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Waste management and its possible development in the Slovak Republic**

Abstract

This paper analyses the climate impacts of the individual waste management activities expressed in the waste management hierarchy. The author seeks to include the mentioned impacts in the Slovak reality of waste management. Moreover, this paper includes foreign approaches to municipal waste management and the analysis of the extent of merits and demerits of waste-to-energy plants. Herein, the author seeks to assess the current possibilities of heat and electricity production from municipal waste. According to the waste management hierarchy, the waste-to-energy approach is better and more suitable than waste landfilling (waste disposal). However, it must not collide with higher methods of waste management hierarchy. The mentioned principle should be respected when performing the waste-to-energy approach; however, some types of materials are not suitable for higher methods of the waste management hierarchy, such as personal protective equipment, including facemasks, protective clothing, helmets, goggles, or other garments, or equipment predominantly designed to protect the wearer's body from infection by COVID-19. Per my perspective, these waste materials are highly suitable for waste-to-energy production because of their depreciation caused by the possible infection. Therefore, the methods of prevention, re-use, or recycling are not applicable to them. However, these objects have the potential to serve as sources of energy. In my knowledge, Slovak legislation has not responded in a specific legislative way that would state how to manage the aforementioned objects. Thus, in general, this paper elucidates the possible development of waste-to-energy plants in the Slovak Republic and also describes the author's approach to the opportunities of the landfill backdown in the Slovak legal environment.

Keywords: waste management, COVID-19 pandemic, renewable energy sources, landfill

1. Introductory remarks

Recently, Slovak companies that are members of the Confederation of European Waste-to-Energy Plants (CEWEP), Association of Towns and Municipalities of Slovakia (ZMOS), and Association of the Automotive Industry of the Slovak Republic (ZAP) have joined the so-called *`Call from Berlin´*, whereby the Association of German Municipal Enterprises (VKU) calls on the EU to continue supporting the energetic recovery of waste. The aforementioned subjects have fully identified with the VKU and its current consensus regarding the waste-to-energy plants' irreplaceable role in the waste management hierarchy. The Call from Berlin builds on the experience of the German waste management model, which is currently the most advanced waste management system in the EU. The waste management model is based on a combination of recycling

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and the energetic use of non-recyclable waste at a high technological level. The authors of the Call claim that waste-to-energy plants are an essential part of services provided in the public interest for several reasons. First, according to them, no more sustainable alternative exists for treating non-recyclable waste streams. Nevertheless, this method enables the production of energy and recycling of inert components and metals in the circular economy while achieving European climate goals. Another reason for the greater involvement of waste-to-energy plants in Slovak waste management is the safe and hygienic recovery of non-recyclable waste and current production of energy in the form of heat or electricity. Additionally, the authors of the call argue that these facilities create suitable conditions for the diversion of waste from landfills, which are the most climatically unfavourable form of waste management. Finally, these facilities are pressurising the packaging policy of products intended for the final consumer, especially in relation to climate goals. Participants of the mentioned call claim that landfilling of untreated and biodegradable municipal waste has been banned in the Federal Republic of Germany since 2005. By 2015, this landfill ban reduced direct methane emissions from landfills by approximately 30 million tonnes of CO2eq. per year. This amount corresponds to a reduction in greenhouse gas emissions of 70% to 80% compared to the reference year 1990. Thus, the waste sector achieved, by far, the largest reduction in greenhouse gas emissions across all sectors.

The Association of German Municipal Enterprises based its call on the experience of German cities and municipalities, which – together with municipal waste management companies – highlight that waste-to-energy plants respect the waste hierarchy and best available techniques and must remain a pillar of waste management in the long-term horizon.[1]

Waste-to-energy plants' importance and contribution can also be appreciated during the COVID-19 pandemic, when hygienically critical waste was safely recovered in these facilities. The Call from Berlin did not go unnoticed beyond Slovakia. Gradually, other German and foreign institutions, cities, and municipalities, as well as companies conducting business in the waste management field have joined it. The Call has already been supported by the German Association of Towns and Municipalities, which

[1] The current landfill capacity in Germany will be depleted in about two decades. In some regions, some places already need to be compensated by the construction of new sites. When waste is delivered to a landfill, it must be tested to ensure that its limit values for pollutants do not exceed the limit values for the class of the landfill concerned. This applies to all types of waste, whether inert, non-hazardous, or hazardous. Some types of waste need to be treated to comply with the statutory limit values. In Germany, this is required by legislation based on strict limits on the concentrations of organic matter in all household waste. Biodegradable waste is landfill gas, half of which is methane, which is a gas with the strongest greenhouse effect. Preliminary processing includes forms such as incineration in waste incineration plants in conjunction with heat recovery. See: Umwelt Bundesamt 2022. In Germany, there also is a practice of the separate collection of organic waste and its subsequent composting, which began approximately 25 years ago. Since then, the use of recycled organic waste has been steadily increasing. According to the Federal Statistical Office (Statistisches Bundesamt), in 2011, approximately 14 million tons of organic waste were composted or converted to digestate (in biogas plants) for use as fertiliser. See: Umwelt Bundesamt 2022.

represents the interests of 11,000 towns and municipalities and entities, including approximately 96% of Germany and 68% of the German population.[2]

Currently, two facilities are orientated towards the waste-to-energy approach in Slovakia. However, considering our country's potential, up to 17 times as many such facilities are possible. The greatest benefit provided by these facilities is the direct supply of heat to consumers, whether in the form of steam or of hot water. In such a case, the waste-to-energy plant's efficiency can be above 80%. Another way of generating energy from waste is producing electricity. Efficiency in this area can be around 25%. A combination of heat and electricity generation is essential for the best use of energy from waste.

Slovakia has a huge advantage of expanding the central systems for heat supply, which have been used in our country since the 1960s. Contrariwise, Western European nations are building these systems only now, except for the Scandinavian countries, which are pioneers of this method of heat distribution. At present, the facilities in question in the EU produce electricity for 19 million people and heat for 16 million people. The mentioned amount of energy is produced from 88 million tons of waste per year. The mentioned amount of energy produced will replace 11–55 million tons of fossil fuels needed for the operation of power plants and heating plants and will prevent emissions of 24–49 million tons of CO2 that would be generated by burning fossil fuels. These facts reveal the potential of using waste as an energy source, especially in the context of the recent European energy crisis and volatile gas supply situation as basic raw material for domestic heating.[3]

2. Pandemic waste and its energetic potential

However, waste-to-energy plants do not always encounter a positive attitude from the public in question, which is particularly concerned regarding the on-site air pollution and high concentration of waste materials. Therefore, positively evaluating the initiative of the interest association of the Slovak cities and municipalities is possible. This association primarily ensures an initial contact with representatives of territorial self-governments, and also provides professional training to its members, and implements the right to territorial self-government for individual cities and municipalities in Slovakia. It is true that the waste hierarchy requires more climate-friendly ways of dealing with waste, such as waste prevention and the reuse of waste materials. On the contrary, indubitably, the COVID-19 pandemic has increased the pressure on the management of non-recyclable waste, which is primarily represented by personal protective equipment.[4]

[2] See: ZMOS 2022

[3] See: EWIA 2022

[4] Globally, there has been growing concern that discarded surgical masks, medical gowns, face shields, goggles, protective aprons, disinfectant containers, plastic shoes, and gloves generated by the COVID-19 pandemic could end up in our aquatic ecosystems. In March 2020, there was an avalanche of COVID-19 cases worldwide. Medical facilities worldwide were faced with shortages of gloves, surgical masks, face masks and other protective medical equipment. Commonly available and recommended types of protective equipment include N95 and KN95 respirators and surgical masks designed for maximum filtration of aerosols and airborne infectious particles, which protect the user from respiratory diseases, including COVID-19, by filtering airborne

Additionally, the aforementioned disease and its pandemic spread brought the operations of waste collection facilities to a halt e.g. in Italy. Moreover, it increased illegal landfills in parts of 2020. The assessment of the pandemic's impact on the management of municipal waste in the mentioned country revealed that only 2 of the 16 analysed municipalities exhibited an increase in the amount of mixed, paper, and packaging waste collected in the first half of 2020, compared to the same period of the previous year. In the other localities, this extent decreased, and in three of them, the extent declined even more significantly. Data on the amount of kitchen waste indicated a decreasing trend in the collected biological fraction in the March–May 2020 period, with decreases of 6–67%.[5]

infectious particles. N95s are tight-fitting respirators, while surgical gowns are loose-fitting medical masks designed in various thicknesses and water-penetrating capabilities. Both types are wearable devices that must be disposed of after a single use. According to various recommendations, respirators, surgical drapes, and face masks are labeled as disposable medical devices or single-use respiratory protection devices and should be disposed of in a *plastic bag* after use and, thereafter, thrown away in the basket. Human activities on land, such as unregulated disposal of biomedical waste, are generally considered potential sources of toxic, infectious, and radioactive pollutants. Medical waste usually includes chemical, pathological, pharmaceutical, radioactive, and general waste. Most of this waste is produced from plastics and predominantly includes common waste, such as syringes, gloves, surgical masks, surgical and isolation gowns, face shields, shoe covers, disinfectant containers, and waterproof aprons. The COVID-19 pandemic has created a great deal of biomedical waste in the form of plastic wastes. In China, where COVID-19 first originated, the Office of Emergency Situations of the Ministry of Ecology and Environment documented a 23% increase in the amount of medical waste produced and processed. Thus, China witnessed the accumulation of 142,000 tons of medical waste, with the national medical waste processing capacity increasing from 4902.8 tons per day before the outbreak of SARS-CoV-2 to the current 6022 tons per day. The amount of plastic waste generated worldwide since the pandemic's outbreak is estimated at 1.6 million tons per day. At the same time, prognoses indicate that approximately 3.4 billion disposable face masks or face shields have been thrown away daily because of the COVID-19 pandemic. Arguably the largest population worldwide, China generated nearly 702 million discarded face masks per day and could potentially produce around 108 million tons of plastic waste by the end of 2020. See: Bensona, Bassey & Palanisamic 2022.

[5] The years 2020 and 2021 saw a production of plastic waste approximately 30% greater than that in 2019. Certainly, recycling systems worldwide had to react to the mentioned onslaught, which began falling apart predominantly owing to the budgetary demands. Where then did all this extra plastic go? In the Western world, much of it ended up either in landfills (primarily in North America) or incinerated (primarily in Europe), and a small amount – approximately 10% on average – was recycled. The US has about 9,000 recycling facilities, most of which are operated by municipalities and tied to local budgets. As individual states bear the brunt of the health and unemployment costs associated with COVID-19, some municipalities had to suspend their recycling services. Cases have begun emerging in states such as Illinois, wherein recycling programmes have ended. Cities such as Omaha and New Orleans have considered massive cuts to save money. In the developing world, plastic ends up – often in a poorly managed stream – in open dumps, eventually escaping into the environment and ending up in rivers and then oceans. Most minimum financial resources intended for waste management infrastructure in developing economies have been reassessed owing to the COVID-19 pandemic. What occurred in the US and Europe was, thus, amplified even more in the economies of countries such as Indonesia, Brazil, India, Kenya, Guatemala, and Haiti. Fifteen million waste-pickers in developing countries

The two-thirds drop occurred in a group of Portuguese cities and towns totalling nearly a million residents, where they reduced the frequency of the door-to-door collection from every other day to twice a week. Practice in Slovakia also clearly points to increased pressure on waste management in the area of local self-government. Food packaging from delivery services, face masks, respirators, and other protective equipment could be included among the most common waste materials during the pandemic. Therefore, waste generation has shifted from offices to households. As residents spent more time inside their residences, they produced more household waste. Therefore, municipalities and cities noted an increase, precisely in the removal of waste from households. A certain amount of hazardous waste was also generated by municipalities during antigen testing for SARS-CoV-2.[6] Currently, pressure on municipal waste management may have also been created by so-called home antigen self-testing. Used antigen tests, protective clothing, and other protective equipment make up a non-negligible, indeed substantial portion, of mixed municipal waste. Municipalities must ensure the disposal of hazardous medical waste by specialised companies.[7]

The situation in Slovakia, in my opinion, was not completely clear and understandable. The legislation differentiated and classified the danger of potentially infected waste according to who its originator was. At the end of last year, the Ministry of the Environment of the Slovak Republic issued a new guideline that explained how to deal with waste from testing for COVID-19 in companies and where to throw away used tests. According to the mentioned material, the relevant fact was who performed the test

collect plastic on the streets. In recent years, some waste-collecting communities have been forced to collect twice as much plastic as they used to for the same amount of money. In some cases, this has discouraged them from capturing plastic at all because other materials are more valuable. In the case of a combination of factors, such as the breakdown of recycling infrastructure in the West and escalation of single-use plastics in the developing world in connection with COVID-19, we can discuss the so-called plastic tsunami in the world's oceans. Ford 2022.

[6] The European Union has also reacted to the mentioned facts. The European Environment Agency published a report entitled Impacts of COVID-19 on single-use plastics in the European environment, according to which, responses to COVID-19 have increased the use of certain products made from single-use plastics over a long period of time. The increased production and consumption of masks and gloves, which are necessary to protect people's health, and certain types of food packaging have resulted in the creation of additional greenhouse gas emissions, as well as the production of waste that can harm ecosystems and animals. The import of protective masks and gloves into the European Union more than doubled during the first half of the pandemic, and the domestic production of the mentioned products within the Union market also grew. A report of the European Environmental Agency estimated that about 170,000 tons of additional protective masks were imported into the Union in the mentioned period, or approximately 0.75 protective mask per person per day, resulting in additional greenhouse gas emissions and other types of pollution. Further, the document estimates that reusable cotton masks are a greener alternative, as they can be used for approximately 13 washings in a home washing machine; nevertheless, the report also noted that reusable masks may not provide the same level of protection, which was a major driver of increased demand after disposable protective equipment. Likewise, in the Union, restrictions on movement, freedom of assembly, and freedom of business have caused restaurant closures, thus increasing the demand for food delivery and associated production of packaging. European Environment Agency 2022

[7] Ďurianová 2022

and where the tests had been conducted. According to several sources, waste from coronavirus testing was a contentious issue for all companies that had to provide testing for their employees. However, testing for COVID-19 was not only provided by companies. According to the guidelines of the Ministry of the Environment of the Slovak Republic, the correct handling of used tests and other waste that was generated during testing depended upon which entity performed the testing. The document distinguished several different options for dealing with the mentioned type of waste. The first group performing testing were natural persons, businesses, and legal entities. Provided that the mentioned entities were not in the position of a medical facility, nor operated a general or specialist doctor's clinic, they were obliged to place the waste generated during testing for the presence of COVID-19 in black containers. This obligation depended on the condition that the waste was created by testing with self-diagnostic tests. Another possible situation distinguished by the document was when the testing had been conducted by a natural person-entrepreneur or a legal entity that was a medical facility. Such subjects can be, for example, mobile specimen collection stations, hospitals, and general or specialist doctor's clinics, including those located in the operation of a natural person-entrepreneur or legal entity. In accordance with Art. 14 sec. 1 letter f) of the Act no. 79/2015 Coll. on waste and on the amendment and supplementation of certain laws as amended (hereinafter referred to as the Waste Act), in such a case, the originator of the waste was obliged to keep the records on the generation and management of waste. Additionally, under Art. 14 sec. 1 letter g) of the Waste Act, such a person was obliged to report necessary data from the register to the competent body of the State Administration of Waste Management and to store the reported data.[8] Moreover, municipalities that conducted testing through mobile specimen collection stations had a legal obligation to proceed in the same way. In that case, they were considered the originators of pandemic waste. This obligation also applied to testing conducted by concluding a contract with an existing health care provider. In that case, the originator of the waste was a third party, i.e., the entity with which the municipality had contracted to test for COVID-19.[9]

The Ministry of the Environment of the Slovak Republic referred to the opinion of the Public Health Office of the Slovak Republic when distinguishing the aforementioned situations. In simple terms, the ministry distinguished between situations in which the originator of probably contaminated waste was a household or employer, and between situations wherein the waste had been generated by a medical facility or municipality. According to the opinion of the Public Health Office of the Slovak Republic, the protection of the health of employees from risks related to exposure to biological factors at work is regulated by the Regulation of Government of the Slovak Republic No. 83/2013 Coll., which establishes the requirements of the European directive for the protection of the health and safety of employees from the risks of exposure to biological factors at work. This regulation concerns employees whose work with biological factors is of the nature of long-term work. Biological waste management in medical facilities is governed by the Decree of the Ministry of Health of the Slovak Republic No. 553/2007 Coll. on the requirements for the operation of medical facilities

[8] See: MŽP SR 2021

[9] See: Slovak Ministry of the Environment 2022

from the perspective of health protection. These legal regulations are intended for specific work activities associated with exposure to biological factors at specific employers, e.g. in medical facilities, veterinary care facilities, laboratories producing vaccines, waste disposal plants, and waste-water treatment plants. Thus, these legal regulations are intended for specific subjects for which they establish a number of special requirements and obligations.[10]

Therefore, companies and individuals (households) had the obligation to handle the mentioned waste as a material of category 20 03 01 – mixed municipal waste. The aforementioned entities had, therefore, proceeded in accordance with the generally binding regulation of the given municipality. The Public Health Office of the Slovak Republic recommended storing the waste from self-diagnostic tests in strong plastic bags, sprayed with a commonly available disinfectant solution, tied off, and then disposed of in municipal waste. A completely different procedure for handling waste from testing was specified in the guidelines of the Ministry of the Environment of the Slovak Republic in cases wherein the waste had been generated by parties other than companies and households. In this case, the waste from testing for COVID-19 had been classified under catalogue number 18 01 03 – waste, the collection and disposal of which are subject to special requirements from the perspective of infection prevention (hazardous waste). This waste must not be mixed with other types of waste. The aforementioned generators of waste from testing had to hand over the generated waste to a person authorised to dispose of waste according to the Waste Act, i.e. to a person to whom the relevant consent by a state authority had been granted. In the given case, such entities had to ensure the transport of the mentioned waste to facilities for energy recovery of waste.[11]

Above all, the approach of the Ministry of the Environment of the Slovak Republic, which realised the impossibility of recycling the mentioned wastes and emphasised their energy potential, can be perceived positively. On the contrary, the probable infectiousness of the same waste from an originator who is a household or an employer will, in principle, not differ from the probable infectiousness of the waste created by a medical facility or municipality during testing for the COVID-19 disease. In my opinion, the aforementioned fact shall also apply in the case of waste generated by using personal protective equipment, such as protective masks, respirators, protective shields, and gloves.

3. Possible risks to the environment of waste-to-energy facilities

However, to summarise the previous data and facts in the context of waste-to-energy facilities, some opinions object that the so-called a `waste-to-energy´ approach can encourage waste production and discourage recycling to ensure regular incinerator feedstock. These facilities do not have a desirable reputation owing to the released toxins and greenhouse gases. In a similar vein, some NGOs present an opinion that the above approach has no place in the circular economy, because in the future, waste-to-energy facilities shall lose their input when there is nothing left to burn. However, the European Commission itself opines that waste-to-energy processes can play a role in the transition

[10] MŽP SR 2021

[11] Slovak Ministry of the Environment 2022

to a circular economy, provided that the EU waste management hierarchy is used as a guiding principle and that the decisions taken do not hinder a higher level of prevention, reuse, and recycling. This does not automatically imply that the Commission is positively inclined to the mentioned facilities because, at the same time, it presents a certain concern regarding the suppression of recycling and disruption of the hierarchy. However, waste-to-energy facilities must fulfil the requirements established in the Industrial Emissions Directive. Even before the pandemic, the Commission itself allowed the existence of input materials that corresponded to the waste-to-energy approach and, simultaneously, respected hierarchy as a fundamental principle of waste management. This is also why European regulations have established the obligation for member states to consider within their waste policies the availability of materials that are necessary for operating a waste-to-energy facilities during their lifetime, i.e. 20–30 years from start-up. At the same time, by operating such a facility, the member state must not neglect the superior principles of the hierarchy.[12]

While there is some scepticism towards waste-to-energy facilities from the perspective of waste management, the situation differs from the perspective of renewable energy. Biomass (which includes the biodegradable part of municipal waste) was and is one of the renewable energy sources defined in the Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.[13] The inclusion of the organic part of municipal waste in the definition of potential renewable energy sources has enabled the Member States to fulfil their national renewable energy targets through the waste-to-energy sector. Statistically speaking, biomass and waste are the largest sources of `renewable energy´ in Europe, representing 63.1% of the total share of renewable energy sources.[14] In November 2016, the Commission published the Clean Energy for All Europeans strategy called the `Winter Package´, wherein it recommended setting a new target of at least 27% renewable energy sources by 2030, according to the aforementioned directive, among the eight legislative instruments.[15] However, the Parliament reiterated its demand for a binding target for at least 30% of total energy consumption to come from renewable energy sources by 2030. Therefore, biomass has enabled the Member states to fulfil the EU's ever-increasing renewable energy target. At the same time, per expert opinions, maintaining the hierarchy of waste management is not climbing the ladder. Incineration with high efficiency energy recovery can be understood as waste recovery, and anaerobic digestion can be considered recycling. Thus, the stated opinions have two consequences. First, they support the conclusion regarding the climatic disadvantage of landfilling waste. Further, they state that waste-to-energy facilities should play a role in waste management and contribute to the coexistence of EU policy in the field of waste management, energy union, and environmental policy (climate change). Therefore, they are intended to enable

[12] European Commission 2022

[13] Čl. 2 ods. 24 uvedenej smernice vymedzuje biomasu ako *biologicky rozložiteľné časti výrobkov, odpadu a zvyškov biologického pôvodu z poľnohospodárstva vrátane rastlinných a živočíšnych látok, z lesného hospodárstva a príbuzných odvetví vrátane rybného hospodárstva a akvakultúry, ako aj biologicky rozložiteľné časti odpadu vrátane priemyselného a komunálneho odpadu biologického pôvodu.*

[14] Eurostat 2014

[15] European Commission 2016

the Member States to fulfil their objectives linked to these policies, particularly in relation to resources and energy efficiency.[16]

4. Climatic impacts of landfills

Information regarding the carbon footprint of landfills and amount of greenhouse gas emissions produced by municipal waste landfills from individual cities in Slovakia resonated in the Slovak media recently. The truth is that the climate impacts of landfills were not discussed in the media and by the public until recently. The attitude towards climate change was primarily influenced by industry, economic production, transport, and motoring.[17] The current climate crisis has sparked discussions on the causes of global warming and is gradually starting to draw attention towards municipal waste landfilling's effects. The professional public highlights the fact that when considering all methods of waste management, considering multiple aspects is necessary. One is the condition that there is no damage to other components of the environment. The stated condition results from the environmental policy enshrined in Art. 191 par. 2 of the Treaty on the Functioning of the EU. A primary goal for the future – also in terms of the hierarchy of waste management – remains the greatest possible removal of waste by placing it in landfills. Therefore, the professional public claims that for the stated purpose combining measures, such as waste recycling and their energy use, is necessary. On the contrary, science adds that excessively focusing on building facilities for the energy use of waste can lead to air damage and gives examples from the Swedish environment.[18] Despite the aforementioned facts, waste disposal remains at the bottom of the waste management hierarchy. Although the law enshrines fees associated with the operation of waste landfills, which are a manifestation of the polluter-pays principle, the importance of the aforementioned principle in environmental law must also be seen in the context of the precautionary principle and prevention principle.[19]

If we wish to apply the aforementioned principles to the Slovak reality, whether we could apply them properly is questionable.[20] In the field of environmental law of the

[16] See: Malinauskaite et al. 2017

[17] In particular, German courts recently dealt with the qualitatively unsatisfactory state of the air in cities. In the German environment, court decisions in relation to the cities of Frankfurt and Berlin, which ordered them to update their air quality plans, resonated in particular. See: Vodička 2019.

[18] See: Dosoudil 2017

[19] See: Vícha 2014

[20] According to the principle of prevention, the essence of environmental protection is primarily the prevention of damage to the environment. The basic premise of this principle, according to professional literature, is that it is preferable to prevent the occurrence of damage or injury than to try dealing with its consequences thereafter. The principle of prevention requires that environmental protection be ensured already at the planning stage at the best possible technical level. Its goal is, as far as possible, to exclude the deterioration of the environment from the beginning and, in the event of adverse effects on the environment, to ensure their minimisation. The principle of prevention is a general legal principle operating across all branches of law. However, it plays a key role in environmental law and can be considered one of the supporting principles on which the said area of law stands. See: Luptáková Urbanová & Figuli 2022.

Slovak Republic, the principle of prevention can be found in Art. 9 of Act no. 17/1992 Coll. on the Environment.[21] Thereafter, the precautionary principle is enshrined in Art. 13 of Act no. 17/1992 Coll. on the environment.[22] The precautionary principle, like the prevention principle, belongs to the newer and more modern principles of environmental law. The difference between the principle of prevention and precautionary principle basically lies in the certainty of the risk of potential damage.[23]

About four years ago, the European Union pointed to the high level of waste landfilling and, simultaneously, to the low fees for this method of waste management. In the period in question, the recycling rate in Slovakia reached approximately 15%-20%, while other EU countries reached an average of 46%. A key reason Slovakia failed to increase the rate of recycling was because landfilling was cheap, and, in several cases, it was not worth recycling (from an economic perspective). Thus, a great deal of waste ended up in the landfills. All countries that have changed landfill fees and increased fees have also changed the targets achieved in the area of recovery and recycling, achieving them at a significantly higher rate. In the mentioned period, Slovakia was in the 27th place among the 28 EU countries in the field of waste recovery and recycling. Only Malta achieved worse results in this area, landfilling up to 98% of waste.[24]

Low fees for landfilling, then, do not correspond to the requirements of the polluter-pays principle, which is supposed to act as an economic tool contributing to a high level of protection in the mentioned area. Consequently, the quantity of landfills, which are the `weakest´ tool in the waste management hierarchy, may not correspond to the principle of prevention in environmental law. At the same time, waste landfills' climatic impacts may not correspond to the content requirements of the precautionary principle if the law also distinguishes more favourable instruments of waste management.

However, experience in the field of municipal waste management also presents examples of positive practice in Slovak cities. Recent information underscore the Košice reality. From the perspective of waste management, the mentioned city is the most ecological city in Slovakia. This results from calculations that also include metal recycling, which has the merit of better statistics, that indicate that the carbon footprint of Košice is at the level of 132 kilogrammes of carbon dioxide equivalent (CO2) per one ton of

[21] Under this provision: *"Environmental protection includes activities that prevent pollution or damage to the environment or limit and eliminate this pollution or damage. It includes the protection of its individual components, or specific ecosystems and their interrelationships, but also the protection of the environment as a whole."*

[22] Under this provision: *"If, taking into account all the circumstances, it can be assumed that there is a danger of irreversible or serious damage to the environment, the doubt that such damage will actually occur must not be a reason for postponing measures to prevent damage."*

[23] The essence of the precautionary principle is, therefore, the obligation to always decide in favour of the environment in cases wherein a sufficient amount of accurate and unambiguous information regarding the possible consequences of decisions for the environment is not available within the decision-making process. This implies that when in doubt about the possible consequences of a decision, one cannot rely on the fact that these negative consequences will not occur, but on the contrary, assume that they will occur. If such a decision were to be issued in favour of the intended activity in the aforementioned situation, it must always be preceded by measures that would prevent – or at least minimise – the occurrence of negative consequences for the environment to the lowest possible level. See: Luptáková Urbanová & Figuli 2022

[24] Maleš 2022

municipal waste. The capital of Slovakia ranked second with a value of 243 kilogrammes. All other regional cities have a carbon footprint above 350 kilos of CO2 equivalent per ton of municipal waste. The carbon footprint levels differ in the individual regional cities of Slovakia. On a positive note, however, the rate of sorted collection or recycling in regional cities is growing from year to year. The better statistics are attributable to the high proportion of metals in the analysts' sorted collection. The contribution of metal recycling represents up to 85% of all avoided greenhouse gas emissions, and the largest carbon footprint is left by the disposal of waste in landfills. The impacts of landfills are reflected in their methane production. From one ton of municipal waste landfilling, 870–880 kilos of carbon dioxide equivalent are produced. Last year, 1.17 million tons of municipal waste ended up in landfills in Slovakia, corresponding to a carbon footprint of one million tons of carbon dioxide equivalent. For comparison, a similar carbon footprint will be left behind by 15,000 passenger cars that travel the return route between Bratislava and Košice every day during the year. At the same time, analysts highlight greenhouse gas emissions arising from the energy recovery of waste in the form of electricity or heat production. However, the mentioned production represents, to a certain extent, a saving, compared to the emissions during the production of energy from classic fossil fuels. The same approach is used to determine the impact on climate change when evaluating `avoided´ emissions in the case of composting and recycling. Avoided emissions are those that have not been released into the air through the use of lower or no-emission practices. Thus, waste can act as a raw material mitigates the use of primary resources, which are primarily natural resources. In the case of bio-waste composting, the net emission value is − 74 kilogrammes of carbon dioxide equivalent per one ton of waste. When recycling one ton of waste, the saving ranges from − 181 kilos of CO2 equivalent in the case of e-waste to − 5891 kilos of CO2 equivalent in the case of textiles.[25]

5. Comparing the climatic impact of waste-to-energy facilities with landfills

An example of the already-mentioned Swedish approach can be the city of Linkoping, whose waste-to-energy facility recovers waste in a boiler under a 10-story shaft. The temperature in the mentioned environment reaches approximately 815 °C, and the process runs 24 hours a day to help power the waste-to-energy plant. In total, Sweden has built 34 power plants to produce energy from waste. Instead of burning coal or gas, these devices burn garbage. For comparison, about 4 tons of waste contain energy equivalent to 1 ton of oil, 1.6 tons of coal, or 5 tons of wood waste. According to data from the mentioned country, less than 1% of household waste goes to landfills. Approximately 49% of household waste is recycled, and approximately 50% of waste is incinerated in power plants. The heat is converted into steam, which spins turbines to produce electricity, like conventional coal or gas-fired power plants. Hence, waste energy provides heat equal to energy for 1.25 million apartments and electricity for approximately 680,000 households. Generally, the energy output when generating electricity is only approximately 40%. However, the aforementioned power plant can use up to 90% of energy in the form of heat and electricity-combined production. Moreover, this device is subject to criticism regarding emissions. On the contrary, it helps reduce

[25] Fontech 2022

methane emissions from landfills, which contribute to climate change up to 72 times more intensively. Despite this, energy conversion of waste is a short-term but, simultaneously, reasonable means of dealing with waste. It is less carbon intensive than coal and uses resources more efficiently than landfilling. In a landfill, these resources would still decompose and release greenhouse gases.[26]

Regarding the Slovak Republic, current studies in the field of environmental law and criminal law highlight that the basic factors in the field of unauthorised waste management are primarily caused by the lack of interest of the individual (as the source of waste), but are shared by the competent authorities, which are municipalities, district offices, the Ministry of the SR environment, as well as police authorities. A review conducted by the General Prosecutor's Office of the Slovak Republic in 2016 clarifies that all the aforementioned authorities did not fulfil their tasks sufficiently at the given time, which was also the reason for the high incidence of the crime of unauthorised disposal of waste according to Art. 302 of Act no. 301/2005 Coll. Criminal Code (hereinafter referred to as the Criminal Code)[27] and high latency. Municipal authorities often do not have sufficient capacity and do not report illegal waste dumps, of which they are often aware, and also because they would have to bear the financial burden of their removal themselves in the event that the offender is not detected. In the period of control carried out by the General Prosecutor's Office of the Slovak Republic, the level of clarification of the aforementioned crime was approximately 10%. Thus, municipalities would almost always have to bear the cost of liquidation of illegal landfills, for which they often do not have sufficient budgetary provision, from their own budgets. In this context, the science of environmental law emphasises the high need for prevention in the field of municipal waste management and the need for education and training in consistently applying the waste management hierarchy.[28]

Waste-to-energy facilities in the US burn municipal solid waste to produce steam in a boiler, which is then used to generate electricity.[29] The European Union is also aware of the aforementioned contribution of waste to electricity production. The EU's plans to become climate-neutral by mid-century further fuel the raging debate regarding the environmental impacts of burning waste for electricity generation. The sector provides a small but significant proportion of the EU's total energy supply, with Germany being the largest consumer. In the EU, waste-to-energy facilities also use household waste as fuel for energy production, like how other power plants use coal, oil, or natural gas. The principle of their operation is basically the same as that in the United States.

[26] Yee 2018

[27] Under the Art. 302 of the Criminal Code: *"(1) Whoever, even through negligence, disposes of waste on a small scale in violation of generally binding legal regulations shall be punished by imprisonment for up to two years. … (2) The offender shall be punished by imprisonment for six months up to three years, if he commits the act referred to in section 1 … a) and puts the environment at risk of greater damage, or … b) and by such act places another in danger of serious injury or death. … (3) The offender shall be punished by imprisonment for one up to five years, if he commits the act referred to in section 1 to a significant extent. … (4) The offender shall be punished by imprisonment for three up to eight years, if he commits the act referred to in section 1 … a) and causes serious injury or death by it, or … b) on a large scale."*

[28] Kučerová 2019

[29] U.S. Energy Information Administration 2020

In 2018, in the EU, the total energy production from all waste (industrial waste, solid municipal waste, non-renewable waste) represented approximately 2.4% of the total energy supply. Municipal solid waste accounts for only approximately 10% of the total amount of produced waste that can be used in facilities for the energy recovery of waste. Changes in waste management legislation – predominantly owing to factors such as requirements for the gradual end of landfilling – caused a dramatic increase in the incineration of waste and, therefore, its energy use. Statistics indicate that the amount of municipal solid waste incinerated in the EU increased from 32 million tons (67 kg per capita) in 1995 to 70 million tons (136 kg per capita) in 2018. At the same time, this underscores that the mentioned phenomenon resulted in a 56% reduction in the share of landfilling. The production of energy from waste in 2018 in the EU was the highest in Germany (7.1 MWh). During this period, Great Britain was still a member of the Union and ranked second in the ranking of producers of energy from waste (4.4 MWh). These states were followed by France (2.5 MWh), Italy (2.4 MWh), and the Netherlands (2.2 MWh). German indicators suggest that the proportion of energy utilisation of waste in this country represents 4.3% of the primary energy consumption in Germany. At the same time, the measurements indicate that up to 18 million European citizens receive electricity produced by waste recovery and approximately 15 million inhabitants heat their homes with heat from waste-to-energy facilities.[30]

Energy recovery significantly affects the volumes of greenhouse gases, especially in Germany and the EU. Proponents claim that the production of heat and electricity in European incinerators prevents the production of up to 50 million tons of CO2 emissions per year, which would otherwise be caused by the burning of fossil fuels. Additionally, this burning diverts waste from landfills, which release huge amounts of methane and also cause air, water, and soil pollution. Thus, the fact, that conventional landfills represent the worst of all options for waste is one of the few facts on which supporters and critics of energy recovery agree.[31]

The production of electricity or heat is only considered secondary by the professional public. Currently, the Union is exerting enormous efforts to develop activities in the area of the circular economy. However, the continent's ambitious waste recycling plans could mean that most of the waste-to-energy generation could eventually become obsolete. The truth is that in the hierarchy of waste management, the goal of energy recovery of waste lies above landfilling. However, this method of waste management is subject to recycling and reuse. The mentioned hierarchy is established by Art. 4 sec. 1 of Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives.[32] Moreover, this directive established European households' obligation to recycle or prepare for reuse 50% of the weight of waste materials, such as paper, metal, plastic, and glass, from 2020. The recycling and preparation for re-use of municipal waste should, subsequently, increase to at least 55%, 60%, and 65% by weight by 2025, 2030, and 2035, respectively.

[30] Clean Energy Wire 2021

[31] Clean Energy Wire 2021

[32] Under the mentioned provision: *"1. The following waste hierarchy shall apply as a priority order in waste prevention and management legislation and policy: (a) prevention; … (b) preparing for re-use; … (c) recycling; … (d) other recovery, e.g. energy recovery; and … (e) disposal".*

The European Commission's new Circular Economy Action Plan (CEAP) aims to lower residual waste by 2030. The European Parliament's CEAP report calls for waste incineration to be minimised, while also asking the Commission to define an Europe-wide approach towards managing non-recyclable residual municipal waste, which ensures its optimal processing. The mentioned document warns against building excessive waste incineration capacity, which could hinder the circular economy's development.[33] The EU's pursuit of climate neutrality raises a large question mark over the future of electricity production by burning waste. Proponents suggest that waste-to-energy recovery prevents even more environmental damage from landfills. Some power plants are promoting a waste-to-energy approach to supplement renewable electricity as part of a decarbonised future. However, critics of this approach are urging immediate decommissioning. The continent's ambitious recycling and circular economy plans are another risk for the industry, as most waste-to-energy generation could eventually run out of fuel and become obsolete.[34]

Under Slovak conditions, energy recovery of waste is regulated by Act no. 79/2015 Coll. on waste and on amendments to certain laws.[35] The conditions for incinerating municipal waste are, subsequently, regulated by Art. 18 sec. 2 of Act no. 79/2015 Coll.[36] Thus, incineration should aim to obtain energy, and it should, by its very nature, be an activity whose primary result is, in accordance with Art. 3 sec. 13 of Act no. 79/2015 Coll., a beneficial use of waste to replace other materials in the production activity or in the wider economy, or to ensure the readiness of waste to fulfil this function. At the same time, considering the requirement of Art. 58 sec. 5 of Act no. 79/2015 Coll. – according to which support for energy recovery is taken into account when determining the rate of recovery and the rate of recycling, if it is preferred over recycling for environmental and economic reasons – is necessary. Waste recovery in the mentioned manner should, therefore, follow environmental goals and economic goals simultaneously. Environmental goals will be expressed primarily by Art. 15 of Act no. 137/2010 Coll. on air (hereinafter referred to as Act No. 137/2010 Coll.), which, in section 1 letter p), establishes the obligation of the operator of a large or medium source of air pollution. A waste-to-energy facility may also be a listed polluter, insofar as it operates with a capacity of two or more tons of incinerated waste per hour. In that case, it is obliged to

[33] Clean Energy Wire 2021

[34] Clean Energy Wire 2021

[35] Under Art. 18 sec. 1 of this Act *"Communal waste incineration in municipal waste incinerators is considered waste recovery by activity R1 according to Annex no. 1, if energy in the form of heat or electricity is produced for commercial purposes and if the energy efficiency of such equipment is equal to or higher than … a) 0.60, if it is a device that received a permit to operate until December 31, 2008 in accordance with generally binding legal regulations,37) or … b) 0.65, if it is a device that received a permit to operate after December 31, 2008."*

[36] Under Art. 18 sec. 2 of this Act "*Incineration of non-municipal waste in waste incinerators is considered energy recovery of waste by activity R1 according to Annex no. 1, if the following conditions are met: … a) it is an activity mentioned in § 3 par. 13, … b) the purpose of waste incineration is energy production, … c) the energy obtained by this incineration of waste is greater than the energy consumed during the incineration process, … d) a larger part of the waste must be consumed during waste incineration and … e) the greater part of the energy obtained during the incineration of waste must be evaluated and actually used, whereby the said use is either immediate in the form of heat obtained by incineration, or after processing in the form of electrical energy."*

prepare an annual report on the operation and control of the source of air pollution.

The said document must, thereafter, be submitted to the district office by 15 February of the following year. The report must include an evaluation of the operation of the source of air pollution and a comparison of actual emissions into the air and water with emission limits. For violating the aforementioned obligation, the district office or environmental inspection imposes a fine on the operator of the facility in the range of EUR 160 to EUR 33,000, according to the Art. 30 sec. 3 letter a) of Act no. 137/2010 Coll. This conclusion is also confirmed by case-law.[37]

6. Conclusion

Opinions on the management of municipal waste in Slovakia differ. The truth is that the high rate of landfilling in Slovakia is an undesirable reality. On the contrary, there are intentions to operate facilities promoting other methods of waste management, which are more favourable from the perspective of the hierarchy of waste management. However, even these do not escape criticism. If we were to consider the energy recovery of waste, it cannot be claimed to be a perfect means to deal with it. On the contrary, neither law nor scientific and technological progress are perfect, but they try responding to past experience and current environmental reality and, simultaneously, plan and prepare solutions for a more favourable climate future, i.e. at least one that will not deteriorate compared to the reality today.

In Slovakia, only two mentioned waste-to-energy facilities are currently in operation, in Bratislava and Košice. The diversified orientation of the mentioned facilities' activities can certainly be considered beneficial. For the village or city where it is located, a waste-to-energy facility is primarily an extremely cheap source of heat. Its production develops from the beginning or end of the heating season, and with the onset of autumn, the waste-to-energy facility is dominantly oriented towards the distribution of the produced heat; then, during the spring, there is a moment when the produced heat is used to drive the turbine, which generates electricity. Operating such a device includes four stages of flue gas cleaning and subsequent monitoring in the device's chimney. Moreover, the technologies also enable the capture of carbon dioxide at the output of the device, which can subsequently be used in agriculture for the production of ornamental plants. The emission limits of the equipment are stricter than those for coal-fired power plants or cement plants.[38]

A further positive example can be adduced of the city of Vienna, where up to four such facilities operate and generate heat from the waste of 210,000 households. Their electricity is used in 45,000 households. Considering the number of Viennese households of 900,000, one can even discuss a strategic share in the case of heat.

[37] For example, the Supreme Administrative Court of the Czech Republic pointed at this part of the Slovak legislation in its decision no. 6 As 288/2016 of 20 December 2017.
[38] EWIA 2021

The remainder of the produced heat and electricity is either consumed by the waste-to-energy facilities themselves or is distributed to nearby industrial plants.[39] One can definitely discuss the negatives in the case of the mentioned devices in the form of emissions into the atmosphere, which are, however, lower than the emissions of waste landfills. Therefore, it is important that decisions on the establishment and operation of the mentioned facilities be taken responsibly and not simultaneously negate the waste management hierarchy's superior goals.

[39] HN Online 2022

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