


A Comparative Analysis of Options for Managing Waste After Recycling–

Vancouver’s Detailed Review of Waste to Energy, MBT and Landfill

Summary of Study Results presented to Southern Alberta Energy-from –
Waste Alliance

October 29th, 2009

Overview

1) Context and Description of Technologies
2) Life Cycle Assessment
3) Air Emissions Comparisons
4) Financial Analysis

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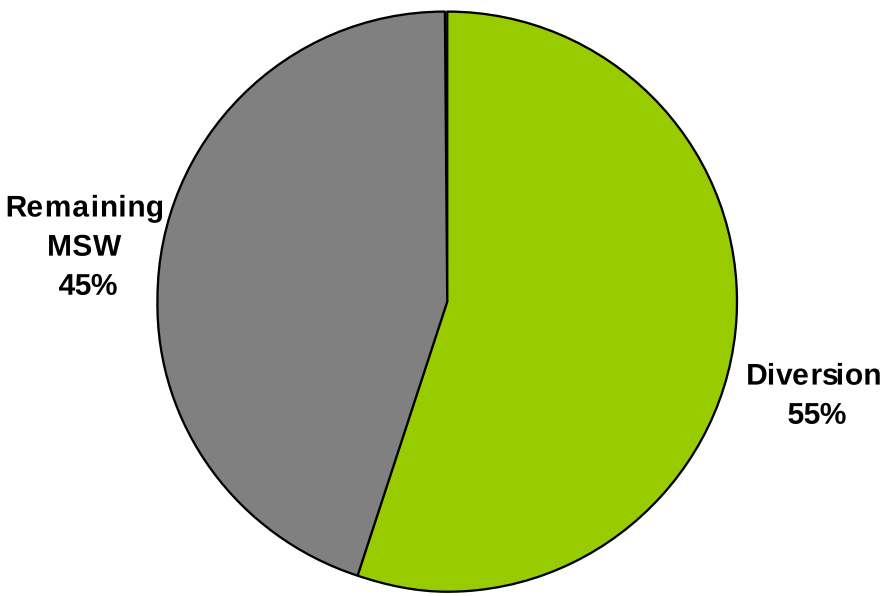
Metro Vancouver: a Zero Waste Region

- Zero Waste Challenge
  - Goal 1: Minimize waste generation
  - Goal 2: Maximize reuse, recycling and material & energy recovery

  - Diversion to increase from current level of 55%
  - Programs identified to reach 70% diversion by 2015

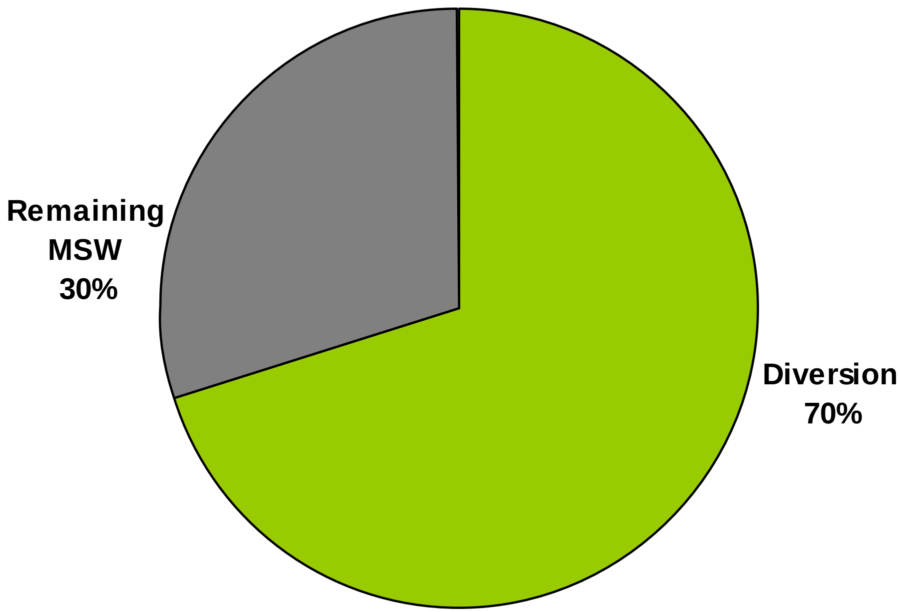
Effect of Increased Waste Diversion

Current Recycling and Diversion



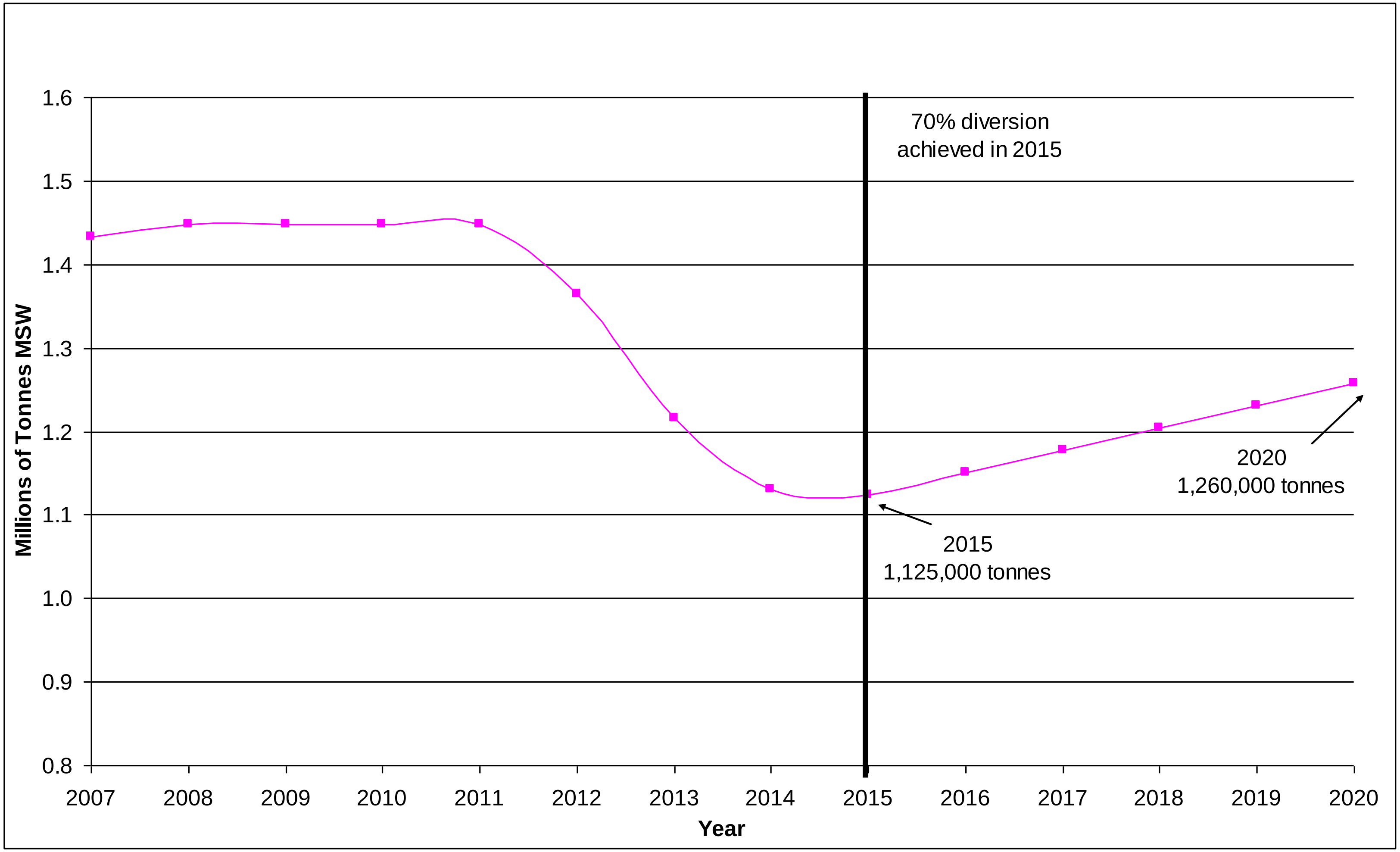
Tonnes remaining for treatment and disposal: **1.45 million**

Future Recycling and Diversion



Tonnes remaining for treatment and disposal: **1.26 million**

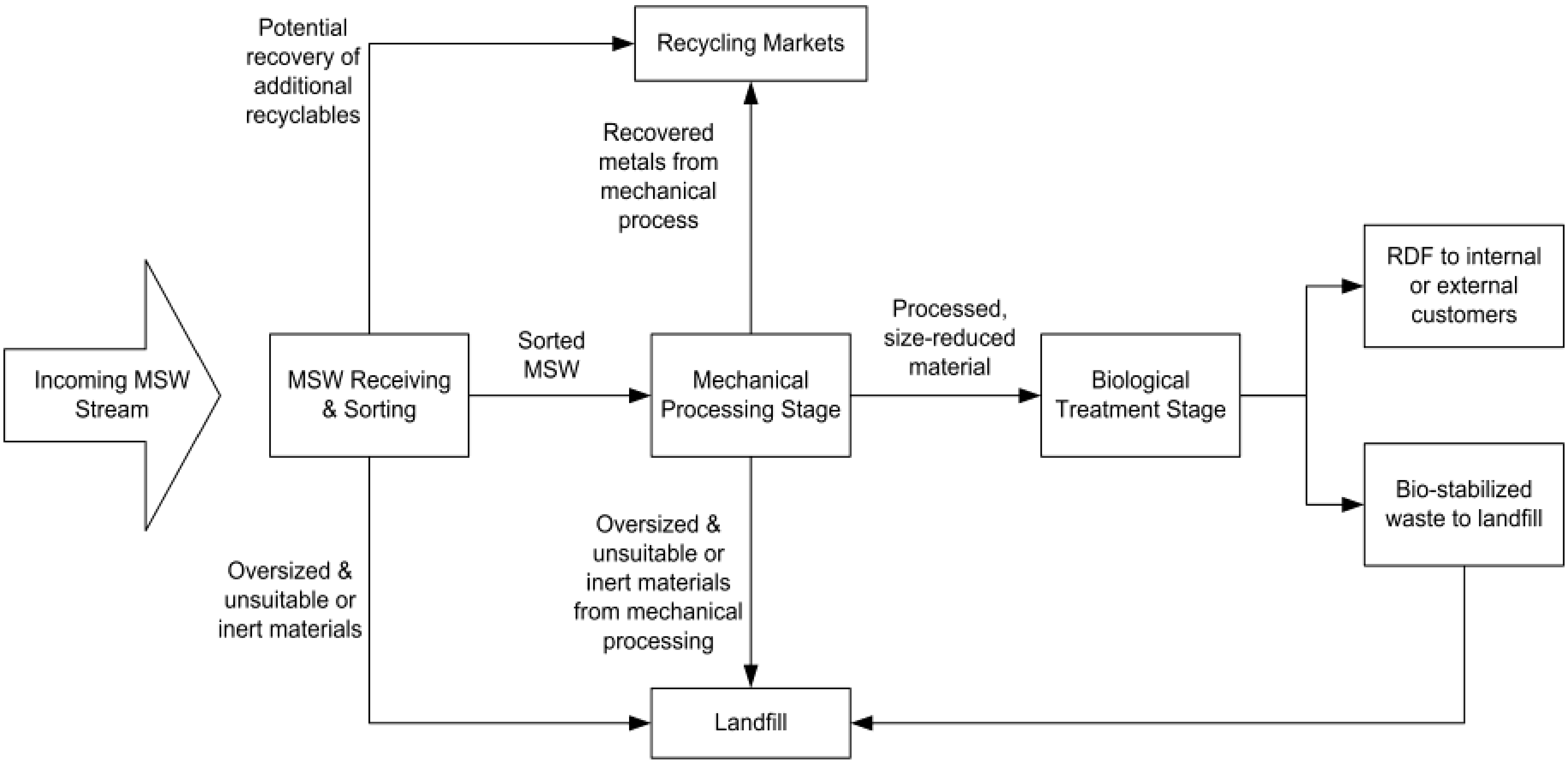
Waste Increase due to Population Growth (despite high diversion/recycling)



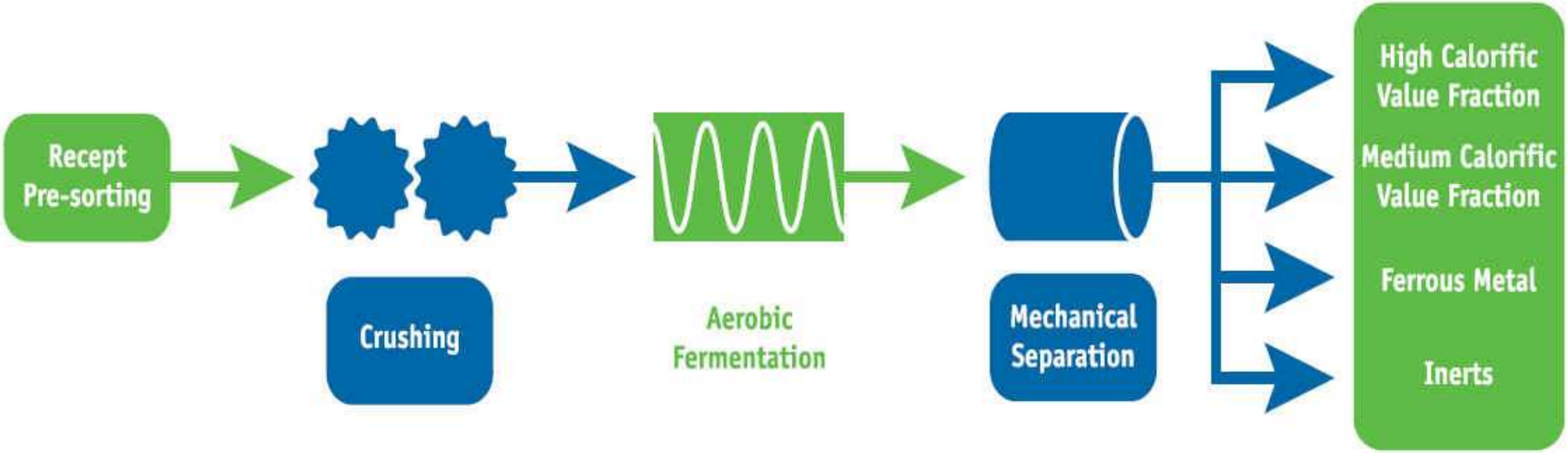
Technologies for Materials & Energy Recovery from MSW

- Mechanical Biological Treatment (MBT)
- Waste to Energy (WTE)
- Landfill, with landfill gas recovery and utilization

MBT Process Details



MBT Alternative Process



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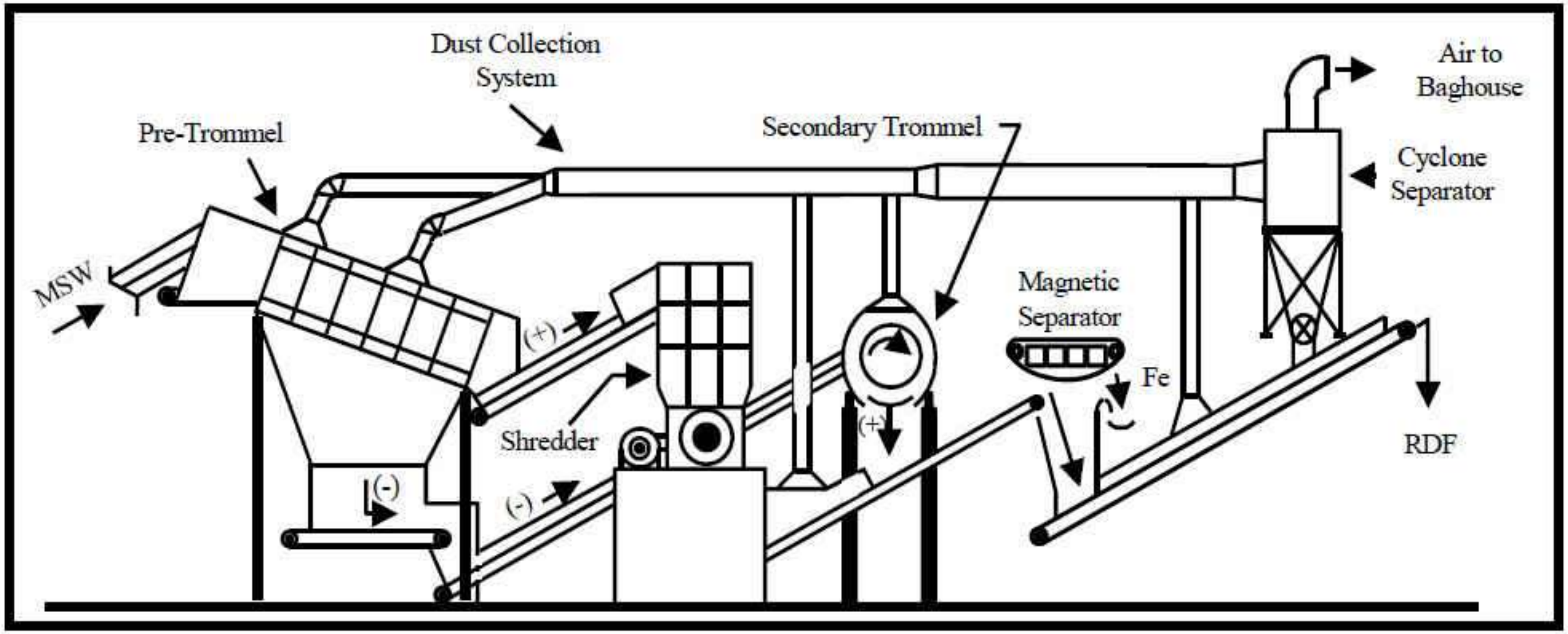
What does MBT do to the Waste?

- Additional recyclables: 5%
- Refuse Derived Fuel (RDF): 55%
- Residue to landfill: 40%

Value of RDF

- Can be used to replace natural gas or coal
  - Cement kilns
  - Coal fired power plants
- Air pollution control upgrades likely required
- Heating value of RDF similar to wood or low grade coal
- Market value somewhere between 0% and 70% of coal or natural gas based on heating value

Mechanical Sorting Systems



Treatment Option: Mechanical Biological Treatment

Biological treatment

Making RDF Pellets may be required

Economic Activity Generated by MBT

- Capital investment:
  - $100+ million
  - Over half of investment for local construction and supply contracts
- Operating personnel:
  - 20 to 25 direct highly skilled jobs
  - Jobs are long term for 20+ years
  - Indirect ongoing requirements for supplies and maintenance from local firms

Waste to Energy Details

- Mass burn technology used in analysis
  - Mass burn is a proven system with over 800 plants worldwide
  - Over 80% of world's facilities use mass burn
  - Generates local, firm electricity with up to 27% electrical efficiency
  - Least amount of waste preprocessing
  - Easiest to finance

Technology Selection

- Ultimate technology will be decided through competitive process
- Locations to be determined through public process and may be in or out of region
- Generally, centralized facility will offer better economies of scale
- Ideally, site would support other users of energy, such as industrial steam and district heat
- Over 90% thermal efficiency possible with district energy systems

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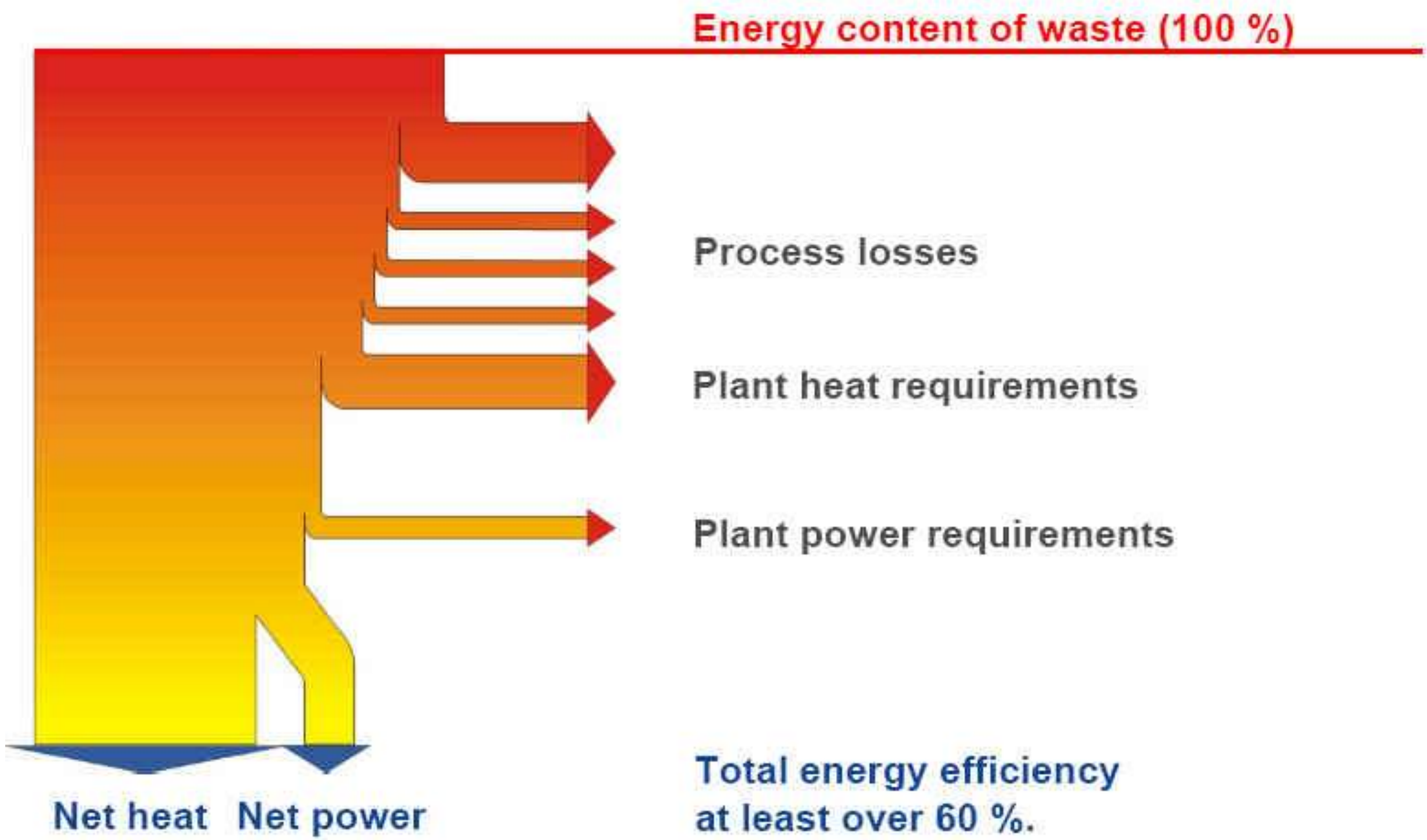
Energy Recovery and Losses



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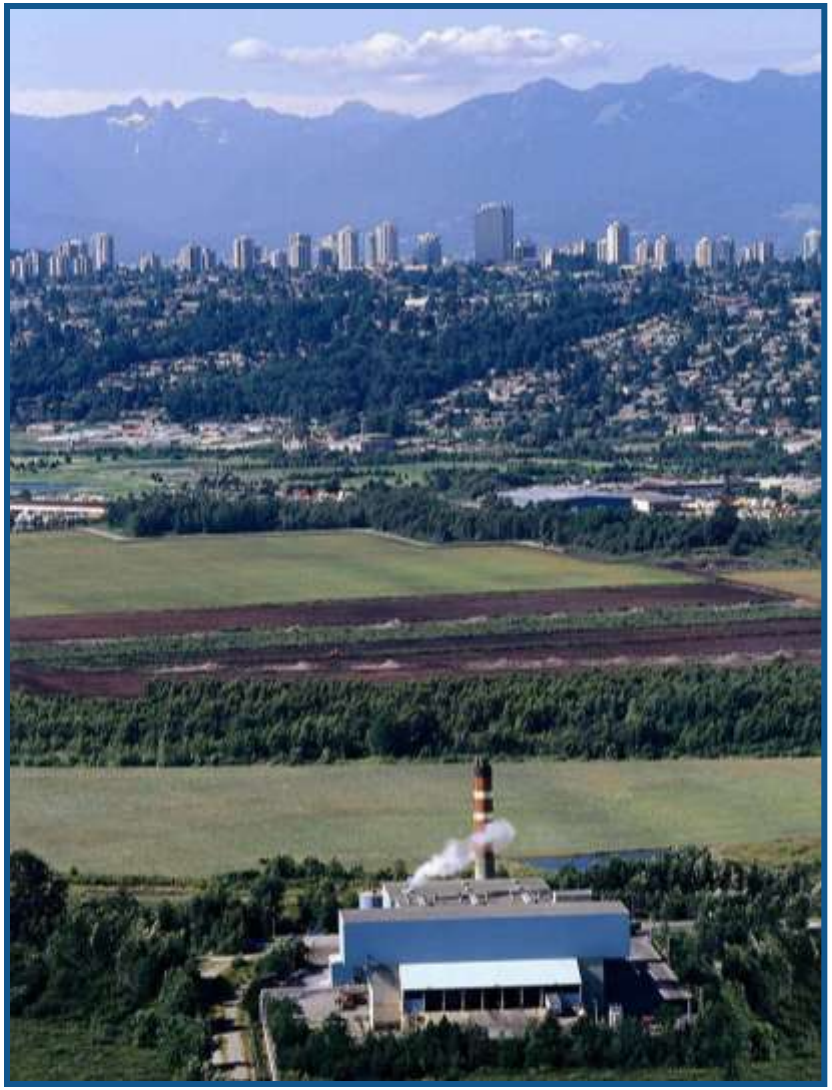
Example WTE in Metro Vancouver



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Example of Modern WTE Facility in Lille, France

Treatment Option: Waste to Energy in Paris, France

WTE Facility in Paris, 500,000 tonnes per year

Economic Activity generated by WTE

- Capital investment:
  - $500+ million
  - Up to half of investment for local construction and supply contracts
- Operations:
  - 50 direct highly skilled jobs
  - Jobs are long term for 40 to 50 years
  - Indirect ongoing requirements for supplies and maintenance from local firms

Landfill Details

- Oldest waste management technology, extensively used in North America
- New landfills are fully lined with leachate collection (New bioreactor technology with leachate recirculation modeled for study)
- Landfill gas (LFG) recovery and utilization
- LFG capture modeled at 75% for new and existing landfills
- 10% of remaining LFG oxidized by cover, balance of LFG escapes to atmosphere

Disposal Option: Modern Landfill

Landfill Gas Collection Piping

Economic Activity Generated by new Landfill

- Capital investment of about $70 to $90 million for initial cell and infrastructure
  - Construction likely out of region
- Operations;
- 40 to 60 full time jobs
  - Long term for life of landfill
  - Resourced from local region where landfill is situated
  - Additional jobs for long distance hauling if out-of-region landfill

Component Operations Costs (based on 500,000 tonne per year facilities)

- MBT - $45 per tonne
  - Add $20 per tonne to pelletize

- WTE - $ 40 per tonne after credit for energy sales

- Landfill - tipping fee $18 per tonne
  - Short haul $10 per tonne
  - Long haul $17 per tonne

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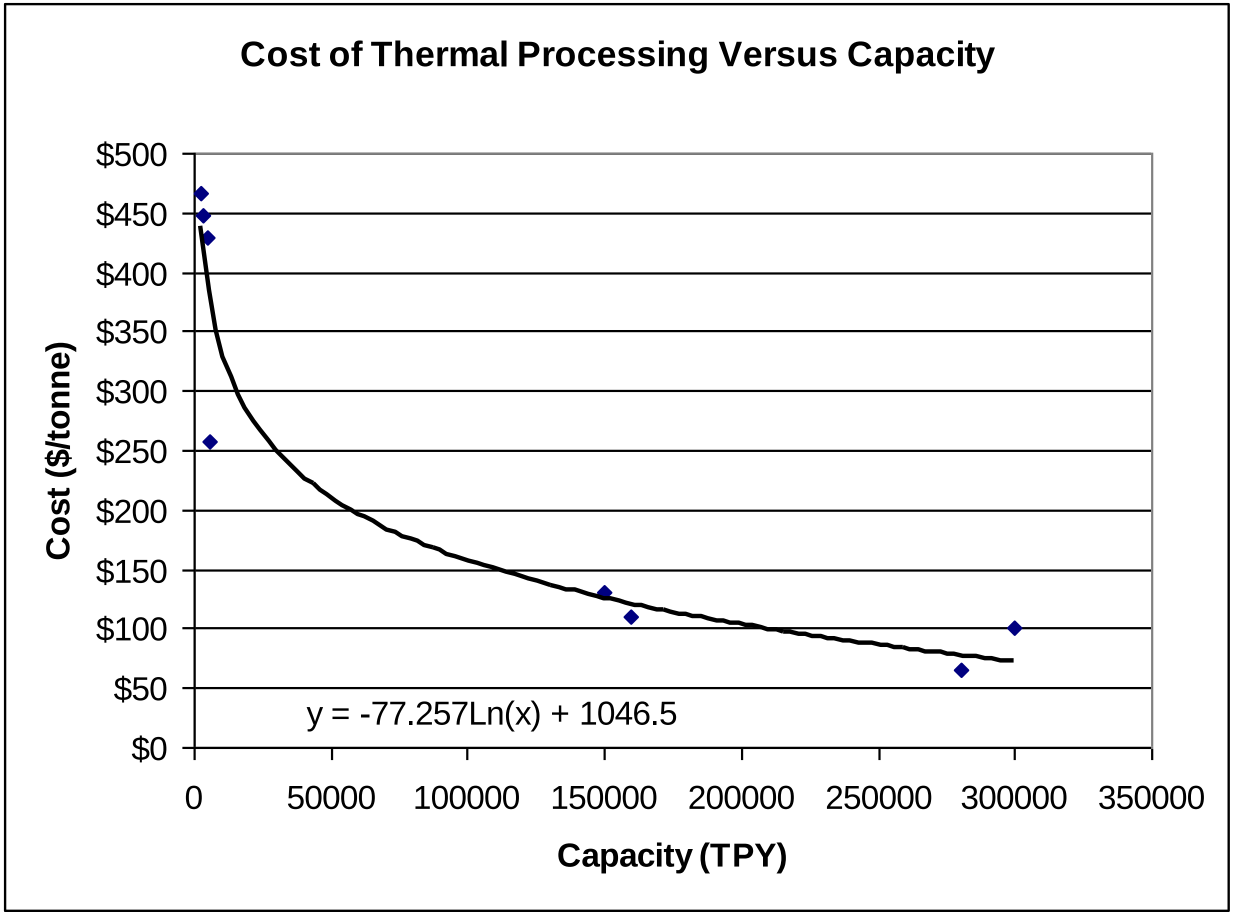
Does Size Matter?

- Economies of scale are achieved with all technologies
- Most obvious with WTE
- Also applies to MBT and landfill, but not so severe

Economies of Scale for WTE



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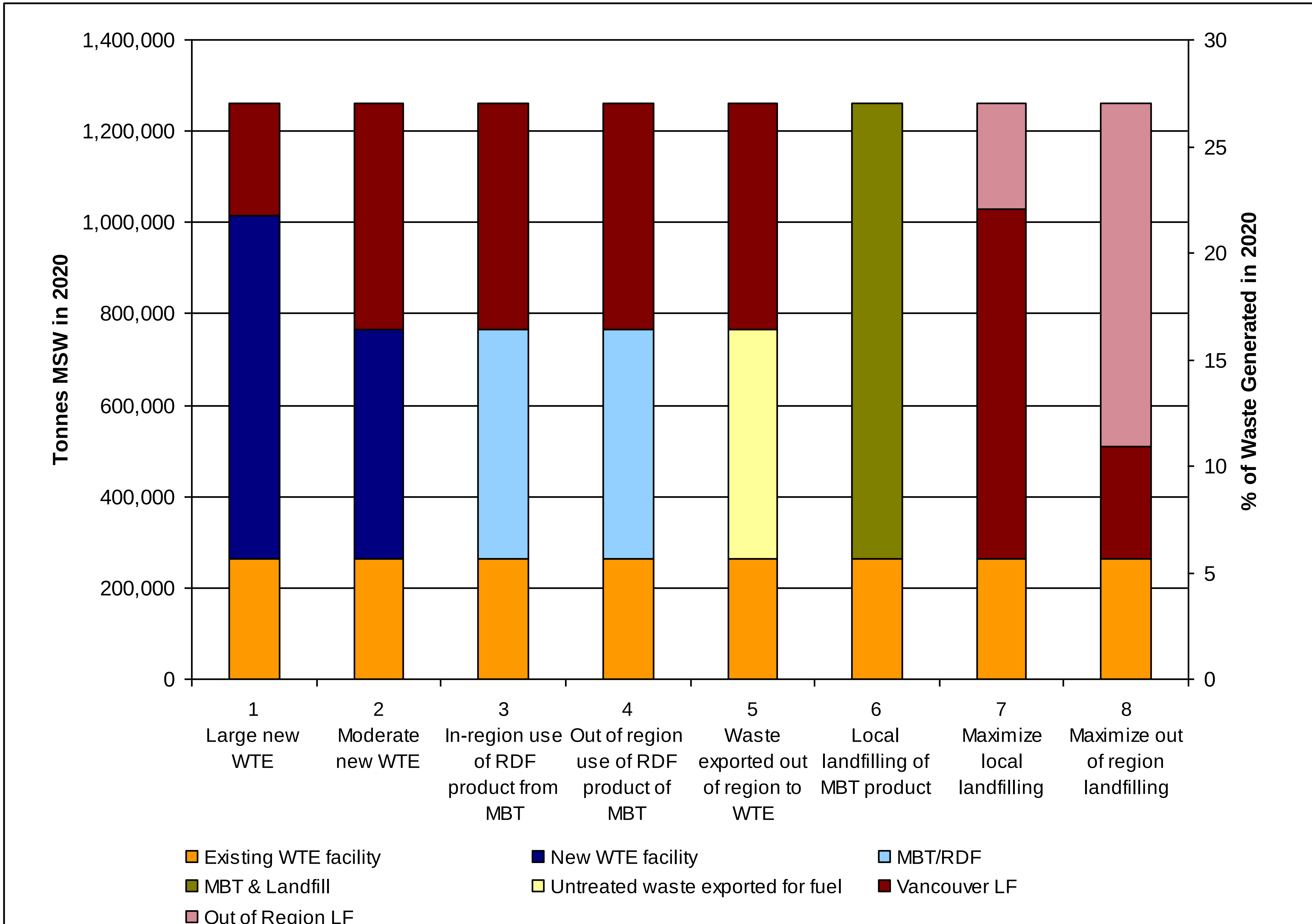
Application of these technologies to Metro Vancouver's MSW

- 8 scenarios involving various combinations of WTE, MBT and landfill
- Life Cycle Assessment (LCA)
  - Energy balance
  - Emissions balance
- Financial analysis
  - Levelized system costs
  - Accounting costs
  - Cash flows
- All scenarios include continued use of Vancouver Landfill and Metro Vancouver WTE Facility

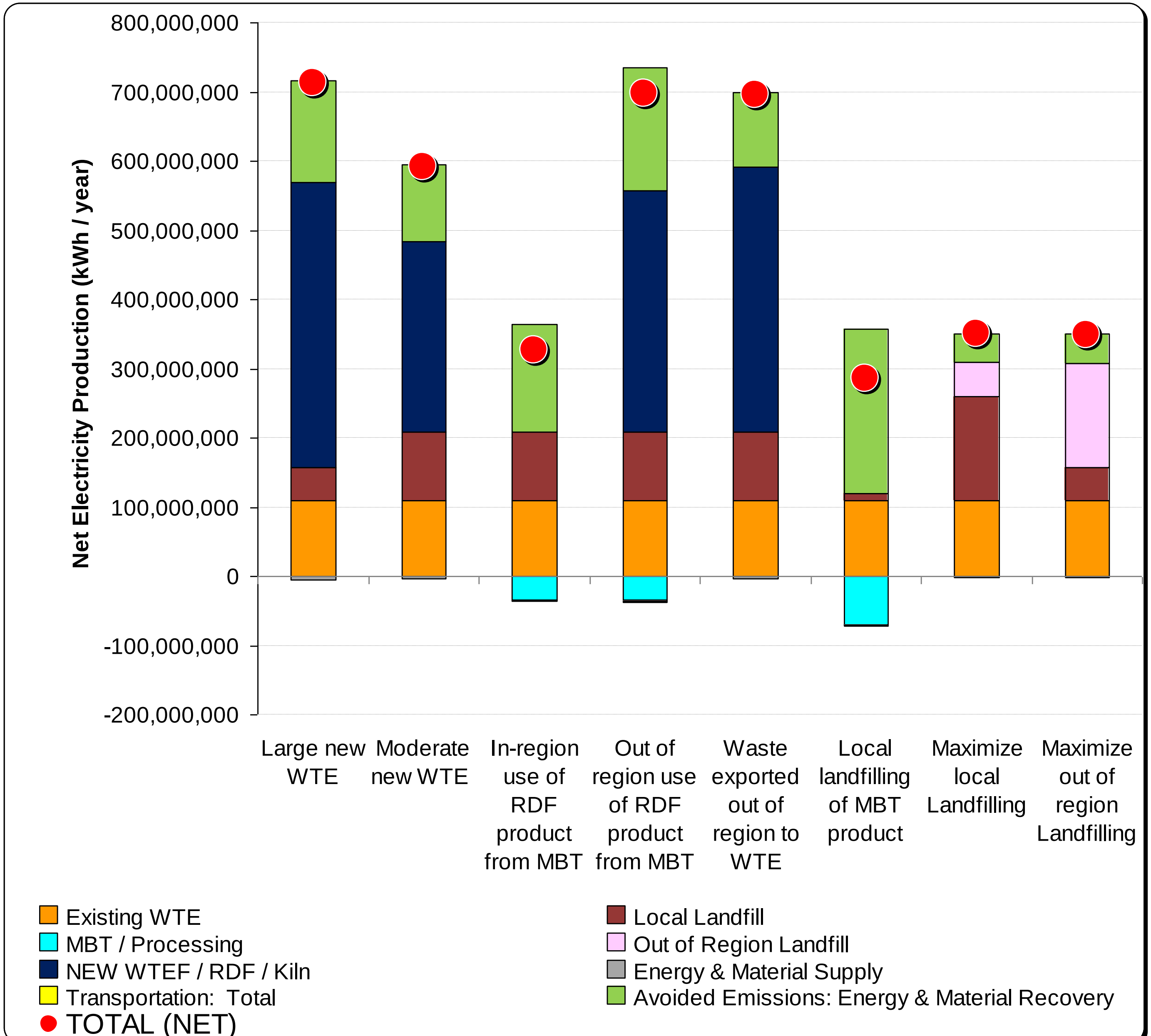
Eight Scenarios for Evaluation and Comparison



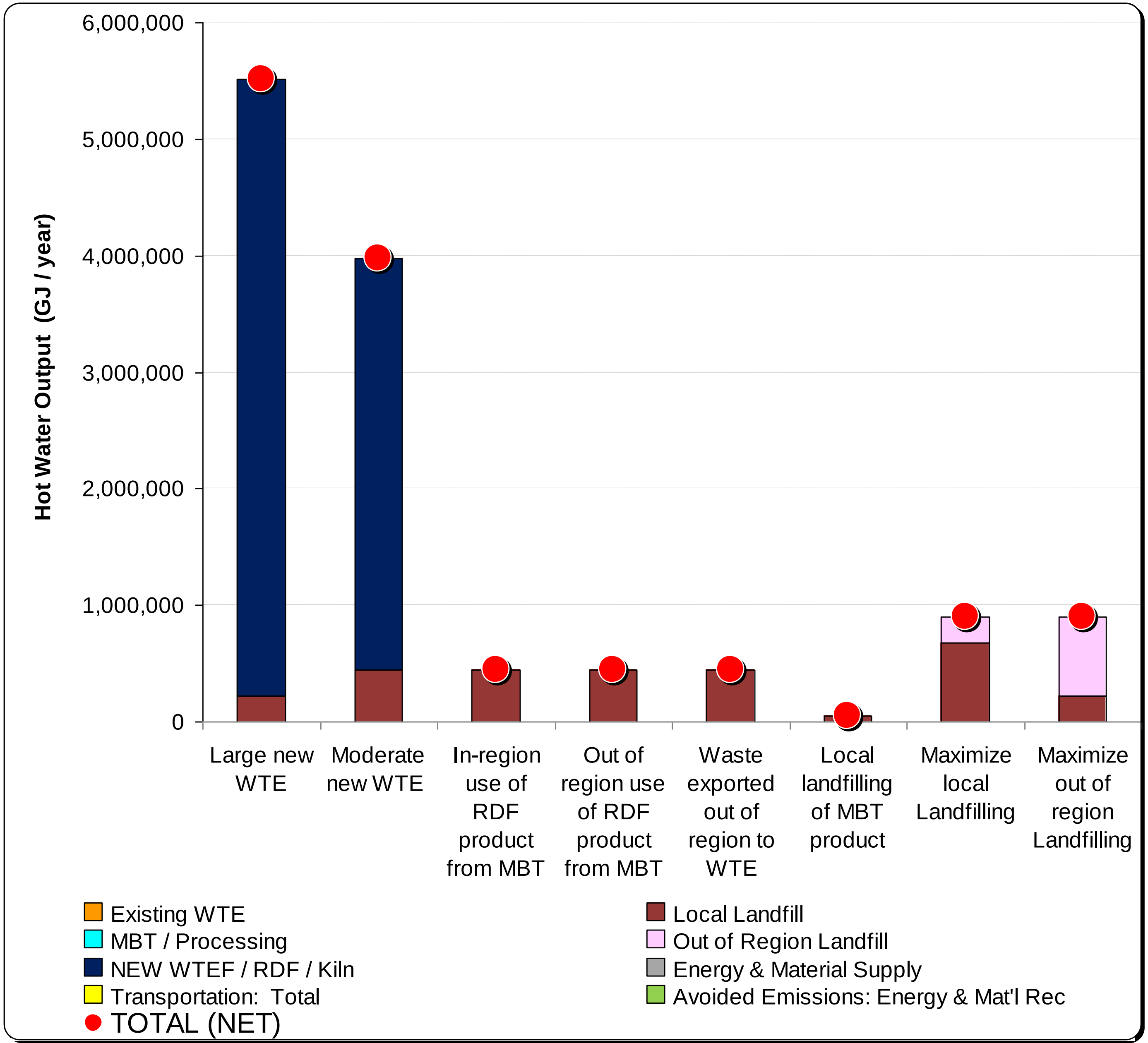
Life Cycle Analysis (LCA) for Emissions

- Key emissions assessed using LCA
  - Global implications
  - Fraser Valley airshed impacts
- Greenhouse gas emissions
  - In provincial context (global emission)
- Energy production and consumption reviewed

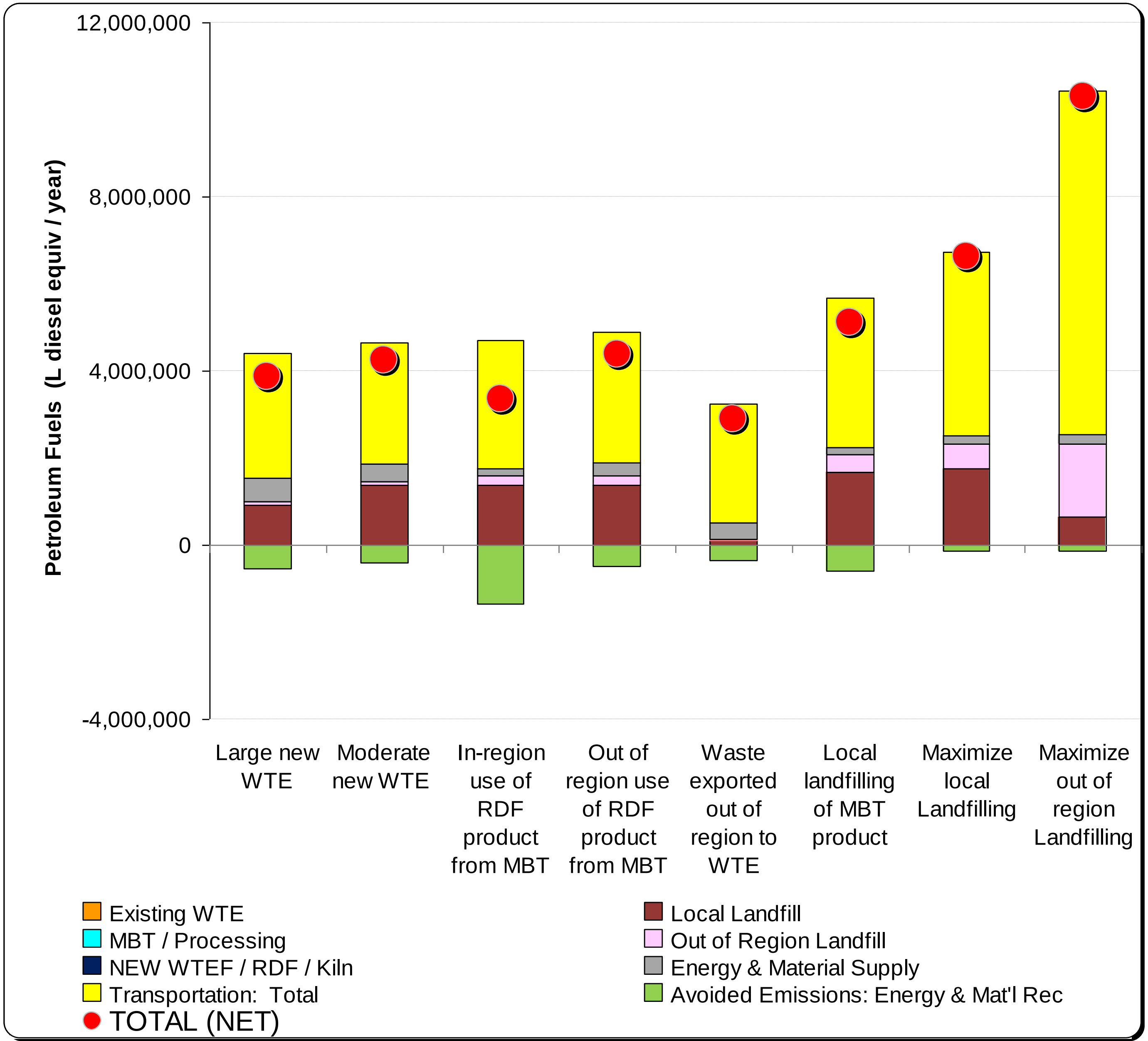
Net Electricity Consumption & Production



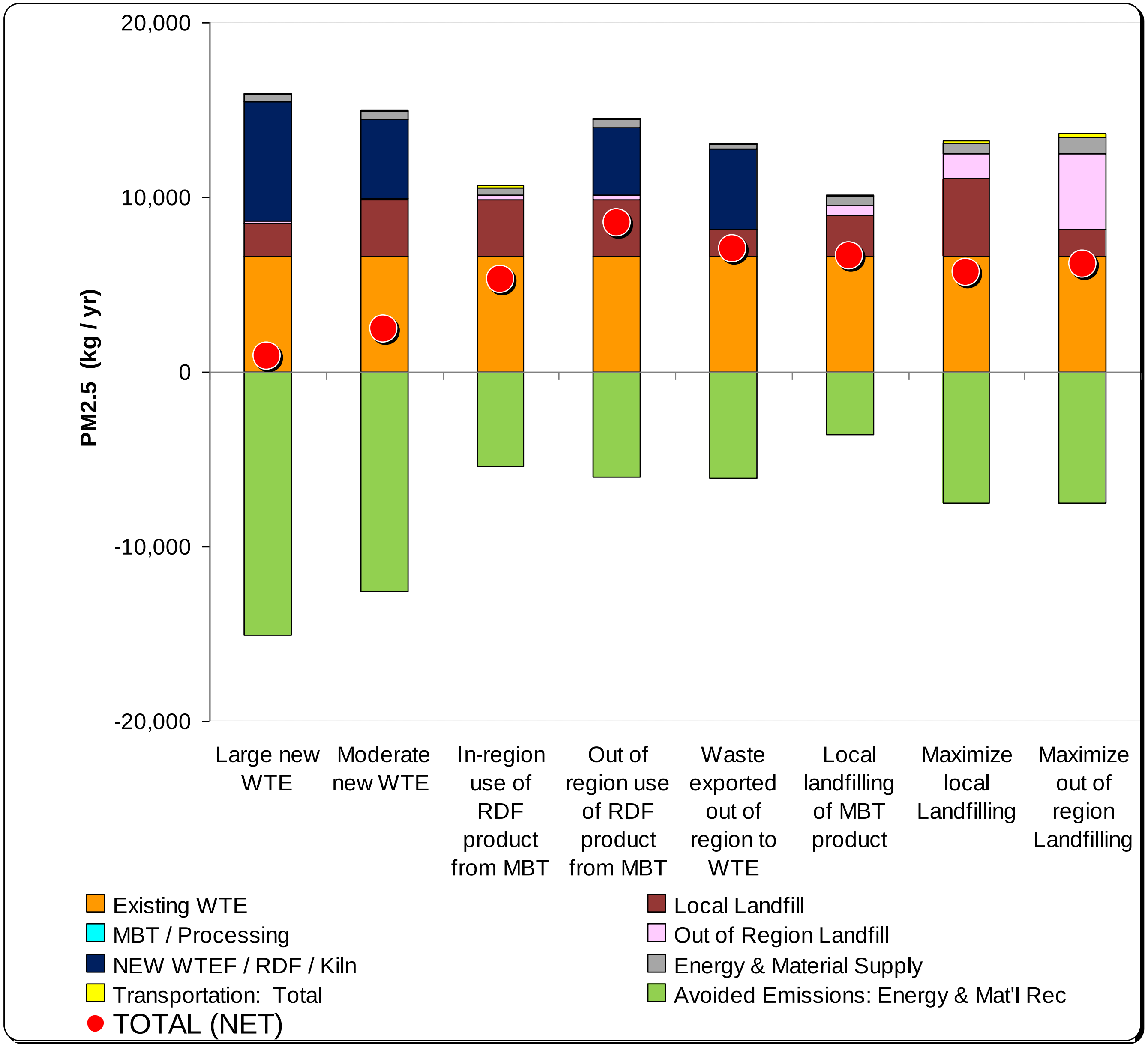
Hot Water Generation for District Energy



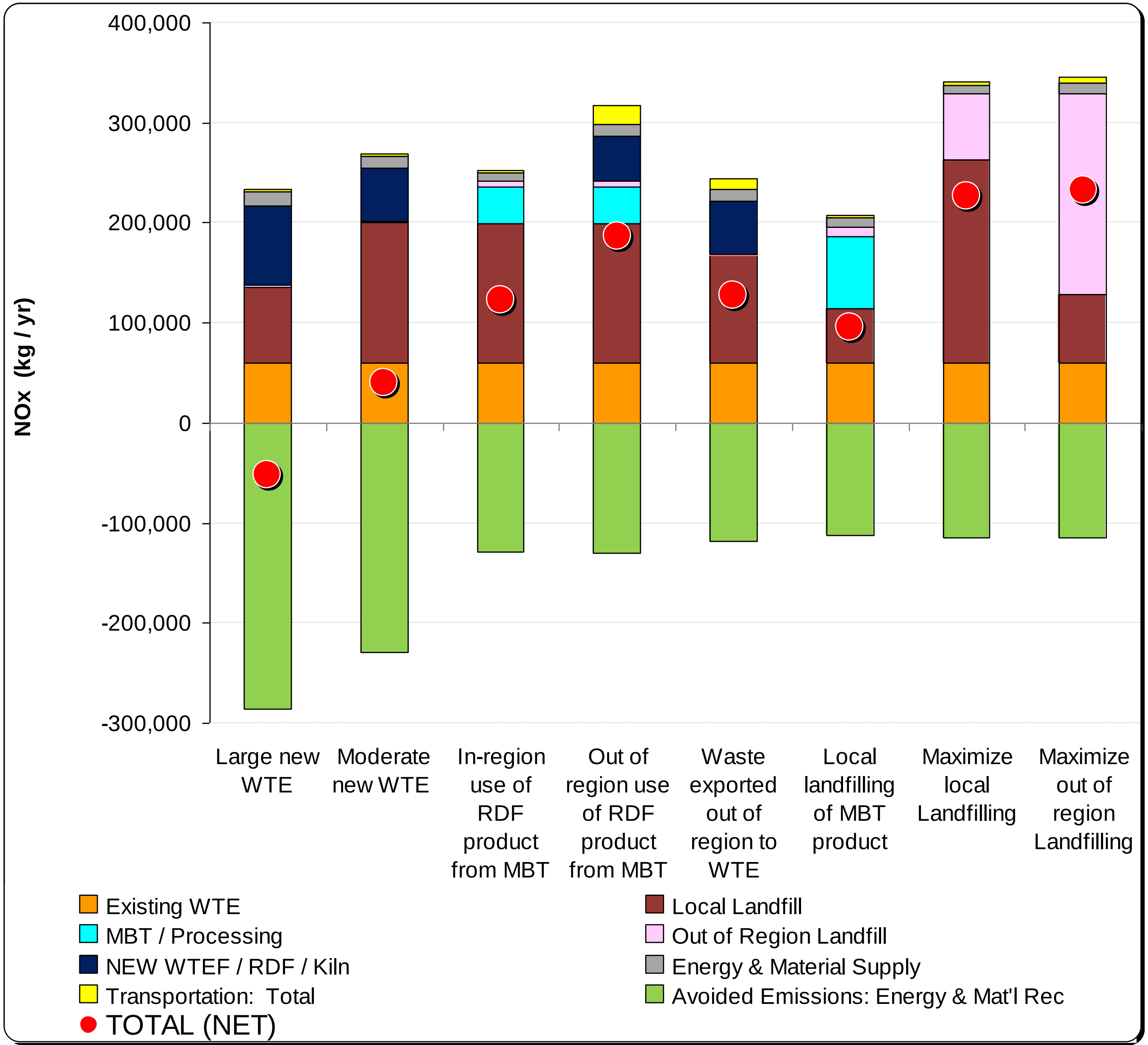
Petroleum Fuel Balance



Fine Particulates PM 2.5 Emissions



NOx Emissions



SOx Emissions

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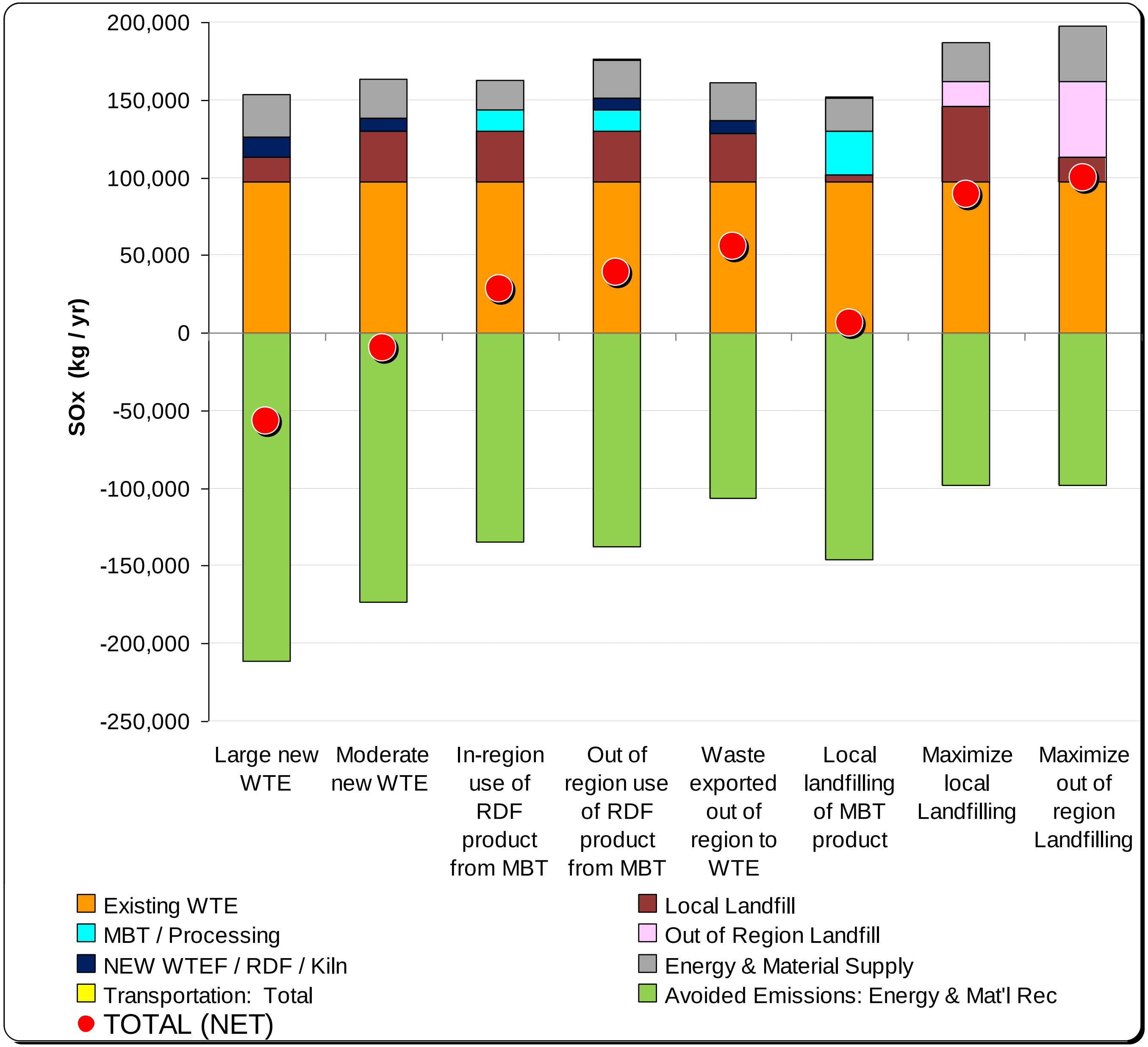
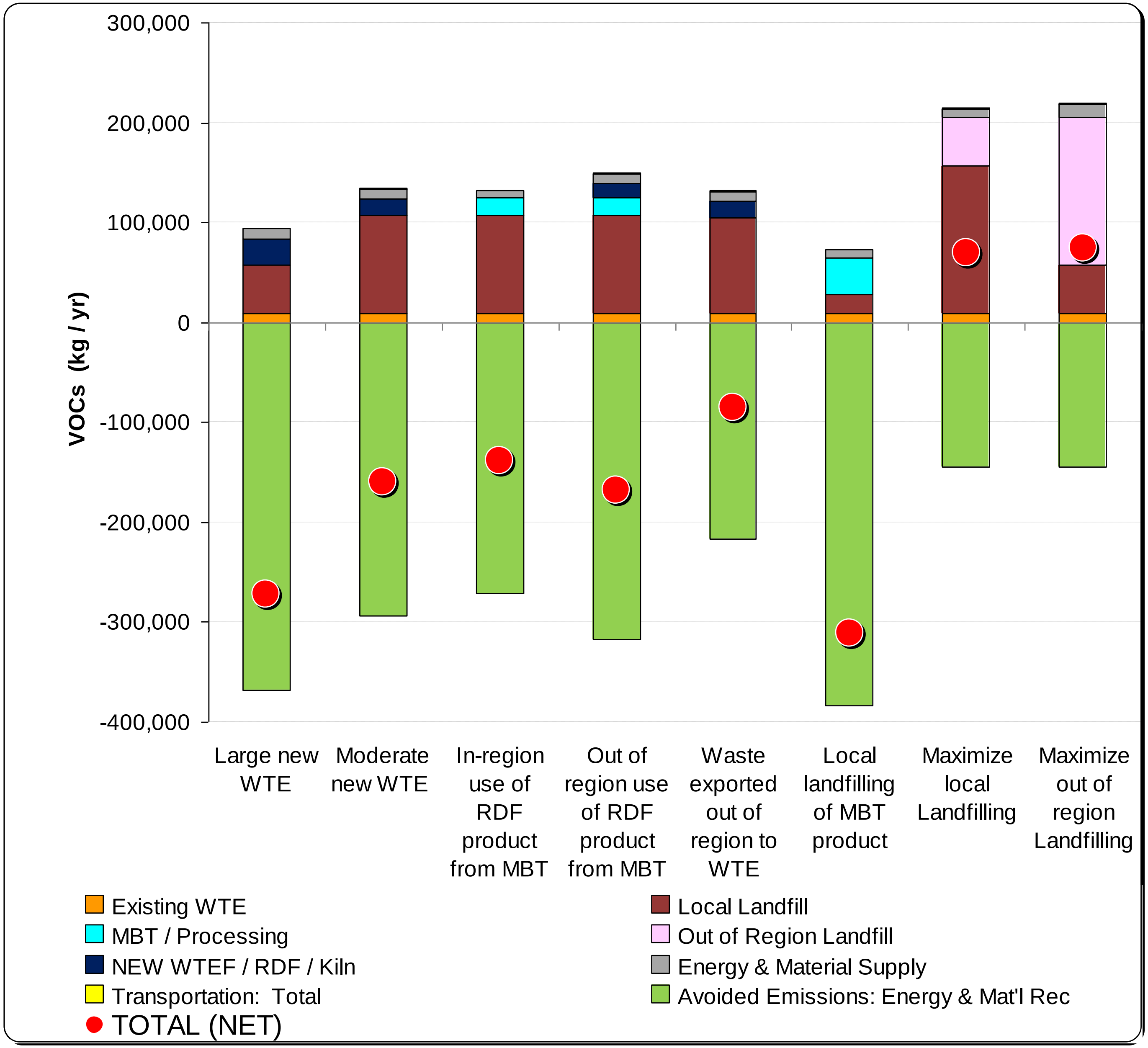
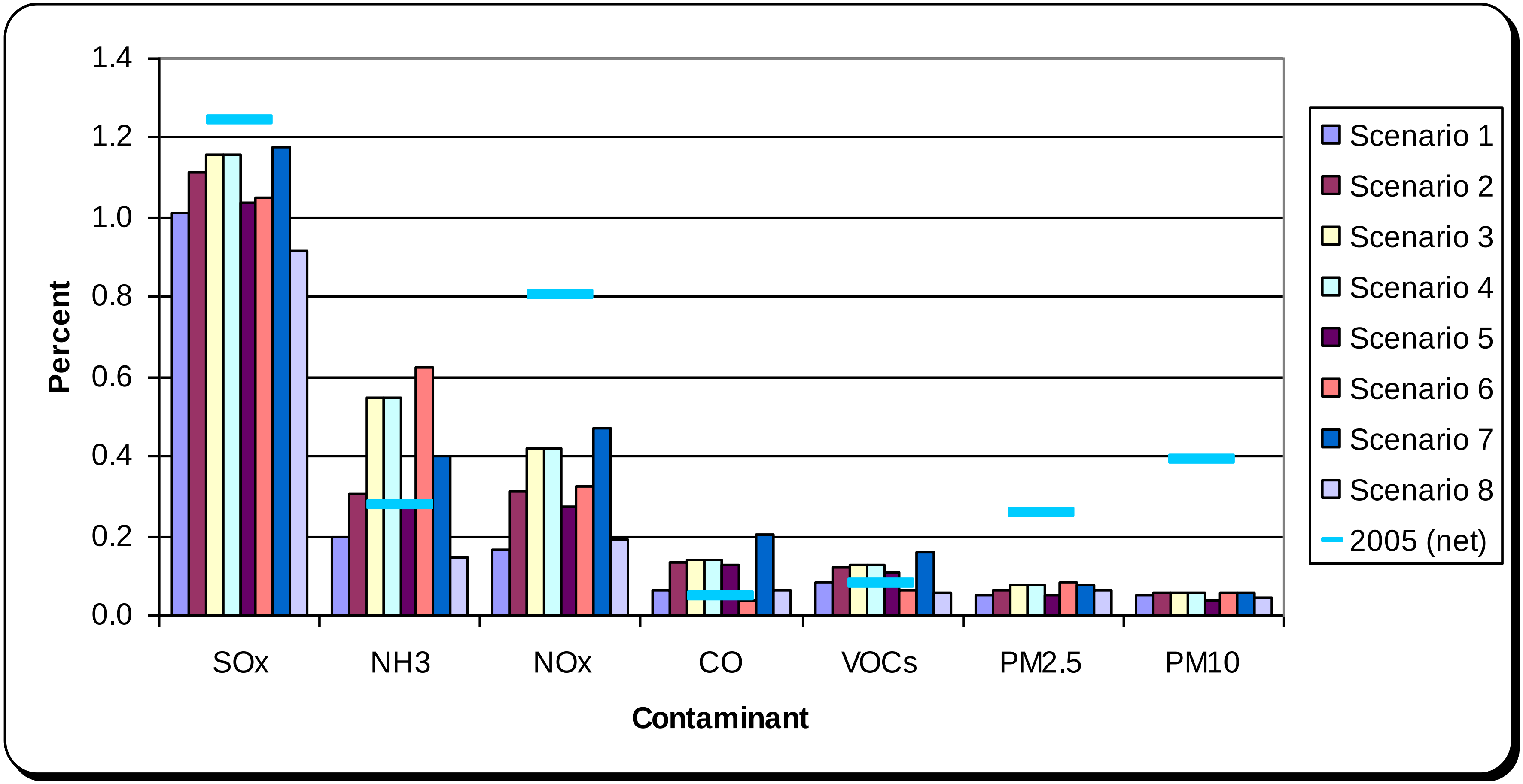


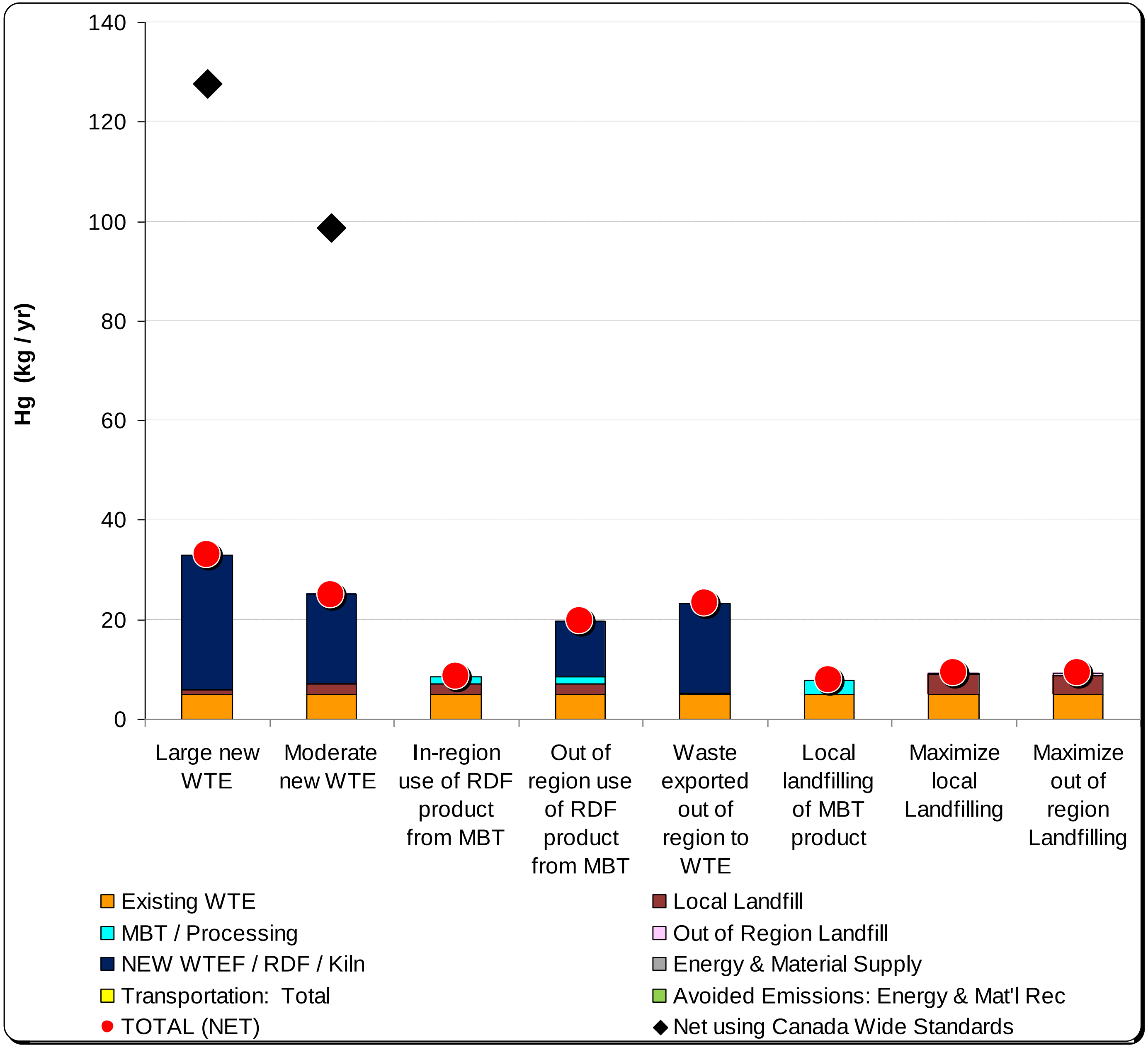
VOC Emissions



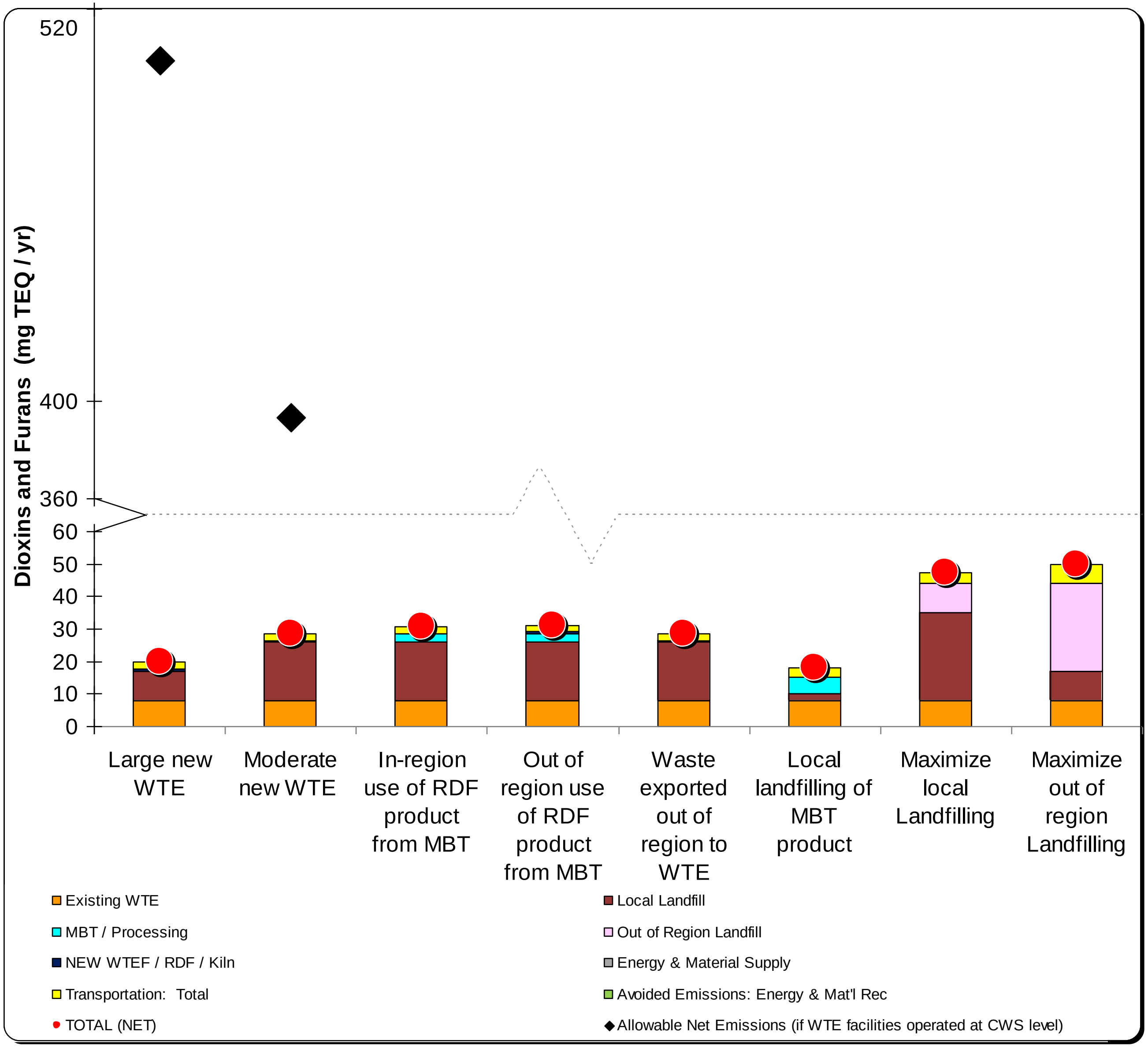
2020 Projected Air Emissions in LFV from MSW Scenarios



Mercury Emissions Total



Dioxin and Furan Total Emissions



Mercury and Dioxins and Furans observations

- Mercury
  - Mercury emissions from waste management scenarios contribute less than 3% to LFV airshed
    - WTE scenarios emit more mercury than landfilling scenarios
  - Estimated emissions only 25% of what Canada Wide Standards would allow
  - Mercury emissions will decline substantially when the Province's product stewardship programs focusing on removing mercury containing products are fully implemented
- Dioxins and Furans
  - Loading on LFV airshed from all scenarios around 1%
    - Landfill scenarios emit more dioxins and furans than WTE scenarios
  - Less than 10% of what Canada Wide Standards would allow

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GHG Production

- Both WTE and landfilling emit GHG
  - WTE produces CO_2 from about 40% of the waste (the portion derived from hydrocarbons)
  - Landfill GHG emissions are from escaped methane (21 times more harmful than CO_2)
- Electricity from WTE and burning landfill gas reduces the need to generate/import power from other sources (fossil fuels)
  - WTE produces far more electricity than landfills, so greater offsets
- Scenario modeled with largest WTE capacity found to have fewer GHG emissions than mostly landfill scenario
- Actual GHG emissions depend on local conditions and assumptions

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Key Lessons from Life Cycle Analysis

- Substantial emission offsets are achieved by displacing fossil fuel energy with WTE
- Transportation is not a key source of air emissions, including GHG (but does consume energy)
- Displacing natural gas through district heating use avoids GHG and air emissions
- If coal sourced electricity is avoided, the GHG emissions of WTE are substantially lower than from landfilling
- Placing a facility outside the local airshed does not change total emissions, but reduces impact on the local airshed

Observations on Lower Fraser Valley Airshed Loading

- Generally, all scenarios have similar loadings on airshed
- Compared to current loadings on airshed from waste management activities, projected emissions will be lower in 2020 for all scenarios
- Emissions are not a deciding factor in scenario selection

Financial Analysis

Financial Model

- *Purpose*: to calculate relative costs of waste management alternatives
- *Scope*: system costs from transfer stations to disposal
  - Costs associated with recycling, composting, diversion, transfer, education, and administration are not included
- *Indicators*:
  - Levelized lifecycle costs per tonne
  - Annual accounting costs per tonne

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System Assumptions

- Continued use of existing Metro Vancouver WTE facility for the duration of the projected timeframe
- VLF accepts up to 750,000 tonnes per year until full (timing varies depending on scenario)
- New in-region WTE facilities would be owned by Metro Vancouver
- All other facilities modelled as being privately owned and operated (costs are tipping fee only)

Discount Rate and Price Assumptions

- *Discount rate:* 5% (real)
- *Energy values*:
  - District heat – 70% price of natural gas
  - Natural gas price – $6/GJ
  - Electricity – $100/MWh
- *Real escalation rates*:
  - Natural gas – 1%
  - Electricity – 0%
  - Truck transportation – 0.3%

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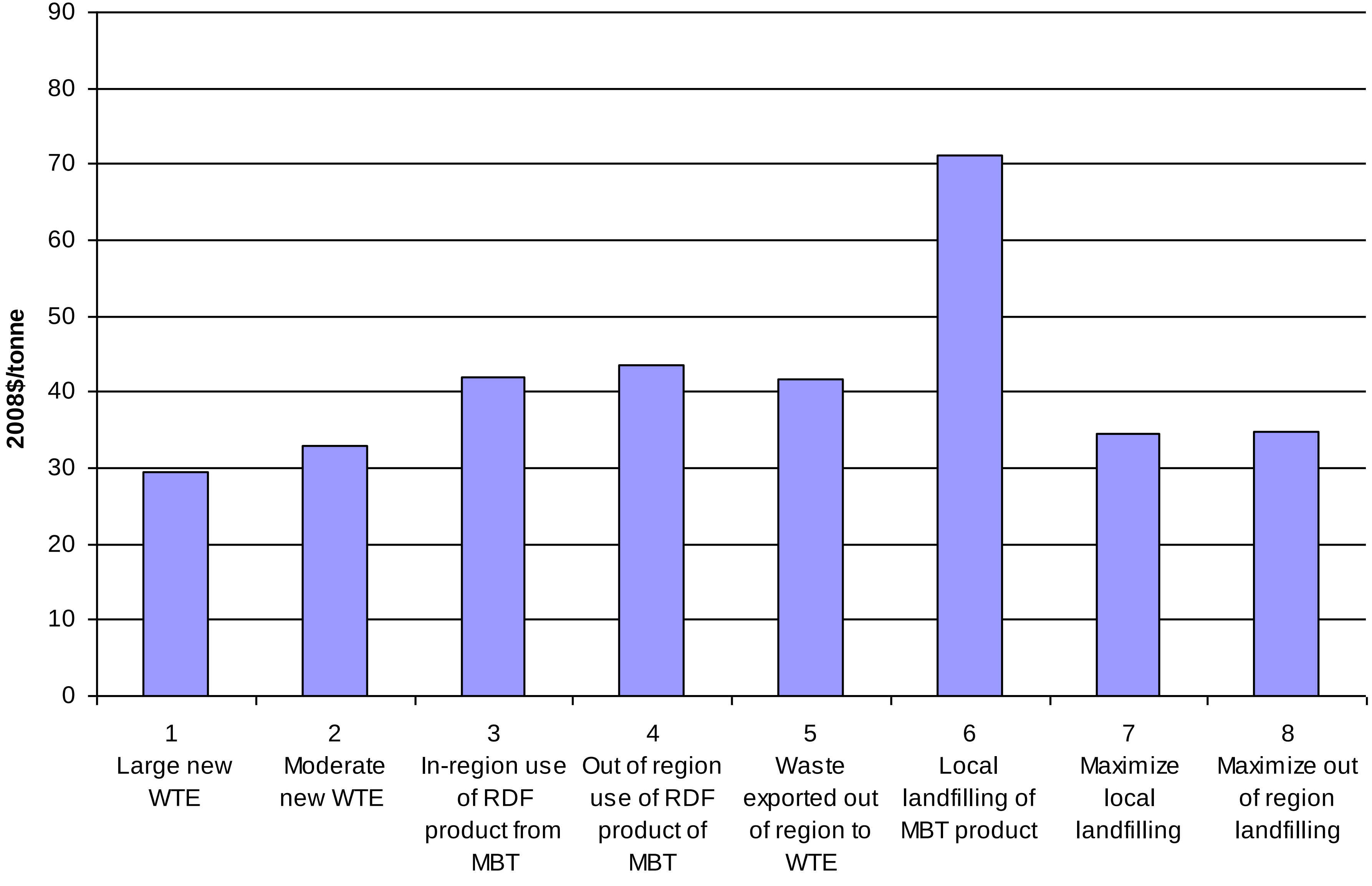
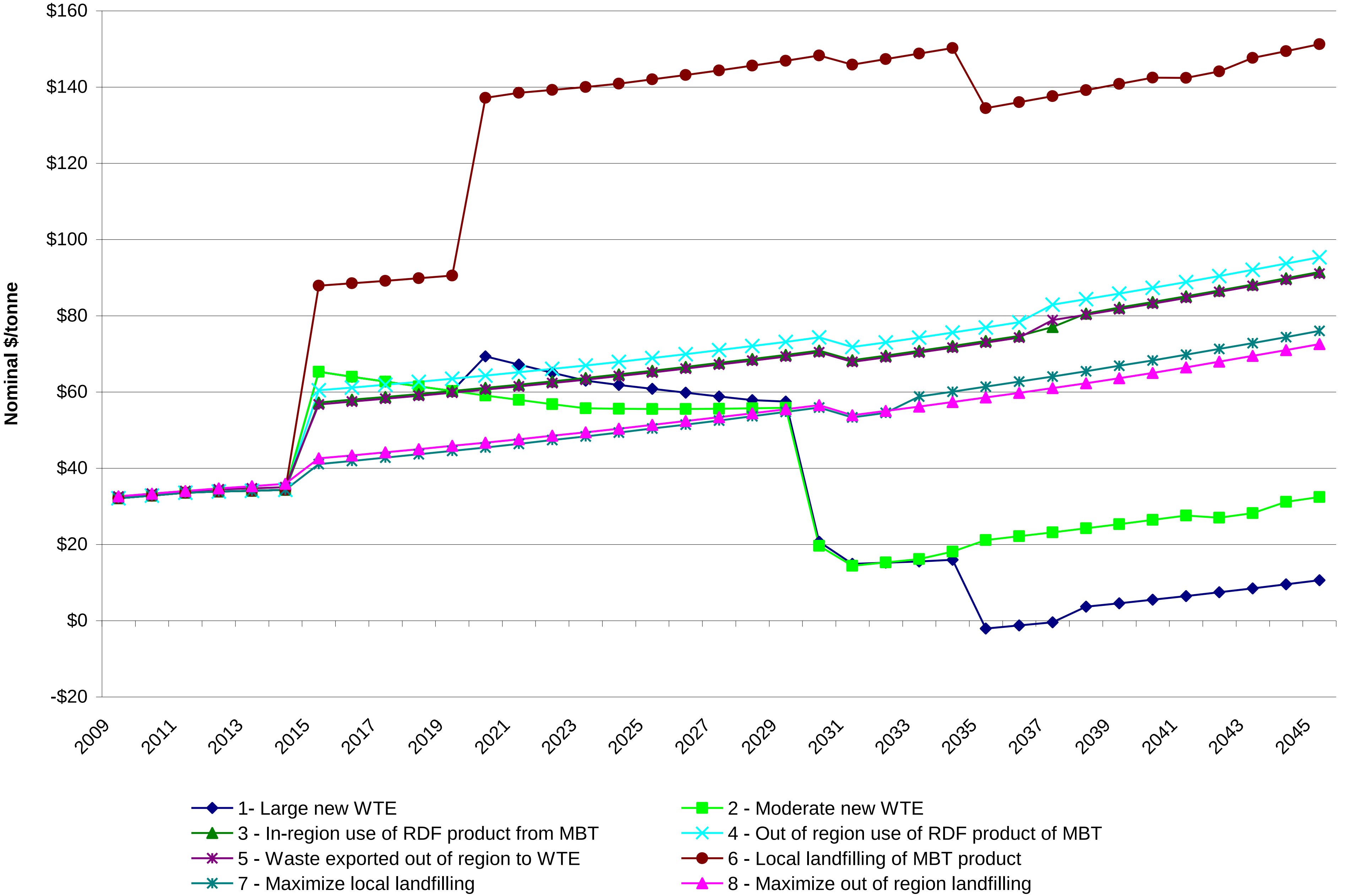
Cost Data

- *WTE*: Based on existing operation and industry standards for new facilities
- *MBT*: Based on some existing operations and industry estimates – less reliable than other estimates
- *Landfill*: Based on information from existing landfills

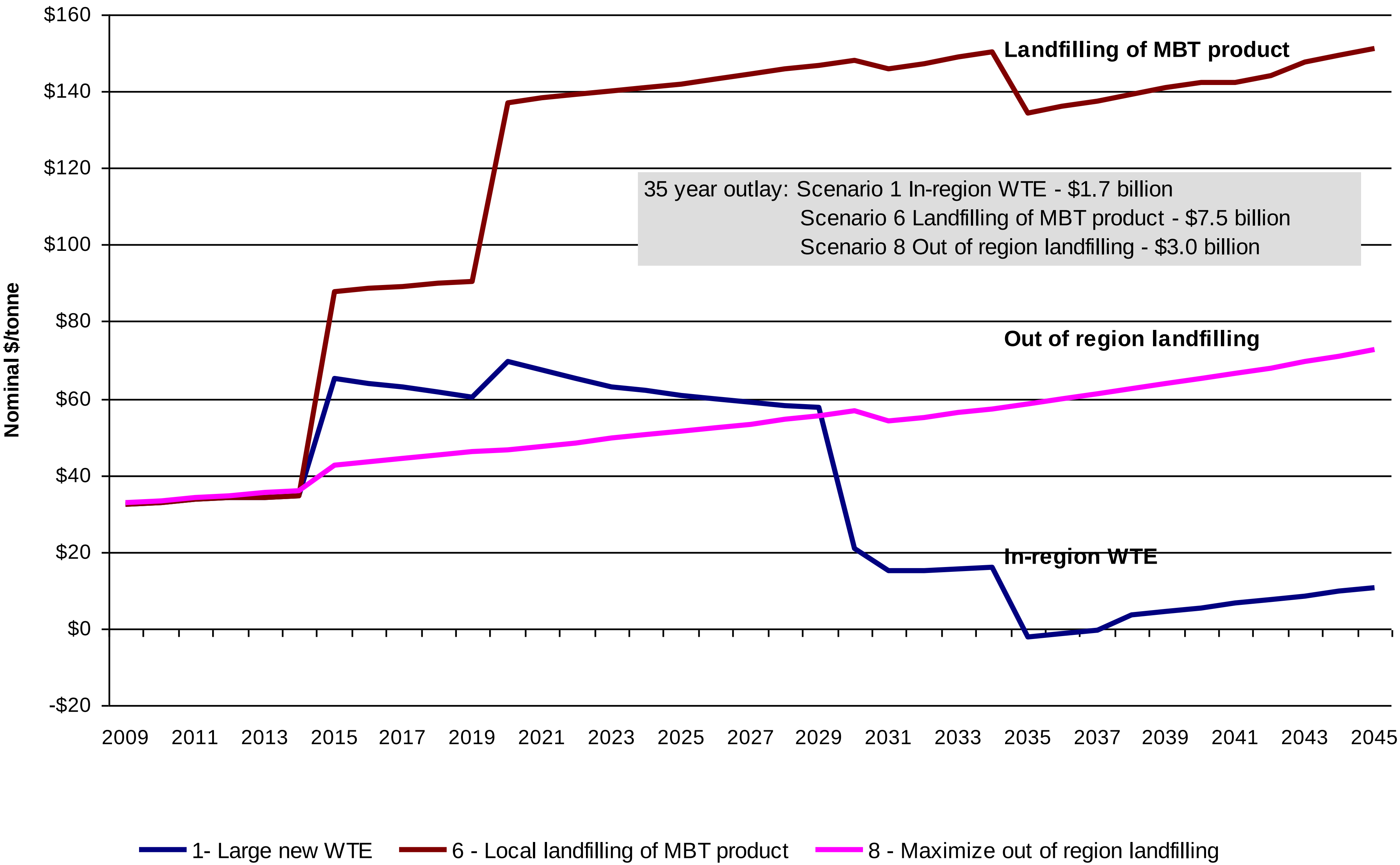
Levelized System Costs



Accounting Costs



Accounting Costs for 3 Key Scenarios



Results

- WTE and landfilling have similar levelized costs – lowest levelized cost is WTE with district heating
- WTE and landfilling have markedly different annual cost profile
  -Landfilling is initially less expensive than WTE, but increasingly higher over long term
- MBT is the most costly scenario

Risks and Uncertainties

- Energy Values
  - District heat
  - Electricity price

- Volume of waste

- Regulatory/legal/senior government intervention

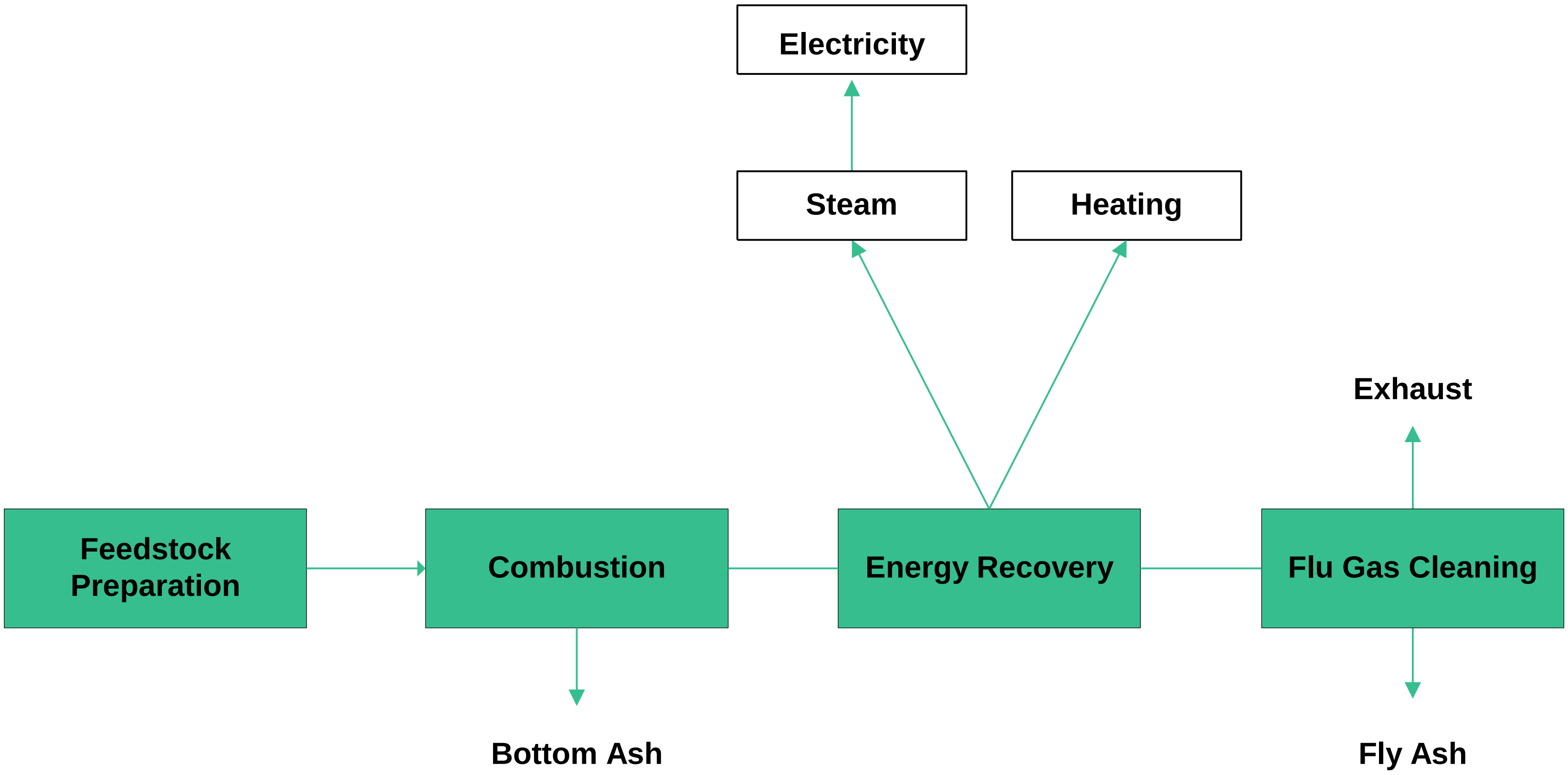
- Costs
  - Capital
  - Ongoing fuel and operating

Overall assessment

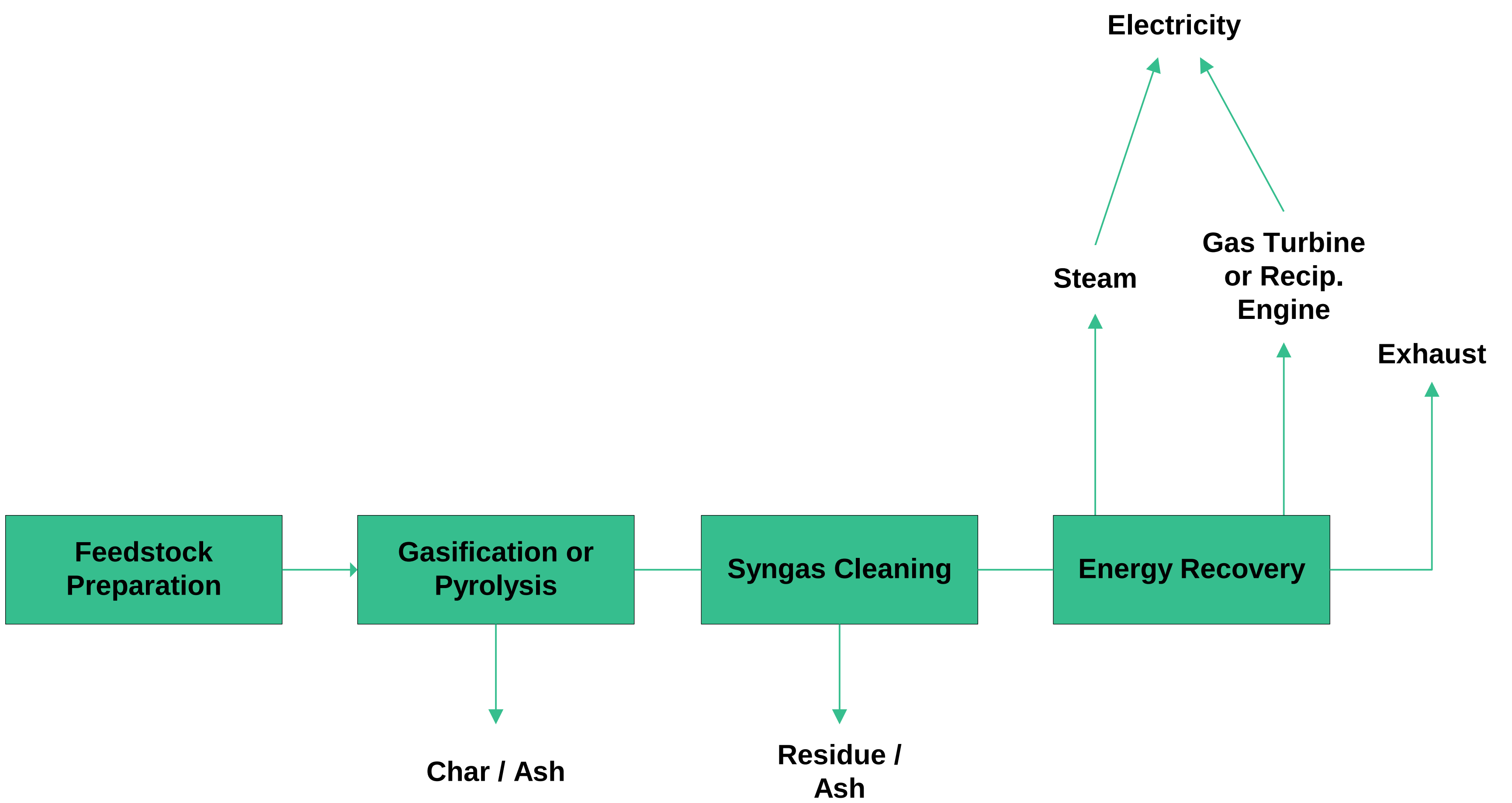
- Key issue – short vs. long term perspective
- WTE – high energy values, especially electricity
- Landfilling – lower short term costs; growing and higher in the long term
- Risks – volume / regulatory-legal / cost
  - Different but significant in all scenarios

THANK YOU

Principle of Conventional Combustion



Principle of Advanced Thermal Technologies



Pros and Cons of Advanced Thermal Technologies

Pros

- Few air emissions during syngas generation
- Lower CO_2 generated when syngas formed
- Ash can be vitrified with some processes
- Recovery of energy from waste
- Better environmental perception
- Smaller scale

Cons

Syngas must be cleaned, leaving residues

- CO_2 formed when syngas burned
- Vitrification has high energy requirement/cost
- Often lower energy recovery efficiency than conventional combustion systems
- No real environmental advantages over combustion if syngas is used for heat/power