Urban waste for biomethane grid injection and transport in urban areas

Project No: IEE/10/251

Städtische Abfallwirtschaft in Graz

Municipal waste management in Graz

WP3 – Task 3.4 / D 3.3

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UrbanBiogas website: www.urbanbiogas.eu

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1 Einleitung / Introduction

Das österreichische Abfallwirtschaftssystem basiert auf der Richtlinie 2008/98/EG, welche 2002 durch das Abfallbehandlungsgesetz zu nationalem Gesetz wurde.

Der Schutz von Mensch und Umwelt hat in der österreichischen Abfallwirtschaft Priorität. Die Grundlagen dafür sind geringe Emissionsmengen und ein effizienter Umgang mit Ressourcen. Österreich kann für die letzten 20 Jahre bezüglich Recycling und dem energetischen Nutzen von Abfall einen großen Erfolg verzeichnen. Auf internationaler Ebene zählt Österreich in der Abfallbehandlung zu den führenden Ländern. In der Abfalltrennung ist Österreich weltweiter an der ersten Stelle. In Zukunft soll das Augenmerk vor allem auf Abfallvermeidung, aber auch auf vermehrtes Recycling gelegt werden, um die österreichische Ökonomie mit Rohstoffen zu versorgen und um natürliche Rohstoffe zu bewahren. [Lebensministerium 2012] Abbildung 1 zeigt die schon erwähnte fortschrittliche Position Österreichs. Viele andere Länder lagern noch immer große Mengen an Hausmüll auf Deponien und verursachen somit Umweltprobleme (Produktion von Methan).

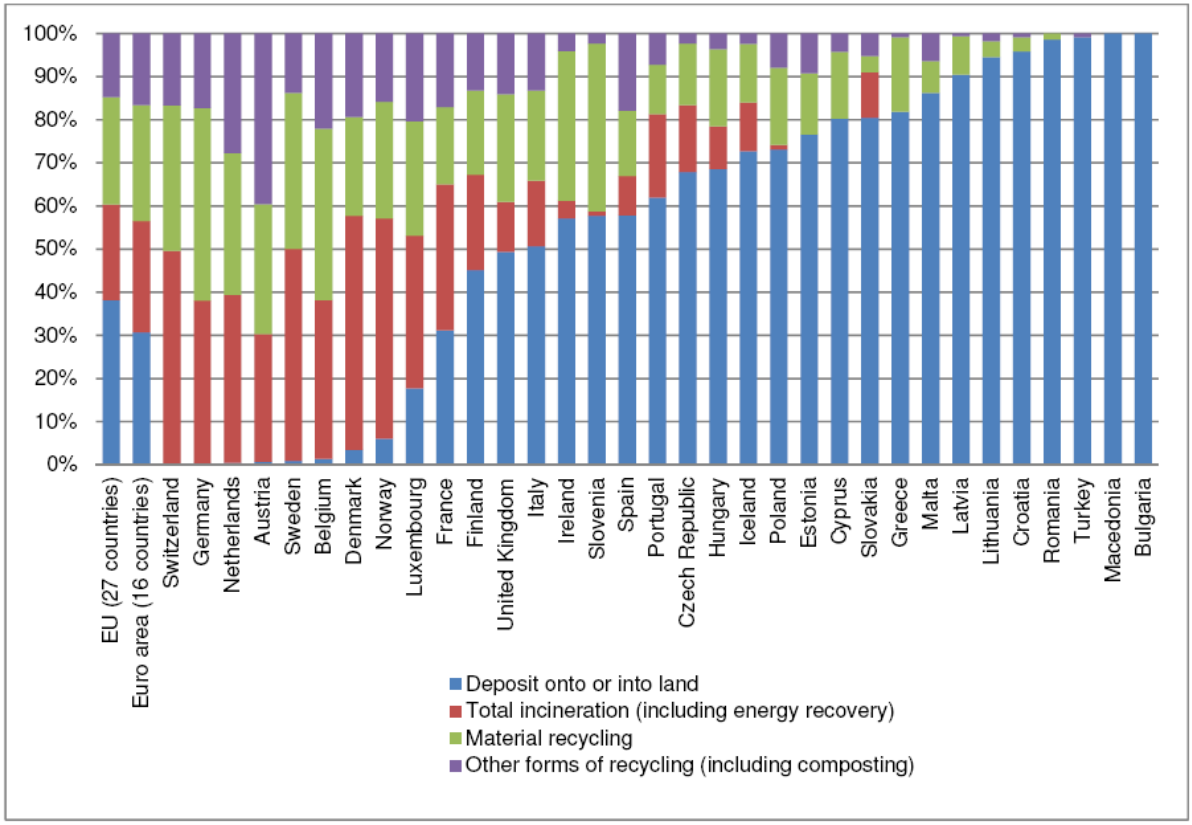

Abbildung 1: Verschiedene Behandlungsoptionen für Stadtmüll in Europa in 2010

(Quelle: Rutz et. al, 2012)

Die Hauptziele des österreichischen Abfallwirtschaftssektors sind:

1. schädliche oder nachteilige Einwirkungen auf Mensch, Tier und Pflanze, deren Lebensgrundlagen und deren natürliche Umwelt vermieden oder sonst das allgemeine menschliche Wohlbefinden beeinträchtigende Einwirkungen so gering wie möglich gehalten werden,
2. die Emissionen von Luftschadstoffen und klimarelevanten Gasen so gering wie möglich gehalten werden,
3. Ressourcen (Rohstoffe, Wasser, Energie, Landschaft, Flächen, Deponievolumen) geschont werden,
4. bei der stofflichen Verwertung die Abfälle oder die aus ihnen gewonnenen Stoffe kein höheres Gefährdungspotential aufweisen als vergleichbare Primärrohstoffe oder Produkte aus Primärrohstoffen und

5. nur solche Abfälle zurückbleiben, deren Ablagerung keine Gefährdung für nachfolgende Generationen darstellt.

Die Zielerreichung soll sich an folgender Hierarchie orientieren:

1. Abfallvermeidung;
2. Vorbereitung zur Wiederverwendung;
3. Recycling;
4. sonstige Verwertung, z.B. energetische Verwertung;
5. Beseitigung.

Einerseits erfüllt der österreichische Abfallbehandlungssektor die Funktion des ökologischen Schutzes, anderseits stellt er Roh- und Brennstoffe für die Wirtschaft zur Verfügung. Sekundären Ressourcen, Techniken zur angemessenen Behandlung und Wiederverwendung wird auf Grund der Ressourcenknappheit immer mehr Wichtigkeit beigemessen. Das Hauptziel ist es, einen nachhaltigen Materialfluss und eine nachhaltige Abfallwirtschaft umzusetzen. [Lebensministerium 2012]

The Austrian waste management system is based on the waste framework directive 2008/98/EG, which was transposed into national law through the waste management law 2002.

Priority of the Austrian waste management is the protection of humans and the environment. The bases for this are low levels of emissions and efficient use of resources. Austria has recorded great successes in the past 20 years as far as recycling and the energetic use of waste are concerned. In the field of waste treatment Austria is even toady among the leading countries on an international scale. Austria is world champion as regards waste separation. In future special attention will be paid to waste avoidance but also to increased recycling in order to supply the Austrian economy with raw materials and save natural resources. [Lebensministerium 2012] Figure 1 shows the already mentioned advanced position of Austria. Many other countries have still dumped large portions of municipal solid waste on landfills and therefore caused environmental problems (production of methane).

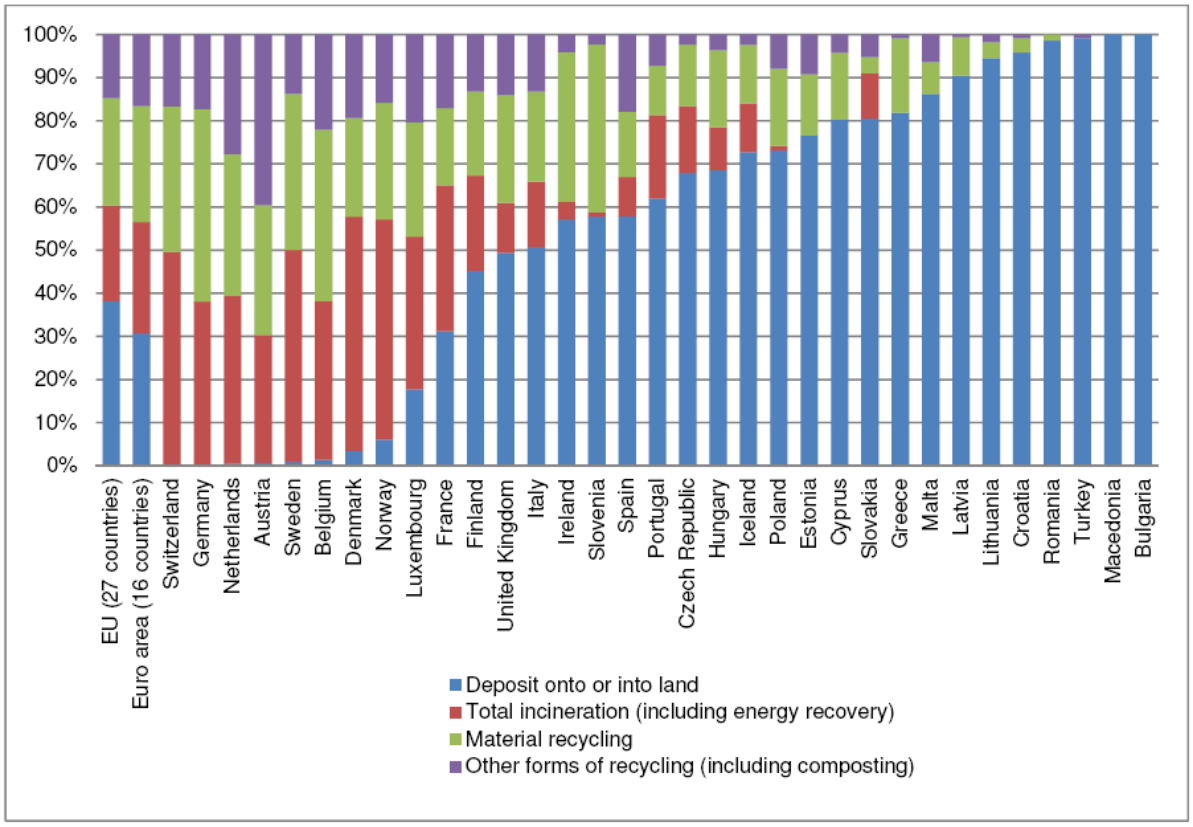

Figure 1: Different treatment options for municipal waste in Europe in 2010
(Source: Rutz et. al, 2012)

The main targets of the Austrian waste management sector are:

- Avoidance of harmful effects on humans and on the environment
- As low as possible emissions of air pollutants or gases with an impact on the climate
- Conservation of resources (raw materials, water, energy, landscape, surfaces, landfill volumes)
- Waste undergoing recovery or the materials obtained from the same shall not present any greater hazard potential than comparable primary raw materials or products from primary raw materials
- Only such materials should remain as waste, which can be deposited without presenting any hazards for future generations

The goal-reaching shall be oriented according to the following hierarchy:

1. Waste avoidance
2. Preparation for re-use
3. Recycling
4. Other types of recovery (eg. Energetic use)
5. Disposal

On the one hand the Austrian waste management sector fulfils an ecological protection function and on the other hand it provides secondary raw materials and fuels for the economy. Because of resource scarcity increasing importance is attached to secondary resources and appropriate treatment technologies as well as to re-use. The main target is to implement a sustainable material flow and waste management. [Lebensministerium 2012]

2 Overview of the waste management system

2.1 Municipal waste management in Styria

2.1.1 Total waste accumulation in Styria

In total, in Styria approximately 523.000 tons of waste per year arise, consisting of 166.000 t secondary waste and packaging, 151.000 t residual waste, 98.000 t organic waste, 48.000 t bulky waste, 48.000 t secondary materials and 12.000 t others. Figure 2 shows this. The amount of waste per inhabitant accounts for 433 kg per year (2009). [Kommunale Abfallerhebung 2010]

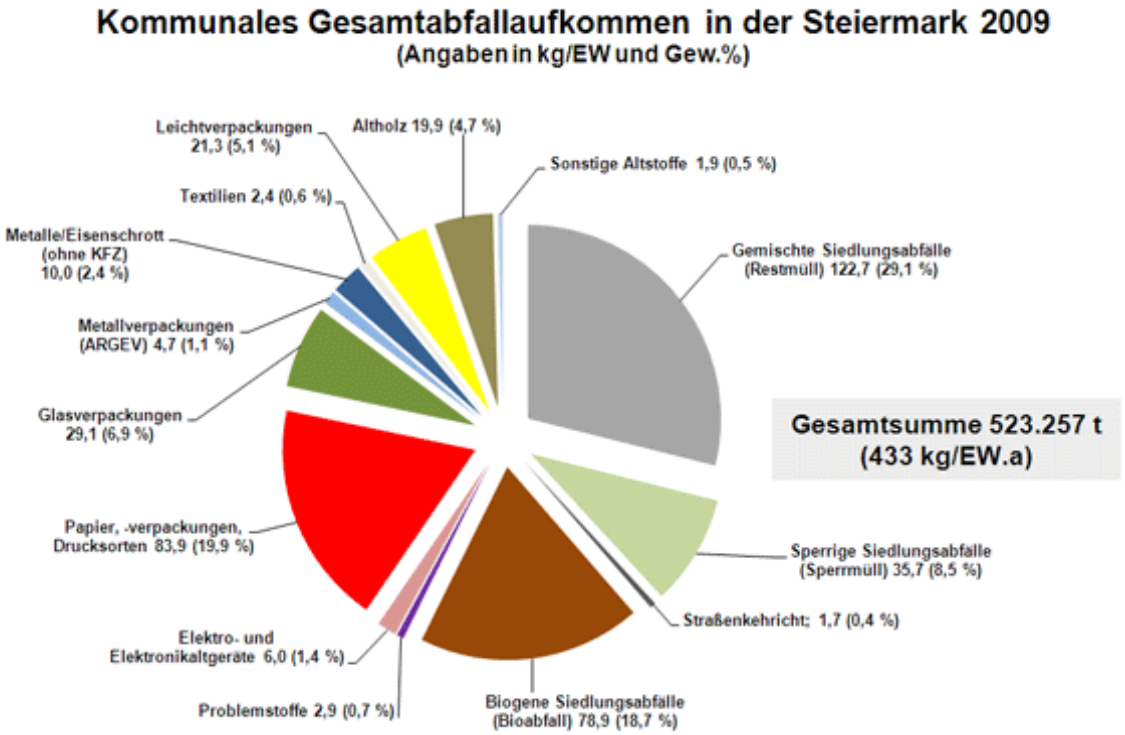

Figure 2: Total waste accumulation in Styria in 2009
(Source: Kommunale Abfallerhebung 2010)

2.1.2 Organic waste accumulation in Styria

The amount of 98,000 t organic waste consists of kitchen waste and garden rubbish (71%), communal garden and park waste (25%) and cemetery waste 4%).

Styria implemented, as the first Austrian federal region, in the year 1990 the separate collection of organic waste through the Styrian waste management act. Now, approximately 51% of the organic waste is collected by using organic waste containers (mostly 120l). The rest, especially green waste, is collected by municipal services. [Kommunale Abfallerhebung 2010]

Unfortunately the residual waste of the inhabitants of Styria contains a huge amount of organic waste (~38%). The analyses of the residual waste provide a basis to evaluate the efficiency of waste management measures and identify necessities for further information campaigns. Figure 3 shows the average analysis of residual waste in Styria.

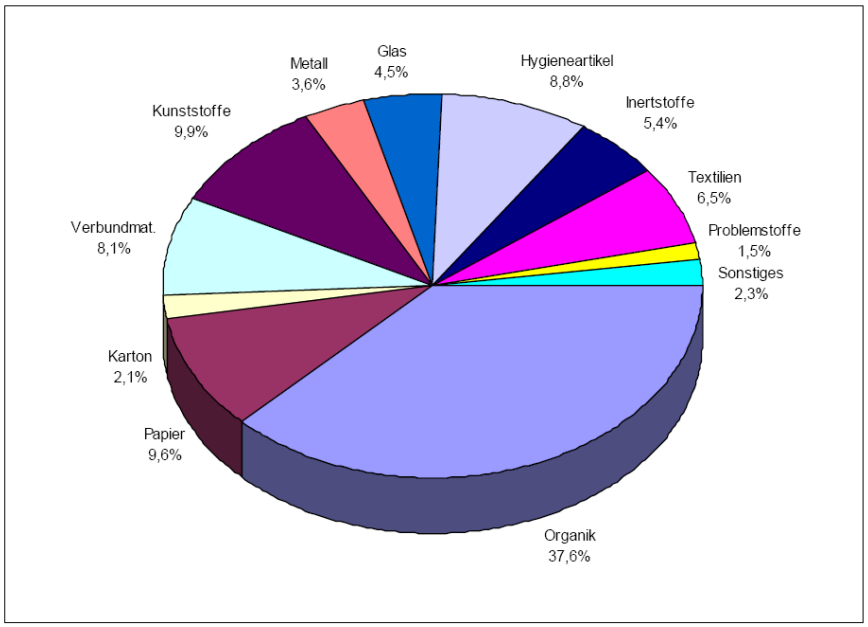

Figure 3: Analysis of residual waste in Styria
(Source: Regionaler Abfallwirtschaftsplan der Landeshauptstadt Graz, 2007)

2.1.3 Utilization of organic waste in Styria

Organic waste in rural areas in Styria is partly composted by the inhabitants their selves. In general, organic waste in Styria is treated both – aerobic and anaerobic. The aerobic treatment of organic waste is carried out in Styria mostly by composting. Impurities, which make the organic waste non-compostable, have to be removed with high technical and personnel efforts. In Styria there are in total 24 municipal or rather commercial and 46 agricultural composting plants operating. The total processing capacity accounts for 117.000 t/a. Furthermore in Styria there are operating 44 biogas plants with a total processing capacity of 500.000 t/a. Most of the biogas plants use energy crops, farm fertilizer, agricultural waste material and commercial waste. The utilization of organic waste in biogas plants plays a subordinate role, although in principle, it is possible to use kitchen waste and green waste in biogas plants. [Land Steiermark 2010]

2.2 Municipal waste management in Graz

2.2.1 Total waste accumulation in Graz

In Graz approximately 130.000 tons of waste are collected per year, consisting of 44.000 t/a non-recyclable waste, 26.200 t/a paper, 20.400 t/a recyclable waste (metal, plastic), 18.200 t/a biowaste, 8.400 t/a glass, 6.700 t/a green waste, 400 t/a hazardous waste and 7.000 t/a others. In the year 1990 the annual amount of waste accounted for 118.170 tons and steadily increased up to the year 2005 (131.515 t). Only 17.500 t/a are land filled, others are used energetically or material. Figure 4 and figure 5 show the development of the amount of waste in Graz from 1990 to 2005. While figure 4 represents absolute numbers, figure 5 represents the amount of waste per inhabitant.

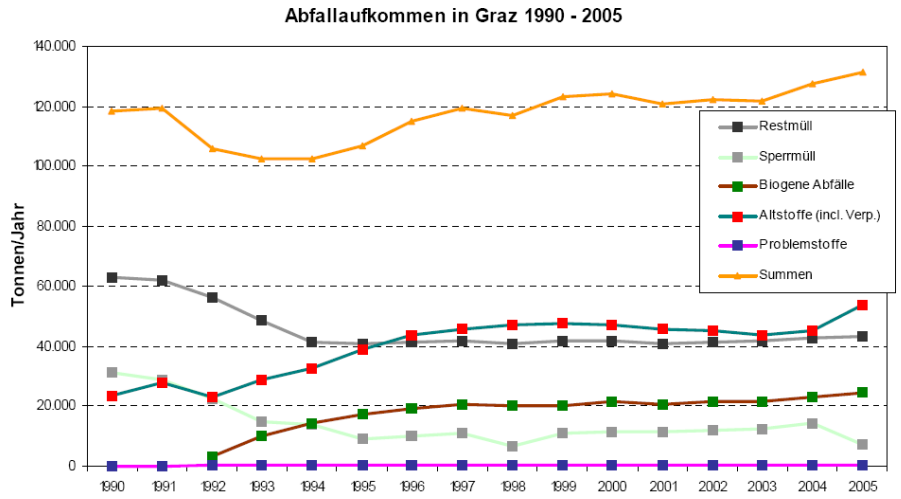

Figure 4: Development of the amount of waste in Graz from 1990-2005
(Source: Stadt Graz - Umweltamt, 2007)

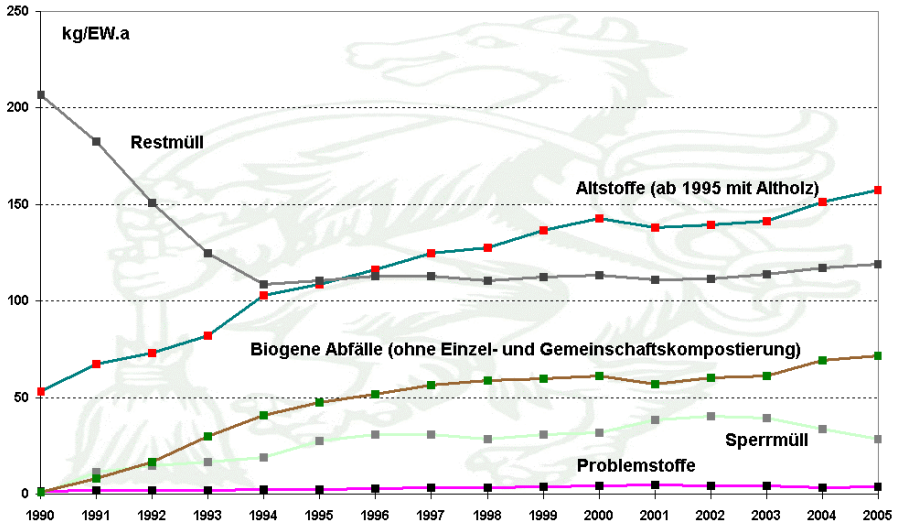

Figure 5: Development of the amount of waste in Graz from 1990-2005 per inhabitant
(Source: Stadt Graz - Umweltamt, 2007)

2.2.2 Organic waste accumulation in Graz

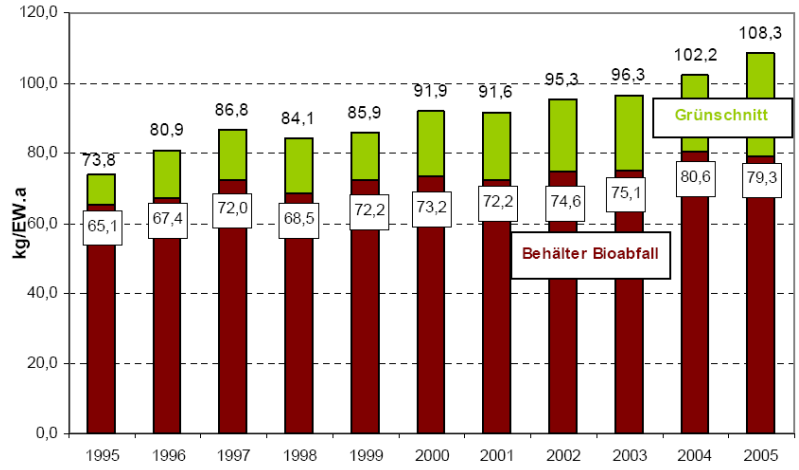

Figure 6: Amount of organic waste from separated municipal solid waste collection in Graz
(Source: Stadt Graz - Umweltamt, 2007)

Figure 6 shows the amount of organic waste from separated municipal solid waste collection in Graz per inhabitant per year. It contains compostable municipal solid waste, like kitchen waste, garden rubbish, market waste and cemetery waste. Organic waste, which is composted by inhabitants by themselves, is not included in that figure, which amounts for approximately 12% of the population of Graz. [Stadt Graz – Umweltamt 2007]

There are additional quantities of organic waste from the industry, like restaurants, super markets, and caterings etc, which are not quantifiable.

2.2.3 Collection of organic waste from municipal solid waste

The Holding Graz, a company of the city of Graz, is in charge for the waste collection and waste treatment for the area of Graz. At approximately 34.000 sites in Graz are located bins for non-recycleable waste, organic waste, paper, glass, metal and plastic. In general, organic waste in Graz is separately collected from households by brown bins. Larger amounts of green waste can be deposited at the Recycling Centre Sturzgasse. Furthermore there is a chaff service for eg. tree-cut material for treatment directly in the garden. Cooking oil and fat is collected separately by yellow buckets or bins. [Stadt Graz – Umweltamt 2007]

2.2.4 Utilization of organic waste

Organic and green waste is mixed and pretreated (release from metals and plastic) in Graz (organic waste treatment plant Sturzgasse) and then/moreover treated in the composting plant in Frohnleiten. The bio-mechanical organic waste treatment plant in Frohnleiten is owned by the SERVUS ABFALL, which cooperates with the city of Graz through a public-private partnership. Furthermore organic waste is composted and used in agriculture.

Cooking oil is recycled to biodiesel, soaps, cleaning agents and machine oils. The city of Graz serves as an exemplary model, because of their use of biodiesel for the public bus transfer.

Unfortunately, the energy from organic waste cannot be used at the moment, but the landfill gas at the site in Frohnleiten is used in two CHP plants for electricity and heat generation.

2.2.5 Actors involved

Figure 7: Public-private partnership
(Source: SERVUS ABFALL Online)

In the year 2002 the SERVUS ABFALL Dienstleistungs GmbH & CO KG was founded as a public-private partnership between the Holding Graz and the EBG (Entsorgungsbeteiligung Graz GmbH NFG & CO KG). Through the public-private partnership, the strengths of all partners are bundled and they focus on clean solutions.

The public part of the partnership is represented by the Holding Graz GmbH, which is together with SERVUS ABFALL responsible for the realization of the separated collection of recovered paper, glass, municipal solid waste and organic waste. Furthermore the Holding Graz runs the above mentioned biological waste treatment plant for municipal solid waste at Sturzgasse. The Holding Graz GmbH is a company owned by the city of Graz.

The private part of the partnership is represented by the EBH (Entsorgungsbeteiligung Graz GmbH NFG & CO KG), that consists of the “Gemeindebetriebe Frohnleiten”, the “Saubermacher AG”, the “Hans Hütter GmbH” and “entsorgt”.

Commercial waste in Graz is collected by Saubermacher, ASA, Müllex or others.

3 Waste treatment technologies

3.1 Biowaste treatment technologies

As above already mentioned, organic waste from households in Graz is separately collected by brown bins. At approximately 34.000 sites in Graz are located bins for organic waste. Larger amounts of green waste can be deposited at the Recycling Centre Sturzgasse. Furthermore there is a chaff service for eg. tree-cut material for treatment directly in the garden. Cooking oil and fat is collected separately by yellow buckets or bins.

Organic and green waste is mixed and pretreated (release from metals and plastic) in Graz (organic waste treatment plant Sturzgasse) and then treated in a composting plant in Frohnleiten or in agricultural composting plants. Afterwards one part is used in agriculture and the other part is land filled.

3.2 Municipal solid waste treatment technologies

The bio-mechanical waste treatment plant in Frohnleiten, which is owned by the SERVUS ABFALL, is one of the most advanced mechanical-biological waste pretreatment facilities in Austria. The input material for the plant consists of domestic/residual waste and sewage sludge with a grit size from 0-80mm. The quantity accounts for 65.000 t per year. Moreover the plant consists of 13 tunnels (32 m x 6,5 m x 5.5 m) with a fully automated tunnel entry. The installed electrical output accounts for 1100kW.

4 Economic and legal considerations

4.1 Current and future costs of disposal

Since 1990 Styria consequently expanded the infrastructure for the separate collection of waste and disposes now of a very convenient collection system (more than 400 waste collection centres and problem material collection centres). The federal region Styria subsidised the municipalities with 21,2 million €. The widespread services concerning waste management are cost intensive and are passed down to the responsible municipalities. Figure 8 shows the costs of disposal in Austria from 1995 to 2006. The annual costs of disposal in Austria (2006) per person amount to 66,4 € and per household 154 €.

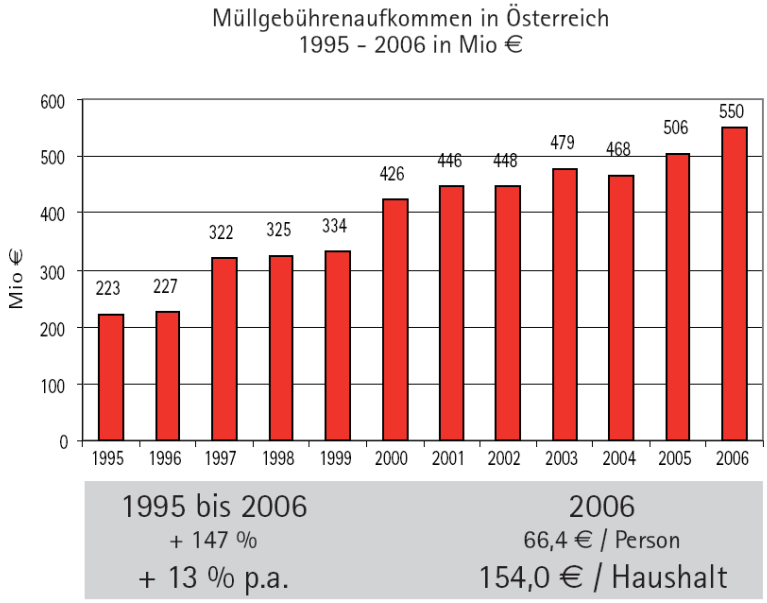

Figure 8: Costs of disposal in Austria
(Source: Land Steiermark – FA 19D, 2008)

In contrast to that, the costs of disposal in the federal region Styria are much lower and accounted in 2006 to 115 € per household. The costs of disposal consist of a base fee and a variable fee. The base fee is independent from the amount of waste and covers 2/3 of the waste management costs. It is calculated per accommodation unit, household or person. The variable fee is dependent on the amount of waste and covers 1/3 of the waste management costs.

The tariffs of disposal for the city Graz are constituted by the Holding Graz GmbH. For municipal solid waste the tariffs consist of a base and a performance fee, whereas the performance fee includes a collecting and disposal fee. As a basis for calculating the fee, serve the collected amount of waste per removal (depending on the size of the bins) and the number of removals. For the collection of organic waste there is an additional fee ("Biozuschlag" – table 1).

Table 1 shows the tariff system in Graz for 120 l bins.

Tarif A
zur Grazer AbfO 2006
(Gebühr in Euro pro Jahr excl. gesetzlicher Umsatzsteuer)

Behälter-größe	Entleerungen	Grund-gebühr	Leistungs-gebühr	Gesamtgebühr mit Kompostbonus	Bio-zuschlag	Gesamtgebühr ohne Kompostbonus
120 Liter	1 x pro Woche	112,20	245,40	357,60	58,80	416,40
	2 x pro Woche	224,40	490,80	715,20	117,60	832,80
	14-tägig	56,10	122,70	178,80	30,00	208,80
	vierwöchig	28,40	60,40	88,80	16,80	105,60

Table 1: Tariff system for costs of disposal in Graz
(Source: Holding Graz Online)

4.2 Legal requirements

All member states of the European Union have to fulfil the Landfill Directive 1999/31/EC, which implemented to prohibit land filling untreated waste, and the Waste Directive 2006/12/EC to reduce land filling of biodegradable part of MSW to 35% within the next five to ten years. Austria implemented on this basis the so-called Abfallwirtschaftsgesetz 2002 (AWG 2002) to fulfil the European directives. The federal region of Styria implemented the StAWG 2004, the so called Styrian Waste Management Law, to regulate all belongings in the competence of the region. The StAWG aims to reduce emissions of air pollutants and greenhouse gases and to preserve the environment from damage. Furthermore it says that just non-hazardous waste, that doesn't harm future generations, is allowed to be left. According to that, the following principles apply:

- Waste avoidance
- Waste recovery
- Waste disposal

5 Strategy proposal for a biowaste use in production of biomethane in Graz

5.1 Superordinate targets influencing Graz

The climate and energy targets of Graz are derived from superordinate targets, like the 20-20-20 targets for the year 2020 of the European Union:

- reduction in greenhouse gas emissions by 20%
- 20% renewable energies
- increase in energy efficiency by 20%

Due to the superordinate targets of the European Union, Austria developed a climate and energy strategy. Especially Styria aims to reduce greenhouse gas emissions, to increase the amount of renewable energies and to strengthen the competitive capacity through a consequent climate policy. To achieve these targets, Styria determined 26 packages of measures. For example, to reach the goal of an increase in renewable energies, the regional climate protection plan suggests amongst others the energetic use of waste. Further goals of the waste management plan of Styria, the energy strategy 2025 and the regional climate protection plan are the energy use of organic waste before the material use, the use of low-emission vehicles and the use of renewable energies in the sectors traffic, industry and buildings. [Land Steiermark 2010a]

5.2 Targets of Graz

The city Graz derived its special targets from the above mentioned superordinate goals and developed the municipal energy strategy 2020 (Kommunales Energiekonzept “KEK 2020”). This strategy is a further development of the municipal energy strategy 1996 and constitutes the future energy and climate policy of Graz. The main targets of the municipal energy strategy are:

- Sustainability principle
- Increase in energy efficiency
- Use of renewable energies
- Conservation of resources
- Use of energy and environmental technologies of local producers to stimulate the economy and to provide new jobs
- Availability of resources and quality of the environment should be preserved for future generations
- Promotion of alternative fuels
- Education, information and consulting

With respect to those targets, the next chapter provides strategy proposals for the city Graz.

[Stadt Graz – Umweltamt 2008]

5.3 Strategievorschläge/ Strategy proposals

5.3.1 Umsetzung einer Biogasanlage/ Implementation of a biogas plant

Wir schlagen vor, auf Grund der oben genannten Ziele Bioabfall in einer Biogasanlage in der Nähe von Graz zu nutzen. Sowohl organische Siedlungsabfälle von Graz (teilweise aus Umgebung), als auch - bis zu einem gewissen Grad- kommerzieller Biomüll sollten gesammelt werden und in dieser Biogasanlage genutzt werden. Eine lokale Firma sollte die Anlage betreiben mit dem Ziel, neue Arbeitsplätze zu schaffen und die Wirtschaft anzukurbeln. Abbildung 9 zeigt den geschlossenen Biogaszyklus.

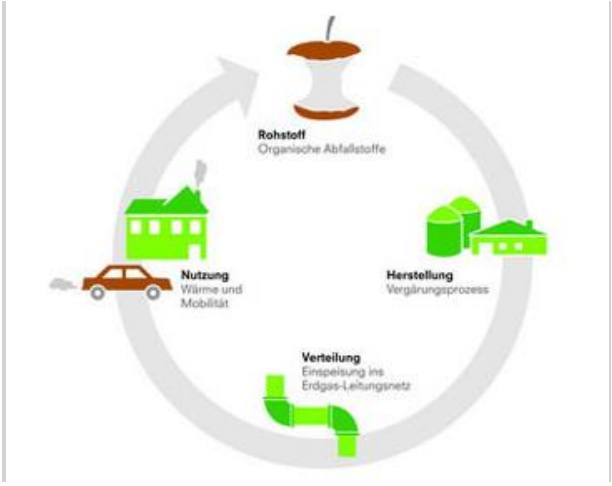

Abbildung 9: Der Biogaszyklus

(Quelle: IBArau Online)

Das produzierte Biogas sollte in das Erdgasnetz eingespeist werden und außerdem im öffentlichen Verkehrssektor genutzt werden, um das Ziel von einer größeren Anzahl emissionsarmer Fahrzeuge zu erreichen. Der öffentliche Sektor sollte als Vorbild dienen indem dass der Sektor des öffentlichen Verkehrs gasbetriebene Fahrzeuge verwendet. Der Gärrest könnte als Düngemittel in der Landwirtschaft verwendet werden und sicherstellen, dass ein geschlossener Kreislauf entsteht. Biomüll wird als Ressource für die Energieerzeugung verwendet, was bedeutet dass er zuerst energetisch genutzt wird und danach als Düngemittel in der Landwirtschaft verwendet wird. Dadurch entsteht eine nachhaltige Abfallwirtschaft und ein nachhaltiger Materialfluss. Biogas, welches aus biogenen städtischen Abfällen produziert wird ist sauber, erneuerbar, permanent verfügbar und ohne weitere Ressourcen verwendbar. Tabelle 2 zeigt die Hauptvorteile der Nutzung einer Biogasanlage in Graz.

Vorteile einer Biogasanlage in Graz
Nutzung von Abfall als Ressource
Nachhaltige Abfallwirtschaft – geschlossener Materialzyklus
Reduktion von Importen fossiler Energie
Reduktion der Treibhausgasemissionen
Schritt 1: energetische Nutzung von Biomüll Schritt 2: Nutzung des Materials
Schaffung von Arbeitsplätzen

Tabelle 2: Vorteile der Nutzung einer Biogasanlge in Graz

Weitere Veränderungen in Graz sind der Ersatz von Diesel durch Biomethan und die daraus folgende Reduktion von Treibhausgasemissionsn um 60-70%, die Reduktion von Feinstaub und von Lärm.

We propose to utilize organic waste in a biogas plant near Graz, because of the above mentioned targets. The municipal organic waste mainly from Graz (partly from surroundings) as well as to some extent commercial organic waste should be collected and fermented in that biogas plant. A local company should operate the plant to reach the goal of providing new jobs and to stimulate the economy. Figure 9 shows the closed biogas cycle.

Figure 9: Biogas cycle
(Source: IBAarau Online)

The produced biogas should be fed in the natural gas grid and moreover used in the traffic sector, to reach the target of an increase in low-emission vehicles. The public sector should serve as a reference example, meaning that for example the public transport sector uses gas-powered vehicles. The digestate could be used as fertilizer in agriculture and makes sure that a closed cycle arises. Organic waste is going to be used as a resource for the energy generation, meaning that it is firstly used energetically and afterwards as a fertilizer for agriculture. A sustainable waste management and material flow emerges. Biogas is

clean, renewable, permanently available and doesn't need any additional resources and surfaces. Table 2 represents the main advantages of the use of a biogas plant in Graz.

Advantages of a biogas plant in Graz
Use of waste as a resource
Sustainable waste management – closed material cycle
Decrease in fossil energy imports
Decrease in green house gas emissions
Step 1: energetically utilization of organic waste Step 2: use of the material
Creation of jobs

Table 2: Advantages of the use of a biogas plant in Graz

Further chances for Graz are to replace diesel by biomethane and therefore decrease green house gas emissions by 60-70% and to decrease particle emissions and reduce noise.

5.3.2 Mögliche Mengen an Bioabfall/ Potential organic waste amounts

Das geschätzte Potential an biogenem Abfall, welcher in einer Biogasanlagen verwendet werden könnte, liegt bei geschätzten 48.000 t/a und besteht aus 33.000 t/a aus Biomüll aus den braunen Biotonnen, aus t/a aus Essensabfällen aus Restaurants, Caterings und der Lebensmittelindustrie, t/a aus Supermärkten und aus t/a aus Brot aus Bäckereien. Circa 50 % des Biomülls entsteht direkt in Graz; der Rest stammt aus der Umgebung. Eines der wichtigsten Ziele ist es, die Transportwege der Müllsammlungspunkte zur Biogasanlage möglichst kurz zu halten. Deswegen sollte die Biogasanlage in der Nähe von Graz sein. Der finale Standort ist bisher noch nicht festgelegt.

Weitere Informationen bezüglich potentiellen Müllmengen, zusätzlichen potentiellen Mengen und dem Standort der Biogasanlage folgen in einem zweiten Schritt.

The estimated potential of organic waste, which could be utilized in the biogas plant, accounts for approximately 48.000 t/a and consists of 33.000 t/a organic waste from the brown organic waste bins, t/a food waste from restaurants, caterings and the food industry, t/a expired food from supermarkets and logistics and t/a old bread from bakeries. t/a About 50% of the organic waste arise directly in Graz; the rest comes from its surroundings AB. One of the most important targets is to have as short as possible transport routes from the waste collection points to the biogas plant. Because of that the biogas plant has to be situated near Graz. The definite site is not yet determined.

Further information concerning potential waste amounts, additional potential amounts and the biogas plant site will follow in a 2nd step.

5.3.3 Informationskampagne/ Information campaign

Wie in Kapitel 3.1.2 gezeigt wurde, beinhaltet der städtische Restmüll große Mengen an Biomüll. Wenn die Stadt Graz Bioabfall in einer Biogasanlage verwendet, scheint der Anteil an Biomüll, der im Restmüll enthalten ist, als verlorene Ressource (versteh den Satz nicht). Daher sollte eine Informationskampagne erstellt werden, welche den Einwohnern zeigt, wie Müll getrennt werden soll und um Bewusstsein zu schaffen.

Das Hauptziel der Informationskampagne ist es, dass die Einwohner von Graz Abfall korrekt trennen und somit der Anteil an Biomüll für die Biogasanlage erhöht wird, im Vergleich zum Anteil an Biomüll, der zuvor in die Restmülltonne geworfen wurde. Außerdem sollten die Einwohner unterrichtet werden, nur den richtigen Biomüll (ohne Grünschnitt) in den Biomüll zu werfen, um die Vorbehandlung des Biomülls zu vereinfachen, bevor dieser in der Biogasanlage verwendet wird.

As shown in chapter 3.1.2 municipal solid waste in Styria contains a huge amount of organic waste. If the city of Graz utilizes organic waste in a biogas plant, the amount of organic waste comprehended in the residual waste, seems to be a lost resource. An information campaign, that shows the inhabitants how to separate waste and to raise awareness, should be prepared.

The main target of the information campaign is, that the inhabitants of Graz correctly separate waste and therefore increase the amount of organic waste for the biogas plant by the amount of organic waste previously thrown into the municipal solid waste bin. Furthermore the inhabitants should be educated to throw just organic waste into the organic waste bin to facilitate the pre-treatment of organic waste before utilizing it in the biogas plant.

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