Life Cycle Environmental Impacts of Two Options for MSW Management in New York City: Landfilling vs. Waste to Energy

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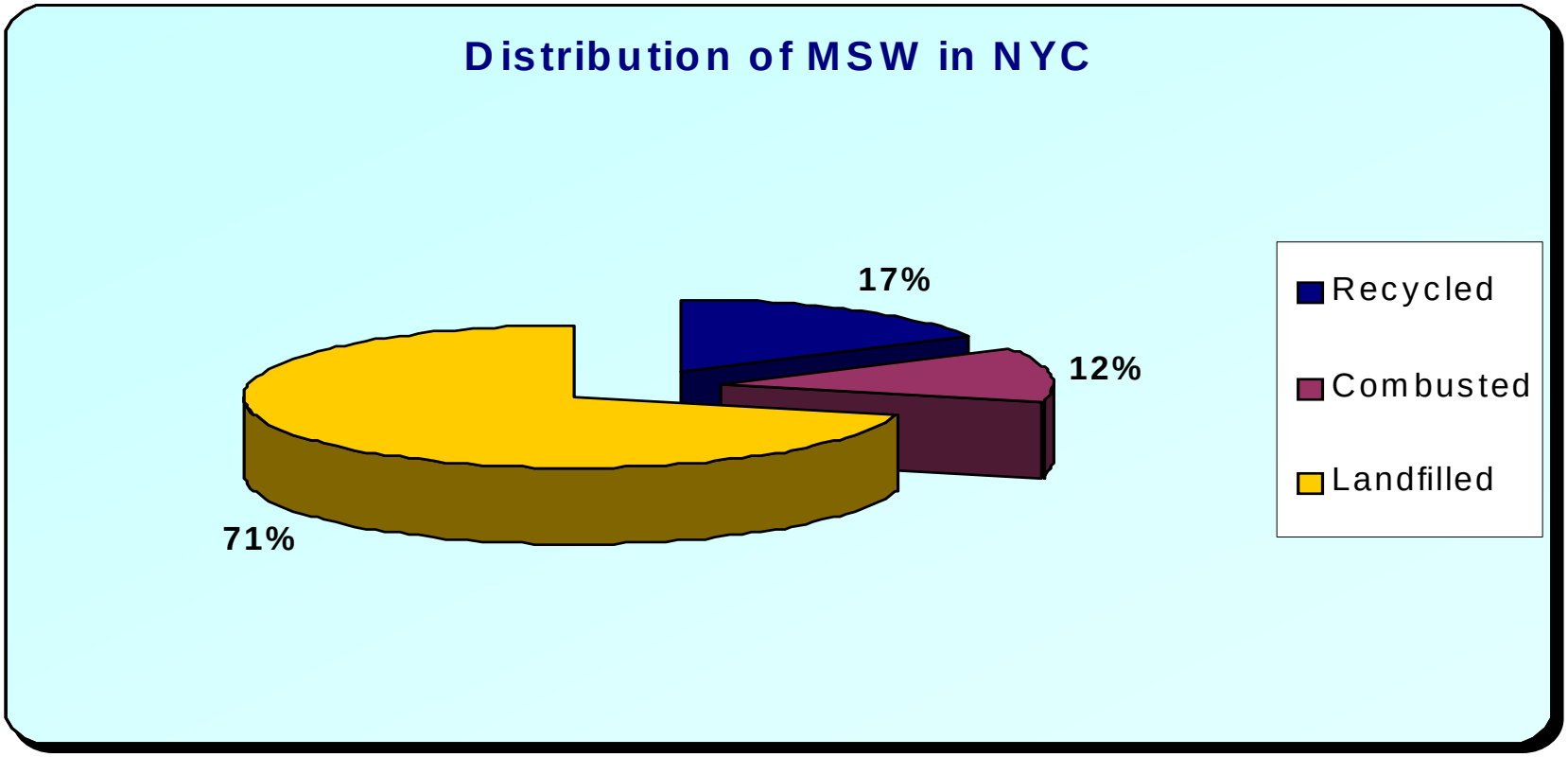
1. Background

- Municipal Solid Waste (MSW) management is a problem of growing importance in New York City (NYC)

- Life Cycle Assessment (LCA) offers an approach to quantify and compare environmental impacts of different waste management options
  - **Use LCA to compare two practical options for MSW disposition in New York City**
  - **For 2005 and 2024**

1. Primarily Landfill Disposal – with NJ WTE
2. Potential Situation with 2 Additional WTE Plants in NYC

Background (contd.)

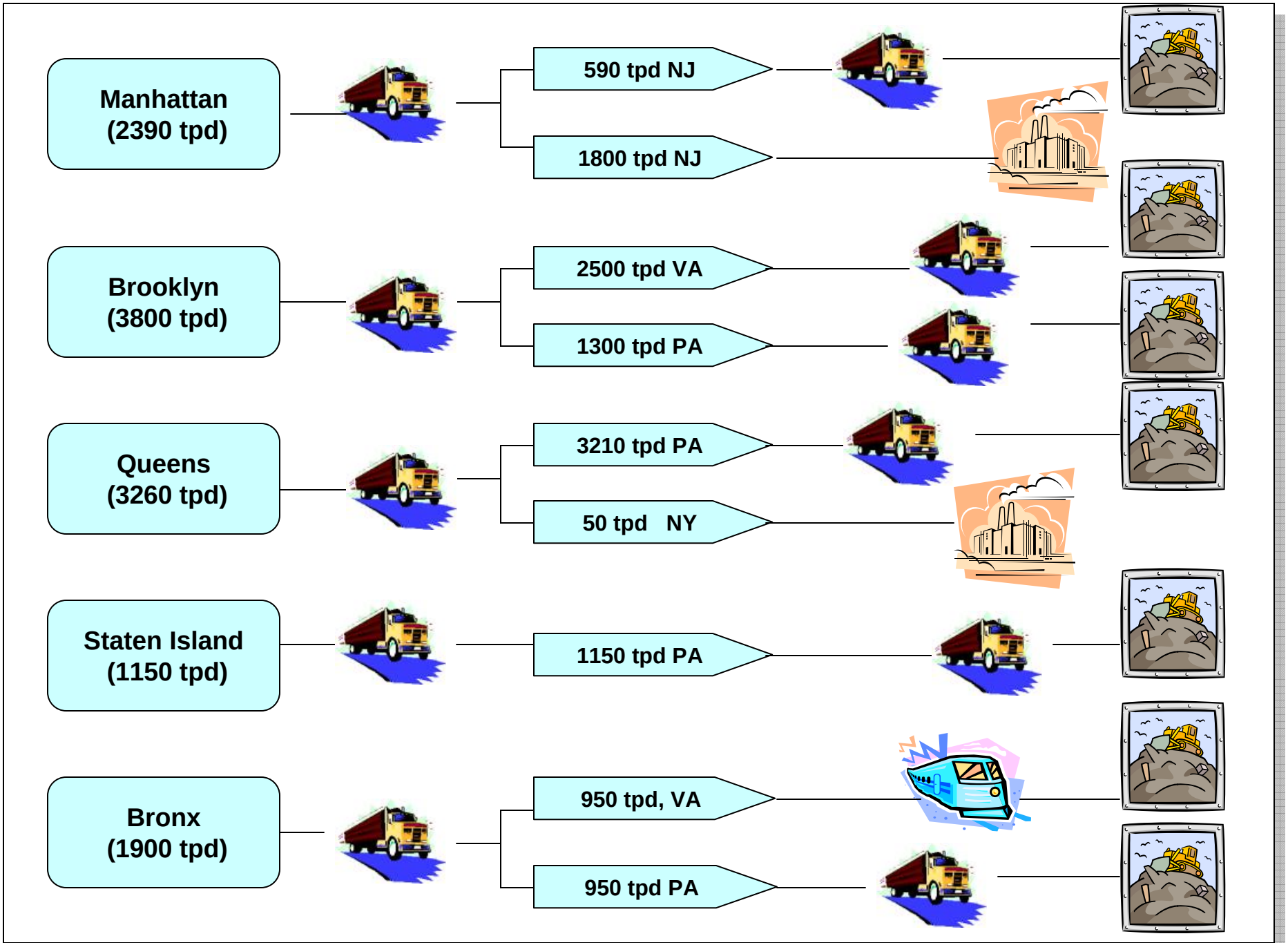


New York City MSW Situation

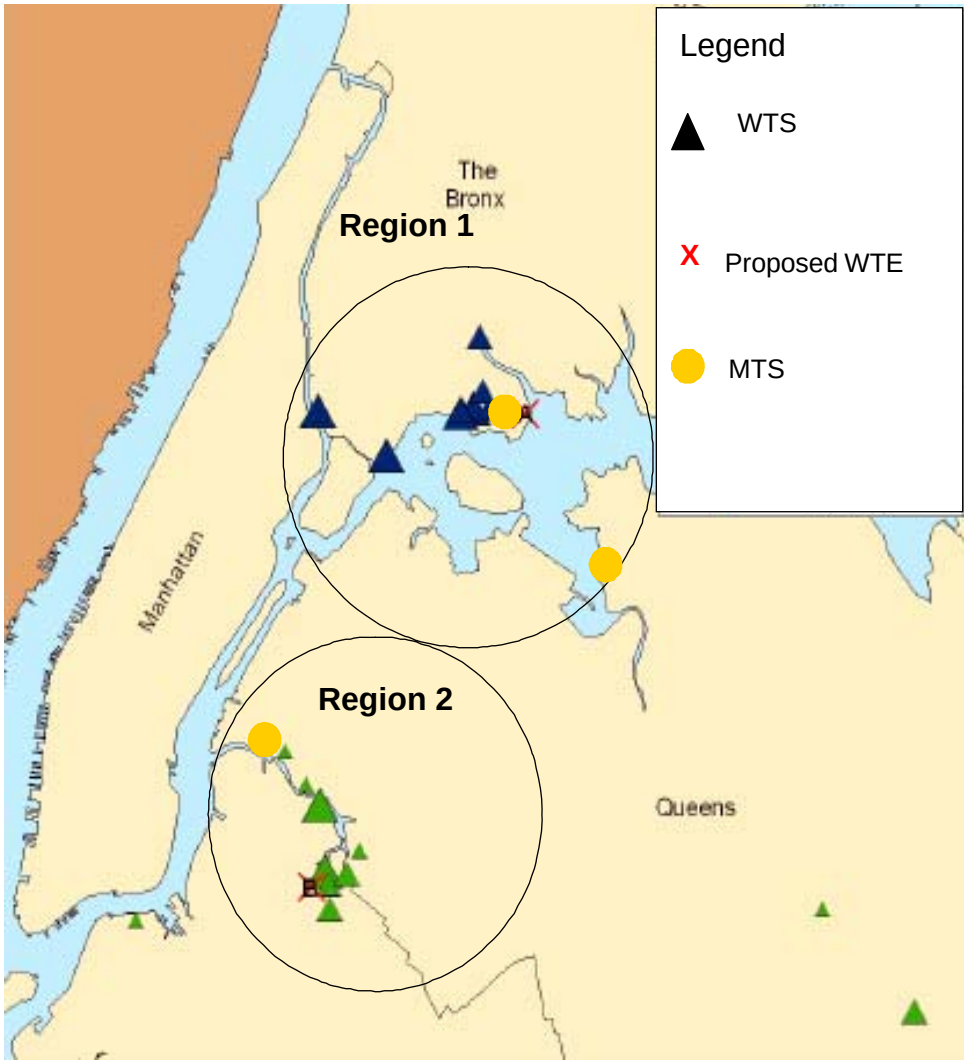
Population	: 8 Million inhabitants	Annual Collection	: ~4.1 million tons of MSW
Exported MSW	: 12,500 ton/day	Tipping Fee	: $75 per ton MSW

Note: ton = short ton

Collection and Disposition of Non-Recyclable Residential MSW of NYC (tpd)



Site Two WTE Plants



- Two WTE plants can be placed in Region 1 and 2
- Can offset some of current WTS

DeAngelo M., MS Thesis, Columbia University, 2004

2. Scope

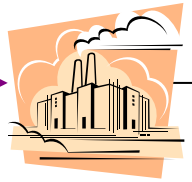
2005 No additional WTE (tons)

Generation | Transportation | Disposition

MSW

560,000

2,750,000



NJ

WTS

112,000

WTE Ash

210,000

2,540,000

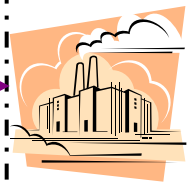
PA & VA

2005 Additional WTE (tons)

MSW

1,930,000

1,380,000



NJ

Q & B

WTS

386,000

WTE Ash

110,000

1,270,000

PA & VA

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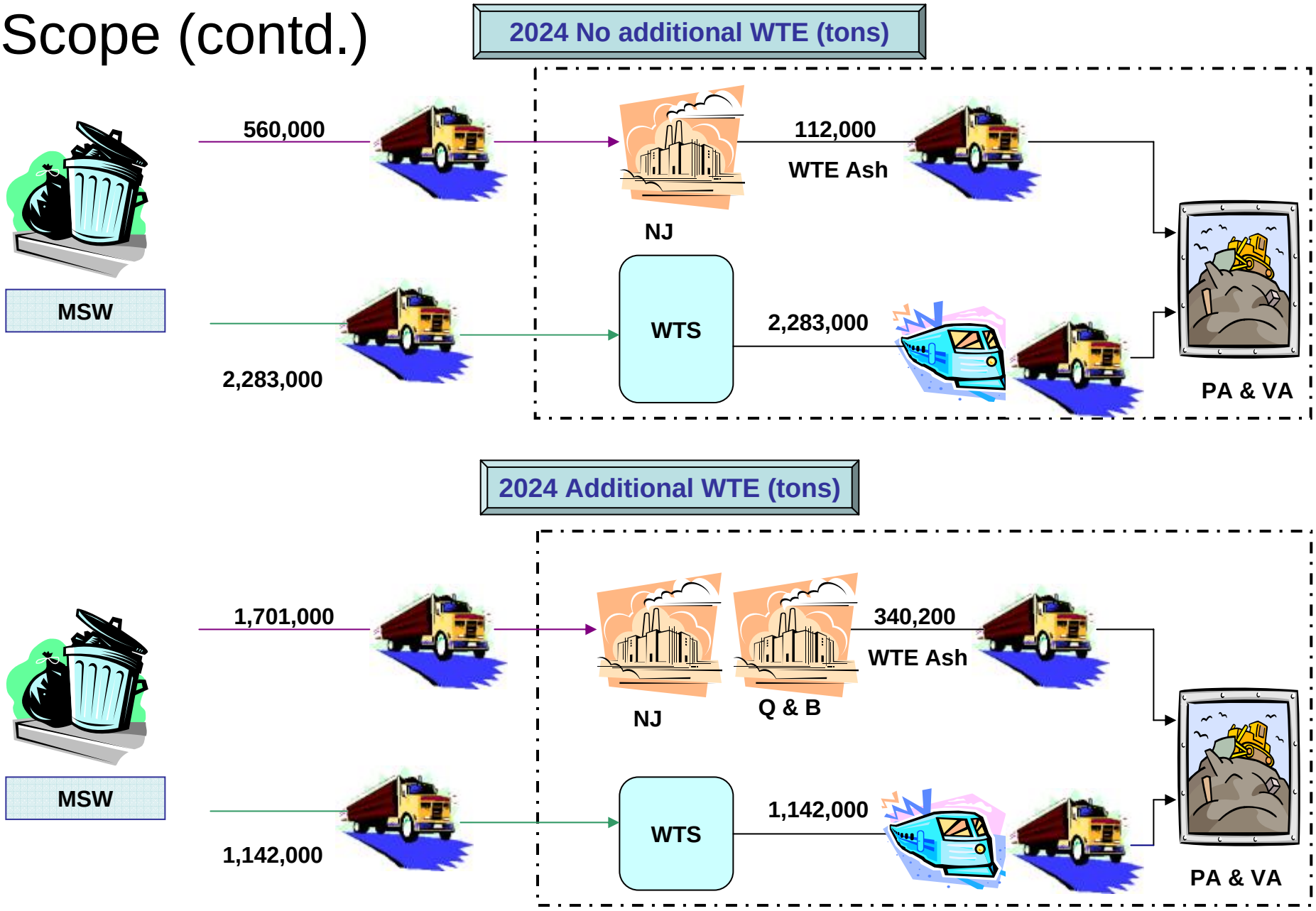
Scope (contd.)



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3. Key Data and Models

- Landfill:
  - Landfill gas (50% CH_4, 50% Biogenic CO_2)
    - Generation based on waste constituents
    - ~100 m^3/ton, 76% collection efficiency
  - Electricity (555 BTU/ft3)
    - Conversion eff. ~30%, 103 kWhr/ton
  - Trace Gas Emissions
    - Concentration data from EPA [AP-42]
  - Leachate
    - Based on rainfall and age of refuse
    - Leachate is treated (for ~100 years)
    - Details – DST1 process model documentation (Life-Cycle Management of Municipal Solid Waste, RTI, http://www.rti.org/)

1 DST: computer-based decision support tool

Data and Models (contd.)

- WTE
  - Estimate post MACT emissions data from EPA[1]
    - Typically using spray dryers, fabric filters, carbon injection and Selective Non Catalytic Reduction (SNCR)
  - Carbon dioxide emissions
    - Based on emission factors for individual constituents of MSW
  - Fly and Bottom Ash
    - Again – based on constituents
    - ~20% weight typically
  - Electricity
    - Based on calorific value and heat rate (typically 17000 BTU/kWhr)
    - Overall ~500 kWhr/ton

[1]Attachment 1 - Emissions from Large Municipal Waste Combustor Units (MWCs) following MACT Retrofit (Year 2000 Test Data), EPA Air Docket A-90-45, VIII-B-8, 2002.

Data and Models (contd.)

- Electricity Offset
  - Assume electricity offset from Northeast Power Coordinating Council (NPCC)
  - Also explore pure natural gas later
  - Upstream emission factors from Franklin Associates
- Transport
  - Waste from transfer station to landfill
    - 20 ton trucks or 100 cu yard (diesel) [5.5 mpg, 50% utilization]
    - Going to PA, VA, IL
    - Basic emission factors from Decision Support Tool (DST)
    - Upstream life cycle inventories from Franklin Associates

[1]State Electricity Profiles, Energy Information Administration, Energy Information Administration, DOE/EIA-0629, 2002, http://www.eia.doe.gov/cneaf/electricity/st_profiles/e_profiles_sum.html,

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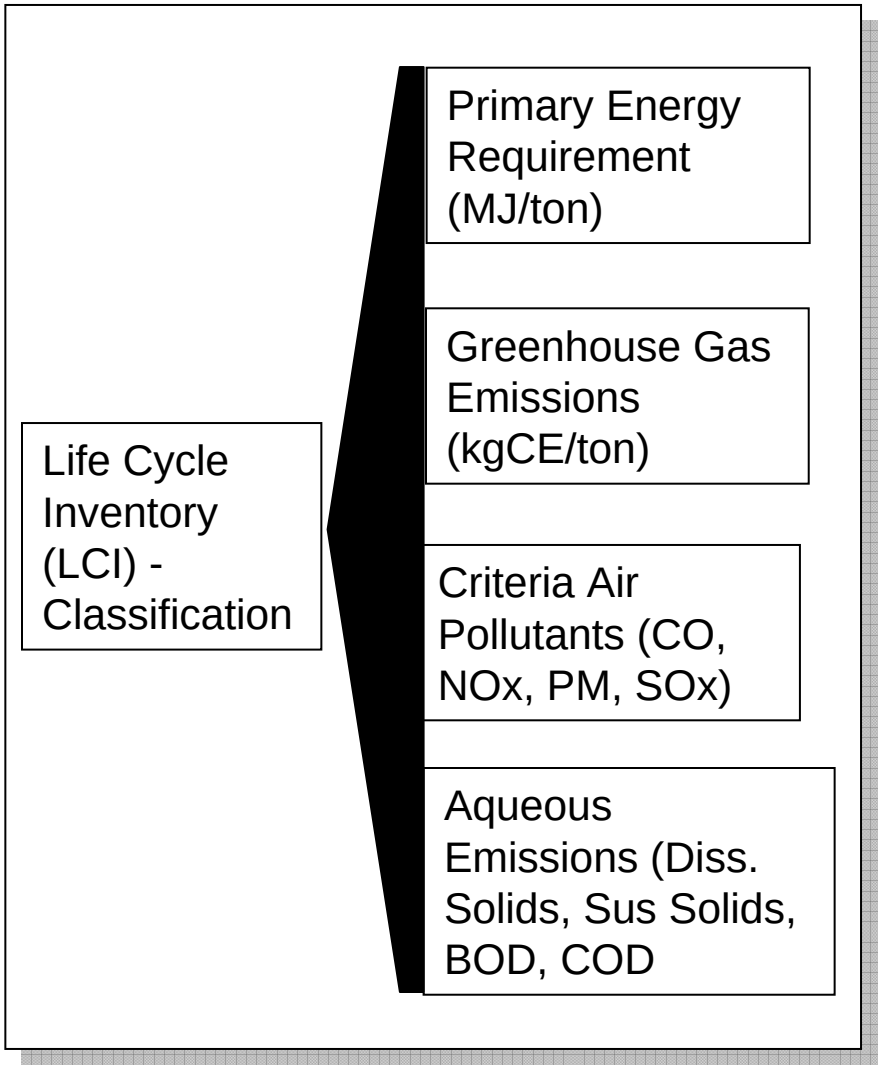
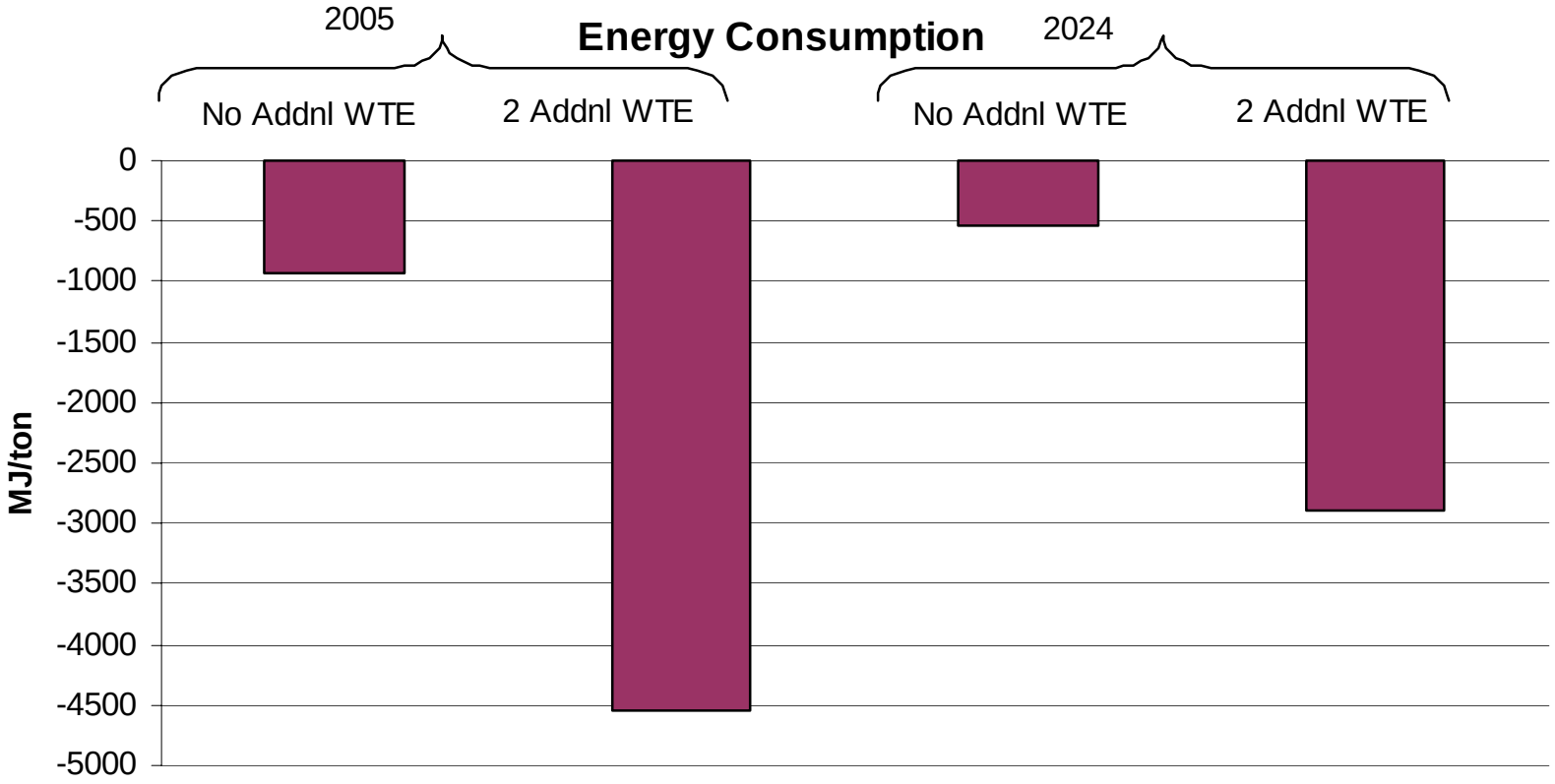
4. Results

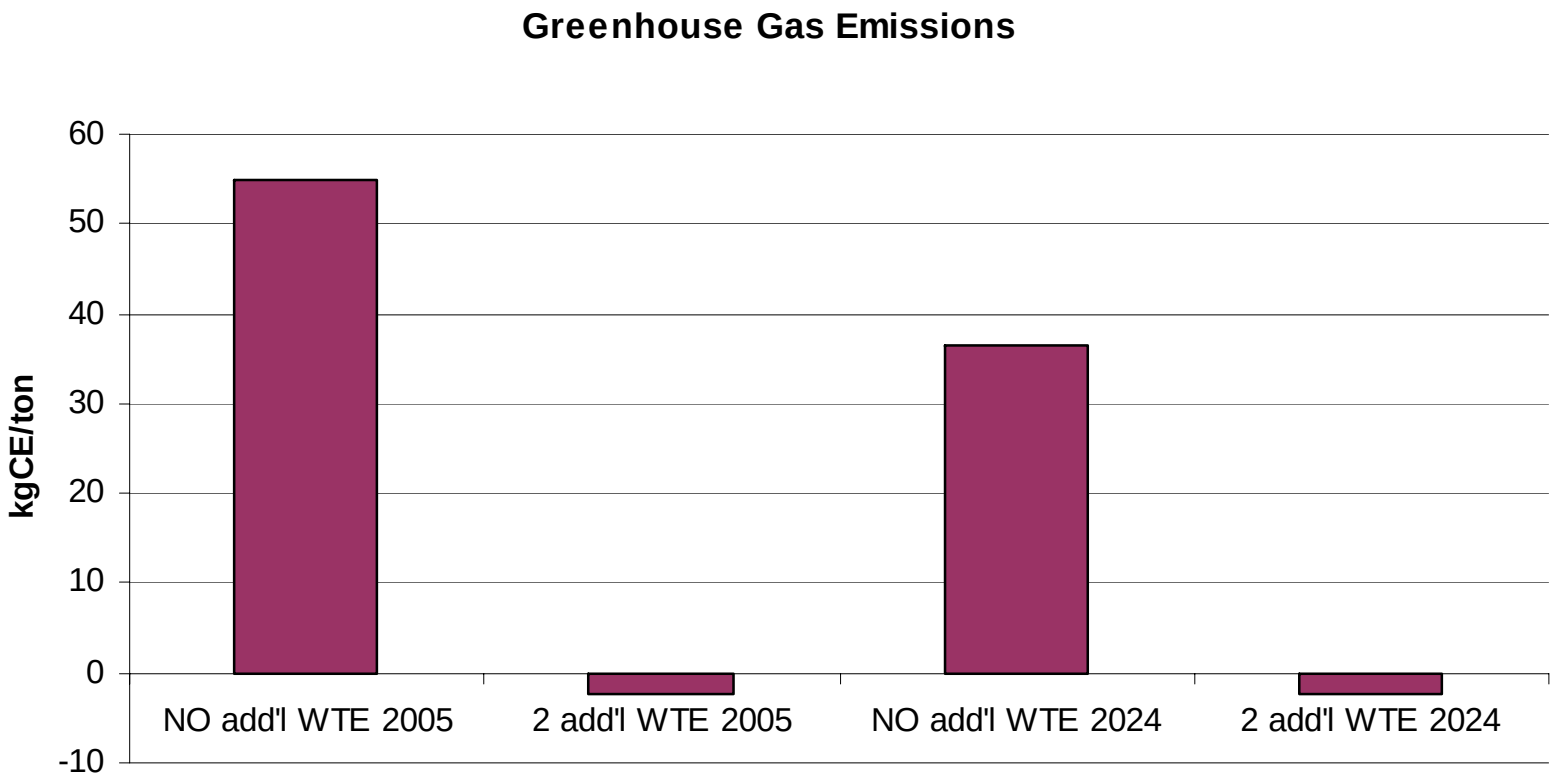


- Developed a Life Cycle Inventory (LCI)
- Go from Inventory to Classification along four categories
  - Energy, GHG, Criteria Pollutants, Aqueous Emissions

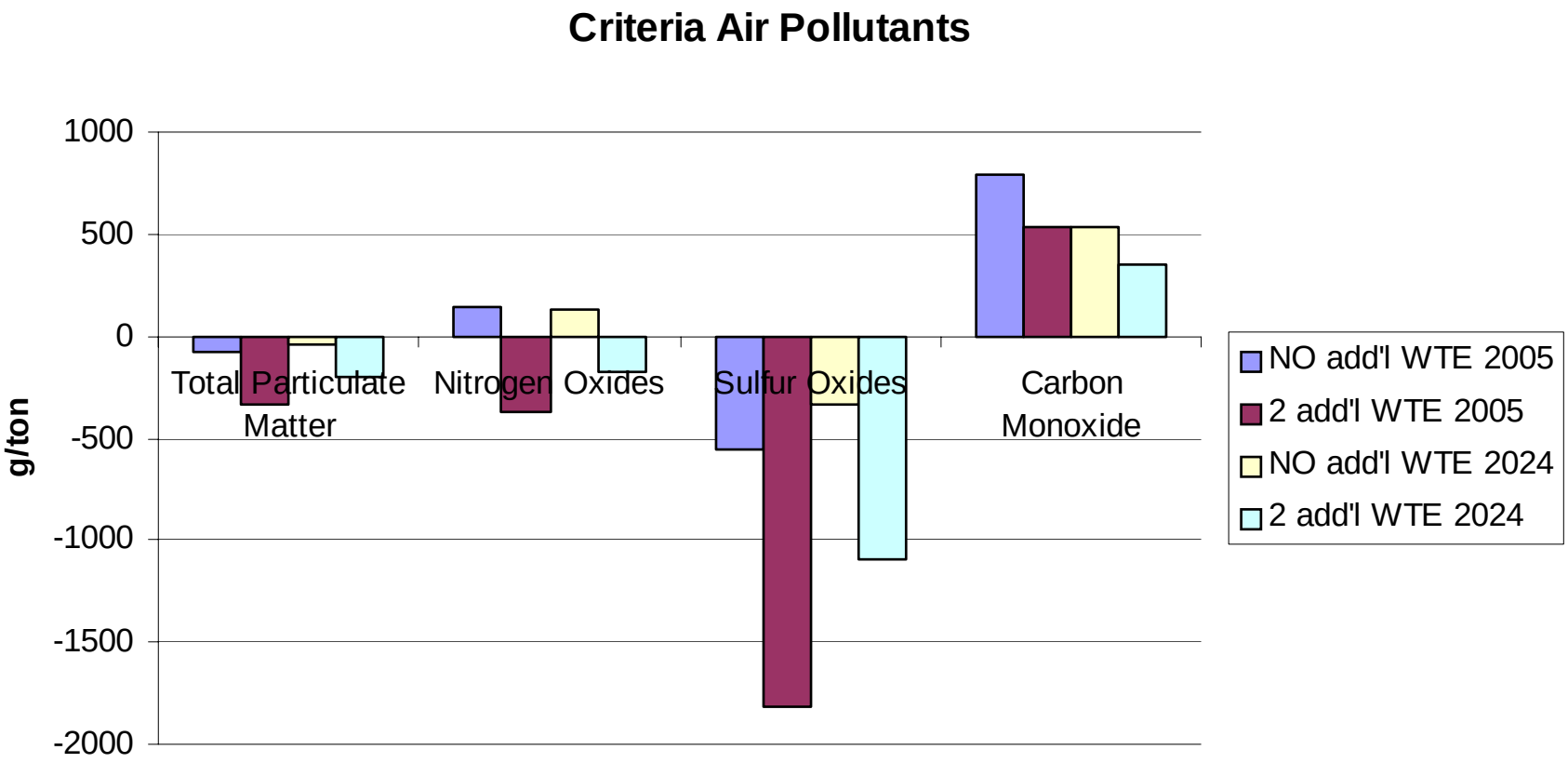
Results (contd.)



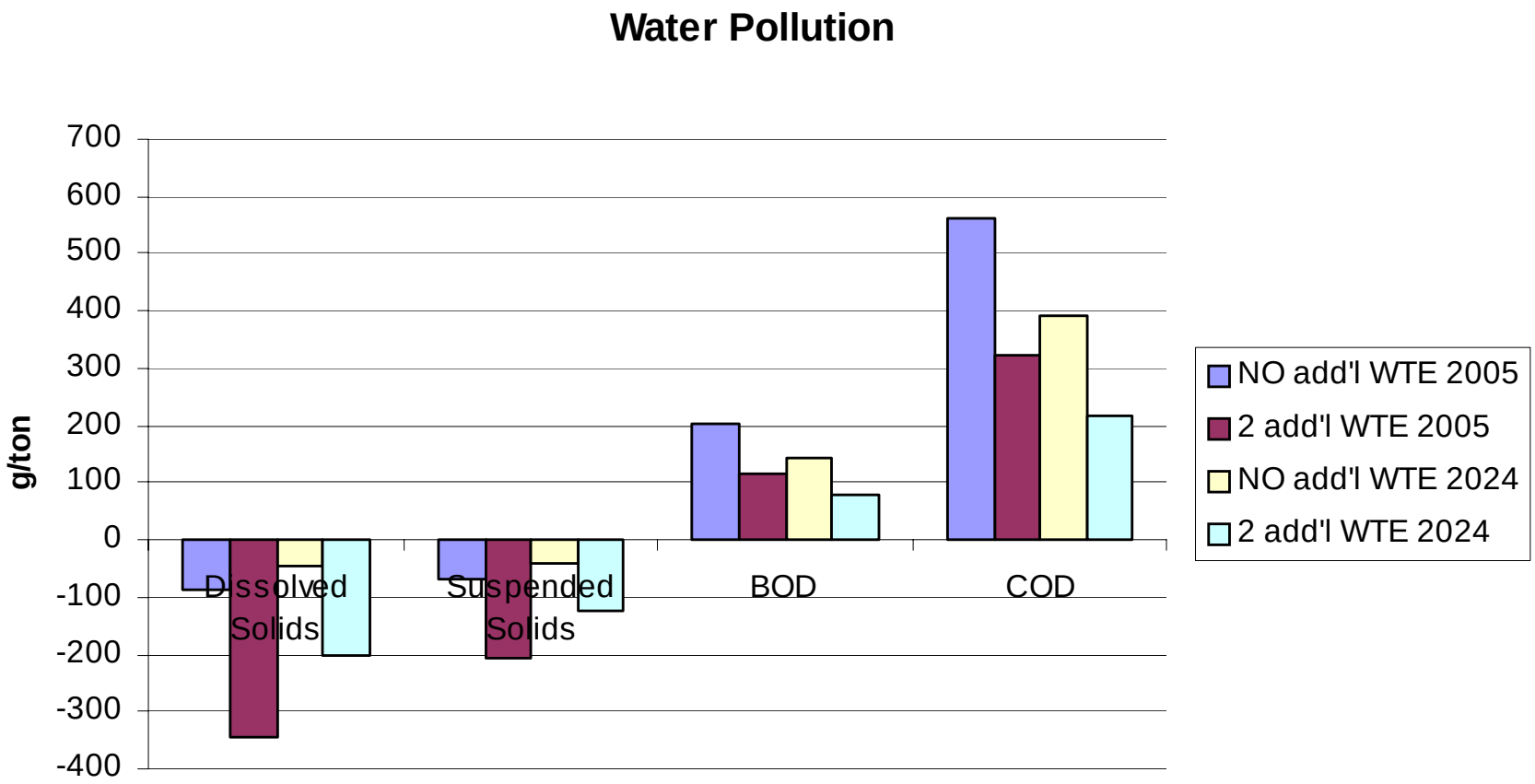
Results (contd.)



Results (contd.)



Results (contd.)



Sensitivity Analysis Summary

- Performed this based on a scenario analysis
- Varied (for 2005)

	Low	Middle	High
Composition[1]	Content	Current Mix	Most Energy Content
Energy Grid Mix[2]	Lower Fossil (Eastern Grid Mix)		High Fossil Content (100% Nat. Gas)
Haul Distance	PA (382 mi)	VA (777 mi)	IL (1910 mi)
LFG Collection Efficiency[3]	0%	76%	88%
WTE Heat Rate[4]	15000 BTU/kWhr	17000 BTU/kWhr	30000 BTU/kWhr

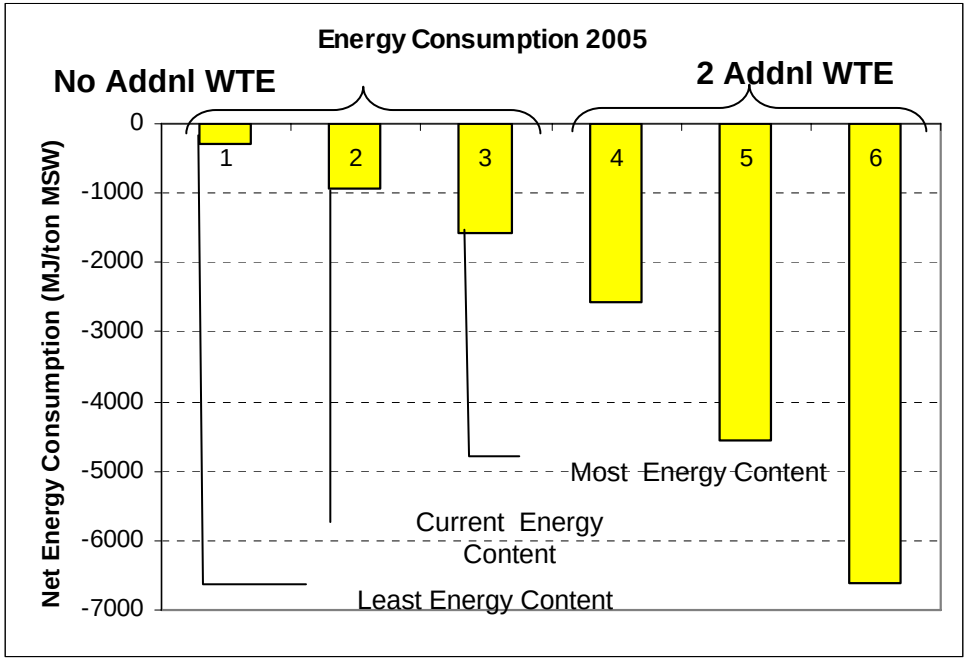
[1]Final Report Preliminary Waste Characterization Study, New York Department of Sanitation, Sept. 2004

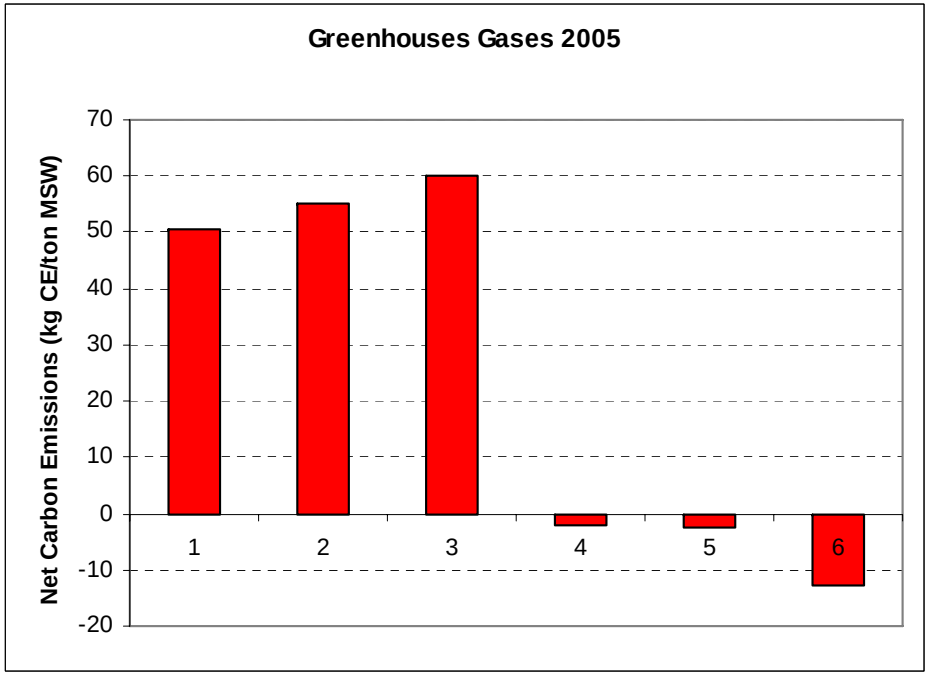
[2]Dumas R. D., "Energy Usage and Emissions Associated with Electric Energy Consumption as Part of a Solid Waste Management Life Cycle Inventory Model," Revision 2, Department of Civil Engineering, North Carolina State University, June 8, 1999

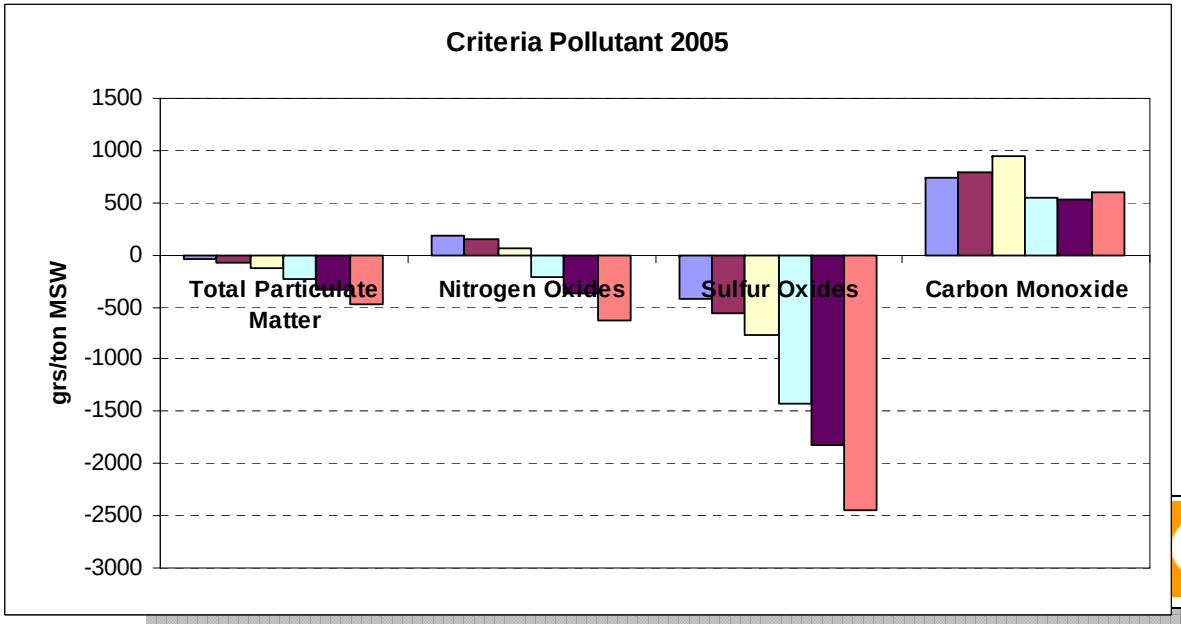
[3]Average of 35 US States - from Berenyi. High estimate from DST

[4]K. Weitz, Waste to energy process model;(2005), p. 22. Variation from 15,000-30,000 BTU/kWhr. Mean calculated from 550 kWhr/ton and 5000 BTU/lb)

Composition - 2005







The 2 WTE's have significant impact

Over a wide range of MSW energy content

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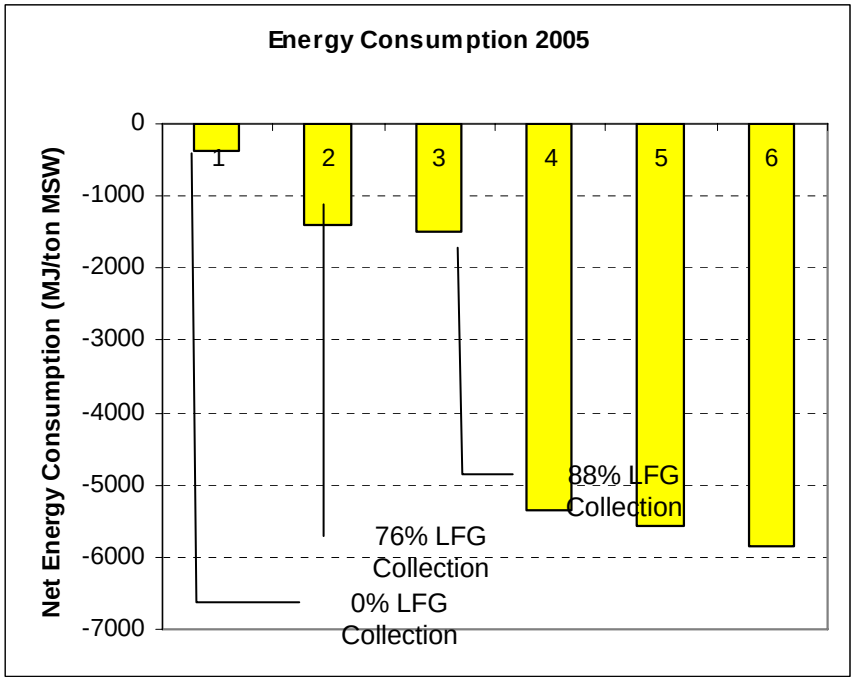
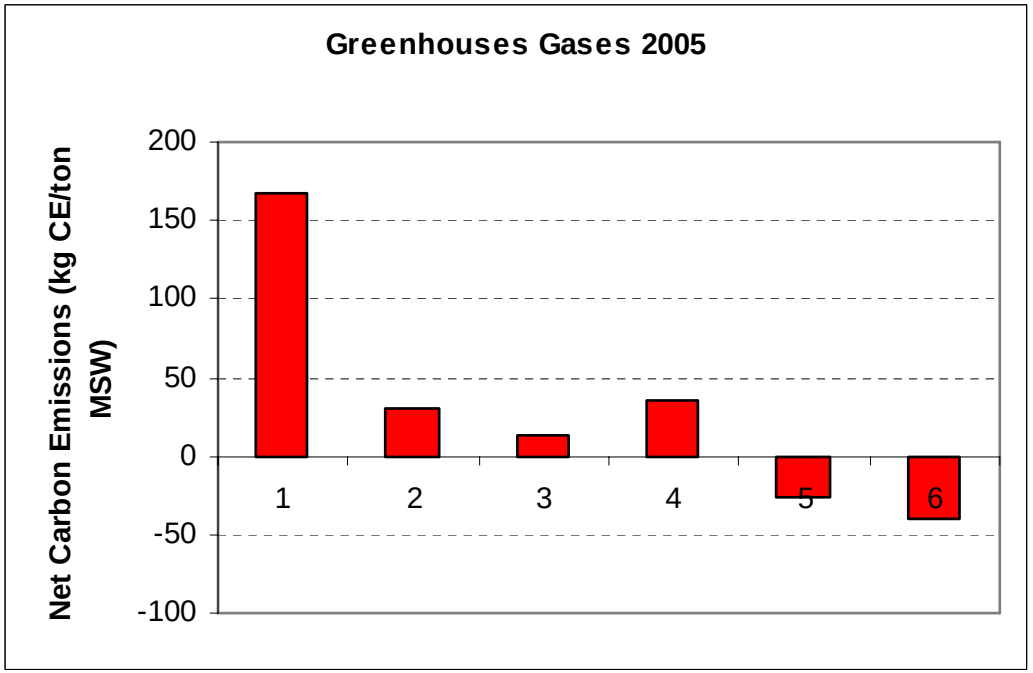
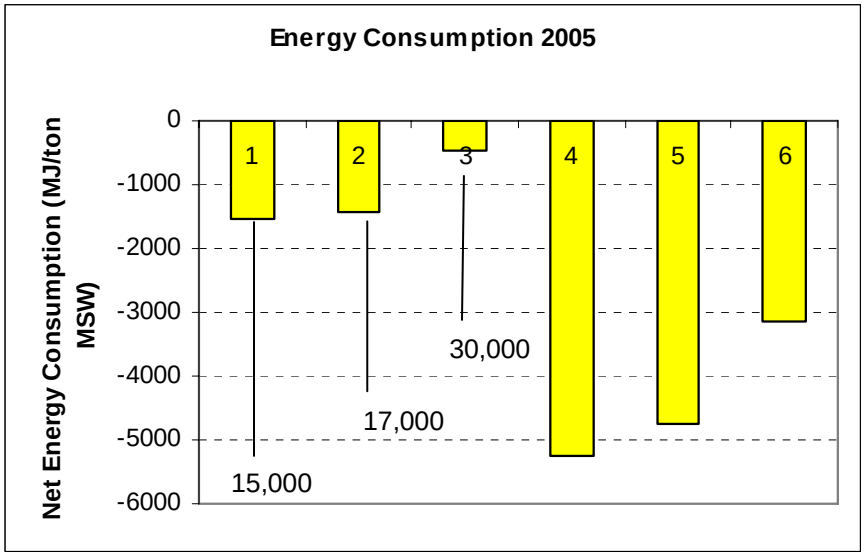
LFG Collection - 2005

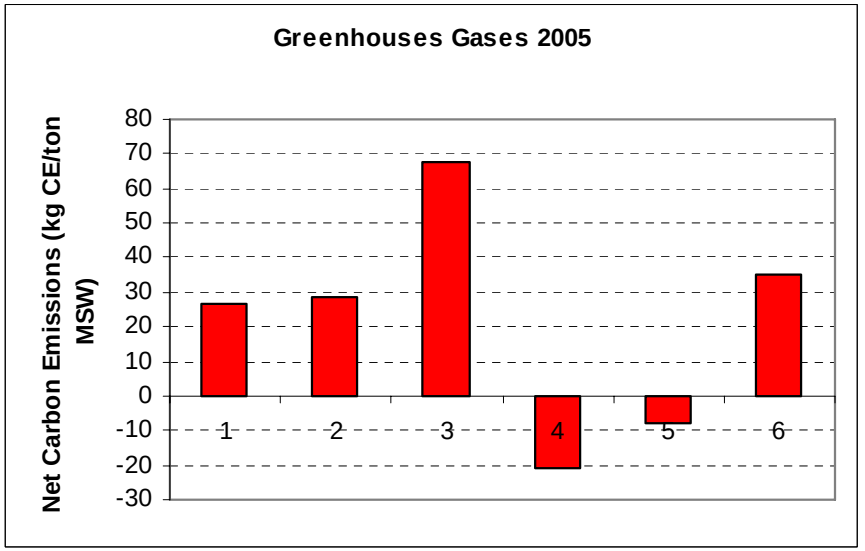


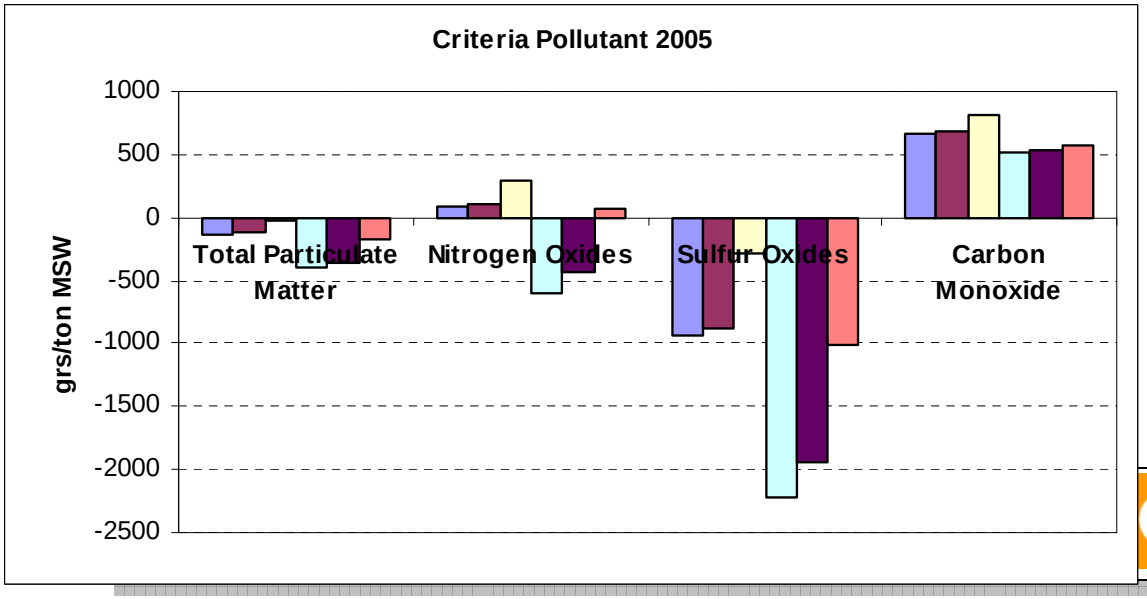


Even with 88% LFG Collection – Much Benefit
Energy Credit Associated with 2 WTEs

Heat Rate - 2005







Even with worst heat rate – still comparable or better to landfilling

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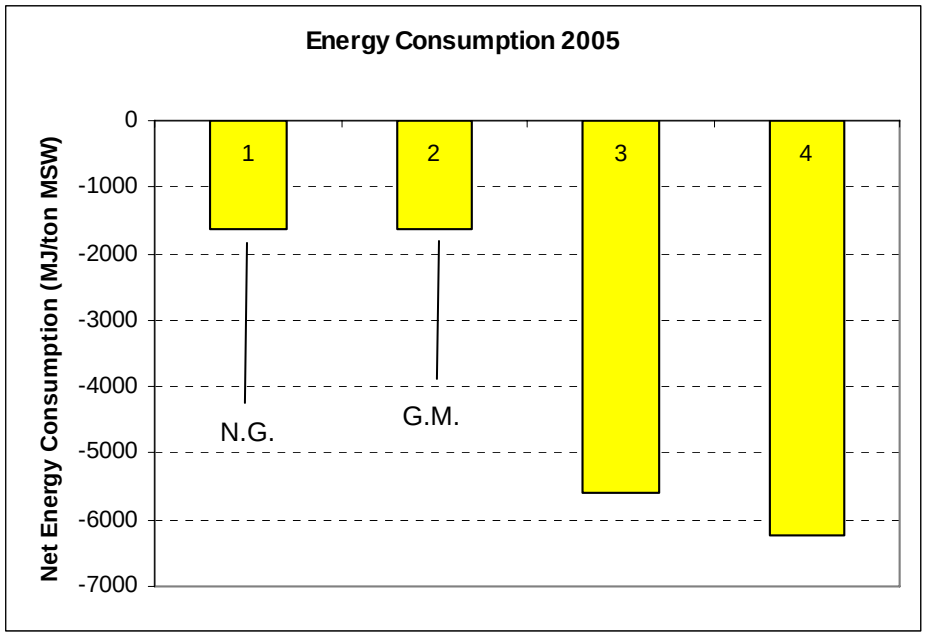
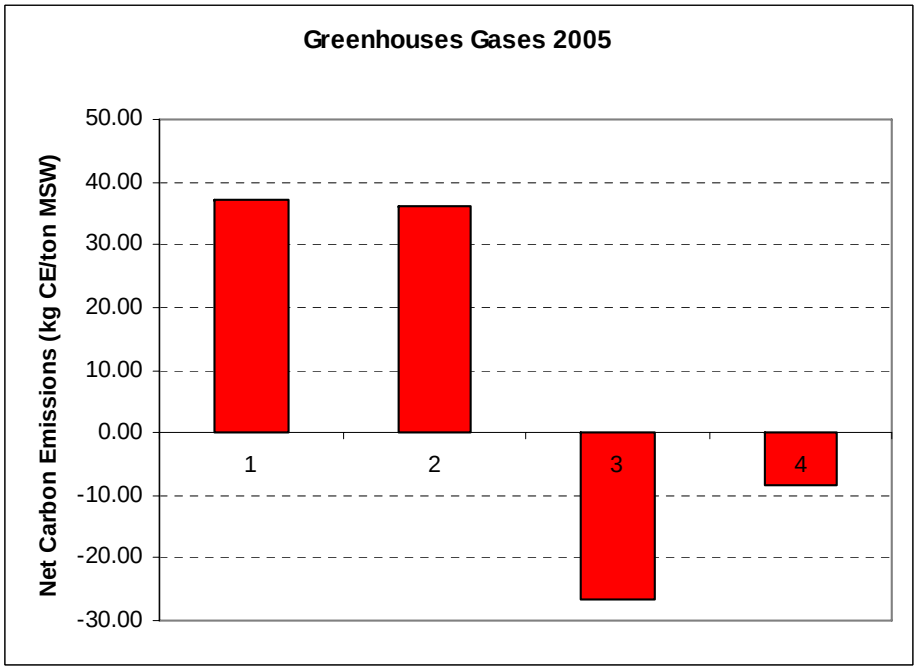
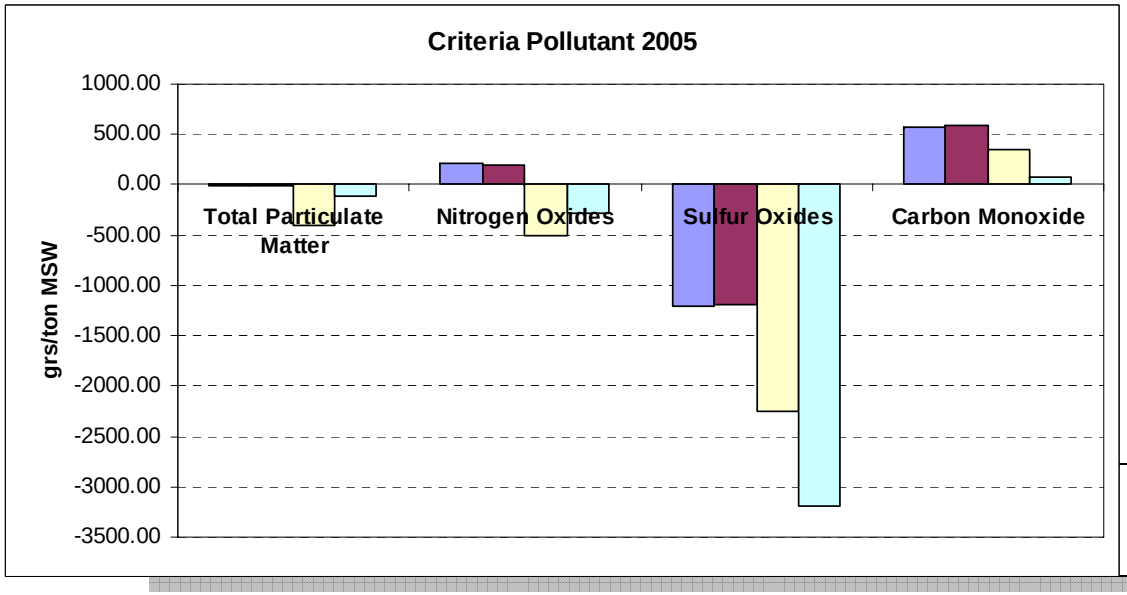
Grid Mix – 2005 – Less important



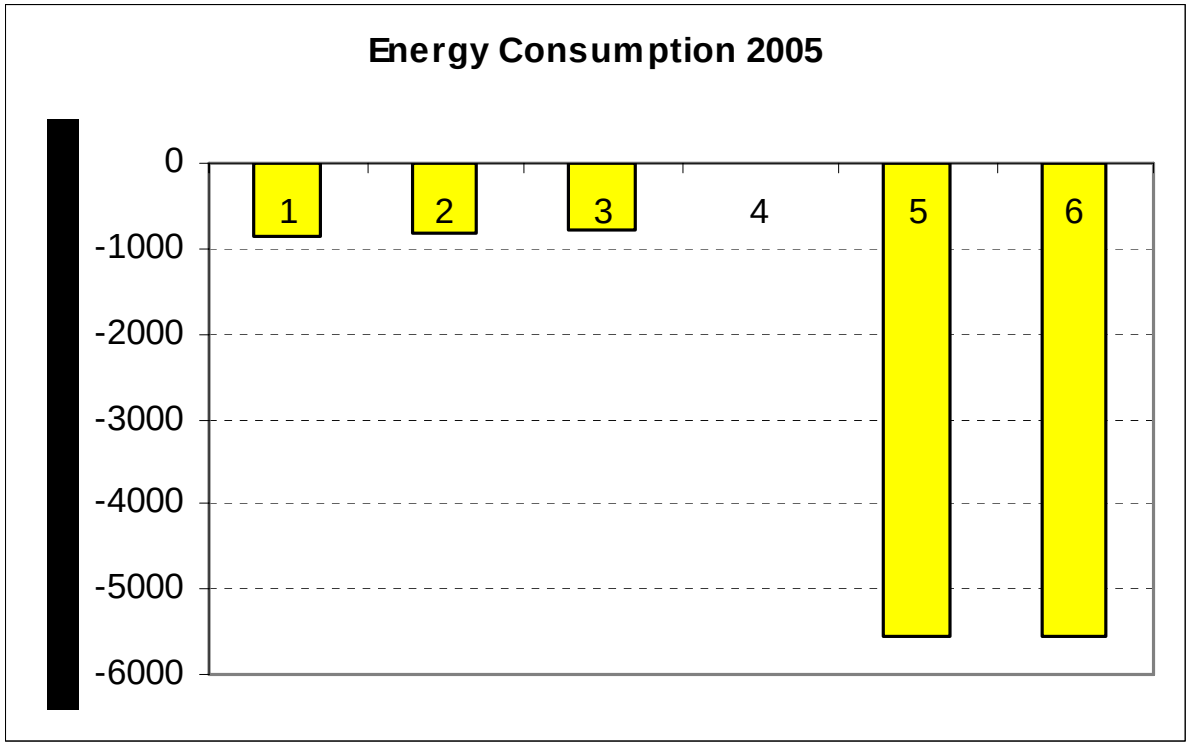




- Mainly important with WTE scenarios
- With Nat gas – larger C credit
- With Average Grid – better SOx credit
- **Different ways of looking at credit. Bottom line is WTE has clear benefits**

Other Sensitivity Results

- Haul distance is not very important



5. Summary

- Quantitative evaluation of WTE Vs. Landfilling for New York City
  - Accounting for upstream factors and transportation
  - Considered several different scenarios for 2005 and 2024
  - Considered a ‘scenario-based’ sensitivity analysis for several unit model parameters
- WTE options have lower impacts than landfills
  - Primarily have lower energy use
  - Also lower GHG emissions and Criteria Air Pollutants
- WTE scenarios could also improve harder-to-quantify impacts
  - e.g.: odors and pestilence
  - Can re-use WTE land

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Future Work

- Examine other locations
  - Suburban/Europe
  - Other states/cities
- Compare and contrast different:
  - Unit Process Models
  - Upstream LCA databases
  - Use hybrid LCA assessment (IO – and detailed) for upstream
- Compare and contrast different impact assessment methods

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