Southern Alberta Alternative Energy Partnership

Industry Sponsor

Waste to Energy Treatment Alternatives In Southwest and South-Central Alberta

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Did You Know...
"*We have to rethink our idea of waste - rather than being something to put in a landfill, it is often something that can be transformed into a valuable resource*"
(Alberta Announces Long-Term Waste Strategy, 2007)

1.0 Executive Summary

The SouthGrow Regional Initiative, Economic Development Lethbridge and Alberta SouthWest Regional Alliance form the Southern Alberta Alternative Energy Partnership (SAAEP) Initiative. The SAAEP initiative represents 37 municipalities in the Southwest and South-Central Alberta region of the province. The objective of the SAAEP initiative is to facilitate the development of alternate energy systems and to attract corresponding businesses to the region.

In September 2007, a study was initiated by SAAEP to investigate energy recovery from wastes in Southwest and South-Central Alberta. The objectives of the study were to:

- Determine current situation with respect to waste management
- Investigate three identified energy recovery processes
- Review sizing and operational consideration

Lethbridge based Trimark Engineering was retained to conduct the energy recovery study. Information was obtained from waste generators, waste management operators and transporters and technology vendors. Data was also obtained from government sources at the municipal, provincial and federal levels.

Key findings of this report are:

- Most solid wastes generated in the region are landfilled as final disposal.
- Agricultural production and secondary processing operations produce high volumes of organic residuals. Most of these organic residuals are land applied for disposal and to enrich soil.
- The composition of the landfilled solid wastes includes materials that may be recovered, reused, composted or used as feedstock for energy recovery.
- The composition of the agricultural residuals includes materials that may be used as feedstock for energy recovery.
- Despite waste reduction initiatives, the quantity of solid waste entering the waste management system continues to increase year after year.
- Based on current trends, municipal costs associated with waste management will increase.
- The assessment of the total cost of waste management should consider factors including environmental, health and social costs.
- Implementation of material recovery, composting and energy recovery processes has the potential to reduce region landfill requirements by 80 to 90%.
- Energy recovery processes may recover up to 500 kWh of electricity per tonne of waste processed. The process may generate an equivalent amount of heat energy, which may be recovered.

- Energy recovery facility capital and operating costs are generally lower per tonne for larger, centralized facilities.
- The scope of this study included the investigation of three identified energy recovery technologies. These technologies consist of Fluid Bed Gasification, Pyrolysis / Thermal Gasification and Plasma Arc Gasification. Development of these technologies is at the pilot plant stage in Canada.
- The City of Edmonton and fifteen Central Alberta municipalities, including the County of Red Deer, are proceeding with energy recovery projects.
- Newer technologies include modular designs adaptable for both small and larger capacities.
- Some technology vendors provide project capital financing. Financing may be repaid from tipping fee revenues.

Key recommendations of this report are:

- Provide leadership to support and investigate energy recovery alternatives.
- Determine total cost of waste management alternatives.
- Conduct detailed investigation and verification of applicable technologies.
- Gain / promote support with the community and with municipal, provincial and federal governments through a communication strategy.
- Investigate cutting edge energy recovery technology and draw from the experience of the current energy recovery projects in Central Alberta.

Did You Know...?
"*At least 80% of material current sent to municipal landfills can be recovered.*"
(Too Good to Waste, 2007)

2.0 Introduction

Different types of waste are generated from many different sources. Alberta Environment defines five broad waste sectors (Too Good to Waste, 2007):

- Municipal solid waste
- Hazardous waste
- Oilfield waste
- Forestry residuals
- Agricultural residuals

As the population and economy grows, more waste is generated. Handling and disposal of the waste has adverse environmental, social and economic impacts within the SAAEP region:

- Waste negatively impacts landscapes and may pollute our waterways
- Waste is a significant contributor to air pollution and greenhouse gas production
- Hazardous wastes threaten health and safety
- Waste management costs continue to escalate

Presently, there is little incentive to reduce waste generation and disposal. Within Canada, Albertans generate more municipal solid waste per capita for disposal than the national average (Too Good to Waste, 2007).

Waste diversion programs like recycling are positive steps in waste management. Still, diversion programs fail to relieve our dependency on landfills as the disposal option of choice. Landfills present potential environmental harm and new landfills are costly and difficult to develop. Landfills continue to be the favoured waste disposal option for the following reasons (Too Good to Waste, 2007):

- The potential environmental, social and human health costs of producing, treating and disposing of wastes are not necessarily reflected in waste disposal fees; and
- Innovative, cost-effective waste reduction options tend to be developed only when waste disposal options become more limited.

As waste generation becomes more costly and disposal options become more limited, there is opportunity to consider alternate waste management options such as energy recovery.

As the most current available (2004) figures in Table 1 indicate, Alberta is below the national average in waste recycling and reuse:

Table 1 - Waste Diversion Rate by Province, 2004
(Waste diversion rate, 2007)

Province	% of total waste recycled or reused
NS	35.5
PE	34.8
BC	30.6
QC	25.7
NB	24.5
[Canada]	[23.7]
ON	22.5
MB	20.2
AB	19.6
SK	13.7
NL	8.1

The current waste management climate challenges us to live less wastefully. Waste reduction, re-using and recycling, known as the "Three Rs" (and with an addition: re-think/recover, the "Four Rs") continue to be viable waste management alternatives. It is important to note that in Alberta:

> More and more household wastes are being recycled. About 27% of residential waste was diverted away from landfill sites and incinerators in 2004, an increase of four percentage points from 2002. In 2004, 7.9 million tonnes of non-hazardous waste were recycled. Non-residential sources accounted for 54% of the materials prepared for recycling; households accounted for 46%. (Solid Waste: Managing our Garbage, 2007)

In order to facilitate the energy recovery assessment, a baseline of waste management profiles was investigated. Most of the recent available data for the SAAEP region and for Alberta was collected from 2004.

In 2004:

- Alberta municipalities paid $181,367,000.00 for waste disposal (Too Good to Waste, 2007)
- It cost each Albertan approximately $57.00 for waste disposal

In quantitative terms (Waste Reduction Week in Canada, 2007):

- Each person generates an average of 2.7 kg (5.95 lbs) of garbage each day.
- Canadians produce more than 31 million tonnes of garbage each year.

The SAAEP Initiative identified that there are serious waste management issues and opportunities. The study report identifies some of those issues and opportunities.

2.1 Study Format

This study provides information relating to energy recovery alternatives in the SAAEP region. Section 3 provides the current situational analysis including the waste management system and services in place in the region.

Section 4 provides information regarding identified waste to energy / energy recovery technologies.

Section 5 provides comparative information on the identified technologies, including comparisons of facility size options.

Section 6 provides siting and operational considerations. Conclusions and recommendations are provided in Section 7 and Section 8.

Section 9 provides supplemental information including a methodology overview, glossary, contact list of technology providers, SAAEP region map and population centres, SAAEP region landfill and waste authority list and copies of survey instruments.

References used during the study are listed in Section 10.

2.2 Waste to Energy and Energy Recovery Terminology

Within the waste management field, “waste to energy” is also referred to as “energy recovery”. This reference avoids the potentially negative perceptions relating to the word “waste”. Within the text of the report, the term “energy recovery” is used to describe the alternatives investigated with the scope of this study.

Did You Know...?
"*Environmental stewardship, at its heart, involves each of us caring for our land, air and water, and is a complex blend of ethics, awareness, education and action"*
(Too Good to Waste, 2007)

3.0 Current Situational Analysis

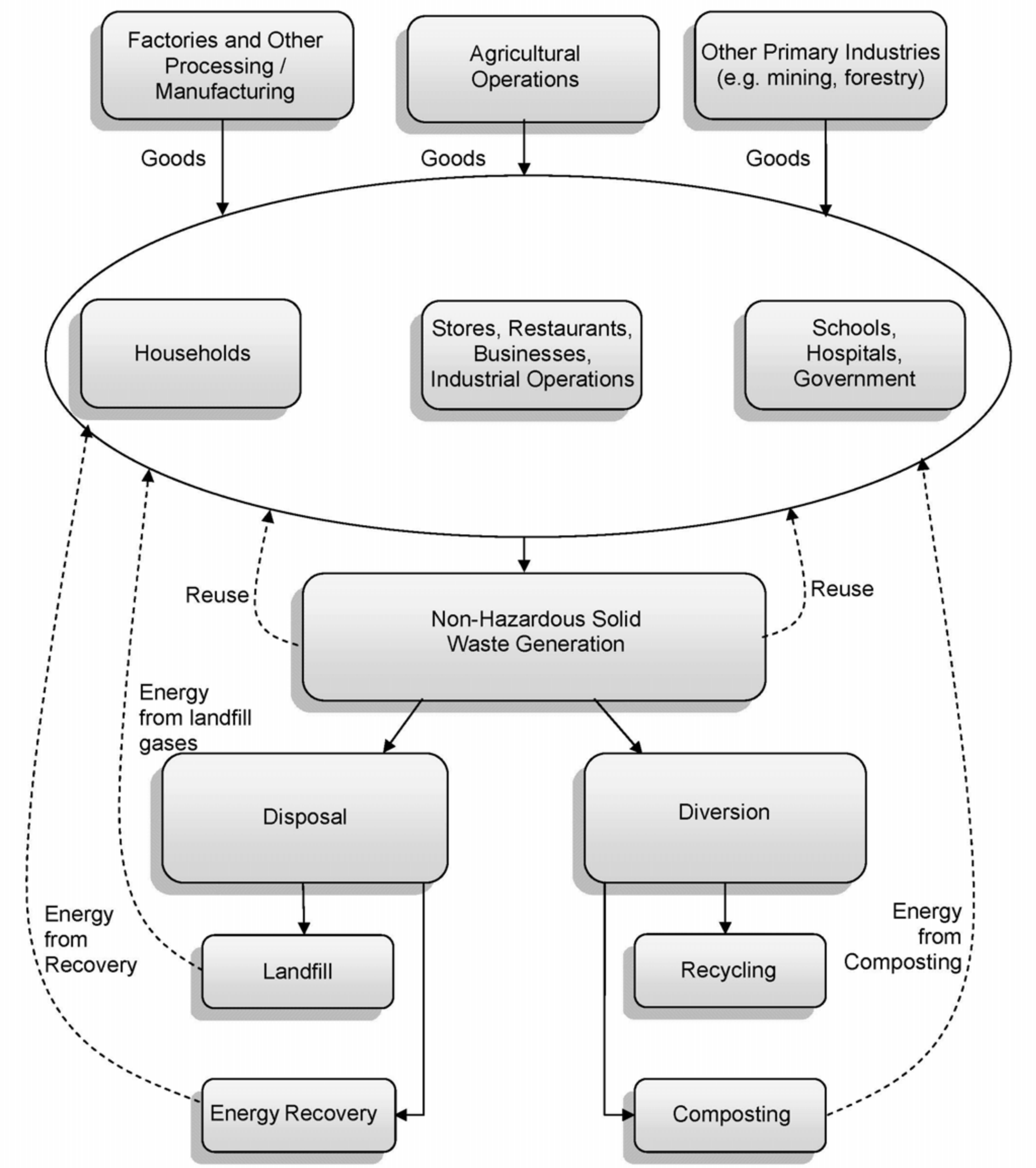
3.1 SAAEP Region Waste Management Structure

Within the SAAEP region waste is generated from economic activities including agriculture, industrial production, resource extraction, distribution and consumption. Non-hazardous solid waste is generated from the following sources (Statistics Canada, 2004):

- Residential—waste from primary and seasonal dwellings, including all single family, multi-family, high-rise and low-rise residences.
- Construction, renovation and demolition—includes materials such as concrete, brick, painted wood, rubble, drywall, metal, cardboard, doors, windows and wiring. It excludes materials from land clearing on areas not previously developed.
- Industrial, commercial and institutional—waste generated by commercial operations such as shopping centres, restaurants and offices; and institutional waste generated by schools, hospitals and government facilities.

Municipal Solid Waste (MSW) is waste managed by municipalities including waste from homes, businesses, institutions, commercial and construction activities. MSW does not typically include waste from industrial processes, biomedical or hazardous wastes. Across Canada, the handling of municipal waste is evolving at a rapid rate, with implementation of new technologies, recycling initiatives and increased sorting at source. Figure 1 illustrates solid waste flow streams across the economy.

Figure 1 - Solid Waste Flows
(Statistics Canada, 2005)



Previous to 1976, MSW and industrial, biomedical and hazardous wastes were directed to local municipal landfills in the SAAEP region, as well as throughout the rest of Alberta. In 1976, the Alberta government established the Waste Management Assistance Program. This program provided financial assistance to municipalities to develop regional waste management plans. The waste management plans included regional sanitary landfills, waste transfer stations and waste diversion facilities.

As a result of the Waste Management Assistance Program, regional waste management systems were established in the SAAEP region and most local landfills were closed or converted to transfer stations as new regional landfills were constructed. Responsibility for landfills was transferred from Alberta Health to Alberta Environment in the mid-1990s. Alberta Environment is now responsible for monitoring landfills within the Province. The decommissioned landfills contain all types of waste.

Currently, landfills that accept more than 10,000 tonnes of waste per year require an approval from Alberta Environment. Smaller landfills have reduced approval and reporting requirements.

The scope of this project included the investigation to utilize solid waste from the 37 municipalities in the SAAEP region as feedstock for an energy recovery facility. In order to economically justify such a facility, a consistent and reliable source of feedstock will be required. To determine the viability, size and capacity of an energy recovery facility, an investigation to assess the characteristics and quantity of the available feedstock waste materials was conducted.

The selection of energy recovery technology will impact feedstock requirements. In general terms, a feedstock suitable for energy recovery must contains a minimum calorific content, contain minimal contaminants and not create hazardous products during processing. Availability and cost of suitable feedstock are critical factors in the assessment of economic feasibility.

Waste may be simply defined as materials or by-products that are unwanted by the producer. Waste materials may include emissions to air and water, as well as solid waste that may be landfilled. Wastes may be hazardous or non-hazardous. The physical and chemical properties of waste materials differ. These differences impact the value of the waste as a feedstock for energy recovery.

3.2 SAAEP Region Waste Management Services

Typical waste management services consist of:

- Collection and transportation of waste and materials for recycling,
- Operation of non-hazardous and hazardous waste disposal facilities,
- Operation of transfer stations,
- Operation of recycling and composting facilities,
- Treatment of hazardous wastes.

Solid waste management services contain some or all of the following elements (Handbook of Solid Waste Management, 2002):

a) Waste generation
Unwanted materials and products enter the waste stream.

b) Waste handling, separation and storage at source
Waste and recyclable materials are sorted, placed in bags or containers, stored until collection and then transported to the collection point.

c) Collection, transfer and transport
Wastes and recyclable materials are collected from homes, businesses, institutions, industry and other locations, then taken to materials recovery facilities (MRFs), transferred onto larger vehicles at transfer stations or taken directly to disposal facilities.

d) Separation and processing
Commingled waste is separated, recyclables are recovered and separated waste is processed further at MRFs, transfer stations, energy recovery facilities, incinerators and landfills

e) Final disposal
Collected wastes are transported to landfills, energy recovery facilities and incinerators and disposed. Residual materials from MRFs and composting facilities, as well as ash from energy recovery and incineration are also disposed.

In the SAAEP region, the following solid waste management service elements are currently in place:

a) Waste generation
Residential, construction, renovation, demolition, industrial, commercial and institutional activities are all present in the region.

b) Waste handling, separation and storage at source
Municipalities in the region encourage residential recycling. Recycle facilities are available in most communities and at some rural transfer stations in the region. Recycle facilities may be publicly or privately operated (often operated by beverage container recyclers). Typical separation and collection types include: cardboard, clear glass, metal cans, mixed paper, numbered plastic and plastic bags. Some sites contain facilities to accept toxic waste and electronic waste. Toxic and E-Waste Round-Up programs are held in many communities on a periodic basis. Municipalities in the region also provide periodic collection of yard wastes or operate sites for the collection of yard wastes.

c) Collection, transfer and transport
Collection and transfer of recyclable materials to collection points are primarily the responsibility of the generator. Public and private waste management operators collect wastes from homes, businesses, institutions, industry and other locations. Wastes are then transferred to larger vehicles at transfer stations or taken directly to disposal locations.

d) Separation and processing
Most collection sites provide designated areas for special wastes and some recyclables. Typically, it is the responsibility of the transporter to sort to the designated areas. Designated sort areas are not uniform at all sites but usually include areas for appliances, electronic waste, batteries, tires, propane tanks, concrete and soil. No material recovery facilities are operated. No commingled waste is processed.

e) Final disposal
Disposal of solid wastes is by landfill.

In the SAAEP region, waste management is provided by two related systems, government / public institutions and private firms. Government and public institutions provide services through city, town, county, municipal district and regional waste commission entities. Private waste management firms are contracted by public institutions, private companies and individuals to provide services. For example, the City of Lethbridge contracts a private waste management firm to operate the region's largest landfill site, the Lethbridge Regional Landfill.

As within the rest of Canada, landfilling is the most common waste disposal practice in the SAAEP. As illustrated in Table 2, landfill facilities are the most common types of waste management facilities in Alberta.

Table 2 - Municipal Waste Management Facility Types in Alberta
(Municipal Waste, 2006)

Type of Waste Management Facility	Definition	No. of Facilities
Sanitary Landfill	Waste material is placed in trenches or on land, compacted by mechanical equipment and covered with earth	43
Regional Landfill	A sanitary landfill serving more than one community. One or more waste transfer stations may be associated with it.	25
Modified Sanitary Landfill	A waste management facility that, by reason of its location and intended purpose, is subject to less stringent operational requirements than a sanitary landfill	275
Dry Waste Site	Restricted to non-offensive classes of waste such as construction or demolition rubble	19
Waste Transfer Station	Specially designated drop-off depots from which waste is collected and transported to a regional landfill	200
Waste Sorting/Processing Station	Waste transfer station where waste is compacted, shredded, ground, sorted or otherwise processed before proceeding to landfill, storage or recycling	19
Waste Storage Station	A facility established to store one or more specific materials where there is an intended use for the material	6
Waste-To-Energy Incinerator	A facility designed for municipal waste having state-of-the-art combustion and waste heat recovery	1

Sanitary Landfill (landfill)
(Solid Waste as a Resource, 2004)

A landfill is a facility in which solid wastes are disposed in a manner that limits the impact of the waste on the environment. Landfills consist of a complex system of interrelated components and sub-systems that act together to break down and stabilize disposed wastes over time. Wide variations in approaches are undertaken for landfill disposal of wastes.

The following lists some of the key factors taken into consideration in the siting and design of contemporary non-hazardous waste landfills:

- Site setting: geology, land use, local impact potential - groundwater, surface water, noise, traffic, dust, visual impacts, odour, air quality
- Public consultation
- Hydrogeology and groundwater protection: natural attenuation capacity
- Ecology
- Site design: disposal capacity, soils balance, configuration, site infrastructure needs
- Leachate containment and collection systems
- Leachate treatment/disposal requirements
- Storm water management and landfill gas collection
- Daily, interim cover materials
- Environmental monitoring and performance
- Operational and maintenance protocols
- Health and safety
- Cap systems closure and end-use
- Post-closure management

Landfills cells are constructed either by excavation below ground surface or by construction of cell containment berms on the selected site. Once the cell is prepared in accordance with design requirements, wastes are placed and compacted into the landfill cell and are generally covered with soil or other alternative cover material at the end of each day of operation. The use of soil or other cover material serves to reduce windblown litter, limits odours and prevents scavenging and burrowing by animals and insects. Waste filling progresses in this manner, until final grades are achieved.

Groundwater protection priorities may be addressed by the natural attenuation characteristics of a site, use of leachate collection systems and / or the use of leachate containment systems.

Landfill gas, composed primarily of methane, carbon dioxide and trace organic compounds, is produced by the decomposition of wastes placed in a landfill. At some sites, emissions of landfill gas to the atmosphere can raise concerns related to odours, air quality and potential adverse health effects. Landfill gas is also a potent greenhouse gas contributing to global climate change. Migration of landfill gas into the soil surrounding a site has the potential to create safety and health concerns, particularly if allowed to accumulate at explosive concentrations within enclosed or low lying spaces.

In the SAAEP region, solid wastes are managed according to the source of the waste and the type of materials. Wastes produced from primary production, including agriculture, forestry and mining, are typically managed by these industries. Manure wastes from the feedlot industry are often applied to the land. Industrial wastes from many production activities, including food processing and fabrication, are contracted to private waste management firms. Private waste management firms also typically manage wastes generated from commercial activities. In the region, some industrial and commercial wastes are diverted to other uses such as rendering or solvent recycling, however much of this waste is directed to municipal managed systems (landfill).

Throughout the region, municipalities have identified minimizing the amount of waste channelled to disposal as a priority. Provincial and federal government programs are in place to encourage and support manufacturers to implement processes that will produce less waste. Opportunities exist for the recycling of certain materials that may be otherwise placed in landfills.

Many government programs and non-profit organizations actively promote waste reduction at source and improved waste handling and recycling activities. The Canadian Council of Ministers of the Environment has established waste reduction targets and supported the reduction of packaging materials. It is expected that industrial, commercial and residential generators of waste will continue to identify and implement waste reduction strategies. It is further expected that additional opportunities for recycling will become available (for example a deposit on milk containers in Alberta has been proposed).

Despite a significant emphasis to reduce and divert wastes, a significant decrease in waste received at landfills in the SAAEP region is not likely to occur. Many factors affect waste production. It is generally recognized that Alberta’s economic growth will continue to lead the nation. This will be reflected in the SAAEP region with increased population and prosperity. As the population of the region increases, total waste production increases. Economic growth and general improvement in the region’s prosperity translates into higher incomes and increased consumption. Increased consumption leads to increased waste. These factors are internationally recognized and have influenced the Organization of Economic Co-operation and Development to recommend that national environmental policies set the goal of decoupling waste generation from economic growth. Despite this goal, increases in an area’s gross domestic product currently correlates to a corresponding increase in waste generated. (Towards Waste Prevention 2004)

3.3 Waste Locations and Quantities

3.3.1 Locations and Quantities

Solid wastes are generated at sources throughout the SAAEP region and transported to landfill facilities (via transfer stations or directly). There are currently four active landfill facilities operating within the SAAEP region. These landfill facilities are located at Lethbridge, Chief Mountain, Crowsnest Pass and Willow Creek. The following Table 3 provides waste quantities generated within the SAAEP region and transported to landfills in the SAAEP region for 2006.

Table 3 - Waste Quantities Generated within the SAAEP Region and Transported to Landfills in the SAAEP Region for 2006

Waste Authority	Waste to Landfill (tonnes)	Percentage
City of Lethbridge	99,000	47.6
Chief Mountain	10,000	4.8
Crowsnest-Pincher Creek	41,500	20.0
Lethbridge Regional	11,000	5.3
Taber and District	22,000	10.6
Vulcan District	3,000	1.4
Willow Creek Regional	6,500	3.1
Unclassified	15,000	7.2
SAAEP Region Total	**208,000**	**100.0**
Diverted to Recycle or Reuse from Landfill site	(16,500)	
Estimated Landfill	**191,500**	

Note: In 2006, 10,000 tonnes of waste from outside of the SAAEP region (including East Kootenay, BC and the Siksika Nation) were transported to the SAAEP region for disposal. Waste quantities from outside the region are excluded from the above quantities.

The total amount of non-hazardous waste and non-residential solid waste generated in the SAAEP region and subsequently disposed of in SAAEP waste disposal facilities (not including waste disposed of in hazardous waste disposal facilities, or waste managed by the waste generator on site) in 2006 was 191,500 tonnes or 1,160 kg (2,557 lb.) per capita.

3.3.2 Trends in Waste Quantities

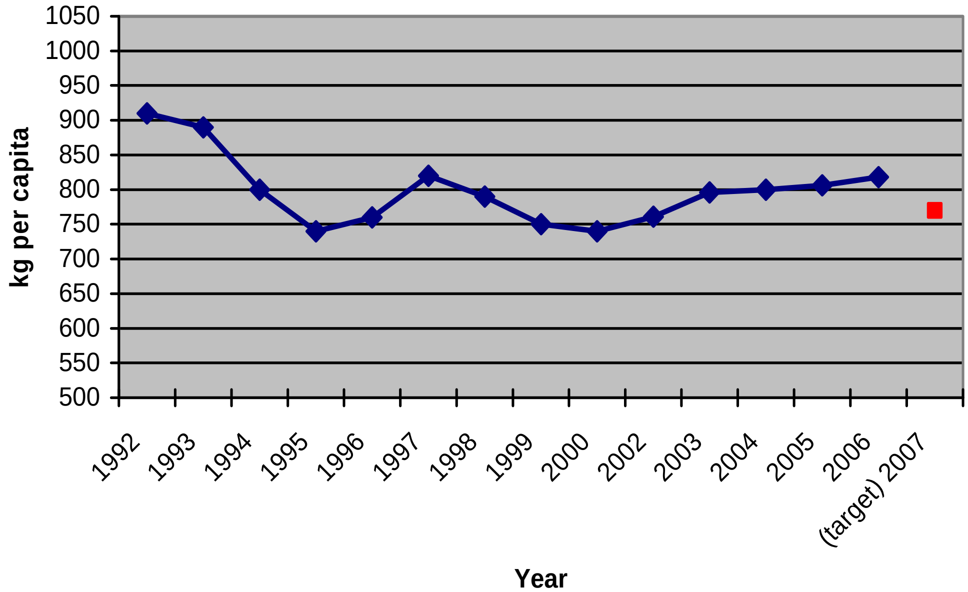
Canada ranks among the highest producers of solid waste per capita in the industrialized world (Landfills and Waste Disposal, 2007).

In 1989, the Canadian Council of Ministers of the Environment set a nationwide goal of a 50-percent reduction from 1988 levels in the per capita weight of municipal solid waste by the year 2000. Alberta adopted this goal and implemented the Action on Waste program to encourage municipalities to adopt measures to reduce the waste sent to landfills. Between 1988 and 1999, the reduction in municipal waste was only 14 percent. Alberta's current goal is to decrease the amount of material sent to landfills to 500 kg per capita by the year 2010.

Solid waste in landfills includes MSW and non-residential solid wastes.

MSW disposed in Alberta landfills increased from 740 kg per capita in 2000 to 818 kg per capita in 2006. The increase is a reflection of Alberta's continued robust economy and population growth. The following graph illustrates that a per capita reduction of solid wastes to landfills has not occurred. The trend from 2000 indicates an increase.

Figure 2 - Alberta MSW to Landfills (Alberta Environment's Performance (Measures and Indicators, April 2002 and Measure Up, 2006-2007)



When all non-hazardous wastes including non-residential solid wastes are added to the MSW totals, it is estimated that 1,025 kg per capita were generated in Alberta in 2006 (in the SAAEP region, an estimated 1,160 kg per capita).

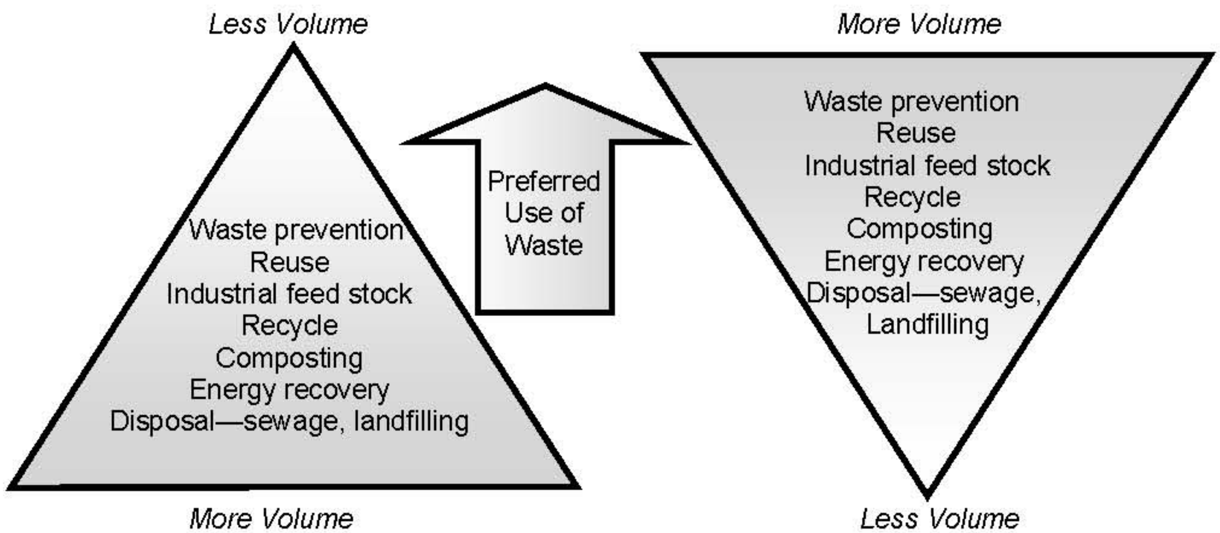
Based on the current trend, it is anticipated that the Alberta 2010 solid waste disposal target will not be achieved. The quantities of solid waste entering the SAAEP region waste management system for either disposal by landfill or an alternate use will not be reduced significantly in the near future.

3.4 Waste Types

3.4.1 Definitions and Classifications of Waste Types

The Use Hierarchy of waste or residue products takes into account both the highest use for the material from resource conservation and / or social perspective as well as the net cost of the processing options. The hierarchy for waste / residue diversion from most preferable to least preferable, based on these criteria, is illustrated as follows:

Figure 3 - Use Hierarchy



Limitations posed by the type, quantity, quality and location of a particular waste material may eliminate the possibility of one or more of the diversion options in the hierarchy. For example, if waste is not in a form that permits composting, then that strategy is not a viable option.

While the waste from each generator is unique, it is possible to analyse and determine the value for potential uses. Moisture (or solids) content, calorific value, quantity, geographic location, potential for contaminants and physical properties affect the value of waste.

The detail of analysis will be dictated by the requirements of the selected technology for energy recovery. Attributes may be quantified for each waste product of a multiple waste stream generating facility. A list of common attributes is provided below for reference:

a) Parent material(s) or source(s)

b) Mass flow
   - Average
   - Maximum
   - Minimum
   - Seasonal trends

c) Value / cost
   - Per unit mass
   - Per unit dry mass

d) Physical properties
   - State(s) liquid, solid
   - % Moisture or % solids, as applicable
   - Bulk density
   - Temperature from process
   - Freezing point
   - Flash point
   - Specific heat
   - Viscosity
   - Particle size
   - Multi-phase description (settling, homogenous, etc)
   - Flammable
   - Free-flowing
   - Other

e) Nutritional composition
   - Fat
   - Protein / bypass protein
   - Energy
   - Fibre

f) Chemical composition
   - Carbon
   - Nitrogen
   - Phosphorus
   - Potassium
   - Sulphur
   - Trace elements

g) Hazards
  - Heavy metals
  - Presence of sanitation chemicals
  - Presence of lubrication chemicals
  - Presence of foreign matter contamination (metal, soil, machine parts, plastic, etc)
  - Potential pathogens

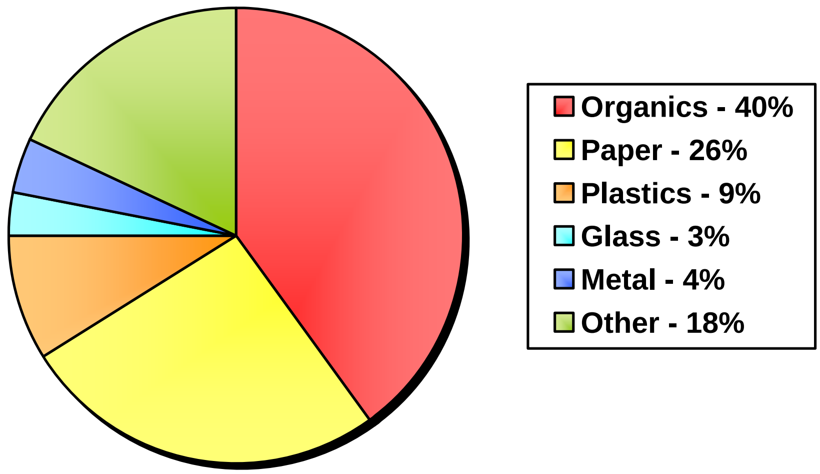
h) Other properties
  - Certified organic
  - Location

Limitations posed by the type, quantity, quality and location of a particular waste material may eliminate the possibility of one or more of the diversion options in the hierarchy. For example, if waste is not in a form that is edible for animals, then that strategy is not a viable option.

Household sources accounted for 39% of total waste generation in 2002. Industrial, commercial and institutional waste generators and construction, renovation and demolition projects accounted for the balance. Canadian households generated 12 million tonnes of waste in 2002, or 383 kg per capita. This represented an increase of 4.9% over the previous year.

The composition of solid waste by weight, generated by households is provided in Figure 4. By weight, organic materials originating from kitchens and yards make up the largest component of household waste. Newspapers and other paper fibres make up the second highest portion.

Figure 4 - Composition of Solid Waste by Weight, Generated by Households, Canada 2002
(Statistics Canada, Environment Accounts and Statistics Division 2005)



"Other" includes animal waste, textiles, tires, inorganic materials, hazardous materials, household hygiene materials, fines and wood.

The waste composition from the Industrial Commercial and & Institutional (IC&I) sector will vary from one commercial sector or industry to another. Within each sector, the waste composition will depend largely on what products are being manufactured. For example, waste from an electronics manufacturer will have more plastics, metal and paper than waste from a furniture manufacturer, which will contain more wood. Similarly, waste from different retail establishments will vary.

Restaurants and retail food establishments generate organic material waste. Some materials, like cardboard packaging, are common to virtually all IC&I facilities. Apart from packaging materials, most waste from the manufacturing sector consists of leftover or ends of materials that were originally purchased as raw materials for the manufacturing process. This waste represents both a cost for the original purchase of raw materials and a cost for disposal. Efficient business practices and lean manufacturing techniques will minimize this waste. Principal waste generators in the SAAEP region may be categorized by material type generated. This information is provided in Table 4.

Table 4 - Principal Waste Generators
(Municipal Waste, 2007)

Material Type	Generator
Paper (Mixed Waste)	households, schools, small business
Paper (Old Corrugated Cardboard)	grocery stores, shopping malls, warehouses, restaurants, construction sites
Paper (Old Newspaper)	households, printing companies, offices
Paper (High Grades)	office buildings, small business
Plastics	households, warehouses, hospitals, restaurants, retailers, grocery stores
MSW Metals	households, restaurants, small business, construction and demolition activity, farms
Glass	households, restaurants, retail and grocery stores, window manufacturers, bottlers, breweries, window repair shops
Concrete	construction/demolition activity, highway reconstruction, sidewalk, gutter and curb repair
Asphalt	demolition activity, pavement repair and reconstruction
Wood	construction/demolition activity, pallet users
Organics	households, hospitals, restaurants, hotels, correctional facilities, grocery/food retail and warehouses, lawn and garden services

The composition of solid wastes landfilled at region landfills is provided in Table 5.

Table 5 - Composition of Solid Wastes Landfilled at SAAEP Region Landfills, by Weight, 2006

Material Type	Weight (tonnes)	Percentage
Mixed Solid Waste	112,900	59.0
Meat Processing Waste	4,600	2.4
Yard / Agricultural Organics	2,600	1.4
Industrial Processing Waste	9,800	5.1
Paint Solids	100	0.1
Biosolids, other sludge	3,200	1.7
Clay	4,100	2.1
Wood	8,900	4.7
Concrete	2,500	1.3
Asphalt	6,200	3.2
Shingles	4,500	2.3
Metal	600	0.3
Contaminated Soil, Clean Fill, Casting Sand	31,100	16.2
Special / Other Wastes	400	0.2
TOTAL	**191,500**	**100.0%**

Hazardous wastes including biomedical wastes and agricultural specified risk material (SRM) require separate consideration as feedstock for energy recovery. Incineration of hazardous waste is a viable and environmentally sound treatment option.

The volume of hazardous waste is greatly reduced by incineration. Toxic compounds are converted into less harmful compounds by incineration. The incineration performance of energy recovery technologies may be reliably predicted and measured. The high temperatures attained by certain energy recovery technologies may provide sufficient thermal decomposition in a highly oxidative environment to decompose organic molecules into simple compounds, predominantly carbon dioxide and water. A necessary property of the waste material is that it is combustible. The incineration of organic compounds is well understood and the end result may be predicted by basic thermodynamic concepts.

Operational, regulatory and cost requirements and related risk factors for a hazardous material treatment facility are significantly more onerous than for an energy recovery facility. Higher capital and operating costs will result from including provisions for hazardous material treatment in an energy recovery facility. Potential concerns regarding the safety of incineration of hazardous materials may mitigate against public support for such a facility. The City of Edmonton determined not to include provisions for incineration of hazardous wastes in the planning for their proposed energy recovery gasification project due to the above factors.

3.4.2 Hazardous Waste

Hazardous wastes are generated in the SAAEP region. If not disposed of correctly, cleaners, solvents, pesticides, paints and other toxic material may contaminate a landfill, leak into the ground water or contaminate rivers resulting in a public health risk. For these reasons, landfills that accept hazardous wastes require an Alberta Environment approval. Accepted options for the treatment of hazardous waste includes biological treatment, chemical oxidation and reduction, neutralisation, stabilisation, incineration and energy recovery prior to landfill. Currently, most hazardous wastes generated in the region are exported out of the region for disposal.

Private companies provide hazardous waste collection, transport and disposal services. Available services for management of hazardous waste include chemical, radioactive and biohazard waste. Two facilities within the SAAEP region are approved under the Environmental Protection and Enhancement Act (Industrial and Hazardous Waste, 2007) to manage hazardous waste and hazardous recyclables. The facilities are:

- DBS Environmental, Lethbridge
- Newalta Corporation, Raymond

3.4.3 Agricultural Wastes

The SAAEP region has some of the largest confined feedlot operations in Canada and a number of small and medium size meat processing facilities. Agricultural production and processing facilities produce high volumes of organic residuals including manure, straw and livestock processing waste.

The disposal of livestock waste associated with cattle, swine, and poultry farming, occurs throughout the region. Areas of the SAAEP region produce over 2,000 kg of manure per hectare of land. The primary contaminants associated with manure include nitrate and ammonia, coliform bacteria, phosphorus, endocrine disrupters and other animal pharmaceuticals. Both the land use and waste management practices commonly employed on farms throughout Canada have impaired the quality of water resources on a regional basis.

Agricultural Specified Risk Material

Bovine spongiform encephalopathy (BSE), commonly known as mad cow disease, is spread when cattle consume feed products contaminated with certain proteins from infected animals.

In infected cattle, BSE concentrates in certain tissues, collectively known as Specified Risk Material (SRM). For public health protection, these tissues are removed from all cattle slaughtered for human consumption. To prevent BSE spread among cattle, the Government of Canada banned most proteins, including SRM, from cattle feed in 1997.

In July 12, 2007, enhanced animal health safeguards came into effect to help eliminate BSE from Canada. SRM must be handled, transported and disposed of under a permit issued by the Canadian Food Inspection Agency (CFIA). This permit control system is intended to ensure that SRM is monitored and does not enter the animal feed system.

Any waste management facility choosing to accept SRM in any form must first apply to the CFIA for a permit. There are specific construction and operating requirements for facilities handling this material.

Disposal procedures must prove to either destroy (deactivate prions) or permanently contain all SRM waste. Proposed disposal procedures must be approved by the CFIA.

The CFIA has determined that SRM incineration may be conducted in a manner that presents a negligible risk of transmission of BSE to domestic ruminants. Based on that risk assessment, the CFIA will issue an approval to incinerators that meet specified standards for handling, storage and incineration. Out put from approved incinerators is not regulated by SRM controls (Bovine Spongiform Encephalopathy Manual of Procedures, 2007).

Permits will be issued only after a CFIA inspector has determined that all requirements have been met.

A CFIA permit is also required to transport any SRM, including cattle carcasses containing SRM. A visible stripe must be applied on the carcass and all SRM must be stained. Waste management facilities must not accept cattle deadstock or SRM in any form from anyone not possessing a CFIA permit. (Enhanced Animal Health Protection from BSE Requirements for Disposing of Cattle Material, 2007)

The transportation of hazardous wastes is subject to the regulations set out in the federal Transportation of Dangerous Goods Control Act. The Act specifies that only workers trained to the requirements of the Act may be responsible for transporting and handling these materials.

3.5 Waste Treatment Practices and Costs

3.5.1 Treatment Practices

In Canada, there is significant variability between provinces in waste disposal, diversion and generation. The following table illustrates that in 2000 on a per capita basis, Alberta generated more waste than national average. In that year, on a per capita basis, Alberta also diverted less waste from disposal to reuse and recycle than the national average. The most currently available diversion figures (2004) show that Alberta's relative position remains unchanged.

Table 6 - Waste Disposal, Diversion and Generation Per Capita, All Sources, by Provinces and Territories
(Statistics Canada, 2004)

	2000			
	Disposal 1	Diversion 2	Generation 3	Rate of diversion per capita
	kg per capita			%
Canada	**746**	**244**	**1,019**	**24**
Newfoundland and Labrador	762	80	841	10
Prince Edward Island	x	x	x	x
Nova Scotia	459	155	613	25
New Brunswick	625	152	749	20
Quebec[4]	936	375	1,312	29
Ontario	640	203	924	22
Manitoba	819	188	1,007	19
Saskatchewan	811	263	1,074	25
Alberta	914	140	1,035	14
British Columbia	638	278	921	30
Yukon, Northwest Territories and Nunavut	x	x	x	x
Canada	**746**	**244**	**1,019**	**24**

x: suppressed to meet the confidentiality requirements of the Statistics Act
Note: Figures may not add up to totals due to rounding.
1. Total amount of non-hazardous waste disposed of in public and private waste disposal facilities. Does not include waste disposed of in hazardous waste disposal facilities nor waste managed by the waste generator on site.
2. Diversion represents the quantity of non-hazardous materials diverted from disposal facilities and represents the sum of all materials processed for recycling or reuse at an off-site recycling facility.
3. Total generation is the sum of total non-hazardous residential and non-residential solid waste disposed of in an off-site disposal facility and total materials processed for recycling at an off-site recycling facility plus net exports. Since this figure includes net exports, disposal added to diversion will not equal generation. Note that these data only include those materials that are managed (disposed of or recycled) off-site by a municipality or waste management firm.
4. Figures are derived from the results of surveys conducted by the province.

In the SAAEP region, the source and type of waste determines management practices. In the region, non-hazardous solid waste may be managed by local government, private waste management firms or on-site by the waste generator. Within the region, the common solid waste management practices include landfill, recycle, compost / mulch and export to outside the region.

Alberta Environment has developed guidelines to enable waste disposal agencies, including industry, to select acceptable waste management options. The guidelines use national and international waste identification and classification codes to categorise wastes and handling options. Waste types are categorised and management options for each type are provided. Disposal operations and recovery options permitted by the guidelines are provided in Table 7.

Table 7 - Disposal and Recovery Operations
(Industrial Waste Identification And Management Options, 1966)

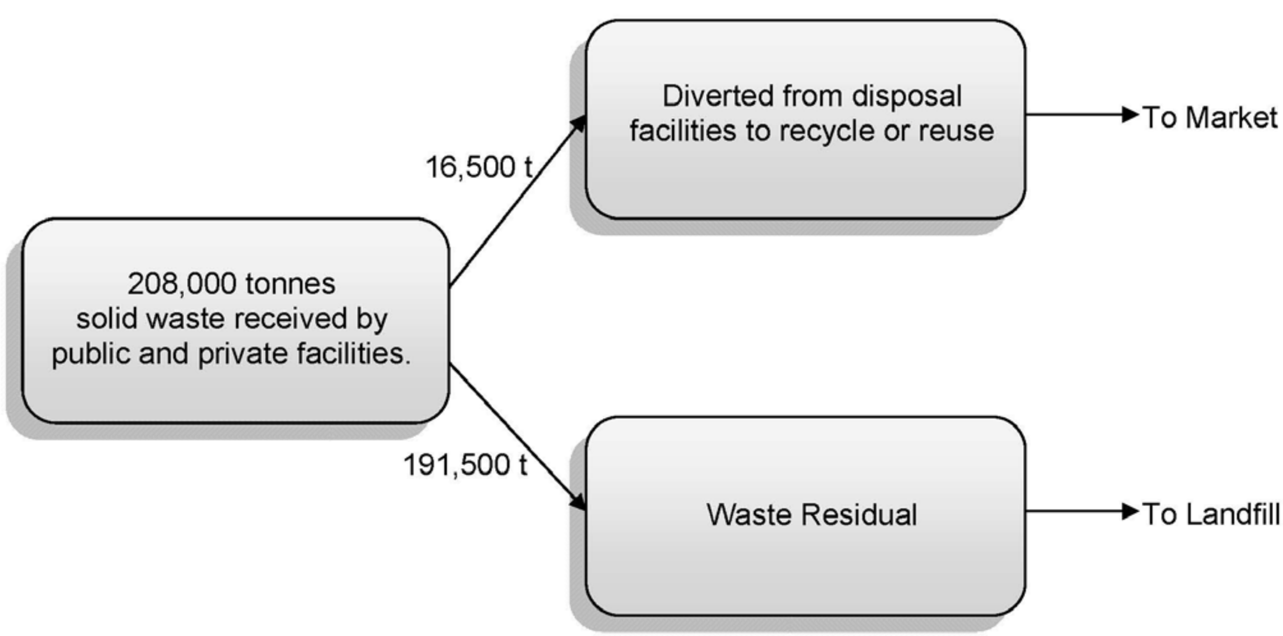
Section A: Operations which do not lead to the possibility of resource recovery, recycling, reclamation, direct reuse or alternate uses:	
Disposal Code	**Typical Disposal Operations**
D1	Deposit into or onto land (i.e., approved landfill, etc.).
D2	Land treatment (i.e., biodegradation of liquid or sludgy discards in soils, etc.).
D3	Deep well injection (i.e., injection of waste fluids and pumpable discards into suitable subsurface reservoirs, caverns, salt domes, etc.).
D4	Surface impoundment, such as placing liquids or sludges into pits, ponds or lagoons.
D5	Specially engineered landfill (i.e., placement into lined discrete cells which are capped and isolated from one another and the environment, etc.).
D6	Release into a water body excluding seas/oceans.
D8	Biological treatment which results in final compounds or mixtures which are discarded by means of any of the operations in this section.
D9	Physico-chemical treatment which results in final compounds or mixtures which are discarded by means of any of the operations in this section (i.e., evaporation, drying, calcination, thermal desorption, neutralization, precipitation, solidification, etc.).
D10	Incineration on land:
D10.1	High temperature incineration with DRE $ 99.99% for nonhalogenated wastes.
D10.2	High temperature Incineration with DRE $ 99.9999% for halogenated wastes.
D12	Permanent storage, such as emplacement of containers in a mine.
D13	Blending or mixing prior to submission to any of the operations in this section.
D14	Repacking prior to submission to any of the operations in this section.
D15	Storage pending any of the operations in this section.

Table 7 Continued - Disposal and Recovery Operations

Section B: Operations which may lead to resource recovery, recycling, reclamation, direct reuse or alternate uses	
Recovery Code	**Typical Recovery Operations**
R1	Use as a fuel (other than in direct incineration) or other means to generate energy.
R2	Solvent reclamation/regeneration.
R3	Recycling/reclamation of organic substances that are not used as solvents.
R4	Recycling/reclamation of metals and metal compounds.
R5	Recycling/reclamation of other inorganic compounds.
R7	Recovery of components used for pollution abatement.
R8	Recovery of components from catalysts.
R9	Used oil re-refining or other reuses of previously used oil.
R10	Land treatment resulting in benefit to agriculture or ecological improvement.
R12	Exchange of wastes for submission to any of the operations number R1 through R10.
R13	Accumulation of material intended for any operation in this section.

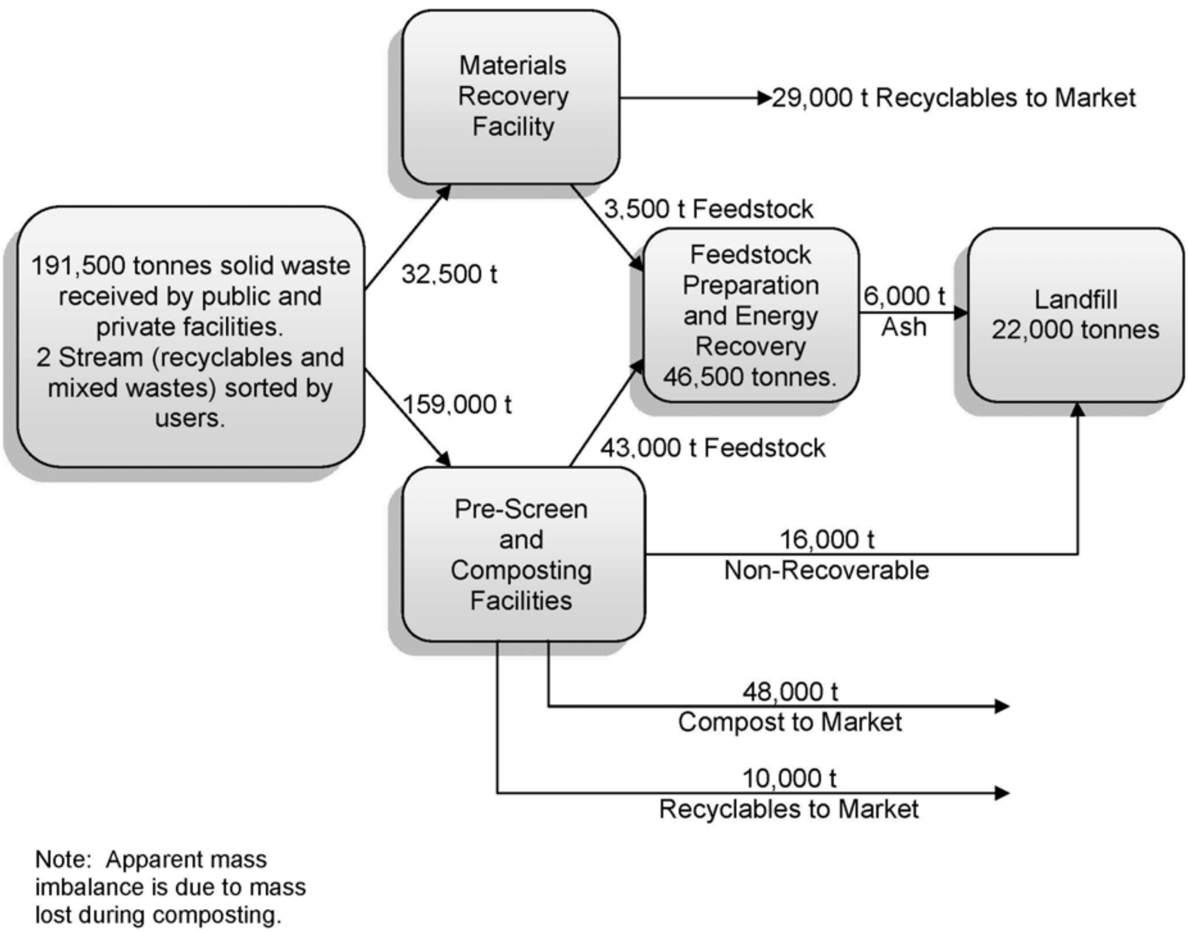
The management model for waste management in the SAAEP region is illustrated in Figure 5.

Figure 5 - SAAEP Region Solid Waste Model (Current)



The adoption of an alternate waste management model has the potential to make a dramatic impact in the outputs of the model. For example, Figure 6 illustrates model outputs that may be achieved by the addition of alternate elements. In this example, the alternate elements are materials recovery, composting and energy recovery (by gasification). Note that each of these elements is available in a range of costs, options, levels of automation and levels of performance. Selection of equipment and processes will determine the actual output of the model. Figure 6 is provided below as an example of what may be achieved.

Figure 6 - SAAEP Region Solid Waste Model with Diversion to Materials Recovery Facility, Compost Facility and Energy Recovery (Gasification)



3.5.2 Agricultural Waste Residuals

Current management practices involve the temporary storage of raw manure in open barnyards, earthen lagoons or concrete tanks. Manure is subsequently spread on cultivated fields at different times of the year as a method of final disposal. Surface runoff from barnyards and storage facilities may lead to direct release into surface water and groundwater.

Manure is a potential feedstock for energy recovery, compost or fertilizer.

Straw residues are also typically returned to the land.

3.5.3 Treatment Costs

In the SAAEP region, most households receive some level of solid waste-management collection service, such as garbage, recyclables and garden waste pickups, typically provided by the local municipality. The collection service is typically provided using municipal staff. The level of service varies by municipality, depending on local circumstances. Region municipal districts and counties provide drop-off collection service directly or with regional waste management authorities. Residential waste management services typically cost $150.00 to $250.00 per household a year in Canada (Taking Out the Trash, 2005).

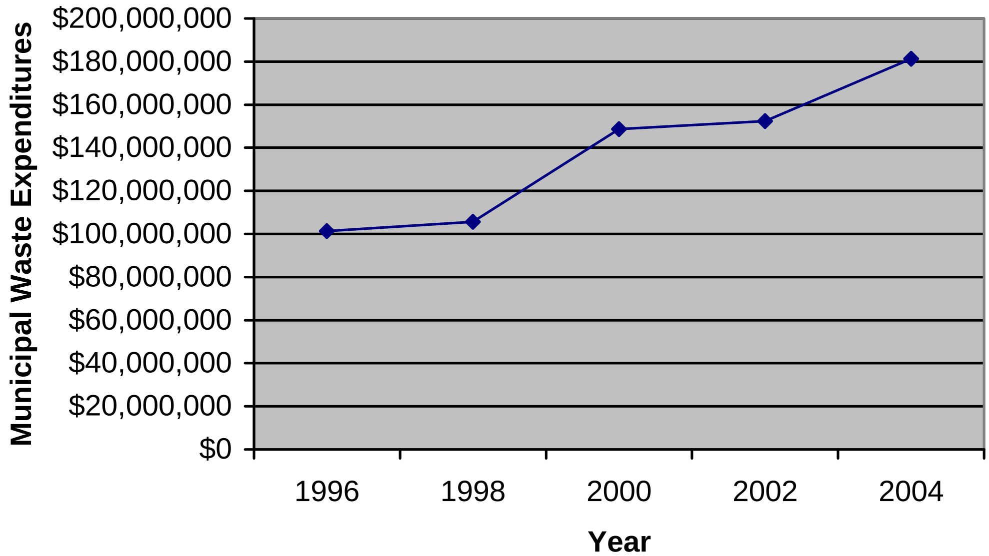
Property taxes have traditionally financed residential waste management costs in Canada. Financing residential waste management services from property tax revenue leads to inequities and cross subsidization because commercial and industrial property owners typically do not receive waste collection service.

Under the traditional property tax arrangement, the costs of waste management are buried along with the costs of other services, such as police and ambulance services.

Currently, municipalities in the SAAEP region finance waste management programs though property taxes and a combination of tipping fees at transfer and landfill facilities, utility fees, pay-per-use pricing mechanisms and recycling revenues.

Expenditures related to managing wastes are increasing and that trend is expected to continue. As indicated in the following Figure 7, Alberta municipalities increased waste related expenditures by nearly 80% between 1996 and 2004.

Figure 7 - Municipal Waste Expenditures
(Statistics Canada, 2005)



Costs per capita to manage municipal waste in Alberta increased by nearly 50% between 1996 and 2004.

Year	Municipal Waste Management Expenditures Per Capita
1996	$37.60
2000	$51.70
2004	$56.30

Costs per tonne to dispose of municipal waste in Alberta also increased by nearly 50% between 1996 and 2004.

Year	Municipal Waste Disposal Expenditures per Tonne
1996	$49.40
2000	$69.50
2004	$70.30

Within the SAAEP region, landfill tipping fees charged to users for varies between region municipalities. Some municipalities provide facilities for the disposal of household mixed wastes and other wastes at collection sites with no user fee. Other municipalities structure user fees to approximately equal waste related expenditures.

For municipalities and regional waste management organizations that charge landfill tipping fees, $40.00 per tonne is the average fee charged for mixed solid wastes and construction and demolition wastes. Fees for clean fill, concrete, contaminated soil and household appliances are typically lower. Fees for Special Wastes including asbestos, sludge, animal processing and industrial wastes are typically higher.

Determining accurate costs for managing wastes requires detailed analysis, beyond reviewing annual expenditures. A full cost analysis of a waste management system must include the environmental, health and social costs, both in monetary and non-monetary terms. The full cost analysis must assign values to environmental, health and social considerations that may not be actually charged but are still real. The release of greenhouse gases or the depletion of non-renewable resources are examples of non-monetary impacts that must be taken into account (A Full Cost Analysis Guide, 1995). While beyond the scope of this study, full cost analysis is recommended for costing waste management options.

Did You Know...
"*Thermal treatment is a term given to any waste treatment technology that involves high temperatures in the processing of the waste feedstock.*"
(Wikipedia, 2007)

4.0 Current Waste Management Technologies

There are different methods and technologies available to process waste, and in particular municipal solid waste, in order to conserve resources, minimize environmental impacts, reduce greenhouse gas emissions, produce energy, lessen dependence on landfills and improve social acceptability.

Organics management and residual treatment / disposal options include:

- Waste composting
- Anaerobic digestion
- Sanitary landfill
- Bioreactor landfill
- Thermal treatment

The Municipal Waste Integration Network (MWIN) and Recycling Council of Alberta (RCA) undertook a comprehensive study to evaluate waste management options for communities with populations of 20,000, 80,000 and 200,000 (Municipal Solid Waste (MSW) Options, 2006). This study was referenced in the preparation of this report.

In order to evaluate thermal energy recovery technologies, a review of the following treatment and disposal options will be provided in this Section.

- Waste composting
- Anaerobic digestion
- Sanitary landfill

A review of energy recovery technologies is provided in Section 5.

4.1 Waste Composting

4.1.1 Source Separated Organics (SSO) and Mixed Waste Composting

There are two widely used system designs for waste composting:

- Source separated organics (SSO) and
- Mixed waste composting

SSO requires separation of materials suitable for composting from the solid waste at the source of generation.

SSO composting has a positive impact as it removes wastes from the disposal stream and produces a beneficial product, which may be reintroduced into the soil.

Mixed waste composting is less widely used. During mixed waste composting, recyclable material is removed from waste using manual or mechanical separation. The quality of compost produced from the resultant material is typically of lower quality than compost produced from SSO. Composted mixed waste may be useful as a source of fuel for thermal treatment. Residual material from either process is more benign for landfilling than raw organic waste.

Reactor (enclosed chamber) composting technologies may also be used for mixed waste composting. The high capital and operating cost of reactor technology may make reactor technology uneconomic.

The following may be expected in communities where diversion of organic wastes from sanitary landfill disposal is practiced:

- Increased effective operating lifespan of sanitary landfills
- Minor increases in the total quantity of leachate generated at sanitary landfills
- Reductions in overall emissions and greenhouse gas emissions from sanitary landfills
- Reductions in available feedstock for renewable energy generation
- Reductions in the annual number of vehicle trips to sanitary landfills
- Small increases in unit costs for waste disposal at sanitary landfills

4.2 Anaerobic Digestion

Anaerobic digestion is a naturally occurring biological process that uses microbes to break down organic material in the absence of oxygen. In engineered anaerobic digesters, the digestion of organic waste takes place in a reactor where critical environmental conditions such as moisture content, temperature and pH levels may be controlled to maximize gas generation and waste decomposition rates.

Limited operational experience with this technology is available in Canada. In Canada, plants are operating in Toronto and Newmarket, Ontario.

Anaerobic digestion has a significant benefit in terms of generation of greenhouse gases. Anaerobic digestion produces methane from the degradation of organic waste. If the digestion occurs in a reactor, the methane may be recovered to replace fossil fuels. If this process occurs in a landfill, the methane is likely to escape into the atmosphere. This is not desirable as methane is a greenhouse gas, with more global warming potential than carbon dioxide.

The net energy yield from anaerobic digestion is less than the yield from thermal processing the same amount of waste material.

4.3 Sanitary Landfill

A sanitary landfill is a facility in which solid wastes are disposed in a manner that limits the impact of the waste on the environment. Waste materials in the SAAEP region are most commonly disposed by landfilling. Current landfills consist of a complex system of interrelated components and sub-systems that act together to break down and stabilize disposed wastes over time. Wide variations in approaches are undertaken for landfill disposal of wastes. For additional information regarding landfill technology and use in the SAAEP region, see Section 3.2.

Did You Know...
"*We shall require a substantially new manner of thinking if mankind is to survive*"
(Albert Einstein, n.d.)

5.0 Energy Recovery Technologies

The scope of this study included review of three thermal treatment technologies:

- Fluid Bed Gasification
- Pyrolysis / Thermal Gasification
- Plasma Arc Gasification

A review of an additional new energy recovery, Bioreactor Landfill technology, is also included in this Section.

5.1 Thermal Treatment, Introduction and Overview

Thermal treatment may be applied to the residual waste stream remaining after recycling and composting to recover renewable energy. Managing waste with thermal technologies involves high temperature processing of waste materials to recover energy, reduce the quantity of material requiring landfill, stabilize the material requiring disposal and potentially produce valuable by-products. Thermal treatment facility design must include provisions for site-specific requirements, energy consumer requirements and regulatory requirements (including air emissions performance standards).

Although individual facilities vary, the process of thermal treatment generally involves the following core process elements:

- Physical processing equipment (mechanical and manual) to remove unacceptable materials and recover recyclable and reusable materials contained within the incoming waste stream
- Thermal treatment unit
- Heat and / or energy recovery system
- Air pollution control system
- Ash / residual management system, including processing to recover materials

Thermal technologies available for use in the management of solid waste include both traditional and advanced technologies.

Traditional technologies include:

- Starved air (or multiple stage) combustion
- Mass burn (single stage combustion)
- Rotary kiln combustion
- Solid recovered fuel production and use (also referred to as refuse derived fuel)
- Co-incineration

Advanced thermal technologies include:

- Fluid Bed Gasification
- Pyrolysis / Thermal Gasification
- Plasma Arc Gasification
- Bioreactor Landfill

Overview of Thermal Treatment

- Thermal processes significantly reduce the amount of material requiring landfill disposal, typically 90% by volume and 70-75% by weight.

- Thermal processes provide the opportunity to recover renewable energy. Typically 450 to 500 kWh of electricity is generated per tonne of waste processed. A typical Canadian home may have its annual electricity requirement generated from 24 tonnes of waste. Energy recovery processes may generate an equivalent amount of heat energy, which may also be recovered.

- Thermal processes are more costly than landfill disposal based on current accounting methods. Capital and operating costs associated with thermal processes are comparable to costs associated with anaerobic digestion processes. Generally, larger thermal process facilities are less costly on a per tonne basis. It is recommended that municipalities investigating thermal processing of wastes consider partnering with neighbouring municipalities to obtain cost savings through economies of scale.

- Thermal treatment facilities may be sited, as a compatible land use, in an industrial area. This significantly reduces the social impact associated with siting.

- Air emissions from advanced thermal treatment facilities are far lower than from many other industrial facilities.

- Thermal treatment may reduce greenhouse gas emissions compared to landfill.

- Some thermal treatment processes generate more emissions of air contaminants compared to landfill.

- Landfill generates more contaminants to water than thermal treatment.

5.2 Traditional Thermal Treatment Technology

This study included a review of the advanced thermal treatment technologies. An understanding of the traditional processing technologies will demonstrate the advantages of the new technologies.

Starved air combustion, mass burn and rotary kiln units have been used extensively for the past 50 years in Europe and North America to treat solid waste. Canadian examples include facilities in Charlottetown, PEI, Quebec City, Quebec, Brampton, Ontario, Wainwright, Alberta and Burnaby, British Columbia.

a) Starved Air (or Multiple Stage) Combustion

Starved air incinerators have been used extensively for solid wastes. Systems permit a high degree of oxygen control. Starved air incineration is a well known and established technology with a stable and reliable process.

Systems are available for treatment of solid wastes in semi-continuous incinerators and batch units.

Semi-continuous starved air systems are appropriate technology for smaller cities as design capacities for individual units are 10 to 100 tonne per day. Larger facilities are comprised of 3 to 5 units. These facilities provide a potential opportunity for energy recovery.

Capacities for batch starved air incinerators range from 1 to 20 tonnes per day. Energy recovery is not generally economical due to facility size. Heat recovery for industrial applications at adjacent facilities may be viable.

b) Mass Burn Combustion

Mass burning is a well-established technology developed over 100 years ago for energy recovery from MSW. Mass burn combustion is typically used in large cities with a population of over 1 million. For large facilities, economies of scale for this technology are well developed. In Canada, typical facilities have a total capacity of between 400 and 850 tonnes per day.

Older mass burn facilities contributed heavily to air emissions. Modern plant design meets current air emission standards.

c) Rotary Kiln Incinerator

Rotary kiln incinerators are two-stage combustion systems that have been used for the thermal destruction of MSW since the 1950s. Rotary kiln incinerators are also widely used for the disposal of a variety of solid and liquid hazardous wastes, including thermally stable compounds such as PCBs.

Rotary kiln incinerators have typical capacities ranging from 10 to 50 tonnes per day.

Given the complexity of its rotating element design, the technology is relatively capital intensive with high operating and maintenance costs.

d) Solid Recovered Fuel technology

Solid recovered fuel systems involve pre-processing of incoming waste to produce a 'refuse derived fuel' and subsequent use of that fuel as a substitute for conventional fossil fuels in energy generation, industrial manufacturing and heating applications.

Solid recovered fuel technology has been employed principally in Europe and in the USA. Regulatory approvals for solid recovered fuel in Canada are onerous (identical to an incinerator facility).

e) Co-Incineration of Waste with Coal

Co-incineration of industrial waste and coal was developed in Europe. This process may have potential applications in coal generating areas of Alberta. Co-incinerating waste with coal may reduce the fuel costs for the coal generator operator.

5.3 Advanced Thermal Treatment

5.3.1 General Characteristics / Background Information

Fluid Bed Gasification, Pyrolysis / Thermal Gasification, and Plasma Arc Gasification technologies have been utilized in Europe and North America for the management of special wastes.

These technologies are now being considered for application to solid waste under the contexts as "new and emerging" technologies. Full commercial scale applications to solid waste in Canada are not yet in place. A pilot scale Fluid Bed Gasification facility developed by Enerkem Technologies Inc. has been tested in Sherbrooke, Quebec. The PlascoEnergy Group has built and commissioned a 100 tonnes per day commercial-scale plasma evaluation and demonstration municipal solid waste conversion facility at Ottawa's landfill site.

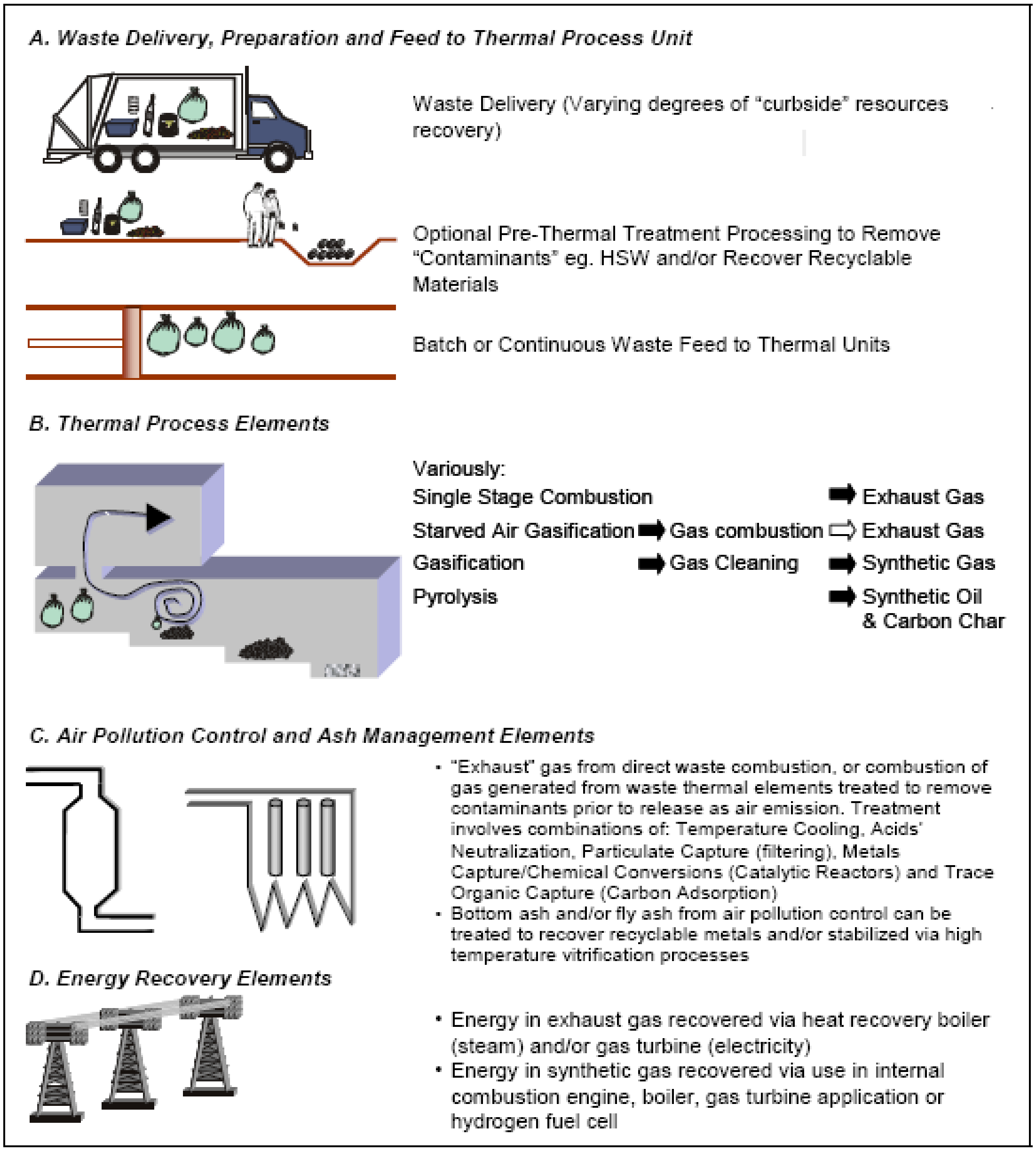
Municipal authorities in a number of Canadian communities are investigating these types of technologies for potential energy recovery projects.

The City of Edmonton is working with Enerkem Technologies Inc. to develop an energy recovery using sorted waste from Edmonton and area.

Fifteen Central Alberta communities, including the County of Red Deer have concluded an agreement with the PlascoEnergy Group from Ottawa to process MSW.

The following Figure 8 illustrates the principal elements of a thermal process.

Figure 8 - Principal Elements of Thermal Technologies
(Municipal Solid Waste (MSW) Options - 2006)



5.3.2 Common Processing Steps

Thermal treatment process share common processing steps including pre-processing, thermal treatment, air pollution control and ash / residual management. A description of the common steps is provided in this section.

a) Waste Pre-Processing

Incoming wastes may be mechanically or manually sorted to remove compostable, reusable and recyclable materials. Wastes may be mixed to create a blend of material that is homogenous in physical, chemical and heat value characteristics. Wastes may be shredded and screened to create uniform particle size.

Once pre-processed, waste is conveyed at a controlled rate into the thermal treatment section of a facility. Feed rates are controlled to protect and optimize the design capacities of the downstream elements of a facility including the thermal units, air pollution control systems, energy recovery and power generation systems.

b) Thermal Treatment

Waste is treated by application of temperature under various chemical environments, principally oxygen concentrations. Temperature drives various physical / chemical transformations of the waste. As a general principle, waste is either rapidly oxidized (combusted) to convert carbon / hydrogen molecules into carbon dioxide and water, or it is reduced (in the reduced presence or absence of oxygen in the case of gasification and pyrolysis technologies) to convert complex carbon / hydrogen molecules into simpler, elements such as constituent oils, carbon monoxide and hydrogen gas.

This oil or gas is subsequently subjected to combustion to release heat and produce carbon dioxide and water. In both cases, the waste materials remaining are substantially reduced in quantity and are of a simpler, stable chemical composition. The water and other elements are volatized (converted from solid to gaseous states). The resulting chemicals are less reactive and less prone to leaching contaminant constituents. The remaining ash / residual material is made more amenable to ultimate management by landfill disposal or potential recycling.

c) Energy Recovery

Solid waste contains substantial heat energy, principally in the form of its constituent organic carbon molecules. Unprocessed, unprepared MSW typically has a heat value of 10,500 to 12,800 kilojoules/kg (4,500–5,500 Btu/lb).

A relatively small facility may supply, after in-plant consumption, 450 to 500 kWh of electricity from each tonne of waste processed. The energy contained in 24 tonnes of waste, may supply the annual power needs of a typical Canadian home for one year.

Actual heat values depend on the specific composition of the waste, including the circumstances of its collection and delivery to a facility, as well as the extent to which the waste is pre-processed at the facility.

Energy recovery systems have typically included boilers. Heat energy released from waste is transformed to steam that is then converted to electricity by turbine / generators. The configuration is similar to a conventional thermal power plant, substituting coal, oil or gas with solid waste. Energy recovery / conversion efficiencies of 20 to 30% are expect from conventional thermal treatment and electricity production.

In recent years, combined cycle gas turbines (combustion exhaust gas powers a gas turbine and excess heat is captured to power a steam turbine) have substantially improved energy efficiencies. Use of newer gasification treatment and combined cycle gas turbine technologies may yield energy efficiencies of 40 to 60%.

d) Air Pollution Control

An air pollution control system is used for the treatment of the gaseous products (mostly flue gas) from the thermal treatment system.

Typical air pollution control systems are comprised of the following elements:

- Flue gas cooling for subsequent physical / chemical capture and removal
- Trace organics (dioxins and furans) destruction and / or avoidance of substance formation; capture (bag house filtering and activated carbon and / or catalytic reactor adsorption)
- Particulate collection (bag house filtering and/or electrostatic precipitators)

Air pollution control systems include equipment to continuously and / or periodically monitor emissions performance and to report performance for process control and regulatory compliance purposes.

e) Ash / Residual Management

The solid residue remaining after thermal treatment is typically termed bottom ash. This material is mechanically collected, cooled (typically water quenched then drained) magnetically / electrically screened to recover recyclable ferrous / aluminum materials (although these metals may be recovered during the solid waste pre-processing step) and removed for ‘ultimate’ management.

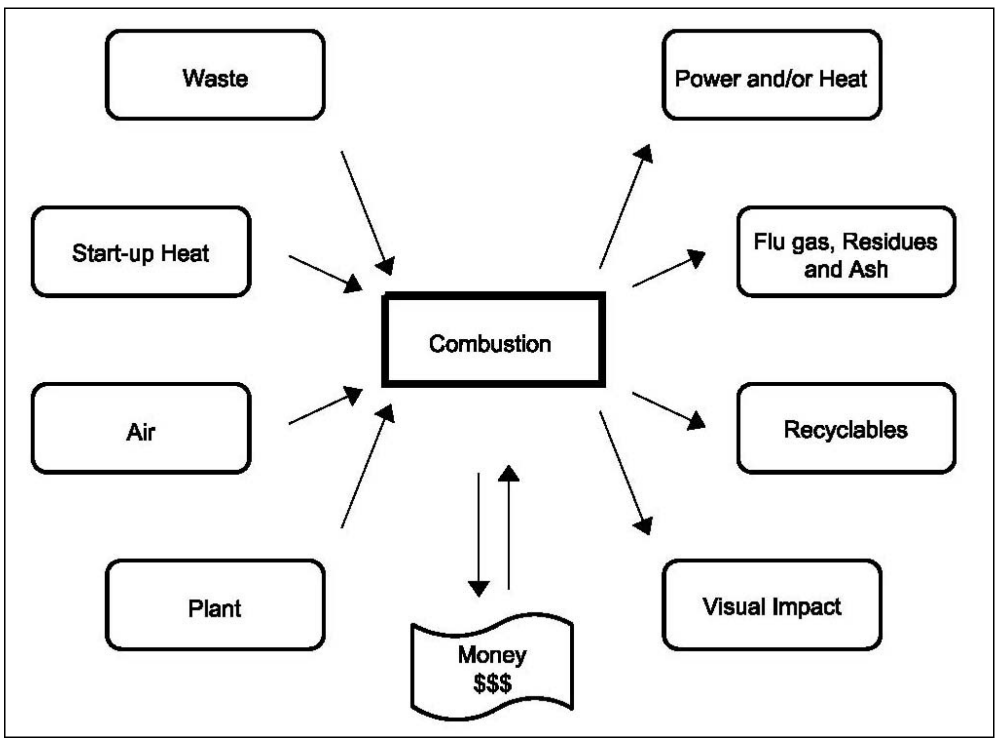
The material may, depending upon its chemical composition, physical state and regulatory requirements, be utilized as a form of aggregate substitute. Bottom ash from a conventional thermal treatment system is typically 10% by volume and 25% by weight of the incoming waste stream.

Air pollution control systems generate the other solid residue from a facility. Termed 'fly ash', this material is comprised of the fine particulate contaminants captured from the flue gas and the reagents used to effect capture. Fly ash may be classified as hazardous waste (higher propensity to leach contaminants in hazardous concentrations) as it contains the contaminants removed from the exhaust gases and is usually managed via further chemical stabilization prior to disposal in landfill sites.

Some thermal technologies use extremely high temperatures to convert ash into inert vitrified substances, either as an integral element of converting the waste into gas and recoverable chemical elements, or as a dedicated ash management process. Residues from a process that vitrifies and recycles ash are usually less than 5% by volume.

Figure 9 illustrates the general process of energy recovery from waste using a thermal process.

Figure 9 - Energy Recovery from Waste
(Refuse Derived Fuel, 2004)



5.4 Fluid Bed Gasification

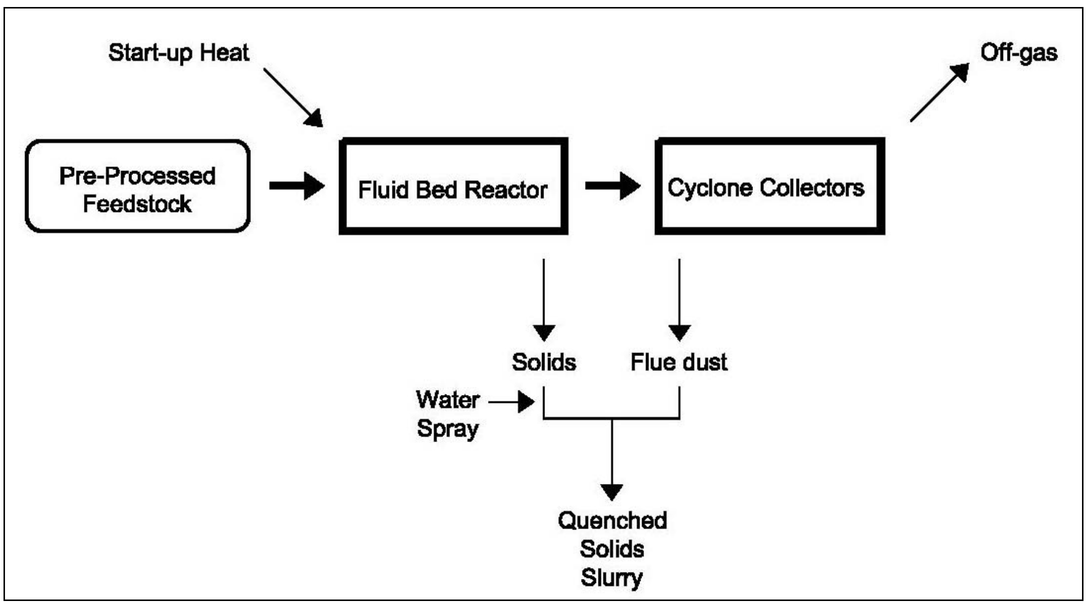
a) Background

Fluid Bed Gasification systems are capable of processing a wide range of wastes including: sewage sludge, petroleum waste and paper industry waste. While the technology is typically used for material of homogeneous nature (sewage sludge), fluidized beds may be used for solid waste treatment if adequate shredding and pre-treatment is applied. There are no such commercially operating facilities processing solid wastes in Canada.

The City of Edmonton is working with Enerkem Technologies Inc. to develop a facility using sorted waste from Edmonton and area.

Figure 10 illustrates the process flow of a fluidized bed gasification system.

Figure 10 - Fluidized Bed Gasification
(Pyrolysis & Gasification, 2004)



b) General Operating Principles

Fluid Bed Gasification is a modification of mass burn technology.

The fluidized bed consists of large combustion chamber with a bed of silica sand at the bottom. Air is injected at the bottom of the bed and is dispersed into the sand through a series of air dispersion nozzles. The density of the sand mass is decreased by the air – commonly referred to as fluidizing the sand mass – so as to enable it to transport air and heat to the particles of waste substance to be combusted. A burner at the bottom of the bed raises the sand mass temperature to about 850°C, prior to initial introduction of the waste stream.

Pre-processed / shredded waste with a relatively uniform particle size is introduced onto the bed. A pre-treatment shredding stage may be required.

The waste material is induced to move into the body of the sand bed by the convection current movement of the air and sand particles. The waste is partially combusted (gasified) to produce carbon monoxide and other volatiles. These gases undergo further combustion in the upper section of the combustion chamber where additional combustion air is injected.

Flue gases are then directed into the air pollution control system. Ash deposited on the bed is evacuated.

Lime may be added to inhibit the production of acid pollutants. The addition of the lime may preclude any requirement for additional flue gas air pollution control systems typically required for mass burn technology. The cost per tonne of processing is not markedly different between the fluid bed processing and mass burn processing.

c) Capacity

Fluid bed systems typically range in capacity from 50 to 200 tonnes of waste per unit per day. Larger systems may be constructed using multiple modular units.

The Enerkem System is highly modular with capacities of up to 15 tonnes per hour. Multiple trains may be added for large scale applications. For small systems, the Enerkem design may be economic at capacities as low as 500 kg/h.

d) Environmental Issues and Energy Implications

Fluid bed systems have a number of environmental advantages. Extensive turbulence and high residence time in the combustion chamber results in smaller amounts of trace organics emissions including dioxins and furans. Pre-processing the waste to ideal particle sizes and the physical action of convection movement through the sand bed medium increases surface areas. Increased surface areas result in good ‘burn-out’ and better ash quality (ash with smaller unburned carbon content).

A number of practical and economic advantages and disadvantages related to fluid bed systems have been identified. Advantages include simple designs, low capital cost, long service life and low maintenance costs. Few moving parts result in less frequent breakdowns and simpler, less costly maintenance.

Due to high thermal inertia, fluid bed systems are also quite versatile. Large fluctuations in both waste composition and the rate of feed are tolerated.

Fluid bed systems require skilled labour to operate. These systems feature more sophisticated electrical components than older technologies. The systems are highly sensitive to particle sizing. If particles are too large, they sink and stay at the bottom of the bed in an unburned state.

Case Study - Edmonton Syngas Plant

The City of Edmonton, the Alberta Energy Research Institute and EPCOR, the Edmonton-based utility, propose to build an $87-million “gasification” plant at the Edmonton Waste Management Centre. The facility will operate using technology developed by Enerkem Inc.

The focus is on developing an environmentally responsible and economic alternative to landfills for the disposal of municipal waste.

In this fluid bed gasification system, solid waste is streamed through a materials recovery facility to remove reusable and recyclable materials. The remaining residual waste will be shredded and sorted again to remove metals and inert materials. The resulting material will be feedstock for the production of synthetic gas (syngas). The syngas will be reformed catalytically into methanol and ethanol.

As part of the project, Enerkem is also working with the City of Edmonton and AERI to build a Research and Pilot Center that will serve to foster research in Alberta in advanced gasification systems.

Construction of the gasification facility will begin in 2008, and will reach completion in 2010.

The plant is expected to process 75,000 to 100,000 tonnes per year of solid waste that cannot be recycled or composted. It will produce enough syngas to generate approximately 12 MW of electricity, enough to power the Edmonton Waste Management Centre and surrounding industries.

The new process will enable Edmonton to divert 90 per cent of residential waste from landfill. It will also result in a net reduction of greenhouse gas emissions equivalent to removing 37,500 cars from Edmonton roads.

5.5 Pyrolysis / Thermal Gasification

a) Background

Pyrolysis / Thermal Gasification technologies, unlike conventional thermal treatment / destruction technologies do not have a history of commercial application to solid waste streams.

Knowledge of the technical design and environmental and economic performance of these technologies for solid waste energy recovery is held by relatively few proprietary technology vendors. The technologies are used in industrial processes, however, development related to solid waste energy recovery has been completed in concept form, bench-scale or as pilot scale demonstration units. Theoretical advantages over conventional solid waste thermal treatment destruction technologies have been identified.

b) General Operating Principles

Pyrolysis and Thermal Gasification are related technologies.

Gasification is the general term used to describe a process of partial combustion in which a feedstock or fuel is combusted in oxygen-restricted environment. The oxygen is restricted below the quantity required for complete combustion. The process results in the partial combustion of fuel and generates a combustible synthetic gas. Thermal gasification is used to describe a partially oxygen-restricted environment and pyrolysis is used to describe a totally oxygen-restricted environment.

Thermal gasification requires an initial heat supply and produces a mixture of combustible gases (primarily methane, complex hydrocarbons, hydrogen and carbon monoxide). The produced gas may then either be used in boilers or cleaned and used in combustion turbines or generators. The generated syngas has an energy content about one third that of natural gas.

The process is either self-sustaining once the operating temperature is reached or may be maintained by recycling a small proportion of the energy produced from the combustion of the fuel gases.

Pyrolysis produces three major component fractions:

- A gas stream containing primarily hydrogen, methane, carbon monoxide, carbon dioxide and various other gases depending on the organic characteristics of the waste material being pyrolyzed. This gas is typically consumed internal to the process of generating the desired liquid and solid product fractions.

- A liquid fraction consisting of an oil stream containing acetic acid, acetone, methanol and complex oxygenated hydrocarbons (tars). The liquid fraction may be further processed for use as a synthetic fuel oil as a substitute for conventional fuel oil.

- A char consisting of almost pure carbon plus any inert material originally present in the MSW.

Both these technologies create more sophisticated ‘environments’ in which thermal reactions occur. Greater control of oxygen concentrations and the use of chemicals as reagents in conjunction with various temperature profiles provide greater control of the outputs.

The following Figure 11 illustrates Thermal Gasification and Figure 12 illustrates Pyrolysis / Thermal Gasification processes.

Figure 11 - Thermal Gasification
(Pyrolysis & Gasification, 2004)

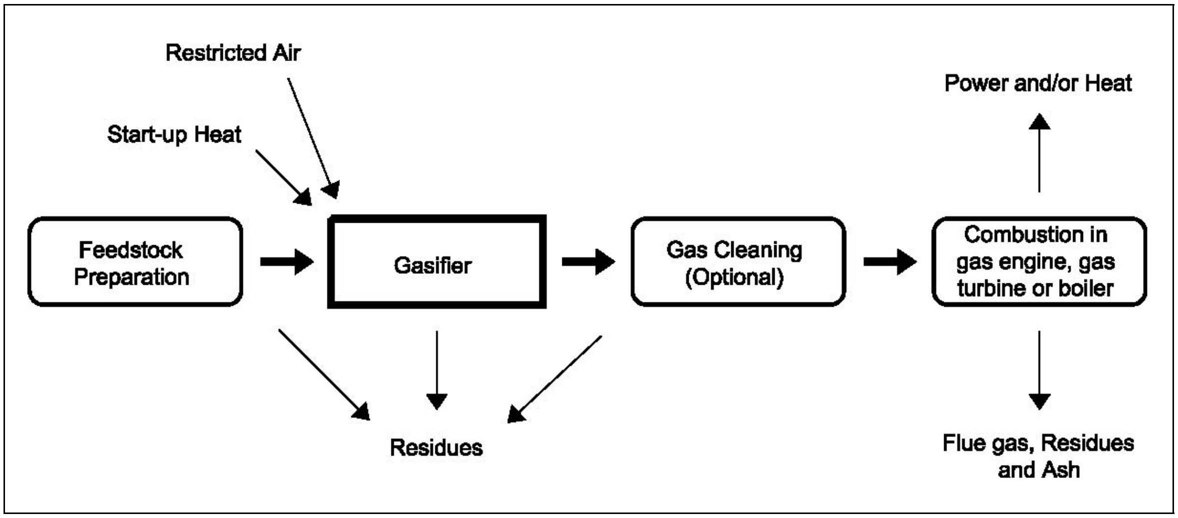
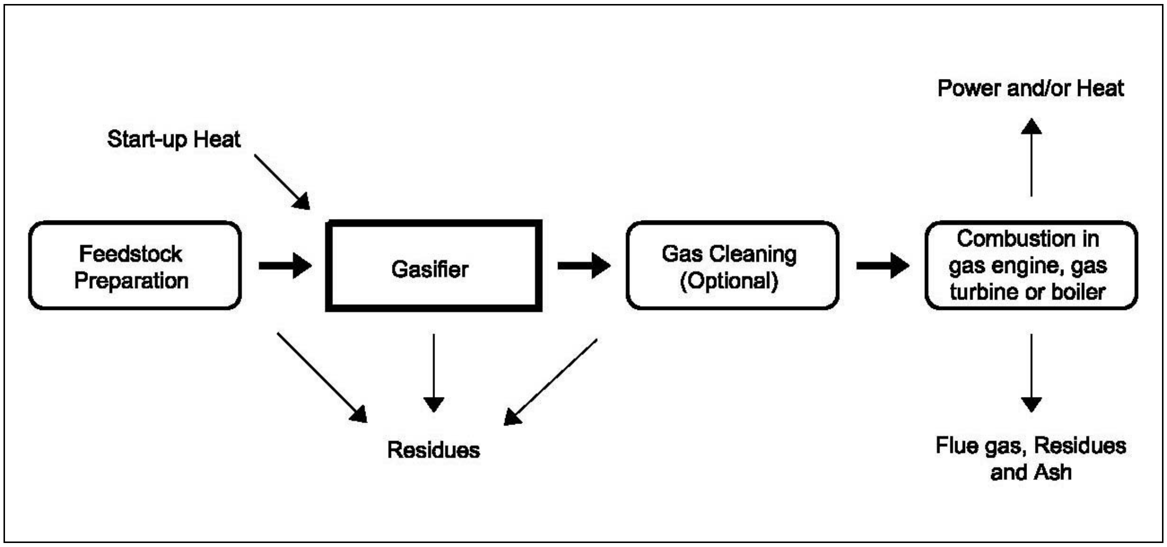


Figure 12 - Pyrolysis Gasification
(Pyrolysis & Gasification, 2004)



c) Costs

Pyrolysis / Thermal Gasification are new technologies. Detailed, verifiable data on costs and capacities is not available. Cost and capacity data was obtained on an 'estimate only' basis from vendors.

d) Capacity

Organic Energy provides gasification technology scaled to small to midsize facilities. Organic Energy has 3 plants in operation since 2001, one in Norway and two in Korea. An additional 7 plants are under construction.

The Organic Energy SK 1000 module has the capacity to process 3,500 to 7,500 tonnes of waste per year, depending on the waste composition. Based on the energy content of the solid waste feedstock available in the SAAEP region, a module will produce about 2 MWth of steam or 0.5 MWe of electricity. By combining modules, the capacity of the system may be increased.

One of the key benefits of modular technology is that solid waste may be processed at small facilities close to the source. Small, locally sized units may provide an opportunity for energy recovery at facilities that are lower in capital cost and do not require long distance transport of solid waste feedstock.

Capital costs of a three unit system, capable of handling 20,000 to 25,000 tonnes per year, is estimated at $15 - $20 million. A 6 unit system is estimated at $25 - $30 million.

Total annual operating costs for a 3 unit system excluding labour but including maintenance / repairs and consumables is estimated at $650,000.00. Total annual operating costs for a 6 unit system is estimated at $1,000,000.00.

Thermoselect S.A. also provides gasification technology. Thermoselect has a full-scale technology application in Japan.

e) Environmental Issues and Energy Implications

Certain environmental advantages may be realized with the use of Pyrolysis / Thermal Gasification technologies.

Gasification technologies have the potential to achieve low air pollution emissions with low cost air pollution control devices.

Theoretically, the relatively high operating temperatures of these technologies are expected to generate reduced trace organics emissions. The processes retain pollutants, including sulphur and heavy metals, in the ash instead of discharge to the atmosphere. Emissions from this technology are much lower than produced by conventional incineration and require less flue gas air pollution control. A smoke stack may not be required, as the only emissions are burning combustible gases from a turbine or boiler.

When comparing to mass burn technology, there are several clear advantages. Pyrolysis / Thermal Gasification may be a more efficient technology. One investigated technology claimed a 36% efficiency compared to 21% for mass burn technology.

These technologies may be less costly to implement on a small scale. Individual Pyrolysis / Thermal Gasification units generally are designed to process 25,000 to 40,000 tonnes per year.

There is less of a requirement to keep Pyrolysis / Thermal Gasification units operating 100% of the time, as start-up periods are shorter than for mass burn incinerators. This permits facility closing on nights or weekends. These systems are able to operate at less than 100% of capacity allowing for flexibility in available feedstock quantity.

Fuel preparation is required for Pyrolysis / Thermal Gasification systems. The fuel material must be shredded before use.

The German government funded a demonstration solid waste pyrolysis facility Burgau, Germany, in 1987. While the plant remains operational, it is not considered commercially successful.

The only full-scale pyrolysis system operated on solid waste in North America was constructed in California. The system failed to achieve its primary operational goal of the production of a saleable pyrolysis oil. The facility was shut down after two years of operation.

Pyrolysis processes are widely used for industrial purposes. Pyromex Ltd., Switzerland provides a pyrolysis system. The Pyromex system heats feedstock to a minimum of 1,200 degrees Celsius. All carbon containing components are reduced to basic elements. The resulting gas is a mixture of hydrogen, carbon monoxide and methane. The gas is collected, cooled and may be used as a fuel. Pyromex systems are available commercially and scalable from a minimum of 25 tonnes per day. The vendor did not provide capital or operating costs.

Pyrolysis of solid wastes has not yet been economically successful and has presented many technical challenges. It is understood that the principal causes for failure of MSW pyrolysis technology are related to high costs, inability to provide a consistent feedstock and the complexity of the system.

5.6 Plasma Arc Gasification

a) Background

Industrial applications of plasma arc technologies are well established and include electric arc furnaces used in the steel industry and arc welding units used in the construction industry. Plasma arc technology is also used for treating hazardous waste materials.

b) General Operating Principles

Plasma arc processes use extremely high temperatures in an oxygen-starved environment to pyrolyze waste into simple molecules. A thermal plasma field is created by directing an electric current through a low pressure gas stream, thereby creating a stream of plasma at temperatures of 5,000 to 15,000°C.
Stage I - Waste Conversion and Refinement

Waste is fed into the primary chamber of the converter where the material is gasified by heat recovered from the gases exiting the refining chamber. The gasified product from the primary chamber contains carbon monoxide, hydrogen, tars and un-reacted carbon. This gas is refined into a cleaner and lighter gas in the secondary chamber. Process air and plasma heat are combined with the gas and the plasma heat is adjusted to maintain the desired process chamber conditions.

Agricultural sulphur is recovered from the process. The solid residue from the primary chamber is sent to a separate high-temperature chamber equipped with a plasma torch where it is melted. Plasma heat is used to stabilize the solids by driving off any remaining volatile compounds. Any volatile gas is passed through several cleaning steps before being combined with the main gas stream. The melted material is poured into a water bath where rapid cooling creates small solid pellets. This vitrified residue is an inert, non-hazardous, glass-like solid, marketable as construction aggregate for roads, concrete or other building materials.

Stage II - Power Generation

Synthetic gas created through the conversion system is used to run internal combustion engines. Because the gas is cleaned prior to being sent to the engines, the exhaust from the engines is clean. Additional electricity may be produced through power generation using captured waste heat from the engines and from the waste conversion process in stage I.

Plasma arc gasification may be either a net energy user or producer, depending on factors such as the composition of the waste feedstock and scale of operation. In theory the synthetic gas produced by plasma technologies may be used in many applications, including fuel cells.

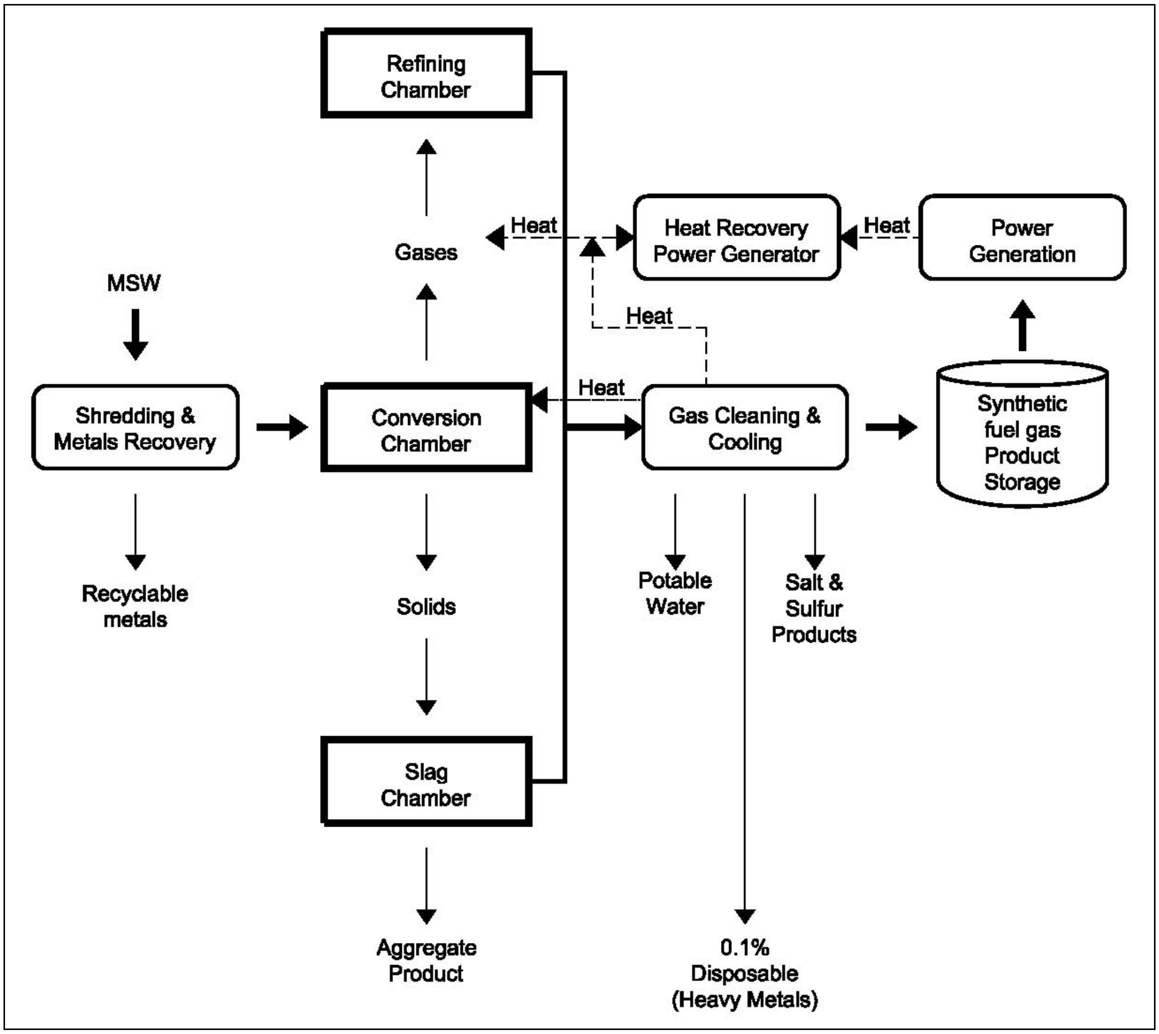
The process forms a synthetic gas composed of simple molecules such as H2, N2, CO and CO2. This gas may be cleaned and combusted in an engine or turbine for energy recovery.

The technology is still at the developmental stage. Currently, there are no commercial scale units processing solid wastes in North America. There are patented plasma arc systems proposed by technology providers for the treatment of MSW.

The by-products of the process are slag and combustible gases. The combustible gases are subsequently either combusted in an afterburner or treated by catalytic conversion. Figure 13 illustrates the process flow of a plasma arc gasification process.

Two Canadian companies market plasma arc systems (Pyrogenesis Inc. and PlascoEnergy Group) for solid waste applications.

Figure 13 - Plasma Arc Gasification
(PlascoEnergy Group, 2007)



c) Cost

Plasma arc gasification requires relatively high capital and operating costs, but may offer environmental advantages in certain applications.

d) Capacity

Technology providers offer systems with capacities from 5 to 200 tonne per day. The City of Ottawa currently operates a 75 tonne per day demonstration installation.

e) Environmental Issues and Energy Implications

The environmental advantages include the 'ultimate destruction' of highly problematic hazardous materials including PCBs and complex stable volatile organic compounds. The materials are processed at extremely high operating temperatures and are converted to vitrified inert ash.

Vendors of some technologies advise that the gasification and plasma arc process have no air emissions.

Case Study – Central Waste Management Commission / PlascoEnergy Group

The Central Waste Management Commission, consisting of 15 Alberta municipalities, including the County of Red Deer, and the PlascoEnergy Group have proposed a plasma arc facility in Central Alberta. PlascoEnergy will finance, build, own and operate the facility. PlascoEnergy will assume all financial and operational risk for the facility. The Commission will guarantee the supply of waste feedstock for 20 years at an agreed tipping fee. PlascoEnergy advised that the facility will be operational 12 months after approval and completion of environmental permitting.

The PlascoEnergy process converts more than 99% of the processed waste into marketable products. Recovered heat from the process is used to gasify the waste. After gasification, a plasma arc is used to refine the gaseous products into a clean, consistent, synthetic fuel gas. This synthetic gas may be sold as feedstock for ethanol production. The synthetic gas may also be used in a combined cycle power plant (international combustion engines, plus heat recovery steam generators) to produce electricity. The process also is expected to produce other marketable co-products including construction aggregate, commercial salt, sulphur and potable quality water.

5.7 Bioreactor Landfill

The bioreactor landfill is a new technology evolved from contemporary landfill design. Bioreactor treatment of solid wastes involves design, construction and operation of a landfill cell that is specifically engineered to enhance the decomposition of wastes through careful manipulation of conditions within the site. Bioreactor technology provides a method of processing or treating wastes within the confines of a tightly controlled landfill cell.

Land area consumption of bioreactor landfills is significantly less than conventional sanitary landfills due to the increased waste density that results from enhanced rates of decomposition and increased waste settlement.

Comparison of sanitary landfills and bioreactor landfills:

- The unit land area consumption of bioreactor landfills is 17 to 22% less than that of sanitary landfills of equivalent disposal capacity due to the significantly higher on site waste density that is achieved in bioreactors.

- The unit leachate generation rates for bioreactor landfills are significantly less than those of the corresponding sanitary landfills. This is due to the significantly shorter leachate management time required at bioreactor landfills and the smaller unit surface area footprint of bioreactors.

- The unit gas generation rates at bioreactor landfills are significantly more than those at sanitary landfills, while the unit emission rates are significantly less (assuming gas collection at both types of sites). Bioreactor landfills have lower greenhouse gas emissions due to the higher rates of gas recovery at bioreactor landfills and the shorter gas generating period.

- The potential for renewable energy recovery at bioreactor landfills is significantly better than at equivalent sized sanitary landfills equipped with gas collection systems.

- Unit costs for disposal of waste in medium to large size bioreactors are less than those for disposal of waste in equivalently sized sanitary landfills due to the shorter post-closure management period of bioreactor landfills as compared to sanitary landfills.

Public attitudes and perception regarding the bioreactor may be better than conventional landfills due to the bioreactor's enhanced environmental performance.

Additional benefits resulting from the rapid stabilization of waste in bioreactor landfills is the reduction in requirements for post-closure monitoring and care. Rapid stabilization reduces the long-term environmental and financial risks that are often associated with old landfills.

Currently, no bioreactor landfill sites are approved for operation in Alberta.

Did You Know...
"*95 per cent less energy is required to produce a new aluminium can from recycled material than from raw material*"
(Waste Facts, 2007)

6.0 Siting and Operational Considerations

6.1 Large and Small Processing Facilities

All of the advanced energy recovery technologies investigated in this study have small processing modules available. Modular units are available to process 8,250 tonnes or less per year (25 tonnes per day). If processing requirements increase, additional modules may be added and operated as one single unit.

Small units, locate near sources of waste generation may more easily gain public acceptance than a large centralized facility. This approach also provides an opportunity to test and verify the technology without committing the entire region waste management system.

6.2 Capital and Operating Costs

Only a handful of advanced technology energy recovery facilities have been constructed worldwide. Reliable, verifiable data relating to capacities and costs of commercial scale applications, particularly related to Canadian waste management, environmental and energy contexts is not readily available. Information provided by technology vendors was provided on a strictly 'estimates only' basis.

A three module unit gasification system with a capacity of 20,000 to 25,000 tonnes per year has an estimated capital cost of $15 to $20 million. A six module unit systems has an estimated capital cost of $25 to $30 million. The capital cost for the three module unit on a per tonne of waste processed basis is $800.00. The capital cost for the six module unit on a per tonne of waste processed basis is only $600.00. This represents an economy of scale saving of 33%. With smaller units, costs will be even less favourable.

Facility operating costs will also benefit from economy of scale savings. Larger facilities will have a lower operating cost per tonne of waste processed.

6.3 Energy Recovery Facility Cost Recovery

Based on order of magnitude (+50%, -30%) cost estimates for facilities for advanced thermal energy recovery technologies, the break-even tipping fees required to cover capital costs, operating costs and finance costs are as follows:

Table 8 - Comparison of Break-Even Tipping Fees
$/tonne of solid wastes processed for a 73,000 tonnes per year facility
(Study of Gasification / Pyrolysis of MSW Residual, 2004)

Fluid Bed Gasification	Thermal Gasification	Pyrolysis
$75.00 - $132.00	$ 78.00 - $ 157.00	$ 107.00 - $ 132.00

No comparison cost information for plasma arc gasification was available.

6.4 Labour Requirements

An energy recovery facility to process 7,000 to 40,000 tonnes per year is effectively operated with 9 to 15 full-time employees. The facility will operate 24 hour per day. Labour coverage does not decrease proportionally with smaller units.

A 170,000 tonnes per year plasma gasification facility will require 45 full-time employees.

This labour estimate does not include requirements for related waste material recovery, composting or feedstock pre-processing.

6.5 Footprint and Land Use

The area required for a thermal treatment facility varies with the type and capacity of the facility. Table 9 illustrates the footprint range (site size) required for various sized facilities. The identified sizes range from minimum requirements to a site provisions for expansion.

Table 9 - Thermal Treatment Facility Site Size

Population Serviced	Range of Annual Quantity (tonnes)	Range of Daily Quantity (tonnes)	Range of Site Size Required (ha)
20,000	3,500 – 6,000	13 – 23	0.4 – 0.6
80,000	14,000 – 24,000	42 – 73	1 – 2
200,000	35,000 – 60,000	106 – 182	2 – 3
1,000,000	175,000 – 300,000	532 - 912	4 – 8

Energy recovery facilities may be sited as a compatible land use in industry areas.

6.6 Nuisance Effects

Potential nuisance impacts of facilities handling solid wastes include dust, noise, odour, vermin and litter. The risk of nuisance issues at will run facilities is low. Wastes are generally enclosed within an enclosed tipping area. The tipping area is operated under negative pressure. Odours and airborne particles are sucked into the building, transferred into the thermal process and destroyed.

6.7 Traffic

The traffic impacts from thermal treatment facility are a function of the quantity of material delivered to the facility and the size of the trucks employed. Table 10 illustrates the estimated number of trucks associated with various sized facilities.

Table 10 – Thermal Treatment Facility Daily Traffic Impacts

Population Serviced	Range of Annual Quantity (tonnes)	Range of Daily Quantity (tonnes)	Tonne Packer Trucks per Day	Number of 30 Tonne Transfer Trailers per Day
20,000	3,500 – 6,000	13 – 23	2 – 3	N/A
80,000	14,000 – 24,000	42 – 73	5 – 8	2 – 3
200,000	35,000 – 60,000	106 – 182	11 – 19	4 – 7
1,000,000	175,000 – 300,000	532 – 912	54 – 92	18 – 31

Did You Know...
"*In 2004, Alberta led the country in the disposal of Municipal Solid Waste*"
(Waste Facts, 2007)

7.0 Conclusions

The management of solid waste is a serious environmental, health, social and economic issue throughout Canada. From an ecosystem perspective, the generation and disposal of waste material constitutes a waste of energy and resources. The majority of material that is disposed by landfill represents a resource that has not been fully used and that may have been reduced at source, reused, or recycled, lessening the need to extract and process new resources.

Existing landfills in Canada are approaching capacity. Suitable new landfill sites that are accessible from the major sources of waste are becoming more difficult to site and to have approved. Landfilling and other solid waste disposal methods are controversial topics.

A variety of energy recovery technologies are emerging to reduce environmental impacts of waste. While not completely free of environmental impacts, these technologies provide reduced impacts as opposed to landfilling or other waste treatment methods.

Consistent volumes of waste are required as feedstock for an energy recovery system. These volumes are critical to economically justify the capital and operating costs associated with the system.

Destruction of hazardous materials with certain energy recovery technologies is considered viable and environmentally sound. Including these provisions will increase capital and operating costs and may reduce public support for an energy recovery project.

The study's conclusions are summarized below.

7.1 Current Situation

- Region waste is generated from economic activities.
- Region waste management is provided by two systems: government / public and private.
- Almost all solid wastes in the region are currently transferred to one of four landfill sites (208,000 tonnes in 2006) for disposal.
- The region landfilled 191,500 tonnes in 2006.
- The largest landfill facility in the region is the Lethbridge Regional Landfill facility.
- Based on current trends, the Alberta solid waste disposal target for 2010 will not be met. The quantity of solid waste transferred for disposal will remain constant or increase.
- Opportunities exist for increased recycling, reuse and composting activities.
- By weight, the 63% of the solid wastes landfilled in the region are categorized as mixed solid wastes. Mixed solid wastes typically consist of 40% organics, 26% paper and paperboard, 9% plastics, 4% metal, 3% glass and 18% other materials.
- Hazardous wastes generated in the region and are exported out of the region for disposal.

- Region agricultural production and secondary processing produces high volumes of organic residuals.
- Disposal of cattle Specified Risk Material must conform to stringent federal regulations.
- A SAAEP Region Solid Waste Model with waste diversions to a material recovery facility, a composting facility and an energy recovery facility has the potential to reduce region landfilling from 191,500 tonnes per year to 22,000 tonnes per year.
- Municipal waste expenditures in Alberta were $56.30 per capita in 2004.
- SAAEP municipalities spent an estimated $13,000,000.00 on waste related expenditures in 2006.
- Destruction of hazardous materials with certain energy recovery processes is considered viable and environmentally sound. Including these provisions with energy recovery processes will increase capital and operating costs and may reduce public support for an energy recovery project.

7.2 Energy Recovery Technologies

- Energy recovery processes may recover up to 500 kWh of electricity per tonne of waste processed. The process may generate an equivalent amount of heat energy, which may be recovered.
- Energy recovery facility capital and operating costs are generally significantly lower per tonne for larger, centralized facilities.
- The scope of this study included the investigation of three identified energy recovery technologies. These technologies consist of, modern Fluid Bed Gasification, Pyrolysis / Thermal Gasification and Plasma Arc Gasification. Development of these technologies is at the pilot plant stage in Canada.
- The City of Edmonton and fifteen Central Alberta municipalities, including the County of Red Deer, are proceeding with energy recovery projects.
- Newer technologies include modular designs adaptable for both small and larger capacities.
- Some technology vendors provide project capital financing. Financing may be repaid from tipping fee revenues.

Did You Know...
"*Studies show that 25 per cent of municipal waste can be diverted away from landfills through changes in consumer behaviour*"
(Waste Facts, 2007)

8.0 Recommendations

It is recommended that a leadership group be established to develop and champion an energy recovery strategy for the SAAEP region. The project leadership group must verify support from the communities. It is recommended that communication of energy recovery concepts and preliminary project scope be provided to the communities prior to the verification process.

The communication process may be accomplished through the issue of an Energy Recovery Project Report to the Community. The Report may provide information regarding:

- Current region waste management system
- Need for an energy recovery strategy
- Proposed project scope
- Work completed to date
- Collaboration and community input strategy
- Preliminary project economics

Options to verify support include polling and commitment at the political level of each region municipality.

Opportunities to obtain financial support from provincial and federal sources should be investigated. Funding programs are available regarding recycling, waste minimization and environment conservation.

The region energy recovery strategy must integrate waste reduction and diversion initiatives throughout region municipalities. The project leadership group would facilitate collaboration with generators, public and private waste management operators, government and the community. A detailed work plan should be developed to define the critical activities, timelines and "go / no go" decision milestones.

Further detailed investigation and verification of energy recovery technologies is required based on the results of this study. This investigation should include the selection of the appropriate technology and preliminary budget information. Opportunities to partner with energy recovery technology providers and with private industry should also be considered.

Investigate active advanced energy recovery projects in Alberta and Canada.

A cost analysis of waste management alternatives should be conducted. That analysis should include the environmental, health and social costs in addition to the economic costs. Preliminary budget information from the investigation of technologies should also be included in this analysis.

Did You Know...
"*There is a 79 per cent increase in costs (1996 - 2004) associated with waste management expenditures for Alberta municipalities*"
(Waste Facts, 2007)

9.0 Supplemental Information

9.1 Methodology Overview

Primary and secondary research was conducted to collect data from relevant sources, based on the objectives of the study. Mail and telephone surveys were used for primary data collection to determine types of waste, amounts, major composition of the wastes and locations.

For purposes of information collection, separate databases of generators and waste management operators in the SAAEP region were developed. Names, addresses, telephone numbers and contact information was obtained and filtered for sites within the SAAEP region (Refer to Section 9.5, SAAEP Region Map).

Two questionnaires for distribution by mail were developed: Generator Mail Survey and Operator Mail Survey. Copies of these questionnaires are provided in Section 9.8 and Section 9.9.

A design consideration for the questionnaires included the understanding that typical response rates to mail surveys is low. Questionnaires were designed to elicit basic information and to make the process easy for the participant. A cover letter from the SAAEP Project Coordinator was provided with the survey forms. The cover letter introduced the survey and listed benefits relating to both the environment and costs that may accrue from the project. The survey cover letter included a toll free telephone help number and a help contact name. Companies were assured of confidentiality and the contact person was requested to complete the survey and return by a designated date. A postage-paid survey return envelope was included in the mail out package.

Questions regarding facility operating schedules and facility capacities were excluded to protect participant confidentiality. It was also determined that data regarding process details, types of waste and volumes would not be linked to surveyed participants. Generators were requested to provide a company profile and company contact information.

To increase the response rate, clarify survey responses and to collect additional information telephone surveys and site visit interviews were conducted as part of the data collection process. Site visit Interview Surveys were developed, both for generators and for operators. Copies of these questionnaires are provided in Section 9.10 and Section 9.11.

A total of 116 generators and 9 operators were identified in the SAAEP region. Surveys were mailed to each generator and operator.

Respective survey packages were sent by mail to generators and operators on October 12, 2007. The designated return date was October 26, 2007. Mail surveys were received until November 9, 2007. Telephone calls to participants and site visit interviews were conducted from October 4 to December 4, 2007.

Telephone calls to the toll free help number were received from October 17 to November 2, 2007.

Total project data collection processes consisted of:

- Surveys
- In-person interviews
- Telephone interviews
- Site visits
- Internet
- Library / Database
- Technical resources
- Trimark Engineering Team members past experience
- Review of existing studies and reports
- Government data and statistics

Data comparisons, data accuracy crosschecking and quality control exercises were conducted throughout the duration of the study.

Waste quantity and waste management cost data collected for the study follows assumptions used by Alberta Environment and the Canadian Council of Ministers of the Environment.

Not all generators and waste management organizations that operate in the region were surveyed. Not all exported waste and imported waste was identified. Due to the nature of the waste management system, not all residential, commercial and industrial waste management activity in the region is captured. The data has been compared to provincial and national data and is considered accurate in identifying waste quantities, types and long-term waste disposal trends.

9.2 Glossary of Terms

Table 11 - Glossary of Terms

TERM	DEFINITION
3 Rs	Reduce, Reuse, Recycle
4 Rs	Reduce, Reuse, Recycle, Re-think/Recover
AD	Anaerobic Digestion
AERI	Alberta Energy Research Institute
Anaerobic Digestion	Waste treatment technology that process in which microorganisms break down biodegradable material in the absence of oxygen (Wikipedia, 2007).
APC	Air Pollution Control
Asphalt	Asphalt paving material.
Biosolids	Nutrient-rich organic materials resulting from the treatment of sewage in a treatment facility. Biosolids are treated sewage sludge.
BNQ	Le Bureau de normalisation du Quebec
BTA	(Patented Process)
C:N	Carbon/Nitrogen
C&D	Construction and Demolition
Carcasses	Carcasses and pieces of small and large animal, unless the item is the result of food preparation in a household or commercial setting. For example, fish or chicken entrails from food preparation and raw, plucked chickens will typically be classified as food, not as an animal carcass, unless the material is from an agricultural or industrial source.
CCME	Canadian Council of Ministers of the Environment
CH4	Methane
CHP	Combined Heat and Power
CO2	Carbon Dioxide
Commercial Waste	Waste originating from businesses, government agencies, or institutions having SIC “major group” designations ranging from 41 to 97
Commingled	To mix or mingle together; combine.
Composition	The average mixture of materials, usually expressed in terms of percents, found in a clearly defined segment of the waste stream.
Compost	The aerobically decomposed remnants of organic matter.
Composting	The controlled aerobic decomposition of biodegradable organic matter, producing compost.
Concrete	Cement (mixed or unmixed), concrete blocks and similar wastes.
Construction and Demolition Waste	Waste originating from businesses engaged in construction or demolition of structures as their primary business activity.
Consumer Waste	Waste originating from households.
Crop Residues	Vegetative materials that are left over from growing crops and that are treated as a waste.
Dioxin	Toxic hydrocarbons that occur as impurities in petroleum-derived herbicides, disinfectants, and other products (Dictionary.com, 2007).
Diversion	See Waste Diversion

TERM	DEFINITION
DRE	Common measurement of performance for Destruction and Removal Efficiency (DRE) for a designated component in waste. DRE is usually expressed as a percentage. The standard of performance for incinerators used for hazardous waste treatment that has been adopted by all major environmental protection agencies, such as Environment Canada, Alberta Environment and the US EPA is 99.9999%.
EC	Environment Canada
eCO_2	Carbon Dioxide Equivalent
Endothermic	Relating to a chemical reaction during which there is absorption of heat (Dictionary.com, 2007).
Energy Recovery	Waste treatment that creates energy in the form of electricity and / or heat from sources that would have alternatively been disposed of in landfill.
EU	European Union
EPA	Environmental Protection Agency
FCM	Federation of Canadian Municipalities
Feedstock	Raw material supplied to a process
FFA	Federal Fertilizers Act
Fluid Bed Gasification	Waste treatment technology that uses a bed of limestone or sand that can withstand high temperatures is fed by an air distribution system. The heating of the bed and the increasing of the air velocities cause the bed to bubble. There is a heat transfer to an energy recovery system (Sound Practices Incineration, n.d.).
Food Waste	Food waste and scraps, including bones, rinds, etc., and including the food container when the container weight is not appreciable compared to the food inside.
Fossil Fuel	Are fossil source fuels, this is, hydrocarbons found within the top layer of the earth’s crust (Wikipedia, 2007).
Full Cost Analysis	The total of all real, definable and measureable costs, both direct and indirect and from all sources, incurred or attributed to the particular project or system in question.
Furan	Any of a group of colourless, volatile, organic compounds containing a ring of four carbon atoms and one oxygen atom. Furans are obtained from wood oils and used in the synthesis of many organic compounds (Dictionary.com, 2007).
Gasification	Waste treatment technology that converts carbonaceous materials, such as coal, petroleum, or biomass, into carbon monoxide and hydrogen by reacting the raw material at high temperatures with a controlled amount of oxygen (Wikipedia, 2007).
GHG	Greenhouse Gases
GMF	Green Municipal Funds (Administered by FCM)
GVRD	Greater Vancouver Regional District
H_2S	Hydrogen Sulphide
Hazardous Waste	Material designated as “hazardous waste” under the Waste Control Regulation, Government of Alberta. Commonly, unwanted substances that may damage the environment and pose a threat to human safety.
HSW	Household Special Wastes

TERM	DEFINITION
Hydrogeology	Area of geology that deals with the distribution and movement of groundwater in the soil and rocks of the Earth.
IC	Industry Canada
IC&I	Industrial, Commercial and Institutional
IMUS	Integrated Manure System
IPCC	Intergovernmental Panel on Climate Change
IWM	Integrated Waste Management
Kg	Kilograms
kWh	Kilowatt-Hour
kW-hr	Kilowatt-Hour
Landfill	Or dump or tip, is a site for the disposal of waste materials by burial and is the oldest form of waste treatment. Landfills are the most common methods of organized waste disposal. Landfills are also used for other waste management purposes, such as temporary storage, consolidation and transfer, or processing of waste material (sorting, treatment, recycling or recovery).
Landfill Classification	LANDFILL CLASSIFICATIONS (Alberta's Municipal Waste Action Plan, 2004-2006) Landfills, in Alberta, are generally classified by the waste they receive. The required design elements for landfill facilities are defined through the Waste Control Regulation and the Code of Practice for Landfills. Class I Landfill: • Accepts hazardous wastes for disposal within the limits as set out in the Waste Control Regulation. • Constructed with two liners (one synthetic) a primary leachate collection and removal system and a leachate collection and removal system between the two liners. Class II Landfill: • May accept wastes for disposal not including hazardous wastes as set out in the Waste Control Regulation. Class III Landfill: • May only accept inert wastes defined as: o a waste that is solid; and o a waste that, on disposal in a landfill, is not reasonably expected to undergo physical, chemical, or biological changes to such an extent as to produce substances that may cause an adverse affect, and includes, but is not limited to demolition debris, concrete, asphalt, glass, ceramic materials, scrap metal and dry timber or wood that has not been chemically treated, but does not include hazardous wastes.
Leachate	Leachate is the liquid that drains or 'leaches' from a landfill; it varies widely in composition regarding the age of the landfill and the type of

TERM	DEFINITION
	waste that it contains. It usually contains both dissolved and suspended material.
Lean Manufacturing	Methodology to minimize the resources required for production by eliminating non-value added activities that inflate costs, lead times and inventory requirements.
Manure	Animal manures and human feces, including kitty litter and any materials contaminated with manures and feces.
MRF	Material Recovery Facility. A specialized plant that receives, separates and prepares recyclable materials for marketing to end-user manufacturers.
MSW	Municipal Solid Waste. Waste managed by municipalities including waste from homes, businesses, institutions, industries and construction activities. Does not include waste from industrial processes, biomedical or hazardous wastes.
Mulch	Protective cover placed over the soil, primarily to modify the effects of the local climate but may also be applied to control weeds or retain water.
MWC	Mixed Waste Composting
MW	Mixed Waste (Unsorted MSW)
MWe	Megawatt
MWIN	Municipal Waste Integrated Network
MWt	Megawatt thermal
MWth	Megawatt thermal
NG	Natural Gas
NRCan	Natural Resources Canada
PGP	Plasma Gasification Process
Plasma Arc Gasification	Waste treatment technology that uses high electrical energy and high temperature created by an electrical arc gasifier (Wikipedia, 2007).
PRRS	Plasma Resources Recovery System
PSI	Pounds per Square Inch
Pyrolysis	Waste treatment technology that use chemical decomposition of organic materials by heating in the absence of oxygen or any other reagents, except possibly steam (Wikipedia, 2007).
RCA	Recycling Council of Alberta
RDF	Refuse-derived Fuel
RPS	Renewable Portfolio Standards
SAAEP	Southern Alberta Alternate Energy Partnership. A partnership of Economic Development Lethbridge, SouthGrow Regional Initiative and Alberta SouthWest Regional Alliance to facilitate the development of alternate energy systems and attract related businesses.
Sanitary Landfill	See Landfill
Sludges	Sludges and other wastes from industrial sources that cannot easily be fit into other material categories. May include liquids and semi-solids but only if these materials are treated as a solid waste.
SCC	Standards Council of Canada
SRF	Solid Recovered Fuel
SSO	Source Separated Organics

TERM	DEFINITION
STDC	Sustainable Technology Development Canada
Syngas	Synthetic gas; gas mixture that contains varying amounts of carbon monoxide and hydrogen generated by the gasification of a carbon containing fuel to a gaseous product with a heating value (Wikipedia, 2007).
TEAM	Technology Early Action Measures (Program under NRCan)
Thermal Inertia	Used by scientists and engineers modeling heat transfers and is a bulk material property related to thermal conductivity and volumetric heat capacity (Wikipedia, 2007).
Thermal Treatment	Waste treatment technology that involves high temperatures in the processing of the waste feedstock (Wikipedia, 2007).
Tipping Fee	The fee levied upon a given quantity of waste received at a waste processing facility.
tpd	Tonnes per Day
tpy or t/y	Tonnes per Year
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
Vitrified	Changed or made into glass or a glassy substance, especially through heat fusion (Dictionary.com, 2007).
VSS	Volatile Suspended Solids
Waste	Materials or by-products that are unwanted by the producer.
Waste Diversion	A method whereby waste is diverted from landfills through recycling, reuse and reduction programs.
Waste to Energy (WtE)	Or energy-from-waste (EfW) is waste treatment that creates energy in the form of electricity and / or heat from sources that would have alternatively been disposed of in landfill, also called energy recovery.
Waste Streams	Types of waste generated by the same business having different quantity or composition characteristics and placed in separate containers or handled through distinct processes.
WTE	See Waste to Energy
Yard, Garden and Prunings	Category of waste that includes grass clippings, leaves and weeds, and prunings six inches or less in diameter

9.3 Technology Providers Contact List

Table 12 - Technology Providers Contact List

Company	Contact	Location	Phone Number
Ebara Environmental Engineering	Adrian Selinger	Zurich, CH	+41-44-307-35-20
Energy Products of Idaho	Joe Goggin	Coeur d'Alene, ID	208-765-1611
Enerkem Technologies Inc.		Montreal, PQ	514-875-0284
OE Gasification	Jan d'Ailly	Waterloo, ON	519-884-9170
PlascoEnergy Group Inc.	Andrea G. Foottit	Ottawa, ON	613-591-9438 ext.225
Prairie Biogas	Jim Ireland	Regina, SK	306-337-2057
Pyrogenesis	Gillian Holcroft	Montreal, PQ	514-937-0002
Red Deer County	Earl Kinsella	Red Deer, AB	403-350-2150
Startech Environmental Corporation	Chad C. Gonzales	Wilton, CT	203-762-2499 ext.140
Thermogenics, Inc.	Tom Taylor	Albuquerque, NM	505-463-8422

9.4 PowerPoint Presentation

9.5 SAAEP Region Map
(Southern Alberta Alternative Energy Partnership, 2007)

9.6 SAAEP Region Population Centres

Table 13 - SAAEP Region Population Centres, 2006
Statistics Canada (2006)

Geographic Name	Geographic Type	Population - 2006
Arrowwood	VL	221
Barnwell	VL	613
Barons	VL	276
Cardston	T	3,452
Cardston County	MD	4,037
Carmangay	VL	336
Champion	VL	364
Claresholm	T	3,700
Coaldale	T	6,177
Coalhurst	T	1,523
Coutts	VL	305
Cowley	VL	219
Crowsnest Pass	T	5,749
Fort Macleod	T	3,072
Glenwood	VL	280
Granum	T	415
Hillspring	VL	192
Lethbridge	CY	74,637
Lethbridge County	CM	10,302
Lomond	VL	175
Magrath	T	2,081
Milk River	T	816
Milo	VL	100
Nanton	T	2,055
Nobleford	VL	689
Picture Butte	T	1,592
Pincher Creek	T	3,625
Pincher Creek No. 9	MD	3,309
Raymond	T	3,205
Stavely	T	435
Stirling	VL	921
Taber	MD	6,280
Taber	T	7,591
Vauxhall	T	1,069
Vulcan	T	1,940
Vulcan County	CM	3,718
Warner	VL	307
Warner County No. 5	CM	3,674
Willow Creek No. 26	MD	5,337
TOTAL		**164,789**

CY - City   MD - Municipal District   VL - Village
CM - County   T - Town

9.7 SAAEP Region Landfill Sites and Regional Waste Management Authorities

Chief Mountain Regional Solid Waste Authority

Mr. Ardell Hartley, Chair
Box 154
Hillspring, AB T0K 1E0
PH: (403) 626-3418

Contact Info:
Mrs. Noell Smith, Secretary-Treasurer
Box 1711
Cardston, AB T0K 0K0
(403) 653-3366 fax: (403) 653-2499
E-mail: noell@cardston.ca
Don Sudo, Operations Manager, Landfill: (403) 653-2703 fax: (403) 653-2704

Members:
Cardston County, Towns of Cardston, Magrath and Raymond, County of Warner #5, Villages of Glenwood, Hillspring, Stirling, Coutts, Warner; Hamlets of New Dayton & Wrentham; Town of Milk River

Status:
Chief Mountain Landfill, also operates push pit type transfer stations at Standoff, Jefferson, Cardston, Glenwood/Hillspring, Mountain View, Del Bonita, Spring Coulee, Magrath, Welling, Raymond, Stirling, Coutts/Milk River, New Dayton, Warner, Wrentham, Masinasin and Waterton.

Crowsnest-Pincher Creek Landfill Association

Box 668
Pincher Creek, Alberta T0K 1W0

Contact info:
Mr. Ted Smith, Chair, M. D. Pincher Creek
Ms. Linda Wollman, Secretary-Treasurer
Mr. Bryan Morgan, Manager – Regional Landfill
Landfill: (403) 628-3849 fax: (403) 628-2258
E-mail: cnpc-bm@jrtwave.com

Members:
Town of Pincher Creek, Municipality of Crowsnest Pass, Village of Cowley and M.D. of Pincher Creek #9

Status:
Operates Crowsnest Pincher Creek Landfill @ Cowley.

<u>Lethbridge Regional Waste Management Commission</u>

P.O. Box 1594
Lethbridge, Alberta T1J 4K3

Contact info:
County of Lethbridge: (403) 732-4722 fax: (403) 732-4328
E-mail: lwieland@county.lethbridge.ab.ca
Eugene Wauters, Chair
Larry Thomson, Vice Chair
Kaylee Carpenter, Sec-Treasurer

Members:
County of Lethbridge, Town of Picture Butte and the Village of Nobleford

Status:
Uses the City of Lethbridge Regional Landfill. Has transfer stations at Picture Butte, Nobleford, Coaldale and Iron Springs

<u>Lethbridge Regional Landfill</u>

910 – 4th Ave. South
Lethbridge, AB T1J 0P6
Location: SW 4-10-21 W4M
Dave Schaaf, Waste Recycling Services Manager
(403) 320-3088 Fax: (403) 329-4657
E-mail: dschaaf@lethbridge.ca

<u>Taber and District Regional Waste Management Authority</u>

c/o MD of Taber
4900-50 Street
Taber, AB T1G 1T2

Contact Info:
Mr. Donald. Johnson, Chair
Mr. Bryan Badura, Manager
(403) 223-3541 fax: (403) 223-1799

Members:
MD of Taber, Town of Taber, Town of Vauxhall, Village of Barnwell.

Status:
Transfer stations located at Taber, Vauxhall, Enchant, Hays and Grassy Lake (transferred to Lethbridge Regional Landfill Facility).

<u>Vulcan District Waste Commission</u>

Box 180
Vulcan, AB T0L 2B0

Contact Info:
Meryl Wyatt, Chair
Emmet Meehan, Vice Chair
Dick Ellis, General Manager cell # 403-485-8442
(403) 485-2241 fax: (403) 485-2920
E-mail: vcounty@telusplanet.net

Members:
Town of Vulcan, Vulcan County, Arrowwood, Carmangay, Champion, Lomond, Milo

Status:
Transfer stations at Champion/Carmangay, Milo, Lomond, Vulcan & Mossleigh (transferred to Lethbridge Regional Landfill Facility).

<u>Willow Creek Regional Waste Management Services Commission</u>

Box 2820
Claresholm, AB T0L 0T0

Contact Info:
Mr. Gerry McGuire, Chair
Barry Johnson, Vice Chair
Mr. Fred Goodfellow, Secretary-Treasurer
(403) 687-2603 Fax (403) 687-2606
Email: wcrwnsc@telusplanet.net

Members:
M.D. of Willow Creek, Towns of Stavely, Claresholm, Granum and Fort McLeod

Status:
Willow Creek Class II Regional Landfill (8 miles southeast of Claresholm).

9.8 Generator Mail Survey

Document attached.

Waste to Energy Treatment Alternatives in Southwest and South-Central Alberta Survey

By-products and wastes from processing, manufacturing and agriculture are often costly to the waste generator and have a negative impact on the environment. While some by-products are successfully reused in Southwest and South-Central Alberta, large amounts are disposed of through landfill and as sewage. Increased landfill costs and waste disposal costs have led to an investigation of treatment of waste to produce energy.

Determining the location, composition and quantity of wastes is the first step to determine feasibility of treatment alternatives. Data from this survey will enable the SAAEP to assist generators of waste to identify alternatives.

Your participation in this Survey will lead to economic and environmentally sustainable solutions that may benefit your Company and all of us who live in Southwest and South-Central Alberta.

To maintain confidentiality, the Survey Report will not link data to specific generators of waste. Please complete this Waste Survey and return by October 26, 2007, using the enclosed postage paid envelope. If you prefer to complete the Survey on your computer, please call the telephone number below and a copy will be emailed to you. Thank you in advance for your assistance.

Questions about the Waste Survey?
Call Jeff Takeyasu, Trimark Engineering, in Lethbridge 328-2910 or toll free: (866) 328-2910.

Waste to Energy Treatment Survey

Please use the back of the page or attach pages if more space is required.

1. Company name and address at which wastes are generated:

   ____
   ____
   ____

2. Name, title and phone number of contact person:

   ____
   ____
   ____

3. Principal products produced at this facility:

   ____
   ____
   ____

4. Describe principal wastes types and amount of each type generated per time period at this facility:

Waste Type	Amount
Example: Used fryer oil (canola) contains potato fines	*2,000 kg. per week*

5. Describe current pre-treatment, if any, of wastes before discharge:

____
____
____

6. Wastes are recycled or discharged to (type, amount, destination, cost / revenue):

Waste Type	Amount	Destination	Discharge Cost or Revenue from discharge in $ per unit
Example: Used fryer oil	*2,000 kg. per week*	*Jean's Swine Feed*	*Revenue of $0.30 per kg.*

7. Describe the known pollutants in the discharge which are controlled by municipal, provincial or federal standards:

____
____
____

8. Describe barriers to recycling of the wastes generated at this facility:

____
____
____

9. Additional comments or questions:

____
____
____
____

9.9 Operator Mail Survey

Document attached.

Waste to Energy Treatment Alternatives in Southwest and South-Central Alberta Survey

Disposal of by-products and wastes from processing, manufacturing and agriculture is often costly and may have a negative impact on the environment. While some by-products are successfully recycled and reused in Southwest and South-Central Alberta, large amounts are disposed of through landfill and as sewage. Increased landfill costs and waste disposal costs have led to an investigation of treatment of waste to produce energy.

Determining the location, composition and quantity of wastes is the first step to determine feasibility of treatment alternatives. Data from this survey will enable SAAEP to assist generators of waste, transporters of waste, waste disposal agencies and regulators to identify alternatives.

Your participation in this Survey will lead to economic and environmentally sustainable solutions that may benefit your organization and all of us who live in Southwest and South-Central Alberta.

To maintain confidentiality, the Survey Report will not link data to specific generators of waste. Please complete this Waste Survey and return by October 26, 2007, using the enclosed postage paid envelope. If you prefer to complete the Survey on your computer, please call the telephone number below and a copy will be emailed to you. Thank you in advance for your assistance.

Questions about the Waste Survey?
Call Jeff Takeyasu, Trimark Engineering in Lethbridge 328-2910 or toll free: (866) 328-2910.

Waste to Energy Treatment Survey

Please use the back of the page or attach pages if more space is required.

1. Name and address of facility:

   ____
   ____
   ____

2. Is this a regional facility? If so, what municipal areas are served by this facility?

   ____
   ____
   ____

3. Name, title and phone number of contact person:

   ____
   ____
   ____

4. Principal wastes and amounts accepted at this facility (please estimate if current statistics are not available):

Waste Type	Amount
Example: Residential, bagged waste	*2,500 tonnes per year*
Residential	
Industrial	
Commercial	
Institutional	
Biomedical	
Construction and Demolition	
Agricultural	
Pesticide Containers	
Plastics	
Soils	
Tires	
Other Types or Categories:	

5. Waste facilities may charge a fee to accept certain materials. Waste facilities may accept other materials and not charge a fee. If a rate schedule or list of tipping fees for your facility is available, please include a copy with the returned survey or list below the waste types accepted at your facility and the fee charged.

Waste Type	Charge to Generator
Example: Demolition Materials	*$25.00 per tonne*
Example: Paper	*No charge*

6. Describe wastes types and amount of each type received at the facility that are disposed by landfill (not recycled or sent to an alternate treatment facility):

Waste Type	Land Fill Per Year	Cost Per Tonne to Transport to Land Fill Site	Land Fill Tipping Fee Per Tonne
Example: Residential, bagged waste	*2,000 tonne*	*$15.00*	*$45.00*

7. What is the total amount per year from this facility disposed to land fill: _______________
(if this amount does not match the totals of Land Fill Per Year in Question 6, please explain):
____
____
____

8. Please provide the location of the landfill site used by this facility:
____
____
____

9. Additional comments and questions:
____
____
____
____
____
____
____
____
____

9.10 Generator Interview Survey

Document attached.

Waste to Energy Treatment Alternatives in Southwest and South-Central Alberta (Industry)

Date of Interview:

Company: Contact:

1. Company name and address at which wastes are generated:

2. Name, title and phone number of contact person:

____

____

3. Principal products produced at this facility:

____

____

____

4. Describe principal wastes types and amount of each type generated per time period at this facility:

Waste Type	Amount
Example: Used fryer oil (canola) contains potato fines	*2,000 kg. per week*

5. Wastes are recycled or discharged to (type, amount, destination, cost / revenue):

Waste Type	Amount	Destination	Discharge Cost or Revenue from discharge in $ per unit
Example: Used fryer oil	*2,000 kg. per week*	*Jean's Swine Feed*	*Revenue of $0.30 per kg.*

6. Describe barriers to recycling of the wastes generated at this facility:
____
____
____

7. Are you familiar with technologies that convert waste to energy (if yes, skip to #9)?
____
____
____

8. Explain waste to energy - thermal process (heat); converts waste to energy; energy is harnessed.

9. What problems do you see in using thermal treatment to convert waste to energy?
____
____
____
____

10. Have you or your organization investigated any type of technologies to convert waste to energy?
____
____

    a. If so, which technologies did you investigate?
    ____
    ____
    ____
    ____

    b. Problems or obstacles identified?
    ____
    ____
    ____
    ____

    c. Conclusions reached?
    ____
    ____
    ____
    ____

11. Is waste to energy treatment viable in SAAEP region municipalities?
____
____
____
____

12. SAAEP region municipalities are investigating waste to energy treatment alternatives. Do you have any recommendations for the region's municipalities?

____
____
____
____

13. Additional comments or questions:

____
____
____
____

9.11 Operator Interview Survey

Document attached.

TRIMARK ENGINEERING LTD

Economic Development LETHBRIDGE | SW ALBERTA SOUTHWEST | SouthGrow Regional Initiative

Waste to Energy Treatment Alternatives in Southwest and South-Central Alberta (Operator)

Date of Interview: ______________

Company: ____________________ Contact: ___________________

1. Name and address of facility:
   ____
   ____
   ____

2. Is this a regional facility? If so, what municipal areas are served by this facility?
   ____
   ____
   ____

3. Name, title and phone number of contact person:
   ____
   ____

4. Principal wastes and amounts accepted at this facility (please estimate if current statistics are not available):

Waste Type	Amount
Example: Residential, bagged waste	*2,500 tonnes per year*
Residential	
Industrial	
Commercial	
Institutional	
Biomedical	
Construction and Demolition	
Agricultural	
Pesticide Containers	
Plastics	
Soils	
Tires	
Other Types or Categories:	

5. Waste facilities may charge a fee to accept certain materials. Waste facilities may accept other materials and not charge a fee. If a rate schedule or list of tipping fees for your facility is available, please include a copy with the returned survey or list below the waste types accepted at your facility and the fee charged.

Waste Type	Charge to Generator
Example: Demolition Materials	*$25.00 per tonne*
Example: Paper	*No charge*

6. Describe wastes types and amount of each type received at the facility that are disposed by landfill (not recycled or sent to an alternate treatment facility):

Waste Type	Land Fill Per Year	Cost Per Tonne to Transport to Land Fill Site	Land Fill Tipping Fee Per Tonne
Example: Residential, bagged waste	*2,000 tonne*	*$15.00*	*$45.00*

7. What is the total amount per year from this facility disposed to land fill: ________________
(if this amount does not match the totals of Land Fill Per Year in Question 6, please explain):
___
___
___

8. Please provide the location of the landfill site used by this facility:
___
___
___

9. Are you familiar with technologies that convert waste to energy (if yes skip to #11)?
____
____
____
____

10. Explain waste to energy - thermal process (heat); converts waste to energy; energy is harnessed.

11. What problems do you see in using thermal treatment to convert waste to energy?
____
____
____
____

12. Have you or your organization investigated any type of technologies to convert waste to energy?
____
____

    a. If so, which technologies did you investigate?
    ____
    ____
    ____
    ____

    b. Problems or obstacles identified?
    ____
    ____
    ____
    ____

    c. Conclusions reached?
    ____
    ____
    ____
    ____

13. Is waste to energy treatment viable in SAAEP region municipalities?
____
____
____
____

14. SAAEP region municipalities are investigating waste to energy treatment alternatives. Do you have any recommendations for the region's municipalities?

____

____

____

____

15. Additional comments and questions:

____

____

____

____

____

____

____

____

____

Did You Know...
"*Albertans fail to redeem more than $18 million worth of empty container deposits by not recycling each year*"
(Waste Facts, 2007)

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