Phase 3, Task 7:

Capital and Operating Costs

An assessment of life-cycle costs and benefits associated with potential development of an energy from waste facility.

IN SUPPORT OF:

Southern Alberta Energy-From-Waste Alliance
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Contents

Figures

Tables

1.0 Introduction

The Southern Alberta Energy-from-Waste Alliance (SAEWA) is a coalition of waste management jurisdictions committed to researching and recommending for implementation, technological applications for recovering energy from waste materials, and reducing reliance on landfills.

The membership of SAEWA consists of 16 waste authorities listed below and shown on Figure 1:

- Bow Valley Waste Management Commission
- Foothills Regional Services Commission
- MD of Ranchlands No. 66
- Crowsnest/Pincher Creek Landfill Association
- Willow Creek Regional Waste Management Services Commission
- Wheatland County
- Vulcan District Waste Commission
- Lethbridge Regional Waste Management Services Commission
- Town of Coalhurst
- Town of Coaldale
- Chief Mountain Regional Solid Waste Authority
- Newell Regional Solid Waste Management Authority
- Taber & district Regional Waste Management Authority
- North Forty Mile Regional Waste Management Commission
- South Forty Waste Services Commission
- Special Areas Board (Big Country)

In July 2010, with the assistance of a grant from Rural Alberta Development Fund, the consulting team led by HDR was retained to assist SAEWA in further exploring the opportunities to develop an Energy-from-Waste (EFW) facility in Southern Alberta. This research project consists of four (4) phases, each with a series of tasks as follows:

Phase 1 (Complete)

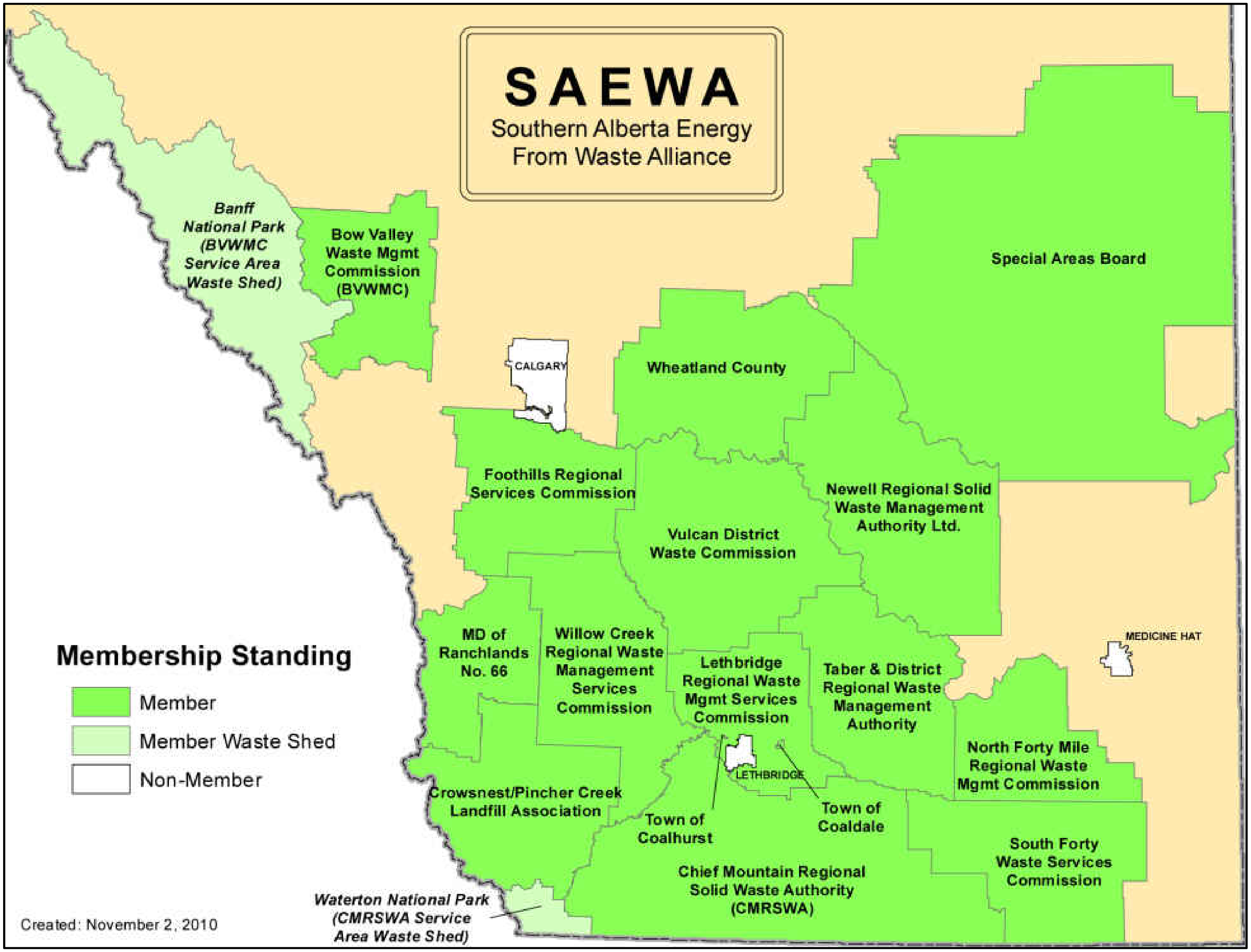
The completion of Phase 1 activities resulted in the identification of waste quantities potentially available to be managed, the size of the facility required to manage these materials; and identification of technologies capable of managing the quantity and composition of available waste streams including anaerobic digestion, refuse derived fuel (RDF) processing and combustion, mass burn combustion, gasification and plasma arc gasification.

Phase 2 (Complete)

- Task 3: Waste Collection, Transportation and Handling;
- Task 4: Heat Recovery/Cogeneration Options
- Task 5: Air Emissions, Greenhouse Gases and Control Options
- Task 6: Permitting, Siting and Future Project Schedule

The Phase 2 analysis concluded that no further consideration should be given to anaerobic digestion technology due to limited applicability, limited energy recovery potential and regulatory and operational challenges. The completion of Phase 2 activities resulted in the identification of waste collection, transportation and handling implications with associated siting opportunities; heat recovery and cogeneration options, including potential market/siting opportunities; an additional level of detail with respect to the environmental implications (including transportation impacts from Task 3), and the facility permitting and siting requirements. A future project development schedule was outlined.

Figure 1 – SAEWA Membership



Phase 3 (Current Task)

Phase 3 builds upon information developed in the preceding project tasks. The completion of Phase 3 activities will result in the identification of the financial and socio/economic implications of moving forward with the development of a facility(ies) and required supporting infrastructure.

Phase 4

The completion of Phase 4 activities may conclude with a visit to, and review of, operational facilities by SAEWA members. This phase will be concluded with the development of a summary report documenting the results of all study tasks and recommendations for next steps.

This report documents the results of Phase 3, Task 7 – Capital and Operating Costs.

2.0 Definitions, Methodology and Assumptions

2.1 Definitions

The following defines some key terms used in this analysis:

Capital cost - an outlay of cash to acquire a resource that will be used in MSW operations over more than one year. Capital outlays (past, present, and future) must be converted into annual costs for full cost accounting purposes.

External costs – are the costs of activities or resources that are the result of, but not directly assigned to or attributed to a specific activity or use of a resource. Sometimes referred to as hidden costs (e.g. depreciation of infrastructure, social/health care costs, long-term environmental liabilities).

Net cost per tonne - the common denominator for comparing the current costs of solid waste management activities or paths within or across local government jurisdictions.

2.2 Methodology and Assumptions

Sustainability is often referred to as the ability to "…meet the needs of the present without compromising the future…"[1]. Achieving sustainability is generally accepted as establishment and maintaining a balance of the interests of:

- The Environment;
- Society or the Community; and,
- Economy.

In simple terms economic sustainability can be considered as the achievement of equity between the sum total of all life cycle costs and financial contributions to an undertaking. Assessment and comparison of the alternatives against this principle forms the basis of the analysis in this report.

Life cycle costing or full cost accounting is[1], "a method of accounting for all monetary costs of resources used or committed for municipal solid waste (MSW) services" and "provides decision-makers with the whole picture of MSW costs in their community on an ongoing basis". Inclusion of long-term environmental liabilities, hidden costs and externalized costs is an important aspect of life cycle costing.

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[1] United Nations World Commission on Environment and Development, 1987

Historically many solid waste management decisions have focused primarily on short-term unit costs with an emphasis on operational outlays. This has contributed to an historic underestimate of the real long-term costs of waste management due to limited consideration of some long-term factors such as the consumption of land, creation of constraints on subsequent land-uses, mitigation of environmental effects, rehabilitation of legacy problems as well as uncertainties associated with the full duration and scope of aftercare.

The financial analysis presented herein models the life cycle costs of the four energy from waste options for comparison with an equivalent "hypothetical" centralized landfill scenario. The purpose of this approach is to provide a common basis to explore and examine the financial implications of each of the energy from waste options while also highlighting key distinctions from a landfill-based system.

This report outlines a number of key assumptions that were required to facilitate this analysis approach and provide a reasonable basis for comparison, taking into consideration that energy from waste undertakings differ from landfill disposal in many key areas. The following figures conceptually illustrate some of the key differences between the generic financial life cycles of a landfill and an energy from waste facility.

Figure 2 – Financial Life Cycle of a Landfill

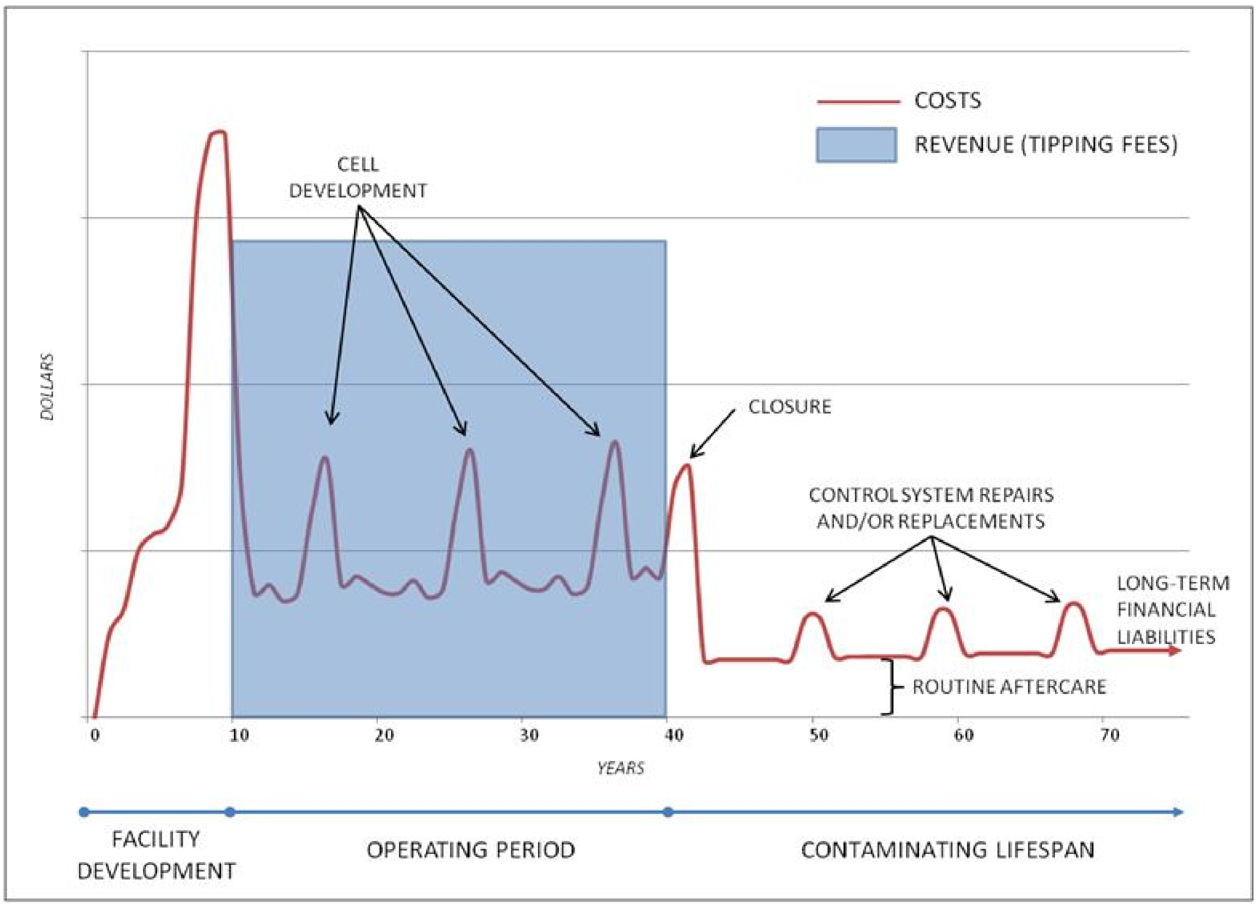
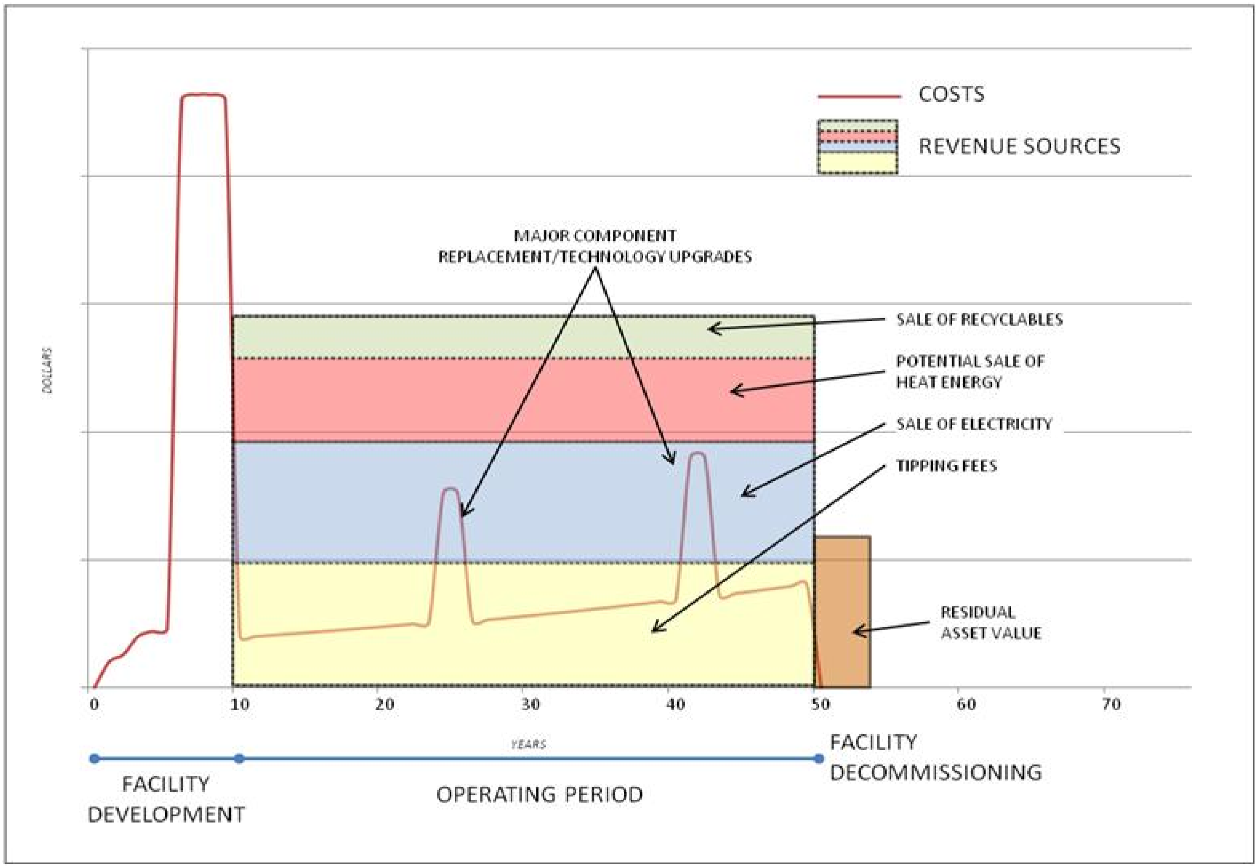


Figure 3 – Financial Life Cycle of an Energy from Waste Facility



Key distinctions between these profiles are:

- Greater up-front capital investment associated with energy from waste;
- Periodic re-investment in technology for energy from waste;
- Typically longer operational period for an energy from waste facility;
- A single source of revenue for landfill (assuming no landfill gas utilization) compared to multiple sources of revenue for energy from waste, including post-operational residual value of the facility; and,
- Uncertainty regarding the end-point of long-term financial liabilities often associated with landfills compared to the known termination of financial obligations following decommissioning of an energy from waste facility.

To inform decision making, the economic analysis will estimate costs for a proposed energy from waste based system in comparison with costs anticipated for the current landfill based system, taking into account the life cycle profiles as generalized above. Recognizing that a landfill or an energy from waste facility are both sub-components of a larger waste management system, to provide a reasonable basis for comparison between the two it is important to appropriately define the ‘boundaries’ for the elements to be included in the financial assessment. The bold elements shown in the following figures illustrate the boundaries applied to the two broad waste management systems being considered as the basis for comparison in this assessment.

Figure 4 – Boundaries of Current Landfill Based System

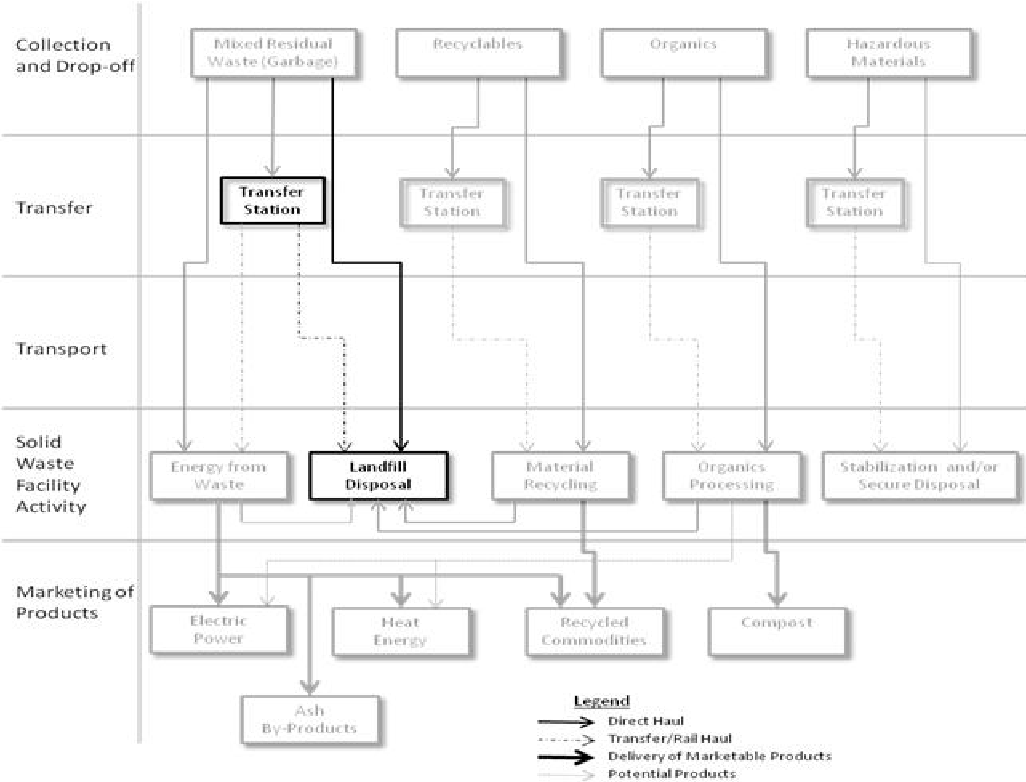
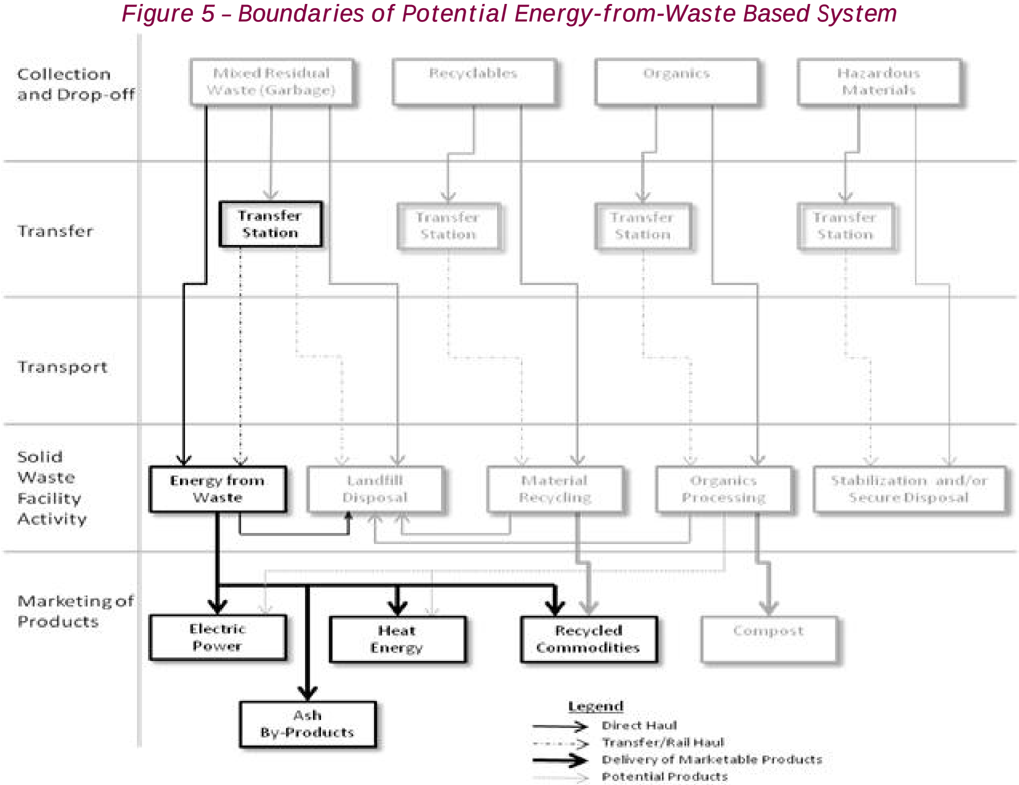


Figure 5 – Boundaries of Potential Energy-from-Waste Based System



Within the energy from waste based system, alternative scenarios are defined and analyzed for each of the technologies remaining under consideration, including:

- Refuse Derived Fuel (RDF) processing and combustion
- Mass burn combustion
- Gasification
- Plasma arc gasification

A number of assumptions are required to allow preparation of financial models for the landfill and energy from waste system scenarios. Table 1 lists the comparative scenarios and assumptions forming the basis for the financial analysis.

Table 1 - Key Assumptions

	Base Case	***Energy From Waste Based Systems***			
	Landfill System	***RDF and Combustion***	***Mass Burn Combustion***	***Gasification***	***Plasma Arc Gasification***
Waste available (tonne/year)	366,032				
Nominal facility size	366,032 (tonne/yr)	1,000 (tonne/day)	1,000 (tonne/day)	1,000 (tonne/day)	1,000 (tonne/day)
Capacity factor (%)	100	90	90	75	70
Waste disposed or processed (tonne/year)	366,032	328,500	328,500	273,750	255,500
Lifespan capacity (tonnes)	11 M	16.4 M	16.4 M	13.6 M	12.8 M
Facility operating lifespan (years)	30	50	50	50	50
Contaminating lifespan (years)	50	0	0	0	0
Electricity revenue ($/MW•hr)	NA	80.00[2]	80.00[2]	77.00[3]	77.00[3]
Ferrous metals recovery ($/tonne)	NA	50	50	50	50
Non-ferrous metals Recovery ($/tonne)	NA	750	750	750	750
Potential heat recovery ($/1000kg steam)	NA	8.24	8.24	8.24	8.24

NA = Not applicable

These assumptions and this analysis are focused on providing a reasonable basis for comparison of the options available. In consideration of some of the fundamental differences between the options and information that remains unknown or uncertain, this analysis should not be interpreted as an optimized "business case" or "business plan" for any of the options. The assumptions made are necessary to allow estimation of long-term costs and benefits on a common basis leading to an equitable life-cycle cost

[2] Assumed pool price of $60/MWhr plus Bioenergy Producer credit of $20/MWhr.
[3] Assumed pool price of $60/MWhr plus Bioenergy Producer credit of $17/MWhr.

comparison of the options to support decision-making. Detailed business planning for a specific facility is a subsequent activity that relies on additional information which can only be developed as SAEWA proceeds with decision-making regarding key matters such as technology selection and siting.

Key among the assumptions is selection of the nominal size of the facility to be assumed for the energy from waste scenarios. Facility size was assumed to be a nominal value of 1,000 tonnes/day for all energy from waste scenarios. This nominal size was chosen primarily as a valid basis for comparison based on the following key considerations:

- Realistic operating efficiencies;
- Consideration of potential input tonnage variations;
- Conservative application of appropriate unit costs relative to the scale of the facility; and,
- No over-sizing was assumed.

It is recognized that there may be alternative assumptions which could suggest that potentially greater financial advantages may be achievable in terms of economies of scale and/or revenue streams. It is felt that the assumptions that have been embedded in this analysis provide a reasonable and appropriate basis for comparison between the options. As commented previously, optimization of a business plan for any particular option or facility is best undertaken at a subsequent stage following initial decision-making. Later sections of this report discuss some of the opportunities for optimization that may exist for some of the options.

In general terms the financial analysis approach involves calculation of all costs (i.e. capital and operating) and revenues (i.e. electrical power and recovered recyclables) spanning the life cycle of each of the scenarios being considered. Financial carrying costs are included in the operating costs and residual asset values are assumed for the energy from waste facilities following the termination of operations. While greenhouse gas emission reductions would occur under all energy from waste scenarios, trading of emission reduction credits (“offsets”) has not been included as a revenue stream.

The overall net life cycle costs are tallied and then divided by the total waste tonnage managed under each scenario to define the average net life cycle unit cost (i.e. $/tonne) for each scenario. To reach this value, tipping fees were excluded from the revenue streams, allowing the average net life cycle unit cost to reflect a “break-even” condition. As a simplifying assumption for the purpose of this comparison only, all dollar figures are presented as 2011 values with no discount rates applied. Development of a future, more detailed business case of a preferred technology should include adjustments to account for the time cost of money.

3.0 Capital Costs

Capital cost estimates have been prepared for the five comparative scenarios including the following major cost elements:

- Planning, approvals and procurement
- Supporting infrastructure
- Facility design, construction, equipment and commissioning
- Future major replacements and technology upgrades
- Decommissioning and post-closure capital works
- Other miscellaneous capital costs

3.1 Landfill System

Capital cost estimates for an hypothetical landfill scenario were developed using recent cost information from existing Canadian landfills. The landfill capital cost estimate is based on the following:

- A central landfill facility sized for disposal of SAEWA's projected annual waste stream
- Approvals, design and construction to meet modern landfill standards including:
    - Leachate containment, collection and disposal/treatment
    - Landfill gas collection and flaring
    - Secure closure, environmental monitoring/reporting and post-closure care
    - Utility services, infrastructure, administration and operational support facilities
- Waste transfer facilities consistent with the current geographic distribution of waste in SAEWA
- No recovery of additional recyclables from waste collected and delivered to facility
- Engineered controls and systems as required to suit the life cycle requirements for a landfill including typical durations for operating and post –closure management (i.e. contaminating lifespan) periods

Table 2 presents the capital cost estimates developed for the landfill-based comparison scenario.

Table 2 - Capital Costs: Landfill System Scenario

Phases & Cost Components	*Cost ($2011)*
Pre-Development Period	
Planning, siting and approvals	12,000,000
Land acquisition	3,707,000
Development & Operating Period	
Transfer Stations	
Detailed design, infrastructure and siteworks	6,650,000
Facility construction	36,580,000
Equipment supply and installation	23,280,000
Landfill Facility	
Detailed design, infrastructure and siteworks	39,000,000
Facility construction	112,500,000
Equipment supply and installation	13,500,000
Closure & Post-Closure Period	
Facility closure	10,000,000
Post closure management	9,500,000
Post closure liabilities (i.e. contingency costs)	undefined
Total Capital Cost	**266,717,000**

The contaminating lifespan of a landfill is a key parameter which can vary from several decades to more than a hundred years dependent on many site-specific considerations. The period of post-closure management based on a contaminating lifespan of 50 years has been assumed as reasonable for the purpose of this comparison, however the duration of post-closure management at many landfills can be longer which can substantially increase the costs of the landfill.

Capital costs to address potential long-term contingencies should be recognized as real financial liabilities however are not defined in this analysis as these costs cannot reasonably be quantified with precision

Based on these considerations, this cost estimate should be taken as a reasonable, low-end estimate of the capital component of the life cycle costs of a landfill of this size.

3.2 Energy from Waste Systems

Capital cost estimates for the energy from waste scenarios were developed based on vendor budgetary quotations, the "RS Means Cost Estimating Guide", and HDR's experience with other projects and recent studies. For each scenario it was assumed that a greenfield site would be developed requiring construction of roads, utilities, drainage system, etc. however no design work has been done as no preferred site has been identified. The estimates assume typical site and infrastructure requirements and typical features for each type of technology.

Table 3 shows capital cost estimates for each of the energy from waste alternatives. It should be noted that the estimate for the gasification option is based on utilization of an advanced technology that requires no processing of MSW. While this may have somewhat higher relative costs for the core gasification technology system and power block, other costs such as additional processing and storage are avoided.

Table 3 - Capital Costs: Energy from Waste Systems

	Cost ($2011)			
Phases & Cost Components	***RDF Processing & Combustion***	***Mass Burn***	***Gasification***	***Plasma Arc Gasification***
Pre-Development Period				
Planning, siting and approvals	12,000,000	12,000,000	12,000,000	12,000,000
Land acquisition	500,000	500,000	500,000	500,000
Development & Operating Period				
Transfer Stations				
Design & siteworks	10,605,000	10,605,000	10,605,000	10,605,000
Facility construction	58,327,500	58,327,500	58,327,500	58,327,500
Equipment & installation	37,117,500	37,117,500	37,117,500	37,117,500
Energy from Waste Facility				
Sitework	229,000	229,000	124,000	124,000
Site improvements	1,500,000	1,500,000	1,500,000	1,500,000
Pre-processing equipment	19,700,000	$0	$0	14,200,000
Design / engineering	17,000,000	17,000,000	17,000,000	15,000,000
Buildings	30,900,000	17,600,000	17,600,000	30,900,000
Power block equipment	164,950,000	189,040,000	192,440,000	139,240,000
Capital contingency	43,500,000	41,700,000	42,300,000	37,200,000
Periodic technology upgrades	80,560,000	78,420,000	79,200,000	72,640,000
Post-Closure Period	0	0	0	0
Total Capital Cost	**476,889,000**	**464,039,000**	**468,714,000**	**429,354,000**

The energy from waste capital estimates include cost components corresponding to those included in the landfill estimate.

4.0 Operating Costs

Operating cost estimates have been prepared for the five comparative scenarios including the following major cost elements:

- Labour
- Consumables
- Utilities
- Maintenance
- Ash management
- Material transfer and transport
- Administration and finance
- Other miscellaneous operating costs

4.1 Landfill System

Table 4 provides an annual operating cost estimate for the landfill scenario, prepared using recent cost information from existing Canadian landfills

Table 4 - Annual Operating Costs: Landfill System Scenario

Operating Cost Components	***Cost ($2011/year)***
Wages, Salaries, and Benefits	4,400,004
Management Administration and Support	3,300,003
Supplies	366,667
Power and Fuel	366,667
Equipment Ownership/Rentals	1,833,335
Equipment Maintenance	476,667
General Site Maintenance	2,933,336
Leachate Treatment*	366,667
Leachate Hauling*	750,000
Contract Services*	623,334
Waste Transfer & Hauling	7,333,340
Annual Cost – Operating Period	**22,750,020**
Annual Cost – Post Closure Period*	**1,616,700**

4.2 Energy from Waste Systems

Operating cost estimates have been prepared for each of the energy from waste technologies being reviewed. The following is a summary of the estimates. As noted above for the capital cost estimate, the gasification estimate does not include MSW processing costs. At least one technology does not require processing of the feedstock. If the technology to be utilized requires processing; additional labor, fuel, and maintenance costs would be incurred. The calculations include consideration of the reliability of the technologies. The RDF and Mass Burn options are based on a 90% capacity factor, while gasification and plasma arc gasification are based on capacity factors of 75% and 70%, respectively. Estimates of annual operating cost are listed in Table 5.

Table 5 - Annual Operating Costs: Energy From Waste System Scenarios

Cost Components	***Energy From Waste Based Systems***			
	RDF and Combustion	**Mass Burn Combustion**	**Gasification**	**Plasma Arc Gasification**
Labour	$7,463,000	$5,485,000	$5,485,000	$7,463,000
Facilities maintenance	$454,000	$128,000	$153,000	$454,000
Stationary equip maintenance	$2,757,000	$2,867,000	$3,009,000	$2,325,000
Rolling stock maintenance	$265,000	$26,000	$26,000	$259,000
Equipment replacement costs	$241,000	$97,000	$97,000	$241,000
Utilities	$140,000	$139,000	$149,000	$143,000
Reagents	$1,395,000	$1,395,000	$1,163,000	$1,085,000
Fuel	$847,000	$88,000	$88,000	$822,000
Ash Disposal	$4,199,000	$3,500,000	$2,916,000	$2,722,000
General & administration	$355,220	$274,500	$261,720	$310,280
Overhead & profit	$1,812,000	$1,400,000	$1,335,000	$1,582,000
Insurance	$193,000	$193,000	$193,000	$193,000
Waste haul & transfer	$6,570,000	$6,570,000	$5,475,000	$5,110,000
Contingency (10%)	$2,669,122	$2,216,250	$2,035,072	$2,270,928
Annual Operating Costs ($2011)	**$29,360,342**	**$24,378,750**	**$22,385,792**	**$24,980,208**

5.0 Revenue Streams

Revenue estimates have been prepared for the five comparative scenarios including sales of electrical power and recovered recyclables as primary revenue streams. All electric operation is estimated.

Table 6 - Revenue Streams

Revenue Streams	***RDF and Combustion***	***Mass Burn***	***Gasification***	***Plasma Arc Gasification***
Power				
Price ($/kW•h)	0.08	0.08	0.077	0.077
Unit Power Production (kW•h/tonne)	540	602	475	320
Annual Production (kW•h/yr)	177,390,000	197,757,000	130,031,250	81,760,000
Electricity Revenue ($/yr)	$14,191,200	$15,820,560	$10,012,000	$6,296,000
Metals Recovery				
Ferrous Recovery (%)	2.50%	2.50%	2.50%	2.50%
Ferrous Recovery (tonne/yr)	8,213	8,213	6,844	6,388
Ferrous Recovery ($/tonne)	$50	$50	$50	$50
Ferrous Recovery Revenue ($/yr)	$410,650	$410,625	$342,000	$319,000
Non Ferrous Recovery (%)	0.35%	0.35%	0.35%	0.35%
Non Ferrous Recovery (tonne/yr)	1150	1150	958	894
Non Ferrous Recovery ($/tonne)	$750	$750	$750	$750
Non Ferrous Recovery Revenue ($/yr)	$862,500	$862,313	$719,000	$671,000
Total Metals Recovery Revenue ($/yr)	$1,273,150	$1,272,938	$1,061,000	$990,000
Total Revenue ($/yr)	**$15,464,350**	**$17,093,498**	**$11,073,000**	**$7,286,000**

Potential Heat Sales

Production of heat energy in combination with electrical power generation is often referred to as combined heat and power (CHP) or cogeneration. Each of the combustion technologies being considered provides the opportunity to recover marketable heat energy in the form of steam. In the production of electricity considered in the revenue estimates, steam is produced and used in a turbine generator to produce electricity while the steam that is exhausted from the turbine is condensed and reused in the cycle as boiler feedwater. Heat rejected in the condensation process represents a loss of energy. Recovery and use for the heat from the steam that would otherwise be lost during the condensation process increases the overall thermal efficiency of the system, however it should be recognized that this also typically reduces the electrical output potential of a facility somewhat.

The marketability of recovered steam heat is dependent on the presence of one or more heat energy consumers with compatible heat demand profiles, located within a reasonable distance from the energy from waste facility. A firm decision regarding the feasibility of steam sales can not be determined definitively until a site is selected and discussions with a specific customer are initiated. Because of this and taking into consideration marketing opportunities in the area, electrical power should be considered the primary energy product of a potential SAEWA energy from waste facility. Sale of steam for heating purposes is an attractive supplementary energy output that should be considered if opportunities are available.

The following analysis is provided to illustrate the potential benefit, should opportunities for recovery and sale of steam heat be realized. In the Task 4 report, a hypothetical value of $8.24 per 1,000 Kg of steam was developed. Task 4 also included ranges of potential steam available for each of these technologies which are reiterated below together with the maximum potential revenue calculated based on the expected capacity factor of each technology.

Table 7 - Potential Heat Revenue

Technology	Potential Steam (1000's kg/hr)	Potential Annual Revenue
RDF processing and combustion	160 – 200	$10.3 - $13.0 Million
Mass Burn Combustion	180 – 220	$11.7 – $14.3 Million
Gasification	120 – 180	$6.5 - $9.7 Million
Plasma Arc Gasification	55 – 125	$2.8 - $6.3 Million

It is unlikely that a steam customer could be identified that would be in a position to purchase all of the quantities of steam indicated above. Without identification of a specific steam customer and the associated usage profile, the estimates above have little meaning other than to point out that locating a reliable steam customer with a consistent load profile would significantly improve facility economics.

6.0 Analysis

6.1 Financial Life Cycle Results

Table 8 presents a summary of the financial life cycles for a hypothetical landfill scenario in comparison with the four energy from waste options under consideration.

Table 8 - Financial Life Cycle Summary

	Base Case	*Energy From Waste Based Systems*			
	Landfill System	**RDF and Combustion**	**Mass Burn Combustion**	**Gasification**	**Plasma Arc Gasification**
Total Waste Disposed (tonnes)	*11,000,000*	*16,425,000*	*16,425,000*	*13,687,500*	*12,775,000*
Operating Lifespan (years)	*30*	*50*	*50*	*50*	*50*
Lifecycle Expenditures					
Capital	$266,717,000	$476,889,000	$464,039,000	$468,714,000	$429,354,000
Operating	$763,333,950	$1,664,446,100	$1,356,937,500	$1,272,689,600	$1,414,693,400
Total Expenditures	$1,030,050,950	$2,141,335,100	$1,820,976,500	$1,741,403,600	$1,844,047,400
Gross Lifecycle Unit Cost ($/tonne)	94	130	111	127	144
Lifecycle Revenues					
Electricity Sales	0	$709,560,000	$791,028,000	$500,620,313	$314,776,000
Sale of Recyclables	0	$63,657,500	$63,646,875	$53,039,063	$49,503,125
Total Revenue	0	$773,217,500	$854,674,875	$553,659,375	$364,279,125
Residual Asset Value	0	$25,000,000	$25,000,000	$25,000,000	$25,000,000
Net Lifecycle Cost	$1,030,050,950	$1,343,117,600	$941,301,625	$1,162,744,225	$1,454,768,275
Net Lifecycle Unit Cost ($/tonne)	**94**	**82**	**57**	**85**	**114**

Key information to note regarding this summary includes the following:

- Gross capital and operating costs and gross unit costs for all energy from waste options are much higher than for landfilling
  - For energy from waste options only, these higher capital and operating costs are offset to varying degrees by revenue from sale of power and recovered recyclables
- On average, net life cycle unit costs for the energy from waste options are comparable or lower than the net life cycle unit costs for landfill
- The estimated costs of landfilling do not include allowances for undefined potential long-term post-closure liabilities that can be associated with landfills
- Among all scenarios and options being analyzed, mass burn energy from waste offers the lowest net life cycle unit cost. This is primarily due to the following:
  - Longer operating lifespan than landfill
  - Greater waste processing capacity
  - Highest electrical generation efficiency of energy from waste options
  - Lack of long-term financial liabilities following facility closure
- The estimated revenues for energy from waste options do not include potential steam heat sales nor sales of greenhouse gas emission reductions

Subject to the assumptions inherent in the analysis, this information suggests that indicates that mass burn energy from waste offers the lowest overall net costs of the options considered.

6.2 Community Factors

Key community financial considerations typically associated with potential development of an energy from waste facility include:

- Job creation
- Indirect or "spin-off" employment and business opportunities
- Effect on property values

It is anticipated that development of an energy from waste facility of the size under consideration would result in creation of roughly 200 full-time construction jobs spanning a period of roughly four years. Over the long-term, roughly 30 to 40 permanent positions would be created associated with operation of the facility.

Additional indirect employment and business opportunities would be expected to result from provision of materials and services to the facility, as well as "spin-off" employment and opportunities associated with the temporary and permanent workforce increases.

Anticipation of development of any waste management facility frequently raises expressions of concern regarding the potential for negative impacts on local property values. Studies have indicated that there is no long-term negative impact on sale-ability or property values in the vicinity of energy from waste facilities. In a situation where district energy can be implemented, property values may even increase due to attraction of energy consuming industries and potential increased development pressures.

Dependent on the approach taken, some energy from waste facilities are also developed to fill a role as a community asset incorporating features such as advanced architectural treatments, educational and conference/visitor centres, cultural venues, and other complementary functions.

6.3 Environmental Life Cycle Considerations

Environmental performance considerations are not typically addressed within the realm of quantifiable financial analyses however energy generation, emissions/greenhouse gases and waste diversion all represent key non-financial factors to take into account.

As the term suggests, "energy from waste" poses an approach to waste management which allows recovery of energy. The energy by-product recovered represents both a financial gain and a prudent resource management opportunity. Increasingly the public, industry and governments are recognizing the imperative for our society to become more efficient in the consumption and use of its finite resources. Recovery of energy from waste represents one option for improving on our resource management efficiency.

Emissions and local air quality are matters that are often expressed as concerns in the context of potential siting of an energy from waste facility. The Task 5 Report of this series concluded that energy from waste facilities equipped with modern air pollution control systems are capable of meeting stringent air emission criteria to protect air quality. In the same report it was also demonstrated that all energy from waste scenarios under consideration result in substantial greenhouse gas reductions in comparison to landfilling of waste.

Energy from waste processes also provide the opportunity for additional recovery of recyclables which may be present in the residual waste stream, above and beyond any recycling efforts that are in place in the community. This additional recovery of recyclables contributes to increased diversion from landfill disposal. While not quantified or included in this assessment, development and implementation of beneficial use of ash as construction aggregate or for other applications and further augment waste diversion associated with energy from waste.

Table 9 summarizes several of the key environmental indicators for the energy from waste options under consideration.

Table 9 - Key Environmental Life Cycle Parameters

Life Cycle Parameters	***RDF and Combustion***	***Mass Burn***	***Gasification***	***Plasma Arc Gasification***
Electricity Production (kW•h)	8,869,500,000	9,887,850,000	6,501,562,500	4,088,000,000
Additional Recyclables Recovered (tonnes)	468,150	468,113	390,094	364,088
Greenhouse Gas Emission Reductions* (tonnes)	4,555,000	5,810,000	3,785,000	2,225,000

* Relative to landfill.