BIOGAS PRODUCTION FROM ORGANIC PART OF MUNICIPAL SOLID WASTE. URBANBIOGAS PROJECT

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ABSTRACT: The European countries have to comply with the Landfill and Waste Directive which calls for reducing landfilling of the biodegradable part of municipal solid waste (MSW) to 35% within next five to ten years. They also have to comply with the Renewable Energy Directive (RED). The simultaneous energetic use of organic waste, such as organic part of MSW and catering/food waste (FW), and the creation of a closed nutrient cycle are only possible with anaerobic digestion (AD) in biogas plants. Therefore, usage of biowaste in order to produce biogas has two major moments: environmental protection – avoiding waste landfilling and renewable energy production. Produced biogas can be utilized as: cogeneration unit (production of electrical and thermal energy), biofuel (compressed biomethane) or natural gas substitute (injected in public gas grid). The quantities of the biowaste in the City of Zagreb will be presented and analysed. The work on various aspects of that project and establishment of the contacts with number of European partners led to successful inclusion of Zagreb City Holding, Waste management division Čistoća, into the Intelligent Energy Program project Urban Biogas - urban waste for biomethane grid injection in urban areas funded by European Union. The details of the project will be presented as well.

Keywords: biowaste, urbanbiogas, biofuel,

1. INTRODUCTION

In many European regions waste management is still a large environmental problem, insufficient waste management practices are more dominant in urban areas.
The two major documents are behind increasing number of biogas plants erected in last decade in Europe: Landfill directive 1999/31/EC and Renewable energy directive 2009/28/EC. Both of them are of environmental nature. First one is concerned with the attempts and goals to divert waste from landfilling and the second one is concerned with exploiting energy contained in the biowaste. Historically though, the biogas plants started flourishing in Germany when it was recognized that the manure generated in numerous farms might be used in order to solve the problem of its handling and obtained to produce energy in even greater amount than needed to satisfy their own needs. As the greenhouse gas effect was recognized as the major environmental problem, the production of biogas received even more attention and various schemes were developed in order to stimulate construction of the new plants.

Biogas production from waste has the potential to contribute to the European targets of the above mentioned directives. Adjacent upgrading to biomethane quality and grid injection in the natural gas distribution network is an opportunity to efficiently use renewable energy in urban areas. This approach, Waste-to-Biomethane (WtB), is promoted by the UrbanBiogas project (Urban waste for biomethane grid injection and transport in urban areas).

2. THE URBANBIOGAS PROJECT

The objective of the UrbanBiogas project is to prepare 5 European target cities for the production of biomethane from urban waste which will be fed into the natural gas grids and optionally used for transport: City of Zagreb (Croatia), Municipality of Abrantes (Portugal), City of Graz (Austria), City of Rzeszów (Poland), and North Vidzeme Region including the City of Valmiera (Latvia). Core of the project is the implementation of more than 130 events, including workshops, working group meetings, study tours and city exchange visits in order to elaborate five WtB concepts for the target cities.
The status of development of the biogas and biomethane sectors as well as of waste management (Figure 1) is currently still very different in European countries.
Germany is certainly the forerunner in biogas plants and also in biomethane upgrading and grid injection. Currently about 6,300 biogas plants are installed. Thereby about 50 plants are

upgrading biogas to biomethane quality for injection into the natural gas grid. Germany furthermore has about 150 filling stations for transport selling biomethane in mixtures and about 3 filling stations selling only biomethane. Furthermore, in many German cities and municipalities, sophisticated waste collection and separation systems were introduced. Other European forerunners are Austria, Denmark, Czech Republic, and Italy on biogas production as well as Sweden and Switzerland on the utilization of biomethane for transport.

Although the development of these forerunners in relation to biogas production is rather advanced, there is still a considerable gap in using organic waste for energy production and much more efforts are needed. However, biogas and biomethane production is much less developed in many other European countries. Sophisticated waste management is not or only partly introduced. As Figure 1 shows in 2005 many countries have still dumped large portions of MSW on landfills.

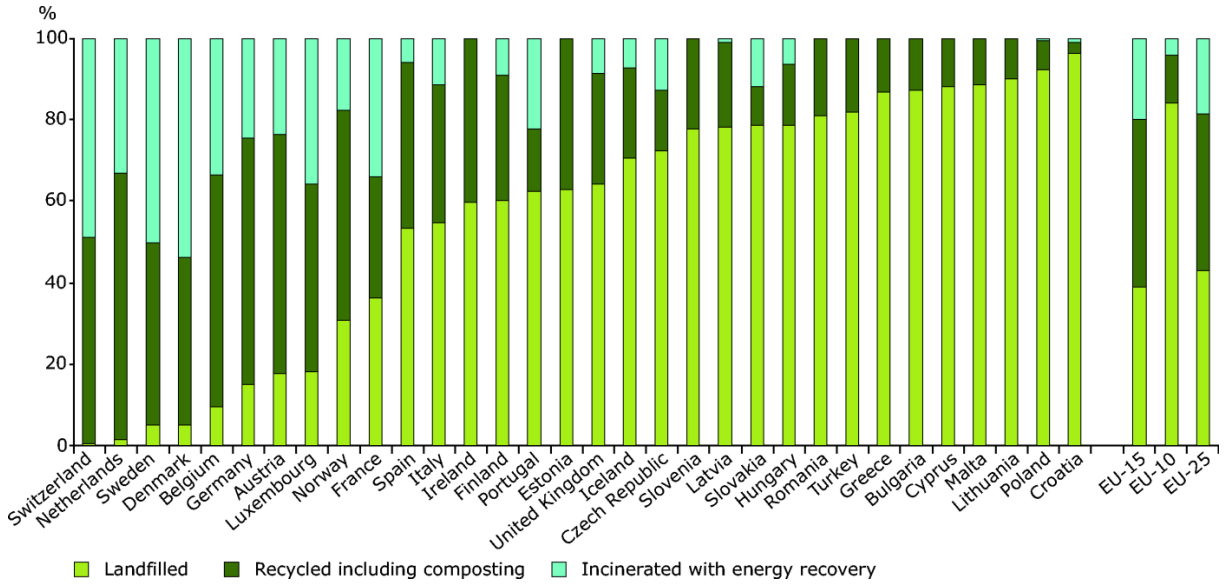

Figure 1: The rate of recycling versus incineration with energy recovery of municipal waste in 2005 (Source: EEA 2007)

The simultaneous energetic use of organic waste, such as municipal solid waste (MSW) and catering/food waste (FW), and the creation of a closed nutrient cycle is one of the main advantages of anaerobic digestion (AD) biogas plants as they turn waste materials to "desirable" feedstock. In addition, the conversion of organic waste in biogas plants has several other advantages in comparison to other common organic uses (landfill, incineration, composting), as briefly summarized in Figure 2.

In comparison to waste incineration plants, AD plants usually need lower investments and the distances for feedstock transport are generally shorter. Nutrients can be easier recovered for agricultural production and wet feedstock does not have to be dried which is required for incineration. Namely, household scale or industrial scale composting also recovers nutrients, but composting leaves the energy content of the biomass unutilised.

Biogas production from organic waste has the potential to contribute to the European waste and renewable energy targets. Adjacent upgrading to biomethane quality and grid injection in the natural gas distribution network is an opportunity to efficiently use renewable energy in urban areas.

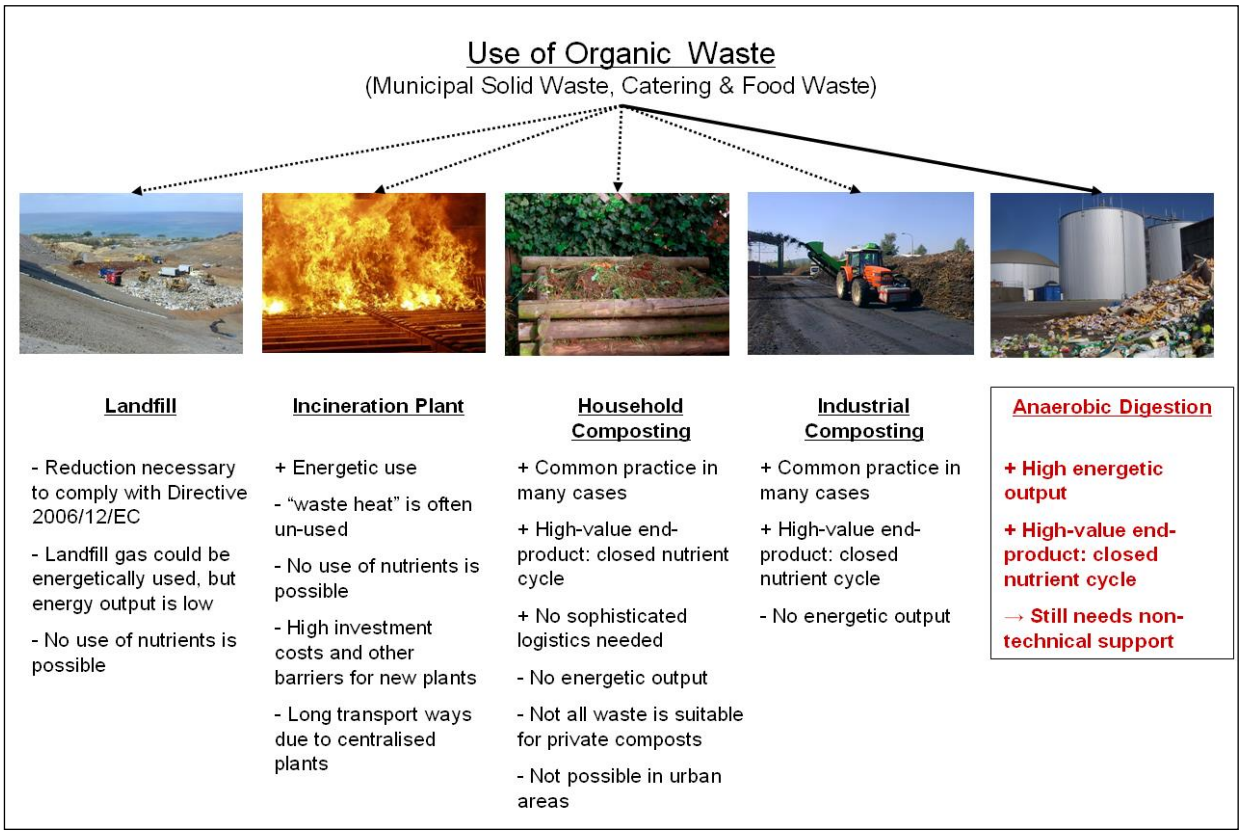

Figure 2: Overview on different treatment options of organic waste

4. ZAGREB CASE STUDY

Currently, the main portion of municipal solid waste generated in Zagreb (around 280 000 t/y) is disposed at the landfill site Jakuševec. The part of the currently collected biowaste is used in a composting plant. The development of the waste separation system, along with increased number of recycling yards will significantly increase the quantity of biowaste suitable for biogas production. This would decrease the amount of biodegradable waste currently land filled in accordance with the EU Landfill Directive. However, signed obligations in the Accession Treaty to European Union call for re-evaluation of the waste management policy where significant effort is needed for implementation of segregated collection of biowaste.

City of Zagreb is planning the construction of a biogas plant which will, in its first phase, use 20,000 t/a municipal biowaste. In the second phase the capacity will be upgraded to 60,000 t/a of biowaste. The first actions in that context commenced three years ago so that many relevant information were collected and various technologies examined. In what follows most important of these findings will be presented. Table 1 shows different biowaste types suitable for biogas production.

Table 1. Biowaste types suitable for biogas production[2]

Type of waste	No.
Biodegradable waste	20 02 01
Edible oil and fat	20 01 25
Biodegradable kitchen and canteen waste	20 01 08
Waste from Agriculture, Horticulture, Aquaculture, Forestry, Hunting and Fishing, Food Preparation and Processing	02

Zagreb Holding - Čistoća Division has began with intensive collecting of biowaste from households, markets, shopping centers, etc. and all of the collected biowaste is used for composting. Due to the technical limitation, only “clean” biowaste, without inorganic impurities, can be recovered which is significant challenge in the waste management. Table 2 shows estimated amount of biowaste planned for the first phase of the biogas plant.

Table 2. Estimated amount of biodegradable waste in the City of Zagreb[3]

Input	Amount (t/y)	Dry matter content (%)	Biogas yield (m^3/y)	Methane amount (m^3/y)
Biowaste from households and shops	5 000	20	500 000	340 000
Biowaste from kitchens and canteens	10 000	20	1 000 000	600 000
Market places	3 000	20	300 000	180 000
Food and beverage industry	1 000	20	100 000	60 000
Dairy waste and eggs	500	17	37 500	20 000
Total	20 000		1 937 500	1 200 000

Based on these amounts of biodegradable waste, calculated biogas potential is about 2 million m^3/year. Utilization of biogas is possible in three different ways:

- for combined heat and power production
- as a biofuel (compressed biomethane)
- direct injection in natural gas grid

Total produced energy and basic economical analysis is shown in Table 3.

Table 3. Produced energy and economical analysis[4]

	Amount	Market price	Cogeneration / €	Biomethane (CNG)/ €	Gas grid/€
Electricity	4 670 160 kWh	0,16€/kW	747.225	-	-
Heat	2 766 390 kWh	0,02 €/kW	55.327	-	-
Biomethane	1 200 000 m^3 860 400 kg	0,49€/m^3 1,00€/kg (CNG)	-	860.400	588.000

5. CONCLUSION

The UrbanBiogas project promotes the use of urban organic waste as a source of renewable energy so that this Waste-to-Biofuel concept results in sustainable energy production and waste treatment. Production of biogas from separately collected biowaste in the cities requires the construction of facilities which must be adapted to the composition of the waste. This means that a significant part of the investment must be allocated to the pre-treatment equipment adequately preparing the feedstock for fermentation. It cannot be neglected the need to implement adequate infrastructure for separate waste collection (bins, trucks). Nevertheless, the biogas plant based on separately collected urban biowaste can be built as a profitable plant.

However, one must always bear in mind two important aspects of the whole concept: the replacement of fossil with renewable energy which helps to protect the environment through energy recovery that is now largely wasted in landfill and reduction of the greenhouse gas emissions. In the case of Zagreb, reducing emissions of greenhouse gases under the above calculation is about 11 000 t/y. It is often neglected that in the case of composting biowaste this beneficial effect is lost. Therefore, the construction of biogas plants is an important contribution to achieving the objectives arising from the obligations which the Republic of Croatia has accepted. The Waste Management Division of Zagreb City Holding has undertaken a numerous activities in realization of the goals described here, not only at domestic but at international level as well.

References:

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