# ENVIRONMENTAL PROTECTION ACTIVITIES IN BULGARIA – COMPARATIVE ANALYSIS IN REGIONAL ASPECT

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#### Abstract

Environmental protection activities differ according the specifics of the regions. They lead to optimal use of resources, reduction of climate impact, ensuring security of energy supply, improving the health of ecosystems etc. The aim of the paper is to be prepared a comparative analysis between the planning regions in terms of environmental protection activities and on this basis to be determined the place of each region and to be evaluated the effectiveness of the financial sources used for environmental protection activities. The paper presents literature review of some environmental protection activities. The paper analyzes data related to the environmental protection activities undertaken in the planning regions related to household waste submitted for recycling, waste water discharged from treatment plants, installed renewable energy sources capacities, research and development expenditure, number of buildings financed under the National program for energy efficiency of multifamily residential buildings. Comparative analysis of environmental protection activities by planning regions is prepared in order to be presented the trends of some indicators and to be made a comparison between the regions. On the basis of the data analysis, the comparison between the planning regions for the period 2017 -2021 was made, and they were ranked in three groups – active, moderately active and low active. The analytical part of the paper also includes DEA analysis to be found the most effective region according to the chosen inputs. In all DEA models, the aim is to evaluate the effectiveness of indicators such as tangible fixed assets (TFA) with ecological use, expenditures for research and development and financial resources under the Operational program environment (OPE). These indicators are defined as Inputs. For outputs are chosen generated municipal waste, waste water discharged without treatment, CO<sub>2</sub> emissions and destroyed territories. Based on the analysis are made some general conclusions and recommendations for increasing the engagement of the region to carry out environmental protection activities. The South Central and South Western regions are the most active in terms of carrying out activities that lead to environmental protection, the South Eastern and North Eastern regions can be defined as moderately active, and the North Central and North Western regions as low active in terms of environmental protection activities. In order to increase the engagement of the regions to carry out environmental protection activities, various initiatives can be taken, most often related to better understanding of ecological benefits, taking political actions and implementation of regulations in economic sectors related to the environment and natural resources, spreading of good practices. Key words: environment, planning region, regional differences

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#### Introduction

The activities that are undertaken to reduce the negative impact of human on the environment are diverse, related to transition to renewable energy and improvement of energy supply, waste management, implementation of integrated water management etc. They depend on the geographical location of the region and its natural characteristics, the government policy to support economic sectors of the countries, the attitudes and behavior of producers and consumers to take measures to reduce the pressure on natural resources.

The transition to renewable energy sources and the optimal use of solar, wind, hydroelectric and geothermal energy to decrease greenhouse gas emissions and reduce the climate change are leading initiatives of the countries. Panwar et al. (2011) consider that renewable technologies are clean sources of energy and have a number of advantages related to the rational use of resources, reducing the impact on the environment by decreasing the greenhouse gas emissions and global warming while at the same time they lead to less waste generation. The authors define renewable energy as sustainable for the current and future needs of society, not only in an ecological aspect, but also in an economic and social one. Zakhidov (2008) relates the role of renewable energy sources to the improvement energy and water supply in a regional aspect, improving the quality of life. The author consider that renewable energy improves the possibilities of disadvantaged areas such as desert and mountain areas to use their regional advantages and to develop sustainably. Owusu and Asumadu-Sarkodie (2016) express a similar opinion, but they also add the possibilities of renewable energy sources to achieve energy security.

Together with the development of the system of renewable energy sources, it is necessary to develop energy efficiency and to be taken measures to improve it in construction, industry, transport and other economic sectors. Mircheva (2022) points out the benefits of the efficient use of resources and the achievement of energy efficiency such as the reduction of the negative impact on the environment and climate change, adding the advantages of energy efficiency for improving the quality of life. Regarding energy efficiency, Georgiev (2011) expresses his concern that a significant increase in greenhouse gas emissions is expected if solutions are not found and measures are not taken for reduce of the consumption of electrical energy. Śleszyński and Frączek (2015) share a similar opinion and consider that achieving energy efficiency, reducing heat waste and the decrease of the amount of used electricity are the key factors for reducing greenhouse gas emissions.

Investing in tangible fixed assets with ecological use is also an activity that would lead to the protection of natural resources such as water, air, soil and would have a positive impact on waste and noise. Chiprianov et al. (2014) consider that because of the requirements laid down in EU policies and the desire of enterprises to produce competitive and ecologically oriented production, more and more of them apply management policies and make investments aimed at the environmental and human health protection, optimal use of resources and sustainable management, carry out pollution control. In his study, Xiaowen (2021) measured and analyzed the relationship between the type of energy used in industry and the environmental impact. The author proved statistically that investment in fixed assets has a positive effect on industrial wastewater emissions, sulfur dioxide emissions and industrial smoke.

Activities related to encourage waste reduction, increasing recycling levels and the development of a circular economy will have a positive effect on the environment, minimizing waste and pollution. According to Ivanova (2016), in order to achieve ecological efficiency in production, it is necessary to take measures, on the one hand, to utilize waste by transforming it into fuels or materials, and on the other hand, to carry out activities to increase energy efficiency. Krasteva (2018) adds that waste management is essential for the efficient use of resources. Petkov et al. (2023) emphasize the negative economic and environmental impact of waste disposal or incineration and the benefits of recycling and reusing valuable materials contained in waste.

Activities related to water resource management have a significant impact on both environmental protection and human health. The health of ecosystems and society is closely related to the quality and quantity of water resources. Integrated water resource management is a process that can help countries to deal with water problems in an efficient and sustainable way (Stoyanova, 2021). When and Montalvo (2018) consider that integrated water management leads to the sustainable use and regeneration of water resources, the protection of ecosystems and the construction of the necessary infrastructure. The complex and interrelated issues in the water sector require an integrated approach in water resource management to cope with uncertainty in water sector.

It can be summarized that activities related to environmental protection lead to the occurrence of many positive effects such as optimal use of resources, reduction of climate impacts, ensuring security of energy supply, improving the health of ecosystems and society, increasing the quality of life etc.

#### Methodology

The aim of the paper is to be prepared a comparative analysis between the planning regions in terms of environmental protection activities and on this basis to be determined the place of each region and to be evaluated the effectiveness of the financial sources used for environmental protection activities.

The paper analyzes data related to the environmental protection activities undertaken in the planning regions related to household waste submitted for recycling, waste water discharged from treatment plants, installed renewable energy sources capacities, research and development expenditure, number of buildings financed under the National program for energy efficiency of multifamily residential buildings. On the basis of the data analysis, the comparison between the planning regions for the period 2017 -2021 was made, and they were ranked in three groups – active, moderately active and low active. The selection of indicators is based on the available data for planning regions from National statistical institute (NSI) and Institute for market economy (IME).

Data envelopment analysis (DEA) is a method that is widely used in environmental research. Sözen and Alp (2009) perform a DEA to evaluate the efficiency in terms of harmful substance emissions and energy consumption. Castellet and Molinos-Senante (2016) in their research measure the effectiveness of the used financial resources for different operational costs for water treatment and pollutants removed from the wastewater. Yang and Chen (2021) also use a DEA to evaluate the efficiency of wastewater treatment plants in terms of energy used and pollutants released from the water. Albores et al. (2016) use DEA to evaluate the efficiency of using waste to create energy. They search also the maximization of positive (energy) and reduce of negative (pollutants) outputs. In this paper DEA was applied in order to be found the most effective region according to the chosen inputs. The decision making units (DMU) are the six planning regions in Bulgaria. The model is Input oriented with constant return to scale (CRS). Four input-oriented models were constructed. In all four models, the aim is to evaluate the effectiveness of indicators such as tangible fixed assets (TFA) with ecological use, expenditures for research and development and financial resources under the Operational program environment (OPE). These indicators are defined as Inputs. For outputs are chosen as follows: generated municipal waste, waste water discharged without treatment, CO<sub>2</sub> emissions and destroyed territories. The results of the DEA show in which of the planning region regardless of the higher use of TFA with ecological use, higher expenditures for research and development and sources under OPE, the amount of the generated municipal waste, waste water discharged without treatment, CO<sub>2</sub> emissions and destroyed territories are the same.

#### Analysis of the environmental protection activities by planning regions

In a comparative aspect for the period 2017-2021, household waste submitted for recycling is increasing in all planning regions. For the analyzed period, the household waste submitted for recycling in the South Central region increased around 4 times from 16 thousand tons to 62 thousand tons (Figure 1). This region is also in the first place in increase of the submitted household waste for recycling per capita from 11 to 45 kg. per person.

In North Central region this indicator increased three times from 14 thousand tons to 42 thousand tons, and per capita it increased from 17 to 56 kg per person. In the

North Eastern region, they increased 2.5 times from 20 thousand tons to 50 thousand tons. In the South Eastern and North Western regions, they increased twice as a total amount and per capita the submitted waste for recycling increase more than twice. The leaders in terms of the amount of household waste submitted for recycling in 2021 are the South Western region with 95 thousand tons and the South Central region with 62 thousand tons.



Figure 1. Household waste submitted for recycling for the period 2017 – 2021, thousand tons Source: NSI, Environment, Waste from economic activity

There is a decrease in the number of municipal waste landfills in all planning regions for the period 2017-2021 (Figure 2). This is due to the creation of regional landfills and closure of existing smaller municipal landfills. In 2021 the largest number of landfills is observed in the South Central region, followed by the South Eastern and South Western. The number of landfills and installations for the treatment of household waste is the least in the North Central region.



Figure 2. Number of landfills and installations for the treatment of household waste for the period 2017 – 2021 Source: NSI, Environment, Waste from economic activity

Statistics regarding the availability of tangible fixed assets (TFA) with ecological use is an indicator which has impact on the activities for environmental protection as they include facilities, installations and equipment through which the environment is protected or restored. TFA with ecological use lead to the protection of water, air, soil, influence in a positive aspect on the waste and noise. According to the NSI methodology, they also include monitoring and control equipment. The data shows that the most investments for the period 2017-2021 for the TFA with ecological use were made in the South Eastern planning region (Figure 3). In second place is the South Western region, where an increase in investments in TFA with ecological use for the period 2017-2021 is observed. The increase is from 2,103,843 thousand BGN to 2,921,972 thousand BGN. South Western region is followed by the South Central region, where also is observed an increase in investments in environmentally friendly TFA. The last three places are occupied as follows by the North Eastern, North Western and North Central regions, and in two of them the availability of TFA with ecological use for the period 2017-2021 increases (North Eastern and North Central) and in one it decreases (North Western).



Figure 3. Availability of tangible fixed assets with ecological use, thousand BGN Source: NSI, Environment, Tangible fixed assets with ecological use

The data on the operating municipal treatment plants can also be linked to the activities for the environmental protection and, in particular, of water resources. In the three Northern planning regions and in the South Eastern they are increasing. In the South Western their number remains the same, and in the South Central region they decrease from 41 to 38 numbers (Figure 4). Comparatively, in 2021, the largest number of operating municipal treatment plants is in the Southern planning regions. In first place is the South Central region (38), followed by South Western (36) and South Eastern (33). The fewest water treatment plants are in the in the North Central region – 19.





In accordance to the air protection in planning regions is papered an analysis of statistical data on installed renewable energy sources (RES). They differ across different planning regions. In the South Central region, the capacities are the highest - 9,963 kW per capita (Figure 5). This is due to the water resources which are found in this planning region.



Figure 4. Installed RES capacity per capita (kW), 2020 Source: IME, 2021

The lowest capacities are in the North Central region -0.744 kW. In the next place is the North Eastern region, where the installed RES capacities are 3,515 kW. Large part of the installed capacities is related to the use of wind energy through the creation of wind energy parks. In the South Eastern region 2,793 kW of RES capacity per capita have been installed. In fourth and fifth place in terms of installed RES capacities are the North Western planning region -2,053 kW and the South Western -1,504 kW per capita.

Figure 6 presents data on the number of buildings financed and put into operation under the National program for energy efficiency of multifamily residential buildings on 30 June 2023.





Source: https://www.mrrb.bg/bg/energijna-efektivnost/nacionalna-programa-za-ee-namnogofamilni-jilistni-sgradi/aktualna-informaciya-za-napreduka-po-programata/

Leading positions are occupied by the three southern planning regions. South Western planning region is in the first place, where the most buildings were financed in the districts of Blagoevgrad and Sofia. In second place is the South Central region, with the highest number of projects under the program realized in the Plovdiv and Haskovo districts, and in third place is the South Eastern region, with leading regions Burgas and Stara Zagora. In the three Northern planning areas, the number of buildings financed under this national program ranged from 155 to 178. Expenditures for research and development follow an increasing trend for the period 2017-2021 in five of the planning regions (Figure 7). They decreased for the analyzed period only in the North Eastern region, from 51,626 BGN to 48,188 BGN. The highest increase was in the South Western and South Central regions, respectively from 538,651 BGN to 827,264 BGN and from 69,352 BGN to 86,104 BGN. The trends in terms of expenditures for research and development activities per capita are similar. They are the highest in the South Western planning region – 399 BGN per capita, and for the period they increased to the highest extent in this region, followed by the South Central region, where they increased from 49 BGN to 62 BGN per capita.



Figure 7. Expenditures for scientific research and development activities by planning regions for the period 2017 – 2021

Source: NSI, Business statistics, Total intramural R&D expenditure by regions and sectors

#### **Results from the DEA model**

Data from the DEA regarding the three types of expenditures related to environmental protection activities and waste water discharged without treatment in 2021 show the effectiveness of the used sources (Table 1). The South Central region is defined as the most effective in terms of the expenditures for environmental protection activities and the amount of waste water discharged without treatment, followed by the South Eastern and North Western regions. The effectiveness of expenditures for research and development, funds from OPE for 2021 and the availability of TFA with ecological use is the lowest in the North Eastern region, i.e. no matter how much these financial sources increase in the region, the amount of wastewater without treatment remains the same. The effectiveness of the three types of expenditures related to environmental protection activities and generated house-hold waste is high in all six planning regions. The most effective DMU are North Central and North Eastern regions. Most efficient in terms of analyzed expenditures and disturbed territory is South Eastern region, followed by North Central. The least efficient DMU in this model is South Central region. Regardless of how much expenditures for research and development, availability of TFA with ecological use and funds from OPE increase, CO<sub>2</sub> emissions remain at the same levels in the North Western, North Central, South Central, and South Western regions. The most efficient unit in terms of analyzed expenditures and CO<sub>2</sub> emissions is the South Eastern planning region.

DMU	Waste water discharged without treat- ment (output), 2021	Rank	Household waste (out- put), 2021	Rank	Disturbed territories (output), 2021	Rank	CO <sub>2</sub> emis- sions (out- put), 2019	Rank
North West- ern	0,71653	3	0,75424	4	0,57606	3	0,16167	5
North Central	0,45114	4	1,00000	1	0,78918	2	0,28058	4
North Eastern	0,11773	6	1,00000	1	0,56852	3	0,52173	2
South Eastern	0,84808	2	0,97178	2	1,00000	1	1,00000	1
South West- ern	0,37478	5	0,87474	3	0,53596	3	0,37452	3
South Central	1,00000	1	0,87576	3	0,40634	4	0,12326	5

Table 1. Results of DEA

Source: own calculation

#### Conclusion

Based on the data analysis, the regions are classified in three groups: active, moderately active and low active according to the realized environmental protection activities. South Eastern and South Central regions have the best positions in terms of most of the analyzed indicators – household waste submitted for recycling, operating municipal wastewater treatment plants, number of buildings financed under the National program for energy efficiency of multifamily residential buildings, expenditures for scientific research and development activities. South Western and South Eastern regions are also leaders in availability of TFA with ecological use (Table 2). South Eastern and North Eastern regions can be defined as regions that are moderately active in environmental protection activities. They are in intermediate positions in four of the six analyzed indicators. The North Central and the North Western regions are in last place in most of the indicators. The North Central region ranks last in five of the six analyzed indicators, and the North Western region in four of the indicators.

Environmental protection activities	Active	Moderately active	Low active
Household waste submitted for recy- cling for the period, 2021	SW, SC	NC, NE	SE, NW
Tangible fixed assets with ecological use, 2021	SW, SE	SC, NE	NW, NC
Operating municipal wastewater treat- ment plants, 2021	SW, SC	SE, NW	NE, NC
Installed RES capacity per capita (kW), 2020	SC, NE	SE, NW	SW, NC
Number of buildings financed under the National program for energy effi- ciency of multifamily residential build- ings, 30 June 2023	SW, SC	SE, NE	NC, NW
Expenditures for scientific research and development activities, 2021	SW, SC	SE, NE	NC, NW

 Table 2. Classification of the regions according to the realized environmental protection activities

*Legend:* NW – Nord Western; NC – North Central; NE – North Eastern; SE – South Eastern; SW – South Western; SC – South Central

Source: own research based on data analysis

The conclusion is that the South Central and South Western regions are the most active in terms of carrying out activities that lead to environmental protection, the South Eastern and North Eastern regions can be defined as moderately active, and the North Central and North Western regions as low active in terms of environmental protection activities.

In order to increase the engagement of the regions to carry out environmental protection activities, various initiatives can be taken, most often related to better understanding of ecological benefits, taking political actions and implementation of regulations in economic sectors related to the environment and natural resources, spreading of good practices. Increasing the amount of waste submitting for recycling can be achieved through complex actions aimed primarily at raising the awareness of both society and business, improving existing infrastructure and creating a new one. Increasing the benefits of TFA with ecological use requires undertaking such business strategies through which the assets are used optimally and the environmental benefits are maximized. Activities related to the dissemination of information about the economic and environmental benefits (energy efficiency, cost savings, environmental protection, etc.) of TFA with an ecological use, the creation of events and demonstrations for the dissemination of good practices, government incentives and policies to promote the acquisition of TFA with ecological use could be a driver for business for increasing such type of assets. The increase of municipal wastewater treatment plants, installed RES, energy efficient building requires precise planning, financial support and opportunities to ensure financing, community engagement, adequate regulation and political focus on business sectors that could have a positive impact on the environment and natural resources.

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NSI, Environment, Tangible fixed assets with ecological use.

NSI, Environment, Waste from economic activity.

NSI, Environment, Water statistic.

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