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Sevda Hacıyeva

Doctor of Economics, Associate professor, Department of Economics of the Agricultural Industry,

Azerbaijan State Agrarian University, Ganja, Azerbaijan.

IDENTIFICATION OF FACTORS AFFECTING THE FINANCIAL COSTS OF ENVIRONMENTAL PROTECTION

Introduction. Stationary and mobile facilities that emit gases (carbon oxides, nitrogen, sulfur dioxide, and dust) that cause environmental pollution are considered the main source of waste.

Рост объема сельскохозяйственных, продуктовых и др. отходов, в растущих городах стран привел к усилению озабоченности общества. К их последствиям можно отнести вред здоровью людей и окружающей среды. Также нужно отметить, что отходы жизнедеятельности человека бесконтрольно утилизируются (Wilson, 2015). The developed prestigious waste-to-energy technologies identify interesting solutions to waste disposal problems. It should also be noted that the introduction of new technologies is faced with common obstacles such as operating costs, low compliance with environmental laws and personnel to effectively manage these systems.

The ability of science is understood as the relationship between goals (socio-ecological- economic). development and orientation. The Global Sustainability Report for 2023 has six chapters that mark the path, shape the future, clarify ways to achieve the goal and accelerate, as well as transform achievements through science (Times of Crisis, Times of Change Science for Accelerating Transformations to Sustainable Development, 2023).

Different approaches to optimizing environmental protection costs are based on research by scientists that focuses on converting waste into energy. The research uses dialectical, analysis and synthesis, comparison, induction and deduction, nonlinear regression models, etc. methods for comparative analysis of optimization of financial costs for environmental improvement using key factors affecting volume.

Analysis of data on increased amounts of waste in the regions shows that, according to experts, in 2050 (compared with 2025) it will increase by 0.85 million tons or by 40.5%, and in rural areas it will decrease by 14.3% and amount to 600 million tons (Dieter, 2017). Without departing from this indicator, different countries are beginning to develop a national strategy for integrated waste management based on the 3Rs concept. The core of this concept is to reduce emissions to the environment.

Technological possibilities for converting POE waste include incineration, co-processing, anaerobic digestion, gas capture, and the production of gaseous fuels. The key parameter of waste recycling is the energy value "low calorific value, LCV" (LCV - 1 kg of boiler fuel 40 MJ/kg). To ensure automatic thermal incineration, the volume of waste should be on average less than 7 MJ/kg per year (The World Bank. Gorenje. Incineration of solid household waste. International Bank for Reconstruction and Development, 1999).

The table shows the preliminary sorting of waste for recycling, which affects the characteristics of the residual waste.

Table 1. Results of pre-sorting for waste recycling

№	The fraction being deleted	Effects of disposal on residual waste
1	Glass, metals, ash, minerals from construction and demolition waste	Increase in calorific value. Reducing the amount of slag and recoverable metals
2	Paper, cardboard and plastic	Reduction of calorific value. Reduction of chlorine content (e.g. from PVC) in emissions
3	Organic waste from kitchens and gardens	Reduction of moisture content. Increase in calorific value
4	Bulky waste	Reduction of labor costs for waste crushing
5	Hazardous waste (batteries, electronic devices, etc.)	Reduction of labor costs for the extraction of toxic volatile heavy metals from atmospheric emissions (mercury, etc.). Reduction of the concentration of toxic impurities in slag and fly ash (cadmium, lead, zinc, etc.)

Source: compiled by the author based on (Dadakhanov, Bankurova, 2017; Nigmatullina, 2020)

Alternative energy sources lead to a change in the energy sector. The potential of waste as an alternative energy source is an important area of development that will lead to significant changes in the energy sector (reduction of greenhouse gas emissions, reduction of dependence on fossil fuels). Integration with energy storage technologies increases the flexibility of the system, and makes them more competitive. For example, the larger use of waste in energy production is technologically limited and different types of waste are difficult to use in energy production (Kozlov, 2022).

Important obstacles include the economic feasibility of recycling waste into energy, packaging production, etc. Investments in energy production plants and the efficient use of waste as an energy source require the development of infrastructure (collection, transportation, recycling and disposal systems).

The global market for this industry in 2024 was 42.4 billion US dollars. Experts predict that the volume of such markets (CAGR) will grow by an average of 6.6% over 10 years (2022-2034) and reach \$78.6 billion dollars (Figure 1).

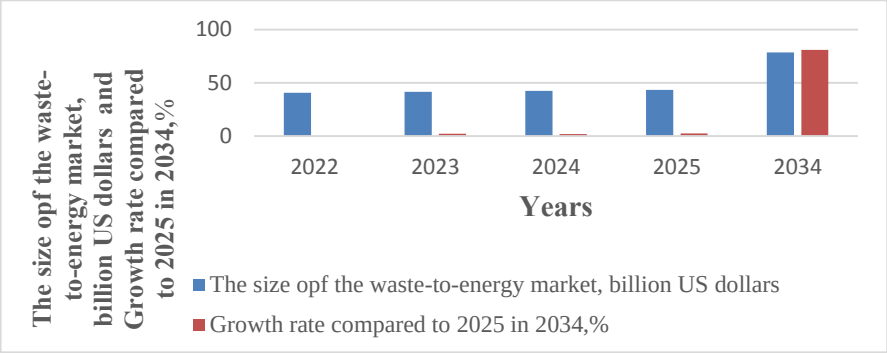


Figure 1. Growth of the waste recycling market

Source: compiled by the author based on (Gupta and Agarwal, 2025)

Governments and relevant authorities are focused on developing a cycle economy and integrating energy portfolios, and this provides an opportunity to strengthen the business landscape in the industry. The expansion of the industry's capacity for waste disposal with electricity generation will give an impetus to its growth. For example, Uzbekistan, actively attracting investments in the processing of various wastes (2024), paid attention to environmental standards using energy. Also, the investment measures prohibit the disposal of waste during recycling by 2030, an increase in the number of corporations in this area, and investments in energy-efficient medical waste recycling projects. Increased investments in the construction of plants in this area will contribute to the entry of such developed products into local and global markets. The commissioning of such plants in Uzbekistan is the first country among the Central Asian countries. (The year 2026 has been declared in Uzbekistan for the "Development of the mahalla and the whole society", 2025).

Figure 2 shows the volume of electricity production, heating, and other activities in the market of this industry in the United States in 2024.

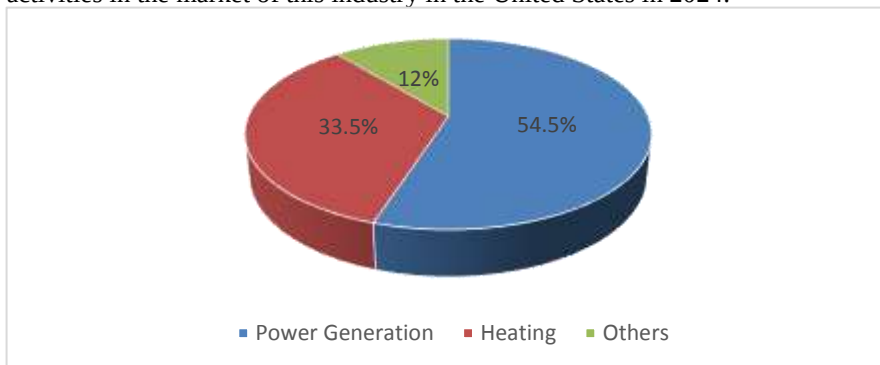


Figure 2. Power generation, heating and others 2024

Source: compiled by the author based on (Gupta and Agarwal, 2025)

The data shows that electricity production accounted for 54.5%, heating for 33.5%, and other activities in the waste-to-energy market accounted for 12%. From this we can conclude that a large number of financial expenses are directed to the production of electricity and heating, which together account for 88% of the total waste conversion into energy.

The results of the environmental performance index of the TOP 5 countries located in the front rows, 5 countries in the middle rows, 5 countries at the end of the ranking and the Transcaucasia countries among 180 countries in the world in 2024 are given in Table 2.

An analysis of the results of the environmental performance index among 180 countries in 2024 shows that the rating of this indicator has changed in almost all countries during the year under study. Since, in 2022, the UK took the 2nd place, and in 2024 only the 5th place. There was also a decrease in the index value by 5.1 points. Among the countries studied, the largest declines in the index were in the UK (-5.1 points), Laos (-4.4 points), Armenia (-3.4 points) and Grenada (-2.1 points) (The Environmental Performance Index 2022. <https://nonews.co/directory/lists/countries/ecology>; Environmental rating of countries 2026: who is leading the fight for nature. <https://krasnodar.allestate.pro/news/30.03.2026/ekologicheskij-rejting-stran-2026-kto-vedet-v-borbe-za-prirodu>)

Based on the study, the author concludes that developed and developing countries are trying to spend a large amount of investment on improving the environment. These States and their other authorities are trying to develop new strategic plans to optimize costs in this industry.

In 2025, the waste recycling market in Azerbaijan is actively transforming with the transition from simple recycling to sorting and recycling within the

framework of the Sustainable Development Goals. The main aspects of the waste market are the introduction of collected garbage in Baku (in the village of Balakhani), the development of waste recycling infrastructure, and the participation of the private sector in this industry with the support of government environmental initiatives. It should be noted that the volume of investment financing in the waste recycling market in Azerbaijan is increasing dramatically. Also, the study highlights the factors (Investments aimed at environmental protection and fixed assets for the rational use of natural resources; carbon dioxide efficiency; gross domestic product; gross domestic product per person) influencing the financial costs for environmental protection.

Conclusion. The use of modern technologies leads to the fact that the energy production of solid waste is at a new level. At the moment, there is a large amount of potential waste from an alternative energy source, and their use for energy processing opens up opportunities to reduce emissions. Thus, the use of waste as an alternative source of recycling pays special attention in the field of environmental protection, as there is significant potential for the sustainable development of the energy sector and the reduction of negative factors affecting the environment of the country. To overcome the challenges of recycling waste into energy, it will require large amounts of innovation, investment, and comprehensive efforts on the part of the government (business, community, etc.).

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