increase of recycling activities

The Expected Result of the learning pathway is:

RA2: Adopt circular closed-loop production processes, implementing lean production logics and techniques, and improving the energy efficiency of production processes to reduce environmental impact.

The main activities envisaged are:

- Optimization of production processes
- Implementation of closed-loop production and waste minimization
- Energy efficiency and use of renewable energy in production processes

It was determined that the four modules could contribute significantly to the formation of the GECA Master's graduate profile. Specifically, they could contribute to developing the learning outcomes related to the process sequence as detailed in Annex A.

Introduction to Module B implementation

Waste management stands as one of the paramount challenges of our contemporary era. What was once relegated to mere discard has undergone a paradigmatic shift, with waste fractions now regarded as valuable resources ripe for recovery and reuse. Legislative frameworks have evolved significantly to address this shift, with stringent regulations and a plethora of laws dictating waste sorting methodologies and shaping the organizational landscape of waste management operations and business models. Simultaneously, the imperative to conserve natural resources has become increasingly urgent, given the exponential rate at which raw materials are consumed, driven by the planet's burgeoning population.

The process of urbanization further complicates the tapestry of waste management dynamics. While developed nations boast sophisticated waste management technologies that are adeptly deployed, the story in less developed regions, experiencing rapid population growth, is markedly different. Here, waste collection and disposal infrastructure lags behind, presenting a significant challenge that is beyond the reach of many. The waste management sector finds itself at the intersection of numerous contemporary local and global challenges. Guiding principles such as the waste hierarchy inform treatment strategies, prioritizing waste reduction and the exploration of recycling avenues. Additionally, concepts like carbon neutrality and digitalization are gaining prominence within the waste management landscape, offering new vistas for sustainable waste management practices.

Given the vast array of national circumstances, encompassing diverse climates, topographies, and local conditions across EU countries, the curriculum on Waste Management & Technologies endeavors to provide a comprehensive framework for tackling waste-related issues in municipalities and companies alike.

Within this curriculum, the scope of Waste Management & Technologies extends to encompass the entire lifecycle of waste materials, spanning from their collection in municipalities to treatment processes and ultimately, their disposal, whether originating from urban centers or industrial plants.

Through a series of comprehensive modules, the course aims to provide students with a thorough overview of the waste cycle and the technologies used to manage it efficiently and effectively. From analyzing sector regulations to understanding material recovery processes, from waste collection systems to treatment methods, students will acquire practical and theoretical skills essential for addressing the challenges of waste management within the context of the circular economy.

Furthermore, the course aims to foster critical awareness of the obstacles and opportunities associated with transitioning towards a more circular waste management approach. Through

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the exploration of case studies, field visits, and company testimonials, students will have the opportunity to apply the knowledge gained in real-world contexts and develop innovative solutions to address environmental challenges.

The "Waste Management & Technologies" course aims to prepare students to acquire fundamental skills for addressing the challenges of waste management within the context of the circular economy. The course aims to provide participants with the skills required for professional roles in waste management and circular economy offering advanced notions and technical-functional management skills.

Target group

The Master GECA in Environmental Management and Control: Circular Economy and Resource Efficient Management envisages a minimum of 15 and a maximum of 24 participants.

Those who have obtained a master’s degree, a specialized degree or an old university degree, or an equivalent qualification obtained at an Italian or foreign university or institute of equal standing may apply for admission.

Undergraduates who have completed their final examinations prior to the start of the master’s course and who plan to acquire the qualification in the extraordinary session of the academic year preceding the start of the Master's course may also apply for admission.

Work required

In the curriculum, the average work required by each module is measured in units of ECTS credit (abbreviated in this presentation as CU). The curriculum consists of three units of total 6 ECTS credit units, corresponding to 95 hours of lectures, professional field visits, individual study and assignments. The Waste Management & Technologies module can be administered individually, thus can be offered to those wishing to implement or develop skills related to the Integrated Waste Cycle management and sustainable management in this field.

Contents of the curriculum

The courses will be taught by lecturers from the Scuola Superiore Sant'Anna and experts in the topics covered by the courses. The aim of the course will not only be to transfer knowledge on the key concepts related to the application of circular economy principles in waste management sector, but also to enable course participants to be autonomous in the search for sectorial best practices, technological-organisational solutions, to be implemented in this sector.

The instructors will ensure:

- the development and maintenance of a positive classroom environment;

- effective interpersonal communication processes, stable relationships of trust and collaboration;

- an adequate evaluation process, with respect to the overall course objectives.

Prior to the start of each module, the participants will be provided with bibliographic reference material for each course, which will be useful in preparing the students for active and expert participation. This bibliographic material will cover not only basic skills, but also further levels of in-depth study.

The module aims to train managers capable of making informed decisions and defining and implementing strategies to address the challenges of the circular economy. Its primary goal is to impart knowledge, skills, and attitudes (knowing, knowing how to do, feeling) related to key managerial methodologies and operational tools that support resource-efficient and circular management practices. This module provides interdisciplinary content to various corporate functions involved in business management, enhancing their role in developing effective circular economy strategies.

Specifically, the module seeks to develop:

a) interdisciplinary skills in Waste Management & Technologies, enriching students' existing knowledge and professional experience;

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b) problem-solving abilities and project development skills;

c) team-working capabilities, active participation in organizational life, and continuous performance improvement in terms of sustainability;

d) expertise in analyzing, measuring, evaluating, organizing, managing, and communicating environmental issues within companies.

The curriculum is divided into three units as follows:

- UNIT 1: The integrated waste cycle
- UNIT 2: Material recovery and End of Waste
- UNIT 3: Sustainable intervention solutions

The curriculum on Green Management & Circular Economy module structure is shown in the following Tables.

Table 1 Contents of Unit 1

Unit 1: **The integrated waste cycle**	**Learning outcomes:** By the end of this module, students will be able to understand and interpret sector regulations and analyze municipal and special waste generation at both national and EU levels. Participants will develop a thorough understanding of the Italian National Recovery and Resilience Plan and National Management Plan, waste collection systems for material valorization, and will gain practical insights from site visits and company testimonials.
Contents: • Sector regulations • Municipal and special waste generation at national and EU level • Italian National Recovery and Resilience Plan (PNRR) and Waste National Management Plan	

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• Waste collection systems for the valorization of materials • Site visits and company testimonials
Student's workload: 25 lecture hours + 8 individual study hours (2 CFU)
Possible materials: Waste Framework Directive https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:02008L0098-20180705 Municipal Waste Statistics, EUROSTAT, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Municipal_waste_statistics Report on Municipal Waste 2022, ISPRA, ISBN 978-88-448-1152-5, https://www.isprambiente.gov.it/files2023/pubblicazioni/rapporti/rapportorifiutiurbani_ed-2022_n-381-bis_versionedati-di-sintesi_en_05_04_2023-1.pdf Piano Nazionale di Ripresa e Resilienza, Camera dei deputati, documentzione parlamentare, https://www.camera.it/temiap/allegati/2021/07/28/OCD177-5053.pdf Arancon, R. A. D., Lin, C. S. K., Chan, K. M., Kwan, T. H., & Luque, R. (2013). Advances on waste valorization: new horizons for a more sustainable society. Energy Science & Engineering, 1(2), 53-71. Ghumra, D. P., Rathi, O., Mule, T. A., Khadye, V. S., Chavan, A., Barba, F. C., ... & Thorat, B. N. (2022). Technologies for valorization of municipal solid wastes. Biofuels, Bioproducts and Biorefining, 16(3), 877-890.

Table 2 Contents of Unit 2

Unit 2: **Material recovery and End of Waste**	**Learning outcomes**: By the end of this module, students will be able to understand material recovery chains from municipal waste and by-products of productive sectors. Participants will gain knowledge about the End of Waste criteria, plants for cycle closure, and innovative technologies. They will also benefit from practical insights

	gained through site visits and company testimonials.

Contents:

- Material recovery chains from municipal waste
- Material recovery chains from productive sectors by-products
- End of Waste
- Plants for waste cycle closure and innovative technologies
- Site visits and company testimonials

Student's workload:

33 lecture hours + 12 individual study hours (3 CFU)

Possible materials:

Cano, N. S. D. S. L., Iacovidou, E., & Rutkowski, E. W. (2022). Typology of municipal solid waste recycling value chains: A global perspective. Journal of Cleaner Production, 336, 130386.

Schneider, D. R., & Tomić, T. (2018). The Interdependence of Material and Energy Recovery of Municipal Solid Waste. In 1st Latin American Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES) (pp. 1-1).

Waste Framework Directive https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:02008L0098-20180705

Zouboulis, A. I., & Peleka, E. N. (2019). "Cycle closure" in waste management: tools, procedures and examples. Glob. Nest J., 21, 1-6.

Kamyshnikov, I. N., Smirnova, T. S., & Tikhonov, A. I. (2021, June). Sustainable Development: Waste Recycling and Circular Economy. In Sustainable Development: Society, Ecology, Economy: Proceedings of the XVth International Scientific Conference 2019, 28 March 2019, Moscow Witte University (pp. 101-108). Cham: Springer International Publishing.

European Commission, Waste and recycling, https://ec.europa.eu/environment/topics/waste-and-recycling_en

European Commission, Implementation of the Waste Framework Directive, https://ec.europa.eu/environment/topics/waste-and-recycling/implementation-waste-framework-directive_en

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Table 3 Contents of Unit 3

Unit 3: **Sustainable intervention solutions**	**Learning outcomes:** By the end of this module, students will be able to identify and evaluate sustainable intervention solutions, as well as understand the processes involved in decommissioning and remediation for decommissioned plants with a focus on material and soil recovery.
Contents: • Sustainable intervention solutions • Decommissioning and remediation for decommissioned plants with material and soil recovery	
Student's workload: 12 lecture hours + 5 individual study hours (1 CFU)	
Possible materials: Fournier, V. (2016). New technologies in decommissioning and remediation. IAEA Bulletin, 23. Lima, A. T., & Ottosen, L. (2021). Recovering rare earth elements from contaminated soils: Critical overview of current remediation technologies. Chemosphere, 265, 129163.	

Teaching methods

Teachers are encouraged to use varying methods containing e.g.:

- Lectures,
- Visiting lecturers,
- Professional field visits,
- Visits in enterprises,
- Videos approaching the topics (Reliability of the source must be evaluated),
- Individual studies

Teaching module delivery schedule

B - Waste Management & Technologies	• From 8 to 9 February 2024 • From 12 to 16 February 2024 • From 20 to 23 February 2024 • From 26 February to 1 March 2024

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Result 5.2
Green Economy Study Modules

Study module B
Waste Management & Technologies

Evaluation Report

PANEVĖŽIO KOLEGIJA

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

REPORT ON THE EVALUATION OF COURSE

Waste Management & Technologies

Prepared by Panevėžio kolegija/University of Applied Sciences

2024

PANEVĖŽIO KOLEGIJA

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

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2. THE COURSE EVALUATION BY STUDENTS........4
3. THE COURSE EVALUATION BY TEACHER........6
CONCLUSIONS........8

1. STATISTICS OF RESPONDENTS (Students)

1. Number of respondents (students):

36 students took part in the survey (PANKO – 29, scuola superiore sant'anna – 7)

2. Number of respondents according to gender:

13 *Man, 23 Woman*

Age group	*Percentage*
Under 20	17
20-29	56
30-39	17
40-49	11
50-59	0
60+	0

3. Number of respondents according to age:

2. THE COURSE EVALUATION BY STUDENTS

Course evaluation by students was performed using online survey. Electronic version of the survey available at https://forms.gle/LRbGeYi12dySA3kV8. 36 students took part in the survey (PANKO – 29, scuola superiore sant'anna – 7).

7. Evaluation of course content and teaching quality

7.1. The objectives of the course and study results, evaluation criteria were clearly defined from the very beginning of the course:

	Number	Percentage
Strongly agree	15	42
Agree	13	36
Neither agree nor disagree	8	22
Disagree	0	0
Strongly disagree	0	0

7.2. Assessment of the study results was appropriate:

	Number	Percentage
Strongly agree	20	56
Agree	6	17
Neither agree nor disagree	8	22
Disagree	1	3
Strongly disagree	1	3

7.3. The content was interesting, relevant, useful and allowed to achieve study results:

	Number	Percentage
Strongly agree	14	39
Agree	13	36
Neither agree nor disagree	7	19
Disagree	1	3
Strongly disagree	1	3

7.4. The course content responds to the latest scientific achievements:

	Number	Percentage
Strongly agree	12	33
Agree	9	25
Neither agree nor disagree	15	42
Disagree	0	0
Strongly disagree	0	0

7.5. Theory was taught in conjunction with the practical examples:

	Number	Percentage
Strongly agree	12	33
Agree	9	25
Neither agree nor disagree	15	42
Disagree	0	0
Strongly disagree	0	0

7.6. Theory was taught in context of the sustainable development issues:

	Number	Percentage
Strongly agree	14	39
Agree	13	36
Neither agree nor disagree	7	19

Disagree	1	3
Strongly disagree	0	0

7.7. The course topics were not repetitive:

	Number	Percentage
Strongly agree	12	33
Agree	9	25
Neither agree nor disagree	15	42
Disagree	0	0
Strongly disagree	0	0

7.8. The teaching materials were presented in an organized manner:

	Number	Percentage
Strongly agree	15	42
Agree	13	36
Neither agree nor disagree	8	22
Disagree	0	0
Strongly disagree	0	0

7.9. The teaching materials distributed were helpful to achieve study results:

	Number	Percentage
Strongly agree	12	33
Agree	9	25
Neither agree nor disagree	15	42
Disagree	0	0
Strongly disagree	0	0

7.10. Lecturer encouraged my participation, initiative and interaction during the lectures:

	Number	Percentage
Strongly agree	14	39
Agree	13	36
Neither agree nor disagree	7	19
Disagree	1	3
Strongly disagree	0	0

7.11. The study methods chosen by the lecturer helped to understand the course:

	Number	Percentage
Strongly agree	12	33
Agree	9	25
Neither agree nor disagree	15	42
Disagree	0	0
Strongly disagree	0	0

7.12. The teaching process included interactive methods:

	Number	Percentage
Strongly agree	15	42
Agree	13	36
Neither agree nor disagree	8	22
Disagree	0	0
Strongly disagree	0	0

7.13. The lecturer was a good communicator

	Number	Percentage
Strongly agree	15	42
Agree	13	36
Neither agree nor disagree	8	22
Disagree	0	0
Strongly disagree	0	0

8. Comments on strengths and ways of improvement

8.1. How do you evaluate the course quality

	Number	Percentage
Very satisfied	12	33
Satisfied	9	25
Neither satisfied nor disstisfied	15	42
Dissatisfied	0	0
Very dissatisfied	0	0

8.2. How do you evaluate the course lecturer

	Number	Percentage
Very satisfied	12	33
Satisfied	9	25
Neither satisfied nor disstisfied	15	42
Dissatisfied	0	0
Very dissatisfied	0	0

8.3. Could you name the main advantages of this course?

Very good teacher; Good training; Interesting topics; I got much new knowledge, Modernity; Practicality; Content, connection to the global village, awareness; Good training; I liked the training, it was very useful for my work; Made me think more about the waste we produce and pushed me a bit to start recycling and try to lower the waste we make.

8.4. Which specific difficulties you encountered while studying the course?

I didn't encounter nothing difficult; There was no difficulties; No problem; I didn't have any difficulties; None; Get information, not much can find.

8.5. Could you name the main disadvantages of this course?

None; I don't know; Too short; No; Intensity; Too many topics.

8.6. What changes would you recommend to improve this course?

Less topics; I don't know; I would like to have more similar trainings; All this is a novelty, a good start, everything will improve in the future; Could be longer; Make it longer.

3. THE COURSE EVALUATION BY TEACHER

Course evaluation by teacher was performed using online survey. Electronic version of the survey available at https://forms.gle/srHZJ1ji7GyJShMm8. Online survey was carried in the last week of the training.

9. Evaluation of course structure and description:
Course teacher agree that:
9.1. The course aims are clear and well defined.
9.2. The competencies clearly describe knowledge and skills of student graduating from this course.
9.3. The learning outcomes correspond to the competencies.
9.4. The division of course hours into contact and self-learning hours is appropriate.
10. Evaluation of course content:
Course teacher agree that:
10.1. The course content corresponds to the learning outcomes.
10.2. The course content is consistent.
10.3. The course topics are not repetitive.
10.4. The course content is modern.
10.5. The learning methods are appropriateto to achieve the intended competences.
10.6. The assessment of competence is appropriate.
11. Comments on strengths and ways of improvement:
11.1. According to the teacher the main advantages of this course:
Novelty, relativeness; Expands students' knowledge of waste recycling; Clarity, consistency.
11.2. According to the teacher the main disadvantages of this course:
Intensity
11.3. The teacher recommends the main changes to improve this course:
There could be more excursions to manufacturing companies.

CONCLUSIONS

After implementation of the course Waste Management & Technologies realized within the Project project „Three-level Centers of Professional Excellence: Qualification, Entrepreneurship and Innovation in the Green Economy " the following conclusions are defined:

- The objectives of the course were achieved.
- The teacher and students highly rated the quality of course content.
- Students were satisfied with the quality of teaching.
- The knowledge and skills learned in the courses were put into practice.
- The course was properly implemented.

Result 5.2
Green Economy Study Modules

Study module C

Management & Technologies of the Circular Economy

Curricula and Teaching Materials

Workpackage 5 Third center level "Higher education"

Activity 8 Preparation and transfer of study modules "Green Economy”

8.3 Module C Management & Technologies of the Circular Economy

Introduction

As part of the project "Management and Technologies of Water, Waste-Water, Waste and Circular Economy" (WWW&CE), Vilnius Gediminas Technical University and Satakunta University of Applied Sciences have developed curriculum and teaching materials for the study module C Management & technologies of the circular economy. Part I below lists this curriculum.

Module C has been practically tested by Gediminas Technical University and integrated into existing Bachelor's programmes. Part II contains the curriculum developed for this and Attachment I contains the teaching materials developed and used by Vilnius Gediminas Technical University.

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Part I

Curriculum C

Management & Technologies of the Circular Economy

Vilnius Gediminas Technical University (VGTU), PP 3

Satakunta University of Applied Sciences (SAMK), PP11

Compiled by Dr Sirpa Sandelin and Dr Kari Lilja

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Introduction

Our global society is not sustainable, but the three pillars of the traditional concept of sustainability are environment, economy and society. We all know about the challenges we are facing waste, climate change, resource scarcity and loss of biodiversity. At the same time, we want to protect our economies and offer opportunities for a growing world population. The circular economy is one of the solutions that has been presented to solve the problems in the linear economy. However, considering the current state of nature, it looks like the prevailing economic practice is not to follow this approach but to choose solutions that seem optimal only in the short term. Most of the actions of companies are closer to the linear "take -use- throw "thinking, which consumes huge amounts of raw materials and energy and has a huge negative impact on nature.

The principles of the circular economy models are appropriate and applicable in many industries. These principles are based on the idea that global supply and consumption chains must rely on renewable resources and no scarce resources. The aim is to preserve the value of products, components and, ultimately, raw materials for as long as possible so that they can be used, repaired, recycled and, in the worst case, disposed of in a landfill for as long as possible. It is important to develop a climate-neutral circular economy. It is necessary for each industry to see and evaluate from where the principles of the circular economy can be applied to change its processes and product and/or to rethink business models.

The beginning of all is to realize that we live in a world of limited resources. First and foremost, this task should be borne by the economy, which needs to reap the maximum benefit from limited resources. An ideal and sustainable economy is one that provides for the greatest amount of general well-being with the least amount of resource use and environmental harm. In economic terms, to be truly sustainable, the overall demand for natural resources (also known as an ecological footprint) must be less than nature's renewable supply of resources (also known as biocapacity).

Because of the very different national circumstances, climate, topography and local conditions in EU countries, the curriculum on Management & Technologies of the Circular economy gives a general framework for managing circularity in municipalities and companies.

In this curriculum Management & Technologies of the Circular Economy refers to a systems solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution.

Target group

The target group of curriculum consists of Bachelor's programme students at universities and universities of applied sciences. The individual modules are well suited also to be applied as the open university courses.

Work required

In the curriculum the average work required by each module is measured in ECTS credit units (abbreviated in this presentation as CU). One credit unit equals 27 hours workload. The curriculum consists of modules totalling 6 ECTS credit units corresponding 160 hours containing lectures, professional field visits, individual studies and assignments. Cooperation with the local experienced industry practitioners is highly recommended. All modules can be studied individually, so the modules can be offered also via open studies to all companies and organizations, that intend to implement or develop sustainable management.

Contents of the curriculum

The variation in regulations and circumstances and qualification requirements are quite different in the BSR-countries, thus the curriculum can be written only as a form of framework inside which the local actors should be able to modify the contents of modules according to their own regulations and local requirements. Using innovative, problem-based and experiential educational approaches, students build on their professional experience to become experts who are able to create and implement effective sustainable economy solutions.

The overall objectives of the curriculum are to

- provide students with the basic knowledge needed to realize economic changes in the transition to the concept of the circular economy
- provide students with an understanding of the multifaceted nature of the circular economy, main challenges and opportunities of circular economy
- emphasize how the transition towards circular economy impact organizational decision-making and behaviour
- demonstrate key processes of circular processes and value of materials and products in changing uses across business sectors

The curriculum is divided into five modules as follows:

- Module 1: Introduction to circular economy concepts
- Module 2: Regulatory frameworks and roadmaps
- Module 3: Circular economy business models and management of operations
- Module 4: Circularity in action
- Module 5: Strategies and approaches for circularity

The curriculum on the Management & Technologies of the Circular Economy module structure is shown in Tables 1- 5 the contents. Part of the proposed course material is available on European Union pages in several languages.

Table 1 Contents of Module 1: Introduction to circular economy concepts

<table>
<tr><td>Module 1:
Introduction to circular economy concepts</td><td>Learning outcomes: Module 1 gives basic knowledge to realize the transition from linear to the circular economy. The module provides students with an understanding of the circular economy and its link to environmental, financial and societal factors in business. It presents some of the indicators used in the circular economy.</td></tr>
<tr><td colspan="2">Contents:

Historical background, definition and concepts of circular economy

Differences between linear economy and circular economy models

The main reasons driving change. The industrial revolution, Anthropocene, a global stocktake

Related definitions (zero waste, sustainability, circular business models, etc.)

Systems thinking and system-level approach to a circular economy (macro, meso and micro levels)

Addressing environmental considerations, financial considerations and societal factors

Indicators for circular economy</td></tr>
<tr><td colspan="2">Student’s workload:
10 lecture hours + 10 individual study hours</td></tr>
<tr><td colspan="2">Possible materials:

Vercalsteren, A., Maarten, C. and Van Hoof, V. Indicators for a Circular Economy. Available https://circulareconomy.europa.eu/platform/sites/default/files/summa_-_indicators_for_a_circular_economy.pdf</td></tr>
</table>

European Commission. 2018. Indicators for Sustainable Cities. Available https://ec.europa.eu/environment/integration/research/newsalert/pdf/indicators_for_sustainable_cities_IR12_en.pdf Desing, H., Brunner, D., Takacs, F., Nahrath, S., Frankenberger, K., & Hischier, R. 2020. A circular economy within the planetary boundaries: towards a resource-based, systemic approach. Resources, Conservation and Recycling, 155, 104673 (14 pp.). https://doi.org/10.1016/j.resconrec.2019.104673 Geissdoerfer, M. Savaget, P., Bocken, N. and Hultink. 2017. The Circular Economy – A new sustainability paradigm? Journal of Cleaner Production. 143: 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048 Selected chapters from Sillanpää, M and Ncibi, C. 2019. The Circular Economy – Case studies about the transition from the linear economy. ISBN: 9780128152676. Academic Press Inc.

Table 2 Contents of Module 2: Regulatory frameworks and roadmaps

Module 2: **Regulatory frameworks and roadmaps** Note: Module 2 must be designed country wise to meet the legislative frameworks and strategies.	Learning outcomes: Module 2 deals with the European circular economy action plans and their application in different countries' regional and local levels. The student gains a solid understanding of normative regulations, standards and roadmaps. He/she understands how to promote a circular economy in local areas.
Contents: European legal framework related to a circular economy EU Circular economy action plan and Green Deal Circular economy standard BS 8001:2017 National legislation and regulations, plans and road maps; Regional and local regulations, plans and road maps Circular economy in cities	
Student's workload: 8 lecture hours + 10 individual study hours	
Possible materials: European Commission. 2020. Circular economy action plan. Available https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN A European Green Deal. Available https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en Circular economy action plan for a cleaner and more competitive Europe. 2020. Available https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf Vanhamäki, S. 2021. Implementation of circular economy in regional strategies. Available https://urn.fi/URN:ISBN:978-952-335-771-6	

Ellen MacArthur Foundation. 2019. Circular economy in cities guide. Available https://ellenmacarthurfoundation.org/circular-economy-in-cities BSI Standards. 2017. Framework for implementing the principles of the circular economy in organizations – Guide. BS 8001:2017. Available file:///C:/Users/sisande/Downloads/BS8001_2017_Framework.pdf World Economic Forum. 2018. Circular Economy in Cities - Evolving the model for a sustainable urban future. Available https://www3.weforum.org/docs/White_paper_Circular_Economy_in_Cities_report_2018.pdf BSI. The rise of the Circular Economy. Available https://www.bsigroup.com/en-GB/standards/benefits-of-using-standards/becoming-more-sustainable-with-standards/BS8001-Circular-Economy/ Selected materials from Ellen MacArthur Foundation https://ellenmacarthurfoundation.org/growth-within-a-circular-economy-vision-for-a-competitive-europe Selected materials from Ceps. 2018. The Role of Business in the Circular Economy - Markets, Processes and Enabling Policies. Available https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/RoleBusinessCircularEconomyTFR.pdf

Table 3 Contents of Module 3: Circular economy business models and management of operations

Module 3: **Circular economy business models and management of operations**	Learning outcomes: Module 3 outlines several circular business models and explains how business benefits from transitioning to a circular business model. Students learn to analyze how circularity enables sustainability and describe the various enablers of sustainability, and learn how to design and manage waste out of business processes.
Contents: Operational principles of circular economy (eco-design, reuse, repair, redistribution, refurbishment, remanufacture or recycling) Circular inputs Sharing economy Product as a service Product use extension Resource recovery Business Value in a Circular Economy Biomimicry Distribution and reverse logistic	
Student’s workload: 12 lecture hours + 20 individual study hours	
Possible materials:	

Weetman, C. 2016. A circular economy handbook for business and supply chains: repair, remake, redesign, rethink. London, United Kingdom: Kogan ISBN 978-0-74947675-5. Fraccascia, L., Giannoccaro, I., Agarwal, A. and Hansen, E. 2019. Business models for the circular economy: Opportunities and challenges. Business Strategy and the Environment 28, 2, (430-432). DOI: 10.1002/bse.2285. Available https://www.researchgate.net/publication/331224413_Business_models_for_the_circular_economy_Opportunities_and_challenges Rubio, S., Jiménez-Parra, B., & Chamorro-Mera, A. and Miranda, F. 2019. Reverse Logistics and Urban Logistics: Making a Link. Sustainability, MDPI, Open Access Journal. Available https://www.mdpi.com/2071-1050/11/20/5684/htm Business models that work in the circular economy https://en.calameo.com/read/005419260d52a4d43aeef?view=slide&page=1 Selected materials from World Economic Forum https://www.weforum.org/topics/circular-economy Selected materials from Sitra https://www.sitra.fi/en/ Selected materials from Ellen MacArthur Foundation https://ellenmacarthurfoundation.org/resources/business/overview Selected materials from Ceps. 2018. The Role of Business in the Circular Economy - Markets, Processes and Enabling Policies. Available https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/RoleBusinessCircularEconomyTFR.pdf Selected materials from Biomimicry Institute https://biomimicry.org/

Table 4 Contents of Module 4: Circular economy in action

Module 4: **Circular economy in action**	Learning outcomes: Module 4 provide an overview of circular economy solutions in various industries. The student understands how materials are utilized and what new materials are being developed in a circular economy. He/she becomes acquainted with industrial symbioses and urban mining processes.
Contents: Fashion and textile industry Industrial manufacturing sector Food and agricultural sector Construction and demolition sector Plastic waste management Industrial symbiosis Urban mining	

Student's workload: 15 lecture hours + 30 individual study hours
Possible materials: Lacy,P., Long, J. and Spindler, W. 2020. The Circular Economy Handbook: Realizing the Circular Advantage. Palgrave Macmillan, UK. ISBN: 9781349959679. Selected chapters from Sillanpää, M and Ncibi, C. 2019. The Circular Economy – Case studies about the transition from the linear economy. ISBN: 9780128152676. Academic Press Inc. Selected materials from European Commission https://ec.europa.eu/environment/topics/circular-economy_fi Selected materials from European Parliament https://www.europarl.europa.eu/news/en/headlines/priorities/circular-economy Selected publications from Ellen MacArthur Foundation https://ellenmacarthurfoundation.org/publications Selected materials from Sitra https://www.sitra.fi/en/projects/interesting-companies-circular-economy-finland/#what-is-it-about Selected materials from Platform for Accelerating the Circular Economy https://pacecircular.org/ CityLoops project https://cityloops.eu/

Table 5 Contents of the Module 5: Strategies and approaches for circularity

Module 5 **Strategies and approaches for circularity**	Learning outcomes: Module 5 provide deeper understanding how sustainability can drive approaches in circularity and describe approaches that have improved sustainability. Students learn to use tools, strategies and frameworks as a springboard for creating sustainable circularity.
Contents: Product life extension Circular design and manufacturing processes (Eco-design) Product design, sourcing and procurement Cradle-to-cradle design Climate-neutral circular economy Zero waste, Zero emission, Zero cities Blue Economy	
Student's workload: 15 lecture hours + 30 individual study hours	
Possible materials: Braungart, M. & McDonough, W. 2002. Cradle to Cradle: Remaking the Way We Make Things. ISBN-10: 0865475873.	

Cradle to Cradle https://www.c2ccertified.org/

Desai, A. and Mital, A. 2020. Sustainable Product Design and Development. ISBN 9780367343217. CRC Press.

Kabre, C. 2021. Synergistic Design of Sustainable Built Environments. ISBN 9780367564834. CRC Press.

Selected materials from European Commission, Sustainable Blue Economy https://ec.europa.eu/oceans-and-fisheries/ocean/blue-economy/sustainable-blue-economy_fi

Selected materials from European Commission, Sustainable product policy & eco-design https://ec.europa.eu/growth/industry/sustainability/sustainable-product-policy-ecodesign_en

Selected materials from World Business Council for Sustainable Development https://www.wbcsd.org/

Selected materials from UNIDO https://www.unido.org/our-focus-building-better-future/resilient-carbon-neutral-growth-and-circular-economy

Further material

Further material can be applied according to needs. Following links, e.g., are worth looking into:

- The Cradle to Cradle Products Innovation Institute https://www.c2ccertified.org/
- Circular economy in cities https://www.ellenmacarthurfoundation.org/our-work/activities/circular-economy-in-cities
- Saarinen, J. 2021. Implementation of Circular Economy Projects: Expectations, Opportunities, and Impediments in Finnish MSMEs. Available https://jyx.jyu.fi/bitstream/handle/123456789/76456/1/URN%3ANBN%3Afi%3Ajyu-202106113662.pdf
- Linturi, R. 2021. Towards a better future - Technological opportunities and threats to the promotion of sustainable development. Publication of the Committee for the Future 1/2021. Available https://www.eduskunta.fi/FI/naineduskuntatoimii/julkaisut/Documents/tuvj_1+2021.pdf
- Bruel, A., Kronenberg, J., Troussier, N. and Guillaume, B. 2019. Linking Industrial Ecology and Ecological Economics: A Theoretical and Empirical Foundation for the Circular Economy, Journal of Industrial Ecology, Vol. 23(1), https://doi.org/10.1111/jiec.12745
- Biloslavo, R., Bagnoli, C., Massaro,M. and Cosentino, A. 2020. Business model transformation toward sustainability: the impact of legitimation. Management Decision. Available https://www.emerald.com/insight/content/doi/10.1108/MD-09-2019-1296/full/html
- SDG Compass guide https://sdgcompass.org/download-guide/#download-translations
- Zero Waste Europe https://zerowasteeurope.eu/
- REDUCE (REthinking Sustainable Development in European Regions by Using Circular Economy Business ModelS) http://www.interregeurope.eu/reduces/
- European Environment Agency https://www.eea.europa.eu/

Modifications allowed

The proportional division and content of separate modules suggested above can be changed if local conditions or needs of participants could be responded better by other solutions.

Examinations and qualifications

Examinations will be coordinated and competences will be controlled according to local regulation and locally required qualifications. It is each local actor's responsibility to take care that the admission requirements are fulfilled before the qualification application.

Notes for the teachers

Satakunta University of Applied Sciences (SAMK), project partner number 11

Compiled by Dr Sirpa Sandelin and Dr Kari Lilja

The material enclosed is an example showing how the topics of this course could be presented. Each teacher should adjust this to the circumstances of his own country, considering the local regulation and the study programme of the students; are they studying engineering, environmental topics, finance or marketing, some examples to be given. Each programme may require different weightings and highlights, and it is on the responsibility of each teacher to consider these special needs.

Target group

The target group of the curriculum consists of Bachelor's programme students at universities and universities of applied sciences. The individual modules are well suited also to be applied as the open university courses.

Work required

In the curriculum, the average work required by each module is measured in ECTS credit units (abbreviated in this presentation as CU). One credit unit equals 27 hours workload. The curriculum consists of modules totalling 6 ECTS credit units corresponding to 160 hours containing lectures, professional field visits, individual studies, and assignments.

Teaching methods

Teachers are encouraged to use varying methods containing e.g.:

- Lectures,
- Visiting lecturers,
- Professional field visits,
- Visits in enterprises,
- Videos approaching the topics (Reliability of the source must be evaluated),
- Individual studies and
- Assignments.

Cooperation with the local experienced industry practitioners is highly recommended. All modules can be studied individually, so the modules can be offered also via open studies to all companies and organizations, that intend to implement or develop water and wastewater systems.

Contents of the curriculum

The variation in regulations and circumstances and qualification requirements are quite different in the BSR-countries, thus the material was written only as a form of framework inside which the local actors should modify the contents of modules according to their own regulations and local requirements, without forgetting the needs of different study programmes. By using innovative, problem-based and experiential educational approaches, teacher will be able to help students to become experts who are able to create and implement sustainable wastewater treatment solutions to regions outside of the sewage network.

The overall objectives of the curriculum are to

- provide students with the basic knowledge needed to realize economic changes in the transition to the concept of the circular economy
- provide students with an understanding of the multifaceted nature of the circular economy, main challenges and opportunities of circular economy
- emphasize how the transition towards circular economy impact organizational decision-making and behaviour
- demonstrate key processes of circular processes and value of materials and products in changing uses across business sectors

The curriculum is divided into modules as follows:

- Module 1: Introduction to circular economy concepts (10 + 10 hours)
- Module 2: Regulatory frameworks and roadmaps (8 + 10 hours)
- Module 3: Circular economy business models and management of operations (12 + 20 hours)
- Module 4: Circularity in action (15 + 30 hours)
- Module 5: Strategies and approaches for circularity (15 + 30 hours)

The slides

It is recommended, that the usability (According to immaterial rights legislation and Copyright clauses) of pictures and other material used in the slides will be checked and sources will be inserted to the slides before publishing them.

Prof. Dr. Romualdas Ginevicius

Prof. Dr. Saulius Vasarevicius

Vilnius Gediminas Technical University

Fundamentals of the Circular economy

PATVIRTINTA
Vilniaus Gedimino technikos universiteto rektoriaus 2015 m. rugpjūčio 6 d. įsakymu Nr. 766

(Pavyzdinė studijų dalyko (modulio) kortelės forma)

VILNIAUS GEDIMINO TECHNIKOS UNIVERSITETAS

STUDIJŲ DALYKO (MODULIO) (SD(M)) KORTELĖ
PIRMOSIOS IR ANTROSIOS PAKOPŲ BEI VIENTISOSIOMS STUDIJOMS

Aplinkos apsaugos ir vandens inžinerijos **katedra**

COURSE CARD FOR THE FIRST AND SECOND CYCLE AND INTEGRATED STUDIES
.... Department

SD(M) dėstomas: ☐lietuvių kalba ☐anglų kalba ☒lietuvių ir anglų kalba
Language of studies: Lithuanian English Lithuanian and English

SD(M) pavadinimas	***Course title***
Žiedinės ekonomikos pagrindai	**Fundamentals of the Circular economy**

SD(M) priklausomybė studijų pakopai
Course subjection to study level

Studijos: *Studies:*	B	– pirmosios pakopos – *First cycle*	☐	A	– vientisosios – *Integrated*	☐	M	– antrosios pakopos – *Second cycle*	☐

SD(M) priklausomybė programai
Course subjection to programme

SD(M) priklausomybė dalykų grupei* *Course subjection to group*	1
SD(M) priklausomybė programos daliai** *Course subjection to part of the programme*	B
Struktūrinė SD(M) priklausomybė*** *Course structural subjection*	K

SD(M) priklausomybė studijų kryptis ir krypčių grupė
Course subjection to science area and field

Studijų krypties ir krypčių grupės kodas *Study area and field code*	
04	T

*) **Grupė:** *) 1 – studijų dalyko (*Course*); 2 – praktikos (*Practice*); 3 – baigiamojo darbo ar projekto (*Final Work or Project*); 4 – tiriamojo darbo (*Research Work*); 5 – profesinio testavimo (*Professional Testing*); 8 – kitas (*Other*).
**) A – Bendrųjų universitetinių studijų (*General*); B – Studijų krypties (*Field*); C – Specializacijos (*Specialization*).
***) U – universiteto (*University*); F – fakulteto (*Faculty*); K – katedros (*Department*).

SD(M) kodas
Course code

Fakultetas *Faculty*		Katedra *Department*		Pakopa*) Study cycle	*SD(M) Nr. 15**)001***)Number*
A	P	A	V	B	93001

SD(M) kreditai
Course volume in credits

Iš viso: *Total:*	Iš jų: KD, KS, KP, PR *There out:*
3	

SD(M) atsiskaitymo forma
Course assessment

Į, E1, E2, E, BE, BD, TD, A	KD, KS, KP, PR
E	

*) B – pirmoji pakopa (*first cycle studies*); A – vientisosios studijos (*integrated studies*); M – antroji pakopa (*second cycle studies*).
**) Naujoms ir atnaujintoms programoms skirtus studijų dalykus siūloma koduoti pirmais dviem skaitmenimis priskiriant 15 (pagal 2015 metus)
***)Dalyko registracijos numeris katedroje.

SD(M) valandų paskirstymas pagal studijų formas ir būdus
Distribution of course hours by study forms and ways

Studijų forma *Study form*	Kodas *Code*	Studijų būdas*) *Study way*	Valandos *(Hours)* Paskaitoms *Lectures*	Laboratoriniams darbams *Laborotory works*	Pratyboms *Practical works*	Konsultacijoms *Consultation*	Savarankiškam darbui *Independent work*	Iš viso *Total*	Iš jų: *There out:* Kontaktinių *Contact*	Auditorinio darbo *Classroom*
Nuolatinės studijos *Full-time studies*	NL	S	30				50	80		30

*) Studijų būdas: S – semestrais (*semesters*); M – moduliais (*modules*); C – ciklais (*periods*); T – nuotolinis (*distance*).
**) Pildoma tik tada, kai taikomas SD(M) kortelėje nenurodytas studijų būdas (*must be used in case study way does not fall into standard category*).

ANNOTATION OF COURSE

Pasaulio visuomenė dabartiniame kontekste nėra tvari, o tradicinės tvarumo koncepcijos ramsčiai yra aplinka, ekonomika ir visuomenė. Aktualūs iššūkiai, su kuriais susiduriama: atliekų susidarymas ir jų tvarkymas, klimato kaita, gamtinių išteklių trūkumas, biologinės įvairovės nykimas. Tuo pat metu valstybiniu požiūriu reikalinga apsaugoti savo ekonomiką ir įvertinti pasaulio gyventojų poreikius. Dalyko studijų metu nagrinėjama linijinės ekonomikos samprata, dabartinės jos tendencijos. Aptariami šios ekonomikos išoriniai padariniai, darantys įtaką mus supančiam pasauliui. Pažvelgus į esamą situaciją studijuosime pereinamojo laikotarpio teoriją ir bandysime išspręsti kai kurias problemas, kurios šiuo metu egzistuoja mūsų ekonominėje sistemoje. Žiedinė ekonomikos principų įgyvendinimas yra vienas iš sprendimų, padėsiančių spręsti linijinės ekonomikos problemas. Kursas skirtas aptarti ir žiedinės ekonomikos principų pranašumus ir trūkumus. Taip pat išnagrinėsime kitus siūlomus sprendimus ir išsiaiškinsime jų skirtumus. Paskaitų metu apžvelgiami reikalingi tolimesni pokyčiai, kuriuos turės atlikti tiek vyriausybės, tiek įmonės, kad būtų pereita prie žiedinės ekonomikos.

Our global society is not sustainable, but he three pillars of the traditional concept of sustainability are environment, economy and society. We all know about the challenges we're facing waste, climate change, resource scarcity, loss of biodiversity. At the same time, we want to protect our economies and offer opportunities for a growing world population. During this course we will observe the linear economy and the current state of it. We will try to identify the externalities of this economy that have influences on the world around us. After having a look at the status quo, we will study transition theory and will try to tackle some of the problems that currently exist in our economic system. The circular economy is one of the solutions has been presented to solve the problems in the linear economy. We will study this solution, its profits and defects in detail. We will also study other proposed solutions (such as doughnut economics and the bio-based economy) and will identify the differences between them. After that we will look at the changes that both governments and companies will need to do to be able to make a change he shift towards a circular economy.

AIM OF COURSE

Šio kurso tikslas yra suteikti studentams bazinių žinių, reikalingų ekonomikos pokyčiams atlikti, pereinant prie žiedinės ekonomikos koncepcijos. Taigi, kursas suteikia studentams supratimą apie pagrindinius žiedinės ekonomikos iššūkius ir galimybes, kartu pabrėžiant, kaip perėjimas prie žiedinės ekonomikos veikia organizacinių sprendimų priėmimą ir tolimesnį elgesį.

The aim of this course is to provide students with the base knowledge needed to realize economic changes in the transition to the concept of the circular economy. Hence, the course provides students an understanding of the main challenges and opportunities of circular economy, while emphasizing how the transition towards circular economy impacts on organizational decision-making and behavior.

Assessments criteria of students achievements

Pagrindinė literatūra (ne daugiau kaip 5 šaltiniai):
Main references (not more than 5 references)

Eil. Nr. No.	Leidinio autoriai ir pavadinimas (elektroninių leidinių ir žiniatinklio adreso) *Authors and title (site address in case of e-publication)*	Egzempliorių skaičius *) *Number of copies*		
		VGTU bibliotekoje ir skaityklose *VGTU library*	Fakulteto ir katedros metodiniuose kabinetuose *Faculty library*	Kitose Lietuvos bibliotekose *Rest of the country*
1.	Lacy Peter, Long Jessica, Spindler Wesley (2020). The Circular Economy Handbook: Realizing the Circular Advantage. Palgrave Macmillan UK ISBN: 9781349959679. P. 350			
2.	Ellen MacArthur Foundation. Growth Within: a Circular Economy Vision for a Competitive Europe 100 (2015)			
3.	Circular economy action plan for a cleaner and more competitive Europe. (2020). P. 27. https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf			
4.	Weetman, Catherine (2016). A circular economy handbook for business and supply chains: repair, remake, redesign, rethink. London, United Kingdom: Kogan ISBN 978-0-74947675-5. OCLC 967729002. P. 432			

5.	A new Circular Economy Action Plan For a cleaner and more competitive Europe (2020). P. 19. https://eur-lex.europa.eu/resource.html?uri=cellar:9903b325-6388-11ea-b735-01aa75ed71a1.0017.02/DOC_1&format=PDF			

*) Kortelės pildymo metu (*at the form filling moment*).

Papildoma literatūra (ne daugiau kaip 10 šaltinių):
Additional references (not more than 10 references)

Eil. Nr. *No.*	Leidinio autoriai ir pavadinimas (elektroninių leidinių ir žiniatinklio adreso) *Authors and title (site address in case of e-publication)*	Egzempliorių skaičius *) *Number of copies*		
		VGTU bibliotekoje ir skaityklose *VGTU library*	Fakulteto ir katedros metodiniuose kabinetuose *Faculty library*	Kitose Lietuvos bibliotekose *Rest of the country*
1.	EUROPEAN COMMISSION, Science for Environment Policy, in-depth report: Indicators for Sustainable Cities, 2018 Available https://ec.europa.eu/environment/integration/research/newsalert/pdf/indicators_for_sustainable_cities_IR12_en.pdf			
2.	Michael Braungart, William McDonough. Cradle to Cradle: Remaking the Way We Make Things. ISBN-10: 0865475873, 193 p.			
3.	Geissdoerfer, Martin; Savaget, Paulo; Bocken, Nancy M. P.; Hultink, Erik Jan (2017-02-01). "The Circular Economy – A new sustainability paradigm?". Journal of Cleaner Production. 143: 757–768. doi:10.1016/j.jclepro.2016.12.048			
4.	Paradigm shift. https://www.pyxeraglobal.org/paradigm-shift/			

Savarankiško darbo turinys
Content of independent work

Užduoties pavadinimas *Assignment title*	Savarankiško darbo apimtis vienai užduočiai valandomis *Amount of hours of independent work for a single task*					Užduočių skaičius *Number of tasks*				Iš viso valandų *Total hours*			
	Rekomenduojamos val. Recommended hours	Skirta val. Separated hours											
		NL(S)	I(S)	I(T)	*)	NL(S)	I(S)	I(T)	*)	NL(S)	I(S)	I(T)	*)
Kolokviumas *Intermediate examination*	8–27	27				1				27			
Egzaminas *examination*	16-24	23				1				23			
									Iš viso: *Total:*	50			

Savarankiško darbo grafikas
Individual work schedule

Užduoties tipas *Task type*	Užduoties pateikimo (*) ir atsiskaitymo (+) savaitė *Week of Assignment setting (*) and assessment (+)*																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Nuolatinės studijos (S) ***Full-time studies (S)***																					
Namų darbas *Home work* Kontrolinis darbas *test* Kolokviumas *Intermediate examination* Kita... *Other*	*) +																				

*) – Žymėjimo pavyzdys.

Paskaitų temų sąrašas
List of the Course lecture topics

Temos pavadinimas *Topic title*	Valandų skaičius *Number of hours*			
	NL	I	I(T)	*)
1. Kas yra tvarumas ir kodėl jis svarbus?	2			

What Is Sustainability and Why Is It Important?				
2. Žiedinė ekonomika - kas tai? Istorija, pagrindinės sąvokos The Circular economy – what is it? History, Basic Concepts	2			
3. Judame toliau nuo „imk, gamink, išmesk“ linijinio modelio Moving away from the "take, make, dispose" linear model	2			
4. Žiedinės ekonomikos principai Operational principles of circular economy	4			
5. Žiedinės ekonomikos Circular economy business models	2			
6. Žiedinės ekonomikos diegimo metodai mikro, makro ir mezo lygmenimis Circular Economy Implementation Methods at Micro, Macro and Meso Levels	2			
7. Verslo vertė žiedinėje ekonomikoje Business Value in a Circular Economy	4			
8. Iš lopšio – į lopšį koncepcija Cradle-to-cradle design	2			
9. Biomimikrija Biomimicry	2			
10. Mėlynoji žiedinė ekonomika The Blue Circular Economy	2			
11. Žiedinio projektavimo ir gamybos procesai (eko-dizainas) Circular design and manufacturing processes (Eco-design)	4			
ES žiedinės ekonomikos veiksmų planas miestams 12. EU Circular Economy Action Plan for Cities	2			
Iš viso: ***Total:***	30			

Business and Circular economy

PATVIRTINTA
Vilniaus Gedimino technikos universiteto rektoriaus 2015 m. rugpjūčio 6 d. įsakymu Nr. 766

(Pavyzdinė studijų dalyko (modulio) kortelės forma)

VILNIAUS GEDIMINO TECHNIKOS UNIVERSITETAS

STUDIJŲ DALYKO (MODULIO) (SD(M)) KORTELĖ PIRMOSIOS IR ANTROSIOS PAKOPŲ BEI VIENTISOSIOMS STUDIJOMS

.... katedra

COURSE CARD FOR THE FIRST AND SECOND CYCLE AND INTEGRATED STUDIES

.... Department

SD(M) dėstomas: ☐lietuvių kalba ☐anglų kalba ☒lietuvių ir anglų kalba
Language of studies: *Lithuanian* *English* *Lithuanian and English*

SD(M) pavadinimas	***Course title***
Verslas ir žiedinė ekonomika	**Business and Circular economy**

SD(M) priklausomybė studijų pakopai
Course subjection to study level

Studijos: ***Studies:***	B	– pirmosios pakopos – *First cycle*	☐	A	– vientisosios – *Integrated*	☐	M	– antrosios pakopos – *Second cycle*	☐

SD(M) priklausomybė programai

Course subjection to programme

SD(M) priklausomybė dalykų grupei* *Course subjection to group*	1
SD(M) priklausomybė programos daliai** *Course subjection to part of the programme*	B
Struktūrinė SD(M) priklausomybė*** *Course structural subjection*	K

SD(M) priklausomybė studijų kryptis ir krypčių grupė
Course subjection to science area and field

Studijų krypties ir krypčių grupės kodas *Study area and field code*	
04	T

*) **Grupė:** *) 1 – studijų dalyko (*Course*); 2 – praktikos (*Practice*); 3 – baigiamojo darbo ar projekto (*Final Work or Project*); 4 – tiriamojo darbo (*Research Work*); 5 – profesinio testavimo (*Professional Testing*); 8 – kitas (*Other*).
**) A – Bendrųjų universitetinių studijų (*General*); B – Studijų krypties (*Field*); C – Specializacijos (*Specialization*).
***) U – universiteto (*University*); F – fakulteto (*Faculty*); K – katedros (*Department*).

SD(M) kodas
Course code

Fakultetas *Faculty*		Katedra *Department*		Pakopa*) Study cycle	*SD(M) Nr. 15**)001***)Number*
A	P	A	V	B	93002

SD(M) kreditai
Course volume in credits

Iš viso: *Total:*	Iš jų: KD, KS, KP, PR *There out:*
3	

SD(M) atsiskaitymo forma
Course assessment

Į, E1, E2, E, BE, BD, TD, A	KD, KS, KP, PR
E	

*) B – pirmoji pakopa (*first cycle studies*); A – vientisosios studijos (*integrated studies*); M – antroji pakopa (*second cycle studies*).
**) Naujoms ir atnaujintoms programoms skirtus studijų dalykus siūloma koduoti pirmais dviem skaitmenimis priskiriant 15 (pagal 2015 metus)
***) Dalyko registracijos numeris katedroje.

SD(M) valandų paskirstymas pagal studijų formas ir būdus
Distribution of course hours by study forms and ways

Studijų forma *Study form*	Kodas *Code*	Studijų būdas*) *Study way*	Valandos *(Hours)*						Iš jų: *There out:*	
			Paskai-toms *Lectures*	Laborato-riniams darbams *Laborotory works*	Praty-boms *Practical works*	Konsul-tacijoms *Consultation*	Savaran-kiškam darbui *Independent work*	Iš viso *Total*	Kontak-tinių *Contact*	Auditorinio darbo *Classroom*
Nuolatinės studijos *Full-time studies*	NL	S	30				50	80		30

*) Studijų būdas: S – semestrais (*semesters*); M – moduliais (*modules*); C – ciklais (*periods*); T – nuotolinis (*distance*).
**) Pildoma tik tada, kai taikomas SD(M) kortelėje nenurodytas studijų būdas (*must be used in case study way does not fall into standard category*).

ANNOTATION OF COURSE

Visa ko pradžia yra suvokti, kad gyvename ribotų išteklių pasaulyje. Visų pirma, ši užduotis turėtų tekti ekonomikai – būtina iš ribotų išteklių gauti kuo didesnę naudą. Ideali ir tvari ekonomika yra tokia, kuri užtikrina didžiausią bendrą gerovę, mažiausią išteklių naudojimą ir žalą aplinkai. Ekonomine prasme, norint būti tikrai tvariam, bendra gamtos išteklių (dar vadinamų ekologiniu pėdsaku) paklausa turi būti mažesnė už atsinaujinančius gamtos išteklių išteklius (dar vadinamus biologiniais pajėgumais). Tačiau iš dabartinės gamtos būsenos atrodo, kad vyraujanti ekonominė praktika – ne vadovautis šiuo požiūriu, o pasirinkti sprendimus, kurie atrodo optimalūs tik trumpuoju laikotarpiu. Dauguma rinkoje veikiančių įmonių, žmonių ir valdžios veiksmų yra artimesni tiesiniam „paimk, panaudok, išmesk" mąstymui, kuriuo vadovaujantis sunaudojami milžiniški kiekiai žaliavų bei energijos ir daromas didžiulis neigiamas poveikis gamtai. Žiedinės ekonomikos modelio principai yra tinkami ir taikytini daugelyje pramonės šakų. Šie principai paremti idėja, kad globalioms tiekimo ir vartojimo grandinėms turi būti pasitelkiami atsinaujinantieji ištekliai ir nenaudojama jokių ribotų išteklių. To tikslas – kiek įmanoma ilgiau išlaikyti produktų, komponentų ir galiausiai žaliavų vertę, kad būtų galima juos kuo ilgiau naudoti, pataisyti, atnaujinti ir, blogiausiu atveju, perdirbti. Svarbu vystyti klimatui neutralią žiedinę ekonomiką. Kiekvienoje pramonėje būtina įžvelgti ir įvertinti nuo ko galima pradėti taikyti žiedinės ekonomikos principus - pakeisti savo procesus ir produktą ar (ir) pergalvoti verslo modelius.

The beginning of all is to realize that we live in a world of limited resources. First and foremost, this task should be borne by the economy, which needs to reap the maximum benefit from limited resources. An ideal and sustainable economy is one which provides for the greatest amount of general well-being with the least amount of resource use and environmental harm. In economic terms, to be truly sustainable, the overall demand for natural resources (also known as ecological footprint) must be less than the nature's renewable supply of resources (also known as biocapacity).
However, from the current state of nature, it seems that the prevailing economic practice is not to follow this approach, but to choose solutions that seem optimal only in the short term. Most of the actions of companies, people and governments in the market are closer to the linear "take -use- throw "thinking, which consumes huge amounts of raw materials and energy and has a huge negative impact on nature. The principles of the circular economy models are appropriate and applicable in many industries. These principles are based on the idea that global supply and consumption chains must rely on renewable resources and no scarce resources. The aim is to preserve the value of products, components and, ultimately, raw materials for as long as possible so that they can be used, repaired, recycled and, in the worst case, disposed of in a landfill for as long as possible. It is important to develop a climate-neutral circular economy. It is necessary for each industry to see and evaluate from where the principles of the circular economy can be applied - to change its processes and product and / or to rethink business models.

AIM OF COURSE

Kurso tikslas – suteikti studentams žinių apie žiedinės ekonomikos daugialypį pobūdį. Svarbu suprasti apie pagrindinius žiediškumo procesus: perdirbimą, efektyvus išteklių naudojimą, atsinaujinančių energijos šaltinių panaudojimą, gaminių ir komponentų perdirbimą, atnaujinimą ir pakartotinį naudojimą, produkto naudojimo laiko pratęsimą, dalijimosi modelius, medžiagų ir gaminių vertę keičiant naudojimo būdus įvairiuose verslo sektoriuose.

The aim of the course is to provide students with knowledge of the multifaceted nature of the circular economy. It is important to understand the key processes of the circular processes: recycling, resource efficiency, use of renewable energy sources, recycling, refurbishment and reuse of products and components, product life extensions, sharing patterns, value of materials and products in changing uses across business sectors.

Assessments criteria of students achievements

Pagrindinė literatūra (ne daugiau kaip 5 šaltiniai):
Main references (not more than 5 references)

Eil. Nr. *No.*	Leidinio autoriai ir pavadinimas (elektroninių leidinių ir žiniatinklio adreso) *Authors and title (site address in case of e-publication)*	Egzempliorių skaičius *) *Number of copies*		
		VGTU bibliotekoje ir skaityklose *VGTU library*	Fakulteto ir katedros metodiniuose kabinetuose *Faculty library*	Kitose Lietuvos bibliotekose *Rest of the country*
6.	Weetman, Catherine (2016). A circular economy handbook for business and supply chains : repair, remake, redesign, rethink. London, United Kingdom: Kogan Page. p. 25. ISBN 978-0-74947675-5. OCLC 967729002			
7.	Circular economy in cities, https://www.ellenmacarthurfoundation.org/our-work/activities/circular-economy-in-cities			
8.	Luca Fraccascia, Ilaria Giannoccaro, Abhishek Agarwal, Erik G. Hansen, Business models for the circular economy: Opportunities and challenges, Business Strategy and the Environment, 10.1002/bse.2285, **28**, 2, (430-432), (2019).			
9.	Aelien Bruel, Jakub Kronenberg, Nadege Troussier, Bertrand Guillaume. Linking Industrial Ecology and Ecological Economics: A Theoretical and Empirical Foundation for the Circular Economy, Journal of Industrial Ecology, Vol. 23(1), 2019, https://doi.org/10.1111/jiec.12745			
10.	Roberto Biloslavo, Carlo Bagnoli, Maurizio Massaro, Antonietta Cosentino, Business model transformation toward sustainability: the impact of legitimation, Management Decision, 10.1108/MD-09-2019-1296			
11.	Harald Desing, Dunia Brunner, Fabian Takacs, Stéphane Nahrath, Karolin Frankenberger, Roland Hischier, A circular economy within the planetary boundaries: Towards a resource-based, systemic approach, Resources, Conservation and Recycling, 10.1016/j.resconrec.2019.104673, **155**, (104673), (2020).			

*) Kortelės pildymo metu (*at the form filling moment*).

Papildoma literatūra (ne daugiau kaip 10 šaltinių):
Additional references (not more than 10 references)

Eil. Nr. *No.*	Leidinio autoriai ir pavadinimas (elektroninių leidinių ir žiniatinklio adreso) *Authors and title (site address in case of e-publication)*	Egzempliorių skaičius *) *Number of copies*		
		VGTU bibliotekoje ir skaityklose *VGTU library*	Fakulteto ir katedros metodiniuose kabinetuose *Faculty library*	Kitose Lietuvos bibliotekose *Rest of the country*
1.	EUROPEAN COMMISSION, Science for Environment Policy, in-depth report: Indicators for Sustainable Cities, 2018. Available https://ec.europa.eu/environment/integration/research/newsalert/pdf/indicators_for_sustainable_cities_IR12_en.pdf			
2.	Sergio Rubio & Beatriz Jiménez-Parra & Antonio Chamorro-Mera & Francisco J. Miranda, 2019. "Reverse Logistics and Urban Logistics: Making a Link," Sustainability, MDPI, Open Access Journal, vol. 11(20), pages 1-17, October.			
3.	https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/RoleBusinessCircularEconomyTFR.pdf			
4.	https://www.ellenmacarthurfoundation.org/assets/downloads/ce100/CE100-CoPro-BE_Business-Models-Interactive.pdf			
5.	https://www.sitra.fi/en/projects/interesting-companies-circular-economy-finland/#business-examples			

*) Kortelės pildymo metu (*at the form filling moment*).

Savarankiško darbo turinys
Content of independent work

Užduoties pavadinimas *Assignment title*	Savarankiško darbo apimtis vienai užduočiai valandomis *Amount of hours of independent work for a single task*					Užduočių skaičius *Number of tasks*				Iš viso valandų *Total hours*			
	Rekomend-uojamos val. Recommended hours	Skirta val. Separated hours											
		NL(S)	I(S)	I(T)	*)	NL(S)	I(S)	I(T)	*)	NL(S)	I(S)	I(T)	*)
Kolokviumas *Intermediate examination*	8–27	27				1				27			
Egzaminas *examination*	16-24	23				1				23			
									Iš viso: *Total:*	50			

*) Papildomas laukas pildomas tik tada, kai taikomas SD(M) kortelėje nenurodytas studijų būdas (*must be used in case study way does not fall into standard category*): M – moduliais (*modules*); C – ciklais (*periods*); T – nuotolinis (*distance*)

Savarankiško darbo grafikas
Individual work schedule

Užduoties tipas *Task type*		Užduoties pateikimo (*) ir atsiskaitymo (+) savaitė *Week of Assignment setting (*) and assessment (+)*																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Nuolatinės studijos (S) ***Full-time studies (S)***																					
Namų darbas *Home work* Kontrolinis darbas *test* Kolokviumas *Intermediate examination* Kita... *Other*	*) +																				

*) – Žymėjimo pavyzdys.
**) Pildoma tik tada, kai taikomas SD(M) kortelėje nenurodytas studijų būdas (*must be used in case study way does not fall into standard category*): M – moduliais (*modules*); C – ciklais (*periods*); T – nuotolinis (*distance*).

Paskaitų temų sąrašas
List of the Course lecture topics

Temos pavadinimas *Topic title*	Valandų skaičius *Number of hours*			
	NL	I	I(T)	*)
13. Pagrindinės priežastys, lemiančios pokyčius. Pramonės revoliucija, antropocenas, pasaulinė akcijų apžvalga The main reasons driving change. Industrial revolution, Anthropocene, a global stock take	4			
14. Maistas ir žemės ūkis - problemos ir iššūkiai Food and agriculture – issues and challenges	2			
15. Mada ir tekstilė - tiekimo grandinės padariniai Fashion and textile - supply chain implications	2			
16. Pramoninė gamyba - klausimai ir iššūkiai, ištekliai Industrial manufacturing - issues and challenges, furthers resources	4			
17. Produkto tarnavimo laiko pratęsimas Product life extension	2			
18. Gaminio projektavimas, tiekimas ir pirkimas Product design, sourcing and procurement	2			
19. Pramonės simbiozė Industrial symbiosis	2			
20. Žiedinė ekonomika plastikams, atliekų tvarkymas A circular economy for plastics, waste management	2			
21. Paskirstymo grandinės ir reversinė logistika Distribution and reverse logistic	2			
22. Mąstymas sistemose Thinking in Systems	2			
23. Miesto kasyba The urban mining	2			
24. Klimatui neutrali žiedinė ekonomika Climate-neutral circular economy	2			
25. Nulis atliekų, nulis emisijų, nuliniai miestai Zero waste, Zero emission, Zero cities	2			

Iš viso: ***Total:***	30			

*⁾ Papildomas laukas pildomas tik tada, kada taikomas SD (M)kortelėje nenurodytas studijų būdas (*must be used in case study way does not fall into standard category*): M – moduliais (*modules*); C – ciklais (*periods*); T – nuotolinis (*distance*).

Attachment I Teaching Material Module C Circular Economy

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

Circular economy

Vilnius Gediminas Technical University (VILNIUS TECH),
Project partner number 3
Compiled by Dr. Saulius Vasarevičius

Introduction (1)

- *COURS CONSIST OF TWO PARTS:*

❖ **Fundamentals of the Circular economy, 3 ECT (80 hours)**

❖ **Business and Circular economy, 3 ECT (80 hours)**

- ***Lectures 30 + 30 hours***
- ***Independent work 50 + 50 hours***

Introduction (2)

- Our global society is not sustainable, but he three pillars of the traditional concept of sustainability are environment, economy and society. We all know about the challenges we're facing waste, climate change, resource scarcity, loss of biodiversity. At the same time, we want to protect our economies and offer opportunities for a growing world population. During this course we will observe the linear economy and the current state of it. We will try to identify the externalities of this economy that have influences on the world around us. After having a look at the status quo, we will study transition theory and will try to tackle some of the problems that currently exist in our economic system. The circular economy is one of the solutions has been presented to solve the problems in the linear economy. We will study this solution, its profits and defects in detail. We will also study other proposed solutions (such as doughnut economics and the bio-based economy) and will identify the differences between them. After that we will look at the changes that both governments and companies will need to do to be able to make a change he shift towards a circular economy.

Introduction (3)

- The beginning of all is to realize that we live in a world of limited resources. First and foremost, this task should be borne by the economy, which needs to reap the maximum benefit from limited resources. An ideal and sustainable economy is one which provides for the greatest amount of general well-being with the least amount of resource use and environmental harm. In economic terms, to be truly sustainable, the overall demand for natural resources (also known as ecological footprint) must be less than the nature's renewable supply of resources (also known as biocapacity).
- However, from the current state of nature, it seems that the prevailing economic practice is not to follow this approach, but to choose solutions that seem optimal only in the short term. Most of the actions of companies, people and governments in the market are closer to the linear "take -use-throw "thinking, which consumes huge amounts of raw materials and energy and has a huge negative impact on nature. The principles of the circular economy models are appropriate and applicable in many industries. These principles are based on the idea that global supply and consumption chains must rely on renewable resources and no scarce resources. The aim is to preserve the value of products, components and, ultimately, raw materials for as long as possible so that they can be used, repaired, recycled and, in the worst case, disposed of in a landfill for as long as possible. It is important to develop a climate-neutral circular economy. It is necessary for each industry to see and evaluate from where the principles of the circular economy can be applied - to change its processes and product and / or to rethink business models.

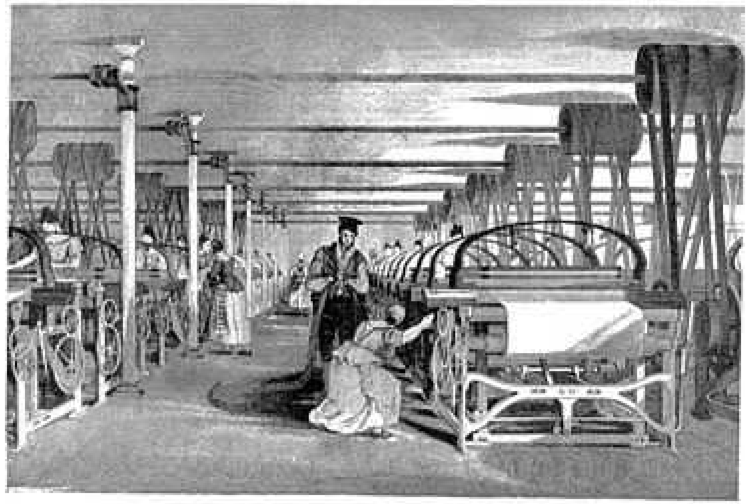
Introduction (4)

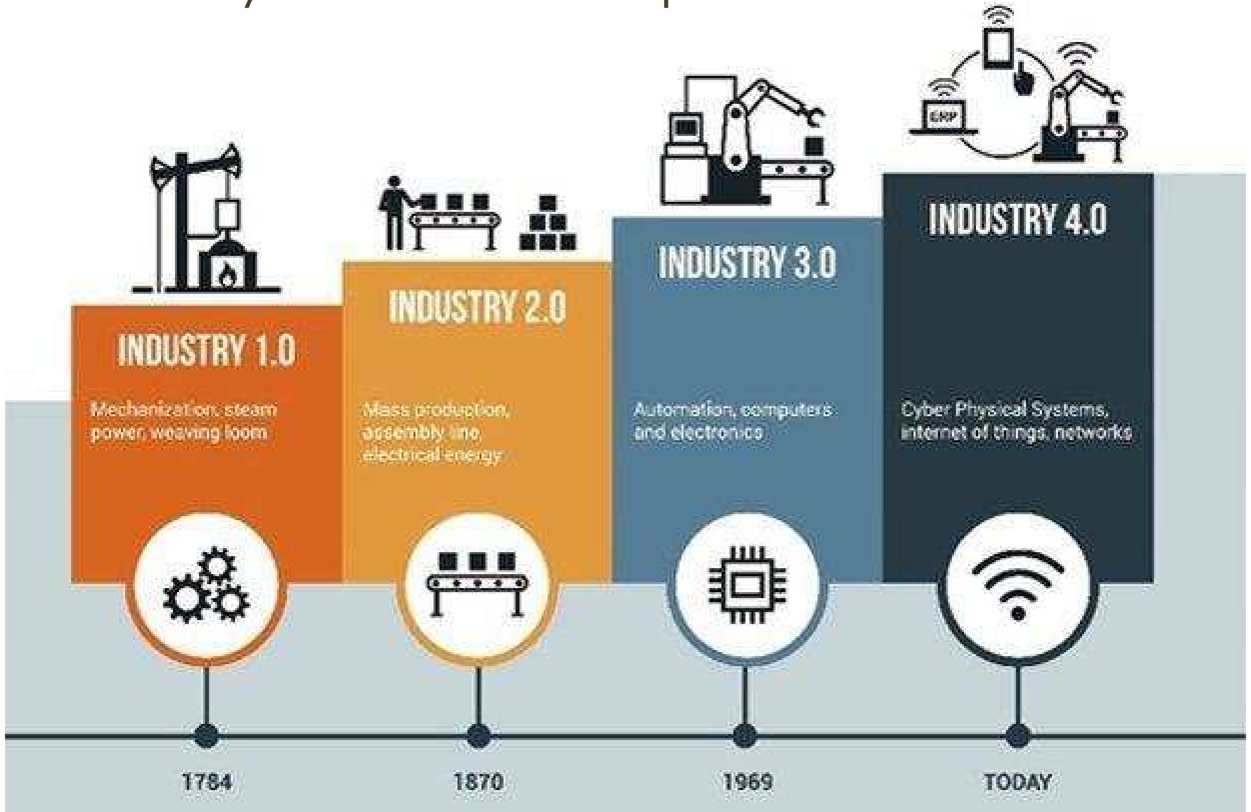
- ***<u>The main aims</u>***
- ***Hence, the course provides students an understanding of the main challenges and opportunities of circular economy, while emphasizing how the transition towards circular economy impacts on organizational decision-making and behavior.***

- ***It is important to understand the key processes of the circular processes: recycling, resource efficiency, use of renewable energy sources, recycling, refurbishment and reuse of products and components, product life extensions, sharing patterns, value of materials and products in changing uses across business sectors.***

Sustainability - where to start?

The Industrial Revolution was the transition to new manufacturing processes in Europe and the United States, in the period from between 1760 to 1820 and 1840.



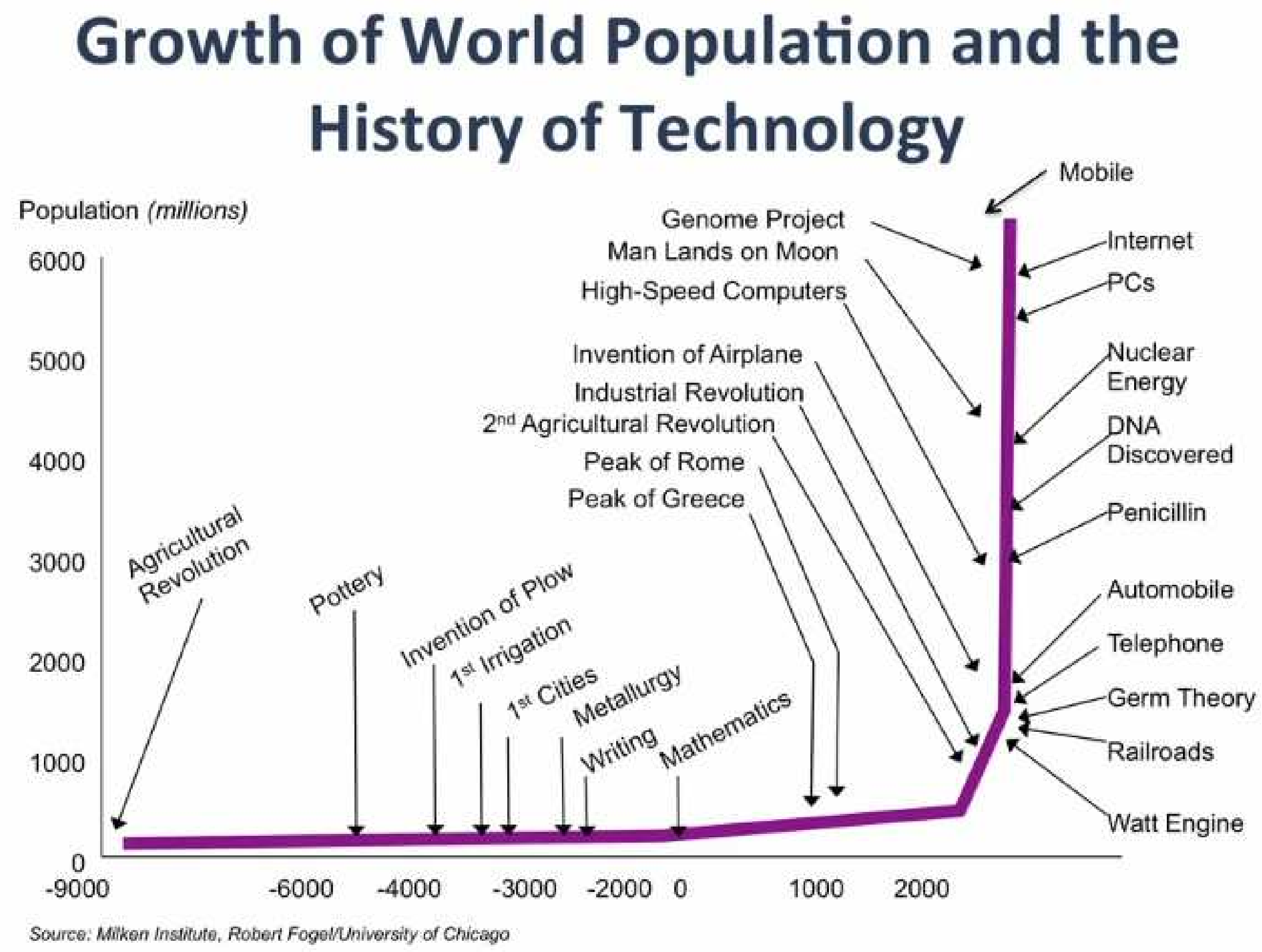


Sustainability - where to start?

- ***Effect on environment***
- The origins of the environmental movement lay in the response to increasing levels of smoke pollution in the atmosphere during the Industrial Revolution. The emergence of great factories and the concomitant immense growth in coal consumption gave rise to an unprecedented level of air pollution in industrial centers.

Sustainability - where to start?

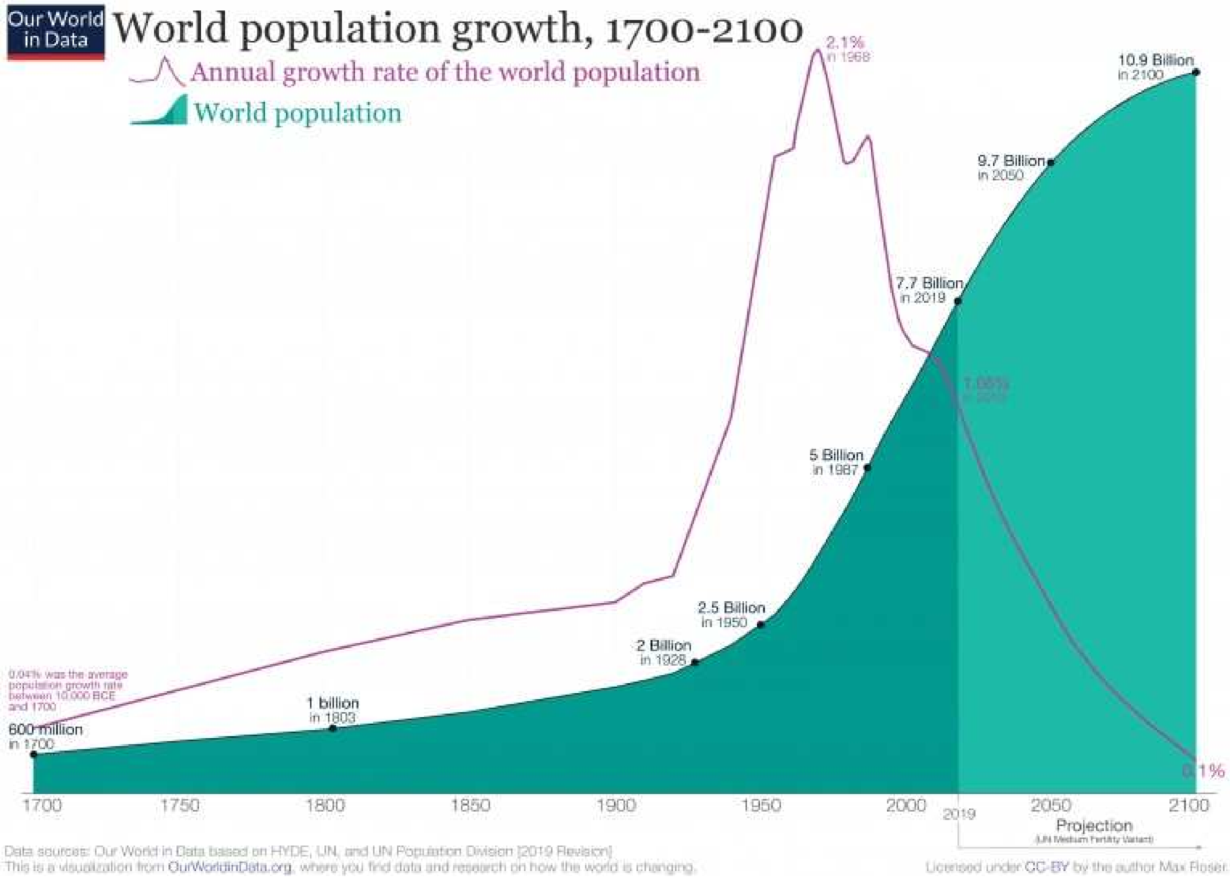
- ***The Industrial Revolution***, which started in the 18th century, was not only the transition from hand production methods to manufacturing, but also the starting point for huge transformative processes within the society.
- ***Unprecedented population growth and technological innovations*** led to increased consumption that, in turn, considering the limited resources, caused the global challenges mankind is facing now.



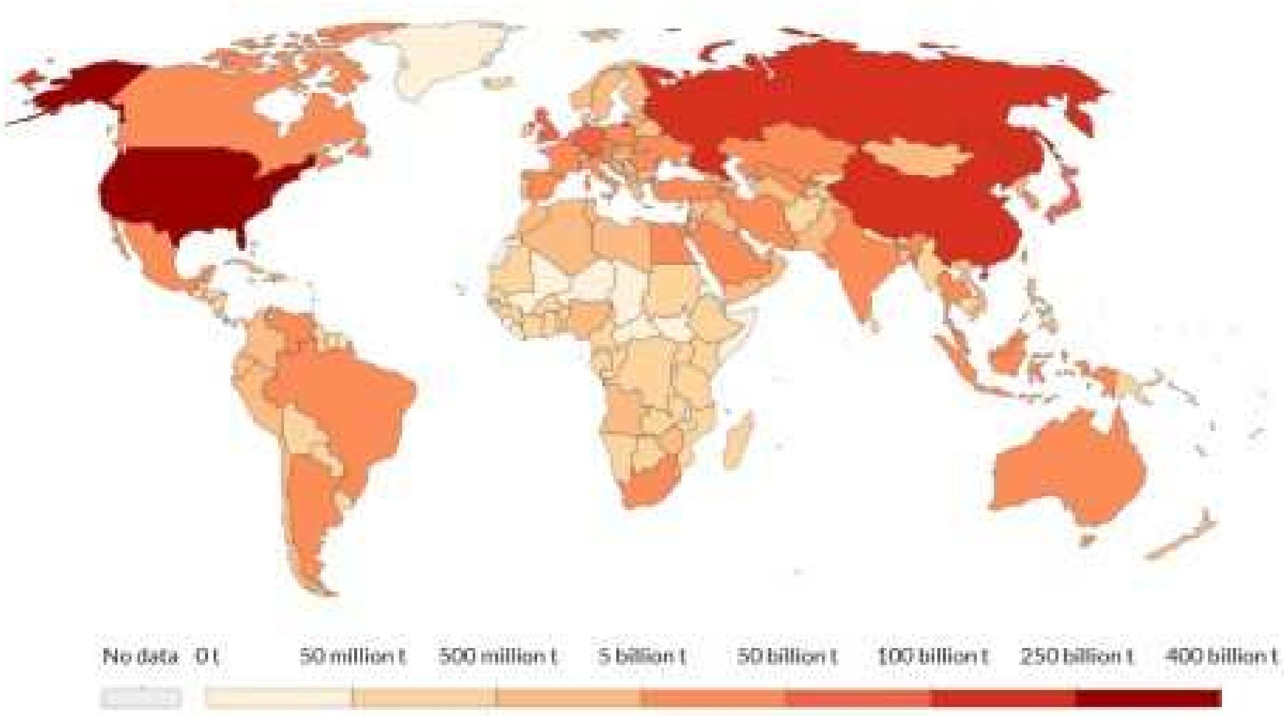
What is sustainability?

- ***Sustainability is the ability to exist and develop without depleting natural resources for the future.***

- The United Nations defined sustainable development in the Brundtland Report as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It assumes that resources are finite, and so should be used conservatively and carefully to ensure that there is enough for future generations, without decreasing present quality of life. A sustainable society must be socially responsible, focussing on environmental protection and dynamic equilibrium in human and natural systems.



Why sustainability?



Environmental pollution, in turn, resulted in land degradation (soil erosion), forest degradation, biodiversity reduction and climate change (global warming).

Cumulative carbon dioxide (CO_2) emissions (total sum of CO_2 emissions produced from fossil fuels and cement)

What are the 3 Pillars of Sustainability?

- **Environmental protection** is the most frequently discussed element. It is concerned with the reduction of carbon footprints, water usage, non-decomposable packaging, and wasteful processes as part of a supply chain. These processes can often be cost-effective, and financially useful as well as important for environmental sustainability.
- **Social development** is about treating employees fairly and ensuring responsible, ethical, and sustainable treatment of employees, stakeholders, and the community in which a business operates.
- **Economic development** is probably the simplest form of sustainability. To be economically sustainable, a business must be profitable and produce enough revenues to be continued into the future. The challenge with this form of sustainability is achieving an equilibrium.

History of the circular economy concept

- There is no clear evidence of a single origin or originator of the CE concept, but contributors include U.S. professor John Lyle; his student William McDonough; the German chemist, Michael Braungart and, architect and economist, Walter Stahel.
- The CE concept may also have been inspired by Rachel Carson's Silent Spring.
- Pearce and Turner developed conceptual frameworks for the CE concept such as resource-products-pollution modes. The principles of the CE concept include the 3Rs (reduce, reuse, recycle) and the 6Rs (reuse, recycle, redesign, remanufacture, reduce, recover).


William McDonough


Rachel Carson

Circular economy history

- It cannot be traced back to a single author or date and is inspired by several schools of thought. In the 1960, ***Kenneth Boulding***, a British economist, described the Earth as a "**closed spaceship**" in Economics of the Coming Spaceship Earth.
- In the 1970, ***the Club of Rome*** came up with the "***Limits to Growth***" concept, according to which humanity can only sustain its survival by restraining production and consumption. In addition to the aforementioned, other theories have also influenced the development of circular economy since the sixties, including Cradle-to-Cradle, Biomimicry, Industrial Ecology, Performance-based Economy, and Blue economy.

Circular economy history

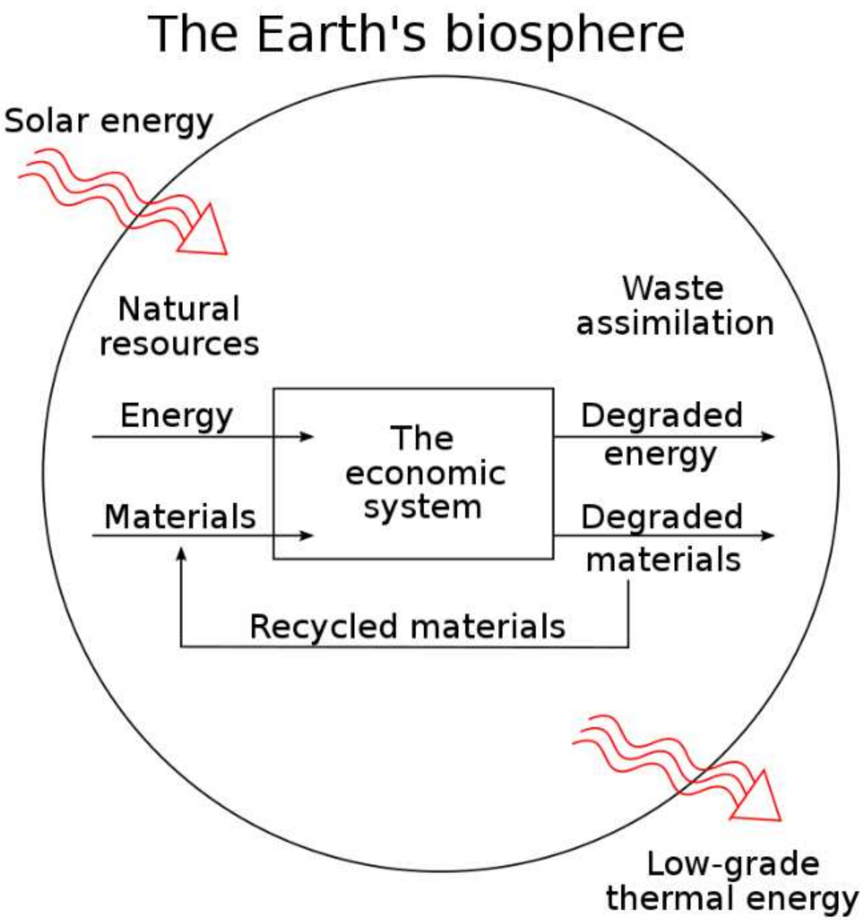
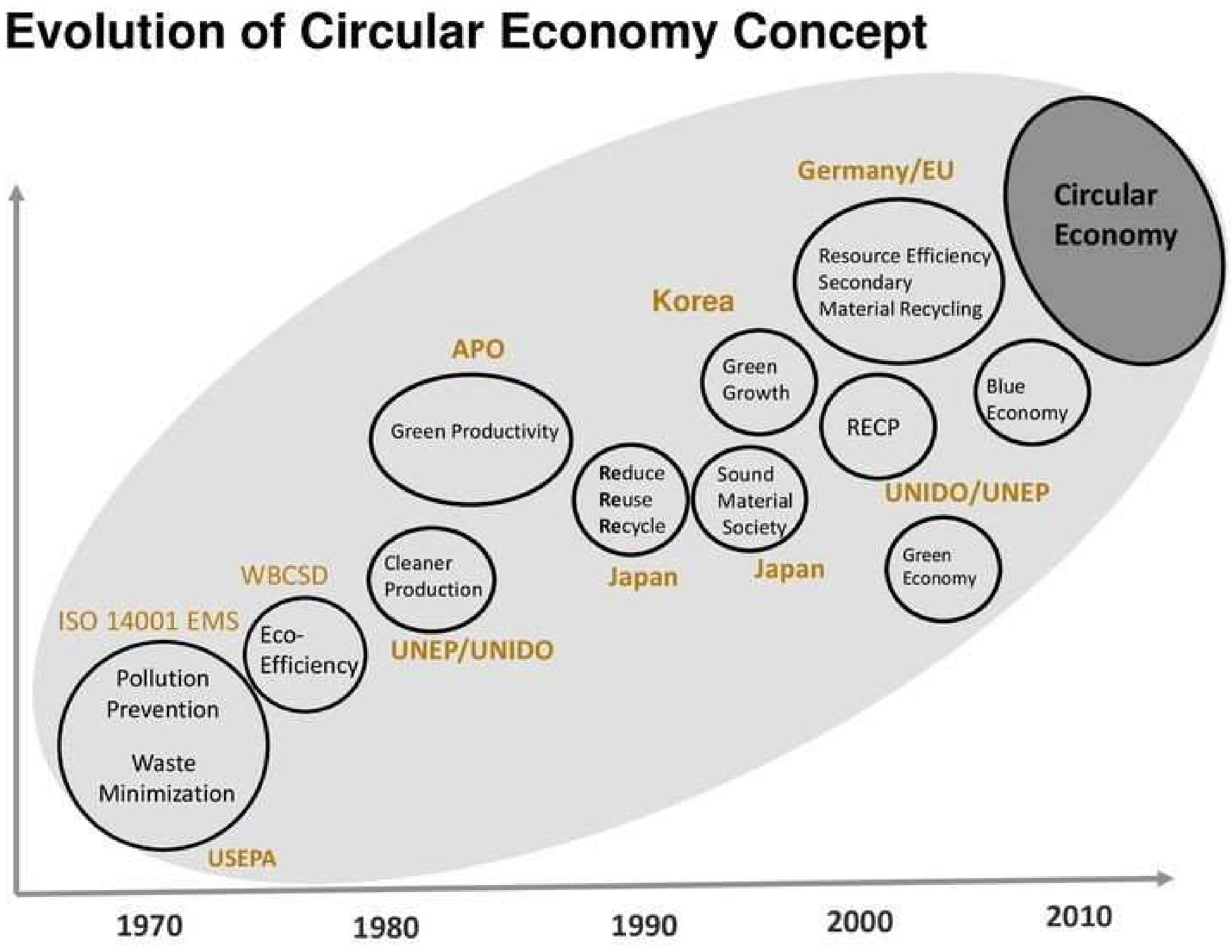


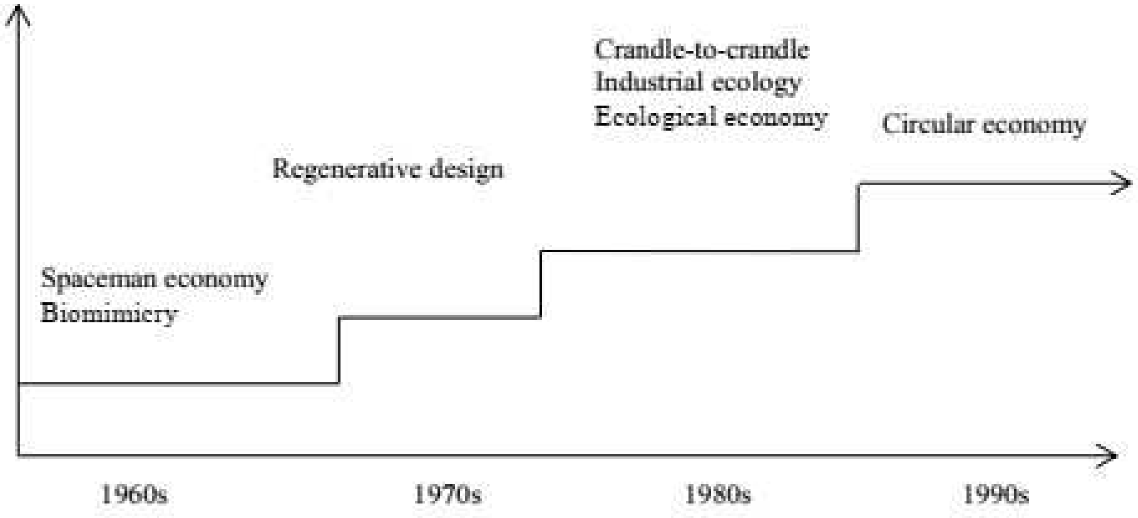
Diagram describing the flow of natural resources through the economy: Valuable resources are procured from nature by the input end of the economy; the resources flow through the economy, being transformed and manufactured into goods along the way; and invaluable waste and pollution eventually accumulate by the output end. Recycling of material resources is possible, but only by using up some energy resources as well as an additional amount of other material resources; and energy resources, in turn, cannot be recycled at all, but are dissipated as waste heat.

Circular economy history



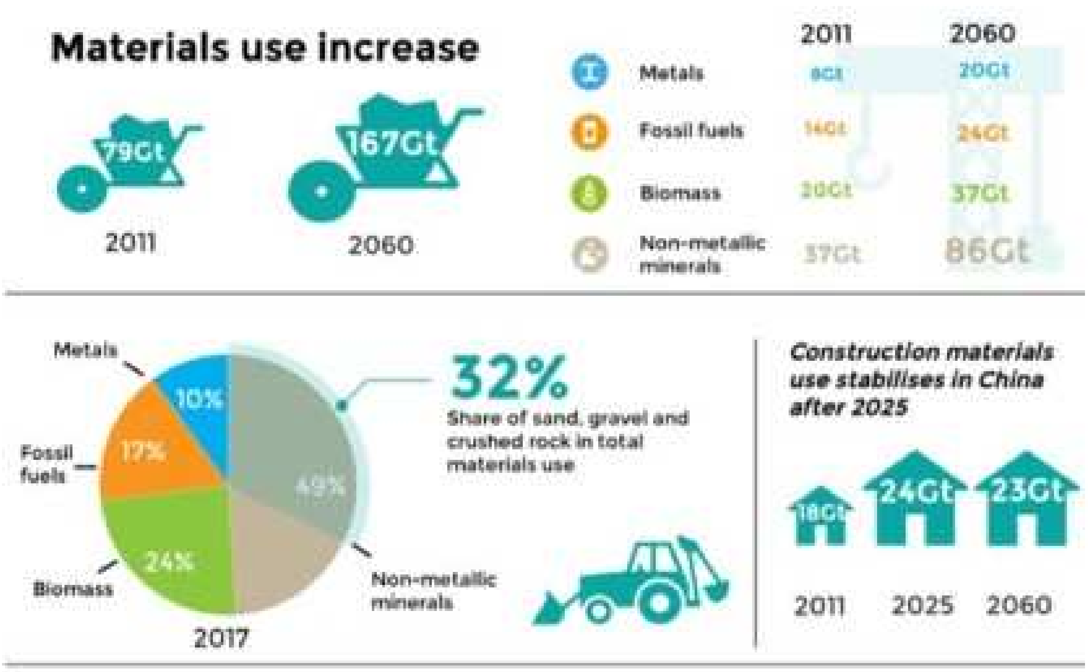
Circular economy history

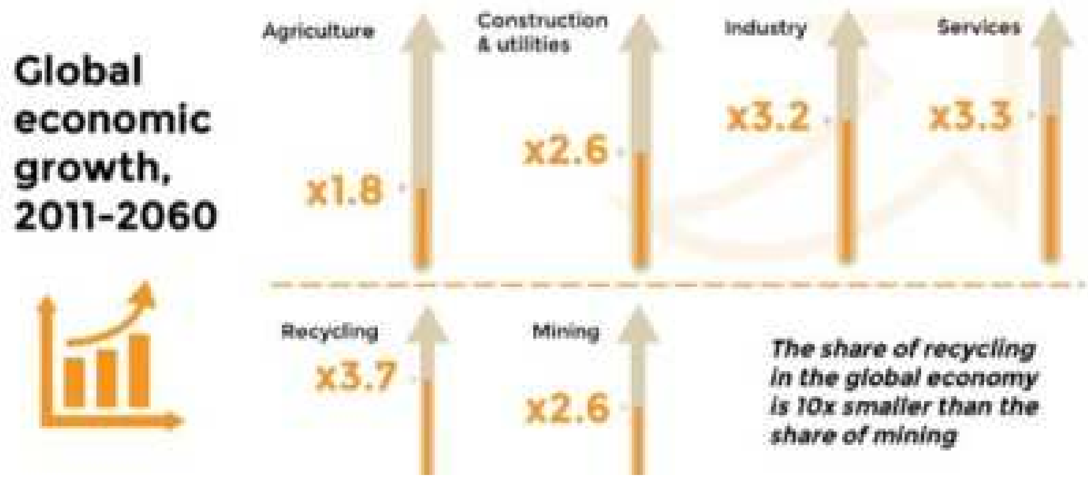
Concept / school of thought	Year	Contribution
Performance economy	1986	Stahel, W.R. "Hidden Innovation, R&D in a Sustainable Society"
Green Economy	1989	Pearce, D.W., Markandya, A., Barbier, E.B. "Blueprint for a Green Economy"
Industrial ecology	1989	Frosch & Gallopoulos "Strategies for Manufacturing"
Regenerative Design	1994	Lyle, J.T. "Regenerative design for sustainable development"
Biomimicry	1997	Benyus, J.M. "Biomimicry: Innovation Inspired by Nature"
Bioeconomy	1998	Enriquez, J. "Genomics and the World's Economy"
Cradle-to-cradle	2002	McDonough & Braungart "Cradle to Cradle: Rethinking the Way We Make Things"
Blue economy	2010	Pauli, G. "10 years, 100 innovations, 100 million new jobs"



Schools of thought contributed to the development of the Circular economy concept

Key facts and projections





What is the definition of a circular economy?

- ***A circular economy is an economic system of closed loops in which raw materials, components and products lose their value as little as possible, renewable energy sources are used and systems thinking is at the core. In this article we will explain this definition in more detail.***

Development of the definition

- More than 100 different definitions of circular economy are used in scientific literature and professional journals. There are so many different definitions in use, because the concept is applied by a diverse group of researchers and professionals.
- *"Circular economy is an economy constructed from societal production-consumption systems that maximizes the service produced from the linear nature-society-nature material and energy throughput flow".* (Korhonen *et al.* (2018))
- *"...a new economic model that represents sustainable progress towards efficient green growth, moving from a consumption and disposal-based linear model to extending the life and use of products and materials and minimizing wastage"* (European Investment Bank (2019, p. 3))
- *The circular economy is a regenerative system in which resource input, waste, emission, and energy leakage are minimized by slowing, closing, and narrowing energy and material loops; this can be achieved through long-lasting design, maintenance, repair, reuse, re-manufacturing, refurbishing, recycling, and upcycling* (Government Europe, 2018)

Development of the definition

- Definitions often focus on the use of raw materials or on system change. Definitions that focus on resource use often follow the 3-R approach:

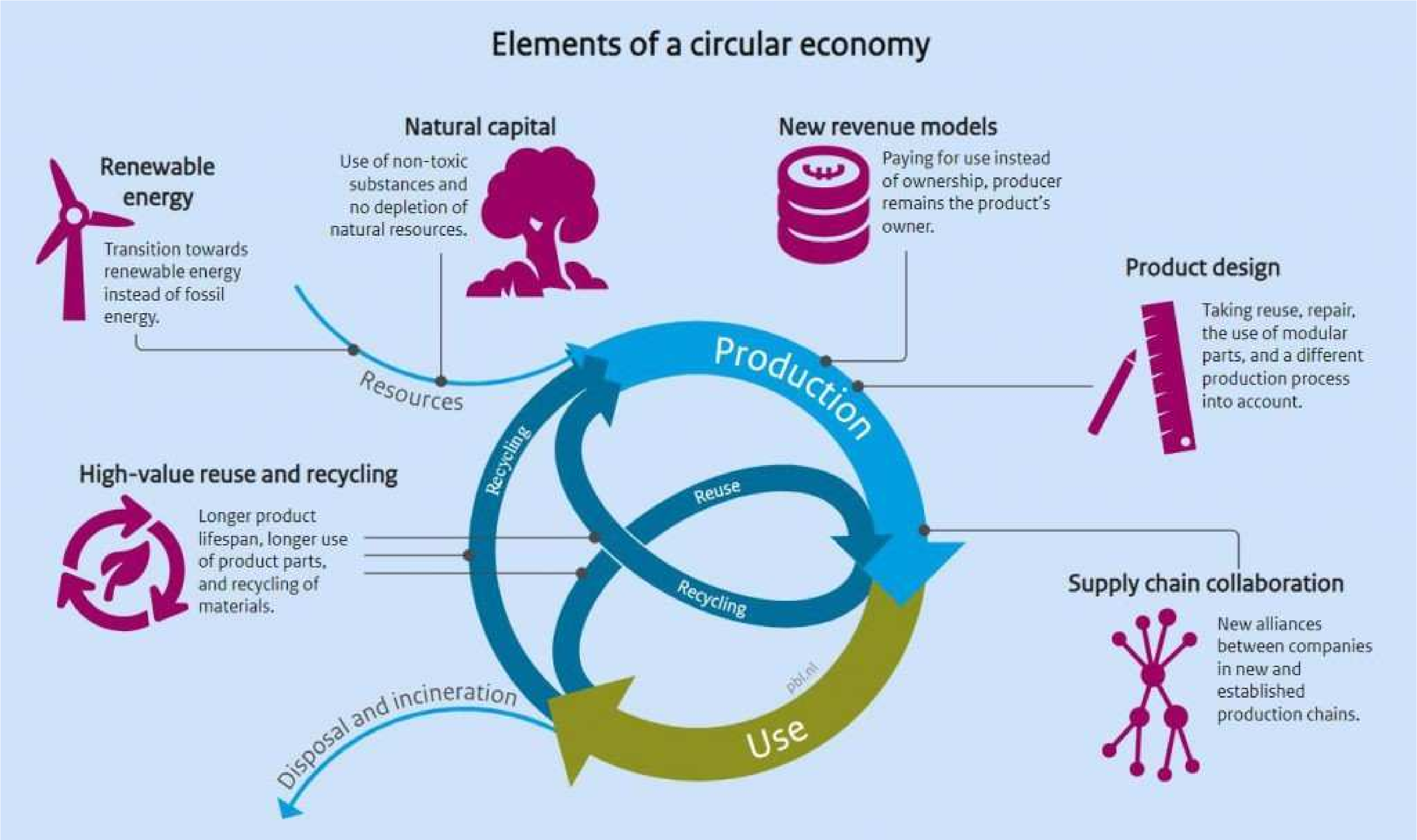
- ***Reduce*** (minimum use of raw materials)
- ***Reuse*** (maximum reuse of products and components)
- ***Recycle*** (high quality reuse of raw materials)

- *Mobility can serve as a good example. Sharing cars, mean that fewer people have to buy their own cars. This reduces the use of raw materials (reduce). If the engine of a car is broken, it can be repaired or the chassis and interior of the car can be used to make or refurbish another car (reuse). When these parts can no longer be reused, the metal, textile and plastic of the parts can be melted down so that a new car can be made of them (recycling).*

Development of the definition

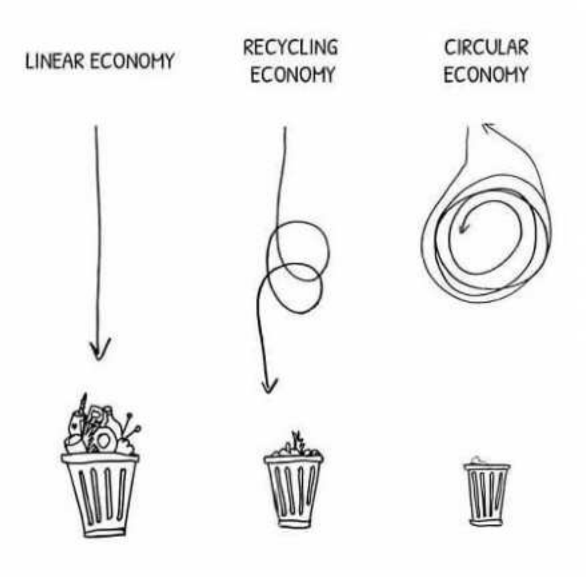
- Focus on system change often emphasize three elements, which are further explained below:
- *Closed cycles. In a circular economy, material cycles are closed following the example of an ecosystem. There is no such thing as waste, because every residual stream can be used to make a new product. Toxic substances are eliminated and residual flows are separated into a biological and a technical cycle. Producers take back their products after use and repair them for a new useful life. In this system, it is therefore not only important that materials are recycled properly, but also that products, components and raw materials remain of high quality in these cycles*
- *Renewable energy. Just like raw materials and products, energy also lasts as long as possible in a circular economy. The circular economic system is fed by renewable energy sources. Because it is not possible to recycle energy, there is no mention of energy cycles or energy cycles, but of 'cascade type energy flows*
- *Systems thinking. The circular economy does not only require closed material cycles and renewable energy, but also systems thinking. Every actor in the economy (company, person, organism) is connected to other actors. Together, this forms a network in which the actions of one player influence other players. To take this into account, the short and long term consequences must be taken into account in choices, as well as the impact of the entire value chain*

Development of the definition



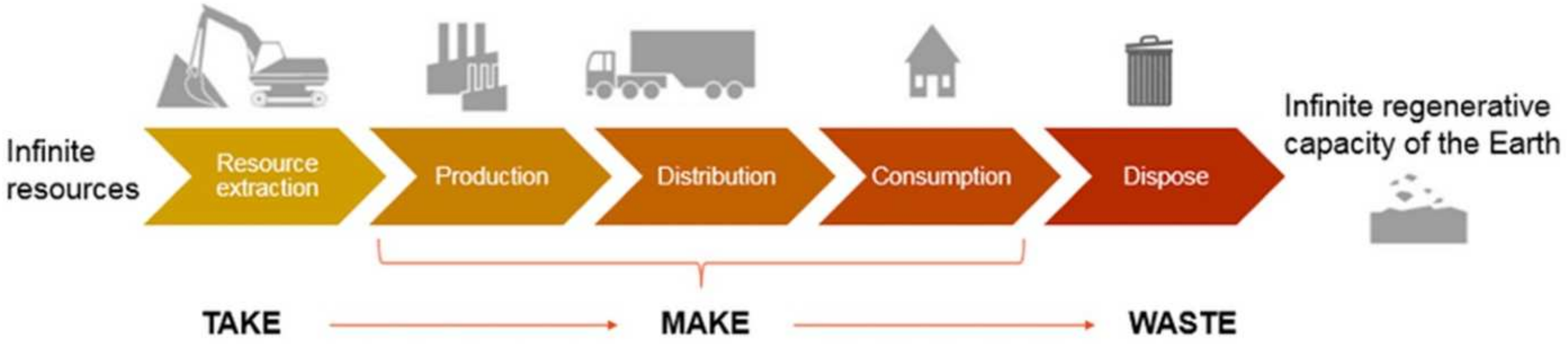
How is a circular economy different from a linear economy?

- The Industrial Revolution created a linear model for a rapid and an efficient production of products — more often with built-in service life – without regard to environmental consequences.
- Historically, manufacturers often took environmentally unsustainable resources, manufactured goods, and disposed of the remaining materials in ways that were harmful to the environment.



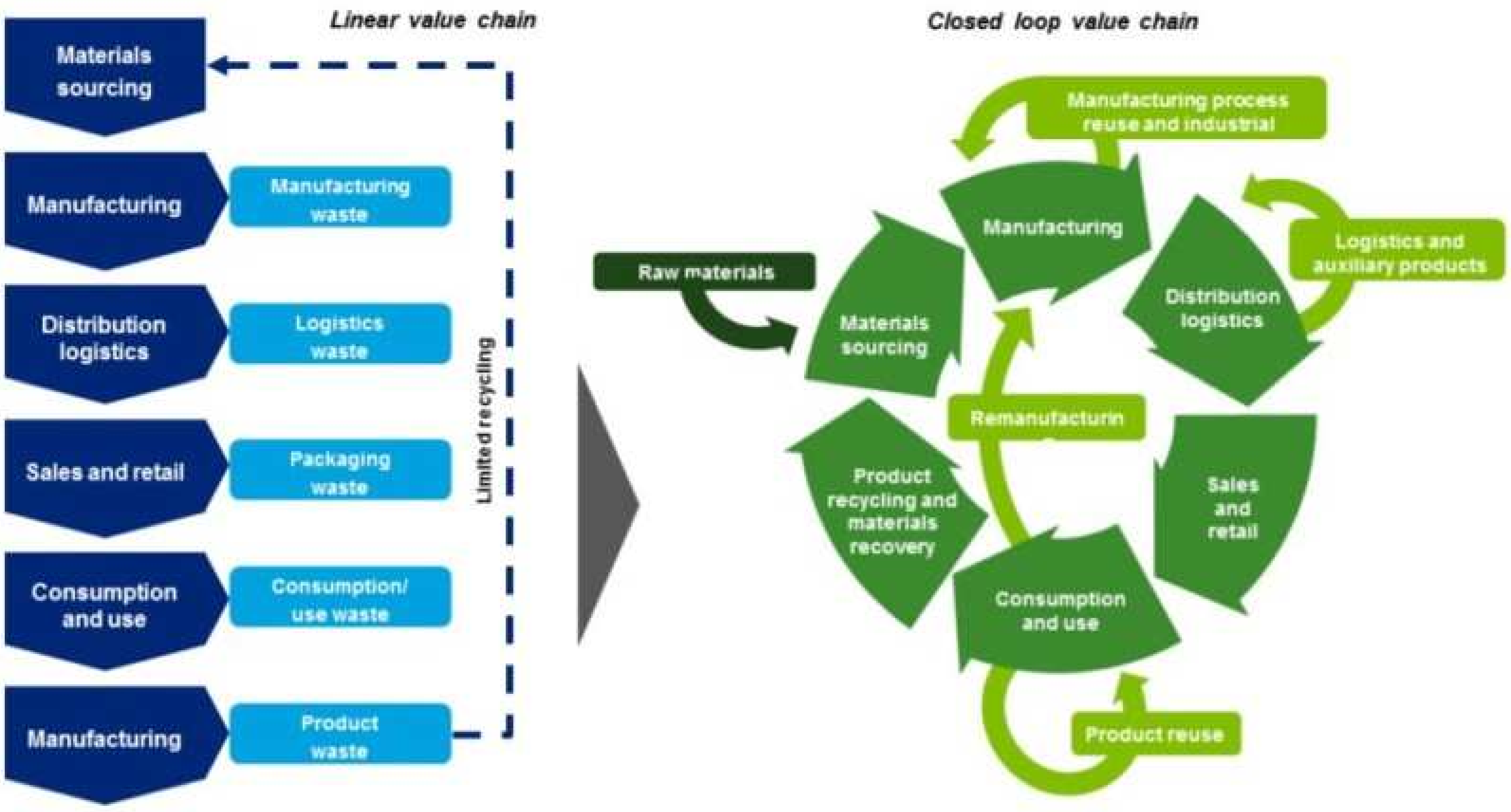
How is a circular economy different from a linear economy?

- The linear economy is based on a linear process. Usually, the process is optimized to make it as efficient as possible, with high throughput and lower production costs based on the availability of various inputs at relatively low cost. The typical process is based on the “take – make – consume – dispose” model and consists of a series of steps: resource extraction, production, distribution, consumption and disposing of products at the end of their life cycle.



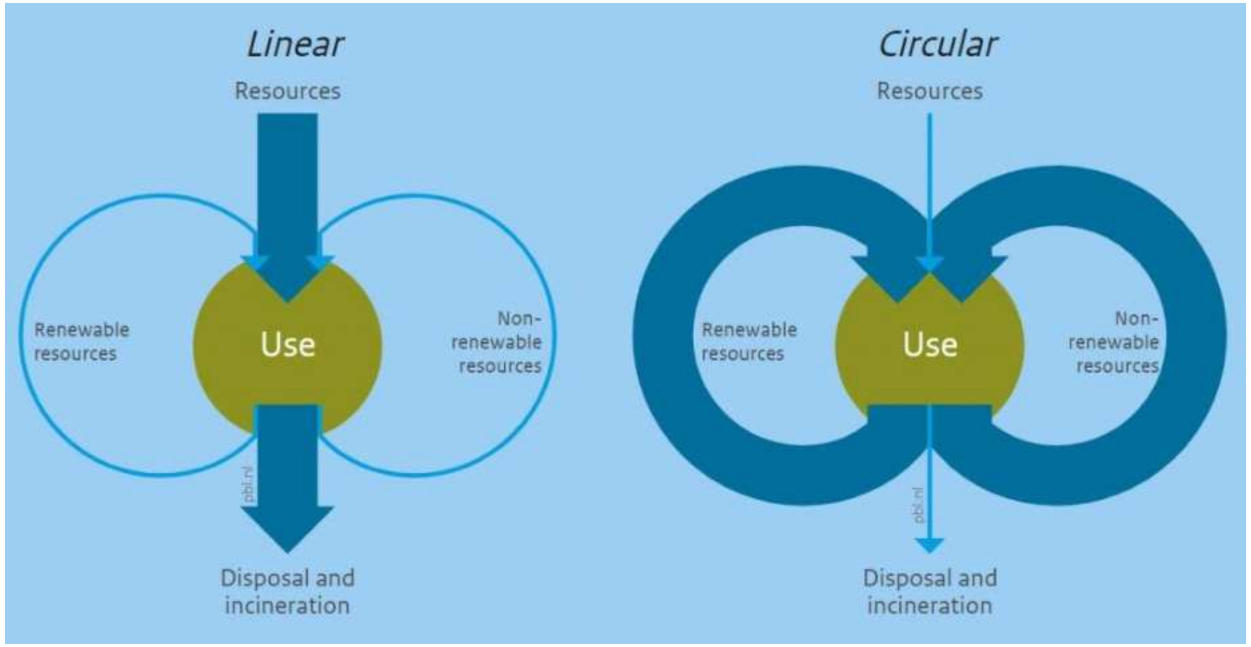
How is a circular economy different from a linear economy?

A key difference between the linear economy and the circular economy is the fact that circular economy is eco-effective instead of eco-efficient.



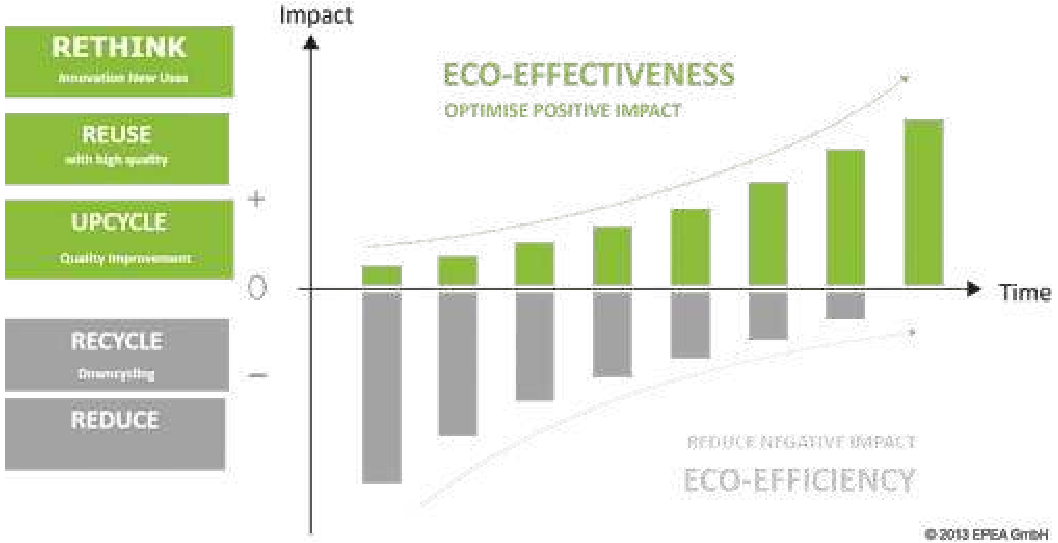
What different?

- ***From new raw materials to value preservation***
- The circular system and the linear system differ from each other in the way in which value is created or maintained. A linear economy traditionally follows the "take-make-dispose" step-by-step plan. This means that raw materials are collected, then transformed into products that are used until they are finally discarded as waste. Value is created in this economic system by producing and selling as many products as possible.



What different?

- ***From eco-efficiency to eco-effectiveness***
- When working on sustainability within a linear economy, the focus is on eco-efficiency, which means we try to minimise the ecological impact to get the same output. Within a circular economy, sustainability is sought in increasing the eco-effectiveness of the system. This means that not only the ecological impact is minimized, but that the ecological, economic and social impact is even positive. When we focus on eco-effectivity to create a positive impact, we strengthen the ecological, economical and societal systems by using them.

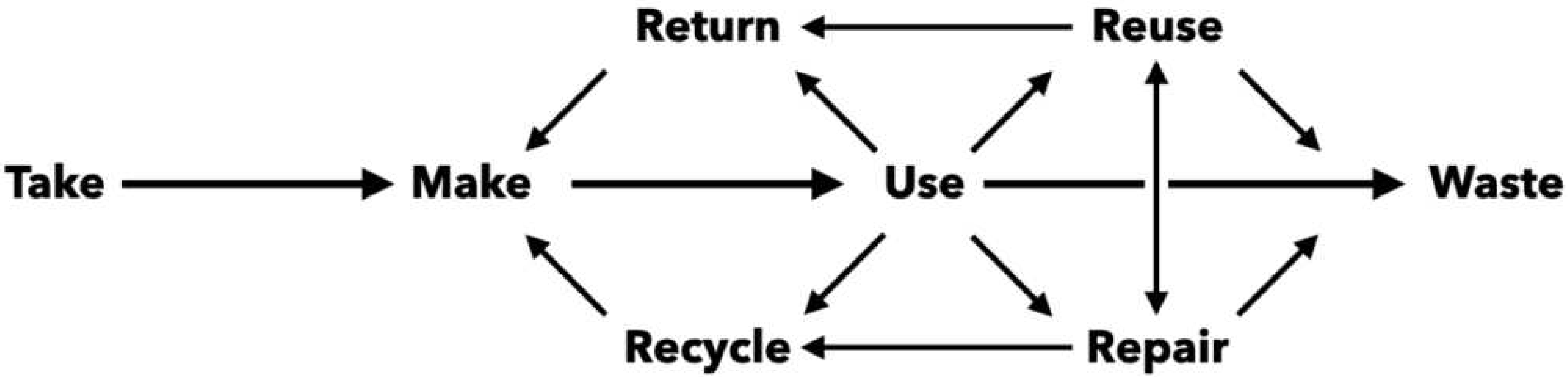


The difference between a linear and a circular economy

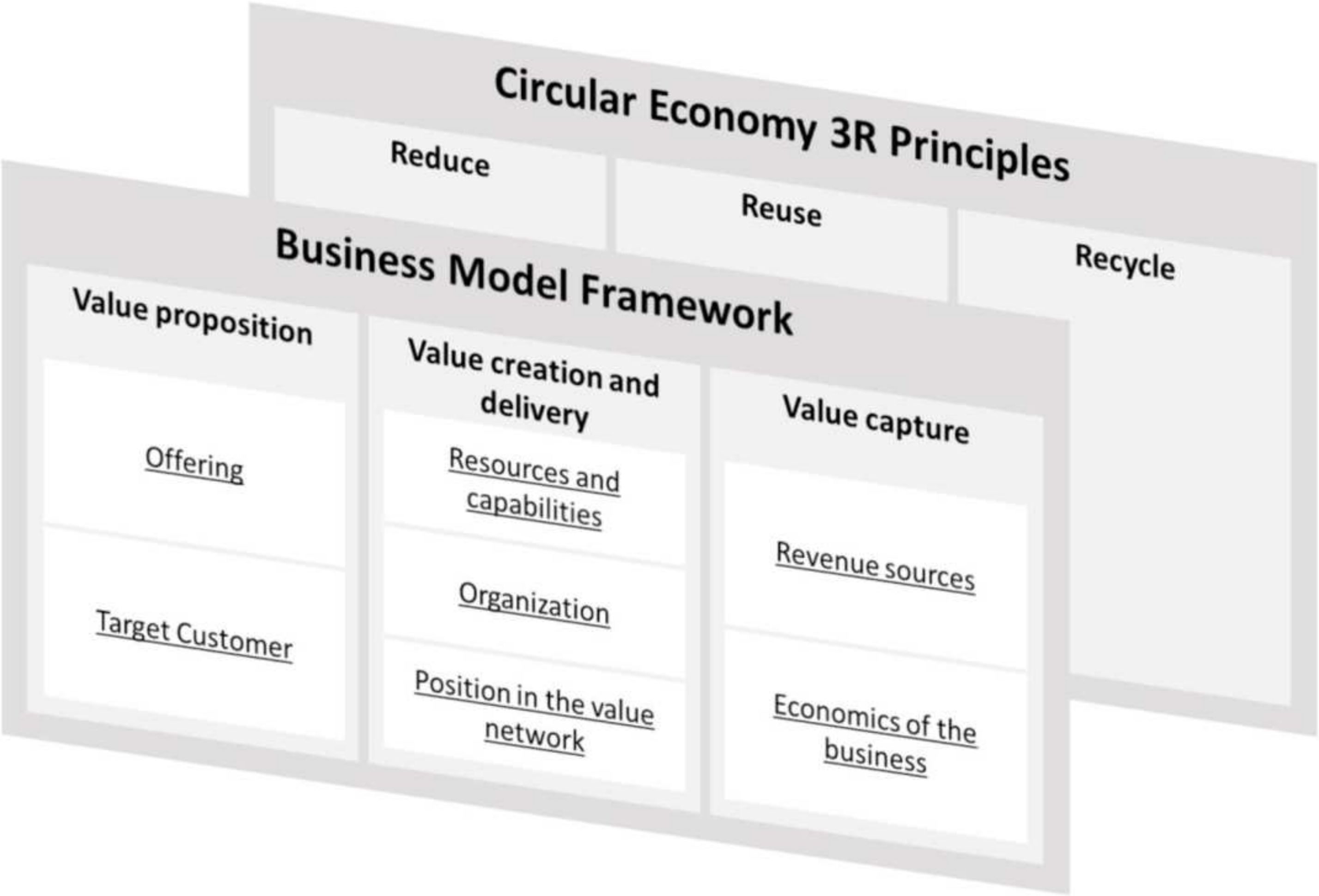
	Linear	Circular
Step plan	*Take-make-dispose*	*Reduce-reuse-recycle*
Focus	*Eco-Efficiency*	*Eco-Effectivity*
System boundaries	*Short term, from purchase to sales*	*Long term, multiple life cycles*
Reuse	*Downcycling*	*Upcycling, cascading and high grade recycling*
Business model	*Focuses on products*	*Focuses on services*

Circular economy business models

- Circular economy business models keep products and materials in use, by design, for as long as possible to get the maximum value from them. A circular economy approach ensures that materials are retained within productive use, in a high value state, for as long as possible.



Conceptual framework for analyzing business models in the Circular economy field

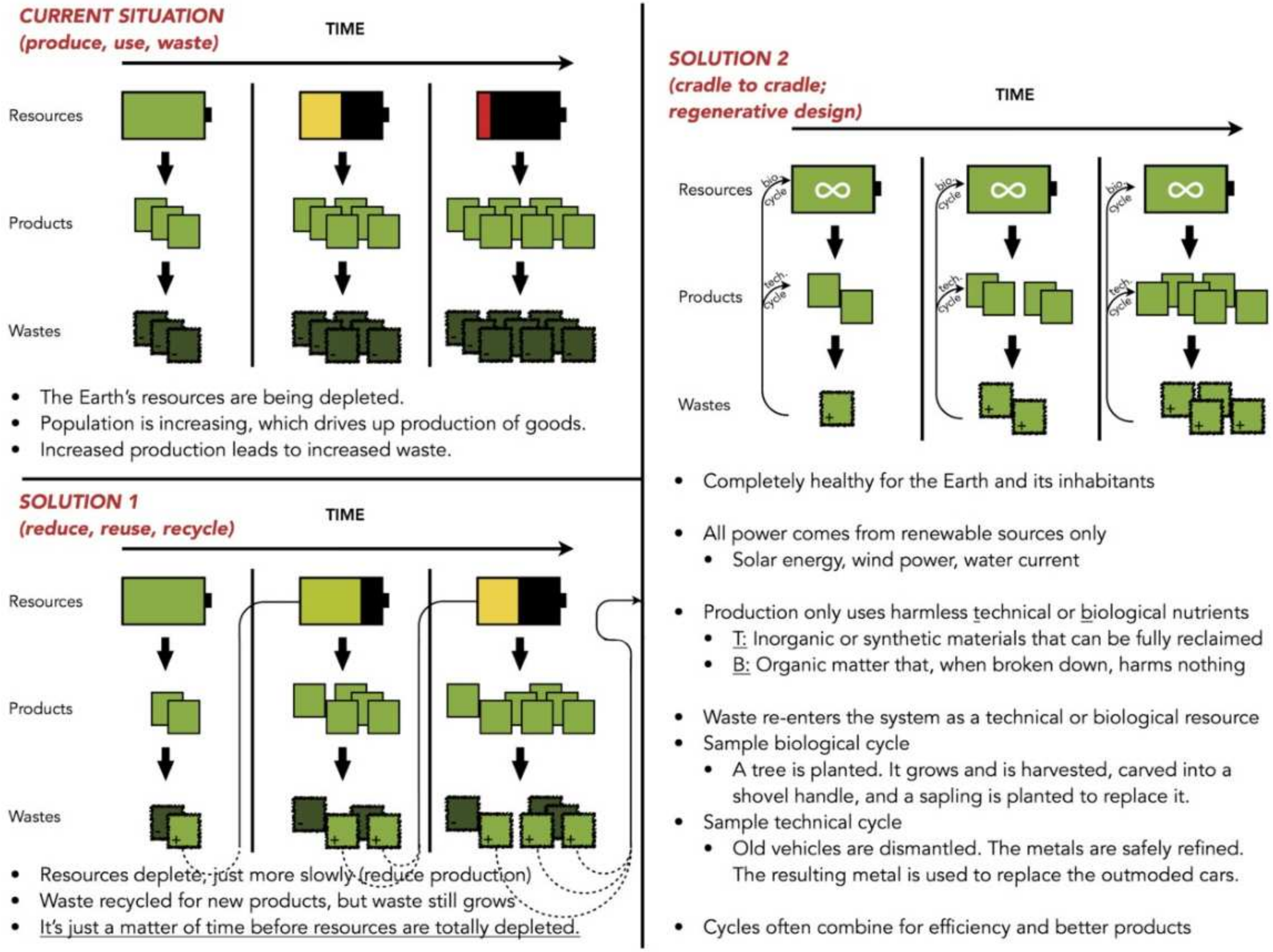


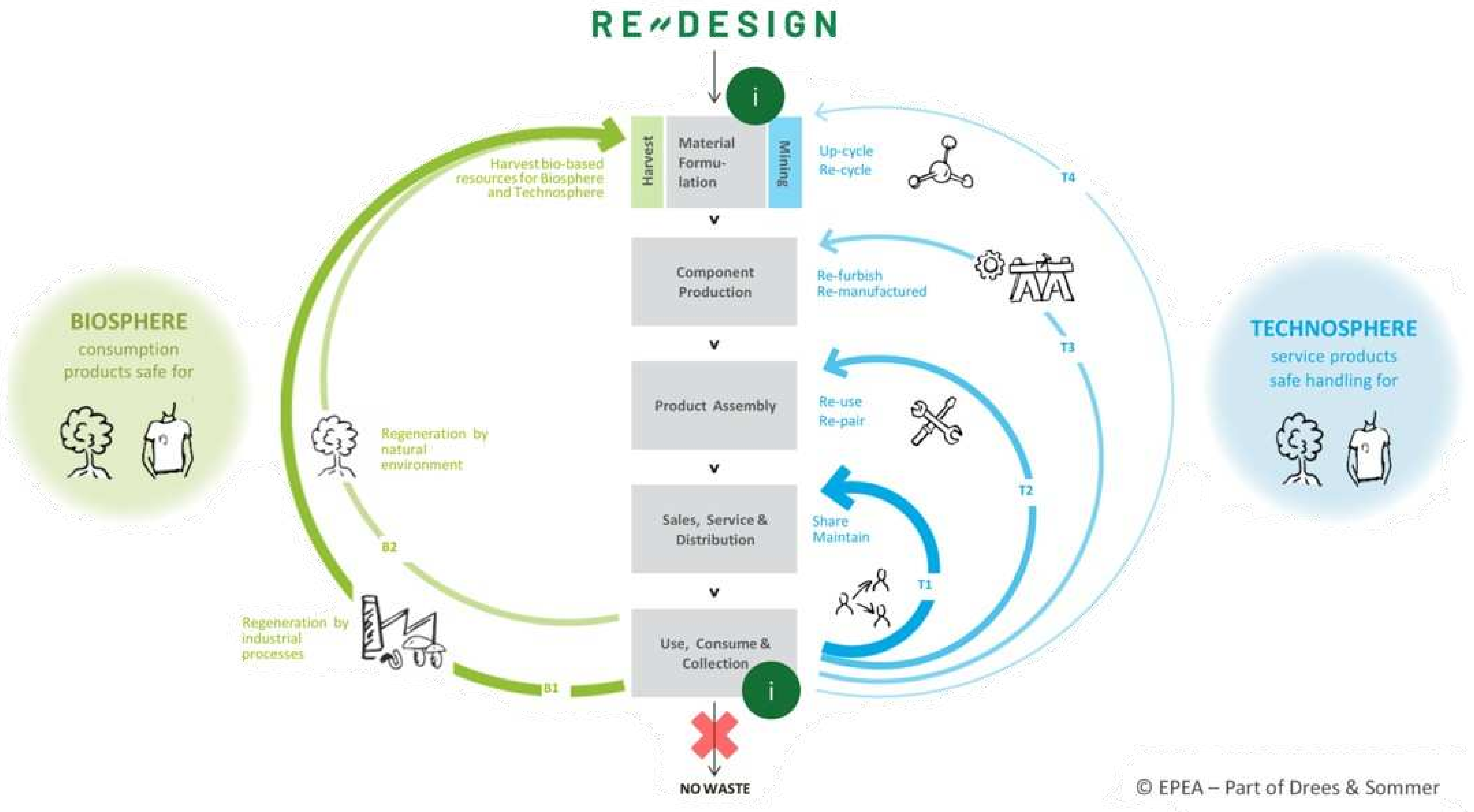
Cradle-to-cradle

- **Cradle-to-cradle design** (also referred to **C2C**, **cradle 2 cradle**) is a biomimetic approach to the design of products and systems that models human industry on nature's processes, where materials are viewed as nutrients circulating in healthy, safe metabolisms.
- The term implying that the C2C model is sustainable and considerate of life and future generations—from the birth, or "cradle", of one generation to the next generation, versus from birth to death, or "grave", within the same generation.
- The term "Cradle to Cradle" is a registered trademark of McDonough Braungart Design Chemistry (MBDC) consultants.

Cradle-to-cradle

- ***In the cradle-to-cradle model, all materials used in industrial or commercial processes—such as metals, fibers, dyes—fall into one of two categories: "technical" or "biological" nutrients***.
- *Technical nutrients* are strictly limited to non-toxic, non-harmful synthetic materials that have no negative effects on the natural environment; they can be used in continuous cycles as the same product without losing their integrity or quality. In this manner these materials can be used over and over again instead of being “downcycled" into lesser products, ultimately becoming waste.
- *Biological nutrients* are organic materials that, once used, can be disposed of in any natural environment and decompose into the soil, providing food for small life forms without affecting the natural environment. This is dependent on the ecology of the region; for example, organic material from one country or landmass may be harmful to the ecology of another country or landmass.


CURRENT SITUATION
(produce, use, waste)
TIME
Resources
Products
Wastes
The Earth's resources are being depleted.
Population is increasing, which drives up production of goods.
Increased production leads to increased waste.
SOLUTION 1
(reduce, reuse, recycle)
TIME
Resources
Products
Wastes
Resources deplete, just more slowly (reduce production)
Waste recycled for new products, but waste still grows
It's just a matter of time before resources are totally depleted.
SOLUTION 2
(cradle to cradle;
regenerative design)
TIME
Resources
Products
Wastes
bio. cycle
tech. cycle
Completely healthy for the Earth and its inhabitants
All power comes from renewable sources only
Solar energy, wind power, water current
Production only uses harmless technical or biological nutrients
T: Inorganic or synthetic materials that can be fully reclaimed
B: Organic matter that, when broken down, harms nothing
Waste re-enters the system as a technical or biological resource
Sample biological cycle
A tree is planted. It grows and is harvested, carved into a shovel handle, and a sapling is planted to replace it.
Sample technical cycle
Old vehicles are dismantled. The metals are safely refined. The resulting metal is used to replace the outmoded cars.
Cycles often combine for efficiency and better products



RE-DESIGN
i
Harvest
Material Formu-lation
Mining
Harvest bio-based resources for Biosphere and Technosphere
Up-cycle
Re-cycle
T4
Component Production
Re-furbish
Re-manufactured
T3
Product Assembly
Re-use
Re-pair
T2
Sales, Service & Distribution
Share
Maintain
T1
Use, Consume & Collection
i
NO WASTE
BIOSPHERE
consumption products safe for
Regeneration by natural environment
B2
Regeneration by industrial processes
B1
TECHNOSPHERE
service products safe handling for
© EPEA – Part of Drees & Sommer

material health

Material Health: ensuring materials are safe for humans and the environment

product circularity

Product Circularity: enabling a circular economy through regenerative products and process design

clean air & climate protection

Clean Air & Climate Protection: protecting clean air, promoting renewable energy, and reducing harmful emissions

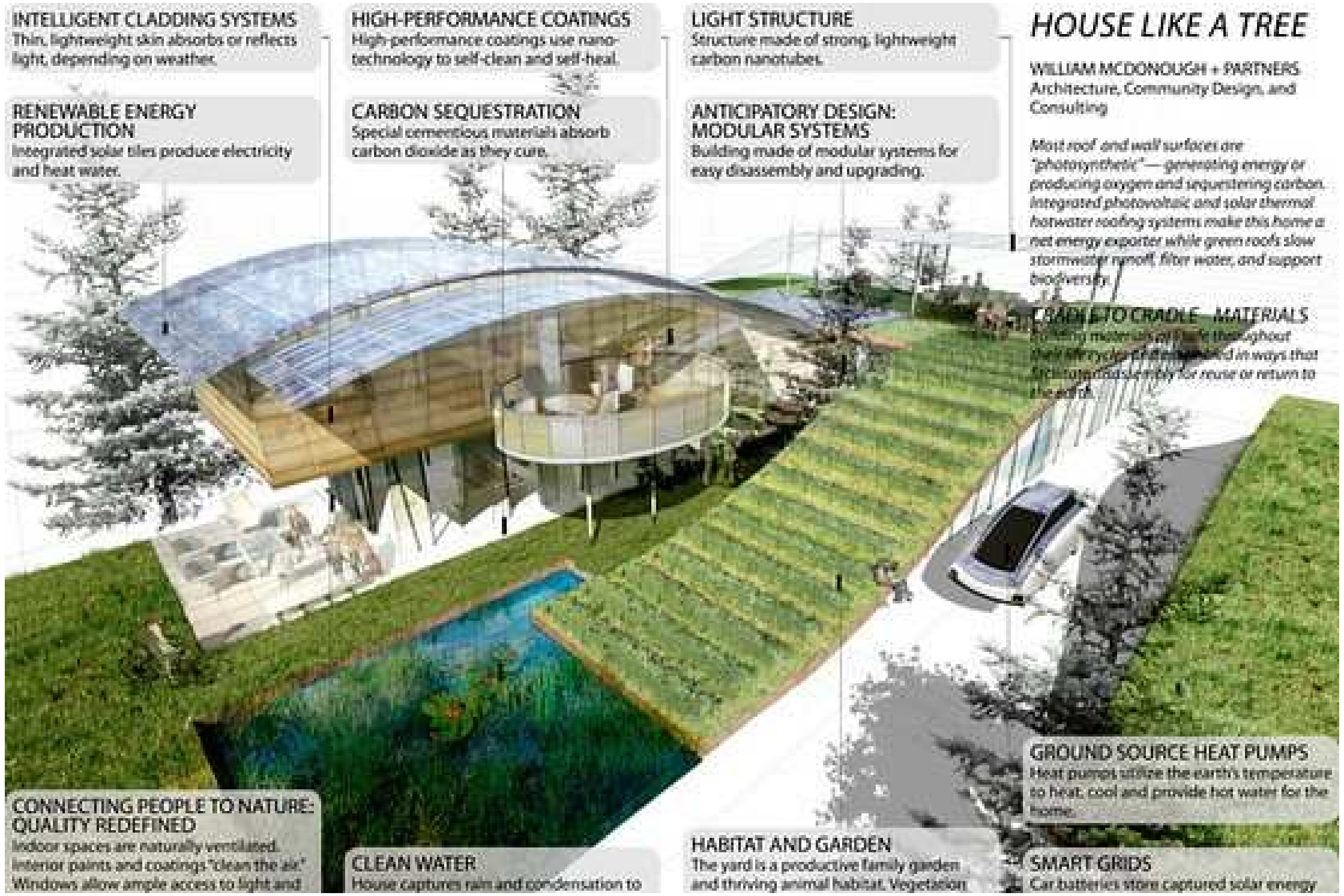
water & soil stewardship

Water & Soil Stewardship: safeguarding clean water and healthy soils

social fairness

Social Fairness: respecting human rights and contributing to a fair and equitable society

THE GREEN HOUSE OF THE FUTURE



cradletocradle®

https://thewere42.wordpress.com/2009/04/27/the-green-house-of-the-future/

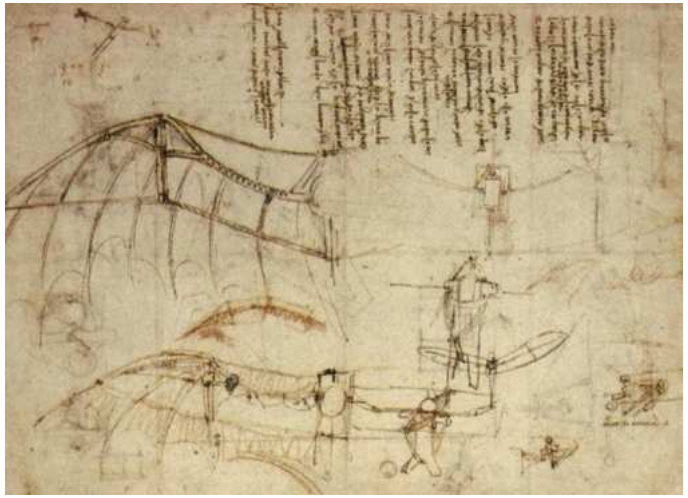
Biomimicry

- Biomimicry offers an empathetic, interconnected understanding of how life works and ultimately where we fit in. It is a practice that learns from and mimics the strategies used by species alive today.
- The goal is to create products, processes, and policies — new ways of living — that solve our greatest design challenges sustainably and in solidarity with all life on earth. We can use biomimicry to not only learn from nature's wisdom, but also heal ourselves — and this planet — in the process.

History

- One of the early examples of biomimicry was the study of birds to enable human flight. Although never successful in creating a "flying machine", **Leonardo da Vinci** (1452–1519) was a keen observer of the anatomy and flight of birds, and made numerous notes and sketches on his observations as well as sketches of "flying machines". The Wright Brothers, who succeeded in flying the first heavier-than-air aircraft in 1903, allegedly derived inspiration from observations of pigeons in flight.

- During the 1950s the American biophysicist and polymath **Otto Schmitt** developed the concept of "biomimetics". During his doctoral research he developed the Schmitt trigger by studying the nerves in squid, attempting to engineer a device that replicated the biological system of nerve propagation. He continued to focus on devices that mimic natural systems and by 1957 he had perceived a converse to the standard view of biophysics at that time, a view he would come to call biomimetics.



Leonardo da Vinci's design for a flying machine with wings based closely upon the structure of bat wings

The 3 Essential Elements of Biomimicry

Emulate

- The scientific, research-based practice of learning from and then replicating nature's forms, processes, and ecosystems to create more regenerative designs.

Ethos

- The philosophy of understanding how life works and creating designs that continuously support and create conditions conducive to life.

(Re)Connect

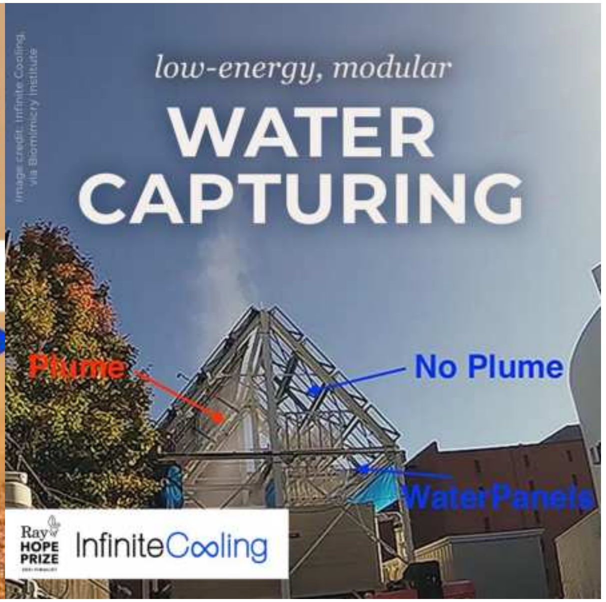
- The concept that we are nature and find value in connecting to our place on Earth as part of life's interconnected systems. (Re)Connect as a practice encourages us to observe and spend time in nature to understand how life works so that we may have a better ethos to emulate biological strategies in our designs.

Examples


SPIDERS
inspired
Spintex
to create
Ray
HOPE
PRIZE

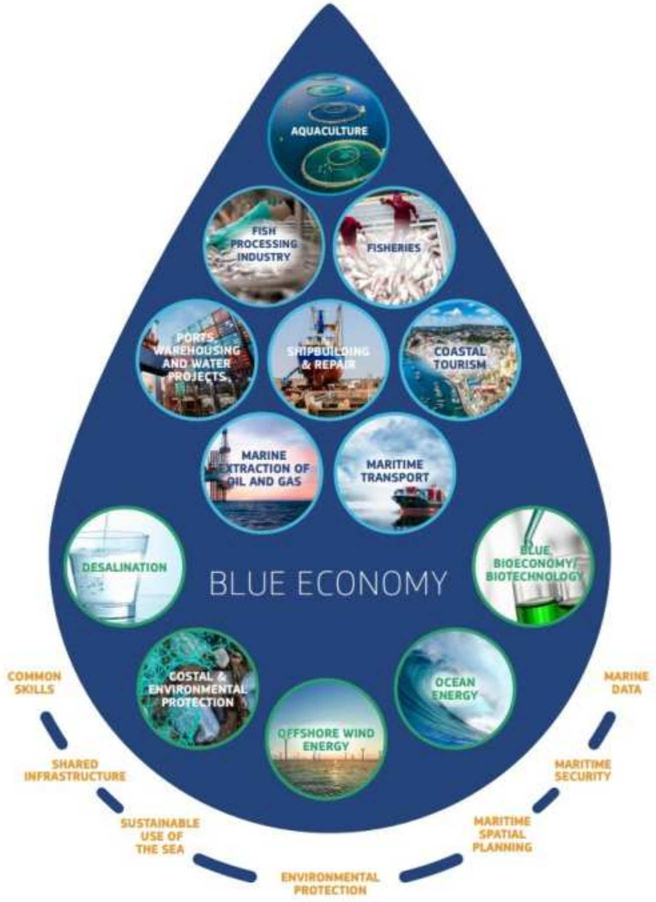

energy efficient, green chemistry
FIBERS
Ray
HOPE
PRIZE
Spintex


FOG HARVESTER
BEETLE
inspired
InfiniteCooling
to create
Ray
HOPE
PRIZE


low-energy, modular
WATER
CAPTURING
Plume
No Plume
WaterPanels
Ray
HOPE
PRIZE
InfiniteCooling

Blue Economy

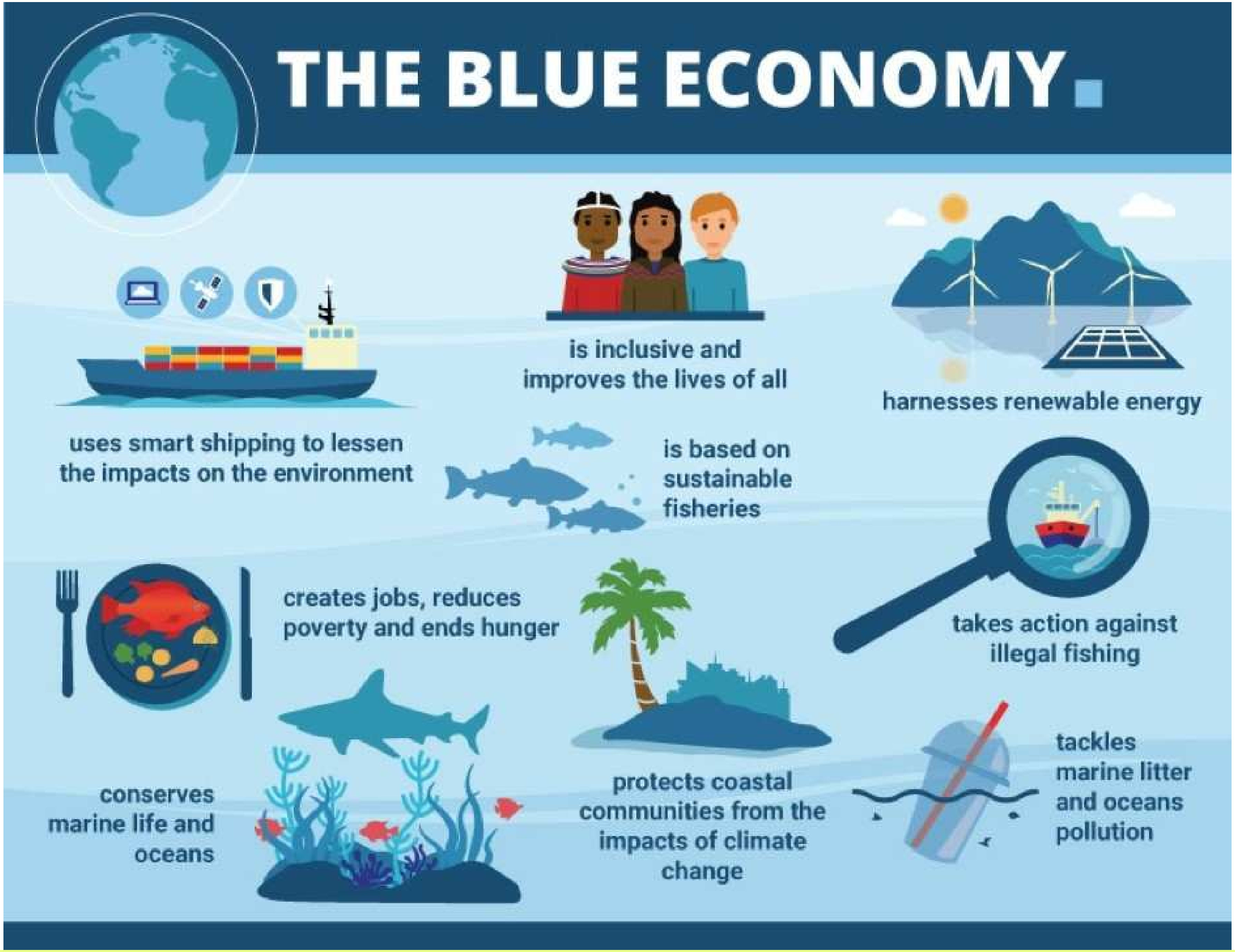
- Blue economy is a term in economics relating to the exploitation, preservation and regeneration of the marine environment. Its scope of interpretation varies among organizations.
- However, the term is generally used in the scope of International development when describing a sustainable development approach to coastal resources.
- This can include a wide range of economic sectors, from the more conventional fisheries, aquaculture, maritime transport, Coastal, marine and maritime tourism, or other traditional uses, to more emergent spaces such as coastal renewable energy, marine ecosystem services (i.e. blue carbon), seabed mining, and bioprospecting..

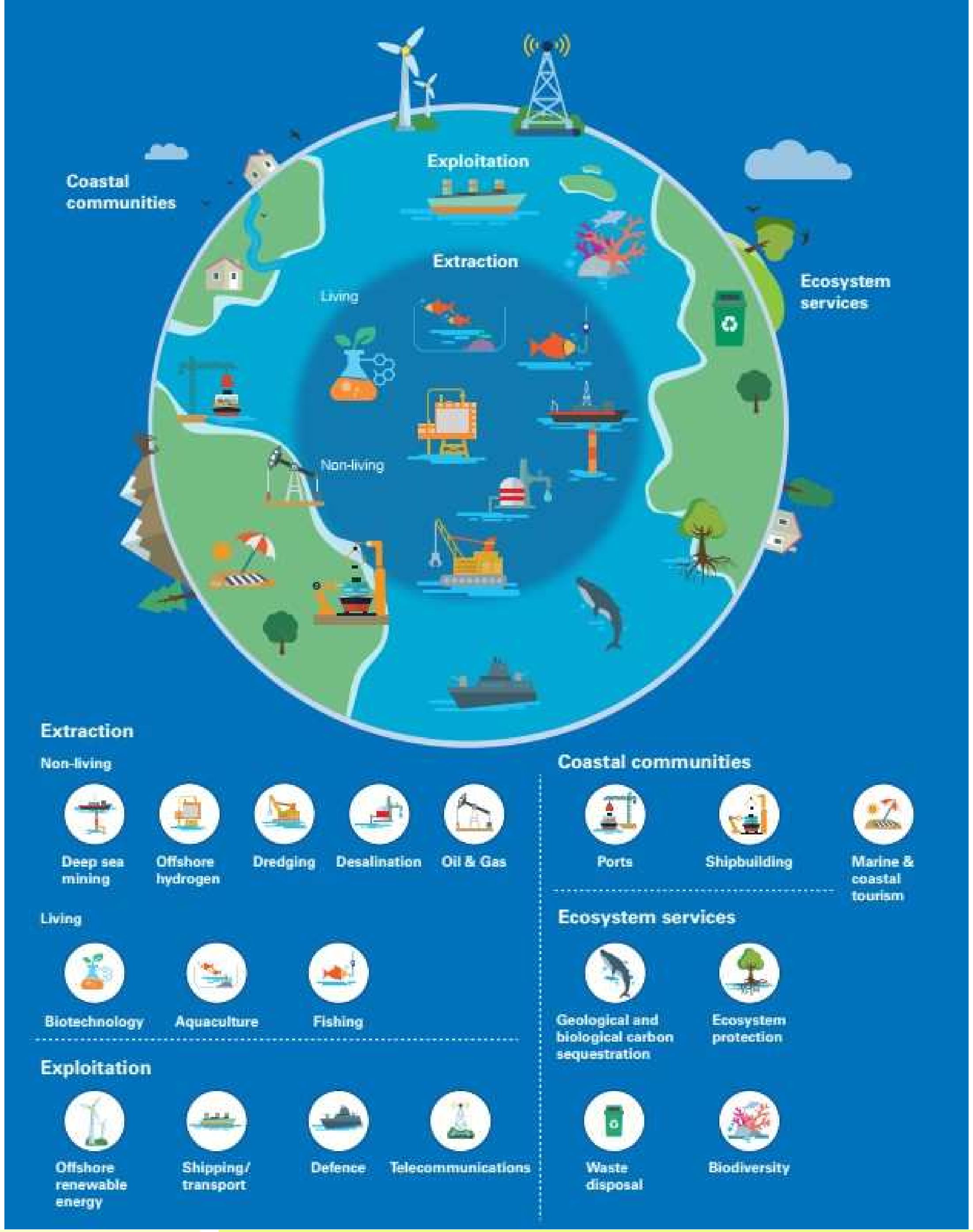


Blue Economy

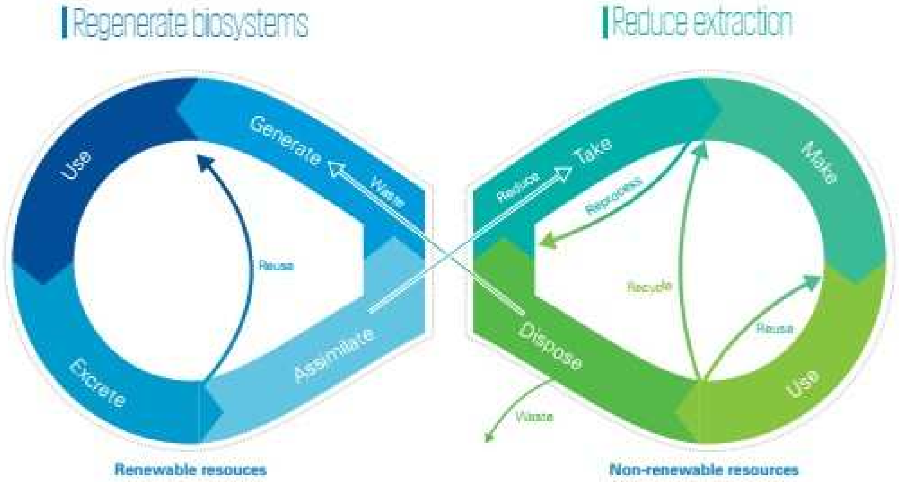
- The Blue Economy established sectors include
- ***Marine living resources,***
- ***Marine non-living resources,***
- ***Marine Renewable energy,***
- ***Port activities,***
- ***Shipbuilding and repair,***
- ***Maritime transport,***
- ***Coastal tourism.***

Sectors of Blue Economy

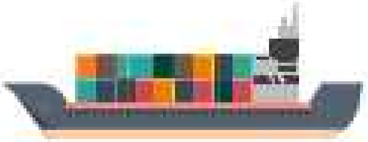

THE BLUE ECONOMY.
uses smart shipping to lessen the impacts on the environment
is inclusive and improves the lives of all
harnesses renewable energy
is based on sustainable fisheries
takes action against illegal fishing
creates jobs, reduces poverty and ends hunger
conserves marine life and oceans
protects coastal communities from the impacts of climate change
tackles marine litter and oceans pollution



The circular use of oceanic resources



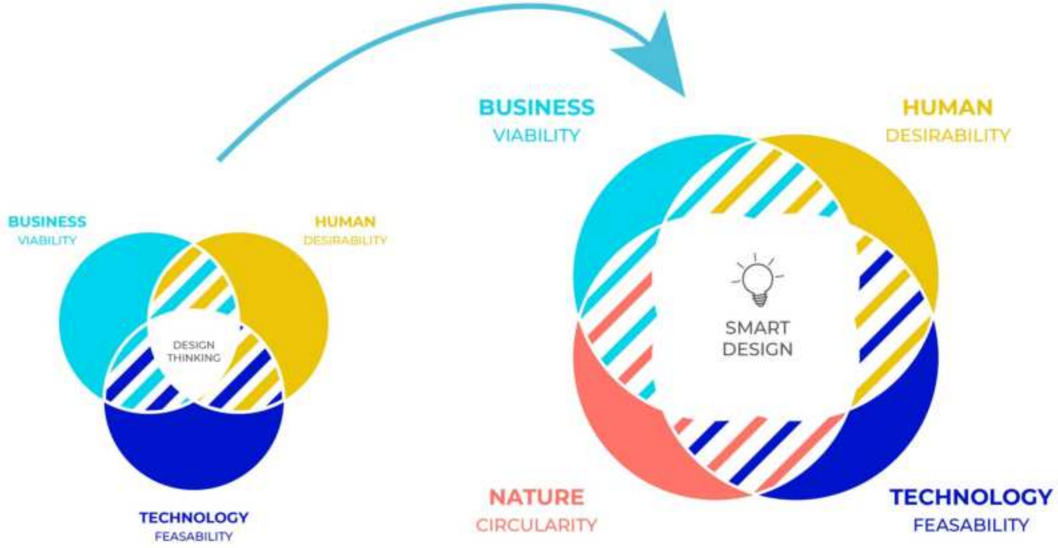
Ocean transport accounts for 2.9 percent of global GHG emissions. This could climb to 10% with a near tripling of maritime trade volumes by 2050[41].

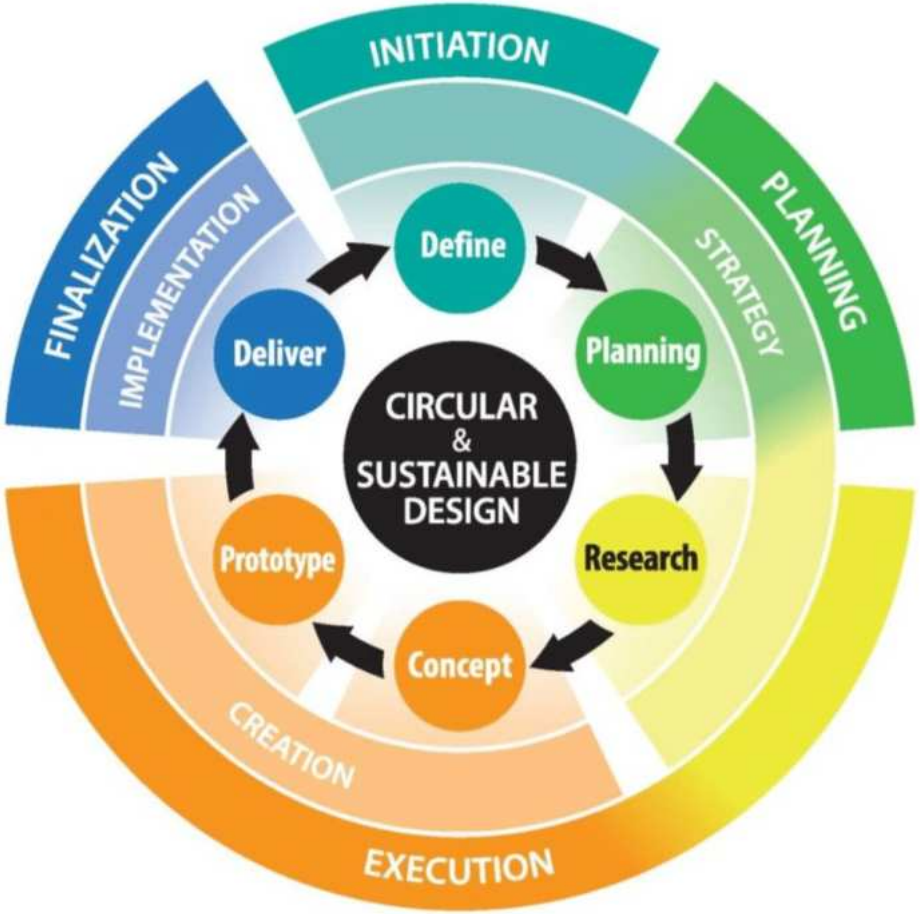


THE CIRCULAR DESIGN PROCESS

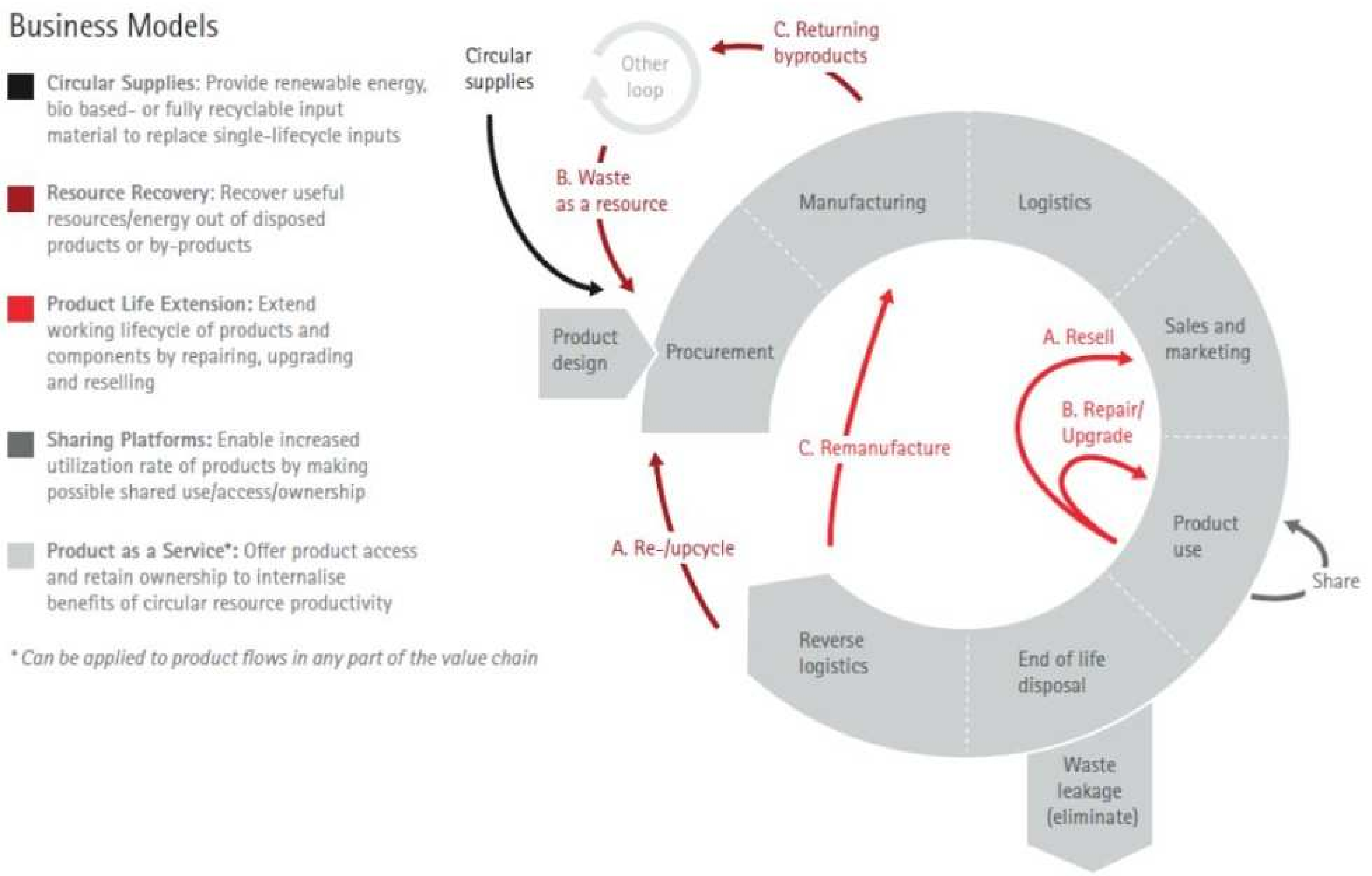
- The circular design process comprises four stages and is informed by approaches such as design thinking and human-centred design.
- **Understand** - Get to know the user and the system
- **Define** - Put into words the design challenge and your intention as the designer
- **Make** - Ideate, design, and prototype as many iterations and versions as you can
- **Release** - Launch your design into the wild and build your narrative - create loyalty in customers and deepen investment from stakeholders by telling a compelling story.

STRATEGIES FOR CIRCULAR DESIGN





Circular business models



How do materials circulate in a circular economy?

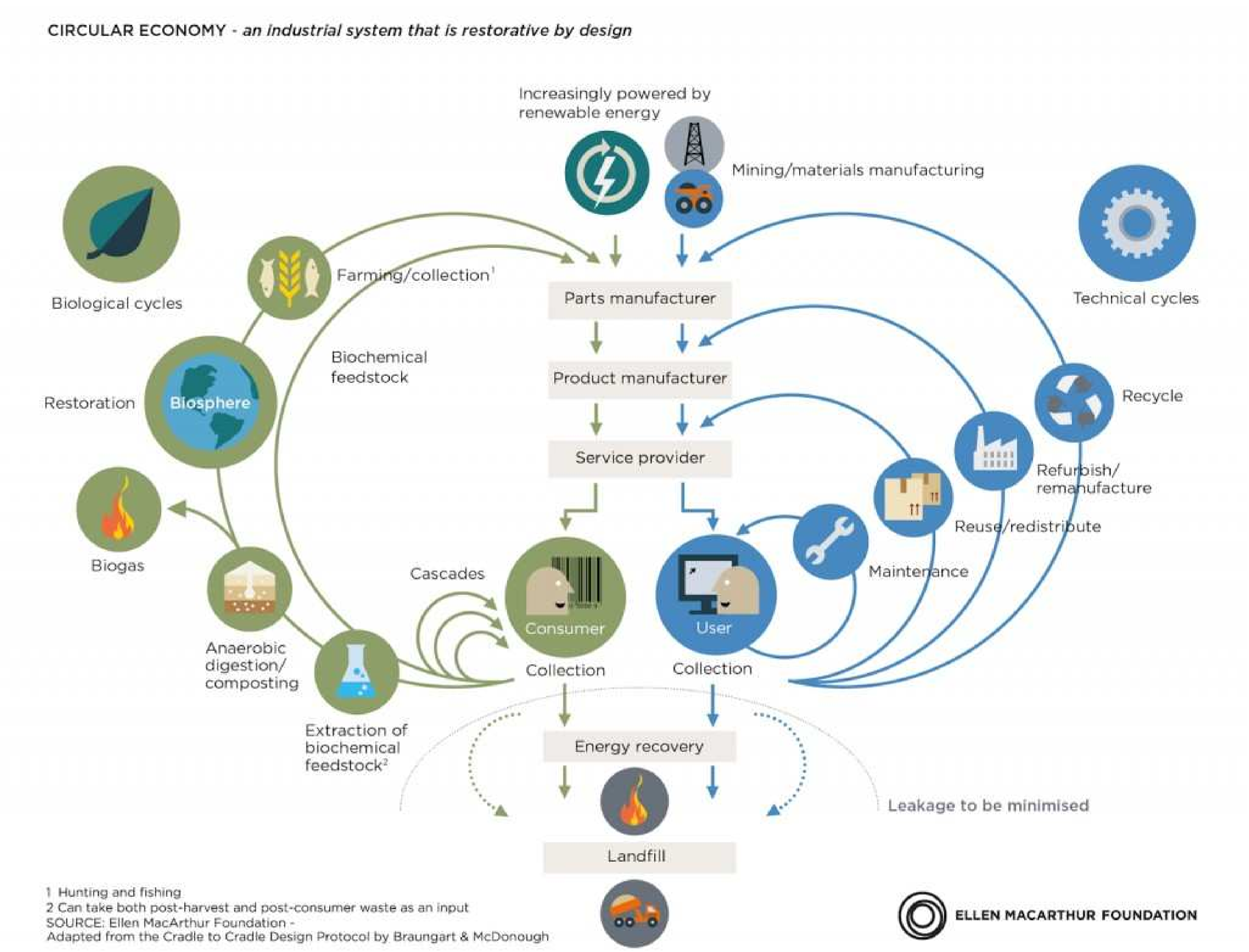
- In a circular economy, materials circulate in two separate cycles: **the bio-cycle and the techno-cycle**.
- The distinction between these cycles helps to understand how materials can be used in a long-lasting and high quality way.
- A general rule of thumb is: if a material has to go through less process steps for reuse, the higher the quality of the remaining material will be.

Technical and organic materials

- Organic materials follow a different reuse process than technical materials. Technical materials are also called synthetic materials. Because of this difference in the reuse process, it is important that after use, organic and technical materials can be properly separated from each other after use.

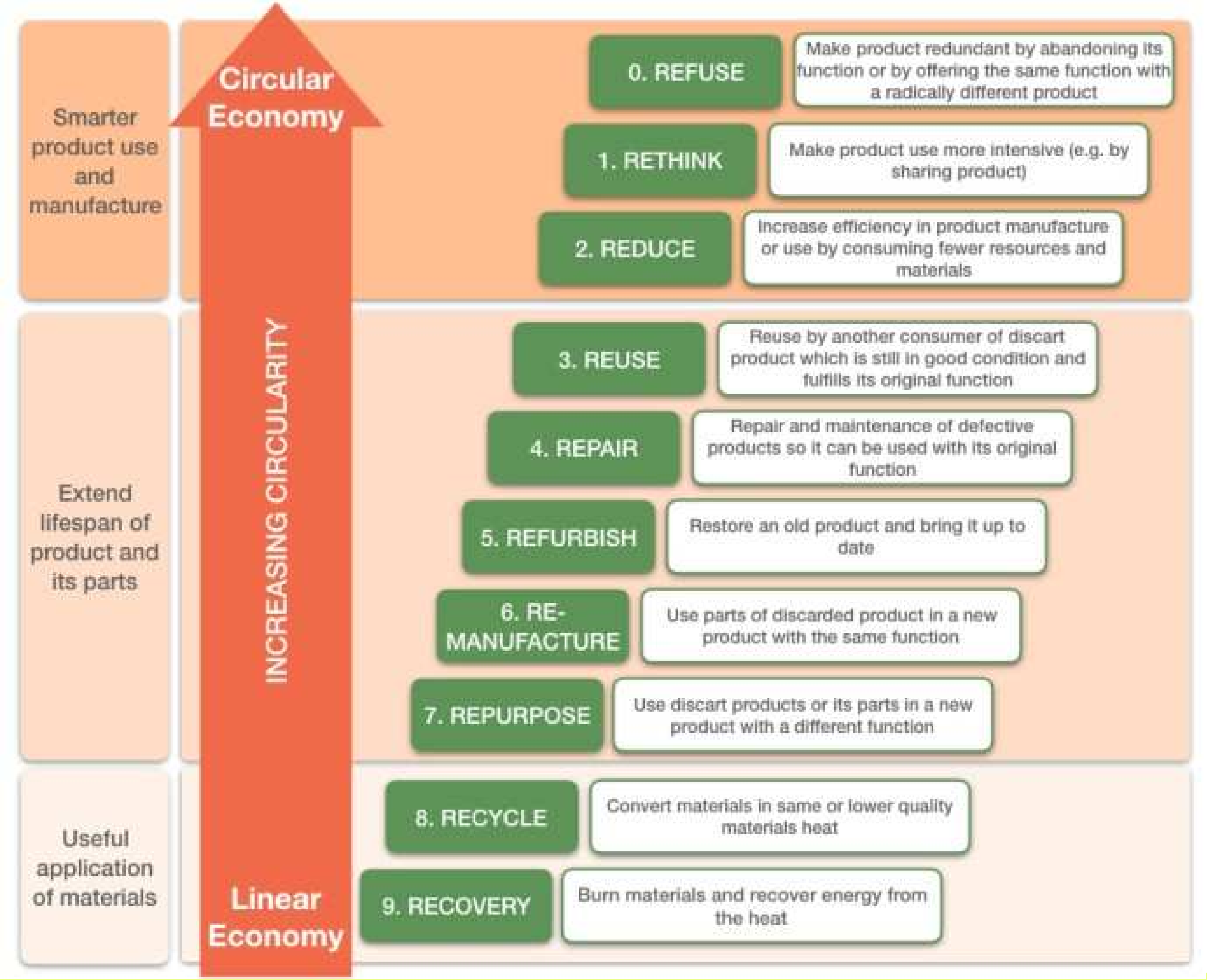
- Technical materials such as fossil fuels, plastics and metals have limited availability and cannot easily be recreated. In the techno-cycle it is important that stocks of such finite materials are properly managed. In a circular economy, these materials are only used instead of being consumed. After use, materials are recovered from residual flows at their original value.

- Organic materials such as wood, food and water can be incorporated into the ecosystem and re-generated through biological processes. In the bio-cycle it is important to let the ecosystem do its work as well as possible. Consumption may take place during this cycle (fertilization, food, water) as long as the streams are not contaminated with toxic substances and ecosystems are not overloaded. Renewable organic raw materials can then be regenerated.



The Butterfly Diagram

The 9R model for circular economy



Elements of circular economy

1. ***Prioritise Regenerative Resources***. Ensure that renewable, reusable, nontoxic resources are utilised as materials and energy in an efficient way.
2. ***Preserve and extend what's already made***. While resources are in-use, maintain, repair and upgrade them to maximise their lifetime and give them a second life through take back strategies when applicable.
3. ***Use Waste as a Resource***. Utilise waste streams as a source of secondary resources and recover waste for reusage and recycling.
4. ***Rethink the Business Model***. Consider opportunities to create greater value and align incentives through business models that build on the interaction between products and services.
5. ***Design for the Future***. Account for the systems perspective during the design process, to use the right materials, to design for appropriate lifetimes and for extended future use.
6. ***Incorporate Digital Technology***. Track and optimise resource use and strengthen connections between supply chain actors through digital and online platforms, and technologies that provide insights.
7. ***Collaborate to Create Joint Value***. Work together throu organisations and with the public sector to increase tran

ACTION AREAS OF THE CIRCULAR ECONOMY

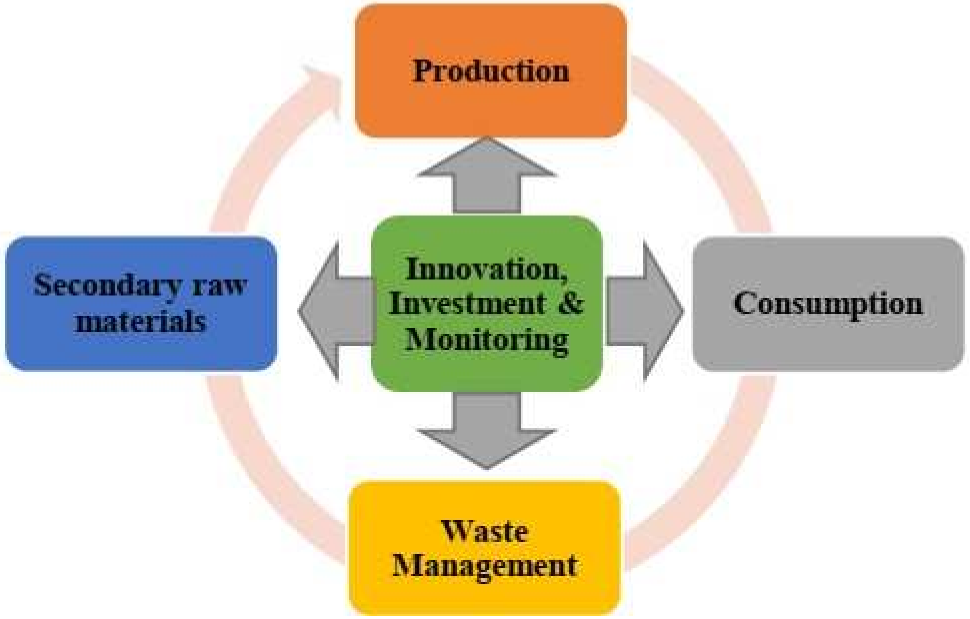
- The circular economy model works on the basis that materials for new products come from old recycled products, which means that the products must be made to be more durable and fit for recycling and reuse. As far as possible, everything is reused, ex works, recycled, used as a source of energy, or at a last resort disposed of.

Key action areas of Circular economy

Measuring the progress towards a circular economy is carried out in five ways:

- production,
- consumption;
- waste management;
- secondary raw materials;
- competitiveness and innovation.

Indicators of circular economy, included in the monitoring structure, have been developed in the indicated directions.



Objectives and key actions of areas of circular economy (1)

Key area	Objectives	Key actions
Production	• Provide incentives to boost circular product design. • Innovative and efficient production processes.	• Reparability, durability, and recyclability in eco-design (e.g. TV screens). • Best practices for waste management and resource efficiency in industrial sectors. • Industrial symbiosis.
Consumption	• Repair and reuse of products to avoid waste generation. • Provide consumers with reliable information on environmental impact of products.	• Encourage reuse activities (e.g. waste proposal). • Eco-design: availability of spare parts. • Guarantees and action on false green claims. • Circular Economy criteria in Green Public Procurement. • Independent testing programme to assess possible planned obsolescence. • Better labelling: EU Eco-label, Environmental Footprint.

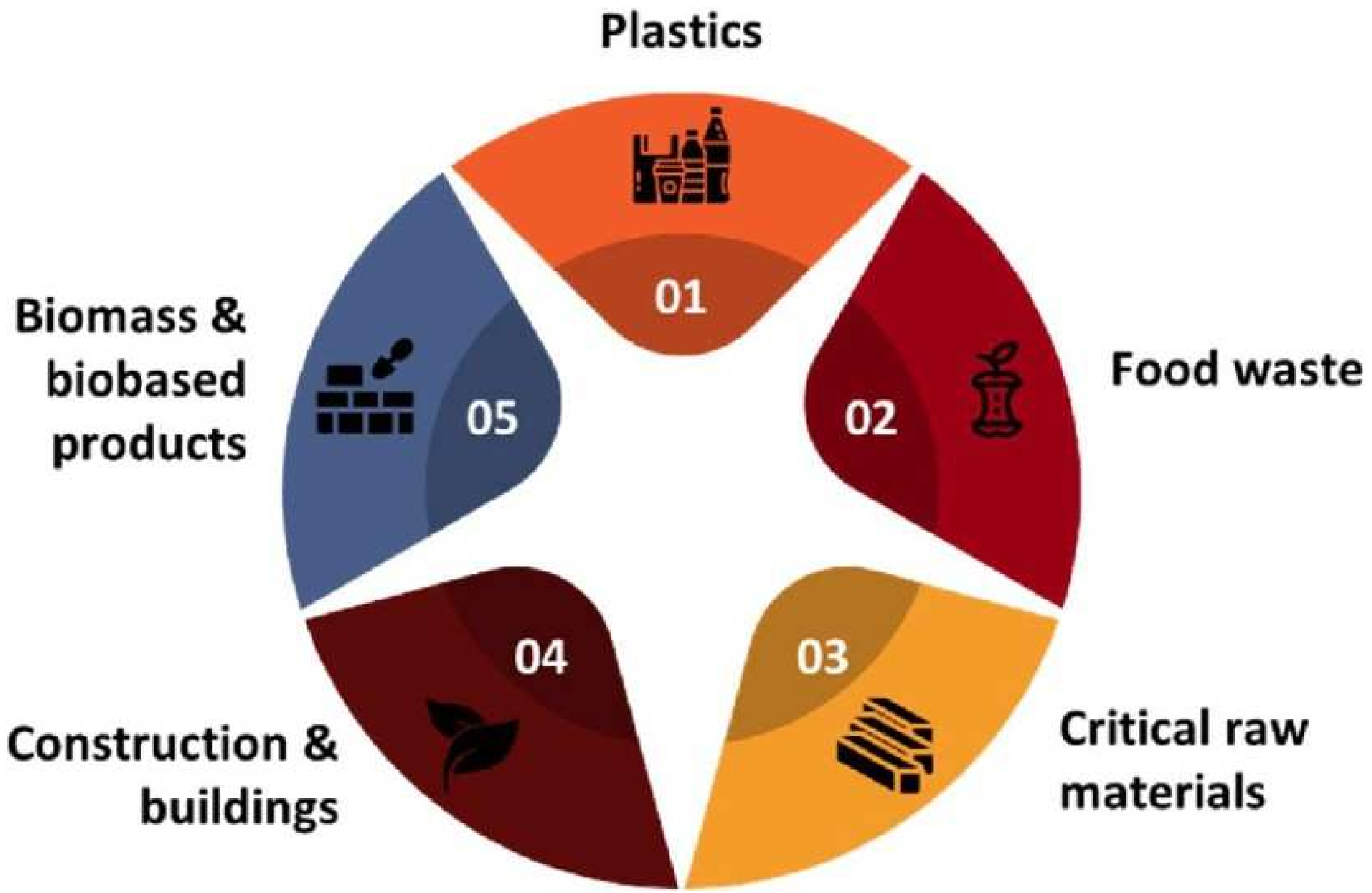
Objectives and key actions of areas of circular economy (2)

Key area	Objectives	Key actions
Waste management	• Improve waste management in line with the EU waste hierarchy. • Address existing implementation gaps. • Provide long-term vision and targets to guide investments.	• Legislative proposals on waste. • Work with Member States to improve waste management plans, including to avoid overcapacity in residual waste treatment (incineration and mechanical biological treatment). • Ensure coherence between waste investments under EU Cohesion Policy and the waste hierarchy.
Market for secondary raw materials	• Increase the use of secondary raw materials. • Increase the use of recycled nutrients and the reuse of treated wastewater. • Safely manage risks of chemicals of concern. • Improve knowledge of material stocks and flows	• Quality standards for secondary raw materials. • EU regulation on fertilisers. • Legislative proposal on minimum requirements for reused water. • Analysis on the interface between chemicals, product, and waste legislation. • EU-wide electronic system for cross-border transfers of waste.

Objectives and key actions of areas of circular economy (3)

Key area	Objectives	Key actions
Innovation & Investment	• Create the right environment for innovation and investment	• Horizon 2020 initiative launched on 'Industry 2020 in the Circular Economy' (EUR 650 million). • Pilot 'innovation deals' to address potential regulatory obstacles for innovators. • Targeted outreach of EU funding, as Cohesion Policy Funds and for SMEs. • New platform for financing Circular Economy with European Investment Bank and national promotional banks.

PRIORITY AREAS OF CIRCULAR ECONOMY



PRIORITY AREAS OF CIRCULAR ECONOMY

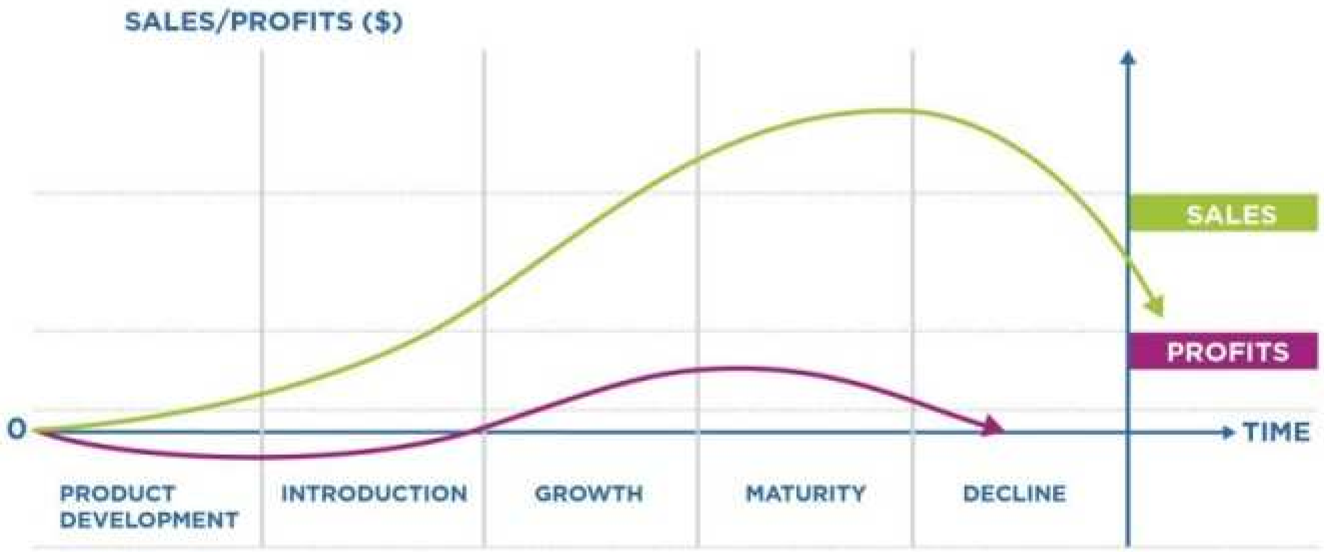
Priority area	Objectives	Key actions
Plastics	• Increase recycling efficiency - less than 25 % of plastic waste collected is recycled, and about 50 % is landfilled.	• Adopt a specific strategy to reduce plastic waste, including marine litter. • Set a more ambitious target for the recycling of plastic packaging in the framework of a new legislative proposal on waste.
Food waste	• Reach the Sustainable Development Goal (SDG) to halve food waste by 2030 – today around 100 million tons of food are wasted every year in the EU.	• Develop an EU methodology to measure food waste. • Create a platform for the SDG on food waste and share best practices and the achieved results. • Clarify the EU legislation on waste, food and feed, and encourage food donation. • Improve the use and understanding of date marking along the food chain (e.g. 'best before' label).

PRIORITY AREAS OF CIRCULAR ECONOMY

Critical raw material (CRMs)	• Increase the efficient use and recovery of CRMs.	• Encourage recovery of CRMs, and draft a report on best practices and options for further action at the EU level. • Encourage action by the Member States.
Construction and demolition	• Identify and increase recovery of valuable materials.	• Ensure recovery of valuable resources and adequate waste management in the construction and demolition sector, as well as facilitate assessing the environmental performance of buildings. • Put in place pre-demolition guidelines to promote high-value recycling, and voluntary recycling protocols.
Biomass and bio-based products	• Support an efficient use of wood and bio-based products. • Increase recycling of bio-waste.	• Promote an efficient use of bio-based resources through series of measures, including promoting the cascading use of biomass and support bioeconomy innovation. • Set a new target for recycling wood packaging and a provision to ensure the separate collection of bio-waste.

CONCEPT OF LIFE CYCLE

- The **product life cycle** is an important concept in marketing. From a marketing point of view, the life cycle of a product is the time from the development of the product to its commencement and cessation of sales. It describes the stages a product goes through from the idea, until it finally is removed from the market. Not all products reach this final stage, some continue to grow and others rise and fall. The duration of each stage is influenced by emerging market factors and customer habits.

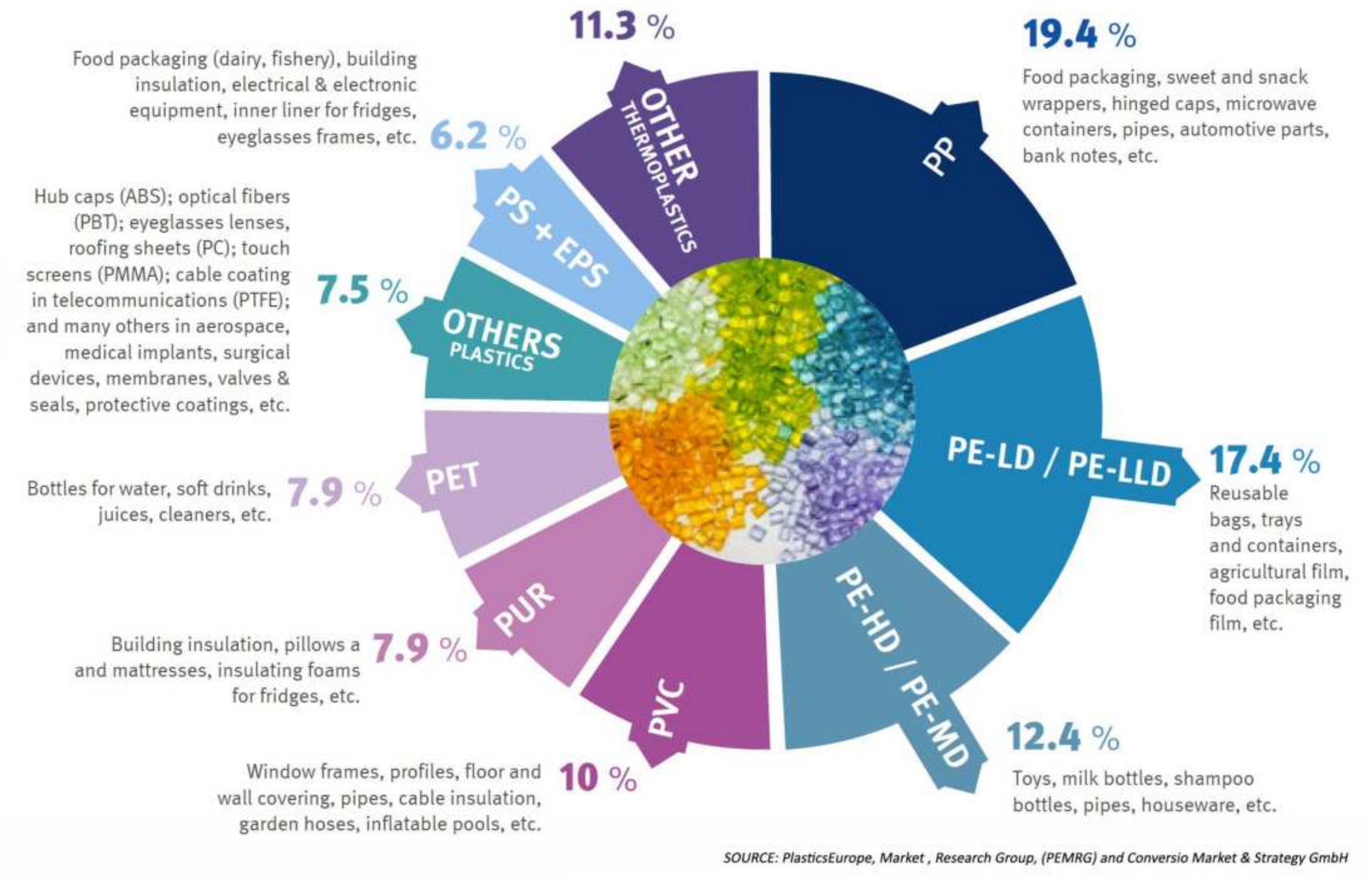


Examples of circular business model adoption

Building blocks of a circular economy	Examples: Mobile phone — From...	Mobile phone — To...	Light commercial vehicle (LCV) — From...	Light commercial vehicle (LCV) — To...	Washing machine — From...	Washing machine — To...
A Product design	Highly integrated product designs and low degree of component standardisation	Component standardisation (e.g., displays) and design for disassembly (e.g., clip-hold assembly)	Limited degree of modularisation (e.g., bolted connections in LCV engine bay)	Design for disassembly—wider design of engine bay and use of quick fasteners	Efficiency gains in energy and water consumption drive economic obsolescence and limit lifetimes	Regular software updates and upgrades of electronics and sensor systems post sale
B Business models	Low customer incentives to return devices after usage	Deposit payment or leasing models	Customer concerns about quality of refurbished vehicles	Warranty offered on refurbished vehicles	Customer concerns about alternative business models	Creation of transparent, 'win-win' leasing contracts and effective marketing
C Reverse cycle skills	Limited development and choice of circular options	Automated disassembly and efficient technologies (e.g., fault-tracking software)	Sub-scale refurbishing facilities	Centralised refurbishment plants with optimised workflows, allowing for economies of scale	Quality losses within inappropriate collection channels	Manufacturer-controlled collection, enabled by leasing models
D Cross-cycle and cross-sector collaboration	High damage/loss rate along all reverse value chain steps	Industry-wide efforts to establish comprehensive collection and treatment system	University curricula for engineers still focused on linear system	OEM/sector initiatives to foster R&D of circular production methods	Diverging incentives of customers and producers in context of new ownership models	Specialised intermediaries enable alternative ownership models on larger scale

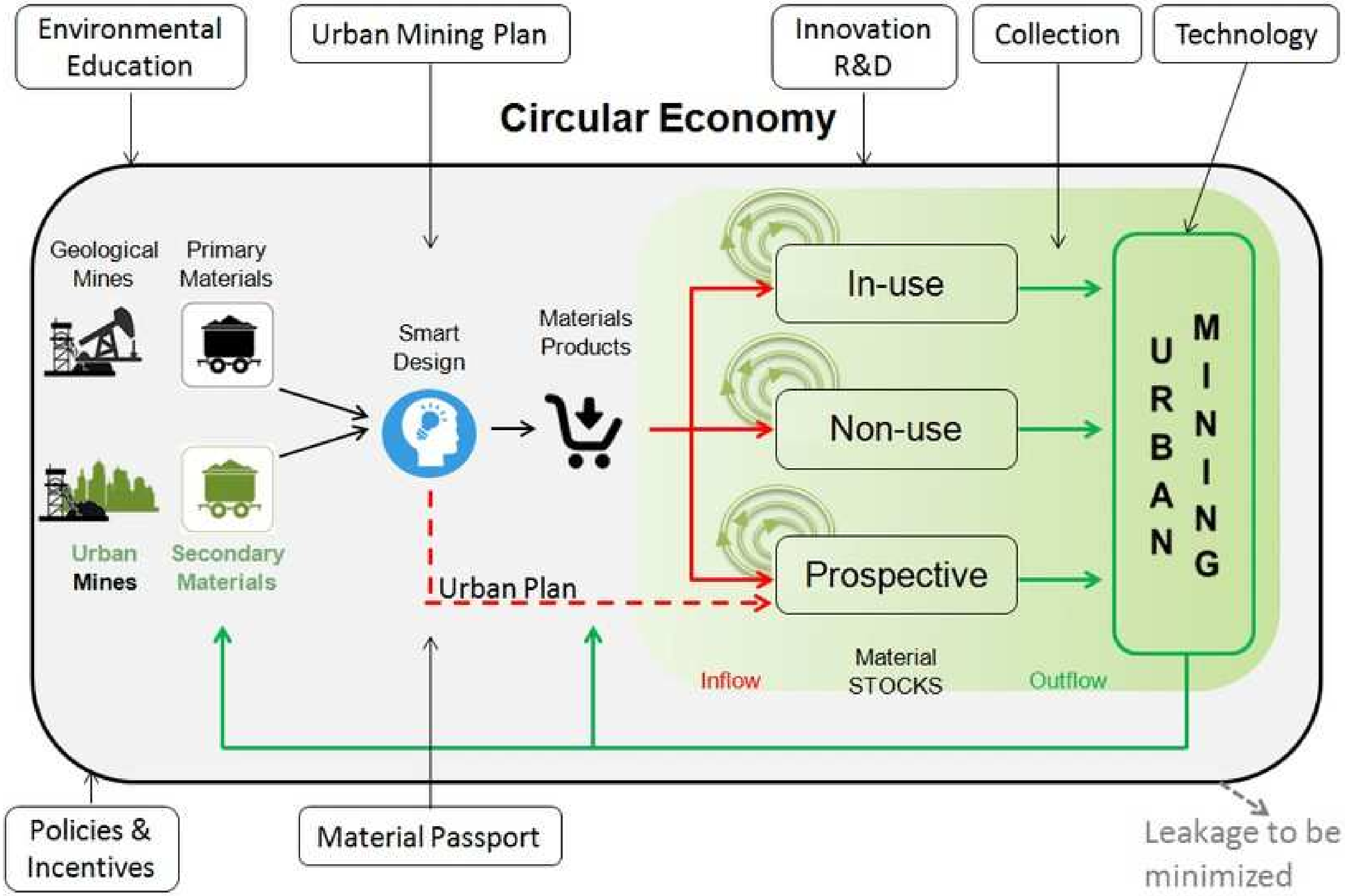
ILLUSTRATIVE

How do we make plastics circular?



	Scenario	End-of-life products million p.a.	Collected Percent	Reused Percent[1]	Refurbished Percent[1]	Remanu-factured Percent[1]	Recycled Percent[1]	Components and business model, transition and advanced scenario
Mobile phone	Status quo	190	15	38	-	-	62	• Improved circular capabilities (products designed for disassembly, firms improve reverse-cycle skills)[2] enable higher remanufacturing rates in transition
	Transition	190	50	38	-	41	21	• Deposit, leasing and buy-back systems push collection rates closer to proposed EU 2016 target of 65% in transition, and beyond that in the advanced scenario
	Advanced	190	95	50	-	50	0	• Industry-wide efforts establish comprehensive collection and treatment systems in advanced scenario
Smartphone (B2B)	Status quo	13	20	-	38	-	62	• Improved circular capabilities (modular design and material choice)[2] foster refurbishment in transition
	Transition	13	50	-	60	-	40	• B2B buy-back systems and software for wiping user data push collection closer to proposed EU 2016 target of 65% in transition (beyond that in advanced scenario)
	Advanced	13	95	-	50	-	50	• Joint vendor-supplier reverse supply chains, intra-firm alignment and regulation further increase collection rates in advanced scenario
Light commercial vehicle[3]	Status quo	1.5	86	-	0	-	100	• Improved circular capabilities (products designed for disassembly, firms improve reverse-cycle skills)[2] enable higher refurbishment in transition scenario
	Transition	1.5	86	-	30	-	70	• Warranty offerings and proactive marketing measures reduce customer concerns about refurbished products
	Advanced	1.5	86	-	50	-	50	• OEM/sector initiatives promoting circular production R&D foster refurbishment in the advanced scenario
Washing machine	Status quo	2.3[4]	40	-	10	-	90	• Improved circular capabilities (pooled, OEM-centric circular activities)[2] boost refurbishment in transition
	Transition	2.3[4]	65	-	50	-	50	• Transparent 'win-win' leasing contracts result in increased collection, controlled by manufacturers
	Advanced	2.3[4]	95	-	50	-	50	• Specialised intermediaries enable alternative ownership models on larger scale in advanced scenario

Urban mining



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

VILNIUS TECH Vilniaus Gedimino technikos universitetas

Hanse-Parlament

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Thank you for your attention

Result 5.2
Green Economy Study Modules

Study module C
Management & Technologies of the Circular Economy

Implementation Reports

Green Economy Study Modules

Implementation Report Training C

Sustainable Management of Wastewater in the Circular Economy: Approaches and Solutions

Prepared by:

AGBAR - Escuela del Agua

September, 2024

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Introduction

- Contextualisation within the overall project:

The sustainable management of water resources is increasingly recognized as a critical challenge in achieving sustainable development. The escalating demand for water, coupled with pollution and the effects of climate change, exerts significant pressure on the available freshwater resources. In this context, the circular economy emerges as a promising framework to address these challenges by advocating for the reuse and recycling of water and the recovery of valuable resources from wastewater.

The training course titled "Sustainable Management of Wastewater in the Circular Economy: Approaches and Solutions" is designed to equip professionals in the water treatment sector with essential knowledge and skills for implementing sustainable practices in wastewater management. By focusing on innovative approaches and technological solutions, this course not only contributes to optimizing water resource use but also helps mitigate the environmental impacts of human activities. It serves as a vital component of the overall project aimed at fostering a more sustainable and resilient future.

Modality, where and when:

The training program “Sustainable Management of Wastewater in the Circular Economy: Approaches and Solutions” is designed to be both accessible and flexible, catering to the diverse needs of professionals in the water treatment sector.

Modality

The training course "Sustainable Management of Wastewater in the Circular Economy: Approaches and Solutions" was delivered entirely online, providing participants with the flexibility to engage with the content at their own pace.

Where

The course is hosted on a virtual learning platform, providing participants with access to all course materials, interactive modules, and assessment tools. The virtual campus is designed to facilitate seamless communication between participants and instructors, as well as to offer a range of digital resources. This online environment is accessible from any location, allowing participants to engage with the course content at their convenience while benefiting from a collaborative learning atmosphere.

When

The training spanned six weeks, commencing on May 20, 2024, and concluding on June 30, 2024. Each ECTS credit was allocated a two-week timeframe, enabling participants to manage their schedules while fulfilling course requirements. The course was structured into three modules, each addressing specific topics related to sustainable wastewater management.

Skills Acquired:

Upon successfully completing the course "Sustainable Management of Wastewater in the Circular Economy: Approaches and Solutions," participants will acquire a comprehensive set of skills essential for effective wastewater management in a circular economy context. These skills include:

Participants will develop a robust understanding of the processes and mechanisms involved in wastewater regeneration, enabling them to select appropriate technologies and define key control parameters. They will be equipped to establish quality requirements and formulate analytical plans for monitoring water quality.

Additionally, participants will identify emerging technologies in wastewater treatment plants and assess their potential as resource generators within the circular economy framework. This knowledge will empower them to explore advanced control systems and address the challenges posed by emerging contaminants in water systems.

Moreover, the course will enhance participants' ability to evaluate energy consumption in water facilities. They will learn to interpret the implications of energy use on operational efficiency and costs, understand energy efficiency indicators and standards, and identify factors influencing energy consumption. This insight will allow them to recognize areas for improvement and propose actionable plans to optimize energy efficiency in their respective facilities.

Attendants:

The training course "Sustainable Management of Wastewater in the Circular Economy: Approaches and Solutions" was designed for a diverse audience of professionals engaged in the water treatment industry. The primary target groups included:

Water Treatment Technicians and Engineers: These individuals are directly involved in the operation and maintenance of wastewater treatment facilities. They play a crucial role in managing the day-to-day functions of these plants and must stay updated with the latest practices and technologies to ensure efficient operations.

Environmental Engineers: Professionals working on projects related to water treatment and environmental protection benefited from the course by gaining a deeper understanding of plant operations and maintenance. This knowledge enhances their ability to design and oversee effective water treatment solutions.

Facility Managers: Those responsible for overseeing the overall functioning of wastewater treatment plants. The seminar will provide them with insights into improving plant efficiency and managing technical and operational challenges.

Competence acquisition methodology:

The seminar "Sustainable Management of Wastewater in the Circular Economy: Approaches and Solutions" employs a comprehensive and effective methodology designed to ensure the acquisition of competencies essential for sustainable management of wastewater treatment facilities. The methodology encompasses several key components:

- **Challenge-Based Learning**: Participants engage with real-world professional challenges that require practical solutions. This approach allows them to apply theoretical knowledge to realistic scenarios, thereby enhancing problem-solving skills and practical application. Each module begins with a challenge that participants must address using the concepts learned throughout the course.

- **Transmedia Learning Resources**: The seminar incorporates a transmedia approach, which involves diverse formats such as interactive content, videos, and simulations. This multifaceted approach ensures that participants can engage with the material in various ways, catering to different learning preferences and reinforcing understanding through multiple channels.

- **Expert Manual**: Participants have access to a detailed manual authored by subject matter experts. This manual provides in-depth explanations of key concepts, processes, and techniques relevant to wastewater treatment. It serves as a crucial resource for detailed study and reference throughout the training.

- **Self-Assessment Exams**: To consolidate learning and gauge comprehension, participants complete self-assessment exams. These exams consist of multiple-choice questions and are linked to the content of each module. Immediate feedback is provided, allowing participants to assess their understanding and identify areas needing further review.

- **Interactive Online Platform**: The seminar is delivered through a virtual learning environment that facilitates interaction between participants and instructors. The platform supports discussion forums, where participants can exchange ideas, ask questions, and engage in collaborative problem-solving. This interactive component enriches the learning experience and fosters a sense of community.

Admission and organization of the trainings

- Organization of the training
    - **School of Water.** created by Agbar in 2012, is the benchmark in training, awareness, talent development and knowledge in the field of water and the environment.Our activity is aimed at training for companies, administrations and professionals in the water sector, as well as for the general public. Thus, we develop training programs, promote dual vocational training in the water sector, develop environmental education programs and design exhibition, museum and hydraulic heritage projects.The training programs, whether those in our catalog or those custom-designed for companies, cover all areas of the

complete water cycle; they use methodologies that facilitate a unique learning experience and immediate applicability in all key positions of an organization. Our approach combines the academic and technical rigor provided by 165 years of experience in integrated water cycle management and collaboration with the best universities, technical schools and business schools.

- Selection of participants, possible admission requirements

  Participants in the seminar were informed by HR for the internal participants and via web for the external participants.

- Brief notes on counselors and teachers:

Throughout the seminar on "Sustainable Management of Wastewater in the Circular Economy: Approaches and Solutions" participants benefit from the support and guidance of two key figures who play crucial roles in enhancing their learning experience:

1. **The Expert**: The expert is a pivotal figure in the training, providing technical support and addressing any queries related to the course content. As the primary authority on the material covered, the expert is responsible for evaluating each module. Participants can turn to the expert for in-depth explanations and clarifications, ensuring they fully understand the complex concepts and processes involved in wastewater treatment.
2. **The Academic Tutor**: The academic tutor offers personalized guidance and support throughout the participants' educational journey. This role involves providing individual assistance and addressing any questions or concerns related to the overall program. The academic tutor helps participants navigate the course structure, manage their progress, and maximize their learning outcomes.

Execution of the training

PERIOD	Credit	CONTENT
20/05/2024 to 02/06/2024	How to Recycle Water from My Treatment Plant	1. Uses of regenerated water. Water quality depending on use. 2. Water regeneration technologies 3. Water quality control and analytical plan 4. Adaptation of resources to client needs
03/06/2024 to 16/06/2024	How to Modernize My Treatment Plant	1. Why a 21st century WWTP? Economic, social reasons and environmental? 2. Emerging technologies 3. By-product recovery 4. Control systems 5. Emerging pollutants
17/05/2024 to 30/06/2024	How to Implement Energy Efficiency in My Water Facilities	1. Energy concepts 2 Energy consumption in the integral water cycle 3. Regulatory framework 4 Comprehensive energy management 5 Energy audit 6 Energy generation

Evaluation Ratings

The participants of the course "Sustainable Management of Wastewater in the Circular Economy: Approaches and Solutions" provided feedback that reflects their experiences and perceptions of the training. The overall satisfaction with the training received was rated at 3.8, indicating a generally positive response from attendees.

The evaluation of the online expert was rated at 3.5, suggesting that while the expert provided valuable insights, there may be areas for improvement in their engagement or availability. Similarly, the academic tutor received a rating of 3.7, highlighting their effectiveness in supporting participants but also indicating potential room for enhancement.

The functionality of the virtual campus was notably well-rated at 4.0, demonstrating that participants found the online platform user-friendly and effective in facilitating their learning experience. Lastly, the overall rating of the course content and resources was 3.8, reflecting participants' appreciation for the materials provided while suggesting the need for further development to meet all learner expectations.

Main Findings and Conclusions

The training course "Sustainable Management of Wastewater in the Circular Economy: Approaches and Solutions" showcased several strengths, particularly regarding the relevance of its content. Participants found the three topics presented highly engaging, especially in relation to wastewater treatment plants. The inclusion of explanatory videos was particularly well-received, contributing to the overall interest in the course. However, attendees noted that while the course was intriguing, the available content often felt insufficient compared to the demands of the subsequent challenges. This resulted in a need for extensive bibliographic research and self-study, which may not align with the intended objectives of the training.

Participants also expressed a desire for more practical tools, such as tables and calculation examples, to facilitate the application of theoretical concepts in real-world situations. The clarity and presentation of the information were positively noted, especially in the first challenge, which included useful explanatory videos.

Concerns were raised regarding the format of course materials, with participants indicating that providing a 50-page PDF for theory and another for challenges did not meet their expectations for an online course. Attendees expressed a preference for a more interactive and engaging learning experience that allows for gradual understanding and practical application of concepts.

Finally, the overall length of the course, requiring 75 hours of commitment within a single month, raised concerns about feasibility. Participants recommended extending the duration of the course to ensure a more balanced and thorough learning experience.

Attachments

- **ATTACHMENT 1: LIST OF PARTICIPANTS**
- **ATTACHMENT 2: PUBLICATION ABOUT THE COURSE (web)**

ATTACHMENT 1: LIST OF PARTICIPANTS Nombre	Company
ALEJANDRO FAUNDEZ	External
Andrés Dávila Montoro	HIDRALIA, GESTION INTEGRAL DE AGUAS DE ANDALUCIA, S.A.
AXEL AGUSTÍ GALLEGO	External
BRAULIO AVILA RUIZ PASTRANA	External
Carlos Enrique Perez Sandoval	External
ENRIQUE GRAU ALBEROLA	External
Eva Maria Garcia Jimenez	HIDROGEA, GESTION INTEGRAL DE AGUAS DE MURCIA, S.A.
JAVIER CAÑAS	External
JAVIER CANINO ATOCHE	External
Javier Martín Javea	External

MARINA ORTOLÀ LAPIEDRA	External
Pablo Alcaraz Navarro	AQUATEC PROYECTOS PARA SECTOR DEL AGUA, S.A.U.
PATRICIO NUNEZ	External
Rafael Fernandez Gonzalez	HIDROGEA, GESTION INTEGRAL DE AGUAS DE MURCIA, S.A.
REYES PRAGA	External
ROBERT AGUILAR NARANJO	External
Sol Gongora Hernandez	AGUAS DE ALBACETE. S.A.
TRINIDAD TORRES CARMONA	External
VIVENTE GOMEZ QUILES	External

ATTACHMENT 2: PUBLICATION ABOUT THE COURSE

https://www.laescueladelagua.com/en/programa/executive-education/seminario/gestion_sostenible_aguas_residuales_eco_circular/

SEMINAR

Sustainable Wastewater Management in the Circular Economy: Approaches and Solutions

Online

+34 932 479 735 +34 616 778 523

CONTACT ADMISSIONS

Presentation | Program | Admission and basic data

The Water School as a participant in the project 3LoE, has organized the course "Sustainable Wastewater Management in the Circular Economy: Approaches and Solutions"75 hours of **online self-study.**

The main objective of this program is to acquire knowledge to cUnderstand the principles and processes involved in recycling water from purification, including technologies and practices for its safe and sustainable reuse.

Acquire knowledge about the technologies and strategies available to modernize a wastewater treatment plant, with the aim of improving its efficiency, performance and regulatory compliance.

Develop skills to identify opportunities to improve the energy efficiency of water-related facilities, as well as to implement measures and solutions that reduce energy consumption and promote sustainable practices.

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PANEVĖŽIO KOLEGIJA

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

REPORT ON THE IMPLEMENTATION OF COURSE

Management & Technologies of the Circular Economy

Prepared by Panevėžio kolegija/University of Applied Sciences

2022

PANEVĖŽIO KOLEGIJA

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

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3. THE COURSE EVALUATION BY TEACHER **7**
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1. THE COURSE IMPLEMENTATION STATISTICS

1. Number of students register in the course:
Autumn semester (*10 students*)

2. Number of students according to gender:
Autumn semester (2 *Man, 8 Woman*)

3. Number of students according to age:

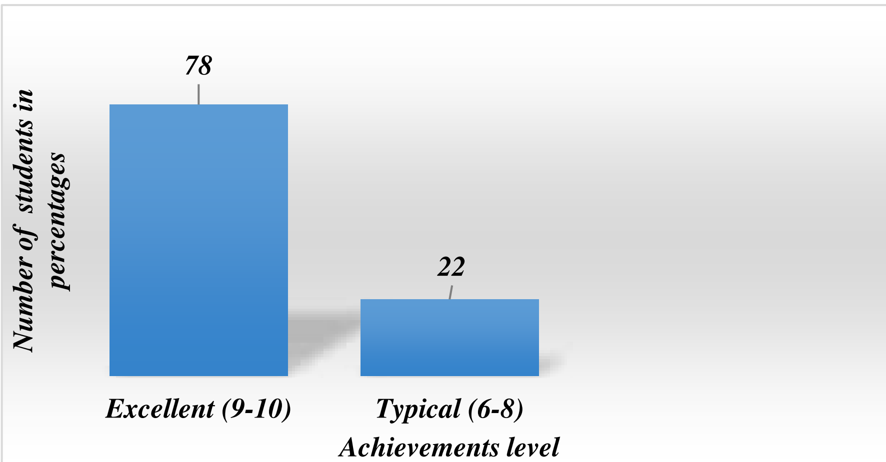
Age group	Autumn semester:	
	Number	*Percentage*
Under 20	2	20,0
20-29	6	60,0
30-39	1	10,0
40-49	0	0,0
50-59	1	10,0
60+	0	0,0

4. Number of students remaining at the completion of the course:
Spring semester (*9 students*)

5. Number of students withdrawn:
Spring semester (*1 student)*

6. Grade Distribution:

Achievements levels	Number	Percentage
Excellent (9-10)	7	78,0
Typical (6-8)	2	22,0
Threshold (5)	0	0,0



2. THE COURSE EVALUATION BY STUDENTS

Course evaluation by students was performed using online survey. Electronic version of the survey available at https://forms.gle/LRbGeYi12dySA3kV8. Online survey was carried in the last week of the training. 9 students took part in the survey, i. e. 100 percent of students who successfully completed the course.

7. Evaluation of course content and teaching quality

7.1. The objectives of the course and study results, evaluation criteria were clearly defined from the very beginning of the course:

	Number	Percentage
Strongly agree	1	11
Agree	6	67
Neither agree nor disagree	2	22
Disagree	0	0,0
Strongly disagree	0	0,0

7.2. Assessment of the study results was appropriate:

	Number	Percentage
Strongly agree	1	11
Agree	5	56
Neither agree nor disagree	3	33
Disagree	0	0,0
Strongly disagree	0	0,0

7.3. The content was interesting, relevant, useful and allowed to achieve study results:

	Number	Percentage
Strongly agree	1	11
Agree	7	78
Neither agree nor disagree	1	11
Disagree	0	0,0
Strongly disagree	0	0,0

7.4. The course content responds to the latest scientific achievements:

	Number	Percentage
Strongly agree	5	56
Agree	2	22
Neither agree nor disagree	2	22
Disagree	0	0,0
Strongly disagree	0	0,0

7.5. Theory was taught in conjunction with the practical examples:

	Number	Percentage
Strongly agree	1	11
Agree	7	78
Neither agree nor disagree	1	11
Disagree	0	0,0
Strongly disagree	0	0,0

7.6. Theory was taught in context of the sustainable development issues:

	Number	Percentage
Strongly agree	1	11
Agree	8	89

Neither agree nor disagree	0	0,0
Disagree	0	0,0
Strongly disagree	0	0,0

7.7. The course topics were not repetitive:

	Number	Percentage
Strongly agree	8	89
Agree	1	11
Neither agree nor disagree	0	0,0
Disagree	0	0,0
Strongly disagree	0	0,0

7.8. The teaching materials were presented in an organized manner:

	Number	Percentage
Strongly agree	4	44
Agree	4	44
Neither agree nor disagree	1	11
Disagree	0	0,0
Strongly disagree	0	0,0

7.9. The teaching materials distributed were helpful to achieve study results:

	Number	Percentage
Strongly agree	2	22
Agree	6	67
Neither agree nor disagree	1	11
Disagree	0	0,0
Strongly disagree	0	0,0

7.10. Lecturer encouraged my participation, initiative and interaction during the lectures:

	Number	Percentage
Strongly agree	6	67
Agree	2	22
Neither agree nor disagree	1	11
Disagree	0	0,0
Strongly disagree	0	0,0

7.11. The study methods chosen by the lecturer helped to understand the course:

	Number	Percentage
Strongly agree	4	44
Agree	5	56
Neither agree nor disagree	0	0,0
Disagree	0	0,0
Strongly disagree	0	0,0

7.12. The teaching process included interactive methods:

	Number	Percentage
Strongly agree	3	33
Agree	5	55
Neither agree nor disagree	1	11
Disagree	0	0,0
Strongly disagree	0	0,0

7.13. The lecturer was a good communicator

	Number	Percentage
Strongly agree	3	33
Agree	5	56
Neither agree nor disagree	1	11
Disagree	0	0,0
Strongly disagree	0	0,0

8. Comments on strengths and ways of improvement

8.1. How do you evaluate the course quality

	Number	Percentage
Very satisfied	4	44
Satisfied	5	55
Neither satisfied nor dissatisfied	0	0,0
Dissatisfied	0	0,0
Very dissatisfied	0	0,0

8.2. How do you evaluate the course lecturer

	Number	Percentage
Very satisfied	6	67
Satisfied	2	22
Neither satisfied nor dissatisfied	1	11
Dissatisfied	0	0,0
Very dissatisfied	0	0,0

8.3. Could you name the main advantages of this course?

Complexity; Novelty; Proactive learning.

8.4. Which specific difficulties you encountered while studying the course?

Struggle with time management; None; Everything all right; No problem.

8.5. Could you name the main disadvantages of this course?

None; I did not see any, Scope, Resources.

8.6.What changes would you recommend to improve this course?

I don't know; None; It is difficult to say; I need more experience in the field to judge.

3. THE COURSE EVALUATION BY TEACHER

Course evaluation by teacher was performed using online survey. Electronic version of the survey available at https://forms.gle/srHZJ1ji7GyJShMm8. Online survey was carried in the last week of the training.

9. Evaluation of course structure and description:

Course teacher strongly agrees that:

9.1. The course aims are clear and well defined.

9.2. The competencies clearly describe knowledge and skills of student graduating from this course.
9.3. The learning outcomes correspond to the competencies.
9.4. The division of course hours into contact and self-learning hours is appropriate.

10. Evaluation of course content:

Course teacher agrees that:
10.1. The course content corresponds to the learning outcomes.
10.2. The course content is consistent.
10.3. The course topics are not repetitive.
10.4. The course content is modern.
10.5. The learning methods are appropriateto to achieve the intended competences.
10.6. The assessment of competence is appropriate.

11. Comments on strengths and ways of improvement:

11.1. According to the teacher the main advantages of this course:
The Way of the Future; Practicality; The Focus of Educational Technology: Putting Students First.
11.2. According to the teacher the main disadvantages of this course:
Scope.
11.3. The teacher recommends the main changes to improve this course:
Students sometimes find they run into challenges or don't understand the material when going through all topics.

CONCLUSIONS

After implementation of the course "Management & Technologies of the Circular Economy" realized within the Project project „Three-level Centers of Professional Excellence: Qualification, Entrepreneurship and Innovation in the Green Economy" the following conclusions are defined:

- The objectives of the course were achieved.
- The teacher and students highly rated the quality of course content.
- Students were satisfied with the quality of teaching.
- The knowledge and skills learned in the courses were put into practice.
- The course was properly implemented.

Work Package 5: Third center level “Higher Education)

(EQF 6)

Activity A8.31 Test study module C

Management technologies of the circular economy

Implemented by:

SFC Sistemi Formatici Confindustria and

Scuola Sant’Anna di Pisa University

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

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Chapter 1: Executive Summary

This report relates to the implementation activities in Italy of the 4 modules:

C – "Management & Technologies of the Circular Economy"

developed by VILNIAUS GEDIMINO TECHNICAL UNIVERSITY (VGTU) and SATAKUNTA UNIVERSITY OF APPLIED SCIENCES (SAMK) in the Project 'Management and Technologies of Water, Wastewater, Waste and Circular Economy (WWW&CE)'

Methodology for adaptation of VGTU – SAMK curricula to Italian training needs

Following the analysis of the Module A-B-C-D curricula developed by the 3LoE partners, SFC found it beneficial to propose to the Scuola Superiore Sant'Anna (SSSA) the validation of potentially integrating the 4 modules, their structure, learning outcomes and main topics into existing university pathways.

This analysis, conducted in March 2023, resulted in Sant'Anna expressing interest in incorporating the four modules into the MASTER GECA specialization pathway.

The GECA Master is a 2nd level university Master's degree program offered by the Institute of Management at the Scuola Superiore Sant'Anna in Pisa. For nearly three decades, it has provided a high-level, continuously updated, multidisciplinary course in the environmental sector and green management.

The professional profile emerging from the GECA Master is that of an "Expert in Corporate Sustainability and Circular Economy."

The GECA Master was identified as the most suitable existing program into which all four modules proposed by the 3LoE project could be integrated.

Meetings to finalize and adapt the contents and learning outcomes of all the 4 modules within the framework of the GECA Master's Course were held from April 2023 to September 2023. This timeline ensured that the necessary authorizations from the college of university

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lecturers could be obtained in time for implementation during the GECA Master's Course, which ran from October 2023 to July 2024.

The competencies of the four modules are attributable, according to the Italian Atlas of Competences and Professions, to:

SECTOR 24: Common Area

PROCESS: Ecological transition, reduction of energy consumption, circularity, and containment of environmental impacts

PROCESS SEQUENCE: Activation of circular production processes and increase of recycling activities

The Expected Result of the learning pathway is:

RA2: Adopt circular closed-loop production processes, implementing lean production logics and techniques, and improving the energy efficiency of production processes to reduce environmental impact.

The main activities envisaged are:

- Optimization of production processes
- Implementation of closed-loop production and waste minimization
- Energy efficiency and use of renewable energy in production processes

It was determined that the four modules could contribute significantly to the formation of the GECA Master's graduate profile. Specifically, they could contribute to developing the learning outcomes related to the process sequence as detailed in Annex A.

The competence related to Module C – Management and Technologies of the Circular Economy are attributed also to the following process, referred to in the Italian Atlas of Competences and Professions:

SECTOR 24: Common Area

- PROCESS: Ecological transition, reduction of energy consumption, circularity, and containment of environmental impacts
    - PROCESS SEQUENCE - Containment of environmental impacts of production activities, materials and packaging

ADA (area of activity).24.08.09 - Assessment and monitoring of environmental impacts of production activities and identification of containment measures

Expected Results are:

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1: Create a detailed action plan with timelines, necessary resources and assigned responsibilities for each containment measure, establishing specific targets for reducing environmental impacts and developing strategies to minimise the negative impacts identified

2: Identify the environmental impact risks associated with the company's activities, performing an analysis of production processes and evaluating the life cycle of raw materials and products

3: Implement technologies and production processes with lower environmental impact and greater sustainability, optimising the use of resources and promoting sustainable waste management.

Annex A and B report the results of the consultation of the Atlas of Professions in Italy, managed by INAPP - National Institute for the Analysis of Public Policy.

Introduction to Module C implementation

The concept of the circular economy began to develop in response to the crisis of the traditional 'linear' model (so-called 'take-make-dispose'), due to the need for economic operators, and in particular companies, to deal with the increasing scarcity and limitedness of many resources (production inputs) hitherto considered abundant and used indiscriminately.

The circular economy is an economy that is designed to 'self-regenerate': materials of biological origin are designed to re-enter the biosphere, and materials of technical origin are designed to circulate within a flow with minimal loss of quality. It is therefore an economy that intentionally 'replenishes' itself: it aims to rely on renewable energy sources, to minimise, track and eliminate the use of toxic chemicals, and to eliminate waste and waste production through careful design.

The implementation of a fully 'circular economy', however, today encounters significant barriers due to the incomplete awareness and knowledge of all the opportunities for saving, reusing, recovering and recycling of resources and materials obtainable from innovations in this field, on the one hand, and the difficulties of undertaking innovative processes that lead the company to targeted actions to 'close' cycles and, thus, optimise the use of resources and minimise waste, on the other.

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The course aims to provide participants with the skills required for the professional role of circular economy manager. Specifically:

- from basic to advanced notions

- from technical-functional circularity management skills to those related to measuring circularity in the company

- from the development of circular business strategies and models to CE communication and marketing

Target group

The Master GECA in Environmental Management and Control: Circular Economy and Resource Efficient Management envisages a minimum of 15 and a maximum of 24 participants.

Those who have obtained a master’s degree, a specialized degree or an old university degree, or an equivalent qualification obtained at an Italian or foreign university or institute of equal standing may apply for admission.

Undergraduates who have completed their final examinations prior to the start of the master’s course and who plan to acquire the qualification in the extraordinary session of the academic year preceding the start of the Master's course may also apply for admission.

Work required

In the curriculum, the average work required by each module is measured in units of ECTS credit (abbreviated in this presentation as CU). The curriculum consists of four modules of total 12 ECTS credit units, corresponding to 189 hours of lectures, professional field visits, individual study and assignments. The Green Management and Circular Economy module can be administered individually, thus can be offered to those wishing to implement or develop skills related to the Circular Economy and sustainable management.

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Contents of the curriculum

The courses will be taught by lecturers from the Scuola Superiore Sant'Anna and experts in the topics covered by the courses. The aim of the course will not only be to transfer knowledge on the key concepts related to the circular economy, but also to enable course participants to be autonomous in the search for sectorial best practices, technological-organisational solutions, to be implemented in their own business activities. Practical exercises will be proposed on emblematic aspects of circularity (e.g. how to evaluate business performance through a measurement tool). The instructors will ensure:

- the development and maintenance of a positive classroom environment;

- effective interpersonal communication processes, stable relationships of trust and collaboration;

- an adequate evaluation process, with respect to the overall course objectives.

Prior to the start of each module, the participants will be provided with bibliographic reference material for each course, which will be useful in preparing the students for active and expert participation. This bibliographic material will cover not only basic skills, but also further levels of in-depth study.

The module aims to train managers who are able to make decisions and to define and implement strategies in the context of the challenges posed by the circular economy. The main objective is to transmit competences and skills (knowing, knowing how to do, feeling) related to the main managerial tools - methodologies and operational tools - supporting management oriented towards circular and efficient resource management.

The Module C aims to provide interdisciplinary content to the various corporate functions involved in business management, which can play a role in the development of effective management strategies from a circular economy perspective.

In detail, it is intended to develop:

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a) interdisciplinary skills on the topics of Green Management and Circular Economy, capable of completing the knowledge base and experience gained by the students in their own study and professional career;

b) problem-solving skills, project development, and the use of tools for the management of environmental issues in companies (from eco-design to efficient management of the finished product)

c) team-working behavior, active participation in the life of organizations, continuous improvement of performance in terms of sustainability;

d) skills in the analysis, measurement, evaluation, organization and management, and communication of environmental issues in companies.

The curriculum is divided into four units as follows:

- UNIT 1: Strategies and Business Model Innovation for a circular and climate-neutral transition
- UNIT 2: Life Cycle Thinking and Ecodesign
- UNIT 3: Operations for a circular and carbon neutral economy
- UNIT 4: Circular and carbon metrics and commitment disclosure

The curriculum on Green Management & Circular Economy module structure is shown in the following Tables.

Table 1 Contents of Unit 1

Unit 1: **Strategies and Business Model Innovation for a circular and climate-neutral transition**	**Learning outcomes:** Learn the principles, approaches and tools to support corporate management of sustainability, the environment and the circular economy. Knowing business models, being able to use methods and tools for the development of CE business strategies.

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Contents: • Business cases on circular economy and decarbonisation • Business models. From the traditional business model Canvas to the inclusion of business purpose. • Circular business models, theory and practice. • Regenerative business models to restore the planet's resources.
Student's workload: 32 lecture hours + 16 individual study hours (3 CFU)
Possible materials: Fraccascia, L., Giannoccaro, I., Agarwal, A. and Hansen, E. 2019. Business models for the circular economy: Opportunities and challenges. Business Strategy and the Environment 28, 2, (430-432). DOI: 10.1002/bse.2285. Available https://www.researchgate.net/publication/331224413_Business_models_for_the_circular_economy_Opportunities_and_challenges Desing, H., Brunner, D., Takacs, F., Nahrath, S., Frankenberger, K., & Hischier, R. 2020. A circular economy within the planetary boundaries: towards a resource-based, systemic approach. Resources, Conservation and Recycling, 155, 104673 (14 pp.). https://doi.org/10.1016/j.resconrec.2019.104673 Geissdoerfer, M. Savaget, P., Bocken, N. and Hultink. 2017. The Circular Economy – A new sustainability paradigm? Journal of Cleaner Production. 143: 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048 Lacy,P., Long, J. and Spindler, W. 2020. The Circular Economy Handbook: Realizing the Circular Advantage. Palgrave Macmillan, UK. ISBN: 9781349959679. Natalia Marzia Gusmerotti, Marco Frey, Fabio Iraldo, 2020. Management dell'economia circolare. Principi, drivers, modelli di business e misurazione.

Table 2 Contents of Unit 2

Unit 2: **Life Cycle Thinking and Ecodesign**	**Learning outcomes**: Knowledge of the Life Cycle Assessment (LCA) methodology for quantifying the potential environmental

	impacts of products, processes, and services. Know the main approaches, techniques, and tools for the design of circular products and processes, know how to use tools to support CE design.

Contents:

- LCA method theory
- The environmental footprint and LCA approach in policies and third-party certification schemes - The European Commission's PEF and OEF initiative - Environmental and carbon footprint certification schemes and programmes
- Practical LCA method with practice on boundaries, functional units, use of software
- How to use LCA and environmental footprinting in company environmental management strategies - LCA at the basis of R&D and design choices - LCA for green supply chain management - How to effectively set up an LCA study in a company
- Ecodesign principles - from theory to practice
- Ecodesign requirements in the wake of the new directions of EU legislation: EcoDesign Regulation and Packaging & Packaging Waste Regulation
- Ecodesign for the circular economy: company case studies and exercises
- Ecodesign tool: how to build a green design support tool based on LCA and application examples

Student's workload:

46 lecture hours + 20 individual study hours (4 CFU)

Possible materials:

Selected materials from European Commission, Sustainable product policy & eco-design https://ec.europa.eu/growth/industry/sustainability/sustainable-product-policy-ecodesign_en

Cayzer S., Griffiths P. and Beghetto V., 2017. Design of indicators for measuring product performance in the circular economy. International Journal of Sustainable Engineering.

Direttiva Ecodesign (2009/125/CE): https://eur-lex.europa.eu/legal-content/IT/TXT/PDF/?uri=CELEX:32009L0125

Proposta di modifica al regolamento Ecodesign (COM 2022/42 final):

EUR-Lex - 52022PC0142 - EN - EUR-Lex (europa.eu)

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Table 3 Contents of Unit 3

Unit 3: **Operations for a circular and carbon neutral economy**	**Learning outcomes:** Know the main theories and approaches to business innovation, to know how to develop innovation strategies in the company, to know the connections between eco-innovation and CE, to know how to investigate the company's change intent and to implement strategies to support eco-innovation.
Contents: • Eco-innovation, industrial ecology, industrial symbiosis, BAT: definitions, policies, tools, practical cases • Resource efficiency, waste optimisation, material recovery from municipal waste streams • Bitcoin, blockchain and the advent of decentralisation in the Green Economy new technologies and blockchain applied to the circular economy • The circular economy in the energy sector and process industry • Circular Bioeconomy the management of biodiversity in a company environment	
Student's workload: 28 lecture hours + 13 individual study hours (3 CFU)	
Possible materials: Tiberio Daddi, Sara Tessitore and Marco Frey, 2012. Eco-innovation and competitiveness in industrial clusters. International Journal of Technology Management. Paul Stegmann, Marc Londo, Martin Junginger, 2020. The circular bioeconomy: Its elements and role in European bioeconomy clusters, Resources, Conservation & Recycling. Abderahman Rejeb, Andrea Appolloni, Karim Rejeb, Horst Treiblmaier, Mohammad Iranmanesh, John G. Keogh, 2023. The role of blockchain technology in the transition toward the circular economy: Findings from a systematic literature review, Resources, Conservation & Recycling Advances. European Commission, 2018. Cooperation fostering industrial symbiosis	

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Market potential, good practice and policy actions : final report. ISBN number 978-92-79-74679-6 doi:number 10.2873/346873

Table 4 Contents of Unit 4

Unit 4: **Circular and carbon metrics and commitment disclosure**	**Learning outcomes:** Know the main methods of measuring circularity in the company, know how to use the main tools available today, know how to carry out risk assessments integrated with key aspects of EC.
Contents: • Sustainability Reporting, GRI standards and connection with the SDGs • Carbon Footprint Standard (ISO14067 and GHG Protocol) • Circularity measurement systems: theory, tools and practices • Standard Carbon Footprint (ISO14067 and GHG Protocol)	
Student's workload: 24 lecture hours + 10 individual study hours (2 CFU)	
Possible materials: Vercalsteren, A., Maarten, C. and Van Hoof, V. Indicators for a Circular Economy. Available https://circulareconomy.europa.eu/platform/sites/default/files/summa_-_indicators_for_a_circular_economy.pdf BSI Standards. 2017. Framework for implementing the principles of the circular economy in organizations – Guide. BS 8001:2017. Available file:///C:/Users/sisande/Downloads/BS8001_2017_Framework.pdf Ellen Mac Arthur Foundation, 2015. "Circularity Indicators – An approach to measuring circularity" https://www.ellenmacarthurfoundation.org/assets/downloads/insight/Circularity-Indicators_Project-Overview_May2015.pdf Saidani M., Yannou B., Leroy Y., Cluzel F. and Kendall A., 2018. A Taxonomy of Circular Economy Indicators. Journal of Cleaner Production.	

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Linder M., Sarasini S. and van Loon, P., 2017. A Metric for Quantifying Product-Level Circularity. Journal of Industrial Ecology

Teaching methods

Teachers are encouraged to use varying methods containing e.g.:

- Lectures,
- Visiting lecturers,
- Professional field visits,
- Visits in enterprises,
- Videos approaching the topics (Reliability of the source must be evaluated),
- Individual studies

Teaching module delivery schedule

C - Green management & Circular Economy	• From 3 to 7 June 2024 • From 20 to 21 June 2024 • From 24 to 27 June 2024 • From 1 to 2 July 2024

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Result 5.2
Green Economy Study Modules

Study module C
Management & Technologies of the Circular Economy

Evaluation Report

PANEVĖŽIO KOLEGIJA

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

REPORT ON THE EVALUATION OF COURSE

Management & Technologies of the Circular Economy

Prepared by Panevėžio kolegija/University of Applied Sciences

2024

PANEVĖŽIO KOLEGIJA

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

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1. THE COURSE IMPLEMENTATION STATISTICS

1. Number of respondents (students):
36 students took part in the survey (PANKO – 10, Scuola superiore sant'anna – 6)

2. Number of respondents according to gender:
5 *Man, 11 Woman*

3. Number of respondents according to age:

Age group	*Percentage*
Under 20	20
20-29	60
30-39	10
40-49	0
50-59	10
60+	0

2. THE COURSE EVALUATION BY STUDENTS

Course evaluation by students was performed using online survey. Electronic version of the survey available at https://forms.gle/LRbGeYi12dySA3kV8. 36 students took part in the survey (PANKO – 10, Scuola superiore sant'anna – 6).

7. Evaluation of course content and teaching quality

7.1. The objectives of the course and study results, evaluation criteria were clearly defined from the very beginning of the course:

	Number	Percentage
Strongly agree	6	38
Agree	6	38
Neither agree nor disagree	4	24
Disagree	0	0
Strongly disagree	0	0

7.2. Assessment of the study results was appropriate:

	Number	Percentage
Strongly agree	8	50
Agree	5	31
Neither agree nor disagree	3	19
Disagree	0	0
Strongly disagree	0	0

7.3. The content was interesting, relevant, useful and allowed to achieve study results:

	Number	Percentage
Strongly agree	6	38
Agree	6	38
Neither agree nor disagree	4	24
Disagree	0	0
Strongly disagree	0	0

7.4. The course content responds to the latest scientific achievements:

	Number	Percentage
Strongly agree	5	31
Agree	7	44
Neither agree nor disagree	4	25
Disagree	0	0
Strongly disagree	0	0

7.5. Theory was taught in conjunction with the practical examples:

	Number	Percentage
Strongly agree	6	38
Agree	6	38
Neither agree nor disagree	4	24
Disagree	0	0
Strongly disagree	0	0

7.6. Theory was taught in context of the sustainable development issues:

	Number	Percentage
Strongly agree	8	50
Agree	5	31
Neither agree nor disagree	3	19
Disagree	0	0

Strongly disagree	0	0

7.7. The course topics were not repetitive:

	Number	Percentage
Strongly agree	8	50
Agree	8	50
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0

7.8. The teaching materials were presented in an organized manner:

	Number	Percentage
Strongly agree	6	38
Agree	6	38
Neither agree nor disagree	4	24
Disagree	0	0
Strongly disagree	0	0

7.9. The teaching materials distributed were helpful to achieve study results:

	Number	Percentage
Strongly agree	8	50
Agree	8	50
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0

7.10. Lecturer encouraged my participation, initiative and interaction during the lectures:

	Number	Percentage
Strongly agree	8	50
Agree	8	50
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0

7.11. The study methods chosen by the lecturer helped to understand the course:

	Number	Percentage
Strongly agree	6	38
Agree	5	31
Neither agree nor disagree	5	31
Disagree	0	0
Strongly disagree	0	0

7.12. The teaching process included interactive methods:

	Number	Percentage
Strongly agree	6	38
Agree	5	31
Neither agree nor disagree	5	31
Disagree	0	0
Strongly disagree	0	0

7.13. The lecturer was a good communicator

	Number	Percentage

Strongly agree	8	50
Agree	5	31
Neither agree nor disagree	3	19
Disagree	0	0
Strongly disagree	0	0

8. Comments on strengths and ways of improvement

8.1. How do you evaluate the course quality

	Number	Percentage
Very satisfied	6	38
Satisfied	6	38
Neither satisfied nor dissatisfied	4	24
Dissatisfied	0	0
Very dissatisfied	0	0

8.2. How do you evaluate the course lecturer

	Number	Percentage
Very satisfied	6	38
Satisfied	5	31
Neither satisfied nor dissatisfied	5	31
Dissatisfied	0	0
Very dissatisfied	0	0

8.3. Could you name the main advantages of this course?

Complexity; Novelty; Proactive learning.

8.4. Which specific difficulties you encountered while studying the course?

Struggle with time management; None; Everything all right; No problem.

8.5. Could you name the main disadvantages of this course?

None; I did not see any, Scope, Resources.

8.6.What changes would you recommend to improve this course?

I don't know; None; It is difficult to say; I need more experience in the field to judge.

3. THE COURSE EVALUATION BY TEACHER

Course evaluation by teacher was performed using online survey. Electronic version of the survey available at https://forms.gle/srHZJ1ji7GyJShMm8. Online survey was carried in the last week of the training.

9. Evaluation of course structure and description:

Course teacher strongly agrees that:

9.1. The course aims are clear and well defined.

9.2. The competencies clearly describe knowledge and skills of student graduating from this course.

9.3. The learning outcomes correspond to the competencies.

9.4. The division of course hours into contact and self-learning hours is appropriate.

10. Evaluation of course content:

Course teacher agrees that:

10.1. The course content corresponds to the learning outcomes.

10.2. The course content is consistent.

10.3. The course topics are not repetitive.

10.4. The course content is modern.

10.5. The learning methods are appropriateto to achieve the intended competences.

10.6. The assessment of competence is appropriate.

11. Comments on strengths and ways of improvement:

11.1. According to the teacher the main advantages of this course:

The Way of the Future; Practicality; The Focus of Educational Technology: Putting Students First.

11.2. According to the teacher the main disadvantages of this course:

Scope.

11.3. The teacher recommends the main changes to improve this course:

Students sometimes find they run into challenges or don't understand the material when going through all topics.

CONCLUSIONS

After implementation of the course “Management & Technologies of the Circular Economy“ realized within the Project project „Three-level Centers of Professional Excellence: Qualification, Entrepreneurship and Innovation in the Green Economy“ the following conclusions are defined:

- The objectives of the course were achieved.
- The teacher and students highly rated the quality of course content.
- Students were satisfied with the quality of teaching.
- The knowledge and skills learned in the courses were put into practice.
- The course was properly implemented.

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Result 5.2
Green Economy Study Modules

Study module D
Management of sustainable economic activity

Curricula and Teaching Materials

Workpackage 5 Third center level "Higher education"

Activity 8 Preparation and transfer of study modules "Green Economy”

8.4 Module D

Management of sustainable economic activity

Introduction

As part of the project "Management and Technologies of Water, Waste-Water, Waste and Circular Economy" (WWW&CE), Satakunta University of Applied Sciences have developed curriculum for the study module D Management of sustainable economic activity. Below is the curriculum listed. Attached are teaching materials that were also developed by Satakunta University.

Module D has been practically tested by Wirtschafts-Förderungsinstitut der Wirtschaftskammer Steiermark (WIFI).

Curriculum
Management of Sustainable Economic Activity

Satakunta University of Applied Sciences (SAMK), project partner number 11

Compiled by Dr Sirpa Sandelin and Dr Kari Lilja

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Introduction

Companies struggle today with several challenges, for example, technological innovations, new legislative decrees and acts, climate change and more stringent environmental permits, demanding stakeholders and customers, economic constraints and digitalization. Thus, companies must create and implement environmentally sound and cost effective management in their business. Achieving sustainable economic activity requires new kinds of thinking and operating models, diverse expertise and a reorientation of business activities. Nowadays, some SMEs are already champions of sustainability. Good example of this is the sector of eco-friendly products. However, actions are needed in many companies, especially traditional ones, who should strive for more greener and circular economy. To respond this challenge, companies have to reskill and upskill their employees to solve the complex problems related to sustainable economy.

Competitiveness can only be secured by combination of technology, which enables

- new solutions,
- sustainability, which improves resource utilization, and
- customer-centricity, which delivers customer outcomes.

Because of the very different national circumstances, climate, topography and local conditions in EU countries, the curriculum on Management of Sustainable Economic Activity gives general framework for the management of sustainable economic activity in companies.

In this curriculum the sustainable economic activity refers, on the one hand, to analyzing company's economic activity in the context of a subset of the broader ecological systems. On the other hand, sustainability is defined according to ecological, rather than economic criteria. However, these issues should be discussed taking into account several academic disciplines and perspectives, to provide deeper insight to the broader understanding of sustainable economic aspects in SME scale.

Target group

The target group of curriculum consists of Bachelor's programme students at universities and universities of applied sciences. The individual modules are well suited also to be applied as the open university courses.

Work required

In the curriculum the average work required by each module is measured in ECTS credit units (abbreviated in this presentation as CU). One credit unit equals 27 hours workload. The curriculum consists of modules totaling 6 – 9 ECTS credit units corresponding 160 – 240 hours containing lectures, professional field visits, individual studies and assignments. Cooperation with the local experienced industry practitioners is highly recommended. All modules can be studied individually, so the modules can be offered also via open studies to all companies and organizations, who intend to implement or development sustainable management.

Contents of the curriculum

The variation in regulations and circumstances and qualification requirements are quite different in the BSR-countries, thus the curriculum can be written only as a form of framework inside which the local actors should be able to modify the contents of modules according to their own regulations and local requirements. Using innovative, problem-based and experiential educational approaches, students build on their professional experience to become experts who are able to create and implement effective sustainable economy solutions.

The overall objectives of the curriculum are to

- develop an overall image of the sustainable economic activities at SMEs, and understand its basic principles

- understand the problems related to sustainable and greener business and how companies can resolve their activities to cope with the legal and regulatory, sustainable development and financial aspects
- become familiar with approaches that could promote the sustainable economy
- create a vision of practical activities that could be undertaken by different sectors to promote sustainable economy at SMEs

The curriculum is divided in modules as follows:

- Module 1: Introduction to sustainability
- Module 2: Regulatory frameworks and strategies
- Module 3: Financial issues related to sustainability
- Module 4: Business planning and circular economy
- Module 5: Management systems and tools
- Module 6: Human resources, marketing and communication

Figure 1 shows the overall contents of the curriculum on the Management of Sustainable Economic Activity, and Tables 1- 6 the contents of the modules. Most of the proposed course material is available in European Union pages in several languages.

Figure 1 Contents of the curriculum on the Management of Sustainable Economic Activity.

Table 1 Contents of the Module 1: Introduction to sustainability.

Module 1: **Introduction to sustainability**	Learning outcomes: Module 1 provide steps for understanding the context, challenges, constraints and opportunities for business and companies deriving from sustainability concerns. Module 1 deepens knowledge of interaction between the company and its environment. It also explores how companies can endure in the face of global change, ecosystem degradation and resource limitations.
	Contents: Perspectives on climate change, resource sufficiency, environmental management, sustainable development, sustainability and circular economy; The Driver-Pressure-State-Impact-Response Framework (DPSIR framework);

	Triple bottom line (TBL); Sustainable development goals (SDGs) ; Green growth; Circular economy

Possible materials:

Video https://www.bain.com/insights/jenny-davis-peccoud-transforming-business-for-a-sustainable-economy-video/

DPSIR Framework
https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=527151

Triple Bottom Line
https://mycourses.aalto.fi/pluginfile.php/825058/mod_folder/content/0/Wilson%20%282013%29.pdf?forcedownload=1

SDGs: https://www.un.org/sustainabledevelopment/

EU Circular Economy Package https://ec.europa.eu/environment/circular-economy/index_en.htm

EU Commission Green Growth and Circular Economy https://ec.europa.eu/environment/green-growth/index_en.htm

Circular economy https://www.ellenmacarthurfoundation.org/

Completing the picture: How the circular economy tackles climate change
https://www.ellenmacarthurfoundation.org/assets/downloads/EMF_COMPLETING_THE_PICTURE_V1.pdf

European Resource Efficiency Knowledge Centre EREK
https://www.resourceefficient.eu/en

Table 2 Contents of the Module 2: Regulatory frameworks and strategies.

Module 2: **Regulatory frameworks and strategies** Note: Module 2 must be designed country wise to meet the legislative frameworks and strategies.	Learning outcomes: Module 2 will tackle the sources, scope and purpose of environmental and climate change related legislation and action plans. Module 2 explains how companies can apply, assess and proactively take them into account in business strategies and day-to-day operations.
	Contents: European legal framework related to environment and climate; National legislation and regulations, plans and road maps; Regional and local regulations, plans and road maps

Possible materials:

Environment and climate change related legislation on European Union legislation https://eur-lex.europa.eu/summary/chapter/environment.html?root_default=SUM_1_CODED=20&locale=en

European Union / Environment
https://ec.europa.eu/info/energy-climate-change-environment_en

See national legislation, for example in Finland the Ministry of the Environment
https://www.ym.fi/en-US, water https://www.ymparisto.fi/en-US/Waters, waste
https://www.ymparisto.fi/en-US/Consumption_and_production/Waste_and_waste_management

Government report on the National Energy and Climate Strategy for 2030 http://julkaisut.valtioneuvosto.fi/handle/10024/79247

Table 3 Contents of the Module 3: Financial issues related to sustainability.

Module 3: **Financial issues related to sustainability** Note: Module 3 must be designed country wise to meet the availability of finance.	Learning outcomes: Module 3 introduces how green financial instruments can provide a means to generate sustainable activities with positive and durable externalities. Module 3 delivers knowledge about the public funding opportunities for sustainable economy investments, technology development and projects, e.g. energy efficiency, water treatment, minimizing waste and improving resource efficiency of materials. Module 3 also introduces costs of different measures and technological solutions, and how much money and resources they can save for business. Furthermore, because most of public funding is intended for investments, the conceptual differences between investments and running cost will be discussed.
	Contents: National finance for the implementation of sustainable management solutions; International funding opportunities for sustainability measures for SMEs; Sustainable management costs in accounting; General principles of European and national public funding, concepts of “cost” and “investment” and differences between national and European level if these exist.
Possible materials: Finance and funding https://europa.eu/youreurope/business/finance-funding/index_en.htm Access to finance https://europa.eu/youreurope/business/finance-funding/getting-funding/access-finance/index_en.htm Relevant financing types for SMEs, financial instruments, Surveys and data https://ec.europa.eu/growth/access-to-finance/data-surveys_en Access to finance https://europa.eu/youreurope/business/finance-funding/getting-funding/access-finance/ InvestEU programme https://europa.eu/rapid/press-release_MEMO-18-4010_en.htm Horizon 2020 https://ec.europa.eu/programmes/horizon2020/en Climate, energy and mobility cluster https://www.errin.eu/events/horizon-europe-climate-energy-mobility-cluster , https://www.era-learn.eu/documents/thematic_analysis_climate_energy_mobility.pdf EREK database of resource efficiency https://www.resourceefficient.eu/en/database Examples from Finland: Ministry of Economic Affairs and Employment of Finland: Enterprise funding options https://tem.fi/en/enterprise-financing , see Energy and investment aid for renewable energy and new energy technology https://tem.fi/en/energy-aid , see Discretionary government transfers for circular	

economy investment and development projects https://tem.fi/en/discretionary-government-transfers-for-circular-economy-investment-and-development-projects Business Finland: Energy aid, see https://www.businessfinland.fi/en/for-finnish-customers/services/funding/energy-aid/ Rules and concepts of sustainable financing https://europa.eu/european-union/about-eu/funding-grants_en Others Eurosif is the leading European association for the promotion and advancement of sustainable and responsible investment across Europe, for the benefit of its members.

Table 4 Contents of the Module 4: Business planning and circular economy.

<table>
<tr><td rowspan="2">Module 4:
Business planning and circular economy</td><td>Learning outcomes:
Module 4 clarifies how sustainability and circular economy actions align with vision, strategy and sustainability programmes. Special emphasis is laid on the changes technological innovation can generate in economic as well as ecological sustainability within business operations. Module 4 focuses also in assessment of technological and environmental impacts. It involves Driving Forces, Pressures, States, Impacts and Responses (DPSIR) and explores how this framework can be used by organisations to investigate environment-economy interactions.</td></tr>
<tr><td>Contents: Sustainability in development of business plans, strategy, vision, mission and operations; Circular economy; Sustainable and environmentally oriented innovation and technology management, environmental impacts mitigation; technological impact evaluation/assessment and forecast; Sustainability programmes</td></tr>
<tr><td colspan="2">Possible materials:

Sustainable business model Canvas https://www.case-ka.eu/wp/wp-content/uploads/2017/05/SustainableBusinessModelCanvas_highresolution.jpg

Developing business models with the Sustainable Business Canvas
https://uol.de/fileadmin/user_upload/wire/fachgebiete/innovation/en/download/Manual_Sustainable_Business_Canvas__EN.pdf

Circular economy playbook http://www.kasvuakiertotaloudesta.fi/

Running a business https://europa.eu/youreurope/business/running-business/index_en.htm

Product requirement, see https://europa.eu/youreurope/business/index_en.htm

EU innovations https://ec.europa.eu/growth/industry/innovation_en

Sustainable Business/The business plan
https://en.wikibooks.org/wiki/Sustainable_Business/The_business_plan</td></tr>
</table>

The most interesting companies in the circular economy in Finland
https://www.sitra.fi/en/projects/interesting-companies-circular-economy-finland/

Playbook for manufacturing industry
https://teknologiateollisuus.fi/sites/default/files/file_attachments/circular_economy_playbook_for_manufacturing_executive_summary.pdf

Business model development toolkit http://www.kasvuakiertotaloudesta.fi/wp-content/uploads/2018/09/CE2018_Business-model-development-toolkit_v1-0.pdf

Advancing circular business https://cris.vtt.fi/en/publications/advancing-circular-business

Water and circular economy https://emf-assets.s3.amazonaws.com/media/18/Water_and_circular_economy_Co.Project_White_paper.pdf?utm_source=All+Subscribers&utm_campaign=cf4857e675-EMAIL_CAMPAIGN_2017_07_13_COPY_01&utm_medium=email&utm_term=0_f507e40a10-cf4857e675-87351965

Good practices https://circulareconomy.europa.eu/platform/en/good-practices

A tool to discover, showcase and collaborate on green best practices
https://greenbestpractice.jrc.ec.europa.eu/

Video
https://www.youtube.com/watch?v=zCRKvDyyHmI

EREK database of resource efficiency https://www.resourceefficient.eu/en/database

Table 5 Contents of the Module 5: Management systems and tools.

<table>
<tr><td rowspan="2">Module 5:
Management systems and tools</td><td>Learning outcomes:
Module 5 gives an overview of the systems and tools used to evaluate and manage sustainability and it’s risks. The goal of sustainability risk management is to make this alignment efficient enough to sustain and grow a business while preserving the environment. As a part of sustainability risks, also the reputational risks, realized if promises of sustainability are failed, for ex. if company is caught of green washing or label swindling, must be taken into account. Module 5 explains the means to establish a strong culture of sustainability risk assessment and processes in the companies, including the management of reputational risks.</td></tr>
<tr><td>Contents: Quality and environmental management systems; Occupational health and safety systems and industry sector specific systems; Corporate social responsibility; Energy audits; Energy and resource efficiency; Carbon footprint; Water footprint; Ecological footprint; Eco-management and audit scheme; REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals); Eco-label; Life cycle assessment (analysis, LCA); Sustainability reporting; Reputational risks</td></tr>
</table>

Possible materials:

ISO standards https://www.iso.org/home.html

Sustainability and enterprise risk management
https://www.wbcsd.org/contentwbc/download/2548/31131

Safety and health in micro and small enterprises https://osha.europa.eu/en/themes/safety-and-health-micro-and-small-enterprises

Energy efficiency https://ec.europa.eu/energy/topics/energy-efficiency

European Resource Efficiency Knowledge Centre EREK https://www.resourceefficient.eu/en

Energy savings http://eedguidebook.energycoalition.eu/images/PDF/energy-audits.pdf

Carbon footprint https://www.carbonfootprint.com/

Water footprint https://waterfootprint.org/en/

Ecological footprint https://www.footprintnetwork.org/our-work/ecological-footprint/

Eco-Management and Audit Scheme https://ec.europa.eu/environment/emas/

Circular economy tools and instruments
https://ec.europa.eu/environment/green-growth/tools-instruments/index_en.htm

REACH https://europa.eu/youreurope/business/product-requirements/chemicals/registering-chemicals-reach/index_en.htm

EU Eco-label https://ec.europa.eu/environment/ecolabel/index_en.htm

Nordic Swan Ecolabel https://joutsenmerkki.fi/wp-content/uploads/2017/03/Motiva_60745-Circular-economy_nordic_ecol.pdf

LCA https://ecochain.com/

Corporate social responsibility ISO standard 26000 https://www.iso.org/standards.html

Sustainability reporting https://www.globalreporting.org/information/sustainability-reporting/Pages/default.aspx

Linking the SDGs and the GRI Standards
https://www.globalreporting.org/resourcelibrary/Mapping%20SDGs-GRI-Update%20March.pdf

Reputational risk management
https://www.raconteur.net/risk-management/reputational-risk-in-the-social-media-age
https://www2.deloitte.com/content/dam/Deloitte/ro/Documents/about-deloitte/ro-managing-reputation-risk-laura-toni.pdf
https://acfeinsights.squarespace.com/acfe-insights/2019/2/18/how-to-manage-reputational-risk

Table 6 Contents of the Module 6: Human resources, marketing and communication.

Module 6: **Human resources, marketing and communication**	Learning outcomes: Module 6 approaches the sustainability in HRM practices including three important point of views: managing people, the notion of sustainability and the importance of human resources for success. Module 6 gives also an overview of practices in corporate communications relating to sustainability with focus on reporting frameworks and responsible marketing communications.
	Contents: Human resources management principles; Responsibilities related to sustainability; Training and engaging employees for sustainability; Communicating sustainability issues to internal and external stakeholders; Links between sustainability and reputation of companies
Possible materials: DRIVING SUCCESS - Human resources and sustainable development http://wbcsdservers.org/wbcsdpublications/cd_files/datas/capacity_building/education/pdf/DrivingSuccess-HumanResources+SD.pdf EU human resources https://europa.eu/youreurope/business/human-resources/index_en.htm Dealing with customers https://europa.eu/youreurope/business/dealing-with-customers/index_en.htm Discovering ISO 26000 https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100258.pdf EU social responsibility https://ec.europa.eu/growth/industry/corporate-social-responsibility_en Sustainability reporting https://www.globalreporting.org/information/sustainability-reporting/Pages/default.aspx Sustainable HR https://www.mdpi.com/2071-1050/10/12/4798/pdf http://jem.pb.edu.pl/data/magazine/article/329/en/2.3_mazur.pdf http://www.ejournals.eu/ijcm/2017/Numer-16(3)/art/11306 (Note the bibliography after the abstract) Course approaching the topic: https://uclouvain.be/cours-2019-LLSMS2283.html	

Further material

Further material can be applied according to needs. Following links, e.g., are worth looking into:

- EU Circular Economy Package https://ec.europa.eu/environment/circular-economy/index_en.htm
- European Federation of Waste, Circular economy https://www.fead.be/circular-economy-intro
- EU Water Directive https://ec.europa.eu/environment/water/index_en.htm
- EU Waste https://ec.europa.eu/environment/waste/index.htm
- European Federation of Waste, Legislation https://www.fead.be/legislative-overview
- EU Commission Water https://ec.europa.eu/environment/water/index_en.htm
- EU Commission Waste https://ec.europa.eu/environment/waste/index.htm
- EIB water sector lending orientation: strengthening water security https://www.eib.org/attachments/strategies/eib_water_sector_lending_orientation_en.pdf
- Taxation https://europa.eu/youreurope/business/taxation/index_en.htm
- European Water Policy http://www.ewa-online.eu/european-water-policy.html
- EC Environment https://ec.europa.eu/environment/index_en.htm

- European Environment Agency https://www.eea.europa.eu/
- EU Science Hub; Water https://ec.europa.eu/jrc/en/research-topic/water
- EU Science Hub, Water Governance https://ec.europa.eu/jrc/en/research-topic/water-governance
- Foundation for Water Research http://www.fwr.org/
- Frontier Economics, Water https://www.frontier-economics.com/uk/en/sectors/water/
- IWA https://iwaponline.com/ebooks

1. The Economics of Waste and Waste Policy https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69500/pb13548-economic-principles-wr110613.pdf

- EU Science Hub: Waste and Circular Economy https://ec.europa.eu/jrc/en/research-topic/waste-and-recycling
- The World Bank, Water https://www.worldbank.org/en/topic/water
- The World Bank, Solid Waste https://www.worldbank.org/en/topic/urbandevelopment/brief/solid-waste-management
- The World Bank, Environment https://www.worldbank.org/en/topic/environment
- The World Bank, Public-Private-Partnerships https://www.worldbank.org/en/topic/publicprivatepartnerships
- How companies manage sustainability https://www.mckinsey.com/business-functions/sustainability/our-insights/how-companies-manage-sustainability-mckinsey-global-survey-results
- Sustainability Management in Practice: Organizational Change for Sustainability in Smaller Large-Sized Companies in Austria https://www.mdpi.com/2071-1050/11/3/572/pdf
- Legislation on the energy efficiency of buildings (Finland) https://www.ym.fi/en-US/Land_use_and_building/Legislation_and_instructions/Legislation_on_the_energy_efficiency_of_buildings
- European directive on the energy performance of buildings https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02010L0031-20181224
- EU SMEs https://ec.europa.eu/growth/smes_en
- Licenses https://www.thebalancesmb.com/business-licenses-and-permits-398925
- How to Increase Employee Engagement in Sustainability https://www.businessnewsdaily.com/10868-increase-employee-sustainability-engagement.html
- The World Business Council https://www.wbcsd.org/
- The Circular Economy a Powerful Force for Climate Mitigation https://media.sitra.fi/2018/05/04145239/material-economics-circular-economy.pdf
- STRENGTHENING CRAFTS & SMES FOR THE FUTURE OF THE EUROPEAN UNION https://smeunited.eu/admin/storage/smeunited/190701-sme2024.pdf

Modifications allowed

The proportional division and content of separate modules suggested above can be changed if local conditions or needs of participants could be responded better by other solutions.

Examinations and qualifications

Examinations will be coordinated and competences will be controlled according to local regulation and locally required qualifications. It is each local actor’s responsibility to take care that the admission requirements are fulfilled before the qualification application.

Attachment I: Teaching Material Module D Management of Sustainable Economic Activity

WWW&CE
Management of Sustainable Economic Activity

Satakunta University of Applied Sciences (SAMK), project partner number 11

Compiled by Dr Sirpa Sandelin and Dr Kari Lilja and Sanna Lindgren

18.11.2023

Introduction

Target group

- Bachelor's programme students at universities and universities of applied sciences.
- The curriculum is well suited to be applied as open university courses.

Work required

- The curriculum consists of modules totaling 6 – 9 ECTS credit units
  - 160 – 240 hours containing lectures, professional field visits, individual studies and assignments.

Contents of the curriculum

- Is possible to be modified according to countries own regulations and local requirements.
- Using innovative, problem-based and experiential educational approaches, students build on their professional experience to become experts, able to create and implement effective sustainable economy solutions.

Picture by Thaliesin from Pixabay.

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Introduction

The modules in the curriculum:

The overall objectives:

- Develop an overall image of the sustainable economic activities at SMEs and understand its basic principles.
- Understand the problems related to sustainable and greener business and how companies can resolve their activities to cope with the legal and regulatory, sustainable development and financial aspects.
- Become familiar with approaches that could promote the sustainable economy.
- Create a vision of practical activities that could be undertaken by different sectors to promote sustainable economy at SMEs.

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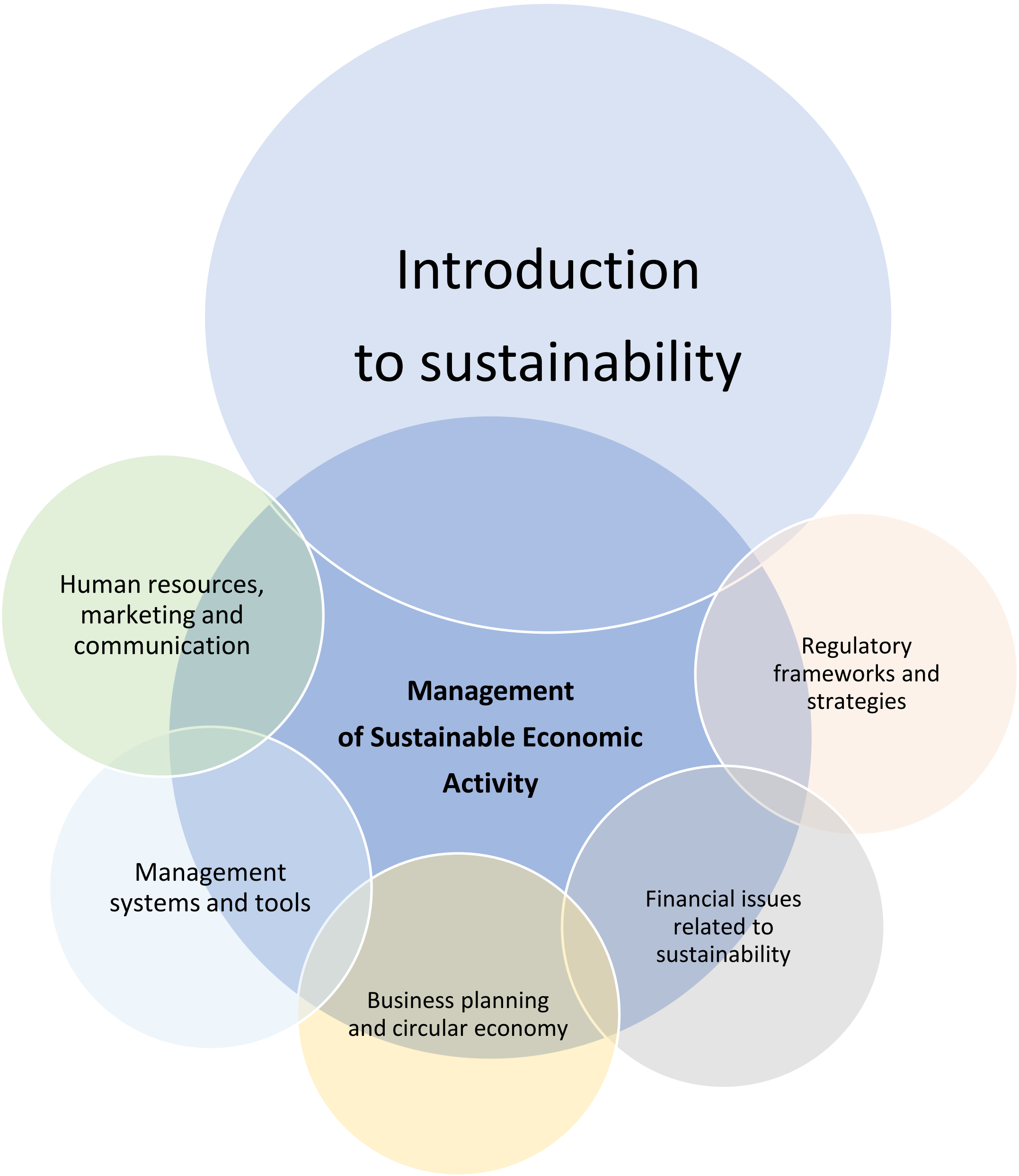

Module 1
Introduction to sustainability

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Module 1:
Common terms

Sustainability: Meeting the needs of the present without compromising the ability of future generations to meet their own needs defined by the UN's Brutland Comission.

Sustainable development: Development that provides economic, social and environmental benefits in the long-term having regard to the needs of current and future generations. Defined by the World Commission on Environment and Development in 1987 as: development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Greenhouse gas: A collective expression for those components of the atmosphere that influence the greenhouse effect, namely carbon dioxide, methane, nitrous oxides, ozone, CFCs and water vapor.

Greenhouse effect: The warming of the Earth's atmosphere caused by the increasing concentration of atmospheric gases, such as water vapor and carbon dioxide. These gases absorb radiation emitted by the Earth, thus slowing down the loss of radiant energy from the Earth back to space.

Climate change: The long-term fluctuations in temperature, precipitation, wind, and all other aspects of the Earth's climate.

Man-made climate change: Man-made climate change may be due to the greenhouse effect and other human activities. For example man-made aerosols produced from the Sulphur released from power stations can modify clouds. Changes in ozone levels in the stratosphere due to CFCs may influence climate.

Environmental degradation: Environmental degradation is a process through which the natural environment is compromised in some way, reducing biological diversity and the general health of the environment. This process can be entirely natural in origin, or it can be accelerated or caused by human activities.

Hazardous waste: Any waste or combination of wastes with the potential to damage human health, living organisms or the environment. Hazardous wastes usually require special handling and disposal procedures which are regulated by national and international laws.

Recycling: A resource recovery method involving the collection and treatment of a waste product for use as raw material in the manufacturing of the same or a similar product.

Waste recovery: The process of obtaining materials or energy resources from waste. [4]

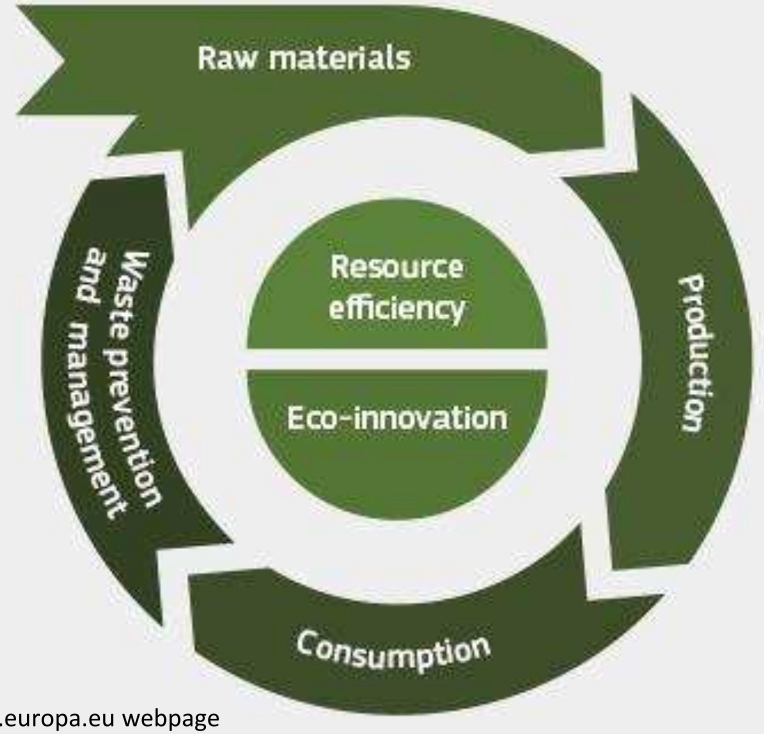
Module 1:
17 Sustainable development goals, SDG

Source: Unicef.org webpage

- 17 goals, 169 targets.
- Ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth
  - All while tackling climate change and working to preserve our oceans and forests.
- The circular economy is relevant to all sectors of the economy.
  - It has gained increasing prominence as a tool which presents solutions to some of the world's most pressing sustainable development challenges. [3]

Module 1:

Green growth and circular economy in EU



Source: ec.europa.eu webpage

- Raw materials
  - Natural resources should be used in the most efficient way and without depleting the planet's resources.
- Production
  - Transform environmental challenges into economic opportunities and provide a better deal for consumers.
- Consumption
  - The European Commission has developed policies and tools to help identify green products and reward sustainable production practices.
- Waste prevention and management
  - To become successful, circular economy requires a consistent implementation and enforcement of existing waste legislation across the EU.
- Resource efficiency
  - The Commission also aims to improve resource efficiency in more specific areas, such as in the building and food sectors, as well as in SMEs, and to turn waste into a resource.
- Eco-innovation
  - Investing in eco-innovation is essential to ensure Europe's global leadership in creating a resource efficient society. [2]

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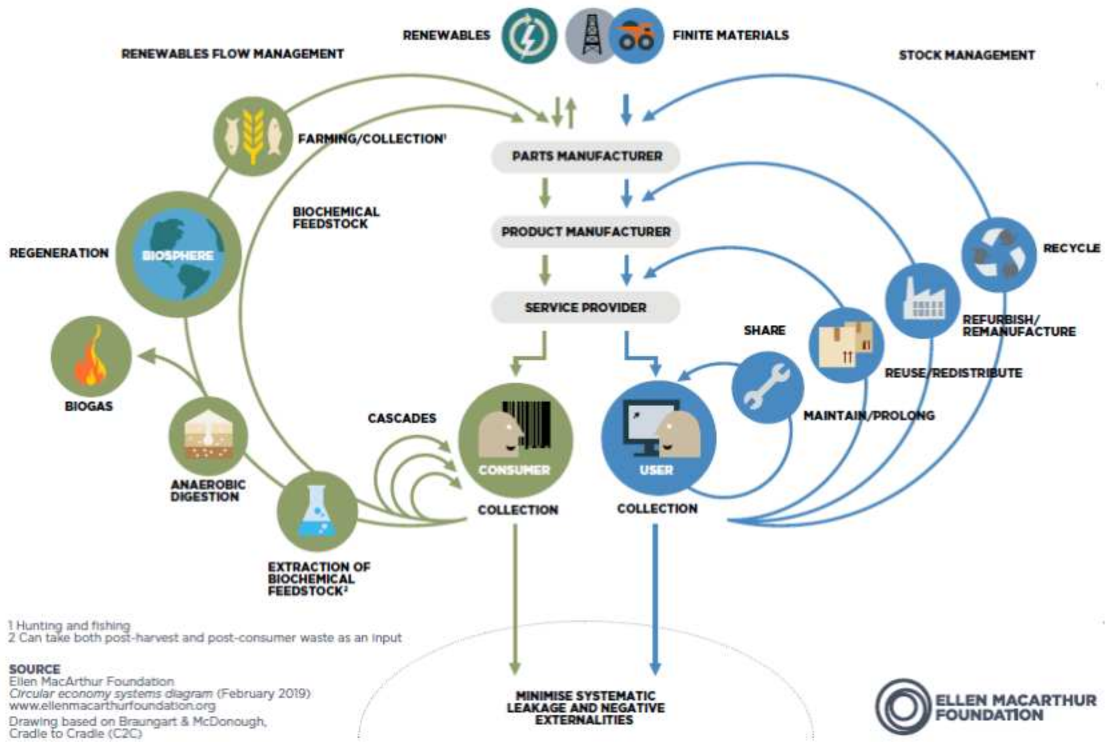
Module 1:

Circular economy system

- Design out waste and pollution to reduce GHG emissions across the value chain
    - Products designed for disassembly, modularity, repairability, flexibility or biodegradability, and to enable reuse, remanufacturing, refurbishment or regeneration.
    - Using of renewable, low carbon, or secondary materials as alternative inputs to new production. [1]
- Keep products and materials in use to retain the embodied energy in products and materials
    - Durability, reuse, remanufacturing, and recycling to keep products, components, and materials circulating in the economy. [1]
- Regenerate natural systems to sequester carbon in soil and products
    - Improving soil structure to enable better water storage and promoting more biologically active soils that generate their own soil fertility without the need for synthetic inputs. [1]

Video: [Sustainability through a circular economy | Maayke Damen | TEDxYouth@Maastricht]

FIGURE 3: CIRCULAR ECONOMY SYSTEM DIAGRAM



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Module 1:

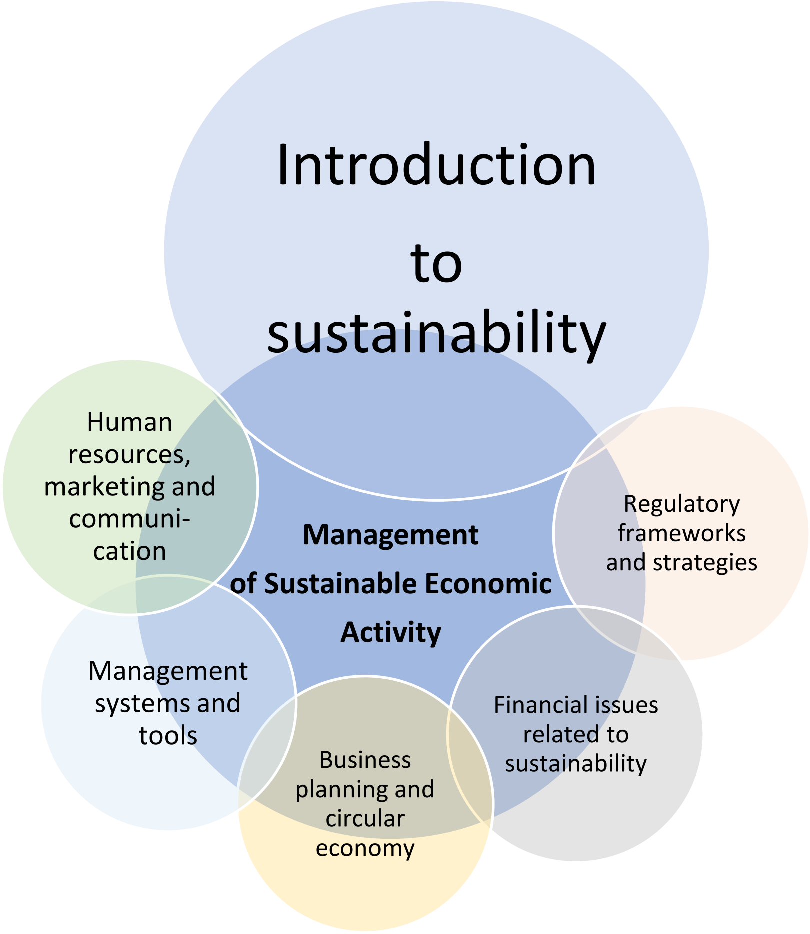
Sources

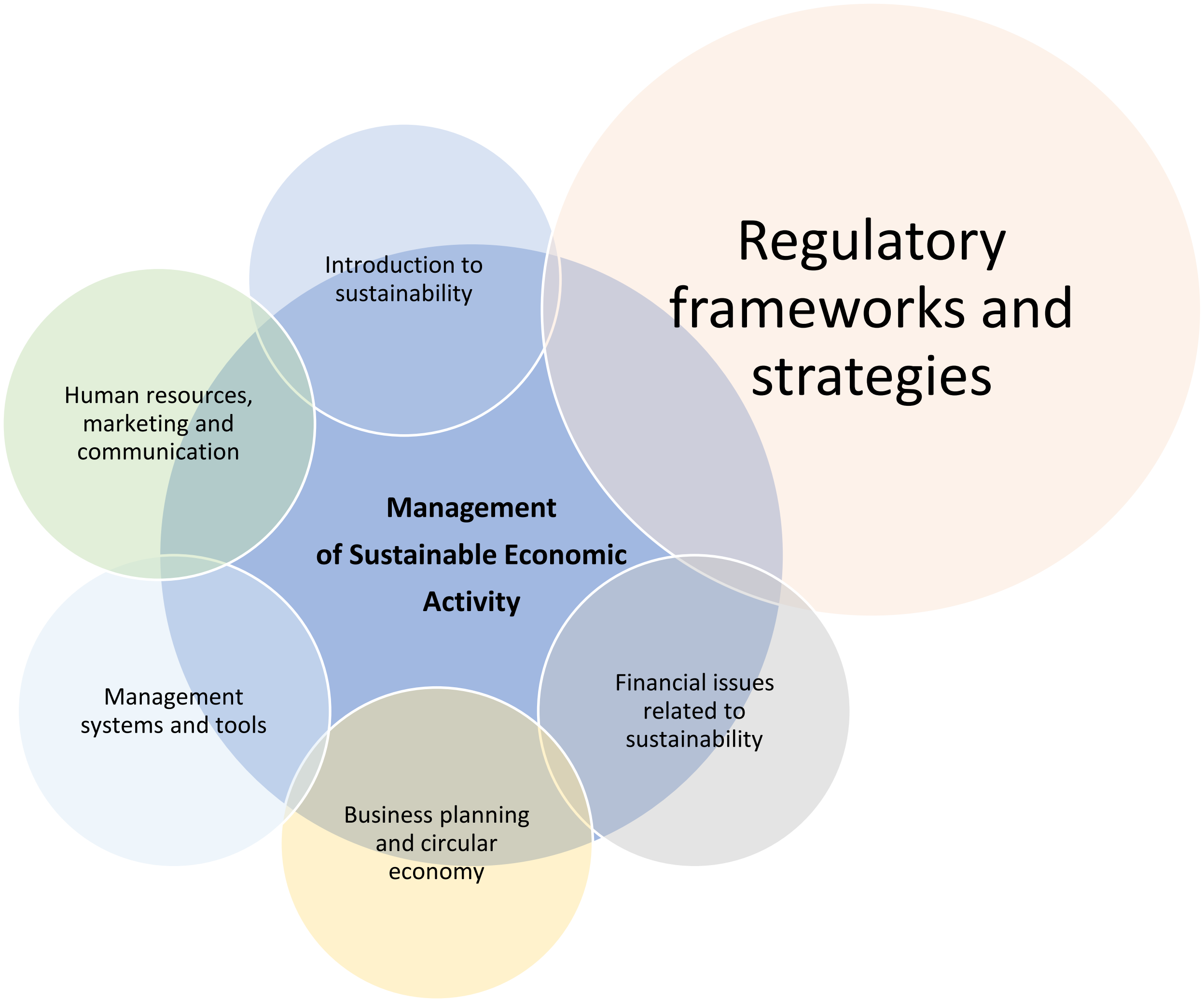
1. Ellen MacArthur Foundation, *Completing the Picture: How the Circular Economy Tackles Climate Change* (2019). Referred 19.5.2020. www.ellenmacarthurfoundation.org/publications

2. European Comission web page. 2020. Green growth and circular economy. Referred 19.5.2020 https://ec.europa.eu/environment/green-growth/index_en.htm

3. United nations web page. Sustainable development goals knowledge platform. 2020. Reffered 19.5.2020. https://sustainabledevelopment.un.org/

4. Gemet. 2020. General Multilingual Environmental Thesaurus. Referred 19.5.2020. https://www.eionet.europa.eu/gemet/en/concept/15154





Module 2

Regulatory frameworks and strategies

Module 2:
Common terms

Clean technology: Cleantech, industrial process which causes little or no pollution.

Circular economy: An economy in which the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste is minimized

Resource efficiency: Supply-side measures that tackle inefficiencies across supply chains; overuse of resources and waste when products and services are produced. Being more material resource efficient means using less to produce the same level of output

Biodiversity: An umbrella term to describe collectively the variety and variability of nature. It encompasses three basic levels of organization in living systems: the genetic, species, and ecosystem levels. Plant and animal species are the most commonly recognized units of biological diversity, thus public concern has been mainly devoted to conserving species diversity.

Pollution: The indirect or direct alteration of the biological, thermal, physical, or radioactive properties of any medium in such a way as to create a hazard or potential hazard to human health or to the health, safety or welfare of any living species.

Environmental friendly procurement: The process of obtaining products and services which are favorably disposed toward the environment.

Energy efficiency: Refers to actions to save fuels by better building design, the modification of production processes, better selection of road vehicles and transport policies, the adoption of district heating schemes in conjunction with electrical power generation, and the use of domestic insulation and double glazing in homes.

Economical-ecological efficiency: The competency in performance in business matters involving the relation between financial and environmental principles.

Environmental degradation: Environmental degradation is a process through which the natural environment is compromised in some way, reducing biological diversity and the general health of the environment. This process can be entirely natural in origin, or it can be accelerated or caused by human activities. Many international organizations recognize environmental degradation as one of the major threats facing the planet, since humans have only been given one Earth to work with, and if the environment becomes irreparably compromised, it could mean the end of human existence. [6]

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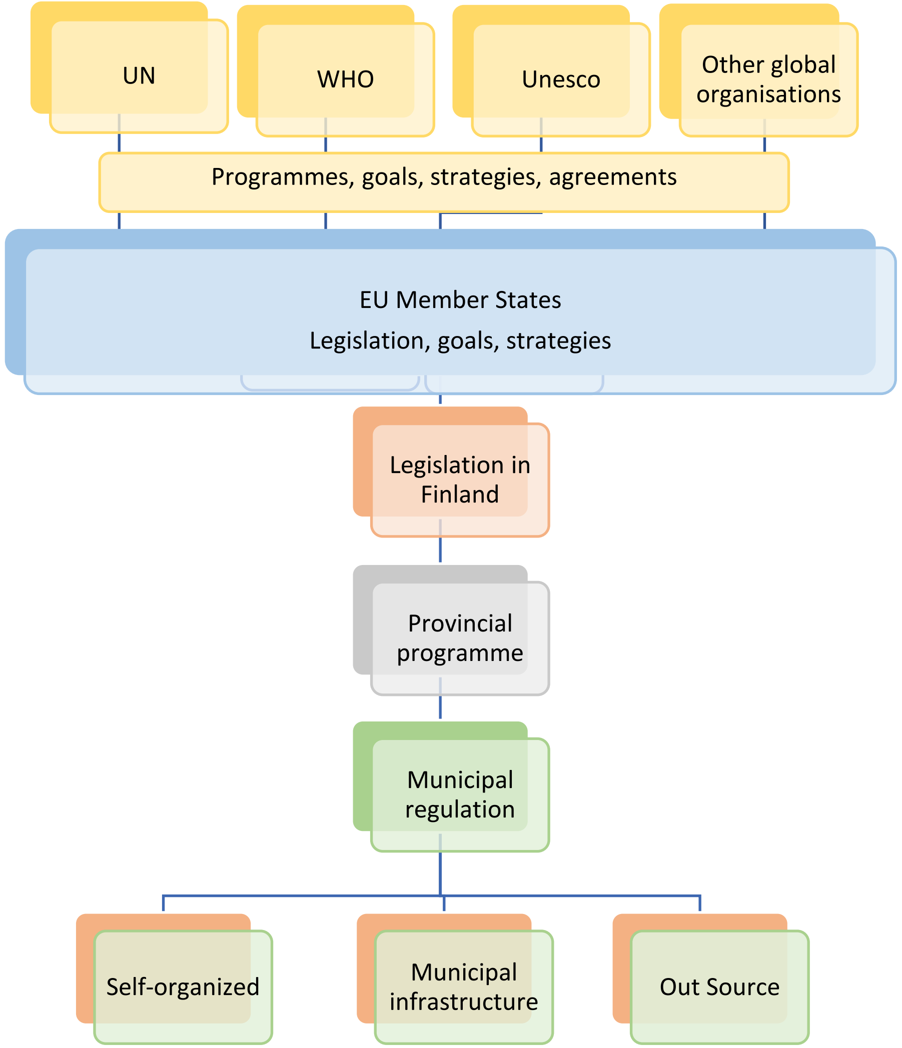
Module 2:

From international goals to local regulations

Sustainable development Continuous and guided social change, globally, regionally and locally, aimed at securing good living opportunities for current and future generations.

- **Ecological sustainability**
  - Preserving biodiversity and ecosystems functionality, as well as adapting human economic and material activities to natural sustainability in the long term.
- **Economic sustainability**
  - Economic sustainability is a measure of balanced growth in content and quality that is not based on long-term indebtedness or reserve disposal.
- **Social and cultural sustainability**
  - To guarantee the passage of conditions for prosperity from generation to generation.
  - Population growth, poverty, food and health care, gender equality, and the organization of education are global social sustainability challenges with implications for ecological and economic sustainability. [4]



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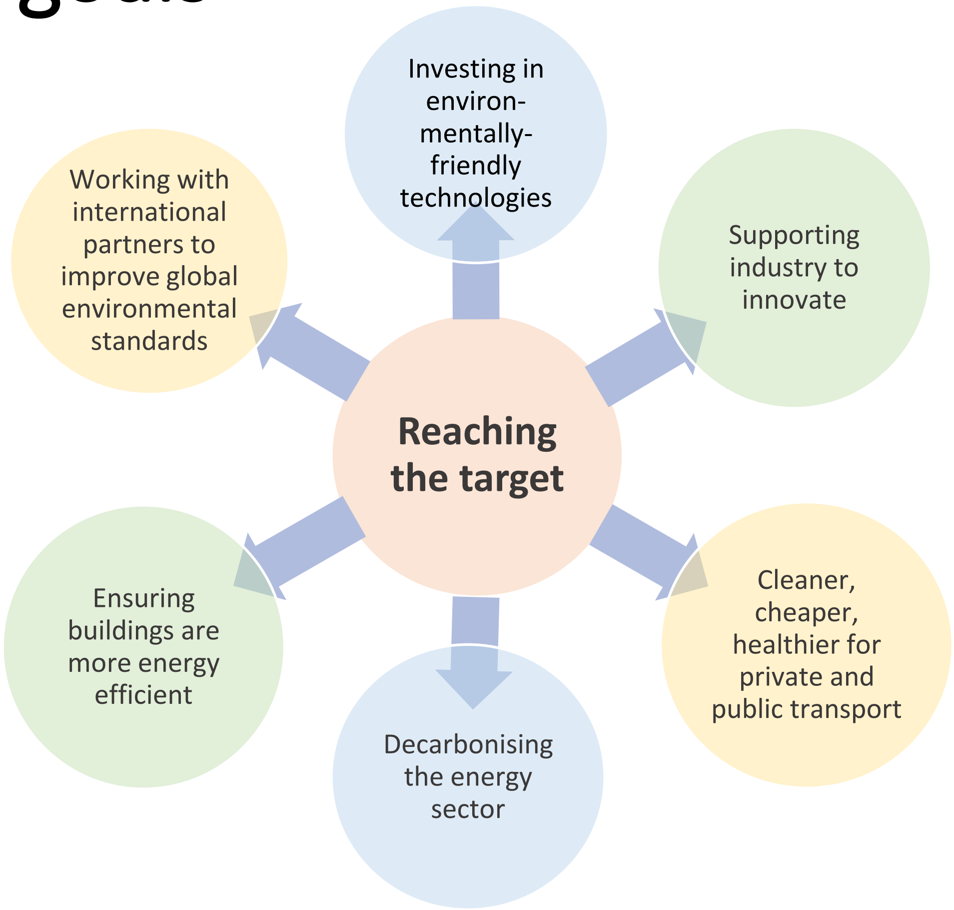
Module 2:

EU contribution to international goals

- The EU has committed to implement the Sustainable Development Goals both in its internal and external policies. The SDGs feature in all the
  - European Commission's 10 priorities.
- Sustainable development has been mainstreamed into EU policies and legislation
  - EU Sustainable Development Strategy
- The European Green Deal
  - provides a roadmap with actions
  - ➢ boost the efficient use of resources by moving to a clean, circular economy
  - ➢ restore biodiversity and cut pollution.
- The EU will be climate neutral in 2050. [3]



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Module 2:

Finland’s contribution to international and local goals

- Finland's national sustainable development work
  - Will be carried out in line with the policies of the UN, the EU, the Arctic Council and the Nordic Council of Ministers.
  - The conclusions reached at the UN's sustainable development follow-up conference (Rio+20) serve as an important framework for Finland's national sustainable development work.
- Society’s Commitment to Sustainability
  - Has been prepared by a wide-ranging strategy group. Through the commitment, the government and the administration, in collaboration with various societal actors, pledge to promote sustainable development in all their work and operations.
- Environmental Protection Act (527/2014)
  - This Act applies to industrial and other activities that cause or may result from environmental degradation. This Act also applies to activities where waste is generated, as well as to the treatment of waste.
  - The act gives the Parliament and the public better possibilities for participating in and influencing the planning of the Finnish climate change policy. [1,2,5,10]

Environmental Protection Decree (713/2014)

- Activities defined as authorised in environmental protection Act, procedure for application and notification of authorisation, organisation of supervision and monitoring

The Water Act (587/2011)

- Promote, organise and coordinate the use of water resources and the aquatic environment, so as to render it socially, economically and ecologically sustainable.

The Waste Act (646/2011)

- The purpose of this Act is to prevent the hazard and harm to human health and the environment posed by waste and waste management, to reduce the amount and harmfulness of waste, to promote the sustainable use of natural resources. Updated 1.1.2020.

The Climate Change Act (609/2015)

- Includes a medium-term and a long-term climate change policy plan. The long-term target reducing greenhouse gas emissions by a minimum of 80 per cent by 2050 compared to 1990 levels.

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Module 2:

Sustainability in business in Finland is not optional anymore

Chemical Regulation REACH

- The obligation to register applies to chemical manufacturers and importers. Importers refer to companies that import a substance from a non-EU country into the EU territory.
- It is necessary for the company to determine whether the chemicals it uses fall within the scope of the Regulation.

Environ-mental permits

- For any measure that may alter or spoil land, water or air, a permit is required. Permits are needed by private citizens and businesses alike.

Waste-water treatment

- According to the Health Protection Act (763/1994), the management and purification of wastewater must be done in such a way that there is no harm to health from wastewater. According to the Health Protection Regulation (1280/1994), sewer must not cause deterioration of the health quality of economic water, bathing or soil. The dry toilet and compost should also be built so that there is no odor or health harm due to soil or domestic water.
- Environmental Protection Act gives rams to sewage purification
- Economic wastewater regulation specifying requirements
- Municipal regulations take into account local conditions

[1,2,5,10]

Waste management

The waste holder shall organise the waste management. The property holder shall arrange waste management if the waste holder does not fulfil his duty or is not pursued, and if the holder of the property has allowed the waste producing activity on the property or the waste to be brought to the property.

- Non-problem wastes arise and assimilated in housing in terms of characteristics, composition and quantity, for which the organisation of waste management is the responsibility of the municipality.
- Business wastes for which the organisation of waste management is in principle the responsibility of the waste producing company, with the exceptions mentioned above.
- Producer liability includes waste for which the manufacturers, importers and packers of the products concerned are responsible for the organisation of waste management.

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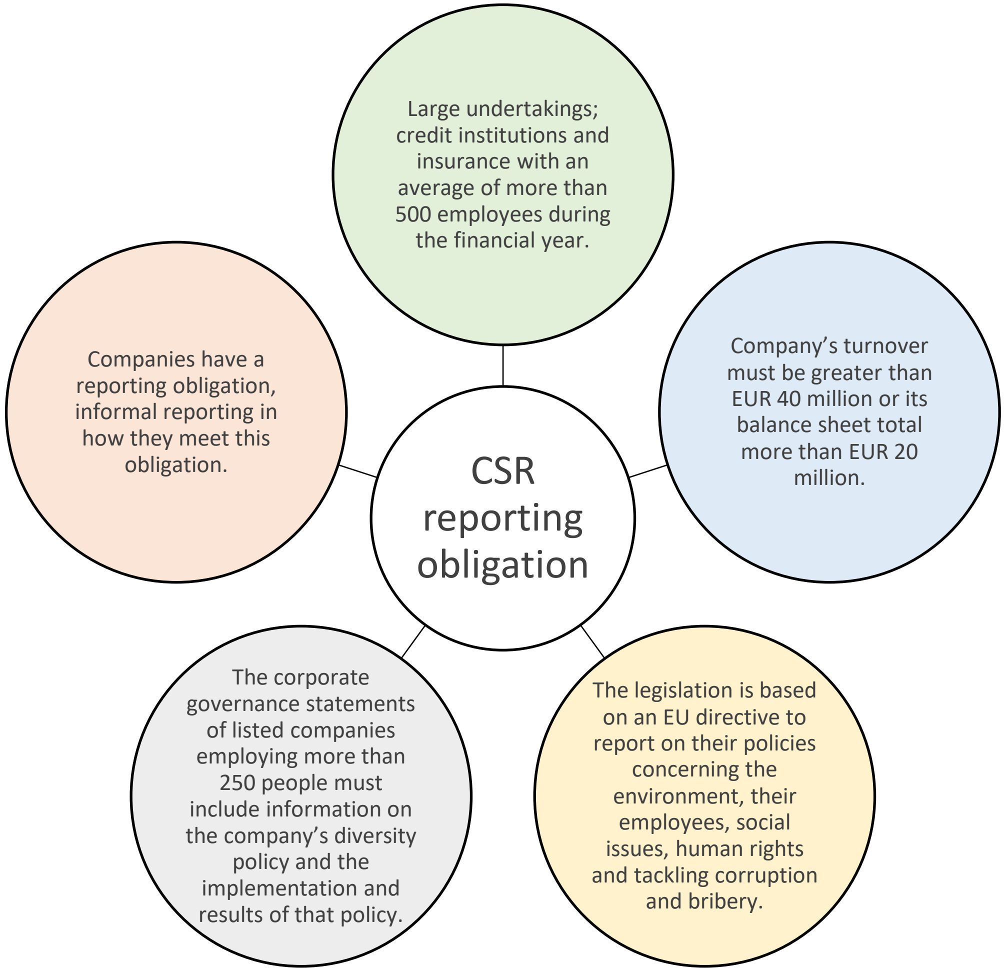
Module 2:

Who has responsibility



Corporate responsibility

- The Ministry of Economic Affairs and Employment creates the conditions for economically, socially and ecologically sustainable growth.
- long traditions in compliance with labor legislation, occupational safety and health legislation and environmental legislation. [9]

Module 2:

Sustainability in business in Finland

Lassila & Tikanoja Oyj

- Sustainability is an integral aspect of L&T’s strategy, business operations and day-to-day work.
- L&T’s management system has been certified in accordance with the following standards: ISO 9001 (quality), ISO 14001 (environment)
- L&T’s corporate responsibility are based on the company’s defined policies, the key stakeholders’ expectations, and on the value created for the stakeholders, the society, the environment and the climate.
- As particular focal areas for our corporate responsibility work, L&T have selected seven of the UN Sustainable Development Goals (SDGs) which we are committed to promoting over the coming years. [8]

7 AFFORDABLE AND CLEAN ENERGY | 12 RESPONSIBLE CONSUMPTION AND PRODUCTION | 13 CLIMATE ACTION

Circular economy and climate change mitigation

- Increasing the carbon handprint of operations faster than net sales
- Reducing carbon footprint by 50% by 2030

8 DECENT WORK AND ECONOMIC GROWTH | 10 REDUCED INEQUALITIES

A healthy, diverse and productive workplace community

- Increasing the employee promoter score to 80%

11 SUSTAINABLE CITIES AND COMMUNITIES | 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Sustainable industry and cities

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Module 2:

Sustainability in business in Finland

Paulig Group

Paulig sustainability Approach 2030 is based on United Nations Sustainable Development Goals and comprises three focus areas and ambitions:

- Fair and inclusive way of working
  - aim is to be a fair and inclusive partner and employer throughout our value chain. All our coffee is already 100% from verified sustainable sources and we aim to extend this work to cover also other raw materials. The goal is that all of our raw materials from high-risk areas come from sustainable sources verified by external parties by 2030.
- Health & wellbeing of people and planet
  - ambition is that, by 2030, 70% of our products and services enable health and wellbeing of people and the planet. Our product portfolio is almost 100% plant-based today, and we will continue to develop our products in a healthier direction as well as innovate new products which are good for both people and the planet. We also aim to systematically reduce the carbon footprint of our products as well as inspire consumers to opt for sustainable choices.
- Climate action & circularity
  - Paulig is among the forerunner companies in the food industry, and we have committed to set science-based climate targets in accordance with the Paris agreement to limit climate warming to 1.5 Celsius. Our ambition is that by 2030, we will reduce the greenhouse gas emissions from our own operations by 80% and our value chain by 50%. The aim is to get the targets validated by the Science Based Initiative in 2020. [11]

8 DECENT WORK AND ECONOMIC GROWTH

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Ensure sustainable consumption and production patterns

13 CLIMATE ACTION

Take urgent action to combat climate change and its impacts

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Module 2:

Sustainability in business in Finland

Honkajoki Oy (Ltd)

- Honkajoki Oy (ltd) is Finland's leading processor of animal by-products.
  - Animal by-products into high-quality, clean and safe raw materials for our customers in various industrial sectors.
  - For example, animal food, fertilizers, cosmetics, pharmaceuticals, and fuels
  - Actions are made to prevent the spread of pathogens, promote the sustainable use of natural resources and minimise the environmental impact of our operations.
- Honkajoki Ltd's concept combines responsible circular economy thinking, agroecology principles and technological innovations.
  - Responsibility is the carrying power of operations.
  - Committed to promote the same sustainable model also in developing countries.
  - Actively seeking new, more sustainable approaches, e.g. by actively cooperating with various research institutes. [7]

Source: Honkajoki web page

Module 2:

Sustainability in SMEs in Finland

MVR

- Construction/reconstruction
- 39 employees
- No mention of sustainable actions on website

Kone- ja vihertyö Haapa-aho

- Machine contracting/earthmoving
- 1-4 employees
- No mention of sustainable actions on website

Vesi & Lämpö Juhola

- HVAC Design, HVAC Contracting and HVAC and Oil Burner Service
- 12 employees
- No mention of sustainable actions on website

Biolan Group

- Manufacture of garden, house plant and ecological housing products
- 132 employees
- Biolan Group has a certified quality and environmental system.
  - The ISO 9001 quality system
  - ISO 14001 environmental system
  - The certificate covers the activities of Biolan Oy, Favorit Product Oy, Novarbo Oy, Biolan Ekoasuminen Oy and Biolan Baltic OÜ in Estonia.
  - No mention of SDGs on website

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Module 2:

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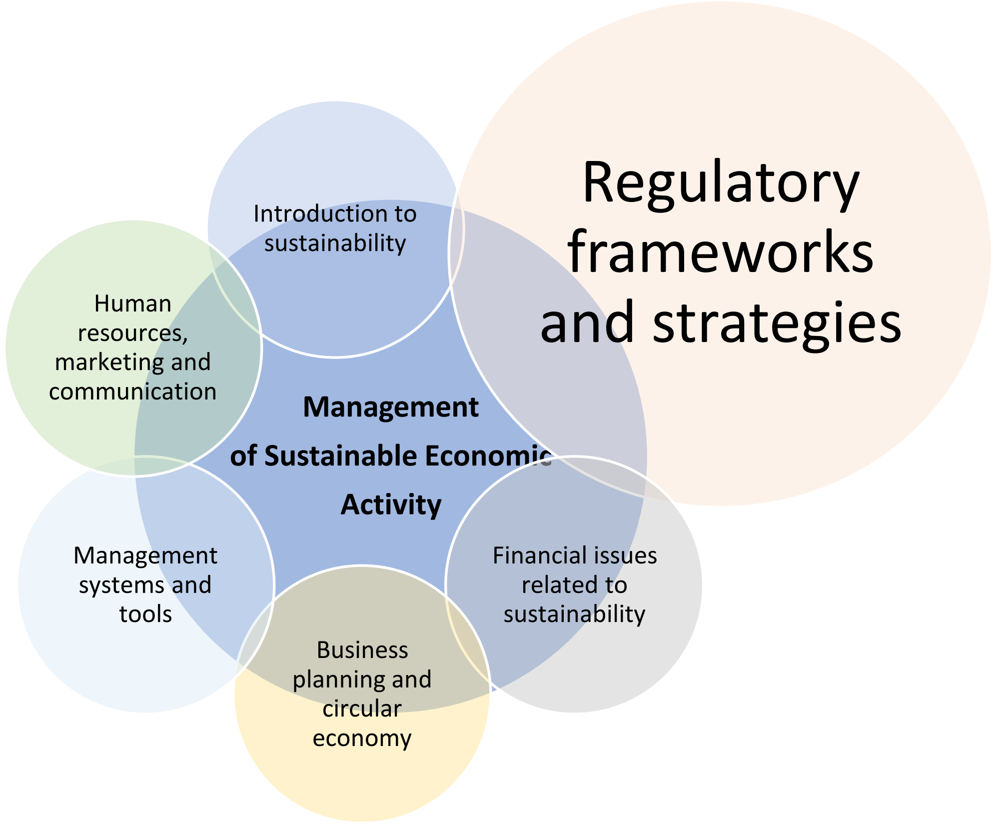

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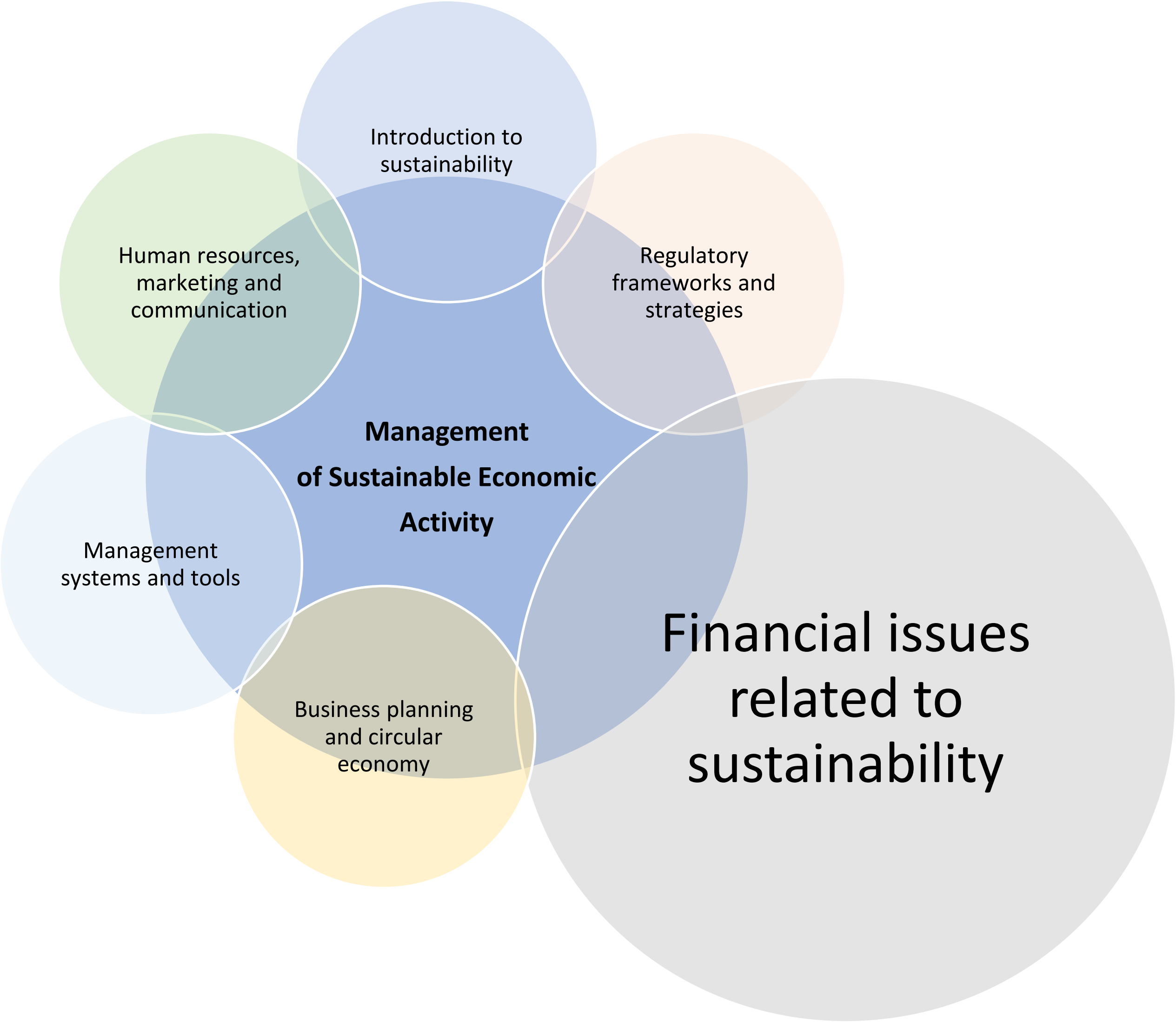

Module 3

Financial issues related to sustainability

Module 3:
Common terms

Renewable energy: Energy derived from natural processes (e.g. sunlight and wind) that are replenished at a faster rate than they are consumed. Solar, wind, geothermal, hydro, and some forms of biomass are common sources of renewable energy.

Microfinance: Microfinance, also called microcredit, is a type of banking service provided to unemployed or low-income individuals or groups who otherwise would have no other access to financial services.

Venture capital: Venture capital is a form of private equity and a type of financing that investors provide to startup companies and small businesses that are believed to have long-term growth potential.

Low-carbon economy: economy based on low carbon power sources that has a minimal output of greenhouse gas emissions into the environment biosphere, but specifically refers to the greenhouse gas carbon dioxide

Biofuel: A gaseous, liquid, or solid fuel that contains an energy content derived from a biological source. The organic matter that makes up living organisms provides a potential source of trapped energy that is beginning to be exploited to supply the ever-increasing energy demand around the world. An example of a biofuel is rapeseed oil, which can be used in place of diesel fuel in modified engines.

Alternative technology: Technology that, as an alternative to resource-intensive and wasteful industry, aims to utilize resources sparingly, with minimum damage to the environment, at affordable cost and with a possible degree of control over the processes.

Conventional energy: Power provided by traditional means such as coal, wood, gas, etc., as opposed to alternative energy sources such as solar power, tidal power, wind power, etc.

Energy analyses: Energy analysis is used to predict the monthly energy consumption and bills, predict the annual energy cost, annual CO2 emissions, compare and contrast different efficiency options, determine life cycle payback on various options [2, 7, 8]

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Module 3:
Who is eligible for EU funding?

- EU Funding is available for all types of companies of any size and sector including entrepreneurs, start-ups, micro companies, small and medium-sized enterprises, and larger businesses. A wide range of financing is available: business loans, microfinance, guarantees and venture capital. [6]

Direct funding

Grants

- Grants are given to specific projects that relate to EU policies, usually following a public announcement known as a **call for proposals**.

Contracts

- Contracts are issued by EU institutions to buy services, goods or works that they need for their operations – such as studies, training, conference organisation or IT equipment.

Indirect funding

Funds

- Indirect funding is managed by national and regional authorities and comprises of nearly 80% of the EU budget, mainly through 5 big funds that come under the umbrella of the European Structural and Investment Funds.

EU funds

- **COSME Programme**
- **InnovFin Programme (Horizon 2020)**
- **Creative Europe**
- **Programme for Employment and Social Innovation (EaSI)**
- **European Structural and Investment Funds (ESI funds)**
- **European Investment Bank**
- **European Investment Fund**

Module 3:

EU funding for ECO-innovation

Horizon 2020	LIFE	COSME	ESIF
To who • resource efficiency • water • waste • key enabling technologies • SMEs What for • innovation action • SME instrument • public procurement of innovation • pre-commercial procurement	To who • environmental technologies • resource efficiency • industry & production • waste • water What for • demonstration & pilot • capacity building • best practice • information, awareness & dissemination	To who • improving access to finance and markets • improving conditions for competitiveness & sustainability • promoting entrepreneurship What for • Loan Guarantee Facility (LGF) • Equity Facility for Growth (EFG) • access to finance for SMEs	To who • regional development • research & innovation • SME competitiveness • low carbon economy • environment & resource efficiency What for • EU Regional Development Fund • EU Social Fund • Cohesion Fund • EU Agricultural Fund for Rural Development • EU Maritime and Fisheries Fund

[4]

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Module 3:

Enterprise financing in Finland

- The Ministry of Economic Affairs and Employment encourages companies to renew and pursue sustainability
- MEAE is responsible for ensuring that domestic state financing and export financing function as well as possible, taking into account the financing needs of companies at different stages of development both national and international regulations governing business financing. [1]

- Loans, guarantees and credits
- Venture capital investment
- European Fund for Stratetegic Investments (EFSI)
- Enterprise developmental support and start-up grants
- Regional aid
- Supporting internationalisation
- Research, developement and innovation funding
- Energy and investment aid
- General criteria for business subsidies on national level

Module 3:

Research, development and innovation funding

- Is intended to encourage businesses, research organizations and public service providers in RDI activity that promotes courageous renewal of industry and society as well as economic growth.
- The Ministry of Economic Affairs and Employment is responsible for controlling Business Finland and preparing legislation that concern its activities and funding. [1]

Module 3:
Energy and investment aid

Energy aid can be granted to investment projects and studies that	Investments in renewable energy use that are eligible for support	Investments in energy savings and energy efficiency that are eligible for support	Studies concerning energy saving, more efficient energy use and the use of renewable energy
• promote the production or use of renewable energy. • promote energy savings or increase the efficiency of energy generation or use. • promote the transition towards a low-carbon energy system.	• small-scale electricity and heat production projects. • projects producing biofuels for transportation. • demonstration projects for new technology.	• projects involving conventional technology for beneficiaries that have signed an energy efficiency agreement. • demonstration projects for new technology. • ESCO projects.	• energy audits. • energy analyses.

[1]

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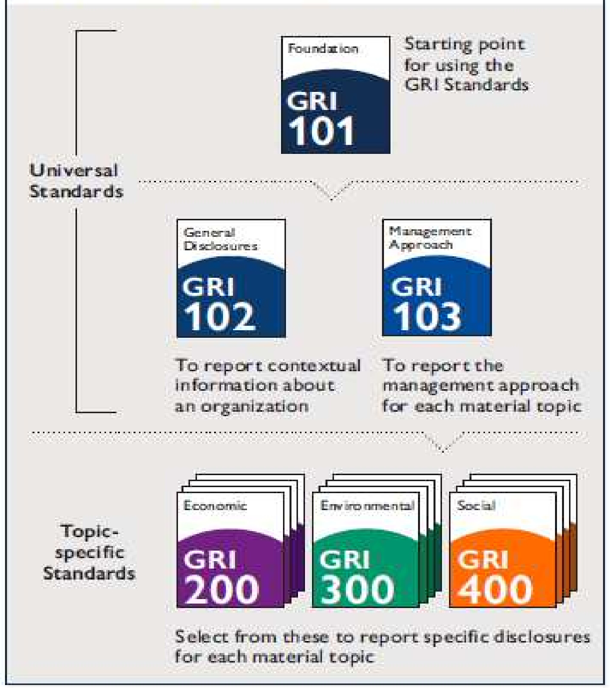
Module 3:

The GRI Sustainability Reporting Standards (GRI Standards)

Figure 1
Overview of the set of GRI Standards



- Designed to be used by organizations to report about their impacts on the economy, the environment, and/or society.
- The practice of disclosing sustainability information inspires accountability, helps identify and manage risks, and enables organizations to seize new opportunities.
- Reporting with the GRI Standards supports companies, public and private, large and small, protect the environment and improve society, while at the same time thriving economically by improving governance and stakeholder relations, enhancing reputations and building trust. [3]

Module 3:
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Module 4

Business planning and circular economy

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Module 4:
Common terms

- ***Economical sustainability:*** The value of products and materials is maintained for as long as possible, bringing major economic benefits.
- ***Renewable resource:*** Resources capable of being continuously renewed or replaced through such processes as organic reproduction and cultivation such as those practiced in agriculture, animal husbandry, forestry and fisheries.
- ***Recyclable:*** Waste that can be transformed into new products.
- ***Energy efficient solutions:*** Actions to save fuels by better building design, the modification of production processes, better selection of road vehicles and transport policies
- ***Carbon economy:*** Economy based on low carbon power sources that therefore has a minimal output of greenhouse gas emissions into the environment biosphere, but specifically refers to the greenhouse gas carbon dioxide.
- ***Bioeconomy:*** The bioeconomy comprises those parts of the economy that use renewable biological resources from land and sea – such as crops, forests, fish, animals and micro-organisms – to produce food, materials and energy.
- ***Biobased product:*** A product which is made wholly or partly derived from materials of biological origin, excluding materials embedded in geological formations and/or fossilised.
- ***Ecological foorprint:*** Area of productive land and water ecosystems required to produce the resources that the population consumes and assimilate the wastes that the population produces, wherever on Earth the land and water is located
- ***Carbon handprint:*** A method to evaluate actions taken to mitigate environmental impact and quantify the positive impacts of a product during its lifecycle. [2, 3, 5]

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Module 4:

Why commit to sustainable action?

Why circular economy? Why now?

- Circular economy is relevant as it offers companies the opportunity to turn inefficiencies in linear value chains into business value
- Utilizing underutilized capacities, premature product lives, unsustainable materials, wasted end-of-life value and unexploited customer engagements
- Sales organisation focus on selling functionality of product rather than the customer problem – engage customers throughout the product life-cycle to offer services and add-on sales [8]

Video: [Jenny Davis-Peccoud: Transforming Business for a Sustainable Economy]()

Picture by Alexas_Fotos from Pixabay.

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Module 4:

Why commit to sustainable action?

CIRCULAR SUPPLY CHAIN	Build to last	Reduce production costs	Wärtsilä achieved **45% reduction in production development expenses**, 44% lower cost for ongoing product care and 50% reduction in assembly time using modular engine architecture
		Increase market share	DESSO **increased market share by 8%** and EBIT from 1% to 9.2% in four years by producing carpets that are easy to disassemble by eliminating toxics and number of materials in carpets
	Circular Supplies	Reduce utility costs	Ecovative **reduced energy costs by 75%** compared to industry averages by developing home compostable bio-plastics based on mycelium
SHARING PLATFORM	Share	Reduce warehousing costs	FLEXE helps companies **lower warehousing costs by 20-70%** by providing a sharing service that helps optimise usage
PRODUCT LIFE EXTENSION	Repair & Maintain	Reduce operating expenses	Nokia **reduced OPEX by 20%** by maximising value of aging equipment through modernisation of logistics, warehousing and dismantling
	Resell	Participate in secondary sales	**~50% revenue increase** from selling 2nd hand products
	Remanufacture	Increase gross profits	Caterpillar achieved **50% higher gross profits** from selling remanufactured products at a 20% discount rate
RECOVERY & RECYCLING	Recycle / upcycle	Generate revenue	GM's by-product recycling and reuse initiatives have not only saved money, but also **generated $1 billion in new revenue** for the automaker
	Return	Reduce input material costs	Ford is **cutting about 20% from the cost** of swapping aluminium for steel in F-150 body panels by sorting, cleaning and returning scrap to the same mills that supply it with metal sheet
PRODUCT AS A SERVICE	Product as a Service	Increase revenues	Michelin sells tires-as-a-service with **a revenue potential of 3bn€ in 10 years**

Source: Sitra, Circular Economy Playbook for Finnish SMEs

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Module 4

Sustainability and circular economy actions

Circular economy cannot be achieved by one company alone, and collaboration between traditional and new actors in the ecosystem will be required to close the loops efficiently

- Owning vs. licensing
- Rethink
- Redesing
- Renewable and Recyclable
- Digital platforms
- Maintenance, repair, refurbisment
- Material and energy efficient solutions
- Data, artificial intelligence and robotics [8]

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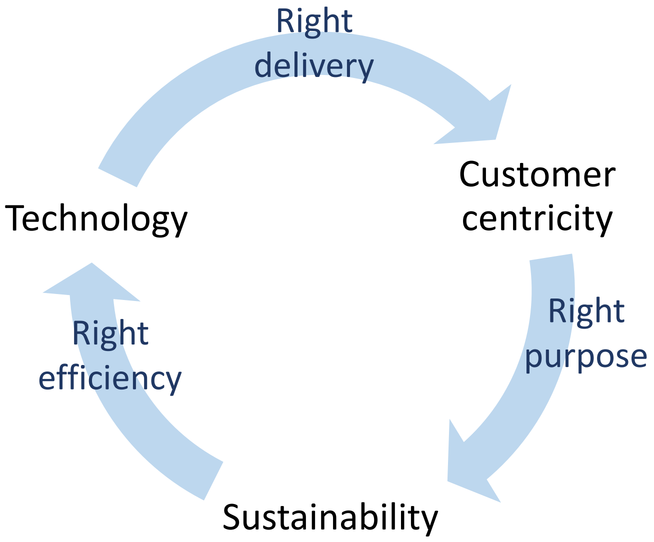
Module 4

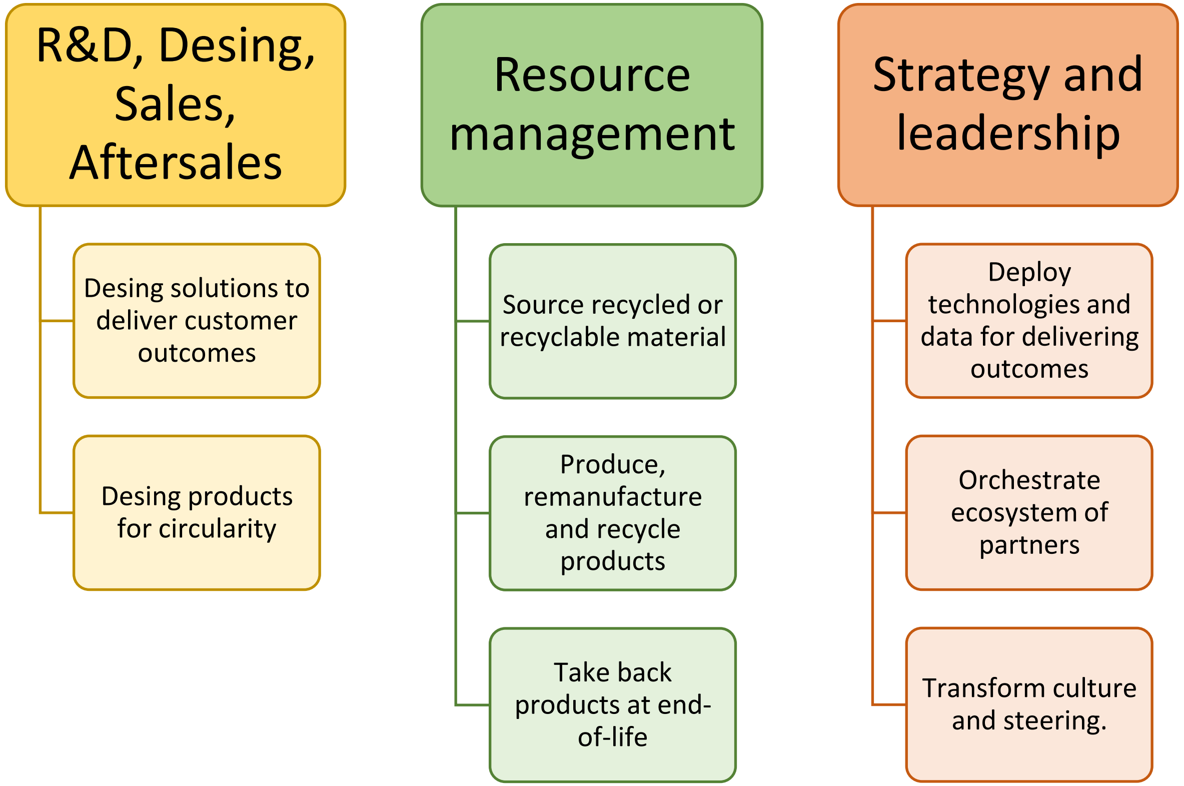
Technological innovations

Successful transition towards circular economy is critical to innovation and continued growth.

In a circular economy, the added value of the entire value chain is created by new business models. [6]



Three drivers of circular economy



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Module 4

Technological innovations

Unsustainable materials:

- Volvo uses **one third recycled materials** in new trucks and designs them for recycling so that 90% can be recycled
- Wärtsilä applies a **modular engine design** to enable increased commonality and backward compatibility of parts

Underutilised capacities:

- Caterpillar acquired Yardclub, a **platform facilitating equipment sharing .**

Premature product lives:

- Bosch operates **remanufacturing chains** for high-quality components to ensure a high fraction stay in its loops
- The Schneider Electric Circuit Breaker Retrofit-program **modernises and updates** electrical distribution centers
- Konecranes provides a Lifecycle Care-program that includes consultation services, **modernisation & maintenance**

Wasted end-of-life value:

- GM recycles 84% of its worldwide manufacturing waste and has **111 landfill-free facilities**
- Maersk introduced a Cradle-to-Cradle Passport for vessels, a **database listing the material composition** of the main parts of the ship enabling better recycling of materials and parts

Unexploited customer engagements:

- Michelin offers **tire as a service** (pay per mile) and sensor-based data analytics for predictive maintenance
- Philips has several contracts signed for providing **light as a service** on a pay-per-lux basis or monthly subscription

[8]

Find more examples of sustainable actions in finnish business here.

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Module 4

Actions for the sustainable environment is profitable business

- The Bio and Circular Finland programme supports companies in internationalisation in a variety of ways.
    - Support the development of competitive bio- and circular economic solutions and ecosystems
    - Advice ahead on applying for EU funding
    - The main goal is to grow exports of bio- and circular economy solutions.
- Sustainable solutions and business models bring competitive advantage in international markets
    - Strengthen the company's brand and
    - Open up new opportunities for success.
- Global demand for bio-based and circular economy solutions is growing strongly. Finland is already known for its bio-based expertise and innovative solutions. [1]

Examples of ecosystems launched in the program

CARBO – Towards a carbon neutral milk chain	• The goal is to reduce the environmental impacts of the Finnish milk and meat chain using research data, new innovations and farm pilots.
ForBest - Environmentally friendly textiles from wood	• Fortum is launching a significant development project that aims to manufacture high-value products from agro residues and woody biomass to replace the use of fossil and other environmentally taxing raw materials.
UPM building a new ecosystem for wood-based biomedical solutions	• Plant-based biocompatible materials can accelerate market breakthrough for several new applications and technologies. In addition to cell culture, wood-based materials can be used e.g. in clinical applications and diagnostics.
Solving the sustainability gap reusing metals	• The project focuses on residues caused by metallurgical processes: mainly slags, sludges, scales, waste heat and process waters.
Environmental handprint tells of positive environmental actions	• The purpose of measuring carbon handprint is to calculate the positive climate impacts of a product provided to customers.

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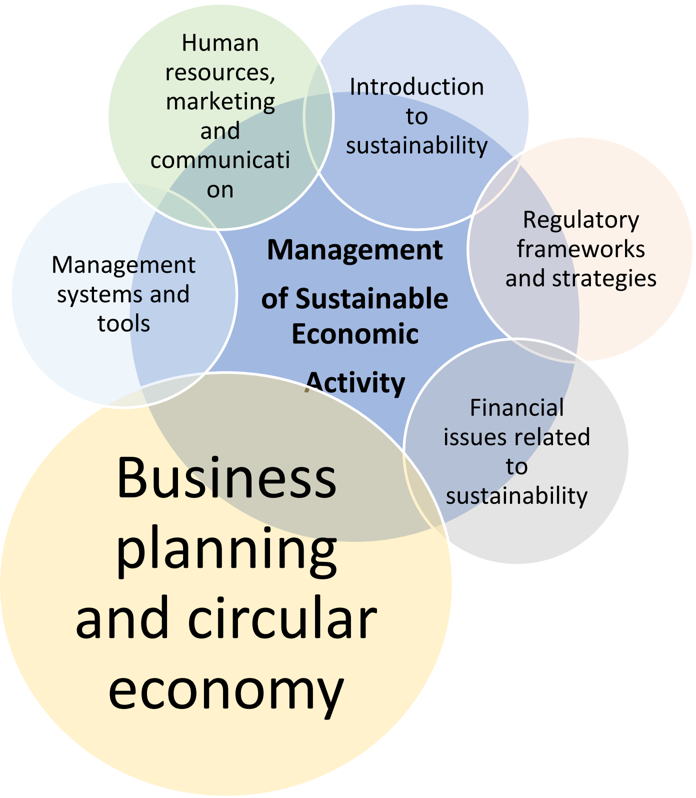
Module 4:
Sources



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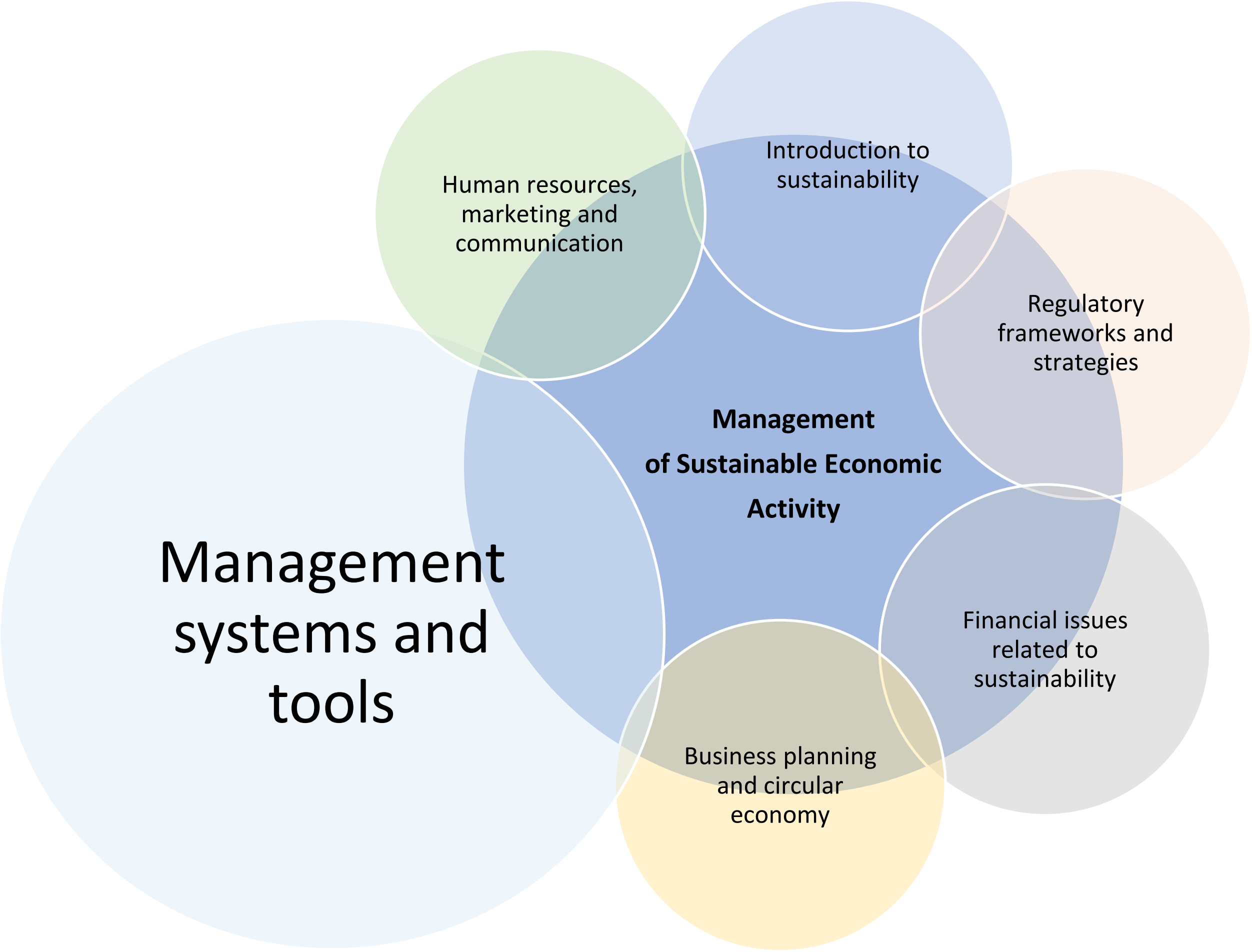

Module 5

Management systems and tools

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Module 5:

Common terms

- ***Label swindling:*** to get money dishonestly from someone by deceiving or cheating them with fake labels
- ***Cradle-to-gate:*** Cradle-to-gate only assesses a product until it leaves the factory gates, before it is transported to the consumer. This means cutting out the use and disposal phase. *Cradle-to-gate* analysis can significantly reduce the complexity of an LCA and thus create insights faster, especially about internal processes. Cradle-to-gate assessments are often used for environmental product declarations (EPD).
- ***Environmental Product Declarations (EPD):*** Environmental Product Declarations are standardized certifications of a life cycle assessment, used mostly to verify impact data from business to business.
- ***Cradle-to-cradle:*** *Cradle-to-cradle* is a concept often referred to within the *Circular Economy*. It is a variation of *cradle-to-grave*, exchanging the *waste* stage with a recycling process that makes it reusable for another product, essentially "closing the loop". This is why it is also referred to as *closed loop recycling*.
- ***Gate-to-gate:*** *Gate-to-gate* is sometimes used in product lifecycles with many value-adding processes in the middle. To reduce complexity in the assessment, only one value-added process in the production chain is assessed. These assessments can later be linked together to complete a larger level life cycle assessment.
- ***Well-To-Wheel:*** *Well-to-wheel* is used for the Life Cycle Assessment of transport fuels and vehicles. Because there are a lot of steps in between – the "Well-to-tank" and "Tank-to-wheels" only two of them, this approach is more precise in calculating and assigning greenhouse gas emissions and energy usage for the different stages.
- ***Economic Input-Output Life Cycle Assessment:*** The EIOLCA aggregates industry data with the goal to create impact data for specific sectors within the economy. These averages are sometimes being used when no exact data is available – they do not provide an exact picture of the impact but help to fill blanks. However, an EIOLCA is not precise enough to make decisions on a product level. [1, 2]

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

Module 5:

Systems and tools

ISO 14000
Standard Tools and techniques of environmental management

ISO 14001
ISO 14004
Environmental systems
Comprehensive management of environmental impacts

ISO 14031
Evaluation the levels of the environmental protection
Evaluation the levels of the environmental protection and informing of it

ISO 14006
ISO 14062
Planning that takes environmental aspects into consideration
Combining environmental aspects to the planning and development

ISO 14064 part 1 – 3
ISO 14065
Calculation and reporting of greenhouse gas emissions
Reducing greenhouse gas emissions

ISO 14051
Cost analysis of material flows
To make the use of the material and energy more effective

ISO 14040
ISO 14044
Life cycle analysis
Illustration and comparison of the environmental impact of products and services

ISO 14064
Water footprint
Reducing the environmental impact to the water

ISO 14020
ISO 14021
ISO 14024 ISO 14025
Ecolabel and specifications
Increasing supply and demand for products and services that are less than the environment

ISO 14063
Environmental communications
Developing the environmental communications strategy and processes

ISO 14067
The carbon footprint of a product
Reducing greenhouse gas emissions

- The CEN Technical Committee, the European Organisation for Standardization, has created a broad collection of standards on sustainable development
- For all types of and size organizations in different industries
- Both private and public sector. [7]

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Module 5:
Systems and tools

ISO 26000

Social responsibility
Encourage organizations to contribute to sustainable development.

- To help organizations promote sustainable development. Its purpose is to encourage them to act more responsibly than required by law
- is designed to be clear and instructive, even to non-specialists, as well as being objective and applicable
- For all types of and size organizations in different industries
- Both private and public sector.
- Provides guidance rather than requirements, so it can't be certified like some other well-known ISO standards. [7]

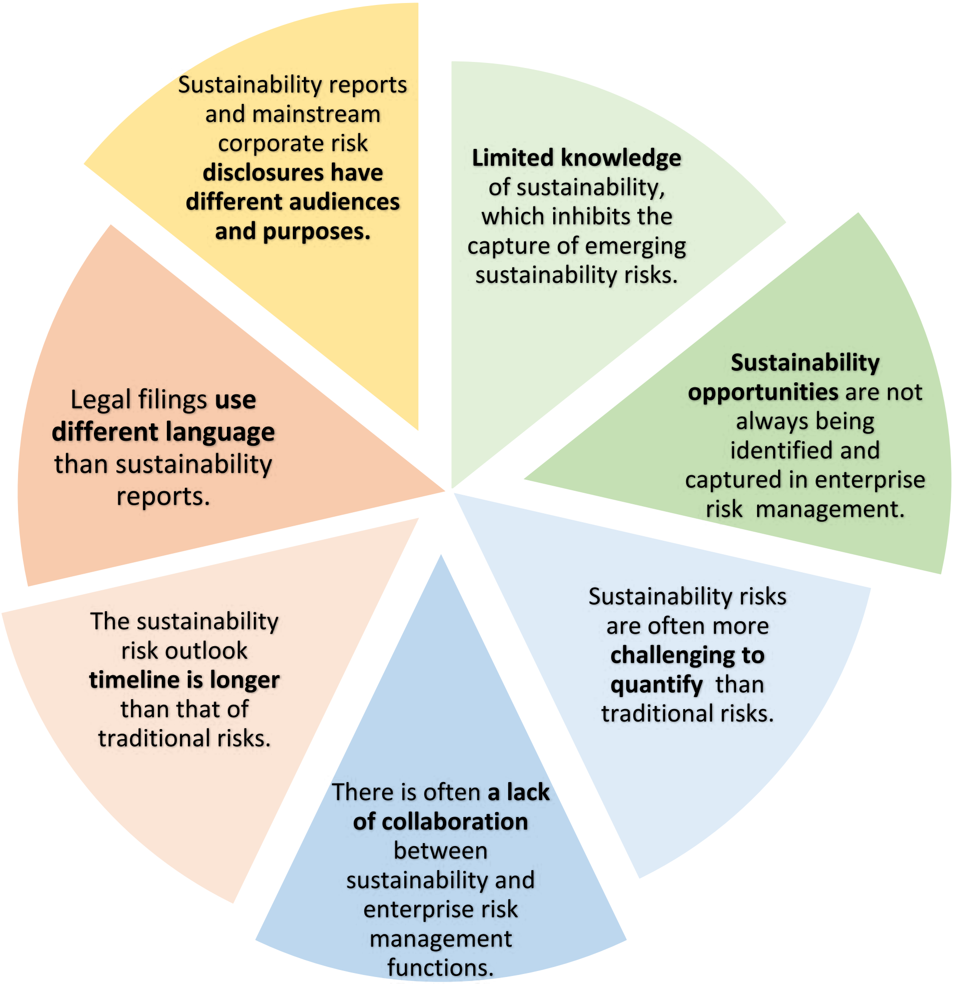
Module 5:

Systems and tools

ISO 9001 Quality management

- Is the only standard in the family that can be certified to (although this is not a requirement).
- Using ISO 9001 helps ensure that customers get consistent, good-quality products and services, which in turn brings many business benefits.
- To help organizations promote sustainable development. Its purpose is to encourage them to act more responsibly than required by law
- For all types of and size organizations in different industries
- Tips for small businesses can be found in the publication
- ISO 9001 for small businesses.
- Both private and public sector. [7]

Module 5:
Sustainability risks

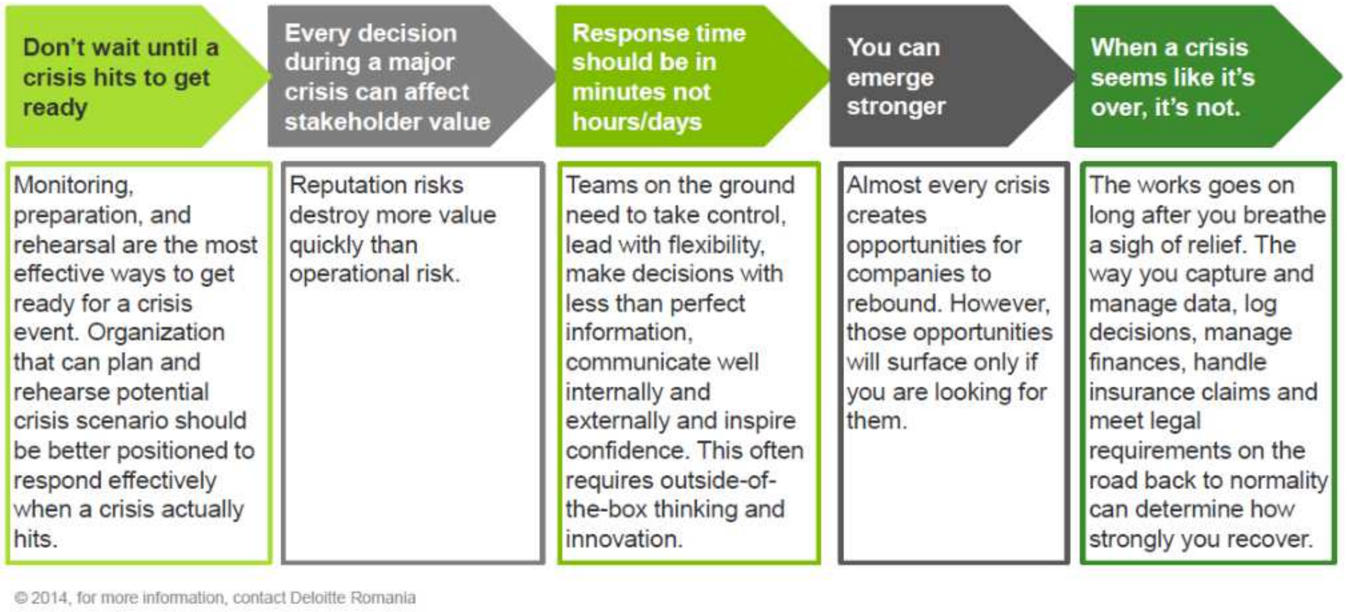


- The reputational risks, realized if promises of sustainability are failed, for ex. if company is caught of green washing or label swindling, must be taken into account [12]

Module 5:

Reputational risk management

- Reputational crises can be divided into four main risk areas
  - Issues of ethics and integrity,
    - Fraud and corruption
  - Security risks, both
    - physical breach
    - cyber breach
  - Product and service risks
    - safety,
    - health and
    - the environment
  - Risks in third-party relationships
    - Being accountable for the actions of their suppliers and vendors. [12]



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Module 5:

Energy label and ecodesign

Energy savings

The EU energy labels provide a clear and simple indication of the energy efficiency of products at the point of purchase.

- Reducing greenhouse gas emissions across the EU.
- A yearly energy saving of around 150 Mtoe (million tonnes of oil equivalent) by 2020, roughly equivalent to the annual primary energy consumption of Italy.
- For consumers, an average saving of up to hundreds of euros per year
- EU has put in place regulations and directives, particularly for energy labelling and ecodesign for products.

washing machines and washer-driers
dishwashers
electronic displays
household refrigerators
light sources
refrigerators with a direct sales function
external power supplies
electric motors
power transformers
welding equipment

Ecodesign

- The EU legislation on ecodesign is an effective tool for improving the environmental performance of products by setting mandatory minimum standards for their energy efficiency.
- The inclusion of elements to further enhance the reparability and recyclability of appliances.
- Several of the new measures include requirements, such as ensuring the availability of spare parts - making key parts more easily replaceable - and access to repair and maintenance information for professional repairers. [3]

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Module 5:

Other systems and tools

Picture by Oimheidi from Pixabay.

European Energy Efficiency Directive (EED)	• Gives energy audits and energy management schemes a substantial role to play in improving energy efficiency in the end-use sectors.
PEF (Product Environmental Footprint)	• A multi-criteria measure of the environmental performance of a good or service throughout its life cycle.
OEF (Organisation Environmental Footprint)	• A multi-criteria measure of the environmental performance of a goods/services-providing by organisation from a life cycle perspective.
REACH	• Stands for the Registration, Evaluation, Authorisation and Restriction of Chemicals.
Ecological Footprint	• Ecological Footprint accounting measures the *demand* on and *supply* of nature.
Water footprint	• Provide powerful insights for businesses to understand their water-related business risk, for governments to understand the role of water in their economy and water dependency, and for consumers to know how much water is hidden in the products they use. • Help drive strategic action toward sustainable, efficient and equitable water use.
Carbon footprint	• The effects of man-made greenhouse gas emissions on the climate can be measured and compared in the form of carbon footprints.
Carbon handprint	• The carbon handprint is a concept, which describes the emission reduction effect that the solutions produced by companies have for the user. The focus is on what can be done and how others can be helped to prevent climate change. In contrast, a carbon footprint describes the harmful effects of our activities that contribute to climate change.

[13, 11, 5]

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Module 5:

Sustainability in business in Finland

Eco-label

- Nordic Swan Ecolabel
    - Requirements for renewable, recycled and sustainable raw materials
    - Strict chemical requirements
    - Reduced use of resources and energy
    - Quality requirements and lifetime
    - Requirements for product design, dismantling and repairability
    - Requirements for optimum waste handling
- EU Ecolabel
    - The EU Ecolabel promotes the circular economy
    - Encouraging producers to generate less waste and CO2 during the manufacturing process. Encourages companies to develop products that are durable, easy to repair and recycle.

EU Ecolabel www.ecolabel.eu

Nordic Swan Ecolabel 1234 5678

Environmental systems

To manage and develop the environmental affairs of a company.

To reduce the company's costs, improve competitiveness, high customer satisfaction, a good employer image, and risk management.

- **Ekocompass** is a lightened environmental system designed for SMEs in Finland, available so far in the metropolitan area, Hyvinkää and Tampere.
- **WWF's Green Office** is an environmental system for offices.
- **ISO 14001** is an international environmental system standard that can be suitable for an SME, especially if an enterprise already has a quality management system.
- **EMAS** is an EU environmental system that requires public environmental reporting and is often unnecessarily burdensome for SME.
- **EMAS** Easy is a lightened SMEs version of EMAS and does not require public environmental reporting. [4, 8]

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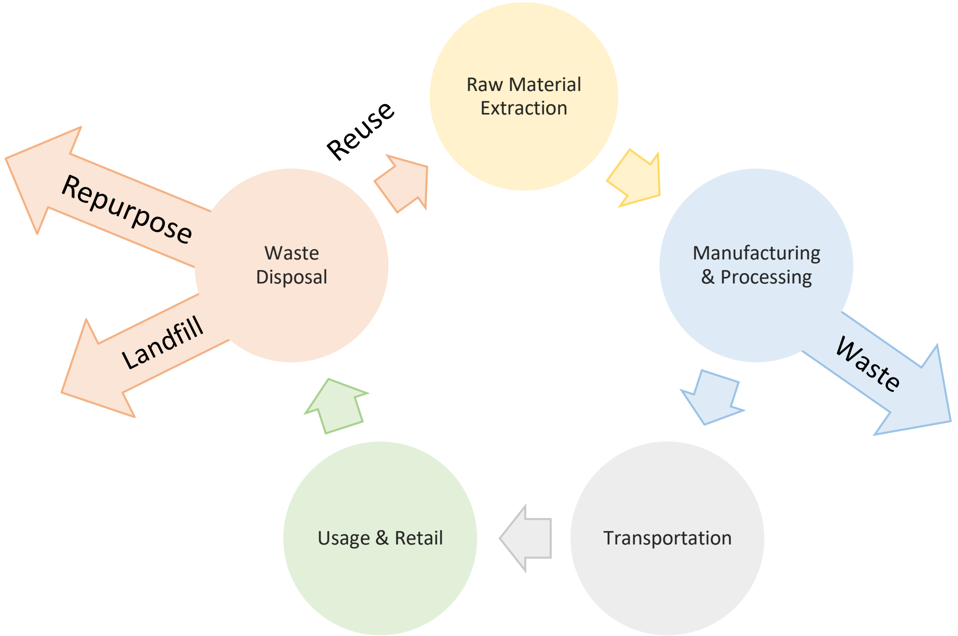
Module 5:

LCA – Life cycle assesment

Who needs an LCA?	• Anyone who is interested in knowing more about the enivronmental impact of their company
The Product Life Cycle	• Raw Material Extraction • Manufacturing & Processing • Transportation • Usage & Retail • Waste Disposal
The 4 Phases of a Life Cycle Assessment	• Definition of **Goal and Scope** • **Inventory** Analysis • **Impact** Assessment • **Interpretation**
LCA Standards and the legal situation - a quick overview	• **ISO and other standards are necessary** • **ISO 14000 family** • **ISO 5001** • **EN 15804** • **PAS 2050 & GHG Protocol** • **Life Cycle Accounting and reporting standards** • **GRI data framework** • European Energy Efficiency Directive (EED) • PEF (Product Environmental Footprint) and OEF (Organisation Environmental Footprint)
LCA: Criticism	• Choosing a more sustainable raw material for one product, when in reality the supply chain of a completely different product makes the biggest impact. • Social aspects are often interconnected with the environmental aspects of sustainability. This is not accounted for in an LCA. However, social LCA is currently under development.

[2]

The Product life cycle



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Module 3:

The GRI Sustainability Reporting Standards (GRI Standards)

- Material topics are those that reflect an organization’s significant economic, environmental and social impacts.
- Organizations might be involved with impacts either through their own activities or as a result of their business relationships with other entities.
- The GRI Standards is expected to report not only on impacts it causes, but also on impacts it contributes to, and impacts that are directly linked to its activities, products or services through a business relationship
- Appropriate tool to support the development of responsible actions and sustainability of SMEs
- SMEs can link the model to their own quality and environmental systems. [6]

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Module 3:
Topic-specific Standards

GRI 200:

- 01 Economic performance
- 02 Market presence
- 03 Indirect economic impacts
- 04 Procurement practices
- 05 Anti corruption
- 06 Anti competitive behavior
- 07 Tax

GRI 300:

- 01 Materials
- 02 Energy
- 03 Water and effluents
- 04 Biodiversity
- 05 Emissions
- 06 Effluents and waste
- 07 Environmental compliance
- 08 Supplier environmental assessment

GRI 400:

- 01 Employment
- 02 Labor management relations
- 03 Occupational health and safety
- 04 Training and education
- 05 Diversity and equal opportunity
- 06 Non-discrimination
- 07 Freedom of association and collective bargaining
- 08 Child labor
- 09 Forced compulsory labor
- 10 Security practices
- 11 Rights of indigenous peoples
- 12 Human rights assessment
- 13 Local communities
- 14 Supplier social assessment
- 15 Public policy
- 16 Customer health and safety
- 17 Marketing and labeling
- 18 Customer privacy
- 19 Socioeconomic compliance

There are three universal Standards that apply to every organization preparing a sustainability report:

GRI 101: *Foundation*
GRI 102: *General Disclosures*
GRI 103: *Management Approach*

From GRIs you can found elements from ISO 26000 standard and SDG goals. [6]

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Module 5:
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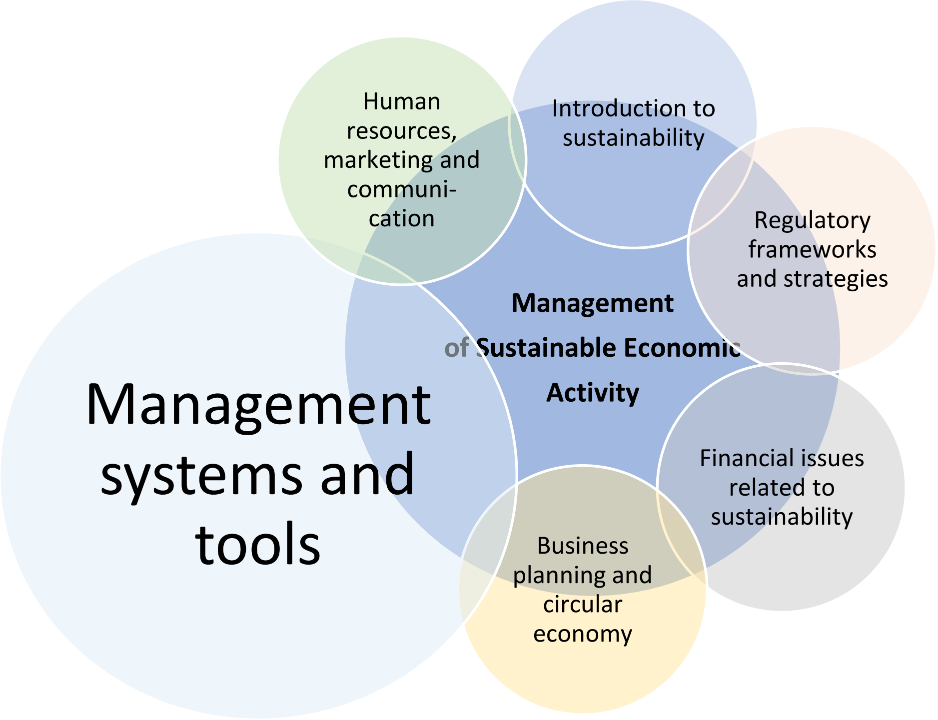

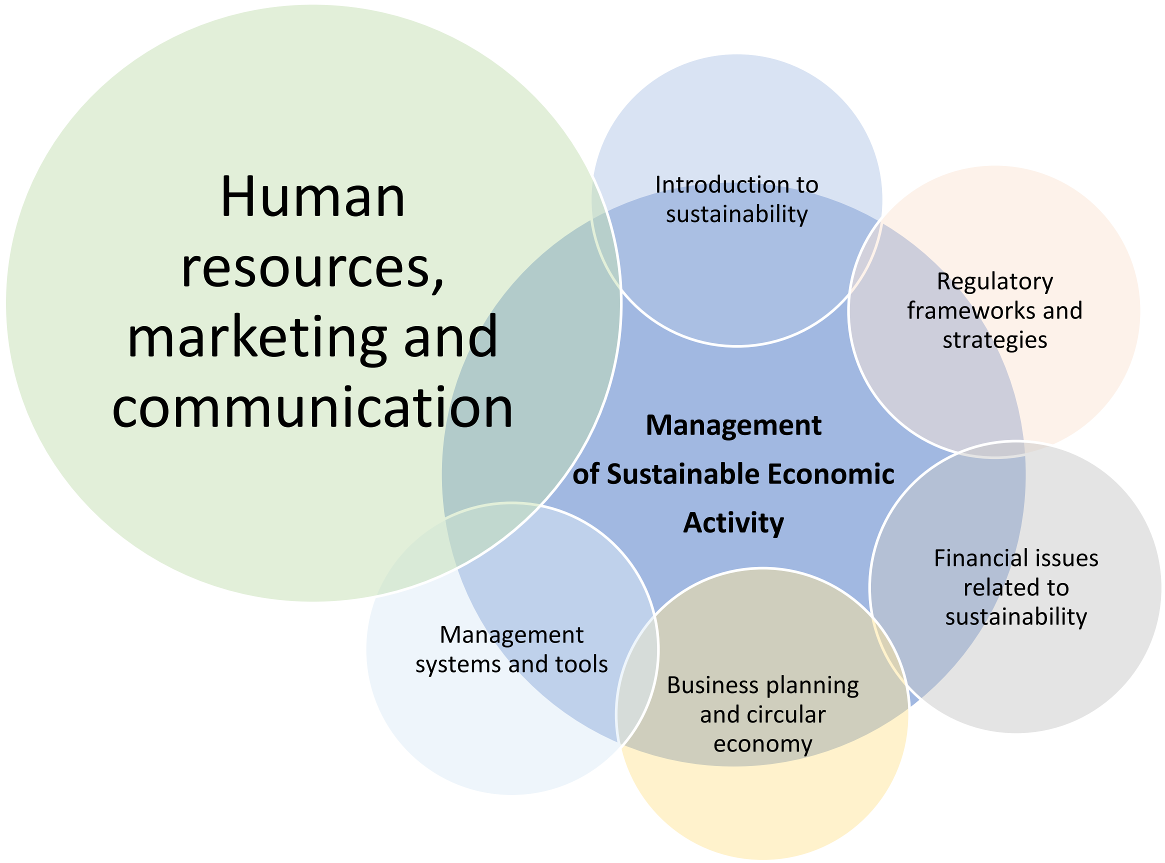

Module 6

Human resources, marketing and communications

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Module 6:

Common terms

Green washing: poor environmental performance and positive communication about environmental performance

Greening: The process of becoming more active about protecting the environment

HRM: Human Resource Management, the activity of managing a company's employees, for example, by employing new workers, training them, managing their employment records, and helping them with problems

Corporate reporting: The act by a company of giving an official report, for example about its accounts or activities

Financial reporting: Information that businesses give about their financial situation, including the profit or loss for a particular period, or the process of giving this information

Environmental reporting: To give a description of or information about environmental activities in business to someone

Stakeholder collaboration: The situation when corporate stakeholders are working together to create or achieve the same thing

Collective agreement: A formal agreement between groups or people, especially an agreement reached by collective bargaining [1]

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Module 6:

The sustainability in HRM practices

To implement sustainability in HRM practices reflects in every function of business and is a way to achieve success.

- Reflecting and inspiring the ambitions of the HR team and other employees.
- Aligning with the company's strategy, values and culture.
- Help deliver sustainable returns to investors.
- Helping to address customer needs.
- Identifying and responding to emerging societal trends.
- Responding to governmental and regulatory expectations and influencing the public policy agenda. [8]

Who is responsible	Supply Chain Management	Human Resources	Marketing	Finance	Public/Corporate Affairs
Responsible for what	Risk Management Product Responsibility	Employee Recruitment and Retention Motivation Competencies	Brands Reputation	Fiduciary Responsibilities Reputation	Reputation
To whom	Management Suppliers Standard Setting Bodies NGOs Competitors	Management Employees Wider Business Community Institutions Regulators	Corporate Affairs Market Awareness International Agencies Regulators Competitors Customers Media NGOs	Shareholders Finance Directors Management The Market Competitors Investors Shareholders Assessment Bodies Regulators	Management Employees NGOs Advisory Panels Competitors Wider Business Community Institutions Regulators
Through what mechanisms	Greater role in strategy Audit Training Standards/Monitoring/Compliance Establishing working relationships	Peer learning Training and development Creating culture amongst employees Leadership	R&D Stakeholder Intelligence (customer feedback, dialogue, benchmarking)	Analysis Investor surveys Annual General Meetings (AGMs) Disclosure	Connecting business functions and management with stakeholder concerns Relationship building
Cross-functional Connection	Sales Marketing Corporate Affairs Product Development	Corporate Affairs Marketing	PR Marketing Corporate Affairs	Public/Corporate Affairs Marketing	All functions and units
With what outcomes	Deliver accountable supply chain through strategic embedding	Use sustainable development as a marketing tool and to enhance employee performance	Create more sustainable products and services	Meet broader fiduciary responsibilities	Raise company profile

Adapted from Beyond Reporting: Creating business value and accountability, Engen, T, and Di Piazza, S, 2005

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Module 6:
The sustainability in HRM practices

Employment contracts

Must respect the minimum requirements set by EU employment law

- Terms of employment
- Changes to staff contracts
- Inform and consult staff

You must remember to follow the principle of non-discrimination when using non-standard forms of employment. Non-standard or other types of work contracts can include:

- Fixed-term work
- Part-time work
- Temporary agency work

Hiring young workers, you must respect specific rules for the employment of workers under 18 years.

- Redundancies
- Young workers

Working hours, holiday and leave

- The minimum EU standards for working hours and rest, breaks, annual leave and night work.
  - Derogations from some of the working time obligations are possible if allowed by national law.
  - Working hours in the EU
- Employees (male or female) can request parental leave for the birth or adoption of a child, regardless of their contract type.
  - **At least 4 months of leave each**.
  - Parental leave in the EU [3]

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Module 6:

Regulations in Finland

General act of confirmation on general applicability of collective agreements

- According to the Employment Contacts Act, employers should observe at least the provisions of a national collective agreement considered representative in the relevant sector (a generally applicable collective agreement).
- Employment Contracts Act, 2001(Finlex)
- The Committee for Confirming the General Applicability of Collective Agreements verifies whether a national collective agreement is representative. The committee operates in connection with the ministry. [7]

Occupational safety and health (OSH)

- The Ministry of Social affairs and Health has published a policy, which aims at fostering healthy and safe work at all workplaces regardless of the form of employment.
- Policy for the work environment and wellbeing at work until 2030. Safe and healthy working conditions and workability for everyone (valto.fi)

Occupational health care and maintaining workability

- The MSAH directs, oversees and develops legislation on occupational health care
- Occupational Health Care Act, 2001

Wellbeing at work

- Promoting wellbeing at work involves employers and employees. Employers have to ensure the safety of the work environment, good management and the fair treatment of employees.
- Finnish Institute of Occupational Health
- Occupational health care and maintaing work ability
- The Centre for Occupational Safety

Equality in working life

- Equality in working life is promoted particularly in pay, working conditions, terms of employment, and career development. The Act on Equality Between Men and Women prohibits discrimination based on gender and requires the promotion of gender equality.
- Act on Equality Between Men and Women (Finlex)

Young people and work

- Under-18-year-olds are subject to stricter regulations concerning working age restrictions and terms of employment.
- Young Workers' Act (Finlex)
- Young worker (Occupational Safety and Health Administration)

Family life and work

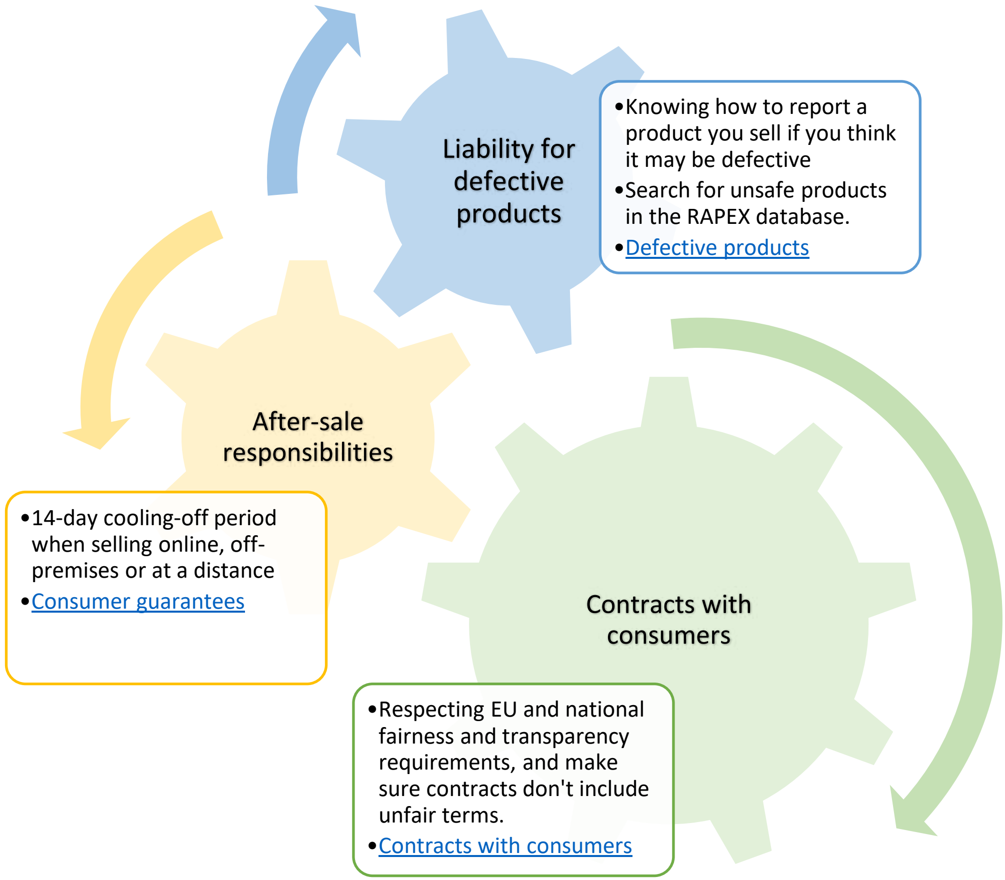
- The Ministry of Social affairs and Health is responsible for developing financial benefits for families with children, as well as care arrangements for small children, so that families have alternative ways to care for their children. The aim is for family leave to be divided equally between fathers and mothers.
- Family benefits

Older workers

- The working career of older workers can be prolonged by maintaining work ability, having flexible working hours and by altering working tasks if their work ability becomes impaired.
- By upgrading working conditions and wellbeing at work, older employees will be motivated to remain at work.
- Working while drawing a pension
- Pensions

Module 6:

Dealing with customers



Solving disputes with customers

- Alternative/online dispute resolution
  - Offers you the chance to avoid court procedures for disputes with consumers
  - Quicker, cheaper and simpler especially if register on the online dispute resolution platform.
  - Ensure smoother complaint handling.
- European small claims procedure
  - Can be used to make a claim (up to EUR 5 000 excluding expenses) against another business, an organisation or your customers in any EU country except Denmark

Data protection

- Data protection under GDPR
  - Understanding what is considered personal data
  - Responsibilities when processing and monitoring personal data within your company.
- Online privacy
  - Several different types of cookie, but not all of them require consent from users.
  - Find out how and when you need to ask for a user's consent. [2]

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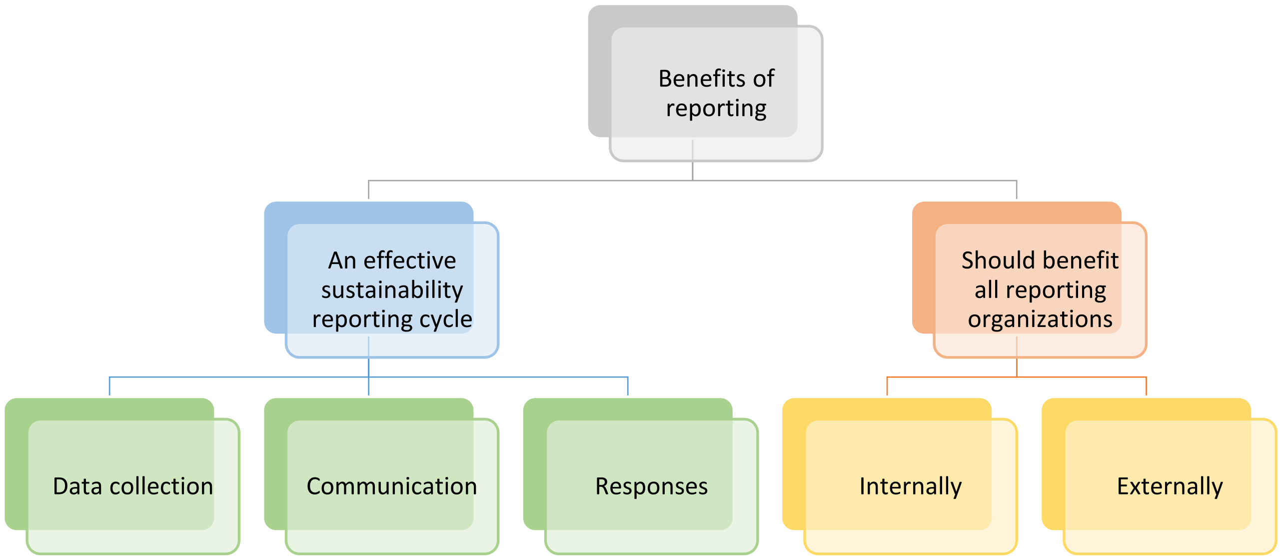
Module 6:

Practices in corporate communications

Sustainability reporting

- Report published by a company or organization about impacts caused by its everyday activities.
  - economic
  - environmental
  - social
- Can help organizations measure, understand and communicate their economic, environmental, social and governance performance, and then set goals, and manage change more effectively.
- Enables organizations to consider their impacts of wide range of sustainability issues
- Enabling them to be more transparent about the risks and opportunities they face. [5]



Module 5:
Disinformation in business

Video: [Are You Falling for Corporate Greenwashing?]

Picture by ajcespedes from Pixabay.

Green washing

Environmental knowledge has grown, and consumers demand greener products

→ Customers are more likely to pay a higher price if they find out about a company's sustainable acts

→ Some companies mislead their stakeholders through a phenomenon called greenwashing.

→ The phenomenon is defined as “the intersection of two firm behaviours: poor environmental performance and positive communication about environmental performance

→ Green skepticism has grown with greenwashing, and it would obstruct green marketing

→ When customers meet greenwashing the trust for the real green products will reduce.

[4]

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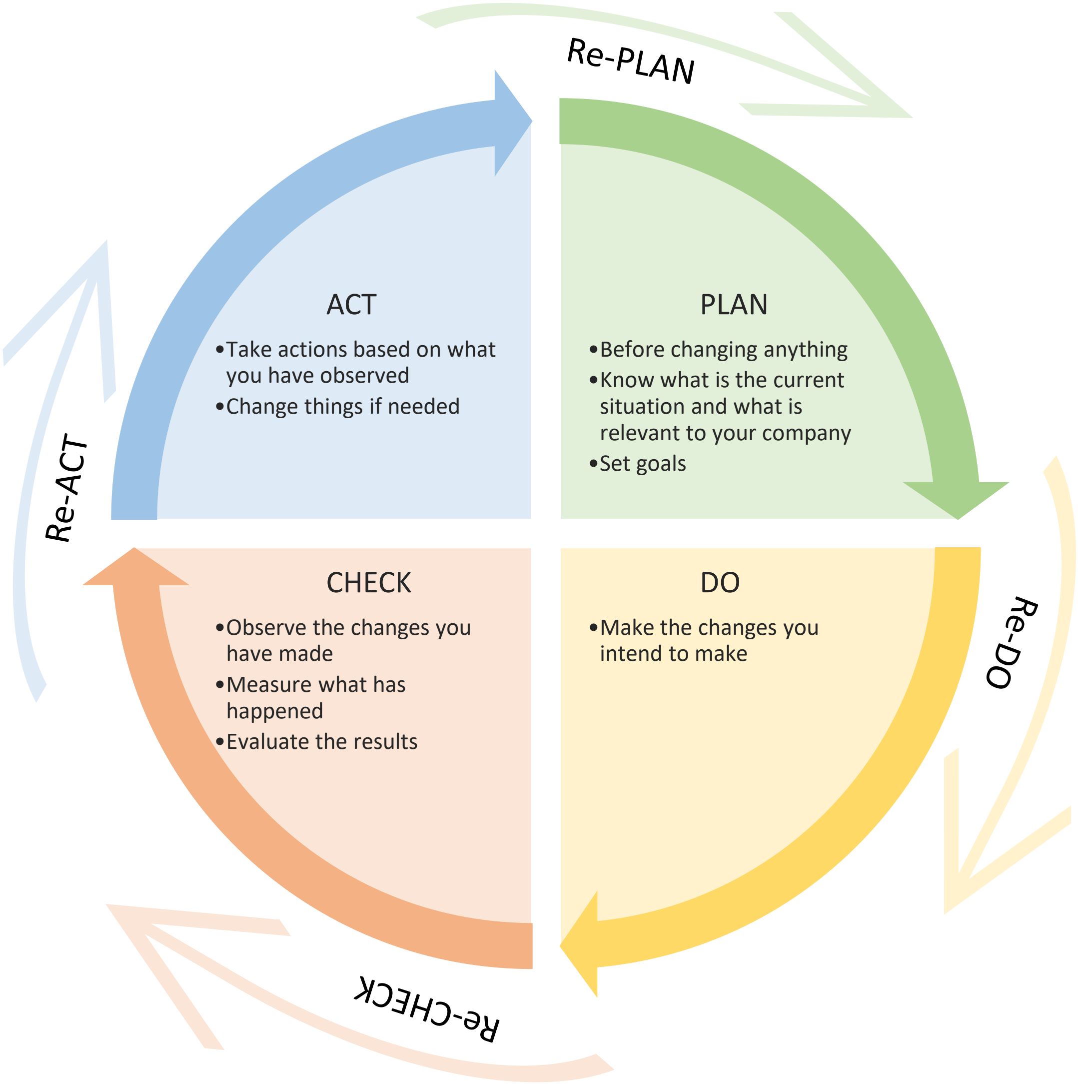
Module 6:
PLAN DO CHECK ACT (PDCA)

- Ongoing process, not a unique task
- Problem solving and process improvement tools
- Simple but effective [6]



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Module 6:
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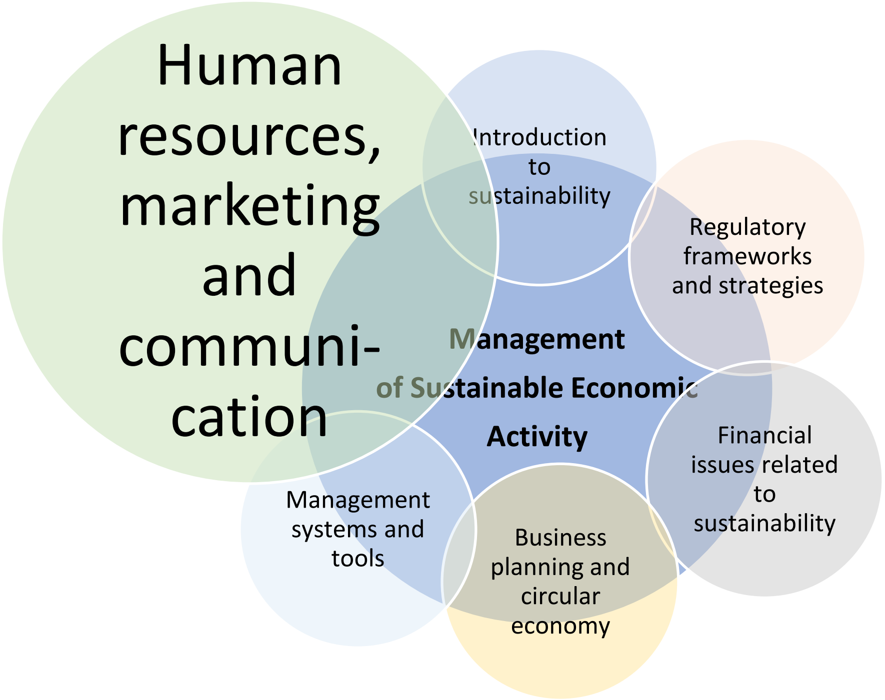

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Possible assignment topic examples

- **Module 1:** What kind of business opportunities within the branch of circular economy could you find in your country / area or company.
- What are the critical barriers faced in these business opportunities?
- Why sustainable economy issues are relevant in business?
- Discuss the rationale for country/area or company to engage in circular economy.
- Watch the animation movie “What Is Sustainable Development?” (03:30 minutes). It gives a short and simple introduction to sustainable development: https://www.youtube.com/watch?v=7V8oFI4GYMY. Read an article about sustainable development, https://sustainabledevelopment.un.org/content/documents/5839GSDR%202015_SD_concept_definiton_rev.pdf. What did you already know about sustainable development? How did the article and the animated movie fit in with your knowledge about sustainable development?
- **Module 2:** If you think about 17 goals of sustainable development https://sustainabledevelopment.un.org/?menu=1300 , how many of the goals do you find to be connected with the business? Name these.
- Find out the requirements set by the national legislation and local municipality on companies sustainability related themes. How do these requirements affect company finances?
- What are the most common legal and regulative sustainability issues companies have to take into account in their operations? What are the economic implications?
- **Module 3:** If you do not count in the outside funding, what would be the most important reason – in financial point of view – to apply and develop sustainability in the business
- What type of funding is available for development of sustainable economy activities promotion/development for companies in your country?
- Discuss about the challenges companies may have in participating national and international projects. What solution proposals could you give?

Possible assignment topic examples

- **Module 4:** What do you think are – from a business point of view - the most important reasons to commit to sustainability in business? Name at least 2 reasons. How about the most common reasons?
- It is worthwhile for companies to take subsidies to deal with sustainable development issues? What other financial options are available?
- **Module 5:** Do you think that the green washing and label swindling are dangerous for business? Why? How common do you think they are? Why are companies doing them?
- Compare LCA and GRI to business you know. How easy it would be to apply them to the business? What could be the most difficult to do?
- Study the sustainable business model canvas https://www.threebility.com/sustainable-business-model-canvas. Which are the most difficult sections and why?
- **Module 6:** Compare General Data Protection Regulations (GDPR) (https://gdpr-info.eu/) to general principles of sustainability, e.g. 17 goals of sustainability, or your own organizations sustainability policy. How many common rules can you find?
- Compare the labour and work legislation in your own country to the goals of sustainable development. How many of the 17 goals the regulation is trying to tackle?
- What kind of sustainable economy expertise is required in companies? What kind of training is needed to achieve a decent level of expertise?
- How visible is sustainable economy in the news? Select a couple of sources in media and discuss about the findings. What is talked about in the different media? Who participates in the debate? What is not talked about? Who does not participate in the debate?
- Explain the sustainability reporting procedures, i.e. what formal reporting requirements exist, in your country.
- Get acquainted with the responsibility reporting of different companies. You can freely choose the companies, but try to find large, SME and micro companies. What are the most significant findings regarding the transparently given information?

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Result 5.2
Green Economy Study Modules

Study module D
Management of sustainable economic activity

Implementation Reports

Three-level Centers of Professional Excellence: Qualification, Entrepreneurship and Innovation in the Green Economy

With the support of the Erasmus+ Programme of the European Union

Green Economy Study Modules

Implementation Report Training D

Addressing the Climate Emergency and its Impact on the Water Cycle: Practical Approaches and Innovative Solutions

Prepared by:

AGBAR - Escuela del Agua

September, 2024

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Introduction

- Contextualisation within the overall project:

The climate emergency has become an undeniable reality, significantly affecting the water cycle and posing challenges for ecosystems, communities, and economic sectors globally. This training program, titled Addressing the Climate Emergency and its Impact on the Water Cycle: Practical Approaches and Innovative Solutions, is designed to equip participants with essential knowledge and practical skills to address these challenges effectively. By focusing on the intricate relationship between climate change and water management, the course aims to foster a deeper understanding of the consequences of climate change and to promote innovative solutions that support sustainable water practices. Ultimately, this initiative contributes to the broader goals of enhancing resilience against climate impacts and achieving the Sustainable Development Goals (SDGs) related to water and climate..

Modality, where and when:

The training program “Sustainable Management of Wastewater in the Circular Economy: Approaches and Solutions” is designed to be both accessible and flexible, catering to the diverse needs of professionals in the water treatment sector.

Modality

The training took place entirely online, leveraging modern technology to reach a global audience. This virtual environment provided participants with the convenience of accessing course materials, lectures, and discussions from their own homes or workplaces. The online format not only removed geographical barriers but also created opportunities for networking and knowledge exchange among professionals from different regions and backgrounds.

Where

The course is hosted on a virtual learning platform, providing participants with access to all course materials, interactive modules, and assessment tools. The virtual campus is designed to facilitate seamless communication between participants and instructors, as well as to offer a range of digital resources. This online environment is accessible from any location, allowing participants to engage with the course content at their convenience while benefiting from a collaborative learning atmosphere.

When

The course was structured over a six-week period, beginning on May 20, 2024, and concluding on June 30, 2024. Each module was allocated a two-week timeframe, allowing participants to delve deeply into specific topics related to the climate emergency and its impact on the water cycle. This structured timeline facilitated a comprehensive learning experience, ensuring that participants could engage fully with the material and apply their knowledge to real-world challenges.

Skills Acquired:

By completing the seminar, participants will acquire a range of essential skills that are critical for effective water management in the context of climate change. They will gain a deeper understanding of the interconnections between climate change and the water cycle, enabling them to assess the implications of environmental shifts on water resources and infrastructure. This knowledge is vital for making informed decisions that enhance water security and sustainability.

Additionally, participants will develop practical skills in identifying and implementing innovative solutions to address water-related challenges posed by climate change. They will learn to explore and evaluate various approaches that promote sustainable practices in water management, including the adoption of technologies that optimize resource use and minimize environmental impact. This skill set empowers professionals to contribute proactively to climate resilience initiatives within their organizations and communities.

Finally, participants will enhance their capacity to align their practices with the Sustainable Development Goals (SDGs) related to water and climate. This includes understanding how to incorporate sustainability principles into their work and advocating for policies that support equitable and sustainable water management. By fostering these skills, the seminar prepares participants to be effective leaders and advocates in the field of water management, contributing to a more sustainable future.

Attendants:

The training course "Addressing the Climate Emergency and its Impact on the Water Cycle: Practical Approaches and Innovative Solutions " was designed for a diverse audience of professionals engaged in the water treatment industry. The primary target groups included:

Water Treatment Technicians and Engineers: These individuals are directly involved in the operation and maintenance of wastewater treatment facilities. They play a crucial role in managing the day-to-day functions of these plants and must stay updated with the latest practices and technologies to ensure efficient operations.

Environmental Engineers: Professionals working on projects related to water treatment and environmental protection benefited from the course by gaining a deeper understanding of plant operations and maintenance. This knowledge enhances their ability to design and oversee effective water treatment solutions.

Facility Managers: Those responsible for overseeing the overall functioning of wastewater treatment plants. The seminar will provide them with insights into improving plant efficiency and managing technical and operational challenges.

Competence acquisition methodology:

The seminar "Addressing the Climate Emergency and its Impact on the Water Cycle: Practical Approaches and Innovative Solutions " employs a comprehensive and effective methodology designed to ensure the acquisition of competencies essential for sustainable management of wastewater treatment facilities. The methodology encompasses several key components:

- **Challenge-Based Learning**: Participants engage with real-world professional challenges that require practical solutions. This approach allows them to apply theoretical knowledge to realistic scenarios, thereby enhancing problem-solving skills and practical application. Each module begins with a challenge that participants must address using the concepts learned throughout the course.

- **Transmedia Learning Resources**: The seminar incorporates a transmedia approach, which involves diverse formats such as interactive content, videos, and simulations. This multifaceted approach ensures that participants can engage with the material in various ways, catering to different learning preferences and reinforcing understanding through multiple channels.
- **Expert Manual**: Participants have access to a detailed manual authored by subject matter experts. This manual provides in-depth explanations of key concepts, processes, and techniques relevant to wastewater treatment. It serves as a crucial resource for detailed study and reference throughout the training.
- **Self-Assessment Exams**: To consolidate learning and gauge comprehension, participants complete self-assessment exams. These exams consist of multiple-choice questions and are linked to the content of each module. Immediate feedback is provided, allowing participants to assess their understanding and identify areas needing further review.
- I**nteractive Online Platform**: The seminar is delivered through a virtual learning environment that facilitates interaction between participants and instructors. The platform supports discussion forums, where participants can exchange ideas, ask questions, and engage in collaborative problem-solving. This interactive component enriches the learning experience and fosters a sense of community.

Admission and organization of the trainings

- Organization of the training
    - School of Water. created by Agbar in 2012, is the benchmark in training, awareness, talent development and knowledge in the field of water and the environment.Our activity is aimed at training for companies, administrations and professionals in the water sector, as well as for the general public. Thus,

we develop training programs, promote dual vocational training in the water sector, develop environmental education programs and design exhibition, museum and hydraulic heritage projects.The training programs, whether those in our catalog or those custom-designed for companies, cover all areas of the complete water cycle; they use methodologies that facilitate a unique learning experience and immediate applicability in all key positions of an organization. Our approach combines the academic and technical rigor provided by 165 years of experience in integrated water cycle management and collaboration with the best universities, technical schools and business schools.

- Selection of participants, possible admission requirements

Participants in the seminar were informed by HR for the internal participants and via web for the external participants.

- Brief notes on counselors and teachers:

Throughout the seminar on "Sustainable Management of Wastewater in the Circular Economy: Approaches and Solutions" participants benefit from the support and guidance of two key figures who play crucial roles in enhancing their learning experience:

1. **The Expert:** The expert is a pivotal figure in the training, providing technical support and addressing any queries related to the course content. As the primary authority on the material covered, the expert is responsible for evaluating each module. Participants can turn to the expert for in-depth explanations and clarifications, ensuring they fully understand the complex concepts and processes involved in wastewater treatment.
2. **The Academic Tutor**: The academic tutor offers personalized guidance and support throughout the participants' educational journey. This role involves providing individual assistance and addressing any questions or concerns related to the overall

program. The academic tutor helps participants navigate the course structure, manage their progress, and maximize their learning outcomes.

Execution of the training

PERIOD	MODULE	CONTENT
20/05/2024 to 02/06/2024	How to Recycle Water from My Treatment Plant	1. Uses of regenerated water. Water quality depending on use. 2. Water regeneration technologies 3. Water quality control and analytical plan 4. Adaptation of resources to client needs
03/06/2024 to 16/06/2024	How to Modernize My Treatment Plant	1. Why a 21st century WWTP? Economic, social reasons and environmental? 2. Emerging technologies 3. By-product recovery 4. Control systems 5. Emerging pollutants
17/05/2024 to 30/06/2024	How to Implement Energy Efficiency in My Water Facilities	1. Energy concepts 2. Energy consumption in the integral water cycle 3. Regulatory framework 4. Comprehensive energy management 5. Energy audit 6. Energy generation

Evaluation Ratings

Course Participation

- Total Registrations: 30
- Internal Participants: 13
- External Participants: 17
- Participants Who Passed the Course: 11
- Participants Who Did Not Pass the Course: 19
- The course attracted a good number of participants, with a balanced mix of internal and external attendees.
- The pass rate indicates that there may be room for improvement in helping participants successfully complete the course.

Satisfaction Ratings

1. Overall Satisfaction with the Training Received: 3.8
    - The overall satisfaction rating is quite positive, indicating that most participants found the training beneficial.
    - There is still some room for improvement to achieve higher satisfaction levels.
2. Overall Rating of the Online Expert: 3.5
    - The rating suggests that while the online expert was generally well-received, there may be areas where their delivery or engagement could be enhanced.
    - Consider providing additional training or resources to the expert to improve their effectiveness.
3. Overall Rating of the Academic Tutor: 3.7

- The academic tutor received a fairly positive rating, indicating that participants were generally satisfied with their support and guidance.
- Further efforts to increase interaction and provide more personalized feedback could help improve this rating.

4. Functionality of the Virtual Campus: 4.0
    - The virtual campus received the highest rating, suggesting that participants found it user-friendly and effective for their learning needs.
    - Maintaining and possibly enhancing the current features of the virtual campus could help sustain this high level of satisfaction.
5. Overall Rating of the Content and Resources of the Training: 3.8
    - The content and resources were well-received, indicating that they were relevant and useful to the participants.
    - Regular updates and the inclusion of more interactive or practical resources could further enhance the learning experience.

Main Findings and Conclusions

Strengths

- **Interesting Content**: All three modules are highly engaging and relevant to wastewater treatment plants.
- **Explanatory Videos**: Participants appreciated the explanatory videos.
- **Course Interest**: The course is very interesting, but there is a need for more content to match the level required for the challenges. It currently demands extensive bibliography and self-study, which may not align with the training objectives.
- **Videos and Manuals:** The videos and manuals were well-received.
- **Well-Presented Information**: The information is well-presented.

- **First Challenge**: The first challenge was appreciated for including explanatory videos.

Areas for Improvement

- **Extended Deadlines**: Participants suggested extending the deadlines for challenges, as balancing work with these tasks is very tedious.
- **Course Format**: The current format of delivering a 50-page PDF with theory and a separate PDF for challenges is not suitable for an online course. Participants expect an online course to be didactic and engaging, allowing them to assimilate concepts gradually and interactively.
- **Practical Content**: The course was perceived as too theoretical and lacking in practical content. More videos and audiovisual materials are needed. The second challenge only had a PDF document, which was difficult to manage without expertise in the subject.
- **Practical Examples:** The first module was more clarifying, but participants missed more explained practical cases and less theory.
- **Course Duration**: The course is too long and concentrated if participants do not have the 75 hours required to complete it in a month. The duration should be extended to match the content provided.

Attachments

- **ATTACHMENT 1: LIST OF PARTICIPANTS**
- **ATTACHMENT 2: PUBLICATION ABOUT THE COURSE (web)**

ATTACHMENT 1: LIST OF PARTICIPANTS Name	Last name	Institution
Miriam	Perozo Mur	Aigues de Barcelona
Gabriel	Lopez Montoya	AQUATEC Proyectos para Sector del Agua, S.A.U.
Viviane	Beiro Gonçalves	Sociedad General de Aguas de Barcelona, S.A.U.
Laia	Arnau Zamora	Sociedad General de Aguas de Barcelona, S.A.U.
Alvaro	Mayor Pillado	External
Raquel	Gayol Traba	Asturagua Servicio Integral del Ciclo del Agua, S.A.
Roberto	Rodriguez Luengo	AQUATEC Proyectos para Sector del Agua, S.A.U.
Juan Antonio	Ruiz Sanchez	Viaqua Gestión Integral de Aguas de Galicia, S.A.U.
Luis	Bravo Casero	Aquambiente Servicios para Sector del Agua, S.A.U.
Desiree	Marin Navarro	Cetaqua, Centro Tecnológico del Agua, Fundación Privada
Ana Maria	Rodriguez Martin	Viaqua Gestión Integral de Aguas de Galicia, S.A.U.

Gonzalo	Bustos Moreno	Hidrogea, Gestión Integral de Aguas de Murcia, S.A.
Natalia	Pallas Martinez	Viaqua Gestión Integral de Aguas de Galicia, S.A.U.
Juan Carlos	Duran Luchena	Aquona Gestión de Aguas de Castilla, S.A.U.
Victor	Pardo Hernandez	Hidrogea, Gestión Integral de Aguas de Murcia, S.A.
Salvador	Martinez de la Cruz	Hidrogea, Gestión Integral de Aguas de Murcia, S.A.
Katiuska Adriana	Dorta Pedreanez	Sociedad General de Aguas de Barcelona, S.A.U.
Alvaro	Bonneville García	AQUATEC Proyectos para Sector del Agua, S.A.U.
Souliman	Rahou El Bachiri	Sociedad General de Aguas de Barcelona, S.A.U.
Monica	Vicente Vilalta	Sociedad General de Aguas de Barcelona, S.A.U.
Alberto	Beltran Rueda	Aguas de Albacete, S.A.
Joseba	Zubiaurre	External
Arnaldo Antonio	Garcia Sosa	External
Maria Pilar	Escrig Font	External

Berta	Melgar Rigau	External
Leoncio Javier	Briones Sepulveda	External
Ricardo S	Santiago Ales	External
Diana Marcela	Sabogal Aguilar	External

ATTACHMENT 2: PUBLICATION ABOUT THE COURSE

https://www.laescueladelagua.com/en/programa/executive-education/seminario/abordo-emergencia-climatica-impacto-ciclo-agua/

Presentation | Program | Admission and basic data

The Water School as a participant in the project 3LoE, has organized the course "Addressing the Climate Emergency and its Impact on the Water Cycle: Practical Approaches and Innovative Solutions"75 hours of **online self-study.**

The main objective of this program is to cUnderstand the interrelationship between water and sustainable development, including the importance of sustainable management of water resources to achieve development goals at local, regional and global levels.

Develop competencies to address the climate emergency and its impact on the water cycle, including the identification of risks, the implementation of adaptation measures and the promotion of mitigation practices that contribute to the resilience of water systems and environmental sustainability.

Work Package 5: Third center level “Higher Education)

(EQF 6)

Activity A8.41 - Test study module D

Management of sustainable economic activity

Implemented by:

SFC Sistemi Formatici Confindustria and

Scuola Sant’Anna di Pisa University

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

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Chapter 1: Executive Summary

This report relates to the implementation activities in Italy of the 4 modules:

D – "Management of Sustainable economic activity"

developed by VILNIAUS GEDIMINO TECHNICAL UNIVERSITY (VGTU) and SATAKUNTA UNIVERSITY OF APPLIED SCIENCES (SAMK) in the Project 'Management and Technologies of Water, Wastewater, Waste and Circular Economy (WWW&CE)'

Methodology for adaptation of VGTU – SAMK curricula to Italian training needs

Following the analysis of the Module A-B-C-D curricula developed by the 3LoE partners, SFC found it beneficial to propose to the Scuola Superiore Sant'Anna (SSSA) the validation of potentially integrating the 4 modules, their structure, learning outcomes and main topics into existing university pathways.

This analysis, conducted in March 2023, resulted in Sant'Anna expressing interest in incorporating the four modules into the MASTER GECA specialization pathway.

The GECA Master is a 2nd level university Master's degree program offered by the Institute of Management at the Scuola Superiore Sant'Anna in Pisa. For nearly three decades, it has provided a high-level, continuously updated, multidisciplinary course in the environmental sector and green management.

The professional profile emerging from the GECA Master is that of an "Expert in Corporate Sustainability and Circular Economy."

The GECA Master was identified as the most suitable existing program into which all four modules proposed by the 3LoE project could be integrated.

Meetings to finalize and adapt the contents and learning outcomes of all the 4 modules within the framework of the GECA Master's Course were held from April 2023 to September 2023. This timeline ensured that the necessary authorizations from the college of university

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lecturers could be obtained in time for implementation during the GECA Master's Course, which ran from October 2023 to July 2024.

The competencies of the four modules are attributed, according to the Italian Atlas of Competences and Professions, to:

SECTOR 24: Common Area

- PROCESS: Ecological transition, reduction of energy consumption, circularity, and containment of environmental impacts
    - PROCESS SEQUENCE: Activation of circular production processes and increase of recycling activities

The Expected Result of the learning pathway is:

Adopt circular closed-loop production processes, implementing lean production logics and techniques, and improving the energy efficiency of production processes to reduce environmental impact.

The main activities envisaged are:

- Optimization of production processes
- Implementation of closed-loop production and waste minimization
- Energy efficiency and use of renewable energy in production processes

It was determined that the four modules could contribute significantly to the training of the GECA Master's graduate profile. Specifically, they could contribute to developing the learning outcomes related to the process sequence as detailed in Annex A.

The competence related to the Module D – Management of Sustainable economic activity are attributed also to the following process, referred to the Italian Atlas of Competences and professions:

SECTOR 24: Common Area

- PROCESS: Ecological transition, reduction of energy consumption, circularity, and containment of environmental impacts
    - PROCESS SEQUENCE - Containment of environmental impacts of production activities, materials and packaging

ADA (area of activity).24.08.09 - Assessment and monitoring of environmental impacts of production activities and identification of containment measures

Expected Results are:

1: Create a detailed action plan with timelines, necessary resources and assigned responsibilities for each containment measure, establishing specific targets for reducing environmental impacts and developing strategies to minimise the negative impacts identified

2: Identify the environmental impact risks associated with the company's activities, performing an analysis of production processes and evaluating the life cycle of raw materials and products

3: Implement technologies and production processes with lower environmental impact and greater sustainability, optimising the use of resources and promoting sustainable waste management.

Annex A and B report the results of the consultation of the Atlas of Professions in Italy, managed by INAPP - National Institute for the Analysis of Public Policy.

Introduction to Module D implementation

The concept of sustainable economic activity has gained prominence as a response to the shortcomings of conventional linear economic models. In the face of resource scarcity and environmental degradation, businesses are increasingly compelled to adopt practices that ensure longevity and resilience. Drawing from four comprehensive modules - Green Marketing, Logistics and Distribution, Sustainable Finance, and Supply Chain Management - this course delves into the intricate web of sustainable economic practices. From analyzing market demand for eco-friendly products to optimizing distribution channels with minimal environmental impact, each module offers invaluable insights into fostering economic activities that harmonize with environmental sustainability.

In the current era of heightened environmental awareness, fostering sustainable economic development has become paramount. Green Marketing initiatives are instrumental in this endeavor, as they explore strategies aimed at aligning consumer behavior with sustainability objectives. Emphasizing the significance of effectively communicating the environmental benefits associated with products and services, Green Marketing endeavors to catalyze consumer demand for eco-friendly alternatives. Logistics and Distribution practices play a pivotal role in mitigating environmental impact. By delving into the fundamental principles of logistics and elucidating their environmental implications, this discipline guides stakeholders in the development of strategies aimed at reducing carbon footprints across supply chains. Through the optimization of transportation and distribution processes, Logistics and Distribution contribute to the overarching goal of sustainable economic development. Sustainable Finance represents another critical facet of this paradigm shift towards sustainability. By introducing participants to the principles of responsible investing and financial decision-making, Sustainable Finance emphasizes the prioritization of environmental and social impacts in investment strategies. By aligning financial decisions with sustainability objectives, Sustainable Finance channels capital towards initiatives that promote long-term environmental and social well-being. Lastly, Supply Chain Management emerges as a cornerstone of sustainable economic development efforts. Equipping participants with the tools and methodologies to streamline operations, minimize waste, and enhance resource efficiency throughout the supply chain, Supply Chain Management plays a pivotal role in optimizing resource usage and reducing environmental footprint. By fostering collaboration and innovation within supply chains, Supply Chain Management facilitates the transition towards a more sustainable economic paradigm.

Through a multidisciplinary approach, this curriculum empowers participants to become adept managers capable of steering organizations towards sustainable economic practices. From understanding consumer behavior and market dynamics to implementing financial strategies that prioritize environmental and social outcomes, participants will emerge equipped with the knowledge and skills necessary to navigate the complexities of sustainable economic activity management in a rapidly evolving global landscape.

Target group

The Master GECA in Environmental Management and Control: Circular Economy and Resource Efficient Management envisages a minimum of 15 and a maximum of 24 participants.

Those who have obtained a master's degree, a specialized degree or an old university degree, or an equivalent qualification obtained at an Italian or foreign university or institute of equal standing may apply for admission.

Undergraduates who have completed their final examinations prior to the start of the master's course and who plan to acquire the qualification in the extraordinary session of the academic year preceding the start of the Master's course may also apply for admission.

Work required

In the curriculum, the average work required by each module is measured in units of ECTS credit (abbreviated in this presentation as CU). The curriculum consists of four units of total 6 ECTS credit units, corresponding to 112 hours of lectures, professional field visits, individual study a,nd assignments. The Management of Sustainable Economic Activity module can be administered individually, thus can be offered to those wishing to implement or develop skills related to the Circular Economy and sustainable management.

Contents of the curriculum

The module "Management of Sustainable Economic Activity" encompasses four distinct courses facilitated by esteemed lecturers from Scuola Superiore Sant'Anna and subject matter experts. The overarching objective extends beyond mere knowledge dissemination about the circular economy; it strives to empower participants to autonomously explore sector-specific best practices and technological-organizational solutions applicable to their own business. Practical exercises will delve into emblematic facets of circularity, such as evaluating business performance utilizing specialized measurement tools.

Instructors are committed to fostering:

- A conducive and positive classroom environment.

- Effective interpersonal communication fostering enduring relationships of trust and collaboration.

- Rigorous evaluation processes aligned with the holistic course objectives.

Prior to the commencement of each course, participants will receive comprehensive bibliographic reference materials tailored to equip them for proactive and informed engagement. This resource will span foundational principles and advanced topics, ensuring a robust learning experience.

The educational program seeks to nurture proficient managers capable of discerning decisions and formulating strategies aligned with the intricate requirements of sustainable economic methodologies. Its fundamental objective is to instill competencies and skills pertinent to the principal managerial frameworks and operational methodologies that support circular and resource-efficient management practices. Moreover, this curriculum strives to provide interdisciplinary perspectives relevant to diverse functional domains within business management, thereby fostering the formulation of practical strategies infused with principles of sustainable economic activities.

Specifically, it aims to foster:

a) Interdisciplinary prowess encompassing sustainable economic activity management, enriching students' existing knowledge and professional acumen.

b) Proficiency in problem-solving, project development, and the utilization of tools tailored to address environmental concerns within corporate frameworks.

c) Cultivation of collaborative teamwork, active engagement in organizational dynamics, and the continuous enhancement of sustainability-driven performance.

d) Proficiency in analysis, measurement, evaluation, organizational structuring, management, and effective communication pertinent to corporate economic sustainability management.

The curriculum is divided into four units as follows:

- UNIT 1: Sustainable Supply Chain Management
- UNIT 2: Sustainable Finance
- UNIT 3: Logistics & Distribution
- UNIT 4: Green Marketing

The structure of the modules D on Management of Sustainable Economic Activity are shown in the following Tables.

Table 1 Contents of Unit 1

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Unit 1: **Sustainable Supply Chain Management**	**Learning outcomes:** Provide a comprehensive understanding of the principles and practices required to manage a sustainable supply chain, with a focus on circular business models, collaborative approaches, sustainable public procurement, and the role of Human Resource Management in driving sustainability initiatives. Students will explore the development and implementation of green and circular initiatives through concrete case studies and practical examples.
Contents: • Introduction to Sustainable Supply Chain Management • Sustainable Supply Chain Management • The role of the supply chain in the development of circular business models • Sustainability and circularity in public procurement, plans and programmes • The role of the collaborative approach for the implementation of green and circular initiatives: analysis of concrete experiences • The role of Human Resource Management in managing a sustainable supply chain	
Student's workload: 29 lecture hours + 12 individual study hours (2 CFU)	
Possible materials: Kumar, A., Shrivastav, S. K., Shrivastava, A. K., Panigrahi, R. R., Mardani, A., & Cavallaro, F. (2023). Sustainable supply chain management, performance measurement, and management: a review. Sustainability, 15(6), 5290. Jraisat, L., Upadhyay, A., Ghalia, T., Jresseit, M., Kumar, V., & Sarpong, D. (2023). Triads in sustainable supply-chain perspective: why is a collaboration mechanism needed?. International Journal of Production Research, 61(14), 4725-4741.	

Long, Y., Liao, H., Lev, B. (2023). Sustainable Supply Chain Management: Definition, Bibliometrics, Applications, and Future Directions. In: García Márquez, F.P., Lev, B. (eds) Sustainability. International Series in Operations Research & Management Science, vol 333. Springer, Cham.

Sönnichsen, S. D., & Clement, J. (2020). Review of green and sustainable public procurement: Towards circular public procurement. Journal of cleaner production, 245, 118901.

Selected chapters from Sustainable Supply Chains: Strategies, Issues, and Models (2020). Springer Cham. https://doi.org/10.1007/978-3-030-48876-5

Table 2 Contents of Unit 2

Unit 2: **Sustainable Finance**	**Learning outcomes**: Provide a thorough understanding of sustainable finance principles and practices, including an introduction to the field, an overview of key international and local regulations and standards, and an in-depth exploration of sustainable finance instruments. Additionally, students will examine innovations and developments in sustainable finance, gaining insights into emerging trends and new financial tools.
Contents: • Introduction to Sustainable Finance • Main international and local regulations and standards. • Sustainable Finance Instruments • Innovation and Development in Sustainable Finance	
Student’s workload: 12 lecture hours + 5 individual study hours (1 CFU)	

Possible materials: Ferretti, P., Martino, P. (2023). An Introduction to Sustainable Finance. In: Banking and Financial Markets. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-031-32562-5_6 2022 G20 Sustainable Finance Report - Sustainable Finance Working Group. https://g20sfwg.org/wp-content/uploads/2022/10/2022-G20-Sustainable-Finance-Report-2.pdf Ferri, G., & Acosta, B. A. (2019). Sustainable finance for sustainable development. Center for Relationship Banking and Economics Working Paper Series, 30. Zetzsche, D. A., Bodellini, M., & Consiglio, R. (2022). The EU sustainable finance framework in light of international standards. Journal of International Economic Law, 25(4), 659-679. Schoenmaker, D., & Schramade, W. (2018). Principles of sustainable finance. Oxford University Press.

Table 3 Contents of Unit 3

Unit 3: **Logistics & Distribution**	**Learning outcomes:** Provide a solid foundation in logistics fundamentals, understand the environmental impact of logistics activities, and learn the key elements of supply chain decarbonisation auditing. Additionally, students will engage in lecturer-assisted group work to analyze real-world scenarios and present their findings, fostering collaborative skills and critical thinking.
Contents: • Logistics foundamentals • Logistics and its environmental impact • Elements of supply chain decarbonisation auditing • Lecturer-assisted group work & presentation of results and discussion	

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Student's workload: 12 lecture hours + 5 individual study hours (1 CFU)
Possible materials: Selected chapters from Sustainable Supply Chains: Strategies, Issues, and Models (2020). Springer Cham. https://doi.org/10.1007/978-3-030-48876-5 Perotti, S., Prataviera, L. B., & Melacini, M. (2022). Assessing the environmental impact of logistics sites through CO2eq footprint computation. Business Strategy and the Environment, 31(4), 1679-1694. EEA No 07/2022.Transport and environment report 2022 - Digitalisation in the mobility system: challenges and opportunities. ISBN 978-92-9480-519-5 Monciatti M., Marcu A. and Mehling M. (2021). The Role of Supply Chain Emissions in Decarbonization and Compliance. European Roundtable on Climate Change and Sustainable Transition ERCST. https://z7r689.n3cdn1.secureserver.net/wp-content/uploads/2021/09/20210921-Report_Role-of-Supply-Chain-Emissions-in-Decarbonization-and-Compliance-v17.pdf

Table 4 Contents of Unit 4

Unit 4: **Green Marketing**	**Learning outcomes:** Deliver a comprehensive understanding of the market demand for green products, explore consumer behavior related to sustainability, and analyze examples and best practices in green marketing. Additionally, students will engage with and present case studies, gaining practical insights into successful green marketing strategies.
Contents: • Analysis of market demand for green products • Consumer behaviour • Green marketing examples and best practices • Presentation of case studies	

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Student's workload: 27 lecture hours + 10 individual study hours (2 CFU)
Possible materials: Correia E, Sousa S, Viseu C, Larguinho M. Analysing the Influence of Green Marketing Communication in Consumers' Green Purchase Behaviour. Int J Environ Res Public Health. 2023 Jan 11;20(2):1356. doi: 10.3390/ijerph20021356. PMID: 36674112; PMCID: PMC9858907. Balasubramanian, S.K., Jain, G. (2011). Green Marketing: A Future Revolution. In: Practical Sustainability. Palgrave Macmillan, New York. https://doi.org/10.1057/9780230116368_6 International Trade Centre (2019). The European Union Market for Sustainable Products. The retail perspective on sourcing policies and consumer demand. ITC, Geneva. Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on substantiation and communication of explicit environmental claims (Green Claims Directive). COM/2023/166 final. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2023%3A0166%3AFIN

Teaching methods

Teachers are encouraged to use varying methods containing e.g.:

- Lectures,
- Visiting lecturers,
- Professional field visits,
- Visits in enterprises,
- Videos approaching the topics (Reliability of the source must be evaluated),
- Individual studies

Teaching module delivery schedule

D - Management of sustainable economic activity	• From 8 to 11 July 2024

Uniwersytet Pomorski w Słupsku

Three-level Centers of Professional Excellence: Qualification, Entrepreneurship and Innovation in the Green Economy

3LoE

Work Package 5, Activity 8.41

Test study module D
"Management of sustainable economic activity"

IMPLEMENTATION REPORT

Prepared by:

Pomeranian University in Słupsk

July-August 2024

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

Introduction

As the world confronts pressing environmental challenges and transitions towards more sustainable economic models, including in the European Union, the demand for professionals who are skilled and knowledgeable in sustainable practices is rapidly growing. To this end, the 3LoE project aims to bridge the knowledge and skills gap at three educational levels, from vocational schooling, through continuing to tertiary education. One of the activities for university partners was the implementation of study modules whose aim would be to train experts in specific areas of the green economy.

The "Management of Sustainable Economic Activity" module is one of them. It represents a highly important addition to the curriculum for future experts in the green economy. The specific implementation solutions, participant profile as well as the outcome of the implementation of the module are discussed below in respective sections.

The implementation is seen as an important milestone in the education of contemporary specialists, answering the needs of the future. "Management of Sustainable Economic Activity" module is essential for preparing future leaders and professionals to navigate the complexities of sustainable development. By providing a thorough understanding of the economic, financial, and ethical dimensions of sustainability, this module equips students with the tools they need to contribute meaningfully to a more sustainable future.

Detailed implementation scheme at Pomeranian University in Słupsk (PP6)

0. Background

The original study module (Module D) was developed and practically tested by Wirtschafts-Förderungsinstitut der Wirtschaftskammer Steiermark (WIFI). Pomeranian University in Słupsk received a complete description and curriculum to be implemented. However, the curriculum proved difficult to implement at Pomeranian University in Słupsk. The original study module envisaged various modules totaling 6 – 9 ECTS credit units corresponding 160 – 240 hours containing lectures, professional field visits, individual studies and assignments. This workload would be impossible to implement to the existing study programmes due to the limitations on the scope of modifications allowed in existing curricula and the time frame necessary to fully implement a new (updated/ upgraded) study programme, which effectively becomes

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fully binding as of the academic year following the official adoption of any modifications. Therefore, Pomeranian University in Słupsk decided to draft a new Module curriculum and implement the study module as an independent, elective study module.

The importance of this module cannot be overstated. First and foremost, it answers to the global threats related to climate change, resource depletion, and environmental degradation. Secondly, it supplements knowledge of traditional economic models, with a priority given to sustainability. The prospect is sustainable economic prosperity. This module addresses this need by providing students with a comprehensive understanding of sustainable economic management, including topics such as circular economy, sustainable resource management, corporate social responsibility, and the integration of sustainability into business strategies.

1. Curriculum development

It was decided that the study module will be an independent programme taught as an elective study programme. The curriculum was developed by the experts from the Institute of Management, where the 3LoE dual Bachelor's Degree Programme: Logistics - Green Supply Chains is also realised. The original programme was designed for 80 teaching hours and 3 ECTS points. However, student and staff feedback prompted the university project team to take a decision to redraft the programme.

The final curriculum envisages **a total of 54 teaching hours**, taught in micromodules. The course **ECTS** value would be **2 points**.

The teaching staff comprised the lecturers from the Institute of Management of Pomeranian University in Słupsk as well as business practitioners. All teaching staff were experts in their related fields, matching the contents of the curriculum.

- 3 professors,
- 5 assistant professors,
- 1 lecturer,
- 2 company CEOs (one retired).

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2. Module content (summary)

The content was designed in such a manner as to account for true beginners (students not acquainted with the subject). This was all the more so important that the participants could be students of any study year. The summary and detailed description below encompass only the updated, new Module programme (see the implementation remarks below).

Training Topics	**Number of Hours**
Introduction to Sustainable Development	2
European Concepts of Sustainable Development	4
Financing Sustainable Development	4
The Importance of Investment in the Concept of Sustainable Development	8
Economics of Sustainable Development	4
Corporate Social Responsibility – Examples of Best Practices	8
Energy Management System – Basics of ISO 50001:2018	6
Quality and Environmental Management Systems	4
Occupational Health and Safety Systems and Industry-Specific Systems	4
Sustainable Human Resource Management	6
Teal Organization – The Organization of the Future	4
TOTAL	**54**

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3. Module content (detailed)

Below is an outline of specific topics taught in the module by respective teachers. The was designed in such a manner as to account for true beginners (students not acquainted with the subject). This was all the more so important that the participants could be students of any study year.

Introduction to Sustainable Development	**2 hours**
Course description: This foundational course provides a comprehensive overview of the principles and practices of sustainable development, equipping participants with the knowledge and skills needed to address global environmental, social, and economic challenges. The course begins by exploring the core concepts of sustainable development, including its history, key frameworks, and the United Nations Sustainable Development Goals (SDGs). Participants will examine the interconnections between environmental stewardship, economic growth, and social equity, and how these pillars work together to create a more sustainable future. The course also covers the critical role of policy, governance, and international cooperation in promoting sustainability at local, national, and global levels. Real-world case studies and examples of successful sustainability initiatives will be discussed, highlighting innovative approaches and best practices. By the end of the course, participants will have a solid understanding of sustainable development principles and be prepared to apply this knowledge to contribute to a more sustainable world in their personal and professional lives.	

European Concepts of Sustainable Development	**4 hours**
Course description: This course delves into the unique approaches and strategies that have shaped sustainable development within Europe, providing participants with a deep understanding of the continent's role in advancing global sustainability goals. The course begins by exploring the historical evolution of sustainable development concepts in Europe, highlighting key policies, regulations, and frameworks that have driven environmental, social, and economic progress. Participants will examine the	

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European Union's Green Deal and its implications for member states, as well as the integration of sustainability into regional and national strategies. The course will also analyse the impact of European innovations and technologies in areas such as renewable energy, circular economy, and sustainable urban development. Case studies of successful European projects will be presented, offering practical insights into how these concepts are implemented on the ground. By the end of the course, participants will have a thorough understanding of Europe's contributions to sustainable development and be equipped to apply these concepts in various contexts, both within and beyond the European framework.

Financing Sustainable Development	**4 hours**
Course description: The course offers a comprehensive exploration of the financial mechanisms and strategies essential for advancing sustainable development initiatives globally. Participants will begin by understanding the fundamental principles of sustainable finance, including the role of public and private sector investments in driving economic growth while addressing environmental and social challenges. The course covers a range of financing options, such as green bonds, impact investing, and blended finance, that are specifically designed to support sustainability projects. Participants will also explore the role of international financial institutions, development banks, and government policies in mobilising resources for sustainable development. The course will provide insights into the challenges and opportunities of financing key areas such as renewable energy, sustainable infrastructure, and social enterprises.	

The Importance of Investment in the Concept of Sustainable Development	**8 hours**
Course description: This course offers an in-depth exploration of the critical role of investment within the framework of sustainable development. Beginning with a thorough understanding of the concept of investment, it covers the various types of investments and the intricacies of investment policy in business operations. Participants will learn how to effectively manage finances related to day-to-day business activities and how to navigate and mitigate associated risks. The course also delves into opportunities for financing sustainable development projects through public funds, focusing on areas such as energy efficiency, water purification, waste minimization, and the improved efficiency of material resource utilisation. The impact of technology on the environment will be critically examined, with an emphasis on how technological advancements can both challenge and support sustainability goals. Finally, the course will present real-world examples of technological solutions and investments that successfully incorporate environmental protection, providing	

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participants with practical insights into implementing sustainable practices in their own ventures.

Economics of Sustainable Development	**4 hours**
Course description: This course provides an in-depth examination of the economic principles and models that underpin sustainable development, focusing on how economic activities can be aligned with environmental stewardship and social equity. Participants will begin by exploring the theoretical foundations of sustainable economics, including concepts such as externalities, public goods, and natural capital. The course will delve into the economic tools and frameworks used to evaluate the costs and benefits of sustainable practices, such as cost-benefit analysis, environmental valuation, and life-cycle assessment. Participants will also study the role of market-based instruments like carbon pricing, subsidies, and taxes in promoting sustainable behaviours among businesses and consumers. The course will further explore the integration of sustainability into economic policy-making at local, national, and global levels, analysing the impact of such policies on economic growth, poverty reduction, and environmental protection. Real-world case studies will illustrate how economies can transition towards sustainability while maintaining competitiveness and fostering innovation. By the end of the course, participants will have a thorough understanding of how economic theory and practice can contribute to achieving sustainable development goals.	

Corporate Social Responsibility – Examples of Best Practices	**8 hours**
Course description: This course provides an insightful overview of Corporate Social Responsibility (CSR), focusing on its key principles and the practical benefits it offers to businesses. Participants will start with a review of various perspectives on CSR, exploring how it has evolved and its importance in today's business environment. The course will cover established CSR standards and frameworks, helping participants understand how to implement and measure responsible practices effectively. Additionally, the course will highlight the potential benefits that CSR can bring to organisations, such as enhanced reputation, customer loyalty, and competitive advantage. Through real-world examples of successful CSR initiatives, participants will gain practical knowledge on how to apply CSR strategies in their own businesses to create positive social, environmental, and economic impacts.	

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Energy Management System – Basics of ISO 50001:2018	**6 hours**
Course description: This course introduces the essential concepts and practices of the ISO 50001:2018 standard, designed to help organisations establish and maintain an effective energy management system. Participants will begin by exploring the importance of energy management and how improving energy efficiency can lead to cost reductions, lower environmental impact, and better overall performance. The course covers the core elements of ISO 50001:2018, including energy planning, performance evaluation, and the continuous improvement cycle. Attendees will learn the process of designing, implementing, and auditing an energy management system that meets the standard's requirements. Through real-world examples and case studies, participants will gain practical knowledge of effective energy management strategies, as well as the challenges and solutions involved in achieving ISO 50001:2018 certification. By the end of the course, participants will be equipped to support their organisations in optimising energy use and aligning with sustainability and regulatory standards.	

Quality and Environmental Management Systems	**4 hours**
Course description: This course offers a comprehensive introduction to the principles and practices of Quality Management Systems (QMS) and Environmental Management Systems (EMS), focusing on the integration of these systems to enhance organisational performance and sustainability. Participants will begin by exploring the core concepts of QMS, such as customer satisfaction, continuous improvement, and process management, with a particular emphasis on the ISO 9001 standard. The course will then delve into the fundamentals of EMS, including environmental policy, impact assessment, and compliance with environmental regulations, guided by the ISO 14001 standard. Through practical examples and case studies, participants will learn how to implement, manage, and audit these systems effectively, ensuring they work in harmony to achieve both quality and environmental objectives. The course also addresses the benefits and challenges of integrating QMS and EMS, providing strategies for seamless implementation. By the end of the course, participants will be equipped to contribute to the development of robust management systems that promote both quality excellence and environmental stewardship within their organisations.	

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Occupational Health and Safety Systems and Industry-Specific Systems	**4 hours**
Course description: The micromodule is an in-depth exploration of Occupational Health and Safety (OHS) management systems, with a focus on tailoring these systems to meet the unique needs of various industries. Discussion points: basic concepts, risk assessment, hazard identification, and the implementation of preventive measures. The role of OHS systems in the customisation in specific risk regulatory requirements of different industries will be discussed. Industry-specific case studies and best practices will be presented. Participants will learn how to design, implement, and audit OHS systems that not only ensure compliance but also promote a culture of safety and well-being within the workplace.	

Sustainable Human Resource Management	**6 hours**
Course description: This class content: the integration of sustainability principles into human resource management (HRM) practices, focusing on how HR can drive long-term organisational success while promoting social responsibility and employee well-being. The combination of HR strategies with sustainability goals, including talent management, diversity and inclusion, and ethical labour practices will be elaborated on. The course also covers best practices for creating a sustainable workplace culture that fosters employee engagement, retention, and overall organisational resilience. Short-term and long-term HRM strategies will be evaluated to show how they can support both business objectives and sustainable development.	

Teal Organization – The Organization of the Future	**4 hours**
Course description: This course provides a comprehensive exploration of the principles and practices of teal organisations, emphasising the shift towards self-management, wholeness, and evolutionary purpose. Participants will begin with an in-depth understanding of the "Decalogue of Building a Teal Organization," which outlines the essential steps for transitioning to this progressive organisational model. The course will then examine global and Polish case studies of companies that have successfully evolved into teal organisations, offering practical insights into their journeys. A critical discussion will follow, exploring whether every company has the potential to adopt the teal model. The course will also delve into the foundational principles of teal organisations, including the core values and culture that support this transformative approach. Finally, participants will be introduced to the tools and	

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techniques commonly used in teal organisations, equipping them with practical methods to implement and sustain teal practices in their own businesses.

4. Participants

The module was addressed to both students of Pomeranian University in Słupsk and external participants willing to take part in the programme.

5. Implementation timeline

November 2022-March 2023: Development of the Module programme

March 2023: Adoption of the Module programme

March-May 2023: Advertising, Spring Enrolment, and Module Management (staffing, classroom assignment, etc.)

May 2023: Decision to postpone the start of the Module

June-August 2023: Drafting of a new Module programme

October 2023: Fall Enrolment and Module Management

November-December 2023: Classroom and online courses and activities

December 2023: Module Completion / Certificates

January 2024: Evaluation of the Module among participants

6. Evaluation

The Module was subject to end-of-course evaluation, which was conducted among all participants. The template evaluation survey used for the assessment of the outcomes of the module is presented in Attachment 7.

The results of the evaluation are presented below.

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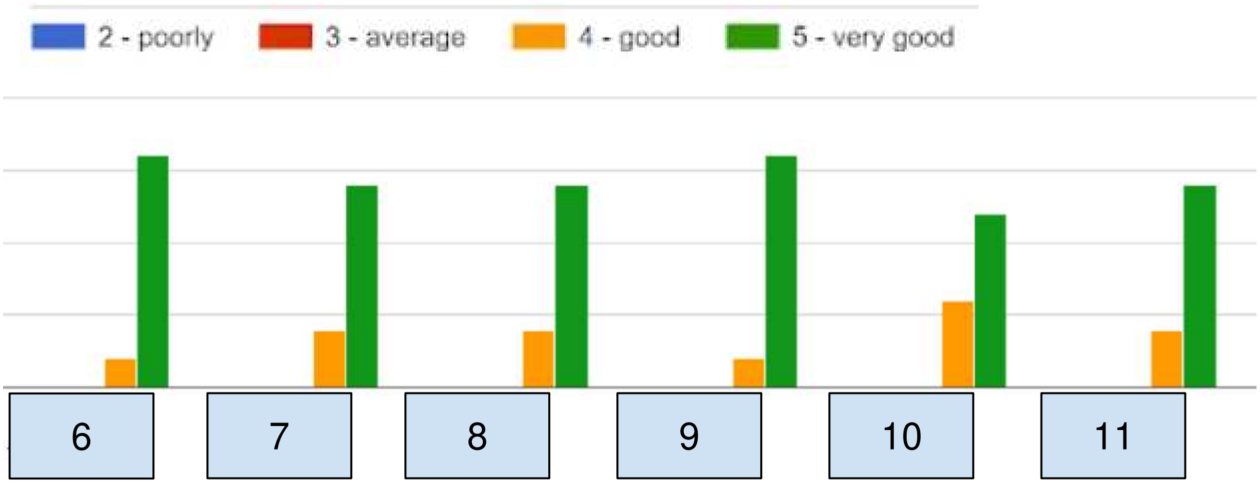
Q1 How would you rate the subject matter of the various thematic blocks?

1. Quality and Environmental Management Systems
2. Introduction to Sustainable Development
3. Teal Organization
4. Safety and Occupational Hygiene Systems and Industry-Specific Systems
5. Corporate Social Responsibility - Examples of Best Practices



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6. The Importance of Investments in Sustainable Development Concepts
7. European Concepts of Sustainable Development
8. Sustainable Human Resource Management
9. Financing Sustainable Development
10. Energy Management System - Basics of ISO 50001:2018
11. Economics of Sustainable Development

<u>Q2. How do you assess the teaching methods and knowledge delivery by the Instructor in the respective thematic blocks?</u>

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1. Quality and Environmental Management Systems – dr A. Rychły-Lipińska

2. Introduction to Sustainable Development – dr A. Sałek-Imińska

3. Teal Organization – Dr hab. P. Walentynowicz, prof. UP

4. Safety and Occupational Hygiene Systems and Industry-Specific Systems – dr inż. I. Osmołska

5. Corporate Social Responsibility – Examples of Best Practices – M. Bączkiewicz, CEO

6. The Importance of Investments in Sustainable Development Concepts – A. Wójtowicz, CEO

7. European Concepts of Sustainable Development – dr hab. B. Tundys, prof. UP

8. Sustainable Human Resource Management – dr E. Matuska

9. Financing Sustainable Development – prof. dr hab. M. Zioło

10. Energy Management System – Basics of ISO 50001:2018 – mgr W. Kamiński

11. Economics of Sustainable Development – dr W. Kunz

Evaluation data analysis:

- The consent of the Module was well-tailored to the needs/ expectations of the target group. The dominant grade ‘very good’ suggests high interest (and possibly motivation) in the areas discussed.
- The course on "Corporate Social Responsibility - Examples of Best Practices" was rated highly, which implies that participants are interested in real-world applications of CSR and are keen to learn from successful implementations. This also suggests a desire for practical, experience-based learning rather than purely theoretical approaches (the course was taught by a CEO).
- The assessment of the contents correlates with the assessment of the teachers/ instructors/ trainers, with only a few minor deviations.

<u>Q3. What did you like most about the training?</u>

- Meetings with practitioners.
- I really liked the open discussion in some classes (e.g., with Mr. Bączkiewicz), the opportunity to gain insights into standards, and curiosities about occupational health and safety (HS).
- Sessions on teal organisation.

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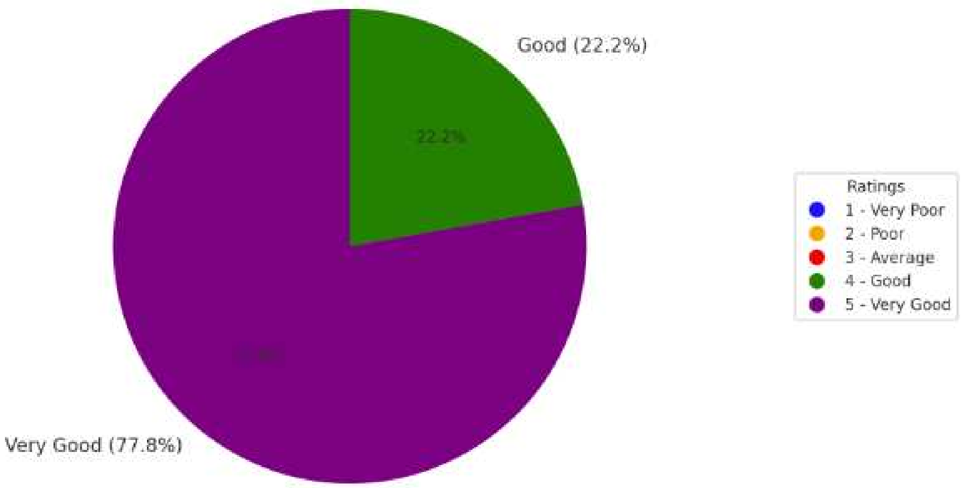
- Receiving materials from the presenters, with specific content for the thematic block.
- It was a nice initiative to receive materials after completing the training.
- The substantive and practical preparation of the lecturers, their approachability, and the preparation of didactic materials.

Q4. What was missing from the training?

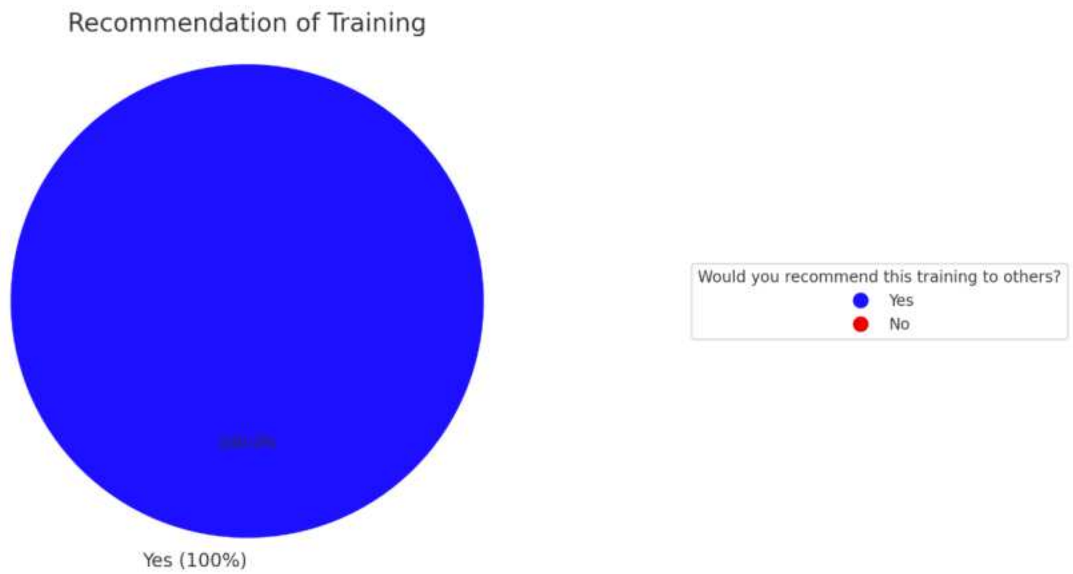
- Lack of workshop-style sessions.
- Silent monologues, too extensive presentations, not enough specifics (teal organisations).
- Lack of materials provided by most presenters.
- Lack of materials shared by the presenters (during the presentation).

Q5. What is your general assessment of the study Module?

‘



Q6. Would you recommend the training?



Summary of evaluation data:

- The Study Module elements were assessed highly by participants, with the final (general;/ global) evaluation being very positive for the entire Module.
- The evaluation shows that the most valued elements were: the practical alignment of the classes, in-depth discussions with practitioners, the preparedness of trainers, and the quality of the materials used in the training.
- Some participants underscored that the module could have been more workshop-oriented.

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Module implementation results

1. Pomeranian University in Słupsk received a ready-to-be-implemented study module from another 3LoE partner. However, upon analyses it was proven that it was impossible to implement the module in its current version. Accordingly, the **university project team decided to develop its own Module programme**. The title of the Module remained the same: “Management of Sustainable Economic Activity”. The study content was so designed that students could obtain an external certificate, such as ones issued by TÜV SÜD Polska (especially in relation to the energy management systems according to ISO 50001:2018 and environment management systems according to ISO 14001:2015). The idea was not further developed due to financial constraints (both on the part of the university and the students).

2. The programme was developed from November 2022 to March 2023, with the final stage encompassing the verification of the documentation. **The original Module programme, as adopted in May 2023, envisaged 80 teaching hours, equivalent ot 3 ECTS points.** The programme was developed by experts from the Institute of Management at Pomeranian University in Słupsk. It was decided that due to formal issues, the programme would be implemented as an independent module beyond any study programme. Upon completion of the Module, each participant would receive a certificate (see Attachment 1).

3. The launch of the Module was scheduled to take place in May 2023 and last till June 2023. The timetable was designed in such a way that all **classes (in-person and online) would take place at weekends (see Attachment 2)**. The recruitment procedure ended in May 2023, and resulted in **17 enrolled students (see Attachment 3). All enrolled candidates were students of Pomeranian University in Słupsk.** However, the attendance turned out to be very low in two consecutive days of the classes, and therefore the university project team cancelled the remaining classes and postponed the launch of the study Module till the following academic year.

4. Due to organisational changes and feedback from the students and academic staff, the original programme was verified and adopted to the needs of the students. The newprogramme envisaged **54 teaching hours, equivalent to 2 ECTS.**

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5. In the second recruitment procedure (October 2023), as many as **61 students enrolled in the Module (see Attachment 4). All enrolled candidates were students of Pomeranian University in Słupsk.** Students attended both on-site and online classes. The on-site classes took place at the premises of Pomeranian University in Słupsk.

6. The classes were taught on weekends on the following **dates: 18.11.2023, 19.11.2023, 25.11.2024, 26.11.2023, 2.12.2023, 10.12.2023.** All classes were fully completed and realised. **The attendance of students was running at 50-75% level**.

7. The Module was designed to also include external participants from companies and other stakeholders. However, the interest in the Module was very low, and therefore the commercial element of the Module training was not launched.

8. The benchmark for obtaining a credit and therefore to successfully complete the Module was a level of 75% of attendance across the entire study programme. Upon completion of the Module, each participant who met the requirement, was issued a Certificate. **The total number of students who received the Certificate = completed the Module was 36**.

9. **STRENGTHS** of the adopted solutions:
   - current topic, well-tailored to the current needs of the job market;
   - development of own Module curriculum, with an optimal number of teaching hours, which made it more appealing for the participants; The original Module training envisaged 80 teaching hours, which proved to be too big a workload during a regula academic year (hence the reevaluation of the programme made it more attractive, resembling a microcredentials course);
   - adoption of a more flexible approach (elective course), which enabled students from different departments to take part in the training; Also, the weekend setup of classes was the best solution to combine regular studies (taught from Monday to Friday) with the classes taught within the Module;
   - adoption of a hybrid teaching approach, i.e. partly taught in the online, and partly face-to-face fashion;
   - the courses taught by experts and practitioners, including two CEOs of big companies in the city, provided fresh and important insight into the workings of companies striving at becoming more sustainable;

   the practical alignment of the trainings.

10. **WEAKNESSES** of the adopted solutions:

   - the lack of external participants limited the scope/ range of influence of the content; it also limited the outreach of the project;

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- the original Module content (as outlined in the programme) was too extensive, especially when considering the number of student-teacher contact hours. This prompted the university project team to verify and adapt the programme, which proved to be labour intensive;
- the courses could have been more workshop-oriented;
- study materials could have been distributed prior to the classes.

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Attachment 1: Certificate Template

Uniwersytet Pomorski w Słupsku

3LoE

Zaświadczenie

Pan

NAME + SURNAME
....

ukończył szkolenie pt.
"Management of Sustainable Economic Activity"

w ramach projektu
„Three – level Centers of Professional Excellence: Qualification, Entrepreneurship and Innovation in the Green Economy (3LoE)"

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Uniwersytet Pomorski w Słupsku
3LoE

Tematyka szkolenia	Liczba godzin
Wprowadzenie do zrównoważonego rozwoju	2
Europejskie koncepcje zrównoważonego rozwoju	4
Finansowanie zrównoważonego rozwoju	4
Znaczenie inwestycji w koncepcji zrównoważonego rozwoju	8
Ekonomia zrównoważonego rozwoju	4
Społeczna odpowiedzialność biznesu – przykłady dobrych praktyk	8
System zarządzania energią – podstawy ISO 50001:2018	6
Systemy zarządzania jakością i środowiskiem	4
Systemy bezpieczeństwa i higieny pracy oraz systemy specyficzne dla sektora przemysłowego	4
Zrównoważone zarządzanie zasobami ludzkimi	6
Organizacja turkusowa – organizacja przyszłości	4
RAZEM	**54**

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Attachment 2: Timetable (first implementation attempt)

Plan szkolenia: „ pt. "Management of Sustainable Economic Activity".

I. 13-14.05.2023

	godziny	SOBOTA - 13.05			godziny	NIEDZIELA - 14.05	
		Przedmiot	sala			Przedmiot	sala
1	8.00 - 8.45	Wprowadzenie do zrównoważonego rozwoju (4 h) dr A. Sałek-Imińska		1	8.00 - 8.45		
2	8.45 - 9.30			2	8.45 - 9.30		
3	9.40 - 10.25	ul. Kozietulskiego 6-7; sala 68	68	3	9.40 - 10.25	Systemy zarządzania jakością i środowiskiem - dr A. Rychły-Lipińska (2h) ul. Kozietulskiego 6-7; sala 68	
4	10.25 - 11.10			4	10.25 - 11.10		68
5	11.20 - 12.05	Zrównoważone zarządzanie zasobami ludzkimi (4h) dr E. Matuska		5	11.20 - 12.05	System zarządzania energią - podstawy ISO 50001:2018 - mgr W. Kamiński (4h)	
6	12.05 - 12.50			6	12.05 - 12.50		
7	13.00 - 13.45	ul. Kozietulskiego 6-7; sala 68		7	13.00 - 13.45	ul. Kozietulskiego 6-7; sala 68	
8	13.45 - 14.30			8	13.45 - 14.30		
9	14.40 - 15.25			9	14.40 - 15.25	Ekonomia zrównoważonego rozwoju - dr W. Kunz (2h) ul. Kozietulskiego 6-7; sala 68	
10	15.25 - 16.10			10	15.25 - 16.10		

II. 20-21.05.2023

	godziny	SOBOTA - 20.05			godziny	NIEDZIELA - 21.05	
		Przedmiot	sala			Przedmiot	sala
1	8.00 - 8.45	Społeczna odpowiedzialność biznesu Prezes M. Bączkiewicz (4h)		1	8.00 - 8.45	System zarządzania energią - podstawy ISO 50001:2018 - mgr W. Kamiński (6h)	
2	8.45 - 9.30			2	8.45 - 9.30		
3	9.40 - 10.25	ul. Kozietulskiego 6-7; sala 70	70	3	9.40 - 10.25	ul. Kozietulskiego 6-7; sala 69	69
4	10.25 - 11.10			4	10.25 - 11.10		
5	11.20 - 12.05	Systemy zarządzania jakością i środowiskiem - dr A. Rychły-Lipińska (4h)		5	11.20 - 12.05		
6	12.05 - 12.50			6	12.05 - 12.50		
7	13.00 - 13.45	ul. Kozietulskiego 6-7; sala 70		7	13.00 - 13.45		
8	13.45 - 14.30			8	13.45 - 14.30		
9	14.40 - 15.25			9	14.40 - 15.25		

III. 27-28.05.2023

	godziny	SOBOTA - 27.05.			godziny	NIEDZIELA - 28.05	
		Przedmiot	sala			Przedmiot	sala
1	8.00 - 8.45	Znaczenie inwestycji w koncepcji zrównoważonego rozwoju - Prezes A. Wójtowicz (2h)		1	8.00 - 8.45	Europejskie koncepcje zrównoważonego rozwoju - prof. B. Tundys (4h) online	
2	8.45 - 9.30	ul. Kozietulskiego 6-7; sala 68		2	8.45 - 9.30		
3	9.40 - 10.25	Organizacja turkusowa - prof. P. Walentynowicz (8h)	68	3	9.40 - 10.25		
4	10.25 - 11.10	ul. Kozietulskiego 6-7; sala 68		4	10.25 - 11.10		
5	11.20 - 12.05			5	11.20 - 12.05		
6	12.05 - 12.50			6	12.05 - 12.50		
7	13.00 - 13.45			7	13.00 - 13.45		
8	13.45 - 14.30			8	13.45 - 14.30		
9	14.40 - 15.25			9	14.40 - 15.25		
10	15.25 - 16.10			10	15.25 - 16.10		

IV. 03-04.06.2023

	godziny	SOBOTA 03.06.			godziny	NIEDZIELA - 04.06	
		Przedmiot	sala			Przedmiot	sala
1	8.00 - 8.45	Społeczna odpowiedzialność biznesu Prezes M. Bączkiewicz (4h)		1	8.00 - 8.45	Finansowanie zrównoważonego rozwoju prof. M. Zioło (4 h) online	
2	8.45 - 9.30	ul. Kozietulskiego 6-7; sala 70		2	8.45 - 9.30		
3	9.40 - 10.25			3	9.40 - 10.25		
4	10.25 - 11.10		70	4	10.25 - 11.10		
5	11.20 - 12.05	Systemy bezpieczeństwa i higieny pracy - dr inż. I. Osmólska (6h)		5	11.20 - 12.05	Zrównoważone zarządzanie zasobami ludzkimi (6h on-line) dr E. Matuska	
6	12.05 - 12.50	ul. Kozietulskiego 6-7; sala 70		6	12.05 - 12.50		
7	13.00 - 13.45			7	13.00 - 13.45		
8	13.45 - 14.30			8	13.45 - 14.30		
9	14.40 - 15.25			9	14.40 - 15.25		
10	15.25 - 16.10			10	15.25 - 16.10		

V. 17-18.06.2023

	godziny	SOBOTA - 17.06.			godziny	NIEDZIELA - 18.06.	
		Przedmiot	sala			Przedmiot	sala
1	8.00 - 8.45	Znaczenie inwestycji w koncepcji zrównoważonego rozwoju (4h) - Prezes A. Wójtowicz		1	8.00 - 8.45	Znaczenie inwestycji w koncepcji zrównoważonego rozwoju (2h) - A. Wójtowicz	
2	8.45 - 9.30	ul. Kozietulskiego 6-7; sala 82	82	2	8.45 - 9.30	ul. Kozietulskiego 6-7; sala 82	
3	9.40 - 10.25			3	9.40 - 10.25	Społeczna odpowiedzialność biznesu Prezes M. Bączkiewicz (4h)	
4	10.25 - 11.10			4	10.25 - 11.10		82
5	11.20 - 12.05			5	11.20 - 12.05	ul. Kozietulskiego 6-7; sala 82	
6	12.05 - 12.50			6	12.05 - 12.50		
7	13.00 - 13.45	Europejskie koncepcje zrównoważonego rozwoju - prof. B. Tundys (2 h) on-line		7	13.00 - 13.45	Ekonomia zrównoważonego rozwoju - dr W. Kunz (4h)	
8	13.45 - 14.30			8	13.45 - 14.30		
9	14.40 - 15.25			9	14.40 - 15.25	ul. Kozietulskiego 6-7; sala 82	
10	15.25 - 16.10			10	15.25 - 16.10		

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Attachment 3: Enrollment (first implementation attempt)

Lista osób zapisanych na szkolenie pt. "**Management of Sustainable Economic Activity**".

13.05.2023 – 18.06.2023

Lp.	Imię i nazwisko	E-mail
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Attachment 4: Enrollment (second implementation attempt)

Enrolment list

„Management of Sustainable Economic Activity"

November-December 2023

1.	Adamczyk Kinga	Pani	kingaadamczyk16@tlen.pl
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11.	Głuszek Kinga	Pani	gluszek.kinga@gmail.com
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13.	Golańska Karolina	Pani	karolina.golanska@wp.pl
14.	Graużenis Sylwia	Pani	sylwia@dc.net.pl
15.	Gurdzielewska Hanna	Pani	hanna.gurdzielewska@wp.pl
16.	Gwizdała Klaudia	Pani	klaudia.gwizdala1422@wp.pl
17.	Harkusha Daniil	Pan	daniilstudia86@gmail.com
18.	Hirhus Alina	Pani	alinkahirhus@gmail.com
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24.	Klimkiewicz Beata	Pani	beaklim@wp.pl
25.	KOS Krystian	Pan	polis_90@o2.pl
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34.	Mazurenko Dmytro	Pan	stevendimetion@gmail.com
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45.	Preis Krystyna	Pani	Krystyna.preis08@gmail.com
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58.	Vilkov Andrii	Pan	scripteeer@gmail.com
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Attachment 5: Timetable (second implementation attempt)

Uniwersytet Pomorski w Słupsku

Three-level Centers of Professional Excellence: Qualification, Entrepreneurship and Innovation in the Green Economy (3LoE)

3LoE

Szkolenie: Management of Sustainable Economic – Zarządzanie zrównoważoną działalnością gospodarczą

Termin szkolenia 18.11.2023 – 10.12.2023

	godziny	SOBOTA - 18.11	
		Przedmiot	**sala**
1	9.40 - 10.25	Systemy zarządzania jakością i środowiskiem – dr A. Rychły-Lipińska (4h)	aula 414 ul. Westerplatte 64 (III piętro)
2	10.25 - 11.10		
3	11.20 - 12.05		
4	12.05 - 12.50		
5	13.00 - 13.45	Wprowadzenie do zrównoważonego rozwoju - dr A. Sałek-Imińska (2h)	
6	13.45 - 14.30		

	godziny	NIEDZIELA - 19.11	
		Przedmiot	**sala**
1	**9.30** - 10.15	Turkusowa Organizacja – dr hab. P. Walentynowicz, prof. UPSL (4h)	aula 414 ul. Westerplatte 64 (III piętro)
2	10.15 - 11.00		
3	11.10 - 11.55		
4	11.55 - **12.40**		
5	13.00 - 13.45	Systemy bezpieczeństwa i higieny pracy oraz systemy specyficzne dla sektora przemysłowego – dr inż. I. Osmólska (4h)	
6	13.45 - 14.30		
7	14.40 - 15.25		
8	15.25 - 16.10		

	godziny	SOBOTA - 25.11	
		Przedmiot	**sala**
1	8.00 - 8.45	Społeczna odpowiedzialność biznesu - przykłady dobrych praktyk - Prezes M. Bączkiewicz (8h)	aula 414 ul. Westerplatte 64 (III piętro)
2	8.45 - 9.30		
3	9.40 - 10.25		
4	10.25 - 11.10		
5	11.20 - 12.05		
6	12.05 - 12.50		
7	13.00 - 13.45		
8	13.45 - 14.30		

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Uniwersytet Pomorski w Słupsku
Three-level Centers of Professional Excellence: Qualification, Entrepreneurship and Innovation in the Green Economy (3LoE)
3LoE

	godziny	NIEDZIELA - 26.11	
		Przedmiot	sala
1	8.00 - 8.45	Znaczenie inwestycji w koncepcji zrównoważonego rozwoju - Prezes A. Wójtowicz (8h)	aula 414 ul. Westerplatte 64 (III piętro)
2	8.45 - 9.30		
3	9.40 - 10.25		
4	10.25 - 11.10		
5	11.20 - 12.05		
6	12.05 - 12.50		
7	13.00 - 13.45		
8	13.45 - 14.30		

	godziny	SOBOTA - 02.12	
		Przedmiot	sala
1	8.00 - 8.45	Europejskie koncepcje zrównoważonego rozwoju – dr hab. B. Tundys, prof. UPSL (4h online)	ZAJĘCIA ONLINE
2	8.45 - 9.30		
3	9.40 - 10.25		
4	10.25 - 11.10		
5	11.20 - 12.05	Zrównoważone zarządzanie zasobami ludzkimi – dr E. Matuska (6 h online)	
6	12.05 - 12.50		
7	13.00 - 13.45		
8	13.45 - 14.30		
9	14.40 - 15.25		
10	15.25 - 16.10		

	godziny	NIEDZIELA - 03.12	
		Przedmiot	sala
1	8.00 - 8.45	Finansowanie zrównoważonego rozwoju - dr hab. M. Zioło, prof. UPSL (4h online)	ZAJĘCIA ONLINE
2	8.45 - 9.30		
3	9.40 - 10.25		
4	10.25 - 11.10		
5	11.20 - 12.05	System zarządzania energią - podstawy ISO 50001:2018 - mgr W. Kamiński (6h online)	
6	12.05 - 12.50		
7	13.00 - 13.45		
8	13.45 - 14.30		
9	14.40 - 15.25		
10	15.25 - 16.10		

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Uniwersytet Pomorski w Słupsku
Three-level Centers of Professional Excellence: Qualification, Entrepreneurship and Innovation in the Green Economy (3LoE)
3LoE

UWAGA! SOBOTA 09.12.2023 – NIE MA ZAJĘĆ!

	godziny	NIEDZIELA - 10.12	
		Przedmiot	**sala**
1	8.00 - 8.45	Ekonomia zrównoważonego rozwoju – dr W. Kunz (4h online)	**ZAJĘCIA ONLINE**
2	8.45 - 9.30		
3	9.40 - 10.25		
4	10.25 - 11.10		

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Attachment 6: List of Students who successfully completed Module training and received a Certificate

3LoE

Certificate list
„Management of Sustainable Economic Activity"
November-December 2023

Uniwersytet Pomorski w Słupsku

1	Aminova Anastasiia
2	Andrushok Anastasiia
3	Bobyr Stanialav
4	Bojanowska Klaudia
5	Frankowski Szymon
6	Głuszek Kinga
7	Godau Wiktoria
8	Graużenis Sylwia
9	Harkusha Daniil
10	Hirhus Alina
11	Hoholiuk Kateryna
12	Janeczek Kinga
13	Karpovich Marharyta
14	Klimkiewicz Beata
15	Kosovan Serhii
16	Krenciszek Paweł
17	Kuz Yaroslav
18	Lypka Vitalina
19	Malska Julia
20	Mazurenko Dmytro
21	Odynska Yuliia
22	Orlianska Anastasiia
23	Popa Oriana
24	Preis Krystyna
25	Prykhodko Svitlana
26	Prysiazhniuk Liudmyla
27	Semenikhin Serhii
28	Skulavets Diana
29	Skulski Mateusz
30	Stenzel Kamila
31	Strzyżewska Monika
32	Sytar Andriana
33	Vilkov Andrii
34	Waśko Grzegorz
35	Wójcik Emilia
36	Yahorau Ivan

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Attachment 7: Evaluation survey

SURVEY OF PARTICIPANTS

(Evaluation survey of the training course “Managing Sustainable Business)

Dear Participants,

This anonymous survey is designed to evaluate the training course entitled. “Management of Sustainable Economic Activity” among its participants. The training consisted of 54 teaching hours, and was held from 18.11.2023 to 10.12.2023.

Your comments and suggestions will allow us to improve the quality of education in the organized training/courses and to better connect the topics, the way of teaching with the expectations of the audience.

We kindly ask you to fill out the following questionnaire (the survey will not take you long).

Q1: How would you rate the subject matter of the various thematic blocks?

2= poor; 3= average; 4=good; 5=very good (the traditional academic grading scheme applied in Polish universities was used throughout unless otherwise indicated).

[1] Quality and environmental management systems	2	3	4	5
[2] Introduction to sustainable development	2	3	4	5
[3] Teal organization	2	3	4	5
[4] Occupational health and safety systems and systems specific to the industrial sector	2	3	4	5
[5] Corporate social responsibility - examples of good practice	2	3	4	5
[6] The importance of investment in the concept of sustainable development	2	3	4	5
[7] European concepts of sustainable development	2	3	4	5
[8] Sustainable human resource management	2	3	4	5
[9] Financing sustainable development	2	3	4	5

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[10] Energy management system - basics of ISO 50001:2018	2	3	4	5
[11] Economics of sustainable development	2	3	4	5

Q2: How would you rate the manner in which the class was conducted and the knowledge transferred by the Instructor in each subject block?

2= poor; 3= average; 4=good; 5=very good

[1] Quality and environmental management systems	2	3	4	5
[2] Introduction to sustainable development	2	3	4	5
[3] Teal organization	2	3	4	5
[4] Occupational health and safety systems and systems specific to the industrial sector	2	3	4	5
[5] Corporate social responsibility - examples of good practice	2	3	4	5
[6] The importance of investment in the concept of sustainable development	2	3	4	5
[7] European concepts of sustainable development	2	3	4	5
[8] Sustainable human resource management	2	3	4	5
[9] Financing sustainable development	2	3	4	5
[10] Energy management system - basics of ISO 50001:2018	2	3	4	5
[11] Economics of sustainable development	2	3	4	5

Q3: What did you like most about the training?

You are encouraged to express your opinion regarding, for example, the specific content of the thematic block, the atmosphere during the training, the interaction with the Trainers, the materials received from the Trainers, etc.

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Q4: What was missing from the training?

We encourage you to express your opinion regarding, for example, organisational shortcomings, lack of materials provided by the Presenters, etc.

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Q5: What is your **overall assessment** of the training?

1=very weak;

2= weak;

3= average;

4=good;

5=very good

Q6: Would you recommend this training to others?

YES

NO

Q7 Comments

If you have additional suggestions/observations that you would like to share with us that were not included in the other survey questions, feel free to write in :)

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Thank you for your answers!

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Result 5.2
Green Economy Study Modules

Study module D
Management of sustainable economic activity

Evaluation Report

PANEVĖŽIO KOLEGIJA

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

REPORT ON THE EVALUATION OF COURSE

Management of Sustainable Economic Activity

Prepared by Panevėžio kolegija/University of Applied Sciences

2024

PANEVĖŽIO KOLEGIJA

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PANEVĖŽIO KOLEGIJA

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1. THE COURSE EVALUATION BY STUDENTS

Course evaluation by students was performed using online survey. Electronic version of the survey available at https://forms.gle/LRbGeYi12dySA3kV8. Online survey was carried in 2023, 15th of January. 26 students (PANKO-22, Scuola superiore sant'anna – 4) (man – 85 percent, women – 15 percent; under 20 – 15 percent, 20–29 – 46 percent, 30–39 – 27 percent, 40–49 – 8 percent, 50–59 – 4 percent) took part in the survey.

7. Evaluation of course content and teaching quality

7.1. The objectives of the course and study results, evaluation criteria were clearly defined from the very beginning of the course:

	Number	Percentage
Strongly agree	15	58
Agree	11	42
Neither agree nor disagree	0	0
Disagree	0	0
Strongly disagree	0	0

7.2. Assessment of the study results was appropriate:

	Number	Percentage
Strongly agree	14	54
Agree	11	42
Neither agree nor disagree	1	4
Disagree	0	0
Strongly disagree	0	0

7.3. The content was interesting, relevant, useful and allowed to achieve study results:

	Number	Percentage
Strongly agree	11	42
Agree	13	50
Neither agree nor disagree	1	4
Disagree	1	4
Strongly disagree	0	0

7.4. The course content responds to the latest scientific achievements:

	Number	Percentage
Strongly agree	13	50
Agree	12	46
Neither agree nor disagree	1	4
Disagree	0	0
Strongly disagree	0	0

7.5. Theory was taught in conjunction with the practical examples:

	Number	Percentage
Strongly agree	10	38
Agree	15	58
Neither agree nor disagree	1	4
Disagree	0	0
Strongly disagree	0	0

7.6. Theory was taught in context of the sustainable development issues:

	Number	Percentage
Strongly agree	10	38

Agree	15	58
Neither agree nor disagree	1	4
Disagree	0	0
Strongly disagree	0	0

7.7. The course topics were not repetitive:

	Number	Percentage
Strongly agree	10	38
Agree	12	46
Neither agree nor disagree	2	8
Disagree	2	8
Strongly disagree	0	0

7.8. The teaching materials were presented in an organized manner:

	Number	Percentage
Strongly agree	10	38
Agree	12	46
Neither agree nor disagree	3	12
Disagree	1	4
Strongly disagree	0	0

7.9. The teaching materials distributed were helpful to achieve study results:

	Number	Percentage
Strongly agree	9	35
Agree	14	54
Neither agree nor disagree	3	12
Disagree	0	0
Strongly disagree	0	0

7.10. Lecturer encouraged my participation, initiative and interaction during the lectures:

	Number	Percentage
Strongly agree	13	50
Agree	12	46
Neither agree nor disagree	1	4
Disagree	0	0
Strongly disagree	0	0

7.11. The study methods chosen by the lecturer helped to understand the course:

	Number	Percentage
Strongly agree	13	50
Agree	12	46
Neither agree nor disagree	1	4
Disagree	0	0
Strongly disagree	0	0

7.12. The teaching process included interactive methods:

	Number	Percentage
Strongly agree	15	58
Agree	9	34
Neither agree nor disagree	2	8
Disagree	0	0
Strongly disagree	0	0

7.13. The lecturer was a good communicator

	Number	Percentage
Strongly agree	13	50
Agree	10	38
Neither agree nor disagree	2	8
Disagree	1	4
Strongly disagree	0	0

8. Comments on strengths and ways of improvement

8.1. How do you evaluate the course quality

	Number	Percentage
Very satisfied	14	54
Satisfied	10	38
Neither satisfied nor disstisfied	1	4
Dissatisfied	1	4
Very dissatisfied	0	0,0

8.2. How do you evaluate the course lecturer

	Number	Percentage
Very satisfied	15	58
Satisfied	9	34
Neither satisfied nor disstisfied	1	4
Dissatisfied	1	4
Very dissatisfied	0	0,0

8.3. Could you name the main advantages of this course?

interesting, valuable, practical; curiosity, value, practicality; Interesante y novedoso; salida laboral; Conocimiento sobre eficiencia energética; Conocimentos Edar , Etap , eficiencia energetica; Un tema muy general, completo y diferente. Muy úti; De manera general,las partes de una EDAR,etc...; El conocimiento aprendido relacionado en los aspectos relacionados con el mundo del agua.; Que es un tema que interesa mucho ; Et fa veure la importancia de l'aigua; Sensibilizarse con la generación de energía renovables y el movimiento de energía verde; Sortides laborals; Hem après i entés aquells coneixements relacionats amb transformadors, etaps, edars, eficiència energètica.; Poder entender les coses mal echas; Consolidar conocimientos de energia y sostenibilidad; Aconseguim tenir una visio mes gloval del cicle integral del aigua; Conocimientos de los procesos de las instalaciones de agua y sus mejoras para mejor rendimiento y eficiencia energetica; Mejorar la conciencia de la gente de la importancia del agua y su uso; Poder conocer en profundidad todos los procesos y tecnologias aplicables en la gestion del agua; He podido saber mas de un tema que me interesa; Els coneixements adquirits els podré possar en practica en la meva vida laboral; Este curso nos enseña al detalle como se subministra el agua desde el medio hasta nuestros hogares. También brinda conocimiento sobre los procesos que realizaremos una vez salgamos al mundo laboral, además de concienciarnos en el proceso sobre el agua y su importancia para nuestro día a día.; Los conceptos *mencionados en la teoria de este curso nos da una idea especifica y fácil de entender de como se suministra el agua potable hacia nuestros hogares y todas aquellas dificultades y puntos que tenemos en cuenta para diversos calculos como cómo conseguir las presiones y el tamaño de las cañerias.*

8.4.Which specific difficulties you encountered while studying the course?

lack of time due to work; Teoria excesiva; las materias de fisica y electricidad son dificiles, cuesta tiempo de verlas; Ninguna; Poca información y implicación por parte de los medios externos; Lo que más me costó fue,en que partes y como ahorrar energía,y como conseguir 0 CO2,etc...; Demasiada carga de trabajo en el conjunto de asignaturas durante el primer año de curso; No habia niguna dificultad especifica; Obtens molta informacio útils per la vida cotidiana; La dificultat de trobar informacio una mes específica de la habitual; Falta d'algun treball aplicat a la realitat; Amb els transformadors; Obtener mucha información; para Quando comience a trabajar; falta de parcticas de laboratorio; Ens va costar trobar les dades de consum energètic de les plantes , per així poder millorar la eficiència energètica.; Se podría facilitar ejemplos reales de auditorias .; Mucha información en poco tiempo; Ver más la parte practica de la teoria; Me ha costado asimilar conceptos que eran nuevos para mi; Poc temari aplicat a la vida real; En mi caso personal, no encontré ningún problema destacable.; Es un concepto que sin tener ninguna idea no llegamos a comprender en la primera instancia. Debido a la dificultad de esto hay muchas personas que incluso los conceptos basicos les cuesta mucho de comprender por todo lo especifico que és.

8.5. Could you name the main disadvantages of this course?

I can't; I can't; Demasiado nuevo y poco complete; la poca organizacion que hay al ser un curso nuevo; la organizacion y el cantidad de horas para cada uf; Poco material de practicas; nada; Poco reconocimiento; No se puede conseguir 0 emisiones de CO2,etc... La principal desventaja es que no se realiza en distintos lugares este curso teniendome que desplazar una hora cada dia para asistir a clase.; Que era algo nuevo para mi y a veces me costaba asimilar conceptos; Poques hora de estudi; Creo que no tienen ningún inconveniente, todo lo que sea aprender sobre eficiencia energética,auditorias etc de cara a un futuro es beneficioso para la Sociedad; Falta de classes practiques; Haver vist mês casos pràcticament d'auditorias energètiques.; Tener mucha información de todo i poca útil ; Falta de salidas a instalaciones reales; Vaig trobar a faltar més visites a industries o instalacions del sector del aigua; No hay desventajas; Pocos centros que hagan este curso.; La falta de vision en campo, hay mucha informacion mucha teoria, pero faltaria poder verlo mas en la vida real para aclarar conceptos.; Información irrelevante que tienes que buscar; poc temps per posar-ho en practica avans dels examens; Hay una gran cantidad de teoría. El temario es dificil para quien no tiene experiencia o algun conocimiento previo.

8.6. What changes would you recommend to improve this course?

more practice; Mejor organizacion; que las materias fueran claras; mejor organizacion y mas practica. mucha teoria que no utilizaremos en el entorno laboral; Un taller de

hidraulica me ha parecido muy didactico; Nothing; Enfocarlos más hacia el ámbito práctico laboral del agua; Realizar el curso en mas lugares y que las clases fueran mas reducidas.; Hacer mas cosas de laboratorio; Tè pocs centres on es far el curs ; Ser más concreto en el sector del agua, no tanto eléctrico, concretar más en el temario de estudio, no sea un abanico tan amplio.; Posar mes clases practiques o fer mes projectes aplicables a la realitat; Veure coses més coses practiques.; Menos teoría i mas ver las cosas en personas; Ampliaria temas sobre instalaciones; Tot es molt correcta; Se podría añadir el funcionamiento de un contador eléctrico para entender como gestionar mejor nuestro consume; Darle importancia a los temarios que vas a ver diariament en el oficio de este sector; Hacer más salidas, más visitas a centros de control de agua potable.; Centrarse en los conceptos principales e importantes y no tanto en detalles insignificantes; Cap canvi; Añadir mas practica, así como hacer mas hincapié los principales problemas que se están dando actualmente; Se podrían hacer más simulaciones en cuanto dimensionamiento de cañerias y alguna vista de como el agua presurizada llega a casa o se queda en el camino y dar más ayuda a la hora de hacer trabajos de este tema como proyectos de dimensionamientio.

2. THE COURSE EVALUATION BY TEACHER

Course evaluation by teachers was performed using online survey. Electronic version of the survey available at https://forms.gle/srHZJ1ji7GyJShMm8. Online survey was carried in 2023, 11th of January. 2 teachers (man – 50 percent, women – 50 percent; 40–49 – 50 percent, 50–59 – 50 percent;) took part in the survey.

9. Evaluation of course structure and description: Course teachers strongly agree and agree that: 9.1. The course aims are clear and well defined. 9.2. The competencies clearly describe knowledge and skills of student graduating from this course. 9.3. The learning outcomes correspond to the competencies. 9.4. The division of course hours into contact and self-learning hours is appropriate. **10. Evaluation of course content:** Course teachers strongly agree and agree that: 10.1. The course content corresponds to the learning outcomes. 10.2. The course content is consistent. 10.3. The course topics are not repetitive. 10.4. The course content is modern. 10.5. The learning methods are appropriateto to achieve the intended competences. 10.6. The assessment of competence is appropriate. **11. Comments on strengths and ways of improvement:**

11.1. According to the teachers the main advantages of this course:
Contenido del curso adecuado para las competencias a adquirir; La visión global sobre las tecnologias que se utilizan actualment en el área de suministramiento de agua, así como su gestión i funcionamento.
11.2. According to the teacher the main disadvantages of this course:
No encuentro desventajas a destacar; Busqueda de información para ampliar los contenidos
11.3. The teacher recommends the main changes to improve this course:
No recomiendo cambios; Aumentar el uso de ejemplos prácticos y reales para que los contenidos teóricos queden claros.

CONCLUSIONS

After implementation of the course Technologies water supply realized within the Project project „Three-level Centers of Professional Excellence: Qualification, Entrepreneurship and Innovation in the Green Economy " the following conclusions are defined:

- The objectives of the course were achieved.
- The teacher and students highly rated the quality of course content.
- Students were satisfied with the quality of teaching.
- The knowledge and skills learned in the courses were put into practice.
- The course was properly implemented.

Result 5.2
Green Economy Study Modules

Training for Farmers and Students from the Secondary Agricultural School

Curricula, Teaching Materials and Implementation

Work Package 5, Activity 8.43

Implementation Report for the "Training for Farmers and Students" 'Green Agriculture'

Developed by Pomeranian University in Słupsk (Uniwersytet Pomorski w Słupsku, PP6 UPS) within the 3LoE Project -

Three-level centres of professional excellence: Qualification, entrepreneurship and innovation in the Green Economy

Słupsk, August 2024

0. The aim

Green agriculture is an approach to agricultural production that integrates the practices of sustainable development, environmental protection and efficient use of natural resources. Its goal is to minimize the negative impact on ecosystems while ensuring high quality and quantity of crops. Green agriculture promotes biodiversity, reduces greenhouse gas emissions and supports local communities.

The "Green Agriculture" training programme aims to educate and empower farmers, students, and other stakeholders in sustainable agricultural practices. Organised under the 3LoE Project by Pomeranian University in Słupsk, the programme aligns with the project's goal of enhancing educational frameworks to tackle modern environmental and economic challenges. By embracing the principles of the European Green Deal[1], the training addresses urgent issues like climate change and the need to improve agriculture's environmental credentials.

The objective is to equip participants with the knowledge and tools needed to adapt to and mitigate the effects of a changing climate on agriculture. We promote farming methods that reduce greenhouse gas emissions, boost biodiversity, and ensure sustainable food systems. By encouraging practices that sustain and regenerate natural resources, the training contributes to environmental conservation and economic viability, enhancing education and awareness in line with the aims of the 3LoE Project, especially green entrepreneurship.

2. Design of the Training Programme

The training will be delivered through an innovative online platform, developed specifically for the implementation and providing a flexible and accessible learning environment. The programme is divided into five comprehensive modules, covering everything from basic concepts to advanced practices in green agriculture. Interactive learning options—such as webinars, video lectures, discussion forums, and virtual workshops—are planned to be included to actively engage participants and foster a collaborative learning experience.

Participants will have access to a resource library filled with the latest research papers, case studies, and government reports, ensuring they have up-to-date information at their fingertips. The programme includes assessments and certifications to evaluate understanding, with quizzes and assignments leading to a certificate upon successful completion. While the main content is in English, we may offer supplementary materials

[1] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

in other languages to cater to a diverse audience, making the programme inclusive and widely accessible.

3. Target Audience and Skills Acquired

The training is primarily aimed at farmers and students but also extends to other stakeholders such as agricultural advisors and consultants, policymakers and government officials, environmental NGOs and activists, and agricultural business professionals.

Farmers will gain practical skills in sustainable farming techniques, including eco-friendly practices like crop rotation, organic farming, and integrated pest management. They'll learn how to manage resources efficiently, particularly in water and soil conservation, and develop strategies to adapt to climate change impacts. Moreover, farmers will understand the economic benefits of green practices, such as cost savings and accessing new markets.

Students of agriculture, environmental science, or related fields - both at secondary and tertiary level - will deepen their theoretical understanding of green agriculture and sustainable development. The programme enhances their research skills, enabling them to analyse data and assess the environmental impact of agricultural practices. Getting familiar with the latest technologies and innovations in sustainable agriculture will prepare them for future careers, making them more competitive in the job market.

Other Stakeholders, like policymakers and advisors, will benefit from insights into policy development and advisory skills, improving their ability to guide and support the implementation of sustainable practices. They will understand market opportunities arising from consumer trends towards sustainable products and learn how to capitalise on them. The programme also encourages a commitment to environmental stewardship through informed decision-making and advocacy.

What is important is that the content offered may easily be transferred to the VET sector, so the training programme may stretch between **EQF3 and EQF6/7**. Taking into account the fact that external stakeholders will probably not belong to any student group, the training naturally embraces the idea of **continuing education**. Also, if implemented correctly, it may be an element (independent or a part of another training) of a **microcredentials course**.

By taking part in this training, all participants will gain a thorough understanding of the importance of green agriculture and practical knowledge to implement sustainable practices. This supports the wider goals of the 3LoE Project and contributes to global efforts like the European Green Deal in tackling climate change and promoting environmental sustainability.

Overall Outcome

The "Green Agriculture" training programme is more than just an educational course; it's a strategic initiative to empower individuals and communities to make informed decisions that positively impact the environment and the economy. By blending advanced learning technologies with practical applications, the programme ensures that participants are not only aware of sustainable practices but are also equipped to put them into action effectively. This holistic approach supports the shift towards a more sustainable agricultural sector, reflecting the objectives of the 3LoE Project and the broader international commitment to environmental conservation.

4. Possible implementation

The programme could be delivered through an innovative online platform, providing flexibility and accessibility to all participants. This platform should be user-friendly and compatible with various devices, ensuring that farmers in rural areas and students alike can engage without technical barriers. Interactive features such as webinars, discussion forums, and virtual workshops would foster active participation and create a collaborative learning environment.

Developing comprehensive content is crucial. External experts will be invited to complete study content. Collaborating with experts in sustainable agriculture to create the modules ensures that the information is accurate, up-to-date, and relevant. Incorporating multimedia elements like videos, animations, and interactive simulations can cater to different learning styles, making the material more engaging and easier to understand.

A pilot testing should be attempted. Conducting a pilot programme with a small group from each target audience—farmers, students, and other stakeholders—would allow for feedback and refinement before a full-scale launch.

5. Content

Module 1: Foundations of Green Agriculture

Short Description:

This module serves as an introduction to the concept of green agriculture, highlighting its significance in today's world. It delves into the fundamental principles and practices that define green agriculture, setting the stage for more detailed exploration in subsequent modules.

Content:

The definition and origins of green agriculture, tracing how it emerged as a response to pressing global issues like climate change, environmental degradation, and the loss of biodiversity. Participants will explore the historical context that necessitated a shift towards more sustainable farming practices. The module discusses the core principles of sustainable development within agriculture, emphasizing the balance between meeting current food production needs and preserving the environment for future generations.

An in-depth look at the impact of conventional agricultural methods on natural ecosystems is provided, illustrating the consequences of practices such as excessive use of chemical fertilizers and pesticides, monoculture, and over-reliance on non-renewable resources. The module highlights how these practices contribute to soil degradation, water pollution, and greenhouse gas emissions.

Participants will also learn about global and local initiatives aimed at promoting green agriculture. This includes an overview of policy frameworks like the European Green Deal, which sets ambitious targets for reducing emissions and enhancing biodiversity within the European Union. The role of international organizations, governments, and non-governmental organizations in supporting sustainable agriculture through funding, research, and education is examined.

Wider Description:

By the end of this module, participants will have a comprehensive understanding of why green agriculture is essential for environmental sustainability and food security. They will appreciate the interconnectedness of agricultural practices with ecological health and climate stability. The module encourages critical thinking about current farming methods and inspires participants to consider how adopting green agriculture principles can lead to positive environmental and socio-economic outcomes.

Module 2: Environmentally Friendly Agricultural Practices

Short Description:

This module focuses on practical approaches to implementing environmentally friendly methods in crop cultivation and livestock rearing. It provides participants with knowledge and tools to transition towards more sustainable farming practices.

Content:

The module explores various ecological farming techniques that reduce environmental impact while maintaining or enhancing productivity. It begins with an examination of crop rotation and intercropping strategies, which improve soil health and reduce pest outbreaks by increasing biodiversity in the fields. The concept of agroforestry is introduced, illustrating how integrating trees with crops and livestock can enhance ecosystem services such as carbon sequestration, soil stabilization, and habitat provision for beneficial organisms.

Participants will delve into biological pest control methods, learning how to manage pests and diseases using natural predators, parasites, and biopesticides. The module emphasizes the importance of reducing chemical inputs, not only to protect the environment but also to improve food safety and farmer health.

In terms of livestock management, the module covers practices that promote animal welfare and reduce environmental footprints, such as free-range grazing, organic feed, and proper manure management to prevent water pollution. The benefits of reducing antibiotic use in animal husbandry are also discussed.

Wider Description:

By adopting the practices discussed in this module, farmers can play a pivotal role in environmental conservation while also potentially improving their economic resilience. The module provides case studies and success stories of farms that have successfully transitioned to sustainable practices, highlighting the challenges faced and how they were overcome. Participants are encouraged to consider how these methods can be adapted to their specific contexts and the potential benefits they may reap.

Module 3: Biodiversity as a Key to Sustainable Agriculture

Short Description:

This module underscores the importance of biodiversity within agricultural systems and explores strategies for its conservation and enhancement. It addresses how preserving biodiversity contributes to the sustainability and productivity of farming operations.

Content:

Participants will learn about the critical role biodiversity plays in maintaining healthy ecosystems and supporting agricultural productivity. The module discusses how diverse biological communities contribute to essential services such as pollination, pest control, nutrient cycling, and soil fertility.

The concept of creating and maintaining buffer zones, such as hedgerows, riparian strips, and field margins, is examined. These areas serve as habitats for wildlife and beneficial insects, enhancing ecological balance within the farm landscape. The module also explores the integration of natural landscape elements into farming practices, such as wetlands and woodlands, and how they can be managed to support both biodiversity and agricultural production.

Strategies for protecting and encouraging populations of beneficial species, including pollinators like bees and butterflies, are presented. The module highlights the threats these species face and the implications for agriculture if their populations decline.

Wider Description:

This module encourages participants to view their farms not just as production units but as integral parts of the broader ecosystem. By fostering biodiversity, farmers can improve the resilience of their farms to pests, diseases, and climate variability. The module provides practical guidance on how to implement biodiversity-friendly practices and discusses the potential economic and ecological benefits.

Module 4: Management of Water and Soil Resources

Short Description:

This module addresses sustainable management practices for water and soil, two critical resources in agriculture. It provides strategies for conserving these resources and improving their quality to ensure long-term agricultural productivity.

Content:

Participants will explore techniques for efficient water use, starting with an understanding of the water cycle and the impact of agriculture on water resources. The module discusses water-saving irrigation methods such as drip irrigation and scheduling irrigation based on crop needs and weather conditions. Rainwater harvesting and the use of retention ponds are presented as ways to enhance water availability and reduce reliance on external water sources.

The module delves into soil conservation practices aimed at preventing erosion, maintaining soil structure, and enhancing fertility. Techniques such as cover cropping, conservation tillage, and the use of organic amendments are explained in detail. The importance of maintaining soil organic matter and promoting a healthy soil microbiome is emphasized.

Participants will learn about the challenges posed by soil degradation and water scarcity, exacerbated by climate change, and how sustainable management practices can mitigate these issues. The module also covers the regulatory frameworks and guidelines related to water and soil conservation.

Wider Description:

Effective management of water and soil resources is crucial for the sustainability of agricultural systems. This module equips participants with practical knowledge to implement conservation practices that protect these resources, enhance farm productivity, and contribute to environmental sustainability. By understanding the interconnectedness of water and soil health with agricultural outputs, participants can make informed decisions that benefit both their farms and the environment.

Module 5: Economics and Support for Green Agriculture

Short Description:

This module examines the economic aspects of green agriculture, including funding opportunities, market access, and the financial benefits of adopting sustainable practices. It provides insights into how farmers and other stakeholders can leverage economic incentives to support the transition to green agriculture.

Content:

Participants will analyze the economic viability of green agricultural practices, exploring cost-benefit analyses that compare traditional and sustainable farming methods. The module discusses how initial investments in sustainable practices can lead to long-term savings and increased profitability through improved efficiency, reduced input costs, and premium prices for organic or sustainably produced products.

Information on available subsidies, grants, and financial support programs is provided, including those offered by governments, international organizations, and private entities. The module covers the process of applying for funding and meeting the criteria for various support schemes.

Certification processes for organic and sustainable products are explained, detailing the standards that need to be met and the steps involved in obtaining certification. The benefits of certification, such as access to new markets and price premiums, are highlighted.

Marketing strategies for green agricultural products are discussed, including branding, participation in farmers' markets, direct sales to consumers, and partnerships with retailers. The module emphasizes the importance of understanding consumer trends and demands for sustainably produced food.

Wider Description:

By understanding the economic landscape of green agriculture, participants can make informed decisions about adopting sustainable practices. This module provides the tools and knowledge needed to navigate financial aspects, access support, and successfully market their products. It highlights that green agriculture is not only environmentally beneficial but can also be economically advantageous.

6. Implementation calendar

January-June 2024 - Concept for the training “Green Agriculture”

June-July 2024 - Draft concept for the online solution

July-September 2024 - Work on the Content of the

September - October 2024 - Implementation and testing of the online platform

7. Implementation results

7.1. Since the timing of the original training was not suitable for either the farmers or the students at the agricultural school, a decision to postpone the training was made. In particular, it was decided that the training would take the form of an online course. This solution has many advantages:

7.1.1. Farmers in remote or rural areas can access training without the need to travel, saving time and resources. This is particularly beneficial for those with limited access to transport or those who live far from training centers. The research and training station in Grzmiąca (currently under development by Pomeranian University in Słupsk) will be accessible only in 2026. This is a possible date from which one should be able to organise trainings on site (the research station and its equipment will be focussed on agricultural topics). By that time, online forms are much better.

7.1.2. The online form guarantees that farmers from beyond the region will be able to access the materials. The outreach can be international, the only prerequisite being that the content should be automatically translated into a language that international partners speak (which in itself is not a problem at the time of writing this implementation report).

7.1.3. Online training allows farmers to learn at their own pace and on their own schedule, accommodating busy farming seasons and personal commitments. This flexibility means they can revisit materials as needed, reinforcing their understanding. This is a solution implemented following initial rejection of farmers as to the late spring-early summer training dates.

7.1.4. Online training typically reduces or eliminates travel, accommodation, and meal costs associated with traditional training. For organisers, it also reduces expenses, making it more affordable to reach a wider audience. This is particularly important in the case of the 3LoE Project, which is nearing its completion (as of October 2024). The online course will be accessible long after the conclusion of the project. This will be guaranteed by way of uploading the website (with the training course) on university servers.

7.1.5. The online platform can be scaled up, the consents updated and new content added in an easy manner. The scalability enables agricultural organisations and governments (if applicable) to disseminate new farming techniques, climate-smart practices, and market information more widely and consistently. This is especially true of the municipality of Grzmiąca (where the university research and training station is located), which is interested in closer cooperation in the area of green agriculture.

7.2. As has been mentioned above, the platform is uploaded and made accessible through a university address: https://agriculture.upsl.edu.pl/. The hosting of project materials by the university (PP6) ensures that the contents are safe, access to the website safeguarded and the life of the website virtually unlimited.

7.3. The design of the website being the interface of the content was commissioned to an expert web designer who eventually decided to keep the website simple. Also, the basic rules of accessibility are observed. The structure of the website is as follows:

- MAIN PAGE
- ABOUT 3LOE PROJECT
- TRAINING <GREEN AGRICULTURE>
- TRAINING MODULES

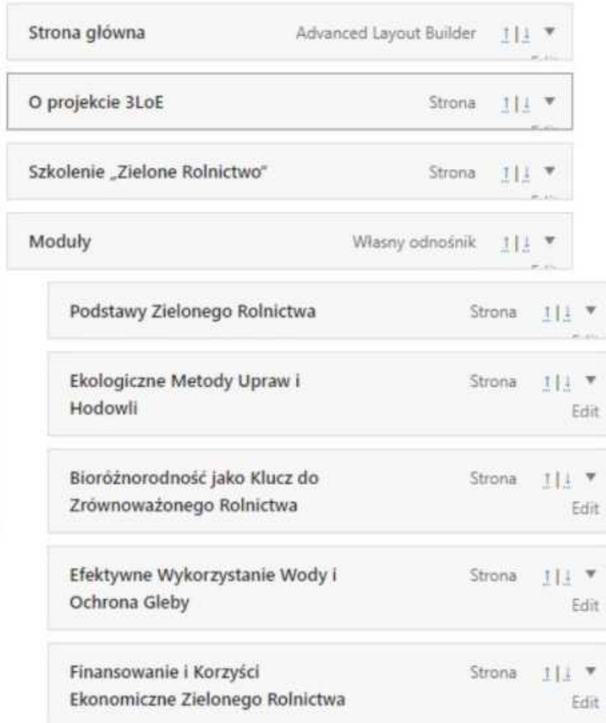
→ Foundations of Green Agriculture

→ Environmentally Friendly Agricultural Practices

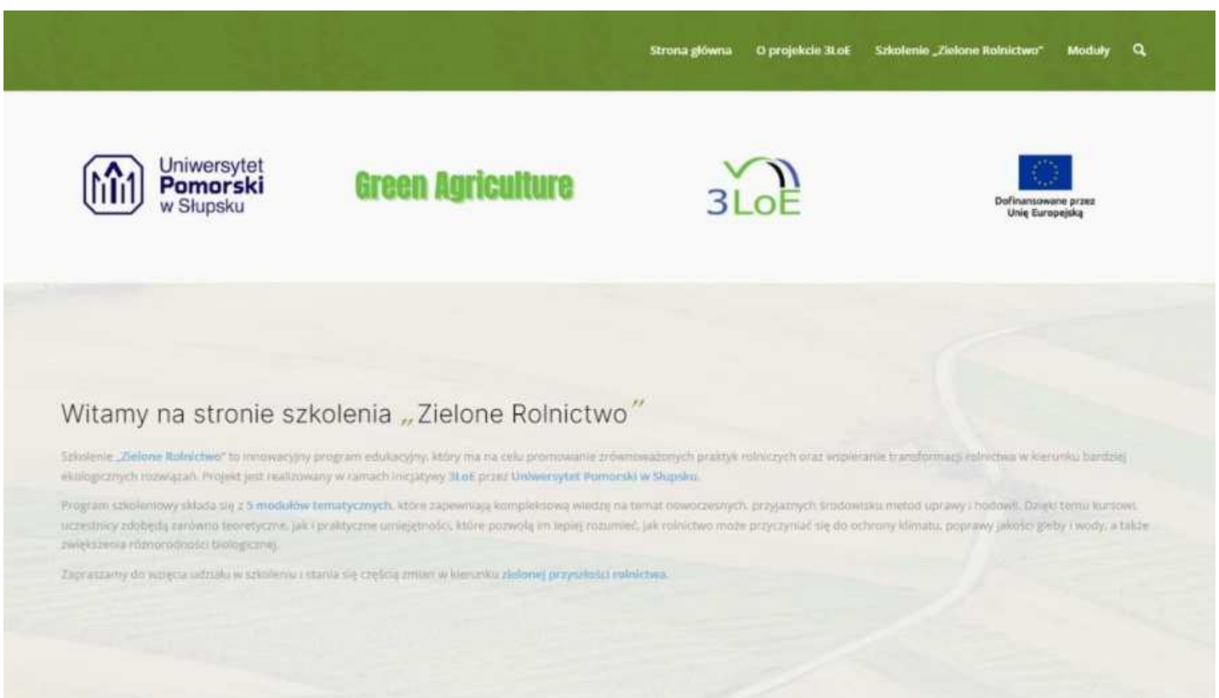
→ Biodiversity as a Key to Sustainable Agriculture

→ Management of Water and Soil Resources

→ Economics and Support for Green Agriculture



The look of the main interface was tested on a small number of users and implemented with some minor changes (in comparison with the original design). A screenshot of the interface is shown below.



Kwalifikacje

Each of the elements is a separate webpage with the descriptive part and/ or teaching content. Below is an example of an opened menu.

7.4. The content of the online course is both textual and audiovisual. In particular, the use of additional materials is a *sine qua non* of today's education, especially amongst young people. Among the visual elements, one of the most important will be infographics - a relatively new form of content propagation, which often appeals to the younger generation and is an example of an efficient teaching form (which is especially useful for farmers whose time is often limited).

7.5. At the moment of drafting of this report (September/ October 2024), the website is being tested both by professional farmers and students at the agricultural school (no. 6) in Grzmiąca. The implementation of the training will have finished by collecting appropriate feedback from users. This will be supplemented to this implementation report in the online version available from this link:

https://docs.google.com/document/d/1v807nF3Vw1hfUmPN7j8gtIFMDN9pIYtdz5pHbcWWjUw/edit?usp=sharing

The evaluation questionnaire was based on the following design:

Green Agriculture Training Platform Feedback Survey

1. **How would you rate the overall design and layout of the website?**
   - Excellent
   - Good
   - Fair
   - Poor
   - Very Poor
2. **The website is easy to navigate and user-friendly.** *(Please rate on a scale of 1 to 5, where 1 = Strongly Disagree and 5 = Strongly Agree)*
   - 1 - Strongly Disagree
   - 2 - Disagree
   - 3 - I don’t know
   - 4 - Agree
   - 5 - Strongly Agree
3. **Which training module did you find most beneficial?**
   - Module 1
   - Module 2
   - Module 3
   - Module 4
   - Module 5
   - All modules were equally beneficial
4. **How satisfied are you with the content quality of the training modules?**
   - Very Satisfied
   - Satisfied
   - I don’t know
   - Dissatisfied
   - Very Dissatisfied
5. **The training content met my learning needs in green agriculture.** *(Rate on a scale of 1 to 5)*
   - 1 - Strongly Disagree
   - 2 - Disagree
   - 3 - I don’t know
   - 4 - Agree
   - 5 - Strongly Agree
6. **How relevant is the training to current practices in green agriculture?**
   - Extremely Relevant
   - Very Relevant
   - Moderately Relevant
   - Slightly Relevant
   - Not At All Relevant

7. **What did you like most about the website or the training modules?**
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………
8. **What improvements would you suggest for the website's design or functionality?**

   ……………………………………………………………………………………………
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………
9. **Would you be interested in participating in more advanced training on green agriculture topics in the future?**
   - ○ Yes
   - ○ Maybe
   - ○ No

Any additional comments or suggestions you would like to share?
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……………………………………………………………………………………………………
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