

Technical review of the utilisation of waste material for biogas production in Eastern Europe



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1 INTRODUCTION

This report reviews possibilities for the utilisation of waste material for biogas production in Eastern Europe and was elaborated in the framework of the BiG>East project, supported in the Intelligent Energy for Europe programme of the European Commission.

The elaboration of this report was guided by Finsterwalder Umwelttechnik (FITEC) who presupposes that all the well known bio-waste streams like, food-waste, expired foods, source separated organic wastes (households) or sewage sludge can be treated in biogas plants and it is only a question of money and time to determine the best technology. To avoid a general overview about available biogas technologies, FITEC decided to do a review of the local waste business markets of the target countries. Understanding structures helps determining whether a biogas plant fits into a country or what is necessary to make it fit.

To collect uniform data, a working template was submitted to the BiG>East partners from Bulgaria, Croatia, Greece, Latvia, Romania, and Slovenia. As a result the standards of waste collection are summarised and recommendations of the most promising approaches to set up waste treatment biogas plants are given.

2 ASSESSMENT OF NATIONAL WASTE BUSINESS STRUCTURES

2.1 Assessment of waste business structures in Slovenia

2.1.1 Introduction

Public waste removal in Slovenia is an activity performed in the public interest mostly by a competent public service (enterprises engaged in community service activities and other enterprises authorised to perform such activity or which hold a license or a concession). There are over 50 waste removal companies and over 90% are publicly owned.

In 2004, 750,000 tonnes of waste was brought to non-hazardous (municipal) landfill sites, of which 648,000 tonnes was collected by the public waste removal scheme. The share of population served by public waste removal services was 94% (1,873,992 people). Nowadays, more and more private companies have the permission to collect waste and also companies to recover or reuse wastes. Waste is treated as any material which the owner or possessor cannot or does not want to use, does not need, is disturbing or damaging to him and which he removes.

Household waste is solid waste originating in households, which does not require special treatment. Household waste is collected in standardised containers standing on public land and removed regularly to public landfill sites by the competent public service. However, we are all aware about the potential of organic household wastes for biogas production. The current obstacle is that a separate waste collection system is not in place in all major cities

and their surroundings. Slovenian households produce yearly more than 600,000 tonnes of waste. Quantity is increasing but the relation to waste has changed. They are not only wastes but are also a material for different sources. Waste recovery is designed for beneficial use of waste or waste components, comprising first of all recycling, reuse, composting, use of waste in fuelling devices and industrial ovens, and use of waste for fuel generation. Household organic wastes are collect with brown containers on collecting points.

The average amount of municipal waste per capita (total population in 2004) is 371 kg, which means 1 kg of waste per person per day.

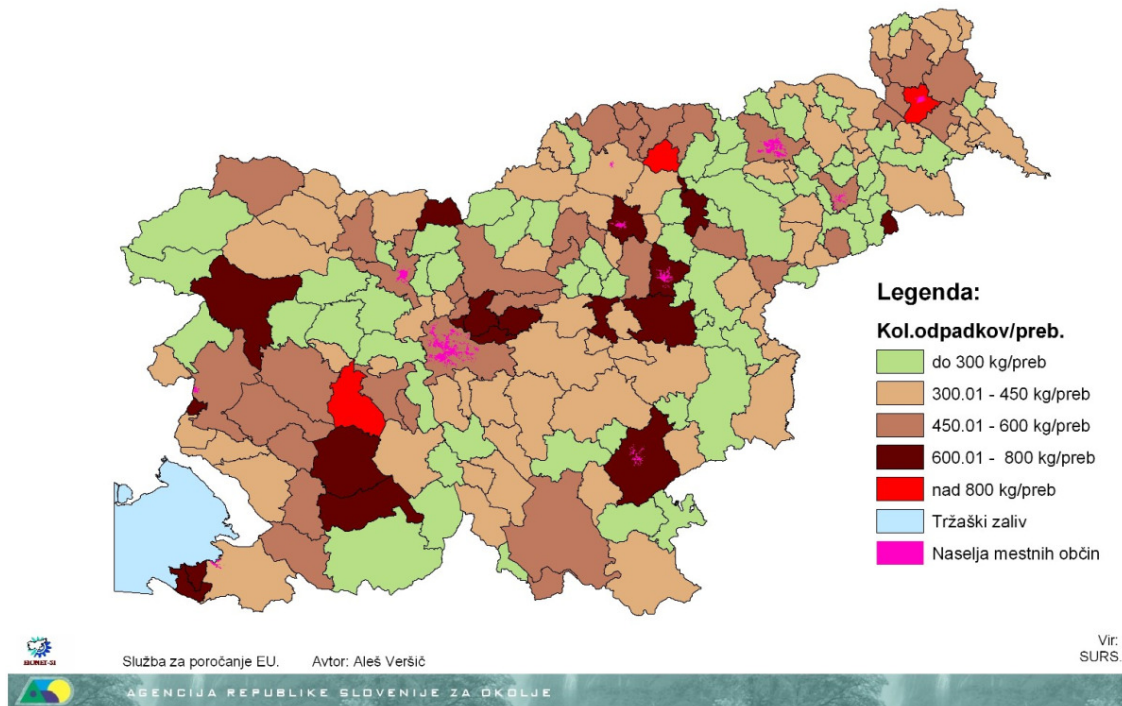


Figure 2.1.1: This picture represents the amount of waste collected in different communities. Amount is in kg per capita.

There were in total 5,585,080 tons wastes in 2005 and 5,893,306 tons in 2004. Quantity has decreased in 2005 compared with 2004 by 5.2%. Most of the wastes are generated in processing industry 38%, supply of electricity, gas and water 27%, in building industry 18%, and remaining 17% in other businesses. In 2005 54% (44% in 2004) of waste were disposed or reused internally and 46% were collected by public or private waste removal companies.

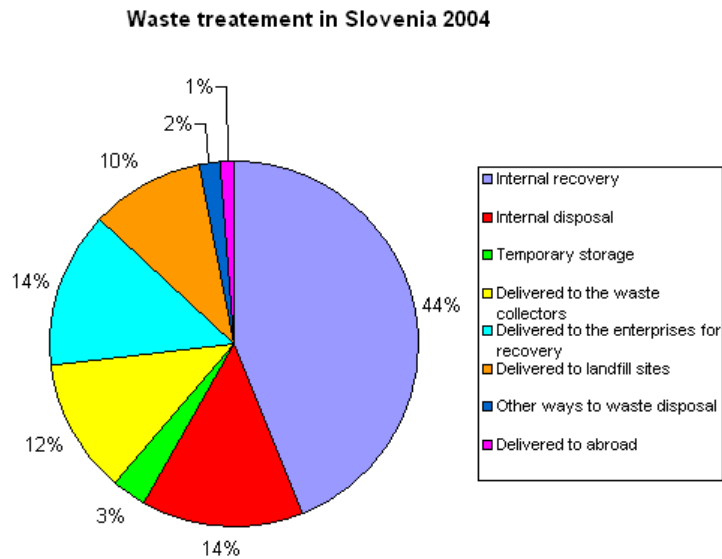


Figure 2.1.2: Waste treatment in Slovenia; Source: SURS

Collected wastes mostly end up on the municipal landfills. For example in 2004 over 70% of the collected wastes from households were delivered to landfills; whereas in 2007 this figure dropped to 40%. Many communities have established a collecting system and more and more wastes are eliminated (incineration, permanent storage or other means) or further treated (recycling, composting, burning as fuels).

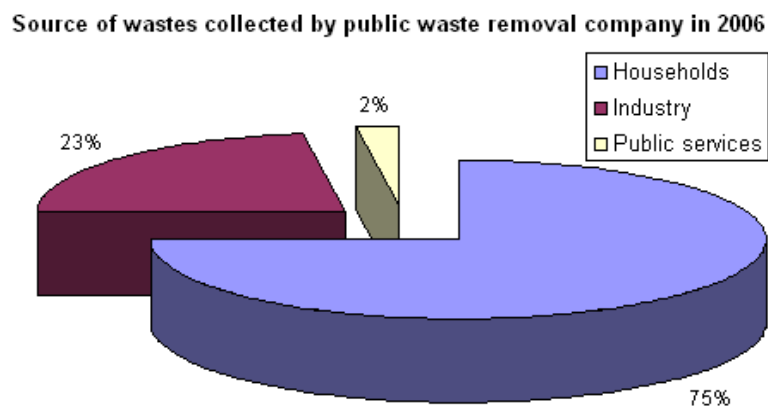
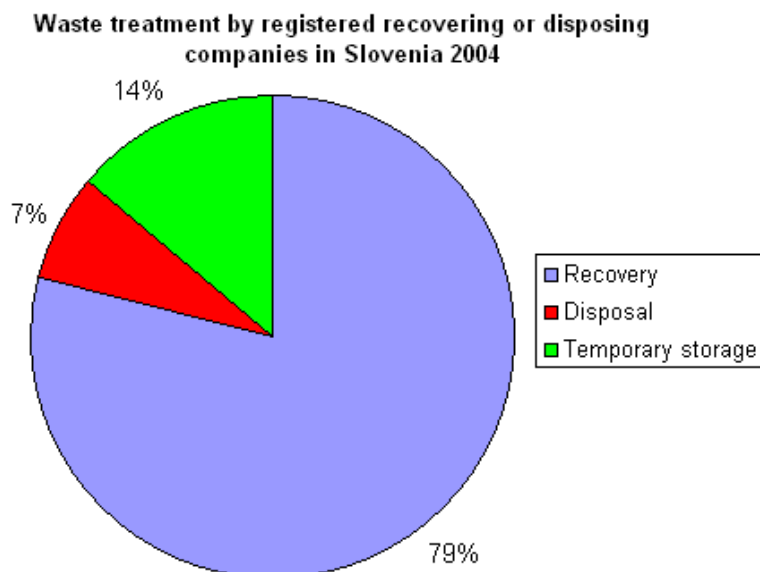


Figure 2.1.3: Sources of wastes: Source: SURS

More and more collected wastes contribute to waste recovery (79%). They are used for recycling, composting, energy generation in fuelling devices and industrial ovens, and for fuel generation. However, incineration of waste and other thermal procedures designed for waste disposal are not considered to be waste recovery. Some wastes are designed for waste disposal. It is an operation aimed at final treatment of waste that cannot be recovered, comprising mostly different waste processing procedures and waste land filling.



Picture 2.1.4: Recovering rates Source: SURS

In the Statistical office of the Republic of Slovenia it is possible to identify the organic waste collected with public waste removal companies.

Table 2.1.1: Total quantity of separately collected fraction of wastes with public waste removal companies in tonnes; source: SURS

Year 2005	Total	Landfill sites	Waste recovery	Other waste remover
Total wastes	797,721	633,239	35,096	58,273
Organic household waste	8,959	4,632	2,274	2,041
Edible oil and fat	177	8	34	72
Waste for composting	8,869	2,729	4,900	193
Waste from animal market	1,812	829	15	-
Year 2006	Total	Landfill sites	Waste recovery	Other waste remover
Total wastes	831,578	701,636	43,467	49,305
Organic household waste	16,568	6,189	9,156	524
Edible oil and fat	191	-	88	73
Waste for composting	12,267	1,345	7,598	1,037
Waste from animal market	1,153	1,110	5	-

Appropriate wastes for biogas power plants are organic household waste, edible oil and fats, and wastes from animal market. 8,959 tons of organic household waste were collected in 2005 and 16,568 tonnes in 2006 (which is 2% of all collected wastes).

2.1.2 Availability of appropriate organic wastes

2.1.2.1 Kitchen wastes

There are 20 registered companies for separate collecting waste from households in Slovenia (public and private). They have special containers (brown) and some of the waste end up in power plants and most of them are delivered for composting or dumped in the municipal landfills. For example, Komunala Murska Sobota collects organic wastes from households, restaurants, supermarkets and hotels. They collect around 1,200 tonnes per year. These wastes are sent for composting. Restaurants and hotels pay for the waste removal. There are 7 registered companies that compost organic wastes. These are Letnik Saubermacher, Mecum d.o.o, Eko d.o.o., Center za ravnanje z odpadki Vrnika, Okolje Piran, JKP Grosuplje and Luka Koper INPO d.o.o.

2.1.2.2 Wastes from Supermarkets

As already mentioned, Komunala Murska Sobota has a separate waste collecting system for organic wastes from supermarkets for composting. However, they do not collect out dated food.

2.1.2.3 Wastes from Industrial production

There are 15 dairy farms in Slovenia and they collect around 420,000,000 liters of milk per year.

Wastes from milk production are currently collected in specialised containers and sent to the municipal landfill sites. In some cases these wastes are treated in waste water treatment plants in digesters. Waste water from the milk industry is also treated in municipal or their own waste water treatment plants.

There are several slaughter houses in Slovenia and many of them export their wastes abroad (mainly Italy) and other deliver to company Koto d.d.. One of the main activities of the KOTO Company refers to managing animal and other organic by-products. They have a concession contract on the performance of the public utility service of managing slaughterhouse waste and infectious materials of animal origin. This contract comprises the collection of Category 1 and Category 2 animal by-products at collection points throughout the territory of Slovenia, and their disposal to the only rendering plant of the open type in Slovenia . In addition to processing of Category 1 and Category 2 animal by-products, KOTO separately also collects Category 3 animal by-products.

Table 2.1.2: Dairy farms in Slovenia

Name of the dairy farm	Location	Million liter of milk per year
Ljubljanske mlekarne	Ljubljana, Vel.Lašče Kočevje	160.3
Mlekarna Celeia	Arja vas at Celju	49.4
Mariborska mlekarna	Maribor	55.8
Pomurske mlekarne	Murska Sobota	32.3
Gorenjska mlekarna	Kranj	41.4
Mlekopromet Ljutomer	Ljutomer	22.9
Mlekarna Ptuj	Ptuj	25.0
Mlekarna Planika	Kobarid	7.3
Mlekarna Vipava Agroind Vipava 1894	Vipava	5.7
KGZ Postojna	Hruševje	4.3
KGZ Škofja Loka	Šk. Loka	3.3
KZ Vrhnika	Vrhnika	5.2
Ogledna sirarna Srednja vas	Bohinj	2.4
KGZ Idrija	Cerkno	4.6
KELE & KELE	Laze at Logatec	n.a.

2.1.2.4 Agricultural wastes

In the following table we can see the distribution of agricultural holdings by size classes of LSU (Livestock Size Units).

Table 2.1.3: Sizes of agricultural holdings in Slovenia; source SURS

3. Razdelitev kmetijskih gospodarstev po velikostnih razredih glav velike živine (GVŽ), Slovenija, 2003 in 2005 Distribution of agricultural holdings by size classes of livestock size units (LSU), Slovenia, 2003 and 2005							
Velikostni razredi GVŽ	2003		2005		Indeks Index 2005 2003		Size classes of LSU
	število number		število number		število number		
	GVŽ LSU	kmet. gospodarstev agr. holdings	GVŽ LSU	kmet. gospodarstev agr. holdings	GVŽ LSU	kmet. gospodarstev agr. holdings	
Skupaj	473706	77149	441125	77173	93,1	100,0	Total
brez GVŽ	0	8320	0	10396	...	125,0	without LSU
>0 - < 0,5	2195	11821	2411	13364	109,8	113,1	>0 - < 0,5 LSU
0,5 - < 1	3354	4613	2787	3862	83,1	83,7	0,5 - < 1 ha
1 - < 2	13220	9215	12639	8894	95,6	96,5	1 - < 2 LSU
2 - < 3	18510	7634	18161	7455	98,1	97,7	2 - < 3 LSU
3 - < 5	40476	10365	38976	10074	96,3	97,2	3 - < 5 LSU
5 - < 10	86227	12308	82347	11545	95,5	93,8	5 - < 10 LSU
10 - < 15	69028	5640	60029	4939	87,0	87,6	10 - < 15 LSU
15 - < 20	46792	2730	42659	2457	91,2	90,0	15 - < 20 LSU
20 - < 30	59313	2436	54250	2231	91,5	91,6	20 - < 30 LSU
30 - < 50	53391	1445	50131	1341	93,9	92,8	30 - < 50 LSU
50 - < 100	31958	488	33561	504	105,0	103,3	50 - < 100 LSU
>= 100	49242	134	43173	110	87,7	82,1	>= 100 LSU
Povprečna velikost kmetijskega gospodarstva, ki redi živino	6,9		6,6				Average size of an agricultural holding which breeds livestock

As we can see only 110 agricultural holdings have more than 110 LSU and there are 504 holdings with LSU from 50-100.

However, there are some farms that have high number of pigs or cattle:

- Pig farm Ihan (25% of Slovenian pig market), with three major farms:
- Ihan with yearly production of 65,000 fattening pigs
- Farm Klinja vas with yearly production of piglets 60,000 and
- Farm Pristava with yearly production of 26,000 fattening pigs
- They have a biogas power plant on farm Ihan, 526 kWe
- Panvita Group, have several farms. Have already 1.5MWe biogas power plant in farm Nemščaki.
- Kras, they slaughter 300 pigs and cows a week. Most of the animals are from nearby farms.
- Pig farm Prašičerija Podgrad d.d.
- Tros d.o.o. farm Zupančič
- JGZ Kozjak Maribor

Some of the bigger farms already have biogas power plants. There are several farms with a high potential for biogas power plants. On the other hand, several agricultural holdings have large areas for agriculture and do not have enough (or any) of their own manure as fertiliser. There is one example of a potential biogas power plant where the nominal power will be 1.5 MWe. Final output could be used as fertiliser in the several surrounding agricultural holdings, since they have very little of their own manure. They are already discussing the possibilities to use this land to scatter final output from biogas production as fertiliser.

In Slovenia there were around 77,200 holdings in 2005 and the total area was 485,364 ha. The average size of an agricultural holding which cultivates agricultural area is 6.3 ha. However, when looking at larger agricultural holdings of over 50 ha in Slovenia we could find only 311 such holdings and only 110 holdings have more than 100 ha.

2.1.2.5 Bio-wastes from local authorities

Nowadays in Slovenia, over 50 different companies collect wastes from households from almost 200 municipalities. Some of them have a long tradition for separate collection of organic wastes from households and some of them have introduced it recently. However, there are many bigger municipalities where a separate collection system for organic wastes is not in place. These local authorities are interested in environmental solutions and new waste removal companies are emerging, which could implement their collecting system. For example, Biotera is collecting organic waste from schools, restaurants, in some cases also from households in whole Slovenia. There are currently 20 companies registered to collect organic household wastes but not all of them are active yet.

At the moment there is a problem with waste in the Gorenjska region where they have problems with municipal waste landfills and are planning a regional centre for waste treatment. They also do not have a collection system for organic household wastes and therefore addressing this region could be done in the next steps in the project.

2.1.3 Potential plant sites

Several bigger pig farms have problems with excess of pig manure and have not yet implemented a biogas plant as a solution. These farms are interested in co-fermentation and will be contacted in the future.

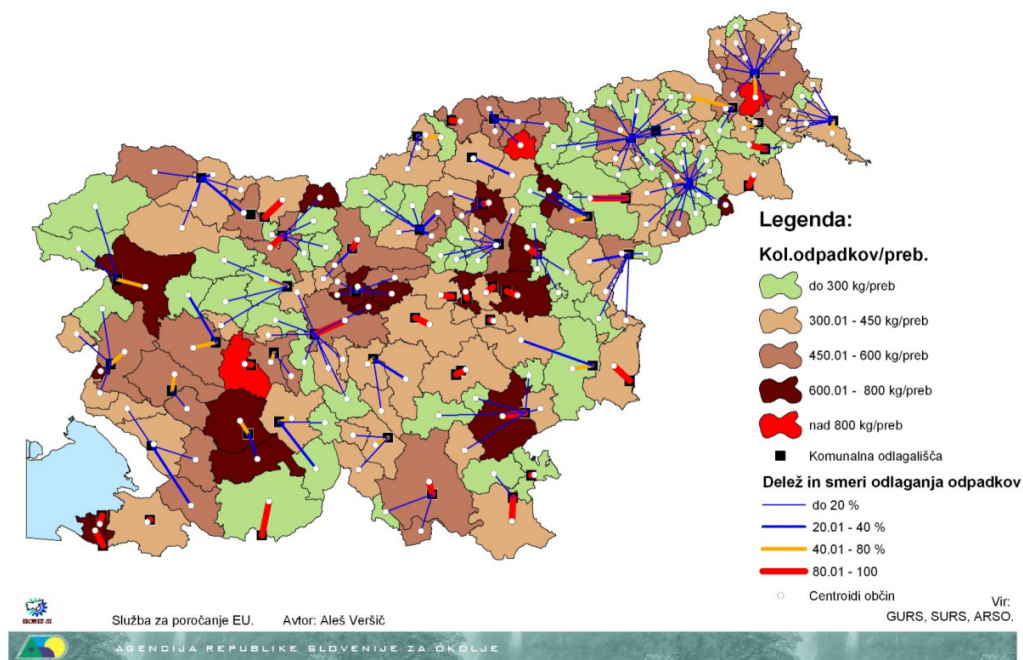


Figure 2.1.4: Locations of municipal landfills

Currently only three municipal landfills exploit landfill gas for the co-generation of heat and electricity. The biggest landfill area is in Ljubljana, where they have around 3.4 MWe. Second is in town Maribor where they have 1.3 MWe and in Celje also 1.3 MWe (are planning new CHP units). There is also another project where negotiations are still running in Nova Gorica, again 1.3 MWe. Other landfill areas have everything prepared for gas collection and storage but many of them are not yet appropriate because of gas quality for CHP exploitation.

Separating the organic fraction of the waste is in place in modern centres for waste treatment and used in a biogas plant.

There is also big potential for waste water treatment plants. There are 6 plants that are producing biogas from waste waters in CHP units. Total installed capacity of CHP units is around 2 MWe. Potential is still big in plants with high number of PE (person equivalents). On the map we can see the locations of all waste water treatment plants and their size of PE.

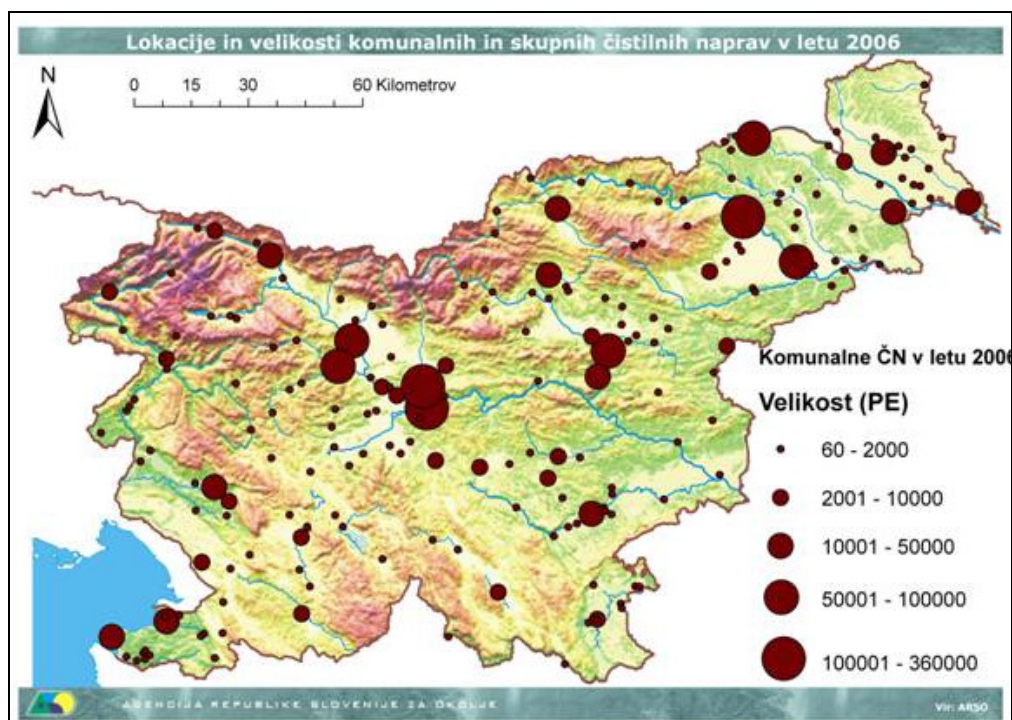


Figure 2.1.5: Location of waste water treatment plants

2.2 Assessment of waste business structures in Greece

2.2.1 Introduction

The production of solid wastes is a result, to a great extent unavoidable, of the production process and consumption. Therefore, the reduction of solid wastes quantity is the long term goal at which the efforts of the state should aim, through the gradual change of producers' and consumers' behavioural patterns and practices.

The targets of the National Strategy for the management of solid wastes, as presented in the National Plan of Integrated Management, aim at the safe disposal and maximisation of recycling. In parallel, long-term actions are mainly promoted for the reduction of the total quantity of produced solid wastes. The basic sectors of action of the NSSD for Solid Wastes are:

- Safe disposal and recycling
- Exploitation of domestic wastes
- Management of industrial and hazardous solid wastes
- Reduction of the solid wastes quantity
- Institutional measures.

Most of waste management law in Greece follows the development of European waste management law.

In 2002, the Ministry for the Environment, Physical Planning and Public Works (YPEHODE) initiated the update of the National Planning, with the aim to:

- Review the Prefectural Schemes according to the Regional Schemes that were elaborated for promoting integrated solid waste management plans at regional level and the clustering of programmes;
- Elaborate integrated solid waste management systems for the 13 Administrative Regions of Greece;
- Control the operation of non-engineered dump sites and take action for their gradual elimination;
- Develop modern sanitary landfills, covering the whole country until the end of 2008.

During 2001-2003, YPEHODE has focused in the transposition of the community legislation on the waste management, into the national legal system. Based on the recent institutional framework and the review process of the 1st National Planning, YPEHODE issued in 2003 JMD 50910/2727/2003 (OJG 1909/2003), on measures and terms for solid waste management, comprising of the following basic axes:

Adaptation and approval of the National Solid Waste Management Planning so as to incorporate the major principles, goals, policies and actions for the rational management of urban wastes, according to the community legal framework and arising national obligations;

Establishment of the Regional Solid Waste Management Schemes as the executive action plans in the area of solid waste management, with specifications and goals in consistency with those of the National Planning.

New Joint Ministerial Decisions that were added to the existing legal framework for waste management in 2002 and 2003, include JMD 3418/2002 that defines the measures and terms for harbour installations delivering wastes produced in ships and shipments residues, JMD 29407/3508/2002 (OJG 1572B/2002) on measures and terms for sanitary disposal (harmonisation with the EU Directive 99/31/EC), and JMD 18083/1098/2003 (OJG 606B/2003), with provisions for general guidelines regarding the reporting, collection and disposal (retraction) of the devices and wastes containing PCBs.

The application field of Law 2939/2001 (harmonisation with the EU Directive 94/62/EEC) on "Packages and the Alternative Management of Packaging and other Materials" extends to packaging wastes, end-of-life vehicles, waste batteries and accumulators, catalysts, used tyres, waste from electrical and electronic equipment, oils and waste oils and demolition and construction waste.

This Law obligates the economic actors (producers, importers) to organise or participate in collective (or individual) systems of alternative waste management (i.e. return, collection, transportation and recovery systems) in order to achieve specific quantitative targets. Pursuant to Law 2939/2001, the Ministerial Decisions 106453/2003 (OJG 391B/2003) and 105857/2003 (OJG 391B/2003) approved the operation of two nation-wide systems for the collective alternative management of packaging wastes.

Most recently, YPEHODE issued JMD 22912/1117/2005 (OJG 759B/2005) with which the EU Directive 2000/76/EC on waste incineration is integrated in the Greek legislation. Furthermore, the revision on the National Legislation on hazardous waste management is at its final stage. This includes three items, namely the measures and conditions for the management of hazardous waste, the technical guidance for the management of hazardous waste and the National Plan for the management of hazardous waste.

In Greece, in principle, the responsibility and liability in terms of waste management activity is at local government level and lies within the competence of the Municipalities.

The legislation gives a priority to waste management as a public service, although it also recognises the shortcomings of a totally public-centred approach. Therefore provides for the private sector to be active, in particular, as:

- subcontractors of the Local Authorities
- and in order to fulfil the duties of the holders of waste (excluding the holders of household waste), when the Local Authority is unable to provide collection and transport services.

Waste management is divided in three levels:

- The first-level Local Authorities, i.e. Municipalities, are responsible for the collection, the temporary storage, and the treatment/recycling/reuse as well as for the final disposal of the municipal solid wastes.
- The second level (prefectural authorities) has the main responsibility for the development of solid waste management master plans.
- At national level the Ministry of Environment, Physical Planning and Public Works has the responsibility for policy making, national planning, technical matters as well as licensing and financing the large WWTP and landfills.

Determination and in-detail specification of the competent bodies for waste management in Greece, i.e. the Local Boards, the Administration of each Prefecture and, in specific cases, the Regional Administration, is provided under JMD 69728/824/96. In 1996, Local Authorities started the elaboration of Prefectural solid waste management schemes, in accordance with JMD 69728/824/96. For the achievement of an integrated approach to the waste management issues and for the homogeneity and delineation of the waste management schemes developed by Local Authorities, JMD 114218/1997 was issued, which sets the framework of technical specifications and general programmes for the management of solid wastes. Together with the latter, JDM 113944/101/97 was also issued for the specification of general guidelines of the solid waste management policy and for setting out the bases for National Planning.

The overall quantity of Municipal Solid Wastes (MSW) in Greece increased rapidly over the last 20 years, from 3 million tonnes in 1990 to 3.9 mt in 1999 and to 4.559 mt in 2001. It is estimated that during 2006 the waste production come up to approx. 5 million tonnes. Each inhabitant generates 1.14kg/day (2001).

In Greece, landfill of municipal waste has been the predominant option. In 1995 the average landfill rate was 100% but in 2004 this has fallen to almost 93% (EEA, 2008).

In Greece, there is no incineration and from the municipal solid wastes, approximately 7-8% is recycled. Recycling rates have improved significantly, but the recycled waste quantities are very low in comparison with those of other EU members. The private sector has a significant participation in this effort, with measurable results.

Table 2.2.1: Waste generated in Greece Source: Eurostat structural Indicators, *Eurostat, data reported by member states to the European Commission (late 2005) (Source: Eurostat structural Indicators, * Eurostat, data reported by member states to the European Commission (late 2005))

Waste generation and treatment in 1000 tonnes									
	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total waste generation	-	33130	-	-	-	-	-	-	-
Municipal waste generated	3200	3600	3900	4082	4264	4447	4559	4640	4710
Municipal waste landfilled	3295	3437	3540	3719	3886	4056	4157	4233	4328
Biodegradable municipal waste generated	*2100	-	-	-	-	-	-	-	-
Biodegradable waste landfilled	-	-	-	-	-	-	2827	2877	2926
Used tyres generated	-	-	-	-	-	-	248	250	252
Waste generation and treatment in kg per capita									
	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total waste generation	-	33130	-	-	-	-	-	-	-
Municipal waste generated	302	337	363	378	393	408	417	423	428
Municipal waste landfilled	311	322	329	344	358	372	380	386	393
Biodegradable municipal waste generated	*199	-	-	-	-	-	-	-	-
Biodegradable waste landfilled	-	-	-	-	-	-	259	262	266
Used tyres generated	-	-	-	-	-	-	23	23	23

In 2002, the composting treatment method has made its first steps, with an insignificant contribution to waste treatment (less than 2%), (Eurostat, 2004). Since then, serious efforts have been made in order to promote biological treatment facilities (eg. Athens, Chania, Kalamata).

According to the Greek Ministry of Environment data there are:

- 2,211 dumps (29 sanitary landfills) in 2002.
- 45 sanitary landfills in 2006 (56 new sanitary landfills are under implementation).
- 2,626 dumps in 2005 and 1,125 in 2006 (an extensive Project of Solid Waste Dumps Closure and Rehabilitation at national scale is in progress since 2004).

Greece has great differences in the generating amounts as well as in the composition of MSW compared to other EU members. Moreover, the composition and the amount of the generated waste quantities differ from place to place within the country. Based on the data of JMD 50910/2727/2003, waste is composed of Fermentable waste (47%), paper 20%, plastics 8.5%, metals 4.5%, glass 4.5%, and other 15.5%. For the year 2003 and based on EEA figures waste in Greece is composed of Food (56.5% compared to 38.9% of EU-27 average), Paper (17% compared to 21.2% of EU-27 average), Plastics (10.3% compared to 10.6% EU-27 average) and Inert (16.1% compared to 24.2% of EU-27 average).

Today practically the whole country is served by well organised collection and transportation of the waste and there is a plan to gradually close down all the dumping sites by the year 2008.

Municipalities are responsible for the collection, the temporary storage, and the treatment/recycling/reuse as well as for the final disposal of the municipal solid wastes. For the improvement of the transportation and final disposal of waste, 15 Waste Transfer Stations, have been constructed up today, as well as 5 Material Recovery Facilities and 1 Mechanical Separation and Composting Facility (2004 data).

In Greece, the supply of clean and sanitarly appropriate water, from underground and surface waters, to every citizen in the country, consists one of the main responsibilities of Public Administration. The state is responsible for providing water and wastewater services to Athens and Thessaloniki and has effectively entrusted water services to two large companies: to EYDAP in Athens, which legally has private status but is supervised by YPEHODE and to DEYATH in Thessaloniki, a public sector company. In cities, over 10,000 municipal companies manage water and wastewater services. In smaller towns and rural areas, communities are directly responsible. Aside from some small wastewater treatment plants installed in private properties, there is no further private sector involvement.

The targets of the National Strategy for Sustainable Development (NSSD) (2002), regarding the management of water resources, are set out in the National Strategy for Water Resources (NSWR) (2002) and aim at the sustainable use of water resources, the efficient protection of water ecosystems and the attainment of high quality standards for all surface and ground water bodies by the year 2015.

Wastewater treatment in all parts of Europe has improved significantly since the 1980s. In several countries in north-western Europe there has been an increase in the population connected to tertiary waste water treatment in the 1990s, resulting in marked reductions in phosphorus and nitrogen discharges. However the percentage of population connected to waste water treatment is relatively low in southern Europe and in the Accession countries.

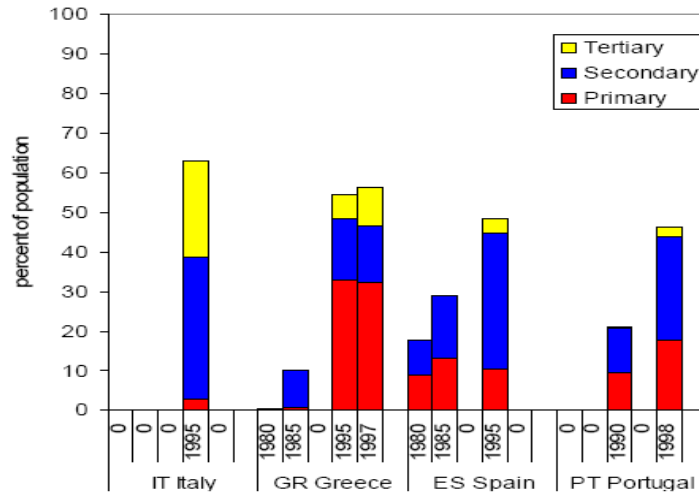


Figure 2.2.2: Changes in wastewater treatment in Southern countries of Europe between 1980s and late 1990s (source: EEA, 2005)

Wastewater from households and industry represent a significant pressure on the water environment. The Urban Wastewater Treatment Directive (UWWT) prescribes the level of treatment required before discharge. It requires Member States to provide all agglomerations of more than 2 000 population equivalents (p.e.) with collecting systems. Secondary treatment (i.e. biological treatment) must be provided for all agglomerations of more than 2,000 p.e. discharging into fresh waters and estuaries and for all agglomerations of more than 10,000 p.e. discharging into coastal waters.

The overall action plan for wastewater treatment is based on the requirements of the EU Directive on Urban Waste Water Treatment (UWWT, Directive 91/271) and has the main objective to complete the infrastructures necessary for wastewater collection, transport and treatment. In recent year rapid progress has been made in wastewater treatment infrastructure in Greece due to funding priorities and implementation of Environmental legislation. The goal for the Greek state is to build a wastewater facility for every Greek city and industrial area.

Significant progress has been made in wastewater management and in 2006 the population covered by wastewater treatment plants (WWTP) was about 74% of the total population. According to the Greek Ministry of Environment WWTP will serve almost 90% of the Greek population by 2008 and must be constructed in the near future 151 new WWTP all over Greece.

Since December 2003, a new legislative and institutional framework has been put into force in the country. It consists of Law 3199/9-12-2003 (Official Journal of the Government - OJG 280A/2003) on water protection and the sustainable management of the water resources with which the EU Water Framework Directive (WFD) (2000/60/EC) is transposed into the national legislation. Generally, the problems of water management mainly concern issues of quantity and not of quality.

Before this new law on water was put into force, the legislative framework of the country on this issue included Law 1739/1987 on Water Resources Management, establishing the

institutional framework for the management of water resources in Greece and the Environmental Protection Law 1650/1986 for the protection of surface and groundwater quality, including control of effluent discharges.

The existing Legal Framework for water resources management in Greece, apart from the above mentioned new Law 3199/9-12-2003, also includes Joint Ministerial Decisions (JMD) and Common Ministerial Decisions (CMD).

The existing main legal framework for the wastewater management includes the following provisions:

- JMD 5673/400/1997 (OJG 192B/1997) for the collection, treatment and discharge of urban waste water and treatment of residual sludge (transposition of the EU Urban Waste Water Treatment Directive 91/271/EEC);
- JMD 80568/4225/1991 (OJG 641B/1991) that defines the measures, terms and limitations for the use of sludge in the agriculture (harmonization with the EU Directive 86/278/EEC);
- JMD 3418/2002 that defines the measures and terms for harbour installations delivering wastes produced in ships and shipments residues.

According to the requirements of the EU Directive 91/676/EEC (transposed into national legislation with JMD 195652/1906/1999, OJG 1575B), four vulnerable zones towards nitrogen pollution from agricultural run-offs have been established and respective special Action Programmes have been planned and adopted, according to art.5 of the Directive, focusing on the minimisation of the adverse impacts on the environment of Greece. The implementation of these programmes is obligatory for all farmers of these vulnerable zones. These Action Programmes include:

- Action programme for Thessaly plain (JMD 25638/2905/2001, OJG 1422B)
- Action programme for Kopaida plain (JMD 20417/2520, OJG 1195B)
- Action programme for Argolida plain (JMD 20416/2519, OJG 1196B)
- Action programme for Pinios basin, Prefecture of Ilia (JMD 20418/2521, OJG 1197B)

In 2001 three more areas were identified as sensitive areas (with JMD 20419/2522, OJG 1212B), completing the list with the sensitive areas, namely: Thessaloniki plain, Strimonas basin, Preveza-Arta plain.

2.2.2 Availability of appropriate organic wastes

2.2.2.1 Kitchen wastes

There is no separate waste collecting system in Greece, except for recycling of paper, glass, and plastic. Only few attempts for composting have been done (see policy chapter). Some pig farms use kitchen waste for feeding. Restaurants and hotels don't have to pay for the waste removal.

2.2.2.2 Wastes from Supermarkets

There is no separate waste collecting system. Usually expired food is dumped with the other waste streams.

2.2.2.3 Wastes from Industrial production

The 96/61/EC Directive on the Integrated Pollution Prevention and Control (I.P.P.C.), was adopted in September 1996 and has entered into force since October 1999 engaging its implementation on the existing industrial units since 2007. The aim of the Directive is the integrated pollution prevention and control that stems from a great number of industrial processes. The number of units that fall under the scope of the Directive is as follows:

- Intensive Rearing of Poultry and Pigs: 294
- Slaughterhouses: 6
- Slaughterhouses by-products processing: 6
- Meat processing: 0
- Fruits and vegetables processing: 26
- Vegetable Oil and Fat Processing: 1
- Dairy Products Manufacturing: 6
- Starch production and starch products manufacturing: 0
- Flour production: 4
- Sugar, biscuits and confectionery products manufacturing: 5
- Distillery products (alcohol, alcohol containing drinks), Beer, Wine, Soft Drinks: 7

The effluents from food industries contain high amounts of easily biodegradable organic compounds. Thus, they can be used as a very good substrate for energy and compost production. In this case AD is a common technology for methane and energy production.

Water consumption in the **milk industry** is relatively high. The water consumption in the milk industry in Greece (L water/L of processed milk) is the following:

- Milk bottling 1.0-4.3 (mean value 2.2).
- Cheese (0.7-5.4, mean value 2.6)
- Milk bottling + cheese production (3.0-4.5, mean value 3.5)

The following values have been reported for the total volume of effluent from the milk industries:

Table 2.2.2: Effluents of milk industries; Source: Greek Ministry of Environment

Final product	Volume of effluent (m ³ / t product)	BOD5 (kg / t product)	COD (kg / t product)	SS (kg / t product)
Receiving station: cans	0.83	0.46	0.84	0.03
Fluid products	3.87	3.21	5.63	1.5
Yoghurt	3.87	3.21	5.63	1.5
Butter	20.9	20.9	36.5	10.4
Cottage cheese with whey recovery	79.4	137	239	3.4
Cottage cheese with no whey recovery	80.3	609	953	3.4
Cheese with whey recovery	14.8	10.3	16.8	5
Cheese without whey recovery	15.7	482	731	5
Ice cream	1.6	0.8	1.4	0.24
Condensed milk	7.2	3.9	6.8	1.5

Waste water from the milk industries has relatively high organic load, since it contains dissolved sugar and proteins. Because of the high organic content of dairy wastewater, anaerobic digestion is essentially a viable treatment method.

The biological processes used in the majority of the EU dairy industries are the biodegradation of organic matter by aeration activated sludge treatment. AD methods among others are applied less frequently.

Water consumption in the **slaughterhouses** is very high. The water consumption in the slaughterhouses in Greece (m³/t product) is the following:

- 1.5-10 for pigs,
- 2.5-40 for cattle and
- 6-30 for poultry.

Liquid effluents from slaughterhouses have the following values:

- 7-9 m³/t live animal weight.
- 22.5 l/bird
- BOD5 = 1.25 kg/head (0.5-2 kg/head) for pigs 90 kg
- BOD5 = 3 kg/head (1.0-5kg/head) for cattles 250 kg
- BOD5 mean values = 1,850-2,000 mg/l and SS = 930 mg/l.
- BOD5 mean values = 15.03 g/bird and SS = 15.4 g/bird.

Usually the solid wastes from the slaughterhouses (animal by-products and other) have a range 25-30% per animal and 20-25% per bird. The by-products usually been treated as cattle feed.

In Greece **olive oil olive mills** operate mainly during winter (for 3 to 4 months from November to February). According to the Greek Ministry of Rural Development and Food there are about 2,800 olive oil mills in Greece (2000 data).

The waste productivity of the olive oil mills depends on the olive trees production (usually after a high olive production year we have a less or no production year).

During olive oil extraction the wastewater consists of olive fruit juice, dilution warm water and washing water too. In the past it was concluded that efficient treatment of olive oil mill wastes can be achieved by controlled AD but only after the addition of adequate liquid ammonia nitrogen and for economy reasons, calcium quantities for pH and C/N ratio adjustment a solution that increase the operational costs for a medium size olive oil mill (Georgakakis et al., 2002).

2.2.2.4 Agricultural wastes

In Greece the size of the pig farms varies from less than 100 sows to more than 2,000 sows. Most of them are modernised farms with different types and construction methods. The most common treatment system used is the anaerobic lagoon and land disposal. There are about 10 pig farms with more than 1,000 sows (Source: Hellenic Ministry of Rural Development and Food, 1997).

According to the General Secretariat of National Statistical Service of Greece, there are (2006 sample survey):

- 4,023 holdings with 50 and over cattle (458,871 cattle) and
- 854 holdings with 100 and over pigs (867,727 pigs).

In Greece, sheep, goat and lamb breeding represents the highest percentage of livestock and its breeding is mainly done by shepherds. On the other hand, cattle and pig breeding is structured with advanced production systems. Medium-large livestock units are located in current regions but the manure density is lower than it is noticed in Western Countries. It must be noticed that the large manure quantities from the above livestock (mainly from goats and sheep) are spread out in the field during grazing.

The common practice of pig manure management is the collection in anaerobic lagoons after the collection mixing and mechanical separation. It is the simplest form of anaerobic treatment and it acts as psychrophilic anaerobic digester open to the atmosphere.

In cattle raising farms, solid manure is collected on impermeable platforms where liquid from dung heap discharges in septic pool. The poultry manure is collected on dung heaps and through composting technique is disposed on the land as a good fertile material.

According to the Hellenic Ministry of Rural Development and Food the total consumption of fertilisers every year is approximately 1,500,000 tons.

2.2.2.5 Bio-wastes from local authorities

The National Framework on household waste management has set up the following targets:

- Prevention or reduction in the amounts of hazardous/non-hazardous household waste produced per capita
- Modernisation and expansion of the collection and transport network
- Exploitation of the useful materials derived from the treatment of household waste
- Disposal in an environmental friendly way and restoration of unauthorised disposal sites

The following actions have been chosen in order to meet the standards set up by the waste management policy:

- Promotion of efforts intended to reuse and recycle the materials
- Utilisation of the best available technologies and standardisation of the collection network
- Organisation of sorting projects at the source and construction of recycling/composting and thermal treatments plants
- Funding studies and expansion of the number of available sanitary landfills in an effort to cover completely the produced amounts of household waste
- Restoration of previously uncontrolled disposal sites

Concerning composting, no source separation schemes are in place for the organic fraction of MSW.

The next figure demonstrates the volumes of vegetable waste (fruits) disposed of in landfills between 1995-1997 in Greece.

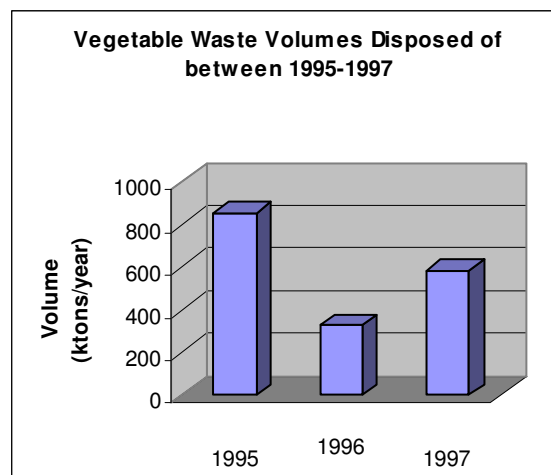


Figure 2.2.3: Amount of vegetable waste disposed in landfills

The fluctuation observed on the volumes of vegetable waste can be accounted for by the EU policy on the production of fruits and the demand levels of the corresponding market.

2.2.3 Potential plant sites

Agricultural production sites like pig farms or cow farms are interested in co-fermentation. Sites have not been earmarked; however there are thousands of potential sites on larger farms, landfills and other waste collection points.

2.3 Assessment of waste business structures in Latvia

2.3.1 Introduction

Legislative framework on waste management in Latvia states that tenants are responsible for organising waste management in their property. Usually they are signing the agreement on waste management directly with a managing company. However, there are also some municipalities that have undertaken the responsibility on waste management in their territory. In this case tenants for waste management are co-operating directly with a municipality. Waste management agreements usually include:

- Time schedule for waste collection.
- Description of waste bins and used equipment.
- Waste collection and transportation to respective recycling or disposal place.

Typical household waste collection and utilisation system is illustrated in Figure 2.3.1.

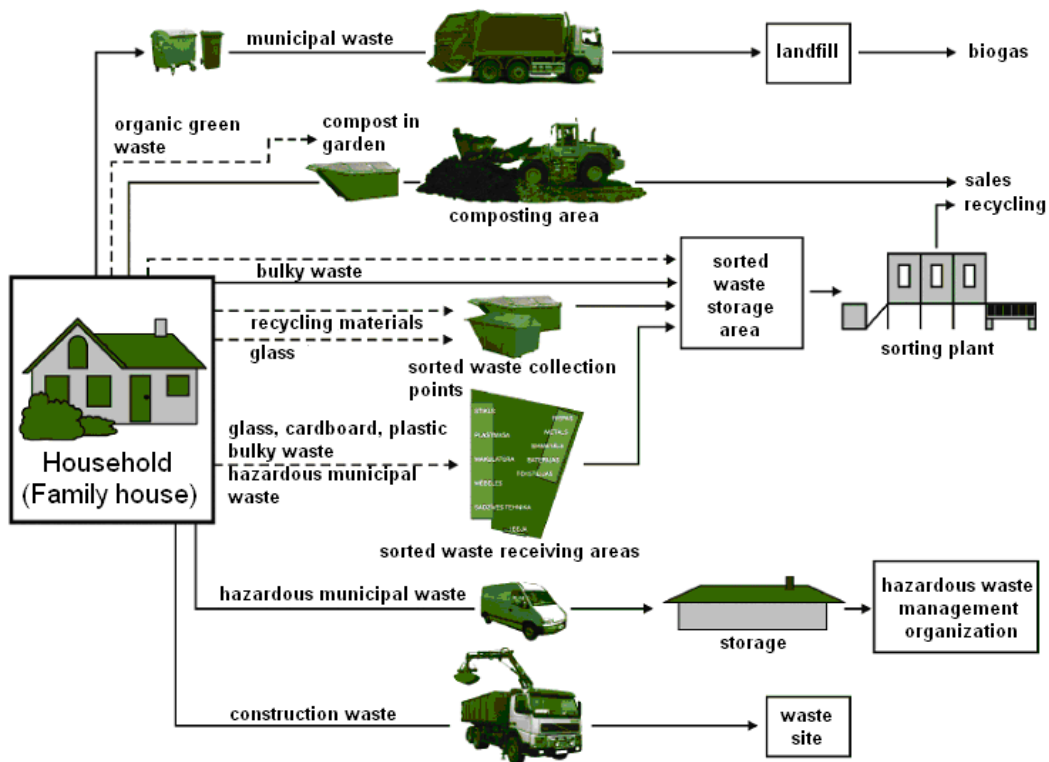


Figure 2.3.1: Typical household waste collection and utilisation system in Latvia

In urban areas the household waste collecting system is organised unitarily where waste producers are in contract relations with waste collecting organisations and those relations generally are co-ordinated and supervised by the municipality. Usually waste bins are used for waste collection, however in the historical centre of Riga and in some other places, where it is not possible to place bins, waste is collected directly from inhabitants who have to wait on the street until the dump truck is passing by. This kind of collecting system is very inconvenient and is not profitable for waste management companies. Besides the problems mentioned before, this situation is also limiting further development of waste management and waste sorting practices.

In rural areas each household has a separate waste bin and waste collecting is done based on an agreement between the house owner and the waste collecting company. The frequency of waste collection is between once per week up to twice per month. Waste collecting frequency is affected by different factors:

- Contract conditions set between particular municipality and waste management organisation.
- Contract conditions set between particular house owner and waste management organisation.
- Volume of used waste bins.

Waste collection from enterprises and companies is done in three different ways:

- Companies with their offices located or registered in apartment houses don't have separate waste collection agreements and their waste is included in household waste bins.
- Considerable part of enterprises has directly contracted waste management company for waste collection and transportation services.
- Limited part of enterprises does the waste collection by themselves. However, this is not easy to define exact amount of self-collected waste due to the widely distributed co-operation practice between those companies.

Households are producing more than a half (around 54%) of municipal waste amount in Latvia¹. The rest is produced by companies and enterprises. According to the information² obtained from State agency „Latvian Environment, geology and meteorology agency“ in 2006 the total amount of produced municipal waste in Latvia was more than 900 000 t. About 40% of all municipal waste was delivered to Riga regional landfill „Getliņi“. Overview on collected sorted biological waste and unsorted municipal waste is summarised in Table 1.

1 *Data source: Ministry of Environment of Latvia (www.vidm.gov.lv)*

2 *Overview on waste in 2006*

Table 2.3.1: Amount of collected biological and municipal waste in Latvia in 2006³

Waste material	Collected waste amount, t
Paper and cardboard	14,601
Biological kitchen waste	50
Food oil and fat	240
Waste from marketplaces	546
Other biological waste	17,608
Total	33,045
Unsorted municipal waste	884,691

Last available information on content of unsorted municipal waste was obtained from investigations prepared in 2004. Results from those investigations shows that the percentage of organics in unsorted municipal waste is about 57%.

2.3.2 Availability of appropriate organic wastes

2.3.2.1 Kitchen wastes

There is no separate kitchen waste collecting system established. Basically kitchen wastes are treated together with unsorted municipal waste. Only in particular cases organic kitchen wastes are collected separately. Restaurants and hotels are paying for the waste removal according to the normal waste management practice established by waste management agreements.

2.3.2.2 Wastes from supermarkets

Only few supermarkets have contracts with some of the by-product processing companies. Thermally processed food waste and food residues according to agreement with waste collecting company are delivered to landfill or in very few cases food waste from supermarkets are feed for fur-bearing animals (non-productive animals). On emergency situations (like storm or electricity outage) all food is delivered to specialised by-product processing company for disposal.

Use of over dated food in Latvia is regulated by EC regulation 1774/2002. This regulation allows thermally processed waste food delivering to landfill, feeding it to fur-bearing animals or disposing in specialised by-product processing company. Over dated raw food is allowed to feed for non-productive animals or to dispose in specialised by-product processing company. Delivery of raw food waste on landfill is prohibited.

Food wastes are not allowed as feed for productive animals (e.g. for pigs). Over dated dairy products, in case if they fulfil microbiological standards, are allowed as feed for animals if they are fattened or breed for food production.

3 *Overview on biological waste and materials in 2006*

2.3.2.3 Wastes from industrial production

To describe food industry development in Latvia, the number of companies and number of employees in each productive industry is given in Table 2.3.2.

Table 2.3.2: Food production industry profile in Latvia⁴

Productive industry	Number of companies	Average number of employees
Meat production and processing	123	6,154
Fish production and processing	112	7,509
Fruit and vegetable processing	32	842
Vegetable and animal oil and grease production	6	200
Dairy production	52	4,242
Flour and starch production	25	728
Animal feeding stuff production	12	490
Bakeries	253	8,161
Confectionery production	19	781
Distilleries	9	1,014
Breweries	19	1,629
Mineral water and soft drink production	23	1,104
Other food production	20	1,262

Description and amount of available organic waste from food production industry in 2006 is summarised in Table 2.3.3.

Table 2.3.3: Organic waste from food production in Latvia in 2006⁵

Waste material	Waste in t
Animal tissue waste	18,256
Agricultural, horticultural, forestry and fishery waste	66
Meat, fish and other animal origin food production and processing waste	11,792
Washing, cleaning, peeling and separation residues	1,916
Materials that could not be used for consumption or processing	115
Fruit, vegetable, cereal, food oil production and processing waste	1,713
Dairy production waste	42,586
Bakery waste	28
Distillery waste	3,078
Total	79,550

⁴ Data source: Central Statistical Bureau of Latvia (www.csb.gov.lv)

⁵ Overview on biological waste and materials in 2006

Currently, every particular food production company is responsible for their organic waste management. More than half of available organic waste material (see Table 2.3.3) is coming from dairy production. Whey is mainly used for cattle and swine breeding. The left is mixed with manure and applied as fertiliser. Animal tissue waste and other meat and fish production waste are given to certified waste management companies for further processing.

Waste from fruit and vegetable processing based on agreements are sold to farms for animal breeding. Waste food oil is used for animal feed production.

Wastes from breweries and distilleries are used for animal breeding or as fertiliser. Based on conditions of particular agreements those waste are sold either given for free.

2.3.2.4 Agricultural wastes

Agricultural waste market in Latvia currently is saturated and at the same time limited. In most cases farmers with additional expenses apply manure directly on fields without any preliminary processing. At the same time many farmers have problems with lack of appropriate storage facilities to follow the regulations on manure storage. At the worst – farmers do not have enough land space for manure spreading. Furthermore, farmers have to pay taxes on emissions generated from manure storage and spreading operations.

From the other hand manure availability is limited by the fact that farmers realise the value of manure as fertiliser. The value is rapidly growing together with price of chemical fertilisers. Thus farmers are not interested to give the manure for other companies for free.

Overview on cattle and pig farm size in Latvia is summarised in Table 2.3.4.

Table 2.3.4: Farms structured by size in Latvia in 20076

Farm size, cattle	Number of cattle farms	Farm size, pigs	Number of pig farms
1	12,311	1	6,155
2	9,775	2	10,470
3-5	10,702	3-4	4,496
6-9	3,868	5-9	1,595
10-19	3,952	10-19	959
20-29	1,435	20-49	591
30-49	1,318	50-99	225
50-99	808	100-199	116
100-199	307	200-399	57
200-299	75	400-999	28
300-499	45	1,000-1,999	11
>= 500	48	2,000-4,999	11
-	-	>= 5,000	22

6 Data source: Central Statistical Bureau of Latvia (www.csb.gov.lv)

Regarding horse farms, there are only 34 farms with size more than 20 animals. Thus horse dung is not considered as significant feedstock for biogas production.

The market situation of agricultural by-products is different from case to case. Depending on agreements and particular conditions, waste suppliers get some payment whether pay by themselves for waste and by-product processing. Only small part of agricultural by-products and agricultural waste is collected separately from total waste stream.

2.3.2.5 Bio-wastes from local authorities

Until now we don't have information on local authorities that are interested in biogas projects. The best way to identify such projects could be to look on authorities with necessity to solve heat supply problems in their region. At the same time there have to be an availability of appropriate bio gas feedstock material.

2.3.3 Potential plant sites

Some previous investigations on identification of potential agricultural biogas plants show that almost all larger pig and poultry farms in Latvia have potential for co-fermentation. The list of big size farms is given in Table 2.3.5.

Table 2.3.5: Potential farms for co-fermentation in Latvia

Farm	Location	Farm type
Vistako, Ltd	Alūksne region	poultry farm
Uzvara – Strauti, Ltd	Bauska region	pig farm
JS company „Balticovo“	Bauska region	poultry farm
Lielzeltiņi, Ltd	Bauska region	poultry farm
Gaižēni, Ltd, farm „Smurģi“	Cēsis region	pig farm
JS company Latgales bekons	Daugavpils region	pig farm
Daugavpils putni, Ltd	Daugavpils region	poultry farm
Baltic Agro Contractor, Ltd, farm „Avoti“	Dobele region	pig farm
LatviDanAgro, Ltd, farm “Ošlejas”	Dobele region	pig farm
PF Vecauce, Ltd	Dobele region	pig farm
Rīgas kombinētās lopbarības rūpnīca, Ltd., farm "Kroņauce"	Jelgava region	pig farm
Sēji, Ltd, farm “Stiebrīņi”	Jēkabpils region	pig farm
JS company “Jēkabpils labība”, farm “Miķelāni”	Jēkabpils region	pig farm
JS company “Šķaunes bekons”	Krāslava region	pig farm
Korkalns, Ltd	Kuldīga region	pig farm
Nīcas rukši, Ltd	Liepāja region	pig farm
Vaiņodes Bekons, Ltd	Liepāja region	pig farm

Farm	Location	Farm type
Ozolāji cūkaudzētava, Ltd	Liepāja region	pig farm
GDG Holding, Ltd	Liepāja region	pig farm
Nygaard International, Ltd, farm „Apriķi Bacon”	Liepāja region	pig farm
Nīca - 1, Ltd	Liepāja region	pig farm
Nīckrasti, Ltd	Liepāja region	poultry farm
Cirmas Bekons, Ltd	Ludza region	pig farm
JS company „Madona”	Madona region	poultry farm
Daugavieši, Ltd	Rēzekne region	pig farm
Kantinieku bekons, Ltd	Rēzekne region	pig farm
Ulbroka, Ltd	Rīga region	pig farm
Baltic Pork, Ltd	Rīga region	pig farm
JS company „Putnu fabrika Ķekava“	Rīga region	poultry farm
Druvas Unguri, Ltd, farm “Krasti”	Saldus region	pig farm
Druvas Unguri, Ltd, farm “Jaunstraumēni”	Saldus region	pig farm
Druvas Unguri, Ltd, farm „Unguri”	Saldus region	pig farm
Starteris, Ltd, farm „Brīvkalni”	Talsi region	pig farm
Mārupes lauksaimniecības centrs, Ltd	Tukums region	poultry farm
Sprīdītis, Ltd, farm “Kalna Eķītes”	Valka region	pig farm

There have been some more discussions and investigations on a potential biogas project in farm “Miķelāni” located in Jēkabpils region. However, currently farm owners are working on other farm modernisation projects and they are ready to start biogas project only after completion of ongoing tasks.

According to the Waste Management Plan⁷, 10 to 12 regional landfill sites will be developed and existing dumping grounds will be closed and recovered in following steps:

- Until 2009 – construction of regional landfills according to requirements of Directive 1993/31/EK
- Until 2009 – closing of existing dumping grounds and their total recovering until 2012
- Inclusion of waste collecting, sorting and processing equipment in new landfill projects

Latvia is divided in 11 waste management regions. For each region separate waste management plan have to be developed and approved by the Cabinet of Ministers of Latvia. Currently 7 regional landfills are in operation and in two of them (landfill “Getliņi” and landfill “Ķīvītes”) landfill gas is collected and used for heat and electricity production. In landfill “Daibe” gas collection project is on the stage of development.

7 *Waste Management Plan for Latvia 2006-2012*

However, organic fraction is not separated from total waste stream on landfill sites. Theoretically all regional landfills are potential sites for this kind of biogas production. The list of regional landfills and their current development status is described in Table 2.3.6.

Table 2.3.6: List of regional landfills in Latvia

Landfill	Location	Status
Landfill "Getliņi"	Rīga region	In operation
Landfill "Kīviķes"	Liepāja region	In operation
Landfill "Daibe"	Cēsis region	In operation
Landfill "Pentulji"	Ventspils region	In operation
Landfill "Auziņas"	Dobele region	In operation
Landfill "Kaudzītes"	Gulbene region	In finalization
South Latgale regional landfill	Daugavpils region	In construction
East Latgale regional landfill	Rēzekne region	In construction
Coastal regional landfill "Janvāri"	Talsi region	In development
Vidusdaugava regional landfill	Jēkabpils region	In development

2.4 Assessment of waste business structures in Croatia

2.4.1 Introduction

Currently, Croatia is in the beginning of harmonising its legislation with the EU legislation regarding waste and waste management. A cornerstone document called Strategy on waste management of the Republic Croatia was delivered in 2005. It is followed by numerous new legal documents delivered in 2007. The system is in its transitional period and it would be difficult to estimate which of the declared goals are going to be implemented and if yes, in what period and to what extent. Therefore, this review will focus more on the existing system with future expectations, where this would be applicable. It has been estimated that the quantity of generated waste in Croatia amounts to 13.2 m t/year or 2.97 tons of waste per capita. Table below classifies waste by type and amount:

Utility company is in charge of collection and transportation of municipal waste. They are covering about 80% of inhabitants with various success (in some counties they cover 50% of inhabitants while Zagreb has 100% coverage). However, there is an upward going trend as the number of inhabitants covered by utility companies increased from 2.7 mil in 1995 (about 60%) to 3.5 mil in 2000 (about 80%).

The collection system of municipal waste is based on collection of mixed waste in containers (1-7 m³), bins (80-1 000 litres) and bags. Newly built (parts of) settlements are mostly choosing bins for waste collection. Bins and containers are usually made according to the German DIN standards. Green markets, retail shops and recycling spots are introducing large containers of 10 to 20 m³ with pressing mechanisms. It is very important to stress that

waste has been collected 2 to 3 times per week. Large municipal waste is collected from households twice per year at designated dates. Most of the vehicles for collection of municipal waste are equipped with press mechanisms.

Table 2.4.1: Waste types and amounts Croatia

Type of waste	Quantity (mil. t/year)
Municipal waste	1.2
Construction and demolition waste	2.6
Processing and mining waste	1.6
Agriculture and forestry and wood processing waste	7.1
Hazardous waste	0.1
Separately collected	0.2
Other	0.4
Total	13.2

Municipal waste generated on islands is either delivered to landfills situated on islands or transported by ferries in collection trucks or containers to the mainland.

Other categories of waste are mostly collected and transported by eligible waste collectors and transporters. The flows of waste other than municipal waste are significantly less controlled.

Utility companies are usually established by local authority where waste collection is main or one among many activities (drinking water supply, waste water management, natural gas supply, heat energy supply, public transport, chimneys, cemeteries, street cleaning and maintenance, green areas, public lightning...). They represent public service and are funded from the local budget. Utility activities, among which is waste collection and transport, could be executed by:

- company established by local authorities
- public body established by local authorities
- service – own operation unit established by local authorities
- legal and private person based on the concession agreement
- legal and private person based on the agreement on the utility service

In 2005, Ordinance on waste from packaging (OG 97/05) was successfully implemented and it could be said that municipal waste is cleared from PET and glass bottles from food product (min content 2 dl), cans from refreshments. Other PET, tin and glass packaging is still unsorted.

About 89% of waste ends on landfills (legal or illegal), 1% is composted and 10% is recycled. The landfills and their management are currently under reform. The intention is to delegate the responsibility of waste management on regions. There are about 10 recycling spots (5 of

them located in Zagreb) that provide about 3,500 paper containers, 3,000 glass containers, 1,100 PET containers and aluminium packaging and 400 containers for old batteries. The problem is that citizens willing to separate waste should collect their waste and take it to the recycling spot. Very few persons really do that. In Zagreb and some other towns, there are facilities for recycling electronic and electric waste, old tyres, cars and accumulators. In total, about 50,000 tons of municipal waste from household is recycled in Croatia. It is consisted from 12,500 tons of paper and cardboard 10,000 t of glass, 1,000 t of PET, 10,000 t of small appliances and cars, 15,000 t of metal and 3,500 t of tyres, wood, textile and styrofoam.

Separate collection of green waste is present only in Zagreb and it covers only 2 city areas. The green waste is composted in 2 facilities: an open composting plant with 35,000 m³/year and tunnel composting plant. The tunnel composting plant started to operate in 2007 and it reports that it has composted 2,000 t of biodegradable waste (726 t of households' green waste, 987 t of green waste, 103 t of waste from open green markets and 185 t of waste from food processing plants). The composting products are fertiliser/manure, sludge for soil treatments and metal waste that is recycled properly.

Croatian weekly municipal waste collection is more frequent than the EU average which introduces additional costs. Citizens are discouraged for any waste management or recycling as the basis for waste cost is the area of the living space (square meters) and not the waste generated. The average cost for waste collection per Croatian household of 60 m² is 32 € without costs of disposal and landfill improvements. In Zagreb, the cost of waste collection is 64 €/t/household that includes improvements of its landfills.

What percentage of organic is in waste from households? The estimated share of organic waste in the mainland is 43.1% while the coast records 41%.

Estimated prices (including taxes) for landfill waste disposal for Croatia are 20 to 62 €/t where the maximum value reflect the costs for Zagreb.

2.4.2 Availability of appropriate organic wastes

2.4.2.1 Kitchen wastes

There is no separate waste collecting system established. In general, they are allowed to use kitchen waste for feeding unless veterinary authorities proclaim prohibition for a temporary period (in case there is a risk for pig health). In practice, large majority of pig growers are using specially prepared feed for pigs. Those that are using kitchen waste would be farmers with one or two pigs for personal consumption but their number is negligible.

Restaurants and Hotels pay the same utility fee as households do which is based on the square meters of the space of the hotel or restaurant. The fees represent a significant cost for their business. By inertia, they separate waste from food preparation and consumption. It has been estimated to have 97,700 t/yr tourism related waste.

2.4.2.2 Wastes from Supermarkets

There is no special waste collecting system. Their waste is also classified as municipal waste so they pay, again, according to the floor space of the supermarket. The largest

supermarket chain in Croatia, Konzum, has made a study for utilising over dated food stuff and green waste in biogas production in Zagreb area (115 shops on 641,355 m² city area and 780,000 inhabitants). The results were that is too expensive.

2.4.2.3 Wastes from Industrial production

Production of the food processing industry has been estimated at 2 m t/yr with estimated amount of waste of 0.3 m t/yr which is partially used for production of feed.

Animal waste is specially described by Ordinance on management of carcass and waste originated from animals. Animal waste as by-product from slaughterhouses and meat processing occurs in the following objects: 226 slaughterhouses for cattle and pigs, 77 slaughterhouses for poultry, 611 objects for meat processing, 315 object for cooling and freezing of meat and meat products, 38 fisheries for freshwater fish breeding, 33 mariculture objects, 75 shell breedings, 41 fish processing plants, 67 places for collecting fish harvest, 11 distribution centres for bivalves, 3 snail breedings, 31 cooling and freezing facilities for fish and fish products, 57 milk facilities, 44 egg farms, 1 object for egg processing, 26 objects for production of daily chickens. Apart of this registered sources of animal waste, there are numerous channels of animal waste that are not covered (green markets, butchers, animal husbandries, custom office terminals etc.). From the total estimated amount of animal waste in 2004 of 120,736 tons, only 78,561 tons were thermally processed in the following objects:

- Agroproteinka – 53,317 tons of animal waste of all kinds (maximum capacity of 75,000 t/yr)
- PIK Vrbovec (meat processing industry) – 7,000 tons of cattle and pig waste from own slaughterhouse
- KOKA d.d. Varaždin (poultry breeding and processing industry) – 9,375 tons of poultry waste from own slaughterhouse
- PURIS d.d. Pazin poultry breeding and processing industry) – 7,220 tons of poultry waste from own slaughterhouse
- Pipo Perutnina Ptuj – Čakovec poultry breeding and processing industry) – 353 tons of poultry waste from own slaughterhouse
- Various plants for thermal processing of fish – 1,296 tons.

The remaining animal waste is scattered around and the authorities are recognising the problem.

2.4.2.4 Agricultural wastes

Farming sector is quite dynamic due to the introduction of EU laws and EU funding opportunities. The latest official data on farms and their size are from Agriculture census in 2003. The Statistical Yearbook provide numbers of heads only (in 2006 there were 486,000 heads of cattle).

Based on the available data, those companies that have corporate responsibility are selling the dung to a third party. There is no established system to control the dung disposal. Most probably they are spreading it on the meadows and fields. Other companies, especially

those involved in pig breeding, make “lagoons” – open pools of liquid manure in the vicinity of the pigsty. They are aware of the problem but there is no system to push the solution. Even green NGO are not considering it as an environmental problem.

The total amount of used mineral fertiliser in 2006 was 364 476 tons. This data could indicate demand for the fertilisers. Horse dung is not perceived as a problem.

2.4.3 Potential plant sites

Sites have not been earmarked; however there are many of potential sites on larger farms, landfills and other waste collection points.

2.5 Assessment of waste business structures in Bulgaria

2.5.1 Introduction

Based on the European legislation, package of laws and directives related to waste collecting and removal have been approved in Bulgaria.

Directly related are:

- Directive 1999/31/EC on waste disposal has been transported into Bulgarian legislation with Waste management Law;
- Regulation No 12 on the requirements which must be met by the waste treatment facility sites (State Gazette No 152/1998);
- Regulation No 13 on the conditions of and requirements for the construction and operation of waste landfills (State Gazette No 152/1998);
- Directive 94/62/EC on packaging and packaging waste has been transported into Bulgarian legislation with Waste management Law, and with Ordinance on packaging and packaging waste;
- Directive 2000/76/EC on the incineration of waste;
- Regulation No 11 on the conditions and requirements for the construction and operating of municipal waste disposal facilities and installations (State Gazette No 152/1998);
- Regulation on the requirements for treatment and transportation of industrial and hazardous waste (adopted with Decree of the Council of Ministers No 53/1999; state Gazette No 29/1999);
- Directive 86/278/EEC on protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture;
- Regulation on the requirements of the soil protection when sewage sludge is used in agriculture (adopted by Decree No 262/2000 of the Council of Ministers, State Gazette No 101/2000);

- Ordinance №7 from 24.08.2004 on the requirements for sites determined for placement of waste treatment facilities (State Gazette nr. 81, 17.09.2004);
- Ordinance №8 from 24.08.2004 on the conditions and requirements for construction and operation of landfills and other facilities and installations for waste disposal and recovery (State Gazette nr. 83, 24.09.2004);

On the basis of the approved legislation, number of documents of public access have been developed and proposed, which analyse and give directions to all interested bodies (public or private), who develop projects related to environment, waste management and treatment, and biomass energy. Some of these documents are:

- National short-term programme for energy efficiency – 2005;
- National long-term programme for energy efficiency – 2007-2013;
- National programme for economical development;
- National strategic plan for stepwise lowering of the amounts of organic waste disposal – 2006-2020 (NSPLAOW, Ministry of Environment and Water)

For the current document the latest “National strategic plan for stepwise lowering of the amounts of organic waste disposal – 2006-2020” (NSPLAOW) is of highest interest.

The main responsibilities for the waste removal and utilisation of the waste material in Bulgaria have:

- Ministry of Environment & Waters: - The Ministry of Environment and Water (MOEW) is the competent authority responsible for the development and implementation of the national waste management policy, including drafting and enforcement of the legislation, strategies, programmes, international projects, as well as regulation of the activities in the public and private sectors. The MOEW performs some of these activities by the Executive Environmental Agency (EEA) and a network of 15 Regional Inspectorates of Environment and Water (RIEW) that are specialised control bodies of the Ministry.
- Ministry of Agriculture & Forestry: - The Ministry of Agriculture and Forestry issues permits for use of waste in agriculture, incl. sludge from wastewater treatment plants, compost etc. It sets out and controls the fulfilment of the requirement for management of the waste from agriculture, meat-processing and food industry establishes the veterinarian and sanitation requirements for collection and disposal of animal waste and performs sanitary control.
- Ministry of Healthcare:- participates in the development of legal documents in the waste management field.
- Ministry of Regional Development & Public Works;- controls the regional development and the communal facilities at national and regional level.

- Ministry of Economy & Energy;- controls the trade activities with ferrous and non-ferrous metal waste, issues licenses for these activities and keeps a register of the permits issued.
- Local Municipalities and Local Governments.

Private owned companies on concession do the waste removal, and municipal programs for waste management have the responsibility for collecting, transfer, hauling and disposal of the solid household waste. The periodicity of the waste disposal depends on the dumping container's capacity as well on the household's number.

Stationary container system is used for the collection of municipal and mixed municipal/commercial waste. The containers are placed on specific places where they are served by the specialised vehicles. A transport-container system is used in some regions. Container carriers are used for transportation of the big containers to the landfills where they are discharged and transported back to the place of collection. This transportation system is used mainly for the waste from the commercial centres, dwelling-places etc. It is also used in residential areas and settlements where the transport access for the big trucks is difficult.

There are several kinds of dumping containers designed for mixed waste, for example:

- Type "Beaver", with capacity 1,1 m³;
- Dumping Container with capacity 4 m³ and
- Type "Meva", with capacity 110 litres.

Following the Directive 94/62/EC on packaging and packaging waste, transported into Bulgarian legislation with Waste management Law, 5 organisations have been created, which have been approved with allowances for organising systems for separate collecting and recycling of packaging waste. The organisations realise projects and programs for separate waste collecting as follows:

- "Ecopack Bulgaria" JSC – in the cities of Razgrad, Smolyan, Bansko, Pravets, Dupnitsa, Hissar, and the regions "Oborishte", "Sredets", "Krasno Selo" and "Triaditsa" of Sofia Municipality;
- "Ecobulpack" JSC – in the regions of "Serdica", "Slatina", "Nadezhda", "Vazrazdane", "Izgreve" of Sofia Municipality, and the cities of Sliven, Yambol, Gabrovo, Sevlievo, Lovetch, Sredets /Bourgas Municipality/, Nevestino and "Albena" resort in Varna;
- "Bulecopack" JSC – in Chepelare Municipality, resort "Pamporovo", Hvoina, Elin Pelin Municipality, and the regions "Lyulin", "Mladost", "Iskar" and "Novi Iskar" of Sofia Municipality
- "Repack" JSC – in the cities of Gotse Delchev, Roman, Ugarchin, Cherven Bryag, Lukovit.
- "Reco Pack" JSC

After introducing of suitable system for waste recycling, the local authorities must stimulate the population by introducing a flexible system for household waste tax of the type "Pay as much as you dispose". Such a scheme could lead to lowering the amount of waste and to increase the effectiveness of separate collecting and composting/anaerobic treatment.

Since the Municipality does not have capital for treatment of the agricultural and farming waste (it is not taken into account in the tax for household waste), there could be conditions for appearing of non-regulated dumps, where the animal waste will be mixed with other household waste. The Municipality could introduce differential tax, where the owners of animals must pay to the Municipality for treatment of the agricultural and farming waste services (separately from the tax for household waste), or they should themselves take the responsibility for agricultural and farming waste treatment (source NSPLAOW).

There are two types of **separating waste collecting systems**. The first one has two containers – one for the glass waste and the other collects paper, plastics and metal in one place. The second system collects glass and paper in separate containers each, while plastics and metal are collected in one place. After collection glass is sorted by colour and transported to plants to be recycled. Plastics, paper and metal are separated manually with the help of a conveyer and finally transported to processing factories. Although the system for separate waste collection is functional it is not used by all of the people. Some of them still use the dumping containers for mixed waste and don't collect it separately. There are no installations for separation and anaerobic digestion of municipal waste.

The **landfilling** of waste remains the main method for waste disposal in the country. About 85% of the generated waste are transported to the landfills. About 52% of the total waste amount is biodegradable waste (NSI).

Incineration is still not a wide spread practice in the country and in actual fact currently it is not used for incineration of municipal waste. The incineration is typical method for disposal of hospital waste – 35% of the annually generated waste are incinerated in small installations that in most cases do not fulfil the present-day requirements. Through the financial support of the Danish Environmental Protection Agency (DEPA) and EMEPA (East Mississippi Electric Power Association) in September 2003, an incinerator for hospital waste on the territory of Medical Academy in Sofia was constructed. The capacity of the incinerator is 2800 tons per year and it is intended for disposal of the hospital waste from the territory of Sofia municipality. This is the first facility on the territory of the country that is constructed in compliance with all European requirements. Incinerators for hospital waste are under construction in the towns of Varna, Plovdiv, Pleven.

Centres for buying back of waste for **recycling** - paper, glass, plastics and metals are operated in the bigger cities of the country. Private companies independently from the municipal waste collection systems operate these centres. The citizens may deliver the waste separated by themselves by type and quality to these centres against small payment.

The amount of the waste treated by physical and chemical methods amounts to 193 936 tons. The greatest part of this waste is waste from the preparation of drinking water or water for industrial use (98%).

The usage of biological treatment methods in the country is limited. In 2000 the quantity of the waste treated using these methods amounted to 7,632 tons mainly sludge from waste water treatment plants.

There is no established usage of waste composting in the country, except the household composting applied in single municipalities.

2.5.2 Availability of appropriate organic wastes

2.5.2.1 Kitchen wastes:

There is no separate waste collecting system for kitchen waste established. Restaurants and hotels don't have to pay for the waste removal.

2.5.2.1 Wastes from Supermarkets

At the moment there are no special taxes for waste from restaurants and hotels. They are collected and mixed with the other waste and brought to the landfills. For Sofia municipally an ordinance for separate collection of the waste from restaurants and shops is under construction. The owners should enter into a contact with the organisations responsible for the waste in the area. One of the main targets of the ordinance will be the reduction of the generated from restaurants and hotels waste.

After research, conducted in big supermarkets, it was found, that near to over date foods usually are offered on low prices. In case that the foods are already over dated, they are eliminated.

2.5.2.2 Wastes from Industrial production

The industry is the major waste producer in the country and the activities of the waste generators from the different industrial branches will be significantly influenced by the legislative amendments and by the higher standards for environmental protection applied towards the waste management activities. The waste can be treated:

- By the waste producer – in own facilities in accordance with the approved plan for industrial activity;
- By persons that have obtained permit in accordance with the Waste Management Act or Integrated Pollution Prevention and Control permit according to the Environmental Protection Act.

Table 2.5.1 shows the quantity of generated non-hazardous waste from industrial production by type in Bulgaria for 2005.

Table 2.5.1: Non-hazardous waste from industrial production by type in 2005 (in thousand tons)
Source: Bulgarian statistical yearbook, 2006.

Type	Generated
Waste from agriculture, horticulture, aquaculture, forestry, hunting and fishing, food preparation and processing	470.4
Waste from wood processing and the production of panels and furniture, pulp, paper and cardboard	149.9
Waste from organic chemical processes	6.1
Waste packaging: absorbents, wiping, cloths, filter materials and protective clothing	29.6
Waste from human or animal care and/or related research (except kitchen and restaurant waste not arising from immediate health care)	2.7
Waste from waste management facilities, off-site WWP and the preparation of water intended for human consumption and water for industrial use	206.9
Municipal waste (household waste and similar commercial, industrial and institutional waste) incl. separately collected fractions	82.1
Other non-hazardous waste	181 668

2.5.2.3 Agricultural wastes

Almost the entire available quantities are being used for other purposes, not for energy generation. The only exceptions are some small quantities of fruit tree and vine pruning branches and of maize cobs that are burned in small individual stoves, as well as some sunflower husks that are used as fuel for steam boilers in sunflower oil refining factories. Only a small part of the available straw is used for heating of farmhouses, for corn drying, etc. Substantial straw quantities are used for litter in animal breeding farms, and most of the remaining straw is being cut in small pieces and ploughed back, thus contributing for improvement of the soil characteristics. There are two principal causes for the still comparatively small use of VAR (Vegetal Agricultural Residues). Firstly, they are seldom yet considered as market commodities, because the general public is not aware of their combustible value. The second cause consists in the still insufficient research activities concerning biomass collection, transport, storage and utilisation. Existing technologies are mostly suitable for obtaining maximum yields of the primary agricultural products. Furthermore, such residues have high specific volume and their handling is financially attractive only if it takes place at a location close to the growing area.

The percentage of VAR, used for energy purposes, will depend in a great extent from the future agricultural policies that will be applied in Bulgaria. From this point of view, it is important that the landowners, co-operative farms and other agricultural producers should provide precise information about the quantities of cultivated crops and the respective yields.

In rural areas practice is the heap up of biodegradable waste. The heaps can be two types- only from manure and from manure mixed with agricultural and food waste. After a period of two-three years the composted natural fertiliser can be used (source NSPLAOW).

In the past few years the following trends are finding out in the stock farming:

- Decrease of livestock breeding - The number of the cattle, sheep and goats-farms for the period 01 May 2006 to 01 May 2007 decrease, but in general it persists a tendency for increase number of the animals, which are in the farms;
- Change of the ownership (from government to private);
- Unprofessional stock-farming, far from the European Standards for efficiency (farmers breed animals only for own consumption), for example most of the farmers breed only from 1 to 5 animals – 84.9% and only 2.6% - over 100 cows.

2.5.2.4 *Bio-wastes from local authorities*

The amount of household waste depends on size and type of the populated area. There are three types of urban areas defined in the Strategic Plan:

Type A: Includes urban areas in big cities composed mainly of apartment buildings. They are characterised with little quantity of biodegradable waste and lots of dumping containers for mixed waste. There are difficulties in applying the system for separate waste collection due to the large population density and lack of information for the advantages of separate waste collecting. In these areas the people do not use the biowaste for heating, feeding of animals and composting.

Type B: Includes family „villas” in the suburbs. They are characterised with a lot of biodegradable waste, individual waste containers and better control from the local authorities in the separated waste collection process. The use of biowaste for heating, feeding of animals and composting in this type areas is on medium level.

Type C: Rural villages. They are characterised with a lot of biodegradable waste, individual waste containers and better control from the local authorities in the separated waste collection process. These areas are the main consumer of biowaste.

At the present moment the waste from households are being dumped in depots, situated at the periphery of the living areas. The households are obliged to pay “municipal waste fee” whose rate is determined per each single service – waste collection and transportation; disposal of the municipal waste on landfills or by other facilities; keeping settlements clean. The citizens are obliged to discharge the waste at sites appointed for this purpose by the municipal regulations and to observe the other conditions and requirements for waste collection and keeping the settlements clean. Table 2.5.2 presents municipal waste management in Bulgaria for the period from 2001 to 2005.

Table 2.5.2: Municipal waste management (2001-2005); Source: Bulgarian statistical yearbook, 2006.

Type	2001	2002	2003	2004	2005
Generated municipal waste (thousand tons)	4,003	3,945	3,916	3,673	3,595
Generated municipal per capita (kg/year)	505	503	502	472	476
Collected municipal waste (thousand tons)	3,211	3,199	3,209	3,092	3,237
Landfill (thousand tons)	3,198	3,188	3,194	3,092	3,144
Temporary storage (thousand tons)	-	-	-	-	93
Landfill sites - number	663	677	706	633	537
Settlements served by municipal waste collection system - number	1,295	1,361	1,465	1,801	2,388

The waste from public parks, gardens and roadside plantations (“green” waste) are being collected separately, most often from Municipal planting companies, and transported separately from the rest of the household waste and are being treated at depots.

2.5.3 Potential plant sites

Agricultural production sites like pig farms or cow farms that are interested in co-fermentation.

Some potential plant sites like pig farms or cow farms, that are interested in co-fermentation are:

- Sliven – pig farm with 12,000 animals;
- Svilengrad – pig farm with 8,000-10,000 animals;
- Yambol - pig farm with 10,000 animals
- Shumen – pig farm with 2,000-2,500 animals;
- Gorna Rossica, Sevlievo district – buffalo farm with 600 buffalos.
- Gramada (under construction) – farm with 600 dairy cows.
- Municipal sites like landfills.

Project “Company with depot for household waste treatment” is in developed stage of preparation. It includes installations for separation and composting, and a depot with four cells. The project will be realised in the vicinity of Shishmantsy village, Rakovski Municipality, at the area of 32 ha, and with capacity of 125,000 t/year and possibility of increasing the capacity to 275,000 t/year.

Rousse Municipality also has prepared a project for “Building of installations for composting and separating of waste – Rousse”, which includes separating installation and installation for composting using the Biodegma technology, with the capacity of 15,000 t/year.

2.6 Assessment of waste business structures in Romania

2.6.1 Introduction

The base document of this section on waste in Romania is the National Waste Management Plan.

In urban areas, the management of municipal waste is performed in an organised system, by specialised services belonging to the municipalities or to private operators. Waste management services are provided based on contracts concluded with individual generators, but this system only covers 95% of all municipal waste generators in the urban areas.

In rural areas, waste management services are not so well organised in many cases the transport to disposal sites being performed individually by the waste generators. Only a limited number of rural settlements are covered by organised waste management services, particularly those located in the immediate vicinity of urban centres. Separate waste collection systems are only implemented in some pilot projects. In total in 2001 the separate waste represented 2% and in 2002 – 7% of the total municipal waste collected. In most of the cases this was recyclable waste separately collected in pilot projects in industrial units, institutions or in sometimes in commerce.

Household waste collection is non-selective (there are only a small number of pilot projects doing that) and usually waste collected it is disposed into land filling (in urban or rural waste disposal sites); according to estimates, a mere 5% of the total quantity of household waste is collected with a view to recovery. There are a number of projects aiming to develop integrated waste management systems in several counties.

The average percentage of biodegradable organic waste from the household waste is 51% (data from 2002). As could be seen in table 1 the biodegradable organic waste increased quantitatively in 2002 as compared with the 1998 data from 139 to 179 kg/inh*year.

Table 2.6.1: Average percentage domestic waste composition for 1998 to 2002 Source: ICIM waste database

Components	1998		2002	
	%	kg/inh. year	%	kg/inh. year
paper, cardboard	13%	34	11%	39
Glass	6%	16	5%	18
Metals	5%	13	5%	18
Plastic	9%	24	10%	35
Textiles	6%	16	5%	18
Biodegradable	53%	139	51%	179
others	8%	21	13%	46
Total	100%	263	100%	352

Two systems for waste collection are used:

- general collection system (no separate collection);
- pilot projects for separate collection of wastes.

Municipal wastes are collected at local levels by the local authorities who have this responsibility (Law 139/2002 to approve the GEO No. 87/2001 regarding the sanitary public services). Every local authority (municipal councils) is obliged to organise this service for the population. Usually in rural areas, the activity of waste collection from the population and economic units is not organised, excepting the rural areas located near the cities. It is estimated that only 5% of the rural population benefits of these services.

Municipal waste from households, institutions, different economical entities (commerce, industry) are pre collected in recipients of different capacities, placed in special locations.

From the total wastewater treatment sludge, only 3% of the annual quantity is used in agriculture. 95% of the municipal waste is disposed every year in the land field. In every urban area at least one waste landfill exists. 252 municipal waste landfills belonging to the cities were registered in 2002, representing 27% of the total number of waste landfills in Romania.

2.6.2 Availability of appropriate organic wastes

2.6.2.1 Kitchen wastes

There is no separate waste collection system implemented up to now. But there are several pilot projects for this.

The pig farms are not using kitchen waste for feeding. Only the small farms are using kitchen waste for feeding.

Hotels and restaurants have to pay for waste removal. The fee for the separate collection is not different, and recently a sanitary tax was introduced, which includes the collection, the transport and the closing of the existing landfill. Thus, this tax reaches 12EUR/tonne and inhabitant (data from 2002).

2.6.2.2 Wastes from Supermarkets

Wastes from supermarkets are collected separately and most of them are recycled. It is not known what happens with it up to this date.

2.6.2.3 Bio-wastes from local authorities

The promotion of new collections systems is already done in pilot projects. This kind of pilot project has been implemented in different counties (e.g. Ramnicu Valcea, Bucharest 2005). A national strategy was developed for a proper management of the waste.

In Romania, according to official data, the average index of municipal waste generation (calculated depending on the inhabitant number from urban and rural areas, respectively of adequate domestic waste generation indexes) had between 1995-2000 a value of 293 kg / inhabitant year, respectively 0.80kg / inhabitant day (comparing to other EU countries, these values are about 40% smaller).

Table 2.6.2: Dense urban areas; Source: ICIM data processing based on the Romania – France Twinning Program

Year	2003	2007	2013
Population evolution (%)	37%	36.5%	35.8%
Populations evolution (no. of inhabitants)	7,992,000	7,805,455	7,538,659
Quantity of produced domestic waste (kg/inhabitant · year)	370	371	400
Quantity of produced municipal waste (kg/inhabitant year)	628	648	680

Table 2.6.3: Urban areas; Source: ICIM data processing based on the Romania – France Twinning Program

Year	2003	2007	2013
Population evolution (%)	15.5%	15.5%	15.5%
Population evolution (no. of inhabitants)	3,348,000	3,314,645	3,268,510
Quantity of produced domestic waste (kg/inhabitant · year)	290	299	314
Quantity of produced municipal wastes (kg/inhabitant · year)	488	504	528

Table 2.6.4: Rural areas; Source: ICIM data processing based on the Romania – France Twinning Program

Year	2003	2007	2013
Population evolution (%)	47.5%	48.0%	48.8%
Population evolution (no. of inhabitants)	10,260,000	10,264,708	10,279,990
Quantity of produced domestic waste (kg/inhabitant · year)	150	154	162
Quantity of produced municipal waste (kg/inhabitant · year)	256	264	277

A series of hypothesis have been proposed in order to develop the scenarios:

- For the dense urban areas, the coefficient of municipal and similar waste collection is 100% and for urban areas is 90% which is estimated to be constant until 2007, when it will increase with 2% per year until 2012, to become 100%.
- For the rural areas, the collection coefficient is about 10%, estimating an annual increase of 1% until 2007 and a 7-8% per year increase between 2008 and 2012. After that, the increase will be 10% until 2013, when the collection coefficient will be 60%.
- The percent of city's wastewater treatment sludge collection is 100%; in urban areas, the percent of collection is 90%, estimating a 1% per year increase to 100% in 2013; in rural areas, the collection coefficient is 10%, estimating a 5% annual increase until 2007, and a later annual increase of 10% until 2014, when it will be 100%.

In Romania, the biodegradable matter from the municipal waste is a major component. This category includes: a) biodegradable waste from household and public alimentation units; b) vegetable waste from parks and gardens; c) biodegradable waste from markets; d) biodegradable component of street waste; e) sludge from treatment of urban waste water;

The percentage of biodegradable matter in the municipal waste decreased from 72% in 1998 to 61% in 2002, but the quantity of biodegradable matter for each inhabitant and year increased in this interval, because the quantity of municipal waste and city sludge also increased (the average of biodegradable waste production during the last 5 years: 243 kg of biodegradable waste per inhabitant and year).

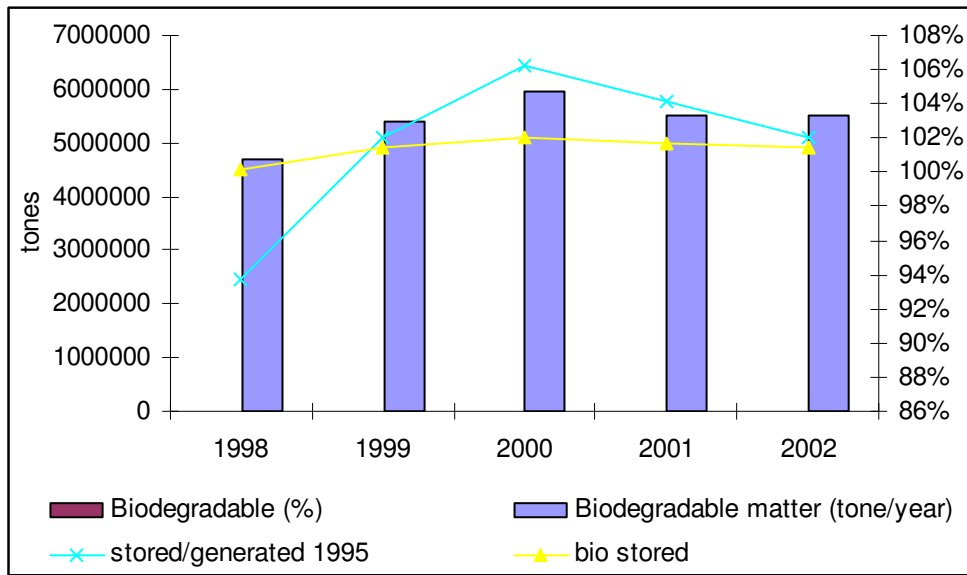


Figure 2.6.1: The dynamics of biodegradable waste generation (Source: ICIM waste database)

For the biodegradable waste, GD No.162/2002 regarding the land fill waste stipulates the necessity of reducing the quantity of biodegradable waste disposed with 25% comparing with the quantity of biodegradable waste produced from 1995 until 2011. Knowing that in the year 1995(year of reference), the quantity of biodegradable waste was 4,800,000.00 tones (representing 70% of the municipal waste), results that the biodegradable waste disposed during 1998 – 2002 increased with 2% in average, having a decreasing tendency. Table 2.6.5 shows the dynamics of biodegradable waste in this period.

Table 2.6.5 The dynamics of biodegradable waste during 1998 - 2002

	UM	1998*	1999	2000	2001	2002	media
Percentage of biodegradable waste in the municipal waste**	%	72	70	67	65	61	67
Quantity of biodegradable matter generated	tons/year	4,677,276	5,412,432	5,942,330	5,520,116	5,520,779	5,414,587
Quantity of biodegradable matter disposed	tons/year	4,500,000	4,900,000	5,100,000	5,000,000	4,900,000	4,880,000
Disposed quantity / generated quantity 1995	%	94%	102%	106%	104%	102%	102%
Tendency comparing with 1995	%	-6%	+2%	+6%	+4%	+2%	+2%
Generated biodegradable	kg/inh. year	208	241	265	246	253	243

* Incomplete data Source: ICIM waste database

** including the biodegradable matter of the wastes from gardens, parks, markets, streets and the wastewater treatment sludge, without the paper and the cardboard,

2.6.3 Potential plant sites

For the moment, Avicola Iasi (Razboieni) announced interest in biogas plant development, and also Copora (Bucharest). Both sites are chicken farms.

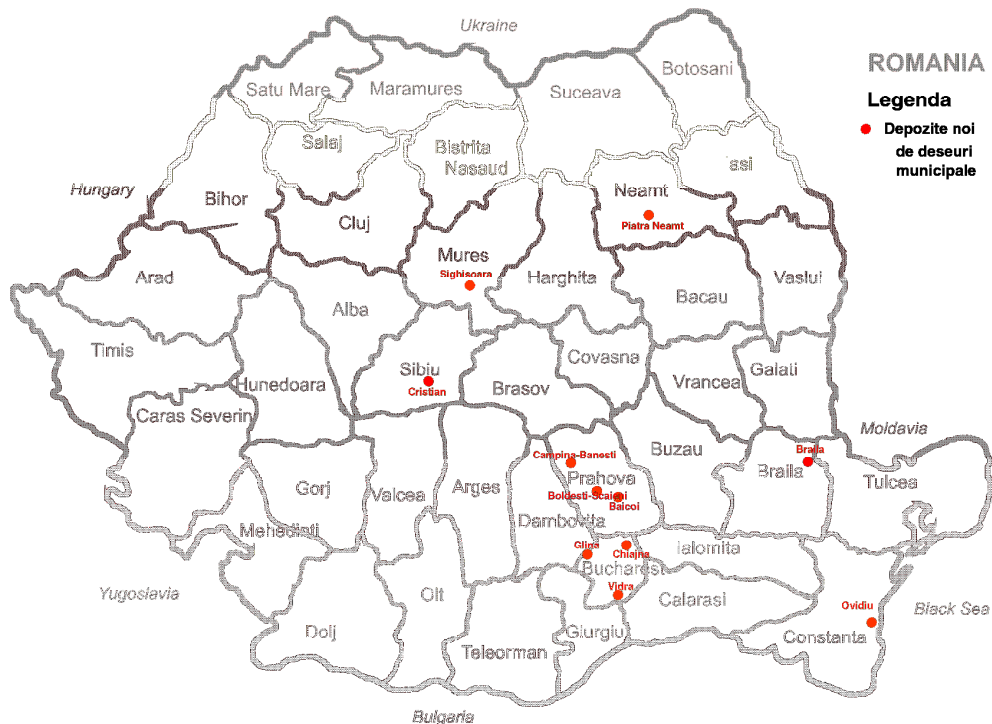


Figure 2.6.2. The new landfill facilities distribution

Table 2.6.5: New municipal waste landfills at national level

No	County	Name of the waste landfill	Opening year	Estimated closing year
1	Constanța	Mixed waste landfill Ovidiu	1997	2025
2	Neamț	Municipal waste landfill Piatra Neamț	1999	2005
3	București	Waste landfill IRIDEX - Chiajna	2000	2019
4	Brăila	Ecologic waste landfill Tracon - Brăila	2001	2031
5	Ilfov	Municipal waste landfill Glină	2001	2005
6	Ilfov	Ecologic waste landfill Vidra	2001	2023
7	Mureș	Municipal waste landfill Sighișoara	2002	2020
8	Prahova	Ecologic waste landfill Băicoi	2002	2012
9	Prahova	Ecologic waste landfill Boldești-Scăieni	2002	2014
10	Prahova	Mixed waste landfill Câmpina-Bănești	2002	2012
11	Sibiu	Ecologic waste landfill Cristian	2003	2034

From total 9,578 thousand tons an uncollected quantity is representing almost 20% (1,946 thousands tons). The total collected (separated and mixed) is representing 7,632 thousand tons, the separated collection representing only 492 tons (ICIM data, 2002).

3 CONCLUSION

The region defined by the countries in this study represents a massive opportunity for the utilisation of biogas technologies. Implementation will enable efficient and environmentally sustainable waste disposal, while at the same time generating a significant amount of energy in a manner that aids the region's responsibility to reduce and offset its carbon footprint. Generally, the countries involved have good infrastructure and framework for waste collection; however the waste is not separated, and largely ends up in landfill sites. EU standards for collection and handling have been largely adopted and there are some (usually small or pilot) programs for separating and recycling. With this basic framework and mentality in place it only requires another step to see the waste streams properly dealt with and used to great benefit, rather than causing environmental, space and economic problems. Most countries are seeing a rise in the amount of waste produced, yet naturally a decline in the availability of space for traditional disposal methods.

There are adequate waste streams to support a variety of biogas technologies and the population density is such that economies of scale can be achieved. The biogas facilities can be distributed to map onto existing waste, industrial and agricultural facilities, thereby introducing very little additional transport costs. The countries also have large agricultural sectors which provide both waste streams, and markets for biogas process by-products such as compost and liquid fertiliser. The overall goal however must be to reduce waste and to recycle as much as possible.

To implement biogas waste treatment and energy production facilities the collection, sorting and recycling economy must be brought up to a standard that treating efforts make sense from the economic point of view. Thereby, tipping fees have to be considered.

With infrastructure and logistics largely in place, and with available waste streams and a healthy agricultural sector, the conditions are very favourable. Options for siting of facilities are numerous as they can be centralised or distributed as required. All the countries involved have ample and well established landfill sites, waste management sites and agricultural farms suitable for co-location of biogas plants. Distributed systems offer more benefits as they can be tailored to specific sites and waste requirements while transport costs are minimised or eliminated. In Germany experience has shown that power generation can be fed into the municipal electricity grid successfully even with very small capacity plants.

Slovenia already has in place some good waste sorting and separation infrastructure and there is a relatively low amount of household waste going into landfill. There are good rates of waste recovery and recycling. Some kitchen waste is collected in brown bins and used in biogas plants and for compost. Some supermarket waste is collected and diverted from municipal waste for compost. There are already biogas plants operating in conjunction with agricultural facilities.

In **Greece**, restaurants and hotels don't currently pay for waste disposal, thereby providing no incentive to separate or reduce the amount. In most other countries waste is charged per square metre of the premises, thus also providing no incentives for reduction.

Latvia also has little or no utilisation of waste streams although some supermarket waste is recovered. In the agricultural sector there are no waste-to-energy processes although like most other countries in the group some wastes from agriculture are returned to the land as fertiliser. There are limited yet growing biogas to heat and electricity plants on landfill sites.

Croatia produces a relatively large amount of waste per capita although there is a reported 10% return through recycling with the balance being land filled. Croatia has a feed in tariff system but low tipping fees.

In **Bulgaria**, approximately 85% of waste is land filled and there is some separation of waste in operation and recycling centres in larger cities. Agricultural holdings are relatively small with much of the production done for self consumption therefore there are fewer opportunities for large farm based biogas plants. Depending on the terrain and road infrastructure this problem can be somewhat overcome however, using community based systems where farmers from the surrounding area all bring their inputs of slurry, silage etc to one location.

In **Romania**, there is very little separation and recovery in operation with only around 5% of household waste being recovered.