Low-carbon development of the municipal solid waste management industry

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Abstract. The current system of municipal solid waste management causes environmental problems such as air, water and land pollution, the possibility of fires, which leads to public health problems. In this case, the quality of clean steam gases was tested during waste management. The analysis of outcome management technologies shows the most promising projects leading to a reduction in greenhouse gas emissions, which can be implemented as climate projects and, thus, attract more investment in the development of the industry. An assessment was made of the possibilities of implementing projects in the field of waste management aimed at reducing greenhouse gas in the Voronezh Region.

1 Introduction

Excessive accumulation and irrational use of waste is currently one of the main problems of concern to the global community.

An assessment of the global municipal solid waste management system in terms of greenhouse gas emissions shows that more than 50% of collected waste is not managed properly, but instead is openly burned or dumped in landfills in most developing countries [7].

The highest levels of uncontrolled waste disposal (dumping and open burning) are observed in sub-Saharan Africa and Central and South Asia, while in North America and Western Europe almost all of this waste is processed at controlled destinations. In North America, sanitary waste disposal is predominantly used, while in Western Europe the recycling rate is higher, and waste-to-energy is the dominant method of municipal solid waste disposal.

In the Russian Federation, according to Rosprirodnadzor, about 50 million tons of municipal solid waste are produced annually. However, only half of all municipal solid waste in Russia is recycled and rendered harmless. And less than 15% of raw materials are reused. About 90% comes from various industries, mainly mining (Figure 1).

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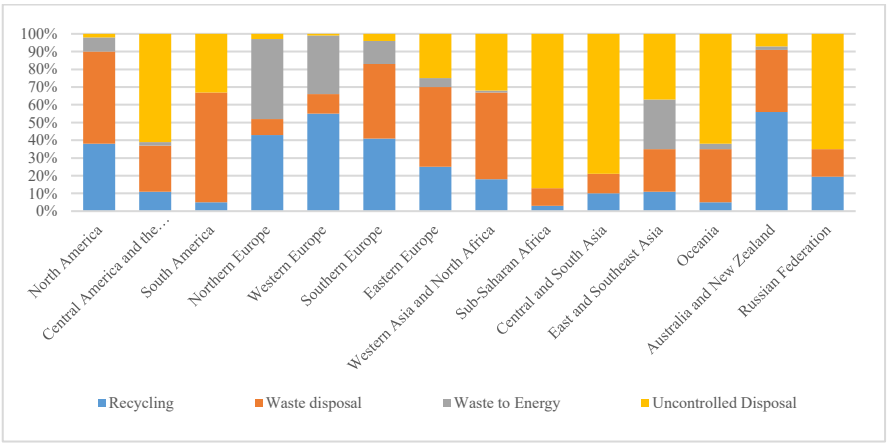

Fig. 1. Regional waste disposal at operating facilities, 2020.

Source: UNEP: The Age of Waste is Over: Global Waste Management Outlook 2024.

Poor solid municipal waste management and its ineffective implementation create environmental problems such as air, water and land pollution, fire hazards, which leads to public health problems [8, 10]. Total greenhouse gas emissions from waste management account for approximately 5% of all greenhouse gas emissions into the atmosphere, which is about 1.65 billion tCO2 equivalent (Figure 2).

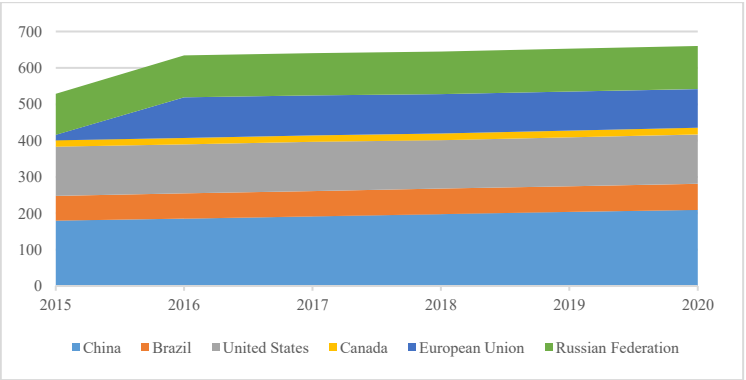

Fig. 2. Greenhouse gas emissions from the municipal solid waste industry, million tCO2-equivalent

Source: according to data Climate Watch. URL: https://www.climatewatchdata.org/ghg-emissions?chartType=area&end_year=2020&sectors=waste&start_year=1990.

The municipal solid waste industry in China is the largest source of greenhouse gas emissions (12%), followed by the United States (8%). The municipal solid waste industry in the Russian Federation accounts for 7% of the world's total greenhouse gas emissions. And the waste management industry in the European Union accounts for only 7% of global greenhouse gas emissions and 4-5% of global methane emissions.

Therefore, sustainable management of the municipal solid waste management system aimed at reducing greenhouse gas emissions is important for maintaining existing resources and protecting the environment.

Many countries around the world are actively addressing this problem using various means, such as economic, political, technological and organizational measures.

2 Materials and methods

The analysis of the most promising technologies for low-carbon development of the municipal solid waste management industry was carried out using data from domestic and foreign information resources for the period from 2000 to 2023 to identify trends in the field of sustainable management of the waste management system aimed at reducing greenhouse gas emissions.

To assess the potential of project activities in the field of waste management in the Voronezh Region, data were used on the volumes of municipal solid waste generated during the reporting year, the volumes of municipal solid waste generated per capita, the volumes of material resources sent for recycling and placed at the landfill, including temporarily stored municipal solid waste, as of February 1, 2020 - 2022.

As an information base for assessing the potential of project activities in the field of waste management in the Voronezh Region, data from official statistical information from Rosprirodnadzor on the formation, processing, utilization, neutralization, placement of production and consumption waste from the form «2-TP Waste» were used.

3 Results

In the United Nations (UN) Agenda for Sustainable Development, one of the key objectives for achieving sustainable consumption and production patterns by 2030 is to reduce waste generation through prevention, recycling and reuse.

Landfills, the most common method of waste disposal, are a major source of greenhouse gas emissions, primarily due to methane emissions from landfills. According to the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report, almost half of the total net global warming comes from higher methane concentrations, and their impact on global warming has become stronger than that of carbon dioxide. According to the National Inventory Report of Anthropogenic Emissions by Sources and Removals by Sinks of Greenhouse Gases, the Russian municipal solid waste management industry is the second largest source of methane emissions in the country, accounting for 18.1% of total methane emissions, primarily in the form of landfill gas.

There are several policy options and technologies for a sustainable production and consumption model aimed at reducing methane emissions and improving not only the climate and environment, but also energy security.

According to the US Environmental Protection Agency's greenhouse gas research, the use of both active landfill gas collection and electricity generation will reduce greenhouse gas emissions by 60-90% compared to traditional methane utilization technology [3, 14]. According to the Agency, this practice is used by at least 500 projects implemented in 49 states and territories [14]. Collected landfill gas can be used as an alternative renewable fuel or to generate electricity that can be sold to the energy grid, which, according to S. Thompson and A. Damgaard, provides additional sources of income for the industry, replaces the use of fossil fuels and reduces greenhouse gas emissions [5,13]. Research by P. Sullivan confirms that any investment in landfill gas will definitely bring profit, despite the existing obstacles to the collection and use of landfill gas [12].

In the Russian Federation, projects in the field of municipal solid waste management related to the capture and utilization of landfill gas in accordance with the approved Decree of the Government of the Russian Federation of September 21, 2021 No. 1587 are classified as green and can apply for existing government support measures related to green financing.

However, landfill gas utilization at municipal solid waste landfills has not received due distribution in the Russian Federation. According to the Ministry of Natural Resources of Russia, the share of landfill gas energy in the total volume of renewable energy production

in Russia does not exceed 10%. Despite the fact that waste disposal technology with landfill gas utilization is currently considered one of the most effective and economically sound options for reducing greenhouse gas emissions [4, 6, 15, 16]. Expert assessment allowed us to determine that 25% of methane savings extracted from landfills can be achieved at a cost of about 20 US dollars/mg CO2-eq/year [9].

In the context of sustainable economic development, waste processing, especially through recycling and composting processes, has significant environmental benefits, helps to reduce the consumption of natural resources and reduce greenhouse gas emissions [1].

We will assess the potential for implementing projects on secondary processing of material resources (recycling) using the example of the Voronezh Region. Currently, the region generates about 1 million tons of municipal solid waste. According to the Federal Service for Supervision of Natural Resources, the volume of waste generated by one resident of the Voronezh Region is growing annually; in 2022 alone, one resident generated an average of 430 kg of waste, which is comparable to the volume of waste generated by one resident of the European Union, and only 3% of the total amount of waste generated is sent for recycling. The rest is sent to landfills, including temporarily stored waste, the capacity of which is close to exhaustion (Table 1).

Table 1. Current situation with solid municipal waste management in the Voronezh region.

Indicator, tons	2020	2021	2022
Waste generation for the reporting year	838 587	970 061	979 182
Volume of waste generation per inhabitant	0.36	0.42	0.43
Sent for processing	402 157	494 006	515 654
Sent for secondary processing of material resources (recycling)	-	204	28 452
Placed at the landfill, including temporarily stored waste	834 027	938 311	929 919

Source: according to Rosprirodnadzor, based on form «2-TP Waste». URL: https://rpn.gov.ru/open-service/analytic-data/statistic-reports/production-consumption-waste/

At the same time, this waste contains a large number of useful fractions: 35% - food waste, 0.7% - paper, cardboard, 0.51% - wood, 0.86% - metals, 0.04% - glass, 0.02% - rubber, 0.3% - PET.

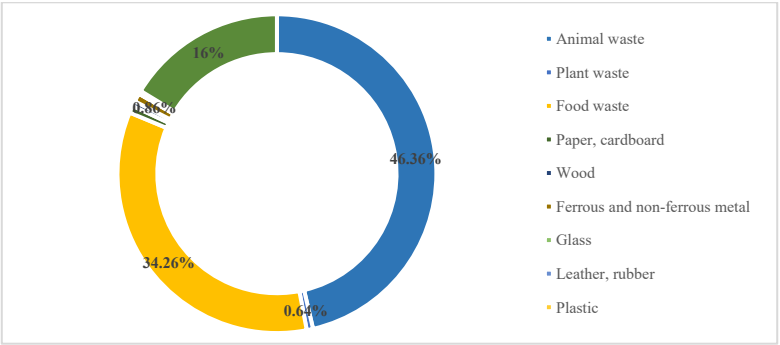

Fig. 3. Morphological composition of municipal solid waste in the Voronezh region, %

Source: according to the Territorial Scheme for Waste Management in the Voronezh Region, approved by the Order of the Department of Housing and Public Utilities and Energy of the Voronezh Region dated 26.12.2022 № 319. URL: https://base.garant.ru/406079141/

4 Conclusion

Analysis of waste generation using the Voronezh Region as an example allows us to conclude that there is a fairly high potential for implementing projects in the field of municipal solid waste management aimed at reducing greenhouse gases, but the lack of capacity for processing, recycling and disposal of waste, as well as the difficulty of attracting investment for the creation and modernization of enterprises in the field of waste management, hinders the implementation of such projects. At present, there is practically no market application of such waste management technologies in Russia without state subsidies, due to the high investment cost of creating infrastructure for capturing landfill gas and processing material resources [2].

Therefore, we believe that an additional incentive for implementing measures for controlled waste management in order to reduce greenhouse gases will be their classification as climate projects and their implementation in accordance with current legislation.

Studies have shown that from the point of view of practical aspects of municipal solid waste management, several types of projects can be identified that are aimed at solving the problems of accumulated environmental damage from landfills and reducing greenhouse gas emissions and can be implemented as climate projects: projects for the useful utilization of landfill gas and projects for the secondary processing of material resources (recycling).

According to experts, controlled waste management technologies can reduce greenhouse gas emissions by up to 70% due to the utilization of landfill gas and the secondary processing of material resources, this volume can be verified in the mass of greenhouse gases equivalent to 1 ton of carbon dioxide in accordance with the rules established by the Government of the Russian Federation and placed on the sites of voluntary carbon markets.

Thus, subject to certain conditions and criteria, a number of projects in the field of handling and consumption of industrial waste can be classified as climate projects, which will attract additional investment and compensate for the costs associated with their implementation.

5 Acknowledgements

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