MUNICIPAL WASTE INTEGRATION NETWORK
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The voice and resource for municipal waste minimization and management

Recycling Council of Alberta

MSW Options Workshop:
Integrating Organics and Residual Treatment/Disposal
Thermal Treatment – Technical Primer

Konrad Fichtner, P.Eng, Gartner Lee Limited

March 6, 2006

Calgary, Alberta

Workshop supported by

Natural Resources Canada | Ressources naturelles Canada

Environment Canada | Environnement Canada

Presentation overview

- Part A: Technical aspects of thermal treatment
  - The role of thermal treatment and how it works
  - Types of thermal systems and main components
  - Issues and examples
- Part B: Current Situation
  - Current use of the technology
    - In Canada, USA, Europe
  - Future of thermal treatment

Recycling maximized ✔

Composting maximized ✔

Residuals ?

The role of thermal treatment

- Waste to Energy (WTE), rather than energy to waste
- Waste volume reduction, preservation of landfill space
- Destruction of contaminants
- Enhancing diversion potential
- Reducing waste transportation requirements
- Dealing with waste here and now

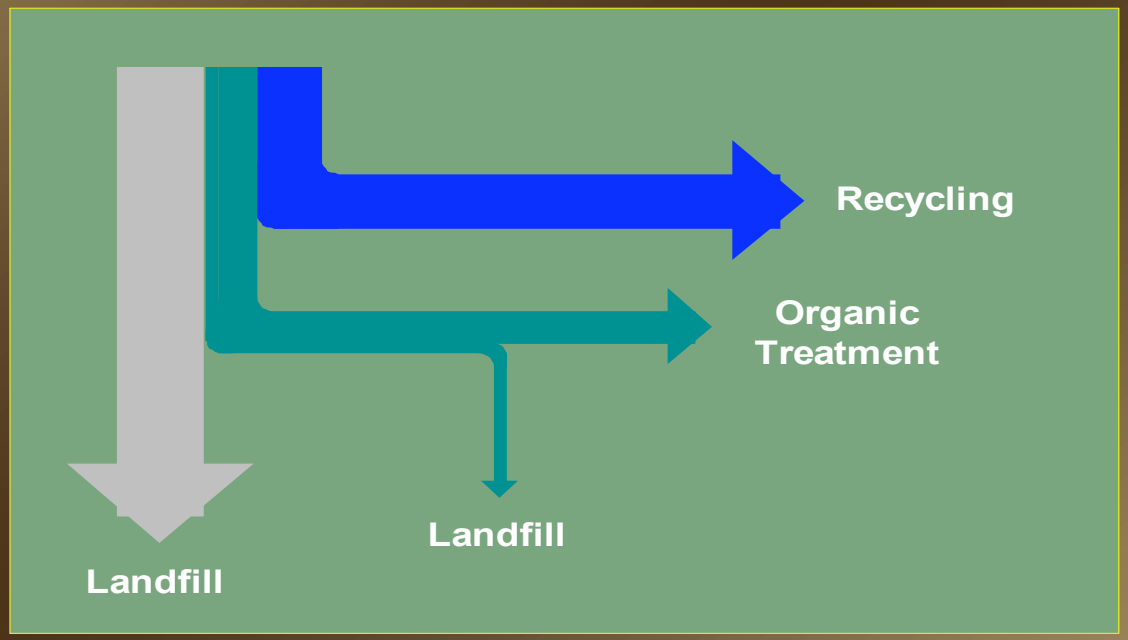
Recycling maximized ✔

Composting maximized ✔

Residuals ?

The role of thermal treatment (2)

- Recycling and organics treatment only:



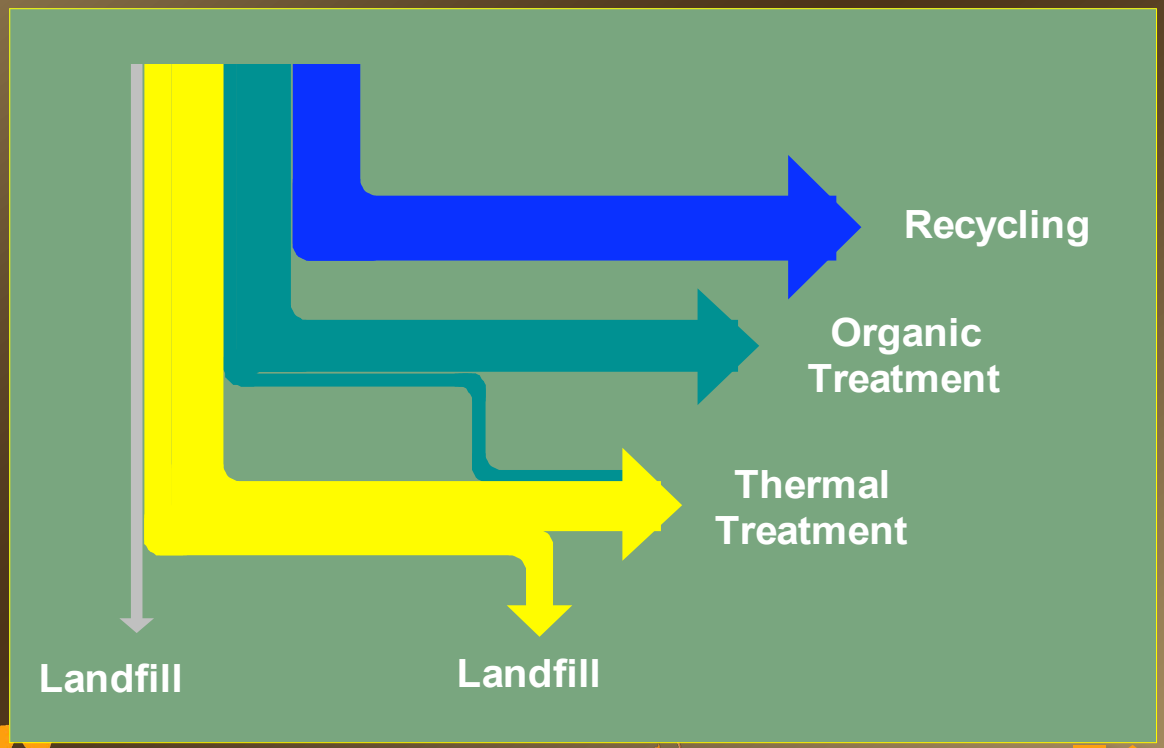
Recycling maximized ✔

Composting maximized ✔

Residuals ?

The role of thermal treatment (3)

- Thermal treatment with recycling and organics treatment:



Recycling maximized ✔ Composting maximized ✔ Residuals ?

The role of thermal treatment (4)

- Last treatment of waste before land disposal
- Applied after recycling, organics management
- Recovers remaining energy
- Converts energy into heat
- Electricity can be sold to the grid
- Offsets fossil fuel use for power generation

Recycling maximized ✔

Composting maximized ✔

Residuals ?

The role of thermal treatment (5)

- One tonne of waste can deliver 500kwh of electricity to the grid
- One tonne of waste has the same energy as one barrel of oil, or a quarter tonne of coal
- 24 tonnes of waste can provide all the electricity for a Canadian home for a year

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Composting maximized ✔

Residuals ?

How thermal treatment works

- Thermal recovery of energy
  - From combustion
  - Through gasification/pyrolysis
  - Plasma systems
- Technologies offer different ways of releasing the energy in the waste
- WTE systems essentially power plants using waste as fuel instead of coal, natural gas or uranium

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Composting maximized ✔

Residuals ?

How thermal treatment works (2)

- WTE plant components:
  - Waste processing
  - Thermal treatment technologies
    - Ash disposal
    - Metals recycling
  - Heat recovery
  - Air pollution control

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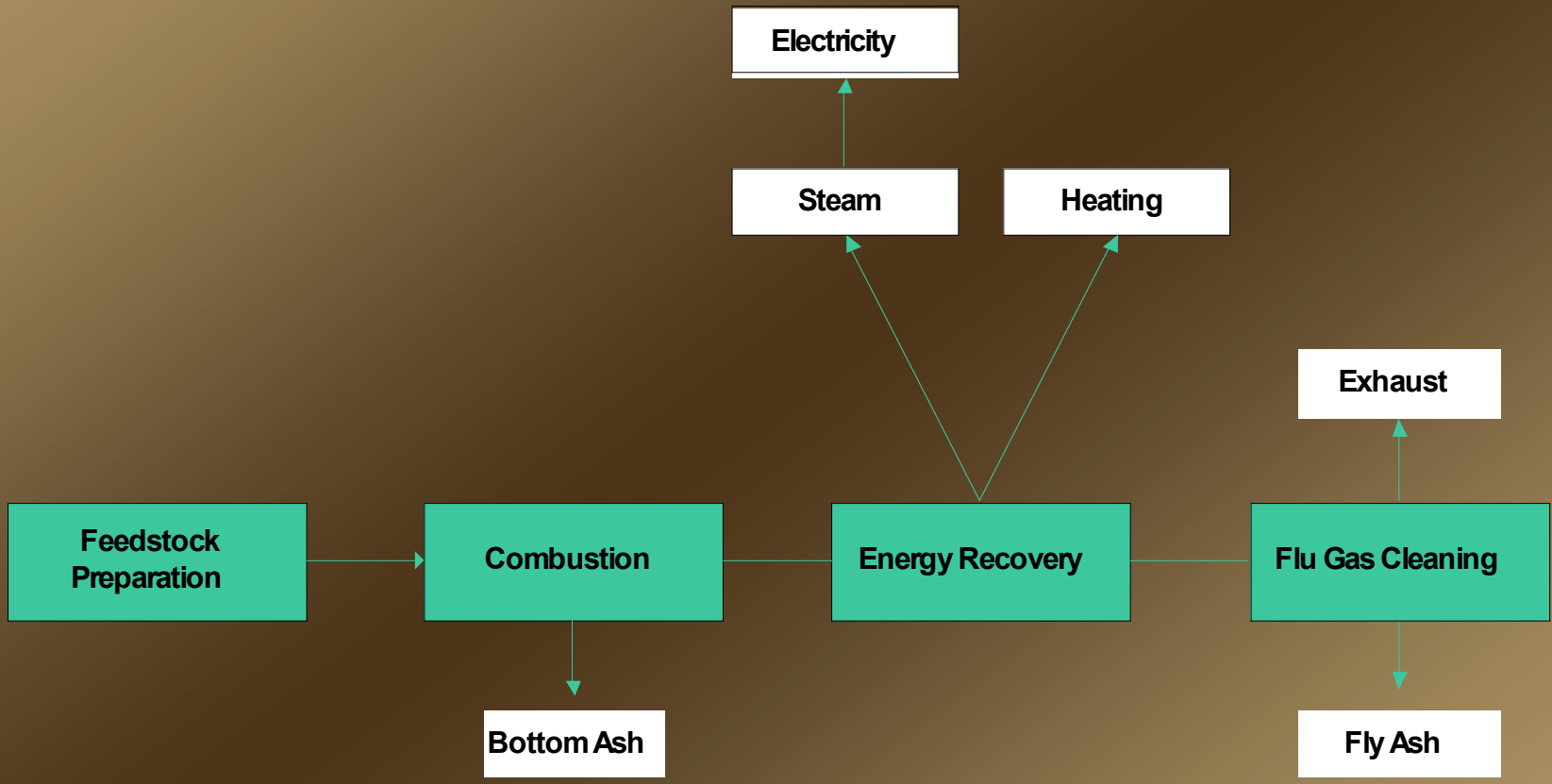
Composting maximized ✔

Residuals ?

Conventional waste to energy process flow



(60160 Waste to Energy 14Feb06.vsd)

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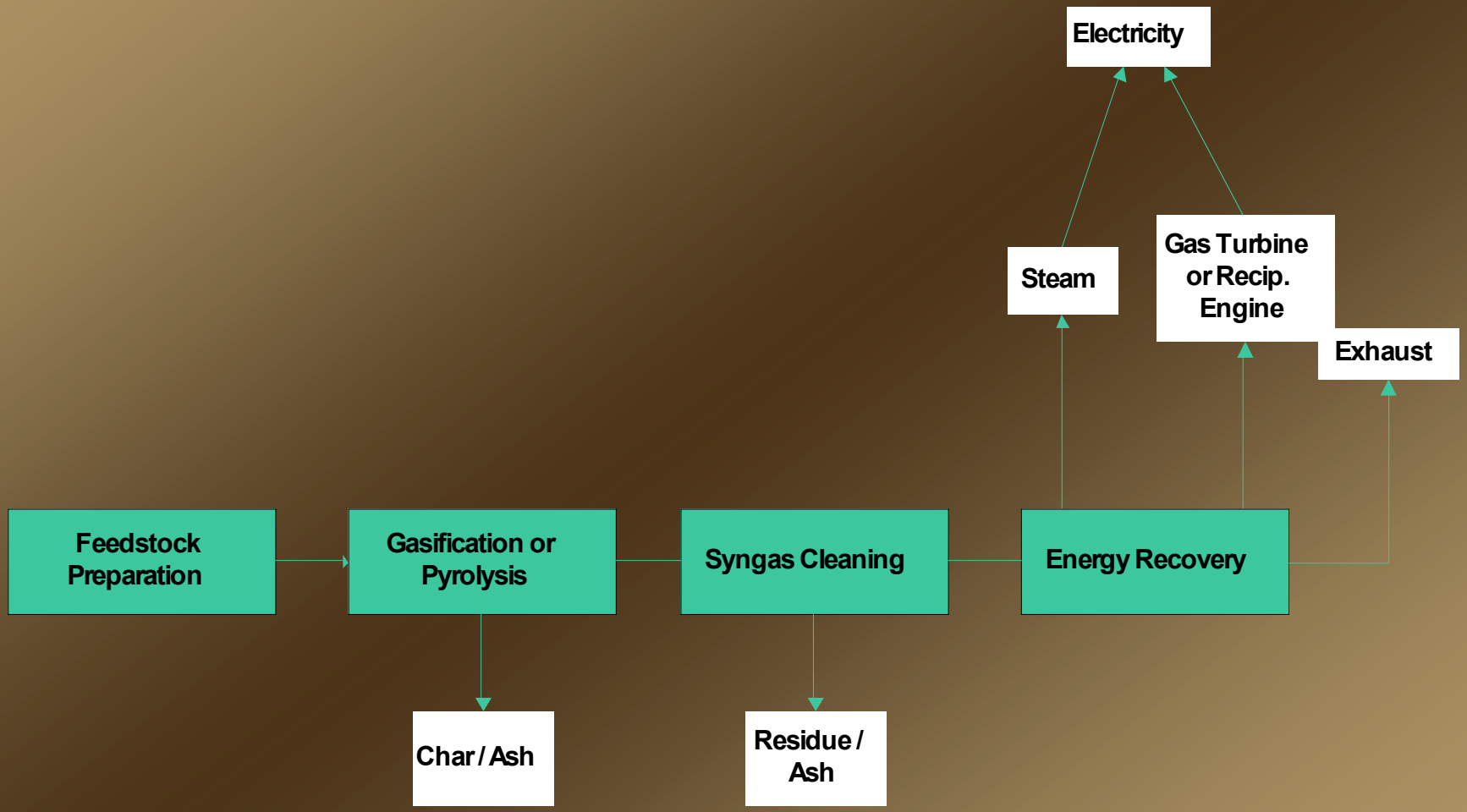
Residuals ?

Gasification/pyrolysis process flow



(60160 Waste to Energy Pyrolysis 14Feb06.vsd)

Recycling maximized ✔ Composting maximized ✔ Residuals ?

How thermal treatment works (3)

- Waste processing
  - Make waste suitable for the chosen treatment technology
    - Size reduction
    - Drying
    - Sorting
  - Recycling
  - Possible removal of organics fraction for composting or AD

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Composting maximized ✔

Residuals ?

Types of thermal technologies

- Traditional combustion
  - Mass burn
  - Fluidized bed
  - Modular
  - Rotary kiln
  - Refuse Derived Fuel (RDF)

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Composting maximized ✔

Residuals ?

Types of thermal technologies (2)

- Gasification and pyrolysis
  - Converts solids into synthetic gas
  - Gas is cleaned before combustion or other uses
  - Complex technology
- Plasma
  - Ultra high temperature process, total organics destruction
  - Creates vitrified slag
  - Lowest residuals

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Composting maximized ✔

Residuals ?

Types of thermal technologies (3)

Refuse derived fuel (RDF)

- Solid waste made into homogenous fuel
- Can be sold and used off site
- Replaces other fuels such as coal or gas
- Used by:
  - Cement kilns
  - Industry power boilers
  - Dedicated WTE plants

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Composting maximized ✔

Residuals ?

Types and components

- Heat recovery
  - Conventional steam boiler technology
    - Generates steam
    - Steam used to generate electricity using steam turbine generator
    - Steam used for industrial process or heating
  - Synthetic gas can be cleaned and fired directly
    - In a reciprocating engine
    - In a gas boiler
    - In a gas turbine
    - Syngas can be raw material for chemical process

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Composting maximized ✔

Residuals ?

Types and components (2)

- Air pollution control
  - Mature technology.
    - Systems available to meet most stringent air emission standards
    - Custom matched to combustion technology
  - WTE most highly regulated form of waste management
  - Emission standards more stringent than for most coal fired power plants or industrial boilers

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Composting maximized ✔

Residuals ?

Types and components (3)

- Ash
  - Bottom ash and fly ash,
    - 25% by weight and 10% by volume of treated waste
    - 20% by weight is bottom ash, 5% fly ash from air pollution control system
  - Metals recovered and recycled
  - Bottom ash suitable for road base, landfill cover or disposal
  - Fly ash usually needs to be stabilized before disposal

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Composting maximized ✔

Residuals ?

Issues: Costs

- The smaller the WTE plant, the higher the cost per tonne
  - 10 TPD, or 3000 TPY: $450 per tonne
  - 20 TPD, or 6000 TPY: $260 per tonne
  - 480 TPD, or 150,000 TPY: $130 per tonne
  - 1000 TPD, or 300,000 TPY: $100 per tonne

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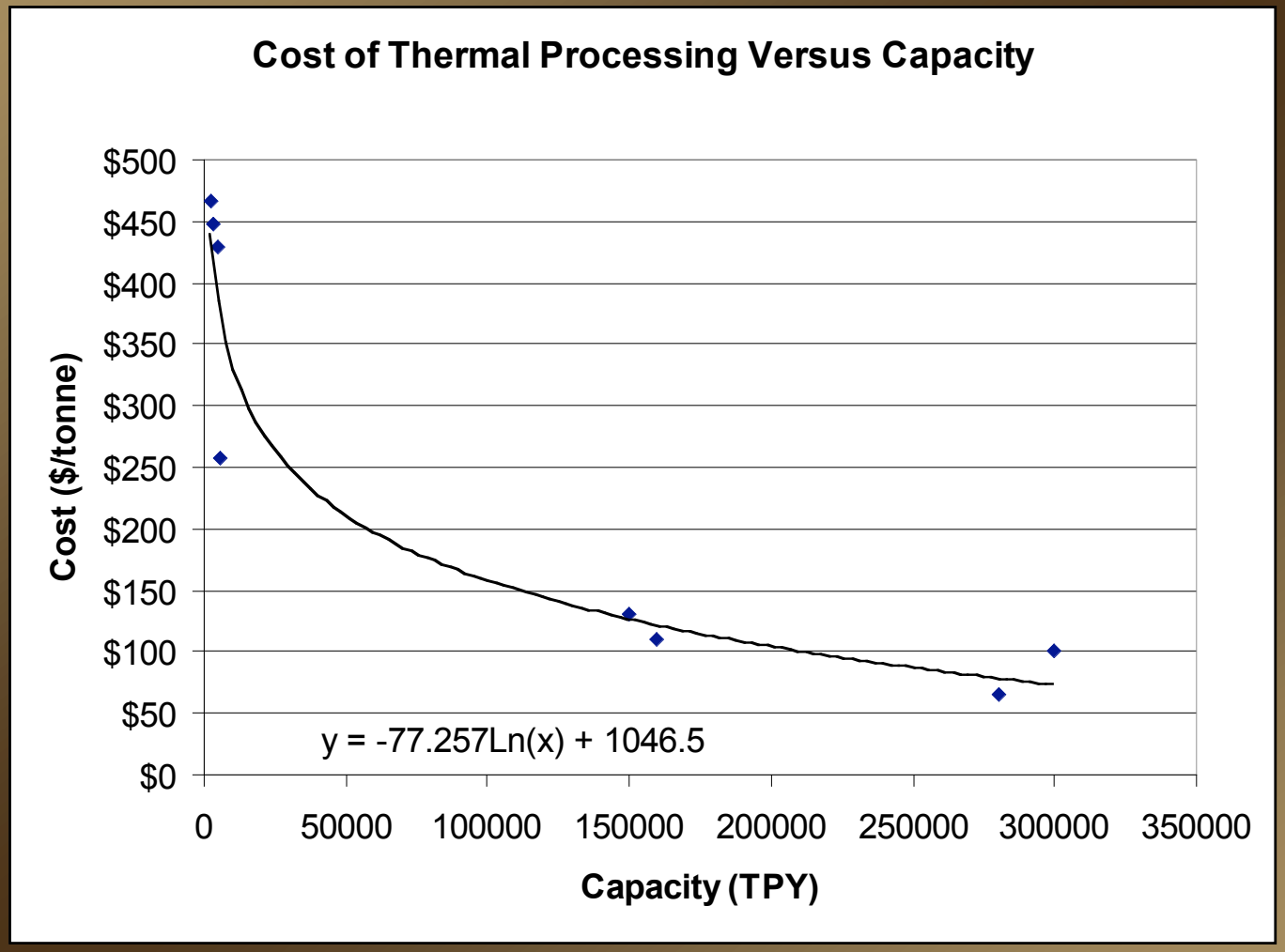
Residuals ?

Issue: Costs



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Composting maximized ✔

Residuals ?

Issues: Opposition and hurdles

- Negative public perception
- Lack of public awareness of technological progress and high regulated standards
- Large initial investment needed
- Higher operating costs than most local landfills
- Need for long term waste supply contracts

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Composting maximized ✔

Residuals ?

Issues: Opposition and hurdles (2)

- Full cost accounting and long term benefits rarely considered
- Waste has not yet been defined as renewable energy in Canada
- GHG credits are difficult to define and do not flow into the economics calculations

Recycling maximized ✔

Composting maximized ✔

Residuals ?

Example 20 tonne per day WTE

- Serves a population of 30,000+
  - Wainwright, Alberta

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Composting maximized ✔

Residuals ?

Example 200 tonne per day WTE

- Serves a population of 250,000+
  - Isle of Man, UK

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Composting maximized ✔

Residuals ?

Example 350 tonne per day WTE

- Serves a population of 450,000+
  - Paris, France

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Composting maximized ✔

Residuals ?

Example 800 tonne per day WTE

- Serves a population of 1,000,000+
  - Burnaby, BC

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Composting maximized ✔

Residuals ?

Example 3000 tonne per day WTE

- Serves a population of 3,000,000+
  - Singapore

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Residuals ?

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MSW Options Workshop:
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Thermal Treatment – Situation Update

Konrad Fichtner, P.Eng. Gartner Lee Ltd.

February 23, 2006

Mississauga, Ontario

Workshop supported by

Natural Resources Canada / Ressources naturelles Canada

Environment Canada / Environnement Canada

Current use of thermal treatment

- In Canada:
  - Burnaby, BC
    - 280,000 TPY, mass burn
  - Quebec City, QC
    - 280,000 TPY, mass burn
  - Algonquin Peel, ON
    - 150,000 TPY, multiple unit modular
  - Wainwright, AB
    - 6,000 TPY, single unit modular

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Composting maximized ✔

Residuals ?

Burnaby Mass Burn Facility

Recycling maximized ✔

Composting maximized ✔

Residuals ?

Algonquin Peel Modular System

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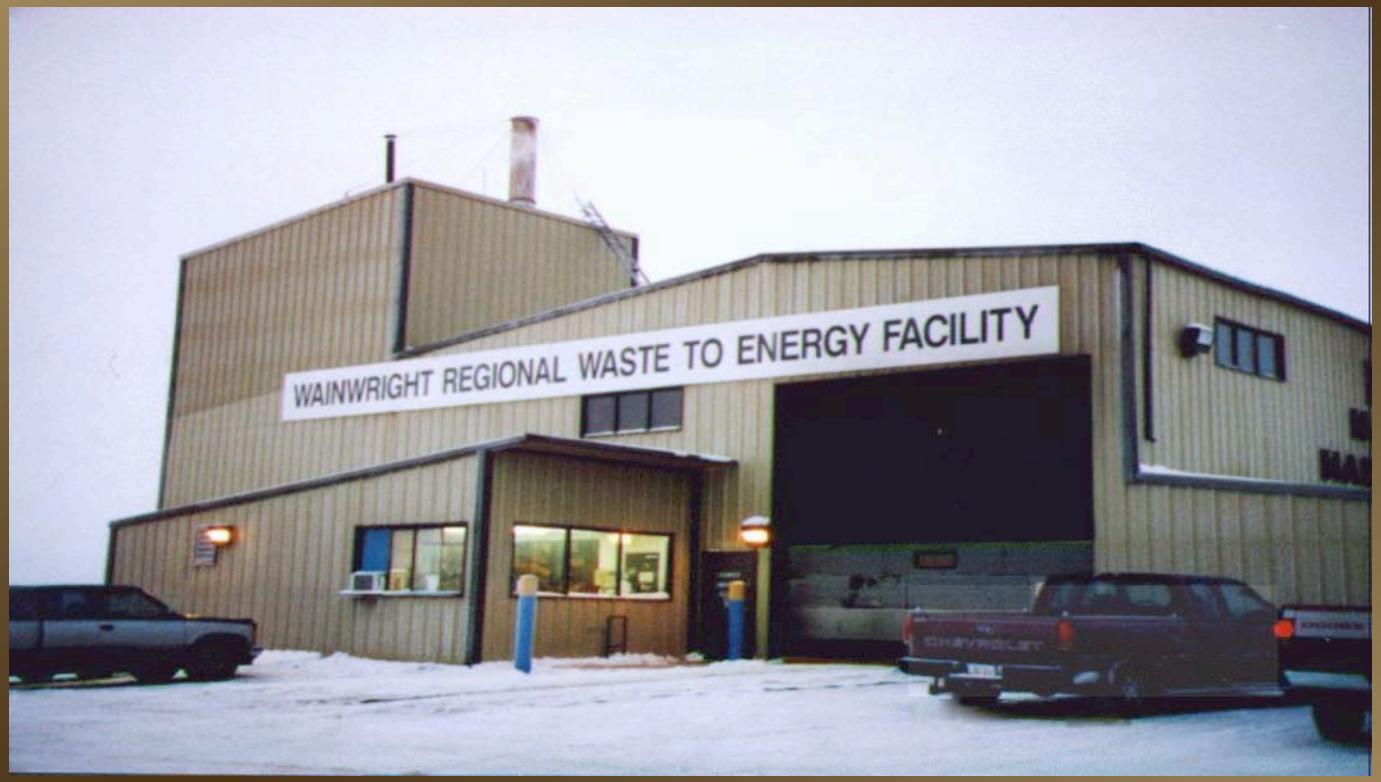
Composting maximized ✔

Residuals ?

Wainwright Modular Facility



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Composting maximized ✔

Residuals ?

Current use of thermal treatment

- In the USA:
  - 65 mass burn plants
    - 20 million tonnes per year capacity total
  - 9 modular and 10 RDF plants
    - About 5 million tonnes per year capacity
  - 13% of USA waste managed by WTE

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Composting maximized ✔

Residuals ?

Current use of thermal treatment

- In Europe:
  - More than 400 plants
    - 52+ million tonnes per year capacity total

Table below courtesy Sita

COUNTRY	% RECYCLED	% EFW	% LANDFILLED
Austria	44	18	32
Denmark	30	58	12
France	14	27	58
Germany	21	36	43
Netherlands	37	41	22
Sweden	32	35	33
Switzerland	39	47	14
UK	**15**	**9**	**78**

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Composting maximized ✔

Residuals ?

Future of thermal treatment

- Rising energy costs will make WTE attractive for power generation/heat utilization
- Increasing costs and environmental concerns with landfills will support WTE
- Energy recovery increasingly recognized as logical and integral part of WM process
- Waste increasingly recognized as renewable energy with GHG benefits
- European legislation supports WTE as opposed to landfilling

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Composting maximized ✔

Residuals ?

Future challenges of thermal treatment

- Education required to achieve a balanced public perception and acceptance
- Achieving greater technical efficiencies
- Finding markets for heat
- Reducing operating costs and increasing revenues from sale of energy
- Regionalization required to achieve economies of scale
- Regulatory and policy support needed
- Acceptance of WTE as renewable energy

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Composting maximized ✔

Residuals ?

Future design possibilities

- Example Vienna, Austria. Designed by famous artist Hunderwasser

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Residuals ?

SUMMARY OF EVALUATION CRITERIA FOR THERMAL TEATMENT TECHNOLOGY			
Criteria	**Population**		
	20,000	**80,000**	**200,000**
Facility Throughput (Tonnes)	6000	24,000	60,000
Major Design Features	Modular combustion technology. Air pollution control system. Heat recovery for steam is possible	Multi unit modular technology. Air pollution control system. Heat recovery for steam, questionable for electricity	Multi modular or fluidized bed technology. Air pollution control system. Heat recovery for steam and electricity
Commercial Status in Canada and elsewhere	Combustion well established/mature. Emerging technologies established	Combustion well established/mature. Emerging technologies established	Combustion well established/mature. Emerging technologies established

Recycling maximized ✔

Composting maximized ✔

Residuals ?

SUMMARY OF EVALUATION CRITERIA FOR THERMAL TEATMENT TECHNOLOGY			
Criteria	**Population**		
	20,000	**80,000**	**200,000**
Total Capital Cost ($1,000s)	$7,200 to $9,500	$29,000	$60,000
Total Operating Cost ($1,000s)	$1,600 - $900	$3,800	$6,500
Cost/Tonne Annualized ($)	$473 - $300	$267	$197
Footprint Size (ha)	0.4 – 0.6	1 – 2	2 - 3
Zoning Requirements	Generally industrial, plus local requirements	Generally industrial, plus local requirements	Generally industrial, plus local requirements

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Composting maximized ✔

Residuals ?

SUMMARY OF EVALUATION CRITERIA FOR THERMAL TEATMENT TECHNOLOGY

Criteria	Population		
	20,000	80,000	200,000
Approvals Required	Varies by province, in Ontario A7 Guidelines for air emissions	Varies by province, in Ontario A7 Guidelines for air emissions	Varies by province, in Ontario A7 Guidelines for air emissions
GHG Emissions	Low (840 Te $CO_{2)}$	Low (3400 Te $CO_{2)}$	Low, (8400 Te $CO_{2)}$
Energy Recovery Potential	Moderate 3MWh $_{Thermal}$	High 12,000MWh $_{el}$	High 30,000MWh $_{el}$
Potential Environmental Impacts	Some increase in air emissions, reduction in water and ground contamination. Fossil fuel offsets/GHG reduction compared to landfilling	Some increase in air emissions, reduction in water and ground contamination. Fossil fuel offsets/GHG reduction compared to landfilling	Some increase in air emissions, reduction in water and ground contamination. Fossil fuel offsets/GHG reduction compared to landfilling

Recycling maximized ✔ Composting maximized ✔ Residuals ?

SUMMARY OF EVALUATION CRITERIA FOR THERMAL TEATMENT TECHNOLOGY			
Criteria	**Population**		
	20,000	**80,000**	**200,000**
Quality of Processed Organics (if applicable)	NA	NA	NA
Public Acceptability	Low to medium	Low to medium	Low to medium
Potential Social Impacts	Local management of locally generated waste. Reduced truck traffic. Lower long-term liability. Smaller footprint than landfilling only.	Local management of locally generated waste. Reduced truck traffic. Lower long-term liability. Smaller footprint than landfilling only.	Local management of locally generated waste. Reduced truck traffic. Lower long-term liability. Smaller footprint than landfilling only.

Recycling maximized ✔

Composting maximized ✔

Residuals ?