Waste: Part 4

Management Strategies

- Goal Setting: Zero Waste or Close
- Education and Peer Pressure
- Regulation
- Market Manipulation
- Innovation and Technological Approaches to manage what is left

How Do You Solve A Problem Like Detritus?

R. Rodgers (sort of)

Opening Thoughts

Turning garbage to ski

By Jack Fuller

THE IDEA of skiing on snow-covered plains around Chicago may sound like a lot of garbage.

But the Du Page County forest preserve district and the City of Evanston think it's great. Both are building ski slopes on mountains of garbage.

Three million cubic yards of garbage and clay have gone into Mt. Hoy, a 150-foot hill in the Blackwell Recreational Preserve just north of Warrenville in Du Page County.

"Garbage is just a resource out of place," said John Sheaffer, a Chicog waste consultant who collaborated on the design of Mt. Hoy. "We found a way

THE GARBAGE is sealed in layers of clay so water will not seep thru it and contaminate the area's water supply, Sheaffer said.

"The same thing could be done in Chicago, if people would realize that garbage is a means to an end and not an end in itself," Sheaffer said.

The end is in sight for Mt. Hoy. By next winter, according to George Bottoms, superintendent of engineering for the forest preserve district, the hill will be fitted with four ski slopes, a snow machine, a chair lift, and a rope tow. It also will have two toboggan slides.

Evanston's ski season will open about Dec. 22 on a 60-foot

THE HILL has been there for many years, said Al Hyman, special facilities manager for the Evanston Recreation Department. But this is the first time it will be used for skiing. Only recently the Evanston City Council allocated $28,000 to equip the hill with two ski slopes, snow machine, rope tow, and two toboggan runs.

A season of skiing on "Mount Trashmore" will cost $6 for Evanston residents and $10 for nonresidents, he said.

The Lombard Park District has operated a toboggan slope for four years on a garbage mountain in Sunset Knoll.

The Cook County Forest Preserve District plans to build a "mountain" similar to



Opening Thoughts

Refuse what you do not need; reduce what you do need; reuse what you consume; recycle what you cannot refuse, reduce, or reuse; and rot (compost) the rest."

- Bea Johnson (1974-present)



Waste Management

Waste Management in its broadest sense is defined as any and all activities designed to properly manage waste, in its many forms (e.g., liquid, solid), from the point of generation through to disposal. The term includes:

- Waste production (making the waste), collection, and storage
- Waste transportation and processing (including reduction)
- Waste disposal and destruction
- System monitoring

Strategies that target waste reduction or waste elimination or, finally, waste destruction/containment are colloquially included in this discussion of "Waste Management".

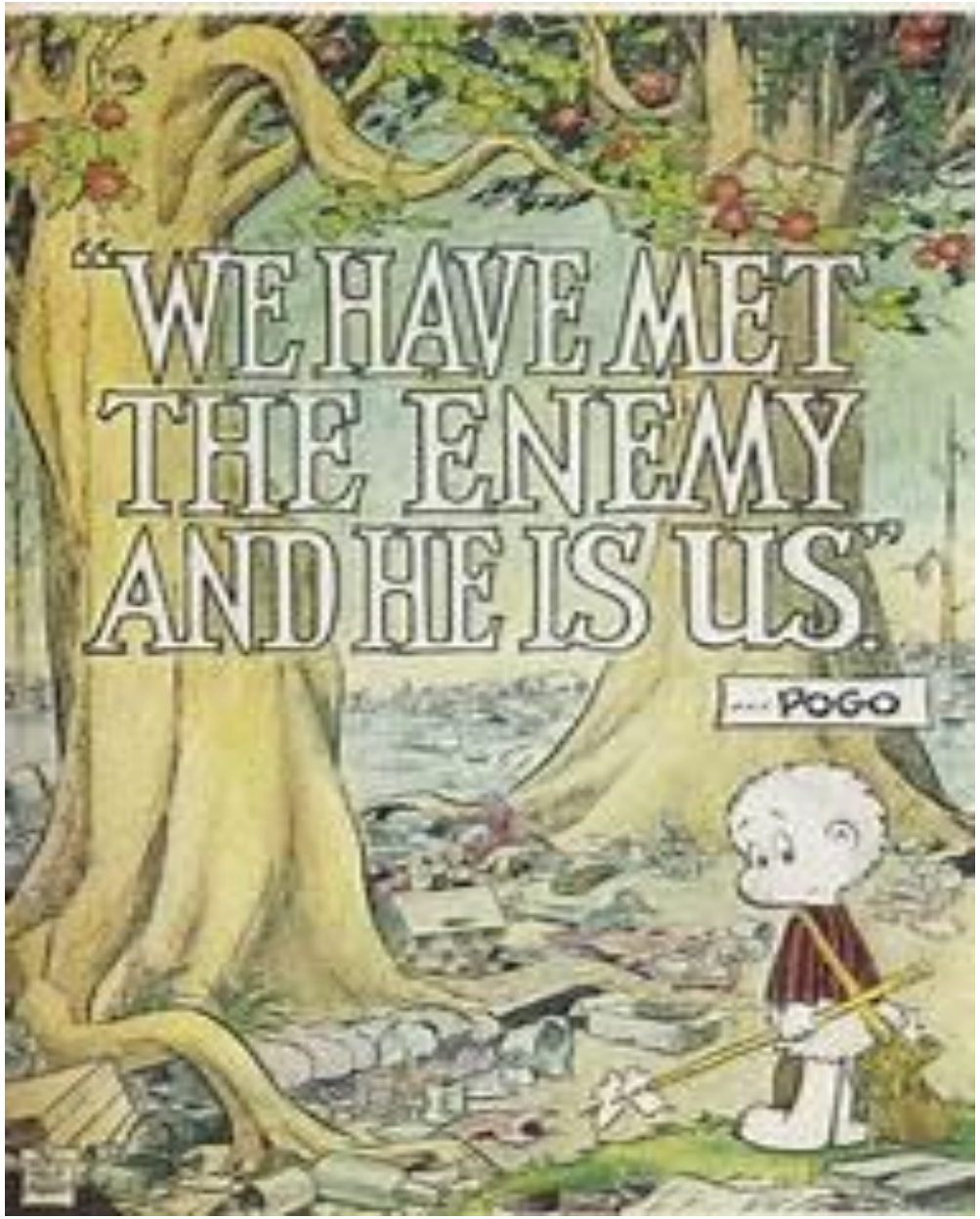
Waste MGMT: General Comments

It bears repeating that…

Waste is an **extension of consumption**…

- Consumption of goods and services is anticipated to increase at a rate faster than population growth (Ehrlich et al) and therefore waste generation is anticipated to increase at a rate faster than population growth*
- Waste volumes are influenced by consumption patterns (i.e., by ***what*** we consume as much as by ***how much*** we consume) which makes our **behavior part of the problem and part of the solution.**

* See reference to the growth of the middle and upper classes in China



Waste MGMT: General Comments

And…

Waste is a **bi-product** of social and/or industrial activities for which there is **no current economic use**.

So….

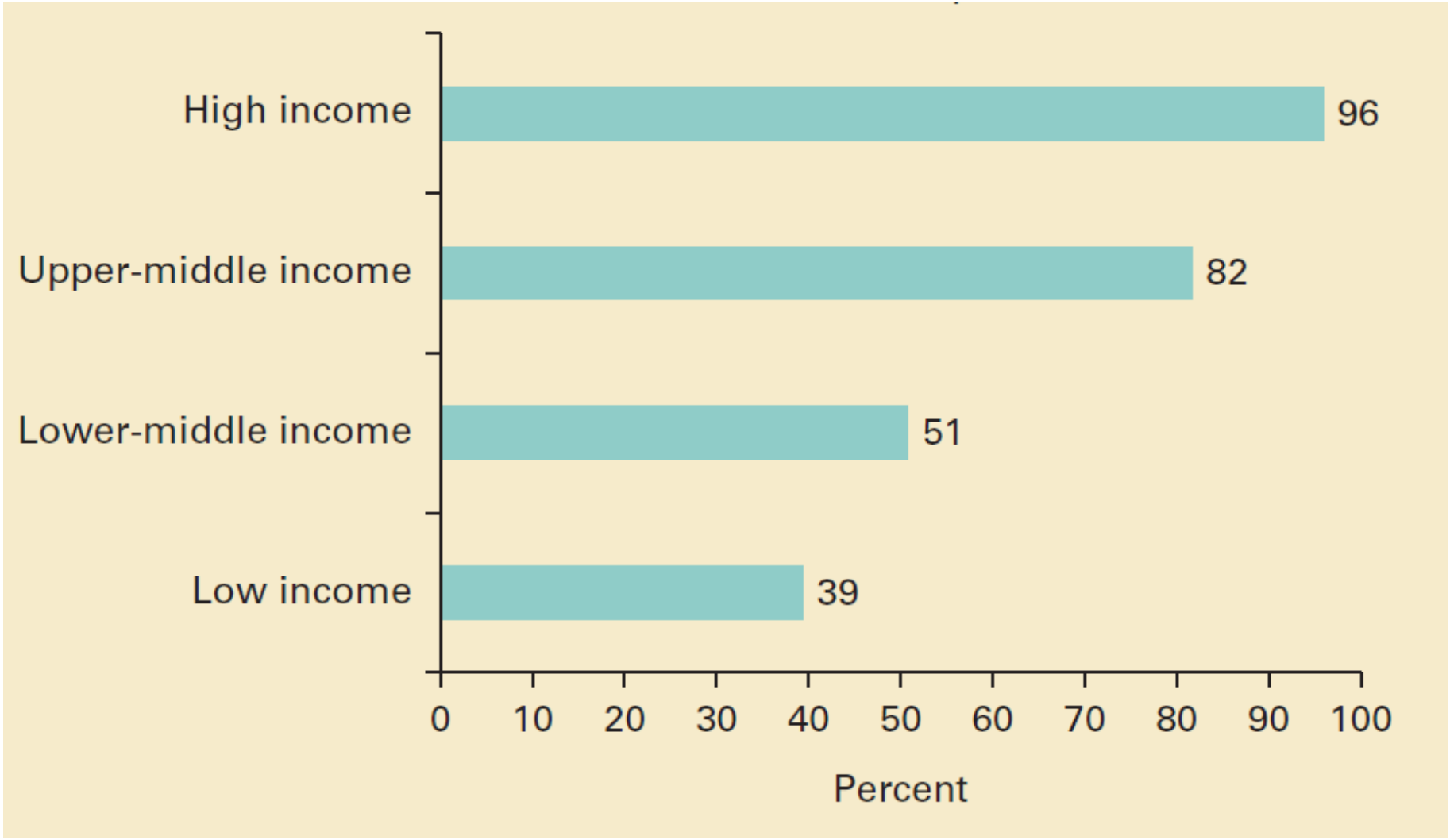


Waste MGMT: General Comments

1. *Waste can be minimized through pricing mechanisms to cause it **not to be generated in the first place** or, at least, to control the volume of waste generated.*
2. *Waste generation practices can be modified through educational programs and peer pressure.*
3. *Waste management can be influenced by government regulations to ensure that long-term costs are incorporated into production functions.*



Waste management is a discussion about the management of waste **that has been collected**. But a sizable percentage of waste is simply not managed solely because it is not collected (at least 33% worldwide, according to the World Bank). This waste often ends up as illegally dumped wastes.



Waste Management

General Waste Management Strategies:

- Waste Reduction techniques
  - Potential Influence of Education and Consumer pressures
- Waste Sorting/value recovery (Recycling)
  - Potential Influence of Pricing and “total” costs
- End of life management (landfill, incinerators, biofuel, etc…)
  - Consideration of Future societies



Waste Management (WM)

Objectives of Socially responsible WM:

- To reduce, to the extent practicable, the amount of waste generated
- To minimize the impacts that the management of the resulting waste will have on human health and the environment

Social responsibility is a contract with both current and future community members (human <u>and</u> non-human).

Sustainability

Waste MGMT: Zero Waste

If the goal of waste management strategies is to minimize the volume of waste requiring “End of Life” strategies ***and*** if waste generation can be influenced through changes in consumption, **can waste be eliminated?**

That is, can society achieve **Zero Waste**?

Zero waste proponents suggest that waste could be eliminated. Conceptually, waste is the bi-product of conscious consumption practices as well as a “potential resource” to future production. That is, ***generating waste is not an inevitability.***

Is Zero waste achievable?

Waste MGMT: Zero Waste

What is ”Zero Waste”?

- Zero Waste is an **ideal**, embodying the concept of totally eliminating the generation of waste in one’s life.
- Zero Waste was a term coined in the 1970s* but is often used colloquially to mean “a reduction, to the maximum extent possible, of waste diverted to End of Life options”.
- Which is to say, Zero Waste as a concept asks consumers to reduce waste generation to the greatest extent possible.

*** The origin of the term “Zero Waste” is attributed to chemist Paul Palmer, founder of Zero Waste Systems**

Waste MGMT: Zero Waste

Zero Waste (not technically "zero") relies on Five Principles:

1. Refuse – refuse to buy products with excessive of packaging, thus pressuring producers to change production processes.

2. Reduce – don't buy things you don't really need

3. Reuse – repurpose worn out items, shop for used goods, and purchase reusable products like steel water bottles. Reuse extends to "upcycle" programs that match used goods with willing future users.

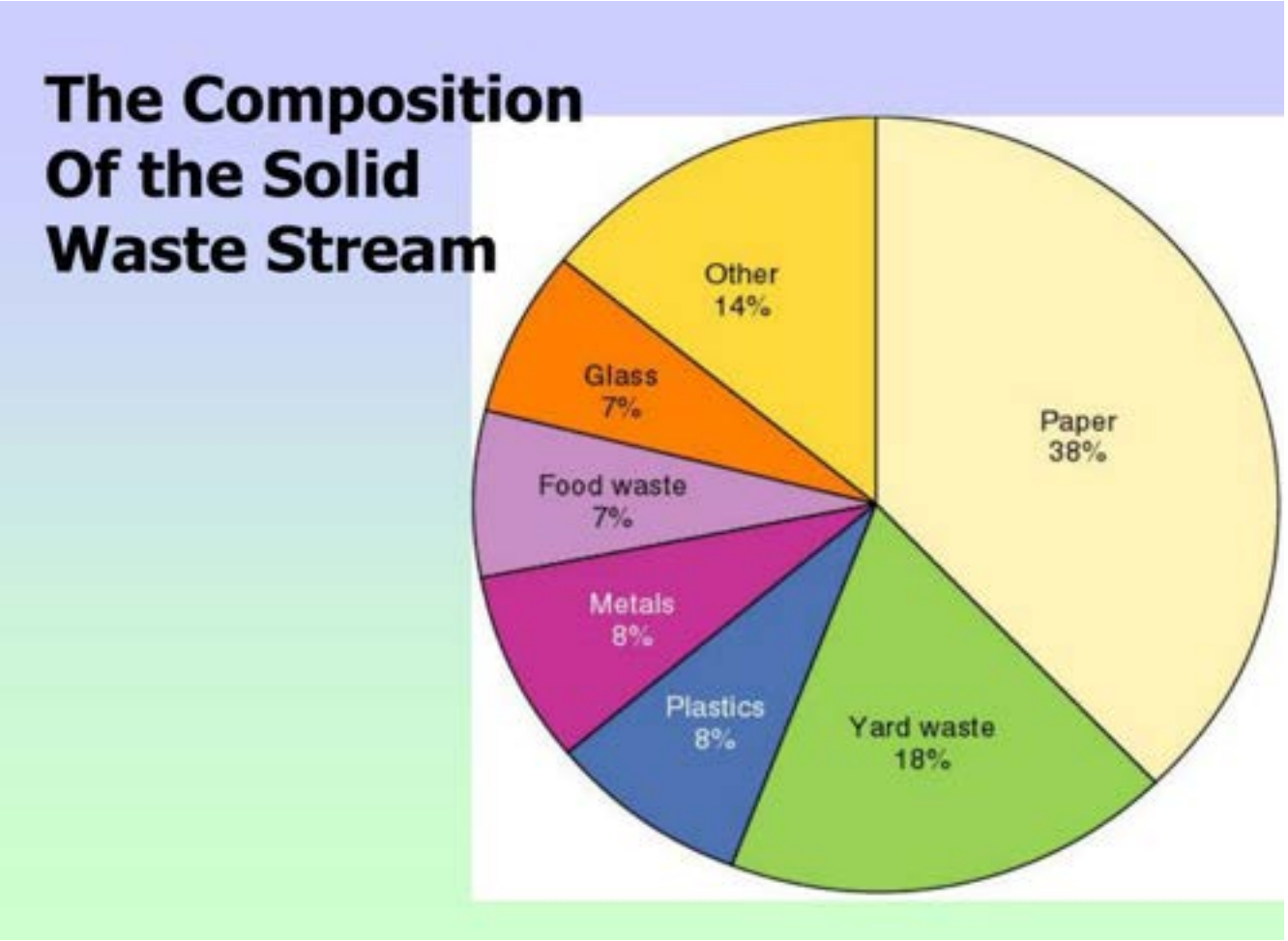
4. Compost – up to 80 percent of waste by weight is organic. But this rarely decomposes in landfills since the process requires oxygen.

5. Recycle – It still takes some energy and resources to recycle, but it's better than sending stuff to the landfill or allowing it to become litter



Waste MGMT: Zero Waste

Can a Household reduce its waste generation to Zero?
Most (all?) wastes in a typical household are recyclable.



Waste MGMT: Zero Waste

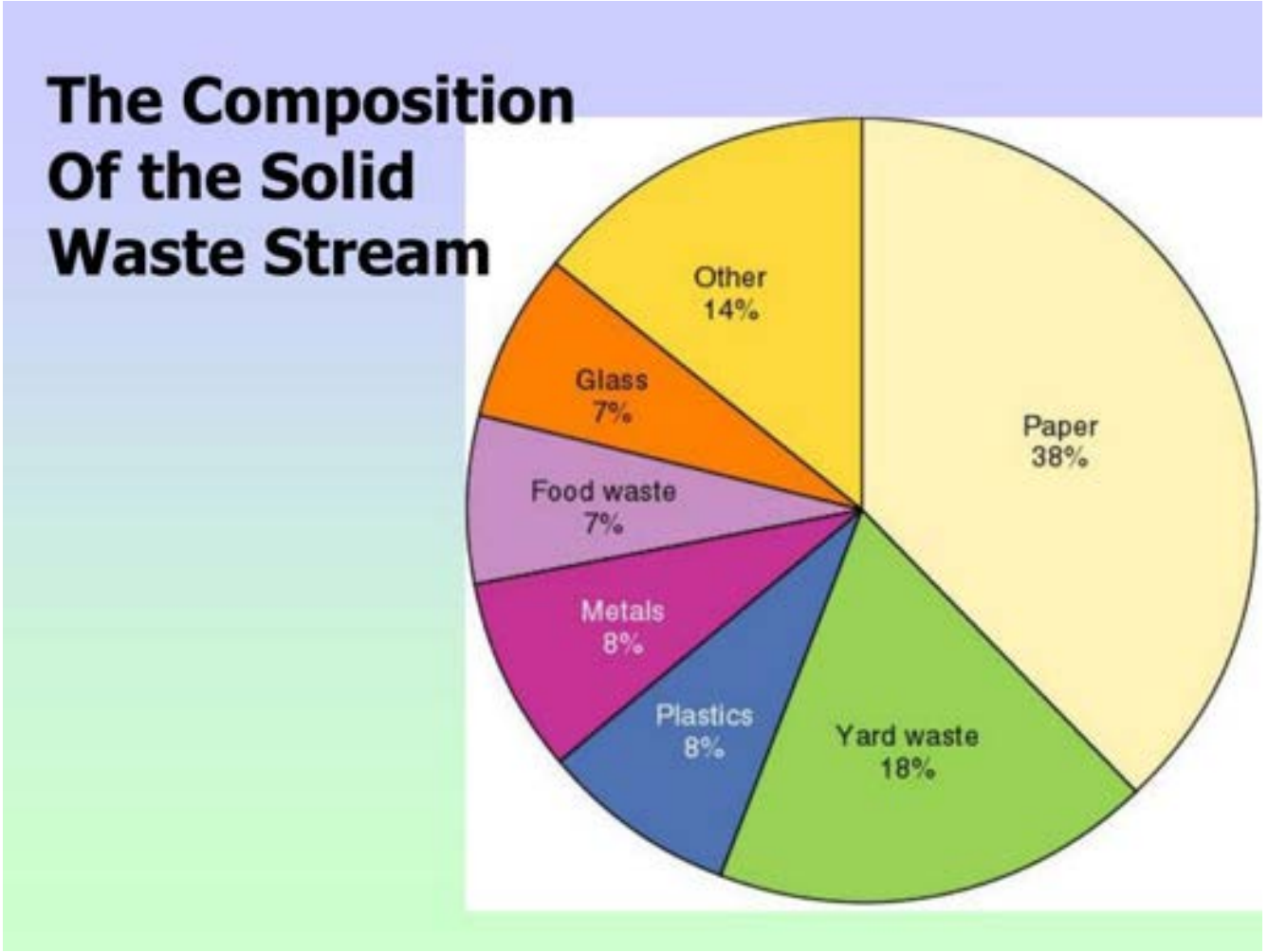
The USEPA estimates that between 75% and 85% of all household solid waste is recyclable* if:

- Organizational opportunities are provided
- Consumer awareness is improved and/or recycling is **mandatory**
- Secondary markets for recycled materials are strengthened

An additional 2-5% of MSW can be removed for re-use and an additional 5% of MSW reduction can be achieved from changes in purchasing decisions.

This amounts to as much as 1500 pounds of waste per person per year diverted.

* The latest USEPA data (2018) estimates that 32% of all solid waste generated in the US is recycled.



Waste MGMT: Zero Waste

For a typical residential property, on-site waste storage is dramatically reimagined.

Composting buckets are used and recycling containers are enlarged and compartmentalized.

Most importantly, waste disposal containers are reduced to a fifth or even a tenth of current size.

But can we achieve even further reductions?



Zero Waste at Home

The “Mason Jar Challenge” imagines an individual’s entire “non-recycled” waste stream over the course of an entire year fitting into a mason jar.

According to people who strive to meet this goal, 3 steps must be taken:

1. Evaluate your waste generation activities which starts with evaluating one’s purchasing decisions
2. Transition to reusable materials
3. Manufacture daily products at home or do without.



Waste MGMT: Zero Waste at a College

If a two-person “household” can reduce its waste volume by up to 90%, what about an institution?

The same general steps to achieving Zero Waste should apply:

1. Evaluate your waste generation activities including an evaluation of purchasing decisions
2. Transition to reusable materials and implement aggressive waste reduction/recycling strategies.
3. Manufacture daily products in-house or do without.



Waste MGMT: Zero Waste at a City/Town/Country

Zero Waste (in its absolute definition) becomes more difficult to achieve as both scale and heterogeneity (of the waste and the waste generator) increases.

Cities use the marketability of the Zero Waste concept to encourage residents to maximize the use of waste reduction and waste recycling programs.

Kamikatsu, Japan declared itself to be a Zero Waste community in 2003. 20 years later, Kamikatsu boasts a total waste diversion of 80% (the remaining 20% is incinerated).



Waste MGMT: Zero Waste at a City/Town/Country

Vancouver (Canada) has demonstrated similarly dramatic reductions in waste generation (not Zero), as measured by diversions from traditional waste management processes (e.g., incineration). Data demonstrate that waste from Vancouver sent to landfills or incinerated decreased from 480,000 tonnes (2008) to 305,000 tonnes (2020).

Impressive reductions, but not **Zero**.



Waste MGMT: Zero Waste at a City/Town/Country

According to a 2025 report, San Francisco currently diverts 80% of generated solid waste to either composting or recycling programs or to designated material/equipment repair shops (this figure is an increase from 68% in 2009).

Even with these efforts, San Francisco still directs 400,000 tons of solid waste per year to a landfill.



Waste MGMT: Zero Waste at a College

Commonalities for urban areas that have achieved significant solid waste reduction:

- Clear and measurable goals set by government and widespread “buy in” from residents
- Detailed waste management plan and continual educational programs
- Effective waste collection systems with separable composting and recycling programs
- Economic incentives/disincentives
- Continual data tracking and system modifications



Waste Management Options

The Role of Government:

- Educate
  - Public Awareness
  - Goal Setting/Data Collection
  - Role modeling
- Manipulate
  - Consumer Pressure
  - Incentives/Disincentives
- Regulate
- Innovate
  - Technology exchange
  - Research grants



Waste Management Options

Ultimately, governmental intervention is intended to change social behavior.

The change can be long-term (often the goal of education strategies) or short-term (e.g., regulations) or somewhere in the middle (e.g., economic incentive programs such as bottle bills).

The effectiveness of change is influenced by public acceptance or buy-in, regulatory enforcement, and/or the magnitude of economic pressures.



Waste Reduction: Educate

Educating consumers to the **consequences** of their behavior and to the **potential benefits** from changes to that behavior will often result in consumers *actually changing their behavior.*

Visitors to Muir Woods (CA) were asked on random “”quiet days” to reduce their voices (no penalty for non-compliance). The mere request resulted in measurably lower noise levels.

But can education result in *lasting* behavioral change?



Waste Management: Educate

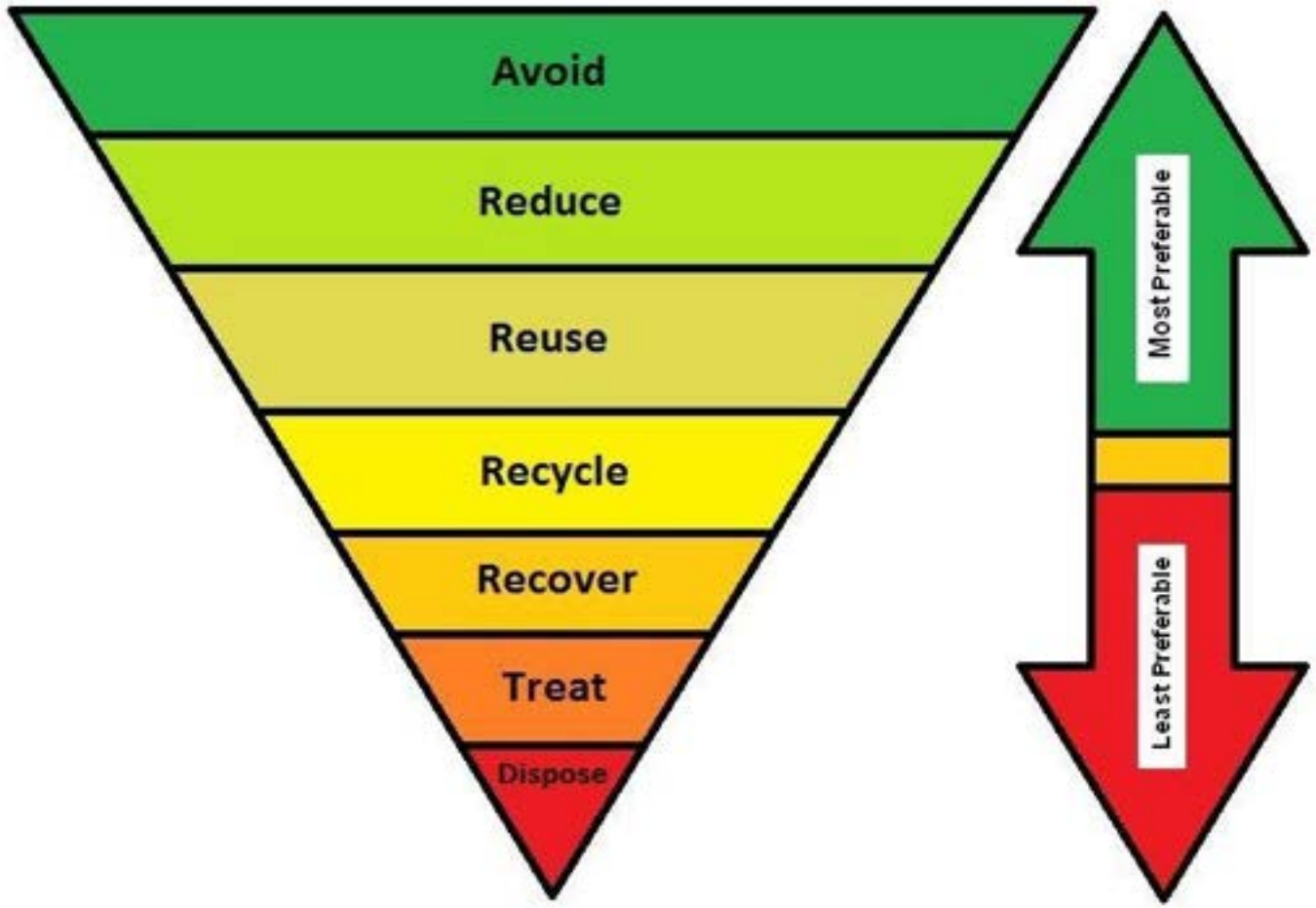
Creation of clear and accurate information is critical to public awareness campaigns and can encourage participation. In contrast, misinformation can result in confusion, apathy and/or loss connection with the overall social goals.

The USEPA has set out a simple public awareness campaign for Municipal Solid Waste.



Waste Management Hierarchy

Updated and Expanded



Waste Management: Educate

Government sets goals based on available data.

USEPA has a goal of 50% recycling of MSW by 2050 (currently at 32%).

New York State has a goal of 85% recycled by 2050 (currently at 40%).

Are goals an impediment to waste reduction?

Need to Conduct a Waste Audit

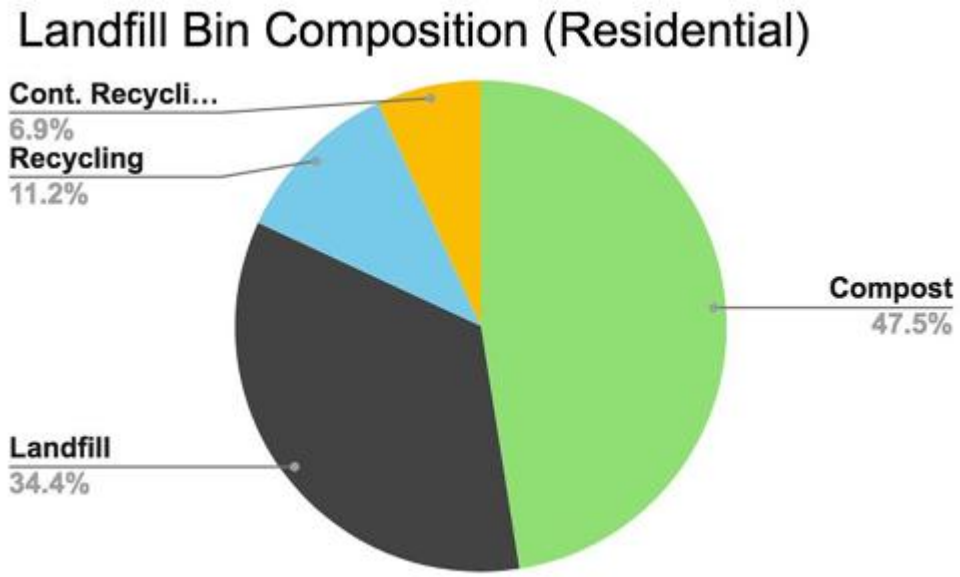


Waste Management: Educate

A waste audit involves examining what wastes are generated and how they are managed throughout your facility. Start with the following questions:

- What type of trash do we generate, and how are we disposing of it?
- Are there items in the trash that could be reduced, reused or recycled?
- Are our trash bins the right size and collected at appropriate intervals?

Vassar conducted a Waste Audit in 2020. The results indicate that most of the waste generated on campus could be recycled or at least diverted from the Incinerator.



Waste Management: Educate

Other Colleges have completed Audits with the following findings:

- Even though recycling is mandatory, many campuses do not actively promote recycling. Composting of food scraps remains the least recycled component of a College's waste stream.
- Campuses experience spikes in waste generation, most notably during "move in" and "move out" periods. At Tufts University (MA), an estimated 15% of all student-generated waste came during these two periods.
- Landfill/waste disposal fee reductions provide economic incentives for aggressive waste reduction programs. Middlebury College (VT) saved an estimated $100,000 on landfill fees as a result of aggressive composting.



Waste Management: Educate

Peer Pressure

Power of Collective Consumer Action

- Challenge to Live Plastic Free has resulted in consumers forcing these changes:
  - Tropicana OJ announcing that all bottles will be glass
  - Pantene experimenting with Aluminum shampoo bottles
  - Dental floss made from silk is now available
  - Metal straws now available from Urban Outfitters

Waste Management Strategies: Educate

Peer Pressure (continued)

McKinsey projects a $1Trillion market for sustainable packaging in response to consumer preferences and, more importantly, consumer actions.

McDonald's set a goal in 2018 for 100% of its packaging (food and toys, not raw materials) to be from recycled/recyclable. In 2013, McDonald's announced that it had a achieved a rate of 86.7%.

But McDonald's still provides single use plastic products.



Waste Management: Reduction

Celebrity Pressure has been shown to have meaningful impacts on consumer purchasing patterns and can convey information that will modify purchase behavior.

Pharrell Williams teaming up with "Bionic Yarns", a firm using recovered plastic for high performance yarn.



Leonardo DiCaprio, named UN Messenger of Peace on Climate Change in 2014.



Waste Management: Reduction Cradle to Cradle Movement

RCRA (1976) regulations codified the concept of “Cradle to Grave” management of waste. While RCRA epitomized to need for extensive oversight of waste, it presumed that the “end of life” for waste was a landfill (the “grave”).

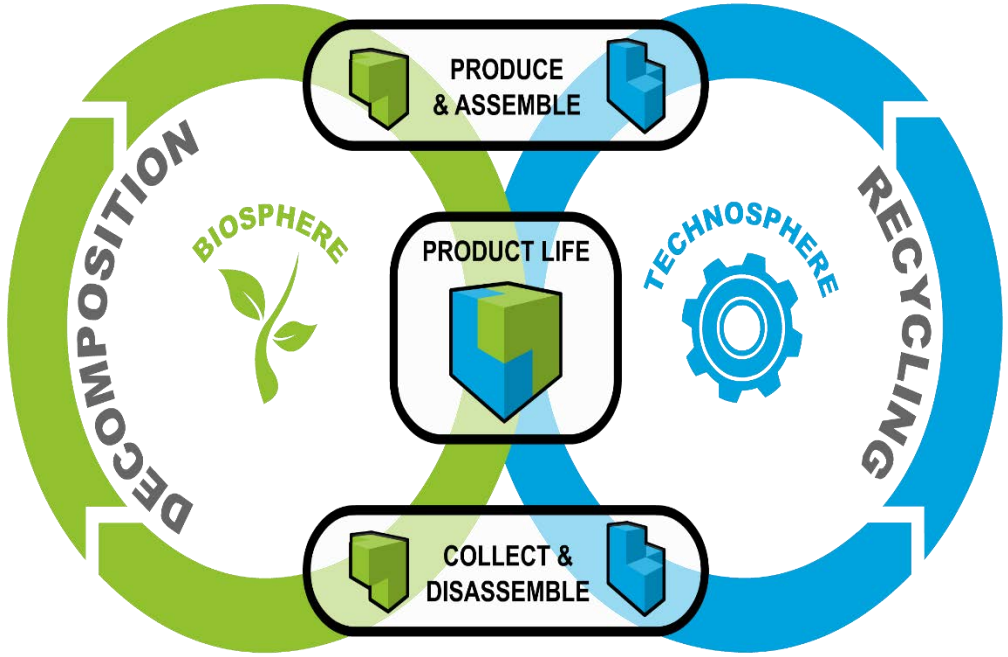
“Cradle to Cradle” (“C2C”) thinking presumes that product design and product manufacturing incorporate the concept of that product being an input to a future product at its natural end.

Such thinking is referred to as “biomimetic”. C2C is also referred to as a “Circular Economy”.

Waste Management: Reduction Cradle to Cradle ("C2C") Movement

This approach is modeled after nature's long-evolved, low-waste, energy-conserving processes. Just like a tree is born from soil created by other dead trees, grows using local resources, produces fruit or seeds, and then dies, in turn creating food and soil for other organisms (a cycle), human beings can make products that are part of an ongoing circular system.

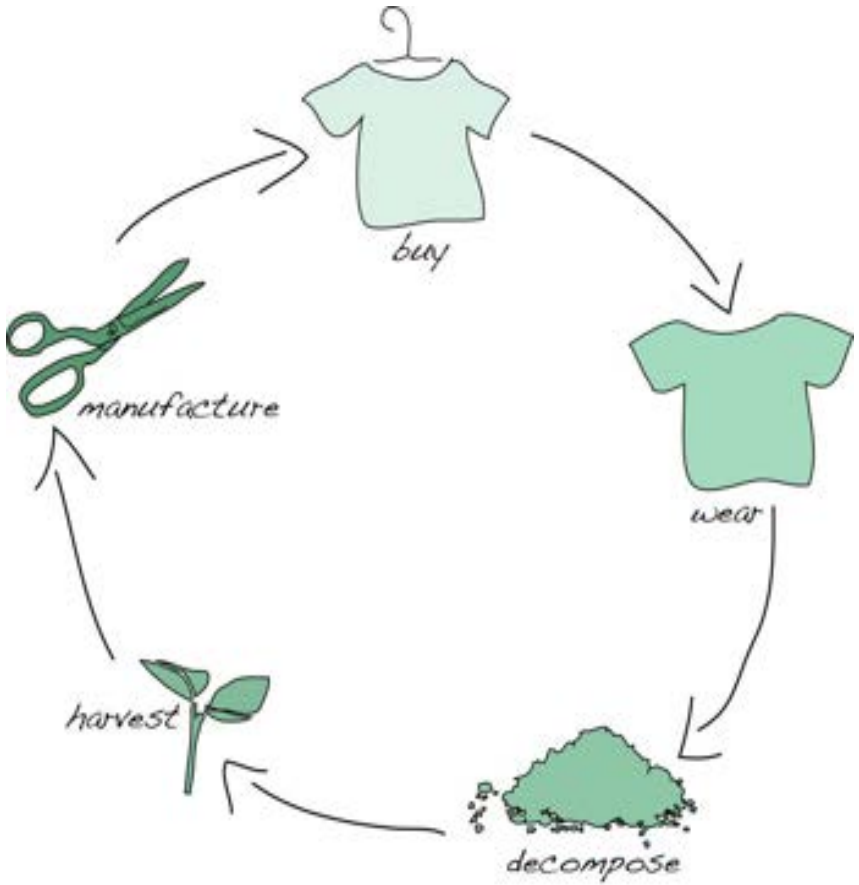
Source: Treehugger.org (10/31/2021)



Waste Management: Reduction Cradle to Cradle ("C2C") Movement

Let's consider the lifecycle of a shirt. The conventional cradle-to-grave model would include extracting petroleum products (for the nylon) and expending energy to manufacture and then transport the shirt that is worn for a few years, then tears or fades and ends up in the landfill.

In the C2C model, the shirt is made from materials that are already part of an existing use cycle, and at end of life, the materials it's made from enter the cycle to be used again to make something else. That could be another piece of clothing or another type of product.



Source: Treehugger.org (10/31/2021)

Waste Management: Reduction
Cradle to Cradle ("C2C") Movement

C2C is a radical rethinking of the product design and manufacture process. It is, at its core, a wholesale incorporation of sustainability into the consumer economy.

C2C's success as a movement depends on:

- Consumer Awareness
- Consumer Activism
- Clear and meaningful Certification



Waste Management: Regulate

Why we Allow Government to Impose Regulations:

- Maintain social order and stability (including economic)
- Protect individual rights and prevent/minimize harm
- Distribute social costs and social welfare

Examples of Solid Waste Regulations

Disposal bans: eliminate specific products from waste stream

Prohibitions on generation of specific wastes

Clarity in what ***must*** be recycled

Waste Management: Regulate

Outright Bans: “Styrofoam”

In 2019, the EU banned the use of Styrofoam in food containers.

In 2020, NY State banned the use of Styrofoam containers in food service (both food and beverage containers).

Other states with Styrofoam food container bans include: Maryland, California, New Jersey, and Colorado.



Waste Management: Regulate

Bans on Single Use Plastic Bags

In 2020, statewide plastic bag laws became active in Maine, New York, Oregon and Vermont, with Connecticut and Delaware joining in 2021. This comes in response to California passing legislation to ban plastic bags in November of 2016. With Hawaii — which has a de facto ban due to all of the state's counties imposing restrictions — added, that brings the total number of states with plastic bag banning laws to eight.

Across 23 states, over 200 counties and municipalities have their own bans in place. Additionally, the U.S. territories of American Samoa, Puerto Rico, the Northern Mariana Islands, Guam and the U.S. Virgin Islands have enacted plastic bag bans.



Waste Management: Regulate

Loopholes in NY Plastic Bans

With Styrofoam, there are exemptions for meat products, prepackaged food, food prepared at or for medical facilities, and/or any facility that can secure a “hardship waiver”.

For plastic bags, the NY State law exempts: carry-out restaurants, bags used to contain fruits, vegetables, and/or meat products at grocery stores, bags for newspapers, and bags used at pharmacies.

Source: NY Assoc. of Counties, May 8, 2019



Waste Management: Reduction

Regulating Waste by Banning Plastic

It’s more than just plastic bags…

- In July 2018, Seattle became the first major US City to ban plastic straws and utensils
- In Kenya, single use plastic water bottles are banned from National Parks
- In 2015, US banned the use of plastic microbeads in cosmetics

It is important to remember that bans are effective but limited to that particular governmental jurisdiction.



Waste Management: Reduction

Regulating Waste by Banning Plastic

In Dutchess County, single use plastic utensils will no longer be provided by take-out restaurants without a specific request (law passed in May 2026).

The impact is expected to be modest (“a simple nudge towards less waste”, says County Legislator Kristopher Munn) but such regulations could be built upon to eventually ban such products.



Waste Management: Manipulate

Governments actively engage in attempts to change consumer behavior through economic incentives/disincentives.

The term “nudging” is defined by the UN as “interventions that predictably alter behaviour by changing the presentation of choices without limiting options, thus preserving freedom of choice”.

With reference to the “materials economy”, the role of government becomes one that ensures true product costs are determined (inclusive of “externalities”) and that those costs are assigned within the marketplace to the entity best suited to absorb them (maximizing efficiency).

Waste Management: Manipulate

Economic strategies available to governments

a) Transfer responsibility of product disposition to the producer (e.g., bottle bills), sometimes referred to as ”Extended Producer Responsibility”, or EPR.

b) Increase the price of waste disposal as a means of influencing the volume generated; known as

PAY AS YOU THROW (PAYT) programs

c) Impose disincentives such as penalties for non-compliance.

Waste MGMT: Manipulate

Use of Extended Producer Responsibility (EPR)

EPR is an economic strategy to impose environmental costs of a product onto the producer of that product.

In theory EPR:

- Encourages design improvements to offset product impacts, thus avoiding or reducing the EPR
- Encourages production efficiencies to reduce “loss”
- Incorporates “externalities” associated with products
- Influences design standards adopted or followed by producers with the intent of avoiding EPRs
- Provides funds used by governments to manage product impacts.



Waste MGMT: Manipulate
Use of Extended Producer Responsibility (EPR)

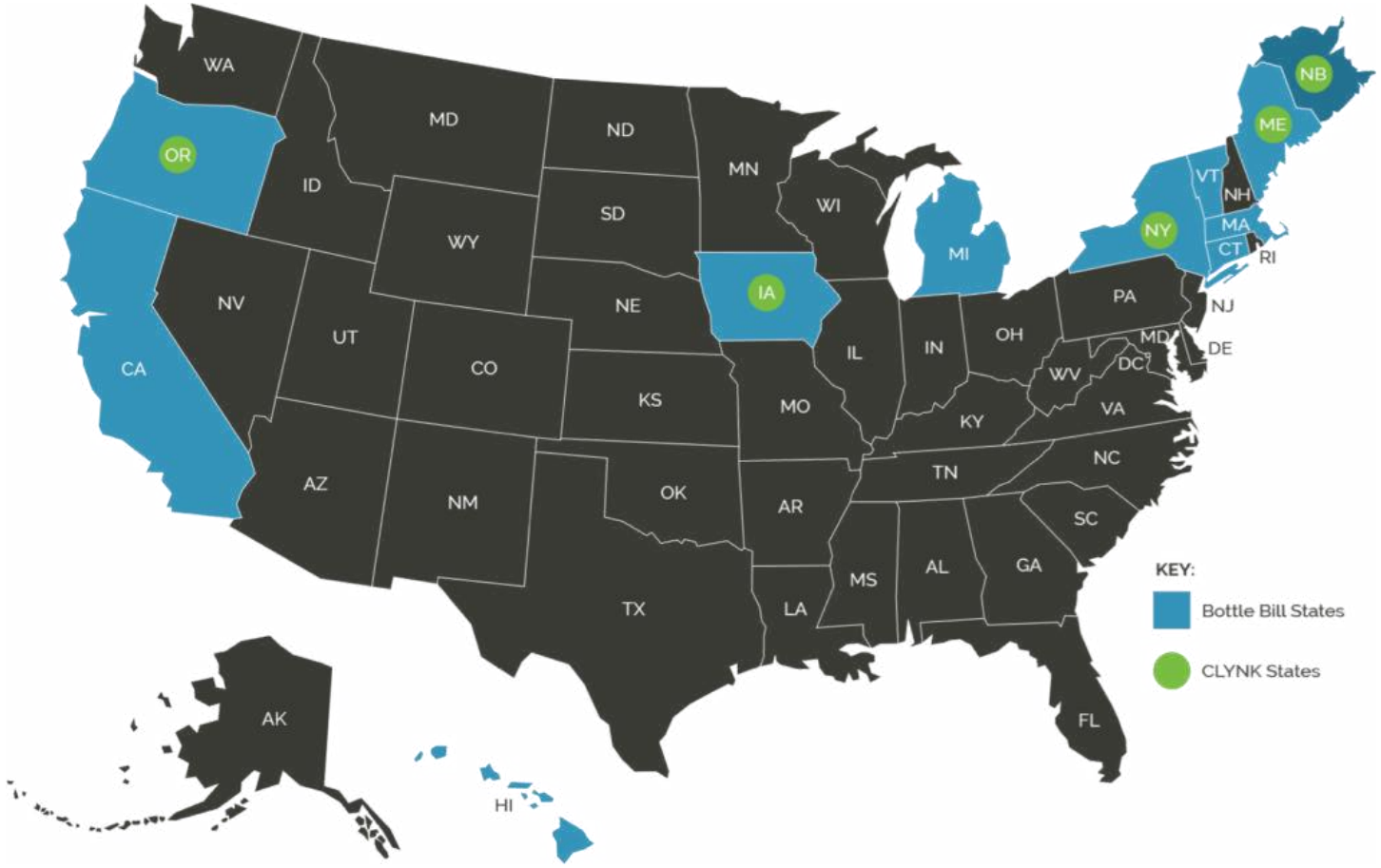
Seven states (California, Colorado, Maine, Maryland, Minnesota, Oregon and Washington) have passed EPR for packaging bills in just the past five years, and several more states are advancing similar measures.



Waste MGMT: Manipulate

Expansion of Container Deposit Laws

One form of EPR is a container deposit laws (commonly referred to as “Bottle Bills”). Ten states have such laws and each state has a slightly different array of products subject to a deposit; the deposit amount varies from 5 to 15 cents.

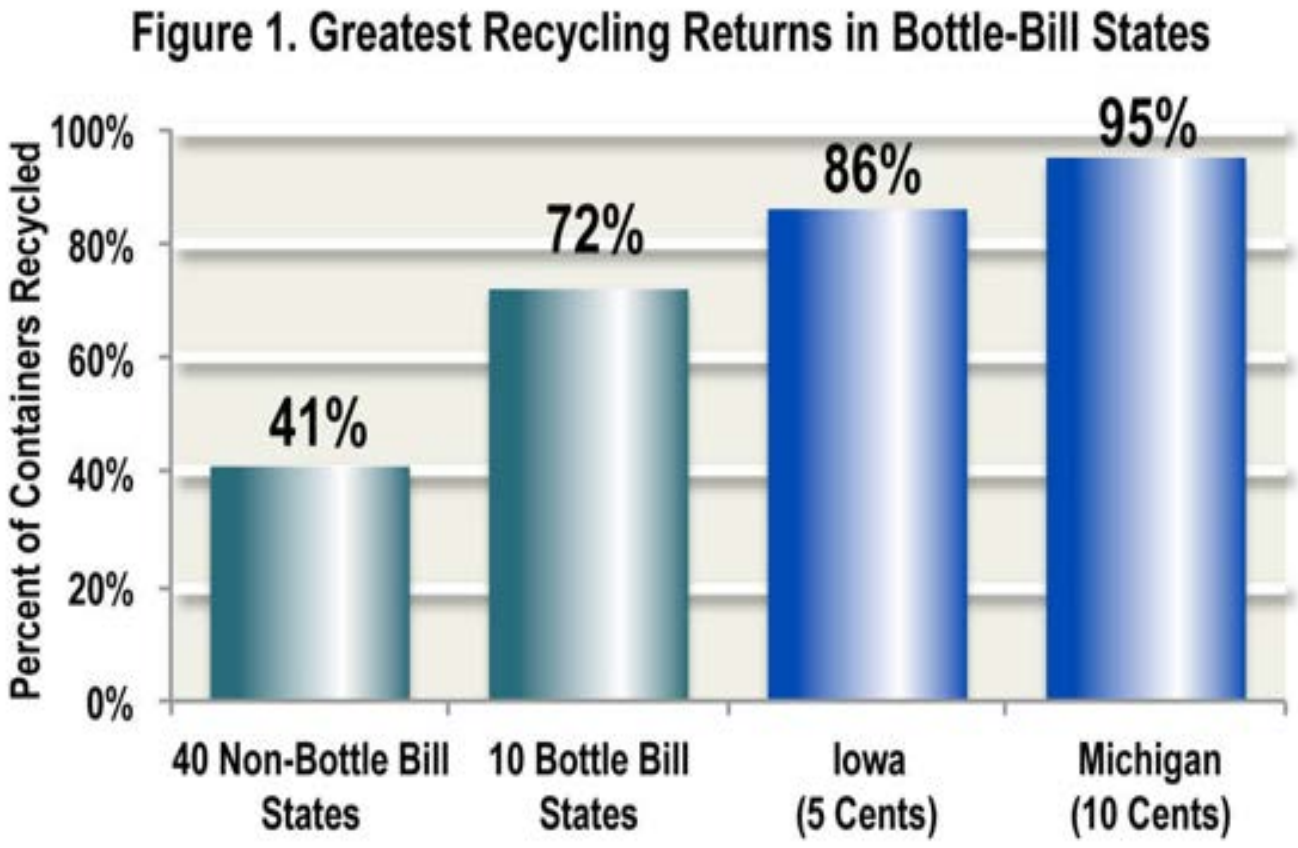


Waste MGMT: Manipulate
Expansion of Container Deposit Laws

Recycling rates for containers subject to a deposit are significantly higher than containers not subject to the deposit.

National average for recycling ***all*** bottles and cans is 33%*. Recycling rates of comparable containers in bottle bill states is often double.

* ***Chart compares recycling rates for only those containers subject to bottle bills.***



Waste MGMT: Manipulate
Expansion of Container Deposit Laws

Questions to consider:

- What would the impact be if container deposit laws were extended to the entire nation?
- What would the impact be if container deposit laws were expanded to other liquid containers (e.g., milk and/or wine bottles)?
- What other consumer products might benefit from deposit laws (e.g., plastic food containers and/or cardboard boxes)?



Waste Management: Manipulation
Pay As You Throw (PAYT)

Basic Elements

- Residents are charged for the amount of trash they set out for disposal. As a variation, different waste streams are given different prices to alter specific waste volumes.
- Residents are educated as to the costs of waste management. In addition, residents become more aware of their waste generation habits.
- Residents are encouraged/manipulated into reducing their waste volumes.

Waste Management: Manipulation
Pay As You Throw (PAYT)

Program Rationale:

- Economic: Users of a municipal service should pay for that service and their payment should be commensurate with their rate of use. From an economic perspective, targeting only service users is considered more *Efficient*.
- Environmental: PAYT programs encourage alternate waste management (e.g., recycling) as a means of reducing costs to the consumer and, in doing so, result in reducing the environmental burden of waste management.
- Social: Charging only users of a service and structuring those costs commensurate with use rates is fair.

Waste Management: Manipulation
Pay As You Throw (PAYT)

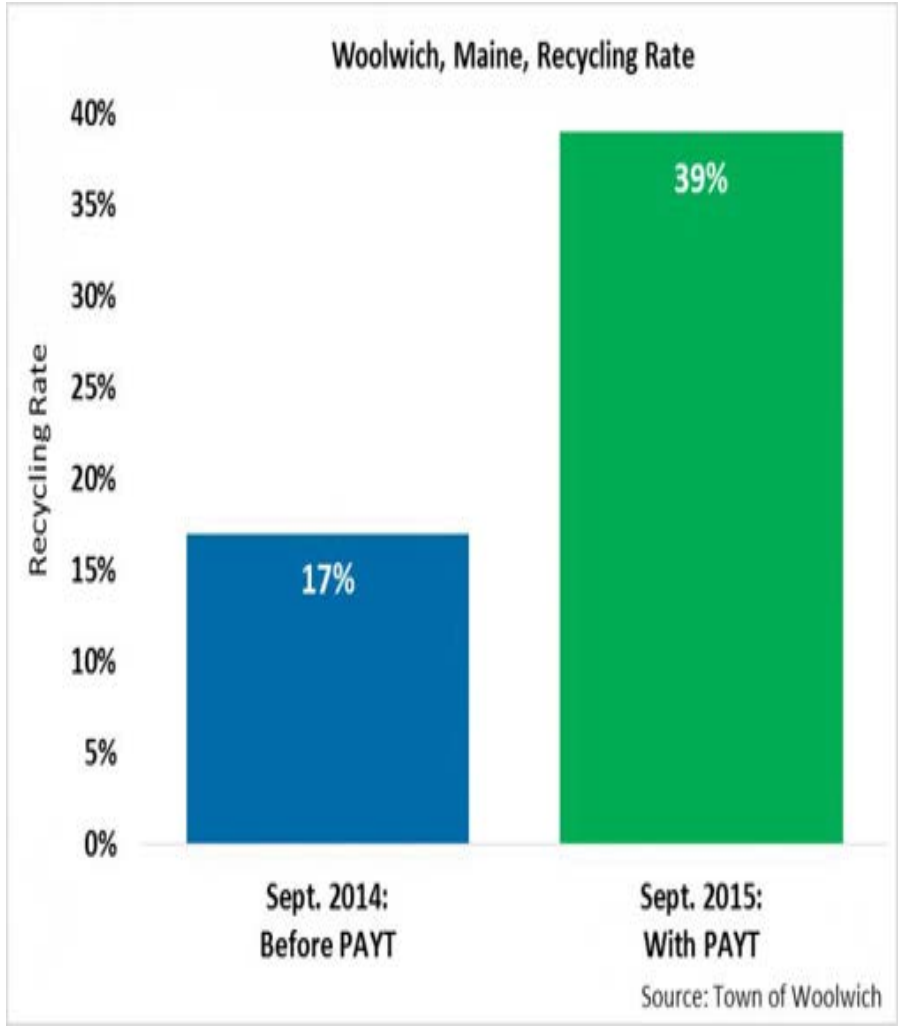
Are PAY AS YOU THROW (PAYT) programs successful?

- More than 7,000 communities use PAYT in the US
- In “PAYT communities”, 43 percent of MSW diverted (on average), with many communities coming close to 50 percent.
- According to a 2010 USEPA study, local governments with PAYT programs produce 467 pounds of landfilled trash per capita per year, compared with 918 pounds of landfilled trash per capita per year in non-PAYT communities.

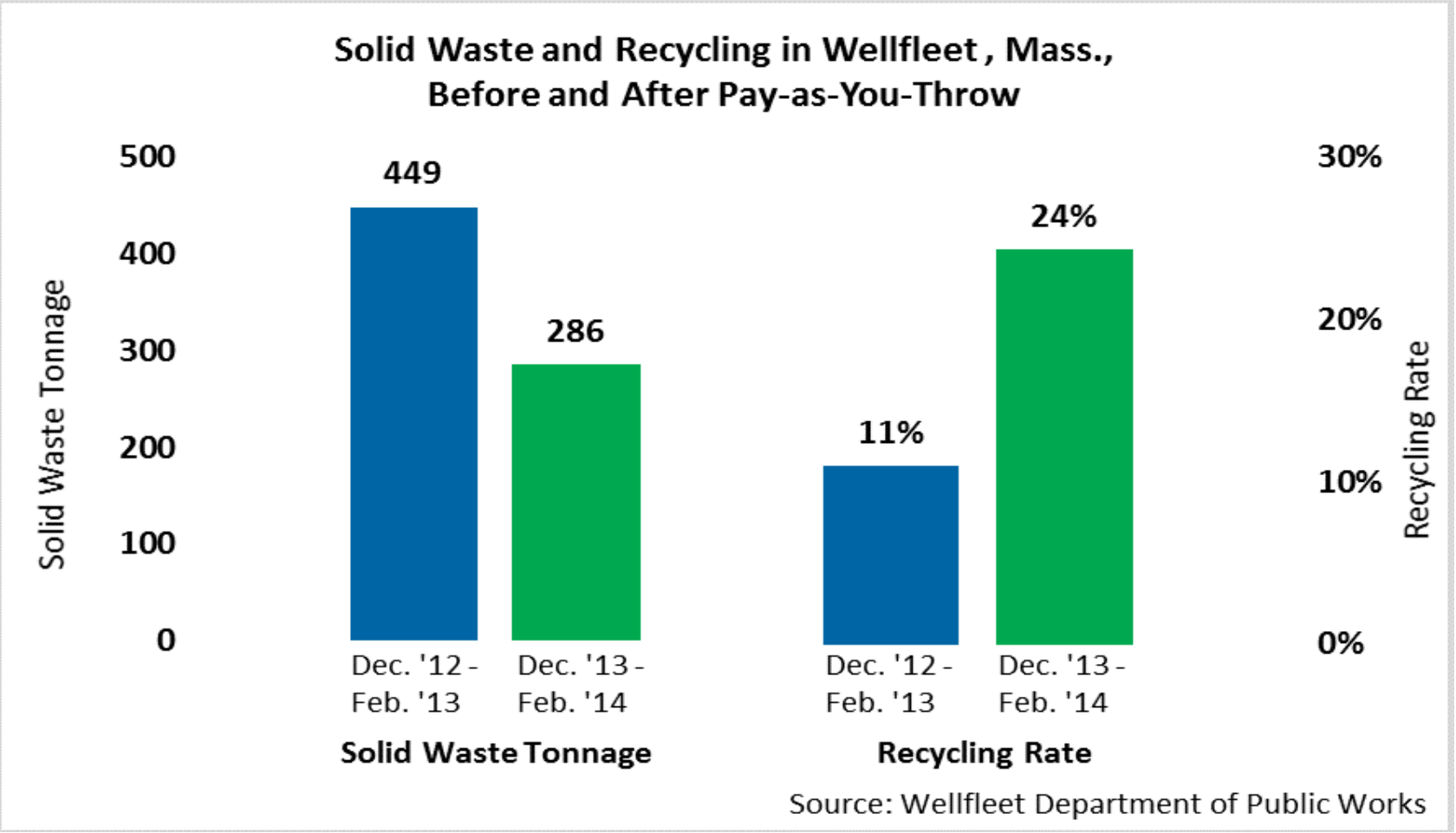
Waste Management: Manipulation
Pay As You Throw (PAYT)

Success Stories for PAYT:

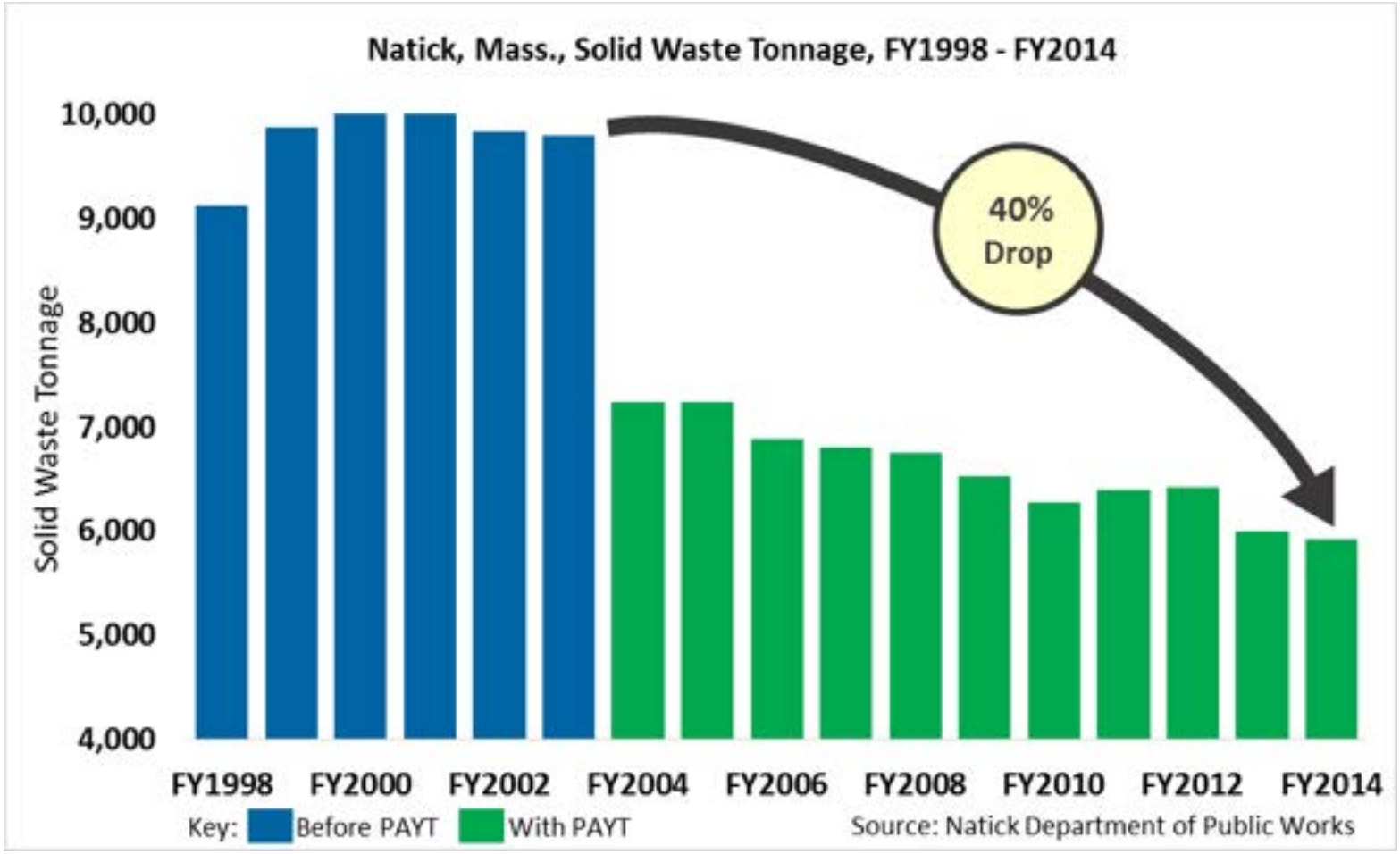
- **Fort Worth, Texas,** cut its landfill disposal costs by more than $7 million after adopting PAYT, and in one year the city also earned $540,000 from the sale of recycled materials.
- The recycling rate in **Woolwich, Maine** more than doubled from 17 percent to 39 percent in the first year of the city's PAYT program.
- **Dover, N.H.,** reduced its annual waste management costs from $1.2 million to $878,000 after adopting PAYT.
- **Worcester, Mass.,** decreased its annual waste management expenses by $1.2 million after adopting PAYT in 1993 and increased its recycling rate from 3 percent to 36 percent.



Waste Management: Manipulation Pay As You Throw (PAYT)



Waste Management: Manipulation
Pay As You Throw (PAYT)



Waste Management: Manipulation

Impose Disincentives

Government can provide financial disincentives as a means of encouraging participation in solid waste management programs. Two common forms of disincentives are:

- Fines for non-compliance
- Tiered pricing schemes

In both instances, the objective is (or should be) clear: to discourage members of society from engaging in behavior that government wants them to avoid.

Disincentives become the “stick” to the proverbial “carrot” represented by incentive programs such as bottle bills.



Waste Management: Reduction

Impose Disincentives

In New York City, residents who choose not to compost may incur fines ranging from $25 per offense to $300 per offense (each day being a separate offense).

Sanitation workers have been directed to inspect waste receptacles and note commingled wastes. Residents will then receive notification of non-compliance and, if it continues, fines.



Waste Management: Reduction

Impose Disincentives

Tiered pricing schemes for solid waste management are modifications to the PAYT concept.

Modifications include:

- Attempts to address excess waste generation by charging larger volumes at higher rates
- Attempts to address concerns of “illegal dumping” by keeping charges for baseline waste generation volume reasonable



Waste Management: Reduction

Impose Disincentives

Tiered pricing might work in the following way:

- All participants are charged $50 for the first 32 gallon garbage container used over a period of time (e.g., per month).
- The second 32 gallon container is charged at $100 and the third is charged at $200.
- The increasing rate encourages waste reduction but accepts a baseline volume “necessary” for members of society.



Waste Management: Reduction

Impose Disincentives

The cost of legal waste disposal influences the probability of an increase in illegal waste disposal. This dynamic is seen clearly in areas of the world with less police presence, less social controls or expectations, and less economic or judicial accountability.

Think Italy.

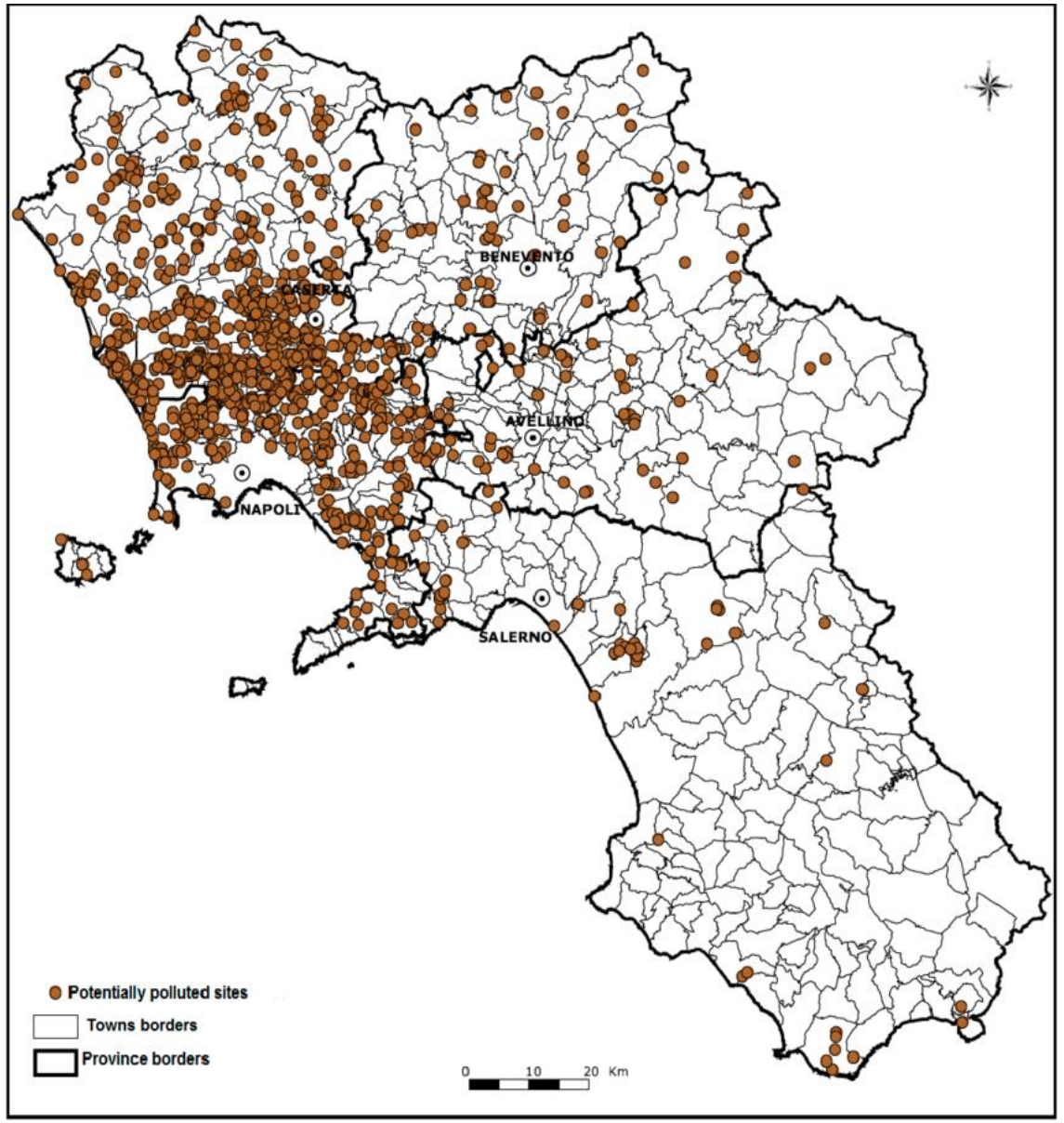


Figure identifies illegal dumping locations in the State of Compania, just south of Naples. The region is known as the "Triangle of Death" where cancer rates are double the national average

Waste Management: Reduction

Impose Disincentives

In 2024 (most recent data), there was a surge (66% increase in one year) of documented crimes relating to illegal waste disposal, managed primarily by the “Ecomafia”.

The estimated revenue from illegal waste management in Italy in 2023 was 8.8 billion Euros.



Waste Management: Increase Recycling/Reuse

- Expand accessibility for Recycling/Reduction Programs
  - Neighborhood centers for Free Cycle and Repair cafes
  - Curbside composting
  - Intensive recycling/reduction on special days
- Provide incentives
  - Financial awards to communities
  - Community-wide recognition
- Expansion of “wastes” subject to recycling
  - Neighborhood composting centers and battery drop-off areas
  - Additional plastic products included as recyclable
  - Expansion of recycling facilities to process commingled and “tainted” wastes
- Compulsory recycling



Waste Reduction: Innovation

Artificial Intelligence (AI) has the potential to identify opportunities for waste reduction and/or improved recycling.

Specific possibilities include:

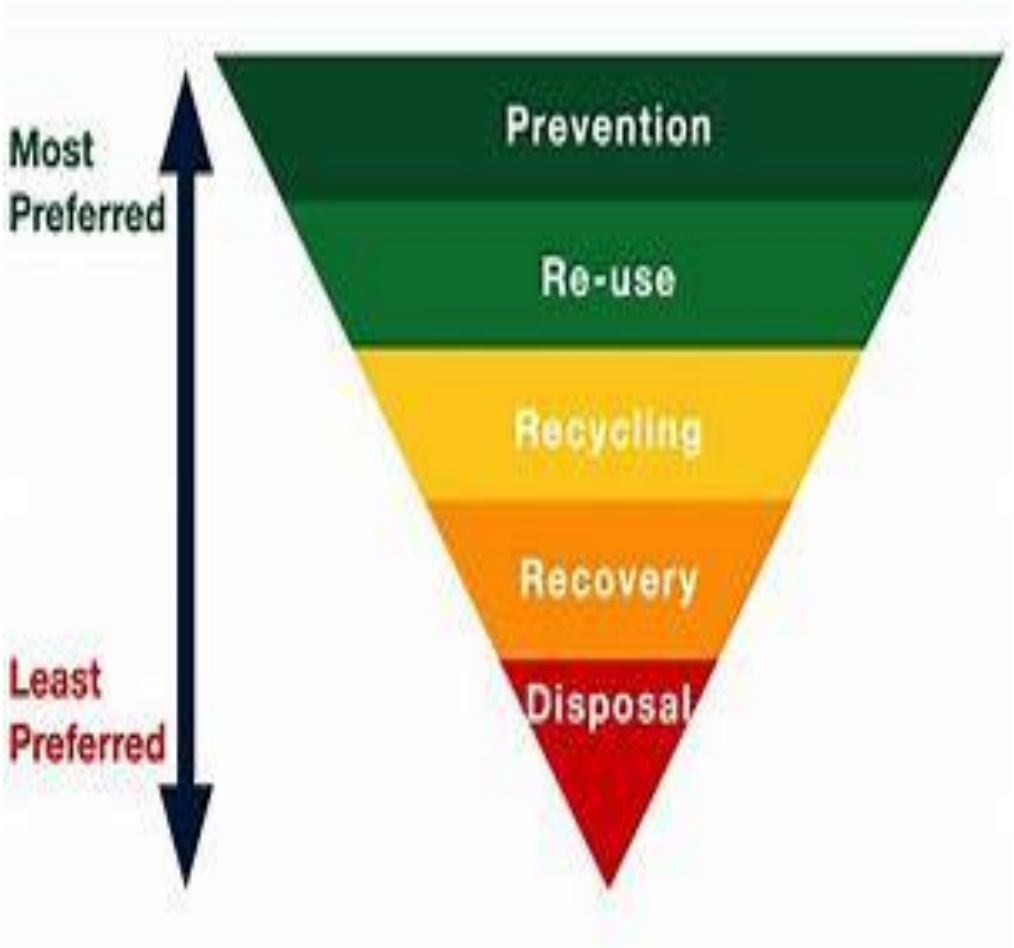
- Robotics is recycling sorting to reduce error
- Robotics in waste collection to increase efficiencies
- Use of “smart bins” to minimize waste collection costs

Waste Management: End of Life Options

"End of Life" management options refer to those options that are utilized for all waste remaining after all reduction strategies have been implemented. In the US, **the most common "end of life" facilities for solid waste are landfills and incinerators.**

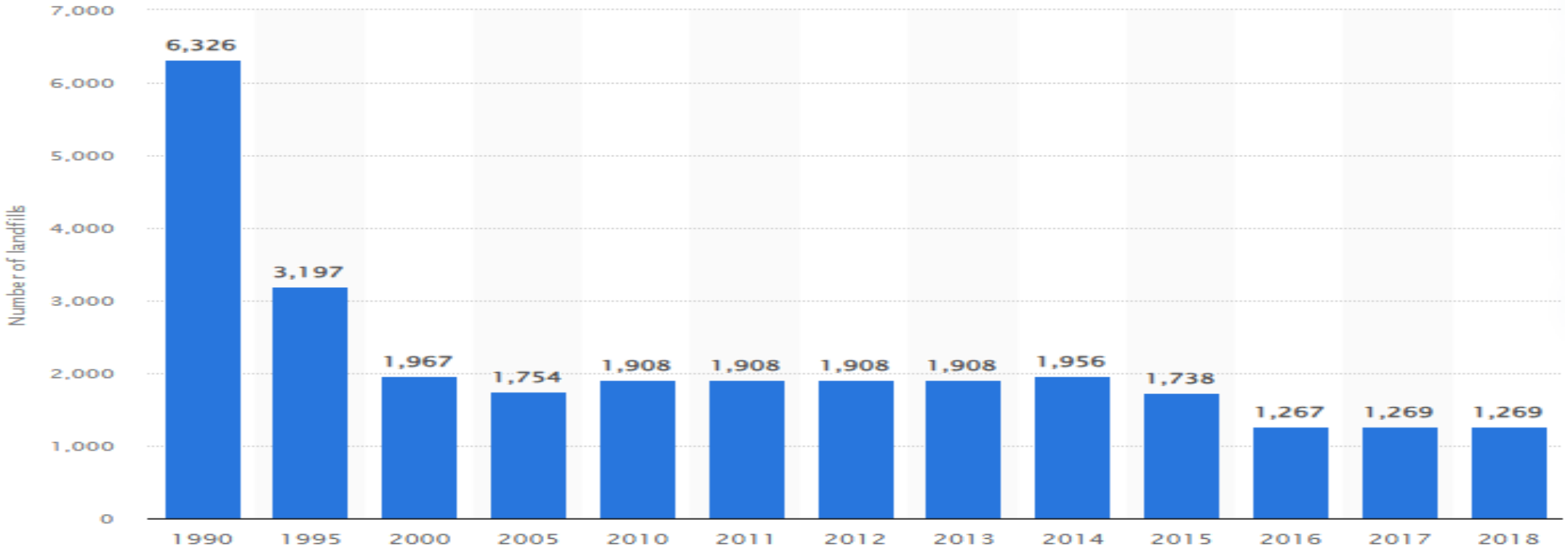
In the US, almost 200 million tons of solid waste was diverted to "end-of-life" facilities in 2018.

In short, "end-of-life" facilities are the "go to" options for waste management in the US.



Waste Management: End of Life Options

Landfills are engineered areas where waste is placed into the land. As of 2018, 66.6% of all MSW (post-recycling) in US was managed at a landfill. Worldwide, only 37% of all solid waste is disposed of in a landfill (source: WorldBank). According to the USEPA, there are 1,269 active (2018) MSW landfills in the US (86 are located in New York).

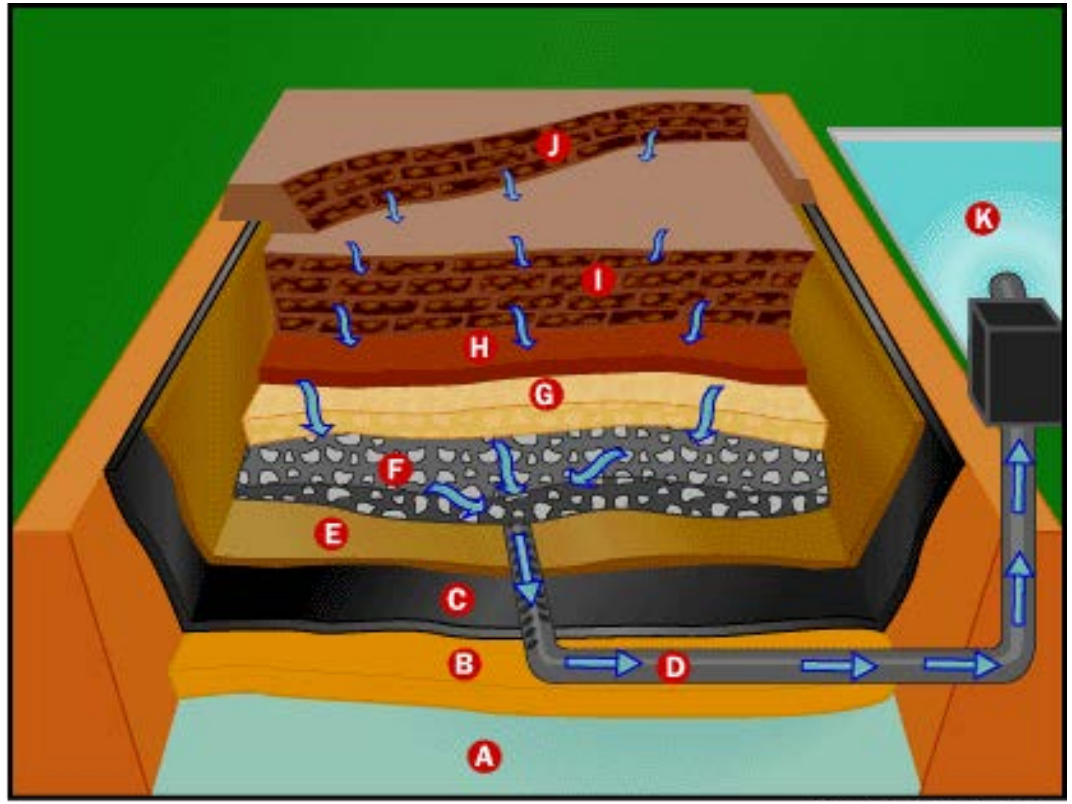


Waste Management:
End of Life Options Landfills

Design Components

- A Ground Water
- B Compacted Clay
- C Plastic Liner
- D Leachate Collection Pipe
- E Geotextile Mat
- F Gravel
- G Drainage Layer
- H Soil Layer
- I Old Cells
- J New Cells
- K Leachate Pond

Landfill Design



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Waste Management:
End of Life Options Landfills

Environmental Impacts of Landfills

1. Potential for leakage/groundwater contamination

   Landfills present a clear and present potential threat to human health as well as a threat to our environment. As noted even the best landfill liners will leak…"82% of surveyed landfill cells had leaks while 41% had a leak area of more than 1 square feet, " according to Leak Location Services, Inc. (LLSI) website (March 15, 2000).

2. Air Pollution/Methane generation

   In a recent study of 288 landfills, **off-site migration of gases**, including methane was detected at 83% of these sites.

3. Vector Control

   Health nuisances such as rats, flies, and mosquitoes

4. Odors

   Putrescible wastes decay, generating odors

Waste Management:
End of Life Options Incinerators

Incinerators are MSW facilities that burn waste, reducing the volume of MSW to as much as 95% (depending on waste composition) by exposing it to high temperatures (1500 to 2000^{0}F).

There are (2026) 72 operational MSW incinerators in the US managing 35M tons (USEPA, 2018 data). In the 1900s, incinerators were considered the “go to” waste management option with as many as 700 incinerators operating in the US in the 1930s (22 in NYC alone). With the advent of Clean Air regulations, most incinerators were forced to close (32 have closed since 2000). Only one new incinerator (Palm Beach, FL in 2015) has opened in that time.

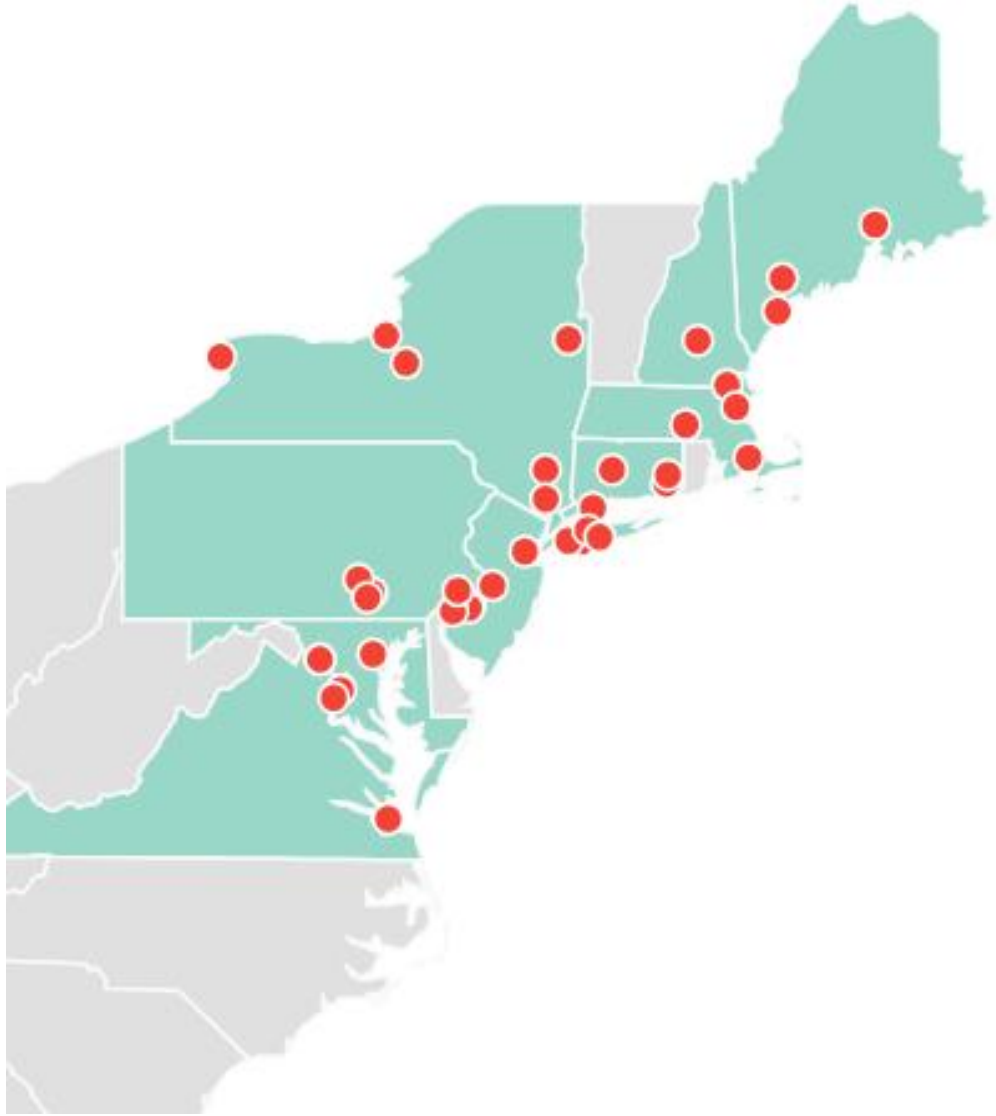


Waste Management: End of Life Options Incinerators

Often MSW incinerators combine their waste reduction service with the generation of electricity, renaming themselves as “Waste to Energy (WtE)” plants. In the US, there are 63 WtE plants across 18 states, with the majority of them concentrated in the northeast.

According to the USEPA (2018 data), only 12% of all MSW is incinerated.

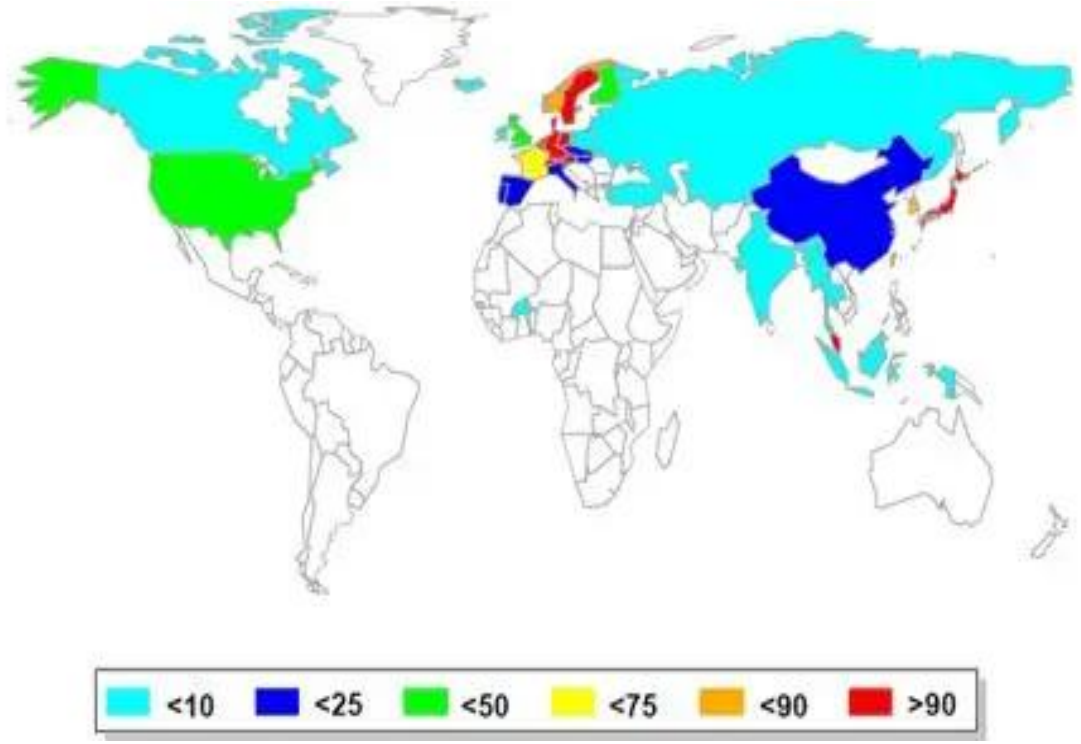
* The Dutchess County facility is a WtE plant with a capacity of 450 tons per day.



Waste Management: End of Life Options

Worldwide, managed MSW incineration varies substantially. In Japan, over 90% of all MSW is incinerated. In Mexico, less than 1% of all collected MSW is incinerated.

These data do not include waste that is burned at landfills or open pit, a strategy employed in many developing nations.

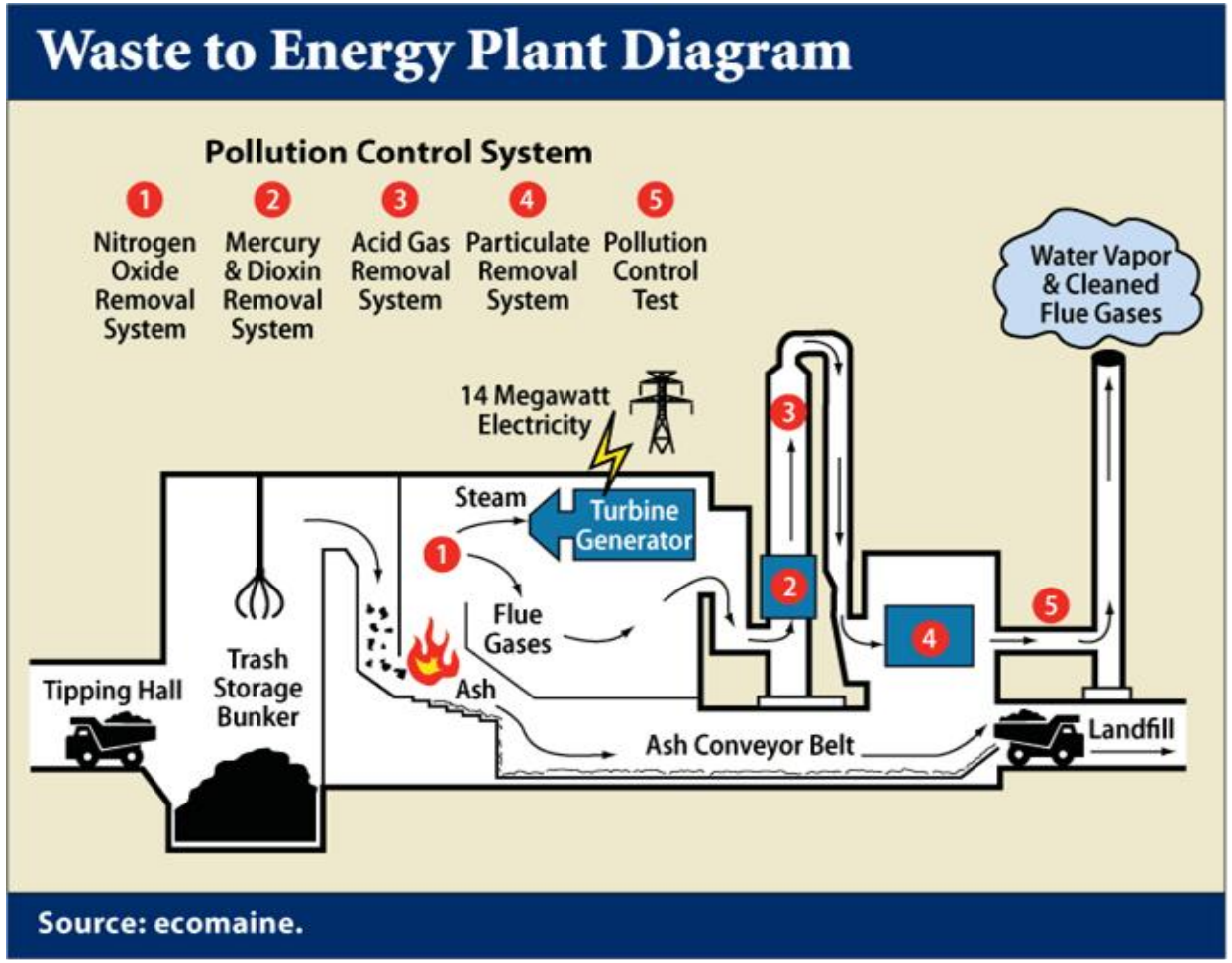


Waste Management:
End of Life Options Incinerators

Incinerator Concerns:

- Air Pollutants
  - Nitrogen Oxide
  - Sulfur Dioxide
  - Metals (Pb, Hg, Cd)
  - Uncombusted organics
- Noise
- Fly ash/particulates
- Environmental justice considerations*

* 79% of all MSW incinerators are located in communities of color (African-American, Latino, etc…) and/or low income communities.



Waste Management:
End of Life Options Incinerators

Perils of Incineration of Solid Waste

- India now (2024) has 60 cities with populations of 1 million or more with massive volumes of trash accumulating in each of these cities (in New Delhi the trash pile covers 150 acres (about 2/3 the Marist campus size);
- India has embarked on an ambitious plan to construct “waste to energy” plants in over half of these cities;
- Current data suggest that air pollution in the vicinity of the incinerators is 50-60 times “acceptable” levels. Impacts include increased asthma rates, reduced birth weights, and increased mortality.



Waste Management:
End of Life Options Incinerators

The alternative is uncontrolled waste management.

Currently (2022), only 20% of all solid waste in India is managed properly (i.e., collected and treated).

As economic growth continues in India, the issue of waste management increases.



Waste MGMT: Final Thoughts

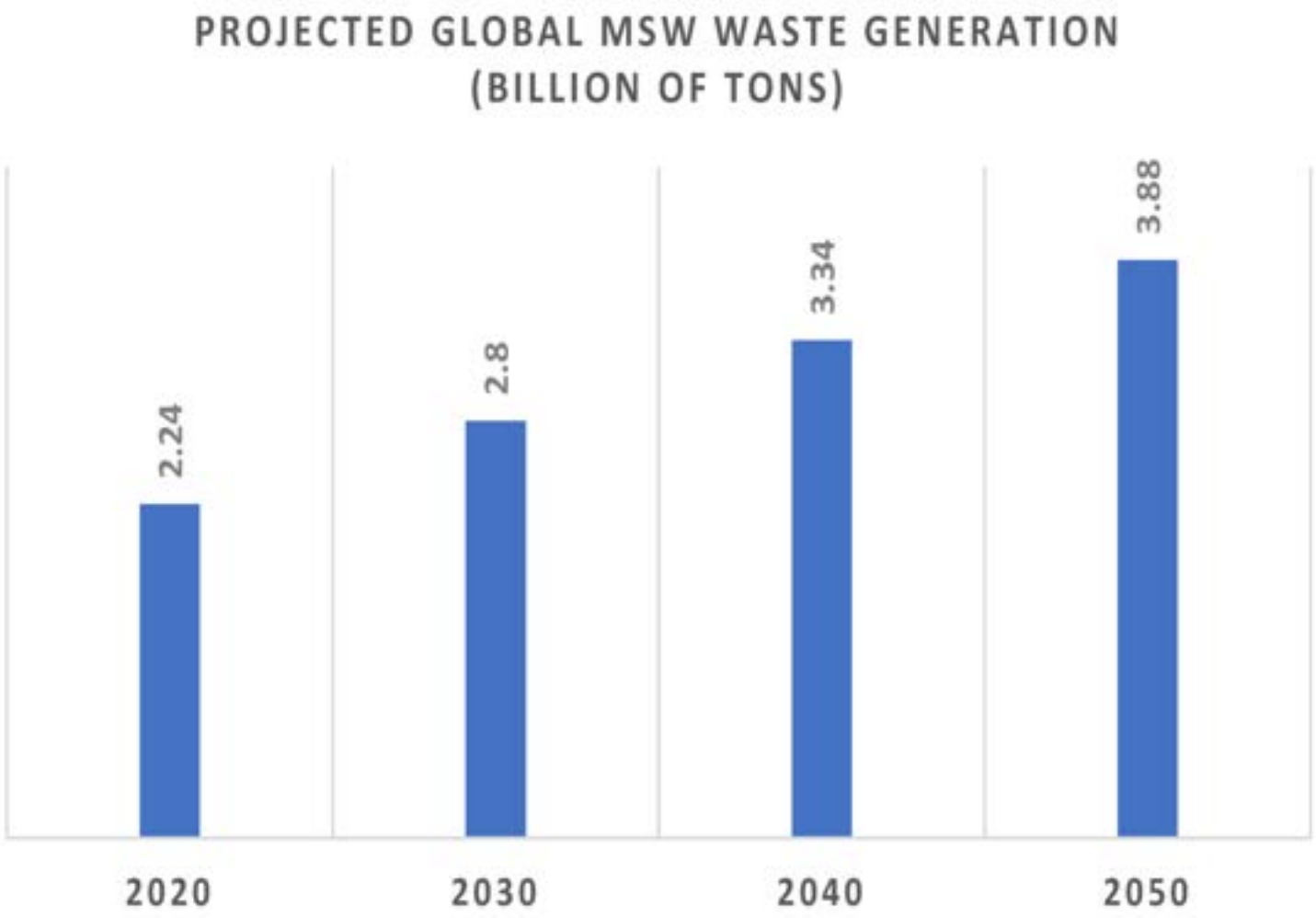
Waste is an extension of consumption habits which makes the consumer simultaneously the **root cause of the problem** and the **source of the solutions**. Social structures (e.g., government and the economy) can be tools to help bring about this change.

While Zero Waste remains an elusive goal in modern society, reasonable and pragmatic steps can (and need to) be taken to significantly reduce waste generation. That is, **meaningful reductions in waste volumes can be easily achieved through the implementation of simple actions.**

Conclusions

Proper management of society's wastes is not a new problem, but it is a problem that is increasing as both the number of people and the wealth of each individual person increases.

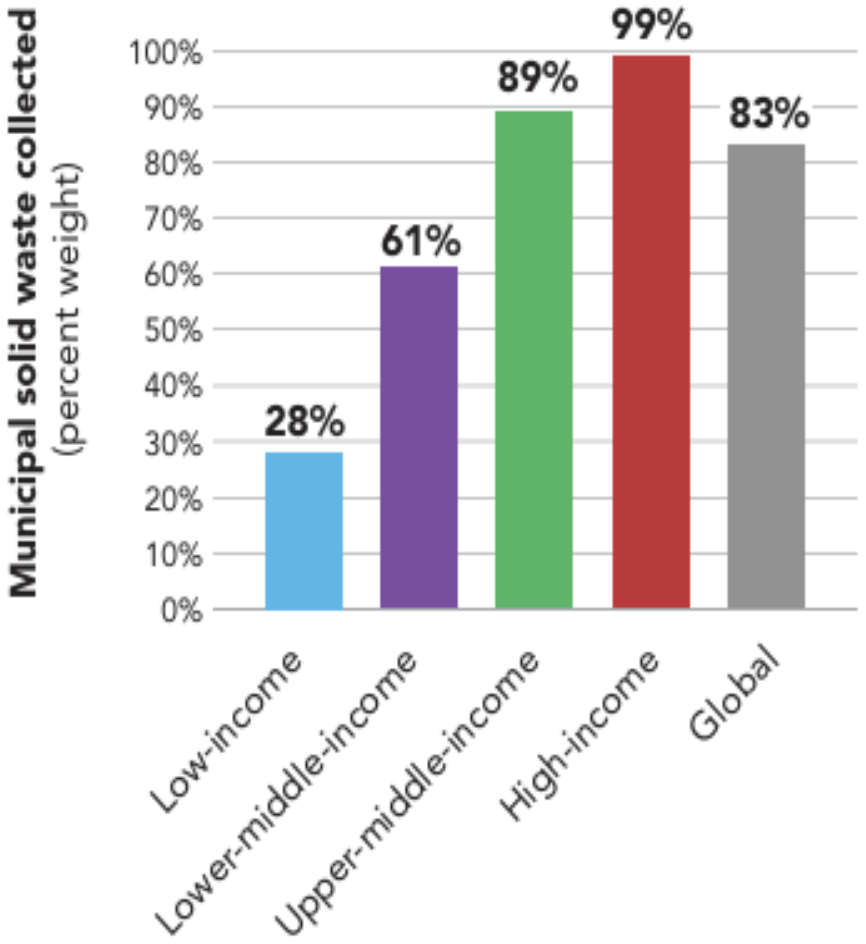
In 2022, an estimated 9 pounds of waste was generated for every person on the planet, and that number is growing rapidly. MSW alone is expected to increase from 2.6B tonnes to 3.9B tonnes within the next 25 years.



Conclusions

We complicate this problem by:

- Mismanaging most of this waste through poor collection practices, poor separation practices, and/or poor disposal practices.
- Transferring responsibility for proper management to future generations.



Source: Original figure for this report.
Note: Mean collection coverage (percent, weighted by the total mass of waste collected in each income group in 2022).

Conclusions

But Society has tools to properly manage this crisis.

Aggressive implementation of all of these strategies can reduce the amount of waste generated by as much as 90% or more.



Waste MGMT: Final Thoughts

Those simple steps include:

- Educating the consumer on strategies that reduce packaging and, by extension, reduce waste. That is **empower** the consumer to choose a less wasteful future.
- Stressing the importance of individual and collective procedures (some conscious and some unconscious) that result in waste generation. That is, moving society closer to Sustainability.
- Implementing pricing schemes that reward waste reduction. That is, using our economic system to encourage social change.
- Utilizing innovative technologies to manage wastestreams.
- Popularizing social programs that redirect waste away from “end-of-life” options including waste reduction programs like composting and aggressive recycling.