Philadelphia Water Department

Energy Planning & Research Team

Effective Food Waste Management in the City of Philadelphia

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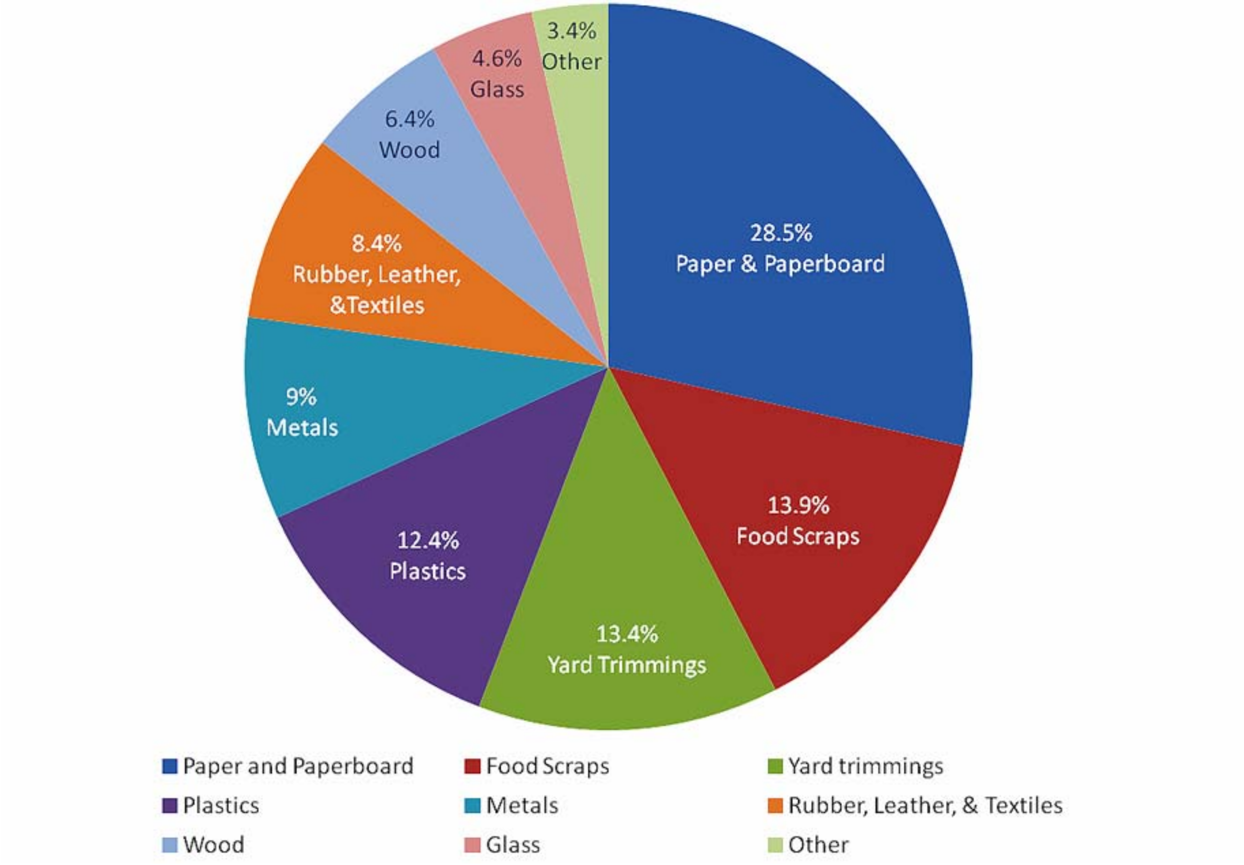
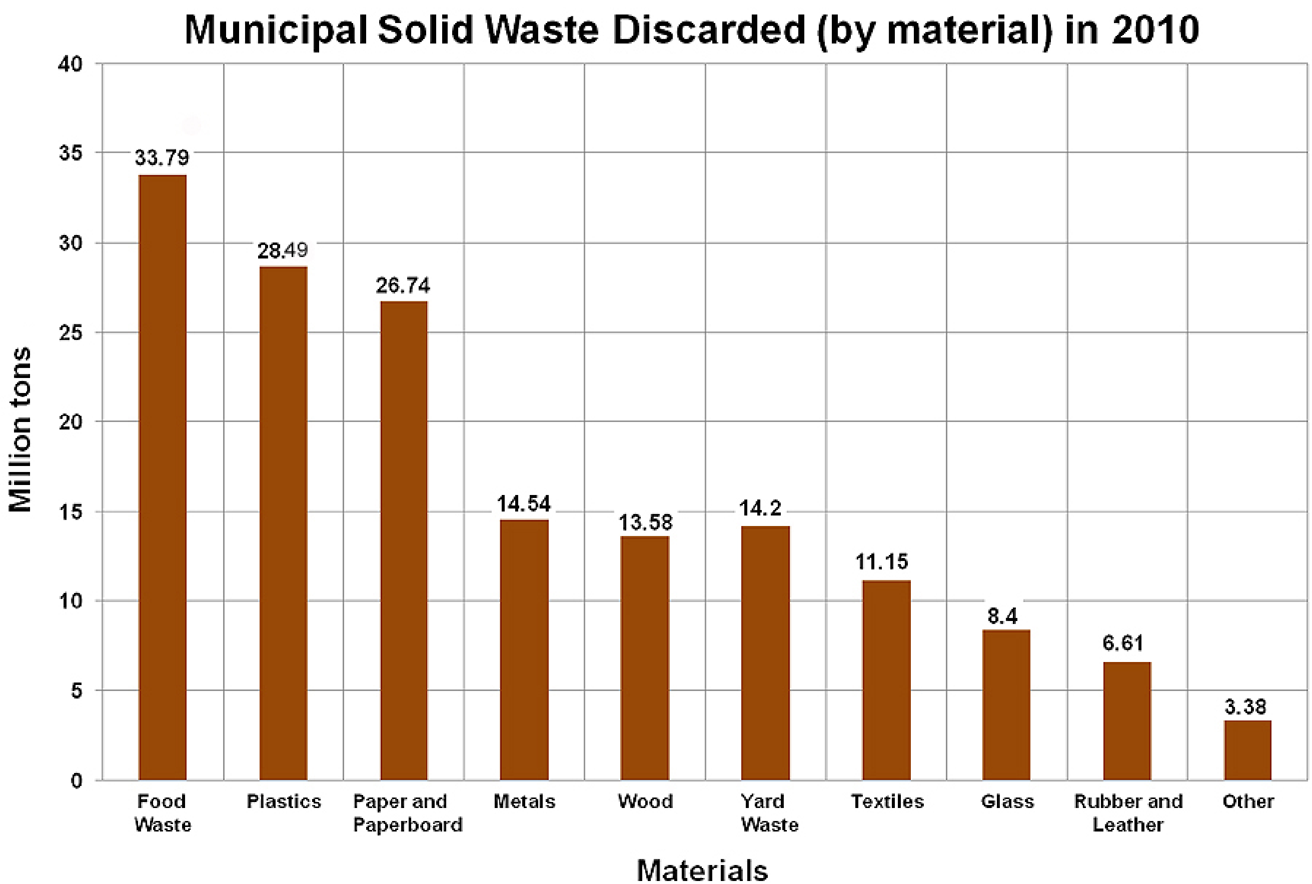
Total U.S. Municipal Solid Waste in 2010

Over **34 million tons** of food waste (FW) generated in the U.S. in 2010, more than any other material category but paper (EPA, 2010).



U.S. FW in 2010 (After Recycling)

After recycling, 33 million tons of FW was thrown away, making FW the **single largest component of Municipal Solid Waste (MSW) reaching landfills and incinerators in the U.S.** (EPA, 2010).



FW in Philadelphia

- Philadelphia Streets Department (Streets Dept.) conducts decennial MSW study:
  - Takes samples of MSW
  - Manually sorts and weighs MSW
  - Analyzes the composition of MSW

- City handles 600,000 tons of non-recyclable MSW annually.
- 11% of MSW is wet organic FW, contributing **66,000 tons** to landfills and incinerators **annually**.

Consequences of Landfill Disposal

Prior to Trash Collection:

- Unfavorable odors from decomposing FW in garbage bins.
- Pests and rodents attracted to garbage bins containing FW.
- Unsightly appearance of overflowing dumpsters in neighborhoods.

During Trash Collection:

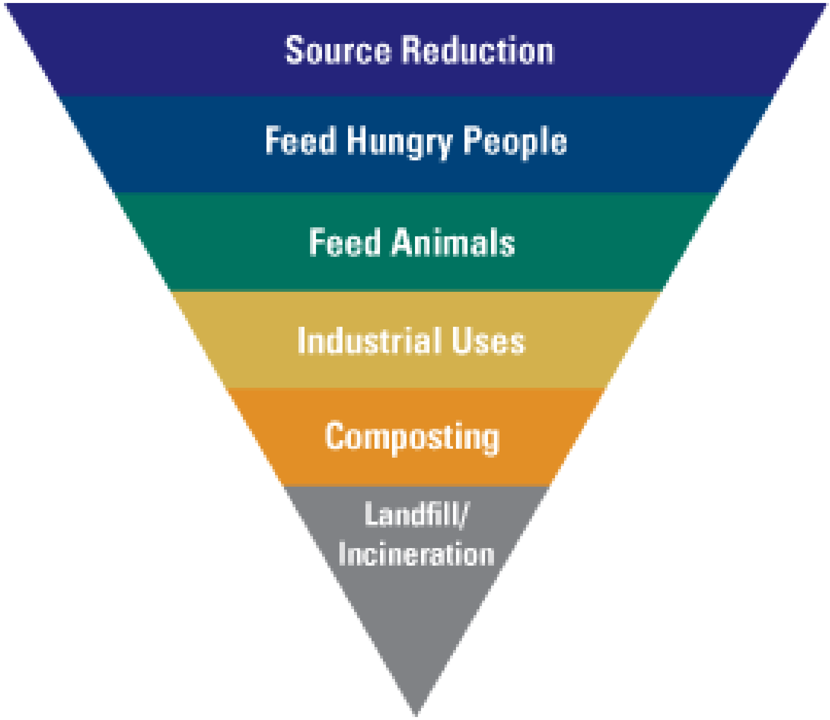
- Fossil fuels consumed by vehicles during collection.
- Harmful carbon monoxide introduced into the environment from collection vehicles.

Following Landfill Disposal:

- Methane production from decomposing FW. Methane is a potent greenhouse gas with 21 times the global warming potential of carbon dioxide (EPA, 2010). Landfills account for more than 20 percent of all methane emissions.
- Contamination of groundwater by toxic liquids that form from interactions between FW and materials in landfills such as metals (InSinkErator, 2012).

Sustainable FW Management

- **EPA Hierarchy for Managing FW Effectively**
  - Improving upstream production and distribution systems.
  - Smart purchasing and use of food.
  - Feeding people with leftover food.
  - **Using a food waste disposer (FWD).**
  - Composting in the backyard, using green bins and maintaining community gardens.



Clean Kitchen, Green Community

- The installation of 100 FWDs throughout the West Oak Lane and Point Breeze neighborhoods, along with the provision of information to residents for the effective use of the FWDs.
- **Purpose of Program: To divert FW from landfills and to assess how FWDs can help the City reach its sustainability goals stated in the Greenworks Philadelphia Initiative.**
- Program launched on May 24, 2012.
- Collaboration between the Streets Dept., Philadelphia Water Department (PWD) and InSinkErator.
- Streets Dept. will carry out a focused MSW study for the West Oak Lane and Point Breeze neighborhoods.

Addenda – Clean Kitchens

- Target Neighborhoods are working class/ moderate income single family row homes.
- Using community groups to facilitate installation
- Comparing morning trash route to afternoon trash route from same neighborhood 450 homes in route
- Estimated 40% already have FWD (200)
- Installing 100 in each area (300 out of 450 homes with FWD or 66% of homes)
- City Wide Incentive ($20 rebate on new InSinkErator) for buying or upgrading FWD.

Debjani Mallick & Noella Maillard of PWD – Streets Dept. collection truck showcased at the launch of Clean Kitchens, Green Community (May 24, 2012)

PWD in Clean Kitchen, Green Community

- Gravity drives the liquefied FW through the underground sewer system for treatment at PWD's wastewater treatment facilities.

  - **Cost-efficient response to a local issue which utilizes existing infrastructure.** Food waste is 70% water and sewers are designed to transport water.

  - At the facility, anaerobic digestion is a part of the wastewater treatment process that can be used to create renewable energy and fertilizer from FW. **This exemplifies the transition of wastewater treatment facilities to resource recovery facilities.**

- Holistic approach to energy recovery and landfill use minimization.

FWDs are Cost-Efficient

Benefits for Residents:

- FWDs use **less than 1% of a household's water consumption**.

- FWDs cost households **less than 50¢/year in electricity** to operate.

Benefits for the City of Philadelphia:

- Every ton of FW diverted from landfills saves the City **$68 in tipping fees**.

Resource Recovery Facilities

Facility under Construction

• 5.6 MW biogas cogeneration facility being constructed at the Northeast Water Pollution Control Plant.

• Facility will use biogas from the anaerobic digestion process to provide over 85% of the power needed for plant operations.

Conceptual Rendering of Facility

Environmental Support for FWDs

- National Green Building Certificate

Green Approved Product

For

National Green Building Certification

This is to signify that the following products for residential construction

Food Waste Disposer

Manufactured by

InSinkErator division of Emerson Electric

Have been approved for points toward National Green Building Certification to the ICC 700-2008 National Green Building Standard as shown on page 2 of this certificate. The NAHB Research Center hereby authorizes accredited verifiers to award these points toward certification when the products are used in accordance with the conditions shown on page 2 and the manufacturer's installation instructions.

This information has been verified by independent third-party testing or evaluation.

Certificate #00015

Signed: Robert L. Hill, Director, Laboratory Sciences and Certification Programs — Issuance Date: April 29, 2009 — Expiration Date: April 30, 2013

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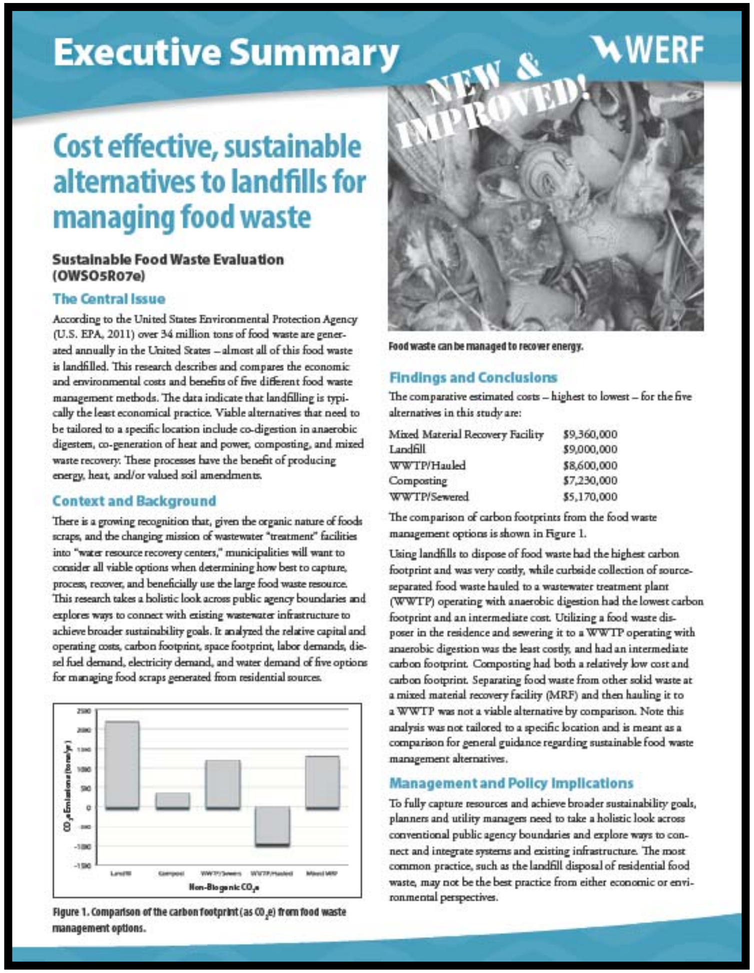
- UK – Chartered Institute of Water and Environmental Management (CIWEM) Policy Statement
- Support from the Water Environment Research Foundation (WERF)

CIWEM Policy Statement

1. CIWEM considers the evidence and demonstrates that FWDs are valid tools for separating kitchen FW at source and diverting it to treatment, use and recycling via the existing infrastructure and that they offer the opportunity for cost savings compared with other routes.
2. CIWEM considers that FWDs offer the opportunity for wider participation in resource recovery from wastes by a greater proportion of the population than has been the case with exclusive advocacy of curbside collection, which whilst acceptable to some, is not acceptable to all.
3. CIWEM considers FW and other organic residuals should (wherever possible) be treated and then used on land to conserve soil organic matter and complete nutrient cycles. The use of biosolids and other organic resources on land should be viewed from the perspective of the soil rather than from the origins of the materials. It is important to move to a holistic view of all aspects of organic resource production, use, soil protection, countryside stewardship, water protection, air protection and crop and livestock production. CIWEM considers there is scope for simplified, proportionate, science-based regulation of all organic resources and for co-treatment.

WERF Report

- Sustainable FW Evaluation.
- Comparison of economic and environmental benefits and costs of 5 different FW management methods.
- FWDs for **cost-efficient** FW management with an intermediate carbon footprint.



Executive Summary

WERF

NEW & IMPROVED!

Cost effective, sustainable alternatives to landfills for managing food waste

Sustainable Food Waste Evaluation (OWSO5R07e)

The Central Issue

According to the United States Environmental Protection Agency (U.S. EPA, 2011) over 34 million tons of food waste are generated annually in the United States – almost all of this food waste is landfilled. This research describes and compares the economic and environmental costs and benefits of five different food waste management methods. The data indicate that landfilling is typically the least economical practice. Viable alternatives that need to be tailored to a specific location include co-digestion in anaerobic digesters, co-generation of heat and power, composting, and mixed waste recovery. These processes have the benefit of producing energy, heat, and/or valued soil amendments.

Context and Background

There is a growing recognition that, given the organic nature of foods scraps, and the changing mission of wastewater "treatment" facilities into "water resource recovery centers," municipalities will want to consider all viable options when determining how best to capture, process, recover, and beneficially use the large food waste resource. This research takes a holistic look across public agency boundaries and explores ways to connect with existing wastewater infrastructure to achieve broader sustainability goals. It analyzed the relative capital and operating costs, carbon footprint, space footprint, labor demands, diesel fuel demand, electricity demand, and water demand of five options for managing food scraps generated from residential sources.

Figure 1. Comparison of the carbon footprint (as CO_2e) from food waste management options.

Food waste can be managed to recover energy.

Findings and Conclusions

The comparative estimated costs – highest to lowest – for the five alternatives in this study are:

Mixed Material Recovery Facility	$9,360,000
Landfill	$9,000,000
WWTP/Hauled	$8,600,000
Composting	$7,230,000
WWTP/Sewered	$5,170,000

The comparison of carbon footprints from the food waste management options is shown in Figure 1.

Using landfills to dispose of food waste had the highest carbon footprint and was very costly, while curbside collection of source-separated food waste hauled to a wastewater treatment plant (WWTP) operating with anaerobic digestion had the lowest carbon footprint and an intermediate cost. Utilizing a food waste disposer in the residence and sewering it to a WWTP operating with anaerobic digestion was the least costly, and had an intermediate carbon footprint. Composting had both a relatively low cost and carbon footprint. Separating food waste from other solid waste at a mixed material recovery facility (MRF) and then hauling it to a WWTP was not a viable alternative by comparison. Note this analysis was not tailored to a specific location and is meant as a comparison for general guidance regarding sustainable food waste management alternatives.

Management and Policy Implications

To fully capture resources and achieve broader sustainability goals, planners and utility managers need to take a holistic look across conventional public agency boundaries and explore ways to connect and integrate systems and existing infrastructure. The most common practice, such as the landfill disposal of residential food waste, may not be the best practice from either economic or environmental perspectives.

FWD Case Histories

- FWDs commonly used in the United States, Japan, Canada, Brazil and Australia; less frequently used in Europe.
- **Case Studies:**
  - **NYC**: Tested local law 74 (1997).
  - **Japan**: Tested effects of FWDs on MSW on an area with 97% market penetration (2010).
  - **Italy:** Tested effects of FWDs on MSW for a small and remote mountain village with 67% market penetration (2007).

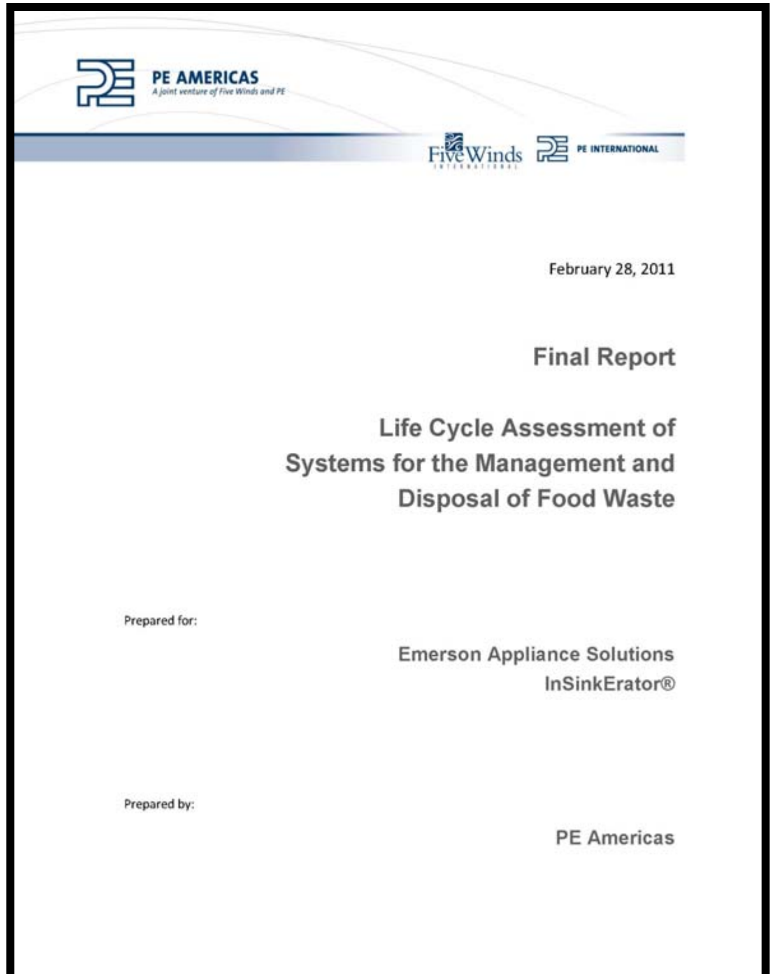
Addenda - more detail on NYC

- NYC – 1950's FWD only banned on CSO systems, not in separated sewer areas.
- Review of ban began early 1990's between DEP commissioner and Sanitation Commissioner in response to City's Solid Waste Management Plan and cessation of ocean dumping.
- 1995 – City Council requested Pilot Study
- 1997 – study completed, effect deemed "de-minimis"; adopted law to allow installation.

Life Cycle Assessment

- Life Cycle Assessment (LCA) is an important and comprehensive method for analyzing the environmental impact of products and services.
- LCA is a critical step in making informed decisions.
- LCA can be understood intuitively to follow a product from the cradle to the grave.
- **Gate-to-grave analysis for assessing the environmental impacts of FWDs.**

LCA Final Report by PE Americas


PE AMERICAS
A joint venture of Five Winds and PE

FiveWinds INTERNATIONAL PE INTERNATIONAL

February 28, 2011

Final Report

Life Cycle Assessment of
Systems for the Management and
Disposal of Food Waste

Prepared for:

Emerson Appliance Solutions
InSinkErator®

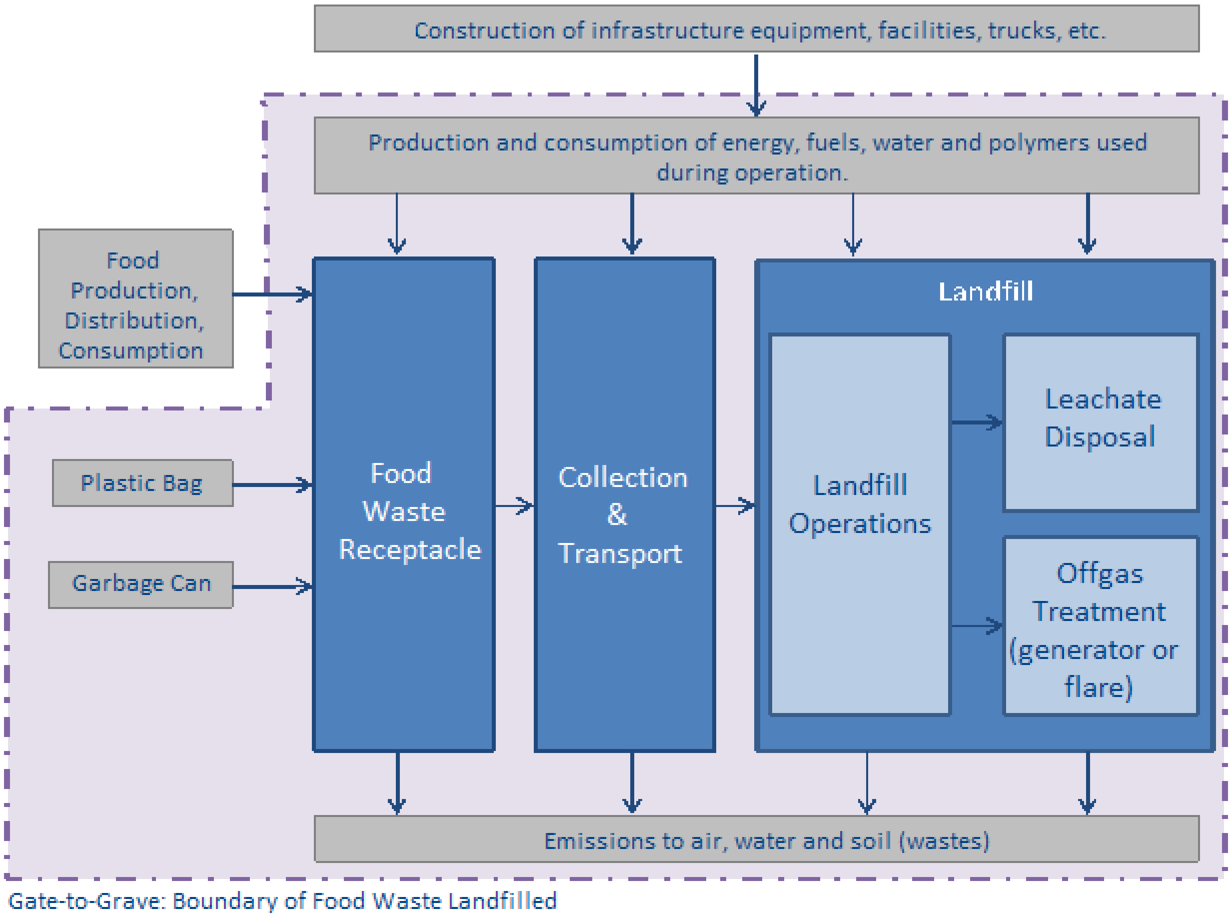
Prepared by:

PE Americas

Functional Unit of LCA

- **FW per Household**
  - 100 kg/year
- **Water**
  - Consumption: 1,000 gallons/year
  - Cost: $3/year
- **Electricity**
  - Consumption: 4 kWh/year
  - Cost: 60¢/year

Boundary for Landfill



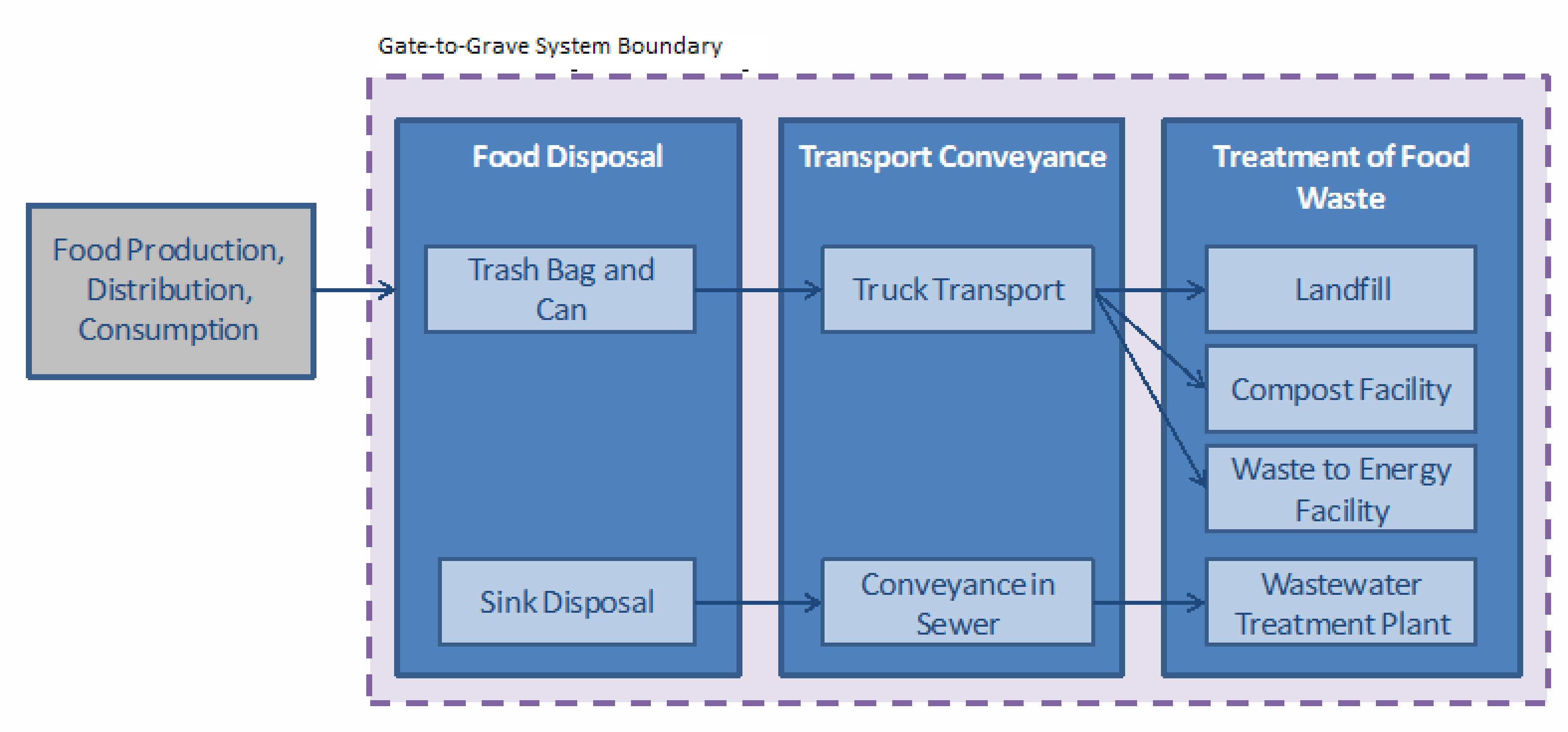
Source: PE Americas, 2011

Gate-to-Gate Life Cycle Inventory of FW Receptacle

Food Waste Receptacle		
Flow	Units	per kg food waste
Inputs		
Dry Food Waste	kg	0.3
Food Waste Water Content	kg	0.7
Plastic Bag		
Polyethylene Film	kg	5.4E-04
Garbage Can		
Polyethylene High Density Granulate (PE-HD)	kg	7.3E-04
Power (Injection Molding)	kWh	1.3E-03
Outputs		
Food Waste	kg	1.0
Plastic Bag to Landfill	kg	5.4E-04
Garbage Can to Landfill	kg	7.2E-04

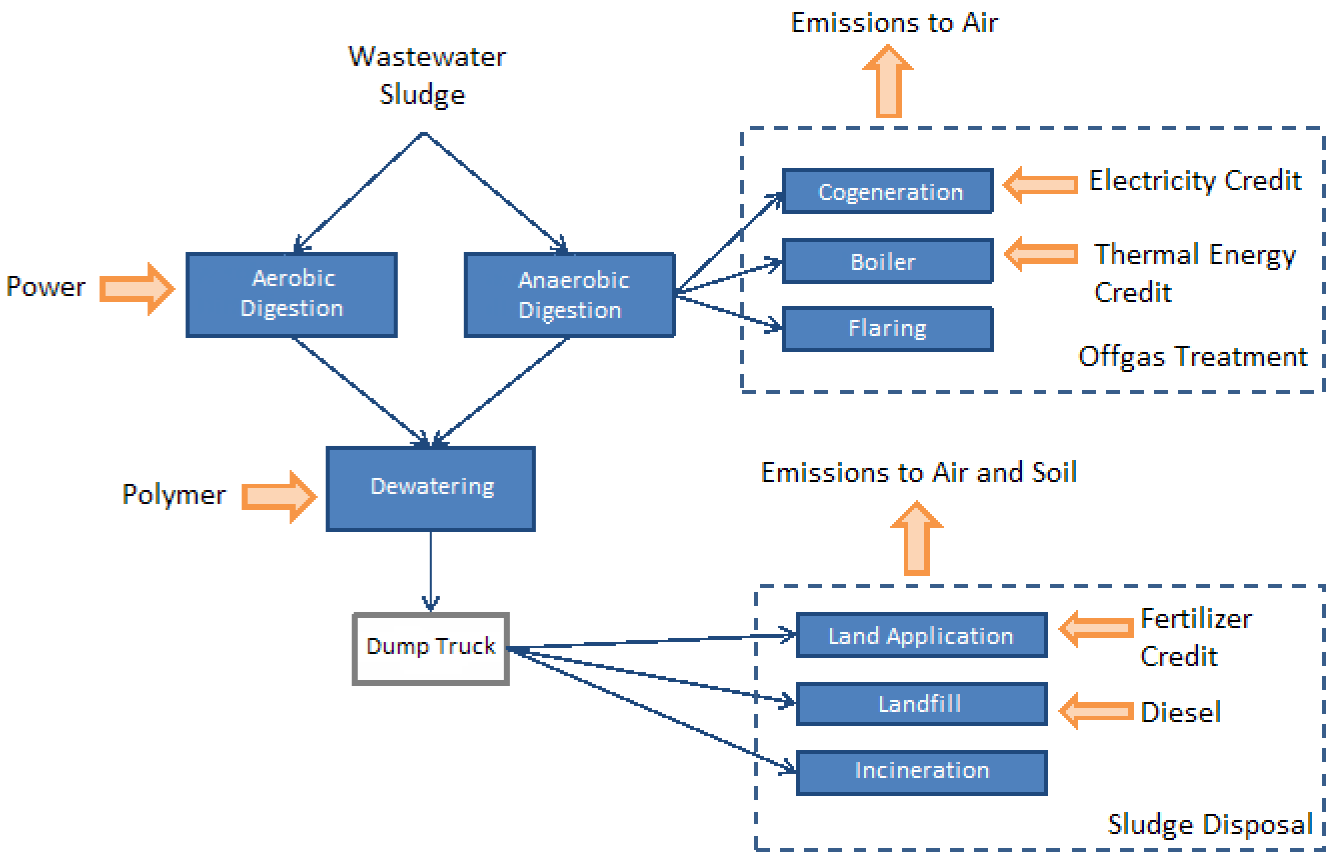
Source: PE Americas, 2011

Summary of Gate-to-Grave FW Disposal System



Source: PE Americas, 2011

Boundary of Sludge Handling



Source: PE Americas, 2011

Important Terms and Definitions

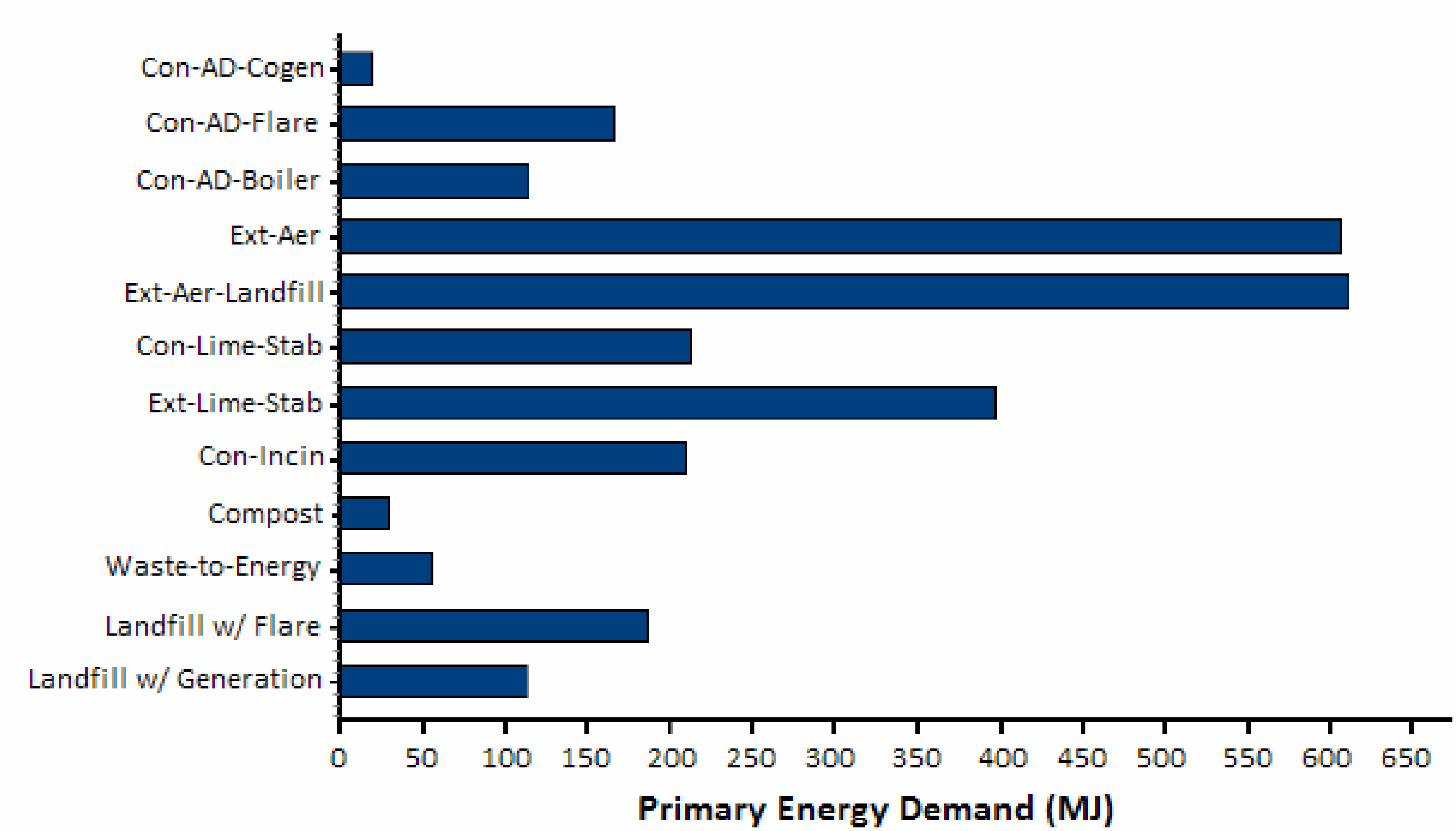
- **Con-AD-Cogen**: Conveyance to conventional activated sludge process with anaerobic digestion, biogas used for cogeneration and biosolids land applied.
- **Ext-Aer-Landfill**: Conveyance to extended aeration sludge process with aerobic digestion and biosolids landfilled.
- **Landfill with Generation**: Biosolids landfilled and biogas used for cogeneration.

1-Year Summary of End-of-Life Disposal Results

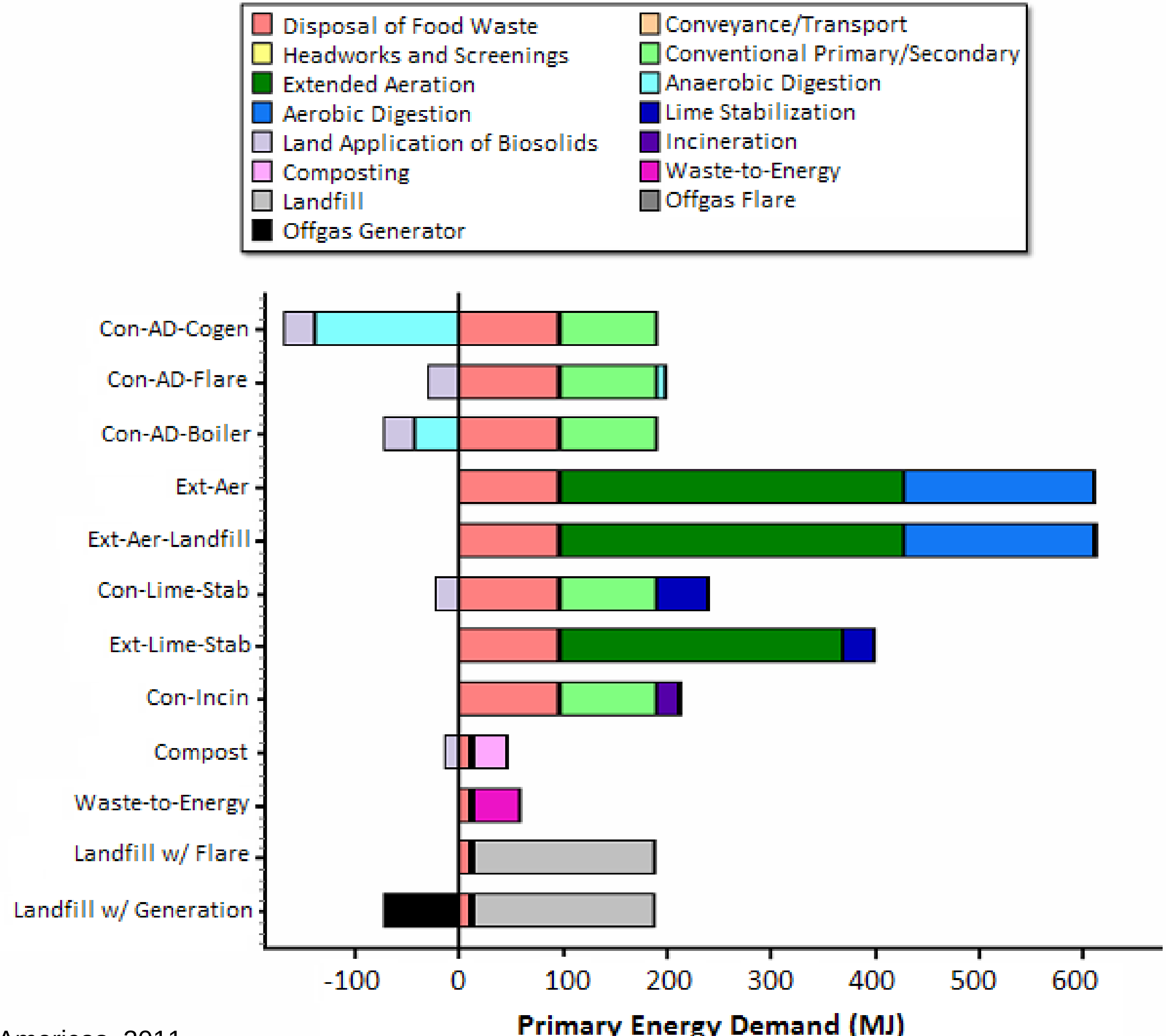
Scenario	Primary Energy Demand	Global Warming Potential	Acidification Potential	Eutrophication Potential	Smog Potential
	(MJ)	(kg CO2-eq)	(mol H+ eq)	(kg N-eq)	(kg NOx eq)
Con-AD-Cogen	19	-0.16	9.8	9.8E-03	2.2E-04
Con-AD-Flare	170	9.8	4.5	1.4E-03	2.5E-05
Con-AD-Boiler	120	6.4	4.2	1.1E-03	1.9E-05
Ext-Aer	610	43	15	8.7E-03	7.6E-05
Ext-Aer-Landfill	610	37	15	8.8E-03	7.8E-05
Con-Lime-Stab	210	14	4.8	1.9E-03	2.5E-05
Ext-Lime-Stab	400	29	10.2	7.1E-03	4.9E-05
Con-Incin	210	14	4.7	2.6E-03	2.7E-05
Compost	30	2.1	4.0	4.4E-03	7.6E-08
Waste-to-Energy	57	3.6	2.2	1.4E-03	2.9E-05
Landfill w/ Flare	190	81	7.1	1.7E-03	4.2E-05
Landfill w/ Generation	110	84	21	1.8E-02	4.2E-04

Source: PE Americas, 2011

Primary Energy Demand (MJ)

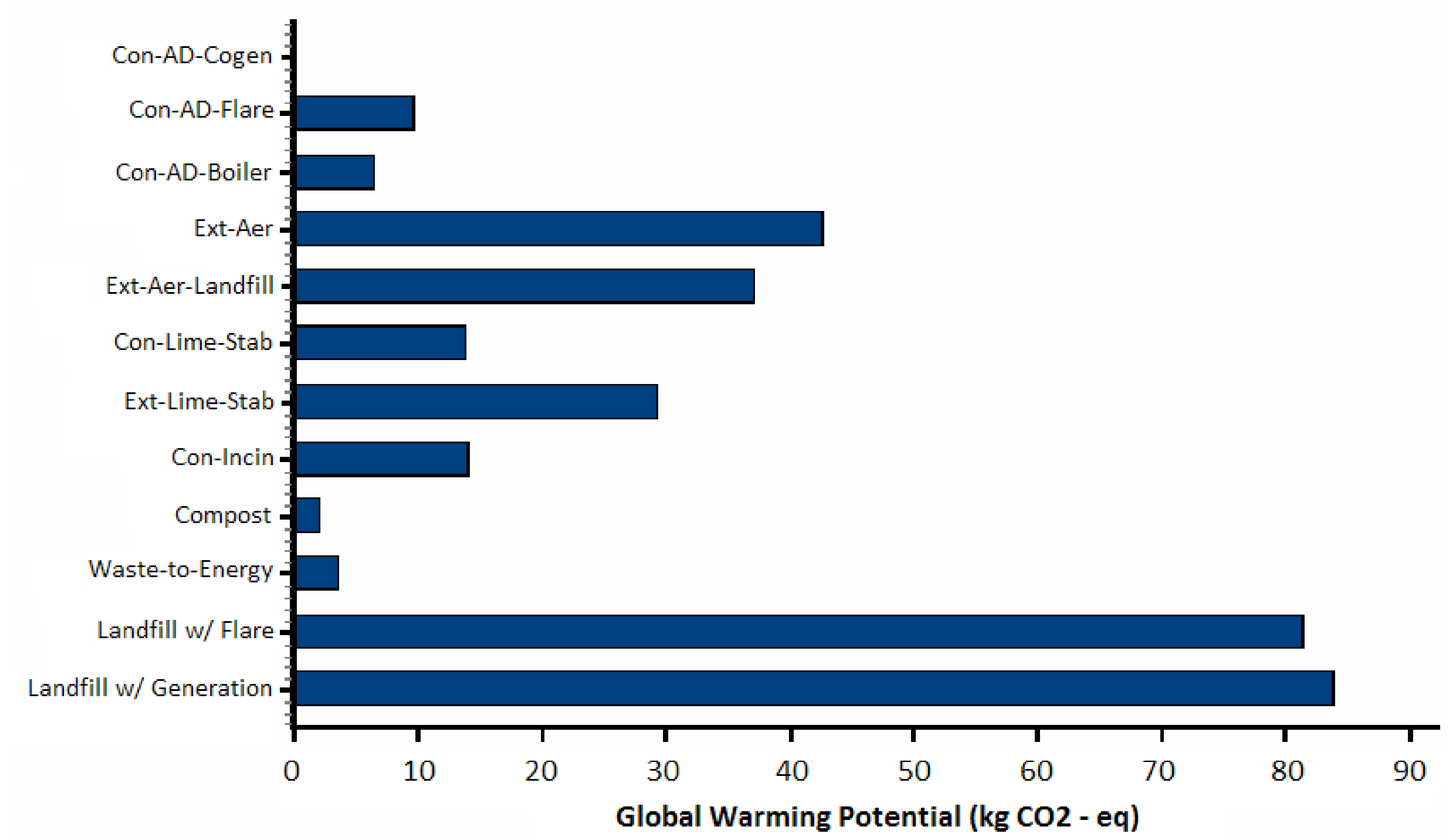


Source: PE Americas, 2011



Source: PE Americas, 2011

Global Warming Potential (kg CO_2 – eq)



Source: PE Americas, 2011

Conclusions

- **Environmental**
  - Reduces landfill use by 70%
  - Increase renewable Energy Production.
  - Reduces primary energy demand and global warming potential.
- **Social**
  - Makes the City cleaner.
  - Allows home owner not currently composting to participate in composting efforts.
- **Economic**
  - Cost-efficient for residents.
  - Saves the City money, reduced cost (tipping fees).
  - Leverages existing infrastructure.

Acknowledgments

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Questions?