Municipal Solid Waste Management:

International Experience and Ukraine Situation

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Executive Summary

The Ukrainian solid waste management sector can provide very attractive opportunities for international private investments. In fact, the industry is now ripe for a major transformation. In the past, solid waste management suffered from chronic underinvestment, which created a large gap between international waste treatment practices and existing local conditions. Most of the waste is dumped (frequently to illegal landfills), waste sorting is rarely practiced, while recycling rates are low. The role of the private sector is largely limited to waste collection and transportation to landfills. The problem of waste disposal in Ukraine looks certain to intensify as increasing waste generation is already placing a huge strain on waste treatment infrastructure.

The current Government wishes to correct this situation by attracting significant foreign direct investments to the sector. The opportunity for foreign investments exists because the composition of municipal solid waste streams in Ukraine allows for a substantial recovery of recyclables – such as plastics, glass, paper and metals. These are commodities whose prices are now booming, but which at present are mostly landfilled. To encourage sector investments, the government has included solid waste management as one of the priority projects under its National Priority Projects Program. Under this program, the Government will encourage private investments to finance the transition to a modern and sustainable waste management industry. It has indicated that it will provide support and take whatever measures are necessary to attract necessary foreign direct investments to the sector.

In many countries, private businesses have proved to play a critical role in the waste industry. Furthermore, private waste management companies tend to outperform other sectors thanks to relatively stable and more diverse revenue streams. This means that there is plenty of untapped potential for international private businesses in the waste management of Ukraine

Our review of the international experience reveals that private sector investments in solid waste management can indeed very financially attractive. In the US the waste management industry includes nearly 20,000 companies with combined annual revenue of about $75 billion. The three largest waste management firms which account for 48% of the sector showed a weighted average return on equity of 18% in 2007. In Europe, solid waste management is also a booming business. The 3000 members of the European Federation representing the European waste management industry account for about two thirds of the European market and have an annual turnover of over €50 billion.

International experience also shows that supportive government policies and incentives are needed in this sector because it involves “public goods”, under which private benefits tends to be lower than social benefits (due in part to externalities and environmental/health benefits). As with any public good, the government needs to provide incentives to the private sector to develop a modern waste management industry. In particular, there is a need for government

policies that would make the untreated dumping of waste a costly option compared to other modern but more expensive waste treatment alternatives. International experience shows that these policies are capable of creating viable and booming private businesses. More than that, when government policies facilitate the proper functioning of the market for waste services, both businesses and households start to treat waste in a more sustainable manner.

Our review of the international experience suggests that the following reforms will be needed for the successful implementation of a SWM project:

- Raise waste service tariffs to the population to economically sustainable levels. Current tariffs do not cover the cost of service provision and most municipal utilities are frequently subsidized.

- Increase landfilling rates for the dumping of untreated waste and ban the landfilling of recyclable waste. These rate increases are needed since lower landfilling rates just encourage waste dumping, without regards to environmental and health costs.

- Implement policies encouraging recycling, including mandatory separation of the waste streams at a source, deposit-refund systems for packaged goods, mandatory levels of recovery and waste recycling, extended producer responsibility systems (take back requirements), requirements on the minimum use of recycled materials in the production of new goods, regulations on the use of recyclables in the public procurement, etc.

- Undertake a broad national education campaign for the public on the merits of sustainable solid waste management.

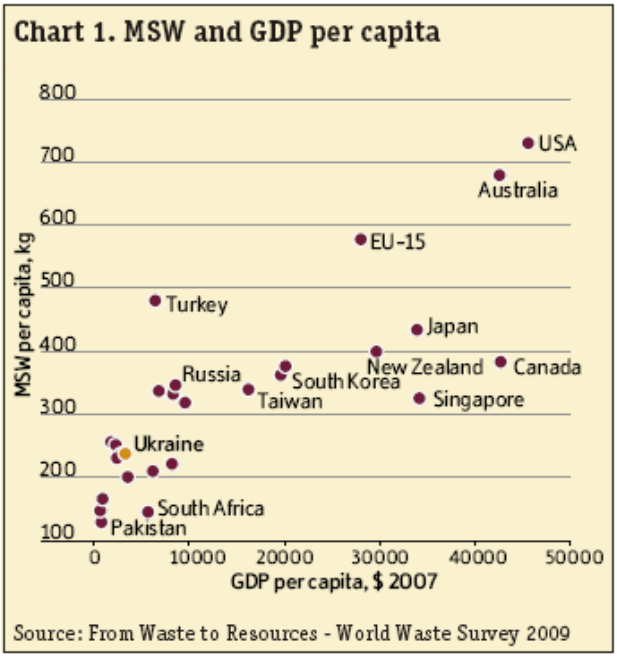
- Adopt a formal national strategy on waste reduction and recycling.

- Develop a workable mechanism for public-private partnerships in waste management; for example, by issuing government guarantees for loans to finance waste management infrastructure.

I. Introduction: Sector overview

Ways to collect, process and dispose municipal solid waste (MSW) differ substantially across countries due to varying composition of solid waste streams, different environmental and economic conditions as well as policies applied to MSW generation and treatment. The purpose of this report is to provide brief background information on global waste management practices and assess the present conditions as well as a potential of this industry in Ukraine.

A typical MSW system involves the following key components: (1) collection and transport, (2) processing, and (3) disposal. **Collection and transport** removes MSW from the point of generation to safeguard public health, limit congestion and preclude unpleasant odors. **Processing technologies** transform MSW by recycling, composting, burning, or compacting to improve its disposability and extract value from the waste. **Disposal** isolates and contains the residual waste left after processing. (See Appendix 1 for an illustration of possible waste management systems.) Waste treatment facilities may be owned and operated by the public sector or by private businesses and/or involve public-private partnerships.



The quality of waste generated by the country is of primary concern, because the structure and physical characteristics of the waste streams affect the economics of the waste treatment technology. Broadly speaking, the volume and composition of the MSW are linked to the level of economic development: high income countries tend to generate more waste per capita versus low income countries (see chart 1). Furthermore, households in the high income countries consume more processed and packaged foods, while MSW in low income countries tend to have a higher fraction of organic food waste (see chart 2 below).

Chart 2. MSW composition and GDP per capita

	Population	Municipal waste quantities in urban areas
High income developed countries	1 billion	Approx. 1.4 million tonnes per day (1.4 kg/capita/day)
Middle income developing countries	3 billion (approx. 30% of the urban population live in shantytowns)	Approx. 2.4 million tonnes per day (0.8 kg/capita/day)
Low income developing countries	2.4 billion (approx. 65% of the urban population live in shantytowns)	Approx. 1.4 million tonnes per day (0.6 kg/capita/day)

	Low income countries	Middle income countries	High income countries
GDP per capita, $	less than $5,000	$5,000 – $15,000	more than $20,000
Consumption of paper and cardboard, kg per capita	20	20 – 70	130 – 300
Municipal waste, kg per capita	150 – 250	250 – 550	350 – 750
Formal collection rate	‹ 70%	70% – 95%	› 95%
Waste policies	No environmental strategy, little application of the statutory framework, absence of statistics	National strategy, Ministry of the Environment, statutory framework but insufficient application, little statistics	National strategy, Ministry of the Environment, statutory framework set up and applied statistics
Informal collection	Highly developed, substantial volume capture, tendency to organize in cooperatives or associations	Developed and in process of institutionalization	Quasi non-existent
Municipal waste composition (%)			
Organic	50 – 80	20 – 65	20 – 40
Paper, cardboard	4 – 15	15 – 40	15 – 50
Plastics	5 – 12	7 – 15	10 – 15
Metals	1 – 5	1 – 5	5 – 8
Glass	1 – 5	1 – 5	5 – 8
Humidity	50% – 80%	40% – 60%	20% – 30%
Calorific value, kcal/kg	800 – 1,100	1,100 – 1,300	1,500 – 2,700
Waste treatment	Wildcat landfills › 50% Informal recycling 15%	Landfill sites › 90%, start of selective collection, organized recycling 5%, coexistent informal recycling	Selective collection, incineration, recycling ›20%
Informal recycling	Highly developed, substantial volume capture, tendency to organize in cooperatives or associations	Developed and in process of institutionalization	Quasi non-existent

Source: From Waste to Resources - World Waste Survey 2009

The physical characteristics of MSW significantly affect the optimal choice of the waste treatment technology as well as the potential to extract value from waste. Among other things they include waste density, biodegradable content, moisture content, the carbon-to-nitrogen ratio of the biodegradable portion, and energy content. For example:

- **Waste density** is important for the landfill capacity and equipment requirements for collection and transport.

- **Biodegradable content** affects the feasibility of composting or/and methane capture to be used as a fuel.

- **Moister content** influences the operational costs of incineration (additional fuel must be used to burn waste) and waste treatment equipment (more moist content usually courses quicker corrosion of the equipment). In addition, if the moisture content exceeds 60%, waste decomposition slows and the odor from anaerobic decomposition is emitted.

- **The carbon-to-nitrogen (C/N) ratio of the biodegradable portion** is an important determinant of the speed and costs of composting. The bacteria and fungi in compost digest carbon as an energy source and ingest nitrogen for protein synthesis. An ideal C/N ratio is about 20 to 25 parts of available carbon to 1 of available nitrogen. A C/N higher than 30/1 can slow the compost process; a C/N that is too low (less than 15/1 to 20/1) leads to the loss of nitrogen.[1]

Equally important, public policies, applied to waste generation and treatment, have a decisive impact on the economic feasibility of various waste treatment options. In general, these policies include:

- Policies affecting the cost of waste disposal and processing options, including landfill (gate) taxes and fees, incineration taxes, safety standards and regulations.
- Pay-As-You-Throw (PAYT) taxes - (or variable-rate pricing) as well as fixed rate user fees are designed to reduce waste and encourage recycling at the point of waste generation.
- Policies encouraging recycling[2], including mandatory separation of the waste streams at a source, deposit-refund systems for packaged goods, mandatory levels of recovery and waste recycling, extended producer responsibility systems (take back requirements), requirements on the minimum use of recycled materials in the production of new goods, regulations on the use of recyclables in the public procurement, etc.
- Tax incentives and subsidies for the construction of MSW treatment facilities.
- Educational campaigns to raise public awareness on the eco-friendly and sustainable ways of waste generation and disposal.

Lastly, both waste stream characteristics and public policies influence the feasibility of extracting value from the MSW. In fact, recycling rates vary greatly across countries, while

[1] Source: Handbook of Solid Waste Management.

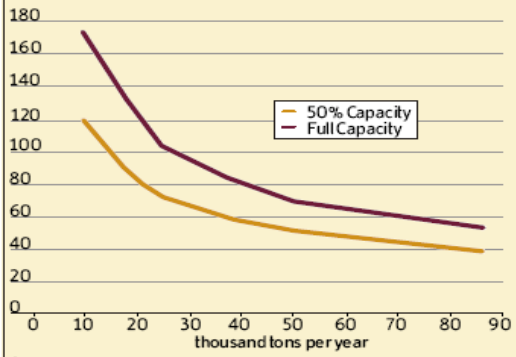
[2] Private sector can also play a role in boosting recycling rates. For example, RecycleBank, which operates in the U.S. and UK, rewards consumers with points (that can be later redeemed with participating retailers) for the volume of waste they recycle.

many governments are working hard to increase the share of waste that can be recycled or used for energy generation. This makes the policy to promote recycling an important component of the MSW management system. After all, these policies have a large impact on the capital and operation costs of the waste treatment plants – from transportation costs to energy tariffs. In particular, the capital and operation costs of the material recovery facilities (MRF) from MSW generally depend on the following processes:

- **Receiving and storing materials**, which may also include the costs of transporting waste from its source and the operation of the waster transfer stations;
- **Pre-sorting** - removal of contaminants early in the sorting process and specific recyclables that may hinder more elaborate sorting activities.
- **Managing flows** - maintaining a continuous and even flow of materials to achieve efficient recovery of recyclables
- **Processing recyclables**
  - Separating and sorting fiber streams (i.e. paper, card, cardboard);
  - Sorting glass;
  - Sorting metal;
  - Sorting plastic.
- **Bailing and shipping** of recovered materials;
- **Disposal of the residue waste** - landfill or incineration.

The specific design (and, hence, construction and operation costs) of the MRF depends on the characteristics of the waste streams, the choice of the sorting technology (manual vs. more technologically advanced) and market specifications on the quality and packaging of the recovered materials. In addition, there are economies of scale, as the cost of a typical MRF tends to fall with the volume of processed waste. This also means that higher costs are incurred if a MRF is not run at its full capacity (see chart 3).[3] Sorting of the single stream waste is usually more costly compared to the separate collection of recyclables.[4]

Chart 3. MRF economies of scale
MRF Gross Costs*



* British pounds per ton.
Source: UK Waste & Resources Action Programme, *A review of key studies relating to the specification, operation and costs of Materials Recovery Facilities*

Because costs of MSW management systems are affected by a wide range of factors, data on capital and operation costs of separation, recycling, and composting tend to show large variations and may be unreliable, especially in the case of developing countries. That said, available information allows for a comparison between various MSW management options (see chart 4).

[3] Source: A review of key studies relating to the specification, operation and costs of Materials Recovery Facilities. For example, this reports estimates that running MRF at 50% of its capacity may increase costs by as much as 50% per ton.

[4] Residential single stream programs, which allow customers to mix recyclable paper, plastic and glass in one bin, have a great potential to increase recycling rates through the use of various mechanized screens and optical sorting technologies. In addition, single stream recycling may save waste collection and transportation costs.

Chart 4. Capital and operation costs for waste treatment systems

System	Major system components	Capital cost basis	Capital cost, $ thousand	Operation cost, $/ton
Waste collection				
Commingled waste	Right-hand stand-up-drive collection vehicle	$/truck	100-140	60-80
	Mechanically loaded collection vehicle	$/truck	115-140	50-70
Source-separated waste	Right-hand stand-up-drive collection vehicle equipped with four separate compart.	$/truck	120-140	100-140
Materials recovery				
Low-mechanical intensity	Processing of source-separated materials only; enclosed building, per day concrete floors, 1st stage handpicking stations and conveyor belts, storage for separated and prepared materials for 1 month, support facilities for the workers	$/ton of capacity per day	10-20	20-40
High-mechanical intensity	Processing of commingled materials or MSW; same facilities as the low-end per day system plus mechanical bag breakers, magnets, shredders, screens, and storage for up to 3 months; also includes a 2d stage picking line	$/ton of capacity per day	20-40	30-60
Composting				
Low-end system	Source-separated yard waste feedstock only; cleared, level ground with equipment to turn windrows	$/ton of capacity per day	10-20	20-40
High-end system	Feedstock derived from processing of commingled wastes; enclosed building with concrete floors, MRF processing equipment, and in-vessel composting; enclosed building for curing of compost product	$/ton of capacity per day	25-50	30-50
Waste-to-energy				
Mass burn, field-erected, modular	Integrated system of a receiving pit, furnace, boiler, energy recovery unit, and air discharge cleanup	$/ton of capacity per day	80-120	40-80
RDF production	Production of fluff and densified refuse-derived fuel	$/ton of capacity per day	20-30	20-40
Landfilling				
Commingled waste	Disposal of commingled waste in a modern landfill with double liner and gas recovery system	$/ton of capacity per day	25-40	10-120
Monofill	Disposal of commingled waste in a modern landfill with double liner and gas recovery system, if required	$/ton of capacity per day	10-25	10-80

Low-end systems contain equipment to perform basic material separation and densification functions.
High-end systems contain equipment to perform multiple functions for material separation, preparation of feedstock, and densification.
RDF - refuse-derived fuel facilities. RDF can be used in a variety of ways to produce electricity.
A monofill is a landfill that contains only ash, no raw garbage
Source: Handbook of Solid Waste Management

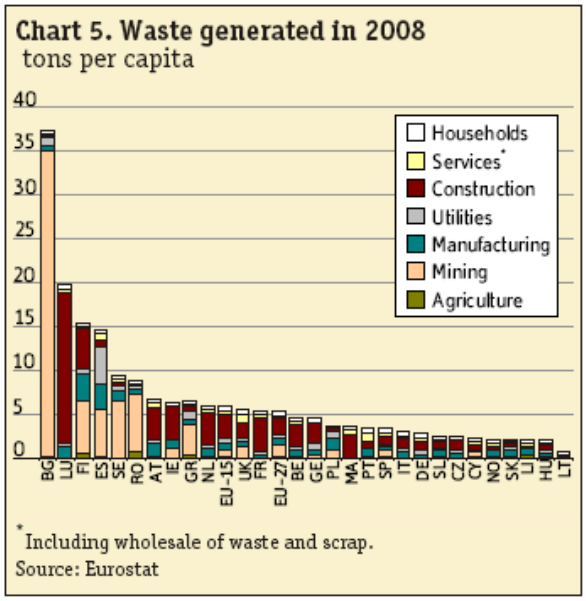
Operation and maintenance costs are affected by local labor rates, energy costs, safety rules, as well as the labor-intensity of the waste treatment technology. Presumably, lower labor costs in developing countries should allow for more labor-intensive technology which saves capital costs and may achieve better accuracy of material recovery.

To conclude, modern waste treatment industry is relatively capital-intensive and requires large investments. At the same time, because the industry provides public services, cost and revenues are more sensitive to various government policies and regulations. Indeed, market may fail to price waste services properly because of many externalities involved, for example, environmental cost and benefits. For this reason, governments introduce policies and regulations to correct market distortions. However, poor policies may lead to serious underinvestment into waste treatment infrastructure with dire environmental consequences. The following section reviews waste management practices in the advanced economies. It argues that good policy initiatives can reduce environmental costs of the MSW and encourage markets to treat waste in a sustainable and eco-friendly manner.

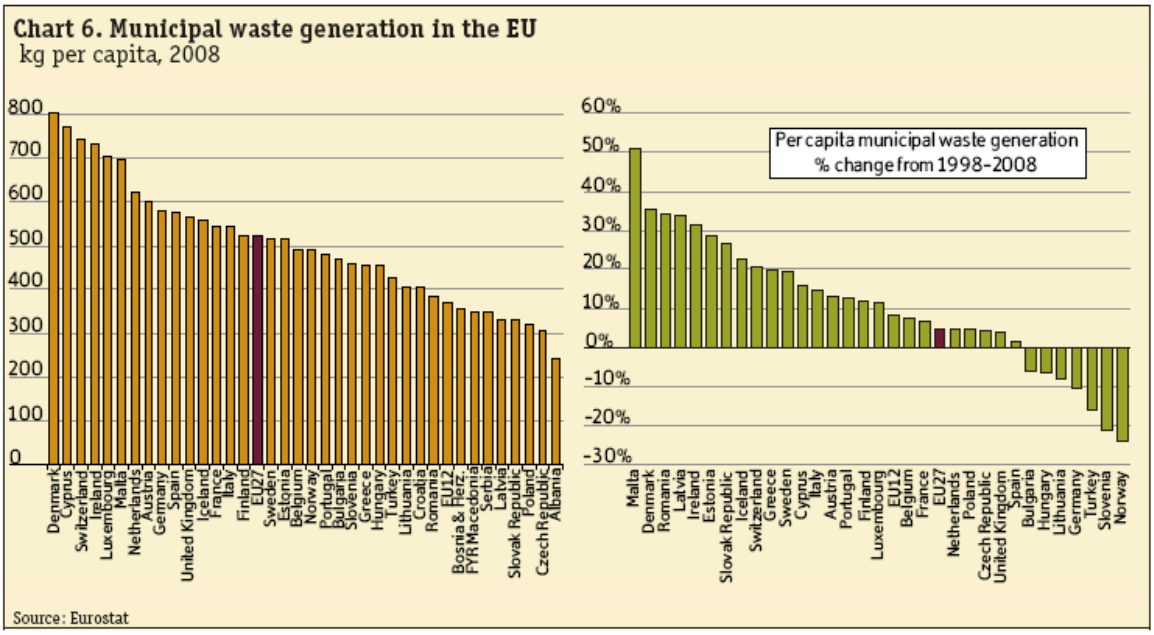
II. International Practices of Waste Management

The European Union

Waste generation in the EU reflects many country-specific factors, including the composition of economic activities, consumption patterns as well as policies adopted to facilitate waste prevention and recycling. For example, the EU economies with relatively large mining and/or construction sectors tend to generate above average waste per capita (see chart 5).



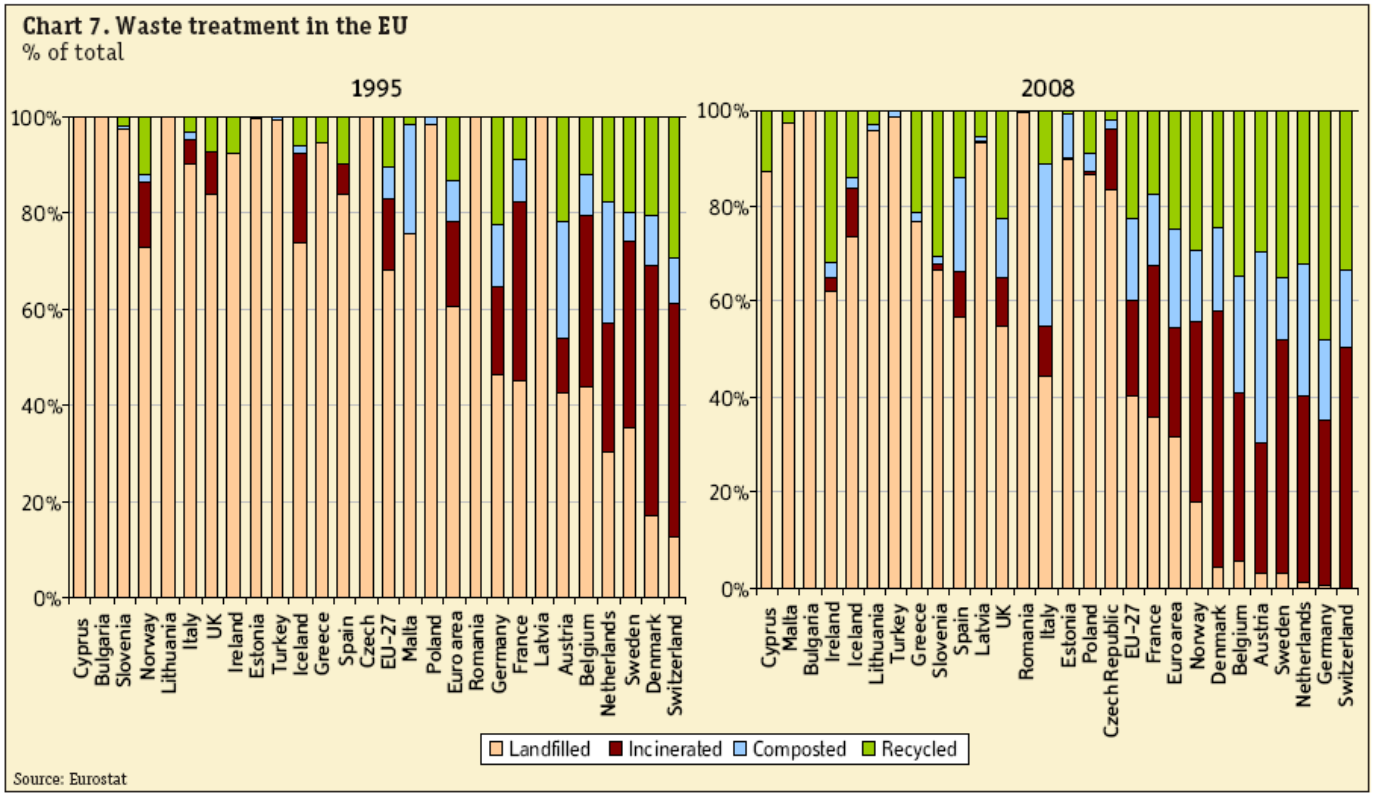
On average, in the EU27, municipal waste in 2008 was 524 kg per capita. The generation of municipal waste per capita ranges between 800 kg in Denmark to 300 kg in the Czech Republic (see chart 6). Evidently, the EU economies with higher GDP per capita tend to generate more waste compared to countries with lower incomes. In addition, consumers in poorer countries spend a higher fraction of their income on foods compared to richer economies. For example, an average household in Poland, Bulgaria and Romania devotes 24%, 30% and 42%, respectively, of its income on foods versus only 13% in the Euro area. [5] This means that waste streams in poorer countries are likely to have lower economic value in terms of the potential for the extraction of recyclables and energy.



[5] Source: Eurostat, Household Budget Surveys.

That said, as incomes increase both the composition and the volume of waste changes. Indeed, from 1995 to 2008, per capita MSW generation in the EU-27 increased by 5% as real GDP per capita grew by 30%. Meanwhile, waste generation in many European countries grew much faster. [6] In fact, new EU member states, which went through a period of rapid economic growth catching up with the rest of the EU, experienced relatively higher growth of the per capita municipal waste generation. True, many of these countries still have lower absolute levels of waste generation per capita. However, as they continue to grow faster than more advanced European economies they will produce more municipal waste, while the composition of this waste will change. For example, according to the latest Eurostat data, recyclables account for only 4.4% of all household waste in Poland[7] versus 25% in Germany.

This trend as well as increasing awareness of the general public of the environmental risks of waste led to better waste policies in the EU. Indeed, thanks to stricter regulation of the MSW treatment (and, in particular, the escalation in landfill gate fees), a smaller share of waste goes to landfills compared to 1995. For example, although Denmark has the highest level of the MSW generation in the EU, it landfills less than 5% of its MSW, while new EU member states (for example, Poland, Bulgaria, Baltic countries, Czech Republic and Slovenia) continue to landfill most of their MSW (see chart 7).



[6] For example, per capita MSW grew by 43% in Ireland (GDP per capita up by 80%), 35% in Denmark and 34% in Romania (GDP per capita up by 72%).

[7] This share, however, more than doubled from less than 2% in 2004 to 4.4% in 2008. During the same period, the gap between the real GDP per capita in Germany versus Poland narrowed from 4.67 to 4.07.

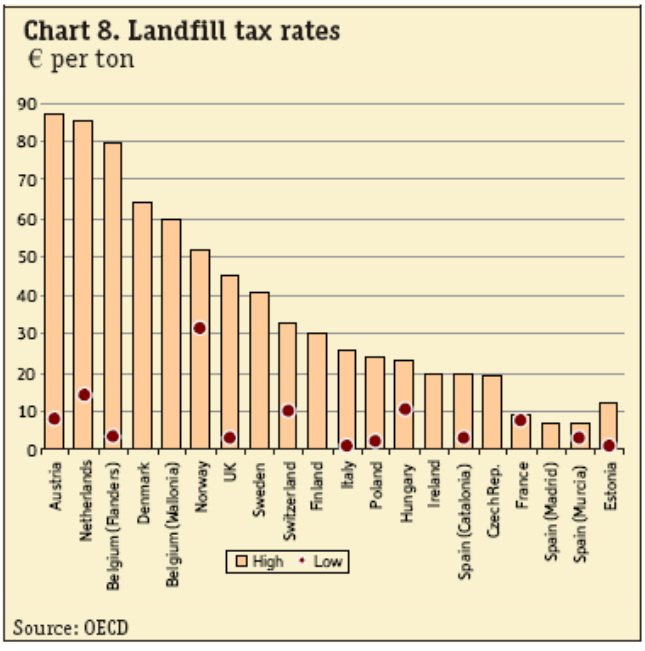
This striking divergence between waste treatment outcomes may be partially explained by stronger public pressure on governments in the richer EU states, where voters attach a high value to the quality of the environment. In addition, new member states were frequently granted with extended deadlines to adopt and enforce the EU rules on waste. As a result, their progress was rather modest because (1) reformers need time to gain public support and break cultural stereotypes on waste treatment and utilization, while (2) the government may have insufficient funds to finance large scale modern waste treatment facilities.

After all, the EU went through a lengthy process of shaping its current waste policies. Governments' attitude towards waste has been gradually strengthening since 1970's, with an increasing emphasis on the prevention and recycling of waste. In particular, the treatment of waste in the EU should comply with the following hierarchy, which places landfilling as the last resort option:

- prevention;
- preparing for reuse;
- recycling;
- other recovery, notably energy recovery;
- disposal.

The EU legislation on waste sets general technical standards for the operation of waste management facilities. All member states must comply with these rules:

- **The Landfill Directive** - set standards for the types of waste that can be disposed in landfills as well as permits' requirements for the operation of the landfills;
- **The Waste Incineration Directive** - sets limit values for incineration plant emissions to the air and requires minimization and recycling of the residues;
- **Specific Waste Streams Rule**s - set standards for the treatment of specific waste streams, such as batteries, packaging waste and electronic equipment. Fore example, the Directive on packaging and packaging waste set specific targets for the recovery of materials or incineration at waste incineration plants with energy recovery.
- **Producer Responsibility Rules** - measures to ensure that businesses take responsibility for their products once they have reached the end of their life.



That said, a significant variation of the waste treatment outcomes does point to the fact that individual member states

tend to apply waste policies in different ways.[8] For example, countries that charge higher landfill taxes are disposing a smaller share of waste to landfills (see chart 8). And charging a proper user fee appears to be the best way to create incentives for sustainable waste management systems. Indeed, an average household spends about €425 annually on waste collection in Netherlands compared to only €25 in Poland.[9] Meanwhile, Netherlands landfills just 0.5% of its MSW compared to over 86% in Poland.

Poland

As a member of the European Union, Poland has to comply with all EU regulations on waste. However, the progress with the adoption of new MSW management has been slow - the country still landfills over 85% of its MSW.[10] As a result, in mid-2010, the European Commission started charging Poland €40,000 per day for failing to reduce the amount of waste going to landfills by 25%. By 2013, Poland will be allowed to landfill only 50% of its waste, with the rest undergoing recycling or being incinerated.[11] From that year, fines for poor waste disposal may exceed €200,000 daily.[12] That said, many experts believe[13] that the country has to increase substantially the amount of waste going to incineration plant for energy recovery to meet its landfill targets.

With only one waste incineration plant in Warsaw, Poland is planning to build 12 new WTE facilities (which will cost about €1.5 billion and have a combined capacity to burn 2.4 million tons of waste annually or about one fourth of the total MSW) in big cities. Most of the funding for these projects is expected to come from the EU. However, the application process for the EU funds has been quite slow - many municipalities failed to submit necessary documentation on time and lacked environmental permits. At the end of December 2010, the Ministry for the Environment announced that the construction of only four incineration plants should start early in 2011. EU funding for the first four plants will reach almost €200 million with a total combined costs of the projects being €420 million.

That said, low public acceptance of the waste incineration in Poland remains a problem. And, as with other waste treatment options, public awareness of the benefits of environmentally-friendly waste treatment technologies is in short supply. Although, several initiatives to improve this awareness were successful[14], the government still devotes insufficient attention to public education campaigns on waste.

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[8] In fact, country-specific rules and regulations do create different waste management outcomes across the EU. In particular, not all EU countries met the requirements of the Packaging Waste Directive (see Appendix 2 for details).

[9] Source: Eurostat, Household Budget Surveys.

[10] Source: The Central Statistical Office of Poland

[11] Poland also has to close about 300 of its 800 landfills by the end of 2011.

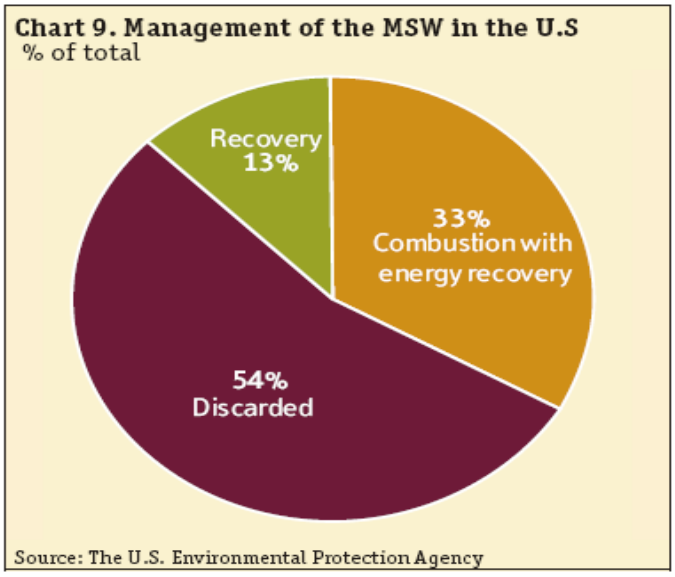
[12] That said, Poland still managed to meet the EU targets on recycling of packaging waste. This is partly attributed to the impact of the Poland's product charge - a fee on companies and packaging recycling operators for failing to comply with recycling targets.

[13] By the end of 2013 Poland should build at least 10 large WTE plants to reduce waste going to landfills. Source: WTE development in Poland. 5th CEWEP Congress on Waste-to-Energy 2010.

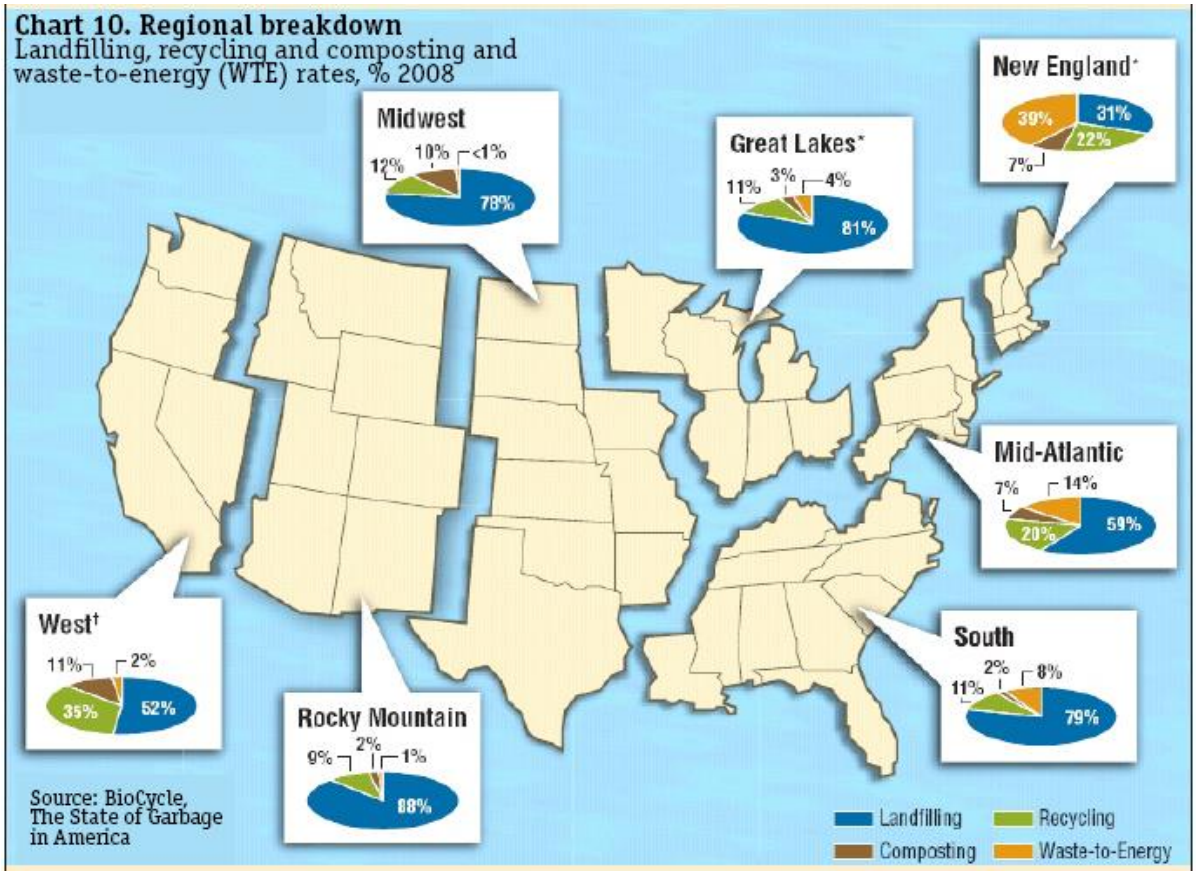
[14] For example, a public education program modeled on the U.K. Recycling Roadshow initiative helped raise recycling rates in some Polish municipalities. Source: Increasing participation in rational municipal waste management - a case study analysis of Jaslo City (Poland).

The United States

According to the U.S. Environmental Protection Agency, over 50% of all MSW in the U.S. still goes to landfills (see chart 9).



However, waste treatment differs substantially across states: the share of MSW going to landfills is high at 88% in the Rocky Mountain, 81% in the Great Lakes, 79% in the South and 78% in the Midwest; but it is only 31% in New England (see chart 10 below).



This situation does reflect local variations in waste policies. In 2008 an average landfill tip fee was $44 per ton and ranged from as high as $96 per ton in Vermont to as low as $22 per ton in Oklahoma. An average WTE tip fee stood at about $68 per ton with $98 per ton in Washington and $25 per ton in Alabama. And states have different requirements and targets

for waste recycling. For example, some states require businesses with liquor licenses to recycle glass.

To conclude, many waste related policies that had an influential impact on the way countries treat MSW appear to have been designed to address the problem of waste indirectly. They are more focused on the reduction of the quantity of waste disposed and seek to increase recycling and material recovery rates rather than trying to bring down the amount of waste at its point of generation (waste prevention policies). These policies significantly raised the costs of waste disposal making alternative waste treatment options, such as recycling and reuse, more economically viable. And this helped create a booming private sector led waste management industry.

IV. Potential for the Private Sector in Waste Management

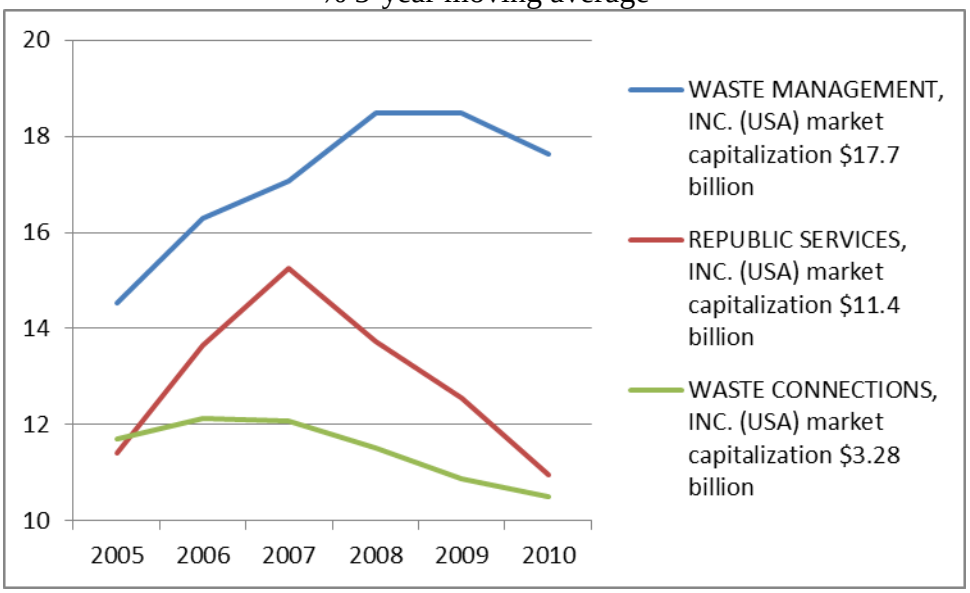
In advanced economies, the private sector is heavily engaged in solid waste management. In fact, the U.S. waste management industry includes nearly 20,000 companies with combined annual revenue of about $75 billion. [15] In the most advanced countries of Europe, solid waste management is also a booming business. The 3000 members of the European Federation representing the European waste management industry account for about two thirds of the European market and have an annual turnover of over €50 billion.[16]

A review of the profitability of private firms engaged in solid waste management reveals that this sector is indeed profitable. The table below gives profitability indicators for 2007 for the three largest US waste management firms, which account for about 48% of the US market for waste management: Waste Management Incorporated (WMI, 28% of the market), Allied Waste (13% of the market), and Republic Services (7% of the market) [17] . The weighted average return on equity for these companies was 18% in 2007.

Profitability Indicator	WMI	Allied	Republic
Gross Profit Margin	36.8%	37.6%	37.6%
Pre-Tax Profit Margin	13.1%	9.6%	15.6%
Net Profit Margin	8.8%	5.0%	9.8%
Return on Equity	20.8%	8.0%	23.4%
Return on Assets	5.9%	2.2%	7.0%
Return on Invested Capital	6.6%	2.5%	8.0%

Return on Equity of the Largest US Waste Management Companies

% 5-year moving average



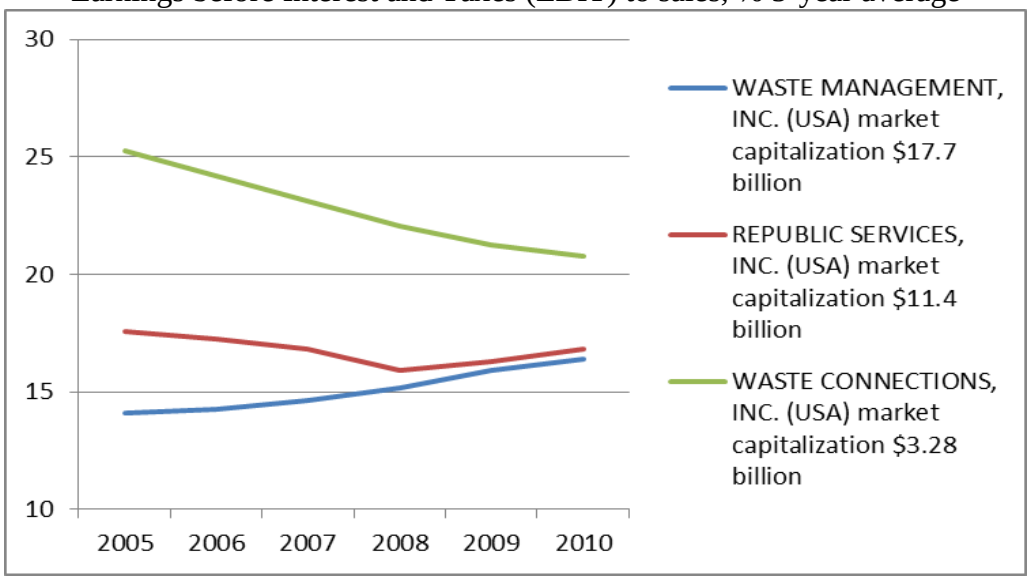
[15] For example, two waste management companies are on the Fortune 500 list. The 3000 members of the European Federation representing the European waste management industry account for about two thirds of the European market and have an annual turnover of over €50 billion (Source: http://www.fead.be).

[16] Source: http://www.fead.be.

[17] Source: Industry Analysis : Waste Management, University of North Alabama, MBA Program. 2008.

Operating Profit Margins of the Biggest US Waste Management Companies[18]

Earnings before Interest and Taxes (EBIT) to sales, % 5-year average

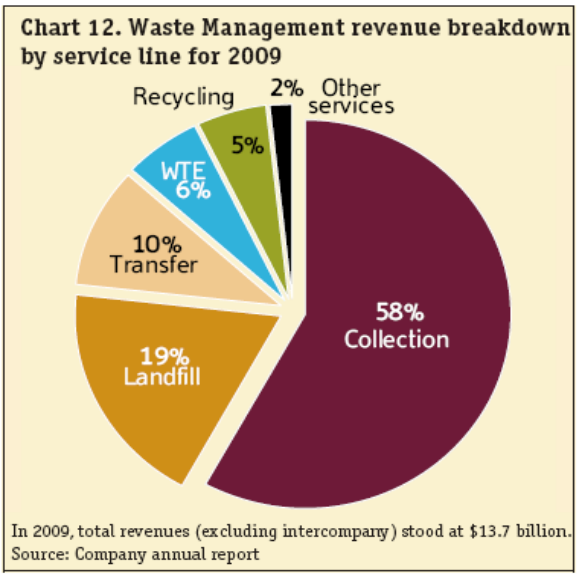


In order to further increase profitability, these firms are engaged in modernization projects to improve technology and reduce costs and energy consumption.

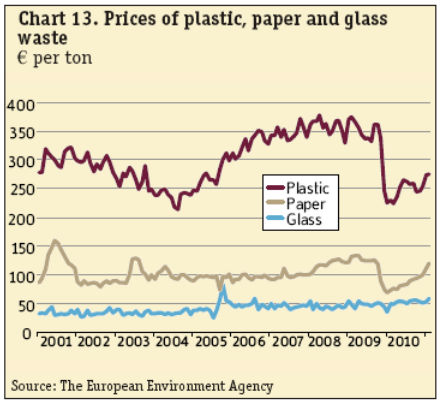
In the US most revenues for the waste management industry are generated from its front-end activities. In particular, waste collection still accounts for over a half of all revenues. Landfill disposal represents the second largest source of revenues. Recycling and other downstream activities still account for a small share of their business portfolios. As a result, the performance of the waste management companies tend to be only somewhat procyclical as waste volumes (both residential and commercial) do not fluctuate significantly during economic downturn. Although, prices of recycled materials do decline in recessions, waste management companies usually benefit from lower fuel and energy costs. In fact, in the US the waste management sector outperformed benchmark stock market indices (especially during the recent economic downturn, see chart 11). After all, its main line of business - waste collection and disposal, is relatively recession-proof. Furthermore, waste management companies in the developed economies usually have diversified sources of income, which makes them more resilient compared to other businesses. For example, Waste Management (the biggest U.S. waste company based in Houston) derives over 13% of its revenues form its WTE facilities, recycling and services (for example, waste management consulting services)

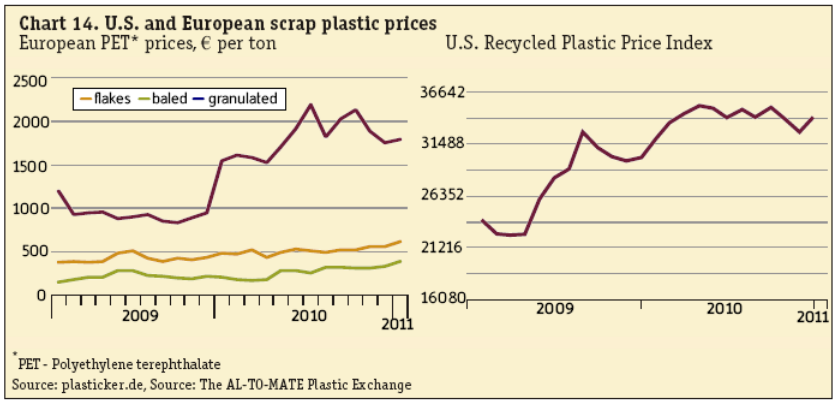
[18] At the end of 2010, the U.S. corporate profit margins (S&P 500 excluding financials) were at about 14%.

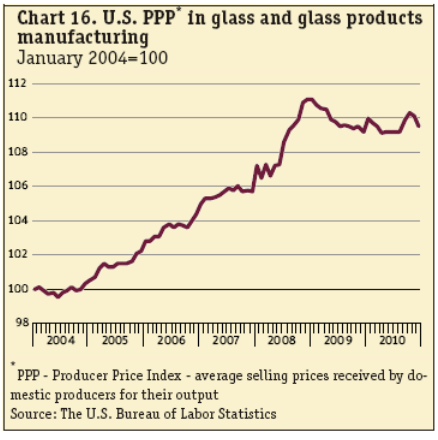
(see chart 12).

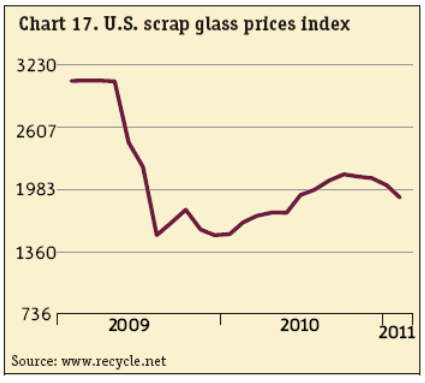


In the most advanced countries of the EU, such as Germany, a larger share of revenues is generated from the transformation of waste to energy (WTE), and the sale of compost and recycled materials. As such, these waste management companies enjoy the benefits associated with the production of energy and primary commodities. Although at the end of 2008, the prices of scrap commodities plummeted following a similar trend in prices of primary resources, such as metals and energy (see chart 13), prices started to recover in the second half in 2009 thanks to a rebound in the world prices for crude oil, steel prices and plastics. In particular, prices of scrap plastic have jumped back from the recession lows both in Europe and the U.S. on increasing crude oil prices (see chart 14). Scrap paper prices are growing as well (see chart 15). All this reflects higher demand for commodities on stronger global economic recovery. The situation with the scrap glass prices is somewhat different - prices of glass products remained relatively stable throughout the recession as a downturn in construction cooled demand (see chart 16). As a result, the scrap glass prices stood mostly flat (see chart 17).









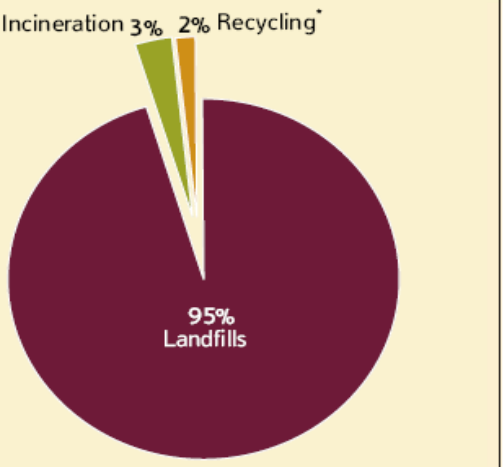
V. MSW Management in Ukraine

Waste statistics in Ukraine is scarce and unreliable. Still, based on various publicly available sources (including online publications), it can be inferred that MSW industry in Ukraine broadly reflects waste generation and treatment practices of the low-middle income countries:

- Over 95% of the municipal waste is landfilled;
- existing landfills are approaching their capacity (especially in big cities), while illegal landfilling is common;
- only a tiny fraction of materials is recovered; small scale manual waste sorting (scavenging) is a widespread practice;
- households' waste collection and disposal are subsidized;
- recyclable waste collection is mostly absent, while the share of organic waste is high;
- waste-to-energy facilities are practically nonexistent;
- corruption and vested interests are widespread in the waste management arrangements between local administrations and private contractors;
- enforcement of the environmental regulations and waste policies is weak.

More specifically, MSW generation in Ukraine is estimated at about 250-300 kg per person (with a higher level in big cities) or over 12 million tons a year. Kyiv, with 1.2-1.5 million tons of MSW per year, accounts for over a tenth of the total municipal waste generation. More than 95% of all MSW in Ukraine is disposed to landfills (see chart 18), while illegal dumping of waste is common due to weak control as well as insufficient service coverage in the rural areas. At present, Ukraine has about 50,000 landfills: 6% have already reached their capacity, while 22% fail to comply with sanitary rules. Waste collection services cover only 70% of the area of Ukraine with 30% coverage in rural areas. As a result, there are over 20,000 of illegal dumping sites in the country.[19]

Chart 18. Management of MSW in Ukraine
% of total



*Including MRFs and Recycling and Transfer Stations (RTS)[12]
Source: ecoclubua.com, Ministry for Regional Development, Building and Housing of Ukraine

The composition of MSW in Ukraine is mostly organic waste (35-50%). Other components include: paper (10-15%), plastics (9-13%), glass (8-10%), metals (2%), textiles (4-6%), wood (1%), construction waste (5%) and other waste (10%). In addition, due to the commingled waste collection, MSW tends to have high moisture content and is contaminated with organic matter which makes material recovery more difficult and costly. Still, a high share of recyclables in MSW means that the untapped potential for recycling remains substantial.

[19] Source: rbc.ua, Ministry for Regional Development, Building and Housing of Ukraine.

Ukraine has two soviet-era waste incineration facilities - in Kiev and Dnepropetrovsk. About 20% of all MSW in Kiev is incinerated; 30-50% is disposed at one major landfill (No. 5), while the rest is transported to other local landfills.[20] After all, low landfill tipping fees[21] make waste landfilling the least costly option. As a result, Ukrainian MSW management companies obtain virtually all of their revenues from the collection and transportation of waste from its source to landfills.

At present, Kiev is served by about a dozen of the waste management companies, with **Kievspectrans** and **Grinko-Kiev**[22] accounting for over a half of the market. **Seltik, Altfater-Kiev**, **Volodar ROZ**, **Kramar-Recycling**, **Evrospecservice** and **Evrotransgroup**[23] - are other major players in the waste transportation market.

- **Kievspectran service** - is majority owned by the Kiev City Council (51%). The company also operates landfill-No.5 and landfill-No. 6 in Kiev.

- **Grinko-Kiev** - is a unit of the Grinko company, which owns a waste sorting facility (Grinko-Center) in Kiev and provides waste transportation services in Donetsk, Dnepropetrovsk, Lvov, Zhitomir and other cities.

- **Seltik** - is a privately owned company accounting for about a fifth of the waste market in Kiev. In the summer of 2010 a controlling stake in the company (61%) was acquired by Remondis Ukraine - a subsidiary of the German group of waste management companies Remondis. Remondis Ukraine launched its operations in Zaporozhe in 2008, where it operates a waste sorting facility. The company is present in 7 Ukrainian cities - Kiev, Zaporozhe, Odessa, Cherkassy, Melitopol, Artemovsk and Pavlograd and manages about 750 thousand tons of waste a year.

- **Altfater-Ukraine** - is a subsidiary of the Veolia Environmental Services (VES) Ukraine, which belongs to VES group - the world's largest waste services company. Altfater-Ukraine manages over a half of all MSW in Chernovcy and Ternopol and nearly all MSW in Yalta. Its share of waste market in Kiev is about 15-20%.

The allocation of the waste management contracts is arranged through auctions by local municipalities. However, there is a need to improve transparency in these auctions. Also, bidders risk being rejected on procedural technicalities. The recently approved government procurement law may help in correcting these deficiencies.

Terminations and refusals to renew waste management contracts by municipal administrations also pose a significant business risk. In fact, conflicts between Ukrainian municipalities and waste management companies are quite common.

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[20] According to the Ministry for Ecology and natural Resources of Ukraine, there are over 30 landfills in Kiev oblast with a combined area of 325 hectares.

[21] In Kiev, landfill tipping fee is about $12 per ton and an incineration fee is $20 per ton. Source: Kiev City Council, A program on MSW management in Kiev in 2010-2015, July 2010.

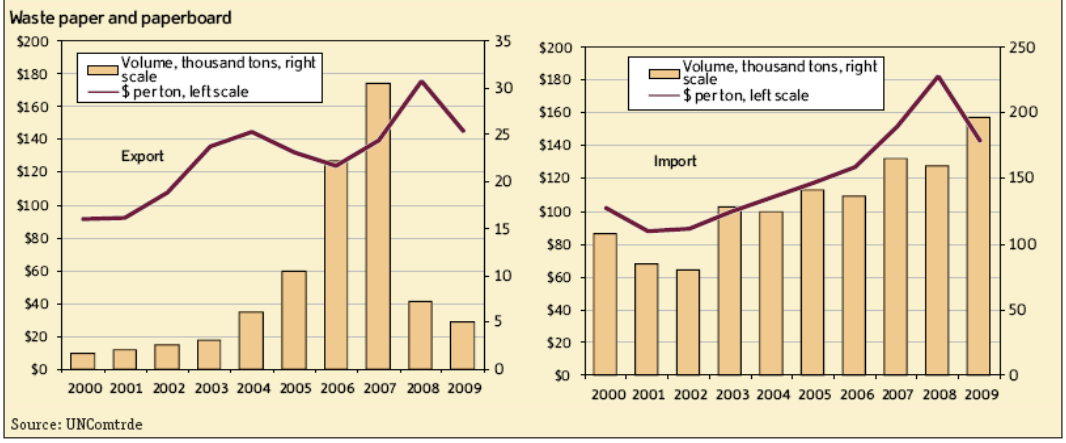
[22] ОАО «Киевспецтранс», ООО «Гринко-Киев».

[23] ООО «Селтик», ДП «Альтфатер Киев», ООО «Володар Роз», ООО «Крамар Рісайклінг», ООО «Євроспецсервіс», ООО «Евротрансгруп».

This means that potential political risks associated with the waste management business are still relatively high in Ukraine. This means that a new project on the Solid Waste Management must be backed by the full support and collaboration of the central government to ensure its success. Indeed, such support could be secured through the arrangements that the government intends to use for its National Priority Projects Program, of which solid waste management is one of the key initiatives. In particular, this Program implies that the central government will design, implement and enforce proper procedures and regulations on waste services that guarantee competitive and attractive returns to private investors.

Finally, because waste recycling rates are low in Ukraine, reliable data on this market is virtually absent. Still, it appears that the prices for products generated in the sector do follow world market trends. Most of waste paper (over 80%) comes from Russia and therefore paper output is priced at import prices. At the same time, Russia is the main export market for the Ukrainian scrap glass. Lastly, Germany (34%), Russia (33%) and China (14%) are the biggest exporters of the recycled plastic from Ukraine, while major importers of scrap plastic in Ukraine are Germany (30%), Russia (26%) and Poland (18%). In fact, both volumes of trade and value of recyclables in Ukraine have followed the trends in international trade (see chart 19).

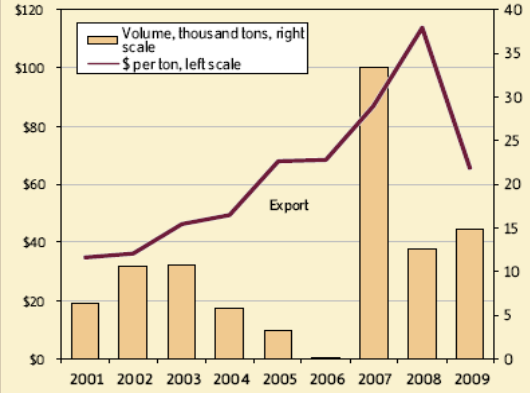
Chart 19. Imports and exports of recyclables in Ukraine

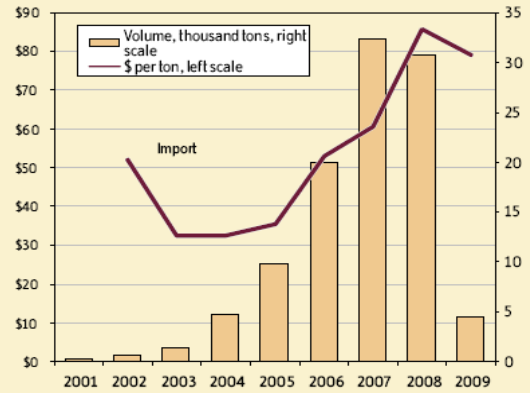


Source: UNComtrde

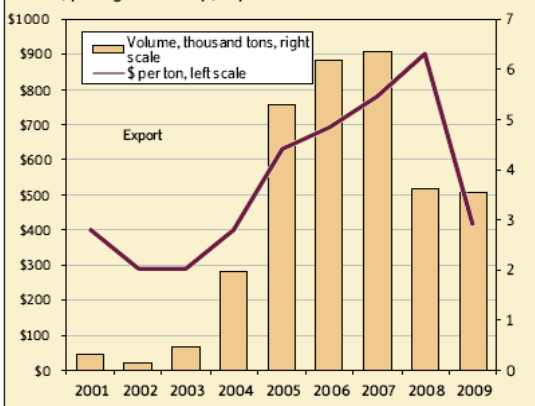
Chart 19. Imports and exports of recyclables in Ukraine

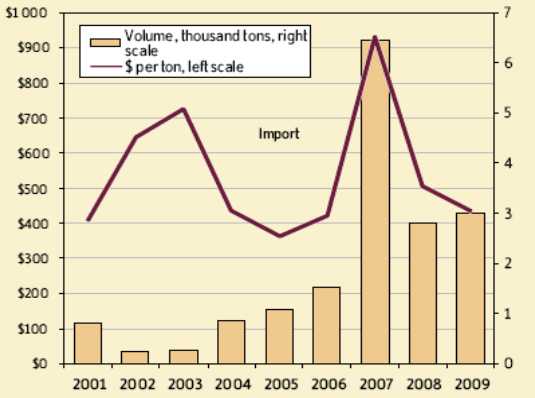
Glass cullet, waste or scrap





Waste, parings and scrap, of plastics





Source: UNComtrde

VI. Conclusions

- Increasing municipal solid waste generation in Ukraine is already placing a huge strain on the country's obsolete and congested waste treatment infrastructure. The need for major investments in this area is becoming critical. A failure to resolve this problem poses considerable environmental risks.

- Waste management is a complex system that requires not only large investments, but also good waste policies and a change of public attitudes to waste. Although many of these elements are lacking in Ukraine, under the new National Priority Projects Program, the government has stated its intention to make the changes necessary for successful investments in this sector. Above all, the government must establish a stable and predictable legal framework on waste that seeks to minimize political risks. Raising waste service user fees to acceptable levels would be a critical step to encourage rational waste treatment. Also stronger enforcement of waste regulations would discourage illegal waste dumping.

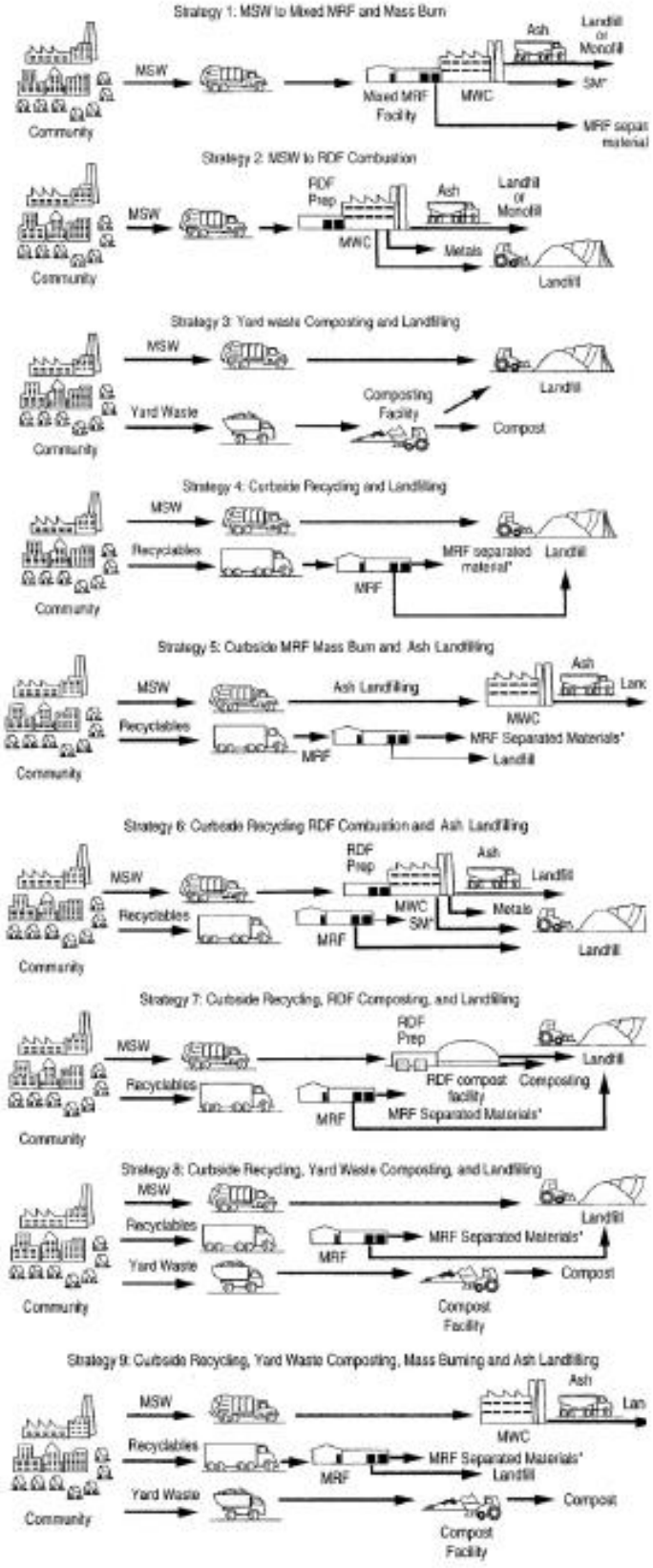
- The composition of MSW streams in Ukraine does allow for the profitable recovery of recyclable materials. This will require adjusting landfilling fees to reflect all environmental costs. This will discourage the dumping of untreated solid waste and would make recycling and waste separation more economically attractive.

- Increasing commodity prices are making material recovery through recycling more attractive. However, most local recycling initiatives are still small-scale and technologically unsophisticated. Larger and technologically oriented recycling projects are needed to make waste management sustainable both at the national and local levels. But changes in other government waste policies should be adjusted to promote more competition, eliminate corruption and foster downstream investments in the sector.

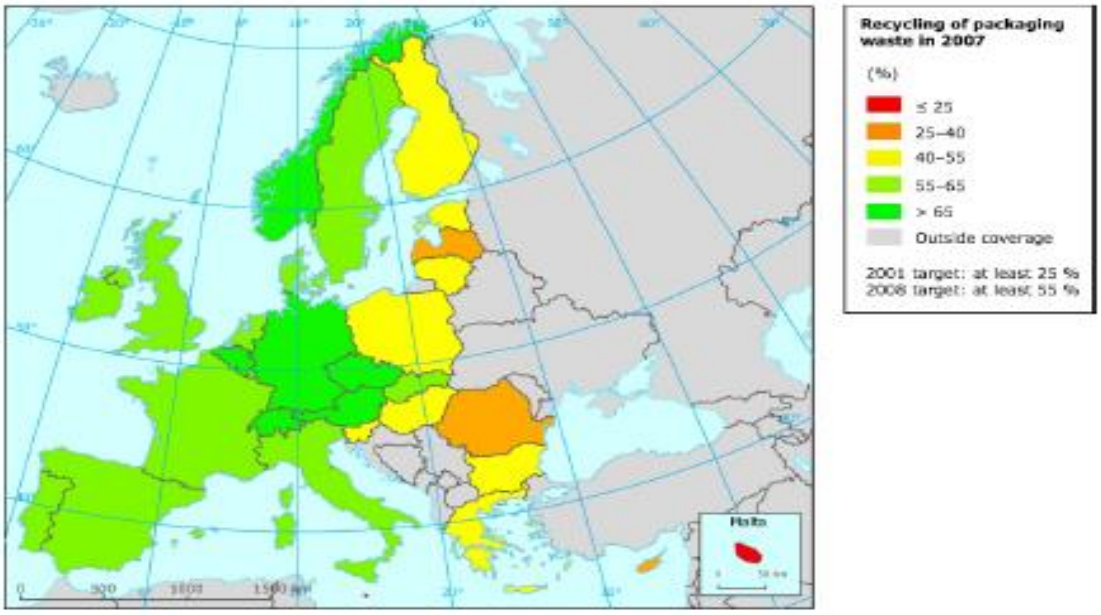
- Finally, policies and incentives to encourage the support of households in doing an initial sorting of solid waste are needed. Today, they are practically absent. Yet, international experience shows that such policies can drastically improve waste management. After all, waste treatment is a public good, which means that waste industry economics is strongly affected by social attitudes.

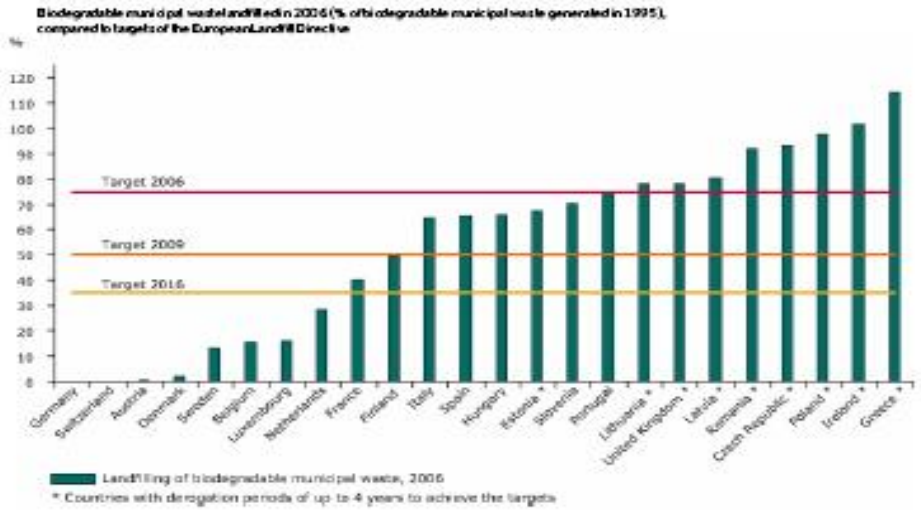
- **Appendix 1: Typical MSW management systems**

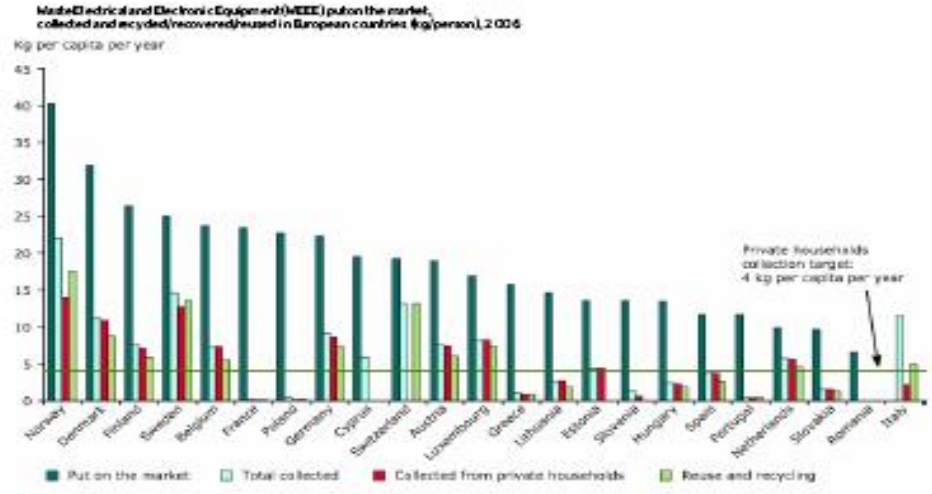
MSW - municipal solid waste
MRF - material recovery facility.
SM - separated material - recovered paper, glass, plastic and metals are channeled for further processing by industry.
MWC - municipal waste combustion
RDF - refuse-derived fuel facilities



Appendix 2: MSW Management Systems Outcomes in European Countries







Landfill taxes and bans in Europe

COUNTRY	Landfill tax/fees implemented in €/t	Landfill tax planned €/t	Landfill ban implemented	Landfill ban planned
Austria VAT 20%	Average net price for landfilling: € 60-130 Landfill tax: € 87 from 1.1.2006 depending on composition of waste and standard of the landfill	Adjustment of prices corresponding to consumer price index	From 1.1.2008 for wastes with TOC> 5% Exception for: - mechanical-biological treatment waste with a calorific value > 6600 kJ/kg dry substance - mechanically treated waste with a calorific value > 6600 kJ/kg dry substance and TOC > 8%	
Belgium, Flanders VAT 21%	2010 Private landfill: € 55.70 combustible waste (+ max 20% local taxes) € 29.71 non-combustible waste (+ max 20% local taxes) Public landfill: € 79.56 combustible waste € 42.44 non-combustible waste	Adjustment of prices to annual consumer price index	- unsorted wastes, sorted and non-sorted wastes for recovery, combustible residual fraction from sorting - several limit values e.g. TOC > 6%	
Belgium, Brussels VAT 21%	No landfill			
Belgium, Wallonia VAT 21%	2010 € 65 hazardous waste € 60 non-hazardous waste	Adjustment of prices to annual consumer price index	Since March 2004	
Czech Republic VAT 19%	For municipal waste average net fee for landfilling € 19			
Denmark VAT 25%	Average net price for landfilling: ~€ 44 (10-95) Landfill tax from 1.1.2010: € 63		On 1.1.1997, a ban on landfilling of waste suitable for incineration took effect.	
Finland VAT 22%	Average net price for landfilling MSW: € 69 (40 - 101) Landfill tax for landfills owned by municipalities: € 30 - no tax for fly ash from power plants, contaminated soil or waste materials used in the constructions of the landfill - private landfills are excepted from the tax		According to the Landfill Directive	Aim to introduce in 2011 a law (with transition period) to ban landfilling of biodegradable waste.
France VAT: 5.5% municipal waste / 19.6% non hazardous industrial waste	From 2009 landfill tax on "non-authorised" landfills € 50, on "authorised" landfills € 15 (€ 20 in 2010), and "authorised + ISO 14001" landfills € 13 and € 10 when the energy is recovered at a minimum of 75% level Taxes will be increased from 1st July 2007 and then increased automatically every 1st January to be in 2015: € 150 on "non-authorised" landfills, € 40 on "authorised" landfills and € 32 on "authorised + ISO 14001" and € 20 if energy is recovered *Exemption:* - inert waste and industrial waste to internal landfill - cement or linked asbestos in mono landfill.		Introduced 2002 (general rules: landfill limited to "residual" wastes, but large discussion about this definition)	No
Germany VAT 19%	Landfill ban for untreated MSW since 1.6.2005			
Hungary VAT 25%	Average net fee for landfilling € 25		From 1st July 2003 for tyre, from 1st July 2006 for rubber scrap	From 2015 for non pre-treated waste

TOC – total organic carbon

CV – calorific value

Landfill taxes and bans in Europe

COUNTRY	Landfill tax/fees implemented in €/t	Landfill tax planned €/t	Landfill ban implemented	Landfill ban planned
Ireland VAT 13.5%	Average net price for landfilling: € 60 Landfill tax in 2010: € 30 (target levels in 2011: € 50 and 2012: € 75) There is exemption for pre-treated waste but this area is still unclear e.g. it appears that the tax will apply to incineration ash. (NB: the overall waste facilities levies structure is under review) Current legislation states tax can only increase by € 5 per annum.	The overall waste facilities levies structure is under review and a higher landfill levy is expected.	None under national legislation. Some landfills ban certain waste streams. New pre-treatment guidance restricts the amount of Biodegradable Municipal Waste landfills can accept to align with the landfill directive limits. This condition is included in the landfill's operating licence.	No
Italy	Net price for landfilling: € 60 – 120 Landfill tax: € 1–10 inert waste € 5–10 other waste (MSW excluded) € 10–25 MSW, depending on Region		Yes (see Landfill Directive)	Combustible waste CV>13MJ/kg from 1st January 2011
Lithuania VAT 21%	Average Net fee for landfilling: € 14.5 Total price for landfilling MSW: 2010: € 17.5 2012: € 39.5	Year 2012: € 22		
Netherlands VAT 19%	Average net price for landfilling: €/tonne 20-30 Landfill tax in 2010: High tax € 107.49 per tonne combustible waste (<1 100 kg/m3) and mono streams Low tax € 16.79 per tonne non-combustible waste (>1 100 kg/m3)		For 35 categories of waste	No
Norway VAT 25%	Landfill tax: € 56/t waste > 10% TOC and € 34/t < 10% TOC Total price for landfilling MSW € 20-231		Landfill ban for all waste > 10% TOC introduced 01.07.09	
Portugal **VAT 5%**	Landfill tax: € 3.5 /t Average net fee for landfilling is different for every system (29 systems in Portugal mainland plus the systems in the autonomous regions of Madeira and Açores)	Taxes are updated every year	No	No
Spain **VAT 7%**	Average net fee for landfilling: Madrid: € 25.36 Catalonia: € 40		No	
Sweden **VAT 25%**	Average net fee for landfilling €/tonne: 50-75 Landfill tax €/tonne: 43 Total price for landfilling MSW €/tonne: 110-160		1.1.2002: Sorted combustible waste (all material continuing to burn when once ignited) 1.1.2005: Organic waste (all waste containing carbon in organic form, e.g. food waste and plastics)	
Switzerland VAT 7.6%	€ 9.65 residual landfill € 12.88 for bio-reactor landfill, e.g. slag € 32.19 for export to disused salt mines (e.g. untreated residues from flue-gas cleaning)	Differs from canton to canton	Since 2000, effective since 2002	
UK	Average gate fee for landfilling £22/tonne (€ 26.80) Landfill tax £48/tonne (€ 58.46)	Rising by £8 (€ 9.76) per annum until 2013/2014 when the standard rate will be £72 (€ 87.73) per tonne.	No	UK Government giving consideration to landfill bans on specific waste streams following a public consultation held in 2010.

TOC – total organic carbon

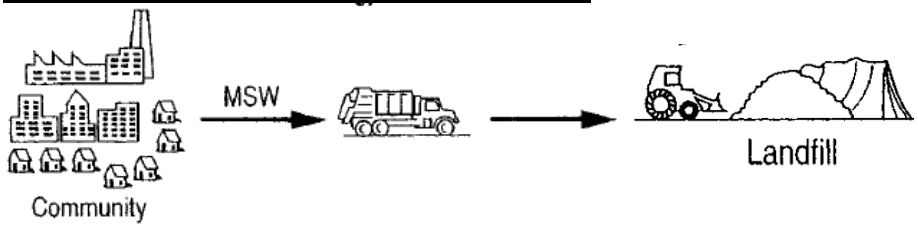
CV – calorific value

Source: Confederation of European Waste-to-Energy Plants

Appendix 3: **Municipal Waste Management: Calculations of Capital Costs and Profitability**

In terms of project size, our baseline scenario assumes that the project will controls 20% of the Kiev waste market, which is approximately 300,000 tons per year of solid waste (or 1 million cubic meters annually). The first project scheme involves just waste collection and landfilling. The second project scheme would involve further downstream processing to recover recyclables and generate electricity.

Scheme A. Waste Collection and Landfilling



In this project, garbage trucks and waste containers are the main capital equipment. Waste collection trucks are designed by installing special containers and lifting equipment on a base commercial truck platform. There are many models available with various capacity and lifting technology. Either foreign made (MAN, MERSEDEC, IVECO, ISUZU, etc) or Russian made (KAMAZ, ZIL, MAZ) platforms can be used. As a result, the final price depends on the truck capacity (which generally ranges from 8 cubic meters to 22 cubic meters) and the country of origin and may range from $80,000 to $120,000 per truck. We assume that the company chooses a truck with an average capacity of about 16 cubic meters and a price of $90,000 (see chart 1).

Chart 1. Rear loader garbage track
Base platform: MA3-533702

If a company has to collect and transport 20% of MSW in Kiev, the daily volume of waste will amount to about 2.8 thousand cubic meters. We assume that a roundtrip (from the source of the waste to the landfill and back) for a single truck is equal to about 80 kilometers, an average speed is 40 km/hour and the number of operating hours per day is equal to 10. As a result, a single truck can make about 5 trips per day to collect waste. This means that an approximate need for garbage trucks for a company collecting 20% of municipal waste in Kiev will be around 35 (see chart 2, bottom line).

Chart 2. Capital Cost for Waste Collection and Landfilling

daily amount of waste, cubic meters	truck capacity, cubic meters	length of a roundtrip, km	average speed, km/hour	operating hours per day	number daily trips per truck	number of trucks	price, $/truck	total capital costs, $
2 800	16	80	40	6	3.0	**58**	$ 90 000	**$ 5 250 000**
2 800	20	100	50	6	3	**47**	$ 110 000	**$ 5 133 333**
2 800	20	100	40	8	3.2	**44**	$ 110 000	**$ 4 812 500**
2 800	10	80	35	10	4.4	**64**	$ 75 000	**$ 4 800 000**
2 800	16	80	35	8	3.5	**50**	$ 90 000	**$ 4 500 000**
2 800	10	80	40	10	5.0	**56**	$ 75 000	**$ 4 200 000**
2 800	10	60	50	6	5	**56**	$ 75 000	**$ 4 200 000**
2 800	16	100	40	10	4.0	**44**	$ 90 000	**$ 3 937 500**
2 800	16	80	35	10	4.4	**40**	$ 90 000	**$ 3 600 000**
2 800	20	80	35	10	4.4	**32**	$ 110 000	**$ 3 520 000**
2 800	16	80	40	10	5.0	**35**	$ 90 000	**$ 3 150 000**

The second component of the waste collection system includes waste containers. In Ukraine there are two types of MSW containers (see chart 3) – regular (with a capacity of about 0.75 cubic meters and an average prices of $200) and Euro containers (with a capacity of 1.1 cubic meters and a price that may exceed $300). A company, collecting 2.8 thousand cubic meters of waste per day will need about 4,000 regular or 2,500 Euro containers. As a result, additional capital costs will range from $800,000 to $900,000.

Chart 3. Typical waste containers

Regular Euro

On this basis, the Capital Cost of the project would be $4,050,000. Working capital expenses (which are assumed at about 10% of the capital cost) will add another $405,000 to the initial investment requirement. As a result, initial investment will stay at about $4,455,000. Project revenues and costs are estimated as follows:

Assuming that the city pays a company an average waste management fee (including) of UAH 40 per cubic meter (or about $5)[24], total annual revenues will amount to $5,000,000 million. However, this fee assumes that a company spends about UAH 14 per cubic meter to landfill household waste. [25] As a result, projected revenues after landfilling cost will stay at $3,250,000. Operating costs are less certain to estimate. In our baseline scenario (chart 2, bottom line) the total mileage of all trucks per day will amount to about 14,000 km. With an average fuel economy at about 22 litters of diesel fuel per 100 km, the total daily consumption of fuel will equal to 3,080 litters. Assuming a diesel fuel price at $1 per litter, the annual costs of fuel will run at around $1.124 million. With an average monthly salary of UAH 4,000 and the number of employees at 45 an annul wage bill will be around $270,000. Rent, maintenance and other administrative costs may amount to another $250,000-$300,000 per year. As a result, a company's earnings before the deduction of interest, taxes, depreciation and amortization expenses (EBITDA) will stay at about $723,000 (see chart 4).

[24] The Kiev City Council sets waste service fees for each company individually. These fees range from UAH 38 to UAH 45 per cubic meter.

[25] In small Ukrainian cities a landfill tax may be as small as UAH 5 per cubic meter.

Chart 4. EBITDA of Waste Collection

Garbage trucks (35 trucks)	$3 150 000
Garbage bins	$900 000
Total capital cost	$4 050 000
Working capital (10% of capital cost)	$405 000
Initial investment	**$4 455 000**
Gross revenues (waste collection)	$5 000 000
of which VAT	$833 333
Revenues net of VAT	**$4 166 667**
Operation costs	
landfilling (UAH 14 per cubic meter)	$1 750 000
fuel	$1 124 000
labor	$270 000
rent, other	$300 000
Total	**$3 444 000**
EBITDA	**$722 667**

On the above basis, the ratio of Capital Invested to EBITDA would be 6.2x. The resulting EBITDA return on capital invested (before taxes) is about 16%. However, because in this scheme waste collection is a single source of revenue, returns are highly sensitive to changes in the fuel cost, landfill disposal fees and exchange rate fluctuations. In particular, landfilling is the largest component of operation costs. This means that an increase in landfilling fee (provided that it is not fully passed to households) will have a significant impact on returns on investments. For example, under our assumptions a 10% increase in landfilling fee (by UAH 1.4) will reduce the return on capital invested by 4 percentage points to 12%.

Scheme B. Solid Waste Management with Waste Processing.

A more sophisticated MSW management scheme will help diversify revenue streams through the extraction of recyclable materials and/or converting waste-to-energy (WTE). However, the capital costs of such schemes are much higher. If a company accounts for 20% of the municipal solid waste in Kiev it has to collect about 800 kg of waste per day.

Capital costs for waste sorting facilities vary greatly depending on its size and automation level. A single waste sorting line may cost from $500,000 to $1,500,000.[26]

[26] Source: http://www.p2sustainabilitylibrary.mil/p2_opportunity_handbook/7_III_11.html

Cost of buildings and land, assuming that a low level of automation is applied, will result in total capital cost of about $12,000,000.[27] We assume that daily operation costs will run at about $10 per ton. This puts total annual operation costs of the waste sorting facility at $2,500,000.
The table below provides our best guess on the potential to extract paper, glass and plastics from the annual amount of waste of 300,000 tons:

[27] We assume that capital costs of low automation level sorting facility amount to $15,000 per ton of daily capacity. Source: Handbook of Solid Waste Management.

	% of waste	thousand tons	% of waste	thousand tons	prices, $ per ton:
Paper	10%	30	20%	60	$80
Glass	8%	24	12%	36	$40
Plastics	3%	9	5%	15	$350
Residual waste		237		189	
Sale of recyclables		**$6 510 000**		**$11 490 000**	
Capital costs					
Waste collection		$4 455 000		$4 455 000	
Waste sorting		$12 000 000		$12 000 000	
Total, including working capital		**$16 455 000**		**$16 455 000**	
Revenues					
Waste collection fees		$5 000 000		$5 000 000	
Recyclables		$6 510 000		$11 490 000	
Total		$11 510 000		$16 490 000	
of which VAT		$1 918 333		$2 748 333	
Revenues net of VAT		**$9 591 667**		**$13 741 667**	
Operating costs					
Waste collection (excluding landfilling)		$1 694 000		$1 694 000	
Waste sorting facility		$2 500 000		$2 500 000	
Landfilling of residue waste		$1 382 500		$1 102 500	
Total		**$5 576 500**		**$5 296 500**	
EBITDA		**$4 015 167**		**$8 445 167**	
Return on capital invested		24.4%		51.3%	

As shown in the above table, the first scenario assumes that the share of recyclable materials in waste is 21% (10% of paper, 8% for glass and 3% for plastics), On this basis the capital invested to EBITDA ratio is 4.1x (or an EDITDA return on invested capital of 24.4%. If the share of recyclables were to be higher (20% for paper, 12% for glass and 5% for plastics) the EBITDA return on invested capital would increase to 51.3%.

Although our numbers are preliminary, they do show that the profitability of extracting recyclables from waste is likely to be much higher that a more simple operation of waste collection and landfilling. The analysis also shows that the profitability of extracting recyclable materials from waste will depend on the quality of waste sorting made by households and the public at the source which should increase the share of recyclable materials in waste. Otherwise, waste sorting facilities will continue to receive waste streams too contaminated to be processed for recyclable materials. For example, in the first scenario we assume that at least 21% of waste is recycled. If this recycling rate were to be lower at 10%, this will reduce the project's return on capital invested to about 9%.

Thus, the profitability of this project will depend significantly on the success of the policies that the government could implement to increase recycling rates. This means that the government needs to implement measures to boost recycling rates, including the requirement that the public carry out initial waste sorting at the origin. Both waste management companies and the government should also be engaged in public education campaign. If adequate sorting is made at the source, indications from other countries are that this sorting project could be financially viable.

Waste-to-energy (WTE) facilities do not appear to be financially viable in Ukraine, given plausible levels of utility tariffs. In theory, waste-to-energy (WTE) facilities should be an interesting option for Ukraine because they co-generate electricity and heating that can be supplied to households. Indeed, many EU's WTE plants produce electricity (about 500 KWh per ton of waste) and district heating (1000 KWh per ton of waste). For example, over a third of Denmark's district heating is provided by their 28 WTE plants. However, most recent estimates of the capital costs of WTE run at $600 to $750 per annual metric ton of capacity[28] . For the volume assumed in Ukraine, this would result in total capital cost of $180-$225 million. This makes electricity generation more than three times more costly compared to conventional coal-fired plants. As a result, the price of electricity generated by WTE plant will not be competitive in Ukraine, especially taken into account that household electricity consumption is still heavily subsidized. To be viable, utility tariff will need to be increased several fold. Equally important, a new WTE facility must be seamlessly integrated into the municipal infrastructure. And this requires large public investments, which may be beyond the fiscal capacity of many local governments in Ukraine. This component could only be justified on environmental grounds.

Policy recommendations to advance sustainable waste management in Ukraine:

- Adopt a formal national strategy on waste reduction and recycling;
- Raise utility tariffs to economically reasonable levels;
- Undertake a broad national education campaign on waste reduction and recycling;
- Increase landfilling rates and ban landfilling of recyclable waste;
- Set mandatory recycling targets;
- Develop a workable mechanism for public-private partnerships in waste management. For example, issue government guarantees for loans to finance waste management infrastructure.

[28] The Waste-to-Energy Research and Technology Council.