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Energy analysis of waste management system *"Ponikve eko otok Krk"*

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Abstract

Solid waste causes endangering human health, harming the environment, increasing greenhouse gas emissions, climate changes, depletion of ozone layer, nuisance through noise and odors and overmuch wasting of the natural resources. Therefore, the European policy encourages waste prevention, sustainable use of natural resources, protection of ecosystem and circular economy. Published studies based on LCA (Life cycle assessment) analysis are primarily concentrated in Europe with little application in developing countries, such as Croatia. This article is an introductory part of the research that will include an analysis of the economic, environmental and energy aspects of the various waste management systems in Croatia. This research will provide a detailed and comprehensive energy analysis and waste structure of system „Ponikve eko otok Krk", Croatia. "Ponikve eko otok Krk" is system in which dominates recycling and re-use of products. Specific data per ton of material are obtained and shown in tables and diagrams. Some of these data are electricity consumption in the sorting expressed through mass of sorted material.

Key words: *energy analysis, recycling, solid waste, waste management system*

1. INTRODUCTION

Waste management is defined by all the activities including collection, transport handling, treatment, material and energy recovery and disposal of waste [1]. The traditional "waste management hierarchy" (Fig 1.) is a preferential order of waste treatment options that aims to reduce environmental impacts by prioritizing prevention, reuse, recycling, and recovery over landfill. Unfortunately, landfill is most commonly used and accounts for approximately 95 % of the total collected municipal solid waste (MSW) worldwide [2]. One environmental problem deriving from landfills is groundwater pollution from leachates. Moreover, there are over 10 toxic gases released from landfills, of the most serious of which is methane [3]. Besides, solid waste causes endangering human health, harming the environment, increasing greenhouse gas emissions, climate changes, depletion of ozone layer, nuisance through noise and odors and overmuch wasting of the natural resources.

Therefore, the European policy encourages waste prevention, sustainable use of natural resources, protection of ecosystem and circular economy. One of those waste management systems is "*Ponikve eko otok Krk*", Croatia. This is a system in which dominates recycling and re-use of products.

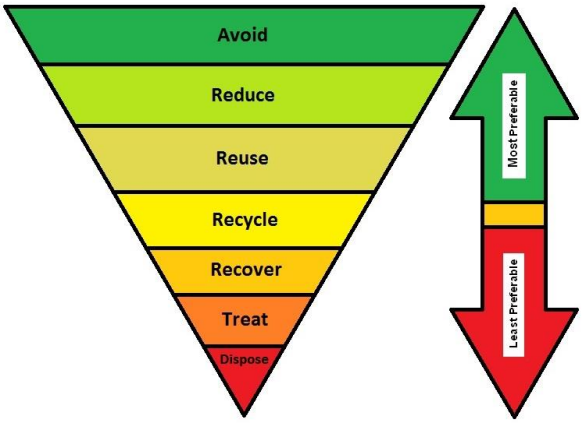

Figure 1. Waste management hierarchy [I]

2. "PONIKVE EKO OTOK KRK"

"*Ponikve eko otok Krk*" is waste management system that refers to the area of Croatian island of Krk. It is popular tourist destination in summer period of the year.

The present waste management system can be divided into two main categories (Fig 2.):

- collection and transport of waste
- treatment of waste and disposal (sorting plant, compost plant and landfill).

The percentage of separated waste in 2016 was about 54 % (Fig 4.). In 2016 started "*door-to-door*" waste

collection when additional bins for bio waste were distributed to households.

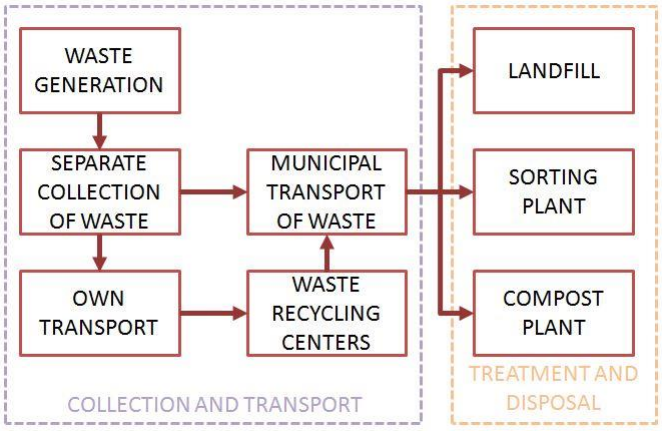

Figure 2. Scheme of waste management system "*Ponikve eko otok Krk*"

3. SYSTEM ANALYSIS

3.1 *Mass analysis*

In Figure 6. overall mass of waste in period 2006-2016 is shown. It is obviously that through years overall mass of waste increases. The cause of that change is not researched yet. Still, it is assumed that one of the reasons is bigger amount of people and another is reduced number of wild landfill. In Figure 7. mass of different waste types in period 2006-2016 is shown. It can be noticed that through years mass of mixed municipal waste decreases when mass of bio waste, paper and cardboard increases. The reason of that is progressively implementing of waste recycling and re-using. It is a slow and complex process in which main role has society and their adaptation.

After all, a minimization of the increase of waste is essential for a more sustainable development of the society [4].

3.2 *Structure of waste*

Waste collection structure is observed from the beginning of transformation of waste management system from period in which disposal of mixed municipal waste was dominated to current state where recycling and reuse of separately collected waste dominates.

Separate waste collection started in 2010 by opening of redemption station for metals and by collecting of olive pomace for the purpose of obtaining high-quality humus. Further activity was the installation of larger containers for different waste types at more frequent locations.

By comparing of figure 3. and figure 4. the change of waste structure in last six years can be observed. It can be noticed increasing of collected bio waste from 12 % in 2010 to 26 % in 2016. The cause of that is implementation "*door-to-door*" collecting system of bio waste. Other values have not been changed during a period 2010-2016.

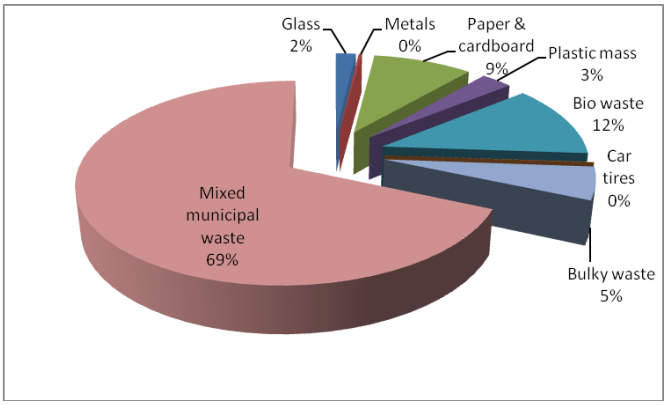

Figure 3. Structure of waste in 2010

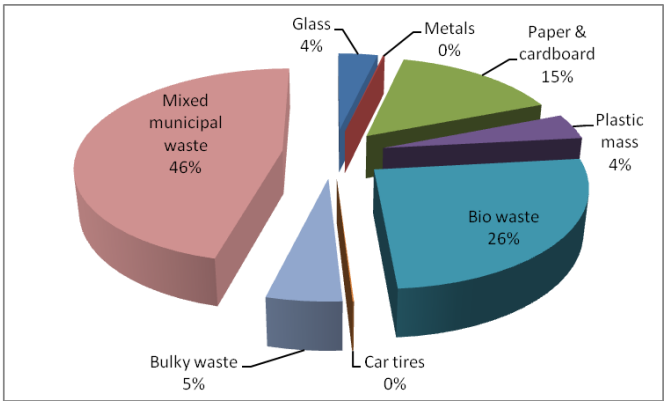

Figure 4. Structure of waste in 2016

In Figure 5. it can be seen that amount of waste significantly increases in summer months (June, July, August and September). This is caused by bigger amount of tourists.

4. ENERGY CONSUMPTION

Energy consumption of this solid waste management system can be divided into three main categories:

- waste sorting plant
- transport of waste
- compost plant.

In this paper electric consumption of waste sorting plant is observed.

4.1 *Waste sorting plant*

Waste sorting plant has an area of 1407 square meters. Over the years the structure of waste sorting plant has been changed. In 2015 the capacity of sorting plant was increased compared to 2012 year (Fig 8. and 9.). Since then two baling presses work at the same time. The reason for change is bigger amount of separated waste (Fig 7).

The consequence of implementation of new sorting structure is increased energy consumption (in kWh per ton of waste) for sorting sector (Fig 10. and 11.). This is because working hours were decreased and nominal power of baling presses was increased.

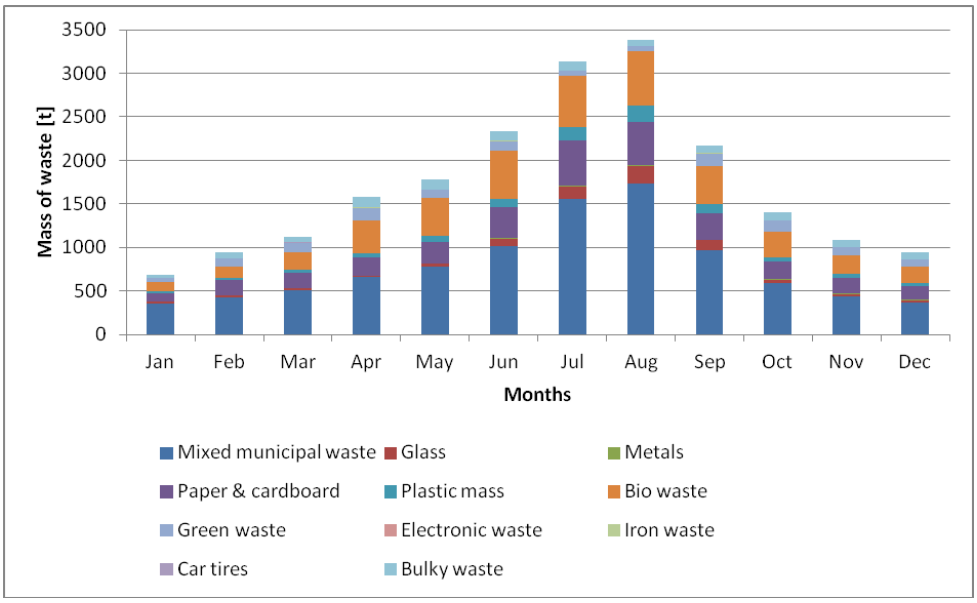

Figure 5. Structure of waste in 2016 per month

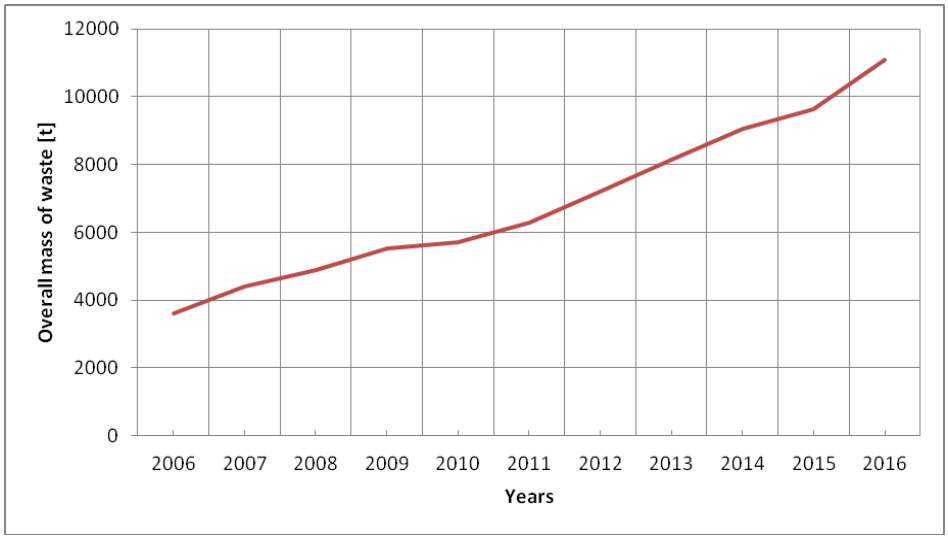

Figure 6. Overall mass of waste in period 2006-2016

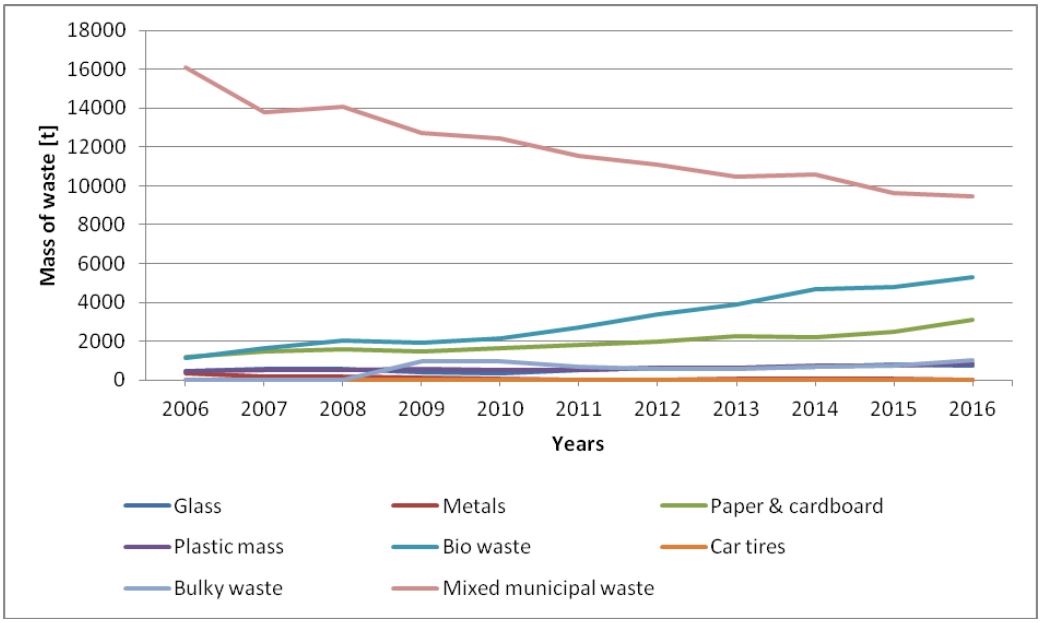

Figure 7. Mass of different waste types in period 2006-2016

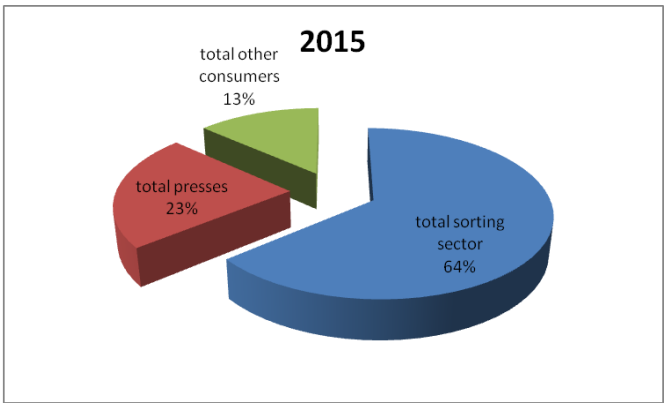

Figure 8. Energy consumption of waste sorting plant in 2015

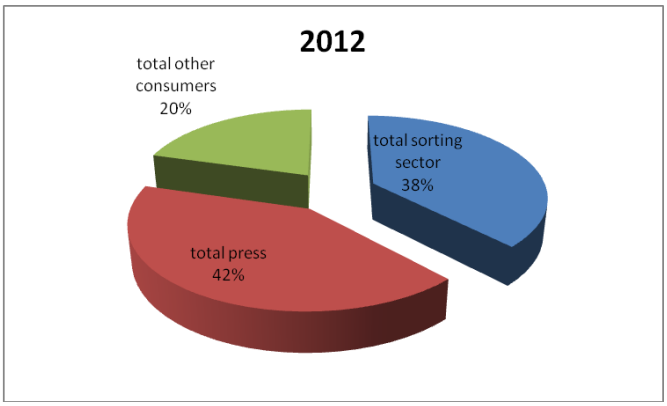

Figure 9. Energy consumption of waste sorting plant in 2012

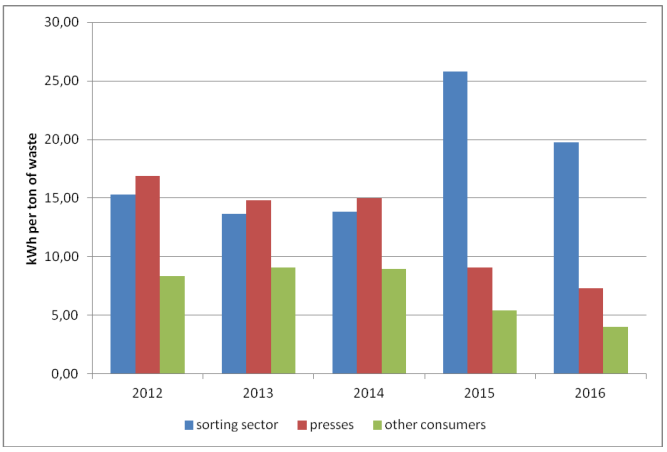

Figure 10. Energy consumption per sector of waste sorting plant in period 2012-2016

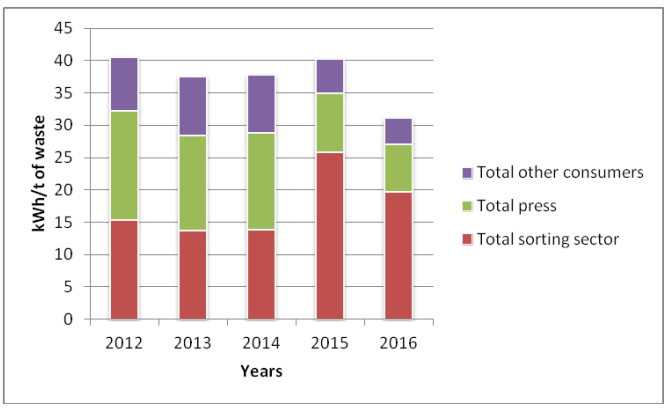

Figure 11. Energy consumption per sector of waste sorting plant in period 2012-2016

5. CONCLUSION

A minimization of the increase of waste is essential for a more sustainable development of the society [4].

For last ten years overall mass of waste in waste management system "*Ponikve eko otok Krk*" increases. The cause of that should be explored in next research. Still, it is assumed that one of the reasons is bigger amount of people and another is reduced number of wild landfill.

The Waste Framework Directive 2008/98/EC include two new recycling and recovery targets to be achieved by 2020: 50 % preparing for re-use and recycling of certain waste materials from households and other origins similar to households, and 70 % preparing for re-use, recycling and other recovery of construction and demolition waste [II]. This goal for waste management "*Ponikve eko otok Krk"* has achieved. The percentage of separated waste from households in 2016 was about 54 %.

The implementation of a new collection system "*door-to-door*" brought a large increasing in separate collection of bio waste.

In further research amount of people for last 5 years should be explored. Afterwards increasing of waste mass can be compared with amount of people.

It should be researched the impact of increasing and decreasing overall energy consumption (in kWh per ton of waste) for sorting plant (Fig 11.).

Moreover, energy analysis for transport of waste and compost plant should be done. Afterwards energy analysis of this waste management system will be complete.

6. REFERENCES

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[I] http://www.moira.vic.gov.au/Environment/Reducing_Our_Ecological_Footprint/Purchasing_Consumption_and_Waste

[II] http://ec.europa.eu/environment/waste/framework/