WASTE MANAGEMENT

WORKING IN WASTE MANAGEMENT SECTOR

GDAŃSK, 2020

BALTIC SOUTH BRIDGE

FOR GREEN TECH FUTURE!

Materials developed within the framework of the "SB Bridge – building bridges for green-tech future" Project.

Author

Ewa Maria Siedlecka

Higher education Faculty of Chemistry University of Gdansk, full professor. Works in University of Gdansk as research and teaching employee. Academic teacher in Faculty of Chemistry with abroad work experience. Creator of multiply courses related to the wastewater and water treatment, environmental protection, green technology and renewable energy dedicated for BSc and MSc students of chemistry, environmental protection, business and environmental technology, chemical business and criminology . Author and co-author of numerous chapters in books two scripts for students and more than 70 original publications focused on the pharmaceuticals and other micropollutants elimination for water by advanced treatment processes. Member of the Stakeholder Council at the Waste Disposal Plant in Gdańsk-Szadółki (2016-2019). Co-implementer and organizer of numerous educational workshops within the framework of the Baltic Science Festival (2007-2017).

President of Polish Ecological Club Pomeranian Branch (PKE OP) for two terms 2008-2011 and 2012-2015. Co-author of many international educational projects with members of PKE OP, e.g. "Green Academy", „Microplastics in Baltic Sea ", „Plastic Free Baltic", "Plastic free oceans" promoting knowledge of the plastic flood and other threats to species diversity in the Seas and Oceans and many educational activities addressed to the young people and local community.

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Introduction

> Currently, the problem of waste generated from both municipal and industrial sources is becoming the most urgent environmental issues.

In the EU-28 countries total waste generation increased by 3.0 % (almost 74.7 million tonnes) in the 2010–2016 period. The average amount of municipal waste generated per person in 2018 amounted to 515 kg, higher than the level in 2017 (487 kg/person). In 4 out of 25 countries more than 600 kg/person of municipal waste was produced: Denmark (766 kg/person), Cyprus (637 kg/person), Germany (615 kg/person),and Luxembourg (610 kg/person). The average amount of household waste in Lithuania and Sweden, was respectively of 464 and 434 kg per person. In contrast, there were two countries which generated less than 350 kg of municipal waste per person: Romania (272 kg/person) and Poland (329 kg/person). **[1]**

Introduction

The treatment of municipal waste in the EU is undertaken using different methods. Overall in 2007, 24% of waste was recycled, 13% composted, 21% incinerated and 43% landfilled. In 2017, the picture was different, 30% of the waste was recycled, 17% composted, 28% incinerated and 24% landfilled. In 2018, 47% of municipal waste was also recycled and composed. The data shows there is a very distinct trend towards less landfilling as countries are obligated to move steadily towards improvement of treating waste. [2]

The EU law has introduced the principles for waste management and priorities for implementing waste management. According to them waste generation should be prevented or limited in volume (waste reduction), and generated waste should be recovered (materials or energy) and reused (circular economy) or disposed. Disposal of municipal wastes in landfills and combustion are the least favorable waste management.

The agreed strategy aims to comprehensively prevent household waste generation and boost recycling.

All EU countries are required to:

- recycle 55% of household waste by 2025, 60% by 2030 and 65% by 2035
- recycle 70% of all packaging – including plastic, paper, aluminum and other materials
- implement a 10% cap on landfill by 2035
- implement stricter and more consistent methods to calculate progress made towards recycling [3]

A symptom of unreasonable landfilling may be ineffective use of waste as the resources of raw materials. The concept based on the principle: "take, make, consume, discard" (linear economy) entails significant resource losses.
Circular economy is an approach that involves using products that can be reused completely, a so-called cradle-to-cradle approach. This approach is essential in reducing the need to use virgin materials (nonrenewable resources). Even if progress is being made in Europe, the significant amounts of valuable resources namely electrical and electronic equipment waste (e-waste), end-of-life batteries, plastic waste and textile waste are still lost through inefficient waste management practices. In many cases those materials/resources are hazardous wastes.
The concept of integrated waste management is based on the combination of waste reduction and waste management. It focuses on separation of municipal waste into specific remainder fractions (organics, aluminium, paper, plastic, glass etc.), allowing optimal recycling and/or energy recovery of each specific waste stream. The organic fraction of the waste is usually treated by an aerobic (in presence of oxygen) or anaerobic (without oxygen) process through composting and digestion to biogas. The non-organic fraction that cannot be recycled or used for generation of energy is considered for heat and/or electricity generation through thermal production processes (waste-to-energy). This residual waste is called refuse-derived fuel (RDF). Other fractions such as steel, aluminium and ash residues are recycled from the municipal solid waste or re-used as sand or granulate for a multitude of construction purposes, as (non)-ferrous metals, as industrial salt, gypsum and many more. The integrated waste management ensures that each fraction of the waste can be re-used, if only it is technological possible. **[4]**

Case study

The ideas to reuse or recycle solid waste:

GERMANY

Innovative plasma based transformation of food waste into high value graphitic carbon and renewable hydrogen, Examples of EU funded projects,

RETRIEVED 19.06.2020

Recovering waste heat in industry, Examples of EU funded projects,

RETRIEVED 19.06.2020

LITHUANIA

Why buy when you can 'servicize'? Examples of EU funded projects,

RETRIEVED 19.06.2020

POLAND

New biogas plant helps to power meat company's premises, Examples of EU funded projects,

RETRIEVED 19.06.2020

DENMARK

From Roof to Road - Innovative recycling of bitumen felt roofing material, Examples of EU funded projects,

RETRIEVED 19.06.2020

SWEDEN

Innovative Centrifugal Separator Technology for Energy Recovery and Oily Waste Volume Reduction, Examples of EU funded projects,

RETRIEVED 19.06.2020

References:

[1] Municipal waste statistics, Eurostat, 2018,

RETRIEVED 19.06.2020

[2] National Waste Report 2018, November 2018, Department of the Environment and Energy,

RETRIEVED 19.06.2020

[3] Resource Efficiency, Waste Prevention,

RETRIEVED 19.06.2020

[4] Integrated waste management, Dec 2007,

RETRIEVED 19.06.2020

EXERCISE (1)

MY PERFECT DEPOSIT RETURN SYSTEM?

Background for the teacher:

In Germany and Sweden consumers use automated handling of beverage containers in shops and supermarkets. They take the empty beverage containers to the supermarket and enter the containers one by one into a Reverse Vending Machine (RVM) without a compactor. The machine prints a refund slip, and then the cashier pays the claimed refund to the customer as indicated on the refund slip. The containers are dropped into a bag by the RVM and are further sent to e.g. recycling company.

Sweden recycled 84.9 % of aluminum cans and PET bottles via the pant system in 2016. That is total of 1.8 billion cans and bottles, or - on average - 177 per person in just one year.

In Lithuania they had a 34% return rate before the deposit system was introduced, while after introduction the deposit system had already increased to 92 %.

EXERCISE (1)

Time: 30 min

	TASK EXPERIENCE	IMPLEMENTATION
1	EXERCISE TITLE:	MY PERFECT DEPOSIT RETURN SYSTEM?
2	TARGET OF THE EXERCISE:	Students know the deposit return system and its main actors. They think about pros and cons of the system and its improvement.
3	DETAILED DESCRIPTION OF THE EXERCISE:	Teacher divides the class into groups of 5. Each group plays a different role: customers, a bottle manufacturing company, a beverage company, a recycling plant, a supermarket. In groups they discuss the perfect deposit return system for one-used and refilled PET-bottles. How do you encourage consumers to return bottles used? How do you collect the highest amount of bottles to refill (good quality bottles), and smallest number bottles to disposal (damage, dirty bottles). Students think about new, unconventional solutions. The customers group: they pay for the bottle, and they want money back. What will encourage for this group to return bottles to the store in good quality (cashback, reward, donating money to a noble cause, charity, other ideas). The supermarket group: How can supermarkets encourage the customers to give good quality bottles back to the store.

	The supermarket group: How can supermarkets encourage the customers to give good quality bottles back to the store. The beverage company: they need good quality bottles to refill. How can they influence stores to provide them only with good quality bottles. The recycling plant: They need a good quality plastic waste for recycling. What should be the price of plastic waste to encourage to cooperation. The bottle manufacturing company: they need recycled materials to produce new bottles, What should be the price of recycled materials to encourage cooperation. How do you implement the bottle collection system? Sweden and Germany: What is your opinion: Is deposit return system used in your country good enough? Students have 5 minutes to discuss in groups. Next, regroup students so that one person from each of the original groups is in each new group and that all actors of the deposit return system are represented in each group. Students have 5 minutes to discuss the topic in new groups. Next based on the previous discussion, the class is drawing (on a sheet of A4 paper) the circulation of used bottles from the consumer to consumer by stores, beverage company, etc. and appropriate actions (students ideas) aimed at 100% return of bottles (15 min).	
4	MATERIALS NEEDED:	SHEET OF PAPER, COLOR MARKERS
5	EFFECTS:	Experience allows to understand the deposit return system working, the motivation of customers to participate in this system, and relationship among various actors. The students identify the pros and cons of the deposit return system, and propose its improvement.

EXERCISE (1)

KNOWLEDGEBASE

Source of knowledge + links

SUBJECT / LINK	SOURCE
THE STORY BEHIND SWEDEN'S BOTTLE RECYCLING SCHEME	Sweden: That's pant! The story behind Sweden's bottle recycling scheme, The local RETRIEVED 19.06.2020
LITHUANIA'S DEPOSIT SYSTEM	Lithuania Lithuania's Deposit System, Public institution Užstato Sistemos Administratorius, Feb 2016 RETRIEVED 19.06.2020
DEPOSIT SYSTEM LAW – GERMANY	Germany: Deposit system law – Germany RETRIEVED 19.06.2020
POLAND'S FIRST PLASTIC BOTTLES REVERSE VENDING MACHINE SET UP IN KRAKÓW	Poland, Poland's first plastic bottles reverse vending machine set up in Kraków, Apr 17, 2019 RETRIEVED 19.06.2020

EXERCISE (1)

DEPOSIT SYSTEM LAW – DENMARK	Deposit system law – Denmark RETRIEVED 19.06.2020

EXERCISE (2)

HOW CAN WE MAKE A PACKAGING MORE FRIENDLY?

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Background for the teacher:

Larger packages use more materials and take more space which makes transport inefficient. Naturally, the more vehicles you use, the higher the fuel usage and emission. The new materials for packaging can allow to extend land travel (e.g. by cars.), and reduce both shipping dimensions and transport costs. The change of air shipping to land transport helps reduce carbon footprint. The reduction in damages of products during transport helps save fuel and emissions otherwise needed to handle returns.

Here are some tips for good practice in packaging:

i. use recycled materials when appropriate;
ii. reduce the amount of packaging materials to save weight;
iii. match material type to product-shipment requirements;
iv. consider reusable packaging.

EXERCISE (2)

Time: 20 min

	TASK EXPERIENCE	IMPLEMENTATION
1	EXERCISE TITLE:	HOW CAN WE MAKE A PACKAGING MORE ENVIRONMENTALLY FRIENDLY?
2	TARGET OF THE EXERCISE:	Students learn about good practice in packaging.
3	DETAILED DESCRIPTION OF THE EXERCISE:	Teacher gives away the various packed products. The students discuss if the packaging of this product is suitable. They suggest different packaging for a given product (different shape, material, size etc.). The students design their own packaging based on the good practice of packaging. The teacher discusses which of the designed packaging is the most ecological and economical solution and why. Students discus how many products in the package and without it can be placed in one carton (take a one to show the students). Does product packaging effect on transport vehicles fuel consumption?

4	MATERIALS NEEDED:	CREAM JUG, PERFUME FLACON, TOOTHPASTE TUBE, MILK IN CARTON, WATER IN BOTTLE ETC.
5	EFFECTS:	Students learn about the good practices in packaging. Students understand that optimization of packaging helps to reduce costs of transportation, fuels combustion and greenhouse gas emissions.

EXERCISE (2)

KNOWLEDGEBASE

Source of knowledge + links

SUBJECT / LINK	SOURCE
General information about the subject	
ECO PACKAGING: ALL ALUMINIUM ADVANTAGES	Eco Packaging: All Aluminium Advantages, June 6, 2019 RETRIEVED 19.06.2020
6 BEST PRACTICES FOR ECO-FRIENDLY PACKAGING	6 Best Practices for Eco-Friendly Packaging, Operations & Fulfillment, July 24, 2019 RETRIEVED 19.06.2020
COMMITTING TO ECO-FRIENDLY PACKAGING PRACTICES CAN SAVE YOUR COMPANY MONEY	Committing to Eco-Friendly Packaging Practices Can Save Your Company Money, Apr 16, 2020 RETRIEVED 19.06.2020

EXERCISE (3)

TURNING TRASH INTO PRODUCTS

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Background for the teacher:

Many companies are making products from recycled materials as a way to bring their environmentally friendly practices to the forefront. *Pentatonic* a European furniture company, makes all its furniture from post-consumer trash. The company can recycle its own products into new products at the end of useful life. Soap company Method launched a dish and hand soap packaged in bottles made of recycled plastic from the ocean. The shoe company Allbirds, which makes shoes from sheep wool, makes laces from recycled bottles. Its packaging is 90 % recycled cardboard.

EXERCISE (3)

Time: 20 min

	TASK EXPERIENCE	IMPLEMENTATION
1	EXERCISE TITLE:	TURNING TRASH INTO PRODUCTS
2	TARGET OF THE EXERCISE:	The students learn that trash is a source of valuable raw materials.
3	DETAILED DESCRIPTION OF THE EXERCISE:	Teacher shows students a short film *"These five companies are turning trash into treasure"* or introduces the case studies that show turning trash into products. Next, a pair of students pull out one item from a bag. Their task is to make an advertisement of this item (used plastic bottle, biomass, unwanted chair, computer etc.) The advertisement is supposed to present the used item as a treasure - useful raw material. There should be shown its useful properties (it is transparent, soft, hard, brittle, etc.) and possible applications. They explain why recycling is important? The students base on their knowledge or look for information on the internet. They have 30s to present their advertisement.

4	MATERIALS NEEDED:	DIFFERENT TRASH, ACCESS TO THE INTERNET
5	EFFECTS:	Students understand that rubbish is a source of valuable raw materials. They understand the need to recycle the recyclable items.

EXERCISE (3)

KNOWLEDGEBASE

Source of knowledge + links

SUBJECT / LINK	SOURCE
General information about the subject	
5 UNBELIEVABLE USEFUL PRODUCTS MADE OUT OF TRASH	5 Unbelievable Useful Products Made Out of Trash, Feb 20, 2017 RETRIEVED 19.06.2020
PLASTIC WASTE AND RECYCLING IN THE EU: FACTS AND FIGURES	Plastic waste and recycling in the EU: facts and figures, News European Parialemnt, Dec 19, 2018 RETRIEVED 19.06.2020
AMAZING PRODUCTS MADE OF TRASH: THE RESOURCE OF THE FUTURE	Amazing products made of trash: the resource of the future, Business of Design, Apr 11, 2018 RETRIEVED 19.06.2020

EXERCISE (4)

HAZARDOUS HOUSEHOLD WASTE

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Background for the teacher:

Hazardous waste are flammable (substances that can easily catch fire), corrosive (substances that can damage or destroy metals), reactive (substances that are readily react with other compounds, explosively, or by producing noxious fumes) and toxic (harmful or fatal when inhaled, ingested, or touched) materials. Hazardous organic waste can act as carcinogens or endocrine disruptors. Electronic waste (computers, mobile phones, printers etc.) is also considered as a hazardous. They include toxic metals such as chromium, mercury, lead, cadmium, tin. Industry produces the most hazardous waste, but it is usually highly regulated. The largest amount of unregulated hazardous waste is produced by households. There are paints, batteries, solvents, cleaning agents, pesticides, fluorescent light bulbs and compact fluorescent lamps, automotive products etc.

To avoid the potential risks associated with household hazardous wastes, it is important that people always monitor the usage, storage, and disposal of products with potentially hazardous substances in their homes. Improper disposal of these wastes can pollute the environment and pose a threat to human health. It is illegal to dispose of hazardous waste in the garbage.

EXERCISE (4)

Time: 20 min

	TASK EXPERIENCE	IMPLEMENTATION
1	EXERCISE TITLE:	HAZARDOUS HOUSEHOLD WASTE
2	TARGET OF THE EXERCISE:	The exercise informs about the safe use of households chemicals and the dangers of its wrong storing and disposing.
3	DETAILED DESCRIPTION OF THE EXERCISE:	WORK IN GROUPS. Students make an infographic about using, storing and disposing of household chemicals safely. Each group gets one hazardous household waste product: unused pharmaceuticals, solvents, weed killers, swimming pool or spa bath chemicals, batteries, mobile phones, light bulbs etc. As a pre-homework students collect data on the internet to answer the questions: *What amount of hazardous household waste is collected each year in your country?* *Why these products / substances are hazardous?* *How should chemicals be stored in household?* *How should hazardous household waste be disposed of?*

		The students discuss in groups and visualize the data and layout the elements of your infographic design (working time 15 minutes) The leader of the group presents infographic in 60s.
4	MATERIALS NEEDED:	SHEET OF PAPER, COLOR MARKERS
5	EFFECTS:	Students identify what makes wastes dangerous. They know how to use, store and dispose hazardous household chemicals, products.

EXERCISE (3)

KNOWLEDGEBASE

Source of knowledge + links

SUBJECT / LINK	SOURCE
General information about the subject	
BUYING, USING, STORING AND DISPOSING OF HOUSEHOLD CHEMICALS	Buying, using, storing and disposing of household chemicals, Department of health, Government of Eastern Australia RETRIEVED 19.06.2020
HAZARDOUS WASTE	Hazardous waste, Better Health Chanel RETRIEVED 20.06.2020
PHARMACEUTICALS	Unused pharmaceuticals: where do they end up? Minska Apr 27, 2016 RETRIEVED 20.06.2020

EXERCISE (5)

CROSSWORD

INTEGRATED WASTE MANAGEMENT

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Background for the teacher:

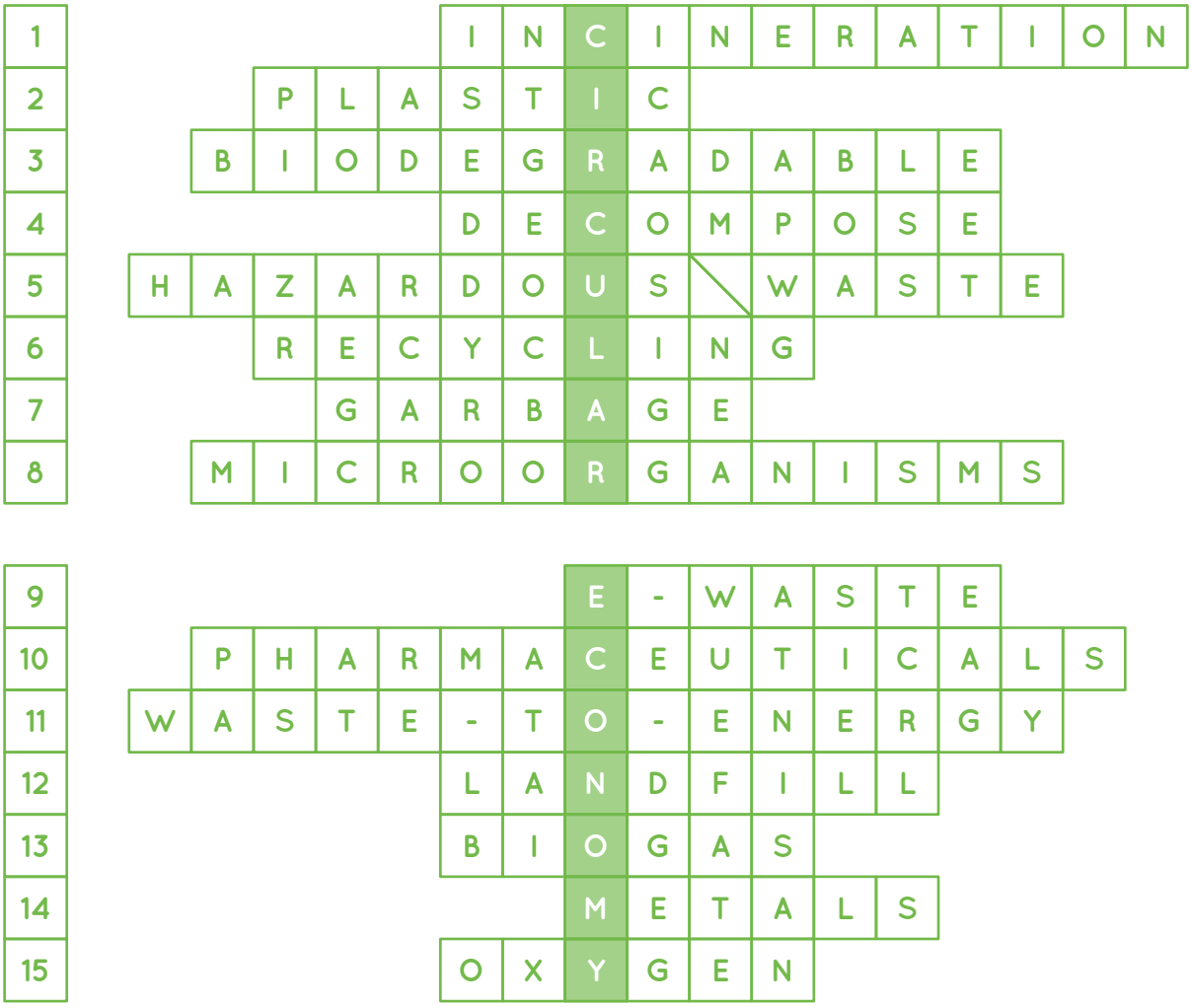
- In the **introduction.**

EXERCISE (5)

Time: 15 min

	TASK EXPERIENCE	IMPLEMENTATION
1	EXERCISE TITLE:	CROSSWORD - INTEGRATED WASTE MANAGEMENT
2	TARGET OF THE EXERCISE:	Knowledge and understanding of concepts related to integrated waste management
3	DETAILED DESCRIPTION OF THE EXERCISE:	Students complete the crossword individually or in teams. Teacher invites the students to compete in teams and sees who can finish first. The main slogan *"circular economy"* appears in the green fields. The students repeat terms related to the integrated waste management based on the phrases entered in the crossword. (15 minutes)
4	MATERIALS NEEDED:	SHEET WITH A CROSSWORD AND SLOGANS A PEN, PENCIL OR MARKER
5	EFFECTS:	The students understand the concepts and terms related to the integrated waste management.

1. A BURNING OF TRASH AT VERY HIGH TEMPERATURE TO CREATE ENERGY
2. A MATERIAL, WHICH REMAINS IN ENVIRONMENT FOR A LONG TIME, AND BREAKS DOWN TO MICRO-PARTICLES
3. A SUBSTANCE THAT NATURALLY TURNS INTO SOIL
4. AN ORGANIC PROCESS, WHERE MATTER BREAKS DOWN INTO ITS COMPONENT PARTS
5. AN UNWANTED IGNITABLE, REACTIVE, CORROSIVE OR TOXIC SUBSTANCE
6. THE ACTIVITY OR PROCESS OF EXTRACTING AND REUSING USEFUL SUBSTANCES FOUND IN WASTE
7. ANY MATTER THAT IS NO LONGER WANTED OR NEEDED
8. THEY CONVERT WET BIOMASS INTO COMPOST
9. UNWANTED COMPUTERS, MOBILE PHONES, PRINTERS ETC.
10. THEY ARE FORBIDDEN TO TOSS INTO THE GARBAGE OR DOWN TO TOILET,
11. THE PROCESSING OF WASTE INTO A FUEL SOURCE.
12. A HUGE PILE OF GARBAGE COLLECTED IN A CONTROLLED MANNER.
13. A LANDFILL GAS OBTAINED BY ANAEROBIC FERMENTATION OF BIOMASS
14. HAZARDOUS SUBSTANCES RELEASED FROM SOLID WASTES SUCH AS COMPUTERS, MOBILE PHONES
15. MICROORGANISMS NEED THIS GAS TO CONVERT BIOMASS INTO A COMPOST



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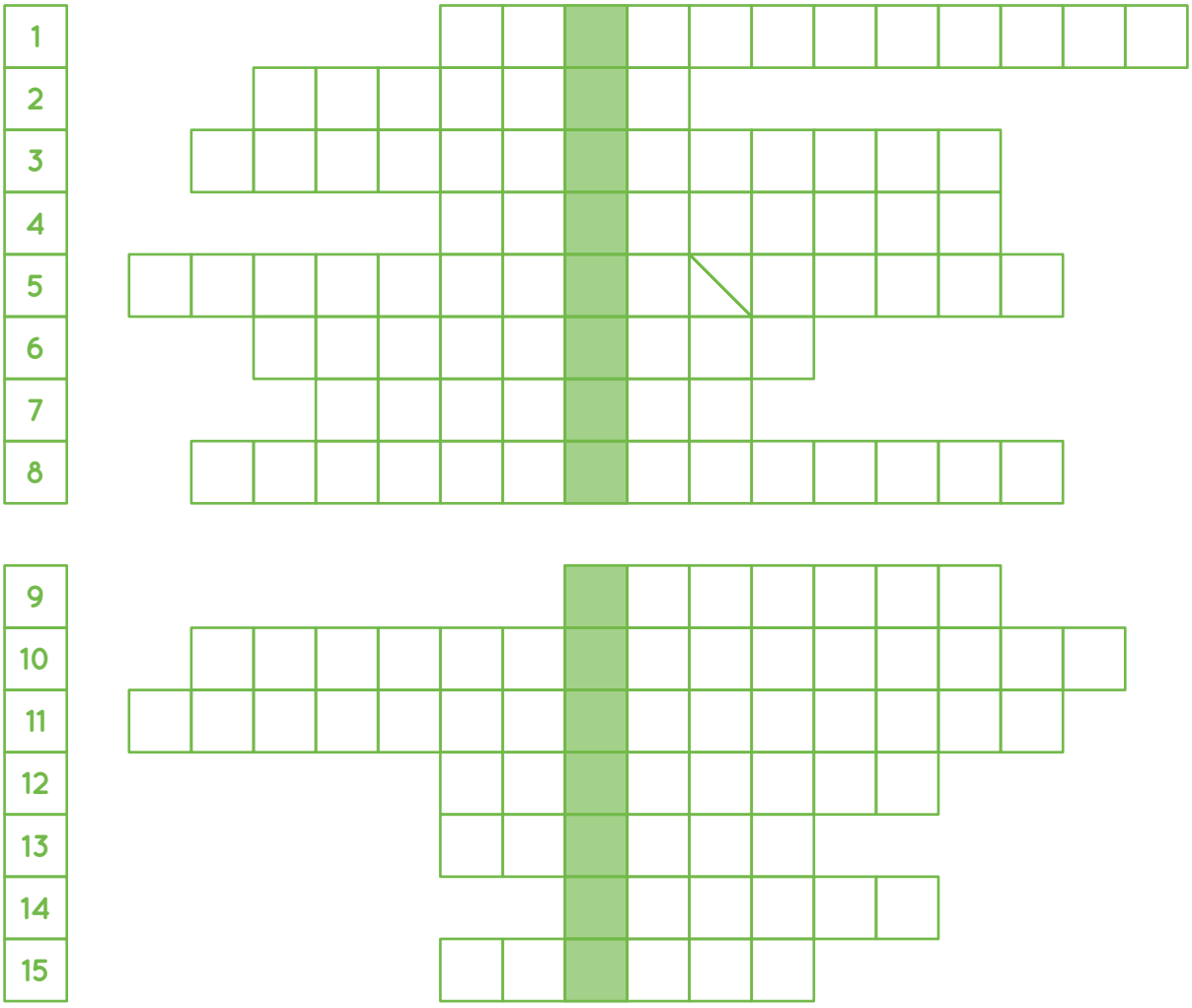

Effects

Students know that the waste generation per capita rate varies from city to city. The rapid urbanization and economic growth are the main drivers of increasing waste generation. This means there is urgent need for cities to manage ever growing piles of garbage. As consumers, we depend a lot on goods and resources produced locally and also on those that are imported. After the use of the goods and resources, people have a habit of treating all of the waste products as worthless. Students understand that rubbish is a source of valuable raw materials. They understand the need to recycle the recyclable items.

Students identify the types of solid waste that are generated in cities. They understand that some solid wastes are hazardous for environment and human life. They identify main components of integrated waste management. They indicate the ways to reduce waste that enters waste stream and describe the conventional waste disposal methods.

Students list the approaches for reducing waste such as: source reduction, reuse, composting and recycling. They know that the reducing waste is better option than disposal. Students define the term waste-to-energy and circular economy.

Students acquire knowledge about hazardous waste. They identify what makes waste dangerous. They know how to use, store and dispose hazardous household chemicals/products. They know that hazardous wastes come from households and industrial sources and that industry waste generation and disposal is highly regulated. They understand that e-waste is new and growing problem.

Students identify the pros and cons of the waste management system in their country.
Students familiarize with the deposit return system, the motivation of customers to participate in this system and relationship among various actors.
Students learn about the good practices in packaging. They understand that optimization of packaging helps to reduce costs of transportation, fuels combustion and greenhouse gas emissions.
Collecting high quality waste streams for re-use, remanufacturing and recycling also requires citizen engagement and integrated infrastructure development from the municipal to the EU level. The students understand the concepts and terms related to the integrated waste management and circular economy.
Students realize that waste management can also be a source of co-benefits such as reducing environmental burden, creating both high-skilled and low-skilled jobs for an inclusive, green economy.

Main goal:

Classes focus on Integrated Waste Management (IWM), which is a comprehensive waste prevention, recycling, composting, and disposal system. They will show how to prevent, recycle, and manage solid waste in ways that most effectively protect human health and the environment. Classes will teach that rubbish can be a source of valuable raw materials and the recyclable items should be recycled.

Knowledge and skills:

THE STUDENT WILL FIND OUT:

- WHAT IS INTEGRATED WASTE MANAGEMENT SYSTEM?
- WHAT PRIORITIES INVOLVES INTEGRATED WASTE MANAGEMENT?
- WHAT IS THE GOOD PRACTICE IN PACKAGING?
- WHAT IS THE RELATION BETWEEN OPTIMAL PACKING AND CARBON FOOTPRINT
- WHAT ECO-FRIENDLY PRODUCTS CAN BE DESIGNED FROM GARBAGE?

THE STUDENT WILL BE ABLE TO:

- UNDERSTAND WASTE MANAGEMENT AND WASTE REDUCTION CONCEPTS
- DEFINE THE CONCEPT OF INTEGRATED WASTE MANAGEMENT
- DESCRIBE EXAMPLES OF INTEGRATED WASTE MANAGEMENT
- DESCRIBES THE INNOVATIVE PRODUCTION FROM GARBAGE
- DESCRIBE THE BEST PRACTICE IN PACKAGING

SCENARIO

Time	Goals, Objectives, Skills achieved	Materials, Contents	Working methods
	Warm up activities		
5	<u>Greeting students</u> Teacher asks students to write on the board what they usually throw away and if they wonder what happens to garbage after it gets to their destination. Asks to brainstorm a list of different ways of disposing trash (burning, store in a landfill, make a compost, etc.)	BLACKBOARD, CHALK AND MARKERS	DISCUSSION, BRAINSTORM
	Development and practice		
10	Teacher defines "integrated waste management (IWM)" concept and its priorities.	A COMPUTER, PRESENTATION WITH SOME EXAMPLES	SHORT TEACHER TALK

Time	Goals, Objectives, Skills achieved	Materials, Contents	Working methods
10	Asks students to describes the examples of integrated waste management including: - waste reduction methods, such as reusing, recycling, burying or incinerating waste to obtain energy and composting - waste management methods such as treating waste to reduce toxicity, burying or incinerating waste and releasing some waste into the environment for dispersal or dilution	OF WASTE REDUCTION AND WASTE MANAGEMENT CHOSEN BY THE TEACHER	SHORT TEACHER TALK
	Development and practice		
5	Teacher shows students a short film "These five companies are turning trash into treasure" or introduces the case studies that show the turning trash into products. Discusses with the class how the companies featured in the film participate in integrated waste management.	COMPUTER, PROJECTOR, ACCESS TO THE INTERNET	WATCHING A MOVIE

Time	Goals, Objectives, Skills achieved	Materials, Contents	Working methods
20	The teacher divides the class into pairs. The students pull out one item (used plastic bottle, biomass, unwanted chair, computer etc.) from the bag. The teacher explains what is their task (to make an advertisement). (Exercise 3) OR:	SHEET OF PAPER, MARKERS, BAG WITH TRASH	CREATIVE WORK IN PAIRS The teacher controls the pace of teamwork and motivates creative thinking
20	The class is divided by the teacher into small groups. The students design their own packaging based on the good practice of packaging – the process of reducing the total amount of waste. (Exercise 4)	BEAUTY PRODUCTS, BLISTER WITH PHARMACEUTICALS, ONE CARTON ETC.	CREATIVE WORK IN PAIRS The teacher controls the pace of teamwork and motivates group toward creative work and unconventional ideas
	Wrap up		
3	The teacher summarizes the work of students, highlights interesting or unconventional ideas.	SHEETS OF PAPER, BOARD, FLIP CHART...	CONCLUSIONS
2	<u>Homework:</u> The teacher distributes cards with the crosswords and explains the homework	LINKS TO CO_2 CALCULATOR	OUT OF SCHOOL STUDENTS' OWN WORK

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