Environmental and Economical Aspects for Municipal Solid Waste Treatment Alternatives in Some Lithuanian Regions: Incineration and/or Mechanical Biological Treatment

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Abstract

Seeking to satisfy the requirements Lithuanian Strategic Waste Management Plan the feasibilities of two main alternatives like incineration and mechanical-biological treatment have been accessed for some Lithuanian waste management regions. This assessment has been performed by use of LCA-IWM assessment tool. It is evident that alternative of MMSW incineration in some energetic and environmental aspects is more advantaged than MMSW mechanical-biological treatment and subsequent incineration of obtained high calorific fraction (HCF). Also only during MMSW incineration the values of waste energy efficiency according to new EU Waste Directive are satisfied.

Keywords

Energy efficiency, environmental impact, high calorific fraction, incineration, life cycle assessment, mechanical-biological treatment, municipal solid waste.

1 Introduction

The implementation of requirements of Council Directives 1999/31/EC (Landfill of Waste) and 2001/77/EC (Promotion of Electricity Produced from Renewable Sources in the Internal Electricity Market) is actual both for Lithuania and for other many new EU members. The incineration of municipal solid mixed waste (MMSW) can be one from some possible means for realisation of these purposes. The main MMSW disposal method in Lithuania leaves still landfilling. It is necessary to underline that already before some years the Lithuanian scientists tried to evaluate the municipal waste incineration feasibilities the energetic and environmental point of view both for Lithuania in general (Denafas, 2003) and for separate Lithuanian regions (Wade, 2006; Rimaityte, 2006). However the Lithuanian government took these feasibilities up only after entrance of Lithuania to EU and corresponding obligation for fulfilment of above mentioned directives. To this aim the special pre-feasibility study had been prepared (Preparation, 2006). This study gave the motive for representatives of private business to construct the waste incineration plants (WIP) in some Lithuanian regions. But this intend rose the stonewalling of Vilnius (Lithuanian capital city) inhabitants, also the opposition of businessmen who planed the development of MMSW mechanical-biological pre-treatment (MBP). Therefore the aim of this publication is to present the MBP and different incineration feasibilities for some waste management regions in Middle-North Lithuania (Ši-

auliai, Panevėžys, Telšiai and Tauragė) and to perform the corresponding environmental and energetic assessment. The borders of all Lithuanian waste management regions are practically congruous with the borders of Lithuanian counties.

The assessment of MBP and incineration alternatives for mentioned waste management regions had been performed in concordance that according to Lithuanian State Strategic waste management plan and considering the recommendations of EU specialists (Deliverable, 2003) the separate collection and recycling of municipal waste fractions will be:

biowaste – 22 %
paper and cardboard - 60 %
plastics and composites – 25 %
glass – 60 %
metals – 50 %
other combustible waste (in fact – wood)) – 3%.

Figure 1 Waste management regions in Lithuania

2 The prognosis of municipal solid waste generation and content for selected waste management regions

By use of prognostic model LCA-IWM (den Boer, 2005) the forecasts of municipal generation have been performed (Figure 2.). Keeping in the mind the proposed separate collection the MMSW should be predominant nevertheless (Figure 3). The forecasted content of MMSW (with biowaste domination) is presented in the Figure 4.

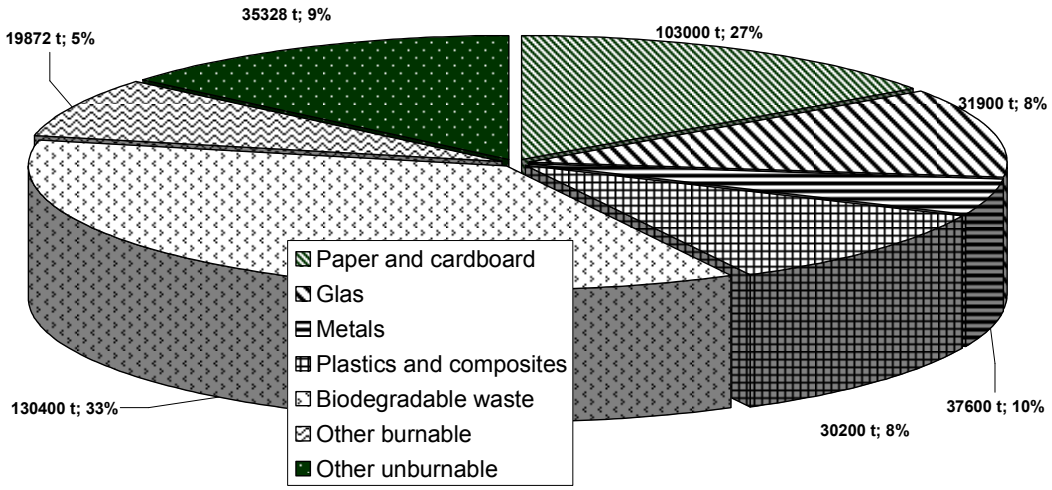

Figure 2 Municipal solid waste generation forecast (2013; Šiauliai, Panevežys, Telšiai and Tauragė waste management regions; Lithuania)

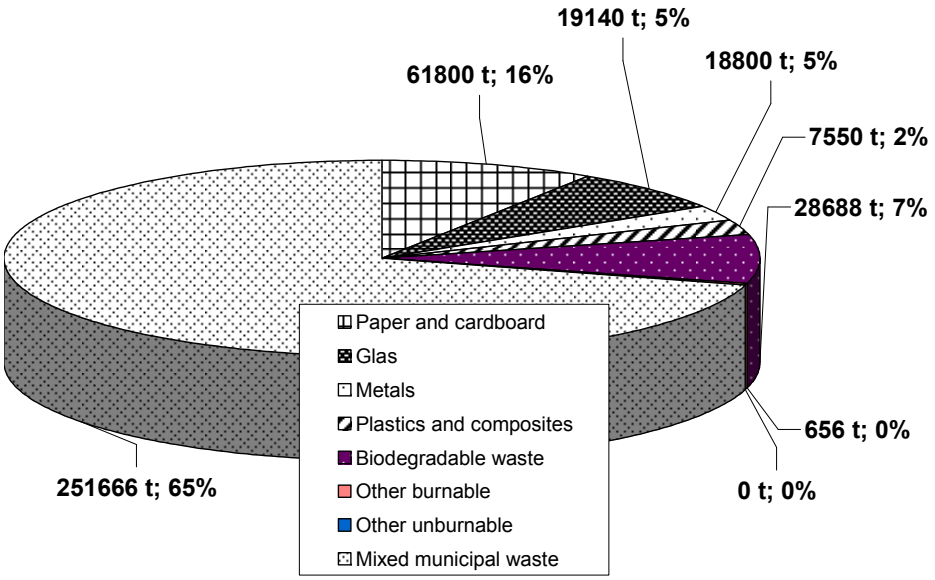

Figure 3 Municipal waste collection forecast (2013; Šiauliai, Panevežys, Telšiai and Tauragė waste management regions; Lithuania)

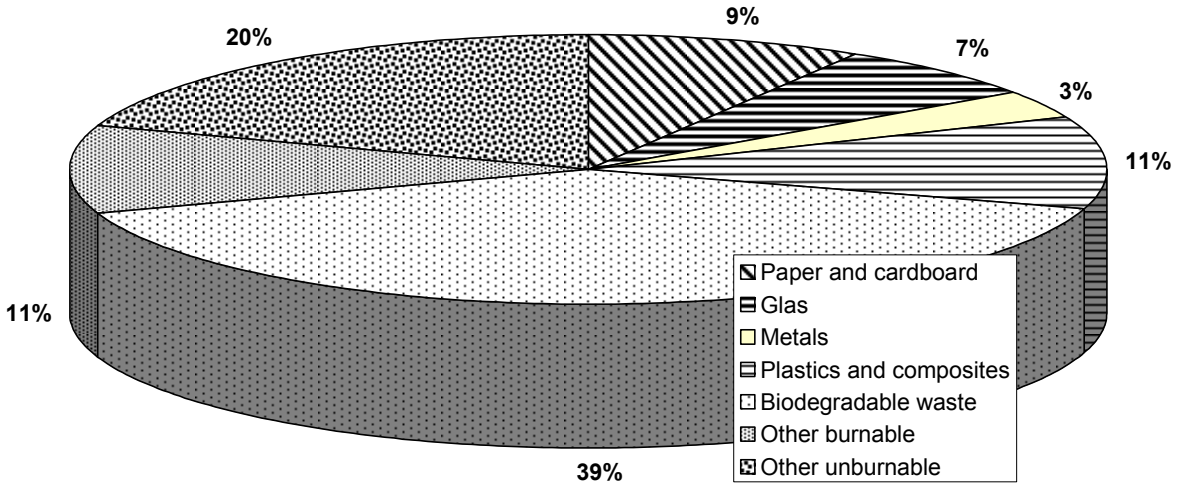

Figure 4 *Mixed municipal solid waste content forecast (2013; Šiauliai, Panevežys, Telšiai and Tauragė waste management regions; Lithuania)*

3 The alternatives of MMSW management

Furthermore by use of the assessment model with the same name LCA-IWM (den Boer, 2005) the some MMSW management alternatives are assessed and compared energetically and environmentally:

Zero alternative: ***MMSW landfilling.***

In this case the collected residual MMSW are landfilled.

1 alternative: ***MMSW mechanical-biological pre-treatment (MBP) and HCF incineration in cement kilns***

In this case:
- collected residual MMSW are treated mechanically with particularly metals separation and dividing to high calorific fraction (HCF) and low calorific fraction (LCF);
- separated metals go to recycling;
- LCF is treated biologically and the content of biowaste is significantly reduced;
- HCF is incinerated in cement kiln (SC “Akmenės cementas”, Naujoji Akmenė).

2 alternative: ***MMSW mechanical-biological pre-treatment (MBP) and HCF incineration in WIP***

In this case:
- collected residual MMSW are treated mechanically with particularly metals separation and dividing to high calorific fraction (HCF) and low calorific fraction (LCF);
- separated metals go to recycling;
- LCF is treated biologically and the content of biowaste is significantly reduced;
- HCF is incinerated in WIP with energy recovering, the 80% of formed slags is used for construction of ways;
- stabilised LCF and rest slag are landfilled.

3 alternative: ***MMSW incineration in WIP***

I this case:
- collected residual MMSW are incinerated in WIP with energy recovering;
- the metals are separated from formed slag and 80% of slag is used for construction of ways;
- the rest slag is landfilled.

The used assessment tool LCA-IWM evaluate the chemical content, moisture and calo-ricity of every waste fraction, also the pollutants emissions conditioned by each waste treatment technology (Deliverable, 2003). The tool considers that fire grate technology (as best available technology) with effective gas cleaning system is used for waste in-cineration. The tool also considers the parts of waste fractions to be divided between HCF and LCF, also the part of biowaste to be destroyed in the biological stage of MBP. The corresponding contents of HCF and stabilised LCF are presented in the Figures 5 and 6.

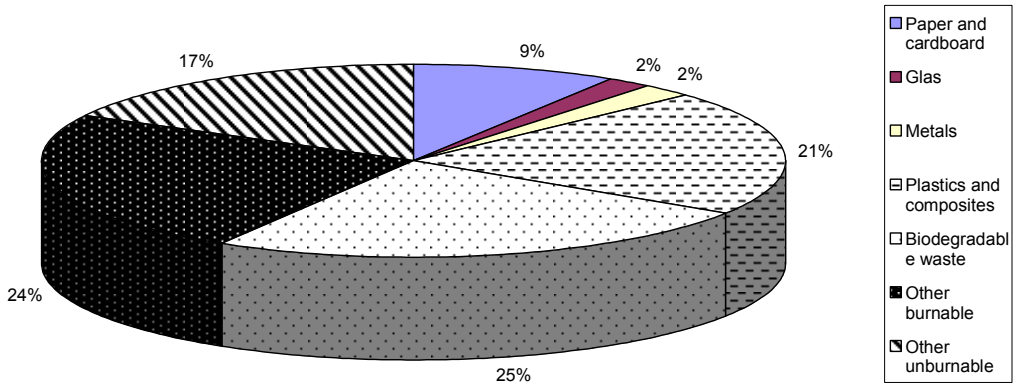

Figure 5 HCF content forecast (2013; Šiauliai, Panevežys, Telšiai and Tauragė waste management regions; Lithuania)

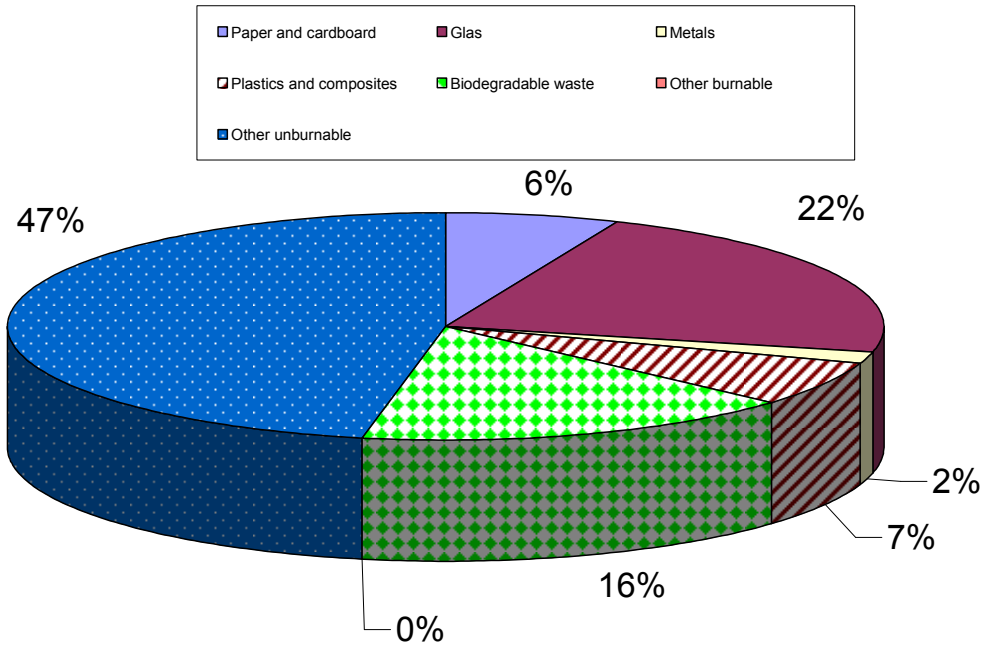

Figure 6 *Dry stabilized LCF content forecast (2013; Šiauliai, Panevežys, Telšiai and Tauragė waste management regions; Lithuania)*

4 Assessment results

First of all we review the differences of waste and/or waste treatment residues flows to the landfills for every alternative (Figure 7). It is evident that:

- due to MBP and following HCF incineration – 2,8 times;
- due to MMSW incineration - 17 times.

It is necessary to have in the mind that namely biowaste accessing to the landfill with MMSW and/or its treatment residues make mostly environmental impact problems because during anaerobic biowaste digestion the main amount of greenhouse gas (methane CH_4) and toxic compounds is emitted together with landfill gas and leachate. The emissions of these environmental pollutants during waste incineration (considering to gas cleaning efficiency) are significantly lower. Figures 8 and 9 clearly illustrate the advantages of MMSW incineration.

The economic assessment of investigated alternatives is characterised in the Figure 10. So the operating costs for MMSW incineration in the WIP are almost 2 times lower than for MBP. However the corresponding investment costs are about 3 times higher. The costs for exploitation of cement kiln during HCF incineration in the already functioning Lithuanian cement production facility are excluded.

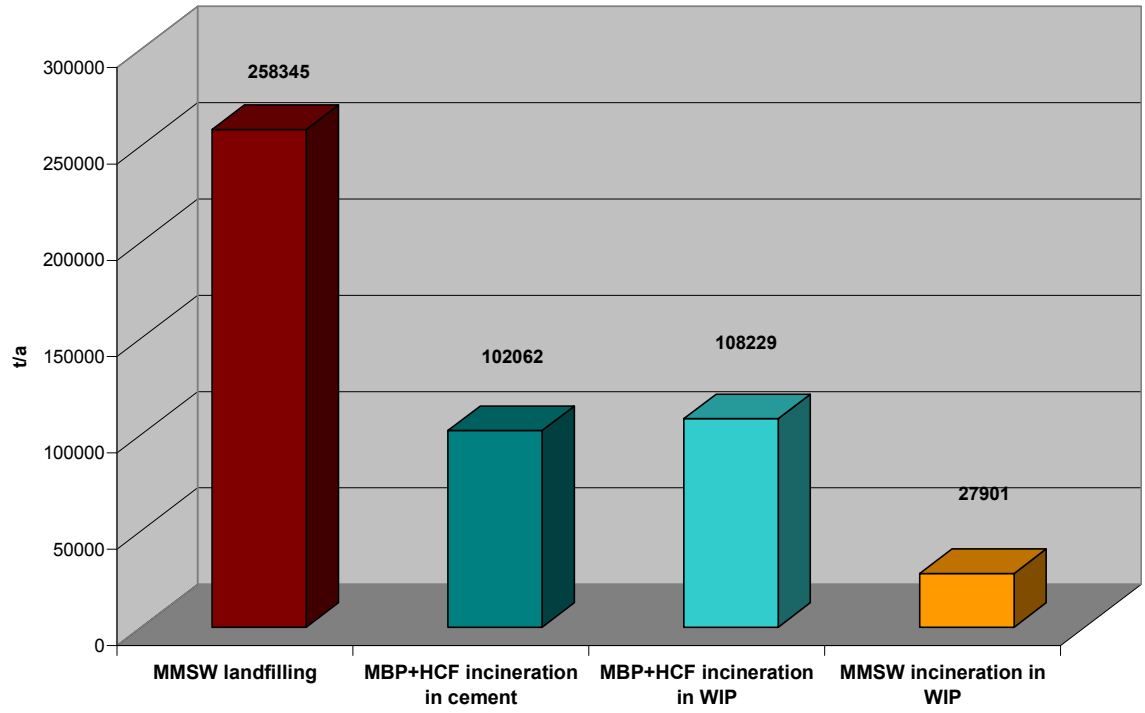

Figure 7 *Waste or waste treatment residues flows to the landfill for MMSW treatment alternatives (2013; Šiauliai, Panevežys, Telšiai and Tauragė waste management regions; Lithuania)*

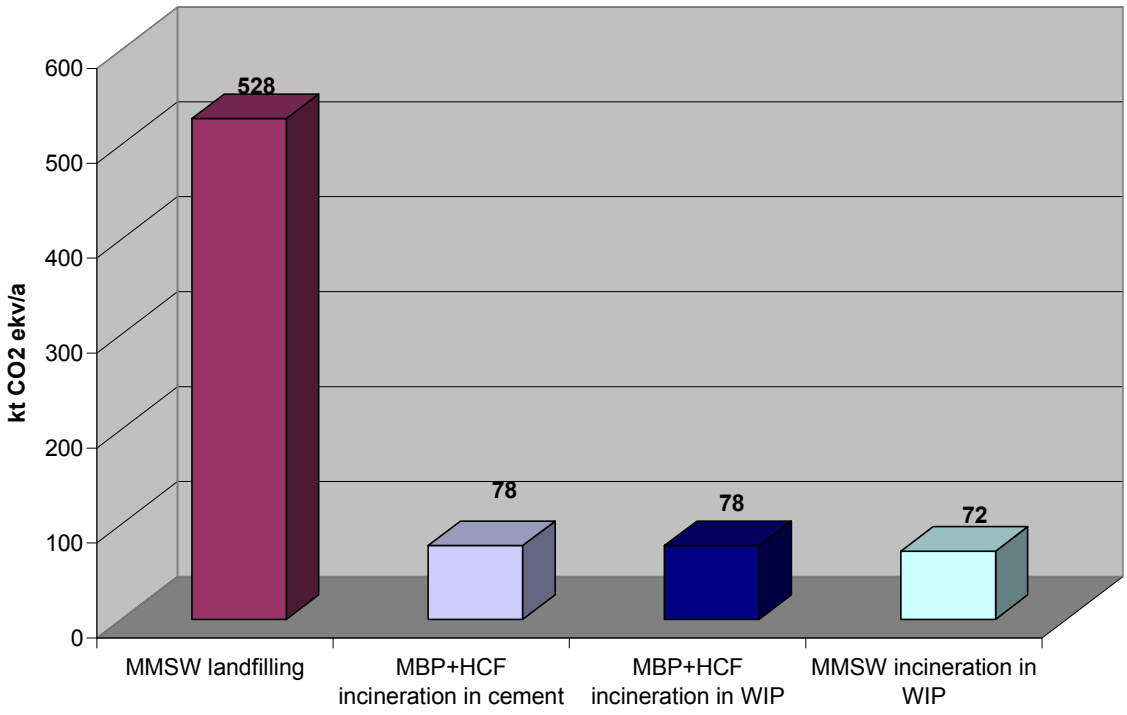

Figure 8 *Greenhouse gas emissions for MMSW treatment alternatives (2013; Šiauliai, Panevežys, Telšiai and Tauragė waste management regions; Lithuania)*

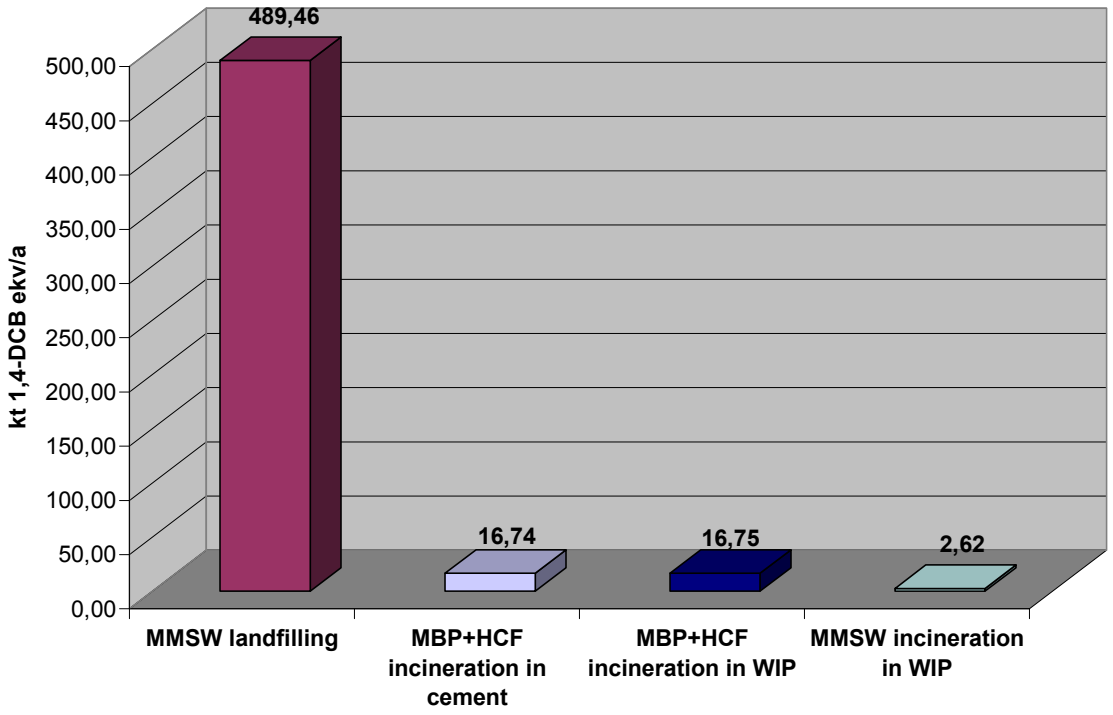

Figure 9 *Human toxicity for MMSW treatment alternatives (2013; Šiauliai, Panevežys, Telšiai and Tauragė waste management regions; Lithuania)*

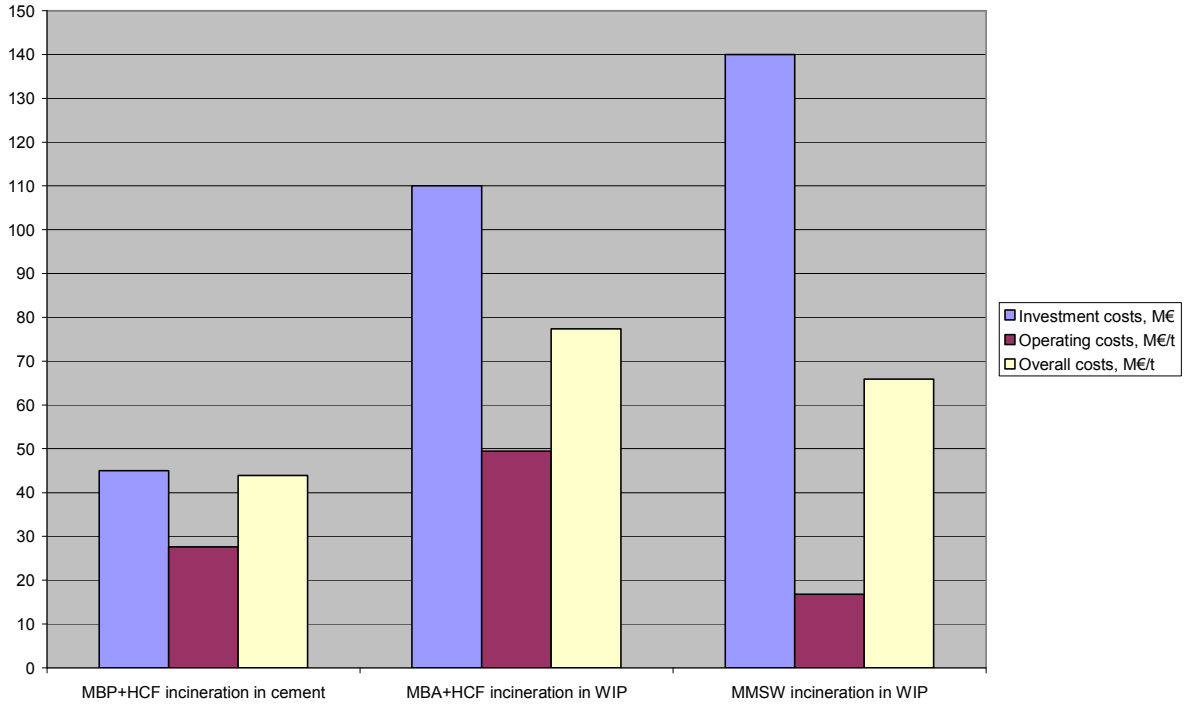

Figure 10 *Possible investment, operating and overall costs for MMSW treatment alternatives (2013; Šiauliai, Panevežys, Telšiai and Tauragė waste management regions; Lithuania)*

5 Conclusions

The performed assessment for Šiauliai, Panevėžys, Telšiai and Tauragė waste management regions in Lithuania shows that:

- Due to MBP process for MMSW and subsequent HCF incineration (both in cement kiln or in WIP) the waste or waste treatment residues flow to the landfill would be reduced about 2,8 times, due to MMSW incineration - 17 times. In comparison with incineration in WIP, HCF incineration in cement kiln reduce the total amount of treatment residues very unsignificantly;
- Due to MBA process and subsequent HCF incineration for MMSW the biowaste flow to the landfill would be reduced 5-6 times, due to MMSW incineration the biowaste flow to the landfill is excluded;
- In comparison with MMSW landfilling the MBP process with subsequent HCF incineration reduce greenhouse gas emissions 7 times, MMSW incineration – 11 times;
- In comparison with MMSW landfilling the MBP process and subsequent HCF incineration reduces the human toxicity 16 times, MMSW incineration - – 232 times.
- In comparison with MBP the economic advantages of MMSW incineration are evident concerning operating costs, however the corresponding investment costs for incineration in WIP are about 3 times higher. HCF incineration in existing cement production facility excludes the costs for construction and exploitation of incineration plant.

6 Literature

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