FROM WASTE TO RESOURCE

An abstract of "2006 World Waste Survey"

CYCLOPE

VEOLIA
ENVIRONMENTAL SERVICES

People will need to readopt this sense of rarity that has been lost or forgotten over the last two centuries. Humans will need to collect, sort, recover and recycle, going back to the old ideal of alchemists: complete the material cycle, turn waste into a resource, reduce all forms of predatory behavior as much as possible.

Turning waste into a resource

In the past, humans regarded their resources as rare, knowing that their demands outweighed supply. Everything available had to be used and almost nothing went to waste. Due to limited techniques, natural resources remained largely unexploited and all types of waste had to be recycled. This attitude still exists today in remote villages in developing countries where everything has a value, and use and people still control the cycle of materials.

The Industrial Revolution that started at the end of the 18th century embraced development, predatory behavior and the apparently unlimited use of renewable and non-renewable resources. Technical developments enabled humans to go further, quicker and deeper, adopting a philosophy of discover and exploit. Little by little, resources to be recovered and waste (increasing at a rate equal to that of urbanization) were seen as pollutants that had to be discreetly collected (the invention in Paris of the "prefet Poubelle" (waste management system implemented by senator Eugène Poubelle) in 1884), hidden or buried and above all, destroyed. Rag-and-bone men in the "recycling" business searching through bins with their hooks looking for garbage only truly exist in emerging countries today, having disappeared from most developed countries in the latter half of the 20th century.

Humans will need to collect, sort, recover and recycle, going back to the old ideal of alchemists: complete the material cycle

At the same time, the world started to become aware of its limits, in particular with the Club of Rome's publication of the famous "Limits to Growth" report in 1972. The first oil crisis happened around the same time as did the raw materials market crisis in 1974. At that time, the main concerns were mainly over pollution and the availability of natural resources. The Club of Rome insisted on the need to treat and recycle waste but its warning was quickly forgotten with the global economic collapse that marked the end of the 20th century. Twenty-five years later, a new shock made us sit up and take note. The sudden rise in oil and metal prices, agricultural conflicts, the economic boom throughout Asia and the continent's increased needs are taking us back to the long-forgotten paradigm of scarcity. While the world's population is set to double in the 21st century, fossil fuels are fast running out and the availability of cultivated area on the planet will decrease as urban areas expand. The management of urban waste sets an unprecedented challenge for our planet and people will need to readopt this sense of rarity that has been lost or forgotten over the last two centuries. Humans will need to collect, sort, recover and recycle, going back to the old ideal of alchemists: complete the material cycle, turn waste into a resource, reduce all forms of predatory behavior as much as possible.

Waste management has always been about proximity and the location of some landfills has even led to parochial quarrels between towns. The implementation of national policies specific to each country is a recent phenomenon. However, the problem of waste management has now been acknowledged as a global issue. In addition to what we hear in the media about the circulation of hazardous waste and movement of all "Clémenceau"-type cases around the planet, flows of scrap metals, recovered cellulosic fibers and recovered plastics between old developed countries exporting to emerging countries are ever-increasing. For many industries, the amount of raw materials recovered through recycling already exceeds that of "primary" materials (paper, certain non-ferrous metals, etc.).

It is therefore more important than ever to work towards establishing a global waste system covering its initial disposal to its end use. The task is particularly difficult as definitions are variable, statistics are few and incomplete and an international vision is virtually nonexistent.

What is waste?

This question forms the basis of all national and international regulations that govern waste markets (treatment methods, industrial facilities, exchange) and sums up all debate over waste, different opinions between countries, manufacturers, lawyers, economists, environmentalists and politicians, statistical problems encountered and difficulties in conducting comparative analyses of national markets.

It is not easy to define waste. How is it possible to make a link between an individual or a school, whose activity is simply life itself, and an industry that produces both desired and non-desired products?

Faced with this complexity, lawmakers have generally come up with a complex answer, combining an objective physical definition (a list of defined substances) with a subjective legal definition ("all substances that the holder (producer or owner) disposes of or is obliged to disposed of"). Most national legal definitions (e.g. in France, the UK or the USA) combine both these physical and legal aspects. There is no definitive list of what does and does not constitute waste. It is often left to the legal profession (refer to rulings of the European Court of Justice) to give a verdict on the qualification of waste. The notion of "refuse" can be problematic depending on the substances or materials in question, particularly in the case of materials reintroduced into the industrial cycle such as scrap metals, paper or recovered plastic bottles. If in some industrialized countries, particularly in Europe, plastic bottles still do not have a clear status, developing countries clearly view recovered scrap metals, paper and plastic bottles to be resources.

Economic theory defines waste as a negative externality. Consumer and industrial activities produce waste that has a negative effect on welfare (environmental pollution), that is not taken into account by competitive markets. Collective solutions (government intervention) is needed to correct this externality by internalizing post-consumption costs. The assessment of environmental pollution generally results from a political decision which determines the level of externality correction and focuses on the costs of site remediation. The fixing of taxes (action on prices) or the drawing up of emission standards (action of quantity) puts a value on waste and a price on externality.

The value of waste is therefore the cost that it represents in terms of the environment and its protection. We distinguish two "types" of waste according to the two economic routes they follow to correct their negative effects. All waste has an initial cost (of collection) then a negative or positive exchange value depending on whether the value of the products (energy or materials) after treatment covers associated site remediation and elimination costs or not, after the addition of any environmental taxes and/or deduction of any subsidies.

This distinction is dynamic. Market development trends show waste as having an increasing positive exchange value and becoming a resource and a secondary material. A growing quantity of "type 1" waste products are moving across to the "type 2" category (toward recovery of energy, a logic of selective collection or even the possible recovery in the future of landfill waste which is currently unused).

There is no definitive list of what does and does not constitute waste.

What is waste?

The ability of waste to be reused and to be reintroduced as part of a recovery process (where it acquires more and more value), and the risks it represents to the environment, help form a criteria that can be used to define waste. It is essentially the clear definition of boundaries between “waste” and “non-waste” that seems to be the deciding factor for economic waste market players. Current debate in Europe instigated by the draft of the new directive presented at the end of 2005 by the European Commission endeavors to provide answers and illustrates this sensitive and complex question of where waste begins and ends. The boundary beyond when waste stops being waste is located at the level of materials than can be recovered, recycled or reused, and therefore in the definition of the terms recovery, reuse, recycling. The difficulty lies in agreeing on clear and precise definitions. This debate is not clear-cut. Crossing the waste boundary is crucial and the stakes are high from an economic point of view, as it conditions the processes of recovery, markets, exchanges (distribution and traceability) and economic profitability.

The transfer from the status of waste to one of resource lies at the very heart of the complex world of the “waste cycle” and of our analysis. As flow and exchanges become more frequent, it is becoming increasingly necessary to reach, if possible, a clear consensus at international level on these waste types.

Where is waste?

Waste production is perhaps the most natural act of life by humans in rural or urban societies. The more sophisticated (and thus wealthy) a society is, the more waste it produces... (however, in practice this theory is not always true!) Waste has many origins. We currently distinguish (in a uniform or more random way depending on the country):

- Household waste, often linked to consumerism and mainly collected by local authorities. Although it is not always possible to make a distinction, household waste includes other urban wastes produced by economic activities (shops, restaurants, etc.) or by public or private establishments (schools, etc.), giving rise to the term "municipal waste".
- Industrial waste, often directly linked to production (and sometimes directly reinjected into the production process) or "end of life" of certain products.
- Two distinctive categories which are waste produced by the construction and demolition sector and mining activities on the one hand and agricultural waste on the other hand.
- Waste from each of the above categories that is considered to be "hazardous" by national and international authorities.

A number of attempts have been made internationally to classify and categorize waste (European Waste Catalogue, OECD lists, Basel Convention). Faced with completely different lists, lack of statistics and the complexity of the waste sector, any global report will include inaccuracies.

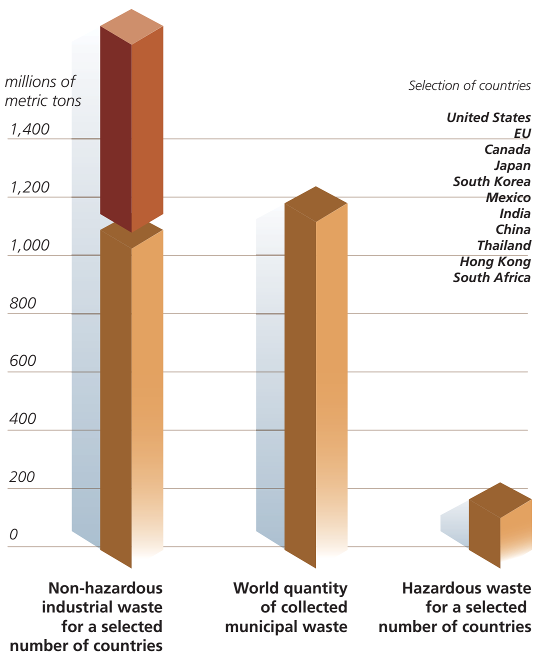
The very precise notion of waste "generation" is ambiguous and practically unmanageable. We therefore prefer to talk about the collection phase, i.e. the time when waste enters the economic stream. As far as it is possible to make a fairly reliable calculation of the volume of municipal waste, limiting ourselves to urban populations in emerging and developing countries, assessments of hazardous and non-hazardous industrial waste are random, even in developed countries. Given the heavy nature of construction and demolition, mining and agricultural waste, and its relatively high rate of reuse within the industries, which limit its exchange, it does not seem vital to include it as part of our international analysis.

Faced with completely different lists, lack of statistics and the complexity of the waste sector, any global report will include inaccuracies.

An assessment of world waste

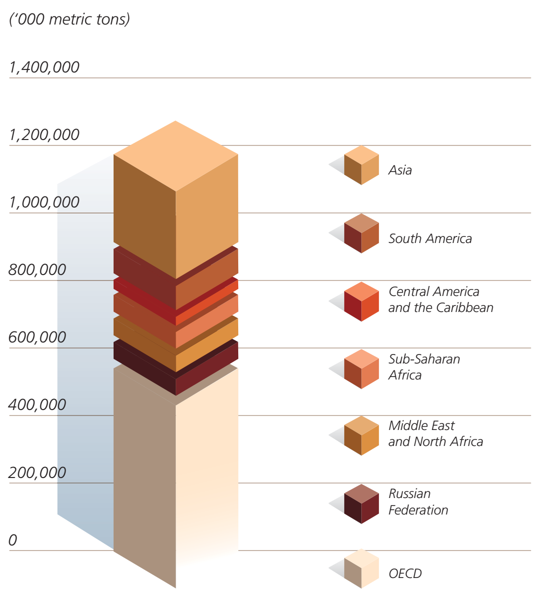
An initial estimate enables us to assess the world deposit of collected waste (not including construction and demolition, mining and agricultural waste) at between 2.5 and 4 billion metric tons. It is unfortunately not possible to arrive at a more accurate figure. This figure includes industrial waste for which estimates made by a number of emerging countries seem a little unrealistic even when issued by recognized national authorities or institutions. The main inaccuracy for industrial waste (hazardous and non-hazardous) is due to waste treated within the industries themselves that does not enter into the statistics of waste collected and does not therefore directly enter the economic stream. We were only able to collect data about this industrial waste for certain countries and it is not always possible to extrapolate data for this category of waste (in contrast to municipal waste) as it depends on the industrial organization of each country. Estimated quantities of hazardous and non-hazardous industrial waste do not therefore cover all geographical areas and are inaccurate due to the lack of reliable data.
The calculation of municipal waste seems more reliable and the figures are therefore more relevant.

Estimated quantity of waste collected worldwide: 2.5 to 4 billion metric tons



Sources: National Environmental Agencies, OECD, Eurostat, CyclOpe

Estimated municipal waste collected worldwide: total 1.2 billion metric tons



Sources: National Environmental Agencies, OECD, Eurostat, CyclOpe

1.2 billion metric tons of municipal waste collected worldwide

The total municipal waste collected worldwide in 2004 is estimated at 1.2 billion metric tons. This global figure is based on the gathering and processing of statistical data for most developed countries. For the rest of the world, the figure is based on samples of countries or urban areas and on extrapolated data based on indicators such as GDP per inhabitant, the rate of urbanization and the consumption ratio of paper and products made from paper per inhabitant.
To be precise, this figure only really covers OECD countries and urban areas in emerging and developing countries. It is impossible to assess the level of waste – which is not formally collected – in rural regions in countries such as India and China.

The collection of waste is globally linked to wealth (GDP per inhabitant) and to urbanization, although an in-depth analysis of certain OECD countries shows us that the GDP per inhabitant is not the most accurate of indicators in terms of the collection phase. An initial classification of all countries based on these indicators is used to distinguish three groups (countries with low, medium and high revenues) within which the ratios of municipal waste per inhabitant, the collection rate, the composition of waste, regulations and treatment methods are relatively similar for low and high-revenue countries and more varied for medium-revenue countries. A more accurate analysis of high-revenue countries will then refine this classification.
By converting our data into metric tons collected per year and per inhabitant, we arrive at more than 700kg in the United States and at less than 150kg in urban areas in certain countries such as India.

The collection of municipal waste worldwide: an attempted estimate for 2004 (in millions of metric tons)

OECD countries	620 (1)
CIS (Baltic states excluded)	65 (2)
Asia (except OECD)	300 (3)
Central America	30 (4)
South America	86 (5)
North Africa and Middle East	50 (6)
Sub-Saharan Africa	53 (7)
Total	1204

(1) Statistics gathered
(2) Extrapolation from data from 10 new EU member countries
(3) Statistics gathered and extrapolated for Vietnam, Indonesia, Bangladesh
(4) Extrapolation from Mexican data
(5) Extrapolation from Brazilian and Argentinean data
(6) Extrapolation from Egyptian data
(7) Extrapolation from Kenyan data

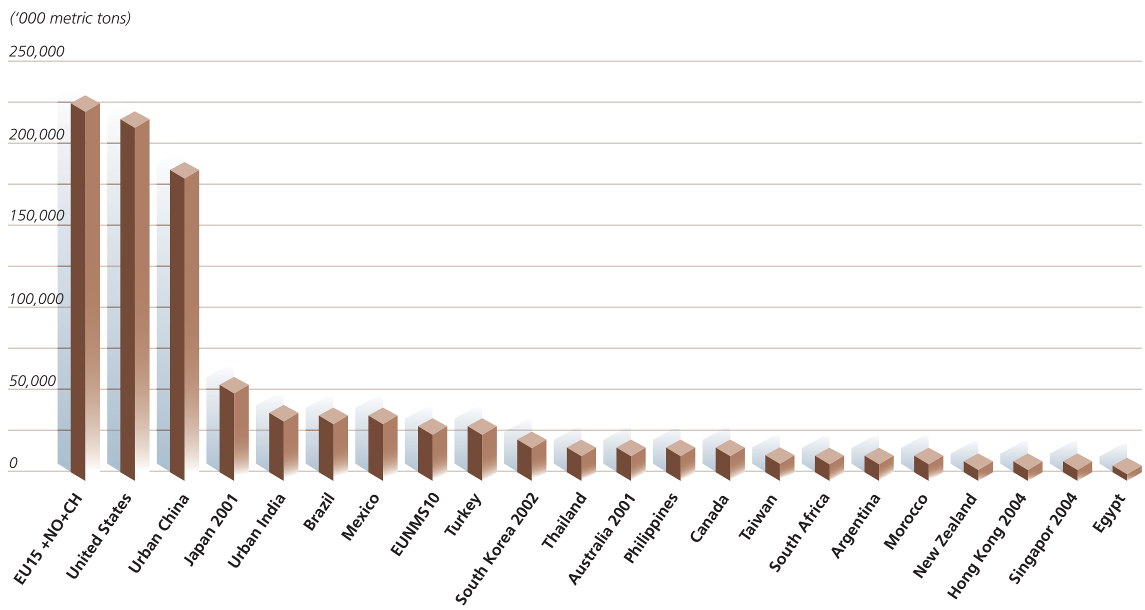
Extrapolations are calculated based on ratios concerning the GDP/inhabitant, the consumption of paper and paper-based products/inhabitant, the rate of urbanization and the total population. For emerging and developing countries, only the amount of urban waste was estimated.

Source: CyclOpe

Between these two extremes, we find contrasting situations in terms of both collection and the type of waste (the wealthier the population, the more sophisticated the waste and the more packaging there is, i.e. contains less food waste and more paper, plastic, glass, metals and toxic products) and obviously in treatment methods and recovery.

In absolute value, the main producers of municipal waste are Europe and the United States. Each “collected” more than 200 million metric tons of this waste in 2004. It is interesting to note that in just a few years, China has adopted an almost Western approach in its urban areas. Out of all Western countries, the United States collects the most waste per capita. However, it appears that municipal solid waste in the US includes a large amount of commercial waste that is normally accounted for as being industrial wastes in Europe, but it is extremely difficult to determine this ratio.

Municipal waste collected by a selected number of countries (total 932 billion metric tons)



Sources: National Environmental Agencies, OECD, Eurostat, CyclOpe

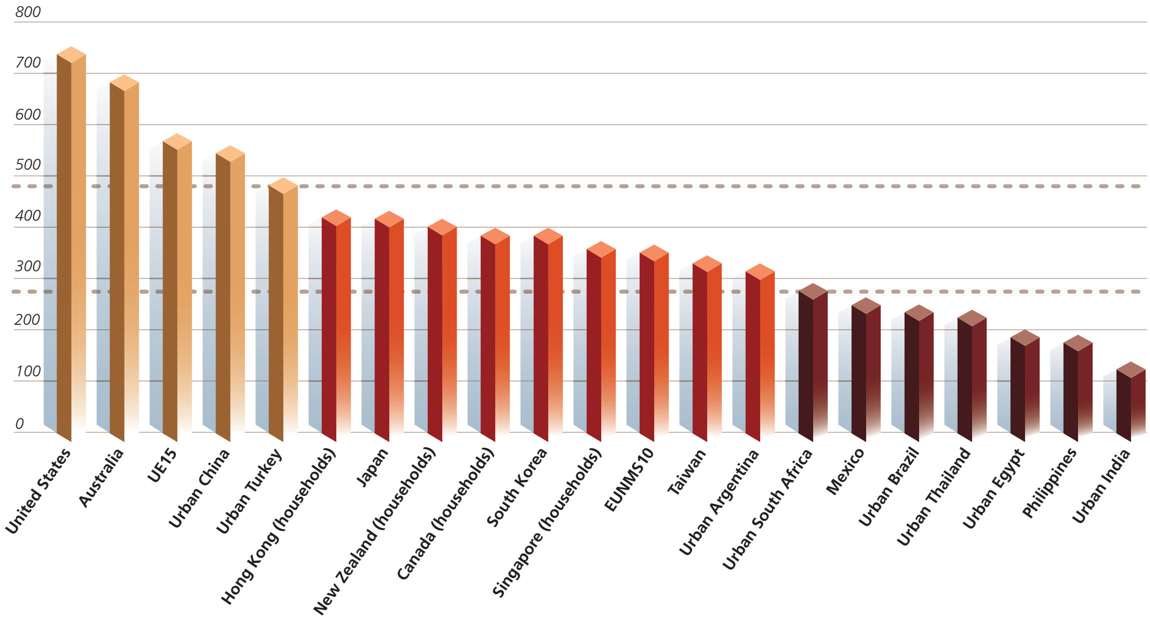
Typologies of municipal waste collection and treatment by country income

	Low-income countries (India – Egypt – African countries)	Medium-income countries (Argentina - Taiwan - Singapore - Thailand - EUNMS10)	High-income countries (USA - EU15 - Hong Kong)
GDP $/capita/year	< $5,000	$5,000 - $15,000	> $20,000
Average consumption of paper/cardboard per inhabitant kg/capita/year	20	20 - 70	130 - 300
Municipal waste kg/capita/year	150 - 250	250 - 550	350 - 750
Collection rate	< 70%	70 % - 95 %	> 95%
Waste regulations	No National Environmental strategy; Regulations practically nonexistent; No statistics	National Environmental Strategy; National Environmental Agency; Environmental legislation; Few statistics	National Environmental Strategy; National Environmental Agency; Strict and complex regulations; Statistics
Composition of municipal waste %			
Food/Putrescible waste	50 - 80	20 - 65	20 - 40
Paper and 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%
Heating value kcal/kg	800 - 1,100	1,100 - 1,300	1,500 - 2,700
Waste treatment	Unauthorized deposits > 50%; Informal recycling 5% - 15%	Landfills > 90%; Start of selective collection; Organized recycling 5%	Selective collection; Incineration; Recycling > 20%

After the United States come Australia and western Europe (600 to 700kg/capita), then other industrialized countries (Japan, South Korea, Eastern Europe) producing between 300 and 400kg/capita. The figures we have for emerging countries are higher in their urban areas as shown in the examples of China and Turkey (around 500kg/capita). However, we should note that the figures recorded in Latin American cities (in Argentina and Brazil) are much lower at around 200 to 300kg/capita. Collection is obviously much lower in poorer regions. The figures we have for these regions are very incomplete, ranging from 220kg/capita in Nairobi, Kenya to 120kg/capita in Mumbai in India.

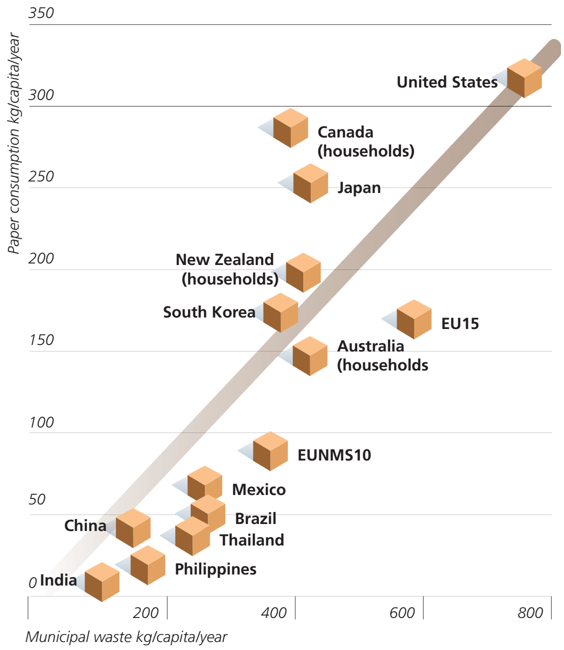
There is a relatively good correlation between the amount of municipal waste collected by countries and a country's wealth. We can also link the volume of waste with the consumption of paper and paper-based products per inhabitant (constituting a large proportion of municipal waste, second to organic waste). The higher a country's GDP, the higher the country's consumption of paper per inhabitant and the higher the quantity of waste produced. However, in some wealthy countries, notably in Europe, when decoupling the consumption of paper from GDP, we observe the start of a decoupling between growth in GDP and the volume of waste collected.

Municipal waste per capita in countries with high, medium and low incomes (kg/inhabitant/year)



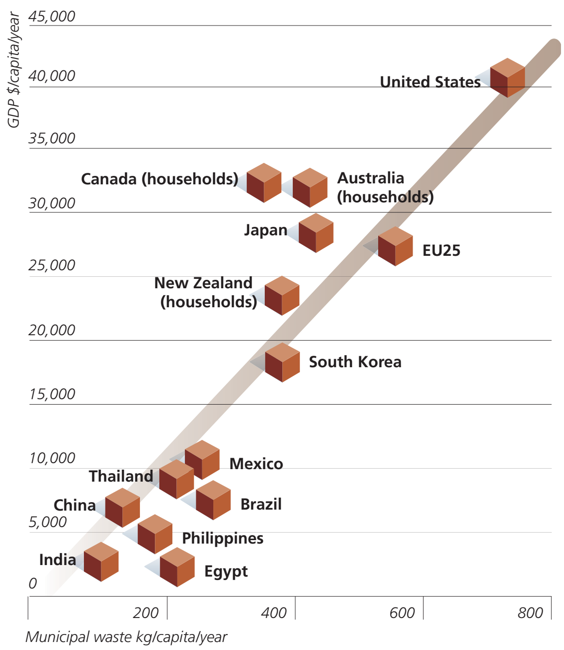
Sources: National Environmental Agencies, OECD, Eurostat, CyclOpe

Municipal waste collected and paper consumption (kg/capita/year)



Sources: National Environmental Agencies, OECD, FAO, CyclOpe

Municipal waste collected and GDP



Sources: National Environmental Agencies, OECD, FAO, CyclOpe

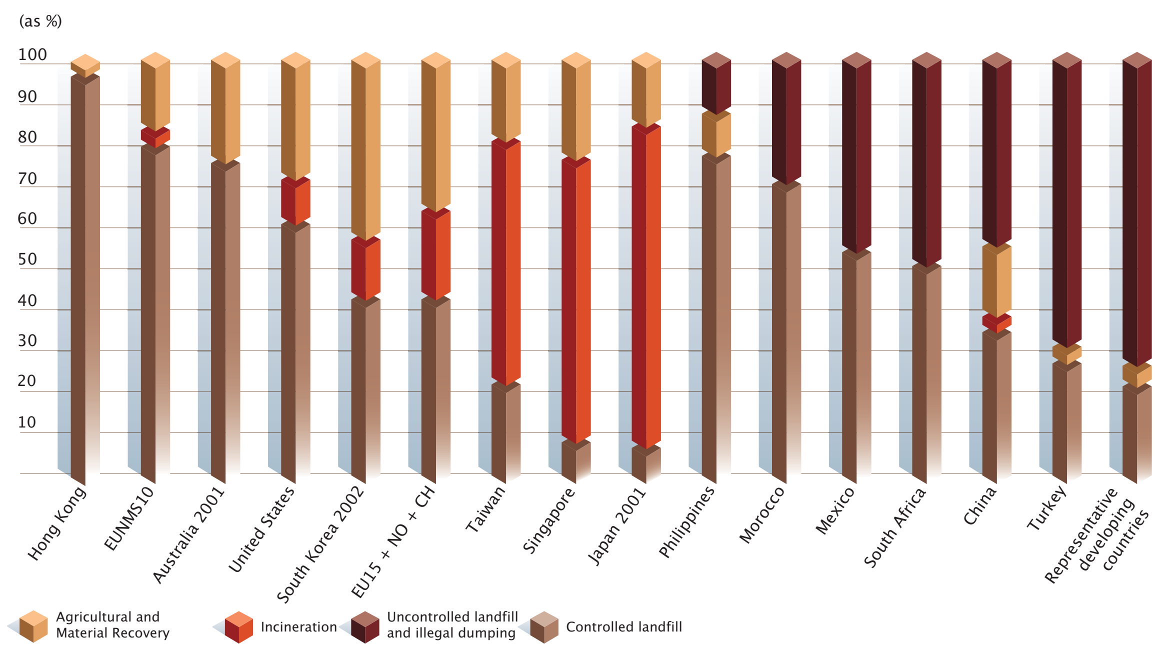
Diverse “waste philosophies”

The attitude to waste and waste treatment varies significantly between countries and depends on their history, their culture and their geography. We can talk about a waste “philosophy” that changes over space and time.

There are four types of waste treatment methods of which the direct cost is on the whole increasing:
- uncontrolled illegal deposits,
- disposal into controlled landfills, from simple open air dumps to “ecological” waste landfill centers using cutting-edge techniques with the recovery of biogases and production of energy,
- incineration with and without energy recovery,
- material recycling: composting (the cost of composting is often lower than the cost of incineration), reuse or recovery.

Several factors have an impact on the waste markets and influence their development in terms of structure and dynamics. These are:
- economic factors: economic growth, rising income of the population and quality of life, industrial structure, secondary material markets,
- social factors: growth and structure of populations and households,
- cultural and historic factors: methods of consumption, environmental awareness, behavior toward others,
- geographical factors: size of country and availability of land, geology, landscape, population density, urbanization,
- regulatory, legislative and political factors: fiscal and regulatory framework, etc.
The various factors listed above influencing the structure and dynamic of waste markets each

Municipal waste treatment breakdown in a selected number of countries (as %)



Sources: National Environmental Agencies, OECD, Eurostat, CyclOpe

The attitude to waste and waste treatment varies significantly between countries and depends on their history, their culture and their geography.

have a varying amount of influence depending on the country and will differ in combination from one country to another. Each country has therefore developed its own waste "history" or "philosophy".

Geographical factors (size of country, low population density) undoubtedly influenced the choice of landfilling in the United States or in Australia. In other countries, as in Europe, cultural factors (environmental awareness) and economic factors (quality of life) strongly influenced preferences for recycling and incineration. In Denmark or the Netherlands, Japan or some Asian megacities, geographical factors (population density, urbanization) and economic factors influenced the choice of incineration as the preferred treatment method. Through history, it is often economic (treatment costs), social and cultural factors that determined the most popular choice of landfill (new EU member countries, the Philippines). Landfill is currently the most widespread treatment method worldwide. In developing countries, illegal dumping and informal recycling sector (primarily based on the work of the poorest urban populations) still remain the most popular methods of waste disposal today.

A classification of countries by treatment method confirms a relatively complex reality:
- countries in which the landfill rate exceeds 40%: Hong Kong, new EU member countries, Australia, USA, South Korea,
- countries in which the incineration rate is greater than or equal to 20%: EU15, Taiwan, Singapore, Japan,
- countries in which the rate of illegal dumping exceeds 30%: Morocco, Mexico, Turkey, African countries.

Of course these waste philosophies and the market structures that they involve are not set in stone and change in line with developing factors, in particular economic factors (country growth rate, level of household consumer expenditure, secondary material market dynamics), social and cultural factors (environmental awareness) and regulatory factors. These changes are highlighted in EU countries and some OECD countries through the use of demographic and economic indicators such as population, GDP per capita and household consumer expenditure.

A high economic value: a municipal waste market estimated at approximately $120 billion in OECD countries

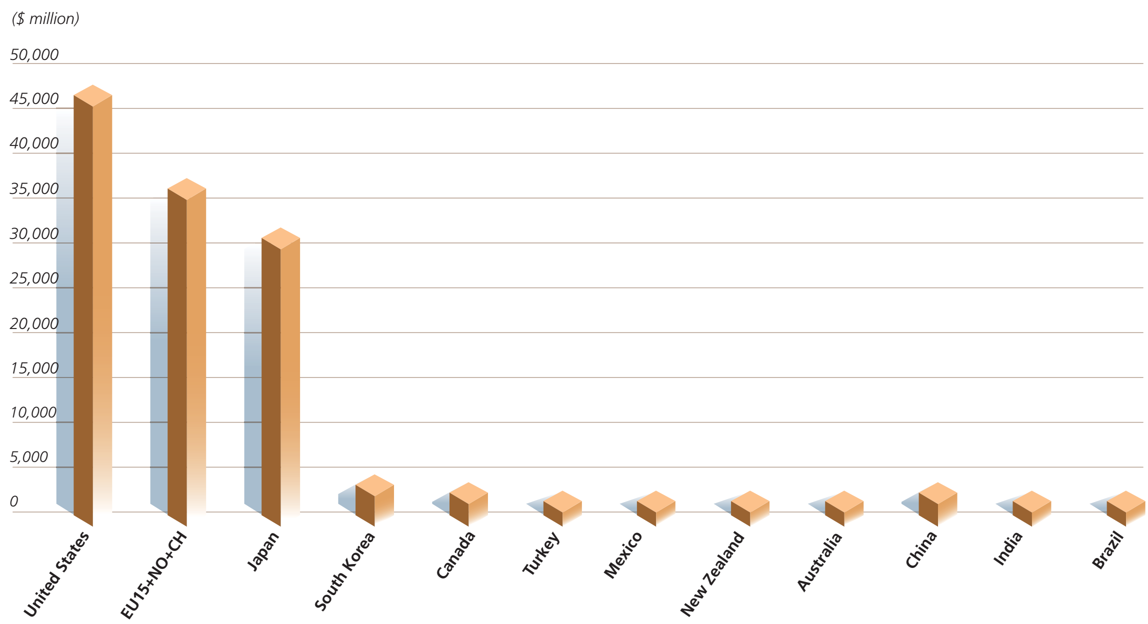
We have estimated the municipal waste market value in OECD countries (excluding new EU member countries) at $120 billion and $125 billion with some emerging countries (China, India, Brazil). This market estimate takes into account the following market segments: collection, landfill, incineration, composting and recycling, in addition to other treatment methods.

The markets with the highest value are the United States (approximately $46.5 billion), Europe (EU15, Norway and Switzerland: approximately $36 billion, another estimate for the EU25 suggests $43 billion) and Japan (approximately $30.5 billion).

Industrial waste is difficult to assess

We can only estimate industrial waste for certain countries for which we were able to obtain data (unfortunately not always very up-to-date or reliable). We obtained data for the EU, the USA, Canada, Japan, South Korea, Australia, Mexico, Brazil, Thailand, Taiwan and China. The most obvious absentee is the Russian Federation for which we do not have any recent or reliable data. This clearly leaves a large gap when estimating world industrial waste.
China is also an issue and estimates can double depending on sources. In 2002, the OECD estimated industrial waste in China at approximately 315 million metric tons, while a recent estimate issued by the Chinese authorities and relayed by market professionals estimated this waste at 1 billion metric tons, but we are unable to determine the exact content of this data (e.g. inclusion of construction and demolition waste).
Lastly, apart from certain specific waste flows such as plastic waste, used tires, construction and demolition waste or toxic waste, there is no clear quantification of industrial waste in the United States. Some of this waste is included as municipal waste and we can only make a default estimation, i.e. waste that is neither toxic nor municipal waste. Estimates for industrial waste in the USA range from 125 million metric tons to 275 million metric tons. We use the figure of 275 million metric tons which seems to be the most realistic figure in terms of industrial reality.
This explains the range in the non-hazardous industrial waste estimate from nearly 1.1 billion metric tons to 1.8 billion metric tons and this estimate must be interpreted with caution.

Estimate of the value of the municipal waste market in OECD countries and in some emerging countries (China, India, Brazil and Mexico): total $125 billion



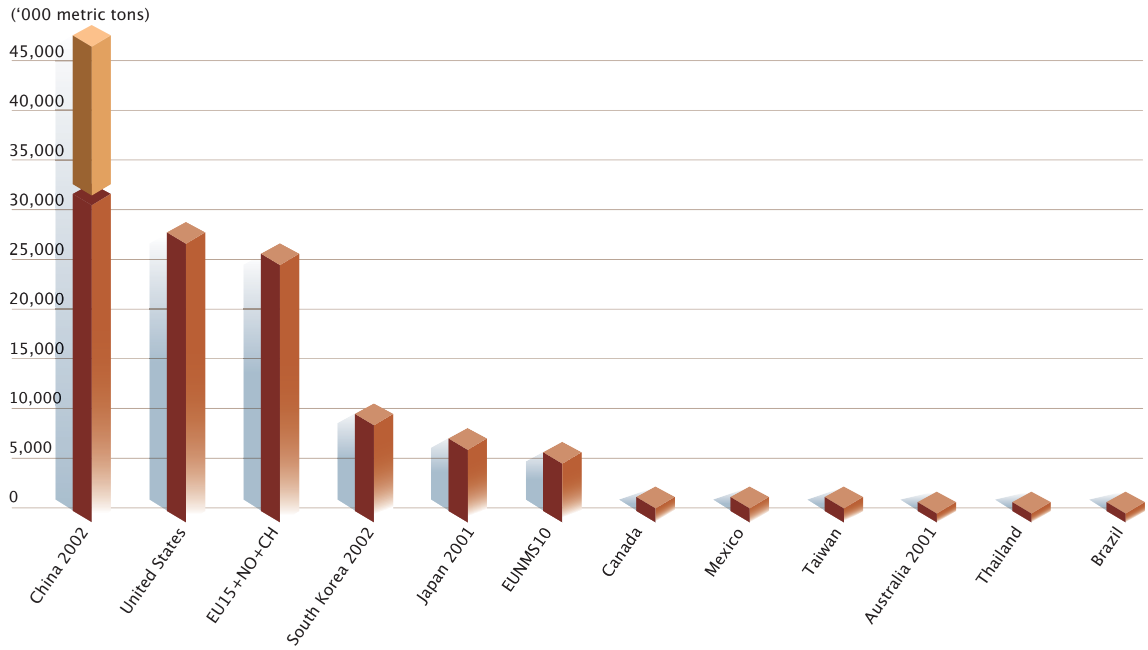
Sources: National Environmental Agencies, OECD, Eurostat, CyclOpe

The markets with the highest value are the United States (approximately $46.5 billion), Europe (EU 15, Norway and Switzerland: approximately $36 billion, another estimate for the EU25 suggests $43 billion) and Japan (approximately $30.5 billion).

The volume of industrial waste to be treated by countries depends on their level of industrialization and on their industrial organization. The manufacturing and industrial sectors producing the most waste are the metallurgy industry, the chemical industry, the food and beverages industry and the wood and paper industry.

These volumes are expressed per capita and should be interpreted with caution. They reach close to 2000kg/capita/year in South Korea and drop to less than 20kg/capita/year in Brazil. Between these two extremes, average volumes range between 400 and 700kg/capita/year in OECD countries. Within the European Union and in neighboring countries, we find a wide range of situations and differences, e.g. between Finland at 2300kg/capita/year and its wood and paper industry, and Denmark

Evaluation of non-hazardous industrial waste in a selected number of countries (total 1.1 billion metric tons to 1.8 billion metric tons)



Sources: National Environmental Agencies, OECD, Eurostat, CyclOpe

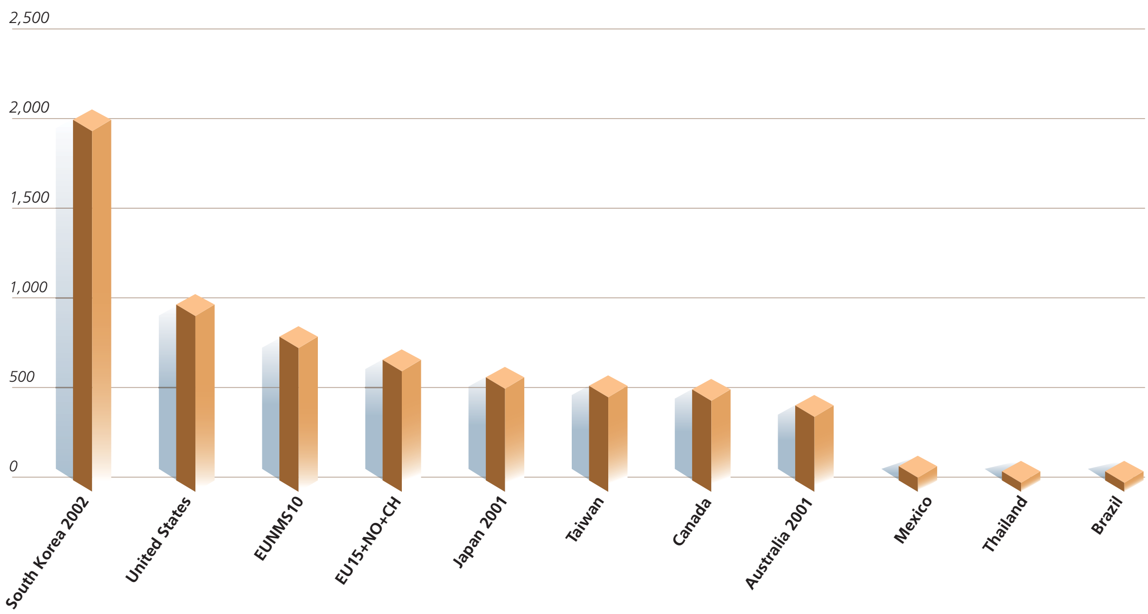
at 340kg/capita/year (a large amount of residue from the wood industry is, depending on the country, either considered as waste or as residue).

Taking into account the difficulties in estimating markets in terms of volume, it becomes very difficult to estimate the value of the world industrial waste market. We were able to estimate this market for certain OECD countries using the average treatment prices supplied by sector professionals. The value of the non-hazardous industrial waste market is therefore estimated at $147 billion for Japan, Europe (EU15, Norway and Switzerland), the United States, South Korea, Australia and Mexico. The market is the largest in Japan at $67 billion. The value of the market in the United States is estimated based on the market volume, which we said earlier was probably underestimated. The value of the market is therefore also probably underestimated.

Hazardous waste is even more difficult to estimate

Following the scandals linked to the export of certain hazardous waste from developed countries to developing countries in the 1980s and the realization that followed, measures were taken at national and international level to control hazardous waste and its transportation. The Basel Convention of March 1989 introduced a system for the control of exports and imports of certain hazardous waste, defined in

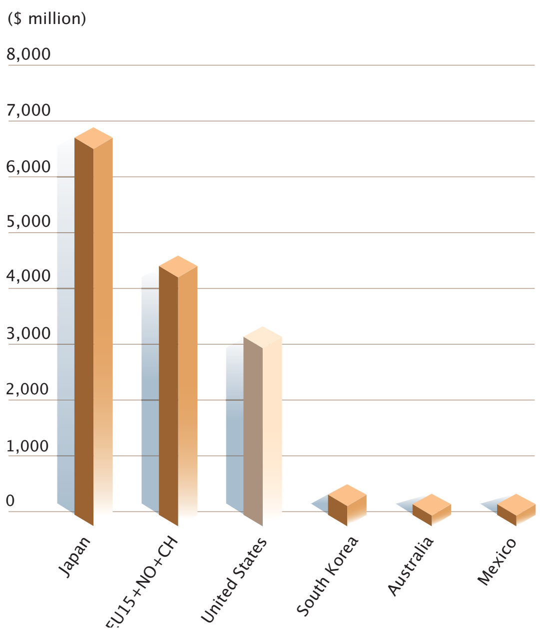
Estimated non-hazardous industrial waste per capita (kg/inhabitant)



Sources: National Environmental Agencies, OECD, Eurostat, CyclOpe

this Convention, and OECD countries introduced regulations to manage this waste. Despite these measures, there is still no real standardization in the definitions of hazardous waste and in its quantification. The complexity of some waste produced from increasingly sophisticated consumer goods (waste of electrical and electronic equipment contains some toxic substances) makes it even more difficult to define what does and what does not constitute hazardous waste.
More so than other waste categories, this waste category strongly depends on what is counted and not counted. Recent statistical changes for this waste in some European countries, notably in new member countries, shows this data to be highly sensitive to definitions and regulations that govern it. It is difficult to make a distinction between hazardous waste treated internally and that treated externally in a large number of countries. For this category, the estimate given is that of the whole deposit.
For all the countries studied (European Union, United States, Canada, Japan, South Korea, Thailand, China, Mexico, India, South Africa), the amount of hazardous waste is estimated at approximately 150 million metric tons (again to be interpreted with caution).

Estimate of the non-hazardous industrial waste market in a selected number of OECD countries (total $147 billion)



Sources: National Environmental Agencies, OECD, Eurostat, CyclOpe

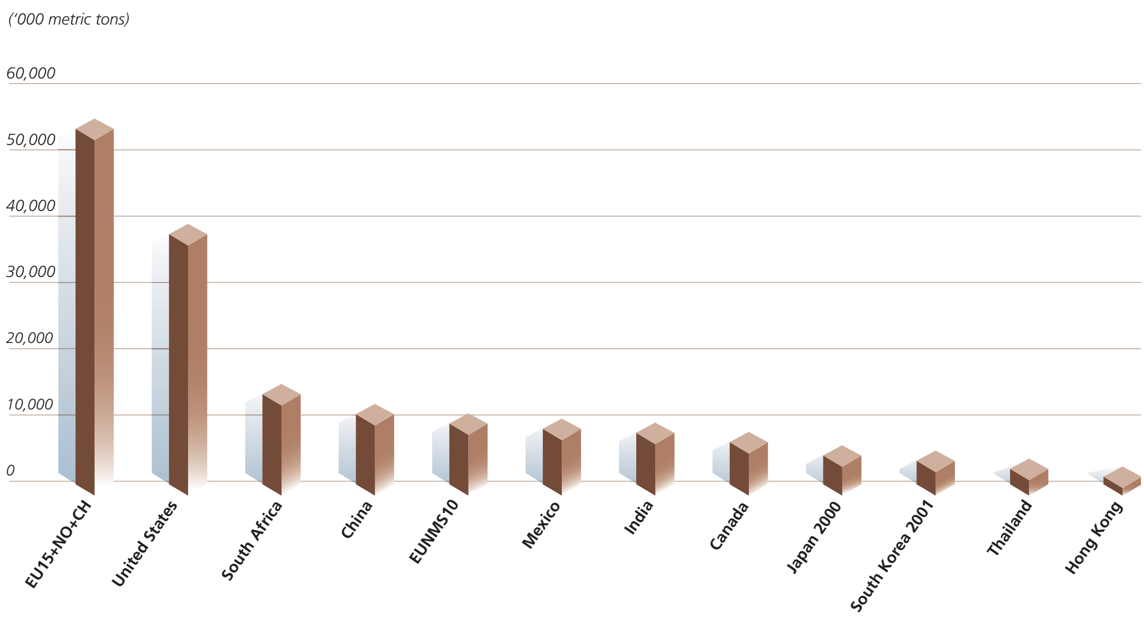
Waste is recycled in a number of ways today both in terms of waste-to-energy and material recovery, and secondary materials markets are becoming increasingly global.

Hazardous household waste is also increasingly diffuse and difficult to quantify as the list of hazardous substances is being added to, particularly in Europe. This waste does not yet represent a large volume but the value of this expanding market is of increasing interest to waste management companies.

This hazardous waste is produced by industry in larger and larger volumes and it is safe to assume that Europe and the United States have the largest hazardous waste amounts, representing more than 53 million metric tons in Europe (EU15 + Norway + Switzerland) and approximately 37 million metric tons in the United States. Market estimation is further complicated by the gap between hazardous waste collected and treated externally by private companies and that treated internally by the waste producer. Unlike municipal waste and non-hazardous industrial waste, we have gathered statistical data covering all listed hazardous waste. For the United States, where statistics are not monitored regularly, the hazardous waste market, as defined under American regulations, treated externally by the private sector only represents 6.5 to 10.7 million metric tons according to estimates.

More surprising still, yet not illogical, are the positions occupied by countries such as South Africa or Mexico. The structure of the mining industry in South Africa and the relocation of certain industries from the United States to Mexico ("maquiladoras") explain these positions.

Estimated hazardous waste in a selected number of countries (total 150 million metric tons)



Sources: National Environmental Agencies, OECD, Eurostat, CyclOpe

From the usage of waste and the sale of waste to how waste is turned into a resource

In addition to discussions concerning the regulatory definitions of disposal or recovery operations conducted notably in Europe, waste recovery is an environmental, social and economic issue that is gaining increasing importance around the world, where the sustainable use of resources is becoming a challenge and creating competition. Waste is recycled in a number of ways today both in terms of waste-to-energy and material recovery, and secondary materials markets are becoming increasingly global.

The recovery of this waste includes all operations carried out to obtain reusable materials from waste by recovering their "material" content or to obtain energy by recovering their "energy" content (calorific value). All of these operations involve a large number of different operators to turn waste deposits into "secondary" materials. Some major operators in industrialized countries are increasingly carrying out all of these operations from waste collection management to the sale of secondary materials. We are mainly interested in the products and their market and the analysis of players is a whole matter that would represent another analysis.

The development of these recovery processes, combined with differences between the regulatory and fiscal context in different countries, leads to waste and secondary material exchange. In Europe, this exchange is relatively limited and localized for "mixed" waste but does exist. In 2004, the Netherlands exported 500,000 metric tons of waste to Germany for disposal (more economically viable landfill or incineration). Some countries (the Netherlands, Germany and Italy) welcome the idea of the opening of a European fuel waste market even though this goes against the will to treat waste locally and to limit waste flows for environmental reasons.

Waste collected separately "travels" and is exchanged. However, it is not really possible to pinpoint the origin of these material flows (municipal or industrial waste). Various organizations are responsible for gathering this data (external trade, customs). We have estimated these flows at close to 59 million metric tons in Europe. However, it is advisable to interpret this data with caution. Waste import and export statistics are not yet unified at European level, and within a single country, different institutions responsible for gathering this data still find it difficult to reach a consensus.

At a world level, accepting that we could combine everything from an old T-shirt to scrap metal, a rough estimate of exchanged secondary material flows (1 million metric tons of textiles, 4 million metric tons of plastics, 35 million metric tons of recycled cellulose fibers, 78 million metric tons of ferrous scrap, 15 million metric tons of non-ferrous metals) gives an order of 135 million metric tons. This gives an idea of the importance of these flows today. Secondary materials currently constitute one of the most important material flows worldwide.

From waste to energy...

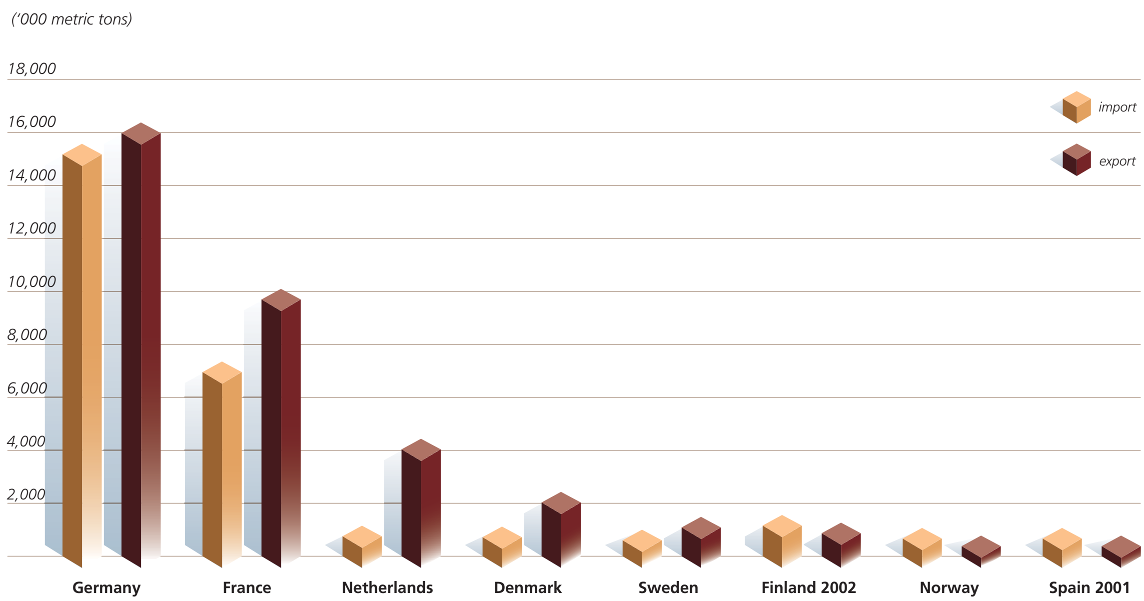
Waste-to-energy involves various waste sources, both hazardous and non-hazardous, and relates to various techniques (from the energy recovery of the waste incineration to the collection of biogases, via the biofuels utilization – Refuse Derived Fuel, used oils and solvents...).

From the usage of waste and the sale of waste

Waste-to-energy is part of the development of the use of renewable resources, the reduction of greenhouse gases and the development of the carbon market as instructed by the Kyoto Protocol.

At an incineration plant, incineration with recovery of energy involves treating waste to produce energy (heat, steam or electricity) to supply other facilities or houses for example. The energy produced by waste incineration in this case outweighs the energy used to operate the plant.
There are currently more than 600 incineration plants recovering energy in approximately 35 countries. These plants treat nearly 170 million metric tons of municipal waste. Approximately 70% of this waste is incinerated in Europe, Japan and the United States.
On a world scale, it is difficult to estimate the quantity of energy recovered as it depends on the calorific value of waste, which can vary depending on its composition. Plastics, paper and textiles have higher calorific values. It also depends on the energy efficiency of the technologies used. Roughly speaking, the energy equivalent of these 170 million metric tons of incinerated municipal waste can be estimated at approximately 220 million barrels of oil, i.e. 600,000 barrels/day. A country such as the United States consumes approximately 20 million barrels per day. This energy contribution represents a significant proportion of energy needs, particularly in OECD countries. The energy produced by waste incineration at 400 European incineration plants is estimated to provide 27 million inhabitants with electricity (equivalent to the population of Denmark, Finland and the Netherlands) or 13 million inhabitants with heat. The incineration market is estimated at 99 billion in the EU15. In Japan, 236 plants produce the equivalent in energy of a nuclear power station. The incineration market in Japan is currently estimated at $4 billion.

Waste import/export (hazardous and non-hazardous) in several European countries in 2003 (total 58.7 million metric tons)



Sources: National Environmental Agencies, National External Commerce Statistics

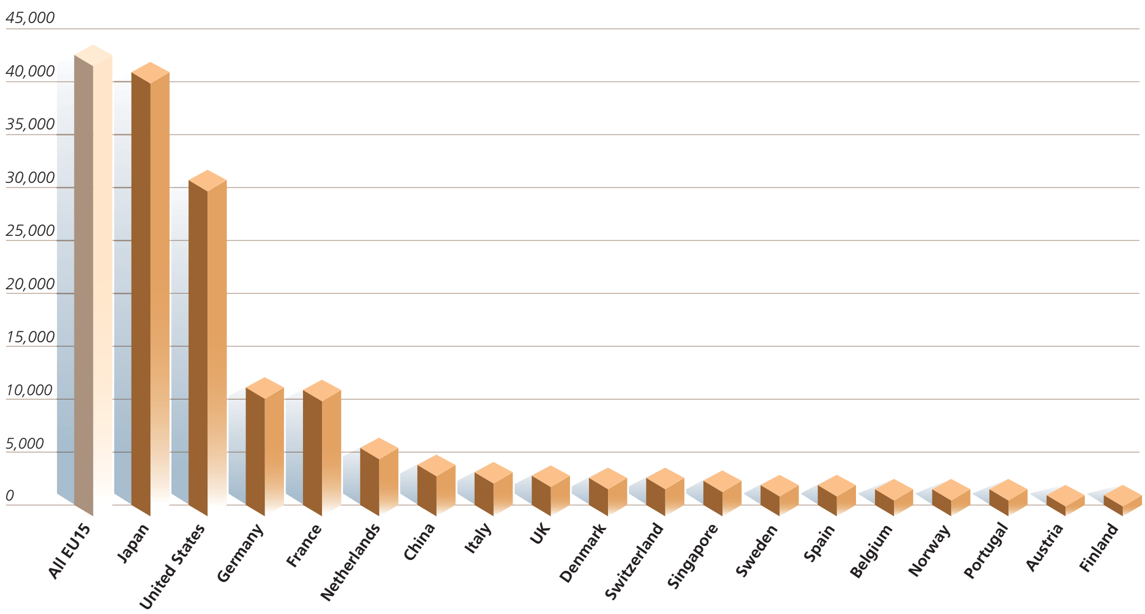
Some countries have relatively high ratios of incinerated municipal waste per inhabitant. This is the case in some Asian countries (Japan and Singapore) and in some European countries (Denmark, Switzerland, the Netherlands, Norway, Sweden and France) who have introduced preferential rates for this energy (purchase of green energy, "green certificate"). Other countries such as the UK, the USA or Canada have not really developed this industry, which is nevertheless expanding. A European directive sets an objective of 12% of gross domestic energy consumption and 22.1% of electricity produced using renewable resources by 2010. As with the development of pre-treatment prior to the landfill of municipal waste in Europe, this directive aims to limit and to stabilize the organic fraction and to provide Refuse-Derived Fuel. It will also promote the development of waste-to-energy. A country such as the UK could thus strongly increase its incineration capacities over the next few years.

Rising energy costs, safety and energy independence, the control of greenhouse gas emissions, compliance with the Kyoto Protocol and improved environmental performances (progress in the strict control of pollutant emissions and in combustion management) are all factors that contribute to the development of this method of recovering waste worldwide. In addition to the economic factor (cost), the main factors limiting the development of this recovery are environmental and cultural (Australia), NIMBY (Not in My Backyard) or BANANA (Build Absolutely Nothing Anywhere, Near Anyone) phenomena and the calorific power of waste (emerging and developing countries).

...to the battle against climate change and greenhouse gas emissions...

The most modern municipal waste landfills currently enable biogas to be produced through the fermenting of this waste. This bio-

Incinerated municipal waste in selected countries (total 124 million metric tons)



Sources: National Environmental Agencies, Eurostat gas mainly comprises methane and carbon dioxide (two of the main greenhouse gases). Once collected, this biogas can be reused in the form of electricity. 340 out of the 2975 landfills in the United States recover biogas. The collection of biogas is now mandatory in Europe and the oldest landfills to be upgraded should also be modernized to be able to ensure this collection. In the future, the development of these landfills into bioreactors should further improve technical, environmental and economic performances related to the production of biogas from waste.

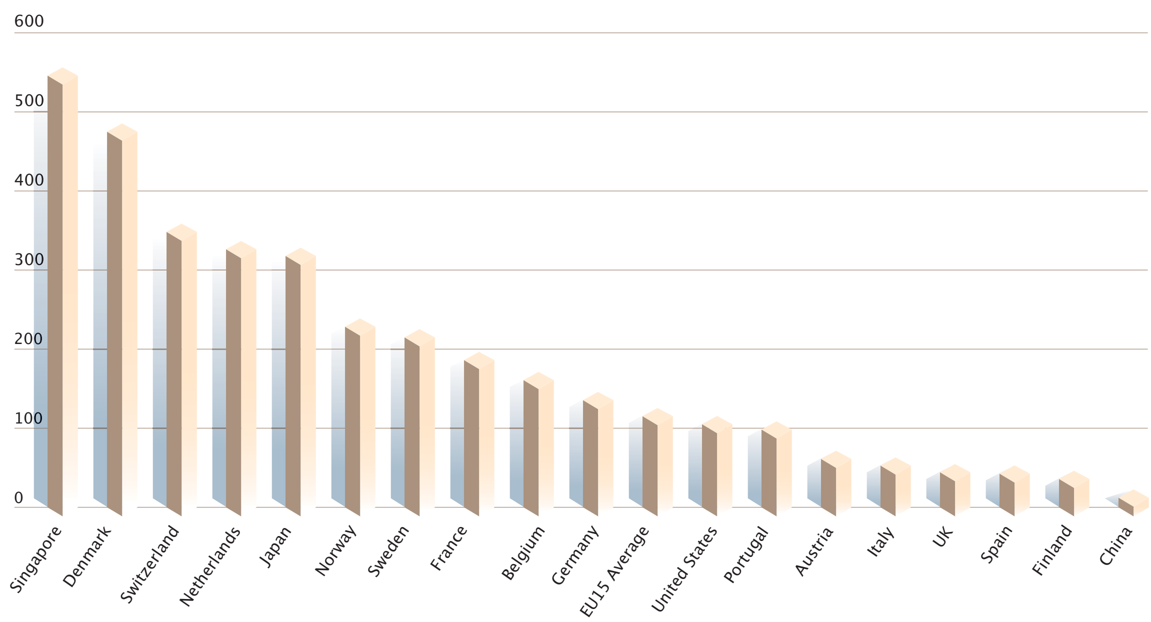
...to carbon market products...

Waste treatment is therefore concerned by the issue of the reduction of greenhouse gases and currently contributes to objectives to reduce these emissions. The Kyoto Protocol enables companies in industrialized countries to obtain emission reduction certificates by making investments to effectively reduce the level of greenhouse gases in developing countries. This Clean Development Mechanism (CDM) is therefore used by sector companies investing in developing countries (Joint Implementation for investments made in Central and Eastern European countries). Projects completed, e.g. a collection and renewable waste-to-energy system for methane produced by a landfill center can be used to obtain emission reduction certificates, which when associated with the CO_2 emission permit market, are carbon market products implemented by the Kyoto Protocol.

...and to resources

The second type of waste recovery involves the recovery of different materials that can potentially be reused. Saving resources is one of the main benefits to recovery and recycling and this is taken into account by the market when its cost

Incinerated municipal waste per inhabitant in selected countries (kg/capita/year)



Sources: National Environmental Agencies, Eurostat is lower than the savings it generates. Another advantage of recycling is the reduction in effects related to the use and the transformation of raw materials (effects on the environment, energy consumption and primary resource multiplier). However, this "positive externality" in terms of the economy is not always taken into account by the market. The main reason for national recycling support programs is to intervene to implement mechanisms that take these externalities into account and that can help to solve the problem of pressure exerted on the planet by the use of resources. This raises the question of choice of method used to promote recycling. This choice has been different in each EU country.

Based on waste deposits, we have estimated the flow of recovered and recycled materials in certain OECD countries. These flows are based on statistical waste data issued by organizations responsible for gathering it, if this data exists, and on recovery industry or recovery process statistics. Waste flow statistics are unfortunately incomplete and only exist for certain materials in a number of countries. Certain materials can be directly reused or recycled and do not pass through a recovery plant. This makes it even more difficult to quantify these materials.

The main materials that are recovered and treated to be reused are:
- organic materials, wood,
- paper and cardboard,
- plastics,
- glass,
- ferrous metals,
- non-ferrous metals,
- textiles,
- batteries,
- electrical and electronic equipment (WEEE) and lastly
- some substances such as solvents.

Most of these materials are part of a regional (compost, wood), national (glass) or international (paper, plastics, ferrous metals, non-ferrous metals and textiles) market that varies in size. In the past, deposits that were the most accessible, the most easy to recover and the most easy to sell (scrap metals, non-ferrous metals, paper) were mobilized first, followed by the next least difficult and so on (plastics, electronic waste).

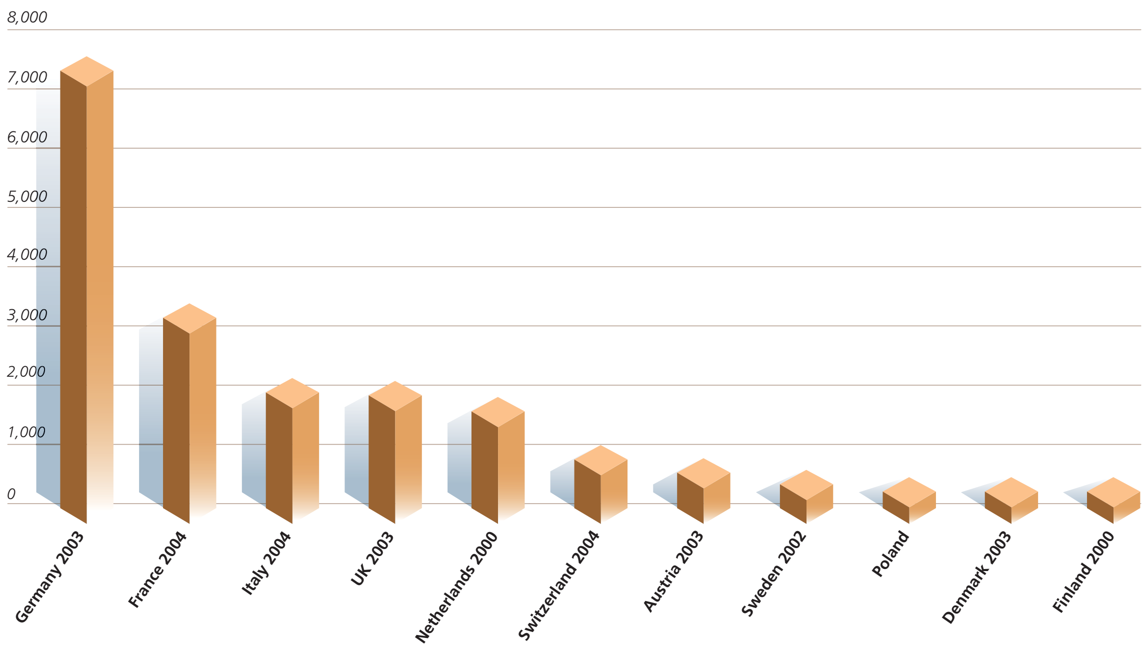
Compost: a local resource

Under the influence of water, air and heat, the controlled aerobic fermentation and decomposition of organic waste (green waste, kitchen waste, paper) by micro and macro-organisms can take from a few weeks up to a few months to form compost or black humus of varying richness. This process reproduces organic components in soil by speeding up the natural decomposition cycle. This compost can be used to improve crops. Its degree of maturity, biological stability and harmlessness will define its agronomic qualities. Produced using a biological process and depending on basic organic waste, several types of compost can be produced. The introduction of standards (the Netherlands were the first country to define standards), certificates, quality charters and traceability has led to the development of an essentially regional and national market in industrialized and developing countries. Rich in organic matter, municipal waste in urban areas of developing countries is particularly suited to this type of treatment as the market is also stimulated by the growing needs for fertilizer in these countries. For example, Alexandria in Egypt turns a quarter of its waste into 120,000 metric tons of compost per year. This is then used to improve soils, in particular sandy desert soils.

It is currently estimated that approximately 18 million metric tons of organic waste (green waste and kitchen waste) is collected separately and turned into compost in Europe (EU 15). A further 3.5 million metric tons of organic waste treated in digestion tanks (anaerobic decomposition) needs to be added to this figure. The recovery rate of organic waste in Europe, which constitutes 30% to 45% of the total tonnage of household waste (including paper/cardboard) is estimated at 42%. Meeting organic waste landfill reduction targets set out in the European directive, promotes the stabilization of organic material and the development of recycling for agricultural purposes. Germany, Austria, the Netherlands, Denmark and France have already met these objectives and Sweden has reached the first target. The recent stance adopted by the European Commission, set against the establishment of a specific organic waste directive, could nevertheless hamper this development.

In addition to regulatory incentives, the future of compost depends on its environmental and agronomic qualities and on the dynamism of its market. At the end of the day, compost must fulfill requirements and be profitable. This market is difficult and requires skillful and adapted marketing.

Organic waste recovered from municipal waste in selected European countries (total 18 million metric tons)



Sources: National Environmental Agencies, European Compost Network

From the usage of waste and the sale of waste

Saving resources is one of the main benefits to recovery and recycling and this is taken into account by the market when its cost is lower than the savings it generates

Textiles: reused and recycled for centuries

The collection and recycling of textile fibers goes back to ancient China when worn clothes were used to make paper (rag paper). Later on, following Gutenberg's invention in the 15th century, the opening of the first paper mills in the United States in the 17th century and the birth of industrialization, the use of textile fibers to make paper gradually gave way to the use of wood and cellulose. If the high price of cotton and linen fibers prior to industrialization meant that old clothes had to be reused, the drop in prices following the industrial revolution did not damage this activity, boosted as it was by the increase in textile consumption. The textile recycling industry therefore goes back over more than 200 years in industrialized countries.

The approximate flow of textile waste in industrialized countries corresponds to the flow of consumed textile fibers. In France and in Germany, this flow is approximately 15kg/inhabitant/year and in the United States, this figure is 30kg/inhabitant/year. Making up less than 5% of the average composition of municipal waste, quantities collected and recovered, notably through charities, vary from country to country. Based on this deposit, approximately 30% to 40% of textiles are reused (second-hand clothes), 45% to 50% are recycled and 15% to 20% are discarded (landfills).

Flows of second-hand clothes in the world have risen tenfold since the 1990s. The non-governmental British organization Oxfam estimates current flows at $1 billion, i.e. 0.5% of the total value of world textile exchange and less than 5% of total exchange volumes. However, this percentage varies considerably from country to country. The second-hand clothes market plays an important role in some developing countries. 15% of Asian textile imports and nearly 30% of sub-Saharan African textile imports are second-hand clothes exported from industrialized countries. Europe and the United States export 20% and 35% of recovered second-hand clothes respectively.

Far from being harmful to domestic textile industries, as it is commonly thought, the informal second-hand clothes recycling sector (commerce, distribution, repair, cleaning) is vital for several hundreds of thousands of people in developing countries. It is the import of new textiles at cut-down prices from Asian countries that poses more of a threat today. These massive imports threaten the informal reuse sector in Africa and the recycling industry in Europe, of which the costs are no longer competitive faced with the low cost of these textiles.

Estimated textiles collected in several industrialized countries in 2003 (in thousand metric tons)

United States	1,250
Germany	1,100
United Kingdom	1,000
France	300
Switzerland	35

Sources: National environmental protection agencies and professional organizations

Secondary material markets: growing markets estimated at nearly 600 million metric tons

Material recovery, i.e. all operations used to obtain reusable materials from waste (reuse or recycling), is considered the most suitable way of dealing with increasing waste deposit management problems by some OECD countries and is at the top of the famous "hierarchy" of waste treatment methods. Although this claim can be questionable (and questioned) in terms of an economic, social and environmental optimum, recent pressures on raw material markets (steel and non-ferrous metals) increasing the cost of primary materials favor and expand material recovery possibilities and the use of secondary materials.

The selective collection of municipal waste and non-hazardous industrial waste is growing in all countries and is higher than 45% for municipal waste in a number of European countries (Austria, Germany, Norway, and the Netherlands). Regulations in OECD countries (introduction of the Extended Producer Responsibility principle) and particularly in the EU (packaging directive, end of life vehicles directive, battery and accumulator directive, electrical and electronic waste directive) encourage the recovery and recycling of "post-consumption" product materials. However, the irregular adaptation of European directives to national laws, and sometimes the lack of clear objectives, results in a relatively varied situation in Europe in terms of selective collection of different materials and the recovery or recycling rate. Northern European countries generally perform better than Southern European countries and new member countries. However, some packaging waste management systems that are successful in terms of recycling rate also have their drawbacks (Duales System Deutschland) such as growing amount of stock to be recycled and high costs.

The material markets arising from recovery are developing and expanding internationally. The Bureau of International Recycling estimates that the recycling industry employs approximately 1.5 million people worldwide and represents revenues of $160 billion. Other estimates place the market in Japan at $67 billion (2000) and the market in the USA at $47.3 billion (2003), giving a global production of more than 500 million metric tons. The rate of growth in the consumption of secondary materials in Asian countries, of which some are becoming recycling workshops for Western countries, should lead to a rapid rise in these figures.

Our estimate of the size of the world secondary material markets in 2004 is 600 million metric tons.

Taking into account the average prices recorded for recovered scrap metals and recycled cellulose fibers, the value of these world productions largely exceeds $100 billion.

However, in relation to the raw material markets, the characteristics of these markets make them complex. Trade barriers, diffused markets, lack of information, impenetrability, manipulation of markets, problems with standards, specifications

Estimated size of main world secondary material markets	
Recovered fibers (paper)	
170 million metric tons	
Recovered ferrous metals (scrap metals)	
405 million metric tons	
Recovered on-ferrous metals	
24 million metric tons	
Recovered plastics	
5 million metric tons *	
Total	~ approx. 600 million metric tons

* estimate

(often in great number) and quality are all factors that may pose a problem for players. The lack of accurate statistics concerning the volume of plastics, ferrous metals and non-ferrous metals recovered and reused is just one example. It is true that for some directly reused materials such as glass or some metals, there is no real distinction between the raw or secondary material used.

Based on statistics concerning the quantity of paper, plastics and glass recovered from municipal waste, we estimate today's deposit in Europe to be more than 50 million metric tons, with 75% in Germany, France, the UK, Spain and Italy.

The deposit recovered from industrial waste can be estimated as the same size for plastics and glass. Working with incomplete data, this gives us a total estimated deposit in Europe of paper, plastics and glass of approximately 65 million metric tons. Approximately 28,000 metric tons of collected and recycled batteries and accumulators need to be added to this figure.

Recovery of materials from municipal waste in Europe and the United States
(in thousand metric tons)

	Germany	France	United Kingdom	Italy	Spain	Remaining EU 15 (1) +NO+Switzlerand Estimate	Total Europe	Etats Unis
Paper and cardboard (2)	8,500	5,200	3,700	2,000	3,500	9,800	32,700	40,000
Plastics	3,850	350	450	350	310	1,200	6,500	1,930
Glass	3,300	2,000	1,500	1,000	510	1,690	10,000	2,350
Non-ferrous metals	1,204	1750	75	278	121	797	3,975	1,750
Total	16,854	9,300	5,725	3,628	4,441	13,487	53,175	46,030
Batteries	11.5	9.6					28	
End of life vehicles Ferrous Metals							11,000	17,000

(1) Estimate: 30% of paper, 20% of plastics, 20% of glass and 20% of non-ferrous metals are recovered in the remainder of the EU15.
(2) Paper and cardboard are recovered from municipal and industrial waste

Sources: National Environmental Agencies

Recovery of plastics and paper: increasingly global markets

Plastics

The recycling rates for plastic waste are still relatively low in OECD countries. According to the European Association of Plastics Manufacturers (PlasticsEurope), the average rate in Europe is 15% (22.5% of plastics are recovered for waste-to-energy). According to the Environmental Protection Agency, the recycling rate for municipal waste in the United States is 5.5%.

Recycled volumes are constantly increasing and now stand at just over 3 million metric tons in Europe (multiplied by three in 10 years), for a quantity of plastic waste of 22.5 million metric tons. Whilst inexistent at the end of the 1980s, plastic recycling is also steadily increasing in the United States.

Total estimated amount of paper, plastics, glass and batteries recovered in Europe from municipal and industrial waste* (in thousand metric tons)	Quantity recovered
Paper and cardboard	35,000
Plastics	10,000 (1)
Glass	20,000 (2)
Batteries	28

(1) Estimate: the industrial deposit of recovered plastics represents 30% of the total deposit
(2) Estimate: the industrial deposit of recovered glass represents 50% of the total deposit
* Excluding end of life vehicles and WEEE

The increase in the selective collection of packaging prompted by increasingly stringent regulations and the growing demand for recovered plastics, particularly in Asia, favors the development and internationalization of this market (PET bottles). In 2002, European exports to Asia reached 340,000 metric tons. In Japan, the export of used plastic bottles, expanded polystyrene waste, plastic parts from domestic appliances, etc., rose from approximately 100,000 metric tons/year in the mid 1990s to 681,680 metric tons in 2003.

The number of different specifications for recovered plastic materials, the cost of collection systems and volatile prices are nevertheless limiting factors, and the recovered plastics market only represents a low proportion of the 169 million metric tons of plastics produced in the world in 2003.

Paper/cardboard

Paper recycling rates range from 10% in Ireland to 100% in Austria. The average rate in the EU rose from 41.5% in 1991 to close to 54% in 2004. Some countries started to disassociate the growth of their packaging waste (packaging paper represents 50% of total packaging waste) from their economic growth (Austria, UK). However, gene-

Recovered plastics for recycling market (in thousand metric tons)	Recovery	Exports
Europe (2002)	3,130	340
United States (2004) - PET bottles	870	235
Japan (2003)		682

Sources: Plastics Europe, American Plastics Council, Japan Plastic Industry Federation

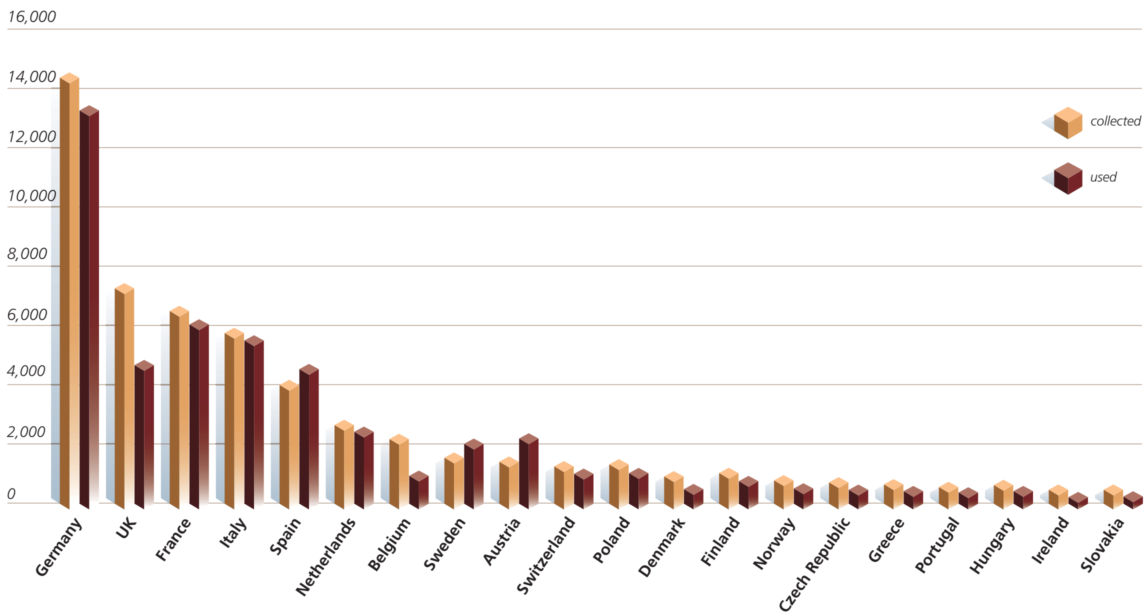
rally speaking, the growth in paper consumption in Europe should remain between 2% and 3%/year. The arrival of new member countries, for which paper consumption and the paper recovery rate are increasing (still lower than the average rate in EU15), will increase the potential European deposit.
In 2004, Europe had an overall surplus of 5.3 million metric tons of recycled cellulose fibers, a figure mainly contributed to by the UK, Germany, Belgium, France and Denmark.

Since 1990, the level of recycled cellulose fiber consumption worldwide has doubled. We estimate the world recovered paper tonnage at approximately 170 million metric tons.

The exchange of recovered paper is increasing, notably with Asia, and in particular China, whose imports are constantly on the up (+5 million metric tons between 2004 and 2005 (+40%) to 17 million metric tons). The recovery rate and the deposit level in Asian countries does not meet their demands. New investments are increasing the need for recovered and less expensive fibers, while most products manufactured are for export, causing a structural shortage of fibers. The United States and Europe (UK, Belgium, Germany) benefit from this boom and export increasing quantities of recycled cellulose fibers (68% between 2000 and 2004) with more than 90% destined for Asia.

An increasingly international market and growing pressure from competitors raises the question of the fixing of recycled cellulose fiber prices. There is no real world indicator. We can only use the United States or German national market prices as a reference and conclude that the recycled cellulose fiber market is not yet organized at international level.

Collection and Recovery of RCF in Europe in 2004 ('000 metric tons)



Source: CEPI

The exchange of recovered paper is increasing, notably with Asia, and in particular China, whose imports are constantly on the up

Secondary ferrous and non-ferrous metals: world markets

Ferrous and non-ferrous metals have a long history of recycling. Scrap metals have been recycled for nearly two hundred years and they are essential in the production of steel. They also play a key role in the reduction of energy consumption and have become true commodities. Ferrous metals recovered from municipal waste deposits ("post-consumption" waste: 10 million end of life vehicles per year in Europe, 15 million end of life vehicles per year in the United States, large electrical appliances, tin cans, etc.) represent approximately 50% of all recovered scrap metals. 25% are recovered from the production of steel (offcuts) and 25% from exchange operations. The recovery rate of end of life vehicles is nearly 85% in the United States and 75% in Europe, where the target is to reach 85% in 2006 and 95% in 2015.
The total world production of steel exceeded a billion metric tons for the first time in 2004 (1.13 billion in 2005) and the production of scrap metals rose to 450 million metric tons. The consumption of scrap metals reached 405.5 million metric tons. The main scrap metal deposits are in Russia, in the United States and in Europe. The main importers of scrap metals are emerging countries including Turkey and China. Taking into account the current growth rate of the market, the scrap metal reuse rate could be as much as 60 to 70%.

World RCF market in 2004 (in thousand metric tons)

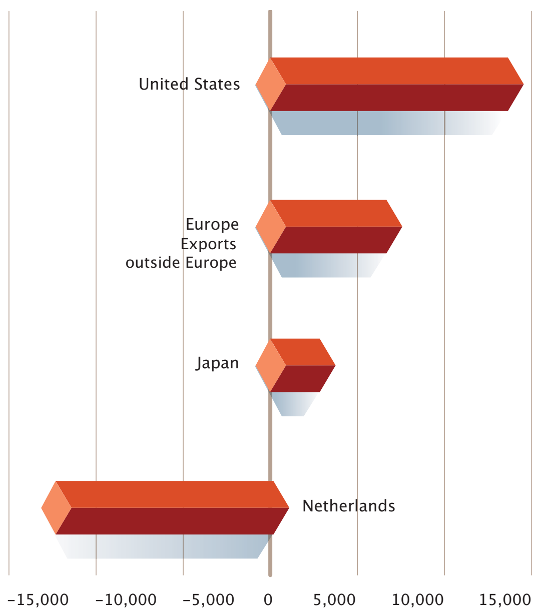
	Recovery of FCR	Use of FCR	Imports	Exports
Europe	51,970	49,074	11,359	14,465
North America	47,467	36,647	2,754	13,574
Asia	58,988	75,121	20,613	4,480
Latin America	7,850	9,837	2,081	94
Oceania	2,422	1,876	2	549
Africa	1,776	1,940	224	60
Total	17,0473	174,495		

Source: PPI

From the usage of waste and the sale of waste

Most non-ferrous metals reached record prices in 2005, which boosted supply and demand of secondary metal. The demand for aluminum, nickel and copper is really taking off in emerging countries to such an extent that for some scrap (aluminum) this demand threatens the European recycling industry now lacking supplies.
The manufacture of secondary aluminum (from aluminum waste) is approximately 7.6 million metric tons worldwide, i.e. approximately 20% of total aluminum production. Added to quantities of secondary aluminum from the manufacture of primary aluminum (new offcuts), which we can estimate as being on the same scale at approximately 15 million metric tons of secondary aluminum which would be recovered in the world. Scrap aluminum is essentially recovered from transport products (approximately 40%), the building industry (approximately 30%) and packaging (approximately 20%). The average recycling rate of aluminum packaging (cans) is 40% in Europe (nearly 80% in Germany) and 50% in the United States. We estimate the world deposit of aluminum packaging at approximately 3 million metric tons per year. End of life vehicle aluminum deposits in Europe, the United States and Japan are estimated at 2.5 million metric tons, and of this figure, we can estimate that 30% (750,000 metric tons) is effectively recovered.
With soaring prices, scrap aluminum has become very sought-after in China (1.2 million metric tons imported in 2004) and in India, where the largest aluminum recycling plants are found.
Recycled copper, turned into refined copper, represents 2 million metric tons worldwide, i.e. approximately 13% of the total copper production. The exchange of copper scrap (including alloys) stood at close to 6 million metric tons worldwide in 2004, of which 3 million were imported by China.
Prices reached by copper, lead, nickel and cadmium over the last few years were high enough to cover the costs of collecting and recycling 15 billion batteries and accumulators thrown out each year around the world. Some countries collect and recycle more than 95% of car batteries (France, Japan).
Scrap nickel represents approximately 40% of primary production, i.e. a world nickel scrap market of approximately 460,000 metric tons. Three quarters of manufactured nickel is used to make stainless steel and stainless steel scrap is also exchanged internationally (exchange of stainless steel scrap estimated at 1.5 million metric tons). In the stainless steel scrap market, Asia (Japan, China, India, Taiwan, South Korea) represented 49.5% of world production in 2004 and 55% of world consumption.
The total recovery of secondary zinc worldwide stood at 2 million metric tons in 2004 with 1 million metric tons resulting from primary zinc manufacture and 1 million metric tons recovered from zinc or zinc alloy waste. 3.2 million metric tons of secondary lead is recovered worldwide. In 2004, the amount of lead recovered and recy-

Import/Export of recycled cellulose fibers in 2004 ('000 tons)



Sources: CEPI, AFPA, FAO

cled in the United States represented 86% of the demand for lead to be used in the manufacture of new batteries.

It is also important to mention the effect of the recovery of many small and precious metals on different markets. These include platinum recovered from automobile catalytic converters, cadmium recovered from recycled batteries (of which one French manufacturer produces 20% of the total world production), titanium recovered from airplanes at the end of their service life, or beryllium, selenium and platinum soon to be recovered from WEEE. The markets for all of these small metals are very dynamic, with growth mainly due to Asian demand. Quoted prices have on the whole been on the increase since 2004.
The recycling of mercury from hazardous waste under proper conditions is vital in terms of both the environment and health. Mercury waste is mostly produced by the chloride industry, by batteries and accumulators, by mercury vapor lamps and dental amalgams. Several hundred million fluorescent strip lights and compact fluorescent lamps are sold annually in the world. Appropriate selective collection and recycling of this hazardous waste is required by the 2003 European directive concerning WEEE (these fluorescent lamp strip lights should gradually be replaced by white light LEDs). Unfortunately, in some countries, notably in the United States where legislation in this field is ambiguous, the landfill of this waste is still possible.

Waste electrical and electronic equipment (WEEE): goldmine for some, litter for others

Focusing on all waste management problems, the management of these flows has become a priority for politicians in OECD countries (Europe,

World scrap metal markets 2003 (million metric tons)

	Consumption	Imports	Exports
European Union	87.2	28.8	30
Other Europe	30.7	15.5	9.3
CIS	46.7	1.2	11.7
Asia	147.3	26.3	7.6
North America	75.9	6.4	13.7
Latin America	13.1	0.2	0.3
Africa	1.9	0.1	0.4
Oceania	2.6	0	1
Total	405.5	78.6	74

Source: IISI

The market for all of these small metals are very dynamic, with growth mainly due to Asian demand

United States, Japan) and is undoubtedly one of the greatest challenges facing waste management worldwide to date. Some electrical equipment (TVs, domestic appliances, fridges) markets are showing signs of saturation but this is far from the case for electronic equipment, which is rapidly expanding in all corners of the globe.
WEEE, and in particular computers, contain a significant quantity of recyclable materials such as metals (steel, aluminum, copper, lead, zinc, silicon), glass, plastic, small precious metals (gold, palladium, platinum and silver) and hazardous substances (arsenic, mercury, cadmium, beryllium, hexavalent chromium). A study conducted by the United States Bureau of Mines in 2001 revealed that the potential quantity of gold that can be recovered from all computers used by Americans to be equivalent to the quantity recovered from the treatment of 2 million metric tons of gold ore – getting it is another story! More seriously, there is no recent data available concerning the quantities of recyclable materials effectively recovered from the treatment of this waste. A typical computer comprises 22% plastic, 20% steel, 14% aluminum, 7% copper, 6% lead and 2% zinc. Estimates calculate that 10 million computers would contain 135,000 metric tons of recoverable materials.
It costs a lot of money to disassemble computers and up to now, if they were not thrown away, they were sold to brokers and shipped to Asia to be torn down as part of an informal system by many resellers, shopkeepers and "recycling" specialists to end up being illegally dumped and burned. Exporting and importing countries are now much more aware of the growing transportation of obsolete devices (now seen as hazardous waste, or second-hand devices to facilitate border crossing) and environmental problems posed by their hazardous content.
Calculating their volumes is still not easy. The 2002 EU directive sets an average recovery target of approximately 4kg/inhabitant/year (for fridges, TVs, computers and photocopiers). Data provided by some national institutions gives us an estimate of the quantities of waste produced which are difficult to compare (from 7kg/inhabitant/year in the United States to 13.5kg/inhabitant/year in Germany and the UK). The problem still lies with categories taken into account when making calculations. Collection statistics for this waste are still very limited.
Legislators and non-governmental organizations are mostly concerned with the growth rates of these flows, which are approximately +25%/year on average worldwide but 3%/year in Europe and more than 100%/year in India and China.

Estimate of the non-ferrous scrap recovery markets (in thousand metric tons)

Total: 24 million metric tons

Aluminum *	15,000
Copper	2,000
Lead	3,200
Zinc	2,000
Nickel and Stainless Steel	2,000

* estimate

Sources : USGS, ICSG, INSG, IAIS, ILZSG

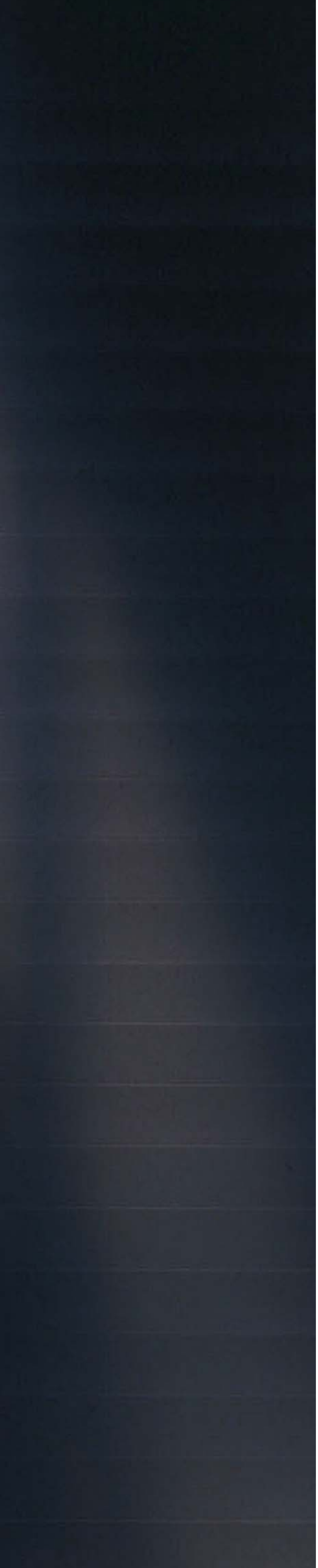
Collection and recycling programs, such as regulations governing hazardous substances contained in eco-design or consumer products, are in the early stages. The 2002 European directive concerning WEEE and the RoHS directive (Restriction of the use of certain hazardous substances) pave the way. Several states in the United States have also implemented a regulatory framework and debate is ongoing at federal level. Countries such as China or India are trying to control their flows that are currently difficult to control under current regulations (Basel Convention and EU or OECD green and orange lists). The question of costs involved in the recovery and treatment of WEEE is crucial. With treatment costs at least 10 times lower in developing countries than in Europe or the United States, only strict regulations can jam these flows.

Estimate of WEEE in several countries (in thousand metric tons)
Difficult to be accurate! WEEE taken into account for each country are different

	Waste produced/year	Waste collected/year
United States (2002) *	2,125	
Germany (2004) **	1,100	104
United Kingdom (1998)	900	
France (2004)	1,700	
Denmark (1997)	118	17
Switzerland(2003)	66	
Thailand (2003)**	60	

* Electrical equipment is not included
** Only some WEEE is taken into account (in France household WEEE)

Sources: National Environmental Agencies and/or National Professional Organizations



A complex world

This brief overview clearly highlights the complexity of the world of waste at international level. It is no coincidence that there is no reliable and coherent analysis of the planet. This study is the first of its kind on the subject.
However, over the last few years, people have become more aware of the essential form that waste, its collection, its treatment and its recovery will take in the 21st century. On an earth that will reach most of its limits this century (demographic, environmental, agricultural, energy), the problem of rarity is becoming essential and the solution lies with the traditional civilizations of which we spoke in the introduction.
The general public often perceives waste in an overcautious and exaggerated manner (overflowing waste containers). Its vision of world markets ignores the constraints of costs associated with the recovery of waste that makes the North a "deposit" that Southern countries are beginning to exploit. The geopolitics of waste is a topic that needs to be further explored and should not be oversimplified or viewed from a Manichean perspective.
The Earth produces as much "economic" waste (i.e. really taken stock of) each year as it does cereals (2 billion metric tons) and steel (1 billion metric tons). Growing deposits! Growing challenges!

Authors

Elisabeth Lacoste

Economist and Agronomist, Elisabeth Lacoste is an expert in European and World Agricultural Commodity Markets and European Trade and Agricultural Policies. Senior Consultant at "CyclOpe", she is the author of "Sugar and Development: Implications on preferential agreements and the opening up of markets", published in June 2004 in "Les cahiers de CyclOpe" n°1. Elisabeth Lacoste is also Consultant for French and international companies and agricultural federations.

Philippe Chalmin

Philippe Chalmin is a professor at the University of Paris-Dauphine where he heads the Master of International Business program.
He is the founding President of CyclOpe, the principal institute of European research for the global markets of primary materials and commodities. He has also taken a keen interest in the waste economy in recent years. Bucking current waste cycles, turning waste into a resource, reducing leakages from controlled waste streams, Philippe Chalmin outlines the history of waste management and considers its future.

Find the entire text of *2006 World Waste Survey. From waste to resource*
in the: Economica Editions – 49, rue Héricart, 75015 Paris – FRANCE
N° ISBN: 2-7178-5310-3 – **Price: 28 € VAT.**

Veolia Environmental Services
Communications & Marketing Department
38, av. Kléber - 75016 Paris - FRANCE
Tel: +33 (0)1 71 75 06 22
fax: +33 (0)1 71 75 06 35
http://www.veolia-environmentalservices.com
Design & Production: entrecom
September 2006

Veolia Environmental Services
Communications & Marketing Department
38, av. Kléber - 75016 Paris - FRANCE
Tel: +33 (0)1 71 75 06 22
fax: +33 (0)1 71 75 06 35
http://www.veolia-environmentalservices.com
Design & Production: entrecom
September 2006

In the past, humans regarded their resources as rare, knowing that their demands outweighed supply. Everything available had to be used and almost nothing went to waste. However, the Industrial Revolution embraced development and the apparently unlimited use of renewable and non-renewable resources. Little by little, wastes were seen as pollutants that had to be collected, hidden or buried in the most environmentally-friendly way possible.

Today, a new shock made us sit up and take note. The sudden rise in oil and metal prices, agricultural conflicts, the economic boom throughout Asia and the continent's increased needs clearly show that on an earth that will reach most of its limits this century (demographic, environmental, agricultural and energy), the problem of scarcity is becoming essential.
Humans will need to collect, sort, recover and recycle, going back to the old ideal: complete the material cycle, turn waste into a resource.
Waste management has always been about proximity, perceived in an exaggerated manner, in its role to reduce environmental pollution. It is seen increasingly as a global issue to manage a volume of resources, exploited for their energy value and their materials. The growth in world flows of scrap metals, recycled cellulose fibers and recovered plastics, makes the developed North a "deposit" that emerging South countries are beginning to exploit.

The Earth produces as much "economic" waste (i.e. really taken stock of – 2.5 to 4 billion metric tons) each year as it does cereals (2 billion metric tons) and steel (1 billion metric tons). Growing volumes of waste mean growing challenges!

This survey has been co-produced by **Veolia Environmental Services,** world number 2 in waste management, and **CyclOpe**, the leading European research institute for the raw materials and commodities markets. It was written by Elisabeth Lacoste, agriculturist and doctor of economics and Philippe Chalmin, professor at the Université Paris-Dauphine and president of CyclOpe.

Find the entire text of *2006 World Waste Survey. From waste to resource* in the: Economica Editions – 49, rue Héricart, 75015 Paris – FRANCE –
N° ISBN: 2-7178-5310-3 – **Price: 28 € VAT.**

CYCLOPE

VEOLIA ENVIRONMENTAL SERVICES

Cover illustration by Nicolas Vial