

Waste in a land of plenty - Solid waste generation and management in the US

The US generates the highest amount of waste per person in the world and continues to rely on landfilling at the expense of recycling and waste-to-energy, according to the latest in an annual series of national surveys on municipal solid waste generation and management

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Article by N.J. Themelis and S.M. Kaufman in WASTE MANAGEMENT WORLD, ISWA (www.iswa.org), September-October 2004 Issue

In the frontier mentality that has evolved over the centuries in America, the abundance of available space has been a reassuring constant. When things get too crowded or too uncomfortable, there is always greener grass to move to, rebuild on and start all over again. This has also been the story of waste disposal in the US: there has been boundless room to grow, with plenty of extra land to dump the by-products. It is for this reason that waste - the consequence of the unprecedented economic expansion during the 20th century - has been for the most part ignored.

This began to change with the birth of modern American environmentalism in the 1970s - somewhere along the line, people began to speak of 'reduce, reuse, recycle' and it became fashionable to 'divert' waste from landfills. Crude metrics such as recycling and diversion rates were instituted by federal and local government as a way of measuring the progress made. Missing from this picture, however, has been a coherent methodology for total accounting of the use and ultimate fate of resources.

As people began to equate recycling with environmental stewardship, the ideal overcame the reality. States would mandate recycling rates with little consideration of whether there were markets for a large fraction of the 'recycled' materials. Others would celebrate '50% diversion' without mentioning the corollary jump in waste generation. When media attention was devoted to issues of waste management, it took on sensationalist tones (the 'New York garbage barge') or vague notions of a prescribed national recycling rate. Lost in this discussion were matters of substance - 30% of how many tonnes, and what are the environmental impacts of dealing with the other 70%?

Though these kinds of questions usually went unanswered, it was important that waste came to be an issue of consequence - at least among some of the population. Once this happened, it seemed time to begin truer accounting of how the US was managing a previously neglected resource.

Measuring waste in the US

Motivated by the principles of industrial ecology, academic institutions have, in recent years, become involved in the study of integrated waste management. In 2002, the Earth Engineering Center (EEC) of Columbia University conducted a comparison of waste generation and disposal in two states (New York and California) and two coastal 'megacities' (New York and Los Angeles).¹ One finding was that, when the data from the two states were scaled up to the US as a whole, the generation of municipal solid waste (MSW) was much higher than that reported annually by the US Environmental Protection Agency (USEPA).² On the other hand, the EEC data were much closer to those reported by *BioCycle*, a US journal specializing in composting and organics recycling that has been conducting an annual survey for a number of years. This survey is known as the State of Garbage (SOG) survey. Following EEC's 2002 study, BioCycle invited the Center to collaborate on its 2002 SOG survey of the US.³

Data collection for the 2002 survey

Earlier SOG surveys had involved sending a questionnaire to the waste management departments of the 50 states. For the 2002 survey (14th SOG), EEC reworked this questionnaire, substituting quantitative questions for previously qualitative ones. The goal was to persuade states to report waste numbers using tonnages only, with any percentages - for recycling, landfilling, waste-to-energy (WTE), etc. - being calculated subsequently by EEC. Extra questions were added to the questionnaire that made cross-comparison of the data provided by each state possible.

In this way, we were able to correct for different methods of collecting data among states. For example, California includes construction and demolition (C&D) wastes in its MSW reports. As this is typically a waste stream with higher recycling rates, combining it with the MSW serves to increase the state's overall 'diversion rate', that is, solid waste that is not sent to landfill.

Of the 50 states, 47 responded, representing 98% of the US population, and provided varying degrees of detail and accuracy. The differences can be partly attributed to the fact that not all state governments monitor waste disposal closely. In general, states that do track wastes closely fall into one or both of the following two categories:

- relatively densely populated states, usually in the Northeast, where traditionally



**Waste to be compacted for processing.
PHOTOS: N. MITSOS,
THERMOELEKTRON**

- easy solutions (landfilling) are becoming more problematic
- 'environmentally conscious' states like California, New York, Minnesota and Oregon, where there is generally greater public awareness and initiative to manage waste in sustainable ways

States were asked to categorize waste by type (residential, commercial, industrial C&D, exported, imported) and by tonnages disposed (recycling, composting, WTE, landfilling). Once all the information was received, much effort was put into ensuring that materials included in one state's definition of MSW would also be included in the calculations for all states. For the purposes of the 14th SOG study, MSW generation was defined as follows:

$$\text{MSW generated} = [\text{tonnes recycled}] + [\text{tonnes WTE}] + [\text{tonnes landfilled}] + [\text{tonnes exported}] - [\text{tonnes imported}]$$

Results of the 2002 survey

Table 1 summarizes the results of the 14th SOG survey and provides a comparison with data from the survey carried out in 2001 by Franklin Associates for the USEPA.² The USEPA numbers were lower by about 120 million tonnes for generation and by 100 million tonnes for landfilling. According to the SOG survey, the average generation of MSW in 2002 was 1.19 tonnes per capita. This is the highest rate reported by any nation and it is nearly twice the reported generation rates for the EU and Japan.

TABLE 1. Generation and fate of MSW in the US				
	14th SOG survey ¹		USEPA 2001 survey ²	
	million tonnes/year	%	million tonnes/year	%
Amount generated	336	100.0	211	100.0
Amount recycled and composted	90	26.7	65	30.8
Amount to WTE	26	7.7	27	12.8
Amount landfilled	220	65.6	119	56.4

The reported recycling rate was 26.7%, of which about one quarter was composted. The 26 million tonnes of MSW treated in WTE facilities represented 7.7% of the amount generated and not 13% as estimated earlier on the basis of the much lower rate of generation reported by USEPA.



ABOVE LEFT Cans, bottles and plastics waste are collected for recycling in Harwich, Massachusetts ABOVE RIGHT A community collection point of clothes and donations at Harwich, Massachusetts

As explained earlier, the 14th SOG survey was based on data recorded or estimated by the state agencies responsible for solid waste management. On the other hand, the USEPA data were based on a 'materials flow' method that compiles industrial production and consumption records. It then makes certain assumptions about the lifetimes of products and materials, and of discard patterns. According to previous SOG surveys (see Figure 1), the generation of solid waste increased by an average of about 11 million tonnes/year between 1990 and 2000. In contrast, the USEPA reported that the rate of growth of MSW generation over this period increased by an average of only 3 million tonnes/year, which corresponded to nearly 1% per year. Coincidentally, the US population during the same period increased by about 3 million people per year, i.e. also 1%.

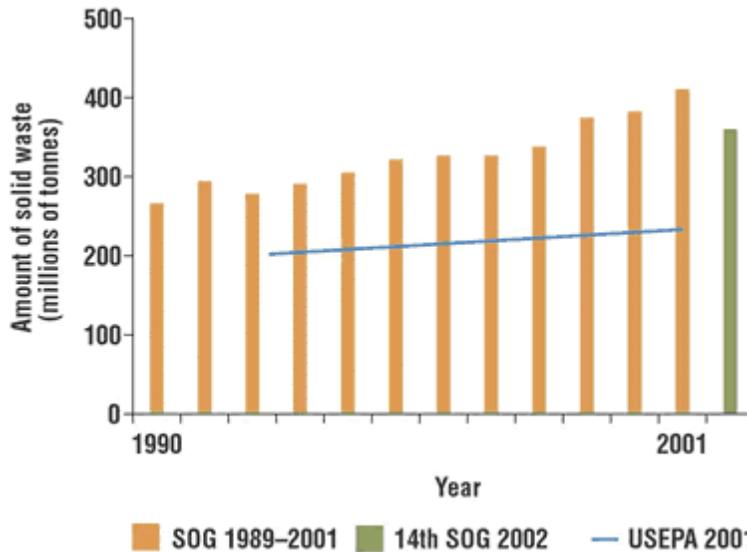


FIGURE 1. Comparison of SOG surveys findings with those from USEPA 2001 survey

Figure 1 also shows the results of the 14th SOG survey, which estimated MSW generation at 336 million tonnes. It is believed that the reported generation in earlier SOG surveys included some C&D waste and wastes from small industrial operations that end up in landfills. For example, the shredding of millions of discarded automobiles generates several million tonnes of automobile shredder residue (ASR). Despite the fact that ASR consists of over 60% combustible plastics, it is currently disposed of in landfills in the US. In another example, repulping of used paper generates 10%-15% of a mixed plastics

and paper residue that is also landfilled. The approach EEC took in the 2002 survey was to make the data and methodology as transparent as possible. While it is certainly important to try to quantify waste reduction, this was outside the scope of the EEC study: the tonnes of waste recycled, combusted or landfilled must add up to the tonnes of waste generated.

Implications of the survey findings

The results of our study showed that, on a per capita basis, the US generates more MSW than any other nation. It also showed that the US relies heavily on landfilling as the primary means of waste management. A number of factors contribute to this situation:

- Large nationwide corporations own a substantial fraction of the contracts with municipalities to haul and dispose of waste, as well as the landfills to put it in.
- The relative abundance of 'open' land - especially in the West - results in very low tipping (gate) fees for landfills. The gate fees reported (by only a few states) in the 14th SOG survey ranged from \$50 to \$90 per tonne of MSW. However, in some states, the gate fees can be as low as \$20 per tonne.
- The USEPA does publish a hierarchy of treatment methods listing landfilling as the last resort, but it has not moved towards legislative action such as the EU Landfill Directive, which requires near-term phasing out of the landfilling of biodegradable materials.

Recycling in the US

The 2002 SOG survey showed that the US recycles about 27% of its MSW. This includes organic wastes that are subjected to composting. Only 35 states reported the fraction of recycling due to organics and wood composting, and the average was 28% of the reported rate of recycling. If it is assumed that all 50 states compost to the same extent, the average US recycling rate in 2002 was 19.2% and the average composting rate was 7.5% of MSW (see Table 2).

	Rate (%)
Landfilling	65.6

WTE	7.7
Recycling	19.2
Composting	7.5
Total	100

States report as recycled all materials recovered either by separation at source or at material recovery facilities (MRFs). Non-recycled residues - either those from the MRF or the plants that process the recyclables - are included and can be substantial. For example, a 2001 study by EEC found that a large fraction of the plastics and glass reaching three New York City MRFs was finally landfilled due to a lack of markets.⁴ In addition, the residue from repulping of used mixed paper is also landfilled. It is therefore possible that some double counting of materials exists (as recycled and then as landfilled) in the data reported by the states. This would reduce the computed rates of recycling and MSW generation shown in Table 1.

Despite the obstacles, the US has come a long way over the years in advancing recycling to the present level. Almost 50% of the population has access to kerbside collection programmes - that's nearly 140 million people.



LEFT AND RIGHT Plastics and glass waste to be recycled. A 2001 study found that a large fraction of the plastics and glass reaching three New York City MRFs was finally landfilled due to a lack of markets.
PHOTOS: NICKOLAS THEMELIS

Waste-to-energy

As was shown in Table 1, the tonnage of MSW combusted is the only constant between the 14th SOG survey and the USEPA study in 2001. This reflects the fact that the WTE industry is one of the most highly regulated in the US. About 26 million tonnes of MSW were combusted in WTE plants, that is, 7.7% of the total US MSW.

The use of WTE does not appear to affect recycling rates. The states that sent the highest percentage of MSW to WTE facilities recycle at rates either slightly below, slightly above, or well above average for the US as a whole (see Figure 2).

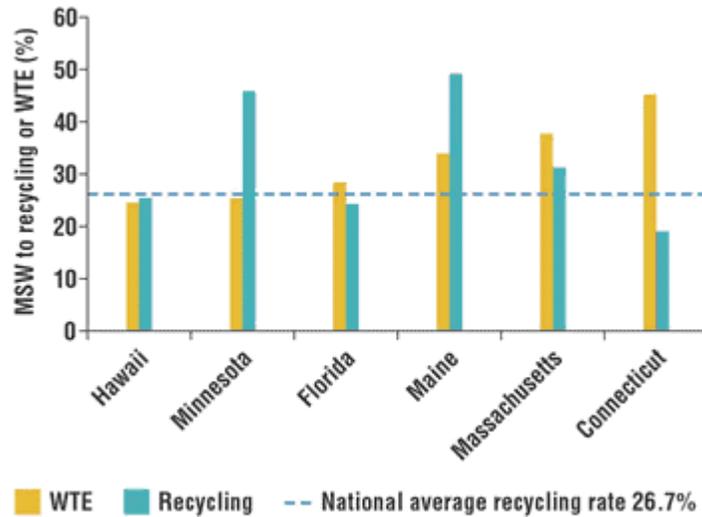


FIGURE 2. WTE and recycling rates for six US states

WTE is used principally by more densely populated US states. In 2002, the 15 states with the highest population densities accounted for 85% of the total tonnage sent to WTE facilities. These states have a mean population density of 163 people/km². The ten states with the lowest population densities had a total of just 0.4% of the WTE tonnage; the mean population density for these states is only 4 people/km².

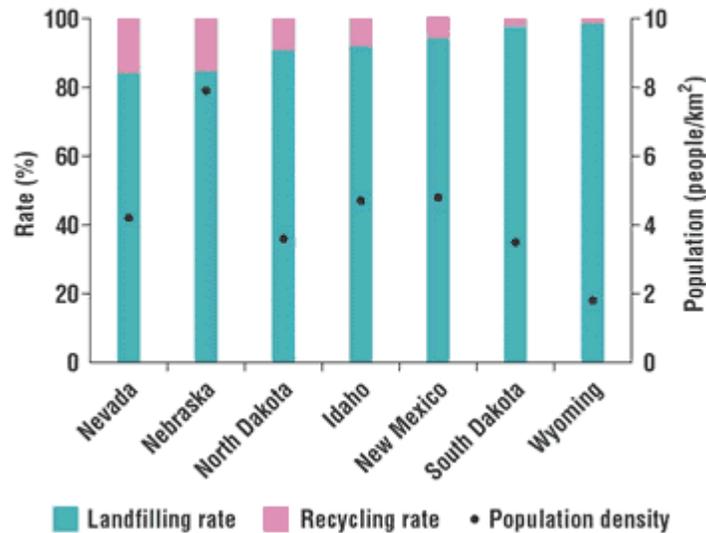


FIGURE 3. Recycling and landfilling rates for US states with the lowest population densities

Landfilling

The American West is the best demonstration of the way in which the US relies on landfilling as a primary means of waste disposal. As land is less expensive than in places like the North-east, landfills are somewhat easier to site and usually have very low tipping fees. The reliance on landfilling is therefore unlikely to diminish in the foreseeable future. In the regions with low tipping fees, both recycling and WTE will continue to be at a significant economic disadvantage and will therefore find it difficult to stay competitive. Figure 3 shows the landfilling and recycling rates for low population density states that responded to the 14th SOG survey. As stated earlier, tipping fees are as high as \$90/tonne in some states. This has led to MSW being transported across state borders and over long distances. The 14th SOG survey reported that nearly 35 million tonnes of MSW were imported by some states - notably Pennsylvania, Virginia, Illinois and Michigan. However, Pennsylvania and Michigan are not states with low tipping fees. Pennsylvania reported tipping fees of \$81/tonne and Michigan \$83/tonne. The reason for the high import levels is that Pennsylvania imports millions of tonnes of MSW from well-to-do New York City, and Michigan from Toronto. The prevailing gate fees in Virginia and Illinois were not reported.

Conclusions



Thermal treatment facility at Stanislaus, California. The WTE industry is one of the most highly regulated in the US. PHOTO: AMERICAN REF-FUEL

The generation of MSW in the US has continued to increase and, by any measure, it is the highest per capita in the world. This is in line with reports that the US has about 5% of the world's population but consumes over 20% of the materials produced globally. As the production of waste by an ever-increasing population generates greater volumes of MSW, it is essential to track accurately the generation of solid wastes and their utilization for material and energy recovery. The 14th SOG survey leads a trend towards more careful collection and analysis of data on the generation and disposal of MSW.

Landfills and WTE facilities are required by law to keep careful records of input and output materials. They are therefore reliable witnesses of the fate of a large fraction of the solid waste generated. Recycling and composting facilities should also be required by states to maintain records of the materials received and of the residues that cannot be recycled or composted and therefore have to be combusted or landfilled.



Waste collection at the central truck-to-rail station at Cape Cod, Massachusetts.
PHOTO:
NICKOLAS THEMELIS

This study also showed that national and state agencies responsible for waste management should be concerned with both MSW and industrial and other residues sent to landfills instead of being recycled or used to recover energy. A kilogram of wood that is sent to a landfill instead of being recycled or combusted in an industrial boiler has the same environmental impact whether it originates in a home or following construction or demolition activity. In another example, solid waste that goes to a waste-to-energy facility is counted as MSW, but the resulting ash that is landfilled may not be. In all cases, society should provide incentives for minimizing all the materials that end up in landfills; landfilling has the highest environmental and land use impacts of all the principal means of waste treatment and disposal.

As nations and communities move forward with analysis of different waste streams and selecting methods of treating them, it is important to remember that statements like 'a 50% rate of diversion' mean little if the computed rates of waste generation are also increasing inexplicably, as was shown to be the case for California by the 14th SOG survey.⁵

Manufacturers, waste haulers, waste processors, government officials and urban planners need more specific accounting of wastes - what is being recovered, in what quantities, and what are the inefficiencies leading to landfilling of non-used materials. This will enable society to better 'metabolize' these lost resources.

Although the US generates and landfills large amounts of solid wastes, it has succeeded in recycling an estimated 90 million tonnes of MSW, and combusts nearly as much as the EU. This is more than the total reported by all other Organization of Economic Co-operation and Development (OECD) countries combined.⁶ It is hoped that the methodology and results presented in this report will be of use to other nations facing similar problems.

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**Article from WASTE MANAGEMENT WORLD, ISWA (www.iswa.org),
September-October 2004 Issue**