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ASSESSMENT OF CLIMATE CHANGE MITIGATION POTENTIAL OF WASTE SECTOR IN A DEVELOPING COUNTRY

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ABSTRACT

As shown in the IPCC Forth Assessment Report, the climate change mitigation potential of waste sector in developing countries is three times higher than the one of developed countries. Analytical framework for assessment of climate change mitigation potential of waste sector is adapted in order to incorporate the specifics of developing countries regarding waste generation, waste disposal and population growth. The evaluation of appropriate mitigation strategies is performed using the GHG Costing Model (GACMO), which compares each mitigation option with the BAU (business-as-usual) scenario and determines its environmental effectiveness (tCO_2 reduced) and economic effectiveness (US$/t CO_2 reduced). In order to reduce the level of uncertainty of emissions calculations two different IPCC methodologies were used - Tier1 mass balance method and Tier 2 – First Order Decay method (FOD). The adapted analytical framework is applied for the waste sector in the Republic of Macedonia, evaluating the option of gas extraction with flaring for existing non-compliant landfills, followed by one of the four mitigation strategies: Mechanical and biological treatment (MBT) with an aerobic treatment (composting), MBT with an anaerobic treatment (anaerobic digesters with energy production), MBT with an anaerobic treatment-anaerobic digesters with energy production and refused derived fuel (RDF) utilization and MBT with an aerobic treatment (composting with RDF utilization).

The resulting marginal cost curve indicates a total achievable reduction of cumulative emissions for the period 2013-2030 of around 20 Mt, or nearly 80% lower than BAU waste sector cumulative emissions, at average specific reduction cost in the range 8.9 to 12.44 US$/t.

INTRODUCTION

Waste sector has become a significant source at 7% of total GHG emissions in the country and needs to be addressed more thoroughly in the future. Some 89% of these emissions are CH_4 emissions from SWDS, incineration and wastewaters, 5% are N_2O from human sewage, incineration and wastewaters, and 6% are CO_2 emissions from waste incineration. In the Key category analysis, the Solid Waste Disposal Sites is the only identified key source category as it emits 82% of total emissions from the waste sector. Waste incineration is responsible for 8%, followed by wastewaters from treatment of domestic households (5%) and from sewages-3.42%, while industrial wastewater treatment is responsible for1.58% of total emissions from the sector. On the state level, Ministry of environment and physical planning (MOEPP) is responsible body for waste management. MOEPP has already adopted national waste management planning documents and gives support for preparation and implementation of regional and municipal waste management plans. Also, the Law on waste management is adopted and there are lots of amendments in order to improve the situation. The related sub laws are adopted and put in force. Municipal waste management is responsibility of the municipalities. The general policy in municipal waste management is regional approach which means construction of regional landfills with appropriate treatment of waste in accordance with EU standards. There are three cases of Public Private Partnership (PPP) in this sector (Skopje, Polog and Southeast regions). Two of these tender procedures were supported by the MOEPP. Introduction of the principle "producer responsibility" is under implementation for packaging waste. Total annual quantities of waste generated in the country are 26,218,257 tonnes/y (data from National Waste Management Plan, 2009-2015) of which the biggest parts (95%) are related with extraction and processing in the mining industry (17,246,000 t/y or 66%), agriculture waste (5,610,000 t/y or 21%) and waste from thermal processing industry (2,015,379 t/y or 8%). The main waste disposal option is landfilling. There are 55 existing municipal landfills which are not in accordance with EU standards (Landfill Directive 99/31) with one exception (Drisla landfill) although there is a lack of basic infrastructure on this landfill. On the whole territory, 70% of population are covered with collection schemes of Public communal enterprises (PCE), but only 10% in the rural areas mainly due to lack of technical equipment (vehicles) and staff in the PCEs. This percentage of 30% not served population is reason for existence of around 1.000 wild dumps.

METHODOLOGY

For emissions calculation in the Third National Communication to UNFCCC [3], two different IPCC methods are used: Tier 1 Mass balance method and Tier 2 First order decay method. The difference is that Tier 1 methodology is obtained from waste emissions in certain year and requires data on population, waste generation per capita, amount of waste disposed to landfill and adequate emission factor, while Tier 2 receives cumulative emissions using half-life of methane decomposition (14 years) from the years prior to observed year.

In order to calculate the greenhouse gas emissions with FOD methodology following parameters need to be determined: methane generation potential (L_0), amount of municipal solid waste generated in a year x (MSW_T), fraction of municipal solid waste disposed in a year x (MSW_F), degradable organic carbon (DOC) derived from different fractions in municipal waste, methane correction factor (MCF) and methane generation rate constant (k).

In order to convert methane emissions to CO_2-eq emissions, a global warming potential (GWP) of 21 was used (IPCC Second Assessment Report). In a year 2013 (*set as base year for emissions prediction calculation*) calculated emissions are actually cumulative emissions from waste accumulated on the landfills in the past 32 years (starting from year 1981). This requires us to be able to calculate the reduction of flaring or those emissions that one can act to decrease. Only 75.1% of municipal solid waste in the country was used for calculation of degradable organic carbon (DOC) value, with following percentage of various fractions in the waste: Fraction of paper in MSW_F (value 21.8%) and textile (4.7%), Fraction of garden waste in MSW_F (value 10.9%), Fraction of food waste in MSW_F (value 30.1%), Fraction of wood waste in MSW_F (value 7.5%).

The GACMO model [1] is used to evaluate the economic and environmental effectiveness of potential mitigation measures. GACMO is based on the principle of calculating the reduction costs when individual reduction strategies replace high emission technologies under the same comparative basis. It aggregates and ranks the average cost of each emission reduction option, and then draws the reduction cost curve. GACMO can be used to rank the cost-effectiveness of various GHG reduction strategies in a transparent way, even when there is no detailed data available. For the purpose of the study, following assumptions and proposals have been made:

The country is divided on 5 waste management regions (WMRs). Time frame of commissioning of new regional landfills and closure and reclamation of the existing landfills will be done by following dynamic:

WMR1 (Skopje region-Drisla) start of the new landfill in 2016, WMR2 (Northeast, East &Vardar regions)-start in 2020, WMR 3 (Southeast region) start of the new landfill in 2016, WMR4 (Pelagonija and Southwest region)-start 2020 and WMR5 (Polog region)-start in 2017.

From total amounts of municipal solid waste disposed at new regional landfills (shall be opened at different times) only 41.9% (garden waste, park waste or other non-food organic and food waste) shall be used for composting or for producing electricity. Garden and food waste are excluded after year 2016 in calculations of landfill emissions.

In respect to existing non - compliant landfills the *only option* are closure and reclamation of the landfill sites and burning of the landfill gas (using the flare). It is assumed that flaring has a lifetime of 10 years. Regarding the treatment of biodegradable waste there are four basic measures applicable for developing countries: Mechanical treatment (MT) followed by a biological aerobic treatment (composting), MBT with an anaerobic treatment (Anaerobic digesters with energy production), MBT with an anaerobic treatment (Anaerobic digesters with energy production plus production of RDF), MBT with an aerobic treatment (composting plus production of RDF).

On the basis of mitigation measures, five different scenarios were considered:

1. Reference scenario-Business as usual, with no investments in new landfills, disposal sites shall have only maintenance costs;
2. Closure and reclamation of existing landfills with burning of the landfill gas on flare and introduction of MBT technology with composting;
3. Closure and reclamation of existing landfills with burning of the landfill gas on flare and introduction of MBT technology using anaerobic digestion with production of electricity;
4. Closure and reclamation of existing landfills with burning of the landfill gas on flare and introduction of MBT technology using anaerobic digestion with production of electricity and production of Refuse Derived Fuel (RDF) intended for cement industry (only for WMR1);
5. Closure and reclamation of existing landfills with burning of the landfill gas on flare and introduction of MBT technology with composting and production of Refuse Derived Fuel (RDF) intended for cement industry (only for WMR1).

RESULTS

The results obtained for specific costs and volume of reduction of CO_2 emissions for each mitigation scenario are presented in a form of MAC (Marginal Abatement Cost) curves. The measures are introduced in the curve according to their cost-effectiveness (the option with the smallest specific costs is introduced first on the left side of the curve).

CONCLUSION

After measures under the four scenarios were introduced in the curves according to their cost-effectiveness, a comparison has been made based on the projected emission reductions and associated implementation costs. Fourth scenario has the best position even the reductions of GHG gases are not the best one. The difference of emission reductions between the third and fourth scenario is 636 kt CO_2eq, which is 3% of the best reducing scenario. But the overall costs of third scenario are 8.94 US$/kt CO_2eq, which is the best option. The third scenario has 11.75 US$/kt CO_2eq which is 31% higher than fourth scenario. To conclude, the combination of MBT plan with selection of recyclables, composting of biodegradable waste and production of RDF intended for cement industry (only for Waste Management Region 1) seems to be the best option for the country.

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