Horizon 2020

Horizon 2020: a cleaner Mediterranean by 2020

مبادرة أفق 2020: تهدف لإزالة التلوث من البحر المتوسط بحلول عام 2020

Horizon 2020: moins de pollution en Méditerranée d'ici 2020

Waste Management Costs & Financing and Options for Cost Recovery

Union pour la Méditerranée
Union for the Mediterranean
الإتحاد من أجل المتوسط

This booklet was compiled within the framework of the EU-funded Horizon 2020 Capacity Building/ Mediterranean Environment Programme (H2020 CB/MEP) which supports the implementation of the Horizon 2020 initiative to de-pollute the Mediterranean by the year 2020. It aims at enhancing capacities to address pollution problems at institutional and society level.

For more information on the Horizon 2020 Initiative visit:

the European Commission's Horizon 2020 website
http://ec.europa.eu/environment/enlarg/med/horizon_2020_en.htm

the Horizon 2020 Initiative's website
www.h2020.net (English, French, Arabic)

October 2014

This is a resource booklet of the Horizon 2020 CB/MEP training: Costs & cost recovery of municipal waste management that took place in Athens, Greece, 14-16 October 2014. More information on the training can be found at:
http://www.h2020.net/en/resources/training-materials/viewcategory/341.html

Trainer in charge and Author of this booklet: Jean-Jacques Dohogne, Association of Cities & Regions for Recycling and Sustainable Resource Management (ACR+)

Table of contents

Production costs in MSWM
1.1 Introduction

Often political decision makers position the efficiency of the municipal solid waste management services by comparing their costs as compared to other municipalities. However, reliability in the presentation of the costs is highly disrupted, because of the variability of the different aspects affecting costs comparison such as production costs related to waste management activities, local conditions, age of equipment, level of subsidies, means for financing, tax policies at national, regional and/ or local level and the differences in sizes of (inter-)municipalities.

Presenting the calculated costs of local authorities as average costs or as a cost range is subject to criticism. It tends to induce the idea, falsely, by which low costs is synonym of proper decision taking and scratches out spatial differences. These costs are findings that do not provide explanations and, for being comparable, should be reported at similar levels of technical and environmental performances based on standard cost calculation methodology. Therefore the data presented in this report, subject to above criticism, should be read with caution and can never be translated as such into a given local or regional authority situation. Also, cost data presented here reflect the situation in EU countries since very little or no data are available from MENA countries.

Waste management operations should be viewed as 'more-or-less integrated' systems of collection and treatment. Within the considerably varied spectrum of systems in existence, however, one finds varying degrees of fragmentation in the collection system, and for obvious reasons, this has implication for the manner in which waste is treated following its collection.

Key questions to ask are:

- Which materials are collected separately?
- How are they collected, and how does this affect collection of residual waste?
- How effective are schemes at capturing the targeted materials?

The diversity of collection strategies and the range of performance in separately collecting fractions of municipal waste, suggests that collection systems are likely to enter a period of considerable change as separate collection of waste will be pursued more vigorously in the future.

Local circumstances clearly influence the strategy to be adopted. However, the differences in approach and performances regarding the quantity of separately collected material suggests that a number of factors influence the degree of which local authorities provide services enabling separate collection. The intensity with which local authorities seek to encourage, enable and engage households to separate their waste will play a determining role in the success of such programs.

1.2. The concept of costs

Production (technical) costs can be related to all kind of activities varying from collection, transport, treatment, storing and can be specified in acquisition and operation costs. Very often the tons treated is used for expressing the production costs.

Table 1: Different notions/ definitions of costs

Type of cost	Notation	Calculation method
Total production cost	PC	FC + VC
Fixed cost	FC	
Variable cost	VC	
Average cost or unitary cost of production	AC	PC/ Q
		AFC + AVC
		FC/Q + VC/Q
Brut production cost	PCB	A + C0 = β + αQ
Capital cost	A	β
Exploitation cost	C0	αQ
Net production cost	PCN	PCB - S
Revenues from selling recyclables	S	

Production costs (PC) correspond to direct charges the operator has to engage to make possible his operations. Fixed costs (FC) are incompressible costs to ensure operations, whatever the level of operations, within the limits of the installed capacity. Variable charges (VC) vary according to the volume of the operations or quantities produced. The average cost (AC), or unit production costs, is the cost of one unit produced. The brut production cost (PC_B) is the sum of capital cost (A) and exploitation costs. The net production cost (PC_N) finally is the brut production cost deducted with the revenues of recyclables (S).

The capital cost (A) is a fixed cost that can be written as a constant β. The use of capital in a given year is calculated by the linear amortization of infrastructure. Exploitation cost C_0 is limited to the costs for the functioning of the equipment that can be calculated as a proportional cost to the tonnage of municipal waste αQ, α being a constant and Q a quantity. It is thus a variable cost.

1.3. Full Cost Accounting (FCA)

Full Cost Accounting (FCA) is a systematic approach for identifying, summing, and reporting the actual costs of solid waste management. It takes into account past and future outlays, overhead (oversight and support service) costs, and operating costs. Knowing the full costs of municipal solid waste (MSW) management can help you make better decisions about your solid waste program, improve the efficiency of services, and better plan for the future. FCA can help you compile the detailed cost information you need to understand what MSW management costs and to communicate these costs to the public.

FCA Helps You Meet Your Goals

FCA supports your:

- **Informational goals** by determining and reporting how much MSW management costs.
- **Management goals** by identifying potential cost savings and providing a sound basis for management decisions such as privatizing services.
- **Planning goals** by documenting current benchmarks that can be used when making or evaluating projections.

- Up-front costs comprise the initial investments and expenses necessary to implement MSW services.
- Operating costs are the expenses of managing MSW on a daily basis.
- Back-end costs include expenditures to properly wrap up operations and take proper care of landfills and other MSW facilities at the end of their useful lives; the costs of post-employment health and retirement benefits for current MSW workers also fall in this category.

These three categories together cover the "life cycle" of MSW activities from "cradle" (up-front costs) to "grave" (back-end costs). These costs give an accurate and useful accounting for management and reporting.

The other categories of costs require special consideration. These costs are:

- Remediation costs at inactive sites. Many local governments have inactive MSW landfills that require "corrective action" for known contamination of ground water, soil, or surface water. These remediation costs can be relatively well estimated, though with somewhat more uncertainty than other types of engineering projects such as roadbuilding. Including these costs in FCA is a matter of choice. Because remediation costs are real and must be paid, they can be included; moreover, they are the result of past solid waste management practices and are thus relevant.
- Environmental costs (see also chapter 1.6) are the costs of environmental degradation that cannot be easily measured or remedied, are difficult to value, and are not subject to legal liability. Such environmental costs often are termed "externalities" by economists. To truly capture all of the important lifecycle cost elements, some people advocate assessing the upstream (and downstream) environmental costs of resource use, pollution, and waste entailed in providing goods and services.
- Social costs (see also chapter 1.6) are adverse impacts on human beings, their property, and their welfare that cannot be compensated through the legal system. Social costs (also termed "social externalities") are similar to environmental externalities and are sometimes grouped together under an umbrella term. Just as with environmental externalities, the costs of social externalities can be difficult to determine. While FCA focuses on costs that can be valued readily in the marketplace, understanding social costs is important for planning efforts. Social costs include the impacts of MSW transport on neighborhoods along the routes taken, as well as the impacts of MSW facilities themselves.

1.4. Cost calculation of waste management activities

Determining of costs per activity implies the knowledge of needed equipment as well as the elements for the good functioning of this equipment.

1.4.1. Pre collection costs

The investments are related to the purchase of recipients (bags, bins, containers) and the way this equipment is fitted in the location (platform …). These costs include: distribution of the recipients, cleaning of recipients costs (washing, disinfection, graffiti…), maintenance costs (replacement of wheels, pins, covers, hinges…), and hiring of containers (if the case).

1.4.2. Collection costs

The investments are related to the purchase of collection vehicles (different kinds according to waste streams, urban realities, container sizes…) and the devices for lifting the recipients, for compaction and possibly the counting and identification of bins/ containers, and embedded computing.

Exploitation costs include a fixed part being the wages of the personnel (technical personnel – drivers, refuse collector, mechanics and, supervising personnel such as the head of exploitation and foreman), maintenance products, supplies, tax and insurance, maintenance costs and repair of vehicles and a proportional part represented by running consumables (fuel, oil, grease, pneumatics, batteries) and small maintenance.

The production costs (PC) are expressed as the costs for the acquisition and functioning of the vehicle and the crew. It is expressed as the sum of costs related to the vehicle and the crew or as the sum of fixed and variable costs: $PC = FC + VC$.

The fixed costs FC can be presented as follows: $FC = L + FCV = L + A + \alpha$ whereby L accounts for the personnel costs (salaries and related costs); FCV accounts for vehicle costs being the technical amortization of the vehicle (A) and related costs linked to the possession for the vehicle (α) being taxes, insurances… The technical amortization of the vehicle: $A = IV/d$ while IV being the amount of the investment of the vehicle.

The variable costs VCV of the vehicle can be presented as follows: $VCV = vcV \times D$ whereby D presents the annual distance traveled: vcV accounting for the kilometer cost of the vehicle (fuel, lubricants, maintenance and pneumatics).

The production cost for vehicles can be presented as follow: $PC = L + FCV + VCV = L + (A + \alpha) + (vcV \times D)$.

1.4.3. Treatment costs

The analyses of the costs related to the different (pre-) treatment operations of waste is subject to the same cadre as presented in the previous chapter. The principal investment costs relate to study work, control, project management, site and construction costs (roads and various networks, civil engineering, mechanical & electric equipment and, offices).

Exploitation costs are either independent from treated tonnage (fixed part of costs) or linked to the volume of activities, that is to say according to the quantities treated (variable part). Fixed costs comprise personnel costs and other fixed costs (insurances, administrative costs, taxes, analysis); for the variable costs the utilities (water, electricity, fuel-oil…) are evaluated per ton treated for the fixed (plant) equipment and mobile materials.

Costs related to major maintenance and renewal vary in the time and increase with the age of the plant. In order to face these works, the operators make provision for an account called: 'account for major maintenance and renewal'.

The general costs and benefits identified in the operating contracts are generally evaluated as a percentage of the total costs mentioned here above. They cover the management costs and the administration costs of the company headquarters. These are indirect costs.

1.5. Determination of production costs

1.5.1 Determinants of collection costs

The different case studies show a large dispersion in the level of average costs regarding the collection of waste. Economist are interested on the one hand in the knowledge of costs determinants of these costs and on the other hand on the evaluation of the impacts when modifying the organization of the waste collection.

Comparison of the collection costs of a same waste stream in different territories

The waste collection in a territory can be defined as the operations of emptying recipients by a crew using a vehicle touring in a given geographical area, according to the collection circuit established and taking into account the constraints that influence the organization of that waste collection operation. The organization of the collection depends on three major types of constraints:

Geographical constraints such as the size of the population to be served, the type of urbanization, the surface to cover, population density , distance to travel and dispersion of houses, determine the waste quantities to be collected.

The challenges to consider when collecting waste can take, depending on local circumstances, into account the sectorization of the territory (city center, commercial zones, collective housing, peri-urban areas…), collection method (door-to-door, voluntary bring system), the nature of the waste streams, the frequency of the collection, types of recipients (bag, bin, containers…), the schedule and days of collection, the types of vehicles dedicated to the service.

Finally, consideration should be given to possible constraints of the operator who has to make best use of the production factors (personnel, vehicles) while taking into account specific local regulation (labor legislation, collective agreements…).

The average cost for the collection (ACC) is in direct relation to the linear load of the collection (LC) expressed in kg collected per km traveled in a given time. This variable LC expresses the density of the waste presented on the circuit traveled by the vehicle and allows for an evaluation of the combined effects of pre-collection mode, frequency and population density. The main characteristic of this model relates to the fact that the linear load determines the average cost of collection. The more waste is collected per km traveled the lower the average costs.

For a given territory, the control of the costs goes via an improvement of the efficiency of the collection that can be achieved, either by an increase of the linear load of the waste collected door-to-door and reduced waste collection frequency or by using larger recipients and by a pre-collection at regrouping points of voluntary bring systems. The comparison of costs of the same waste stream has to be analyzed with the collection variable 'linear load'.

The following three tables provide data, to use and consider with caution, of same waste streams in different territories. In this case the territories are presented as countries but difference may also appear with countries between regions and (inter-) municipalities.

Table 2: Comparative costs of Residual Waste collection in selected countries[1]

Country	Costs per ton	Costs per hhld	Frequency
Belgium (Flanders)	€75/t	€18/hhld	Biweekly mainly
Denmark	€126/t	€62/hhld	Weekly
Germany	€67/t	€30/hhld	Biweekly mainly
Ireland	€65/t	€75/hhld	Weekly
Spain	€60/t	€25/hhld	Daily
United Kingdom	€42/t	€31/hhld	Weekly mainly

The costs of separately collecting dry recyclables in a given location depends upon the approach used and the composition of the municipal waste stream and the relative capture of the different materials targeted. Typically bring schemes involve lower

[1] Costs for Municipal Waste Management in the EU, Final report to Directorate General Environment, European Commission, Eunomia on behalf of ECOTEC

outlays than doorsteps ones, though it is generally accepted that the implied inconvenience makes it impossible to achieve such high captures as with doorsteps schemes. As such, the costs of collecting different fractions of the waste stream in a given location depend upon how they are being collected, what is being collected along with them, and the relative capture of the different materials in the collection approach.

Table 3: Comparative costs of dry recyclables collection[1]

	Approach	Paper & Cardboard	Packaging
Belgium (Fl)	Door-to-door	€61/t	€194-356/t
Germany	Door-to-door	€125/t	€250-300/t
Italy	Door-to-door Road containers	€30-125/t €90-150/t	€300-750/t (1) €230-500/t (1)
Spain	Road containers	€40-60/t	€180/t
			[1] Plastics only

Countries moving to bio waste separate collection often move to less frequent collections of residual waste. This is important, especially in MENA countries where the frequency of residual waste is high (7/7).

Table 4: Comparative costs of collecting bio waste[1]

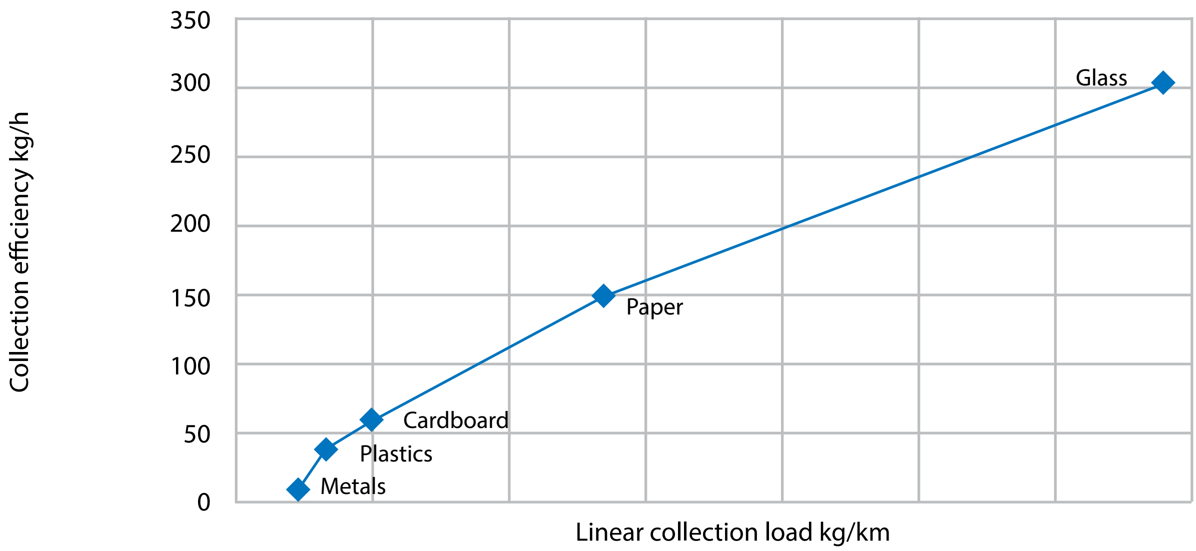
	Nature of compostable materials	Frequency	Estimated costs
Belgium (Fl)	Kitchen & green waste Green waste	Weekly (season), biweekly	€45-106/t €38/t
Finland	Bio waste	Weekly (season), biweekly	€63/t
Italy	Kitchen waste only	Once or twice weekly	€54-302/t

Comparison of collection costs of different waste streams on a same territory

The variability of collection costs of different waste streams on a same territory, all other things being equal (including the collection frequency and collection mode) can be explained by the nature and characteristics of the waste streams. The number of waste streams will vary from municipality to municipality. The collection quantities of the usual waste streams (residual waste, light packaging waste (without glass), paper/ cardboard) vary in high proportions.
The relationship between linear load and the efficiency of the collection is the collection speed. This speed will be the same for all materials when making use of compartmented waste vehicles. The linear loads however per collected material varies according to the quantities of materials disposed simultaneous in the recipients for collection.

[1] Costs for Municipal Waste Management in the EU, Final report to Directorate General Environment, European Commission, Eunomia on behalf of ECOTEC

Figure 1: Collection efficiency of different dry recyclables on a circuit by a compartmentalized waste truck[2]



When extrapolating the results of figure 1 with the collection of the different waste streams on a same territory, the linear collection load of a given waste stream decreases with the quantities collected making the efficiency is weaker. Similarly, the lower the density (e.g. light packaging waste, paper mixed with cardboard), the higher the waste volume to be collected for a given quantity: the consequences are more recipients to empty and as such a drop of efficiency. One of the limiting factors in the collection is the number of bins/ containers that can be emptied by a crew per day (more or less 1000 bins/ containers 1100l per crew per day). This work load is little dependent on the nature of the waste stream and thus the lower the density of the waste stream to be collected the lesser the efficiency of the collection and the more the unit costs for collection (expressed in Euro/ ton) is high.

Finally, the payload of a collection vehicle is lower with the density of the waste stream, because of the lesser compaction possibility of the waste stream, especially for light weight packaging. As such, for a given tonnage to collect, the emptying's are more numerous in the case of a waste stream with a lesser density.

1.5.2. Determinants of treatment costs

In general, the more waste streams offered for collection, the more difficult to optimize the collection. The knowledge on waste to be treated (quantities, composition, evolution) are essential prerequisites for the dimensioning of treatment plants.

The comparison of the production costs of the different technologies or treatment facilities is a prerequisite for the choice of the treatment technology for a LRA. Often, decision makers focus only on investments costs even though the operation costs, throughout the lifetime of a project, may represent several times the investment amount. A simpler technology may incur lesser investment costs but at the cost of recurring operation expenses, often higher. In example, a mechanical biological treatment center will require variable investment costs depending on the composting technology chosen: windrows handled with a loader, windrows turned mechanically, continuous layers under shed with a mechanical device and automated aeration, silo with automated wheel turning, tunnels with machine for loading and emptying… Through the choice of aeration and loading/ emptying will result the need for personnel assigned for these handlings and thus a different personnel and operation cost according to the technology.

Tenders often underestimate the operation costs in order to increase the laureate of the contest.

Different online simulation tools for decision support have been developed (Competop, Ecobio…).

Costs for packaging waste (pre)treatment

The degree to which sorting facilities are required, and the complexity of their design, depends on the nature of the collection system in place. There is considerable variation in approaches to the collection of materials separated at source, and so, the requirement for sorting varies across, and within countries. Further complicating matters is the fact that for a given operation, facilities of differing capital intensities can be designed.

[2] Que faire des déchets ménagers ? A. Le Bozec, S. Barles, N. Buclet, G.Keck – Editions Quae, 2012

Table 5: Unit costs for sorting waste materials[3]

	Mixed packaging waste
Belgium	€193/t
France	€183-229/t
Germany	€250/t

Cost reduction can best be achieved by economies of scale in sorting centers, by developing higher capacity centers, mutualized by different municipalities. Automation can further reduce the costs depending on the tonnage treated per year (less 30% for 30 000 tons treated).

Costs for bio waste treatment

Source-separated collection scheme

The choice of operational options, as highlighted in the strategy description, will influence the cost of a household bio-waste source-separated collection scheme. The operational options such as material types collected (e.g. green waste, food waste, cardboard), collection system, container options (e.g. bins, buckets, paper sacks, kitchen caddies…), coverage, frequency of collections, and finally vehicle options (e.g. compacting or non-compacting trucks, load size) as well as the possible use of transfer stations play a key role in the final costs of such a strategy.

In general, systems collecting green waste free of charge, or green waste and food waste together, on a fortnightly basis are more expensive than systems collecting food waste only on a weekly basis. The key reason for this is that additional waste is being pulled into the formal waste collection system through the provision of a service which is free at the point of provision. In terms of financial costs, separate collection systems which target food wastes are likely to be the most cost-effective[4]. The research in this report could not however provide evidence for this statement.

Table 6: Program costs per tonne diverted for household source separated composting[5]

	Collection costs	Composting costs (in-vessel)	Total costs
Costs range	€40 – 178/t	€39 – 94/t	€79 – 272/t
Median costs	€82/t	€70/t	€152/t

[3] Costs for Municipal Waste Management in the EU, Final report to Directorate General Environment, European Commission, Eunomia on behalf of ECOTEC
[4] Dealing with food waste in the UK, Eunomia, Dr Dominic Hogg, 2007
[5] ACR+, 6 composting strategies, 2014

Overall costs for municipal waste management do not necessarily increase when introducing source separated bio-waste collection strategies[6]

Research carried out by the Scuola Agraria del Parco Di Monza shows that source segregation of food waste with door-to-door schemes can be run with no substantial increase in overall costs, and sometimes costs are even lower than with traditional collection (no segregation of food waste) or with food. To understand the unexpected outcomes of the survey, it must be underlined that if source separation of food waste is added to that of commingled municipal waste, with no modification in the pre-existing scheme for MSW collection, total costs are likely to rise.

This actually tends to happen with the segregation of food waste by means of road containers. But this does not necessarily happen when food waste collection is introduced in such a way that the overall collection system is optimised. The key point is that intensive door-to-door schemes for food waste – when made "comfortable" for households - yield high captures. This sharply reduces the percentage of food waste in residual waste, which can then be collected less frequently with fewer complaints regarding odours. This approach might be considered likely to be especially effective in municipalities where households are charged on the basis of frequency of residual waste collection.

Mixed waste composting

Major cost elements for mixed waste composting facilities (MBT) include siting, capital expenditures for equipment and odour control devices, and operating costs. Mixed waste composting facilities use much higher levels of technology than other bio-waste diversion strategies in order to sort recyclables and compostables. Facilities have dramatically different capital costs depending on the level of technology employed and the reliance upon low-skilled labour for sorting. Capital costs for MBT facilities are relatively high and have been estimated at around 60 to 150 million euro for MBT facilities in the capacity range 80 000 to 225 000 t/y[7] . Odour control technologies also have associated design, construction, and operating costs that vary widely from project to project. Operating costs include labour, operation and maintenance, utilities, and residuals disposal. The technology used will determine labour requirements. Residuals disposal can be a very large cost item depending on compost quality, the corresponding degree of contaminant removal, and the cost of disposal.

In addition to facility costs, mixed waste composting involves collection costs. Unlike other bio-waste strategies, however, mixed waste composting does not require a separate collection system. There is therefore no additional collection cost for a community that changes from hauling its waste to a landfill to hauling its waste to a mixed waste composting facility.
The economic viability of MBT projects depends heavily on the existence of stable, long term opportunities for outputs (products and energy). Financial balance might be delicate as the income generated from compost might be very low. Additionally, there is a risk of producing compost not meeting the standards, causing supplementary costs for storing and disposal. Finally, the treatment of the RDF generates costs (recovery costs by cement facilities or Waste-to-Energy plants) only partially compensated by the sale of energy.

The following table presents the costs associated to the collection and treatment of residual waste in MBT plants.

[6] Strategies and practices for the management of bio-waste: in the light of EU waste policy and environmental drivers, Enzo Faviono, Scuola Agraria del Parco di Monza, 2005
[7] Mechanical Biological Treatment of Municipal Solid Waste, DEFRA, February 2013

Table 7: Program costs per tonne diverted for collection and bio-waste treatment (MBT)[8]

	Capacity (t/y) (€/t)	Collection costs	Treatment cost (1)	Total costs
Europe [9]		€67/t	€75 – 126/t	€142 – 193/t
France [10]	+/-30 000	€85/t	€76/t €100 - 110/t [11]	€161/t
Germany	100 000	€67/t	€100 – 130/t	€167 – 197/t
Italy		€75/t	€70 – 100/t	€145 – 175/t
FNADE study		€60/t	€80 – 125/t	€140 – 185/t

[1] Residual waste management (incineration and landfilling) included

Costs for Waste-to-Energy (WtE) plants

Waste-to-Energy is a capital intensive business. However, the size matters, large plants are favored from cost and energy point of view. Energy revenues are key, preferably both by supply of electricity and heat. The required gate fee for a WtE plant is the balance of costs minus the revenues.

The costs of incineration plant are typically affected by:

- Costs of land acquisition
- Scale
- Plant utilization rate
- The requirements for treatment of flue gases
- The treatment and disposal/ recovery of bottom ashes
- The efficiency of energy recovery, and the revenue received for energy delivery
- The recovery of metals and the revenues received from it
- Taxes on incineration

The total capital investment costs typically range, based on assumptions for European circumstances, between €550 – 800 per ton per year. A range of € 275 – 400 million for a 500 kt/annum plant depending on various key factors such as: plant size: smaller plants are high in the range, specific requirements on Flue Gas cleaning and emissions, energy generation and efficiency: high energy efficiency increases required capital (trade-off!), location and architectural demands, cost of construction labor and local engineering, the cost of land...

The operating cost structure in Europe excluding depreciation, interest, finance vary in the range €35 – 80 per ton of waste treated, the lower figure for large, modern, efficient well run plants. The breakdown of these costs can be presented as follows: 40% for maintenance, 30% for labor and other personnel, 15% for consumables, 5 – 10% for residues and 10 – 15% others.

[8] Costs for Municipal Waste Management in the EU, Final report to Directorate General Environment, European Commission, Eunomia on behalf of ECOTEC
[9] Zeschmar-Lahl et al. (2000) Mechanisch-Biologische Abfallbehandlung in Europa, Berlin: Blackwell Wissenschafts-Verlag GmbH,
[10] Indicateurs de coûts et de performance de la gestion des déchets organiques, exemples de schémas de gestion, Amorce, Octobre 2011
[11] Acte du colloque ADEME déchets et territoires – Juin 2013

Table 8: Cost differentials for a Selective Catalytic Reduction (SCR) incinerator in Flanders[12]

	Euro
COSTS	
Capital costs per ton	€37
Operational costs	€40
Fixed	€32
Variable	€8
Overhead	€10
Total	€87
REVENUES	
Materials	€0
Electricity production	€12
Total	€12
NET COST	**€75**

Costs for landfilling

Landfill costs can typically be disaggregated into the following components:

- Acquisition costs
- Capital expenditure costs
- Operating costs
- Restoration
- Aftercare costs

Under a given regime, the unit costs are affected by fill rates and the total capacity. The two together effectively determine the period over which waste is accepted, and thereby, the depreciation period for capital.

Capital expenditure and development costs are affected by country regimes in terms of the requirement for liners, as well as the geology of the site, and the site's proximity to sensitive aquifers… Operating costs for landfills can be quite small, whilst restoration costs are determined more on an area basis than on quantity of material received.

The costs in the following table are not 'costs' in all cases. In some cases, only gate fees have been obtained. There is enormous variation in the cost net of taxes.

[12] Costs for Municipal Waste Management in the EU, Final report to Directorate General Environment, European Commission, Eunomia on behalf of ECOTEC

Table 9: Comparative costs of landfilling[13]

Country	*Costs (excl. tax)*	*Gate fees (excl. tax)*	*Tax*	*Total costs*
Austria	€67		€43	€110
Belgium (Fl)		€47,5	€52-55	€100
Denmark		€44	€50	€94
France	€31-85		€9	€40-94
Italy	€52		Varies	€70-75
Spain	€25-35		-	€25-35

1.5.3 Summarising and breakdown of municipal waste management costs

Finance for solid waste management needs to cover capital, operating and maintenance costs. While solid waste management is often quite labor intensive, the cost of labor in developing countries is so low that labor need not be the main expenditure in a well-managed solid waste service..

For a perspective of how capital and operating costs break-down by solid waste activity, the following ranges are observed to be common ranges for well managed solid waste services in developing countries, as noted below.

Table 10: Breakdown of costs for different waste management[14]

	capital costs	**labor costs**	**consumables and maintenance costs**
Solid waste collection	30-40%	15-40%	30-45%
Sweeping	20-30 %	50-70%	10-20%
Transfer	50-65%	10-15%	20-30%
Composting	40-60%	15-30%	10-20%
Anaerobic digestion or Incineration	60-85%	5-10%	10-30%
Sanitary landfill	40-70%	10-20%	20-30%

1.6. Cost of externalities

The social cost of an activity of production of a good or service equals the private costs made by the producer (enterprise) plus the costs of negative externalities of production (pollution costs for the society). Through a similar reasoning, the consumption of a good or service can generate positive or negative externalities affecting the social benefit. Economists will try to quantify this environmental cost related to loss of welfare.

Internalization is based on the polluter pay principle and consists of making the polluter pay for costs resulting from damage and will require prevention measures, and pollution control.

[13] Costs for Municipal Waste Management in the EU, Final report to Directorate General Environment, European Commission, Eunomia on behalf of ECOTEC

[14] Costs for Municipal Waste Management in the EU, Final report to Directorate General Environment, European Commission, Eunomia on behalf of ECOTEC

1.6.1. External costs of recycling

Recycling saves resources and primary materials and energy and reduces the Green House Gas (GHG) emissions, water consumption and waste generated. The positive externalities or external benefits expressed in monetary terms, linked to avoided pollution and saved energetic resources account for €300/ton. The environmental benefit of a material is measured by the difference between the environmental costs of recycling as compared to the environmental cost of landfilling or incineration. These environmental costs are estimated at 2100 - 2300€/ton for aluminum, 510 - 1262€/ton for plastics (mainly PET and LDPE), 211 – 531€/ton for paper and cardboard and 60 - 120€/ton for glass. These benefits come mainly from savings in raw materials and fuels.

1.6.2. External costs of landfilling

External costs related to landfilling refer mainly to the emissions of methane, risk of pollution of surface- and groundwater and soil due to leachate percolation as well as possible nuisances for residents such as odors, noise living close by the landfill. More, the irreversible use of the soil requires to consider an opportunity costs linked to soil use to the detriment of other land use.

1.6.3. External costs of composting/ anaerobic digestion

The gaseous emissions determine the negative externalities. Benefits of anaerobic digestion relate in the production of biogas that can be substituted to a non-renewable energy. Compost on the other hand can substitute peat. Very few studies evaluate these externalities in monetary terms.

1.6.4. External costs of incineration

The negative externalities of incineration relate mainly to toxic gaseous emissions and GHG. The method used for measuring the externalities is the impact-pathway. The pollution impact is directly linked to the population density in the vicinity of the installation. The external benefits related to energy recovery has to be evaluated as according to the energy it substitutes (nuclear energy, energetic mix, coal, natural gaz…) and depends also on the method of recovery (heat, electricity, co-generation). Again monetization of the negative and positive externalities is very difficult.

In summary, external costs have not been studied in detail and therefore gaps exist in calculating external costs. However, seen the exhaustion of natural resources, the environmental pollution, nuisances (odor, noise…) generated by installations it can be justified to take into consideration and compare the environmental costs and benefits of waste treatment practices.

Table 11: Externalities in MSWM

Negative externalities:	**Positive externalities:**
• Environmental impact of collection and transport • Local pollution • Global pollution (GHG) • Risks of pollution and health impacts at long term • Nuisances • Social refuse (NIMBY) • Opportunity selective collection cost for citizens	• Reduction of pollution potential of waste • Energetic resource savings • Natural resource savings • Avoided pollution

1.6.5. Internalization of external costs

The two most common economic approaches for internalizing external costs are taxes and producer responsibility schemes and are described in the chapter financing mechanisms and cost recovery.

Waste management financing and options for cost recovery

2.1. General overview

Waste management comes at its costs. Solid waste management is an indispensable but expensive service that consumes a large proportion of available operational budgets for municipal services. The responsibility for the financing of waste management should be shared between the state and the municipalities. State policy must govern the enforcement of environmental objectives, also by financial means whereas financial organization of the actual waste services is given in the hand of the municipalities.

At the level of the municipality one has to distinguish between the financing of the services citizens obtain for their waste, and the financing of municipal investments into improved waste management solutions. Services to the citizens should be levied to the citizens by the way of dedicated fees or charges stipulated in municipal waste ordinances or waste statutes. For investments the municipalities have to employ adequate financing models which take into account all the advantages and risks of the respective application.

In regard of the fact that environmental protection is of importance for the national economy, also the financial instruments of the state need to be considered. Governments can influence the impacts of society on environmental developments by means of different policy instruments at their disposal. This can for instance be:

- Limiting resources consumption for example through the introduction of a commodity tax
- Limiting the release of unwanted material into the environment for example through landfill taxation, bans on landfilling of recyclable materials or mandatory environmental licenses
- Promoting certain environmental benign measures such as recycling through a special taxation or charging system (e.g. mandatory waste disposal charge) in order to close the loop from the waste arising to secondary material production

2.2. Financing options of the municipal sector

2.2.1. Financing of public services

A principle of waste management should be that contributions should in particular be coming from those who benefit from the system in order to recover the cost. That's why charges should be levied for availed public services.

A key element in such approach is that of "willingness-to-pay". If people are willing to pay for the full costs of a particular service, then it is a clear indication that the service is valued and therefore will most likely be used and maintained. Hence it will be possible to generate the funds required to sustain the service.

However, the extent to which an individual is willing to pay for a hypothetical service also depends on how much he or she can afford. Therefore, next to the willingness-to-pay, the "affordability-to-pay" is a key element in the marketing of solid waste services. Intelligent charging mechanisms and models may be required to overcome these challenges.

Costs for waste management, as seen in the previous chapter, are in general related to the following types of services:

- The collection, transport, pre-treatment and treatment of the various types of collected waste and recyclables
- The operation of special recycling programs (e.g. take back schemes...)
- The provision of waste consultation and public information
- Administrative services

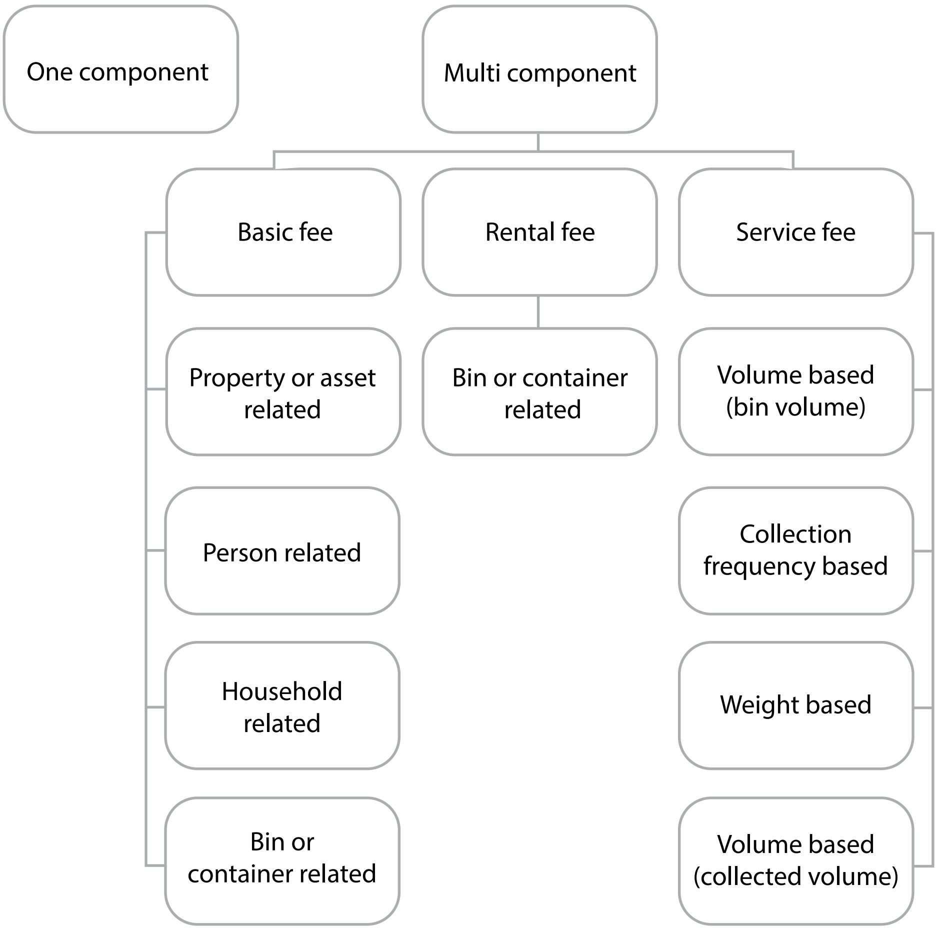
The fees to be charged to the waste generator are linked to the service provided based on the expenses for providing those services. The minimum requirement in this respect should be the recovery of the share of the inevitable or fixed costs for the collection and treatment independently from the actual use of the provided services.

The fixed costs in conjunction with waste management can be described as those expenses incurring independently of the amount of collected waste and extend of real use of waste services. Expenses that accrue in conjunction with the actual performance of the service and are thus also dependent from the amount of waste and extent of real use of the waste services shall be considered variable costs.

Fixed and variable costs cannot always be differentiated clearly. As a rule of thumb it can be said that the costs considered as the fixed part make up a proportion of 60 to 80% of the total cost whereas the variable part very seldom goes higher than 20-40%.

Waste charging schemes should for these reasons consider a splitting of the overall charge into one, non-service dependent part plus another, service dependent part and further differentiated fees for various surplus services. A waste charging scheme should in any case make sure the full coverage of the waste management related costs and the fair allocation of these costs to the population as beneficiaries of the services.

Figure 2: Suitable components for the design of a waste charge



The one-component charge system represents the simplest charge model. It consist of only one type of fee. Classical is the flat rate scheme. It consists of a fixed fee which is charged independently of the actually generated waste amount or availed services. This fee is supposed to cover fixed and variable parts of the waste management costs. This system doesn't provide for any incentive to reduce the amount of generated waste or engage in source separation activities.

The multi-component includes as a basic component a fixed fee from each household. This fee is either unified (e.g. a certain annual amount) or non-unified (according to specific criteria, e.g. a function of the surface of the real estate). Further charged is a variable fee component which is in relation to the collection service actually availed, for instance for each unit of waste set out for collection, and may be combined with other components. Multi-component waste charge models are best suited to realize the polluter pay principle.

The implementation of waste charging by the way of pay-as-you-throw (PAYT) schemes must be considered as the most suitable option to ensure fairness in paying for waste management services and moreover proved to be very efficient in promoting the reduction of disposable waste. The polluter pays principle aims to charge citizens in a fair manner in accordance to the actual quantity of waste generated by them and the corresponding service they obtained for its management.

To perform such way of variable waste charging requires:

- The measurement of the generated amount of waste and/or services obtained for it
- A kind of identification for reasons of accountability to the waste generator
- The unit pricing for individual charging according to collected amount or availed services

Pay-as-you-throw (PAYT)

The aim of PAYT schemes is maximizing recycling, minimize generation of waste as well as minimize residual waste going for final treatment. It allows for improved transparency of costs to the citizen, and make the users more responsible regarding their household waste.

Effects of PAYT on quantities of different waste streams:

- Decrease of residual household waste by 15 to 50%
- Increase by 30 to 80% of household waste sorted for recycling
- Development of backyard composting and reduction at source of household waste by 3 to 12%
- Increased use of recycling yards for the recovery of bulky waste and green waste

Regarding net costs it should be stated that the net total cost of the service decreases much slower than the tonnage of household residual waste collected as in general it is more costly to sort and recycle than treating residual waste. However, depending on the taxes put on landfilling/ incineration selective collection and recycling may become more advantageous.

Currently very few examples exist in setting targeted social tariffs as according to social criteria. Some inter-municipalities in Flanders provide 'social' discounts for waste brought to recycling yards.

Finally after introduction of the PAYT system the incomes of the municipality will decrease because of the incentive to generate less and sort better. Prior simulations are therefore important and some municipalities will want to keep the fixed art of the charges high in order to secure their budget.

Although a fully variable waste charging model seem to be possible to realize PAYT, it has to be noticed that multi-component waste charge models offer indeed the more suitable solution here. Such model however make consideration only to the indispensable costs for delivering the waste service in its fixed part whereas a sufficient variable part must be maintained to keep the incentive for waste reduction and diversion. Also a minimum mandatory charge can be included for reasons of additional revenue security.

The case of municipalities in middle-income countries

Municipalities in developing countries are seldom empowered by central and provincial government to address their solid waste responsibilities in the most cost-effective manner. They are also commonly restricted from developing sufficient local revenues to cover expenses.

For example, municipalities may be restricted from:

- increasing local property taxes to include a designated amount for solid waste management;
- creating new solid waste or environmental taxes;
- creating and collecting solid waste user fees or landfill tipping fees;
- contracting for service delivery beyond a one-year budget period;
- tendering for any contractor above a certain allowed total contract price ceiling;
- reducing redundant municipal employees to free up budget for contracting or capital investment;
- issuing municipal bonds or borrowing for capital investment;
- initiating inter-municipal arrangements that would capture economies-of-scale; and
- entering into private sector concession agreements to design, build and operate new facilities.

The preferred approach to addressing these issues is to delegate more authority to municipalities to address their local service delivery and related cost-recovery needs. These measures typically improve the overall financial health of municipalities for this and other services.

To help municipalities reach a higher standard of environmental protection, carefully earmarked and time-limited intergovernmental incentives could encourage municipalities to address provincial or national targets. This is particularly relevant for public health and environmental goals that affect people and resources beyond municipal boundaries, such as in the control of communicable diseases or pollutant discharges related to poor waste disposal.

To avoid the administrative costs of separate collection of yet another charge or tax uniquely for solid waste, an effective expedient involves tying a solid waste surcharge to utility bills, such as electricity or water. This solution works well when utility services cover most households and charges are linked to consumption.

Fees that reflect affordability (and related consumption that leads to waste) are relatively easy to develop and preferable to customer-specific cost of service fees. For households, this typically means setting the tariff based on one of the following:

- Size of property, category of neighborhood (by income) and related property tax,
- Water consumption and billings, and
- Electricity consumption and billings.

In order to discourage excessive waste generation, waste generators that regularly produce large quantities are typically charged by the size of their containers. The cut-off for a large generator is any establishment with containers that can hold, for example, over 1 cubic meter of waste per day.

As countries develop and solid waste systems become more regulated, it becomes possible to increase quantity-based charges. This may be done, for example, by selling specially colored or labeled plastic bags for a price that would enable cost recovery and then collecting only waste that is in these specially marked plastic bags. At this time, few low and middle income countries have the monitoring and enforcement system that would enable this system to be put in place without significant potential for illegal dumping.

Basic fee(s)

The determination of a fixed basic fee shall reflect that certain expenses already accrue with the installation of a system whether a household is going to use them or not (fixed costs). The fee thus does not serve as a payment for availed services but as a compensation for the provided opportunity to do so. To the eligible costs belong, for example, costs for the accounting and billing, the service routing and the fleet, for the purchase and supply of waste containers, personnel and maintenance costs, rents, capital and depreciation costs. It is recommended to charge the basic fee in the form of a flat rate.

There are various ways to define a basic fee. The most applicable solutions are:

- Person related (i.e. charging a unit price per household member)
- Bin or container-related (i.e. charging a fee for each provided bin/ container in relation to the volume)
- Property or asset-related; (i.e charging a fee per property including the possibility of a differentiation based on certain parameters (e.g. size of property, type of property, i.e. private, commercial or mixed utilization, first or second home, permanent or temporary occupation);
- Household-related

A bin or container-related arrangement combines with the need to have the containers registered. This can be achieved through the assignment of the container to the waste generator or a subscription.

Service-related fee(s) or Pay-as-you-throw

The charging of service fees for an unambiguous perpetuation of evidence on the extent of the services availed by the payer of the charge. The most applicable ways of defining service related fees are shown in the following table:

Table 12: Common options for service-related fee arrangements

Volume –based (container volume)	**Pickup frequency based**
i.e. charging for the collection service based on the provided container volume and frequency of emptying. The frequency of emptying is fixed. Such arrangement could include the determination of a minimum chargeable volume per person.	i.e. charging in dependence from the actual number of emptying for a standard bin or other receptacles of a defined size. The frequency of emptying is optional. Such arrangement could include the determination of a minimum chargeable number of pickups.
Weight-based	**Volume-based (actual volume collected)**
i.e. charging per unit weight of collected waste (typically applying to residual and bio waste collection). In this arrangement, the accountability of the collected waste to the generator is a precondition. A weight based service fee can possibly be charged in combination with a fee per emptying.	i.e. charging requires the actual volume of the waste inside the receptacle to be established or known in the moment of pick-up. Aside from a few solutions where the waste container's filling level is measured, this typically applies to pre-paid arrangements e.g. prepaid sack or tag-a-bag scheme.

Advantages and inconvenient of the above options are described in detail in the following table.

Table 13: Advantages and inconvenient of different service-related fees systems		
System	**Advantages**	**Inconvenient**
Volume-based (container volume)	• Simplicity of tariff • Incentive for waste avoidance and waste separation • Calculation reliable and transparent • Well acceptable by citizens if applied in conjunction with a flexible choice of bin size	• Limited acceptance if applied without freedom of choice of bin size • Danger of bypassing in the absence of provisions for a minimum chargeable volume per household or capita • Compaction of waste • Tendency to subscribe for small sized bins • Less an incentive than weight-based system
Frequency based	• Incentive for waste avoidance and waste separation • Better filling of containers • Collection becomes transparent to citizens and waste collection company	• Compaction of waste • Danger of bypassing in the absence of provisions for a minimum chargeable volume per household or capita • High administrative effort required • Arbitrary frequency of emptying can be associated with hygienic problems and the use of undesired forms of waste disposal
Weight based	• Provides a high incentive for the avoidance and separation of waste • Perfectly producer oriented • Allows the permanent monitoring of waste flow developements	• Investment intensive • Higher expenses for system maintenance • Danger of bypassing in the absence of provisions for a minimum chargeable mass per household or capita • Discriminates households who do not have the possibility for backyard composting
Actual volume based (service) fee	• Provides a high incentive for the avoidance and separation of waste • No accounting of the unused volume of the bin • Billing becomes transparent for the citizen (price per volume unit)	• High costs for measuring equipment, its calibration and maintenance • Sensitiveness of measuring and proneness to errors • Incentive for illegal dumping/ littering or pollution of the recyclable fractions

Underestimated capacities in the volume-based arrangement are by far the largest problem since the arrangement usually offers the households freedom of choice for the container size used. That's why such arrangements should normally be offered in combination with the determination of a minimum chargeable volume per person.

The prescription of a fixed frequency of emptying does permit the regular pickup of the waste and helps thus to avoid the development of odour nuisances and health risks. Such measure is most suitable for the collection of bio-waste.

Pickup frequency based arrangement can be best realized with the help of bin-identification systems. Identification systems make sure the accountability of the collected waste to the waste generators. This is a precondition for weight-based arrangement as well. As an incentive for households to render containers for emptying only when they are full, an extra fee for each pickup can be charged together with the weight based service fee.

Rental fee

A rental fee is meant to cover the costs for the provision of a waste collection container by a public authority of any other body in charge for waste related services different from the waste generator. The fee varies in dependence from the container size or volume. Alternatively, these costs can also be accounted as part of the basic fee or included into a service-dependent fee.

2.3. Options for financing of investments

2.3.1. Loan financing

The usual procedure for waste management investments are loans of money. A suitable way is bonded loans. In this case, the municipality is not bound to a certain financial institution but free in the choice of creditors. The advantage of local authority loans lies in the favourable conditions which can be obtained due to the higher solvency and creditworthiness public enterprises supposed to have. Latter derives from the lower risk of failed repayments since public bodies are not in danger to go bankrupt and dispose of the means to secure the credit rates through the power to impose charges.

2.3.2. Shared financing

Participation of public bodies (municipal associations)

The creation and participation of public bodies in target-oriented municipal associations (administrative unions) is a common and very useful way of inter-municipal co-operation. By enlarging the jurisdiction area for waste management optimal structures and investments can be achieved and positive effects obtained from task sharing and the possible rationalization of operations. A municipal association should enjoy financial autonomy, meaning that it can also impose special levies or even charges for its services.

Third party participation

Municipalities may decide for themselves if and to what degree they want to privatize or not. Complete privatization, however, may only be permitted in selected cases and under considerable stipulations. The most common organizational forms are as follows:

- Municipal department: operated within the scope of the regular municipal administration;
- Municipal utility: operated by the municipality in a separate capacity with independent bookkeeping
- Municipal company: private entity company in the hands of the municipality
- Joint venture: municipal utility with the involvement of a private firm
- Management and service contract: the plant property belongs to the municipality, but the operations and any further management tasks are delegated to a private firm
- Operator model: delegation of the plant operation to a private firm, whereas the responsibility for the fulfilment of tasks remains with the municipality
- Public Private Partnership

Partnerships with the private sector – better known as Public-Private-Partnerships (PPP) describe a rather new model. Public private partnerships are a generic term for the relationships formed between the private sector and public bodies often with the aim of introducing private sector resources in order to help provide and deliver public sector assets and services.

The term PPP is used to describe a wide variety of working arrangements from loose, informal and strategic partnerships to design build finance and operate type service contracts and formal joint venture companies.

Contracts integrate often the following features:

- A long term service contract
- The provision of capital assets and associated services by the operator
- The integration of design, building, financing and operation in the operator's proposals
- The allocation of risk to the party best able to manage and price it
- Service delivery against performance standards set out in an 'output specification'
- A performance related payment mechanism
- ...

PPPs are of special interest for municipalities because of the savings that can be achieved on the side of the municipal budget in parallel with private capital investments, but also because of the existing expertise on the side of established private enterprises and the higher flexibility and efficiency of these partners. A PPP should not be seen as the financier of last resort because there is unlikely to be a benefit to the public, if PPPs deliver more expensive services. PPPs must be able to deliver significant performance improvements and efficiency savings. Make no mistake, PPPs are not always better in managing and providing assets and services than the public sector.

From the perspective of encouraging private sector participation in the solid waste sector, evidence of self-sustaining revenues at the local government level may affect the private sector's willingness to invest in solid waste infrastructure and enter into long-term service agreements. In a few cases, central government payment guarantees enabled city-wide contracting for all solid waste services.

Operator models

Operator models are very complex arrangements of organizational and financing schemes which include interrelations between public body organisations and the private sector in financial matters and the provision of services. The basic idea of such model is that a private enterprise takes over the financing, establishment and operation of a treatment facility on public ground.

The selection of the future operator is done through a public tender procedure. The waste management authority the uses the facility to meet the waste management needs of the respective area and pays the operator remuneration for the provided services. Basis for all that is contracting arrangements of a complex and long lasting (up to 30 years) nature.

2.4. Economic instruments of environmental policy governed by the state

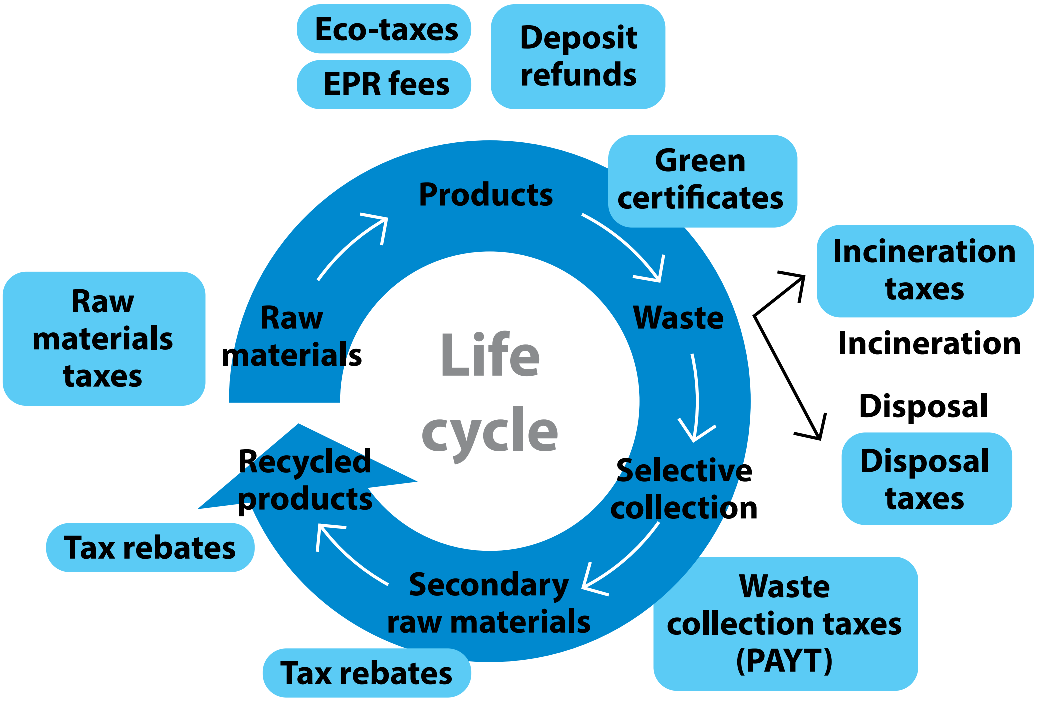
The Economic Instruments (EIs) in state environmental policy have the function of creating incentives and to provide the financial resources needed to meet certain environmental objectives. The costs arising thereof make the use of certain environmental resources more expensive. This creates an incentive for the sparing use of these resources and the applications of environmentally benign technologies.

In Solid Waste Management it is not simply a question of choosing either economic instruments (EIs) or command and control strategies (CACs) but adopting harmonious balance of both. General, economic instruments introduce more flexibility, efficiency and cost-effectiveness into sold waste management measures. Specifically, in solid waste management, EIs can be used as a tool to:

- Reduce the amount of waste generated
- Reduce the proportion of hazardous waste in the waste generated
- Improved product design
- Encourage recovery, reuse and recycling of wastes
- Decrease incineration and landfilling

- Minimize adverse environmental impacts related to solid waste collection, transport, treatment and disposal systems
- Encourage the use of recyclables in products
- Generated revenues to cover costs
- ..

Figure 3: Use of Economic Instruments in the resource/ product/ waste life cycle



2.4.1. Environmental taxes/ Eco taxes

Opposite to environmental charges which are levied directly on environmentally relevant activities, revenues from these taxes are included in the general budget and not directly of automatically earmarked for the specific area under which they were collected. Their character is that of revenue-raising and incentive taxes, and the money a contribution of the citizens to the public budgets needed to finance collective services provided by public authorities.

Revenue-raising taxes

Commodity tax (Resource consumption tax): this tax is aimed at the sparing use of certain resources and intended to promote the development of product saving processes and technologies. A well-known example is the tax on mineral oil or fuel. Revenue-raising taxes influence behavior but still yield substantial revenues over and above those required for related environmental regulation

Incentive taxes

Tax on waste disposal are employed with the intention to strengthen waste avoidance efforts. They should encourage the production of products which have a long life span, are reusable, can be recycled and generate little waste and environmental impacts during disposal. The aim is a closed loop economy with a minimum of negative impacts to the environment. Incentive taxes are levied purely with the intention of changing environmentally damaging behavior and without any intention to raise revenues.

Tax on municipalities

A special instrument imposed by state authorities is a tax on municipalities for exceeding (residual) waste amounts. This tax shall force municipalities to improve their waste management systems, to raise the general awareness of waste minimization among their population and thus to limit as much as possible the quantity of waste produced. Every ton of waste that exceeds the allowed level will be charged with a special tax that has to be paid by the municipality to the authority who imposed the tax.

2.4.2. Environmental charges

Environmental charges shall have an incentive function and likewise raise the money needed to finance the respective environmental services. The proceeds are being used to recover the costs and to invest into the specific sectors through which they were obtained.

Charges for waste material management

The charge is levied together with the price for a product or availed service. In this way the consumer of the product/ service bears for the costs which incur from the disposal of this product or from the service impact on the environment. Many countries have initiated a number of arrangements where charges for waste material management being levied, e.g.:

Green dot scheme for packaging waste: a license fee imposed on packaging authorizes for the use of the 'Green Dot' which indicates to the consumer that collection and sorting is financed by producers and retailers (www.gruener-punkt.de).

Extended Producer Responsibility (EPR) aims at extending the responsibility of producers from the consumption phase (put a product on the market) up to the full life cycle of a product including end-of-life management. It corresponds to the polluter-pay principle.

The physical or moral person that creates, produces, treats, sells or imports products (product producer) will be subject to the principle of Extended Producer Responsibility and will so contribute/ reinforce reuse, prevention, recycling and other recovery regarding waste.

Producers, importers and distributors can either choose for individual schemes whereby they organise collection and treatment of their products themselves or transfer the obligation to a body, eco-organism, to which they pay a contribution while ensuring governance.

EPR has impact on the financing:

- Transfer of waste management from municipalities to producer
- Transfer of financing by the user or taxpayer to the consumer
- Internalization, within the product price, of the end-of-life costs

The system has also impact on the producer:

- Encourages Eco design
- Reduction of potential toxic inputs
- Reduction of waste generation
- Design of recyclable products

By internalizing environmental costs in product price, public authorities hope that by introducing EPR, enterprises will be sensitized and engaged in putting 'eco' products on the market and so contribute to higher recycling rates.

[15] 'Effectiveness of economic instruments for packaging' – Final draft , ETC/SCP May 2012

Economic instruments for regulating packaging waste[15]

Different economic instruments for regulating packaging waste create different incentives for both consumers and producers. In general, these instruments are introduced in order to frame a system which is to achieve various targets in waste policies like e.g. waste prevention and recycling. The introduction of an economic instrument will mean that failure to fulfil these two objectives will carry a price, and will therefore create an incentive for the producer to change behavior. Overall, it can be said that economic instruments are efficient for society, since they achieve environmental objectives at a relatively low cost.

The three price-instruments which have been most commonly applied in the EU packaging markets are EPR, deposit-refund system and packaging taxes. All three instruments can in principle be applied at the same time, but there is little empirical evidence of this in practice. Most EU countries and Tunisia for the MENA region have only made use of the EPR scheme. Some countries have combined EPR and deposits, yet very few countries have combined taxes and deposits.

	EPR	Deposits	Taxes
Improvement of product design	+	+	++
Use of environment friendly materials	0/+	0	++
Optimise the weight of the packaging (prevention)	++	+	+++
Optimise reuse (prevention)	0	+	++
Optimise recycling rates	++	+++	(+)
Increase the quality of waste materials (clean fractions)	+	+++	0
Minimise litter	0	+++	0
Means to finance general waste mngt of packag.waste	+++	+	0
Overlap with existing waste data & planning system	++	+	0
Induce transaction costs	++	+	++
Easy to use for all kinds f packaging	++	--	+

0 = no impact;
+ = high;
++/-- very high or difficult;
+++ = very high

Based on the finding of the investigation, the following table is an indicative of each instrument and the potential changes that they can make within the industry:

Product charges

Product charges are specially levied to minimize the use of a certain material for environmental and other reasons. The charges on cans (formerly imposed in Denmark) or mandatory deposits (such as on one-way bottles and cans in Germany).

Waste treatment charges/ taxes

Taxes in waste management are used to move activities up the waste hierarchy. Therefore taxes will be used to discourage less performant waste management practices such as landfilling and incineration. These taxes push for prepare for reuse and recycling, preferable options, being more competitive with lower end waste treatment practices such as landfilling and incineration.

The most widely applied taxes are:

- The landfill tax is a tax imposed on waste amounts sent to landfill. In order to take a steering function as regards the diversion of the waste to recycling and other appropriate treatment facilities, a differentiated levy in dependence from the waste material and the state of the facility must be applied. The revenues should flow into a special trust fund from where it is especially used to finance the sanitation and remediation of older landfills.
- The incineration tax is a tax imposed on waste amounts sent to waste incinerators. Through a differentiation of

the levy dependence from the kind of waste and the type of facility a steering effect can also be achieved with regard to the supply of the waste to facilities with a higher environmental standard (I.e. from the pure waste incinerators of the older type to facilities with energy recovery or modern waste-to-energy plants. Generally such tax is meant to ensure that waste management will not simply shift from being a landfill dominated system to an incineration-centered one. It helps to shift waste management thinking from end-of-pipe solutions to materials recovery.

Table 14: Average landfill gate fees, landfill taxes, total landfilling costs and residual waste collection costs for selected countries (source: EEA, Eurostat, MEDSTAT, 2007-2010)[16]

Country	Landfill gate fee[17] in €/t (1)	Landfill tax[18] in €/t (2) excl. VAT	Landfill charges (1+2) in €/t	Collection costs Residual waste (€/t)	TOTAL Landfilling + collection (€/t)
Austria	70	87*	157	70	227
Belgium (Wallonia)	40	65	105		
Bulgaria		7-15			
Czech republic	16	20	36		
Denmark	44	63	107	126	233
Estonia	40	12	52		
Finland	59	50	109		
France	60	9-30	80	60	140
Germany		-	140	67	207
Greece		-	23	30	53
Ireland	70	75	145	65	210
Italy	90	7-30	102	75	177
Latvia	16	22	38		
Netherlands	25	107	132	100	232
Poland	70	27	97	45*	142
Portugal	11	4	15		
Slovenia	105	19*	124		
Spain (Catalonia)	41.7	12.4	54.1	50	118
Sweden	106	47	153		
United Kingdom	27	80 (2012) 100 (2014)	91	42	133
United States	36	-	36		
Australia	110	4 of the 6 states	110		
Canada		16	40-60		
Morocco			6.25	40	46.25
Tunisia			8	21.5	29.5
Jordan			3	25.4	28.7
Palestine			5	31	36

(*) Taxes for bio-waste only

(**) Estimate

[16] Etat de l'art de la collecte séparée et de la gestion de proximité des bio déchets, Partie 1: analyse comparative, ADEME, 2013

[17] Gate fees: charges set by the operators of the landfills for the provision of the service (i.e. waste disposal) and which are designed to cover their costs and profit. This type of fee is subject to variation according to the landfill site used, and to other factors such as available landfill capacity and market variations. Gate fees do not always cover an operators' cost due to the market situation at a given time. In this report, the term 'gate fees' refers to the costs before the application of landfill taxes.

[18] Taxes: a levy charged by public authorities (in most cases at national level, although is some cases (e.g. Italy, Spain) regional) for the disposal of waste in a landfill site, usually with an environmental purpose in mind, and where the revenue is accruing to the body responsible for the levy;

2.4.3. Environmental licenses and certificates

Environmental licenses and certificates form a financial instrument of environmental policy in that governments are selling rights for the release of emissions to the environment in order to provide an incentive for the reduction of these emissions to those generating them and reward those investing in clean technologies.

Clean Development Mechanisms (CDM) and Emission Reduction Units from Joint Implementation (JI) are the best known examples. Both mechanism are 'project-based' mechanisms which involve developing and implementing projects that reduce greenhouse gas (GHG) emissions, thereby generating carbon credits that can be sold on the carbon market.

JL is a mechanism that allows the generation of credits (known as Emission Reduction Units) from projects within industrialised countries, whereas the CDM allows the generation of credits known as Certified Emission Reductions from projects within developing countries.

A guide on CDM has been produced by UNEP and is accessible at:
http://cd4cdm.org/publications/financecdmprojectsguidebook.pdf

Carbon financing

It is well known that compostable waste left in a landfill generates methane, a greenhouse gas. Hence the capture and/or conversion of methane from decomposing solid waste is necessary to reduce greenhouse gas emissions (GHG). But, the methane could be used to produce power, which is the basic principle of bio mechanization. Since methane has a much higher global warming potential (GWP) than carbon dioxide, it is efficient from a GHG standpoint to convert methane to carbon dioxide in the process of power generation.

The Kyoto Protocol provides options for carbon trading between developed and developing countries.
If a developing country like India can reduce GHG emissions from solid waste by capturing methane, then it is eligible for certified emission reductions (CER) which can be sold in the carbon market. The World Bank has estimated that methane capture from landfills, composting and bio methanization will be eligible for carbon finance, expressed in 'per ton of municipal solid waste'. Another vehicle for carbon financing is the Clean Development Mechanism (CDM), whereby a developed country invests in solid waste disposal in a developing country and claims some or all of the emission reduction for its country. Developed countries find it cost-effective to either buy carbon credits in the market or invest in CDM projects compared to incurring the cost of reducing greenhouse gas emissions. Since GHG are global pollutants, it does not matter where the reduction takes place as long as the reduction targets for each country are met.

2.4.4. Solid Waste Revenues – Additional sources of income?

These sources of revenues may also be used to augment the funds available to cover costs:

- penalties for littering, clandestine dumping and other solid waste infractions
- license fees from collectors/haulers of special categories of solid waste (e.g., construction/demolition debris, medical waste, bulky waste);
- share of gross revenues from collectors/haulers having a franchise (i.e., zonal monopoly) for waste collection;
- revenues from sale of recyclables (e.g., secondary materials), recovered resources (e.g., compost), and energy (e.g., steam, electricity) from treatment and disposal facilities;
- tipping fees from individuals, private establishments, and waste haulers at transfer, treatment, and disposal facilities.

Figure 4: Volatility of revenues (in €/ton) for the selling of dry recyclables[19]

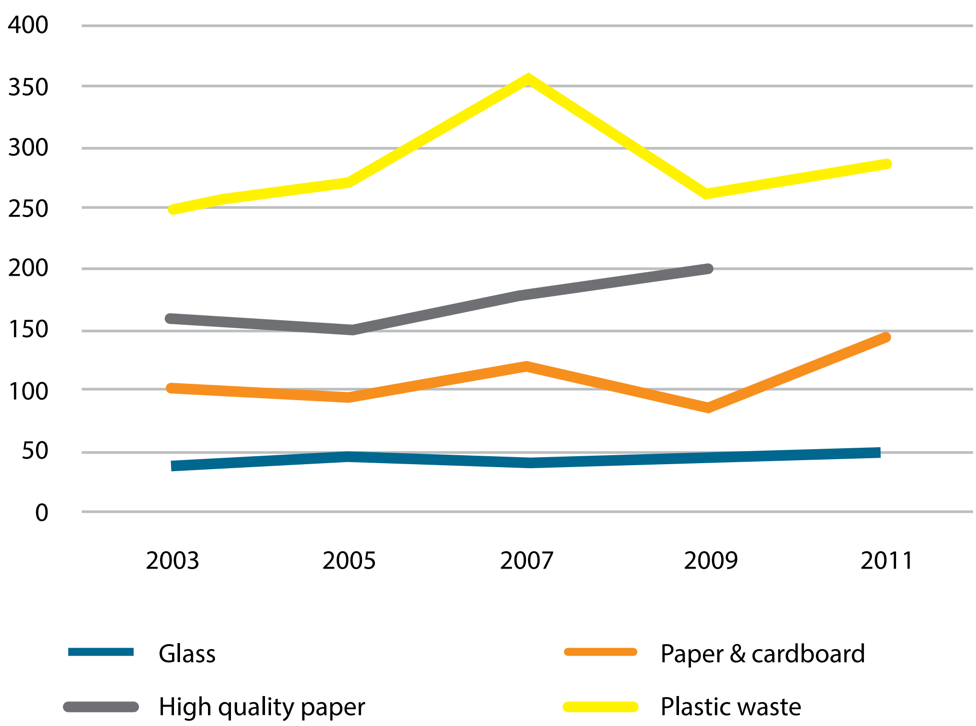


Table 15: Revenues from bulk sales of compost end-products for selected countries[20]

	Average compost Sales	Green waste compost sale	Mixed waste Compost sale	Highest quality compost sale
Europe	€5/t (1)			
France		€0 to 10–12/t (2)	€0 to 2–3/t (3)	
Austria				€12.5/t (4)
Denmark		€8 - 9/t		
Italy	€3 - 10/t			
Portugal (Lipor)				€70/t

1. Often, compost is actually given away to farmers free of charge
2. €0 in most cases, €10-12 includes the cost for transport and spreading,
3. €0 in most cases, €2-3 includes the spreading
4. Used in organic farming

[19] Interza intermunicipality (Flanders, Belgium)
[20] Study report on End-of-Waste criteria for Biodegradable waste subjected to biological treatment – Draft final report, IPTS Seville, Spain, July 2013

References

Solid Waste Management Conceptual Issues on Cost Recovery, Financial Incentives, and Intergovernmental Transfers; Author: Sandra Cointreau, September 2005

Proceedings of the International Conference on Sustainable Solid Waste Management, 5 - 7 September 2007, Chennai, India. P.537-542, Financing Solid Waste Management: Issues and Options Paul P. Appasamy and Prakash Nelliyat, Madras School of Economics, Chennai 600 0 25

UNEP, Options for Waste Management Financing – Best practice Municipal Waste Management,

Costs for Municipal Waste Management in the EU, Final report to Directorate General Environment, EC, Eunomia on behalf of ECOTEC, 2004

Indicateurs de coûts et de performance de la gestion des déchets organiques – exemples de schémas de gestion – Amorce, Octobre 2011

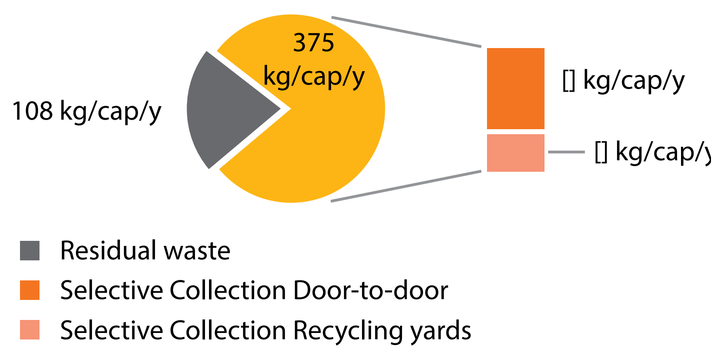
Que faire des déchets ménagers ? A. Le Bozec, S. Barles, N. Buclet, G.Keck – Editions Quae, 2012

Full Cost Accounting for Municipal Waste Management : A handbook – United States Environmental Protection Agency, 1997

Annex 1: Interza Intermunicipality factsheet

General data			
Population	77 000	Administration	Inter-municipality INTERZA www.interza.be
Density	785 inhabitants/km^2		
Year of introduction PAYT	2004		

Municipal waste generation and collection (2011 data)



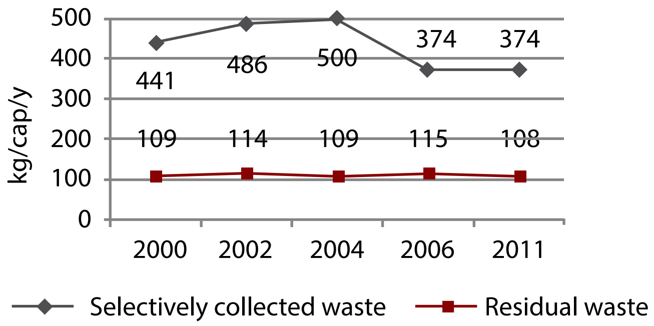
	Tons	kg/capita/y
Municipal waste		483.00
Selectively collected waste		375.00
Door-to-door		227.00
Recycling yards		148.00
Road containers		<
Residual waste		108.00

Flanders set quantitative objectives regarding the maximum amount of residual waste to be collected (150 kg/cap/y by 2015). 23 inter-municipalities (IM) operate in Flanders and serve more than 6 million inhabitants. All IMs put in place selective collection combining door-to-door schemes with recycling yards (voluntary bring). Road containers available for textile collection only. Interza has a selective collection of more than 75% of its municipal waste (incl. C&DW from hhld)

Selective collection scheme (2011 data)					
Door-to-door	Recipient	Frequency	Costs	Tons	kg/capita/y
Residual waste	60l bag	weekly	€2/bag		108.26
Bio waste	140l bin	biweekly	€30/year		132.28
Packaging waste	60l bag	biweekly	€0,125/bag		11.92
Paper & Cardboard	Loose - option: container	monthly	Loose: free Container: €50 (once off)		56.88
Glass	Loose - option: container	monthly	Loose: free Container: €50 (once off)		24.87
Recycling yard	Recipient	Frequency	Costs	Ton	kg/capita/y
22 waste fractions including C&DW, hazardous waste, WEEE, textiles,…	By car (with trailer)	No limits	Recyclables: €0 for car, €5 for car with trailer <1.5m, €10 if 1.5-2.5m Non recyclables: €5 for car, €25 for car with trailer <1.5m, €50 if 1.5-2.5m		148.00

The fees for selective collection pushes citizens towards reducing the quantities of residual waste €2/ 60l bag as compared to €0.125 for 60l bag for packaging. Recycling yards differentiate between recyclables and non-recyclables as well as between small and larg(er) waste generators.The transition towards PAYT came in force as from 2004/2005 and Interza is slowly but steady increasing the fees for residual waste. No figures are available regarding losses in the recycling process also determined as 'destination to recycling (DREC)'

Evolution waste



Kg/cap/y	Recycling yards	DtD Sel. collection	DtD Res. waste	Total
2000	146	295	109	550
2002	194	292	114	600
2004	199	301	109	610
2006	124	250	115	490
2011	147	227	108	482

The new PAYT system introduced in 2004 had visible and tangible consequences in the total amount of waste collected. The waste streams most affected were bio waste (yearly fee for DtD collection combined with incentives for home composting including a permanent communication campaign) and a variable fee system for some recyclables (C&DW & bulky waste) and non-recyclables at the recycling yard. Those fractions decreased by nearly 25%.

Costs

The cost and cost recovery mechanism changed throughout the years: overall costs were reduced (nearly 12%) through process efficiency and increased revenues from recyclables sales while the contribution of the municipalities decreased since the citizens paid higher fees through the PAYT system (up to 65% in 2011). The remaining costs are covered by the municipality however cost recovered through general taxes.

Horizon 2020

www.h2020.net

For more information on the Horizon 2020 Initiative visit:

the European Commission's Horizon 2020 website
http://ec.europa.eu/environment/enlarg/med/horizon_2020_en.htm

the Horizon 2020 Initiative's website www.h2020.net (English, French, Arabic)