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A GUIDE TO EU EXPERIENCE AND BEST WASTE SEPARATION / RECYCLING PRACTICES IN RURAL AREAS

Common borders. Common solutions

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INTRODUCTION

The environment is a responsibility we must take on jointly. Against the background of the advanced ecological deterioration of the last decade, the degree of involvement and responsibility of international actors has increased. Environmental concern arose on the European agenda in the early 1970s. The European Union's (EU) environmental policy was created by the Treaty establishing the European Community and aims at ensuring the sustainability of environmental protection measures. Based on the Maastricht Treaty, environmental protection becomes a key priority of the European Union, where the need to integrate and implement environmental policy in sectoral policies such as agriculture, energy, industry, transport is signaled. The main pillar of the environmental policy is the concept of sustainable development, which is a cross-cutting policy that encompasses all other Community policies, emphasizing the need to integrate environmental protection requirements into the definition and implementation of all European policies.

The European Union's determination to protect the environment and promote sustainable development worldwide is internationally acknowledged. The concept of sustainable development entails the implementation of mechanisms and policies that allow both economic development and the environmental preservation, while capturing both the increase of responsibility and the economic efficiency growth in order to minimize the costs of reducing environmental damage generated by the human consumption. The European Union's policy in this field has gradually evolved, from the stage of implementing minimum environmental protection measures, to an increased commitment to environmental issues by way of complex and specific solutions. Thus, the EU has become a global promoter of sustainable development. The European Union's environmental policy is becoming increasingly comprehensive and closely linked to other European Community policies.

OVERVIEW

Solid waste management has to be planned, developed and operated taking into account the availability of local resources as well as economic and environmental issues.

Municipal solid waste management strategies can both reduce GHG emissions from landfills, improve storage practices, avoid significant GHG generation through controlled composting and integrate some waste into the energy generating facilities.

By understanding the benefits and disadvantages of various management technologies, local decision makers can best allocate resources, select processes, and develop policies and procedures to meet the needs of the community.

Solid waste is a vital responsibility of the local authorities and one of the biggest challenges they face today, due to the amount of waste generated that exceeds the technical and financial capacity for collection and storage. Solid waste has negative effects with an impact on the environment and public health. Uncollected or inappropriately managed, solid waste becomes the breeding ground for larvae and insects that proliferate and contribute to the spread of airborne and waterborne diseases. Improper disposal can often lead to uncontrolled leaks of leachate causing additional contamination of groundwater and soil resources, while open field fire leads to the release of toxins and particles such as carbon black.

The emissions coming from the waste management and disposal represent an increasing percentage of greenhouse gas emissions.

The actions to reduce these impacts will be essential, as the amounts generated by waste grow faster than any other environmental pollutant, especially in developing regions, or in rural areas where waste accounts for a larger share of the global emissions.

Data show that solid waste landfills and wastewater systems contribute about 3% to 5% to current global anthropogenic greenhouse gas emissions, but the sector has excellent potential to limit emissions throughout the economy by means of waste prevention and recovery as recyclable materials.

Solid waste disposal and management activities generate emissions of methane (CH₄), carbon dioxide (CO₂), nitrous oxide (N₂O) and carbon black.

Landfills are the third largest anthropogenic source of methane, accounting for about 11% of the estimated global methane emissions, or almost 800 MtCO₂e (2017). A forecast suggests that this figure could double by 2021 and increase fourfold by 2050 in the absence of mitigation measures.

A good waste management is to prioritize actions according to the waste hierarchy (see the diagram below)

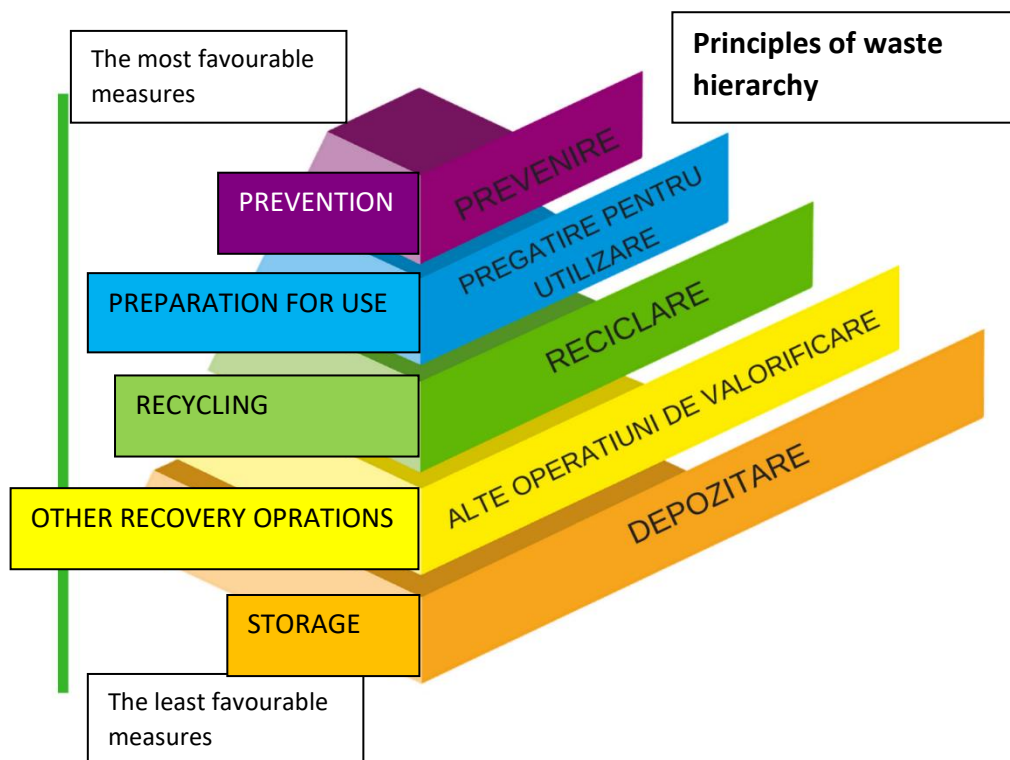


Figure no1: Waste hierarchy

The waste hierarchy is an assessment of processes with view to protecting the environment and reducing resources and energy consumption ranging from the most favorable to the least favorable actions. This hierarchy sets the priorities of the preferred programs based on sustainability.

A good waste management system aims to obtain maximum benefits from products and generate the minimum amount of waste. Efficient waste management systems can provide **significant benefits** beyond emission reductions, which could serve as the main goal.

Some of these co-benefits include:

❖ **Public health:** unmanaged waste often ends up on the streets or in water drains, attracting pests and larvae. Waste dumped in pits or non-compliant landfills can contaminate groundwater with toxic leachate. Improving waste collection and disposal practices can have a direct impact on public health, access to clean water and a cleaner environment.

❖ **Air quality:** waste burning in open air is persistent practice in many regions of the world and a major source of carbon black. Failure to plan waste collection routes or the use of old vehicles for waste collection also increases vehicle emissions, adversely affecting the air quality.

❖ **Poverty reduction:** In many areas, waste is an important source of income for a significant part of the population and raw materials for many sectors of the economy. The actions of local authorities can have a profound impact on the economic life, conditions and quality of life of those sectors of society involved in waste management.

❖ **Social justice:** Solid waste management is very visible and affects people's perception of the authorities and society.

Extensive use of natural resources threatens to exceed the Earth's transport capacity. The concept of circular economy offers a way to grow sustainable, healthy, decent jobs, saving the natural resources and protecting the environment.

The transition from a linear economy (take over, produce, throw away) to a circular economy (renew, rebuild, distribute) is expected to significantly support the achievement of the Sustainable Development Goals especially on responsible consumption and production.

So far, however, the health implications of the transition to a circular economy have been relatively limited.

The transition to a circular economy offers a major opportunity to reap substantial health benefits, such as direct benefits to healthcare systems and indirect benefits coming from the reduction of the negative impact on the environment.

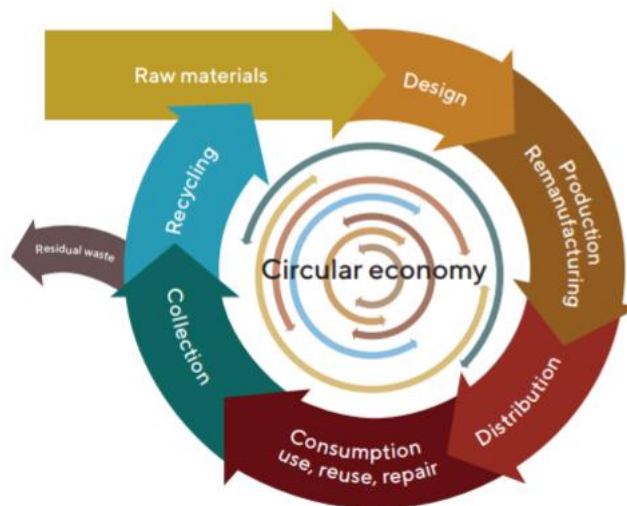


Figure no. 2: Circular economy system

Waste recycling in EU countries

The escalation of the climate crisis has drawn attention to waste, as landfills give off harmful greenhouse gases, adding to the global warming.

Based on data from a 2017 European Environment Bureau (BSE) report, combined with statistics from the United Nations Statistics Division (UNSD), we can get an image of the countries that have the best and the lowest recycling rates (with the derogation that many countries are shipping recyclable waste abroad and it can be difficult to know how much they recycle).

Scotland ranks 15th, recycling a significant 44.2% of its waste in 2017. The amount of household waste recycled in Scotland has exceeded the percentage of waste sent to landfills. In Livingston, the largest recycling plant in the UK, Brewster Bros., opened in August 2018, deals extensively with construction waste and can recycle 400,000 tonnes of construction waste per year.

Almost half of the waste in **Denmark** (46.3%) is recycled, the remaining waste being sent to incineration plants, where it is burned and used to heat homes. A new incinerator opened in Copenhagen in October. CopenHill, the cleanest energy recovery facility, can convert 440,000 tonnes of waste into clean energy each year. The site serves the dual purpose of an incineration plant that is completed with hiking trails and ski slopes on the roof, and on its facade is "the highest artificial climbing wall in the world."

Sweden (48.1%) has a long-term bottle recycling scheme, which began in 1984. Swedes can give up empty glass and plastic bottles and cans from "vending machines", which give vouchers in return. In fact, Sweden has now banned the sale of any bottles or boxes that are not part of the program. Returpack, the company that manages the scheme, processed an impressive 2.05 billion bottles and cans last year. Although Sweden's recycling rate for bottles and cans is 84.8%, its total recycling rate is lower, as in Denmark, much of Sweden's waste is being incinerated.

Luxembourg could be a model in recycling, (48.3%) - its citizens produce the fifth largest amount of waste in any EU country, at over 1,322lb (600 kg) per person, according to Eurostat. In its 2017 national waste and resource plan, the government set out key recycling targets. Among other things, it will increase the recycling rates of packaging waste to 70% by 2022, promote the use of reusable packaging, reduce the amount of garbage and reduce food waste.

Broadly speaking, **Italy** has a high recycling rate (52.6%), but there is a huge variation between municipalities. The northern city of Mantua, which uses a color-coded bag system to sort garbage, has been named the most sustainable city in Italy after reporting 80% recycling rates in 2017. However, in the south, waste is much less managed, with the rate of the recycled waste amount in the south of Catania lower than 9.34%. The image is Zero waste for energy installations in Brescia, northern Italy.

Switzerland has long been at the top of the list when it comes to recycling (52.7%). In the 1990s, this country introduced the "polluter pays" principle, where people are taxed on garbage bags to stimulate recycling. The scheme has been extremely efficient, doubling the recycling rate in 20 years. It is also one of the world's leading countries in terms of recycling the glass bottles, with 96% being recycled according to the European Container Glass Federation (FEVE) – significantly above the EU average of 73%.

Belgium is one of the most important recycling countries in Europe (53.5%), with the Flanders region being one of Europe's recycling centers. The Flanders' Materials program, launched in 2012, helps companies use sustainable design and state-of-the-art recycling and it won an award at the World Economic Forum in 2016. Belgium recycled almost 10 million light bulbs last year due to the non-profit organization Recupel, which collects e-waste and light bulbs to be transformed into new electronics. The company is also a pioneer in the use of AI for sorting and processing electronics, which would improve the efficiency.

It may seem small, with a population of just over 2 million, but Slovenia is ahead of many larger countries when it comes to recycling (53.9%). In its capital, Ljubljana, the Ljubljana Regional Waste Management Centre (RCERO) handles over 170,000 tonnes of rubbish every year. While most of the waste sent there is recycled, converted into biofuel or composted, only 4.9% of the waste sent to the plant, ends up in a landfill.

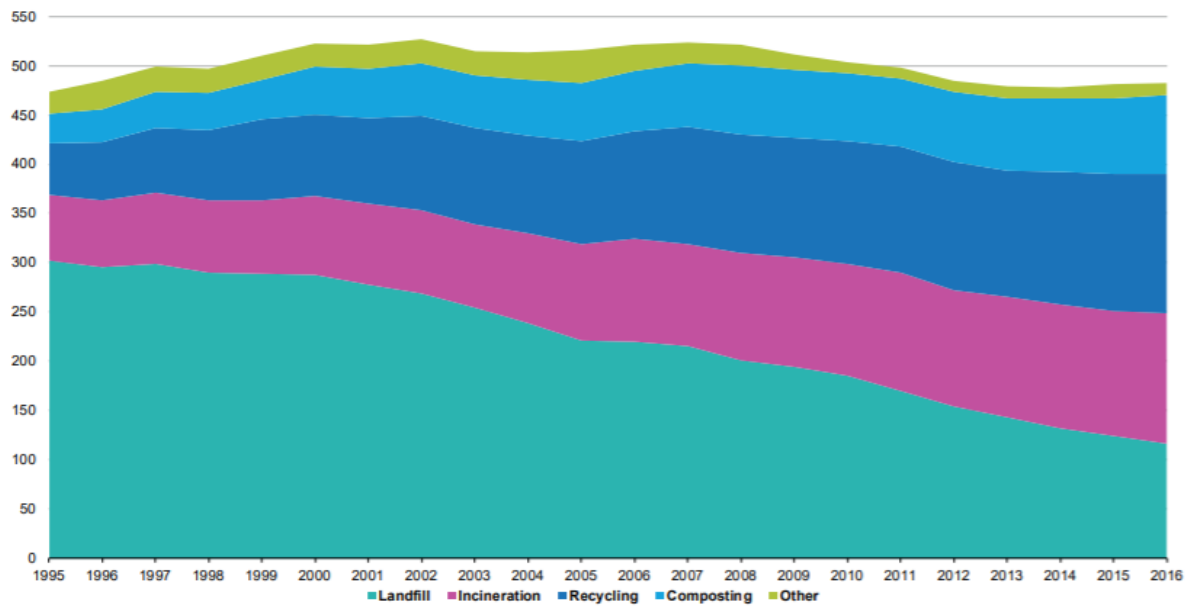
Garbage is hard to find in Vienna, the super-clean capital of **Austria** (55.9%). The government has several initiatives - encouraging citizens to use reusable coffee cups, reduce food waste and use reusable diapers - to help people reduce waste. Vienna also owns three waste incineration plants, which deal with any non-recyclable waste. Pfaffenau, an energy-transformed waste facility at a six-mile distance from the city centre, produces enough heat to supply to 50,000 homes each year and enough electricity to power 25,000 homes.

The Netherlands (56.6%) has several key initiatives to thank to for their high recycling rates. In Amsterdam, the Waste scheme rewards citizens who recycle plastic with tokens, which can be bought back by discounts at the local shops and businesses. Meanwhile, innovative companies are coming up with new ways of recycling.

The Dutch company EverUse recycles the paper and turns it into insulation materials for homes. Even the Dutch monarch Willem-Alexander made the official opening of the EverUse factory in Sneek, in January 2018.

On the second position comes **Wales, Tara Galilor**, with a recycling rate of **63.8%** of its waste, leaving the neighboring England lagging behind with a recycling rate of 42.8%. Wales was the first British nation to start charging for bags / plastic bags in 2011, leading to a 70% drop in their use. The country's success in increasing its recycling rate is due to local authorities by improving separate waste collection services and involving communities in recycling.

Germany leads the ranking with **66.1%** of recycled waste. It has six different bins: black for general waste, blue for paper, yellow for plastic, white for clear glass, green for colored glass and brown for composting. This means that citizens have to sort themselves, which reduces the amount of money the government has to spend on sorting, as well as it cuts down contamination. The German law requires the companies responsible to reuse or recycle packaging, operating in accordance with the "polluter pays" principle, and all recyclable items are identified with a green dot.



Source: Eurostat

Figure no. 3: Methods of treating municipal waste in the EU during 1995 - 2015

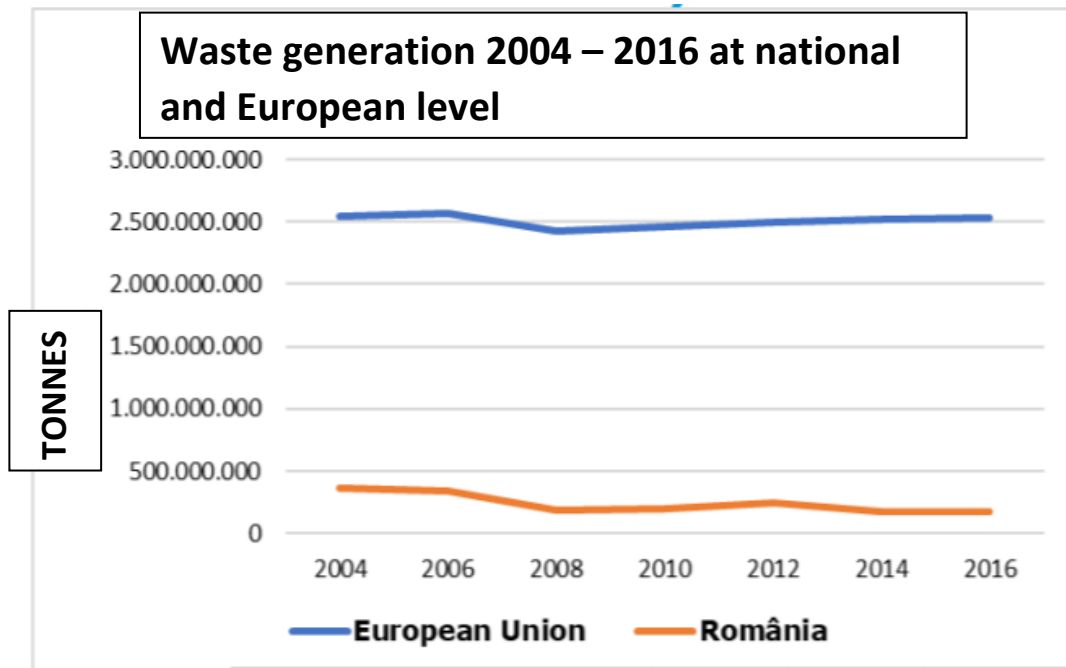
Municipal waste generated in 2017 (EUROSTAT data):

- EU-28: over 249 million tonnes;
- Romania: over 5 million tonnes (2% of the quantity generated in the EU).

There is a relatively constant trend with slight oscillations in terms of municipal waste generation for the period 2008-2017, both nationally and at European level.

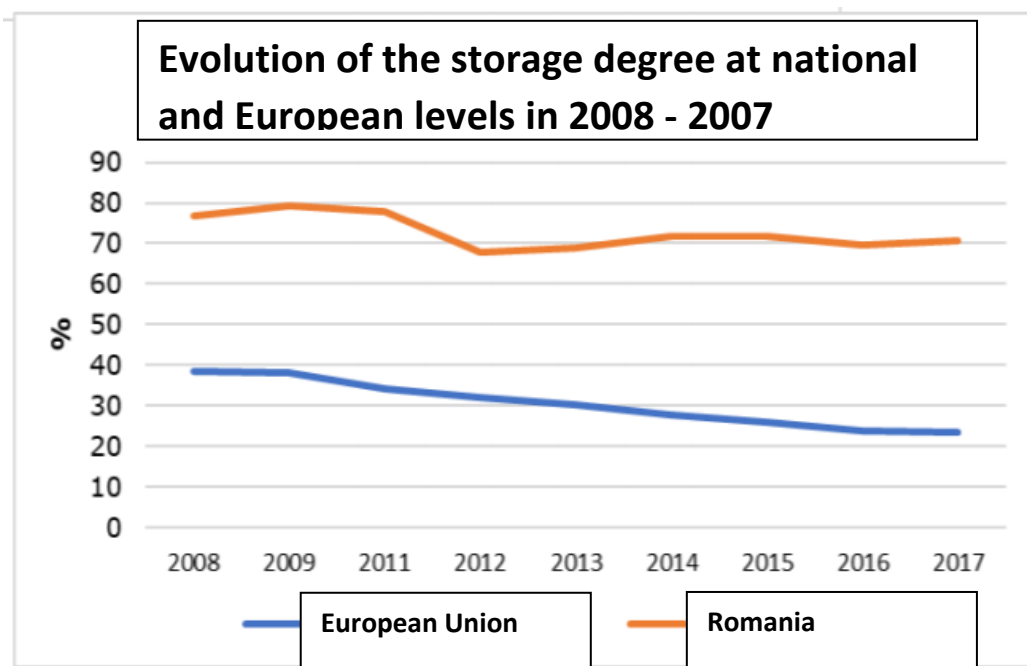
At European level, efforts are being made to reduce the amount of municipal waste that is disposed of by landfill (steady reduction from 38% to 23%).

Romania continues to store significant amounts of waste, not respecting the waste hierarchy in this regard. It currently recycles approximately 14% of total waste, with the lowest percentage in the EU.



Source: Eurostat

Figure no. 4: Quantities fo waste generated (at national and European level)



Source: Eurostat

Figure no. 5: Evolution of the waste degree (at national and European levels)

WASTE MANAGEMENT IN THE RURAL AREAS

Deficiencies and causes

Various technical and social innovations are needed for the solid waste management sector in large cities and rural areas, as specific geographical regions. Despite the fact that landfills are the worst-case scenario in current waste management practices in terms of environmental protection and sustainability, they have been used worldwide, especially in peri-urban and rural areas.

Former communist countries face serious challenges with the closure of "non-compliant landfills" that do not meet the criteria of the EU Landfill Directive 1999/31. Some of these sites need to be upgraded to meet current EU standards, and the new integrated waste management system needs to replace outdated infrastructure.

Sweden, Denmark and Germany have developed their waste management towards "zero waste disposal".

Developed, transition and emergent countries have not eradicated the problems of non-compliant deposits. Despite the fact that these sites are smaller than formal urban landfills and are scattered in peri-urban and rural areas, they are still a significant source of pollution. Monitoring illegal storage activities is crucial even in high-income countries because it affects public land, roadsides or water bodies.

Landfills are historically, the basic and most convenient option in waste management treatment used by human settlements around the world, along with ocean and river pollution practices.

Factors that contribute to the existence of non-compliant landfills today:

lipsa politicii și finanțarilor guvernamentale,

- lack of government policy and funding,
- difficulties in policy issues related to long-term planning in waste management,
- social behavior and resistance to change,
- poor waste management infrastructure,
- low quality of waste management services,
- lack of funds,

- low public awareness of environmental protection,
- low market for recycled materials.

Frequently, such uncontrolled disposal sites are located near households and water bodies. Landfills are a complex source of pollution (air, water, soil and biodiversity) that threatens public health. Mixed waste fractions (municipal, agricultural, construction and demolition, WEEE [i.e. Waste Electrical and Electronic Equipment], bulk items), including hazardous waste, are dumped in such locations causing serious public health problems.

In some cases, such dumps are a strong source of pollution due to the illegal disposal activities carried out by the mafia in southern Italy (the so-called mafia dumping). Particular geographical areas are presented, such as the "death triangle" in the Campania region (the area between the municipalities of Acerra, Nola and Marigliano) or the extended area called "Land of Fires" which includes 88 municipalities in the provinces of Naples and Caserta.

The extent of illegal dumping is a serious problem for an EU country where statistically the entire population has access to reliable waste management services. This highlights the fact that developed countries may have serious gaps in their waste management systems, which favor the existence of non-compliant landfills scattered in rural areas (UK, Mediterranean countries, Central and Eastern Europe). Thus the "Let's do it! World" movement is further evidence of this global environmental issue.

For instance, in the 1990s, more than 3,500 such sites were estimated in rural Greece where waste was disposed of illegally without further treatment (into natural valleys, old quarries, rivers). In the mid-1990s, the Israeli government began replacing all unregulated landfills with a streamlined system of large-scale regional landfills. The same threats have taken place in other countries. The new EU members had until July 16th, 2009 to close and rehabilitate non-compliant rural dumps; in the meantime, the EU candidate countries are expected to address the issue of non-compliant dumps in rural communities.

Solutions and overtures

The traditional recovery of household waste, home composting and animal feed has taken over a part of the bio-waste fraction from the waste volume dumped in these areas.

Improving the home composting procedure in rural communities is a cost-effective and environmentally friendly solution, if done correctly, avoiding the loss of bio-waste. The reuse and recycling of various items (glass, plastic bottles, building materials and metal) in the household also reduces the potential amounts of waste disposed of uncontrollably. Frequently, the rural population in low- and middle-income countries relies on solid fuels (firewood, manure and crop residues) as a source of energy for domestic use.

Fractions of wood, sawdust, paper and cardboard are used for direct burning as a source of heating energy in the household or animal manure in the regions without access to forest areas.

Unfortunately, in many rural areas, traditional ovens are primitive clay stoves and ovens, extremely polluting for the air and extremely energy inefficient. Incomplete combustion of solid biomass or combustion at temperatures below 800 ° C lead to the exposure of particles (PM), carbon monoxide (CO), nitrogen oxides and sulfur oxides (SO_x, NO_x) and phosgene, which has been linked to high morbidity and mortality rates in these areas.

The agricultural waste (eg. straw, stalks, bark, wood and sawdust) is often disposed of by being burnt in open fields with a risk of wildfire. Household waste (biological waste, plastics, textiles, etc.) is also prone to open combustion practices. Mixed waste may contain hazardous items (electronic waste, batteries, oils, solvents, paints, contaminated wood and pharmaceuticals) that are released into the atmosphere, soil and groundwater. Common hazardous substances used in rural areas include insecticide, pesticide, fungicide, herbicide, chemical fertilizers, chemicals used in smoking, cleaning agents used in animal husbandry and medical waste. Such a hazardous fraction must be separated, collected and managed separately from the ordinary household waste.

In the worst case, rural households may not have access to basic utilities (improved source of drinking water, sanitation, waste management services), and nearby water bodies are polluted by landfills and open toilets.

Quantities of municipal waste generated and not collected by waste operators or public sanitation services are likely to be incinerated or dumped uncontrollably, polluting the local environment and threatening public health. Such waste pollutes tributaries and rivers, lakes and coastal areas; thus, floating debris invades marine and oceanic ecosystems. Plastic pollution, especially non-compostable microplastics, is a notorious threat to marine wildlife, and large ocean surfaces concentrate such plastic debris due to currents.

Rural areas without access to formal waste collection services should be encouraged to practice home composting or vermicomposting in order to obtain a quality natural fertilizer. Organic farming aims to reduce external costs, produce good yields, save energy, maintain biodiversity and maintain soil health. The composting process can cover various sources of biological waste (municipal, sewage and agricultural) thus taking fractions from the practices of open discharge or open combustion.

If all global household waste from organic materials leaving cultivated land each year (6.8 billion tonnes) were treated through the anaerobic / aerobic process, approximately 4 billion tonnes of very good soil could be produced, avoiding emissions of 1.4 billion tons of CO₂ equivalent.

Sparsely populated rural areas, which are far from major urban areas, are usually the most neglected by waste management services. Waste operators avoid such areas, and local authorities provide little or no financial resources to provide adequate public services. In addition, geographical constraints (mountains, hills, high plateaus, karst regions and wetlands) make it difficult to implement adequate waste management facilities.

The four core technologies for agricultural waste and the organic fraction of municipal solid waste suitable for rural communities consist of:

- a) animal feed,
- b) briquetting,
- c) anaerobic digestion (biogas) and
- d) composting with other solid waste recycling techniques

Such facilities can serve rural communities without access to formal urban waste management systems. These technologies can be integrated into a single rural waste complex to achieve a desirable goal of zero waste and pollution.

Small anaerobic digesters that use agricultural and food waste can be operational at the household level to obtain energy (biogas) for cooking and other basic needs. The construction materials and design of such digesters vary depending on the geographical location, the availability of the substrate and the climatic conditions.

In many cases, animal manure, agricultural plant residues (straw, garden waste, roadside grass) and food waste (OFMSW – Organic Fraction of Municipal Solid Waste) are co-digested together to achieve a better nutritional balance in the anaerobic digestion process.

Community-type biogas digesters have a larger volume and can produce biogas for several homes instead of a single household.

Decentralized facilities are suitable in remote rural areas.

Organic waste treated in a household biogas digester provides energy for cooking, lighting and heating, along with an improved organic fertilizer in digestors for the farmers.

Subsidies from government or local authorities could expand the use of household biogas digesters in rural communities, reducing landfilling, thus reducing greenhouse gases and environmental leachate emissions. The development of an easy-to-use technology and its economically viable development will increase the use of biogas digesters, which are an advantage for low-income and rural people.

Large and expensive anaerobic digestion facilities and central composting facilities are found in integrated regional municipal waste management systems in developed countries covering cities and surrounding rural areas. Biogas technology is a proven and well-established technology in many parts of the world, such as Germany, the United Kingdom, Switzerland, France, Austria, the Netherlands, Sweden, Denmark, Norway, Finland, the Republic of Ireland.

The European Union requires each Member State to reach a 20% share of the renewable energy in the total amount of the energy consumption by 2020 and to reduce the amount of biodegradable municipal waste landfilled to 35% of the levels recorded in 1995 by 2016 (for some countries by 2020) under the Landfill Directive (1999/31 / EC). In this context, anaerobic digestion plants could emerge in the coming years across Europe as an alternative energy source to fossil fuels, encouraging the transition to a circular economy approach.

Instalațiile centralizate de compostare au, de obicei, ca materie primă OFMSW din zonele urbane. Cu toate acestea, zonele rurale metropolitane și înconjurătoare pot contribui, de asemenea, cu cantități semnificative de OFMSW în cazul unor scheme de colectare pe scară largă de separare a surselor. Centralized composting plants usually have OFMSW as their raw material in urban areas. However, metropolitan and surrounding rural areas can also contribute significant amounts of OFMSW in the case of large-scale source separation schemes. The population needs to be aware that a clean source, separate from organic and recyclable dry waste, will improve composting and recycling activities.

Inter-municipal cooperation between cities and rural municipalities is mandatory for a successful regional waste management system.

Low-tech composting plants should be implemented in rural areas, whereas in high-density areas, combined mechanical anaerobic and aerobical treatment plants (MBT plants) are preferred due to the higher impurities of OFMSW.

The transport of waste from the generation source (villages) to treatment plants (transfer station, recycling centers, composting plants, waste from power plants and landfills) is a key logistical problem in rural areas.

The budgets of local authorities allocated to the waste management sector are limited. Waste management associations bring together several municipalities or even an entire county / region to economically support waste management services.

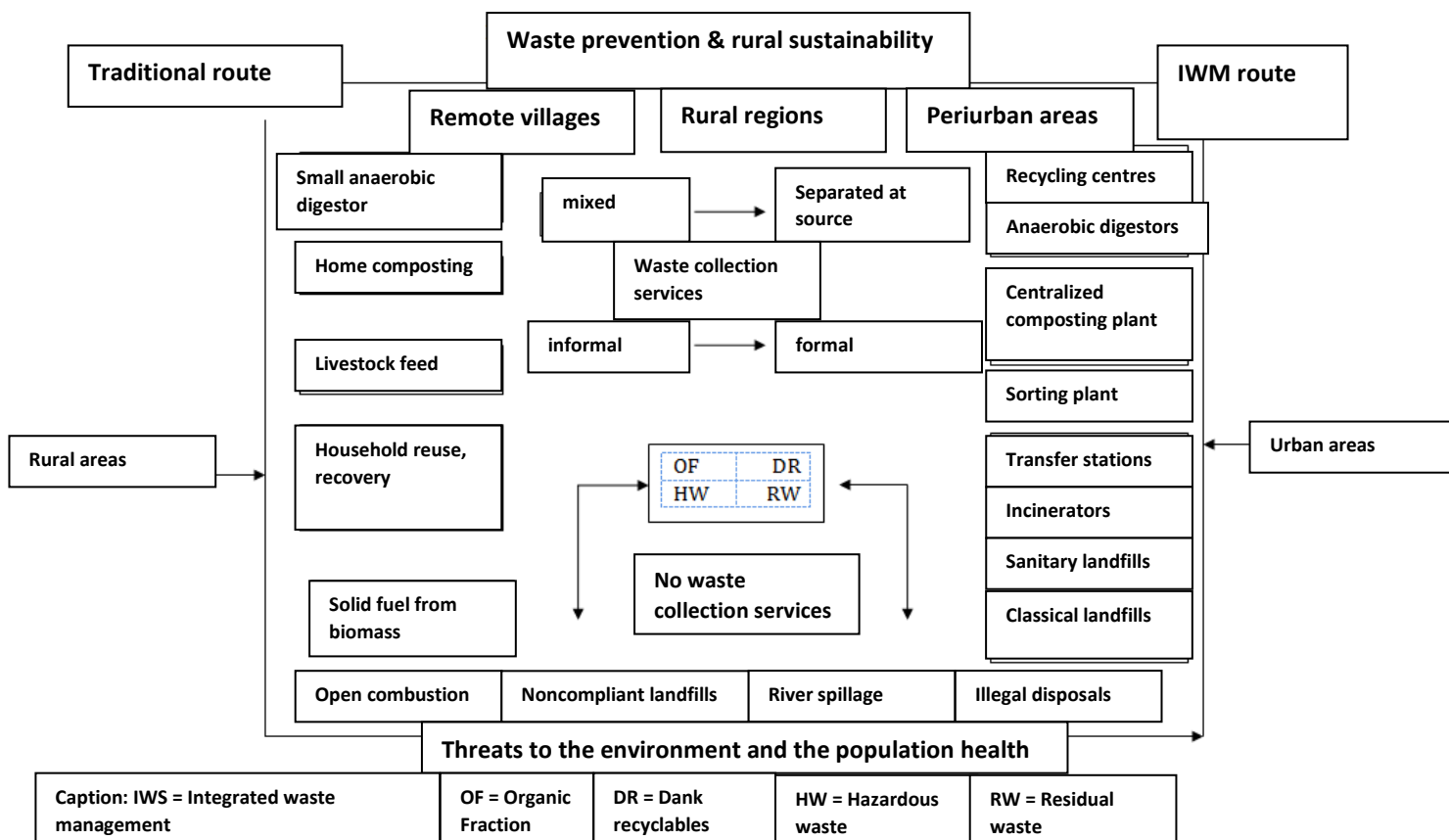
Major investments are needed to extend waste management services from larger cities to rural settlements and towns. EU funds play an important role in this matter in the case of Central and Eastern European countries. The EU Landfill Directive requires all Member States to close non-compliant municipal landfills and rural wild dumps. They are replaced at county level by transfer stations, waste to power plants or regional sanitary warehouses. At the same locations, sorting stations, composting plants and crushing plants (construction and demolition waste) can be operational to optimize costs. These integrated waste management systems are based on separate waste collection schemes ("door to door", collection points and public places).

Mixed waste collection needs to be replaced with such facilities in order to achieve a high rate of waste reduction from landfills.

There are two main ways that can help rural communities around the world to achieve a sustainable waste management system, as shown in Figure no. 6.

Both paths can be applied at regional level taking into account the specific geographical conditions (natural and socio-economic) that may vary at different scales (village, municipality, county, region and country).

Environmental pollution seems to be more common in sparsely populated rural areas, but the threats remain at the same level as for the urban areas. Moreover, pollution activities that have taken place in rural areas are more likely to occur in an uncontrolled manner. Poor monitoring and poor law enforcement make rural areas vulnerable to such practices in both developed and emerging economies.



Source: adapted after Mihai and Grozavu, 2019

Figure no. 6: Ways to prevent waste accumulation and to rural sustainability

Home composting and biogas production through individual or community digesters are suitable alternatives for rural communities in countries with less developed economies, where the share of bio-waste in the total fraction of municipal solid waste is significant and agriculture plays a key role in their economy. However, such practices need to be carried out properly on a local scale in order to obtain a viable solution for energy and fertilizer demands.

Environmental awareness and proper training are crucial for further development by way of government programs, local authorities and civil society. Local municipalities need to be supported by financial instruments (subsidies, loans, tax incentives, national and international funds) to provide adequate facilities for bio-waste management.

The process of regionalization of waste management infrastructure aims to mitigate environmental pollution and expand standardized waste management services in rural communities and municipalities. However, bureaucracy and delays in the construction of waste management facilities can lead to serious problems at regional level.

Rural-urban relations must be integrated into a sustainable cohesion policy on public utilities, with a special focus on the solid waste management sector.

Conclusions

All these need to draw attention to the solid waste management sector to rural areas where bad practices and threats to public health could be avoided through traditional and integrated waste management channels.

Expanding waste collection services in rural municipalities should be a priority for many countries. Reducing agricultural and municipal waste from non-compliant landfills and open burning practices must be avoided through smart, cost-effective local solutions.

Recycling models in the EU

In densely populated and urbanized areas of the European continent, there are many alternatives for waste management, establishing measures to avoid the negative impact of waste on the environment or human health is a priority. But it is also necessary to carry out such actions in rural or semi-rural areas. Waste management must be adapted to the needs of each area, so that the objectives set by regulations can be achieved in viable economic and environmental conditions.

Rural areas face serious problems in complying with EU waste management regulations. Firstly, the share of the rural population is higher and has a lower standard of living and, secondly, waste collection services are poorly developed, covering some rural regions. In these areas, waste disposal in conventional landfills is an appropriate solution for waste disposal, generating complex pollution (Apostol and Mihai, 2012).

Rural household waste is defined as solid waste, which includes damp waste (scrap, foliage, meat residues), recyclable waste (paper, plastic bottles, metal, cloth) and non-recyclable waste (plastic bags, glass, metal). Among them, kitchen waste is the main part of rural solid household waste (Wang et al, 2018).

Methods of disposing of solid waste of rural residents include recycling, landfilling and burning or dumping in open spaces without any treatment.

In most rural areas, waste collection programs cover only a part of the population, burning household waste, animal waste or food waste are predominant options among rural communities (Mihai and Grozavu, 2019).

Rural areas are often neglected by waste management services due to several factors, such as geographical barriers, low population densities, poorer socio-economic conditions, long distances from urban areas, transport costs, etc. (Mihai and Grozavu, 2019).

Currently, the waste management system in rural areas is characterized by traditional collection and storage that corresponds only in part to Romanian legislation in the field and European recommendations.

European Union members are struggling to mitigate these traditional landfill practices among rural communities and to provide reliable waste management services, however, there are still countries (eg Spain, Romania) where waste disposal in conventional landfills represents the basic and conventional option of their final treatment used by the majority of the rural population (Mihai and Grozavu, 2019).

The practice of illegal dumping has taken place even in countries where waste management systems are better developed and cover almost the entire population such as in Spain or Italy (Mihai, F.C., 2017).

The rural waste management sector is in a process of complete expansion at national, regional and local level in order to comply with Romania's targets to the EU.

The precarious infrastructure and the few separate collection facilities in Romania reveal the incipient stage of the waste management system in rural areas.

According to the data presented in the study conducted by Schneider et al. (2017) in **Germany**, the average rate of waste production in rural areas varies between 0.65 and 1.37 kg / capita / day, compared to urban areas where the average rate of waste production is between 1.37 and 2.2 kg / capita / day. In Germany, the selective collection system is implemented (glass, paper, plastic bottles (PET), other plastics, metals, biodegradable waste). Waste collection is carried out in urban and rural areas by municipal, communal or private sanitation operators. There are also PET collection stations in the area of supermarkets or shops in rural areas where the poorer population brings the bottles collected from the streets and receives a certain amount of money (eg for a plastic bottle they receive about 0, € 26, and for a glass bottle € 0.08). In 2017, there was no guarantee-reimbursement system for alcohol bottles in Germany, but it was under discussion at the government level. All untreated municipal landfills were closed in 2005, with Germany opting for a system in which pre-treatment of waste before recycling or reuse is a priority option, only hazardous waste being disposed of.

In **Austria** the situation is similar to that in Germany. The average waste production rate is 1.58 kg / capita / day. There are also bottle collection stations in Austria, where people receive € 0.33 for a PET. € 0.09 and € 0.36 for special types of beer bottles are reimbursed for simple reusable beer bottles.

In the Czech Republic the average waste production rate is lower: 0.8 kg / capita / day and significantly lower than the EU average of 1.3 kg / capita / day. No refunds apply for aluminum cans or plastic bottles in the Czech Republic, only 3 Czech crowns (approximately \$ 0.11) are refunded for certain types of glass bottles. Therefore, the "secondary" collection of this type of waste is negligible in this region. The law on waste in the Czech Republic requires the administration of municipalities and communes to set up places where waste is collected separately (especially glass, paper, plastic, metals and biodegradable waste). The way of waste management in rural areas is the same as in and in urban areas (Schneider et al., 2017).

For a correct understanding of the existing situation, the evolution and the results obtained in the recycling of rural waste, the number of the population in the EU countries must also be taken into account.

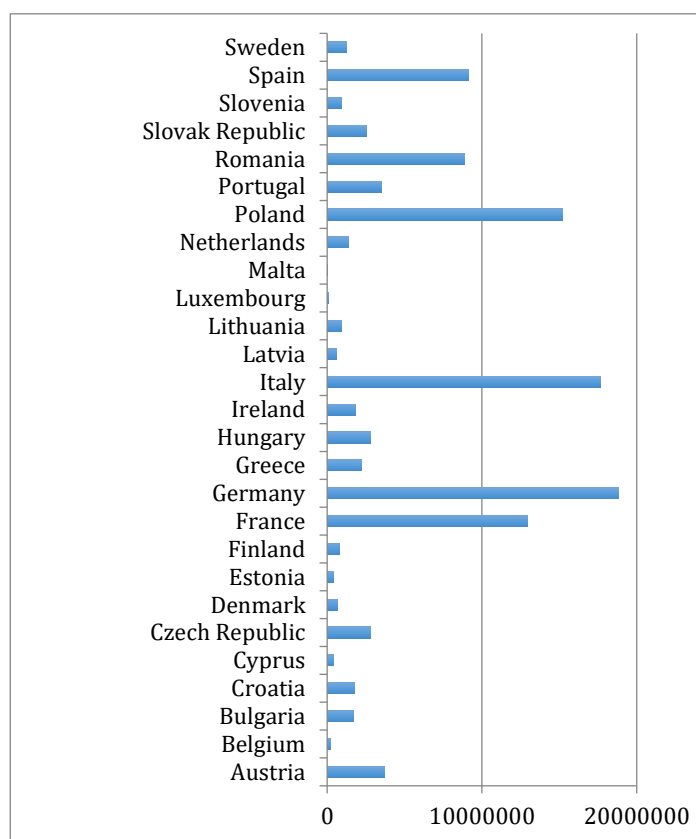


Figura nr. 7: Population in the rural areas at the level of the European Union countries in 2019 (Source: The World Bank (<https://data.worldbank.org/indicator/SP.RUR.TOTL>))

In 2019, according to the data presented by The World Bank, approximately 25% of the population of the European Union lived in rural areas (113088432 inhabitants). The country with the largest number of inhabitants in rural areas is Germany (18807964 inhabitants), followed by Italy with 17645430 inhabitants, Poland with 15174300 inhabitants and France with 12936523 inhabitants. On the other hand, among the countries with the lowest number of inhabitants living in rural areas are Luxembourg with 54,408 inhabitants and Malta with 26,751 inhabitants.

In Romania, in 2019, there was a number of 8887751 inhabitants living in rural areas, approximately 48% of the total population.

Models for the implementation of Rural Recycling programmes

Developing a successful rural recycling program is a challenge. When state legislative bodies imposed by law measures to reduce and recycle waste and place the responsibility on the local authorities, only a few paid special attention to rural areas.

These communities are working with their urban counterparts to meet recycling and reduction targets of 15 to 70%. Efforts in rural areas, however, can be hampered by low population and tax base, limited local government budgets and staff, low-density housing and limited commercial development.

For some areas, the volume of solid waste fluctuates due to seasonal residents or tourists.

For many, the difficulty of accumulating enough processed materials can limit cost-effective marketing options. However, rural areas have strengths that can help them in the development and operation of recycling programs. For example, rural people have a strong sense of community, a history of volunteering, and often take a creative and cost-effective approach to solid waste management.

Usually, rural waste streams come from homes / households and small businesses. As a result, they are smaller and contain lighter materials than those found in urban waste streams with large amounts of commercial waste.

An extremely successful rural recycling program can extract about 9% of the residential waste stream if items such as glass, metal containers and cardboard are recovered.

A regional recycling approach needs to be considered in order to overcome the barriers faced by rural authorities. Among the benefits there are:

- increased volumes of recyclable materials, a fact that opens up marketing opportunities;
- a potential for cooperative marketing, which can substantially increase revenues;
- preserving storage capacity and avoiding filing fees;
- regional economic stimulation starting from new collection and processing jobs;
- common costs for equipment, personnel, processing, transport, marketing and installation capital and operating costs.

It should be noted that recycling is often not a money-generating tool, despite its many benefits. Because markets can be volatile, don't rely on recycling your sales revenue to support a regional program. Instead, look at recycling costs as part of your overall municipal solid waste management strategy. For example, a recycling program should be considered a viable method of reducing total disposal costs.

Although each program will experience various economies of scale, each successful program will require its participating authorities to share the costs.

For the development of a regional rural recycling program, the following steps should be considered as a general framework.

Of course, each regional effort will be different and it may take several years to fully plan and implement a successful recycling strategy.

- **Identification of potential recyclable materials**

Carry out a waste stream assessment to determine the current level of recycling and to identify the types and quantities of recyclable materials in the regional waste stream.

- **Establishment of a RAC**

Create a Regional Recycling Advisory Committee (RAC) that includes members from the private and public sectors, non-profit organizations and the general public with experience in recycling. During planning and implementation, hold regular meetings to discuss the needs and concerns of the private and public sectors. Committee members may provide information on markets, material specifications, transport and processing costs. The committee may also develop regional policies and objectives.

- **Determining regional markets**

Assess the availability and level of demand in the markets in your area. This will help determine which materials will be recycled.

- **Exploring export markets**

- **Identifying industries that accept recyclable materials**

- **Specific recyclable targets**

Regional waste reduction targets, the amount of recyclables in the waste stream and the availability of the market influence the materials that will eventually be destined for recycling.

- **Consider cooperative marketing**

Often, individual rural governments are unable to negotiate optimal market conditions due to the small volumes of materials. Cooperative marketing allows rural regions to deliver greater volumes to potential end markets. This strategy helps them to obtain a higher market value, to obtain better transport rates and to increase the types of materials accepted by the manufacturer. For example, some end-users will provide free shipping to their factory if a region can supply substantial quantities.

- **Investigation of collection and processing**

Many options are available for the collection and processing of recyclable materials. Residential options include collection by the household or the mailbox and permanent or mobile delivery centers. Trading options include richload collection, transfer stations and private contract collection.

Analyze all available options and make decisions based on region size, quantity and type of materials, and market availability. Often, regional collection of recyclable materials involves a hybrid of local and regional approaches using both the public and private sectors.

- **Public involvement**

Public participation is imperative for a successful regional recycling effort. A regional committee on education and public involvement is a great way to coordinate activities and information.

- **Evaluate, evaluate, evaluate**

Develop a monitoring system to track the progress of each jurisdiction to reach the goals of the recycling programme. The system should also monitor the quantities of recyclable materials collected and processed.

Monitoring and evaluation can help determine any necessary adjustments or extensions. It can also help make long-term decisions about the future of the program. These could include replacing the targeted recyclable materials, adding new materials or switching from a voluntary to a mandatory recycling program.

Rural areas can present unique alternatives for the use of recyclable materials. For example, old newspaper and mixed paper can be used as a straw substitute for animal bedding. In fact, wastepaper exceeds the straw in animal waste absorption and may be less expensive, according to pilot projects in some areas. Used paper can also be used to insulate cellulose-type buildings and as a filler for hydrosowing.

Potential uses for mixed glass include glass (a mixture of glass and asphalt for paving roads), landfill coating, fiberglass, glass concrete (a mixture of glass and concrete), sandblasting, filling, road coating material, erosion control, septic fields and as a sand supplement or substitute.

Mixed plastics can be crushed and applied with dirt on the parking areas of unpaved vehicles. The shredded plastic can also be used as a septic material for field drainage if it is approved by the local health department

Involvement of the population in the waste management in the rural areas

Rural solid waste (RSW) should be part of integrated solid waste management, as rural waste increases in quality and quantity due to changing lifestyles and increasing incomes. Solid waste management (SWM) requires a systematic approach that integrates environmental protection, public acceptance and affordability.

Public acceptance refers to the favorable reception and active approval and adoption of newly introduced technical devices and systems. Public acceptance in waste management can be measured by the rate of public participation. Public participation is recognized as a way to achieve sustainable waste management (WM) and can reduce the gap between government and citizens in managing environmental conflicts.

Public participation in solid waste management should be promoted as "waste as a resource" and "waste as a source of income" for rural households. It serves the purpose of daily reduction of waste storage, the use of waste as a resource for certain local productions, as income generator and benefit agent for households involved in solid waste management.

The involvement of households in solid waste management can take the form of waste separation and recycling. Waste management (WM) involving the separation and recycling of waste will only be successful if it is supported by the public, including local residents.

Locals are important stakeholders in both decision-making and waste management, as they are both the subject and the object of waste management services. Community performance models and attitudes, shaped by the local cultural and social environment, determine the structure and functions of public participation. Therefore, the challenge for waste management (WM) is to increase public participation nowadays.

The amount of research focused on the public's willingness to participate in WM and its influencing factors depends on demographic variables, for example, age, gender and type of household use, knowledge and recycling time, and level of education, occupation or income level. The results of each study often depend on the sample used. Identifying these factors and their importance can be beneficial for improving public participation in WM, as it depends on the local situation. However, the design of a successful scheme cannot necessarily be replicated elsewhere. Public acceptance may be reflected in the willingness to accept (WTA).

There are Community initiatives that carry out waste separation and landfilling to reduce inorganic waste, ie plastics, paper, metal and glasses, and to bring in revenue from the sale of waste. Unfortunately, public participation in waste separation is very poor.

Good practice models in UE countries

Innovative rural municipal waste management is a key factor for resource efficiency. However, for many regions in Europe, especially for the "remote" or "isolated" ones, optimizing municipal waste management is problematic.

The main challenge here is to move these remote areas in the waste hierarchy to minimizing, recycling and reusing waste.

Waste management in isolated Spanish rural communities

23% of the Spanish population lives in rural areas. Some of these areas also have characteristics that make them isolated areas, such as the distance to the transfer / processing / selection facilities or the difficulty of access at certain times of the year. These characteristics represent a challenge for municipal waste management.

According to a study conducted by Hidalgo (2016), the production of waste per capita in rural areas does not differ significantly from the urban areas. In rural areas the major fraction of waste is organic in nature.

The waste collection service in rural areas is usually provided by associations, consortia, regional councils or county councils.

The lack of recycling facilities in these waste areas associated with long distances from treatment facilities leads to the disposal of most waste without prior treatment. The situation is aggravated by the fact that there are no taxes on municipal waste disposal in most rural areas.

In order to improve waste management models in remote rural areas, the main action proposed is to carry out the process of self-composting of organic waste (household and community composting) and decentralized composting. Existing experiences in Spain show that it is possible to treat most of the organic fraction produced in rural areas using these options and this results in lower management costs, as a large part of the waste generated is diverted from the usual collection system.

Good practices in terms of waste management in remomote Spanish rural areas

A small town in Mallorca, Puigpunyent, has been implementing selective door-to-door collection since 2004.

In this locality, the collection of the organic fraction is made separately. The use of compostable bags for the organic fraction is mandatory, and the Local Council distributes them free of charge through retail partners. The stores keep records of the delivered bags, periodically informing the Local Council.

Paper / cardboard and glass are still collected in containers by means of "non-permanent contribution areas" which are present one day a week by placing a container of about 100 liters in a certain place. These areas are located on the most populated streets (about 50 points for a population of 1,500 inhabitants).

The introduction of the door-to-door collection system allowed in this location: colectarea fracției organice cu un procent foarte mic de material impropriu (3,5% în medie).

- collection of the organic fraction with a very small percentage of inappropriate material (3.5% on average).
- reduction of the remaining fraction collected by more than 70%.
- increase in the collection of light packaging by more than 300%.
- increase of paper / cardboard collection by 166%.
- increase of glass collection by over 115%.
- 20% reduction in garbage tax.

The people of Riudecanyes have provided an excellent example of how individuals can help improve municipal waste management. Since 2000, the locals collect their waste individually in small containers. Moreover, people receive immediate feedback if their waste has not been properly collected.

Waste is divided at home into 3 groups: compostable organic waste; packaging papers; glass and non-compostable waste. Compostable waste is usually collected three to four times a week, while non-compostable waste is collected once or twice a week.

Due to the implementation of this system, selective waste collection increased from 10% to 80%, compared to the typical rate of 10-20% before the implementation of the initiative.

In 2004, the door-to-door collection system was introduced in Argentona, so the waste recycling rate increased.

Later, in 2009, a pay-as-you-throw payment model was implemented for both households and businesses. It was based on the "who recycles, pays less" principle. The model was called the "air charge" and was designed as a bag payment scheme. It is mandatory to use standardized bags of known volume.

Moreover, an overall waste reduction of 10% has been achieved, largely attributed to lifestyle changes.

Waste management in rural areas in the Czech Republic

A model of good practice in waste management in rural areas is present even in the Czech Republic.

In the Czech Republic the average waste production rate is lower: 0.8 kg / capita / day and significantly lower than the EU average of 1.3 kg / capita / day. The law on waste in the Czech Republic requires the administration of municipalities and communes to set up places where waste is collected separately (especially glass, paper, plastic, metals and biodegradable waste). All rural areas are managed by their central municipalities, which means that **the legislation and waste management in rural and urban areas are the same** (Schneider et al., 2017).

The National Waste Management Plan 2015-2024 and the Regional Waste Management Plans set out measures to increase recycling rates, namely:

- Gradual increase of the existing tax for the storage of waste in conventional landfills. The use of revenue to support separate collection and alternative infrastructure.
- Avoiding to build excessive infrastructure for waste treatment, e.g. mechanical biological treatment facilities (MBT) or incinerators.
- Improve and expand separate waste collection infrastructure, including for bio-waste.
- Establishing minimum standard methods for separate waste collection (eg collection rate, collection methods, types of containers, etc.) to increase the rate of recyclable waste collection.
- Mandatory separate collection of used vegetable oils and fats will be introduced throughout the country.
- Applying a new economic instrument, based on the "You pay for what you throw away" principle - an instrument implemented by most European countries in order to encourage waste recycling, where technically, economically and environmentally feasible - aims at reducing the amount of waste that get to landfills and increasing the reuse / recycling rate.
- Improving the operation of extended producer responsibility systems, in line with the general minimum EPR requirements set out in Article 8a of Directive 2018/851 / EU (The Environmental Implementation Review 2019 - Country Report Czech Republic).

Recycling and recovery are already a well-established treatment option in the Czech Republic.

About 14% of municipal waste is recycled and about 15% is incinerated with energy recovery in the three existing incinerators. Thus, the first promising investments in new waste infrastructure have been made in the past.

Although the effectiveness of some investments has been noted, the main option for municipal waste treatment is still disposal in landfills with an actual disposal rate of around 68%. Despite an encouraging increase in recycling rates (especially for paper and glass), CZ is unlikely to reach the 50% recycling target by 2020 without substantial investment.

CZ is self-sufficient for municipal waste treatment (sufficient capacity for landfills by 2050). However, in this context, the problem of overcapacity could arise in the future, thus avoiding the development of alternative waste management options, in particular recycling and energy recovery. Moreover, waste storage and incineration are relatively cheap (only a low fee is required for municipal waste disposal, currently about 20 € / t and there is no incineration fee).

To this end, recycling / composting may not be a valuable economic option without the introduction of new economic instruments. A higher recycling potential is especially identified for bio-waste (the current composting rate for municipal waste is around 12%). It should be discussed whether there are deficiencies for metal packaging waste (not enough boxes and metal boxes used in CZ) and according to [CZ EKOKOM 2012] for household paper waste.

Progress has been made on other packaging waste (eg beverages) in recent years: the guarantee on returnable packaging under the Packaging Act is set at a uniform amount for certain types of returnable packaging, refund systems have been introduced for glass bottles already in 1950 [OECD / EEA 2012] and commercial spaces larger than 200 m² are required to provide beverages in reusable packaging if this type of packaging is available on the market. However, there are problems on the part of the market to comply with this requirement [CZ FoE 2012]. For the selected types of returnable packaging, the guarantee levels have been aligned by a decree.

The 2019 EIR report confirms that, although progress has been made in particular in improving the infrastructure environment, the Czech Republic still has different levels of performance in effectively implementing environmental policies.

The Czech Republic is on track to meet the EU 2020 recycling target - according to the methodology chosen to comply - however much more effort is needed to meet the recycling targets set for the post-2020 period when the main recycling option waste treatment remains the storage system.

Air quality remains a significant issue. Although the national scheme to replace household boilers, supported by EU funds, is being implemented in some regions, the burning of domestic solid fuels remains the largest source of air pollution. Suspended particles, nitrogen dioxide, ozone and benzo (a) pyrene are the main concerns due to the health risks for citizens.

Examples of good practice:

- The national scheme, supported by EU funds, for the replacement of approximately 80,000 old and poor quality boilers in 300,000 households using solid fuels for heating;
- National education network through a single network of over 100 environmental non-governmental centres established in the last 20 years in all regions of the country .

Developed European countries have urban waste management strategies similar to rural areas. The challenges arise in the field of waste management for isolated areas and remote islands.

Thus, the 2018 conference on Waste Management in Islands and Remote Areas held in Malta focused on these issues through discussions and exchange of experience by various European public authorities, along with other presentations on how to improve the recycling performance of municipal waste in such areas.

Norway presented data from the remote Stavanger area.

Recyclable waste collected from households (2017):

- ❖ 46.1 kg / locality - all paper categories (approximately 84% of the total)
- ❖ 5.6 kg / locality - plastic packaging (approximately 32% of the total)
- ❖ 8.0 kg / locality - glass packaging (approximately 71% of the total)
- ❖ 2.3 kg / locality - metal packaging (approximately 28% of the total)

Note: a very effective refund system for plastic and metal bottles and boxes.

Paper: • System of baskets or underground containers

- Larger quantities of cardboard: recycling station or pick-up service

Plastics: • Recycling points, basket, bag or underground container

Glass and metal: • Recycling points, basket, bag or container.

Performance improvement measures:

- preservation of individual sorting systems; except for plastic and metal packaging - the waste is sent back to the residual waste to be sorted at a sorting station.
- the decision to build a new modern sorting plant of 11,000 m² for residual waste (start-up by the end of 2018);
- construction including a sorting line for "paper" and equipment for washing and pelletizing different categories of plastic;
- The fee for the collected waste expected at the same level or lower.

Results achieved:

- increasing the level of sorted waste for recycling from 65% today to over 75%;
- increasing the quality of materials for recycling;
- improving the 'GHG emissions footprint' of waste;
- inclusion of parts of commercial waste.

Malta, an island country in Southern Europe, consisting of an archipelago in the Mediterranean, has a special position in terms of waste management.

Ruth DeBrincat Tabone, Ministry of Environment, Sustainable Development and Climate Change, gave a brief presentation at the conference.

Malta is in a group of EU countries where the landfill rate is high.

Perspectives on waste management in Malta:

- maximizing the existing treatment capacity of the mechanical-biological treatment facility in Sant 'Antnin;
- the national launch of separate organic waste collection at source;
- modernization of the fleet of waste collection vehicles;
- harmonization of waste collection programs on islands;
- construction of a new mechanical-biological treatment plant in northern Malta (animal manure treatment);
- the construction of a waste transfer station in Gozo;
- assessment of the feasibility of an energy recovery waste recovery facility;

- providing additional revenue from commercial waste collection;
- promoting waste separation at the source and avoiding disposal at the landfill;
- collection of organic waste through specific contracts at regional level - three times a week;
- collection of dry recyclables: collection twice a week (where possible);
- collection of residual waste through funding allocated to Local or Regional Councils: three times a week in 2019 and twice a week in 2020;
- adopt a harmonized national waste collection program;

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Organic and residual waste	Recyclable waste	Organic waste	Residual waste	Organic and recyclable waste	Residual waste	-

- development of a model for setting fees for commercial waste collection;
- differentiated fees to stimulate waste separation;
- sanctions covering the non-compliance at the household level;
- sanctions targeting non-compliance at administrative level (Local and Regional Councils) (Performance monitoring system to be developed by the Department of Local Government).

Legislative amendments:

- the subsidiary legislation of CAP 363 to impose on the regions:
- separate waste collection at source;
- assigning responsibility for contributing to national objectives;
- ensuring that commercial entities enter into agreements with Local and Regional Councils for waste collection;
- defining reporting obligations and concluding data sharing agreements.
- legislation in favor of the obligation to separate waste.

Targets:

- prevention and minimization of waste;
- limiting the use of disposable plastic materials;
- creation of secondary markets - BCRS (Beverage Container Refund Scheme) a first step in addressing certain waste streams;;
- construction and demolition waste management.

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