An Evaluation of the Effectiveness of Organics Recycling & its Impacts on MSW Landfills in NYS

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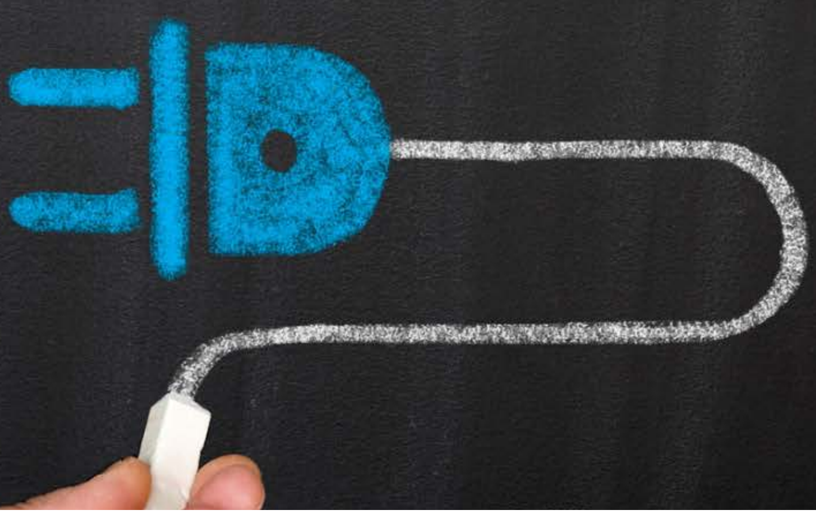


Presentation outline

Introduction

Part 1 – Comparison of Organics Recycling Versus Traditional Landfill

Part 2 – Measuring Cost Effectiveness of Organics Recycling

- Example 1: Large-scale Digester Plant
- Example 2: Large-scale Compost Facility

Conclusions / Findings

Introduction

Regulatory agencies have increasingly promoted organics recycling over landfilling

- Reduces greenhouse gas emissions
- Creates soil amendments
- Energy benefits
- Creates jobs
- Reduces reliance on waste disposal

Do benefits of organics recycling outweigh the increased costs?

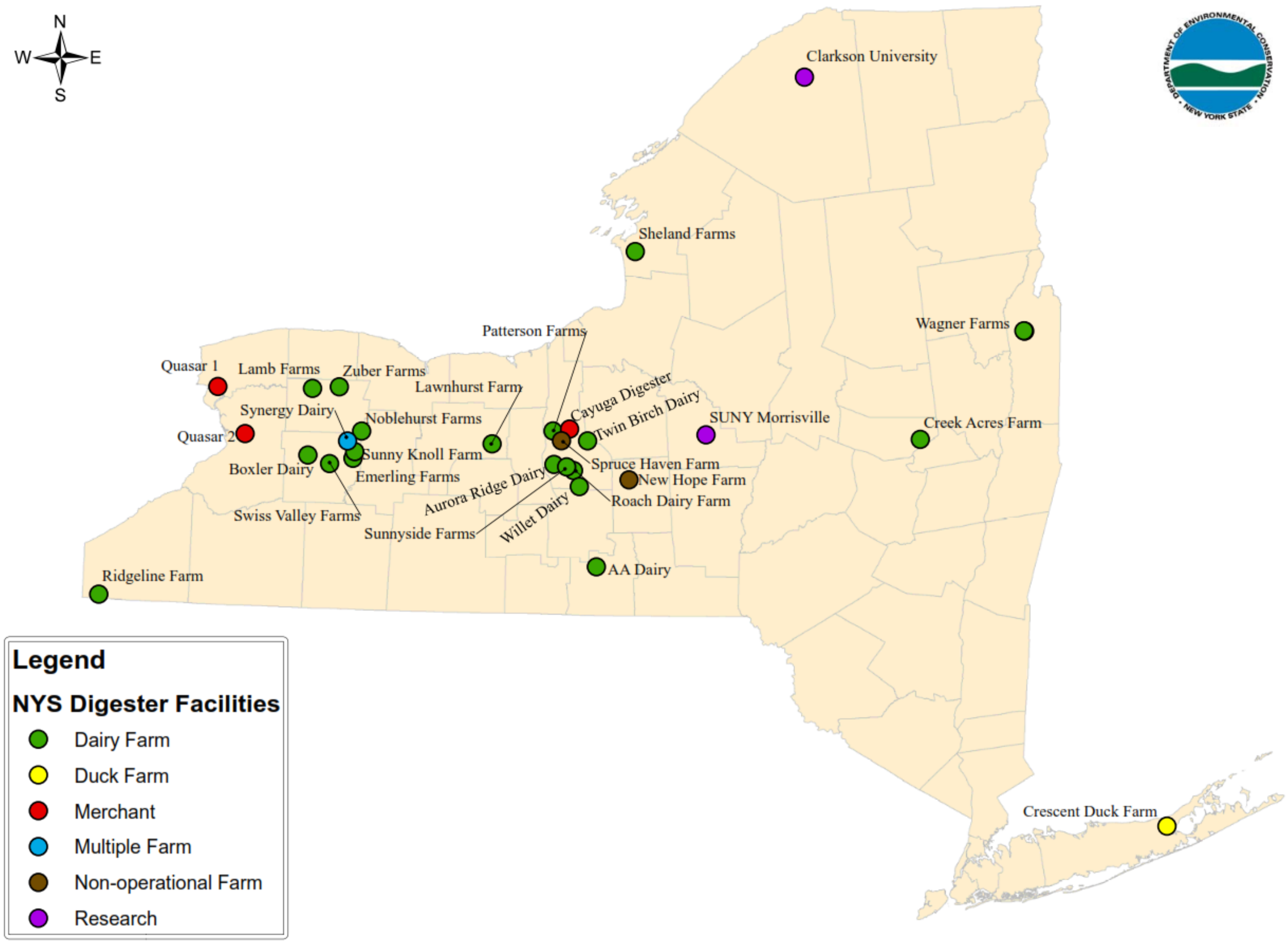
What effects will MSW landfills experience?

Can we model cost effectiveness of large-scale organics recycling over baseline landfill?

Part 1 Anaerobic Digester Versus MSW Landfill

Anaerobic Digesters	MSW Landfills
• Organic waste processed in controlled container (anaerobic).	• Mixed waste (organic & inert waste) buried with daily cover
• Separation of organic waste	• MSW & Non-hazardous waste
• Extremely fast kinetics	• Slower kinetics = longer degradation
• ~100% collection of biogas (60% CH_4, 40% CO_2)	• Landfill w/ collection system = 75-95% collection of LFG (50% CH_4, 50% CO_2)
• Biogas and heat can be processed as renewables	• LFG can be processed as renewable energy source or flared
• Diegestate can be used as fertilizer, landfill application material	• Waste stays in place, carbon material has long retention time (carbon sink)
• Much more costly and difficult to implement on a large scale	• Less costly option,more infrastructure in place

Part 1 Anaerobic Digester Projects in New York State



* From NYSDEC website

Part 1 Compost Facility Versus MSW Landfill

Compost Facility	MSW Landfills
• Organic waste processed in controlled vessel (aerobic).	• Mixed waste (organic & inert waste) buried with daily cover (anaerobic)
• Separation of organic waste	• MSW & Non-hazardous waste
• Moderately fast kinetics	• Slower kinetics = longer degradation
• No collection of biogas (90-99% CO_2, low amount of antropogenic GHG)	• Landfill w/ collection system = 75-95% collection of LFG (50% CH_4, 50% CO_2)
• Compost is produced and sold, can be used as fertilizer	• LFG can be processed as renewable or flared
• Much more costly and difficult to implement on a large scale	• Waste stays in place, carbon material has long retention time (carbon sink)
• Requires large amount of land area as do landfills	• Less costly option, more infrastructure in place

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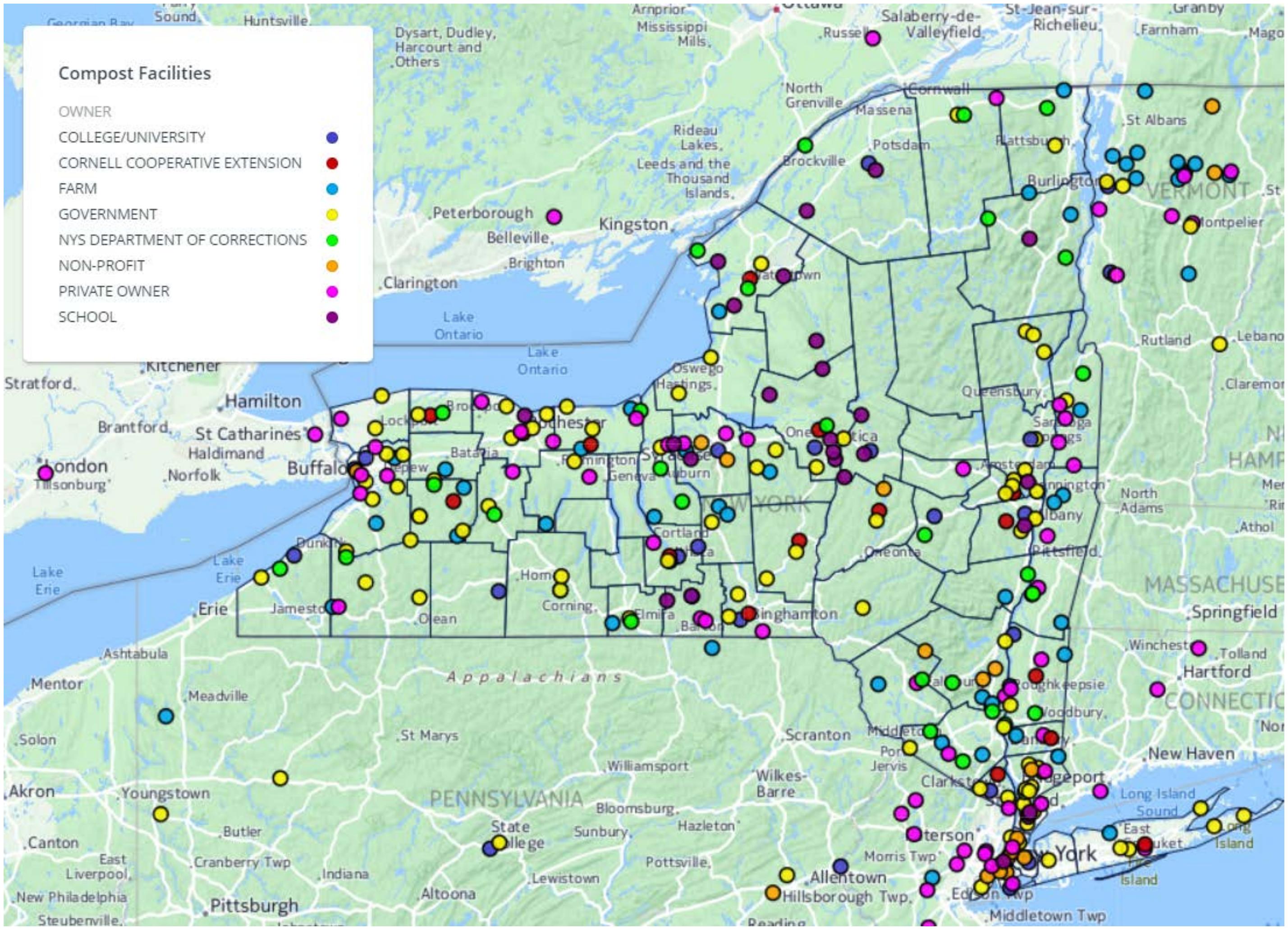
Part 1 Compost Facilities in New York State



* From Cornell Waste Management Institute

Part 1 Effects on MSW Landfills

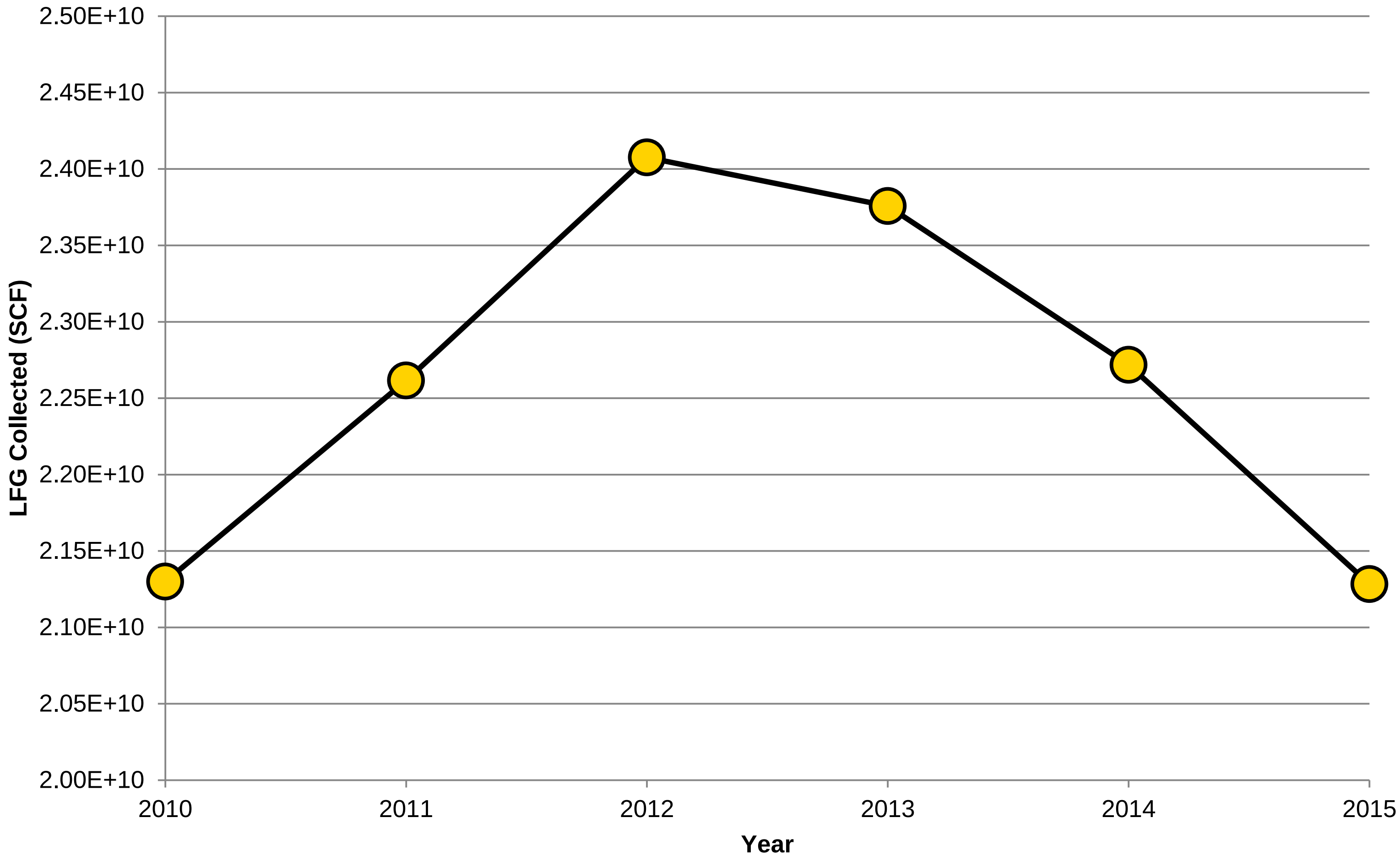
Short-term effects

- Less waste sent to MSW Landfills = Less revenue
- Waste contains less organic materials = Lower BTU landfill gas
- Decline in recovered LFG / methane (for landfills with collection system)

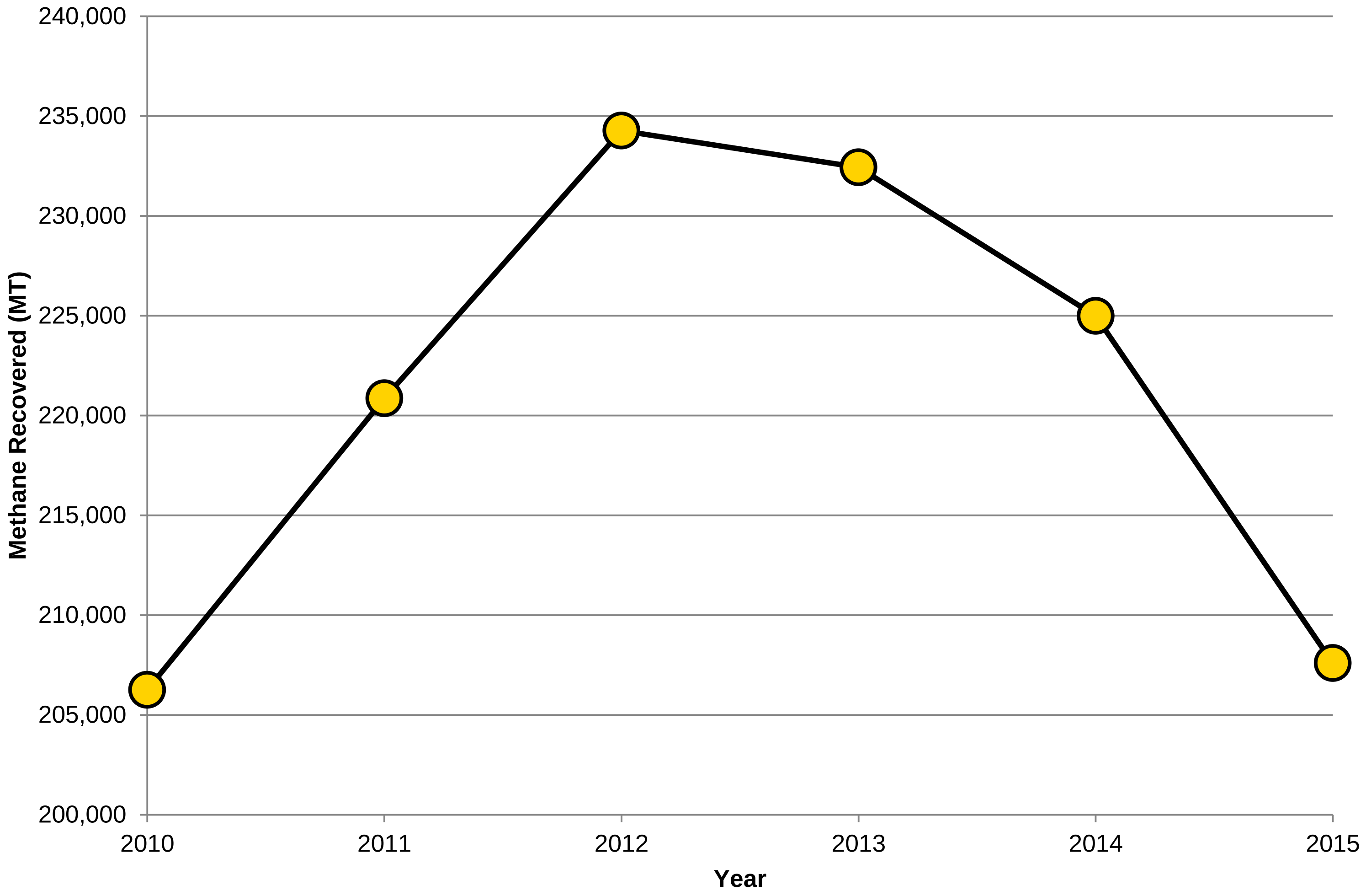
Are we seeing some effects on NYS landfills already?

- USEPA GHG Reporting Program – 40 CFR 98, Subpart HH
  - MSW landfills began self-reporting in 2010; USEPA provides results to public
  - Monitoring Requirements
    - Continuous monitoring of collected LFG (every 15 minutes)
    - Periodic monitoring of methane concentration
    - Annual waste accepted
  - Reporting Requirements
    - Total LFG Collected (scf), Total methane recovered (metric tons), Average CH_4 concentration (% by volume), Total waste accepted (metric tons)
  - Query run for New York landfills: 2010-2015 data
    - Remove closed landfills and landfills that do not have complete 6-year set

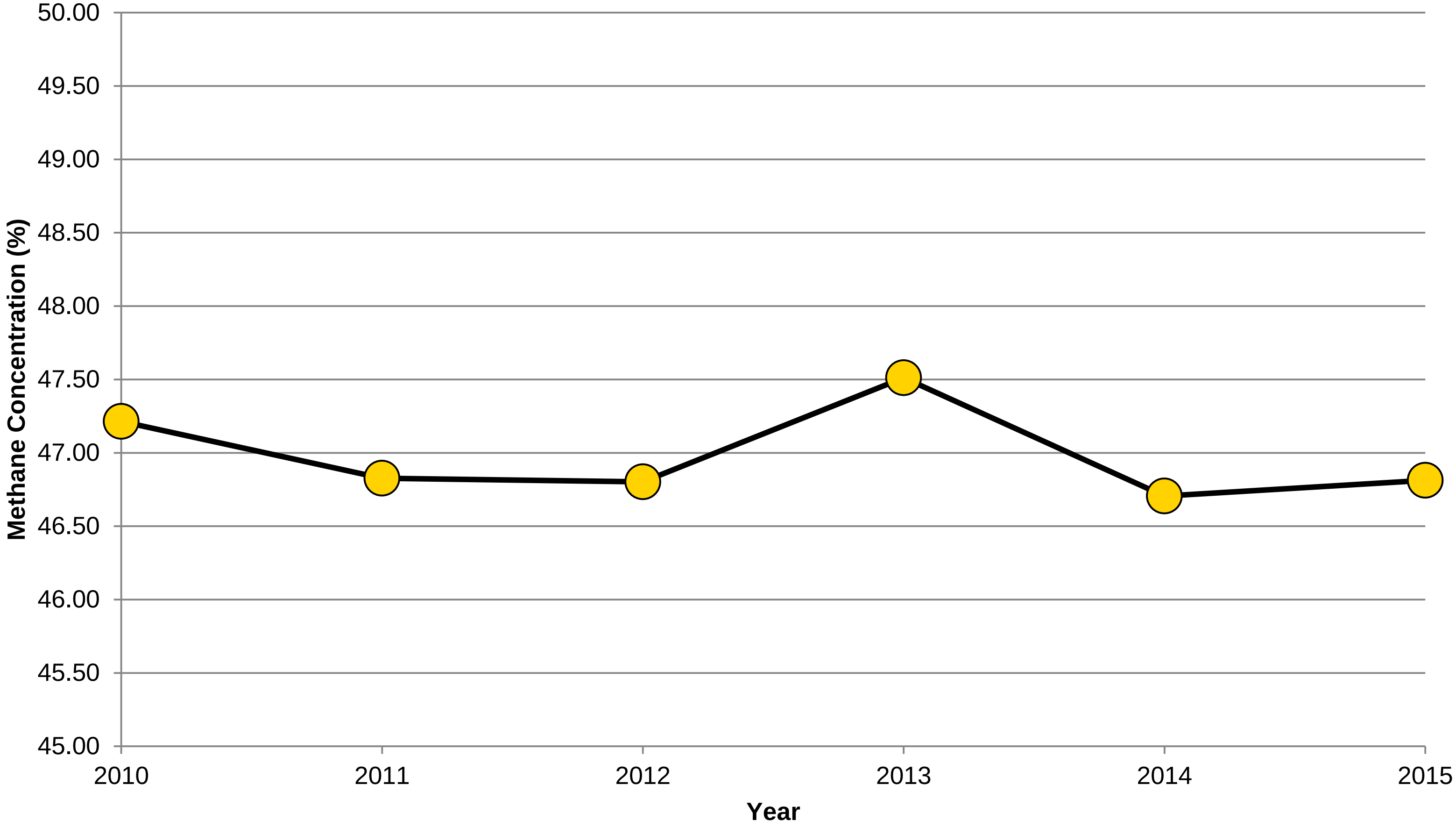
Part 1 LFG Collection Rates for Open NYS Landfills



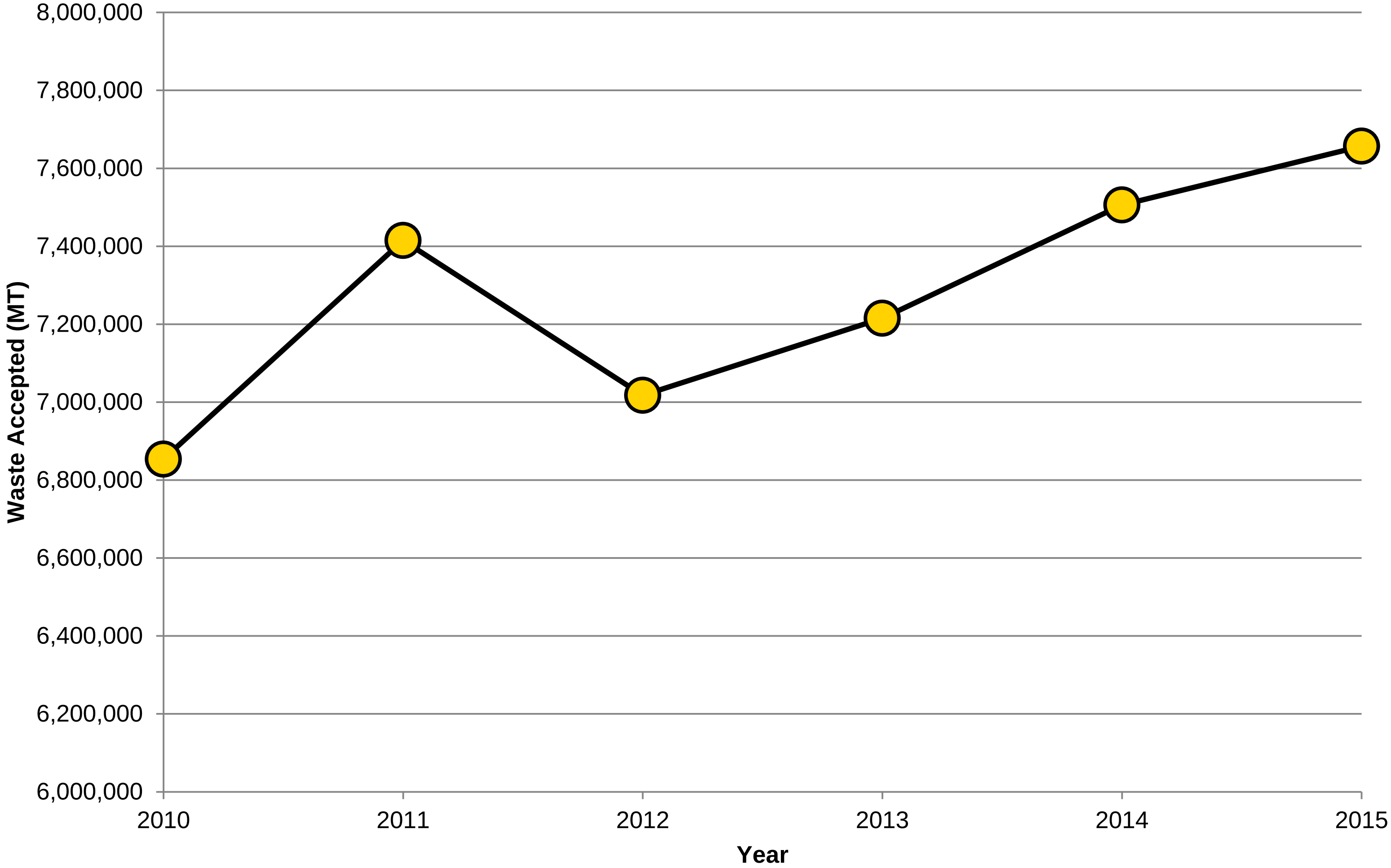
Part 1 CH_4 Recovery Rates for Open NYS Landfills



Part 1 Average CH_4 Concentration - Open NYS Landfills



Part 1 Total Waste Landfilled - Open NYS Landfills



Part 1 Effects on MSW Landfills

Long-term effects

- Existing energy projects may have shortened lifespan
- Could see decline in future energy projects at MSW landfills
- Decommissioning of active gas collection systems may occur sooner

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Part 2 Measuring Cost Effectiveness of Organics Recycling

Is large-scale organics recycling cost effective in terms of reducing GHG emissions?

Building a Cost Effectiveness Model

- Similar to conducting a BACT Analysis
- Examine net reduction in GHG by implementing technology with landfill as baseline (only anthropogenic GHG is considered)
- Estimate cost difference of organics technology (MSW landfill is baseline)
- Examine environmental, energy and economic costs and benefits
- Only direct effects within facility property boundary were considered

$$Cost\ Effectiveness = \frac{Cost\ of\ Technology\ Compared\ With\ Baseline\ (\$)}{Net\ Reduction\ of\ Anthropgenic\ GHG\ (Ton\ CO_2e)}$$

$$Cost\ Effectiveness = Cost\ (\$)\ per\ Ton\ CO_2e\ reduced$$

Part 2 Measuring Cost Effectiveness - Digester Project

Example 1 – Large-scale anaerobic digester project

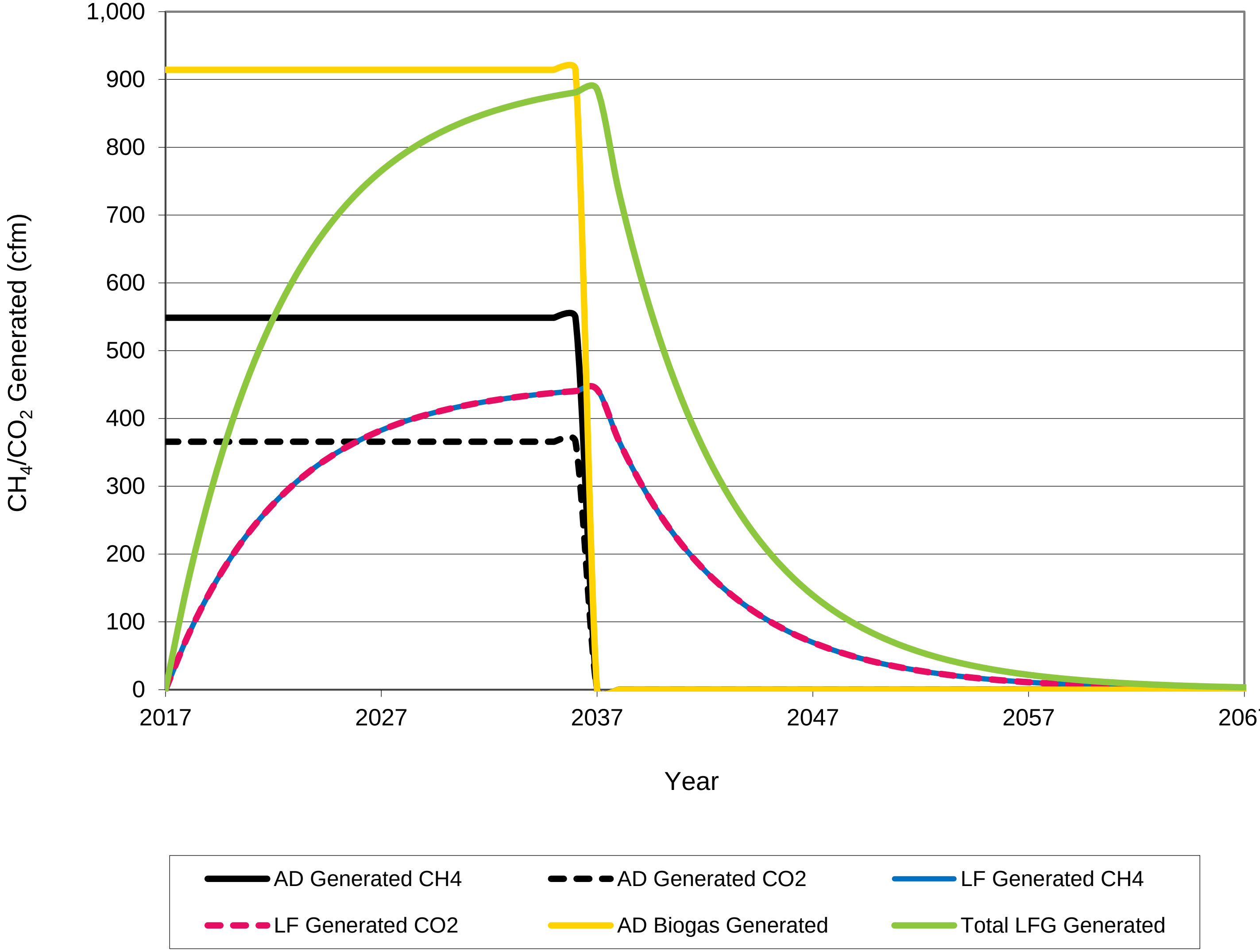
Assumptions – Digester Plant

- 100,000 TPY food waste; 20-year project life
- Biogas production rate = 150 m^3/metric ton food waste
- Biogas composition: 60% CH_4, 40% CO_2
- Energy Project: IC engines generating electricity (99% destruction of methane)

Assumptions – MSW NSPS Landfill

- 100,000 TPY food waste
- 120 year project life for landfill
- LFG Production based on USEPA LandGEM model, version 3.02
  - DOC = 0.15, k = 0.185 yr^{-1} (referenced from USEPA GHG Reporting Rule)
- LFG composition: 50% CH_4, 50% CO_2
- Collection efficiency = 75%, Cover oxidation factor = 0.10
- Control device destruction efficiency = 99%

Part 2 Biogas Generation – Digester vs. MSW Landfill



Part 2 Net GHG Reduction - Digester Project

Total Anthropogenic CH_4 (Digester) = 30,491 tons CO_2e (20 years)

Total Anthropogenic CH_4 (Landfill) = 567,724 tons CO_2e (120 years)

Total GHG Reduction = 537,233 tons CO_2e

Average Reduction (over 20 years) = 26,862 tons CO_2e / year

What happens when a gas collection efficiency of 90% is assumed for NSPS landfill?

Total Anthropogenic CH_4 (Digester) = 30,491 tons CO_2e (20 years)

Total Anthropogenic CH_4 (Landfill) = 227,090 tons CO_2e (120 years)

Total GHG Reduction = 196,598 tons CO_2e

Average Reduction (over 20 years) = 9,830 tons CO_2e / year

* A well operated landfill collection system reduces GHG reduction

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Part 2 Approximate Costs – Large Scale Digester Project

Capital Costs: ~ $530 per ton per year

Annual O&M Costs: ~ $60 per ton per year

Total Annual Cost = $10.2 million per year

Annual Cost of Energy Project = $1.6 million per year

Annual Revenue of Energy Project = $1.9 million per year

Annual Revenue of Digestate = $1 million per year

Net Cost = $8.9 million per year

Break-even Tipping Fee (Digester) = $89 per ton

Average Landfill Tipping Fee (2016) = $49 per ton (National Average)

Tipping Fee Differential (Digester) = $40 per ton

Part 2 Cost Effectiveness – Large Scale Digester Project

Additional Consumer Cost = $4 million per year

Net GHG Reduction ranges from 9,830 - 26,862 tons CO_2e / year

Cost Effectiveness = $150 - $412 per ton CO_2e reduction

What happens when we assume a landfill tipping fee of $70 per ton?

Additional Consumer Cost = $2 million per year

Net GHG Reduction ranges from 15,507 - 26,862 tons CO_2e / year

Cost Effectiveness = $73 - $199 per ton CO_2e reduction

* Areas with higher landfill tipping fees provide more cost-effective options for anaerobic digester projects

Part 2 Measuring Cost Effectiveness – Compost Facility

Example 2 – Large-scale Compost Facility

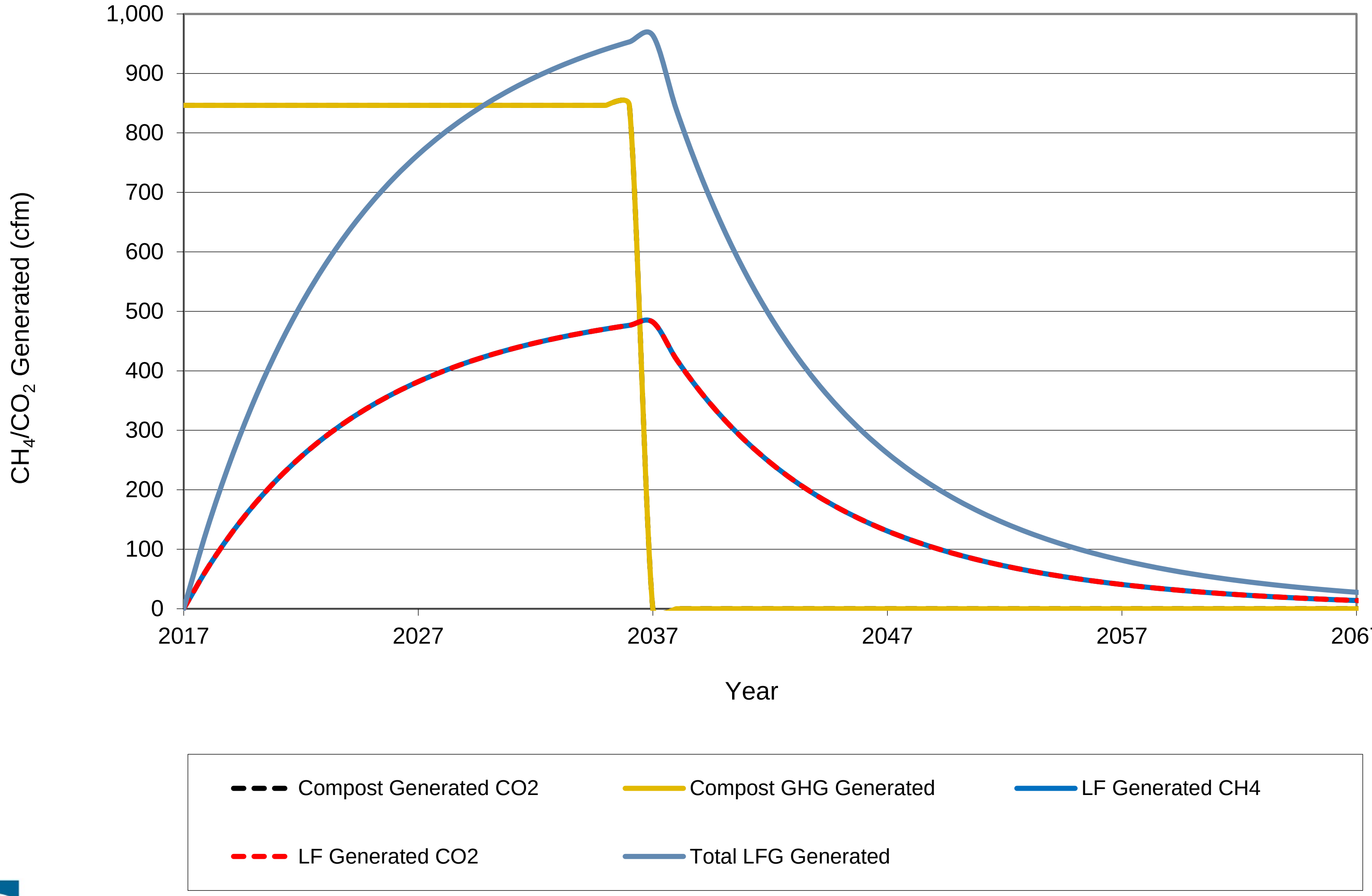
Assumptions – Compost Facility (In-Vessel)

- 50,000 TPY food waste, 50,000 TPY yard waste; 20-year project life
- GHG emissions = ~100% biogenic (No CH_4 production)
- Compost Revenue Rate: $25 per cubic yard (bulk)
- Volume Reduction Rate = 50%

Assumptions – MSW NSPS Landfill

- 50,000 TPY food waste, 50,000 TPY yard waste
- 120 year project life for landfill
- LFG Production based on USEPA LandGEM model, version 3.02
  - Food waste Parameters: DOC = 0.15, k = 0.185 yr^{-1}
  - Yard waste Parameters: DOC = 0.20, k = 0.10 yr-1
- LFG composition: 50% CH_4, 50% CO_2
- Collection efficiency = 75%, Cover oxidation factor = 0.10
- Control device destruction efficiency = 99%

Part 2 GHG Generation – Composting vs. MSW Landfill



Part 2 Net GHG Reduction – Compost Facility

Total Anthropogenic CH_4 (Composting) = ~ 0 tons CO_2e (20 years)

Total Anthropogenic CH_4 (Landfill) = 682,761 tons CO_2e (120 years)

Total GHG Reduction = 682,761 tons CO_2e

Average Reduction (over 20 years) = 34,138 tons CO_2e / year

What happens when a gas collection efficiency of 90% is assumed for NSPS landfill?

Total Anthropogenic CH_4 (Composting) = ~ 0 tons CO_2e (20 years)

Total Anthropogenic CH_4 (Landfill) = 290,724 tons CO_2e (120 years)

Total GHG Reduction = 290,724 CO_2e

Average Reduction (over 20 years) = 14,536 tons CO_2e / year

* A well operated landfill collection system reduces GHG reduction

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Part 2 Approximate Costs – Large Scale Compost Project

Capital Costs: ~ $662 per ton per year

Annual O&M Costs: ~ $53 per ton per year

Total Annual Cost = $10.6 million per year

Compost Volume Reduction Rate = 0.50

Annual Revenue Rate= $25 per cubic yard

Annual Revenue of Compost = $1.9 million per year

Net Cost = $8.7 million per year

Break-even Tipping Fee (Compost Facility) = $87 per ton

Average Landfill Tipping Fee (2016) = $49 per ton (National Average)

Tipping Fee Differential (Compost Facility) = $38 per ton

Part 2 Cost Effectiveness – Large Scale Compost Project

Additional Consumer Cost = $3.8 million per year

Net GHG Reduction ranges from 14,536 to 34,138 tons CO_2e / year

Cost Effectiveness = $111 - $261 per ton CO_2e reduction

What happens when we assume a landfill tipping fee of $70 per ton?

Additional Consumer Cost = $1.7 million per year

Net GHG Reduction ranges from 14,536 to 34,138 tons CO2e / year

Cost Effectiveness = $50 - $116 per ton CO_2e reduction

* Areas with higher landfill tipping fees provide more cost-effective options for compost facilities

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Findings/Conclusions

Small-scale organics recycling projects have increased in recent years

- Recent drop in methane production observed in NYS Landfills
- Could have a number of short-term and long-term effects if trends continue

Cost effectiveness model can estimate whether large-scale project benefits outweigh higher costs

- Net Reduction in GHG very sensitive to collection efficiency assumed for MSW Landfills

Further improvements to cost effectiveness model could include

- Incorporate indirect off-site effects of large-scale AD / compost projects
- Measure and incorporate impacts on MSW landfills

QUESTIONS

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