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ENERGY-ENVIRONMENT INTERACTIONS FOR AN IMPROVED SUSTAINABILITY OF DÂMBOVIȚA COUNTY - THE ROLE OF INNOVATION AND TECHNOLOGY TRANSFER FROM UNIVERSITIES

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Abstract

The paper presents an assessment of the status of the sustainability of Dâmbovița County with special attention to the energy and environment interactions. A society seeking sustainable development ideally must utilize only energy resources that cause low or no environmental impact meaning no emissions released to the environment. In this matter, several indicators were analyzed and discussed such as increasing the share of renewable energy sources and low-carbon fuels in the transport sector (electric vehicles), including alternative fuels, and environmental issues in terms of energy conservation and renewable energy technologies, together with limitations on increased energy efficiency, and the relations between energy and sustainable development, and between the environment and sustainable development. To complete this complex approach, the role of innovation and technology transfer from universities actively involved in regional development was briefly discussed.

Key words*: critical analysis, energy efficiency, energy-environment interaction, low emissions, sustainable development goals.*

INTRODUCTION

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, outlines a global vision for peace and prosperity for people and the planet. At the core of this agenda are 17 Sustainable Development Goals (SDGs) and 169 targets, addressing critical issues such as poverty, health, education, clean energy, and climate action (European Commission, 2015).
The European Union (EU) and its member states are fully committed to the 2030 Agenda, implementing it through comprehensive strategies including the 2030 Climate and Energy Framework and the Territorial Agenda 2030 (European Commission, 2020). (https://www.iea.org/policies/1494-2030-climate-and-energy-framework) particularly to These frameworks contribute significantly to SDG 13 (Climate Action) and SDG 7 (Affordable and Clean Energy), with targets to:

- Reduce greenhouse gas emissions by at least 55% by 2030 (compared to 1990 levels);
- Increase the share of renewable energy in gross final energy consumption to at least 42.5%, aiming for 45%;
- Improve energy efficiency by reducing final energy consumption by at least 11.7%.

The EU is implementing various policies and legislation to achieve these targets, aiming to become the first climate-neutral continent by 2050. The Territorial Agenda 2030 focuses on the territorial dimensions of sustainable development across Europe. It aims for an inclusive and sustainable future for all places and people in Europe and emphasizes the importance of strategic spatial planning and strengthening the territorial dimension of sector policies at all levels of governance.
Romania, as an EU member state, has aligned its national policies with the 2030 Agenda through the National Sustainable Development Strategy 2030. This strategy focuses on

economic, social, and environmental dimensions and emphasizes innovation, resilience, and citizen-centered development (FAO, 2018)

Romania's commitment includes:

- *National Sustainable Development Strategy 2030*, which is a central guiding document outlining Romania's framework for implementing the 2030 Agenda and achieving the 17 Sustainable Development Goals (SDGs), focusing on the three dimensions of sustainable development: economic, social, and environmental. The strategy follows a citizen-centered approach, innovation, employment, resilience, and environmental protection.
- *Aligning with the EU Green Deal.* Romania actively participated in the development of the 2030 Agenda and is committed to its implementation at the national level. The National Strategy 2030 directly addresses all 17 SDGs.
- *EU Green Deal Alignment*. As a member of the European Union, Romania is also committed to the EU's Green Deal, which aims to make Europe the first climate-neutral continent by 2050. Romania's national strategies and policies are increasingly aligned with the EU's ambitious climate and environmental targets.
- *Climate Action Commitments*. Romania has ratified key international agreements such as the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreement, integrating them into national legislation. The country is working towards the EU's goal of reducing greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels.
- *Renewable Energy and Energy Efficiency*. Romania has made progress in increasing the share of renewable energy in its energy production and is committed to further expanding this sector. Energy efficiency improvements are also a key focus.
- *The Romanian Sustainability Code* aims to promote sustainability and transparency within the Romanian business environment by increasing the number of entities reporting sustainability information, improving the transparency of these reports, and ensuring their comparability.
- *Green Financing Initiatives*: The National Bank of Romania (NBR) has established a working group to stimulate green financing and raise awareness about the importance of sustainability within the financial sector. Measures to incentivize private investment in sustainable projects, such as reduced VAT rates, have also been introduced.
- *Focus on Environmental Protection*: Romania recognizes the importance of environmental protection and is addressing challenges such as waste management, air quality, biodiversity protection, and sustainable forest management. Initiatives like the national afforestation program demonstrate a commitment to a cleaner environment.
- *Urban Sustainable Development*. Strategies are being developed at the urban level to address environmental issues and promote sustainable development in cities.

While Romania has established a strong framework and demonstrated commitment, progress towards achieving all SDGs is ongoing. Some areas where further effort is needed include waste management and recycling by improving recycling rates and waste management systems (it still remains a significant challenge), reducing inequalities (disparities between urban and rural areas need to be addressed to ensure inclusive and equitable growth), policy coherence and implementation (the principles of sustainable development should be reflected throughout the policy framework and effectively implemented at all levels), and data collection and monitoring (strengthening regular reporting mechanisms and data collection for the SDGs for tracking progress) (GR, 2023). Overall, Romania has made significant progress in committing to sustainability and has established a comprehensive framework to guide its efforts towards achieving the goals of the 2030 Agenda (GR, 2023). Continued dedication and effective implementation of policies will be key to realizing a sustainable future for the country.

A strong link between energy, environment, and sustainable development is well-documented (Dincer & Rosen, 1999). At the regional level, Dâmbovița County shows

progress in natural gas distribution and urban infrastructure but remains deficient in household drinking water supply (Davidescu et al., 2020).

From an energy perspective, Dâmbovița County's installed power capacity declined from 596.5 MW in 1989 to 133.2 MW in 2020. The county contributed just 0.7% to the national power system in 2020, with an average energy production of 285 GWh since 2018 (Badita, 2025). A major upcoming development is an 80 MWp solar project in Răscăeți village, led by the Swiss-based MET Group.

In this context, this paper explores key energy and environmental sustainability indicators relevant to Dâmbovița County. It also examines the role of universities, particularly Valahia University of Târgoviște, in supporting regional development through innovation and technology transfer.

MATERIALS AND METHODS

To evaluate the status of energy and environmental sustainability in Romania and Dâmbovița County, data were extracted from the Tempo Online database (http://statistici.insse.ro:8077/tempo-online/), focusing on time series spanning 2008 to 2020. The year 2020 represents the most recent period for which comprehensive data are available.

The assessment of objective achievement within each of the 17 Sustainable Development Goals (SDGs) necessitates measurable targets. Within Romania's SNDDR, 104 such targets have been defined for the 2030 horizon.

To effectively monitor the implementation of this strategy, the national sustainable development indicators - Horizon 2030 - were developed, encompassing 242 unique indicators, of which 99 are designated as core framework. This set received validation from the Sustainable Development Advisory Council on February 14, 2022, during a technical workshop facilitated by the Romanian National Institute of Statistics.

For this study, the analysis concentrated on three SDGs relevant to energy and environment:

- **SDG 7: Affordable and Clean Energy**
- **SDG 11: Sustainable Cities and Communities**
- **SDG 13: Climate Action**

Relevant indicators selected from the Tempo Online database include:

SDG 7: Affordable and Clean Energy

- ZBW0712 (Level 3 - Economic): Romania's foreign trade in electricity.
- ZBY0714 (Level 3 - Environment): Share of renewable energy in gross final energy consumption.
- ZBZ0715 (Level 3 - Environment): Share of electric vehicles in the total fleet.

SDG 11: Sustainable Cities and Communities (Natural Disasters and Climate Change)

- ZCV1111 (Level 3 - Environment): Expenditures for air and climate protection as a percentage of GDP.
- ZCW1112 (Level 3 - Environment): Investments in air and climate protection as a percentage of GDP.
- ZCX1111 (Level 4 - Environment): Production of environmental goods and services.
- ZCZ1113 (Level 4 - Environment): Deaths from respiratory and circulatory diseases.

SDG 13: Climate Action

Natural Disasters and Climate Change

- ZAB1311 (Level 1 - Environment): Greenhouse gas emissions by NACE Rev.2 economic activities.
- ZAG1312 (Level 1 - Environment): Average CO2 emissions per km from new passenger cars.

Education in Climate Change

- ZDP1321 (Level 2 - Environment): Yearly average temperatures in Romania.

Additionally, data reflecting the status of sustainable development in Dâmbovița County and, where unavailable, the South Muntenia Region, were selected to provide context-specific insights. These figures were primarily drawn from national social and economic statistics and include localized indicators on energy consumption, prosumer activity, and environmental health.

RESULTS AND DISCUSSIONS

At the national level, the foreign trade in electricity, corresponding to the ZBW0712,

was shifting towards a higher import in 2019 and 2020, with a corresponding negative trade balance. The average of the period between years 2008 and 2020 for export was 210.6 million euros, while the import was 117.2, and the trade balance was 93.4, respectively (Figure 1).

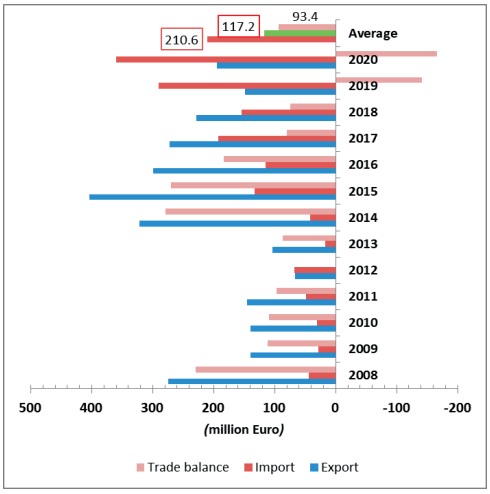

Figure 1. Romania's foreign trade in electricity, corresponding to the ZBW0712 (Data sources: National Institute of Statistics - Romania)

Figure 2 shows the expenditures for air and climate protection and investments for air and climate protection as a percentage of GDP, corresponding to the ZCV1111 and ZCW1112. A decrease in the percentage was observed for the investments starting from 2016 to 2020. The average of the 2008-2020 period was 0.1% of GDP for investments, while the expenditures reached 0.3.

Figure 3 highlights the percentage of renewable energy in gross final energy consumption (%), corresponding to the ZBY0714. A constant increase was observed from 2008 to 2020, with an average of the period of 23.5%. This can be related to the continuous development of new renewable installations.

The efforts of Romania to reduce the emissions from conventional vehicles were combined in a few initiatives, including the Rabla program. Despite the Rabla Program's efforts to promote electric and hybrid vehicle adoption in Romania's public transport and personal car sectors - evidenced by 2021 registrations of 6,903 electric and 38,531 hybrid vehicles, and a total of 26,277 electric vehicles registered in 2022 - the overall presence of these vehicles remains limited.

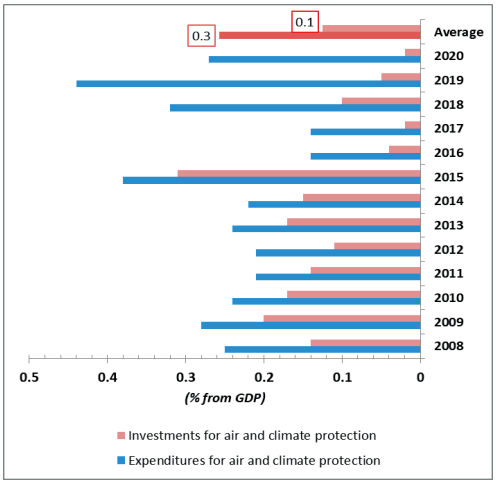

Figure 2. Expenditures for air and climate protection and Investments for air and climate protection as a percentage of GDP, corresponding to the ZCV1111 and ZCW1112, respectively (Data sources: National Institute of Statistics - Romania)

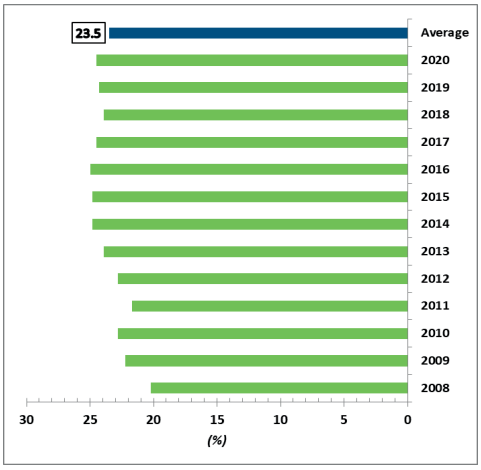

Figure 3. The percentage of renewable energy in gross final energy consumption (%), corresponding to the ZBY0714 (Data sources: Eurostat database - https://ec.europa.eu/)

As of the latest data, electric vehicles constitute a mere 0.07%, and hybrid vehicles 0.44% of the total vehicle count in Romania (GR, 2023). Figure 4 shows the evolution of the percentage of electric vehicles in the total fleet of vehicles from 2008 to 2020.

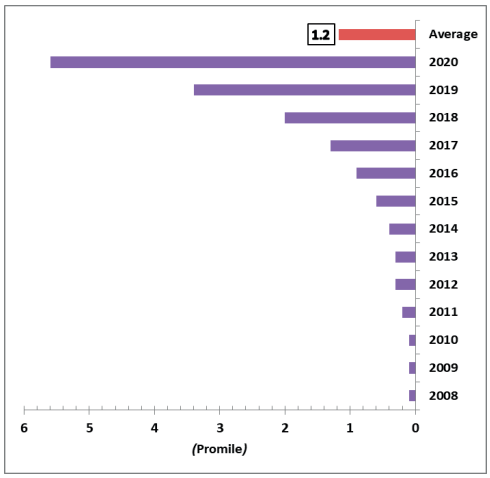

Figure 4. The percentage of electric vehicles in the total fleet of vehicles (promile), corresponding to the ZBZ0715 (Data sources: NIS Statistical survey on registered vehicles in circulation)

Figure 5 provides information regarding the production of environmental goods and services for the protection of the surrounding air and climate in millions of lei, showing a constant decrease and an average of the 2008-2020 period of 21635.1 million lei.

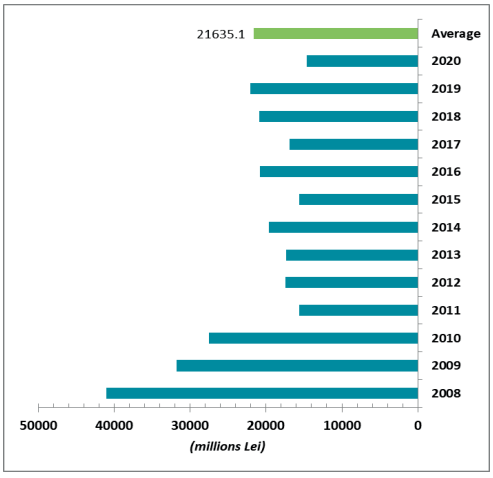

Figure 5. Production of environmental goods and services for the protection of the surrounding air and climate in millions of lei, corresponding to the ZCX1111 (Data sources: National Institute of Statistics - Romania)

Figure 6 shows the deaths from respiratory and circulatory diseases (number of persons), corresponding to the ZCZ1113. An increase in the deaths caused by diseases of the respiratory system occurred especially in 2020, being potentially correlated with air pollution in urban areas and other associated factors such as meteorology and topographical conditions (Dunea et al., 2015; Oprea et al., 2015).

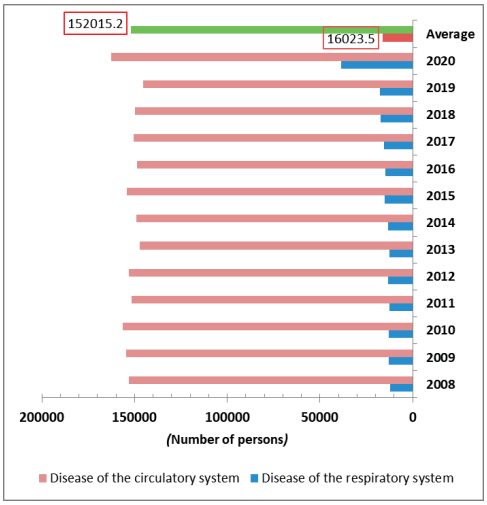

Figure 6. Deaths from respiratory and circulatory diseases (number of persons), corresponding to the ZCZ1113; causes of death are according to the WHO - ICD - 10th revision starting with 1994 (Data sources: National Institute of Statistics - Romania)

Regarding the greenhouse gas emissions by NACE Rev.2 economic activities, as sources of GHG emissions, corresponding to the ZAB1311, a decrease in the emissions can be observed. The average of the 2008-2020 period is 108,545.5 thousand tons of CO_2 equivalent (Figure 7).

On the other hand, the average CO_2 emissions per km from new passenger cars were 140.9 g CO_2/km from 2008 to 2020 (Figure 8).

Figure 9 shows the yearly average temperature recorded at Varfu Omu Meteorological station from the Bucegi Mountains located in the north of Dambovita County. An increase in the annual average temperature is evident compared to the 1901-2000 period, pointing out the effects of climate change (Venturi et al., 2025). This is related to the emissions effect and emphasizes the need for further exploration of the energy-transport-environment interaction in a complex approach and the fulfilment of the corresponding SDGs (Nakhle et al., 2024).

Dâmbovița County is one of the 41 counties of Romania, situated in the south-central part of

the country, within the historical region of Muntenia. Its capital city is Târgoviște, which holds significant historical importance as the former capital of Wallachia province. It covers an area of approximately 4,054 km^2, representing about 1.7% of Romania's total land. As of December 2021, the population of Dâmbovița County was approximately 479,404 inhabitants, making it one of the more densely populated counties in Romania. The county has 7 cities and towns (two of which are municipalities - Târgoviște and Moreni) and 82 communes with 361 villages (NIS, 2024). The county has been focusing on attracting EU funds for various development projects, including infrastructure improvements, tourism development, and environmental protection. The GDP per capita in 2023 was 11,439 euros per capita (NIS, 2024).

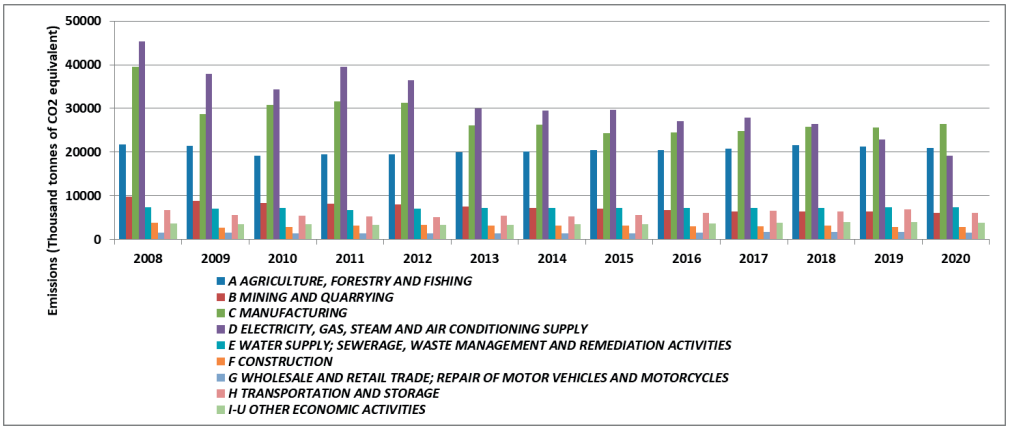

Figure 7. Greenhouse gas emissions by NACE Rev.2 economic activities, as sources of gas emissions, corresponding to the ZAB1311 (Data sources: National Institute of Statistics - Romania)

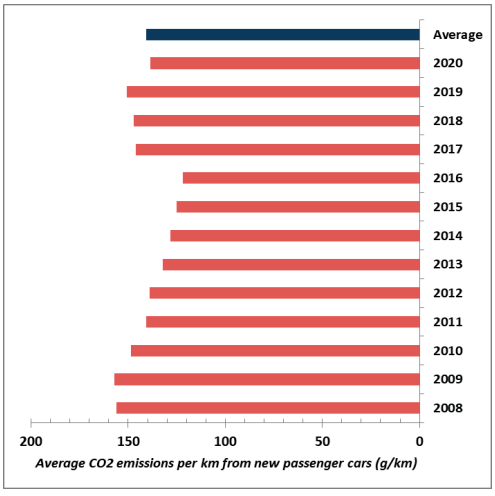

Figure 8. Average CO_2 emissions per km from new passenger cars, corresponding to the ZAG1312 (Data sources: National Institute of Statistics - Romania)

Table 1 shows some characteristics regarding the electricity and natural gas consumption in Dambovita County from 2021 and 2023. Both household and non-household consumption of electricity and natural gas have continuously decreased from one year to another.

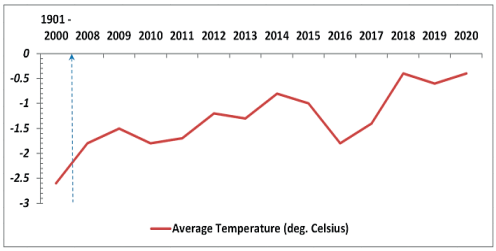

Figure 9. Yearly average temperature recorded at Vârfu Omu Meteorological station from the Bucegi Mountains located in the north of Dâmbovița County, corresponding to the ZDP1321 (Data sources: National Administration of Meteorology)

Furthermore, the number of prosumers increased considerably each year, contributing to the renewable energy production.

Another step for reducing the emissions and the environmental impact was the increase in the number of electric and hybrid vehicles

registered (Figure 10). Both directions contribute to the share of renewable energy and low-carbon fuel used in the transport sector (electric vehicles), including the use of alternative fuels. However, the monitoring of the air pollutants is not sufficient in Dambovita County to be able to quantify the benefits to the environment in urban areas.

Table 1. Details of electricity and natural gas consumption in Dâmboviţa county (Source: https://energymap.ro/en/)

Year	2021	2022	2023
Total Prosumers	200	586	2,258
Household consumption of electricity (MWh)	348,800	326,662	277,430
Non-household consumption of electricity (MWh)	1,062,355	958,503	901,012
Household consumption of natural gas (MWh)	1,026,064	975,523	971,525
Non-household consumption of natural gas (MWh)	1,160,538	1,115,428	936,177

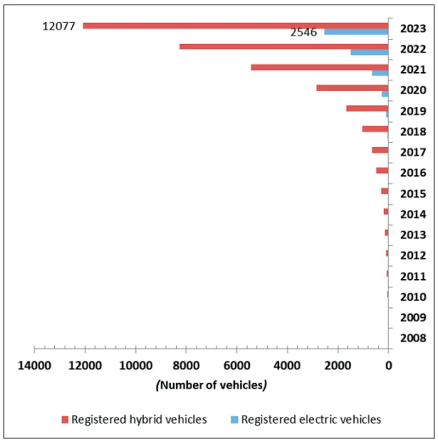

Figure 10. Target 4 - Environment - Number of electric and hybrid vehicles registered (Data sources: Ministry of home affairs - Direction of Driving-licenses Regime and Vehicles Registration)

There are only two urban background monitoring stations located in two towns, i.e., Târgovişte and Fieni. Unfortunately, the data reported from these stations did not meet the data capture criteria, and consequently, there were significant data gaps due to malfunction (Figure 11).

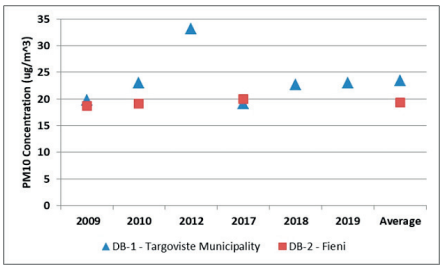

Figure 11. Target 7 - Environment - average annual levels of particulate matter PM10 at urban background monitoring stations, corresponding to the TMP1173 at the two monitoring stations located in Dâmboviţa County (Data sources: National Agency for Environmental Protection)

Furthermore, important pollutants that are responsible for serious adverse effects are not measured (e.g., PM1, PM2.5, PAH, etc.). Therefore, it is difficult to assess the exposure and the effects on human health. Figure 12 presents the number of deaths caused by respiratory and cardiovascular diseases (number of persons) in Dâmboviţa County. An increase in the number of persons affected by respiratory diseases was observed in 2020 and 2021, probably related to the COVID pandemic factors.

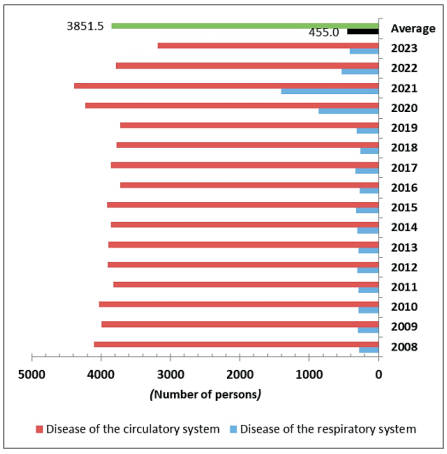

Figure 12. TMK1165 - Target 6 - Environment - number of deaths caused by respiratory and cardiovascular diseases (number of persons) in Dâmboviţa County, causes of death are according to the WHO - ICD - 10th revision starting with 1994 (Data sources: NIS - Statistical survey on mortality)

To establish the intrinsic aspects related to the energy-environment interactions, research

programs and entities should be sustained within a national and regional strategy. It is important to improve the number of employees from research-development activity (Figure 13) and the total expenditure from research-development activity (Figure 14).
Universities and research entities should be key vectors for sustainability, especially through the research results, including scientific articles, patents, and innovation items facilitating the transfer of technology to industry.

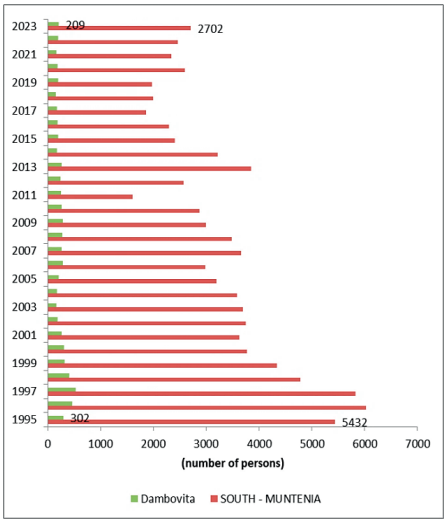

Figure 13. CDP103E - Employees from research - development activity (in full-time equivalent), by macroregions, development regions, and counties – Data for Dâmbovița County and South-Muntenia region (Data sources: National Institute of Statistics - Romania)

Valahia University is committed to contributing to sustainable development through the performed research. Figure 15 shows the research performed at Valahia University on the SDGs based on Scopus-indexed publications in the specific domains. From the 2,609 documents indexed in the Scopus database, 1064 are in Engineering, 200 in Environmental Sciences, and 196 in Energy. Important SDGs are related to SDG 12, SDG 8, SDG 9, SDG 11, SDG 6, and SDG 7. Valahia University is consistently promoting multi- and interdisciplinary research. This is reflected in the Institute of Multidisciplinary Research for Science and Technology, a research-dedicated facility with 36 laboratories with state-of-the-art equipment and spaces for scientific events, offering open access to all academic staff.

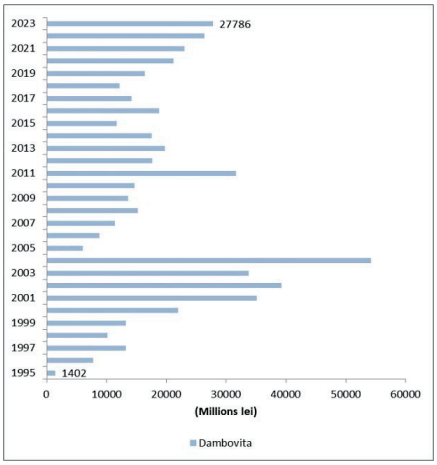

Figure 14. CDP104B - Total expenditure from research-development activity by macroregions, development regions and counties - current prices (millions of lei) – Data for Dâmbovița County (Data sources: National Institute of Statistics - Romania)

Valahia University of Târgoviște (VUT) cooperates with a key regional NGO (www.adrmuntenia.ro/) active in developing the Smart Specialization Strategy of South-Muntenia Region (2021-2027) and other policy documents related to SDGs, and the Management Authority for structural funds projects dedicated to regional development.
The university actively fosters cross-sectoral dialogue on SDGs, particularly through its engagement in projects focused on energy, environmental sustainability, and social inclusion. For instance, its contribution to the E-LAND project (https://elandh2020.eu/) is creating smarter energy systems using solar power and advanced building controls, actively involving energy businesses, regulatory bodies, and local communities. Furthermore, the university drives SDG progress through its research, educational projects, and scientific events centred on air quality, circular design, advanced materials, resource valorisation, food safety, and social inclusion.
This proactive, cross-sectoral approach enables the university to facilitate impactful discussions and contribute significantly to addressing current and future sustainability challenges.

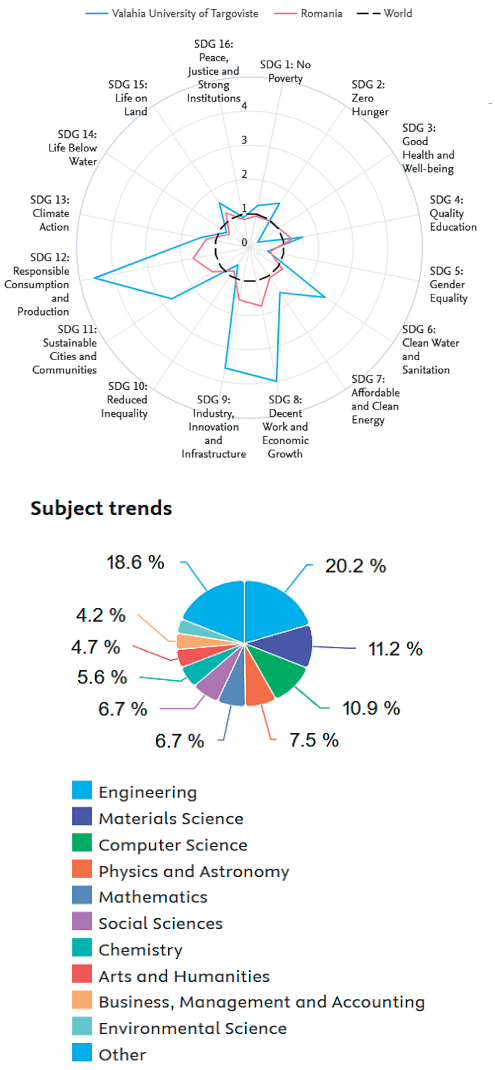

Figure 15. Contributions of the research performed at Valahia University to the SDGs based on Scopus indexed publications in the specific domains (Source: Scopus database)

Recognizing the importance of robust SDG data, VUT actively participates in international collaborations, including the development of the KreativEU university alliance. This alliance strives to be a catalyst for positive transformation at all levels by strategically linking cultural and ecological stewardship with a dedicated effort to gather and measure data relevant to achieving the SDGs.

CONCLUSIONS

In conclusion, the "European 2030 Agenda" is the main framework of the EU's commitment to the UN's 2030 Agenda for Sustainable Development, which includes ambitious climate and energy targets and a focus on territorial cohesion within Europe. Romania, as a member of the European Union, is committed to the Sustainable Development Goals outlined in the 2030 Agenda. The national Sustainable Development Strategy 2030 provides a framework for local and regional efforts. Projects in Dâmbovița County, particularly those funded by the EU, are likely aligned with these national and international sustainability objectives.

Dâmbovița County is engaged in various initiatives that contribute to sustainability, particularly in water management, renewable energy adoption, and the preservation of cultural heritage for sustainable development. These efforts reflect a commitment to both environmental protection and the well-being of its communities within the broader context of national and European sustainability goals. Romanian universities require advanced capacities in the field of interdisciplinary research and innovation for energy-environment interactions, ICT and bioeconomy to provide technology offers and transfer. VUT is actively involved in research and innovation, particularly in energy and sustainability. It has developed advanced Energy Management Systems (EMS) to support decarbonization and energy efficiency, aligning with EU strategies.

Additionally, research efforts have focused on initiatives that support sustainability, human health, and economic efficiency across the entire supply chain. With demonstrated engagement in European projects, VUT plays a vital role in advancing knowledge and innovation in key strategic areas at regional level.

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