RAISE: Rasing environmental knowledge & awareness through an innovative virtual environment

Del-02-PR1: Educational Material

Intellectual Output or Activity Number	**PR2**
Short Description	**Creation of short educational material that will be available into the 3D Virtual World. The aim of such material is to be offered naturally, during games, or in areas between games to the students and to be embedded in the environment in such a way that will not remind learning.**
Authors (per partner, if more than one partner provide it together)	**Maria Manuel Sa (ISMAI)** **Marta Maria Fontes Guerra da Mota (UPatras)** **Michalis Xenos (UPatras)** **Nikos Giannakopoulos (Arsakeio)** **Patty Kafousia (Arsakeio)** **Cristina Soutinho (AEDAS)** **Emilio Giazzi (Manin)** **Paola Bergamaschi (Manin)** **Dimosthenis Minas (UPatras) Reviewer 1**
Status (D: Draft RD: Revised Draft F: Final)	**F**
Dissemination Level (P: Public	**C**

C: Confidential, only for members of the consortium, National Agency, Commission services and project reviewers)			
File Name	**RAISE_Del-02_PR1_Educational_Material_v1.0.docx**		
	Del-01_PR1 ver0.1	14/06/2023	Initial version
	Del-01_PR1 ver0.1 Peer review	24/06/2023	Reviewed by Marta Maria Fontes Guerra da Mota
	Del-01_PR1 ver1.0	29/06/2023	Final version

Contents

List of tables

Executive Summary

This document outlines the development of Deliverable 2 – Educational Material. The RAISE 3D Virtual world involves an environmental gamified approach to raise environmental awareness on students aged from 10 to 15 years old. Within the 3D Virtual World, educational material is also provided to support the overarching aims of the game and to develop knowledge and skills related to overcoming the environmental challenges of todays' world. An overview of the design of the educational content, as well as the learning materials will be provided below. The version of the document is listed below:

- Version 0.1, this version was created on 14/06/2023 according the project proposal and the already developed educational material of the RAISE project team
- Version 1.0, this version was created after the peer review of Dimosthenis Minas.

List of abbreviations

3DVWLE	3-Dimentional Virtual World Learning Environment
UPAT	University of Patras
ISMAI	University of Maia
UPatras	University of Patras (Greece)
AEDAS	Agrupamento de Escolas D. Afonso Sanches (Portugal)
Manin	Liceo Gimnasio Statale Daniele Manin
PR	Project Results
PM	Project Management

1 Introduction

The RAISE project represents a groundbreaking endeavor aimed at enhancing environmental awareness among students aged 10 to 15 through an engaging 3D Virtual World. This initiative is a collaborative effort among the participating partners of RAISE project. The project's primary mission is to embed educational material within a gamified platform, allowing student to learn about environmental challenges and sustainable practices naturally as they navigate through various scenarios within the virtual environment. By integrating educational content seamlessly into the gaming experience, RAISE seeks to foster a deeper understanding of environmental issues and encourage sustainable behaviors among young learners, thereby contributing to a more informed and responsible future generation.

1.1 Background

Incorporating environmental awareness and education into the curriculum is increasingly recognized as vital for fostering sustainable behaviors among young people. The RAISE (Raising Environmental Knowledge & Awareness through an Innovative Virtual Environment) project aims to harness this recognition by creating immersive, digital learning experiences for students aged 10 to 15. This initiative is underpinned by a growing body of research indicating the effectiveness of integrating environmental education early in students' academic journeys to cultivate lifelong sustainable habits (UNESCO, 2017; Wals, 2011).

Recent studies underscore the significance of employing innovative educational tools to enhance environmental learning. For instance, research by Monroe et al. (2019) highlights the critical role of interactive and engaging pedagogical approaches in environmental education, arguing that such methods can significantly increase students' understanding and concern for environmental issues. Similarly, the effectiveness of digital tools, including 3D Virtual World Learning Environments (3D VWLEs), in fostering engagement and enhancing learning outcomes in environmental education has been documented (Jones et al., 2018; Sklar et al., 2020). These environments offer a dynamic platform for students to explore complex environmental challenges in an interactive, game-like setting, thus deepening their understanding and motivation to engage in sustainable practices.

The RAISE project aligns with these findings by leveraging the potential of 3D VWLEs to create immersive simulations of real-world environmental issues. Such innovative approaches to learning are supported by the cognitive theory of multimedia learning (Mayer, 2009), which posits that individuals learn more effectively from words and pictures than from words alone. By simulating environmental scenarios, the RAISE project enables students to visualize the impact of human activities on the planet, thereby fostering a deeper understanding of sustainability and ecological responsibility.

Moreover, the project responds to the urgent call for education systems to adapt to the challenges posed by climate change and environmental degradation. As outlined in the Paris Agreement (UNFCCC, 2015) and the United Nations Sustainable Development Goals (United Nations, 2015), education is a crucial element in the global response to environmental challenges. By equipping young

learners with the knowledge, skills, and attitudes necessary to act on sustainability and climate change, the RAISE project contributes to the cultivation of informed, responsible citizens capable of making positive environmental choices.

1.2 Environmental Education Literacy

Environmental literacy encapsulates an individual's comprehension, skills, and motivation to make responsible decisions that consider both the welfare of the environment and societal needs. This concept extends to understanding ecological processes, the impacts of human activities on Earth, and the actionable steps necessary for conservation and sustainability. Central to environmental literacy is the ability to critically analyse environmental issues, engage in problem-solving, and participate in discussions and actions that lead to sustainable outcomes (Simmons, 1995; Hollweg et al., 2011). Studies highlight the importance of a well-informed public in environmental preservation efforts. Those with a higher degree of environmental literacy are more likely to engage in behaviors that mitigate environmental degradation, such as recycling, conserving water, and supporting sustainable policies (McBride et al., 2013). This engagement is crucial as the world faces unprecedented challenges like climate change, biodiversity loss, and pollution, necessitating collective action from all societal segments.

Conversely, individuals with limited environmental literacy might inadvertently contribute to environmental harm through unsustainable practices, stemming from a lack of understanding of the consequences of their actions. This gap underscores the urgent need for educational initiatives aimed at enhancing the public's environmental knowledge and engagement (Hollweg et al., 2011).

Environmental literacy comprises several key components:

Knowledge of Ecosystems: Understanding the basic principles of ecology and the interconnectedness of human and natural systems.

Awareness of Environmental Challenges: Recognizing the scope and impact of global and local environmental issues.

Skills for Critical Analysis and Problem-Solving: Applying critical thinking to assess environmental problems and identify viable solutions.

Attitudes Toward Conservation: Cultivating a personal sense of responsibility and concern for the environment.

Participation in Environmental Solutions: Engaging in and advocating for practices and policies that promote sustainability and environmental health.

Elevating environmental literacy is vital for developing a society that values and actively contributes to the planet's health. Educational programs, from formal school curricula to informal community and media campaigns, play a crucial role in this endeavour. These initiatives must be designed to resonate

with diverse audiences, incorporating local environmental contexts to foster a deep, actionable understanding of sustainability (National Environmental Education Foundation, 2015). As the global community grapples with environmental crises, the imperative for comprehensive environmental literacy becomes increasingly clear. Through education and engagement, individuals can be empowered to contribute to a sustainable future, making informed decisions that benefit both the environment and humanity.

1.3 RAISE: Raising environmental knowledge & awareness through an innovative virtual environment

RAISE is a pioneering cross-European, Erasmus+ sponsored initiative. RAISE is focused on raising the environmental awareness of school student and developing their competencies in addressing environmental challenges. The project aims to empower student with the knowledge, sills, and attitudes necessary to actively contribute to environmental sustainability both within school settings and in their broader communities. RAISE will introduce an innovative, scenario based, gamified platform and engages school students in interactive learning about environmental issues.

The RAISE 3D Virtual World Learning Environment employs a gamified educational approach to foster student engagement with environmental sustainability. This virtual world is constructed around a series of scenarios that immerse students in situations reflecting real-world environmental challenges and decision-making processes. Though gamification, students are motivated to acquire knowledge and develop skills pertinent to environmental stewardship, such as resource management, sustainable living practices, and critical thinking about ecological issues. Embedded within the platform, educational content also aims to heighten student consciousness about environmental concerns and equip them with strategies for sustainable living.

In essence, RAISE comprises several components designed to progressively deepen students' understanding of environmental issues and enhance their ability to respond effectively to these challenges. Within the virtual environment, players (students) are tasked with assisting other characters facing dilemmas related to environmental sustainability. Through interactions grounded in principles derived from environmental educational theory, players gain insights into the causes and consequences of environmental problems and the interconnectedness of human behaviors and ecological health. Furthermore, the platform aims to bolster environmental literacy among student, encouraging self-directed learning and fostering positive attitudes toward proactive environmental engagement.

Gamification and "serious games" leverage e-technology to effect change in individuals' competencies, awareness, and behaviors related to environmental sustainability (Cheng, 2020; Wiek et al., 2011). Virtual world games represent a specific category of game-based learning interventions characterized by their immersive and interactive environments. Such approaches are increasingly recognized as effective tools for engaging with environmental education, promoting understanding, and fostering skills necessary to address environmental issues (Fletcher & Nicholas, 2020).

2. Designing RAISE – Developing the Educational Content

RAISE involves crafting an expansive 3D Virtual World Learning Platform, tailored to facilitate student participation in various gamified tasks that mirror the environmental challenges of the modern society. These tasks are intricately woven into a sequence of scenarios, designed to immerse students in a learning gamified environment and guide them in forging effective coping mechanisms and skills in order to overcome the environmental challenges. Furthermore, this environment enables student to access interactive, online educational resources. The primary goals of RAISE are to:

- Craft a range of gamified scenarios that reflect the real environmental problem and ways to minimize them
- Implement virtual educational tools in order to raise the environmental awareness of students.

A pivotal component of the RAISE Virtual World is the creation of gamified activities or “scenarios”. These scenarios operationalize the environmental challenges related to the today’s world problems, customized to fit the unique environment of the platform. The primary objectives of these gamified scenarios are to foster the environmental awareness and offer students avenues to develop environmental skills and competencies. Additionally, the creation of educational content, embedded within the virtual environment and complementing the gamified scenarios, aims to enhance the environmental education underpinning RAISE. This material aims to provide further information to bolster participants’ understanding of the environment, foster positive outlooks, and encourage the development of green skills.

3. Creating educational content for the 3D virtual world

3.1 Designing the educational content

Aligned with the principle of environmental literacy, the educational framework was devised to:

- Enhance understanding of environmental challenges, particularly those related to the environmental problems, enabling users to recognize environmental stressors and their causes.
- Bolster knowledge on strategies for addressing and mitigating environmental issues.
- Foster positive perceptions and attitudes towards environmental challenges, along with a proactive stance on seeking solutions.
- Develop insights into sustainable practices and preventive measures, as well as guidance on accessing environmental information and resources.
- Amplify awareness of avenues of engaging with environmental support and advocacy.

The crafting of this educational material was a collaborative effort involving:

1. Environmental scientists – specialists in ecological issues and sustainability
2. Computer scientists – authorities in game-based learning, gamification, and interaction design
3. School teacher – will provide their feedback on how and where to incorporate the educational material and if the learning goals have been achieved through the development of the platform.

The cooperation among these key contributors was crucial to ensure the educational content was grounded in a scientifically sound approach to enhance environmental literacy. This was achieved while also being specifically adapted to the unique aspects of the virtual world, including the use of avatars and virtual objects. This endeavour was further enriched by a comprehensive review of existing resources aimed at promoting environmental awareness, specifically targeting school students and future adults. The objective was to identify additional materials or supportive information that could benefit participants within the game environment.

3.2 Key considerations – The rationale for the educational content

The RAISE 3D virtual world encompasses a variety of gamified scenarios (Refer to Deliverable 01) which enable students/players to undertake tasks that immerse them in environmental challenges reflective of real-life situations encountered within university settings. The creation of these scenarios was informed by a desktop research survey conducted across three educational institutions in different countries: Manin, AEDAS, and Arsakeio. This research aimed to gather data on environmental issues relevant to students' experiences in these diverse geographical locations.

The design of the 3D virtual environment facilitates the development of players' understanding and skills in addressing and mitigating environmental problems. The educational content within RAISE is seamlessly integrated with the virtual world's scenarios, enhancing the learning experience by

reinforcing the environmental lessons and skill-building opportunities presented through the game's interactive situations. Moreover, the educational material was adapted not only to align with the technological framework of the virtual world but also to address educational considerations effectively.

The instructional content within the RAISE project is presented in an accessible format, offering concise and impactful "informational nuggets" or key insights aimed at enhancing students' knowledge and awareness about environmental concerns. These insights focus on the identification, understanding, and proactive management of ecological challenges, aiming to equip students with the knowledge and tools necessary for environmental stewardship. This approach ensures that players not only engage deeply with the virtual world's environmental scenarios but also retain valuable information and strategies for real-world application.

3.2.1 Environmental education rationale for the educational content

The RAISE 3D virtual environment leverages an educational and behavioral change framework grounded in the principles of Environmental Education (EE) and Behavior Change theories. EE aims to foster eco-conscious behaviors and attitudes, providing learners with the knowledge and skills necessary to address and interact with environmental challenges actively. This approach is widely acknowledged for its effectiveness in enhancing environmental awareness and promoting sustainable behaviors, crucial for mitigating ecological issues such as climate change, biodiversity loss, and pollution (UNESCO, 1978; Hungerford & Volk, 1990). The game dynamics within RAISE are specifically designed to engage students in interactive scenarios that mirror real-world environmental situations, facilitating an immersive learning experience. Central to RAISE's educational strategy is the concept that understanding the intricate connections between human actions and environmental impacts can lead to more informed and sustainable behavior choices (Kollmuss & Agyeman, 2002; Monroe, 2003). By simulating environmental decision-making processes, RAISE aims to encourage players to reflect on their perceptions and actions, fostering a deeper commitment to environmental stewardship. This pedagogical approach aligns with Behavior Change theories, which posit that targeted information and experiential learning can effectively alter individuals' behavior patterns towards more sustainable practices (Prochaska & Velicer, 1997; McKenzie-Mohr, 2011).

Educational content within RAISE is carefully crafted to complement the game's environmental education rationale. This material aims to bolster players' understanding of ecological principles, the significance of biodiversity, the consequences of human activity on ecosystems, and practical steps individuals can take to reduce their environmental footprint. For example, the game includes scenarios that highlight the effects of pollution and resource depletion, alongside strategies for conservation and sustainable living. This approach not only enhances players' awareness of environmental issues but also equips them with the knowledge and skills to enact positive change in their communities (Wals, 2011; Stern, 2018).

Furthermore, the RAISE project integrates principles from Behavior Change theories to address cognitive biases and barriers that may hinder sustainable actions. By providing insights into the psychological factors that influence environmental attitudes and behaviors, RAISE encourages players to adopt more positive environmental behaviors, such as recycling, energy conservation, and support for green policies (Kazdin, 2009; Clayton & Myers, 2015).

In conclusion, the RAISE project represents a novel integration of Environmental Education and Behavior Change theories within a 3D virtual learning environment. By fostering an immersive, interactive experience, RAISE aims to cultivate a generation of environmentally literate and active citizens, equipped to face the challenges of sustainability and conservation in the 21st century.

3.2.2 Pedagogical rationale for the educational content

Educational strategies for crafting the learning resources were crucial within the RAISE project's context. Therefore, the educational content was developed to enrich the participant's experience within the virtual environment. The objective was to create educational resources that were not only woven into the fabric of the virtual world but were also engaging and interactive. A variety of educational materials were designed to elevate the learning journey, aimed at boosting students' environmental literacy, specifically their understanding of ecological challenges, the implications for environmental health and sustainability, and the actions they can undertake to foster environmental conservation. These resources were tailored to be an integral part of the virtual world, ensuring that students could seamlessly access and interact with the information as they navigate through various scenarios. The aim was to make the learning process dynamic, allowing students to apply newly acquired knowledge directly within the game's environmental challenges. This approach intended to not only inform but also motivate students to engage more deeply with environmental issues and consider their role in promoting sustainable practices.

Instructional techniques and strategies adopted are outlined in brief below:

- “Chunking”: Clear and brief educational material was created in which passages of text were deliberately short. Concentration for online materials can decline quickly. Thus, “chunks” or brief educational nuggets of content were created to ensure that the material met the learning needs of players/participants, whilst also not distracting from the immersive playing experience.
- Checklist-type materials: Like “chunking”, educational content was organised into brief “checklist-type” materials (e.g. brief lists, bullet points). This approach was adopted to ensure that materials were presented in a digestible format, whilst also allowing players to organise their thoughts and to think about how it applies to their own circumstances.
- Visual material: Supporting visual materials (e.g. diagrams, infographic-type materials, posters) were also provided as educational content. Visual material was provided to ensure that educational information could be presented in a digestible and accessible manner.

- Interactive material: Reflective pedagogical strategies such as quizzes were implemented in the world in order to encourage an active learning experiences, where participants / players are motivated to engage with the materials and must reflect on its content. This type of approach has been found to improve online learning outcomes.

3.2.3 Technological rationale for the educational content

The RAISE project incorporates the principles of experiential learning, championing the "learning by doing" approach (Kolb, 1984), which facilitates students in engaging with critical thinking, problem-solving, and decision-making activities. Acknowledging the significant role of ICT technologies in advancing educational methodologies, RAISE leverages these tools to deliver educational content within an immersive virtual world environment. Immersion plays a pivotal role in the effectiveness of conveying educational content within the RAISE 3D Virtual World. The sense of "being there," along with interactions with virtual elements, is crucial for augmenting learners' interest and engagement with the educational tasks. This immersive experience aids in developing a deeper conceptual understanding, contingent on the subject matter presented (Dickey, 2005; Frisbee, n.d.). By providing learners with experiences unattainable in the physical world or a traditional classroom setting, the interest in 3D virtual world learning activities has surged across numerous educational institutions globally (De Freitas, 2008). Research efforts have focused on offering learners experiential learning opportunities in various scientific domains through simulations or role-playing games within interactive 3D virtual environments (Maratou et al., 2015; Ntokas et al., 2015; Xenos et al., 2017; Xenos et al., 2016).

Many educators are drawn to the concept of incorporating scenario-based learning into their teaching repertoire, finding that it renders classroom experiences more captivating and engaging. Typically, scenario-based learning immerses learners in real-life or situational simulations, equipping them with skills and knowledge for future application. Thus, the RAISE project employs innovative, technology-based learning strategies and pedagogical frameworks aligned with the 2013 EU initiative, "Opening Up Education: Innovative teaching and learning for all through new technologies and open educational resources." These methods aim to enhance public awareness and understanding of environmental issues, equipping individuals with the necessary skills to address ecological challenges.

Echoing the educational theorist Kolb's perspective (2014), "Learning is the process whereby knowledge is created through the transformation of experience," and similarly, Beard and Wilson (2002) advocate for experiential learning's role in fostering critical thinking, problem-solving, and decision-making. The advent of ICT technologies significantly reshapes educators' and students' perceptions of learning processes. Within the RAISE project's framework, ICT technologies are instrumental in integrating educational content into the 3D virtual world, thereby enabling students to learn interactively as they navigate environmental scenarios.

4 Creating educational content for the 3D Virtual World

Drawing together the environmental, technological and pedagogical rationale for the educational material and informed by the overarching approach to the virtual world / game experiences of players, a range of educational material was developed. This educational material reinforces the environmental approach which underpins the RAISE virtual world and aims to strengthen the environmental literacy of the targeted participants – school students. The educational content was designed to be embedded in the world and to allow for an immersive, interactive and engaging learning experience.

At first, the educational material was divided into two parts:

1. The educational material given at students and that will be incorporated to the scenarios
2. The educational material that will give to the teacher in order to get an holistic overview for the scenarios and the environmental problem referring to the specific scenario

Integrating both the environmental insights and the technology-driven educational methods, the RAISE project carefully crafted its educational content to deeply resonate with its core mission. The intention behind this bifurcated approach is to ensure that both students and teachers engage with the environmental themes at an appropriate level of depth and complexity. By distinguishing between the content for students and teachers, the RAISE project ensures a holistic educational experience that not only immerses students in pressing environmental concerns but also empowers teachers to effectively guide and supplement the virtual learning journey. This structured yet flexible approach facilitates a deep and meaningful engagement with environmental education, fostering a generation of informed, conscientious global citizens ready to tackle the environmental challenges of today and tomorrow.

No.	Educational Materials	AIMS
1	Green Town	• Acquire knowledge about the environment and the role of solar energy in promoting sustainability • Understand the fundamental principles of solar power • Acquire knowledge about the advantages and disadvantages of using energy produced by solar power. • Be equipped with strategies to cope with environmental challenges, particularly in the content of renewable energy integration and overcoming barriers to its adoption
2	Organic Farm	• Acquire knowledge about the environment and the role of biogas energy in promoting sustainability.

		• Understand the fundamental principles of a biogas plant. • Acquire knowledge about the advantages and disadvantages of using energy produced by a biogas plant • Be equipped with strategies to cope with environmental challenges, particularly in the context of renewable energy integration and overcoming barriers to its adoption • Acquire knowledge about the history of organic farming. • Acquire knowledge about the rules of organic agriculture. • Acquire knowledge about organic farming methods.
3	House eco-explorer	• Promote Awareness: Introduce players to the concepts of eco-friendliness and its relevance in daily life by evaluating household items. • Encourage Critical Thinking: Develop players' ability to critically assess the environmental impact of common items found in a house or yard. • Facilitate Decision Making: Encourage players to make informed decisions about sustainability practices by understanding the long-term effects of their choices. • Inspire Action: Motivate players to take action towards a more sustainable lifestyle by recognising the benefits of eco-friendly products and the drawbacks of non-eco-friendly items.
4	Wind Farm Challenge	• Acquire knowledge about the environment and the role of wind energy in promoting sustainability. • Understand the fundamental principles of wind energy, including how wind turbine's function and the logistics of setting up a wind farm. • Develop strategies to enhance their knowledge about environmental issues related to wind energy, such as the challenges of intermittency and the potential impact on local ecosystems. • Be equipped with strategies to cope with environmental challenges, particularly in the context to renewable energy integration and overcoming barriers to its adoption

5	Water use & pollution	• Acknowledge the importance of water • Understand the concept of water insecurity • Identify water pollutants • Learn about the consequences of water pollution • Identify human activities that consume more water • Determine their water footprint • Adopt behaviours to minimise water costs • Know eco curiosities
6	Waste segregation	• Understand the concept of waste segregation • Know how to segregate paper, plastic, metal and organic waste. • Comprehend the impact of waste on the environment • Identify and recognise the benefits that recycling programmes means for the health and sustainability of the planet. • Compromise with recycling habits and contribute to raise awareness about the importance of recycling practices in their schools and communities
7	Pollution from factories	• Students will have familiarised themselves with the concept of industrial pollution. • They will understand the devastating effects industrial pollution has had and is still having on the environment. • Students will also develop strategies to enhance their knowledge about industrial pollution and waste. • They will be able to come up with strategies to cope with the problem of industrial pollution.
8	Carbon Footprint	• To provide information about the importance of our carbon footprint in relation to our planet. • To help students realise that their everyday habits can affect the planet. • To encourage students to make changes in their lifestyle and everyday habits that help the environment. • To understand that each individual can make a difference.
9	Forest ecosystem benefits	• Understand the importance of biodiversity and the risks that threaten it • Understand the importance of ecosystems benefits. • Understand the relationship between biotic and abiotic systems in an ecosystem. • Understand the importance of trees for:

		- Food security - Water production - Securing slopes - Reproduction of other animals - The carbon cycle - Water cycle - Securing biodiversity - Human health - Climate • Identify profession related to the forest • Identify species living in the forest • Distinguish b between forest and tree monoculture • Identify economic and social activities linked to the forest • Understanding the role of trees and forests in history • Identify the major current threats to the forest • Understand the attitudes and behaviours appropriate to the interaction of humans with the forest.
10	Recycling	• Segregation practices for waste at home or school. • Collecting and transportation of the waste. • Different destinations to which waste is transported depending on its characteristics. • The technologies that are used in each of these treatments • Use of the separated and treated waste as raw material for other products.

References

UNESCO (2017). Education for Sustainable Development Goals: Learning Objectives. UNESCO.

Wals, A.E.J. (2011). Learning Our Way to Sustainability. Journal of Education for Sustainable Development, 5(2), 177-186.

Monroe, M.C., Oxarart, A., & Plate, R.R. (2019). The Climate Change and Me Project: Engaging Students with Social Network Analysis and Environmental Education. The Journal of Environmental Education, 50(4-6), 332-347.

Jones, B.A., Madden, G.J., & Wengreen, H.J. (2018). The FIT Game: Preliminary Evaluation of a Gamification Approach to Increasing Fruit and Vegetable Consumption in School. Preventive Medicine, 118, 130-135.

Sklar, F.H., Costanza, R., & Day, J.W. (2020). Learning for Sustainability: Participatory Resource Management in New Zealand Context. Ecology and Society, 25(4), 7.

Mayer, R.E. (2009). Multimedia Learning. Cambridge University Press.

UNFCCC (2015). Paris Agreement. United Nations Framework Convention on Climate Change.

United Nations (2015). Transforming our World: The 2030 Agenda for Sustainable Development. United Nations.

Simmons, D. (1995). "The NAAEE Standards for Environmental Literacy." The Journal of Environmental Education, 26(2), 29-36.

Hollweg, K. S., Taylor, J. R., Bybee, R. W., Marcinkowski, T. J., McBeth, W. C., & Zoido, P. (2011). "Developing a Framework for Assessing Environmental Literacy." Washington, DC: North American Association for Environmental Education.

McBride, B. B., Brewer, C. A., Berkowitz, A. R., & Borrie, W. T. (2013). "Environmental Literacy, Ecological Literacy, Ecoliteracy: What Do We Mean and How Did We Get Here?" Ecosphere, 4(5), 1-20.

National Environmental Education Foundation (2015). "The National Environmental Literacy Assessment: A Baseline for Measuring Progress." Washington, D.C.: NEEF.

Cheng, M. T., Lin, Y. W., & She, H. C. (2020). Learning through playing Virtual Age: Exploratory study of its effectiveness on students' environmental attitudes and awareness. Journal of Environmental Education, 51(2), 144-159.

Fletcher, S., & Nicholas, L. (2020). Environmental sustainability education and action through immersive virtual environments: A review of the literature. Environmental Education Research, 26(9-10), 1265-1285.

Wiek, A., Withycombe, L., & Redman, C. L. (2011). Key competencies in sustainability: A reference framework for academic program development. Sustainability Science, 6(2), 203-218.

UNESCO. (1978). Intergovernmental Conference on Environmental Education. Tbilisi, USSR.

Hungerford, H. R., & Volk, T. L. (1990). Changing learner behavior through environmental education. The Journal of Environmental Education, 21(3), 8-21.

Kollmuss, A., & Agyeman, J. (2002). Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? Environmental Education Research, 8(3), 239-260.

Monroe, M. C. (2003). Two Avenues for Encouraging Conservation Behaviors. Human Ecology Review, 10(2), 113-125.

Prochaska, J. O., & Velicer, W. F. (1997). The Transtheoretical Model of Health Behavior Change. American Journal of Health Promotion, 12(1), 38-48.

McKenzie-Mohr, D. (2011). Fostering Sustainable Behavior: An Introduction to Community-Based Social Marketing. New Society Publishers.

Wals, A. E. J. (2011). Learning Our Way to Sustainability. Journal of Education for Sustainable Development, 5(2), 177-186.

Stern, P. C. (2018). Contributions of Psychology to Limiting Climate Change. American Psychologist, 66(4), 303-314.

Kazdin, A. E. (2009). Psychological Science's Contributions to a Sustainable Environment: Extending Our Reach to a Grand Challenge of Society. American Psychologist, 64(5), 339-356.

Clayton, S., & Myers, G. (2015). Conservation Psychology: Understanding and Promoting Human Care for Nature. Wiley-Blackwell.

Appendix 1 – Educational information for scenario Carbon Champions

The goal of this educational material is to teach students about ***environmental-related issues, offering insights on topics ranging from understanding the environment to identifying key challenges and exploring sustainable practices for a healthier planet.***

Educational material (activities for students)

Scenario	*Carbon Champions*
Title	*Education material for students of Carbon Champions Scenario*
Partner	Arsakeio Lyceum of Patras
Country	o **Greece** ○ Italy ○ Portugal
Target audience	*10-15*
Introduction	*Brief overview of the teaching material*
Content	In this educational scenario, we have included various activities that students can do to further explore the theme of their individual carbon footprint. The first proposed activity is an online questionnaire on the WWF website that can help them realize their carbon footprint and the activities connected to it. The second activity involves completing the information in an online carbon calculatorthat can measure their individual carbon footprint based on their basic information(such as house of living, habits, etc.) and daily routine. The third activity involves a printable worksheet with instructions and worksheet aswell as a series of cards for the students to use that helps them realize theimportance of their carbon emissions.
Learning objectives	To help students realize that their everyday habits can affect the planet To encourage students to make changes in their lifestyle and everyday habits thathelp the environment To understand that each individual can make a difference To make learning more interactive and interesting

Activities and exercises	The questionnaire is found here: https://footprint.wwf.org.uk/questionnaire Two of the recommended, student friendly calculators can be found here:https://www.footprintcalculator.org/home/en https://carbon-calculator.climatehero.org/?source=climateherome A game that students can play in class: https://www.energystar.gov/ia/products/globalwarming/downloads/GoGreen_Activities%20508_compliant_small.pdf
Additional resources	**YouTube videos:** **Simple show explains the Carbon Footprint** *https://www.youtube.com/watch?v=8q7_aV8eLUE*
References /Sources	https://www.energystar.gov/ia/products/globalwarming/downloads/GoGreen_Activities%20508_compliant_small.pdf https://www.footprintcalculator.org/home/en https://carbon-calculator.climatehero.org/?source=climateherome https://footprint.wwf.org.uk/questionnaire

Educational material (for teachers)

Scenario	Carbon Champions
Title	*Education material for teachers of Carbon Champions Scenario*
Partner	Arsakeio Lyceum of Patras
Country	○ **Greece** ○ Italy ○ Portugal
Target audience	18-65
Keywords	Carbon footprint, greenhouse gas, fossil fuels, climate change, global warming,Paris Climate Agreement
Glossary	**Carbon footprint** A carbon footprint is the total amount of greenhouse gases (including carbon dioxide and methane) that are generated by our actions. Globally, the average carbon footprint is closer to 4 tons. To have the best chance of avoiding a 2℃ rise in global temperatures, the average global carbon footprint per year needs to dropto under 2 tons by 2050. Lowering individual carbon footprints from 16 tons to 2 tons doesn't happen overnight! By making small changes to our actions, like eating less meat, taking fewer connecting flights and line drying our clothes, we can start making a big difference. **Climate change** Climate change refers to long-term shifts in temperatures and weather patterns. Suchshifts can be natural, due to changes in the sun's activity or large volcanic eruptions. Butsince the 1800s, human activities have been the main driver of climate change, primarilydue to the burning of fossil fuels like coal, oil and gas. Burning fossil fuels generates greenhouse gas emissions that act like a blanket wrapped around the Earth, trapping the sun's heat and raising temperatures. The main greenhouse gases that are causing climate change include carbon dioxide andmethane. These come from using gasoline for driving a car or coal for heating a building,for example. Clearing land and cutting down forests can also release carbon dioxide. Agriculture, oil and gas operations are major sources of methane emissions.

Energy, industry, transport, buildings, agriculture and land use are among the main sectors causing greenhouse gases.

Global warming

Global warming is the long-term warming of the planet's overall temperature. Though this warming trend has been going on for a long time, its pace has significantly increased in the last hundred years due to the burning of fossil fuels. As the human population has increased, so has the volume of fossil fuels burned. Global warming causes climate change, which poses a serious threat to life on Earth in the forms of widespread flooding and extreme weather. Scientists continue to study global warming and its impact on Earth.

Greenhouse gas

Greenhouse gases are those gases in the atmosphere that have an influence on the earth's energy balance. They cause the so-called greenhouse effect. The best- known greenhouse gases, carbon dioxide (CO_2), methane and nitrous oxide, can be found naturally in low concentrations in the atmosphere. However, the proportion has increased significantly since the beginning of the last century due to various man-made sources.

Fossil Fuels

Fossil fuel is a generic term for non-renewable energy sources such as coal, coal products, natural gas, derived gas, crude oil, petroleum products and non- renewable wastes. These fuels originate from plants and animals that existed in the geological past (for example, millions of years ago). Fossil fuels can be also made by industrial processes from other fossil fuels (for example in the oil refinery, crude oil is transformed into motor gasoline).

For decades fossil fuels satisfy most of the human energy requirements. Fossil fuels are carbon-based and their combustion results in the release of carbon into the Earth's atmosphere (carbon that was stored hundreds of millions of years ago). It is estimated that roughly 80% of all manmade CO_2 and green-house gas emissions originate from fossil fuels combustion.

Paris Climate Agreement

The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at the UN Climate Change Conference (COP21) in Paris, France, on 12 December 2015. It entered into force on 4 November 2016.

Its overarching goal is to hold "the increase in the global average

	temperature to well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels." However, in recent years, world leaders have stressed the need to limit global warming to 1.5°C by theend of this century. That's because the UN's Intergovernmental Panel on Climate Change indicates thatcrossing the 1.5°C threshold risks unleashing far more severe climate change impacts, including more frequent and severe droughts, heatwaves and rainfall. To limit global warming to 1.5°C, greenhouse gas emissions must peak before 2025at the latest and decline 43% by 2030. The Paris Agreement is a landmark in the multilateral climate change process because, for the first time, a binding agreement brings all nations together to combat climate change and adapt to its effects.
Content	The game "**Carbon Champions**" is an educational virtual game designed to teach students about their carbon footprint and practical ways to reduce it. Firstly, students complete a quiz that tests their basic knowledge around the concept and significance of human carbon footprint. Then they choose their avatar and go through a typical weekday, making a number of decisions and choices: determiningwhere they live (e.g. flat, two-story house), what they eat (meat meals, vegetarian), their means of transport, how they decide to heat or cool their homes, how much water they use in everyday tasks (washing, watering, etc.), what they buy when they go shopping, how much electricity they consume (if they turn on/offappliances and the light). All these choices affect the game and calculate the character's carbon footprint. If they get more points than those determined to reach their carbon neutral goal, then a thermostat/sound alarm can become red/go off to notify them that they need to make changes in their lifestyle. They can then go back and make changes or proceed by being very careful. If they manage to keep their emissions to the desired level, they become Carbon Heroes! The philosophy behind the game is that reducing our climate impact doesn't requiredramatic changes to our lifestyle, like selling our car or becoming a vegetarian. Evensmall changes to our daily routine can have a big impact on our carbon footprint. Inthis way, students realize that they can be agents of change and that even small changes in our everyday routines can make a huge change and help protect the planet. **Background knowledge** Climate change is affecting the entire globe, causing extreme weather events suchas flooding, extreme heat waves, heavy downpours, as well as rapidly changing climate conditions. Understanding the sources of carbon dioxide

and other greenhouse gas emissions is crucial for taking action to reduce emissions to keep global warming to 1.5C and reach carbon neutrality, as advised by the IPCC and the2015 Paris Agreement.

What is a carbon footprint?

Greenhouse gases are emitted through the production and consumption of goods and services. Carbon footprint is a concept used to quantify the impact of an activity, a person or a country on climate change.

How much carbon is emitted to produce your t-shirt, meal, or phone?

The amount will depend on production and consumption choices. If we take the example of transport, taking the plane emits 285g of carbon per kilometer, compared to 104g for a car and 14g for a train. The same goes for the type of meator fish you eat or the type of jeans you buy.

Why should we care?

The seven billion people on the planet use resources in different proportions. Thepopulation of the world is expected to grow to nearly 11 billion people by 2100 and

9.7 billion people by 2050, according to UN estimates. Population growth increasesemissions and depletes the resources of the world.

Elevated emissions of greenhouse gases directly contribute to global warming. Climate change is accelerated by it, with catastrophic consequences for our world. We can all help combat global warming by incorporating climate-friendly decisionsinto our daily lives.

How can we reduce our carbon footprint?

Understanding your carbon footprint can help limit the impact of your consumption on the environment. There are different online solutions to help youestimate your carbon footprint.

Small changes can make a big difference in the long run, for example when itcomes to transportation, food, clothing, waste, etc. Here are some tips:

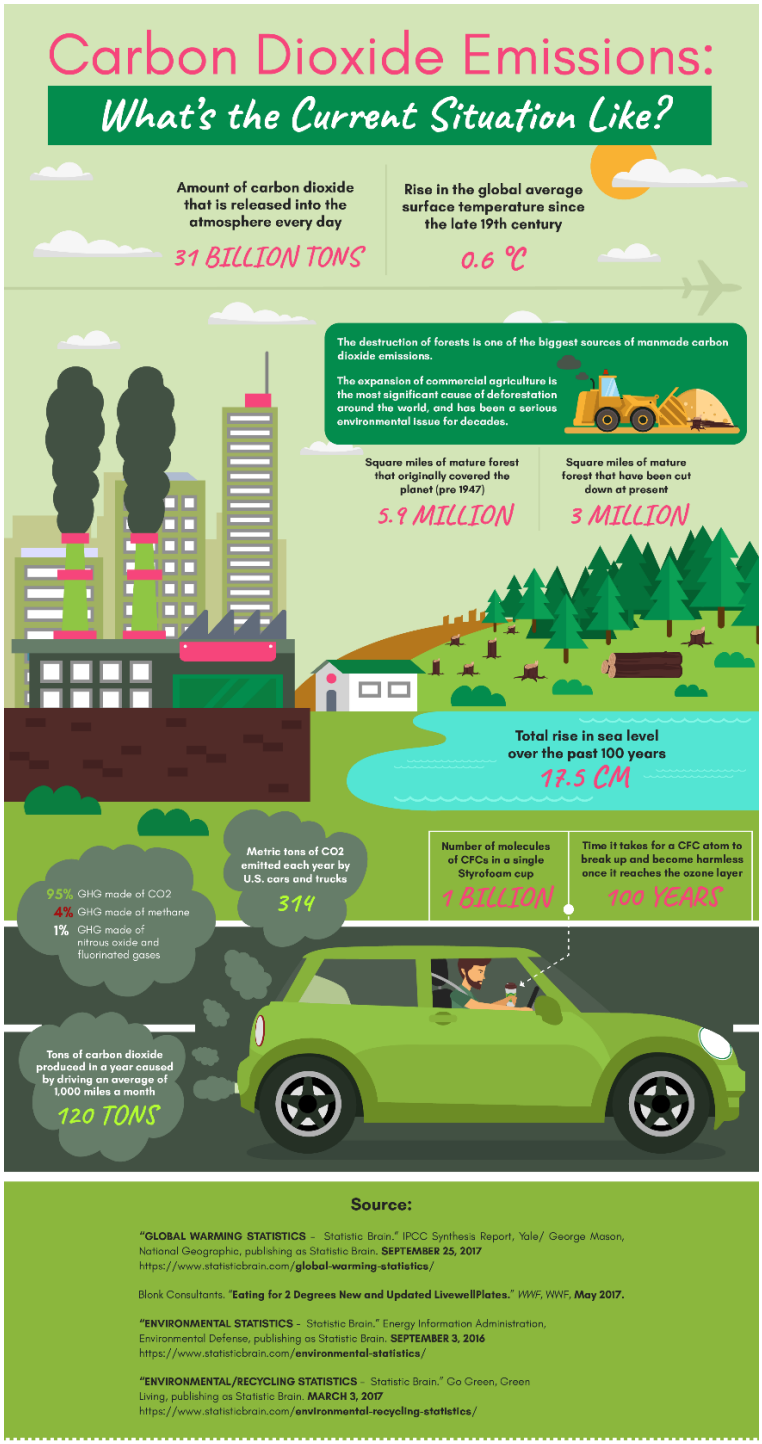
Food

- Consume local and seasonal products (forget strawberries in winter)
- Limit meat consumption, especially bee
- Select fish from sustainable fishing
- Bring reusable shopping bags and avoid products with excessive plasticpackaging
- Make sure to buy only what you need, to avoid waste

Clothing

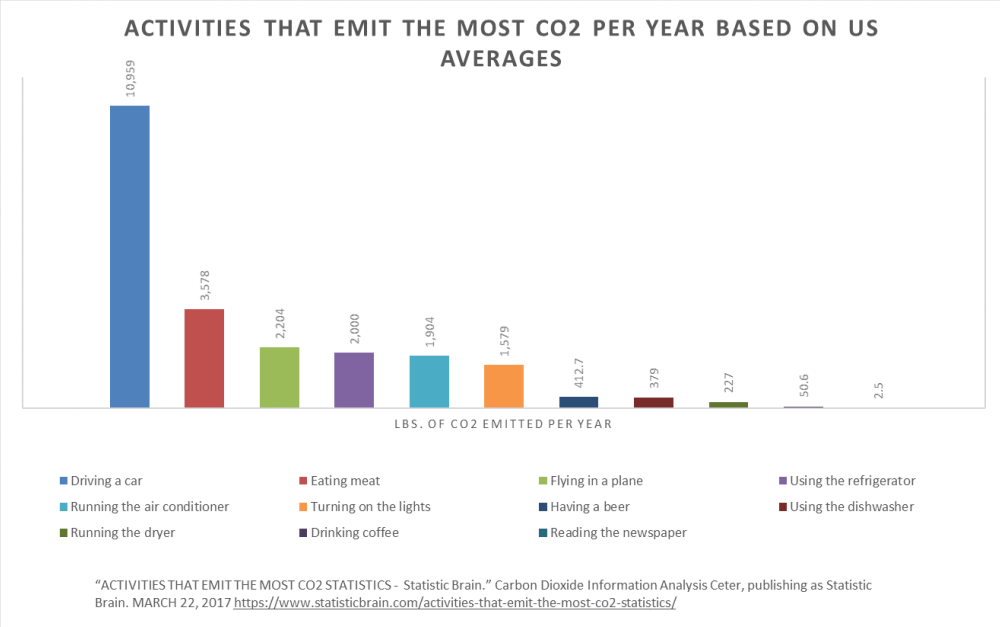
	• Take good care of your clothes • Try swapping, borrowing, renting or buying second-hand • Buy responsibly-made clothes, e.g. made from recycled material or withan eco-label **Transport** • Cycle or use public transport • Be smart about when and how you drive • Try the train for your next holiday. **Energy and waste** • Turn down the heating by 1°, it will already make a difference • Take short showers • Turn off the water while you brush your teeth or clean the dishes • Unplug your electronic equipment and don't leave your phone on charge when the battery is already full • Don't store unnecessary data in the cloud (learn more about your digitalfootprint!) • Select energy efficient products with an "A" label (EU Energy Label) Limit and recycle your waste In this educational scenario, we have included a series of images and infographics that help further enhance students' awareness of environmental issues concerning carbon footprint and carbon footprint statistics, so that students fully realize the impact of a high or low carbon footprint. More specifically, the first poster shows the current situation regarding carbon dioxide emissions. It includes statistics concerning current emissions data and it shows the rise in the Earth's average temperature over the years. It also presents information regarding deforestation, rising sea levels, and the emitted gases from driving and cars. The second inforgarphic depicts all greenhouse emissions by sector and also showsthe largest emitting countries. The third table of statistics provides information regarding the activities that have the heaviest carbon impact on the planet. The fourth poster includes information regarding how our daily activities affect the planet. They all help students acquire a fuller

understanding of their individual carbon footprint and the impact on the environment.




CARBON FOOTPRINT
4.2%
Fuel Production and Transmission
4%
Non-road Transportation
2.6%
Petroleum Refining
1.4%
Landfill, Waste
6.4%
Buildings
15%
Agriculture
9%
Land Use Change and Forestry
10%
Road Transportation
18%
Electricity & Heat
9.6%
Other Energy
19.6%
Industry
THE LARGEST EMITTING COUNTRIES
The Russian Federation
Japan
China
India
The United States
dreamstime.com
ID 213988746 © Maryna Hlushko


How Your Daily Activities Impact the Planet
A closer look at your individual carbon footprint
What's a carbon footprint?
According to greenhouse gas foot-printing expert Mike Berners-Lee, a carbon footprint is a way of estimating the total climate change impact of something you do or buy — all along the supply chain, from manufacturing to delivery to use. Its metric is called carbon dioxide equivalent, or CO2e, which translates all the different greenhouse gases into a comparable amount of CO2 by impact.
An individual's carbon footprint, like real footprints, will vary from one individual to another. The data below are the average amount of individual carbon dioxide emissions emitted per year as we go about our daily life.
Global experts call for a target limit of approximately 2 tonnes (roughly 4400 lbs) per person per year.
Currently, the global average is 4 tonnes (roughly 8800 lbs) per person, with wide variation between countries.
Activities that emit the most CO2 per year based on U.S. averages
Flying in a plane
2,204 lbs.
Turning on the lights
1,579 lbs.
Running the air conditioner
1,904 lbs.
Eating meat
3,578 lbs.
Using the dishwasher
379 lbs.
Having a beer
412.7 lbs.
Drinking coffee
50.6 lbs.
Reading the newspaper
2.5 lbs.
Using the refrigerator
2,000 lbs.
Running the dryer
227 lbs.
Driving a car
10,959 lbs.

	 "ACTIVITIES THAT EMIT THE MOST CO2 STATISTICS - Statistic Brain." Carbon Dioxide Information Analysis Ceter, publishing as Statistic Brain. MARCH 22, 2017 https://www.statisticbrain.com/activities-that-emit-the-most-co2-statistics/
Learning objectives	The learning objectives of the Carbon Champions game are: • To provide information about the importance of our carbon footprint inrelation to our planet • To help students realize that their everyday habits can affect the planet • To encourage students to make changes in their lifestyle and everydayhabits that help the environment • To educate and inform about the various aspects of the issue of high carbon emissions. • To emphasize the importance of the problem and show its seriousness. • To use a graphic way to inform about the breadth of the problem of carbon emissions and catch students' attention • To understand that each individual can make a difference
Activities and exercises	Relating the scenario and other that may complement the learning (optional)

Additional resources	Some ideas are: • Use online carbon calculators to understand the impact of carbonfootprint on a more detailed basis • Watch videos that inform and sensitize further the students about theircarbon footprint Climate Change: Your carbon footprint explained - BBC News: https://www.youtube.com/watch?v=a9yO-K8mwL0 What is a CARBON FOOTPRINT? How to calculate and reduce it? https://www.youtube.com/watch?v=bYb7YLsXvzg What is Carbon Footprint? - Environmental Science for Kids https://www.youtube.com/watch?v=DKDq1RMHscQ The Carbon Footprint of A Sandwich: https://www.youtube.com/watch?v=jRQEi-C5GDg Why CO2 matters for climate change - BBC News *https://www.youtube.com/watch?v=rFw8MopzXdI* Simple show explains the Carbon Footprint *https://www.youtube.com/watch?v=8q7_aV8eLUE*
References/ Sources	**https://www.easel.ly/blog/do-you-know-your-carbon-footprint-a-case-study- infographics/** **https://www.aljazeera.com/news/2022/6/5/infographic-how-can-you-reduce- your-carbon-footprint**

Appendix 2 – Educational information for scenario Green Champions

The goal of this educational material is to teach students about ***environmental-related issues, offering insights on topics ranging from understanding the environment to identifying key challenges and exploring sustainable practices for a healthier planet.***

Educational material (activities for students)

Scenario	*Green champions*
Title	*Education material for students of Green Champions Scenario*
Partner	AEDAS - Agrupamento de Escolas D. Afonso Sanches
Country	o Greece o Italy o **Portugal**
Target audience	*10-15 years old*
Introduction	In a rapidly advancing world, where progress and development often seem synonymous with consumption, the importance of recycling cannot be overstated.Recycling stands as a beacon of hope, offering a tangible solution to the environmental challenges posed by excessive waste generation and resource depletion. If you learn how to recycle, you will help to minimize the amount of waste sent to landfills and incinerators. You should prioritize recycling as a means to conserve valuable resources and reduce the environmental impact of waste disposal. You will learn how to recycle and sort waste correctly and also know about more ways to reduce the consumption of products that have a lot of packaging. The contents to be included in this scenario contemplate the waste recycling/ segregation process. You are expected to know in which recycling container you have to place each waste item by choosing the green, blue, yellow or brown container according to the EU directive. You should be aware of local variations though if their municipality isn't following the EU directive. The specific rules and practices regarding waste management, including the color coding of containers, can vary from one country to another and from a municipality to another. Local authorities provide guidelines to residents onhow to sort and dispose of their waste properly, so it's recommended to check with local waste management authorities or consult informational materials provided byyour community to understand the proper use of different waste containers in eacharea. Let's see if you know how to segregate waste properly!
Content	**Waste**: Any material, substance, or object hat is discarded, unwanted, or no longer useful. It refers to materials that are no longer needed and are destined for disposal, recycling, or other forms of treatment. Waste can take

	various forms, including solid waste (such as household trash and industrial debris), liquid waste (like wastewater and sewage), and gaseous waste (such as emissions from industrial processes) **Waste management**: it involves reducing, reusing, recycling, and properly disposing of waste to minimize its impact on the environment and human health. **Sustainable waste management** aims to reduce the amount of waste generated, promote recycling and reuse, and ensure the safe and environment and human. **Waste segregation**: aims to reduce the amount of waste generated, promote recycling and reuse, and ensure the safe and environmentally responsible disposal of waste that cannot be recycled or reused. **Waste segregation**: it refers to the process of separating different types of waste materials at the source or point of generation based on their characteristics. This practice helps ensure that each type of waste is treated appropriately, maximizing the potential for recycling and minimizing the amount of waste sent to landfills or incineration. **Recycling** is a process through which materials are collected, processed, and transformed into new products, reducing the need for raw materials and decreasing the environmental impact associated with the production of goods. The primary goal of recycling is to conserve resources, reduce energy consumption, and minimize the amount of waste sent to landfills or incineration. **Circular economy:** it is an economic model designed to minimize waste, make themost of resources, and promote sustainability and it is a sustainable alternative to the traditional linear economy in which products are just manufactured, used, andthen disposed of as waste. In contrast, a circular economy aims to close the loop and create a cyclical system, a regenerative and restorative economic model that benefits both the environmentand society. Many businesses and governments around the world are exploring and adopting circular economy principles as part of their sustainability efforts. E.g. fromsustainable agriculture and renewable energy, to restore ecosystems and promotelong-term environmental health. **Sustainable waste management** aims to reduce the amount of waste generated, promote recycling and reuse, and ensure the safe and environmentally responsible disposal of waste that cannot be recycled or reused. **Waste segregation:** it refers to the process of separating different

	Key principles of waste segregation include: **1. Source separation:** Waste segregation begins at the source, such as households,businesses, or industries. Individuals categorize their waste into distinct bins or containers based on the type of material. **2. Color-coded bins or containers:** many waste management systems use color-coded bins or containers to signify different types of waste. **3. Types of segregation** **3.1. Recyclables**: Materials that can be recycled, such as paper, cardboard, plastics,glass, and metal **3.2. Organic waste:** Biodegradable materials like food scraps and garden waste. **3.3. Non-recyclable/residual waste:** items that cannot be easily recycled or composted, often sent to landfills or incineration. **4. Benefits:** Waste segregation helps improve the efficiency of recycling processes,reduces the burden on landfills, conserves resources, and minimizes environmentalpollution. **5. Community education:** Successful waste segregation programmes often involveeducating communities about the importance of proper waste disposal and the environmental benefits of recycling and reducing waste. **Key elements of the recycling process include:** **1.Collection:** collecting recyclable materials from various sources, such as households, businesses, and industries. **2. Sorting:** separating different types of recyclable materials from the collected waste. This can be done manually or with the help of automated sorting systems. **3.Processing:** recyclable materials are processed to remove contaminants, clean and prepare them for recycling. This may involve shredding, melting, or other methods depending on the material. **4. Manufacturing:** After being processed, the materials are used to manufacture new products. For example, recycled paper can be used to make new paperproducts, recycled plastic can be used to produce new plastic items, and so on. **5. End-product:** The final result of the recycling process is the creation of new products from the recycled materials, identical to those made from virgin materials. **Benefits of recycling include:**

	1. **Conservation of resources:** recycling reduces the demand for raw materials, conserving natural resources. 2. **Energy savings:** manufacturing products from recycled materials often requires less energy compared to producing goods from raw materials. 3. **Waste reduction:** recycling helps divert materials from landfills, reducing the environmental impact of waste disposal. 4. **Lower greenhouse gas emissions:** recycling can contribute to a reduction in greenhouse gas emissions associated with the extraction and processing of raw materials.
Learning objectives	By the end of this educational module/scenario you are expected to: • Understand the concept of waste segregation. • Learn how to segregate paper, plastic, metal and organic waste. • Comprehend the impact of waste on the environment. • Identify and recognize the benefits that recycling programmes means forthe health and sustainability of the planet. Compromise with recycling habits and contribute to raise awarenessabout the importance of recycling practices in their schools and communities.
Activities and exercises	This scenario is set at a school, after a students' party and the sports facilities are filled with waste. Students arrive at the field for a Physical Education (PE) lesson, but they can't play or run due to the amount of litter scattered around the floor. In this scenario there will be a student/player that will try to clean up the sports field. The PE teacher decides to play a game where students must know/learn how to sortout and recycle waste appropriately. The school sports facility can be the basketballfield outdoors. The teacher informs the student from the Eco-school's programme that he/she has to clean the floor before the class starts. Each student will play the game in turns. There will be 4 different basketball hoops: a green, a yellow, a blue and a brown one. There will be 3 items of each type of waste spread around on the floor: • 3 items made of plastic or metal waste (for example: a coke can, a bag of potato chips and a carton of milk); • 3 items of paper waste (a paper cup for hot drinks, a paper cup for cold drinks and a popcorn pack); • 3 different items made of glass (a candy jar, a soda bottle and a

	yogurt cup); • 3 items of organic waste (a banana peel, an apple core and a cookie). In this scenario there will be a student/player that will try to clean up the sportsfield. The Physical Education (PE) teacher will also act as a referee. There will be a timer to start, pause and finish the game. The PE will give feedbackevery time a player misplaces a waste item. There will be a speech bubble for each correction or recommendation or a videopop-up window. The player can choose his/her avatar which is optional (the options should includegender, seize and mandatory protection equipment: a pair of gloves and tweezers). Every time the player makes a mistake sorting the waste items, a pop-up windowwill appear with a message or a video with further explanations. **Paper /blue container message to student:** *"When disposing of a paper waste item, you should place it in a designated recyclingbin or container which is typically blue or marked with a recycling symbol. If your local recycling programme accepts paper products, you can usually include newspaper, cardboard, office paper and paper packaging in the cycling bin.* *Be sure to remove any non-paper materials like plastic or metal before placing it inthe recycling bin, as contamination can hinder the recycling process."* **Plastic/metal yellow container message to student:** *"When disposing of a plastic item, you should place it in a designated recycling bin or container which is typically yellow or marked with a recycling symbol. If your localrecycling programme accepts plastic products, you can usually include single-use plastics, plastic containers, plastic packaging, plastic water bottles, among other items.* *Make sure that you, whenever possible, reduce your consumption of single-use plastics and replace them with reusable alternatives. This helps minimize plastic waste in the first place.* *Also consider reusing plastic items, when possible, to reduce waste. For example, you can use plastic containers for storage, refill plastic water bottles, or repurpose plastic bags.* *Please look for recycling symbols, such as the recycling arrows with a number inside,usually found on the plastic item. If it's recyclable, rinse it clean of any residue and place it in your recycling bin.*

	Common recyclable plastics include PET (#1), HDPE (#2), and LDPE (#4). If the plastic item is hazardous waste, such as certain electronics or chemicals contained in plasticcontainers, follow your local regulations for hazardous waste disposal. Do not dispose of hazardous plastics in regular trash or recycling bins." **Glass green container message to student:** *When disposing of a glass waste item, it's important to follow recycling guidelines and local regulations.* *Typically, glass waste should be placed in a designated recycling bin or container specifically designated for glass recycling. This could be a green or blue bin or a separate glass recycling container provided by your local waste management or recycling programme.* *Here's a short description of where to place a glass waste item:* *First, rinse out the glass container to remove any remaining food or liquid residues. Only then, place the clean glass item in the appropriate recycling bin or container. Ensure that it is empty and not contaminated with non-recyclable materials.* **Organic brown container message to student:** "*When disposing of organic waste items, it's important to follow proper guidelines.Organic waste, such as fruit and vegetable scraps, coffee grounds, eggshells, and yard debris like leaves and grass clippings, should be placed in a designated compostbin or pile.* *Make sure the composting area is well-aerated and balanced with a mix of green (nitrogen-rich) and brown (carbon-rich) materials for efficient decomposition.* ***You can also use an indoor compost container** for kitchen scraps, consider using a small container with a lid to collect organic waste indoors. Empty this container intoyour larger outdoor compost bin or pile regularly to avoid odors and pests.* ***I**f you have limited outdoor space, consider setting up a worm bin indoors or on abalcony. Worms can efficiently break down organic materials into nutrient-rich vermicompost.* *Please do not place organic waste in regular trash bins that go to landfills. Organic matter in landfills generates methane, a potent greenhouse gas.*"
Additional resources	Article: process the oil for renewable fuel production https://www.mahoneyes.com/blog/15-creative-uses-of-used-cooking-oil-you- never-knew/ Use of recycled tires:

	https://www.webmd.com/balance/how-to-recycle-tires Videos to be used every time they get a wrong answer in the scenario Green Championship: I. Recycling and waste management: 1. How to take care of the environment https://www.youtube.com/watch?v=belXC_Io W4o 2. Why Recycling Is Important https://www.youtube.com/watch?v=eSeXWk3U TWQ 3. Proper Waste Management | How waste reduction and recycling help our environment https://www.youtube.com/watch?v=Qyu-fZ8BOnI 4. The Paper Recycling Process https://www.youtube.com/watch?v=jAqVxsEg WIM 5. Recycling Glass | Environmental Chemistry | Chemistry | FuseSchool - YouTube https://www.youtube.com/watch?v=vhpc0UULjDU II. Composting 6. Why is composting good for the environment: https://www.youtube.com/watch?v=oFlsjRXbnSk 7. Vermicomposting: https://www.youtube.com/watch?v=V8miLevRI_o III. Impact of Plastic 8. A brief history of plastic https://www.youtube.com/watch?v=9GMbRG9 CZJw 9. Plastic Pollution Video https://www.youtube.com/watch?v=UXlxMfs W0nk 10. Microplastic is Everywhere. And in You, Tool https://www.youtube.com/watch?v=TwKc2C

	NLTIs 11. Plastic Free Oceans | The Gravity Wave https://www.youtube.com/watch?v=_tFWhetuTZw 12. A brief history of plastic https://www.youtube.com/watch?v=9GMbRG9CZJw 13. Plastic Pollution Video https://www.youtube.com/watch?v=UXlxMfsW0nk

Educational material (for teachers)

Scenario	Green Champions
Title	*Education material for teachers of Green Champions Scenario*
Partner	AEDAS - Agrupamento de Escolas D. Afonso Sanches
Country	○ Greece ○ Italy ○ **Portugal**
Target audience	18-65
Keywords	*Waste segregation, recycling, reusing, reducing, circular economy*
Glossary	**Waste**: it is generally defined as any material, substance, or object that is discarded,unwanted, or no longer useful. In the context of environmental and waste management, it refers to materials that are no longer needed and are destined fordisposal, recycling, or other forms of treatment. Waste can take various forms, including solid waste (such as household trash and industrial debris), liquid waste (like wastewater and sewage), and gaseous waste (such as emissions from industrial processes). The classification of waste often depends on its origin, composition, and characteristics. **Waste management**: it involves practices like reducing, reusing, recycling, and properly disposing of waste to minimize its impact on the environment and humanhealth. **Sustainable waste management** aims to reduce the amount of waste generated, promote recycling and reuse, and ensure the safe and environmentally responsible disposal of waste that cannot be recycled or reused. **Waste segregation:** it refers to the process of separating different types of waste materials at the source or point of generation based on their characteristics. The primary goal of waste segregation is to facilitate the efficient management and disposal of waste, with an emphasis on reducing environmental impact and promoting recycling. This practice helps ensure that each type of waste is treated appropriately, maximizing the potential for recycling and minimizing the amount ofwaste sent to landfills or incineration Waste segregation is a crucial aspect of overall waste management practices and contributes to the broader goal of sustainable and environmentally friendly waste disposal. Many municipalities and regions have specific guidelines and regulations in place to encourage and enforce waste segregation practices. It's important to note that the specific guidelines for waste separation and recyclingcan differ from one location to another, so it's recommended to check with local waste management authorities or consult informational materials provided by your community to understand the proper use of different waste containers in your area.

Key principles of waste segregation include:

1. **Source separation:** Waste segregation begins at the source, such as households, businesses, or industries. Individuals categorize their waste into distinct bins or containers based on the type of material.
2. **Colour-coded bins or containers:** many waste management systems use colour-coded bins or containers to signify different types of waste.
3. **Types of segregation:**
   - 3.1 **Recyclables**: Materials that can be recycled, such as paper, cardboard, plastics,glass, and metal
   - 3.2 **Organic waste:** Biodegradable materials like food scraps and garden waste.
   - 3.3 **Non-recyclable/residual waste:** items that cannot be easily recycled or composted, often sent to landfills or incineration.
4. **Benefits:** Waste segregation helps improve the efficiency of recycling processes,reduces the burden on landfills, conserves resources, and minimizes environmental pollution. It also promotes a more sustainable and responsible approach to waste management.
5. **Community education:** Successful waste segregation programs often involve educating communities about the importance of proper waste disposal and the environmental benefits of recycling and reducing waste.

Recycling is a process through which materials are collected, processed, and transformed into new products, thereby reducing the need for raw materials and decreasing the environmental impact associated with the production of goods. Theprimary goal of recycling is to conserve resources, reduce energy consumption, and minimize the amount of waste sent to landfills or incineration.

Key elements of the recycling process include:

1. **Collection:** collection recyclable materials from various sources, such as households, businesses, and industries. This may involve the use of separate recycling bins or designated collection points.
2. **Sorting:** separating different types of recyclable materials from the collected waste. This can be done manually or with the help of automated sorting systems. The sorting process is essential to ensure that materials are properly processed and recycled.
3. **Processing:** recyclable materials are processed to remove contaminants, clean, and prepare them for recycling. This may involve shredding, melting, or other methods depending on the material.

4. **Manufacturing:** After being processed the materials are used to manufacture new products. For example, recycled paper can be used to make new paper products, recycled plastic can be used to produce new plastic items, and so on.
5. **End-product:** The final result of the recycling process is the creation of new products from the recycled materials, identical to those made from virgin materials. Commonly recycled materials include paper, cardboard, glass, plastics, metals (such as aluminum and steel), and certain types of electronics.

Benefits of recycling include:

1. **Conservation of resources:** recycling reduces the demand for raw materials,conserving natural resources.
2. **Energy savings:** manufacturing products from recycled materials often requiresless energy compared to producing goods from raw materials.
3. **Waste reduction:** recycling helps divert materials from landfills, reducing theenvironmental impact of waste disposal.
4. **Lower greenhouse gas emissions:** recycling can contribute to a reduction in greenhouse gas emissions associated with the extraction and processing of raw materials.**:**

To promote recycling, many communities have established recycling programmes, implemented waste segregation practices, and set up recycling facilities. Public awareness and participation are crucial for the success of recycling initiatives.

Circular economy: it is an economic model designed to minimize waste, make themost of resources, and promote sustainability. In a traditional or linear economy, products are manufactured, used, and then disposed of as waste. In contrast, a circular economy aims to close the loop by emphasizing the principles of reduce, reuse, and recycle. The circular economy is seen as a sustainable alternative to the traditional linear economy. By closing the loop and creating a cyclical system, the circular economy aims to create a regenerative and restorative economic model that benefits both the environment and society. Many businesses and governments around the world are exploring and adopting circular economy principles as part oftheir sustainability efforts.

The key features of a circular economy include:

1. **Design for longevity and reusability:** products are designed with durability and the potential for reuse. This involves creating goods that have a longer lifespan, easy to repair, and can be disassembled for components to be

	reused. 2. **Resource efficiency:** maximizing the use of resources and minimizing waste is a core principle. This involves using materials more efficiently, reducing overconsumption, and optimizing production processes. 3. **Product as a service:** Instead of owning products outright, consumers may subscribe to a service or lease products. This encourages manufacturers to deign products with durability and recyclability in mind, as they retain ownership of the materials. 4. **Regenerative practices:** beyond minimizing harm, a circular economy aims to have a positive impact on the environment. This involves adopting regenerative practices, such as sustainable agriculture and renewable energy, to restore ecosystems and promote long-term environmental health.
Content	**Description of the waste segregation management system of each participating country:** **Blue container**: in the context of waste management and recycling, the "blue container" often refers to a recycling bin or container that is designated for the collection of recyclable materials. Depending on the region's waste management system, the blue container usually is for paper products, including items such as newspaper, cardboard, office paper and paper packaging. We must remove any non-paper materials like plastic or metal before placing it in the recycling bin, as contamination can hinder the recycling process. The blue container for paper is used in Portugal, Italy and Greece. **Yellow container**: the exact items accepted in yellow recycling containers can vary depending on local recycling guidelines. In most European countries, the yellow container is used for plastic products including single-use plastics, plastic containers, plastic packaging, plastic water bottles, among other items. Whenever possible the consumption of single-use plastics should be replaced with reusable alternatives in order to minimize plastic waste. Some waste management systems use a yellow container to collect or dispose of hazardous waste which includes materials that can pose a risk to human health or the environment if not handled properly. To sort the plastic items, we should look for recycling symbols. If it's recyclable, it should be rinsed clean of residues before disposal. Common recyclable plastics include PET (#1), HDPE (#2), and LDPE (#4). If the plastic item is hazardous waste, such as certain electronics or chemicals contained

	in plastic containers, follow local regulations for hazardous waste disposal. Some countries accept metal waste in yellow containers so, it's important to follow local waste disposal guidelines and consider recycling options. Before disposing of the metal item, consider if it can be reused or repurposed. Metals such as aluminum, steel and copper are recyclable. If the metal item contains hazardous materials, such as chemicals or batteries, it should be taken to a designated hazardous waste disposal facility. Some larger metal items, like appliances or automotive parts, can be taken to metal scrap yards. In Portugal we use the yellow container for plastic and recyclable metal. In Italy we use the yellow container for plastic and the turquoise container for metal. **Organic/brown container**: in some waste management systems in Europe, the brown container is often associated with the collection of organic or biodegradable waste, particularly materials that are suitable for composting. It is typically used for collecting organic waste, which includes kitchen scraps (e.g., fruit and vegetable peels, coffee grounds), food leftovers, coffee grounds, and yard waste (e.g., grass clippings and small branches). **Composting**: The organic waste collected in brown containers can also be sent to composting facilities, where it undergoes controlled decomposition to produce compost, a nutrient-rich soil conditioner. Some municipalities offer composters to households so that the population can produce their own compost for domestic use. Separating organic waste for composting helps divert this material from landfills, reducing methane emissions associated with organic waste decomposition in anaerobic conditions. It also produces valuable compost that can be used to enrich soil. It's important to note that waste management practices and color-coding systems can vary from one country or region to another within Europe. Therefore, it's recommended to check with local waste management authorities or refer to guidelines provided by the municipality or waste collection service in a specific area to understand the exact requirements for waste segregation, including the use of brown containers for organic waste. **Worm Bin (Vermicomposting)**: Worms can efficiently break down organic materials into nutrient-rich vermicompost. **Glass/green container**: in some waste management systems in Europe, the green container is often associated with the collection of glass. When disposing of a glass waste item, it's important to follow recycling guidelines

and local regulations.

Typically, glass waste should be placed in a designated recycling bin or container specifically designated for glass recycling. This could be a green or blue bin or a separate glass recycling container provided by your local waste management or recycling programme.

Ensure that the glass item it is empty and not contaminated with non-recyclable materials. It should be rinsed out to remove any remaining food or liquid residues.

What are used tires for? Tire recycling originates new products, such as fuel, paving for playgrounds, shoe soles, bicycle saddles and asphalt for roads. Thus, it contributes to the reuse of end-of-life materials, promoting the circular economy and environmental sustainability. In Portugal, around 80 thousand tons of end-of-life tires are sent for recycling per year.

How to recycle electric light bulbs?

Each type of light bulb is recycled differently and, in fact, there are even light bulbs that are not recycled. It is important to keep the following points in mind:

- You should not dispose of these lamps in the trash, much less in the glass jar. Fluorescent or discharge lamps contain dangerous substances and must therefore be collected separately.

When placing them in the trash container or green recycling bin (glass), they will break and release these substances. On the other hand, the glass that makes them up has a different composition than the packaging glass, which means that they should not be delivered to the recycling bin.

- When a lamp of this type burns out, you can return it, free of charge, to the establishment where you are going to buy the new one. You can also deliver it to collection centers for waste electrical and electronic equipment, or to recycling centers that accept them.

Many European countries have special waste collection centers where citizens can take dangerous items, including fluorescent lamps and others that contain mercury. These centers can be located in specific areas or can be established in partnership with DIY stores or supermarkets.

Waste Electrical and Electronic Equipment (WEEE)

The amount of electrical and electronic equipment waste (widely known as WEEE or e-waste) generated every year in the EU is increasing rapidly. It is now one of the fastest growing waste streams. It includes a large range of devices such as mobile phones, computers, televisions, fridges, household appliances, lamps but also medical devices and photovoltaic panels.

EU rules address environmental and other issues caused by the growing

	number of discarded electronics in the EU. The aim is to contribute to sustainable production and consumption by: • preventing the creation of WEEE as a priority; • contributing to the efficient use of resources and the retrieval of secondary raw materials through re-use, recycling and other forms of recovery; • improving the environmental performance of everyone involved in the life cycle of EEE; Many European countries have specific collection points for electronic waste. These could be municipal collection points, electronics stores or designated recycling facilities. Some manufacturers and retailers offer recycling programs for their products. They may receive old devices when you buy a new one. Some electronics stores accept old devices for recycling when you buy a new one. Electronic devices often contain batteries. Make sure you recycle them correctly as they can also be harmful to the environment. Some electronics stores and supermarkets have collection points for batteries
Learning objectives	By the end of this educational module/scenario students are expected to: • Understand the concept of waste segregation. • Know how to segregate paper, plastic, metal and organic waste. • Comprehend the impact of waste on the environment. • Identify and recognize the benefits that recycling programmes means for the health and sustainability of the planet. • Compromise with recycling habits and contribute to raise awareness about the importance of recycling practices in their schools and communities.
Activities and exercises	The player goes to the basketball court and when he arrives there, he finds a lot of waste items scattered all over the floor, due to a party that took place at school the day before. The student/player that arrives at the court belongs to the Eco-schools' programme and wants to start playing basketball, but he can't. The player starts talking to the PE teacher that is already there to clean up and prepare for the class. Students are asked to identify and sort waste items in order to learn how to recycle them appropriately and reduce their impact on the environment.

Additional resources	**Article: process the oil for renewable fuel production** https://www.mahoneyes.com/blog/15-creative-uses-of-used-cooking-oil-younever-knew/ **Use of recycled tires:** https://www.webmd.com/balance/how-to-recycle-tires Recycled tires can be used in several ways. Just a few examples of how tires can be recycled and reused include: 1. Gravel substitute. 2. Crumb rubber. 3. Landfill medium such as a liner, cover, or insulation for landfills. 4. Wastewater treatment filters. 5. Garden mulch. 6. Tires can also be used for engineering purposes including building roads, supplementing asphalt, and creating drainage materials. Videos to be used every time they get a wrong answer in the scenario Green Championship: I. Recycling and waste management: 8. How to take care of the environment https://www.youtube.com/watch?v=belXC_Io W4o 9. Why Recycling Is Important https://www.youtube.com/watch?v=eSeXWk3U TWQ 10. Proper Waste Management | How waste reduction and recycling help our environment https://www.youtube.com/watch?v=Qyu-fZ8BOnI 11. The Paper Recycling Process https://www.youtube.com/watch?v=jAqVxsEg WIM 12. Recycling Glass | Environmental Chemistry | Chemistry | FuseSchool - YouTube https://www.youtube.com/watch?v=vhpc0UULjDU II. Composting

	13. Why is composting good for the environment: https://www.youtube.com/watch?v=oFlsjRXbnSk 14. Vermicomposting: https://www.youtube.com/watch?v=V8miLevRI_o III. Impact of Plastic 14. A brief history of plastic https://www.youtube.com/watch?v=9GMbRG9CZJw 15. Plastic Pollution Video https://www.youtube.com/watch?v=UXlxMfsW0nk 16. Microplastic is Everywhere. And in You, Tool https://www.youtube.com/watch?v=TwKc2CNLTIs 17. Plastic Free Oceans | The Gravity Wave https://www.youtube.com/watch?v=_tFWhetuTZw 18. A brief history of plastic https://www.youtube.com/watch?v=9GMbRG9CZJw 19. Plastic Pollution Video https://www.youtube.com/watch?v=UXlxMfsW0nk
References/Sources	Recycling of communal waste: Current state and future potential for sustainable development in the EU M Taušová, E Mihaliková, K Čulková, B Stehlíková - Sustainability, 2019 - MDPI A modern solid waste management strategy–the generation of new by-products S Fudala-Ksiazek, M Pierpaoli, E Kulbat - Waste Management, 2016 - Elsevier Municipal **solid waste** generation, composition, and management: the global scenario KD Sharma, S Jain - Social Responsibility Journal, 2020 – Emerald Guide on separate collection of municipal waste in Greece- Final Report https://ypen.gov.gr/wp-

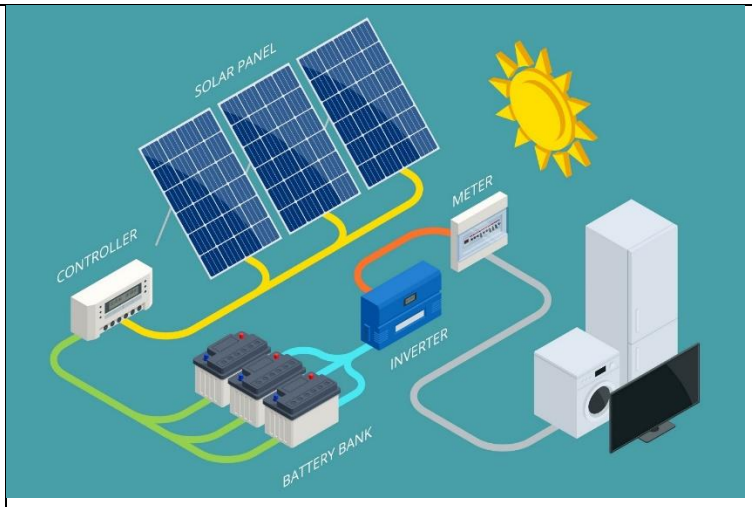
	content/uploads/2021/09/FinalReport_A1.1_Separate_Collection_20200624_final_short_edition.pdf

Appendix 3 – Educational information for scenario Visiting Green Town

The goal of this educational material is to teach students about ***environmental-related issues, offering insights on topics ranging from understanding the environment to identifying key challenges and exploring sustainable practices for a healthier planet.***

Educational material (activities for students)

Scenario	*Visiting Green Town*
Title	*Education material for students of Visiting Green Town Scenario*
Partner	Liceo Manin
Country	o Greece o **Italy** o Portugal
Target audience	*10-15 years old*
Introduction	In our quest for sustainability and environmental preservation, modern technology and innovative practices offer promising solutions. Solar panels harness the immense power of the sun, converting sunlight into electricity to meet global energy demands efficiently and cleanly. In urban planning, the adoption of electric buses and the establishment of cycle lanes are pivotal in reducing urban pollution and promoting healthier lifestyles. Meanwhile, the planting of evergreens provides year-round ecological benefits, from air purification to natural habitat provision. Together, these initiatives represent a multifaceted approach to tackling climate change and fostering a sustainable future.
Content	SOLAR PANELS The amount of sunlight that strikes the earth's surface in an hour and a half is enough to handle the entire world's energy consumption for a full year. Solar technologies convert sunlight into electrical energy either through photovoltaic (PV) panels or through mirrors that concentrate solar radiation. This energy can be used to generate electricity or be stored in batteries or thermal storage. When the sun shines onto a solar panel, energy from the sunlight is absorbed by the PV cells in the panel. This energy creates electrical charges that move in response to an internal electrical field in the cell, causing electricity to flow.



*DC vs AC Electricity

What's the difference between direct current and alternating current electricity?

In brief, DC or direct current power is straight or linear electrical current. It means that the electricity goes in a straight line or goes from point A to point B without changing its charge. Direct current is special because its voltage delivery (i.e. how powerful it is) is more consistent than that of current.

AC or alternating current electricity, on the other hand, has a current flow that can swap between positive and negative. In other words, it goes in two directions.

Both AC and DC electricity are used for everyday devices and applications. For example, many electronic devices or handheld things use DC electricity. But many household appliances, like washing machines, refrigerators, and even household lights use AC power.

AC electricity is actually more common. Power outlets in homes bring energy into buildings as alternating current. The house then uses a converter to change the alternating current into DC electricity. Why? DC electricity can't travel as far as AC electricity. Plus, AC electricity is cheaper to make.

ELECTRIC BUSES AND CYCLE LANES

Many municipalities have decided to invest money on an electric bus fleet because they are very silent, they have zero tailpipe emissions and they help fight climate change.

In many cities you can also find cycle lanes and bike docking stations The bicycles are locked into the docks and must be unlocked using an app or ride code. Each dock contains a keypad where ride codes can be entered. This is very convenient and has lots of advantages. They cut down on traffic congestion, they create a sense of safety and they encourage a safer lifestyle.

	EVERGREENS – BENEFITS These are the advantages of evergreens: 1. When cold air prevents pollutants from escaping the atmosphere, they're the only trees that continue to purify our air. 2. Evergreens are as close to maintenance-free as you can get. Their ability to retain moisture is near the top of the list of other trees. 3. Evergreens provide homes and shelter for many birds and wildlife. Nests are safe from predators and weather, and the many branches give plenty of birds and small animals a home. 4. The foliage and seeds provide food for flora and fauna and can protect birds and wildlife from freezing weather.
Learning objectives	1. **Understand Solar Energy Conversion**: Students will learn how solar panels convert sunlight into electrical energy, including the processes involved in photovoltaic (PV) systems and concentrated solar power (CSP) technologies. 2. **Differentiate Between DC and AC Electricity**: Students will comprehend the differences between direct current (DC) and alternating current (AC) electricity, including their characteristics, uses, and why AC is more commonly used for household electricity. 3. **Explore the Advantages of Electric Buses**: Learners will understand the benefits of electric buses over traditional diesel buses, focusing on their environmental impacts, operational efficiencies, and contributions to urban noise reduction. 4. **Appreciate Urban Cycling Infrastructure**: Students will investigate the role of cycle lanes and bike docking stations in promoting sustainable urban transport, reducing traffic congestion, and enhancing public health. 5. **Recognize the Environmental Benefits of Evergreens**: Learners will explore the ecological advantages of evergreen trees, including their year-round air purification capabilities, low maintenance needs, and support for wildlife.
Activities and exercises	N/A
Additional resources	N/A

Educational material (for teachers)

Scenario	Visiting Green Town
Title	*Education material for teachers of Visiting Green Town Scenario*
Partner	Liceo Manin
Country	○ Greece ○ **Italy** ○ Portugal
Target audience	18-65
Keywords	*Evergreens, Electric buses, batteries, sustainability, Cisterns, rainwater, Solar Panels, DC/AC electricity*
Glossary	1) **Rainwater:** water that has fallen as or been obtained from rain. 2) **Potable Water**: Potable water, also known as drinking water, comes from surface and ground sources and is treated to levels that that meet state and federal standards for consumption.. 3) **Pump:** a piece of equipment that is used to cause liquid, air, or gas to move from one place to another:. 4) **Sedimentation tank**: A sedimentation tank allows suspended particles to settle out of water or wastewater as it flows slowly through the tank, thereby providing some degree of purification. 5) **Impervious Surface**: Impervious surfaces are mainly artificial structures—such as pavements (roads, sidewalks, driveways and parking lots, as well as industrial areas such as airports, ports and logistics and distribution centres, all of which use considerable paved areas) that are covered by water-resistant materials such as asphalt 6) **Gutter:** a shallow trough fixed beneath the edge of a roof for carrying off rainwater. 7) **Solar Panels:** panels designed to absorb the sun's rays as a source of energy for generating electricity or heating. 8) **Battery cell**: *a closed electrochemical system that converts chemical energy from oxidation and reduction* reactions directly into electric energy . 9) **DC electricity:** it *is one-directional flow of electric charge*. 10) **AC electricity**: it is an electric current *which periodically reverses direction and changes its magnitude continuously with time*. 11) **Inverter**: a device that converts either of the two binary digits or signals into the other. 12) **Battery Bank**: A battery bank is made up of two or more batteries connected together, either in series or in parallel. A battery is made up of one or more cells. 13) **Evergreens:** Plants that retains its leaves through the year and into the following growing season. 14) **Endangered**: seriously at risk of extinction 15) **Oxygen:** a colourless, odourless reactive gas, the chemical element of atomic number 8 and the life-supporting component of the air.

	16) **Carbon monoxide**: a colourless, practically odourless, and tasteless gas or liquid. It results from incomplete oxidation of carbon in combustion. 17) **Heating bill**: a bill for the supply of energy to heat a building 18) **Low Maintenance:** requiring little work to keep in good condition. 19) **Electric buses:** buses whose propulsion and accessory systems are powered exclusively by a zero-emissions electricity source. 20) **Maintenance savings**: the operating expenses eliminated and future capital replacement expenditures avoided as a result of new equipment installed or services performed by the performance contractor. 21) **Utility benefits:** comprehensive benefits obtained from consuming an item or service. 22) **Vehicle-to-grid**: it is a technology that enables energy to be pushed back to the power grid from the battery of an electric vehicle (EV) 23) **Particulate**: matter in the form of minute separate particles.
Content	EVERGREENS DEFINITION FROM ENCYCLOPEDIA BRITANNICA: Any plant that retains its leaves through the year and into the following growing season. Planting evergreens ensures they never become endangered and brings many benefits to us all. **Benefits of Planting Evergreens** Evergreens have forever been a favorite tree, especially at Christmastime. Everyone who celebrates Christmas has memories of hunting for the perfect evergreen to put in their home and decorate with ornaments, lights and tinsel. But do evergreens exist for our holiday pleasure alone? Of course not. Evergreens belong to the conifer species, meaning they have needles and cones instead of leaves and flowers. Ultimately, planting evergreens ensures they never become endangered and brings many benefits to us all. We'll discuss just a few benefits in this blog. **Just Plain Beauty** Let's start with the easy one. Evergreens are beautiful trees that add a lovely touch of color to a winter landscape. They send out the unrelenting message that life still abounds even when things look bleak and cold. **Boundaries**

	Nothing sets off a property line like a row of evergreens. The best-looking fence cannot compare with the natural beauty and protection of evergreen trees as a boundary to your property. Planting evergreens will define your boundaries for generations. Oxygen Evergreens are excellent for the environment. First, they provide oxygen and reduce carbon monoxide. A single acre of evergreens can provide enough oxygen for 18 people. But more than providing air to breathe, evergreens help clean the air by removing toxins and other pollution and leaving healthier air to breathe. When we participate in planting evergreens regularly, we are helping the environment to heal. Privacy Because evergreens never lose their needles but instead are thick and lush all the time, they provide great privacy screens. Planting a row of evergreens provides privacy, so you can rest assured prying eyes will have no easy access. Home, Sweet Home In addition to providing oxygen and cleaning the air, evergreens provide homes and shelter for many birds and wildlife. Nests are safe from predators and weather, and the many branches give plenty of birds and small animals a home. In addition, the foliage and seeds provide food for flora and fauna and can protect birds and wildlife from freezing weather. Energy Efficiency Evergreen borders save energy inside your home. In the summer, the shade will lower your air conditioning bill because the entire house stays cooler. In the wintertime, while other shade trees lose their leaves (and temperature control), evergreens can help hold in the heat that other trees cannot. Planting a row of evergreens on the north side of your building can substantially reduce your heating bill. Low Maintenance Evergreens are as close to maintenance-free as you can get. Their ability to retain moisture is near the top of the list of other trees. While the first year after planting will require attention, once an evergreen is off to a healthy

start, with proper drainage and access to natural groundwater and rainfall, it won't need much maintenance to grow to great heights and live for decades.

ELECTRIC BUSES

An Electric Bus is any bus whose propulsion and accessory systems are powered exclusively by a zero-emissions electricity source. The electricity source can be onboard batteries, a hydrogen-fuel cell, overhead wires, like a trolleybus application, or ground-based non-contact conductors.

Transportation electrification is continuing to expand as more medium- and heavy-duty vehicles enter the market. Electric buses in particular — both transit and school buses — are hitting roads across the country as cities, schools, airports and other large organizations add them to their fleets. These buses provide a unique set of benefits to the organizations purchasing them, the communities they drive through, the environment around them and the electric utilities that power them.

Operational Benefits

Electric buses are highly efficient and have lower operating costs than diesel buses. Fuel savings can be significant when comparing electricity with diesel, and the buses also have fewer moving parts and maintenance needs. Between fuel and maintenance savings, they can save hundreds of thousands of dollars over their lifetimes that can be invested back into the operating organization or community.

One example of these savings was seen in Greensboro, North Carolina. Adam Fischer, former transportation director for the City of Greensboro, discussed savings estimates during a presentation he gave at a Plug-in NC event. His team calculated that switching from a diesel to an electric bus would save nearly $160,000 in fuel and $185,000 in maintenance over the bus's lifetime.

Community Benefits

Electric buses are safe, reliable and have similar rates of downtime to other technologies. Their quiet, smooth rides allow passengers to relax and easily have conversations, and the lack of a diesel engine reduces noise pollution.

In addition, both transit and school buses are often used in areas with high concentrations of people, and children are particularly susceptible to the negative effects of pollution, which has been linked to asthma and poor test performance in schools. Without vehicle emissions and particulates, electric

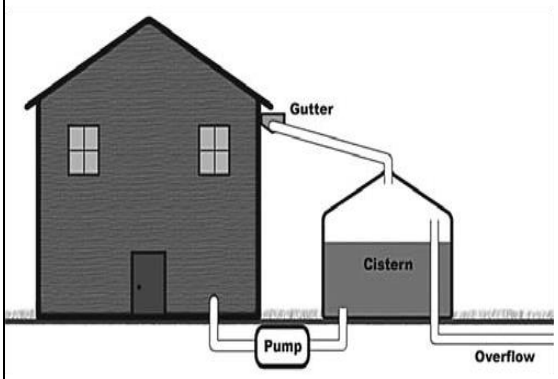
	buses provide cleaner air for our communities. They are even superior when considering the emissions associated with the electricity used for charging. In North Carolina, a diesel bus would need to average 14.7 mpg to achieve life-cycle emissions equal to that of an electric bus; actual mpg is closer to 4.8. Dominion Energy recognized the community advantages of electric buses and created a program to deploy school buses throughout Virginia. On the program's website, Dominion explains the benefits for students and communities, including inside air quality being six times better than non-electric models and greenhouse gas emission reductions of 54,000 pounds each year. Utility Benefits For the utilities that power electric buses, the technology can improve grid reliability and sustainability by helping to manage peak demand and supporting renewable energy integration. Many buses will run all day and charge in a garage at night, during off-peak times. The University of Georgia is taking advantage of off-peak charging as it prepares to have more electric buses than any university in the nation. The campus receives a reduced electricity rate to charge its buses at night in its transit facility, and this new rate has helped lower fueling costs from $100 per day with diesel to $5 – $10 with electricity. Students are now working to redesign the campus transit facility to add solar panels. With their large batteries and energy storage capabilities, electric buses also offer strong potential for vehicle-to-grid applications, allowing stored energy to be supplied back to the grid. Con Edison in New York City launched a program in 2018 to use electricity from electric bus batteries to support its grid during hot summer months. The utility receives 75 kilowatts from five buses that it discharges when grid demand is high. As part of its electric school bus program, Dominion Energy is similarly planning to tap into vehicle-to-grid opportunities. The Bus of the Future While there is a lot of warranted excitement around electric buses, there are still some drawbacks, like higher purchase prices, a need for new charging infrastructure and limited driving ranges. As the buses continue to be deployed and improved, though, these challenges will become less of a bump

in the road. Electric buses have a promising future, and the benefits they bring to all involved will further encourage their success.

Cisterns

What are Cisterns?

Cisterns are large tanks that store rainwater collected from impervious surfaces for domestic uses or for consumption.



Why use Cisterns?

The water collected in cisterns can be used for two purposes: domestic use and consumption. Some domestic uses of the water are flushing toilets, watering gardens, cleaning laundry, and washing cars. Using rainwater to perform these functions can reduce the costs associated with the delivery of potable water from traditional supply systems (i.e. normal tap water).

Cisterns can also be used to collect rainwater for consumption. This application is appropriate in areas where there is not a constant supply of potable water, such as rural agricultural areas or at backwoods camp sites. However, if rainwater stored in these tanks is consumed, the cistern design must ensure that the water is contaminant free to prevent health issues associated with consumption of toxic chemicals.

How do they manage stormwater?

Cisterns help manage stormwater by reducing peak runoff volumes. One benefit of this is that less water enters the storm sewer systems which means less water is delivered to a treatment facility. This lowers the cost, energy, and resources associated with cleaning this water. An ecological benefit that comes with reduced runoff volumes is that the streams that convey this

storm water are less like to become eroded by high flow rates and polluted by the surface contaminants that the storm water contains.

Cisterns work by collecting the rainfall that lands on impervious surfaces. Rooftops are the best impervious surface for this application because surfaces like parking lots and driveways collect petroleum products like motor oil that should be kept out of the cisterns. Also, since rooftops are elevated, the cisterns can be filled gravitationally. This technique is not as easy when collecting water from roadways. Rainwater falls on the rooftop, travels downhill into the gutter, and then eventually travels to ground level through downspouts. Before it enters the cistern, large debris is filtered from the water by mesh screens. Cisterns are often concealed underground, to mitigate the effects of temperature changing, and limit the access of insects and animals.

Are there any other benefits to having Cisterns?

An obvious benefit provided by cisterns is an additional supply of water. Instead of rainwater being routed away quickly, it is retained for later use. This is extremely beneficial in areas that do not have a constant water supply, or in areas where a clean water source is miles away. This on-site collection and storage lowers the land owner's water bill, and also helps the global community by reducing the amount of fossil fuel energy used to supply water from a remote site.

Are there any constraints / design considerations?

There are a few features that can be included within a cistern systems to maximize efficiency. First, there should by an overflow pipe which prevents the cistern from filling above a certain depth. Also, the cistern should be lined with a plastic membrane to prevent any part of the tank structure from fracturing and dissolving into the water. Additionally, a pump may want to be included to provide sufficient pressure to deliver the water wherever it is needed, especially if the cistern is at lower elevation (i.e. underground). The tank should also be cylindrical, as it has a high strength to weight ratio when filled with water.

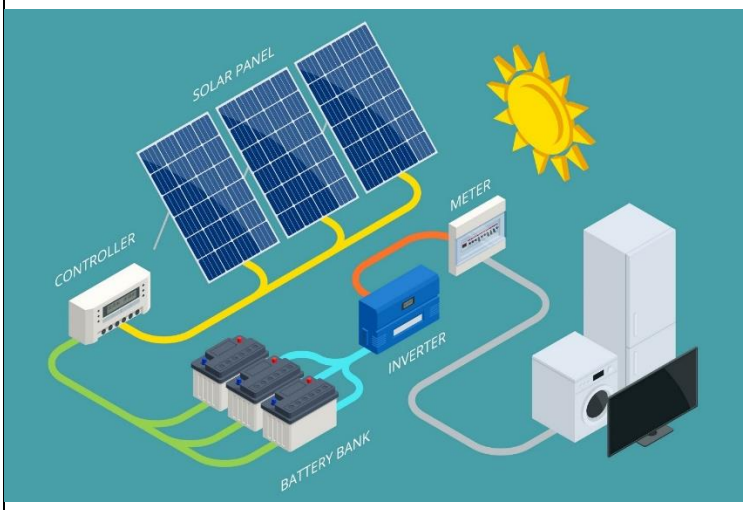
If the retained water is to be consumed, then designing the cistern system must be done very carefully. Contamination must be prevented during every component of the system. First, the rooftop which is collecting the rainwater should be made of galvanized steel or aluminum because these smooth surfaces prevent the buildup of organic solids. Also, the area around the roof

should be devoid of trees to prevent leaves, twigs, insects and bird feces from landing on the roof. Next, the gutters and downspouts used should be lined with the same steel/aluminum material for the same reason as the roof. Before the water enters the cistern, it should be filtered either by using either a sedimentation tank or more preferably a sand or charcoal filter. Sometimes, mechanisms are included that divert the first flush of stormwater from entering the cistern. The reason for this is that the first flush usually has the highest concentration of pollutants, which are best kept out of the tank. Finally, it is recommended that a chlorinator is included in the design to kill any microbial pathogens.

SOLAR PANELS

The amount of sunlight that strikes the earth's surface in an hour and a half is enough to handle the entire world's energy consumption for a full year. Solar technologies convert sunlight into electrical energy either through photovoltaic (PV) panels or through mirrors that concentrate solar radiation. This energy can be used to generate electricity or be stored in batteries or thermal storage.(https://www.perchenergy.com/blog/energy/renewable-solar-power-explained)

When the sun shines onto a solar panel, energy from the sunlight is absorbed by the PV cells in the panel. This energy creates electrical charges that move in response to an internal electrical field in the cell, causing electricity to flow.



Reorder the following steps: (4 points)

	Depending on your system, the DC* electricity is either stored or converted into AC* electricity for immediate use Sunlight is captured In both cases, excess electricity is stored in a solar battery as DC power The sunlight is converted into DC electricity **DC vs AC Electricity** What's the difference between direct current and alternating current electricity? In brief, DC or direct current power is straight or linear electrical current. It means that the electricity goes in a straight line or goes from point A to point B without changing its charge. Direct current is special because its voltage delivery (i.e. how powerful it is) is more consistent than that of current. AC or alternating current electricity, on the other hand, has a current flow that can swap between positive and negative. In other words, it goes in two directions. Both AC and DC electricity are used for everyday devices and applications. For example, many electronic devices or handheld things use DC electricity. But many household appliances, like washing machines, refrigerators, and even household lights use AC power. AC electricity is more common. Power outlets in homes bring energy into buildings as alternating current. The house then uses a converter to change the alternating current into DC electricity. Why? DC electricity can't travel as far as AC electricity. Plus, AC electricity is cheaper to make.
Learning objectives	By the end of this educational module, students will: • Acquire knowledge about the environment and the role of solar energy in promoting sustainability. • Understand the fundamental principles of solar power. • Acquire knowledge about the advantages and disadvantages of using energy produced by solar power. • Be equipped with strategies to cope with environmental challenges, particularly in the context of renewable energy integration and overcoming barriers to its adoption • Acquire knowledge about the environment and the role of cisterns in promoting sustainability. • Understand how cisterns work.

	• Acquire knowledge about the benefits of using cisterns. • Be equipped with strategies to cope with environmental challenges, particularly in the context of renewable energy integration and overcoming barriers to its adoption • Acquire knowledge about the environment and the role of electric buses in promoting sustainability. • Understand how electric buses are powered. • Acquire knowledge about the advantages and disadvantages of using electric buses. • Be equipped with strategies to cope with environmental challenges, particularly in the context of renewable • Acquire knowledge about the role of evergreens in protecting the environment. • Acquire knowledge about all the benefits of evergreens • Be equipped with strategies to cope with environmental challenges, energy integration and overcoming barriers to its adoption
Activities and exercises	There are both advantages and disadvantages to this choice. I am going to list some. **Please write D or A near the sentence: (6 points)** 1) Capturing runoff water from a park reduces the quantity of stormwater discharged from the park. 2) This captured water can be a source of much needed water for irrigation. 3) Especially in times of drought, captured runoff can be a beneficial source of water. 4) You need to be aware that runoff water captured and stored in a cistern, **must** be used before the next runoff event or the system becomes ineffective and will not accomplish its stormwater management purpose. 5) Since runoff water is rarely potable, the uses for this water are limited. The most common use is for irrigating lawns, gardens, or flower beds Video: https://www.youtube.com/watch?v=94Kf1Yuq_94
Additional resources	Video: https://www.youtube.com/watch?v=5Zf3hz3dxTs Video: https://www.youtube.com/watch?v=ZzCjZb8mFwM Video: https://www.youtube.com/watch?v=6EiRsOTlgAM Video: https://www.youtube.com/watch?v=24dFuDx8P-k

	 s
References/Sources	Taken from www.esf.edu Taken from https://www.perchenergy.com/blog/energy/renewable-solar-power-explained Taken from: www.advancedenergy.com Taken from: www.frarborist.com

Appendix 4 – Educational information for scenario House Eco-explorer

The goal of this educational material is to teach students about ***environmental-related issues, offering insights on topics ranging from understanding the environment to identifying key challenges and exploring sustainable practices for a healthier planet.***

Educational material (activities for students)

Scenario	House eco-explorer
Title	*Education material for students of House Eco-Explorer Scenario*
Partner	University of Patras
Country	☒ **Greece** ☐ Italy ☐ Portugal
Target audience	10-15
Introduction	Brief overview of the educational material of students
Content	In this scenario, we have included a series of images that emphasize the diverse strategies and initiatives that are crucial in the global movement towards sustainability and environmental stewardship. The first infographic presents a snapshot of the ecological impact of various sectors, highlighting the growth of solar power, the importance of water conservation, andthe increasing reliance on renewable energy. The second image delves into the world of recycling, detailing the significant stridesmade in waste management. The third image serves as a blueprint for the myriad objectives that nations and organizations are working towards. It includes goal for no poverty, zero hunger, and affordable and clean energy, forming an interconnected framework for a sustainable future. The last image simplifies the message into five key areas: recycling and waste reduction, the use of sustainable materials, environmental education, energy-efficient upgrades, and water conservation. In summary, the message is clear: sustainability is a multifaceted endeavour that requires a concerted effort in areas ranging from energy production and waste management to education and global policy.

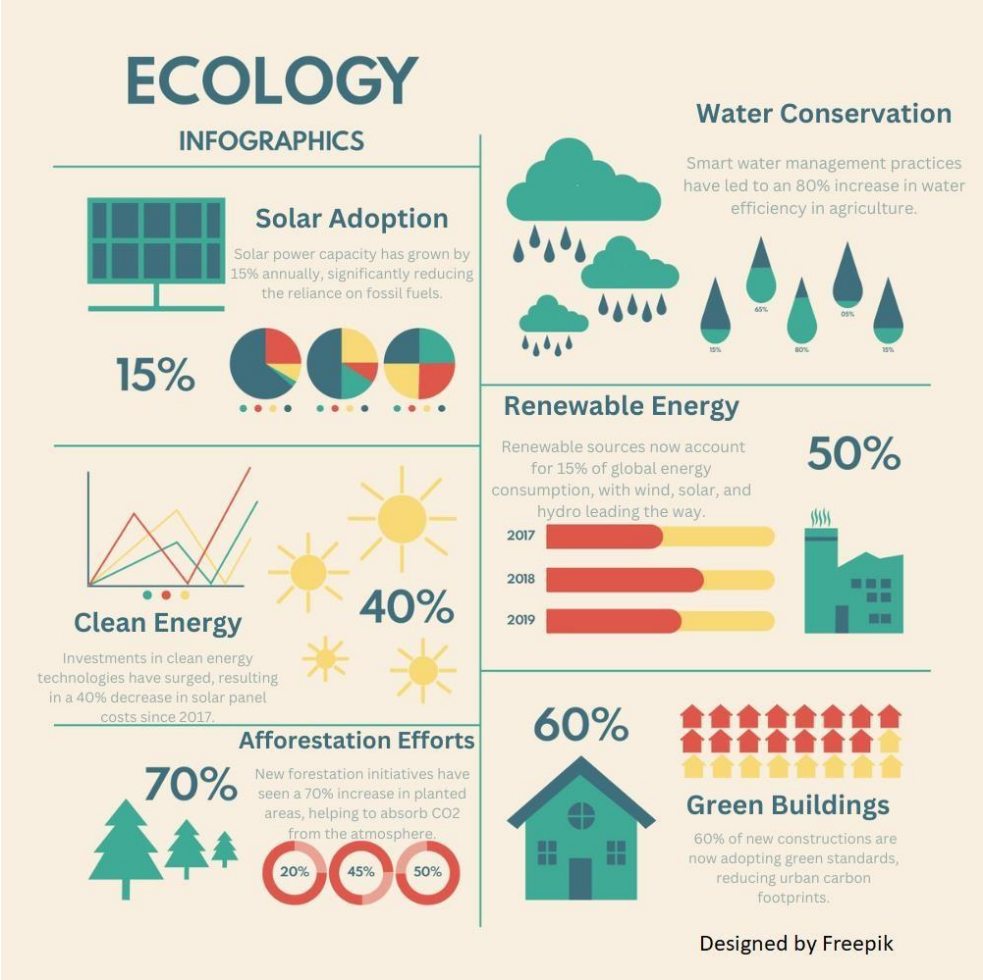


Figure 1: A visual summary of ecological progress, detailing solar energy adoption, water conservation, and trends in renewable energy.

Figure 2: A colorful wheel diagram outlining the United Nationals' Sustainable Development Goals, symbolizing a holistic approach to global sustainability

Figure 3: An educational graphic showing recycling statistics, waste management efficiency, and global recycling efforts.

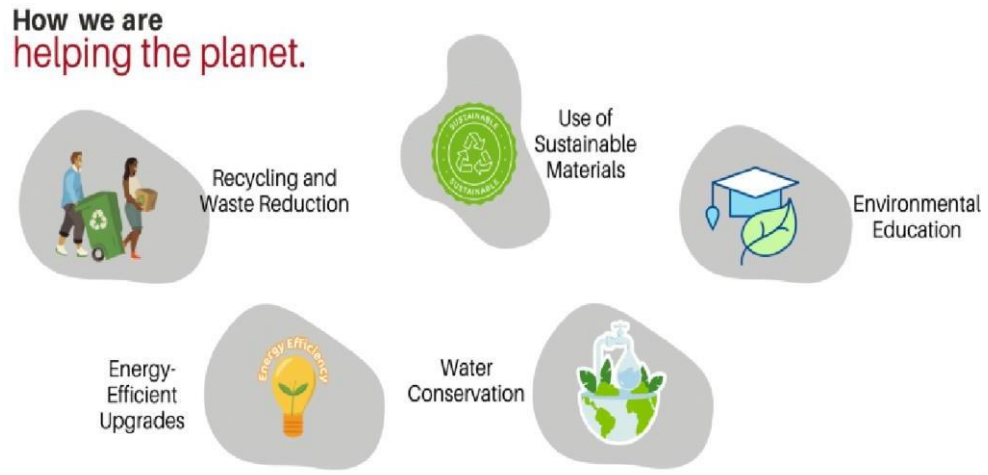


Figure 4: A concise depiction of key sustainability themes, including recycling, sustainable materials, energy efficiency, and water conservation, intended for quick reference and education on environmental actions.

Learning objectives	The learning objectives of the provided educational material are to educate and inform about the various facets of environmental sustainability. They aim to highlight the critical importance of renewable energy, such as the increase in solarpower capacity, and the role it plays in reducing reliance on fossil fuels. The images also focus on waste management, illustrating the need for efficient recycling systems and the global efforts in place, like those in Germany, to reduce waste. Additionally, they address the need for water conservation and how smart practices can greatly enhance water efficiency in agriculture. The Sustainable Development Goals infographic serves as an educational tool to broaden understanding of the global initiatives targeting poverty, hunger, health, education, and more, underpinning the interconnected nature of these goals with environmental sustainability. Lastly, the images emphasize the importance of integrating sustainable materials and practices into everyday life, showcasing how individual and collective actions are paramount in driving environmental education, energy efficiency, andconservation efforts. These visuals serve not only as an informative overview but also as a call to action, encouraging proactive engagement with sustainabilitypractices.
Activities and exercises	The gameplay involves the following activities: 1. **Role Selection**: Players choose their roles, which determine their tasks in the game. 2. **Item Identification**: Players identify eco-friendly and non-eco-friendly items within the virtual house and yard. 3. **Educational Interaction**: After identifying an item, players receive educational content about it, including environmental impact and recyclinginformation. 4. **Scoring**: Points are awarded or deducted based on correct or incorrect itemidentifications. The team's score is displayed at the end of each round. 5. **Communication**: Players must communicate to share information and strategize on item selection. 6. **Role-Specific Actions**: Each role has specific interactions with items to unlock educational content or determine if the selection was correct.

Additional resources	Overview of what exactly sustainability is: **What is Sustainability? | Mocomi Kids** Short film showcasing the environmental issues:One Earth – Environmental Short Film Screenshots from the 3D Virtual World Learning Environment 

	 How we are helping the planet. Recycling and Waste Reduction Use of Sustainable Materials Environmental Education Energy Efficient Upgrades Water Conservation RECYCLING INFOGRAPHIC RECYCLING FACTORY RECYCLABLE MATERIALS RECYCLING WORLDWIDE FOOD WASTE WASTE MANAGEMENT WASTE SEGREGATION Admin VL

Educational material (for teachers)

Scenario	House eco-explorer
Title	*Education material for teachers of House Eco-Explorer Scenario*
Partner	University of Patras
Country	☒ Greece ☐ Italy ☐ Portugal
Target audience	18-65
Keywords	Sustainability, Recycling, Energy Efficiency, Environmental Impact
Glossary	N/A
Content	The House eco-explorer scenario is an educational game designed to teach students about the environmental impact of everyday items found in a house or a yard. The scenario is structure to embed educational content that helps students understand how certain household items can be eco-friendly, such as recycling bins which conserve energy, and others that may not be, like single-use plastics. The goal is to promote awareness and encourage eco-conscious decisions by illustrating the potential energy savings or waste reductions associated with common objects. The item list is: 1. Armchairm (eco friendly) 2. Bicycle (eco friendly) 3. Bookcase (non-eco friendly) 4. Candle (eco friendly) 5. Ceiling fan (eco friendly) 6. Chemical fertilizer (non-eco friendly) 7. Cigarettes (non-eco friendly) 8. Coal (non-eco friendly) 9. Coathanger (eco friendly) 10. Coca cola can (non-eco friendly) 11. Couch (eco friendly) 12. Fanta can (non-eco friendly) 13. Fireplace (non-eco friendly) 14. Garden (eco friendly) 15. Glass bottle (eco friendly) 16. High-Tech Fridge(eco friendly) 17. Houseplant (eco friendly) 18. Incandescent light bulb (non-eco friendly) 19. Jars (eco friendly) 20. LED light bulb (eco friendly) 21. Lawnmower (non-eco friendly) 22. Leaf blower (non-eco friendly) 23. Mug (eco friendly) 24. Oil barrels (non-eco friendly)

	25. Organic fertilizer (eco friendly) 26. Oven (non-eco friendly) 27. Painting (non-eco friendly) 28. Paper Bag (eco-friendly) 29. Plastic Chair (non-eco friendly) 30. Plastic water bottle (non-eco friendly) 31. Plates (eco-friendly) 32. Radiator (non-eco friendly) 33. Recycle bins (eco-friendly) 34. Solar panel (eco-friendly) 35. Steam BBQ (non-eco friendly) 36. Swimming pool (non-eco friendly) 37. Synthetic carpet (non-eco friendly) 38. TV (non-eco friendly) 39. Thermostat (eco-friendly) 40. Water collector (eco-friendly)
Learning objectives	The learning objectives of the House eco-explorer scenario are to educate and foster a deeper understanding of environmental sustainability issues through interaction with a simulated real-world environment. So, this scenario will: 1. **Promote Awareness:** Introduce players to the concepts of eco-friendliness and its relevance in daily life by evaluating household items. 2. **Encourage Critical Thinking:** Develop players' ability to critically assess the environmental impact of common items found in a house or yard 3. **Facilitate Decision Making:** Encourage players to make informed decisions about sustainability practices by understanding the long-term effects of their choices. 4. **Inspire Action:** Motivate players to take action towards a more sustainable lifestyle by recognizing the benefits of eco-friendly products and the drawbacks of non-eco-friendly items.
Activities and exercises	In-Scenario Activities: 1. **Sustainability Scavenger Hunt:** Students navigate the virtual house and garden to find and categorize items based ont heir environmental impact. This hands-on activity enhances their understanding of sustainability in a household context. 2. **Interactive Learning Points:** Clicking on items in the game by the eco-educator role reveals information about their sustainability, helping students understand the ecological footprint of common household items. Complementary Exercises:

	1. Debate and Discussion: Organize debates or discussions on topics like the use of chemical versus organic fertilizers, or the impact of renewable energy sources versus non-renewable ones. This encourages critical thinking and deeper understanding of environmental issues
Additional resources	As an additional resource, I propose students use carbon footprint calculators to understand their impact on the environment. This exercise involves data collection, analysis, and setting goals to reduce their carbon footprint (https://www.teachstarter.com/us/blog/environmental-activities-for-students-sustainability-classroom/)
References/ Sources	A whiteboard animation video on YouTube that provides a clear and simple explanation of sustainability for children: Sustainability for kids (whiteboard animation) The second resources provides a variety of materials for educators, including lessons plans, workshops, and information sites on climate change and global warming. It includes resources developed by the Center for Global Studies, such as "The Field Guide to Teaching Sustainability ", as well as external resources like NASA's Global Climate Change website and the EPA's Climate Change page Teaching Sustainability: Resources for Educators

Appendix 5 – Educational information for scenario Something lost in the waste

The goal of this educational material is to teach students about ***environmental-related issues, offeringinsights on topics ranging from understanding the environment to identifying key challenges and exploring sustainable practices for a healthier planet.***

Educational material (for teachers)

Scenario	Something lost in the waste
Title	*Education material for teachers of Something lost in the waste Scenario*
Partner	University of Maia - ISMAI
Country	o Greece o Italy x **Portugal**
Target audience	18-65
Keywords	Solid waste management plant, recycling, circular economy,
Glossary	N/A
Content	Some of the following contents are designed for older students, from 15 to 18 andare properly marked. The game takes place in an integrated waste treatment plant. Each treatment system has its own set of activities (sorting, composting, in addition to the laboratory of the circular economy researcher/scientist). The sorting plant includes an unloading bay for lorries, a magnetic capture system for metallic materials, a manual plastic separation line, a compacting and baling machine, a storage area for segregated materials. The composting station integrates a tunnel, loading machines, a shredding machineand a compost bagging system. The scientist's laboratory has several items distributed on shelves that allow the scientist to explain which waste was used for its production and why this solution is important. **Glass** The waste placed in the glass recycling bins is brought here by the collection lorriesthat collect it the streets. Glass does not need any prior treatment and can be sentdirectly to the companies that recycle it. There the pieces are separated by color using special equipment. Then it is sent to a furnace where it is melted at high temperatures and used to produce new packaging. Glass can be recycled countless times, with no loss of quality.

Paper and cardboard

Preparing the paper is simple and involves separating the cardboard from the thinner paper and checking that it is not mixed with other materials. Then it is just compacted and packaged in bales.

Plastic

Plastic, on the other hand, has a more complicated process and goes through several types of equipment. Waste treatment plants use various technologies for segregating plastic from the mixed waste to facilitate proper recycling and waste management. Some of the common technologies for segregating plastic in waste treatment plants include:

1. **Mechanical Sorting**: Mechanical sorting involves the use of conveyor belts, screens, and separators to separate plastic from other materials based on their size, shape, and density. This process can separate larger plastic items from the rest of the waste.
2. **Magnetic Separation**: Magnetic separators are used to remove ferrous metals from the waste stream. While not directly related to plastic segregation, this step can help in removing metal components attached to plastic items.
3. **Air Classification**: Air classifiers use air streams to sort lightweight plastics from other heavier materials. Plastics are separated from the waste stream and collected based on their aerodynamic properties (content for older students).
4. **Eddy Current Separation**: Eddy current separators can separate non-ferrous metals, including aluminum and some types of plastic, from the waste stream. The technology relies on inducing currents in conductive materials, causing them to be repelled and separated from other materials (content for older students).
5. **Optical Sorting**: Optical sorting systems use sensors and cameras to detect different types of plastics based on their optical properties, such as color and transparency. The system then directs jets of air or mechanical arms to sort the plastics accordingly.
6. **Density Separation**: Density-based separation techniques involve using water or other liquids of varying densities to separate plastics based on their buoyancy. Plastics with different densities will float or sink in the liquid, enabling their segregation (content for older students).
7. **Near-Infrared (NIR) Sorting**: NIR sensors can identify different types of plastics by analyzing their unique spectral characteristics. This enables efficient sorting of various plastic polymers (content for older students).
8. **Electrostatic Separation**: Electrostatic separators use electric charges to separate plastics based on their triboelectric properties, which vary between different plastic types (content for older students).

9. **Handpicking and Manual Sorting**: In some waste treatment plants, manual sorting by trained workers is still employed to segregate plastics that automated systems might have difficulty identifying.

10. **Hydro cyclones**: Hydro cyclones use centrifugal force to separate plastics from the waste stream based on their size and density (content for older students).

The effectiveness of each technology depends on factors such as the level of contamination in the waste stream, the type of plastic polymers present, and the overall waste composition. This is why we use a combination of these technologies to achieve optimal plastic segregation and increase recycling efficiency.

Activity suggestion: This way of treating plastics prevents them from accumulating on land or reaching the sea. Discuss with your students the problems that may arise from the accumulation of plastics on land and on the sea.

Composting

The composting process involves a series of activities and steps to facilitate the natural decomposition of organic materials into nutrient-rich compost. These activities include:

1. **Collection of Organic Waste**: The first step is to collect organic waste from various sources, such as kitchen scraps, yard trimmings, and agricultural residues. This waste is the raw material for composting.

2. **Segregation and Preprocessing**: Before composting, it's essential to segregate the organic waste from non-compostable items like plastic, metal, and glass. Large items, such as branches and twigs, may be shredded or chipped to accelerate decomposition.

3. **Balancing the Compost**: Achieving the right mix of organic materials is crucial for successful composting. The ideal compost pile should have a balance of green (nitrogen-rich) and brown (carbon-rich) materials. Green materials include food scraps and fresh plant trimmings, while brown materials include dried leaves, straw, and paper.

4. **Layering and Aerating**: In larger composting setups, the organic materials are layered to ensure proper airflow and oxygen supply. Oxygen is vital for aerobic composting, which is the most common method of composting. Regularly turning or aerating the compost pile ensures that microbes get the oxygen they need to break down the materials effectively.

5. **Moisture Management**: The compost pile should have the right level of moisture, similar to a wrung-out sponge. It should not be too dry or too soggy. Proper moisture levels promote microbial activity and decomposition.

6. **Monitoring Temperature**: As the organic matter decomposes, the compost pile generates heat. Monitoring the internal temperature of the pile is crucial, as

	higher temperatures (between 120-160°F or 49-71°C) can kill pathogens and weed seeds, making the compost safer to use. 7. **Microbial Breakdown**: Naturally occurring microorganisms, such as bacteria, fungi, and actinomycetes, are responsible for breaking down the organic matter into compost. These microbes thrive in the presence of oxygen and moisture. 8. **Curing**: Once the composting process is complete, the compost needs to cure or mature. Curing allows any remaining organic matter to break down further, and it helps stabilize the compost before use. 9. **Screening**: The final compost may undergo screening to remove any remaining large particles or contaminants, ensuring a uniform and fine-textured compost product. 10. **Application**: The finished compost can be used to enrich soil in gardens, farms, or landscaping projects, providing essential nutrients and improving soil structure. Throughout the composting process, it's important to monitor and adjust the conditions as needed to create high-quality compost efficiently. Properly managed composting can take a few weeks to several months, depending on the materials used and the composting method employed. Composting facilities are designed to process organic materials, which are biodegradable and can break down naturally over time. These materials provide the necessary nutrients and organic matter for the composting process. Some of the common materials that can be processed in a composting facility include: 1. **Yard Waste**: Leaves, grass clippings, branches, and other garden trimmings are commonly accepted materials in composting facilities. 2. **Food Waste**: Fruit and vegetable scraps, coffee grounds, tea bags, eggshells, and other food leftovers are ideal for composting. 3. **Agricultural Residues**: Crop residues, straw, husks, and other by-products from agricultural activities can be composted. 4. **Manure**: Animal manure from herbivores, such as cows, horses, and chickens, can be composted, but it requires proper management to avoid odor and contamination issues. 5. **Paper and Cardboard**: Non-glossy paper, cardboard, and shredded paper can be composted, but it's essential to ensure they are free of any coatings or chemicals. 6. **Wood and Sawdust**: Untreated wood chips, sawdust, and small wood scraps can be added to compost, but they take longer to break down. 7. **Plant Trimmings**: Plants that are disease-free and not invasive, such as pruned branches, flowers, and stems, can be composted.

8. **Coffee Filters and Tea Bags**: As long as they are made from biodegradable materials (without plastic or metal elements), they can be composted.
9. **Compostable Bioplastics**: Some composting facilities accept compostable bioplastics made from renewable sources, but not all facilities can process them effectively.

It's important to note that not all composting facilities are the same, and the materials they accept may vary depending on their processing capabilities and local regulations. Contaminants like plastic, metal, glass, or non-biodegradable materials should be kept out of composting facilities as they can disrupt the composting process and reduce the quality of the final compost product.

Additionally, some composting facilities may also accept certain industrial or municipal organic wastes, like food waste from restaurants and food processing industries, but such materials may require specific processing protocols to ensure proper composting and avoid contamination issues.

Suggested activity: Identify with your students the materials that, in your school, could be used for composting. There are several options form homemade domestic composters. Can you create a solution with your students to implement in your school?

Circular Economy

The following innovative products demonstrate the power of recycling and upcycling, transforming waste materials into valuable and functional items, reducing the environmental impact and promoting a circular economy.
Some of innovative products that can be made with recycled materials are:

1. **Recycled Plastic Furniture**: Furniture items like chairs, tables, and benches made from recycled plastic are not only eco-friendly but also durable and stylish.
2. **Eco-Friendly Clothing**: Fashion brands are now creating trendy clothing items using recycled fibers like recycled polyester or organic cotton.
3. **Recycled Glass Artware**: Artists and craftsmen create beautiful glass artware like vases, bowls, and sculptures from recycled glass, adding an eco-friendly touch to home decor.
4. **Upcycled Accessories**: Entrepreneurs and artisans craft unique accessories such as bags, wallets, and jewelry using upcycled materials like old leather, bicycle inner tubes, and bottle caps.
5. **Recycled Paper Products**: Recycled paper is used to make a variety of products like notebooks, stationery, and greeting cards, reducing the demand for new paper production.

	6. **Recycled Plastic Building Materials**: Companies are producing innovative building materials like recycled plastic lumber and bricks, which are lightweight, durable, and weather-resistant. 7. **Recycled Tire Products**: Used tires are upcycled to create products like rubber flooring, doormats, and playground surfaces, giving a new life to old tires. 8. **Recycled PET Bottles Apparel**: Brands are producing athletic wear and sportswear using recycled PET bottles, providing sustainable activewear options. 9. **Recycled Electronics Accessories**: Entrepreneurs design phone cases, laptop sleeves, and tablet covers using recycled materials, giving a tech-savvy twist to recycling. 10. **Eco-Friendly Footwear**: Shoe manufacturers are using recycled materials like ocean plastic, cork, and rubber to produce eco-friendly and comfortable footwear. 11. **Recycled Plastic Planters**: Gardeners and plant lovers can find stylish planters made from recycled plastic, reducing plastic waste while enhancing green spaces. 12. **Recycled Metal Art**: Artists create stunning sculptures and decorative items from recycled metal, showcasing creativity and sustainability. 13. **Recycled Denim Products**: Innovative brands are using old denim jeans to craft unique products like bags, pillows, and even insulation materials. 14. **Eco-Stationery Sets**: Stationery sets made from recycled materials like cardboard and paper are not only practical but also contribute to waste reduction. 15. **Recycled PET Fleece Blankets**: Cozy blankets made from recycled PET bottles provide warmth while promoting recycling and sustainability.
	Suggested activity: Ask your students to perform research relating the use of waste materials to produce new ones. Share and discuss the results obtained.
Learning objectives	The educational contents that are related to the processes and activities of recycling waste, such as: - Segregation practices for waste at home or school - Collecting and transportation of the waste - Different destinations to which waste is transported depending on its characteristics. - The technologies that are used in each of these treatments (sorting and baling, composting). - Use of the separated and treated waste as raw material for other products. - Introduction to the concept of circular economy

	These educational contents allow players to: - Understand where the waste generated is sent to and what destinations it is given. - Understand in a simple way the different technologies and biological solutions for treating the waste generated at home and at school. - Become aware of the importance of their actions to saving the planet's resources and motivate them to make more conscious decisions. - Understand emerging applications and solutions in the circular economy area.
Activities and exercises	Relating the scenario, other educational activities that may complement the learning: Designing a waste treatment system for children between (10-18) involves creating an eco-friendly and age-appropriate solution that encourages responsible waste management and instills good environmental practices. Some ideas for a simple waste treatment system that students can implement: 1. **Recycling Bin Setup**: Place separate recycling bins for different materials like paper, plastic, glass, and metal in the child's room or a designated area of the house. Label each bin clearly to make it easy for the child to identify and sort waste accordingly. 2. **Compost Bin**: Introduce a small compost bin in the backyard or on a balcony (if applicable) for organic waste like fruit and vegetable scraps, coffee grounds, and eggshells. Teach the child what can and cannot be composted. 3. **Educational Materials**: Provide the child with educational materials such as posters, books, or videos about waste management, recycling, and composting. This will help them understand the importance of their actions and the impact on the environment. 4. **Reducing Single-Use Plastics**: Encourage the child to use reusable water bottles, lunch containers, and cloth bags to reduce their consumption of single-use plastics. 5. **Cleanup Campaigns**: Organize periodic cleanup campaigns in the local community or nearby natural areas. This can be done with friends or classmates, fostering a sense of community and responsibility towards the environment. 6. **Upcycling Projects**: Encourage the child to engage in creative upcycling projects where they can turn old items into useful or decorative objects. This will promote creativity and reduce waste. 7. **Water Conservation**: Teach the child about the importance of water conservation and encourage them to turn off the tap while brushing teeth and take shorter showers.

	8. **Setting a Personal Example**: As a parent or guardian, set a positive example by following the same waste treatment practices and being environmentally conscious in your daily life. 9. **Involvement in Local Programs**: Research local waste management programs or environmental initiatives that the child can get involved in. This could include participating in local recycling drives or attending environmental workshops. 10. **Reward System**: Implement a reward system to motivate the child to be consistent with their waste treatment efforts. Recognize and praise their eco-friendly actions to encourage continued commitment.
Additional resources	Waste management in Sweden (video) https://www.youtube.com/watch?v=8krzjlHaGes Factora - Entire Recycling Process Explained (video) https://www.youtube.com/watch?v=cNPEH0GOhRw Britannica – Different forms of solid waste management https://www.britannica.com/technology/solid-waste-management/Composting Ellen McArthur Foundation (videos, case studies, reports, podcasts) https://www.ellenmacarthurfoundation.org/
References/ Sources	N/A

Appendix 6 – Educational information for scenario Eco Farm Explorer

The goal of this educational material is to teach students about ***environmental-related issues, offering insights on topics ranging from understanding the environment to identifying key challenges and exploring sustainable practices for a healthier planet.***

Educational material (activities for students)

Scenario	Eco Farm Explorer
Title	*Education material for students of Eco Farm Explorer Scenario*
Partner	University of Patras
Country	☒ Greece ☐ **Italy** ☐ Portugal
Target audience	10-15
Introduction	Brief overview of the educational material of students
Content	1. Pesticides: substances used for destroying insects or other organisms harmful to cultivated plants or to animals. 2. Nitrate: a chemical that includes nitrogen and oxygen, often used as a fertilizer . 3. Leaching: (with reference to a soluble chemical or mineral) draining away from soil, ash, or similar material by the action of percolating liquid, especially rainwater. 4. Nitrogen-fixing: nitrogen fixation refers to the chemical processes by which atmospheric nitrogen is assimilated into organic compounds, especially by certain microorganisms as part of the nitrogen cycle. 5. cover crops: crops grown for the protection and enrichment of the soil. 6. Ionizing radiaton: it is a form of energy that acts by removing electrons from atoms and molecules of materials that include air, water, and living tissue. 7. Pest: a destructive insect or other animal that attacks crops, food, livestock, etc.  8. Pollen: a fine powdery substance, typically yellow, consisting of microscopic grains discharged from the male part of a flower or from a male cone. Each grain contains a male gamete that can fertilize the female ovule, to which pollen is transported by the wind, insects, or other animals.

9. Miticides: substances or preparations for killing mites. A mite is a minute arachnid which has four pairs of legs when adult, related to the ticks. Many kinds live in the soil and a number are parasitic on plants or animals.
10. Anaerobic digestion: Anaerobic digestion is a process through which bacteria break down organic matter—such as animal manure, wastewater biosolids, and food wastes—in the absence of oxygen. Anaerobic digestion for biogas production takes place in a sealed vessel called a reactor, which is designed and constructed in various shapes and sizes specific to the site and feedstock conditions.
11. Manure: animal dung used for fertilizing land.

12. Slurry: a semi-liquid mixture, typically of fine particles of manure, cement, or coal suspended in water.
13. Hydrogen sulfite: Hydrogen sulfide (also known as H_2S, sewer gas, swamp gas, stink damp, and sour damp) is a colorless gas known for its pungent "rotten egg" odor at low concentrations. It is extremely flammable and highly toxic.
14. Landfill: A *landfill* site, also known as a tip, *dump*, rubbish *dump*, garbage *dump*, or dumping ground, is a site for the disposal of waste materials.

15. Digestate: *it* is the material remaining after the anaerobic digestion of a biodegradable feedstock.

16. Breed: to keep animals for the purpose of producing young animals in a controlled way.
17. Amino-acids: a simple organic compound containing both a carboxyl (—COOH) and an amino ($—NH_2$) group. Although over 500 amino acids exist in nature, by far the most important are the alpha-amino acids, from which proteins are composed.
18. Suckling animals: infant or young animals that are still taking milk from the mother.
19. Cowshed: a farm building in which cattle are kept when not at pasture, or in which they are milked.

20. Livestock: animals such as *cows*, sheep, etc. that are kept or traded as a source of income.

OTHER DEFINITIONS

ORGANIC FARMING

Organic farming is a sustainable agricultural system that uses ecologically based pest controls and biological fertilizers derived largely from animal and plant wastes and nitrogen-fixing cover crops. Modern organic farming was developed as a response to the environmental harm caused by the use of chemical pesticides and synthetic fertilizers in conventional agriculture, and it has numerous ecological benefits. Producing organically means respecting the rules on organic farming. These rules are designed based on general and specific principles to promote environmental protection, maintain the biodiversity of Europe and build consumer trust in organic products.

ORGANIC HONEY

Organic honey is produced from the pollen of organically grown plants, and without chemical miticides to treat the bees. Buying organic honey ensures that you avoid

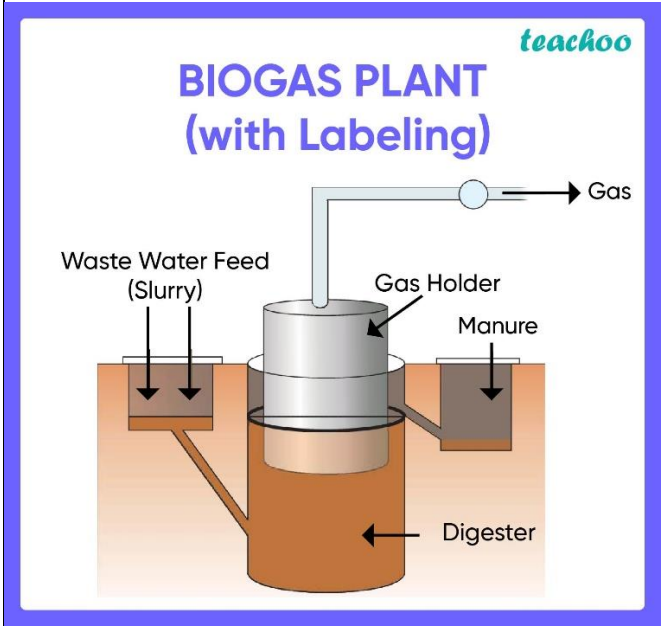
contact with pesticides that may be sprayed on or near the plants visited by honeybees.

ORGANICALLY FARMED ANIMALS

Livestock farmers have to fulfil specific conditions including respect for animal welfare and feeding animals in accordance with their nutritional needs since they have to protect the animals' health and environment. Most importantly they must ensure that organically farmed animals are kept separate from non-organic.

BIOGAS PLANTS

Biogas plants rely on anaerobic digestion, a fermentation process in which waste is digested by microbes to produce methane gas (biogas). The waste can be converted into biofertilizer and spread directly onto fields, or the biogas itself can be used interchangeably with natural gas or fuel.



Learning objectives	**Agricultural Practices and Environmental Impact** Understanding Soil Management: Discuss the role and impact of substances like nitrates and pesticides, and processes like leaching in soil health. Plant Growth and Protection: Explain the function of cover crops, nitrogen-fixing, and the use of miticides in supporting plant health and enhancing soil fertility. Water Quality and Waste Management: Analyze the effects of agricultural practices on water pollution through substances like slurry and digestate, and the environmental management of waste through landfill and anaerobic digestion. **Biodiversity and Ecological Processes** Pollination and Ecosystems: Describe the role of pollen in plant reproduction and its significance in ecological biodiversity. Pest Management: Discuss the ecological impact of pests on crops and livestock and evaluate different pest management strategies. **Livestock and Animal Welfare** Breeding and Care: Explore breeding practices, the care of suckling animals, and the design and use of structures like cowsheds for animal welfare. Role of Livestock in Agriculture: Assess the economic and environmental implications of livestock farming, including organic practices and the management of organic wastes. **Organic and Sustainable Farming** Principles of Organic Farming: Understand the principles behind organic farming, its environmental benefits, and the standards required for producing organic products like honey and organically farmed animals. Renewable Energy in Agriculture: Examine the use of biogas plants in agriculture for renewable energy production and waste reduction. **Chemicals and Health in the Agricultural Environment** Hazards of Chemical Use: Discuss the impact and safety measures related to using chemicals like hydrogen sulfite and ionizing radiation, both in agricultural settings and general environmental health.
Activities and exercises	***N/A***
Additional resources	***N/A***

Educational material (for teachers)

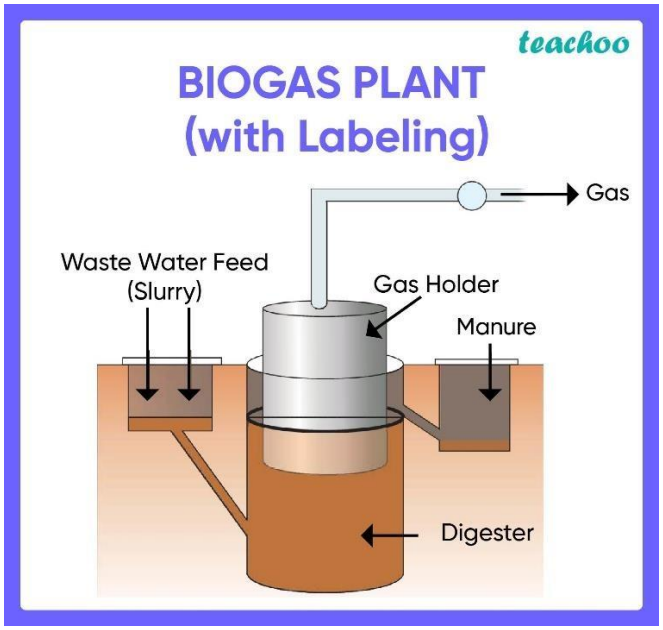
Scenario	Eco Farm Explorer
Title	*Education material for teachers of Eco Farm Explorer Scenario*
Partner	Liceo Manin
Country	☐Greece ☒**Italy** ☐Portugal
Target audience	18-65
Keywords	Biogas plant, renewable energy, waste organic material, advantages, disadvantages, clean energy.
Glossary	**Biogas: it** is a gaseous renewable energy source[1] produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, greenwaste, wastewater, and food waste. **Digestate: it** is the material remaining after the anaerobic digestion (decomposition under low oxygen conditions) biodegradable feedstock. **Anaerobic digestion: it** is a sequence of processes by which microorganisms breakdown biodegradable material in the absence of oxygen. **Environmental Impact**: The effect of human activities on the environment, which can be positive or negative. In the context of the scenario, it refers to the potentialeffects wind farm might have on local ecosystems, wildlife, and landscapes. **Renewable Energy**: Energy from a source that is not depleted when used. It is naturally replenishing but flow-limited; examples include wind, solar, and geothermal energy. **Organic farming**, sustainable agricultural system that uses ecologically based pest controls and biological fertilizers derived largely from animal and plant wastesand nitrogen-fixing cover crops **Fertilizers** a chemical or natural substance added to soil or land to increase its fertility. **Pesticides** chemical (such as carbamate) or biological agents (such as a virus, bacterium, or fungus) that deter, incapacitate, kill, or otherwise discourage pests.

Content

BIOGAS PLANTS

Biogas plants rely on anaerobic digestion, a fermentation process in which waste isdigested by microbes to produce methane gas (biogas).

The waste can be converted into biofertilizer and spread directly onto fields, or thebiogas itself can be used interchangeably with natural gas or fuel.



Advantages of Biogas production

Biogas production may just seem as a process where the organic materials can be converted to methane that can be used as a source of fuel, but the process of biogas production has larger impact environmentally and financially.

1. At first the process of biogas production reduces the load of solid waste management. Many landfills have installed biogas digesters to dispose the organic waste with known high volatile solid content into an enclosed chamber and get useful end products from it. The segregation of organic waste from garbage can help reduce the load on landfills.
2. The biogas is a clean and renewable source of energy, where the energy can be continuously harnessed by addition of waste organic material. Methane combustion produces no green-house gases making it ecofriendly. Harnessing biogas for industrial processes & transportation could be key to reducing the dependency on fossil fuels.
3. For many developing countries it can be source if fuel for cooking. Many big canteens dispose their organic waste material into the biogas digester and the methane obtained from the process is used for

cooking. Biogas production can help make the hotel and restaurant industry self-sufficient and help decrease costs.

4. The solid digestate remaining after the digestion process is a stable product that can be used in agriculture as organic fertilizer. The digestate is a highly nutritious slurry containing nitrogen, phosphorus, potassium, and trace elements. Most of the nitrogen being available in the form of ammoniacal nitrogen, which are known to be directly assimilated by plants.
5. Many countries have developed huge power station grid that run on the process of biogas production for generation and supply of electricity to cities.
6. The process of biogas production can be used even for wastewater treatment. Various technologies in wastewater treatment like UASB allow biogas production from effluents with high organic load.
7. Due to availability of digester in variable sizes, biogas production can be carried out at landfill sites to even household level.

Disadvantages of biogas production

1. Requirement of skilled labor- Biogas production needs a controlled environment to function efficiently. It needs to be constructed using skilled labor as slightest mistake can cause it to dysfunction.
2. Downstream processing- Even though biogas contains large portion of methane, it also contains other gases as the end product. The biogas needs to be purified in order to efficiently use methane gas. The water vapor needs to be trapped and separated using a T junction pipe. The Desulphurization process helps remove H2S gas.
3. High capital investment-To ensure efficient biogas production with coupled with a higher life span for the bioreactor requires high capital investment. Therefore, unless constructed by government authorities, biogas treatment system is not affordable to most of the people in developing countries.
4. Maintenance-Constant monitoring and repairing is a must for any bio-digester tank. Gas leaks or any mechanical damage due to wear and tear or corrosive gases needs an early fixing in order to assure good operating conditions.
5. Presence of pathogens-The digestate used from mesophilic digester as organic fertilizer may contain some pathogenic bacteria or weed seeds unlike thermophilic system. Hence the digestate needs to be treated before addition as organic fertilizer to an agricultural field
6. Energy recovery-More development in technologies should be made

for efficient use of methane for electric generation. Currently only 30% of the biogas energy is transformed as electricity.

Definition from Encyclopedia Britannica:

Organic farming, sustainable agricultural system that uses ecologically based pest controls and biological fertilizers derived largely from animal and plant wastes and nitrogen-fixing cover crops. Modern organic farming was developed as a response to the environmental harm caused by the use of chemical pesticides and synthetic fertilizers in conventional agriculture, and it has numerous ecological benefits.

Vertical farming

Compared with conventional agriculture, organic farming uses fewer pesticides, reduces soil erosion, decreases nitrate leaching into groundwater and surface water, and recycles animal wastes back into the farm. These benefits are counterbalanced by higher food costs for consumers and generally lower yields.
Indeed, yields of organic crops have been found to be about 25 percent lower overall than conventionally grown crops, although this can vary considerably depending upon the type of crop. The challenge for future organic agriculture will be to maintain its environmental benefits, increase yields, and reduce prices while meeting the challenges of climate change and an increasing world population.

History

The concepts of organic agriculture were developed in the early 1900s by Sir Albert Howard, F.H. King, Rudolf Steiner, and others who believed that the use of animal manures (often made into compost), cover crops, crop rotation, and biologically based pest controls resulted in a better farming system. Howard, havingworked in India as an agricultural researcher, gained much inspiration from the traditional and sustainable farming practices he encountered there and advocated for their adoption in the West. Such practices were further promoted by various advocates—such as J.I. Rodale and his son Robert, in the 1940s and onward, who published *Organic Gardening and Farming* magazine and a number of texts on organic farming. The demand for organic food was stimulated in the 1960s by the publication of *Silent Spring*, by Rachel Carson, which documented the extent of environmental damage caused by insecticides.

Organic food sales increased steadily from the late 20th century. Greater environmental awareness, coupled with concerns over the health impacts of pesticide residues and consumption of genetically modified (GMO) crops, fostered the growth of the organic sector. In the United States retail sales increased from $20.39 billion in 2008 to $47.9 billion in 2019, while sales in Europe reached more than $52 billion (€45 billion) in 2019.

The price of organic food is generally higher than that of conventionally grown food.

Depending on the product, the season, and the vagaries of supply and demand, the price of organic food can be anywhere from less than 10 percent below to more than 100 percent above that of conventionally grown produce.

Regulation

Certified organic

Organic agriculture is defined formally by governments. Farmers must be certified for their produce and products to be labeled "organic," and there are specific organic standards for crops, animals, and wild-crafted products and for the processing of agricultural products. Organic standards in the European Union (EU) and the United States, for example, prohibit the use of synthetic pesticides, fertilizers, ionizing radiation, sewage sludge, and genetically engineered plants or products. In the EU, organic certification and inspection is carried out by approved organic control bodies according to EU standards.

Organic farming has been defined by the National Organic Standards of the U.S. Department of Agriculture (USDA) since 2000, and there are many accredited organic certifiers across the country.

Although most countries have their own programs for organic certification, certifiers in the EU or the United States can inspect and certify growers and processors for other countries. This is especially useful when products grown organically in Mexico, for example, are exported to the United States.

Organic farming methods

Fertilizers - Compost

Since synthetic fertilizers are not used, building and maintaining a rich, living soil through the addition of organic matter is a priority for organic farmers.

Organic matter can be applied through the application of manure, compost, and animal by-products, such as feather meal or blood meal. Due to the potential for harboring human pathogens, the USDA National Organic Standards mandate that raw manure must be applied no later than 90 or 120 days before harvest, depending on whether the harvested part of the crop is in contact with the ground.

Composted manure that has been turned 5 times in 15 days and reached temperatures between 55 and 77.2 °C (131 and 171 °F) has no restrictions on application times.

Compost adds organic matter, providing a wide range of nutrients for plants, and adds beneficial microbes to the soil. Given that these nutrients are mostly in an unmineralized form that cannot be taken up by plants, soil microbes are needed to break down organic matter and transform nutrients into a bioavailable "mineralized" state. In comparison, synthetic fertilizers are already in mineralized form and can be taken up by plants directly.

Pest control

Organic pesticides are derived from naturally occurring sources. These include living organisms such as the bacteria *Bacillus thuringiensis*, which is used to control caterpillar pests, or plant derivatives such as pyrethrins (from the dried flower heads of *Chrysanthemum cinerariifolium*) or neem oil (from the seeds of *Azadirachta indica*). Mineral-based in organic pesticides suchas sulfur and copper are also allowed.

In addition to pesticides, organic pest control integrates biological, cultural, and genetic controls to minimize pest damage. Biological control utilizes the natural. enemies of pests, such as predatory insects (e.g., ladybugs) or parasitoids (e.g., certain wasps) to attack insect pests. Pest cycles can be disrupted with cultural controls, of which crop rotation is the most widely used. Finally, traditional plant breeding has produced numerous crop varieties that are resistant to specific pests. The use of such varieties and the planting of genetically diverse crops provide genetic control against pests and many plant diseases.

Organic production rules

Producing organically means respecting the rules on organic farming. These rules are designed based on general and specific principles to promote environmental protection, maintain the biodiversity of Europe and build consumer trust in organic products. These regulations govern all areas of organic production and are based on a number of key principles, such as:

- prohibition of the use of GMOs;
- forbidding the use of ionizing radiation;
- limiting the use of artificial fertilizers, herbicides and pesticides;
- prohibiting the use of hormones and restricting the use of antibiotics to only when necessary for animal health.

This means that organic producers need to adopt different approaches to maintaining soil fertility and animal and plant health including:

- crop rotation;
- cultivation of nitrogen fixing plants and other green manure crops to restore the fertility of the soil;
- prohibition of use of mineral nitrogen fertilizers;

- to reduce the impact of weeds and pests, organic farmers choose resistant varieties and breeds and techniques encouraging natural pest control;
- encourage the natural immunological defense of animals;
- in order to maintain animal welfare and health, organic producers need to prevent overstocking.

Rules on livestock

Livestock farmers must also fulfil specific conditions if they wish to market their products as organic. These rules include respect for animal welfare and feeding animals in accordance with their nutritional needs, and are designed to protect the animals' health and environment. These rules also help to build public trust as they ensure that organically farmed animals are kept separate from non-organic. Examples of rules which apply to livestock farmers include:

Abiding by organic principles

Non-organically raised animals may be not brought onto holdings unless forbreeding purposes and then must comply with specific rules.

- Farmers have to provide 100% organic feed to their animals in order to market their products as organic.
- The feed should primarily be obtained from the farm where the animals are kept or from farms in the same region.
- Cloning animals and or transferring embryos is strictly forbidden.
- Growth promoters and synthetic amino-acids are prohibited.
- Suckling mammals must be fed with natural, preferably maternal, milk.
- Natural methods of reproduction must be used, artificial insemination is however allowed.
- Non-organic feed materials from plant origin, feed materials from animal and mineral origin, feed additives, certain products used in animal nutrition and processing aids can only be used if they have been specifically authorised for use in organic production.

Animal welfare

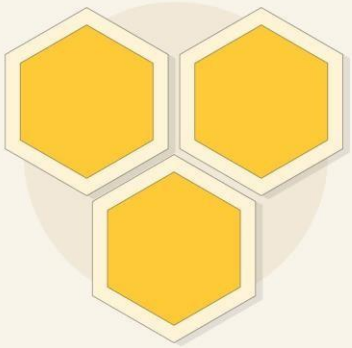
- Personnel keeping animals must possess the necessary basic knowledge and skills regarding the health and welfare needs of the animals.
- Particular attention should be paid to housing conditions, husbandry practices, respect of set stocking densities and minimum surfaces for indoor and outdoor areas.
- The number of livestock must be limited to minimise overgrazing, erosion, or pollution caused by animals or by the spreading of their manure.
- Animals should have, whenever possible, access to open air or grazing areas.
- Tethering or isolating livestock is prohibited aside from individual animals for a limited period of time and only for welfare, safety or veterinary reasons.
- Hormones or similar substances are not permitted, unless as a form of veterinary therapeutic treatment for an individual animal.

	• When the animals are ill, allopathic veterinary medicinal products including antibiotics may be used where necessary and under strict conditions. This is only allowed when the use of phytotherapeutic, homeopathic and other products is inappropriate. The use of immunological veterinary medicines is permitted. **HONEY** **Why do bees make honey?** Honey is bees' way of preserving their food, so they have something to eat when there aren't many flowers in bloom. Honey can be stored in the hive and consumedwhen needed. If bees stored nectar without turning it into honey first, it would ferment. **What is honey made of?** Bees eat two types of food, both of which come from flowers. Pollen is their proteinsource, and nectar is their carbohydrate. Nectar is a sugary liquid produced by plants, with sucrose being the main sugar. Enzymes in the bees' honey stomachs break this down into the simpler sugar glucose and fructose. Honey also contains vitamins, minerals, amino acids, enzymes, and compounds from the flowers. The unique flavors, fragrances and colors of different kinds of honey depend on the type of plants the nectar comes from

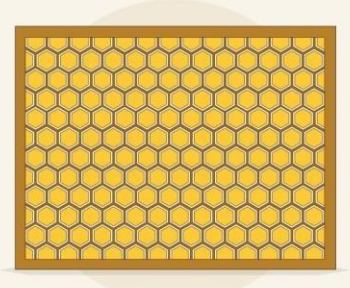
HOW HONEY IS MADE

1. A bee forages from flowers and collects nectar through a specially evolved tongue called a proboscis.
2. To transport the nectar back to the hive, the bee stores it in a special organ called the honey stomach.
3. Enzymes in the honey stomach begin to break down the nectar into simpler sugars.

4. Back at the hive, forager bees pass the collected nectar to younger house bees.
5. The nectar is passed mouth-to-mouth from one house bee to another – this process further breaks down the sugars and begins to reduce the water content of the nectar.
6. The nectar is then deposited into hexagonal cells in the honeycomb.



7. To reduce the water content of the nectar further, the bees fan their wings to evaporate it.
8. When the water content gets below 20%, the honey is ready or "ripe".



9. Once the honey is the correct consistency, the bees seal the honeycomb cell with a wax capping.
10. The honey is now preserved indefinitely!

FLOW

	Sweet honey facts • A single bee will create about one 12th of a teaspoon (0.8g) of honeyduring her lifetime. • It takes 2 million flower visits for a honeybee colony to produce 500g (1lb)of honey. • Honey is not a uniform substance - it ranges in color from almosttransparent to very dark. • There are as many different flavors of honey as there are floweringplants for bees to forage on. • Honey has anti-bacterial, anti-inflammatory and probiotic properties. Ifstored correctly, honey never goes off. **What do bees do with honey?** Honey is bee food - when there's plenty of nectar to be had, a colony will produce enough to store. During periods when there are not a lot of flowers in bloom or the bees can't get out to forage due to bad weather, they'll use up the stored honey. Coming up to winter, bees need to have plenty of honey stored to feed on and keepwarm through the winter months. Bees will gorge on honey before swarming. Thisgives them the energy needed to build a new nest. So next time you're enjoying some tasty honey, save a thought for these industrious insects and the incredible teamwork it takes to make honey.
Learning objectives	By the end of this educational module, students will: • Acquire knowledge about the environment and the role of biogas energy in promoting sustainability. • Understand the fundamental principles of a biogas plant. • Acquire knowledge about the advantages and disadvantages of using energy produced by a biogas plant. • Be equipped with strategies to cope with environmental challenges, particularly in the context of renewable energy integration and overcoming barriers to its adoption. • Acquire knowledge about the environment and the role of organicfarming in promoting sustainability. • Understand the fundamental principles of organic farming. • Acquire knowledge about the history of organic farming. • Acquire knowledge about the rules of organic agriculture.

	• Acquire knowledge about organic farming methods. • Be equipped with strategies to cope with environmental challenges,particularly in the context of renewable energy integration and overcoming barriers to its adoption • Acquire knowledge about why bees make honey. • Acquire knowledge about what honey is made of. • Acquire knowledge about how honey is made. • Acquire knowledge about the benefits of honey.
Activities and exercises	Video*:* https://www.youtube.com/watch?v=WhOrIUlrnPo Video: https://www.youtube.com/watch?v=ymCQWxwatuk
Additional resources	N/A
References/ Sources	Taken from https://organicabiotech.com/biogas-production/ https://www.britannica.com/explore/savingearth/organic-farming https://agriculture.ec.europa.eu/farming/organic-farming/organic-production- and-products_en

Appendix 7 – Educational information for scenario Polluting Factory

The goal of this educational material is to teach students about ***environmental-related issues, offering insights on topics ranging from understanding the environment to identifying key challenges and exploring sustainable practices for a healthier planet.***

Educational material (activities for students)

Scenario	Polluting Factory
Title	*Education material for students of Polluting Factory Scenario*
Partner	Arsakeio Lyceum Patras
Country	X **Greece** o Italy o Portugal
Target audience	10-15
Introduction	Brief overview of the educational material of students
Content	In this scenario, you will be familiarized with the concept of industrial pollution. Youwill see how harmful a factory can be to an area. First, you will see the first signs of industrial pollution by seeing the effects of it onflowers, trees, local wildlife etc. You will also see examples of water pollution. Additionally, you will also be presented with a quiz about environmental pollution.Here is the quiz: 1. According to NASA, how much is the sea level expected to rise by the year 2050? A. 15 to 20 centimeters B. 20 to 25 centimeters C. 25 to 30 centimeters D. 30 to 35 centimeters 2. How much of the Amazon rainforest was cut down from 1988 to 2022?A. 200,000km² B. 375,000km² C. 425,000km² D. 450,000 km² 3. Which of these is not a renewable form of energy? A. Natural gas B. Wind C. Solar D. Geothermal

	4. How do people celebrate World Environment Day? A. Street parades B. Tree planting C. Organized clean-up events. D. All of the above 5. How much plastic is there in the world? A. 750 million tones B. 8.3 billion tones C. 10 billion tones D. 12.4 billion tones 6. Which year was the hottest ever year on record? A. 1996 B. 2008 C. 2016 D. 2021 7. Recycling an aluminum can uses what percentage of the energy used to create it? A. 1% B. 5% C. 20% D. 50% Finally, you will be able to choose solutions about this problem. Answers: 1. C, 2. D, 3. A, 4. D, 5. B, 6. B, 7. B
Learning objectives	Students will enrich their knowledge about environmental pollution and, more specifically, about the catastrophic effects of industrial pollution. They will be able to visualize the damage by the inclusion of photos and videos. Through the environmental quiz, they will be able to see the bigger picture of environmental pollution. Finally, in the negotiating stage they will appreciate the importance of coming up with solutions.
Activities and exercises	The scenario has to do with industrial pollution and its effects on the local environment so we give theoretical and visual information about different aspects of factory pollution.
Additional resources	Videos: • China Aerials: Industrial Lands, Factories, Exhaust Gas, Pollution in China • Climate Health Connection Environmental Pollution

Educational material (for teachers)

Scenario	Polluting Factory
Title	*Education material for teachers of Polluting Factory Scenario*
Partner	Arsakeio Lyceum Patras
Country	X **Greece** ○ Italy ○ Portugal
Target audience	Teachers
Keywords	Pollution, Factory, Environment, Lake, Water, Toxic, Waste, Industrial
Glossary	1. Water Pollution: Water pollution occurs when harmful substances—often chemicals or microorganisms—contaminate a stream, river, lake, ocean, aquifer, or other body of water, degrading water quality and rendering it toxic to humans or the environment. 2. Toxic Waste: chemical waste material capable of causing death or injury to life. 3. Industrial Pollution: Pollution whose source originates directly from industry is known as industrial pollution. 4. Emissions: an amount of something, especially a gas that harms the environment, that is sent out into the air. 5. Radioactive Waste: Radioactive waste is defined as any material that is either radioactive or contaminated by radioactivity and for which no further use is foreseen, and it encompasses a wide range of radioactive isotopes in a variety of physical and chemical forms (aqueous waste, liquid organic waste, solid waste, wet solid waste, biological and medical waste, etc. 6. Soil Pollution: Soil pollution is defined as the presence of toxic chemicals (pollutants or contaminants) in soil, in high enough concentrations to pose a risk to human health and/or the ecosystem
Content	Introduction to the problem of Industrial Pollution: After the Industrial Revolution, manufacturing and technology made advances, which resulted in more factories and more industry. These factories emitted smoke into the air. The effects of the smoke, along with the pollution that industries cause to water and even the land beneath and around the factories are becoming obvious. Industrial pollution is also pointed out as a major factor in wildlife extinction and eventually, even global warming. The global environment, even areas that are not industrial, have been impacted. Arctic and Antarctic ice samples have been shown to have high levels of pollutants, demonstrating the great distances that pollutants can travel. It is clear that environmental degradation is happening as a direct result of industrial pollution and something needs to be done. Effects of Industrial Pollution on the Environment:

	1. Water Pollution: Factories use large amounts of water for their work. After being involved in various processes, the water becomes contaminated with heavy metals, hazardous chemicals, radioactive waste and organic sludge. These are dumped into the oceans or rivers and this impacts the health of our ecosystem. 2. Soil Pollution: Problems in agriculture and local vegetation. It can cause chronic health problems for the people that come into contact with the soil. 3. Air Pollution: Air pollution causes and increase to many illnesses. 4. Wildlife Extinction: It is becoming more and more difficult for the environment to recover from pollution. As a result, wildlife species are affected. 5. Global Warming: Emissions of smoke and greenhouse gases contribute to global warming. 6. Biodiversity Loss: Damage to the Earth and its inhabitants. Ways to Reduce Industrial Pollution: 1. Recycling 2. Clean Resources 3. Proper Treatment of Industrial Waste 4. Stricter Laws
Learning objectives	By the end of this educational module: • Students will have familiarized themselves with the concept of industrial pollution. • They will understand the devastating effects industrial pollution has had and is still having on the environment. • Students will also develop strategies to enhance their knowledge about industrial pollution and waste. • They will be able to come up with strategies to cope with the problem of industrial pollution.
Activities and exercises	Relating the scenario and other that may complement the learning (optional) Other activities that may complement the scenario: • Organize a visit to a local factory or a local business/farm with your students in order to see how the nearby environment has been affected by the existence and activity of the factory/business/farm. • Ask the students to create short social media reels/tiktoks recreating the interactions in the video game as short videos which could go viral. • Ask the students to create posters about industrial pollution and how harmful it can me to the environment.
Additional resources	Videos:

	• China Aerials: Industrial Lands, Factories,Exhaust Gas, Pollution in China • Climate Health Connection Environmental Pollution
References/ Sources	1. Ghosh, A. (2023, June 20). Causes, effects and solutions to industrial pollution on our environment - Conserve Energy Future. Conserve Energy Future. https://www.conserve-energy-future.com/causes-effects-of-industrial-pollution.php 2. Water Pollution: Everything You Need to Know. (2023, January 11). https://www.nrdc.org/stories/water-pollution-everything-you-need-know#causes 3. WonderWorks. (2018, September 9). Industrial Pollution | WonderWorks Online. WonderWorks Online. https://www.wonderworksonline.com/science-library/environmental-issues/industrial-pollution/#:~:text=Pollution%20whose%20source%20originates%20directly,emitted%20smoke%20into%20the%20air.

Appendix 8 – Educational information for scenario Walk in the forest

The goal of this educational material is to teach students about ***environmental-related issues, offering insights on topics ranging from understanding the environment to identifying key challenges and exploring sustainable practices for a healthier planet.***

Educational material (for teachers)

Scenario	Walk in the forest
Title	Benefits of trees and forest ecosystems
Partner	University of Maia - ISMAI
Country	○ Greece ○ Italy x Portugal
Target audience	Teachers
Keywords	Forest; ecosystem; autochthones species, ecosystem benefits
Glossary	
Content	The walk in the forest scenario is an educational game, designed to teach students about the importance of forests and the ecosystem benefits. The educational contents embedded in the scenario allow to: • Characterize species of different forest ecosystems (animals and plants) • Characterize ecosystem services provided by forests • Apprehend the importance of the forest for human activities and human-forest dynamics. • Identify the human activities that can be developed in the forest • Identify threats and risks to the forest • Identify new approaches and innovations The game takes place in a forest where the player goes for a walk. The player comes into contact with landscapes with different characteristics (proximity to a river, residential area, production forest, mountain forest) and with other visitors and residents. The different landscapes are: • Grazing area • River bank • Mountain zone • Mixed zone, a forest near a village Some of the themes that are treated in the game are:

Forest plants provide a wide range of food and medicinal resources. Some examples of forest food are:

1. Fruits: Forests are abundant sources of various fruits such as berries, wild apples, mangoes, avocados, and bananas.
2. Nuts: Many trees in forests produce nuts that are consumed as food, such as walnuts, chestnuts, hazelnuts, and Brazil nuts.
3. Mushrooms: Forests are home to a diverse array of edible mushrooms, including chanterelles, porcini, morels, and truffles.
4. Leafy Greens: Some forest plants offer edible leaves, such as wild spinach, watercress, and stinging nettle, which can be used in salads or cooked as greens.
5. Honey: Bees forage on the nectar of various forest flowers, producing delicious and nutritious forest honey.

Some examples of forest-based medicines are:

1. Willow Bark (Salix spp.): Willow bark contains salicin, a compound with pain-relieving and anti-inflammatory properties. It has been traditionally used to alleviate headaches, muscle aches, and fever.
2. Ginkgo (Ginkgo biloba): Ginkgo leaves have been used in traditional medicine to improve cognitive function, enhance memory, and promote overall brain health.
3. Echinacea (Echinacea spp.): Echinacea is a herb known for its immune-boosting properties. It has been used to support the body's natural defenses and help fight off common illnesses.
4. Yarrow (Achillea millefolium): Yarrow has been traditionally used as a natural remedy for wound healing, gastrointestinal issues, and fever reduction.
5. Ginseng (Panax spp.): Ginseng roots are highly valued in traditional medicine for their potential to increase energy, reduce stress, and support overall well-being.

These are just a few examples of the many food and medicinal resources provided by forest plants. Forests are incredibly rich ecosystems with a vast array of plant species, each with their own unique contributions to human well-being. It's important to approach the utilization of these resources sustainably and with respect for the ecosystems they come from.

Suggested activity: identify various types of forest and challenge your students to identify the species that exist there. Collate the information on a panel to give them an overview of the world's forests.

Mediterranean forests can be found in Portugal, Italy and Greece, among other places and they integrate an ecosystem rich in biodiversity, adapted to the climatic conditions' characteristic of the region. Here are examples of plant species characteristic of this forest:

1. White oak (Quercus faginea)
2. Holm oak (Quercus ilex)
3. Cork Oak (Quercus suber)
4. Stone pine (Pinus pinea)
5. Maritime pine (Pinus pinaster)
6. Strawberry tree (Arbutus unedo)
7. Lentiscus (Pistacia lentiscus)
8. Juniper (Juniperus communis)
9. Rosemary (Rosmarinus officinalis)
10. Cistus (Cistus ladanifer)
11. Cistus albidus (Cistus albidus)
12. Thyme (Thymus vulgaris)
13. Lavender (Lavandula angustifolia)
14. Cypress (Cupressus sempervirens)
15. Holly (Ilex aquifolium)
16. Azalea (Rhododendron ponticum)
17. Horehound (Crataegus monogyna)
18. Laurel (Laurus nobilis)
19. Fig tree (Ficus carica)
20. Carob tree (Ceratonia siliqua)

These species are just a small sample of the rich plant diversity found in the Mediterranean forest. Each of them plays an important role in sustaining and maintaining the ecosystem services of this unique ecosystem.

Activity suggestion:

Identify with your students' other Mediterranean forest plants that are characteristic of your local ecosystem.

Organize a photo exhibition with information about these species and its conservation status.

Collect branches and leaves and complements the previous exhibition.

Mediterranean forest plants offer a diverse range of food and medicinal resources. Some examples of Mediterranean forest food are:

1. Olives (Olea europaea): The Mediterranean region is famous for its olive trees, which provide olives and olive oil—a staple in Mediterranean cuisine.
2. Figs (Ficus carica): Fig trees thrive in the Mediterranean climate and produce sweet and nutritious fruits that are consumed fresh or dried.
3. Grapes (Vitis vinifera): Mediterranean forests are home to vineyards where grapes are grown for wine production, as well as for fresh consumption.
4. Almonds (Prunus dulcis): Almond trees flourish in the Mediterranean region and provide a versatile nut used in various culinary dishes and desserts.
5. Herbs and Spices: Mediterranean forests are rich in herbs and spices like rosemary, thyme, oregano, and sage, which add flavor and aroma to Mediterranean cuisine.

Some examples for Mediterranean forest-based medicines are:

1. Lavender (Lavandula spp.): Lavender is well-known for its calming properties and is often used in aromatherapy and herbal remedies for relaxation and stress relief.
2. Sage (Salvia officinalis): Sage leaves have long been used in traditional medicine for their medicinal properties, including as a natural remedy for sore throats and digestive issues.
3. Rosemary (Rosmarinus officinalis): Rosemary has antioxidant properties and is used in traditional medicine for improving digestion and as a memory enhancer.
4. Thyme (Thymus vulgaris): Thyme is known for its antibacterial and antifungal properties. It is used in natural remedies for respiratory ailments and as a culinary herb.
5. Aloe Vera (Aloe vera): Aloe vera is a succulent plant that grows in the Mediterranean region. Its gel is used topically to soothe burns, cuts, and skin irritations.

There are much other examples of the food and medicinal resources provided by Mediterranean forest plants. The unique climate and biodiversity of the Mediterranean region contribute to a rich variety of plant species with culinary and healing properties. As with any natural resources, it's important to use them sustainably and with respect for the environment.

Activity suggestion:

Identify with your students' other forest plants that are used in your area for medicinal or food purposes.

Collect traditional recipes from your area that use these species as ingredients or spices.

	The Mediterranean Forest is home to a variety of animal species adapted to the specific conditions of this ecosystem. Some animal species characteristics of the Mediterranean forest are: 1. Iberian lynx (Lynx pardinus) 2. Iberian imperial eagle (Aquila adalberti) 3. Hunting turtle (Circus pygargus) 4. Iberian toadfish (Alytes cisternasii) 5. Red-cockaded Woodpecker (Dendrocopos major) 6. White-rumped weasel (Neomys fodiens) 7. Horned viper (Vipera latastei) 8. European otter (Lutra lutra) 9. Lusitanian salamander (Chioglossa lusitanica) 10. Fox (Vulpes vulpes) 11. Barn Owl (Strix aluco) 12. Griffon vulture (Gyps fulvus) 13. Sardinian (Lacerta lepida) 14. Big-eared bat (Tadarida teniotis) 15. Black vulture (Aegypius monachus) 16. Audouin's Gull (Ichthyaetus audouinii) 17. Great egret (Ardea cinerea) 18. Genet (Genetta genetta) 19. Badger (Meles meles) 20. Hedgehog (Erinaceus europaeus) These species represent a part of the animal diversity found in Mediterranean forests. Each of them plays a key role in maintaining the ecological balance of this unique ecosystem. Unfortunately, several species found in the Mediterranean forest are threatened due to human activities and habitat loss. Here are some of the species mentioned above that face significant threats: 1. Iberian lynx (Lynx pardinus): It is one of the most threatened cat species in the world due to habitat loss, population fragmentation and illegal hunting.

2. Iberian Imperial Eagle (Aquila adalberti): It is a rare and threatened eagle species, mainly due to habitat destruction and lack of available prey.

3. Hunting turtle (Circus pygargus): Suffers from the loss of suitable breeding habitats, such as grasslands and open fields, due to intensive agriculture and urbanisation.

4. Iberian toad (Alytes cisternasii): Faces threats due to degradation and destruction of aquatic habitats, as well as water pollution.

5. Red-cockaded woodpecker (Dendrocopos major): The loss of old and dead trees, which are essential for its feeding and nesting, puts this species at risk.

6. European Otter (Lutra lutra): Destruction of aquatic habitats, water pollution and accidental capture in fishing nets are threats to this species.

7. Lusitanian salamander (Chioglossa lusitanica): Faces habitat loss due to deforestation and wetland destruction.

8. Black vulture (Aegypius monachus): This is a threatened scavenger bird species due to habitat loss, accidental poisoning and lack of available food.

9. Audouin's Gull (Ichthyaetus audouinii): Loss of suitable nesting areas and reduced prey availability due to overfishing threaten this species.

These are just some of the threatened species found in the Mediterranean forest. Conservation and protection of these species and their habitats are key to ensuring their long-term survival.

Activity suggestion: Identify some animal species that are characteristic of the forests in your area, signaling which species are threatened or at risk.

Organize a photo exhibition with information about these species and its conservation status.

Riparian ecosystems are transitional areas between aquatic and terrestrial environments, usually found along the banks of rivers, streams, lakes and wetlands. These ecosystems play a key role in maintaining overall ecosystem health and provide a range of ecosystem benefits and services, namely:

1. Stabilizing the banks of water bodies: Plants found in riparian ecosystems, such as trees, shrubs and herbaceous vegetation, have dense root systems that help stabilize the banks of rivers and streams. This reduces soil erosion and the loss of soil into water bodies, preserving water quality and preventing siltation.

2. Natural filter: Riparian vegetation acts as a natural filter for pollutants and sediments carried by water from agricultural or urban land. It helps trap and remove harmful substances before they reach water bodies, contributing to improved water quality.

	3. Biodiversity and habitat: Riparian ecosystems provide vital habitat for a variety of plant and animal species. The diversity of habitats, such as wetlands, riparian forests and scrublands, harbor a wide variety of terrestrial and aquatic species, including fish, birds, amphibians, reptiles and mammals. These areas are often used as ecological corridors, allowing animals to move between different habitats. 4. Flood control: Riparian vegetation acts as a natural sponge, absorbing water during periods of heavy rainfall and helping to reduce the risk of flooding. The presence of dense vegetation and roots helps to retain water, slowing the rate of surface runoff and allowing water to be absorbed into the soil. 5. Recreation and tourism: Riparian ecosystems provide opportunities for outdoor recreational activities such as hiking, nature watching, fishing and canoeing. These areas attract tourists and contribute to the local economy by promoting ecotourism and nature conservation. 6. Nutrient cycling: Riparian ecosystems play a key role in nutrient cycling. The vegetation and fauna of these areas contribute to the decomposition of organic matter, releasing essential nutrients into the soil and water, which are recycled and reused by other organisms. Therefore, riparian ecosystems play a vital role in preserving water quality, biodiversity, nutrient cycling and mitigating natural disasters. The protection and conservation of these ecosystems are key to ensuring the health and resilience of aquatic and terrestrial ecosystems. **Species of riparian ecosystems** In a riparian ecosystem, it is possible to find a variety of animal species, adapted to life both in the water and in the surrounding terrestrial areas. Some common animal species found in these ecosystems are: 1. Fish: Riparian ecosystems provide habitat for a variety of fish species, such as trout, salmon, carp, lambari, and others. Fish often use riparian areas for spawning, feeding, and shelter. 2. Amphibians: Frogs, toads and salamanders are often found in riparian ecosystems. They rely on water for breeding, but also spend part of their time in nearby terrestrial environments. 3. Reptiles: Turtles, lizards and snakes are some of the reptile species that can be found in riparian ecosystems. These animals take advantage of both aquatic and adjacent terrestrial areas. 4. Waterfowl: Species such as ducks, herons, grebes, sandpipers and kingfishers are often found in riparian ecosystems. They feed on fish, aquatic invertebrates and other resources available in these areas.

5. Semi-aquatic mammals: Some mammal species, such as otters, beavers and water rats, can be found in riparian ecosystems. They utilise water for feeding, moving around and building burrows.

6. Aquatic invertebrates: Several aquatic invertebrates, such as aquatic insects, dragonfly larvae and snails, inhabit riparian ecosystems. They play important roles in the food chain and nutrient cycling.

There are much more animal species that can be found in riparian ecosystems. The variety and presence of animals depend on the specific characteristics of each site, including the availability of water, the vegetation present, and the interconnectivity with other habitats.

Activity suggestion: Identify some animal species that are characteristic of the riparian ecosystem in your area, signalling which species are threatened or at risk. Organise a photo exhibition with information about these species and its conservation status.

Distinction between forest and monoculture of trees

Tree monoculture forest is characterised by the intensive planting of a single tree species on large tracts of land. Some distinctions of this form of forest compared to natural forests are:

1. Species diversity: In natural forests, there is a wide diversity of plant species, with different types of trees, shrubs and herbaceous plants coexisting. Whereas in monoculture tree forest, only a single tree species is planted, resulting in a significant reduction in diversity.

2. Vegetation structure and height: In natural forests, trees have different heights, shapes and structures, creating a varied and complex canopy. In tree monoculture, trees are usually planted in straight lines and are of similar height, which results in a uniform and less complex canopy.

3. Nutrient cycling: In natural forests, nutrient cycling is a complex process, with different plant species playing specific roles in decomposing organic matter and recycling nutrients. In tree monoculture, nutrient cycling may be more limited as only one dominant species is present.

4. Biodiversity: Natural forests harbour a wide variety of plant, animal and microorganism species, resulting in high biodiversity. Tree monoculture, on the other hand, generally has low biodiversity, as only one species is grown on a large scale.

5. Resilience and resistance to diseases and pests: Natural forests tend to be more resilient to diseases and pests, due to the genetic diversity of the species present. On the other hand, tree monocultures are more susceptible to

outbreaks of pests or diseases that can spread rapidly through the uniform population of trees.

6. Ecosystem services: Natural forests provide a wide range of ecosystem services such as climate regulation, soil protection, water purification, biodiversity conservation and habitat for diverse species. Tree monoculture can provide some services, such as large-scale timber production, but may be less efficient at providing other ecosystem services.

It is important to emphasize that tree monoculture forests can have their place in forestry, meeting specific demands such as large-scale timber production. However, it is crucial to seek a balance between natural forests and areas destined for agricultural production to ensure the conservation of biodiversity and ecosystem services.

Activity suggestion: Discuss with your students what kind of forest they can find in your area and identify the services it provides.

Positive and negative examples of human interaction with the forest

These examples highlight the importance of conserving forests and the ecosystem services they provide, as well as the negative consequences that occur when they are not properly protected and managed.

1. Positive example: Amazon rainforests provide essential ecosystem services such as global climate regulation, oxygen production and maintenance of biodiversity. In addition, local communities depend on these forests for their livelihoods, through fishing, fruit gathering and medicinal plants.
2. Negative example: Uncontrolled logging in the Amazon Rainforest results in deforestation, leading to loss of habitat for numerous animal and plant species, contributing to climate change and jeopardising the ecosystem services provided by the forest.
3. Positive example: The Białowieża Forest, located on the border between Poland and Belarus, is one of the last and largest primary forests in Europe. It is an outstanding example of biodiversity conservation, harboring a wide variety of plant and animal species, including the European bison, a threatened species.
4. Negative example: Degradation of the Amazon rainforest due to illegal mining, such as gold extraction, results in mercury contamination of rivers, polluting the environment and affecting aquatic life. This jeopardises the health of indigenous communities that depend on these natural resources.
5. Positive example: The Tongass National Forest, located in Alaska, is one of the largest intact temperate rainforests in the world. It plays a crucial role in absorbing carbon dioxide, helping to mitigate climate change. The forest

	is also home to several species of animals, including bears and eagles, and offers opportunities for sustainable tourism and recreation. 6. Negative example: The uncontrolled expansion of large-scale agriculture, such as palm oil production, has led to the destruction of vast tracts of tropical forests in Indonesia and Malaysia. This results in the loss of critical habitats for endangered species such as orangutans and contributes to greenhouse gas emissions and global warming.
	Suggested activity: Conduct a short research with your students to complement the list of good and bad examples of human interaction with the forest.
Learning objectives	These educational contents allow players to: • Understand the importance of biodiversity and the risks that threaten it • Understand the importance of ecosystem benefits • Understand the relationship between biotic and abiotic systems in an ecosystem • Understanding the importance of trees for: - food security - water production - securing slopes - reproduction of other animals - the carbon cycle - water cycle - securing biodiversity - human health - climate - Identify professions related to the forest - Identify species living in the forest - Distinguish between forest and tree monoculture - Identify economic and social activities linked to the forest - Understanding the role of trees and forests in history (in symbols, stories, events, culture) - Identify the major current threats to the forest - Understand the attitudes and behaviors appropriate to the interaction of humans with the forest
Activities and exercises	In-scenario activities: (See scenario) Other activities that may complement the learning: **Activities and initiatives that you may organize with your students to promote forest protection:** 1. Awareness campaign: Organise an educational campaign at school to raise awareness among students about the importance of protecting forests. You can create posters, presentations, informative videos or even an exhibition about the ecosystem services of forests and the impacts of fires.

	2. Tree planting: Encourage tree planting in and around the school. Organise a tree planting day with the participation of students, teachers and staff. Make sure to choose native species suitable for the region. 3. Partnerships with local organisations: Establish partnerships with local environmental organisations working on forest protection. Invite representatives of these organisations to give talks, workshops or practical activities at the school. 4. Recycling project: Promote a recycling project in the school, encouraging separate collection and raising awareness about reducing the consumption of natural resources. Explain how recycling can indirectly contribute to forest protection. 5. Thematic day: Organise a thematic day dedicated to forest protection. Hold activities such as lectures, debates, film screenings or theatre plays related to the theme. Involving learners of different ages can help spread awareness. 6. Volunteering in forest areas: Organise visits to nearby forest areas and encourage students to participate in volunteer activities such as trail cleaning, planting seedlings or species identification. 7. Environmental monitoring project: Create an environmental monitoring project where students can collect data on air quality, water quality and biodiversity in the forest areas near the school. This information can be shared with researchers or competent authorities. 8. Partner with other schools: Establish partnerships with other schools interested in forest protection. Hold joint events, exchange information and experiences, promoting a network of schools engaged in environmental conservation. **Forest-related questions for discussion or exploration in class work:** 1. What are ecosystem services and why are they important for forests? 2. What are some of the ecosystem services provided by forests? 3. Why are forests considered the "lungs of the planet"? 4. How do forests help regulate the global climate? 5. What are the benefits of forests for biodiversity? 6. How do forests contribute to the quality of the water we drink? 7. What types of food can we get from forests? 8. How can forests help prevent natural disasters such as floods and landslides? 9. Why are forests important to local communities and indigenous peoples?

	10. What are the main threats to forests and the ecosystem services they provide? 11. What can we do to protect and conserve forests and their ecosystem services? 12. How can we promote the sustainable use of forest resources? 13. How can education and awareness-raising help to conserve forests? 14. What are some creative ways to utilise forest resources without causing harm to the environment? 15. Why is it important to plant trees and restore degraded forest areas?
Additional resources	The wolves that changed the river (video) https://www.youtube.com/watch?v=ysa5OBhXz-Q FAO Food and Agriculture organization – Strategic Framework on Mediterranean Forests https://www.fao.org/forestry/36306-08872a0d33e559c4f5c42304068d43763.pdf WWF – The Mediterranean forests – new conservation strategy https://wwfeu.awsassets.panda.org/downloads/brochure_english.pdf
References/ Sources	Nocentini, S., Travaglini, D. & Muys, B. (2022). Managing Mediterranean Forests for Multiple Ecosystem Services: Research Progress and Knowledge Gaps. *Curr Forestry Rep* **8**, 229–256. https://doi.org/10.1007/s40725-022-00167-w https://link.springer.com/article/10.1007/s40725-022-00167-w

Appendix 9 – Educational information for scenario Water Treasure

The goal of this educational material is to teach students about ***environmental-related issues, offering insights on topics ranging from understanding the environment to identifying key challenges and exploring sustainable practices for a healthier planet.***

Educational material (activities for students)

Scenario	*Water Treasure*
Title	*Education material for students of Water Treasure Scenario*
Partner	AEDAS Agrupamento de Escolas D. Afonso Sanches
Country	○ Greece ○ Italy X **Portugal**
Target audience	*10-15 years old*
Introduction	This scenario is about the importance of water. Water is present in all aspects of our lives and the way we treat this resource directly impacts our health and ecosystems. Access to safe drinking water and sanitation has been considered, since 2010, one of the Human Rights defined by the United Nations (UN). This common good is also a limited resource that must be protected and used sustainably, both in terms of quantity and quality. This resource is subject to increasing pressures arising from its use by a wide variety of sectors, such as agriculture, industry, tourism, transport and energy, pressures that are aggravated by the effects of climate change. For all these reasons, an adequate management of water resources is fundamental for human society and for the integrity of the natural environment, without which, we can see the competition for water between the different sectors and the escalation of water crises of various types, with negative consequences for the various sectors that depend on water. Today we face **big challenges such as** population growth, urbanization, pollution, and the effects of climate change are putting enormous pressure on the availability and quality of water in Europe. Water scarcity will tend to increase until 2050, either due to the increase in the world population or the increase in demand by the various sectors of emerging economies and due to the increase in the world population.

	This situation, already difficult to manage in itself, will tend to be aggravated by climate change, caused by changes in precipitation patterns, with a tendency towards the worsening of extreme phenomena such as floods and floods or drought phenomena, therefore, balancing the demand for water resources and the needs of the populations will be fundamental to manage the tensions created by situations of scarcity. On the other hand, we are faced with the problem of the quality of water bodies which, despite the progress achieved with the increase in wastewater treatment, continues to be precarious, with a large part of water bodies in Europe not being able to comply with the minimum objective of "Good" ecological status as recommended by the European Union Water Framework Directive
Content	Water scarcity It will tend to increase until 2050, either due to the increase in the world population or the increase in demand by the various sectors of emerging economies and due to the increase in the world population. This situation, already difficult to manage in itself, will tend to be aggravated by climate change, caused by changes in precipitation patterns, with a tendency towards the worsening of extreme phenomena such as floods and drought phenomena, therefore, balancing the demand for water resources and the needs of the populations will be fundamental to manage the tensions created by situations of scarcity. On the other hand, we are faced with the problem of the quality of water bodies which, despite the progress achieved with the increase in wastewater treatment, continues to be precarious, with a large part of water bodies in Europe not being able to comply with the minimum objective of "Good" ecological status as recommended by the European Union Water Framework Directive. The Planet's glaciers are melting The planet contains large ice sheets that cover the north pole and south pole areas. These glaciers are responsible for the largest volume of fresh water on the planet. Many species remain alive thanks to the melting of these areas in the warmer seasons. Calving is when chunks of ice break off at the terminus, or end, of a glacier. Ice breaks because the forward motion of a glacier makes the terminus unstable. We call these resulting chunks of ice "icebergs." With global warming, the average temperature of the oceans, changes. The high concentration of greenhouse gases causes the sun's heat to be blocked and this heat hovers around the surface, raising the planet's temperature. According to climate reports, global warming is directly associated with various human activities and everything indicates that by 2100, the Earth's temperature could increase by between 1.8ºC and 4ºC. Studies indicate that if there is no considerable reduction in carbon emission rates, sea levels will continue to rise, exposing the population of around 400 million people, in several countries, to major coastal floods in the coming decades. It took the polar ice caps around 30 years to respond to climate change and

	accelerate melting. However, once this process is triggered, it cannot be reversed, even if gas emissions are reduced. However, its reduction can minimize future damage to the planet. The first measure to reduce these impacts is adopting renewable energy sources, reducing the use of fossil fuels. Another initiative is to reduce waste production by encouraging recycling practices. Water pollutants Many human activities can have adverse effects on the quality of rivers, lakes, seas and groundwater. Water quality is influenced by direct discharges, for example from a factory or wastewater treatment plant (so-called "point source pollution"), but also by pollution from disseminated sources such as nutrients and pesticides from agricultural activities and pollutants released into the air by industry which then return to land and sea (so-called 'diffuse pollution'). The main point source of water pollution is wastewater treatment whereas, in the case of diffuse pollution, the main sources are agriculture and power plants fueled by fossil fuels (through the air). It should be noted that, although wastewater treatment plants are identified as a «point source», they are not exactly a source, since they only treat what we pour into the toilet and sink. Human activities that consume more water According to the Food and Agriculture Organization of the United Nations (FAO), in terms of world average, the activity that consumes the most water is agriculture, responsible for 70% of all water used. In second place is the industry, responsible for 22% of consumption. Finally, there is domestic and commercial use of water, which totals only 8%. This means that, in order to save water, it is also necessary to involve economic activities in the countryside and also in the factories. Consequences of water pollution Deteriorating water quality has a negative impact on the environment, health and the global economy. **1.** Destruction of biodiversity - water pollution impoverishes aquatic ecosystems and facilitates the uncontrolled proliferation of phytoplankton algae in lakes — eutrophication. **2.** Pollution of the food chain - fishing in contaminated waters, as well as the use of wastewater in livestock and agriculture, can transmit toxins to food that harm our health when ingested. **3.** Scarcity of drinking water - the UN admits that there are still billions of people in the world without access to clean water and sanitation, especially in rural areas. **4.** Illnesses - the WHO estimates that around 2 billion people drink water contaminated by excrement, exposing themselves to diseases such as cholera, hepatitis A and dysentery. **5.** Child mortality - according to the UN, diarrheal diseases linked to poor hygiene cause the death of about a thousand children a day worldwide.

Water footprint

The water footprint measures the amount of water used to produce each of the goods and services we use. It can be measured for a single process, such as growing rice, for a product, such as a pair of jeans, for the fuel we put in our car, or for an entire multi-national company. The water footprint can also tell us how much water is being consumed by a particular country – or globally – in a specific river basin or from an aquifer.

Questions:

1. Do you know how much water was used to grow your food and to produce your clothes and the things you buy?

It is a surprising amount. You may not see this 'invisible' water, but it accounts for most of the water you use, far more than you use from the tap. Our use of water is not limited to kitchens, bathrooms, and gardens.

Daily, we contribute to the consumption of large quantities of water when buying various products, from the food we eat, paper and cotton to biofuel. This way, we indirectly affect water resources throughout the world.

By measuring water footprints, we can get a clear picture of how water is used in today's consumer society, in the same way that carbon footprints measure contributions to climate change.

Your water footprint is the amount of water you consume in your daily life, including the water used to grow the food you eat, to produce the energy you use and for all the products in your daily life – your books, music, house, car, furniture and the clothes you wear.

2. What do we need to do?

Understanding our water consumption can help us provide a solution to one of our most pressing problems: making sure there is enough water to sustain all living things on our planet.

The current and future challenges facing water resources require robust, clear, and result-oriented public policies. Water governance will make a strong contribution to the design and implementation of these policies, involving a shared responsibility among different actors in society and an active and conscious intervention by citizens is fundamental for the success of public water policies.

Water management measures

For a good management of the resource, it is necessary to:

- Define clear limits for abstractions and reflect the scarcity, degradation potential and economic value of water in its price - including the cost of public investments to be reflected in improvement fees.
- Improve the monitoring and knowledge network.
- Ensure a parsimonious and efficient use of water.
- Guarantee the correct planning, use and occupation of the land in REN's areas for the sustainability of the water cycle.

- Promote efficient irrigation compatible with the preservation of biodiversity, which promotes territorial cohesion and responds to national food needs.
- Ensure civic participation in the management of water resources.

Behaviors to minimize water costs. (recommendations for students)

Drinking water is a finite and limited resource since the portion available for consumption is less than 1%. According to the Food and Agriculture Organization of the United Nations (FAO), water scarcity will affect two thirds of the world's population in 2050 due to the excessive use of water resources for food production. In this way, it is essential for the survival of humanity to acquire water saving habits.

1. In the kitchen

- Use only the water you need, adapting your spending to your needs.
- Defrost food in the refrigerator, not under running water.
- Fix dripping faucets. A faucet dripping every 5 seconds consumes 30 litters of water in 24 hours, that is, more than 10 thousand litters in a year.
- Use washing machines and dishwashers only when they are full.
- Wash the vegetables and fruits in a basin and reuse the water to water the plants.
- If you drop an ice cube, put it in a potted plant

2. In the bathroom

- Close the faucet when you are not using the water.
- Keeping the tap running while brushing your teeth can lead to consumption of around 10 litters of water per day, as opposed to using a glass, which uses less than 1 litter.
- Choose the shower. A 15-minute shower, soaping you up with the tap turned off, uses around 60 litters, unlike an immersion bath, which can consume 200 litters of water.
- Take advantage of the shower water. While the water for the shower heats up, store it in a bucket to later water the plants or flush it down the toilet, avoiding flushing the cistern.
- Decrease the flushing flow. If your cistern does not have a double flush, place a full plastic bottle inside the tank in order to reduce the volume of the flush.
- Install a flow reducing compressor on the taps. This change can reduce water waste by about 50%.

3. Outdoors

- Sweep up the rubbish instead of dragging it with a jet of water and collect it.
- Water the garden in the morning or evening to minimize water loss through evaporation.
- Wash the car using a bucket of water. The use of the hose leads to consumption of 500 litters of water, as opposed to a bucket that consumes about 50 litters.
- Store and reuse rainwater.

Eco curiosities

1. What to do with used cooking oils?

In Portugal, the estimated production of used cooking oil (UCO) is around 43,000 to 65,000 tons per year, of which around 62% comes from the domestic sector, 37% from hotels and a residual fraction from industry. to feed. The collection in oil tanks and consequent recycling of these oils thus avoids their emission into the sewerage systems, and also promotes their recovery, enabling their reuse by the industry, for example in the production of paints, candles, soaps and biodiesel.

2. Did you know that a litter of cooking oil poured into the sink or toilet contaminates about a million liters of water?

This volume is equivalent to a person's water consumption for 14 years.

3. What are used tires for?

Tire recycling originates new products, such as fuel, paving for playgrounds, shoe soles, bicycle saddles and asphalt for roads. Thus, it contributes to the reuse of end-of-life materials, promoting the circular economy and environmental sustainability. In Portugal, around 80 thousand tons of end-of-life tires are sent for recycling per year.

4. Scientists Create Efficient, Cost-Effective Water Treatment System

There are millions of people without access to clean water in various regions of Africa. The population normally uses untreated and dangerous river water. To make water safe, authorities are testing a new pilot water treatment system developed in partnership with European scientists. The aim is to treat hazardous pollutants such as pesticide residues and to inactivate microbes and pathogens. It is a technology that creates ozone in polluted water, working as a cleaning agent.

5. MAELSTROM Project in Vila do Conde

Project MAELSTROM brought together a consortium of 14 international partners with the mission to investigate and implement innovative technologies for the identification, collection, recycling, and recovery of marine litter. As part of the 'removal' of marine litter, the EU-funded Horizon project launched a Bubble Barrier in the Ave River, with the Municipality of Vila do Conde on November 25th, in Vila do Conde, to collect the plastic from the river and convert it into new products, in a circular economy circuit.

6. How much water do you use daily?

- A five – 5 minutes shower: 60 litters
- An immersion bath: 180 litters
- Brush your teeth under running water: 10 to 30 litters
- Flush: 6 to 10 litters
- Use the dishwasher: 25 to 60 litters
- Use the washing machine: 60 to 90 litters

Learning objectives	By the end of this educational module/scenario you are expected to: • Acknowledge the importance of water • Understand the concept of water insecurity. • Identify water pollutants • Learn about the consequences of water pollution • Learn how to segregate paper, plastic, metal and organic waste. • Comprehend the impact of waste on the environment. • Human activities that consume more water • Determine your water footprint. • Adopt behaviors to minimize water costs. • Know eco curiosities
Activities and exercises	The scenario will take place along the river Po, the longest in Italy, which flows very near the town of Cremona or Ave river, in Vila do Conde, Portugal. The activity begins at the source of the river and ends at its mouth. You and your class are going on a field trip to the river for a hiking tour and outdoor and river activities. When you arrive at the source of the river and start walking along the water until you reach its mouth, you encounter a polluted river and dirty banks. The pollution is such that you are unable to carry out some of the outdoor activities you had planned. Upset by the situation, your class decides to take action. Along the way you will meet some people that will explain you the main environmental problems we face today that affect water. You will meet an engineer, an environmentalist, a fisherman and a farmer that challenge you to answer some questionnaires about water related problems. As you respond correctly, the river gets cleaner, and you can proceed with your hiking trip till the mouth of the river. In order to go to the beach, you have to play a matching game where you are asked to identify all the environmental problems addressed during the game.
Additional resources	1. How to take care of the environment https://www.youtube.com/watch?v=belXC_IoW4o 2. Why Recycling Is Important https://www.youtube.com/watch?v=eSeXWk3UTWQ 3. Fast Fashion and Its Environmental Impact https://earth.org/fast-fashions-detrimental-effect-on-the-environment/ 4. A just transition to agroecology https://www.fian.org/en/press-release/article/a-just-transition-to-agroecology-3176

	5. Hunger is increasing worldwide but women bear the brunt of food insecurity https://theconversation.com/hunger-is-increasing-worldwide-but-women-bear-the-brunt-of-food-insecurity-188906 6. Climate change explained by Njoroge Kimani, November 28, 2022 https://www.cespafrica.com/climate-change-explained/ 7. New model for urban food waste collection https://wastewise.be/2022/07/new-model-for-urban-food-waste-collection-breaking-down-barriers-with-kat-heinrich/ 8. Plastic Pollution Video https://www.youtube.com/watch?v=UXlxMfsW0nk

Educational material (for teachers)

Scenario	*Water treasure*
Title	*Education material for teachers of Water Treasure Scenario*
Partner	AEDAS
Country	*Portugal*
Target audience	*18-65 years old*
Keywords	Water; water pollutants; water footprint; water insecurity; environmental problems
Glossary	**Water:** Water is a transparent, odorless, tasteless, and nearly colorless chemicalsubstance that is essential for all known forms of life. It is a polar molecule, composed of two hydrogen atoms bonded to one oxygen atom, forming H2O. Water exists in various states, including liquid, solid (ice), and gas (water vapor), and plays a crucial role in many physical, chemical, and biological processes on Earth. **Water Pollutants:** Water pollutants are substances or agents introduced into waterbodies that cause harm or undesirable effects to the environment, aquatic ecosystems, and human health. These pollutants can be of various types, including chemical, physical, or biological contaminants. Examples include industrial chemicals, heavy metals, nutrients, pathogens, and sediment. Pollution can occur from point sources (e.g., industrial discharges) or non-point sources (e.g., runoff from agricultural fields). **Water Footprint:** The water footprint is a measure of the total amount of freshwater that is used directly or indirectly by an individual, organization, community, or country in the production of goods and services. It includes both thewater consumed (withdrawn and not returned to the source) and the water polluted during the production process. Water footprints are often expressed in terms of volume (cubic meters or litters) and provide insights into water-usepatterns and sustainability. **Water Insecurity:** Water insecurity refers to the lack of reliable access to sufficient,safe, and affordable water resources for human needs. It can result from factors such as water scarcity, inadequate infrastructure, pollution, and poor water management. Water insecurity has implications for public health, agriculture, and overall socio-economic development, and it can lead to conflicts over water resources, particularly in regions facing water stress. Environmental Problems: encompass a broad range of challenges affecting the natural world and ecosystems. These issues may arise from human activities, natural processes, or a combination of both. Common *environmental problems include deforestation, air pollution, climate change,*

	loss of biodiversity, soil degradation, and water pollution. Addressing these problems often requires interdisciplinary approaches, international cooperation, and sustainable practices to ensure the well-being of the planet and its inhabitants.
Content	**. The importance of water** Water is present in all aspects of our lives and the way we treat this resource directly impacts our health and ecosystems. Access to safe drinking water and sanitation has been considered, since 2010, one of the Human Rights defined by the United Nations (UN). This common good is also a limited resource that must be protected and used sustainably, both in terms of quantity and quality. This resource is subject to increasing pressures arising from its use by a wide variety of sectors, such as agriculture, industry, tourism, transport and energy, pressures that are aggravated by the effects of climate change. For all these reasons, an adequate management of water resources is fundamental for human society and for the integrity of the natural environment, without which, we can see the competition for water between the different sectors and the escalation of water crises of various types, with negative consequences for the various sectors that depend on water**.** **. The big challenges** Population growth, urbanization, pollution, and the effects of climate change are putting enormous pressure on the availability and quality of water in Europe. **C. The Planet's glaciers are melting.** **What are polar caps?** The planet contains large ice sheets that cover the north pole and south pole areas. These large glaciers are present both in the sea and in the mountains and when these masses cover large areas, we call them polar ice caps. This entire ice cover has been forming since the ice age and these areas are of great importance as they result in the formation of landscape, soil and relief. Furthermore, these glaciers are responsible for the largest volume of fresh water on the planet. Many species remain alive thanks to the melting of these areas in the warmer seasons**.** Calving is when chunks of ice break off at the terminus, or end, of a glacier. Ice breaks because the forward motion of a glacier makes the terminus unstable. We call these resulting chunks of ice “icebergs.” **What actions accelerate the melting of polar ice caps?** It turns out that with global warming, the average temperature of the ocean’s changes. The high concentration of greenhouse gases causes the sun's heat to be blocked and this heat hovers around the surface, raising the

planet's temperature. According to climate reports, global warming is directly associated with various human activities, and everything indicates that by 2100, the Earth's temperature could increase by between 1.8ºC and 4ºC.

Studies indicate that if there is no considerable reduction in carbon emission rates, sea levels will continue to rise, exposing the population of around 400 million people, in several countries, to major coastal floods in the coming decades.

The main elements produced in greenhouse gases, in addition to carbon dioxide, are: methane gas, sulfur hexafluoride, nitrous oxide, perfluorocarbons and chlorocarbons. Most of these gases are produced by human activities such as the use of vehicles, industrial processes, livestock farming and the burning of fossil fuels.

It took the polar ice caps around 30 years to respond to climate change and accelerate melting. However, once this process is triggered, it cannot be reversed, even if gas emissions are reduced. However, its reduction can minimize future damage to the planet.

How to reduce these impacts?

The first measure is adopting renewable energy sources, reducing the use of fossil fuels. Another initiative is to reduce waste production by encouraging recycling practices.

D. Water scarcity

It will tend to increase until 2050, either due to the increase in the world population or the increase in demand by the various sectors of emerging economies and due to the increase in the world population.

This situation, already difficult to manage, will tend to be aggravated by climate change, caused by changes in precipitation patterns, with a tendency towards the worsening of extreme phenomena such as floods and drought phenomena, therefore, balancing the demand for water resources and the needs of the populations will be fundamental to manage the tensions created by situations of scarcity.

On the other hand, we are faced with the problem of the quality of water bodies which, despite the progress achieved with the increase in wastewater treatment, continues to be precarious, with a large part of water bodies in Europe not being able to comply with the minimum objective of “Good” ecological status as recommended by the European Union Water Framework Directive.

E. Water pollutants

Many human activities can have adverse effects on the quality of rivers, lakes, seas, and groundwater. Water quality is influenced by direct

	discharges, for example from a factory or wastewater treatment plant (so-called "point source pollution"), but also by pollution from disseminated sources such as nutrients and pesticides from agricultural activities and pollutants released into the air by industry which then return to land and sea (so-called 'diffuse pollution'). The main point source of water pollution is wastewater treatment whereas, in the case of diffuse pollution, the main sources are agriculture and power plants fueled by fossil fuels (through the air) It should be noted that, although wastewater treatment plants are identified as a «point source», they are not exactly a source, since they only treat what we pour into the toilet and sink. **F. Human activities that consume more water** According to the Food and Agriculture Organization of the United Nations (FAO), in terms of world average, the activity that consumes the most water is agriculture, responsible for 70% of all water used. In second place is the industry, responsible for 22% of consumption. Finally, there is domestic and commercial use of water, which totals only 8%. This means that, to save water, it is also necessary to involve economic activities in the countryside and also in the factories. **G.** Consequences of water pollution Deteriorating water quality has a negative impact on the environment, health, and the global economy. 1. **Destruction of biodiversity** - water pollution impoverishes aquatic ecosystems and facilitates the uncontrolled proliferation of phytoplankton algae in lakes — eutrophication. 2. **Pollution of the food chain** - fishing in contaminated waters, as well as the use of wastewater in livestock and agriculture, can transmit toxins to food that harm our health when ingested. 3. **Scarcity of drinking water** - the UN admits that there are still billions of people in the world without access to clean water and sanitation, especially in rural areas. 4. **Illnesses** - the WHO estimates that around 2 billion people drink water contaminated by excrement, exposing themselves to diseases such as cholera, hepatitis A and dysentery. 5. **Child mortality** - according to the UN, diarrheal diseases linked to poor hygiene cause the death of about a thousand children a day worldwide **H. Water footprint**

The water footprint measures the amount of water used to produce each of the goods and services we use. It can be measured for a single process, such as growing rice, for a product, such as a pair of jeans, for the fuel we put in our car, or for an entire multi-national company. The water footprint can also tell us how much water is being consumed by a particular country – or globally – in a specific river basin or from an aquifer.

Questions to be used in class before playing the game:

1. **Do you know how much water was used to grow your food and to produce your clothes and the things you buy?**

It is a surprising amount. You may not see this 'invisible' water, but it accounts for most of the water you use, far more than you use from the tap. Our use of water is not limited to kitchens, bathrooms, and gardens.

Daily, we contribute to the consumption of large quantities of water when buying various products, from the food we eat, paper and cotton to biofuel. This way, we indirectly affect water resources throughout the world.

By measuring water footprints, we can get a clear picture of how water is used in today's consumer society, in the same way that carbon footprints measure contributions to climate change.

Your water footprint is the amount of water you consume in your daily life, including the water used to grow the food you eat, to produce the energy you use and for all the products in your daily life – your books, music, house, car, furniture, and the clothes you wear.

2. **What do we need to do?**

Understanding our water consumption can help us provide a solution to one of our most pressing problems: making sure there is enough water to sustain all living things on our planet.

The current and future challenges facing water resources require robust, clear, and result-oriented public policies. Water governance will make a strong contribution to the design and implementation of these policies, involving a shared responsibility among different actors in society and an active and conscious intervention by citizens is fundamental for the success of public water policies.

I. Water management measures

For a good management of the resource, it is necessary to:

• Define clear limits for abstractions and reflect the scarcity, degradation potential and economic value of water in its price - including the cost of public investments to be reflected in improvement fees.

	• Improve the monitoring and knowledge network. • Ensure a parsimonious and efficient use of water. • Guarantee the correct planning, use and occupation of the land in REN's areas for the sustainability of the water cycle. • Promote efficient irrigation compatible with the preservation of biodiversity, which promotes territorial cohesion and responds to national food needs. • Ensure civic participation in the management of water resources. **J. Behaviors to minimize water costs (recommendations for students)** Drinking water is a finite and limited resource since the portion available for consumption is less than 1%. According to the Food and Agriculture Organization of the United Nations (FAO), water scarcity will affect two thirds of the world's population in 2050 due to the excessive use of water resources for food production. In this way, it is essential for the survival of humanity to acquire water saving habits. **1. In the kitchen** • Use only the water you need, adapting your spending to your needs. • Defrost food in the refrigerator, not under running water. • Fix dripping faucets. A faucet dripping every 5 seconds consumes 30 litters of water in 24 hours, that is, more than 10 thousand litters in a year. • Use washing machines and dishwashers only when they are full. • Wash the vegetables and fruits in a basin and reuse the water to water the plants. • If you drop an ice cube, put it in a potted plant. **2. In the bathroom** • Close the faucet when you are not using the water. • Keeping the tap running while brushing your teeth can lead to consumption of around 10 litters of water per day, as opposed to using a glass, which uses less than 1 litter. • Chose for the shower. A 15-minute shower, soaping you up with the tap turned off, uses around 60 litters, unlike an immersion bath, which can consume 200 litters of water. • Take advantage of the shower water. While the water for the shower heats up, store it in a bucket to later water the plants or flush it down the toilet, avoiding flushing the cistern.

	• Decrease the flushing flow. If your cistern does not have a double flush, place a full plastic bottle inside the tank to reduce the volume of the flush. • Install a flow reducing compressor on the taps. This change can reduce water waste by about 50%. **3. Outdoors** • Sweep up the rubbish instead of dragging it with a jet of water and collect it. • Water the garden in the morning or evening to minimize water loss through evaporation. • Wash the car using a bucket of water. The use of the hose leads to consumption of 500 litters of water, as opposed to a bucket that consumes about 50 litters. • Store and reuse rainwater. **K. Eco curiosities** **Questions to be used in class before/after playing the game:** **1. What to do with used cooking oils?** In Portugal, the estimated production of used cooking oil (UCO) is around 43,000 to 65,000 tons per year, of which around 62% comes from the domestic sector, 37% from hotels and a residual fraction from industry to feed. The collection in oil tanks and consequent recycling of these oils thus avoids their emission into the sewerage systems, and also promotes their recovery, enabling their reuse by the industry, for example in the production of paints, candles, soaps and biodiesel. **2. Did you know that a litter of cooking oil poured into the sink or toilet contaminates about a million litters of water?** This volume is equivalent to a person's water consumption for 14 years. **3. Scientists Create Efficient, Cost-Effective Water Treatment System** There are millions of people without access to clean water in various regions of Africa. The population normally uses untreated and dangerous river water. To make water safe, authorities are testing a new pilot water treatment system developed in partnership with European scientists. The aim is to treat hazardous pollutants such as pesticide residues and to inactivate microbes and pathogens. It is a technology that creates ozone in polluted water, working as a cleaning agent. **4. MAELSTROM Project in Vila do Conde**

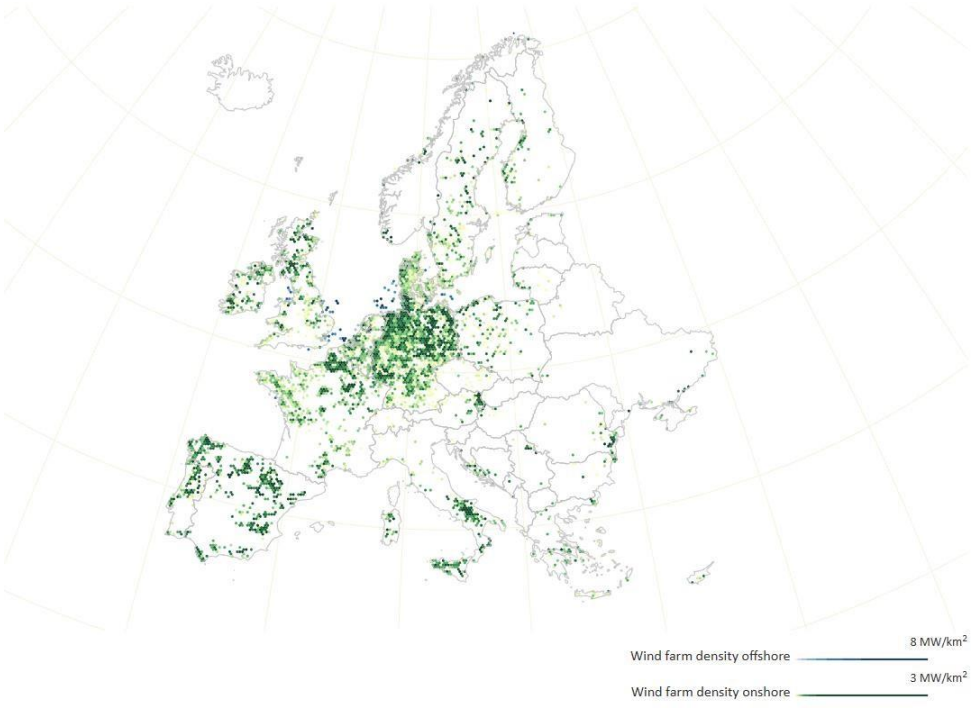
	MAELSTROM launched a Bubble Barrier to catch plastic in the Ave River, in Portugal, near AEDAS school. Project MAELSTROM brought together a consortium of 14 international partners with the mission to investigate and implement innovative technologies for the identification, collection, recycling, and recovery of marine litter. As part of the 'removal' of marine litter, the EU-funded Horizon project launched a Bubble Barrier in the Ave River, with the Municipality of Vila do Conde on November 25th, in Vila do Conde, to collect the plastic from the river and convert it into new products, in a circular economy circuit. **5. How much water do you use daily?** • A five – 5 minutes shower: 60 litres. • An immersion bath: 180 litres. • Brush your teeth under running water: 10 to 30 litres. • Flush: 6 to 10 litres. • Use the dishwasher: 25 to 60 litres. • Use the washing machine: 60 to 90 litres.
Learning objectives	By the end of this educational module/scenario students are expected to: • Acknowledge the importance of water • Understand the concept of water insecurity • Identify water pollutants • Learn about the consequences of water pollution • Understand the impact of waste on the environment • Identify human activities that consume more water • Determine their water footprint. • Adopt behaviors to minimize water costs. • Know eco curiosities
Activities and exercises	The scenario will take place along the river Po, the longest in Italy, which flows very near the town of Cremona (or Ave river, in Vila do Conde, Portugal). The activity begins at the source of the river and ends at its mouth. The class is going on a field trip to the river. Students plan to do various outdoor and river activities. When they arrive at the source of the river and start walking along the water until they reach its mouth, they are faced with a polluted river and dirty banks. The pollution is such that the students are unable to carry out some of the outdoor activities they had planned. They are upset by the situation and decide to take action. As they move along the river, they encounter an engineer, an

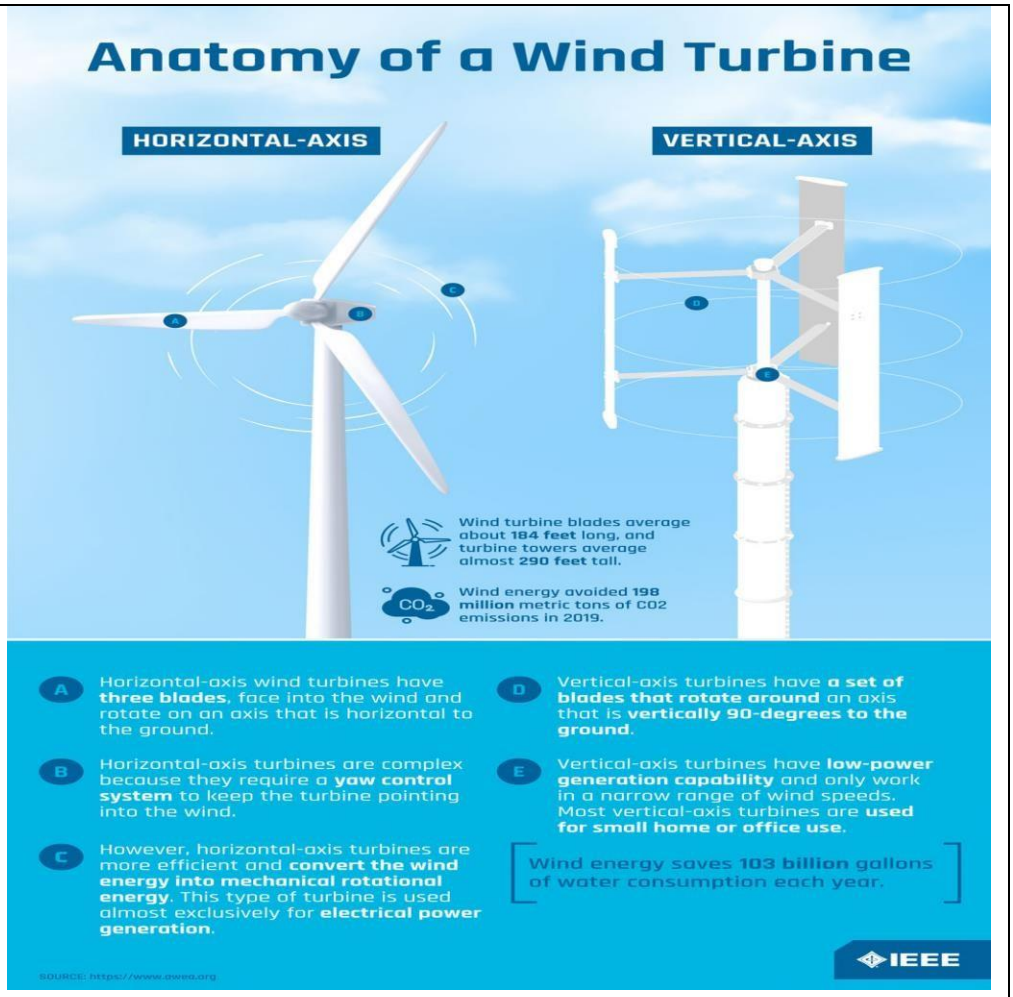
	environmentalist, a fisherman and a farmer that pose them some questionnaires about water related problems. As they respond correctly, the river gets cleaner, and they proceed with their hiking trip till the mouth of the river. In order to go to the beach, they have to play a matching game where they have to identify all the environmental problems addressed during the game.
Additional resources	Fast Fashion and Its Environmental Impact https://earth.org/fast-fashions-detrimental-effect-on-the-environment/ A just transition to agroecology https://www.fian.org/en/press-release/article/a-just-transition-to-agroecology-3176 Hunger is increasing worldwide but women bear the brunt of food insecurity https://theconversation.com/hunger-is-increasing-worldwide-but-women-bear-the-brunt-of-food-insecurity-188906 Climate change explained by Njoroge Kimani, November 28, 2022 https://www.cespafrica.com/climate-change-explained/ New model for urban food waste collection https://wastewise.be/2022/07/new-model-for-urban-food-waste-collection-breaking-down-barriers-with-kat-heinrich/
References/ Sources	EU Water Framework Directive https://environment.ec.europa.eu/topics/water/water-framework-directive_en Water scarcity https://www.fao.org/land-water/water/water-scarcity/en/ The big challenges https://zero.ong/quem-somos/areas-tematicas/agua-e-oceanos/ Water pollutants https://www.eea.europa.eu/pt/help/perguntas-frequentes/quais-sao-as-principais-fontes Water footprint https://www.waterfootprint.org/ UN World Water Development Report. https://www.unwater.org/publications/un-world-water-development-report- 2023 Imminent risk of a global water crisis, warns the UN World Water Development Report 2023 https://www.unesco.org/en/articles/imminent-risk-global-water-crisis-warns-un-world-water-development-report-2023

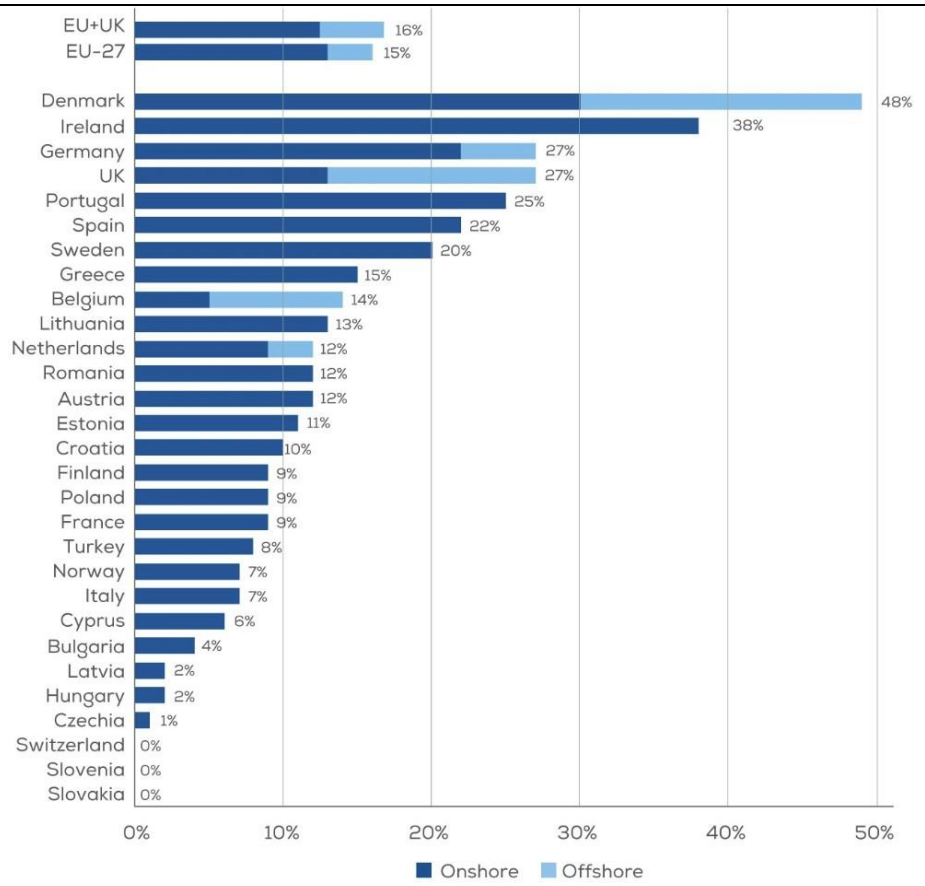
Appendix 10 – Educational information for scenario Wind Turbine Challenge

The goal of this educational material is to teach students about ***environmental-related issues, offering insights on topics ranging from understanding the environment to identifying key challenges and exploring sustainable practices for a healthier planet.***

Educational material (activities for students)

Scenario	Wind Turbine Challenge
Title	*Education material for students of Water Treasure Scenario*
Partner	University of Patras
Country	☒**Greece** ☐Italy ☐Portugal
Target audience	10-15
Introduction	Brief overview of the educational material of students
Content	In this scenario, we're integrating two visuals directly related to wind energy for inclusion in the virtual world. First, you'll encounter an image showcasing wind farm locations throughout Europe. Following that, you'll find a detailed depiction differentiating between horizontal-axis and vertical-axis wind turbines. As you review, kindly note the placement and details of these visuals within the virtual context. Additionally, to provide a comprehensive perspective on the impact of wind energy, I've incorporated a graphic that illustrates the percentage of the average annual electricity demand met by wind power in Europe. 


Anatomy of a Wind Turbine
HORIZONTAL-AXIS
VERTICAL-AXIS
Wind turbine blades average about 184 feet long, and turbine towers average almost 290 feet tall.
Wind energy avoided 198 million metric tons of CO2 emissions in 2019.
A
Horizontal-axis wind turbines have three blades, face into the wind and rotate on an axis that is horizontal to the ground.
B
Horizontal-axis turbines are complex because they require a yaw control system to keep the turbine pointing into the wind.
C
However, horizontal-axis turbines are more efficient and convert the wind energy into mechanical rotational energy. This type of turbine is used almost exclusively for electrical power generation.
D
Vertical-axis turbines have a set of blades that rotate around an axis that is vertically 90-degrees to the ground.
E
Vertical-axis turbines have low-power generation capability and only work in a narrow range of wind speeds. Most vertical-axis turbines are used for small home or office use.
Wind energy saves 103 billion gallons of water consumption each year.
IEEE

	 Figure 3: Percentage of the average annual electricity demand covered by wind energy
Learning objectives	In the first snip, students are presented with a visual guide pinpointing the locations of wind farms across Europe, offering them insight into the continent's commitment to renewable energy. The second snip delves into the intricacies of wind turbine technology, breaking down the distinctions between horizontal-axis and vertical-axis turbines. To round out the educational experience, the third snip serves to contextualize the significance of wind energy. Through a compelling graphic, learners can grasp the scale at which wind energy contributes to Europe's annual electricity consumption, underscoring the vital role of this renewable energy source in the continent's energy matrix.
Activities and exercises	The scenario has to do with wind farms in general, so we give information about different aspects of wind farms.
Additional resources	Anatomy of wind turbine: Anatomy of an Eco-Friendly Wind Turbine - IEEE Transmitter Map of Wind Farm Locations around Europe: Interactive data & maps | WindEurope Percentage of the average annual electricity demand covered by wind energy: Windeurope-Wind-energy-in-Europe-2021-statistics.pdf Screenshots from the 3D Virtual World Learning Environment


Admin VL


Quiz
Turbine Technician
Admin VL


Anatomy of a Wind Turbine
HORIZONTAL AXIS
VERTICAL AXIS
Admin VL

Educational material (for teachers)

Scenario	Wind Farm Challenge
Title	*Education material for teachers of Water Treasure Scenario*
Partner	University of Patras
Country	☒**Greece** ☐Italy ☐Portugal
Target audience	18-65
Keywords	Wind Turbines, Minigame, Experts Feedback, Quiz, wind farm, environmental feedback, wildlife
Glossary	Wind Energy: Energy: The process of creating electricity using the wind, or air flows that occur naturally in the earth's atmosphere. Wind turbine blades capture kinetic energy from the wind and turn it into mechanical energy, which is then converted into electricity. Wind Turbine: A device that converts the wind's kinetic energy into electrical energy. They can be onshore (on land) or offshore (at sea). Wind Farm: An area of land or water where multiple wind turbines are set up to produce electricity. Kinetic Energy: Energy that a body possesses by virtue of being in motion. Environmental Impact: The effect of human activities on the environment, which can be positive or negative. In the context of the scenario, it refers to the potential effects wind farm might have on local ecosystems, wildlife, and landscapes. Renewable Energy: Energy from a source that is not depleted when used. It is naturally replenishing but flow-limited; examples include wind, solar, and geothermal energy.
Content	**Introduction to Wind Energy:** Wind energy is one of the most promising renewable energy sources that has the potential to alleviate some of the major environmental problems we face today. Wind is essentially air in motion, which is caused by the uneven heating of the Earth's surface by the sun. This energy source is inexhaustible and harnessing it causes no pollution or greenhouse gas emissions.

	Components of Wind Turbines: At the core of wind energy production are wind turbines. A typical wind turbine consists of a foundation, a tower, a nacelle, and rotor blades. The rotor captures the wind's energy, and through a series of mechanical processes inside the nacelle, this kinetic energy is converted into electricity. • Foundation: It supports the turbine and prevents it from tipping over. • Tower: Made of tubular steel, concrete, or steel lattice, it supports thenacelle and rotor • Nacelle: Positioned on top of the tower, it contains the key components of the wind turbine. • Rotor Blades: usually made of lightweight composite materials, they capture the wind's energy. **The Wind Farm Challenge:** Students will be introduced to the complexities of setting up a wind farm. While the primary goal is to generate electricity, several factors come into play, such as: • Site selection: It's crucial to sites with consistent and strong winds. This usually involves detailed wind resource assessments. • Environmental Considerations: The potential impact on local ecosystems, especially birds and bats or the negative impact on the surface, is a key concern. Measures should be placed to mitigate these impacts. • Economic Considerations: Setting up wind turbines requires significant capital investment. However, once operational, the costs are minimal and the returns, in terms of clean electricity, are significant. **Challenges and Solutions:** While wind energy has immense benefits, it's not without its challenges. Intermittency (wind doesn't blow all the time) is a major concern. Solutions include battery storage, grid interconnections, and complementary renewable sources.
Learning objectives	By the end of this educational module, students will: • Acquire knowledge about the environment and the role of wind energy in promoting sustainability. • Understand the fundamental principles of wind energy, including how wind turbine's function and the logistics of setting up a wind farm. • Develop strategies to enhance their knowledge about environmental issues related to wind energy, such as the challenges of intermittency and the potential impact on local ecosystems. • Be equipped with strategies to cope with environmental challenges, particularly in the context of renewable energy integration and overcoming barriers to its adoption....

Activities and exercises	*Relating the scenario and other that may complement the learning (optional)*
Additional resources	• ***Videos:*** *1) How do Wind Turbines work? (5' video that could be used before children play the scenario)* *2) What is the Future of Wind Energy Technology? (3' video that could be used after playing the scenario to stimulate discussions)* • *Case Studies:* *1) "The Success of Denmark's Wind Energy Initiative" – A deep dive into how Denmark became a global leader in wind energy production. (Article in English for the ones that would like to read further)* *2) "Exploring Wind Energy's Impact/s on Wildlife"- Exploring the impact of wind farms on avian populations and the strategies implemented to mitigate them. (Article in English suitable for the teachers who like to discuss further about the impact on wildlife)*
References/ Sources	*1) Barthelmie, R. J., & Pryor, S. C. (2021). Climate change mitigation potential of wind energy. Climate, 9(9), 136.* *2) Drewitt, A. L., & Langston, R. H. (2006). Assessing the impacts of wind farms on birds. Ibis, 148, 29-42* *3) Østergaard, P.A., Duic, N., Noorollahi, Y., & Kalogirou, S. (2022). Renewable energy for sustainable development. Renewable Energy, 199, 1145-1152*