Role of Sustainable Waste Management in Reducing Methane Emissions

Mike Van Brunt, P.E.

Clean Air Council
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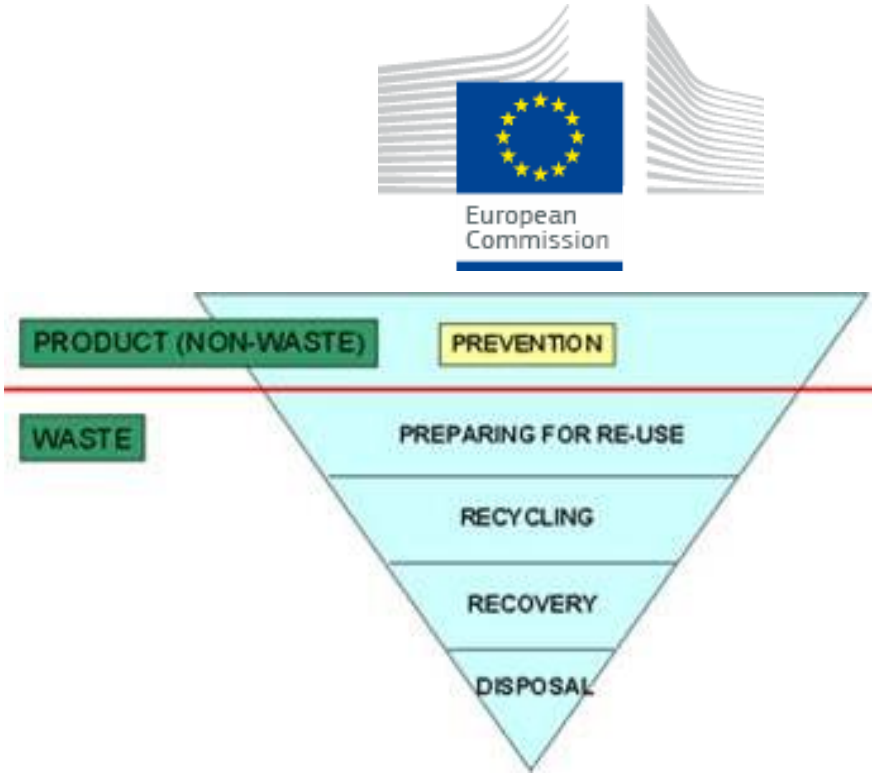
Sustainable Materials Management

The EPA and the EU have ranked the most environmentally sound strategies for municipal solid waste. Source reduction (including reuse) is the most preferred method, followed by recycling, energy recovery, and, lastly, treatment and disposal.

http://www.epa.gov/osw/nonhaz/municipal/hierarchy.htm



http://ec.europa.eu/environment/waste/framework/index.htm

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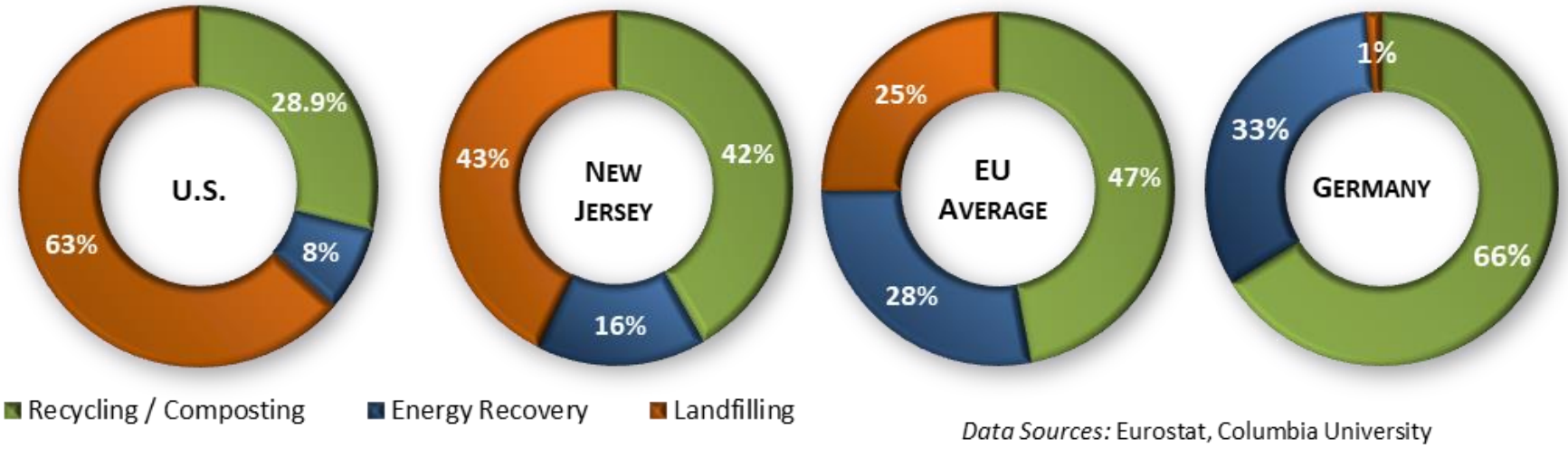
The United States gets a Failing Grade...



Data Sources: Eurostat, Columbia University

New facility being built in Copenhagen, Denmark

Spittelau Waste-to-Energy Facility, Vienna, Austria

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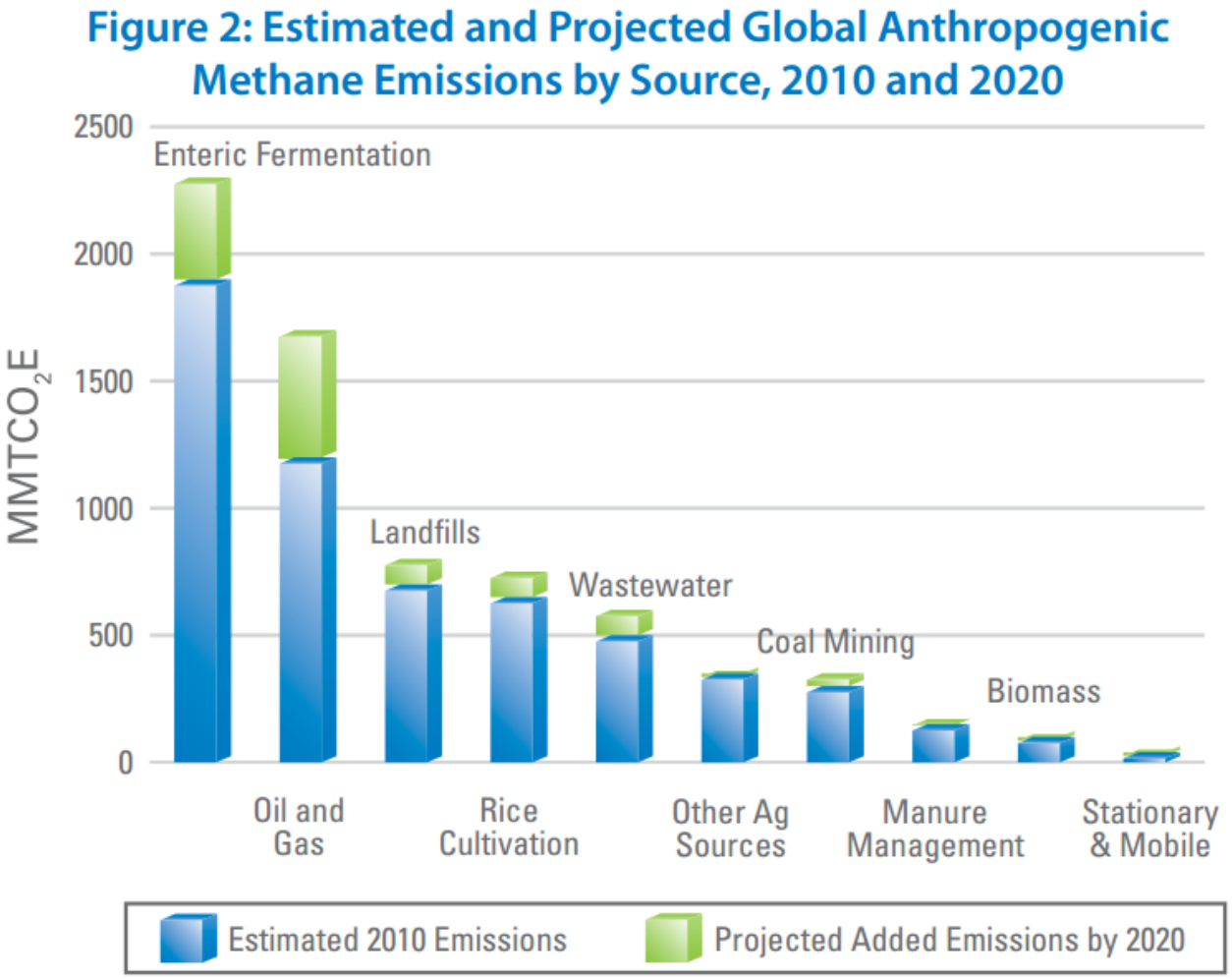
Landfills are the 3rd largest global source of CH_4



Source: Global Methane Initiative https://www.globalmethane.org/documents/analysis_fs_en.pdf

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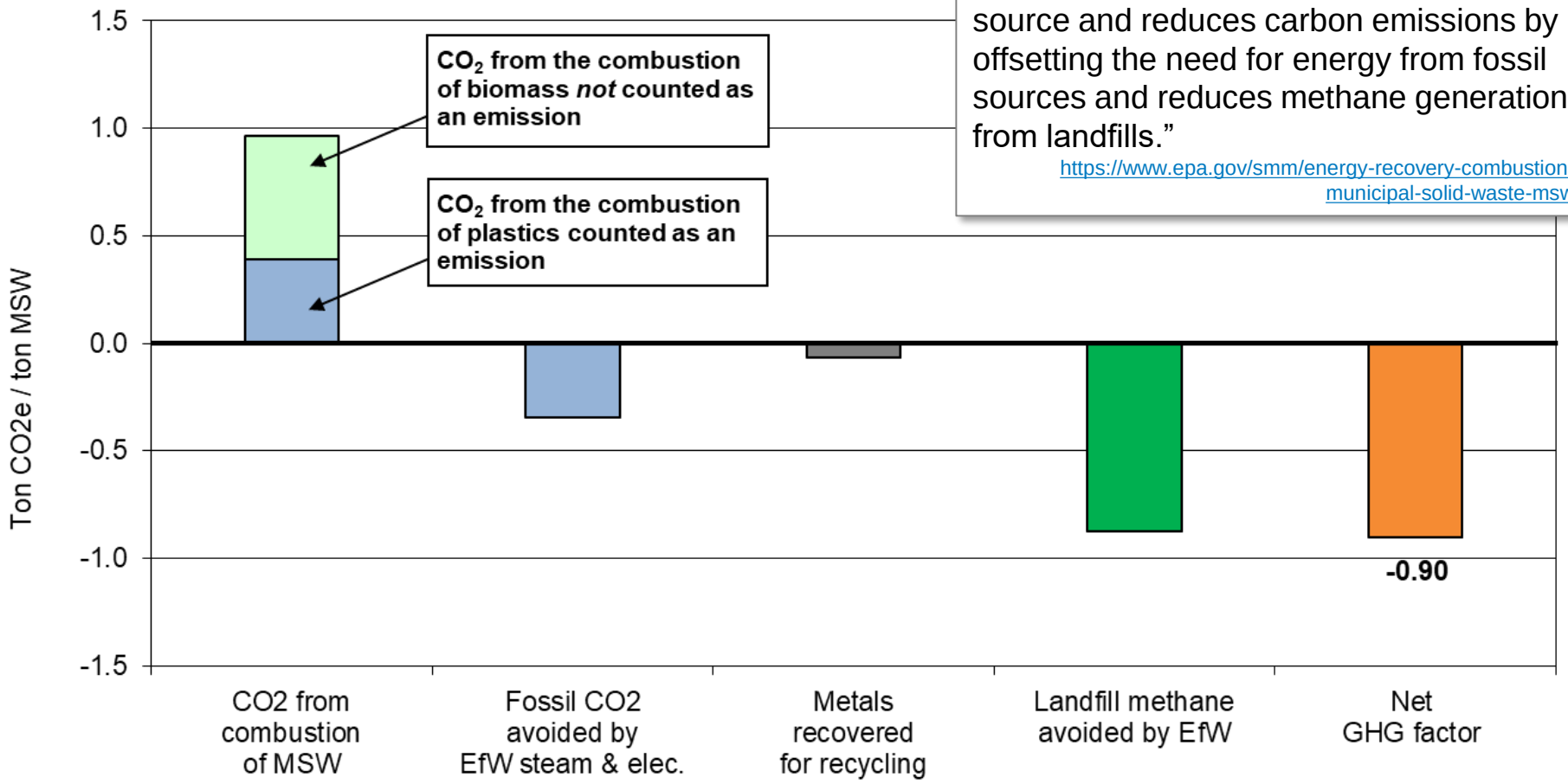
Methane Reduction Approaches – Waste Management

Category	Detail	Other GHG Reduction Benefits	
Reuse	Food banks	• Avoid upstream food production emissions	PREVENTION
Recycling	Animal feed, forest products recycling	• Avoid upstream feed / product emissions • Forest preservation / sequestration	
Composting	Soil amendments / compost	• Fertilizer production offsets • Soil carbon	
Anaerobic Digestion	Soil amendments / compost / energy recovery	• Displacement of fossil fuel grid electricity • Fertilizer production offsets • Soil carbon	
Energy Recovery	Energy recovery	• Displacement of fossil fuel grid electricity • Metals recovery (avoid upstream emissions)	
Landfill	Additional monitoring, direct measurement, greater well density, longer collection	• Displacement of fossil fuel grid electricity	TAILPIPE

GHG Benefits of Energy from Waste

U.S. EPA
"[EfW] generates a renewable energy source and reduces carbon emissions by offsetting the need for energy from fossil sources and reduces methane generation from landfills."
https://www.epa.gov/smm/energy-recovery-combustion-municipal-solid-waste-msw



Note: Based on 2015-2017 Covanta NJ EfW facility operating data, RFC East non-baseload factor from U.S. EPA's E-Grid, national average landfill practices.

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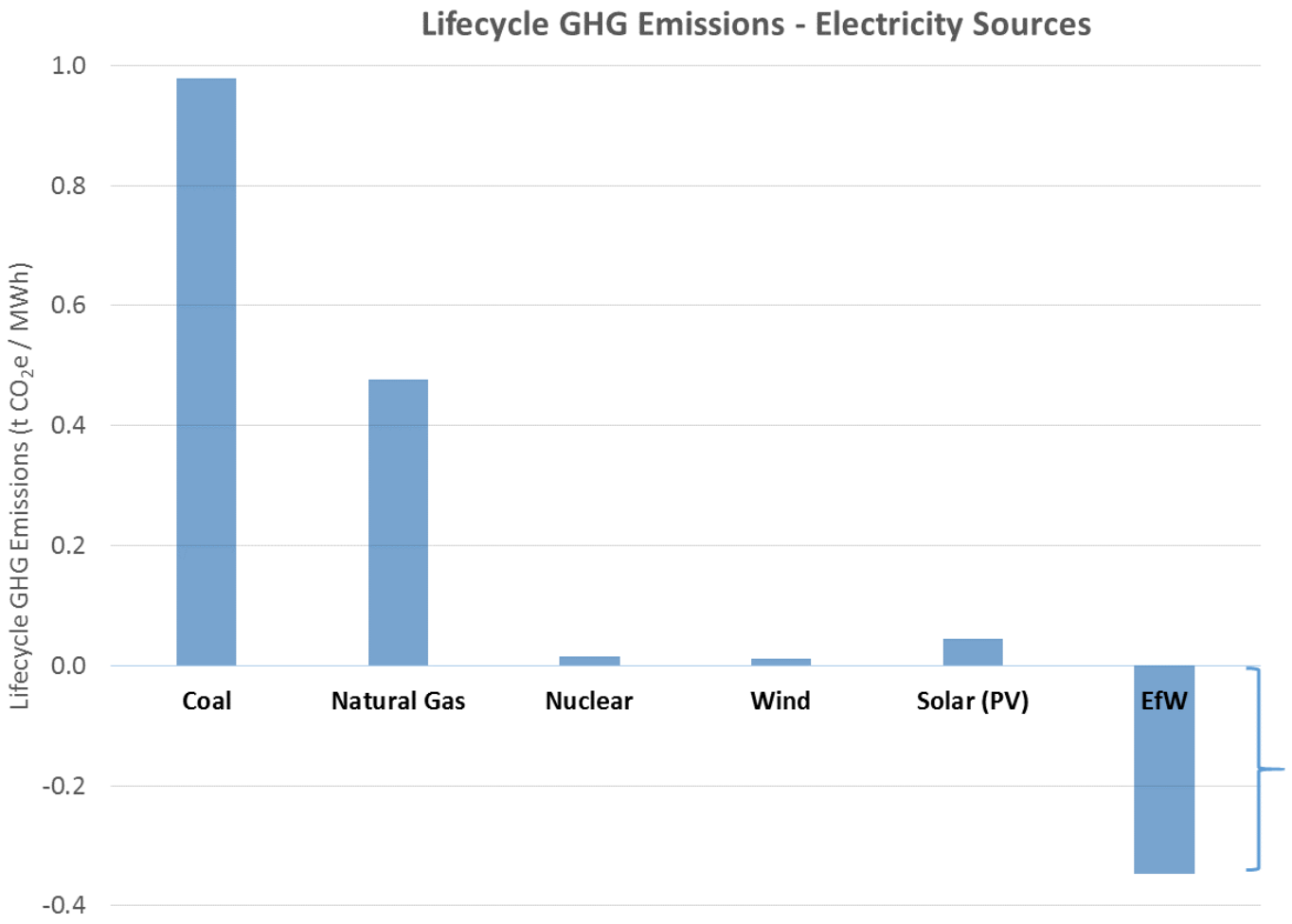
Lifecycle GHG Comparison: Major Electricity Sources



EfW is a net GHG negative source of electricity when including avoided landfill CH_4 emissions

Sources: Sathaye *et al.* (2011) "Renewable Energy in the Context of Sustainable Development"; NREL Life Cycle Assessment Harmonization Results and Findings webpage, accessed 8/2015; U.S. EP, NC State University, RTI International (2014) MSW

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Increasing Trend in Methane GWP

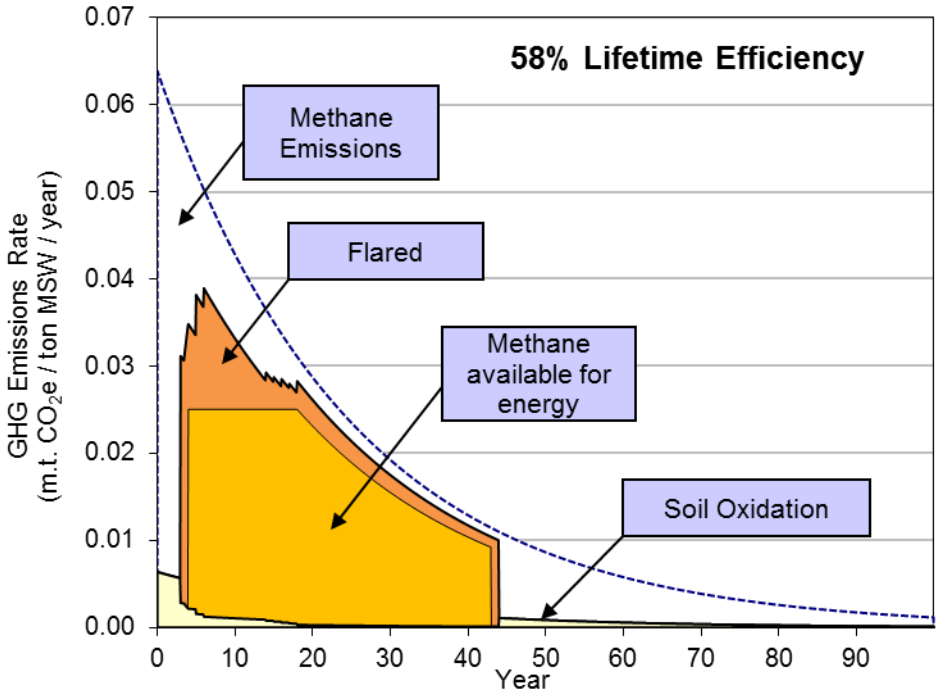
Source	Year	GWP	Time Horizon (years)
IPCC 2nd Assessment	1995	21	100
IPCC 3rd Assessment	2001	23	100
IPCC 4th Assessment	2007	25	100
Shindell *et al.*	2009	34	100
IPCC 5th Assessment	2013	**28 / 34**	100
IPCC 5th Assessment	2013	**84 / 86**	20

Many still refer to outdated methane GWPs of 21 or 25.

LFG Collection: Lifetime v. Instantaneous

Instantaneous

- Applies to a point in time: of the gas generated right now, how much is collected?
- EPA longstanding default = 75%, industry asserts much higher.
- Does NOT account for changes in efficiency over time OR periods of no collection fully allowed by current regulations.



Lifetime Efficiency

- Answers the question: of the methane generated over the life of waste in a landfill, how much is collected?
- Necessary for life cycle analysis & waste management comparisons, although instantaneous values (i.e. the 75% default) are often misused (including in a current EPA tool)

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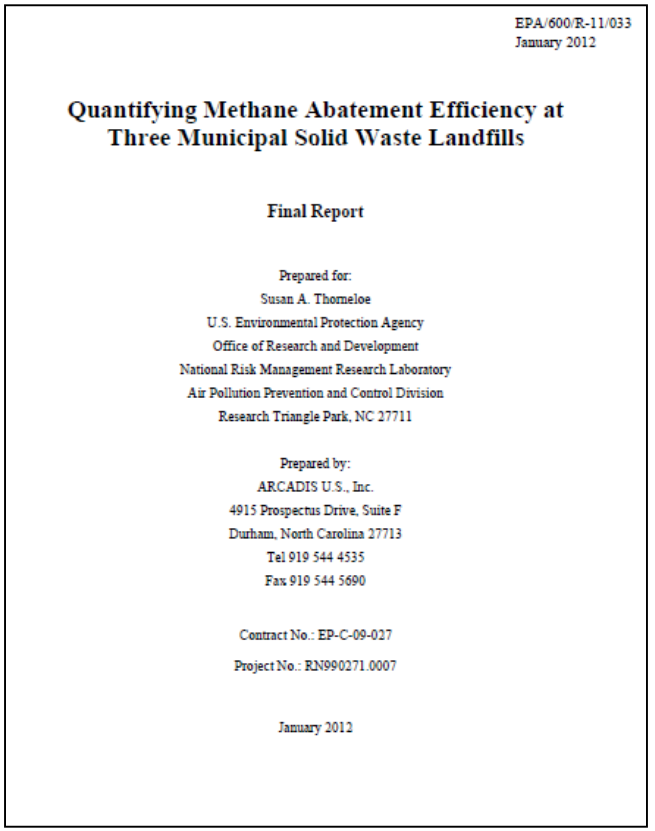
Measuring Landfill Emissions: U.S. EPA Study

Orange County Voice [N.C.] Press Release on Study:

- "For landfills/landfill sections with final cover/caps as proscribed by USEPA regulation, the report found 'the data collected *does not support* [*emphasis added*] the use of [methane] collection efficiency values of 90% or greater as has been published in other studies.' "
- "The landfill sites studied with temporary covers showed that methane capture ranged from 40-80% with the average being 62%, versus industry claims of 75%."
- "Measurements of uncontrolled toxic mercury emissions were 3 - 9 times greater than estimated an earlier 2008 EPA landfill study."



EPA/600/R-11/033
January 2012

Quantifying Methane Abatement Efficiency at Three Municipal Solid Waste Landfills

Final Report

Prepared for:
Susan A. Thorneloe
U.S. Environmental Protection Agency
Office of Research and Development
National Risk Management Research Laboratory
Air Pollution Prevention and Control Division
Research Triangle Park, NC 27711

Prepared by:
ARCADIS U.S., Inc.
4915 Prospectus Drive, Suite F
Durham, North Carolina 27713
Tel 919 544 4535
Fax 919 544 5690

Contract No.: EP-C-09-027
Project No.: RN990271.0007

January 2012

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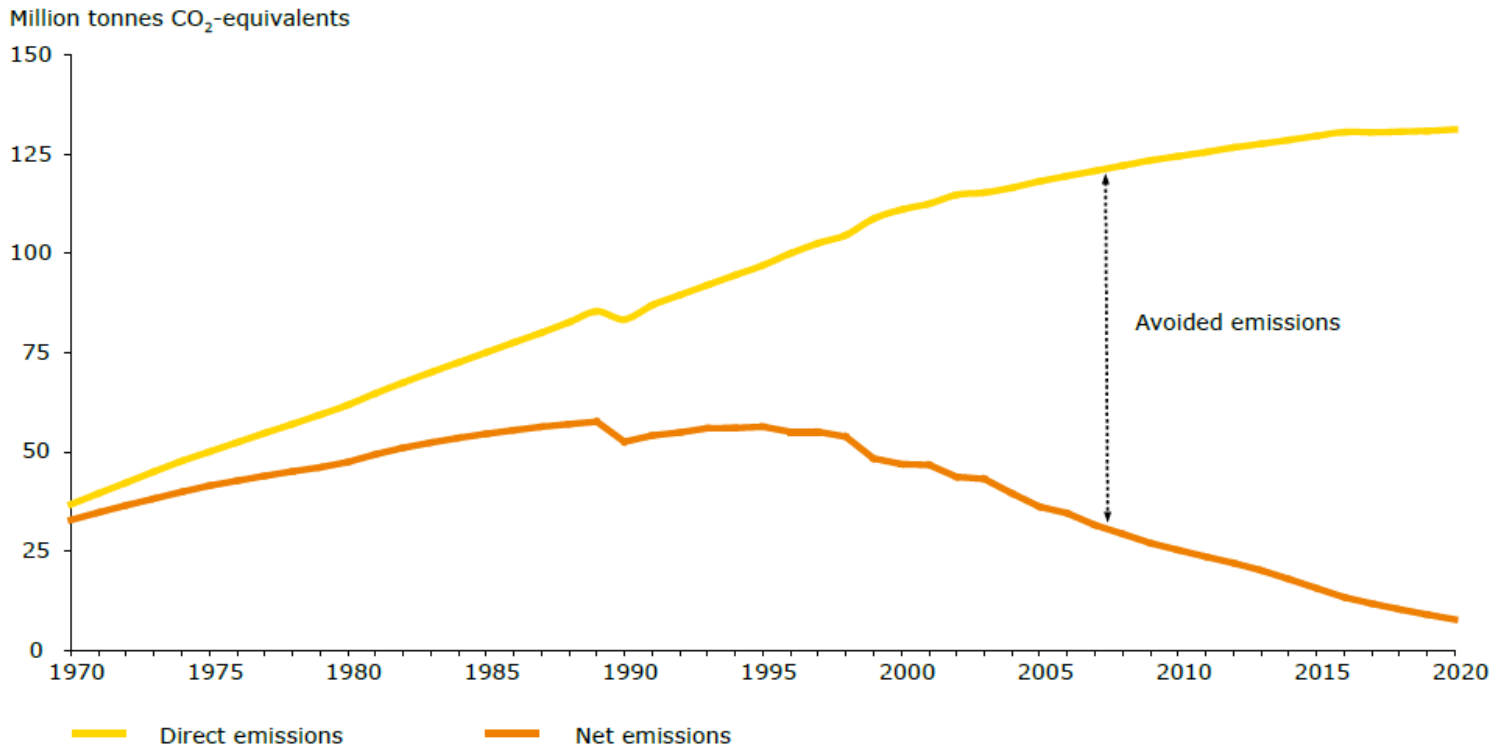
GHG Benefits of EfW: International Recognition

- **U.S. EPA Clean Power Plan**
- **U.S. EPA Scientists:** "If the goal is greenhouse gas reduction, then WtE should be considered an option…"
- **European Environment Agency:** "As recycling and incineration with energy recovery are increasingly used, net greenhouse gas emissions from municipal waste management are expected to drop considerably by 2020"
- **IPCC:** WTE recognized as a "key GHG mitigation technology"
- **Rio UN Conference:** "We therefore commit to further reduce, reuse and recycle waste (3Rs), and to increase energy recovery from waste"
- **Davos World Economic Forum:** WTE included in the list of 10 low-carbon energy technologies

EU: Translating Sustainable Waste Management into GHG Success

EEA Briefing, “Better management of municipal waste will reduce greenhouse gas emissions”



Source: ETC/RWM.

European Environment Agency

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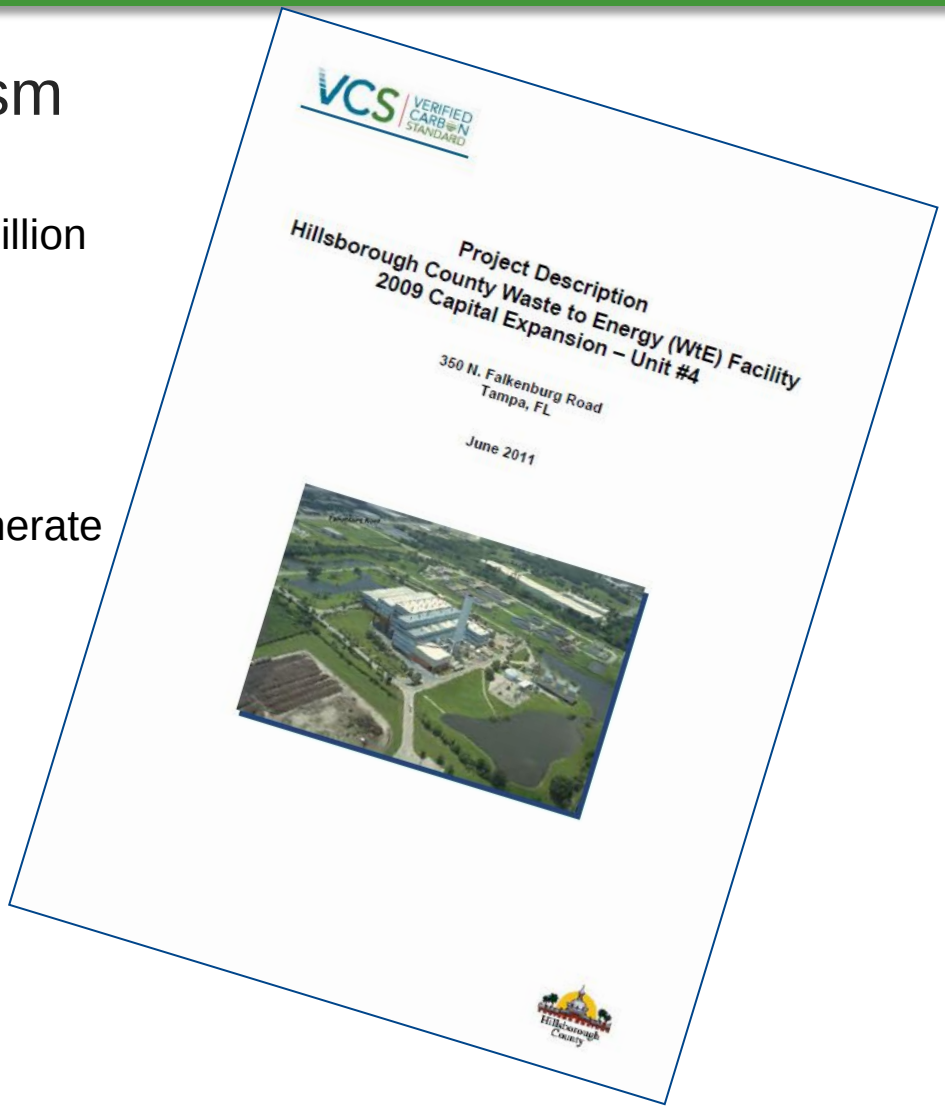
Carbon Offsets

- Clean Development Mechanism
  - Over 40 EfW projects registered
  - Combined annual GHG reduction of 5 million metric tons of CO2e per year
- Voluntary Market (VCS)

  Lee County, FL
  - First EfW facility in North America to generate carbon offset credits
  - Validated & 1st verification - 2009

  Hillsborough County, FL
  - Validated & 1st verification – 2011

  H-Power (Honolulu)
  - Validated – 2014



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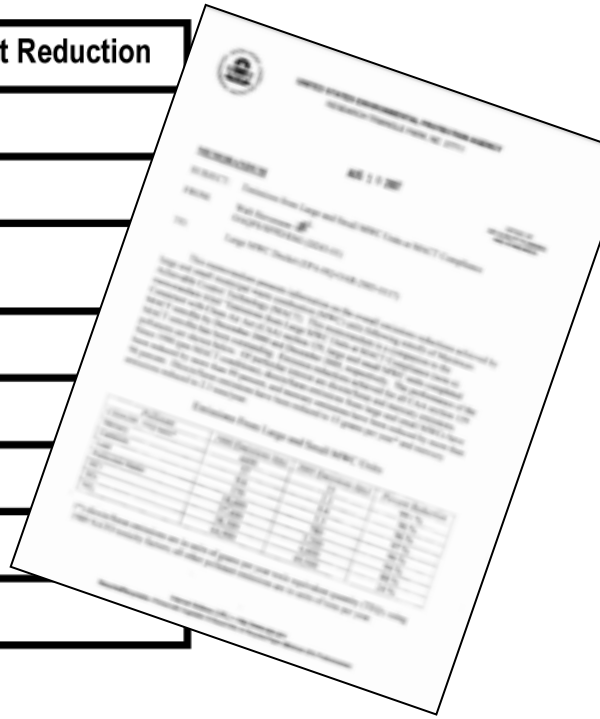
Emissions Performance

"The performance of the MACT retrofits have been outstanding."

Pollutant	1990 Emissions (tpy)	2005 Emissions (tpy)	Percent Reduction
CDD/CDF, TEQ basis*	4400	15	99+%
Mercury	57	2.3	96%
Cadmium	9.6	0.4	96%
Lead	170	5.5	97%
Particulate Matter	18,600	780	96%
HC1	57,400	3,200	94%
SO_2	38,300	4,600	88%
NO_x	64,900	49,500	24%



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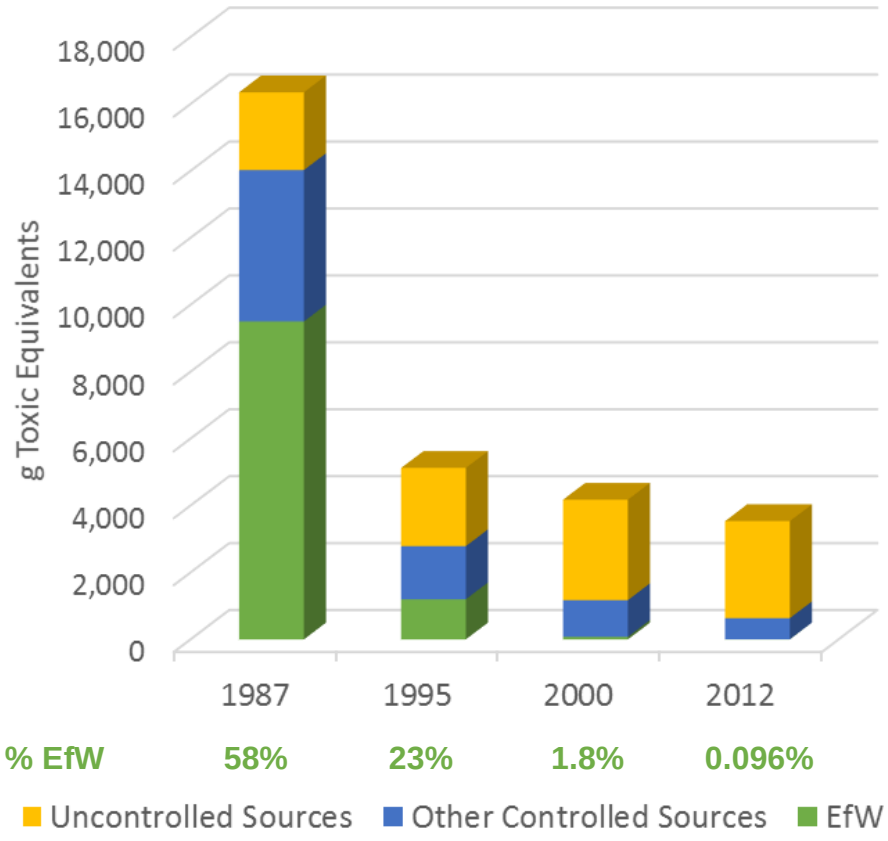
U.S. EfW Dioxin Emissions: Lower than Ever



	Source	g TEQ / yr
1	Landfill fires	1,300
2	Forest & brush fires	837
3	***Backyard*** burning	385
4	Agricultural burning	131
5	Diesel fuel combustion	118
6	Wood combustion	92
7	Vehicle fires	86
8	Coal combustion	85
9	Land clearing debris burning	72
10	Ferrous smelting	64
⋮		
26	**Waste-to-energy**	**3**

Source:
Dwyer & Themelis (2015) Inventory of U.S. 2012 dioxin emissions to atmosphere, *Waste Management,* **46**, 242 – 246.

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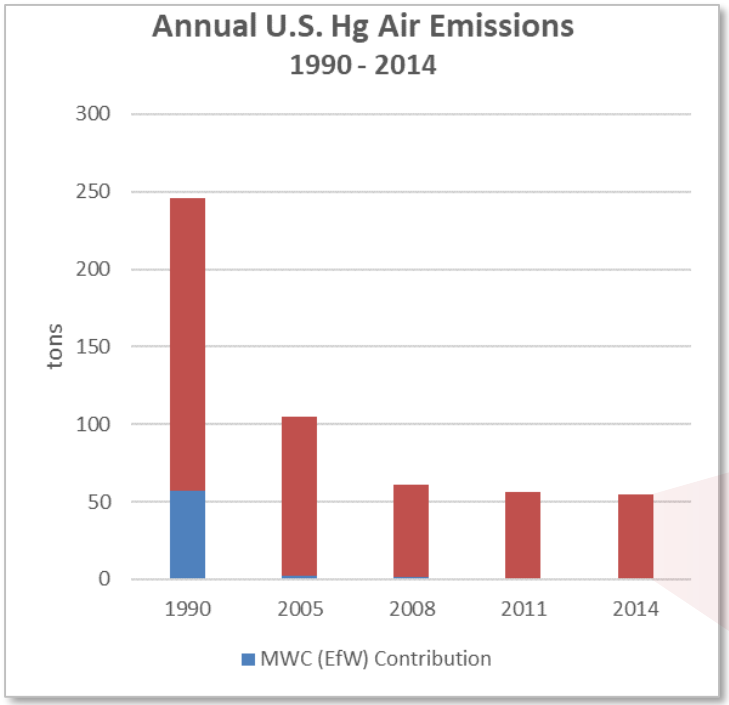
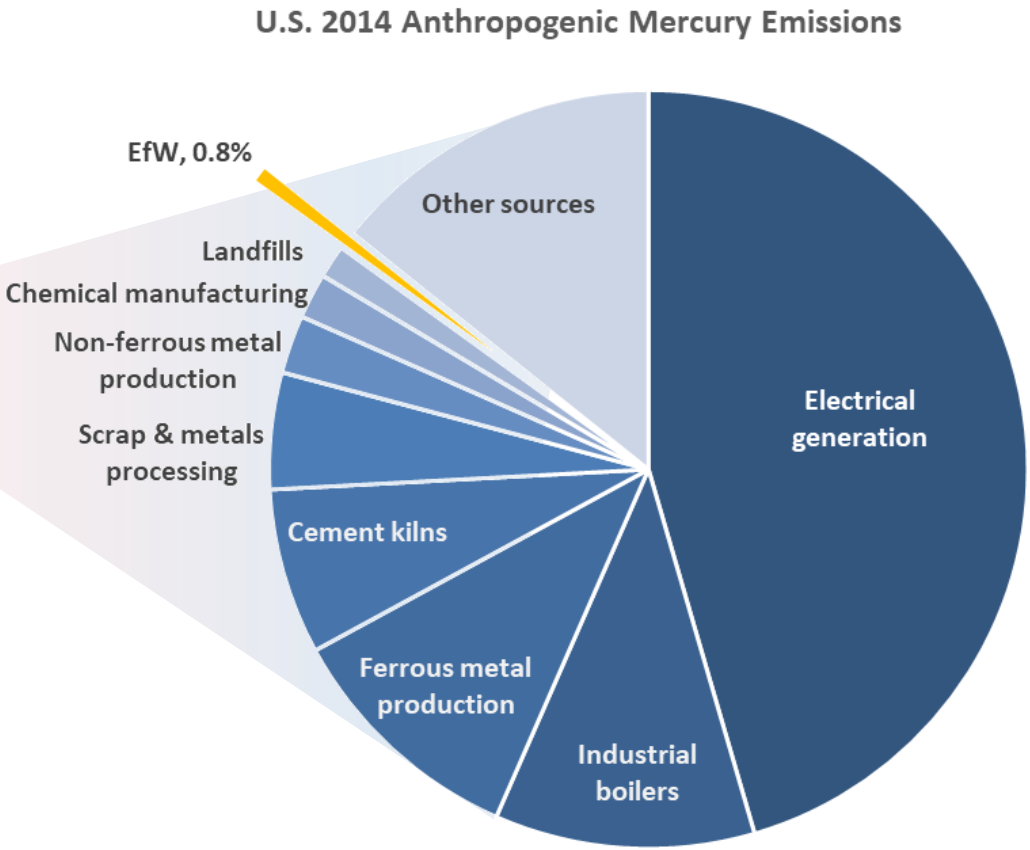
U.S. Mercury Emissions Falling as Well





Source: Themelis & Bourtsalas (2019) Major sources of mercury emissions to the atmosphere: The U.S. case, *Waste Management,* **85**, 90-94.

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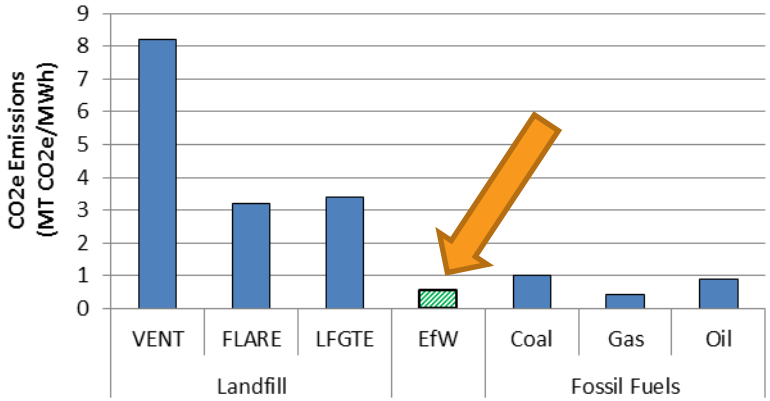
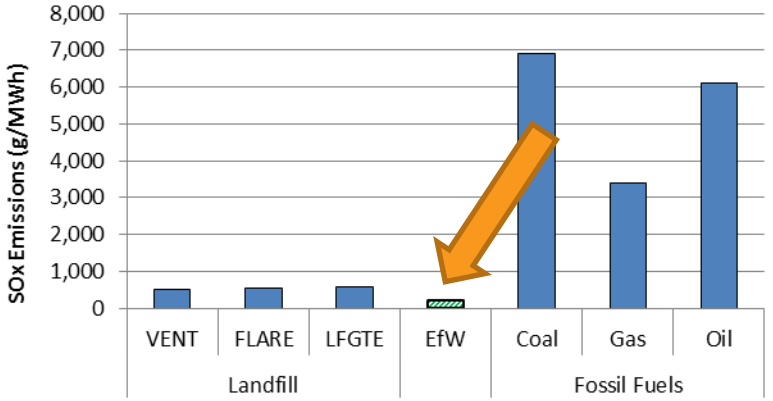
EPA Study: Lifecycle Energy Emissions

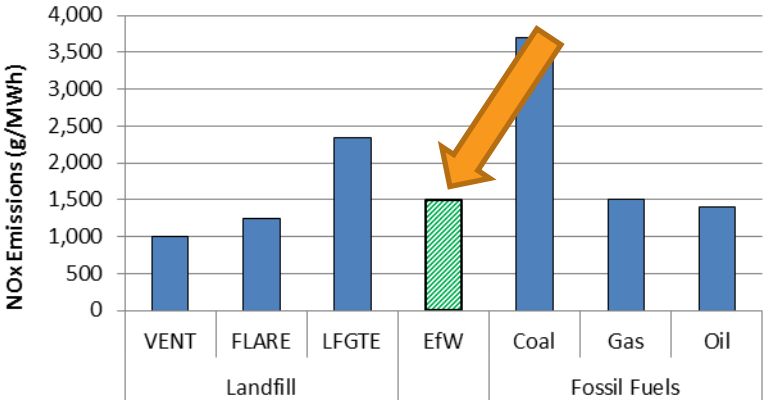
EfW is far below landfill gas to energy (LFGTE) in every category: CO_2, SO_x, NO_x, CO, PM



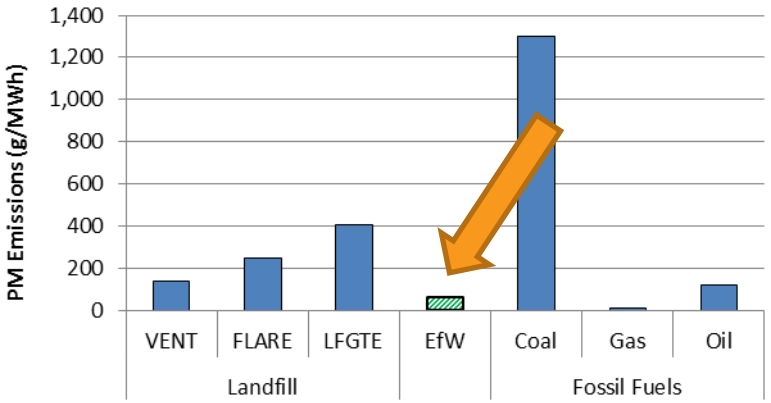
CO_2--EfW better than landfills, coal, oil, and on par with natural gas.



SO_2--EfW better than landfills, coal and oil.



NOx--EfW better than landfills & coal. On par with oil & natural gas.



PM--EfW better than landfills, coal and oil.

Source: Kaplan,P.O., J. DeCarolis, S. Thorneloe, Is It Better To Burn or Bury Waste for Clean Electricity Generation?, *Environ. Sci. Technol.*, 2009, 43 (6), 1711-1717

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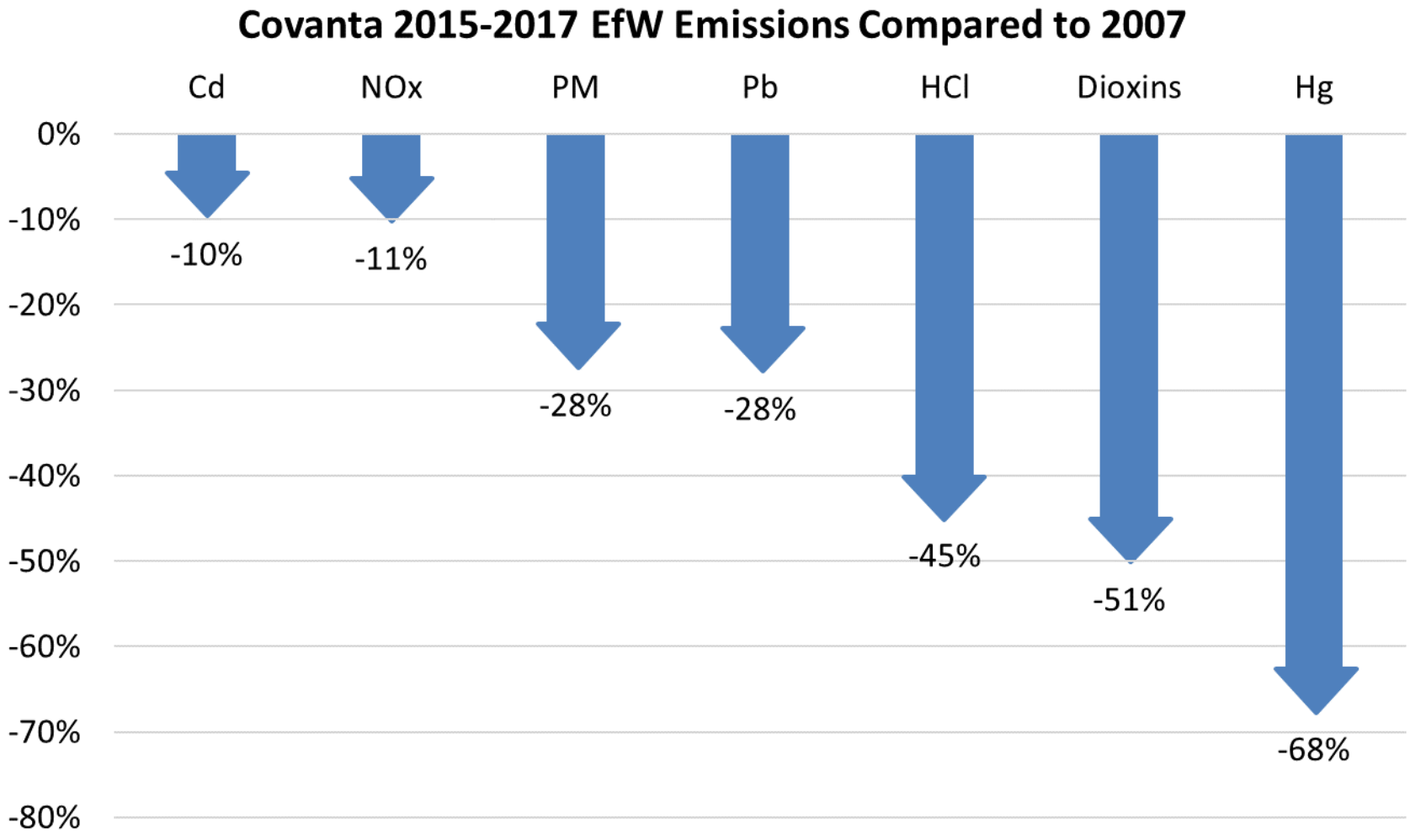
...And we continue to improve our performance



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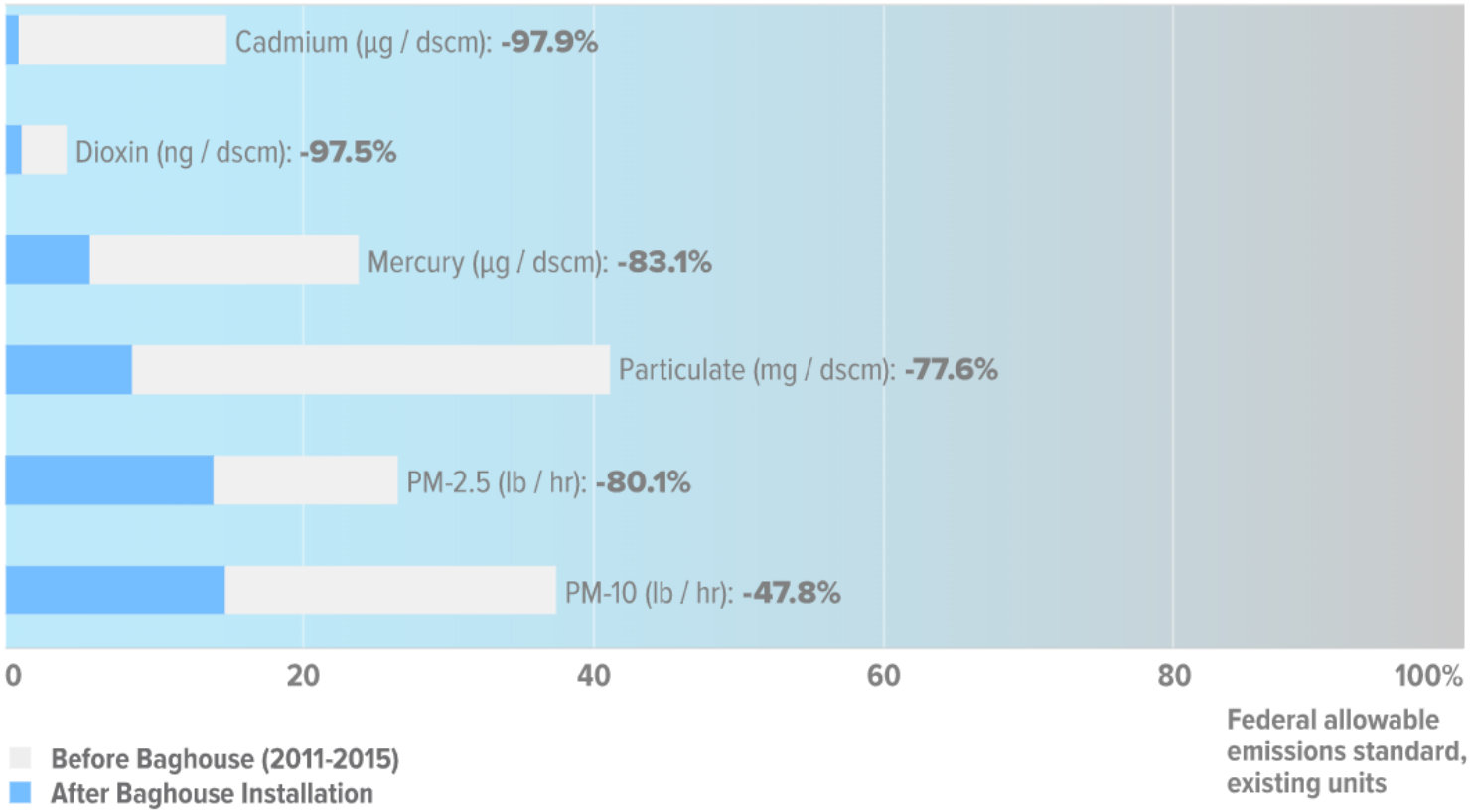
Results

Essex County EfW Emissions with Baghouse Compared to Previous APC System



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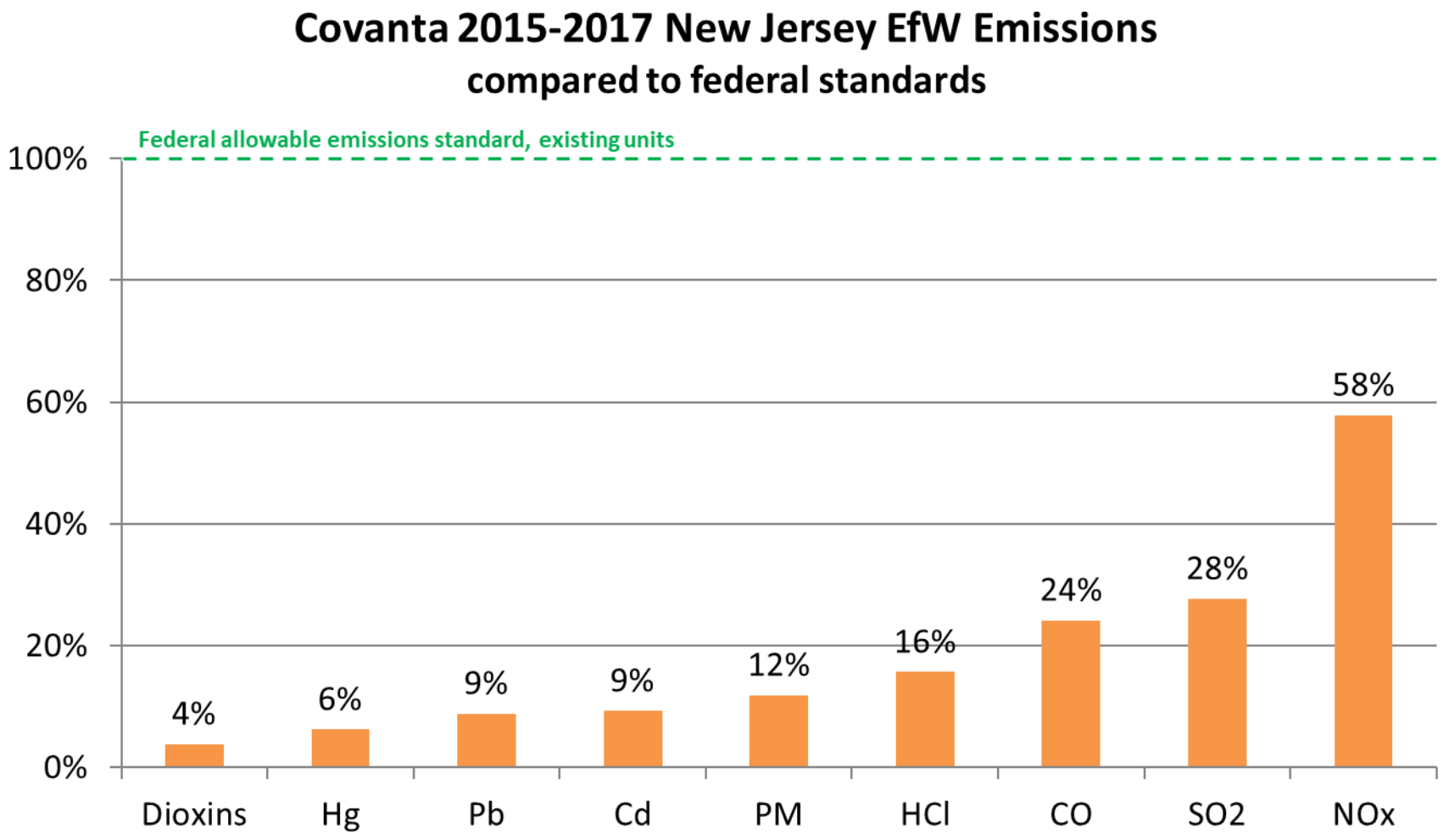
Leading to emissions well below federal standards



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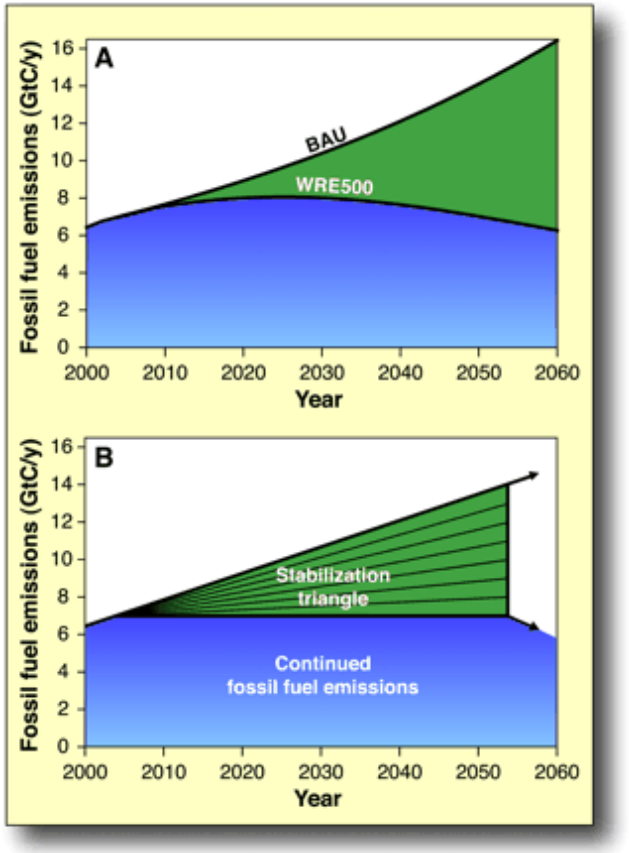
Putting the Benefits into Perspective

Background

- 2004 Drs. Pacala and Socolow (Princeton) introduced the stabilization triangle
- 7 gigaton of carbon per year (7 GtC/yr) reduction needed by 2054 versus BAU
- Seven wedges together would *stabilize* world-wide greenhouse gas *emissions* at today's emission rate

Global Results – the "Waste Wedge"

- 1 billion metric tonnes of carbon. Equivalent to:
  - ✓ Closing 1000 large coal-fired power plants
  - ✓ Building 2 million 1MW wind machines
  - ✓ Doubling our nuclear power plant capacity



S. Pacala et al., Science 305, 968 -972 (2004)

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What if New Jersey more closely followed the Waste Hierarchy?

	Business as Usual*		Sustainability Scenario
Recycling	41.7%	→	65%
EfW	15.6%		25%
Landfill	42.7%		10%

- ***GHG Savings***

  3.3 million tons CO_2e

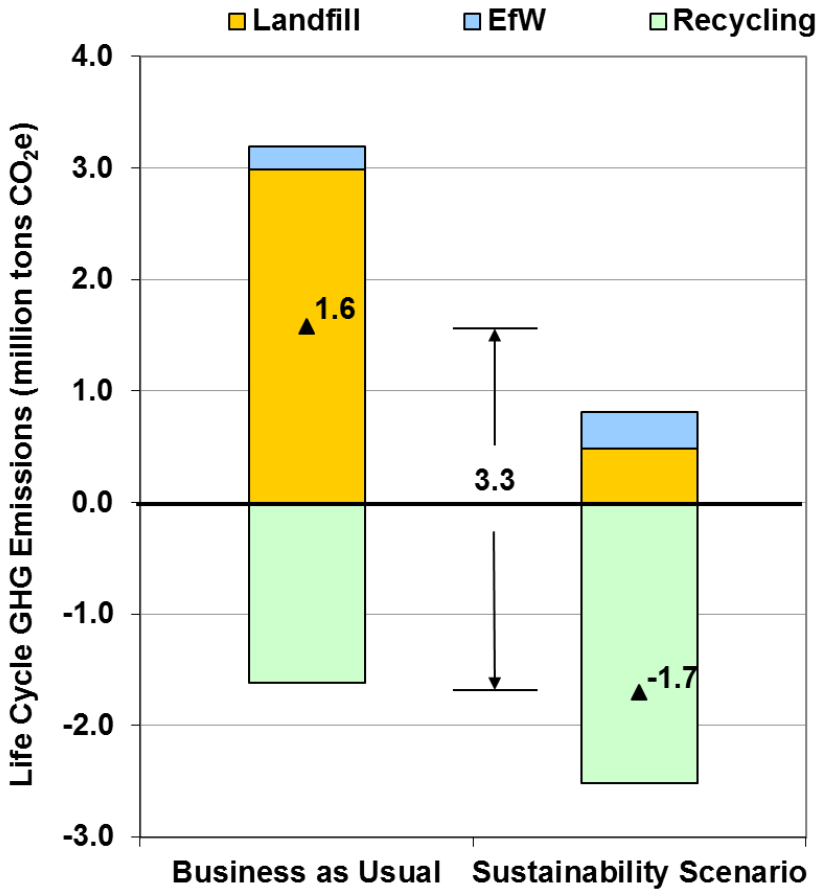
  ≈ pulling **640,000 cars** off the road

  or replacing over **100 million** incandescent light bulbs with LEDs

- ***Energy Savings***

  equivalent of **1,600 GWh** of electricity

  ≈ the energy in **16,000** tanker trucks of fuel oil



* Does not sum to 100% due to rounding

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