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U.S. Trends in Solid Waste Management and GHG Emissions for Workshop on "Methods to Calculate GHG Mitigation Potentials in Solid Waste Management"

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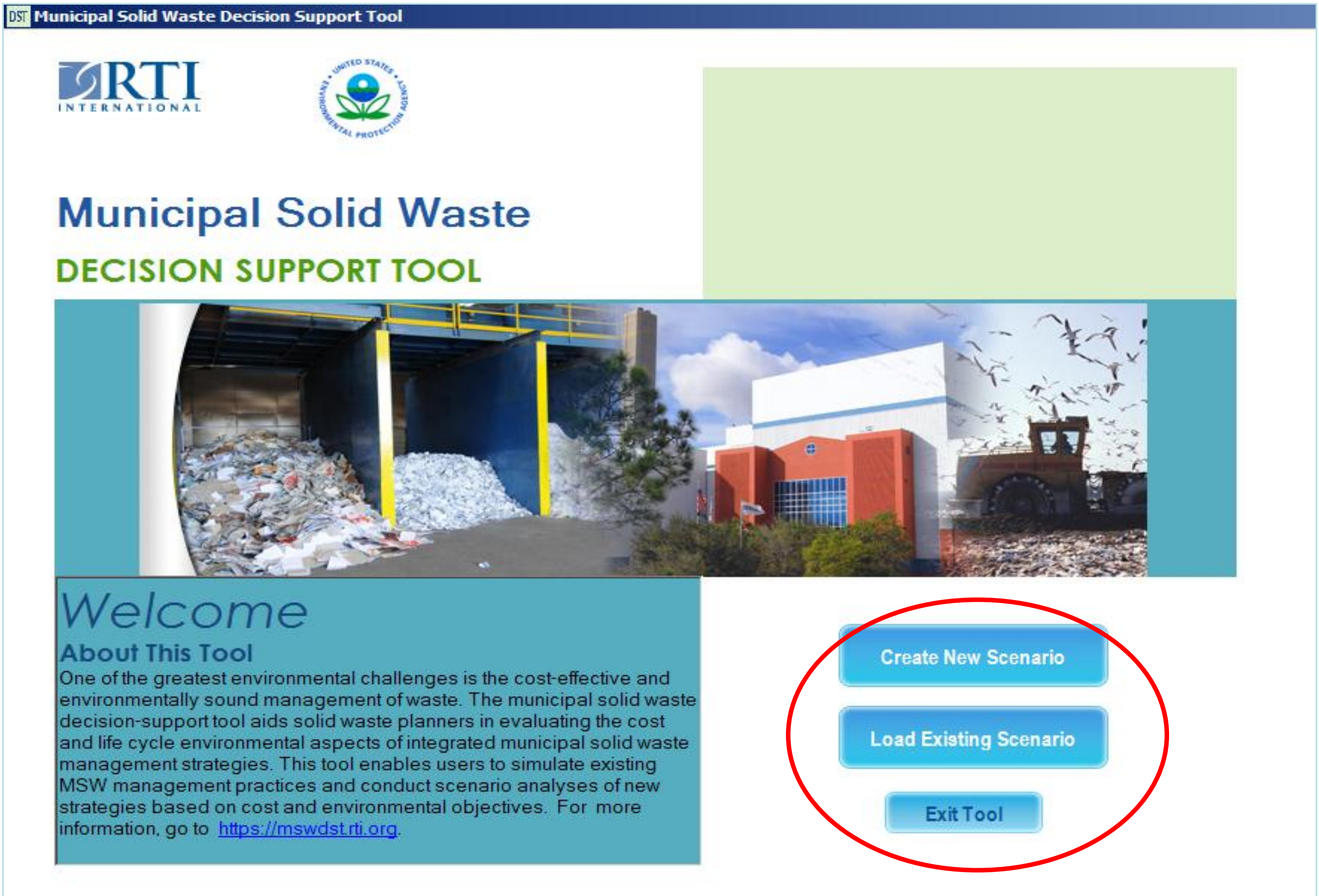
U.S. Municipal Solid Waste Decisio Support Tool (MSW-DST)



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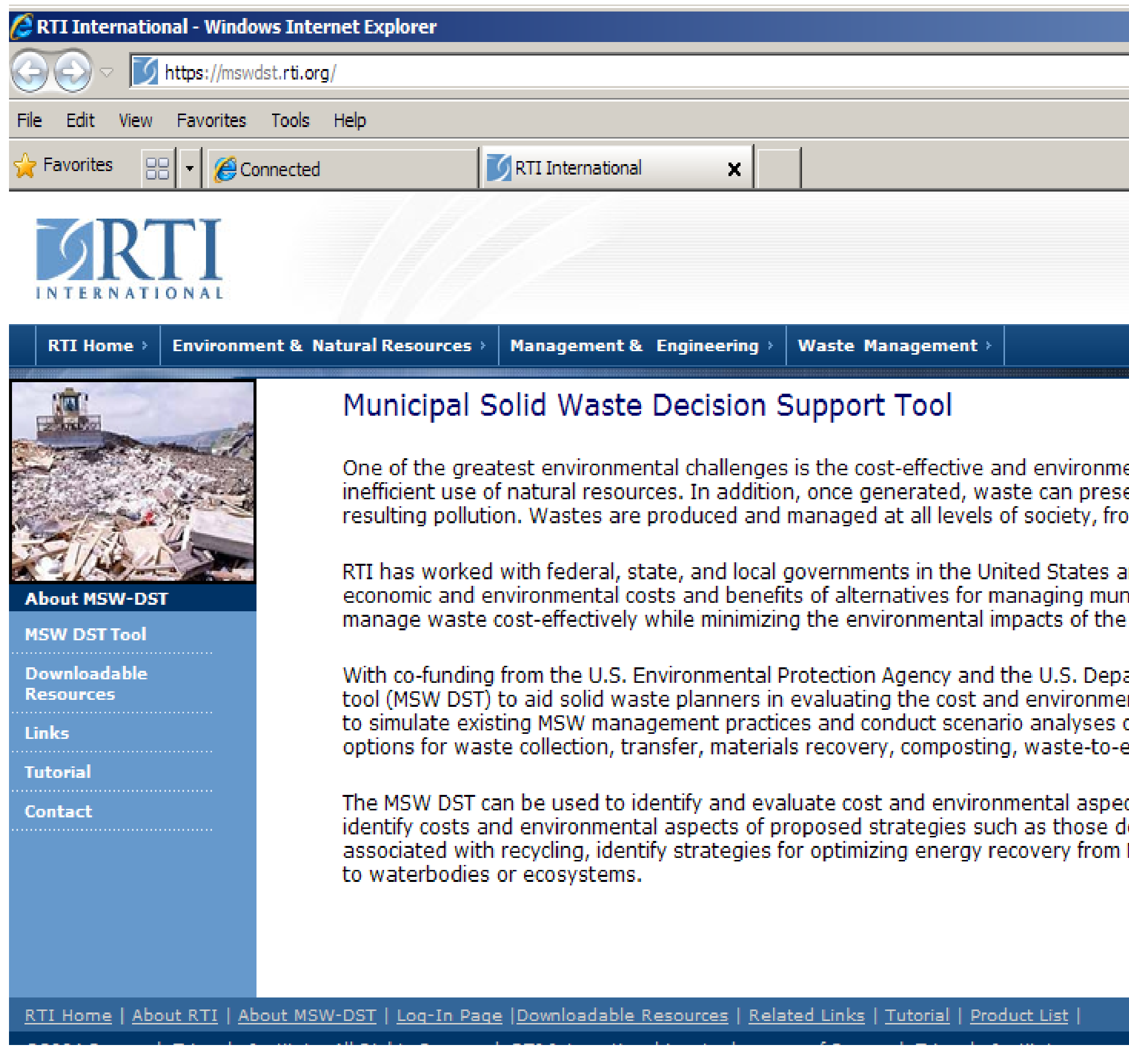
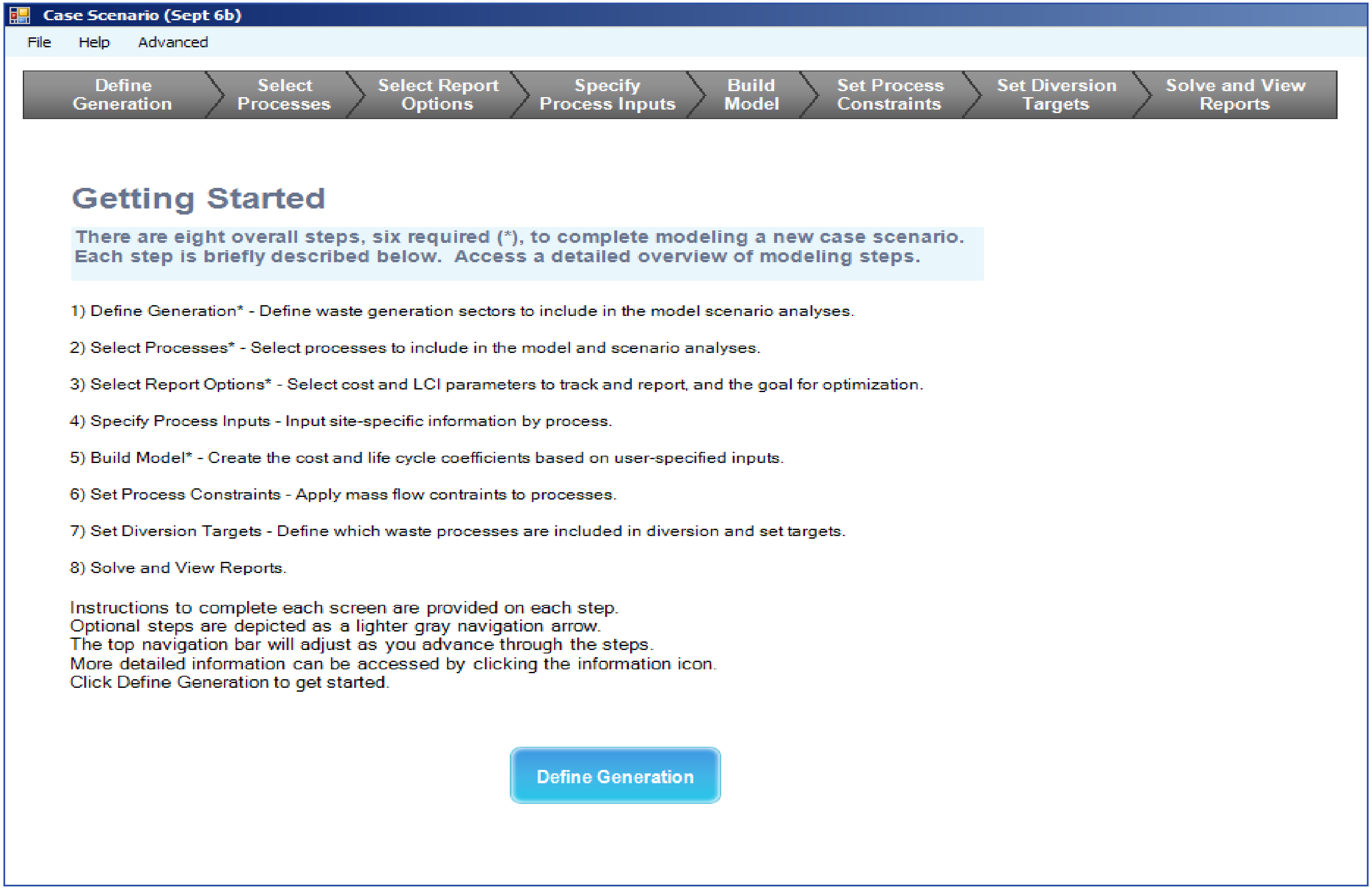
The U.S. MSW-DST was used to develop information for this presentation

- Information about how to access the MSW DST is available at: https://mswdst.rti.org
- Site includes:
  - Basic information
  - Technical documentation
  - Research papers



Getting Started

Opening the MSW DST



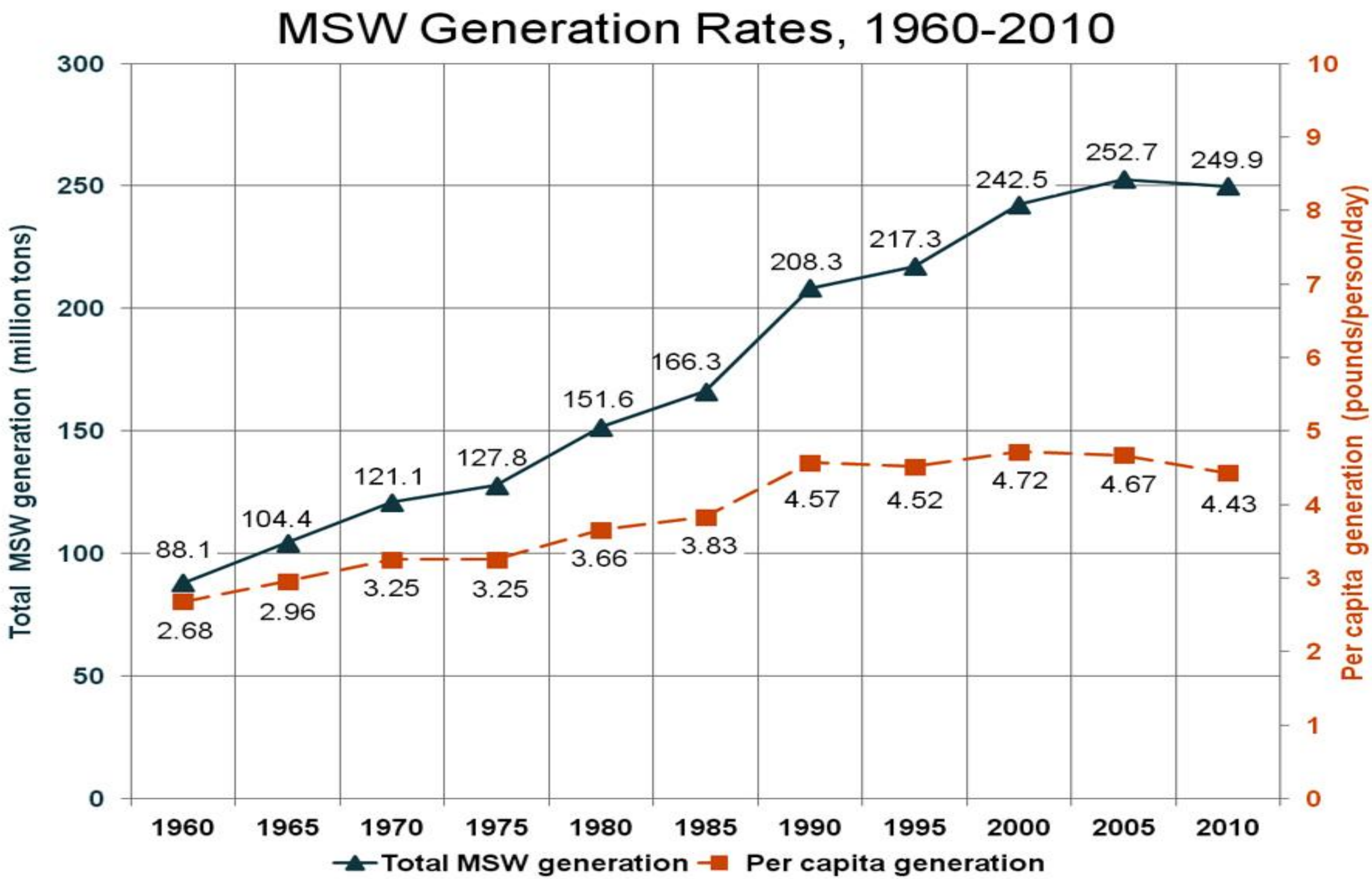
Health and Environmental Concerns for Landfills

- Once waste is deposited in a landfill, emissions are generated for decades
- Most immediate concern is for the explosive potential of the gas and potential for landfill fires
- Emissions of concern include
  - GHG emissions (largest methane source in the U.S.)
  - volatile organic compounds
  - hazardous air pollutants
  - persistent bioaccumulative toxics
  - hydrogen sulfide, and H_2

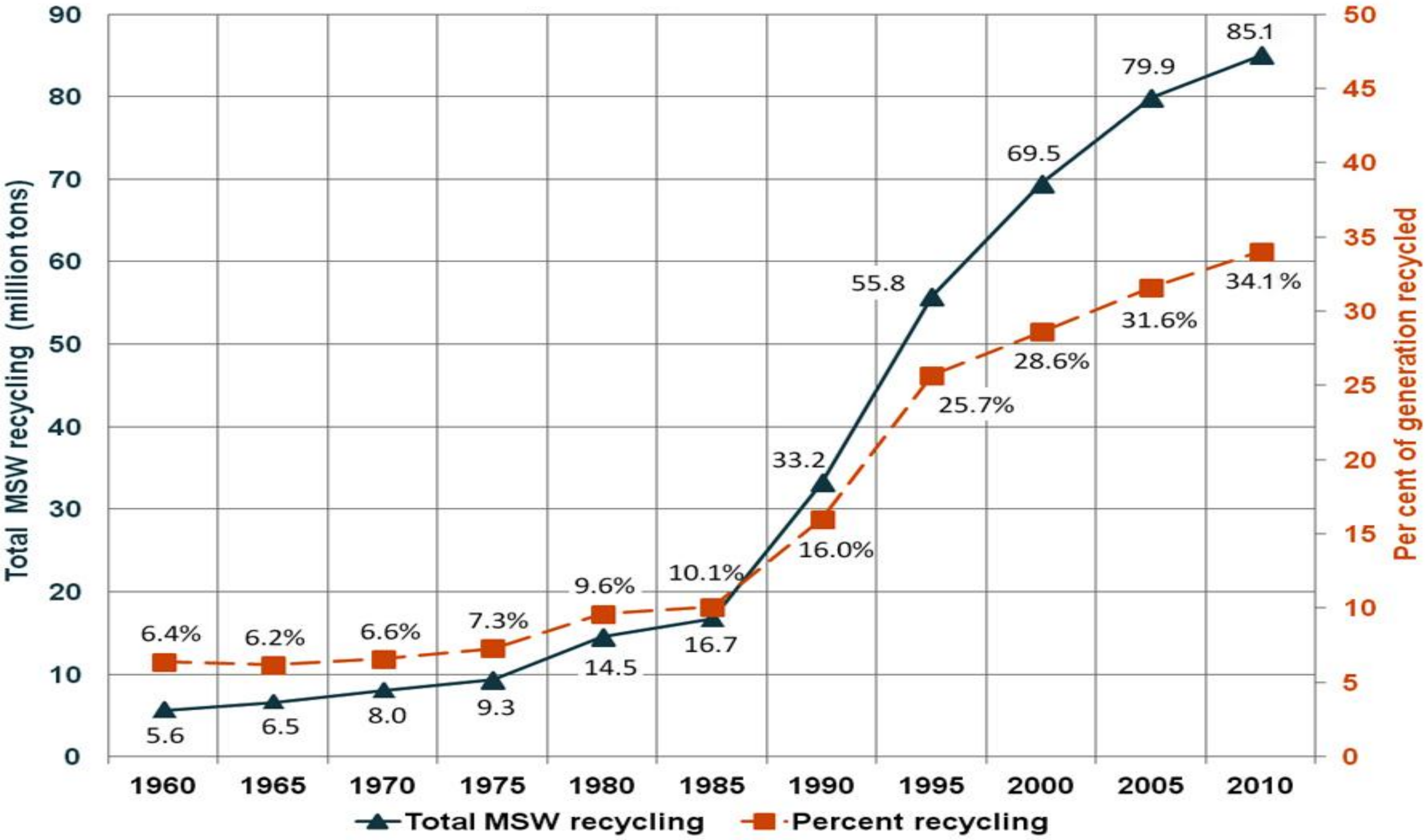
Sources of and sinks for GHG emissions from MSW management-related technologies included in the analysis

Waste Management Activity	GHG Emissions (CH_4 and CO_2) Sources and Sinks
Collection (recyclables and mixed waste)	Combustion of diesel in collection vehicles
	Production of diesel and electricity (used in garage)
Material Recovery Facilities	Combustion of diesel used in rolling stock (front-end loaders, etc.)
	Production of diesel and electricity (used in building and for equipment)
Yard Waste Composting Facility	Combustion of diesel used in rolling stock
	Production of diesel and electricity (used for equipment)
Combustion (also referred to as waste to energy)	Combustion of waste
	Offsets from electricity produced
Landfill	Decomposition of waste
	Combustion of diesel used in rolling stock
	Production of diesel
	Offsets from electricity and/or steam produced
Transportation	Combustion of diesel used in vehicles
	Production of diesel
Reprocessing of Recyclables	Offsets (net gains or decreases) from reprocessing recyclables recovered; offsets include energy- and process-related data

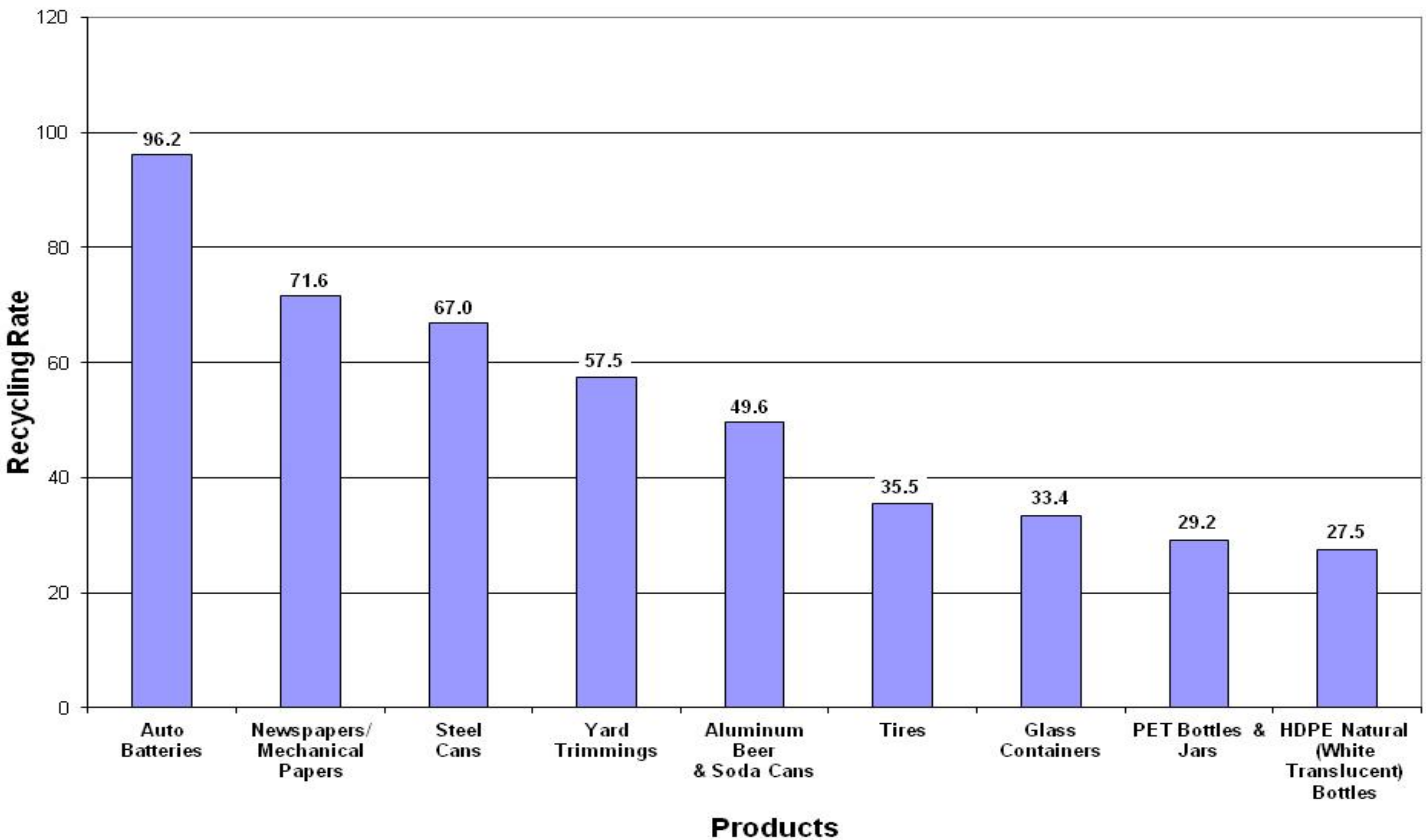
Trends in U.S. MSW Generation



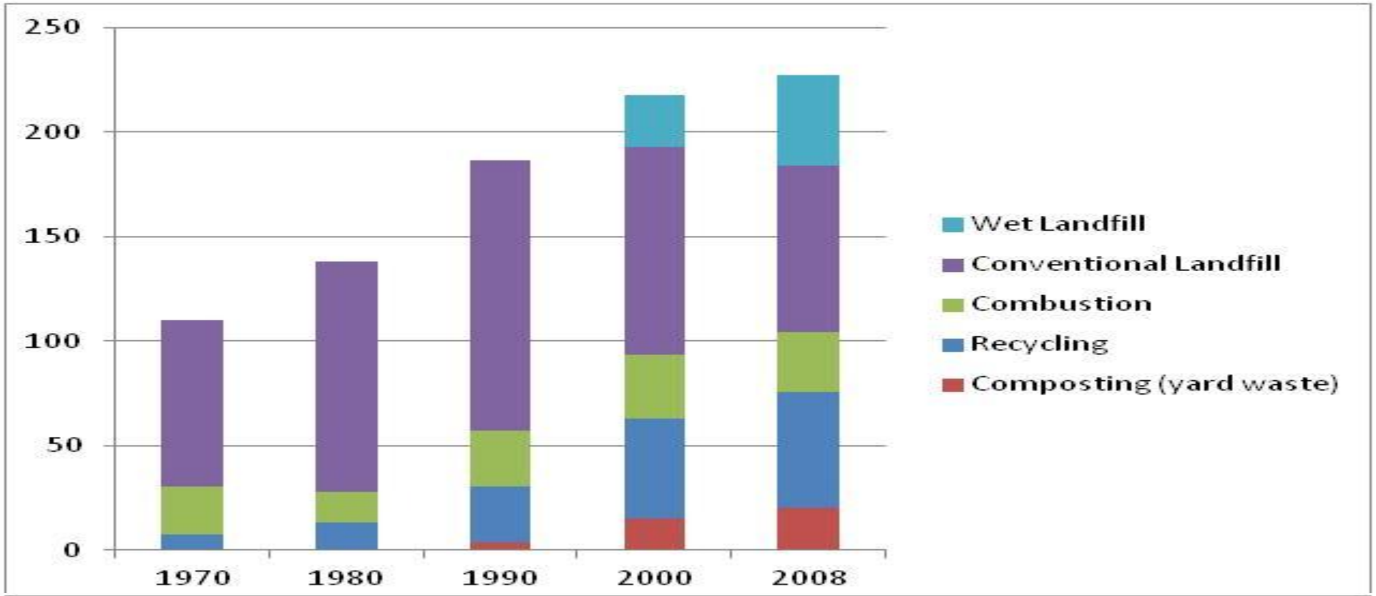
U.S. MSW Recycling Rates, 1960 - 2010

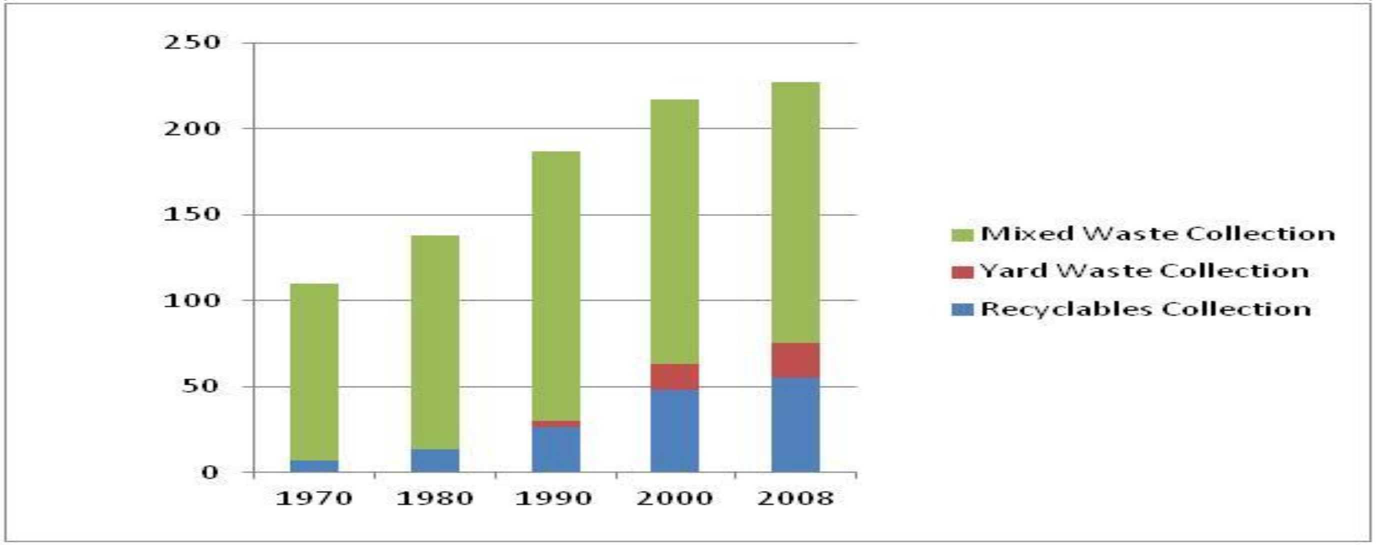


U.S. Recycling Rates of Selected Products for 2010

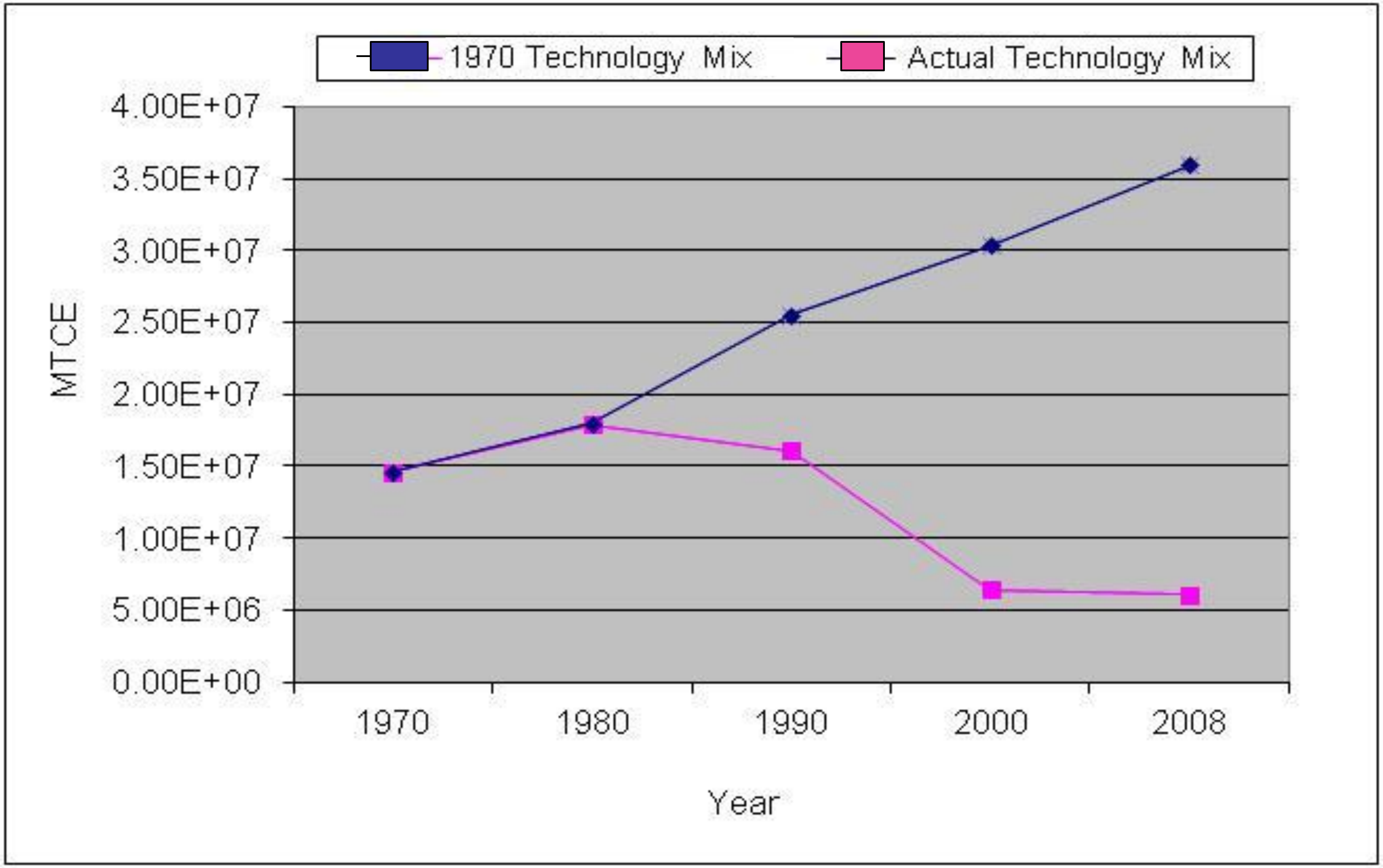


Trends in How U.S. MSW is Collected and Managed (metric tons)



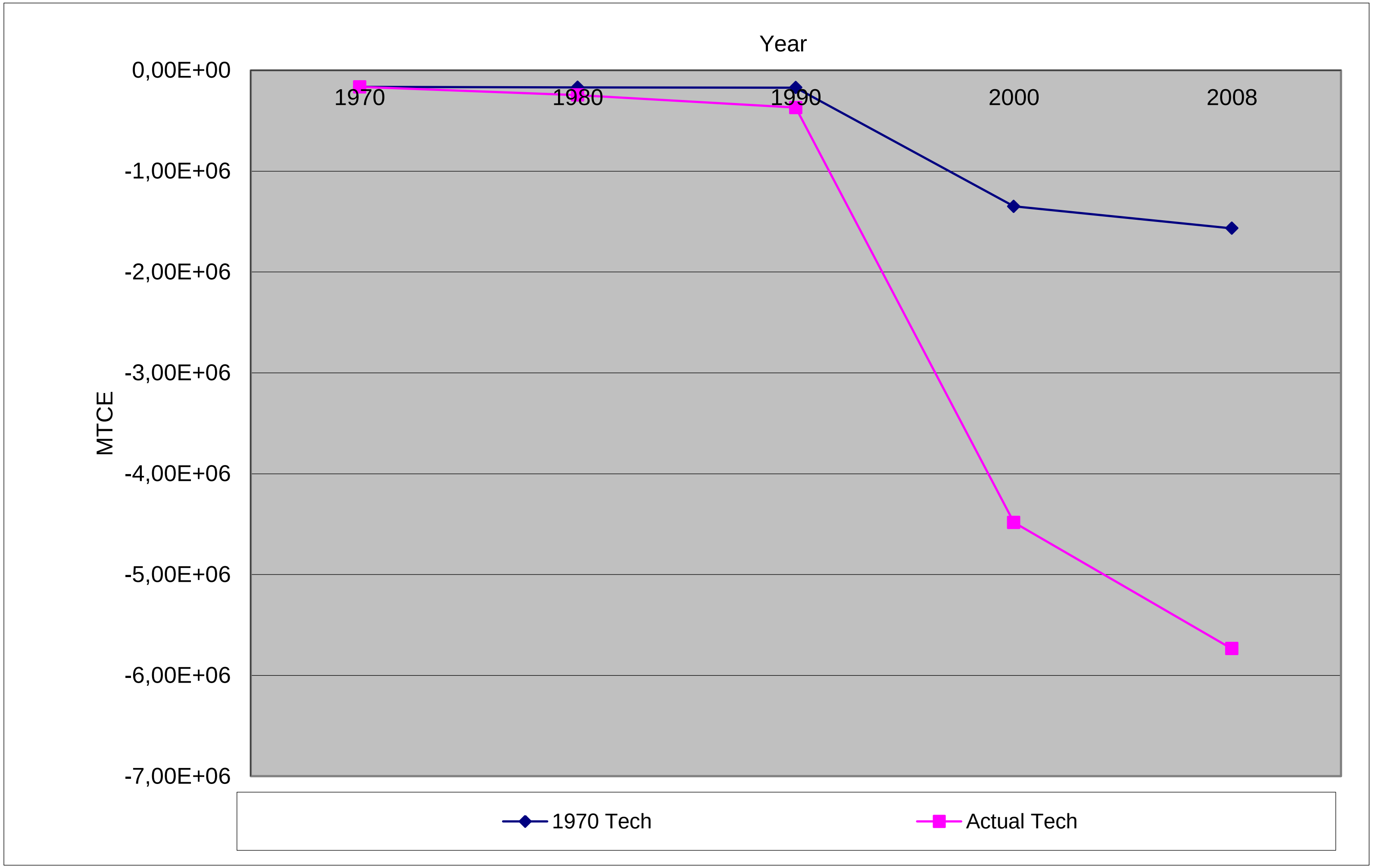


Preliminary results to compare net GHG emissions from MSW management reflecting technological changes, landfill diversion, and source reduction

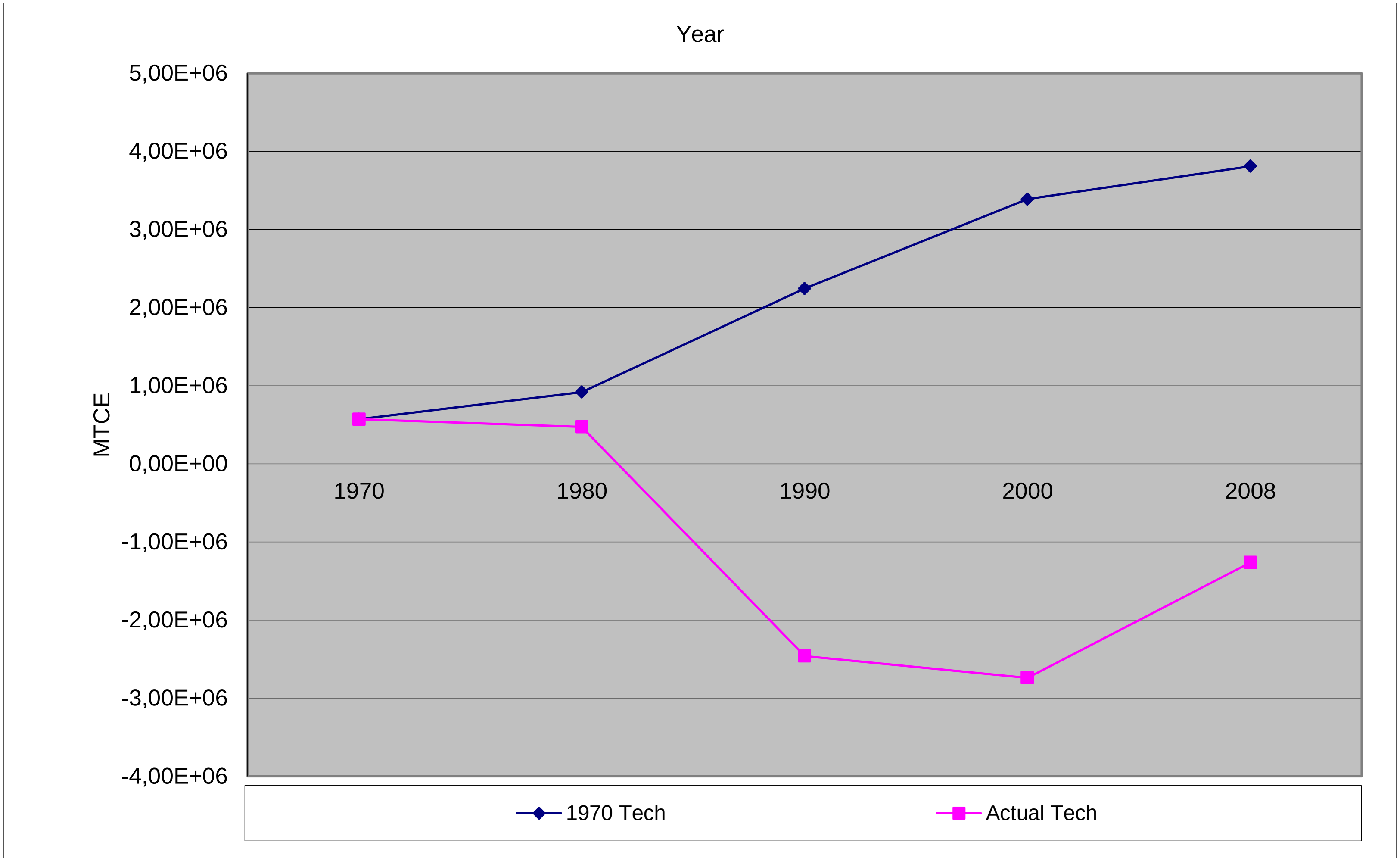


Note: 1980 with and w/o 1970 technology is pretty much the same because the mass flow breakout is very similar 1970 vs. 1980 and the only difference in the waste management is 100% LF venting in 1970 vs. 90%.

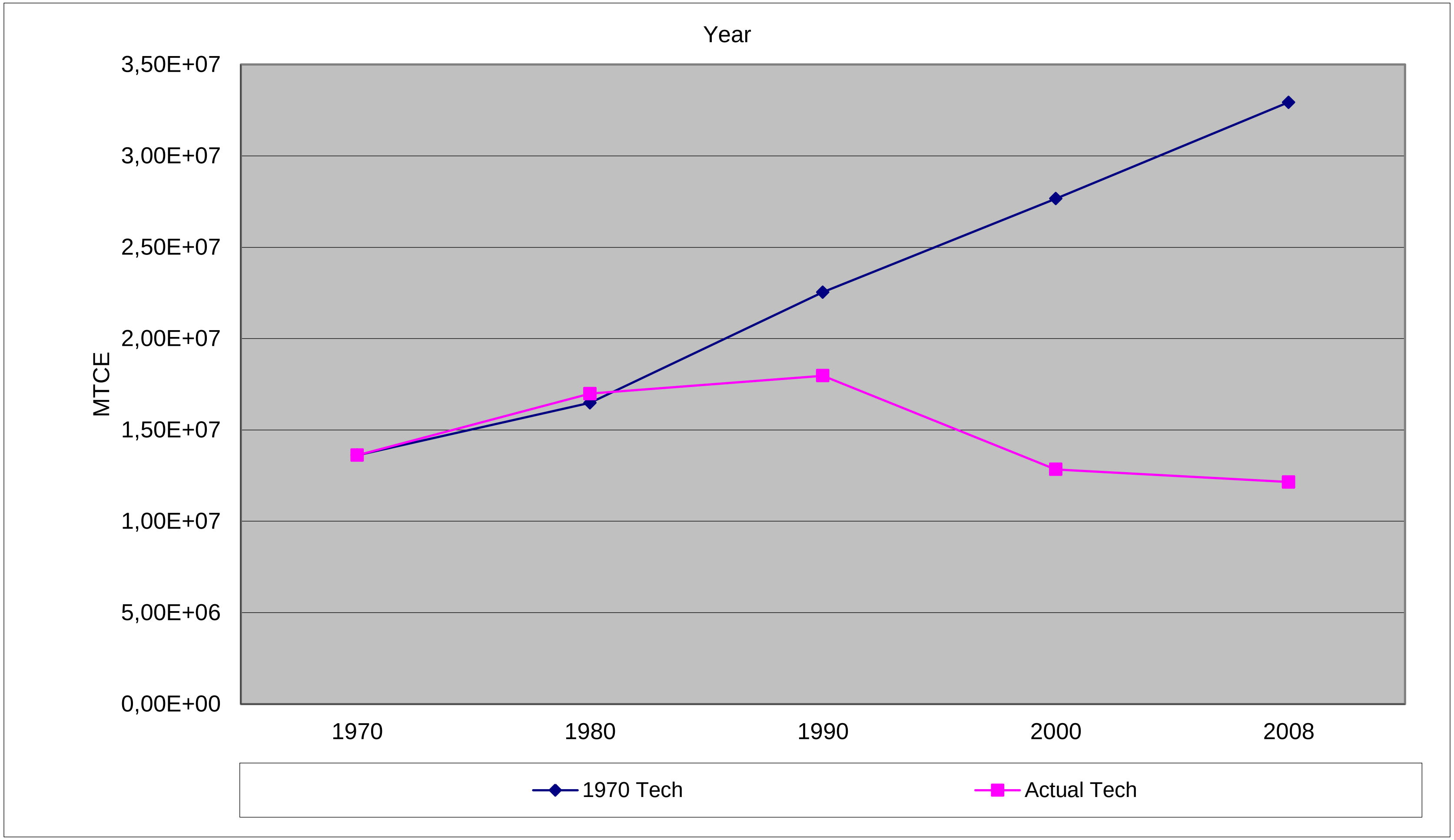
Preliminary results to compare net GHG emissions for recycling and composting (Avoided emissions reflect offsets from resource conservation)



Preliminary results to compare net GHG emissions from MSW combustion (Avoided emissions reflect offsets from fossil-fuel conservation from energy that is produced)



Preliminary results to compare net GHG emission reductions from landfills due to diversion of waste from landfills, increased landfill gas control, and landfill CH4 recovery



Findings from 2009 ES&T Publication Compared LFGTE and WTE for Electricity Production

- When comparing electricity (kWh) per ton of municipal waste, WTE is on average six to eleven times more efficient at recovering energy from wastes than landfills.
- For even the most optimistic assumptions about LFGTE, the net life-cycle environmental tradeoffs is 2 to 6 times the amount of GHGs compared to WTE.

  - GHGs for WTE ranged from 0.4 to 1.4 MT MTCO2e/MW h where as the most aggressive LFGTE scenario is resulted in 2.3 MTCO2e/MWh.

Kaplan, P. O.; DeCarolis, J.; Thorneloe, S. (2009) ***Is It Better to Burn or Bury Waste For Clean Electricity Generation?*** *Environmental Science and Technology*, 43, (6), 1711-1717.

Measurement (not modeling) of Landfill Gas Collection Efficiency

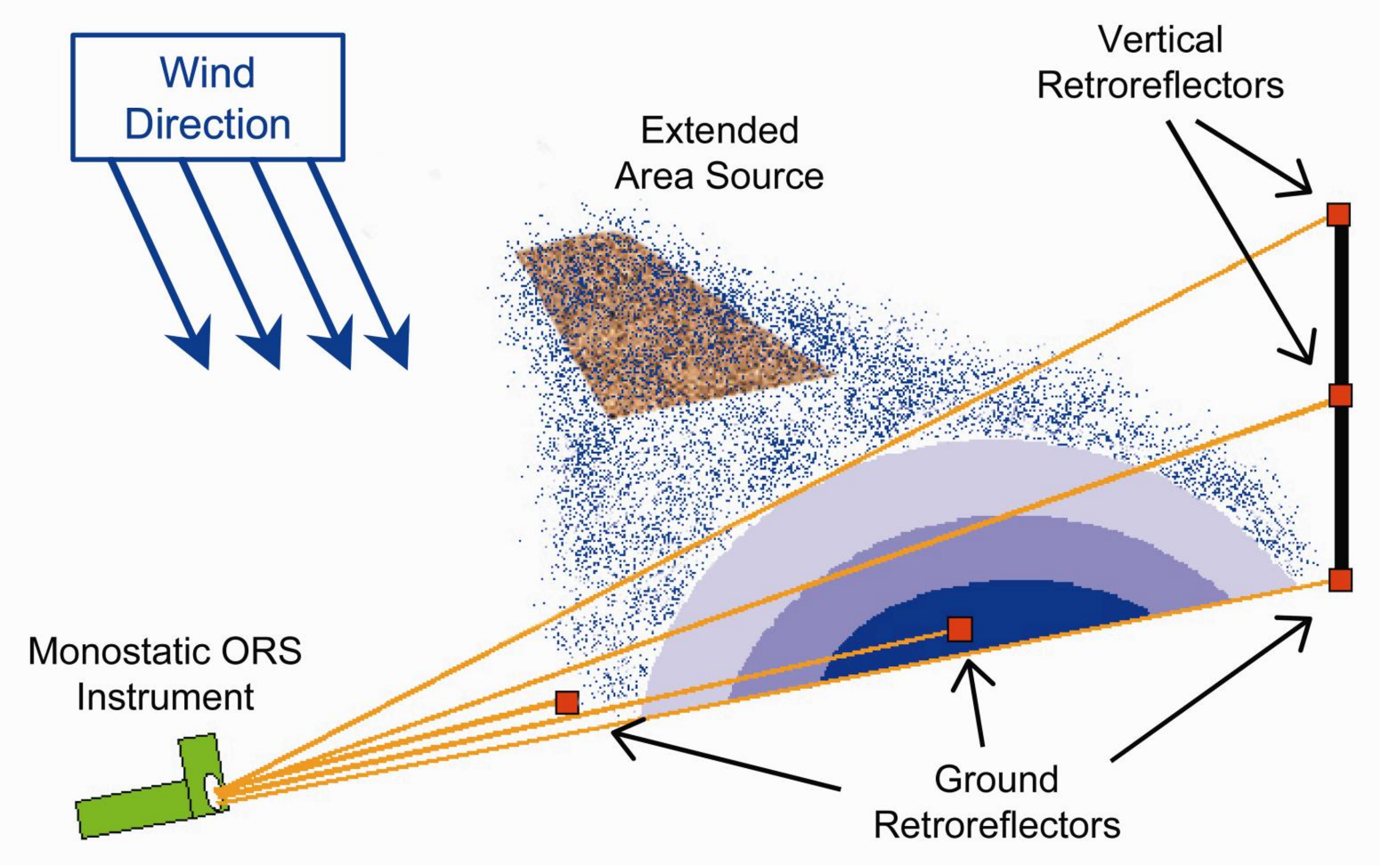
Conducted optical remote sensing (ORS) measurements using tunable diode laser for quantifying methane flux for entire landfill (top surface and side slopes).

Measurements conducted at three sites. At two of the sites the measurements were repeated within 6 months on initial measurements.

EPA Report documenting results:

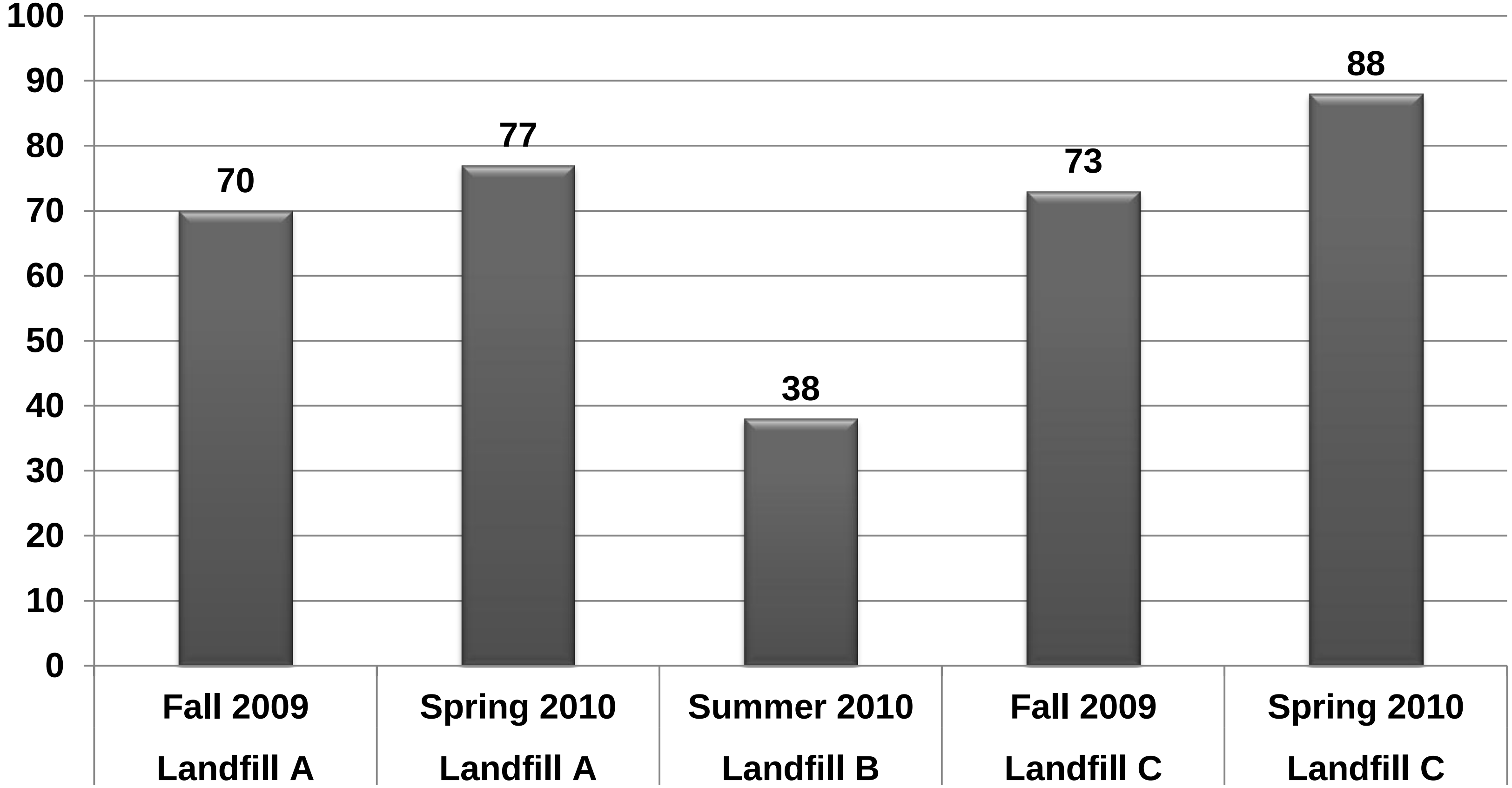
Quantifying Methane Abatement Efficiency at Three Municipal Solid Waste Landfills, EPA/600/R-12/003, Jan 2012, http://www.epa.gov/nrmrl/pubs/600r12003/600r12003.pdf

EPA Method OTM 10 for Nonpoint Source Measurement



Vertical Radial Plume Mapping (VRPM)

Results from Measurements of Methane Collection Efficiency



* Calculated as CH_4 Collected / (CH_4 Collected + CH_4 Emissions). Conventional collection efficiencies used in AP 42 and other documents can include soil oxidation in the denominator which would lower the efficiencies.

Ongoing study to Identify Tipping Points that Influence Energy and GHG Emissions

- Using data from existing ORCR studies of communities that are reaching higher levels of materials recovery, identify tipping points that influence energy and GHG emissions considering
  - Local infrastructure and policies
  - Geographical differences in waste composition
  - Transportation modes, fuels, and distances
  - Electrical energy grid mixes
  - Energy prices and renewable energy initiatives
  - Long term carbon storage
  - Recycling and composting rates
  - Recyclables markets and prices
  - Conversion efficiencies for waste-to-energy and landfill gas-to-energy

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Selected Publications

- Kaplan, P. O.; Ranjithan, S. R.; Barlaz, M.A. (2009) ***Use of Life Cycle Analysis To Support Solid Waste Management Planning for Delaware***. *Environmental Science and Technology*, 43 (5), 1264-1270.
- Kaplan, P. O.; DeCarolis, J.; Thorneloe, S. (2009) ***Is It Better to Burn or Bury Waste For Clean Electricity Generation?*** *Environmental Science and Technology*, 43, (6), 1711-1717.
- Thorneloe, S. A.; Weitz, K.; Jambeck, J. (2007) ***Application of the U.S. decision support tool for materials and waste management.*** *Waste Management*, 27, 1006-1020.
- Jambeck, J., Weitz, K.A., Solo-Gabriele, H., Townsend, T., Thorneloe, S., (2007). ***CCA-treated Wood Disposed in Landfills and Life-cycle Trade-Offs With Waste-to-Energy and MSW Landfill Disposal,*** *Waste Management* , Vol 27, Issue 8, Life-Cycle Assessment in Waste Management.
- Kaplan, P.O., M.A. Barlaz, and S. R. Ranjithan (2004) ***A Procedure for Life-Cycle-Based Solid Waste Management with Consideration of Uncertainty.*** J. of Industrial Ecology. 8(4):155-172.
- Weitz K.A., Thorneloe S.A., Nishtala S.R., Yarkosky S. & Zannes M. (2002) ***The Impact of Municipal Solid Waste Management on Greenhouse Gas Emissions in the United States***, Journal of the Air and Waste Management Association, Vol 52, 1000-1011.

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Conclusions

- A holistic approach is needed using a life-cycle analysis to compare carbon emissions for differences in waste components, regional population, and infrastructure for materials and discards management
- Analysis for discards management found WTE is on average six to eleven times more efficient at recovering energy from waste than landfills
- Even though U.S. MSW has more than doubled since the 1970s, GHG emissions are significantly decreased as a result of
    - Improvements in technology including collection, transport, recycling, and discards management
    - Adoption of programs to reduce waste and increase recycling and composting
    - Adoption of combustion with energy recovery and
    - Better collection and control of landfill gas (including use of methane for energy recovery)
- Ongoing study using the MSW-DST to explore tipping points to identify strategies that can further reduce GHG emissions
- Within the couple of months, we will release a web accessible version of the U.S. DST with a new user interface and tutorials

The New York Times

Environment

Europe Finds Clean Energy in Trash, but U.S. L

By ELISABETH ROSENTHAL
Published: April 12, 2010

HORSHOLM, Denmark — The lawyers and engineers who dwell in an elegant enclave here are at peace with the hulking neighbor just over the back fence: a vast energy plant that burns thousands of tons of household garbage and industrial waste, round the clock.

Enlarge This Image

Johan Spanner for The New York Times

Far cleaner than conventional incinerators, this new type of plant converts local trash into heat and electricity. Dozens of filters catch pollutants, from mercury to dioxin, that would have emerged from its smokestack only a decade ago.

Friday, May 14, 2010

ONE TON OF WASTE CAN CREATE ...

65 kWh of electricity | **590** k

EMISSIONS FOR ONE MEGAWATT-HOUR OF ELEC

3.35
metric tons,
carbon dioxide equivalent

0.56
metri
carbo

600 grams of sulfur oxides | **220** g

2,300 grams of nitrogen oxides | **1,450**

One metric ton is one million grams, or 1.1 short tons.

ONE YEAR'S WORTH OF WASTE COULD GENERA

9 million MWh of electricity ...

... enough to power **800,000** homes for one year.

80 mi

... eno
home

Sources: P. O. Kaplan, J. DeCarolis, S. Thorneloe, "Is It Better to Bu
Generation?" Environmental Science & Technology 2009, E.P.A.; En

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Energy from Waste: burn or bury?

EPA researchers have completed the first scientific comparison of whether it is better to burn or bury waste when trying to recover energy and minimize greenhouse gas emissions.

When most people think of alternative energy sources, they probably picture gleaming solar panels or wind turbines with long, white blades spinning above rich green cornfields. They probably don't think of landfills or waste combustion facilities. Although municipal solid waste (MSW) may not be very picturesque, 14 percent of renewable electricity generation (not including hydroelectric dams) comes from operations that recapture energy from discarded waste.

In 2007, Americans recycled or composted about a third of the 250 million tons of the municipal solid waste generated in the country. The rest was either buried (54 percent) or burned (13 percent), and both of these "discard management" options offer the potential to recover energy.