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Establishment of Energy Potential of Norio Landfill of Municipal Solid Waste of Tbilisi

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Abstract

In November 2010 the new landfill has been put into service in Tbilisi, the territory of which equals to 94 ha and is divided by inner roads into several areas, on which the waste disposal cells (area 5ha) are installed. The goal of our project was the determination (elaboration of energetic scenarios) of economically profitable ways of utilization/application of basic greenhouse gas CH_4, on the basis of inventory of methane emission from Norio landfill of municipal solid waste of Tbilisi city by IPCC methodology, and prevention from global climate changes caused by greenhouse gases with the use of methane in the energy sphere. The share of the landfill of municipal solid waste in the greenhouse gases emission in Georgia equals to 7% of the total emission of CH_4 and CO_2 that is very high rate. Our goal was the determination of amount of greenhouse gases (CH_4 and CO_2) emerged on the Norio landfill and forecasting of gases emission for the subsequent period. According to inventory data the whole potential of methane emission from Norio landfills equals to 930 mln. m^3.

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Keywords:Greenhouse Gases, landfill, Energy Potential;

Introduction

The new landfill has been put into servicing of Tbilisi since November 2010, which territory equals 94 ha and is divided by inner roads into several areas, on which the waste disposal cells (sectors) (area 5ha) are installed. The first sector operation started in November 2010 and closed in January 2014.The depth of the sector are 30 meters and is equipped with 39 plastic tubes for gas collecting. Nowadays, landfill gas are emitting to the atmospheric air and as a result: locally -in surrounding areas occurs the air pollution and globally - climate change.

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Literature review

After waste disposal in the cells and its covering with the ground are rapidly developed anaerobic conditions, in which under the influence of methanogenic microorganisms occurs the process of organic substances' bioconversion. As a result of this process is emerged the biogas, i.e., so-called "landfill gas" (LG), which microcomponents are methane and carbon dioxide. Percentage distribution of microcomponents fluctuates from 40-70% to 30-60%. Besides the above mentioned, the "landfill gas" contains nitrogen, oxygen and hydrogen in much less concentrations. In the form of microorganisms dozens of various organic compounds can be the part of LG that define its features and among them the toxicity. Proceeding from its content and the nature of environmental influence the "landfill gas" ranks among so-called "greenhouse gases" that stipulates the global value of its utilization (recycling).

Emission of gases from the every ton of waste disposed at the landfill will last during 45 years in average, while for the landfill this period, by taking into account the filling time, will last during 75 years. Full time of "landfill gases" emission is divided into 4 periods, in the course of which the process of gases emission passes with various intensity and has a different duration (Table 1) (N. Dvalishvili, et al, 2014; SazonovE.V, 2010).

Table 1: Theoretical amount of biogases emission during operation of MSW (municipal solid waste) landfill

Name of the period	Duration of the period, years	Amount of gas emitted, %
Initial	5	8
Peak	2	4
Stable	20	83
Descendant	18	5
The whole period	45	100

Figure 1

$$\boldsymbol{CH_4}\ Emission = \left[\sum_{x} CH_4 generated_{x,T} - R_T\right] \bullet (1 - OX_T)$$

Where:
CH_4 Emissions = CH_4 emitted in year *T*, Gg
T = inventory year
x = waste category or type/material
R_T = recovered CH_4 in year *T*, Gg
OX_T = oxidation factor in year *T*, (fraction)

The received results were compared with experimental results, which were conducted by Scientists of Institute of Hydrometeorology at Georgian Technical University in 2014 (S. Mdivani, et al, 2014).

Results and discussion

The results of theoretical inventory and the experimental evaluation of emitted methane from a landfill body are shown in Table 2 (2.1 and 2.2). The findings show that the accuracy theoretical inventory is about 25%. According to experimental observations, the quantity of carbon dioxide in the landfill gases is half times less than quantity of methane.

Table 2-(2.1):Theoretical inventory (1.1 and 1.2) and the experimental evaluation (1.2) of emitted methane from landfill in Tbilisi (Norio)

Year	CH_4							
	Gg	mln m^3	Year	Gg	mln m^3	Year	Gg	mln m^3
2011	0.24	0.34	2021	8.71	12.09	2031	13.71	19.05
2012	1.66	2.31	2022	9.24	12.84	2032	14.22	19.75
2013	2.87	3.98	2023	9.76	13.56	2033	14.73	20.46
2014	3.89	5.40	2024	10.27	14.26	2034	15.25	21.18
2015	4.76	6.61	2025	10.77	14.95	2035	15.78	21.91
2016	5.55	7.71	2026	11.26	15.64	2036	16.32	22.66
2017	6.27	8.71	2027	11.75	16.31	2037	16.87	23.43
2018	6.94	9.64	2028	12.23	16.99	2038	17.43	24.21
2019	7.56	10.50	2029	12.72	17.67	2039	18.01	25.02
2020	8.15	11.32	2030	13.22	18.36	2040	18.60	25.84

Table 2-(2.2):Theoretical inventory (1.1 and 1.2) and the experimental evaluation (1.2) of emitted methane from landfill in Tbilisi (Norio)

Method	Year	CH_4, Gg
Experimental	2014	4.93
Theoretical	2014	3.89

Unfortunately, In Georgia don't exist practice of separate collection of MSW (municipal solid waste) and all types of municipal and other wastes are concentrated in landfills. Current year, we have surveyed the population of several cities in Georgia, including Tbilisi, also were conducted quantitative measurements and compositions of rubbish which have been formed by population. The capital waste compositionvery differs from other less large cities. Was observed a high content of organic waste In Tbilisi city (Table. 3), in contrast to the provincial towns and villages, where the food waste usually usesfor animal feeding and other organic waste is burning for household purposes.

Table 3:The percentage composition of waste in Tbilisi

Fraction of MSW	Year				
	2010	2011	2012	2013	2014
Food	71	70	69	68	67
Paper	6	7	8	9	10
Wood	3	3	3	3	3
Textile	3	2	2	1	1
Hygienic Waste	2	2	1	1	1
Plastic	5	6	7	7	8
Other	10	10	10	11	11
Sum	100	100	100	100	100

Also in the capital of Georgia, are forming approximately 40-45% of whole country wastes, which is related with a higher level of life and improved system of waste collection. Although in the capital is not observed high demographic growth (approximately 0.5% /year), the quantity of waste in the city of Tbilisi is increased approximately 2.5% per year (Table 4).

Table 4:The Quantity of MSW in Tbilisi city

Year	MSW, t	Population	Waste per capita
2010	353 164	1 152 500	306.43
2011	356 123	1 162 400	306.37
2012	359 082	1 172 700	306.20
2013	362 041	1 171 200	309.12
2014	365 000	1 175 200	310.59

Conclusion

The landfill in Tbilisi has a good potential of using of emitted methane in the energy sector, as high content of organic fraction of the waste leads to a high concentration of methane in the landfill gas. The share of the landfill of MSW in the greenhouse gases emission in Georgia equals to 7% of the total emission of greenhouse gases that is very high rate.

According to our currently calculations, Norio landfill is generating about 7 million m^3 /year of methane, which will provide a year's supply of
natural gas at least for 14 000 family and this date is growing every year. Duration of operation of the landfill in Tbilisi is yet about 40-45 years old and according to the inventory dates the whole potential of methane emission from Norio landfills equals to 930mln. m^3.

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