HEAT CONSUMPTION AND HAZARDOUS WASTE MANAGEMENT IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT. CASE STUDY BASED ON ECONOMIC PERFORMANCE IN ROMANIA

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Abstract

In the context of climate change, population growth and resource-intensive lifestyles, the analysis of thermal energy consumption and hazardous waste management can provide a useful picture of the current situation in Romania. Eco-management of waste and the use of secondary materials in it are key elements of the European Union's environmental policy. Thus, the European Union's waste policy aims to contribute to the circular economy by extracting high-quality resources from waste as much as possible. According to the European Commission, energy production and consumption are responsible for 75% of greenhouse gas emissions, and in terms of waste, a European citizen produces an average of 5 tonnes of waste per year. Unfortunately, only 38% of waste produced in Europe is recycled and more than 60% of household waste is still improperly stored in the Member States. Thus, the European Union's waste management policy sets targets and targets to improve waste management, stimulate innovation in recycling and limit waste disposal. In addition to the European Union's Waste Management Policy, the importance of this issue is set out in both the European Green Pact and the Sustainable Development Goals. Thus, in Agenda 2030 - Objective 12 - Responsible consumption and production, provides for the achievement of sustainable waste management, in accordance with the principles of the environment. The aim of the paper was to highlight, on the one hand, the profitability of the sectors of collection, treatment and disposal of hazardous waste in Romania and, on the other hand, to analyze the footprint of the thermal energy of the counties. The objective of this research was to make a ranking of the best performing counties in terms of turnover and profitability for CAEN codes 3812 and 3822.

Keywords: energy, hazardous waste management, sustainable development, circular economy

Introduction

Among the targets set under the Sustainable Development Goal 12- Responsible consumption and production, there is also the implementation of ecological management of chemicals and all waste during their life cycle, as well as the significant reduction of their emissions to air, water and soil. , in order to minimize their adverse effects on human health and the environment. In other words, by 2030, we want to significantly reduce waste generation, through prevention, reduction, recycling and reuse (developers of sustainable. gov.ro). Under the European Green Pact - the Waste Framework Directive sets out basic concepts and definitions related to waste management, including definitions of waste, recycling and recovery. In this context, waste must be managed without endangering human health and the environment, without risk to water, air, soil, plants or animals, without causing noise or odor and without adversely affecting the environment. rural areas or places of special interest (ec.europa.eu). This directive provides an explanation of when waste ceases to be waste and becomes a secondary raw material and how to distinguish between waste and by-products. The directive also introduces the „polluter pays" principle and „extended producer responsibility". The cornerstone of waste management in the European Union is the five-step „waste hierarchy" set out in the Waste Framework Directive. It establishes an order of preference for waste management and disposal. The following stages are part of the waste hierarchy: Prevention, Preparation for re-use, Recycling, Recovery and Disposal, according to the European Green Pact. Among the categories of waste, there are also hazardous waste. Hazardous waste poses a greater risk to the environment and human health than non-hazardous waste and therefore requires a stricter control regime. Explosive, hazardous waste also includes explosive, oxidizing, flammable, toxic, irritating, harmful, carcinogenic, corrosive, infectious or other substances and preparations harmful to human health and the environment, such as used oil from ships and garages, waste biohazardous waste, nuclear waste or used batteries (caen.ro). In terms of thermal energy, according to the Department for Sustainable Development, the aim is to ensure access to energy for all citizens, increase the share of green energy in the national energy structure and improve energy efficiency by 2030. In addition to the 2030 Agenda, the importance of developing the energy sector is also set out in the 2030 Energy and Climate Change Framework Package, which focuses on reducing Greenhouse Gas emissions by 80-95% by 2050 (average. gov.ro). Moreover, the same directions are

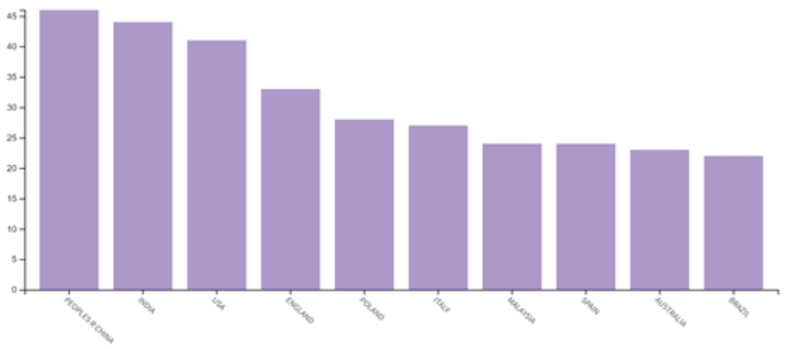
provided in the Energy Strategy of Romania 2020-2030, with the perspective of 2050 (mmediu.gov.ro). In other words, the objective of this research was to explore the link between the energy sector and waste management by statistical analysis of financial and economic indicators reported by enterprises active at the county level, based on data from the Romanian Ministry of Public Finance. This research paper is structured as follows: after the introduction, the next section analyzes the literature, which brings to the fore the existing situation in the energy sector and in that of waste management. The Research Methodology section presents both the method and the source of collecting the data necessary for the analysis, as well as the analysis of the economic indicators in the waste collection, treatment and disposal sector. Moreover, the thermal energy consumption associated with the counties of the country is presented, at the level of 2015 and 2019. In this sense, the decrease of thermal energy consumption (million kw / hour) is registered as progress (Petrariu et al, 2021) . The next section of the paper is Results and Discussions, which interprets the results obtained from the analysis performed. Finally, the last section concludes the main results of the research and highlights the relevance of this paper. Moreover, this section aims to support decision makers to better understand the link between the energy sector and waste management in Romania in terms of economic and environmental factors. Last but not least, the limits of this research and future directions have been explained in the Conclusions section.

Review of the literature

The Web of Sceince platform was used to review the literature. To perform the analysis, a search was conducted on scientific materials in the field of waste and energy management, published in the last 5 years. The figure below shows the states that have the highest number of published scientific papers and meet the criteria set out above.

Analysis of the states that have published the most scientific papers in the field of energy and waste management, Unit of measure: number of publications

Fig.1

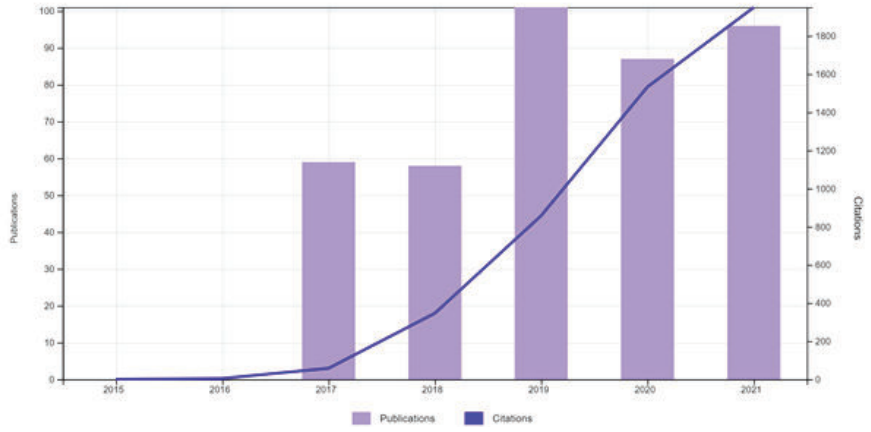


Source: Web of Science

There were identified 401 documents that meet the above criteria. According to the graph (Figure 1), the country with the most published documents in the field of waste and energy management is China, with 46 publications, which means 11.4% of the total documents considered for analysis. In second place is India with 44 publications (10.9%) and the United States with 41 publications (10.1%). At the end of the ranking is Brazil with 22 published documents (5.4%). The figure below (Figure 2) shows the evolution of the number of publications and the number of citations in the period 2015-2021 for the 401 documents identified in the previous analysis.

Analysis of the evolution of publications and citations in the period 2015-2021, Unit of measure: number of publications and number of citations

Fig.2



Source: Web of Science

According to the graphical representation (Figure 2), the number of publications fluctuated during the analyzed period, while the number of citations registered an upward trend. Thus, most publications in the field of waste and energy management were reported in 2019, respectively 101 publications and 858 citations, reaching that in 2021 to be published 96 documents that accumulated 1950 citations. In total, in the period 2015-2021, 401 papers were published that meet the established criteria, and were cited, in total, 4,795 times, and on average, 11.96 times each article. According to the European Green Pact, the Waste Framework Directive defines by-products as a substance or object, resulting from a production process, the main purpose of which is not to produce that article. By-products can come from a wide range of business sectors and can have very different effects on the environment. It is important to classify by-products correctly to avoid environmental damage or unnecessary business costs. Moreover, the end-of-waste criteria specify when certain wastes cease to be waste and become a secondary product or raw material (eur-lex.europa.eu). The Waste Framework Directive provides for additional labeling, record keeping, monitoring and control obligations from waste generation to final disposal or recovery. It is also forbidden to mix hazardous waste with other categories of hazardous waste and non-hazardous waste (expertdeseuri.ro). In other words, the amount of municipal solid waste (municipal waste), one of the most important by-products of urban lifestyle,

is growing even faster than the rate of urbanization (Hoornweg & Bhada-Tata, 2012). As for the energy sector, according to the UK Climate Change Committee, there are two main ways to reduce carbon emissions, one of which is energy efficiency (the other is decarbonisation of supply). The European Council for an Energy Efficient Economy is committed to keeping „energy efficiency at the forefront" of climate change responses, and the International Energy Agency (IEA) states that „Energy efficiency is key to ensuring a safe, reliable and affordable system. and a sustainable energy system for the future „„ also suggesting that it is the only energy resource that each country has in abundance and is the fastest and least expensive way to address energy security, environmental and environmental issues. economy (Shove, 2017).

Research methodology

The data used to conduct this research were taken from two sources:

a) The data regarding the active enterprises in Romania and their financial and economic results for the year 2020 were taken from the TopFirme platform (https://www.topfirme.com/, site accessed on 3.11.2021). TopFirme is based on data provided by the Ministry of Public Finance. At the time of this research, the financial and economic data for 2020 were the most recent reported by the active companies analyzed;

b) The TEMPO platform, of the National Institute of Statistics (http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table, site accessed on 3.11.2021), used for the collection data on thermal energy consumption in Romanian counties.

The tables below provide an overview of the types of business activities analyzed, as well as the set of indicators established for the research. The tables below (Table 1 & Table 2) show the type of activities chosen for the analysis, as well as the set of indicators.

CAEN Code	Activity	Description of activity
3812	Hazardous waste collection	This class includes the collection of hazardous wastes, whether solid or not, for example, including explosive, oxidizing, flammable, toxic, irritating, harmful, carcinogenic, corrosive, infectious or other harmful substances for human health and the environment. It includes the identification, treatment, packaging and labeling of waste for transport
3822	Treatment and disposal of hazardous waste	This class includes the disposal and pre-disposal of hazardous wastes, solid or non-hazardous, including wastes that may be explosive, oxidizing, flammable, toxic, irritating, carcinogenic, corrosive, infectious and other substances and preparations harmful to human health and the environment.

Source: caen.ro

Overview of the indicators chosen for the research

Table 2

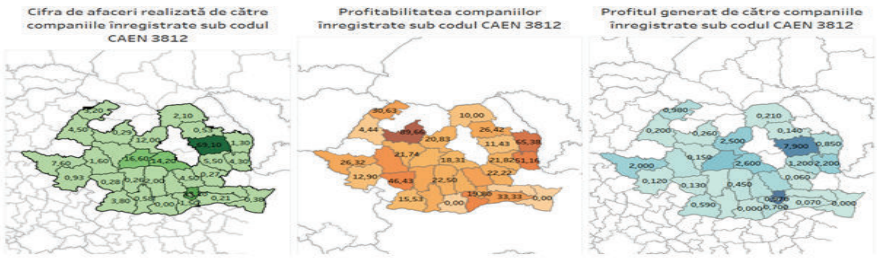
Indicator	Explanantion
The turnover of the companies registered under the caen code X from each county	The turnover registered by the companies with the CANE X code at the level of each county will be analyzed
The profit registered by the companies under the CAEN X code from each county	The profit registered by the companies with the CANE X code at the level of each county will be analyzed
The profitability registered by the companies under the CAEN X code from each county	The profitability registered by the companies with the CANE X code at the level of each county will be analyzed

Source: own conceptualization

The following are the graphs corresponding to the analyzed indicators: turnover, profit and profitability of companies registered under CAEN code 3812 and 3822 at the level of 2020, as well as the evolution of thermal energy consumption from 2018 compared to 2015 (Battle & Heer, 2019) .

Analysis of the turnover, profit and profitability of the companies registered under CAEN code 3812, unit of measurement million lei and percentages for the graph representing profitability

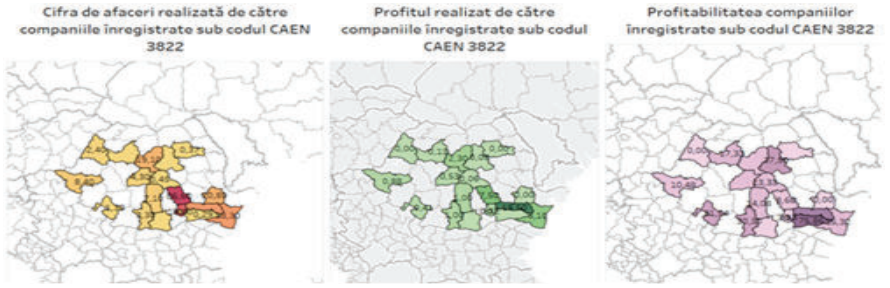
Fig.3



Source: own conceptualization

Analysis of the turnover, profit and profitability of the companies registered under CAEN code 3822, unit of measurement million lei and percentages for the graph representing profitability

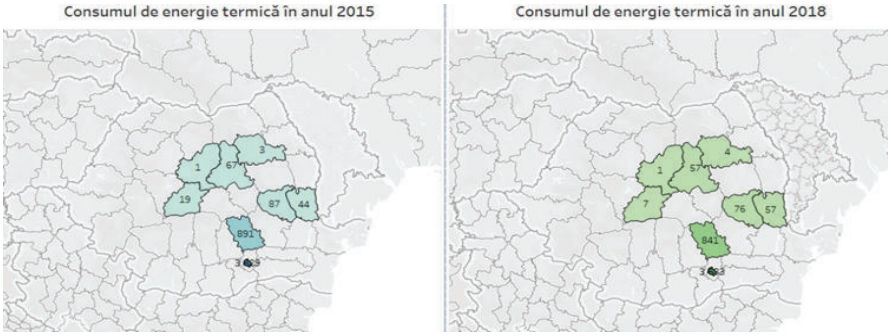
Fig.4



Source: own conceptualization

Analysis of thermal energy consumption in 2015 vs. 2018, unit of measurement thousand Gigacalories

Fig.5



Source: own conceptualization

Results and discussions

Analyzing the turnover achieved by the companies registered under the CAEN code 3812 in 2020, 4 clusters were identified:

1. Counties that registered a turnover between 0.21 million lei and 2 million lei (Călărași - 0.21; Vâlcea - 0.26; Buzău - 0.27; Gorj - 0.28; Cluj-0, 29; Constanța-0.38; Neamț-0.53; Olt-0.58; Alba-0.69; Caraș-Severin-0.93; Vaslui-1.3; Giurgiu-1.5; Hunedoara-1, 6; Argeș-2)
2. Counties that registered a turnover between 2.1 million lei and 5.5 million lei (Suceava-2.1; Dâmbovița-2.8; Satu Mare-3.2; Dolj-3.8; Galați -4.3; Prahova-4.5; Bihor-4.5; Bucharest-4.9; Vrancea-5.5)

3. Counties that registered a turnover between 7.6 million lei and 14.2 million lei (Timiș-7.6; Mureș-12; Brașov-14.2)
4. Counties that registered a turnover between 16.6 million lei and 69.1 million lei (Sibiu-16.6; Ilfov-33.2; Bacău-69.1)

As it can be seen, the county with the highest turnover in 2020 is Bacău with 69.1 million lei, followed by Ilfov with 33.2 million lei and Sibiu with 16.6 million lei. At the end of the ranking is the county of Călărași with 0.21 million lei Turnover in 2020.

Regarding the Profit realized by the companies registered under the CAEN code 3812 at the level of the year 2020, 5 clusters were identified:

1. The counties that registered a Profit between 0.06 million lei and 0.21 million lei (Buzău-0.06; Călărași-0.07; Vâlcea-0.07; Caraș-Severin-0.12; Gorj- 0.13; Neamț-0.14; Olt-0.14; Alba-0.15; Bihor-0.2; Suceava-0.21)
2. The counties that registered a Profit between 0.26 million lei and 0.64 million lei (Cluj-0.26; Argeș-0.45; Dolj-0.59; Dâmbovița-0.61; Hunedoara-0, 64)
3. The counties that registered a Profit between 0.7 million lei and 0.98 million lei (Giurgiu-0.7; Vaslui-0.85; Bucharest-0.97; Satu Mare-0.98)
4. The counties that registered a Profit between 1.2 million lei and 3.2 million lei (Vrancea-1.2; Prahova-1.4; Timiș-2; Galați-2.2; Mureș-2.5; Brașov-2.6; Sibiu-3.2)
5. The counties that registered a Profit between 7.9 million lei and 9.1 million lei (Bacău-7.9; Ilfov-9.1)

Therefore, the counties that achieved the highest level of profit in 2020 are Ilfov with 9.1 million lei and Bacău with 7.9 million lei. The lowest level of profit was achieved in Buzau - 0.06 million lei.

The level of profitability of companies registered under CAEN code 3812, at the level of 2020, is distributed within 6 clusters, as follows:

1. The counties that registered a level of Profitability between 4.44% and 12.9% (Bihor-4.44; Suceava-10; Bacău 11.43; Caraș-Severin-12.9)
2. The counties that registered a level of Profitability between 15.53% and 20.83% (Dolj-15.53; Brașov-18.31; Sibiu-19.28; Bucharest-19.80; Mureș-20, 83)
3. The counties that registered a level of Profitability between 21.74% and 26.32% (Alba-21.74; Dâmbovița-21.79; Vrancea-21.82;

Buzău-22.22; Argeș-22, 5; Olt-24.14; Timiș-26.32)
4. The counties that registered a level of Profitability between 26.42% and 33.33% (Neamț-26.42; Vâlcea-26.92; Ilfov-27.41; Satu mare-30.63; Prahova-31 , 11; Călărași-33,33)
5. The counties that registered a level of Profitability between 40% and 46.67% (Hunedoara-40; Gorj-46.43; Giurgiu-46.67)
6. The counties that registered a level of Profitability between 51.16% and 89.66% (Galați-51.16; Vaslui-65.38; Cluj-89.66)

In this context, the county with the highest Profit Rate is Cluj with 89.66%, and at the end of the ranking is Bihor with 4.44%. The same methodology was kept for the analysis of the data corresponding to the CAEN code 3822. In other words, the county that registered the highest turnover in 2020 is Prahova with 86.6 million lei; at the opposite pole is Teleorman with 0.06 million lei. The highest value of the profit was registered in Ialomița County - 19.5%, and at the end of the ranking is Teleorman County with 0.0009 million lei. The most profitable county, from the point of view of the field of treatment and disposal of hazardous waste, is Calarasi with a profit rate of 75.86%. Regarding the consumption of thermal energy, there was a downward trend from 2015 compared to 2018, especially in the counties of Mureș, Sibiu, Harghita, Vrancea, Prahova and Bucharest.

Conclusions

European Union legislation on waste batteries (part of hazardous waste) is intended to help protect, preserve and improve the quality of the environment by minimizing the negative impact of batteries and accumulators and waste batteries and accumulators (ec.europa.eu). It also aims to improve the environmental performance of all operators involved in the life cycle of batteries, for example producers, distributors and end-users, and in particular operators directly involved in the treatment and recycling of waste. As far as waste oils (another component of hazardous waste) are concerned, they are regulated by the Waste Framework Directive (ec.europa.eu). In order to detect the impact of this type of hazardous waste, the following example is provided: One liter of used oil can contaminate one million liters of water. In this context, waste oils from rivers, lakes and streams threaten aquatic life. Also, if used oils are left on the ground, they can contaminate the soil. Both the manufacturing sector and consumers have a key role to play in recovering waste oil. They must ensure that they deliver the used oil to authorized collectors and avoid disposing of it at any cost. On the other hand, heating and cooling play a crucial role in the EU's ambition to move to a clean, climate-

neutral economy by 2050, especially as heating and cooling in buildings and industry account for half of the Union's energy consumption. (ec.europa.eu). At the level of 2016, in the households of the community states, heating and hot water represented 79% of the total final energy consumption, according to a study on mapping and analysis of the implementation of heating and cooling. According to Eurostat data, in 2019, about 75% of heating and cooling was generated from fossil fuels, while only 22% was generated from renewable energy (ec.europa.eu). In order to meet the EU's climate and energy goals, the heating and cooling sector needs to drastically reduce its energy consumption and fossil fuel use (Xiong & al, 2015). In other words, reducing energy demand for heating and cooling is an important element of decarbonisation policy. The objective of this research was to make a ranking of the best performing counties in terms of turnover and profitability for CAEN codes 3812 and 3822. The aim of the paper was to highlight, on the one hand, the profitability of the collection, treatment and the elimination of hazardous waste from Romania and, on the other hand, to analyze the footprint of the thermal energy of the counties. In this context, it was found that the counties that recorded high values for the analyzed indicators are distributed approximately evenly within the development regions. Thus, for the CAEN code 3812, the county with the highest level of profitability is Cluj with 89.66%. Regarding the CAEN code 3822, the county with the highest profit rate is Călărași with 75.86%. Moreover, the consumption of thermal energy registered a downward trend in 2018 compared to 2015, for the counties of Mureș, Sibiu, Harghita, Vrancea, Prahova and Bucharest. The limits of the research were represented by the non-existence or inaccessibility of accessing data on thermal energy consumption for all counties in Romania. The applicability of the paper consists in the fact that this type of graphical analysis, using maps, can be useful for observing other types of phenomena. Also, two important elements were discussed in terms of impact on the natural environment, namely energy consumption and waste management. Therefore, in the context of sustainable development, the aim is to reduce energy consumption and the introduction of green energy sources, as well as the introduction of the concept of circularity in waste management systems.

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