United Nations Development Programme Azerbaijan
 "EU4Climate" Project

FULL REPORT

ISLAM MUSTAFAYEV -   Local Expert in Waste Sector

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CONTENTS

1. Acronyms

EU - European Union

AR - Republic of Azerbaijan

NK - Cabinet of Ministers

UN - United Nations

SH Waste - Solid household waste

GHG – Greenhouse gases

GDP - Gross domestic product

DEP - District Executive Power

OJSC- Open Joint Stock Company

NGO - Non-governmental organization

2. **SUMMARY**

Greenhouse gas emissions from household waste, which affect climate change, were assessed. It was indicated that the emitted amount of these gases depends on the amount of household wastes, their fractional and carbon composition, as well as of their management method. The origin of carbon is also a factor that affect emissions. The results of the studies on the daily amount and composition of solid household waste per capita conducted in 2008-2020 were summarized, compared with the data of "Tamiz Shahar" OJSC and the State Statistics Committee, and trends for the last 10 years were identified. At present, the amount of CO_2 emitted from solid waste and wastewater is equal to 2899 tons of CO_2 equivalent. Taking into account the growth of the country's population and GDP, this figure can increase to 3,434 tons in the next 10 years and can reach 6.8% of the country's total emissions. Information was provided on the projects implemented in this area in the country for the last 15 years and it was indicated that no serious activities were undertaken in this sector to reduce GHGs. Likewise, the laws and policy documents adopted in the country should include provisions to reduce the impact of climate change. This report analyzes these issues in detail and identifies gaps in policy and legislation. Proposals are made to reduce GHG emissions in this sector.

Keywords: Solid waste, wastewater, greenhouse gases, policy, legislation, management mechanism

Report: 33 pages, 6 tables, 1 diagram, 22 references

3. Introduction

The Republic of Azerbaijan has undertaken to limit the emissions of greenhouse gases in the country by signing the UN Framework Convention on Climate Change and the Paris Agreement. To fulfill this obligation, the sources of GHGs in different sectors of the country's economy should be inventoried, and the share of each sector in the total emissions of the country should be determined. At the same time, the potential to limit these emissions in each sector should be identified. This report assesses GHG emissions from the waste sector and makes projections for the next 10 years.

By examining this sector for many years, the author has collected a large amount of original materials and proposed a new method for inventory. The author has proposed the developed method for the implementation of several projects. The author has resolved the issues of the Project related to the waste sector by analyzing the data.

4. Assessments and recommendations to take into account the reduction of GHG emissions in the waste sector development policy and strategies

4.1. Inventory of solid household waste

In developing waste management policies (national action plans, strategies, concepts, legislation development, etc.), it is important to take into account the generation of greenhouse gases (GHGs) from substances and their role in climate change.

Being one of the main factors that affect climate change, greenhouse gases (GHGs) include CO2 from the combustion of fossil fuels, CH4 emissions leaking into the environment during production, preparation, transportation and use of oil and gas, N2O emitted from different sectors of production, and other

gases. However, CO2 and CH4 gas can also be emitted from solid waste while being stored at landfills and processed in different natural and climatic conditions. In many countries that do not have oil and gas industry, the share of emissions in the GHG emissions can be up to 40%. All statistics [1] on Azerbaijan show that more than 95% of all GHG emissions from waste are separated from solid waste and sewage water. Therefore, in this report we have analyzed only emissions from these categories of waste.

First, it's to note that the origin of these emissions are carbon-containing substances in the waste. In fact, main greenhouse gasses (GHGs) consist of CO2 and CH4.

There are two main points of reference for reliable assessment of the mechanism and intensity of GHGs generation:

- The amount of annual waste generated in the country, their range and carbon composition

- Waste management method

To obtain accurate information on the amount and composition of waste, as well as their changing trends, is problematic. Especially in the countries of the former Soviet Union, it is not possible to conduct long-term analysis and accurately identify trends, as reports are conducted only by waste transportation operators and these figures are expressed only in units of volume. Because in terms of GHG emissions, not only transported but also generated wastes must be considered. Prior to transportation, waste can be sorted several times, which vary in both quantity and composition. It is possible to separate paper, glass, metal and plastic materials from waste at the source of generation, collection points and during transportation. Wastes are sorted without due care and unsystematically in order to provide raw materials to about 100 secondary waste treatment plants created in Baku and Sumgayit in the last 10 years. Second, the

density of solid waste varies between 60 and 700 kg/cubic meter [2], as shown in the table below, mainly depending on the location.

Table 1. Density of solid household waste stored in different conditions

#	Condition	Density, kg/cubic meter
1	In natural condition	60-120
2	In container	180-220
3	Upon unloading at landfill	210- 240
4	In garbage truck	300-420
5	In shredded condition	350-530
6	In packaged form	470-700

Therefore, analyzes based on information on the number and composition of solid household waste in previous reports are usually invalid. For the first time, these issues were analyzed in detail under the "Improving Solid Waste Management in Azerbaijan" (2009-2012) Project implemented by UNDP and the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan with the financial support of the Norwegian Government. In this Project, the amount and composition of household waste was determined at the source (households), in yards, in collection point and in landfills by applying different methods and approaches in 3 stages and 4 seasons. Meanwhile, some scattered and inconsistent information was clarified by conducting surveys [3] among the population and decision-makers.

According to the application of solid waste management method, the population of Azerbaijan is conventionally divided into 4 groups:

- The population of Baku and surrounding settlements (approximately 3 million);

- Population living in cities with 70-300 thousand population (including Mingachevir, Shirvan, Ganja and Sumgayit);

- Population living in district centers and urban settlements

- Population living in villages

Although the daily solid household waste amount for all population groups is slightly different, the national average for 2012 was 248 kg/day. The average composition of the wastes is shown in the diagram in Figure 1.
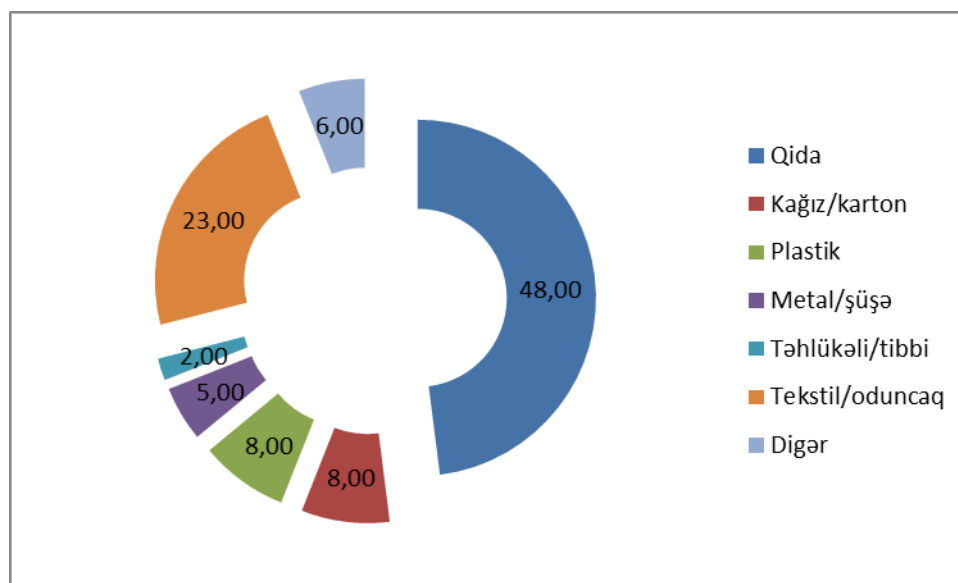
Figure 1. Summarized composition of solid household waste in Azerbaijan [4-6]

These figures were confirmed by subsequent studies [7] by the Asian Development Bank in 2016 with tolerance of 10-15%.

These results were largely confirmed by the results of experimental studies conducted in households in 2020, but the total amount of solid waste increased up to 10%, and the share of plastics increased from 8% to 10%. These figures refer to the waste generated in households. In fact, before the management phase, some of this waste (metal, glass, paper, soft plastics is unsystematically sorted in the yards of houses, food waste is given to animals in

the villages and is not considered by the government's management mechanism. Taking into account these considerations, the approximate amount of solid household waste generated in Azerbaijan in 2020 by population category is given in the table below.

Table 2. Approximate amount of solid household waste generated in Azerbaijan in 2020 by population category

Population Group	Approximate number of population, in thousand	SHW, thousand ton	Degree of management
Baku	3000	626	Fully managed
Cities	2200	812	Partially managed
Villages	4860	945	Not managed
Total	**10060**	**2383**	

For Baku, this figure is confirmed in the report of "Tamiz Shahar" OJSC [8].

It is to note that the increase in the total amount of solid household waste per capita by about 10% in 8 years is due to changes in the socio-economic conditions and lifestyle of the population. In some cases, this may be related to the historical living traditions of the population, or even to the local food rituals. The most universal indicator of the factors affecting the amount of solid household waste per capita is the amount of Gross Domestic Product per capita.

The rate of change in the socio-economic conditions of the population in the country is mainly determined by changes in GDP (gross domestic product). Studies conducted over the last 30 years in more than 20 countries [9-12] have shown that changes in GDP in countries lead to changes in solid waste. The

changes that may occur in this area until 2030 are mainly due to changes in two macro indicators: 0.9% population growth per year and 2% GDP growth [1] is peculiar in Azerbaijan. Of course, these figures may change for a variety of unforeseen reasons, but most likely the figures mentioned are projected.

If we accept these figures, the change in these macroeconomic indicators by 2030 will be as shown in Table 6.

The impact of changes in GDP per capita on the amount of solid household waste per capita has been analyzed for 16 countries [10]. Data on changes in GDP and solid household waste in countries with different levels of development [10] show that, for example, in countries where per capita GDP differs by 3 times, the solid household waste per capita differs by 2 times.

If we accept these figures, the change in these macroeconomic indicators by 2030 will be as shown in Table 6.

On the other hand, the relationship between GDP growth for Russia over 30 years and the solid household waste growth per capita has been studied [10]. These studies show that despite the threefold increase in GDP per capita in Russia between 1985 and 2014, the amount of solid household waste has doubled. In fact, unless specific governance policies are implemented, the solid household waste growth will be determined by annual population growth (0.9%) and GDP growth (2%).

4.2. Estimation of GHG emissions from the waste sector

Statistics of the last 20 years in Azerbaijan [1] show that the share of the waste sector in the GHG emissions did not exceed 4-5%. In this case, the emission of these gases from solid waste and sewage water can be calculated in accordance with the first level of the existing methodology [12-15].

In terms of emissions from solid waste, it is necessary to distinguish two processes:

1) Biodegradation of wastes in the environment and production of biogas consisting mainly of CO_2 and CH_4

2) Partial (open combustion) or complete (more than 95%) conversion of carbon in waste into CO_2 resulted from burning of waste in incinerator or open combustion.

In the first process, due to the generation of methane along with carbon dioxide in the generated biogas (Table 3) and as the greenhouse effect of methane is 25 times higher, the total greenhouse effect of emitted gases from degradation in landfills is greater than that of gases generated from incineration (CO_2) [2,34].

The production of biogas, consisting mainly of methane and carbon dioxide, as a result of the decomposition of organic matter in the anaerobic environment has long been known in science [12,13, 17, 18,19, 23,32]. The total amount of generated gas and the composition of the gases depend on the characteristics of the raw material, whether the environment is aerobic or anaerobic, and parameters such as temperature, humidity, etc. The total amount of gases usually varies between 60-300 grams per kilogram of raw material. High yields are achieved from plants specially grown to this end. The main role played here depends on the ratio of organic-biological (plant-based) and fossil (oil-gas) parts of carbon in the raw material. For example, plastics of petroleum origin and synthetic textiles emit less gas than vegetable origin substances. Since solid household waste contains carbon of both origins, different yield results are obtained depending on the composition of the waste. Estimates show that for real conditions, 170 grams/kg of gas is generated from solid waste under anaerobic conditions [12-15]. The volume composition of gases varies in the following intervals: CH_4:50-75%, CO_2: 25-50%, N_2: 0-10%, H2S: 0-3, O2: 0-2, H2: 0-1. According to statistics, the calculations show that for gas from the solid household waste, the volume ratio of methane and carbon dioxide can be taken

as an average of CH4: CO2 = 1.4, and the mass ratio as 1:2. For sure, for accurate calculations for separate landfills, this ratio can change in one or another direction.

Table 3. Composition and specific amount of biogas generated from the biodegradation of solid waste

Biogas type *)	Methane,%	Carbon dioxide, %	Oxygen,%	Nitrogen,%
Anaerobe	55	45	-	-
Only when oxygen enters the surface	45	35	1	18

The average density of biogas is 1.25 kg/m^3 and the yield from solid waste is 0.17 kg/kg (waste) [2,12,13,17,18,22,30]. When converted to mass, 0.33 part is CH_4 and 0.66 part is CO_2. In the case of solid household waste combustion, depending on the conditions, the carbon atoms in it are partially (open combustion) or completely (incinerator combustion) oxidized and turn to CO_2. CO2 emissions can be calculated in the case of burning of sorted and unsorted waste in incinerator. The main quantity that we will include in the calculation system is the type composition of the waste [5]. The amount of carbon in various types of waste is known [16-18]. This information is provided in Table 4.

Table 4. Mass and carbon composition of solid household waste

Name	Mass composition,%		Carbon composition, mass %	Carbon amount, kg/ton	
	Before sorting	After sorting		Before sorting	After sorting
Food	48	60.7	12	57.6	72.8
Paper/cardboard	8	-	28	22.4	0
Plastic	8	-	55	44	0
Metal/glass	5	-	-	-	-

Dangerous/medical	2	2.5	-	-	-
Textile/wood	23	29.1	40	92	116.4
Other	6	7.6	0	0	0
TOTAL				216	189.2

As can be seen from the table, in Azerbaijan, by incineration of 1 ton solid household waste after sorting

$M(CO_2)$= 189.2x44/12x0.96=667 kg/ton CO_2 is generated.

This figure is 760.3 tons in incineration of unsorted waste.

For comparison, 170 kg of biogas is generated in the case of biodegradation of 1 ton of waste at the landfill, of which about 56 kg is CH_4 and 112 kg is CO_2. Amount of emissions in CO_2 equivalent will be:

CO_2 (eq.) = 56x25+112 = 1514.5 kg

In the case of combustion in incinerator after sorting, this figure is 667 kg. In fact, the amount of GHG emitted during biodegradation at the landfill is about 2.3 times higher than the gas generated from combustion.

Likewise, using the coefficients obtained above, we can calculate emissions for 3 groups of emissions.

1. Waste collected in Baku is sorted in "Tamiz Shahar" OJSC and combusted in incinerator. In this case, 95-97% of all carbon atoms in the waste are converted into CO_2. In fact, calculations show that the amount of CO_2 generated is about 333,000 tons. About 15% is captured during treatment at the outlet. As the amount of waste increases, the capacity of the plant and sorting shop will be increased accordingly. Here, there is no need to calculate emissions. Combustion products are filtered and treated and the amount of CO2 emitted into the atmosphere is reported. According to the 2019 report [8], "Tamiz Shahar" OJSC received about 620,000 tons of waste, and after sorting, 494,000

tons were incinerated and 286,000 tons of CO_2 were released into the atmosphere upon treatment.

It's to note that "Tamiz Shahar" OJSC produces 230 million kWh of electricity annually. In world practice, in similar cases, emissions are attributed to the energy sector, not the waste sector. Given that this energy has only 0.8% share in the country's energy balance, emissions can be attributed to the waste sector.

Naturally, due to macroeconomic indicators, as the amount of waste received by "Tamiz Shahar" OJSC increases, the processing capacity will also increase.

2. 812,000 tons of household waste generated by 2,200,000 people living in district centers of the country, in cities of republican subordination (Ganja, Sumgayit, Mingachevir and Shirvan), as well as urban-type settlements are stored in the open air in similar conditions, and GHGs are generated during biodegradation and oxidation processes. Calculations show that currently the amount of GHG generated in this process per year is equal to $CH_4 = 44.6$ thousand tons, $CO_2 = 89.3$ thousand tons. The total amount of emissions in CO_2 equivalent is 1204.3 thousand tons. These figures are shown in Table 4.

3. The situation in rural areas is different in that people dispose of their waste in small groups or individually, feed food waste and organic waste to domestic animals, or use it as fertilizer in the backyard. In fact, the amount of waste per capita is reduced by about 30%. In this way, 945,000 tons of solid household waste collected in rural areas undergo biodegradation and generate 51.9 tons of CH_4 and 103.9 tons of CO_2, which is equal to 1,401.4 tons in CO_2 equivalent.

The GHG gas emissions from the waste generated by all 3 categories of the population at present is given in Table 5 and is to 2891.2 thousand tons. As can be seen, solid household waste accounts for about 5-6% of the total GHG emissions.

Table 5. Prices for GHG emissions from solid household waste for 2020

	M Min ton	CH$_4$ min ton/il	CO$_2$ Min ton/il	Cəmi, CO$_2$ ekv min ton/il
Baku	626	0	286.0	286.0
Cities	812	44.6	89.3	1204.3
Villages	945	51.9	103.9	1401.4
Total	2383	96.5	479.2	2891.7

Reducing GHG emissions from the waste sector requires first of all the removal of as much waste as possible from landfills. This is especially true for the biodegradable part of the waste. In Azerbaijan, the amount of waste belonging to this category in the composition of solid waste is an average of 70%. This includes food waste, garden and orchard waste, textile/firewood, and waste from food and catering sector.

The **wastewater** also contribute to the GHG emissions. In many countries, wastewater accounts for 14-20% of emissions from the waste sector.

"Azersu" OJSC does not have accurate data on methane and N$_2$O emissions from wastewater treatment. What is known is that "Azersu" OJSC provides 289.2 million cubic meters of water to the population, 224.6 million cubic meters of water enters the central sewer, of which 186 million cubic meters are treated [22]. Wastewater, as well as its sedimentary components, can emit CH$_4$ when anaerobically decomposed [19]. The CH$_4$ emission volume depends mainly on the amount of decomposable organic material in the wastewater and the temperature and type of treatment system. This ratio is related to the

biological oxygen demand (BOD) or chemical oxygen demand (COD) in the environment by the following formulas:

M(CH4)=0.6 kqCH$_4$/kg BOD

M(CH4)= 0.25 kg CH$_4$/kg COD

When conducting analysis in this direction and using the reference coefficient of 1130 mcl/l, the figure A = 80 mg/m^3 is obtained. This ratio applies to general sewage water.

In this case, $M(CH_4) = 0.8$ gram/m^3 x 224.6 10^6 m^3 = 181 ton

M(CO$_2$) eq. =4525 ton

Nitric oxide (N$_2$O) is related to the breakdown of nitrogen components in wastewater, such as urine, nitrate, and protein. As a universal coefficient, taking into account the appropriate coefficients

M (N2O) = 3.2 grams of N$_2$O/person x years [19] has been selected.

In Azerbaijan, only in Baku wastewater is treated and its quantity is controlled. If we take the population equal to 3 million:

M(N$_2$O)= 3.2x 3x10^6= 9.6 ton/year

M(N$_2$O) CO$_{2\,eq.}$ =9.6 x298= 2860 ton

The amount of GHG emitted from wastewater annually:

M(CO$_2$) eq. = CO$_2$ (CH$_4$)eq. + CO$_2$ (N$_2$O)eq. = 4525 ton+ 2860 ton =7385 ton.

In fact, the GHG emission from wastewater for the current period is 7385 tons. Of which, 4,525 tons are methane emissions and 2,860 tons are NOx emissions.

So, the total GHG amount from solid and liquid phase household waste for the current period is calculated according to the following formula:

M (CO2 eq.) = M bt + Mks

Mbt-emissions from solid household waste

Mks - emissions from wastewater

Table 6. GHG emissions from household waste

	Amount of wastes	CH$_4$ emission thousand ton/year	N2O emission thousand ton/year	CO$_2$ emission thousand ton/year	Total, CO$_2$ eq. thousand ton/year
Solid household waste amount, thousand ton/year	2383	96.5	-	479.2	2891.7
Sewage water amount, million m^3/year	224,6	0.181	0.0096	-	7.385
TOTAL					**2899.0**

In fact, 2899.0 thousand tons of CO2 equivalent GHG is generated annually from the household waste sector, which is equal to 5.7% of the total amount of GHG in the country.

However, this amount is projected to increase by 24% over the next 10 years and to reach 3,434,000 tons due to population and GDP growth.

As can be seen, the GHG emission from household waste largely depends on its management mechanism. The generation of methane in landfills complicates the situation in this area. There are two principal ways to reduce emissions, but both are related to reducing methane emissions.

1. *Eliminate landfills and install incinerators instead*. In this case, since no methane is generated, the greenhouse effect of the emitted gases will be reduced.

2. ***Construct modern landfills*** and capture and use the generated methane

Strategies and action plans should be developed that include both methods, and legislation should make it necessary to apply the above methods.

During the reporting period, the following legislative documents related to waste management and atmosphere air protection were analyzed.

Naturally, in order to reduce GHG in the waste sector, waste must be fully managed. In this case, the possibility of reducing greenhouse gas emissions from organized waste sources can be studied. Legislation and Policy documents of the Republic of Azerbaijan in the solid waste management area were analyzed and gaps in the legislation concerning the reduction of the greenhouse gas emissions from the waste sector were identified.

5. Legislation and Policy Documents on Solid Household Waste Management

5.1. Laws and regulations

- Law of the Republic of Azerbaijan "On industrial and household waste". June 30, 1998
- "Rules of regulating the settlement areas in accordance with the sanitary rules, hygienic and ecological regulations, temporary storage, regular transportation and processing of domestic waste". Decision of the Cabinet of Ministers of the Republic of Azerbaijan (April 21, 2005, No 74)
- "Rules of defining the charges for collecting, disposal, use and processing of wastes" Decision of the Cabinet of Ministers of the Republic of Azerbaijan (August 12, 2008, No 185)
- "Rules for payment for natural resources and payments and penalties for harmful substances released into the environment and the use of these payments", March 3, 1992

- Order on permitting the construction of hazardous waste treatment plants. June 29, 1999
- "Rules for inventory of wastes generated in the production process". January 25, 2008
- "Rules for certification of hazardous waste". March 31, 2003
- Law of the Republic of Azerbaijan "On Environmental Protection". June 8, 1999
- "Requirements for Medical Waste Management". December 28, 2007
- Law of the Republic of Azerbaijan "On the Fundamentals of Urban Planning". October 23, 2003
- Law of the Republic of Azerbaijan "On Environmental Security". June 8, 1999
- "Instruction on the inventory and classification (classification) system of wastes generated in the production process and service areas". March 31, 2003
- Law of the Republic of Azerbaijan "On protection of atmospheric air". March 27, 2001
- "Rules for inventory of harmful substances emitted into the atmospheric air and harmful physical influences on it",
- "Rules for the implementation of state control on air protection", 2001
- "Rules for the protection of atmospheric air by legal entities with sources of harmful chemical, biological and physical effects on the atmosphere", 2001
- "List of objects with applicable technical standards of discharge and permitted effluent discharge levels"

5.2. Policy documents

1. National Program on ecologically sustainable socio-economic development in the Republic of Azerbaijan. February 18, 2003
2. Order on improvement of household waste management in Baku. August 6, 2008

3. "Comprehensive Action Plan on improving the environmental situation in the Republic of Azerbaijan for 2006-2010". September 28, 2006

4. "State Strategy for Hazardous Waste Management in the Republic of Azerbaijan" August 25, 2004

5. "National Strategy for Improving Solid Waste Management in the Republic of Azerbaijan for 2018-2022". 01 November 2018

6. "Action Plan to reduce the negative impact of plastic packaging waste on the environment in the Republic of Azerbaijan for 2019-2020". February 7, 2019

Although the above-mentioned Policy documents contain provisions regulating the emission of greenhouse gases from the waste sector to some extent, there are no articles in the normative-legal acts that make these provisions mandatory.

Therefore, the following gaps have been identified:

1. Installation of separate containers for reusable basic products such as glass, paper, plastic, metal and organic (compostable) food waste at the waste collection points

2. Availability of visual explanatory boards at waste collection points for proper disposal of waste

3. Separation of solid waste, separate transportation, prevention of mixing in subsequent management processes

4. Staff working in management should have certain individual capacities

5. Auditing waste collection and disposal points

6. Organization of pre-planned monitoring of waste collection, storage and disposal services

7. 13. Landfills should meet the minimum requirements and such requirements should be defined

8. Assess the impact of waste management improvement projects on the environment and human health

9. Draft permissible waste standards for waste landfills periodically

10. Use and neutralize wastes by environmentally friendly methods as close as possible to the source of their generation.

11. Determine the rate of liquid and solid waste generation for each region and settlements of different status;

12. Disposal of waste that is not suitable for use only at landfills or incineration at appropriate facilities

13. Develop the mechanism to control gasses emitted from waste

14. Prevention of fires, odors, dust, wind-blown wastes at all stages of waste management;

The elimination of gaps mentioned above in further Policy and Legislative Documents to be adopted is important.

6. Projects implemented in the waste sector in Azerbaijan and taking into account the GHGs generation in these projects

As the Republic of Azerbaijan has prioritized the solid waste management, international organizations have also paid more attention to this issue over the past 10-15 years. The European Neighborhood Policy Action Plan (2006) provides for the development of framework laws in the field of waste management and their harmonization with EU legislation.

The plan pays special attention to improving waste management plans and practices, especially household waste, and the use of information and experience exchange in this regard.

6.1. "Solid waste management improvement in Azerbaijan" Project implemented in Azerbaijan in 2009-2012 by UNDP and the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan

The project was the first and relatively large project in this sector.

The following issues targeted in the project have been resolved for the first time:

- The amount and composition of solid waste generated daily in 4 seasons of the year in the settlements of different status of the country (megacities, cities, district centers, settlements and villages) were determined.
- Samples were taken from the soil and the nearest water basin in 53 solid waste landfills of the country, heavy metals and microorganisms were analyzed.
- Inventory of solid household waste was conducted throughout the country.
- "RRR-strategy was developed for solid waste management".
- Legislation and Policy documents in this area have been analyzed, gaps have been identified, and a package of proposals for the improvement of legislation has been prepared.
- Electronic database in the field of solid waste management was created and placed in the Internet database.
- A methodology for calculating technical and economic indicators in the field of solid waste management has been developed.
- "Clean technologies mechanism" for solid waste management has been established and a methodology for environmental impact assessment has been developed.
- A technical study tour of stakeholders' representatives to the Czech Republic was organized for the exchange of experience and information.

- A strategy for awareness raising and education of the population on the problem has been developed.
- A pilot plant for processing plastics has been installed at the Ismayilli Solid Waste Landfill.

6.2. World Bank's "Integrated Solid Waste Management" project

In order to comprehensively address the issue of solid waste management in accordance with modern standards, a loan agreement was signed between the Ministry of Economic Development and the World Bank on May 20, 2009 and the "Integrated Solid Waste Management" project was launched.

This is one of the current components of the long-term multiyear loan program agreed between the Government and the World Bank, and is intended to be implemented through the Ministry of Economic Development and relevant government agencies. The main focus of the project is waste management. It targets large-scale environmental regulation and infrastructure investments. The project covers both hazardous waste and solid household waste. In total, of the $ 41.5 million investment, $ 29.5 million is a loan from the EBRD, and the rest is government co-financing. The main investments were made in the rehabilitation and renewal of Balakhani lands, the closure of other landfills in Baku and the increase of waste collection capacity in Baku. Additional components include the development of national institutional capacity for solid waste management (especially for management and control through national public authorities) and the development of future projects for solid waste management at the national level. The project's Country Partner is "Tamiz Shahar" OJSC, the operator of the Balakhani landfill and the general landfill accepted from the city management in 2009. Initially, "Tamiz Shahar" OJSC is also expected to take responsibility for waste collection in Greater Baku. Despite the fact that "Tamiz Shahar" OJSC has launched large-scale operations at the Balakhani landfill, the

main authority for garbage collection and transportation belongs to Baku Department of Public Utilities. Back-up construction works have been conducted to use renovated landfills to put out fires, create more formal reception infrastructure (access, weighting, fencing and sorting before disposal), as well as to create a payment system for waste disposal. Operating equipment is currently being procured, as well as engineering and operational technical assistance based on international agreements are underway. The purchase of basic equipment for the upgrade of the collection system is also underway. Cooperation is made with the World Bank on national institutional aspects of the issues included in the project.

The duration of the project is 5 years. According to the project, solid waste management in Baku should be organized in accordance with modern standards that have proven themselves in international practice. The project is being implemented in cooperation with "Tamiz Shahar" OJSC.

The main components of the project are:
- Institutional reform, capacity building;
- Restoration, improvement and management of Balakhani landfill;
- Closing and management of other landfills;
- Procure waste collection equipment;
-Technical preparation of post-project investments.

The following actions have already been undertaken under the project:
The Danish company COWI was selected as the consulting company to write the technical specifications for the implementation of the first group of consulting services under the project. COWI initially developed proposals to address the following issues:
- Solid household waste strategy and action plan for sector restructuring;
- Support to increase the institutional capacity of "Tamiz Shahar" OJSC;
- Rehabilitation of Balakhani landfill, closure of other waste sites (landfills);

- Environmental impact assessment for Balakhani landfill rehabilitation and closure of other landfills;

- Development of a communication program on public relations and mitigation of the impact on social groups;

- Establishment of financial accounting and waste information system.

In order to reduce the negative impact on the environment at the Balakhani landfill, an Environmental Management Plan, classification of solid waste, environmental requirements for waste disposal at the Balakhani landfill, rules of control and monitoring during operation and a list of wastes prohibited to be brought to the landfill have been prepared.

"Tamiz Shahar" OJSC has established a Working Commission with the Ministry of Emergency Situations, the Ministry of Ecology and Natural Resources, the Ministry of Health, the Ministry of Internal Affairs and the National Agency for Mine Action to resolve emergencies at the Balakhani landfill as soon as possible.

The main landfill in Balakhani is now being brought up to international standards, and other smaller landfills that have historically been used by the city are being closed as part of the World Bank's current project.

In general, the project and some aspects of the UNDP's Solid Waste Management Improvement Project duplicate or complement each other. In fact, the waste reuse and recycling strategy developed within the UNDP project should in fact be part of the National Solid Waste Management Strategy to be established under the World Bank project. On the other hand, while the activities such as the creation of database, public awareness, etc. cover Baku in the World Bank project, they cover the whole country in the UNDP project. However, generally accepted technical standards that meet international practice will effectively set precedents, as defined by the World Bank's environmental policies, that will require consideration of UNDP projects. It should be reiterated that one of the distinguishing features between the WB and UNDP projects is

that their owners vary across the country, i.e., the WB Project is implemented by the Ministry of Economy, while the UNDP Project is implemented by the MENR. It's to note that although the implementing agency on behalf of the Government is the Ministry of Economy, it's necessary that the project is implemented in partnership with the MENR in terms of the application of environmental standards, environmental impact assessment and other aspects.

World Bank's economic and sectoral activities and future investment projects

The World Bank stated that, in the course of developing a long-term loan program for the country, they proposed to the government through the Ministry of Economy to include two additional investment projects for solid waste management in the regions outside Greater Baku and the Absheron Peninsula. These conditionally designated regions are Aran and Mountainous Shirvan. The aim is to support the development of a national SWM (solid waste management) strategy to optimize regional collection and disposal systems. It is acknowledged that such activities, along with the preparation of investment plans for the selection of regional landfills for rehabilitation and related support infrastructure (e.g., collection systems, transfer points, processing plants), first of all, it is necessary to develop the provision of economical use of available resources. According to the draft version of the Concept Note provided by the World Bank, the study will cover the following four stages:

- data collection and analysis;

- legal, institutional and financial analysis;

- define investment needs;

- policy recommendations for strategy development.

The outcome is expected to provide significant support to define national solid waste management policies, institutional measures and activities for the future. Given its high level of implementation, it is likely to form the basis for defining a national solid waste management strategy. In this regard, it is

necessary to establish a key driving force for priorities and decision-making on all aspects of solid waste management.

6.3. **Household Waste Landfills Reconstruction projects by Japanese Government**

The Japanese government has funded two projects related to wastes. Small bilateral grant projects cover demonstration projects in Ismayilli and Zagatala districts, including waste sorting for recycling and improved disposal. These projects could be more useful in terms of developing improved waste management practices and potential pilot projects outside the Absheron Peninsula.

6.4. European Union - European Neighborhood and Eastern Partnership Instrument (ENPI), Waste Management Project (2011-2013)

Solid waste management has emerged as serious environmental and economic problem not only for Azerbaijan, but also for all the newly independent states that emerged upon the collapse of the USSR. A number of international financial institutions are implementing regional projects in order to carry out joint activities in the field of prevention of transboundary pollution of the environment with solid waste, to ensure the exchange of best practices and information in this area. A similar initiative on the goals of the CIS countries, as well as in a number of other countries, is currently being implemented in Azerbaijan. The initiative is led by a local project office and managed by one of the international consulting firms that oversees participating countries in the region. The main national partner for the project is the Ministry of Economic Development. The MENR and local authorities of the selected pilot district (Lankaran) are involved in the project with certain level of participation. The project aims to reduce the risks arising from inefficient waste management through sustainable consumption and production practices, as well as by

supporting higher standards in waste-producing plants, more effective waste prevention initiatives, increasing capacity for waste collection and sorting, as well as recycling, recovery and safe disposal of waste. Among the six areas of activity, the following areas are directly related to the issues covered by the Solid Waste Management Improvement Project (SWMIP):

Area of Action B - Inventory of illegal places for waste disposal;

Area of Action C - Strengthening waste classification practices;

Area of Action D - Development of pilot regional strategies for waste management;

Area of Action F - Public awareness, dissemination of information and capacity building.

More broadly, public awareness and dissemination activities should be of common interest. In general, it is possible that the main outcome of the current project can be a strong impact for the application of EU rules, standards and practices. A joint working group was established to ensure that the results of the above-mentioned projects complemented each other and to avoid duplication, and the results obtained and planned activities were discussed together by organizing regular workshops.

6.5. Asian Development Bank's Solid Waste Management Project for Medium-Sized Cities (2016-2017)

The Asian Development Bank's project is dedicated to determining the rate and composition of waste generation for the cities of Tartar, Barda, Dashkasan, Gadabay, etc. in Azerbaijan and to prepare projections for changes in this information by 2020. Using ready-made methodologies, the Project team created a database for these areas over a two-year period and provided recommendations for the development of institutional and legislative framework for waste management.

6.6. A joint project of UNECE and the Ministry of Environmental Protection of the Republic of Azerbaijan has been implemented for the preparation of the 2nd Environmental Impact Assessment for the country, which includes the impact of solid waste on the environment.

6.7. Projects implemented by non-governmental organizations

Since solid waste management is maintained with the participation of the population, relevant government agencies, and in many cases the private sector, effective cooperation between different sectors is required to make progress in this area. Therefore, many donors have funded regional projects to increase NGO participation in addressing this issue. In 2007, with the financial support of the Eurasia Foundation, **"Ecoil" Scientific and Ecological Public Union** implemented the project "Solid Waste Management in the South Caucasus". The main goal of the project was to develop a regional policy document in this area. Under the Project, the situation in the solid waste management in Azerbaijan was analyzed, needs and existing potential were assessed. Scenario for solid waste management was selected through the surveys conducted among 1,000 people and decision-makers in 4 settlements of different categories (Baku, Ganja, Salyan, Jalilabad's Ojagli village). Different alternatives to increase the institutional capacity to the required level were discussed, and feasibility studies were conducted on the selected scenario. The results of the project have been widely disseminated among relevant government agencies and the public.

In 2007-2008, Sheki "**IRS NGO Coalition**" implemented the project "Clean Triangle - clean street, prosperous city, healthy life" with the financial support of the United States Agency for International Development. The main goal of

the project was to improve the management of household and industrial waste in the area along the Gurjana River, which flows through the historical reserve of Sheki. To this end, surveys were conducted among the population and the decision-makers in urban management, the reasons for the shortcomings in this area were identified, education and awareness-raising activities were conducted. With the involvement of large segments of the population, the Gurjana River and the Reserve area were completely cleared of household waste, proposals were prepared and submitted to the relevant authorities to increase the technical, financial and administrative capacity of relevant organizations to keep the area clean. Trainings and lectures were organized in this area, educational booklets were prepared and distributed to the population. Within the framework of the project, 3 round tables, 2 public hearings were held, a cooperation agreement with Sheki municipality, and a Memorandum of Understanding on joint activities with the **IRS Coalition**, including Sheki Executive Power and other government agencies in target group were signed. This ensured the sustainability of the project.

"Ruzgar" Ecological Public Union implemented the project "Organization of social-ecological movement for effective management of solid waste" in 2008 with the financial support of the Council of State Support to NGOs under the President of the Republic of Azerbaijan. Within the framework of the Project, study tours were organized to Aran, Mountainous Shirvan and Sheki-Zagatala regions of the country, the issues of collection, transportation and disposal of solid waste in the country were studied. The collected information was discussed at round tables in Sheki and Shirvan, and disseminated among the population through press conference in Baku. Within the framework of the project, the book "Household Waste and Environment" was published and distributed among stakeholders. Proposals were made to establish a national program in this area.

"Energy and Ecology" Education Public Union implemented 2 projects in the solid waste management area in 2009-2010:

1) The project "Awareness of the population to promote People's participation in solid waste management" was implemented in Yasamal district of Baku with the financial support of the Council of State Support to NGOs under the President of the Republic of Azerbaijan. Within the framework of the project, 2 round tables and 8 awareness trainings were held in Yasamal Municipality, 2 in secondary school No. 175, and 2 in the University of Architecture and Construction. An information magazine and booklets on solid waste were published and disseminated to relevant institutions, training participants and the public.

2) The OSCE-funded project "Awareness of hazardous industrial waste in Sumgayit" was implemented in Sumgayit. Within the framework of the project, 2 round tables and 4 awareness trainings were held for "Azerkimya" Production Association, 4, and 8 awareness trainings for teachers and students of ecology-oriented specialties at Sumgayit State University. A 30-minute short educational film entitled "Hazardous Industrial Waste" was made and shown to the participants during the trainings. The film was donated to Sumgayit State University as a full-time teaching aid. The film has been shown more than 20 times on Public TV and Regional TV.

At present, International Financial Institutions have included solid waste management in their priority activities in projects implemented by them in Azerbaijan. In the European Neighborhood Policy and Eastern Partnership Programs, the Asian Development Bank, the World Bank, etc. are giving serious consideration to this issue. These organizations declare their intention to deepen their activities in solid waste management. Using these opportunities, it is possible to make significant progress in solid waste management, and the existence of a special National Program in this area may be more effective.

6.8. MENR's project "Clean city, beautiful village and worthy citizen" (2003-2005)

The Project-competition "Clean city, beautiful village and worthy citizen" implemented by the Ministry of Ecology and Natural Resources has yielded positive results in many districts. The issue of improving the sanitary-ecological condition of landfills in the district centers, isolation from the environment, especially from reservoirs, has been partially resolved. Solid waste landfills were inspected in more than 50 regional centers of the country, their impact on the environment was assessed and "hot spots" were identified. In many districts, household waste dumped into river valleys has been cleaned, and waste landfills have been relocated. The winners of the competitions, which were attended by representatives of NGOs, the media, local executive authorities and municipalities, were awarded prizes for solid waste management. As a result, the level of awareness among the general public, decision-makers and agencies that implement such decisions has increased, and mass awareness-raising activities have been undertaken.

Outcome: The vast majority of the projects listed above aim to transform unsanitary, unregistered and uncontrolled landfills into modern landfills, reduce environmental impact and, if possible, recycle or reuse, and generate energy by incineration. Reduction of GHG emissions that affect climate change very rarely and indirectly exists as a target among the goals. Such a goal is not set as the "main line" of Project.

At present, there are plans to start construction of solid waste landfills in Azerbaijan. Initially, it is possible to develop solid household waste landfill projects aimed at reducing GHG as a pilot in the construction work to be started in the liberated from Armenian occupation territories.

7. References

1. Azərbaycan Respublikasının Statistik Məlumatları (Statistics of the Republic of Azerbaijan): www.stat.gov.az.

2. Мусоросортировочные предприятия. Справочник. А.Ю. Масленников, Москва 2006, 127 с (Garbage sorting enterprises. Directory. A.Y. Maslennikov, Moscow 2006, 127 p)

3. İ.Mustafayev.Məişət tullantıları və Ətraf mühit .”Adiloğlu”-2008 (I.Mustafayev. Household waste and Environment. ”Adiloglu” -2008)

4. Məişət tullantıları və Ətraf mühit. “Bərk tullantıların idarə olunmasının təkmilləşdirilməsi”Layihəsinin nəticələri. BMT İP “Adiloğlu” -2012 (Household Waste and the Environment. Outcomes of the Project “Improvement of solid waste management”. UNDP. “Adiloğlu” -2012)

5. Worldbank National Solid Waste Management Project.2011-2014

6. ADB, Solid waste management project for intermediary cities. ADB .2016-2017

7. Waste Governance in the ENPI East. 2011-2014

8. “Təmiz Şəhər” ASC-nin Məlumatları. 2019 (Data of “Tamiz Shahar” OJSC. 2019)

9. W. N. Schirmer, J. F. T. Jucá, A. R. P. Schuler, S. Holanda, L. L. Jesus. Methane production in anaerobic digestion of organic waste from Recife (Brazil) landfill: evaluation in refuse of different ages. Braz. J. Chem. Eng. vol.31 no.2 São Paulo Apr./June 2014

10.7. 2nd Worldbank National Solid Waste Management Project.2019

11. Implementation of the Shared Environmental Information System principles and practices in the Eastern Partnership countries (SEIS East) - Waste Statistics.2017

12. Ole-Kenneth Nielsen, Malene Nielsen, Katja Hjelgaard, Peter Coleman, Otto Rentz, Dagmar Oertel, Haydn Jones, Michael Wenborn and Mike Woodfield. Municipal waste incineration.EMEP/EEA emission inventory guidebook 2013.

13. Методические указания по расчету выбросов парниковых газов в атмосферу от полигонов твердых бытовых отходов. Министерство охраны окружающей среды Республики Казахстан. Алматы-2010 (Guidelines for the calculation of greenhouse gas emissions into the atmosphere from solid waste landfills. Ministry of Environmental Protection of the Republic of Kazakhstan. Almaty-2010)

14. Mr. Bernt Johnke (Germany) . Emissions from waste   incineration. 2018

15. Eva Rendek. Carbon dioxide sequestration in municipal solid waste incinerator (MSWI) bottom ash. Journal of Hazardous Materials 128(1):73-9. Institut National des Sciences Appliquées de Lyon February 2006

16. Методические Рекомендации по проведению добровольной инвентаризации объема выбросов парниковых газов в субъектах российской федерации. Утверждены распоряжением Минприроды России от 16 апреля 2015 г. N 15-р (Methodological Recommendations for voluntary inventory of greenhouse gas emissions in the constituent entities of the Russian Federation. Approved by the order of the Ministry of Natural Resources of Russia of April 16, 2015 N 15-r)

17. Методические указания по расчету выбросов загрязняющих веществ в атмосферу от мусоросжигательных и мусороперерабатывающих заводов. Отдел научно-технической информации. Москва 1989. (Methodology Guidelines for the calculation of emissions of pollutants into the atmosphere from incineration and waste processing plants. Department of Scientific and Technical Information. Moscow 1989.)

18. Рекомендация по инвентаризации и национальному учету выбросов парниковых газов в атмосферу. Министерство Экологии и Природных

ресурсов РФ. 2005г. (Recommendation on inventory and national accounting of greenhouse gas emissions into the atmosphere. Ministry of Ecology and Natural Resources of the Russian Federation. 2005)

19. Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, 2006. Chapter 2. Waste Generation, Composition and Management Data. Chapter 4. Biological treatment of Solid Waste. Chapter 5. Incineration and Open Burning of Waste. Chapter 6. Wastewater Treatment and Discharge.

20. Biodegradation in Municipal Solid Waste landfills. Geoenvironmental Engineering. Nov. 19, 2015

21.Производство Биогаза. Государственный департамент статистики Грузии (2001), Тбилиси 1996-2001. 21. (Biogas Production. State Department of Statistics of Georgia (2001), Tbilisi 1996-2001.) http://www.agry.purdue.edu/landuse/septic/cttpp2/buried.htm, www.epa.gov/owm/mab/indian/wwtp.pdf

22. "Azərsu" ASC-nin məlumatları. 2020 (Data of "Azersu" OJSC. 2020)