ORGANIC WASTE FOR BIOGAS PRODUCTION IN URBAN AREAS

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ABSTRACT: In many European regions waste management is still a major problem and only few biogas plants use organic waste for biogas production. Upgrading biogas to natural gas quality (biomethane) and grid injection into 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) which is supported by the Intelligent Energy for Europe Programme of the European Union. The use of the untapped fraction of organic urban waste for biogas production is promoted by a bottom-up approach in which cities (municipalities) are directly involved in all UrbanBiogas activities. The objective 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. The present paper presents the UrbanBiogas project and gives an introduction into the WtB concept.
Keywords: biogas, biomethane, organic waste, cities, Waste-to-Biomethane

1 INTRODUCTION

In many European regions waste management is still a major problem and only few biogas plants use organic waste for biogas production. Insufficient waste management practices are more dominant in urban areas.

At the same time, European countries have to comply with the Landfill Directive 1999/31/EC and Waste Directive 2006/12/EC to reduce land filling of the biodegradable part of MSW to 35% within the next five to ten years. They also have to comply with the Renewable Energy Directive (RED) 2009/28/EC.

Biogas production from waste has the potential to contribute to the European targets of the above mentioned directives. Adjacent upgrading to natural gas quality (biomethane) and grid injection into 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 or 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.

Figure 1: UrbanBiogas logo

UrbanBiogas officially started on 1 May 2011 and runs for 3 years. The project is coordinated by WIP Renewable Energies (Germany) and involves ten partners: Fraunhofer Institute for Wind Energy and Energy System Technology (Germany), HrvojePozar Energy Institute (Croatia), Polish Biogas Association (Poland), IrRADIARE (Portugal), Câmara Municipal de Abrantes (Portugal), Ekodoma (Latvia), City of Zagreb (Croatia), North Vidzeme Waste Management Organisation (Latvia), Graz Energy Agency (Austria), and Podkarpacka Energy Management Agency (Poland).

UrbanBiogas is supported by the Intelligent Energy for Europe Programme of the European Union (Contract No IEE/10/251).

3 THE WtB CONCEPT IN EUROPE

The status of development of the biogas and biomethane sectors as well as of waste management (Figure 2) is currently still very different in European countries.

Germany is certainly the forerunner in agricultural and waste biogas plants (both dry and wet fermentation) and also in biomethane upgrading and grid injection.

Currently about 6,300 biogas plants are installed and the German Biogas Association (Fachverband Biogas e.V.) estimates this number to increase to 6,800 installations by the end of 2011. 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 2 shows many countries have still dumped large portions of MSW on landfillsin 2009.

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) with biogas plants as they turn waste materials into "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 3.

In comparison to waste incineration plants, AD plants usually need lower investments and the distances for feedstock transport are often shorter. Nutrients can be recovered easier 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 recover 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 natural gas quality and grid injection into the natural gas distribution network is an opportunity to efficiently use renewable energy in urban areas too. This approach, Waste-to-Biomethane (WtB), is promoted by the UrbanBiogas project. Figure 4 shows the Waste-to-Biomethane value chain promoted in the UrbanBiogas project.

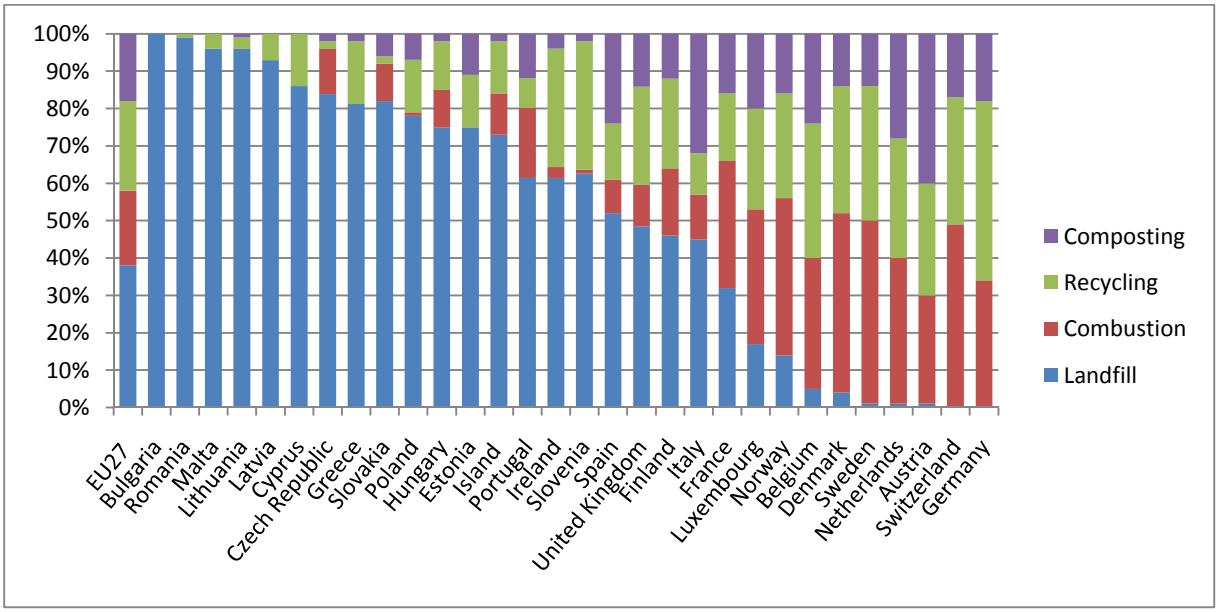

Figure 2: The share of different treatment options for municipal waste in Europe in 2009 (Data: EUROSTAT) (1)

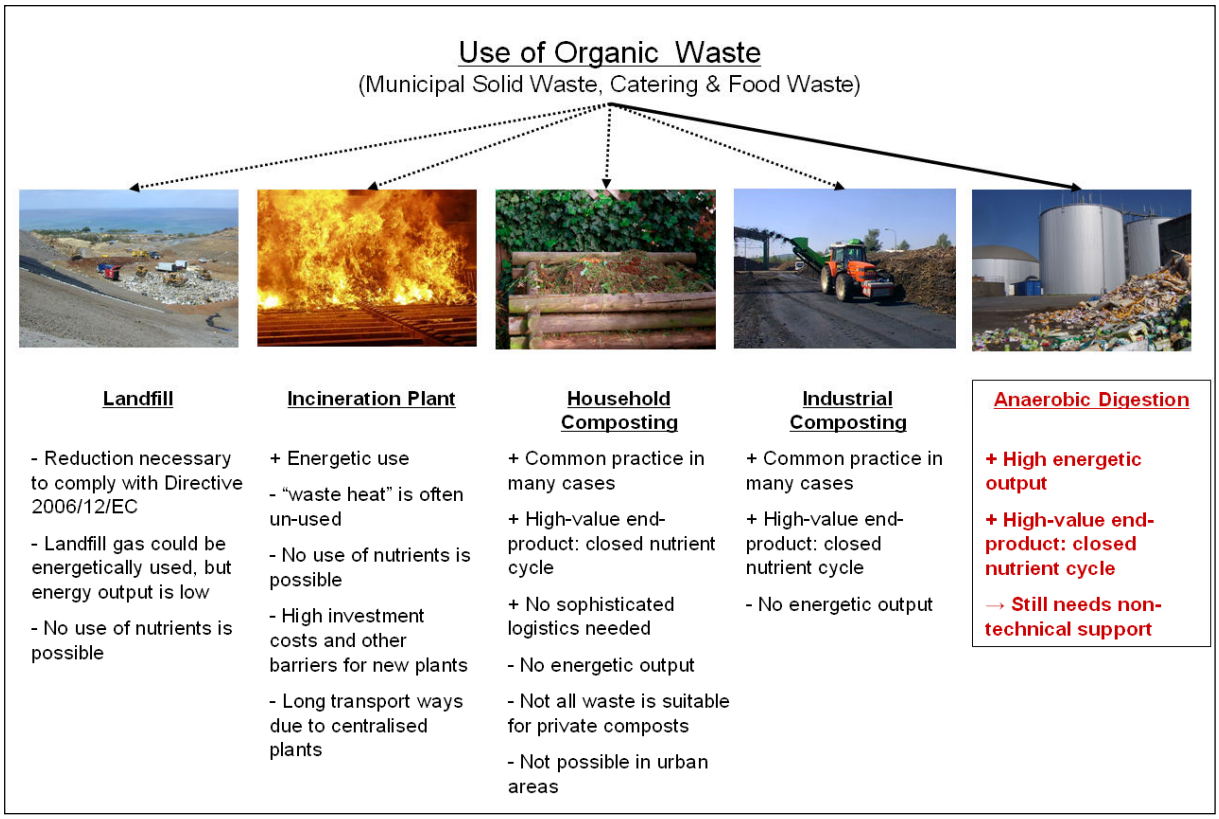

Figure 3: Overview on different treatment options of organic waste

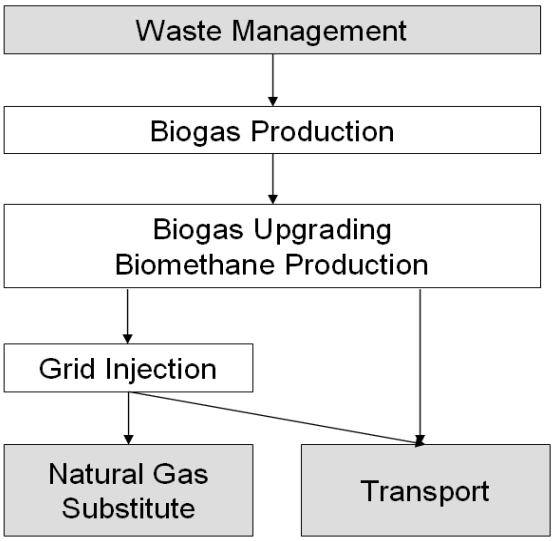

Figure 4: Waste-to-Biomethane value chain of the UrbanBiogas Project

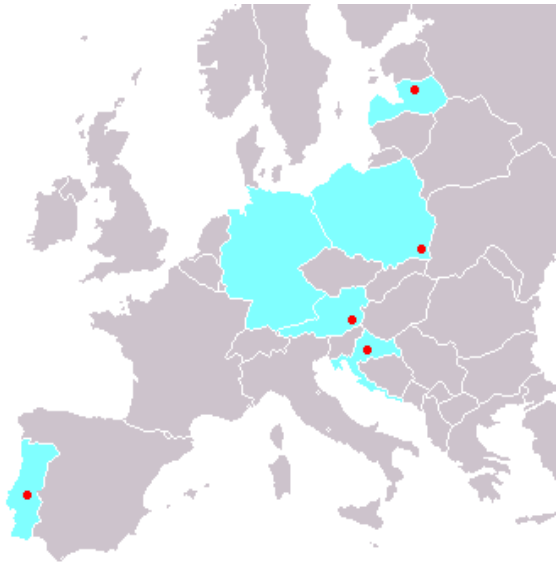

Figure 5: Involved countries in UrbanBiogas (blue) and target cities (red points)

4 URBANBIOGAS TARGET CITIES

The following chapters present the target cities in the UrbanBiogas project: 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). A map of the target cities is shown in Figure 5.

4.1 Austria – City of Graz /Region of Styria

The target city of Graz is the capital of Styria. Graz is represented in the UrbanBiogas project by the partner Graz Energy Agency (GEA) which is owned by the city of Graz (47.5%) as well by the two energy utilities Energie Graz GmbH (47.5%, electricity), and Energie-Steiermark (5%; natural gas and heat). The regional energy utility Energie-Steiermark is operational in the whole region Styria, which is also the focus of the Austrian UrbanBiogas activities because of the existing good gas-grid and waste separation infrastructure in whole Styria.

Due to the good framework conditions of the Green Electricity Act, Austria has a well-established biogas market with currently about 344 biogas plants, which mostly use energy crops. Numerous changes of the Green Electricity Act have led to a decline of the feed-in tariffs, which led to a near stop of implementations of new biogas plants. This is also due to the worsening of the economic conditions at the agricultural market, and due to lack of public acceptance. In recent years first pilot upgrading-plants to produce biomethane were realized, to make research and to become familiar with the technology.

Although the Austrian biogas market is very advanced in comparison to the other UrbanBiogas countries, it is a target of the regional climate protection plan (KlimaschutzplanSteiermark) from 2010 to promote the energy utilisation of organic waste instead of composting. The protection plan also indicates the stronger utilisation of low-emission vehicles like CNG passenger cars or trucks as well as the stronger utilisation of renewable energies for industry and buildings. These targets also match the targets of the Austrian climate strategy 2010.

Organic waste from separated municipal solid waste (MSW) collection in Styria is about 36,000 t/a. Currently, large parts of these wastes are composted to use the compost as agricultural substrate and fertilizer. Thus, they are not used energetically. The rest of the organic waste is currently co-fermented in about 15 biogas plants.

In total there are 47 biogas plants in operation.

In addition to the MSW, about 7,000 t/a sludge from wastewater treatment plants are produced of which 1/3 is land filled, 2/3 is used in agriculture. Waste from landscape management is about 5,000 t/a, which is mainly composted. Catering and food waste is about 9,000 t/a, wastes from dairy about 12,000 t/a, and wastes from meat production about 9,000 t/a.

Thus, in summary about 88,000 t/a organic waste is produced in Styria. The estimated biogas potential (estimated by GEA and the energy utility of Styria) from industrial and municipal wastes is about 20 Million m³ biogas.

4.2 Croatia – City of Zagreb

Zagreb is the capital of Croatia with approximately 800,000 inhabitants and a surface area of 640 km².

Currently, the main portion of municipal solid waste (350,000 t/year all together) is disposed at the landfill site Jakuševec. In the last couple of years systematic action has been undertaken to increase the quantity of separately collected biowaste. The part of the currently collected biowaste is used in a composting plant. The significant proportion which is contained in the MSW is a basis for the planning of 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 biowaste.

Developing waste separation system, along with the increased number of recycling yards (17 in total) will significantly increase the quantity of biowaste suitable for biogas production. This will also decrease the amount of biodegradable waste currently land filled in accordance with the EU Landfill Directive. Waste separation and sorting in the city is somewhat lagging behind the targets set by the Waste framework (2008/98/EC) and Landfill Directive (1999/31/EC) due to insufficient funds allocated in the past to the implementation of modern waste separation systems. This resulted in the insufficient number of recycling yards, containers, vehicles and other equipment which are necessary for efficient waste separation systems. The lack of education and awareness among citizens and inadequate penalties for polluters, contributed to the unsatisfactory results in achieving goals defined by the above mentioned directives regarding the recycling of high-value materials such as biowaste, paper, plastic, metals, glass etc. The actions taken in the last couple of years are changing and improving the situation: systematic approach for source separated biowaste collection from restaurants, schools and kindergarten canteens, market places, shopping centers and green waste from households. In order to more precisely determine the possibilities and costs of citywide source separated waste collection, the two pilot projects are currently underway encompassing 10,000 households.

In accordance with the Renewable Energy Directive (2009/28/EC) as well as with participation of Zagreb in the Covenant of Mayors and with the participation in the CivitasElan FP7 project, certain divisions of ZAGREB CH have already begun replacing part of fossil fuels with renewable fuel such as biodiesel. For that reason biogas produced from biowaste and its upgrading to biomethane would diminish the consumption of fossil fuel (natural gas) in their vehicles. The natural gas grid in Zagreb is city owned, spread in the whole city, and managed by the company Zagreb City Gasworks (GradskaPlinara Zagreb). Almost 90% of the inhabitants in the city are connected to the gas grid making natural gas a major energy source. City industry is also using natural gas as primary source for production.

The city of Zagreb is represented in UrbanBiogas by the “City of Zagreb Holding, Waste management division - PodruznicaCistoca” (ZAGREB CH) which is owned 100% by the City. It plans the construction of a biogas plant that would use the collected bio-waste for the production of combined heat and power (CHP), for biomethane grid injection, and for the utilization of biomethane in a city owned fleet of vehicles.

4.3 Latvia – North Vidzeme Region – City of Valmiera

The North Vidzeme region is located in the Northern part of Latvia and includes 22 municipalities in 4 former administrative districts – Valmiera, Cēsis, Limbaži and Valka. North Vidzeme region has 181,483 inhabitants living in the 10,455 km^2 area. The biggest city is Valmiera with 27,371 inhabitants, located in the centre of the region. Valmiera is one of the target cities of the UrbanBiogas project.

The North Vidzeme Waste Management region has most developed waste management practices. The UrbanBiogas project partner ZAAO ltd (SIA "Ziemeļvidzemesatkritumuapsaimniekošanasorganizācija " – North Vidzeme Waste Management Organization) (ZAAO) is the main waste company in the North Vidzeme Region. It has implemented waste separation systems for paper, cardboard, glass, plastic, metal and PET. ZAAO is owned by 22 municipalities located in the North Vidzeme region with 47% owned by city of Valmiera.

Currently all unsorted and sorted municipal solid waste in the region is collected and transported to the landfill site "Daibe" which is located in equal distance from 3 main region cities (35 km –Valmiera; 30 km – Cesis; 30 km- Limbaži). The separated packaging waste is recycled and sent to different producers for recycling.

The organic fraction of waste is usually partly separated in private households in the country area. Kitchen waste in these households is usually composted for private use. Households in the city area usually do not separate the organic fraction from the main MSW stream and it goes to landfill sites.

Although industrial organic waste (waste water sewage sludge, food and catering waste etc.) has national and EU regulations till now there is no substantial progress into practical implementation of regulations.

After the administrative reform in 2010 some local governments have approved local binding regulations for industrial waste management. It says that all companies which produce organic waste must have a contract with a specific organic waste service company. Until now the local governments had not started actual control of these regulations. 2 regional cities Cesis and Limbazi are doing open windrow composting of sewage sludge and use compost in agriculture. Valmiera city deliver`s sludge to "Daibe" landfill where it is composted and used as landfill cover material. According to official statistics in average 1485 t/sludge/dry matter are generated annually in the region (which correspond ~7500 t/wet sludge).

Shops and catering companies have contracts for the animal by-products collection with companies "Re Cikls" and "Reneta", but there are no sound data available about volumes and means of utilizations of these waste streams.

The annual amount of MSW produced in North Vidzeme Region is about 50,450 t/a. Most of this (about 40,067 t/a) is land filled. The other parts are composted (4,344 t/a), sorted (3,286 t/a) and temporary stored (6,753 t/a). The main barriers for the implementation of waste separation systems in the North Vidzeme Region are:

- low tariffs for the collection of unsorted MSW which do not motivate the industry and private sector to implement advanced waste management options;
- low income of the inhabitants which does not allow an increase of costs for waste management services;
- low environmental awareness and education of the society;
- lack of legal, financial and administrative instruments for the implementation of advanced waste management options

By the end of 2007, Valmiera city approved the new Development Strategy for 2008-2014. According to the strategy, infrastructure and environment is one of the four priorities. However, there are no particular renewable energy targets for the city. Nevertheless, Valmiera and other cities in North Vidzeme have to contribute to the national renewable energy targets (40% of RES in final energy consumption by 2020).

Since 2006 ZAAO is working on development of bio-waste management options. In 2008 ZAAO has done a feasibility study on bio-waste management in the North Vidzeme region. The organization had discussed different aspects of bio-waste management with all main governmental and private institutions involved in the regulation and management of this sector. From 2009 ZAAO had started a pilot project of organic waste collection from private food companies.

There is a cross-country (magisterial) gas pipe going through the region. The natural gas grid in Valmiera is well developed. The gas grid is also available in Cēsis, but is not available in Limbaži and Valka. ZAAO has already done all needed administrative procedures for the connection to the natural gas grid in Valmiera city.

ZAAO together with the Valmiera City Council is very interested in the production of biogas that could be used as fuel in public transport. This would improve the air quality and the overall environmental quality in the city. Valmiera city and ZAAO acknowledge that there is a need for a pilot project which can stimulate interest of other market participants in the future.

4.4 Poland – City of Rzeszów

In Poland, currently (2010) 6 agricultural biogas plants, 78 landfill gas plants, 73 sewage sludge biogas plants, and 73 industrial waste water biogas plants are in operation. The annual electricity production from biogas is 276,500 MWh. However no biogas plant uses MSW and FW as feedstock. Furthermore, no upgraded biomethane is used or grid-injected.

The Energy Law Act of 1997, which after its most recent amendment mentions a privileged grid access for renewable energy, is currently being revised and foresees a large improvement of the situation in particular concerning biogas. Therefore, the Ministry of Environment and the Ministry of Economy have developed extensive program, which, amongst other aspects, will approve the construction of 2,000 biogas plants by 2020. However, legislation for biogas grid injection has to be established.

A strong incentive for investment is the currently available direct renewable energy investment subsidies granted within the European Structural Funds 2007-2013 Program. It is possible to obtain up to 70% of the investment costs in the form of non-refundable subsidies, and in the case of the special Public-Private Partnerships Program, even more than that. Apart from that, investors can count on support from various national programs, special institutions such as the National Fund for Environmental Protection and Water Management as well as tax reliefs within special economic zones.

In Poland, the most common way to threat municipal waste is to dump it on landfill sites. Composting is only made very rarely and only for single households. Only

very few projects are ongoing on waste separation and adjacent biological processing. In Poland, waste water plants and landfills still burn off most of the biogas in flare stacks. If biogas is retrieved, it is usually used to produce electric and thermal energy.

Rzeszów is a city in south-eastern Poland with a population of 172,813 (2009). It is located on both sides of the river Wisłok, in the heartland of the Sandomierska Valley. The city, which was granted a town charter in 1354, has been the capital of the SubcarpathianVoivodeship since 1999, and is also the seat of the Rzeszów County. The surroundings of Rzeszow belong to the richest in deposits of natural gas and crude oil in Poland.

Currently no organic waste is separately collected in Rzeszów. The wastes from the city area are transported to the landfill in Ostrów (about 60 km). There is no MSW biogas plant in operation. However the city of Rzeszów is highly interested in the development of WtB projects in order to overcome the waste problems of the city and to fulfill the renewable energy targets. Rzeszów has a big operating waste water treatment plant and in the industrial zone located nearby the plant where it plans to locate a biogas plant for communal wastes.

The City of Rzeszow has recently introduced CNG buses for public transport. In 2003 the public transport company MPK Rzeszow gained support to invest in CNG infrastructure from local authorities. The Karpacka GAS company declared that it would like to set-up a CNG filling station.

4.5 Portugal – Municipality of Abrantes

The Municipality of Abrantes occupies an area of 700 km^2, spread over 19 parishes. Abrantes is inserted in the transition zone of Beira Baixa, Alto Alentejo and Ribatejo and is characterized by hydrographical irregularities, in particular from the river Tagus. In terms of tourism, the county is inserted in the Tourist Region of the Templars, Central Forest and Reservoirs.

The economic activity in the municipality of Abrantes is diversified and activities are mainly related to agricultural activities. The main products are olive oil, wine and cereals. Forestry also has a significant relevance in this county. Another focus of this region is on industry including automotive components, mechanical engineering, machinery, transport equipment, metallurgy, and industries of footwear, garments, textiles, wood and cork. The economic base is very diverse and this is one of the most important capabilities of the municipality.

In the last years, Abrantes entered a new phase of growth, resulting from the emergence of new companies, which have fundamentally altered the existing framework. The emergence of new companies allowed diversifying the economic basis and investment.

93.2% of the total waste collected in 2006, corresponds to solid waste. For the selective collection, 3.8% is paper and cardboard, 2.2% glass and 0.8% packaging material. In 2007, Abrantes increased significantly the collection of recoverable waste for recycling - paper / cardboard, packaging / metal and glass.

However, currently no organic waste is separately collected in Abrantes. It is currently treated together with the remaining waste in incineration plants and/or dumped on landfill sites. However, due to the experience in the above mentioned waste separation initiative, the awareness of the need for a sustainable waste management is increasing among the citizens. However, a mayor challenge in the waste management is the heat during summer.

5 CONCLUSION

The UrbanBiogas project promotes the energetic use of urban organic waste by AD. Since the project has just begun in May 2011, preparatory work was implemented, such as the Kick-off-Meeting and the organisation of a study tour to biogas plants in Germany using the organic fraction of MSW.

In the following three years, the UrbanBiogas consortium will implement more than 130 events, including workshops, working group meetings, study tours and city exchange visits in order to support the five target cities in the set-up of WtB plants. A main tool will be a series of so-called Task Force Meetings involving city representatives, energy utilities, waste companies and other stakeholders. UrbanBiogas partners will develop in cooperation with the Task Force Members five WtB concepts for the target cities as preparation for the installation of WtB plants.

Finally, the WtB concept as a sustainable energy production and waste treatment option will be promoted among other European cities in order to contribute to the fulfilment of several waste, renewable energy and environmental targets of the European Union.

Figure 6: UrbanBiogas study tour: MSW reception hall of the Ganser biogas plant in Munich, Germany

Figure 7: UrbanBiogas study tour: Digesters of the biogas plant for organic household waste of WurzerUmwelt in Eitting, Germany

6 NOTES

(1) http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/8-08032011-AP/DE/8-08032011-AP-DE.PDF