ECONOMIC AND ENVIRONMENTAL EFFICIENCY OF SOLID WASTE RECYCLING IN AZERBAIJAN

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Abstract. In modern times, waste management has become one of the most pressing environmental and economic problems worldwide. According to the 2024 report of the United Nations Environment Program, the world's solid waste is projected to increase from 2.1 billion tons in 2023 to 3.8 billion tons by 2050. In Azerbaijan, as a result of population growth, accelerated urbanization and increased consumption levels, the volume of solid waste is increasing year by year. The country receives daily solid waste, of which 25% is recycled. However, this figure is very low compared to the average of 48.6% in the European Union countries. This situation creates serious problems from both an ecological and economic perspective.

Keywords: waste, efficiency, recycling, ecological, income, savings.

Thousands of tons of household waste are generated in Azerbaijan every day, and a large part of it is accumulated in landfills. This waste releases harmful substances into the soil, water sources and the atmosphere, creating serious environmental problems. Proper waste management is vital for preserving the ecological balance of the Caspian Sea.

The recycling process offers great economic advantages. Firstly, it reduces dependence on raw material imports and stimulates local production. Secondly, it leads to the creation of new jobs - in the areas of collection, sorting, processing and sale of household waste. Thirdly, it significantly reduces the costs of maintaining landfills.

The production of biogas from organic waste, recycled paper from paper and cardboard, and new products from plastic allows for more efficient use of the country's energy and material resources. This is especially important in the context of the country's diversification strategy.

Baku and other large cities have a high population density and the demand for landfill space is increasing. Recycling significantly alleviates this problem and improves the quality of living areas around the city.

Azerbaijan is a party to international environmental agreements and must improve waste management in order to achieve sustainable development goals. This is also an important step in the process of harmonizing with EU standards.

The formation of a recycling culture contributes to increasing environmental awareness in society and preserving a cleaner environment for future generations. For these reasons, the establishment and development of a waste recycling system in Azerbaijan should be considered a national priority.

There are 2,540 garbage collection points in Baku city and three landfills are located in Sabunchu, Surakhani and Garadagh districts. The Balakhani city waste disposal landfill, which has been operating since 1963, is the largest among them. The composition of solid household waste generated in Azerbaijan is as follows:

- Organic waste: 45-50%
- Paper and cardboard: 15-18%
- Plastic: 12-15%
- Glass: 8-10%
- Metal: 3-5%
- Textiles and other materials: 10-12%

It is noted that humanity currently produces approximately 2.3 billion tons of solid waste. 4000-4500 tons of solid household waste are generated daily in Baku, and 9500-10000 tons in Azerbaijan. Taking into account the economic, social, and ecological importance of their management, in accordance with the Decree of the Head of State "On Improvement of Municipal Waste Management in Baku" dated August 6, 2008, "Tamiz Shahar" OJSC was established on March 12, 2009. A waste incineration plant and a solid waste sorting facility were built in Balakhani settlement. Currently, the existing infrastructure in the country consists of the following:

• Energy Recovery Plant: 500,000 tons of solid municipal waste per year, 10,000 tons of clinical waste; 231.5 million kWh of electricity production per year;

• Material Recovery Facility (sorting line);

• Balakhani Eco-Industrial Park.

The Law of the Republic of Azerbaijan "On Waste" and the National Strategy "Improving Solid Waste Management in the Republic of Azerbaijan for 2018-2022" constitute the legal basis for solid waste management. Currently, the application of the principle of Extended Producer Responsibility and the draft law "On Packaging and Packaging Waste Circulation" are being discussed.

The main investment directions for the development of the solid waste recycling industry can be divided into two: the provision of technological equipment and the development of infrastructure. The provision of technological equipment includes the construction of modern sorting lines and plastic recycling facilities, while the development of infrastructure mainly includes the modernization of collection and transport systems, storage facilities and utilities.

Referring to the facts, it can be said that in 2020 the direct global cost of waste management amounted to approximately 252 billion US dollars. Direct revenues from recycling amounted to $50-80 million per year from the sale of recycled materials, $20-30 million from energy production (biogas, etc.) and $15-25 million from compost sales. In addition, indirect savings, including a reduction in landfill costs of $40-60 million and health costs of $25-35 million, were noted.

With the establishment of a new recycling plant, more than 130 people were created with government contracts and health insurance. The development of the recycling industry can create 15,000-20,000 new jobs. It should be noted that globally 19% of waste is recovered through recycling and composting. The resource saving effect of recycling is estimated at approximately 50-70 million m^3 per year for water resources, 200,000-300,000 m^3 per year for forest resources, and 500,000-800,000 tons per year for wood and mineral raw materials.

Taking into account the above, the establishment of modern sorting centers in Baku and Sumgayit cities in Azerbaijan, the establishment of plastic and paper recycling plants, and the expansion of organic waste composting systems have been identified as short-term priorities for 2025-2027. A number of institutional reforms should also be implemented during this period. Thus, the implementation of the Extended Producer Responsibility concept, which covers all stages of the production cycle - design, production, use and, finally, waste management, is considered important, as is the phased implementation of the waste separation system and the implementation of the principle of producer responsibility.

Within the framework of medium-term goals, it is planned to increase the recycling rate to 15-20% in 2027 and to 30-35% in 2030. In addition, active work is underway to create a modern infrastructure for waste collection, sorting and recycling in the liberated territories. Nine landfills for solid waste disposal are planned to be created in Karabakh and East Zangezur

Consequently, long-term prospects imply the adoption of the "Zero Waste - Baku" initiative within the framework of the transition to a circular economy, the development of public-private cooperation models, as well as the implementation of the tasks of effective use of export potential.

From the perspective of global experience, it can be noted that, based on the European Commission's Waste Framework Directive, European Union (EU) member states will have a legal obligation to recycle (or prepare for reuse) 60% of waste by 2030. By 2035, they will have to reach the 65% target. In accordance with the EU Landfill Directive, EU countries must ensure that the amount of waste sent to landfills is reduced to 10% of total waste by 2035.

The development of solid waste recycling in Azerbaijan has high efficiency from both an economic and environmental perspective. By taking measures to control, prevent and manage waste, it is expected that annual costs can be limited to 270.2 billion US dollars by 2050. The establishment of a plastic waste recycling and hose production facility for technical water supply in Sheki city, a plastic recycling facility and bioenergy production facilities in Sumgayit city are currently important and effective investment measures. Their successful implementation is based on technological decisions such as the application of artificial intelligence technologies in sorting, the development of blockchain-based tracking systems and mobile applications.

Currently, within the framework of the "Clean Gala" project, a system of collection and disposal of household waste is being organized in the territory of the historical Gala village, voluntary initiatives are being supported, and within the framework of the "My Clean Country" pilot project, plastic containers collected in special containers placed in parks, residential areas and universities are being recycled. According to preliminary estimates, the implemented and planned measures can bring a total economic benefit of 200-300 million manats per year, create 15,000-20,000 new jobs and increase GDP. As for environmental benefits, it is projected that 1.1-1.7 million tons of CO_2 emissions will be reduced per year, protect and sustainably use natural resources, and restore ecological balance.

The effective implementation of solid household waste recycling is an important step for Azerbaijan to achieve its sustainable development goals and transition to a green economy. Azerbaijan has adopted a green development course as one of the main goals in its national priorities, which means transition to a green economy. For this process to be successful, coordinated cooperation between the state, the private sector and society is necessary. The development of recycling is not only an ecological necessity for Azerbaijan, but also a great economic opportunity. With a properly planned and phased implementation strategy, the country can become a regional leader in this area by 2030.

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