Hamilton Material Recovery Facility
Energy Savings Assessment

Submitted to:

City of Hamilton
Operations & Waste Management Division
Public Works Department

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Confidentiality Statement

Rose Technology Inc. respectfully requests that Waste Diversion Ontario (WDO) and the City of Hamilton (Hamilton) treat this report and all matters connected with this report as confidential information and that WDO and Hamilton, or their agents, acting on their behalf, not disclose any of the foregoing to any person. If requested to disclose the foregoing, WDO and Hamilton will claim an exemption for disclosure to the Freedom of Information and Protection of Privacy Act and the Access to Information Act.

1.0 Executive Summary and Corporate Profile

1.1 Executive Summary

Rose Technology Inc. (Rose) is pleased to provide this report and proposal to the City of Hamilton for energy efficiency improvements at their Material Recovery Facility located at 1575 Burlington Street in Hamilton, Ontario.

Our site visit and subsequent analysis of energy bills provided by Horizon Utilities and Union Gas have resulted in recommendations for retrofits to the MRF as summarized here. Sections 2.0 through 6.0 of our report detail the retrofits which have an economic return as follows:

- **Total Program Cost - $471,081**
- **Net Program Cost (after incentives) - $424,118**
- **Energy Savings - $67,565/yr – a 25.6% reduction**
- **Simple Payback - 6.3 years**

Rose Technology provides all of the necessary services to undertake the detailed design and implementation of the energy retrofits.

1.2 Profile and Corporate History

I - A Long History of Providing Energy Performance Solutions…

Rose Technology is the founder of energy performance contracting in Canada. We began as an engineering consulting firm specializing in energy related services. At that time we were the only company in Canada offering energy performance contracting, an idea that quickly took hold in the institutional market place – hospitals being among the first to embrace the concept.

Rose Technology founded the energy performance-contracting industry in Canada over 25 years ago.

Since 1985, Rose has worked in thousands of buildings and successfully completed hundreds of energy-related projects totaling over $500 million, with project sizes ranging from $100,000 to $30 million. Rose's projects contribute to society by saving energy and operating costs, saving electricity, natural gas, oil, and potable water; displacing greenhouse gas emissions; and creating local and regional employment.

The Rose Headquarters is located in the west end of Toronto, Ontario. Our sister company, ESC Automation Inc., is also located in Toronto, and is the prime distributor for Delta Controls building automation products in Southern Ontario.

II – Award Winning Work

Rose Technology in partnership with our clients has won more than 26 industry awards.

Our most two most recent awards are both for the City of Toronto where we completed a $9.9 million program for the retrofit of 100 recreational facilities.

The City of Toronto received national recognition for this project when it received the Federation of Canadian Municipalities CH2M Hill Sustainable Community Award. ***Toronto Mayor, David Miller accepted the award on behalf of the City at a recognition ceremony held at the Federation of Canadian Municipalities' 71st Annual Conference and Municipal Expo in Quebec City in May 2008.***

And recently the City of Toronto project won another award from the Association of Energy Engineers…

Association of Energy Engineers®
April 21, 2009

AEE 2009 International Awards

The Association of Energy Engineers is pleased to announce that the City of Toronto Arenas Energy Savings Project has been selected by the AEE Awards Committee to receive the Award for ***2009 Energy Project of the Year: International***. We understand that as the Project Manager, you (Peter Daldoss) will be accepting this award. Congratulations from all of us at AEE!

Cordially,

Albert Thumann
Executive Director

III - Acknowledgement

We wish to thank the City of Hamilton, Operations and Waste Management Division, for allowing us to submit this proposal and their cooperation afforded us during the development of this report.

2.0 Utility Usage Summary

Electrical, water and sewer services are provided by Horizon Utilities Corporation. Correspondence with Horizon reveals the electrical rate structure is *3IN*. Natural gas services are provided by Union Gas. A total of twelve months of electrical, gas and water usage was provided to Rose Technology for analysis; the results for electricity and gas are summarized here. Water use at the MRF is attributable mainly to washroom use only; was almost negligible and was therefore not pursued.

2.1 Electricity

The Hamilton Material Recovery Facility (MRF) has a primary electric power meter which feeds two separate facilities; the Material Recycling Facility (MFR) – which encloses the paper and Container recycling facility; and the Central Composting Facility (CCF) – which houses an array of exhaust fans and mechanical equipment. The CCF is not part of the scope of this audit, and no savings calculations or ECMs were performed for this facility. A break-out of the energy usage by the MRF was provided by the City of Hamilton.

Electricity Rates

The electricity bills for the months of April 2010 to March 2011 were received from Hamilton MRF. These bills were balanced against usage data that was collected directly by Rose from Horizon Utilities. On average, the City of Hamilton pays $0.078 per kWh for electrical usage and $4.11 per kW for electrical demand at the MRF facility; the total annual electrical cost is approximately $204,000 per year. Trending the data reveals a very stable usage and demand profile. Refer to Figure #1.

2.2 Natural Gas

Natural Gas is metered separately for the facility and is used almost exclusively for comfort heating; this is delivered through an array of infrared heaters. To support the energy usage calculations, a regression analysis was performed comparing gas usage to seasonal outside air temperatures. The analysis indicated that 95 percent of the gas usage at the MRF can be explained by correlation to the outside air temperature; very little or none is used for any processes.

From this regression, we can comfortably map the month's current gas usage of the facility using the Heating Degree Days with the following formula:

$$m^3 = 193.2 * HDD + 62.1$$

This will provide a benchmark for quantifying savings as we proceed.

Natural Gas Rates

Natural gas use for the facility is approximately 200,000 cubic meters per year, at a cost of $60,000. The average cost for a cubic meter of natural gas is $0.3025.

Charts and Graphs

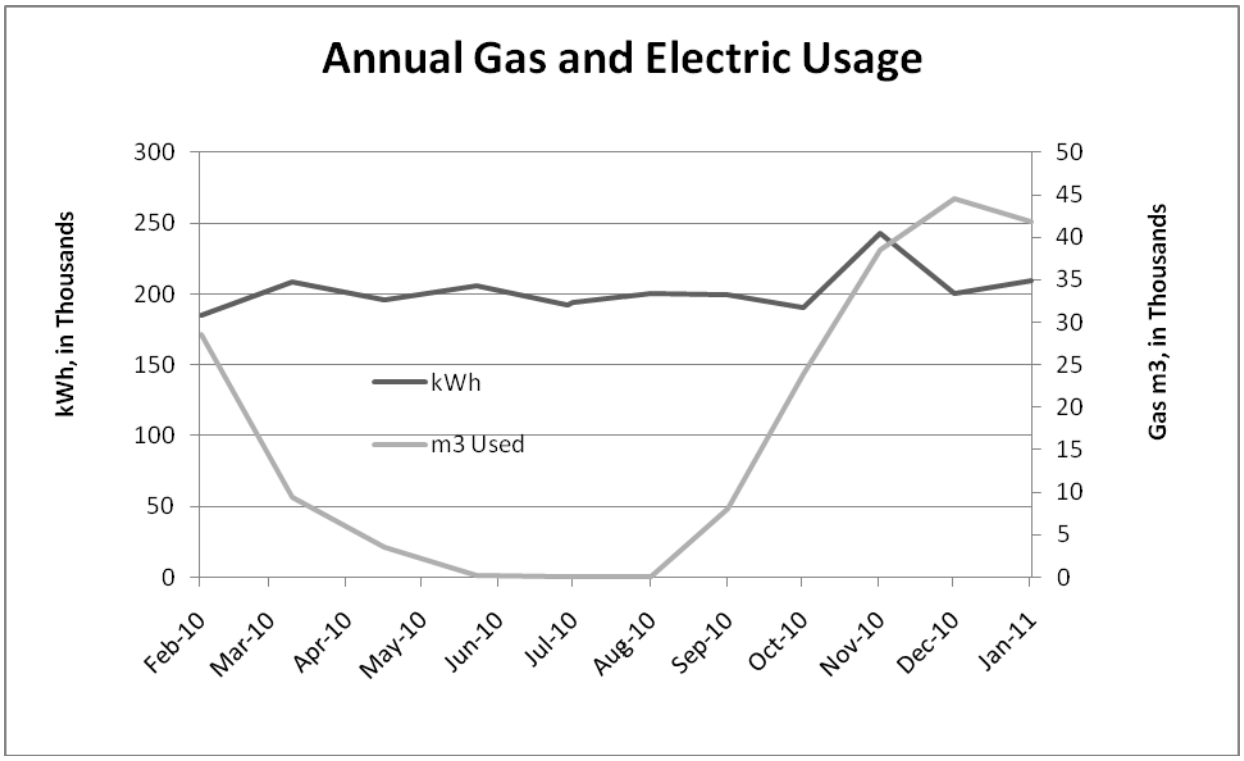


Figure 1: Electrical and Gas Usage

As mentioned earlier, gas usage is directly related to the outside temperature with virtually no consumption taking place during the summer months.

Electricity usage is flat, indicating consumption is directly related to the processing activities of the MRF.

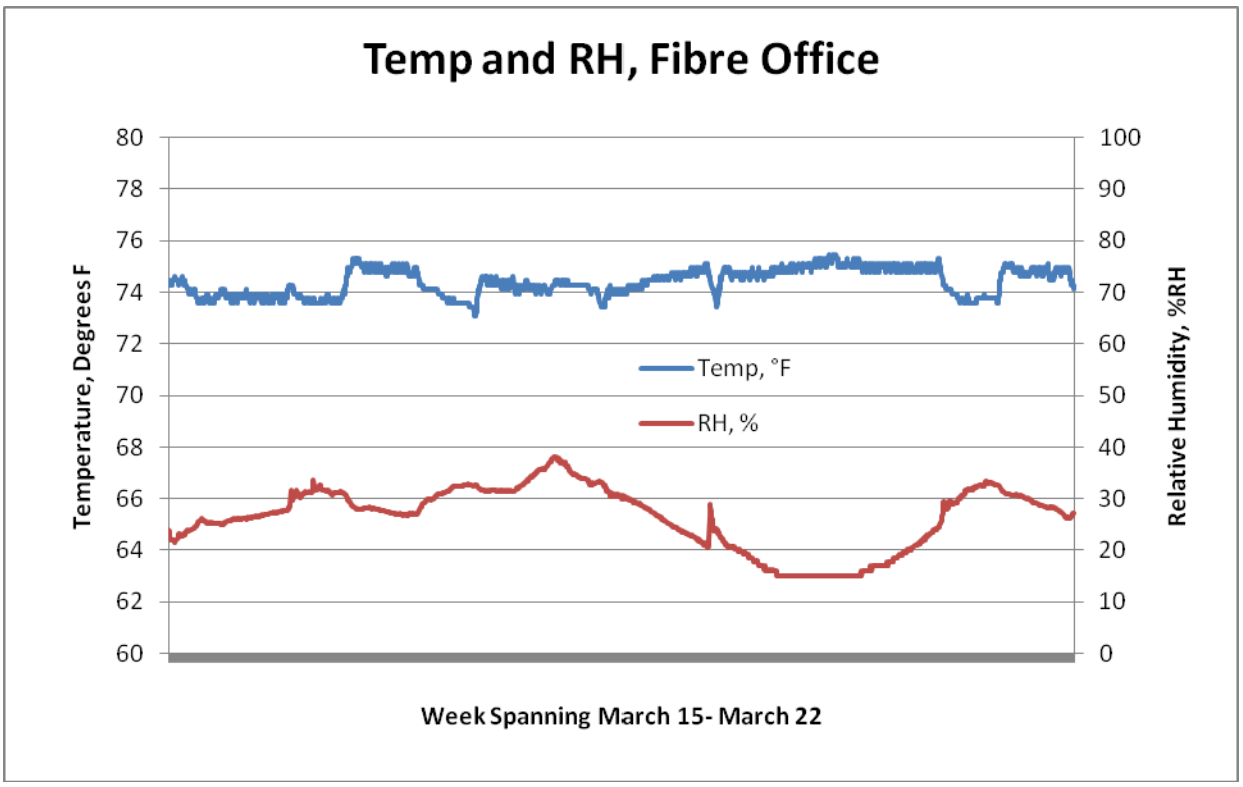


Figure 2: Fiber Office Space Temperature and RH Levels

We monitored the Fibre Offices to confirm the level of control and to observe if any temperature setback for the space was occurring. The monitoring encompassed a full week of operation during heating conditions and no setback was detected.

3.0 Mechanical and HVAC Systems

3.1 General Information and Observations

The Hamilton Material Recycling Facility is housed in a re-purposed tire manufacturing warehouse. The entire area is approximately 273,000 square feet; this is divided into a number of separate industrial sections.

These include storage areas in the west and north section, and a Fiber recycling area, and a Container recycling area. There are three office areas: a newly built section in the northwest, an office in the Fiber area (accessible through the Container facility), and a small administration office to the south of the Fiber area.

The Fiber and Container recycling areas are heated using an assortment of infrared heaters; most are controlled by a standard on/off light switch, with no ability to adjust the set-point. The west and north storage areas contain IR heaters, but these have been abandoned and are not operational.

Currently, the practice is to enable these heaters at the beginning of the winter season, and turn them off at its conclusion. This might infer that the units will run continuously throughout the heating season, however analysis of the gas bills indicate the units must shut off when a certain ambient temperature has been reached in the warehouse.

The operational heaters have been strategically placed to satisfy worker comfort, safety, and to maintain tolerable temperatures for equipment operation. A key safely concern in the warehouses is water that collects on the floors. This water is brought in as snow or rainwater with the recycled material, and becomes a slip or skid hazard. The IR heaters are used to help dry off this water.

3.2 Existing Operational Concerns

IR heaters typically require a certain amount of distance set-back from combustible materials.

We observed thick levels of dust, particularity in the Fiber areas, on top of the heaters.

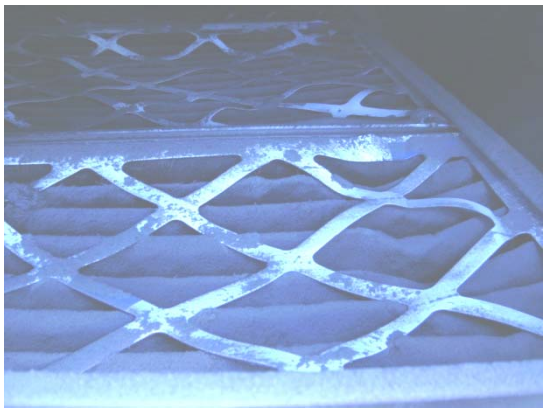
This layer of dust creates a fire hazard, as temperatures in the heat exchangers can reach 700°F.

One heater in particular, located to the east of Fiber sorting belt, had started to grow dust stalagmites. Since this heater is located in non-critical area, we suggest disabling the heater, or postponing the operation until it has been cleaned.

Space ventilation is provided via rooftop exhaust fans that are enabled or disabled based on the output of CO and NO2 sensors (pictured at right).

These sensors are able to detect the products of vehicle combustion from the diesel equipment operating in the facility. These exhaust units see extreme conditions with the dusty environment they serve.

We inspected one such unit, and found the filters were found to be heavily laden with dust (pictured at right). We recommend that the filters be replaced on a more frequent schedule. This will help with ease the restriction of airflow across the filters, and allow the fans to remove more air for less power. Since the fans are intermittent, we have not suggested at the possibility of using differential pressure sensors across the filter media, as the payback was unattractive.



The IR heater serving the loading bay doors in the Fiber area was non-operational when we performed our inspections. Since this is an area for cold air to enter the warehouse, and is an area where water collects on the floor, we suggest the heater be serviced or repaired so that it can be made operational.

The Fiber Office is served by an antiquated Trane rooftop unit (RTU). This system has two A/C compressors for cooling, electric resistance heat, and an economizer/outside air system that is non-operational. ASHRAE 62.1 requires a set amount of ventilation air be required for the occupants. No ventilation air service could be found. Our estimation is that the RTU has reached the end of its serviceable life. We recommend the A/C system be replaced, and understand the City of Hamilton has commissioned a HVAC design for the area.

3.3 Energy Conservation Measure No. 1 Building Automation System for Control of Mechanical & HVAC Systems

We are recommending a Building Automation System (BAS) be installed in the MRF to control all of the major mechanical and HVAC equipment. In addition to providing control of the various MRF systems, the BAS will monitor several space operating conditions and will serve as a powerful monitoring tool to which additional capabilities can be added should the needs or operation of the MRF change going forward.

This section describes the three most significant control strategies for the BAS:

Control Strategy #1 – Scheduling and Setback of IR heaters

Current Condition and Operating Method

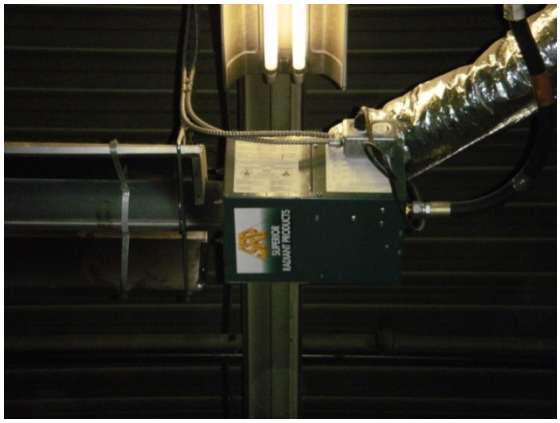
There are a total of 15 operational IR heaters located throughout the facility, including 5 in the Fiber area and 10 in the Container area. Refer to Appendix 1 for a sketch of the heater locations.

Most of the heaters are controlled by light switches and mechanical thermostats; these switches are located on a column (as shown on the pictures) or at the control section of the heater. The current operation has these heaters switched on at the beginning of the heating season and switched off at the end. Our survey took place in the winter, so we were able to review the heaters in operation. To supplement our visual inspection, we checked the heater operation with a non-contact thermometer.

The existing operational heaters include:

- Heater 4 – located over the Fiber manual sorting conveyer.
- Heaters 10 though 14 – located over the Container manual sorting conveyer.
- Heater 5 – located above a walkway to the Fiber sorting conveyer. We recommend turning this system off.
- Heaters 7, 1 – located over the loading bay doors.
- Heater 2, 3 – located above the general Fiber area.
- Heater 6, 8, and 9 – located above the general Container area.

Infrared heaters are typically a very effective and economical way to keep warehouses heated. Rather than using air handlers or makeup air units to heat the air, infrared heater emit radiation travels through the air and heats any contacted material. This works to heat (and dry) the floor, and warms the occupants without having major inefficiencies such as stratification and infiltration/exfiltration.



Proposed Retrofit:

The current operation of the IR heaters is very inefficient as they are in operation whether the space is occupied or not. We propose controlling the heaters via a Building Automation System (BAS). The BAS will enable the heaters when the building is occupied and operational, and set back the heaters during unoccupied times to keep the warehouse at a minimum temperature. In the areas where there may be water on the floor, we will install a manual override switch to keep the heater on for an additional 8 hours – this will give the heater opportunity to heat and dry the floor.

Some specifics of the retrofit include:

- Installing a Delta Controls BMS (wired or wireless) system as a communications backbone between the operational IR heaters in the warehouse.
- Adding a stainless steel room temperature sensor in the space for each heater located in the general warehouse.
- Adding a motion detector or equipment operation detector (equipment amps) to enable or disable the IR heaters above the sorting areas
- Adding a heater-specific control point to enable or disable the heaters based on the current room temperature
- Adding a manual over-ride that will override on a heater when there is water on the floor, or a period of occupancy override.

Impact on Maintenance

The BAS system does not require any regular annual service. If a wireless option is implemented, the controller will pull power from the heater, and not require any batteries to be changed.

New Skills or Procedures Requirement

An operator will need to become familiar with the operation of the BMS. This will likely be a point and click graphic interface that will allow for scheduling, setbacks and equipment troubleshooting. Rose will provide the appropriate training as part of the work for the BAS.

Estimated Service Life

This measure will have no quantifiable impact on the equipment itself. The lifespan of a BAS system is expected to be 15-20 years.

Control Strategy #2 – Setback of Roof-Top-Unit Serving Fiber Office

Current Condition and Operation Method

The existing roof-top-unit (RTU) providing heating and cooling to the Fiber Office is quite old and close to the end of it serviceable life. This unit operates under the control of a non-programmable thermostat. This thermostat does not limit the set-point, setback the unit, nor does it switch over between heating and cooling. During winter operation, the unit maintains a 74F temperature in the office on nights and weekends.

Rose installed a data logger in the space to analyze the conditions in the space; the graph of the output is shown in Figure 2. The system has a heating set-point of approximately 73°F.

Proposed Retrofit:

Specifics for the retrofit include:

- Removal of the existing thermostat
- Installation of a DDC thermostat, capable of set-point adjustment and setback override. This thermostat will be connected to BAS proposed in ECM #1
- The daytime heating set-point will be lowered to 70F, and the daytime cooling set-point will be raised to 76F. During unoccupied periods, the space will be maintained between 60 and 80F
- Unit shall be scheduled “on” in advance to bring the space to proper conditions in time for when the building is occupied
- Set the thermostat back to a level of 70-71°F for winter conditions, and

Consideration has been given to the age of the unit. The BAS automation system will be able to be reconfigured and expanded with the installation of most new mechanical HVAC systems.

Impact on Maintenance

There should be no perceivable impact on maintenance.

New Skills or Procedures Requirement

Operators will require limited training on thermostat limits, and operation setback on BMS system. Rose will provide this training.

Estimated Service Life

This measure will have no quantifiable impact on the equipment itself. The lifespan of a BAS system is expected to be 15-20 years.

Control Strategy #3 – Scheduling of ERV

Current Condition and Operating Method

An Energy Recovery Unit (ERV) serves the newly refurbished office area in the NW corner of the facility.

This ERV is located between the exhaust air and the makeup air, and functions to transfer the energy recovered from the exhaust air into the ventilation air via a heat wheel. The ERV system is operating continuously; this is unnecessary given the intermittent occupancy in the locker and toilet area. Currently, energy is being wasted with the operation of supply and exhaust fans and wheel, the electric heat for the defrost cycle and the energy required to condition the tempered air directed into the facility.

ASHRAE standard 62.1 recommends an exhaust air rate from both the locker rooms and toilet areas. It is safe to assume the systems are operating with the desired airflow, but not the desired schedule.

Proposed Retrofit:

The following changes are proposed:

- Control the ERV based on a schedule and an occupancy sensor located in the entrance to the men's and women's restroom. This will enable the ERV to operate on a predetermined schedule, and for two hours past any occupancy.

Impact on maintenance

There will be a reduction in the amount of time spent changing filters for the ERV. Otherwise, there should be no secondary increases to the maintenance.

New Skills or procedures Requirement

This system will operate automatically without operator input. Basic troubleshooting skills may be required to unit fails.

Estimated Service Life

We would expect an increase in the life of the ERV wheel, as well as the mechanical exhaust and supply fans.

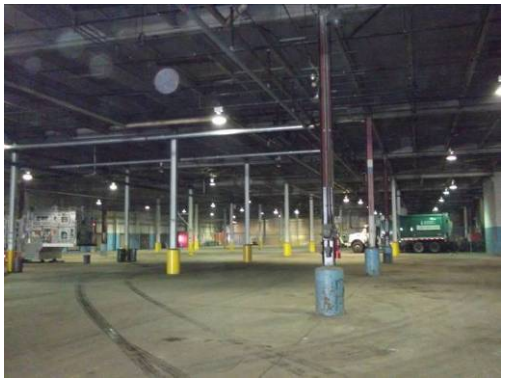
4.0 Lighting

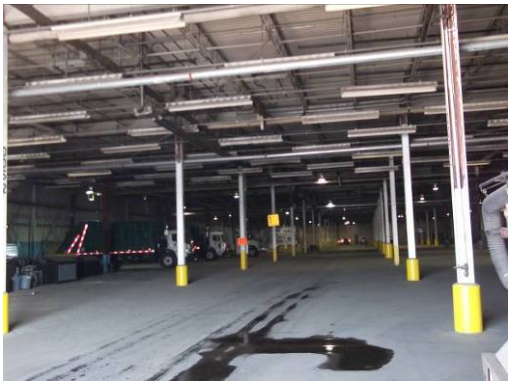
4.1 General Information and Observations

The MRF facility encompasses warehousing, processing and administration areas. The warehousing and processing areas are divided into four major sections with each having a separate function and lighting requirement.

The West Section of the MRF is used for vehicle storage and parking year round, the Center South Fiber Section houses the Fiber material sorting process and bailing equipment with areas for tipping and bail warehousing, the Center North Storage Section is generally vacant space used for warehousing of residential waste containers, and the East Container Section houses the Container sorting process and bailing equipment with areas for tipping and bail warehousing.

West Section - Truck Storage and Parking



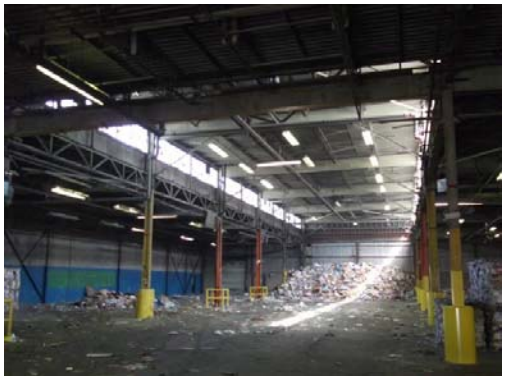


The majority of the lighting in the West Section consists of industrial 400-Watt Metal Halide high-bay HID luminaires suspended from the open ceiling structure with two areas of concentrated fluorescent lighting at the south-end and north-end of the section.

The fluorescent lighting typically consists of 8-foot industrial type fluorescent lighting equipped with reflectors and a variety of 8-foot F96T12 lamps operated on magnetic ballast and a few newer F59T8/HO industrial luminaires with electronic ballast; installed during the last renovation in 2007. The lighting is generally in poor condition with several HID and fluorescent fixtures burned-out and at different levels of disrepair.

Illumination levels are poor at best with numerous dark locations well below IESNA standards for parking garage of 20 – 50 lux (~2 – 5 footcandles).

Center South Fiber Section – Fiber Processing, Tipping and Bailing



General illumination of the Center South Fiber Section spaces consists of combination of daylight from two high-ceiling clear stories (skylights) locations and typical industrial type fluorescent luminaires equipped with F96T12 lamps and very few F32T8 lamp and F59T8/HO lamp luminaires.

We found very few industrial type 400-Watt Metal Halide high-bay HID luminaires randomly located throughout the space. Illumination under the two skylight locations; fibre tipping area and fibre sorting main conveyor line were found well above recommendations. Existing illumination levels ranged from 1,600 Lux to 15,000 Lux with overcast daylight contribution

While higher light levels are generally not a bad thing, the surrounding spaces have very poor illumination levels ranging from 73 Lux to 202 Lux resulting in a contrast ratio of 10:1 at critical locations near bailing equipment.

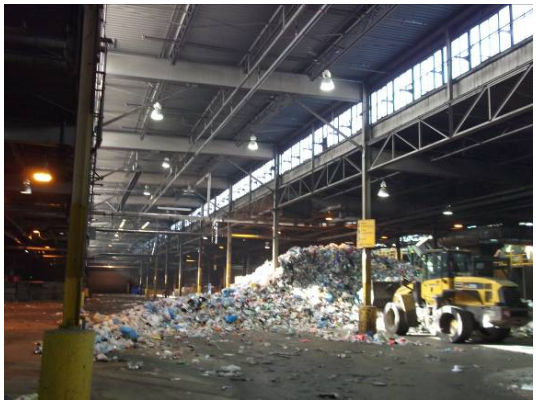
Such high contrast ratios will cause issues with vision eye adaption when transitioning between the brightly lit spaces and dark surroundings. This is especial important for visual acuity and eye fatigue of equipment operators who move quickly through differently lit spaces while hauling heavy bails of material. The lighting is generally in poor condition with several fluorescent fixtures burned-out and at different levels of disrepair.

Center North Storage Section – Residential Container Storage

The lighting in the Center North Storage Section area consists of a combination of daylight from two high-ceiling clear stories (skylights) with industrial 400-Watt Metal Halide high-bay HID luminaires and fluorescent industrial luminaires with F96T12 lamps and some F59T8/HO lamps suspended from the open ceiling structure.

The illumination levels in this storage area are not as critical as the Fiber Section sorting and tipping spaces with illumination levels measured as low as 80 Lux to 440 Lux with daylight contribution. The lighting is generally in poor condition with several HID fluorescent fixtures burn-out and at different levels of disrepair.

East Container Section – Container Processing, Tipping and Bailing



General illumination of the East Container Section spaces consist of a combination of daylight from skylights and 1,000-Watt and 400-Watt High Pressure Sodium high-bay HID luminaires suspended from the open ceiling structure with some industrial type 400-Watt Metal Halide high-bay HID luminaires randomly located throughout the space.

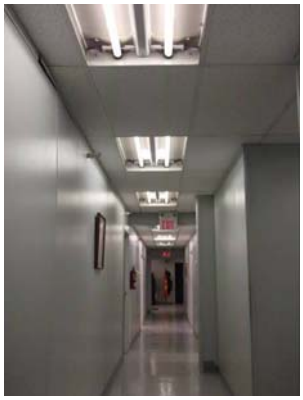
Industrial fluorescent luminaires equipped with F96T12 lamps and F32T8 lamps and F59T8/HO lamp luminaires are also found throughout the space. Illumination under the two skylights; Container tipping area and Container sorting main conveyor line were found well above recommendations.

Once again, existing illumination levels ranged from 1,600 Lux to 15,000 Lux with overcast conditions over the sorting line and 520 Lux to 2,000 Lux in area with direct daylight contribution. As is the case with the Fiber Section, the result is a very high 10:1 contrast ratio in certain locations, especially around tipping trucks, bailing equipment and front-end loader operating zones.

The lighting is generally in poor condition with several fixtures were found with burn-out lamps and at different levels of disrepair.

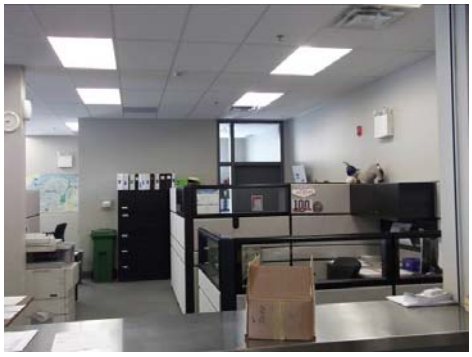
Canada Fiber Office

The Canada Fiber Office area consists of administration offices and staff lunchroom and change rooms. General illumination is provided by 2x4 2-lamp and 4-lamp F34T12 fluorescent recessed luminaires with magnetic ballast installed in inverted t-bar ceilings.



Our assessment found very few fixtures were converted to newer F32T8 fluorescents. Many fixtures were missing lenses and had dirty reflective interiors. Existing lighting controls consist of local manually operated wall switches. The meeting room was had a failed occupancy sensor that was being operated as a manual switch.

Main MRF Office and Operation & Waste Management Office



These administration and staff spaces have been recently renovated with T8 and compact fluorescent lighting. Generally the lighting and lighting controls which have occupancy sensors, were found to be in very good condition.

EXIT Signs

A majority of the existing EXIT signs have been replaced with LED (light emitting diode) technology. The few exceptions still use incandescent lamps and are good candidates for conversion with LED retrofit kits.

4.2 Energy Conservation Measure No. 2 Lighting Retrofit Program

Lighting Redesign Methodology for the Hamilton Material Recovery Facility

The Metal Halide (65 CRI) and High Pressure (22 CRI) HID industrial lighting found in the Hamilton MRF is a prime candidate for replacement (redesign) with high efficiency T5 High-Output (HO) fluorescent lighting technology. T5HO fluorescent lamps have a Colour Rendering Index (CRI) of 82% to 95% (daylight having a CRI of 100), therefore the resulting light colour rendering in the work spaces will be vastly improved.

A complete redesign and replacement will also provide numerous benefits over the existing MRF lighting systems:

- The lighting system will be completely new, eliminating any lighting maintenance or replacement requirements for many years into the future
- Lamp life will be 35,000 hours – years worth of operation
- The startup and re-strike delays inherent to the HID lamps after a brown-out or from being switching off will be eliminated – the T5 lamps will turn on immediately
- The new lighting system will have built-in redundancy with multiple lamps per fixture to reduce dark spots should one lamp in a fixture fail
- The “flicker or strobe effect” on motors or rotating equipment will be eliminated
- Vastly improved visual acuity and safety for occupants and personnel from the significantly higher CRI and improved visual acuity

The purposed T5 high-output luminaires also can also be equipped with the option of an internal standby battery pack in ballast technology for “ride-through” capability during a power outage or utility generated brown-outs – another safety benefit for the MRF staff.

A final benefit is the OPA supported ERIP (Electrical Retrofit Incentive Program) for lighting eligible incentives on high efficiency lighting technology to the estimated value of $42,764 for the Hamilton MRF.

The next sections provide specific information regarding retrofits to each of the MRF areas.

West Section - Truck Storage and Parking

The Metal Halide luminaires in this area are 400-watt high-bay lights producing a poor white-green light source with a low colour rendering Index of 65% CRI. This type of Metal Halide HID industrial lighting is a prime candidate for redesign with high efficiency T5 High-Output (HO) fluorescent lighting technology.

High performance fluorescent T8 and T5HO lamps have a typical CRI of 82% to 95%, therefore the resulting lighting will provide better colour rendering for work tasks and visual acuity.

We recommend redesign of the West Section lighting, replacing the existing 400-Watt Metal Halide luminaires and F96T12 and F59T8/HO fluorescent luminaires with new 6-lamp and 4-lamp T5HO fixtures suspended from the open ceiling. In addition to providing a superior lighting environment, the T5 High-Output luminaires will reduce the electrical load and usage for this space by 45% compared to the existing lighting.

Center South Fiber Section – Fiber Processing, Tipping and Bailing

We recommend redesign of the Center South Fiber Section lighting, replacing the existing F96T12 and F59T8/HO fluorescent and 400-Watt Metal Halide luminaires with new 6-lamp and 4-lamp T5HO fixtures suspended from the open ceiling.

The existing T8 fixtures located over the pre-sorting and sorting conveyor lines will remain. Again, in addition to providing a superior lighting environment, the High-Output system, will reduce the electrical load and usage this space by 30% compared to the existing lighting system.

Center North Storage Section – Residential Container Storage

We recommend redesign of the Center North Storage Section lighting, replacing the existing 400-Watt Metal Halide, F96T12, and F59T8/HO fluorescent fixtures with new 4-lamp T5HO fixtures suspended from the open ceiling. The fluorescent T5 High-Output system will reduce the electrical load and usage for this space by 45% compared to the existing lighting system.

East Container Section – Container Processing, Tipping and Bailing

We recommend redesign of the East Container Section lighting, replacing the existing 400-Watt and 1,000-Watt High Pressure Sodium fixtures, and the 400-Watt Metal Halide, and F96T12 and F59T8/HO fluorescent fixtures with new 6-lamp and 4-lamp T5HO fixtures suspended from the open. The new T5 lighting system will reduce the electrical load and usage for this space by 45% compared to the existing lighting.

Canada Fiber Office

Due to the very poor condition of the fixtures in this area, we recommend a redesign of the Canada Fiber Office and Staff areas.

The new lighting system would replace the existing 2x4 2-lamp and 4-lamp F34T12 and F32T8 fluorescent fixtures with new 2-lamp 2x4 high performance T8 fluorescent luminaires equipped with new K12 framed lens. Included in the redesign would be automatic occupancy sensing lighting controls installed in all office spaces, kitchen, lunchroom, staff washrooms and staff change rooms. The new lighting system will reduce the electrical load and usage for these spaces by 50% compared to the existing lighting system.

EXIT Signs

Incandescent EXIT signs found throughout the MRF will converted to energy efficient LED (Light Emitting Diode) by use of a retrofit kit.

5.0 Additional Energy Conservation Measures

5.1 Energy Conservation Measure No. 3 Power Factor Correction

Current Condition and Operation Method of the Affected Equipment

The MRF site has two 1000 KVA, 600/347 transformers feeding a 1200 amp double ended switchboard with a tie breaker. The total harmonic current distortion was 8.1% (considered to be moderately high), as there are a number of VFD (variable frequency drives) in the facility.

The following analysis of demand use at the MRF summarizes the penalties that were paid in power factor penalties in the past year, and the amount of capacitance to eliminate these penalties. Notice in the tables the different demand for each month. The amount of kVAr of capacitance required to eliminate the monthly power factor penalty varies from month to month. This range sometimes generates a better pay-back if less than the maximum kVAr is installed.

Year	Month	KVA	KW	Billing Demand .9 of KVA	Actual P.F.	P.F. Penalty	KVAR Req'd
2011	Jan	1241	1084	1117	87.4%	$155	79
2011	Feb	1395	1161	1256	83.2%	$448	212
2010	Mar	1180	1007	1062	85.3%	$262	129
2010	Apr	1156	1003	1040	86.8%	$177	89
2010	May	1528	1321	1375	86.5%	$255	128
2010	Est	1375	1180	1238	85.8%	$271	135
2010	Jul	1430	1223	1287	85.5%	$300	148
2010	Aug	1370	1150	1233	83.9%	$392	188
2010	Sep	1420	1209	1278	85.1%	$328	161
2010	Oct	1373	1145	1235	83.4%	$426	203
2010	Nov	1368	1189	1231	87.0%	$196	99
2010	Dec	1294	1076	1165	83.1%	$418	198
						$3,627	
To Ensure		90 % PF Each Month, use			212	KVAR	

Based on the past year of demand usage, power factor penalties of $3,627 were paid.

and indicated on the billing analysis, a minimum of 212 kVAr is required to maintain a 90% power factor, and would save $3,627 in annual penalties. The kVAr requirements range from 79 to 212 kVAr per month over a year.
TBD

Proposed Retrofit:

Based on the harmonics, a harmonically filtered capacitor bank is recommended to reduce nuisance tripping of the drives during utility switching disturbances. It should be noted that conventional (non-filtered) capacitors could cause some harmonic interaction with other services fed from the same primary transformer.

We would recommend a maximum of 120 kVAr fixed on this system, the balance of capacitors should be switched to avoid more than a 1% voltage rise during low load conditions.

It is proposed to install 175 kVAr as follows:

- 2 X 60 kVAr 600 volt fixed harmonic filtered capacitor bank complete with tuning reactors and operational/fuse failure LED's to be fed from a 100 amp breaker for both PP-1 and PP-2
- 30 kVAr switched capacitor would be installed on the 100 HP bailer contactor
- 25 kVAr switched on the 75 HP bailer contactor.

Year	Month	KVA	KW	Billing Demand .9 of KVA	Actual P.F.	P.F. Penalty	KVAR Instl'd
2011	Jan	1165.8	1083.9	1083.9	92.98%	$0	175
2011	Feb	1306.4	1160.7	1175.7	88.85%	$71	175
2010	Mar	1098.9	1006.5	1006.5	91.59%	$0	175
2010	Apr	1079.8	1003.0	1003.0	92.89%	$0	175
2010	May	1447.8	1320.9	1320.9	91.24%	$0	175
2010	Jun	1294.1	1180.0	1180.0	91.19%	$0	175
2010	Jul	1347.3	1222.9	1222.9	90.77%	$0	175
2010	Aug	1283.4	1149.9	1155.0	89.60%	$24	175
2010	Sep	1336.8	1208.7	1208.7	90.42%	$0	175
2010	Oct	1284.4	1144.8	1155.9	89.13%	$53	175
2010	Nov	1290.4	1189.4	1189.4	92.17%	$0	175
2010	Dec	1205.9	1076.1	1085.3	89.23%	$44	175
						$191	

175 KVAR WOULD HAVE REDUCED ANNUAL PENALTIES TO
THEREFORE SAVING $3,436

As illustrated in the above table, the 175 of kVAr will virtually eliminate power factor penalties for the facility.

Impact on Maintenance

The power factor correction equipment will not require any maintenance other than period checking of LED indicators for fuse failure (a rare occurrence).

New Skills or Procedures Requirement - Estimated Service Life

None required; Service life is 25+ years.

5.2 Energy Conservation Measure No. 4
Vending Machines - Vending Miser Control

Vending Machines General Information & Observations

The Hamilton MRF has cold beverage and snack dispensing machines installed in staff lunchrooms.

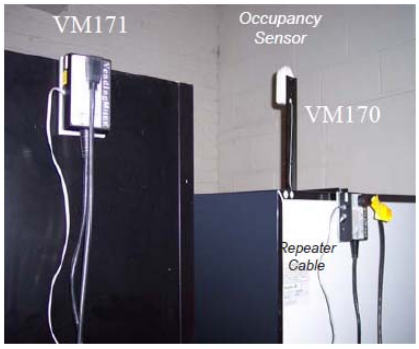
Typically these appliances' refrigeration system and display lighting consume an estimate 7,880 kWh per year. The MRF has two cold beverage machines and one snack machine.

Vending Miser Control

We propose installing Vending-Misers on the vending machines in each lunchroom. Through the utilization of a custom passive infrared sensor, the Vending-Miser will power down the vending machine when the area surrounding it is unoccupied and automatically powers up the vending machine when the area is occupied. Vending-Miser's intelligent controller uses a logic controller to learn from the habits of the building occupants, and modifies the time-out period accordingly.

Additionally, Vending-Miser monitors the ambient temperature while the vending machine is powered down. Using this information, the Vending-Miser automatically powers up the vending machine at the appropriate intervals, independent of occupancy, to ensure that the vended product stays cold.

The Vending-Miser also monitors electrical current used by the vending machine. This ensures that Vending-Miser will never power down a vending machine while the compressor is running, so a high head pressure start never occurs. In addition, the current sensor also ensures that every time the vending machine is powered up, the cooling cycle is run to completion before again powering down the vending machine. This unique process also ensures a cold vended product.



On average the Vending-Misers units are estimated to save 3,805 kWh/year, a savings of 48% compared with existing vending machines without control.

5.3 Energy Conservation Measure No. 5 Engine Blocker Heater Receptacles Control

Engine Block Heater Receptacles - General Information & Observations

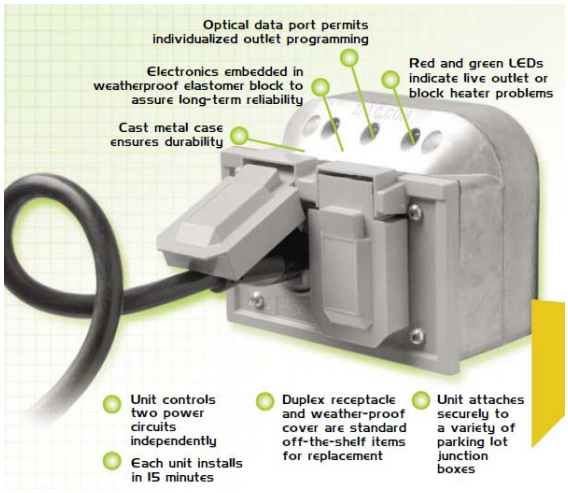
Currently the Operations and Waste Management fleet has thirty-one rear loading trucks and eleven side-loader diesel trucks. All forty-one diesel trucks are equipped with engine block heaters averaging 750-Watts per vehicle. Due to air tank freezing the eleven side-loader trucks are parked indoors in the West Section vehicle storage area during the winter. The remaining thirty trucks utilize engine block heaters plugged into receptacle stations during the winter season beginning with the end of November through to the first few weeks in April depending on outdoor temperatures.

There are forty-eight available parking stalls at the rear of the MRF each serviced by a 15 Amp block heater receptacle. These receptacles are fed from two separate electrical distributions systems: one fed from a 30kVA transformer service located on the north wall inside the Center North Storage Section of the MRF, and the second distribution system fed from 45kVA transformer service located outside behind concrete barriers

adjacent to the old Goodyear building at the rear of the truck parking lot.

Each transformer steps-down 600/347V to 120/208V 3 phase. The 30kVA transformer feeds a 3-pole contactor switching receptacle panel P3 and the 45kVA transformer feeds a 3-pole contactor switching receptacle panels P1 and P2. Both contactors are in turn controlled by Intermatic time clocks which are set to power receptacle panels for twelve hours each night starting by switching ON an applies constant power to block heater receptacles starting at 6:00 pm each evening and switching OFF at 6:00 am in the morning irrespective of outdoor temperature. Diesel trucks require block heaters to be switched on at temperatures below 5°C to allow oil flow and cold engine startup.

Engine Block Heater Control



Powering the receptacles for 12 hours each day regardless of the ambient temperature or other conditions can be wasteful. We therefore propose control of the engine block heaters with an IPLC (Intelligent Park Lot Controller) programmed receptacle especially designed for diesel truck applications.

The IPLC controller is design to replace existing duplex receptacles used for truck block heater stations. The IPLC is an intelligent programmable controller with two separate 15Amp receptacles with separate programming capability and control logic which is designed specifically for diesel truck engine block heater applications.

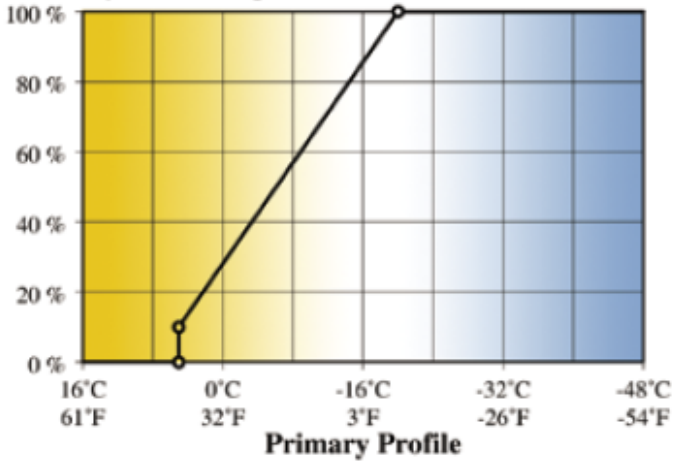
When the truck is first plugged into the IPLC controller, full power is applied for 2 to 3 minutes to check the function of the vehicle's heating equipment and extension cable conductivity. The unit is equipped with a green LED (good) and red LED (bad) indicators for power ON and diagnostics of vehicle heating equipment. The controller will also sense if the heater cable has a short circuit or open condition and will automatically disconnect power to that individual receptacle outlet if failure occurs while truck block heater is plugged into the IPLC – a good safety measure.

This system check is followed by a period where power is switched off if the vehicle's engine is still warm from use. After two hours, the controller starts a cycle-mode where full power is applied for part of each 4.5-minute cycle depending on the outdoor temperature:

Trucking / Diesel: Factory Pre-Programmed Schedule

Primary Profile	
Temperature	**Percent ON**
> 5.0˚C [41˚F]	0.00 %
5.0˚C [41˚F]	10.16 %
<= -20.0˚C [-4˚F]	100.00 %

LOAD LIMIT: 1800 W (15 Amps)
INTIAL POWER DELAY = 2.05 hours



The control is structured as follows:

- Above 5°C – no power is applied
- Below 5°C to -20°C - power is applied form 10% to 100% of the cycle
- Below -20°C - power is applied constantly until outdoor temperature rises above -20°C at which time the IPLC returns to cycle-mode;

Finally, the IPLC enters full-power mode for three hours, to prepare the vehicle for use in the morning. The IPLC two-hour power delay at the beginning of the cycle alone is responsible for a 25% energy savings over other cycling controls. Savings have been calculated using BIN data analysis to determine cycle-mode operating hours during typical seasonal conditions for Hamilton when temperatures drop below 5°C. On average each IPLC unit is estimated to save 870 kWh/year, a savings of 56% compared with existing time-clock control alone.

6.0 Energy Conservation Measures Not Recommended

6.1 General Information and Observations

Over the course of our study, we observed some additional opportunities which are described here, but are not recommended at this time for either economic or technical reasons.

These are summarized here.

I - Sentinel (Outdoor) Lighting

The MRF exterior sentinel lights consist of various wattage Metal Halide fixtures installed on light standards as well as being building mounted.

A possible retrofit is LED conversion and replacement. Due to high initial capital costs of this new technology and the lack of OPA ERIP incentives for this specific retrofit, we recommend this measure be deferred to a future time.

II – Power Transformers Retrofit

The operating voltage electrical service to the MRF is provided by two wet-type PCB transformers, converting the 13,800 V utility power to 600 V.

During our audit, we were told there may be an initiative to replace the existing transformer with ones that do not use environmentally harmful PCB's.

Assuming the existing transformers are replaced with "normal efficiency" equivalents, we wished to quantify the energy savings associated with a "high efficiency" transformer.

Our findings indicate, with the current equipment load, that the savings from a high efficiency transformer would be in the range of $700 to $800 per year, while the cost of the transformer would be in the $75,000 range. Since the payback would not alone drive an energy project, we suggest addressing this e the conversation open when the City of Hamilton is closer to implementation.

III – Conversion of Fiber Office Heating from Electric to Gas

The existing roof-top-unit (RTU) serving the Fiber area uses electric resistance for heating the office. This is a very expensive way to heat the space. Given the electrical and gas costs, heating using natural gas would cost less than half what the electrical costs currently are.

We initiated studying a measure where we would disable the electric resistance heat in the RTU, and install a gas heating system in series with the supply airflow to the office area.

Unfortunately our figures indicated the payback would be beyond 10 years, especially once this space is properly controlled via ECM No. 1. Also, the RTU is quite old. If the MRF was to replace the unit, adding gas heat at the purchase time would be a much more cost effective option.

7.0 Financial Summary

The table below summarizes the financial aspects of the MRF Energy Program. Considering the program will provide the City of Hamilton with a new Building Automation System and completely new lighting throughout, we believe the return to be quite reasonable.

The program will also produce environmental benefits in the form of 267 metric tonnes of avoided green house gases per year.

City of Hamilton – Material Recovery Facility
Financial Summary of Recommended Measures

Measure	Cost ($)	Incentives ($)	Costs less Incentives ($)	Savings					GHG Avoided (Tonnes)	Simple Payback (years)
				Fuel (cu-m)	Electrical (kWh)	Demand (kW)	Other ($)	Total ($)		
ECM #1 - Building Automation System	83,819	4,199	79,620	83,981	17,167	0.0	0	26,745	164	3.0
ECM #2 - Lighting	322,040	42,764	279,276	0	368,604	92.1	1,850	35,180	95	7.9
ECM #3 - Power Factor Correction	23,370	0	23,370	0	0	0.0	3,436	3,436	0	6.8
ECM #4 - Vending Machine Control	1,026	0	1,026	0	2,106	0.0	0	164	1	6.2
ECM #5 - Block Heater Control	10,176	0	10,176	0	26,112	0.0	0	2,039	7	5.0
Sub Totals	**$440,431**	**$46,963**	**$393,468**	**83,981**	**413,990**	**92**	**$5,286**	**$67,565**	**267**	**5.8**
Project Management	30,649		30,649							
Grand Totals	**$471,081**	**$46,963**	**$424,118**	**83,981**	**413,990**	**92**	**$5,286**	**$67,565**	**267**	**6.3**