Urban waste for biomethane grid injection and transport in urban areas

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Authors: IrRADIARE, Lda
Municipality of Abrantes
Energy Agency MédioTejo21 on behalf of the Municipality of Abrantes

Editors: Filipa Pessoa, Marcos António Nogueira, Flávia Duarte IrRADIARE Lda
José Martins, João Goulart, Paula Grijó, Mónica Martins Municipality of Abrantes/MédioTejo21

Contact: flavia.duarte@irradiare.com
IrRADIARE, Science for Evolution
Rua Marcos Portugal, 8-A
1495-091 Algés
http://www.irradiare.com

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Introduction

Region Note

Medio Tejo and Pinhal Interior Sul (NUTSIII PT166 and P16C) 280000 inhabitants, 4,211km^2 and 3,610M€ of GDP, 5 cities, including the following municipalities: Abrantes, Alcanena, Constância, Entroncamento, Ferreira do Zêzere, Tomar, Torres Novas, Oleiros, Ourém, Proença-a-Nova, Sardoal, Sertã, Vila de Rei, Mação, e Vila Nova da Barquinha.

To consolidate a network of actors as platform for exchange and dissemination of experiences made in the context of implementation of new financial instruments to support investment in sustainable energy solutions, SMEs operating in the energy sustainability sector and sustainable policy development. The focus will be on the development and implementation of non-grant based financial support instruments, such as revolving funds, transregional funds with public counter guarantee and venture capital funds.

The region is committed with innovation, sustainability and growth as a comprehensive approach aimed at repositioning it among the European emergent and competitive regions, manage a better entrepreneurial environment and create more and better jobs. Regional economic clusters promotion aims to exploit opportunities emerging from recent economic landscape changes –recent industrial investments, high way, research facilities, higher education school and investments in tourism infrastructures.

Abrantes is a Portuguese city in the District of Santarém, in the subregion of the Médio Tejo region, in the central region, with about 19132 inhabitants. Belongs to the province of Ribatejo today but without any administrative-political meaning.

It is headquarters of a municipality with 714.73 km^2 of area and 39325 inhabitants (2011), subdivided into 19 parishes. The population density is of 56 inhabitants per km^2.

The municipality is bordered to the North by the municipalities of Vila de Rei, Mação and Sardoal, the East by Gavião, on the South by Ponte de Sor and the West by Chamusca, Constância, Vila Nova da Barquinha and Tomar.

The municipality includes a city, Abrantes, and a village, Tramagal.

Regional adhesion to the covenant of mayors

Changing the paradigm to invest in energy efficiency, performance and renewables is a condition to achieve success in the Covenant of Mayors movement. Scaling-up dispersed projects in order to build-up critically massed networks offers an additional alternative to the already deployed financing mechanisms and opens a notable potential to support the implementation of local sustainable energy action plans. By exhibiting investment opportunities under this paradigm, the involved energy agency contributes to accelerate the enterprises and Society engagement in supporting, investing and participating in the sustainable energy action plans.

Document Organization

This document is organized as follows:

Chapter 1 – Introduction - This section of the introduction summarizes the contents of the remaining chapters and appendices. It gives some information about involved case studies.

Chapter 2 – Overview of municipal waste management – Describes municipal waste generation and municipal waste management in Portugal, Médio Tejo and Pinhal Interior Sul (including Abrantes).

Chapter 3 – Technical requirements for biowaste management system implementation – Describes the collection system approaches and some technologies used on biowaste proceeding treatment.

Chapter 4 – Economic and organizational considerations – Describes the economic side of biowaste management system.

Chapter 5 – Involved parties in the biowaste management chain – Describes which entities are involved in biowaste management chain and their activity.

Chapter 6 – Strategy proposal for a biowaste use in production of biomethane – Development of three ideas related with biomethane production (scenarios).

References

Appendix – Documents with information about the case-studies (description of all), Action Plan for Sustainable Energy and Covenant of Mayors measures.

Important Definitions

For the purposes of this regulation, the following definitions shall apply:

a) Storage — temporary deposition and controlled, for a fixed period, of waste before your treatment, recovery or disposal;

b) Landfill — disposal facility used for controlled deposition of waste, above or below the surface of the soil;

c) Contract — document concluded between the Company and any person, singular or collective, private or public, for which is established between the parties a provision, permanent or temporary or seasonal, service on the terms and conditions of this regulation;

d) Deposition – urban waste packaging in the premises or equipment previously determined by the managing body, to be collected;

e) Undifferentiated Deposition – deposition of municipal waste without prior selection;

f) Selective Deposition – deposition made in order to keep the flow of waste separated by type and nature (as waste paper and cardboard, glass packaging, plastic packaging, biodegradable municipal waste, WEEE, RCD, bulky waste, green, batteries), with a view to specific treatment;

g) Ecocentre — receiving centre endowed with large capacity equipment for selective collection of materials which are suitable for recovery, such as paper, plastic and metal containers, Garden trimmings, bulky objects out of use, or other materials that they have technical feasibility of recovery;

h) Ecopoint — set of containers, placed on public roads, schools, or other public spaces, and for selective collection paper, glass, plastic and metal packaging or other materials for recovery;

i) Elimination — any operation which is not recovery even as secondary consequence the reclamation of substances or energy. Annex III of the Ordinance on March 3, 2092004, contains a non-exhaustive list of disposal operations;

j) Transfer Station — installation where the waste is unloaded in order to prepare to be transported to another place of treatment, recovery or disposal;

k) Marshalling Yard — installation where the residue is separated by manual or mechanical processes in different constituent materials for recovery or other operations management;

l) Fare Structure — calculation rule set expressed in generic terms, applicable to a set of unit values and other parameters;

m) Waste management — collection, transport, recovery and disposal of waste, including the supervision of such operations, the maintenance of the sites after closure and the measures taken as a dealer or broker;

n) Prevention — measures taken before a substance, material or product has become waste, to reduce:

i. the amount of waste, in particular through the re-use of products or the extension of product life time;

ii. The adverse impacts on the environment and human health resulting from waste generated;

or

iii. the content of harmful substances present in materials and products.

o) Waste producer — any person, singular or collective, acting on their own behalf or providing service to third parties, whose activities produce waste or that log pre-treatment, mixing or other that alter the nature or composition of this waste;

p) Recycling — any recovery operation by which waste materials are processed into products, materials or substances for their original purpose or for other purposes. Includes the reprocessing of organic material, but does not include energy recovery or reprocessing into materials that should be used as a fuel or in filling operations;

q) Collection — collection of waste, including sorting and preliminary storage of waste for the purposes of transport to a waste treatment facility;

r) Undifferentiated Collection — urban waste collection without prior selection;

s) Selective Collection — collection made in order to keep the flow of waste separated by type and nature, with a view to specific treatment;

t) Removal — set of operations aimed at the removal of waste from production sites, upon the deposition, collection and transport;

u) Residue — any substance or object which the holder discards or intends or is required to discard, in particular those identified in the European list of waste;

v) Construction and demolition Waste (RCD) — waste originating from construction, expansion, reconstruction, conservation and demolition of buildings and the collapse of buildings;

w) Electric and electronic equipment Waste (WEEE) – electronic and electrical equipment which is a residue, including all components, subassemblies and consumables which are an integral part of the equipment at the time it is thrown;

x) Urban Residue (RU) — waste from households as well as other waste which, because of its nature or composition, is similar to waste from households, including also in this definition the following waste listed:

i. Green Residue — waste from cleaning and maintenance of gardens, green spaces and public areas of cultivation and dwellings, in particular chips, trunks, branches, cutting grass and herbs;

ii. Urban Waste from commercial activity — residue produced by one or several commercial establishments or services sector, with a common administration on each place of waste generation which, because of its nature or composition, is similar to waste from households;

iii. Urban Waste from an industrial unit — residue produced by a single entity as a result of ancillary activities of industrial activity, because of its nature or composition, is similar to waste from households;

iv. Bulky Waste — bulky object out of use from the dwellings which, by its volume, shape or dimension, cannot be collected by normal means of removal. This object is called commonly "Monster" or "mono";

v. WEEE from private households — domestic sector from WEEE, as well as the WEEE from commercial sources, institutional or other industries, which, because of its nature and quantity, is similar to WEEE from the domestic sector;

vi. Packaging Waste — any packaging or packaging material covered by the definition of waste, adopted the relevant legislation applicable in this area, excluding production residues;

vii. Hospital Waste non-hazardous — residue of medical activities developed in units of prevention, diagnosis, treatment, rehabilitation and research related to human beings or animals, in pharmacies, in medico-legal, educational activities and any other involving invasive procedures, which by its nature or composition, is similar to municipal waste;

viii. Urban Waste of large producers – urban waste produced by private individuals or commercial units, industrial and hospital whose daily production exceeding 1100 litres per producer and whose responsibility for its management is of its producer.

y) Reuse — any operation by which products or components that are not waste are used again for the same purpose for which they were conceived;

z) Contract holder — any individual or collective, private or public, that celebrates with the management company a contract, also referred to in the applicable legislation in force by the user or users;

aa) Treatment — any recovery or disposal operations, including preparation prior to recovery or disposal;

bb) Home user – one that use the urban building served for housing purposes, with the exception of uses for common parts, in particular those of condominiums;

cc) Non-domestic-that that User is not covered by the preceding paragraph, including the State, local authorities, autonomous and funds and services of business entities of State and Local industries;

dd) End user – individual or collective, private or public, who are assured of continued form the waste management service and not as an object of its activity the provision of such services to third parties;

ee) Appreciation – any operation the principal result is the processing of waste in order to serve a useful purpose by replacing other materials that otherwise would have been used for a particular purpose, or the preparation of waste to that end, in the installation or in the economy as a whole.

Methodology

The methodology adopted in this document focuses primarily on the study and analysis of the waste management and recovery from 14 European cities. We call this analysis “case-studies”. After the analysis of waste management in 14 European cities mentioned above we have taken a few ideas for creating three different scenarios. These scenarios have as main objective the creation of biomethane through municipal solid waste for later use in fleets.

It was also made an integration of Covenant of Mayors in the created scenarios.

A survey was made to the citizens of Abrantes whose aim is to achieve a large number of citizens and know their opinion regarding the implementation of separate waste collection, and what the possible obstacles.

Present indicators are for the year 2010, for Abrantes area.

Case studies

Amsterdam

The City of Amsterdam has the ambitious plan to cut CO_2-emissions with 40% in 2025 in comparison to the emission level of 1990. In addition the municipal organisation aims to be climate neutral by 2015, with no CO_2 emissions or fully compensating them. To fulfil these ambitions a vast number of actions and measures have to be taken by the municipal organisation, the citizens of Amsterdam and by businesses in the Amsterdam area.

The main activity of AEB (Waste and Energy Company) is to generate energy from Municipal Solid Waste (MSW). This is done by incineration of MSW to produce heat for district heating and electricity production. Furthermore heat and electricity is produced by using biogas from the municipal waste water treatment plant as a fuel for four Combined Heat and Power (CHP) engines. Although waste incineration and biogas utilization both deal with co-generation, the WtE activities will only be discussed briefly. Focus will be on the biogas utilization.

Bern

Bern Township is mandated to recycle by the Municipal Waste Planning, Recycling and Waste Reduction Act (Act 101) to provide curbside recycling services, including curbside leaf waste collection, for all residential households in the Township. Township staff and the Board of Supervisors will need to make a number of decisions pertaining to recycling in order to implement a recycling plan and to make enhancements to the recycling and waste collection system. The Township should view recycling issues and services together with waste collection, not as separate issues.

Birmingham

The Local Strategic Partnership, through the Birmingham Environmental Partnership (BEP), has set a challenge to ensure no more than 50% of all waste produced in the Birmingham City Council local authority area is sent to landfill be 2015 and 0% by 2026. This Total Waste Strategy (TWS) has been developed in response to this challenge and considers the options for meeting the aim of zero waste to landfill.

The total waste arisings, for MSW, C&I, CD&E and hazardous waste streams in Birmingham are estimated to be 3.2 million tons. Moving forward up to 2025, the mid range forecasts remain in the order of 3.1 – 3.2 million tonnes. The analysis of capacity at permitted and exempt waste management facilities and at accredited reprocesses in Birmingham is in the range of 4 to 4.5 million tonnes, of which 2 – 2.5 million tonnes is waste transfer capacity. Birmingham has limited disposal capacity with no active landfill in the city, and the Tyseley EfW facility taking only municipal waste.

Brussels

Since 1992, every 5 years, the Region adopts a "waste prevention and management plan", in short "waste plan". It includes all the means and actions foreseen in order to minimize waste and manage waste products in a sustainable way, and is followed by an evaluation of its implementation.

- 1st waste plan (1992-1997) focused on the introduction of selective collection of waste.
- 2nd waste plan (1998-2002) focused on waste prevention with a goal of reducing the quantities produced by 10%.
- 3rd waste plan (2003-2008) emphasized dematerialization and recycling of waste.
- The 4th waste plan was adopted in 2010 which included: accompanied by an environmental impact assessment (in accordance with EU legislation), indeterminate duration, evaluated every 2 years (instead of 5) and quantitative waste prevention targets to be achieved by 2013 and 2020

Göteborg

At present, household waste that is not subject to producer responsibility is collected by municipalities themselves or by their contractors. Bulk household waste, electrical and electronic waste, and hazardous waste is often taken to municipal recycling stations or left in a bulk waste room. Other types of waste, such as packaging, newspapers, glass, metal, plastics

and batteries, are collected from recycling stations or collection centres in residential areas on the instructions of producers. Municipalities increasingly arrange for household food waste to be collected from homes

The waste water treatment plant at Gryaab has been digesting waste water sludge anaerobically since 1990. The two reactors were built to handle the sludge produced from the treatment of waste water at the Rya plant in Göteborg. The biogas was originally used to generate electricity and heat. Later, the biogas was distributed through the Göteborg gas grid. Gryaabs biogas plant produces each year c. 60,000 MWh of raw gas.

The 50,000 tons of digested sludge produced annually at the biogas plant is composted. Trucks deliver sludge from the Rya plant to the composting facility 6 or 7 times daily. The sludge is first mixed with sawdust or bark. Rock flour and sand is also added after composting, and the final product is marketed as a soil material for construction. Of the order of 194,000 tons of soil material is produced annually for construction of golf courses and roads etc. and as a cover material in landfills.

Helsinki

Helsinki Region Environmental Services Authority (HSY) is responsible for arranging the waste management and transport for residential buildings and the properties of the public administration throughout the metropolitan area. There are several recyclable wastes that are collected. These include organic waste, paper, carton, cardboard, metal, glass, wood and hazardous wastes.

The top priority in the waste management sector is waste prevention. HSY has had a waste prevention strategy from year 2002.

The average inhabitant in the Helsinki metropolitan area produces annually about 300 kilos of household waste. About 55% of household waste is recycled or reused. Compost made from organic waste is used in landscaping. Biogas is also collected from old landfills and waste treatment plants. HSY is planning to increase the efficiency of organic waste management by constructing a biogas digester to extract biogas from the collected organic waste before the composting process.

In recent years, Finland has begun applying the principle of producer responsibility in waste management. This obliges the producer or importer to organize waste management for their products. The principle already applies to waste from electrical and electronic appliances, used tyres, paper products, end-of-life vehicles, batteries and to some extent packages and packaging waste.

Jomala

The Municipality of Jomala was nominated as a finalist for the Nordic Energy Municipality 2011 with the project Jomala Energy Ab. In Åland the district heating system of the Jomala municipality, which has 4100 inhabitants, caters for the heat delivery to 11 public and private sector buildings, among them the local co-operative dairy. In 2005-2010 a project was carried out to replace many old boilers in individual buildings by building a local district heating network. Simultaneously the dairy built a gasification plant to utilize its process waste in gas production. In 2010 the district heating system, operated by the municipality owned company Jomala Energi Ab, was in operation.

The produced biogas now replaces 200 m3 of fuel oil per year in heating also to the dairy premises. In addition, the using of woodchips in the district heating substitutes 600 m^3 of fuel oil per year.

Lidköping

The city of Lidköping, having 38,000 inhabitants, is located in south- western Sweden close to Lake Vänern. The development of biomethane production in the City of Lidköping was initiated in 1990, and in autumn 2011 the plant at the Kartåsen refuse treatment plant will operate with full capacity. It is one of the first of its kind in the world producing both compressed and liquid biomethane for vehicles. The production will be sufficient to cover the consumption of 6,000 cars driving 17,000 km annually.

The Lidköping plant offers a model for compressed and liquefied biomethane production from biological waste. Vehicles are filled up with compressed biomethane at the plant and the gas is transported to near-by filling stations. Big thermostankś are filled with liquid biomethane and transported to bigger cities.

Münster

A functional waste management depends on the participation of all citizens. The waste-conscious behaviour is crucial for the volume and type of waste to be disposed of in Münster. The recycling facilities can only be operated problem-free if waste containers and recycling facilities are properly used. The presentation of recycling products creates an additional motivation to participate in the overall system.

At the end of each year, all citizens will receive a waste disposal calendar that includes the collection schedules for the bio-waste container, yellow bag, residual waste container and paper container but also other important information.

The waste organisation of Münster provides different services to support schools and nurseries, clubs and associations and others who want to teach about waste management. In addition to the personal or telephone consultation, there is information available in class sets as well as a library which contains technical literature. Moreover, you can rent material boxes on different topics. They contain books or videos for all age groups to be used in class. Resources to be used for project weeks or special promotion days can be rented.

Riga

One way how to avoid and reduce waste is to introduce and use the recognized environmental management procedures and systems (EMS).

Waste collection in Riga is centralized. Waste producers sign agreements with waste collection and transportation organizations. Municipal Department of Environment acts as a supervisor and coordinator of the waste management in the city. 6 specialized waste collection and transportation organizations operate in Riga. 173 enterprises collect special waste fractions (construction waste, scrap-iron, used packaging materials etc).

In 2004, total amount of CO_2 and CH_4 emissions per capita was 4.04 tons in Riga, which is quite low in comparison with other European cities.

However, in comparison with year 2000 the emissions per capita have grown by 7%. Such a relatively rapid growth of emissions is connected not only with the growth of the amount of emissions in these years, but also with the decreasing population of Riga City.

Riga City has an environmentally friendly heating balance with a dominating proportion of natural gas (> 60% of the total energy resource consumption). The proportion of natural gas in the aggregate balance has increased in the recent years, similarly also the consumption of natural gas in absolute units has been increasing since 1999. In future it is expected that the role of natural gas will increase even more.

Rogerstone

Construction of a new facility that will not only reduce the amount of waste sent to landfill, but reduce carbon emissions by around 8,500 tonnes each year. The excess heat produced by this process is also returned to the factory. It is forecast to cut energy bills at RF Brookes by up to 10 per cent each year and is part of the company's commitment to produce no landfill waste by 2012.

Stavanger

Stavanger has come far in the area of waste management. About 65% of all household waste is sorted.

Most of this goes to material recovery (paper, glass, metals, bio-waste, plastics, etc.), some consists of quality fire wood, and some again require special waste treatment (hazardous waste, refrigeration units, EE waste). 25% of household waste consists of residual waste for incineration which has a certain degree of energy utilization (energy utilization degree in 2005: 53%), whereas the remaining 10% of total waste goes directly to landfills.

As a municipal organization, the City of Stavanger has the opportunity and obligation to work actively to minimize its own material consumption and waste generation.

The City of Stavanger will thus make its own experiences in a more eco-friendly consumption of resources, and install positive attitudes and awareness among its employees. We will also take the lead and act as a good example for both private citizens and commercial players in the municipality.

Stockholm

Waste management has gone through major changes during the last decade. The implementation of producer responsibility, successive landfill bans for different waste types, national environmental targets for biological treatment and nutrient recycling, as well as taxes on landfills have together with different private and municipal initiatives contributed to more resource-efficient waste management. However, the amount of waste generated in society is generally still increasing.

The best way to reduce the amount of waste is to make sure that it is never generated. Therefore, prevention has top priority in the EU waste hierarchy. Second comes re-use, material recycling and energy recovery. The waste should generally speaking flow upwards in this hierarchy.

New goods and products can be manufactured using recycled material, electricity and district heating can be produced from sorted combustible waste, and biogas and plant nutrients can be made from sorted food waste.

Tallinn

Tallinn has organized municipal waste transport system to avoid illegal waste disposal and harm to the environment:

- city sets service fee limits and standard terms, joining is mandatory for all residents and businesses
- this service is outsourced to the public sector on the basis of procurement results

City-wide network of 23 waste stations accept recyclable, electronic and hazardous waste free of charge from residents.

Tallinn has further plans to cut back reliance on natural gas and increase the share of locally sourced biofuels

In 2008 the new Tallinn Power Plant was completed, utilizing renewable biofuels (wood chips and peat), provides 22% of the city's district heating needs and 9% of electricity and in 2011 Tallinn successfully merged the primary district heating areas, allowing for the increase in biofuel based heating to rise to 30%.

Reference Cases

	Amsterdam	**Bern**	**Birmingham**
Separation			The feedstock would be separately collected food waste from households and commercial and industrial customers
Collection		Citizens have to pay a supervisor	The majority of waste is going through a waste transfer station
Incineration	To generate energy from Municipal Solid Waste	Local energy supplier for the City of Bern supplies energy	As a help for the production of energy
Anaerobic Digestion			Link the AD facility to a further CHP system. A better approach to save energy
Biogas	Biogas is used as a fuel from the municipal waste water plant	Local Waste Water Treatment Plant produces biogas and up-grades it to biomethane	Can be used to generate electricity for export or used on site. Used in some instances as a bio-fuel.
CO_2 Emission	Development of smart ICT solutions to decrease CO_2-emissions		Create a vibrant low carbon low waste economy

	Brussels	**Göteborg**	**Helsinki**
Separation	The introduction of selective collection of waste.	Bulk household waste, electrical and electronic waste, and hazardous waste is often taken to municipal recycling stations or left in a bulk waste room.	The waste treatment centre receives unsorted waste and separately collected organic waste from over a million inhabitants
Collection	Activities for the '-100 kg' campaign	Household waste that is not subject to producer responsibility is collected by municipalities themselves or by their contractors	The average inhabitant in the Helsinki metropolitan area produces annually about 300 kilos of household waste. About 55% of household waste is recycled or reused.
Incineration	Undertake a study to consider an incineration tax		Helsinki has decided to introduce a new incineration plant in 2014.
Anaerobic Digestion		The waste water treatment plant at Gryaab has been digesting waste water sludge anaerobically since 1990.	Helsinki is planning to increase the efficiency of organic waste management by constructing a biogas digester to extract biogas from the collected organic waste before the composting process
Biogas		The biogas was originally used to generate electricity and heat. Later, the biogas was distributed through the Göteburg gas grid	Biogas is also collected from old landfills and waste treatment plants.
CO_2 Emission			

	Jomala	**Lidköping**	**Münster**
Separation			Brochures covering all topics related to the avoidance and separation of waste are vitally important for the information of Münster citizens
Collection			At the end of each year, all citizens will receive a waste disposal calendar that includes the collection schedules for the bio-waste container, yellow bag, residual waste container and paper container but also other important information.
Incineration			
Anaerobic Digestion			
Biogas	The main byproduct utilized in the gasification is whey. The gas is fed to the district heating boiler and also used for heating in the dairy process	It is one of the first of its kind in the world producing both compressed and liquid biomethane for vehicles.	Sewage gas, landfill gas and biogas gained from fermentation run a combined heat and power plant
CO_2 Emission		Reduction of 16,000 tonnes of CO_2 emissions per year	Reduction of CO_2 Emissions 1995 – 2005 • Target: - 25% • Achievement: - 21%

	Münster	**Riga**	**Rogerstone**
Separation	Brochures covering all topics related to the avoidance and separation of waste are vitally important for the information of Münster citizens	The recycling process of waste has been implemented and today 25% of the total amount of waste is recycled.	
Collection	At the end of each year, all citizens will receive a waste disposal calendar that includes the collection schedules for the bio-waste container, yellow bag, residual waste container and paper container but also other important information.	Waste collection in Riga is centralized. Waste producers sign agreements with waste collection and transportation organizations.	
Incineration			
Anaerobic Digestion			
Biogas	Sewage gas, landfill gas and biogas gained from fermentation run a combined heat and power plant	Old landfill area has been covered and land-fill gas production system (13 million Nm3/year – 26000 MWh) has been built	By-products from a food factory are converted into methane, which is burned to generate electricity that feeds back into the factory
CO_2 Emission	Reduction of CO_2 Emissions 1995 – 2005 • Target: - 25% • Achievement: - 21%	In 2004, total amount of CO2 and CH4 emissions per capita was 4.04 tons in Riga, which is quite low in comparison with other European cities	The new facility will not only reduce the amount of waste sent to landfill, but reduce carbon emissions by around 8,500 tonnes each year.

	Stavanger	**Stockholm**	**Tallinn**
Separation	Stavanger has come far in the area of waste management. About 65% of all household waste is sorted.	All of the City's operations will sort their food waste for biological treatment aimed at biogas production and nutrient recycling	City-wide network of 23 waste stations accept recyclable, electronic and hazardous waste free of charge from residents
Collection	In 2002 every inhabitant of Stavanger generated 372 kg of household waste, while in 2008 this figure had grown to 427 kg	Differentiated waste fees, weight-based fees and similar actions can inspire and motivate to changed behaviour aimed at minimizing waste quantities and directing towards increased sorting	Tallinn has organized municipal waste transport system to avoid illegal waste disposal and harm to the environment
Incineration	25% of household waste consists of residual waste for incineration		
Anaerobic Digestion			
Biogas	Bio-waste collected from the households to be used for production of bio-gas	The City will strive to increase biogas production in the region.	In 2010, heat and electricity co-production started in new landfill from gas gathered from landfill deposits
CO_2 Emission	Stavanger will endeavour to ensure that all stages of the chain are optimized with a view to minimizing greenhouse gas emissions.		

Overview of municipal waste management

Municipal waste generation in Portugal

The total production of Urban Waste in Portugal, in 2010, was approximately 5.239 million tons, and there has been a decrease of about 0.03% compared to 2009. In regard to the quantity of waste produced per capita, it is found that the annual capitation in 2010 was 512 kg/cap.year, corresponding to a daily production of 1.4 kg urban waste per capita.

In the table below it is possible to see the amount of waste by sector in Portugal (glass, paper and cardboard, packaging, batteries and biodegradable).

Table 1 - Total amount of urban waste and waste composition (2010) in Portugal (Font: INE)

Municipal waste collected per capita (kg/cap.)	**Selectively collected municipal waste (t) by type of waste collected separately; Annual**					
	Type of waste collected separately					
	Total	Glass	Paper and Cardboard	Packaging	Batteries	Biodegradable
Kg/cap	t	t	t	t	t	t
512	523950	182541	182981	77840	169	80420

In Portugal recycling and organic recovery rates are progressing favorably, approaching gradually EU average (16.4% and 9.8%, respectively).

10,1% of the total waste produced were send for recycling, 7,6% were send to organic valorization, 18% were send to energetic valorization and 64,3% were send to landfill. This scenario must change, we should send to landfill less percentage of waste and we should recycle more. Portugal is doing an effort to change and to get closer of UE averages.

Municipal waste generation in Médio Tejo and Pinhal Interior Sul Regions

The total production of urban waste in Médio Tejo and Pinhal Interior Sul in 2010 was 107.028t. In regard to the quantity of waste produced per capita, it is found that the annual capitation in 2010 in Pinhal Interior Sul was 310Kg/cap and in Médio Tejo was 411Kg/cap.

In the table below it is possible to see the amount of waste (t) by sector in Pinhal Interior Sul and Médio Tejo (glass, paper and cardboard, packaging, batteries and biodegradable).

Table 2 - Total amount of urban waste and waste composition (2010) in Médio Tejo and Pinhal Interior Sul (Font: INE)

	Municipal waste collected per capita (kg / cap.)	**Selectively collected municipal waste (t) by Geographic localization and type of waste collected separately; Annual**					
		Type of waste collected separately					
		Total	Glass	Paper and Card	Packaging	Batteries	Biodegradable
	Kg/cap	t	t	t	t	t	t
Pinhal Interior Sul	310	743.935	203.564	282.596	257.453	0.322	0
Medio Tejo	411	8213.621	3126.824	3165.628	1914.012	7.157	0
Total		8957.556	3330.388	3448.224	2171.465	7.479	0

11,6% of the total waste produced were send for recycling, 7,9% were send to organic valorization, 0% were send to energetic valorization and 80,5% were send to landfill.

Municipal waste generation in Abrantes

The total production of urban waste in Abrantes in 2010 was 17.747t. In regard to the quantity of waste produced per capita, it is found that the annual capitation in 2010 was 450Kg/cap.

In the table below it is possible to see the amount of waste (t) by sector in Abrantes (glass, paper and cardboard, packaging, batteries and biodegradable).

Table 3 - Total amount of urban waste and waste composition (2010) in Abrantes (Font: INE)

	Municipal waste collected per capita (kg / cap.) By geographical location; Annual	**Selectively collected municipal waste (t) by Geographic localization and Type of waste collected separately; Annual**					
		Type of waste collected separately					
		Total	Glass	Paper and Card	Packaging	Batteries	Biodegradable
	Kg/cap	t	t	t	t	t	t
Abrantes	450	1877.966	547.036	895.242	434.396	1.292	0

19,3% of the total waste produced were send for recycling, 35,7% were send to organic valorization, 0% were send to energetic valorization and 45% were send to landfill.

Municipal waste management system in Portugal

Organizational model of waste management sector in Portugal is historically associated with municipalism by its proximity and association with health conditions and safeguard public health. However, the Community requirements and the need for large investments in infrastructure of reasonable size such as landfills, organic recovery stations and/or energy recovery centers, imposed the development of an organizational model that exceeded the boundaries of municipalities. There were well-municipal systems consisting of two or more municipalities and companies managed by majority public-owned utilities.

Currently, we are witnessing a new trend which involves the integration and merger of some of these systems that gaining size, acquires new economies of scale, looking for profitable means and equipment available, as well as ensuring sustainability for the future and positioning to ensure support financial community.

Waste management is currently carried out by 23 waste management systems, in Portugal, 12 municipalities associations and 11 municipal systems. The distribution systems are as follows:

- Northern Region: 8 systems, including 5 multimunicipal systems;

- Central Region: 5 systems, which 3 are multimunicipal systems;

- Region of Lisbon and Tagus Valley: 5 systems, including 2 multimunicipal systems;

- Region Alentejo: 5 Systems, including 1 multimunicipal system;

- Algarve Region: 1 System which is multimunicipal.

Municipal waste management legal framework

The current waste policy of the European Union is based on applying so-called "hierarchy of waste management." That means, preferably, should opt for that waste prevention and whose production can’t be avoided, preferably, reused, recycled or reclaimed where possible, and its disposal in landfill reduced to a minimum. The elimination is considered the worst option for

the environment as it involves a loss of power and resources to become a future environmental liability (CEC, 2005).

European legislation has been transposed into national law, and the general rules which govern the management of waste in the country established by Decree-Law 178/2006 of 5 September. This law aims to contribute to the prevention and reduction of production or harmfulness of waste, particularly through the reuse and modification of production processes, through the adoption of cleaner technologies, as well as awareness of economic agents and consumers.

Another important decree-law is Decree-Law No. 45/2008, of 11 March 2008, that ensures the performance and respect under national legislation of the obligations upon the Portuguese State of Regulation (EC) No 1013/2006 of the European Parliament and the Council, of 14 June 2006 on the transfer of waste.

Decree-Law No. 183/2009 of 10 August 2009, establishing the legal framework for landfilling of waste, the technical characteristics and requirements to be followed in the design, licensing, building, operation, closure and post-closure of landfills, transposing Council Directive No 1999/31/EC of 26 April 1993 on landfilling of waste, amended by Regulation (EC) No 1882/2003 of the European Parliament and the Council, of 29 September 2003, applies Decision No. 2003/33/EC of 19 December 2002 and repeals Decree-Law No. 152/2002 of 23 May 2002.

A series of strategic guidelines for waste management have been laid down in specific waste management plans, particularly from the late 1990s onwards. The most significant examples include the Strategic Solid Urban Waste Plan (PERSU), the Strategic Hospital Waste Plan (PERH) and the Strategic Industrial Waste Management Plan (PESGRI).

Table 4 - Sectorial waste management plans (Font: APA, 2009)

Waste	Sectorial management plans	
Urban Waste	PERSU (1997)	Strategic Solid Urban Waste Plan
	ENRUBDA (2003)	National Strategy for the Reduction of Biodegradable Urban Waste for Landfill
	PIRSUE (2006)	Solid Urban Waste and Equivalent Action Plan
	PERSU II (2007)	Strategic Solid Urban Waste Plan (revises the PERSU, ENRUBDA and PIRSUE)
	PPRU (2009)	Urban Waste Prevention Programme
Industrial Waste	PESGRI (1999)	Strategic Industrial Waste Management Plan (amended by PESGRI 2001)
	PNAPRI (2000)	National Industrial Waste Prevention Plan
	PESGRI (2001)	Strategic Industrial Waste Management Plan
Agricultural Waste	PERAGRI	Strategic Plan of Agricultural Wastes (orientation document)
Hospital Waste	PERH (1999)	Strategic Hospital Waste Plan Strategic Hospital Waste Plan 2010-2016 (open to public consultation)

Municipal waste management system in Médio Tejo and Pinhal Interior Sul Regions

Municipal waste management system in Médio Tejo and Pinhal Interior Sul is responsible for collection, sorting, recovery and treatment of solid waste in 25 municipalities and its main mission is the environment preservation where it operates and improves the service provided to people in Urban Solid waste management.

Consumption tends to increase waste production and waste quantities are nowadays one of the problems that modern societies are struggling and these environmental pressures require careful attention.

The solution to these problems is thus the adoption of responsible behavior from people with the support and encouragement of their representatives, Local Authorities and Governments. In recent years has been traversed a path whose results were rewarding, and, continuing its policy of improving continues to work knowing that there is still much to do. Public contribution and encouragement is essential to proceed, facing the municipal solid waste as a raw material with economic value and contribute to sustainable development of our region, which is essential for improving the quality of life of all of us.

It was assumed from the beginning of its constitution an integrated treatment of all waste. Over the years, this goal has become a reality and the system has extended its range of intervention, assuming today as a system of treatment and recovery of waste truly integrated.

Municipal waste management system in Abrantes

Abrantes municipal waste management system works the same way as Médio Tejo and Pinhal Interior Sul.

Technical requirements for biowaste management system implementation

Biowaste collection systems/approaches

On average, 40% of EU bio-waste is still landfilled in 2010 (up to 100% in some Member States). Big improvements have been made in the last decade in order to ensure better landfill management. However, landfilling invokes major environmental risks such as emissions of greenhouse gases (methane) and pollution of soil and groundwater and, withdraws valuable resources (compost, energy) irrevocably from economic and natural cycles.

In addition to mixed waste collection, which severely limits the possible treatment options, different collection schemes are practiced for bio-waste. Source separated collection (source separated collection means only bio-waste is targeted, not plastics or other non-biodegradable (e.g. retail) waste), this can be organised in different ways:

Door-to-door;

Bring to centralised or decentralised (road/neighbourhood) container systems.

The decision whether a selective collection system should be introduced and the choice of the best system are crucial questions public authorities must answer. It is up to Member States to determine whether separate collection of bio-waste is appropriate. This depends on:

- **Adaptation of the collection schemes to the local context**

Population density is an important element since source-separated collection can be difficult to implement:

• in highly-populated areas, i.e., due to insufficient space for storage of several waste streams inside home sorting as underlined in the cannex of the COM(2010)23528 may be ineffective, leading to lower amount and lower purity of the targeted selective stream,

• in very rural areas, i.e., great distances covered per amount collected (however, this plays a limited role in the overall impact)

- **Climate may play a crucial role in the decision of collection frequency**

Depending on temperature and/or moisture, bio-waste collection will take place more or less frequently with the aim to prevent odour and hygiene problems. This is of course also valid for unsorted household waste.

- **Existing legal framework**

E.g. the Landfill Directive targets determine the need for alternatives to landfilling. If mixed waste is incinerated or treated with Mechanical-Biological Treatment (MBT) (stabilisation of organic matter), no selective collection is required. In other cases, both composting and anaerobic digestion need source separated collection.

- **Potential amount of bio-waste that can be collected**

- **Type of waste streams collected**

Garden waste and food waste. Indeed, garden waste has characteristics that make it very different from food waste, including:

• A low putrescence and generally low moisture level;

• Generally lower density;

• A production rate that varies during the year;

• A production that varies geographically.

- **Downstream treatment options and existing collection, processing and disposal infrastructures**

- **Market for the compost (easier to find if good quality) and other recyclables (biogas, digestate, Refuse Derived Fuel)**

Biowaste treatment

The treatment methods aiming at valorising the organic content of bio-waste on land work better with source separated waste, as the risk of contaminated biowaste is too high when using mixed waste that is separated after collection. This does not apply to mechanical biological treatment, incineration and landfilling.

Table 5: Main treatment methods for bio-waste

Treatment method	Further characterisation
For source separated bio-waste collection	
Anaerobic digestion	Solid and liquid digestion with and without post-composting of digestate composting, efficiency of the energy recovery, dry or wet, mesophilic or thermophilic, continuous or discontinuous, 1-stage or multi-stage. Gains linked to energy production and use as fertiliser in agriculture
Composting	Open and closed types (pile, tunnel, composting in boxes/containers, etc.), centralised or home composting, type of ventilation system maturation time. Gains linked to use as fertiliser in agriculture
Pyrolysis and Gasification	Mainly applied on dry streams, with the view of burning for energy recovery. They are intrinsically attractive technologies but still present technical challenges and cannot be considered as technically mature enough for bio-waste management. Could also be applied on mixed streams

For mixed waste collection (i.e. bio-waste together with non-organic fractions)	
Mechanical biological	Is the pre-treatment to separate biodegradable waste followed by treatment treatment similar to "source separated waste". Separation is based on mechanical properties. Possible treatments of organic fractions are: composting (stabilization), and anaerobic digestion with energy recovery. In case of AD, additional treatment of the digestate is needed (composting) before use as filling/covering material or before incineration
Incineration	Type of flue gas treatment. Efficiency of the energy recovery (energy recovery is currently widespread and even systematic in new plants)
Landfilling	The recovered landfill gas can either be burnt in flares or be recovered for energy (electricity and/or heat) generation

Pyrolysis and Gasification are much less applied than the other techniques.

Incineration can also treat oversized rejects from green waste compost facilities (after selective collection).

For each of these treatment methods there are a number of essential factors that can influence environmental performance and must be considered. These will be explored in the following subchapters.

Anaerobic digestion

Background and principles

Anaerobic digestion is a process that breaks down organic matter into simpler chemical components without oxygen input, avoiding oxidation of the matter (under anaerobic conditions). This degradation process involves methanogenic bacteria which work at different temperatures and various pH values. Anaerobic digestion also generates considerable gas emissions (e.g., methane, ammonia, nitrous oxide) that need to be captured (and preferably used for energy recovery).

Anaerobic digestion may treat a wide range of organic waste streams including sewage sludge, municipal solid waste, and organic industrial, commercial and agricultural waste. Digestion of mixed waste renders it almost impossible to use the digestive as a fertiliser in agriculture because of the high risk of contamination. Digestion of separately collected biowaste allows energy production and use of the digestion as a fertiliser in agriculture.

The high moisture content of kitchen waste and biowaste from canteen, hotels and restaurants render these wastes particularly suitable for anaerobic digestion.

On the contrary, ligneous elements (green waste in particular) are typically not directly degradable by anaerobic digestion (not without resorting to a range of chemical/physical processes). However, it is possible to separate the wood fraction and use it as an energy carrier.

Technology and key parameters

The following factors are essential to have an efficient anaerobic digestion process, but are not exhaustive:

• Temperature (T): the higher the temperature, the more effectively pathogens, viruses and seeds are destroyed. Other parameters also influence the efficiency of this destruction;

• Retention Time (RT): it represents the time the feedstock spends in the digester: the longer, the better. The rate of the reaction is not constant, but decreases with increasing residence time. The "optimal" retention time depends on the feedstock and the operational parameters (in particular temperature);

• PH: A pH value near neutral is the optimum for anaerobic digestion and below 6.8 methanogenic activity is inhibited;

• Ammonia concentration is a critical parameter. The optimum C/N (Carbon/Nitrogen) ratio in anaerobic digesters is between 20 and 30, but it is less crucial than for composting);

• Water content;

• Mixing: Good mixing is required to obtain homogeneous optimal process conditions;

• Redox conditions;

• Content of lignin in waste.

A range of different technologies for anaerobic digestion of organic waste exists, the digestion system can be:

• Dry, semi-dry or wet (containing typically <10%, 10-20% and 20-40% dry matter, respectively);

• Wet and semi-dry processes normally require stirred reactors and frequently treat a mixture of municipal organic waste, industrial organic waste and manure or sewage sludge. In dry anaerobic digestion, the municipal organic waste is often mixed with drier waste, e.g., garden

waste, to obtain a good structure. The dry process may be batch wise or continuous (plug flow);

• Continuous, semi-continuous or in batch;

• Semi-continuous systems aim to optimise digestion and improve control of the process in separating the stages of digestion;

• Thermophilic (49-60°C) or mesophilic (25-35°C);

• Thermophilic digesters might be more efficient (shorter retention times, higher loading rates and gas production, more effective sterilisation), but also require closer process control than mesophilic digesters.

The outputs are:

• Digestion, which is made up of fibres and liquid residues. The digestion can be:

- Directly used on land as fertilizer (e.g., digested is often applied directly on farmland in Sweden). In this case, the organic matter is not stabilised or sanitised, which may lead to leaching of pollutants to soil. Digested is a liquid fertiliser providing soil nutrients, but does not improve soil structure.

- Composted. This is necessary to sanitise the digested and reduce the risk of toxicity to humans. The organic matter is stabilised and sanitised, leading to increased organic content of the soil. When the digested is composted, the resulting compost is similar in quantity and composition to the compost from direct composting of biowaste.

Biogas is made of methane, carbon dioxide and water vapour (and possibly hydrogen sulphide). After possible treatment to remove hydrogen sulphide, it can be used as a source of energy to replace natural gas for the production of heat, electricity and as a fuel for vehicles (as a substitute for natural gas, gasoline or diesel).

Composting

Background and principles

Composting is the aerobic degradation of waste by micro-organisms and fungi to produce compost that can be used as a soil improver and organic fertiliser. Due to the high temperature generated (55°C and more) by the process, harmful microorganisms and undesirable seeds and weeds or roots are destroyed. Though CO_2 (of biogenic origin) is the main gaseous emission from the composting process, other gases are typically found including

methane, ammonia and nitrous oxide. To reduce environmental impacts from composting, it is therefore important to minimise generation and emission of these gases, e.g., using biofilters.

Compost can have an added value on fields as it can improve soil structure and quality by adding organic matter, nutrients and a diversified biologic life (micro-organisms).

Technology and key parameters

The following factors affect the overall performance of the composting process, and should be carefully monitored:

• Nature of the input waste, in particular the nature of the organic carbon (as this determines the actual biodegradability);

• Aeration (in order to maintain aerobic conditions within the whole composting mass and to avoid the formation of anaerobic pockets within the mass and to avoid odours): effectiveness of the turning, airflow systems, frequency of turning;

• Temperature (in order to degrade unwanted matter without destroying all microbiological activity);

• Moisture content and pH;

• C/N (Carbon/Nitrogen) ratio of the biowaste;

• Availability of a growing medium that provides living organisms the energy required for their development;

• Low content of potential pollutants (heavy metals, organic pollutants);

Besides this, valorisation of outputs also increases the environmental balance of the composting process: in particular, using the residual heat from composting is a promising new technique that might lead to an improved environmental profile.

The following aspects markedly influence the quality of compost:

• Separate collection is necessary to ensure the compost is uncontaminated. The composting process must operate continuously under aerobic conditions at optimum moisture content in order to provide favourable conditions for humus formation;

• Good control of the composting process (mainly optimum temperature) to ensure pathogen destruction.

• Compost should undergo a sufficiently long maturation process. Due to the high temperature during a sufficient period, sufficient moisture and shifting conditions, harmful micro-organisms and undesirable seeds or weeds/roots are destroyed;

• Compost must not contain toxic nor visible elements, like plastic particles.

As selective collection normally delivers pure organic, clean and not contaminated raw materials, compost usually contains a low amount of pollutants (heavy metals, organic pollutants).

It is possible to separate the wood fraction and use it as an energy source.

Mature compost is used in applications such as for peat substitution, mineral nutrient substitution, erosion control, increasing water-holding capacity, and organic matter content of the soil.

Composting of biowaste fractions can take place in a number of different ways:

• Home composting is the composting of biowaste as well as the use of the compost in a garden belonging to a private household". Recycling at the point of production has the advantage of avoiding the collection step and buying alternatives. On the other hand, it is necessary to ensure that the citizens have enough knowledge and commitment to compost their waste correctly, otherwise it can generate greenhouse gases such as methane and be environmentally problematic.

The most common home composting techniques are:

- Heap/piles;
- Composting bins;
- Silos or open boxes;
- In-house worm composter;

Pyrolysis and Gasification (Other options for energy recovery)

A wide range of emerging thermal treatments exist for the treatment of municipal waste (not only biowaste), Pyrolysis and Gasification being perhaps the most promising at this time.

Pyrolysis is a thermal process where the organic fractions in the waste are broken down the absence of oxygen and under pressure. The process efficiency increases for increasing content of carbon in the waste input. Also, it is important that the waste input is selectively collected,

so that most of the non-organic components are removed and the waste is homogeneous. The Pyrolysis process produces both a liquid residue and gaseous output; the latter may be combusted to generate electricity. In addition, a solid char is produced which may require disposal (e.g., landfilling) or additional processing (e.g. gasification).

Gasification requires the addition of an oxidant (e.g. air or oxygen) and typically operates at a higher temperature than pyrolysis. The solid char output from a pyrolysis plant may be fed into the gasification process. Gasification of organic waste (e.g. biowaste) generates a gas that can be burnt to generate electricity and a char. The latter may be used as secondary construction material, thereby substituting virgin materials; if no markets are available, it usually requires disposal.

These technologies still present technical challenges and are not as extensively applied as e.g. incineration or composting. Some of them are still in a pilot stage and experiences with large scale facilities (e.g. with an annual capacity of 10.000 tonnes) may be limited. Extensive and robust data-sets on pyrolysis and gasification plants is therefore still limited, which in turn does not allow conducting extensive assessment of their actual environmental performance. However, pyrolysis and gasification of waste are generally expected to become more widely used in the future. A main reason for this is that public perception of waste incineration in some countries is a major obstacle for installing new incineration capacity.

Mechanical Biological Treatment (MBT)

Background and principles

Mechanical-biological treatment (MBT) is a general term covering a variety of combinations of centralised mechanical separation systems linked to one or many biological treatment methods, which allow:

• Extraction of biodegradable waste for specific treatment;

• Pre-treatment of biodegradable waste to be landfilled, reducing its mass and stabilising it;

• Diversion of the biodegradable fraction from landfill.

Mechanical biological treatment is often used to reduce waste volume and mass and to stabilise the biodegradable fraction of MSW before it is landfilled. This in turn leads to reduction of landfill odours and of biogas generation and to generation of leachate with lower concentrations of organic matter and other pollutants. MBT is frequently employed to comply with the landfill Directive, i.e., to reduce the biodegradable fraction of waste going directly to landfill. The MBT process may lead to the generation of a variety of gaseous pollutants (e.g.

methane, ammoniac, laughing gas), which makes it crucial to implement extensive emission control measures.

Technology and key parameters

MBT plants combine several types of waste treatment (i.e., sorting, biological treatment, etc.).

The biological process in the MBT can be:

• Aerobic: the process is conducted as a classic composting process (on selected organic fractions);

• Anaerobic: the biological process consists of a fermentation stage producing biogas and a digestion that can be composted, but cannot be used for soil improvement. Application of anaerobic digestion to biowaste derived from mechanical sorting of mixed waste has often proved to be very critical for the process itself (clogging of the reactor due to inert materials, etc.). Therefore, most often composting is preferred.

The following outputs can be recovered from MBT facilities:

• Compost, not suited for application on soil because of the high contamination risk; this is more likely to be called Compost-Like Output (CLO). The organic fraction is bio-stabilised. This has the advantage of reducing biodegradation inside the landfill and the associated odours and methane emissions;

• Recyclable materials (e.g., metals, plastics), containing more impurities than materials from selective collection (of packaging);

• Biogas (in case anaerobic digestion is applied). However, application of Anaerobic Digestion to "dirty" bio-waste, i.e., to that derived from mechanical sorting of mixed waste, has often proved to be very critical for the process itself (clogging of the reactor due to inert materials, etc.);

• Refuse Derived Fuel (RDF), i.e., pellets of fluff with high caloric value, for energetic valorisation.

Incineration

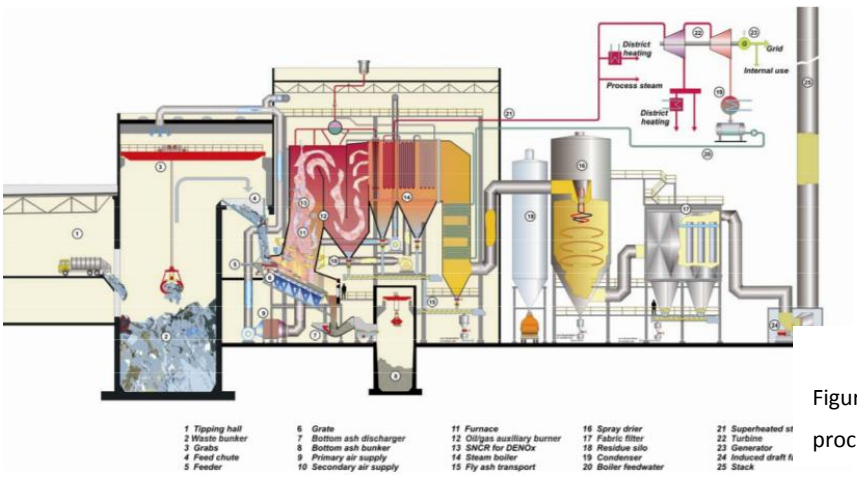

Figure 1 – Waste incineration process.

Background and principles

Incineration is a waste treatment method that involves combustion of waste material. It is used to treat of solid and liquid wastes. Incineration is further described according to the type of waste incinerated:

• Mixed municipal and similar industrial and commercial waste incineration;

• Hazardous waste incineration (such as biological medical waste);

• Sewage sludge incineration;

• Pre-treated municipal or other pre-treated waste incineration (RDF), although it is usually intended for co-combustion;

The objective of waste incineration, common to most waste treatments, is to treat waste to reduce its volume and hazard, whilst capturing (and thus concentrating) or destroying potentially harmful substances. In the case of biowaste, there is (almost) no residue from incineration (it is fully combustible or evaporable (water)).

Incineration processes can also provide a means to enable recovery of the energy, mineral and/or chemical content from waste. The heat produced by the combustion is nowadays extensively recovered, by producing steam that can be converted into hot water (for heating purposes), steam (industrial processes) and electricity. The process (fans, electrofilters pumps, etc.) consumes about 10% of the energy produced.

Incineration also produces solid residues:

• Bottom ash: Ferrous (iron, steel) and non-ferrous metals (such as aluminium, copper and zinc) are extracted from the bottom ash. After extraction of metal objects and further processing, bottom ash can be used as secondary raw material, e.g., in road construction, as a foundation material (conditions are to be respected to avoid leakages of potential toxic substances), in noise barriers, as a landfill capping layer and in some countries as an aggregate in asphalt and concrete. In practice, this does not concern as biowaste as such is fully burned and produces no bottom ash (only some fly ash).

• APC residues: A solid residue separated from the incinerator flue gas. APC residues composition depends on the design and operation of the flue gas treatment plant. Typically, APC residues consist of one or more of the following components: fly ash, boiler ash, activated coal, flue gas cleaning reaction products and unreacted flue gas cleaning chemicals. To avoid negative impacts of the APC residues on the environment, they have to be managed or treated in specific ways. Some of these gas cleaning residues can be partially recovered to produce secondary raw materials for the chemical industry (e.g., sodium bicarbonate).

Technology and key parameters

The overall environmental performance of an incineration plant is highly variable and depends on aspects such as emission levels, energy recovery efficiency, type of energy that is substituted by the energy produced from the incineration process, amount and type of residues, distribution of pollutants among air emissions, water emissions (if any) and residues. Those specific values depend on:

• Waste composition: the net calorific value is perhaps the single most important waste-specific parameter;

• Emission control technology, e.g., type of flue gas cleaning and neutralising agent;

• Energy balance;

• Efficiency of material recovery (steel, aluminium, solid inert material).

Landfilling

Background and principles

Manfredi & Christensen (2009) state that: "Conventional landfilling typically relies on anaerobic degradation of waste. Typical technical measures implemented include bottom line, top soil cover, gas and leachate collection and treatment systems."

Although these technical measures can significantly reduce the uncontrolled release of gas and leachate, potential environmental impacts still remain high, and threats to the environment exist far beyond the time frame of a generation. New, ''active" waste landfilling technologies have therefore been developed in the last couple of decades, including bioreactor and semi-aerobic technologies with the aim of minimizing environmental impacts from landfilling."

New technologies reduce the duration of active operations required at the landfills. In addition, active landfill technologies (i.e. leachate recirculation, waste flushing and air injection) often use the collected gas for electricity and/or heat generation, thus bringing environmental benefits compared to older technologies (the overall environmental value changes according to the efficiency of energy recovery).

However, it should be stressed that landfilling of biodegradable waste is an option that can only be employed as an interim solution as European legislation will progressively divert more and more organic matter away from landfills (Directive 1999/31/EC).

Technology and key parameters

The following parameters play an important role in determining the environmental performance of biodegradable waste landfilling:

Landfill gas generation is related to the:

- Carbon content of the waste;
- Carbon degradation rate, faster for sugars than for lignin and some cellulose;
- The specific degradation condition, e.g., redox conditions, availability of water and nutrients, presence of compounds that could inhibit the degradation process, degree of compaction of the waste.

Landfill gas capture:

- "At times of high flux, emissions can be greater than the capacity of the engines and, thus, a proportion of the gas must be flared"
- "At times of low flux, i.e., towards the end of the site lifetime, emissions may be too small for the gas engines to function effectively

This last case remains throughout the post-operative life of the landfill site (the long tail of landfill gas production).

Therefore, generated gas can be:

- Flared (CH_4 is converted to CO_2-biogenic);
- Recovered to produce energy (heat, electricity, or combined heat and power);
- Released to the atmosphere (CH_4 is emitted to the atmosphere; some of it will be converted into CO_2-biogenic due to interaction with O_2 in the air).

In landfill operations involving biowaste, key aspects include biogas production, capture efficiency and gas use to produce energy. Efficient gas capture and recovery allow for more energy production (and resource saving) and less methane emissions that would contribute adversely to climate change. Thus, the positive effect of a good landfill gas capture system on climate change is doubled. Moreover, a good capture system ensures fewer odours. As a result, it is important to use appropriate technologies to reduce the negative environmental impacts from fugitive gas releases as far as possible.

Solutions

As per the Waste Framework Directive, prevention is the first priority. However, there can be some exceptions to the rationale of this priority for biowaste that may require further analysis, which are identified by life cycle thinking.

There are two main methods to reduce biowaste generation as part of waste prevention:

• Smart food consumption/food wastage e.g. buying only what is needed, timely consumption, reducing waste in preparation, etc.

• Smart gardening, e.g., choosing low-yield plant species, grass mulching.

Smart gardening mainly means choosing low growth plant species to lower the production of biowaste and, therefore, the need to treat this biowaste. As stated above, this is not (necessarily) advantageous for the environment. Grass mulching consists in cutting grass into very small pieces that fall on the soil and enrich the soil with organic matter while nutrients are sent back to the soil (local loop).

Home composting should not be regarded as a biowaste prevention action. Indeed, home composting reduces the amount of organic waste contributing to municipal waste streams but, in practice, it has to be regarded as a local, decentralised treatment of waste.

Economic and organisational considerations

Current and future costs of organisational disposal

Costs of Main Infrastructure (CMI)

The cost of main infrastructure associated to undifferentiated waste collection (CMI, which are intended/house) include:

CMI = Cmb + Ca + Cin

which:
Cmb - cost of mechanical-biological treatment with the production of compost and biogas

Cin - cost of disposal by incineration with energy recovery

Ca - cost of landfill disposal

Cost of mechanical-biological treatment (Cmb)

Anaerobic digestion infrastructure with biogas and compost production with annual processing capacity of 60,000 tons of waste with a lifetime of 20 years.

Considering the per capita annual management process, can be reached by house cost over 30 years:

- In undifferentiated collection system including bio-waste it can reach 484,4€/house

- In the collection system excluding undifferentiated where biowaste have no place to recovery operations organic waste, as all organic matter is subjected to composting, corresponding to a cost of 0€/house.

Cost of incineration with energy recovery (Cin)

Infrastructure incineration with energy recovery capability processes 380,000 tons of annual waste with a lifetime of 20 years.

Considering the per capita annual management process, the costs by house for a horizon of 30 years:

- In undifferentiated collection system including biowaste is 217,2€/house

- In the collection system excluding undifferentiated biowaste is 222,3€/house

Cost of landfilling (Ca)

Infrastructure with total processing capacity of 175,000 tons of waste with lifetime of 10 years, assuming an annual capacity of 17,500 tons.

Considering the per capita annual management process, the costs by house for a horizon of 30 years are:

- In undifferentiated collection system including biowaste is 107,4€/house
- In the collection system excluding undifferentiated biowaste is 110,2€/house

Transport

Regarding the costs of initial investment for a vehicle used to collect undifferentiated waste in 2009 it costs 132.038,15€ to SMA (Municipal Services of Abrantes) to collect this type of waste.

Reference costs adopted:

- For undifferentiated collection vehicle: 130,000 €

- For the collection vehicle: 110.000 €

Future costs of disposal

In the future with the constant increase of fossil fuels price, these costs associated to waste disposal will tend to increase considerably.

This paradigm may change if the companies involved in waste management bet in energy recovery through waste or renewable energies.

Contract durations

It follows then Article 34 and 38 to the respective contract management of municipal waste and its suspension.

Article 34. º Contract management of municipal waste

1. The provision of the municipal waste management is subject to agreement between the SMA and the users that have valid title to the occupation of the property.
2. When the service management of municipal waste is made available concurrently with the service of water supply and sanitation or wastewater, the contract is unique and includes all services.
3. The contract is prepared in printed its own model of the manager and instructed in accordance with the legal provisions in force at the date of its conclusion, and shall include contractual conditions of service provision, including the main rights and obligations of users and entity management, such as billing, collection, pricing, claims and dispute resolution.

4. At the time of conclusion of the contract shall be delivered to the respective user copy.

5. In situations not covered by paragraph. 2, the service of urban waste management contractor since it is considered that there is effective use of the service and SMA referring in writing to users, the contractual conditions of the respective provision.

6. The owners of the buildings, where the contract is not in his name, shall report to the manager, in writing and within 30 days, the departure of tenants.

7. The owners, beneficial owners, lessees or any individual or entity that has valid title, which legitimizes the use and enjoyment of the site providing the service, or those who hold the legal administration of the buildings must effect change of ownership of contracts whenever these are not in your name.

8. Changes in the identification of the holder, provided involving alteration of the taxpayer identification, motivate the termination of the contract coming into effect and the conclusion of a new contract, except change holder within the same household and then settled any debts existing on behalf of any member of the household, in which case it applies the next step.

9. The transfer of rights under the existing contract can be transmitted to the heirs legally entitled to remain in the place of consumption after passing user holder by simple endorsement of the holder of the contract, provided it is done for first degree of parentage to the previous holder. Shall be submitted and attached to the contract the replacement document proving that qualification.

10. The SMA is not the holder shall amend or enter into new service agreements with members of the same household where there are debts to be regularized.

Article 38. Contract suspension

1. Users may request, in writing and with a minimum of 10 days, the suspension of the waste management contract, due to temporary unemployment of the property.

2. When you dispose of both waste management service and the service of water supply, the waste management contract is suspended when the suspension is requested service water supply is resumed and the same date as this.

3. In situations not covered by the preceding paragraph, the contract may be suspended upon proof of vacating the property.

4. The suspension of the contract implies the correctness of invoice issued before the date of suspension and termination of the billing and collection of monthly rates associated with normal service provision, until the contract is resumed.

Legal requirements/improvements for biowaste management system implementation

Then it will presented the legal requirements and improvements for biowaste management system implementation:

1. All that is missing in this Regulation, are applicable to the legal provisions in force relating to waste management systems, in particular those set out in Decree-Law No. 1942009 of 20 August and Decree-Law No. 1782006, September 5, all in current writing.

2. Collection, treatment and recovery of waste, in particular the following laws are observed, in its current wording:

a) Decree-Law No. 366-A97, of 20 December, concerning the management of packaging and packaging waste;

b) Decree Law No. 2302004, December 10, concerning the management of waste electrical and electronic equipment (WEEE);

c) Decree Law No. 462008 of 12 March and Ordinance No. 4172008, June 11, relating to the management of construction and demolition waste (RCD);

d) Decree-Law No. 62009, January 6, concerning the management of waste batteries and accumulators;

e) Decree-Law No. 2662009, of 29 September, on the management of used cooking oils (OAU);

f) Ordinance No 33597, May 16, on the transport of waste.

3. The waste management service complies with the rules for the provision of essential public services for the protection of the users who are included in the legislation in force, in particular those contained in Act No. 2396, 26 July, and of law no 2496, of 31 July, in newsrooms in force.

4. In the case of misdemeanour's procedure shall apply, in addition to the specific rules laid down in this regulation, the General Regime of Contraordenations and Fines

The owner and Manager of the system

1. The city of Abrantes is the Titular Entity that, in accordance with law, have by assignment to ensure the provision of the municipal waste management service in the respective territory.

2. In the whole area of the municipality of Abrantes, the SMA (Serviços Municipalizados de Abrantes) are the managing body responsible for undifferentiated collection of municipal waste.

3. In the whole area of the municipality of Abrantes, VALNOR is the managing body responsible for selective collection, sorting, recovery and disposal of municipal waste.

Principles of management

The provision of the municipal waste management service complies with the following principles:

a) Principle of universality and equality of access;

b) Principle of quality and continuity of service and protection of the interests of users;

c) Principle of transparency in the provision of the service;

d) Principle of protection of public health and the environment;

e) Principle efficiency assurance and continuous improvement in the use of resources affects, responding to evolving technical requirements and the best environmental techniques available;

f) Principle of promoting economic and social solidarity, the correct planning and regional development;

g) The polluter-pays principle;

h) Principle of hierarchy of waste management operations;

i) Principle of responsibility of the citizen, by adopting preventive behaviors on waste production, as well as practices that facilitate their reuse and recovery.

Business model for the biowaste management

The growth rate of production of municipal waste is one of the challenges of modern society, in protecting the environment.

In Portugal, the period from 2007 to 2009, it appears that the production of waste, although strongly correlated (92%) with increasing population has grown faster than the rate of population growth, suggesting that increased waste production results not only from population growth but also new consumption habits and behaviors that generate more waste.

In Portugal, the amount of municipal waste produced in the period, grew at an average annual rate of 5%, registering in 2009, a production of 5 million tons.

As regards the amount of waste produced by local, it appears that the pickup national average was 500 kg / hab.ano, which corresponds to a daily average of about 1.4 kg per head.

Noting the average capitation in three years under review, it appears that the Algarve region and the autonomous regions of Azores and Madeira are strongly influenced by the phenomenon of tourism, taking into account the observed deviation between the quantities of waste generated per capita and its . In other regions, although the volume of waste generated by the effect tourism can also be significant, particularly in the region of Lisbon, which has been asserting itself as a tourist destination at the international level, the activity ends up being diluted by the large effective population size in each one of the regions (North, Central and Lisbon), reaching values of waste generated per capita, near the national average.

In 2009, with regard to municipal waste collected selectively and undifferentiated, it appears that the northern region has the largest waste collection undifferentiated (1,489,000 tons), the Lisbon region and the largest volume of waste collection selective (196,000 tons).

With regard to the waste collection selectively, this represents about 12% of the total residue.

In Portugal, the amount of waste collected separately in 2009 stood at 649,000 tons, corresponding to about 61 kg of waste per capita recovered.

In three years under review, it is noted that in terms of operations of destination, most of the waste produced is destined for landfill. In 2009, about 61% of waste was sent to landfill, followed by energy recovery (20%) and collection (12%), and only referred to organic recovery, about 8% of the waste.

Although the government has postponed the goals of diversion of biodegradable municipal waste landfill, the organic recovery recorded the highest average growth rate (15%) in the three years under review, together with the collection (11%).

Analyzing the waste collected selectively, it appears that there was an increase in the amount of municipal waste collected selectively.

In terms of total waste separated at source, paper and board materials were collected in greater quantity over the three year period.

In the period under review, "Paper and Cardboard" stood out as the row with the highest relative weight, about 44%.

Packaging waste stand out as the row which has recorded the highest average annual growth about 37%. With regard to the paper and cardboard and batteries, they recorded an average growth of 11%, followed by the row "Glass" with an increase of about 9%.

When comparing the amounts of municipal waste collection in the ecopoints, door-to-door and approved recycling centers, it appears that the ecopoints are the primary means of selective waste collection.

Over the next three years, the method of collection port-to-port appears as the system with less material collected, and this can be justified by the costs that this type of collection carries.

On the Continent in 2009, it is noted that approximately 70% of waste collected for recycling have been selectively deposited on ecopoints.

In terms of distribution of ecopoints in the country, it appears that only the system RESINORTE with an average of 745 people served by the recycling center has not yet reached a level of coverage less than 500 inhabitants per collection point, as recommended in the Strategic Plan for Solid Waste (PERSU).

In terms of distribution of ecopoints in the country, it appears that only the system RESINORTE with an average of 745 people served by the recycling center has not yet reached a level of coverage less than 500 inhabitants per collection point, as recommended in the Strategic Plan for Solid Waste (PERSU). Nevertheless, according to data available to the Continent, the threshold was exceeded PERSU in 2009, with an average of 329 people served by the recycling center.

The analysis of the structure of the waste generated by economic activity signal to the "Trade and Services" and "Manufacturing" as activities with a greater production of waste (about 35% and 31% respectively), as opposed to "Agriculture , Forestry and Fishing "which was only responsible for the production of less than 1% of the waste.

Between 2007 and 2009, Portugal has generated about 82 million tons of waste sector. In 2009, production fell by around one third of the figure recorded in 2008, as a result of slowing economic activity.

In absolute terms there is a continuing trend to reduce the waste sent for disposal. We noted also that over the three years under review, over 50% of generated waste sector were sent to recovery operations.

The ratio obtained from the quantities of waste generated per unit of GDP reflects the degree of efficiency of the economy in general, being an indicator of the degree of development of a country. Thus, a country is the more efficient the lower the waste generated per unit of GDP.

The year 2009 was one that recorded the lowest ratio of waste generated per unit of GDP, reflecting a higher degree of efficiency in terms of sectoral waste generated. Protection is, however, that this value may be influenced by the decrease in production of the construction sector, from 2008, which was of the order of 60%, which represents approximately less than 5 million tonnes of waste.

The break is not unrelated to the implementation of Decree-Law 46/2008 which allows for the reuse of soil and stones not containing dangerous substances, derived from the construction activity, other works, in addition to the original as well as in environmental remediation , thereby enhancing the prevention of waste and simultaneously preserving natural resources used for identical.

Involved parties in the biowaste management chain

Médio Tejo + Pinhal Interior Sul

Médio Tejo

Médio Tejo is a Portuguese NUTS3 subregion, part of the central region and the District of Santarém. It is bordered to the North with the Pinhal Interior Norte, on the East by Pinhal Interior Sul and Alto Alentejo, the South with the Lezíria do Tejo and the West by the Pinhal Litoral subregion. The city has a total area of 2283 km² and a population of 220660 inhabitants (census of 2011). Consists of 11 municipalities:

- Abrantes
- Alcanena
- Constância
- Entroncamento
- Ferreira do Zêzere
- Mação
- Ourém
- Sardoal
- Tomar
- Torres Novas
- Vila Nova da Barquinha

Pinhal Interior Sul

Pinhal Interior Sul is a Portuguese NUTS3 subregion, part of the Central region, located in the District of Castelo Branco. It is bordered to the North with the Pinhal Interior Norte and the Cova da Beira, on the East by the Beira Interior Sul, the Alto Alentejo to the South and the West with the Médio Tejo. Had until 2010 a 1903 km² and a population of 40705 inhabitants (census of 2011). Consists of 4 municipalities:

- Oleiros
- Proença-a-Nova
- Sertã
- Vila de Rei

Waste operators on regions of study

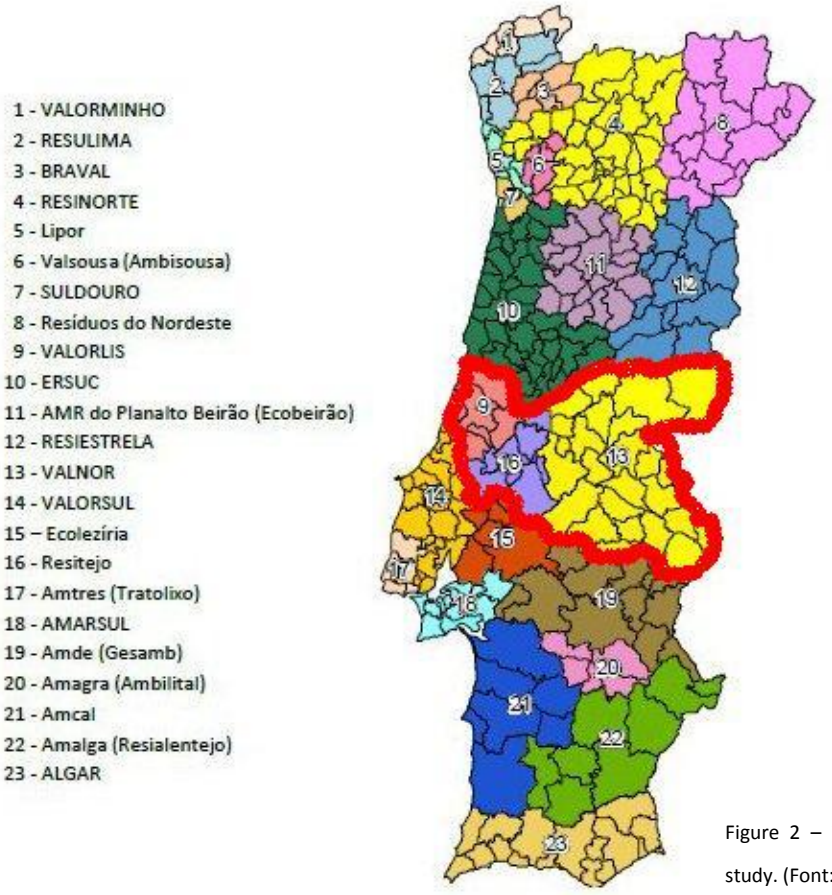

Figure 2 – Waste operators on regions of study. (Font: APA)

There are several waste operators working on both regions. To add all the municipalities it is needed to talk about 3 waste operators, RESITEJO, VALNOR and VALORLIS.

RESITEJO

RESITEJO, an association of Management and Treatment of Waste of the Médio Tejo region, covers the geographical area of the municipalities of Alcanena, Chamusca, Constância, Entrocamento, Ferreira do Zêzere, Golegã, Santarém, Tomar, Torres Novas and Vila Nova da Barquinha, covering 209.586 inhabitants.

The waste management from Resitejo entered into operation and May 1999 and consists of:

- sanitary landfill
- triage Station
- transfer units
- transfer centers
- recycling centers
- 1201 Ecopoints
- 298 Insulated bottle banks
- 34 places where to deposit used cooking oil

VALNOR

VALNOR, the company responsible for the collection, sorting, recovery and treatment of solid waste in 25 municipalities in its area of influence, has as its main mission the preservation of the environment where inserts and improving the service provided to the population in the management of solid urban waste. The shareholders of VALNOR S.A. are the municipalities of Abrantes, Alter do Chão, Arronches, Avis, Campo Maior, Castelo Branco, Castelo de Vide, Crato, Elvas, Fronteira, Gavião, Idanha-a-Nova, Mação, Marvão, Monforte, Nisa, Oleiros, Ponte de Sôr, Portalegre, Proença-a-Nova, Sardoal, Sertã, Sousel, Vila de Rei and Vila Velha de Ródão.

The consumerism which tends to increase waste and the quantities of all kinds of waste is, nowadays, one of the problems that modern societies face, and these pressures on the environment require increased attention.

The solution to these problems is thus, by adopting responsible behaviour on the part of the populations, with the support and encouragement of their representatives, local authorities and Governments.

In recent years was traversed a path whose results were rewarding, being that, pursuing its policy of improvement, VALNOR will continue to work knowing that there is still much to do.

The contribution of peoples and encouragement of all, is essential for the VALNOR can proceed, facing the municipal solid waste as a feedstock with economic value and thus

contribute to the sustainable development of our region, essential to improve the quality of life for all of us.

VALORLIS

The VALORLIS is the selective collection, sorting, recovery and treatment of municipal solid waste of the six counties that make up the Alta Estremadura: Batalha, Leiria, Marinha Grande, Ourém, Pombal and Porto de Mós. In total, these six municipalities comprise an area of approximately 2,157 Km^2, and has a population of approximately 317,000 inhabitants (INE, 2004 data).

The action plan of the Multimunicipal system of VALORLIS, which means from now ahead by PAPERSU, gives effect to the provisions of art. 16 of Decree-Law No. 1782006, September 5, and takes as its reference to implementation of the guidelines contained in the Strategic Plan for solid urban waste, PERSU II, approved by Ordinance No. 1872007 of 12 February.

Being a basic plan on municipal solid waste management for the period 2007-2016, duration of PERSU II, the PAPERSU that presents itself, in addition to addressing the type, origin and quantities of waste to manage, standards and technical provisions and apply the frame buildings and installations, includes also the quantitative and qualitative achieve objectification in accordance with the objectives and targets defined by national and Community legislation applicable.

Abrantes Region

VALNOR - Constitution and objectives

VALNOR is the company responsible for selective collection, sorting, recovery and disposal of municipal waste in the municipality of Abrantes.

It was formed in 2001 by Decree-Law No. 23 of January 112001 and concerns the exploitation and management of the Multimunicipal recovery and treatment of municipal solid waste of Norte Alentejo.

VALNOR is today a company with strong deployment in his region, certified and recognized nationally and internationally for the quality of its management, for its accuracy in attention to standards that environmental protection, occupational health and safety, as well as by the prevalence of the principles of sustainable development and optimization of resources in the development of its activity.

Currently VALNOR covers an area of about 12.000 Km^2, corresponding to 25 municipalities. In this area, about 279 thousand inhabitants are served by VALNOR services.

Mission

Adopt a system of excellence of recovery and treatment of municipal solid waste, contributing to the sustainable development of the region and ensuring the well-being of the populations of the area, in logic of improvement of assistance to populations and preservation of ecosystems.

Corporate Responsibility Policy

The corporate responsibility, integrating the aspects quality, environment, safety and Social responsibility are a permanent concern of VALNOR since its creation, and is considered a fundamental value and always present in your organization. This results in the permanent concern to clearly define the roles and responsibilities of each of the organic areas, either in their internal relationship either in relation to all its stakeholders.

SMA (Municipal Services of Abrantes) - Constitution and objectives

In the whole area of the municipality of Abrantes, SMA (Municipal Services of Abrantes) is the managing body responsible for undifferentiated collection of municipal waste.

Generally, the goals of the SMA are:• Ensure the satisfaction of the needs of population of the municipality of Abrantes;

•Monitor and supervise the concession contract of service of urban waste in the municipality of Abrantes;

• Ensure the planning, organization, collection and transport to the appropriate destination of municipal solid waste.

General duties of SMA

It is the responsibility of the SMA, in particular:

a) Ensure the management of municipal waste whose daily production does not exceed 1100 litres per producer, produced in your geographic area, as well as other waste which is assigned by law;

b) Ensure proper routing of the waste it collects or receives from your geographical area, without such liability exempt residents from the payment of fares for the service provided;

c) Ensuring the quality, regularity and continuity of the service, except in unforeseeable circumstances or in cases of force majeure, which do not include strikes, without prejudice to the taking of immediate steps to resolve the situation and, in any case, with the obligation to notify immediately the users;

d) Take responsibility for design, construction and operation of municipal waste management system in technical components provided for in this regulation;

e) Promote the elaboration of plans, studies and projects that are necessary for the proper management of the system;

f) Keep the register of equipment and infrastructures impacting waste management system;

g) Promote the installation, renovation, the good operation and maintenance of equipment and infrastructure of the waste management system;

h) Ensure the cleaning of the equipment of waste disposal and surrounding area;

i) Promote the technological upgrading of the waste management system, in particular, when resulting an increase in technical efficiency and environmental quality;

j) Have services targeted to users, the resolution of your problems related to the waste management system;

k) Promote the annual update of the tariff and ensure their dissemination among users, particularly in offices and on the website of the management company;

l) Proceed in due time, the issuing and sending of invoices relating to the services provided and their recovery;

m) Billing services Available, so that users can fulfil their obligations with the lowest possible discomfort;

n) Keep an updated record of complaints and suggestions from users and ensure their response in the legal deadline;

o) Provide essential information about your activity;

p) Comply with and enforce the provisions of this regulation.

Strategy proposal for biowaste use in production of biomethane

In this chapter we suggest 3 scenarios according to biowaste use in production of biomethane. These 3 scenarios were created thinking on improving the infrastructures that already exists as well as the final production of biomethane. It is referred current situation and the future situation (how we wish it would be in a nearly future).

SWOT Analysis is done to know what the strengths and weaknesses are and try to understand if the scenario can be applied to the region. It is done an integration with Covenant of Mayors too.

Scenario 1

"User-Pays" Scenario – Payment for all produced waste

Summary - Among the basic principles of environmental policy, it includes the "principle of responsibility" that "points to the assumption by polluters for the consequences in others for their action, direct or indirect, over natural resources". Thus, the consumer (polluter) is forbidden to pollute, so you should pay the costs of waste disposal and if you don't, you will have the responsibility of paying the "social" cost of a pollutant action (through fines, damages, etc.).

Before	After
Green containers system for mixed waste deposit	Creating a single container that includes a scale (where you can weigh the waste), a payment system (e.g. ATM) and an opening that only opens if the person makes their waste payment.
Selective Deposition: Yellow container is used for plastic deposition, blue container is used for deposition of paper and similar, green container is used for deposition of glass, red container is used for deposition of batteries and cells and orange container is used for deposition of cooking oils.	
Mixed waste is processed in a transfer station, but most are sent to landfill	At the transfer station should be done the separation of mixed waste that will join already separated waste by people in the single container (on the street).
Selective waste are sent directly to the transfer station and treated according their type (paper, plastic or glass)	

Payment of a waste fee that comes along with water invoice	The fee that comes along with water invoice disappears and a fee would be applied to mixed waste and selective waste. This fee would have different values for each of cases; it would be assigned a higher value in case of mixed waste, thus forcing people to make separation of their waste.
Scenario Principle	"User-Pays" Principle
Food distribution companies, eg, use unnecessary plastic packaging – it produces too many waste	Make an effort to minimize the production of plastic packaging - Involvement of companies that are responsible for packaging product.
Plastic bags utilization	Remove the habit of plastic bags using in shopping and introduce a new technology that consists in bags with easy degradation or biodegradables bags. It may be used cloth or paper bags.
Plastic packaging utilization	Place on market organic biodegradable packages or lighter packages that are easily biodegradable. Avoid as much as possible plastics use and replace plastic packaging for packaging with a specific expiration date (past the expiration date, the package will begin to degrade itself – new technology).
Bulky waste, scrap metal, end of life cars and garden leftover are free removed. You should make a call for the entity who is responsible for the collection and combine a day and time to be collected	The collection of such waste should be carried in the same way however the service should be charged.

Waste collection in Abrantes is made up of two entities, VALNOR (selective waste) and SMA (mixed waste).	The collection could now be done only by one company to save resources.
Use of used cooking oil for biodiesel production and use of it in their equipment	Sale of over produced biodiesel
Existence of an unit which allows to obtain Anaerobic Digestion gains in energy production.	Make a connection between Anaerobic Digestion and Cogeneration thus achieving energy savings
	Create a partnership with wastewater treatment plants in the area to use their sludge in anaerobic digestion
	Create optimal conditions within anaerobic digester for digestion becomes faster and more efficient
	Use of biomethane in vehicles
Energy production	Injection of excess energy in the network and use of produced energy

Indicators 2010	
Number of residents covered by VALNOR	167.771
Total MSW (t)	126.467
Capitation of MSW (kg/inhab.year)	461
Total selective collection (t)	8.638,9
Capitation of selective collection (kg/inhab.year)	45
Amount of waste sent to landfill (t)	107.509
Municipal waste sent to units of organic recovery (t)	7.508
Municipal waste sent for recycling (t)	11.450
Number of ecopoints	1.060
Amount of waste exported for recovery operations and disposal (t)	56.109
Expenditure of Local Government per capita in waste management field (€/inhabitant)	25 - 50
Number of campaigns characterization of MSW (No/year)	10
Expense of Public Administration with Waste Management (10^3 Euros)	552.927

	Before	After
Capitation of MSW (kg/inhab.year)	461	+
Capitation of selective collection (kg/inhab.year)	45	+
Inhabitants/Ecopoints	158	++
% Mixed Waste		0
% Selected Waste (by people)		++
Average rate charged for the services of waste disposal (€)		++
% Recycling of plastic packaging		-
Use of plastic bags/capita		--
Quantity of biodiesel /year (L/year)		+
Energy produced in anaerobic digestion		+
% Energy injected into the network		++

Legend:
++ ➔ Great growth
+ ➔ Smooth growth
0 ➔ Stabilization
- ➔ Decrease
-- ➔ Abrupt decrease

SWOT Analysis

Strengths	**Weaknesses**
Policy and regulatory framework positive to the implementation of measures to promote energy efficiency; Policy and regulatory framework positive to the implementation of measures to reduce dependence on fossil fuels, particularly for	Limitations on the ability of public investment, which leads to the implementation of measures occur predominantly based on structural funds or private investment; This limitation leads to greater dispersion in leadership processes and introduces greater

renewable generation; Local dynamism and entrepreneurship of community; Waste reduction by the population; Increased conditioning of waste produced.	weakness in waste management; Objection by the population of the implementation of the new measures
Opportunities	**Threats**
Existence of funding opportunities for energy efficiency measures in private investment (VALNOR); Global political context favors the action at local level; Awareness of people for the amount of waste produced; Actions of awareness that allows the minimization of waste production in their homes; Opportunity for packing companies to show new technologies and expansion in international market, these same technologies	Existence and perception of a serious economic crisis may make it difficult to implement measures with investment; Natural resistance to change may dictate the use of traditionally used solutions; Difficulties in obtaining financing; Vandalism of containers; Waste disposing in inappropriate places; Waste accumulation in people's homes

Integration with Covenant of Mayors	
Measure	**Impact**
ACTIVE MONITORING Provide technologies that enable smart metering energy data collection like water use, electricity and gas, in order to create a more efficient management of resources analyzed.	The introduction of appropriate waste management, consumption monitoring and adoption of good practice in equipment use allows minimizing energy waste. Monitoring lets you analyze and receive all data collected in real time, ie, checks the entire system and where there is something irregular on system it generates an alert that allows a correction in real-time.
DOMESTIC EQUIPMENT RENEWAL Promote a gradual household renewal that are energy inefficient, especially appliances.	Due technological advances growing consumers have at their disposal equipment more efficient and therefore should be promoted more or less regular replacement of existing household equipment in housing with more efficient models. However this will

	have consequences in terms of waste production. The old equipment should be sent to appropriate locations, dismantled and the parts that can be grasped should be seized.
MODERNIZATION EQUIPMENT Gradually renew the equipment, replacing equipment by more efficient equipment in particular driving forces equipment.	All equipment has a life time. With the passage of the "year" equipment begin to be less efficient, i.e., begin to spend more energy resources for the same function, and this increases the waste production. However, as the domestic equipment renewal, the old equipment should be referred to appropriate locations, dismantled and parts that can still be reused should be exploited in new equipment.

BIODIESEL Biodiesel use as a main fuel for the fleet for cars with internal combustion engine of diesel type.	Currently transport sector is almost entirely dependent on petroleum products, which makes it a major contributor to greenhouse gases emissions. As the biodiesel produced from oils, used or new, of vegetable or animal origin, this biofuel is a sustainable energy source alternative to using diesel so there is a reduction of greenhouse gases emissions and waste recovery.
WASTE MANAGEMENT Designing or improving waste management model, achieving maximum efficiency in energy use.	The organic recovery is a strategic measure to reduce GHG emissions. The separation, collection and routing of organic matter to a treatment station allows biogas production which can be used to produce energy and for producing a "compound" of high quality for agriculture. The waste sector is responsible for direct and indirect emissions that can be reduced using a waste management model. Direct emissions arise primarily from support activities, such as the consumption of fossil fuels in incineration and composting operation and collection fleets and mobile machinery existing in landfills. Indirect emissions are associated with electricity consumed on facilities.
GREEN PUBLIC PROCUREMENT Designing a tool to measure ecologically all purchases as energy using equipment, vehicles and contracts.	The purchase of ecological products or services by public bodies gives a positive image to the market, serving as an example to other identities, and encourages companies to seek innovate their products so that these products are truly sustainable. Comes the need to develop a tool that takes into consideration ecological criteria to be applied under new public procurement policy and to measure ecologically all products and services to be contracted by municipal services.

Scenario 2

Waste separation incentive scenario

Summary - In terms of waste prevention policy, it is important to raise awareness and involvement of all stakeholders in order to develop promotional activities that contribute to waste production prevention. It can therefore be considered monetary incentive a promotional action for waste separation in source.

<table>
<tr><th>Before</th><th>After</th></tr>
<tr><td>Green containers system for mixed waste deposit</td><td rowspan="2">Separation is performed in respective houses, waste delivery is done in transfer stations and reception of a monetary incentive for waste produced. People only receive monetary incentives for separated waste (paper, plastic, glass, batteries and oils).</td></tr>
<tr><td>Selective Deposition: Yellow container is used for plastic deposition, blue container is used for deposition of paper and similar, green container is used for deposition of glass, red container is used for deposition of batteries and cells and orange container is used for deposition of cooking oils.</td></tr>
<tr><td>Mixed waste is processed in a transfer station, but most are sent to landfill</td><td rowspan="2">At the transfer station should be done the separation of mixed waste that will join the waste already separated and delivered by people at transfer station</td></tr>
<tr><td>Selective waste are sent directly to the transfer station and treated according their type (paper, plastic or glass)</td></tr>
</table>

Payment of a waste fee that comes along with water invoice	Should keep up the fee on waste production since there is waste that can't be delivered on transfer station (mixed waste)
Scenario Principle	Prevention Principle
Food distribution companies, eg, use unnecessary plastic packaging – it produces too many waste	Make an effort to minimize the production of plastic packaging - Involvement of companies that are responsible for packaging product.
Plastic bags utilization	Remove the habit of plastic bags using in shopping and introduce a new technology that consists in bags with easy degradation or biodegradables bags. It may be used cloth or paper bags.
Plastic packaging utilization	Place on market organic biodegradable packages or lighter packages that are easily biodegradable. Avoid as much as possible plastics use and replace plastic packaging for packaging with a specific expiration date (past the expiration date, the package will begin to degrade itself – new technology).
Bulky waste, scrap metal, end of life cars and garden leftover are free removed. You should make a call for the entity who is responsible for the collection and combine a day and time to be collected	The collection of such waste should be carried in the same way however the service should be charged.
Waste collection in Abrantes is made up of two entities, VALNOR (selective waste) and SMA (mixed waste).	The collection could now be done only by one company to save resources.
Use of used cooking oil for biodiesel production and use of it in their equipment	Sale of over produced biodiesel

Existence of an unit which allows to obtain Anaerobic Digestion gains in energy production.	Make a connection between Anaerobic Digestion and Cogeneration thus achieving energy savings
	Create a partnership with wastewater treatment plants in the area to use their sludge in anaerobic digestion
	Create optimal conditions within anaerobic digester for digestion becomes faster and more efficient
	Use of biomethane in vehicles
Energy production	Injection of excess energy in the network and use of produced energy
Indicadors 2010	
Number of residents covered by VALNOR	167.771
Total MSW (t)	126.467
Capitation of MSW (kg/inhab.year)	461
Total selective collection (t)	8.638,9
Capitation of selective collection (kg/inhab.year)	45
Amount of waste sent to landfill (t)	107.509
Municipal waste sent to units of organic recovery (t)	7.508
Municipal waste sent for recycling (t)	11.450
Number of ecopoints	1.060
Amount of waste exported for recovery operations and disposal (t)	56.109
Expenditure of Local Government per capita in waste management field (€/inhabitant)	25 - 50
Number of campaigns characterization of MSW (No/year)	10
Expense of Public Administration with Waste Management (10^3 Euros)	

	552.927

	Before	After
Capitation of MSW (kg/inhab.year)	461	+
Capitation of selective collection (kg/inhab.year)	45	++
Inhabitants/Ecopoints	158	+
% Mixed Waste		-
% Selected Waste (by people)		++
Average rate charged for the services of waste disposal (€)		++
% Recycling of plastic packaging		++
Use of plastic bags/capita		-
Quantity of biodiesel /year (L/year)		++
Energy produced in anaerobic digestion		+
% Energy injected into the network		++

Legend:
++ ➔ Great growth
+ ➔ Smooth growth
0 ➔ Stabilization
- ➔ Decrease
-- ➔ Abrupt decrease

SWOT Analysis	
Strengths	**Weaknesses**
Policy and regulatory framework positive to the implementation of measures to promote energy efficiency; Policy and regulatory framework positive to the implementation of measures to reduce dependence on fossil fuels, particularly for renewable generation; Local dynamism and entrepreneurship of community; Lower costs associated with moving from companies in waste collection	Limitations on the ability of public investment, which leads to the implementation of measures occur predominantly based on structural funds or private investment; This limitation leads to greater dispersion in leadership processes and introduces greater weakness in waste management
Opportunities	**Threats**
Existence of funding opportunities for energy efficiency measures in private investment (VALNOR); Global political context favors the action at local level; Awareness of people for the amount of waste produced; Actions of awareness that allows the minimization of waste production in their homes; Opportunity for packing companies to show new technologies and expansion in international market, these same technologies; Save money in collecting waste and investment in another areas	Existence and perception of a serious economic crisis may make it difficult to implement measures with investment; Natural resistance to change may dictate the use of traditionally used solutions; Difficulties in obtaining financing; Vandalism of containers; May have little adhesion due to the movement that people have to make
Integration with Covenant of Mayors	
Measure	**Impact**
ACTIVE MONITORING Provide technologies that enable smart metering energy data collection like water use, electricity and gas, in order to create a	The introduction of appropriate waste management, consumption monitoring and adoption of good practice in equipment use allows minimizing energy waste. Monitoring

more efficient management of resources analyzed.	lets you analyze and receive all data collected in real time, ie, checks the entire system and where there is something irregular on system it generates an alert that allows a correction in real-time.
DOMESTIC EQUIPMENT RENEWAL Promote a gradual household renewal that are energy inefficient, especially appliances.	Due technological advances growing consumers have at their disposal equipment more efficient and therefore should be promoted more or less regular replacement of existing household equipment in housing with more efficient models. However this will have consequences in terms of waste production. The old equipment should be sent to appropriate locations, dismantled and the parts that can be grasped should be seized.
MODERNIZATION EQUIPMENT Gradually renew the equipment, replacing equipment by more efficient equipment in particular driving forces equipment.	All equipment has a life time. With the passage of the "year" equipment begin to be less efficient, ie, begin to spend more energy resources for the same function, and this increases the waste production. However, as the domestic equipment renewal, the old equipment should be referred to appropriate locations, dismantled and parts that can still be reused should be exploited in new equipment.

BIODIESEL Biodiesel use as a main fuel for the fleet for cars with internal combustion engine of diesel type.	Currently transport sector is almost entirely dependent on petroleum products, which makes it a major contributor to greenhouse gases emissions. As the biodiesel produced from oils, used or new, of vegetable or animal origin, this biofuel is a sustainable energy source alternative to using diesel so there is a reduction of greenhouse gases emissions and waste recovery.
WASTE MANAGEMENT Designing or improving waste management model, achieving maximum efficiency in energy use.	The organic recovery is a strategic measure to reduce GHG emissions. The separation, collection and routing of organic matter to a treatment station allows biogas production which can be used to produce energy and for producing a "compound" of high quality for agriculture. The waste sector is responsible for direct and indirect emissions that can be reduced using a waste management model. Direct emissions arise primarily from support activities, such as the consumption of fossil fuels in incineration and composting operation and collection fleets and mobile machinery existing in landfills. Indirect emissions are associated with electricity consumed on facilities.
GREEN PUBLIC PROCUREMENT Designing a tool to measure ecologically all purchases as energy using equipment, vehicles and contracts.	The purchase of ecological products or services by public bodies gives a positive image to the market, serving as an example to other identities, and encourages companies to seek innovate their products so that these products are truly sustainable. Comes the need to develop a tool that takes into consideration ecological criteria to be applied under new public procurement policy and to measure ecologically all products and services to be contracted by municipal services.

Scenario 3

Technological development of transfer stations scenario

Summary - Waste Recovery is currently a popular subject. Most companies are dealing with waste management strives his best in forefront of technological development of their business. It is important in this scenario that technologies used are high because just in this case it is possible to maximize efficiency process and have good success rates.

Before	After
Green containers system for mixed waste deposit	People have to put their waste into one bag containing only: paper, cardboard, glass, batteries and used cooking oil. In another bag they should put mixed waste.
Selective Deposition: Yellow container is used for plastic deposition, blue container is used for deposition of paper and similar, green container is used for deposition of glass, red container is used for deposition of batteries and cells and orange container is used for deposition of cooking oils.	
Mixed waste is processed in a transfer station, but most are sent to landfill	At transfer station should be done a separation of all waste using high technology equipment.
Selective waste are sent directly to the transfer station and treated according their type (paper, plastic or glass)	

Payment of a waste fee that comes along with water invoice	Should keep up or increase the fee on waste production.
Scenario Principle	Recovery and Waste Treatment Principle
Food distribution companies, eg, use unnecessary plastic packaging – it produces too many waste	Make an effort to minimize the production of plastic packaging - Involvement of companies that are responsible for packaging product – High Technology
Plastic bags utilization	Remove the habit of plastic bags using in shopping and introduce a new technology that consists in bags with easy degradation or biodegradables bags. It may be used cloth or paper bags.
Plastic packaging utilization	Place on market organic biodegradable packages or lighter packages that are easily biodegradable. Avoid as much as possible plastics use and replace plastic packaging for packaging with a specific expiration date (past the expiration date, the package will begin to degrade itself – new technology) – High Technology
Bulky waste, scrap metal, end of life cars and garden leftover are free removed. You should make a call for the entity who is responsible for the collection and combine a day and time to be collected	The collection of such waste should be carried in the same way however the service should be charged.
Waste collection in Abrantes is made up of two entities, VALNOR (selective waste) and SMA (mixed waste).	The collection could now be done only by one company to save resources.
Use of used cooking oil for biodiesel production and use of it in their equipment	Sale of over produced biodiesel

Existence of an unit which allows to obtain Anaerobic Digestion gains in energy production.	Make a connection between Anaerobic Digestion and Cogeneration thus achieving energy savings
	Create a partnership with wastewater treatment plants in the area to use their sludge in anaerobic digestion
	Create optimal conditions within anaerobic digester for digestion becomes faster and more efficient
	Use of biomethane in vehicles
Energy production	Injection of excess energy in the network and use of produced energy – High Technology

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Number of campaigns characterization of MSW (No/year)	10
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	Before	**After**
Capitation of MSW (kg/inhab.year)	461	++
Capitation of selective collection (kg/inhab.year)	45	++
Inhabitants/Ecopoints	158	+
% Mixed Waste		-
% Selected Waste (by people)		++
Average rate charged for the services of waste disposal (€)		+
% Recycling of plastic packaging		+
Use of plastic bags/capita		-
Quantity of biodiesel /year (L/year)		++
Energy produced in anaerobic digestion		++
% Energy injected into the network		++
Legend: ++ ➔ Great growth + ➔ Smooth growth 0 ➔ Stabilization - ➔ Decrease -- ➔ Abrupt decrease		

SWOT Analysis	
Strengths	**Weaknesses**
Policy and regulatory framework positive to the implementation of measures to promote energy efficiency; Policy and regulatory framework positive to the implementation of measures to reduce dependence on fossil fuels, particularly for renewable generation; Local dynamism and entrepreneurship of community; Strong adherence by the population because the effort implicit in this case the separation is not very significant	Limitations on the ability of public investment, which leads to the implementation of measures occur predominantly based on structural funds or private investment; This limitation leads to greater dispersion in leadership processes and introduces greater weakness in waste management

Opportunities	**Threats**
Existence of funding opportunities for energy efficiency measures in private investment (VALNOR); Global political context favors the action at local level; Awareness of people for the amount of waste produced; Actions of awareness that allows the minimization of waste production in their homes; Opportunity for packing companies to show new technologies and expansion in international market, these same technologies; Creating more jobs in transfer stations (would require more hand labor to do the waste separation); More effective waste recycling because of high technology used.	Existence and perception of a serious economic crisis may make it difficult to implement measures with investment; Natural resistance to change may dictate the use of traditionally used solutions; Difficulties in obtaining financing; Waste contamination (if we mix liquids with wet paper, this will be contaminated).
Integration with Covenant of Mayors	
Measure	**Impact**
ACTIVE MONITORING Provide technologies that enable smart metering energy data collection like water use, electricity and gas, in order to create a more efficient management of resources analyzed.	The introduction of appropriate waste management, consumption monitoring and adoption of good practice in equipment use allows minimizing energy waste. Monitoring lets you analyze and receive all data collected in real time, ie, checks the entire system and where there is something irregular on system it generates an alert that allows a correction in real-time.
DOMESTIC EQUIPMENT RENEWAL Promote a gradual household renewal that are energy inefficient, especially appliances.	Due technological advances growing consumers have at their disposal equipment more efficient and therefore should be promoted more or less regular replacement of existing household equipment in housing with more efficient models. However this will have consequences in terms of waste production. The old equipment should be sent to appropriate locations, dismantled

	and the parts that can be grasped should be seized.
MODERNIZATION EQUIPMENT Gradually renew the equipment, replacing equipment by more efficient equipment in particular driving forces equipment.	All equipment has a life time. With the passage of the "year" equipment begin to be less efficient, ie, begin to spend more energy resources for the same function, and this increases the waste production. However, as the domestic equipment renewal, the old equipment should be referred to appropriate locations, dismantled and parts that can still be reused should be exploited in new equipment.
BIODIESEL Biodiesel use as a main fuel for the fleet for cars with internal combustion engine of diesel type.	Currently transport sector is almost entirely dependent on petroleum products, which makes it a major contributor to greenhouse gases emissions. As the biodiesel produced from oils, used or new, of vegetable or animal origin, this biofuel is a sustainable energy source alternative to using diesel so there is a reduction of greenhouse gases emissions and waste recovery.

WASTE MANAGEMENT Designing or improving waste management model, achieving maximum efficiency in energy use.	The organic recovery is a strategic measure to reduce GHG emissions. The separation, collection and routing of organic matter to a treatment station allows biogas production which can be used to produce energy and for producing a "compound" of high quality for agriculture. The waste sector is responsible for direct and indirect emissions that can be reduced using a waste management model. Direct emissions arise primarily from support activities, such as the consumption of fossil fuels in incineration and composting operation and collection fleets and mobile machinery existing in landfills. Indirect emissions are associated with electricity consumed on facilities.
GREEN PUBLIC PROCUREMENT Designing a tool to measure ecologically all purchases as energy using equipment, vehicles and contracts.	The purchase of ecological products or services by public bodies gives a positive image to the market, serving as an example to other identities, and encourages companies to seek innovate their products so that these products are truly sustainable. Comes the need to develop a tool that takes into consideration ecological criteria to be applied under new public procurement policy and to measure ecologically all products and services to be contracted by municipal services.

Implementation

Scenario 1

Special containers implementation

A previous study evaluation of strategic points for covering the largest number of people in the city

After certain strategic points should proceed to the emplacement previously agreed

Waste disposal procedure

Put your bag with waste in the balance available in special container, it will appear on container screen multiple options and that means the type of waste that can be deposited, then you choose the type of waste to be deposited, the machine calculates the weight with the type of waste and will appear on the screen the amount you have to pay. Payment can be made via ATM or notes and coins.

After you made the payment of their respective waste you can put the bag in the groove now open.

Applied rates

The rates to be applied are different depending on type of waste. For mixed waste and batteries have a higher rate compared to other types of waste.

Special containers characteristics

The containers shall contain:

Scales for people to weigh their waste;

A digital system that provides information about kind of waste (paper, cardboard, plastic, organic, batteries and used cooking oil), weigh and amount to pay;

A system of payment by ATM or notes and coins;

An opening to the outside that opens only if the person makes payment of their respective waste;
The system must be prepared to recognize what kind of waste is being deposited, so there are no mistakes in fees;

The containers must be large since it will accommodate almost any type of waste (all in one)

Containers must have multiple partitions for the various wastes listed. These can't be mixed to avoid contamination.

Waste transportation

Transportation must be made by SMA or VALNOR also in special vehicles with partitions so there is no mixing of waste or contamination.

Waste arrival into transfer station

The waste arriving at the transfer station are removed separately for further treatment The waste considered undifferentiated still have to go through a sorting station (separation process).

Bulky waste, **scrap metal, end of life cars and** garden **leftover**

The collection of these waste types should be combined with involved entity (VALNOR or SMA). Citizens should call involved entity and must combine a date and time to make the collection. This collection should also be taxed because the entity has to expend resources on travel.

The waste must be deposited in the appropriate places in the transfer station for further treatment.

Awareness to reduce the use of plastic bags and packaging

Must be performed some workshops to raise awareness of reducing the use of plastic bags and packaging because their treatment when compared with paper and glass processing, is expensive.

It should indicate the alternatives of plastics use such as: use of cloth bags, paper bags, or even those with simple degradation (new technology).

Involve distributors and packers in actions to decrease the number of packages.

Biodiesel purchase

VALNOR through used cooking oil can produce biodiesel and simultaneously integrate it into the company's own fleet. If collection of used cooking oil increases, there will be an even bigger production and the excess can be sold on market.

Energy production

Energy production through anaerobic digestion is a great investment that VALNOR must do to satisfy their energy needs. To maximize energy it could link anaerobic digestion process to cogeneration.

By creating optimal conditions inside anaerobic digestion digester it becomes faster and more effective. Biomethane use in vehicles is also an alternative, as if there were eg biodiesel enough to "feed" the entire company fleet, this could be a viable option to avoid fossil fuels using.

It should be created a partnership with wastewater treatment plants to use its sludge in anaerobic digestion.

Thus, with so many alternatives, it would be possible that VALNOR's installations become energetically self-sufficient and it would still be possible to sell some of its energy produced to network having profits. Over the years the investment made initially begins to be amortized.

Scenario 2

Containers
Study evaluating feasibility of already existing containers. If they are well distributed it must be properly maintained.

Waste disposal procedure

The waste may take two forms of deposition:

- In selective or undifferentiated containers next dwellings (traditional way of deposition)
- The waste can be taken by people themselves to transfer station

Existing containers should be maintained in the future so that people can continue to separate their waste.

The innovation of this scenario comes from the fact that people have the opportunity to take their waste to transfer station closest to their houses (selective and undifferentiated). In the waste transfer station are weighed according to their category (paper, glass, plastic, used cooking oil, batteries) or mixed waste. After weighing the person is given a small amount corresponding to the weight of the waste delivered to the transfer station.

Monetary incentives

The monetary incentive given to people depends on the type of waste delivered and its weight. It offered a higher value when delivered selective waste, it encourages the selection of waste in the respective houses.

Waste transportation

Waste transportation containers next dwellings should be done by SMA or VALNOR in special vehicles with partitions to avoid contamination of the waste mixture.

The waste can also be transported by private way (people who go to the transfer station to deliver their waste).

Scenario application

This scenario should be applied for a short period of time. It serves for people to learn to separate their waste. After application of this scenario people should continue to separate their waste without need for incentives to do so.

Bulky waste, scrap metal, end of life cars and garden leftover

The collection of these waste types should be combined with involved entity (VALNOR or SMA). Citizens should call involved entity and must combine a date and time to make the collection. This collection should also be taxed because the entity has to expend resources on travel.

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Must be performed some workshops to raise awareness of reducing the use of plastic bags and packaging because their treatment when compared with paper and glass processing, is expensive.

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Thus, with so many alternatives, it would be possible that VALNOR's installations become energetically self-sufficient and it would still be possible to sell some of its energy produced to network having profits. Over the years the investment made initially begins to be amortized.

Scenario 3

Containers
Study evaluating feasibility of already existing containers. If they are well distributed it must be properly maintained.

Waste disposal procedure

The separation of waste is carried out in respective houses.

People should put a bag with selective waste (paper, glass, plastic, used cooking oil, batteries). In another bag separately should put the mixed waste.

The waste must be placed on selective blue containers suitable for the purpose. The mixed waste should be placed in green containers.

People should take some care in the selective separation of waste before disposal. Should have to wash some packages (such as packages of yogurt, milk, etc.) to avoid waste contamination.

Blue containers characteristics

This form of separation is used in some municipalities in country. Currently blue containers have a capacity of about 60L/90L (small containers). Applying this scenario these containers must have the ability to 800L/1000L (large containers).

There should be a balance between blue and green containers. Ecopoints may remain nevertheless it would be expected to have less demand.

Applied rates

Fees for waste production should remain or increase. This rate should come along with water bill as is done currently.

Waste transportation

All waste (selective and undifferentiated) from the collection must go through a sorting process. It would be necessary labor, as well as machines with high technology. These machines should be prepared to assist in sorting process and make it faster and more effective.

Bulky waste, scrap metal, end of life cars and garden leftover

The collection of these waste types should be combined with involved entity (VALNOR or SMA). Citizens should call involved entity and must combine a date and time to make the collection. This collection should also be taxed because the entity has to expend resources on travel.

The waste must be deposited in the appropriate places in the transfer station for further treatment.

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Biodiesel purchase

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Energy production

Energy production through anaerobic digestion is a great investment that VALNOR must do to satisfy their energy needs. To maximize energy it could link anaerobic digestion process to cogeneration.

By creating optimal conditions inside anaerobic digestion digester it becomes faster and more effective. Biomethane use in vehicles is also an alternative, as if there were eg biodiesel enough to "feed" the entire company fleet, this could be a viable option to avoid fossil fuels using.

It should be created a partnership with wastewater treatment plants to use its sludge in anaerobic digestion.

Thus, with so many alternatives, it would be possible that VALNOR's installations become energetically self-sufficient and it would still be possible to sell some of its energy produced to network having profits. Over the years the investment made initially begins to be amortized.

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Appendix

Energy sustainability measures commitment with Covenant of Mayors

In Action Plan for Sustainable Energy, have been defined multiple sustainable energy measures whose implementation will enable the fulfilment of the commitment with Covenant of Mayors signing, including a reduction of at least 20% of emissions by 2020 . To ensure the implementing feasibility of proposed measures and the success of implementation of action plan, all presented measures were analyzed from potential reduction emissions viewpoint in the County, based on specific characteristics of County, energy characterization and identifying sources of CO_2 emissions resulting from implementation of reference inventory emissions.

Measures considered in this SEAP were selected taking into account the following options:

EFFICIENT LIGHTING

Elaboration of "Efficient Lighting Plan" that relies on the participation of energy managers in services and public facilities and/or private agents.

This plan should promote the replacement of inefficient lighting equipment by other energy efficient without compromising population needs in this area and light quality, reflecting a consumption reduction in fuel, consequently reduction of CO_2 emissions and energy invoice.

Illumination is one of energy uses that introduction of energy efficient solutions most offset in terms of energy bill and comfort level. Typically, in a dwelling it is possible to reduce electricity consumption just in lighting from 15 to 20%, without prejudice the light quality. This reduction potential still can reach 30 to 50% in offices, commercial buildings and leisure facilities.

In this context, we analyzed multiple possibilities of increasing efficiency indoor lighting, especially the replacement of incandescent light bulbs with compact fluorescent lamps (CFLs) or tubular, that can achieve savings of approximately 75%. This measure will reflect a reduction also in costs both for the reduction of energy invoice or durability of CFLs. Fluorescent lamps have a high shelf life, approximately 8000 hours, 15 times higher lifetime than incandescent lamp.

It was considered the possibility that, in particular cases, occurred replacing inefficient lamps by lamps with LED (Light Emitting Diode), obtaining an even greater reduction in consumption, which can achieve 90% reduction consumption in relation to incandescent lamps. Additionally, LED technology gives lamps a long-lived, made a lifetime about 50 times superior than a conventional incandescent lamp.

Besides directly reduction energy mentioned above, replacement of inefficient lamps also contributes to reduction in consumption of indirect cooling air, due to greater conversion ability of energy into light in more efficient lamps, thus minimizing the heat waste of it.

STREET LIGHTING OPTIMAL MANAGEMENT, (BALLAST REGULATING FLOW AND EFFICIENT)

Energy resources management improves with gradual replacement of inefficient ballasts with more efficient, including ballasts that allow better management of energy flow/light on PL.

Public lighting is one of the plots of major energy bill in cities, there is a high potential for energy savings associated with low expression of reducing current flow and twilight sensors to control the operating period, as well as low efficiency of ballasts used.

Luminous flux regulators are devices that automatically reduce public lighting luminous flux, resulting in the reduction of energy consumption during this period, without compromising the quality and safety of site to be lit. Thus, the flow regulators allow increasing the useful life of each light point and reduce energy consumption in hours of little movement on public roads, leading a energy consumption in street lighting a reduction of up to 40%. This equipment also has the advantage of being applicable on all circuits equipped with lighting discharge lamps such as fluorescent, mercury vapour, sodium vapour and metal halide.

Ballasts are devices that connect between the power supply of an electrical circuit and one or more discharge lamps. The main functions allow the start and limiting the lamp current to a normal range during operation.

The advantage of replacing conventional electromagnetic ballasts by electronic ballasts is that the latter allow better management of luminous flux and energy as a function of traffic density, weather conditions, adaptability to local parameters of lighting project and the compensation maintenance factor of luminous flux of lamps that depreciate over its lifetime. As electronic ballasts are electronic power converters used to control discharge lamp, allow substantially reduce energy losses compared to electromagnetic ballasts, the most common premises IP. This solution can be implemented in new equipment and equipment already in operation.

LEDS LAMPS AND EFFICIENT

Replacement of inefficient lighting fixtures by more efficient to improve quality/cost. LED technology is the most efficient solution within the Public Lighting (IP) and traffic light signalling.

High energy consumption in street lighting is often driven by a low efficiency of lighting system, a consequence of predominance of inefficient use of equipment such as mercury vapour lamps - highly inefficient lamps and traffic lights in low efficiency, including others. Currently there are already market solutions that enable an efficient IP with the same quality. One possibility is replacing inefficient lamps, such as lamps which emit light in different directions or areas which do not require illumination, for example emitted light towards the sky (light pollution).

Another solution consists in replacement of external fixtures to the lamps, for example. Mercury vapour lamps usage in street lighting is not advisable because these have a low light output as they age and their flow is reduced considerably. Use of lamps with a high luminous efficiency, as the case of sodium vapour lamps, for example, it is possible to reduce the power consumption and have a colour rendering suitable for urban roads lighting and pedestrian areas.

For public lighting lamps, market solutions also pass by LED technology, highlighting its use in traffic light signalling. The use of this technology allows a reduction in traffic lights consumption of about 80% to 90% when compared to the same intensity use of lamps. In addition, due to their low power consumption, LEDs may also be powered by solar panels.

Another advantage mentioned are related to the improvement of road safety, given that the index of reflection of sunlight is 50 percent lower than in the traditional system, allowing greater visibility and ending with illusion that the lights are connected, when actually they are not.

BUILDINGS CERTIFICATION

Conduct audits in buildings, utilities and industries to assess the degree of energy efficiency in it and identify the potential improvement.

Buildings sector is responsible for about 40% final energy consuming in Europe. Over 50% of this consumption can be reduced using energy efficiency measures.

Energy Certificate for a building should describe the actual energy performance of that building and including energy consumption calculation provided from their use, allowing proving the correct application of thermal regulation and indoor air quality in force for building and their energy systems. In existing buildings, the energy certificate provides information on measures to improve energy performance, economic viability that owner can implement to reduce their energy costs, risk-free to leverage, comfort and productivity. So with this classification it is known the level assigned to the building and what the next steps to achieve better efficiency for the building, service or industry certificate.

The certification process involves the action of a qualified expert, which will have to check through audits, regulatory compliance within the building(s) regulation(s) apply (RCCTE and/or RSECE) classifies it according to energy performance, based on a scale from A + (best performance) to G (poor performance) and eventually to propose measures for improvement. In legal context, the energy certification is compulsory from 1st January 2009 for all buildings that are in sale or rental process.

ACTIVE MONITORING

Available technologies that enable smart metering of energy consumption water data collection, electricity and gas, aiming to create a more efficient use of resources examined.

An appropriate introduction in energy management, consumption monitoring and adoption of good practice in equipment using allows the minimization of energy waste and a reduction in total energy consumption. Monitoring allows you to analyze and receive all data collected in real time, it checks the entire system and whenever there is something irregular, the system generates an alert that allows its real-time correction. The installation of measuring devices for

energy consumption to provide immediate feedback helps reduce energy consumption in homes by 20%.

Beyond that, system maintenance procedures can be performed less frequently, since there is a parallel process which collects and processes the information in work areas, minimizing costs.

HOUSEHOLD EQUIPMENT RENEWAL

Promote a gradual of household renewal equipment consumers of energy inefficiently by other top-class energy, especially home appliances.

Appliances are common use equipment in a dwelling and use of more efficient equipment is preferred. Due to technological advances increasing consumers have at their disposal more efficient equipment and should therefore be promoted more or less regular replacement for more efficient models. For illustrate the potential in reducing consumption of this measure presents the scenario of replacement of all household equipment of a dwelling that could result in reduced annual electrical consumption in order of 30%.

In order to identify energy efficiency of home appliances, there is energy label. It's used is common throughout Europe and it is an informational tool to the service consumer. According to current law the seller is required to display the energy label for each type of appliance. The Energy Star label and GEA are used in office equipment and electronics consumer.

OFFICE EQUIPMENT RENEWAL

Provide the gradual renewal of office equipment energy consumers with more efficient ones. The increasing introduction of electronic and electrical equipment in offices in recent years represents a considerable rise in energy consumption of buildings. Moreover, there is also a high energy potential savings associated with using such equipment.

Full exploitation of potential energy savings of some electrical and electronic equipment can be achieved through the selection and purchase of energy-efficient equipment.

For example, refers the possibility of achieving an energy saving up to 80% by substituting a desktop to portable computers. Similarly, the replacement of a conventional CRT monitor panel may lead to lower fuel consumption by about 50%, and the replacement by Mono-function devices that multifunction centralized devices allows also the order of 50% reduction in consumption.

In this context, we highlight the importance of promoting the energy efficiency criteria during selection of office equipment to purchase, including equipment that have opt-Energy Star label (equipment used in low power standby), showing a right-sizing, which have inhibitors of energy consumption in off mode, among others.

EQUIPMENT MODERNIZATION

Renew equipment gradually, substituting more efficient equipment in particular driving forces equipment.

All equipment has a lifetime. Over the years equipments begin to be less efficient, they begin to spend more energy for the same function.

In addition, technology evolves very quickly, always aiming to improve equipment performance and reduce power consumption per device/function.

Investment in efficient equipment can reduce energy consumption consequently reduction greenhouse gases emissions, highlighting the importance of efficient motive power equipment (electric motors), as they represent a major end uses electricity and that its application covers all activity sectors, from simple household appliances to industrial machinery.

SOLAR POWER

Installing solar thermal collectors in buildings for tourist accommodation, domestic activities of human health, sports and recreational activities and promote the production of electricity using photovoltaic systems.

Hot water production is a process which consumed a large amount of energy. Installation of solar thermal collectors, which harness the energy from the sun to heat water, thus presents a major impact on reducing energy consumption, saving as much as 70% of energy needed to heat water.

Energy provided by sun is transformed into heat/hot water by installing a screen placed on the roof or elsewhere in the building with plenty of sun exposure. Downstream of the panel there is a closed circuit of water to heat and maintain the hot water, even during the night.

All this system achieves the results with conventional systems of water heating gas, diesel or electricity, with however the advantage of power supplied by sun has no cost, enabling a huge reduction in the emission of greenhouse gases.

Photovoltaic systems allow the conversion of solar energy into electrical energy through photovoltaic cells that create an electric potential difference by light action. Photovoltaic cells

are made of semiconductor materials, typically silicon and can convert 7-16% of solar energy captured into electrical energy, with a peak power from 60 to 140 W/m^2.

Evolution of technologies associated with photovoltaic systems and rising cost of fossil fuels has contributed to economic viability of photovoltaic power generation, which is further enhanced by reduced maintenance costs and high service life of these systems. The production of photovoltaic's can be aimed at home consumption or sale to public grid. The production for self allows the producer to replace the use of energy sources with greater environmental impacts of a renewable source, while still allowing a reduction in energy bills associated with acquisition of energy from these same sources. In turn, the production for sale to public allows the producer to obtain an attractive source of monthly income, especially by the application of subsidized rates, and simultaneously contribute to the increased rate of renewable in national energy mix.

HEAT PUMPS

Install heat pumps in buildings for tourist accommodation, domestic activities of human health, sport and recreational activities.

Heating systems play a crucial role in maintaining thermal comfort of the building, on cold days. However, these systems are responsible for a significant part of building energy bill and greenhouse gases emissions into atmosphere, so improving its energy efficiency is the key.

Heat pumps are thus sustainable as an option. Outside air temperature is the main energy source of heat pump regardless its temperature. When pulling and compressing the outside air through a compressor, this device allows, with the aid of a heat exchanger, warming the air within the building.

These systems allow hot water and ambient air in an efficient way, because this technology requires only 25% of electric energy in compressed air, obtaining of outside air the remaining 75% of the energy needed for heating.

ADVANCED BOILER

Install heat pumps in buildings for tourist accommodation, domestic activities of human health, sport and recreational activities.

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EFFICIENT VEHICLE ACCESSORIES AND EFFICIENT FLEET RENEWAL

Efficient vehicles incorporation through gradual renewal of vehicle fleet in land transport.

Road transport is responsible for most of mobility generated and the car in European Union in 2008 represented 72% of total motorized mobility. The growing dependence on private transport and the increase number of trips per passenger has caused serious social, economic and environmental impacts, including inefficient energy consumption in transport sector. Currently, over 20% of final energy consumed in European Union is the transport sector responsibility. Portugal, in 2008, was responsible for 28% of total final energy consumption in transport sector.

Efficiency and reducing emissions of greenhouse gases are increasingly present in auto industry: the automotive industry has been experiencing tremendous progress towards reducing CO_2 emissions and technological development has been evident in achievement this goal. At present, the replacement of older vehicles for new cars in the same range ensures alone an increase in energy efficiency and therefore energy reduction of fuel consumption per kilometre travelled.

However, it isn't necessary replace the full benefits of the vehicle for environmental and energy level, in many vehicles effective maintenance can be significant in terms of efficiency of vehicle.

ELECTRIC VEHICLES (EV)

Purchase of electric vehicles and creating a network to supply them.

As mentioned, transport is responsible for more than a third of final energy consumption in Portugal. To promote energy efficiency in this area, have already been launched several programs including the Mobi.E Program, an initiative of Portuguese electric mobility that put Portugal as a pioneer in the development and adoption of new energy models for sustainable mobility.

MOBI.E Program electric vehicles promotion will create a charging network nationwide, user-centered, accessible anywhere in the country and compatible with all brands of vehicles, open to all operators, enabling you to enter the electric vehicle as an alternative to road transportation using fossil fuels. By mid-2011 will be completed a pilot network of vehicle charging that incorporate 25 municipalities participation.

Electric vehicle purchase allows a great energy and financial savings because electric motors are more efficient than internal combustion engines. An electric vehicle spends, on average, between 0.1 to 0.23 KW/ h per kilometre, while a vehicle with an internal combustion engine spends, on average, about 0.98 KW/ h per kilometre. With this performance electric vehicle allows a great reduction in cost per travel, besides not being subject to large fluctuations in the cost of traditional fuels in recent years.

SUPPLY IMPROVEMENT AND TRANSPORT NETWORK

Study and create new routes for transport network, with more and better linkages between them and study population displacement flow.

With an increasing in offer on public transportation which is responsible for serving population, there is a greater increase in moving people from starting point to destination also permitting gradual improvement of urban mobility system.

Analyzing and restructuring public transport system, creating new routes, adjusting schedules to people's daily lives and promoting synergies between different transport modes it is possible to put public transport network as a real alternative to private transport.

Reducing car using will promote a reduction in fuel consumption in a sector with high energy needs, which will bring many benefits to environmental, health, quality of life and even economics.

URBAN RENEWAL AND ROADS IMPROVEMENT

Develop a plan to better know the needs of collective transportation of new urbanizations in order to improving urban access through the rehabilitation and urban network improvement.

For the elaboration of the plan for urban renewal and accessibility improvement is crucial to identify areas with higher population flow, with more hits. Is necessary to understand where people go.

The majority of population movements is made between home and work, and should therefore be promoted the concentration of services sets that minimize travel distances and, simultaneously, allows you to create a good network of access to these sites and allow a wide range of collective public transport.

The plan should also structure urban primary road network for this to facilitate city crossing, as well as input and output of it to make it fully functional for different users and to liberate the secondary network for local easier access, focusing on pedestrian and cycling modes and using of public transport. Thus contributes significantly to increase the quality of life of citizens, as well as to promote sustainability of the city.

A city with good mobility urbanization policies, population quality of life increased because there is a reduction in travel times as well as necessary energy for the transport and greenhouse gases emissions.

INCREASED "PEDESTRIAN" AND USE OF BICYCLE

Create a network that allows making the city more pedestrian and cycling.

Currently, for environmental and public health issues it is increasingly recognized that soft modes (individual movement and locomotion on wheels without use of fuel energy) are may be an alternative in a short-distance travel or in a combination with other modes. The promotion of this type of travel would reduce the number of vehicles in circulation, so an asset for reducing energy dependence and of greenhouse gases emissions and also for human health.

In order to promote increased walking and cycling mobility, it is essential to ensure Ecopistas availability and qualification, providing better conditions for comfort and highest level of priority routes in higher flows or those who need for urgency improvement.

In this context it is argued that pedestrian and cycling networks are to serve areas with more intensive trade and services as well as poles of higher tourist concentration, surrounding areas with major travel generators and with interfaces, transport stops that serve residential areas.

The quality of network to create/maintain should be permanently guaranteed through an adequate monitoring of their condition and maintenance actions appropriate. Should be further promoted to increase the safety of its users by improve the urban design and correction situations that lead to risk of pedestrian accidents.

As an incentive to bicycle use, should be further promoted the existence of equipment and infrastructure to support the use and parking of bicycles.

To a greater successful in Ecopistas should proceed to population awareness and training for interaction and use these modes.

ENERGY OPTIMIZATION AND CLIMATE POLICY ASPECTS OF URBAN PLANNING AND MUNICIPAL

Municipality Master Plan (PDM) reviews considering energy sustainability as a core element in planning decision.

In a city where home to workplaces trips account for most of needs of population displacement, it is essential that PDM adapts to these needs in order to shorten distances.

A regional planning thought and weighted to maximize energy efficiency will contribute to a significant improvement in residents and employed quality of life in county, either by reducing costs and emissions associated with mobility or by reducing the travel length.

WATER MANAGEMENT

Improve the current model of demand management and water consumption, to search for better energy efficiency.

Water sector is a source of renewable energy and clean, as a consumer of energy, contributing to the greenhouse gases emissions when it is produced from fossil fuels. This sector is a major consumer of energy, particularly in areas of collecting, treatment, distribution of drinking water and drainage, treatment and discharge of wastewater.

Water management process should start in capturing maintained until the end customer and wastewater treatment. The prediction of water consumption per hour and the identification of peak hours allow management to better serve the customer and supplier, ensuring the maintenance of supply using the lowest energy consumption and therefore less CO_2 emissions.

Water heating for domestic use is also responsible for significant energy consumption, as collecting and pumping for agricultural use, another area where energy consumption can be significant. Awareness and implementation of measures to moderate the water consumption in these sectors may also be reflected in energy savings.

The possibility of treatment plants wastewater centers are energy producers using cogeneration and energy production in anaerobic digesters.

Water reduction consumption and increasing energy efficiency of operation systems and management of the resulting optimization model of water management thus contributes to a reduction in energy consumed.

WASTE MANAGEMENT

Designing or improving the model of waste management, achieving maximum efficiency in energy use.

In Portugal is produced daily on average 1.4 kg of household waste per inhabitant, it is important to raise awareness and education for prevention of waste production.

The energy impacts resulting from proper management of waste are enormous, in that preventing waste is allowed to consume a large amount of energy in processes of extraction, transport and raw materials transformation and then collecting and treating their own waste.

On the other hand, investment in education and awareness for equipment and materials reuse, separation and recycling materials such as glass, plastic, paper and metal allows to save resources, to combat pollutants emission and greenhouse gases and limit the occupation of land for disposal of waste, contributing to a sustainable development model and a better environment.

Organic recovery is also a strategic measure to reduce GHG emissions. Separation, collection and routing of organic material to a treatment station allow biogas production that can be used to produce energy and for producing a high quality "compound" for agriculture.

Used cooking oil can also be reused for biodiesel production, as previously mentioned.

Waste sector is responsible for direct and indirect emissions that can be reduced with an appropriate model for waste management. Direct emissions result primarily in support activities, such as fossil fuels consumption, incineration and composting operation, collection

fleets and mobile machinery in existing landfills. Indirect emissions are related to electricity consumed on facilities.

FLEET MANAGEMENT DISTRIBUTION

Conceive a plan for improving transport network in distribution and urban support services and better manage their fleets.

Many companies have fleets of vehicles that affect the activity and/or assigned to company's staff, typically with management functions (county administration, staff directors). Thus, fleet management, particularly in logistics terms, assumes a central role in improving business efficiency, since it integrates the management of supply chain that plans, implements and controls goods flow, services and information between origin point and consumption point, in order to meet customer needs.

Measures typology to be implemented within fleet management includes routes optimization – it is especially important in cases of distribution companies or whose activity involves regular visits to customers - the purchase less polluting vehicles fleets (eg. hybrid vehicles, electric vehicles, use of bicycles for local distribution or others that allow the reduction of environmental externalities) and allocation policy review of company cars in order to promote the rationalization of vehicles allocation. A good fleet management leads to a competitive advantage and cost savings, as well as reduction of energy consumption and respective CO_2 emissions.

OCCUPATIONAL AND COMMUTING MOBILITY OPTIMIZATION

Realization and implementation of integrated plans for mobility in public transportation level should be adaptive for workers and customers of business establishments in county.

Workers movement, visitors and service providers constitute a significant share of trips made daily in county and therefore the poles generators/attractors of travel, have an important role in mobility and sustainability system management. As such the adoption of good practices of mobility should establish itself as a reality within labor activity, especially in large companies and generators/attractors poles of trips.

In this context, conception and implementation of integrated mobility plan that encourages the use of public transport especially for commuting becomes relevant and it is a valuable tool to promote energy sustainability.

There will always be a group of individuals who for professional or personal life will continue to use the car to do their movements, should also be advocated measures to optimize/streamline car use. In this case it should be done a feasibility study for implementation of measures to promote Carpooling (sharing a car between employees performing the same route by allocating the travel cost), Carsharing (vehicle use available/rented at certain points to local displacement) or Vanpooling (shared minibuses available for traveling to specific points, such as companies, business services, among others), for example, would reduce both the number of vehicles on road daily.

The creation management models of parking can also be used as a management instrument and demand control for individual transportation. In city central areas, including the use of long-term parking on public roads associated with commuting (employees in commerce and services) will ensure the existence of rotational parking for visitors, including customers and suppliers. In addition, availability of parking areas free or reduced cost on outskirts of the city served by an adequate network of public transport provides a private transport alternative in inner cities.

AWARENESS, EDUCATION AND PREMIUMS FOR ENERGY EFFICIENCY

Planning a set of actions to raise awareness and educate the population to environmental and energy practices.

Some social, cultural and psychological prevent users from making energy savings. These barriers are associated to energy-efficient behavior, especially the lack of awareness and information and bad habits.

Sustainability path involves permanently affect the behaviour and then acquire new habits. Information and education are the keys elements to transform knowledge into action.

This includes population awareness/education, highlight adapted campaigns to various age groups of population, especially in energy efficiency, labelling machines, equipment warnings about energy efficiency or performance education in schools, use information technologies such as consumption meters. Counselling experts during audits may be necessary to help people become aware of possible energy savings and to measure the impact of their behaviour. Well-informed consumers choose actions to save energy with minimal impact on their comfort. The perception of comfort is important, there must be a balance between energy saving and perception of any comfort loss.

CONDOMINIUS SUPPORT AND RESIDENTS ASSOCIATIONS FOR ENERGY EFFICIENCY MANAGEMENT

Promote and create a technical framework for counselling in energy efficiency area for domestic sector with a strong focus on condominiums and/or neighbourhood organizations.

The network creation of experts to conduct audits in domestic sector will allow the identification and presentation of measures with technical and economic feasibility, which allow the effective reduction of consumption in buildings audited.

After the audit will facilitate awareness, collective or individual small changes residents that lead to more efficient habits and possible promotion rules to implement efficiency in buildings audited.

OPTIMIZATION OF PROFESSIONAL PERFORMANCE

Implement training, awareness and education for municipal workers and private companies that operate vehicles or equipment-intensive energy consumers.

Good practices awareness against waste allows for workers to increase environmental consciousness. Although there are its countless applications of control in order to consume as little as possible by performing the same task, there are factors that are totally controlled by worker.

Promote awareness of a worker through formation can create a contagion effect, according as learner can teach colleagues, friends and family to have a more sustainable attitude in their actions.

In this context, and presents itself as an example the fact that few drivers know how to exploit optimally the potential of vehicles with increasingly lower average consumption and CO_2 emissions per kilometre. Implement training-formations, awareness and education allow instil changes in driving habits that can translate into significant gains.

NATURAL GAS CONVERSION

Convert gradually heat consumer equipment to natural gas.

Natural gas has significantly increased its participation in national energy balance bringing a number of advantages in terms of environmental impacts, safety and convenience of use.

This fuel has a broad spectrum of applications in domestic and industrial use. In domestic sector, natural gas consumption allows replacement of petroleum gas (LPG), reducing the amount of CO_2, according as natural gas combustion results in an amount of CO_2 lower than any product petroleum origin. In industrial sector natural gas can be used in boilers substituting less sustainable fuel to produce steam for heating. Heat transfer fluids used in various industries or for use in industrial furnaces.

Natural gas can also be used as automotive fuel, reducing pollutants emission and greenhouse gases in transport sector. It is considerably more expensive than diesel and petrol, its use as fuel increases the lifetime of engine, reducing maintenance costs and consumption of lubricating oils.

CARBON EMISSIONS VOLUNTARY REDUCTION

Promote and create a technical framework for counselling in energy efficiency area for industry and services sector.

Voluntary Carbon Market appears in parallel with Regulated Carbon Market and aims to offset individuals or companies emissions that have no legal obligation in accordance with European Emissions Trading Scheme (ETS) in order to mitigate their environmental effects on units of CO_2 equivalent.

Scientific principle is based on fact that greenhouse gases are mixed rapidly in dispersing air throughout the world. As such, it is irrelevant where GHG reductions occur; only that matter is emitted less carbon into atmosphere.

Voluntary Carbon Market has grown strongly in recent years given companies growing concern with their emissions increasing the number of related projects, for example, renewable energy and planting forests.

The main advantage of this market is the possibility of being accepted small projects, unlike what happens in arranged market today.

Currently, there are still many industries without limitation in greenhouse gases emissions, but through these markets, may help to reduce those. For this a technique structure should be established to promote the potential of Voluntary Carbon Markets and promotes the inclusion of projects in this market. This team should also have the technical capability to undertake the implementation of emission inventories fit to specifics of each client and adaptable to a specific period, enabling accounting any specific production (any product or service), event, or other unanticipated, based on international guidelines calculation.

Implementation of this measure in many companies will voluntarily change their history in energy and increase their sustainability and it is vital awareness of business sector.

GREEN PUBLIC PURCHASE (GPP)

Designing a tool to measure all purchases as environmentally, energy-using equipment, vehicles and contracts

Procurement accounts for over 16% of European Union Gross Domestic Product. Thus, there is a great potential that GPP have for sustainable development and reducing GHG.

At the same time, buying green products or services by public bodies conveys gives a positive image to market, providing an example to other identities, and encourages companies to innovate their products and show that these are true sustainable products.

Recognizing the contribution that GPP will have for sustainable development, it was presented a Resolution of the Cabinet of Ministers n.º 65/2007, approving the National Strategy for Green Public Purchase 2008-2010. This Strategy sets out the priority products and services which public authorities should start their green purchasing policy. In relation to these products and services, it was also developed ecological criteria to be implemented by various agencies in their procurement policy.

Thus, arises the need of design a tool that takes into account ecological criteria to apply under the new public procurement policy and to measure all eco products and services to be contracted stamps municipal services.

SUPORT URBAN INVESTMENT AND SUSTAINABLE BUSINESS

Sustainable technical support and positive discrimination to new sustainable real estate investments and certificates.

Support for new investments is extremely important to region's economic development and should therefore be offered support and information that would allow attracting investment and encouraging entrepreneurship. It is essential in this step providing the necessary support to promotion of sustainable projects, aiming at economic growth that contributes to sustainability goals of region and does not compromise the quality of life of surrounding where it belongs.

With the positive discrimination becomes easier for companies that don't have yet a sustainable activity to focus on environmental issues when developing their business plan. Positive discrimination should focus on investments that take into account sustainable growth and encouraging the development of projects/activities sustainable and energy efficient.

MOBILITY FOR EVENTS OPTIMIZATION

Designing and planning a network of transport and parking for events with presence of broad public.

The shift from public to major events always brings with it several factors that are hardly controlled as traffic jams, difficulties associated with vehicles parking, among others, often compromising sustainability of these initiatives.

As such, one of fundamental measure in planning events is the availability of parking for public who travels by car. Parking areas should provide multiple areas and information about being full.

It should also be planned availability public transportation between the event and the local focus of all public transport and car parks. Thus, it should minimize the movement of visitors in private transport and corresponding CO_2 emissions.

Reference Cases

Amsterdam

Amsterdam Climate Policy

The City of Amsterdam has the ambitious plan to cut CO2-emissions with 40% in 2025 in comparison to the emission level of 1990. In addition the municipal organisation aims to be climate neutral by 2015, with no CO2 emissions or fully compensating them. To fulfil these ambitions a vast number of actions and measures have to be taken by the municipal organisation, the citizens of Amsterdam and by businesses in the Amsterdam area. Actions can include e.g.:

- Improvement off thermal isolation of houses and apartments. This will be done for new build housing but especially the refurbishment of housing estates build in the 1950's to 1970's;

- Use of (surplus) heat from industry in district heating;

- Promotion of energy efficient vehicles for the municipal organisations;

- Use of biomass for energy generation;

- Development of smart ICT solutions to decrease CO2-emissions (in cooperation with Cisco and the cities of Seoul and San Francisco within the Clinton Global Initiative).

A major role in the development and execution of all these initiatives is played by the City of Amsterdam Waste and Energy Company (or Afval Energie Bedrijf, AEB, as it is called in Dutch).

City of Amsterdam Waste and Energy Company (AEB)

The Waste and Energy Company (AEB) is a City of Amsterdam public utility company. It operates as an independent business, but is an integral part of the municipal organisation of the City of Amsterdam. AEB is since 1993 situated in Amsterdam's western port district. In this year AEB opened its new Waste to Energy plant. AEB activities expanded with the cooperation with the neighbouring municipal waste water treatment for biogas utilisation and sludge processing, and the start of operation of the new Waste Fired Power Plant (WFPP). Some of the key figures for 2006 and 2007 are given in table 1.

Co-generation at AEB

The main activity of AEB is to generate energy from Municipal Solid Waste (MSW). This is done by incineration of MSW to produce heat for district heating and electricity production. Furthermore heat and electricity is produced by using biogas from the municipal waste water treatment plant as a fuel for four Combined Heat and Power (CHP) engines. Although waste incineration and biogas utilization both deal with co-generation, the WtE activities will only be discussed briefly. Focus will be on the biogas utilization because these activities are part of the ECOSTILER project.

Waste to Energy Plant (WTE PLANT)

The Waste to Energy (WtE) plant has a net electrical efficiency of more than 25%. Thanks to an effective approach to reduce discharge of dioxins and other toxic substances, it was in 1993 the first new built plant in the Netherlands to comply with the then new emission regulations. Today the existing plant processes some 850,000 tonnes of urban waste and 100,000 tonnes of sewage sludge each year. And next to 150,000 Gj district heating, it delivers 530,000 MWh of electricity to the national grid annually.

Waste Fired Power Plant (WFPP)

The starting point for the development of the Waste Fired Power Plant (WFFP) was the sense that waste to energy is more than only a clean solution to get rid of waste. The conventional WtE should be adapted to maximizing the recovery of energy and materials. This led to the development of the fourth generation WtE that is 'designed for output'. The result is the new Waste Fired Power Plant achieving a 30% net electrical installation efficiency. Bottom ash will be washed to produce clean sand and aggregate and to maximize recovery of metals. From fall 2007, the existing WtE plant and the WFPP operate in parallel, both under the name of AEB. Their total processing capacity is 1.5 million tons of waste and sewage sludge per year.

European co-operation at AEB

As an innovating company AEB co-operates with various organisations in European or nationally funded projects. The purpose of these projects is to develop and demonstrate new technologies, also within the framework of Amsterdam's climate change ambitions. Some examples are:

- LIFE project to demonstrate the recovery of metals, and the production of

building materials from bottom ash (LIFE);

- NextGenBioWaste, innovative demonstrations for the next generation of

biomass and waste combustion plants for energy recovery and renewable

electricity production (FP6);

- Ecostiler, Energy efficient COmmunity STimulation by use and Integration of

Local Energy Resources (FP6);

- High Energy Recovery, demonstration of the WFFP (FP6)

- Utilisation of surplus heat in Amsterdam North (Dutch funded)

- Training and dissemination network for Waste to Energy (in preparation, IEE)

Bern

Waste management

Bern Township is mandated to recycle by the Municipal Waste Planning, Recycling and Waste Reduction Act (Act 101) to provide curbside recycling services, including curbside leaf waste collection, for all residential households in the Township. Township staff and the Board of Supervisors will need to make a number of decisions pertaining to recycling in order to implement a recycling plan and to make enhancements to the recycling and waste collection system. The Township should view recycling issues and services together with waste collection, not as separate issues. Key findings and recommendations from this study include:

- 70 percent of the households in the Township have private subscription waste collection service at a cost of $350 - $400 per household per year. 30 percent of households are under contract collection in the "Garbage Collection District" for waste and recycling service with Lebanon Valley Farms Disposal, Inc. for $235 per household per year.

- Generally, the existing Ordinance (133) meets the minimum Act 101 and PADEP requirements for "mandated" recycling programs. However, the leaf waste collection requirements as specified by Act 101/PADEP guidelines are not fully addressed in the Ordinance and should be revised. It is noted that if the Township takes the position to only meet the minimum Act 101 requirements for curbside recyclable collection of commingled materials (e.g. monthly collection) and leaf waste (e.g. two leaf collections and two yard waste collections annually), it is believed by this author that the Township's recycling program will 1) continue to suffer from compliance issues; 2) will have poor participation by residents; 3) will have a poor recycling rate; 4) and may not meet the disposal/recycling needs of many households in the Township. Leaf waste requirements, including supplement leaf waste drop-off site requirements, are included in the PADEP guidance document in Appendix B.

- Bern Township is required by Act 101 to ensure curbside recycling services are provided for

all households in the Township. Because the existing cost for 70 percent of households is $350 - $400, there is an opportunity to implement an enhanced recycling program throughout the entire Township without increasing the overall cost per household or assessing an increase in the tax base. For example, the neighbouring Township of Muhlenberg has a municipal-wide contract with J.P. Mascaro through 2008 for trash (twice per week) and recycling service (bi-weekly) at a cost of $300 per household per year. Bern Township may be able to implement a comprehensive, cost- effective and environmentally responsible waste collection system through a well-designed Request for Proposal (RFP) and municipal bid process that bundles waste collection and recycling services and possibly considers joint-bidding with Muhlenberg or one or more other neighbouring municipalities.

- If it is decided in the future the Township will pursue such a municipal bid, it is recommended the Township contact several local hauling companies to discuss the Township's intent so that the Township can be well-informed as it develops a municipal wide waste and recycling contract.

- It is recommended the Township implement changes to the program as follows:

1. Develop a permanent recycling and waste management committee.

2. Evaluate Township needs and goals and complete a Recycling Plan/waste management plan that expands upon the Conceptual Recycling Plan initiated in this study.

3. Begin implementation of an enhanced recycling and waste management program via a new or revised municipal ordinance.

4. Confirm the feasibility of implementing a municipal-wide contract collection system.

5. Collection of plastic bottles and jugs (HDPE and PETE) should be required for the entire Township.

6. Residents should recycle Christmas trees through a program offered by the Township.

7. At a minimum, the curbside recyclables collection schedule is recommended to be bi-weekly. However, depending on the final waste and recycling program structure chosen, weekly collection of recyclables may be advantageous.

8. If the Township decides to implement a municipal wide contract, the Township Board of Supervisors and Staff should begin making decisions (as early as possible) to confirm the waste and recycling services that will be offered to residents. A bid specification should be prepared and issued on a schedule that does not legally conflict with any existing waste and recycling contractual commitments.

9. Education of residents as well as commercial, institutional and municipal establishments must occur at a minimum of once every six months.

Biogas Project:

Goal

Replace all diesel buses by biogas buses in a defined time period.

Partners

Energy Wasser Bern (ewb)

BERNMOBIL

Arabern

Energie Wasser Bern (ewb)

Local energy supplier for the City of Bern (Supplies electricity, natural gas, water and distant heating out of its incineration plant and operates the corresponding grids including bio methane grid injection)

BERNMOBIL

Public transportation in the City of Bern and neighbourhood (Operates the Tramways and Bus lines)

Arabern

Local Waste Water Treatment Plant (WWTP) for the City of Bern and agglomeration (operates the WWTP, produces biogas and up-grades it to bio methane)

Contract ewb / BERNMOBIL

Most significant points:

ewb pays for all additional costs, i.e. for BERNMOBIL the change from diesel to gas is «cost neutral»

. ewb builds and operates the gas filling station

. ewb delivers biomethane for at least 30 buses

. ewb becomes the only supplier for gas and electricity (whereby price for 1 kg gas is similar to 1 lt diesel, assuming the gas bus drives as far with 1 kg gas as a diesel bus with 1 lt diesel)

Contract ewb / arabern

Most significant points:

. ewb pays for the connecting pipe to the gas grid for biomethane injection

. ewb pays 50% of the up-grading system and provides engineering support

. ewb receives 13 million kWh p.a. for approx. 50% of the biomethane market price for 10 years (this is good enough for 30 gas buses)

Main Additional Costs (BERNMOBIL)

- Gas buses are 10 % more expensive in purchase and operation compared to similar Diesel buses

- Need of fuelling station (including powerful back-up)

- Interconnection with gas grid

- In our case, adaptation of building infrastructure such as: gas sensors, automatic door and roof opening, ventilation, fire proof pillars and walls, "sparkle-free" electrical installations (lamps, switches, motors), etc.

- Adaptation of garage tools

- Training of engineers and drivers

Main Additional Costs (arabern)

- Engineering and purchase of up-grading system

- Grid injection including

    . Gas quality assurance

    . Monitoring and measurement

- Interconnection with gas grid

Birmingham

Introduction

The Local Strategic Partnership, through the Birmingham Environmental Partnership (BEP), has set a challenge to ensure no more than 50% of all waste produced in the Birmingham City Council local authority area is sent to landfill be 2015 and 0% by 2026. This Total Waste Strategy (TWS) has been developed in response to this challenge and considers the options for meeting the aim of zero waste to landfill.

The TWS builds on a Waste Capacity Study already carried out for Birmingham City Council and considered a number of elements to address the zero waste challenge, including:

Literature and good practice review – to look at the key strategic drivers to divert waste from landfill, information on how Birmingham may meet aspirations for diverting waste from landfill and case studies which highlight the key opportunities and the barriers to implementing these opportunities.

Quantification of waste arisings and the current treatment / disposal routes of the different waste streams – this included estimations of how waste might grow in the future and also attempted to estimate the baseline position of the current percentage of waste in Birmingham sent to landfill.

Assessment of waste facilities – in order to provide detail on the number, capacity and type of facilities in Birmingham and neighbouring waste planning authorities and how the options for zero waste to landfill affect the capacity need for different treatment/disposals facilities.

Stakeholder mapping – to identify the key people who will be responsible for making decisions, changing behaviour, influencing and supporting the development of the TWS.

Stakeholder workshops – to engage stakeholders in the development of the TWS and discuss the options for meeting the zero waste challenge.

Options appraisal – covering financial and carbon modelling to look at the cost implications and carbon impact of different proposed scenarios.

Following completion of the above elements of the TWS, a short term action plan and communication plan has been developed to look at driving longer term actions to achieving the aim of the TWS.

Sustainable Community Strategy – Birmingham 2026. Our Vision for the Future (Be Birmingham and Birmingham City Council, September 2008)

The Sustainable Community Strategy sets out a vision for the Birmingham to be the first

sustainable global city by 2026. It addresses five key outcomes – succeed economically, staying safe and clean in a green city, being healthy, enjoying a high quality of life and making a contribution.

In relation to the TWS, this strategy sets out the following aspirations and targets:

Create a vibrant low carbon low waste economy, including the best use of environmental technologies, and ensure that Birmingham is prepared for the impacts of climate change.

Reduce the production of waste and increase recycling, including encouraging and promoting community based recycling and reuse schemes such as Freecycle, Betel and the Ladywood Furniture Project.

Focus on growth of the City Centre with the Big City Plan. This would lead to increased energy demand and waste generation in this area.

The need for 50,000 new homes in the next 20 years will increase the energy demand and waste generation.

The aspirations for carbon reduction and waste management detailed in the Sustainable Community Strategy have been formed from the views of local residents and businesses. The recommendations should be taken into account as a clear direction of how local stakeholders want to see these aspects developed. These aspirations form the basis for a number of local strategies for example the Core Strategy and City Plan which form part of the Local Development Framework. The key messages are that Birmingham will in 2026 be a sustainable city with a vibrant low carbon economy, processing waste up the waste hierarchy and linking energy from waste opportunities into the development of City Centre and additional housing developments.

Waste – A Future Resource for Business (SLR, March 2008)

This report reviews the existing treatment capacity against projected increases in waste arisings (municipal and C&I) to identify the treatment gap in the future. The treatment gap is further defined by facility type and at district/authority level. The report also reviews the key legislation in relation to driving the development of treatment facilities as an alternative to landfill.

This report was reviewed as part of the Waste Capacity Study finalised by SKM Enviros in February 2010 and is therefore not detailed in this desk based review.

Waste Capacity Study, Birmingham City Council (SKM Enviros, February 2010)

The Waste Capacity Study was developed to help provide the technical evidence base,

establishing the need and capacity for waste management facilities, in order to allow informed decision on the Birmingham Core Strategy. The study looked at a number of elements including:

Existing and emerging legislation and policy which should inform decisions related to waste and planning;

Current and future waste arisings for municipal, commercial & industrial, construction demolition and excavation waste and hazardous waste;

Number, location and capacity of existing waste facilities; and

Future waste capacity need in Birmingham.

The total waste arisings, for MSW, C&I, CD&E and hazardous waste streams in Birmingham are estimated to be 3.2 million tonnes. Moving forward up to 2025, the mid range forecasts remain in the order of 3.1 – 3.2 million tonnes. The analysis of capacity at permitted and exempt waste management facilities and at accredited reprocessors in Birmingham is in the range of 4 to 4.5 million tonnes, of which 2 – 2.5 million tonnes is waste transfer capacity. Birmingham has limited disposal capacity with no active landfill in the city, and the Tyseley EfW facility taking only municipal waste.

The headline waste capacity information suggests that Birmingham is achieving the 'equivalent self sufficiency' principle; however the majority of waste going through a waste transfer station will require further treatment/disposal. If the transfer station capacity in Birmingham is discounted from the assessment of 'equivalent self sufficiency' (2 – 2.5 million tonnes) there could be scope for additional treatment/disposal facilities to be developed or expanded to cover the equivalent quantity of waste arising.

In terms of future planning in Birmingham there is a need to consider the waste types, for example C&I waste or specific waste streams e.g. food waste, which the authority may wish to plan to manage in the future and the type of facilities which the authority may wish to focus on planning to accommodating, for example anaerobic digestion. It is unlikely given the urban nature of Birmingham that a landfill would be developed in Birmingham.

The capacity study highlights the importance that any future waste facilities should help move waste management practices up the hierarchy and allow waste to be treated as a resource, ensuring waste is treated as near to the source of generation as possible.

A conclusion of the West Midlands Regional Spatial Strategy is highlighted in the study, that it is not commercially feasible for each Waste Planning Authority to have sufficient facilities to manage all their own waste streams with different characteristics. However, each Waste

Planning Authority area should ensure they manage the equivalent tonnage of waste arising in their area, the 'equivalent self sufficiency principle'.

The report notes that different authorities in the West Midlands will be better placed to treat certain types of waste and accommodate the appropriate types of waste facilities. As part of the TWS study, neighbouring authorities to Birmingham will be contacted to ascertain their views on futures planning for waste management facilities.

Tyseley Energy from Waste Plant: Feasibility into the future possibilities for the use of waste heat (Urban Design, June 2009)

This feasibility study assesses the options for the use of waste heat associated with the generation of electricity from the two stream Tyseley EfW plant. The options include - anaerobic digestion (AD) with separately collected food waste feedstock, drying of biomass and utilising the waste heat through a district heating scheme.

It is important to consider these options in order to generate additional revenue from the EfW facility, as the existing special purchase agreement for the sale of electricity (currently electricity is sold at a premium rate) expires in 2011. Therefore, post 2011 revenue could decrease from the reduced electricity sale price. The use of the waste heat as an additional revenue stream will be important to maintain the financial viability of the plant.

In the review of this feasibility report to assess the use of the waste heat from the EfW facility, it is important to note that the facility generates 26.3 MW of electricity and during this process produces a low grade heat at 34 ºC that is currently dissipated to the atmosphere.

The report concluded the following against each of the options for using the waste heat from Tyseley: Anaerobic Digestion – This was considered to be a feasible option to use the waste heat in the operation of an AD facility. The feedstock would be separately collected food waste from households and commercial and industrial customers in Birmingham and from neighbouring authorities. The report modelled 3 scenarios dependant on the volume of feedstock available and this demonstrated that the larger facilities generate higher net revenues. Some of the key aspects to consider include:

Waste Heat – The waste heat from the EfW facility is low grade (34 ºC). However, the assessment has been based on an AD system requiring high grade heat (55 ºC), which generates higher revenues. Options for increasing the heat would need to be investigated and the report discussed linking the AD facility to a further CHP system.

Feedstock – A detailed feasibility study on the available tonnages of food waste would need to be carried out. This would involve liaising with local authorities, to confirm their aspirations for separate food waste collections and commercial and industrial customers to evaluate their

interest to participate in such a scheme. As retailers are currently excluded from the C&I feedstock, the feasibility of engaging with local retail outlets to increase the supply of feedstock, should be investigated.

End Markets – The AD plant will be commercially viable if suitable end markets are located for the outputs. For biogas this can be used to generate electricity for export or used on site or biogas can be used in some instances as a bio-fuel, providing adequate gas cleaning equipment is provided. The market for the digestate will need to be investigated further and suggestions include PAS 110 fertiliser, biomass rich refuse derived fuel (RDF) or landfill. The end market for the digestate from AD can have a significant impact on the commercial viability of a plant, as sending the material to landfill will attract a fee of £60 per tonne.

Using the waste heat to dry and process biomass feedstock - This was considered to be a feasible option and the report identified over 600 businesses within a 20 miles radius of Birmingham that may be able to provide waste materials that could be used as biomass feedstock and subsequently dried. This would divert this waste stream from landfill and allow it to be used in a biomass system to generate heat or heat and power. The report highlighted the lack of firm data on the volumes of biomass feedstock that would be available and it is recommended that further studies are undertaken to determine the availability of biomass feedstock.

CHP/District heating system - The report looks at the ability to use the outputs from Tyseley to provide heat and power via a district heating network to schools under the 'Building Schools for Future Programme' and public sector high rise accommodation. The report concluded that the waste heat could be used in a district heating scheme as Tyseley is close to the City Centre with accessible transport routes. However, this needs to be linked to a suitable heat demand to make the scheme commercially viable.

To conclude there are a number of options to use the waste heat from the Tyseley EfW facility. These should be investigated further to determine the tonnages of feedstock available and the end markets for the outputs e.g. heat, electricity, digestate and biomass fuel. Improving Infrastructure – Heat Mapping and Decentralised Energy Supply, Advantage West Midlands (Halcrow, November 2007)

This report outlines the opportunities which exist in the region for CHP and decentralised energy supply through district networks. Decentralised energy is defined as energy supply (electricity, heat, cooling) from on or near site sources. This can include wind, solar, biomass or lower carbon sources such as gas fired boilers. There are improved efficiencies as the energy is produced near to the customer and this is further improved if this is incorporated into a CHP district energy network.

The report reviews the opportunities for CHP through the spatial heat demand and through a practical assessment of potential locations for CHP. The key findings and recommendations from this report include:

Key opportunities for CHP are in domestic, public and commercial sectors, particularly in hospitals, flats, offices and retail premises;

There is the potential to treble the uptake of CHP in the region in the public and commercial sector; and

Awareness raising and financial incentives are recommended to stimulate an increase in demand for CHP.

The report highlights that there are clear opportunities for implementing decentralised CHP systems in both the commercial and public sector. The TWS should consider this opportunity when reviewing approaches for reducing waste sent to landfill as there may be opportunities to utilise waste as a fuel in these CHP system (e.g. waste wood as a biomass fuel). In considering this opportunity consideration should be given to the additional regulation which may be applicable to these facilities through the Waste Incineration Directive and whether the CHP will meet the requirements to be eligible for the Renewable Obligation Certificates.

Tyseley EfW Plant: Third Stream Feasibility Report (Fichtner, February 2010)

This report on the Tyseley Energy from Waste (EfW) facility report reviews the technical and financial feasibility of introducing a third stream at the Tyseley EfW plant. In assessing the feasibility, the report highlights the various considerations that need to be taken into account for the existing operations and reviews the additional revenue that could be generated from the sale of electricity to the grid and through the export of heat through a combined heat and power (CHP) system.

The Tyseley EfW facility is owned and operated by Veolia Environmental Services Birmingham (VESB). The facility started operating in 1996 and processes 350,000 tonnes of municipal waste from Birmingham per year. The facility currently processes this waste through two streams and generates 26.3 MW of electricity. The generation of this electricity produces a low grade heat at 34 ºC that is currently dissipated to the atmosphere. The site also has a separate high temperature facility for processing clinical waste. The plant is expected to operate at this capacity until 2028 and Birmingham City Council has a contract with Veolia Environmental Services for the operation of the plant until 2019.

The report concludes that it is technically feasible to install a third stream on the EfW facility and that this can be achieved within the current site boundary. The third line would process an additional 175,000 tonnes per year. This will be a standalone system, however, the stream will

use existing site infrastructure such as the waste bunker and waste reception hall. It is technically feasible to install this third stream as a CHP plant, generating additional revenues from the export of heat.

The procurement and build time is estimated at between 4 – 5 years depending on whether a two stage procurement process is required, with an engineering, procurement and construction (EPC) cost of £109 million. This cost has been calculated using the Fichtner costs model and is estimated to be accurate within plus or minus 15%. Operating costs for the third line are estimated to be £4.2 million per year covering additional staff, consumables, and maintenance and disposal costs. The additional costs for installing the infrastructure required to have the third stream operating as a CHP is estimated at £1.7 million. These prices are all subject to review until formal tenders have been received.

Discussion

A number of reports have been reviewed as part of the background work for informing the development of the Birmingham TWS. These reports have been reviewed in relation to the key strategic drivers and opportunities available for diverting waste from landfill in Birmingham.

Overall the reports concluded the following key messages:

The strategic direction for the region is one of a vibrant low carbon low waste economy, including the best use of environmental technologies. Waste will be processed up the waste hierarchy with energy from waste opportunities linked into the development of City Centre and additional housing developments.

There is a commitment from AWM to attaining Low Carbon Economic Area status for the West Midlands and this would attract investment for the development of innovation approaches and technologies for diverting waste from landfill.

There are numerous opportunities to develop decentralised CHP systems in the commercial and public sector, especially in the development of new housing. Opportunities exist to divert waste from landfill through processing materials into biomass feedstock. Considerations should be given to the impacts of the Waste Incineration Directive on using waste as a biomass feedstock.

It is feasible to install a third line at Tyseley EfW facility and that this line could be installed as a CHP system exporting heat. However, this is dependent on locating a suitable heat demand;

It is feasible to use the waste heat in the operation of an AD facility, the drying and processing of biomass feedstock and in district heating CHP schemes. Considerations should be given to the availability of feedstock and the end markets for outputs e.g. electricity, heat, biomass and

digestate.

Other opportunities which have been highlighted in the reports include:

Reduce the production of waste and increase recycling, including encouraging and promoting community based recycling and reuse schemes.

Generating bio-fuels from waste oils; and

Sustainable procurement and design to reduce amount of residual waste generated.

In line with the key messages set out above, a number of case studies have been provided which provide examples of how other cities and regions both in the UK and internationally are striving to meet the challenges of being low carbon places and sending zero waste to landfill. Information from these case studies, demonstrating how other areas are attempting to meet the zero waste to landfill challenge, should be considered when developing the action plan and communication strategy as part of the Birmingham TWS.

Brussels

Introduction

Waste fraction / Specific Waste Type: Several / all the solid waste produced in the Brussels Region by households, businesses, industries and any other economic activities (but not waste abandoned on the public roads, nor waste from street sweeping and cleansing, which is covered by a sanitation plan).

Target Audience: Households, businesses and schools in Brussels

Objectives

The plan provides for implementing a number of measures (145 provisions). The objective is to introduce all these measures by 2013 Among these, priority will be given to the following:

• modification and simplification of the legislation on take-back obligation

• establishment of waste counsellors

• improvement of data on household and similar waste

• simplification/rationalization of the waste legislation in the context of transposition of the Waste Framework Directive

• doubling the number of regional waste reception centres

• re-examining the subsidies provided to communal container parks

• re-examining the subsidies provided to the social economy

• promotion of the anti-junk mail sticker campaign and its annual review

• activities for the '-100 kg' campaign

• prevention activities in schools and offices

• undertake a study to consider an incineration tax.

Preconditions

Since 1992, every 5 years, the Region adopts a "waste prevention and management plan", in short "waste plan". It includes all the means and actions foreseen in order to minimize waste and manage waste products in a sustainable way, and is followed by an evaluation of its implementation.

• 1st waste plan (1992-1997) focused on the introduction of selective collection of waste.

• 2nd waste plan (1998-2002) focused on waste prevention with a goal of reducing the quantities produced by 10%.

• 3rd waste plan (2003-2008) emphasized dematerialization and recycling of waste.

In 1992, the Region had incorporated into its program what can be considered a first attempt to raise awareness about eco-consumption. It was not until the second plan that priority was given to prevention.

With the introduction of the concept of dematerialization, the third plan highlighted the close link between our lifestyles and the preservation of natural resources through waste prevention. It set, as primary objectives:

• setting out the relationship between lifestyles and the quantities of resources consumed, and drawing attention to wastage

• promoting products without waste and recycled products

• making good use of the new information and communication technologies (ICT) by studying their potential and helping people to make best use of them.

Specificities of the 4th plan

The 4th waste plan was adopted in 2010 following a preparation initiated in 2008 – time at which the 3rd plan ended and was evaluated.

New features included in the present include

• Accompanied by an environmental impact assessment (in accordance with EU legislation)

• Indeterminate duration

• Evaluated every 2 years (instead of 5)

• Quantitative waste prevention targets to be achieved by 2013 and 2020

These quantitative targets have been set based on estimates of the flows and reduction potentials:

1. Municipal waste flows are estimated per source (in tones/year: households, schools, offices, shops, and green spaces

2. Each flow, is broken down into fractions based on sampling: food waste, garden waste, newspapers, junk mail, A4 paper, drink containers, plastic bags...

3. For each fraction the reduction potential is calculated in kg per inhabitant per year taking into account:

• expected impact in %, e.g. a household can reduce food wastage by up to 80% (based on pilot studies), a no-advertisement sticker reduces unaddressed junk-mail by 100%...

• share of the population already implementing action in %

• maximum share of the population that could implement the action in %

The calculation requires a series of estimates and approximations which induces uncertainties. Still it allows to compare different reduction potentials, helping priority setting.

Structure of the Plan

The plan combines a thematic and instrumental structure.

This approach follows a management philosophy. Management of household waste is under the exclusive jurisdiction of public authorities (ABP and Brussels Environment). Management of ‘similar’ waste (that is, waste of a nature and volume comparable to household waste) is

provided by both ABP and private parties. Management of industrial, special or hazardous waste is provided almost exclusively by private parties.

There are methods of action that the Region intends to implement, depending on their nature. These are mainly regulatory and economic instruments, voluntary instruments, take-back obligations, partnerships with other regions and countries, and finally instruments for follow-up and evaluation.

Göteborg

Collection waste

Operators are responsible for waste from industrial and other operations. This is often collected by private contractors. Some municipalities offer small and medium-sized businesses the opportunity to take their waste to recycling centres.

At present, household waste that is not subject to producer responsibility is collected by municipalities themselves or by their contractors. Bulk household waste, electrical and electronic waste, and hazardous waste is often taken to municipal recycling stations or left in a bulk waste room. Other types of waste, such as packaging, newspapers, glass, metal, plastics and batteries, are collected from recycling stations or collection centres in residential areas on the instructions of producers. Municipalities increasingly arrange for household food waste to be collected from homes.

Nowadays spent batteries can be placed in one of numerous collection boxes or in shops, whereas household hazardous waste must be taken to special collection stations. Hazardous waste collection methods vary from one municipality to another; this waste is usually collected from boxes left at the gate, hazardous waste collection stations at selected petrol stations or from recycling centres. Producers and municipalities assume joint responsibility for end-of-life electrical and electronic products, which are taken to municipal recycling centres.

Biogas plant

Upgrading with the Cooab technique and distribution to the gas grid. The upgrading plant is one of the largest in the world.

The wastewater treatment plant at Gryaab has been digesting waste water sludge anaerobically since 1990. The two reactors were built to handle the sludge produced from the treatment of wastewater at the Rya plant in Göteborg. The biogas was originally used to generate electricity and heat. Later, the biogas was distributed through the Göteborg gas grid. On the initiative of the foundation 'Svensk Metanteknik' (Swedish methane technology), a small upgrading plant was built at Rya in 1992 to convert some of the biogas to vehicle fuel quality. The development

of biogas purification technology continued at Gryaab, and in 1994 the first biogas filling station in Sweden for private cars was opened at the plant. Starting in 1996, fatty wastes destined for the reactor at Gryaab could be handled separately. The energy company 'Göteborg Energi' (Göteborg Energy) soon noted an increased demand in the region for environmentally-friendly vehicle fuels, and decided to increase the capacity to upgrade biogas. In 2007, a new upgrading plant owned by Göteborg Energi was opened in Arendal, which purifies the gas by chemical absorption.

Although it was a small-scale operation, the Rya plant was, together with Linköping, the first in the country to purify biogas from sludge. The facility to handle fatty wastes was also one of the first of its kind. The new upgrading plant in Arendal is one of the largest in the world. Göteborg Energi is aiming to replace all the natural gas used in Göteborg with biogas and is continuing to invest resources in projects that promote biogas production in the region. For example, there are plans to produce bio-methane from combustion of biomass waste from the forest industry (e.g. branches, twigs etc. remaining after felling).

The Gryaab plant treats c. 430,000 m3 per year of thickened raw sludge from the wastewater treatment plant at Rya, equivalent to 21,000 tons dry weight. There are two mesophilic (37oC) one-step (continuously-mixed) anaerobic digesters, each with a volume of 11,400 m3. The retention time for the material is c. 20 days. In 1996, the reactors also started to treat sludge from grease separators and other organic substrates such as ground food wastes from restaurants and schools in the Göteborg region, which has increased the production of biogas. The fatty wastes are received in a separate closed system, from where the organic material is pumped directly into the reactor without mixing with the other substrates.

Upgrading and use of the biogas

Gryaabs biogas plant produces each year c. 60,000 MWh of raw gas. This is sold to Göteborg Energi, and most is then upgraded to natural gas quality. There is also a smaller upgrading plant at Gryaab that has been operating since 1992 using PSA- technology. Only 0.2% of the biogas production is upgraded to run cars owned by the treatment plant.

Upgrading capacity increased significantly in 2007 when the new plant started operations. At this facility, chemical absorption is used to separate carbon dioxide from methane. A solvent (Cooab) is added, which effectively absorbs carbon dioxide. The Cooab solution is then regenerated in the process. The upgrading plants at Göteborg and Borås are the only ones in Sweden that use this technology. The capacity of the new upgrading plant is 1,600 Nm3 per hour, which makes it one of the largest in the world. Roughly 60,000 MWh of purified gas is produced each year, equivalent to c. 6 million litres of petrol. Methane leakage from the plant is very small (less than 0.1%).

Digestion residue

The 50,000 tons of digested sludge produced annually at the biogas plant is composted. Trucks deliver sludge from the Rya plant to the composting facility 6 or 7 times daily. The sludge is first mixed with sawdust or bark. Rock flour and sand is also added after composting, and the final product is marketed as a soil material for construction. Of the order of 194,000 tons of soil material is produced annually for construction of golf courses and roads etc. and as a cover material in landfills. Gryaab is also working towards the goal of returning some of the sludge to agricultural land.

Helsinki

Waste management

Helsinki Region Environmental Services Authority (HSY) is responsible for arranging the waste management and transport for residential buildings and the properties of the public administration throughout the metropolitan area. There are several recyclable wastes that are collected. These include organic waste, paper, carton, cardboard, metal, glass, wood and hazardous wastes.

The top priority in the waste management sector is waste prevention. HSY has had a waste prevention strategy from year 2002.

The Ämmässuo waste treatment centre in Espoo receives unsorted waste and separately collected organic waste from over a million inhabitants and 50,000 firms in the Helsinki metropolitan area. HSY also provides advice to citizens, firms and other organisations on preventing, sorting and recycling waste.

The average inhabitant in the Helsinki metropolitan area produces annually about 300 kilos of household waste. About 55% of household waste is recycled or reused. Compost made from organic waste is used in landscaping. Biogas is also collected from old landfills and waste treatment plants. HSY is planning to increase the efficiency of organic waste management by constructing a biogas digester to extract biogas from the collected organic waste before the composting process.

According to a survey by HSY, domestic recycling has generally become more popular. Over 90% of the residents state that they recycle paper, nearly 80% recycle cardboard and approximately 70% recycle glass waste on a regular basis. Domestic recycling has been a steadily increasing trend during the first decade of the new millennium.

HSY is currently building a gas power plant which will use biogas collected from the

Ämmässuo landfill. The first phase of the plant will be ready in 2010 and it the output capacity of the plant will be 15 MW of electricity.

There is going to be a new phase in the waste policy of the Metropolitan area. HSY has decided to introduce a new incineration plant in 2014. The plant will be built by one of the local energy production companies (Vantaa Energy) in the Långmossebergen area in Vantaa. An environmental impact assessment of the project was made before the final decision on building the plant and the granting of the environmental permit.

In recent years, Finland has begun applying the principle of producer responsibility in waste management. This obliges the producer or importer to organize waste management for their products. The principle already applies to waste from electrical and electronic appliances, used tyres, paper products, end-of-life vehicles, batteries and to some extent packages and packaging waste.

Jomala

Waste management

The Municipality of Jomala was nominated as a finalist for the Nordic Energy Municipality 2011 with the project Jomala Energy Ab. In Åland the district heating system of the Jomala municipality, which has 4100 inhabitants, caters for the heat delivery to 11 public and private sector buildings, among them the local co-operative dairy. In 2005-2010 a project was carried out to replace many old boilers in individual buildings by building a local district heating network. Simultaneously the dairy built a gasification plant to utilize its process waste in gas production. In 2010 the district heating system, operated by the municipality owned company Jomala Energi Ab, was in operation.

The main by product utilized in the gasification is whey. The gas is fed to the district heating boiler and also used for heating in the dairy process.

The project provides the following benefits:

• Lower district heat energy costs

• Independence of fossil fuels

• Utilizing waste of the dairy process

• Pre-cleaning of the drained liquids of the process

• Eliminating road transportation of the waste

• Reinforcing the relationship between the municipality and the business community.

The produced biogas now replaces 200 m3 of fuel oil per year in heating also to the dairy premises. In addition, using woodchips in the district heating substitutes 600 m3 of fuel oil per year.

The majority of the funding, 81 %, to the district heating investment came from the municipality, and the rest as investment subsidies from the county government and the EU. The investment to the gasification plant was made by the dairy co-operative.

In December 2009, the Municipality Council decided on the objectives and outlines for 2011-2012 in which ecologically sustainable development is included as one of the overall targets.

The district heating project is the start of actions for reaching the objectives.

The next step could be connecting additional consumers to the heating network, and later on to have the three municipalities of Mariehamn, Jomala and Finström in the same heating system which is using only renewable fuels.

Lidköping

Waste Management

The city of Lidköping, having 38,000 inhabitants, is located in south- western Sweden close to Lake Vänern. The development of biomethane production in the City of Lidköping was initiated in 1990, and in autumn 2011 the plant at the Kartåsen refuse treatment plant will operate with full capacity. It is one of the first of its kind in the world producing both compressed and liquid biomethane for vehicles. The production will be sufficient to cover the consumption of 6,000 cars driving 17,000 km annually.

The cutting-edge elements of the project are:

• the use of residues from local food industries

• the liquefaction of purified gas.

• biomethane produced where the supply of refuse is good with transport to the market.

Benefits brought along by this project include the following:

• Reduction of 16,000 tonnes of CO2 emissions per year

• Contribution to the realization of the cities environmental goals and to boost green growth

and business development

• Opportunity for the City of Lidköping to start using biomethane in its own vehicles.

The Lidköping plant offers a model for compressed and liquefied biomethane production from biological waste. Vehicles are filled up with compressed biomethane at the plant and the gas is transported to near-by filling stations. Big ´thermostanks´ are filled with liquid biomethane and transported to bigger cities.

The project is a cooperation between the Lidköping Municipality as the initiator, Gothenburg Energy, Swedish Biogas International and Fordonsgas Sverige AB. The digester part of the plant is owned by Swedish Biogas International Lidköping AB and the liquefaction by Gothenburg Energy and Lidköping Municipality. A prerequisite for the project is very good cooperation between stakeholders in the project and local farmers, transport, suppliers of vehicles, food companies and others.

The total cost of the project is 170 million SEK, the funding coming from private partners (45 %), Gothenburg Energy (35 %), the Swedish Government (19 %) and Lidköping Municipality.

Münster

Introduction

A functional waste management depends on the participation of all citizens. The waste-conscious behaviour is crucial for the volume and type of waste to be disposed of in Münster. The recycling facilities can only be operated problem-free if waste containers and recycling facilities are properly used. The presentation of recycling products creates an additional motivation to participate in the overall system.

Brochures covering all topics related to the avoidance and separation of waste are vitally important for the information of Münster citizens.

At the end of each year, all citizens will receive a waste disposal calendar that includes the collection schedules for the bio-waste container, yellow bag, residual waste container and paper container but also other important information.

The waste organisation of Münster provides different services to support schools and nurseries, clubs and associations and others who want to teach about waste management. In addition to the personal or telephone consultation, there is information available in class sets as well as a library which contains technical literature. Moreover, you can rent material boxes on different topics. They contain books or videos for all age groups to be used in class. Resources to be used for project weeks or special promotion days can be rented.

Münster's Climate Protection Concept

Reduction of CO2 Emissions 1995 – 2005

• Target: - 25%

• Achievement: - 21%

The City Council set new climate protection targets in March 2008:

• CO2 reduction by 2020: - 40%

• 20% of the energy production has to be covered by renewables by 2020

Consists of:

1. Old Building Renovation Concept

2. Energy Efficiency for New Buildings

3. Generation of Sustainable Energy

4. Climate-friendly Traffic Planning

Climate-protecting Traffic Planning

A matter of choice:

38 % of all distances by bike,

16 % on foot,

10 % by bus

= 64 % of environmentally friendly traffic!

Waste Management Concept:

Targets:

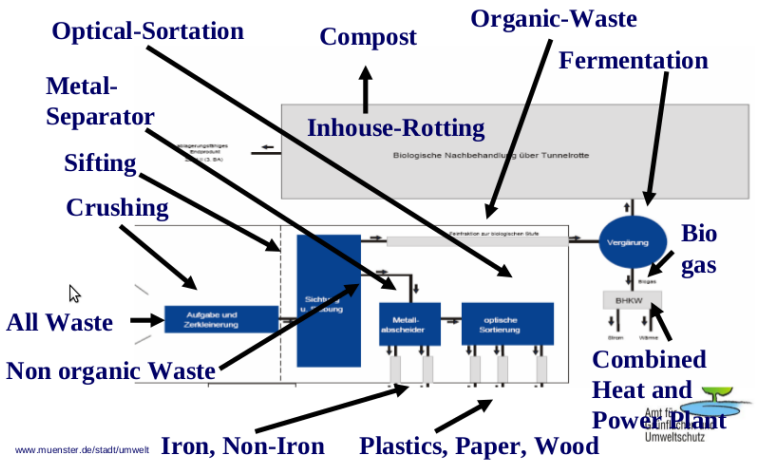
1. Decrease the quantity of waste

2. Environmentally friendly waste management

3. No waste incineration

Waste management is handled by the waste management department

Sewage gas, landfill gas and biogas gained from fermentation run a combined heat and power plant



Riga

Waste management

One way how to avoid and reduce waste is to introduce and use the recognized environmental management procedures and systems (EMS).

The recycling process of waste has been implemented and today 25% of the total amount of waste is recycled.

But the negative trend is that the amount of the household waste per capita is slowly growing reaching about 360 kg per capita in 2006.

Waste collection in Riga is centralized. Waste producers sign agreements with waste collection and transportation organizations. Municipal Department of Environment acts as a supervisor and coordinator of the waste management in the city. 6 specialized waste collection and transportation organizations operate in Riga. 173 enterprises collect special waste fractions (construction waste, scrap-iron, used packaging materials etc).

Sorted waste amount increases every year. 5600 containers for waste sorting (paper, cardboard, glass, plastics) are located in the city.

Riga has one waste disposal place in Getlini, which was recently modernised. Total area is about 87 ha (old land-fill 37 ha, new waste disposal places 20 ha). Old landfill area has been covered and land-fill gas production system (13 million Nm3/year – 26000 MWh) has been built. The new waste disposal place with isolated bottom has been created, contaminated water purifying (900 m3/day) realized, weight-bridge with automatic registration system established and place for sorted waste (large scale waste, green waste, construction waste etc) created.

Local contribution to global climate change (ECI No 2)

In 2004, total amount of CO_2 and CH_4 emissions per capita was 4.04 tons in Riga, which is quite low in comparison with other European cities.

However, in comparison with year 2000 the emissions per capita have grown by 7%. Such a relatively rapid growth of emissions is connected not only with the growth of the amount of emissions in these years, but also with the decreasing population of Riga City.

Simultaneously it must be noted that the growth of GDP in Riga over the period has been more rapid than the growth of the emission indicator that on the whole indicates gradual increase of the energy efficiency in Riga economy.

Emissions of these gases are generated by various processes, the most important being the combustion of fossil fuels and the decomposition of organic matter.

The aggregate energy resource consumption in Riga City covers the heating and transport fuel as well as the electrical energy that is consumed in Riga City. The proportion of the renewable resources – hydro energy and wood in the aggregate consumption balance accounted for approximately 11%.

The main conclusions arising from the indicator (ECI No 2) data are as follows:

• the total consumption of fuel and transport fuels over the recent 5 years has been rather stable but with slight grows of consumption;

• the consumption of fuel resources for energy production and in the industry and service sectors has been practically stable since year 2000;

• the consumption of fuel resources in households has only slightly increased as a significant majority (84.3%) of Riga households uses the services of the centralized district heating system;

• the level of district heating in Riga City is comparatively high. Its contribution to the total energy resource consumption is 30% that compares to the indicators of such cities as Malmö (~

30%), Stockholm (32%) and Tampere (~35%).

• the consumption of transport fuel is tended to increase.

Simultaneously the consumption of energy resources in Riga City will also be influenced by a new factor – changes of the infrastructure of electric energy production in Latvia (closing of the existing thermal energy station TEC-1 and its reconstruction to a combined gas cycle station, increasing of the production load of the station and foreseeable reconstruction of the thermal station TEC-2 that is in the stage of design at the moment).

Riga City has an environmentally friendly heating balance with a dominating proportion of natural gas (> 60% of the total energy resource consumption). The proportion of natural gas in the aggregate balance has increased in the recent years, similarly also the consumption of natural gas in absolute units has been increasing since 1999. In future it is expected that the role of natural gas will increase even more.

From the point of view of the reduction of the green house gas emission a positive quality of Riga is that coal accounts for insignificant proportion in the aggregate balance. Besides in comparison with 1998 the consumption of coal in absolute units has decreased approximately by a half. Similarly the consumption of peat is comparatively small.

The consumption of wood is mainly connected with its use in the local and individual heating. The growth of its consumption took place in the first half of 1990s; however the analysis of the situation in the recent 5 years does not demonstrate any significant changes in the consumption of the wood fuel. The consumption of wood accounts for ~ 43% of the total fuel that is consumed in the individual heating in the households of Riga City. However, as it was referred to before, majority (~ 85%) of households use the centralized district heating system where wood as a fuel accounts for a very slight proportion (less than 3%).

Rogerstone

Project description:

By-products from an RF Brookes food factory are converted into methane, which is burned in a combined heat and power engine to generate electricity that feeds back into the factory. RF Brookes is one of the leading producers of Marks & Spencer's ready meals and is owned by Premier Foods.

The new facility will not only reduce the amount of waste sent to landfill, but reduce carbon emissions by around 8,500 tons every year. The excess heat produced by this process is also returned to the factory. It is forecast to cut energy bills at RF Brookes by up to 10 per cent each year and is part of the company's commitment to produce no landfill waste by 2012.

Stavanger

Waste, recovery and recycling

Stavanger has come far in the area of waste management. About 65% of all household waste is sorted.

Most of this goes to material recovery (paper, glass, metals, bio-waste, plastics, etc.), some consists of quality fire wood, and some again require special waste treatment (hazardous waste, refrigeration units, EE waste). 25% of household waste consists of residual waste for incineration which has a certain degree of energy utilization (energy utilization degree in 2005: 53%), whereas the remaining 10% of total waste goes directly to landfills.

Well-equipped to handle commercial waste

Norwegian municipalities are not responsible for collecting and treating commercial waste. Nor are there any local statistics concerning these types of waste products.

We may nonetheless claim that the Stavanger region is well equipped to handle commercial waste generated here. We operate several sites for waste recycling, as well as reception centers for special types of waste products (e.g. offal, metals, restaurants, building materials, etc.).

Use of materials should be halved world-wide

In 2002 every inhabitant of Stavanger generated 372 kg of household waste, while in 2008 this figure had grown to 427 kg.

All member countries (incl. the EEA area) must have established waste prevention programs by 12 December 2013.

The following framework conditions and stipulations apply to formulating the City of Stavanger's targets in the fields of resource use, consumption and waste:

- The City of Stavanger has a regulatory responsibility for the collection and management of household waste only. However, Stavanger wants to also contribute to setting up resource- and eco-friendly solutions for local business and industry, while committing the municipality's own undertakings and agencies to act in a waste-responsible manner.

- Stavanger's ambition is to view its use of resources in a global perspective.

- Waste avoidance must be given a more prominent position in the municipal waste and resource policy.

- The time perspective must cover several decades backwards as well as forwards in time for waste-related goals and actions.

- Considerable emphasis is placed on the global climate impact of measures regarding resources and waste management.

- The waste management policies of the future will, to a greater extent than at the present, be characterized by focusing on material flow rather than waste handling of individual products/waste fractions.

- The regional collaboration in the intermunicipal service provider company IVAR is an essential element which should be developed further.

The following key targets have been established for the planning period:

- Increased levels of material recovery

- Increased use of waste-based energy

- More eco-friendly waste collection, transportation, and management

- Lower resource consumption and waste general in municipal undertakings

- More resource-efficient local communities

Enhanced material recovery

Studies prove that material recovery is in most instances better for the climate than is energy production from waste.

The City of Stavanger therefore aims to increase its recycling portion from 65% at present to 75% at the expiry of the plan period.

Enhanced recovery proportion will be attained through the following measures:

- Establishment of a recycling site for residual waste in the IVAR region. This plant will recover the main fractions of plastics, metals, drinks cartons and cardboard/paper. Should this sorting plant fail to be realized, we will start up a collection scheme for plastic packaging etc.

- Further deployment of recycling stations for glass, alternatively introduction of a collection scheme

- Intensified information dissemination and motivational work towards the citizens to produce/maintain good recycling habits.

- Help set up a reception centre for gypsum/plaster products from the construction industry

- Re-use of heavy waste from the building industry, e.g. for road works

- Systematic review of import, application and spread of certain specifically selected elements, for the purpose of reducing the loss of important resource .

Increased application of waste-based energy

The City of Stavanger aims to comply with the EU standards for energy recovery from waste products, as well as to develop new energy carriers from bio-waste.

- The energy utilization from the plant at Forus Energigjenvinning KS to be increased to a minimum of 60%, preferably 65%

- Transition from composting plant to bio-gas plant. Bio-waste collected from the households to be used for production of bio-gas, to ensure that we benefit from both the energy content and soil improvement potential of the biomass

- The industry is ordered to sort waste in new building projects, so that combustible material can be better recovered and put to better use.

More eco-friendly waste collection, transportation and management

The City of Stavanger will endeavour to ensure that all stages of the chain, from waste collection and to recycling and final treatment, is optimized with a view to minimizing greenhouse gas emissions.

Based on experience, there is a greater benefit in correct treatment of the waste fractions, while transport only accounts for a minor part of overall emissions. Nevertheless all elements will be reviewed.

- An extension of the arrangement of buried waste containers. These will also be made available to business and industry.

- Collection vehicles to change fuel source to gas, combined with purchase of bio-gas/bio-gas quotas for approximately climate-neutral transport

- Introduction of a coordinated collection scheme for bulky waste, to reduce driving of individual vehicles to the recycling sites. Alternatively, establish mini recycling centers in the various urban districts.

- Annual greenhouse gas accounts for the household refuse collection in Stavanger

municipality. A climate impact analysis to be conducted for all major investment projects in the refuse collection service.

- Local control of parts of commercial waste fractions, for example in the city center and with regard to building and demolition waste, to promote optimum common systems and solutions.

Less waste generation in municipal undertakings

As a municipal organization, the City of Stavanger has the opportunity and obligation to work actively to minimize its own material consumption and waste generation.

The City of Stavanger will thus make its own experiences in a more eco-friendly consumption of resources, and install positive attitudes and awareness among its employees. We will also take the lead and act as a good example for both private citizens and commercial players in the municipality.

The following measures are relevant:

- Special focus on waste and resource consumption issues in connection with EcoLighthouse and Green Flag certification.

- Explicit formulation and active adherence to environmental requirements, such as climate effect and material consumption, when purchasing goods and services. Buy CO2 quotas for specific activities.

- Balanced scorecard (BASIS) indicators stating consumption of materials and energy to be used in all municipal undertakings.

- Conducting a pilot project "Waste avoidance in the activities". Three different municipal undertakings to be enabled to systematically review their resource consumption and adhere to a plan to minimize waste.

- Establishing an intranet-based "second-hand market" in the local administration. This would be where departments with goods to spare, e.g. office furniture, may place an ad, while other departments can post their requirements in the 'wanted' column.

- Eco driving courses (how to drive eco-friendly) for all employees driving municipal vehicles.

A more resource-efficient local community

The City of Stavanger will help motivate Stavanger inhabitants to act in a more resource-aware manner

We need to attain a lifestyle and behavioural patterns that will utilize energy and raw materials

in a better way - without a deterioration of the citizens' fundamental quality of life.

- Intensify the promotion and support to the already existing individual facilities such as reuse stations, nappies made from fabric, reusable shopping totes, second-hand markets, stickers saying 'no thanks to adverts' on individual mailboxes, etc.

- New measures for reuse drives: Collection schemes for mobile phones in working order, free ads for people wanting to give away useful things, subsidized rental scheme for durable dinner services, cutlery, cups, etc for use at events (in preference of disposable articles).

- Application for new municipal control tools: introduction of local regulations such as taxing plastic disposable shopping bags or plastic plates, cups, cutlery, etc. However, municipalities need to be granted permission from central government to introduce such measures.

- Apply to the Government for a VAT exemption for repairs. Application for a time-limited pilot project where repair shops handling for example white goods, electronics and clothing are exempt of VAT on their services, in order to make repairs more competitive in comparison with new acquisitions.

A special action plan to be drawn up for waste avoidance and resource efficiency in the City of Stavanger.

Stockholm

Environmentally efficient waste management

Waste management has gone through major changes during the last decade. The implementation of producer responsibility, successive landfill bans for different waste types, national environmental targets for biological treatment and nutrient recycling, as well as taxes on landfills have together with different private and municipal initiatives contributed to more resource-efficient waste management. However, the amount of waste generated in society is generally still increasing.

All waste must be taken care of in a correct manner in order not to cause damage to human health and the environment. The waste is in many cases a valuable resource if waste management is adapted to the characteristics of the waste. For example, certain types of furniture and other products can be recycled, food waste can be utilised for energy production and plant nutrients, packaging material can be recycled, remaining waste in garbage bags can be burned under controlled circumstances to extract district heat and electricity. The most energy-efficient method, however, is still to prevent the generation of waste in the first place. The City’s waste management shall furthermore contribute to closing resource loops, saving energy and natural resources.

What all these waste management systems have in common is that they should be simple and adapted to those who will use them in order to function optimally. The design of the systems should encourage people to adjust their habits and behaviour to a sustainable waste management, in a sustainable society.

Targets for the City of Stockholm The following interim targets will be met during the programme period:

Waste from the City's activities will be reduced and unavoidable waste will be put to good use

The best way of reducing the amount of waste is to see to it that waste is never generated in the first place. This is why prevention of waste generation has the highest priority in the EU waste hierarchy. After that comes re-use, recycling and energy recovery. The waste should in general be moved upwards in this hierarchy. New goods and products can be manufactured with the help of recycled materials, electricity and district heating can be produced from sorted combustible waste, and biogas and plant fertilizer can be obtained from sorted food waste. The city's operations can, by working with this target, contribute to saving large amounts of energy and natural resources.

According to this target:

The City's committees and boards will in their procurements strive to always adopt a mindset that incorporates long-term sustainability and quality when purchasing goods and services. Demands can be put on, for example, goods being packaged in a way so as to generate as little waste as possible.

Waste from the City's operations will be so free of pollutants that the best possible material recycling, energy recovery and nutrient recycling is possible. Products and fixtures that are no longer used in operations will to the largest extent possible be put to re-use. Facilities for sorting out packaging (plastic, paper, glass and metal) and recyclable paper (newspapers and paper) will be available at all of the City's operations.

All of the City's operations will, when practically possible and environmentally motivated, sort their food waste for biological treatment aimed at biogas production and nutrient recycling. Needlessly discarded food can be minimized with the help of careful planning and logistics.

This target involves all committees and boards.

Follow-up responsibility: The Traffic and Waste Management Committee is responsible for the follow-up of the target in cooperation with the municipality administration.

The proportion of incorrectly recycled hazardous waste will be reduced

Hazardous waste has a special status when it comes to waste management. Its management is strictly regulated and it is of the utmost importance that this waste is collected and disposed of in a correct manner, separate from other waste in order to avoid harm to the environment and people's health. As with other waste, however, preventing the generation of hazardous waste is what society should strive for.

The City supplies a combination of stationary and mobile collection systems for dangerous household waste. Households have the opportunity to dispose of their hazardous waste to any of the City's environmental stations, recycling centres, contracted paint dealers, housing unit collection or to the mobile environmental station.

The City's operations will contract certified transport companies and receiving facilities to take care of its hazardous waste. The term 'hazardous waste' in this interim target is defined in the Waste Act and also encompasses batteries and electric waste, although this comes with a producer responsibility.

According to this target:

- The proportion of hazardous waste will continue to decline from today's already low level.

- The Traffic and Waste Management Committee and other affected committees and boards will inform about what constitutes hazardous waste, how it is sorted and where it should be returned.

- The City's operations will have an overview of which hazardous waste is produced through its own activities, which quantities are involved and ensure that handling, removal and disposal are carried out correctly.

- The opportunity for the city's inhabitants to dispose of their hazardous waste to one of the City's systems will be increased.

- Knowledge among Stockholmers regarding the City's system for collecting hazardous waste and how these are used will increase.

This target involves all committees and boards.

Follow-up responsibility: The Traffic and Waste Management Committee is responsible for the follow-up of the target in cooperation with the Environment and Health Committee.

Waste from housing and industry in the city will decrease and unavoidable waste will be put to good use.

The best way to reduce the amount of waste is to make sure that it is never generated. Therefore, prevention has top priority in the EU waste hierarchy. Second comes re-use, material recycling and energy recovery. The waste should generally speaking flow upwards in this hierarchy.

New goods and products can be manufactured using recycled material, electricity and district heating can be produced from sorted combustible waste, and biogas and plant nutrients can be made from sorted food waste.

The interim target encompasses household waste and its equivalents from activities, meaning that the municipality is responsible for collecting the waste.

According to this target:

- The City can through information activities and in its own work inspire and motivate to a change in behaviour, aimed at minimizing waste quantities and directing towards increased sorting.

- Differentiated waste fees, weight-based fees and similar actions can inspire and motivate to changed behaviour aimed at minimizing waste quantities and directing towards increased sorting.

- The proportion of collected food waste will increase. The City will strive to reach the national collection target for food waste, which at the moment is 35 %.

- The City will strive to increase biogas production in the region.

- The City can participate in creating better conditions for re-use of goods and products.

- Waste from the City's inhabitants will be so free from pollutants so as to enable the best possible material recycling, energy recovery and nutrient recycling. The proportion of newspapers, packaging and other recyclable material is reduced in garbage bags and bulky waste.

This target involves the Traffic and Waste Management Committee, the Environment and Health Committee and Stockholm Vatten AB.

Follow-up responsibility: The Traffic and Waste Management Committee is responsible for follow-up of the target in cooperation with the Environment and Health Committee and Stockholm Vatten AB.

Tallinn

Waste management

Tallinn has organized municipal waste transport system to avoid illegal waste disposal and harm to the environment

– city sets service fee limits and standard terms, joining is mandatory for all residents and businesses

– this service is outsourced to the public sector on the basis of procurement results

City-wide network of 23 waste stations accept recyclable, electronic and hazardous waste free of charge from residents.

The old city landfill was closed in 2003 with essential EU support and a new modern landfill Tallinn Waste Recovery Centre was opened the same year In 2010, heat and electricity co-production started in new landfill from gas gathered from landfill deposits.

In 2011 Tallinn Waste Recovery Centre opened new fuel production line, recycling up to 120 000 tons of municipal waste into shredded fuel

Regular campaigns to raise awareness about waste management, waste sorting, recycling, reduction of waste generation.

Waste burning – an innovative approach to produce heat and electricity:

– a special production block is under construction at Iru Power Plant

– block intake capacity is 220 000 tons of waster per year

– production capacity - 17 MW electricity & 50 MW heat energy

Energy sustainability

Tallinn has further plans to cut back reliance on natural gas and increase the share of locally sourced biofuels

District heating

– In 2008 the new Tallinn Power Plant was completed, utilizing renewable biofuels (wood chips and peat)

– Tallinn Power Plant provides 22% of the city's district heating needs and 9% of electricity

– In 2011 Tallinn successfully merged the primary district heating areas, allowing for the

increase in biofuel based heating to rise to 30%

Energy efficient construction

– to motivate large-scale insulation of big apartment buildings, the city has several support measures for housing associations

– renovation of city kindergartens and schools, partly funded by Kyoto protocol emission quota sales

– Tallinn's new, modern and energy efficient city hall, estimated time of completion 2014 Biogas utilization

– Biogas derived from solid sewerage waste is used as furnace fuel, the goal is to use all of the biogas for electricity production

– Tallinn has explored options for a pumping station to produce both heat and electricity from sewage water residual heat, covering up to 7% of the city's heating requirements.